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The 2003 GRP meeting (Appendix A), held in Victoria, Canada, on 10-12 November 2003, was attended by about 30 scientists (Appendix B). The meeting was followed by a Workshop on 3-D Clouds and Radiation on 13-14 November 2003. Both meetings were hosted by the Cloud Physics Research Division of the Meteorological Service of Canada.

1. Executive Session & Overview of Old/New Issues

The GRP chairman opened the Executive Session by highlighting a number of issues that will need to be addressed at this meeting and during the coming year. He noted that a number of the GRP satellite projects are coming to the end of their current commitment period in 2005, that the JSC WG on Satellite Matters (WGSM) is discussing an overall (pan-WCRP) global satellite data analysis strategy that encompasses the GRP projects, and that the JSC is also considering both a WCRP-wide coordination of data analysis activities and a possible new grand initiative. Moreover, the GEWEX SSG is planning to formulate at its next meeting specific milestones towards achieving its objectives. Consequently, the GRP needs to review the status and accomplishments of all its projects, identify its own milestones and proposed contributions to GEWEX/WCRP objectives, and decide how best to proceed towards these goals. In particular, the chairman noted these key topics.

(1) The radiation budget problem is quite mature with the major questions answered, the data products showing excellent quality, and top-quality radiative transfer models exhibiting high accuracy (some remaining research issues will be discussed in the following workshop), so the GRP needs to plan how to finish its current activities and to decide whether there are any further initiatives that should be initiated.

(2) Given the maturity of the radiation physics and cloud observations, the cloud-climate problem seems now to have come down to a focus on 'cloud dynamics', which also encompasses the aerosol-cloud interaction problem, so the GRP needs to decide whether it is appropriate for it to still be the lead group on this problem.

(3) There are crucial problems involving precipitation, but a way forward from where we are is not clear. Moreover, as observational difficulties are reduced, the scientific problem is, again, cloud dynamics.

(4) A number of GRP initiatives, including the SeaFlux project and the Feedback study, have coalesced into the preparation and analysis of a comprehensive collection of satellite-based global datasets as suggested by the Working Group on Data Management and Analysis (WGDMA). Such an activity could be called the Global Water and Energy Budget Study (GWEBS) as a major contribution of the GRP to GEWEX near-term milestones.

The GRP chairman opened the full meeting with a summary of the executive session discussion of key issues for this meeting followed by a review of outstanding actions and open issues. In addition to the above issues, he mentioned particularly a review of the status of BSRN with respect to GCOS, whether the GRP should initiate specific activities to encourage progress in other areas of Earth remote sensing, and that the first meeting of the merged project data management groups (WGDMA) had forwarded a suggestion that GRP undertake formal assessments of its data products as possible inputs to the next IPCC report. He also mentioned that there had been a suggestion for joint activity between ICRCCM and the ARM project to complete the on-line radiative transfer model test kits and that the survey of GCM radiative transfer models has been initiated. Finally, proposed GRP milestones as part of GEWEX Phase II were presented: near-term highlights included completion of the ICRCCM and SeaFlux projects and the data products assessments by 2005 and completion of a merged Global Water and Energy Study (GWEBS) and Climate Feedback Study by 2006.

2. Satellite Agency Reports

Reports were presented by representatives from ESA, NOAA, NASA, EUMETSAT, JAXA and JMA. ESA reported that Envisat operations continue successfully and that preparations are going forward for CryoSat, GOCE, SMOS (recently approved) and ADM. Currently under study are EarthCare, WALES, SPECTRA, ACE+ and EGPM. Also mentioned is a CNES mission, MeghaTropiques, that is of great interest to the GRP because it proposes to make very high time resolution joint measurements of radiation and precipitation. The GRP expressed concern that recent

funding cutbacks threatened the ESA EarthCare mission and expressed very strong support for EGPM plans to put significant effort into snowfall measurement. Also a similar problem plagues the CNES MeghaTropiques mission, also of concern. NOAA reported a healthy constellation of two polar orbiters and two geostationary satellites; however, AMSU-A was lost on NOAA-17 in October. A potentially serious gap in afternoon coverage may be created by the accident with NOAA-N, the last polar orbiter before NPOESS launches begin, since the NPOESS schedule has slipped. The GRP agreed to renew its climate-oriented recommendations for the GOES-R (next generation) series and to express its concern about the NPOESS schedule. NASA reported that TRMM, TERRA and AQUA all continue operating successfully and that many of the new data products are now becoming available. IceSat lost the first of its three lasers much earlier than expected, leading to a much more conservative (degraded) observation plan in future. TRMM operations may be terminated in early 2004 for safety and budgetary reasons. Recently completed major field campaigns, CRYSTAL-FACE and ACE-ASIA, continue NASA-sponsored research on cirrus clouds and aerosols; these datasets are now becoming available. A major aerosol network, AERONET, has also been established to evaluate new satellite aerosol products from MODIS and MISR, as well as GACP. EUMETSAT reported continued operations of METEOSAT-7 (located over Europe and Africa) and METEOSAT-5 in the Indian Ocean sector. MSG-1 (to be renamed METEOSAT-8) is nearing the end of its commissioning phase; full operations are planned for early 2004. EUMETSAT has recently completed re-processing of the whole METEOSAT archive (except for METEOSAT-1) cloud-tracked winds in support of the ERA-40 reanalysis, giving them a lead in experience with reprocessing from the archives. As of 1 October 2003, the National Space Development Agency (NASDA), the National Aerospace Laboratory (NAL) and the Institute of Space and Astronautical Science (ISAS) were merged into the Japanese Aerospace Exploration Agency (JAXA) The main Earth science satellite missions of JAXA are TRMM, Midori-2, with ALOS, GOSAT and GPM in planning. Concern was expressed, seconded by the GRP, about NASA's plan to terminate TRMM operations early for both safety and budgetary reasons. Midori-2 was lost in late October; nevertheless, early results from GLI show intriguing results for the study of cloud-aerosol interactions and from AMSR for all-weather SST determinations and cloud/water vapor studies, both reinforcing the importance of flying more of these advanced instruments. JMA reported the successful replacement of GMS-5 by GOES-9 until the launch of MTSAT-1R in 2004.

G. Stephens presented a project concept being studied as a possible NASA-led initiative under the U.S. Climate Change Science Program (CCSP). The key scientific questions concern the processes governing cloud-aerosol-precipitation interactions with project goals to

(1) determine climate forcing by natural and anthropogenic aerosols and
(2) advance capability to predict those changes in the hydrological cycle in response to climate forcing that involve aerosols, clouds and precipitation.

NASA's focus would be on the improvement of remote sensing capabilities to address these problems by exploiting existing observations more completely, promoting new observational techniques, advancing modeling of aerosol-related microphysical processes and their parameterization in climate models, and integrating satellite and in situ observations. NASA is seeking international support for this initiative. The GRP members encouraged the continuation of this study, planned to consider this topic further with regard to GRP projects and participation in study workshops, and to forward this concept for broader consideration within WCRP.

Action: Letters will be sent to express GRP opinions about issues raised in these presentations: to ESA concerning support for EarthCare, as well as snowfall measurements in EGPM, to CNES concerning support for MeghaTropiques, to NOAA concerning climate requirements for GOES-R and concerns about a possible afternoon polar orbiter gap before NPOESS begins, to NASA raising concerns about early termination of TRMM operations and discussing possible roles for AERONET and the proposed initiative on clouds and aerosols, to EUMETSAT concerning climate requirements for MTG and to JAXA about TRMM and supporting the GOSAT mission concept.

