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

Coordinated Enhanced Observing Period

Newsletter No 2

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CEOP Web Site: http://monsoon.t.u-tokyo.ac.jp/ceop/

CEOP – Global Monitoring for Improved Prediction

Hartmut Grassl *, Chairman of the CEOP Scientific Steering Committee

Only the continuous global observation of the three-dimensional structure of the atmosphere, oceans, biosphere, cryosphere and lithosphere will lead to validated global numerical models of the Earth system. These models will enable the extraction of the predictable portion of natural variability or change, which can be used for different forecasting purposes and to support decision making for intelligent Earth system management. While we have learned from past satellite observations of the Earth, we still lack an adequate operational global observing system for the ocean interior, the biosphere, the cryosphere and the lithosphere.

The World Climate Research Programme (WCRP) is now in a good position to help with the design of such an observing system for climate parameters and validated coupled climate models (encompassing atmosphere, ocean and land surface, including vegetation). Initiated by scientists within the Continental Scale Experiments (CSEs) of the Global Energy and Water Cycle Experiment (GEWEX), and also endorsed by the Climate Variability and Predictability (CLIVAR) study, the Coordinated Enhanced Observing Period (CEOP) is working to establish a prototype of the future observing system for the atmosphere and the entire surface (ocean, vegetation and ice), which will incorporate:

•Active and passive microwave sensors on several satellites for observing radiation matter interactions from the top of the atmosphere through the clouds to the surface.

•Reference sites for high quality *in-situ* measurements and surface-based remote sensing to obtain globally validated satellite-based time series of physical, chemical and biological parameters.

CEOP data sets should provide the basis for testing of global and regional coupled models in unique ways that may improve their ability to predict "signals" within the climate system such as those associated with ENSO, soil mositure, sea ice, extratropical upper ocean temperature/salinity and other related phenomena that occur at timescales from weeks up to interannual.

Because of the telecommunication links between the ocean, atmosphere and land that are being shown to exist on very rapid temporal scales and over vast distances across the globe, the coordinated global observation scheme under implementation in CEOP is perhaps the only means by which such prediction studies can be undertaken.

CEOP will endeavour to provide the distinct pilot data sets necessary for this challenge during its observational phase that extends up to December 2004. The work will be carried out as an element of WCRP initiated by GEWEX and accepted as a part of the Integrated Global Observing Strategy Partners (IGOS-P) Integrated Global Water Cycle Observations (IGWCO) theme, in which, among others, space agencies belonging to the Committee on Earth Observation Satellites (CEOS) are participants.

* The author was the Director of WCRP from 1994 to 1999 and is now at the Max Planck Institute for Meteorology in Hamburg, Germany.

Calendar of CEOP Meetings :

- **GEWEX Hydrometeorology Panel (GHP) MEETING #8: CEOP Session**
  New York: 12-13 September 2002.
  http://www.usask.ca/geography/MAGS/GHP/ghp8/ceop_agenda.html
- **CEOP Implementation Planning / Review Meeting**
  Berlin, Germany: 2-4 April 2003.

Contents:

Summary of Kick-off Meeting

Sam Benedict, CEOP International Coordinator

Professor T. Koike, the Lead Scientist for CEOP, welcomed over 40 International participants to the first formal CEOP implementation planning meeting, which took place from 6 to 8 March 2002, at the Earth Observation Research Center (EORC) of the National Space Development Agency (NASDA), in Tokyo, Japan. It was reaffirmed at the meeting that CEOP, now in a buildup phase following an initial enhanced observing period (EOP-1) from July through September, 2001, will have two enhanced observing periods from October, 2002 to December, 2004.

The CEOP Science Steering Committee (SSC), chaired by Dr H. Grassl, addressed a number of important issues. These included finalizing the CEOP Data Policy statement; setting minimum standards for temporal sampling of CEOP Reference Site parameters (hourly); and setting a goal, of the end of 2002, for delivery of a CEOP seasonal data product (EOP-1).

Characteristics of the CEOP reference sites, presented at the meeting, have been placed in the CEOP Reference Site Table at: http://www.joss.ucar.edu/ghp/ceopdm/rsite.html. In response to the main action item established at the meeting for the CEOP Data Management Working Group (DMWG), the Co-Chairs of the Working Group, Drs Wiliams and Isemer, have established a File Transfer Protocol (FTP) for delivery of data from the CEOP Reference Sites to the CEOP Central Archive in the USA. The data are currently being delivered for EOP-1.

