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SUMMARY OF GRP-13 MEETING
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The 13th meeting of the GEWEX Radiation Panel (GRP) was hosted by the Institute for Atmospheric and Climate Science ETH. An important focus of this meeting was to review the status of the Baseline Surface Radiation Network (BSRN) and the Surface Radiation Budget (SRB) Project, as well as the general activities of the other GRP projects.

The BSRN and SRB reviews indicated that both projects are now well underway and did not raise any substantive issues. Both projects are rapidly eliminating data processing backlogs and releasing their data sets. There are over 35 active stations participating in BSRN and the archives (located at ETH) have all irradiances available for over 1,800 data-months, equivalent to an average of 4 years of data for each site. Some sites have more than a decade of data available. All the related ancillary data sets have also been collected and are being placed on the BSRN archives web site for ftp access. The SRB shortwave products are available for almost 10 years; longwave products will follow more slowly, but should be available early next year. Current plans are to process surface radiative fluxes for the period July 1983 through December 1995; however, the GRP recommended that SRB continue processing the remaining years (1996–2001) by switching to another source of atmospheric data.

The review of the other radiation projects highlighted several important activities that are underway. Recent analyses of the 20+ year record of top-of-atmosphere radiative fluxes from Nimbus-7, the Earth Radiation Budget Experiment (ERBE), the Scanner for Radiation Budget (ScaRaB) and the Clouds and Earth's Radiant Energy System (CERES) show not only features associated with ENSO events and the El Chichon and Mt. Pinatubo eruptions, but also inter-decadal changes that appear to be associated with changes in clouds found in the International Satellite Cloud Climatology Project (ISCCP) data set and upper atmosphere water vapor found in the analysis of High resolution Infrared Radiation Sounder (HIRS) data by John Bates [National Oceanic and Atmospheric Administration (NOAA)]. The report of the Intercomparison of 3D Radiation Codes (I3RC) Project (http://climate.gsfc.nasa.gov/I3RC/index.html) contained several notable items: (1) the first two phases of the project to compare 3-dimensional (3-D) radiative transfer codes are now complete and papers are being submitted for publication of the results and conclusions; (2) a model test kit is now on-line to allow other investigators to test their 3-D radiative transfer (RT) codes; and (3) efforts are now being made to link with cloud-large-eddy-simulation and land-surface-vegetation modelers to examine the role of 3-D radiative effects in planetary boundary layers and in land-atmosphere exchanges. The preliminary results of a survey of recent changes to global circulation model RT codes showed that there has been rapid progress lately to improve the physical detail of these codes. GRP plans to complete and publish this survey and to foster some renewed attention to testing these codes more thoroughly. The following issues regarding radiative transfer modeling were discussed: (1) the notable lack of quantitative data about the properties of cirrus cloud particles, especially those smaller than about 50–100 mm [some better data may come from the recent Cirrus Regional Study of Tropical Anvils and Cirrus Layers–Florida Area Cirrus Experiment (CRYSTAL-FACE)]; (2) the lack of a general radiative transfer theory to handle scattering by such small, nonspherical particles (also relevant for aerosols); and (3) no agreement on a practical way to represent the wide variety of shapes/sizes of particles encountered in cirrus.

The water projects, especially the Global Precipitation Climatology Project (GPCP) and Tropical Rainfall Measuring Mission (TRMM) were reviewed and recent activities highlighted three points, leading to some recommendations: (1) the GRP endorsed GPCP plans to produce Version 3 products, which will be anchored on TRMM results, but noted that the passive microwave analysis should be made consistent with microwave-based water vapor and cloud water results; (2) actions to obtain better snowfall data are still not adequate, so the GRP recommended exploring a tighter collaboration with the Climate and Cryosphere (CLiC) Study to improve this aspect of global precipitation; and (3) a possible gap in the tropical precipitation record may occur between TRMM and the planned Global

Precipitation Mission (GPM). A special presentation by Toshio Iguchi (Communications Research Laboratory) and the subsequent discussion highlighted the fact that validation of satellite precipitation measurements is not yet successful and that more needs to be done to understand the radiative transfer physics of this remote sensing problem. Finally, at the request of the GEWEX Scientific Steering Group (SSG), the GRP discussed its possible contributions to a GEWEX-wide precipitation initiative based on the global satellite data sets.

The review of ISCCP and the Global Aerosol Climatology Project (GACP) indicated that both of these projects had recently completed production of their data products through September 2001, at which time the reference polar orbiter was changed from NOAA-14 to NOAA-16, necessitating a transfer of the calibration standard. Two issues were discussed: (1) GACP (also ISCCP) should now make connections with the International Global Atmospheric Chemistry (IGAC) Project, the Global Atmosphere Watch (GAW) Programme, the Stratospheric Processes and their Role in Climate (SPARC) Programme, and the BSRN/Aerosol Robotic Network (AERONET) to exploit the different sources of information that these groups have that is related to clouds and aerosols; and (2) both projects need to formulate plans for exploiting the new satellite instruments making advanced measurements of clouds and aerosols.

The final discussion encompassed a number of possible actions being considered by the GRP to foster more integrative analyses of the global data sets. A significant action to facilitate better connections among the GRP satellite projects and with other data analysis activities within GEWEX was the decision to organize all of the GRP data activities into a single Working Group on Data Management and Analysis (WGDMA). The first tasks of WGDMA would be to undertake some common statistical analysis tasks, possibly including the creation of a merged collection of data, for all of the GRP global satellite projects (ISCCP, GACP, GPCP, SRB, SeaFlux) and to make plans for the exploitation of new satellite observations. This new group would also liaise with the GEWEX Cloud System Study (GCSS)/Data Intergration for Model Evaluation (DIME), the Global Land Atmosphere System (GLASS)/Assistance for Land-Surface Modelling Activities (ALMA), the International Satellite Land-Surface Climatology Project (ISLSCP), as well as the GRP Data Management Working Group. The first meeting of this group is planned for April–May 2003 in Asheville, North Carolina, hosted by NOAA's National Climatic Data Center.

Also discussed was what could be done to fill in the missing global land surface data sets needed to complete a description of the global energy and water cycles (referred to as LandFlux). The GRP chairman reported that the GEWEX SSG had given the lead of this activity back to GRP, and as a result, he would be attending forthcoming meetings of the GEWEX Hydrometeorology Panel (including the Water and Energy Balance Study and ISLSCP) to discuss how to proceed.

Two workshops are being organized by GRP to foster development of integrative data analysis methods: (1) the Workshop on Climate Feedbacks (jointly with WGCM) to be held 18–20 November 2002 in Atlanta, Georgia, USA; and (2) the Workshop on Objective Analysis Techniques being organized by GPCP to be held 11–13 March 2003 at the European Centre for Medium-Range Weather Forecasts, UK.

1. GENERAL TOPICS

1.1 GEWEX strategy and goals relevant to GRP

The GEWEX Radiation Panel was welcomed by its Chairman, William Rossow, by local host Atsumu Ohmura, Professor at ETH and Director of the BSRN archive, and by WCRP/JPS representative, Gilles Sommeria.

The panel was informed by the Director of the International Project Office (IGPO), Paul Try, about new developments in GEWEX following the GEWEX SSG in Reading in January and the WCRP Joint Scientific Committee in Hobart in March. Rossow, emphasised implications of those developments for GRP activity and reviewed pending actions from last year's GRP. Main issues requiring action are summarised below either as part of "general topics" or "specific projects" to which they are related.

As part of the GEWEX general strategy, six main items were extensively discussed: the global satellite observing and data analysis strategy, the co-ordination with GHP activities with the development of CEOP, the planning of a new phase of ISLSCP, co-ordination with the modelling activities in WCRP and the contribution of GRP to the cross-cutting effort of GEWEX on precipitation.

The following actions have been identified:

(A1) The data management, validation and exploitation of new satellites, as well as some common analysis tasks, will now be co-ordinated for all GRP global satellite projects by a new Working Group on Data Management and Analysis. The first meeting of the new group chaired by Rossow is planned for spring 2003.

Its tasks will involve the definition of a strategy to merge existing data sets and common tools for statistical analyses. This working group will also work with GCSS/DIME, with GLASS/ALMA as well as with the CEOP/CSE's data management working group.

Rossow will lead the drafting of a white paper on "global satellite observing and data analysis strategy", in order to set up the basis for the working group' activity (such a paper is also being prepared at the NASA level).

(A2) There should be a co-ordination between the reference surface sites used by CEOP and those used as baseline by GRP, particularly BSRN. This co-ordination should also include AERONET, CPROF and TRMM validation sites. CEOP should upgrade some of their sites at BSRN standard and each Continental Scale Experiment should have a BSRN type site within its catchment basin.

(A3) Rossow plans to organise a Landflux Workshop in Spring 2003 to deal with the research strategy needed for the global characterisation of land surfaces, including multi-year global maps of albedo, emissivity and skin temperature and the building up of a climatology for land surface heat and moisture fluxes.

The on-going redefinition of ISLSCP's objectives should take into account GRP plans for global data sets and fill existing gaps identified in relation to land surface parameters and their climatology.

This question as well as the corresponding funding issue will be addressed at the next GEWEX SSG.

(A4) The link between GRP and the modelling community will be reinforced in at least two domains: the use of Cloud Resolving Models simulations in the development and validation of retrieval schemes, the co-ordination of the development of global data sets with the evolution of Global Circulation Models requirements.

(A5) GRP will be a major contributor to the cross-cutting effort of GEWEX on precipitation. One important issue is the development of a co-ordinated approach on precipitation measurements or estimates by the various communities involved, namely surface and aircraft radar methods, satellite active and passive and model derived methods. This requires the organisation of inter-comparison exercises.

(A6) A second issue in the cross-cutting effort on precipitation is the improvement of global precipitation data sets: this requires the collection of high density, high time-resolution precipitation data sets by CEOP/CSEs to test satellite retrievals, to overcome the satellite sampling effect, and to test GCM predictions. In addition, a co-ordinated work between GRP and GCSS should enable to make use of GCM results to provide extensive (global, long-term) data sets.

1.2 GEWEX/GRP links to space agencies

Links between the GEWEX community and satellite agencies have been established primarily through GRP activities. GEWEX SSG 14 has recommended to reassess the situation and to update the requirements of GEWEX towards space agencies, mainly with respect to the types of observations which are missing from space agency plans and to the type of support which would be needed from space agencies in data management and processing. These will be included with requirements from other WCRP programs in a paper to be produced by WCRP for the next "consultative meeting on high-level policy on satellite matters" which will take place next February in Geneva. An informal WCRP working group on satellite matters will gather the material and co-ordinate this activity. Recommendations from GRP on this subject concern mainly the continuity of space observing systems and the calibration and validation of satellite data, and can be expressed as follows:

(A7) GRP stresses the central importance of long-term homogeneous data sets for climate research.

(A8) GRP expressed concern for the continuity of the measurement of the components of the earth radiative budget. This is one area where there is a potential data gap in top-of-atmosphere, broadband radiative flux measurements between the end of AQUA mission and the beginning of NPOESS mission which is planned for the 2008-2010 period. A quick action from GEWEX Chair may be needed (this depends on the decision calendar for the pre-NPOESS mission, to be clarified by Wielicki).

(A9) GRP expressed concern for the continuity of precipitation measurements by space radar between TRMM and the first GPM radar satellite scheduled around 2008. One issue is the de-orbiting of TRMM at the end of its lifetime, which would shorten its operating period. The panel's opinion is that this operation would be seriously detrimental to the scientific output of the mission and should be avoided.

(A10) Major new spacecraft are being flown by several countries (Japan - ADEOS, Europe - ENVISAT, and US - TERRA, AQUA) but these programs have no plans for cross-calibrating similar spectral channels. GRP recommends that the issue be raised to space agencies and also suggests that the general question of cross-validation be considered by CEOS.

(A 11) All GRP project leaders are to send to Rossow a list of meta-data parameters to be suggested to CGMS. GRP will seek more information on CGMS cross-calibration plans. Keep Paul Menzel informed of this action.

(A12) Data policy is a general issue for scientific users. GRP expressed a need for clarification concerning the Japanese data policy for surface validation data sets and for the ADEOS instruments.

1.3 General issues

(A 13) Rossow will update the web site and requests input from each member for providing corrections or suggest changes and additions. He specifically requests from satellite agencies a list of "information Web sites" that show satellite operating and launch status.

