

ATMOSPHERIC ICE—A MAJOR GAP IN UNDERSTANDING THE EFFECTS OF CLOUDS ON CLIMATE

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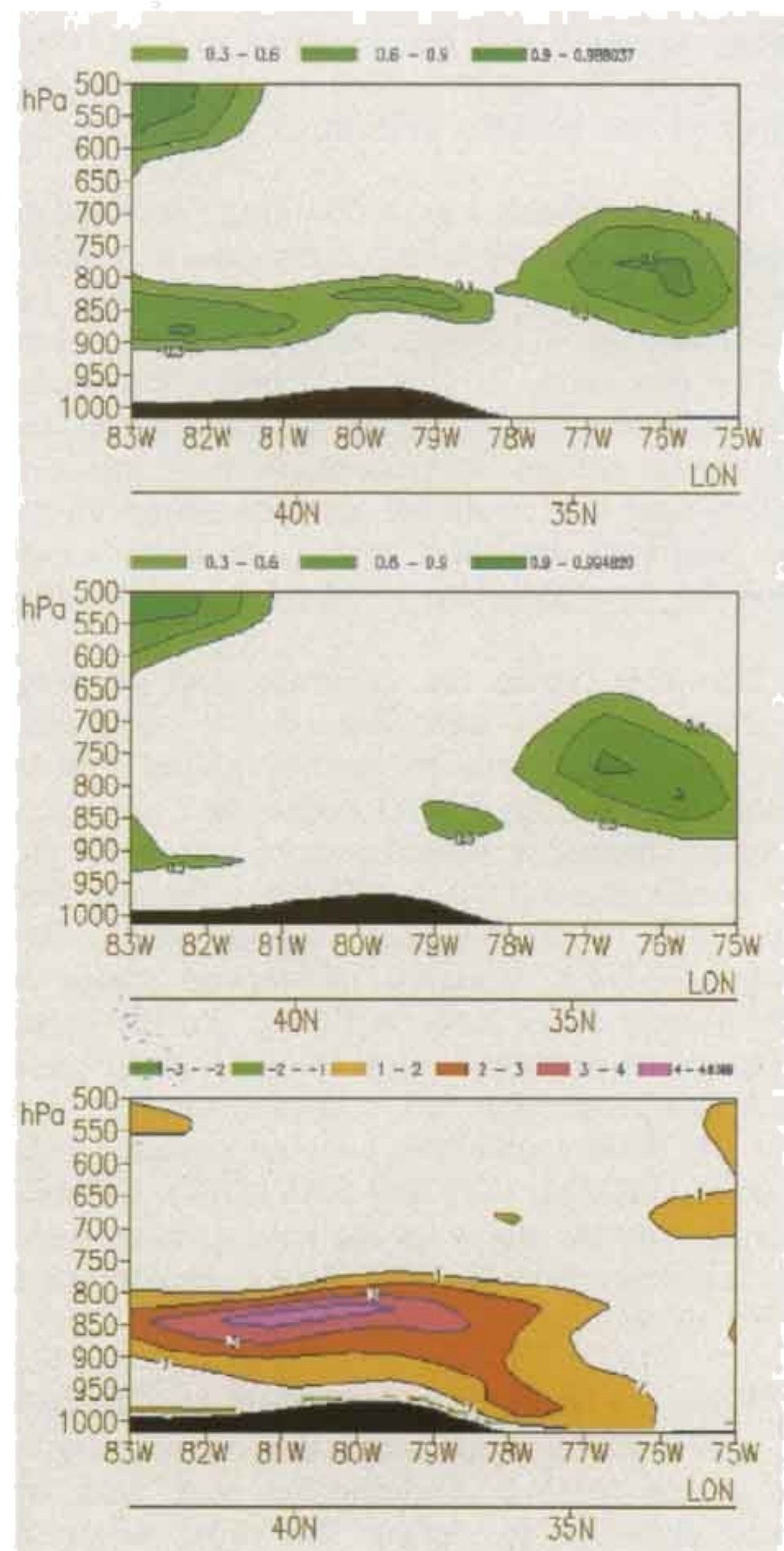
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To a large extent, the climate of the Earth is governed by the reservoirs of water on the planet and the exchanges of water and the associated exchanges of heat between these reservoirs. A quantitative understanding of the way water is exchanged between these reservoirs in the form of the so-called hydrological cycle is viewed as crucial for understanding climate and climate change. Processes that govern the way water is exchanged between its three phases in the atmosphere, the smallest of the reservoirs, are particularly critical to understanding climate change. In one way or another these atmospheric processes underpin the important feedback mechanisms that are thought to govern the response of global climate to greenhouse gas forcing. For example, water vapor is the principal greenhouse gas (e.g., Chahine, 1992) and the absorption and emission of infrared radiation by water vapor in air is the mechanism of the water vapor feedback. Water

(Continued on page 4)

MODEL TREATMENT OF CLOUD ICE LEADS TO LARGE FORECAST ERRORS



Vertical cross section of clouds forecast by control model (top panel) where a fraction of condensate is assumed to exist as water below 0°C. The middle panel forecast treats all clouds below 0°C as ice. The bottom panel is the resulting temperature difference (see text of Stephens et al. article that begins on this page).

WHAT'S NEW IN GEWEX

- Results from the First WCRP Conference on Reanalyses
- SCSMEX Coordinated with GAME-Tropics, GAME-Tibet and GAME-Hubex
- GHP Planning for a Coordinated IOP to Complement New Satellite Measurements
- GCSS Workshops Showing Good Results
- Winter GCIP Surface Flux Measurements Provide a Challenge for the Models

COMMENTARY

A LOOK AT THE START OF THE THIRD PHASE OF GEWEX

**Moustafa T. Chahine, Chairman
GEWEX Scientific Steering Group**

From its inception in 1989, GEWEX has embarked on a two-phase strategy of interdisciplinary research and observations to understand and model the hydrological cycle and energy fluxes in the climate system.

The first phase was a "buildup" focused on improving and validating atmospheric circulation and climate models and advancing our understanding of clouds, atmosphere and land surface processes. In this early phase the needed observations were obtained by assembling and integrating surface measurements with meteorological data and available satellite observations. We produced data sets which, in many cases, were the first assemblage of such information.

However, since the accuracy and coverage of these data sets were limited, we recognized that further progress to predict global climate anomalies, such as ENSO events and variations in water resources, would require improved global observations from satellites. To this end, and nearly in parallel with the start of the first phase, GEWEX initiated its second phase by establishing close links with the world's space agencies to deploy a new generation of more capable operational and research satellite systems. As these capabilities become available (e.g., ADEOS, TRMM, EOS and ENVISAT), GEWEX will incorporate many of the new measurements (see Commentary, *GEWEX News*, November 1, 1996) in its studies.

Now, 10 years since the start of GEWEX, we are working again with the meteorological and space science communities and with the space agencies to define the third phase of GEWEX. New observing capabilities are needed that resolve the vertical structure of clouds, atmospheric constituents and particulate matter, detect the activity of terrestrial vegetation, and determine soil moisture. These measurements are essential to achieve GEWEX long-term goals (see Commentary, *GEWEX News*, August 1997)

of documenting and modeling transient climate variability and predicting dependence of hydrological regimes on changes in the global climate.

The GEWEX Scientific Steering Group in its 1998 Annual Meeting in Rio De Janeiro will be discussing the development and deployment of several of these powerful new global observing tools with representatives from the world's space agencies.

EARLY ANNOUNCEMENT

THE THIRD INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE

The Conference will be held in March 1999 in China. Details regarding the location, topics, abstract deadlines and other information will be available soon at the GEWEX web site.

<http://www.cais.com/gewex/>

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RESULTS OF THE WCRP FIRST INTERNATIONAL CONFERENCE ON REANALYSES

Roger Newson
WCRP

The Conference was held at the National Oceanic and Atmospheric Administration (NOAA) in Silver Spring, Maryland, on 27–31 October 1997. More than 200 scientists and experts, including atmospheric scientists, hydrologists, oceanographers and polar researchers from over 20 different countries, participated in this review of the results of the reanalysis projects undertaken by several groups over the past years. Major efforts in this respect include the reanalyses carried out by the European Centre for Medium-Range Weather Forecasts (ECMWF), the NOAA National Centers for Environmental Prediction (NCEP) in collaboration with the National Center for Atmospheric Research (NCAR), and the National Aeronautics and Space Administration (NASA) Goddard Space Flight Centre (GSFC) Data Assimilation Office (DAO). These reanalyses were undertaken with changes of fixed state-of-the-art data assimilation/analysis methods to provide multi-year data sets for a range of investigations of many aspects of climate, particularly, interannual variability, and for model validation and predictability studies. The large spurious effects present in operational analyses arising from changes in assimilation systems are absent from these data sets, which thus provide a much more homogeneous time series for studies; however, there are still effects from the varying observational data base.

Comprehensive results from the three major reanalysis efforts at ECMWF, GSFC/DAO, NCEP/NCAR have become available over the past two or three years. Studies of the reanalysis data sets that have been generated, as well as detailed assessments of the qualities or deficiencies of the almost endless variety of reanalysis products, are now advancing. It is apparent that the reanalyses have provided much-improved global fields of a range of key parameters, such as diabatic heating, surface fluxes and components of the hydrological cycle. Results from the reanalyses and the diagnostic studies based on these are of fundamental interest to all components of WCRP, particularly, GEWEX, the Climate Variability and Predictability (CLIVAR) study, and the Climate Modeling Program.

One of the key goals of the Conference was to identify the strengths and deficiencies of the reanalyses, especially those common to all, and many specific examples of studies of the different characteristics of reanalysis products were presented at the Conference. There were several illustrations of observation/model inconsistency as manifested in spin-up effects in fields such as surface fluxes and the hydrological cycle, observation/model biases, and budgets which are not closed. Lines of investigation that need to be followed up further include checking whether there are statistically significant biases between analyses and observations and whether the fit of the analysis to observations corresponds to the "assumed" observation error (as used in the analysis process). Inhomogeneities in the basic input observational data sets show up in the reanalyses, such as changes or drift in satellite sensors, and modifications in retrieval methods, as well as changes in the characteristics of radiosonde observation over the period of the reanalyses. In the NCEP reanalysis (extending from 1958 to 1996), clear positive effects are apparent as satellite data were introduced during the 1970s, especially in the southern hemisphere. All three reanalyses, particularly that from ECMWF, indicate improved characteristics in various features for periods when there are two polar orbiting satellites rather than one.

Among the deficiencies detected in the reanalyses are, for example, inconsistencies in evaporation and precipitation over land and in surface fluxes over oceans, an unsatisfactory representation of the diurnal cycle over continental areas in summer and significant artificial trends in stratospheric temperatures (apparently in some reanalyses linked to bias in satellite retrievals and satellite versus no-satellite periods). Although, for the first time, there is a fair representation of the quasi-biennial oscillation (providing the basis for some informative studies), this feature is not yet entirely realistic. In the tropics, variability (e.g., such as that associated with El Niño), is not always adequately captured and there are sometimes shortcomings in tropical divergence/heating fields. Different analyses have different deficiencies in cloud distributions, but in general low-level marine stratus does not appear to have been well treated; in addition, problems in soil moisture (long-term drifts or biases) and in snow cover are apparent. Surface fields in Arctic and Antarctic regions (over ice-covered land or sea-ice) tend to show particular limitations.

These findings led to the recommendation that attention be given to a number of physical parameterizations in the assimilating models. Furthermore, climate simulations or Atmospheric Model Intercomparison Project (AMIP) integrations with the assimilating models should be produced in order to assess the long-term model biases, which might be reflected in the reanalysis fields, especially in data sparse areas or in variables, such as soil moisture and seasonal precipitation. In this perspective, the Conference recognized that, although the reanalysis data sets were excellent for the study of interannual variability, they were not suitable for detection and assessment of long-term trends in climate variables, such as temperature, humidity and precipitation. The reason is that, as noted above, the observing systems changed significantly over the period of the reanalyses. New data sources were used as they became available so that the reanalyses would be based on the largest possible set of observational information. Furthermore, there are changing and unknown biases in observing systems that are not eliminated by reanalysis. Thus, fictitious and/or misleading trends are inevitably produced.