A main scientific goal of CEOP that would document the seasonal march of the monsoon systems, assess the monsoon systems driving mechanisms, and investigate the possible physical connections between such systems, was endorsed. The result of discussions included the initial definition of a CEOP Inter-monsoon Model Validation Project (CIMVP). Drs Lau and Yasunari, as Co-Chairs of the CEOP Monsoon Systems Working Group are organizing a CIMVP planning meeting this year and a CIMVP Workshop, possibly jointly with CLIVAR and GEWEX, in 2003.

The aim of CEOP to apply enhanced observations to better document and simulate water and energy fluxes and reservoirs over land on diurnal to annual temporal scales and to better predict these on temporal scales up to seasonal for water resource applications, was accepted. Drs Roads and Marengo as Co-Chairs of the CEOP Water and Energy Simulation and Prediction (WESP) Working Group have produced an action plan for this CEOP science initiative that also deals with CEOP Model products including Model Output Location Time Series (MOLTS).

Interaction with a 500 tera-byte data archival system at the University of Tokyo (UT) for use in CEOP satellite data integration work, was demonstrated. This NASDA/UT capability will produce and archive satellite data products for CEOP reference sites, in

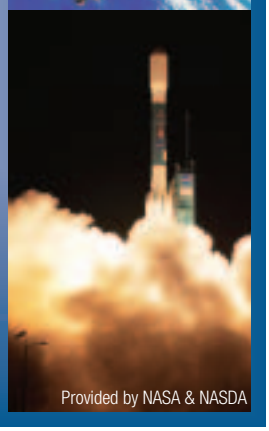
phases. Data received from NASDA and the UT for all of the CEOP Reference Sites will be delivered during phase one. NASDA reported that a proposal has been submitted for a CEOP Test Facility to be developed to assist with the derivation of CEOP special products from each satellite sensor. This proposal, which now includes a Satellite Data Integration Center in Japan and possibly another in the USA, was accepted for further implementation with the support of the Working Group on Information Systems and Services (WGISS) and the Integrated Global Observing Strategy Partners (IGOS-P).

Presentations were made that related to Land Data Assimilation System (LDAS) projects developing at both continental and global (GLDAS) scales. CEOP expects these projects to lead to more accurate reanalysis and forecast simulations by models. Drs Houser and Bosilovich are integrating this work with CEOP Satellite Data Integration and WESP activities.

Relevant links include; the CEOP Internet site: http://monsoon.t.u-tokyo.ac.jp/ceop/; the meeting presentations site: http://monsoon.t.u-tokyo.ac.jp/ceop/meeting/kickoff/presentation/index.htm; and The CEOP Implementation Plan site: http://www.gewex.com/ceop/ceop_ip.pdf.

Aqua SPACECRAFT LAUNCHED

Naoto Matsuura, EORC, NASDA



Provided by NASA & NASDA

Earth observing satellite, **Aqua**, successfully launched on May 4, 2002 at 2:55 a.m. PDT. The primary goal of **Aqua**, as the name implies, is to gather information about water in the Earth's system. Equipped with six state-of-the-art instruments **(AIRS, AMSR-E, AMSU, CERES, HSB, MODIS). Aqua** will collect data on global precipitation, evaporation, and the cycling of water. This information will help scientists all over the world to better understand the Earth's water cycle and determine if the water cycle is accelerating as a result of climate

CEOP Working Group Report
Data Management

Steve Williams, UCAR/Joint Office for Science Support(JOSS)
Hans-Jörg Isemer, GKSS Research Center Geesthacht, Germany

New information concerning the CEOP reference sites continues to be incorporated into the Table of CEOP Site Characteristics at: http://www.joss.ucar.edu/ghp/ceopdm/rsite.html. In order to stay on schedule with the CEOP Data Management Working Group Major Activities Plan, priority has been given to the collection and formatting of the data available for the CEOP EOP-1 data set (1 July through 30 September 2001). To expedite delivery of the data from the reference sites to the CEOP Central Archive, a CEOP EOP-1 File Transfer Protocol (FTP) Procedure has been implemented. Representatives of the CEOP Reference Sites have all acknowledged their willingness to ensure the data are submitted according to this protocol, which requires a naming convention for the files, that includes the reference site name, start/stop dates, and an identifier related to the data type (e.g. soundings, flux, surface met, tower, soil, etc.). The files identified in this manner are to be transferred to ftp.joss.ucar.edu using an anonymous login and the site representatives email as a password. Each regional experiment can then be specifically recognized by their sign in, which is formatted as: cd pub/incoming/ceop/cse, where "cse" is substituted for the respective experiment name (e.g. BALTEX, LBA, MAGS, GAPP, GAME/CAMP, etc.). An e-mail to Dr Steve Williams (sfw@ucar.edu) is required to confirm whether or not a successful transfer has taken place. It is planned that all EOP-1 data will be transferred in this manner by the end of August 2002 and that the data will be sorted and composited into a CEOP EOP-1 reference site data set by the end of 2002.

