An Element of WCRP initiated by GEWEX

A Precursor to IGOS Water Cycle Them

A First Step of IGWCO

One of the Candidate Sub-Projects of IGWCO

……

Criteria for measuring CEOP Progress

Technical Requirements, P, I, F (Planned, Initiating, Functioning)
Scientific Requirements B, Pr, C (Beginning, Progressing, Completed)

Data Management	Reference Site Composite Data Archive	F	35 Reference Sites, EOP-1: completed, EOP-3/4: on-going
	Model Output Archive	F	9 NWP centers and 2 Data Assimilation Centers
	Satellite Products Archive	F	TMI,PR, SSM/I, AMSR, AMSR-E, AIRS, AVHRR, MODIS, GMS: *on-going*
	Interoperability Arrangement	I-F	Meta Data Design, GCMD portal
	Distributed Data Integration System	I-F	Demo at GHP,CEOS and CEOP. To be open in Mar. 2005
	Centralized Data Integration System	I-F	Demo at GHP,CEOS and CEOP. To be open in Mar. 2005
WESP	Water and Energy Budget	Pr	3 articles on the CEOP Newsletter 1 Workshops (Irvine) GLDAS Product generation: on-going
	Model Output Validation by NWP Centers	Pr	
	GLDAS	Pr	
	GHP/CEOP Model Transferability Study	B	
	Model Inter-comparison Study	B	
CIMS	Monsoon Intercomparison Study	Pr	2 article on the CEOP Newsletter 2 Workshops (Milan, Montevideo)
	Diurnal, Intraseasonal and Seasonal Variability	Pr	
	Monsoon Process Study by Using Models	B	
	Impacts of Local & Remote Forcings on Monsoon	B	
Satellite	Algorithm Development and Validation	Pr	Soil moisture, Snow, 2 articles on the CEOP Newsletter
	Satellite Data Assimilation for Land Hydrology	Pr	Soil moisture, Surface fluxes, 2 journal papers
Project Management	Establishment of Direct Links and Connections	F	Reference Sites, NWPCs, Space Agencies
	CEOP Meetings	F	Implementation Planning Meeting, Workshop, Tele-Conf.
	Scientific Conferences	F	AGU:2, AOGS:1, AMS:1
	Levy Actions/Milestorne Documentation and Tracking	F	Working Group, Phase-II Planning
	Newsletter	F	Twice a Year (1-7)

An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN

- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN

- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

CEOP Hydrology Reference Sites

The current sites include:

- Kyeamba Creek, NSW Australia
- Sleeven Polder, lower Feale River basin, County Kerry, Ireland
- Walnut Gulch, Arizona, USA
- Igarape Asu, Central Amazonia, Brazil
- Zwalm river basin, Belgium
- Volta river basin, Ghana
- Wolf creek, Canada
- Naqu river basin, China

Brief summaries are accessible from the web for each of the sites, as is a data entry form for entering summary information for new sites.

An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN

- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

Main issues

1. Identify the present condition and needed observation network for detecting cryosphere change (Snow cover, frozen ground and glaciers) and expand and/or improve observation for related hydrological components, atmospheric (eg. Solid precipitation, moisture), vegetation etc. related to water/energy cycle.
2. Improve understanding of processes and land surface models in cold regions for better climate and hydrological prediction.
   - Sub-grid scale non-uniform snow cover
   - Forest snow processes
   - Blowing/drifting snow processes
   - Drainage runoff processes (1-1000km^2) uniform climate
3. Climatologically important hydrological phenomena
   - Increase/Variability in the runoff of Arctic draining large rivers.
   - Water (Liquid/Solid) balance of the large basins.
4. Improve the quality and amount of the hydrological and cryosphere data-sets of past and present.
5. Improve representation of snow/frozen ground in large scale

Frozen Precipitation Questionnaire

Which CEOP Continental Scale Experiment (CSE) and Reference Site are these repsonses related to?:	BALTEX Cabauw
Which Station at the Reference Site are these repsonses related to?:	
Does snowfall (frozen precipitation) occur at this site? (Yes/No)	Yes / No
Is total precipitation (rain and frozen) measured at this station? (Yes/No)	Yes / No
If you answered yes to the previous question: • How is it measured (include instrument type, manufacturer, model, gauge orifice size, and shielding information)? • At what interval is it measured? • Do you separate rain and snow totals? • Any additional important siting information?	
Is wind speed measured at the gauge location? (Yes/No)	Yes / No
If you answered no to the previous question: • At what height and location is it measured? • Can it be reduced to the height of the gauge?	

An Element of WCRP initiated by GEWEX

Part-II(2007-2010)

•Undertake and conclude a Cold Region Study in Cooperation with the WCRP Climate and Cryoshpere (CliC) Project and the International Polar Year (IPY) effort

- **Reference Site Network in Arctic**
- **Satellite Algorithm Development**
  snowpack, snowfall
- **Data Assimilation in Cold Region**
- **WESP in Cold Region**

CliC-CEOP Closer Cooperative Framework Need!

An Element of WCRP initiated by GEWEX

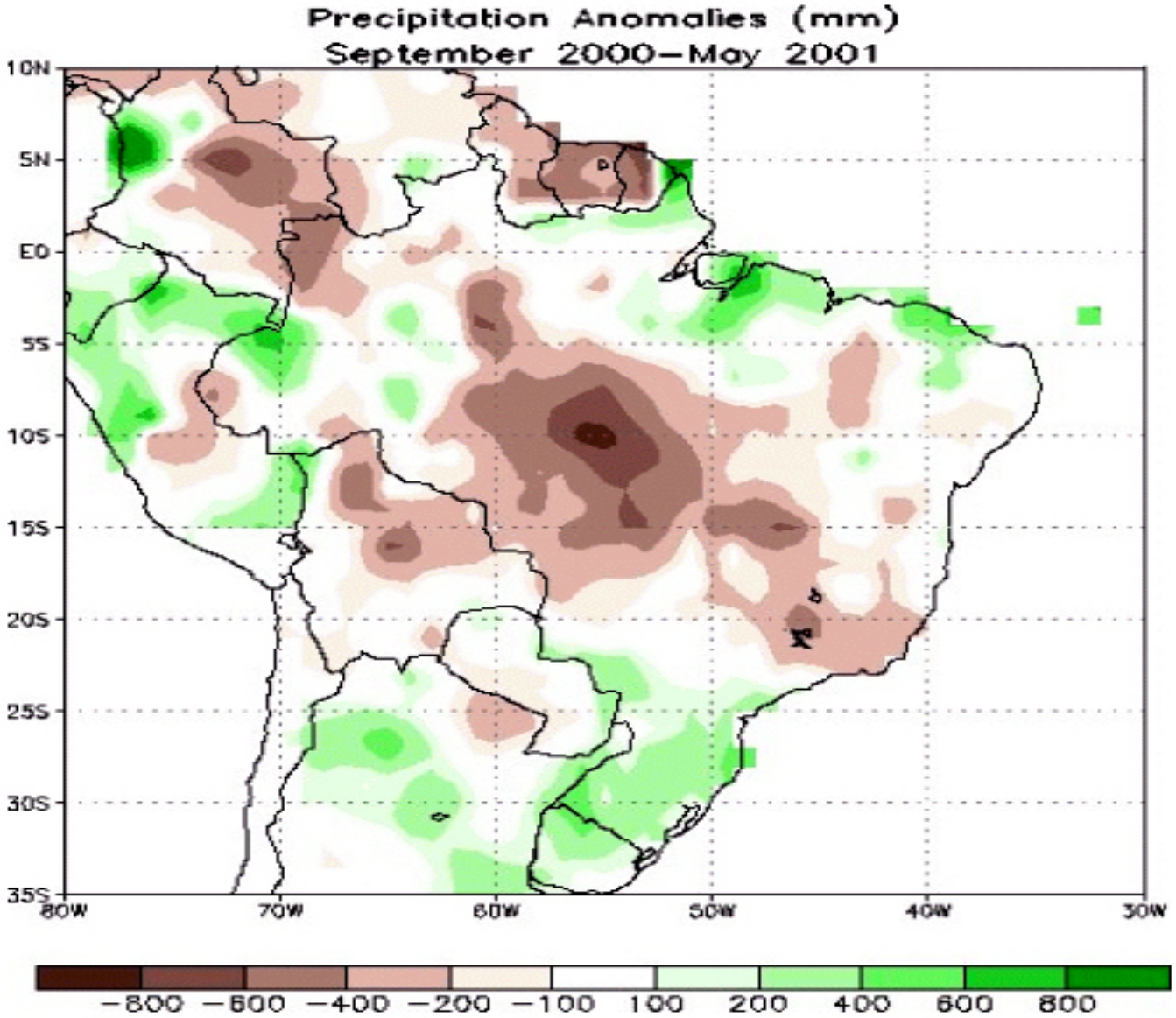
CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN

- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

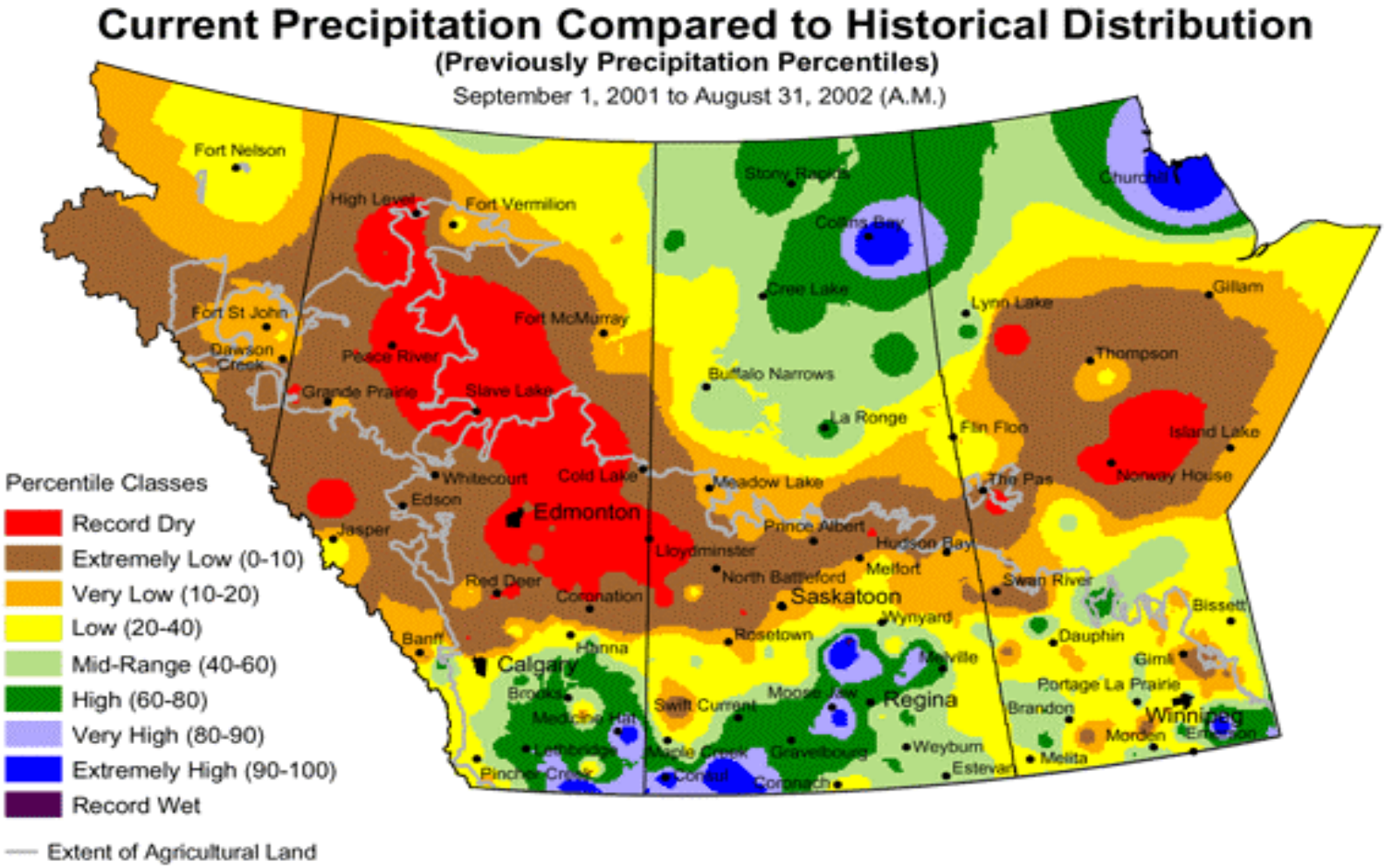
Into summer 2001



Prolonged dry period

95% of energy in Brazil is hydropower: Power shortages!

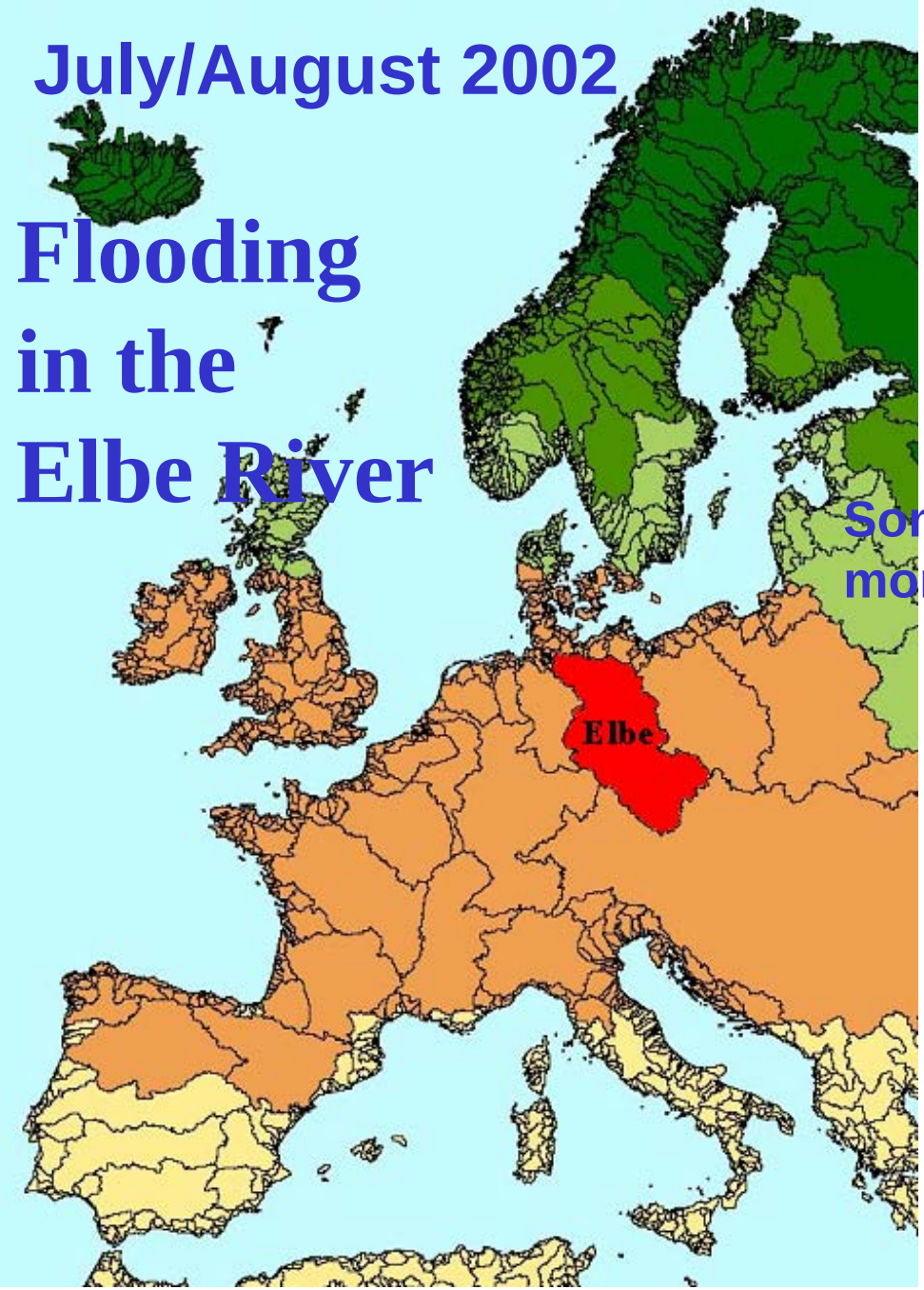
CANADIAN PRAIRIES
2002



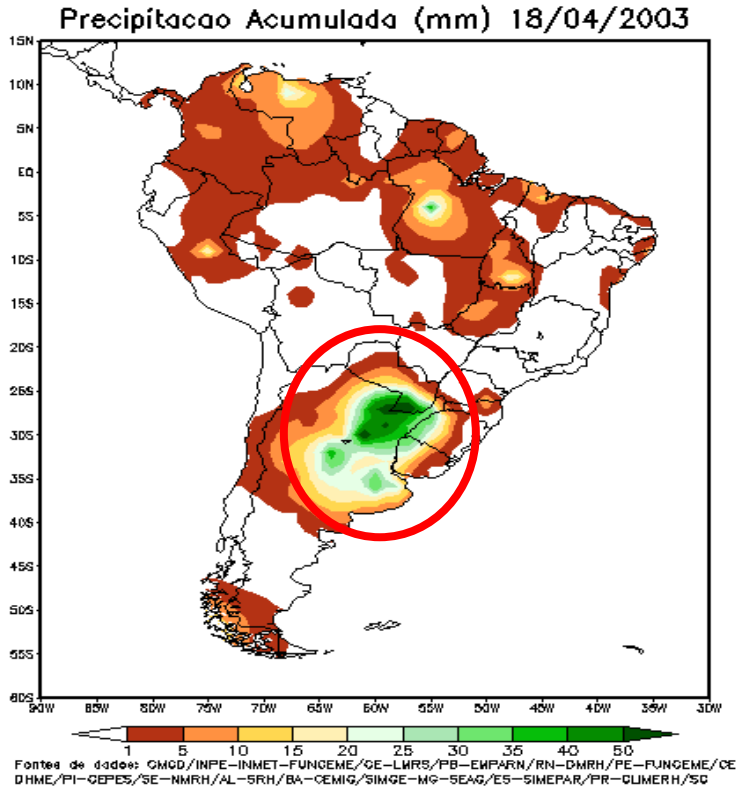
Prepared by PFRA (Prairie Farm Rehabilitation Administration) using data from the Timely Climate Monitoring Network and the many federal and provincial agencies and volunteers that support it.

