



# **STATUS OF REFERENCE SITE PHASE-1 ARCHIVE**

**Steve Williams**

**NCAR/Earth Observing Laboratory (EOL)  
CEOP 5<sup>th</sup> International Implementation Planning Meeting**

**Paris, France**

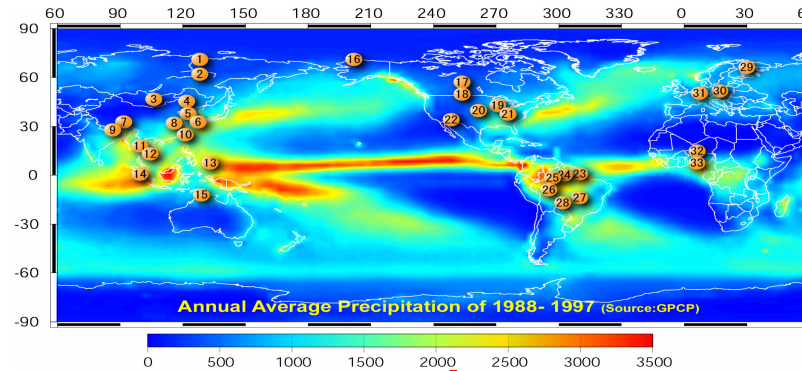
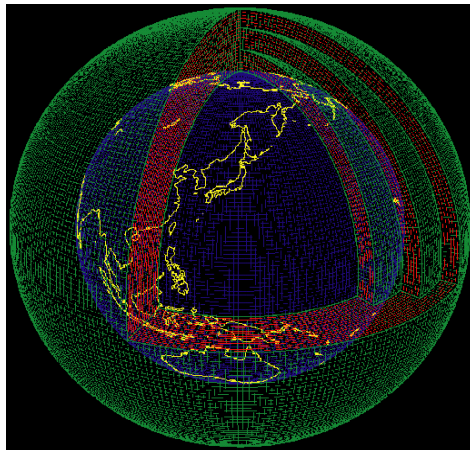
**26-28 February 2006**





# Coordinated Enhanced Observing Period Three Unique Capabilities

## A Well Organized Data Archive System



Model Output Data Archiving  
Center at **the World Data  
Center for Climate, Max-Planck  
Institute for Meteorology** of  
Germany

In-Situ Data Archiving  
Center at **NCAR (National  
Center for Atmospheric  
Research)** of USA

Data  
Integrating/Archiving  
Center at **University of  
Tokyo and JAXA** of  
Japan



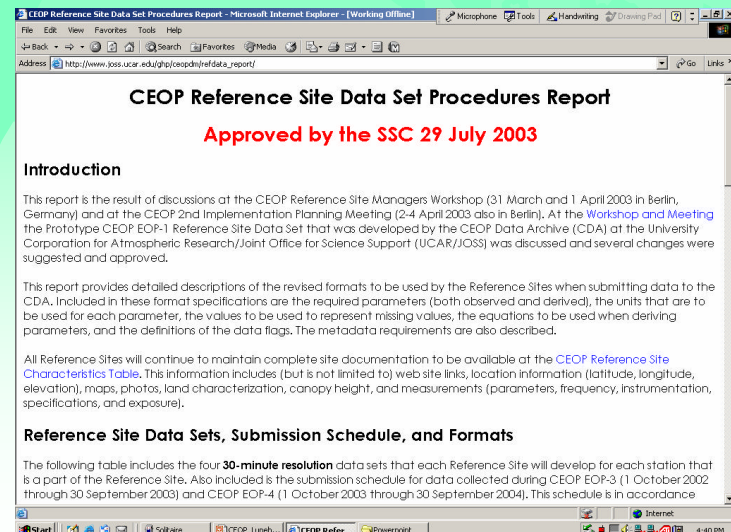


# Reference Site Data Set Procedures Report

## (Approved by the SSC on 29 July 2003)

- Introduction
- Data Set Description, submission schedule, formats
- Metadata
- Gap filling
- Quality Control/Quality Assurance
- File naming convention
- Submission instructions to CDA
- CDA Composite formation
- CDA Quality Assurance
- Rawinsonde Data Sets
- Ancillary Data Sets

Data Set	Data Category	Submission Date (First Half EOP-3)	Submission Date (Second Half EOP-3)	Submission Date (First Half EOP-4)	Submission Date (Second Half EOP-4)	Detailed Format Description
Surface Meteorological and Radiation Data Set	Category 1	1 October 2003	1 April 2004	1 October 2004	1 April 2005	Surface Meteorological and Radiation Format
Flux Data Set	Category 2	1 July 2004	1 January 2005	1 July 2005	1 January 2006	Flux Format
Soil Temperature and Soil Moisture Data Set	Category 1	1 October 2003	1 April 2004	1 October 2004	1 April 2005	Soil Temperature and Soil Moisture Format
Meteorological Tower Data Set	Category 1	1 October 2003	1 April 2004	1 October 2004	1 April 2005	Meteorological Tower Format



**CEOP Reference Site Data Set Procedures Report**  
Approved by the SSC 29 July 2003

**Introduction**

This report is the result of discussions at the CEOP Reference Site Managers Workshop (31 March and 1 April 2003 in Berlin, Germany) and at the CEOP 2nd Implementation Planning Meeting (2-4 April 2003 also in Berlin). At the Workshop and Meeting the Prototype CEOP EOP-1 Reference Site Data Set that was developed by the CEOP Data Archive (CDA) at the University Corporation for Atmospheric Research/Joint Office for Science Support (UCAR/JOSS) was discussed and several changes were suggested and approved.

This report provides detailed descriptions of the revised formats to be used by the Reference Sites when submitting data to the CDA. Included in these format specifications are the required parameters (both observed and derived), the units that are to be used for each parameter, the values to be used to represent missing values, the equations to be used when deriving parameters, and the definitions of the data flags. The metadata requirements are also described.