CEOP Working Group Report
Water and Energy Simulation and Prediction

John Roads, Scripps Institution of Oceanography
Jose Marengo, INPE/CPTEC

The scientific objective for CEOP WESP is --- To use enhanced observations to diagnose, simulate and predict water and energy fluxes and reservoirs over land on diurnal to annual temporal scales as well as apply these predictions for water resource applications. WESP studies are designed to understand what components of the global water and energy cycles can be measured, simulated, and predicted at regional and global scales? In particular: (1) what are the gaps in our measurements? (2) What are the deficiencies in our models? (3) What is our skill in predicting hydroclimatological water and energy budgets?

Starting from the current GEWEX Hydrology Panel (GHP) efforts to close simplified vertically integrated water and energy budgets with observations and analyses, and beginning efforts to simulate these budgets regionally, CEOP WESP will begin the effort to transfer this knowledge to global scales, include more water and energy cycle processes, and begin to examine the vertical structure in the atmosphere and land. Specific tasks for the WESP working group during CEOP include:

- Summarizing component and coupled system modelling studies currently underway.
- Articulating scientific issues that need to be addressed in light of advances in each CSE.
- Defining guidelines for commonality and standards in the background fields and measure of progress.
- Devising the detailed nature of the experimental periods.

Water and Energy Budget Syntheses (WEBS) activities will be reported on at the upcoming 2002 fall GHP meeting, which will discuss the eventual transition to CEOP. Scientific meetings for the community are being planned as part of upcoming special sessions at the 2003 Spring EGS/AGU and 2003 Summer IUGG meetings. Transferability projects over the Baltic Sea and La Plata River Basin catchments have begun. Global and regional land data assimilation projects have also begun. Initial WESP activities will help to define and analyze in situ reference site data, satellite data, model output location time series (MOLTS), and gridded model output data for the CEOP period. WESP strongly encourages the international research community to begin making plans to cooperate on the development and utilization of the planned CEOP data sets.

CEOP Working Group Report
Monsoon System Studies

William Lau, Climate & Radiation Branch, NASA/GSFC
Tetsuzo Yasunari, University of Tsukuba

Detailed plans are being developed for the accomplishment of one of the main CEOP aims associated with the documenting of the seasonal march of the monsoon systems, assessing the monsoon systems driving mechanisms, and investigating the possible physical connections between such systems. The result is an initial definition of a CEOP Inter-monsoon Model Validation Project (CIMVP). CIMVP will be an international research project to assess, validate and improve the capabilities of climate models in simulating physical processes in monsoon regions around the world. The objectives are to provide better understanding of fundamental physical processes underpinning the diurnal and annual cycles, and intraseasonal oscillations in monsoon land and adjacent oceanic regions of Asia, Australia, North America, South America and Africa, and to demonstrate the synergy and utility of CEOP integrated satellite data, *in-situ* observations and assimilated data in providing a pathway for model physics evaluation and improvement. The aim is to give CIMVP a unique characteristic by placing its focus on issues relevant to model physics improvement, via simulations, and cross-validation of model outputs with detailed observations. The synergistic use of global data, in conjunction with high-resolution space and time observations from field sites is, therefore, critical. For CIMVP, validation data will be derived from CEOP reference sites, which include GEWEX continental scale experiments (CSE) and planned CLIVAR field campaign sites. Numerical experiments will be designed to target the simulation of fundamental physical processes that are likely to uncover limitations in model physics. A CIMVP planning meeting and a broader Workshop, possibly jointly with CLIVAR and GEWEX, will be organized in 2002 and 2003, respectively.

