Mesoscale Models, Eta, Maps, CMC for GCIP, Part 1

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   ・ 4 slides to give information (July 2003)

2) A paper in JGR about model data for GCIP (Jul 2003, 1 p here) .................. 5

3) Text about mesoscale model data for GCIP (6 p, Apr 2000) .......................... 6

4) Status of GCIP model archives (R. Jenne, Mar 1998, 7 p) ........................... 12

5) The GCIP model archive (Jun 1998, 7 p) ..................................................... 19
   ・ Variables in Eta 3D data

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7) Canada CMC regional model (May 1998, 7 p) ............................................. 36

8) Eta model information (Feb 1995, 3 p) ....................................................... 43

9) Canadian model-surface conditions (Feb 1997, 11 p) .................................. 46
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    ・ Includes a brief history of Global Models at NCEP (1978 – 1993) ......... 72

11) Mesoscale model data for GEWEX (RJ, Sep 1993, 3 p) ............................. 82

NCAR DSS has archives from the three mesoscale models starting about 1995. There have been many model changes. This shows the history. For most purposes, users should use data from the new NCEP regional reanalysis for N. America, resolution 32 km, finished about Oct 2003 for years 1979 – 2003, data each 3 hours.

- Roy Jenne

Ready Oct 21, 84 pages, Doc RJ0307

Roy Jenne
Oct 20, 2003
# GCIP Data Volume at NCAR, by Mesoscale Model

*(Valid July 7, 2003)*

<table>
<thead>
<tr>
<th>Period</th>
<th>From</th>
<th>To</th>
<th>No. of Years</th>
<th>Vol/Yr (GB/Yr)</th>
<th>Total Vol (GB)</th>
<th>DSS Dataset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eta*</td>
<td>05/95</td>
<td>06/03</td>
<td>8.2</td>
<td>120</td>
<td>1000.1</td>
<td>ds609.2</td>
</tr>
<tr>
<td>Maps</td>
<td>08/96</td>
<td>06/03</td>
<td>6.9</td>
<td>40</td>
<td>276.8</td>
<td>ds609.1</td>
</tr>
<tr>
<td>GEM</td>
<td>04/97</td>
<td>12/02</td>
<td>5.8</td>
<td>12</td>
<td>72.3</td>
<td>ds609.3</td>
</tr>
<tr>
<td>extra Maps</td>
<td>11/97</td>
<td>12/00</td>
<td>3.2</td>
<td>27</td>
<td>85.1</td>
<td>ds070.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>199</strong></td>
<td><strong>1434.3</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Eta data: When there is not much data missing, the mords data (or GRIB files) stay at about 102 GB/yr. The molts data volume grows. For example, molts data (or BUFR files) of 2001 is about 80 GB. In 2002, it has 93 GB. Eta data for 2001 is 182 GB. It grows to 195 GB in 2002.*

Roy Jenne  
Chi-Fan Shih  
July 7, 2003
Selected Wide Area Analyses at NCAR, DSS

<table>
<thead>
<tr>
<th></th>
<th>Dates</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NCEP/NCAR Reanalysis, global</td>
<td>1948 – 2003</td>
</tr>
<tr>
<td>2.</td>
<td>NCEP-2 Reanalysis, global</td>
<td>1979 – 2003</td>
</tr>
<tr>
<td>3.</td>
<td>NCEP Operational, global</td>
<td>1976 – on</td>
</tr>
<tr>
<td>4.</td>
<td>NCEP Opnl N. Hemisphere</td>
<td>1962 – on</td>
</tr>
<tr>
<td>5.</td>
<td>NCEP 700 mb Z &amp; Temp, N. Hem.</td>
<td>1947 – on</td>
</tr>
<tr>
<td>6.</td>
<td>500 mb Z for N. Hemisphere</td>
<td>1946 – on</td>
</tr>
</tbody>
</table>

Roy Jenne
Will Spangler
July 2003
Mesoscale and Global Model Data

1. Older mesoscale model data
   - LFM data starts 10/1971 (180 km)

2. Present operational Eta archives, for GCIP
   - Archives for GCIP start 05/1995 (now 8 years)
   - North America (resolution 30 to 40 km)
   - Now production is at a higher resolution

3. The NCEP/NCAR global reanalysis
   - Data is for 1948 – 2003 (55.5 years)
   - A global analyses is needed for boundary conditions for a regional reanalysis.

4. The NCEP regional reanalysis (N. America)
   - Data will be for 1979 – 2002 (24 years)
   - Resolution 30 km
   - Production started late June 2003

Roy Jenne
July 2003
A paper about data collection for GCIP (publ. in JGR)

- See #9 below
- There were also a number of manuals printed by the NOAA GCIP office.

R. Jenne

July 2003

9. A PAPER FOR JGR; LAST PROOF JULY 7, 2003

   Data collection and management for Global Energy and Water Cycle Experiment (GEWEX) Continental-Scale International Project (GCIP)

   J. Leese, Annapolis, MD, USA
   S. Williams, UCAR, Boulder CO, USA
   R. Jenne, NCAR, Boulder CO, USA
   A. Ritchie, Information Technology and Scientific Services, Raytheon, Huntsville AL, USA

   Citation:

   Copyright 2003 by the American Geophysical Union.
Operate a Mesoscale Model Archive for GCIP  
(Statement of work by Roy Jenne, made Apr 2000)

This briefly describes the work that will be done during the next two years.
- The work for the first and second year of the 3-year grant has nearly been completed.

1. Keep updating the archives

It is very important that we keep updating the model archives to bring them up-to-date. We obtain data on tapes (from Eta and Gem), and by internet (Maps model).

2. Prepare the main archives of GCIP mesoscale model data.

Each of the 3 model groups will send NCAR selected model data from both analyses (assimilation cycle) and from periodic forecasts out to about 36 hours. The archives will consist of grids each 3 or 6 hours. In addition, the models will output hourly vertical profiles of data at about 300 chosen locations (called MOLTS data).

One set of grids has all the fields to describe the water and energy cycles, mainly at the surface (these are MORDS data). These are output on the NWS AWIPS – 212 grid, 40 Km resolution.

All three models (NCEP Eta model, Canada’s CMC GEM Model, and the NOAA FSL Maps Model) will deliver MORDS and MOLTS data. Eta will also send an extensive set of data for the free atmosphere. NCAR will archive all of this data. We are also getting “extra” data from the FSL Maps model.

3. User access to the data.

Portions of the data will be on-line on Internet. Larger amounts of data will be sent to users on tapes (such as Exabyte or DLT). To save costs, it has been suggested that we limit the data selection capability to provide requested time periods of major types of files. These methods still give good service. Users of the NCAR computers (450 staff at NCAR, and 750 people from universities) will be able to obtain the data directly from the mass store at NCAR and feed it into their programs running at NCAR.

4. Create a better choice of large subsets.

If too many types of model data are grouped together, we have to pass through too much data volume to extract the right subsets that people want. NCAR will continue the work to create a better choice of large data types than are now available. Then we can make the bulk delivery of data faster and cheaper. The charge for delivery of bulk data was reduced from $50 per Gbyte to $30 in Sep 1998. We will keep trying to find ways to reduce these costs (method: bulk delivery of data).

5. Information about the model data.

We plan to gather more summary information about model characteristics and model changes. Users will also be pointed to more information of the Web pages of the modeling groups. Gathering this information, and trying to keep it up to date is a larger task than one would at first guess. We need somewhat more help from the modeling groups to make this work smoothly.

6. Participate in selected meetings and training sessions.

We anticipated one or two trips to distant US meetings each year. Funds for only one meeting are included in the budget for Jul 00 – Jun 01. The meetings include science meetings, and meetings about the data archives.
7. **Archive of associated data for GCIP model comparisons.**

When PIs are working with GCIP model data, it is helpful to have easy access to associated gridded data such as (1) SST, (2) ice cover, (3) snow cover, (4) clouds from ISCCP project, (5) Top outgoing radiation, long and short wave, (6) calculations of surface radiation based on satellites, (7) daily and hourly precipitation grids, etc.

We plan to maintain and update a selection of these data as they become available. We already have some. Most of this work is done under other projects.

8. **Archive of other model data for comparisons.**

NCAR has archives from two global operational models (NCEP and ECMWF). In addition, we have extensive archives of global reanalysis data. Users will have access to most of these data. Monthly global grids are very useful for many comparisons, and they will be available.

9. **The subcontract with CMC Canada.**

Canada will deliver the required model data to NCAR (they receive $15k of funds).

10. **How did we adjust the budget?**

The budget had $80k for the year starting Jul 98, and $70k for the next year. The year starting Jul 00, will again have $70k. This will provide: a) $32.7k for our work (including $4.4k for computing), b) $15k for Canada, and c) $22.3k for overheads at UCAR/NCAR.

For next year (Jul 00 – Jun 01), the budget will be $70k. To live within this budget, we will do the following:

a. Reduce the number of service options (such as subsetting) to save cost.
b. The cost of computing has come down by a factor of 2 (almost offset by the increasing volume of data).
c. The money for Canada will be $15k as suggested (not $20k as for year 1).
d. Try to make further improvements in the ability to deliver big datasets at low costs. We are already a lot cheaper than most others.
e. A little more work is being co-sponsored by NCAR.


We will continue routine updates of data from the three models. We will add to the overview metadata about the models. We expect that the amount of user services work will increase as more years and better models become available.

- We sent 450 GBytes of GCIP model data to 42 users during 10/1997 – 12/1999. This work will continue.
Model Data Center for GCIP, Progress Report
(Roy Jenne, NCAR, Apr 2000)

This report summarizes the progress in the Model Data Center for GCIP during the past year. Our center archives data output from three mesoscale models and makes it available for research use. Prior to March 1998, we had received almost no data from the NCEP Eta model. Now we have a very extensive archive from them. The other two models are the Canadian GEM model and the NOAA FSL Maps model.

1. The Change In Data Holdings at NCAR, In 1998 – 1999

   a. Eta Model (NCEP)
      
      | Date Range Held | Years |
      |-----------------|-------|
      | Mar 98          | None  | 0    |
      | 27 May 98       | Oct 97 – Apr 98 | 1.0  |
      | Mar 99          | Sep 95 – Jan 99 | 3.4  |
      | Apr 2000        | Sep 95 – Aug 99 | 4.0  |
      | *(Note: A fire at NCEP [Fall 99] delayed shipments.)*

   b. Maps Model (Boulder)
      
      | Date Range Held | Years |
      |-----------------|-------|
      | 30 Apr 98       | 11 Aug 96 – Apr 98 | 1.7  |
      | Mar 99          | 11 Aug 96 – Feb 99 | 2.5  |
      | Apr 2000        | 11 Aug 96 – Mar 2000 | 3.6  |

   c. GEM Model (Canada)
      
      | Date Range Held | Years |
      |-----------------|-------|
      | 30 Apr 98       | 1 Apr 97 – Feb 98 | 0.9  |
      | Mar 99          | 1 Apr 97 – Jun 98 | 1.2  |
      | Apr 2000        | 1 Apr 97 – Dec 99 | 2.7  |

2. GCIP Meeting In Boulder, about Feb 16 – 17, 2000

   There are several different groups in the USA that archive and distribute data for the North American GCIP experiment (active about 1993 – 2001). We are the model archive center. I prepared a 20-minute talk, but had to be gone. Dennis gave the talk. Chi-Fan was also there.

   We are doing a big job of obtaining the archives from these mesoscale models for North America (NCEP Eta), (FSL Maps), and (Canada GEM). We are splitting up some huge data files so that data access by users is easier. We point users to the model groups’ web pages for information about the models. We still have to gather more model summary information.

3. The Use of Data

   In Jan 2000, our total archive of GCIP model data was 510 GBytes. During 10/1997 – 12/1999 (2.2 years), we sent a total of 450 GBytes of this model data to 42 users. The use has been increasing. In addition, a few PIs have used the data in computer programs run at NCAR.

4. Attend GCIP PI meeting on Mar 27 – 28, 2000

   Jenne attended the meeting of GCIP-funded PIs, held in Potomac, MD, during Mar 27 – 28. There were about a dozen 20-minute talks. And other PIs gave 3-minute talks about their own project. I gave one of these. It was a useful exchange of information.
5. The Funding for Our Model Center

The funding is rather small because it is shared with others ($70k/yr total). This is split up as $15k Canada, $32.7k for our data support at NCAR (and $4.4k of this is computing), and $22.3k overhead. The money to CMC, Canada is so that they will send us their model data.

6. Desirable Additions to the Archive (monthly data)

To help understand the output of the mesoscale models, a series of first-order comparisons are needed, such as for precipitation, surface radiation, etc. These are best done using monthly data. Some of these comparisons are:

a. Compare mesoscale models with each other.
b. Compare these models with observations.
c. Compare the mesoscale models with global models.
d. Compare mesoscale data from the assimilation cycle with data from the forecast cycle.

The monthly data should be prepared for most of the native grid, not only for the AWIPS-40 grid. The trouble is that monthly data is not being routinely prepared. Therefore it is much harder for people to do these comparisons. We will try to gather back some monthly data if it is prepared.

7. Participants in the NCAR model project for GCIP

Roy Jenne, Dennis Joseph and Chi-Fan Shih work together to handle the data and answer questions. Chi-Fan is an expert atmospheric scientist that came to NCAR from CSU. He does most of the work on handling the GCIP archives and the user interfaces.
Mesoscale Model Data for GCIP
(By Roy Jenne, Dennis Joseph, Chi-Fan Shih)

Mar 3, 2000

The model data center for GCIP is located at NCAR. Data from three models are archived. Table 1 and Figure 1 show the extent of the archives in Jan 2000. The total volume is now about 510 Gbytes. The models typically have a resolution of about 30 km, but the data for the GCIP archives is output on a 40 km AWIPS grid.