Numerous benefits of the reanalysis exercises were pointed out: learning about the performance of components of the observing systems and how they affect analyses; judging how to exploit information from the various satellite systems in an optimum fashion—a painstaking process, demonstrating the effects of shortcomings in satellite data retrieval techniques, benefits of satellite data reprocessing and the potential advantages of direct use of satellite-measured radiances. The centers carrying out the reanalyses have also learned a great deal about the performance of the assimilating models in both operational and research activity. Also notable was the outstanding cooperation and interaction between the centers in the planning of the reanalyses, exchange of data sets and experience, and the general open approach in assessing problems.

The Conference demonstrated the success of the first round of analyses and showed that further reanalyses should be undertaken using a systematic basis. The value of having two or three parallel reanalyses as a basis for cross-comparison was stressed. The next Conference is tentatively planned is about two years time (i.e., towards the end of 1999).

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(Continued from page 1)

in the form of precipitation-sized particles is an important source of energy fueling circulation systems, is the fundamental supply of fresh water to life on Earth, and is an integral part of snow - sea-ice and vegetation albedo feedbacks. Water in the form of cloud droplets significantly modulates the radiative budget of the planet (e.g., Wielicki et al., 1995) leading to poorly understood but perhaps the largest of all climate feedbacks.

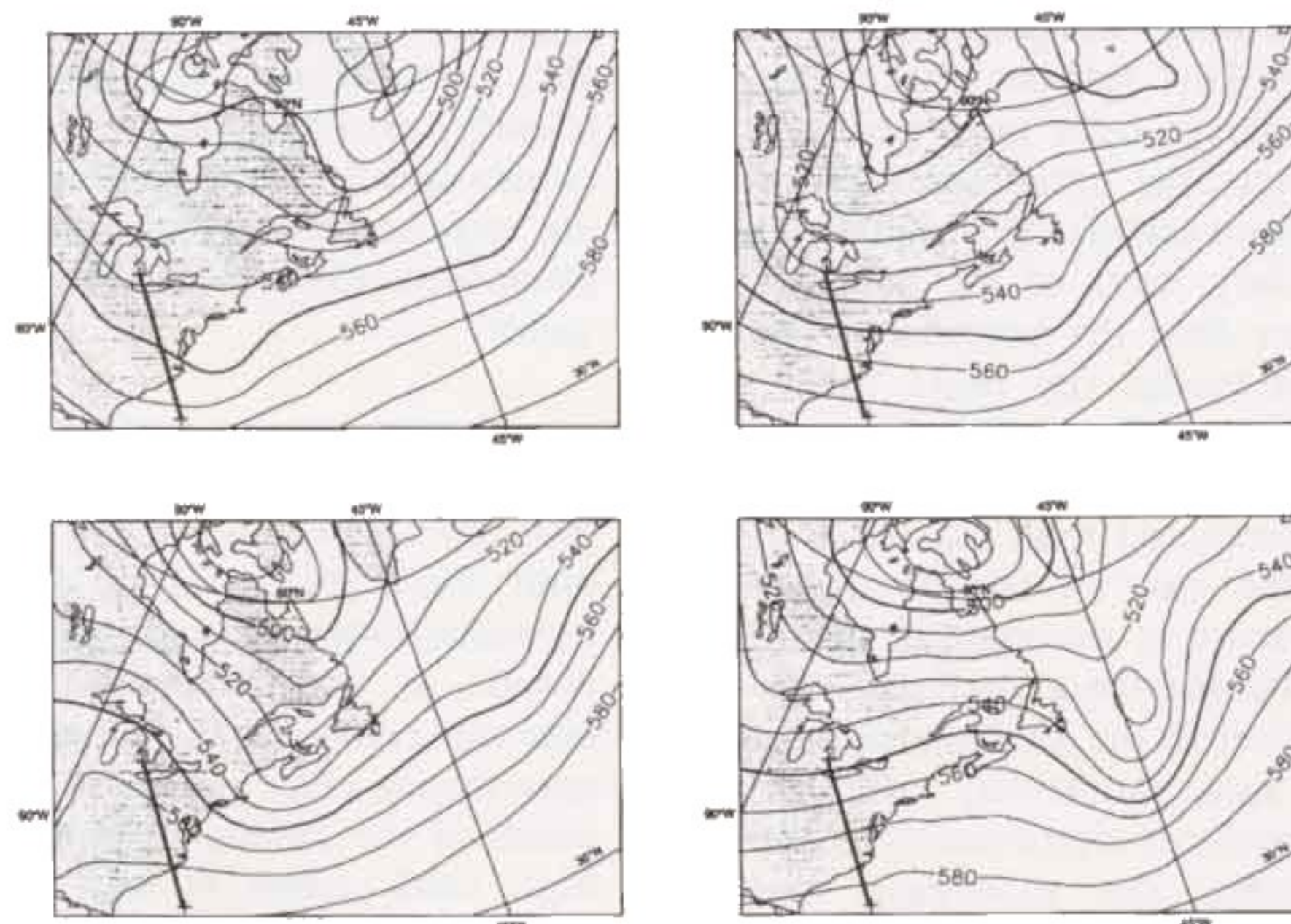
The most uncertain contribution to the atmospheric reservoir of water is the portion that resides in the atmosphere in the form of ice. The purpose of this article is provide a number of illustrations of the importance of ice clouds on both climatology and weather forecasts. We do this using the operational model of the European Centre for Medium-Range Weather Forecasting (ECMWF) and explore the sensitivity of this model to the way ice clouds are parameterized in the model.

Our ability to estimate the amount of water in the atmosphere is limited by a lack of observations, and, for the most part, these observations are only column-integrated quantities. Programs such as the GEWEX Global Water Vapor Project (see e.g., NVAP CD-ROM, 1997) provide us with reasonable estimates (perhaps to the level of 5%) of total column water vapor. However, we are much less certain about how this water vapor is distributed vertically. This information is, unfortunately, important for at least two reasons. The presence of low amounts of water vapor high in the atmosphere has a significant influence on the emission of radiation to space and thus a disproportionate influence on water vapor feedback (e.g., Lindzen, 1990). Knowledge of the vertical distribution of water vapor is also required to understand and predict the evolution and maintenance of cloud knowledge that is an essential ingredient of cloud feedback problem. Our current ability to partition water vapor vertically using present satellite data is limited to a few layers (3–4 at most) and even then accuracies of layered water vapor amounts are no better than 30% (e.g., Engelen and Stephens, 1998).

Quantitative estimates of condensate, including cloud water, cloud ice and precipitation are also limited to column integrated quantities. Programs like the GEWEX Global Precipitation Climatology Project (Huffman et al., 1997) provide us with surface estimates of global precipitation based on microwave and infrared emission measurements using approaches that are limited in application. Satellite data when composited into monthly mean values are probably no more accurate than 10%–20% (this is the goal of the Tropical Rainfall Measurement Mission, Simpson et al., 1988). Cloud liquid water path estimates, on the whole, have been limited to microwave emission measurements over oceans and are only accurate to the 20%–30% level when clouds are not precipitating (Greenwald et al., 1995). Global determinations of ice content are even less direct and are the most uncertain of all. Current methods to determine this quantity rely substantially on indirect *a priori* relationships of one form or another. An example is the work of Lin and Rossow (1996) who use the relation between visible optical depth, ice water path and particle size. The accuracy of this method is not known but estimated to be about a factor of 2. Unfortunately, none of the approved satellite observing systems that are expected to be launched in the coming few years, including operational systems under National Polar-orbiting Operational Satellite System, will provide measures of ice cloud content that are likely to improve on exist-

ing crude estimates. Millimetric radar observations also provide information about the ice content of clouds with an accuracy approaching the 30% level when other observations are combined with the radar. Combinations of active and passive observations, like that described in Evans et al. (1998), are perhaps the most promising method available for providing quantitative information about the ice content of clouds.

A new cloud parameterization (Tiedtke, 1993) was introduced into the ECMWF operational forecast model in 1995 (Jakob, 1994). The scheme is based on two prognostic equations for cloud cover and cloud condensate (i.e., water and ice) and its introduction has led to a number of improvements in the model including cloud forecasts and model climatology. One of the more sensitive aspects of the new scheme concerns the various assumptions associated with the treatment of cloud ice. In many models this treatment assumes the fraction of condensate assumed to exist as water (f_i) rather than ice is simply defined by the temperature of the volume of cloud. In reality the relationship between f_i and temperature is very complex. The nature of such relationships has important consequences not only for climate model simulations, as pointed out in the study of Senior and Mitchell (1993), but also has direct influence on forecasts produced by the operational model. The impact of different forms of the $f_i - T$ relationship on a forecast is illustrated by the figure



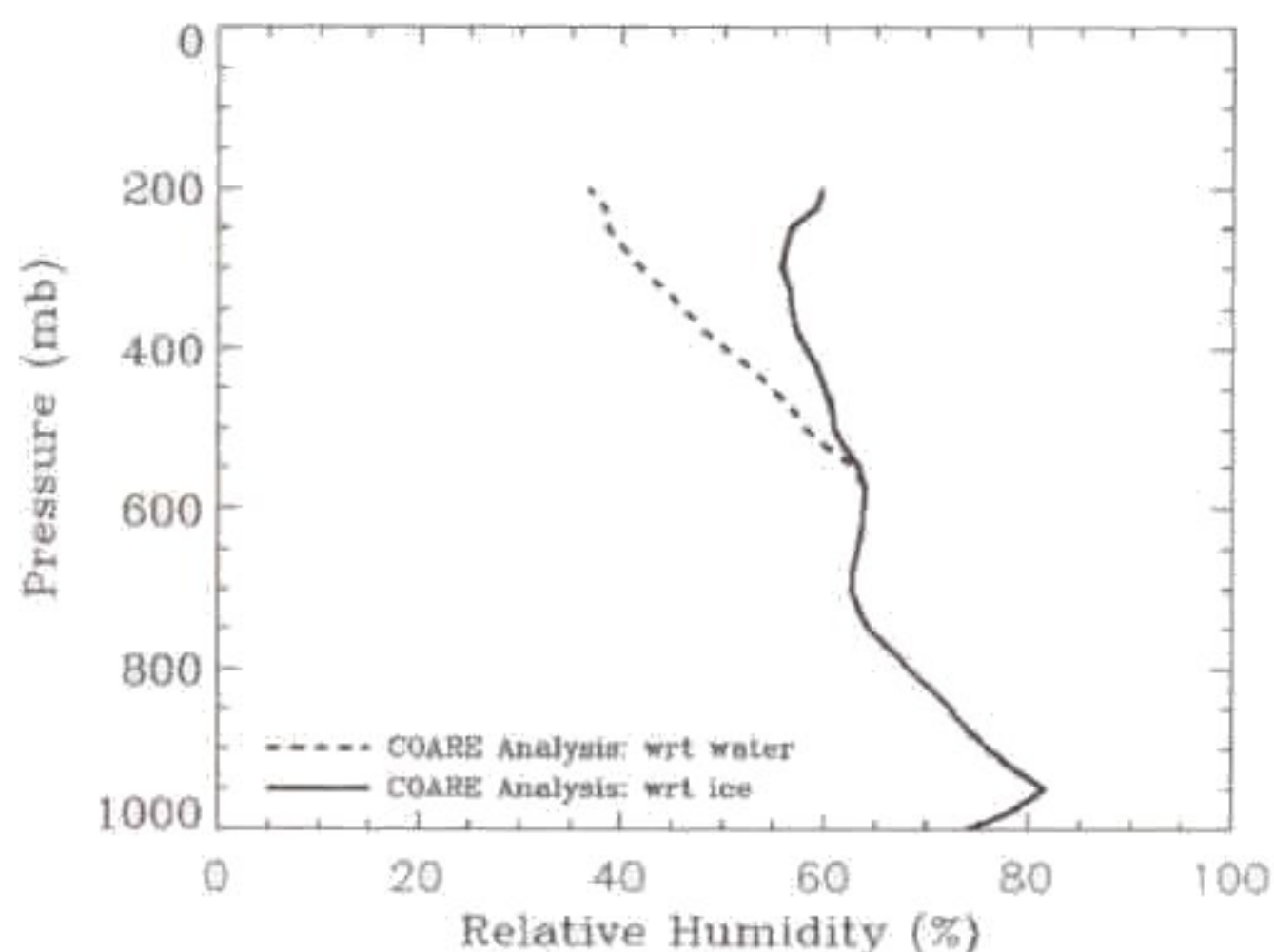
The 500 hPa analyses for a 4-day period from 11 February 1997 (top left) to 14 February 1997 (bottom right). In this sequence a trough deepens as it progresses eastward over the eastern USA and into the Atlantic. Note: the cross points and lines defining the segment cross section used in the figure on page 1.

on page 1 and the figure on page 5 showing the 500 hPa analyses for a 4-day period from 11 February 1997 to 14 February 1997. In the sequence a trough can be seen to deepen as it progresses eastward over the eastern USA and into the Atlantic. This is a typical scenario whereby the strong lower tropospheric temperature gradients between the continent and ocean lead to strong synoptic developments.