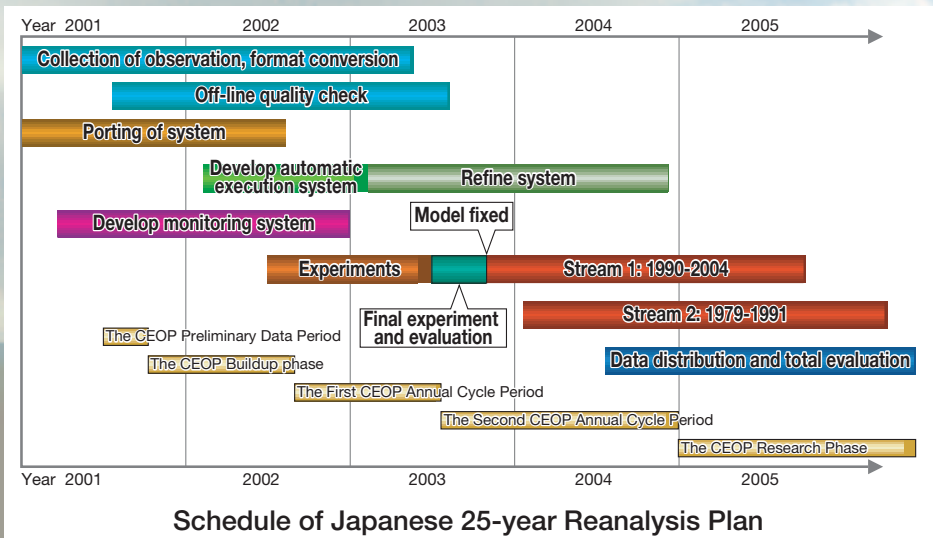
Contribution of JMA to CEOP

Nobutaka Mannoji, Japan Meteorological Agency

The Japan Meteorological Agency (JMA) has contributed to GEWEX Asian Monsoon Experiment (GAME). One of the activities is to perform and provide GAME Reanalysis data. JMA will contribute CEOP by providing re-analysis data for 26 years including CEOP primary period as well as possibly part of Model Output Location Time Series (MOLTS) and gridded data.

The operational global four dimensional data assimilation (4DDA) system of JMA uses a Global Spectral Model (GSM) with T213 horizontal resolution and 40 vertical layers, and a three dimensional variational method is implemented in 2001. JMA is now preparing to supply as much as possible MOLTS and gridded data produced by the operational 4DDA system.

JMA and the Central Research Institute of Electric Power Industry (CRIEPI) started to conduct Re-Analysis project "JRA-25" in 2001. The re-analysis will be completed in 2005, and the dataset will be open to the research community. The period of re-analysis is 26 years from 1979 to 2004, which contains two CEOP annual cycle periods (Oct. 2002-Dec.2004). The assimilation system is similar to that of the operational 4DDA system except for the horizontal resolution of the model, which is T106. The accuracy of JRA-25 will be estimated by comparing the observed data at the reference sites with corresponding data of JRA-25. Then, the water cycle over 26 years would be estimated by using the JRA-25 data. Details are described at the JRA-25 web page "http://www.jreap.org/indexe.html".



Schedule of Japanese 25-year Reanalysis Plan

Special Report
CEOP Satellite Data Integration

Toshio Koike, University of Tokyo
Paul Houser and Matthew Rodell, Hydrological Sciences Branch, NASA/GSFC

Figure 1. 500Tera-byte data archive system at the Institute Industrial Sciences, University of Tokyo

To provide satellite data integration products including 4DDA "value-added" Global Land Data Assimilation System (GLDAS) datasets, of water cycle variables, two CEOP Satellite Data Integration Centers (CSDICs) are to be established, one at the University of Tokyo (UT) in cooperation with NASDA and the other at NASA's Goddard Space Flight Center (GSFC).

The CSDIC at UT will receive CEOP customized levels 1b and 2 and standard level 3 earth observation satellite data from space agencies and archive them by using a 500 tera-byte data archival system at the Institute of Industrial Sciences of UT as shown in Figure 1. The Committee on Earth Observation Satellite (CEOS) Working Group on Information Systems and Services (WGISS) Test Facility for CEOP (CEOP-WTF) advanced by NASDA and NASA will be developed for providing catalogue interoperability with CEOS agencies' systems by using CEOS' protocols and exchanging data and information with CEOS agencies and affiliates as well as users through automated links. Integrated CEOP satellite products overlaid with *in-situ* data and model output will be delivered to users by Web Mapping Technology and other visual technologies through networks. UT and NASDA propose a three phased approach for production and archiving of satellite data products; Phase I, for all reference sites, started in June, 2002, Phase II, for the monsoonal regions, begin in June, 2003, and Phase III, fully operational, beginning in September, 2005. To support phenomena detection, knowledge discovery and coincident search capabilities across a huge amount of very heterogeneous datasets, "Visual Data Mining" combined with the artificial intelligence approach in the computer sciences is now being developed as an important function of the CSDIC at UT.

