CEOP Coordinated Enhanced Observing Period

An Element of the World Climate Research Programme (WCRP),
initiated by the Global Energy and Water Cycle Experiment (GEWEX)

Newsletter No. 3
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CEOP Web Site: http://www.ceop.net

INTERNATIONAL COMMITMENT & CO-OPERATION: KEYS TO A SUCCESSFUL CEOP

David Carson, Director, World Climate Research Programme

In situ measurements, enhanced satellite observations, and model products are the fundamental components of the CEOP strategy, and a uniquely co-ordinated set of these data types is necessary to address the CEOP scientific objectives. Planned, co-ordinated and structured international commitments, co-operation and collaboration are therefore crucial elements of the implementation of CEOP, and so it is most gratifying to be able to acknowledge a wide range of colleagues whose individual and collective efforts are shaping CEOP towards a realization of these goals.

A key factor are the commitments from the CEOP surface reference sites, which are associated with the Global Energy and Water Cycle Experiment (GEWEX) Continental Scale Experiments that are located in Africa, the Americas, Asia, Australia, and Europe. Data from these sites are being received at the CEOP Central Archive that has been established temporarily through a commitment of the USA.

Data from the suite of operational and experimental remote-sensing satellites, including the GMS, METEOSAT, GOES and POES, ADEOS-II(Midori-2), ENVISAT, TRMM, Aqua, Terra, etc., being provided by National Meteorological and Hydrological Services and Space Agencies, such as JMA, EUMETSAT, NOAA, NASA, NASDA, ESA, NASA, and others, are expected to be available for various times over the CEOP Observational Period from 2001 to the end of 2004. These will be co-ordinated in space and time with the *in situ* data to provide enhanced observing capabilities to quantify critical atmospheric, surface, hydrological and oceanographic data. Multi-national agreements have already ensured that data sufficient to meet the requirements of the initial enhanced observing period (EOP-1) will be available from at least a subset of these spacecraft.

The requirements for model output data are divided into: one-dimensional vertical profile and surface time series at selected locations, referred to as Model Location Time Series (MOLTS); gridded two-dimensional fields, especially ground-surface state and flux fields, top-of-the-atmosphere (TOA) flux fields, and atmospheric fields; and gridded three-dimensional fields of the atmospheric variables. Agreements have been reached with global modelling centres in Australia, Brazil, Japan, UK and USA to generate and deliver the required model output products. A central, model-data handling and retention centre for CEOP has been contributed through the Max Planck Institute for Meteorology, Hamburg, Germany. A subset of these contributors has agreed to generate regional and global MOLTS for the EOP-1 period. Because of the large volumes of data involved, the requirements for the full 3-D output for the CEOP annual-cycle periods are being addressed carefully in terms of their relevance to specific CEOP investigations.

The data and related products being provided to CEOP are, of course, of value in a wider sense, to both the originators and others, and their provision and use are encouraging a synergistic gearing of mutual benefit to all parties involved. Practical examples of this new co-operative approach to broad climate research issues can be found elsewhere in this Newsletter in the article related to the Water and Energy Simulation and Prediction (WESP) scientific component of CEOP, and also in the proceedings of the first CEOP Monsoon Systems Studies Working Group Workshop, which defined a CEOP Inter-monsoon Model Study (CIMS). The latter document is available in draft form (from chautard_a@gateway.wmo.ch) and will soon be available in the WCRP Informal Report series.

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Calendar of CEOP Meetings :

- **CEOP Reference Site Managers Meeting:** Berlin, Germany 31 March-1 April 2003
- **The 2nd CEOP Implementation Planning Meeting:** Berlin, Germany, 2-4 April 2003
- **CEOP/GEWEX Workshop on the role of the Himalayas and the Tibetan Plateau within the Asian Monsoon:** Milan, Italy: 7-8 April 2003