(A14) Rossow will prepare and distribute an announcement/summary of GRP datasets now available.

(A15) Recommendations for the preparation of future GRP meetings: (i) conduct mid-term e-mail discussion of status of issues and actions, (ii) request project reports two months before GRP meeting, specifying minimum list of informational items, to be distributed to attendees one month before, (iii) begin and end meeting with Executive Sessions; Satellite Agency Reports and talks by Invited Science Experts should be in the first half of agenda, project reports and discussions (focused on issues, actions, recommendations) should be in the second half of the agenda.

2. SPECIFIC PROJECTS

2.1 BSRN (E. Dutton, A. Ohmura)

The BSRN review was particularly comprehensive with the participation, in addition to the chair, E. Dutton, of A. Ohmura, A. Raesh, M. Wild and R. Philipona who each gave a review in relation to their activity within the programme.

Overview and Background - The Baseline Surface Radiation Network (BSRN) was established by the WCRP in the early 1990s to provide, where practical, the best possible surface-based solar and thermal irradiance observations for applications in climate research. Such observations were deemed useful, if not necessary, to

aid in the development of satellite-based observations, which in concert with the surface based observations could be used to improve numerical simulation of these quantities within global climate models. Other applications of the surface-based observations are in the development of radiation climatologies for specific regions, the testing of single column and 3-D radiative transfer models, and the inference of atmospheric characteristics, such as cloud and aerosol effects.

The BSRN's initial core participants derive from the existing international surface radiation measurement community that had for years been pursing the establishment of an absolute reference for direct solar irradiance. That community working within the framework of the WMO consisted of a World Radiation Center in Davos, Switzerland, six regional divisions, and many national centers. The BSRN drew on the most talented and eager members of that group to move on to establish exceptionally high-quality operational measurements of surface irradiance. This is accomplished by specifying standard observation methodologies to provide the best possible measurements given the state of the art, while continuing to pursue development of reference standards for irradiance quantities not available as are those for the direct solar irradiance.

Although surface radiation measurements have been made for a number of decades prior to BSRN, refinement of the knowledge of their absolute accuracy had been largely neglected. The first BSRN task was to assess both the current level of uncertainty in current irradiance measurement technology, and the related needs for the climate research community. It was determined that the verifiable accuracy of observations was less than required for the most demanding climate research applications. The primary goal of the BSRN is to move the measurements towards and beyond the necessary accuracy to assure their integrity.

To obtain observations adequate for climate applications, two major steps are needed. First is the establishment of measurement reference standards so that the accuracy of routinely deployed instrumentation can be evaluated. Second step is the deployment of such instrumentation to obtain data on suitable time scale at appropriate globally distributed locations. The need for data at the level of accuracy available at the start of the program was sufficient for some applications, so, the two development paths were pursued in parallel. The following reports on the progress of these activities.

Field Network – The original network was envisioned to consist of 16 to 17 stations covering major climate regions of the earth. Most of the sites original selected have provided data to the BSRN Zurich Archive, while many other sites were developed that met the measurements' specifications and demonstrated that they were capable of making a substantial contribution to BSRN. Becoming a BSRN qualified site has become a desired status for a surface irradiance measurement program. Currently there are 35 sites participating in BSRN by contributing data to the Archive with another 6 nearing the point where they will submit data, with another 15 sites being offered or proposed. Still, there is need for further geographic and climatological coverage, particularly in Asia and Oceania. Initially, a requirement for a BSRN site was to be particularly representative of a region globally significant in extent. It has since been realized that smaller and more unique regions are also of scientific interest, particularly in the discipline of remote sensing but also as a result of increased resolution of climate models and satellite programs. Criteria for evaluating the desirability and suitability of new sites have been developed. Well-supported sites in currently under-represented climatic and geographic areas are given priority.

Measurement improvements - Currently there are BSRN working groups pursuing 7 different topics leading to improved measurement capabilities. They are:

1. Diffuse Solar WG
2. Thermal IR WG
3. Direct Solar WG
4. Albedo WG
5. Aerosol Optical Depth WG
6. UV WG
7. PAR WG.

Each of these groups is tasked to pursue the further development of measurement reference standards and/or to improve upon procedures for routine surface analysis. The Diffuse Solar and Thermal IR groups are conducting instrument intercomparisons and testing of new instrumentation that address previous known sources of uncertainty in the measurement. Both groups are moving towards the specification of the reference instrument or group of instruments. An intensive field campaign for diffuse solar observations was held in September of 2001, for thermal IR in March of 2001, and for PAR measurements in May of 2002. From the range in observational results made under controlled conditions, it appears that both solar diffuse and IR are narrowing absolute uncertainties to somewhat less than 5 Wm^{-2}, a number that was closer to 20 W m-2 at the start of the BSRN program. Still, there are operational hazards that can and do result in larger uncertainties when instrumentation is placed into continuous, mostly unattended, service in the field. Sensor cleanliness and

orientation have adverse effects on data quality and methods for addressing these have been implemented and are being refined and improved. The results from the PAR intercomparison are still preliminary but indicate relatively large discrepancies between instruments of different manufacturers. The Aerosol Optical Depth group has developed outstanding specifications for acquisition and reduction of AOD measurements that will avoid pitfalls of previous international attempts in this area. Those specifications are being implemented within the program and are awaiting implementation at the Archive. The UV working group has explored various observational capabilities and has been working with other UV measurement programs in an effort to identify suitable instrumentation and observational methods for the BSRN program. The Albedo WG is examining various observational practices and procedures to help identify more rigorous specifications for albedo measurements and to better understand the requirements for the measurement.

Data Archive - The BSRN data archive in Zurich continues as the core of the program, not only inspiring many of the original observational methodologies and data evaluation criteria, but also excels in the scientific applications of surface irradiance data. The Archive is operated at considerable expense to the Swiss and is one of their many contributions to the world climate research community. Recently, the Archive has undergone personnel, hardware, and software turnovers that have affected its operations. However, at present the Archive is operating at or near its full capacity and is awaiting additional programming capability to implement some of the latest advances spawned by the needs of the BSRN.

Research and Applications - Shortly after the first data were submitted to the archive, they were applied to satellite product development, primarily for validation of surface products of the WCRP SRB program. These data have proved quite valuable in this application as well as other satellite programs. There has been a growing awareness and interest in the feasibility of using BSRN data for comparisons to GCM generated surface irradiances. Both ECMWF and GFDL have made use of these data, along with some broader comparisons published by various individuals. Also, there has been a growing interest and need to compare more detailed radiative transfer calculations to BSRN observations, under both clear and cloudy sky conditions. These comparisons have resulted in improvements in both the models and observations and have led to better understanding of atmospheric processes and our ability to observe them. Small discrepancies still exist in comparisons to clear-sky solar diffuse models where specifying complete aerosol properties is crucial. Comparisons under cloudy and partly cloud conditions, while promising, depend on complete specification of clouds and geometrical differences. Comparisons between IR and modeled (LBL) irradiances in night-time clear skies are in agreement to within 2-3 Wm^{-2} and indicate the level of fundamental uncertainties in the models, specifically the water vapor continuum and exact specification of absorption coefficient over the compete range of interest.

Overall Status of BSRN - The energy and enthusiasm within BSRN is high. This is notable for a project entering its second decade, which is a time scale necessary both to satisfy the program's intent and to continue the development and refinement of measurement reference standards that have eluded us in the past. Many of the field stations have found it difficult to attract adequate funding to pursue all the advances and potential extensions in their measurement capabilities that have become available, such as lidars, automated photometers, and digital sky cameras. These sites and their associated site scientists continue to provide the basic data to the BSRN archive. Additional sites are expected to be offered to the BSRN because of the prestige of being identified as a BSRN site, and the stated needs of BSRN. The BSRN organization will continue to pursue its goals as well as identify and encourage those new sites that will be of greatest benefit to the network.

For a list of reference to BSRN related publications and other details on the status of BSRN, see the BSRN web site at: <http://bsrn.ehtz.ch>

Recommendations:

(A16) The WCRP/GCOS Atmospheric Observation Panel for Climate (under the chairmanship of Dr. M. Manton) has recently questioned the long-term perspectives of BSRN, which is recognised as an important contribution to climate monitoring. The exact terms of the request will be clarified by B. Rossow, in order to enable GRP to respond adequately.

(A17) In view of the success of BSRN, a letter should be drafted to WMO signature to thank BSRN station operators, archiving centre and Project Manager. A specific letter should be sent to Switzerland (either ETH or University or both) urging for a strengthening of the Archives and suggesting the support of a visitors programme. Dutton will draft letters and provide list of addressees.

(A18) A strategy should be developed involving WCRP, GCOS and AREP aiming at a better co-ordination of radiative fluxes and aerosol measurements in the perspective of their integration in the climate observing system. BSRN and AERONET should be central anchors of the climate observing system and should

at some stage become operational. BSRN/GRP will prepare a draft statement of principles for this purpose.

(A19) Although shortwave and longwave irradiances are now available from about 30 sites for many years, related ancillary datasets are not available. BSRN archive should implement a simple catalogued ftp access to all datasets. It is also strongly recommended that the Archives re-combine the meta data with the actual measurements, with a quality flag that indicates whether the dome corrections have been made for SW irradiances.

2.2 SRB (P. Stackhouse)

The following report summarizes the status of the WCRP/GEWEX Surface (SRB) Climatology Project since November 2001. During 2002, work has continued under the the NASA Modeling Data Analysis Research (MDAR) as part of Earth Observing System Interdisciplinary Science Program (EOS/IDS). GEWEX SRB processed 7 years of an eventual 12 year SRB data set spanning July 1983 – October 1995. The proposal calls for data processing, validation and analysis activities as illustrated in Figure 1. During the past year, extensive processing was completed. Measurements of shortwave (SW; 0.28 – 5.0μm) and longwave (LW; 4.0 - ∞ μm) were compared to the processed surface fluxes. Processed SRB parameters are also being compared to other surface radiation data sets. As of the date of this writing, 7 full years (1986-1990;1992-1993) of data have been processed through the GEWEX SW, SW Quality Check (QC) and LW QC flux algorithms. Of these data the GEWEX SW and the LW QC surface fluxes are being delivered to the International Satellite Land Surface Climatology Project (ISLSCP). The GEWEX LW is also running and is being tested more extensively with Baseline Surface Radiation Network (BSRN) and TOGA-COARE observations. The current status, recent accomplishments and schedule are summarized below.

Current Status:

During the past 9 months, the NASA Langley Atmospheric Sciences Center (ASDC – or formerly DAAC) has processed 7 years of data for 3 of the 4 SRB algorithms. Below is a review of the SRB project status.

Code Status (codes running at NASA Langley ASDC see Table 1):

a. International Satellite Cloud Climatology Project (ISCCP) DX processing operational; 84 months archived
b. NASA DAO GEOS-1 processing operational; 84 months archived.
c. TOMS column ozone processing complete; July 1983 – Dec. 1994
d. SW (Pinker/Laszlo) processing operational; 84 months archived
e. LW (Stackhouse/Fu) running at 1^{o}, not operational at ASDC; testing and validation continuing. Run for years 1992 and 1993 over the BSRN sites. Run for TOGA-COARE domain in December 1992. Also run globally for January and July 1993. The results are being compared w/ LW QC and other data sets.
f. SW Quality Check (QC; originally Staylor model, now updated and corrected and called Langley Parameterized Shortwave Algorithm, LPSA) processing operational; 84 months archived
g. LW QC (Gupta) processing operational; 84 months archived

Data status:

h. 5 years of data have been sent to International Satellite Land-Surface Climatology Project (ISLSCP) Initiative II CD group.
i. Delivered mid-seasonal months of 1992 to the European Surface Radiation Budget (ESRB)
j. Delivered 3 years of data to the Global Precipitation Climatology Project (GPCP).

Validation and Research Activities:

k. Continuing comparisons between surface flux measurements and newly processed products. Found a trend in the bias from 1986 to 1992 compared to World Radiation Data Center SW measurement daily averaged data when compared to all sites. More analysis is needed to confirm.
l. Concluding comparisons between the NASA GEOS version 1 reanalysis (GEOS1), the European Community Medium-Range Weather Forecast 15-year reanalysis (ERA-15), the NASA Water Vapor Project (NVAP) water vapor data set and ISCCP surface meteorological parameters. Analysis includes the diurnal cycles. Collaborating with NASA Goddard Institute of Space Studies (GISS) to compare other data sets.
m. Begun a study comparing the new fluxes to TOGA-COARE observations.
n. Processed 2 seasons of 2 years (1986 and 1992) of convective cloud top albedos. The work still preliminary at this stage is meant to be an additional calibration monitoring of the ISCCP visible calibration for each satellite.

