The NOAA Operational Model Archive and Distribution System

NOMADS

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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.

Retrospective analysis and model inter-comparison are necessary to verify and improve short term NWP models, seasonal forecasts, climate simulations, assessment and detection efforts.
To overcome this deficiency, some of the Nations top scientists are actively engaged in a grass-roots framework to share data and research findings over the Internet.

NCDC, NCEP and GFDL initiated the NOAA Operational Model Archive and Distribution System.

NOMADS is a distributed data services pilot for format independent access to climate and weather models and data.
The goals of NOMADS are to:

- provide access to models,
- promote product development,
- foster research within the geo-science communities (ocean, weather, and climate) to study multiple earth systems using collections of distributed data,
- expand institutional participation via distributed technologies.
• With NOMADS, users at any skill level will be able to obtain weather and climate information: web browsers to advanced scientific data visualization packages. NOMADS is a flexible approach to data access- promoting standards, based upon what users use most.

• As users require new data types, under NOMADS, they can be added or replaced. Over the years, NOAA has developed several different data conventions and data access protocols. NOMADS allows the use of all these most widely used formats.

• This will allow the users to make better, informed decisions about how nature will impact their future, either in their life, or business decisions.
NOMADS participants serve their data sets through a client-server relationship, that is, the data sets are internet ready and the display is done by the client.

GDS combines both GrADS, a freeware client (from COLA) and DODS (OPeN-DAP) server to compress and exchange data in many formats with http.

This means that data appears to the user or client application as a local file! Like a network file system over the web!

DODS requests are made by many freeware and commercial high level language clients.

Simple http queries to the DODS servers can create value added products.
NOMADS is an agreement between agencies who participate to have common …

- Data and observation distribution software, format independent and description methods (metadata).
- Documentation and organizational framework.
- Forum to plan and organize (science drivers).
- Funding avenue to direct $ for intra-Agency partnerships

… for university, federal agencies, and organizations, a mechanism to obtain support for the dissemination of their data sets.
So What?

“But I just want the Data”

The idea of pulling information, not bytes or data, is new and hard to convey

- NOMADS is a pull technology. Users can become servers of data!
- Why transport millions of files if only a subset is needed?
- Will networks ever keep up with growing data sets?
- Data management at the grass roots level with science driven requirements.
- Many efforts in distributed access. How best to coordinate (metadata) efforts?
- Vision, planning, and cooperation needed w/ Agency attribution!
- A dynamic system, not over engineered and built upon existing users needs but extensible for future requirements.
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.
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.
Collaborating Programs

CAP     Climate Action Partnership
CDP     Community Data Portal
CEOS    Committee on EO Satellites
CEOP    Coordinated Earth Obs Period
EPA     Air Quality Models
ESP     Earth Science Portal
NASA GCMD
NERC DataGrid
NSF Cyberinfrastructure
NSF LEAD & Geo-Science Tech Forum (GTF)
NVODS / US GODAE / GOOS
Unidata THREDDS, NSDL, DLESSE
WCRP World Climate Research Program

DOC DOE EPA State Dept
NCAR
NOAA Representative
NOAA Representative
Founding Member
Science Advisory Board
Advisory Committee
Data / Planning Committee
Data Provider
Data Provider
JSC/CLIVAR Briefings
The Partnerships

CDC
COLA  co-PI
FSL
GFDL  co-PI
LLNL
NCAR
NCDC  PI
NCEP  co-PI
PMEL  co-PI
Unidata

BADC (UK)
CEOP
CEOS
LEAD & GTF (NSF)
NASA GCMD
NERC DataGrid (NDG)
NSSL w/UW/SSEC
THREDDS
United Nations FAO
NOMADS is a founding member of the Global Organization for Earth System Science Portals (GO-ESSP).

GO-ESSP is a collaboration designed to build the infrastructure needed to create web portals to provide access to observed and simulated data within the climate and weather communities.

The infrastructure created within GO-ESSP will provide a flexible framework that will allow interoperability between the front-end and back-end software components. ESP is an international collaboration involving software developers from both Europe and the United States. See http://esportal.gfdl.noaa.gov/
• The basic philosophy of distributed modeling is to extend a framework so it can discover and execute libraries of reusable models within OGSA, the Grid and Internet, that are "owned" by domain experts and signed for authenticity. EPA, NASA, NOAA, and others can "publish" official models.

• The Weather Research and Forecast (WRF) model participants (via the ESMF) addresses modular coding design, however an overarching Agency program element for models or for distributed modular computing for AOGCM’s are not being directly addressed.