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We cannot, however, be complacent about the level of success achieved so far. The current commitments are *ad hoc* and barely sufficient for the short-term focus within CEOP on the EOP-1 dataset, for July-September 2001. In some cases, even these are in jeopardy. I support wholeheartedly, therefore, the redoubling of the efforts of the CEOP Organizational Structure to formalise current agreements. **I also appeal to all relevant Agencies and Organizations to help establish a more formal and longer-term funding structure that recognises CEOP as an important and useful scientific undertaking. We need current groups to formally commit to the delivery of their contributions to CEOP to meet its near term goals associated with finalizing work on EOP-1 and ideally to establish the budgets, resources, and work programmes needed to ultimately deliver the two CEOP annual cycle datasets. Corresponding commitments are also sought for the CEOP Research Phase, beyond the end of 2004. As Director of WCRP, I remain committed to helping achieve the full implementation and success of CEOP.**

Scientific Report on WESP CEOP Pilot Data Comparisons

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Abstract CEOP has begun to collect the model and *in situ* data needed to validate water and energy budgets at a wide variety of international reference sites. This brief analysis is only one example of how the CEOP *in situ* and model output datasets may be of value to the research community. There are clearly difficulities that models have in depicting the diurnal and seasonal cycles that need to be addressed. As a more complete set of observations (*in situ* and remotely sensed) and model output becomes available at a wide variety of locations, through channels established by CEOP, it can be expected that these new tools will provide the basis for efforts that may improve understanding of these issues and also lead to their mitigation. These efforts could then ulitmately be expected to lead to improved global hydrometeorological predictions.

1. Background

CEOP is an element of the World Climate Research Program (WCRP) initiated by the Global Energy and Water Cycle Experiment (GEWEX) to develop *in situ*, satellite, and model data focused on hydroclimatological processes in the atmosphere and land surface. The observation and data collection phase extends from 1 July 2001 to 31 December 2004. During the data collection phase, a number of investigations will commence and continue into an extended CEOP Research Phase.

As an example of some of the model output products and *in situ* data that will be available from CEOP and how they may be applied, a preliminary effort has been accomplished that compares results between models and observations. The models utilized in this comparison were the USA National Centers for Environmental Prediction (NCEP) Seasonal Forecasting Model (SFM) being run at the Scripps Experimental Climate Prediction Center (ECPC) for CEOP, the USA National Aeronautics and Space Admistration (NASA) Data Assimilation Office (DAO) global model and the NASA Global Land Data Assimilation System (GLDAS) land-surface model (referred here as GLD, for convienence). The DAO and GLD schemes are both being run at NASA's Goddard Space Flight Center (GSFC). The *in situ* observations (OBS) for this exercise were taken from data provided to CEOP from the Canadian Boreal Ecosystem Research and Monitoring Sites (BERMS).

2. Representative Model Output

The ECPC version of the NCEP SFM (Kanamitsu et al. 2002, hearafter referred to as ENP) originated from the NCEP Global Spectral Model (GSM). The model uses the spectral transform method to solve the atmospheric primitive equation system for vorticity, divergence, virtual temperature, specific humidity, and logarithm of surface pressure. A triangular truncation of 62 spherical harmonics (T42), equivalent to a horizontal resolution of about 280 km, and a vertical sigma coordinate system which contains 28 layers and 29 levels from the surface to zero hPa is used for these experiments. The GSM was used for the NCEP/NCAR reanalysis, designated RI, (Kalnay et al. 1996; Kistler et al. 2001), and the NCEP/DOE reanalysis-II or RII (Kanamitsu et al. 2002). ENP differs from the RII model mainly by its parallelized code structure and improved physical parameterizations. ENP, however, starts from the RII and given the similarity of ENP to the RII model many of the ENP processes are likely to be highly similar to RII processes.