2. Documentation:
    a. Processing System/Algorithm/validation documentation being drafted for reports and publications
    b. Web pages being upgraded to include processing status links
    c. Data files being prepared for inclusion into ASDC archive

Accomplishments for GEWEX SRB Project: 11/01 – 8/02

SRB Processing System/Algorithm Updates and Status

The most important accomplishment from the last 9 months was the completion of processing 7 years of the SRB data from 3 of the 4 radiative algorithms. 5 Years of this data were delivered to be included on the ISLSCP II CD. Data sets were also delivered to other users. The 4th algorithm is also being processed now and is being compared to BSRN flux measurements and to measurements from TOGA-COARE.

Validation Results

The output flux products from the GEWEX SW, SW QC, and the LW QC algorithms were compared to the daily and monthly averaged observations from the World Radiation Data Centre (WRDC) and the NOAA Climate Modeling Diagnostics Laboratory (CMDL) data sets, the Baseline Surface Radiation Network (BSRN) and the radiometric data from the Meteorological Service of Canada from 1983 through 1995.

The new estimates of surface fluxes were compared to BSRN measurements for both SW and LW estimates in 1992 - 1993. There were many more observations in 1993. In the SW, 1992 monthly bias differences were –1.6 W m^{-2} and increased to 3.2 W m^{-2} in 1993. In the LW QC, the monthly averaged bias were much closer between the 2 years and were –1.1 W m^{-2} in 1992 and –0.7 W m^{-2} in 1993. The GEWEX LW is giving bias differences 3 W m^{-2} less. Monthly RMS differences in the SW were about 22 W m^{-2} for each year and in the LW were about 18 W m^{-2}. For the SW, a daily averaged "clean-sky" radiative flux was computed for each site using the Fu/Liou radiative transfer model. The "clean-sky" represents an upper bound to the measurement since no clouds or aerosols are included. For the BSRN site at Illorin, a distinct bias developed and then faded during the December and January months. This bias is believed to be due to aerosol effects of biomass burning and is the first evidence of such events seen with BSRN data. More work will be done to study this.

The WRDC data set includes a number of broadband hemispheric radiometric time series from as many as 1000 sites distributed globally. Comparisons of the SW algorithm results to these observations are now being analyzed in terms of latitudinal zones, surface types (including coastal vs. non-coastal) and by topography in an effort to better understand the results. In general, the bias errors have become systematically less in an absolute sense (i.e., some biases errors changed sign from positive to negative) and RMS differences remain very close to those obtained from the previous version using ISCCP C1 at the 280 km equal area grid.

Other Research

a. Intercomparisons: We have intercomparisons with the surface albedo and spectral emissivity with those used by the Goddard Institute of Space Studies (GISS) surface radiation budget calculations led by Dr. William Rossow. These intercomparisons will be more developed in the coming year as an attempt is made to assess these fundamental surface properties.

b. Calibration monitoring: This year the months of March, April, and May were added to the analysis of convective cloud top albedos. Albedos for most instruments excluding the GOES satellite are higher for 1992 than for 1986. The differences are large but are still consistent with the stated absolute uncertainty of the ISCCP calibration. The results were given at the Fall AGU meeting.

c. 7-year analysis: As a first step the global annual mean surface radiation budget parameters were computed to examine the interannual variability. The parameters along with parameters from other investigators are given in Table 2. Year-to-year comparisons yielded the result that the means varied by about +/- 2 W m^{-2}. Year-to-year variability in the zonal annual means was about +/- 5 W m^{-2}. Monthly averages varied between 5 and 10 W m^{-2} with more variation at the poles.

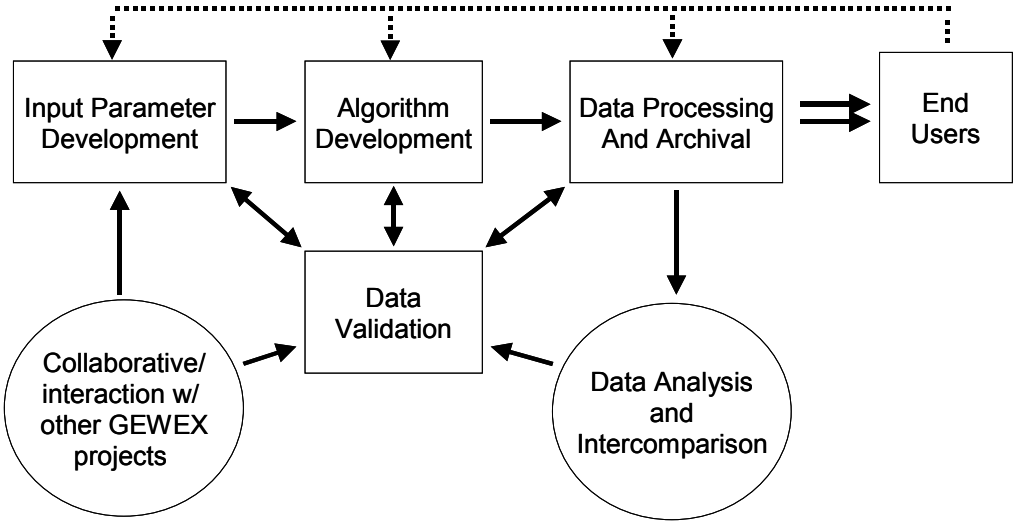
d. Tropical Pacific: Anomalies in the Tropical Pacific were examined on local (grid box level) and a regional basis. We find SW and LW flux anomalies compared to the 7-year mean during the 1992 El Niño and 1988 La Nina exceed 40 W m^{-2} on a monthly basis. The spatial scales of the responses to these events were noted. A monthly averaged time series of the response in the eastern Pacific region (20S - 20N and 180 – 120W) mirrors very well the multi-variate El Niño index. The region in the western had no

such correlation and was indicative of the difference in spatial scales of the response. Data for the Western Pacific region will be compared to TOGA-COARE measurements during the Nov. 1992 – Feb. 1993 period.

Current Timeline Schedule

Figure 2 delineates the tasks and milestones planned through August 2003. The most important of these is to complete the processing of this GEWEX SRB Release 2 and provide for its distribution through the Atmospheric Science Data Archive at NASA Langley Research Center. At our current rate of processing, including the implementation and processing of the GEWEX LW code, we expect a 118 month data set (Jan. 1986 – Oct. 1995) near October 2002. The processing of the GEWEX LW has begun and more validation is being performed. The validation effort for surface observations will be completed shortly and the emphasis will be switched to Top of Atmosphere fluxes. Access to the data processed to date is currently being readied so that the lagging of the processing of the GEWEX LW will not affect distribution. As noted above the GEWEX LW QC is comparing nearly as well as the GEWEX LW to date. Concurrent with this processing, we plan to submit a Bulletin of American Meteorological Society article in the Winter 2003 and release a NASA technical report documenting the data set. Additionally, validation and intercomparisons are planned between SRB and researchers with other surface radiation products.

Figure 1: SRB logistical organization under the new proposal. The end users include a SRB Users Group that will assist with feedback on the data quality.



Nodes	Status	Months Processed	Years Processed to Date	Months Released
ISCCP merged DX	Operational	84	’86-’90; ’92-’93	0
ISCCP gridded DX	Operational	84	’86-’90; ’92-’93	0
GEOS-1	Operational	84	’86-’90; ’92-’93	0
TOMS (TOVS) O_3	Complete	137	’83 – ‘95	0
SW	Operational	84	’86-’90; ’92-’93	60
SW QC	Operational	84	’86-’90; ’92-’93	60
LW	Operational	limited	Parts ’92, ‘93	0
LW QC	Operational	84	’86-’90; ’92-’93	60

137 months from July 1982 through October 1995.
*Monthly averaged results released only.

Figure 2. Schematic of task plans and milestones for 2002.

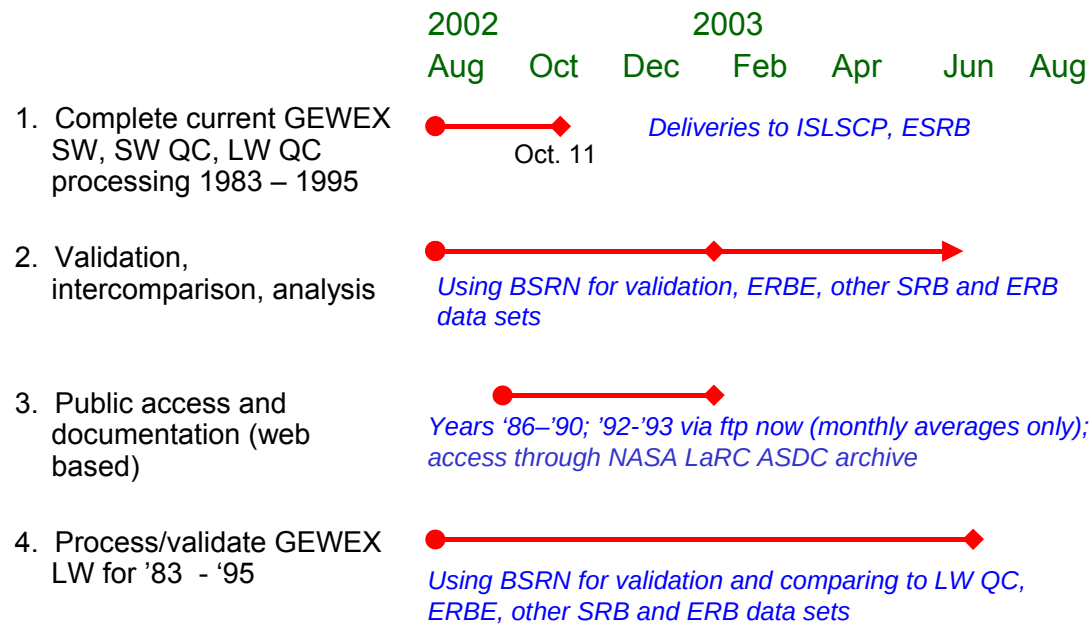


Table 2: Global Annual Mean Surface Radiation Budget Parameters from previous and current studies. All the solar fluxes were normalized to a solar constant of 1367.0 W m^{-2}.

Parameter	Rossow & Zhang (JGR, 1995) *4 yr Avg. Mid-Seasonal Months*	Kiehl and Trenberth (BAMS, 1997) ERBE/CCM3	Gupta et al. (1999)* *10 yr Mean ('83-'93)*	Zhang & Rossow (latest) *5 yr Mean ('85-'89)*	GEWEX SRB Rel. 2* *7 yr Mean ('86-'90', '92-'93)*
SW Down	193.4	198	185.0	189.4	186.2
SW Net	165.1	168	161.1	164.7	164.8
LW Down	348.3	324	347.8	344.6	345.2
LW Net	-45.8	-66	-47.9	-50.9	-47.1
Total Net	119.2	102	113.0	113.8	117.7

Recommendations

(A20) SRB should continue processing beyond 1995 without delay by switching to NCEP-2 reanalysis from GEOS-1; re-process 1995 with NCEP-2 to indicate possible changes introduced. Focus comparison of atmospheric and surface datasets on the period from 1994-1996. ERA-40 is also considered as a likely candidate for global analysis fields but a clarification should first be obtained from ECMWF concerning the conditions on redistribution of ERA-40 data by a project such as SRB.

(A21) A letter to NASA will be drafted by GRP to commend Stackhouse about SRB achievements, to stress the central importance of long-term, homogeneous data sets and of the continuity of the observation of the components of the Earth radiative budget.

