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WORLD METEOROLOGICAL ORGANIZATION

WORLD CLIMATE RESEARCH PROGRAMME

REPORT OF THE NINTH SESSION OF THE

GEWEX SCIENTIFIC STEERING GROUP

(GEWEX SSG)

(Hamburg, Germany, 6-10 January 1997)

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LIST OF ACRONYMS

AAN	-	Asian AWS Network
ACSYS	-	Arctic Climate System Study
ADEOS	-	Advanced Earth Observation Satellite
AERONET	-	NASA Aerosol Robotic Network
AGCMs	-	Atmospheric General Circulation Models
AMIP	-	Atmospheric Model Intercomparison Project
ARM	-	Atmospheric Radiation Measurement
AVHRR	-	Advanced Very High Resolution Radiometer
AWS	-	Automatic Weather Station
BALTEX	-	Baltic Sea Experiment
BASE	-	Canadian project over the Beaufort Sea
BSRN	-	Baseline Surface Radiation Network
CART	-	Cloud and Radiation Testbed (ARM)
CAS	-	Commission for Atmospheric Sciences
CERES	-	Cloud and Earth Radiant Energy System
CLIVAR	-	Climate Variability and Predictability Programme
CMC	-	Canadian Meteorology Center
COARE	-	Coupled Ocean-Atmosphere Experiment
COLA	-	Centre for Ocean Land-Atmosphere Interactions
CPTEC	-	Centro de Previsão de Tempo e Estudos à (Brazil)
CRMs	-	Cloud Resolving Models
CSEs	-	Continental-Scale Experiments
DAO	-	Data Assimilation Office
DARF	-	Direct Aerosol Radiative Forcing
4DDA	-	4-Dimensional Data Assimilation
DNAEE	-	Brazil's Water Authority
DOE	-	Department of Energy (USA)
DWD	-	Deutscher Wetterdienst (Germany)
ECMWF	-	European Centre for Medium-Range Weather Forecasts
ENSO	-	El Niño-Southem Oscillation
ENVISAT	-	ESA Environmental Satellite Series
EOP	-	Enhanced Observation Schedule
EOPP	-	ESA Observation Preparatory Programme
EORC	-	Earth Observation Research Centre (NASDA)
EOS	-	Earth Observing System
ERBE	-	Earth Radiation Budget Experiment
ERBS	-	Earth Radiation Budget Satellite
ERS	-	Earth Remote Sensing Satellite
ESA	-	European Space Agency
ESSP	-	Earth System Science Pathfinder (NASA)
ETH	-	Swiss Federal Institute of Technology
EUMETSAT	-	European Organisation for the Exploitation of Meteorological Satellites
FIRE	-	First ISCCP Regional Experiment
FSL	-	Forecast Systems Laboratory (USA)
GACP	-	GEWEX Aerosol Climatology Project
GAIN	-	GAME Archive and Information Network

GAME	-	GEWEX-related Asian Monsoon Experiment
GCM	-	General Circulation Model
GCIP	-	GEWEX Continental-Scale International Project
GCSS	-	GEWEX Cloud System Study
GEWEX	-	Global Energy and Water Cycle Experiment
GHP	-	GEWEX Hydrometeorological Panel
GISS	-	NASA Goddard Space Institute for Space Studies
GMPP	-	GEWEX Modelling and Prediction Panel
GMS	-	Geostationary Meteorological Satellite (Japan)
GNEP	-	GEWEX Numerical Experimentation Panel
GPC	-	Global Processing Center
GPCP	-	Global Precipitation Climatology Project
GRDC	-	Global Runoff Data Centre
GRP	-	GEWEX Radiation Panel
GSFC	-	Goddard Space Flight Center
GSWP	-	GEWEX Global Soil Wetness Climatology Project
GvaP	-	GEWEX Water Vapour Project
IAMAS	-	International Association of Meteorology and Atmospheric Sciences
ICARUS	-	Interagency Climate-Aerosol Radiative Uncertainties and Sensitivities Programme
ICC	-	Intercomparison Centre
IFO	-	Intensive Field Observation
IGAC	-	International Global Atmospheric Chemistry
IGBP	-	International Geosphere-Biosphere Programme
INPE	-	Institute for Space Studies (Brazil)
IOH	-	Institute of Hydrology
IOP	-	Intensive Observing Period
IPCC	-	Intergovernmental Panel on Climate Change
ISCCP	-	International Satellite Cloud Climatology Project
ISLSCP	-	International Satellite Land Surface Climatology Project
ISP	-	International Science Panel
ITCZ	-	Inter-Tropical Convergence Zone
JCC	-	Joint Coordination Committee
JMA	-	Japan Meteorological Agency
JPS	-	Joint Planning Staff (for WCRP)
JSC	-	Joint Scientific Committee for WCRP
KORMEX	-	Korean Monsoon Experiment
LBA	-	GEWEX Large Scale Biosphere-Atmosphere Experiment in Amazonia
LSA-E	-	Large-Scale Area-East
LSA-NC	-	Large-Scale Area-North Central
LSA-SW	-	Large-Scale Area-Southwest
LSP	-	Land Surface Process
LW	-	Longwave
MAGS	-	Mackenzie River GEWEX Study
MAPS	-	Mesoscale Analysis and Prediction System
MERIS	-	Medium-Resolution Imaging Spectrometer
METEOSAT-		Meteorological Satellite (European Operational System)

METOP	-	ESA Operational Meteorological Satellite Series
MISR	-	Multi-Angle Imaging Spectroradiometer
MODIS	-	Moderate-Resolution Imaging Spectroradiometer
MSG	-	METEOSAT Second Generation
MTPE	-	Mission to Planet Earth (NASA)
NASA	-	National Aeronautics and Space Administration
NASDA	-	National Space Development Agency of Japan
NCAR	-	National Center for Atmospheric Research (USA)
NCEP	-	National Center for Environmental Prediction
NEG	-	Numerical Experimentation Group
NESDIS	-	National Environmental Satellite Data and Information Service (NOAA)
NH	-	Northern Hemisphere
NOAA	-	National Oceanic and Atmospheric Administration
NRA	-	NASA Research Announcement
NSERC	-	Natural Sciences and Engineering Research Council (Canada)
NWP	-	Numerical Weather Prediction
OCTS	-	Ocean Colour Temperature Scanner
PACS	-	Pan-American Climate Study
PAR	-	Photosynthetically Active Radiation
PIDCAP	-	BALTEX Intensive Observation Period
PILPS	-	Project for Intercomparison of Land-surface Parameterization Schemes
PIRCS	-	Project to Intercompare Regional Climate Simulations
POLDER	-	Polarization and Directionality of Earth Reflectance
RFE	-	Regional Finite Element
SAR	-	Synthetic Aperture Radar
SCAR	-	Smoke, Cloud, Atmosphere, Radiation Programme (NASA)
SCC	-	Satellite Calibration Center (France)
SCM	-	Single Column Model
SDAC	-	Satellite Data Analysis Center
SeaWIFS	-	Sea-Viewing Wide Field-of-view Sensors second
SH	-	Southern Hemisphere
SI	-	Seasonal-to-Interannual
SPARC	-	Stratospheric Processes and their Role in Climate
SPC	-	Sector Processing Centre
SRB	-	Surface Radiation Budget
SSG	-	Scientific Steering Group
SSM/I	-	Special Sensor Microwave Imager
SST	-	Sea Surface Temperature
STE	-	Stratosphere-Troposphere Exchange
SW	-	Shortwave
TOA	-	Top of the atmosphere
TOGA	-	Tropical Ocean-Global Atmosphere programme
TOMS	-	Total Ozone Mapping Spectrometer
TRMM	-	Tropical Rainfall Measuring Mission
UKMO	-	United Kingdom Meteorological Office
UTH	-	Upper Tropospheric Humidity

3D-VAR	-	3-Dimensional Variational Assimilation System
4D-VAR	-	4-3-Dimensional Variational Assimilation System
WCRP	-	World Climate Research Programme
WDC	-	World Data Center
WGNE	-	Working Group on Numerical Experimentation
WMO	-	World Meteorological Organization
WWRP	-	World Weather Research Programme

1. OPENING OF THE SESSION

The ninth session of the GEWEX Scientific Steering Group (SSG) took place in Hamburg, Germany, from 6 to 10 January 1997. The list of participants is given in Appendix A.

1.1 Summary of progress and main developments

The Joint Scientific Committee (JSC) for WCRP endorsed the organizational structure formulated for GEWEX that arranges the existing sub-activities and projects into three branches having activities focused on integrating GEWEX's global data and process studies to develop accurate model formulations of the water budget and transport, as well as the energy budget and radiation transfer in the climate system. The disciplines that are of major concern to GEWEX in this phase of its observational period are Atmospheric Radiation Processes, Land Surface Processes and Hydrology, and Modelling and Prediction. The GEWEX Hydrometeorology Panel (GHP) reported on progress in coordinating plans and focusing on the scientific issues related to the development and implementation of the GEWEX Continental-Scale Experiments (CSEs). Outreach by GHP to other WCRP projects and activities has been promoted by agreements of participation between GHP and the Arctic Climate System Study (ACSYS) and GHP and the Centres for Global Precipitation Climatology (GPCC) and Global Runoff Data (GRDC). Important progress in the planning and implementation of the GEWEX Global Soil Wetness Climatology Project (GSWP) was also addressed.

The GEWEX Radiation Panel (GRP) reported on plans for the next phase of the GEWEX Global Water Vapour Project (GVaP), a strategy for initiation of a GEWEX Global Aerosol Climatology Project (GACP), release of the Global Precipitation Climatology Project (GPCP) merged dataset, status of efforts to define a GEWEX multi-sensor international cloud, radiation and aerosol mission, collaborations with the GEWEX Cloud System Study (GCSS) and progress by the International Cloud Climatology Project (ISCCP).

The GEWEX Modelling and Prediction Panel (GMPP) was organized and given responsibility to establish projects specifically focused on producing improved cloud and land-surface parameterizations for use in Atmospheric General Circulation Models (AGCMs). GMPP will also oversee continued progress by the Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS) and GCSS. The JSC/CAS Working Group on Numerical Experimentation (WGNE) will have a key supporting role in the activities undertaken by GMPP. With the activation of the GMPP the GEWEX Numerical Experimentation Panel (GNEP) was dissolved. The JSC will be asked to confirm these adjustments in the GEWEX organizational framework as now reflected in Figure 1.

Other actions and recommendations included issues associated with current space agency Earth observing plans, remaining challenges within the GEWEX research strategy, coordination of GEWEX global datasets, refinement of research themes for the GEWEX Panels, interfaces with the Climate Variability and Predictability Study (CLIVAR), and the Stratospheric Processes and Their Role in Climate (SPARC) Study, and the role of GEWEX in WCRP.

The success of the Second International Scientific Conference on GEWEX held in Washington DC, USA, (17-21 June 1996) was emphasized. The conference followed an interdisciplinary science theme highlighting GEWEX scientific interests involving the climate feedback associated with cloud, radiation and hydrological processes and their modelling and prediction. The SSG decision to utilize poster sessions as the primary forum for presenting the scientific results provided a more prominent position within the conference for the over 300 high quality abstract submissions which had been received. Several significant research results were introduced at the Conference. Plans for a Third International Scientific Conference on GEWEX to be held in Asia in 1999 were discussed.

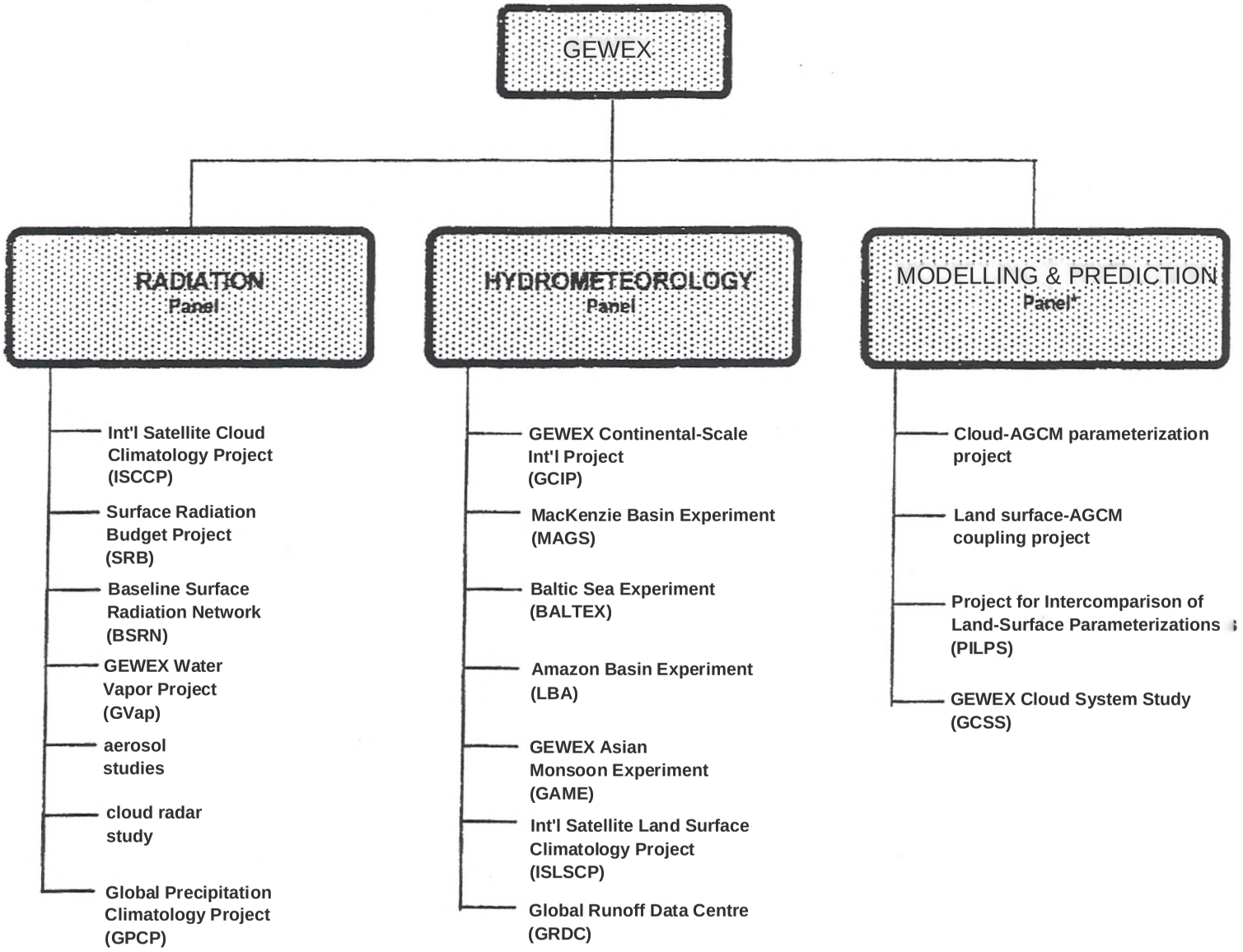

Figure 1. GEWEX Organizational Structure

1.2 Next Session

The SSG accepted the offer made by Dr Carlos Nobre, on behalf of the Institute for Space Studies of Brazil (INPE), to host the next (tenth) SSG session in Brazil from 2 to 6 February 1998.

2. GEWEX GLOBAL OBSERVATION PHASE REQUIREMENTS

The systematic monitoring of climate, identified as a key task in the UN Framework Convention on Climate Change has now entered a new era after the determination in the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 1995 that "the balance of evidence suggests a discernible human influence on global climate". A quantitative attribution of climate change to a distinct cause remains however a distant goal, and in this context, space missions will remain key contributors to further advances in such knowledge. It is a WCRP requirement, therefore, to maintain homogeneous and consistent global records of key climate variables that control the energy budget and water cycle in the atmosphere and at the earth surface. The important parameters include extent and optical properties of clouds, atmospheric temperature, sea surface temperature, water vapour, winds and precipitation.

2.1 Operational Meteorological Satellite Measurements

The fundamental basis for the atmospheric data required by GEWEX is the NOAA series of polar orbiters and geostationary satellites, the European METEOSATs and the Japanese GMS spacecraft, which constitute the existing array of operational meteorological satellites. The maintenance of this array and the continuity of related observations and the continued international support of the ISCCP and GPCP and the potential benefits that can be expected from on-going improvements of existing instrumentation, are necessary for meeting the objectives of the GEWEX global observation phase.

2.2 GEWEX Large Earth Observing Space Platform Observational Phase

The period of global observations for climate research by a series of large space platforms began on 17 August 1996, with the successful launch, checkout and operation of all eight instruments on board the Japanese National Space Development Agency's (NASDA) ADEOS-I earth observing spacecraft. NASDA's Earth Observation Research Centre (EORC) has provided access to the ADEOS data by way of the Internet and is promoting GEWEX related research activities utilizing the earth observation satellite data (see Appendix B).

The success of ADEOS-I confirms the SSG's conclusion that the operational satellites together with the current configurations of Japan's ADEOS-II, the European environmental satellites (ESA's ENVISAT-1 and the ESA/EUMETSAT METOP-1, which is the first of a series), and the two NASA earth observing system satellites (EOS-AM1, EOS-PM1) will nearly fulfill the main requirements of WCRP and GEWEX.