3. Invited Scientist Talk & Discussion of Satellite Mission Plans and Advanced Remote Sensing

C. Prigent (new GRP member) presented an overview of remote sensing of land surface properties that would be useful for weather and climate modeling and for monitoring of natural hazards, environmental change and climate change. Although a large number of satellites (60 Earth-observing satellites have been launched since 1992) provide global coverage, some at very high spatial resolution, and land surface measurements at a diversity of wavelengths from visible to microwave, some covering more than 20 years, there are no satellites specifically designed to study land surfaces, except for the high-resolution imagers making measurements in a very limited range of solar wavelengths. There are few systematic analyses of these data to produce long-term, global products. In preparation for missions such as SMOS and HYDROS, as well as for more general missions like the A-train constellation and NPOESS, much could be learned from a systematic analysis of the existing suite of satellite observations (the GRP strongly encouraged the few such analysis efforts, such as studies to understand the relation between active/passive microwave measurements and soil wetness). Most analyses use only one wavelength or one instrument, so they have great difficulty separating the surface signal from the atmospheric signal and disentangling the many surface factors influencing the observation to isolate well-defined physical quantities. A comprehensive analysis would require inter- and cross-calibrations and radiative transfer models that are physically consistent across the whole range of wavelengths. Much effort would also have to be focused on collection of proper validation datasets, for example from CEOP. A focused effort is needed to extend land surface analyses to a more comprehensive approach that exploits the available data more thoroughly and to bring the land remote sensing datasets up to the same standard as those of the radiation and atmospheric datasets. If such an effort were undertaken, the new products would be a substantial contribution to GSWP. It is recommended that GRP become more active in this area.

In the ensuing discussion of satellite mission plans, climate requirement inputs were requested by NOAA for GOES-R planning and by EUMETSAT for Meteosat Third Generation planning. It was reported that the decision to fly the spare CERES instrument on NPP, which the GRP had recommended, had recently been reversed, so it was proposed that the GRP concerns will be expressed this time directly to the US CCSP. Although GRP concerns about early termination of TRMM and the lack of support for MeghaTropiques and EarthCare have already been articulated through the report of WGSM to CEOS, a GRP letter to the cognizant agencies will be sent to draw attention to this fact and to articulate concerns. In addition, it was decided to request that a letter be sent from the GEWEX SSG concerning TRMM.

The WGSM 'master plan' for analysis/re-analysis of satellite data to produce global, long-term climate data products is being built around the GRP projects and the GRP idea of coordinated re-processing, but the people needed to extend this concept to land, ocean and sea ice datasets have not been identified. The GRP chair will distribute to the members copies of a NOAA workshop on calibration (part of preparation for re-processing), the draft re-processing plan submitted to WGSM representing GRP activities, and the WGSM report to CEOS.

4. Invited Scientist Talk, Reports for GACP/ISCCP & Discussion of Cloud-Aerosol-Related Activities

J. Haywood (new GRP member) showed comparisons of the several satellite aerosol products now available, including from GACP, and emphasized that the range of total optical thickness values is at least a factor of three. AERONET was conceived to provide validation of the new NASA satellite results based on surface sun photometer measurements, but such measurements still need to validated themselves. He summarized attempts to validate the surface-based aerosol measurements with in situ aircraft measurements. He highlighted two problems:

(1) differences in space-time sampling between the surface point measurements and aircraft transects (also between surface and satellite measurements), noting that there were currently some problems with access to raw AERONET data to examine this issue, and

(2) varying spectral dependencies of aerosol mixtures being misinterpreted as changes of total optical thickness and size.

He also illustrated a case where biomass burning aerosol advected over marine stratus causes an apparent decrease in a satellite-based retrieval of cloud optical thickness and particle size that mimics aspects of the expected aerosol effect on clouds even though the clouds do not change.

B. Rossow reported on the status of the GACP and ISCCP. After eliminating calibration artifacts, the aerosol data product (monthly mean optical thickness, Angstrom coefficient over oceans) has been produced for the period 1983-2001 (this is being extended back to late 1981). The main processing center for GACP has received renewed funding, but the larger aerosol research team that worked with the processing center is no longer funded under this acronym. The NASA funding of many of the former GACP participants has been renewed as part of more general research program, but whether a focused aerosol-related research initiative will exist is still under discussion. In addition to continuing validation and intercomparison work, examples of which were presented, efforts are underway at the GACP processing center to extend the analysis to land areas. SAGE data for the stratospheric aerosols will also be used to isolate the tropospheric aerosol component throughout the record. The next version of the aerosol product will be merged with the ISCCP cloud data product at pixel-level to facilitate studies of the so-called indirect aerosol effect. ISCCP has completed its 20th year with data products available for the period 1983-2001. Funding for the main processing center was renewed; all other centers have made commitments through 2005. In the coming year, cloud particle size and cloud type products will be released. Then plans are to spend 2-3 years exploiting the new satellite instruments with more spectral and angular coverage to refine the ISCCP analysis to reduce remaining systematic errors. The entire dataset will then be re-processed with improved ancillary data and accounting explicitly for aerosols in the analysis based on the combined SAGE-GACP products. A possibility to process B1 (nominal 10-km sample), instead of B2 (nominal 30-km sample) radiances is being explored with the help of NCDC which has archived all of these data.

The following discussion focused on two questions: (1) what more needs to be done to characterize the properties of aerosols and advance understanding of the processes controlling them and (2) how should the problem of cloud-aerosol interaction be advanced? The first GRP action would seem to be to organize an international workshop to understand the current large disagreements among the available satellite aerosol products, including the newer ones. However, this recommendation raised the question of whether or not we have adequate data for validation of the satellite products. It was also recalled that GRP had endorsed the plans of BSRN to extend its baseline observations to include aerosols to augment the capability to interpret surface radiation data products and that AERONET was established to provide validation of new satellite aerosol measurements but not to serve as the anchor for an aerosol monitoring network the way that BSRN anchors the SRB satellite-based surface radiation products. Although a NASA-sponsored activity led by Z. Li to establish aerosol measurement sites in China should improve coverage in this critical area, systematic monitoring and validation of aerosols, clouds and surface radiation continue to be lacking over the oceans. It was noted that the ARM SOAR project is no longer being funded. It was also noted that there are many more aerosol-measuring sites organized under the WMO GAW and IGAC programs, but that these focus on different issues. At this time 13 of the BSRN surface radiation sites are colocated with AERONET aerosol sites, but a coordination of aerosol and surface radiation measurements is lacking. Despite all of this surface-based activity, a general observing strategy that includes a network for clouds, aerosols, surface radiation as the complement to satellite-based determinations of these quantities is not in place. A second action is for the GRP to write a letter to NASA to outline these points and to suggest that AERONET, in collaboration with BSRN, could evolve into the required aerosol-radiation monitoring network. Although the plans for a merged aerosol-cloud product from GACP and ISCCP are a valuable contribution, a general approach to the aerosol-cloud

problem is lacking, as the proposed initiative outlined by G. Stephens makes clear. In fact, the emphasis in this problem seems to be shifting from primarily one of making the measurements (hence within the purview of GRP) to one of interpreting the measurements in terms of processes, which would seem to be more within the purview of GCSS, for example. Some recommendations along these lines were drafted (Appendix C) to be conveyed to GCSS for consideration, including the possibility of organizing a joint workshop on this topic, possibly in collaboration with plans of G. Stephens. This whole topic, with regard how best to organize and exploit the large amount of (uncoordinated) activity already underway, needs much more consideration.

5. Status of SeaFlux, LandFlux and GVAP

A SeaFlux workshop was held on 12-13 February 2003 at Long Beach, California. Work on improving the bulk formulae used to calculate surface turbulent fluxes appears to be winding down, although work is still needed for the high windspeed regime but data are lacking. The focus of effort is now on completing the comparison of global products for 1999, culminating in another workshop either in late 2004 or early 2005. Work is also on-going with regard to obtaining improved skin SST datasets (in collaboration with GODAE-SST) and better estimates of near-surface air temperature and humidity. A new JSC WG, chaired by C. Fairall (who participated in SeaFlux), has been formed to consider air-surface fluxes, with an initial focus on air-sea fluxes. Discussions are underway to determine what activities this new WG will undertake and whether the continuation of SeaFlux activities can be incorporated within its purview.