**Table 1. GCIP Data Volume at NCAR (as of 26 Jan 2000)**

<table>
<thead>
<tr>
<th>Period</th>
<th>Years</th>
<th>Vol/Yr</th>
<th>Total Vol, GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eta</td>
<td>05/95 – 08/99</td>
<td>4.3</td>
<td>90 GB</td>
</tr>
<tr>
<td>Maps</td>
<td>08/96 – 12/99</td>
<td>3.4</td>
<td>40 GB</td>
</tr>
<tr>
<td>Gem</td>
<td>04/97 – 06/99</td>
<td>2.3</td>
<td>12 GB</td>
</tr>
<tr>
<td>Extra Maps</td>
<td>01/98 – 05/99</td>
<td>1.4</td>
<td>27 GB</td>
</tr>
<tr>
<td>All GCIP Data</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **MONTHLY MEAN DATA FOR GCIP GRIDS.**

   It is useful for people to have access to selected monthly mean grids from GCIP mesoscale models in order to make easy data comparisons between models on the monthly time scale. With monthly grids of observed temperature and precipitation, other comparisons of models with "reality" could also be made.

   In the GCIP model archive, monthly model data are not yet available, but we are hopeful that a selection of these grids may be ready by late 2000.

**Figure 1.** Mesoscale model data for North America held at NCAR as of Jan 2000. The data includes analyses and forecasts. Eta, Maps and Gem have a resolution of about 30 km. We will not obtain any more earlier data from Eta or Maps. NCAR also has the earlier LFM grids from NCEP (Oct 71 – Dec 93), and the NGM grids for Oct 1984 – present. The archive resolution of LFM and NGM is about 180 km.
2. CONTACTS TO OBTAIN MODEL DATA

Data Support Section Web Page - http://www.scd.ucar.edu/dss/

Phone and email for Chi-Fan Shih, chifan@ucar.edu
303-497-1833

Phone and email for Dennis Joseph, joseph@ucar.edu
303-497-1216

3. THE FLOW OF MODEL DATA TO NCAR

NCAR usually obtains Eta model data on tapes from NCEP about 3 weeks after the end of each month; however, in March 2000 we have not received any data since Aug 1999. There were computer problem (caused by a fire) and heavy time pressures during Fall 1999 at NCEP. We expect this data flow to start again soon.

The Maps GCIP model data from FSL, Boulder comes daily by Internet. FSL makes a table of what files NCAR should get. NCAR checks on receipt of the proper files. In several cases the automation warned NCAR and FSL about data delivery problems which still could be fixed. The special hi-resolution data from FSL comes on tape, delivered several times each year.

Data from Canada’s Gem model is batched into 6-month segments (Jan – Jun, Jul – Dec), and is usually received by NCAR within 3 months after the end of a period on DAT or now Exabyte tapes.

4. NCAR PLANS FOR MESOSCALE MODEL DATA

NCAR has archives of mesoscale model data that first started from the LFM model (NCEP) in Oct 1971. There are still archives from the NGM model. Data for the GCIP archive started as early as May 1995. Even if GCIP changes, NCAR plans to keep updating archives of mesoscale data.

5. USERS

During 1998 – 99, a total of 42 off-site users obtained GCIP model data. They received 450 Gbytes. A few other people ran programs on the NCAR computers, and read GCIP data into these programs.

6. PLANS FOR A MESOSCALE REANALYSIS

NCEP plans to prepare a mesoscale reanalysis for North America at a resolution of about 30 km, using a new version of the Eta model. The period will probably be 1979 – 2003. NCEP has been preparing the model for almost two years. Operations may start about Mar 2001.

The output will be extensive. It will include data for several ground following levels in the deep boundary level. NCAR plans to have a copy of the Eta output to help give users access to the data.

7. RELATED DATA ARCHIVES AT NCAR

NCAR has archives from the 50-year NCEP/NCAR global reanalysis for 1948 – 1999 (208 km resol.) An NCEP 2 reanalysis has done 1979 – 97 with a newer model. Operational global analyses from NCEP and ECMWF are also archived. There are also data from observations such as precipitation, clouds from ISCCP data (07/1983 – on), OLR radiation data, total ozone grids from NASA, etc.
Status of GCIP Model Archives

- GCIP Model data received at NCAR
- Terrain elevation for GCIP studies
- Data delivery from NCAR
- The cost of selected tape drives
- How does the model handle the surface?
  — Some questions
- River flow (for USA)
  — And precipitation over oceans

For a GCIP talk at NCEP
March 1998
Roy Jenne
March 1998
GCIP Model Data Received at NCAR

1. FSL Maps.

Jan 97 Jan 98 % receipt
6/19 71% 88% Molts
08/11 56% 69% 87% Mords

2. Canadian GEM

Jan 97 Jan 98
Aug 97 100% Mords, anal,
Apr 99% Sep Mords fcst
Data Delivery from NCAR

a. Use data files on computers at NCAR
   • 1200 users can access these computers
     — 450 users at NCAR
     — 750 users from Universities, etc.

b. Tapes: large amounts of data are sent on tape.

c. CD-ROMs: copies of 20 CD-ROMs are available (Mar 1998).

d. Internet server: for small datasets and information files.

How Much Data did NCAR Deliver?
(During January – December, 1997)

<table>
<thead>
<tr>
<th>Data Delivery</th>
<th>Gbytes</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. On computers at NCAR</td>
<td>~8200</td>
<td>NCAR + University use</td>
</tr>
<tr>
<td>b. Sent on tapes (some by ftp)</td>
<td>2068*</td>
<td>There were 328 orders</td>
</tr>
<tr>
<td>c. Sent on CD-ROMs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Northern Hemisphere daily grids</td>
<td>65</td>
<td>50 sets (2 CD’s each)</td>
</tr>
<tr>
<td>• Reanalysis CD-ROMs</td>
<td>~950</td>
<td>~150 orders (1300 CDs)</td>
</tr>
<tr>
<td>d. Internet</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

*These data are used by more than one user
Figure 1: Data from Data Support archives that are read into user programs (not DSS), which are run on main computers at NCAR. The Gbytes read during each year are shown. A large portion of the use is by the universities. Most of the "other users" are NCAR users.
### DSS Data Archives Used from NCAR Mass Store

The use on NCAR computers, by NCAR staff (not DSS) and universities

<table>
<thead>
<tr>
<th>Year</th>
<th>Only NCEP/NCAR Reanalysis</th>
<th>Total DSS Archive Use on MSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>—</td>
<td>2638 GB</td>
</tr>
<tr>
<td>1993</td>
<td>—</td>
<td>3626</td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td>4397</td>
</tr>
<tr>
<td>1995</td>
<td>416 GB</td>
<td>4666</td>
</tr>
<tr>
<td>1996</td>
<td>2679</td>
<td>5621</td>
</tr>
<tr>
<td>1997 (only 6 mo)</td>
<td>2063</td>
<td>4423 (6 mo)</td>
</tr>
</tbody>
</table>

Roy Jenne
Oct 1997
The Cost of Selected Tape Drives

The data capacity of selected tape drives is given for uncompressed and compressed. The data rate given in twice the uncompressed rate.

<table>
<thead>
<tr>
<th>Drive type</th>
<th>Capacity (GB)</th>
<th>Rate (MB/min)</th>
<th>11/96</th>
<th>03/97</th>
<th>07/97</th>
<th>09/97</th>
<th>02/98</th>
<th>03/98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exabyte</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eliant 820</td>
<td>7-14</td>
<td>120</td>
<td>None</td>
<td>None</td>
<td>1580</td>
<td>1550</td>
<td>1480</td>
<td>1480</td>
</tr>
<tr>
<td>8700 LT</td>
<td>7-14</td>
<td>60</td>
<td>$1149</td>
<td>1030</td>
<td>735</td>
<td>690</td>
<td>675</td>
<td>675</td>
</tr>
<tr>
<td>8900 (Sep 96)</td>
<td>20-40</td>
<td>360</td>
<td>5480</td>
<td>4800</td>
<td>4330</td>
<td>3770</td>
<td>3400</td>
<td>3360</td>
</tr>
<tr>
<td>DLT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000 (1993)</td>
<td>15-30</td>
<td>150</td>
<td>2500</td>
<td>2680</td>
<td>2800</td>
<td>2680</td>
<td>2500</td>
<td>2500</td>
</tr>
<tr>
<td>4000 (04/1995)</td>
<td>20-40</td>
<td>180</td>
<td>4560</td>
<td>4180</td>
<td>4270</td>
<td>4100*</td>
<td>3000</td>
<td>2760</td>
</tr>
<tr>
<td>7000 (01/1997)</td>
<td>35-70</td>
<td>600</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>None</td>
</tr>
<tr>
<td>DDS243</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDS2; 3 drives</td>
<td>4-8</td>
<td>48/66</td>
<td>810</td>
<td>810</td>
<td>740</td>
<td>680</td>
<td>740</td>
<td></td>
</tr>
<tr>
<td>Sony DDS-3</td>
<td>12-24</td>
<td>144</td>
<td>None</td>
<td>1399</td>
<td>1130</td>
<td>1050</td>
<td>1030</td>
<td>1000</td>
</tr>
</tbody>
</table>


b. The Exabyte 8700 LT is cheaper than other Exabyte drives of 60 MB/min., but it really is the same drive.

c. The Exabyte Eliant drive started selling about June 1997.

d. The Quantum DLT7000 was first in Computer Shopper (from 3 or 4 vendors) in March 1998. It first started selling in other markets about January 1997.

e. In November 1996, there were only 4 mm 4-8 GB drives (DDS2), not 12-24 GB drives (DDS3). The cheapest of the DDS2 drives is listed. One costs $100 to 150 more than this.

Note: slides about precip, elev, date, etc have been moved

Roy Jenne
5 Mar 1998
Mesoscale Model Data in NCAR DSS Archives

1. The model archives for GCIP and GAPP
(These data have a resolution of 30 to 40 km.)

<table>
<thead>
<tr>
<th>Date</th>
<th>Amt of Data in Archives</th>
<th>Cumulative Data Sent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2000</td>
<td>510 GB</td>
<td>450 GB</td>
</tr>
<tr>
<td>Feb 20, 2001</td>
<td>807 GB</td>
<td>763 GB</td>
</tr>
<tr>
<td>May 2002</td>
<td>1046.2 GB</td>
<td>1017 GB</td>
</tr>
<tr>
<td>July 7, 2003</td>
<td>1434.3 GB</td>
<td>1241 GB</td>
</tr>
</tbody>
</table>

2. Earlier mesoscale model data at NCAR

Data from the LFM model from NCEP is for Oct 1971 – Dec 1993. Resolution about 180 km. Data from the NCEP NGM model starts Oct 1984, resolution 180 km.

Roy Jenne
Chi-Fan Shih
July 2003
The GCIP Model Archive

Roy Jenne
Dennis Joseph
Chi-Fan Shih
June 1998

- Model output available; time summary

- Volume of model data

- Access to data
  - Free on-line; cost to send data
  - Volume, cost, and constraints

- Information packages for three models

- Discuss GEM, MAPS, Eta

- Review of home pages
Summary of Model Output Availability

This gives the data status at NCAR in late April 1998, and the estimate of data holdings on later dates.

a. MAPS (FSL) Model:

b. Eta (NCEP) Model:
   Later: Apr 1995 – on

c. GEM (CMC, Canada) Model:
   30 Apr 1998: 1 Apr 1997 – 28 Feb 1998 (MORDS is here, MOLTS is arriving)

Data at NCAR on Different Dates

[Diagram showing data availability for Maps (FSL), Eta (NCEP), and GEM (Canada) models with dates for April 1997 to March 1999]

Note: Some slides removed.
# Monthly Volume of GCIP Data

<table>
<thead>
<tr>
<th>Type</th>
<th>Volume total</th>
<th>Analysis</th>
<th>1st guess</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Eta</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-D</td>
<td>4.9 GB</td>
<td>1.2 GB</td>
<td>1.2 GB</td>
<td>2.5 GB</td>
</tr>
<tr>
<td>Surface</td>
<td>2.0 GB</td>
<td>330 MB</td>
<td>570 MB</td>
<td>1.1 GB</td>
</tr>
<tr>
<td>MOLTS profiles</td>
<td>0.93 GB</td>
<td>60 MB</td>
<td>60 MB</td>
<td>870 MB rough</td>
</tr>
<tr>
<td>Obs. Precipitation</td>
<td>3.7 MB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7.8 GB</strong></td>
<td><strong>1.6 GB</strong></td>
<td><strong>1.80 GB</strong></td>
<td><strong>4.5 GB</strong></td>
</tr>
<tr>
<td>One year</td>
<td><strong>93.6 GB</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. GEM

<table>
<thead>
<tr>
<th>Type</th>
<th>Volume total</th>
<th>Analysis</th>
<th>1st guess</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>MORDS UPA</td>
<td>287 MB</td>
<td>52 MB</td>
<td></td>
<td>235 MB rough</td>
</tr>
<tr>
<td>MORDS sfc</td>
<td>588 MB</td>
<td>52 MB</td>
<td></td>
<td>536 MB rough</td>
</tr>
<tr>
<td>MOLTS profiles</td>
<td>125 MB</td>
<td>25 MB</td>
<td></td>
<td>100 MB rough</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.1 GB</strong></td>
<td></td>
<td></td>
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<tr>
<td>One year</td>
<td><strong>13.2 GB</strong></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

3. MAPS

<table>
<thead>
<tr>
<th>Type</th>
<th>Volume total</th>
<th>Analysis</th>
<th>1st guess</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>MORDS UPA</td>
<td>910 MB</td>
<td>240 MB</td>
<td></td>
<td>670 MB</td>
</tr>
<tr>
<td>MORDS sfc</td>
<td>1950 MB</td>
<td>150 MB</td>
<td></td>
<td>1800 MB</td>
</tr>
<tr>
<td>MOLTS profiles</td>
<td>960 MB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.8 GB</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One year</td>
<td><strong>45.6 GB</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tape Technology Status (April 1998)