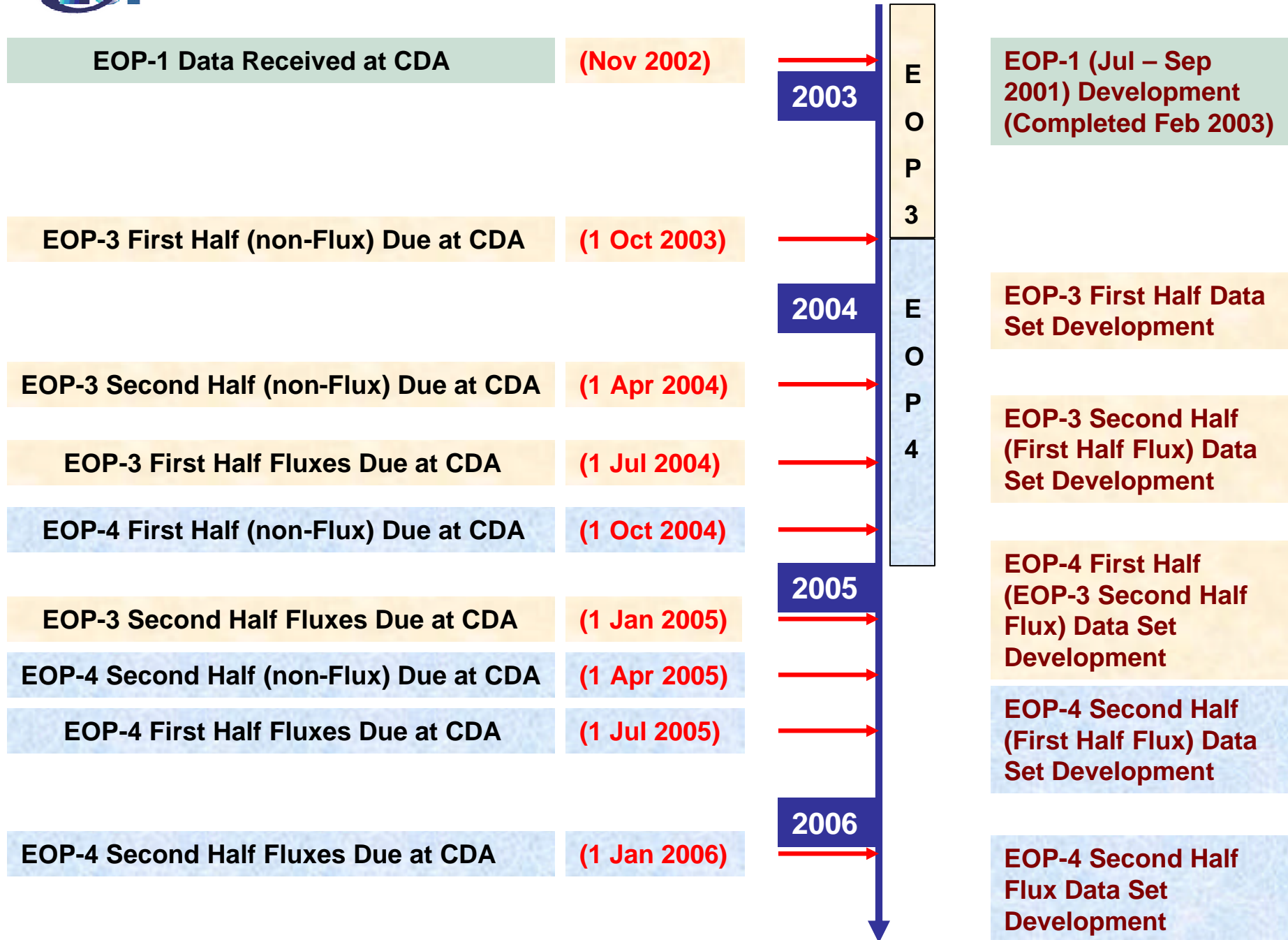
All Reference Sites will continue to maintain complete site documentation to be available at the [CEOP Reference Site Characteristics Table](#). This information includes (but is not limited to) web site links, location information (latitude, longitude, elevation), maps, photos, land characterization, canopy height, and measurements (parameters, frequency, instrumentation, specifications, and exposure).

**Reference Site Data Sets, Submission Schedule, and Formats**

The following table includes the four **30-minute resolution** data sets that each Reference Site will develop for each station that is a part of the Reference Site. Also included is the submission schedule for data collected during CEOP EOP-3 (1 October 2002 through 30 September 2003) and CEOP EOP-4 (1 October 2003 through 30 September 2004). This schedule is in accordance



# Reference Site Data Set Development Timeline



<http://www.joss.ucar.edu/ghp/ceopdm/>

**Coordinated Enhanced Observing Period  
Data Management**



**INTEGRATED**



**CEOP Data Access**

**Integrated Data Servers**  
 WTF-CEOP Distributed Data Integration Prototype System  
 CEOP Centralized Data Integration System  
 GCMD CEOP Portal

**In-Situ**

**Data Sets**  
 CEOP EOP-3/4 Data Sets  
 CEOP EOP-1 Data Sets  
 NASA/GMAO GRADS/DODS Server  
 Baseline Surface Radiation Network (BSRN)  
 GEWEX Land Processes Database Map Server  
 IAEA Global Network of Isotopes in Precipitation

**Information**  
 CEOP Reference Site Data Set Procedures Report  
 CEOP Reference Site Station Characteristics  
 Virtual Tour of Reference Sites Slideshow  
 CEOP Reference Site Map  
 CEOP Hydrology Reference Sites  
 Reference Site Data Management Update (GEWEX SSG Meeting, 20-24 January 2003)  
 CEOP In-Situ Data Source Agency Links

**Satellite**

**Data Sets**  
 EOP-1 Satellite Data Sets  
 NASA/GMAO GRADS/DODS ISCCP Surface T and Cloud Amount for CEOP EOP1  
 NOAA CLASS Archive  
 TRMM Online Visualization and Analysis System

**Information**  
 CEOP Satellite Data Source Agency Links

**Model**

**Data Sets and Information**  
 Model Output and Information

**IN-SITU**



**CEOP Documentation**

**Data Policies**  
 CEOP Reference Sites Data Release Guidelines  
 BALTEx  
 CAMP  
 AMMA  
 GAPP  
 LBA  
 MAGS

**Data Standards Information**  
 CEOP Metadata Design (Proposed)  
 National Spatial Data Infrastructure (NSDI) Presentation (September 2004)  
 Assistance for Land-surface Modelling activities (ALMA)  
 Atmospheric Model Intercomparison Project (AMIP)  
 ISO/TC 211