2.3 Requirements for Additional Global Measurements and Data Analysis Support

The SSG acknowledged the responses from space agencies to the main concerns in climate research relevant to GEWEX which were notably missing from current earth observation plans. A letter from the Director of WCRP to the Heads of Space Agencies identified the parameters of greatest relevance to be:

Global 3-dimensional Distribution of Clouds, Radiation and Aerosols
Global Soil Moisture (upper 5-10cm)
Global 3-Dimensional Distribution of Tropospheric Wind

The ESA Earth Explorer Programme has recently recommended four missions for further study which largely encompass the fields of research identified by the SSG as critical to GEWEX. The next phase of study to be undertaken through the ESA Earth Observation Preparatory Programme (EOPP) will involve identification of various possibilities for international cooperation (i.e. with NASDA, NASA and other agencies) leading to an implementation plan for a relevant mission in the post-2000 time period. Similarly, a 1996 announcement of opportunity released under the auspices of the NASA Earth System Science Pathfinder (ESSP) Programme has drawn proposals which respond to GEWEX requirements for profiles of 3-Dimensional cloud fields and major aerosol layers together with characterizations of cirrus cloud extinction and ice mass and crystal size. In addition, NASDA is exploring the possibility of responding to the specialized WCRP/GEWEX objectives by developing specific instruments and flying them on one or more spacecraft in the early part of the next decade.

The SSG was encouraged by these various prospects and recommended that the Chairman of the GEWEX Panels and Leaders and Managers of the GEWEX research projects continue to follow and review the parallel planning activities underway in their areas of expertise in an effort to find the most appropriate and timely, internationally supported, options for the projects of interest.

The Tropical Rainfall Measuring Mission (TRMM) was reaffirmed to be a mission which must be supported. This mission jointly developed by NASA and NASDA, which is to be launched in 1997, is a critical step in the development of methods to predict changes in the global distribution of the phases of water. The data from TRMM are also vital to long-term studies of atmospheric and ocean circulation and of the Earth's Biosphere. Continuity of the measurements are important for these studies which makes it necessary to plan for a follow-on mission that should include mid-latitude precipitation.

The need to place additional emphasis on data analysis issues during mission planning was addressed. The SSG recommended calling the attention of the space agencies to the importance of systematic analysis, intercomparison and merging of remote sensing products inferred from different satellite systems or instruments as well as the need to support the integration of satellite-based estimates and *in situ* observations. The agencies will be encouraged to make these activities more visible in their strategic planning exercises as stand-alone initiatives related to existing data archives and to include them as an integral part of the implementation plans for future missions.

3. MANAGEMENT OF GEWEX GLOBAL DATA SETS

GEWEX has taken responsibility for consolidating WCRP climatological data projects based on merging satellite data with current atmospheric and (land/ocean) surface measurements. This role includes interacting with space agencies to track the status of global environmental observing systems, providing scientific overview of the retrieval procedures and data quality, organizing data archiving and distribution on appropriate media and assisting, through conferences, workshops, symposia, and data management meetings, with the international co-ordination of these projects. GEWEX is employing new methods of making data available through existing networks including various electronic file transfer schemes and connections to on-line databases by way of the Internet. The goal is production of reliable, quality-controlled and documented global climatological datasets for advancing climate research.

A protocol for normalizing these activities across all of the GEWEX data projects was discussed at the meeting. Consideration was given to documentation, quality assessment, calibration, gridding and geo-location standards, and formatting specifications. The SSG endorsed the baseline framework for addressing these issues which was drafted by a small writing team, chaired by Dr D. Hartman, (see Appendix C). The Director of the IGPO agreed to work with the relevant GEWEX Projects to consider this protocol in the context of the current GEWEX distributed data system and to continue to facilitate the effort to improve consistency of the GEWEX data management procedures.

The SSG agreed that no immediate change in GEWEX data set development and management policies was necessary with the initiation of a new series of Earth Observing System (platforms with significant application to GEWEX). The Group concluded that initially there would be large variations in the character of the climate related parameters derived from these large earth observing platforms. These variations will be associated with the individual sensors, each of which have unique algorithmic formulations with instrument-specific mechanisms for selecting/updating these algorithms. Processing and management of the resultant data sets will depend primarily on oversight by the different investigators and their related science teams.

It is important that WCRP/GEWEX move ahead with its integrated, inter-disciplinary, multi-instrument/satellite based data product strategy until competing "level-3" global "blended" products begin to emerge from the large earth observation platform data systems. It will only be at that time (post-2000) that resources will come available that will make it possible to add value to the initial earth observation system retrieval processes by organizing intercomparisons, applying merged data techniques and participating in unified algorithm development ventures. The SSG recommended that individual researchers remain cognizant of the large earth observing platform data retrieval process within their particular fields and to report new developments as they arise. The SSG Chairman will act as a focal point for reports on this issue and will work with the JPS for WCRP to ensure further discussions are scheduled at subsequent meetings as required. GEWEX will also continue to participate and monitor existing related activities such as NASA's Pathfinder and Data Assimilation Office (DAO) projects.

4. GEWEX ROLE IN WCRP

The Director of WCRP placed the scientific issues under discussion at the meeting in the context of the primary goals of WCRP which he formulated as being:

- To design and implement observational and theoretical research programmes that will lead to a quantitative understanding of significant climate processes and

- To develop models capable of simulating the climate system and predicting climate variations on a wide range of space- and time-scales.

4.1 GEWEX Contributions to WCRP Goals

WCRP has been organized to encompass all of the important scientific topics necessary to meet its overall goals. With the help of a multi-disciplinary group of international scientists, including representatives from the other WCRP projects, the GEWEX-SSG has provided a forum for resolution of the main scientific and technical issues necessary to enable GEWEX to improve the ability to observe, understand, model and predict the global hydrological cycle and, thereby, to make significant contributions toward meeting WCRP's main goals. Cooperation and collaboration with the other elements of WCRP including CLIVAR, ACSYS and SPARC is an integral part of GEWEX. The cooperative, interactive framework built up in WCRP is flexible enough to enable GEWEX to address a broad range of scientific problems, including seasonal to interannual predictions, the variability of the hydrological cycle and long term climate change.

4.2 Remaining Challenges to the GEWEX Research Strategy

WCRP/GEWEX is supported by a range of international research/operational facilities, climate analysis centres and funding agencies. Relevant International Geosphere-Biosphere Programme (IGBP) core projects have also been engaged for collaborative activities. Particular challenges remaining for GEWEX in support of WCRP goals include a) developing a more focused cryospheric research thrust, b) defining and implementing a framework that improves communications with scientists and programme

managers in the water resource management and agricultural research fields, c) responding to the movement toward convergence of large national and international climate research endeavours and themes, and d) helping to select a consistent strategy for narrowing the uncertainty about the climate system sensitivity to external forcing.

5. GEWEX CONNECTIONS TO NATIONAL AND INTERNATIONAL CLIMATE RESEARCH INITIATIVES

Representatives of national and international agencies provided the SSG with an overview of major climate research initiatives underway that have connections to WCRP/GEWEX objectives.

5.1 NASDA

NASDA's Earth Observation Research Center (EORC) has been initiated by NASDA to act as a bridge between the Space Agency and the science/user communities. The Center is acting as a main focal point for the initial validation and assessment of data from the ADEOS-I instruments and is continuing to expand NASDA's activities in the application of remote sensing techniques for global climate research. The GEWEX science programme being promoted within EORC includes data acquisition and data and information systems groups which are establishing working arrangements with various elements of the international GEWEX community. These connections include activities related to TRMM including a joint research announcement for which over fifty proposals for post launch research have been received. The development of the science programme in EORC will continue to emphasize the support of the GEWEX Asian Monsoon Experiment (GAME) and preparation is underway for a NASDA research announcement for GEWEX/GAME. Proposals will be required to promote the utilization of earth observation satellite data and GEWEX related goals in climate change prediction.

The EORC is providing an important interface between the ADEOS-I investigators and the broader climate research community. Data released at the various Internet sites, set up by EORC, have given an early indication of the potential value of the ADEOS data. The SSG, however, asked the NASDA/EORC representative to convey to all of the ADEOS investigator teams the WCRP/GEWEX concern over instrument specific data management policies which restrict data access to only a small number of researchers for extended periods of time. The POLDER data was cited as an example of an important data set that could contribute directly to GEWEX analyses if access to the data could be made more timely.

5.2 NASA

Dr J. Arnold noted that the science priorities of NASA's Mission to Planet Earth (MTPE) Programme in the time period from 1995-2000 had been established to be:

- Atmospheric Ozone
  - Detection, causes and consequences of changes in stratospheric and tropospheric ozone
- Natural Hazards
  - Apply unique MTPE remote sensing science and technologies to disaster characterization and risk reduction from earthquakes, fires, floods and droughts
- Land Cover Change and Global Productivity
  - Document and understand the trends and pattern of changes in land cover, biodiversity, and global primary production
- Seasonal-to Interannual Climate Prediction
  - Provide global observations and scientific understanding to improve forecasts of the timing and regional extent of transient climate anomalies

- Long-term Climate Variability
  - Provide global observations and scientific understanding of the mechanisms and factors which determine long-term climate variations and trends

MTPE has a primary intersection with GEWEX in hydrometeorology where the interest is in macroscale issues that emphasize the use of remote sensing data in combination with traditional data and modelling. The surface and the atmosphere are being addressed and constitute the "global hydrology system". The goal is to develop and use remote sensing techniques together with in-situ observations to monitor, describe, and understand the regional water budget and surface hydrology as well as to contribute to the understanding of the seasonal-to-interannual variability of the system. A series of Research Announcements in Hydrometeorology are tentatively scheduled for release in 1997 including a GEWEX Continental-Scale International Project (GCIP) joint announcement with NOAA, a GEWEX Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) hydrometeorology announcement and a hydrometeorology announcement with a seasonal to interannual emphasis.

5.3 NOAA

The SSG was informed that the observational aspect of the NOAA Climate and Global Change Program encompassed precipitation, clouds, radiation/land-surface and water vapour. This effort provides support for GPCP, and will play an important role in the next phase of GVaP as well as linking to the advancement of cloud profiling activities. The Climate Change Data and Detection element of the programme has as it main thrusts data management support for specific WCRP activities such as GCIP and the World Ocean Circulation Experiment (WOCE) but also involves reference data set development and the detection, documentation and analysis of climate variations/changes.

An important new NOAA initiative is the Seasonal to Interannual Climate Prediction Programme (SCPP) which is intended to support economic and environmental needs for an extended period into the future. Effective applications of climate diagnostics and predictions will be used to help deal with the variability related to ENSO. By promoting the Pan-American Climate Study (PACS) and the International Research Institute (IRI) for Climate Prediction as part of this initiative, SCPP plans to ensure that an infrastructure exists to incorporate regional forecasts into a wide range of agrarian, economic and social planning processes.

5.4 ESA

The current ESA Earth Observation Programme was presented by Dr C. Readings, Head of the Earth Sciences Division. This effort spans METEOSAT and METEOSAT Second Generation (MSG) and METOP series of satellites which are implemented in cooperation with EUMETSAT, but also includes the first Earth Remote Sensing Satellite (ERS-1) and its follow-on ERS-2, and ENVISAT-1 and the Earth Watch and Earth Explorer Missions. The SSG was advised that the overall objectives of the ESA Polar Missions Scenario requires that the ENVISAT-1 maintain continuity of ERS observations for the monitoring of coastal zones, open oceans, ice and land surface processes; improve on the oceanic mission with observation of biological components and color of the oceans and make major contributions to understanding, monitoring and modelling of atmospheric chemistry processes. The overall objectives of the METOP series of polar missions encompass the provision for ensuring collection and enhancement of observations from the "morning" polar orbit for operational meteorology as well as for contributing to the routine long term observation of key climate variables.

The ESA Earth Observation Preparatory Programme (EOPP), as noted in Item 2.3, is the Agency's mechanism to prepare future earth observation missions for consideration and decision. Initiated in 1986, EOPP is being considered for further extention to ensure continuity of the planning process. The Earth Explorer research and development missions focused on specific topics and techniques and the Earth Watch thematic pre-operational missions focused on specific emerging earth observation application areas are the two general classes of missions being proposed within the EOPP context. A rigorous selection process, with provision for full consultation of the user community at all stages, has been put in place for selection of the Earth Explorer missions. This mechanism has resulted in nine candidate missions being endorsed as having high scientific importance. Of those nine, four have been recommended for Phase "A" study. These four respond well to WCRP requirements by encompassing missions which relate to: Gravity Field and Steady State Ocean Circulation; Atmospheric Dynamics; Earth Radiation; and Land Surface Processes and Interactions. The SSG was encouraged by these developments and expressed interest in being advised of further developments in the EOPP review process especially as they relate to the possibility of international cooperation in the possible implementation of the relevant missions early in the post 2000 era.

5.5 GEWEX Contributions to Improved Seasonal-to-Interannual Climate Predictions

In the ensuing discussion the SSG recognized that seasonal-to-interannual (SI) climate prediction is gaining visibility as an important climate issue and sought to characterize the contribution GEWEX is making in this domain. The SSG Chairman noted that the developing capability to extend useful weather forecasts based on knowledge of sea surface temperature and soil moisture patterns over land has given hope that predictions one or two seasons in advance (or longer) will soon be possible for many regions of the world, and GEWEX is making major contributions to advances in this area.

Several fundamental scientific questions must be addressed to demonstrate skill in the prediction of seasonal-to-interannual variations and their effects. These questions range from documenting the patterns of variability to specifying the mechanisms underlying this variability, and understanding how these mechanisms vary in space and time. Ultimately, the objective is to determine the effects (e.g. flood and drought) of SI variability on human social and economic activities (e.g. agriculture, water resources) as well as on the biosphere as a whole. GEWEX, was established in WCRP in order to foster a number of fundamental studies that are required to answer these questions. Various aspects of GEWEX research are, therefore, now recognized as a prerequisite for investigating and predicting the variability of the Earth climate system on time scales ranging from days to seasonal and interannual and beyond. These include:

(i) Development of regional and global datasets of key climate parameters, such as rainfall, radiation and clouds, and land-surface parameters, to document climate variability on SI time scales and beyond.

(ii) Direction of five continental-scale experiments designed to identify the mechanisms that control the hydrological cycle over land and contribute to SI variability in time and space. Specifically, identifying the contribution of land surface processes and soil moisture to the persistence of atmospheric regimes over periods of months to seasons and the impact of the memory of soil moisture on the predictability of floods and droughts over continents.

(iii) Improvement of the formulation of energy and fresh water transport and exchanges in atmospheric circulation models. Of particular significance are the GEWEX radiation studies aimed at producing accurate energy fluxes in atmospheric columns from the surface to the top of the atmosphere, with reduced systematic errors to eliminate the need for empirical corrections in general circulation models.

(iv) Improvement in formulations of land-surface/atmosphere coupling and parameterization of cloud and atmospheric processes in global weather and climate models. A goal of GEWEX is to demonstrate skill in predicting changes in water resources and soil moisture on seasonal and annual time scales.

In addition, closer collaboration being developed between CLIVAR and GEWEX relates to activities that address many SI issues such as the predictability and variability of the Asian monsoon and the Pan-American monsoon. The SSG has also addressed the impact on human activities, by requiring each, GEWEX endorsed, continental scale experiment enter into collaborative agreements with water resource agencies and related client/users to better utilize improved continental scale information for regional water resource assessments.

6. REVIEW OF GEWEX MAJOR FUNCTIONS AND PRIORITIES

Although the main thrusts in the implementation of GEWEX to achieve scientific objectives have remained the same, the research in the individual elements has been focused on specific scientific goals that have been developed to unify their efforts in meeting the higher level global scale objectives. Since the current configuration has been officially endorsed by the JSC the SSG undertook to review the scientific themes and related activities within this framework.

7. HYDROMETEOROLOGY

Dr R. Stewart, current Chair of the GEWEX Hydrometeorology Panel (GHP) opened the review of the Panel's activities by noting that to advance knowledge about the global climate system, GEWEX has generated an important scientific effort to combine various regional modelling and field research activities to study the physical processes that directly influence the fluxes of energy and water. These multi-disciplinary scientific Continental-Scale Experiments (CSEs) are adding to WCRP's efforts to develop an understanding of the physical climate system and processes. There are currently five such projects based in large river basin/drainage areas; the GEWEX Continental-Scale International Project (GCIP) in the Mississippi River Basin, the Baltic Sea Experiment (BALTEX), the Mackenzie River Basin GEWEX study in Canada (MAGS), the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) and an experiment in a large area influenced by the Asian monsoon, identified as the GEWEX Asian Monsoon Experiment (GAME).

The GHP has been chartered to oversee continued development of these studies on behalf of the GEWEX-SSG and the Joint Scientific Committee (JSC) for WCRP. The purpose of the review was, therefore, to establish a clear assessment of the current status of work being accomplished as part of the CSEs and to promote further progress toward the accomplishment of a collective GEWEX research initiative related to prediction of regional precipitation and runoff. The SSG was reminded that as part of its outreach effort GHP has established a Home Page at the World Wide Web (WWW), Uniform Resource Locator (URL): **<http://www.tor.ec.gc.ca/GEWEX/GHP/ghp.htmb.**

7.1 Research Focus for GHP

A principal contribution GHP will make to the overall objectives of WCRP will be in fostering the coupling between the atmospheric science/meteorological community and the hydrological science community, as well as giving more attention to boundary layer physics over vegetated areas. The CSEs will also encourage further advances in the understanding and modelling of water resources and also the distribution of sensible and latent heat in the atmosphere, an important aspect of seasonal and longer-range climate predictions. The premise is that the prediction of regional precipitation and runoff anomalies over periods of several months is a possibility with improved understanding of water cycle processes. One of the critical issues is what can be done to improve collaboration with water resources agencies on how to better use improved information. Other questions relate to the influence of local versus non-local controls on precipitation over land, how do local controls vary from region-to-region, what are the feedback mechanisms in the water cycle and to what degree do they affect wet and dry spells and how well can we determine the soil moisture field.

The focused research task for GHP incorporates these points. A statement of the task was revised at the second GHP meeting. The current formulation endorsed by the SSG reads in the following manner:

> "The GHP will be responsible for assisting GEWEX to demonstrate skill in predicting variabilities in water resources and soil moisture on time scales up to seasonal and annual as an element of WCRP's prediction goals for the climate system."