<table>
<thead>
<tr>
<th>First out</th>
<th>Tape drive</th>
<th>Tape Gbyte</th>
<th>Native MB/sec</th>
<th>Date</th>
<th>Price</th>
<th>Price per tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/1994</td>
<td>Exabyte 8505 XL (8 mm)</td>
<td>7/14</td>
<td>0.5</td>
<td>09/1996</td>
<td>$2000</td>
<td>$14</td>
</tr>
<tr>
<td>09/1996</td>
<td>Exabyte Mammoth (8 mm)</td>
<td>20/40</td>
<td>3.0</td>
<td>11/1996</td>
<td>$5500</td>
<td>—</td>
</tr>
<tr>
<td>04/1995</td>
<td>DLT 4000 (0.5 inch)</td>
<td>20/40</td>
<td>1.5</td>
<td>09/1996</td>
<td>$4650</td>
<td>—</td>
</tr>
<tr>
<td>01/1997</td>
<td>DLT 7000 (0.5 inch)</td>
<td>35/70</td>
<td>5.0</td>
<td>03/1998</td>
<td>$2760</td>
<td>$85</td>
</tr>
<tr>
<td>03/1997</td>
<td>Sony DDS3 (4 mm)</td>
<td>12/24</td>
<td>1.2</td>
<td>03/1997</td>
<td>$1400</td>
<td>$32</td>
</tr>
<tr>
<td>04/1998</td>
<td>AIT (Sony &amp; Seagate), 8 mm</td>
<td>25/50</td>
<td>3.0</td>
<td>05/1998</td>
<td>$2550</td>
<td>$80</td>
</tr>
</tbody>
</table>

Note: One inch equals 25.4 mm

Plans for New Tape Drives

1. Exabyte plans.

<table>
<thead>
<tr>
<th>Drive</th>
<th>Start Date</th>
<th>Capacity</th>
<th>Native speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Mammoth</td>
<td>09/1996</td>
<td>20/40 GB</td>
<td>3 MB/sec</td>
</tr>
<tr>
<td>New Drive</td>
<td>~11/1998</td>
<td>70/140 GB</td>
<td>12 MB/sec</td>
</tr>
<tr>
<td>Another upgrade</td>
<td>Year 2000</td>
<td>200/400 GB</td>
<td>20 MB/sec</td>
</tr>
</tbody>
</table>

2. IBM, HP, Seagate plan.

<table>
<thead>
<tr>
<th>Drive</th>
<th>Start Date</th>
<th>Capacity</th>
<th>Native speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrim (.5 inch)</td>
<td>07/1999</td>
<td>100/200 GB</td>
<td>10 MB/sec</td>
</tr>
</tbody>
</table>
Output of NCEP/NCAR Reanalysis

Basic set of outputs

- 54 Gbytes/year (big volume)
- Obtain data on tape, or on-line at NCAR

CD-ROMs (One CD hold 660 MB)

- Monthly statistics (select, ~13years/CD)
- One CD-ROM per year (more daily data)

Send data on tapes

- Typical archive price ($600-$1500 per GB)
- NCAR price
  
  a. Big datasets
     Earlier $430/GB
     April 1998-on $310/GB
  b. Bulk cost, no select
     $50/GB
     $30/GB

Papers

- Bull AMS, Dec 1991 --Kalnay & Jenne
- Many data papers at NCAR

Roy Jenne
May 1998
Figure 1: Data from Data Support archives that are read into user programs (not DSS), which are run on main computers at NCAR. The Gbytes read during each year are shown. A large portion of the use is by the universities. Most of the "other users" are NCAR users.
### 19 Variables in 3-D File

<table>
<thead>
<tr>
<th>Precipitable water</th>
<th>FWAT kg/m^2</th>
<th>54,200, 0, 99999 HH 00 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total precipitation</td>
<td>APCP kg/m^2</td>
<td>61, 1, 0, 0 HH-6 HH 004</td>
</tr>
<tr>
<td>Convective precipitation</td>
<td>ACPCP kg/m^2</td>
<td>63, 1, 0, 0 HH-6 HH 004</td>
</tr>
<tr>
<td>Water equiv. of accum. snow depth</td>
<td>WEASD kg/m^2</td>
<td>65, 1, 0, 0 HH-6 HH 004</td>
</tr>
<tr>
<td>Water equiv. of accum. snow depth</td>
<td>WEASD kg/m^2</td>
<td>65, 1, 0, 0 HH-6 HH 004</td>
</tr>
<tr>
<td>Soil temperature</td>
<td>TSOIL K</td>
<td>85,111, 300, 99999 HH 00 000</td>
</tr>
<tr>
<td>Soil temperature</td>
<td>TSOIL K</td>
<td>85,112, 0, 10 HH 00 000</td>
</tr>
<tr>
<td>Soil temperature</td>
<td>TSOIL K</td>
<td>85,112, 10, 200 HH 00 000</td>
</tr>
<tr>
<td>Soil moisture content</td>
<td>SOILM kg/m^2</td>
<td>86,112, 0, 200 HH 00 000</td>
</tr>
<tr>
<td>Snow melt</td>
<td>SNOM kg/m^2</td>
<td>99, 1, 0, 0 HH-6 HH 004</td>
</tr>
<tr>
<td>Mean sea level pressure (ETA model)</td>
<td>MSLET Pa</td>
<td>130,102, 0, 0 HH 00 000</td>
</tr>
<tr>
<td>Best (4-layer) lifted index</td>
<td>LFTX K</td>
<td>132,116, 180, 0 HH 00 000</td>
</tr>
<tr>
<td>Horizontal moisture divergence</td>
<td>MCONV kg/kg/s</td>
<td>135,116, 30, 0 HH 00 000</td>
</tr>
<tr>
<td>Volumetric soil moisture content</td>
<td>SOILW fraction</td>
<td>144,112, 0, 10 HH 00 000</td>
</tr>
<tr>
<td>Volumetric soil moisture content</td>
<td>SOILW fraction</td>
<td>144,112, 10, 200 HH 00 000</td>
</tr>
<tr>
<td>Convective inhibition</td>
<td>CIN J/kg</td>
<td>156, 1, 0, 0 HH 00 000</td>
</tr>
<tr>
<td>Convective Available Potential Energy</td>
<td>CAPE J/kg</td>
<td>157, 1, 0, 0 HH 00 000</td>
</tr>
<tr>
<td>Moisture availability</td>
<td>NSTAV %</td>
<td>207,112, 0, 200 HH 00 000</td>
</tr>
<tr>
<td>Plant canopy surface water</td>
<td>CNWAT kg/m^2</td>
<td>223, 1, 0, 0 HH 00 000</td>
</tr>
</tbody>
</table>

### Summary of these 19 variables in Eta 3D

1. Precipitation
   - Total and convective
2. Total precipitable water
3. Convection
   a. Precipitation
   b. Lifted index
   c. Inhibition
   d. Available energy
4. Snow depth (water equiv)
   - 6-hour and instant
5. Snow melt
6. Soil moisture
   - For 0-200 cm (Kg/m2)
   - For 0-10 cm and 10-200 cm
7. Soil temperature
   - At 0-10 cm (layer); 10-200 cm (layer); 300 cm
8. Horizontal moisture divergence
9. Plants
   - Plant canopy surface water
   - Moisture availability

Roy Jenne
May 1998
MAPS

1. The primary coordinate system
   - Sigma near ground
   - Isentropic aloft

2. The down solar at surface
   - It is about right
   - Used solar stations from John Deluisi

3. The diurnal trend of sfc temperature
   - The cycle is a little too flat
   - 7 am (15Z) — 1.5° C too warm
   - 10 am (18-21Z) — ok
   - afternoon — 1° C too cool

4. The full MAPS archive
   - The full grid archive is on FSL mass store
   - But it is hard to retrieve

9 pages
- 3 p here, rest in box
The MAPS Mesoscale Model of NOAA, FSL

The MAPS mesoscale model is run by NOAA in Boulder, Colorado. It has sigma levels (terrain following) near the ground and isentropic levels above. Stan Benjamin has a text about the model. A reference is ( ).

Output data is derived on pressure levels, each 25 mb (37 levels 1000-100 mb). Stan Benjamin is the expert for this model in NOAA (303-497-6387, fax x7262), benjamin@fsl.noaa.gov. The model makes an analysis each 3 hours, by using observations and a guess (a 3-hour forecast). Forecasts are made out to 12 hours and done each 3 hours. The model continually cycles on itself; it does not keep restarting from a climatology. The domain of the model is shown by the attachments.

Some fields such as a good soil moisture are probably a year away; this is also true of other available models. The model is now (Aug 1995) running at a 60-km resolution. By around Dec 1995 it will be in production at 40-km resolution:

<table>
<thead>
<tr>
<th>Date</th>
<th>Levels</th>
<th>Resolution</th>
<th>Points</th>
<th>Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 1995</td>
<td>25</td>
<td>60 km</td>
<td>81 x 62</td>
<td>polar stereo</td>
</tr>
<tr>
<td>Dec 1995</td>
<td>40</td>
<td>40 km</td>
<td>151 x 113</td>
<td>Lambert Conf.</td>
</tr>
</tbody>
</table>

Information about the variables follows:

- 3-d variables $\theta$: $P$, $M(=C_p T + gz)$, $\theta_v$, $q$, u, v
- 3-d variables - isobaric: T, Z, RH, u, v
- Number of "surface" 2-d variables: about 20

An analysis or forecast "step" results in a full output of 3-d and 2-d fields. Each 3 hours there is an analysis, and there are forecasts out to 3h, 6h, 9h, and 12h. In the archives, we plan to save forecasts only to 6 hours (but we will see that hourly forecasts at point locations are archived out to 12 hours). We will have 24 steps of output each day. The volume of data from the 24 steps each day will be about:

1) The 3-d archive of model data in model coordinates: 40 levels; 4600 MB/month (for 12 bits/number)
   — This archive will be kept at FSL, but not at NCAR.

2) The 3-d archive of model data in pressure coordinates (each 25 mb, 1000 to 100 mb): 37 levels; 3900 MB/month (for 11 bits/number).
   Question: Is there a sigma level in this too?


Note for the above three items: 33% of the grid volume is in the analyses and 67% is in the forecasts.
4) Vertical profiles (Molts data). Each vertical profile will have a sounding given by variables from the model. There will also be some surface information such as precipitation. We plan to save molts data each hour out to 12 hours, done each 6 hours. Therefore there will be 48 profiles at each location for each day.

Top of the Model

In the 60-km model the top isentropic level is at 410°K, which is around 80 to 100 mb. In the new 40-km version, the top level will be at 450°K (about 60-80 mb).

The Computer

The FSL experiment model is now being run on an HP 755 computer. In a few months it will be run on an SGI.

References

Date: Thu, 24 Aug 1995 18:22:48 -0600 (DST)
To: jenne@ncar.ucar.edu
From: benjamin@apache.fsl.noaa.gov (Stan Benjamin)
Subject: reference

Roy,

Thanks for putting together that sheet. It looks good. You asked for a reference. Let's put in the following two references:


Thanks.

Stan
MAPS land-use index
(from NCAR data base)

* : agriculture
/: range-grassland
.: deciduous forest
+: coniferous forest
$: forest & wet-land
-: water
1: marsh or wet-land
=: desert
A: tundra
$: savannah

60 km Map Model

29
41 variables in FSL maps *99HH.grib files, where HH=01, 02, 03, 06, 09, 10, 12
*HH=10 exists when reference time at 03Z and 18Z, but should not be used.
*HH=3=0 when HH=01, 02, 03

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pressure - b</td>
<td>PRES</td>
<td>Pa</td>
</tr>
<tr>
<td>height - b</td>
<td>HGT</td>
<td>gpm</td>
</tr>
<tr>
<td>temperature - p</td>
<td>TMP</td>
<td>K</td>
</tr>
<tr>
<td>u-component of wind - b</td>
<td>U GRD</td>
<td>m/s</td>
</tr>
<tr>
<td>v-component of wind - b</td>
<td>V GRD</td>
<td>m/s</td>
</tr>
<tr>
<td>specific humidity</td>
<td>SPF H</td>
<td>%</td>
</tr>
<tr>
<td>precipitable water</td>
<td>PWAT</td>
<td>kg/m**2</td>
</tr>
<tr>
<td>total precipitation accumulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sub-grid scale precipitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>snow accumulation</td>
<td>ACPCP</td>
<td>kg/m**2</td>
</tr>
<tr>
<td>snow accumulation</td>
<td>WEASD</td>
<td>kg/m**2</td>
</tr>
<tr>
<td>low-level cloud cover percentage</td>
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</tr>
<tr>
<td>mid-level cloud cover percentage</td>
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<td></td>
</tr>
<tr>
<td>high-level cloud cover percentage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>surface albedo</td>
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<tr>
<td>soil temperature at surface</td>
<td>TSOIL</td>
<td>K</td>
</tr>
<tr>
<td>soil temperature at surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil temperature at surface</td>
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<td></td>
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<tr>
<td>soil temperature at surface</td>
<td></td>
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</tr>
<tr>
<td>soil volumetric moisture content at surface</td>
<td>SOIL M</td>
<td>kg/m**2</td>
</tr>
<tr>
<td>soil volumetric moisture content at surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil volumetric moisture content at surface</td>
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<td>soil volumetric moisture content at surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil volumetric moisture content at surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>snow melt accumulated</td>
<td></td>
<td></td>
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<tr>
<td>latent heat flux</td>
<td>LHTFL</td>
<td>W/m**2</td>
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<tr>
<td>latent heat flux</td>
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<td>sensible heat flux</td>
<td>SHTFL</td>
<td>W/m**2</td>
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<td>sensible heat flux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sensible heat flux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAPS mean sea level pressure</td>
<td>MSLMA</td>
<td>Pa</td>
</tr>
<tr>
<td>convective available potential energy</td>
<td>CAPE</td>
<td>J/kg</td>
</tr>
<tr>
<td>time averaged downward short wave rad. flux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time averaged downward long wave rad. flux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time averaged upward short wave rad. flux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time averaged upward long wave rad. flux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time averaged snow phase change heat flux</td>
<td></td>
<td></td>
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<tr>
<td>surface runoff accumulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>surface drag coefficient</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hi Roy:

As promised, here is what I found in reference to model spin-up in MAPS.