The figure on page 1 shows results of forecasts from two versions of the operational model. One version, labeled 'control,' uses the new cloud scheme with a relation that assumes $f_1 = 1$ at $T = 0^\circ\text{C}$ and decreases monotonically to $f_1 = 0$ at $T = -23^\circ\text{C}$. Forecasts labeled 'mod' are obtained using the new scheme with a form of f_1 that treats all clouds colder than 0°C as being all ice. Shown in the upper two panels is the vertical distribution of clouds forecast by the control version of the model (upper panel), the mod version of the model (middle panel) and the mod-minus-control temperature differences (shown bottom panel). The cross sections are defined by the latitude and longitude as given and correspond to the segment indicated in the figure on page 5 by the two cross-points. **Significant amounts of low cloud were forecast over the land area of the segment by the control model. This cloudiness was substantially reduced in the modified forecast as a result of the assumption that more of these clouds contain ice, and individual ice particles being more massive than individual water droplets, fall from the atmosphere faster.** This fall-out of condensate reduces the cloud cover over land which in turn substantially impacts the temperature forecasts in that region (bottom panel). The significant result is that the boundary layer of the modified forecast is much warmer than the boundary layer forecast by the control model (by more than 3 degrees). Conversely, the surface temperature is colder for the mod-forecast. Both effects can be attributed to changes associated with the radiative heating by cloud. In the case of the control, a warmer surface temperature is maintained by the presence of the low cloud and the associated emission of longwave radiation to the surface by these clouds. This cloud, in turn, radiatively cools the lower atmosphere and produces significantly colder atmospheric temperatures. The mod-case with warmer boundary layer temperatures significantly reduces the low-level baroclinity and underdevelopment of the trough occurs in the resulting (poor) forecast.

One of the most noticeable changes caused by the introduction of the new cloud scheme was evident in the humidity structure of the tropical atmosphere. A 3-month average (DJF 1987/88) of the profile of relative humidity over the Western and Central Pacific (15°N to 5°S , 130° to 180°E) taken from T63L31 integrations of the global ECMWF model with the new prognostic cloud scheme is shown in the figure on the next page. The profile derived with the new scheme is given by the solid curve. The difference between this profile and that obtained using the old diagnostic cloud scheme which was operational before April 1995 and shown by the dashed curve is substantial. The decrease in relative humidity just above 200 hPa and the increase in a thick layer between 300 and 700 hPa are due to the strong coupling of the clouds to the convection scheme. Instead of evaporating all detrained condensate it is now able to precipitate into lower layers providing a source of water vapor on evaporation increasing the relative humidity in this broad layer. It is worthwhile noting that the humidity structure below 300 hPa using the new scheme is in much better agreement with TOGA/COARE observations of Lin and Johnson (1996) also shown for reference. Within the climate context, changes of humidity profile of the type shown are profound. **This result serves to illustrate an important point—that the water vapor budget of the climatically sensitive region of the upper troposphere is greatly influenced by the amount of condensate (in the form of ice) and the vertical distribution of this condensate.** Clearly, observations of the ice water content of clouds and the vertical distribution of these clouds are required to verify these more advanced cloud prognostic schemes and model predictions of water vapor.

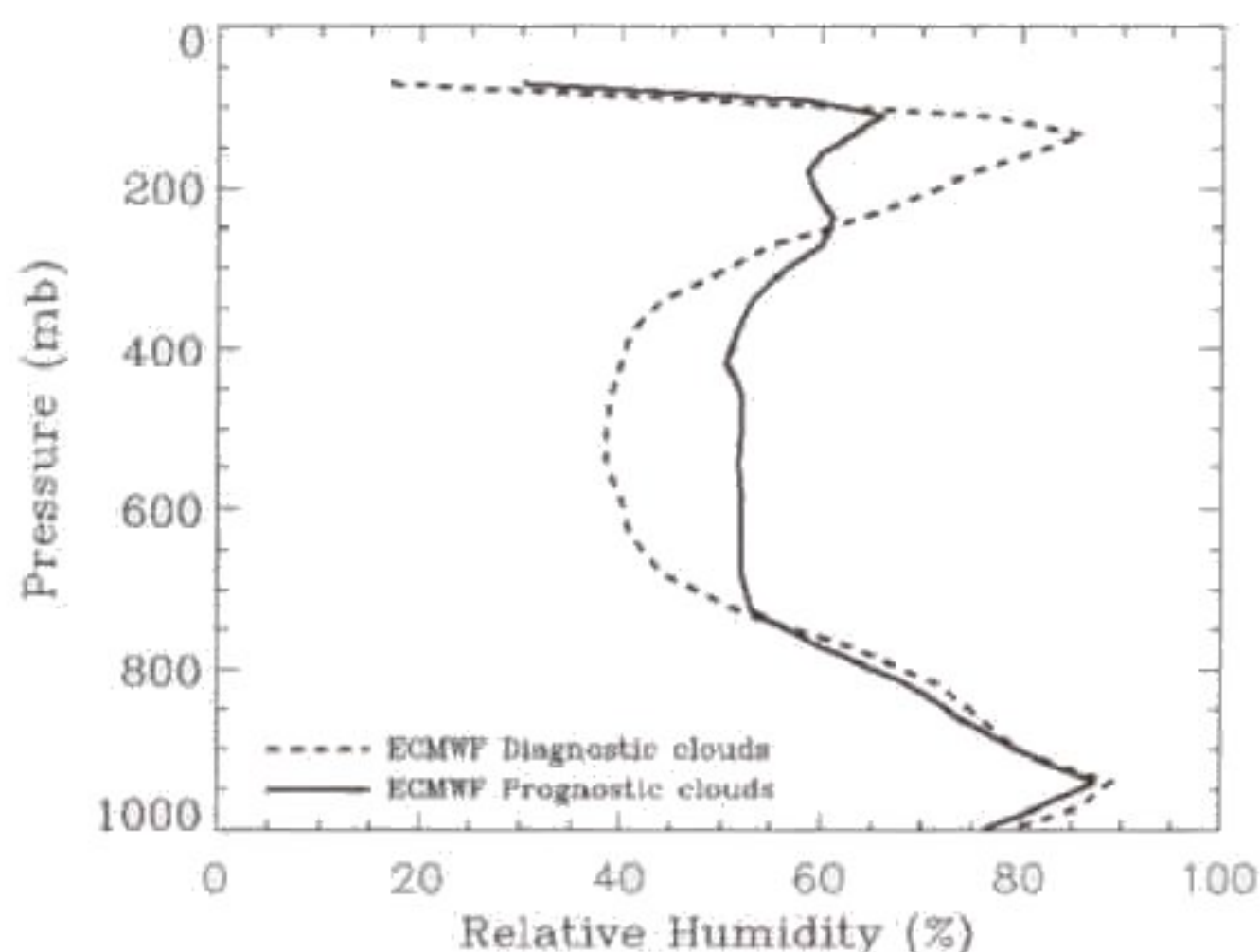
Another reason upper tropospheric clouds are important to climate is because they are high and thus cold. Because these clouds are cold, they emit much less radiation to space (referred to as outgoing-longwave-radiation, OLR) than either low clouds or the surrounding clear sky. This decreased emission is sometimes described as the greenhouse effect of these clouds, and the importance of the enhanced greenhouse effect of these high cold clouds is well recognized. The treatment of ice clouds and the way ice settles in the atmosphere not only affect the humidity profile but also determine their ice content (Jakob and Morcrette, 1995). The radiation balance at the



A profile of relative humidity averaged over DJF 1987/88 and averaged over the region of the tropical pacific (15°N to 5°S, 130° to 180°E). Shown are radiosonde observations from TOGA COARE (Lin and Johnson, 1996).

top of the model atmosphere, in turn, is governed by the ice content of clouds and the way ice is distributed in the vertical. The figure on the left side of back page shows the difference between longwave radiation emitted to space observed by the Earth Radiation Budget Experiment (ERBE) (see Wielicki et al., 1995) minus that obtained by the model. For both cases, the OLR is averaged over the DJF 1987/88 season. The upper panel is the difference between ERBE and the model with the diagnostic version of the cloud scheme and the lower two panels show differences between ERBE and the new scheme with different assumptions about the fall speed of ice particles. The results show substantial differences between ERBE OLR and model OLR derived with the old scheme. Although the new scheme provides significantly better estimates of the OLR, the degree of agreement is a product of tuning the assumptions of the parameterization.

Very little quantitative data exist for testing predictions of ice content by cloud parameterization schemes. To date, we have had to resort to limited observations from a handful of case studies, or to observations obtained from surface radars at a handful of locations, including the cloud radar that is now just beginning to run routinely at the U.S Department of Energy Atmospheric Radiation Measurement (ARM) site in Oklahoma. Mace et al. (1998) provide an analysis demonstrating how composite data available from a continuously operating surface radar can also be



The solid line is the profile obtained from a new ECMWF prognostic scheme; the dashed line is from a previous version of the model with the diagnostic scheme.

used to help verify the model forecasts. We have no way of testing these cloud schemes in a more global context and we are forced to resort to tuning to bring the model into agreement with other observations.

The figure on the right side of the back page is an example of how data from one particular case study has been used to test the cloud scheme. The case study used to produce is the cirrus cloud observed on November 26, 1991, over Coffeyville, Kansas, as part of the FIRE II IFO (see the FIRE II special issue of J. Atmos. Sci., Dec. 1995, for a number of papers describing results of analyses of FIRE II data). The occurrence of cirrus observed on November 26 over Coffeyville was well forecasted by the operational model using short-range forecasts of the ECMWF model at T213L31 resolution (Klein and Morcrette, 1997). Forecasts were run with two different numerical versions of the ice-settling formulation as mentioned above. The upper panel shows time-height radar reflectivity data obtained from the NOAA ERL 35 GHz radar (e.g., Matrosov et al., 1995) converted to ice water content.

The bottom two panels are equivalent time-height cross sections of ice water content obtained by the operational model, but at a much coarser resolution than the radar data. The difference in ice water content between the two versions is large and matches to radar data of this type to help constrain the parameterization.

It is evident from the examples shown above how changes in the treatment of clouds in large-scale models profoundly influence quantities that determine the heat and moisture budgets of the planet. In particular, the radiation and moisture budgets are grossly affected by the way ice clouds are treated in models. Unfortunately, our ability to verify whether or not new and physically improved cloud schemes like that now implemented at ECMWF adequately represent real clouds cannot be properly determined at this time. The limited amount of data such as described above are invaluable, but even these data lack quantitative accuracy in the sense that ice water content obtained directly from radar data alone has significant uncertainties. However, even these data with the attendant uncertainties, if collected from a satellite orbiting Earth, would provide a major advancement on our understanding and prediction not only of ice clouds, but also of upper tropospheric water vapor. **The lack of quantitative global observations of ice content is now deemed to be one of the highest observing needs by the cloud-climate modeling community (WMO, 1995). Sensors that lead to improved methods to observe ice content such as that described by Evans et al. (1998) need to be flown on satellites to obtain observations in climatically critical areas of the globe.** Furthermore, maintenance of long-term observations like those now becoming available as part of ARM is an essential part of this observing philosophy. The combination of these surface observations with new observations from satellites, together with their integration in advanced assimilation/forecast systems, represents a sensible approach to advance our knowledge about these complex but important clouds.

