(1) COSP be used in a subset of the main numerical experiments that will be coordinated by the Coupled Model Intercomparison Project (CMIP) in support of the next IPCC assessment report;

(2) a few idealized experiments be included in the set of the next climate model intercomparison project (CMIP5) experiments; and

(3) additional cloud diagnostics proposed by CFMIP-GCSS be extracted from the models participating in CMIP5.

A broad scientific community interested in cloud studies, both on the modelling and observation sides, is keen to participate in this effort and contribute to advances in cloud-climate feedback assessments by the time of the Fifth Assessment Report of the IPCC. By that time and beyond, these initiatives will also benefit from and support GEWEX-WGNE joint efforts on the improvement of physical parameterizations in climate models.

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Meeting/Workshop Reports

WATCH/LoCo Workshop

25–27 June 2008
De Bilt, The Netherlands

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The joint workshop of the European Union Water and Global Change (WATCH) Project and GEWEX Local Coupled Project (LoCo) Workshop brought together experts on hydrological land-atmosphere coupling to assess current knowledge of land-atmosphere coupling and develop plans for future studies. Research in modelling and observing the degree of land-atmosphere coupling and feedbacks on local and regional scales has been evolving since the start of the well-known GEWEX Global Land Atmospheric Coupling Experiment (GLACE). WATCH addresses hydrological land-atmosphere coupling, and LoCo under the GEWEX Global Land Atmosphere System Study (GLASS) is studying local land-atmosphere coupling to identify conditions or areas where land-atmosphere interaction has a significant impact on the local climate. LoCo also designs model intercomparison studies. Results from the workshop included a better definition of local coupling and an outline of an overview scientific paper on the topic.

A good conceptual definition of local land-atmosphere coupling involves the temporal and spatial scale of all land surface-related processes directly influencing the state of the Planetary Boundary Layer (PBL) (see figure on page 13). These processes include:

(1) direct moistening/drying and heating/cooling of the PBL, and the feedback exerted by this PBL change on the surface fluxes;

(2) impact of the change of the PBL depth or thermodynamic state on the formation/disappearance of PBL clouds (shallow cumulus) induced by land surface fluxes;

(3) triggering and fuelling of shallow or deep convection; and

(4) accumulation of hydrological anomalies in the soil water or snow reservoir, as well as the subsequent impacts of these surface states on the surface energy balance.

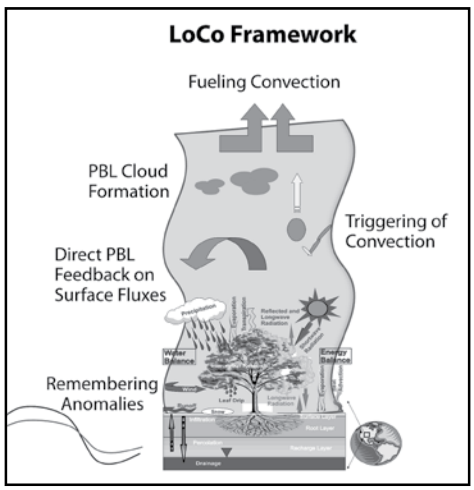
It was also recognized that many expressions of land-atmosphere coupling are not easily tied to the local scale, such as precipitation response to changing soil moisture in GLACE. Large-scale atmospheric circulation—under certain conditions—is also clearly affected by the state of the land surface. These examples are considered to be beyond the immediate scope of the LoCo theme. Each of the processes listed above is briefly discussed below, guided by the presentations and discussions that emerged during the workshop.

Direct Land-PBL Feedback
While evaporation clearly moistens the atmosphere, it does

(partly) rely on the atmospheric demand for water, depending on the moisture condition: a straightforward feedback loop is evident. However, the state of the (well-mixed dry) PBL is not only dependent on the surface fluxes of heat and moisture but also on the overlying free atmosphere. Daytime PBL drying occurs due to a mixing-in of dry air, in spite of an upward surface moisture flux. This feedback needs to be considered when trying to estimate surface evaporation from simple environmental variables, like available energy (A) or vapor pressure deficit (D).

A number of diagnostics and concepts were discussed at the workshop. Jim Shuttleworth used the definitions of “climatological resistance” (defining the ratio between A and D and the “area average surface resistance” to give a theoretical explanation for differences in trends between open water and actual evaporation rates, depending on the aridity of the climate. Compared to earlier concepts of the Priestly-Tailor coefficient or McNaughton’s coupling coefficient, the role of PBL feedback in the characterization of the surface state is clear.