>From


"Figure 4 shows the equitable skill score for the 24h03CNT versus the 24h12CNT runs of the RUC. Here the sample size is 146 cases. The higher scores of the combined 3-h forecasts (as compared to the 12-h forecasts) should be of interest to modelers. If the RUC suffered from the model spin-up we would have expected the lower skill scores for the 24h03CNT (3-h forecasts), not the 24h12CNT (12-h forecasts). This is not an unexpected result; according to Johnson et al. (1993), which investigated the advantages of using the hybrid-isentropic coordinate in relation to model spin-up problems....."

The paper regarding rawinsonde humidity changes that affect the climatological record is:


Specifically tables 2-3 outline all the significant changes regarding humidity that I could come up with based on the station history work we did here around 1990 or so. It needs updating for changes made in the 90s.

I will be sending these papers to you along with another regarding the occurrence of super adiabatic lapse rates in U.S. radiosonde data.

All stuff from my past-life so to speak.

I hope this has been helpful. I have a listing of all my past-life and current life papers on my homepage:

http://maps.fsl.noaa.gov/barry.html

Regards,

Barry

*******************************
*                           *
* Barry E. Schwartz R/E/FS1  *
* NOAA/Forecast Systems Laboratory  *

3
MAPS questions

Subject: MAPS questions
Date: Thu, 4 Jun 1998 09:36:14 -0600 (DST)
From: Stan Benjamin <benjamin@fsl.noaa.gov>
      To: jenne@ncar.ucar.edu
      CC: schwartz@fsl.noaa.gov

Roy,

I hear you just talked to Barry. I concur with what he told you about precip
spin-up. We think it is fairly small. We suspect it is lower than that from
the Eta model, but we say this only from looking at Eta precip forecasts
subjectively. We haven't seen Eta stats on this, but have done them ourselves.
John B. will have a figure next week showing MAPS precip for May 1998 from 0-1,
0-3, 3-6, 6-9, and 9-12h fcst's for the month. This figure confirms the idea
that the spin-up is not too bad from MAPS. Actually, there is a slightly
spin-down from 0-1 to 3 h. The 0-1h is what really matters in the MAPS 1h
assimilation cycle.

I will be out from 2:30-4:30 this aft and 9:30-11:30 and 1-2:30 tomorrow, but
you can call at other times if you have further questions after reading the web
stuff that Barry pointed you add (web address also shown below).

regards, Stan

Stan Benjamin
NOAA/ERL Forecast Systems Laboratory
benjamin@fsl.noaa.gov
http://maps.fsl.noaa.gov

Phone: 303-497-6387
FAX: 303-497-7262
Mesoscale Model Archives, December 1996

1. Mesoscale model data from Canada.

Talk with Hal Ritchie December 9, 1996.

The archives are coming along well, and it appears that they could be sent at any time. Their plan is to send all of the agreed data starting with October 1, 1995. We should note that the model changed from a resolution of 50 Km to 35 Km in December 1995.

2. Data from MAPS mesoscale model at FSL (December 1996).

Talked with Stan Benjamin (303-497-6387), December 9.

FSL prepared the grid data for the 3-day model intercomparison test in May 1996. The data looks OK.

Soil temperature and moisture have been cycling properly since April 1996. The USAF makes a snow analysis. This field is read into the model one time each day. They obtain the snow grid via NCEP (note that these changes in snow will act like an unknown source term in the water budget).

The MORDS data (analyzed grids) for May 1996 and later will soon be sent to NCAR. There is now a file of MORDS on-line for one week (330 MB for a week). There were 2 or 3 cases where a day has lost its proper history of cycling. They have repaired these cases.

• FSL has this MORDS data on some Exabyte tapes. NCAR should have copies within about two weeks. Then NCAR will prepare an inventory.

Molts data (hourly vertical soundings): These data have not yet been prepared.

FSL will prepare a text file with information about the grid fields that we can give to users.

3. A year of data starting 1 April 1997.

John Leese especially wants this year of data in the archives.
CMC Regional Forecast System

Changes in Canada’s regional model

- 1st October 1995: start of the special GEWEX archive at CMC RFE (Regional Finite Element) model, 50 km/25 levels Regional assimilation system (12h spin-up), 50 km analysis
- 21 December 1995: increase of model resolution to 35 km/28 levels
- 24 February 1996: new regional model and assimilation system GEM (Global Environmental Multiscale), 35 km/28 levels input; also has global analysis (~100 km)
- 18 June 1997: new data assimilation system –3D-VAR
- 24 September 1997: re-introduction of regional assimilation system 12-h spin-up with 3D-VAR analysis and GEM 35 km/28 levels
- September 1997-June 1998: no further changes

CMC Archives

- The archive will be for October 1995-on.

Primary GCIP archive period started 1 April 1997

Technical improvements to meet GCIP needs since then:
- Elimination of horizontal interpolation before data storage (16 May 1997)
- Extension of archive to full global grid of GEM to meet data needs outside GCIP main area (24 Oct 1997)

--- Note: NCAR does not have global data

Mesoscale data from Canada

12 pages
- 3 p here, rest in box

36

Roy Jenne
May 1998
Figure 2 - RFE GC1P grid

Canadian Mesoscale Archive

- Data starts 1 October 1995
  - 50 Km, 25 levels
- Resolution on 21 December 1995
  - 35 Km, 28 levels (and global at 100 Km)
- In June 1998
  - Resolution same as the above
<table>
<thead>
<tr>
<th>Fields</th>
<th>Analysis Grid(s)</th>
<th>Method</th>
<th>Trial Field</th>
<th>Frequency</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface air temperature</td>
<td>0.9x 0.9 global</td>
<td>Optimum interpolation</td>
<td>Spectral model forecast of surface temperature</td>
<td>6 hours</td>
<td>Land Synops, SAs, Ships, Buoys, Drifters</td>
</tr>
<tr>
<td>Surface air temperature</td>
<td>GEM grid</td>
<td>Optimum interpolation</td>
<td>Regional GEM model forecast</td>
<td>24 hours (1800 UTC)</td>
<td>Land Synops, SAs, ships, buoys, drifters</td>
</tr>
<tr>
<td>Surface dew point depression</td>
<td>GEM grid and 0.9x 0.9 global</td>
<td>Optimum interpolation</td>
<td>Spectral model forecast</td>
<td>6 hours</td>
<td>Land Synops, SAS, ships, buoys, drifters</td>
</tr>
<tr>
<td>Sea surface temperature anomaly</td>
<td>GEM grid</td>
<td>Optimum interpolation</td>
<td>Regional GEM model forecast</td>
<td>24 hours</td>
<td>Land Synops, SAS, ships, buoys, drifters</td>
</tr>
<tr>
<td>Snow depth</td>
<td>0.9x 0.9 global</td>
<td>Optimum interpolation</td>
<td>Previous analysis merged with climatology</td>
<td>12 hours</td>
<td>Land Synops, SAs</td>
</tr>
<tr>
<td>Ice cover</td>
<td>0.9x 0.9 global</td>
<td>Data averaging with a return to climatology in areas where data are not available.</td>
<td>24 hours</td>
<td>SSM/I, Ice Centre Data</td>
<td></td>
</tr>
<tr>
<td>Deep soil temperature</td>
<td>0.9x 0.9 global</td>
<td>Derived from climatology and a running mean of the surface air temperature analysis</td>
<td>6 hours</td>
<td>No measurements available</td>
<td></td>
</tr>
<tr>
<td>Albedo</td>
<td>0.9x 0.9 global</td>
<td>Derived from albedo climatology, vegetation type, the snow depth analysis and the ice cover analysis</td>
<td>12 hours</td>
<td>No measurements available</td>
<td></td>
</tr>
<tr>
<td>Soil moisture</td>
<td>Regional GEM model</td>
<td>Statistical technique based on the surface temperature and the 6-h forecast errors of the dew point. The following two analyses are used by this technique.</td>
<td>24 hours (1800 UTC)</td>
<td>No measurements available</td>
<td></td>
</tr>
</tbody>
</table>

[previous: Gewex archives overview]

[next: Description of the model outputs, time series and analyses]
Recherche en prévision numérique
2121, Trans-Canada Highway, room 500
Dorval, Quebec
Canada H9P 1J3

17 December 1996

Dr. Roy Jenne
National Center for Atmospheric Research
P.O. 3000
Boulder, CO 80307
U.S.A.

Dear Roy:

Following your phone call of 10 December, please find enclosed a computer diskette containing 3 files describing some aspects of the RFE model. The files have been prepared on a MacIntosh (using Microsoft Word version 5.1a). I also enclose copies of the text.

Sincerely,

Jocelyn Mailhot
Research Scientist

Tel: (514) 421-4760
Fax: (514) 421-2106
Email: Jocelyn.Mailhot@ec.gc.ca
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Data assimilation and initialization

- 12-h spinup cycle with 6-h trial fields from RFE model;
- 3-D multivariate statistical interpolation;
- analysis on 50-km grid (16 pressure levels);
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- pseudo-analysis of soil moisture;
- implicit normal mode initialization (adiabatic).

Dynamics

- Hydrostatic primitive equations;
- 305 x 255 variable-resolution horizontal grid overlaid on a polar stereographic projection (35 km in central domain);
- semi-implicit semi-Lagrangian time integration (timestep of 600 sec, spatially-averaged Eulerian treatment of orography, off-centering coefficient of 0.1);
- 28 $\sigma$ levels (normalized pressure) with top at $\sigma_T = 0.01$ and high vertical resolution close to the surface (11 levels below 700 hPa);
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Handling of snow in the RFE model

Recently, corrections to treat snow more adequately have been introduced in the RFE model: a) snow is now considered as a specific type of soil; b) a snow melt algorithm has been added in the calculation of the energy balance at the surface.

a. Soil types

The treatment of the land surface processes now considers three types of soil, namely clay, snow and ice. Soil types are characterized by their thermal characteristics, the heat capacity $C_s$ and the thermal diffusivity $\kappa_s$. The task of specifying these parameters for snow is not easy since snow does not have uniform properties: for instance, snow can be wet or dry, and old snow is different from new snow because it can be infiltrated by melting snow. Typically, $C_s$ can be four times larger for old snow than for fresh snow. To represent those variations in a simple way, $C_s$ and $\kappa_s$ are made to vary according to latitude and time of the year. The idea behind this is that snow is more likely to be wet in spring and early autumn, and dry during winter. Furthermore, vegetation is implicitly included in our surface processes, since $C_s$ varies according to the albedo which is itself modulated by the presence of vegetation. For example, the surface albedo over a coniferous forest is on the order of 25% even if there is 1 m of snow at the ground while it is close to 80% over a tundra covered by 20 cm of snow. Therefore, the value of $C_s$ does not represent only snow (when it is present), but a composite of snow and the surrounding vegetation.

b. Snow melting

Snow melting is energetically important during the springtime. A simple procedure is taken to include this process. Theoretically, during melting, the snow temperature should be around 0°C (ignoring any vertical temperature gradient in the snow pack), but our surface temperature $T_s$ must also account for the presence of vegetation. To simulate melting, we first compute $T_s$ using the "force-restore" method and ignoring the possibility of snow melting. Then, if $T_s$ is above 0°C, we partition those extra degrees between melting of the snow and heating of the vegetation. To do this we use the albedo in an empirical way: the higher the value of the albedo (i.e. the lesser the amount of vegetation), the closest to 0°C will be $T_s$ during a melting episode. Also, since our actual procedure keeps the snow depth constant during the (48-h) integration, a threshold of 5 cm is used to decide whether there is snow or not (this value is large enough so that snow would not melt completely in only a few hours). Note that this new scheme usually produces a strong horizontal gradient in the surface temperature near the snow line; therefore, large errors will result if the analysed snow line is not located accurately.
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To estimate the surface albedo, climatology is used where there is no snow or ice. Where snow is present, an empirical algorithm combines the snow depth with known terrain and vegetation properties. For instance, the surface albedo is close to 0.80 (i.e. the albedo of snow only) over a tundra completely covered by 30 cm of snow, while the same 30 cm of snow at the ground will result in an albedo on the order of 0.25 over a boreal forest. Where water surfaces have an ice cover, the albedo is set to 0.80. The RFE model uses a regional albedo analysis which is produced using the regional ice cover analysis (see below) and the global snow analysis interpolated to the RFE model grid.