Discussions were conducted over the past year to ascertain how best to produce similar turbulent fluxes at land surfaces (*aka* LandFlux) that are needed to complete the global energy and water cycle datasets. These discussions focused on the roles that could be played by ISLSCP (part of GHP), GSWP (a project under GLASS) and GRP. The current situation is that GSWP-2, already underway, will produce a 10-yr dataset that includes these surface fluxes. These fluxes are calculated by a global land surface model forced by observed atmospheric properties that were supplied by ISLSCP in their Initiative II dataset. The main problem with this arrangement is that ISLSCP does not produce any of these datasets, but simply collects and re-packages other data products. Consequently, only a small amount of the forcing data came from GRP projects, some of that is used incompletely or inconsistently, and some key land surface properties of comparable quality were not obtained even though they were available (see Item 3). Nevertheless, the GSWP-2 products, when they become available can be used in a first global analysis to evaluate their consistency and accuracy. This analysis and evaluation activity could lead to another processing round after more work is done to develop more comprehensive surface property datasets that are consistent with the other GRP products. Moreover, the next analysis could use the GRP datasets more fully and consistently. The CSEs and newer CEOP datasets could also be used to help evaluate these surface flux products. All of these possibilities require closer coordination between GSWP and GRP, so it would seem that this task should be carried out by a direct partnership between GSWP and GRP. This idea will be recommended to the GEWEX SSG.

During the pilot phase of GVAP a prototype global dataset (called NVAP) was produced and a range of field experiments, encouraged by GRP/GVAP, were carried out, most notably at the heavily instrumented ARM site in Oklahoma, that have significantly improved understanding of the accuracy of various water vapor measurement systems. One important conclusion from some of these studies is that radiative transfer model calculations of satellite observations are sufficiently accurate that, subject to the usual limitations of inverting the radiative transfer equation, satellite measurements of water vapor are of comparable quality to the best of the in situ approaches. The expense of the best in situ measurements strongly suggests that operational water vapor measurements should now be based on improved satellite retrievals, replacing the conventional water vapor products. The next phase of GVAP was discussed at the first meeting of the merged GRP project data management groups (this group is now called the Working Group on Data Management and Analysis, WGDMA) (see Item 8), where it was decided that, before undertaking any data processing, the six existing global water vapor datasets (some profiles, some total column, some for specific portions of the troposphere or

statosphere, including the reanalyses) should be evaluated exploiting all available results. It was recommended that this evaluation be conducted in partnership with the International TOVS WG (ITWG) and completed in time to provide input to the next IPCC climate assessment (late 2005). Discussions at the subsequent meeting of the ITWG on 3-4 November 2003 led to combining this idea with one that NOAA, the Hadley Center and the ITWG were already discussing, which was an re-evaluation of all satellite and conventional temperature records. This is also consistent with specific task assigned to NOAA in the US CCSP. If the evaluation of all temperature measurements is to be performed, an evaluation of the water vapor measurements that many of the same sensors make would be required as well. A workshop is planned in summer 2004 to launch this activity.

6. Reports for GPCP & Discussion of GPCP Possibilities

R. Adler presented an overview of GPCP processing activities. The main products (2.5 degree, monthly and pentad precipitation) are available for the period January 1979 through October 2002. The delay in processing, having to do with a computer system change at NASA Goddard where the TOVS products are analyzed to provide polar precipitation estimates, has been resolved and processing has resumed. Also a 1 degree, daily product is available for the period October 1996 through October 2002. The possibility of using the ISCCP B1 radiance archive to extend this product back in time is being explored. A provisional dataset, using a different gauge analysis from CAMS (from NOAA/CPC) and lacking a polar component, was released by NASA/GSFC covering the period from November 2002 through September 2003. Several problems with the current precipitation analysis were outlined:

(1) the representativeness of the gauge data in rough topography has been found to be poor, even in the U.S.,
(2) the current SSM/I algorithm is very old and could be updated based on what has been learned from the TRMM analyses,
(3) the group analyzing the TOVS data for the polar regions is not formally funded to participate in GPCP, so this situation needs to be clarified,
(4) TRMM data have not yet been exploited to improve GPCP,
(5) a snow algorithm is needed,
(6) the data record is noticeably inhomogeneous because of the changing sources of information, and
(7) the specifications (time and space resolutions, reported quantities) of GPCP Version 3 need to be determined.

R. Adler went on to discuss possible uses of TRMM data in GPCP. The most direct uses are 'calibrations':

(1) the SSM/I algorithms can be directly compared with the TMI algorithm, which in turn is evaluated by comparison with the PR results, and
(2) the GPCP products can be directly compared with the TRMM results in the overlap period, from 1998 onwards.

In addition to revising the GPCP microwave algorithms, based on TRMM comparisons, the TRMM results could be directly merged into the GPCP products from 1998 onwards; in particular, the TRMM 3-hr product, produced since January 2002, could be used as the basis for pseudo-3-hr analysis back in time.

A major cause for concern to the whole GEWEX program is the possible early termination of TRMM operations next year that NASA is considering. This would not only preclude the **unique** opportunity of operating two differing-sensitivity precipitation radars at the same time, when CloudSat is launched in early 2005, but would eliminate any chance that TRMM could operate until replaced by GPM. The TRMM-CloudSat combination would provide early experience with a two-frequency radar system that is qualitatively similar to the GPM design concept (though using a different high frequency) and would

actually provide complete global precipitation coverage for the **first time** because the CloudSat radar will be sensitive to snowfall. The early termination would create a gap in the radar-based precipitation record of more than 5 years.

A. Gruber presented the report of GPCC on behalf of B. Rudolf. Work as begun on developing a longer-term gauge-based precipitation climatology, which would also support CLIVAR goals; the GRP welcomed this development. It was also reported that GPCC had been asked at the WGDMA meeting to study the feasibility of a reanalysis of the gauge data to separate snow and rain averages. Several important questions were raised:

(1) What can be done to obtain access to the time-resolved ('raw') gauge data, which is needed to study improvements of its analysis and to work on validation of satellite measurements?
(2) What is the relation between the GPCC gauge data collection and other gauge datasets and analyses (*i.e.*, GHCN, CAMS, CRN)?
(3) Is it worth collecting and analyzing island and open ocean precipitation datasets?
(4) Shouldn't GPCC and SRDC be working much more closely with the GEWEX CSEs and CEOP to evaluate GPCP global products, particularly satellite-only products?

A. Gruber also reported on two addition GPCP activities that he is leading. The first was a Workshop on Objective Analysis sponsored by GPCP and ECMWF, held at ECMWF on 11-13 March 2003 to improve understanding of issues involved in objective analysis of precipitation using many inputs and to make recommendations to GPCP on better analysis methods. The three main conclusions from the workshop are that current-day assimilation methods are not sufficiently accurate for precipitation that they can replace data-only analyses, that new more advanced analysis methods are needed for data-only analyses and that further development of validation datasets is a critical need to make further progress. The second activity is planning, in partnership with the International Precipitation WG, for an assessment of the global, long-term precipitation data products (see Item 8), initially focused on satellite algorithms.

The following discussion evaluated the status of GPCP products and general precipitation problems to identify needed actions. Several key scientific difficulties that need focused effort are:

(1) precipitation in rough topography: the satellite measurements have intrinsically superior spatial sampling but care is needed to account for the changing atmospheric column height and land surface effects on the measurements,
(2) snowfall is not well or separately treated in the current GPCP analysis: in addition to snow in mountainous areas, there are actually much larger flat areas with snow cover for which prototype satellite algorithms exist but have not been investigated by GPCP,
(3) precipitation data products must be extended to higher time resolution to allow study of the interaction of the atmospheric circulation and clouds-precipitation and
(4) the lack of quality validation data suggests the need for focused efforts to improve both gauge measurements (and data collections) and to work more on analysis of precipitation radar network (e.g., NEXRAD) datasets. Satellite remote sensing may become the standard for measuring precipitation (like for radiation, clouds and water vapor).

