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1. SUMMARY OF PROGRESS AND MAIN DEVELOPMENTS

The organizational structure formulated for GEWEX has grouped the existing sub-activities and projects into three disciplines namely Hydrometeorology, Atmospheric Radiation Processes and, Modelling and Prediction. Appendix A contains a list of participants at the meeting and, Appendix B provides a concise overview of the main dicussion points, actions and recommendations.

The GEWEX Hydrometeorology Panel (GHP) is continuing the development of plans for the five GEWEX Continental Scale Experiments (CSE's) to participate in a Co-ordinated Enhanced Observing Period (CEOP). Emphasis was placed on more clearly articulating strategies for the use of satellite data, distribution of as much data as possible by way of the Global Telecommunications System (GTS), management and collection of results into a single unique dataset on appropriate media (i.e. CD-ROM), and execution of activities that could be undertaken jointly with other elements of WCRP (e.g. CLIVAR, CLIC). A Water and Energy Balance Study (WEBS) and a Water Resources Applications Initiative have been organized to focus on specific research goals as reflected in the criteria for establishment of the CSE's. The Coupling of the Tropical Atmosphere and Hydrological Cycle (CATCH) Project in Africa, was given Continental-Scale Affiliate (CSA) status within GHP. This action acknowledges the important contributions CATCH can make toward the GHP/GEWEX global objectives, but recognizes the difficulty CATCH will have in fully meeting all of the CSE criteria.

Under the auspices of the GEWEX Radiation Panel (GRP), climate forcing and climate feedback have become the two broad science issues of importance in fulfilling the main GRP research goals. The need to identify gaps and reduce the uncertainties associated with these phenomena is critical to making significant progress toward improved climate predictions. The technical issues in understanding these principals and acting on them are forming the framework for research being fostered by GRP. A workshop and a journal article are planned to synthesize progress associated with both the observational and model based assessments being undertaken within the GRP sub-projects. The SSG was informed of relevant actions associated with this strategy that are underway as part of the GEWEX Global Aerosol Climatology Project (GACP); the next phase of the GEWEX Global Water Vapour Project (GVaP); Global Precipitation Climatology Project (GPCP) enhanced datasets; efforts to build and launch international GEWEX multi-sensor cloud/radiation/aerosol missions; and continuation, beyond 2000, of the International Satellite Cloud Climatology Project (ISCCP) and other GEWEX global data projects.

The GEWEX Modelling and Prediction Panel (GMPP) is working in association with the Working Group on Numerical Experimentation (WGNE) to meet its commitment to assist in the production of improved cloud and land-surface parameterizations for use in General Circulation Models (GCMs). There was endorsement of plans to move forward with a GEWEX Global Land/Atmosphere System Study (GLASS), which was formulated by the community in a series of workshops. GLASS has four main activity elements, which correspond to work on off-line and coupled functions at both the point to regional scales and the global scale. Development of a standardized interface that will facilitate the inter-comparison activities within GLASS is also underway. GLASS will work in close association with GHP and especially with the International Satellite Land-Surface Climatology Project (ISLSCP). Connections between ISLSCP and the Biospheric Aspects of the Hydrological Cycle (BAHC) core project of the International Geosphere/Biosphere Program (IGBP), have led to an agreement for GLASS to co-ordinate the model inter-comparisons BAHC wishes to perform.

A strategy for updating the existing science and implementation plan for the GEWEX Cloud System Study (GCSS) was reviewed and accepted by the SSG. Among other changes, the plan will formalize an *ad hoc* effort to evaluate and integrate GCSS test cases for use in advanced model evaluation studies.

2. GEWEX GLOBAL OBSERVATION SCIENTIFIC REQUIREMENTS

GEWEX has taken responsibility for consolidating WCRP global climatological data projects based on merging satellite data with current atmospheric and (land/ocean) surface measurements. In this context the SSG acknowledged the responses from space agencies toward addressing a set of scientific issues of greatest relevance to GEWEX including:

- All flux components of a Precision Atmospheric Radiation Transfer Scheme
- Specific quantitative knowledge of Cloud Microphysical Properties and Dynamics
- Constituents of the Ageostrophic Atmospheric Circulation
- Soil moisture and other parameters that could come from a focused Land-Surface Mission

This set of measurements incorporates the parameters expressed earlier by WCRP/GEWEX which specifically identified global 3-dimensional distribution of clouds, radiation and aerosols; global soil moisture (upper 5-10cm); and global 3-dimensional distribution of tropospheric wind as being of importance to GEWEX but which up to now were notably missing from prevailing earth observation plans. There was concurrence that these requirements are consistent with the needs of the large scale modelling community (NWP and GCM) where the availability of high quality data on all the important aspects of the atmosphere and its boundary conditions, represents the most critical aspect of the process for extending accurate predictions. The SSG concluded that the operational satellites together with the missions currently planned by NASA, ESA, NASDA and other national and international agencies, as presented at the meeting, will, therefore, provide the framework for the main thrust of the third phase of GEWEX and, simultaneously, will nearly fulfil the main requirements of WCRP as a whole.

The initial success of the Tropical Rainfall Measuring Mission (TRMM) was also identified as an example of the type of international effort which must be supported. TRMM is providing unprecedented coverage of the horizontal and vertical structure of tropical rain systems and these data are already being exploited as a valuable resource for parameterization and assimilation studies. The SSG emphasized the importance of continuity of these measurements and called for a review of precipitation measurement missions to be carried out at its next session, this review is to examine the potential for a TRMM follow-on mission and other synergistic proposals such as the Global Precipitation Mission.

The fundamental basis for the atmospheric data required by GEWEX is the NOAA series of polar orbiters and geostationary satellites, the European METEOSATs and the Japanese GMS spacecraft, which constitute the existing array of operational meteorological satellites. The maintenance of this array and the continuity of related observations and the continued international support of the ISCCP and GPCP and the other GEWEX global climatological data projects, coupled with the potential benefits that can be expected from on-going improvements of existing instrumentation, are necessary for meeting the objectives of the GEWEX global observation phase.

These examples of domestic and international partnerships being applied toward answering major climate-related scientific questions, when grouped together with the other Earth Observing Platforms, will establish the scientific basis for understanding the dynamics and energetics of Earth's atmosphere in support of WCRP/GEWEX related goals especially associated with short-term weather and long-term climate forecasts. The SSG commended efforts by Space agencies to meet the main cloud/radiation/aerosol scientific foci related to future GEWEX contributions to WCRP and to note that efforts need to be sustained to achieve further success. In the same context, the SSG undertook a discussion related to the success GEWEX has had representing WCRP interests to the main space agencies and began considering steps to ensure that efforts are made to engage other agencies and institutions around the globe, which can influence development of all types of observing and computational networks and systems that can support the advancement of relevant research.

3. MANAGEMENT OF GEWEX GLOBAL PRODUCTS AND PLANS FOR EXPLOITATION OF NEW DATA

GEWEX has taken responsibility for consolidating WCRP global climatological data projects based on merging satellite data with current atmospheric and (land/ocean) surface measurements. This role includes interacting with space agencies to track the status of global environmental observing systems, providing scientific overview of the retrieval procedures and data quality, organizing data archiving and distribution on appropriate media and assisting, through conferences, workshops, symposia, and data management meetings, with the international co-ordination of these projects.

A working group on data continuity and utilization was convened at the meeting and made several recommendations related to the collection and management of data during the GEWEX phase 2 time period when the exploitation of observations from the new earth observing system platforms would be a high priority objective. As a result of the deliberations the SSG has tasked the chairs of the main GEWEX Panels (GHP, GRP and GMPP) to derive a minimum set of observations required to close the global water and energy cycles and to conclude the state of the availability of this set of measurements (past and future). A co-ordinated report on the results of this evaluation, led by the Chair of the GRP, should be given at the next session of the SSG. By considering previous GEWEX SSG recommendations to evaluate progress and identify gaps in collection of these data, this report should help formulate an initial GEWEX position on progress in this respect and establish a framework for work in Phase 2 of GEWEX. Using this evaluation the SSG will direct all its components to determine as soon as possible whether the new satellite observing systems to be launched during Phase 2 are helping to achieve its objectives by providing new data products or whether new analysis techniques will still be needed for this purpose. These recommended actions

delineate the strategy that GEWEX has evolved for obtaining the data needed to realize its objectives that requires continued analysis of data by its current global data projects, and evaluation of the utility of new satellite data to provide the needed information. It is necessary, therefore, that research funding sources, operational services and space agencies continue adequate support of the GEWEX global data projects and that they provide additional funding to enable the evaluation of the existing datasets against new satellite and ground-based observing system results. This process will allow the SSG to decide whether the existing datasets need to continue to be produced to achieve GEWEX objectives. This evaluation process will provide the means for determining if a scientific rationale exists for continuation of the current data projects and, if so, will also lead to the relevant data sources, needed analysis methods, and required organizational structure to successfully complete Phase 2 of GEWEX.

The previous discussion, not-with-standing, the SSG agreed that the success of WCRP research programs requires a long series of comprehensive observations with an integrated analysis of the datasets. It was recommended, therefore, that since current plans for the satellite and surface observing systems do not dictate a change of analysis schemes in the near future, ISCCP and the other GEWEX data projects should continue for at least another five years. The JPS for WCRP has the action to ensure that letters are drafted to the major space agencies to secure support of the current GEWEX global climate information projects including ISCCP GPCP, SRB and GACP well into the next decade. It will only be at that time (post-2000) that resources will come available that will make it possible to add value to the new earth observation system retrieval processes by organizing intercomparisons, applying merged data techniques and participating in unified algorithm development ventures. This exploitation requires not only that the participating GEWEX International data centres collect, analyze and disseminate their data products, but also that they calibrate, quality check, adapt processing software to changing operational systems, and validate their products. Therefore, the request to agencies for a renewal of their commitments to these projects will include the need for minimum funding levels to be established which are sufficient to support all of these tasks.

4. OVERALL GEWEX CO-ORDINATION

As noted in the opening section of this document, GEWEX activities have been organized into three branches. The GEWEX Hydrometeorology Panel (GHP-see Item 5.) is undertaking the integration of large-scale experiments to demonstrate skill for predicting processes including precipitation, and changes in water resources and soil moisture over continental regions, as elements of seasonal-to-interannual climate predictability. These tasks are linked to efforts by the GEWEX Radiation Panel (GRP-see Item 6.) to determine the radiation budget and fluxes in the atmosphere and at the surface, as an element of seasonal-to-interannual climate variability, and the response of the climate system on decadal-to-centennial time scales to changes in anthropogenic forcing. The GEWEX Modelling and Prediction Panel (GMPP-see Item 7.) has the target of developing accurate model formulations of the water budget and transport and the energy budget and radiation transfer in the climate system and, thereby, provide the basis for demonstrating the extended predictions highlighted in the goals of the radiation and hydrometeorology initiatives.

Although the main points in the implementation of GEWEX to achieve the required scientific progress have remained the same, the research in the individual elements has been focused on specific scientific issues that have been developed to unify their efforts in meeting the higher level global scale objectives. In the context of this emphasis on “inter-panel” co-operation, the SSG recommended that the three panels (GHP, GRP and GMPP) develop further specific co-operative/co-ordinated activities whose progress can be tracked and jointly reported at subsequent SSG meetings. New actions will take place as a result of recommendations made at the meeting (see Item 3.). Some progress has also been made on a specific recommendation raised at the previous meeting, which relates to GHP and GRP organizing the collection/processing of high resolution satellite datasets/products for each of the GRP global climatology data projects, over each of the GEWEX Continental-Scale Experiments (CSEs) and for the GEWEX Cloud System Study (GCSS) and other modelling and analysis elements of GMPP and GHP to exploit these high resolution datasets for their case studies, supplemented by their own field measurements. The issue of the development of a credible data collection and management scheme being necessary for the success of CEOP was raised and specific action recommended to GHP for advancing this activity. Reports on the outcome of work on these tasks must be given to the GEWEX SSG Chairman by the Chairs of the GEWEX Panels in a timely manner, so that progress can be assessed in advance of the next SSG session. An additional need for specific steps to be taken toward co-operation in the collection of data for the existing GEWEX datasets was called for. The SSG in, executive session, has tasked the Chair of GRP to ensure that progress is made in this arena and to report on steps that are to be initiated, including joint meetings of the collection and processing teams for these datasets that will address commonality of collection and production of the relevant products, especially GPCP and ISSCP, but with the intention of encompassing work in GMPP (GCSS and GLASS), and in GHP (CEOP). Other specific actions should be developed and discussed, following a report on the matter at the next SSG meeting.