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Ice cover is analysed once a day, using current data and climatology. Over the oceans, we use global ice cover data derived from the SSM/I (Special Sensor Microwave/Imager) satellite. Over North America, there is another complementary data source originating from ICEC (Ice Centre Environment Canada), i.e. ice cover data over small areas (e.g. Gulf of St.Lawrence) which usually follow the ice edge. Climatology is used for inland waters and within the first 100 km of continental shorelines. The analysis technique is a simple one, which consists in a weighted average of all data received in 24 hours within a grid square. The regional ice cover analysis is performed directly on the RFE model variable grid.
The Eta Model

- 80 Km 38 levels: Started operations about March 1993

- 40 Km 38 levels
  - In parallel production same time
  - Used for summer 94 GCIP

- 48 Km 38 levels
  - September 94 - expanded grid, resolution cut
    (This is it for at least two years.)
  - This started production January 95
  - Official field evaluations ~ March 95
  - Probably official use July 95
  - Top level 25 Km

Precip grid

Summer 94 archive

- Daily grids and daily data

April - October 95

- Daily grids and data

December 95

- NMC starts hourly precip
- Hourly archive starts ~ summer 96
Climate Models and Forecast Models

1. Climate model changes

<table>
<thead>
<tr>
<th>Period</th>
<th>1984-88</th>
<th>1989-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>~5x7° (600 km)</td>
<td>~2.5x3° (300 km)</td>
</tr>
<tr>
<td>Levels</td>
<td>~9 levels</td>
<td>~14-18 levels</td>
</tr>
<tr>
<td>Ocean</td>
<td>1 layer-slab</td>
<td>(dynamic ocean for transients)</td>
</tr>
</tbody>
</table>

2. Forecast models (hemispheric, then global)

<table>
<thead>
<tr>
<th>Years</th>
<th>Resolution</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955-75</td>
<td>~380 km</td>
<td>1 level, incr to 10</td>
</tr>
<tr>
<td>1991-94</td>
<td>70 to 100 km</td>
<td>19 to 31 levels</td>
</tr>
</tbody>
</table>

Slide added
Roy Jenne
Feb 1995
climate models

1. Types of model runs
   - Single and double CO₂ equilibrium climate (1x CO₂ and 2x CO₂)
     - run about 10 years each
   - Transient runs
     - control run and transient
     - each about 100 years

2. Present estimates of change

   Global warming by year 2050

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimates</th>
<th>Sensitivity</th>
<th>Warming by 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1.5°C</td>
<td>~0.5°C</td>
<td></td>
</tr>
<tr>
<td>Best</td>
<td>2.5°C</td>
<td>~1.2°C</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>4.5°C</td>
<td>~2.1°C</td>
<td></td>
</tr>
</tbody>
</table>

3. See new IPCC data model forum (Oct 1994), and Wigley-Raper paper (1992)

Roy Jenne
Feb 1995
The Handling of Surface Conditions in Forecast Models

For the use of model data in GCIP studies, there will be a special focus on the surface variables. It would help to provide the users of these data with a little guidance information about these variables which are often the more difficult ones to get right. We should consider the tone of the text so that it is neither too optimistic, nor too pessimistic about the data. I imagine that this text for each model could be fairly short, perhaps 5-10 pages. It could point to more information.

1. The type of surface at a grid square.

Briefly describe the surface types (vegetation type, lake, ice cap, etc.) What database of types is used? Can there be more than one type of surface in a grid cell (with fractional types)? Does vegetation change with the seasons? Do crops grow in the model?

Can there be fractional coverage of some surface types? For example, can one grid square have a partial coverage of both forests and cropland?

2. Soil type information and soil water.

Does each grid cell have only one soil type? How deep is the soil layer(s)? Does the depth vary with the type of vegetation? Is there a grid that shows the depth for each grid cell?

Is the soil water ever imposed from another model? How often? Is there any regression to climatology? Is there a parallel run that estimates soil water that is based on precipitation observations and modeled radiation? If yes, does the result of that run interact with the assimilation cycle?

3. Snow cover (and water amount).

Is the snow cover imposed from an external analysis (if yes, how often)? What is the source of external snow data?

4. Surface Albedo.

Please briefly describe how it is obtained. I assume that this is a function of vegetation type, the season, recent snow, the age of the snow, and maybe the wind speed.

5. How are small lakes handled?

If a large region has 30% coverage of small lakes, how is this handled? Does each grid cell have to be total lake coverage or no lake? Is this handled well enough that the land temperatures and the evaporation terms in such regions will be roughly correct?

How is the surface water temperature handled for small and large lakes? Is it calculated or imposed from another source?
Environnement Canada
Service de l’environnement atmosphérique

Recherche en prévision numérique
2121, Trans-Canada Highway, room 500
Dorval, Quebec
Canada H9P 1J3

17 December 1996

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CMC MODEL ARCHIVE AND ACTIVITIES IN SUPPORT OF GEWEX

RICHARD HOGUE and EKATERINA RADEVA
Operations Branch, Canadian Meteorological Center

1. GEWEX model output archiving project at CMC

1.1 Main goal

To provide high resolution model output data required by the GEWEX project to the scientific community involved in MAGS (MAckenzie Gewex Study) and GCIP (Gewex Continental-scale International Project).

⇒ Collaboration with scientific community involved in GEWEX
⇒ Improvements of operational models and assimilation systems

1.2 GEWEX archive support at CMC

⇒ Operational archiving scripts: monitoring, maintenance and improvements; follow up on the model changes; content modifications to meet the scientific community requirements

⇒ Post processing scripts: de-archiving scripts; computation of non-conventional model outputs e.g. mean surface fluxes, vertical means, surface runoff, etc.; interpolation on different projection grids (PS, LAT/LON, LAMBERT - AWIPS 212); conversion to various output formats (ASCII, GRIB, BUFR)

⇒ Maintain and upgrade the GEWEX model outputs WEB home page:
   http://www.cmc.oea.ca/cmc/CMO/htmls/Gewex_archa.html

Informations and GEWEX model output data requests
Richard Hogue - e-mail: richard.hogue@ec.gc.ca
Ekaterina Radeva - e-mail: ekaterina.radeva@ec.gc.ca
2. GEWEX archive content

⇒ FORECASTS:

◆ outputs of the operational regional model - GEM (Global Environmental Multiscale) on the full GEM grid:
  - 256 x 289 points; grid uniform portion - 130 x 150 points
  - 0.33° x 0.33° horizontal resolution (∼ 35 km)
  - 28 eta levels [η = (p−p_f)/p_s−p_f]

◆ 46 fields available: 25 surface fields archived every 3hrs; 10 upper atmospheric fields - every 6hrs and 11 fixed fields

◆ 2 model runs/day: 00 and 12 UTC (00 to 24 hr)

◆ dimension: 270 Mbytes/day

⇒ ANALYSES:

◆ regional analysis with a 12-hour spin-up cycle on the full GEM grid:
  - 256 x 289 points; grid uniform portion - 130 x 150 points
  - 0.33° x 0.33° horizontal resolution (∼ 35 km)
  - 28 eta levels [η = (p−p_f)/p_s−p_f]

◆ 14 fields available: 8 surface fields and 6 upper atmospheric fields

◆ 4 analysis cycles/day: 00, 06, 12 and 18 UTC

◆ dimension: 58 Mbytes/day

⇒ TIME SERIES:

◆ 217 locations (closest grid point, no interpolation)

◆ spot forecasts - temporal resolution: 1h30 (from 00 to 36 hr)

◆ 2 model runs/day: 00 and 12 UTC

◆ 59 variables available: 23 surface fields, 31 upper atmospheric fields and 5 fixed fields

◆ dimension: 28 Mbytes/day
3. CMC regional forecast system and GEWEX archive milestones

⇒ 1st October 1995: start of the special GEWEX archive at CMC
  ∗ RFE (Regional Finite Element) model, 50km/25levels
  ∗ Regional assimilation system (12h spin-up), 50km analysis

⇒ 21 December 1995: increase of model resolution to 35km/28levels

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- elimination of horizontal interpolation before data storage (16 May 1997);
- extension of archive to full global grid of GEM to meet data needs outside GCIP main area (24 Oct. 1997).

4. Future plans

⇒ Develop tools allowing easier and more direct WEB access to the GEWEX model output data archived at CMC, considering the constraints due to the specificity and the size of the data requests:

⇒ Compile pre-packaged datasets (MORDS and MOLTS) on tape or CD-ROM.

⇒ Maintain and upgrade our GEWEX WEB home page:
  ∗ document the archives (changes, missing or incomplete files, etc.)
  ∗ document the archived fields
  ∗ add examples of fields archived
GEM MODEL

GLOBAL
ENVIRONMENTAL
MULTISCALE

CANADIAN
METEOROLOGICAL
CENTER

• Short-range regional forecast model
  • 35 km - 28 Levels - 48 hour forecast
  • Operational since Feb. 24 1997

• Regional Variational Assimilation System
  • Operational since Sept. 24 1997

• High resolution Model Applications Project
  • 15 km - 35 Levels - 24 hour forecast
  • Experimental/operational since Oct. 24 1997

DATA ASSIMILATION & INITIALIZATION

• Intermittent (12h) regional cycle
• 3D Var analysis procedure
• Analysis in spectral space
  • T108 spectral resolution
  • 16 pressure levels
• Interpolation of increments
  • 35 km model grid
  • 28 η levels
• Digital filter initialization
  • 6 hour span
DYNAMICS

- Hydrostatic primitive equations

- 289 X 255 variable-resolution lat-lon grid
  - .33° (~35 km) uniform-resolution window
  - 180 X 235 in central window

- Implicit two-time level semi-Lagrangian
  - uncentered time average
  - Δt = 1350 sec

- 28 η levels, top at 10 hPa
  \[
  η = \frac{P - P_{top}}{P_{surface} - P_{top}}
  \]

- 3D(λ,θ, η) finite-differences

- No motion across η=0,1 surfaces

- \(\nabla^2\) horizontal diffusion on all prognostic variables

- No stratospheric sponge (yet)
PHYSICS

• Gravity wave drag

• Prediction of surface temperature over land
  • force-restore method

• Soil moisture quasi-analysis
  • temperature error feedback

• Solar and infrared fluxes

• Shallow convection

• Kuo type deep convection scheme

• Sundqvist condensation scheme
  • stratiform precipitation

FUTURE

• Nonhydrostatic

• Higher resolution 20 km or better

• Better defined surface fields

• Adapted physics
  • deep convection (Fritsch-Chappel, Kain-Fritsch, etc)
  • surface schemes (CLASS, ISBA)

• directional roughness length

• improvements in data assimilation
  • model error statistics
  • new data sources
How are Surface Processes Handled?

For each model, we need a summary description of how the surface is handled. Also, we need a list of dates when there are changes in these answers.

1. Land classification (water, land, ice cap, forest, etc.)
   • What data is used by the model?

2. For one grid cell
   • Can it be part land (30%) and part water (70%)
   • Can there be 2 or 3 types of vegetation?

3. Vegetation
   • What data are used?
   • Does the model decide when plants should grow?
     — Or is that fixed by date and plant type?

4. How is the soil handled?
   • Number layers, thickness, etc.
   • Is the soil always the same depth? (grasslands vs. forests, etc.)

5. Sea surface temperature
   • Is SST a boundary condition; what is the source of SST?
   • Is it changed each day?

6. Snow cover.
   • Is this put in as a boundary condition each day or each week?
   • What is the source of the snow cover?
   • If snow cover is a boundary condition (which the model then changes), how is the initial water content calculated?
   • Do you have a separate archive of snow cover grids?

7. Sea ice.
   • Is sea ice a boundary condition? What is the source?
   • Is it changed once a day?

8. How does the model cycle?
   • Does it cycle on itself or does it periodically get a guess from another model?
   • Does it ever get new soil properties from an off-line model?
Some Questions for Mesoscale Reanalysis
(Roy Jenne, 18 Sep 2000)

1. Should daily co-op reports be used to help calculate daily snow cover?

2. Does the model handle convective precip quite well?

3. Consider key observations in the US.
   a. The US has about 7500 active daily co-op stations.
   b. The US has about 2500 active hourly precip stations (at NCDC).
   c. Shouldn't both be used to calculate grids of hourly and daily precip?
      a. Or has this been done?

4. Does the model produce down surface solar rather well?

5. Measured surface solar radiation at stations
   a. There is hourly data.
   b. There are NOAA and DOE stations.
   c. We need to gather the data together again.
   d. And we need the calculated data from satellites.

6. How is the surface albedo handled?
   a. Is it constant except for seasonal and snow changes?
   b. Is the albedo consistent with clear sky satellite data?

7. The archive of the model data
   a. Should the archive record cut off some edge points because they do not mean much?
   b. Will we keep a detailed archive over the large Pacific Ocean?
   c. We need to separate data types more than for present Eta archives (not just one big tar file).

8. The archive of boundary layer data
   a. Perhaps we should calculate a level near 30 or 35 meters (for the wind energy people).
Mesoscale Model Data at NCAR; Eta Status

This text provides an overview of the Eta model archives at NCAR and data that is planned. Some comparisons are made with other model archives.

1. History of NMC Mesoscale Model Data at NCAR

We will see later that LFM model archives started Oct 1971, and data from NGM started Oct 1984. The main Eta model data archives will start April 1995. Attachment 1 contains information about related mesoscale data and global archives. It also includes the dimensions (number of points) in a selection of models and output grids. The horizontal resolution in several models can be compared.

2. History of Eta Model Data

Operations for the NMC Eta model started in Jun 1993, with a resolution of 80 km and 38 levels. The top level was at 50 mb. A routine parallel run of a 40-km, 38-level Eta model started in Jul 1993 (but not official). In late 1994, the domain of Eta was increased and the resolution became 48 km, 38 levels. This model went into routine parallel production in Jan 1995. It is expected to become the official operational model in Jul 1995. Figure 1 shows the domain of the 48-km Eta model.

3. Overview of Eta Archives Starting April 1995

The Eta archives starting May 1995 will be on the standard 40-km grid (AWIPS 212 grid, Figure 2), but there will be fewer vertical levels than in summer 1994. This is to help control the volume for various users including those in the Weather Service, FAA, and the GCIP project. The forecast grids go out to 36 hours. Table 1 gives a summary of the NMC Eta model archives and the data volume.