**Documents**  
 CEOP Implementation Plan  
 3rd Implementation Planning Meeting Report (March 2004) Executive Summary Appendices  
 2nd Implementation Planning Meeting Report (July 2003)  
 WESP Major Activities Plan (1 June 2003)  
 Establishment of a Global Hydrological Observation Network for Climate" GCOS/GTOS/HWRP Meeting Report (June 2000)

**Questionnaires**  
 CEOP Land Cover and Soils Questionnaire Responses  
 CEOP Frozen Precipitation Questionnaire Responses  
 CEOP Reference Site Rawinsonde Station Responses

**Other Links**  
 CEOP Home Page  
 WCRP Home Page  
 GEWEX Home Page  
 CLIVAR Home Page  
 CLIC Home Page  
 ACSYS Home Page  
 Global Modeling and Assimilation Office (NASA/GSFC)  
 Land Information System (NASA/GSFC)  
 Model Parameter Estimation Experiment (MOPEX)  
 NASA/Goddard Institute for Space Studies (GISS) Data  
 International Atomic Energy Agency (IAEA)  
 IAEA Isotope Hydrology Section

**SATELLITE**



**MODEL**



# CEOP REFERENCE SITE DATA ACCESS



## EOP-3 and EOP-4 Reference Site Data Sets



Last Updated: 19 December 2005.

**Most recent updates:** 19 Dec (LBA Brasilia STM), 09 Dec (LBA Manaus SFC), 08 Dec (CAMP Himalayas SFC, STM; CAMP Korean Haenam SFC, STM; LBA Manaus FLX; Other ARM NSA TWR), 01 Dec (GAPP Bondville FLX, SFC, STM), 11 Nov (Other ARM NSA SFC), 03 Nov (Other ARM TWP SFC),

To order individual data sets click on the appropriate "X" below

Additional documentation can be obtained by clicking on the Reference Site Name.

**SFC** - Surface Meteorology and Radiation

**TWR** - Meteorological Tower

**STM** - Soil Temperature and Moisture

**FLX** - Flux

[CEOP Reference Site Data Set Procedures Report](#)

To jump to a particular CSE click on the appropriate logo:



CSE	Reference Site Name	Data Set	EOP-3 First Half 1 Oct 2002 - 31 Mar 2003	EOP-3 Second Half 1 Apr 2003 - 30 Sep 2003	EOP-4 First Half 1 Oct 2003 - 31 Mar 2004	EOP-4 Second Half 1 Apr 2004 - 31 Dec 2004
BALTEX	Cabauw	SFC	X (13 Oct 2005)			
		TWR	X (13 Oct 2005)			
		STM	X (13 Oct 2005)			
		FLX	X (13 Oct 2005)			
		Soundings (Raw)	X (03 Oct 2005)			
	Lindenberg	SFC	X (05 Jul 2005; Forest station currently only includes 2003 data)			
		TWR	X (05 Jul 2005; Forest station currently only includes 2003 data)			
		STM	X (05 Jul 2005; Forest station currently only includes 2003 data)			
		FLX	X (09 May 2005; Forest station currently not included)			
		Soundings (Raw)	X (10 May 2005)			
		SFC				

# CEOP LAND COVER AND SOILS QUESTIONNAIRE

CEOP Land Cover and Soils Information - Mozilla Firefox

http://www.joss.ucar.edu/cgi-bin/ceop/ceop\_ve

Land Cover and Soils Questionnaire

Minimum Requirements - All Reference Sites are requested to fill out this portion

Which CEOP Continental Scale Experiment (CSE) and Reference Site are these responses related to?: BALTEX Cabauw

Which Station at the Reference Site are these responses related to?:

**Soils Minimum Requirement**

Surface sand, silt and clay percentages; or [texture class](#)

Surface porosity (%)

**Land Cover Minimum Requirement**

Dominant land cover at the ground measurement location (detailed description or [USGS class](#) preferred; other classification optional, but specify)

Has there been a major change in land cover at the ground measurement site during the period from 1 October 2002 to 31 December 2004 (e.g. deforestation, crop rotation, fires, etc)? If yes, please provide details.

**Elevation Minimum Requirement**

Elevation (m) at the ground measurement location

Enhanced Information - All Reference Sites may fill out this section, but BALTEX Lindenberg, CAMP Tongyu, GAPP Bondville and MDB are specifically requested to fill out this section.

**Soils Enhanced Information**

Textures in deeper soil layers  
Layer sand, silt and clay percentages; or [texture class](#)

Porosity (%) in deeper soil layers

Soil infiltration rate (mm/hr)

Bulk dry density (g/cm<sup>3</sup>)

Saturated hydraulic conductivity (cm/s)

**Reference Site (Station)**

**Minimum Soils Information**

Texture Class, Porosity

**Minimum Land Cover**

USGS Class, Site Changes

**Enhanced Soils Information**

Profile (texture, porosity, infiltration, bulk dry density, saturated hydraulic conductivity, reference groups)

**Enhanced Land Cover Information**

Land cover (50m, 500m, 12km, seasonal changes)

Elevation information (slope)



## Lindenberg Reference Site



### STATION NAME:

Falkenberg

### CONTACT:

**Name:** Dr. Frank Beyrich

**Affiliation:**

Meteorologisches Observatorium Lindenberg  
Deutscher Wetterdienst (DWD)

**Address:**

Am Observatorium 12  
D - 15848 Tauche - OT Lindenberg  
Germany

**E-mail:** frank.beyrich AT dwd DOT de

**Telephone:** +49 33677 60228

**Fax:** +49 33677 60280

### WEB PAGES:

- ◆ [Lindenberg Meteorological Observatory Web Page](#)
- ◆ [BALTEX Home Page](#)

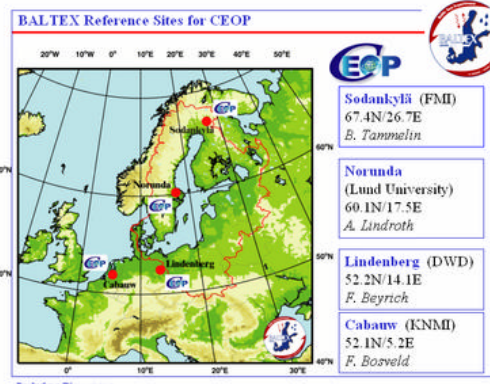
### STATION LOCATION:

All meteorological, radiation, soil, tower and flux measurements have been performed at the Falkenberg Boundary Layer Field Site of the Meteorological Observatory Lindenberg (MOL).