Scientists at GSFC have developed a high-resolution GLDAS in cooperation with researchers at NOAA's National Centers for Environmental Prediction (NCEP). The goal of GLDAS is to produce optimal output fields of land surface states and fluxes by making use of data from advanced observing systems (see GEWEX News May 2002 and http://ldas.gsfc.nasa.gov/ for further details). GLDAS uses various new satellite and ground based observation systems within a land data assimilation framework to produce optimal output fields of land surface states and fluxes. GLDAS includes four components implemented globally at 1/4 degree resolution (higher resolutions are planned) in near real time: land modeling, land surface observation, land surface data assimilation and calibration and validation. The core advantage of GLDAS is its use of satellite-derived observations (including precipitation, solar radiation, snow cover, surface temperature, and soil moisture) to realistically constrain the system dynamics. This allows it to avoid the biases that exist in near-surface atmosphere fields produced by atmospheric forecast models, minimize the impact of simplified land parameterizations, and to identify and mitigate errors satellite observations used in data assimilation procedures (Figure 2 shows the GLDAS system). These value-added GLDAS data will improve land surface, weather, and climate predictions by providing global fields of land surface energy and moisture stores for initialization. GLDAS is a valuable tool for CEOP because it assimilates the information from multiple models and observation platforms to provide the best available assessment of the current state of the land surface. In addition, an interface to access data from the near-real time GLDAS operational model runs is provided through the web site (http://ldas.gsfc.nasa.gov/map/webout.html). A region can be specified by either manually entering the coordinates in the text boxes or automatically by creating a rectangle on the map. Users can subset the data by time period as well as parameter type. The international GEWEX and CEOP communities have recognized that GLDAS can be leveraged and further developed to address the needs of CEOP. The CSDIC at NASA GSFC is working with the CEOP-GLDAS products in cooperation with NASA Data Assimilation Office (DAO).

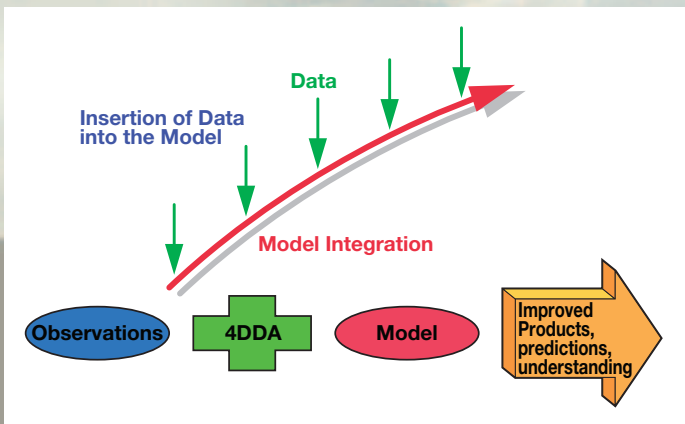
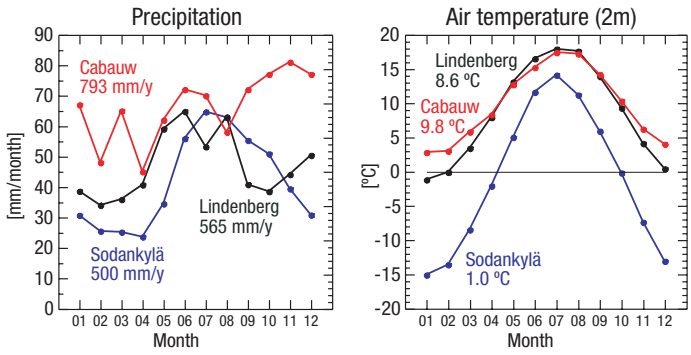


