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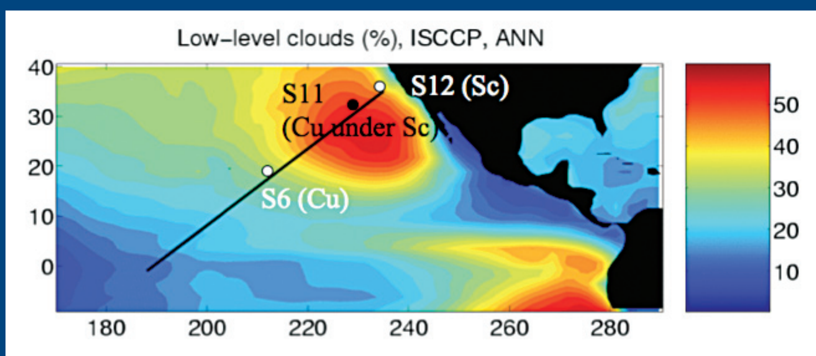
GCSS Teams with CFMIP to Understand the Physical Mechanisms of Low Cloud Feedbacks in Climate Models



The CGILS intercomparison transect overlaid on the Northeast Pacific annual-mean low cloud amount. Initially, CGILS focused on location S11 (32°N, 129°W) near the northern end of the GCSS Pacific Cross-Section Intercomparison study region. The other two locations are S6 and S12. S11 is near the climatological summertime maximum of low-level cloud cover. S6 is characterized by shallow cumuli, and S12 by shallow coastal stratocumulus.

CFMIP-GCSS Intercomparison of Large Eddy Models and Single Column Models (CGILS)

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Despite progress in recent years in understanding cloud processes and feedbacks in General Circulation Models (GCMs; Bony et al., 2006; Stephens 2005), knowledge is lacking about the physical mechanisms of cloud feedbacks and the causes of model-to-model variation in simulated cloud feedbacks. These issues are related to several factors: (1) the transient and spatial variability of clouds is typically much larger than the small signal of cloud feedbacks; (2) clouds are highly interactive with atmospheric dynamical circulations; and (3) in a GCM, clouds are simulated with an interactive web of physical parameterizations of subgrid structure, microphysics, turbulent mixing, cumulus convection, radiation and surface fluxes, which are poorly resolved by the model grid.

The World Climate Research Programme (WCRP) Working Group on Coupled Modelling (WGCM) **Cloud Feedback Model Intercomparison Project (CFMIP)** and the **GEWEX Cloud System Study (GCSS)** Boundary Layer Cloud Working Group have initiated a joint project—the CFMIP-GCSS Intercomparison of Large Eddy Models and Single Column Models (CGILS)—that uses idealized large-scale dynamical conditions to evaluate subtropical marine boundary layer cloud feedback processes in GCMs. The working hypothesis of CGILS is that the model

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Commentary

GEWEX "GREW" and Continues to Grow

Kevin E. Trenberth
Chair, GEWEX Scientific Steering Group

I look forward to the challenge of helping to restructure and transition GEWEX into the next phase of the World Climate Research Programme (WCRP), which begins post 2013. My nomination for Chair of the GEWEX Scientific Steering Group (SSG) came as a surprise to me because I was already the Chair of the WCRP Observation and Assimilation Panel (WOAP), a position I have held since the Panel's inception 6 years ago. This alone is enough of a full-time (unpaid) job. I have been a member of the GEWEX SSG for 3 years and previously served on the Tropical Ocean Global Atmosphere (TOGA) Project SSG, was co-chair of the Climate Variability and Predictability Project (CLIVAR) SSG for 4 years, and served on the WCRP Joint Scientific Committee for 8 years.

At the same time I have been very involved in the Intergovernmental Panel on Climate Change assessments, as a Convening Lead Author in the Second Assessment Report, a Lead Author in the Third Report, and a Coordinating Lead Author in the Fourth Report, each time with a different chapter and with full involvement in writing the Summary for Policy Makers and participation in intergovernmental meetings. This exposure to the climate change community has led me to the strong conviction that understanding global and regional energy flows through the climate system is a key to both variability and change. Moreover, the biggest component of net loss of surface energy globally is through evaporative cooling, thereby involving the hydrological cycle. I believe that the biggest impacts with global warming on society will likely occur through changes in water availability. Accordingly, a considerable part of my research has been framed to better understand the global energy and water cycle, with emphasis on developing a holistic view framed by the physical constraints of conservation of both energy and water.

GEWEX successfully completed its first phase in 2002 and launched its second in 2003. WCRP is currently examining how best to reorganize and move itself and its four core projects into a completely new phase (post 2013). GEWEX is designing its Phase 3 in response to the following questions:

- What will be the key science issues each project aims to address over the coming years to 2013?
- What elements of this science do you see as needing to be taken beyond the next decade?
- What new science do you see WCRP needing to address beyond 2013 in the context of your project?

Good progress was made in planning for this at the recent SSG meeting in January, where it was agreed that the three major research foci of GEWEX (Radiation, Hydroclimate, and Modelling and Prediction) fit together; however, better

> ***Imperatives (Post 2013)***
>
> **Data:**
>
> Develop climate data records of atmospheric and land variables, complete with metadata and error bars.
>
> Provide descriptions and analyses of observed variations, trends and extremes in hydrological and energy-related quantities.
>
> *For a complete listing of the Imperatives, see pages 4 and 5.*

linkages between them are needed. The main discussion focused on what GEWEX must do and what major new horizons or frontiers should be addressed.

The idea of renaming GEWEX was suggested and received surprisingly little opposition. "GEWEX" has good name recognition but is a bit of a misnomer as it has never been an "experiment." Why is the "EX" in GEWEX? Accordingly, my suggestion is to rename GEWEX as the Global and Regional Energy and Water Project (GREW). We would then be able to say that "GEWEX grew" into something better. GREW would be the core WCRP project dealing with land-atmosphere interactions. The following is a possible new mission statement that embraces this role:

Mission Statement: *Develop improved observational, diagnostic, and modelling capabilities focusing on land-atmosphere interactions to measure and predict global and regional energy and water variations, trends, and extremes such as heat waves, floods, and droughts; and provide the science underpinning climate services.*

New challenges are expected as increased attention is placed on seasonal to decadal prediction as an initial value problem. How do we build upon new observational capabilities from space? How do we build upon the heritage of the Coordinated Energy and Water Cycle Observations Project (CEOP) to develop robust (not model dependent) descriptions of the state of the land-surface (including soil moisture), its vegetation, and water levels? How will this information be used to initialize models? How can WCRP contribute to building Earth system models?

These kinds of questions are what has given rise to the new imperatives and for each imperative there will be a more complete description that includes who takes the lead, who are the main partners are, and what actions are required. Here I provide one example for the first Data Imperative:

Develop climate data records of atmospheric and land variables, complete with metadata and error bars.

The leads for this imperative would be the GEWEX Radiation Panel and CEOP, and the partners would include the Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM), the Committee on Earth Observation Satellites (CEOS) and WOAP. The main actions of the next phase would include:

- Reprocessing GEWEX data sets, providing advice on other efforts and lead evaluations.
- Continuing evaluation and refinement of sensor algorithms, influencing next generation spaceborne platforms and reprocessing.
- Developing appropriate calibration/validation/evaluation data sets to confront models.
- Devising robust ways of dealing with the more diverse, complex, and higher spatial and temporal resolution, along with much greater volumes of data.
- Building on CEOP's experience in data management, archival, and access.

It is expected that a fuller description will be further fleshed out at the the Second Pan-GEWEX Science Meeting to be held August 23–27 in Seattle, Washington. The outcome of this meeting will be a document that states where GEWEX or GREW is headed and how this will be accomplished, which will feed directly into WCRP plans. Details will be forthcoming on what tasks are to be set before the panels and working groups meeting in Seattle. Hope to see you there.

Moustafa Chahine to Receive Goddard Award

Dr. Moustafa T. Chahine of the Jet Propulsion Laboratory in Pasadena, California is the 2010 winner of the George W. Goddard award in recognition of his exceptional achievement in optical science and instrumentation for aerospace and atmospheric research. Dr. Chahine, the first chairman of the GEWEX Scientific Steering Group, is currently Science Team Leader for the Atmospheric Infrared Sounder (AIRS) flown on the NASA Aqua spacecraft. He is internationally recognized for his work in atmospheric remote sensing and its applications to weather and climate research. Dr. Chahine is credited with developing an efficient inversion algorithm known as the "relaxation method" to convert satellite radiances by use of the radiative transfer equation to atmospheric variables (e.g., temperature, humidity, fractional cloud cover), enabling the early satellites of the 1970s with infrared sounders to gather vital vertical profiles needed for advancing numerical weather prediction models.