From assimilation (EDAS) runs

- 3D grid analyses each 3 hours (8/day)
- 3D guess each 3 hours (8/day)
- Flux fields each 3 hours (8/day)
- Data for point locations (see below) (24 hr/day)

From the two forecast runs each day out to 48 hours

- 3D grids each 6 hours to 36 hours (12/day)
- Flux fields each 3 hours to 36 hours (24/day)
- Hourly vertical data for about 685 locations to 48 hours (96 hr/day)
  - Standard output for all stations
  - Also full diagnostics for 20% of stations

Note: I also sent this to Ron Mitchell (Eta model support at NCEP)
<table>
<thead>
<tr>
<th>Table 1. Eta Data Archives and Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Volume each month</td>
</tr>
<tr>
<td><strong>File</strong></td>
</tr>
<tr>
<td>Eta 3D upper Air</td>
</tr>
<tr>
<td>--- 3 hourly analysis</td>
</tr>
<tr>
<td>and guess</td>
</tr>
<tr>
<td>each day</td>
</tr>
<tr>
<td>6 hourly forecasts</td>
</tr>
<tr>
<td>(8 forecasts/day)</td>
</tr>
<tr>
<td>Volume per month</td>
</tr>
</tbody>
</table>

| Flux fields (precip, etc.)           |                  |         |
|     --- cycles from forecasts        | 8 from forecasts  | 24 from forecasts |
|     --- cycles from EDAS             | 18 per day        | 8 per day |
|     --- from EDAS and forecasts      | 257 sites         | 585 sites |

| Hourly profile                      | 1049 MB/mo       | 2090 MB/mo |

| Precip observations                 |                  |         |
|     TOTAL VOLUME                     | 7839 MB/mo       | 7371 MB/mo |

| 2) Forecasts (3D data)              |                  |         |
|     --- each 6 hours                | to 24 hours      | to 36 hours |
|     --- 4 cycles                    |                  | 6 cycles |

| 3) Flux files                       |                  |         |
|     --- forecast each 3 hours       | EDAS each 3 hours | EDAS each 3 hours |
|     --- forecast to 24 hours        | forecast to 24 hours | forecast to 36 hours |

| 4) Hourly profile (MOLTS)           |                  |         |
|     --- 24 hours from EDAS          | 24 hours from EDAS | 24 hours from EDAS |
|     --- from EDAS and forecasts     | 36 + 36-hr forecasts | 48 + 48-hr forecasts |

| 5) Volume for 52 days in summer 1994 (Jul 11 - Aug 31) |
| Pressure                                      | 9317.020 MB      | The 3D analysis and forecast data |
| Flux                                          | 2231.588         | Precipitation, radiation, clouds, soil, etc. |
| PRCP                                          | 11.520           | Observations and grids precipitation (daily) |
| BUFR                                          | 1049.327         | Vertical hourly soundings |
| GCIP pressure                                  | 192.264          | A fixed field |
4. What Kinds of Data are in the Flux Files?

The flux files include a variety of data, mostly from the forecast (or guess) model. These include:

- 2-meter temperature and humidity
- 10-meter wind
- precipitation and evaporation
- snow information
- visible and IR radiation at surface and top atmosphere
- soil data
- clouds
- other data

5. Plans for Archive Changes Made March 1995

During summer 1994, the archives were from the 40-km Eta model with 38 layers (top 25 mb). The new routine archives will start in April 1995. They will be from the 48-km Eta model that started routine production in Jan 1995. It also has 38 layers. In both cases, the data are remapped to the standard 40-km CONUS grid (AWIPS 212 grid, Figure 2) defined by NWS. Table 3 shows the location of the levels in the 38-layer Eta model when (previously) the top was at 50 mb.

There will be fewer levels in the April 1995 output compared with summer 1994. The volume of data even makes it hard to deliver it to operational users. In 1994, 39 levels plus 6 boundary levels were output. In April 1995, the main stack of levels (19) will be each 50 mb with extra levels near the tropopause. These levels will be on constant pressure surfaces (unlike the model). The number of levels will be about 19 plus 3 (near the tropopause) plus 6 (near the ground). Therefore the archived levels will decrease from about 45 to 28, which reduces the volume by 38%. The 3-hour flux grids and the 6-hour 3D fields will be given out to 36 hours in the forecast; not to only 24 hours as for summer 1994.

Also note that in the flux files there are data such as 10m winds and 2m temperature.

6. Archive of Eta Data, Status and Plans

- NCAR received Eta data for the summer 1994 test period (52 days)
  — It has grid data for analyses, the guess, and forecasts
  — It has hourly data for 257 point locations (called MOLTS data).

- Continuous Eta data will be captured starting April 1995.
  — It will have grid data as before for the analyses, the guess and forecasts, but there will be fewer levels.
  — It will have data for about 585 point locations.
There are two options for MOLTS data: (1) give full vertical sounding data and diagnostics data each hour, or (2) give a reduced set without diagnostics (this is half the volume). NCAR got the full set for all locations in summer 1994. In 1995 the reduced set will be given for all locations, and the full set will be given for 20% of the locations.

7. **Use Standard AWIPS 212 grid for U.S.-48**

Data from Eta will be saved on the standard AWIPS 212 grid (40 km), that will be kept constant for the next 5 years (Figure 2). It is also called the AWIPS CONUS grid and covers about 17N-60N, and 60W-140W. The AWIPS CONUS grid has been defined as a standard that will be used to send products to NWS forecast offices. It will also be used for data sent to NCAR for GCIP and other users.

- The 40-km CONUS grid has 185 x 129 points. There were 39 + 6 (or 45) levels saved in summer 1994.
- There will be about 19 plus 3 plus 6 (or 28) levels saved starting April 1995. These levels are at every 50 mb up to 50 mb. In addition, they are at each 25 mb near the tropopause. The six levels near the ground are spaced 30 mb apart.

8. **Vertical Motion Fields**

People probably don’t need a full 50-level stack of vertical motion, but data at a few of the levels does help. This philosophy will be maintained in the archive.

9. **Temperature Archives and Model Balance**

The archive data from the NMC NGM has been real temperatures since at least 1985. The ETA model also outputs real temperatures for the archive. They are not virtual temperatures (as has been done for the global model).

The analyses are not in perfect balance, but they also are not initialized. After a few time steps, the forecast model brings the system into balance.

There are grid point values under the Earth’s surface when the elevation is above sea level. What values are in these cells in the archives?

10. **What is Special About the 12- to 36-hour Forecast Period?**

During data assimilation, the model is pushed one way and another by the observed data. Overall, this is good, but some descriptions of the real atmosphere may be better from the forecasts than from the assimilation cycle. The cleanest period in a forecast run is often between 12 and 36 hours (after the spinup and before significant errors start accumulating). Model errors have not accumulated very much by 36 hours; therefore, the forecast period from 12 to 36 hours may give one of the best descriptions of the real atmosphere that we have, especially for flux fields. The archives starting May 1995 will have forecast data for
0-36 hours from each of two forecast each day. The forecast archives have 3-hourly flux fields and 6-hourly upper air fields.

11. **Eta Upper Air Grid Data (pressure file)**

Data are available on the standard 40-km grid for summer 1994 and starting May 1995. There are 45 levels for 1994; to reduce the volume, there will be about 28 levels starting May 1995. See Figure 5; a summary of the data follows:

**Summer 1994 (45 levels), 3D files**

- 10/day analysis cycle (each 3 hours). Only need 8/day; see Figure 5.
- 8/day guess (each 3 hours)
- 8/day forecasts; the data is for each 6 hours, out to 24 hours from two forecast runs.

**May 1995 (28 levels)**

- 8/day analysis cycle (each 3 hours)
- 8/day guess (use 8/day) (each 3 hours)
- 12/day forecasts; data each 6 hours out to 36 hours from two forecast runs

**Volume:** 5467 MB/mo in summer 1994
3663 MB/mo starting May 1995 (more cycles, fewer levels)

12. **Archives of Flux Fields (precip, clouds, etc.)**

The archives of flux fields are as follows for summer 1994 and May 1995. These fields are archived each 3 hours. There are about 50 of these fields for each time with such variables as precipitation radiation and clouds (Figure 5).

**Summer 1994:**

- 10/day from EDAS analysis cycle (none of these have good data)
- 8/day from guess (good fields, but 2 are poor)
- 8/day from forecast runs (6-hour periods to 24 hours, from each of 2 forecasts).

The 10/day from EDAS are largely trash. For example, precip or radiation would be from the first time step in the model, rather than from a 3-hourly average during the model run.

**May 1995:**

- 8/day fields from guess
- 24/day forecast steps. At 0 and 12Z, run the forecast to 48 hours. Give flux data to 36 hours in 3-hour steps (12 steps from each run).

Note that the bad data from the EDAS cycle has been removed for this new archive.
Compare flux volume:

- 1309 MB/mo in summer 1994
- 1611 MB/mo starting April 1995

13. Hourly Vertical Data at Point Locations (MOLTS data)

NMC outputs hourly profile data from the forecast (and guess) model for a selection of points. These points include the locations of the rawinsonde sites plus many more. In summer 1994, data for 257 sites were in the GCIP archives. The NMC archives now (Mar 1995) have hourly data for about 533 points. The public archives starting 1 May 1995 will have data for about 585 point locations. The volume will be controlled by reducing the number of sites that have full diagnostic output. Only about 20% of the sites will have full diagnostics: A set of places in the "inner GCIP box" around Oklahoma, and a set for the MacKenzie basin in northwest Canada. Figure 3 gives an idea of where the points are located. There will be changes.

Table 2 summarizes the output in summer 1994 and May 1995, and the volume. Each day, NCAR will obtain the following data for each point:

For summer 1994:

- 24 hours of data from the assimilation run
- 36 hours of data from each of two forecast runs
- During summer 1994 there were 257 point locations (all had full output)
- Volume is about 262 MB/mo from EDAS and 787 MB/mo from forecasts

Starting May 1995:

- 24 hours of data from the assimilation run
- 48 hours of data from each of two forecast runs
- There will be about 585 point locations (all have only standard output; plus 20% full output)
- Volume is about 418 MB/mo from EDAS and 1672 MB/mo from forecasts

Notes: (1) These data points are not interpolated from the Eta grid; the closest grid point is used. With 48-km resolution, the closest point is within 24 km.

(2) The hourly data for the assimilation cycle (EDAS) comes completely from the forecast model (from the guess). At time zero it will be very close to the data in one of the 3D files at a 3-hour assimilation archive time. These hourly data are in 3-hourly files.
Table 2. Information about hourly profile data (MOLTS)

The estimates for May 1995 assume that the volume for a station with full diagnostics is double the standard output.

<table>
<thead>
<tr>
<th></th>
<th>Summer 1994</th>
<th>Starting May 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archive sites:</td>
<td>257</td>
<td>585</td>
</tr>
<tr>
<td>Type:</td>
<td>All full diagnostics</td>
<td>Standard output for all; 20% have full output</td>
</tr>
<tr>
<td>EDAS cycle:</td>
<td>Each hour</td>
<td>Each hour</td>
</tr>
<tr>
<td>Forecasts:</td>
<td>To 36 hours</td>
<td>To 48 hours</td>
</tr>
<tr>
<td>Volume/mo (EDAS):</td>
<td>262 MB</td>
<td>418 MB</td>
</tr>
<tr>
<td>Volume/mo (forecasts):</td>
<td>787 MB</td>
<td>1672 MB</td>
</tr>
<tr>
<td>Total volume/mo:</td>
<td>1049 MB</td>
<td>2090 MB</td>
</tr>
</tbody>
</table>

14. **A Larger Region for Eta (Sep 1994)**

About Sep 1994, a decision was made to enlarge the region covered by the Eta model. Now it includes all of Alaska and some of E. Russia (it has 160 x 261 points (fix this); 261 is north-south). Because of the larger region, the resolution had to be reduced. It went into production in early Jan 1995 with a resolution of 48 km and 38 levels. The top level is at 25 mb. There had been plans for an operational resolution of 30 km. This was changed to 48 km when the region was increased in size. We will note, however, that a 29-km model with more limited domain will start in April 1995.

Data for GCIP and other users will be from the 48-km Eta, with 38 layers. The official archive will have a resolution of 40 km. It had 45 levels in 1994. Starting May 1995, it will have about 28 levels.

15. **The Boundary Layer**

The Eta model does not have a boundary layer that follows the terrain. NMC is working on adding a boundary layer that is one slab, 20 meters thick (10m to center). It will first be added to the 29-km Eta model. Boundary layer data are now calculated from the other levels that are available. See below.
16. **Boundary Layer Data from the Eta Model**

The Eta model output includes surface level data plus data for six layers, each 30 mb thick, that give boundary layer information for about the lowest 1.5 km of the atmosphere above the ground.

In the native Eta model, the first level above the ground may vary from about 1 to 25 mb above the local elevation, and this distance will vary from day to day, as the sea level pressure changes. When the data are interpolated for the 40-km grid, levels are calculated that are a standard pressure distance above the terrain (terrain valid for the 40-km grid). These 6 layers are each 30 mb thick, and data is given for the mid point of each layer. Thus data for the lower 3 levels are at 15 mb, 45 mb, and 75 mb above the surface (about 120, 360, and 600 meters above the ground). We have noted that 10m winds and 2m temperatures are also provided.

17. **When will NWS Field Forecast Offices Receive 40-km Eta?**

People hope that the first AWIPS computers will go into the field in 1996 (the contract has had problems). These computers will have access to the 40-km data. However, the 40-km data is now (Feb 1994) available via Internet from NMC.

18. **The ETA Model**

The top level of this model (40 km, 38 level) is at 25 mb. The lowest level is at sea level. The level at sea level at a given time has actual sea level pressure, which varies in space and time. The approximate separation between levels (in mb) is given in Table 3. It is approximate because at any one time and location, the actual layers are divided up between the sea level pressure and the pressure at the top.

- The Eta grid is a staggered grid. For example, the wind points are between the temperature points. It is complicated. See Figure 1 for the region covered.

- The 40-km Eta grid for users is an ordinary (easy to use) grid and is not staggered. Points are interpolated from the original Eta using 4-point interpolation.

19. **Top Level of Model**

We will see below that the top level of the production of 80-km Eta (38 layers) at NMC is at 50 mb. The top of the models being used for GCIP (also 38 layers) is at 25 mb. Table 3 shows how the layers are divided up when the top is at 50 mb. This changes when the top is higher, or when more levels are added.

- From about 1991 to 1993 the 80-km Eta model had a top at 100 mb
- The 80-km Eta (38 layers) that started official production in Jun 1993 had a top at 50 mb (it is still the official Eta in Mar 1995).
• The 40-km Eta (38 layers) used for summer 1994 GCIP had a top at 25 mb (it was in routine production starting Jul 1993 and was frozen for summer 1994).
• The 48-km Eta (38 layers) that started routine production in Jan 1995 has a top at 25 mb.
• The 29-km Eta (50 layers) has a top at 25 mb. It will start routine production in Apr 1995.

Note: NMC expects that around 1997-98 an Eta model with a resolution of 15 km and 70 levels may be in production.