July/August 2002

Flooding in the Elbe River



Some stations had 300% of monthly rain within 24 h



2003

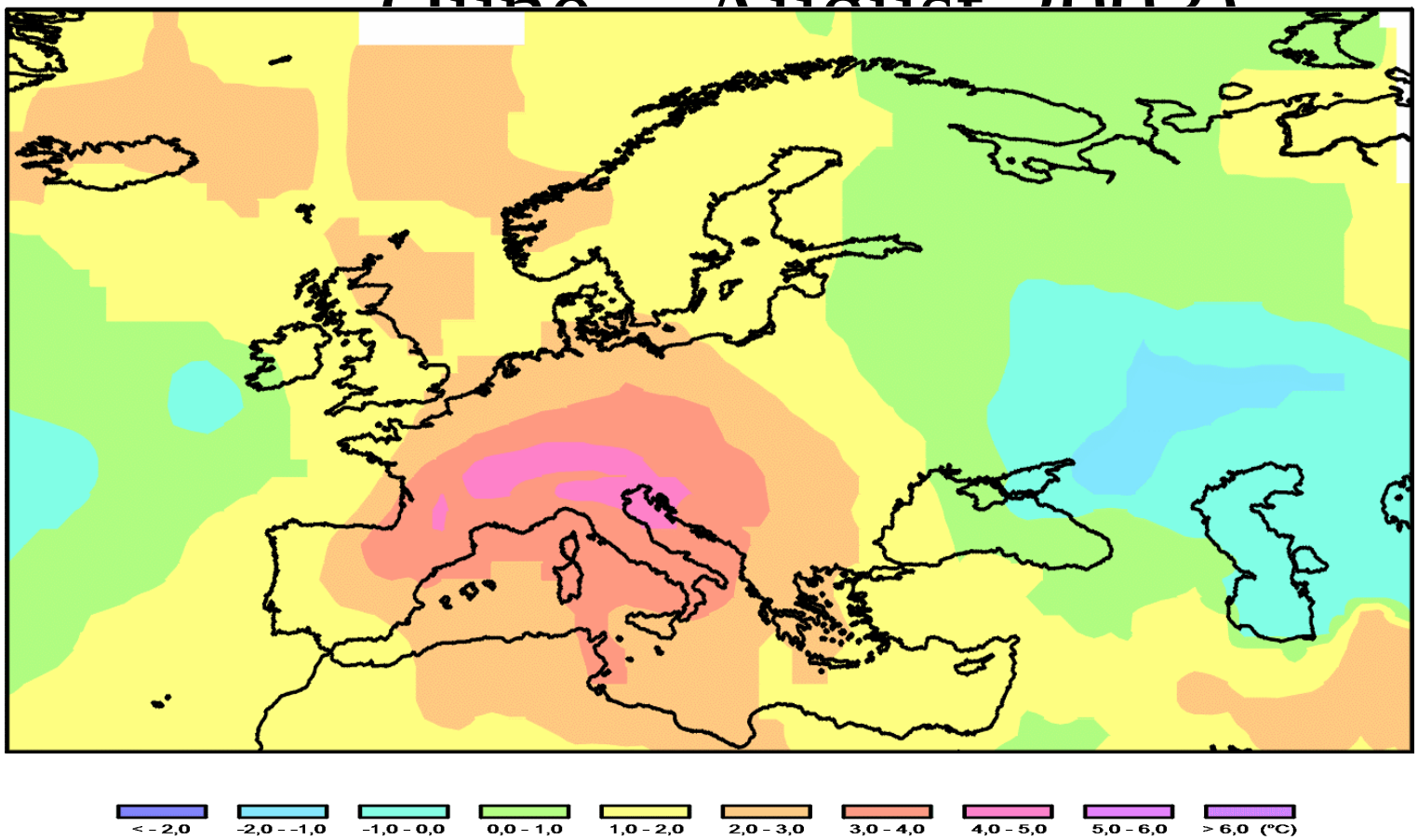
Forecast of extreme rainfall and floods in Santa Fe-Argentina

Eta/CPTEC 40 km
April 15 2003

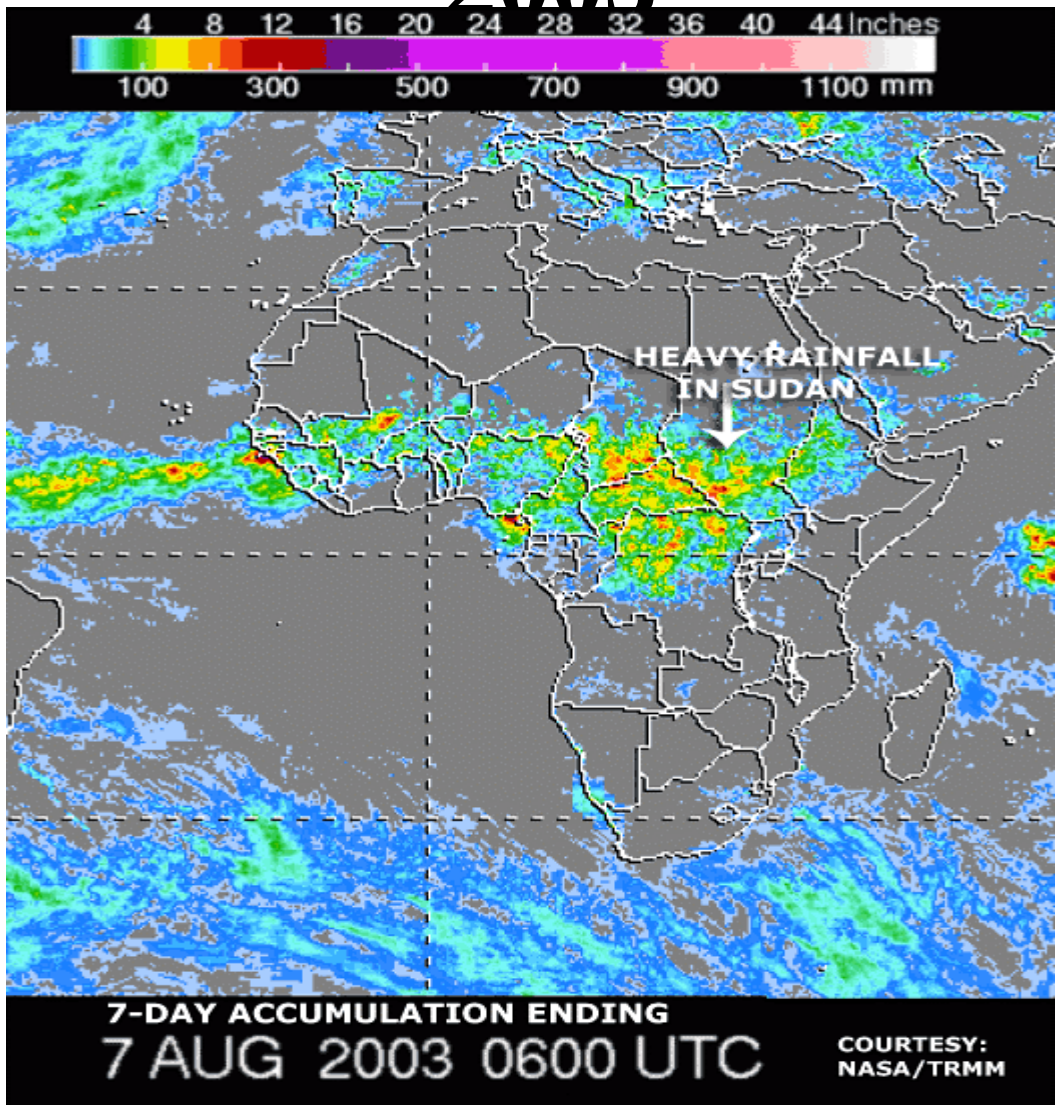
President Duhalde said that "there is no system that can anticipate events that happen every 400 years".