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THE SOUTH CHINA SEA MONSOON EXPERIMENT (SCSMEX)

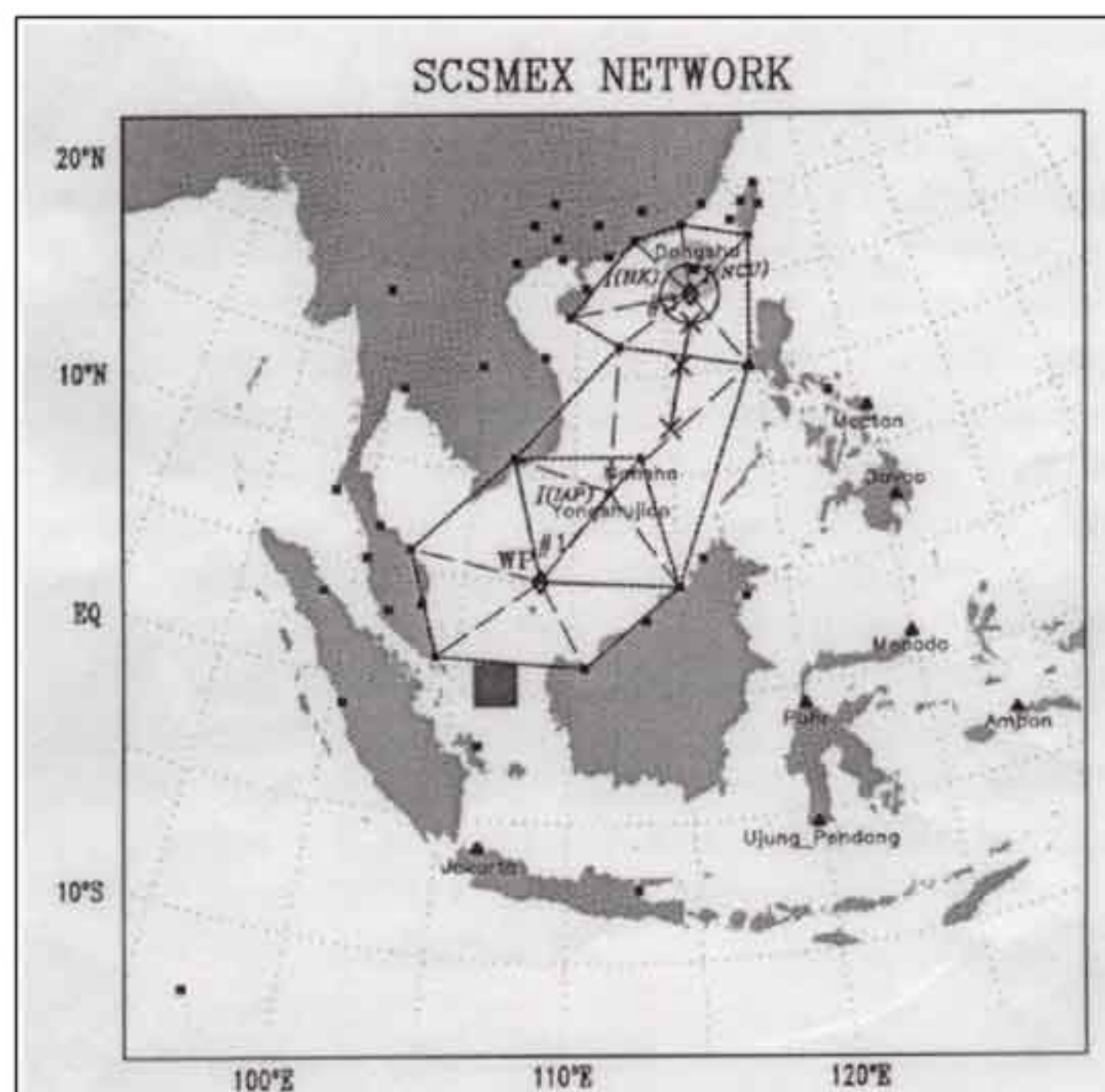
William K.-M. Lau
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SCSMEX is a multinational endeavor that is closely linked to and coordinated with activities of national weather services and research institutions of East Asian countries and adjacent regions, as well as ongoing and planned United States and international field experiments and research programs, such as GEWEX and Climate Variability and Predictability (CLIVAR).

The goal of SCSMEX is to provide a better understanding of the key physical processes responsible for the onset, maintenance and variability of the monsoon over Southeast Asia and southern China leading to improved predictions.

SCSMEX has the following components:

- Pilot Study (1996–1998) — climatological data analysis, including satellite OLR, GPCP, re-analysis, pilot stations and mooring sites, and planning of intensive observation period (IOP) strategies.
- Field Experiment Phase (May 1–July 31, 1998) — upper air sounding stations around the rim of the South China Sea (SCS) will provide routine and enhanced surface observations four times daily. Other measurements will be provided by ATLAS buoys, dual Doppler radar observations on ship and on islands, integrated sounding systems, aerosondes, PBLs, and ocean survey ships.
- Satellite Component (1996–2000) — rainfall estimates from TRMM; deep convective indices and cloud track wind and infrared cloud information from GMS and FY-2; surface winds from ERS 2; moisture data from SSM/I and TMI/TRMM; and AVHRR for sea surface temperature and outgoing longwave radiation.
- Field Data Analysis (1998–2002) — analysis and interpretation of special and routine observations obtained during the field phase.



Tentative upper air sounding network for SCSMEX showing location of stations for Category 1 (■), Category 2 (•), and Category 3 (▲). Approximate locations of ships (◇) and the FY-2 Geostationary satellite (■) are also included.

- Modeling (1996–2002) — mesoscale model simulations, GCMs, nested mesoscale models and global and regional 4-dimensional assimilation.

SCSMEX will be closely coordinated with the GEWEX Asian Monsoon Experiment (GAME). GAME will launch a land atmosphere field campaign over Thailand (GAME-Tropics) from April through August of 1998 that will provide data for the upstream wind and moisture sources that precede the onset of the SCS monsoon. Other components of GAME that are closely linked to the onset and subsequent evolution of the SCS monsoon are GAME-Tibet and GAME-Hubex. Two SCSMEX IOPs will be conducted, one from May 5 to May 25, and another from June 5 to June 25, 1998.

The SCSMEX observational network is shown in the figure above. One of the key observational platforms is an intensive flux array (IFA) consisting of a dual Doppler radar pair for measuring rainfall, convective scale motions and surface fluxes over the open water of the SCS. Being

planned is the deployment of the TOGA radar on board a ship and the Bureau of Meteorology Research Center polarimetric radar on Dongsha island in the northern SCS, situated to the southwest of Taiwan and southeast of Hong Kong (see figure on previous page). The dual radar coverage will be collocated with an ATLAS buoy, which measures rainfall, surface meteorology and subsurface oceanic temperature and salinity. Spatial rainfall information will be provided by the TRMM satellite overflying the area. This configuration will provide a unique validation platform for TRMM ground truth. The radars will be operated for the entire period of May 1 to June 30 to provide rainfall coverage over the northern SCS continuously. Additional raingauges will be deployed on islands and on buoys in the vicinity of the IFA, to provide ground validation data for radar and satellite rainfall estimates.

Enhanced upper air sounding measurements from key stations surrounding the SCS, and continuous wind and temperature measurements from three Integrating Sounding Systems will be provided four times daily during the IOPs. Hourly surface radiation observations will be maintained in all coastal as well as island sites over the SCS during the entire period of the experiment. Aerosonde flights will be carried out during the IOPs to take atmospheric soundings for temperature and moisture for disturbed and undisturbed periods, before and after the monsoon onset. Three Atlas moorings will be deployed in a line from Dongsha to the vicinity of Nansha at the center of the SCS, to monitor thermal structures in the upper ocean and their changes accompanying the onset of the SCS monsoon. During the IOP, two ships will be conducting oceanic surveys of temperature, current and salinity measurements in the northern and southern part of the SCS, and drifting buoys will be deployed to measure surface ocean currents. The SCSMEX Operations Center for the field phase will be set up at the Guangdong Meteorological Bureau in Guangzhou. **A key SCSMEX contribution to GEWEX will be the data and analyses of the land-atmosphere and ocean-atmosphere processes and modelling activities describing a single monsoon system.** For more details of the SCSMEX Operations Plan, interested readers are referred to the web site for SCSMEX:

http://www.joss.ucar.edu/joss_psg/project/scsmex/

WINTERTIME SURFACE ENERGY BUDGET WITHIN THE GCIP DOMAIN

Tilden P. Meyers¹ and Steven Hollinger²

¹NOAA/ARL/Atmospheric Turbulence and Diffusion Division
²Illinois State Water Survey

As part of the GEWEX effort to improve the parameterizations of the land-surface processes in short-, medium- and long-range forecast models, long-term continuous direct measurements of the components of the surface energy balance have been initiated at several locations within the GCIP domain. In June of 1995, the first system was installed within natural rangeland in the Little Washita Watershed, which is located in the GEWEX/GCIP large-scale area (LSA) southwestern (SW) region. In August 1996, a second flux measurement system was deployed within an agricultural area near Champaign, Illinois, which is in the GEWEX/GCIP north central (NC) region. These sites are typical of the land surface characteristics for their respective region and will provide detailed information on the seasonal and annual cycle of the local surface energy budget. One area of special interest to the GCIP program is the cold season energy budget, which is affected by both land surface and hydrological processes.

At the earth's surface, the net radiant flux (R_n), which consists of outgoing and incoming longwave ($\uparrow R_s, \downarrow R_s$) radiant components, is used to warm the air (sensible heat flux, H), evaporate water (latent energy flux, LE), and warm the ground (ground heat flux, G). In the case of a forest, a significant amount of energy can be stored or released (S) from the woody biomass of the stand. On average, the incoming and outgoing energy fluxes are balanced, such that

$$R_n = \uparrow R_s + \downarrow R_s + \uparrow R_L + \downarrow R_L = H + LE + G + S$$

The latent energy flux, also called evapotranspiration (ET), is the amount of water lost from the earth's surface to the atmosphere because of both transpiration by plants and evaporation from the surface itself. During the winter season, evapo-

ration is mainly from the ground surface since most plant communities have completed their growth cycle or are dormant. Measurements made during the winter of 1996–97 at Champaign, Illinois have provided new information on the cold season characteristics of the surface energy budget, some of which will be highlighted here.

The energy fluxes of latent and sensible heat are measured at the GCIP sites using the eddy covariance method (Businger, 1986; Baldocchi et al., 1988). Using this technique, the average vertical turbulent eddy fluxes of sensible and latent heat (and other scalars) are each determined as

$$\overline{w'\chi'} = \frac{\sum_{i=1}^n (w - \langle w \rangle)(\chi - \langle \chi \rangle)}{n}$$