• Distributed modeling can be applied to other data forms as well as local and remote data mining operations. Some products can be pre-generated by mining tools, while allowing authorized scientists access to petabytes of archive for exploration.
Climate model output and observations are vital to providing timely assessments of climate change and impacts.

Collaboration between Global Climate Model (GCM) and NWP researchers using large data volumes of data.

Assess the affect of inadequate spatial and temporal sampling.

Models can be used to guide the spatial and temporal sampling frequency for observing network design and operation to resolve distributions for specific variables.

Accurate estimates of future climate variability and trends.

Long-term protection of climate simulations and NWP analysis.
• NOMADS promotes systematic model evaluation and model inter-comparison; and a feedback mechanism from research to operations.

• Departure of observations from NWP and a fixed reference climatological background can help identify time-dependent changes in the observations. Dynamics in climatological analysis!

• A NWP re-start and re-run capability.
• Model input data assimilation fields for Regional model initialization (e.g., WRF, MM5,) and Regional Climate Models.

• Analysis of historical NWP for operational forecaster training.

• Third-world internet access to NWP for forecast operations.

• Subsets of high volume NWP and GCM avbl over the Internet.
**Data Philosophy and Retention**
- Data are free.
- NWP forecast data are retained for five years.
- Analysis, Reanalysis, observations, and GDAS model input are retained for long term stewardship.

**Data Users**
- Resolution of IP addresses indicate a broad range, and consistent use of NOMADS available data:
  - U.S. Agencies, Academic Institutions: K-12 to Research
  - International governments, (Italy, Japan, countries within South America and Africa. Many others).
  - Private Sector and Non-Government Organizations NGO’s
  - World Bank, United Nations (FAO), others.
**NCDC Ingest Volume**

**Tb/Yr**

- **GCM**
- **Reanal**
- **NWP**

* 5-YR retention of forecasts. Long term for analysis.

**NOMADS Downloads / month**

- **Web/ftp**
- **NOMADS**
- **Total**

**Existing and Projected Volume**

**NOMADS Archive and Users**

**2004**
**NOAAPort**

**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 R/T Monitoring
- Index File generation
- Control and OPeNDAP metadata generation
- CVS Backup (code)
- NCDC Archive Interface

**Data Access**
- Earth System Grid & CEOS-Grid
  - NOMADS Web/DODS
  - NCDC Archive
Dynamic Ingest Monitoring

Dual Site Ingest and Dynamic error reporting for a serially complete archive. QC architecture discovered NOAAPort labeling errors.
Multiple paths to format independent data access:

- Direct Client Access
  - GrADS, Ferret, MatLab, IDL, IDV, Web browsers or any OPeNDAP enabled client
- Web/Grid Catalog
  - THREDDS, DLESE, GCMD, DIMES...
- Web/Browse & Compute
  - NCDC Web Interface & ftp
  - CEOS-Grid
  - Earth System Grid
Datasets in any format supported by GrADS
GrADS binary
GRIB, HDF
NetCDF
Station data
BUFR
etc..

For GRIB / 2 and BUFR users, multi-dimensional data (space/time), and data subsets are extracted on the fly.

Source: B. Doty (COLA) & G. Rutledge
Data Transport

• What’s Needed?
  – Subsetting
  – Format-independence
  – Aggregation (GDS, Unidata)
  – Compression
  – Security

• CF – model dataset standards
  – structures and semantics
• NOMADS uses the Open Source XML based OPeNDAP.

• OPeNDAP is a binary-level protocol designed for the transport of scientific data subsets over the Internet. Provides server side data manipulation on-the-fly (e.g., GrADS-DODS).

• Data formats: GRIB, GRIB2, BUFR, HDF, NetCDF, ascii... Conventions: COARDS, CF, FGDC, DIF....libraries built as necessary.

• APIs: JAVA-OPeNDAP, C++-OPeNDAP, NetCDF, GRIB, BUFR, THREDDS, Python.
Utilize Binary data and metadata through OPeNDAP …
The OPeNDAP data access protocol supports containers for semantic metadata, but places no requirements on the contents of these containers.

- Some data sets are well described, others are not.
- OPeNDAP does not mandate semantic interoperability although it does allow for it.
The two types of metadata suggest two levels of interoperability:

- **Syntactic** interoperability – Consistent format representation across data sets.

- **Semantic** interoperability – Consistent semantic interpretations of the data.

