



NWP and Climate Model Data Access

The NOAA Operational Model Archive and Distribution System

NOMADS

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National Oceanic and Atmospheric Administration

National Climatic Data Center

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Overview



➤ Retrospective analysis and model inter-comparison are necessary to verify and improve short term NWP models, seasonal forecasts, climate simulations, assessment, and detection efforts.

➤ Until now there existed no long-term archive for Climate and Weather models.

➤ University and Institutional research goes largely untapped by NOAA scientists. Effort is wasted on data receipt and format issues with no infrastructure to collaborate.

- To overcome a deficiency in model data access, some of the Nations top scientists are actively engaged in a grass-roots frameworks to share data and research findings over the Internet.
- In 2001 NCDC, NCEP and GFDL initiated the NOAA Operational Model Archive and Distribution System.
- Operational in 2003, NOMADS is a distributed data services pilot for format independent access to climate and weather models and data.

NOMADS
 The NOAA Operational Model
 Archive and Distribution System

GO-ESSP

Core NOAA NOMADS Collaborators

- ◆ Climate Diagnostics Center (CDC) Boulder, CO
- ◆ Geophysical Fluid Dynamics Laboratory (GFDL) Princeton, NJ
- ◆ National Climatic Data Center (NCDC) Asheville, NC (Project Lead)
- ◆ National Centers for Environmental Prediction (NCEP) Camp Springs, MD
- ◆ Pacific Marine Environmental Laboratory (PMEL) Seattle, WA
- ◆ NOAA Forecast Systems Laboratory (FSL) Boulder, CO

External Core Collaborators

- Center for Ocean-Land-Atmosphere Studies (COLA) (Maryland)
- Department of Energy's Argonne, Los Alamos, Oak Ridge, Lawrence Berkley, Livermore National Laboratories & Information Sciences Institute (ISI), University of Southern California under the Earth System Grid Project
- National Center for Atmospheric Research (NCAR) Colorado
- Unidata Program Center (UCAR/Unidata) Colorado
- LLNL Program for Climate Model Diagnosis and Intercomparison
- NASA's Global Change Master Directory (GCMD) Maryland
- National Coastal Data Development Center
- University of Rhode Island (OPeNDAP Consortium)

External Collaborators include

- Center for Earth Observing and Space Research (CEOSR), NASA-GSFC Maryland
- George Mason University (NASA SI-ESIP), Virginia
- National Severe Storms Laboratory (NSSL), Oklahoma/SSEC University of Wisconsin
- Universities of Alabama (Huntsville), California (Santa Barbara), Washington & Iowa St.
- National Science Foundation (NSF) CyberInfrastructure

International Participants

- British Atmospheric Data Center, Oxfordshire, United Kingdom)
- UK's Natural Environment Research Council (NERK DataGrid Project)
- Committee for Earth Observing Satellites (CEOS) Grid Project
- Climate Action Partnership (CAP), BOM Australia (US Depts. of Commerce, Energy, State, and EPA)

The NOAA Operational Model Archive and Distribution System

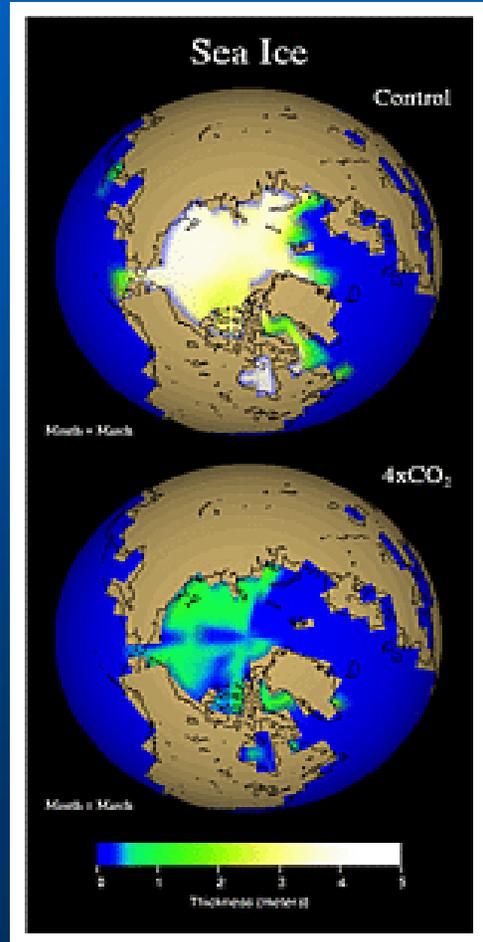
NOMADS

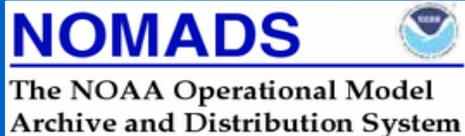


The NOAA Operational Model
Archive and Distribution System

NOMADS Goals

- provide distributed access to models and associated data,
- promote model evaluation and product development,
- foster research within the geo-science communities (ocean, weather, and climate) to study multiple earth systems using collections of distributed data,
- develop institutional partnerships via distributed open technologies.