5. HYDROMETEOROLOGY

The GEWEX Hydrometeorology Panel (GHP) has been chartered to oversee development of the multi-disciplinary scientific Continental-Scale Experiments (CSEs) which are adding to WCRP's efforts to develop an understanding of the physical climate system and processes. There are currently five such projects based in large river basin/drainage areas; the GEWEX Continental-Scale International Project (GCIP) in the Mississippi River Basin, the Baltic Sea Experiment (BALTEX), the Mackenzie River Basin GEWEX study in Canada (MAGS), the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) and an experiment in a large area influenced by the Asian monsoon, identified as the GEWEX Asian Monsoon Experiment (GAME). The Science and Implementation Plans for a Continental Scale Affiliate Experiment (CSA) to study the Coupling of the Tropical Atmosphere and Hydrological Cycle (CATCH) in West Africa have been advanced. The GHP is promoting further progress toward the Co-ordinated Enhanced Observing Period (CEOP) initiative and the accomplishment of a collective GEWEX research initiative related to prediction of regional precipitation and runoff and is integrating the data collection and model development initiatives within each CSE to meet the global objectives of GEWEX. As part of its outreach effort GHP has established a Home Page at: http://www.tor.ec.gc.ca/GEWEX/GHP/ghp.html. Contributions to GHP/GEWEX efforts by the China Meteorological Administration (CMA) were noted. The SSG was informed that CMA with support from the State Ministry of Science and Technology and the National Natural Science Foundation, initiated a series of projects that have contributed to efforts to improve the understanding of the water cycle in the Asian Monsoon region. These activities have included the South China Sea Monsoon Experiment (SCSMEX), a combine observations and theoretical study of physical processes over the Tibetan Plateau (TIPEX), a GEWEX related regional experiment along the Huaihe River (HUBEX), and a torrential rain fall experiment (HUAMEX).

GEWEX Continental Scale Experiment Plans

Utilizing a unified action plan adopted earlier, GHP with the International Satellite Land-Surface Climatology Project (ISLSCP) and the CSE's, is moving into its next phase involving research into prediction and predictability with a continuing focus on land-atmosphere interactions. The under lying theme for this work is the understanding that the GHP is responsible for examining the role of continental-scale hydrometeorology issues within the climate system and ensuring that these issues are well represented in climate simulations for improved prediction. Progress is being built on the successes that each CSE has had in developing databases, and carrying out process and modelling studies.

In recognition of the maturity of field activities within LBA and to return to the normal GHP Chair rotation cycle in 2000, the point of contact for LBA will Chair the GHP meeting for 2000. The LBA Secretariat has agreed to act as host for this meeting that will take place in Brazil, from 11 to 15 September 2000. With CATCH attaining affiliate status it was agreed that the Co-Chair should be associated with CATCH. A specific individual to fill this role will be named shortly. Specific plans and progress for each CSE can be found in Appendix "A" of the draft report of the 1999 GHP meeting at http://www.wmo.ch/web/wcrp/documents/others/ghp99drft.html.

Important milestones in 1999 include: tasks associated with water/energy budget closure; CEOP and its sub-tasks including hydrological model application, transferability, and predictability; and water-resource community interactions.

Water and Energy Budget Closure Task (WEBS)

It was agreed that GHP would continue its focus on closing the water and energy balance for each of the CSEs. The rationale is that the budgets be closed regionally with appropriate uncertainty estimates that are then used to assess the performance of GCMs and RCMs whose performance is, in turn, verified against reanalyses/observations to provide a determination/quantification of the CSEs' "impact" within the global climate system. The process must take into account the seasonal and diurnal cycles, the interannual variability and regional variations. The CSEs have undertaken the process of implementing this action and reports on this work were made at a GHP Water and Energy Budget Analysis Study (WEBS) Workshop that was held in conjunction with the GHP meeting 13-14 September 1999. It was agreed that WEBS would be a specific activity within the context of GHP. The GHP Senior Scientist, agreed to Chair this activity and to be a focal point for ensuring this initiative is carried forward during the next year. The theme of this work will focus on the stated objective of the WEBS effort to use observations and model analyses to close the water and energy budget on a regional scale within a level of uncertainty and that it can be understood what that uncertainty is within a specified level of confidence. It was also agreed that the WEBS effort within GHP should look at the issue of the aerial estimation of evapotranspiration.

A few crosscutting statements were generalized from the presentations at an earlier GCIP WEBS Workshop:

(i) High temporal resolution data that resolve important processes is essential for accurately resolving the water budget.
(ii) The domain over which a budget can be resolved is sensitive to the spatial resolution of the sampling.
(iii) Although it is a difficult standard to establish, runoff appears to be a valuable independent variable for testing closure.
(iv) High resolution models in 4-DDA mode, plus data inputs provide the best products for atmospheric budgets.
(v) "Tuning" and "nudging" techniques limit the utility of models in budget studies.
(vi) Process research (on precipitation and cloud processes; soil moisture/runoff generation processes, etc.) are needed to improve the ability to model water and energy budgets.

A second WEBS workshop will be organized for one and half days (11-12 September 2000) in conjunction with the regular GHP business meeting to be held for three and a half days from 12-15 September 2000.

The GHP members and relevant affiliate groups, presented their work and contributions to WEBS at the 1999 workshop. Summaries of the presentations are provided in Appendix B of the GHP meeting report at http://www.wmo.ch/web/wcrp/documents/others/ghp99drft.html.

Further Development of CEOP

CEOP has been planned as a GEWEX inter-panel research initiative led by the GEWEX Hydrometeorological Panel (GHP) with contributions from the GEWEX Radiation Panel (GRP) and the GEWEX Modelling and Prediction Panel (GMPP). CEOP will also depend significantly on the WEBS datasets. The main scientific focus within GHP and the underlying basis for CEOP relates to assisting GEWEX to demonstrate skill in predicting variabilities in water resources and soil moisture on time scales up to seasonal and annual as an element of WCRP's prediction goals for the climate system. It is expected that this can be realized by about the 2005-06 time period. The CEOP contribution to this thrust is to better understand and model the influence of continental hydroclimate processes on the predictability of global atmospheric circulation and changes in water resources, with a particular focus on the heat source and sink regions that drive and modify the climate system and anomalies. A major change in strategy has been to agree that the CEOP activities associated with the data collection phase should be extended a year to cover the period 2001-2003. A major science theme for the CEOP is the impact of land and hydrological processes on predictability and prediction on weather and climate time scales. Availability of suitable data sets for land surface process and modeling studies is an important requirement to be fulfilled to enhance the progress in this area. The opportunity presented by CEOP to compile such data sets for the same time period and distributed over different continental areas of the globe is proposed as one of the high priority tasks to be carried out during the CEOP data collection period. Action had been given to organize a workshop on CEOP data reference sites before the end of January 2000. Subsequently the scope of this workshop was expanded to include finalizing plans for the work needed to specify CEOP reference sites, with necessary model outputs and satellite remote sensing data and to define more specifically the participants in CEOP and their planned contributions. A workshop was held from 27 to 29 January 2000 in Honolulu, Hawaii, USA. The goal of the meeting was to gather material to produce a "near-final" activities plan for the three-year data collection phase of CEOP in 2001 and 2003. More details on CEOP can be found at http://www.tor.ec.gc.ca/GEWEX/GHP/ceop.html.

The priority activities during the CEOP Data collection Phase were further developed at the workshop:

(i) Reference Site Data Sets for applications to Land/Hydrology/Atmosphere Coupling Issues

A number of reference datasets distributed over the land areas of the globe and covering the same time period of at least one year is necessary for advancing modeling of land/hydrology/atmosphere coupling for applications to global NWP and climate models. The opportunity presented by CEOP to compile such data sets is a primary objective of the CEOP data collection period. Reference data sets will consist of a composite set of atmospheric, hydrologic and land surface characteristics variables that can meet the data requirements for a number of activities and that a minimum set of requirements should be established for CEOP related reference data collection sites. This work was

completed to a sufficient degree to satisfy the SSG that goals for collection of a single "co-ordinated" dataset for these sites could be reached.

(ii) Coupled Hydrologic/Atmospheric Model Transferability Experiments

The overall objective of this aspect of CEOP is to evaluate the performance of coupled hydrologic/atmospheric models in different geographical and climate regions as well as the performance of coupled model components over the same region at a different scale/resolution. The results from the workshop were formulated into a Process, Modelling and Prediction (PROMOP) element of CEOP designed to demonstrate skill in predictions up to seasonal for water resources applications using improved land-hydrology models.

(iii) Satellite Remote Sensing Validation, Data Products And Applications To Global Land Masses

A number of GEWEX Projects including ISCCP, SRB, GPCP and GVaP are producing satellite based global data sets of hydrometeorological variables. The GHP/CSEs have made only limited applications of these data sets to date. CEOP provides an opportunity to enhance the co-operation between the CSE Projects and the other GEWEX Projects concentrating on compiling global data sets of hydrometeorological variables, especially in data sparse regions outside the nominally, *in situ*, data rich, CSE boundaries. Action is on the CSE POCs to establish working arrangements to take advantage of this existing infrastructure to obtain research quality data products needed for CEOP research. The overall objective for this CEOP activity is to contribute to the validation of land surface characteristics data products and apply these data products in the CEOP research activities. The SSG felt this aspect of CEOP had not matured to the point where sufficient details for the co-ordinated usage of satellite data sets had been set forth to warrant endorsement. The SSG called for additional work in this area and asked that updates be forthcoming, by mid-2000 on the detailed plans for the collection, management and application of appropriate satellite data sets in CEOP. A list of relevant space instruments compiled at the Workshop was considered only a first step in planning for the use of satellite data in CEOP.

(iv) Regional Co-ordinated Experiment in the Asian/Australian (A/A) Monsoon Region

A co-ordinated research activity focused on the characteristics of the A/A Monsoon during a common time frame based on inter-project co-operation to understand the mechanisms of the seasonal to interannual variations induced by the pertinent land-atmosphere-ocean interactions and to improve the accuracy of the seasonal predictions has already been strongly recommended. GAME has accepted responsibility to lead an effort, in the CEOP framework, to co-ordinate a focused regional experiment designed to understand and model seasonal to interannual variations of the A/A Monsoon and its influence on changes in water resources. This Coordinated Asian Monsoon Project (CAMP) will be carried out by way of co-ordination of a number of relevant research projects which are already ongoing and planned within this region during the CEOP observations period including efforts in Mongolia, Tibet, the Bay of Bengal, Thailand, the Eastern Indian Ocean, Indonesia and the Western Pacific Ocean. Plans presented at the meeting include the exploitation of data from a number of earth observing system platforms and instruments which will be launched by the end of 2000.

With the exception of the need to reflect a more coherent approach to the use of satellite data in the CEOP Science and Implementation plan, the SSG endorsed the current approach, level of planning and status of implementation of CEOP and commended the work done by the group of experts working within the WCRP/GEWEX framework to make this activity a success.

