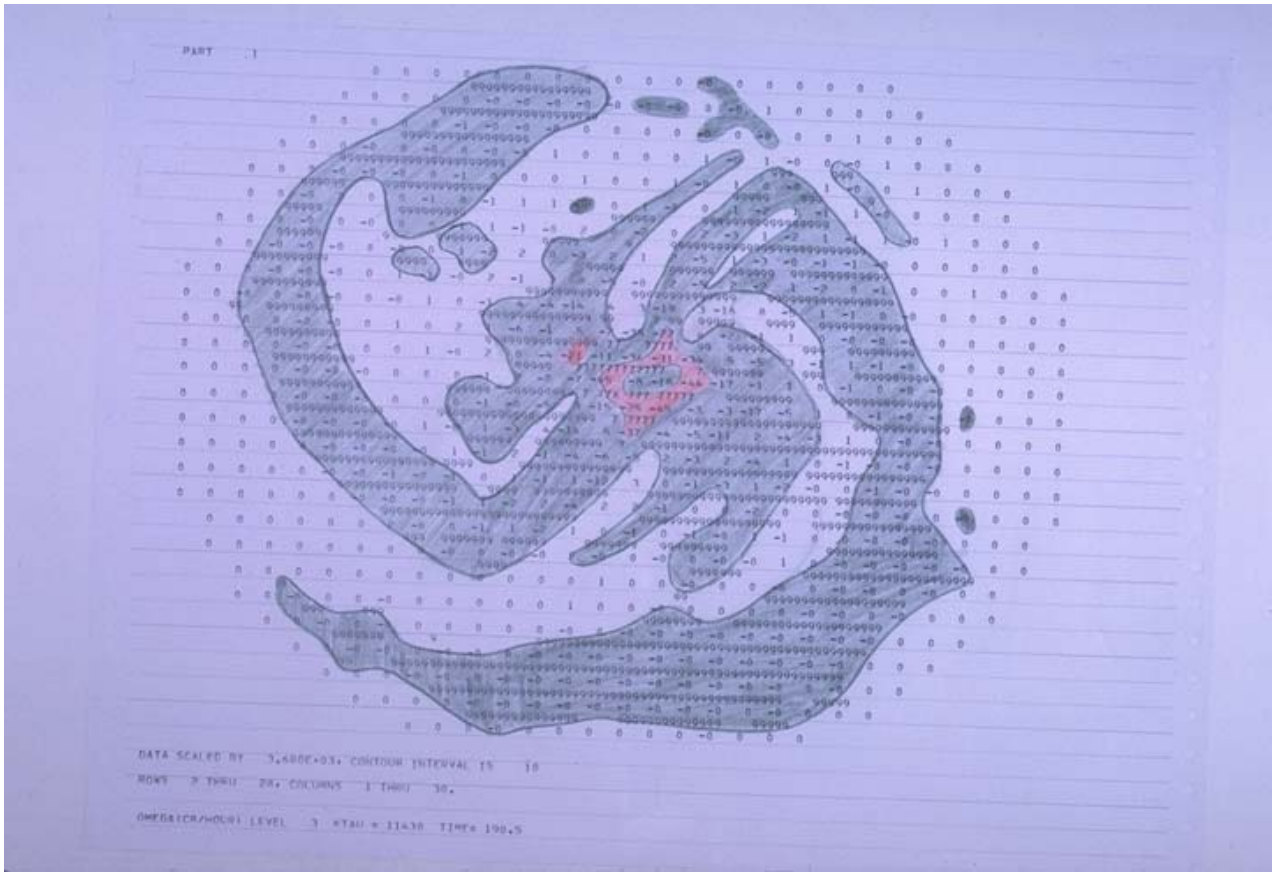
WRF Post-Processing



Cindy Bruyère
NCAR/MMM

outline

- netCDF Data
- NCL
- RIP4
- WRF-to-GrADS
- WRF-to-VIS5D

netCDF data

- **netCDF is one of the current supported data formats chosen for WRF I/O**
- **What is netCDF?**
  - netCDF stands for ***net****work* ***C****ommon* ***D****ata* ***F****orm*
  - netCDF is "an interface to a library of data access functions for storing and retrieving data in the form of arrays." (**http://www.unidata.ucar.edu/**)
- **Documentation available at above site**

