

Overview:

Within the World Climate Research Program (WCRP) and its Global Energy and Water Cycle Experiment (GEWEX), the GEWEX Radiation Panel was organized to review theoretical and experimental knowledge of radiative processes in and for the study of the climate system. These processes are central to the climate's energy cycle: climate is determined by the imbalances of solar radiative heating and longwave radiative cooling. The circulation of the atmosphere and ocean, the environment on land, and the biosphere are all driven by local radiative imbalances. Changes in climate can be caused by alterations of the radiation budget at the top of the atmosphere or at the surface, such as those induced by changing amounts of greenhouse gases or aerosols in the atmosphere or by changing land surface properties. The sensitivity of the climate response to a change in radiative forcing is determined by many feedback processes that alter the radiation budget, especially those involving clouds and water vapor.

The main source of global information about the climate system comes from the analysis of satellite remote sensing data which requires detailed models of the interaction of radiation with the atmosphere and the ocean-land-ice surfaces (including the effects of vegetation) as a function of wavelength, polarization state and observing geometry. Water is unique in its role on Earth. Not only does it provide the necessary sustenance to support life, it also acts as an energy storage and transport mechanism as it changes phase from solid to liquid and vapor. Together with water vapor in the atmosphere, the reservoirs of water are continually exchanging mass. Water evaporates from the ocean and land surfaces, is transported by the atmosphere, forms clouds and returns to the surface as precipitation. Rainfall on land can return to the sea via rivers or be stored in lakes and aquifers. Snowfall on land can melt into rivers or build up into ice sheets, which can melt into rivers later. The cycle of water is thus inextricably linked with the cycle of energy by clouds, water vapor and precipitation, so it makes sense to study these water processes together with radiation processes.

The GPR thus focuses on answering the following specific questions:

- How can we better measure and characterize the state and the variations of the climate using global observations?
- What are the changes in radiative forcing that cause climate change?
- How do the interactions of radiation with changes of the internal state of the climate (a.k.a. radiative feedbacks) affect the climate's sensitivity?
- How do the internal water exchange and transport processes in the climate (a.k.a. water feedbacks) affect the climate's sensitivity?

Status:

ISCCP: The International Satellite Cloud Climatology Project continues to process cloud data from geostationary and polar orbiting satellites. Production is currently completed through June 2008. The primary set of cloud data products (DX, D1 and D2) and the two ancillary data products (atmospheric temperature and humidity, snow/ice cover) have been delivered for the period July 1983 through June 2008. The radiative flux product produced by ISCCP (called FD) is available and has been compared to the Surface Radiative Budget (SRB) values. Other specialized products (mesoscale convective tracking, CT, tropical, low latitude and midlatitude weather states analysis, WS, cyclone tracking, CY) are currently being extended through 2008

Shannon Macken 12/18/09 2:27 PM

Comment: Acronym for what?

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Comment: Acronym for what?

also. A new cloud particle size climatology has been completed and is awaiting publication of its review article for release.

ISCCP (based on various assessments) suffers from inconsistencies in the TIROS Operational Vertical Sounder (TOVS) products – specifically that Advanced Microwave Sounding Unit (AMSU) instrument and AMSU retrieval methods impact ISCCP but are not controlled by ISCCP or GRP. This makes a strong case for coordinated global activity. GRP strongly endorsed GCICS activity to bring infrared and microwave instrument calibration under one umbrella. The GEWEX SSG can help promote the consolidation of these activities.

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Comment: Acronym for what?

ISCCP is getting close to handing off routine production to the National Oceanic and Atmospheric Administration (NOAA) and National Climatic Data Center (NCDC). This ensures long-term production and frees scientists up for product improvement. GRP had a productive joint meeting with SCOPE-CM to discuss ways of continuing this transition from research to operations for additional products.

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Comment: Acronym for what?

Cloud Assessment: The GEWEX Cloud Assessment was initiated by the GEWEX Radiation Panel (GRP) in 2005 to evaluate the reliability of available, global, long-term cloud data products. An article was written for GEWEX News in Feb. 2009 summarizing results to that date.

Key results include:

- 70% ($\pm 5\%$) clouds: ~ 40% high clouds and ~40% single-layer low clouds
- Geographical cloud structures and seasonal cycles agree quite well
- Absolute values depend on instrument sensitivity (and retrieval method)
- Detection thresholds also affect average cloud optimum depth and temperature
 - e.g. CALIPSO highest CA (*sensitive to subvisible Ci*)
- Infrared sounders approx 10% more sensitive to cirrus than ISCCP (20% in tropics)

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Comment: Means what?