The SSG acknowledged that work already underway by GAME, in the context of CEOP, would include association with activities being undertaken under the auspices of CLIVAR that are focused on monsoonal circulations in the Asian/Australian region. There was sufficient information provided from the CEOP workshop to also enable the SSG to continue its backing of CEOP in the context of a broad "Inter-WCRP" activity that also encompasses the American monsoons (GCIP, LBA and VAMOS) along with the African monsoons (CATCH). Studies in other regions can also be expected to benefit, including those which address land-area generated climatic anomalies with a particular focus on Arctic and mid-latitude regions (GAME, GCIP, MAGS and BALTEX). A critical aspect of the effort is that it will also consider the degree to which these monsoonal and/or climatic anomaly generation source and sink regions are linked on seasonal through annual and inter-annual scales. Details of contributions to CEOP by each of the CSE's and

the other relevant components of GHP can be found in Appendix "D" of the draft report of the GHP 1999 meeting http://www.wmo.ch/web/wcrp/documents/others/ghp99drft.html.

Review of ISLSCP Role in GHP

ISLSCP Chair noted that work could be done to assist GHP with the WEBS measurement needs. Suggestions included continuous (inter-annual) flux measurements from the Fluxnet towers at several points co-located with the CSE regions could be provided for WEBS. Assistance on development of good characterizations of vegetation cover in the regions can also be (1 km, 0.5^o to 1^o resolutions) would be important. Work on seasonal to inter-annual leaf area index/dynamics can part of the ISLSCP contribution along with a recycling rate product developed through isotopic studies. Measures of shallow convection and turbulence with knowledge of land-surface heterogeneity (local rain) would be other areas of investigation. From the modelling perspective issues of importance would be associated with the use of hi-resolution atmospheric models coupled to the a specific level of complexity of the land-surface scheme and performance of sensitivity studies linked with the stages of vegetation cover characteristics with their contribution to either the energy or water balance of each region at varying time and space scales (i.e. diurnal, seasonal, inter-annual and local, catchment, regional/continental, global). ISLSCP would assist with developing a matrix scheme for these parameters for the WEBS process that would reflect this "partitioning". ISLSCP will want to advance work on the assimilation of the land surface data from the ISLSCP Initiative II data Products as a further contribution to WEBS. In this context the ISCCP has agreed to supply land surface skin temperature data for the ISLSCP Initiative II dataset. Development of This link and coordination between these Projects had been requested by the SSG at its last meeting. The SSG was pleased to learn that this action had been advanced and that the data exchange would take place in support of the ISLSCP effort (Reference Item 6, *ISCCP*, below).

GPCP Contribution to GHP

The Global Precipitation Climatology Project (GPCP) currently produces global precipitation estimates on various time and space scales that can be used in WEBS. The standard product is a monthly mean estimate on a 2.5^o grid, which begins in 1979 and is continuing to be processed up to the present. Experimental products include a 1^o x 1^o daily estimate, which begins in 1997 and will be carried forward from that time. This product is a based only on satellite remote sensing where as the standard (2.5^o) product is based on merging of satellite and gauge data. Also, available in the GPCP data base are the individual components of these products (i.e., both the infrared and microwave satellite data sets and the gauge analyses) with associated error estimates of the observations. The error estimates can help in the WEBS effort by giving a quantitative aspect to the confidence to which the water balances can be closed. All GPCP data sets are available on line with full documentation. The standard approved products are available at WDC-A with a mirror site at the GPCC in Offenbach, Germany. Other experimental data sets are in individual locations, which can be accessed via links from the GPCP web site. The pertinent addresses include the GPCP home page http://orbit-net.nesdis.noaa.gov/arad/gpcp, WDC-A FTP site http://ftp.ncdc.noaa.gov/pub/data/gpcp/version1, mirror site at GPCC ftp://ftp.dwd.de/pub/mirror/data/gpcp/version1. GPCP products that will be readily available during the CEOP time period include 2.5°x 2.5° latitude/longitude monthly mean blended satellite and gauge precipitation analysis, 1°x 1° daily precipitation analysis (satellite only) and gridded gauge analyses. Future plans include development of satellite based regional precipitation data sets at spatial and temporal resolution higher than currently available. Temporal resolution as high as 1 hour and spatial resolution of 0.25° are under consideration. Interaction with the CSE's by way of GHP will include using CSE data sets for validation of remotely sensed precipitation estimates allowing for transfer of rain estimation models to areas outside the CSE's. There is agreement to advance these plans by way of development of a regional component within GPCP. This initiative will be worked through the GPCP Working Group on Data Management and the GPCP Surface Reference Data Center (SRDC) with support from the GPCP Science Advisory Panel. A report on the progress of this action will be provided at the next GHP meeting.

Cryosphere in Climate (CLIC)

In March 1998 the Joint Scientific Committee (JSC) for WCRP established a CLIC Task Group to map out a full CLIC science strategy and define other cryosphere-related scientific and observational programmes for WCRP. The main goals of CLIC are to: improve understanding of the physical processes and feedback through which the cryosphere interacts within the climate system; improve the representation of cryospheric processes in models to reduce uncertainties in simulations of climate and predictions of climate change; assess and quantify the impacts of past and future climatic variability and change on components of the cryosphere and their consequences, particularly for global energy and water budgets, frozen ground conditions, sea level change, and the maintenance of polar sea ice covers; and enhance the observation and monitoring of the cryosphere in support of process studies, model evaluation, and change

detection. A CLIC science and implementation plan will be presented to the JSC-XXI in March 2000 for review. It is anticipated that CLIC will be established as a WCRP component following the JSC meeting. If CLIC is adopted, the ACSYS SSG will become an ACSYS/CLIC SSG and work will begin to be focused on the co-ordination issues between ACSYS and CLIC and on plans and an implementation timetable for key elements of the science strategy. Briefings to national programme managers in the major countries will be undertaken and consideration will be given to the organization of a CLIC International Science Conference to seek national commitments. The SSG recognized this action as an important development in WCRP and noted that agreements of participation that have been established between GEWEX and ACSYS in relevant scientific endeavors that deal primarily with cold regions hydrology, will be reviewed in the context of the objectives and strategy for implementation being considered by CLIC and that where applicable these agreements will be extended and expanded as appropriate.

World Weather Research Programme (WWRP)

The WMO Executive Council at its fiftieth session in June 1998 endorsed a proposal by the Commission for Atmospheric Sciences (CAS) to establish a World Weather Research Programme with its mission to develop improved and cost effective forecasting techniques, with emphasis on high impact weather and to promote their application among WMO members. High impact weather is defined as weather that affects quality of life, is economically disruptive, or is life threatening. High impact weather can occur in forecast ranges from the very short-range to the long-range, up to a season. The objectives of WWRP were stated as to: improve public safety and economic productivity by accelerating research on the prediction of high impact weather; facilitate the integration of weather prediction research advances achieved via relevant national and international programmes; demonstrate improvements in the prediction of weather, with emphasis on high impact events, through the exploitation of advances in scientific understanding, observational network design, data assimilation and modelling techniques, and information systems; encourage the utilization of relevant advances in weather prediction systems to the benefit of all WMO Programmes and all Members; and improve understanding of atmospheric processes of importance to weather forecasting through the organization of focussed research programmes. In the group of projects under development two specific programme areas were identified for potential collaboration between WCRP/GEWEX and WWRP:

(i) a continuation of Fronts and Atlantic Storm Fronts Experiment (FASTEX)-type research to be carried out in the context of The Hemispheric Observing System Research and Predictability Experiment (THORPEX);
(ii) an investigation of warm season rainfall and flooding with China as a preferred test region.

It is important to continue FASTEX-type research (i.e. THORPEX) to reduce analysis errors over oceanic regions and remote continents, where a sparcity of conventional observations and the under-utilization of remote sensing observations persists. Such a programme of research would focus on:

(i) interpretation of existing predictability theory;
(ii) development and testing of data assimilation techniques;
(iii) simulation and validation of sensitivity to advanced remote sensing data in the absence of confirmatory in situ data;
(iv) consideration of a field campaign that would provide confirmatory in situ data in addition to and conjunction with remote sensing data.

The immediate action recommended is to accept the WWRP/WGNE invitation to appoint a GEWEX SSG representative to the WWRP/WGNE ISWG for participation in discussions on further definition of this research. The ISWG will produce a preliminary research proposal by September 2000 for consideration of the WWRP/SSC, WGNE, and GEWEX/SSG.

Special consideration should be given to research associated with continental warm season heavy precipitation and flooding in the lee of steep terrain (cordillera). This work would improve representations and predictions of monsoon-related precipitation, including extreme seasonal episodes, such as those experienced in China in 1998. There is emerging evidence of long coherence times and distances of such precipitation systems. This has been shown in the lee of the Rocky Mountains in the USA where the analysis was performed on examination of WSR-88D weather radar data across the North American (NA) continent. The patterns of precipitation strongly suggest a pronounced remote effect of the NA monsoon across most of the eastern two-thirds of the continent, thereby lending added significance to monsoon precipitation over the region and elsewhere when in the lee of cordillera. Propagation of heavy rainfall areas is often rapid, well in excess of that which can be attributed either to large scale forcing or to "steering level" winds. The time/distance coherence of rainfall patterns suggests an "intrinsic predictability" of rainfall that

exceeds the lifetime of individual convective systems by a factor of several fold. A statistical-dynamical approach to warm season heavy rainfall prediction could evolve from these findings. This is dependent upon research to adequately represent the location, amplitude and organization of antecedent convection, including the rapid propagation regimes observed. Since the WWRP does not yet have a well defined research effort in this area, the recommended course of action is for GEWEX to be represented at the next WWRP/SSC meeting to explore the formation of an *ad hoc* working group, the purpose of which would be to investigate a common basis for an appropriate research initiative in this field.

The SSG agreed to consider co-ordination with WWRP on the recommended research topics. The relevant points of contact in GHP and GMPP/GCSS where this work would be carried out were asked to ensure WWRP representatives are contacted for further discussion on the potential for collaborative activities.

Hydrology for Environment, Life and Policy (HELP)

The HELP initiative is to serve to provide the scientific basis for improved land and water management through a global network of experimental basins. The goal of this effort has been stated to be to deliver social, economic and environmental benefit to stakeholders through sustainable and appropriate use of water by directing hydrological science towards improved integrated catchment management. The core scientific issue for HELP relates to an experimental catchment framework for studying important and locally appropriate hydrological processes. The main areas of scientific research are associated with hydrological variability and change; biophysical processes that control movement of water between different elements of the landscape; hydro-chemical pathways and processes controlling the fate and transport of pollutants; and development and application of global models and remote sensing. HELP's primary objective during its implementation is to establish a global network of experimental hydrological catchments - in a range of bio-climatic zones and socio-economic/cultural activities, with the intent to build on existing networks and develop new scientific knowledge where gaps exist. An initial effort will be expended to select five to ten demonstration drainage basins (10^4 – 10^6 km^2) worldwide. These will be selected with financial support by donors and national sources in regions where it will be possible to address the most critical water policy issues. In the next stage of implementation an additional 100 to 200 catchments of similar dimensions would be selected worldwide. These would be representative of a wider region and would be expected to be nominated by national institutions and financially underpinned at the national level. Some of these catchments may come from the GEWEX CSEs, from work at basin scales being undertaken by CLIVAR in WCRP and from basin scale regions of scientific interest to IGBP , others may build on existing networks such as UNESCO's Flow Regimes of International and Experimental Network Data (FRIEND) activity. Work on these initial stages of implementation are expected to continue until mid-2000.

Interfaces between HELP and WCRP/IGBP programmes will center around two fundamental conditions associated with the basins targeted by HELP: (i) For basins of common interest it is assumed that complimentary work can be defined and carried out, (ii) In basins which only fit the HELP criteria but for which documenting, understanding, and predicting climate variability and change is at least part of the need for improved policy/management/development; contributions of global and regional scientific data, products and expertise from the international science-driven programmes will be sought by HELP by way of direct contacts with these programmes and their sub-projects. These interactions will be built on the perspective that:

(i) HELP seeks to exploit, not duplicate, the basic scientific understanding and data from the science driven programmes to contribute to resolving policy, management, and development issues and

(ii) because HELP will document not just hydrological, but also bio-eco-land-cover and socio-cultural-economic variables for a world wide network of catchments, there is a potential for a validation network to result that would benefit the scientific programmes.