A Precipitation Cross-Cut has been discussed at the past couple of GEWEX SSG meetings, but the participants and tasks for this undertaking have not yet been defined. Given the issues discussed by the GRP, the following will be recommended to the GEWEX SSG. R. Adler has volunteered to lead the Precipitation Cross-Cut to provide the coordination of this effort with the global analysis of GPCP (TRMM, GPM). Each of the GEWEX panels would continue their precipitation-related efforts but now with a focus on the above issues. Possible roles of the three GEWEX Panels could be as follows:

(1) GRP takes the lead on investigation of new satellite snow algorithms and examination of high spatial resolution satellite observations in mountainous areas (depending on instrument, this can range from of order 5-25 km but this is still higher resolution than provided by the gauge networks).

(2) GHP takes the lead to develop and analyze new high quality surface gauge measurements (with GPCC, SRDC), including the surface precipitation radar analyses, and special datasets from the CSEs and CEOP.

(3) GCSS takes the lead to examine cloud-precipitation processes in process models to be compared with GPCP and GHP datasets; GLASS continues to evaluate the importance of small scale variability in precipitation to land-atmosphere interactions.

7. Reports for CERES, SRB, BSRN, ICRCCM, 3DRT WG and CPROF WG & Discussion of Radiation Activities

B. Wielicki reported on the status of the CERES experiment, which currently has operating instruments (two each) on TERRA and AQUA. The ERBE-like radiative flux products for TRMM, TERRA and AQUA have been released. The major improvement in the CERES products will be based on new Angular Distribution Models (ADMs) derived from a conically-scanning instrument and from implementation of much more detailed scene identification based on cloud analysis of MODIS observations. Although the global mean fluxes will not change too much, it is expected that these new products will have much better regional accuracy, especially when a region is dominated by a specific cloud type with properties very different from global mean cloud properties. Re-processing of the TERRA data with the new ADMs has commenced and the first results should be released in spring 2004. Additionally, the CERES analysis is being extended to produce surface radiative fluxes (in a similar fashion to SRB using ISCCP) and eventually to radiative flux profiles. The first version of the surface and top-of-atmosphere radiative flux products from 3 years of TERRA data was released in March 2003; the new radiative flux profile products will be released late next year.

B. Wielicki further noted that the decision to fly a spare CERES instrument on the NPP mission to mitigate the risk of a gap in the radiation budget time record between AQUA and NPOESS had recently been reversed. Further, he noted that the new Climate Change Science Plan issued by the U.S. government makes a commitment to Climate Data Records, specifically including radiation budget, without identifying specific agency responsibilities. This problem appears in the fact that the NPP mission does not have adequate analysis funding or a plan for data archival, yet it is supposed to bridge from AQUA to NPOESS specifically to maintain the records begun by TERRA/AQUA.

P. Stackhouse reported on the status of SRB; Version 2 data products have now been completed and released for the period from July 1983 through 1995, when the NASA DAO reanalysis being used for atmospheric properties ended. The next reanalysis product from NASA GMAO (formerly DAO), called GEOS-4, will be produced for more recent years first, but will soon be processed backwards, allowing SRB to extend its record from 1995 to current. This plan will probably result in a discontinuity in the SRB record, but will allow for overlap and comparison with the similar CERES products. Based on renewed funding, the plan is to extend the record through 2003 or 2004, finish extensive validation studies focused particularly on aerosols, and re-process the whole record using GEOS-4 or 5 by the end of 2005. The main near term activity will be a thorough exploitation of the BSRN datasets to evaluate the surface radiation under a variety of meteorological conditions. Discussion is underway to consider increasing the SRB spatial resolution, if ISCCP shifts processing to B1 resolution.

E. Dutton reported on the status of BSRN: more than 2500 data-months from 35 active sites (equivalent to about 6 years of data per site) are now available from the archives. Further effort will be applied in the coming year to improve the rate of data delivery and quality checking into the archives. All data, including ancillary atmospheric observations, are now available via ftp. Another 15 sites have been proposed and are being considered. In particular, there has been progress on establishing needed sites in China. On-going activities to improve the dataset involve defining procedures and

standards for aerosol optical thickness measurements and improvement of the radiation measurement standards for diffuse solar (a recent experiment at the ARM SGP site showed low errors) and infrared radiation. Key scientific issues concern establishing more collocations of BSRN and AERONET sites (13 already exist), finishing application of "diffuse-offset" corrections to the downwelling shortwave datasets, and finding some way to estimate "routine" accuracies for broken cloud conditions. Concerns were also raised about finding a way to enhance the representativeness of the data collection, particularly by extending observations to oceanic sites (are buoys a possibility?).

One BSRN project issue concerns establishing firm funding for the archives (at ETH in Zurich): although some progress has been made, this question is still not completely resolved.

GCOS had approached WCRP to investigate whether BSRN could serve as the surface radiation component of the climate observing system, but had expressed some concerns regarding data accuracy, representativeness and reliability of funding. BSRN, in turn, was concerned as to whether there would be any conflict between research and monitoring goals and whether the GCOS monitoring strategy was the best one. With regard to the last, the point is that the WCRP/GRP strategy is to use a surface reference network, like BSRN, to anchor a satellite-based (hence, truly global) surface radiation product, like SRB, whereas GCOS apparently was focused on a stand-alone surface network. A joint GRP/BSRN-GCOS/AOPC committee was organized to formulate specific terms of reference for BSRN to serve as **the** surface radiation component of GCOS, while continuing its role in WCRP. This formulation has been completed and agreed to (Appendix D).

R. Ellingson and H. Barker reported on the status of ICRCCM. A new Web site for the infrared test cases has been established (temporary address is http://metsat.met.fsu.edu/jgu/LBLWeb); all of the model calculations for these test cases have been completed and the results are now being posted to the Web site. Preparations have started to conduct a study of 3-D effects on infrared radiation, following the study for solar radiation conducted by H. Barker. The paper reporting the results of 3-D code comparisons and various 1-D approximation will appear soon; the Web site that supported this comparison is still available. In the following discussion, the proposal to join forces with the ARM Broadband Heating Rate Profile project, which has been working to set up on-line cases based on measured input atmospheric and cloud properties, with reference model calculations and measured surface and top-of-atmosphere fluxes. An ad hoc working group (chaired by L. Oreopoulus, with R. Ellingson, H. Barker, T. Ackerman, P. Stackhouse, N. Loeb) was formed to represent GRP/ICRCCM ideas/concepts and to collaborate with ARM BBHRP representatives to prepare a comprehensive on-line "test kit" with a variety of synthetic and observed cases, together with baseline line-by-line radiative model calculations and corresponding verifying measurements. The plan is to organize an international workshop on code comparisons using the first released version of this test kit, possibly in early 2005. Most ICRCCM activities would then be completed in 2005.

The International Radiation Commission has established 3D Radiative Transfer WG (3DRT) to continue studies of 3D radiative effects, following on the completion of the I3RC project. R. Cahalan (chairman) reported that the I3RC Phase 1 results (and possibly Phase 2) are available at (http://climate.gsfc.nasa.gov/I3RC/index.html). In addition to continuing some specific code-comparison activities (some issues to be discussed at the following WS), particularly looking at the results of time-dependent calculations to determine the time-scale characteristics corresponding to the space-scale studies, this group will begin to interact with other 'process' communities to examine the importance of 3-D radiative effects as recommended by the GRP. The first activity will involve radiation in vegetation canopies and the question of the effects of small-scale variations and 3-D radiative effects on surface-atmosphere interactions. The GRP endorsed these plans.