20. The Cycles of Eta Model Data Assimilation and Forecasts

The Eta model archives for GCIP and other uses start with a guess from the global GDAS model, then they ingest observations for 12 hours, followed by a 48-hour forecast. Each 12 hours, Eta makes a fresh start with global model input. It does not cycle on itself. Figure 4 illustrates the cycling of the Eta model. Figure 5 shows the output for each 12-hour period.

We will use an example to show how the Eta model cycles. Suppose that it is April 10, 14Z and we want to make a 48-hour forecast that will start from 12Z data, using the Eta model. We use global GDAS model input for t minus 12 hours (April 10, 00Z). This forms the starting point for 12 hours of data assimilation within Eta (each 3 hours) to provide us with an analysis at 12Z. Then the 48-hour forecast will start from this data. What lateral boundary conditions are used during the forecast? When the global analysis was prepared for 00Z data, a global forecast was also run for several days. Sixty hours of this forecast are used to provide lateral boundary conditions for the 12-hour assimilation and the 48-hour forecast. Figure 5 shows the output for each 12-hour period.

Then 12 hours later, we will start a similar Eta run that uses global model input, does 12 hours of assimilation, and makes a 48-hour forecast.


At the start of each 12-hour data assimilation, an annual mean (not monthly) field of surface wetness is picked up. This is modified by the 12-hour assimilation, but it does not feel the effects of earlier precipitation. After some months, Eta will start its 12-hour assimilation with soil moisture from the cycling within the global model. Also a better 2-layer soil model is being tested for Eta (it is like the Aug 1994 version that is being used in reanalysis). It will probably go into operational production in Eta about 1 Oct 1995.

Is soil moisture from the cycling global model the best to use? It is better than using a climatology as done now, but the model precipitation from any model will have some problems. This will affect soil moisture and evaporation. Some regions, such as the U.S., probably have enough precip observations, so that observed precip is better than using model precip. Using this idea, Ken Mitchell at NMC is working on a separate "LDAS" cycle (land data assimilation) for the surface that is prepared separately from the assimilation and forecast models. It uses surface observed data such as precipitation, wind, temperature, humidity, and solar energy calculated from GOES-8 satellite data. Much of the
observed data will be hourly data. Using this, NMC will prepare surface data, including snow and soil data for N. America. It will cycle on itself so the soil moisture will be based on a proper history. We will have to see how this development works out. The earliest that it could go into production is about mid 1996. In regard to the solar data, NMC will obtain hourly surface solar radiation from GOES-8, on a 0.5° grid prepared by NESDIS.

22. How Reliable are Selected Fields from Eta (Mar 1995)

- Snow cover and snow water fields will be poor because the model starts with a crude climatology each 12 hours.

- Soil moisture is also poor because of climatology. This will also affect evaporation, but not as much.

- Fields like 2m temperature, 10m wind, downward solar, etc., should be good. The soil moisture will have some effect on skin temperature and 2m temperature, but perhaps not too much.

23. Water Budgets (prepare a vertical integral of water vapor flux)

One reason that people need most model levels is to be able to calculate a vertically integrated water vapor flux. This isn't a trivial calculation. NMC plans to prepare grids of these vertical integrals each 3 hours; the procedure may be in production by about Oct 1995, or more likely by Mar 1996. If these grids were available, people working on hydrological problems usually would not have to use the 3D atmospheric data that are in the large "pressure" files.

24. Observed Precip Data in Eta Archives

The data in the flux files includes model precipitation. The Eta archives also include both observed precipitation and gridded precipitation. It is daily data in 1994-95. It will become hourly data.

The summer 1994 archives have daily precip grids and daily observed data. This procedure also will be used for the archive for Apr 1995 to about Jun 1996. About Dec 1995, NMC hopes to start making hourly precip analyses; the archive of hourly grids and hourly data may start about summer 1996.

This grid, based on observations, is now a 40-km grid on a polar stereo map. It does not match the 40-km AWIPS 212 grid, but it will later be changed to the AWIPS 212 grid. Not sure when this will happen. The daily precipitation is from 12Z to 12Z.

25. The Alaska Grid

The grid for Alaska (AWIPS 214) has a resolution of about 48 km. It will not be on the archive tapes at NCAR (see Figure 2).
26. **How will NCAR Make the Data Available?**

This section describes several ways that users are able to obtain model data from the Data Support Section at NCAR.

- Put the data on the mass store at NCAR.

  There are many people who can use the NCAR computers. Any of these people can access our data from the mass store if they want to. They can select data as desired, make calculations, and take reasonable amounts of data home via Internet. During last year (FY'94), there were the following number of separate users of the main equipment at NCAR:
  
  — 566 from NCAR or UCAR groups
  — 755 from universities
  — 116 in "other" category (Cray grants, sales, etc.)
  — total of 1437 users

- Put the data on Exabyte tapes at a big cost reduction for users. The user will get a package deal, like a CD-ROM. A master tape will be prepared that can be copied in bulk, if needed.

- Make the data available on the normal variety of tapes at normal costs. The normal costs (with volume discounts) is about $450 per gigabyte. This is a lot less expensive than most archives charge, but it is still much too costly for datasets that are very large.

- There will be a paper about methods and costs to distribute large datasets. Part of this information is in the Aug 1994 report (Status of Reanalysis).

- We have discussed elsewhere how NMC makes a portion of the data available online. This is true for reanalysis and for the mesoscale model data.

- Also, NMC is putting a selection of data on a CD-ROM (for reanalysis).

27. **NMC Online Data and Information for the Eta Model**

There will be at least a day of Eta model data online at NMC. Ken Mitchell at NMC hopes that there will be enough disks to hold a few days. The data will include:

- Data from the full native Eta 48-km run;
- Data on the AWIPS 212 grid (our main 40-km archive for GCIP and other users);
- Data on the AWIPS 214 grid (a 48-km archive that covers Alaska); and
- The hourly profiles at point locations.
The address of the system is 140.90.50.22; ID = anonymous; PW = your email address. Then CD/pub/gcip (by May 1995 this will be CD/pub/gcp).

The browse filename = gcip.doc

The online area includes information about the model, including some key references. It was written in summer 1994 (needs an update).
Attachment 1

Information About Related Data

1. **Mesoscale Model Archives at NCAR (Feb 1995)**

   NMC mesoscale model archives exist at NCAR for a number of years as shown below. The LFM and NGM archives include 6-hourly forecasts out to 48 hours.

   - **LFM data** 31 Oct 1971 - Nov 1994 (23.1 years) ~14.7 GB
   - **NGM data** Oct 1984 - Oct 1994 (10.1 years) ~ 8.7 GB
   - **Eta data** 11 Jul - 31 Aug 1994 (52 days) 12.80 GB

   These archives have regional grid data for N. America. The old hemispheric NMC grids had a resolution of 381 km (60°N). The LFM and NGM archive grids have a resolution twice as good (190.5 km). The Eta archive has a resolution of 40 km.

   The NGM archive is at a resolution of 190.5 km as noted. The real resolution of the innermost grid in the NGM model is 84 km at 45N and 91 km at 60N. The outermost grid is hemispheric in scope. NMC refers people to a key paper for information about the NGM (in *Weather and Forecasting*, Vol 4, pp 323-334, Sep 1989). It was written by Hoke, et al., and is titled: "The Regional Analyses and Forecast System of the National Meteorological Center."

2. **NMC Plans for the NGM and LFM Mesoscale Models**

   The LFM model stopped about early 1994 for external use (but NCAR still gets it!). For awhile longer, it was used internally at NMC for MOS forecasts, but that is now (Feb 1995) all changed to NGM. The NGM model will be used at NMC for about 4 more years. This information was from Ken Mitchell at NMC, Feb 1995.

3. **The Dimensions of a Few Model Grids**

   NCAR has archives of both global model grids and mesoscale grids.

<table>
<thead>
<tr>
<th>Grid Dimensions</th>
<th>Resolution (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some NMC N. American grids</td>
<td></td>
</tr>
<tr>
<td>NGM (of NMC) starts Oct 1984</td>
<td>41*38</td>
</tr>
<tr>
<td>Actual NGM model resolution</td>
<td>84</td>
</tr>
<tr>
<td>Eta 48-km basic model</td>
<td>~160*131 (fix)</td>
</tr>
<tr>
<td>Eta AWIPS 212, main grid for users</td>
<td>185*129</td>
</tr>
<tr>
<td>Eta AWIPS 214 for Alaska</td>
<td>7</td>
</tr>
</tbody>
</table>
4. Archives of Global Analyses from NMC

The recent archives at NCAR of global analyses from NMC are as follows:

- 2.5° analyses start July 1976
- Advanced analyses and flux files from NMC

<table>
<thead>
<tr>
<th>Points</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>243*122</td>
<td>165 km (1.48°)</td>
</tr>
<tr>
<td>384*190</td>
<td>104 km (0.938°)</td>
</tr>
<tr>
<td>512*256</td>
<td>78 km (0.703°)</td>
</tr>
</tbody>
</table>

Gaussian grid: 192*94 km (1.875°)
2.5° grid: 144*73 km (2.5°)

Notes:
(2) Reanalysis will cover 1957-95. In Feb 1995, the years 1985-91 are completed. Reanalysis started production in Jun 1994.
(3) New model: NMC is testing a new T170, 42-level model (Mar 1995). The Gaussian grid for T170 is 512*256 points (resolution 78 km, 0.703°).
(4) Some history: From about 1955 (I think) NMC used the 47 x 51 octagonal grid for some purposes (1977 points, resolution 381 km, covers much of N. Hemisphere, about 12°-90°N). Starting 1963 NCAR has NMC analyses on these grids for a number of levels (NCAR also has earlier data). Starting 1 Dec 1974, NCAR has NMC analyses on the 65 x 65 grid that covers the N. Hemisphere. The octagonal grid is a subset of this grid, both are the same resolution.
(5) A brief NMC global model history:
- 22 Sep 1978 Start 9-level global grid point model (now the tropical winds will be all right).
- 22 May 1980 Start 12-level spectral model (R24, like T33)
- 28 May 1986 Start 18 levels (R40, like T56)
- 12 Aug 1987 Start T80
- 6 Mar 1991 Start T126, 18 levels
- 25 Jun 1991 New T126, 18 levels. New assimilation methods (SSI methods); a big change.
- 11 Aug 1993 Start T126, 28 levels in production.

And: The 40-year reanalysis started production in Jun 1994 (T62, 28 levels).
Figure 1  The full domain of Eta model runs at NMC. This shows the region for the 48-km, 38-level Eta and the 29-km, 50-level Eta. The plot was prepared Feb 1995 by NMC.
Figure 2  Domain of the 48-km Eta model at NMC. The main grid for public use will be 40-km data interpolated to the AWIPS 212 grid. The AWIPS 214 grid will be extracted for Alaska users. The dots along the boundaries are for each grid point. (From Mitchell at NMC.)
Figure 3  The 1994 Eta data had 257 locations for which hourly profiles of model data were given. In 1995, there will be about 685 sites in the data. The above plots (prepared Feb 1995) show the location of the hourly model profile data.
a) Operational 80 km "Early" Eta

b) 29 km Mesoscale Eta

c) 48 km Operational "Early" Eta upgrade

Figure 4: The flow of data at NMC in Eta model operations. Suppose that it is now about 14Z and we want to prepare an Eta forecast. The vertical dark bars show when the Eta model ingests observations. In March 1995 (and before), the 80-km operational Eta starts with a global model (GDAS) forecast. In 'C', the 48-km Eta starts with a global model and ingests data for 12 hours before an Eta forecast is made. The procedures in 'C' will lead to the 40-km archives for public use during at least 1995-97. Item 'b' will be another test model starting in 1995. (Chart from Ken Mitchell, NMC, March 1995.)
Figure 5. Data from Eta model each 12 hours. The symbols (x + o) show whether NCAR will obtain a set of data fields at the particular time. Note that x is for summer 1994 and o is for 1995 archives.
Table 3

Eta Model 38-Layer Distribution

<table>
<thead>
<tr>
<th>Pressure Level</th>
<th>Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mb</td>
<td>20 mb</td>
</tr>
<tr>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>28</td>
<td>26</td>
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<tr>
<td>24</td>
<td>24</td>
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<td>25</td>
<td>28</td>
</tr>
<tr>
<td>28</td>
<td>32</td>
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<tr>
<td>34</td>
<td>34</td>
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<td>33</td>
<td>33</td>
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<td>32</td>
<td>32</td>
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<td>31</td>
<td>31</td>
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<tr>
<td>30</td>
<td>28</td>
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<td>27</td>
<td>27</td>
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<td>26</td>
<td>26</td>
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<td>24</td>
<td>24</td>
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<tr>
<td>22</td>
<td>22</td>
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<tr>
<td>21</td>
<td>21</td>
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<tr>
<td>19</td>
<td>17</td>
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<tr>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Sea Level</td>
<td></td>
</tr>
</tbody>
</table>

Note: These pressure increments add up to 960 mb.