The strategy for attaining this goal was also modified by the Panel. The following formulation has been accepted.

To work toward the following scientific milestones with relevance to policy:

- By the year 2000 quantify evaporation, precipitation and other hydrological processes as required to improve prediction of regional precipitation over periods of one to several months.

- By the year 2005 predict variabilities in water resources and soil moisture on time scales of seasonal to annual as an element of WCRP's prediction goals for the climate system.

Interim steps toward meeting these objectives were proposed. It has been recommended that by the end of 1998 there should be an appreciation, in a conceptual manner, of the ways in which the continental-scale water and energy cycles operate. To do this a commitment is required by the CSEs to develop conceptual models that describe the critical processes and their feedbacks that operate over the continental-scale regions during typical and anomalous periods on time scales of up to a few months. Additionally, by 2003, it will be necessary to have validated the models so that the continental-scale water and energy cycles can be accounted for on periods of one to several months when the large scale forcing is specified.

7.2 GEWEX Continental Scale Experiment Status Reports

The GEWEX-SSG, in keeping with its goal of increased interaction with other programmes, both within and outside of the WCRP, established the GHP in order to provide an international framework for the CSEs. Reviews at the meeting of the main elements of the five most comprehensive GEWEX CSEs indicated that this framework allows them to benefit from cooperative planning and implementation and is helping to ensure their regional results contribute to improvements in global scale climate models.

The most recent significant milestones achieved by the CSEs were summarized as an update to material presented at the 1996 meeting. Many of these activities correlate with the criteria established earlier by the SSG, that characterize these studies as part of GEWEX. The SSG was able to relate the planning and implementation status of each CSE to their compliance with these endorsed standards by way of brief summaries of their significant events under each criterion. The five categories by which the status of each CSE was assessed incorporate items related to:

1) Obtaining support of a numerical weather prediction (NWP) centre;
2) Developing and applying suitable atmospheric-hydrological models, data management and assimilation schemes;
3) Developing mechanisms for collecting and managing adequate hydrometeorological datasets;
4) Meeting WCRP practices for international exchange of scientific information;and
5) Interacting with water resource agencies and related client/user groups.

The overall effort is at stages ranging from items being planned, to tasks already implemented and functioning. While the effort to meet these criteria is most mature under GCIP all the CSEs have made considerable progress in each of the most important categories.

7.2.1 *Baltic Sea Experiment (BALTEX) Implementation Status*

The level to which BALTEX is meeting the criteria for GEWEX CSE's is partly reflected in the co-operation the Experiment is receiving from NWP centres in Germany at the Deutscher Wetterdienst, (DWD) and the Meteorological Institutes in Sweden, Denmark and Finland. Data sets for specific BALTEX key periods have been established and analyzed and study versions of the DWD models for the entire BALTEX region are being run at different research institutions. The SSG was advised by Dr L. Bengtsson, BALTEX-SSG Chairman, that two programmes of numerical experimentation in BALTEX including atmosphere, hydrological, and ocean-sea ice modelling are now being funded by national and international (European Union) sources. Examples were shown which illustrated that these programs included efforts to couple individual model components.

The BALTEX Intensive Observation Period PIDCAP (Pilot Study for Data Collection and Analysis of Precipitation) was cited as an example of the process which would be used to collect and manage the hydrometeorological data sets necessary to continue the required research and validate model outputs. The Study was successfully conducted during the period from August to November 1995 and has resulted in a consistent set of data exchange rules for meteorological data which are now being established among the multi-national participants. These data management rules for meteorological and oceanographic data are implemented and partly functioning. Agreements between various data suppliers and the BALTEX Meteorological Data Centre at DWD are signed and in operation.

Interactions with water resource agencies and related client/user groups are continuing to be developed. Potential client organizations of BALTEX (e.g. NWP centres, national hydro-meteorological services) in up to 10 different countries are actively contributing to the overall planning and implementation of BALTEX. Contacts to national and regional water management authorities are planned.

7.2.2 *GEWEX Continental Scale International Project (GCIP) Implementation Status*

GCIP has a fully functional relationship with the National Center for Environmental Prediction (NCEP) and is archiving GCIP data assimilation products that are being routinely produced by the Center using the Eta model. Outputs covering the GCIP domain are also being produced by the Forecast Systems Laboratory (FSL) using the Mesoscale Analysis and Prediction System (MAPS) model and by the Canadian Meteorology Center (CMC) using the Regional Finite Element (RFE) model. GCIP related

research at NCEP includes the development of better land surface schemes for regional models and a project to nest the Eta model in a global NWP model. Additional support is being provided in the form of suitable atmospheric-hydrological models, data assimilation schemes and data management protocols. Significant progress has been made in the development and implementation of the GCIP modelling strategy through a number of research projects. A wide range of models and land surface schemes are being used in this work. New priorities, such as modelling the effects of precipitation and its sub-grid scale variability, were identified as areas where GCIP will want to increase its efforts.

A regional scientific co-operation mechanism for collecting and managing adequate hydrometeorological datasets, including satellite observations, for supporting and validating the GCIP model development activities is nearly complete. GCIP has developed observational networks and data flows for the Large-Scale Area-Southwest (LSA-SW). In addition to obtaining routine data for its archives, GCIP has established a soil moisture network which is nearly fully installed. Several flux towers have also been installed. An enhanced seasonal observing period was carried out in 1995 and another one in 1996. In addition, a 5-year enhanced observing period for the entire basin got underway in the fall of 1995. GCIP is now implementing an observational programme in the Large-Scale Area-North central (LSA-NC). The extent of this network will be dependent on the Fiscal Year (FY)-97 and FY-98 budgets which are currently under significant pressure.

WCRP practices for international exchange of scientific information are being met by GCIP but the SSG was informed that there are some concerns in this area. A number of data sets have been prepared and distributed internationally both on CD-Roms and via the Internet. Possible delays in being able to provide some data sets internationally may arise. However, options are being investigated to ensure the widest possible distribution of the entire dataset. Dr R. Lawford agreed to keep the SSG informed of what action were being taken to assist with the release of data to the international community.

Some progress has been made in establishing links with client groups and water resource agencies. A water resources conference being held in Colorado Springs, Colorado, USA, in 1997 is being partially sponsored by GCIP. A GCIP Water Resources Climate Science Conference, which involves support of the Tennessee Valley Authority in the Large-Scale Area-East (LSA-E), is being planned for 8-12 June 1998 at St. Louis, Missouri, USA. The conference will involve states bordering the Mississippi River and will have a public education thrust dealing with climate variability, climate prediction and water resources.

7.2.3 *Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) Implementation Status*

To ensure the support of an NWP Centre, LBA is developing agreements with The Centro de Previsão de Tempo e Estudos Climaticos (CPTEC) which has implemented the NCEP Eta model for South America. A high resolution 4-Dimensional Data Assimilation (4DDA) product is currently being implemented as part of the process associated with further coupling to the Eta model. To meet the GEWEX requirement in this area the process is designed to be a state-of-the-art atmospheric and surface data assimilation procedure that will deliver estimates of hydrometeorological properties in a form directly comparable to observables. In conjunction with the activity suitable atmospheric-hydrological models, and data management and assimilation systems are being developed in collaboration with groups in South America, USA and Europe. Plans for a mechanism for collecting and managing adequate hydrometeorological datasets are partly dependent on implementation of the Amazonia Surveillance System (Sivam) project. This project would modernize the meteorological network with the installation of 15 upper air stations and 75 automatic weather stations (AWS).

LBA expects to meet WCRP practices for international exchange of scientific information and plans are being developed to establish formal processes to ensure data are available to the climate community. These plans will be in place and tested before the beginning the field phase in 1999 including the release of a pre-LBA data set on CD-ROM.

Interactions with water resource agencies and related client/user groups are progressing. Clients of LBA are primarily in the public sector and include national services in several South American countries. The national committees in these countries are planning to establish contacts to national and regional water management authorities to expedite development of important infrastructure such as the telecommunications network being established in Brazil with the involvement of Brazil's Water Authority (DNAEE).

7.2.4 *GEWEX Asian Monsoon Experiment (GAME) Implementation Status*

The Japan Meteorological Agency (JMA) global assimilation with its T213L30 model has been underway since March 1996. The details of the data acquisition for 4DDA through the use of this model for the GAME-Intensive Observing Period (IOP) in mid-1998 is being discussed between JMA and GAME regional experiments groups. Regional 4DDA with the JMA mesoscale model is planned over the HUBEX area. A regional modelling working group has been established and GAME community models have been prepared for all GAME-research participants. The AAN (Asian AWS Network) will be a primary element of the mechanism for collecting and managing adequate hydrometeorological datasets for GAME. The automated stations being deployed are capable of flux measurements and each regional experiment has begun to initiate the deployment of surface observational networks. Enhanced radiosonde observations are being tested in Thailand and other regions will participate with enhanced measurements.

Data management criteria and a data information network (GAIN) were established at the GAME International Science Panel (ISP) meeting in March 1996. A preliminary GAIN-Hub station has been established at MRI. The data exchange policy is being discussed among the GAME-related countries and progress on this issue is expected at the second ISP meeting in Korea, 24-25 March 1997.

Interactions with water resource agencies and related client/user groups continue to be developed. Clients of GAME (e.g., meteorological agencies, hydrological agencies, environmental agencies etc.) have been formally involved in the GAME activity in Japan, China, Thailand, Malaysia, India, and Mongolia and the Korean Meteorology Service is involved in KORMEX (Korean Monsoon Experiment), the Korean contribution to GAME. A joint coordination committee (JCC) has been instituted to coordinate GAME-Tibet, Chinese TIPEX and related Chinese/Japan cooperation in investigations of the Asian monsoon mechanisms. The committee is expected to address the application of the scientific results to regional agricultural and water resources projects. Of particular interest are the data sets of surface wetness and snow and of seasonal and diurnal atmospheric water vapour content being derived from satellite data over the region. Results of special field campaigns in the GAME-Siberia component are also expected to assist local and regional water resources planning agencies. Special meteorological and hydrological data sets are being prepared in cooperation with GAME-Japan and Russia's State Hydrological Institute.

7.2.5 *Mackenzie GEWEX Study (MAGS) Implementation Status*

A key milestone was reached in 1996 with the decision to provide funding on an extended basis for the MAGS university research effort. The Natural Sciences and Engineering Research Council of Canada (NSERC) agreed to fund sixteen different groups of university researchers for four years beginning in the last quarter of 1996. The modelling strategy calls for improvements in the regional climate model which is currently being tested with the Canadian climate model. Plans call for input from

operational weather prediction models in the near future and direct comparisons will be possible between the regional climate model fields and observational fields from projects over the Basin itself or as functions of time at various locations. Interactions with BALTEX have also developed to the extent of assessing the degree to which the REMO model is able to replicate water and energy cycles of events occurring during a special Canadian project over the Beaufort Sea (BASE). Canadian models are being exercised in the same mode for an event during the BALTEX PIDCAP.

Ground-based observational networks are being augmented to ensure collection of required hydrometeorological data sets including satellite observations. An operational 5-cm wavelength radar is being installed over the Basin, plans for an additional six observing sites are being made, and detailed planning for greatly improved measurements for a one year period are underway. Precipitation fields are being estimated from available satellite and radar measurements, and use is being made of Radarsat data for snowfield classification. Surface radiation fields are being generated with information from the ScaRaB satellite. Substantial effort has been made to improve the management of these data sets. Regional products are also being produced and this includes estimates of precipitation over the last twenty years as well as surface evaporation and surface vegetation. The data management plans for MAGS are being implemented, data are being made available on-line, and discussions have started with other CSEs in order to improve the exchange of information.

Connections with several client groups have been developed by MAGS. British Columbia Hydro has been asked to join the MAGS Management Committee and is very interested in working on short-term, episodic event investigations. The Aurora Research Institute in Inuvik will provide a link between the science activities and the residents of the Basin who are concerned that global change may impact their local communities. A set of informal lectures may be given to the residents of Inuvik in 1997. Connections are also being established with the pulp and paper companies and the transportation industry.

7.3 Future Plans

A unified GHP action plan has been developed. The basis for the plan is the understanding that the GHP is responsible for examining the role of continental-scale hydro-meteorology issues within the climate system and ensuring that these issues are well represented in climate simulations for improved prediction. The action plan which was endorsed by the SSG, reflects examples of work completed, items under development and new initiatives being considered.

Important milestones in 1996 included an inventory of models (including current coupled hydrological models) and assessment of their transportability. In 1997 an evaluation of the International Satellite Land Surface Climatology Project (ISLSCP) Initiative-II 10 year (1986-95) dataset will be undertaken and the best available gridded precipitation datasets and historical river discharge values and variations for all CSE Basins summarized. The CSE's are planning co-ordinated presentations at the International Association of Meteorology and Atmospheric Sciences (IAMAS) Meeting (July 1997, Melbourne, Australia). It is projected that by the next GHP meeting (September 1997) reports would be ready for discussion on transportability, inception of other CSEs, assessment of differences in fluxes and reservoirs at typical and anomalous periods in each CSE, identification of key phenomena affecting water and energy cycles in each Basin, assessment of water and energy cycle simulations given large scale forcing and identification of scientific issues affecting the results. The Chair of GAME will chair GHP for the coming year and will act as host for the next meeting.

7.4 Modelling and Data Management Strategies in GHP

A major element of GHP future plans relates to issues dealing with consistent modelling and data management strategies among all of the CSEs. The SSG endorsed a joint set of specific actions, recommendations and conclusions covering the topics of Model Identification, Model

Commonalities/Differences, Data for Model Validation/Transferability and Data for Land Surface/Hydrologic Model Testing. As an initial step in this process a list of over 30 models (atmospheric, land-surface, hydrological) in use in the five CSE's has been compiled. Agreement has also been reached to document different modelling and data management strategies being applied in each CSE. Emphasis has been placed on determining the model coupling schemes.

Data Sets required for full model validation (CSE transferability) are also being identified and categorized by types such as "constant" data (topography, etc.), initial and boundary data (usually analyzed fields) and validation data (analyzed fields, observed data). Each data set must be available separately for each CSE and globally. As an initial step the ISLSCP Initiative-II data set (1987-94) of world wide land surface parameters, re-gridded at .5 x .5 degree resolution (ready mid-1997), may be applied (see Item 4.8). However, the models in the CSE's have different requirements on data sets (different parameters, different temporal and spacial resolution etc.). These parameters will be identified as part of this exercise.

To successfully apply hydrological models that have been developed and tested in a research mode their transferability to other areas must be evaluated. In GHP this must be done at regional and global scales. An important aspect of this process is the estimation of model parameters which requires development of, model dependent, *a priori* relationships between the model parameters and land surface and climate characteristics. To assist in the development and testing of these parameter estimation techniques GHP has taken under advisement initiation of a Model Parameter Estimation Exercise (MOPEX) that could collect the appropriate hydrometeorological and land characteristics data for 100-200 river basins, globally, and promote development of parameter estimation methods. The SSG reviewed the MOPEX concept and concurred with the GHP plan to test the transferability of models and parameters by defining several small test beds within the CSE boundaries and to initially investigate the necessary relationships within the context of a more restricted parameter estimation project carried out under the auspices of the GHP or the GEWEX Modelling and Prediction Panel. Full endorsement of MOPEX was withheld, at this time, because the broader long term, global applications for such a task far exceed the more near term and regionally constrained goals of the CSEs.

7.5 GHP Process Study Implementation Plans

An important conclusion concerning the process studies planned in the CSEs is that the majority of them are focused on relatively short duration Enhanced Observation Schedule (EOPs) (see Figure 2). This situation may not provide the best means of investigating the dynamics inherent to the processes which are relevant to water and energy cycles (e.g., soil moisture dynamics, dynamics of the biosphere). The dry bias during the summer period in most climate models is, for example, related to the soil moisture-evaporation feedbacks which may need to be measured on seasonal time scales (i.e., a continuous soil moisture record may be needed covering (inter)seasonal dynamics). As a consequence the SSG recommended that the CSEs should evaluate the design of their experimental (field) activities and where relevant, evaluate the need for continuous, long-term data collection efforts.

A number of field campaigns, intensive observation periods and related projects are already underway or planned as part of the CSEs scientific programmes. The SSG asked that an inventory of these activities be developed and presented at the 1998 meeting, including information on when they are scheduled, specific objectives, parameters being measured, duration of measurements, instrumentation and possible opportunities for coordination/cooperation, etc.