netCDF data

- **Advantages of using netCDF?**
  - Platform-independent
    (*big_endian / little_endian*)
  - A lot of software already exist which can be used to process netCDF data

netCDF utilities

- **ncdump**
  reads a netCDF dataset and prints information from the dataset

  ncdump –h *file*

  print header (inc. list of variables in the file)

  ncdump –v *VAR file*

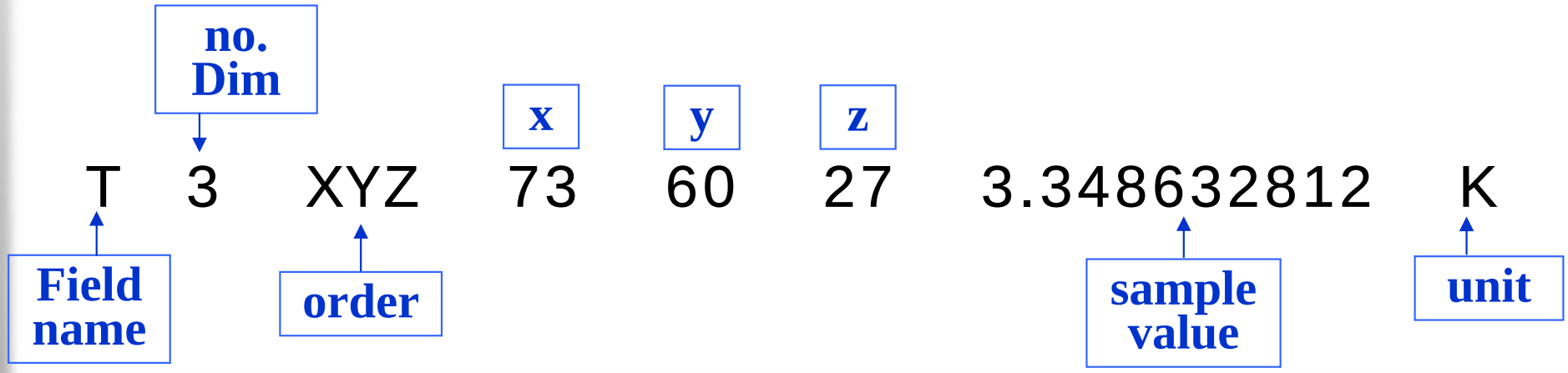
  print data of the variable VAR

- **ncgen**
  generates a netCDF file or a C or FORTRAN program that creates a netCDF dataset

netCDF utilities

- **read_wrf_nc**
  - Supported by NCAR
  - FORTRAN program
    Easy to use
    Easy to add your own code

- **Sample output**



netCDF utilities

- **read_wrf_nc : Options**

-head	Header information
-m	Min/Max values for each field
-M z	Min/Max values for each field (values for 3D fields @ **z** level)
-s	List of available fields + a sample value ***(default)***
-S x y z	List of available fields + value at point **x y z**
-t	List of times in file
-v VAR	Basic information about field **VAR**
-V VAR	Basic information about field **VAR**, and dump the full field out to the screen
-w VAR	Write the full field out to a file **VAR.out**

SPECIAL option : **-EditData VAR**

netCDF utilities

- **Other netCDF operators**
  - http://nco.sourceforge.net/
  - Stand alone programs to, which can be used to manipulate data
    - performing grid point averaging
    - file differencing
    - file 'appending'

netCDF utilities

In WRF system, simple utilities are also available. See for example:

- ☑ **module_wrf_to_v5d_util.F**
  (wrf2vis5d.tar file)

- ☑ **module_wrf_to_grads_util.F**
  (wrf2grads.tar file)

netCDF utilities

Fortran calls to access the data *(example)*

☑get dimensions of field T in an array dims

```
call get_dims_cdf( file(1),'T',     &
dims, ndims, debug )
```

☑get attributes from a netCDF file

```
call get_gl_att_real_cdf( file(1),  &
'CEN_LON', cen_lon, debug )
```

☑get the 2D field XLAT (similar call for a 3D field)

```
call get_var_2d_real_cdf( file(1),  &
'XLAT', xlat, dims(1), dims(2), 1,  &
debug)
```

available graphics

- NCL
- RIP4
- GrADS
- Vis5D
- IDL
- Matlab
- GMT
- FX-Net
- Interactive Visualization Environment (*IVE*)