Heat Wave

(June – August 2003)



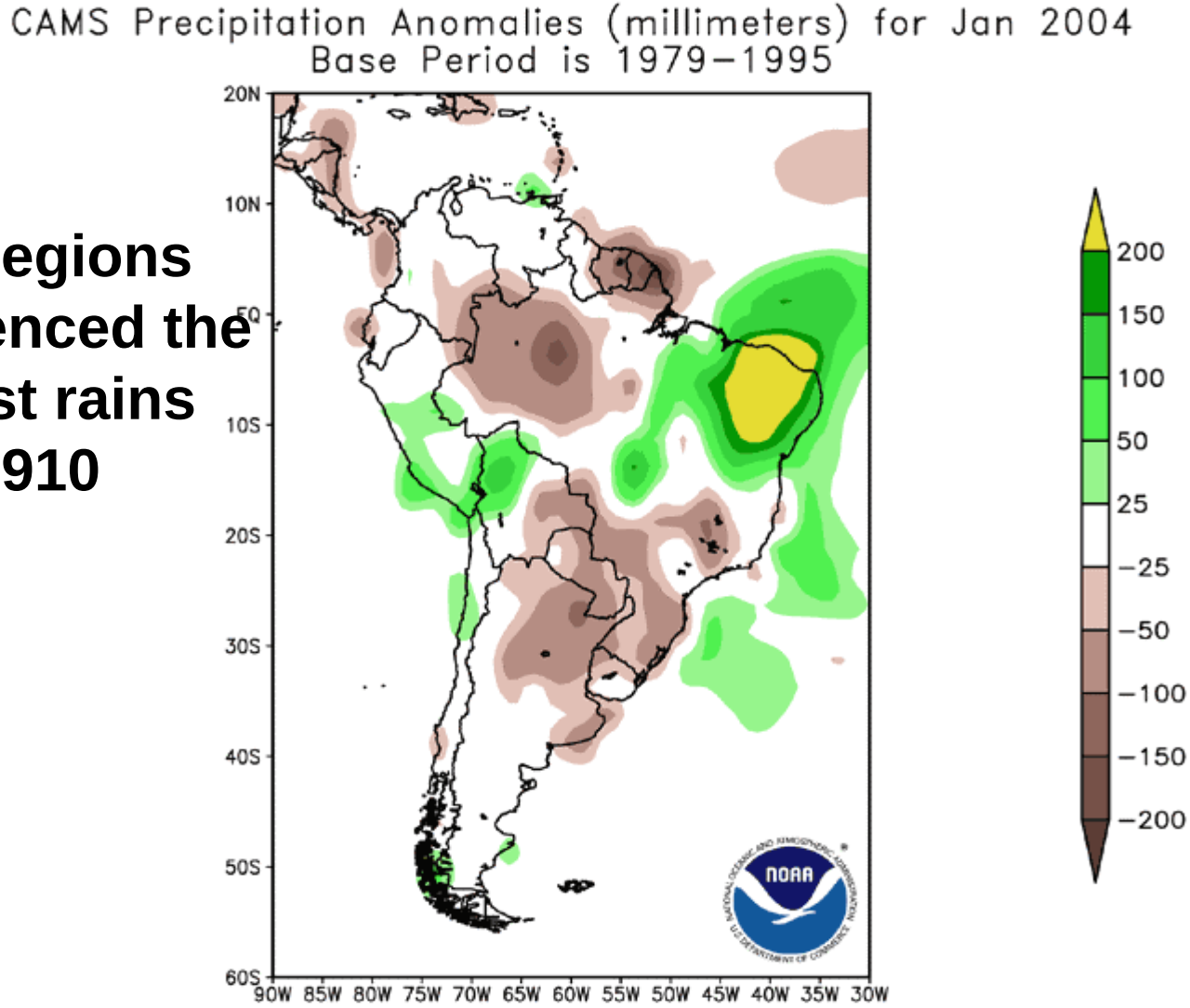
AFRICAN FLOODS 2003



Worst flooding in 70 years in some regions

BRAZIL

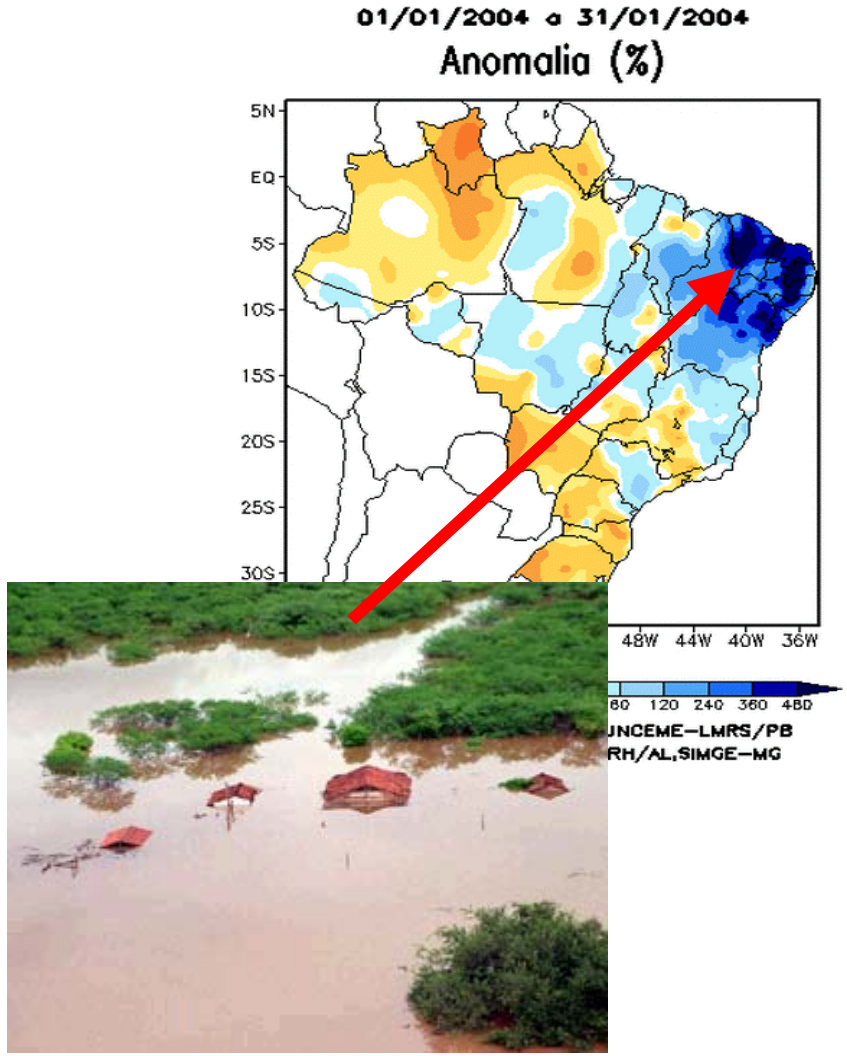
Some regions experienced the heaviest rains since 1910