**OPeNDAP mandates syntactic interoperability via a strict syntactic description of all data available via the system.**
The required metadata falls in two classes:

- **Syntactic** metadata – Information about the data types and structures at the computer level - the syntax of the data; *e.g., variable T is a 20x40 element floating point array*

- **Semantic** metadata – Information about the contents of the data set. *e.g., variable T is sea surface temperature with units of °C*
Semantic metadata provides the information needed to label the axes in a plot:
Syntactic metadata provides the information needed to read and plot the data, but in general not to label the axes.
Objective of OPeNDAP

- To provide a data access protocol allowing for machine-to-machine interoperability with semantic meaning in a distributed, heterogeneous data environment.

- The scripted exchange of data between computers, without human intervention.
OPeNDAP System elements

- Servers
- Clients
- Aggregation Server
- Processing Servers
- Ancillary Information Services
- Browser Interfaces
- Data System Integrators (ODC)
Servers receive requests and provide responses via the DAP.

Servers convert the data from the form in which they are stored to the OPeNDAP data model.

Servers provide for subsetting of the data.
The Aggregation Server receives requests and makes responses via the DAP and It makes requests and receives responses via the DAP.

The Aggregation Server presents a single data object to the user for multi-file data sets of arrays or grids.
The processing server performs operations on the data in addition to transformation to the OPeNDAP data model and subsetting, e.g.

- Average
- Sum
- ...

There are currently two examples of processing servers:

- GrADS Data Server (GDS)
- Ferret Data Server (FDS)
Anagram - a modular Java framework for high-performance scientific data servers (http://grads.iges.org/anagram/)

**What is Anagram?**
Anagram is a prototype framework designed to ease the development of the diverse data servers which will be needed as the community moves towards distributed data processing.

It provides a collection of reusable components that address the needs common to high-performance scientific data servers. In particular, Anagram can greatly facilitate the development of new servers that support the OPeNDAP (a.k.a. DODS) subsetting protocol on a diverse range of back-end data storage formats.

**GDS and Ferret DODS Server**
Note that in distributed systems responsibility is distributed. The data and metadata lies with the data providers.

- The data access protocol lies with OPeNDAP.
- Application packages (Matlab, Ferret, GrADS, IDL, IDV, Excel…) with the developers of these packages.
- Data location: GCMD, THREDDS, DIMES, ...
Data Availability Overview

CDC: Reanalysis, climate weather models, in-situ
GFDL: Coupled Models, Control and Perturbation Integrations and historical 20th century simulations using solar, volcano, GHG and aerosol forcings.
FSL: MADIS mesoNets, Hi-Res RUC-II
NCAR: Community Climate System Model / Land Surface CO2 predictive models (VEMAP), Reanalysis / Eta
NCDC: Archive for NCEP model input/output / Select NCDC Observation datasets, Ocean/Ice WAVE, NARR, SST’s...
NCEP: Real-time Input/Output, Reanalysis (I&II), Ensembles, Sea Ice Ocean, CDAS, Hourly Eta, Climate Forecast Models...
LLNL: AMIP / Probabilistic information
PMEL: Ocean and Climate datasets
NCDC and NCEP Data

• NCDC NOMADS Archive
  • NWP from NCEP
    • POR: 2002 to Real-Time
    • Eta (12km); GFS (1 degree); GDAS; NARR 12km 30yrs
    • RUC-II 20/40km; Ocean and Ice WAVE Models
    • NCDC Reference Data Sets (Reynolds SST’s, GHCN...)
    • NCDC Mirror site to NCEP NOMADS for Eta & GFS

• NCEP Real-Time NOMADS
  • Global Forecast System GFS 1 degree
  • Hourly Eta at 12km
  • Regional Spectral Model (RSM) and Ensembles
  • Climate Data Assimilation System (CDAS)
  • AMIP Climate Monitoring, Climate Forecast Model
  • NCEP/NCAR Global Reanalysis 1&2
NOMADS saves the minimum data necessary to regenerate model output products as close as possible to NCEP operations.

The analysis files will be in the models own coordinate system.

Files are constructed with computer and computational efficiency in mind, and not in standard coordinate systems.

Programs to convert these files are available upon request:

- spectral to gaussian
- gaussian to lat/lon
- sigma to pressure
The minimum set for Global Spectral Forecast Model and the Spectral Statistical Interpolation Cycling Analysis System contains ~0.5Gb /run:

- NOAA-15/16 AMSU-A/B TOVS 1B Radiances (IEEE)
- Analysis Bias Corrected Information / Obs Toss List
- SFC U/A, ACRS, Aircft (BUFR)
- 6HR fcst guess from previous run (BUFR)
- ERSCAT Sat obs / HIRS 14/15, MSU TOVS (IEEE)
- Guess prep and and fcst guess output (BUFR)
- Analysis ready QC’ed Obs. (prepBUFR)
- Profiler, TOVS, Wind Obs. (BUFR)
- SFC Analysis Restart Files
- SST’s (GRIB), Radar VAD Winds (BUFR)
So, how can I **find** this data?
And now the OPeNDAP Home Page http://www.opendap.org/
A GCMD Portal to Model Output Data Sets

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
Access to Community Data

Portals
The ODC

[Image of a computer interface with various options and checkboxes for data selection, including fields for latitude and longitude.]