- General Meteorological Package / National Advanced Weather Interactive Processing System (GEMPAK / NAWIPS, e.g. "garp" and "nmap")
- Integrated Data Viewer *(IDV)*
- Open-source Data Explorer *(OpenDX)*

supported graphics

	NCL	RIP4	GrADS	Vis5D
Directly ingest WRF model output	✓	✖ converter	✖ converter	✖ converter
Vertical Coordinate	n/p/h	n/p/h	n/p/h	n/h
Model input & output	i/o	i/o	i/o/s	o
WRF I/O API	✖ netCDF	✖ netCDF	✖ netCDF	✖ netCDF
Ideal	✓ 3D/2D	✓ 3D/2D	✓ 3D/2D/1D	✖

NCL

Mesoscale & Microscale Meteorology Division of NCAR

what is NCL?

- **NCL stands for *NCAR Command Language***
- **NCL is an interpreted programming language**
  - Array based algebraic operators
  - Support netCDF data
  - Wide variety of graphics capabilities:
    - Maps, Contours, XY, Vectors, Streamlines, Label Bars, Text, Tick Marks
    - Output to X, NCGM, PostScript

what is NCL?

- **NCL is available on most UNIX platforms**
- **NCL can run in batch or interactive mode**
  - Interactive mode has command history and command line editing
- **Many useful functions and procedures**
- **Code integration tool (ability to import FORTRAN)**
- **Pre-compiled binaries are free**

downloading NCL

- **Go to:**
  - **http://ngwww.ucar.edu/ncl/download**
- **Read and agree to GPL license**
- **Fill out short registration form**
- **Download binaries**
- **Set NCARG_ROOT environment variable:**
  - *setenv NCARG_ROOT /usr/local/*
- ***Recommended to install NCAR Graphics first and then NCL on top of NCAR Graphics***

using and learning NCL

- **NCL home page:**

  http://ngwww.ucar.edu/ncl

  Contains links to documentation, examples, FAQ, NCL-talk email list, and update information

- **Main reference documentation**

  http://www.ncl.ucar.edu/Document/index.shtml

- **Main resources**

  http://www.ncl.ucar.edu/Document/Graphics/Resources/

using and learning NCL

- **NCL users email list**

  http://www.ncl.ucar.edu/Support/ncl_talk.shtml

  Email list devoted to NCL discussion

  Read by NCL developers and support staff

- **Examples page**

  http://www.ncl.ucar.edu/gallery.shtml

NCL for WRF model data

- **The NCL scripts for plotting WRF model output are provided**
  - They can do vertical interpolation (so one can plot data on pressure / height levels), skew-T, and vertical cross-sections
  - They currently plot model output variables plus a few diagnostic variables, such as SLP, dew point temperature, and RH
  - Can work with multiple input files and sub-domains
  - Use with real and idealized data
  - *We are in the process of updating all the scripts, but the basic flow will remain the same as describes here*

download NCL for WRF

- From wrf-model.org web site (*wrf_ncl_tar.gz*):

  http://www.mmm.ucar.edu/wrf/users/download/get_source.html

- "How to" and examples:

  http://www.mmm.ucar.edu/wrf/users/graphics/WRF_NCL/NCL.htm

NCL for WRF

README_FIRST

README_NCL

wrf_user_fortran_util_0.f
make_ncl_fortran
make_ncl_fortran.alpha
make_ncl_fortran.linux
make_ncl_fortran.sun

wrf_em_b_wave.ncl
wrf_em_hill2d.ncl
wrf_em_grav2d.ncl
wrf_em_qss.ncl
wrf_em_squall_2d_x.ncl
wrf_em_squall_2d_y.ncl

wrf_em_real_input.ncl
wrf_em_real.ncl
wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

README files

- "How to"
- About NCL

NCL for WRF

gsn_code.ncl
skewt_func.ncl
wrf_plot.ncl
wrf_user_mass.ncl

wrf_user_fortran_util_0.f
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wrf_em_grav2d.ncl
wrf_em_qss.ncl
wrf_em_squall_2d_x.ncl
wrf_em_squall_2d_y.ncl

wrf_em_real_input.ncl
wrf_em_real.ncl
wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