R. Cahalan also reported on the status of 'solar constant' measurements, particularly from the new multi-instrument SORCE mission. All the instruments are operating well. He also noted that there will likely be a gap in the measurements between the end of the SORCE mission in 2008 and the NPOESS in 2013, although there is a mission in the planning (currently called GLORY) to fly a polarimeter for aerosol studies that will also fly the TIM, but not the SSI, instrument.

T. Ackerman reported on the activities of the new GRP WG (currently called the WG on Column Profiling, CPROF). The past year was spent getting organized (writing terms of reference, recruiting participants) with the first two meetings held in January 2002 in Reading, UK, and in September 2003 in Leipzig, Germany. A. Illingsworth has agreed to be co-chair of this WG. There are now 10 participating sites, 8 of which are also BSRN sites, which is a very important achievement. There is a notable lack of sites in Asia and South America. The GRP members from Japan and Brazil agreed to investigate the possibility of getting participants from these locations. The WG plans to consider more specific foci after taking an inventory of the capabilities available at the various sites. Other early activities are to define common data product formats, establish a GCSS DIME-like Web site so that cloud researchers can access the results, and to work on producing a prototype joint data product, covering 3-6 months and containing surface radiation, surface meteorology and cloud radar/lidar profiles, as well as any available satellite observations over each site. The issue was raised as to whether the archival of aircraft data should be undertaken; the recommendation from the GRP was to avoid delaying other activities by this probably very large task, but to capture some specific campaign datasets when the opportunity arises.

In the following general discussion of radiation activities, the plans of SRB, BSRN, ICRCCM and CPROF were endorsed. In particular, the SRB processing using GEOS-4 will resume with data-year 2000, continuing forward through next year, but once the retrospective reanalysis is completed, it is expected that the years 1996-1999 will be completed by late 2004, early 2005. Then in mid-2005, the whole SRB product will be re-processed using GEOS-4 throughout. With regard to BSRN and aerosol data, further recommendations on this activity will follow once there is a clearer, more comprehensive idea of what all the various aerosol-related projects plan to do. The key ICRCCM activity is to finish, in collaboration with ARM BBHRP, the on-line radiation code test kit and to organize one more round of RT code comparisons based on it. The survey of current GCM RT codes, being led by Ramaswamy, was reported to be nearing completion (Appendix E); in fact, a similar activity is also underway, led by Q. Fu, so these two efforts are now being 'merged' with the hope of producing paper reporting on the results. The key CPROF activity is to produce a prototype common dataset and make it available on-line to illustrate the value of further investment in such atmospheric profiling sites that collect long-term datasets. Finally, in discussing what other radiation activities should be undertaken by GRP, two issues were identified with regard to remote sensing. One is the issue of advancing quantitatively rigorous analysis of lidar measurements of clouds, exploiting more advanced features such as multi-wavelength polarization and time-resolved measurements that isolate aspects of the multiple scattering. The main concerns are accurate, realistic and practical treatments of ice clouds and practical codes that can be applied to actual datasets. The second issue concerns development of radiative transfer codes that use physically consistent cloud models across most of the electromagnetic spectrum that can be used for combined analysis of multiple satellite instruments (e.g., visible, infrared and microwave imagers). In particular, codes currently being used for different kinds of microwave measurements, from precipitation and cloud radars to scatterometers to passive microwave imagers, use different cloud-precipitation particle representations. In both cases, it was proposed that the possibility/interest in workshops on these topics be investigated. R. Cahalan agreed to discuss a possible workshop, co-sponsored by GRP and 3DRT WG on the lidar topic; C. Prigent agreed to discuss the idea for a microwave RT workshop with several colleagues in Europe, Japan and the U.S.

8. Report from first meeting of WGDMA

All of the GRP project data management groups (for GPCP, ISCCP, GACP and SRB with representation from BSRN and GPCC) were merged into a single WG on Data Management and Analysis (WGDMA); members of the group represent each participating data center in these projects. As the name implies, it is intended that this group take on some tasks beyond the processing required to produce the project-specific data products. W. Rossow reported on the first meeting of this group, which was held 12-16 May 2003, hosted by NCDC in Asheville, North Carolina, USA. In addition to status reports on each project, there was discussion of several possible tasks that could be undertaken with the whole collection of data products now available (Appendix F shows the primarily GEWEX data

products that provide long-term global coverage) to stimulate more scientific analysis. Particular note was taken of the model of SRB and BSRN, where the latter not only provides an anchoring validation/calibration for the SRB satellite-based products, it also advances the state-of-the-art in measuring radiation at the surface, while the former concentrates on advancing the state-of-the-art in radiative transfer and calculating the radiation budget and produces global, long-term data products. It was recommended that GPCP and GPCC/SRDC should move more towards this model. The first task was investigation of snow-rain separation in the various GPCP datasets: the GMDC was to determine the feasibility of such a separation in the daily mean product using an atmospheric temperature dataset and the GPCC/SRDC were to investigate re-analysis of the gauge data to make a similar separation. There was a discussion of liaison between the various GRP projects and other activities in GEWEX and WCRP; the most crucial cross-connects that need attention are the interaction between GPCP and the CSEs/CEOP to provide better evaluation of the global products and ISCCP/SRB and CLIC concerning evaluation of clouds and radiation in the polar regions. Two other connections that should be investigated are ISCCP/GACP with SPARC concerning volcanic aerosols, cirrus and upper tropospheric humidity and GACP with the several other national and international aerosol-related activities.

A major proposal was developed during the discussion of how to proceed with GVAP. Given that the IPCC plans another climate assessment in 2007 that will have a focus on 'water' and that the GEWEX global data products, most of which now cover periods of 15-20 years, are becoming key datasets to monitor climate behavior, it was suggested by WGDMA to GRP that they undertake formal assessments of the main data products. In particular, it was proposed that the GRP should lead the evaluation of the ISCCP products (since this project has conducted such international evaluations before), that the GPCP products should be evaluated in partnership with the International Precipitation WG (IPWG), that the SRB product be evaluated in combination with NASA's ERB products, and that the GRP seek a collaboration with the International TOVS WG (ITWG) to evaluate the satellite-based water vapor products. Subsequent to the WGDMA meeting but prior to the GRP meeting, the IPWG agreed to participate in the evaluation of the GPCP products. Discussions at the ITWG meeting led to a reformulation of the idea: since planning was underway by the Hadley Center and NOAA to evaluate available global temperature datasets (NOAA having received a specific mandate to do this under the US CCSP), it was proposed that water vapor also be evaluated as part of this activity since many of the satellite instruments measuring temperature also are sensitive to water vapor. After discussing this proposal, the GRP agreed to lead evaluations of ISCCP (led by W. Rossow), GPCP (led by Adler and Gruber from GRP and Levizzani from IPWG), and SRB/ERB (led by Stackhouse with support from Wielicki). Rossow and Bates will continue to represent GRP at meetings to discuss an evaluation of satellite temperature and humidity data products.

For the past several years, there have been discussions at GRP meetings about stimulating the use of the GRP data products by producing merged data products and/or by conducting joint data analyses applied to the whole GRP collection. This topic was also discussed at the WGDMA meeting at some length to identify specific tasks. In addition, the GRP-sponsored workshop on climate feedbacks identified the need for comprehensive (i.e., multi-variate), global, long-term dataset collections to further research on this topic. Discussions at GEWEX SSG and WCRP JSC meetings have also identified the compilation of such data collections as now both opportune and imperative to making further progress. The GEWEX SSG has formulated the concept of completing a long-term diagnosis of the global energy and water cycle by augmenting the GRP data products. The JSC has formed a WG on Satellite Matters, which has suggested that a comprehensive analysis of global, long-term satellite data be fostered by WCRP across all its programs. All of these discussions come to the same point, regardless of who actually undertakes the analysis of these data: general research into the global energy and water cycle, climate feedbacks and climate response sensitivity would be greatly facilitated if a systematic collection of data were made available in a single comprehensive package, much like the reanalysis data products being produced by the weather forecast centers, that describes the 'complete' variations of the climate over the past 10-20 years. The GRP agreed that this task

should be taken up by the WGDMA; NCDC has agreed to act as the archives for the GRP datasets, including this new merged version, possibly offering the latter on-line. Other countries have been contacted to find 'mirror' data servers that can provide these data locally; T. Iguchi and J. Ceballos agreed to look for data servers in Japan and Brazil, respectively.

