

18<sup>th</sup> Meeting of the GEWEX Radiation Panel  
9-12 October 2007  
Buzios, Brazil

The 18<sup>th</sup> meeting of the GEWEX Radiation Panel was hosted by Luiz A.T. Machado (CPTEC, INPE) and began with an Executive session. The main goals of the meeting were to discuss plans for finishing the data product assessments, plans for re-processing all the global data products, progress on the SeaFlux and LandFlux activities and a possible polar data initiative. Discussions were also to be focused on assessing the goals and overall progress of the GRP and its projects and on consideration of new directions as William B. Rossow steps down as chairman after this meeting to be succeeded by Chris Kummerow.

W. Rossow opened the meeting with a review of the GRP objectives he outlined as incoming chairman in 2001: (1) fostering advances in remote sensing analysis, (2) evaluating GCM radiative flux codes, (3) advancing 3-D radiation modeling to investigate scale-dependent coupling of the atmosphere and land surface, (4) fostering studies of cloud and aerosol interactions, (5) fostering studies of clouds and precipitation, (5) developing remote sensing-based inferences of ocean surface turbulent fluxes, (6) developing remote sensing-based inferences of land surface turbulent fluxes, (7) advancing analysis of natural climate variability and feedbacks, (8) diagnosing atmospheric energy and water transports and (9) diagnosing oceanic energy and water transports. Progress has been made on all of these objectives, especially 2, 3, 5, 8 and 9; less progress than hoped has been made on objectives 1, 4, 5 and 7. A good start has been made on objective 6. C. Kummerow followed with some thoughts about GRP activities in the next few years. Continuing work on the global data projects could now be usefully directed towards objectives 4 and 5, as well as 7, 8 and 9, by producing merged products that bring together the separate “parameter-centric” products at the highest feasible space-time resolution for “global process” studies. The planned re-processing of the global data products should be focused on improving the “long-time-record” quality of the products so that they can be used more confidently for climate monitoring studies. This activity should now make plans for the long-term stewardship of these products, including continuing to lead efforts to convert research analyses to “climate operations”.

The next session contained reports from the Brazilian space agency (INPE), the Korean space agency (KARI), as well as reports from JAXA, ESA and EUMETSAT. L. Machado reported that the INPE flight program began 12 years ago with the launch of SCD-1; since then the launches of SCD-2, CBERS-1 and CBERS-2 (with China) followed. CBERS-3 and CBERS-4 are under construction. Brazil recently took over data collection from the NOAA GOES-10 moved to 60E; these data will be contributed to ISCCP. B.J. Sohn reported on the development of a Korean geostationary weather/communication satellite (COMS) to be launched in 2009. T. Iguchi presented the status of the JAXA Earth observation program; planned missions include GOSAT (launch in 2008), GCOM-W (launch in 2011) and GCOM-C, a cloud profiling radar for the EarthCare mission (jointly with ESA and a dual-frequency precipitation radar for the GPM (jointly with the NASA). P. van Oevelen described the ESA Earth Explorer missions: the approved Core missions are GOCE (launch 2008), ADM-Aeolus (launch 2009) and EarthCare (launch 2013) and the approved Opportunity missions are SMOS (launch 2008), Cryosat-2 (launch 2009) and Swarm (launch 2010). A selection process is underway for a new Core mission to be launched in 2015. Y. Govaerts presented the status of EUMETSAT satellite operations. METEOSAT-7 (last of the first generation satellites) is operating over the Indian

ocean sector, METEOSAT-9 (second generation) is operating over Europe/Africa with METEOSAT-8 as backup. The third generation satellites are to begin launching in 2015 and will include infrared sounding, lightning and UV-VIS sounding capability in addition to enhanced imaging. The first polar orbiter, METOP-1 is now operating as well. Eight Satellite Application Facilities (SAF) are now operating, some delivering data products and some still developing.

A special briefing on the US Department of Energy ARM program was presented by J. Mather. He described the five active, long-term measurement sites in Oklahoma, Barrow and Atkasuk, Alaska, on Manus and Nauru and at Darwin, Australia. He highlighted the new ARM Mobile Facility that has already deployed for two field experiments, notably for AMMA in coordination with measurements from GERB. AMF goes to China in 2008. Most of these sites include active profiling sensors for clouds, aerosols and atmospheric properties. In addition to a wide range of routine site data collection and data from numerous special campaigns, ARM is creating a Best Estimate Dataset for Climate Modelers that merges many of the clouds and radiation products into a common product.