2.3 ERB (B. Wielicki)

We now have several Earth radiation budget (ERB) datasets available covering the period from 1979 to 2002: (1) the NIMBUS-7 ERB dataset for 1979 – 1985, (2) the ERBE scanner datasets for 1984-1990, (3) the ERBE non-scanner dataset for 1984 to 2001, (4) the SCARAB ERBE-like dataset for 1994 and (5) the CERES ERBE-like datasets for 1998 and from 2000 onwards. A low-level activity is underway to re-process the ERBE scanner dataset employing improved techniques developed as part of CERES. A refined analysis of the SCARAB dataset is also underway. The long record of the ERBE non-scanner was recently re-processed to improve the treatment of time sampling (Edition 2 is available from http://eosweb.larc.nasa.gov/HBDOCS/langely_web_tool.html); a paper considering the observed variations of the radiation budget was published in the 1 February issue of Science (Wielicki *et al*. 2002).

A new generation of radiation data products is planned from the CERES experiment. A much more detailed set of angular distribution models is being developed from the rotating azimuth plane datasets produced by the second instrument on the TERRA and AQUA satellites and the more extensive scene characterization based on an analysis of MODIS surface and cloud property measurements. The rotating azimuth plane data can also be integrated over angles directly and compared with the angle-corrected cross-track scanning results: early results improvements by factors of 2-10 over the ERBE angular distribution models depending on the space/time sampling and viewing conditions. These new results will be much better at discriminating the flux variations over different surface and cloud types than the ERBE products. These new analysis techiques will be further tested against the Geostationary Earth Radiation Budget (GERB, recently successfully launched on MSG-1), which provides a completely different set of viewing geometries.

The CERES analysis continues with an enhanced time/space interpolation analysis that employs the 3-hourly observations from the ISCCP collection of geostationary weather satellite radiance measurements. These top-of-atmosphere fluxes are then integrated with 4-D assimilation atmospheric state to produce a consistent set of surface, atmosphere and TOA radiative fluxes, together with the cloud properties derived from MODIS. These products are compared with observations made at the BSRN and ARM sites, where the latter is being used to investigate the role of cloud vertical structures on the results.

Recommendations

(A21) A concern about the continuity of the ERB datasets between the AQUA and NPOESS missions was expressed and it was recommended that the GRP express this concern in a letter to NASA about the possibility of flying a spare CERES instrument on the NPP mission to ensure that there is no gap in coverage later this decade.

2.4 I3RC (R. Cahalan)

The first phases of the I3RC project (comparing the available and different techniques for calculating 3-D radiative transfer) have been completed. A test kit for 3-D radiative transfer models has not been placed on-line at http://climate.gsfc.nasa.gov/I3RC/index.html. A particular new result is to investigate the space-scale dependence of the 3-D radiative effects. It was suggested that a similar investigation was needed for the time-scale dependence and to look more closely at the characteristic space-time scales of 3-D effects on atmospheric radiative heating and the dynamical consequences. Working links have now been established with the cloud (LES) resolving modeling groups to carry this study forward. Links have also been established with the land-surface process modelers to examine the 3-D effects on coupling of radiation to land surface processes.

Recommendations

(A22) The GRP commended the excellent progress of the I3RC projects and endorsed the formation of a WG under the International Radiation Committee to carry on 3-D radiation applications studies in collaboration with the clouds and land surface modeling communities.

2.5 ICRCCM and associated radiation activities (H. Barker, W. Rossow for R. Ellingson)

ICRCCM - Longwave (R. Ellingson)

Following the January 2002 recommendations of the GRP, R. Ellingson is preparing a web site that will include the standard case study inputs and LBLRTM flux results for further RT code intercomparisons. He plans to work with Brian Soden to specify the format of Jacobians of results to address uncertainties in sensitivities that will be included in the package. The standard case study inputs and the LBLRTM flux results should be completed by 1 January 2003.

As we near completion of the clear-sky case, R. Ellingson plans to proceed with preparations for clear and cloudy sky intercomparisons with climate model calculations as outlined in Fall 2001 report. He will work closely with Howard Barker in contacting participants and in developing the protocol for the intercomparisons. Preliminary results from the intercomparisons are expected by the end of 2003.

ARM scientists are developing a value added product entitled Broad Band heating Rate Profiles (BBHRP) that will provide, in one location, vertical profiles of short- and long-wave radiation model calculations, simultaneous radiation observations, and the observed inputs to the model calculations. BBHRP will provide a 'test suite' for radiation and single column modelers to evaluate new parameterizations and data sources. The product is being prepared at two temporal scales, instantaneous for the Southern Great Plains Central Facility around each sonde launch, and averaged for the roughly 250x250 km grid cell corresponding to the ARM Extended Facility every 3 hours. The former will eventually be done operationally, whereas the latter will be performed for intensive observation periods when soundings are obtained over the domain. Access to these data will be linked with the ICRCCM homepage, now under development.

ICRCCM - Shortwave (H. Barker)

A manuscript describing the evaluations of parameterizations of cloud 3-D radiative effects at solar wavelengths was submitted to *J. Climate* in mid-February 2002. Plans to develop a web-based *test kit* that will enable 1D modellers to assess their codes with ICRCCM cases are still being worked on. One effort is to employ S. Kato's *dial-up* CKD algorithm to perform 3D Monte Carlo, domain-averaged, broadband flux profiles at fairly high spectral resolution. This might be completed by the end of 2002. The basic idea is still to provide spectral domain-averaged flux profiles at high enough resolution so that modellers will be able to perform spectral integrations that approximately match the resolution of their own code.

General radiation activities

Barker and Ellingson will finish putting model test kit data sets and documentation on-line.

Barker and Cahalan will organize a workshop to assess techniques for treating 3-D effects in different radiation sub-communities (remote sensing, LES modelling, GCM modelling - flux calculations), to highlight different techniques and to kick off liaison with GCSS/GLASS/GABLS.

Many problems remain concerning cirrus clouds: lack of reliable data on particles smaller than about 50-100 microns, particularly shape information, and lack of a general radiative transfer theory to handle scattering by such small, non-spherical particles. Also, there is no agreement on practical ways to represent the wide variety of shapes/sizes of particles encountered in cirrus.

(A23) Macke will prepare a letter from GRP to NASA/CRYSTAL and JACCS requesting that these programs give special attention to the above research issues.

(A24) There is a need for more cloud profiling data over oceans and GRP recommends an ARM type of experiment over the ocean. The co-location of radiation and microphysical measurements is essential. GRP also recommends to CPROF that they put special emphasis on more "3-D" cloud datasets and that they might add C. Fairall to the working group to facilitate release of ocean datasets.

2.6 GPCP and TRMM (A. Gruber, R. Adler)

Routine Background

The Global precipitation Climatology Project (GPCP) is one of the more mature GEWEX data Projects. We have developed and are producing three precipitation products:

Monthly Mean - This is a global monthly mean estimate of precipitation at the 2.5 x 2.5 degree latitude by longitude grid scale. It is a merger of satellite estimates of precipitation and gauge data. The satellite data consist of geostationary infrared in the 40N,S latitude zones, supplemented with polar orbiting IR data, where the geostationary data are unavailable, polar orbiting microwave data (SSM/I) and polar orbiting TOVS data at high latitudes where SSM/I is unreliable. The data are produced from 1979 and are continuing. Prior to 1987, there is no SSM/I data and an estimates using polar orbiting IR anomalies, calibrated against the GPCP data from 1988 onward is used. Gauge data are from the GPCC from 1986 onward and prior to then the GHCN/CAMS data are used. Details are described in Adler et al, 2002.

Pentad Data - Similar to the monthly mean in length of record (1979- present) and spatial scale 2.5 x 2.5 degree. It also merges satellite and gauge estimates of precipitation, however, this data sets provides greater temporal resolution (5days) making it superior for analysis of phenomena such as Madden-Julian waves. It is calibrated to the sum of the monthly mean values. Details are available in Xie et al, 2002.

Daily Data - Daily product rainfall estimate is produced on a 1 x 1 degree grid. It is based on geostationary and polar orbiting satellite estimates adjusted locally by monthly accumulations of microwave estimates where available. There are no gauges in this data set, but the data is calibrated to the sum of the monthly mean values of GPCP. Recently these data were extended back to October 1996. Details of the analysis procedure are available in Huffman et al, 2001.

These data sets as well as intermediate outputs are available on line from WORLD Data Center A at NOAA/NCDC**:** http://lwf.ncdc.noaa.gov/oa/wmo/wdcamet-ncdc.html.
These data sets are updated with about a 3 month time lag.

Other Items

The GPCP has supported the ISLSCP II project with pentad, monthly mean and gauge analyses. The effort to desegregate monthly mean precipitation using ISCCP DX data was judged to be unreliable. Consequently it was recommended to the ISLSCP II that they use a daily gauge analysis prepared by Pinping Xie of the NOAA/NWS.

The GPCC has completed an analysis of monthly mean precipitation from the “Full Data Product” (28,000-40,000 gauges) and compared them to the Monitoring Product (about 6000 gauges, readily available from the GTS) for the period 1986 through 1985. On average the full product is up to 5% higher than the monitoring product. Use of these data in our blended products have to be evaluated.

Analysis of the global water balance by A. Gruber and K. Syed has continued. We have calculated the water balance from the NCEP re-analysis and compared it to the calculations using Gvap water vapor and GPCP precipitation and re-analysis wind data. In both cases the evaporation was calculated as a residual in the water balance equation. In the latter case unrealistic negative evaporation was obtained in the tropics and it was concluded that the mix of observed and model data was incompatible. The all Re-analysis calculations were much more realistic supporting that conclusion. However, they were still significantly different from directly calculated evaporation. This difference was attributed to the spin up of the model.

Some initial work has begun on identifying solid precipitation using high frequency microwave channels form AMSU B.

And initial plans were discussed at the 16th WGDM meeting to develop a three hourly product using the suite of microwave instruments (SSM/I. AMSU, AMSR, TRMM) along with geostationary IR data.

The GPCP approved the plans for a Workshop to examine the objective analysis of precipitation.

The final annual GPCP Working Group on Data Management Meeting was held in Tokyo Japan, May 2002. Future meetings will be combined with other GRP data management meetings.

Future Plans

- Encourage work on identifying and estimating solid precipitation;
- Continue planning for three hourly global precipitation product;
- Test the usefulness of the GPCC expanded gauge analysis in the monthly mean blended analysis;
- Hold the Workshop on Objective Analysis of Precipitation at ECMWF in February/March 2003.

References

Adler, Robert F. , George J. Huffman, Alfred Chang, Ralph Ferraro, Ping-Ping Xie, John Janowiak, Bruno Rudolf, Udo Schneider, Scott Curtis, David Bolvin, Arnold Gruber, Joel Susskind, and Philip Arkin (2002): The Version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979-Present). Sub. J. Hydromet.

Huffman, G., R. F. Adler, M. Morrissey, D. T. Bolvin, S. Curtis, R. Joyce, B. McGavock, and, J. Susskind, 2001: Global precipitation at one-degree daily resolution from multi-satellite observations. *J. Hydrometeor*., **2**, 36-50.

Xie, P., J.E. Janowiak, P.A. Arkin, R.F. Adler, A. Gruber, R. Ferraro, G.J. Huffman, and S. Curtis, 2002: GPCP pentad precipitation analyses: an experimental data set based on gauge observations and satellite estimates*. J. Climate,* (submitted).

Report on GPCP and TRMM

The three GPCP products (monthly, pentad and daily) are routinely produced and available through web sites. Validation results indicate the stepwise bias removal procedure is effective at blending the satellite and then the satellite with gauge information. A large number of individuals and groups contribute to the production of the GPCP input data sets and precipitation products. The final monthly and daily merged products are produced by the Goddard group, with the pentad merged product produced by NOAA/CPC and then calibrated against the Goddard's group monthly product to produce a consistent set of precipitation products. These products have been used by the science community in various research activities. Examples include looking for global and regional trends in precipitation and examining precipitation patterns in relation to phenomena such as ENSO. The pentad and daily products have been used to monitor 30-60 day variations and their link to the initiation of El Niño.

The TRMM mission has been flying since the end of 1997 and the nearly five years of data are strong candidates for inclusion into the GPCP analyses. TRMM, with its combination of both radar and passive microwave data, is providing the best estimates of tropical precipitation and therefore should eventually become the keystone of merged precipitation analysis for its period. Currently TRMM data is being used in TRMM project merged analyses, including monthly analyses similar to the GPCP monthly and fine-time-scale (3-hr) analyses in real time. With Version 6 of the TRMM products (available in Spring 2003) there will be a 3-hr merged analysis for the entire period from January 1998 to the present, available with about a one month lag. The similar real-time product will be available until the research data set catches up. The 3-hr research product can be the basis for a new version of the GPCP products as it is extended into middle and polar latitudes. The five years of the new TRMM-based product could also be used to calibrate the monthly product for all 20+ years to provide a new climatology calibrated by TRMM. Details of using this approach are being discussed within the GPCP group.