To assess the impact of soil moisture variability on energy and water cycle processes at the hemispheric- to global-scale, the SGG concluded there was a need to explore the possibility of coordinating IOPs between the CSEs. Such cooperation appears essential for evaluation of soil moisture measurements from Earth observing platforms such as ENVISAT-1, EOS-AM1/-PM1 and ADEOS-II

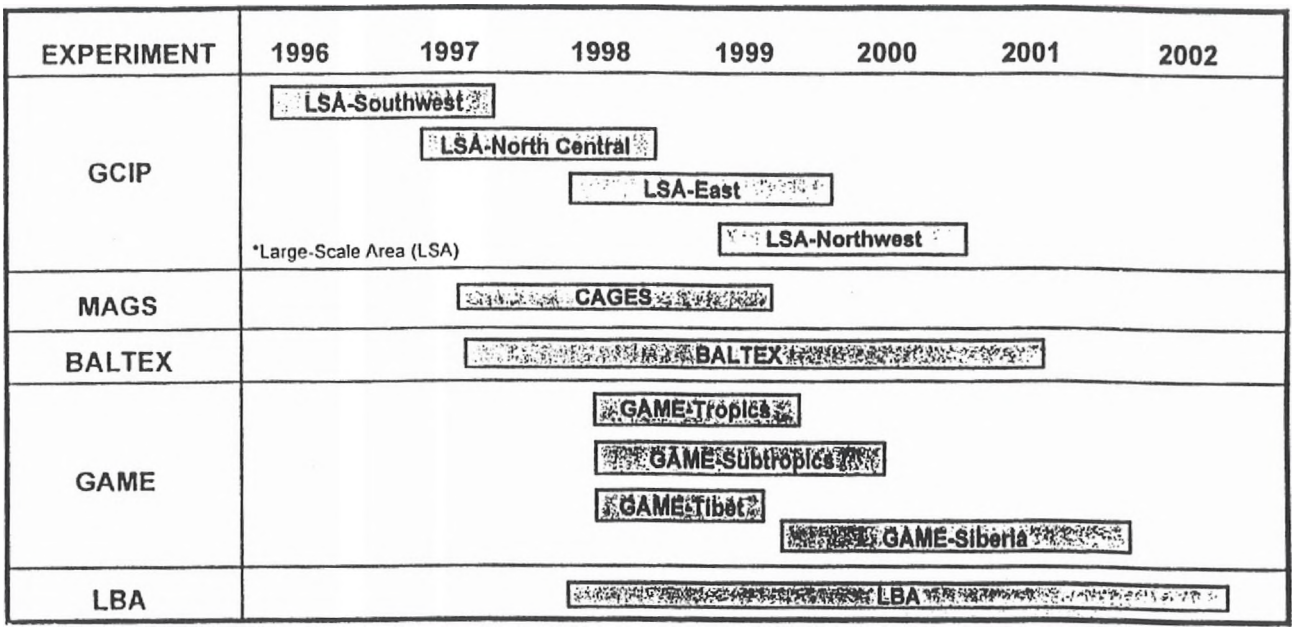

Figure 2. Enhanced observations schedule for GEWEX Continental-Scale Experiments (CSE)

all planned for launch in the 1998-2000 time period. Global-scale 4DDA will depend on results from such cooperative studies as well. The GHP was tasked to ensure that this coordination takes place. Drs Yasunari and Stewart as Chair and Co-Chair of GHP respectively for the 1997-1998 time period, were also asked to address a number of other gaps which were identified in the current CSE strategies for experimental field studies. They agreed to coordinate with the other CSE representatives, under the auspices of GHP, to form the links necessary to assess (a) coordinated process studies of the vertical structure of energy and water budgets, (b) systematic evaluation of orographic effects and the associated physical processes, (c) evaluation of biospheric processes and the enhancement of relevant measurements, (d) evaluation of using stable isotopes to trace water in hydrological studies. Reports of progress in each area will be made at the February 1998 SSG meeting.

7.6 GHP Co-operation with the international Association of Hydrological Sciences (IAHS)

The IAHS representatives report was given in the context of the ex-officio status of the IAHS in GHP. The SSG welcomed the review of the main conclusions and recommendations from the joint IAHS and Institute of Hydrology (IOH) workshop on the theme of "Continental-scale Hydrological Models: Charting the Future" held at the IOH in Wallingford, UK, in November 1996. The aim of the workshop, attended by 44 invited participants from 14 countries, was to enable scientists working in the GEWEX CSEs and related studies to share modelling expertise and compare experiences of different approaches in representing near-surface hydrological processes within atmospheric models. Each CSE was presented with particular emphasis on the coupled land-surface/meso-scale atmospheric modelling.

It was concluded that the workshop had provided an excellent opportunity to discuss relevant issues of large-scale hydrological and atmospheric modelling but that additional fora should be investigated to provide for the periodic exchange of ideas and experiences in this field. It was noted that the GHP meetings had been developing into opportunities for more intense working sessions for interaction of this type between the CSEs. The SSG recommended that consideration be given to arranging the next GHP meeting (September 1997) to allow for a day of work group discussions that, although reduced in scope, none-the-less, focus on one or more of the most relevant atmospheric and hydrological process components discussed at the workshop including precipitation, evapotranspiration,

flow generation, river routing and basin storage, and snow and ice. The SSG endorsed a plan for larger scale meetings similar to the Wallingford workshop to be held within the framework of the IUGG General Assemblies in the form of joint IAHS/IAMAS symposia or workshops. The GHP, IAHS representative was asked to make a proposal to the IAHS Bureau for holding such a meeting during the IUGG General Assembly in Birmingham, UK, in 1999.

7.7 Global Runoff Data Centre. (GRDC) and Global Precipitation Climatology Centre (GPCC)

The GRDC and GPCC provide essential contributions to the CSEs and representatives of these Centres have become ex officio members of the GHP. Although there has been a general agreement for these centres to take action to assist the CSEs in the assembly of global runoff and precipitation datasets the GHP raised concern that the linkages between CSEs and the two global data centres were not functioning as efficiently as they could. As a result an agreement of participation was developed between the GHP and the GRDC and GPCC. Therein the CSEs agreed to provide regional data sets or meta data, as required, on data sets (precipitation, runoff) to the Centres; to facilitate the acquisition of the data and the establishment of linkages with the regional/national data providers; and to document cases where use of streamflow data has had an impact on regional water resources studies. To compliment the actions the GRDC and GPCC will provide special analyses to the CSEs that relate to hydro-climatologies of the various CSEs, statistics showing the in-month variability of precipitation and runoff, and the application of gridded data sets.

The SSG endorsed the agreement and recommended that additional joint activities be undertaken which build on the informal linkages already established between GHP and the Centres. Examples of such efforts include the independent validation of GPCC/GPCP products, development of new methods for correcting precipitation (systematic measurement errors), and development of techniques for using streamflow data to calibrate precipitation measurements.

7.8 Selection of New Chair and Review of ISLSCP Role in GHP

Dr Piers Sellers tendered his resignation as chair of ISLSCP effective at the closing of Second International Scientific Conference on the Global Energy and Water Cycle, in June 1996. The SSG has agreed to the nomination of Dr Pavel Kabat, at the Windand Staring Centre for Integrated Land, Soil and water Research, Wageningen, The Netherlands, as the acting chair for one year in succession to Dr Sellers. Dr Kabat has accepted the Project Chairman task and will oversee ISLSCP as an element of GHP. Dr Kabat has agreed to provide the SSG with his views and advice on ISLSCP during the GHP portion of the February 1998 SSG meeting including a report on progress on the topics outlined below.

The primary role of the ISLSCP representative in GHP was reaffirmed to be the point of contact for international consultations on the planning, organization and scientific exploitation of land-surface process studies relevant to the CSE's. ISLSCP is also the advocate for the use of remote sensing data in the CSEs and must, therefore, assist in the development and management of regional and global data sets of relevant satellite data correlated with in situ measurements that offer consistent data formats spanning multiple studies and field experiments. In this context the SSG reaffirmed its endorsement of an, ISLSCP led, effort (Initiative II) to produce a 10 year (1986-1995) GEWEX multi-disciplinary land surface climatology dataset on a uniform 0.5° x 0.5° grid for release in 1997. ISLSCP is also required to continue to specify and support plans for appropriate ecosystem components as part of the CSEs.

The GEWEX Global Soil Wetness Climatology Project (GSWP) is continuing to advance with support from ISLSCP. A Project Design Document has been finalized and distributed. The model generated global fields for 1987-1988 have been archived at the Intercomparison Centre (ICC) at the Centre for Climate System Research, University of Tokyo. The Winand Staring Centre for Integrated Land, Soil and Water Research at Wageningen, The Netherlands, has taken the lead in the validation

process. Initial results from the ICC, validation and sensitivity studies will be presented at the American Meteorological Society (AMS) Conference on Hydrology and at a subsequent GSWP Workshop held in conjunction with the AMS meeting (6-7 February 1997, USA). A final project review will take place later in 1997.

The SSG endorsed plans by ISLSCP to review development of land surface process and soil-vegetation-atmosphere transfer (LSP-SVAT) models and their applications in hydrology by way of a workshop bringing together scientists active in PILPS, the Global Runoff Data Centre (GRDC), and the International Geosphere Biosphere Programme's (IGBP) core project on the Biological Aspects of the Hydrological Cycle (BAHC). One objective of the workshop will be to examine the different approaches used in LSP-SVAT submodels to represent aerodynamic transfer, radiative transfer, canopy biophysics, soil water/heat and snow/ice processes and runoff. The workshop has been scheduled for 10-14 February 1997 at the Scripps Institution of Oceanography, La Jolla, California, USA.

8. RADIATION

Since the Working Group on Radiative Fluxes (WGRF) has the responsibility for promoting research on climate-related radiation issues for GEWEX it is formally regarded as the GEWEX Radiation Panel (GRP). The JSC has agreed that the two groups should no longer be considered as functionally separate. The designation GRP has been adopted for future reporting.

8.1 Research Focus for. GRP

The GRP has agreed to assist GEWEX in addressing a specific scientific theme related to determining radiative fluxes and heating within the atmosphere and at the surface with the precision needed to predict transient climate variations and to move towards understanding natural and anthropogenically forced climate trends. The scientific milestones to be achieved are currently formulated as:

- Understand and determine net radiative fluxes in the atmosphere and at the Earth surfaces and the variation of the these fluxes to an accuracy of:

  $\Delta F \sim 20$ W/m^2 by the year 2000 to support improved weather forecasting (i.e., 1 day, mesoscale resolution),

  $\Delta F \sim 15$ W/m^2 by the year 2005 to support prediction of climate anomalies like ENSO (i.e., 5 day, 200 km resolution),

  $\Delta F \sim 5$ W/m^2 by the year 2010 to support prediction of climate change (i.e., monthly, 200 km resolution).

The Panel is continuing to review and refine this statement to correlate it with previous findings and ensure its consistency with recent strategies for future research and related plans for field experiments, instrument developments and missions. The effort is to integrate the Panels activities around the most pressing needs particularly in the area of improved observations. The areas of greatest concern are measurements at the boundary layer, within the atmosphere and at the surface that include: cloud and cloud vertical distribution (occurrence/properties); and values/profiles of temperature and moisture, aerosol properties, surface boundary conditions and water vapour.

There is a special need not only for the distribution (occurrence) of clouds but also for improved measurements of how much water exists in the cloud in liquid and solid form. This information coupled with knowledge about the cloud microphysics dictates how much radiation is absorbed and reflected as well as governing the interchange of substance between different phases.

8.2 Multi-sensor International Cloud/Radiation/Aerosol Mission

As an important step in obtaining improved observations the Panel has worked on the development of the concept of a mission dedicated to describing the global three dimensional (3-D) structure of clouds. The suite of instruments and measurements necessary to achieve this objective remains a notable gap in current approved space agency plans (see Item 2.3). An international consortium of investigators and agencies has developed an instrument package that meets the main scientific needs and have responded to a NASA announcement of opportunity for a satellite mission in its Earth Systems Science Pathfinder (ESSP) class. The instrument complement consists of active and passive systems. A millimeter-wave cloud profiling radar will probe clouds ranging from thin cirrus to optically thick stratus while the passive instruments will provide complementary information to determine microphysical properties and provide synoptic-scale information on cloud fields. An airborne version of the radar is already undergoing flight testing and preliminary results indicate their value in resolving the pertinent science issues. These tests indicate that it is possible to group data into classes of cloud systems with emphasis on layered clouds rather than on individual clouds (see Figure 3). This approach integrates well with the GEWEX Cloud Systems Study (GCSS) and can be easily linked to the cloud modelling activities of that group (see Item 6.4). Both ESA and NASDA are studying the feasibility of flying missions that could provide complimentary measurements to the one proposed in the USA. The SSG, therefore, endorsed plans for additional international workshops which will provide the opportunity to review the important science topics, instrument developments and mission opportunities in this field of research. The goal is to find the most appropriate and timely, internationally supported, options for these projects.

8.3 International Satellite Cloud Climatology Project (ISCCP)

The Group was informed of the status of the activities at the Global Processing Center (GPC) located at the NASA Goddard Institute for Space Studies (GISS) in New York, NY, USA, as well as progress at the Sector Processing Centres (SPCs) in Japan, Canada, Europe and the USA. ISCCP completed its 13th year of data collection on 30 June 1996. Radiances from all operating meteorological satellites, with the exception of INSAT, are being routinely collected by the cognizant Sector Processing Centres (SPC) and delivered to the GPC in accordance with project requirements. Currently operating satellites are NOAA-12, NOAA-14, GOES-8, GOES-9, GMS-5 and METEOSAT-5. The Satellite Calibration Center (SCC) in Lannion, France, provides periodic satellite-to-satellite radiance normalizations. Normalization data are complete up to January 1996.

Previously approved modifications to the ISCCP analysis procedures that were based on extensive validation studies have been incorporated into the processing scheme at the GPC. The resulting new (reanalysed) data products, called Stage D1 and D2, resemble the Stage Cl and C2 (cloud product) datasets but report more cloud types and more cloud type information.

The GPC, monitors the calibration of the polar orbiting radiometers (AVHRR) that serve as the reference standard for the radiance data. The GPC has also completed a re-evaluation of the normalizations of all the polar orbiters to the new reference satellite, NOAA-9, removing small artifacts in the previous analysis. The entire Stage B3 (30 km, 3 hr, reduced resolution radiance) dataset has been re-calibrated and a second version of the BT (calibration) dataset has been issued. Documentation of this new calibration was published and distributed in February 1996. Relative errors in calibration have now been reduced to less than 5 percent over the whole data record.

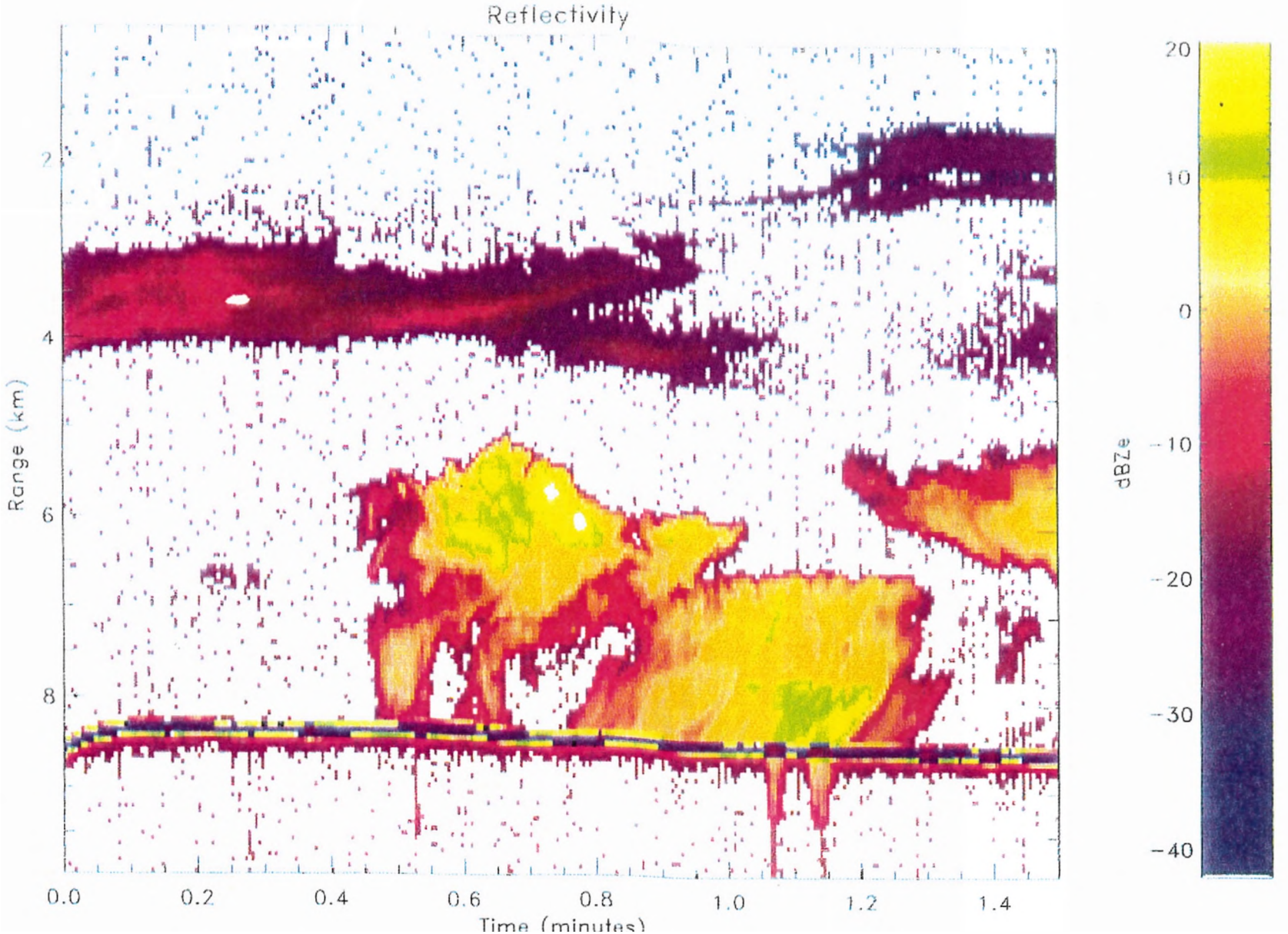

Figure 3. **Detailed view of reflectivity structure, covering minutes 6.5-8.0 of a 20 minute segment of reflectivity data acquired over a mountainous region in Alaska. The horizontal scale now corresponds to around 20 km. At right, 4 distinct cloud layers can be seen - cirrus at 1-2 km range, cirrus at 4 km range, middle level clouds at 6 km range, and cumulus at 7 km range. Mirror image return from precipitation can be seen just below the surface at time 1.1 minutes. (Data taken during the JPL/University of Massachussetts Airborne Cloud Radar, 12 June 1996 engineering flight).**

The pixel-level cloud analysis (DX) dataset will be archived at NASA Langley to support GEWEX Continental-scale Experiments (CSEs) and related process studies. This product represents areas about 4-7 km across, sampled at intervals of about 30 km every three hours. Sample subsets of DX have already been sent to representatives of a few of the CSEs, and DX datasets for **TOGA-COARE, FIRE** Cirrus 1 & 2, and FIRE Marine Stratus have been delivered to the respective archives. Archiving of the DX dataset and development of a capability for special processing of higher resolution datasets for limited areas and time periods has been provided in partial response to the requests for more detailed cloud information. All of these datasets and other related information and documentation including published papers based on or related to ISCCP products are available on the **ISCCP** World Wide Web Home Page on the Internet at **<http://isccp.giss.nasa.gov> .** All **ISCCP** related material can be viewed and downloaded from this location. Data sets which the ISCCP Central Archive receives from the GPC and which are currently available are the following:

Stage B3 and BT:	July 1983 - June 1994
Atmospheric Correlative data:	July 1983 — December 1995
Sea ice and snow data:	July 1983 — December 1994
Stage C1 and C2:	July 1983 - June 1991
Stage DX, D1 and D2:	January 1986 -- December 1986
	January 1990 - December 1993

Future plans will follow the recommendations of an international scientific workshop held in April 1996 to review research being done with ISCCP datasets. 50 scientists from 10 countries presented a total of 46 papers. The enhancements suggested include improved detection and identification of specific cloud types, measurement of effective particle sizes for both liquid and ice clouds, measurement of cloud liquid water path and estimates of cloud ice water path and improved determination of cloud properties at night and in the polar regions. Possible datasets that will be used for these analyses include the extra AVHRR spectral channels, microwave radiances from the SSM/I instrument, and IR radiances from the HIRS/2 sounder. Software revisions have been started to transfer the ISCCP processing system to a workstation-based system. Transition to the new system should be completed in 1997. The new system will be used to process new data (beyond 1993) more efficiently and provide for the incorporation of proposed enhancements.