W. Rossow reported on the Working Group on Data Management and Analysis activities during the past year. All projects are now funded again and working towards a coordinated re-processing to begin in 2009. Significant progress in finding and restoring older satellite datasets has extended the imaging record back to 1978, the infrared sounder record back to 1973 and is refurbishing the microwave record over the early years. Significant new work on radiance calibration has begun through a CGMS group GSICS (Global Space-based Inter-Calibration System), new NASA and NOAA proposals, work at CSU; moreover, the NASA CLARREO mission is being considered as a constellation calibration mission. A key goal for the re-processing of the global projects is to use common ancillary datasets to improve the physical consistency of the products; the most difficult problem is finding an atmospheric temperature and humidity dataset that is more homogeneous over the past two decades and that will be continued into the future. Also being considered are some subsets of the products that will be placed into a common framework – same time sampling interval (3 hr or 1 day) and map grid (0.5 to 1.0 degree equal-area) – and format, possibly merged.

W. Rossow presented a report from NOAA on behalf of J. Bates concerning the continuing study of ways to recover the climate capabilities lost in the NPOESS re-scoping and continuing development of a description of the necessary attributes of a data processing system to produce Climate Data Records. Later, J. Schulz reported on similar efforts on-going at the Eumetsat Climate SAF.

Two guest scientific lectures were presented next by M. Yamasoe and L. Machado from Brazil. The first described a field experiment to investigate the coupling between biomass burning-produce aerosols with a consequent reduction of surface solar heating and subsequent vegetation activity. This experiment was conducted in the Amazon Reserva Biologica do Jaru in August 2007. Early conclusions are that, although the fire-produced aerosols do reduce solar radiation at the surface, which reduces sensible and latent fluxes, the effects on vegetation activity were much more complex. The second reported on use of high time resolution geostationary satellite cloud observations in severe weather nowcasting: the satellite images are able not only to detect and track the motions of large storm systems but also to measure their growth rate, which significantly improved the short-range precipitation forecasts.

R. Adler reported on the status of GPCP. While production of the current version (Version 2) of the products continues routinely and is up-to-date, studies continue to develop improvements to be implemented for Version 3. These improvements concern precipitation

underestimates in mountainous areas, modernizing the microwave algorithm to increase time sampling frequency to once- or twice-daily, using or incorporating more recent precipitation measurements (such as the 10-yr TRMM record) to anchor the product's time record and increasing the sampling homogeneity of the gauge dataset used to produce the products. Also being studied are possible rain-snow discrimination procedures and explicit snowfall algorithms. Version 3 will also be produced with smaller time sampling intervals (at least daily if not 3 hourly) and space sampling intervals (at least 50 km). Production of this version is planned to start in 2009. J. Schulz, on behalf of U. Schneider, reported on activities at GPCP. Several new products have been produced from the gauge collection, including products that include measurements from the maximum number of sites and from the most homogeneous collection of sites. The latter now covers a 50-yr period at 9400 sites. As part of the GPCP production of Version 3, all of these gauge products will be re-processed to increase the number of sites included; a discrimination of rain and snow will also be performed. P. Arkin reported on an activity, organized by the IPWG of CGMS, to evaluate new high resolution precipitation products (PEHRPP). There are at least four such products providing nearly global coverage that are being compared and tested. The first planning workshop will be held 3-5 December 2007 in Geneva. T. Iguchi described a new high resolution (10 km, 1 hr) precipitation product being produced in Japan.

J. Schulz reported on progress toward producing improved global water vapor products, particularly activities at the Eumetsat Climate Monitoring SAF. The current focus is on the analysis of combinations of newer instruments: SMM/I, ATOVS (IASI) and SEVERI measurements are employed to increase confidence in the results. Separate products exist at present from these instruments. The current ATOVS product provides daily, global temperature and humidity profiles at 90 km intervals; this product is currently based on the HIRS/AMSU combination but efforts are underway to incorporate IASI measurements into it. In the next phase of the CMSAF, a long-term, global water vapor product will be produced. W. Rossow, on behalf of J. Bates, reported on efforts to improve the inter-calibration of the HIRS series of infrared sounders (including the predecessor VTPR instrument) in order to re-process this data record into a global, long-term temperature and humidity climate data record.