Figure 2. Concept of the Land Data Assimilation System

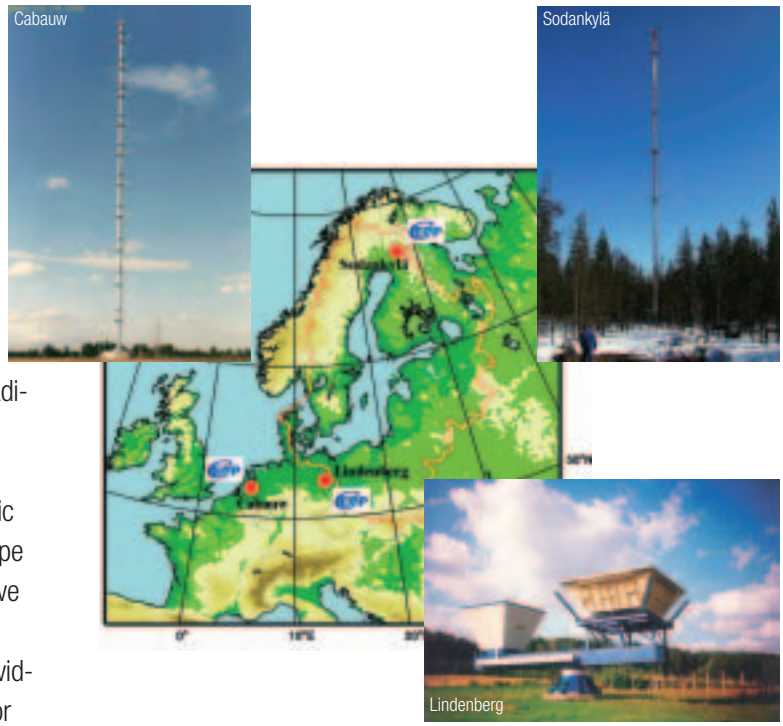
Report on European CEOP Reference Sites

Hans-Jörg Isemer, International BALTEX Secretariat head; GKSS Research Centre Geesthacht, Germany

Three CEOP reference sites are located in Europe. Their contribution to CEOP is coordinated through the Baltic Sea Experiment (BALTEX). All three sites are operated by national weather services and share several common characteristics which are important for an ambitious initiative such as CEOP. At present, the BALTEX reference sites for CEOP include: 1) the *Sodankylä* Observatory in Finland, operated by the Finnish Meteorological Institute (FMI), 2) the Meteorological Observatory *Lindenberg* in Germany, operated by the German Weather Service (DWD), and 3) the experimental Atmospheric Boundary Layer Measurement Site at *Cabauw* in The Netherlands, operated by the Royal Netherlands Meteorological Institute (KNMI). The responsible local CEOP site managers are Bengt Tammelin (FMI), Frank Beyrich (DWD), and Fred Bosveld (KNMI). Common features of these sites include their long tradition in performing and contributing to international experiments and monitoring activities providing for outstanding experience in various modern tropospheric and soil measurement techniques, data quality measures and storage. All sites will deliver high-resolution radiosonde, mast, various modern ground based remote sensing, complete surface radiation and turbulent flux, standard surface meteorology, and soil data, thus meeting requirements for a CEOP 1-D site. The three sites are located at the northern and southern edges of the Baltic Sea catchment encompassing different climate regimes in Europe (see map and climate diagrams). Most recently, negotiations have been initiated for a 4th CEOP reference site in Europe. The new candidate is *Norunda* in Sweden (located at 60.1N / 17.5E) providing data from the central Baltic Sea catchment representative for boreal forest conditions.

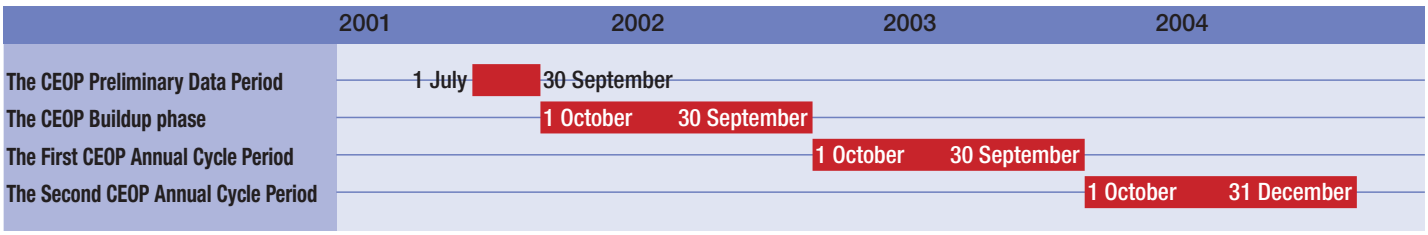


The long-term climate



Locations of the three CEOP reference sites

Schedule of CEOP



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