CORRECTIONS: February 2010 Issue

Page 3: The correct URL for the International Soil Network is: *http://www.ipf.tuwien.ac.at/insitu/*

Page 6: Corrected text for Column 1, paragraph 1, and equation (3): "As a result of this well-known behavior, the sensitivity of cloud albedo to optical depth (∂α/∂τ) at τ~8 is about 4-fold greater than is the sensitivity at τ~20-30. These differences are relevant to the discussion below."

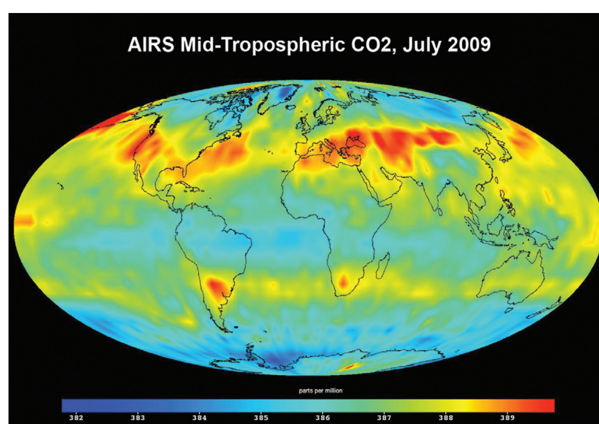
$$\frac{\Delta A_c}{\Delta T_s} \equiv \frac{\partial A_c}{\partial T_s} \quad (3)$$

GEWEX Radiation Panel Vice-Chair

Dr. Jörg Schulz is the new Vice-Chair of the GEWEX Radiation Panel (GRP). He is a senior scientist at the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and leads a group concerned with the creation of fundamental climate data records from satellite data. Dr. Schulz has served as a member of GRP for 5 years. His major interests are remote sensing of water vapor and precipitation, as well as satellite instrument calibration and time series homogenization. Dr. Schulz obtained his Ph.D. in meteorology in 1993 from the University of Hamburg. Following several years at different research institutions, he became the scientific leader of the EUMETSAT Satellite Application Facility on Climate Monitoring at Deutscher Wetterdienst, before moving to EUMETSAT in 2010.

Aqua/AIRS Mid-Troposheric Data Show Previously Unknown Carbon Dioxide Belt

A time-series of a visualization of the global distribution and variation of the concentration of mid-tropospheric CO_2 observed by the Atmospheric Infrared Sounder (AIRS) is available at *http://svs.gsfc.nasa.gov/goto?3685*. The data show the average concentration in parts per million over an altitude range of 3–13 km, whereas the Mauna Loa data show the concentration at an altitude of 3.4 km. Both AIRS and Mauna Loa data exhibit an annual increase at a rate of approximately 2 ppm per year. Although the mid-latitude jet streams are not visible in the map, their influence upon the distribution of CO_2 can be seen globally. These rivers of air occur at an altitude of about 5 km and rapidly transport CO_2 around the globe. In the Northern Hemisphere, the mid-latitude jet stream undergoes significant variation over the period of a few days due to the continental land masses. In the Southern Hemisphere the jet stream flow is nearly zonal from west to east. From July (see below) to October, the CO_2 concentration is enhanced in a belt delineated by the jet stream and the flow of CO_2 around the globe at the latitude of South Africa, Southern Australia and Southern South America is readily apparent.



Planning for GEWEX Post 2013

The following will be discussed at the Second Pan-GEWEX Science Meeting in Seattle on August 23–27.

Draft Mission Statement

Develop improved observational, diagnostic, and modelling capabilities for measuring and predicting global and regional energy and water variations, trends, and extremes, such as heat waves, floods, and droughts, and provide the science underpinning climate services.

Draft Imperatives:

Data

Develop climate data records of atmospheric and land variables, complete with metadata and error bars.

Lead: GRP, CEOP; Partners: SCOPE-CM, CEOS, WOAP

Actions:

- Reprocess GEWEX data sets, provide advice on other efforts and lead evaluations.
- Continue evaluation and refinement of sensor algorithms, influencing next generation space-born platforms and reprocessing.
- Development of appropriate calibration/validation/evaluation datasets to confront models.
- Devise robust ways of dealing with the more diverse, complex, higher spatial and temporal resolution, and much greater volumes of data.
- Build on CEOP experience in data management, archival and access.

Provide descriptions and analyses of observed variations, trends and extremes in hydrological and energy-related quantities.

Partners: Rest of WCRP

Actions:

- Analyze, evaluate and compare observations, and document results.
- Work to close moisture and energy budgets, regionally and globally.
- Determine the geographical and seasonal characteristics of key water and energy cycle variables especially over land areas.
- Close catchment water budgets.
- Integrated product assessment, data assimilation into hydrological models.

Analysis

Develop advanced diagnostic tools and identify pathways for model improvement.

Lead: GRP, GMPP, CEOP; Partners: WGNE, CAS

Actions:

- Spin up a new joint GRP-GMPP-CEOP effort in advanced diagnostics.
- Build on GEWEX's combination of observations and modelling capabilities.
- Identify and entrain collaborators from other WCRP and CAS groups.

Increase understanding of energy and water cycle processes, quantify their contribution to climate feedbacks, and develop improved hydrometeorological parameterizations.

Lead: GMPP, CEOP; Partners: CLIVAR, CliC, SPARC, WGCM, WGNE

Actions:

- Observations, process studies, field programs.
- Investigate alternative representations of sub-grid processes in Land Surface Schemes.
- Develop improved understanding of climate variability and change on land surface properties, including soils, vegetation, and hydrological processes, and an associated modelling capability.
- Investigate the scope for development of next generation land surface models with improved representation of subsurface hydrology, including groundwater processes; identify suitable areas for their evaluation.
- Develop more modular Land Surface Models and components for use in Earth system models.

Develop and exploit methods of dealing with non-stationarity of hydrological variables, and especially extremes of floods and droughts, associated with climate and global change.

Partners: CLIVAR, IHDP (Global Water System Project, GWSP), UNESCO (International Hydrological Programme, IHP), Hydrological community

Actions:

- Define requirements for data types, sampling, and resolution.
- Develop new statistical methods for planning for extremes.
- Develop new generation methodologies for quantification and prediction of extremes.

Contribute to building a comprehensive end-to-end pan-WCRP initiative on climate extremes such as heat waves, floods, and droughts, addressing the compound nature of extreme events, their ubiquity, and risk-coping issues.

Partners: WCRP (CLIVAR, CliC), Hydrological community, IRDR (Integrated Research on Disaster Risk)

Actions:

- Define requirements for data types, sampling, and resolution.
- Model development, focused on extremes, and definitions consistent with observations (upscaling and downscaling).
- Characterize the entire pdf and especially the characteristics of precipitation (frequency, intensity, amount, type, duration).
- Assist in reducing vulnerability and planning for adaptation to and coping with changes.

Modelling

Attribute causes of trends, and determine the predictability of energy and water cycles on a global and regional basis in collaboration with the wider WCRP community.

Partners: WCRP projects and WGs, IPCC

Actions:

- Develop links between global, regional, and local scales.
- Model detection and attribution studies.
- Coordinate data set generation, process studies, and modelling.

Accelerate developments in models of the land, atmosphere, and entire climate system.

Lead: GMPP, CEOP; Partners: WGNE, WGCM

Actions:

- Strengthen the model improvement activities within GMPP.
- Strengthen collaboration with the modelling centers.
- Consider how the components interact and makeup a complete system through improved understanding of coupling and feedbacks.
- Continue evaluation of developing earth system model products.
- Develop archives to support model development and intercomparison.
- Develop forecasting algorithms including ensemble techniques.
- Promote regional application and evaluation studies.
- Improve representation of hydrological processes – lakes, wetlands, groundwater, river routing.
- Improve the representation of the atmospheric energy and water cycle, in particular clouds and precipitation.
- Improve representation of non-stationarity in land surface properties under global change.

Improve capabilities predictions of water and energy cycle variability on all time scales.

Partners: CLIVAR, CLiC, WGSIP, WGCM, UNESCO (IHP), IAH

Actions:

- Diagnose model errors and exploit GEWEX datasets and focused process studies.

Applications

Develop observational sites, data processing tools, data management and archival systems, model initialization and synthesis capabilities, and other research outcomes for transition to operations.