SRB: The Surface Radiation Budget project completed Version 3 (V3) of its product in October of 2008. V3 (July 1983–June 2007) includes:

- New fixed background aerosols climatology (from MATCH)
- Angular Distribution Model interpolation
- Add special desert surface treatment
- Added new output products: upper troposphere daily average
- Cloud Filling v3.0 (Completed all 23 years)
- Corrected issues with inconsistent high/middle/low clouds
- Corrected issues with terminator and sun glint

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Comment: Means what?

Shannon Macken 12/18/09 2:19 PM

Comment: Acronym for what?

New radiation budgets are available. Differences with ISCCP are slight and probably due to differences in surface temperature. There are significant differences (15 W/m^2) against other analyses. Science activity is focusing against the Baseline Surface Radiation Network (BSRN), concentrating on understanding what causes the differences. Clear sky and completely cloudy sky will be investigated first to see what causes biases.

Surface observations from BSRN now total over 5,000 station months in the archive. Global Models are converging towards BSRN numbers. Data submission has improved dramatically since moving archive to AWI.

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Comment: Acronym stands for what?

GPCP: The Global Precipitation Climatology Project continues to process data smoothly with research products coming out about three months after observation time. The project produced an interim version (V2.1) to take advantage of the latest GPCC reprocessing. V2.1 shows significant improvement in regions of orographic precipitation. The focused has moved recently to uncertainties, although methods are still crude.

The Version 2.1 dataset averages 2.68 mm per day over the whole globe. Confidence in the results varies by region, with developed land areas leading in certainty and high-latitude ocean areas trailing. The new average is about 2% higher than for the previous Version 2 GPCP

dataset with essentially all of the change occurring over land due to the new gauge analysis. Notably higher values are now analyzed in tropical mountain regions (northwestern South America, Papua New Guinea, the Himalayas and along the east coast of the Bay of Bengal), along the mountainous Pacific coasts of northwestern North America and southern Chile, in New Zealand and in central Africa. These are all high-precipitation areas that benefited from the improved quantity of input data and the revised analysis approach in the new GPCC dataset.

SeaFlux: Version 1.0 of climatological flux data has been completed for years 1998-2005. Version 2 will include diurnal Sea Surface Temperature (SST) variability from the Clayson and Curry algorithm. The diurnal cycle computations use Surface Radiation Budget (SRB) solar radiation and NOAA blended winds. Collaboration with GHRSSST is ongoing but the SST product is primarily meant for oceanographers, who will remove the skin temperature and diurnal cycle to produce a value close to the upper ocean heat content. SeaFlux data retains the skin temperature and diurnal cycle.

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Comment: Acronym for what?

LandFlux: LandFlux activities continued during the past year with a meeting at the Joint GEWEX-ILEAPS Scientific Conferences in August 2009. An inventory of available global surface latent and sensible heat flux products was produced. Available products include:

- Satellite measurements consisting of radiance based evapotranspiration estimates
- Diagnostic estimates using atmospheric water balance to estimate evapotranspiration
- Empirically-based estimates are flux-net driven estimates extrapolated via satellite observables
- Models consist of Land Surface Models forced by observations

The first results from global, monthly (1993-1995) comparisons indicated that overall geographical patterns are consistent among data sets (dry vs. wet regions), but there exist a large range between datasets in some regions, especially in tropical/rainforest areas.

The first intercomparison also noted that differences among observationally based estimates of Fluxes are of the same order of magnitude as differences between existing model based estimates.

GACP: The Global Aerosol Climatology Project has been relatively inactive; aerosol product generation has some funding for current NASA missions but GACP is not specifically funded at the moment. There is little progress except to compare existing product with newer ones. An assessment activity led by Sundar Christopher is being organized.

Since GACP is ocean only, discussions focused on the possibility of using aerosol source with dynamics type models such as SPRINTARS to complete the global aerosol picture.

CIRC: Continuous Intercomparison of Radiation Codes activities focused on four outcomes. These included:

- Maintained and improved website
- Reached 20 registered participants (9 from USA, 2 from Brazil, 2 from France, 2 from Russia, 1 from Australia, 1 from Canada, 1 from UK, 1 from Finland, 1 from China)
- Results from 23 RT codes (short wave and long wave, including non-GCM) available for evaluation
- Bulletin of the American Meteorological Society article (in press), GEWEX newsletter article and JRS proceedings article published; Journal of Geophysical Research article in preparation

Shannon Macken 12/18/09 3:02 PM

Comment: Global Climate Model or Global Circulation Model?