The coordinates of the GM Falkenberg are given by:  
52° 10' 01" N (52.17°N) and 14° 07' 27" E (14.12°E) at 73 m elevation.

The radiosondes are released at the site of the Meteorological Observatory Lindenberg (MOL) which is about 5 km to the North of the Falkenberg site.

The co-ordinates of the MOL are given by:  
52° 12' 36" N (52.21°N) and 14° 07' 12" E (14.12°E) at 112 m elevation.

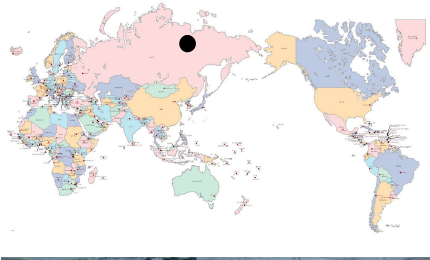


### STATION DESCRIPTION:

## Individual Site Metadata includes:

- Station (s)
- Contact (s)
- Links to relevant web pages
- Station location (e.g. maps, photos)
- Station description (e.g. vegetation characteristics, soil types, climate)
- Parameters and Instrumentation descriptions (SFC, TWR, STM, FLX, UA)
- Links to presentations
- Links to data sets and additional documentation

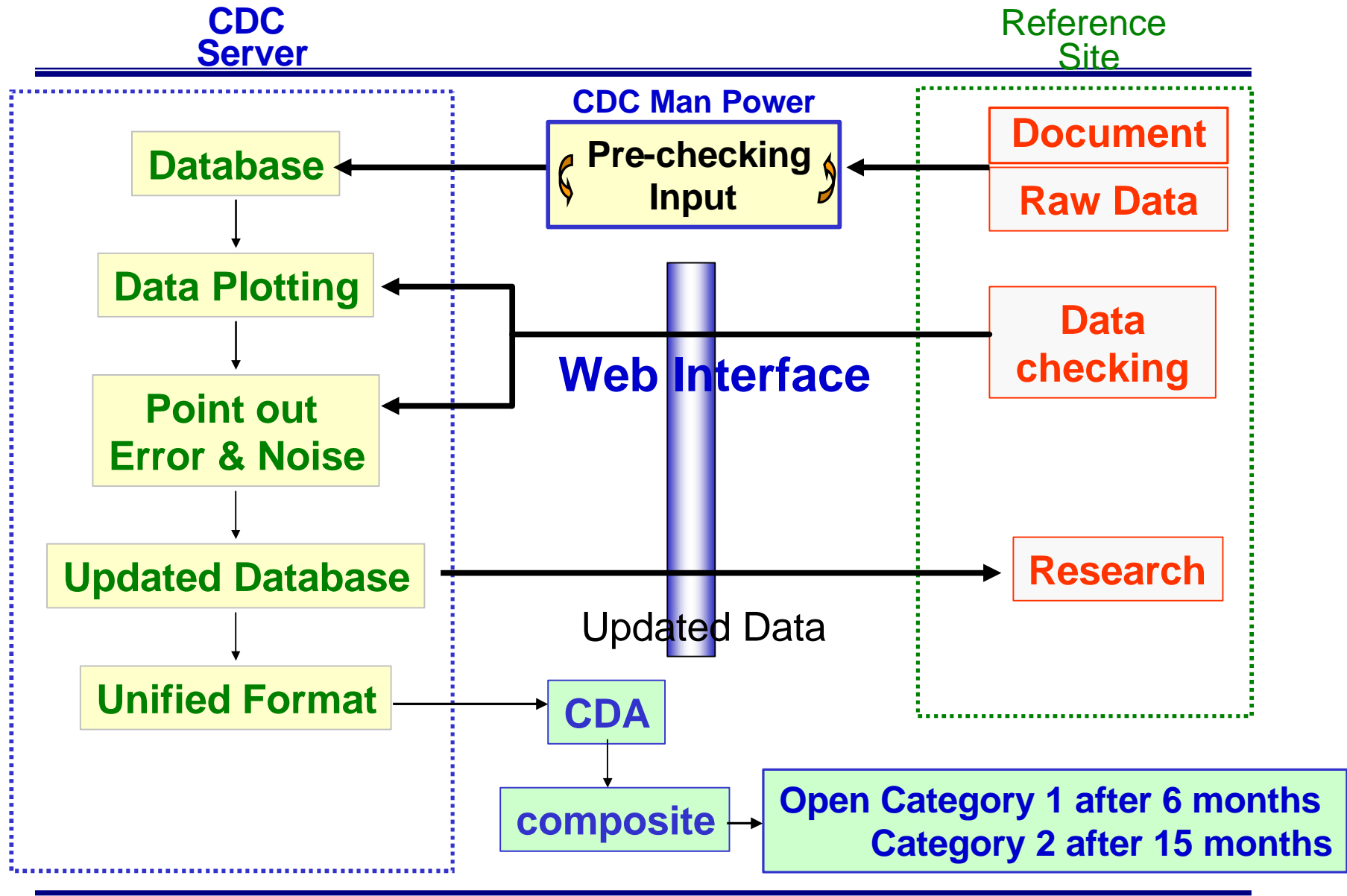




# Eastern Siberia Taiga (Yakutsk)

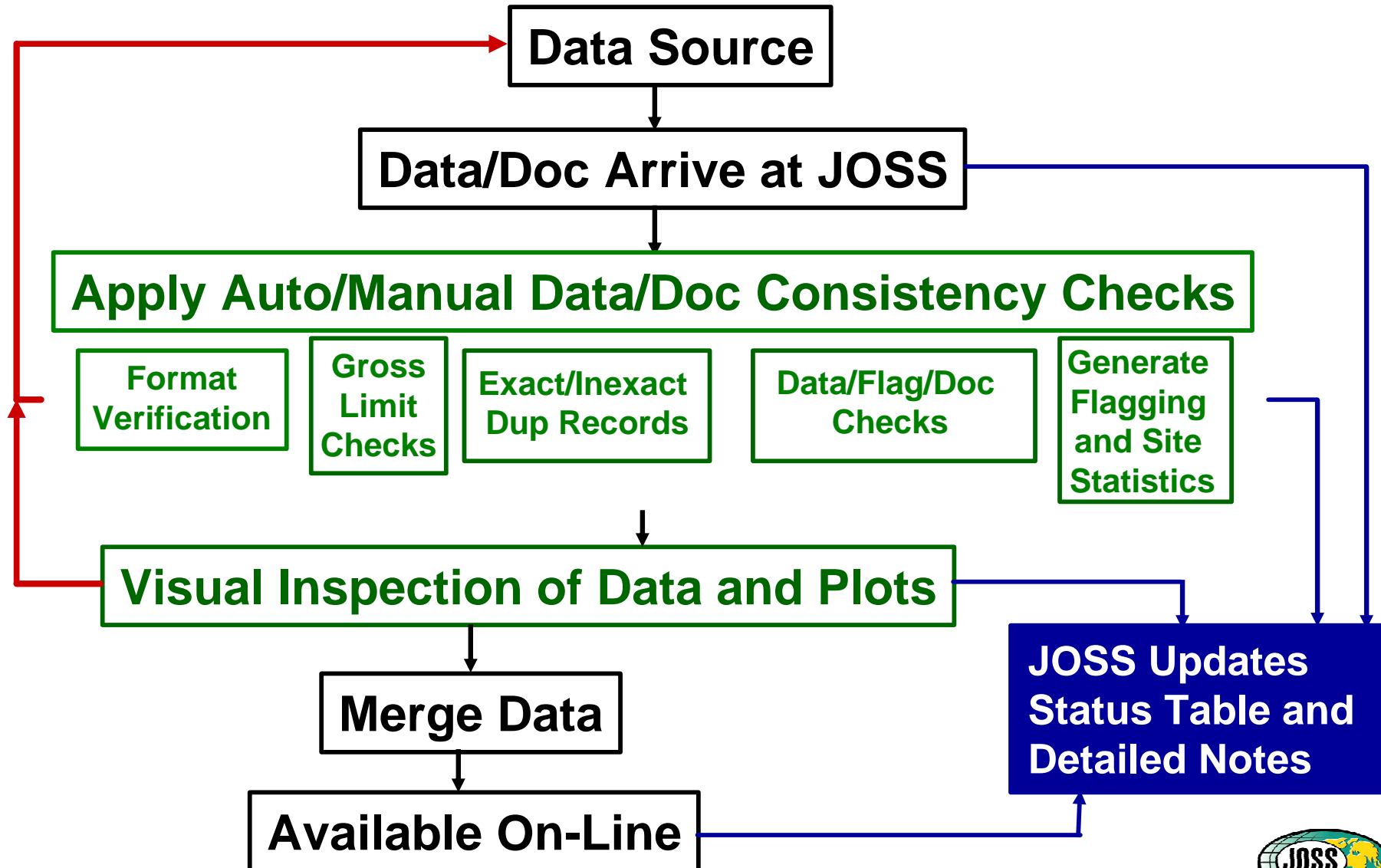


# CAMP Data Center(CDC)



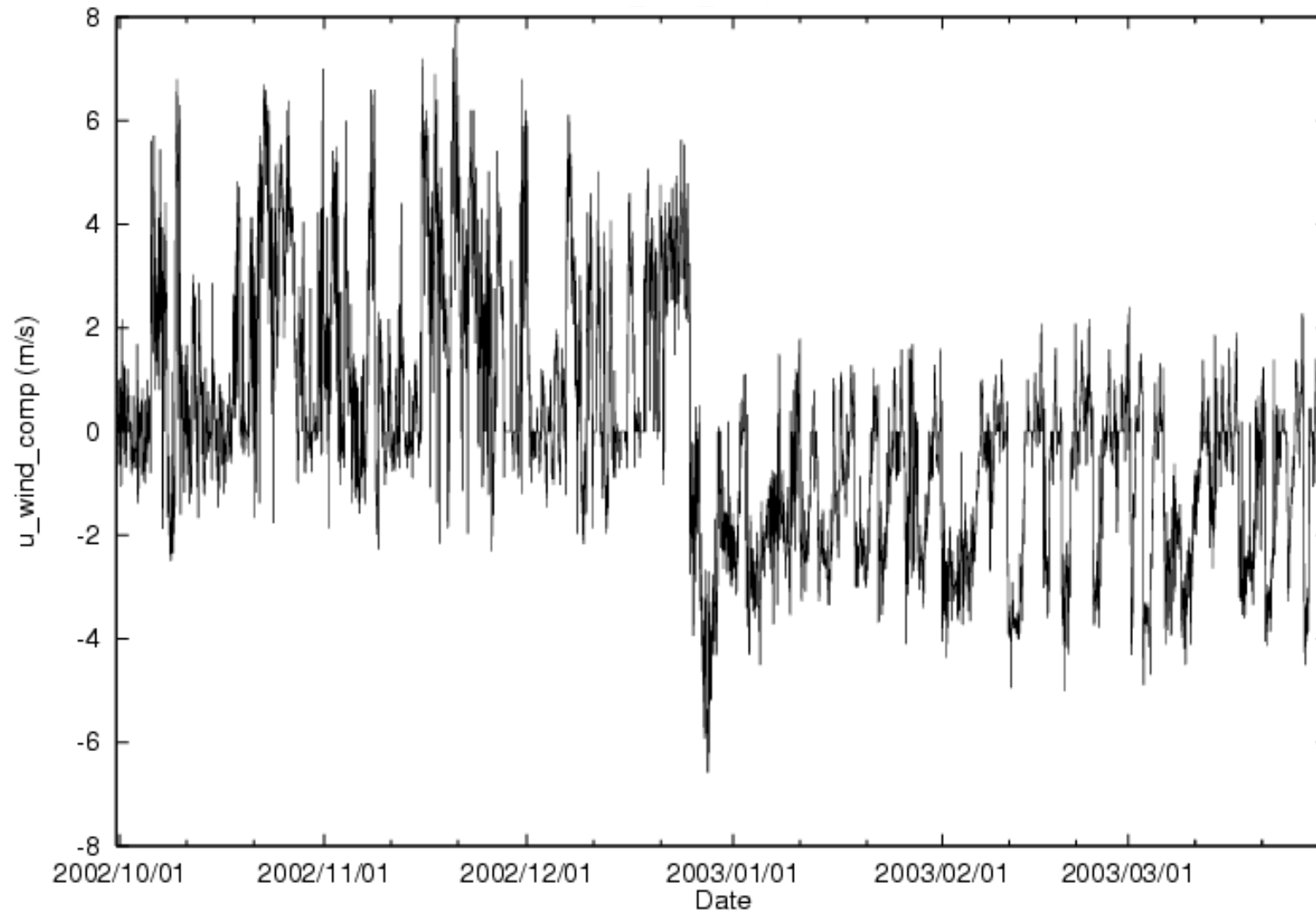


# Reference Site EOP-3 and 4 Data Flow



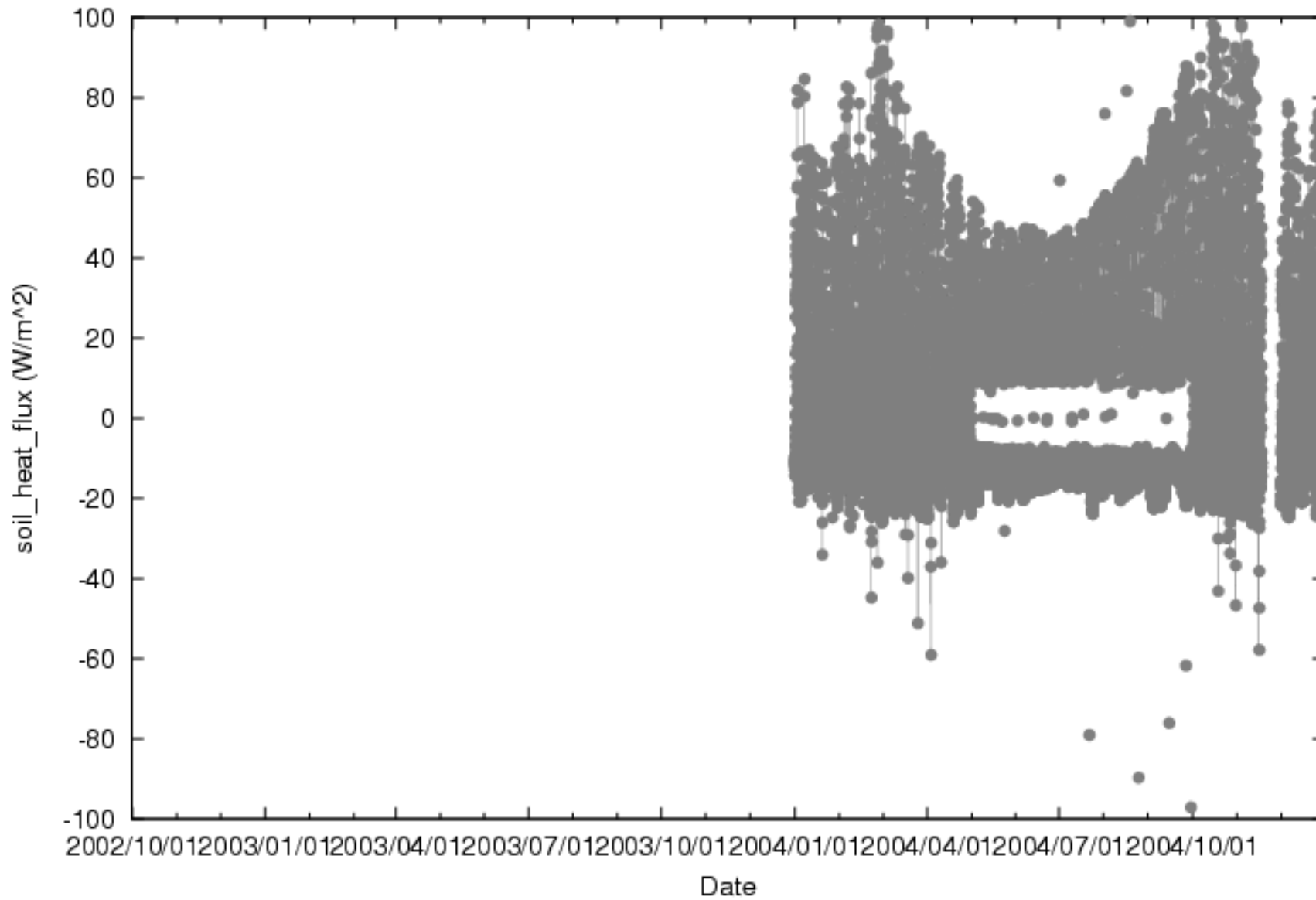


# U-WIND COMPONENT





# SOIL HEAT FLUX





# EOP-3/4 REFERENCE SITE QUALITY ASSURANCE (QA) STATISTICS (24 February 2006)

- Currently, over 3.7 Gb (90 Datasets) of finalized data on-line from 33 Reference Sites
- Complete EOP 3/4 Data on-line from 9 Sites
- >4800 data files have been checked from all versions (some sites >8 times!)
- >5200 Data Quality Assurance logs created
- >30,000 Data Plots generated and visually checked
- All data available on DODS Server → available through CEOP Distributed archive