The SSG endorsed the HELP initiative but established the work that GEWEX is doing to improve regional hydrological models and down scaling products and procedures as the most basic practical common scientific element of interest between its self and HELP. The formation of collaborative links with HELP may best be explored by way of a focused workshop specifically designed to address that issue. The SSG Chair has the action to advise the JSC of these considerations and to suggest ways WCRP may address its interactions with the broader hydrological and water resources management communities.

Water Resources Management Community Links

The Chairman of the GEWEX-Scientific Steering Group (SSG) confirmed that the central challenge for the second phase of GEWEX is the exploitation of the new and more diverse measurements of the new Earth Observing System platforms and the application of our improved understanding of regional processes derived from the GEWEX Continental-scale Experiments (CSEs) to the global applications needed to improve climate prediction capabilities. The SSG Chair, also, noted that one of the main initiatives needed by GEWEX to meet this challenge is promoting the participation of the hydrological modeling community and supporting operational environmental services in their efforts to develop improved and more accurate hydrometeorological predictions. The principal responsibility for this outreach will fall on the GEWEX Hydrometeorology Panel (GHP).

To more clearly define the options for improving GEWEX links with the water resources management community a working group was convened at the meeting to address this issue. The water resources links working group recommended that GEWEX, through the GHP, should develop an initiative to improve the integrated predictability of the coupled climate and land hydrologic systems, and to utilize such improved predictability to enhance the benefits of operation of the water resources systems within large continental river basins. This initiative should focus on a small number of large continental river basins, preferably within the CSEs. Each of the target river basins should identify a collaboration with one or more of the global climate forecast centers. The participating centers should, in turn, agree to an experimental program that would include various aspects of retrospective forecast archiving and analysis, in addition to a near-real time (or emulated real-time) element.

A second topic of discussion by this group dealt with the need for GEWEX to exert more influence on land surface hydrologic data needs. There is a need for a new approach toward the role of surface measurements in the face of new technologies, both for remote and surface-based observations. The group noted the potential relevance of the Hydrology, Environment, Life and Policy (HELP) initiative, which is expected to help instrument a set of global river catchments. It is likely, however, that the scale of these catchments will be fairly small, and there is in any event a need to co-ordinate these activities with GEWEX interests like CEOP, and related global flux measurement initiatives like AmeriFlux, EuroFlux, and FluxNet. To address these issues, it was recommended that GEWEX should form a working group on land surface observation, which would serve as the liaison with HELP, but which would also help to facilitate, via appropriate workshops and other means, a plan for global land surface observations relevant to GEWEX programs. This working group would be expected to draw on and co-ordinate GEWEX activities with other related international programs, including HELP, but also IGBP programs like GTOS, GCOS, and relevant national programs.

The working group discussed the relevance of GEWEX programs to climate assessment activities, like IPCC, and the recently completed U.S. National Assessment. Whether, and to what extent, GEWEX should be involved in assuring that recent research advances are integrated into the climate models used in assessment exercises, is a questions that the working group believes should be addressed explicitly by the SSG. Therefore, it was recommended that the SSG should consider how best (if at all) GEWEX programs should interact with international climate assessment activities like IPCC, and resulting policy decisions. In particular, the SSG should determine whether a GEWEX activity to assure better interaction between GEWEX research programs aimed at improving climate model parameterizations, and assessment activities like IPCC, is in order.

The recommendations of this working group are under consideration by the GEWEX SSG and a response to the proposals will be addressed in due course.

6. RADIATION

Cloud Feedback and Forcing

Climate forcing and climate feedback are the two broad science issues of importance in fulfilling the main GRP research goals. The need to identify gaps and reduce the uncertainties associated with these phenomena is critical to making significant progress toward improved climate predictions. The technical issues in understanding these principals and acting on them are framing the strategy GRP plans to use to meet its goals. The plan is to revisit the current set of goals and objectives by means of an assessment study that began in 1999. The purpose is to move away from a two-dimensional, static view of fluxes and their distribution toward a more dynamic three-dimensional paradigm. The strategy for undertaking this work is being developed along two tracks. Integrated observations are being applied from all available sources to define the state of the atmosphere and determine the fluxes. At the same time, efforts are being supported

to improve the appropriate formulations in models (radiative transfer and related parameterizations in process models, enhancement of Cloud Resolving Models and better representations in NWP and GCMs). The integration of the improved models with the best available observations is expected to result in reduction in uncertainties in results to meet the stated goals. The issues associated with this strategy were reflected in actions related to a number of discussion topics. The Observational Based Assessments include:

- TOA flux assessments,
- Surface flux assessments including radiative fluxes (Surface Radiation Budget) and turbulent fluxes (SeaFlux),
- Atmospheric flux assessments including water vapour (GVaP), clouds (ISCCP), precipitation (GPCP), aerosols (GACP) and an overall flux profile assessment , and
- New measurement capabilities/integrated data sets status.

The Model Based Assessments include:

- recent progress and plans for new formulations/parameterizations,
- convergence by way of an expanded intercomparison initiative, namely phase three of the Intercomparison of Radiation Codes used in Climate Models (ICRCCM-III).

The SSG endorsed this approach and concurred with the action accepted by the GRP Chair to work with other members to articulate this strategy in an article for publication in a suitable scientific journal. The article will reflect the integrated scientific framework that has been formulated to understand climate forcing and climate feedback and to specifically quantify the impact of cloud feedback on the climate system as the main scientific theme for GRP. This effort will document the process by which GRP expects to link the current radiation data observational projects with the exploitation of observations expected from the new era of instruments planned for launch during Phase II of GEWEX, and to integrate these observations with improved models to attain the goals specified by GEWEX for GRP. In conjunction with the preparation of this article and to support efforts by the GRP to implement a consistent strategy of assessment and thereby to advance knowledge of radiative feedbacks and responses in the climate system, it was recommended that a workshop on feedbacks in the climate system be organized in 2000. The workshop would be sponsored by WCRP/GEWEX and would be undertaken by GRP in co-ordination with the other main components of GEWEX. The organization of the workshop will especially take into account requirements reflected by CEOP in GHP and by the GEWEX Cloud System Study (GCSS) as part of GMPP. A framework for the this workshop was presented at the meeting and efforts are underway to organize and plan such an event in a timely manner. More details on GRP related activities with a background and purpose statement for the workshop can be found in the draft report of the GRP 1999 session at http://www.wmo.ch/web/wcrp/documents/others/grp-11draftrpt.html.

Ocean Surface Turbulent Fluxes Workshop

As a separate component of the effort toward an improved determination of surface fluxes a study project was initiated by GRP dealing with turbulent fluxes, specifically, ocean surface turbulent fluxes. This activity, was endorsed by the GEWEX SSG at its 1999 session and approval was given to move forward with two Workshops on this topic. Results from the first Workshop are provided in Appendix B of the GRP 1999 meeting report at http://www.wmo.ch/web/wcrp/documents/others/grp-11draftrpt.html. On the basis of the report from the first Workshop the GRP agreed that the second workshop should be held as planned in 2000 and that this initial *ad hoc* effort be considered for full sub-project status under the auspices of GRP. As a result of this action, work is now underway to develop a draft science and implementation plan with milestones and examples of interim products that can be taken forward to the 2000 Workshop. Final comment and further distribution of this plan will be made following a review at the next GRP meeting. The SSG endorsed these plans but reaffirmed its position that GRP continue to undertake this initiative in co-ordination with the WCRP Working Group on Air Sea Fluxes which is working on a detailed study of available surface flux and flux-related data sets. Co-ordination of surface flux research within WCRP will be a point of discussion at the March 2000 JSC meeting. Any further developments on this topic, which may come from those discussions, will be considered by the SSG at its next meeting.

The GEWEX Water Vapour Project (GVaP)

The international base of support for GVaP is being broadened in order to move it beyond its original pilot effort. The GVaP plans have been modified to direct them toward more actual implementation steps. An outline of the steps necessary to reach the next level of maturity for this data set was considered by the SSG. The material, which had been formulated following reviews by the NRC, GEWEX Panel, is under going further national review. The overarching objective is to quantify and understand the role of water vapour in

the meteorological, hydrological, and climatological processes by improving knowledge of its variability, radiative effects, feedbacks, and change due to human activities. Another in a series of GVaP workshops was held in 1999 to synthesize all of the scientific and technical issues necessary to finalize the plans for the next version of the dataset and to prepare it for systematic processing and distribution within an international framework. The SSG agreed that the importance of this work was not in question, but there were concerns that it was still not being sufficiently co-ordinated with other national and international efforts in the field. The need for a more thorough assessment of the approach and linkages to other relevant initiatives, such as SPARC, was recognized. The SSG Chairman, will want the GRP Chair to assist in organizing and moderating such a review at the SSG meeting in 2001.

Baseline Surface Radiation Network (BSRN)

The BSRN project continues to pursue the goal of providing the accurate surface-based routinely observed broadband solar and longwave irradiances from a globally diverse network. In addition, observations of supporting meteorological variables are also acquired. Currently, there are 37 field sites involved with, or under consideration for inclusion in, the network. Thirty-three of those sites are currently producing complete or partial BSRN quality data and 19 of the sites have submitted data to the BSRN archive in Zurich. As a result of concerns voiced at the last SSG meeting that dealt with the lack of compliance to the BSRN standards for timely collection and submittal of the relevant measurements, 6 sites were dropped from program this year because of lack of performance or inadequate progress. An additional 7 sites were placed on a probationary status because the lack of timely completion of obligations to the BSRN program. The central BSRN data archive is Zurich remains a focal point for the collection, archiving, distribution and analysis of BSRN data. The next general BSRN meeting is planned for May 2000. The SSG was pleased to know that, based in part on concerns brought forward by GEWEX at last year's meeting, efforts had been taken to ensure that the highest level of commitment is made and sustained by each participant in the Network and that when these standards are not maintained procedures exist and are applied, which allow appropriate action to be taken to support the underlying principles of BSRN. Status of the data archive is available at http://bsrn.ethz.ch/wrmc/status.html/ or by way of the BSRN Internet home page http://bsrn.ethz.ch/**,** which can also be reached from the GEWEX home page.

In the ensuing discussion, the SSG stated that it supported the SURFRAD initiative and expressed the hope the community would continue to have free and open access to data from this network.

Radiation Code Intercomparisons in Models

Additional model-observation comparisons within the Intercomparison of Radiation Codes used in Climate Models (ICRCCM) framework in both clear-and-cloudy conditions are being planned. Priority will be given to extending the clear-sky comparisons to water vapour conditions more typical of tropical and Arctic conditions. Pleas for the assessment of GRP research foci have motivated a third phase of ICRCCM. As a result of a request at the 1999 SSG meeting, the goals of ICRCCM-III, the Intercomparison of 3-Dimensional Radiation Codes (I3RC), have been drafted for further discussion and review. This work has been motivated by the understanding that: (i) radiative transfer algorithms used in climate models assume that clouds are homogeneous at unresolved scales; (ii) 3-D radiative transfer is complex and assumptions imbedded in different methods need to be tested; (iii) 3-D effects can introduce systematic errors in the estimation of fluxes and heating rates; and (iv) most algorithms introduce fractional cloudiness to deal with 3-D effects, but there are a number of assumptions concerning how fractional cloudiness is used resulting in different methodologies that require testing. The goals of this effort are:

(i) the development of better 3-D computational methods for use in guiding parameterization development;
(ii) a determination of how 1-D codes interpret 1-D descriptions of cloud properties;
(iii) establishment of the range of flux and heating rate estimates from 1-D models when operating on identical cloud descriptions; and
(iv) the testing and development of parameterizations for subgrid-scale variability suitable for use in climate models.