Partners: Pan-WCRP, IGBP, hydro-meteorological and climate services

Actions:

- CEOP reference sites heritage.
- Undertake joint activities with operational hydro-meteorological and climate services, and hydrological research programs to demonstrate the value of the capabilities, data sets, technology, tools, and information products that address societal needs.
- Promote collaboration among climate system science, engineering hydrology and socio-economic sciences.
- Demonstrate a prototype of an end-to-end fully collaborative study.
- Work with operational agencies to transition new capabilities.

Promote and foster capacity building through training of scientists and the user community.

Partners: ESSP, START

Actions:

- Publish results and lessons learned.
- Collaborate on observations.
- Participate in outreach and workshops.
- Provide tools for diagnoses and analysis.

Special JGR Issue on Global Dimming and Brightening

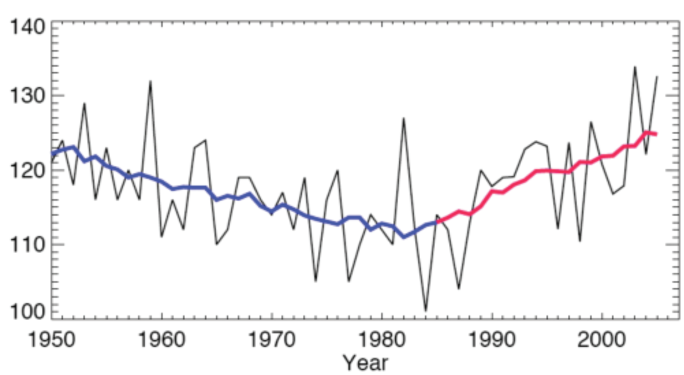
"Global dimming and brightening" is a popular expression which relates to the recent evidence that solar radiation incident at the Earth's surface is not stable over time, but undergoes significant decadal variations. The first special issue about this phenomenon was recently published in the *Journal of Geophysical Research (JGR)* and is accessible online at: *http://www.agu.org/journals/jd/special_sections.shtml?collectionCode=DIMBRIGHT1&journalCode=JD*.

While observational records show a decline in solar radiation at widespread locations between the 1950s and 1980s (global dimming), a partial recovery (brightening) can be noted more recently at many of these sites (see figure below). These variations are thought to be at least partly caused by anthropogenic air pollution and related aerosol burdens in the atmosphere, which largely increased during the dimming phase.

The brightening coincides with a phase of reduced pollution due to the implementation of air quality measures and the economic decline in former communist countries. These variations may significantly affect various aspects of the global climate system and climate change, such as global warming, the intensity of the global water cycle, and glacier retreat, as well as biospheric growth and related carbon uptake. In this special issue of the *JGR*, a comprehensive collection of more than 20 papers sheds new light on various aspects of global dimming and brightening. Magnitude, origins, significance, model representation and possible impacts are discussed by the various studies.

Reference

Wild, Martin, 2010. Introduction to special section on Global Dimming and Brightening, *J. Geophys. Res.*, 115, D00D00, doi:10.1029/2009JD012841.



Annual records of surface solar radiation observed at Potsdam, Germany, between 1950 and 2006. Five-year running means show a decline (dimming) between the 1950s and the 1980s (in blue), and a recovery (brightening) in more recent years (in red).

CFMIP-GCSS Intercomparison of Large Eddy Models and Single Column Models (CGILS)

(Continued from Page 1)

diversity of simulated cloud feedbacks can mainly be explained as model-dependent cloud responses to the same warming and warming-induced change in large-scale conditions. The CGILS objectives are: (1) to understand the physical mechanisms of cloud feedbacks in GCMs by using Single-Column Models (SCMs); and (2) to assess the physical credibility of low cloud processes in the SCMs by using cloud-resolving models (CRM) and large eddy simulations (LES).

The approach of carrying out idealized simulations has advantages and limitations. The advantages are: (1) it isolates the model physics from dynamics, thus dramatically simplifying the problem; (2) it allows the use of LES, whose fine grids provide a considerably more realistic description of subgrid scale processes in the GCMs, to be compared with SCMs forced under identical conditions; and (3) it allows the sensitivity of the simulated clouds to various aspects of the changed large-scale dynamical conditions to be isolated. A major limitation of this approach is that the cloud response to climate change cannot be determined or constrained by current observations. However, this is a fundamental property of cloud feedbacks in climate models, not specific to CGILS, and is a part of the motivation for using LES models. In CGILS forcings used for the control climate are very close to observed large-scale conditions in July, allowing the clouds simulated by the SCMs and LESs to be tested against observations in the control climate.

CGILS focuses on the marine stratus, stratocumulus, and shallow cumulus clouds in the subsidence regions of the subtropics because these clouds have been identified as the main cause of model discrepancies (Bony and Dufresne, 2005). The study region is the northern half of the GCSS Pacific Cross-Section Intercomparison (GPCI) cross section, which traverses the northeast subtropical Pacific from California to Hawaii, and across the central Pacific Intertropical Convergence Zone (Siebesma et al., 2004). The large-scale forcing data is derived starting with the European Centre for Medium-Range Weather Forecasts (ECMWF) analysis for July 2003 (courtesy of Martin Kohler). GCM simulations from the NCAR CAM3 and GFDL AM2, as well as simulations from the super-parameterized CAM were used as a guide to how forcings will change if sea surface temperature (SST) is uniformly warmed to 2K as a representative climate perturbation. In summary, as the climate warms, changes in free-tropospheric temperature are assumed to follow moist adiabats, relative humidity is assumed constant, profiles of horizontal heat and moisture advection are treated as invariant, and vertical motion is derived so as to balance advective warming and radiative cooling above the boundary layer. The dynamical conditions emulate the large-scale forcing in the control and warmer climate in the GCMs, but they are independent of any physical parameterizations. The derivation procedure follows Zhang and Bretherton (2008) with further refinements described at: *http://atmgcm.msrc.sunysb.edu/cfmip_figs/Case_specification.html*. Our initial hypothesis is that the clouds respond mostly to time-mean forcing changes. Thus, for simplicity, we use time-independent forcing.

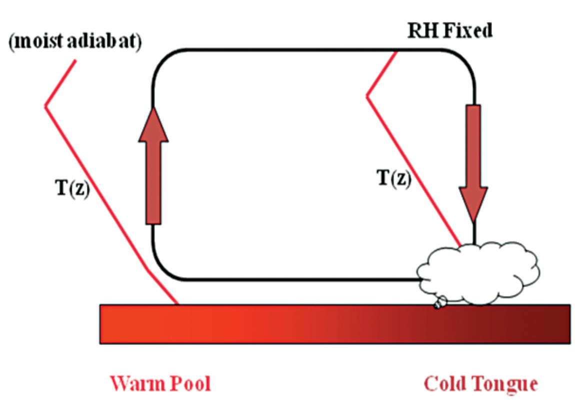
The figure below shows the schematic design of the study, where the key underlying variable is SST. For each set of SSTs (control climate and warmer climate), the corresponding large-scale subsidence is calculated. The SST and the subsidence rate are then used to force the SCM and LES. Simulation results from the control case are used to understand the physical processes in the models that generate the clouds, while the changes of clouds from the control SST to warmer SST are used to understand the cloud feedbacks in the same spirit as the Cess-type experiments (Cess et al., 1990).

Initially, CGILS focused on location S11 (32°N, 129°W) near the northern end of the GPCI cross-section. The figure on page 1 shows that this is near the climatological summertime maximum of low-level cloud cover. Physical properties of observed clouds (derived from satellite data) in July near this location are shown in the figure in the next column (Lin et al., 2009). Other CGILS study locations are S6 (characterized by shallow cumuli) and S12 (characterized by shallow coastal stratocumulus).

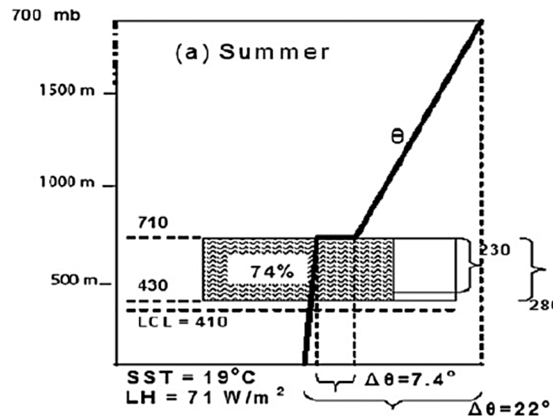
Table 1 lists the models that have submitted results and includes 16 SCM and five LES models. Other groups have expressed interest in participating and will be added.