Likewise, Joe Santanello expanded on earlier work by Alan Betts by decomposing the diurnal evolution of the surface temperature and humidity into a surface driven and entrainment driven component. Pilot studies with the National Aeronautics and Space Administration’s (NASA) Land Information System (LIS) were carried out to identify the impact of switching between a suite of land surface or PBL models. The diagnostic is also built into the Single Column Model (SCM) testbed environment developed by Roel Neggers, which is used more and more in GEWEX Cloud System Study (GCSS) and GEWEX Atmospheric Boundary Layer Study (GABLS) model intercomparison studies.



Cumulus Formation

Michael Ek cast the relative contribution of land wetness versus atmospheric entrainment nicely in an expression of the PBL relative humidity tendency. He performed SCM studies for a few special cases where PBL cloud formation appeared to be highly sensitive to both surface evaporation and atmospheric stability above the PBL. However, cloud formation (and its impact on surface radiation and conditional stability) is not well embedded in the diagnostics above, so these feedbacks need to gain more attention in future diagnostic studies.

Triggering and Fuelling Convection

Although she was not present at the workshop, the work of Kirsten Findell proved a valuable component of the LoCo theme, particularly those pieces dealing with the creation of area maps and conditions where soil moisture values affect the formation of convection (Findell and Eltahir, 2003). SCM models were forced with observed atmospheric profiles that were used to identify when and where different soil moisture states were able to determine whether or not convection was triggered. Although in many cases convective triggering is not determined by the local soil moisture state, cases can be found where convection is preferably triggered over either moist or dry soils. Craig Ferguson expanded on this concept by calculating the Convective Triggering Potential (CTP) and the atmospheric dewpoint depression from Atmospheric Infrared Sounder (AIRS) satellite data, as a first promising step to create land-atmosphere feedback maps from spaceborne observations. In addition, he explored the correlations between soil moisture and Lifting Condensation Level (LCL) using Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) data.

On a somewhat smaller scale, Chris Taylor studied the formation and dynamics of Mesoscale Convection Systems in the Sahel region, depending on the spatially varying surface temperature pattern induced by earlier rain storms. He argues that convective triggering often takes place at the interface between wet and dry soil patches, where both a sufficient surface heating and further fuelling of the convective system with moisture occur. His work clearly points at the need to consider spatial variability as a contributor to convective activity and land-atmosphere feedback within the scope of LoCo.

Accumulation of Anomalies

The (hydrological) land state has a long memory; many observational and modelling studies have shown the importance of hydrological anomalies in the past to explain extreme conditions in the present. Local land-atmosphere interaction may turn into long-lasting positive feedback loops when critical thresholds are exceeded. Sonia Seneviratne used a plot of monthly mean surface evaporation /sensible heat versus a soil moisture index to demonstrate a clear difference in memory (causing hysteresis in the plot) for a Northern and Southern European Fluxnet site. This type of analysis can be used to evaluate the realism of land-atmosphere coupling representation in current climate models.

One of the ultimate goals of the LoCo community is to produce comprehensive global distributions of where and when the land surface and the atmosphere have a strong mutual feedback, either positive or negative. The importance of this is demonstrated by Stefan Hagemann, who reviews the various pathways of land-atmosphere coupling and their representation in global climate models (GCMs) used for present-day and future climate calculations. Bernie Bisselink’s precipitation recycling analysis made clear that on relatively short mutual distances within Europe, strong recycling is favored under very different climatological conditions. Since multiple diagnostics and processes are involved, multiple maps already exist. Randy Koster provided observational support of the earlier defined “hotspots” of land atmosphere coupling by pinpointing areas where the correlation between temperature and precipitation identifies regions where evaporation is both highly variable (by a variation in the degree to which it is controlled by radiation or soil water content) and highly coherent (expressing a strong surface control on the evaporation). Such hotspot regions are highly dynamic and are expected to be geographically shifted with climate change, as highlighted by Sonia Seneviratne. Richard de Jeu used satellite imagery of surface soil moisture to plot the global distribution of typical time scales of changes in soil moisture, another way to express the potential soil control on evaporation variability. Together with the remote sensing based maps of Craig Ferguson, a suite of coupling products will become available that highlights different aspects of the coupling: the PBL feedback (Betts' soil moisture LCL diagram), convective triggering, soil memory (satellite soil moisture), and pathways possibly including large scale processes (Koster's coupling coefficient).