The SSG felt that the motivation and goals set forth for the revival of work in the ICRCCM framework were commendable and encouraged further work of this type in support of efforts by GRP to quantify the uncertainties associated with radiative forcings and feedbacks in the climate system. More information on these efforts can be found at http://climate.gsfc.nasa.gov/I3RC/, http://climate.gsfc.nasa.gov/I3RC/.

Surface Radiation Budget

The Satellite Data Analysis Center (SDAC) at NASA Langley has made significant progress in all areas of the SRB Project in 1998. Preparations are underway to begin processing and archiving a 10+ year surface and top-of-atmosphere (TOA) radiative budget climatology, designated Release 2, (See processing schedule in Table 1, below). Funding levels have been augmented sufficiently to ensure further progress will be accomplished at least up to the end of 2000. A major part of the current strategy is to obtain the assistance of the Langley, Atmosphere Sciences Data Center (ASDC) to provide processing and archival support to the Project. SDAC has also expanded collaboration with ISCCP, the University of Maryland and ECMWF. These initiatives have led to participation in comparative analyses of meteorological parameters with re-analysis values and to development of improved gap filling strategies, validation of surface SW fluxes and implementation of a new background aerosol.

Table 1: Timeline Schedule for GEWEX SRB/TOARB Release 2 production.

1. Delivery and Implementation LW and SW QC	September-November 1999
2. GADS/ERA-15	September 1999-January 2000
3. Process/validate test months	September 1999-March 2000
4. Test month validation	January-May 2000
5. Process test years ’86 and ‘92	March-July 2000
6. Begin processing and archival of Release 2	March 2000-onward

International Satellite Cloud Climatology Project (ISCCP)

ISCCP completed its 16th year of data collection on 30 June 1999. The ISCCP World Wide Web home page can be accessed at URL http://isccp.giss.nasa.gov. Radiances from all operating meteorological satellites, with the exception of INSAT, are being routinely collected by the cognisant Sector Processing Centers (SPC) and delivered to the Global Processing Center (GPC) in accordance with project requirements. Delivery backlogs for NOAA-12/14 continue because of budget shortfalls in support of this work at NOAA. Problems with data format have also delayed deliveries of some GOES-8 and all of the GOES-9 and GOES-10 data. Currently operating satellites are NOAA-14, NOAA-15, GOES-8, GOES-10, GMS-5, METEOSAT-5 and METEOSAT-7. NOAA-15 replaced NOAA-12 in the "morning" position in December 1998, but funding shortfalls have delayed delivery of these data. METEOSAT-5 has been operating over the Indian Ocean since July 1998; plans call for it to continue operating until the end of 2001. If launch of MSG to replace METEOSAT-7 is successful and either METEOSAT-6 or -7 is still healthy, one of these satellites will be moved to replace METOESAT-5. The launch of MTSAT to replace GMS-5 failed; actions are being taken to extend the life of GMS-5.

Processing of new data Stage D1 and D2 data through the end of 1998 should be completed by mid-2000. Once 1998 data are completed, another CDROM of D2 for 1994 –1998 will be issued to compliment the two earlier releases of D2 data for the periods 1983 –1988 and 1989 – 1993 respectively. Work is on going to verify that the new ISCCP products are actually an improvement over the first “C” version. A paper summarizing the differences between the C-series and the D-series datasets and the supporting evidence for accuracy estimates of the ISCCP cloud climatology appeared in the November 1999 issue of the Bulletin of the American Meteorological Society.

Funding shortfalls, which are delaying continuation of the ISCCP dataset must be restored. Work is underway to invite international agencies to renew their commitments to the GEWEX global climatological dataset projects well into the current decade as outlined in Item 3 above. It is not sufficient, however, that only the collection, processing and dissemination of these products be supported but there must be adequate support allow these centres to calibrate, quality check, adapt processing software to changing operational systems, and validate their products. Therefore, the request to agencies will include the need for minimum funding levels to be established which are sufficient to support all of these tasks. The SSG Chair has the action to invite the JSC to join the SSG in recommending the continuation of the current datasets, at this level of support. This action will be carried forward in the context of the recommendations made to the SSG in this regard by the Data Continuation/Utilization working group convened at the meeting (See Item 3 above).

In addition to continuing production of the Stage B3 and D-series datasets through the year 2005, as proposed, some enhancements of the ISCCP products have been investigated based on recommendations made by the WCRP/GEWEX Radiation Panel. These have included development of methods for improved identification of the thinnest cirrus and multi-layered clouds continues through comparisons of ISCCP and other cloud analyses and for the determination of effective particle sizes for both liquid and ice clouds. Although useful results can be obtained from the merger of ISCCP and microwave measurements, these retrievals are limited to open water locations and cannot be done globally; therefore, these analyses will not be implemented as part of ISCCP. In support of GCSS activities, new techniques are being developed for identifying and tracking specific types of cloud systems to allow for lifecycle studies of different dynamical systems and the clouds that they produce in a form that more specifically reveals the processes governing the behavior of clouds. Development is, also, underway of an adaptation of the ISCCP analysis system that can be applied to other satellites at higher resolution for experimental uses: the ISCCP analysis has already been applied to the whole ScaRaB narrowband dataset and work has begun to apply it to the TOGA-COARE dataset from GMS and to VIRS on the TRMM satellite. The importance of a skin temperature climatology for the validation of land-surface schemes was recognized earlier. It was recommended that the impact on the observed variable of sub-grid scale surface variability or shading within the grid-box be studied. To encourage research in this direction and the development of methods for comparing observed skin temperature and the modelled counterpart a request was made for support from ISCCP in the production of such a data set. This request has been acted upon and agreement has been reached to supply land surface skin temperature data for the ISLSCP Initiative 2 data collection activity.

DATA DELIVERED

Stage B3 and BT:	July 83 - April 95	(11.8 years)
Atmospheric data:	July 83 - December 97	(14.5 years)
Sea ice and snow data:	July 83 - December 97	(14.5 years)
Stage C1 and C2:	July 83 - June 91	(8.0 years)
Stage DX, D1and D2:	July 83 - August 94	(11 years)

GEWEX Aerosol Studies

The action plan for developing a GEWEX Global Aerosol Climatology Project (GACP) that utilizes remotely sensed dataset(s) augmented with surface observations and ground validation sites was accepted by the GEWEX-SSG at its 1997 session. Its main objective is to analyze satellite radiance measurements and field observations to infer the global distribution of aerosols, their properties, and their seasonal and interannual variations.

The Global Aerosol Climatology Project (GACP) was established in 1998 to analyze existing satellite radiances, field experiment and surface measurements in order to infer the global distribution of aerosols, their properties, and their seasonal and interannual variations. A science team was also formed through a competitive announcement in 1998, to study the radiative impact of aerosols on climate. Data sets and analyses generated by GACP are used by the science team in studying the radiative impact of aerosols, to improve understanding and to stimulate the development of climate models which include the effects of aerosols. First year progress reports of each of the science team member investigations are available on the web at the following URL: http://gacp.giss.nasa.gov/science_team/

The second meeting of the aerosol science team took place on 29 September through 1 October, 1999, at the NASA Goddard Institute for Space Studies in New York City. Most of the 32 investigations funded by NASA's Radiation Science Program were represented at this meeting. In addition, approximately fifteen US and international team members whose work is supported by other means, participated in the meeting. This second aerosol science team meeting had two primary objectives:

(i) discussion of recently conducted aerosol model inter-comparisons, and
(ii) discussion of the availability and characteristics of data sets to be used in these aerosol studies.

A detailed report of the outcome of this meeting can be found at http://gacp.giss.nasa.gov/meeting/curran_summary.pdf.

In a related matter the first annoucement of an European Workshop “Aviation, Aerosols, Contrails and Cirrus Clouds” (A^2C^2), was made. The scientific premise of the meeting is that aircraft engine emissions cause the formation of small aerosol particles in the upper troposphere and lower stratosphere, which, together with other aerosols, may influence cirrus cloud formation. The meeting will be held near Frankfurt, Germany, from 10-12 July 2000. More information is available from Dr U. Schumann at email: ulrich.schumann@dlr.de.

Global Precipitation Climatology Project (GPCP)

The monthly mean 2.5°x 2.5° time series has been extended through at least July 1999. It is updated approximately every 3 months. A version 2 data set has been created. It consists of an extension of the 2.5°x 2.5° monthly mean data back to 1979, and is globally complete by using TOVS data to fill in the polar regions. Other data sources include an OLR based algorithm. This data set is still under assessment and evaluation. However, it is available to the scientific community at http://rsd.gsfc.nasa.gov/912/gpcp/.

Satellite data are routinely collected at 1°x 1° three hourly daily space/time resolutions. These data are used in both the 2.5°x 2.5° product and in the daily 1°x 1° product. The 1°x 1° product is available for the period January 1997 through April 1999, but is still under evaluation. This data set is composed primarily of geostationary satellite data, and is designed to so that it scales appropriately to the 2.5°x 2.5° monthly mean values. Daily gauge analyses are being developed by the Global Precipitation Climatology Center (GPCC), at Offenbach, Germany and they will be incorporated into the one degree analysis as they become available. A GPCP data users workshop was held in 1999. For reference, the report of the workshop was published in the August 1999 issue of the GEWEX News.

The main GPCP datasets can be accessed by way of the following links:

The complete GPCP Data Set from July 1987 up to the present;

Data sets: WDCA ftp://ftp.ncdc.noaa.gov/pub/data/gpcp/version1/
Mirror site in Europe: ftp://ftp.dwd.de/pub/mirror/data/gpcp/version1

The complete gauge data sets from January 1986 up to the present;

NCDC USA: ftp://ftp.ncdc.noaa.gov/pub/data/gpcp/gpcc/
Europe (mirror site see above): ftp://ftp.dwd.de/pub/mirror/data/gpcp/gpcc/
Global Precipitation Climatology Center's Web page: http://www.dwd.de/research/gpcc/

The developmental data sets:

ftp://ftp.ncdc.noaa.gov/pub/data/gpcp/
http://rsd.gsfc.nasa.gov/912/gpcp/

GPCP data on CD-ROM media is available by request through the JPS for WCRP or by way of the International GEWEX Project Office at email: gewex@cais.com

Atmospheric Radiation Measurement (ARM) Program

The Atmospheric Radiation Measurement (ARM) Program, sponsored by the US Department of Energy, currently maintains four ground-based remote sensing facilities. These four facilities are located in Oklahoma (USA), the North Slope of Alaska (USA), Manus Island (Papua New Guinea), and the Republic of Nauru. The instrumentation operated by the ARM program at each of these sites includes a broad suite of solar and thermal infrared radiometers, a microwave radiometer, a millimeter-wavelength (35 GHz) radar and a micropulse lidar (MPL). The Oklahoma site instrumentation includes a Raman lidar system as well. Radar, MPL, and Raman lidar profiles are obtained at high temporal and vertical resolution. Data from all instruments are collected routinely and are available through the ARM archive to interested scientists.

ARM has a significant interaction with a number of GEWEX programs, some of which rely heavily on ARM data and related resources. The Oklahoma site served as one of the most important measurement facilities for radiative fluxes, surface energy budget, and water vapor profiles during GCIP. ARM also supported research studies as a component of GCIP comparing output from regional models to measurement time series. ARM is a key component of GVaP and is leading the development of baseline water vapor measurement standards based on the ARM program experience. The Oklahoma site has been a

consistent contributor to the BSRN database since the site opened in 1994. The remote sites are already taking BSRN-level measurements and will be submitting that data to the archive on a regular basis this calendar year. Radar measurements at the Oklahoma site have provided a critical source of information for the design and evaluation of algorithms for CloudSat. The ARM program actively supports this use of ARM data by GEWEX programs. Scientists at the ESA, NASDA and other agencies and institutions who are interested in the use of these data for design studies of satellite instruments and related applications were encouraged to request them by way of the GEWEX Radiation Panel connections to ARM or directly from ARM sources. The ARM web site is at http://www.arm.gov/docs/about/toc.html. The ARM program intends to operate these four sites for at least a decade. Both radar and lidar data from the ARM sites will be used to provide validation of retrieved products from satellite based radar and lidar systems such as those planned to be aboard the NASA ESSP, CloudSat and PICASSO-CENA missions and other planned cloud/radiation missions that may take place later in the decade. The ARM program management views this validation research as highly desirable and will actively seek to support any additional data processing that may be required to expedite these comparisons.