Preliminary SCM Results

Many SCM simulated low clouds at S11 are similar to those in the parent GCM. In some models a constant forcing at a single point can represent GCM cloud processes, while in other models this is not the case. This feature depends upon the mechanism used for cloud generation in the models. An interesting result obtained by LMD/IPSL was that when a random transient component is added to the large-scale forcing, SCM simulated clouds and feedbacks are more representative of their GCM. Other CGILS groups will explore the importance of time-varying forcing to reproduce GCM clouds using their SCMs.



Schematic of the experiment. Low clouds in the subsidence region are the subject of the CGILS study.



Synthesis of observed low clouds near S11 in July. The numbers correspond to: (i) cloud amount in percentage in the shaded box; (ii) cloud top and base heights, as well as lifting condensation level (LCL) to the left of the shaded box; and (iii) cloud thickness. The adiabatic liquid water thickness (to the right of the cloud box) is calculated from the in-cloud liquid path. The thick lines represent schematic vertical profiles of potential temperature. Shown at the bottom are: SST, latent heat flux, lower-tropospheric stability (LTS), and inversion strength (adapted from Lin et al., 2009).

Cloud feedbacks simulated by the SCMs show two distinct groups of large negative and positive feedbacks. Two models with relatively large negative cloud feedbacks are CAM4 and CSIRO, and two with relatively large positive cloud feedbacks are GFDL and GISS. The mechanism of negative feedbacks in

Table 1: CGILS Participating Models and Investigators

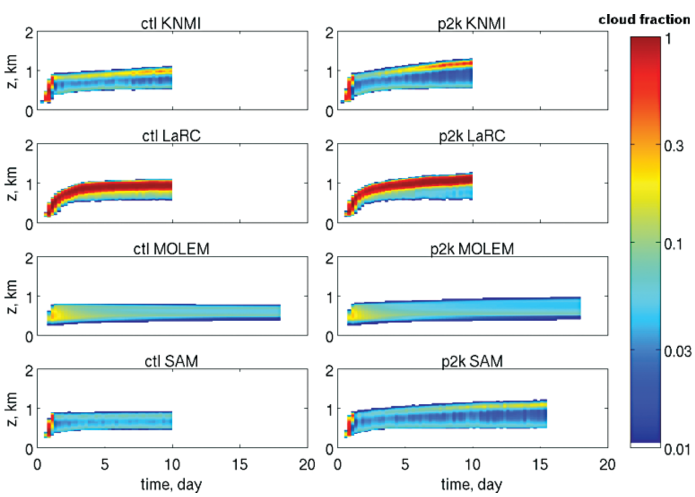
Models	Model Institution	Participants
SCM 16		
CAM4	National Center for Atmospheric Research (NCAR), USA	Minghua Zhang, Chris Bretherton
CAM5	NCAR, USA	Cecile Hannay, Minghua Zhang
CCC	Canadian Climate Center, Canada	Phil Austin
CSIRO	Australian Commonwealth Scientific and Research Organization	Charmaine Franklin
ECHAM5	Swiss Federal Institute of Technology, Switzerland	Colombe Siegenthaler-Le Drian, Isotta Francesco, Ulrike Lohman
ECHAM6	Max-Planck Institute of Meteorology, Germany	Suvarchal Kumar, Bjorn Stevens
ECMWF	European Centre for Medium-Range Weather Forecasting	Martin Koehler
GFDL	Geophysical Fluid Dynamics Laboratory, USA	Chris Golaz, Ming Zhao
GISS	Goddard Institute for Space Studies, USA	Tony DelGenio, Audrey Wolf
GSFC	Goddard Space Flight Center, USA	Andrea Molod, Max Suarez, Julio Bacmeister
JMA	Japanese Meteorological Center, Japan	Hideaki Kawai
KNMI	Royal Netherlands Meteorological Institute, The Netherlands	Roel Neggers,Pier Siebesma
LMD	Laboratory of Dynamic Meteorology, France	Florent Brient, Sandrine Bony, Dufresne Jean-Louis
SNU	Seoul National University, Korea	Sing-Bin Park, In-Sik Kang
UKMO	Met Office, United Kingdom	Adrian Lock, Mark Webb
UWM	University of Wisconsin at Madison, USA	Vincent Larson, Ryan Senkbeil
DALES	Technical University Delft, The Netherlands	Stephan de Roode, Pier Siebesma
SAM	System for Atmospheric Models-University of Washington/Stony Brook University, USA	Peter Blossey, Chris Bretherton, Marat Khairoutdinov
UCLA	University of California at Los Angeles, USA	Irina Sandu, Bjorn Stevens
UCLA/ Langley	NASA Langley Research Center, USA	Anning Cheng, Kuan-man Xu

the SCMs tends to be similar to those in well-mixed boundary layer models (Caldwell and Bretherton, 2009) and the LES results of Blossey et al. (2009). In the SCMs, the reduced subsidence leads to a deeper and stronger trade inversion and supports a thicker cloud layer. SCMs with positive cloud feedbacks tend to have more decoupled boundary layers with more frequent episodes of cloud break up in the warmer climate due to activation of shallow cumulus convection, and in some cases (e.g., UKMO), more efficient cloud-top entrainment.

Preliminary LES Results

The 3-dimensional LES models have 25-m vertical and 50-m horizontal grid spacing and a double-periodic domain of 6.4 km per side. This vertical resolution is relatively coarse for stratocumulus simulations, a compromise that makes very long 10-30 day simulations computationally cheaper. The figure below shows a time-height plot of the simulated evolution of cloud fraction for the LES models. In the control climate, three of the four LES models that had submitted results by late February 2010 produced broken cloud layers whose area-mean albedo is much thinner than observed. This bias may occur because the specified vertical resolution of 25 m is too coarse and leads to spurious numerical mixing of dry warm air down through the inversion that quickly evaporates clouds. The fourth LES simulated too thick a cloud, even at this resolution. These strikingly different results are being investigated and may be due to a setup issue rather than the LES formulation.

All the LES models exhibit slightly increased cloud albedo in the specified warmer climate. This increase seems to be driven mainly by the weaker subsidence in the warmer climate, which allows the inversion to deepen and fill in with clouds. Thus far, the LES cloud biases limit their usefulness as a benchmark for the LES, but the consistency between their cloud responses to the climate change (except LaRC) is quite encouraging. The LES models will repeat the CGILS simulation with 5-m vertical resolution, which should increase the simulated cloud cover and thickness and decrease the LES biases.



Time-height sections of cloud fraction from four LES with identical boundary forcing and resolution for a control simulation using mean conditions from point S11 (left) and from a simulation with boundary conditions adjusted to reflect a +2K overall low-latitude warming (right). The models have diverse control clouds, but all show boundary layer deepening and a slight albedo increase in the +2K climate.

In the near-term the LES models will run cases using forcings from two additional locations (the shallow cumulus and stratus at S6 and S12), where almost all SCMs have already submitted results. The SCMs will be run with slightly modified large-scale forcing data to match slight improvements made during the LES study. In additon, systematic testing will be conducted of the sensitivity of an S11 simulation to vertical grid resolution with the SAM LES to identify a fine enough LES grid spacing to achieve approximate convergence of cloud characteristics.

Longer-term plans include separating out the effects of the different climate-related changes to large-scale forcings (vertical motion, free tropospheric temperature and relative humidity, advection, and CO_2 changes) in both SCM and LES simulations; more careful use of the observations and LES results to improve the SCM physical parameterizations; and use of a common set of time-varying advective forcings for a more realistic comparison with observations and GCM simulations. New results from CGILS will be published in the future.

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WACMOS – A Water Cycle Multimission Observation Strategy

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To understand the role of the global water cycle it is essential to measure from space such variables as radiation, precipitation, evapotranspiration, soil moisture, clouds, water vapor, surface water and runoff, vegetation state, albedo, and surface temperature. These measurements are important, not only for our understanding of the different components of the water cycle and their spatial and temporal variability, but also for characterizing the processes and intractions between the terrestrial and atmospheric branches of the water cycle, and how this coupling may influence climate variability and predictability.

Enhancing the observational capacity and the capabilities of models to predict the variations in the global water cycle is key to improving water governance and mitigating water-related damages. We are now transitioning into a new era where the increasing number of missions and sensors available for scientific and operational applications, besides the advances in computer science, modelling, and data assimilation, open unprecedented opportunities to observe, understand and predict the water cycle and its variability in time.