NASA's DAO maintains operational analyses in support of NASA instrument teams. The current global operational system produces data on a 1 by 1.25 degree regular grid (global 1/2 degree resolution may be realized relatively soon). The two-dimensional (surface and vertically integrated atmospheric) data are stored three hourly while the three dimensional meteorological fields are stored 6 hourly. Complete budget data are available, and nearly all the CEOP data are being stored. Since 1998 the operational system has been based on GLA and ARIES GCMs. In October 2002, a new system, developed in collaboration with the National Center for Atmospheric Research (NCAR) took over operations. This is called the Finite Volume Data Assimilation System (FVDAS). The atmospheric model consists of a semi-Lagrangian dynamical core and the atmospheric physics developed at NCAR (much like the Community Climate Model version 3, except it will use the Common Land Model, CLM). MOLTS diagnostic routines are being developed for the FVDAS (hourly or finer time scales), so that CEOP data can be produced on the fly. However, since this is an operational system, it is under continuous development. For example, the assimilation of remotely sensed skin temperature will be implemented in early 2003. Because the development can affect budgets and the background climate of the system, the DAO plans to perform a CEOP reanalysis using a proven and consistent system.

GLD was developed as a joint collaboration between scientists at GSFC and NCEP. Its purpose is to produce optimal output fields of states and fluxes by forcing and constraining, through data assimilation, sophisticated land surface models with data from advanced observing systems (Rodell et al., 2002). By running the models offline (not coupled to the atmosphere) and using observation-based precipitation and solar radiation, GLD avoids the biases that often exist in fully coupled modeling systems and which accumulate as errors in the land surface states of water and energy. The results described here were output from the GLD version of the Mosaic LSM (Koster and Suarez, 1996), running on a 0.25° global grid, forced by a combination of satellite-derived precipitation and solar radiation fields with additional forcing from NASA's GEOS numerical weather prediction model. A vegetation-based "tiling" approach was used to simulate sub-grid scale variability, based on a 1 km global, AVHRR-derived landcover map. High-resolution soils and elevation datasets were also used to parameterize the model. Future contributions to CEOP from GLD may include output from additional LSMs and may be produced using advanced options, such as a routine for satellite-based updates of leaf area index, canopy greenness, and albedo; assimilation of soil moisture, snow, and temperature data; simulation of the atmospheric boundary layer; and runoff routing.

3. *In Situ* Data Description

The BERMS project (see Szeto et al. 2003) is a 5 year field study partly designed on the framework of the earlier BOREAS (Boreal Ecosystem-Atmosphere Study) experiment. The BERMS dataset available for this comparison exercise includes near-surface meteorological measurements of three forest biomes in the southern boreal forest of Saskatchewan. The three sites named after the dominant biomes include Old Aspen, Old Jack Pine and Old Black Spruce. There are several meteorological measurements made, including temperature and precipitation, sensible heating, latent heating, net surface radiation. Measured hourly accumulated precipitation was further accumulated to 3 hour increments to match model output. In a similar manner hourly sensible and latent heat fluxes and net surface radiation were averaged for the corresponding 3 hour interval. Temperature was taken as the instantaneous value to match the output of these parameters by the models. Only the average of all 3 sites is shown in this example. More information about BERMS can be found at the "CEOP Reference Site Station Characteristics" link on the University Corporation for Atmospheric Research/Joint Office for Science Support (UCAR/JOSS), CEOP Data Management page: (http://www.joss.ucar.edu/ghp/ceopdm/).

4. Preliminary Comparison Results

Fig. 1 shows the water budget comparison of daily averages. Note that the observed and various model precipitation, evaporation, moisture convergence and precipitable water have similar daily values, although the absolute values are noticeably different. For example, the ENP has too high evaporation and runoff in comparison to GLD. Runoff was not available from DAO. The residual for ENP (imbalance in surface water equations) is also too large and could be related to the RII updated soil moisture, which is updated by the model precipitation and the difference between this precipitation and observed precipitation. It might also be related to the use of different soil types in the ENP from the original RII, indicating that some additional care may need to be taken when initializing land surface variables from the RII. The residual was not available for the other models, which were missing runoff and surface water tendencies. The residual was also not available for the atmospheric budget since the moisture convergence was deduced as the difference from the precipitable water tendency (ignored for observations), precipitation and evaporation.