D. Barber (a new GRP member) described research on sea ice climate change, as well as providing some background information on IPY plans and activities. In addition to the widely publicized indicators of dramatic sea ice changes in the summer of 2007, there were other indicators: the International Arctic Buoy Program for tracking sea ice has had difficulty finding sea ice thick enough to install buoys in the past couple of years (the SHEBA project in 1997-98 also found much thinner sea ice than expected) and transit times for ice being tracked through exit straits were found to be dramatically shorter. There are also noticeable changes in the atmospheric weather systems. Consequently and as part of IPY, Canada has planned a number of ambitious field campaigns over the next few years, including the Circumpolar Flaw Lead Study, Hudson Bay ice studies, research on impacts of these changes in partnership with Inuit communities and participation in other IPY projects. He suggested that the GRP data products could be useful in supporting these studies and that GEWEX might consider a field study, like Baltex or MAGS, for the Hudson Bay region. T. Uttal also described several other IPY activities underway, including a network of observing sites with cloud radar systems, plans for organizing standard data sources into a special Arctic-focused subset, a polar aerosol optical depth study and a polar aerosol-chemistry-meteorology study. She highlighted the fact that most of these projects did not employ satellite observations, focusing totally on surface measurements. Although

involving many difficulties, she suggested that a focused GRP initiative to bring the satellite products together with the extensive new surface observations being collected for IPY might prove useful. In the discussion that followed, the GRP members decided to undertake a small pilot activity along these lines. Two actions were decided upon: (1) extract a subset of the GRP global products coincident with the main surface sites active for IPY and also covering a time period when observations are available from CloudSat/Calipso and AIRS/IASI and (2) organize a workshop, preferably in association with an IPY meeting, to advertise the existence of this data collection and foster studies using it and the surface measurements.

D. Winker presented an update on the status and activities of the Calipso and CloudSat missions, both launched in April 2006 and continuing to perform well. Approval has been received to extend the original 22-month mission through 2011. Work continues to refine basic products and develop enhanced ones. A merged Calipso-CloudSat cloud mask is nearing release and the next release of basic Calipso products is being prepared. An intriguing result from Calipso is a stronger than expected effect of “plate-like” cloud/precipitation particles on the lidar returns when pointed at nadir, which is especially notable in the polar regions. A team debate is underway whether to maintain this geometry to provide a survey of the frequency of occurrence of this phenomenon and the circumstances that produce it or to change the pointing to slightly off-nadir to allow for meaningful cloud extinction retrievals for all clouds. Developments underway include for CloudSat: (1) a combined MODIS-CloudSat hurricane product, (2) analysis of CloudSat to estimate light rain and snowfall rates, (3) cloud liquid and ice water contents and (4) determinations of cloud effects on the vertical distribution of atmospheric heating by radiation. Developments underway for Calipso include: (1) a “reference” cloud amount climatology (Calipso is the most sensitive nadir pointing instrument ever flown – it provides better statistics than IceSat, so it provides an upper limit on total cloud amount), (2) improved aerosol height distribution analysis, including extinction and (3) profiles of cloud extinction.

C. Stubenrauch (new GRP member) described research on the vertical distribution of cirrus clouds and atmospheric properties obtained from infrared sounder instruments, especially contrasting the changes from “channel radiometers” like HIRS to spectrometers like AIRS/IASI. Analyses of these products are now providing information about the microphysical properties of cirrus and their association with upper tropospheric humidity and how both of these are influenced by atmospheric motions from convective to planetary scales.

W. Rossow summarized the status of the ISCCP project, now in its 25<sup>th</sup> year. All products have been delivered through June 2006 but processing is underway on the next year of data. This processing is being delayed by problems with several new satellites in the constellation. The global processing center funding extension has not yet been approved (after the meeting, approval was received): the new funding will allow a switch of the processing from the 30-km-sampled radiances to a 10-km-sampled version, thereby increasing the value of the ISCCP products for cloud process studies. For the first time, the radiance data being contributed to ISCCP comes from more satellites than needed, the number could soon be 10. At the most recent WGDMA meeting, it was decided to process all available data and include them in the products: the first new contribution to be implement in 2008 will be from the Chinese geostationary satellite. The re-processing will allow for a refinements of the analysis, which will only produce small (but systematic) changes in the results; the most important problem limiting the value of ISCCP as a climate data record is associated with the ancillary atmospheric temperature and humidity dataset; the operational TOVS product has changed character

(climatological mean) several times over the past 25 years and needs to be replaced by a homogeneous dataset. Although there are some efforts underway, no clear solution to this problem is apparent at this time.