The GEWEX SSG recognized that the ground-based facilities of the USA DOE ARM program are unique resources. They represent the only continuously operating collection sites of simultaneous millimeter-wavelength radar and lidar data. These data sets are extremely useful for scientific understanding of cloud variability on seasonal and interannual timescales. As such they are rich data sources for the design of spaceborne cloud profiling radars and lidars. Equally importantly, when spaceborne instruments are flown, the ARM sites can serve as core validation locations for cloud and aerosol properties retrieved from space. The SSG strongly endorses the continued operation of these sites with their complete suite of instrumentation at least through the lifetime of the currently proposed cloud/radiation satellite missions. Furthermore, the GEWEX SSG recommended that the ARM program and their related observing sites be integrated more formally into the structure of the GEWEX programs. The data collected at these highly-instrumented surface sites, along with the data analysis and research sponsored through the ARM program, provides a unique resource to characterize the atmospheric state and quantify the physical processes that determine that state. This in turn is leading to better understanding of the global products that are an important element of the overall GEWEX scientific strategy. These include surface radiation budget terms (SRB), cloud occurrence and cloud properties (ISCCP), water vapor (GVaP), aerosol properties (GACP), and hydrologic cycles (GCIP, etc.). Integration of the spatial climatologies, largely derived from satellites, with temporal climatologies, largely derived from ground based observations, promises to provide a better understanding of global energy and water cycles. GEWEX, therefore, fosters and encourages this integration.

7. GEWEX MODELLING AND PREDICTION

The CAS/JSC Working Group on Numerical Experimentation (WGNE) and the GEWEX Modelling and Prediction Panel (GMPP) met jointly in October 1999 (see also JSC-XXI/Doc. 7).

GCSS and Cloud/Radiation Parameterization Main Objective and Current Framework

The objective of GCSS remains the development of refined parameterizations of cloud systems within GCMs (climate and numerical weather prediction models) through the improvement of the understanding of the coupled physical processes within different types of cloud systems. The GEWEX Scientific Steering Group (SSG) has continued to endorse GCSS because the Cloud Resolving Models (CRMs) and Single Column Models (SCMs) being exploited by GCSS, are the scientific link between cloud process studies and GCM's. The Group is focused on improving these models by applying specialized computing techniques/resources which have recently become available, with better validation datasets. Each one of the five working groups associated with analyses of boundary layer, cirrus, extra-tropical layer, precipitating convective, and polar cloud types respectively has been making progress in mobilizing the CRM community to provide observational/model datasets for many phenomena/processes of importance to GCM development. The GCSS strategy considers that the two main issues in studying the effects of cloud systems are coupling and scales. Rather than try to isolate the individual processes and study them separately, GCSS has undertaken to apply SCMs, CRMs and mesoscale models to study the processes as a coupled system giving rise to phenomena spanning a broader range of scales than any individual process. The models required are being developed and validated in the GCSS using observations from regional field experiments. These models are being used as experimental testbeds to develop improved understanding of the processes and to provide realizations of cloud systems (4-Dimensional datasets). These in turn are used to derive and evaluate parameterization schemes for the large-scale models.

GCSS Science and Implementation Plan Revision

In response to a recommendation from the joint ECMWF and WCRP/GCSS Workshop (9-13 November 1998, at ECMWF in the UK), the GCSS Chair has organized a drafting team and is acting as lead editor in the production of a new version of the Plan. A draft of this plan was provided at the meeting. The outline and main points to be addressed in the plan were reviewed and endorsed.

Significant departures from the original GCSS Science and Implementation plan were noted to include the specific identification of data integration as a separate component of GCSS. Recognition of the importance of this activity will be noted in the new plan and the formerly "ad hoc" Data Integration for Model Evaluation (DIME) effort will be formally identified as a response to the need for this work in GCSS. A paragraph has been added to the new Plan, which identifies a specific GCSS strategy for dealing with cloud process modelling issues. A statement has been incorporated in to the Plan, which stipulates the substantive scientific basis for GCSS to contribute to the resolution of the main technical questions associated with an improved understanding of cloud/radiative feedbacks in the climate system. GCSS will have a specific role to play in any effort to address cloud feedbacks in climate including a major contribution to the planned Workshop on Feedbacks in the Climate System being planned by GRP in 2000 (See Item 6, Cloud Forcing and Feedback, above). The Plan will discuss the rationale for maintaining the goal in GCSS to certify CRM's as tools for providing a substitute for certain types of data under certain conditions.

The intent is to publish the Plan by mid-2000 and then to use its main elements to develop an article on GCSS for publication in the Bulletin of the American Meteorological Society (BAMS), or an equivalent publication, providing the past results and future thrust of GCSS.

GCSS Working Group 4/Precipitating convectively-driven cloud systems Report (Chair: Dr S. Krueger)

The SSG was pleased to hear some additional details of the work being done in GCSS. An important question for this group is how to better represent ice-phase microphysical processes in a cloud system model. Another is how to more realistically simulate the convection initiation process over land. Deep convective cloud systems are extremely active over large portions of the tropics and also over the summer continents in the northern hemisphere. These clouds produce very strong shortwave and longwave cloud forcing, and vigorous precipitation. In addition they transport energy and moisture through the depth of the troposphere and even across the tropopause. The goal of GCSS WG4 is to improve the parameterization of precipitating convective cloud systems in GCMs through an improved physical understanding of cloud system processes.

The convection and cloud schemes used by ECMWF have been revised in light of diagnostics from a 3D CSM simulation of the WG4 Case 1 squall line (Guichard and Gregory 1999, Gregory and Guichard 1999). The revised scheme exhibits a better partitioning of the surface precipitation between convective and large-scale (or "stratiform") precipitation. The scheme was tested in SCM simulations of WG4 Case 2 convection. The results suggest that the revisions based upon Case 1 are valid over a wider range of convective situations. The new schemes are being tested in the ECMWF model. Early results suggest improved tropical precipitation patterns in seasonal simulations.

GCSS WG4 has made major contributions to the analysis of the multi-scale convection which was observed during TOGA COARE. The scientific objectives of TOGA COARE call for an improved understanding of the large-scale effects of tropical convection and its interaction with the ocean, while the main objective of GCSS is to improve the parameterization of cloud systems in large-scale models. In view of this scientific overlap, GCSS WG4 undertook cloud system studies consistent with COARE objectives. A number of key findings by members of GCSS Working Group 4 in selected areas of mutual relevance to COARE, GCSS and the cloud-climate community at large, were summarized.

A WG4 continental deep convection case is being developed. This case will be drawn from data taken at the ARM Southern Great Plains experimental site during July 1997 (Leaders: Steve Krueger and Kuan-Man Xu). Specialized instrumentation including a millimeter cloud radar (MMCR) and an extensive array of other meteorological instruments were operational at that time. This case will be done in collaboration with the ARM Single Column Modelling Group as a means of involving more of the SCM community to participate in the process and to gain support of the ARM Data and Science Integration Team (DIST) in the provision of forcing data and the compilation of results submitted by the modelling groups. DIME will asked to lend expertise and resources to develop the necessary data sets and, in addition, to format them for other studies. More information about WG4 activities is available at http://www.met.utah.edu/skrueger/gcss/wg4.html.

Land Surface Parameterization-AGCM Coupling Project

The SSG endorsed the action to highlight the Land Surface Parameterization-AGCM Coupling Project as the focus for the next phase of work in this field for GEWEX. The SSG has concluded over the last three years, that the role of the land-surface in the climatic system can not be limited to the water cycle and that as a consequence more physical processes need to be represented in the schemes. It has also become evident that land-surface processes lie at the intersection of a number of geophysical and biological disciplines and that the next generation of models should be the result of multidisciplinary collaborations. During this time, actions given to the GMPP Land Surface Parameterization-AGCM Coupling Project have caused the evolution toward a second generation of complex land-surface schemes to crystallize during three workshops. The first one was held in La Jolla, California, USA (February 1997) and was aimed at reviewing our knowledge on the land-surface processes which interact with the climatic system, and our ability to model them. This workshop was jointly organized by GEWEX and BAHC/IGBP. The second one was organized by ECMWF and GEWEX in Reading, UK (July 1998) and was a call from the numerical weather prediction community to the land-surface modelers for advice on the future developments which would help better monitor and forecast surface and near surface conditions. The last workshop was organized by GEWEX and INSU in Gif-sur-Yvette, France (October 1999) on modelling land-surface atmosphere interactions and their role in climate change and variability. There was full agreement that more traditional land-surface processes such as soil freezing are going to evolve and bring new prognostic variables to LSSs, but none is going to be as far reaching as the “greening” of the LSSs. The first generation of complex LSS was characterized by a highly detailed representation of the vertical processes and very simple assumptions on the horizontal variability. In the La Jolla and Reading workshops it was concluded that the next generation of LSSs will increase their horizontal complexity by including a representation of the sub-grid variability of surface properties. The workshops gave complementary reasons for the need to reduce the complexity imbalance between the vertical and the horizontal structures. The surface hydrology was considered to be the main cause of this evolution in the first workshop.

At the Gif-sur-Yvette workshop, it was agreed that the challenge to support the development of the second generation of complex schemes, as discussed in all three workshops, needs to be addressed by way of a new and responsive structure made up of complementary elements. The greening of the LSSs will require international inter-comparisons to validate the new developments and help the teams that wish to include these features in their LSS. An experimental framework like the one of the Project for Intercomparing Land-surface Parameterization Schemes (PILPS) phase 2 will be necessary. The type of exercises undertaken in the Global Soil Wetness Project (GSWP), which can be administered in association with ISLSCP, will also enable the community to compare the new schemes at the global scale and identify the critical regions in which the lack of knowledge and data lead to a divergence of results. Data is available for a few regions of the world that will help to bridge the gap from the point validation scale to the global GSWP exercises which can be run at a 1°x 1° resolution. The structure proposed at the Gif-sur-Yvette workshop was presented in the context of a Global Land/Atmosphere System Study (GLASS) that contains point validation type activities, with GSWP-like initiatives, paired with a data assimilation function and a coupled action element. The actions described in each area will emphasize off-line (un-coupled) versus on-line (coupled) modelling with local (point, plot, catchment) versus large (continental and global) spatial scales. To assist the participants with the analyses, the organization also includes an infrastructure project which will co-ordinate logistics for the entire set of activities.

GLASS was endorsed by the SSG and action was given to finalize the Science and Implementation Plan by mid-2000 and to hold an advisory team meeting, made up of the points of contact for each element of the Study plus other interested researchers, by the end of 2000 and to report progress on all aspects of GLASS at the 2001 session of the SSG. The endorsement for GLASS was provided with the understanding that this element of GEWEX would be carried out in close association with ISLSCP and other relevant national and international initiatives such as BAHC, for which GLASS will be suited to co-ordinate the model intercomparisons BAHC wishes to perform.

In keeping with the general call for “inter” GEWEX co-operation the SSG requested that both the cloud (GCSS) and land (GLASS) components of GMPP in their efforts to work in association with WGNE also ensure that they develop specific plans for studies to be carried out in concert with GHP and GRP, which more fully exploit the integrative role of cloud system models in the analysis and understanding of observations. The GMPP Chair should report actions taken in this regard to the SSG at its meeting in 2001.