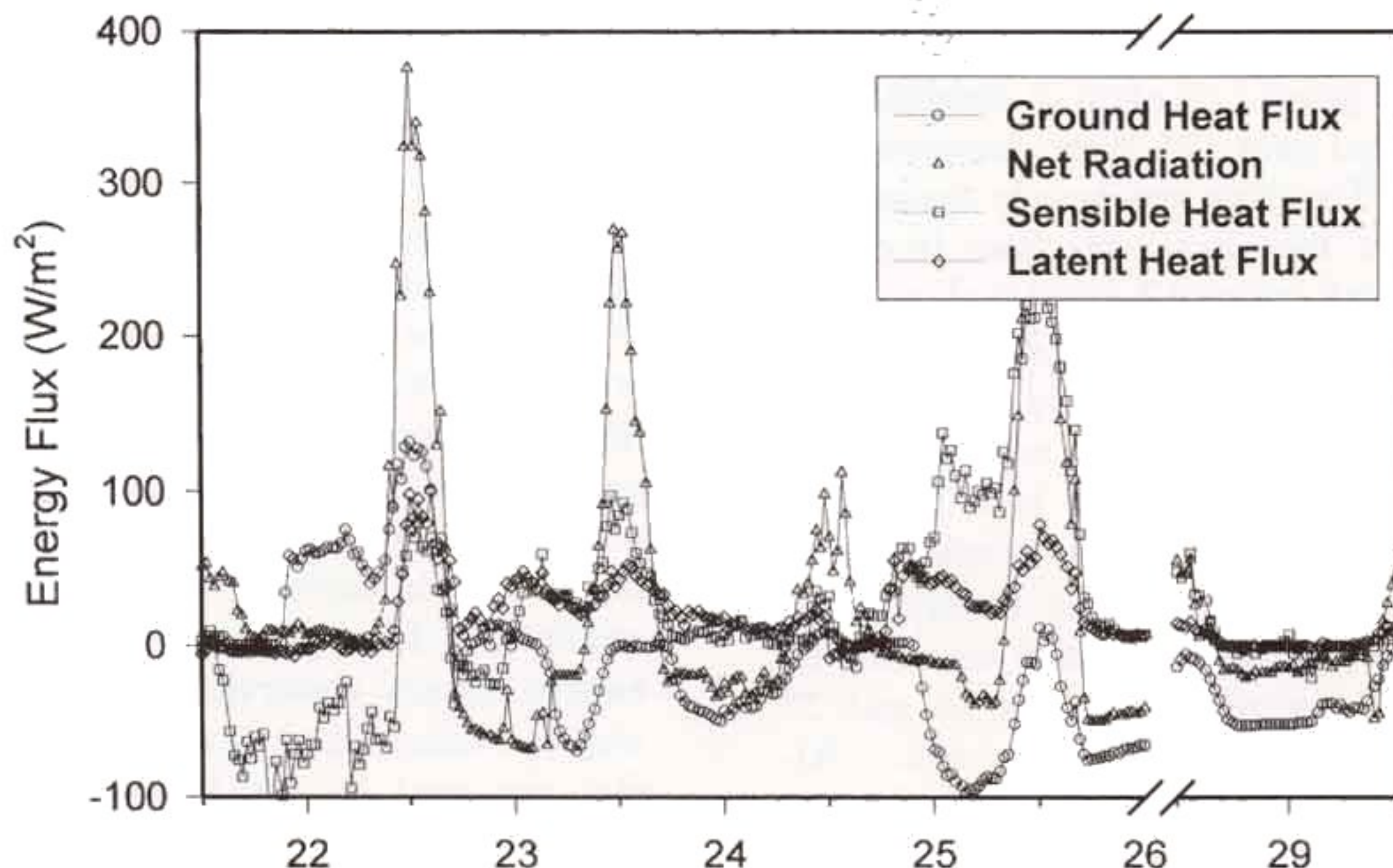
where w is the vertical velocity component of the wind vector and x is the scalar of interest (e.g., water vapor concentration). Here, the bracketed quantities denote a time average or "mean" that is subtracted from the instantaneous values to obtain the fluctuating component.

Wind component and temperature measurements are made with a 3-dimensional sonic anemometer (Solent model R2). Water vapor

and CO_2 concentration measurements are made with an open-path, fast response infrared gas analyzer (Auble and Meyers, 1992). Data from these sensors are obtained at 10 Hz, and recorded with a laptop computer. Standard meteorological data include air temperature and relative humidity, precipitation, net radiation, incoming global radiation, incoming and reflected visible radiation, barometric pressure, ground heat flux, surface wetness, and soil temperatures at 6 depths (2 cm, 4 cm, 8 cm, 16 cm, 32 cm, and 64 cm). Soil moisture sensors are located at depths of 4, 20 and 60 cm. These standard meteorological sensors are sampled every 2 seconds with a data logger and averages are computed every 30 minutes.

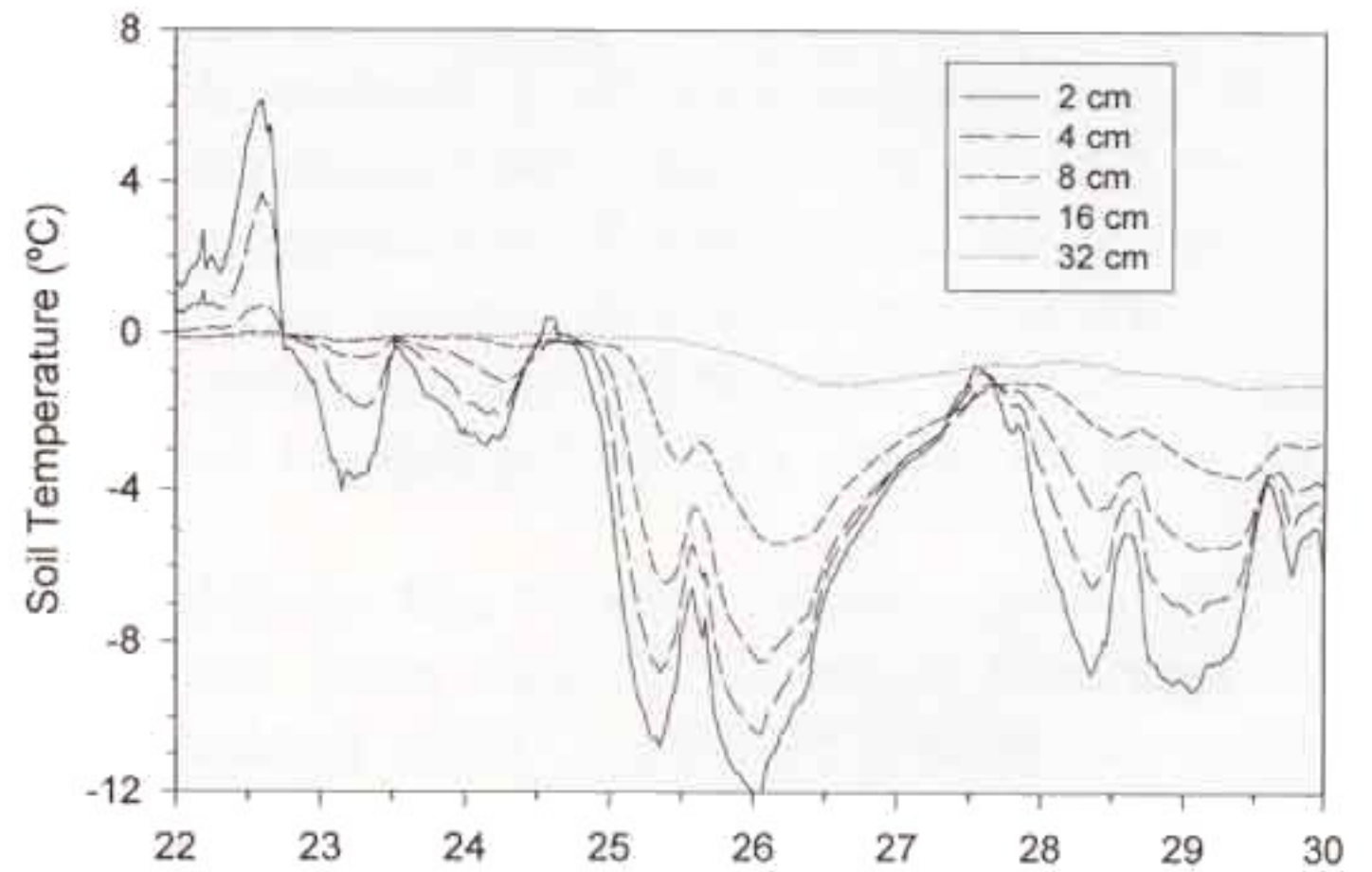
Data are retrieved on a daily basis from the laptop computer, which is equipped with a modem and cellular phone. The entire flux system, including all the instruments, data logging devices, and communication equipment is powered by nine deep-cycle 12-volt batteries that are charged daily by an array of ten solar panels.

The diurnal cycle of the energy budget depicted in the figure below from January 21–31, 1997, is typical of that often observed at the central Illinois flux system. There are several key aspects of this 10-day period that reflect



Winter energy fluxes, January 1997, Champaign, Illinois.

many of the processes that govern the wintertime surface energy balance. Just before this period, the ground was covered with some snow and the average temperatures were well below freezing. Beginning early January 22, just after midnight, a rapidly developing low pressure system was approaching from the west, resulting in a relatively warm southwest wind. With the air temperatures warming above the near freezing ground temperatures, heat was being transferred from the air to the surface (negative heat flux), with sensible heat fluxes near -100 W/m^2 . This warming of the upper layers of the ground surface by the overlying warmer air produced positive ground heat fluxes (heat conducted into ground) of nearly 80 W/m^2 . As day 22 unfolded, the effect of the relatively cloudless sky (good solar heating) combined with the warm southerly breezes, resulted in daytime ground heat fluxes of nearly 125 W/m^2 , followed by a latent heat flux of 100 W/m^2 and sensible heat flux of nearly 80 W/m^2 . As the storm system passed, winds shifted to the northwest, bringing colder air to the region. During the early morning hours of day 23, a weak high pressure system brought in enough cold dry air to maintain both H and LE fluxes near 50 W/m^2 . That is, the ground heat was being lost to the air while at the same time evaporating water. Following a weak low that passed through on January 24, a stronger Arctic high pressure system ushered in much colder air during the early morning hours on the 25th. The cold air blowing over the relatively warmer ground resulted in sensible heat fluxes that averaged over 125 W/m^2 between midnight and 9 AM. This flux was largely maintained by the rapid rate that heat was lost from the ground surface with ground heat fluxes peaking near -100 W/m^2 . Sky conditions the following day (day 25) were partly to mostly sunny. The combined effect of the solar heating and the passing cold air mass drove the sensible heat fluxes to values near 250 W/m^2 , comprising nearly 90% of the net radiation, a sharp contrast to day 22 in which ground heat fluxes consumed most of the available energy. Snowfall on days 26 and 27 produced a 10 cm snowpack at the site. Although days 29–31 were partly to mostly sunny, net radiation only reached 80 W/m^2 because of the high albedo from the fresh snowcover. The



Soil temperature, January 22–30, 1997, Champaign, Illinois.

resulting fluxes from this available energy were equally partitioned between sensible, latent and ground heat fluxes during the daytime period.

During this 10-day winter period, the sensible heat flux shows little evidence of a diurnal cycle until after the ground is covered with snow, which provides insulation from the large temperature excursions associated with the changing air mass temperatures. The ground temperatures at 2, 4, 8, 16, 32 and 64 cm show some evidence of a diurnal cycle. However, this cycle is superimposed on a larger amplitude pattern that, like the sensible heat flux, is associated with the changes in the air mass temperatures from synoptic scale systems. The time series of the winter heat fluxes and associated ground temperatures are markedly different from those observed during the spring, summer and fall periods. During these periods, energy fluxes and temperatures are driven mostly by the available incoming solar energy, whereas the influence of passing air masses is more important during the winter. **Note that short- and medium-range forecast models, which simply parameterize the surface energy balance components as seasonally dependent fractions of the available energy (net radiation), would be challenged to reproduce the observed surface energy fluxes reported here.** Plans are under way to evaluate and test the land surface schemes that are used by the European Centre for Medium-Range Weather Forecasting (ECMWF) and the National Centers for Environmental Prediction (NCEP) with the observations from this study.

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Businger, J.A., 1986. Evaluation of the accuracy with which dry deposition can be measured with current micrometeorological techniques. *J. Clim. Appl. Met.*, 25, 1100-1124.

Baldocchi, D.D., B.B. Hicks and T.P. Meyers, 1988. Measuring biosphere-atmosphere exchanges of biologically related gases with micrometeorological methods. *Ecology*, 69, 1331-1340.

PIERS SELLERS HONORED



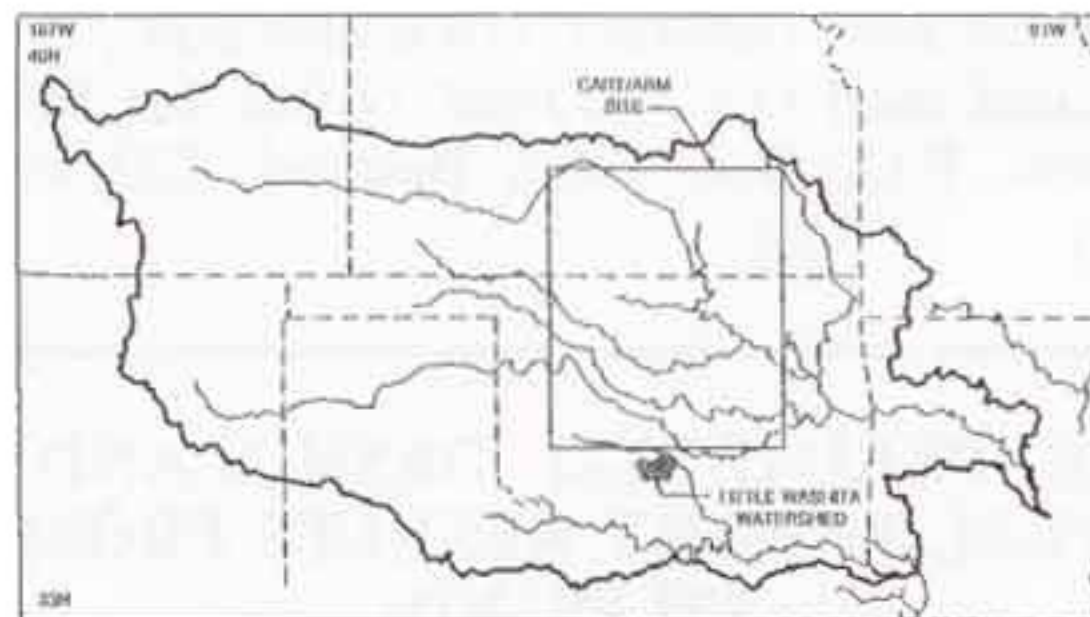
Presentation of the American Meteorological Society (AMS) 1997 Henry G. Houghton Award to Dr. Piers J. Sellers by Dr. Paul D. Try.