10 layers, 286 mb thick

10 layers, 115 mb thick

by Ken Mitchell, NMC, 1993
## Table 9. Model Output Requirements for GCIP

### Valid Sep 1993

#### A. 2-DIMENSIONAL FIELDS (on model grid)

<table>
<thead>
<tr>
<th>Field Description</th>
<th>A or I</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Surface evaporation</td>
<td>(A)</td>
</tr>
<tr>
<td>2 - Potential evaporation</td>
<td>(A)</td>
</tr>
<tr>
<td>3 - Surface sensible heat flux</td>
<td>(A)</td>
</tr>
<tr>
<td>4 - Subsurface heat flux</td>
<td>(A)</td>
</tr>
<tr>
<td>5 - Snow phase-change heat flux</td>
<td>(A)</td>
</tr>
<tr>
<td>6 - Downward surface solar radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>7 - Upward surface solar radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>8 - Downward surface longwave radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>9 - Upward surface longwave radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>10 - Upward TOA longwave radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>11 - Upward TOA shortwave radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>12 - Total cloud amount</td>
<td>(AVG)</td>
</tr>
<tr>
<td>13 - Skin temperature</td>
<td>(I)</td>
</tr>
<tr>
<td>14 - Soil temperature (each soil layer)</td>
<td>(I)</td>
</tr>
<tr>
<td>15 - Soil moisture (each soil layer)</td>
<td>(I)</td>
</tr>
<tr>
<td>16 - Plant canopy surface water</td>
<td>(I)</td>
</tr>
<tr>
<td>17 - Snow temperature (if not skin)</td>
<td>(I)</td>
</tr>
<tr>
<td>18 - Snow water equivalent</td>
<td>(I)</td>
</tr>
<tr>
<td>19 - Percent snow cover</td>
<td>(I)</td>
</tr>
<tr>
<td>20 - Snow melt or accumulation</td>
<td>(A)</td>
</tr>
<tr>
<td>21 - Sea ice mask</td>
<td>(I)</td>
</tr>
<tr>
<td>22 - Storm-surface runoff</td>
<td>(A)</td>
</tr>
<tr>
<td>23 - Baseflow-groundwater runoff</td>
<td>(A)</td>
</tr>
<tr>
<td>24 - Total precipitation</td>
<td>(A)</td>
</tr>
<tr>
<td>25 - Convective precipitation</td>
<td>(A)</td>
</tr>
<tr>
<td>26 - Sea level pressure</td>
<td>(I)</td>
</tr>
<tr>
<td>27 - Surface pressure</td>
<td>(I)</td>
</tr>
<tr>
<td>28 - Surface drag coefficient</td>
<td>(I)</td>
</tr>
<tr>
<td>29 - Surface U wind stress</td>
<td>(I)</td>
</tr>
<tr>
<td>30 - Surface V wind stress</td>
<td>(I)</td>
</tr>
<tr>
<td>31 - U wind at lowest model level</td>
<td>(I)</td>
</tr>
<tr>
<td>32 - V wind at lowest model level</td>
<td>(I)</td>
</tr>
<tr>
<td>33 - Temperature at lowest model level</td>
<td>(I)</td>
</tr>
<tr>
<td>34 - Specific humidity at lowest level</td>
<td>(I)</td>
</tr>
<tr>
<td>35 - U wind at 10 m</td>
<td>(I)</td>
</tr>
<tr>
<td>36 - V wind at 10 m</td>
<td>(I)</td>
</tr>
<tr>
<td>37 - Temperature at 2 m</td>
<td>(I)</td>
</tr>
<tr>
<td>38 - Specific humidity at 2 m</td>
<td>(I)</td>
</tr>
</tbody>
</table>

*About 50 or so fields here*

---

From Ken Mitchell
NMC
Sep 1993

---

**Note:**
- "A" indicates an average value.
- "I" indicates a constant value.
Table 3. Model Output Requirements for GCIP (continued)

B. 3-DIMENSIONAL ATMOSPHERIC FIELDS (on model vertical coordinate)

Note: ** denotes unlikely availability from operational models (except in profiles in Section C)

<table>
<thead>
<tr>
<th>Conventional Model</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - U wind velocity component</td>
<td>(I)</td>
</tr>
<tr>
<td>2 - V wind velocity component</td>
<td>(I)</td>
</tr>
<tr>
<td>3 - Temperature</td>
<td>(I)</td>
</tr>
<tr>
<td>4 - Specific humidity</td>
<td>(I)</td>
</tr>
<tr>
<td>5 - Vertical motion</td>
<td>(I)</td>
</tr>
<tr>
<td>6 - Height</td>
<td>(I)</td>
</tr>
<tr>
<td>7 - Cloud water content</td>
<td>(I)</td>
</tr>
</tbody>
</table>

**Temperature Budget**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 - Adiabatic tendency</td>
<td>(A)</td>
</tr>
<tr>
<td>9 - Diabatic heating (DH) by convection</td>
<td>(A)</td>
</tr>
<tr>
<td>10 - DH by large-scale condensation</td>
<td>(A)</td>
</tr>
<tr>
<td>11 - DH by vertical diffusion</td>
<td>(A)</td>
</tr>
<tr>
<td>12 - DH by horizontal diffusion</td>
<td>(A)</td>
</tr>
<tr>
<td>13 - DH by shortwave radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>14 - DH by longwave radiation</td>
<td>(A)</td>
</tr>
<tr>
<td>15 - Cloud fraction</td>
<td>(AVG)</td>
</tr>
</tbody>
</table>

**Moisture Budget**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 - Adiabatic tendency</td>
<td>(A)</td>
</tr>
<tr>
<td>17 - Condensation by convection</td>
<td>(A)</td>
</tr>
<tr>
<td>18 - Large-scale condensation</td>
<td>(A)</td>
</tr>
<tr>
<td>19 - Vertical diffusion of humidity</td>
<td>(A)</td>
</tr>
<tr>
<td>20 - Horizontal diffusion of humidity</td>
<td>(A)</td>
</tr>
</tbody>
</table>

**Momentum Budget**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 - Vertical diffusion of U component</td>
<td>(A)</td>
</tr>
<tr>
<td>22 - Vertical diffusion of V component</td>
<td>(A)</td>
</tr>
<tr>
<td>23 - Horizontal diffusion of U component</td>
<td>(A)</td>
</tr>
<tr>
<td>24 - Horizontal diffusion of V component</td>
<td>(A)</td>
</tr>
<tr>
<td>25 - Gravity wave drag of U component</td>
<td>(A)</td>
</tr>
<tr>
<td>26 - Gravity wave drag of V component</td>
<td>(A)</td>
</tr>
<tr>
<td>27 - U-component momentum exchange by convection</td>
<td>(A)</td>
</tr>
<tr>
<td>28 - V-component momentum exchange by convection</td>
<td>(A)</td>
</tr>
</tbody>
</table>
Table 3. Model Output Requirements for GCIP (continued)

C. VERTICAL PROFILE TIME SERIES (for selected points in GCIP area)

For selected locations, vertical profile time series of instantaneous values at a
temporal frequency of hourly or better are needed by GCIP researchers for all
variables 1-38 in Section A and all variables 1-28 in Section B. It is in the local
time series that operational models are most likely to provide the "budget" variables
8-28 listed in Section B.

For cloud and radiation studies, GCIP researchers urge that the cloud-free
counterparts of the radiation variables 6-11 in A and 13-14 in B also be provided
in the profile time series.

For surface hydrology studies, researchers urge that the local time series of surface
evaporation be provided in terms of the components of direct evaporation from the
surface, transpiration from vegetation, and evaporation from wet plant surfaces.

D. FIXED FIELDS

Fixed fields refer to those gridded fields that remain fixed from day to day and
throughout each forecast.

1 - Latitude, longitude value of each grid point
2 - Vertical coordinate value by layer
3 - Land-sea tag
4 - Terrain characteristics (height, slope, etc.)
5 - Vegetation characteristics
6 - Soil characteristics
7 - Capacity of surface moisture stores
8 - Surface roughness length

Adiabatic temperature tendencies, which are sometimes output for special short-duration
experiments. As an alternative, some of these additional diagnostic quantities may be provided in
the vertical profile time series.

The GCIP researchers will, to the extent possible, make use of the model output from
existing operational numerical analysis and prediction centers. These centers are
Mesoscale Model Data for GEWEX

Archives from global models and mesoscale models are needed to support the goals of the GEWEX and GCIP programs. The archives will also support the ARM program and much other research.

A meeting was held on 3 Sep 1993 in Washington, DC, to discuss the options for the archive. The volume of data is also an issue. Ken Mitchell (NMC, ext. 8161) worked out some of the volume characteristics of different options (Attachment 1). It shows that saving a lot of the data every 3 hours would result in an archive of 93.6 Gbytes each month. This is a lot of data! It is the same as 720 round tapes (6250 BPI) or 20 high-density Exabyte tapes every month. There are options to slim down that volume to make it more practical.

The GCIP program is a continental-scale GEWEX program. It is mostly a NOAA program and partly a NASA program.

So far there is no support for PIs by NSF, but this may change. Pam Stephens (NSF) is coming to the Oct 1994 meeting.

1. NMC Mesoscale Models in Sep 1993

- The present NMC operational model is 80 km, 38 levels. It started operations in Jun 1993.
- Now NMC is running a test model (40 km, 38 levels). It is run routinely. Forecasts are made twice a day (00 and 12Z) and are run out to 36 hours. The top level is at 50 mb. This 38-level version will never be operational.
  - The wall clock time for a 36-hour forecast (using 6 Y-MP processors and operational priority) at NMC is 49.87 minutes. The associated CPU time on the 6 processors is 146.88 minutes. The time step of this 40-km, 38-level model is ________.

2. Starting Apr 1994

- The 30-km model will become operational at NMC in Apr 1994. Then it will be a 30-km, 50-level model. Its region of coverage will be between the present 80-km and 40-km models. See the figure. #/!

- About 1997, NMC expects another computer. Then they expect to run a 15-km, 75-level model. The domain of the grid will be about the same as for the 1994 30-km model. Therefore, the volume of a vertical stack of grids will be about 5 times the 1994 volume.

3. Number of Grid Points

Table 1 shows the number of grid points for different models and subregions.
Table 1. Horizontal Points in Mesoscale Grids

<table>
<thead>
<tr>
<th>Grid</th>
<th>Dimension</th>
<th>Points</th>
<th>Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 km (Jun 1993)</td>
<td>92 x 141</td>
<td>12,972</td>
<td>0.179</td>
</tr>
<tr>
<td>40 km (Jul 1993)</td>
<td>127 x 191</td>
<td>24,257</td>
<td>0.334</td>
</tr>
<tr>
<td>ETA 30 km (Apr 1994)</td>
<td>220 x 330</td>
<td>72,600</td>
<td>1.0</td>
</tr>
<tr>
<td>AWIPS CONUS (40 km), 12N-56N</td>
<td>129 x 185</td>
<td>23,865</td>
<td>0.329</td>
</tr>
<tr>
<td>AWIPS MARD (40 km), 22N-50N</td>
<td>81 x 101</td>
<td>8,181</td>
<td>0.113</td>
</tr>
<tr>
<td>CONUS region (30 km)</td>
<td>~172 x 247</td>
<td>42,484</td>
<td>0.585</td>
</tr>
<tr>
<td>MARD region (30 km)</td>
<td>~108 x 135</td>
<td>14,580</td>
<td>0.201</td>
</tr>
<tr>
<td>210-km box (30 km)</td>
<td>8 x 8</td>
<td>64</td>
<td>0.001</td>
</tr>
</tbody>
</table>

4. The ETA Model

The top level of this model (40 km, 38 level) is at 50 mb. The lowest level is at sea level. The level at sea level has actual sea level pressure, which varies in space and time. More information about the model is given in Attachment 2. The approximate separation between levels (in mb) is given in an attachment.

5. The Edge of a Mesoscale Grid Feels the Boundary

- Mesoscale model grids cover a larger region than necessary, because points near the edge feel too much of the effects of the boundary conditions.
  - About 25% of the grid points (the ones around the edge) could be thrown away without losing any real information.
  - The grid is a staggered grid, roughly in a lat-lon coordinate system. For example, the wind points are between the temperature points.

6. Some Surface Fields will not be Calculated at First

If a field has no useful information, I see no need to put in a dummy grid in the output file. As long as each field has an internal identification, the place-holders are not needed.

7. Data from Analysis and Forecast Cycles

Data are desirable for both analysis and forecast cycles, and this is planned. During the assimilation cycle, a model in balance is pushed one way and another by the data. This is associated with the spin up or spin down of forecast models as they leave a time-zero analysis. Some fields from the assimilation cycle are a better description of the real atmosphere than the forecasts. Other fields are more like the real atmosphere during the forecast, especially for hours 12-36 of the forecast which covers a 24-hour period.

Since forecasts are run 2 times a day, the state of one diurnal cycle is described twice a day in the forecast cycle and once in the assimilation cycle.
• During the assimilation cycle, data are inserted every 3 hours.

8. Use Standard AWIPS grid for U.S.-48

An attractive option is to save data on the standard AWIPS grid (40 km), that will be kept constant for the next 5 years. The AWIPS CONUS grid covers about 12-55N, and 60-140W. The AWIPS CONUS grid has been defined as a standard that will be used to send products to NWS forecast offices.

The ETA 30-km model will start Apr 1994. This interpolated 40-km CONUS grid will start then and remain stable for at least 1994-98.

• This grid covers 58% of the area of the whole ETA 30-km grid.
• The archive is 3-hour surface fields and 6-hour UA; it has data from the analysis cycle and forecasts to 36 hours (from 00 and 12 GMT).
• The 40-km grid has 129 x 185 points. There are 35 levels saved.
• The volume (16 bits per point) is a bit grim: 4.4 Gbytes per month
  — GRIB packing may bring this down to 3.4 Gbytes per month
• Data for the smaller MARD region could be used. It would have only 34% of the volume of data for the CONUS grid.

9. Vertical Motion Fields

People probably don't need a full 50-level stack of vertical motion, but a selection of a few of the levels would help.

10. Save Surface Fields in Model Coordinates, each 3 hours

About 50 surface fields will be archived each 3 hours. Table 3A (attached) shows many of the fields. The accumulation period for many surface fields is each 3 hours. One option is to save these for the whole ETA grid, each 3 hours. The volume would be:

• For grid (220 x 330), 8 analyses and 2 * 12 forecasts per day
• If 16 bits per point, get 7.2 Gbytes per month
• GRIB will probably do 7 bits per point on these fields, then get 3.2 Gbytes per month
• The CONUS grid has 58% of the ETA points, and the MARD grid has 20%. The use of these subgrids could reduce the volume

Options: Save only about 10 of the most important 30-km surface fields on the whole ETA grid, and save the rest on the MARD grid. The volume of 10 fields is only 20% of 50 fields. The 10 fields might be:

— 2m temperature and RH
— 10m wind
— total precipitation
— evaporation
— down. rain & ice
— total clouds and low clouds