The International Pacific Research Center (IPRC)

The IPRC mission statement provides for an international, state-of-the-art research environment to improve understanding of the nature and predictability of climate variability in the Asia-Pacific sector,

including regional aspects of global environmental change. Given this framework, IPRC may provide important links to the modelling and prediction component of GEWEX. The IPRC science themes focus on the Indo-Pacific ocean climate, regional-ocean influences, the Asian-Australian Monsoon system and impacts of global environmental change. To achieve its mission, IPRC has adopted a research strategy, which emphasizes numerical modelling and diagnostic studies, rather than observational elements. More observational emphasis is, however, under consideration and may provide for additional links to GEWEX data initiatives particularly those being undertaken in GHP as part of the CEOP/CAMP studies (see Item 5, *Further Development of CEOP* (iv), above). The Asian-Australian Monsoon theme has as it main goal to understand the processes responsible for climatic variability and predictability of the Monsoon and its hydrological cycle at intraseasonal through interdecadal time scales. Work in 1999 has focused on developing and improving numerical simulation of the Asian-Australian (A-A) Monsoon using general circulation and regional climate models and developing and improving a hydrological model. Data analyses have included the study of the interaction between monsoon seasonal cycle and active and break periods and the study of the influence of oceanic mixed layer on Sea-Surface Temperature (SST) and A-A Monsoon variability. This work, which has led to specific monsoon indices (Wang and Fan 1999) may provide connections to the GEWEX CEOP and monsoon teleconnection thrusts. Because of the possible synergy between IPRC studies and GEWEX the SSG will want to remain aware of the status of the Centre at future meetings.

Connections to NWP Centres and other Relevant Developments in Modelling

A report was provided which emphasized recent improvements, use of new data and potential links between DAO and GEWEX. The DAO's primary product is global analysis, focusing on the accurate 4-Dimensional representation of the Earth system. Its mission includes assimilation of data types that cannot be a part of the operational data system or have little impact on NWP. DAO products are validated as much by climate datasets as forecast skills and include an extensive user-driven list of diagnostics for process studies. The science driven issues considered by DAO include the:

(i) role of cloud/precipitation processes in weather and climate especially rainfall and cloud modeling/assimilation;
(ii) role of land hydrology in weather and climate especially land surface modeling and assimilation;
(iii) role of atmospheric-ocean interaction associated with winds and surface fluxes;
(iv) quality of data in specific science applications such as global water and energy balance, weather and climate predictability, climate sensitivity, mechanism of low-frequency variability (ENSO, MJO, monsoons, PNA, NAO, AO); stratospheric/tropospheric chemistry; and global biological/carbon cycle.

Links with GEWEX include the use of GEWEX datasets for validation of DAO products; modeling, analysis and prediction of global water and energy cycles especially associated with the DAO NASA-TRMM reanalysis initiative and improving the understanding of interactions of the atmosphere and surface processes as highlighted in work on land-surface modeling and assimilation and the impact of land-surface parameters on seasonal forecast and assimilation of surface wind data. An agreement of participation between GEWEX and DAO is being developed that provides for DAO to perform impact studies by way of observing system simulation experiments (OSSEs) and real data impact studies. The SSG will want to continue to review these interactions.

National Center for Environmental Prediction (NCEP) interactions with GEWEX panels and sub-project groups have included active participation by NCEP in GCIP, PILPS, ISLSCP/GSWP, GCSS and GRP/ARM. A specific, recent outcome of NCEP involvement in GCIP efforts in land surface modeling has been development of a community land-surface model, named the NOAH model. NCEP is spearheading a GCIP-sponsored initiative/demonstration of a real-time, hourly, national (U.S. domain), one-eighth degree, year-round, uncoupled, Land Data Assimilation System (LDAS). This work is a major multi-agency collaboration with the NWS Office of Hydrology, NASA/GSFC, NESDIS/ORA, and four universities (the University of Washington, the University of Maryland, Princeton University, and Rutgers University). Another relevant development related to the interaction between GEWEX and NCEP is GCIP sponsorship of a 20-25 year, 30km, Regional Reanalysis over USA domain (GCIP) using the NCEP Eta Model Data Assimilation System (EDAS). The main feature of this regional reanalysis is hourly, 4km, precipitation assimilation (gauge/radar). The result of interactions with GCSS resulted in a "fellowship" initiative whereby at least one visiting scientist has spent time at NCEP on research related to the application of GCSS results. Development of an NCEP Single Column Model (SCM) is a specific product of this relationship. NCEP has recently established a formal atmospheric 4DDA collaboration with NASA/DAO and NESDIS/ORA ten to twelve teams have been identified, each focussing on a 4DDA observation source target of opportunity, the

majority involving satellite data sources. In developments that may have an impact on other WCRP research initiatives, it was noted that within the context of NCEP's Medium Range Ensemble Prediction System, using the formalism of Selective Vector Decomposition (SVD), upstream oceanic regions are identified where aircraft dropsonde observations will improve downstream continental forecasts. Three winter experiments ('98, '99, '00) have been carried out testing impact of augmented oceanic dropsondes on medium-range forecasts. One source of information related to NCEP can be found at http://www.cpc.ncep.noaa.gov/.

The connection between GEWEX and the major modelling centres has been especially synergistic in the area of the major reanalysis projects being undertaken by these centres. GEWEX data projects have played an essential validation role in these efforts and the reanalysis projects have, in turn, provided for systematic prediction studies on seasonal forecasting. The SSG was pleased to hear that the European Centre for Medium Range Weather Forecasts (ECMWF) 40 year reanalysis (ERA-40) project had been funded and was plans were in place to begin the processing in the second quarter of 2000. Production is expected to be completed in a two year period. Many of the model and assimilation developments that will be used in the ERA-40 have benefited from the continued relationship with WCRP/GEWEX and application of results that have accrued from the methodology GEWEX has used in the development of improved parameterizations. In a specific case, development work on a revised deep convection scheme where initially stimulated, in part, by results of a GCSS Working Group 4 intercomparison project. The updraught vertical velocity calculation was improved by the introduction of a vertical pressure gradient term into the processing scheme. The convection microphysics were returned and the initiation of downdraughts changed to allow them to occur more frequently. In a similar fashion ECMWF is contributing to GEWEX related activities in very specific ways including carrying out intercomparison simulations with the Single Column Model (SCM) and assisting with diagnostic studies for test cases being performed as part of GCSS Working Groups 2 and 3. One of the preliminary results from this work is that the SCMs extratropical clouds are less frequent than observed but are too thick when present. It was recognized that these results have been brought about by way of an active interdisciplinary dialogue and exchange of information and concepts between the field experimenters and remote sensing communities, the operational and climate modelling centres (ECMWF, NCEP, DAO, JMA and others) and the large-eddy-simulation and single column modelling/cloud resolving modelling communities.

In the ensuing discussion, it was noted that significant advances in computing technology, particularly efficient processing techniques that have been developed to run on massively parallel processing systems. The basic element of importance to the work WCRP/GEWEX is promoting will be runs which look ahead one-hundred years, with one-hundred member ensembles at resolutions below 60km. With the systems now under development around the globe, such as the Earth Simulator being developed in Japan, it is expected that by the start of 2002, thirty such runs could be made per year. These initial results will be with basic model physics and more work will be required to add more complex formulations associated with atmospheric chemistry and land and ocean surface characteristics. Although the SSG welcomed these improvements, concerns were expressed about the need for quantitative expression of how these results can be analyzed and responsibility applied toward the resolution of existing issues in climate system research. It was felt that some of these concerns are already being addressed through the development of improved statistical techniques that are being advanced in parallel with the changes in hardware systems and coding schemes. These techniques are expected to go a long way toward providing the large amounts of computational results in formats that can be analyzed and applied within existing research structures such as the WCRP/GEWEX framework and other national and international organizations. The SSG agreed to consider these developments more closely in subsequent meetings and especially to begin considering what the implications are of reduced resolution products on the methods and procedures that are currently used in describing the physical processes of the climate system and subsequently in developing the associated physical parameterization for use in these high resolution global models. There is an additional need to address these issues in the broader WCRP context.

Real-time access to data from GEWEX field studies/regional experiments

GEWEX field studies and related regional experiments play a major role in stimulating advances in instrumentation, improving modelling techniques and stimulating new results in the broader climate research domain. The SSG, however, reaffirmed its position that action continue to be taken to ensure that the planning of regional experiments include a strategy for ensuring that the different observational data measurements associated with each experiment are made compatible with and are "placed" on the World Meteorological Organization's Global Telecommunications System (GTS) for access in (near) real-time by the major modelling and analysis centres. This is especially true of the upcoming CEOP initiative. In this context, the SSG asked the GHP Chair to act on suggestion to form a direct connection between the major processing centres whereby, ensemble forecasts can be provided for the CSE large river basin areas in conjunction with efforts to place as much data as possible on the GTS for use in the production of such

forecasts. The SSG will want to be informed when this connection has been made. An initial contact should be established, as soon as possible, between ECMWF and the GHP/CEOP Data Management Team, which is made up of points of contact from each CSE that have the expertise to undertake and report results of analyses associated with these forecasts.

APPENDIX A

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APPENDIX B

SUMMARY OF MAIN DISCUSSIONS, ACTIONS AND RECOMMENDATIONS FROM THE GEWEX SCIENTIFIC STEERING GROUP (SSG) MEETING (31 JANUARY – 4 FEBRUARY 2000, HONOLULU, HAWAII, USA)

The following items have been taken from the full report of the Twelfth Session of the GEWEX SSG, which took place at the East-West Conference Center, at the Campus of the University of Hawaii, in Honolulu, Hawaii, USA from 31 January to 4 February 2000. The meeting was hosted by the International Pacific Research Center (IPRC). The topics are presented in a summary presentation format and are keyed to the various sections of the report where more detail is available.

7. GEWEX GLOBAL OBSERVATION SCIENTIFIC REQUIREMENTS (See Report Item 2.)

GEWEX has taken responsibility for consolidating WCRP global climatological data projects based on merging satellite data with current atmospheric and (land/ocean) surface measurements. In this context the SSG acknowledged the responses from space agencies toward addressing a set of scientific issues of greatest relevance to GEWEX including:

- All flux components of a Precision Atmospheric Radiation Transfer Scheme
- Specific quantitative knowledge of Cloud Microphysical Properties and Dynamics
- Constituents of the Ageostrophic Atmospheric Circulation
- Soil moisture and other parameters that could come from a focused Land-Surface Mission

This set of measurements incorporates the parameters expressed earlier by WCRP/GEWEX which specifically identified global 3-dimensional distribution of clouds, radiation and aerosols; global soil moisture (upper 5-10cm); and global 3-dimensional distribution of tropospheric wind as being of importance to GEWEX but which up to now were notably missing from prevailing earth observation plans.

7. GEWEX GLOBAL OBSERVATION SCIENTIFIC REQUIREMENTS (See Report Item 2.)

The SSG concluded that the operational satellites together with the missions currently planned by NASA, ESA, NASDA and other national and international agencies, as presented at the meeting, will, therefore, provide the framework for the main thrust of the third phase of GEWEX and, simultaneously, will nearly fulfil the main requirements of WCRP as a whole.

TRMM is providing unprecedented coverage of the horizontal and vertical structure of tropical rain systems and these data are already being exploited as a valuable resource for parameterization and assimilation studies. The SSG emphasized the importance of continuity of these measurements and called for a review of precipitation measurement missions to be carried out at its next session, this review is to examine the potential for a TRMM follow-on mission and other synergistic proposals such as the Global Precipitation Mission.

7. GEWEX GLOBAL OBSERVATION SCIENTIFIC REQUIREMENTS (See Report Item 2.)

The Chair of the SSG will report on the success GEWEX has had representing WCRP interests to the main space agencies. He will also, open discussions, at the Joint Scientific Committee (JSC) for WCRP March 2000 meeting, to consider steps that may be necessary to ensure WCRP more fully engages other agencies and institutions around the globe. It is important that all possibilities are considered which can influence not only space missions but the development of all types of observing and computational networks and systems that can support the advancement of relevant WCRP research.