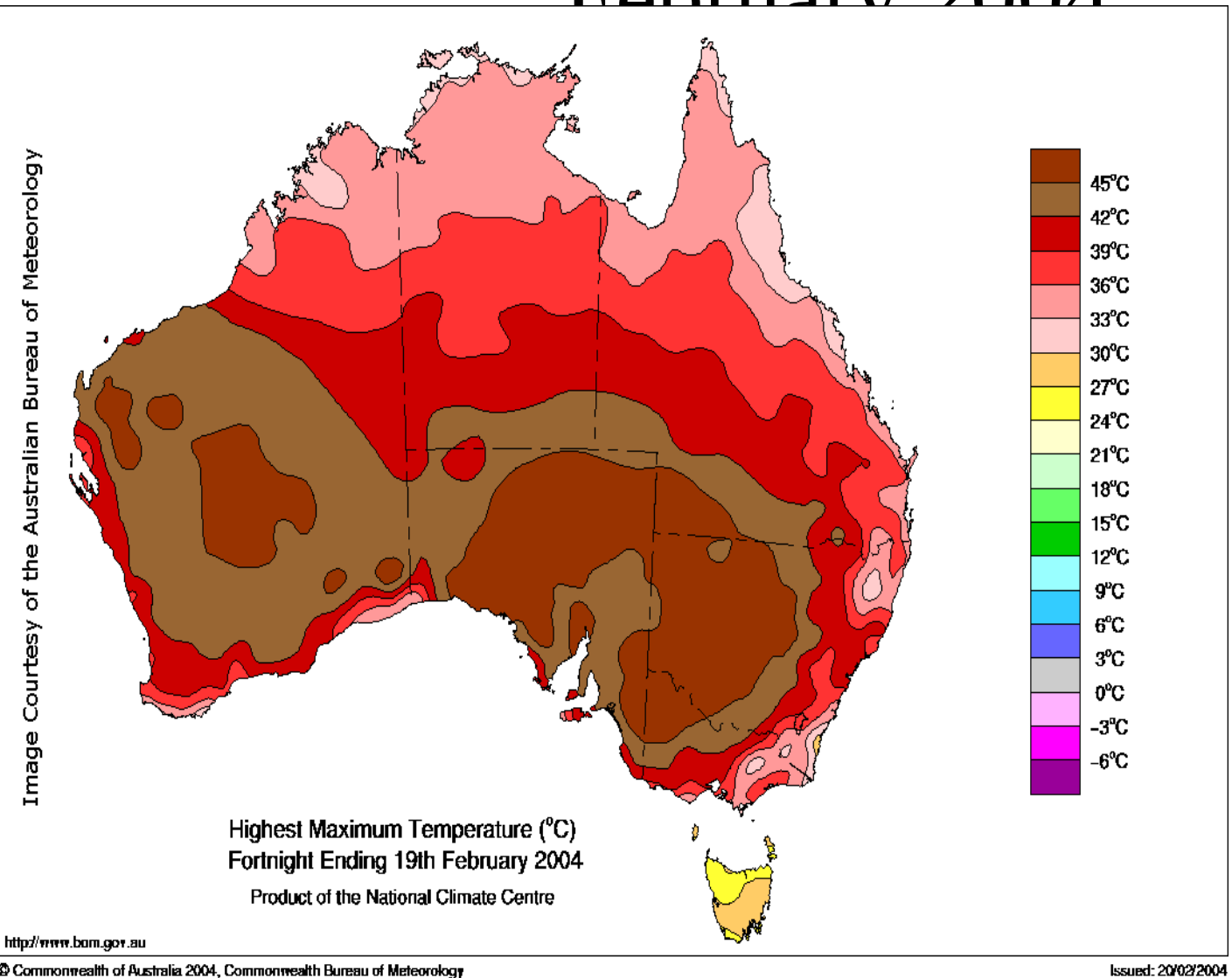
2001 versus 2004 in NE Brazil

Dry summer 2001 in NE Brazil

600% of rainfall above the normal in NE Brazil during January 2004



AUSTRALIAN HEAT WAVE
February 2004

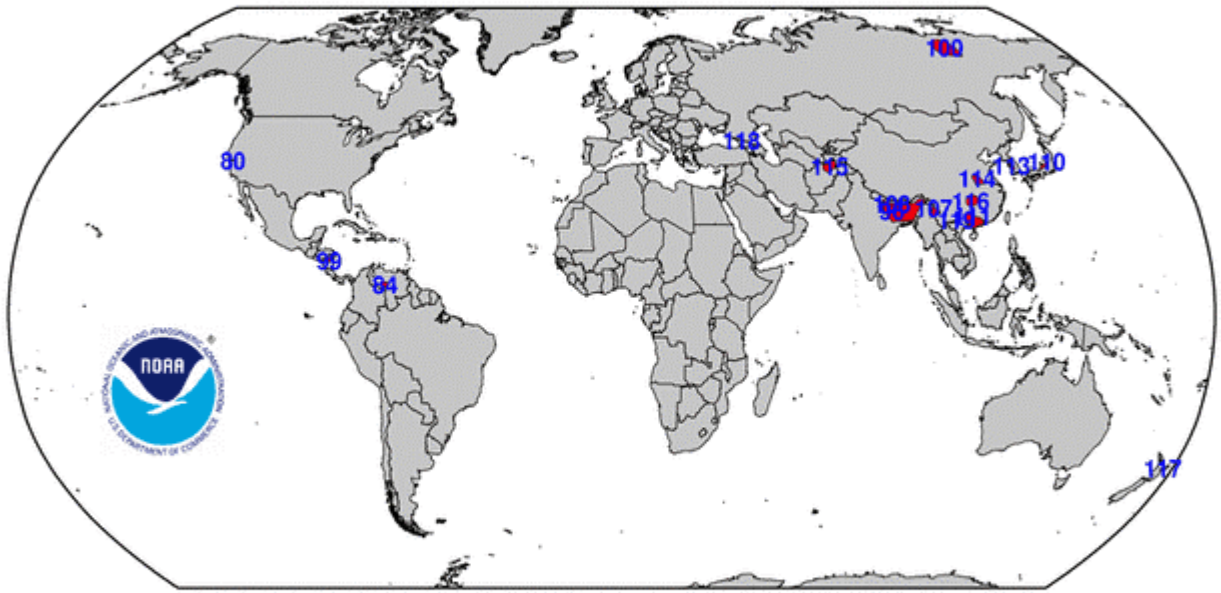


One of the most intense heat waves in a century

ASIAN FLOODS

Areas Affected by Flooding

For The Week Ending July 24, 2004

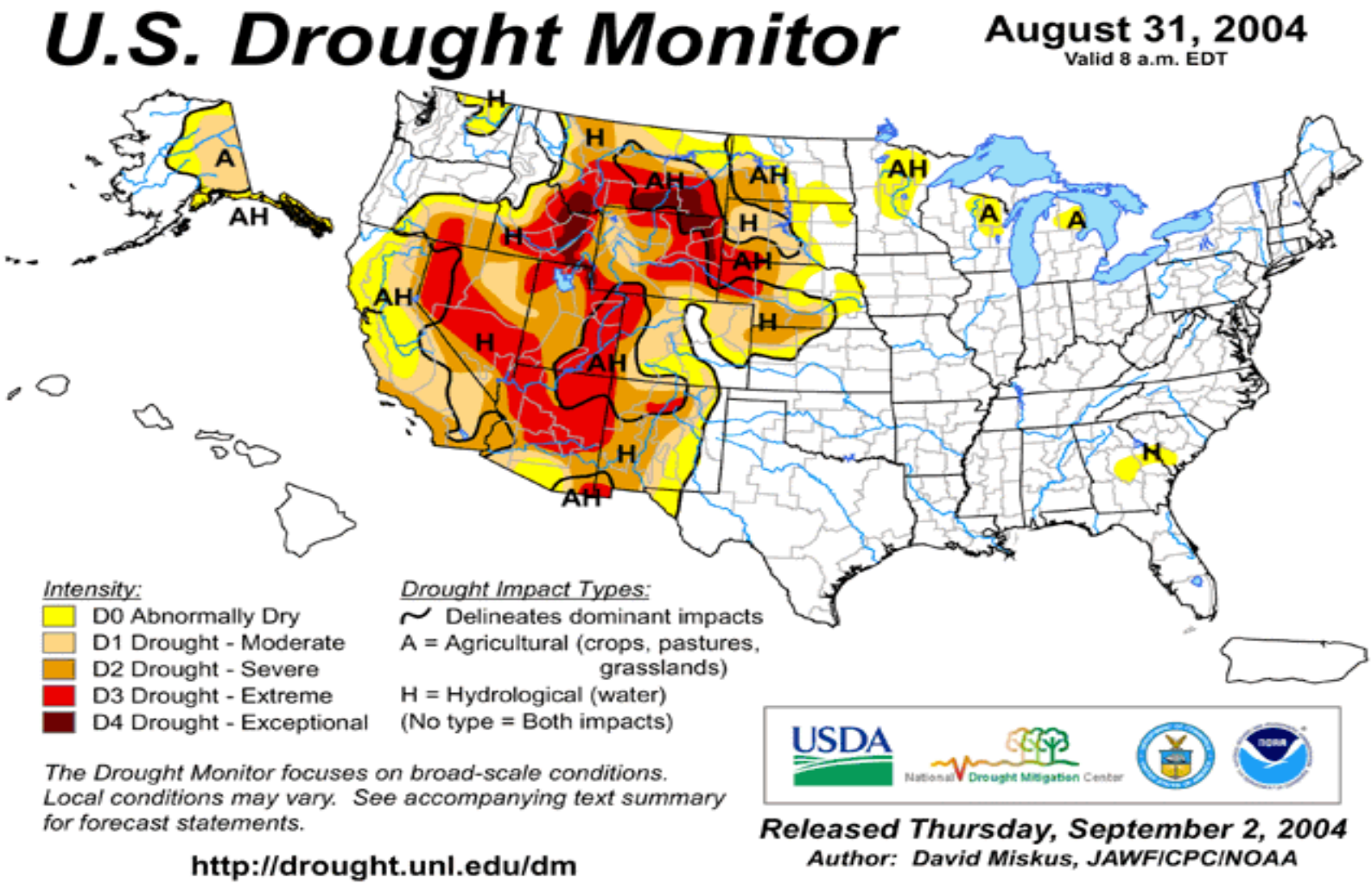


Data provided by Dartmouth Flood Observatory

See http://www.dartmouth.edu/~floods/Archives
for a description of numbered flood events

US DROUGHT

August 2004



Extremes and CEOP

Focus on extremes during CEOP

Approach:

- **Determine the occurrence of extremes**
- **Examine some of these extremes individually**
- **Relate to each other as well as to the overall water cycle**

Benefits:

- **Efficient process since using many of same datasets**
- **Hands-on experience with carrying out such studies**