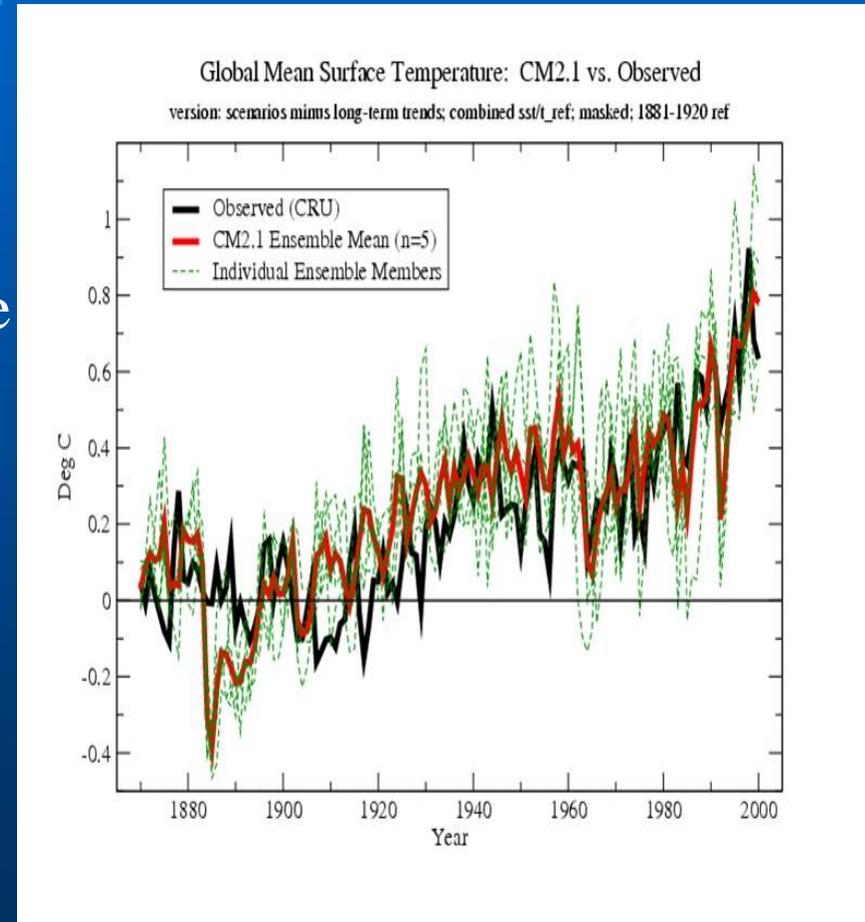


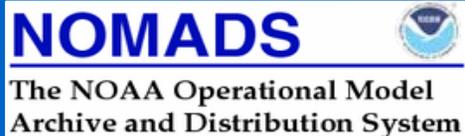
Model Data Access

- The users experience is often frustrating—
 - What data of interest exist?
 - Are they going to be useful to me?
 - How can I obtain them in a usable form?
- Time and effort are wasted on data access and format issues.
- As a result atmosphere/ocean/climate data are under-utilized. Model inter-comparison nearly impossible.



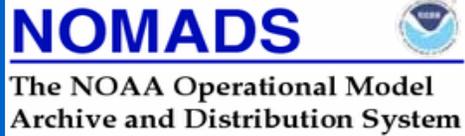
- Long-term stewardship of NWP analysis and forecasts.
- Accurate estimates of future climate variability and trends
- Improved climate and weather assessments.
- Promote collaboration of climate and weather researchers.





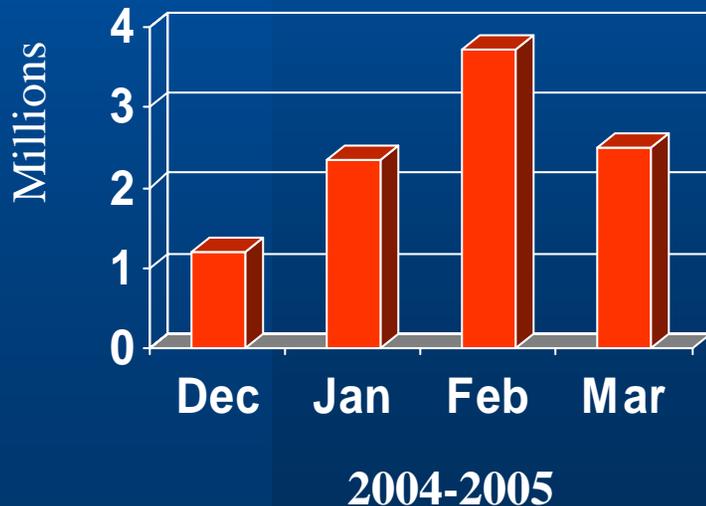
Tools for Users

- Pare down large file sizes of high resolution data and products.
- (re-) Group different data sets to create needed products – such as initialization files for model development, analysis, or by forecast projection.
- Subset the data:
 - in parameter space
 - in physical space
 - in temporal space

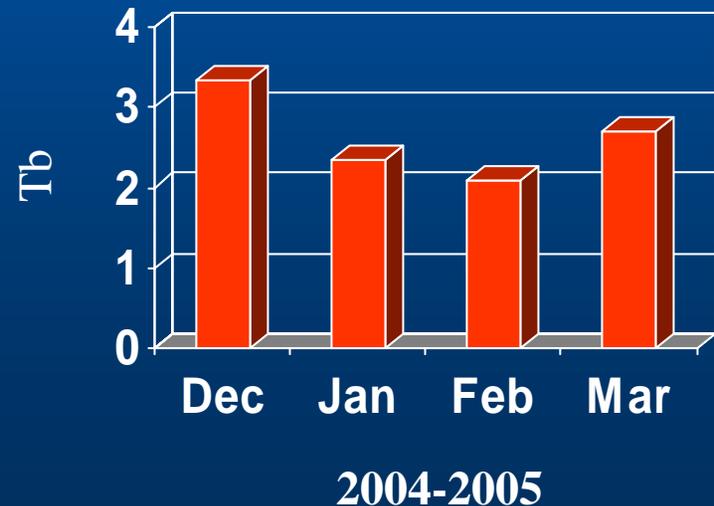


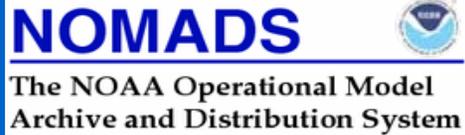
NOMADS Archive and Users

Data Requests- Individual Downloads (millions)



Data Requests- Data Volume (Tb)





Other Providers: NCEP

N.O.M.A.D.S.

N.O.M.A.D.S. NOAA Operational Model Archive Distribution System



[Real Time NOMADS NCEP Component](#)

Caution: this web server is in testing mode. Applications are being developed and we are using it for live testing.

Forecasts may not be current and historical data set may not be complete.

[Comprehensive forecast archives and reanalysis-2 daily archives on this machine.](#)



NOMADS



The NOAA Operational Model
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Providers: FSL

FSL NOMADS Data Portal

Forecast Systems Laboratory NOMADS Data Portal



The [Forecast Systems Laboratory \(FSL\)](#) has made available the following data as a [NOAA Operational Model Archive and Distribution System \(NOMADS\)](#) [Data Access Protocol \(OPeNDAP \(Formerly DODS\)\)](#)-enabled clients may be used to access and display these data:

- [Meteorological Assimilation Data Ingest System \(MADIS\)](#) (restricted)
- [20km Backup Rapid Update Cycle \(RUC\)](#)
- Coastal Storms Initiative (CSI) (coming soon)

[Forecast Systems Laboratory \(FSL\)](#)

[NOAA Operational Model Archive and Distribution System \(NOMADS\)](#)

[Open source project for Network Data Access Protocol \(OPeNDAP\)](#)

[Distributed Oceanographic Data System \(DODS\)](#)



NOMADS



The NOAA Operational Model
Archive and Distribution System

Providers: GFDL



geophysical fluid
dynamics laboratory

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Spotlight on NOMADS

NOMADS is being developed as a Unified Climate and Weather Archive to provide Web access to model information so that users can make decisions about their specific needs. This spans time scales from days (weather), to months (El Nino), to decades (global warming). For more, see NCDC's [nomads](#) page.

Spotlight on ESP

The Earth Science
Portal (ESP) is a

[gfdl's home page](#) > [products and services](#) > data portal

gfdl's data portal

Our Data Portal Services

Public data sets from GFDL are made available through the GFDL Data Portal. The data portal is designed to provide access to: data attributes, and graphical display the data. Download provides "http" access to download complete files. Display of data attributes includes global attributes and the variables available in the files. Graphical display uses the Live Access Server to graphically display the data.