However, to fully take advantage of this increasing potential and bring this newly available capacity to practical operational levels, significant scientific efforts are required to: (1) develop novel and enhanced geophysical products exploiting available synergies among different observational systems; (2) consolidate the development of consistent long-term data sets integrating different Earth observation systems in a synergistic manner; and (3) develop methodologies to integrate and assimilate space observations and in situ measurements into robust coupled models that are able to describe biophysical processes and interactions between ocean, land, and atmosphere describing the water cycle and hydrological processes.

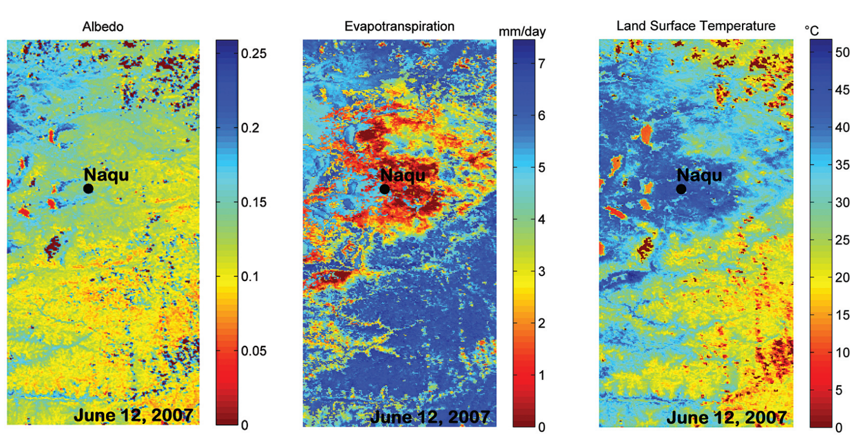
In this context, the European Space Agency (ESA) in collaboration with GEWEX launched the Water Cycle Multi-mission Observation Strategy (WACMOS) in 2008. The Project, funded under ESA's Support To Science Element Programme, has two primary objectives: (1) developing and validating a product portfolio of novel geo-information products that respond to GEWEX scientific priorities and that exploit the synergic capabilities between data from ESA and other Earth observing missions; and (2) exploring and assessing different methodologies towards the development of long-term consistent data sets of key variables describing the water cycle. WACMOS is focused on four components of the water cycle: evapotranspiration, soil moisture, clouds, and water vapor.

WACMOS Water Cycle Products:

Evapotranspiration (ET)

ET is of utmost importance in understanding the terrestrial water and climate systems because it represents a direct feedback of moisture to the atmosphere from the land surface. Thus, the quantification of terrestrial evapotranspiration helps determine the biological environment and its water use efficiency. Accurate ET data is also needed to estimate the loss of useable water from the soil column and to help determine plant water stress for applications that include drought assessment, agricultural irrigation management, and forest fire susceptibility. Surface ET can also be used to estimate the formation of summertime convective precipitation patterns.

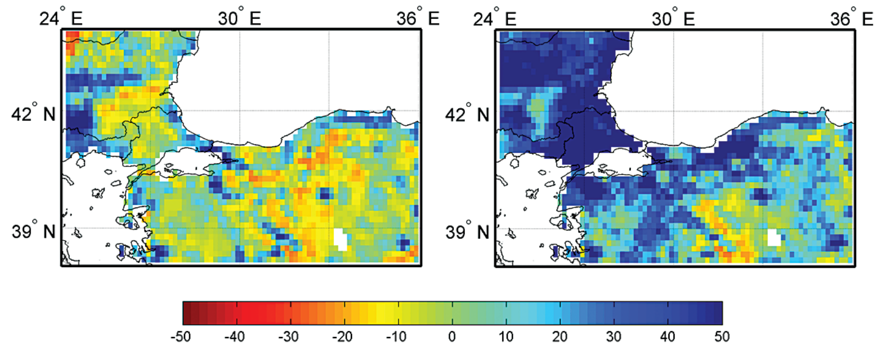
Currently, there is no available global ET product or an algorithm commonly available to the scientific community for estimating this critical variable. WACMOS aims at developing a global ET product based on the use of Medium-Resolution Imaging Spectrometer (MERIS), Envisat Advanced Along-Track Scanning Radiometer (AATSR), and National Aeronautics and Space Administration (NASA) Moderate Resolution Imaging Spectroradiometer (MODIS) data.



Albedo, land surface temperature and daily evapotranspiration map generated with MODIS L1B data (12 June 2007, China). WACMOS ET products will consist of daily ET over land and ocean (as shown in this figure), with a spatial resolution of 1 km² and 1-day maximum temporal resolution.

Soil Moisture

Soil moisture can be thought of as the switch that controls the proportion of rainfall that percolates, runs off, or evaporates from land. Understanding the dynamics and variability of soil moisture is crucial to understanding the role of the hydrological cycle and many ecological and biogeochemical processes. However, soil moisture is difficult to observe at the regional to global scale due to its large spatial and temporal variability. The limited understanding of the role of soil moisture in meteorology, hydrology, ecology, and biogeochemistry has developed from a small number of point studies with emphasis on the variation of soil moisture with depth. Satellite remote sensing, particularly in the microwave domain, can be a powerful tool in bridging the gap between detailed point observations and spatially variable processes as it can monitor environmental processes in both spatial and temporal terms.



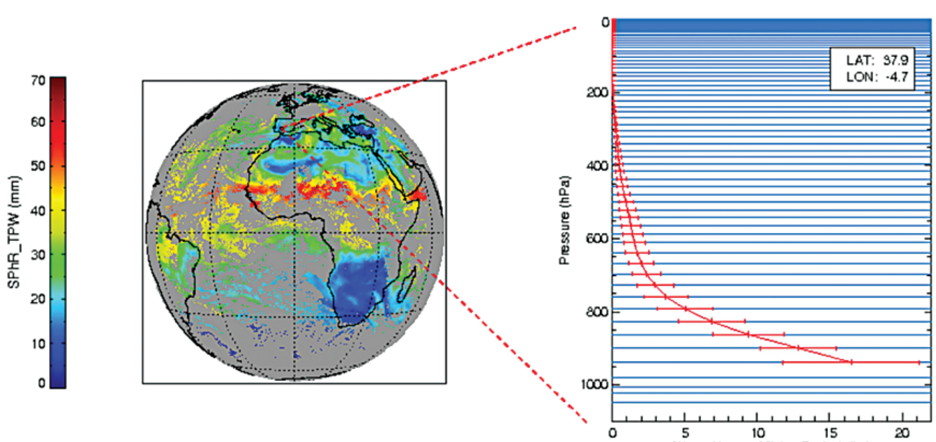
Soil moisture anomaly patterns prior to and after the September 2009 flooding event in Northwest Turkey (data from the Advanced Scatterometer instrument on ESA's MeTop satellite).

A number of global soil moisture products have been made available by different scientific groups using different sensors (e.g., synthetic aperture radar, passive microwave, scatterometers). WACMOS will investigate exploiting these products to deliver the first multi-decadal (30+ years) multi-mission soil moisture data set based on the synergic use of products derived from scatterometer data (e.g., Earth Remote Sensing Satellite, ERS-1/2, and MeTop) and passive microwave observations (e.g., Advanced Microwave Scanning Radiometer, AMSR-E). This will represent a milestone towards the development of long-term consistent soil moisture data sets and will establish a solid scientific basis for the exploitation of the data from the ESA Soil Moisture and Ocean Salinity Mission(SMOS) in combination with sensors already operational.

Clouds

Accurate information on the distribution of clouds is essential for water and energy balance studies. Water vapor is created through evaporation from liquid water bodies (~90%) and transpiration from plants (~10%). Clouds are formed in lifting air parcels, in which water vapor condenses into cloud particles due to the cooler temperatures. Once in the atmosphere clouds are moved around the globe by strong winds and either evaporate back into water vapor or dissipate as precipitation to replenish the earthbound parts of the water cycle. The radiative impacts of the changes in cloud cover and cloud properties are closely related to the role of clouds on the hydrological cycle. Shortwave and longwave radiation that reaches the Earth's surface directly affects evaporation (latent) and sensible heat fluxes.

Although clouds are important modulators in the Earth's climate system, they are not understood well enough to fully quantify their influence on the global energy budget and hydrological cycle. Satellites can provide the required information on clouds at adequate temporal and spatial scales. Satellite observations derived from the Meteosat Second Generation (MSG) satellites and Envisat missions have been used successfully to retrieve key cloud physical properties over Europe and Africa (MSG disk). WACMOS aims at developing novel and enhanced products on a global scale based on the use of Spinning Enhanced Visible and Infrared Imager (SEVIRI) and Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY) data.