Fig. 2 shows the energy budget comparison of daily averages. Note that the sensible heating is largest in the GLD and smallest in the ENP, in contrast to the latent heating. In comparison to latent heat released by precipitation, the sensible heating is quite small and the atmospheric balance is mainly between the radiative heating, latent heating, and heat convergence (see Roads et al. 2002). The atmospheric radiative cooling is fairly constant, whereas the surface radiative heating shows a strong decrease from summer to fall. The subsurface heat flux is small but significant, especially in the ENP, and modulates the surface temperature by cooling the ground during the summer and heating it during the winter. The surface temperature is emulated best by the ENP.

Fig. 3 shows the water budget diurnal variations. Note first of all a common model problem in that the GLD precipitation, which comes from observations peaks in the early morning hours (3Z), although not as much as the BERMS observations, whereas the atmospheric models tend to peak earlier. This erroneous model peak is presumably related to too little convergence although both the ENP and DAO have much larger day-time evaporation. Interestingly, the soil moisture diurnal cycle approximately balances the atmospheric water diurnal cycle, presumably mainly due to the diurnal cycle of evaporation, which acts with opposite sign in both equations. Runoff is fairly constant during the day, albeit, again, too large in the ENP. Again, the residual, which could only be calculated for the ENP, is too large. We have not been able to ascertain yet the cause for this ENP problem, which also may be related to excessive evaporation in the model.

Fig. 4 shows the energy budget diurnal variations. In the atmosphere, the heat convergence is positive during the day and negative during the evening hours, mainly because it is balancing the heating by diurnal precipitation processes. Surprisingly, perhaps, the atmospheric radiation cooling has a strong diurnal cycle and even becomes positive during the early evening. At the surface, solar radiation dominates during the day, and then long wave cooling becomes dominant during the evening. The heating by the subsurface heating is mostly positive during the evening and early morning hours, and negative during the afternoon hours and is well emulated by the models. All models emulate well the ground heating during the night and the ground cooling during the day.

Acknowledgements

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References

Kalnay, E., et al., 1996: The NCEP/NCAR 40-Year Reanalysis Project. Bull Amer. Meteorol. Soc, 77, 437-471.

Kanamitsu, M., et al., 2002: NCEP dynamical seasonal forecast system 2002. Bull Amer. Meteor Soc, (submitted).

Kanamitsu, M., W. Ebisuzaki, J. Woollen, S. -K. Yang, J. Hnilo, M. Fiorino, and J. Potter, 2002: NCEP/DOE AMIP-II REANALYSIS (R-2). Bulletin Amer. Meteor. Soc. (In press)

Kistler, R., et al., 2001: The NCEP-NCAR 50-year reanalysis: Monthly means CD-ROM and documentation. Bull Amer. Meteor. Soc, 82, 247-267.

Koster, R. D., and M. J. Suarez, 1996: Energy and Water Balance Calculations in the Mosaic LSM. NASA Technical Memorandum 104606, 9, 76 pp.

Roads, J., M. Kanamitsu, R. Stewart, 2002: CSE Water and Energy Budgets in the NCEP-DOE Reanalysis II. J. Hydrometeorology , Vol. 3, Issue 3, p. 227-248.

Rodell, M., P. R. Houser, U. Jambor, J. Gottschalck, K. Mitchell, C. -J. Meng, K. Arsenault, B. Cosgrove, J. Radakovich, M. Bosilovich, J. K. Entin, J. P. Walker, and D. Lohmann, The Global Land Data Assimilation System. Submitted to Bull. Amer. Meteor. Soc., 2002.

Szeto, K., A. Barr, B. Goodison, 2003: Report on Canadian CEOP Reference Sites. CEOP Newsletter, No.3, P6 .