The SSG endorsed decisions taken at the July 1996 meeting of the WGDM for WCRP Radiation Projects to interact with space agencies to ensure consistency and continuity of the ISCCP data set up to the end of the decade. The Project Manager and the Director of the WCRP agreed to assist with correspondence related to strategies for spacecraft coverage and data collection schemes in support of ISCCP. Particular items to be addressed include the NOAA-K "launch-on-failure" strategy, plans for the switching of the 1.6 and 3.7 μm channels on NOAA-L and -M, modified "eclipse" operations with the new GOES (8, 9) to reduce systematic biases introduced in the ISCCP data and possible repositioning of spacecraft by EUMETSAT to reduce gaps in the ISCCP global cloud and radiation products. Letters covering the main points of these issues have been drafted for review and action in 1997.

8.4 Surface Radiation Budget

The SSG recalled that the first (Version 1.1) data set of WCRP/SRB global fields of surface radiation Shortwave fluxes (SW) and related parameters for the period March 1985-December 1988 had been available to the scientific community since October 1993. During 1996 the number of registered users of this dataset increased from 478 to 610 from several scientific disciplines and from other fields outside the originally targeted climate research community. The SSG endorsed continued analyses by the Satellite Data Analysis Center (SDAC) at the NASA Langley Research Center to improve this product by reducing errors over snow and other bright surfaces, explaining differences in some surface albedo values, adjusting for errors found in some regions during dry seasons, adding a LW product and

investigating other enhancements prior to production of a Version 2 (10-12 year), GEWEX/SRB, climatology covering the period from July 1983 up to mid-1995 or beyond.

Analyses of LW algorithms included development and validation of previously approved GEWEX experimental and quality-check LW methods. Comparison of results with Baseline Surface Radiation Network (BSRN) site data indicates that both LW algorithms have average biases of 5 W/m^2 or less, well below the GEWEX accuracy specification of 20 W/m^2. Development of a new experimental GEWEX LW formulation was initiated in order to respond to the recent GEWEX requirement for both surface and top of the atmosphere (TOA) values. It is desirable that this method also be consistent with the NASA EOS, Clouds and Earth's Radiant Energy System (CERES) instrument data scheme and joint collaborations are underway to ensure this compatibility. The LW experimental GEWEX algorithm (Gupta, 1989; Gupta, et al., 1992) is the new LW quality-check method and is the surface-only EOS/CERES LW algorithm.

With respect to the SW analyses, additional research was accomplished on the issue of biases due to biomass burning aerosol. The aerosols in the biomass burning regions were found to be the principle cause of the large errors in the SW results. Seasonal aerosol errors were also found in other regions. Aerosol corrections have been initiated using clear-sky SW flux estimates for all 12 months of 1986 derived from a synthesis of ground measurements and ISCCP cloud fraction data. Results from applying these data to both the GEWEX SW algorithms over Africa suggest that the correlation coefficient between all-sky satellite-derived and ground-measured data improves from 0.5 (uncorrected) to 0.85 (aerosol corrections only). As part of this effort a collection of TOMS smoke/dust plume patterns over the globe and fire maps and computation of smoke-only plumes over Africa were completed for 1986. The SSG acknowledged the work accomplished by the SDAC and the LW and SW algorithm teams which produced these results.

Near term plans were endorsed for completing the new GEWEX LW algorithm development by March 1997. Production testing of both the LW and uncorrected SW algorithms will begin at that time. Seasonal aerosol corrections will be applied to other continents and distributed to cells without ground sites in accordance with TOMS smoke/dust plume data, smoke-only plume calculations, winds and surface characteristics for 1986. The SW ground-site data set will be analyzed for 12-year trends over all continents to assess validity of 1986 SW assumptions for other years. The overall strategy for the SW product that was recommended is to move ahead with production of a Version 2 dataset of solar radiation parameters (surface/TOA) over all regions of the globe for the specified period (July 1983 - June 1995). Research should be continued on aerosol associated errors (e.g. biomass burning) and an initial assessment of those errors provided as part of the delivery package. The recommendation for the LW project is to continue the NASA supported pilot study related to evaluation of the existing experimental algorithm including the provision for providing an outgoing longwave radiation value as well as a diagnostic surface radiation flux. The data and procedures from this evaluation process including the latest validation parameters from the BSRN are to be expanded and organized into a generalized longwave algorithm intercomparison dataset. An international algorithm intercomparison workshop will be organized to evaluate the GEWEX longwave algorithm pilot study results with the performance of competing approaches. The workshop will result in the final selection of a GEWEX LW algorithm with which processing for the period July 1983 - June 1995 can be started before the end of 1997.

8.5 Baseline Surface Radiation Network (BSRN)

The BSRN remains a major component of the global surface radiation measurement capability. Data are now being forwarded to the BSRN World Radiation Monitoring Centre at the Swiss Federal Institute of Technology (ETH) from fourteen BSRN stations with 6 to 8 more stations actively collecting and preparing data for archival. These stations are expected to be on line in the next few months. Current activities have been related to issues and concerns for improving the network including a review

of the instrument complements and geographic distribution of stations, more timely submission of data to the archive by all stations, more simplified access to the data by the user community, access to correlative non-radiative data and the addition of ancillary measurements at the sites. Recent accomplishments include having the data archive become fully operational; adding aerosol optical depth, cloud base, UV-B and PAR measurements at some sites; development of strategies for improving quality control of the data including site audits; upgrading to fully operational status several sites initially set up as evaluation/demonstration sites; and reviewing the scientific basis for establishment of a station to evaluate the extent to which practical considerations are playing a role in the geographic locations and instrument complements. The SSG urged the continued support by the international community to provide a more complete global distribution of BSRN sites particularly expansion into currently data sparse regions. Efforts in this respect were acknowledged especially recent instrument purchases and shipment for the Amazon site (Balbina), international funding for establishment of a new site in South Africa and updates to several other sites world wide. Support of such activities will ensure that the BSRN will become an important tool in improving knowledge of the global surface radiation budget and its determination via satellite observations.

8.6 Earth Radiation Budget

An update on the CERES was provided. The Instrument has been fully integrated on the TRMM spacecraft. Work has moved ahead in all areas where the instrument is expected to advance understanding of the climate system including broadband radiometry, cloud and radiation remote sensing, and climate modelling. The system meets all of the TRMM performance requirements and is being tested to ensure its compatibility with the large earth observing platform environment. The SSG will want to stay informed of further testing and integration of CERES on TRMM especially in the areas of flight qualification tests, validation plans and algorithm testing. The SSG endorsed plans for an overlap between the viewing times of TRMM and the Scanner for Radiation Budget (ScaRaB) instrument in order to allow for possible improved accuracy of TOA fluxes prior to launch of the larger earth observing mission instrument packages later in the decade. The Group also acknowledged efforts which may lead to deployment of two CERES scanners on a USA/Japan TRMM follow-on mission, as well as possible use on the USA National Polar Orbiting Environmental Satellite System (NPOESS) starting in 2007. Additional information on the project can be obtained from the CERES experiment home page site **< http://asd-www.larc.nasa.gov/ceres/ASDceres.html >.**

The SSG was informed that ERBS and NOAA-9 ERBE non-scanners continue to operate. The NOAA-10 non-scanner is functional but because that spacecraft is not being operationally supported by NOAA no data are being collected. Research was described which has resulted in a new method for simultaneous intercomparison of the ERBS, NOAA-9, and NOAA-10 radiance measurements at "simultaneous" satellite orbit crossings. The method uses carefully matched nadir data over a period of 2 years of orbital crossings which occurred within 10 minutes. Initial results indicate a potential for intercalibration to 0.5% or better and may, thereby, be useful in intercomparison of the ScaRaB and CERES observations planned for 1998.

8.7 GEWEX Water Vapour Project (GVaP)

A summary of the results of the International Workshop on the GEWEX Water Vapour Project (GVaP) was presented. The workshop, which was co-hosted by WCRP with the NOAA and NASA, took place at the World Meteorological Organization (WMO) offices, in Geneva, Switzerland from 12 to 15 November 1996.

The main goals of the Workshop were to characterise the most compelling science issues confronting GEWEX and the other WCRP programmes that involve the role of water vapour, to identify all of the existing and planned national/international endeavours in the field and to develop a strategic plan for further development of GVaP. The participants addressed these issues in the context of the current state of knowledge in the observation and analysis of water vapour and its impact on the Earth's weather and climate and incorporated them into a resolution for consideration by the SSG.

THE PARTICIPANTS,

Considering:

(1) The importance to society of improving prediction of weather and climate,

(2) That water vapour is the principal greenhouse gas,

(3) That water vapour is a key component of both the energy and water cycles and, therefore, is critical to the biosphere,

(4) That the variability of water vapour on a variety of time- and space-scales remains poorly known,

(5) That the understanding of water vapour and its influence on the energy and water cycles can be improved

Urges GEWEX to:

(a) Incorporate understanding and predicting water vapour variability, forcing and feedback in the Earth's weather and climate into the goals of GVaP,

(b) Incorporate improving predictions of (i) weather, (ii) seasonal and interannual climate variability, and (iii) long term climate changes, into the objectives of GVaP,

(c) Ensure these objectives are met by assigning GVaP the responsibility,

To improve the models and related tools that predict global and regional climate and hydrology including (long term) variations in extreme hydrological events (floods and droughts),

To establish an accurate and validated water vapour climatology on the relevant time and space scales,

To identify the horizontal and vertical fluxes of water vapour and the processes that control those fluxes and the associated phase changes of atmospheric water.

The SSG concurred with the resolution, accepted the main conclusions of the Workshop and approved the nomination of Professor Tom Vonder Haar to be the Research Project Manager of the next phase of GVaP which is planned to extend over the period 1997-2003. Professor Vonder Haar agreed to organize and direct the activities of an international GVaP Working Group on Science and Data (WGSD) which will develop a detailed implementation plan, expand on cooperative initiatives with other WCRP/GEWEX projects and secure the international commitments necessary to move GVaP beyond its original pilot effort. The GVaP WGSD will be an integral element of the functions overseen by the GEWEX Radiation Panel, on behalf of the GEWEX-SSG, that have been designed to respond to the overall goals of WCRP.

Following a broader review, the Workshop draft report, will be released in final form as part of the WCRP report series. Invitations to participate in the GVaP WGSD will be made by the Research Project Manager in consultation with the Chair of the GEWEX-SSG. Notification of the time and place of the first meeting of the Working Group will be made by the Joint Planning Staff for WCRP on behalf of the Research Project Manager.

8.8 GEWEX Aerosol Studies

Under the auspices of the GRP. work has progressed on developing a GEWEX Aerosol Climatology Project (GACP) that utilizes remotely sensed dataset(s) augmented with surface observations

and ground validation sites. A draft action plan for the assembly and critical assessment of a global set (over land and ocean) of information on the geographical distribution and seasonal (or better temporal resolution) variability of aerosol optical properties for the purposes of understanding aerosol radiative impact on current climate and to support satellite remote sensing was endorsed and Dr R. Curran, with NASA Headquarters, was confirmed as the leader of an *ad hoc* group which will be organized to promote the development of the proposal and report further advancement toward its accomplishment by way of the GRP presentation at the next SSG meeting. The goal is to have an initial global climatology to provide timely input to studies of aerosol radiative forcing, including "first guess" corrections for satellite borne earth surface observations planned for later in the decade (such as those from EOS-AM1 in 1998).

Findings from two important workshops support the decision to proceed with GACP at this time. A workshop co-sponsored by WCRP took place from 30 October to 2 November 1995 in Columbia, Maryland, USA. Although this workshop focused primarily on aerosol research in the USA, a National Academy of Sciences (NAS) strategy for an Interagency Climate-Aerosol Radiative Uncertainties and Sensitivities (ICARUS) Programme, which was initiated at the meeting, calls for close co-ordination with similar efforts in the national and international communities. The section on aerosols contained in the NASA Science Research Plan that responds to the NAS ICARUS initiative is the basis for a NASA research announcement (NRA) for proposals to address the effects of aerosols on the global environment that is expected to be released in 1997. The SSG was encouraged that this plan provides the framework within which to organize an international project to meet GEWEX needs for an aerosol climatology.

An Aerosol Remote Sensing Workshop (15-19 April 1996, Washington, DC) undertook a review of retrieval techniques to be applied to future satellite-borne instruments (MODIS, MISR, SeaWiFS, OCTS, MERIS, and others) as well as schemes currently applied to conventional systems such as the AVHRR. The SSG was informed about a two channel retrieval technique that had been applied to AVHRR data to derive aerosol optical thickness. The results presented by Dr T. Nakajima, from the University of Tokyo, were found to retrieve optical thickness and size distribution parameters with good accuracy when correlated with validation data from the NASA Aerosol Robotic Network (AERONET) over dark land surfaces. It was concluded that aerosol absorption and non-spherical scattering cannot be ignored and has to be assumed properly to obtain other aerosol parameters. Some techniques to obtain single scattering albedo were also presented at the workshop while other studies indicated that a reasonable scattering phase function can also be constructed for retrieval of aerosols from remote sensing data. A complete report of the Workshop findings will be published in a special issue of the Journal for Geophysical Research (JGR).

The GEWEX aerosol initiative will be closely co-ordinated with other relevant aerosol research activities including the Brazil component of NASA's Smoke, Cloud, Atmosphere, Radiation Programme, (SCAR-B) which completed a successful Intensive Field Observation (IFO) phase during the period from 15 August to 22 September 1995; the Tropospheric Aerosol Radiative Forcing Observational Experiment (TARFOX) which had an IFO from 10-31 July 1996; the single channel AVHRR optical thickness products being produced operationally by NOAA; the aerosol focus within the International Global Atmospheric Chemistry (IGAC) Project including especially the Direct Aerosol Radiative Forcing (DARF) project and the new Focus on Atmospheric Aerosols (FAA) initiative which has been designed to evaluate the radiative forcing due to aerosols; and the Sulphate Aerosol Radiative Forcing Intercomparison Project (led by Dr S. Schwartz of the USA Brookhaven National Laboratories).

8.9 Global Precipitation Climatology Project (GPCP)

The GPCP Manager highlighted the Project's most important near term goals including:

(i) Extend forward in time the 7.5 year (July 1987 - December 1994) merged 2.5°x 2.5° gridded global monthly mean precipitation climatology data set released through the World Data Center-A (WDC-A) in early May 1996.

(ii) Incorporate reduced gauge data for 25,000-30,000 stations into the merged data set (for at least a 5 year period) by increments as soon as they are available from the Global Precipitation Climatology Centre (GPCC), in Offenbach, Germany.

(iii) Select a model re-analysis precipitation product for possible use in the merged data product at high latitudes where other data collection and analysis schemes are ineffective.

(iv) Continue collection of satellite data beyond 1995, at the same level as currently exists, and plan for higher spatial and temporal resolution to address user requirements such as ISLSCP, TRMM, CLIVAR-GOALS and others.

(v) Extend rainfall estimates back in time by applying GPI to AVHRR Pathfinder data and exploring the possibility of using other datasets.

(vi) Plan for evaluation of the newly released GPCP global dataset feedback from the user community and results in a list of potential enhancements to be made in a second phase of the project to begin later in the decade.

An analysis procedure has been developed that successfully blends gauge and infrared and microwave satellite estimates of precipitation to produce a monthly mean 2.5° latitude/longitude gridded precipitation analysis. The monthly precipitation estimates and associated error estimates (totalling 19 products altogether) for 8.5 years (July 1987 - December 1995) are available through the WDC-A at Asheville, North Carolina, USA, either directly or by electronic transfer at **< http://www.ncdc.noaa.gOv/wdcamet.html#GPCP>.**

Preliminary time series analyses have shown that these data are capable of defining the seasonal and interannual variability of the precipitation field. The zonal average precipitation in the tropics shows a well defined annual cycle; precipitation maxima occurring in the summer months of each hemisphere and minima in the winter months. The intensity is however, larger in the Northern Hemisphere (NH) than in the Southern Hemisphere (SH), a consequence of the summer monsoon circulation and the tendency for the ITCZ over the oceans to remain north of the equator. The range of the annual cycle variation in the tropics (20°N-20°S) is about 8 mm/day. In the mid-latitudes centered near 40°N and 40°S there is a well defined but weaker annual cycle (range about 1-2 mm/day) with winter season maxima, that is apparently associated with variations in storm track precipitation. And over continental areas of the NH there is a well defined annual cycle with winter minima and summer maxima.