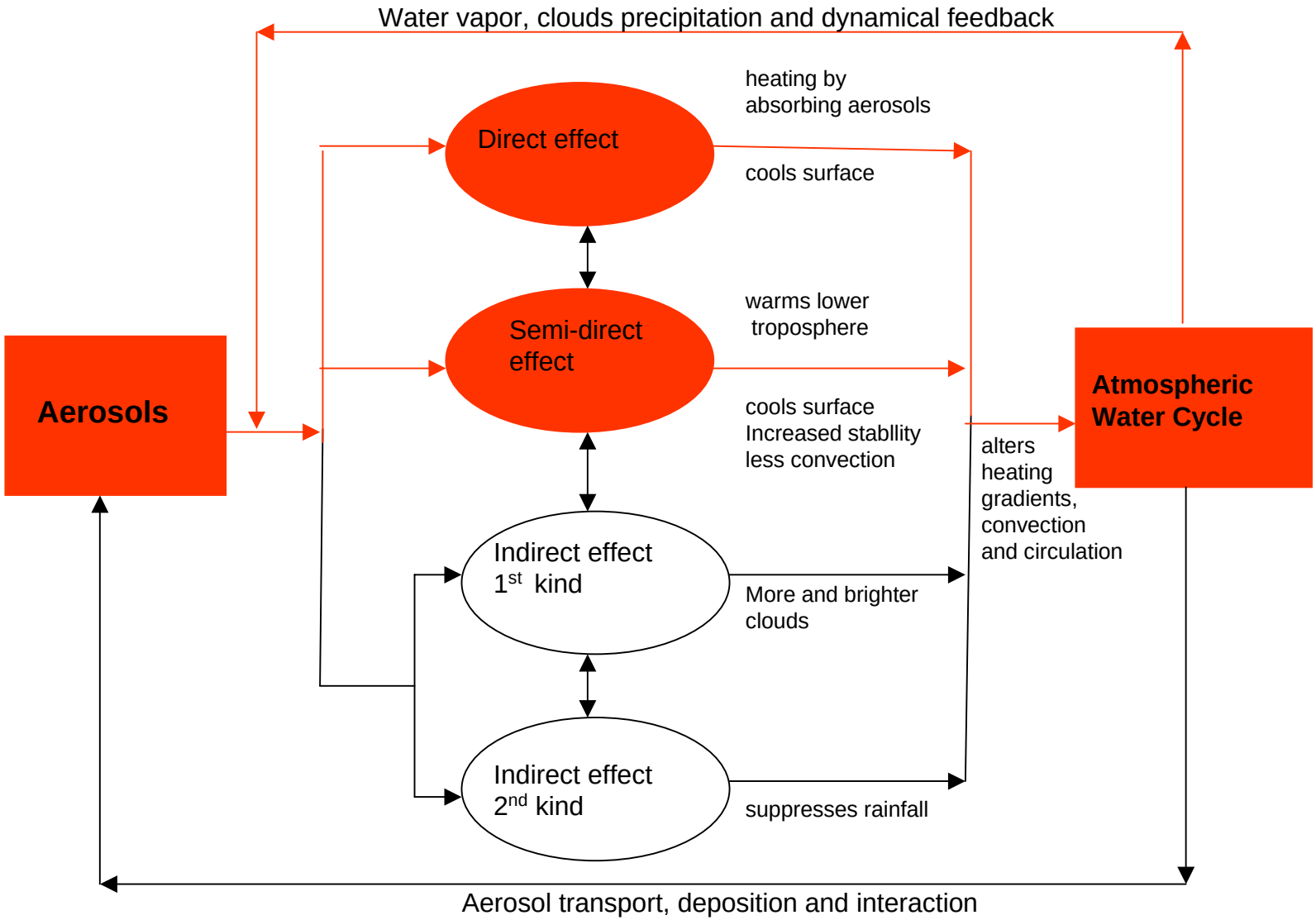
An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN

- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**


Water vapor, clouds precipitation and dynamical feedback
heating by
absorbing aerosols
Direct effect
cools surface
warms lower
troposphere
Semi-direct
effect
cools surface
Increased stabllity
less convection
Aerosols
Atmospheric
Water Cycle
alters
heating
gradients,
convection
and circulation
Indirect effect
1st kind
More and brighter
clouds
Indirect effect
2nd kind
suppresses rainfall
Aerosol transport, deposition and interaction

Sun overhead

Flux (Watt/m^2)

1360 81

Clear Sky

1098 32

ARF ^{TOA} = 53 Watt/m^2

1360 134

Haze / Sulfate

1039 30

Both Cool Earth-Atmosphere

ARF ^{TOA} = 78 Watt/m^2

1360 159

Both Warm Atmosphere

Mineral Dust

918 27

Ocean

ARF ^{surf} = 57 Watt/m^2

ARF ^{surf} = 175 Watt/m^2

Both Cool Surface

Sun overhead

Flux (Watt/m^2)