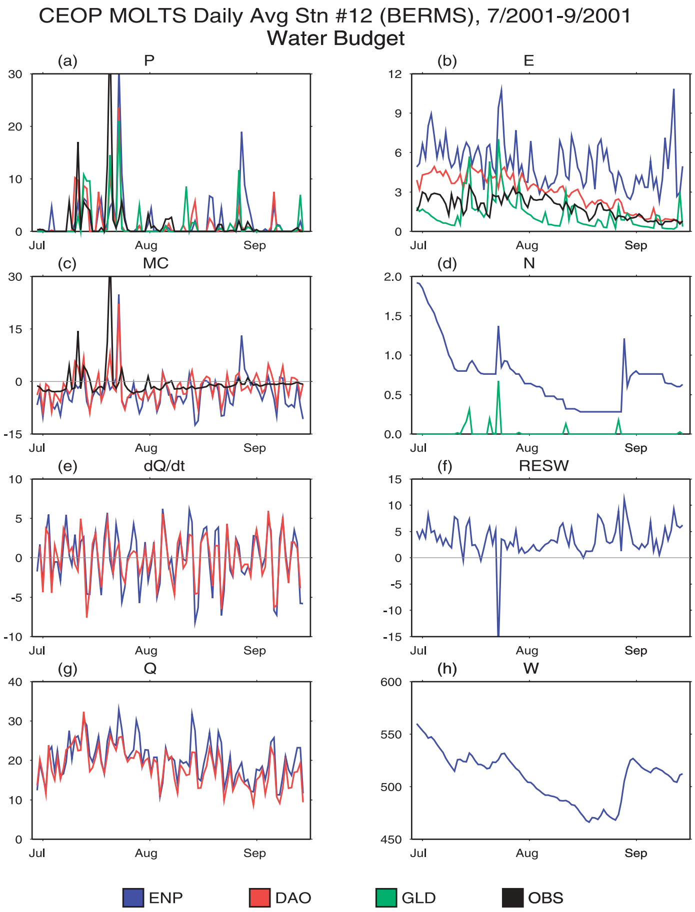

Fig. 1 BERMS daily water budget from the observations and models: (a) precipitation, P, mm/day; (b) evaporation, E, mm/day; (c) moisture convergence, MC, mm/day; (d) runoff, N, mm/day; (e) precipitable water tendency, dQ/dt, mm/day; (f) surface water equation residual, dW/dt+RESW', mm/day; (g) precipitable water, Q, mm; (h) surface water, W, mm.