Our Public Data Files

Registration for the GFDL Data Files is free. Users are requested to complete the Registration Form for Public Data Files (found on the Data Portal) before they first begin using the data portal. Information from this form will be used to provide registered users with news on when additional data files are added, and when corrections are made to existing public data. The information gathered will not be used for any purposes other than to provide Portal Services.

Data Storage

The data files on the data portal are stored in netCDF (network Common Data Form), and can be identified by the suffix ".nc". The data files are available for download from the GFDL Data Portal. For more information about netCDF, see the netCDF website.



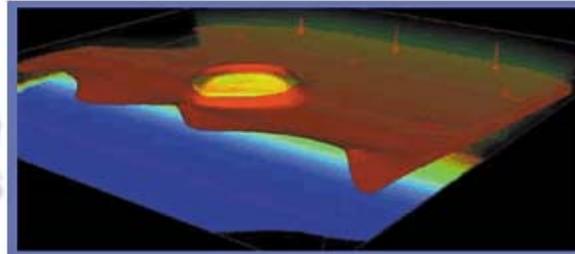
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Collaborator: NASA GCMD

A GCMD Portal to
Model Output
Data Sets



National Partnership for Advanced Computational
Infrastructure
Feature Image (3/08/00)

Keyword Search

Agriculture

- [Forestry](#) - [Soils](#) - [more](#)

Atmosphere

- [Temperature](#) - [Winds](#) - [more](#)

Biosphere

- [Vegetation](#) - [Wetlands](#) - [more](#)

Cryosphere

- [Sea Ice](#) - [Snow Cover](#) - [more](#)

Human Dimensions

- [Environmental Impacts](#) -
[Human Health](#) - [more](#)

Land Surface

- [Land Use / Land Cover](#) -
[Soils](#) - [more](#)

Oceans

- [Temperature](#) - [Circulation](#) -
[Coastal Processes](#) - [more](#)

Paleoclimate

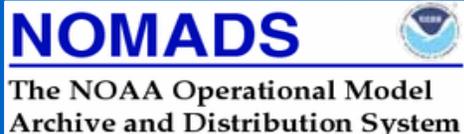
- [Ice Cores](#) - [Tree Rings](#) - [more](#)

Radiance / Imagery

- [Infrared Wavelengths](#) -
[Radar](#) - [more](#)

Sun-Earth Interactions

- [Solar Activity](#) -
[Sunspots](#) - [more](#)



NCDC NOMADS Data

NWP Model

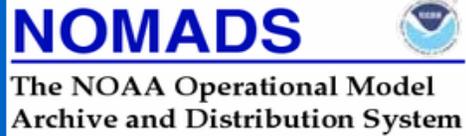
- Global Forecast System (GFS), Model output and Input (SSI) with Restart
- North American Mesoscale (NAM, formally Eta)
- NOAAPort Rapid Update Cycle (RUC) forecast output (FSL)
- NCEP Spectral Statistical Interpolation (SSI) Global Data Assimilation System (GDAS) model input and restart files
- NCEP North American Regional Reanalysis (NARR) (Figure 3)
- NCEP/NCAR R1/R2 Reanalysis (Climate Data Assimilation System -CDAS)
- NCEP Regional Special Model (RSM)
- NCEP Global Ensembles
- NCEP Climate Forecast System (CFS) coupled climate model.
- NCEP Ocean Wave models
- NCEP Sea Ice Models

In situ

- NCDC Global Historical Climate Network (GHCN) surface temperature and precipitation anomalies (Figure 4)
- NCDC Integrated Global Radiosonde Archive (IGRA) upper air reference quality data set (formally the Comprehensive Aerological Data Set- CARDS)
- NCDC Smith-Reynolds Extended Reconstructed Sea Surface Temperatures (ERSST) climatologies (see Figure 5)
- *c. Satellite and Radar*
- National Ocean Data Center (NODC) Advanced Very High Resolution Radiometer (AVHRR), Pathfinder Sea Surface Temperature (SST) analysis datasets provided through a link to NODC
- Other satellite and Radar data are currently being developed with various partners for access to limited Geostationary Operational Environmental Satellite (GOES), data and the National Aeronautics and Space Administration (NASA) satellite and other data via OPeNDAP.

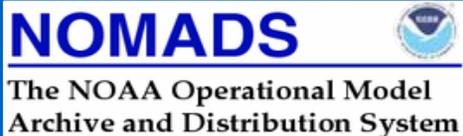
Climate: Coupled AOGCM

- GFDL GCM
- GFDL CM2.0 and CM2.1 Climate Experiments
- GFDL_R15_b - Low resolution (R15L9 atmosphere, 4 degL12 ocean)
- GFDL_R30_c - medium resolution (R30L14 atmosphere, 2 degL18 ocean).
- ...



N.A. Regional Reanalysis

- Create a long-term set of consistent climate data on a regional scale on a North American domain.
- Superior to NCEP/NCAR Global Reanalysis (GR):
 - use of a regional model (the Eta model)
 - advances in modeling and data assimilation since 1995 especially:
 - Precipitation assimilation
 - Direct assimilation of radiances
 - Land-surface (NOAH) model updates



Scientific Data Networking

- NOMADS simplifies scientific data networking, allowing simple access to high volume remote data, unifying access to Climate and Weather models:

- **Data access (client)**

- Access to remote data in the users normal application
 - IDL / IDV / Matlab / Ferret
 - GrADS (GRIB/BUFR w/ GDS)
 - Netscape / Excel / http (wget)
 - CDAT (PCMDI)
 - **Any netCDF application** (i.e., AWIPS)

- **Don't need to know the format in which the data are stored.**

- **Data publishing (server)**

- **Can serve data in various formats**
 - netCDF / GRIB / BUFR / GRIB2
 - HDF (3-5) / EOS
 - SQL / FreeForm
 - JGOFS / NcML
 - DSP
 - ascii, others...