Shannon Macken 12/18/09 3:01 PM

Comment: Acronym means what?

Key results:

GRP products continue to set standard for quality products and independent assessment activities. GPCP alone, for instance, has over 1000 references in journal publications to date. Citation list can be found at: ftp://precip.gsfc.nasa.gov/pub/gpcp-v2/doc/gpcp_citation_list.pdf.

LandFlux activity is moving ahead with broad interest from research community to produce a global product.

New radiation budgets are produced using the latest satellite products produced by SRB. Preliminary information shows that long wave downwelling may increase even more once active sensors are fully incorporated into flux calculations.

The earnest shift from research to operations is beginning with ISCCP transitioning to NOAA/NCDC, with the Scientific Committee on Problems of the Environment (SCOPE)-CM welcoming such partnerships.

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Comment: Acronym means what?

Plans for 2010:

All GRP products are preparing for the reprocessing cycle to begin in the fall of 2010. This reprocessing cycle not only improves each of the products separately, but uses common ancillary data so that products can be merged into the Integrated GEWEX W&E Product. NCDC has tentatively agreed to put together the product and host it. Key activities within the GRP projects relate to improving their own product to accommodate this integrated W&E cycle product.

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Comment: Water and Energy?

ISCCP will focus primarily on ancillary data issues. Assessment reports have highlighted TOVS problems. In particular, the use of the newly reprocessed HIRS will be investigated to assess if the AMSU-related artifacts are eliminated from the data.

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Comment: Acronym means what?

It is expected that ISCCP will spend significant effort in the coming year to prepare for the transition to operations at NCDC.

The **Cloud Assessment** project is working on the final WCRP report that should be finished mid-2010. It discusses the existing long-term climatologies and also compares these to improved instruments aboard the NASA Earth Observing Satellites (EOS) and the A-Train. Climatological averages as well as their regional, seasonal and diurnal variations will be presented, and differences between results from the various datasets will be discussed. Specific next steps include:

- Distribute all data sets to assessment groups
- Analyze data sets and sort into mature, less mature and complementary data sets [Pathfinder-Atmosphere-X (PATMOSX), Along Track Scanning Radiometer-Global Retrieval of ATSR Cloud Parameters and Evaluation (ATSR-GRAPE)] and complementary [(MISR), POLarization and Directionality of the Earth's Reflectances (POLDER)]
- Actualize sections about cloud amounts (global, maps, season cycles, interannual variations, long term anomalies, regions, diurnal cycle)
- Write section on new variables (ct, cod, crei, crew, ciwp, clwp; averages standard variations and histograms)
- Make database public
- Berlin meeting (22-25 June 2010)

Shannon Macken 12/18/09 3:58 PM

Comment: Multi-angle Imaging SpectroRadiometer or Multi-angle Infrared Scanning Radiometer?

Shannon Macken 12/18/09 4:03 PM

Comment: Acronyms mean what?

SRB plans involve preparing for homogenized GRP reprocessing. This includes:

- Evaluate and implement homogenization of SRB inputs/ancillary data sets. Potential data parameters include:
 - Standardized surface topography » w/ISCCP

- Surface and atmospheric temperature and water vapor profiles [alternative to GEOS-4, Modern Era Retrospective-analysis for Research and Applications (MERRA) (GEOS-5)] » new HIRS, corrected TOVS, or reanalysis?
- Ozone and other trace gas concentrations » use ISCCP
- Total solar irradiance and variability » new Kopp time series
- Surface spectral emissivity annual variability » review w/ISCCP
- Surface spectral albedo treatments » update spectral models w/University of Maryland; temporal change
- Aerosol properties in climatological and historical sense » assess various data sets, i.e., Global Ozone Chemistry Aerosol Radiation Transport (GOCART), AeroCom median, MATCH, etc.
- Implement/assess codes to process new ISCCP "NX" products for production of 1°x1° and/or 1/2° x 1/2°

Shannon Macken 12/18/09 4:16 PM

Comment: Acronym stands for what?

BSRN expressed a strong desire to add measurements and reporting of Aerosol **OD** as highest priority from BSRN sites. Second priority for these sites is spectral measurements. These can be used for independent validation of models as they do not assimilate downwelling radiances.

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Comment: Acronym means what?