Requirements for specialized GPCP data products exist in conjunction with the regional GEWEX continental scale experiments (GCIP-Mississippi River basin, BALTEX-Baltic Sea catchment, MAGS-Mackenzie River basin, LBA-Amazonia, and GAME-Asian Monsoon region) and perhaps other regional experiments, as well as globally. The SSG, therefore, endorsed the GPCP pilot study, that will allow evaluation of a higher temporally and spatially sampled GPCP global precipitation product. The data processing center representatives for EUMETSAT, GMS and GOES have begun to produce 1° histograms at 3 hourly intervals, daily. A quantitative evaluation of this 3 hourly, daily product, presented on a 1° x 1° spatial scale will be accomplished in 1997.

Other research activities being undertaken by GPCP to improve the accuracy and usefulness of its rainfall estimates include temporal and spatial analyses of rainfall data, new and enhanced algorithms that provide identification of rain type, and investigations into the extension of the data back in time. The SSG felt that a particularly promising algorithm activity is the use of neural network techniques applied to monthly mean ISCCP data to estimate monthly average rainfall. A successful application of this process will allow extension of global rainfall estimates back in time to 1983, of 3 hourly resolution data.

8.10 Reanalyses Products

One improvement proposed for the GPCP dataset, as well as for other GEWEX climatology data projects, is to fill gaps in the existing global data record by using appropriate (gridded precipitation) products from the reanalyses being carried out at various centres. The SSG agreed that this would be an acceptable means of providing a complete global product but that documentation would be necessary to ensure users understood that such data were incorporated in the blending scheme and exactly how and where it appears in the dataset. In addition, an all-observation data product would always be required and be distinctively labelled to certify its independence from the results which contain the reanalysis fields.

In this context, plans are already in place for a WCRP Working Group on Numerical Experimentation (WGNE) conference to evaluate the results of the reanalyses, and to demonstrate clearly the progress achieved. The meeting to be held in Washington, DC, USA, from 27-31 October 1997 will be fully interdisciplinary and will aim to cover atmospheric, hydrological and oceanographic interests. A particular focus will be the validation of the reanalyses results against the range of GEWEX global climatological datasets. Procedures for obtaining reanalysis data, by the Internet, are currently being standardized for distribution in the announcements for the conference. The IGPO is assisting with preparation of this material and has agreed to facilitate coordination between WGNE, the reanalysis centres and the GEWEX data projects (i.e., GPCP, ISCCP, SRB, GVaP) to encourage intercomparisons in support of the conference objectives. The SSG recommended that the Project Managers of the GEWEX climatological data projects begin requesting the reanalysis data, as soon as possible, for study within the framework being established for the conference but to delay incorporating reanalysis products into their data processing schemes until the results of the reanalysis product intercomparison exercise are known.

9. MODELLING AND PREDICTION

The principal research task of the modelling and prediction focus in GEWEX is to exploit the scientific insight from GEWEX global data sets to develop accurate model formulations of both the water budget and transport, and the energy budget and radiative transfer in the climate system, and to extend predictions of the variability of these components of the global climate system. In the framework of the current organization, the GEWEX Modelling and Prediction Panel (GMPP) will, therefore, develop, evaluate and integrate improved interactive model formulations of the land-surface and atmospheric processes that regulate the global hydrologic and energy cycle. This task is designed to contribute to the broad WCRP goal to develop models capable of simulating the climate system and predicting climate variations on a wide range of space- and time-scales. As part of GEWEX, GMPP will be required to produce and demonstrate improved extended predictions of the principle components of the global energy and hydrologic cycle (precipitation, water storage, runoff and others) as an element of seasonal-to-interannual climate predictability and provide validation and accurate computation of the radiation budget and fluxes, as part of decadel-to-centennial climate variability and response to changes in external parameters.

Recent events were considered by the SSG in the decision to realign the functions and tasks under the supervision of the GMPP. The desire expressed by Dr E. Kalnay to step down from the chairmanship of the GEWEX Numerical Experimentation Panel (GNEP), increased cooperative dialogue with the CAS/JSC Working Group on Numerical Experimentation (WGNE) and enhanced capability within the GEWEX Continental-scale atmospheric/hydrologic Experiments (CSE's) to develop hydrological data assimilation systems and promote the development of basin/catchment scale hydrologic models, were factors in the decision to dissolve GNEP. Dr Kalnay's request to stand down was acknowledged and special note was made of her exceptional service to WCRP/GEWEX in advancing the development of interactive model formulations of the key factors regulating the global energy and water cycle. GNEP was suspended in favor of focused task assignments under GMPP and GHP. In specific, GMPP will:

- Guide the development of improved cloud and land-surface parameterizations schemes and ensure their successful integration into GCM's in support of enhanced weather and climate predictions at all time scales,

- Produce and evaluate improved longer term predictions of the key elements of the global energy and water cycle as an element of seasonal-to-interannual climate predictability,

- Provide validation and accurate computation of the radiation budget and fluxes, as part of decadel-to-centennial climate variability and response to changes in external parameters,

- Oversee and coordinate the activities of the GEWEX Cloud System Study (GCSS) and the Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS)

The SSG is accepting nominations for the chair of GMPP. Drs M. Miller at ECMWF and L. Dumenil at the Max Planck Institute have been proposed as Research Project Chairs for the Cloud Parameterization/GCM Integration and the Land-Surface Parameterization/GCM Integration tasks respectively. Dr K. Browning has now been succeeded as Chairman of the GEWEX Cloud System Study (GCSS) by Dr D. Randall, at Colorado State University and Dr A. Henderson-Sellers is continuing as Manager of the Project for Intercomparison of Land-Surface Parameterization Schemes (PILPS). It is expected that additional members of GMPP will come from the members and participants previously involved in relevant GNEP activities possibly including Drs E. Kalnay, A. Betts, N. Sato, K. Mitchell, M. Fennessy, and others. The terms of reference for the Land-Surface and Cloud Parameterization tasks will be explicitly defined to reflect the coordination required in the evaluation/integration in GCM's of improved parameterizations being developed within GCSS and PILPS. GMPP will oversee this collaboration.

In representing a comprehensive GEWEX modelling and prediction thrust GMPP will facilitate co-operation with other elements of WCRP/GEWEX in particular GRP, GHP and WGNE. In this regard, GMPP will encourage consultations between GCSS and GRP in the area of cloud resolving model development. Analyses of data from the airborne version of the cloud radar system being developed under the auspices of the GRP can easily be linked with the cloud modelling activities of GCSS. GMPP will be required to consult with GHP which has responsibility for coordination of the GEWEX hydrologic model development activities and promotion of interactive hydrological-atmospheric modelling/prediction. Following the recommendation of the JSC, GMPP will also seek support of the WGNE. The main area of co-operation needed between WGNE and GEWEX is in investigating the physics of the sub-grid scale/boundary layer processes to develop more accurate parameterizations. Links with WGNE will further allow closer co-operation between WCRP/GEWEX and emerging developments within the WMO Commission on Atmospheric Sciences (CAS) of relevance to WGNE, including the initiative for a World Weather Research Programme (WWRP) that is interested in issues at all timescales associated with weather prediction.

At the general meeting, an alternative possibility for organization of the GEWEX modelling and prediction activities was discussed which would require the formal designation of WGNE as the GEWEX Modelling and Prediction Panel. This plan would require WGNE's acceptance to become an integral part of GEWEX and to carry out its functions under the auspices of the GEWEX-SSG. Tasks for which WGNE is responsible to CAS would initially be excepted from review by the SSG but opportunities would be sought for convergence of the interests between GEWEX and CAS in this field to an extent which would enable WGNE to functionally become GMPP. In the ensuing executive session, the SSG determined that this strategy should not be pursued at a time when consideration is being given to the overall structure of WCRP modelling activities in which WGNE may be required to play a role that is largely distinct from that of GMPP's. It was, therefore, agreed that informal interactions through the appropriate involvement of members in both relevant GEWEX and WGNE activities could well be an effective means of achieving the desired objectives, for instance in dealing with land-surface processes and hydrology, and with the representation of clouds and boundary layer processes.

The first meeting of the GMPP is expected to be held in conjunction with the WGNE meeting during the week of 3 November 1997 in Washington, DC, USA, following the WGNE reanalysis conference to be held the previous week. The JPS for WCRP and the International GEWEX Project Office will assist the new GMPP Chair in development of the agenda and logistics material for the meeting and with the drafting and distribution of the meeting report.

9.1 Working Group on Numerical Experimentation

In consideration of developing closer interactions with WGNE the SSG invited Dr D. Williamson, Chairman of WGNE, to describe activities related to (atmospheric) climate modelling being undertaken by the group which have an impact on GEWEX objectives.

In general GEWEX (and the climate research community in general) depend on WGNE for development and improvement of atmospheric GCM's and their application in a range of investigations from numerical weather prediction to predictions of climate or global change. The Atmospheric Model Intercomparison Project (AMIP) has been particularly effective in advancing this area of research. The **SSG** was informed that this study of simulations by 30 different atmospheric models under specified conditions of the same ten-year period 1979-1988 had identified a number of systematic model deficiencies. The need for more comprehensive reliable observational data sets and refined methods of diagnosis also became evident. A follow-on project "AMIP-II" has been defined and is being implemented. Simulations will be delivered before the end of 1997 and progress can be tracked by way of the AMIP home page on the Internet at URL **<http://www-pcmdi.llnl.gov/amiphome.html> .**

WGNE reviews the status of many questions related to the behaviour and development of the atmospheric models used in climate simulations and in numerical weather prediction, as well as progress in data assimilation at the main operational centres. Some specific activities required to support WCRP/GEWEX were discussed, including the WGNE promotion of further experimentation by NWP groups using current models with specified sea surface, sea ice, soil moisture, etc. Other WGNE initiatives that would enhance GEWEX analyses had been reviewed at the 1996 WGNE meeting. The SSG concurred on the importance of three of those issues that encompass further refinement of estimates of surface fields and fluxes; explicit prediction of cloud water and ice particle size and density in cloud parameterization schemes; and determination of the three-dimensional distribution of atmospheric heating and vertical stability of the troposphere and the dependence on parameterizations of mesoscale convective, radiative and boundary layer processes as well on the large-scale dynamics. The SSG endorsed plans for a joint WGNE and GCSS workshop which is related to testing of physical

parameterizations in single column and cloud resolving (SCM/CRM) models independent of interactive dynamics. Data from the DOE/ARM field programme, operational forecasts and reanalysis fields from ECMWF and other operational centres and GCSS cloud ensemble model results will be part of the experiment package being readied for the workshop which is expected to take place in 1998.

9.2 GEWEX Numerical Experimentation Panel (GNEP)

A final report on projects undertaken by GNEP in support of GEWEX modelling and prediction activities was submitted by Dr E. Kalnay. With the activation of the GMPP and the connection of the GNEP studies with other GEWEX projects, the SSG stipulated that the work begun by GNEP be merged with on-going tasks under the direction of GHP (especially ISLSCP data initiatives and specific CSE activities in hydrologic modelling), or otherwise be carried forward without disruption as part of the GMPP responsibilities for oversight of PILPS, GCSS and GEWEX land-surface and cloud parameterization formulation exercises.

GNEP undertook to co-ordinate comparisons of global data assimilation products, free running global climate models, nested model schemes and land-surface hydrological models.

As part of its work in the area of land-surface data assimilation, GNEP, through the National Center for Environmental Prediction (NCEP), contributed to the ISLSCP Initiative-I dataset and the GEWEX/ISLSCP Global Soil Wetness Project. Estimated 6 hourly accumulated precipitation for the years 1987-88 from the NCEP reanalysis has been provided in order to scale the GPCP monthly observed fields for the ISLSCP CD-ROM. GMPP will ensure that this effort advances in support of the ISLSCP Initiative-II project and that comparisons of soil moisture initializations are provided as part of the soil wetness activity. Cooperation with GCIP will also continue in efforts to improve its data assimilation capability by assisting with the development of a detailed land-surface data assimilation system for the ETA model that includes observed clouds, radiation, high resolution precipitation, etc.

Several comparisons at continental-scales of various quantities of primary concern in land surface process studies have begun. Three centres (NCEP, ECMWF, NASA/GSFC), which are performing long reanalyses, together with JMA have agreed to participate in this exercise. The SSG recommended that GMPP continue the co-operation GNEP began with WGNE in the consideration of such intercomparisons for the conference being planned to evaluate the results of the reanalyses in October 1997.

The GNEP proposal to prepare simulations of the 1988 and 1993 summers using regional models derived by boundary conditions from the reanalyses was subsequently adopted by the Project to Intercompare Regional Climate Simulations (PIRCS). The reanalysis data from the 1988 and 1993 summers has already been provided to PIRCS. Preliminary results of several simulations were presented at a PIRCS workshop in December 1996. The outcomes reflected a significant sensitivity to the size of the regional domain used and highlighted the importance of smoothing the topography of the imbedded regional model near the lateral boundaries in order to prevent it from departing significantly from the coarser "parent" reanalysis global model. The workshop intercomparison results were considered to be encouraging with respect to other models which use only boundary information and remained reasonably close to the reanalysis. The SSG will want GMPP to follow these studies in conjunction with WGNE to consider their impact on both climate simulation/climate change impact assessment and on actual seasonal forecasting.

GMPP will also be required to continue monitoring GNEP initiated projects for performing GCM sensitivity experiments for 1988 and 1993 to explore to what extent drought and flood conditions could be predicted on time scales of one to three months and the impact of the initial soil moisture. The Centre for Ocean-Land-Atmosphere Interactions (COLA), together with the National Center for Atmospheric Research (NCAR) and NCEP are implementing one such study and another is being coordinated by

ECMWF with the UK Meteorology Office (UKMO). The impacts of alternate initial soil moisture conditions and land surface hydrological parameters are of greatest interest to GEWEX. Co-operation with other programmes such as CLIVAR is also important in order to examine other parameters such as global sea surface temperature.

GNEP had been co-operating with PILPS (see Item 6.3) on a number of studies which were related to the comparison of coupled hydrological models including the regional calibration of LSP models. GMPP will maintain oversight of these activities to ensure their results are considered in GEWEX model developments and numerical experimentation studies. WGNE has assisted the GEWEX-SSG in guiding the development of PILPS and will be asked to work with GMPP to continue the development of joint exercises in the PILPS framework.

9.3 Project for Intercomparison of Land Surface Parametrization Schemes (PILPS)

PILPS is organized by the Climate Impacts Centre, Macquarie University, Sydney, Australia and reports to the SSG as a part of the GEWEX modelling and prediction focus. The primary goal of PILPS is to achieve greater understanding of the capabilities of land surface schemes in atmospheric models. The Project is into its second and third phases which are designed to exploit observational data and to review the performance of land-surface schemes when coupled to their host models, and in particular, to understand the large differences found in Phase 1 (equilibrium off-line simulations with artificial forcing data).

Of particular interest to the SSG were findings related to the PILPS 2c study which represented the first PILPS analysis over a large horizontal domain and the first to include hydrological calibration and validation. Common conditions incorporating observed streamflow, river routing and river flow data at 1 degree for 10 years (1980-1989) over the entire Arkansas-Red River Basin were used in a number of participating LSP formulations. Preliminary results and diagnoses were presented at a PILPS 2c Workshop in October 1996. The initial findings demonstrated that good simulations of observed river flow can be obtained by "hydrological calibration" over a limited number of small basins where only a few parameters are adjusted and the calibrated parameters are extrapolated over a very large basin. These results and similar GSWP outcomes are consistent with studies of earlier PILPS results that have shown that the large spread in the dynamic range of soil moisture obtained from the LSP's can be explained by the direct interplay among a very few model parameters such as wilting point, field capacity, soil depth and surface runoff "coefficient" dependence on soil moisture. The conclusion being drawn from these studies is that a given LSP (in an coupled model or land-surface data assimilation scheme) cannot, in the absolute sense, be initialized using the soil moisture derived from another LSP. The implication that each LSP must convert its absolute soil moisture into a soil moisture fraction relative to its own dynamic soil moisture range and that such fields may show potential of being transferable is a factor that must be considered in studies which apply or develop soil moisture climatologies (including the Reanalysis).

In Phase 3, the performance of schemes in their host models is being assessed in an AMIP diagnostic sub-project and in Phase 4, selected land-surface schemes will be coupled to certain host atmospheric models.

9.4 GEWEX Cloud System Study (GCSS)

Dr K. Browning tendered his resignation as chair of GCSS effective at the closing of the December 1996 GCSS Science Panel meeting. The SSG has agreed to the nomination of Dr D. Randall to replace Dr Browning as chair of GCSS. Dr Browning's exceptional service to GEWEX and the broader WCRP research community in guiding GCSS from its inception was acknowledge by the SSG.

The objective of GCSS remains the development of refined parameterizations of cloud systems within GCMs (climate and numerical weather prediction models) through the improvement of the understanding of the coupled physical processes within different types of cloud systems. The emphasis continues to be on determining the effect of clouds acting as systems.