- **Spatial and temporal sub-setting and host side computations on the fly.**



NOAAPort



DAB/NOMADS Ingest Processes

NCDC ftp
AAB Ingest Processes

Unidata IDD



Data Ingest*

**Obs, Eta,
GFS, RUC**

**Hi-Res
GFS, Eta,
NARR and
GDAS**

**Dual
Redundant
Ingest**

Data Management

- Data & Directory structures “merged”
- Daily Data Ingest inter-comparison
- QC and Monitoring
- Index File generation
- Control and DODS metadata generation
- CVS Backup (code)
- HDSS/HAS Injection

Data Access

CEOS-Grid
(exploratory)

**NOMADS
Access**

NCDC Archive

**DSI 6172
DSI 6173
DSI 6174
DSI 6175**

AAB Archive Processes



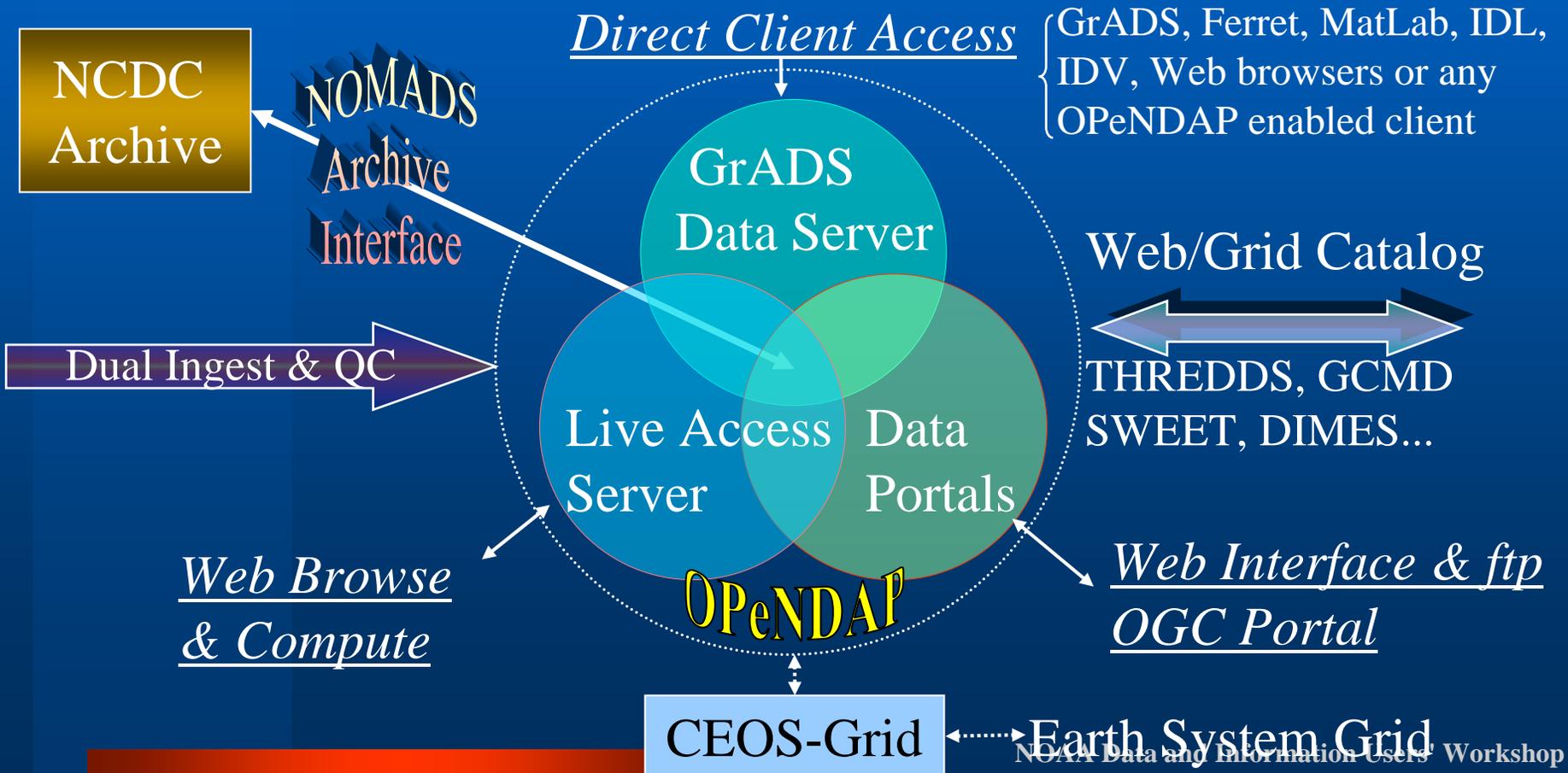
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Advancing Collaborations

The NOMADS Philosophy

Multiple paths to format independent data access:





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NCDC Web Interface

Three primary methods for data access:

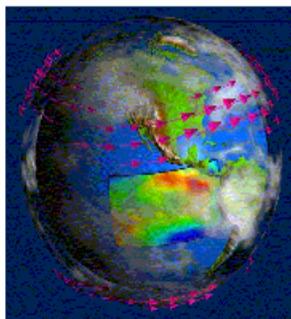
- Web Interface
- GDS OPeNDAP
- ftp w/ on the fly Grib subsetting

On-line or
Off-line (archive)

- Server-side data computations

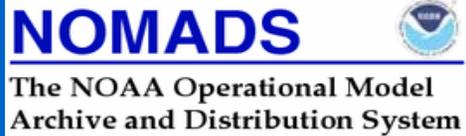
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Model Resources



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Promoting Model Collaborations

NCDC Web Interface (cont.)

The NCDC Web Interface originally developed at NCEP:

NCEP NWP Model Datasets in NCDC Repository

model	grid/scale	freq	plot	ftp	http	nomads gds	contact 1	contact 2
GFS Analysis and Forecasts								
GFS-AVN	201	00,06,12,18Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-AVN	202	00,06,12,18Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-AVN	203	00,06,12,18Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-AVN	211	00,06,12,18Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-AVN	213	00,06,12,18Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-MRF	201	00Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-MRF	202	00Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-MRF	203	00Z	plot	ftp4u	http	gds	Glenn Rutledge	T
GFS-MRF	205	00Z	plot	ftp4u	http	gds	Glenn Rutledge	T
ETA Analysis and Forecasts								
Early-ETA	212	00,12Z	plot	ftp4u	http	gds	Glenn Rutledge	T
Meso-ETA	211	00,12Z	plot	ftp4u	http	gds	Glenn Rutledge	T
Meso-ETA	212	00,06,12,18Z	plot	ftp4u	http	gds	Glenn Rutledge	T

Variable:

- capes 1 level * Convective Available Potential Energy (Surface) [J/kg]
- cins 1 level * Convective Inhibition (Surface) [J/kg]
- p 1 level * Total Precipitation [kg/m^2]
- pc 1 level * Convective Precipitation [kg/m^2]
- ps 1 level * Surface Pressure [Pa]
- pwat 1 level * Entire Atmosphere Precipitation [kg/m^2]
- rh2m 1 level * Meter Relative Humidity [%]
- slpe 1 level * Sea Level Pressure, ETA re...
- t2m 1 level * Meter Temperature [K]
- u10m 1 level * Meter U Winds [m/s]
- v10m 1 level * Meter V Winds [m/s]

Note: Some of the above listed variables may not be available at your time or model level. To see what data is present, use your Back button to return to the main page and use the review links at the bottom of the page or see the variable list on the right.