GPCP's plans, aside from continuing to process data on a timely manner, is to focus on the V3 plans for the algorithm that will have significantly higher time and space resolutions (approximately 3 hr. 25 km) for part of the period. V3 requires major revisions through the sue of:

- New passive microwave algorithm (GProf), new passive microwave data [Advanced Microwave Scanning Radiometer-E (AMSR-E), Tropical Rainfall Measuring Mission (TRMM), Advanced Microwave Sounding Unit (AMSU)]
- Integration of high time space resolution period with longer period with coarser time space resolution
- Rain/snow discrimination (by temperature)

SeaFlux

Intercalibrated data set from Special Sensor Microwave Imager (SSM/I) is an issue. Level 1C from Colorado State University (CSU) is introducing a trend in wind speed that does not appear to be real. CSU group will look at using Data Stewardship support from NOAA. Specific algorithm work includes:

- Finishing Version 1 back through 1987
- Full analysis of Version 1
- Improved SST diurnal cycle (Version 2)
- Better aerosol effect characterization
- Higher resolution/more satellites–Non climatolgoical data set Version 1.
- Continued comparisons with MERRA, Intergovernmental Panel on Climate Change (IPCC)

LandFlux

The integrated water and energy product requires latent and sensible heat flux over land. Because this is still immature, the goal is to continue with the assessment activity and then select one or more of the mature data sets for use in the GEWEX LandFlux product. This decision will be made in mid-2010 to allow for the product(s) to be processed or integrated if a combination of products is selected.

CIRC plans for 2010 include:

- Addition of "pristine" and "cloudless" Phase I sub-cases soon to be calculated and released
- A few more submissions expected (no GCM Radiative Transfer codes)
- Complete analysis of Phase I and submit paper
- Phase II preparation [Atmospheric Radiation Measurement (ARM) Broadband Heating Rate Profile (BBHRP) 1.5 + CLAMS?]
- Evaluate response so far and redefine our strategic goals?

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Comment: Acronym means what?

There is some concern from CIRC's perspective that the GCM community believes that radiative transfer is solved within its models and that the CIRC activity, despite immediately highlighting errors with most submitted codes, is not a high priority.

Science Highlights:

The Landflux activities made significant progress in 2009 with the first intercomparison of global products. This intercomparison of the submitted global products, based on analyses of the Observatoire de Paris (1993-1994) and ETH Zurich (1989-1995/2006), proved to be an extremely interesting and valuable exercise, particularly in identifying consistencies and disparities between remote sensing and other model based estimation approaches. While there seemed to be generally good agreement between spatial patterns among the various approaches, there was also a large range in values across many regions of the world (Fig. 1). Identifying the causes and mechanisms producing these differences, model dependencies and sensitivities and the complicated issue of how to actually evaluate global products remains a major challenge. The LandFlux-EVAL intercomparison effort will shed more light on addressing these important issues.

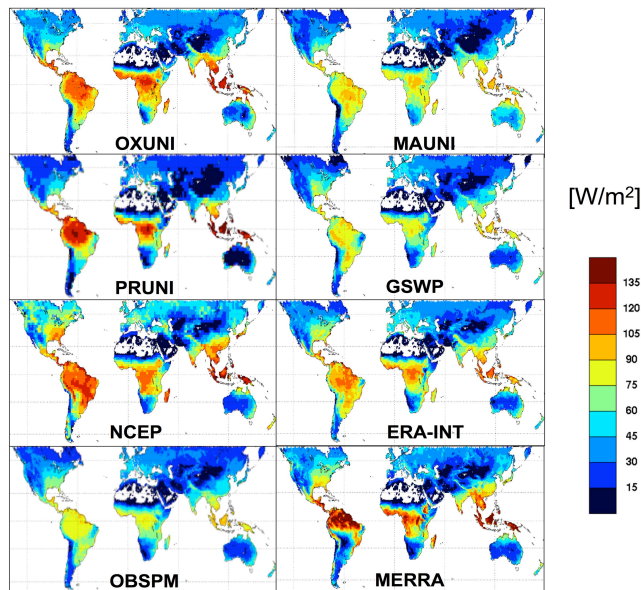


Figure 1. Yearly averaged latent heat fluxes for 1993 from a suite of different products. The following products are displayed: (a) four remote sensing products from Oxford University (OXUNI, provided by Joshua Fisher), the University of Maryland (MAUNI, provided by Kaikun Wang), Paris Observatory (OBSPM, by Carlos Jimenez), and Princeton University (PRUNI, by Justin Sheffield and Eric Wood); (b) Land surface model estimate from the GSWP-2 multi-model ensemble; (c) three reanalysis estimates (MERRA, NCEP-DOE and ERA-INTERIM). *Note that these data represent a subset of products considered as part of LandFlux-EVAL.*

GPCP found 2008 to have record low precipitation. The ocean decreased because of La Niña but land did not compensate as it usually does.