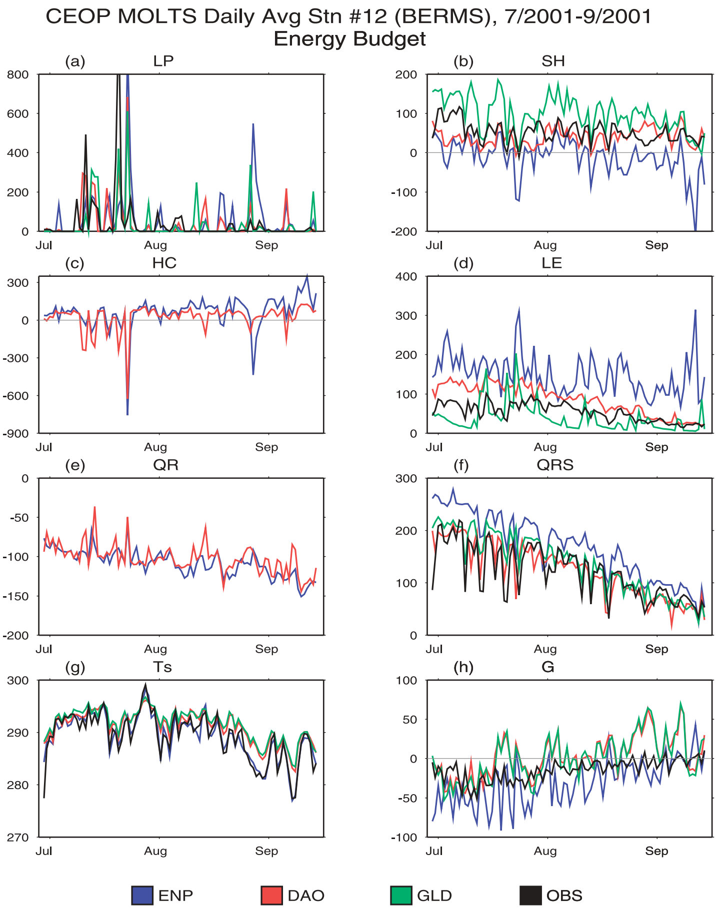

Fig. 2 BERMS daily energy budget from the observations and models: (a) latent heat of precipitation (net condensation), LP, W/m2; (b) sensible heating, SH, W/m2; (c) energy convergence, HC, W/m2; (d) net downward solar radiation, NDSW, W/m2; (e) atmospheric radiative cooling, QR, W/m2; (f) surface radiative heating, QRS, W/m2; (g) surface air temperature, Ts, K; (h) surface ground heating, G, W/m2.

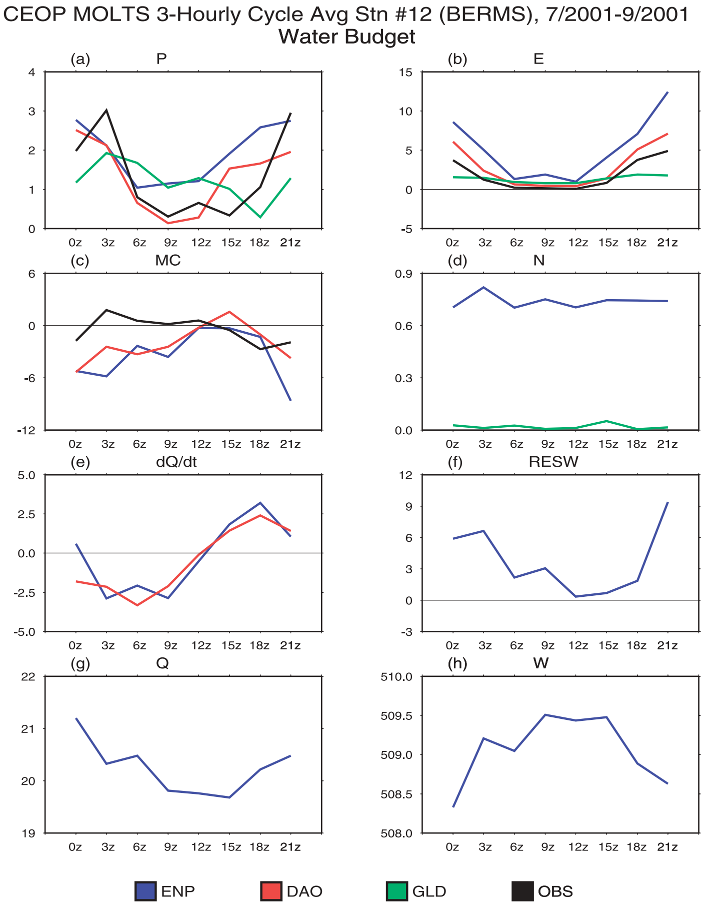

Fig. 3 BERMS diurnal water budget from the observations and models: (a) precipitation, P, mm/day; (b) evaporation, E, mm/day; (c) moisture convergence, MC, mm/day; (d) runoff, N, mm/day; (e) precipitable water tendency, dQ/dt, mm/day; (f) surface water equation residual, dW/dt+RESW', mm/day; (g) precipitable water, Q, mm; (h) surface water, W, mm.