Level: 1

extra operation 1: (none) 2: (none)

Data available from 00Z 28 dec 2003 to 06Z 29 dec 2003 at 6 hour intervals

Time 00Z 28 dec 2003

Map projection: lat-lon (180E) only for custom maps long: 280 long width: 50 lat: -60 lat height: 60

Draw: shaded Contour interval: def white: def Plot size: 800x600

NOMADS leverages efforts across the community.



NOMADS



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NOMADS “Web Plotter”

- NCDC NOMADS ingests 250K grids day. POR 2002 to present.

- Any one of these accessible in seconds

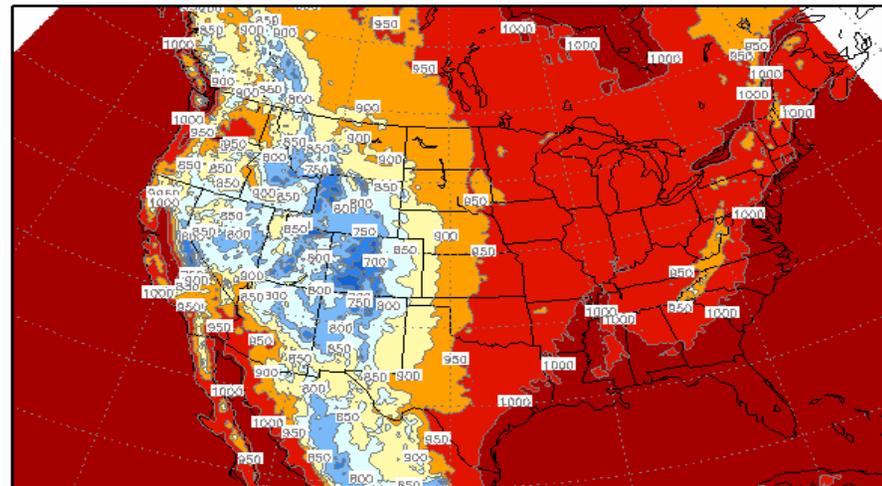
Via: OpENDAP
GDS
ftp
Web Plotter
LAS
mySQL

NOMADS Interactive Web Plotter - Order # 1052 ./meso-eta-hi_218_20040529_1800_fff.ctl