# BALTEX REFERENCE SITE STATUS

## (24 FEBRUARY 2006)

CSE	Reference Site Name	Data Set	EOP-3 First Half 1 Oct 2002 - 31 Mar 2003	EOP-3 Second Half 1 Apr 2003 - 30 Sep 2003	EOP-4 First Half 1 Oct 2003 - 31 Mar 2004	EOP-4 Second Half 1 Apr 2004 - 31 Dec 2004	
BALTEX	Cabauw	SFC	X (13 Oct 2005)				
		TWR	X (13 Oct 2005)				
		STM	X (13 Oct 2005)				
		FLX	X (13 Oct 2005)				
		Soundings (Raw)	X (03 Oct 2005)				
	Lindenberg	SFC	X (14 Feb 2006) <b>NEW</b>				
		TWR	X (15 Feb 2006) <b>NEW</b>				
		STM	X (14 Feb 2006) <b>NEW</b>				
		FLX	X (14 Feb 2006) <b>NEW</b>				
		Soundings (Raw)	X (10 May 2005)				
	Norunda	SFC					
		TWR					
		STM					
		FLX					
		Soundings (Raw)					
	Sodankylä	SFC	X (22 Oct 2004)				
		TWR					
		STM					
		FLX					
		Soundings (Raw)					