The Henry G. Houghton Award is given to an individual in recognition of research achievements in the field of physical meteorology, including atmospheric chemistry. The AMS President presents the award at the AMS Annual Meeting. Piers Sellers, former Chairman of the International Satellite Land-Surface Climatology Project, was unable to attend the Awards Ceremony held in Long Beach, California, last year. He is presently in astronaut training to be a mission specialist in the U.S. space program. Using an opportunity of a visit by Piers Sellers to the Washington, D.C. area, Paul Try presented him with the award. Dr. Sellers was honored "for outstanding achievements in the development and field testing of models describing land biosphere-atmosphere interactions".

**WARM SEASON GCIP
DATA SET AVAILABLE ON-LINE
AND ON COMPACT DISK**

**Steven F. Williams
University Corporation of
Atmospheric Research (UCAR)
Joint Office for Science Support (JOSS)
and John A. Leese, GCIP Office**

The last in a series of GCIP Initial Data Sets is now available. Future data sets are being compiled as part of the 5-year Enhanced Observing Period from 1996 through the year 2000. The Warm Season data set contains the data collected during the Enhanced Seasonal Observing Period conducted in the Arkansas-Red River basin from 1 April through 30 September 1995 (see Figure below) and is identified as the ESOP 95 data set.



Arkansas-Red River Basin Boundary

The ESOP-95 data can be obtained through on-line access using the UCAR/JOSS Cooperative Distributed Interactive Atmospheric Catalog (CODIAC) system at the url address on the World Wide Web: (http://www.joss.ucar.edu/gcip/gcip_in_situ.html) or through the GCIP Home Page (<http://www.ogp.noaa.gov/gcip/>) and selecting the "In-situ Module" under the Data Access heading.

UCAR/JOSS in cooperation with NOAA's Office of Global Programs have published a subset of ESOP-95 data on CD-ROM. The CD-ROM includes imagery (GOES satellite infrared, visible, and water vapor channels; radar and derived precipitation composites, surface/upper air maps, and vegetation index, surface meteorological composites, rawinsonde and profiler data, hydrologic data (streamflow and reservoir), observing station lists, data extraction software tools, and

complete file documentation. The CD-ROM has been mastered in ISO9660 allowing for easy use on a variety of computer systems and work stations.

The data on the CD-ROM set are provided in a format compatible with a variety of commercially available software packages (i.e., GIF image viewers and most spreadsheets). Also, a "browse" software tool set compatible for use with the CD-ROM set has been compiled and is available through UCAR/JOSS. Various versions of this software package compatible with either DOS personal computers, UNIX, and Macintosh are available. Copies of the CD-ROM and "browse" software package are available from UCAR/JOSS.

Please direct all requests or questions regarding the ESOP-95 data to JOSS by telephone (303) 497-8987, Facsimile (303) 497-8158, electronic mail (Internet: sfw@ucar.edu), or conventional mail (UCAR/Joint Office for Science Support, P.O. Box 3000, Boulder, CO 80307, USA).

EXPERIMENTAL DESIGN AND PRELIMINARY RESULTS FROM PILPS 2(D)

AUTHORS' ADDENDUM

In the article by Schlosser et al. (1997) (Experimental design and preliminary results from PILPS Phase 2(d), GEWEX News, November 1997, pp 9-11) the source of the data being used for the Valdai experiments in PILPS was inadvertently omitted. These data were obtained through the considerable efforts of Alan Robock, Konstantin Vinnikov and Nina Speranskaya. Further information on these data can be obtained in Robock et al. (1996) and Fedorov (1977), or at the Web site: http://metosrv2.umd.edu/~alan/soil_moisture/. We wish to apologize for omitting this information from the original article.

Vinnikov, K. Ya., A. Robock, N.A. Speranskaya and C.A. Schlosser, 1996. Scales of temporal and spatial variability of midlatitude soil moisture. *J. Geophys. Res.*, 101, 7163-7174.

Fedorov, S.F., 1977. A Study of the Components of Water Balance in Forest Zone of European Part of the USSR (in Rus.). *Gidrometeoizdat, Leningrad*, 264 pp.

MEETING SUMMARIES

GEWEX CLOUD SYSTEM STUDY (GCSS) WORKING GROUP 3 (WG-3) WORKSHOP

10-12 July 1997

Brian Ryan
CSIRO

The 3rd GCSS WG-3 Workshop was held in Echuca, Australia. Topics addressed were: (a) model intercomparisons, (b) regional case studies, (c) orographic clouds, (d) archiving, and (e) frontal systems in large-scale climate models.

The model intercomparison based on the south-eastern Australian extra-tropical layering case was made using a domain at 20-km resolution for limited area models (LAM), a domain at 5-km resolution using cloud resolving models (CRM) and single column models (SCM) over a 300 km domain. The models taking part at 20-km resolution were the Commonwealth Scientific and Industrial Research Organization (CSIRO) limited area model (DARLAM), the Colorado State University model Regional Atmospheric Modeling System (RAMS) run by CSIRO, a high resolution European Centre for Medium-Range Forecasting (ECMWF) simulation (T213), the Canadian limited area model MC2, and the German REMO/GESIMA limited area model from GKSS. The models taking part at 5 km resolution were the Canadian MC2 model, the German REMO/GESIMA model and RAMS. The SCM models used were the Canadian CCCma, the German ECHAM and the ECMWF SCM.

The model intercomparison showed that:

- There is similarity between the ECMWF simulation (T213) and the 20-km LAM simulations.
- MC2 run at 5-km resolution suggests that the LAM models are predicting the correct cloud types.
- Cloud top pressure-tau (optical depth) diagrams showed that the LAM simulations and MC2 run at 5-km resolution behaved well in strongly forced situations but poorly in weakly forced situations.

- LAM is a valuable intermediate step between the GCM and the CRM.
- The technique of how to force a single column model in a frontal case was resolved by deciding to force the SCM with the advection computed from "average" DARLAM values of the winds for the box.
- A consequence of the long life-times of the frontal systems is that the effects of the planetary boundary layer (PBL) scheme and specification of surface conditions can have significant effects on the model frontal clouds in the LAMs.

The workshop considered regional case studies identified by Working Group 3 as suitable for investigating the impact of the parameterization of cloud processes in climate and numerical weather prediction models. In particular, preliminary modelling results from the Beaufort Arctic Storm Experiment (BASE), Canadian Atlantic Storm Project II (CASP II) and Baltex Pilot Study for Intensive Data Collection and Analysis of Precipitation (PIDCAP), and overviews of the Fronts and Atlantic Storm-Track Experiment (FASTEX) and, the Southern Alps Experiment (SALPEX) were discussed at the workshop.

The deliverables from the workshop were:

- Outline of Cold Fronts Research Program (CFRP) methodology paper
- A strategy to improve the parameterization of orographic clouds
- Survey and compositing strategy to generalize case studies
- CD Data archive for field observations and model intercomparisons

The 4th GCSS WG-3 Workshop is planned to be hosted by GKSS in Geesthacht, Germany from 2–4 June 1998. The aim of the next intercomparison is to test the methodology developed for the Australian case study on case studies from CASP II and FASTEX. Updates on the activities of WG3, including preparation for the 4th workshop, can be found on the WG-3 home page.

The WG-3 home page is linked to the GEWEX Projects web site via the GCSS web site.

GEWEX RADIATION PANEL (GRP)

22–25 July 1997

The ninth session of the GRP was held in Honolulu, Hawaii. The main topic addressed at the meeting was how to advance our understanding of the effect of aerosol radiative forcing on the global climate. To address this issue, the GRP at its 1996 meeting, proposed the organization of the GEWEX Global Aerosol Climatology Project (GACP). At the January 1997 meeting of the GEWEX Science Steering Group, GACP, was officially endorsed. In September 1997, a NASA Research Announcement was released for the formation of an aerosol radiative forcing science team. As GACP becomes an active effort, it is anticipated there will be considerable collaboration with other GEWEX projects, such as the International Satellite Climatology Project, GEWEX Cloud System Study, Surface Radiation Budget, and the GEWEX Global Water Vapor Project.

Progress reports on GEWEX activities included the status of the Baseline Surface Radiation Network. It was reported that 14 sites are providing data to be archived and another 12 sites will soon be operational. The Clouds and Earth Radiant Energy System (CERES) investigation of cloud/radiation feedback on the climate system was also reviewed. Specifically discussed was the schedule for the CERES instruments and algorithms for upcoming satellite missions, such as the Tropical Rainfall Measurement Mission (launched in November 1997), the Earth Observing System (EOS)-AM (June 1998), and EOS-PM (December 2000). CERES will provide improved estimates, for use in global climate models, of broadband shortwave and longwave fluxes at the earth's surface and in the atmospheric column. Methods on how to determine diurnal and other natural variability of radiation, clouds and precipitation were discussed; for example, merging daily 1x1 degree satellite-derived data with statistics or conventional data to identify the diurnal cycle. However, the complicated relationships between temperature and column water vapor, combined with feedback by clouds and latent heat associated with precipitation, were identified to

be important in the governing of the global hydrological cycle.

In addition to the scientific deliberations and briefings on WCRP radiation projects, there were presentations on the recently launched Chinese satellite (FY-2); the Global Positioning System; and on proposed efforts, such as the Arctic Cloud Experiment, which is designed to improve understanding of the role of arctic clouds in the global climate system.

The 1998 meeting of the GRP is tentatively scheduled to be held in Scotland.

TRADE CUMULUS WORKSHOP GCSS WORKING GROUP-1

24-25 July 1997

**Christopher S. Bretherton
University of Washington**

Approximately 35 people from the United States, the Netherlands, the United Kingdom, Germany, France, Spain, and Canada participated in a very successful workshop on the simulation of trade cumulus convection. This workshop, held in Seattle, Washington, was an activity of the GEWEX Cloud System Study (GCSS) Boundary Layer Cloud Working Group (WG1).

A case study from the 1969 BOMEX trade cumulus experiment was used to intercompare 6-hour simulations from eleven 3-D and two 2-D eddy-resolving simulations, and 36-hour simulations from six 1-D models such as might be used within GCMs.

In general, turbulence and cloud statistics agreed quite well with the 3-D models. Mean cloud amounts of 0.06-0.2 were obtained by all models, in agreement with the observations. Sensitivity studies conducted with several of these models suggested that the resolution (50 m horizontal/100 m vertical) and domain size (6.5 km wide by 3.2 km high) used were adequate to obtain reliable statistics. This is in contrast to results from earlier workshops on stratocumulus clouds under strong inversions, which showed that the vertical resolution must be as low as 5-10 m to predict entrainment rates into the clouds. The 1-D trade-

cumulus models tended to predict more cloud cover and have 2- to 4-fold higher average liquid water path than the 3-D models. In general, the 3-D results were surprisingly consistent with entraining plume models of clouds; results will be analyzed further for more evidence of buoyancy sorting effects on the mean cloud properties. A comparison of 1-D and 3-D model-predicted momentum fluxes will also be carried out by WG1.

Another intercomparison workshop on a trade cumulus case with somewhat higher cloud fractions will be held 24-26 August 1998, in Madrid, Spain. The possibility of organizing a new field experiment on trade cumulus clouds that would coordinate modern surface-based remote sensing technology with *in situ* measurements was also discussed. For updates on WG1 activities, visit the GEWEX web site, select "GEWEX Projects," then find the link to the GCSS web site.