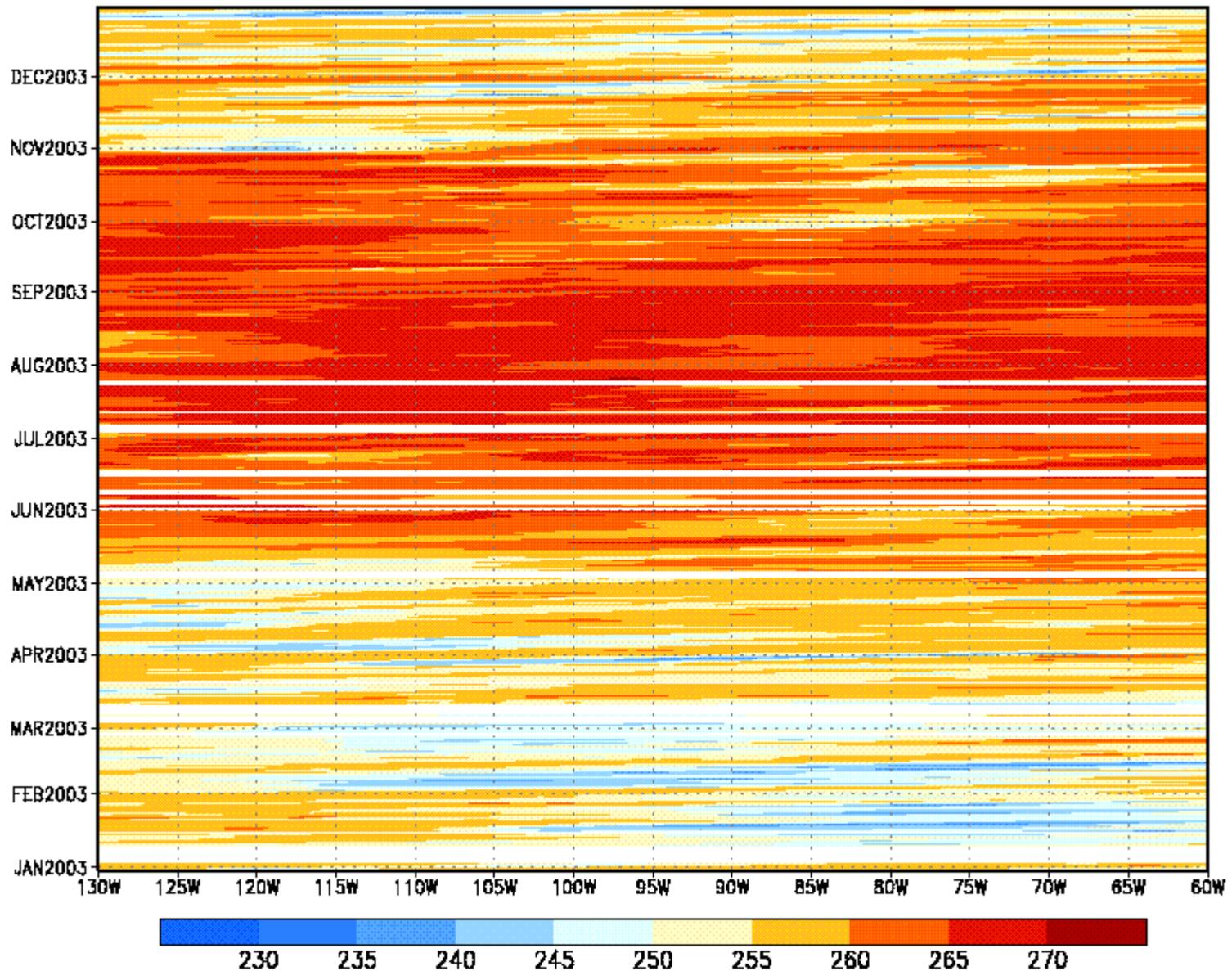
PRESsfc 1000

18Z29may2004 to 06Z01jun2004

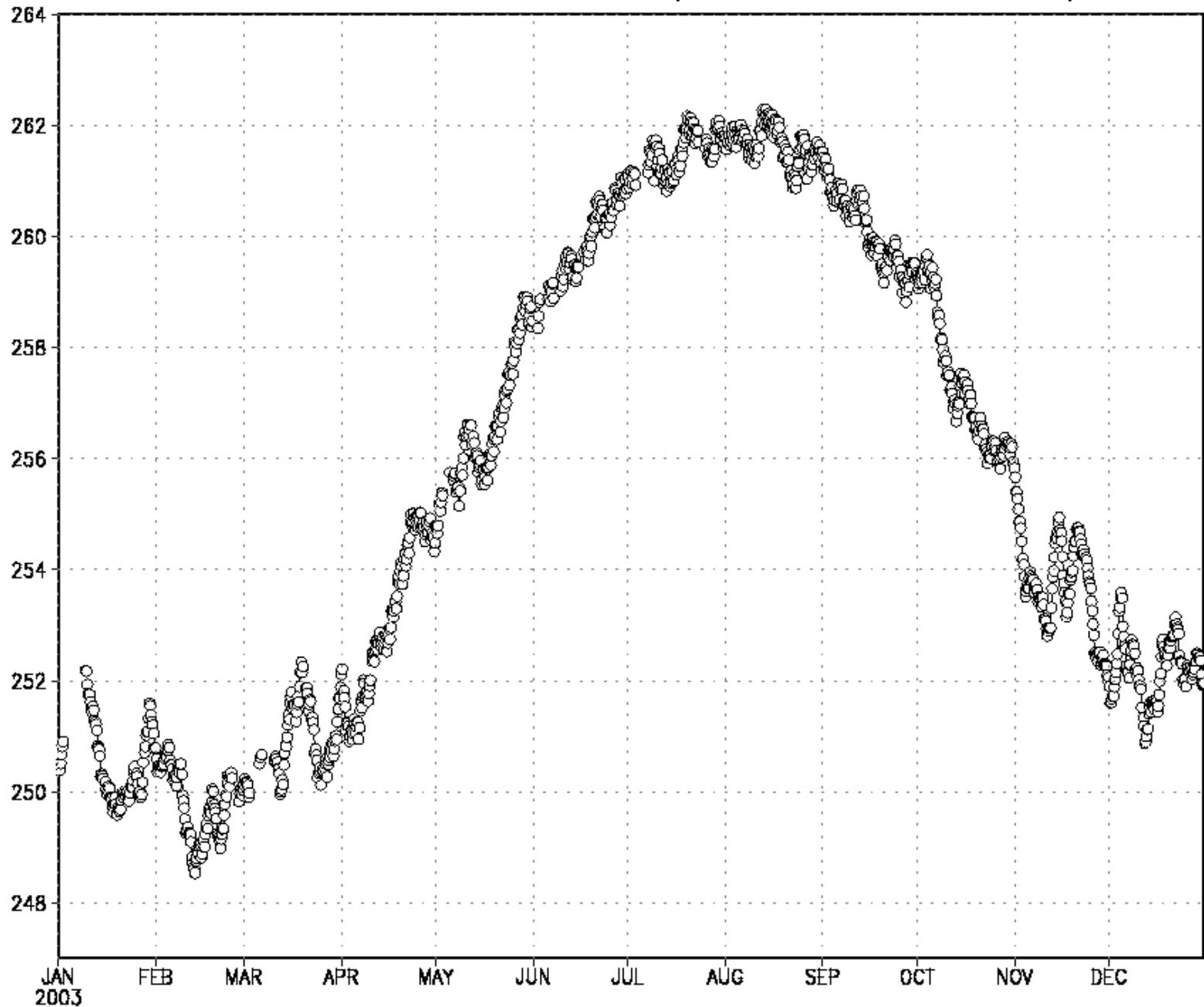
PRESsfc 18Z29MAY2004



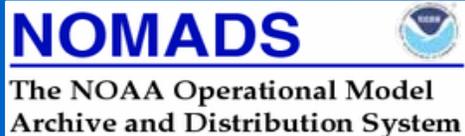
30 degree lat CONUS Hovmoller 500mb ANAL 2003



Global Time Series GFS/AVN 500mb Temp

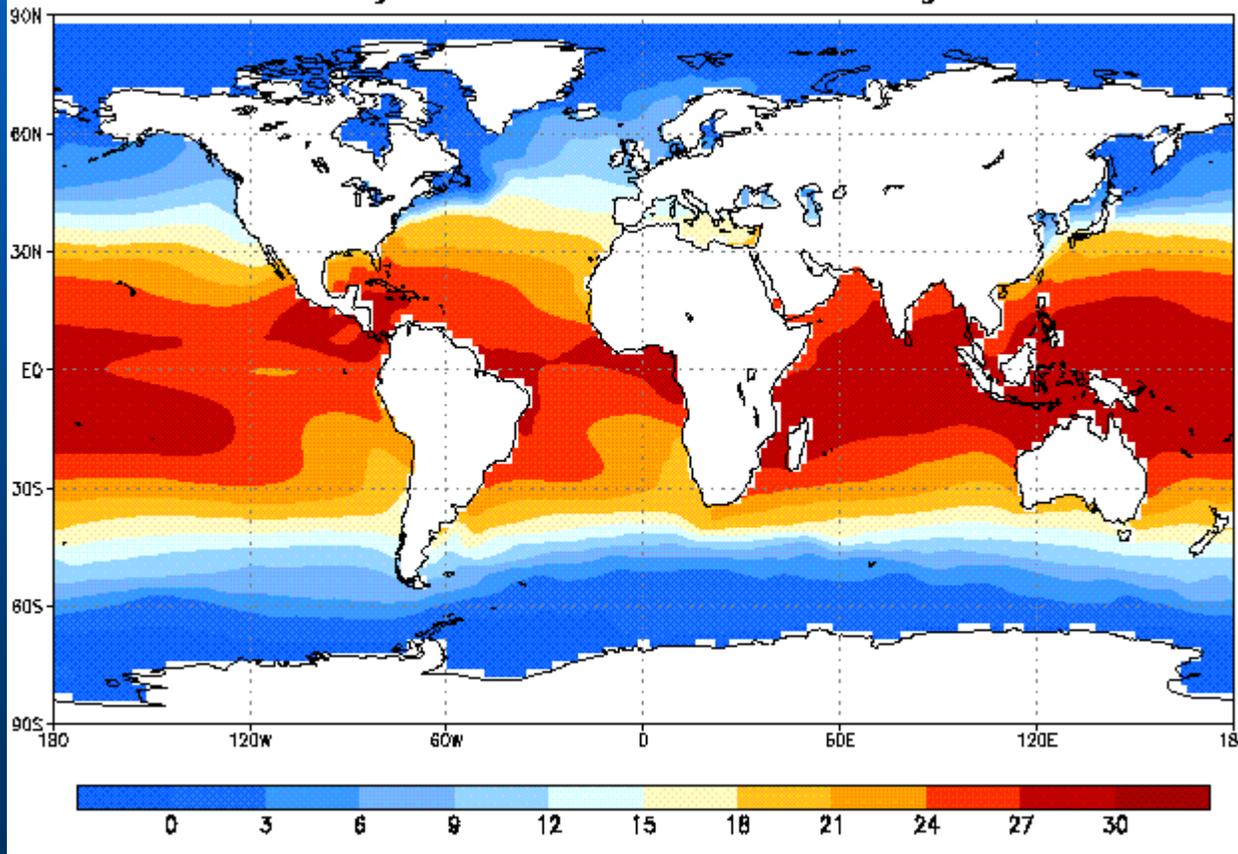


Promoting Model to Obs. Intercomparisons



NCDC Reference Datasets

Smith Reynolds ERSST Jan 1854 Degrees C



NCDC reference
And others
datasets also available:

- CARDS (IGRA)
- GHCN
- NARR
- Ocean WAVE

- Accessible via
OPeNDAP

Unidata's IDV & NOMADS Access

Data selector

File Edit Displays Data Help

Data sources: Formulas
dods://nomads.ncdc.noaa.gov:9090

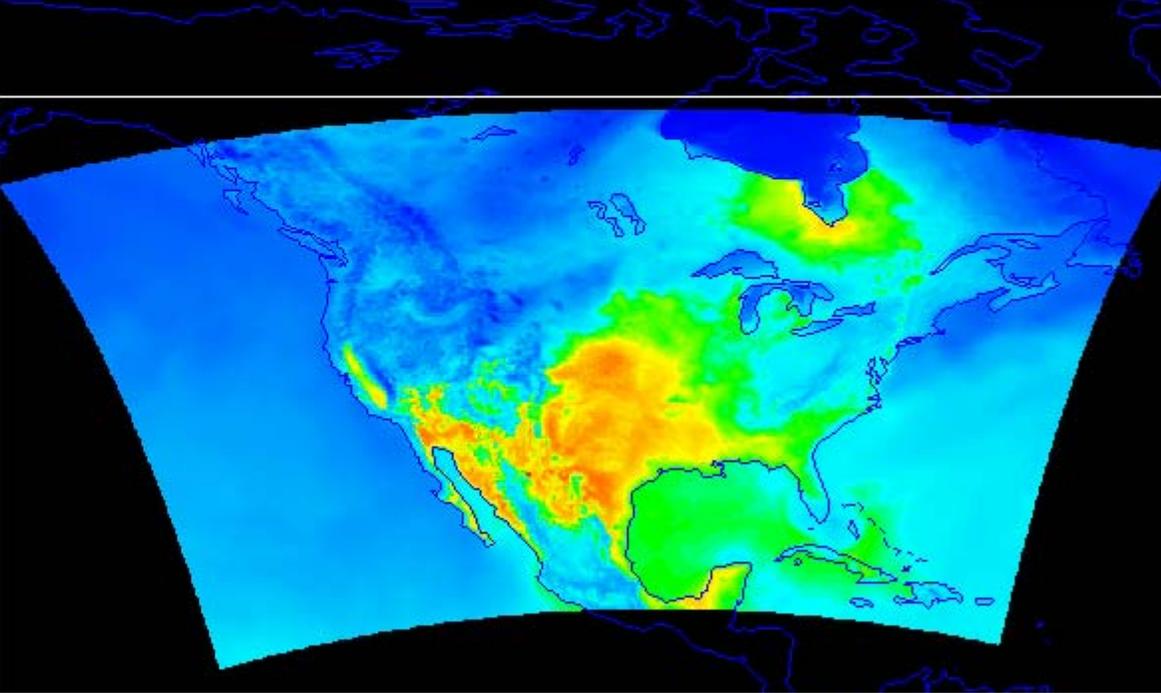
Fields: 2D grid
convective available po

Displays: Contour Plan view
Color-Filled Contour Plan View

Unidata IDV

File Edit Displays Data Help

View Maps 2003-06-24 00:00:00Z



#1 12m Color-Shaded Plan View 272.6 314.9

Memory: 30.49/51.93 MB (58%) Latitude: 42.7 Longitude: -149.2 Altitude: -8568.5 m

Data source selection

Files/Urls Gridded data Image data Radar Data Point

Data source type: Default

Look in: glenn.rutledge

- .java
- .jpi_cache
- .metapps
- Application Data
- Cookies
- Desktop
- Favorites
- Ire

File name:

Files of type: All Files (*.*)

Url: http://nomads.ncdc.noaa.gov:9090/dods/NCDC_NOAAP

Data Transfer: Order Number: 1700

FTP4YOU

FTP4YOU will FTP raw GRIB files from the NOMADS host computer to a public access FTP server at NCDC where you can use anonymous FTP to retrieve your files. Select the files and fill out the FTP information.

Select at least one file (size in bytes)

- | | | | | | |
|---|---------|---|------|---|---------|
| <input type="checkbox"/> grib218.pdef | 5432136 | <input type="checkbox"/> masks.dat | 49 | <input type="checkbox"/> meso-eta_218_20031229_0000_000.grb | 2990519 |
| <input type="checkbox"/> meso-eta_218_20031229_0000_fff.ctl | 1460 | <input type="checkbox"/> meso-eta_218_20031229_0000_fff.idx | 5617 | <input type="checkbox"/> meso-eta_218_20031229_0600_000.grb | 2924821 |
| <input type="checkbox"/> meso-eta_218_20031229_0600_fff.ctl | 1460 | <input type="checkbox"/> meso-eta_218_20031229_0600_fff.idx | 4561 | <input type="checkbox"/> meso-eta_218_20031229_1200_000.grb | 3056219 |
| <input type="checkbox"/> meso-eta_218_20031229_1200_fff.ctl | 1459 | <input type="checkbox"/> meso-eta_218_20031229_1200_fff.idx | 2449 | <input type="checkbox"/> meso-eta_218_20031229_hh00_000.ctl | 1470 |
| <input type="checkbox"/> meso-eta_218_20031229_hh00_000.idx | 865 | <input type="checkbox"/> nomads-order-1700.cfg | 476 | | |

You can also select files by entering a string below (*=any-string ?=1 character).

Select files

Grib Filter

Grib Filter: Many times you may only want a section of a huge data file. Rather than transferring the entire file, this section will allow you to select some or all (1) levels, (2) variables, and (3) dates of a GRIB file. The buttons represent common choices which may or may not be relevant to the files that you want transferred. For example choosing RH (relative humidity) would be pointless in file of sea-surface temperatures. In addition, not all possibilities are allowed. For example, suppose you only want the virtual temperature at the tropopause at 01Z. Too bad because you have to transfer the entire file.

For GRIB data only.

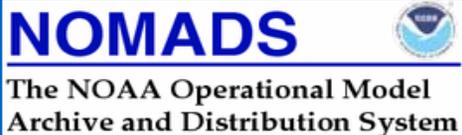
Select the levels desired:

- all 10 m above gnd 2 m above gnd MSL atmos col sfc

Select the variables desired:

- all ACPCP APCP CAPE CIN MSLET PRES PWAT RH TMP UGRD VGRD

Enabling private sector access: An example



NOMADS Ensemble Access



TODAY is: 2004, 08, 09

Please select :

STATION NAME

ASHEVILLE MUNICIPAL NC US

STATION Latitude: 35.43 STATION Longitude: -82.55

Date (HR/DD/MM/YY)GMT

14 09 08 04

Cycle

00z

NOMADS Ensemble Probabilities on the fly

Create an event:

● No need for image generation of ensembles...