Each one of the four working groups associated with analyses of boundary layer, cirrus, extra-tropical layer and precipitating convective cloud types respectively has been making progress in mobilizing the Cloud Resolving Model (CRM) community to provide observational/model datasets for many phenomena/processes of importance to GCM development. Model validation/improvements have resulted from several case studies of boundary layer clouds and the impact of mesoscale structure of extra-tropical layer cloud systems on GCM-grid scale parameters has been demonstrated through a series of test case model studies. Production of validated CRM TOGA-COARE results, including mass flux datasets are being produced under the direction of the precipitating convective layer cloud working group. The two-dimensional TOGA-COARE mass flux products are currently available and the three-dimensional products are on schedule for release in 1997. The Cirrus Cloud System Working Group has scheduled a special planning workshop to coordinate modelling and observational efforts between process research and large-scale modelling groups. Other GCSS working groups have also made very effective use of workshops and intercomparison studies which have strengthened links to the GCM community.

Following the recommendation of the SSG, a GCSS "fast-track". methodology has been developed to ensure results are reported to the broader research community in the most direct manner. This process is being helped by the development of connections with other WCRP/GEWEX activities such as GRP's airborne cloud radar studies, GHP CSE intensive observation periods and GMPP/WGNE modelling and data assimilation projects. The DOE ARM programme and the Mesoscale Alpine Project (MAP) are other research initiatives that are being contacted for collaborative cloud system studies.

9.5 Modelling Activities at Various Centres and Related Data Issues

The SSG was interested in knowing that direct interactions between the European Centre for Medium Range Forecasts (ECMWF) and other modelling and forecast centres and GEWEX had been undertaken and that more activities were planned in the future. Although representatives from the USA National Centre for Environmental Prediction (NCEP) were unable to attend the meeting several presentations had confirmed that NCEP is playing a major role in WCRP/GEWEX modelling and prediction efforts. NCEP has been active in several GEWEX projects including the ISLSCP data set initiatives, PILPS, the GEWEX Global Soil Wetness Project, GCIP and LBA modelling schemes and others. Close co-operation will also be carried over from NCEP and GNEP to GMPP activities. The NASA/GSFC Data Assimilation Office (DAO) was also not represented at the meeting but has shown interest in assisting GEWEX with evaluation of datasets and performance of special modelling exercises.

Dr T. Hollingsworth reported on developments in modelling activities at ECMWF. The GEWEX GCSS jointly organized a Workshop in 1996 with ECMWF which emphasized convective cloud systems in modelling and in GCSS activities. Results from this meeting are currently in publication and other similar workshops are being planned with other GCSS working groups and ECMWF. Changes to the ECMWF model which have taken place recently include operational implementation of the three-dimensional variational assimilation system (3D-VAR) in January 1997. Impacts in extratropical cases have included distinctly positive results. The encouraging extratropical performance of 4D-VAR has been confirmed in test simulations but development of tangent and adjoint physics versions must be completed before good results can be obtained in the tropics. Following a commissioning phase (January-March 1996) scatterometer data from the ERS-2 spacecraft instrument was introduced in the operational assimilation. A combination of the NESDIS SSM/I sea-ice product and the NCEP 1-degree SST analysis became operational in April 1996.

There was special interest in the ECMWF land-surface and boundary layer studies which focused on a near surface cold bias in the operational forecasts over Europe over the past year. This analysis showed that, at low wind speeds, a decoupling develops in the model between the lowest model level and the layers above, together with excessive soil cooling. These findings led to the conclusions that the vertical diffusion of heat is too weak in stable conditions and soil freezing, which is not represented in the current model, plays an important role in the evolution of soil/surface temperatures in winter. Experiments with long model runs at T63 resolution with increased heat diffusion and soil freezing have shown that these changes alleviate the 2 m cold basis to a large extent and that the soil/surface temperature evolution is much closer to observations (see Figure 4). The revised formulation was tested further in data assimilation to confirm the long runs and will be introduced into operations in 1997.

The SSG concluded that these results warranted additional research into the issue of soil moisture and soil freezing coupled with the work being undertaken by ISLSCP and GHP. The CSE's under the oversight of GHP were, therefore, encouraged to provide data on soil moisture profiles which could help in the validation of LSP models in PILPS point model analyses. GHP was also asked to consider the issue of aggregation on microscale to grid scale levels to determine how to better exploit point data. The ISLSCP supported BOREAS transects and the ARM CART site measurements are examples of *in situ* studies which are addressing these research needs. In addition it appears that it is possible to infer global soil moisture profiles by combining L-Band Synthetic Aperture Radar (SAR) data with a characterization of the historical precipitation record. The SSG Chairman agreed to provide a written endorsement of the L-Band SAR mission on behalf of GEWEX.

New surface radiative conditions for both longwave and shortwave radiative computations have been introduced as part of a set of changes to address a range of problems in the radiation package of the ECMWF operational model. The monthly mean albedos from ISLSCP datasets will be tested as possible replacements for the current annual mean surface albedo. This issue led to a discussion of changes to a more realistic spectrally dependent shortwave albedo for all surface types and accounting in the longwave for the temperature discontinuity between the surface and the air just above with a spectrally and soil moisture dependent surface emissivity. It was noted, that there has been a long standing question concerning the adequacy and handling (as well as the definition) of "skin temperature" (as seen by satellites) and the diurnal cycling of that parameter in land-surface parameterizations. The SSG asked the GRP to investigate the options available for improving the understanding and determination of surface spectral albedo.

10. LINKS TO OTHER PROJECTS

Representatives from other WCRP projects provided the SSG with a review of their programmes and discussed possible collaborations with GEWEX. ACSYS, CLIVAR and SPARC were represented in these discussions.

10.1 Arctic Climate System Study (ACSYS) and GEWEX Polar Region Data Products

Dr Dennis P. Lettenmaier noted that the five ACSYS sub-projects address objectives related to Arctic Ocean circulation, Arctic sea-ice climatology and research, the Arctic atmosphere, the hydrological cycle in the Arctic region and modelling (with the goal of improving the representation of Arctic processes in global climate models). These objectives are expanded further in material which appears on the ACSYS home page on the World Wide Web at URL **<http://npolar.no/acsys>.**

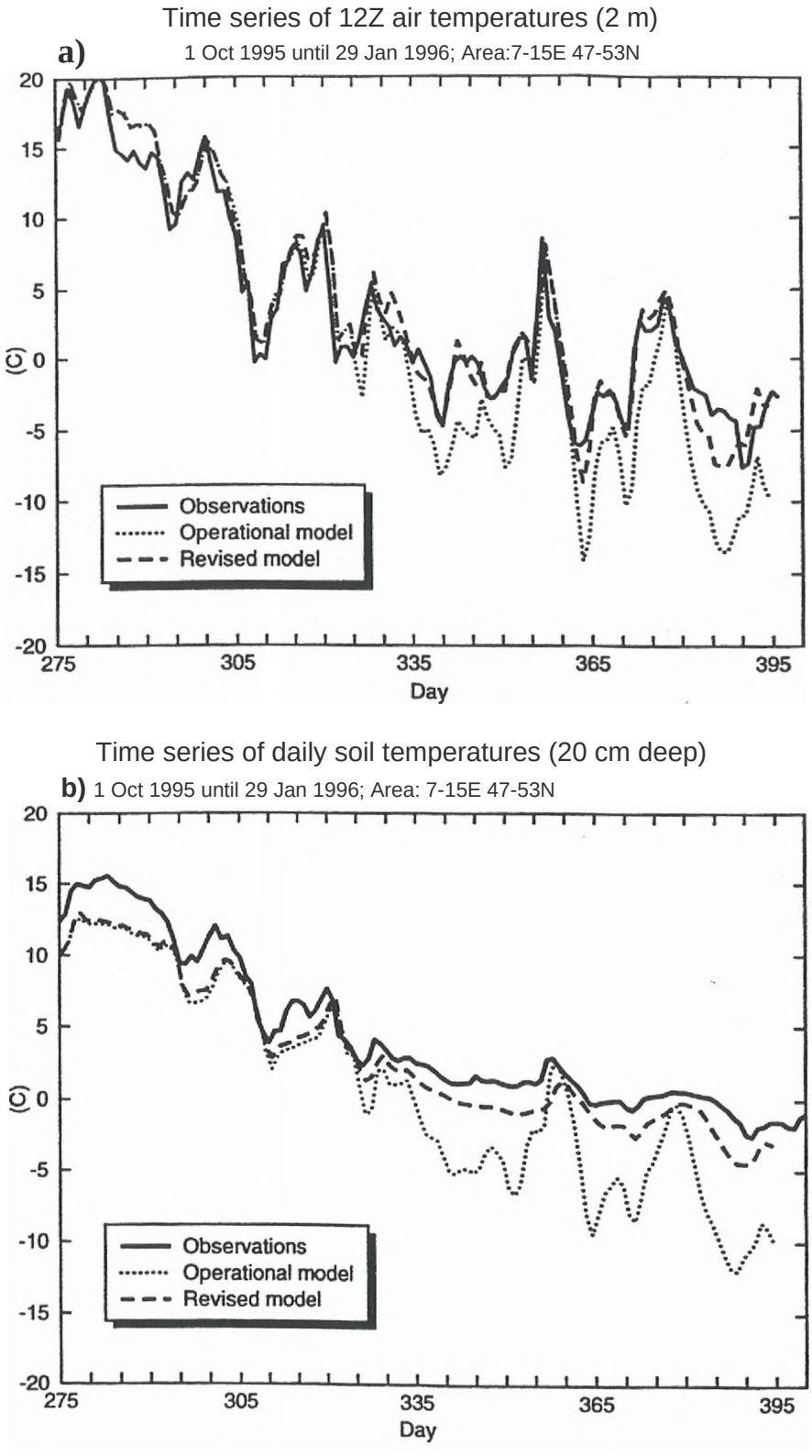

Figure 4. a) Area averages (7-15E, 47-53N) of 12 UTC temperatures at 2 m from long runs at T63 resolution with relaxation towards the analysis above the boundary layer in comparison with observations. The operational model version (dotted), the revised model (dashed) and observations (solid) are shown, b) As a) but for soil temperatures (20 cm depth).

Areas where GEWEX hydrological modelling efforts may be able to support ACSYS investigations of Arctic basin hydrology were discussed. The CSEs with high latitude processes to consider such as MAGS, GAME and BALTEX have interests which relate to ACSYS efforts in the Arctic. MAGS has already undertaken to model the hydrology of the Mackenzie River including an approach that represents the relationship between meteorological variables (primarily precipitation and temperature) and streamflow for various locations in the basin, typically at time scales of about one day. The GAME-Siberian project, BALTEX and even GCIP will have to contend to some degree with frozen soils, sublimation and drifting snow in their hydrological modelling analyses.

The new material presented at the meeting added value to the earlier recognition that there were distinct possibilities for cooperation between GEWEX and ACSYS. Following the SSG recommendation, the GHP Chair and representatives of MAGS, GAME and BALTEX have outlined in a draft plan which was endorsed by the SSG, a set of specific interactions to be carried out with ACSYS. The plan has been formatted as an agreement of participation between GHP and ACSYS that covers GEWEX/GHP - ACSYS scientific collaboration in high latitude processes and modelling.

The premise of the agreement is that GEWEX and ACSYS have a common goal of deepening our understanding of the climate system and some of the continental-scale efforts taking place under GEWEX/GHP address high latitude climate issues of concern to ACSYS. GEWEX is however concentrating on fast climate processes to address seasonal and annual issues, whereas ACSYS is concerned with time scales ranging up to decades. GAME, MAGS and BALTEX are the three main continental-scale experiments that are directly concerned with high latitude issues but components of GCIP are very relevant as well. Linkages include water and energy cycles at high latitudes; coupled atmosphere-surface models; remote sensing of high latitude features; fresh water discharge into the Arctic Ocean; precipitation (often snowfall) at high latitudes; snow/ice cover and their evolution; high latitude clouds and their impacts; radiation and its role on high latitude climate and permafrost and tundra and their role in climate. Details of the agreement can be found on the GEWEX/GHP home page (see Item 4.). The SSG endorsed action by GHP and ACSYS to plan a workshop to identify the current capabilities of models to simulate high latitude water and energy cycles, to identify gaps, and to determine a joint course of action for addressing these issues.

ACSYS aims to develop, test and implement improved models of Arctic ocean-atmosphere-ice processes and to improve the interpretation of satellite remote sensing data in the Arctic, also parallel the Arctic science interests of the GEWEX cloud and radiation community. The strategies currently employed or planned by the GEWEX global climatological data projects (ISCCP, GPCP, SRB, GVaP, etc.), which rely primarily on retrievals from satellite remote sensing systems for the production of global datasets, may not provide adequate results in the polar regions. However, since responsibility within WCRP for the development of such datasets resides in GEWEX the SSG asked the GRP to evaluate whether the collection and production of satellite datasets related to the surface radiation flux over the Arctic Ocean is an adequate GEWEX contribution to the ACSYS, Arctic Cloud and Radiation Programme. It was further recommended that the GEWEX global climatology data projects consider the difficulties of satellite remote sensing of polar regions, determine if special algorithms are needed and identity input *(in-situ* and space-based) data sources necessary to improve the accuracy of the GEWEX polar products. This initiative should consider the high latitude rainfall/snowfall requirements of other WCRP Projects such as CLIVAR and will coordinate with the national and international activities that are planned as part of the Cloud and Radiation component of ACSYS. The IGPO agreed to coordinate a preliminary set of activities related to the topic of GEWEX polar products, leading to the development of an initial framework for this endeavour.

10.2 CLIVAR

There is a wide range of mutual problems that can benefit from interactions between the communities and various organizational structures already established in GEWEX, CLIVAR and the Global Ocean, Atmosphere, Land System (GOALS) component of CLIVAR. Questions are already being discussed in common meetings of the SSGs, numerical experimentation panels, and other project working groups, and Panels such as GHP and GRP. For example, GHP is responsible for developing better models of the surface hydrological processes and obtain large scale land surface hydrological data for the initialization of coupled models and for their validation. CLIVAR requires these elements in order to predict the variability of the atmosphere and the ocean on time scales of years to decades/centuries. GMPP modelling and prediction tasks will also overlap with CLIVAR research issues.

Strong connections between CLIVAR-GOALS and the GEWEX regional continental-scale experiments, especially GCIP and GAME are being defined to cover investigations being undertaken as part of the Pan-American Climate Study (PACS) which is the CLIVAR point of contact regarding precipitation in the Americas. In addition the predictability of the Asian-Australian monsoons are under investigation by the CLIVAR Numerical Experimentation Group (NEG-1). Additionally, a CLIVAR Monsoon Panel has been established with the overall responsibility of developing a strategy to investigate climate variability and predictability of the coupled ocean-atmosphere-land system in the Asian-Australian-African region. These areas of concern to CLIVAR are a natural complement to the land-atmosphere interactions being emphasized in GAME. Agreements are being developed between GAME and CLIVAR which will consider both the summer and winter monsoon(s) seasons. The absence of a climatology of tropospheric water vapour and its variability on the time scales of months to years impacts both GEWEX and CLIVAR-GOALS. Thus, the GEWEX Water Vapour Project (GVaP) is a central issue for both communities.

10.3 Stratospheric Processes and their Role in Climate. (SPARC)

Important issues in the development of SPARC and areas of possible collaboration with GEWEX were discussed. Dr M.-L. Chanin reported that a major research focus of SPARC will be on the upper-troposphere and lower stratosphere since there is evidence that changes occurring in that region appear to have a dominant impact on climate. This is also the region where existing and future aircraft can have the greatest effect on the chemical and radiative properties of the atmosphere and, thereby, their largest impact on climate. This region is the subject of a joint SPARC/IGAC Project entitled “Upper Tropospheric/Lower Stratospheric Ozone, Aerosols and Climate. This thrust overlaps with the issue of stratosphere-troposphere exchange (STE) which is now designated stratosphere-troposphere transport and mixing. Previously viewed as a topic primarily associated with dynamics, the use of chemical tracers has given STE a chemistry component.

Collaboration between GEWEX and SPARC will occur as a result of the need to define the data, validation and model support required to respond to questions of what the roles are of processes that maintain the 3-dimensional distributions of water vapour. STE is a primary mechanism associated with this issue along with convection, clouds, and evaporation over ocean. A set of topics of mutual concern in this area of study have, therefore, already begun to be addressed in workshops and implementation plans for GVaP and the SPARC Water Vapour Initiative. Closer ties between the stratospheric and the tropospheric science communities will provide a better understanding of STE and its role in large-scale water vapour processes. The SSG recommended immediate cooperation with SPARC to fill the need

for datasets characterizing STE occurrences and the determination of related distributions of water vapour. Data from recent field experiments must be examined which are associated with stratospheric chemistry measurements and include satellite products, to determine the extent to which they reveal the amount (frequency), intensity, and impact of these events. The SSG felt that Global Positioning System (GPS) data should be considered as a possible means of defining tropospheric heights and determining intrusion locations and depths.

To better understand and quantify the effect of convection on upper tropospheric and lower stratospheric humidity in the tropics and mid-latitudes a series of topics need to be investigated that are of concern to both GEWEX and SPARC, including whether the moistening effect of stratospheric convective detrainment is stronger than the drying effect of subsidence. Other characteristics of convection also need determination such as where the convective detrainment layer is located and how much water is transported into the upper troposphere through detrainment as well as the effect of detrainment on upper tropospheric humidity (UTH) and cirrus cloud formation. The data needed to answer these questions are available from recent field experiments (i.e. TOGA-COARE, CEPEX, MOSAIC) and their analysis should be carried out through collaborative GEWEX/SPARC efforts. The SSG asked GRP to ensure that such initiatives are undertaken as part of GVaP and requested that the GEWEX Panel Chairs keep the Group informed of related interactions with SPARC.