SEVIRI total precipitable water on 1 August 2008, obtained with the Nowcasting and Very Short Range Forecasting SEVIRI Physical Retrieval (left). Water vapor mixing ratio profile from the EUMETSAT Infrared Atmospheric Sounding Interferometer (IASI) Level 2 product at one pixel in Spain for 1 August 2008 (right).

Water Vapor

Water vapor is a key variable of the Earth's water cycle and the climate of the Earth. In the lower troposphere, condensation of water vapor provides latent heating, which dominates the structure of tropospheric diabatic heating (Trenberth and Stepaniak, 2003a, b). The response of tropospheric water vapor to a warming of the Earth, such as from anthropogenic carbon dioxide increases, provides the largest positive radiative feedback (Held and Soden, 2000). In global climate models, this feedback roughly doubles the warming in response to forcing from greenhouse gases. There are also possible stratospheric water vapor feedback effects due to tropical tropopause temperature changes and/or changes in deep convection.

An analysis of long-term water vapor products together with appropriate cloud data sets may increase our knowledge of the link between water vapor and clouds. High-spatial resolution observations may give insights into the role of water vapor in the vicinity of clouds.

WACMOS aims to explore novel methodologies to deliver enhanced water vapor products that could exploit the synergies among different observation systems providing high vertical resolution (MetOp Infrared Atmospheric Sounding Interferometer, IASA), high temporal sampling (MSG SEVIRI), and high spatial resolution (Envisat MERIS). In this context, WACMOS will develop and validate two novel products based on the combination of SEVIRI and IASI observations at 0.25° spatial resolution and SEVIRI and MERIS at 0.025° spatial resolution.

The first WACMOS water vapor product will consist of tropospheric integrated water vapor content for 3-5 layers at full disc with 3-hourly temporal sampling (as in the figure at the bottom of page 10). The second product will be based on SEVIRI data with high temporal sampling and MERIS measurements with high spatial resolution.

The end product is total column water vapor over northeastern Europe with high spatial and 3-hourly temporal sampling during day times. For both data products an objective analysis method (Kriging) will be applied to achieve an interpolation with the possibility to provide uncertainty information for the merged products as well.

For more information about the WACMOS Project, see: *http://wacmos.itc.nl/*.

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Third Time's the Charm: Piers Sellers Launches in STS-132

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On 14 May 2010, and on schedule, Dr. Piers Sellers was launched into space aboard the Space Shuttle Atlantis (STS-132). This was the third flight for Piers (his previous flights STS-112 in 2002 and STS-121 in 2006 were delayed by weather).

Piers was a key leader within GEWEX Phase I as he led the International Satellite Land Surface Climatology Project (ISLSCP) and orchestrated the development of a set of co-registered global data sets for ISLSCP Initiative I.

Piers was also a key player in both the Boreal Ecosystems-Atmosphere Study (BOREAS) and the early development of the Large-scale Biosphere Atmosphere Experiment in Amazonia Project (LBA). Most recently he was a keynote speaker at the Joint GEWEX/Integrated Land Ecosystem-Atmospheric Processes Study (iLEAPS) International Science Conferences held in Melbourne, Australia in August 2009, where he spoke about future opportunities and challenges in understanding the climate system.

For this mission, Piers was one of the "Rassvet Rammers," working with the robotic arm to dock the 17,760-pound mini-research module, known as Rassvet to the space station. The module is packed with 3,086 pounds of NASA equipment and supplies, and carried an experimental airlock and European robot arm equipment that will be attached to other modules later.

As a high profile astronaut with over 41 spacewalk hours, Piers has served to promote education and climate science around the world and never fails to highlight the key role field projects, model development, and satellite observations play in advancing weather prediction and climate science. Although Piers left Goddard Space Flight Center and GEWEX in 1996 to, as he likes to say, "pursue my own career as a satellite," he remains a strong voice for climate science and has indicated he will probably return some day to this field of work.

Improved Daytime Precipitation Estimates Using SEVIRI Retrieved Cloud Properties

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Royal Netherlands Meteorological Institute, De Bilt, The Netherlands

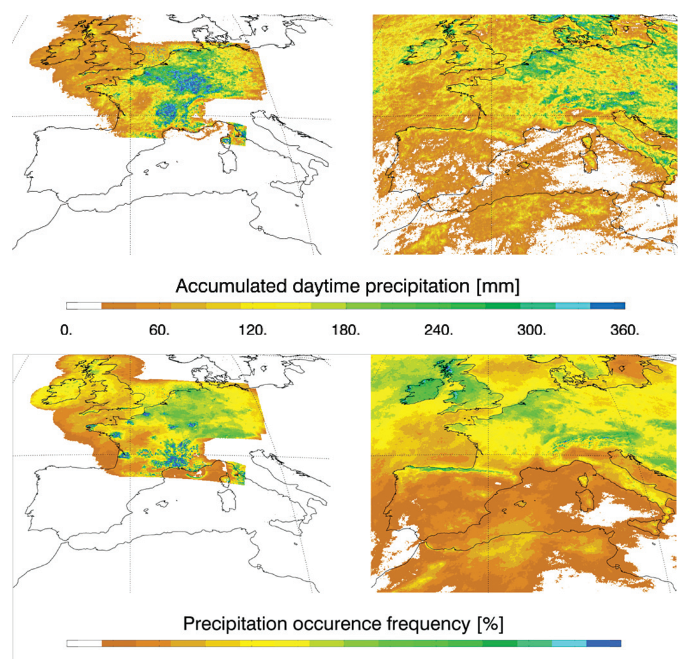
Precipitation is an important geophysical quantity that forms a crucial link between the atmosphere and the surface in weather and climate processes. Quantitative precipitation estimates at high spatial and temporal resolutions are of increasing importance for water resource management, for improving the understanding and prediction of precipitation in climate models, and for monitoring climate variability. Although operational networks of weather radars are expanding over Europe and North America, large areas remain where information on precipitation is lacking. Precipitation estimates from passive imagers may bridge this gap. Polar satellites can provide information on seasonal and interannual variations in precipitation at the global scale while geostationary satellites can provide this information on diurnal variations at quasi-global scales.

Over the past decades, several rain rate retrieval methods based on observations from visible (VIS) and infrared (IR) sensors were developed. The methods based on geostationary (GEO) satellites often use thermal IR observations and relate daily minimum cloud top temperatures (Anagnostou et al., 1999) or Cold Cloud Durations (CCD) to rain rates (Todd et al., 1995). These methods tend to perform reasonably well over areas where rainfall is governed by deep convection, but are less effective at higher latitudes, where precipitation originates from both convective and stratiform systems. A major limitation of the CCD methods is that rain rates are proportional to cloud duration, which is an assumption that fails in cases with high rain intensities occuring over short time periods (Alemseged and Rientjes, 2007).

The use of information on cloud physical properties provides an attractive alternative for the estimation of precipitation for different rainfall regimes. Nauss and Kokhanovsky (2007) showed that cloud liquid water path retrievals from the Moderate resolution Imaging Spectroradiometer (MODIS) daytime observations are directly proportional to the probability of rainfall. On the other hand, Rosenfeld and Lensky (1998) found that clouds require droplets with effective radii > 14 µm for the onset of precipitation. Roebeling and Holleman (2009) developed a novel approach, which uses information on cloud condensed water path, cloud thermodynamic phase, droplet effective radius, and cloud top height to estimate precipitation occurrence and intensity (rain rate) from VIS, near-infrared (NIR), and IR observations. They compared their retrievals, applied to observations from the Spinning Enhanced Visible and InfraRed Imager (SEVIRI), against corresponding weather radar observations for The Netherlands. The results show that their method is very accurate in retrieving precipitation occurrence (corr. ≈ 0.90), while the rain intensities are retrieved with a reasonable correlation (corr. ≈ 0.63) but a high accuracy (bias ≈ 0.1 mm hr-1). The fact that their approach can be applied to observations from geostationary satellites allows for the provision of precipitation estimates every 15 minutes on a quasi-global scale, and thus to study diurnal variations in precipitation.

The Operational Program on the Exchange of weather RAdar Information (OPERA) is a joint effort of 30 European countries consisting of more than 150 weather radars, aiming to provide a harmonized radar product over Europe. Although OPERA stimulates the harmonization of weather radar products, it needs to be emphasized that differences will remain, partially because the network comprises different types of radars (doppler and polarization radars) and each radar is calibrated separately.