(A25) GPCP should proceed with its Version 3 plans (anchored to TRMM) but the passive microwave analysis should be made consistent with microwave water vapour and cloud water retrievals.

(A26) Up to now validation of satellite precipitation measurements has not been successful, particularly as there are not really sufficiently dense and extensive observations with known accuracy available. GPCP should work with NOAA NCDC, Japan and European groups, to obtain other dense rain/snow gauge network data sets for validation studies. Special emphasis should be put on the development of case studies for orographic precipitation.

(A27) The retrieval of solid precipitation remains a delicate problem as shown during the recent workshop at Fairbanks. Activities to obtain snow data are still inadequate and GPCP should strengthen its ties to CLIC to improve this.

(A28) GRP supports Gruber's plan for a workshop to be organised in Feb-March 2003 at ECMWF on objective analysis of precipitation. He should liaise with Martin Miller who was the GEWEX contact for the humidity analysis workshop held in July at ECMWF.

2.7 GVAP (W. Rossow)

An assessment of upper tropospheric water vapor measurements was made at the ARM site in Oklahoma, USA, by a group composed of B. Soden (NOAA/GFDL), R. Ferrare (NASA/LARC), D. Tobin (U. Wisconsin), D. Turner (DOE/PNNL), H. Revercomb (U. Wisconsin), W. Smith (NASA/LARC) and D. Whiteman (NASA/GSFC). Comparisons were made of measurements from two Raman lidars, the LASE DIAL lidar and the NAST-I interferometer measurements: these all agreed to within 10% of satellite-measured values of upper tropospheric humidity (UTH). In contrast, radiosonde measurements (Vaisala RS80, RS90 and chilled mirror) were all systematically drier by about 40%; recent correction procedures do not improve this result much. These results are being prepared for publication.

A group representing NOAA and EUMETSAT is working to create a new UTH dataset with 3-hr resolution by cross-calibrating and analyzing the 6.7, 11 and 12 micron radiances from GOES-8, GOES-10, METEOSAT-5, METEOSAT-7 and GMS-5 for all of 1999. NOAA-14 radiances are being used for the cross-calibration.

A small international working group led by B. Soden is being organized to evaluate the treatment of the differential (spectrally dependent) changes of radiative fluxes to changes in water vapor profiles in broadband flux and line-by-line radiative transfer codes. Representative atmospheric profiles will be distributed to interested participants late in 2002 along with guidelines for computing partial derivatives (radiative adjoints).

(A29) GVAP should expand the assessment of tropospheric water vapour data set quality, including both RAOB and satellite data.

2.8 ISCCP and GACP (W. Rossow)

(ISCCP) Current Project Status: July 2002

ISCCP completed its 19th year of data collection on 30 June 2002. Radiances from all operating meteorological satellites, with the exception of INSAT and FY-2B, are being routinely collected by the cognisant Sector Processing Centers (SPC) and delivered to the Global Processing Center (GPC) in accordance with project requirements. All project datasets are now being delivered via Internet except for the DX product. Currently operating satellites are NOAA-16, NOAA-17, GOES-8, GOES-10, GMS-5, METEOSAT-5 and METEOSAT-7 with METEOSAT-6, GOES-9, GOES-11 and GOES-12 in reserve. NOAA-17 was launched on 24 June 2002 to replace NOAA-15 in the morning orbit; however, the equator crossing time for this and subsequent satellites will be later in the morning at about 1000 local time. Plans call for METEOSAT-5 to continue operating over the Asian sector until the end of 2003. If the launch of MSG-1 to replace METEOSAT-7 is successful and either METEOSAT-6 or 7 is still healthy, then one of these satellites will be moved to replace METEOSAT-5 by the end of 2003. METOP-1 launch is now planned for 2005. The launch of the first MTSAT to replace GMS-5 failed. Actions have been taken to extend the life of GMS-5 until launch of MTSAT-1R, now planned for mid-2003: as of July 2001 the frequency of whole-Earth images has been reduced to avoid scan-motor jamming, but this reduced imaging schedule has not affect the images collected for ISCCP. Nevertheless, GOES-9 will be moved to provide coverage of this sector until MTSAT-1R is launched. MTSAT-2 launch is planned for 2004. China successfully launched FY-1D (polar orbiter) in 2002.

The Satellite Calibration Center (SCC) in Lannion, France, provides monthly satellite-to-satellite radiance normalization for four wavelength channels, nominally at 0.6, 6.7, 11 and 12 mm. Normalization data are complete through March 2002, except for the water vapor channel (6.7 mm).

The GPC monitors the calibration of the polar orbiting radiometers (AVHRR) that serve as the reference standard for the radiance data. Monitoring results are complete through October 2001. Up-to-date calibration information is posted on the ISCCP Web site.

Routine archival of Stage B3 data is complete through September 2001 (18.25 years). Further deliveries will be delayed until sufficient statistics are developed for the new calibration standard. Since parallel collection of NOAA-16 data began in March 2001, deliveries of Stage B3 data may resume near the end of 2002. However, the newer satellites have more than five wavelength channels, so the ISCCP Stage B3 format will have to be re-designed. Also, the split-response of the new AVHRR solar wavelength channels may make calibration much more challenging.

Atmospheric temperature and humidity profiles and sea ice and snow correlative datasets are complete through September 2001.

Stage DX, D1 and D2 data have been completed for July 1983 through September 2001 (18.25 years). Two CDs of D2 data have been released covering the period 1983 - 1988 and 1989 - 1993; a third CD of D2 is planned to cover the period 1994-1998. All D2 data are now on-line on the ISCCP Web site. Processing of D data beyond September 2001 will be delayed until the calibration standard is re-established at the end of 2002.

Since sampled AVHRR data were obtained back to the beginning of the life of NOAA-7 in August 1981, these data will be processed to provide partial coverage of the El Nino in 1982-83 and the El Chichon eruption. A special polar-orbiter-only climatology will be prepared (with an adjustment for limited diurnal sampling) to produce a 20-yr record of ENSO anomalies.

Complete datasets currently available at the ICA are:

Stage B3 and BT:	July 1983	—	September 2001
Atmospheric data:	July 1983	—	September 2001
Sea ice and snow data:	July 1983	—	September 2001
Stage DX, D1 and D2:	July 1983	—	September 2001

The ISCCP Web pages can be found at: http://isccp.giss.nasa.gov

The contents of the ISCCP Web site have been significantly expanded to include: (1) an expanded set of links to other extensive cloud datasets from satellites, radars and lidars, (2) complete D2 dataset which can be downloaded, (3) a climatology of small-scale cloud optical thickness and top temperature spatial variability that can be used in GCM radiative transfer models, (4) complete radiance calibrations for all weather satellites used by ISCCP from July 1983 to September 2001, (5) a graphical illustration of the results of an extensive climatological analysis of the ISCCP dataset (which will be expanded soon to present cloud-type results), (6) links to several other climate data analyses including radiation budget and surface temperatures, (7) several more satellite-based, global datasets and (8) expanded links to related projects, data centers and web sites.

A separate Home page for the GEWEX Cloud System Study - Data Integration for Model Evaluation (GCSS - DIME) can be found at: http://gcss-dime.giss.nasa.gov

This site contains four categories of data for all of the GEWEX Cloud System Study cases: data for model initialization, large-scale satellite observations, selected field study observations and climatological composites to used to generalize results. Overall, about 6 Gbytes of data can be obtained from this site, comprising 10 different kinds of data for the 21 cases (664 days of data) defined by the five GCSS Working Groups.

Four diagnostic products are being worked on: (1) a survey of midlatitude cyclone-anticyclone cloudiness produced by combining the NCEP and ECMWF re-analyses with ISCCP, (2) a survey of tropical mesoscale convection produced by identifying and tracking the motions of all high-cloud clusters that contain convective clouds at some stage, (3) a climatology of cloud particle sizes, both for liquid and ice clouds, and (4) a complete analysis of radiative flux profiles at mesoscale resolution. Cyclones are identified by negative anomalies in the surface pressure and tracked through time; the collocated clouds are combined with other meteorological information to describe these cloud systems (Tselioudis, G., Y-C. Zhang and W.B. Rossow, 2000: Cloud and radiation variations associated with northern midlatitude low and high sea level pressure regimes. *J. Climate*, **13**, 312-327). This survey has been completed and the dataset is being prepared for release. Deep convection is identified as cold (i.e., high altitude) cloud tops with very high optical thicknesses; the analysis identifies and tracks the motions and evolution of each system (Machado, L.A.T., W.B. Rossow, R.L. Guedes, and A.W. Walker, 1998: Life cycle variations of mesoscale convective systems over the Americas. *Mon. Wea. Rev*., **126**, 1630-1654). These data will provide statistics regarding the formation, maturation and decay of individual systems as functions of size, shape and location. This survey is underway and should be completed by early 2003. Still being prepared is an analysis of cloud particle sizes to complement the GACP aerosols product for study of the so-called indirect effect (Han, Q., W.B. Rossow, J. Chou and R.M. Welch, 2000: Near-global survey of cloud column susceptibilities using ISCCP data. *Geophys. Res. Lett.*, **27**, 3221-3224). The fourth product contains complete radiative flux profiles (Chen, T., Y-C. Zhang and W.B. Rossow, 2000: Sensitivity of radiative heating rate profiles to variations of cloud layer overlap. *J. Climate*, **13**, 2941-2959) based on the ISCCP D1 (3 hr, 280 km) dataset and a climatology of cloud layer structure from rawinsondes (Wang, J., W.B. Rossow and Y-C. Zhang, 2000: Cloud vertical structure and its variations from a 20-year global rawinsonde dataset. *J. Climate*, **13**, 3041-3056). This product is now being produced. All of these products will cover the whole ISCCP time period.

New scientific result based on the ISCCP datasets are reported in:

Hahn, C.J., W.B. Rossow and S.G. Warren, 2001: ISCCP cloud properties associated with standard cloud types identified in individual surface observations. *J. Climate*, **14**, 11-28.

Han, Q., W.B. Rossow, J. Zeng and R. Welch, 2002: Three different behaviors of liquid water path of water clouds in aerosol-cloud interactions. *J. Atmos. Sci.*, **59**, 726-735.

Rossow, W.B., C. Delo and B. Cairns, 2002: Implications of the observed mesoscale variations of clouds for Earth's radiation budget. *J. Climate*, **15**, 557-585.

Luo, Z., W.B. Rossow, T.Inoue and C.J. Stubenrauch, 2002: Did the eruption of the Mt. Pinatubo volcano affect cirrus properties? *J. Climate*, (in press).

Funding Status

All ISCCP data processing centers are now funded as part of satellite operations with the exception of the Global Processing Center funded by NASA. Currently approved funding for the GPC ends this year. A renewal proposal for five more years of funding will be submitted in the next two months.

Plans for Exploitation of New Satellites

Many new satellite instruments have been or will soon be launched that sense clouds at a new set of wavelengths and/or employ novel measurement techniques. Among the latter are MISR (which multi-angle measurements at solar wavelengths) on TERRA and POLDER (which makes multi-angle and polarimetric measurements at solar wavelengths). Among the former are spectrometers, such as SCIAMACHY, AIRS and GLI. The most similar style instruments are the new multi-wavelength imagers, MODIS on TERRA and AQUA and MERIS on Envisat. Efforts have begun at the GPC to acquire and process MODIS data with the ISCCP (2-wavelength) analysis procedure to facilitate pixel-level comparisons with the results obtained using many more wavelengths. These data will also be used to compare calibrations at common wavelengths.