1360 339

Clear Sky

1118 331

Warm Earth-Atmosphere

ARF ^{TOA} = – 8 Watt/m^2

1360 331

Warm Atmosphere

Mineral Dust

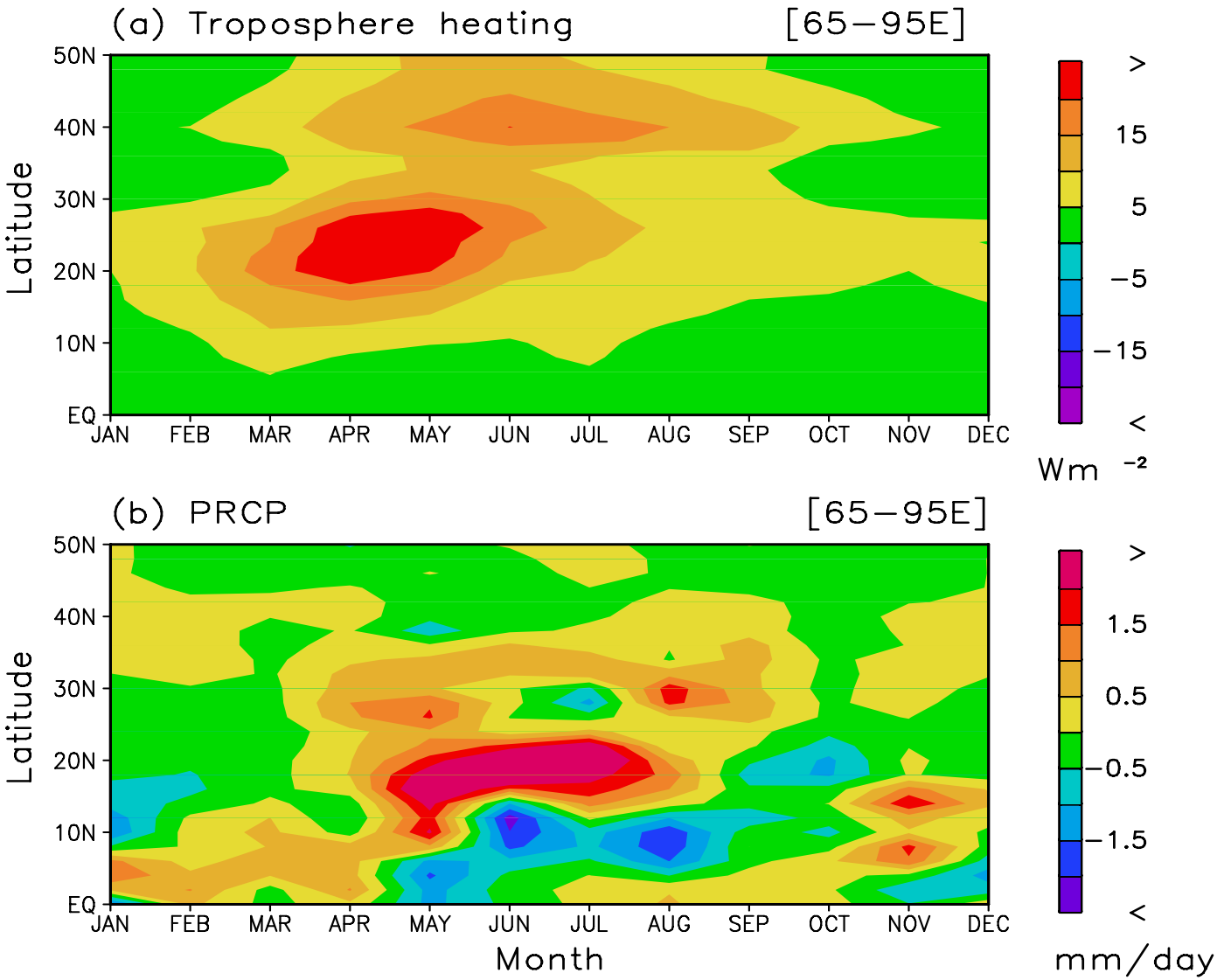
974 194

Desert

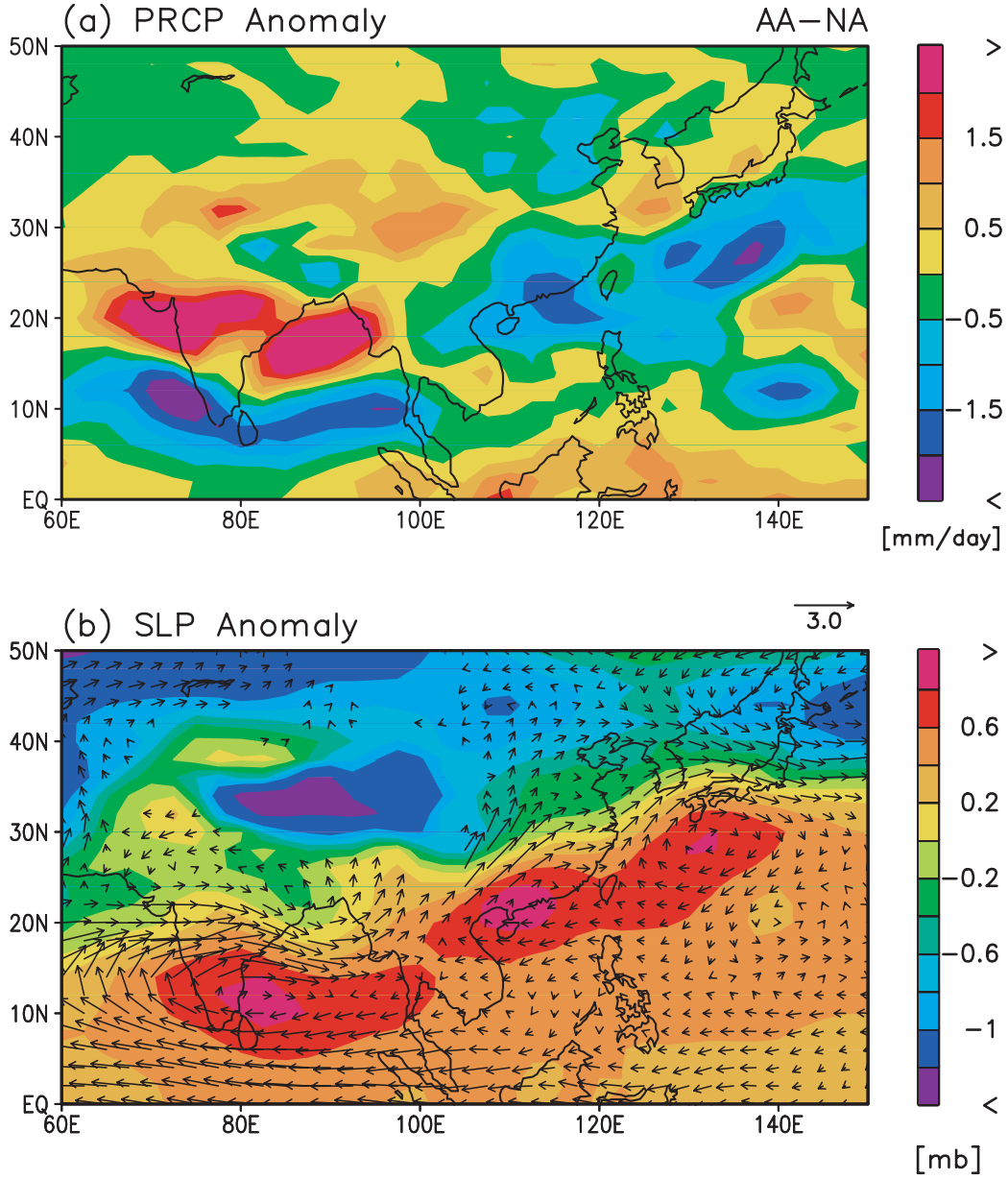
ARF ^{surf} = 7 Watt/m^2

Cool Surface

Anomalies of shortwave heating



Anomalies of summer SLP and 850hPa wind



An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN
- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

PARALLEL BREAKOUT SESSIONS
- **Observational Data Session**
- **Water and Energy Budget Science Session**
- **Monsoon Systems Science Session**
- **Data Integration/Assimilation and Modeling Session**

An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN
- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

PARALLEL BREAKOUT SESSIONS
- **Observational Data Session**
- **Water and Energy Budget Science Session**
- **Monsoon Systems Science Session**
- **Data Integration/Assimilation and Modeling Session**

Proposed Sample

Vegetation,

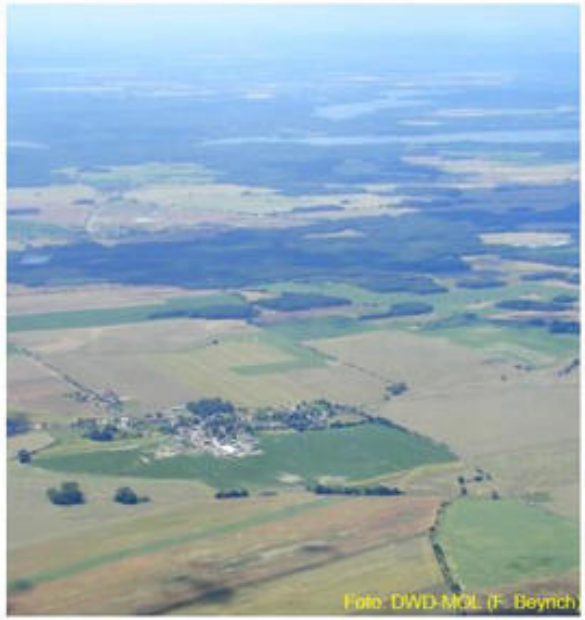
Land Use, and

Soil Types

Descriptions from

Lindenberg Reference Site

VEGETATION AND LAND USE: The land use is dominated by forest and agricultural fields (40 - 45 % each), lakes cover 6- 7 %, villages and traffic about 5 %. Both, the orography and the mixture of surface types are rather typical for large parts of northern Central Europe south of the Baltic Sea. For the agricultural fields, triticale (a hybrid between wheat = triticum and rye = secale) is the dominating vegetation, significant parts of the farmland are also covered by grass, rape and maize.



SOIL TYPES: The soil type distribution is dominated by sandy soils. In the forested parts west of Lindenberg, the sand reaches a depth of several meters. At the GM Falkenberg, sandy soils (pale soil - Eutric Podzoluvisol, brown soil - Cambic Arenosol) cover a layer of loam, which can be typically found at a depth of between 50 cm and 80 cm, locally even below.

Table 1 - Physical parameters of the soil at GM Falkenberg

layer no.	horizon	upper boundary [cm]	lower boundary [cm]	clay / poor clay [M%]	sand [M%]	dry density [g/cm³]	pore volume [%]	field capacity [V%]	wilting point [V%]	hydraulic conductivity [cm/d]	soil heat capacity [*10⁶ J/(K*m³)]
1	Ap	0	30	26	74	1.6	37	16	4	110	1.32
2	Al	30	60	26	74	1.7	36	18	3	80	
3	Bt	60	120	40	60	1.7	34	24	11	20	

CEOP HYDROLOGY REFERENCE SITES

Steps (to be done as soon as possible):

<u>From 8 candidate sites, start with easiest 4 sites:</u>

Nagu River (China) – This is already a CEOP Reference Site and all that is needed is to add the streamflow and any ancillary precipitation data in the basin.

Walnut Gulch (US) – Data already exists in SALSA project database. Request for data to be made.

Zwalm River (Belgium) – Request for the data to be made.

SGP (US) – This data is already a CEOP Reference Site and the data already exists at JOSS (including streamflow). Data only needs to be re-organized.

CEOP PHASE II REFERENCE SITES

Steps (to be done as soon as possible):

1. Each CSE to survey sites to determine which sites have the potential to be operating during Phase II.
2. From subset list of available sites, a scientific evaluation is needed to determine which are needed as a minimum to fulfill CEOP II objectives (as well as the necessary parameters)
3. Request to CEOP SSC to draft letter (for WCRP) encouraging continuation of measurements from 2005 through 2010. This letter to be sent from WCRP to each site.
4. Add new sites (or parameters) as needed (e.g. LaPlata or “ocean“ sites)

An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN
- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

PARALLEL BREAKOUT SESSIONS
- **Observational Data Session**
- **Water and Energy Budget Science Session**
- **Monsoon Systems Science Session**
- **Data Integration/Assimilation and Modeling Session**

An Element of WCRP initiated by GEWEX

Review/Realignment of CEOP Science Foci/Organization

- **Atmosphere, land surface, snow cover, and coupled interactions**
- **Implications for predictability**
- **Interannual variations and extreme events**
- **Connections to subgrid processes, possibly via higher resolution non-hydrostatic models (e.g. GCSS)**

Milestones/Results achieved/remaining in Phase I

- **GLDAS**
- **Diurnal cycle**
- **Vegetation interaction**
- **Surface fluxes and variables**
- **Seasonal variations in different climatic regimes**

An Element of WCRP initiated by GEWEX

Planned for Phase II

- **semi-arid regions in Asia and globally**
- **Extreme events**
- **Gglobal, regional, land surface and process models**

Evaluation of Current Data Collection/Archive/Application processes

- **Heterogeneity**
- **Upscaling**
- **Downscaling**
- **Water Resources**

New/Different In-situ, Satellite, Model Data Requirements

Frameworks for accommodating new Science Foci

Connections/Joint activities with other Projects including unified test cases

An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN
- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

PARALLEL BREAKOUT SESSIONS
- **Observational Data Session**
- **Water and Energy Budget Science Session**
- **Monsoon Systems Science Session**
- **Data Integration/Assimilation and Modeling Session**

An Element of WCRP initiated by GEWEX

1. Soil moisture and the South American monsoon
2. Pan-WCRP Workshop
3. Diurnal cycle : TRMM data/reference site data/ model
   - parametalization
   - Diurnal cycles - ISO
   - Collaboration with WESP is needed

4. New science foci: monsoon-aerosol interaction

Chemical component of deposition in the Himalaya

differences between pre-monsoon and monsoon, between west and east

ABC observation in the Himalayas -> more collaboration is needed between chemist and atmospheric scientists

Physical climate/environment interaction -> aerosol problem

Aeronet observation results -> include CEOP data, Add CEOP Himalayan or some other stations to Aeronet in CEOP II.