# GAPP REFERENCE SITE STATUS (24 FEBRUARY 2006)

CSE	Reference Site Name	Data Set	EOP-3 First Half 1 Oct 2002 - 31 Mar 2003	EOP-3 Second Half 1 Apr 2003 - 30 Sep 2003	EOP-4 First Half 1 Oct 2003 - 31 Mar 2004	EOP-4 Second Half 1 Apr 2004 - 31 Dec 2004
GAPP	Ft. Peck	SFC	X (23 Jan 2004)			
		TWR				
		STM	X (23 Jan 2004)			
		FLX	X (23 Jan 2004)			
		Soundings (Raw)			X (19 May 2005)	
	Mt. Bigelow	SFC				
		TWR				
		STM				
		FLX				
		Soundings (Raw)			X (19 May 2005)	
	Oak Ridge	SFC	X (23 Jan 2004)			
		TWR				
		STM	X (23 Jan 2004)			
		FLX	X (23 Jan 2004)			
		Soundings (Raw)			X (19 May 2005)	
	SGP	SFC			X (14 Sep 2005)	
		TWR			X (12 Sep 2005)	
		STM			X (13 Oct 2005)	
		FLX			X (9 Sep 2005)	
		Soundings (Raw)			X (17 May 2005)	
GAPP	Bondville	SFC			X (01 Dec 2005) <b>NEW</b>	
		TWR				
		STM			X (01 Dec 2005) <b>NEW</b>	
		FLX			X (01 Dec 2005) <b>NEW</b>	
		Soundings (Raw)			X (19 May 2005)	





# LBA REFERENCE SITE STATUS (24 FEBRUARY 2006)

CSE	Reference Site Name	Data Set	EOP-3 First Half 1 Oct 2002 - 31 Mar 2003	EOP-3 Second Half 1 Apr 2003 - 30 Sep 2003	EOP-4 First Half 1 Oct 2003 - 31 Mar 2004	EOP-4 Second Half 1 Apr 2004 - 31 Dec 2004	
LBA	Caxiuana	SFC					
		TWR					
		STM					
		FLX					
		Soundings (Raw)					
	Manaus	SFC		X (09 Dec 2005)			
		TWR					
		STM					
		FLX		X (08 Dec 2005)			
		Soundings (Raw)					
	Pantanal	SFC		X (18 Apr 2005)			
		TWR					
		STM					
		FLX					
		Soundings (Raw)					
	Rondonia	SFC					
		TWR					
		STM					
		FLX					
		Soundings (Raw)					
Santarem	SFC		X (13 May 2005)				
	TWR		X (13 May 2005)				
	STM		X (26 May 2005)				
	FLX		X (26 May 2005)				
	Soundings (Raw)						
LBA	Brasilia	SFC					
		TWR					
		STM			(19 Dec 2005)		
		FLX			X (20 Jan 2006)		
		Soundings (Raw)					



# REFERENCE SITE STATUS (24 FEBRUARY 2006)

CSE	Reference Site Name	Data Set	EOP-3 First Half 1 Oct 2002 - 31 Mar 2003	EOP-3 Second Half 1 Apr 2003 - 30 Sep 2003	EOP-4 First Half 1 Oct 2003 - 31 Mar 2004	EOP-4 Second Half 1 Apr 2004 - 31 Dec 2004
MAGS	BERMS	SFC				
		TWR		X (23 Feb 2006) <b>NEW</b>		
		STM		X (23 Feb 2006) <b>NEW</b>		
		FLX		X (23 Feb 2006) <b>NEW</b>		
		Soundings (Raw)		X (24 Feb 2006) <b>NEW</b>		
MDB	Murrumbidgee	SFC				
		TWR				
		STM				
		FLX				
		Soundings (Raw)				
	Tumbarumba	SFC				
		TWR				
		STM				
		FLX				
		Soundings (Raw)				
ARM	NSA	SFC		X (11 Nov 2005)		
		TWR		X (08 Dec 2005)		
		STM				
		FLX				
		Soundings (Raw)		X (19 May 2005)		
	TWP	SFC		X (3 Nov 2005)		
		TWR				
		STM				
		FLX				
		Soundings (Raw)		X (19 May 2005)		

Additional Data Available in Raw Format:  
 CATCH (AMMA) Precipitation Data Set (2001 to 2003) (09 Nov 2004)  
 CATCH (AMMA) Streamgauge Data Set (2001 and 2002) (02 Mar 2004)



# CAMP REFERENCE SITE STATUS (22 FEBRUARY 2006)

Reference Site Name Site rep./ manager	Soil&Vege info	Data Set	EOP-3 First Half ( 1 Oct 2002 - 31 Mar 2003 )	EOP-3 Second Half ( 1 Apr 2003 - 30 Sep 2003 )	EOP-4 First Half ( 1 Oct 2003 - 31 Mar 2004 )	EOP-4 Second Half ( 1 Apr 2004 - 31 Dec 2004 )
<b>Siberia Tundra</b>		Submission to CDC	0	0	0	
		Compile to DB	0	0	0	
Dhata		Quality Control	0	0	0	
Yabuki		Submission to UCAR	0	0		
<b>Siberia Taiaga</b>		Submission to CDC	0	0	0	
		Compile to DB	0	0	0	
Dhata		Quality Control	0	0	0	
Yabuki		Submission to UCAR	0	0		
<b>Mongolia</b>		Submission to CDC	0	0	0	
	0	Compile to DB	0	0	0	
Davva		Quality Control	0	0	P	
Kaihotsu		Submission to UCAR	0	0		
<b>Tongyu</b>		Submission to CDC	0	0	0	
	0	Compile to DB	0	0	0	
Liu		Quality Control	0	0	0	
Liu		Submission to UCAR	0	0		
<b>Korean Peninsula</b>		Submission to CDC	0			
	0	Compile to DB	0			
Kim		Quality Control	0			
Jinkyu		Submission to UCAR	0			
<b>Korean Haenam</b>		Submission to CDC	0	0		
	0	Compile to DB	0	0		
Kim		Quality Control	0	0		
Jinkyu		Submission to UCAR	0	0		