Joint Diagnostic Studies

Recent publications have shown that, in addition to anomalies in the top-of-atmosphere radiative fluxes in the tropics and subtropics induced by volcanic events and ENSO events, there appears to also be a "slow" change between the 1980's and 1990's. These changes appear to be related to changes in clouds and upper tropospheric water vapor that are consistent with changes in the tropical-subtropical mean circulation. However, all of the datasets being used for this analysis have several problems that cast doubt on the reality of such small changes. If the changes are real, then it would also be important to diagnose the related changes in the surface radiation budget and precipitation to see how the atmosphere, land and ocean exchanged energy and water over this two-decade period. To do this requires: (1) that all the relevant datasets be re-examined to remove any sources of inhomogeneity by comparisons and consistency checks and (2) that the statistics of these datasets be analyzed, together, in a consistent fashion and extended to include, at least, surface radiation and precipitation. As one example, note that the current ISCCP and SRB products have not made use of the GACP aerosol product, so that these are not consistent. As another example, current upper tropospheric water vapor and precipitation datasets have not employed the available cloud datasets to remove cloud effects, so that these are also not consistent. Given the current maturity of these various datasets, such an integrated, consistent analysis could be performed.

GACP Report

Results obtained during the first phase of GACP

Extensive theoretical studies (reported in 23 published papers) supported the development of a two-wavelength aerosol retrieval method to be applied to AVHRR radiances; subsequent validation studies confirmed theoretical expectations, namely, that with a two-wavelength analysis, the uncertainty in the retrieved aerosol optical thickness is much reduced compared with a single-wavelength analysis. The most invariant measure of aerosol particle size, and therefore the best parameter to retrieve, is the Ångstrom coefficient. Aerosol column number density cannot be reliably inferred from a two-wavelength retrieval however. Although the specified optical parameters (real and imaginary indices of refraction, *i.e.,* composition) and microphysical properties (particle shape) appear to be appropriate for a good estimate of global mean aerosol optical thickness and Ångstrom coefficient, regional and/or seasonal biases are likely to be significant because of systematic regional differences in these aerosol properties. In particular, the nonsphericity of mineral dust and sea salt particles can lead to very large biases.

The new, two-wavelength analysis method was applied to the ISCCP pixel-level cloud product covering July 1983 – December 1999 (these results will shortly be extended to cover August 1981 – September 2001) . The resulting product is available at: http://gacp.giss.nasa.gov/retrievals.

Evaluation of these results against surface and aircraft measurements indicates that the main sources of uncertainty, aside from those associated with the specified optical and microphysical properties, are cloud-contamination and radiance calibrations. At low optical thicknesses, the treatment of diffuse reflection from the ocean (that is a function of the abundance of particles suspended in the water) and surface windspeed effects can also be important. With AVHRR data alone, a definitive separation of remnant clouds (likely to be optically thin cirrus) and aerosols cannot be achieved (although the errors can be minimized). The current product still has discontinuities and spurious trends probably caused by calibration errors in Channel 2 (» 0.8 mm wavelength): the range of published calibrations is equivalent to a very large uncertainty in aerosol optical thicknesses (the Channel 1 calibration is that used by ISCCP).

The overall average aerosol optical thickness over oceans is found to be 0.14 with an Ångstrom coefficient of 0.75 (approximately equivalent to an effective radius of 0.4-0.5 mm). Because these two parameters are weakly correlated, the linear and optical-thickness-weighted aerosol sizes are similar. The average aerosol optical thickness in the Northern Hemisphere exceeds that in the Southern Hemisphere. Both hemispheres show a seasonal cycle with maximum optical thicknesses occurring in summertime. The total aerosol optical thickness variations in 1991-1993 are consistent with the additional stratospheric aerosol created by the Mt. Pinatubo volcanic eruption, as obtained from SAGE observations.

Planned Research

Although the initial processing of the entire AVHRR-ISCCP dataset over the oceans is completed, several important improvements can still be made. These include (1) an improved calibration of AVHRR Channel 1 and 2 radiances, (2) refined cloud clearing tests, (3) analysis of nonsphericity effects and of systematic variations of composition, (4) extending aerosol retrievals over land, (5) using SAGE data to account and separate the stratospheric from the tropospheric aerosols, (6) validation and comparison of AVHRR and MODIS/MISR retrievals and (7) study of aerosol indirect effects using the combined GACP - ISCCP datasets (where the latter has been extended to include cloud particle sizes).

(1) Preliminary tests show that the introduction of a small linear trend in the additive correction to the Channel 2 radiances on NOAA-11 can eliminate a spurious trend in both optical thickness and Ångstrom coefficient. Hence, the remaining data can be examined for discontinuities between satellites and correlated trends in the retrieved parameters.

(2) Recent studies have shown that we may be able to employ more sensitive tests using the two infrared wavelength channels on AVHRR to detect thinner cirrus clouds. Further study is warranted to reduce cloud contamination, especially over land areas.

(3) Tests of retrievals assuming nonspherical particle shapes show that, in regions where mineral dust predominates, the retrieved optical thickness is about 50% (on average, and may be as more than 300%) larger than when the aerosols are assumed to be spherical. Some unusual combinations of the retrieved parameters using the spherical assumption may give an indication of the presence of nonspherical aerosols.

(4) Aerosol retrievals over land are more difficult, both because the surface albedo is generally larger (reducing the sensitivity to aerosol), especially in Channel 2, and because the land surface albedo is more variable and not known *a priori*. Some concepts for extending the retrieval to land area need to be explored.

(5) SAGE data can be used to separate the stratospheric aerosol from tropospheric aerosol during volcanic eruption events like El Chichon and Mt. Pinatubo, but the retrieval code has to be modified to account explicitly for the stratospheric aerosols, which are much smaller.

(6) A number of new, very detailed surface and field experiment datasets with composition information are becoming available or will be available in the near future, so the capability of verifying the satellite-based results for a number of locations will improve. Moreover, new satellite instruments, particularly the MODIS/MISR combination and POLDER will provide additional, global scale evaluations of the AVHRR product. Once these comparisons are completed, a revised retrieval method can be applied to the whole AVHRR data record.

(7) Since GACP obtains its results from the ISCCP-processed AVHRR data, from which cloud optical thickness, top temperature and, eventually particle size, information will also be available, the study of the interaction of clouds and aerosols can be conducted with this combined dataset, since the cloud and aerosol information will be as closely related as can be done with current satellite instruments.

Main issues concern the continuity of support by NASA of this type of activity, and the continuity of the data sources. The overall strategy of this type of data set will be part of the new working group. As a reminder, the cloud-radiation feedback workshop will be focussed on methodology and is organised 18-20 November in Atlanta.

(A30) GACP should make connections to IGAC/GAW, SPARC and BSRN. In next round of analysis, additional satellite data sets should be employed (TOMS, HIRS) and new instruments should be exploited, namely MODIS, MISR and POLDER. Mishchenko should prepare a plan for GRP in this perspective.

2.9 Clouds-Radiation Review (V. Ramaswamy, B. Wielicki)

Future Radiation Activities (A. Macke)

The presentation focused on two major issues in cloud radiative transfer modeling: nonspherical particles in cirrus clouds and the spatial structure of low and mid-level clouds.

1) Nonspherical particles in cirrus clouds

Modeling studies have shown that cirrus clouds can have a net cooling or warming effect on the climate system depending on the effective size of the ice crystals. However, our understanding of real cirrus cloud radiative properties is hampered because of a) large uncertainties in observed size and shape of ice particles smaller than about 50 micron and b) because of the lack of accurate light scattering models for these particles. It is therefore recommended to intensify research in quantitative measuring systems and in light scattering theory to account for small particles with arbitrary geometry.

Present microphysical observations with standard optical array probes show large variabilities and discrepancies in direct inter-comparisons even for the same type of instruments on the same aircraft at the same time. These discrepancies are attributed to uncertainties in the measurement - and the analysis methods as well as to the strong natural variability of cirrus microphysical properties. It is therefore recommended to narrow down these uncertainties by laboratory or theoretically based error analysis. It should be clearly stated as to what extend in-situ measurements of ice particle size distributions provide correct and statistically significant informations.

Given the above mentioned observational and theoretical shortcomings it is further suggested to exploit the construction of phase functions and single scattering albedos from collocated multi-viewing angle radiance and polarization measurements (as it was demonstrated with the first satellite based POLDER) rather than calculating the optical properties from explicit but errornous assumptions regarding the size and shape distributions. Such reconstructions can be performed for different synoptical and climatological situations. The results will substantially improve future remote sensing and radiation budget calculations for this cloud type.

2) Inhomogeneous clouds

Present cloud remote sensing algorithms and most cloud radiative transfer models in large scale atmospheric models are based on the assumption of a plane parallel homogeneous cloud geometry. Numerous studies have demonstrated that large systematic errors result from this simplified representation of clouds. However, improvements are basically hampered by the lack of 3d-cloud informations. Over the past couple of years cloud resolving atmospheric circulation models with prognostic cloud microphysical properties (type of hydrometeor, effective particle size) have become available and may fill this gap with physically based fully 3d cloud informations. Both the cloud modeling and cloud radiative transfer community should be encouraged to collaborate in detailed cloud physics and cloud radiative transfer modeling for a large number of cloud scenarios covering the different synoptical and climatological appearances of 3d inhomogeneous clouds. This effort should provide the basis for future radiative budget parameterizations and remote sensing algorithms.

The above mentioned modeling approach is suggested because current observational techniques are not able to instantaneously measure the full 3d structure of water content and particle radius. However, collocated ground based cloud radar and passive microwave radiometer measurements have demonstrated the ability to infer the spatial distribution of cloud liquid water content. Although such radar/microwave radiometer combinations are tedious and will not provide large enough data sets for parameterization purposes at any time

soon, it is recommended to extent this work in order to add more and more "ground truth" to an otherwise purely modeling initiative.

Upgrades to physics formulations in GCM radiative transfer codes (V. Ramaswamy)

A number of developments have taken place over the last decade leading to substantive advances in the understanding of basic shortwave and longave radiation and in the enhancement of radiative transfer codes used in general circulation models (GCMs). These steps have come in the wake of several activities. One is the accomplishments of the Intercomparison of Radiation Codes in Climate Model (ICRCCM) projects. Another is the series of reliable observations now available concerning the radiation and climate variables. The first ICRCCM project began in early 1980s leading to results (JGR special issue, 1991) that highlighted a number of important fundamental aspects that were either lacking in or poorly represented in GCM radiation codes. The project led to the first field measurements of spectral radiation fields - the SPECTRE campaign. Then followed a number of dedicated field campaigns, new satellite observations (A VHRR, ERBE, ISCCP, CERES), and the onset of continuous monitoring of radiation quantities at a number of sites around the world (e.g., CART site, BSRN). With time, and owing to the considerable emphasis placed on accuracy, calibration and sampling matters, there has resulted a reliable base of information related to radiative processes. Besides the improvements in basic knowledge (e.g., water vapor continuum, cloud inhomogeneity), the observational datasets have provided realistic verification bases for the radiation codes. Very recently, ICRCCM has completed yet another project that has focused on the shortwave radiation transfer. An interesting new development is the prospect of obtaining observations of vertical profile of condensates in clouds in the near future, an element that remains largely untested in models.

In an attempt to obtain information concerning the present-day GCM radiation codes, a questionnaire was sent to several institutions. The tables describing the model attributes should be juxtaposed with the descriptions appearing in Barker et al. (2002). Radiation codes in GCMs have matured substantially through the 1990s. It is evident that they have benefited, both through improvements in theoretical aspects and observations. Not only do the present GCM radiation codes have considerable flexibility, but they are calibrated more carefully (nearly all have compared with some 'benchmark' calculation). Steps have been taken to perform diagnostic comparisons with observations. Through the 1990s, this has usually consisted of comparing time-mean cloud amount frequency (e.g., ISCCP), TOA irradiances (e.g., ERBE). The model-observation diagnostic studies need to be extended to the examination of other climate variables so that a proper perspective of the radiation-climate interactions can be obtained on the various spatial and temporal scales.

The issue of the assessment of RT “public” codes was raised.

(A31) GCM Radiative Transfer codes have been significantly improved over the past few years, but this is not well appreciated. Ramaswamy will continue survey of GCM RT code attributes and prepare brief summary publication for BAMS, GEWEX News and/or GRP Web site.

(A32) An article describing GCM test metrics from the perspective of clouds, aerosols and radiation will be prepared for publication (Wielicki and Rossow)

2.10 Remote sensing, sounding (C. Stubenrauch) and precipitation (T. Iguchi)

Reanalysis of TOVS Path-B: Longterm atmospheric properties (C. Stubenrauch)

Since 1979, the TOVS instruments aboard the NOAA Polar Orbiting Environmental Satellites have measured radiation emitted and scattered from different levels of the atmosphere, and therefore are an important tool for a continuous survey of the state of the atmosphere over the whole globe.