An Element of WCRP initiated by GEWEX

CEOP WORKSHOP
43 Extended Abstracts
29 Oral Presentations &
14 Poster Presentations

→CEOP Special Issue of JMSJ
Paper Submission Due : 30 Sep. '05
Publication: Jan. '07

DEVELOPMENT OF THE CEOP II IMPLEMENTATION PLAN
- **Watershed Hydrology**
- **Cold Regions Hydrology Study Jointly with CliC and IPY**
- **Extreme Events Mechanism Study**
- **Aerosol Interactions with the Water Cycle**

PARALLEL BREAKOUT SESSIONS
- **Observational Data Session**
- **Water and Energy Budget Science Session**
- **Monsoon Systems Science Session**
- **Data Integration/Assimilation and Modeling Session**

Burning Questions

- Core variables - paired with observations
  - Need to be coordinated with other groups - aligned commonality in data archives
  - Primary variables that all models need vs. science needs
- Frequency of time series data.
  - Varies among data producers
  - Analysis vs. forecast - need to identify analysis times for MOLTS data
  - Propose to separate 6 hr analyses from hourly forecasts
  - Whatever, must be described in provided documentation
    - Done previously? Mike to check.

Burning Questions (cont.)

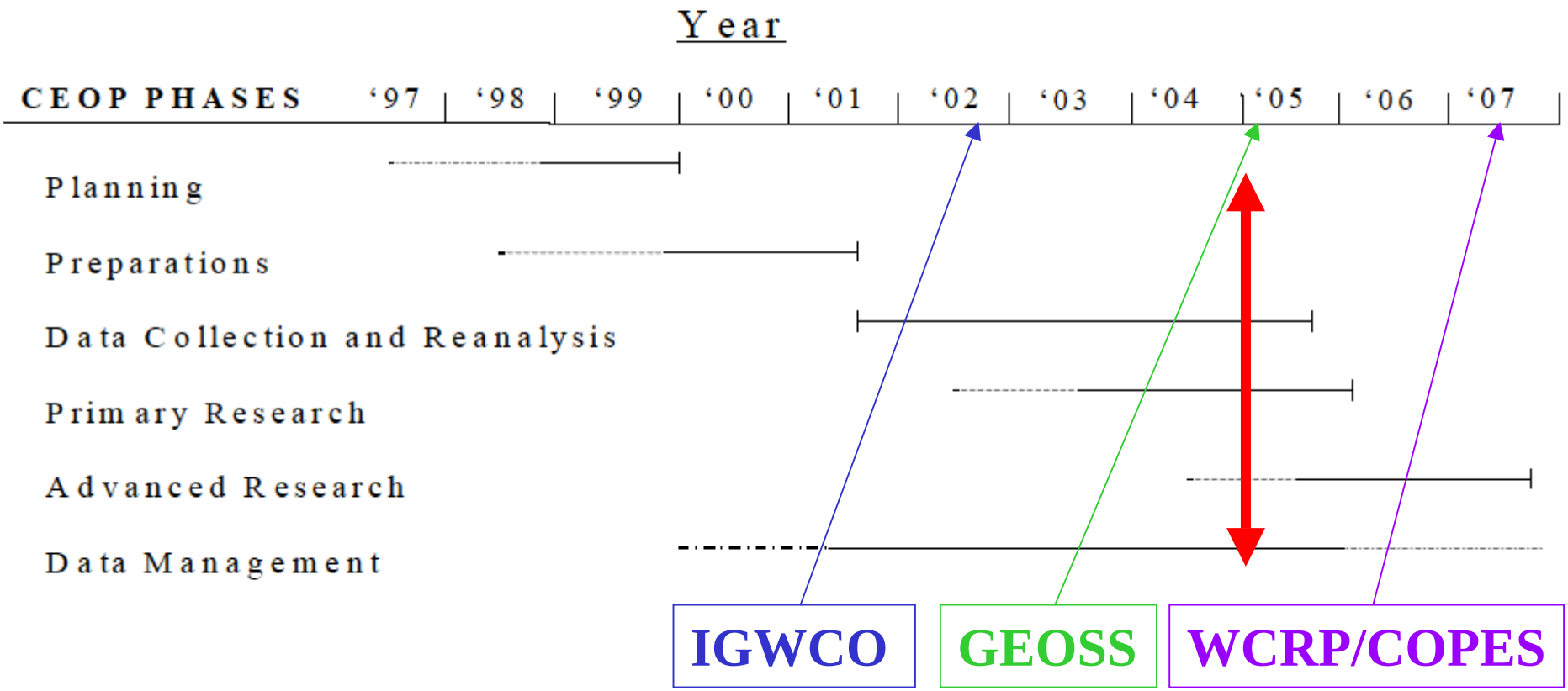
- How to organize MOLTS data
  - Along centers, stations, variables, analyses vs. forecast,
  - Model after Steve's organization of station observations where possible?
  - Complicated by differences in variables of MOLTS data sets.
  - Centers will decide to provide analysis or forecast time series or both.
  - Default will be forecast time series.
  - Issue - forecast/analysis decision function of variable (e.g. precipitation)
  - Documentation should include variable list, analysis/forecast time series description and time interval.

Burning Questions (cont.)

- How to organize MOLTS data (cont.)
  - Gridded data - forecast and analysis stored separately.
  - CEOP II - Good to resolve issues raised in CEOP I and reach consensus on organization prior to CEOP II
- Metadata standard, Tokyo workshop results.
- Network between data archives.
- Discussion on intercomparisons of data.

An Element of WCRP initiated by GEWEX (May, 2001)

Figure 3-1. CEOP "Life-Cycle" Schedule



An Element of WCRP initiated by GEWEX

Uniqueness of CEOP
Integrated Data/Information and Services

A New Global Observation System of Systems for the Water Cycle in the local-regional-global scales

n observed
r on ERS-1

A comprehensive, coupled, land-atmosphere-ocean data assimilation capability is needed to optimize the use of advanced data systems. The process and budgeting for the transfer of systems from a research environment to operations needs to be strengthened. Currently, although data archives exist for special collections, there is insufficient integration capacity for global observing systems. This situation is aggravated by incompatible data management plans among the individual components. A special challenge is the development of assimilation methodologies to integrate satellite and *in situ* observations, and the development of high-performance distributed data management and archiving systems with harmonized access nodes to use data from largely different sources for studies of the global water cycle. A prototype data integration system is being demonstrated by the CEOP (Coordinated Enhanced Observing Period). An overall plan for *in situ* and satellite water cycle observational systems is needed so that data can be readily exchanged, standards can be set, and data quality can be monitored. Elements of such planning do occur at present within the IGOS-P Water Cycle Theme. Also, a strong application plan is necessary for GEOSS to demonstrate its practical use. For this it is important to provide the methodology to translate the GEOSS data into the information needed, e.g. translating remote-sensing data into local discharges for ungauged basins. Demonstration programmes are especially important in countries that suffer from lack of data or have little expertise in data assembly and interpretation.

An Element of WCRP initiated by GEWEX

Uniqueness of CEOP
Integrated Data/Information and Services

A New Global Observation System of Systems
for the Water Cycle
in the local-regional-global scales

CEOP Unique Sciences
on Understanding and Prediction of Tele-connections
by Using
the Unique Data/Information and Integration Services

An Element of WCRP initiated by GEWEX

Part-I(2005-2006)

- **Complete Data Archive and Integration**
- **CEOP Phase I Research and Analysis Objectives of WESP and CIMS**
- **Build up a CEOP Hydrologic Reference Basin network**
- **Expand the CEOP Reference site network closely related with the GEOSS 10-Year Implementation**
- **Efforts for Continuous Ref. Site Data / Model outputs Archive**

An Element of WCRP initiated by GEWEX

Part-II(2007-2010)

- **Implement the CEOP-II Enhanced Observation**
- **Improve the CEOP Data Integration Systems**
- **WESP Extension**
  - **Transferability and Down-scaling**
  - **Extreme Events**
  - **Cold Region**
  - **Semi-arid Region**
- **CIMS Extension**
  - **Closely related with the WCRP Pan Monsoon Study**
  - **Intra-seasonal Variation**
  - **Aerosol-Monsoon interaction**

An Element of WCRP initiated by GEWEX

GEO /IPTT: Implementation Plan Task Team

An Element of WCRP initiated by GEWEX

CEOP/IPTT: Implementation Plan Task Team

S. Benedict	:Coordination
M. Bosilovich	:Global Model
C. Fu	:Semi-Arid Region
T. Koike	:Cold Region/ Data Integration
W. Lau	:Aerosol
M. Lautenschlager	:Model Output Management
J. Matsumoto	:CIMS
J. Roads	:WESP
R. Stewart	:Extreme
S. Williams	:Ref. Site Data Management
E. Wood	:Hydrologic Ref. Basin

An Element of WCRP initiated by GEWEX

Implementation according to the CEOP Implementation Plan Planning Schedule (*modified*)

- Distribution of the Draft (Ver.0) of the Plan: January 2005.
- Discussion of the Draft was taken place at the GEWEX SSG Meeting: 31 January to 4 February 2005;
-Discussion of the Draft will be taken place at the CEOP-IGWCO joint meeting in Tokyo: 28 February to 4 March 2005.

- Draft Ver.1 of the Plan will be finalized by the CEOP/IPTT by June 2005.
- Submission of the Draft Ver.1 to CEOP AOC/SSC, GEWEX SSG, IGWCO SAG
- Endorsement & Publication