7. MANAGEMENT OF GEWEX GLOBAL PRODUCTS AND PLANS FOR EXPLOITATION OF NEW DATA (See Report Item 3.)

Issues related to data continuity and utilization led to:

7. The SSG tasking the chairs of the main GEWEX Panels (GHP, GRP and GMPP) to derive a minimum set of observations required to close the global water and energy cycles and to conclude the state of the availability of this set of measurements (past and future).

7. A statement that research funding sources, operational services and space agencies must continue adequate support of the GEWEX global data projects and that they provide additional funding to enable the evaluation of the existing datasets against new satellite and ground-based observing system results.

7. Recognition of the fact that success of WCRP research programs requires a long series of comprehensive observations with an integrated analysis of the datasets leading to the conclusion that since current plans for the satellite and surface observing systems do not dictate a change of analysis schemes in the near future, ISCCP and the other GEWEX data projects should continue for at least another five years (through 2005).

7. A request to agencies for a renewal of their commitments to the WCRP/GEWEX global data projects that includes the need for minimum funding levels to be established which are sufficient to support the participating GEWEX International data centres not only for the collection, analysis and dissemination of their data products, but also the calibration, quality checking, adaption of processing software to changing operational systems, and validation of their products. The SSG Chair will as the JSC to join the SSG in recommending the continuation, of the current datasets, at this level of support.

7. THE GEWEX HYDROMETEOROLOGY PANEL (GHP) STATUS (See Report Item 5.)

GHP continues to coordinate work in five multi-disciplinary Continental-Scale Experiments (CSEs) which include:

- GEWEX Continental-Scale International Project (GCIP)
- The Baltic Sea Experiment (BALTEX),
- The Mackenzie River Basin GEWEX study in Canada (MAGS),
- The Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) and
- The GEWEX Asian Monsoon Experiment (GAME).

Plans for a Continental Scale Affiliate Experiment (CSA) experiment to study the Coupling of the Tropical Atmosphere and Hydrological Cycle (CATCH) in West Africa have also been advanced.

7. THE GEWEX HYDROMETEOROLOGY PANEL (GHP) STATUS (See Report Item 5.)

Co-ordinated Enhanced Observations

GHP is continuing the development of plans for the five GEWEX CSE's to participate in a Co-ordinated Enhanced Observing Period (CEOP). The emphasis is now being placed on:

- More clearly articulating strategies for the use of satellite data,

- The distribution of as much data as possible by way of the Global Telecommunications System (GTS),

- Management and collection of results into a single unique dataset on appropriate media (i.e. CD-ROM), and

- Execution of activities that could be undertaken jointly with other elements of WCRP (e.g. CLIVAR, CLIC).

7. THE GEWEX HYDROMETEOROLOGY PANEL (GHP) STATUS (See Report Item 5.)

Water and Energy Balance Studies

A Water and Energy Balance Study (WEBS) is being developed by GHP to meet the goal of closing the water and energy balance for each of the CSEs. Points that need to be considered in WEBS are:

(i) High temporal resolution data that resolve important processes are essential for accurately resolving the water budget.
(ii) The domain over which a budget can be resolved is sensitive to the spatial resolution of the sampling.
(iii) Although it is a difficult standard to establish, runoff appears to be a valuable independent variable for testing closure.
(iv) High resolution models in 4-DDA mode, plus data inputs provide the best products for atmospheric budgets.
(v) "Tuning" and "nudging" techniques limit the utility of models in budget studies.
(vi) Process research (on precipitation and cloud processes; soil moisture/runoff generation processes, etc.) are needed to improve the ability to model water and energy budgets.

A second WEBS workshop will be organized for one and half days (11-12 September 2000) in conjunction with the regular GHP business meeting to be held for three and a half days from 12-15 September 2000.

8. THE GEWEX HYDROMETEOROLOGY PANEL (GHP) STATUS (See Report Item 5.)

Connections to Water Resources Agencies

A Water Resources Applications Initiative is underway within GHP with the premise that the GHP, should develop an initiative to improve the integrated predictability of the coupled climate and land hydrologic systems, and to utilize such improved predictability to enhance the benefits of operation of the water resources systems within large continental river basins.

In this context, the potential relevance of the Hydrology, Environment, Life and Policy (HELP) initiative was noted. It was recommended that GEWEX should form a working group on land surface observation, which would serve as the liaison with HELP, but which would also help to facilitate, via appropriate workshops and other means, a plan for global land surface observations relevant to GEWEX programs and related to other programs such as those in IGBP.

The SSG will determine whether a GEWEX activity to assure better interaction between GEWEX research programs aimed at improving climate model parameterizations, and assessment activities like IPCC, is in order.

9. GEWEX RADIATION PANEL (GRP) STATUS (See Report Item 6.)

A workshop and a journal article are planned to synthesize progress associated with both the observational and model based assessments being undertaken within the GRP sub-projects. These activities will reflect the integrated scientific framework that has been formulated to understand climate forcing and climate feedback and to specifically quantify the impact of cloud feedback on the climate system as the main scientific theme for GRP.

10. GEWEX RADIATION PANEL (GRP) STATUS (See Report Item 6.)

Ocean Surface Turbulent Fluxes

Activity related to developing methodologies to retrieve Ocean Surface Turbulent Fluxes from satellite data, was endorsed by the GEWEX SSG at its 1999 session and approval was given to move forward with two Workshops on this topic. On the basis of the report from the first Workshop the SSG agreed that the second workshop be held as planned in 2000 and that this initial *ad hoc* effort be considered for full sub-project status under the auspices of GRP. This initiative will be carried out in co-ordination with the

WCRP Working Group on Air Sea Fluxes. Co-ordination of surface flux research within WCRP will be a point of discussion at the JSC meeting.

11. GEWEX RADIATION PANEL (GRP) (See Report Item 6.)

GEWEX Water Vapor Climatology Project (GVaP)

The SSG agreed that the importance of the work to develop a GEWEX Water Vapor Climatology dataset, was not in question, but there were concerns that it was still not being sufficiently co-ordinated with other national and international efforts in the field. The need for a more thorough assessment of the approach and linkages to other relevant initiatives, such as SPARC, was recognized. The SSG Chairman, asked the GRP Chair to assist in organizing and moderating a review of this aspect of GVaP at the SSG meeting in 2001. The SSG Chair will inform the JSC of the status of this effort and the decision by the SSG to review the overall effort at its next meeting.

12. GEWEX RADIATION PANEL (GRP) (See Report Item 6.)

Intercomparison of Radiation Codes

Additional model-observation comparisons within the Intercomparison of Radiation Codes used in Climate Models (ICRCCM) framework in both clear-and-cloudy conditions are being planned. The SSG felt that the motivation and goals set forth for the revival of work in the ICRCCM framework were commendable and encouraged further work of this type in support of efforts by GRP to quantify the uncertainties associated with radiative forcings and feedbacks in the climate system.

13. GEWEX RADIATION PANEL (GRP) (See Report Item 6.)

GEWEX Climatological Dataset Projects

Funding shortfalls, which are delaying continuation of the ISCCP dataset must be restored. Work is underway to invite international agencies to renew their commitments to the GEWEX global climatological dataset projects well into the current decade. It is not sufficient, however, that only the collection, processing and dissemination of these products be supported but there must be adequate support to allow these centres to calibrate, quality check, adapt processing software to changing operational systems, and validate their products. Therefore, the request to agencies will include the need for minimum funding levels to be established which are sufficient to support all of these tasks. The JSC will be asked to join the SSG in recommending the continuation, of the current datasets, at this level of support.

14. GEWEX RADIATION PANEL (GRP) (See Report Item 6.)

Atmospheric Radiation Measurement (ARM) Program

The GEWEX SSG recognized that the ground-based facilities of the USA DOE ARM program are unique resources. The SSG strongly endorses the continued operation of these sites with their complete suite of instrumentation at least through the lifetime of the currently proposed cloud/radiation satellite missions. Furthermore, the GEWEX SSG recommended that the ARM program and their related observing sites be integrated more formally into the structure of the GEWEX programs. The JSC will be asked to join in this endorsement of ARM.

15. GEWEX MODELLING AND PREDICTION (See Report Item 7.)

GCSS Science and Implementation Plan Revision

The JSC will be advised of the intent to publish a revised GCSS Science and Implementation Plan by mid-2000 and then to use its main elements to develop an article on GCSS for publication in the Bulletin of the American Meteorological Society (BAMS), or an equivalent publication, providing the past results and future thrust of GCSS.

Significant departures from the original GCSS Science and Implementation plan include:

- The specific identification of data integration as a separate component of GCSS,
- A specific GCSS strategy for dealing with cloud process modelling issues,
- A GCSS contribution to the resolution of the main technical questions associated with an improved understanding of cloud/radiative feedbacks in the climate system in connection with GRP, and
- A rationale for maintaining the goal in GCSS to certify CRM's as tools for providing a substitute for certain types of data under certain conditions.

16. GEWEX MODELLING AND PREDICTION (See Report Item 7.)

GEWEX Global Land-Atmosphere System Study (GLASS)

The structure of the Global Land/Atmosphere System Study (GLASS) contains point validation type activities, with GSWP-like initiatives, paired with a data assimilation function and a coupled action element. The organization also includes an infrastructure project which will co-ordinate logistics for the entire set of activities.

GLASS was endorsed by the SSG and action was given to finalize the Science and Implementation Plan by mid-2000 and to hold an advisory team meeting, made up of the points of contact for each element of the Study plus other interested researchers, by the end of 2000 and to report progress on all aspects of GLASS at the 2001 session of the SSG.

This element of GEWEX will be carried out in close association with ISLSCP and other relevant national and international initiatives such as BAHC, for which GLASS will be suited to co-ordinate the model intercomparisons BAHC wishes to perform.

17. GEWEX MODELLING AND PREDICTION (See Report Item 7.)

Real-time access to field studies/regional experiments data

The SSG, reaffirmed its position that action continue to be taken to ensure that the planning of regional experiments include a strategy for ensuring that the different observational data measurements associated with each experiment are made compatible with and are "placed" on the World Meteorological Organization's Global Telecommunications System (GTS) for access in (near) real-time by the major modelling and analysis centres. The SSG asked the GHP Chair to act on suggestion to form a direct connection between the major processing centres whereby, ensemble forecasts can be provided for the CSE large river basin areas in conjunction with efforts to place as much data as possible on the GTS for use in the production of such forecasts.

18. GEWEX MODELLING AND PREDICTION (See Report Item 7.)

DAO links with GEWEX:

- The use of GEWEX datasets for validation of DAO products;
- Modeling, analysis and prediction of global water and energy cycles especially associated with the DAO NASA-TRMM reanalysis initiative;
- An agreement of participation between GEWEX and DAO for DAO to perform impact studies by way of observing system simulation experiments (OSSEs) and real data impact studies.

19. GEWEX MODELLING AND PREDICTION (See Report Item 7.)

NCEP interactions with GEWEX:

- Development of a community land-surface model, named the NOAH model;
- An initiative/demonstration of a real-time, hourly, national (U.S. domain), one-eighth degree, year-round, uncoupled, Land Data Assimilation System (LDAS);
- GCIP sponsorship of a 20-25 year, 30km, Regional Reanalysis over USA domain using the NCEP Eta Model Data Assimilation System (EDAS);
- Development of an NCEP Single Column Model (SCM) from connections with GCSS.

20. GEWEX MODELLING AND PREDICTION (See Report Item 7.)

GEWEX Connections to ECMWF:

- Many of the model and assimilation developments that will be used in the ECMWF 40 year reanalysis (ERA-40) have benefited from the continued relationship with WCRP/GEWEX and application of results that have accrued from the methodology GEWEX has used in the development of improved parameterizations.

- Development work on a revised deep convection scheme were initially stimulated, in part, by results of a GCSS Working Group 4 intercomparison project.

- ECMWF is contributing to GEWEX by carrying out intercomparison simulations with the Single Column Model (SCM) and assisting with diagnostic studies for test cases being performed as part of GCSS Working Groups 2 and 3.