Temperature:

Notes: you can create a temperature event by giving a lowest temperature or a highest temperature or a range of temperature. For example, for freezing event, giving lowest temperature lower than 32F and do not check the highest temperature.

Lowest TEMP:

Higher than

UNIT: K

Highest TEMP:

Higher than

UNIT: K

Precipitation

Higher than mm/day

Wind Speed

Higher than

UNIT: m/sec

Click YES to show URL query for ensemble members:

OPeNDAP constraint expression

NO

YES

URL is: [http://nomad3.ncep.noaa.gov:9090/dods/enshires/archive/ens20040809/ensc00z_1x1.ascii?pratesfc\[3:3\]\[125:125\]\[277:277\]](http://nomad3.ncep.noaa.gov:9090/dods/enshires/archive/ens20040809/ensc00z_1x1.ascii?pratesfc[3:3][125:125][277:277])

00z_1x1.ascii?pratesfc[3:3][125:125][277:277]

EventProbability

Reset

```
* January Mean 500 Height (1981 to 1989) minus (1990 to 1998)
* Mean & Standard Deviation for all 10 ensembles
* Time required: 60 secs
'reinit'
'ldate'
* baseURL = 'http://motherlode.ucar.edu:9090/dods/_expr_'
* GKR 2/13/03 New NCAR URL
baseURL = 'http://dataportal.ucar.edu:9191/dods/'
expr = 'ave(z,t=387,t=483,12)-ave(z,t=495,t=591,12)'
xdim = '0:360'
ydim = '20:90'
zdim = '500:500'
tdim = '1nov1978:1nov1978'
```

At left is the complete script for generating mean and sdev at 500mb analyzing 20 years of “Climate of the 20th Century” from NCAR.

Traditional vs. NOMADS method:

Data volume transported:	100Gb vs. 2Kb
Time to access data:	2 days vs. 60 sec
Code development:	days vs. minutes
Fortran based LOC:	1000 vs. 50 LOC

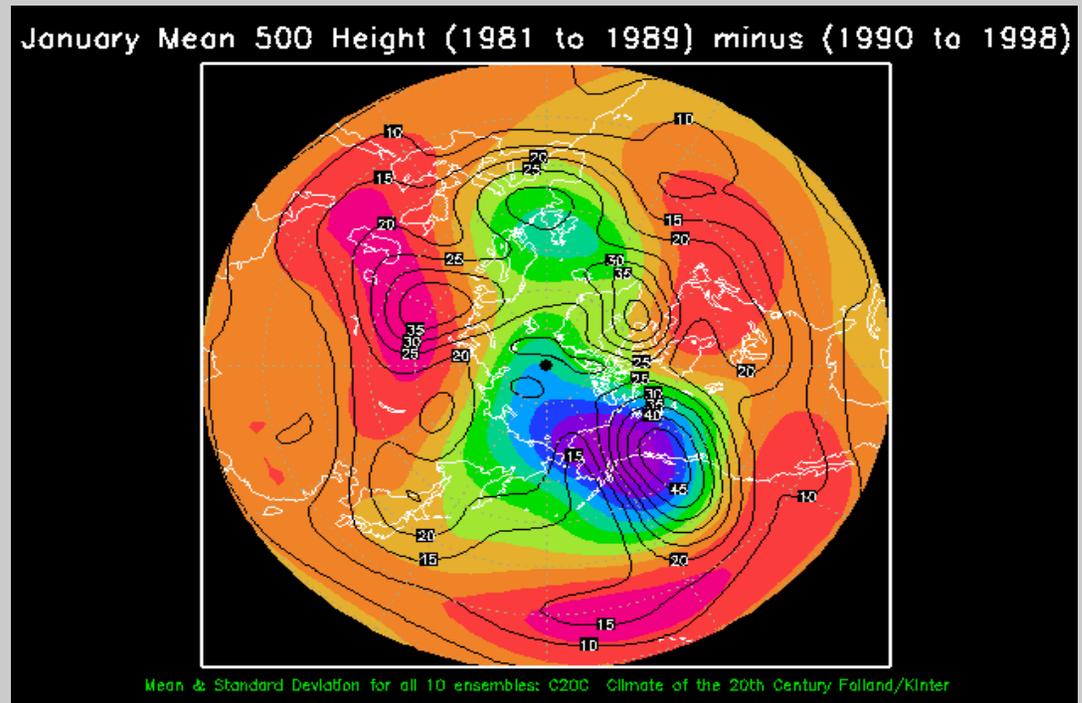
```
'define resa = result.1'
'define resb = result.2'
'define resc = result.3'
'define resd = result.4'
'define rese = result.5'
'define resf = result.6'
'define resg = result.7'
'define resh = result.8'
'define resi = result.9'
'define resj = result.10'
say 'got data'

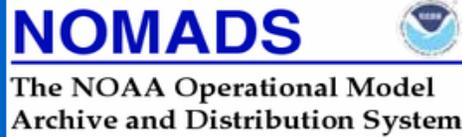
'set lev 500'
'set lat 20 90'

'define mean = (resa + resb + resc + resd + rese + resf + resg + resh + resi + resj)/10'

'define d1 = (pow(resa-mean,2)) ; 'define d2 = (pow(resb-mean,2))'
'define d3 = (pow(resc-mean,2)) ; 'define d4 = (pow(resd-mean,2))'
'define d5 = (pow(rese-mean,2)) ; 'define d6 = (pow(resf-mean,2))'
'define d7 = (pow(resg-mean,2)) ; 'define d8 = (pow(resj-mean,2))'
'define d9 = (pow(resi-mean,2)) ; 'define d10 = (pow(resj-mean,2))'
'define stddev = pow((d1 + d2 + d3 + d4 + d5 + d6 + d7 + d8 + d9 + d10)/10,0.5)

'set gxout shaded'
'set mproj nps'
'display mean'
'draw title January Mean 500 Height (1981 to 1989) minus (1990 to 1998)'
'set string 3 bc 1'
'draw string 5.5 .5 Mean & Standard Deviation for all 10 ensembles:
'C20C Climate of the 20th Century Folland/Kinter'
*cbarh'
'set gxout contour'
'set ccolor 0'
'display stddev'
'ldate'
```





For more information...

- For NOMADS Program Information see:

<http://www.ncdc.noaa.gov/oa/climate/nomads/nomads.html>

- For NOMADS Model Data Access:

NOAA NCDC Main Page → Upper-Air → Data and Products

- Or contact:

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