

**GEWEX Cloud System Study (GCSS)**  
**Chair: Steve Krueger, University of Utah**

## **Background**

The goal of GCSS is to improve the parameterization of cloud systems in GCMs (global climate models) and NWP (numerical weather prediction) models through improved physical understanding of cloud system processes. The main tool of GCSS is the cloud-resolving model (CRM), which is a numerical model that resolves cloud-scale (and mesoscale) circulations in either two or three spatial dimensions. The large-eddy simulation (LES) model is closely related to the 3D CRM, but resolves the large turbulent eddies. The primary approach of GCSS is to use single-column models (SCMs), which contain the physics parameterizations of GCMs and NWP models, in conjunction with CRMs, LES models, and observations, to evaluate and improve cloud system parameterization.

GCSS is composed of five working groups:

- Boundary-layer cloud systems (Chair: C. Bretherton)
- Cirrus cloud systems (Chair: P. Brown)
- Extratropical layer cloud systems (Chair: G. Tselioudis)
- Precipitating convective cloud systems (Chair: W. Grabowski)
- Polar cloud systems (Chair: J. Curry)

C. Bretherton and P. Brown began serving as WG chairs during 2002.

## **Status**

In May 2002, a Workshop organized by GCSS was held at Kananaskis Village, Alberta, Canada, that brought together a diverse group of over 70 scientists from 9 countries. This group included global modelers with an interest in cloud parameterization, mesoscale and microscale cloud modelers and observationalists, radiative transfer specialists, cloud microphysics/aerosol specialists, and re-mote sensing specialists. Representatives from many global modeling and NWP centers were present.

In addition to plenary sessions devoted to activities of each of the five GCSS Working Groups, there were sessions on the representations of clouds and radiation in GCMs, general observations of clouds and radiation, and on modeling cloud microphysics, chemistry, aerosols, and radiation. In comparison to the 1998 Workshop, the talks reflected the increasing interaction of GCSS with the radiation, microphysics, aerosol, and cloud-remote sensing communities. Based on the talks presented at the workshop, the following scientific advances are expected in the GCSS WGs during the next several years:

- (1) rapid progress on the representation of sub-grid scale cloud overlap and inhomogeneity due to the combination of CRMs, cloud radar observations, and faster methods of calculating radiative fluxes for arbitrary cloud configurations;
- (2) steady progress in the understanding and representation of cloud microphysical, formation, and dissipation processes due to integrated use of LES (large-eddy simulations) models, CRMs, SCMs, GCMs, and cloud-scale observations, plus insights from recent and upcoming field experiments; and
- (3) use of super-parameterizations (i.e., CRMs used as parameterizations) in some GCMs will provide more physically realistic representations of cloud processes, to increase knowledge and understanding of interactions between cloud processes and large-scale processes (including cloud feedbacks), and to help improve conventional parameterizations.

## Highlights of recent and planned working group activities:

**Working Group 1 (WG1), Boundary-Layer Cloud Systems** (Chair: C. Bretherton), has recently completed a model intercomparison project (MIP) on the diurnal cycle of shallow cumulus over land and another on the diurnal cycle of marine stratocumulus. In coordination with the EUROpean Cloud Systems (EUROCS), WG 1 is also undertaking a survey of how well large-scale models represent boundarylayer clouds over the northeast Pacific in a cross section from California southwest to the Inter-Tropical Convergence Zone (ITCZ) (<http://www.knmi.nl/samenw/eurocs>).

An important step toward WG 1's goal of a trade cumulus experiment occurred during 2002 as WG 1 participated in the collaborative preparation of the scientific overview document for RICO (Rain In Cumulus over the Ocean) Experiment (<http://rico.atmos.uiuc.edu>). RICO should take place near Puerto Rico in December 2004.

WG 1 is planning a series of intercomparisons on both stratocumulus and shallow cumulus clouds. Their initial focus will be on the nocturnal stratocumulus-capped mixed layers observed in DYCOMS (Dynamics and Chemistry of Marine Stratocumulus)-II (<http://www.atmos.ucla.edu/~bstevens/papers/dycoms.pdf>). DYCOMS-II was planned to be the basis of WG 1 modeling studies by a member of WG 1 (B. Stevens). Margreet van Zanten of UCLA will organize a comparison of two DYCOMS-II cases: the first nonprecipitating and the second heavily drizzling. Future cases will be based on EPIC (Eastern Pacific Investigations of Climate) 2001 (S.E. Pacific stratocumulus) and RICO (Caribbean trade cumulus).

**WG 2, Cirrus Cloud Systems** (Chair: P. Brown) has completed two idealized MIPs, one for cirrus parcel models and another for cirrus CRMs. The next MIP will be based on cirrus from Hurricane Nora as observed at the ARM (DOE Atmospheric Radiation Measurement program) Southern Great Plains (SGP) site.

The current MIP for **WG3, Extratropical layer cloud systems** (Chair: G.Tselioudis), is based on the March 2000 Intensive Observation Period (IOP) at the ARM SGP. In addition to ground-based and satellite remote-sensing measurements of clouds, there were many obtained from aircraft. WG 3 is also undertaking a survey of cloud properties in large-scale models for a climatological March using March 2000 surface boundary conditions. Model results are to be submitted by the end of April 2003. Analysis of the results will be presented at a Fall 2003 workshop in Greece.

**WG 4, Precipitating Convective Cloud Systems** (Chair: W. Grabowski), is continuing analyses of Case 3, a MIP based on the summer 1997 IOP at the ARM SGP site. The current MIP is an idealized case based on the observed diurnal transition from shallow to deep convection over the Amazon.

**WG 5, Polar Cloud Systems** (Chair: J. Curry) current activities include participation in the Arctic Regional Model Climate Model Intercomparison Project, a Radiation Model Intercomparison Project, and Stable Boundary Layer Model Intercomparison Project.

## Other Activities

An Ad Hoc activity called the Data Integration for Model Evaluation (DIME) has the goal is to provide "test kits" for model evaluation based on the GCSS MIPs, including detailed results from the participating CRMs. DIME (chair: W. Rossow) has a website at <http://gcss-dime.giss.nasa.gov>.

A collaborative effort by GCSS, EUROCS, ARM, and AMIP (Atmospheric Model Intercomparison Project) to systematically evaluate clouds in GCMs began to take shape during 2002.

The revised GCSS Science Plan ([http://www.gewex.org/gcss\\_sciplan.pdf](http://www.gewex.org/gcss_sciplan.pdf)) is described in this article (accepted by Bulletin of the American Meteorological Society): Randall, D.A., and 10 coauthors, 2003: Confronting Models With Data: The GEWEX Cloud Systems Study.

The highlight is a new strategy that includes a more active role for the large-scale modeling community, and an explicit recognition of the importance of data integration.