W. Rossow reported on the status of GACP on behalf of M. Mishchenko. The aerosol climatology (monthly mean values of optical depth and size index over global oceans) now covers the period from August 1981 through June 2005; this record will be extended to June 2007 as soon as the ISCCP processing is completed. Funding to continue has been approved. During the past year, the product was re-processed to make two small improvements. The most notable result from the longer record is a clear decrease of total aerosol optical depth following the Pinatubo volcanic eruption; since the SAGE-monitored stratospheric aerosol optical depth decreased to a nearly un-detectable level, this decrease can be ascribed to tropospheric aerosols. The next phase of the project will involve investigations of the differences among the various aerosol products now available, including those produced from MODIS and MISR measurements, as well as comparisons with aircraft polarimetry and, soon, spaceborne polarimetry.

C. Stubenrauch reported on the continuing cloud product assessment activity. A comprehensive set of results about which all the products agree is beginning to emerge, including the total global cloud amount, its partitioning among low/middle/high levels, the geographic distribution, seasonal and diurnal variations. There are systematic differences in total cloud amount but these are understood to depend on differences in cloud detection sensitivity among different instruments: Calipso results will be brought into this understanding this coming year. The products do not yet agree on longer-term (multi-year to decadal) variations. The third workshop is planned for the summer of 2008 at which other cloud properties will also be compared.

B.J. Sohn (new GRP member) discussed comparisons of water budgets inferred from satellite observations and the weather reanalyses. The intensity of the Hadley-Walker circulation has a well-known seasonal variation but may also begin to change in a warming climate. This study aims to develop methods for deriving the water vapor transports by the general circulation and to relate variations in changes in other water-related quantities such as precipitation, evaporation and clouds. Both regional studies (*e.g.*, Asian monsoon) and global studies are underway. The mean water vapor transports determined in the reanalysis datasets agree well with that inferred from microwave-based precipitation-evaporation differences. These SSM/I-based results and the reanalyses all show an increase in the wintertime Hadley circulation strength over the past decade, whereas the Walker circulation strength shows a weakening.

R. Chahalan reported on research on 3-D radiative transfer under two groups, one focusing on clouds (I3RC) and one focusing on vegetation canopies (RAMI). I3RC is completing its Phase 3 experiments (12 models) to evaluate 3D photon transport by cloud scattering (no absorption). As a result, several codes considered to be the "industry standard" have been released on a website for other researchers to use; Release 3 is scheduled for October 2007. The next activity is to begin evaluation of remote sensing retrievals for cloudy conditions, testing multi-wavelength, multi-angle and multi-instrument analysis approaches, including parameterizations of 3D effects. RAMI is evaluating various models of radiative transfer in vegetation canopies against more rigorous 3D calculations. They have completed their third round of studies (now published) and are beginning a fourth round. In the third round the RT models continued to show improvement; a website for comparing parameterized models with rigorous calculations has been established. In the next phase, evaluation of remote sensing

products and radiative parameterizations in land surface models will be undertaken, including collecting surface datasets and developing methods for representing surface variability at larger scales.