It was proposed and endorsed that future meetings of the WGDMA will be held in conjunction with GRP meetings.

9. Invited Scientist Talk

Z. Li presented a review of the status of the controversy concerning so-called anomalous absorption (solar flux absorption in clouds that has been claimed to be unaccounted for in current radiative transfer models). There have now been a number of careful reanalyses of the original studies, together with two major field campaigns over the ARM SGP site, to address this question. Some studies have shown that there are indeed a number of subtle processes not usually accounted for, particularly in GCM radiation codes, that enhance shortwave absorption when included, no one of which is very large; hence, when these processes are included, particularly accounting for more absorptive aerosols (desert dust and biomass burning output) and water vapor in clouds, the total atmospheric shortwave absorption does increase by 5-10 Wm^{-2}, depending on the particular model. Although some of these subtle processes involve clouds, this extra absorption is not entirely cloud related. The best results from the ARM experiments confirm this theoretical conclusion, showing that there is not a discrepancy of the size originally proposed; the best measurements and modeling are consistent to within the limits of the measurements themselves, about 5 Wm^{-2}.

10. Wrap-up Action Items & Executive Session

The actions, recommendations and issues actions arising from this meeting are summarized in Appendix G.

In the Executive Session, it was noted that the idea of holding a mid-year discussion by e-mail didn't work, but that distributing to the GRP members some sort of summary of events at that time was useful. It was suggested that Ells Dutton attend the GEWEX SSG meeting, in addition to the GRP chair, to highlight the accomplishments of BSRN, to suggest that the SRB/BSRN model be adapted by GPCP/GPCC and GACP/AERONET, and to discuss the dual role of BSRN in WCRP and GCOS. B. Wielicki retires as a GRP member, but has agreed to continue reporting to the GRP on Earth Radiation Budget missions. The chair of GRP solicited suggestions for new members from the current members.

11. Next Meeting

The next meeting of the GRP in fall 2004 will be hosted by Kyoto University (T. Hayasaka).

Appendix A
FINAL GRP Meeting Agenda for 2003

10 November 2003, Monday

0830-0930:	Executive Session
0930-1000:	Overview of Old and New Issues [Rossow]
1000-1030:	Break
1030-1200:	Satellite Agency Reports
	[ESA-Ingmann, NOAA-Bates, NASA-Anderson]
1200-1330:	Lunch
1330-1500:	Satellite Agency Reports
	[EUMETSAT-Tjemkes, JAXA-Iguchi, JMA-Hayasaka]
1500-1530:	Break
1530-1600:	New Aerosol Initiative [Stephens]
1600-1630:	Invited Scientist Talk [Land Remote Sensing - Prigent]
1630-1730:	Discussion of Satellite Mission Plans and Advanced Remote Sensing
1730:	Adjourn

11 November 2003, Tuesday

0830-0900:	Invited Scientist Talk [Aerosols-Haywood]
0900-1000:	Project Reports [GACP & ISCCP-Rossow]
1000-1030:	Break
1030-1130:	Discussion of Cloud-Aerosol-Related Activities
1130-1200:	Status of SeaFlux and GVAP [Rossow]
1200-1330:	Lunch
1330-1430:	Project Reports [GPCP - Adler, GPCC - Gruber]
1430-1500:	Discussion of GPCP Possibilities [Gruber]
1500-1530:	Break
1530-1730:	Project Reports [ERB - Wielicki, SRB - Stackhouse, BSRN - Dutton]
1730:	Adjourn

12 November 2003, Wednesday

0830-0930:	Project Reports [ICRCCM - Ellingson/Barker]
0930-1000:	Report from 3DRT WG [Cahalan]
1000-1030:	Break
1030-1100:	Report from CPROF [Ackerman]
1100-1200:	Discussion of Radiation Activities (including RTM Review)
1200-1330:	Lunch
1330-1415:	Report from WGDMA (GWEBS, Assessments, Feedback Plan) [Rossow]
1415-1500:	Wrap-up Action Items
1500-1530:	Break
1530-1600:	Invited Scientist Talk [Shortwave Atmospheric Absorption - Li]
1600-1700:	Executive Session
1700:	Adjourn
1700:	Icebreaker

Appendix B
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Appendix C
Draft Statement on Modeling of Cloud-Aerosol-Precipitation Interactions

The GEWEX Radiation Panel is concerned that many studies of the interaction of aerosols, clouds, precipitation and radiation are unable to demonstrate the statistical significance of their results for climate change. Often this shortcoming is due to a reliance on a few case studies that, while suggestive, are not conclusive at the accuracy required to imply significance for climate change. Climate is by definition the ensemble of weather. Therefore the impact on climate must be determined by ensembles of case studies in order to rigorously demonstrate climate impact. For clouds, aerosols, precipitation and radiation, this is especially critical and difficult. The variability on small time and space scales is similar in magnitude to the mean value, so that a large number of cases is required. There are many new cloud, aerosol, precipitation and radiation datasets from satellites (MODIS, MISR, POLDER, GACP, ISCCP, TRMM, AMSR, CERES) and surface observations (AERONET, BSRN, ARM) that have sufficient sampling and coverage to achieve the required statistical rigor. The difficulty often lies in the extensive analysis and modeling needed to achieve this rigor. It is typically outside the reach of small groups, as well as current cloud modeling resources in particular. The GEWEX Radiation Panel strongly encourages the GEWEX Cloud System Study (GCSS) to take advantage of the new datasets to test cloud models in more statistically robust tests as part of their model validation strategy. Since such tests are usually beyond the scope of most GCSS investigators with current funding levels (almost non-existent), the GEWEX Radiation Panel also strongly encourages funding agencies to be aware of this difficulty and to establish competitive research programs that can achieve large statistical sampling of comparisons of cloud models and observations. These comparisons should be encouraged across the range of cloudy physical models from Large Eddy Simulation models, to Cloud Resolving Models, to the Single Column Models representing one grid cell in weather and climate GCMs, to the full GCMs. Finally, we note that such comparisons will also be key to resolving the importance of aerosols to cloud properties, often called the aerosol indirect effect.

Appendix D
BSRN Agreement to Serve as Component of GCOS

Following are the terms and conditions by which the World Climate Research Program (WCRP) Baseline Surface Radiation Network (BSRN) proposes to satisfy the requirements for being identified as the Global Climate Observing System (GCOS) global baseline surface radiation network. With the mutual agreement to these terms, BSRN will be pleased to be designated as the GCOS global baseline surface radiation network.

1. The BSRN will remain institutionally and organizationally as it currently is within the domain of the Global Energy and Water Experiment (GEWEX) of WCRP and will be identified in all GCOS documentation and distributions as the WCRP GEWEX BSRN or spelled out as necessary.
2. Both BSRN and GCOS principals will agree to the items set forth in this document.
3. To avoid potential confusion and dilution of the integrity of the BSRN program, GCOS will not endorse, sanction, or otherwise identify any other surface radiation measurement program or effort as part of the GCOS global baseline radiation network.
4. New sites will be accepted into the BSRN program only as discussed below under Principle #7.
5. BSRN will adhere to the GCOS ten monitoring principles as presented and discussed below. While most of the principles are already being followed by BSRN because of their inherent merit for long-term research-quality observations, BSRN documentation (Operations Manual or OM) does not specifically address some of the points and will be modified accordingly.

The following version of the GCOS Climate Monitoring Principles is taken from GCOS/AOPC-IX, Doc. 18 and each is slightly shortened here for simplicity but with no intent to change the meaning of the full original version.