The TOVS system consists, in particular, of two sounders: the High resolution Infrared Radiation Sounder (HIRS/2) with 19 infrared (IR) spectral channels between 3.7 and 15 microns and one visible (VIS) channel (0.7 microns) and the Microwave Sounding Unit (MSU) with four microwave channels around 5 mm. In order to convert these measured radiances into atmospheric properties, complex inversion algorithms are necessary. The TOVS Path-B dataset (Scott et al. 1999) provides atmospheric temperature profiles (in 9 layers) and water vapor profiles (in 4 layers) as well as cloud and surface properties at a spatial resolution of 1° latitude x 1° longitude. A fast line-by-line radiative transfer model (4A) and a huge collection of radiosonde measurements of temperature, humidity and pressure that are grouped by atmospheric conditions are used to generate a dataset for the initial guess of the atmospheric temperature profile retrieval (TIGR database). Clouds are detected at HIRS spatial resolution (17 km at nadir) by a succession of threshold tests, which depend on the simultaneous MSU radiance measurements that probe through the clouds. To insure more coherence with the MSU spatial resolution (~100 km at nadir), the HIRS radiances are averaged separately over clear pixels and over cloudy pixels within

100 km x 100 km regions. Average cloud-top pressure and effective cloud emissivity over cloudy pixels are obtained from four radiances in the 15 microns CO_2 absorption band (with peak responses from 400 to 900 hPa levels in the atmosphere) and one in the 11 μm IR atmospheric window. Empirical weights reflect the effect of the brightness temperature uncertainty within an airmass class on these radiances at the various cloud levels. The method is based on the coherence of the effective cloud emissivity, obtained from the five wavelengths at the pressure level of the real cloud.

Whereas the International Satellite Cloud Climatology Project (ISCCP) is the cloud climatology with the best diurnal sampling and spatial resolution, cirrus (semi-transparent ice cloud) properties, obtained from TOVS vertical sounders with a relatively high spectral resolution, are especially reliable, day and night. For climate studies, using one of these datasets, it is important to understand how cloud properties are perceived by these different instruments and inversion methods. A detailed comparison has shown that both datasets agree quite well. Discrepancies can be explained by differences in temperature profiles, horizontal (partial cloud cover) and vertical (multi-layer clouds) heterogeneities. For example, in the case of thin cirrus overlying low clouds, one determines with TOVS the cirrus properties, whereas ISCCP determines a mixture of both clouds, from the visible channel.

Mean effective ice crystal sizes and ice water path for cirrus clouds are retrieved for medium thick cirrus clouds, taking advantage of the fact that spectral cirrus emissivity differences between 11 and 8 μm depend on this parameter (Stubenrauch et al. 1999). This method is sensitive to sizes up to 70 microns. An eight year survey of these cirrus properties will be available within the framework of the European project CIRAMOSA (web-site: http://www.lmd.polytechnique.fr/CIRAMOSA/ Welcome.html).

Eight years of TOVS Path-B data (1987 – 1995) are available in HDF format at NASA DAAC. The analysis of this time series of data has lead to some minor improvements. The recently reanalyzed data set is stored at LMD. The reanalysis should be extended soon after solving the difficulties met in creating a collocated radiosonde-satellite data set, similar to the DSD5 data set provided by NOAA/NESDIS for this time period, which was used to remove systematic biases due to the radiative transfer model, instruments and unexpected events (such as the Mt Pinatubo eruption). Currently, the complete radiosonde collection used for the ERA40 reanalysis is being transferred from ECMWF. We are developing a clear sky identification algorithm for the computation of the channel biases. Once these constants are determined and evaluated, the reanalysis will continue over the whole life time period of the NOAA platforms. This will happen before the end of 2002. To reanalyze 8 years of data takes about 2 months at the computation center of C.N.R.S. (IDRIS). The new reanalysis will also use improved versions of the 4A and 3R (fast parameterized) models, as well as extended TIGR and GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques) databases.

Scott, N. A., A. Chédin, R. Armante, J. Francis, C. J. Stubenrauch, J.-P. Chaboureau, F. Chevallier, C. Claud and F. Chéruy, Characteristics of the TOVS Pathfinder Path-B Dataset. Bull. Amer. Meteor. Soc. 80 (1999) 2679-2701.

Stubenrauch, C. J., R. Holz, A. Chédin, D. Mitchell and A. J. Baran, Retrieval of Cirrus Ice Crystal Sizes from 8.3 and 11.1 μm Emissivities Determined by the Improved Initialization Inversion of TIROS-N Operational Vertical Sounder Observations, J. Geophys. Res. 104 (1999) 31793-31808.

Precipitation Measurement from Space (T. Iguchi)

T. Iguchi reviewed the various methods for determining tropical precipitation from satellite measurements, including visible infrared radiometer, microwave radiometer and radar measurements. All three of these methods are now being intercompared using observations from TRMM, which has all three instrument types viewing the same locations. These observations are also being compared with special intensive collections of measurements at several reference sites. He illustrated the importance of spatial resolution to the results and demonstrated the improvements in microwave-based analyses that have been obtained using the TRMM Precipitation Radar. TRMM data are also being assimilated into weather forecasts on an experimental basis and already show important improvements. Additional new results from TRMM include an all-weather SST product and an experimental soil moisture product, made possible by the low-frequency channel on the TRMM Microwave Imager.

Although there have been significant improvements in the radar determinations of precipitation, validation remains very difficult and several important issues have not yet been resolved. One problem that affects even the quality of the surface datasets collected for verification purposes is caused by variations in the drop-size distribution. These variations are not yet accounted for by most precipitation measurement systems, thereby introducing a persistent source of bias error. This shows up in the persistent inability to define a unique relationship between surface precipitation and the radar reflectivity. The TRMM experience has also shown that surface radar systems are not as well calibrated as the TRMM PR. Probably the biggest problem is that the

space-time scales over which precipitation varies not only include a wide range but include very small scales that challenge all of the existing datasets. The variety of vertical profiles and microphysics encountered in different storm types interferes with our ability to determine precipitation rates accurately with “simple” one or two component measurements. A lot of work is still required to understand this situation and it will have to be advanced before the flight of the Global Precipitation Mission. GPM will fly a two-frequency radar to improve on some of the difficulties encountered but the nature of the microwave radiometers and the analysis strategy to be used to obtain global, 3-hr coverage still needs study.

Some Issues on Long-term Satellite Remote Sensing of Clouds (T. Hayasaka, K. Kawamoto, H. Iwabuchi)

Long-term monitoring of clouds from space is quite important for climate studies. It has been more than 20 years since the quantitative satellite remote sensing of clouds has started. In this presentation we show an example of long-term measurements of clouds by using AVHRR on board NOAA-9 and NOAA-11 and point out some issues.

We are analyzing AVHRR data over the East Asia region to retrieve cloud optical thickness and effective particles radius for the past 20 years. It is shown from AVHRR analysis that the temporal variation of retrieved effective particle radius has a gap between NOAA-9 and NOAA-11. However, the results obtained from the both satellites are consistent with each other if the effective particle radii are related to local standard time of satellite overpass. It appears that the effective particle radius decreases with delaying the satellite overpass. Since the orbit of NOAA series satellite drifts after the launch, the overpass time changes, for example, from 13:30LT to 17:00LT for NOAA-11. During three hours in the afternoon cloud itself might change even if the cloud is typical one in the same season and same region. Also the solar zenith angle changes for three hours. It is known that cloud inhomogeneity and cloud top shape affect the reflected radiances, and those effects depend on solar zenith angle and satellite viewing angle. Therefore we compared the optical thickness of cloud for different geometrical angle condition of the satellite and the sun, using two orbits with 100 minutes time lag. The cloud inhomogeneity effect is recognized from this comparison. 3-D radiance calculations were also carried out with a simulated inhomogeneous cloud model which is expressed by optical thickness and geometrical thickness, and the results are consistent with the above observations. The 3-D calculations with the simulated cloud model suggest that an averaged value of optical thickness for 8km x 8km domain has small error if we use nadir-looking data or data around the nadir.

(A33) Satellite sounder analysis methods are still being tuned to RAOBS, even though the latter are known to be inaccurate, particularly for water vapour. There is a need to establish new standards for satellite remote sensing of water vapour.

(A34) Several analysis approaches are followed by different precipitation measurement communities (satellite active and passive methods, surface and aircraft radar methods, modellers especially CRMs and RT specialists); these need to be compared and reconciled. A message for satellite agencies is that, to prepare for GPM, they must bring these groups together, must focus on better retrieval physics and more intensive validation efforts. Also there is a to support more studies of microphysics relationship to precipitation.

(A35) Relation between GRP and GCSS should be encouraged with respect to the 3D simulation of observation systems by cloud resolving models. CRM runs would also allow to test precipitation retrievals, similarly to what is being done for 3-D radiation schemes. (proposal to be worked out by Macke)

2.11 Seaflux and Landflux (J. Curry, W. Rossow)

J. Curry reported on activities of SeaFlux. The on-line database of ship case studies now encompasses over 300 data months. Moreover, there is a complete collection of collocated satellite products available, including SST, clouds, surface winds, atmospheric temperature and humidity, surface radiative fluxes, and derived turbulent fluxes. Several global products have also been made available. Planning is underway for a workshop to be held in Long Beach, CA, USA to review progress on the intercomparison projects (SST, air temperature and humidity, turbulent fluxes) being done in two ways: collocated comparisons with the ship and buoy experimental results and global comparisons of products for 1999. W. Rossow attended the meeting of the GODAE-SST group in Tokyo in May 2002 to make sure that methodologies and datasets are exchanged and coordinated between these two groups.

(A36) The SeaFlux project is making good progress but is still lacking adequate funding support. This project should be co-sponsored by CLIVAR.

W. Rossow reported that the GEWEX SSG assigned responsibility for organizing a similar LandFlux activity to the GRP to complete the surface flux components needed to describe the global energy and water cycles. For that purpose, Rossow will attend the meeting of the GHP-WEBS group in New York in September 2002 and the next meeting of ISLSCP in Washington in October 2002 to discuss what actions can be organized.

The next GRP meeting will take place 3-6 November 2003 near Toronto. Japan is a possible candidate for 2004.

APPENDIX A

SUMMARY OF ACTIONS AND RECOMMENDATIONS

(A1) The data management, validation and exploitation of new satellites, as well as some common analysis tasks, will now be co-ordinated for all GRP global satellite projects by a new Working Group on Data Management and Analysis. The first meeting of the new group chaired by Rossow is planned for spring 2003.

Its tasks will involve the definition of a strategy to merge existing data sets and common tools for statistical analyses. This working group will also work with GCSS/DIME, with GLASS/ALMA as well as with the CEOP/CSE's data management working group.

Rossow will lead the drafting of a white paper on "global satellite observing and data analysis strategy", in order to set up the basis for the working group' activity (such a paper is also being prepared at the NASA level).

(A2) There should be a co-ordination between the reference surface sites used by CEOP and those used as baseline by GRP, particularly BSRN. This co-ordination should also include AERONET, CPROF and TRMM validation sites. CEOP should upgrade some of their sites at BSRN standard and each Continental Scale Experiment should have a BSRN type site within its catchment basin.

(A3) Rossow plans to organise a Landflux Workshop in Spring 2003 to deal with the research strategy needed for the global characterisation of land surfaces, including multi-year global maps of albedo, emissivity and skin temperature and the building up of a climatology for land surface heat and moisture fluxes.

The on-going redefinition of ISLSCP's objectives should take into account GRP plans for global data sets and fill existing gaps identified in relation to land surface parameters and their climatology.

This question as well as the corresponding funding issue will be addressed at the next GEWEX SSG.

(A4) The link between GRP and the modelling community will be reinforced in at least two domains: the use of Cloud Resolving Models simulations in the development and validation of retrieval schemes, the co-ordination of the development of global data sets with the evolution of Global Circulation Models requirements.

(A5) GRP will be a major contributor to the cross-cutting effort of GEWEX on precipitation. One important issue is the development of a co-ordinated approach on precipitation measurements or estimates by the various communities involved, namely surface and aircraft radar methods, satellite active and passive and model derived methods. This requires the organisation of inter-comparison exercises.