R. Chahalan also reported on the status of and research being done with measurements of the solar irradiance from SORCE since 2003. The total solar irradiance value obtained from SORCE,  $1361 \text{ Wm}^2$ , is  $5 \text{ Wm}^2$  lower than from the ACRIM series of instruments (which were themselves lower than earlier measurements by about the same amount), which has triggered intense calibration and instrument characterization studies to determine the cause(s) of this difference. NIST calculations of the aperture diffraction in ACRIM (already determined for TIM on SORCE) suggest a reduction of its solar irradiance values by nearly  $2 \text{ Wm}^2$ ; calculations to confirm aperture area are still on-going. The SORCE mission also started the first systematic spectral measurements of solar irradiance, confirming much more complex and larger variability of the sun at wavelengths shorter than visible, which has implications for variations of the upper atmospheric chemistry. The issue of the continuation of the solar irradiance monitoring record, which is now about 30 years long (just shy of three solar cycles) was discussed. Although the SORCE mission was recently approved to continue to 2011, the launch of the next instrument to measure total (but not spectral) solar irradiance on the GLORY mission has suffered some delays and is now scheduled for 2009. More importantly the NPOESS program removed the solar irradiance instrument so that the future of these measurements is in doubt. Moreover, there are no plans as yet to continue measurements of the spectrally-resolved irradiance. The GRP's strong support for continuation of this data record was communicated to the NPOESS program and through the WCRP to the US.

L. Oreopoulos reported on the status of the Continuous Intercomparison of Radiation Codes project. This project, sponsored by ARM, was proposed four years ago to continue progress on evaluating GCM radiation codes by ICRCM. CIRC is working to establish an online capability for testing such RT codes by providing synthetic and observation-based test cases as well as the fluxes calculated by a few state-of-the-art line-by-line codes. ICRCM had developed an (incomplete) set of synthetic test cases, but now another observation-based set is being developed from ARM site observations that provide as complete a set of measured atmospheric properties, including clouds, together with directly measured fluxes at the surface. The top-of-atmosphere fluxes come from CERES. After testing the idea with the first cases at a workshop, planned for 2008, then work will continue to add more complicated cases. In the following discussion, it was noted that this type of effort that combines the best observations with state-of-the-art physical codes to verify the parameterized codes used in climate models would meet IPCC requirements for evaluating these models.

P. Stackhouse reported on the status of SRB and the Radiation Assessment. All products have been delivered through June 2005 (depends on availability of ISCCP products); minor changes to the shortwave algorithm were implemented during the past year to better account for low sun fluxes in the polar regions and to use a more accurate solar geometry, as well to report clear sky aerosol radiative effects. A number of other corrections were made to fix problems induced by the input data products. Work is already underway to implement improvements based on the Radiation Assessment; further homogenization of the input datasets is being worked on (with the other GRP projects) to prepare for a total re-processing in 2009. In addition, new results from CERES and CloudSat/Calipso are being studied for improvements to the SRB products. The SRB products are being evaluated as part of the Radiation Assessment, along with products from ISCCP, ERBE, CERES, GERB and BSRN. After the first workshops, specific

subsets and statistics from all the products to be evaluated have collected on a website at NASA Langley to produce a uniform and comprehensive set of comparison statistics. One notable result of the assessment is that the differences in cloud radiative effect calculated by SRB and ISCCP-FD are about three times smaller than the differences among the 20 IPCC climate models. Writing of the report is underway for a first draft by early 2008.

E. Dutton reported on the status of BSRN, which is now comprised of 60 active stations (the continuation of a few is in doubt). A replacement for ETH as the BSRN archives institution is being worked on (after the meeting it was announced that Alfred Wegner Institute in Bremerhaven had agreed to take on this responsibility). There are now 3850 station-months of data archived at 1-min resolution, an average of 8.2-yr per site for 39 sites. Two issues have been investigated in the past year: (1) checking with a number of different communities, it is found that PAR (photosynthetically active radiation) is not precisely or even well defined and (2) the SOLAS project is not specifically collecting PAR measurements and what measurements are being made are with ill-defined commercial instruments. Hence, if BSRN (and others) are to collect PAR datasets, a standard definition will have to be developed; BSRN is continuing to work with SOLAS to define measurement specifications and procedures. BSRN working groups continue to development measurement standards for longwave fluxes, diffuse and total shortwave fluxes, direct beam calibration, inferring cloud properties from flux measurements, measuring the radiative properties of aerosols and making measurements at sea. BSRN continues to work with CIMO to establish consensus on reference standards. An issue was raised as to whether travel support funding would continue to be available for the biennial meetings (the issue was only temporarily resolved for the 2007 meeting)..