New directions:

GRP is best known for its global long-term products and this focus will be maintained. The new objective for 2010 is to produce an Integrated Water and Energy (W&E) cycle product that combines the existing data products into a unified data set. Two key objectives of this product are to allow closure studies on regional scales and process studies involving the exchange between energy and water. The data will thus be generated on a 50 km, 3-6 hour time scale. This composite product is envisioned to usher in a new era of interaction between GRP and the modelling community as well as other satellite providers **vis-à-vis** closure of the water and energy budgets at both global and regional scales.

Aside from the broad push for the integrated product, GRP continues to work through a series of white papers to define its future directions. These include "Assessments" where GRP notes the need to make assessments a more important activity of space agencies as the number of data products related to water and energy cycles increases. A paper on water vapor, in the meantime, points clearly at the need to begin a water vapor assessment activity before launching into the creation of the new product. This will be initiated in 2010.

A validation white paper is being formulated that thus far hints at the need for GRP to lead the way in developing W&E validation strategies that not only test a climate model's fidelity at reproducing individual fields (e.g. clouds or surface fluxes) but the interaction between these. GRP would help find robust data sets for these interactions and better connect the observations to the model physics that each of these possible validation studies might help elucidate.

Also related to the unification of the water and energy variables, GRP continues to foster the Cloud/Aerosol/Precipitation Initiative. While not independent of the modelling activity, GRP sees potential in collecting simultaneous global scale data on aerosols, clouds and precipitation in order to broaden what otherwise tend to be a very case-oriented analysis.

Finally, GRP feels that although perhaps not central to its initial charter, it must get involved in the data stewardship activities springing up. A consistent, high quality data set is critical for the long term products being produced by GRP. Unfortunately, each calibration/intercalibration and stewardship activity has its own objectives that only sometimes fit the GRP needs. As a panel, we want to encourage communities to use GRP algorithms to assess the stability of their long-term data products.

Recommendations and issues for attention of the SSG

GRP in general, but GPCP in particular, needs a closer working relation with Climate and Cryosphere (CliC) for joint evaluation of products in high latitudes.

GRP strongly endorsed GCICS activity to bring (infrared) IR and microwave instrument calibration under one umbrella. SCOPE-CM can likewise bring climate product generation under a single umbrella. The GEWEX SSG can help consolidate these activities.

GRP hopes the SSG can help convince space agencies about the importance of properly undertaken assessment activities in addition to the development of new products and sensors. GRP has had good experiences with the Cloud and Radiation budget assessments that can be used to provide guidance to the agencies. These assessments are necessary to place historical data in the context of newer products as we construct long term climate series.

Contributions to WCRP strategic themes

The production of global data sets is a strategic theme that GRP addresses directly.

Summary: 10-15 lines (for possible use in the report to the JSC)

GRP projects are making headway for the first-ever integrated data set that combines the different projects to produce a integrated product for water and energy variables. This product will contain water variables in the form of water vapor, clouds and precipitation, short and long wave radiation at the top of the atmosphere as well as the surface will be provided, as will surface turbulent (latent and sensible) fluxes. The integrated data, planned for 50 km and 3-6 hr intervals will be the first data sets that tries to close budgets at regional scales and should be useful for process studies.

The radiation code intercomparison activity is up and accessible through the web. Unlike previous efforts, the current CIRC activity uses actual observations from the ARM site and Lawrence Berkeley National Laboratory (LBL) calculations as a reference. It is available to all participants—including the IPCC models if they wish to avail themselves of this opportunity.

Planned Meetings

- LandFlux workshop together with Global Soil Wetness Project 3 (GSWP3) in Tokyo
- Potential Water Vapor Workshop with International TIROS Operational Vertical Sounder Working Group (ITWG)
- Sea Flux Workshop with CLIVAR high latitude Sfc. Flux Working Group (Boulder, 17-19 March 2010)
- Cloud Assessment Workshop Berlin (22-25 June 2010)
- GRP meeting with PanGEWEX (23-27 August 2010)