(A6) A second issue in the cross-cutting effort on precipitation is the improvement of global precipitation data sets: this requires the collection of high density, high time-resolution precipitation data sets by CEOP/CSEs to test satellite retrievals, to overcome the satellite sampling effect, and to test GCM predictions. In addition, a co-ordinated work between GRP and GCSS should enable to make use of GCM results to provide extensive (global, long-term) data sets.

(A7) GRP stresses the central importance of long-term homogeneous data sets for climate research.

(A8) GRP expressed concern for the continuity of the measurement of the components of the earth radiative budget. This is one area where there is a potential data gap in top-of-atmosphere, broadband radiative flux measurements between the end of AQUA mission and the beginning of NPOESS mission which is planned for the 2008-2010 period. A quick action from GEWEX Chair may be needed (this depends on the decision calendar for the pre-NPOESS mission, to be clarified by Wielicki).

(A9) GRP expressed concern for the continuity of precipitation measurements by space radar between TRMM and the first GPM radar satellite scheduled around 2008. One issue is the de-orbiting of TRMM at the end of its lifetime, which would shorten its operating period. The panel's opinion is that this operation would be seriously detrimental to the scientific output of the mission and should be avoided.

(A10) Major new spacecraft are being flown by several countries (Japan - ADEOS, Europe - ENVISAT, and US - TERRA, AQUA) but these programs have no plans for cross-calibrating similar spectral channels. GRP recommends that the issue be raised to space agencies and also suggests that the general question of cross-validation be considered by CEOS.

(A 11) All GRP project leaders are to send to Rossow a list of meta-data parameters to be suggested to CGMS. GRP will seek more information on CGMS cross-calibration plans. Keep Paul Menzel informed of this action.

(A12) Data policy is a general issue for scientific users. GRP expressed a need for clarification concerning the Japanese data policy for surface validation data sets and for the ADEOS instruments.

(A 13) Rossow will update the web site and requests input from each member for providing corrections or suggest changes and additions. He specifically requests from satellite agencies a list of "information Web sites" that show satellite operating and launch status.

(A14) Rossow will prepare and distribute an announcement/summary of GRP datasets now available.

(A15) Recommendations for the preparation of future GRP meetings: (i) conduct mid-term e-mail discussion of status of issues and actions, (ii) request project reports two months before GRP meeting, specifying minimum list of informational items, to be distributed to attendees one month before, (iii) begin and end meeting with Executive Sessions; Satellite Agency Reports and talks by Invited Science Experts should be in the first half of agenda, project reports and discussions (focused on issues, actions, recommendations) should be in the second half of the agenda.

(A16) The WCRP/GCOS Atmospheric Observation Panel for Climate (under the chairmanship of Dr. M. Manton) has recently questioned the long-term perspectives of BSRN, which is recognised as an important contribution to climate monitoring. The exact terms of the request will be clarified by B. Rossow, in order to enable GRP to respond adequately.

(A17) In view of the success of BSRN, a letter should be drafted to WMO signature to thank BSRN station operators, archiving centre and Project Manager. A specific letter should be sent to Switzerland (either ETH or University or both) urging for a strengthening of the Archives and suggesting the support of a visitors programme. Dutton will draft letters and provide list of addressees.

(A18) A strategy should be developed involving WCRP, GCOS and AREP aiming at a better co-ordination of radiative fluxes and aerosol measurements in the perspective of their integration in the climate observing system. BSRN and AERONET should be central anchors of the climate observing system and should at some stage become operational. BSRN/GRP will prepare a draft statement of principles for this purpose.

(A19) Although shortwave and longwave irradiances are now available from about 30 sites for many years, related ancillary datasets are not available. BSRN archive should implement a simple catalogued ftp access to all datasets. It is also strongly recommended that the Archives re-combine the meta data with the actual measurements, with a quality flag that indicates whether the dome corrections have been made for SW irradiances.

(A20) SRB should continue processing beyond 1995 without delay by switching to NCEP-2 reanalysis from GEOS-1; re-process 1995 with NCEP-2 to indicate possible changes introduced. Focus comparison of atmospheric and surface datasets on the period from 1994-1996. ERA-40 is also considered as a likely candidate for global analysis fields but a clarification should first be obtained from ECMWF concerning the conditions on redistribution of ERA-40 data by a project such as SRB.

(A21) A letter to NASA will be drafted by GRP to commend Stackhouse about SRB achievements, to stress the central importance of long-term, homogeneous data sets and of the continuity of the observation of the components of the Earth radiative budget.

(A21) A concern about the continuity of the ERB datasets between the AQUA and NPOESS missions was expressed and it was recommended that the GRP express this concern in a letter to NASA about the possibility of flying a spare CERES instrument on the NPP mission to ensure that there is no gap in coverage later this decade.

(A22) The GRP commended the excellent progress of the I3RC projects and endorsed the formation of a WG under the International Radiation Committee to carry on 3-D radiation applications studies in collaboration with the clouds and land surface modeling communities.

(A23) Macke will prepare a letter from GRP to NASA/CRYSTAL and JACCS requesting that these programs give special attention to the above research issues.

(A24) There is a need for more cloud profiling data over oceans and GRP recommends an ARM type of experiment over the ocean. The co-location of radiation and microphysical measurements is essential. GRP also recommends to CPROF that they put special emphasis on more “3-D” cloud datasets and that they might add C. Fairall to the working group to facilitate release of ocean datasets.

(A25) GPCP should proceed with its Version 3 plans (anchored to TRMM) but the passive microwave analysis should be made consistent with microwave water vapour and cloud water retrievals.

(A26) Up to now validation of satellite precipitation measurements has not been successful, particularly as there are not really sufficiently dense and extensive observations with known accuracy available. GPCP should work with NOAA NCDC, Japan and European groups, to obtain other dense rain/snow gauge network data sets for validation studies. Special emphasis should be put on the development of case studies for orographic precipitation.

(A27) The retrieval of solid precipitation remains a delicate problem as shown during the recent workshop at Fairbanks. Activities to obtain snow data are still inadequate and GPCP should strengthen its ties to CLIC to improve this.

(A28) GRP supports Gruber’s plan for a workshop to be organised in Feb-March 2003 at ECMWF on objective analysis of precipitation. He should liaise with Martin Miller who was the GEWEX contact for the humidity analysis workshop held in July at ECMWF.

(A29) GVAP should expand the assessment of tropospheric water vapour data set quality, including both RAOB and satellite data.

(A30) GACP should make connections to IGAC/GAW, SPARC and BSRN. In next round of analysis, additional satellite data sets should be employed (TOMS, HIRS) and new instruments should be exploited, namely MODIS, MISR and POLDER. Mishchenko should prepare a plan for GRP in this perspective.

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(A32) An article describing GCM test metrics from the perspective of clouds, aerosols and radiation will be prepared for publication (Wielicki and Rossow)

(A33) Satellite sounder analysis methods are still being tuned to RAOBS, even though the latter are known to be inaccurate, particularly for water vapour. There is a need to establish new standards for satellite remote sensing of water vapour.

(A34) Several analysis approaches are followed by different precipitation measurement communities (satellite active and passive methods, surface and aircraft radar methods, modellers especially CRMs and RT specialists); these need to be compared and reconciled. A message for satellite agencies is that, to prepare for GPM, they must bring these groups together, must focus on better retrieval physics and more intensive validation efforts. Also there is a to support more studies of microphysics relationship to precipitation.

(A35) Relation between GRP and GCSS should be encouraged with respect to the 3D simulation of observation systems by cloud resolving models. CRM runs would also allow to test precipitation retrievals, similarly to what is being done for 3-D radiation schemes. (proposal to be worked out by Macke)

(A36) The SeaFlux project is making good progress but is still lacking adequate funding support. This project should be co-sponsored by CLIVAR.

APPENDIX B

SUMMARY OF ACTION STATUS FROM GRP-12

AI: Rossow to improve GRP/CEOP interactions by ensuring GRP/GHP Web pages are linked. **Done**

A2: Rossow to investigate with Chair of GHP joint initiatives in closing water and energy budgets. **Hosting meeting of GHPIWEBS in September 02 to discuss this.**

A3: Wielicki to formulate contents of overview article on accomplishments in atmospheric radiation. **Delayed**

A4: Rossow to solicit review articles for special issue on accomplishments in atmospheric radiation. **Delayed**

A5: Rossow to write letter to NOAA summarizing GRP position on GOES planning. **Done**

A6: Panel to review Climate SAF concept for discussion at next GEWEX SSG; Rossow to report back on discussions. **Done**

A7: Panel to advise Rossow of relevant links for GRP Web pages; Rossow to update and maintain GRP Web site. **Done**

A8: Rossow to advise GEWEX SSG, Director JPS and JSC to request secure funding for current global projects. **Done; high level workshop being organized. Communication with NASA HQ on-going.**

A9: Rossow to organize e-discussion of common formats and standard statistical analyses. **To begin at this meeting.**

A10: Rossow to recommend to GEWEX SSG that Landflux be organized and that GRP and GMPP work together on 3-D radiation coupling to cloudy boundary layer. **Done; GHPIWEBS meeting to discuss first item in September 02; GCSS discussion in May 02. Note strengthened relation of GRP to GCSS through DIME.**

A11: Each project lead to report at this meeting on plans for exploiting new satellite datasets. **Open**

A12: Barker and Hayasaka to draft discussion points for radiative treatment of ice clouds. **Done; issues raised at GCSS meeting in May 02.**

A13: Ramaswamy to compile list of recent upgrades in physics formulations in GCM radiative transfer codes. **Open**

A14: Ceballos to prepare proposal for additional case studies to evaluate radiative transfer codes. **Done**

A15: Gruber to organize a workshop on methods for combining datasets with differing space-time resolutions. **Open**

A16: Soden to organize GVAP advisory panel. **Open**

A17: Ackerman to lead development of Column Profiling Working Group. **Done; first organizational meeting held in January 02; further e-discussion of terms of reference has occurred.**

A18: Rossow and Curry to organize Feedback Workshop. **Done; joint with WGCM, workshop to be held in November 02.**

A19: Panel to provide suggestions for workshop participants. **Done**

A19b: GACP recommended to implement a land aerosol algorithm and to collaborate with SP ARC on joint analysis during volcanic eruption periods. **Former item open; latter item underway.**

A20: Gupta and Stackhouse to ensure that SRB documentation explains quality control procedures and develop a plan for processing data beyond 1995. **Open**

A21: Dutton to develop criteria for identifying needed BSRN stations. **Open**

A22: Rossow to make contact through GEWEX SSG and JSC with Chinese and South American authorities to gain access to satellite, surface radiation and aerosol datasets. **Done for China but not for South America.**

A23: Dutton to draft letter to recommend collocation of BSRN and aerosol (specifically AERONET) stations. **Done**

A24: Curry to contact ARM Ocean Surface Flux project. **Done**

A25: Curry to provide links for future merger of SeaFlux and GPCP datasets. **Underway**

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APPENDIX D

AGENDA REVISED TO REFLECT ACTUAL MEETING

Day 1

Session 1: Welcome (Rossow, Ohmura)
GEWEX Overview (Try)
Review of GRP Issues/Actions and Agenda (Rossow)

Session 2: Satellite Agency Reports (Hayasaka - NASDA, Ingmann - ESA, Tjemkes - EUMETSAT, Bates - NOAA)

Session 3: SeaFlux (Curry)

Session 4: BSRN Review (Dutton, Ohmura, Raesch, Wild, Philipona)
SRB Review (Stackhouse)

Day 2

Session 1: ERB Review (Wielicki)
I3RC Report (Cahalan)

Session 2: ICRCCM (Barker, Rossow for Ellingson)
Discussion of Future of Radiation Activities (Barker, Hayasaka, Macke)

Session 3: GPCP Review (Gruber)
TRMM Report (Adler)

Session 4: GVAP & CPROF Reports (Rossow)
Discussion of Future Water Activities (Rossow)

Day 3

Session 1: ISCCP/GACP Report (Rossow)
Clouds-Radiation Review (Ramaswamy, Wielicki)

Session 2: Re-analysis of Sounder Measurements (Stubenrauch)
Remote Sensing of Precipitation (Iguchi)

Session 3: Joint Diagnostic Studies (reports on planning of Feedback WS, organization of WGDMA & DIME, LandFlux initiative)

Session 4: Executive Session