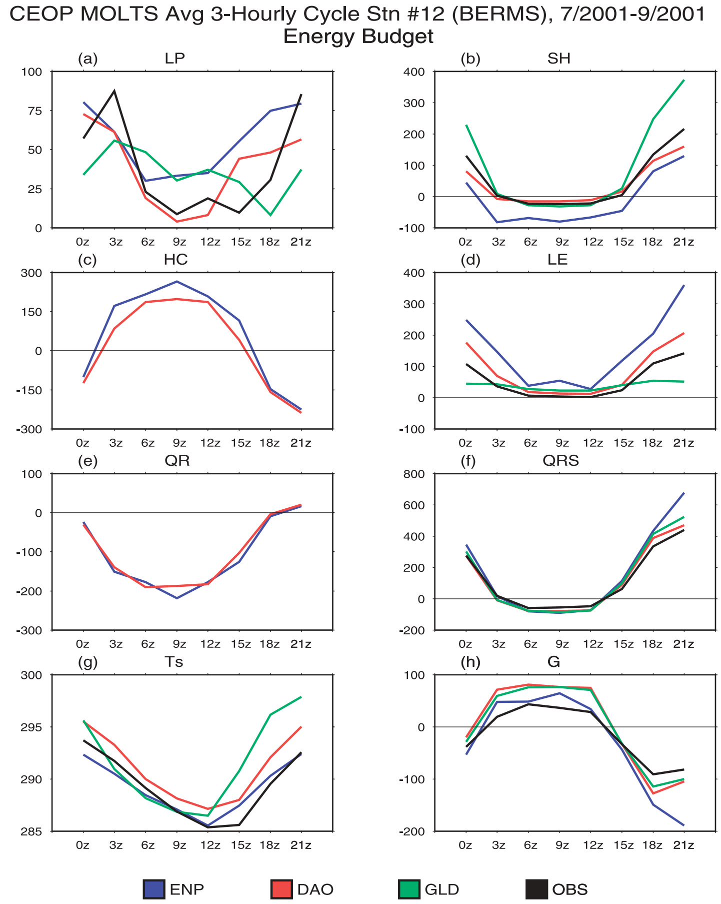

Fig. 4 BERMS diurnal energy budget from the observations and models: (a) latent heat of precipitation (net condensation), LP, W/m2; (b) sensible heating, SH, W/m2; (c) energy convergence, HC, W/m2; (d) net downward solar radiation, NDSW, W/m2; (e) atmospheric radiative cooling, QR, W/m2; (f) surface radiative heating, QRS, W/m2; (g) surface air temperature, Ts, K; (h) surface ground heating, G, W/m2.

CEOP Related News

ADEOS-II SPACECRAFT LAUNCHED AND FIRST IMAGES PROCESSED

Naoto Matsuura, EORC/NASDA

NASDA launched the Advanced Earth Observing Satellite-II (ADEOS-II) on the H-IIA Launch Vehicle No. 4 at 1:31 (UT) on December 14, 2002 from the Tanegashima Space Center. The flight went normally, and it was confirmed that ADEOS-II was successfully separated 16 minutes and 31 seconds after liftoff. The spacecraft is nicknamed 'Midori II'. ADEOS-II was in a nominal operational mode by December 17 2003. ADEOS-II has now moved into an initial verification phase that will last untill mid-April 2003. The function of its on-board equipment and sensors will be verified during this period.

ADEOS-II, has 5 sensors on board that will observe the Earth and provide data that will address issues related to changes in the global water and energy circulations, carbon circulation, and ozone in the stratosphere. NASDA's Earth Observation Center (at Hatoyama-machi, Hiki-gun, Saitama Prefecture) has already acquired image data from the Advanced Microwave Scanning Radiometer (AMSR), which is expected to make a contribution to CEOP water and energy cycle simulation and prediction (WESP) studies as well as other CEOP scientific goals.

Report on Canadian CEOP Reference Sites

Kit Szeto, Alan Barr and Barry Goodison, Climate Research Branch, Meteorological Service of Canada, Canada

Three of the study sites used during the Boreal Ecosystem-Atmosphere Study (BOREAS) and then enhanced for the Canadian Boreal Ecosystem Research and Monitoring Sites (BERMS) project were arranged to be Canadian reference sites for CEOP. These sites have a long history in performing and contributing to international climate programs.