The spatial variations in occurrences and accumulated precipitation from OPERA and SEVIRI reveal some remarkable differences (see figure below). In general, SEVIRI seems capable of retrieving spatial variations in precipitation occurrence realistically. Over the study period, the occurrence frequencies vary between 2% in Southern Europe and 25% in Northern Europe. Although the OPERA frequencies cover a similar range of values, OPERA shows up to 20% higher frequencies around the radar stations in France. These artefacts are probably caused by the calibration procedures applied to these radars. The accumulated daytime precipitations from OPERA and SEVIRI are in the same order of magnitude, and range between 30 and 300 mm. Still, there are significant differences in the spatial patterns. Over France OPERA values are generally higher than those of SEVIRI, while the opposite is found over the United Kingdom. Offline comparison with accumulated rain gauge data of the European Climate Assessment & Data set (ECA&D) revealed



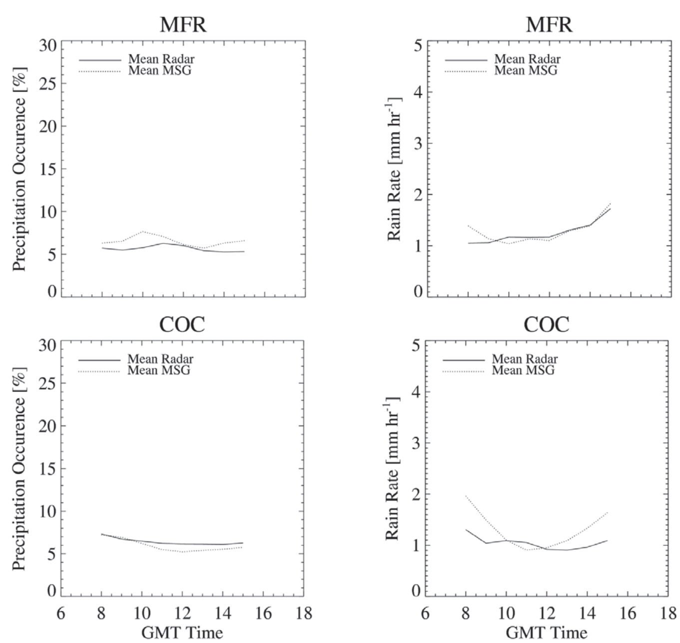
Precipitation occurrence frequencies and accumulated precipitation over Europe from OPERA (left) and MSG-SEVIRI (right) for daylight hours during the period of May through September 2006.

that SEVIRI reproduces the spatial patterns of ECA&D better than OPERA. This indicates that satellite instruments are favored over networks of ground-based radars for the retrieval of spatially consistent data sets of precipitation.

The high temporal resolution of SEVIRI advocates the use of precipitation retrievals from SEVIRI for studying the diurnal cycle. The figure below compares an ocean and land rain regime diurnal cycles of precipitation occurrence and intensity from OPERA and SEVIRI. For these rain regimes, the diurnal cycles of both observations agree well in magnitude and in daytime cycle. Over land the precipitation occurrence shows little variation, while the intensity increases as the day progresses. Over oceans there is a slight decrease in occurrence frequency in both data sets. In the OPERA data set the precipitation intensity decreases during the day, while in SEVIRI the minimum intensity occurs round noon.

The number of climatological applications is expected to increase substantially over the next few years, given the global character of satellite data. The GEWEX Global Precipitation Climatology Project (GPCP; Adler et al., 2003) has been collecting global satellite data since 1979. GPCP products are now used to evaluate models and verify scenarios on the impacts of various phenomena (e.g., El Niño Southern Oscillation or volcanic eruptions) on climate.

The key to success in using satellite data is in the retrieval accuracy. Although the use of VIS and NIR observations limits studies to daylight hours, having quantitative information on precipitation from geostationary satellites would constitute a major added value for climate studies. We have shown that



Daytime cycles of precipitation occurrence (left) and intensity (right) over land in central France (MFR) and ocean (COC) for OPERA and SEVIRI for the period of May to September 2006.

SEVIRI is well capable of deriving accurate retrievals of rain occurrence and intensity for different rain regimes. During daylight hours diurnal cycles of these properties can be derived. Because SEVIRI retrievals are based on a single instrument and algorithm, their quality is arguably spatially consistent. This spatial consistency is harder to achieve for weather radar based networks, which rely on different radars and different retrieval algorithms. In future research, SEVIRI based precipitation retrieval will be further improved by correcting for below-cloud evaporation and validation over other regions and against other types of information (e.g., Tropical Rainfall Measuring Mission Precipitation Radar; Wolters et al., 2010).

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Meeting/Workshop Reports

11th BSRN Scientific Review and Workshop
Queenstown, New Zealand
13–16 April 2010

Ellsworth Dutton[1] and Dawn Erlich[2]

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There were 39 scientific and programmatic talks along with 15 posters presented at the eleventh biennial Baseline Surface Radiation Network (BSRN) Workshop, which was hosted by Richard McKenzie, with the support of Graeme Strang, both of the New Zealand National Institute of Water and Atmospheric Research (NIWA). The workshop brought together BSRN scientists, station managers, and data users to review the status of BSRN activities, including the latest developments in instrumentation, operational procedures, data management, and quality control; to discuss some of the scientific progress achieved as a result of the availability of the BSRN and its data archive; and to consider future needs and plans for BSRN.

The BSRN Project is under the oversight of the GEWEX Radiation Panel and provides structure and general guidance to a select group of international surface radiation observing sites. These sites voluntarily contribute their efforts and data to a central BSRN data archive while adhering to a set of requirements and specifications developed by and for the BSRN. Those requirements and specifications, as well the overall goals have been subject to review and revision as new needs, capabilities and technology appear. The network has grown from nine reporting sites in 1992 to 47 sites that have provided data by 2010, although three of those sites are considered no longer active. There are about 20 additional sites that have indicated an intent to participate and may be able to provide both prior and current data. This workshop provides and excellent forum where many of those in attendance share similar interests and often conduct related investigations. Most presentations were given on the work being performed by BSRN site scientists or others on topics related to the observation and analysis of surface solar and infrared radiation. A few of those are summarized in the following paragraphs. The complete agenda and copies of the presentations are available at: *http://www.gewex.org/bsrn.html.*

The World Radiation Monitoring Center (WMRC) at the Alfred Wegener Institute (AWI) of Polar and Marine Research in Bremerhaven, Germany serves as the central archive for BSRN data and has operated at AWI since July 2008. As of January 2010 there were a total of 5622 station-month data sets from 47 BSRN stations available at WRMC. For data retrieval, the information system, Publishing Network for Geoscientific and Environmental Data (PANGAEA; *http://www.bsrn.awi.de/en/data/data_retrieval_via_pangaea/*) is a good alternative to the complex WMRC ftp-access for BSRN data. Atmospheric optical depths (AOD) as well as the corresponding transmission measurements will be included in the WRMC PANGAEA-service in the near future. An updated Technical Plan for BSRN Data Management that will include some of the new parameters, such as pyrgeometer temperatures, is in preparation.

Representatives from the Global Climate Observing System (GCOS) and GEWEX reported on recent activities of their respective organizations. BSRN was encouraged to identify potential projects that might help improve the operation of certain stations.

In March 2010, the Japan Meteorological Agency began operation of four new BSRN-type stations in Japan (Sapporo, Fukuoka, Ishigakijima and Minamitorishima) and requested the approval of these as BSRN sites. Two stations in Tenerife were proposed as BSRN stations—Izana located at an elevation of 2400 m and the Santa Cruz station at sea level. Two stations, in addition to the five already operating in Brazil, and a site on Reunion Island, were also proposed to join the network.

An analysis of BSRN data for validating the GEWEX Surface Radiation Budget (SRB) Project 3.0 data is focused on the the downwelling components of the radiation budget. Considerable effort has gone into the evaluation of the data quality with several specific issues highlighted. Overall, the study found that SRB and BSRN comparisons in the shortwave (SW) depend, in part, on the evaluation criteria, while longwave (LW) comparisons are less sensitive to the methodology. AOD measured from 1996–1997 (and continuously since 1999) over the Lauder BSRN station (located in Central Otago, New Zealand) have mean values that are among the lowest observed worldwide. There was an insignificant downward trend in mean AOD over the

Particpants at the 11th BSRN Scientific Review and Workshop.

period 1999–2008. Global dimming and brightening in New Zealand is apparent in the pyranometer data taken from four long-term sites. Attribution to the direct aerosol effect is uncertain from clear-sky vs. all conditions, but AOD data from Lauder are too low for this to be a substantial component. Using the 20 BSRN sites with at least one decade of useful data, an update of trends in global surface solar radiation to 2009 indicates a slow-down of global brightening after the year 2000, compared to similar earlier analyses. See page 6 for information about a special issue of the *Journal of Geophysical Research* on global dimming and brightening.