GEWEX HYDROMETEOROLOGY PANEL (GHP)

9-12 September 1997

**T. Yasunari
University of Tsukuba**

The charge for the third meeting of the GHP, held in Sapporo, Japan, was to develop specific actions to advance progress on the scientific themes that relate to assisting GEWEX in demonstrating 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.

Scientific issues and specific science and implementation questions raised at the previous session were addressed. Each Continental Scale Experiment (CSE) was reviewed in terms of its specific objectives and strategy; progress towards GHP goals and milestones; modelling capabilities; ground-based and satellite observational networks; data centers and regional data products; and interactions with other CSEs and GEWEX projects.

Two breakout groups were formed to address the main scientific issues. The **Modelling Group**



Participants at GHP Third Session, Faculty House Trillium, Hokkaido University, Sapporo, Japan.

discussed a strategy for global applications; the current level of modelling activities in the CSEs; other modelling efforts needed; ways to ensure consistent boundary conditions; the treatment and archival of model data; and connections to water resource managers and to other elements of the research community. The **Observations/Processes Group** discussed ways of ensuring current process/diagnostic studies are broadened over all of the CSEs; the identification of other process studies of importance that are not currently under way; data sets of relevance to GHP that currently exist or will be acquired in the near future; and a consistent intensive operations strategy.

Both breakout groups addressed a number of specific questions. The **Observations/Processes Group** discussed the strategy for global applications of the specialized data sets being developed within each CSE and the role of the CSEs in providing intensive data sets that can be used for validation of models and remote sensing. **There was an agreement that a database should be developed for common data elements, over a common time period and with common formats that GHP can provide for global models and remote sensing comparison exercises.** This conclusion was partially motivated by the realization that the next generation of earth observing system satellites will make a major contribution to global climate research only if improved algorithms and validation schemes are in place. GHP is uniquely positioned to ensure that these goals

are met. **The GHP adopted the recommendation that a drafting team with at least one representative from each CSE plus an expert from ISLSCP, produce a strategic planning document that addresses the implications of a "Coordinated Intensive Field Observing Period (CIOP)."** The plan would address the basic science objectives and practical implementation and coordination issues associated with such an effort.

The **Modelling Group** addressed the implications of a strategy for global model transferability and applications. A separate drafting team was recommended to complement and work with the processes study group to ensure a consistent overall GHP strategic approach. However, this group will emphasize the implications of the transferability of coupled land/atmosphere models and the management of the data required to address the transference of these models as a first step to their application globally. These elements of the overall plan will be ready in draft form, at least one month prior to the next GHP meeting to allow a full review of the science and implementation issues by the full Panel.

It was agreed that the next meeting of the Panel would be hosted by GCIP with Rick Lawford acting as Chair. The meeting will take place in Boulder, Colorado, from 14 to 18 September 1998, including a 3-day small scientific workshop.

**GEWEX CLOUD SYSTEM
STUDY SCIENCE PANEL
(GCSS) MEETING**

1-5 December 1997

The Sixth Session of the GCSS Science Panel met in Boulder, Colorado, USA. At the meeting the 1997 activities of the four GCSS working groups were presented and plans for 1998 discussed. In addition, there were presentations on related activities to GCSS including updates on the Tropical Rainfall Measuring Mission satellite cloud radar, field projects such as Surface Heat Budget of the Arctic Ocean (SHEBA), new regional cloud data sets produced by the International Satellite Cloud Climatology Project, and modeling activities such as the Atmospheric Model Intercomparison Project (AMIP).

The meeting opened with a discussion addressing GCSS connections to other GEWEX and WCRP activities. Items included improving interaction between GCSS and the GEWEX Modeling and Prediction Panel (GMPP), the Working Group on Numerical Experimentation (WGNE) and with large-scale modeling centers. Overviews of relevant GCSS activities at the European Centre for Medium-Range Weather Forecasting (ECMWF) and the National Centers for Environmental Prediction (NCEP), were presented the first day. In the discussions of the coupling of Cloud Resolving Models (CRM) to GCMs, the cloud feedback issue was identified as the leading cause of uncertainty in the large-scale models. Results from the GMPP were reported to include cloud feedback issues on the role of convection in producing precipitation and cirrus clouds.

The GCSS working group presentations reviewed results of recent workshops:

The Working Group 1 (WG-1) Boundary Layer Clouds report included a discussion of the workshop held in 1997 (see page 16) in this issue and plans for the next workshop to be held in Madrid, Spain, 24-26 August 1998.

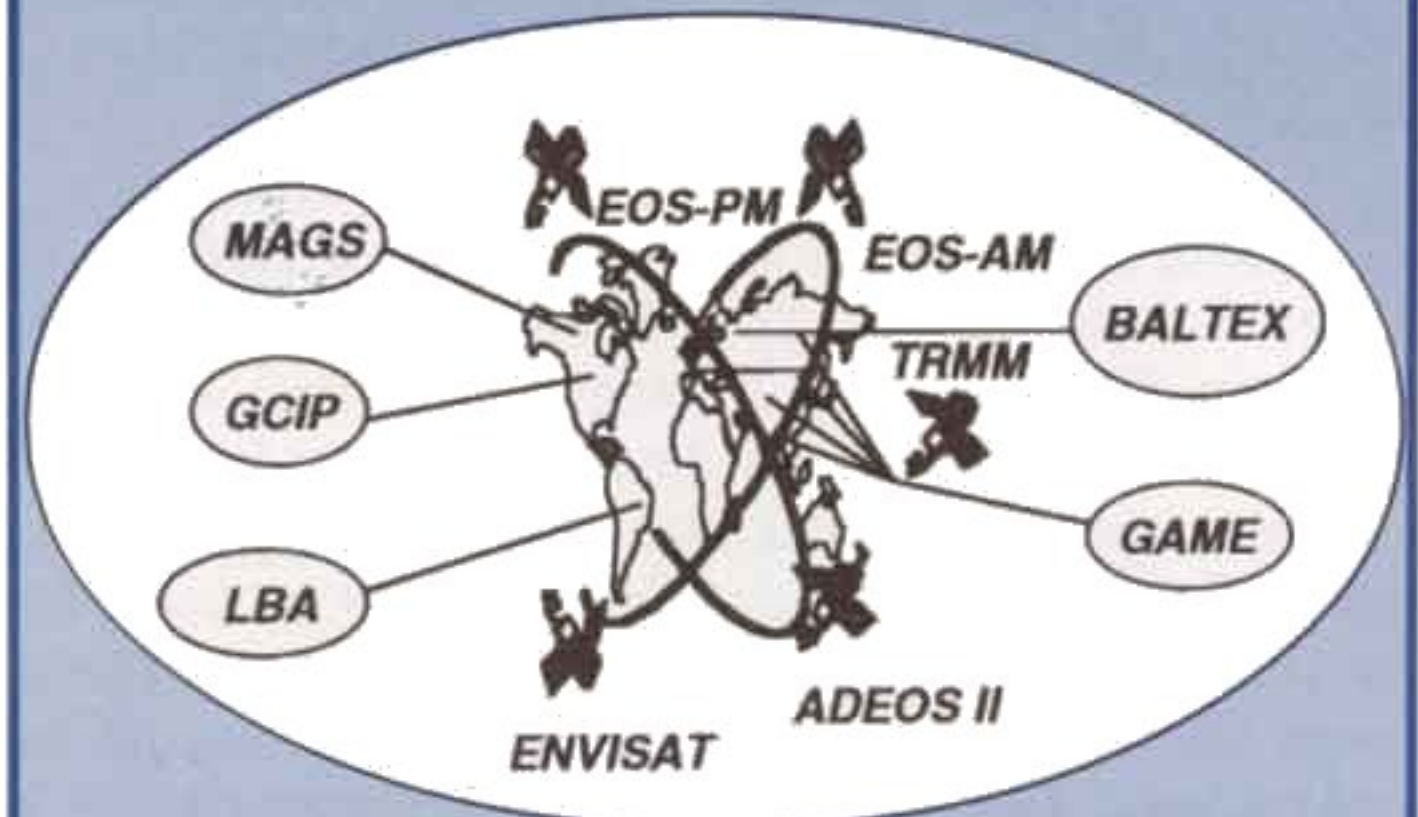
The Working Group 2 (WG-2) Cirrus Cloud Systems discussion included the problem of ice falling speed from cirrus and the need of *in situ* aircraft measurements. A case study was proposed as one of the agenda items at the 1998 Spring workshop in Europe.

There was considerable discussion of the Working Group (WG-3) Extra-Tropical Layer Cloud Systems Activities including a WG-3 workshop held in Australia, the Fronts and Atlantic Storm-Track Experiment (FASTEX) (see November 1997 issue of *GEWEX News*), orographic issues, connection to the AMIP and other modeling activities. The next WG-3 workshop is scheduled for 2-4 June 1998 in Geesthacht, Germany. The new chairman of WG-3 is Brian Ryan of CSIRO.

Working Group 4 (WG-4) Precipitating Cloud Systems Activity report included a discussion of a TOGA COARE case study on fluxes using an ISCCP cloud data set (for details see Bulletin of American Meteorological Society, Volume 78, No. 5, May 1997 pages 831-845). The next WG-4 workshop is scheduled for the summer of 1998 in Salt Lake City, Utah, USA.

The next GCSS Science Panel Meeting is planned for 1-4 December 1998 in Kauai, Hawaii, USA.

**GEWEX BEGINS PLANNING
FOR A COORDINATED
INTENSIVE OBSERVING
PERIOD (CIOP)**



To take advantage of the new suite of satellites and instruments, a Coordinated Intensive Observing Period has been suggested for the GEWEX Continental-Scale Experiments [BALTEX, GAME, GCIP, LAB and MAGS] in the 2001-2002 time frame. The GEWEX Hydrometeorology Panel has adopted the recommendation and has formed a committee to draft a planning document that addresses the implementation of CIOP.

WCRP/GEWEX MEETINGS CALENDAR

For calendar updates consult GEWEX Web Site:

<http://www.cais.com/gewex/>

18-19 March 1998—GAME REMOTE SENSING MEETING, Tokyo, Japan.

16-21 March 1998—WCRP, JOINT SCIENTIFIC COMMITTEE, Capetown, South Africa.

14-17 April 1998—GPCP WORKING GROUP ON DATA MANAGEMENT, LaJolla, California, USA.

20-23 April 1998—SECOND MEETING OF THE CLIVAR ASIAN - AUSTRALIAN MONSOON PANEL, Kyongju, Korea.

22-25 April 1998—INTERNATIONAL CONFERENCE ON MONSOON AND HYDROLOGIC CYCLE, Kyongju, Korea. For conference information contact Prof. In-Sik Kang, Seoul University, Seoul, Korea. Tel: 82 2 880-6718; Fax: 82 2 885-7357; E-mail: kang@climate.snu.ac.kr or Paul Try, IGPO, Silver Spring, Maryland, USA, Fax: 301-427-2222, E-mail: gewex@cais.com.

27 April - 1 May 1998—ISLSCP SCIENCE PANEL; JOINT ISLSCP/BAHC INTERNATIONAL WORKSHOP ON LAND SURFACE DATA IN CLIMATE AND WEATHER MODELS; AND BAHC SCIENCE STEERING GROUP, Paris, France.

18-22 May 1998—5TH BSRN SCIENTIFIC AND REVIEW WORKSHOP, Budapest, Hungary.

24-29 May 1998—OCEAN CIRCULATION AND CLIMATE: THE 1988 WOCE CONFERENCE, Halifax, Nova Scotia, Canada. For conference information, WOCE IPO, UK, Tel: 44 1703 596789; Fax: 44 1703 596204; E-mail: woceipo@soc.soton.ac.uk.

25-29 May 1998—2ND STUDY CONFERENCE ON BALTEX, Island of Ruegen, Germany. For information contact Dr. Hans-Joerg Isemer, International BALTEX Secretariat, GKSS Forschungszentrum Geesthacht, Germany. Phone: +49 4152 87 1536, Fax: +49 4152 87 2020, E-mail: isemer@gkss.de.

2-3 June 1998—GVaP UTH COMPARISON WORKSHOP, Darmstadt, Germany.

2-4 June 1998—GCSS WORKING GROUP III WORKSHOP, Geesthacht, Germany.