Principle #1: The impact of new systems or changes to existing systems should be assessed prior to implementation.

Such an assessment was completed before BSRN began operations. However, a major goal of BSRN is the improvement of measurement capability, so, as those improvements have been made they have been implemented *after being assessed as to the merit of and gain due to the improvement*. Although this requirement is not explicitly stated in the OM it has been generally followed to date and a formalization of such a policy will be included in the OM.

Principle #2: A suitable period of overlap for new and old observing systems is required.

This is inherent in the BSRN mode of operation but is not specifically identified as the requirement in the OM. It is assumed that this principle applies to the exchange of sensors for routine calibration and maintenance as well as the integration of new systems replacing older ones. Overlap in BSRN is achieved by the pre- and post-characterization, calibration, traceability of instruments and systems prior to deployment and removal from service so as to be consistently intercompared with the new and old systems or instruments. Traceability may be achieved either in the field or at a suitable characterization and calibration facility. The OM will be modified to reflect this principle but will not significantly change the current mode of operations.

Principle #3: The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting the data (*i.e.*, metadata) should be documented and treated with the same care as the data themselves.

This is already an integral part of the data reporting and data archival procedures within BSRN. BSRN will review the required metadata currently being acquired to identify any missing information.

Principle #4: The quality and homogeneity of data should be regularly assessed as a part of routine operations.
This is currently done in at least two places during the BSRN data collection and archival. By basic program design, BSRN site scientists are responsible for maintaining quality control and data homogeneity at their individual sites before submitting the data to the archives. Also, the central archives at ETHZ performs data quality flagging as well as data completeness assessments.

Principle #5: Consideration of the needs for environmental and climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.

BSRN's primary goal is to address climate related research issues. The placement and design of BSRN is to provide information for climate analysis and research assessment. The complete data product is freely available for applications in additional disciplines.

The BSRN archives will not necessarily develop any new products to satisfy this principle given that its resources are currently fully committed.

Principle #6: Operation of historically-uninterrupted stations and observing systems should be maintained.

BSRN was the beginning of the system now recognized as the BSRN surface radiation measurement methodology. It is the intention of the BSRN and most of its participants to operate these programs indefinitely as long as they can be practically maintained. Predecessor radiation measurement capabilities existed at several of the current and prospective BSRN sites and the BSRN program extends a subset of those earlier measurements. However, BSRN does not give preference to an existing measurement record at a candidate site based solely on the existence of those records, although long records are one of the goals of BSRN. BSRN asserts that sites with long BSRN records are of particular value and additional funding consideration should be given to those sites.

Principle #7: High priority for additional observations should be focused on data-poor regions, poorly observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution.

BSRN will continue to pursue additional observations in data-poor and under-represented regions. BSRN will add stations to the network only by its current set of standards, which require application to, and review by, BSRN management. This is meant to be exclusive to the extent to assure that the proper measurement capabilities exist and are likely to be maintained, preferably at globally under-represented but regionally representative sites pursuant to this Principle. GCOS and others are encouraged to recommend potential sites with consideration to be given to those sties as outlined above. Collocation with other climate related observations is desirable.

BSRN will determine if under-sampled or poorly-observed parameters are appropriately represented within the realm of the program and will address them accordingly. BSRN is currently pursuing some such cases, *e.g.*, aerosol optical depth, UVB and cloud-base temperature/height.

Temporal representativeness was given high priority in the design of BSRN and current measurement programs meet or exceed all currently known or anticipated needs for this requirement.

While efforts to extend the representativeness of the BSRN are underway and will continue, it has always been recognized that surface-based radiation observations will never be able to completely represent the climatologically significant variation on the planet. It is only through combined satellite and modeling programs, such as the Surface Radiation Budget (SRB) project and various GCMs that this complete representativeness can be obtained.

Principle #8: Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation.

Each BSRN station is intended to be long-term and the data sampling and collection continuous and durable. This was the original design of BSRN as indicated in the letters of invitation that were extended to member nations. In those agreements there was the implicit expectation that the commitment was long-term. While the specific duration of the BSRN is not identified in any current institutional documentation, it always has been intended by the participants to be an indefinitely long program. Additional emphasis on this aspect of the network will be added to the OM.

Given the funding realities for scientific exploration and the lack of a definitive description from GCOS as to what constitutes adequate institutional structure for adequate longevity, it is felt that BSRN more than adequately fulfills this requirement.

Principle #9: The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted.

There is no distinction between research and long-term observations relative to BSRN surface radiation observations. The intent of all the BSRN observations is for research applications. An observational method that would be considered developmental would need to be further developed into an operational state before ever being deployed in the BSRN routine system. BSRN will continue to be a research network in that the purpose of the observations is for research applications. BSRN will continue to ensure that developed observation systems will be suitable for long-term, remote deployment before being a required measurement of the program. This should satisfy the letter and intent of this monitoring principle.

GCOS confirms that this principle is primarily intended to encourage establishment of strong, continuing institutional support for all aspects of the ongoing network activities.

Principle #10: Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.

This is already the case for BSRN. The BSRN archives are an integral part of the network in that it includes personnel intimately familiar with the field collection of the data and its scientific applications. The archives maintain the program's web site and contribute greatly to the overall management and operation of the network. Organizational investigations are currently underway to ensure the integrity of the archives for the long-term and the eventual turn-over of personnel involved.

The longevity of the BSRN archives is an important aspect of the network and there are current efforts to ensure that the archives will be sustained indefinitely into the future.

Appendix E
An Update on Survey of "Modern-Day" Radiation Codes - November 2003

V. Ramaswamy
NOAA/GFDL

In the wake of ICRCCM and field campaigns involving more reliable radiation measurements (including spectral), there has been a resurgence of attention towards calibration and improvements of the solar and longwave radiation codes used in weather and climate models. Particularly, when compared to the first published journal report of the intercomparisons conducted under the ICRCCM umbrella (JGR 1991), there has been a vast undertaking carried out in several, if not most, of the GCM institutions to fine-tune the radiation parameterizations against the "reference" computations (usually line-by-line or line-by-line-plus-doubling-adding or high-order-discrete-ordinate methods). The "reference" computations themselves have evolved with advancements in the knowledge of spectral lines and empirically-based information on spectral line characteristics.

In order to gage the evolution of the codes and determine what are the new elements incorporated in the current codes, a survey was undertaken in which GCM (and other) institutions were asked a set of questions concerning the algorithmic details. The survey stated that this was for the sake of the GEWEX Radiation Panel (GRP), that it was meant for assessing the nature of upgrades that have occurred, and that the exercise was not intended to be used as a "beauty contest". It was pointed out that the results would be used to assess what further progress was needed in weather and climate models' radiation codes and how GRP could best foster this. When the survey was initiated about a year ago, the motivation was provided by the fact that substantive updates have occurred in the following areas over the past decade: improvement of molecular absorption, especially carbon dioxide and water vapor; treatment of non-plane-parallel, inhomogeneous clouds, with account being made of the subgrid scales; improved treatment of the interaction of radiation with cloud particles and water vapor; nonspherical cloud particle effects; inclusion of the diverse aerosol species (external and internal mixtures) in radiation codes with attention to spectral properties; recognition of the need to incorporate spectral features of different land and ocean surfaces; and the overall recognition that the codes need to be compared against field measurements of the spectral radiation to develop a sense of robustness concerning the radiation aspects of climate.

The initial set of questions posed appears below.

WCRP/GEWEX Radiation Panel Questionnaire

[Consider both the SOLAR and LONGWAVE sections of the radiation code]

1. How is molecular absorption treated (exponential-sum fit, Pade approximation, correlated-k, transmission function, etc.)? How is the water vapor continuum taken into account, if at all?

2. How is multiple scattering treated (2-stream, delta-Eddington, etc.)? Is there an explicit treatment of in-cloud gas absorption in the multiple-scattering treatment?