A study for the period 1961–2005 in China investigated dimming and brightening of surface solar radiation (SSR) and its relationships to total cloud cover (TCC). The surface records suggest a renewed dimming beyond 2000 in North China after the stabilization in the 1990s. However, a slight brightening appears beyond 2000 in South China. Decreased atmospheric transparencies during 1991–2005 in North China in most cases led to the dimming. TCC frequency changes also contributed to the dimming during this period in North China. In South China, increased atmospheric transparencies lead to a slight brightening during 1991–2005. With the recently available Clouds and the Earth's Radiant Energy System (CERES) instrument Energy Balanced And Filled (EBAF) data sets, it is now possible to combine surface SW absorption (calculated from BSRN data and surface albedo from the Moderate Resolution Imaging Spectroradiometer-MODIS) and the CERES top-of-atmosphere (TOA) SW absorption, to determine atmospheric column SW absorption above the BSRN sites along within estimation of partitioning between surface and atmospheric absorption. The combination of BSRN observations with satellite TOA observations will also allow a better identification of origins of trends in surface solar radiation and a view of the full 3-dimensional picture of radiation changes.

A brief synopsis of other important reports given on instrument performance and evaluation, along with presentations on specific interests and needs of BSRN follows. A preliminary result from an extended intercomparion of commercially available pyrheliometers showed in some cases, reasonably good near-replication of reference windowed cavity radiometers. One new working group is fostering various interests in the evaluation of long-term variability of surface radiation, while another is addressing the needs for making BSRN measurements in cold regions. Procedures by which spectral direct beam observations at the network field sites will be centrally submitted and processed into a BSRN aerosol optical depth product were finalized. Continued efforts to refine thermal infrared observations and reference calibration standards at the World Radiation Center in Davos, Switzerland were discussed. The measurement of and health issues relating to solar UV exposure were highlighted in three separate talks. Several studies related to contributions from clouds to variability in the radiation data, always an interesting topic with this group, were presented and evaluated.

ESA Climate Change Initiative – Climate Modellers User Group (CMUG)

Roger Saunders
Met Office Hadley Centre

The future improvement of climate models and reanalyses depends on high quality global observational data for initializing models, validating model simulations and for developing parameterizations to represent complex physical (subscale) processes. The European Space Agency (ESA) has 20 years of satellite observation data sets and many of these are going to be reprocessed specifically with climate applications in mind. In the initial effort, climate quality data sets for 11 Essential Climate Variables (ECVs) are being addressed.

	Phase I ECVs
	Oceanic Domain
O.1	Sea Ice
O.2	Sea Level
O.3	Sea-Surface Temperature
O.4	Ocean Color
	Terrestrial Domain
T.1	Glaciers & Ice Caps
T.2	Land Cover
T.3	Fire Disturbance
	Atmospheric Domain
A.1	Cloud Properties
A.2	Ozone
A.3	Aerosol Properties
A.4	Greenhouse Gases

To ensure that climate modellers' requirements are met, ESA is funding an overarching initiative to scope out the following: (i) What types of observational data are needed for climate modelling and climate services? (ii) What are the most important climate variables and how should they be processed? (iii) What are the requirements for integrating satellite data products with climate models? (iv) What data formats are needed and how will the data be accessed by the climate community ?

This activity is being led by the Climate Modellers User Group (CMUG), a consortium of four partners, the Met Office Hadley Centre, the Max Planck Institute for Meteorology, the European Centre for Medium-Range Weather Forecasts (ECMWF), and MétéoFrance.

The overall objectives of CMUG are threefold:

1. Support integration within the Climate Change Initiative (CCI) Programme by providing ESA and data producers with requirements and user assessment from the climate modelling community, and feedback from a "climate system" perspective (e.g., examining consistencies across ECVs, synergies).

2. Foster the exploitation of global satellite data within the climate modelling community by promoting the use of ESA-CCI data sets to climate modellers, and by building partnerships and links with existing research organizations, networks, and scientific bodies of the climate modelling community.

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3. Assess the quality and impact of individual/combined Global Satellite Data Products in the Climate Model and Data Assimilation context by assessing suitability of products for climate applications (e.g., climate modelling, decadal prediction, reanalysis), and by quantifying their incremental value on model performance in an objective manner.

Starting with the observation requirements as formulated by the Global Climate Observing System (GCOS) for all selected ECVs, CMUG has started the process of gathering feedback from climate modellers to refine these requirements. CMUG is interested in reaching out to all organizations with a need for quality climate satellite datas sets. More specifically, if you are a climate modeller or at least are working with reanalyses or climate data, CMUG hopes that you will share your thoughts and suggestions.

Please complete the questionnaire at the CMUG website (*http://www.cci-cmug.org*). This is a unique opportunity to help shape the outcome of the entire program and it is important to ensure that the data sets produced are fit for their purpose. You may also contact us via E-mail (*cmug@metoffice.gov.uk*).

GEWEX/WCRP Calendar

For the complete listing, see the GEWEX web site: http://www.gewex.org

14–18 June 2010—6th Study Conference on BALTEX—Miedzyzdroje, Island of Wolin, Poland.

22–25 June 2010—2nd Hydrology delivers Earth System Science to Society (HESSS) International Conference—Tokyo, Japan.

22–25 June 2010—Joint Meeting for GSWP/GLASS, AsiaFlux/FLUXNET, and LandFlux-EVAL—Tokyo, Japan.

22–25 June 2010—GEWEX Cloud Assessment Workshop—Berlin, Germany.

28–30 June 2010—15th International Symposium for the Advancement of Boundary Layer Remote Sensing—Paris, France.

28 June–2 July 2010—13th Conference on Cloud Physics and Atmospheric Radiation—Portland, Oregon, USA.

28 June–2 July 2010—ESA Living Planet Symposium—Bergen, Norway.

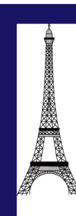
29 June–1 July 2010—International Climate Change Adaptation Conference: Climate Adaptation Futures: Preparing for the Unavoidable Impacts of Climate Change—Queensland, Australia.

2–3 July 2010—10th Kovacs Colloquium Hydrocomplexity: New Tools for Solving Wicked Water Problems—Paris, France.

7–9 July 2010—THORPEX/WGNE Workshop on Diagnosis of Model Errors—Zurich, Switzerland.

WCRP/UNESCO Workshop on Metrics and Methodologies of Estimation of Extreme Events

Paris, France
27-29 September 2010



19–21 July 2010—Second CAS-CEOP International Workshop on Energy and Water Cycle over the Tibetan Plateau and High-elevations—Lhasa, China.

19–23 July 2010—British Hydrological Society's Third International Symposium: Role of Hydrology in Managing Consequences of a Changing Global Environment—Newcastle upon Tyne, UK.

21–23 July 2010—The 4th International Workshop on Catchment-scale Hydrological Modelling and Data Assimilation (CAHMDA-IV)—Lhasa, China.

23–27 August 2010—2nd Pan-Gewex Science Meeting—Seattle, Washington, USA.

23 August–3 Sept 2010—2010 International Aerosol Conference—Helsinki, Finland.

1–4 Sept 2010—12th Plinius Conference on Mediterranean Storms—Dassia, Corfu Island, Greece.

13–17 Sept 2010—2010 Storm Surge Risk and Management Congress—Hamburg, Germany.

13–17 Sept 2010—10th Annual Meeting of the European Meteorological Society—Zurich, Switzerland.

26–30 Sept 2010—International Conference on Global Change and the World's Mountains—Perth, Scotland.

27–29 Sept 2010—WCRP/UNESCO Workshop on Metrics and Methodologies of Estimation of Extreme Climate Events—UNESCO, Paris, France.

4–6 Oct 2010—14th Session of the Working Group on Coupled Modelling (WGCM)—Exeter, United Kingdom.

11 Oct 2010—Joint GEWEX International Soil Moisture Working Group (ISMWG) and CEOS Soil Moisture Validation (SMV) Meeting—Vienna, Austria.