Three guest presentations were made by E.B. Pereira, S.Mantelli and S. Colle. The first concerned a project (SONDA) in Brazil to assess solar energy resources that combined satellite-based surface insolation products with a network of ground sites. The main purpose of the project is to organize and mobilize national resources to make measurements of and model surface solar fluxes matching international standards and requirements. The next two presentations were by BSRN site scientists who are benefitting from the SONDA project to renew and upgrade their sites at Balbina and Florianopolis. The presentations described the equipment upgrades being performed and the new measurement capability being added, including better computerized data logging and PAR sensors. This initiative also allowed for the Brazilian sites to do more quality checking, catch up on sending data to the BSRN archives and to improve the staffing reliability.

W. Rossow presented a brief update on the CERES project status on behalf of B. Wielicki. Data collection and processing activities are continuing routinely; Edition 2 data products are now available through 2006. Work is underway to produce an Edition 3 beginning sometime in 2008. With the removal of the ERBS instrument from NPOESS and delaying the flight of the spare CERES instrument until 2014, studies have been undertaken to evaluate the consequences for the long-term ERB data record and to determine whether the spare CERES instrument can instead be flown on the NPP mission that is to launch in late 2009. This option would continue the record long enough to find some alternate plan for the future flights. A description was presented of the idea to use the planned NASA CLARREO mission as a "NIST" standard in space for the earth satellite constellation. The GRP has sent letters to CGMS, GCOS and GEO endorsing this concept, as well as presenting it to the GSICS group.

C.A. Clayson described the current activities and status of the SeaFlux project. Two workshops in the past year continue progress towards completing the comparison of a common

year of global products, based on “old” and “new” instruments. This year not only allowed for overlap of different kinds of instruments but had a good collection of *in situ* surface flux measurements for continued improvement of the flux formulae. The comparison and its results should be wrapped up next year. Version 1 of a new SST product that resolves diurnal and weather-scale variations of skin temperatures (most previous SST products are estimates of bulk temperature and provide only the variations on “ocean” time scales) has been produced and is now being tested. Work also continues, in collaboration with the other GRP projects, to improve the quality of near-surface atmospheric datasets used for these flux determinations. A first long-term, global product based on all the research fostered by SeaFlux will be produced (possibly by more than one group) next year.

W. Rossow reported on activities of the LandFlux project, launched at the last GRP meeting, to obtain the turbulent fluxes over land (and ice) surfaces. The first international workshop was held in May 2007. After reviewing possible methodologies and the status of land remote sensing more generally, the workshop participants agreed that work needs to pursue two parallel pathways: (1) systematic data products (global, long-term) for the basic properties of the land surface (albedo, emissivity, temperature, some vegetation indicator, possibly soil moisture information) need to be evaluated and brought up to the same standard as some of the other GRP products and (2) the several very different methods for estimating surface turbulent fluxes need to be compared and differences investigated. The next year will focus on workshops to address the first of these topics (albedo, surface temperature and soil moisture workshops are being planned); a comparison of methodologies and early products might be organized for early 2009.

The last two sessions resumed the discussion of continuing and new directions for GRP and wrapped up the meeting. The consensus was that a main activity of GRP would continue to be the set of projects leading to a complete description of the weather-to-climate scale variations of the global energy and water cycle. The assessments of the more mature products (precipitation, radiation, clouds and aerosols) should be completed. With SeaFlux nearing readiness to produce a new product, the focus should be on bringing LandFlux to the same status as SeaFlux, using the polar initiative activities to include frozen surface processes as well. The coordinated re-processing of all the current global products will also focus not only on increasing the physical consistency of the products (*e.g.*, using common ancillary datasets) but also on reducing spurious variations in the long-term record (based on the assessment results), moving these products towards climate data record quality. GRP will also continue to work with the space agencies and other international groups to define a climate observing system and climate data records. With these continuing activities as a foundation, more emphasis now needs to be focused on determining atmosphere and oceanic transports of energy and water, which should also involve more interaction with general circulation modeling groups. It was concluded that there is a smaller, more focused working group on cloud processes, aerosol interactions and precipitation, needs to be organized to investigate using the global satellite products and field experiment datasets. To that end, the membership of GRP should be shifted to bring back in some representatives of modeling studies in this area. Another frontier that should now be explored is remote sensing of large-scale land hydrological quantities.

The GRP meeting adjourned before lunch on Friday, 12 October. The venue for the 2008 GRP meeting was announced as South Korea, hosted by B.J. Sohn; subsequently, the dates for the next meeting were announced as 14-17 October 2008.