A global map with coupling strength diagnostics needs to incorporate these various coupling mechanisms. As a start, we propose to apply a hierarchy approach where the coupling pathway may be associated with an index, which is subsequently plotted. The first level of coupling is the direct PBL feedback, which may be expressed as the degree to which evaporation is sensitive to soil moisture. A positive feedback may emerge when low evaporation/high sensible heat flux may enhance PBL growth that leads to further drying and a higher Bowen ratio. A second level would cover the formation of PBL clouds and its radiative consequences. A positive feedback here might be a case where clouds develop at high moisture contents, reducing surface radiation, surface heating, and PBL growth and allowing for a further build-up of PBL humidity. The third level is the triggering of convection, which may show positive or negative feedbacks via the likelihood of generating precipitation that moistens the soil, as detailed by Findell and Taylor. Finally, level four expresses an overall hydrological feedback signature that is produced by the impact of land surface on precipitation, i.e., diagnosed from the coupling coefficient detailed by Koster.

What would such a map look like? Starting from the first level coupling, areas will be highlighted where changes in soil moisture do have a pronounced effect on the daytime PBL. For instance, the ratio between the surface and entrainment Bowen ratio diagnosed from Santanello's framework changes significantly for small soil moisture perturbations. Where this is not the case, a strong impact of land surface on the atmospheric state cannot be expected, and further analysis is not necessary. For areas where index 1 is significant, the second and third feedback via cloud formation or convective triggering can be tested. Likewise, a small soil moisture perturbation leads to cloud formation which is either shallow without rain (index 2) or deeper with possible rainfall (index 3). The formation of rainfall will at the end be labeled as index 4. If somewhere in the chain this feedback appears weak or even negative, a strong impact of (local) land state on (local) precipitation is not expected.

This framework is still maturing; a proof of concept will be examined using the NASA LIS coupled to the Weather Research Foundation atmospheric model featuring a suite of land, PBL and convection parameterization schemes. For a number of different climate regimes, a set of snapshot experiments will be set up and perturbation experiments applied to determine the hierarchy of coupling indices. If this set-up is successful, we will extend it to the multi-year global scale. For more information, visit *http://www.knmi.nl/~hurkvd/LoCo_workshop_2008.html.*

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10th BSRN Scientific Review and Workshop

De Bilt, The Netherlands
7–11 July 2008

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More than 50 scientific talks and 20 posters were given at the tenth biennial Baseline Surface Radiation Network (BSRN) Scientific Review and Workshop, held at the Royal Netherlands Meteorological Institute (KNMI). Over 60 BSRN station managers, data users and experts in the field of surface radiation measurements attended.

Dr. Reinout Boers, KNMI, gave the first presentation, an overview of the observations and research activities at the Cabauw Experimental Site for Atmospheric Research (CESAR). In addition to its monitoring activities for BSRN, CESAR participates in other projects such as the GEWEX Coordinated Energy and Water Cycle Observations Project (CEOP) and the World Meteorological Organization Global Atmosphere Watch (GAW) Programme.

Gert König-Langlo of the Alfred Wegener Institute (AWI), reported on the progress of the relocation of the World Radiation Monitoring Center (WMRC), housing the BSRN data archive, from the Federal Institute of Technology Zurich (ETHZ) to AWI in Bremerhaven, Germany. In June 2008, full responsibility for the operation of WRMC was transferred to AWI. Currently, the archive holds 4,032 station-months from 43 stations. Data can be accessed at *http://www.bsrn.awi.de.*

Four new BSRN sites are now operational in Brazil (Rolim de Moura, Brasília, Petrolina, and São Martinho da Serra), along with the two existing sites in Florianopolis and Balbina. The Florianopolis site is being moved to a new location outside the city and there is a proposal to move Balbina (now in the Amazon) to a Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA) site because its current location is too remote and hard to maintain.

The National Renewable Energy Centre (CENER) in Pamplona, Spain, and Eureka station in Nunavut, Canada, were approved as new BSRN stations.

Richard Thigpen, Global Climate Observing System (GCOS) Secretariat, reported on WMO Activities aimed at improving the operation of GCOS networks, mainly the surface (GSN) and upper air (GUAN) networks. Several upper air and surface stations have been renovated, and workshops focused on surface and upper air measurements have led to improved quality of observations. Four technical support projects have been established in developing areas to provide direct technical support to GCOS stations. Nine Commission for Basic Systems (CBS) Lead Centers for GCOS have been established around the world