The three main BERMS study sites are located in the southern boreal forest of the Saskatchewan Basin, each representing a different forest type with mature tree species ranging in age from about 70-130 years. The Old Aspen (OA) site is about 10km north of the transition between cropland and forest. Trembling aspen overstory and hazel understory are the two main vegetation types at this site. The other two sites, Old Black Spruce (OBS) and Old Jack Pine (OJP) are approximately 60km from the forest-grass boundary. The vegetation at the OBS site is mostly black spruce but approximately 15% of the forest consists of deciduous-type larch. This type of forest is quite boggy, and has many small pockets of standing water. For the OJP site, nearly all of the vegetation is jack pine with lichen groundcover.

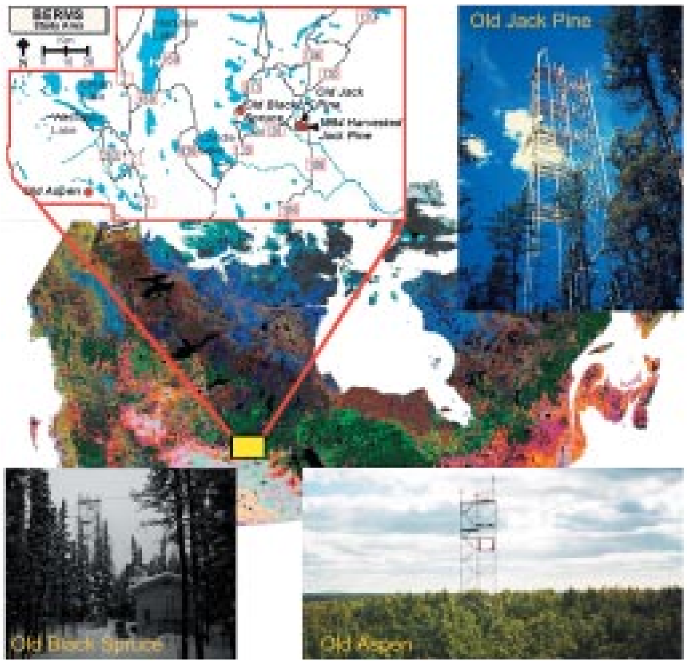

Fig. 1 Locations of the BERMS sites.

The BERMS sites qualify as 2.5D Type-A CEOP reference sites. The sites are located in a region characterized by cold winters and warm summers. Mean annual precipitation is around 450 mm with most of it falling during the summer. Strong interannual variability is observed for both temperature and precipitation. All sites measure standard surface and near-surface meteorological variables, above-canopy radiation and turbulent fluxes (including water, heat, and CO2 fluxes), precipitation, snow depth, and soil temperature and moisture. Dr. Alan Barr is the contact for the BERMS site data and more information about the sites can be obtained at the BERMS website (http://berms.ccrp.ec.gc.ca/).

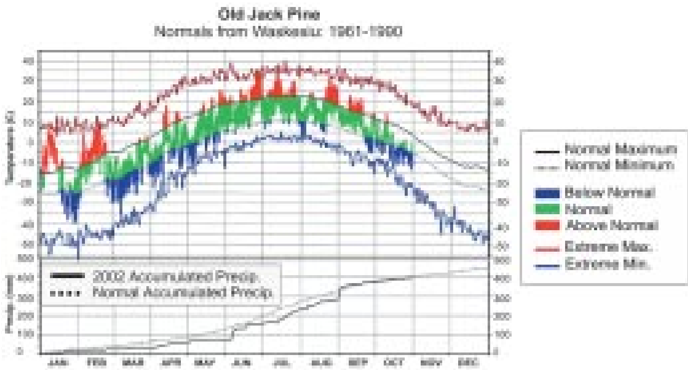

Fig. 2 The long-term climate at the BERMS sites.

References: Roads, J., Bosilovich, M., Kanamitsu, M., Rodell, M. Scientific Report of WESP CEOP Pilot Data Intercomparisons, CEOP Newsletter, March 2003, Issue No. 3, 2-5.

Schedule of CEOP

	2001	2002	2003	2004
The CEOP Preliminary Data Period	1 July	30 September		
The CEOP Buildup phase		1 October	30 September	
The First CEOP Annual Cycle Period			1 October	30 September
The Second CEOP Annual Cycle Period				1 October – 31 December

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