8-12 June 1998—GCIP MISSISSIPPI RIVER HYDROMETEOROLOGICAL CONFERENCE, St. Louis, Missouri, USA. For information contact Adrienne Calhoun or Rick Lawford, GCIP Project Office, NOAA Office of Global Programs, 1100 Wayne Avenue, Suite 1210, Silver Spring, Maryland, 20910, USA. Tel: 301-427-2089 ext. 511; Fax: 301-427-2222, or for general information on the Mississippi River Celebration visit the web site at: <http://www.ogp.noaa.gov/gcip/miss/missceleb.html>.

22-26 June 1998—GEWEX ISCCP WORKING GROUP ON DATA MANAGEMENT Meeting, Beijing, China.

29 June - 2 July 1998—ECMWF/GMPP WORKSHOP ON MODELLING AND DATA ASSIMILATION FOR LAND-SURFACE PROCESSES, Reading, UK.

7-10 July 1998—COUPLED OCEAN-ATMOSPHERE RESPONSE EXPERIMENT (COARE 98) DATA ANALYSES, AND MODELLING TRANSFER TO GEWEX/CLIVAR PROGRAMMES, Boulder, Colorado, USA.

12-19 July 1998—32ND COSPAR SCIENTIFIC ASSEMBLY - 40TH ANNIVERSARY, Nagoya, Japan. For information contact Copernicus Gesellschaft, E-mail: COSPAR@COPERNICUS.ORG.

20-24 July 1998—GEWEX GLOBAL AEROSOL CLIMATOLOGY PROJECT GACP MEETING, Seattle, Washington, USA.

17-21 August 1998—INTERNATIONAL CONFERENCE ON SATELLITES, OCEANOGRAPHY AND SOCIETY, Lisbon, Portugal. For information contact D. Halpern, Jet Propulsion Laboratory, MS 300-323, California Institute of Technology, Pasadena, California 91109-8099; Fax: 818/393-6720; E-mail: halpern@pacific.jpl.nasa.gov.

24-26 August 1998—GCSS WORKING GROUP I WORKSHOP ON TRANSITIONAL CUMULUS CASE FROM ATEX, Madrid, Spain. Local organizer Joan Cuxart Rodamilans (j.cuxart@inm.es); Fax: 34 1 544-5823.

14-18 September 1998—GEWEX HYDROMETEOROLOGY PANEL MEETING, Boulder, Colorado, USA.

9-13 November 1998—GCSS AND WGENE WORKSHOP ON CLOUD PROCESSES AND FEEDBACKS OF LARGE-SCALE MODELS, European Center for Medium-Range Forecasting, UK.

30 November - 4 December 1998—GCSS SCIENCE PANEL, Hawaii, USA.

10-15 January 1999—AMERICAN METEOROLOGICAL SOCIETY ANNUAL MEETING, Dallas, Texas, USA. The meeting theme is "Climate and Global Change: Focus on the Americas." Conference and Symposia include: 14th Conf. on Hydrology (GEWEX sessions on regional studies), 5th Conf. on Polar Meteorology and Oceanography (MAGS, GCSS, etc.), 11th Conf. on Applied Climatology, 13th Symposium on Boundary Layers and Turbulence, 10th Symposium on Global Change Studies, and others. Call for papers found in Bull. American Meteorological Society. Abstracts due at AMS Headquarters, 45 Beacon Street, Boston, Massachusetts 02108-3693, no later than 1 October 1998.

March 1999—THE THIRD INTERNATIONAL SCIENTIFIC CONFERENCE ON THE GLOBAL ENERGY AND WATER CYCLE, China.

19-30 July 1999—GHP-RELATED SYMPOSIA AND WORKSHOPS AT THE 22ND GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS (IUGG), Birmingham, UK. Further information is available from IUGG99, School of Earth Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK; Fax: 44 121 414 4942; E-mail: IUGG99@bham.ac.uk.

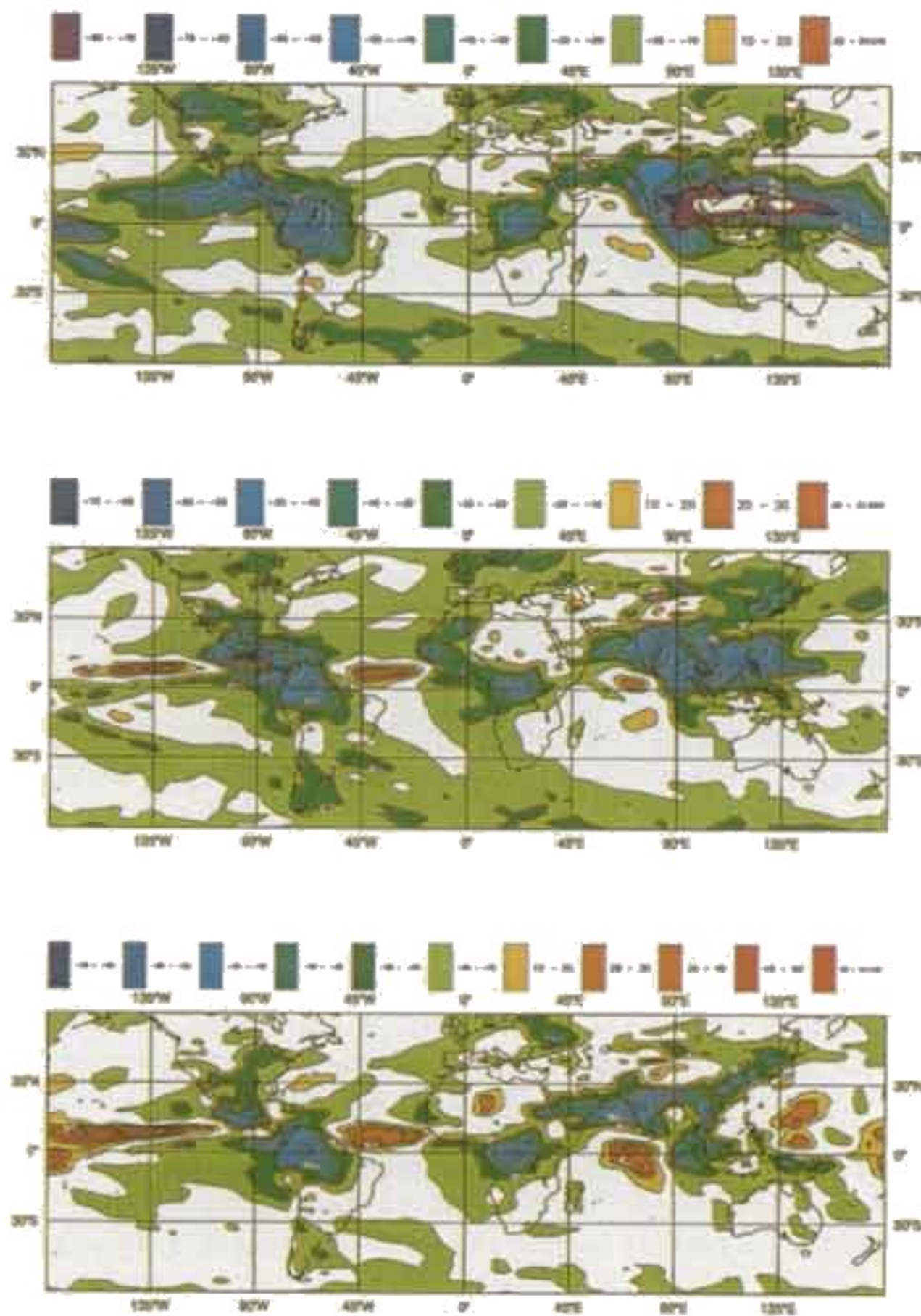
GEWEX REPORTS AND DOCUMENTS (Available from IGPO)

For complete listing of GEWEX reports and documents, consult the GEWEX Web Site:

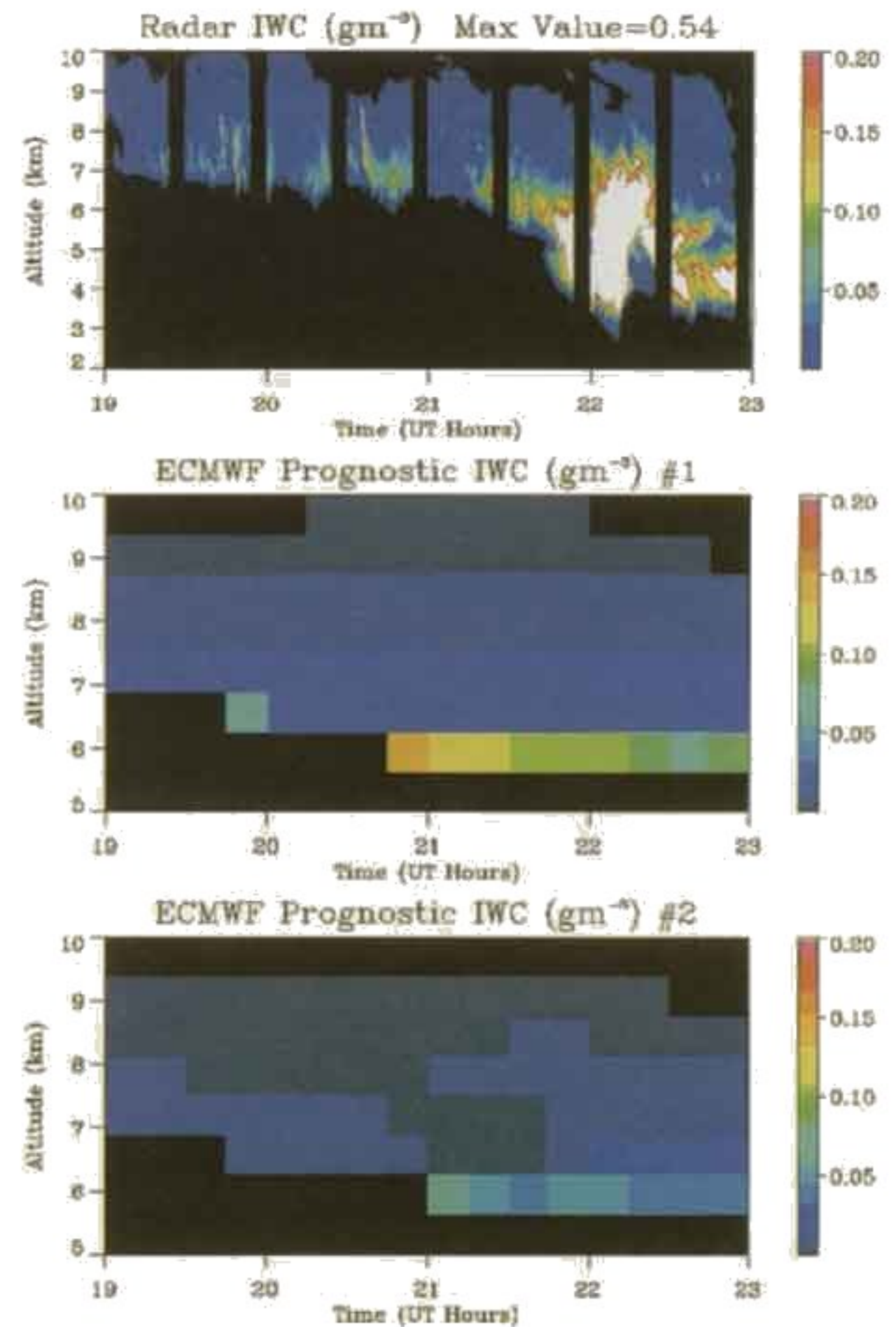
<http://www.cais.com/gewex/>

OUTGOING LONGWAVE RADIATION GOVERNED BY ICE CONTENT OF CLOUDS

VERIFICATION OF ICE CLOUD PROPERTIES



The difference between OLR observed by Earth Radiation Budget Experiment (ERBE, see Wielicki et al., 1996) minus that obtained by the model for the three month period DJF 1987/88. The upper panel is the difference between ERBE and the model with the diagnostic version of the cloud scheme and the lower two panels show differences between ERBE and the new scheme with two different representation of fall speeds of ice crystals.



The upper panel is the time-height radar reflectivity data obtained from the NOAA ERL 35 GHz radar (e.g. Matrosov et al., 1995) converted to ice water content. The bottom two panels are equivalent time height cross sections of ice water content obtained by the operational model for two ice settling formulations at a much coarser resolution. (See page 7).

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