# CAMP REFERENCE SITE STATUS (22 FEBRUARY 2006) (Continued)

Reference Site Name <small>Site rep./ manager</small>	Soil&Vege info	Data Set	EOP-3 First Half <small>( 1 Oct 2002 - 31 Mar 2003 )</small>	EOP-3 Second Half <small>( 1 Apr 2003 - 30 Sep 2003 )</small>	EOP-4 First Half <small>( 1 Oct 2003 - 31 Mar 2004 )</small>	EOP-4 Second Half <small>( 1 Apr 2004 - 31 Dec 2004 )</small>
<b>Tibet (East)</b>		Submission to CDC	0	0	P	
		Compile to DB	0	0	P	
Ma/Ueno		Quality Control	0	0	P	
Li/Tanaka		Submission to UCAR	0	P		
<b>Tibet (West)</b>		Submission to CDC	0	0	0	0
		Compile to DB	0	0	0	
Haginoya		Quality Control	0	0	0	
Haginoya		Submission to UCAR	0	0		
<b>Himalayas</b>		Submission to CDC	0	0	0	0
		Compile to DB	0	0	0	0
Tartari		Quality Control	0	0	0	0
Bertolani		Submission to UCAR	0	0	0	0
<b>Northern South China Sea - Southern Japan (NSCCSJ)</b>	0	Submission to CDC	0	0	0	0
		Compile to DB	0	0	0	
Chen		Quality Control	0	0		
Yen		Submission to UCAR	0	0		



# CAMP REFERENCE SITE STATUS (22 FEBRUARY 2006) (Continued)

Reference Site Name <small>Site rep./ manager</small>	Soil&Vege info	Data Set	EOP-3 First Half <small>( 1 Oct 2002 - 31 Mar 2003 )</small>	EOP-3 Second Half <small>( 1 Apr 2003 - 30 Sep 2003 )</small>	EOP-4 First Half <small>( 1 Oct 2003 - 31 Mar 2004 )</small>	EOP-4 Second Half <small>( 1 Apr 2004 - 31 Dec 2004 )</small>
<b>Northern South China Sea - Southern Japan (NSCCSJ)</b> Chen Yen		Submission to CDC	0	0	0	0
	0	Compile to DB	0	0	0	
		Quality Control	0	0		
		Submission to UCAR	0	0		
<b>Chao-Phraya River</b> Aoki Aoki		Submission to CDC	0	0		
	0	Compile to DB	0	0		
		Quality Control	0	0		
		Submission to UCAR	0			
<b>Northeast Thailand</b> Aoki Aoki		Submission to CDC	0	0		
	0	Compile to DB	0	0		
		Quality Control	0			
		Submission to UCAR	0			
<b>Western Pacific Ocean</b> Shirooka Shirooka		Submission to CDC	0	0	0	
	0	Compile to DB	0	0	0	
		Quality Control	0	0		
		Submission to UCAR	0	0		
<b>Equatorial Island</b> Sribimawati/Yamanaka Darmawan		Submission to CDC	0	0	0	
	0	Compile to DB	0	0	0	
		Quality Control	0	0		
		Submission to UCAR	0	0		

0 : Completed  
P : Partially Submitted



# CEOP HYDROLOGY REFERENCE SITES

## What is this?

### Candidate Sites

- > Kyeamba Creek (Australia)
- > Sleeven Polder (Ireland)
- > Walnut Gulch (US)
- > Igarape Asu (Brazil)
- > Zwalm River (Belgium)
- > Volta River (Ghana)
- > Wolf Creek (Canada)
- > Naqu River (China)

[Submit Your Site](#)  
[Current Entries](#)

## What is this?

CEOP, the [GEWEX](#) Coordinated Enhanced Observing Period, has as its overarching goal "*To understand and model the influence of continental hydroclimate processes on the predictability of global atmospheric circulation and changes in water resources ...*". The first of two CEOP objectives is "*To use enhanced observations to better document and simulate water and energy fluxes and reservoirs over land and diurnal to annual temporal scales and to better predict these on temporal scales up to seasonal for water resource applications.*" One major element of CEOP is a set of reference sites, which per the Implementation Plan, are to be "*Well-instrumented locations of small to intermediate scales area (10,000 km<sup>2</sup> or less) distributed around the globe in different climatic regimes [that] will provide the data needed on a mesoscale or smaller scale for research in land area and hydrology processes and model validation.*" To date, about 40 sites have been identified (see [www.joss.ucar.edu/ghp/ceopdm/ref\\_site.html](http://www.joss.ucar.edu/ghp/ceopdm/ref_site.html) for a map of the sites, and [www.joss.ucar.edu/ghp/ceopdm/rsite.html](http://www.joss.ucar.edu/ghp/ceopdm/rsite.html) for a summary of their characteristics).

Few of these sites have a surface hydrologic context, however, which for sake of discussion, we define as being the ability to observe directly most of components of the surface water budget (precipitation, streamflow, evapotranspiration, and surface and subsurface storage change). Most of the CEOP reference sites are in fact flux towers, or groups of flux towers, at which precipitation and other surface meteorological variables may also be measured. Very few lie within gaged catchments, hence arguably the most hydrologically important variable is not observed at more than a small handful of the sites. Clearly, the surface flux information collected at the reference sites is extremely useful for a variety of purposes related to CEOP objectives, but it cannot, at least alone, fulfill the stated purpose of the reference sites related to hydrological processes.

We are attempting to augment the CEOP tower flux sites with a small set of hydrological reference sites that will have the following purposes:

- To serve as validation sites for the land surface parameterizations in coupled land-atmosphere-ocean models, essentially at a point or small area scale;
- To serve as "tie points" or ground truth reference sites for remote sensing products

And that meet the following criteria:

- Stream gauge information should be available for a reference catchment within which the other (e.g., tower) observation sites lie. The catchment drainage area ideally should be in the range 100–1000 km<sup>2</sup>, recognizing that for some sites drainage areas as small as 10 km<sup>2</sup> and as large as 10,000 km<sup>2</sup> may be acceptable;
- Precipitation data, either from gauges or radar, sufficient to resolve the major modes of spatial variability within the catchment;
- Tower flux observations available for at least one site within the catchment, and land cover, soil and other ancillary data sufficient to support flux transfer methods such as those utilized by Betts(?) and Nijssen and Lettenmaier which could provide spatial interpolation of tower evapotranspiration estimates;
- Ideally, multiple year time series of the major water and energy balance terms.

Although we expect that in most cases streamflow observations would focus attention on a drainage area, there may be some situations where other observations would meet the requirement. This might be the case, for instance, in areas of very low relief, where drainage catchments are not well defined and hence stream discharge measurements are