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EORC HomePage	http://www.eorc.nasda.go.jp/
ADEOS HomePage	http://www.eorc.nasda.go.jp/ADEOS/
ADEOS DATA	ftp://ftp.eorc.nasda.go.jp/pub/ADEOS

[cf.]

GOIN Project	http://www.goin.nasda.go.jp/
G-7 ENRM Project	http://www.goin.nasda.go.jp/G7/

APPENDIX B

APPENDIX C

GEWEX DATA MANAGEMENT

1) Data Gridding and Formats

GEWEX data sets from global and regional projects should be held and distributed in a form that is accessible on a wide range of computational machinery. As a general principle, software to read the data, identify variables and locate data in Earth co-ordinates should be provided with each data set. The format and gridding can be chosen to be the most suitable to the particular GEWEX data set in question. To facilitate transferability it may be advisable to use a self-describing data format that is freely available such as net CDF or HDF. In addition, public domain gridding software is available (e.g. USGS), and should be considered for use by GEWEX. It would be useful to identify a recommended common data formatting and gridding software package (or a few of them).

2) Documentation

GEWEX data sets should be fully documented, including the algorithms and code used to produce the data products as well as, when applicable/feasible, the input data used to derive the data products. This is to both understand the data products fully and allow for the development and testing of improved algorithms.

Calibration methods and the constants describing the calibration should also be part of the documentation. Known calibration is important to uses of GEWEX data that would apply them to the evaluation of physical processes or to seasonal and interannual climate research.

3) Accessibility

The goal of GEWEX is to produce high quality data sets that are useful in research, modelling prediction and application to economic and policy decision-making. In this respect it is a goal of GEWEX to produce the best data set possible for the particular variable in question (e.g., precipitation, clouds, surface radiation budget, water vapor ....). In developing this data set GEWEX should encourage development and testing of competitive approaches, but should distribute only one data set per variable, which is the best estimate available at the time. These data should be distributed through WCRP specialized institutions and other related institutions such as START regional research centres. Convergence toward this optimal data set should be guided by a careful and open peer review process using the following general criteria:

1. Scientific foundation of the retrieval/estimation process
2. Comparison with other available data to estimate uncertainties or validate/verify analysis processes.
3. Ability to address users' needs

    a) Research
    b) Modelling
    c) Prediction
    d) Application (Resource Management, policy, etc.)

In pushing toward a single, optimal data product, creativity in considering alternative methods should be encouraged. Careful evaluation should continue and reprocessing or reanalysis should be conducted where needed as determined by a community-based, peer review process.

Data sets should be provided at the maximum resolution that the information sources can sustain adequate accuracy, but not more. Data sets at lower spatial and temporal resolution should also be produced by GEWEX data projects to serve the different needs of the research, forecasting and applications communities.

In the development of global data sets from satellite radiance measurements a tension may arise between internal radiative consistency of the derived products and an optimal fitting to in situ verification data from scattered locations. Maintaining physical consistency is given a strong preference, but this preference may have to be relaxed to achieve specific objectives. If physical consistency must be compromised by adjustment to other data, then it is important to perform this adjustment at the end and preserve the physically consistent data set as part of the documentation for the final adjusted data set.

The purpose of GEWEX climatological data projects is to produce a common climatological data base, incorporate available information sources using the best processing schemes currently known, based on the judgment of peers. This process recognizes the need for further research in information retrieval from on-going and new observing systems, on-going review and comparison of the quality of alternative retrieved products and periodic reanalyses, as warranted by advances in understanding and technique.

4) Data Scientist

Scientists who will use the data in research or applications and publish their results should have a working knowledge of the organization and management of the GEWEX data set production projects.

5) Data Management

A task force should be charged with reviewing GEWEX data management issues discussed above, particularly technical issues surrounding data formats and gridding and the issues involving data centres and policies for GEWEX data distribution. This task force will meet as needed to perform this function.

Consideration should be given not only to passive on-demand data distribution, but also to more active data distribution, e.g. through START centres.

SUMMARY OF RECOMMENDATIONS AND ACTIONS
for WCRP/GEWEX Scientific Steering Group (SSG) 9th Session
(6-10 January 1997, Hamburg, Germany)

The following is a compilation of the recommendations and related action items that came out of the deliberations of the GEWEX-SSG at its ninth session (6-10 January 1997, Hamburg, Germany);

1. The SSG endorsed the action taken by the Director of WCRP to encourage Space Agencies to address the main concerns in climate research relevant to GEWEX which were notably missing, in jeopardy of being excluded or were otherwise inadequately addressed by the current earth observation plans, including:

- Global 3-dimensional Distribution of Clouds, Radiation and Aerosols
- Global Soil Moisture (upper 5-10cm)
- Global 3-Dimensional Distribution of Tropospheric Wind

The SSG acknowledged the various national and international efforts being undertaken by the major space agencies to address these issues as reflected in their responses to a letter from the Director of WCRP and their presentations at the meeting. (See Item 2.3)

2. A general recommendation was made for **all members of the SSG** to follow and encourage support for developments in the areas of relevant GEWEX research where gaps in observations exist. In addition, the SSG recommended that a high priority be specifically maintained in the WCRP/GEWEX scientific strategy for the acquisition of global cloud data, including relevant optical properties and their 3-dimensional distribution. The **Chairman of the GRP** was asked to continue to follow and review parallel planning activities within Space Agencies in an effort to find the most appropriate and timely, internationally supported option for development of a research satellite mission to provide the desired products. (See Items 2.3/8.2)

3. There was agreement on the general need by **all SSG members** to call the attention of the space agencies to the importance of systematic analysis, intercomparison and merging of remote sensing products inferred from different satellite systems or instruments as well as the need to support the integration of satellite-based estimates and *in situ* observations. The **Director of WCRP** agreed that future WCRP correspondence with the Agencies will encourage adoption of policies which will make these activities more visible in their strategic planning processes. (See Item 2.3)

4. The SSG endorsed a baseline protocol for normalizing the development and management of the GEWEX global data sets. The proposed framework, developed at the meeting, considered documentation, quality assessment, calibration, gridding and geo-location standards, and formatting specifications. The **Director of the IGPO** agreed to work with the relevant GEWEX Projects to consider this protocol in the context of the current GEWEX distributed data production and management scheme and to continue to facilitate the effort to improve consistency of the GEWEX data management procedures. (See Item 3.)

5. There was agreement that no immediate change in GEWEX data set development and management policies was necessary as a specific result of the initiation (ADEOS-I, launch) of a new series of Earth Observing System platforms with significant application to GEWEX. It was recommended that individual **SSG members/researchers** remain cognizant of the large earth observing platform data retrieval processes within their particular fields and to report new developments as they arise. The **SSG Chairman** will act as a focal point for reports on this issue and will work with the **JPS** for WCRP to ensure further discussions are scheduled at subsequent meetings as required. (See Item 3.)

6. The SSG acknowledged the role of NASDA's Earth Observation Research Center (EORC) as an important interface between the ADEOS-I investigators and the broader climate research community. Data released at the various Internet sites, set up by EORC, have given an early indication of the potential value of the ADEOS data. The SSG, however, asked the **NASDA/EORC representative (Dr T. Tanaka)** at the meeting to convey to all of the ADEOS investigator teams the WCRP/GEWEX concern over instrument specific data management policies which restrict data access to only a small number of researchers for extended periods of time. The **POLDER** data was cited as an example of an important data set that could contribute directly to GEWEX analyses if access to the data could be made more timely. (See Item 5.1)

7. It was acknowledged that some success had been achieved in the support of the GEWEX Continental Scale Experiments as now administered under the auspices of the GEWEX Hydrometeorology Panel (GHP). There was agreement, however, on the general need for **all SSG members** to continue to encourage the partners contributing to the CSEs to identify and increase their funding for each experiment's planning and implementation. The SSG asked the **Director of the WCRP** to continue his efforts to emphasize to the major funding agencies for each CSE the importance of these efforts to the overall progress of GEWEX. Of particular importance are the resources necessary for adequate data observation and collection networks and for development and validation of coupled hydrological/atmospheric models. The JSC will also be asked to lend its support to this action. A unified GHP action plan was endorsed by the SSG which emphasizes that the GHP is responsible for examining the role of continental-scale hydro-meteorology issues within the climate system and ensuring that these issues are well represented in climate simulations for improved prediction. (See Item 7.3)

8. The SSG reviewed a Model Parameter Estimation Exercise (MOPEX) that could collect the appropriate hydrometeorological and land characteristics data for 100-200 river basins, globally, to assist in the development and testing of model dependent, *a priori* relationships between the hydrological models parameters and land surface and climate characteristics. Full endorsement of MOPEX was withheld, at this time, because the broader long term, global applications for such a task far exceed the more near term and regionally constrained goals of the CSEs. The **GHP Chair** was asked to reconcile MOPEX with a GHP plan to test the transferability of models and parameters within the context of a more restricted parameter estimation project carried out under its own auspices or that of the GEWEX Modelling and Prediction Panel. A report of further developments will be given at the next SSG session. (See Item 7.4)

9. Other issues raised by the SSG in the context of GHP included: recommendations that 1) the design of the CSE experimental (field) activities be evaluated and, where relevant, consideration be given to the need for continuous, long-term data collection efforts that may provide better means of investigating the longer term (up to seasonal) dynamics inherent to the processes which are relevant to water and energy cycles; 2) an inventory be provided at the next meeting of the field campaigns, intensive observation periods and related process studies/projects already under way or planned as part of the CSE's scientific programmes, including information on when they are scheduled, specific objectives, parameters being measured, duration of measurements, instrumentation and possible opportunities for coordination/cooperation, etc.; 3) the GHP seek additional opportunities at its meetings and relevant workshops/conferences to compare experiences of different approaches in representing near-surface hydrological processes within atmospheric models and, thereby, promote development of a synergistic modelling effort with particular emphasis on the coupled land-surface/meso-scale atmospheric modelling. (See Items 7.5/7.6)

10. The SSG acknowledged the work accomplished by the Satellite Data Analysis Center (SDAC) at the NASA Langley Research Center and the algorithm development teams which have continued analyses of the Version 1.1 data set of WCRP/SRB global fields of surface radiation Shortwave fluxes (SW) and related parameters for the period March 1985-December 1988. The work done in relation to improvements of the results where biases due to biomass burning were causing inconsistences in the data record was especially recognized. The SSG endorsed the recommendation developed at the last GEWEX Radiation Panel (GRP) meeting to move ahead with these analyses and other enhancements prior to production of a Version 2, GEWEX/SRB, product. Of particular concern to the Group is further evaluation of experimental algorithms. A proposal was endorsed for development of a validation dataset using newly obtained data from the Baseline Surface Radiation Network (BSRN) that could be used as the basis for organizing an international algorithm intercomparison project leading to final selection of a GEWEX LW algorithm for application in the Version 2 dataset. The GRP was asked to develop this proposal during the next year. (See Item 8.4)

11. The SSG acknowledged that the BSRN remains a major component of the global surface radiation measurement capability and urged the continued support by the international community to provide a more complete global distribution of BSRN sites particularly expansion into currently data sparse regions. Progress in this respect was noted, especially recent instrument purchases and shipment for the Amazon site (Balbina), international funding for establishment of a new site in South Africa and updates to several other sites world wide. Support of such activities will ensure that the BSRN will become an important tool in improving knowledge of the global surface radiation budget and its determination via satellite observations. To foster further support of the BSRN the **Director of WCRP** agreed to continue to emphasize expansion of the network as a high priority in WCRP. (See Item 8.5)

12. The SSG concurred with the resolution of the participants at the International GEWEX Water Vapour Project (GVaP) Workshop (12-15 November 1996, Geneva, Switzerland) which urges GEWEX to consider improvement of models, establishment of water vapour climatology and identification of the fluxes of water vapour and the related processes that control them to be the three main elements of the next phase of GVaP. The SSG also approved the nomination of Professor Tom Vonder Haar to be the Research Project Manager of the next phase of GVaP. **Professor Vonder Haar** agreed to organize a Working Group on Science and Data for GVaP and to proceed with the development of a detailed implementation plan for this activity. The **Chair of GRP** agreed to continue to provide oversight to GVaP as an integral element of the functions managed by the Panel, on behalf of the GEWEX-SSG. (See Item 8.7)

13. A draft action plan for the assembly and critical assessment of a global set (over land and ocean) of information on the geographical distribution and seasonal (or better temporal resolution) variability of aerosol optical properties for the purposes of understanding aerosol radiative impact on current climate and to support satellite remote sensing was endorsed by the SSG. **Dr R. Curran,** with NASA headquarters, was confirmed as the leader of an *ad hoc* group to promote the development of the proposal and report further advancement toward its accomplishment by way of the GRP presentation at the next SSG meeting. (See Item 8.8)

14. The SSG, endorsed the Global Precipitation Climatology Project (GPCP) pilot study, that will allow evaluation of a higher temporally and spatially sampled GPCP global precipitation product, primarily in support of the GEWEX Continental-Scale Experiments (CSEs). The data processing center representatives for EUMETSAT, GMS and GOES have begun to produce 1° histograms at 3 hourly intervals, daily. A quantitative evaluation of this 3 hourly, daily product, presented on a 1° x 1° spatial scale will be accomplished in 1997 and the results reported by the **GPCP Research Project Manager** during the **GRP** presentation at the next SSG meeting. (See Item 8.9)

15. The SSG was informed of plans for a conference to evaluate the results of the reanalyses being carried out by several international NWP centres. The meeting to be held in Washington, DC, USA, from 27-31 October 1997 will be fully interdisciplinary and will aim to demonstrate clearly the progress achieved. The **Director of IGPO** agreed to facilitate coordination between the WCRP Working Group on Numerical Experimentation (WGNE), the reanalysis centres and the GEWEX data projects (i.e., GPCP, ISCCP, SRB, GVaP) to encourage intercomparisons in support of the conference objectives which include validation of the reanalyses results against the range of GEWEX global climatological datasets. The SSG recommended that the **Project Managers** of the GEWEX climatological data projects begin requesting the reanalysis data products, as soon as possible, for study within the framework being established for the conference but to delay incorporating reanalysis products into their data processing schemes until the results of the reanalysis product intercomparison exercise are known. (See Item 8.10)

16. Dr E. Kalnay's request to stand down as Chairman of the GEWEX Numerical Experimentation Panel (GNEP) was acknowledged by the SSG and special note was made of her exceptional service to WCRP/GEWEX. It was agreed that GNEP would be suspended in favour of focussed task assignments under the GEWEX Modelling and Prediction Panel (GMPP) and GHP. **GMPP** will work in association with WGNE. (See Item 9.)

17. The **SSG** will want to ensure that the **Chair of GMPP** interacts with **WGNE,** particularly on issues which encompass further refinement of estimates of surface fields and fluxes; explicit prediction of cloud water and ice particle size and density in cloud parameterization schemes; and determination of the three-dimensional distribution of atmospheric heating and vertical stability of the troposphere and the dependence on parameterizations of mesoscale convective, radiative and boundary layer processes as well on the large-scale dynamics. The **SSG** endorsed plans for a joint **WGNE** and **GCSS** workshop, in 1998, which is related to testing of physical parameterizations in single column and cloud resolving (SCM/CRM) models independent of interactive dynamics. (See Item 9.1)

18. The SSG accepted Dr K. Browning's resignation as chair of GCSS which was tendered at the closing of the December 1996 GCSS Science Panel meeting. The SSG has agreed to the nomination of **Dr D. Randall** to replace Dr Browning as chair of GCSS. Dr Browning's exceptional service to GEWEX and the broader WCRP research community in guiding GCSS from its inception was acknowledged by the SSG. The **SSG Chairman** will note Dr Browning's contributions to GEWEX in a letter on behalf of the Group, and the **Director of WCRP** will take similar action on behalf of the SSG Chair, to acknowledge the action of the SSG in accepting Dr Randall's nomination to lead GCSS. (See Item 9.4)

19. In the review of modelling activities at various specialized NWP and climate research centres it was noted that since it may be possible to infer global soil moisture profiles by combining L-Band Synthetic Aperture Radar (SAR) data with a characterization of the historical precipitation record the **SSG Chairman** should provide a written endorsement of the L-Band SAR mission on behalf of GEWEX. In a separate discussion it was noted, that there has been a long standing question concerning the adequacy and handling (as well as the definition) of "skin temperature" (as seen by satellites) and the diurnal cycling of that parameter in land-surface parameterizations. As a result the SSG asked the **GRP Chairman** to investigate the options available for improving the understanding and determination of this concept and its relationship to surface spectral albedo. (See Item 9.5)

20. In discussing GEWEX links to other projects, the SSG endorsed plans for **GHP** and ACSYS to organize a workshop in 1997 to identify the current capabilities of models to simulate high latitude water and energy cycles, to identify gaps, and to determine a joint course of action for addressing these issues. The **Chair of GRP** was also asked to evaluate whether the collection and production of satellite datasets related to the surface radiation flux over the Arctic Ocean is an adequate GEWEX contribution to the ACSYS, Arctic Cloud and Radiation Programme. It was further recommended that the GEWEX global climatology data projects consider the difficulties of satellite remote sensing of polar regions, determine if special algorithms are needed and identify input *(in-situ* and space-based) data sources necessary to improve the accuracy of the GEWEX polar products. This initiative should consider the high latitude rainfall/snowfall requirements of other WCRP Projects such as CLIVAR and will coordinate with the national and international activities that are planned as part of the Cloud and Radiation component of **ACSYS.** The **Director of IGPO** agreed to assist in the coordination of a preliminary set of activities related to the topic of GEWEX polar products, leading to the development of an initial framework for this endeavour. In discussing the links to SPARC, the SSG agreed that collaboration between GEWEX and SPARC will occur as a result of the need to define the data, validation and model support required to respond to questions of what the roles are of processes that maintain the 3-dimensional distributions of water vapour. (See Items 10.1/10.3)