- lat: lat=[0, 1023]
- lon: lon=[0, 1023]
- Grid:
  - dsp_band_1: lat=[350, 351], lon=[500, 512]
So, how can I get this data?

The NOAA Operational Model Archive and Distribution System (NOMADS) is a pilot project designed to provide real-time and retrospective format independent access to climate and weather model input and output data.

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<td>NOMADS Web Interface</td>
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http://www.ncdc.noaa.gov/oaclimat/nomads/nomads.html
Created by Glenn.Rutledge@noaa.gov
NCDC Web Interface

Three primary methods for data access:

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

On-line or Off-line (archive)

Server-side data Computations...
The NCDC Web Interface originally developed at NCEP:

NOMADS leverages efforts across the community.
Developed at NCEP.
NCDC ingests 250K grids/day. POR 2002 to present.
Any one of these accessible in seconds
Via: OpENDAP GDS ftp Web Plotter LAS (soon)
N.O.M.A.D.S.

NOAA Operational Model Archive and Distribution System

Real Time NOMADS NCEP Component

Providers: NCEP

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.
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: catalog of attributes, and graphical display the data. Download provides "http" access to download complete files. Display of data attributes is available, 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 first page). Information from this form will be used to provide registered users with news on when additional data are added and when corrections are made to existing public data. The information gathered will not be used for any purposes other than to distribute the data.

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". This complies with the GOARDC requirements for the standardization of netCDF files. More information about netCDF can be found in the documentation provided with the data.
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)
So, how can I work with this data?

- 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, and intercomparison.
- Subset the data sets in parameter space
- Subset the data sets in physical space
- Subset the data sets in temporal space
Using http to extract data from a NOMADS OPeNDAP Server:

- http://140.90.198.156:9090/dods/eta/eta20030527/eta_00z.ascii?tmpprs[0:0][0:0][130:130] [290:290]

  the order of the square bracket values is:
  - [time][level][lat][lon]
  - where lat is measured from the south pole (0) to NP (180)
  - In units represented by the metadata descriptor file.
  - (Use a “wget” and the URL in cron or a cgi-bin script provides needed values.)

Example for OLR:
Retrieving ascii from binary GRIB
ulwrfSfc (OLR) from NCEP

wget w/ OLR example
File (url): level, lat, lon ()time is known using [Fn]
-- I need to know what variable I want and where in the given coordinate system:
    ULWRFsfc 1 level * surface Upward long wave flux [W/m^2] (lat/lon)

-- and where the data is located (url):
http://nomad2.ncep.noaa.gov:9090/dods/gdas/rotating/gdas2003092000/

-- then pull an ascii value directly from grib binary using OPeNDAP constraint:
.ascii?ulwrfSfc[0:1][140:140][200:200]\n
Returned by http:
256
This is ULWRFsfc in W/m^2 !!!
You can easily develop scripts

Imagine the power here for users of NWP data—
Data is extracted on the fly—without large expensive data ingest systems, no grib decoding necessary.

One just gets the INFORMATION desired. Many other examples freely avbl...
*Initialize GrADS and get the latest available model run
'reinit' '!date -u +%y%m%d%H > dummy'
modeldate = read(dummy)
newdate = sublin(modeldate,2)
year = substr(newdate,1,2)
month = substr(newdate,3,2)
day = substr(newdate,5,2)
hour = substr(newdate,7,2) fhr = hour-2
'sdfopen http://nomads.ncdc.noaa.gov:9090/dods/NCDC_NOAAPort_RUC/20
'year month'/20'year month day'/ruc2_236_20'year month day'_'fhr'00_fff'

*Prepare the map
'set mpdset hires'
'set mproj scaled'
'set lat 25 45'
'set lon -95 -75'
'set grid off'
'set grads off'
*Query the user for a variable to plot and display it prompt 'What variable would you like to display?'
' pull variable
'set t 2'
'd 'variable
'*run cbarn.gs'
'q time'
date = subwrds(result, 3)
hour = substr(date, 1, 3)
day = substr(date, 4, 2)
mon = substr(date, 6, 3)
iyr = substr(date, 9, 4)
'draw title RUC2 'variable' : 'hour' 'mon' 'day', 'iyr
'set t 1'
time='query time'
time
timea = substr(result, 8, 3)
timeb = substr(result, 11, 2)
timec = substr(result, 13, 3)
timed = substr(result, 16, 4)
'draw string 0.25 0.40 Model run from '
'draw string 0.25 0.25 ' timea '-' timeb '-' timec '-' timed '
'draw rec .19 .13 2.23 0.55 '

These two slides show the entire programming effort to obtain real-time RUC models and display or analyze that data!