3. Are natural and anthropogenic aerosols considered explicitly? Are all aerosol species lumped together? If not, what are the various species considered?

4. Are clouds treated as plane-parallel elements? Or are non-plane-parallel, inhomogeneous, finite clouds considered (explicitly or implicitly)?

5. Is there an explicit or implicit treatment of sub-grid scale clouds in the radiation scheme?

6. How is cloud overlap treated?

7. Are nonspherical particles considered in the radiation treatment?
8. Has the radiation model been calibrated against "benchmark" computations (i.e., line-by-line or LBL, LBL+discrete ordinate, LBL+doubling-adding, etc.)?

9. Have the fields emerging from the model calculations been compared/verified against observations (satellite, ground, other)? for (a) aerosols, (b) clouds, (c) irradiances?

10. Can you cite one recent paper published with the above model?

11. Do you have any other comments/questions of your own to add to the list, especially concerning recent radiation upgrades in GCMs?

There were responses from 13 institutions (Hadley Center, NCEP, UCLA, NOAA/GFDL, MGO, LMD, CSU, BMRC, JMA, UIUC, Imperial College, NASA/GISS, ECMWF). A few more institutions have promised to send responses soon. Although this must be considered encouraging, changes in the responses (signifying ongoing updates in solar/longwave codes) since the initial returns are inhibiting final collection. It is hoped that the process will come to a conclusion shortly. Meanwhile, Q. Fu (Univ. Washington) began an independent survey, partly as a basis for his talk at the 2003 Gordon Research Conference on "Solar Radiation and Climate". Exchanges with Fu reveal that there are some common questions in the two surveys. A more substantive comparison between Fu's and the GRP survey results will take place within the next 4-6 months.

The initial findings from the GRP survey reveal that, in general, codes at almost all GCM institutions have become considerably mature, e.g., incorporation of explicit scattering treatments, inclusion of more than two spectral intervals in the solar, improved implementation of the water vapor continuum, accounting for solar features of aerosols (and not prescribing these perturbations as surface albedo changes), inclusion of various aerosol species, accounting for non-CO2 trace gases in the longwave, and improved cloud treatments. Also as the recent paper by Barker et al. reveals, many modeling groups consider it mandatory now to test the codes against "benchmark" computations. Currently, widespread use of "benchmark" computations from AER and GFDL is occurring, considering both solar and longwave spectra.

It is clear, however, that many treatments especially in the cloud-radiation arena are *ad hoc* and would benefit from close scrutiny by GRP, perhaps in the form of fine-tuned and focused intercomparisons. Aerosol treatments, too, could benefit from such an exercise. It would be useful to recognize that IPCC (2007) is about to formally start, and it would be timely for GRP to undertake some sort of an evaluation of the ability of codes to determine accurately water vapor and cloud feedbacks, and compute reliably the forcings due to different aerosols. Furthermore, one of the things that I think the JSC would be delighted about is a highly visible contribution by GRP to both the next IPCC and WCRP JSC's recent (2003) reiteration of its overall objectives [I say this wearing a hat as a JSC member]. I note that GRP is the only unit in WCRP that can competently assess the all-important accuracy of weather and climate model radiation codes.

Appendix F
GEWEX GLOBAL DATASETS Now Available

(1983-2001) **Clouds** from ISCCP (also Top-of-Atmosphere and Surface Radiative Fluxes)

(1983-1995) **Surface Radiative Fluxes** from SRB and BSRN (35 sites, 1994-2001)

(1979-2000) **Top-of-Atmosphere Radiative Flux Compilation** (Wielicki et al.) and from ERBE, SCARAB and CERES

(1979-2001) **Precipitation** from GPCP and GPCC (more than 3000 gauges)

(1983-2001) **Aerosols** from GACP

(1988-2001) **Water Vapor** from NVAP and NOAA TOVS (also Temperature, 1981-2001)

(1987-2000) **Ocean Surface Latent/Sensible Heat Fluxes** from GSSTF-2 and HOAPS (based on SeaFlux)

Appendix G
Summary of Recommendations and Actions

Actions

(1) GRP Chair to draft letters to satellite-operating agencies about the following: to ESA expressing concern about support for the EarthCare mission as well as endorsing the emphasis on snowfall measurements in EGPM, to CNES expressing support for the MeghaTropiques mission, to EUMETSAT about climate requirements for MTG planning, to NOAA about climate requirements for GOES-R planning and expressing concern about a possible afternoon polar orbiter coverage gap before the first NPOESS launch, to NASA outlining a possible role for AERONET and a cloud-aerosol-precipitation initiative and expressing concern about the early termination of TRMM, and to JAXA expressing support for continuation of TRMM and for the GOSAT mission.

(2) GRP Chair to draft a letter to US CCSP expressing concern about removal of CERES from NPP.

(3) J. Haywood and M. Mishchenko to take the lead to plan a workshop on satellite-based aerosol products.

(4) GRP to formulate a more comprehensive aerosol research strategy (draft text from Haywood, Dutton, Stackhouse).

(5) GPCP centers (GMDC, GPCC) to investigate the feasibility of separating current precipitation products into rain and snow.

(6) L. Oreopoulis (chair), R. Ellingson, H. Barker, T. Ackerman, N. Loeb, P. Stackhouse to meet with representatives from the ARM BBHRP to plan an on-line 'test kit' for broadband radiative flux codes, including synthetic and measurement-based cases, reference line-by-line results and verifying measurements, and to organize a workshop comparing such codes in GCMs based on the test kit.

(7) GRP chair to draft data product assessment plans.

(8) W. Rossow to take the lead to organize a cloud product comparison workshop.

(9) A. Gruber and R. Adler to take the lead (with V. Levizzani from IPWG) to organize a precipitation product comparison workshop.

(10) J. Bates and W. Rossow to continue to liaise with the group (NOAA, Hadley Center, ITWG) planning an assessment of global, long-term temperature datasets to foster the idea of combining this activity with an assessment of water vapor datasets.

(11) R. Cahalan (under 3DRT WG) to take the lead to plan a workshop on advanced radiative transfer codes for lidar analysis.

(12) C. Prigent to take the lead to plan a workshop on microwave radiative transfer codes.

(13) B. Wielicki to provide a copy of the NOAA climate requirements workshop report to the GRP chair for distribution to GRP members.

(14) GRP Chair to distribute a white paper that has been submitted to WGSM proposing a coordinated reanalysis of global satellite datasets and a recent WGSM report to CEOS.

(15) GRP members to forward suggestions for new members to the GRP chair.

Recommendations

(1) That GCSS focus more on and give more consideration to uses of satellite observations for cloud-aerosol-precipitation-radiation process modeling (based on text from Gruber, Wielicki and Haywood, Appendix C).

(2) That BSRN develop a quantitative estimate of actual operational uncertainties of measured surface radiative fluxes.

(3) That WGDMA proceed with collecting all of the GRP (and other relevant global, long-term) data products and produce a merged version to be made available on a number of data servers around the world to support climate feedback and sensitivity studies and an analysis of the global energy and water cycle.

(4) That the GEWEX Precipitation Cross-Cut should specifically tackle high-resolution studies combining GOES-NEXRAD-TRMM (and equivalent systems elsewhere in the world0 to address questions of space-time sampling.

Issues

(1) Lack of access to comprehensive collections of time-resolved precipitation gauge data.

(2) Should role of GPCC/SRDC in GPCP be more like BSRN in SRB? Should GPCC evolve into GCOS element like BSRN?

(3) Lack of open-ocean surface radiation and aerosol measurements and the future of SeaFlux activity should these issues be taken up by the new JSC WG?

(4) Should the working arrangements for GSWP-3 involve a direct partnership of GRP/WGDMA and GSWP to foster more development of more pertinent land surface quantities and, hence, should GRP undertake more activities to foster production of better land surface data analyses?