Many scripts exist with a large Grads member Community and a growing Script library...
The IGES/COLA GrADS Script Library

http://grads.iges.org/grads/gadoc/gadocindex.html

COLA → GRADS → Documentation → Index
“S” → “Script Library”
At left is the complete script for generating mean and sdev at 500mb analyzing 18 years of “Climate of the 20th Century” over the Internet:

**Traditional vs. NOMADS methods:**

- **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
MATLAB: A Commercial Client

- server='nomad2:9090';
- directory='~/dods/gdas/rotating/'; fext='ascii';
- model='gdas'; datestr='YYYYMMDDHH'; varname='hgt';
- varlevs='1';
- Arrc=['['+t1+':'+t2+'],['+nlev1+':'+nlev2+'],['+ilat1+':'+ilat2+'],['+ilon1+':'+ilon2+']]';
- urlstring=['http://'+server+directory+model+datestr+'.'+fext+'?'+varname+Arrc];
- url = java.net.URL(urlstring); % connect to web page

Try
- stream = openStream(url)
- ireader = java.io.InputStreamReader(stream);
- breader = java.io.BufferedReader(ireader);
- Line = readLine(breader);
- disp(line);
Value added retailers who make value added products can use NOMADS GDS to get the meteorological data they need without downloading entire files.

Users (forecasters) of NDFD can create their own products using GDS server accessing only data they need. No need for image generation of ensembles...

GDS reduces the bandwidth needed to create products in weather service operations.

For internet-2 bandwidth, servers at Regional Centers can distribute data to WFO’s for their operations.
Ensemble Probabilities

Value Added Products (cont.)

TODAY is: 2004, 08, 13

Please select:

STATION NAME
ASHVILLE_MUNICIPAL NCUS

STATION Latitude: 33.43
STATION Longitude: 92.55

Date (HR/DD/MM/YY) GMT
08 13 06 24

Cycle
00z

Create an event:

- 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: °C

- Highest TEMP:
  - Higher than
  -
  UNIT: °C

- Precipitation:
  - Higher than
  - mm/day

- Wind Speed:
  - Higher than
  - m/sec
  UNIT: m/sec

Click YES to show URL query for ensemble members:

http://nomad3.ncep.noaa.gov/cgi-bin/var/ensprob1.pl

Event Probability
Reset
Today is: 2004, 08, 13 The station is: ASHEVILLE_MUNICIPAL NC US

Lat: 35.43 N, Lon:-82.55 W
FORECAST: 12 Z, aug 13, 2004

Event:
Precipitation, gt 1 mm/day

member=c0
URL is: http://nomad3.ncep.noaa.gov:9090/dods/enshires/archive/ens20040813/
ensc0_00z_1x1.ascii?pratesfc[2:2][125:125][277:277]
rainmem=1.3824

member=n1
URL is: http://nomad3.ncep.noaa.gov:9090/dods/enshires/archive/ens20040813/
ensn1_00z_1x1.ascii?pratesfc[2:2][125:125][277:277]
rainmem=1.0368

member=n2
...
NOMADS: OPeNDAP Enabled Portals

CDC: http://www.cdc.noaa.gov/cgi-bin/nph-nc/Datasets/
COLA: http://cola8.iges.org:9090/dods
FSL: http://nomads.fsl.noaa.gov/
GFDL: http://nomads.gfdl.noaa.gov/
NCDC: http://nomads.ncdc.noaa.gov/
NCEP: http://nomad1.ncep.noaa.gov/
Unidata: http://www.unidata.ucar.edu/cgi-bin/dods/datasets/
For more Program Information see:
http://www.ncdc.noaa.gov/oa/climate/nomads/nomads.html

To get data:
NOAA NCDC Main Page ➔ Climate ➔ Model Resources
http://nomads.ncdc.noaa.gov

Or contact:
Glenn.Rutledge@noaa.gov

Selected Publications:
http://www.ncdc.noaa.gov/oa/model/publications/publications.html

Live Demo and Questions...