NCL functions and procedures used by the plotting scripts

- skew-T plots
- maps, contour and color-filled plots, vectors, used by all NCL scripts
- Make Fortran calls to routines in `wrf_fortran_user_util_0.f`
  - used to obtain native model output variables, or diagnose new variables
  - this is where a user may choose to add new variables for plotting
- Must be loaded at top of NCL script
  `load "wrf_plot.ncl"`

NCL for WRF

gsn_code.ncl
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wrf_em_b_wave.ncl
wrf_em_hill2d.ncl
wrf_em_grav2d.ncl
wrf_em_qss.ncl
wrf_em_squall_2d_x.ncl
wrf_em_squall_2d_y.ncl

wrf_em_real_input.ncl
wrf_em_real.ncl
wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

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make_ncl_fortran.alpha
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make_ncl_fortran.sun

wrf_em_b_wave.ncl
wrf_em_hill2d.ncl
wrf_em_grav2d.ncl
wrf_em_qss.ncl
wrf_em_squall_2d_x.ncl
wrf_em_squall_2d_y.ncl

wrf_em_real_input.ncl
wrf_em_real.ncl
wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

FORTRAN shared library

- Contains Fortran routines for diagnostic calculations
- Fortran routines are stubbed with '*NCLFORTSTART*' and 'NCLEND'.

eg

```
C NCLFORTSTART
  subroutine comp_rh(qv,p,t,rh)
  implicit none
  real qv(nx,ny,nz),                &
       p(nx,ny,nz),                 &
       t(nx,ny,nz),                 &
      rh(nx,ny,nz)
C NCLEND
```

NCL for WRF

README_FIRST
README_NCL
gsn_code.ncl
skewt_func.ncl
wrf_plot.ncl
wrf_user_mass.ncl

make_ncl_fortran
make_ncl_fortran.alpha
make_ncl_fortran.linux
make_ncl_fortran.sun

wrf_em_b_wave.ncl
wrf_em_hill2d.ncl
wrf_em_grav2d.ncl
wrf_em_qss.ncl
wrf_em_squall_2d_x.ncl
wrf_em_squall_2d_y.ncl

wrf_em_real_input.ncl
wrf_em_real.ncl
wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

makefiles to create shared object file from Fortran code

```
make_ncl_fortran
    wrf_user_fortran_util_0
```

☑ creates wrf_user_fortran_util_0.so

Potential problem:

wrapit77 is part of NCAR Graphics, and the path to this function needs to be correctly specified (.cshrc file)

NCL for WRF

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README_NCL
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wrf_em_hill2d.ncl
wrf_em_grav2d.ncl
wrf_em_qss.ncl
wrf_em_squall_2d_x.ncl
wrf_em_squall_2d_y.ncl

wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

Plotting scripts for idealized cases:

- baroclinic wave
- 2D flow over a mountain
- 2D gravity wave
- 3D quarter-circle shear supercell thunderstorm
- 2D squall line

NCL for WRF

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README_NCL
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wrf_em_b_wave.ncl
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wrf_em_real_input.ncl
wrf_em_real.ncl
wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

Plotting scripts for real cases:

- Input data
- Real data
- Cloud water
- Rain water
- Surface fields
- Sea level pressure
- theta

NCL for WRF

README_FIRST
README_NCL
gsn_code.ncl
skewt_func.ncl
wrf_plot.ncl
wrf_user_mass.ncl

wrf_user_fortran_util_0.f
make_ncl_fortran
make_ncl_fortran.alpha
make_ncl_fortran.linux
make_ncl_fortran.sun

wrf_em_b_wave.ncl
wrf_em_hill2d.ncl
wrf_em_grav2d.ncl
wrf_em_qss.ncl
wrf_em_squall_2d_x.ncl
wrf_em_squall_2d_y.ncl

wrf_em_real_input.ncl
wrf_em_real.ncl
wrf_em_qc.ncl
wrf_em_qv.ncl
wrf_em_sfc.ncl
wrf_em_slp.ncl
wrf_em_the.ncl

Plotting scripts will all be updated for next release

More user friendly

a script

```
load "wrf_plot.ncl"
load "wrf_user_mass.ncl"
load "gsn_code.ncl"
load "skewt_func.ncl"

a = addfile("wrfout_d01_2000-01-24_12:00:00.nc", "r")

;wks = wrf_open_X11()                ; output to screen
wks = wrf_open_ncgm("wrf_plots")     ; output to ncgm
;wks = wrf_open_PS("wrf_plots")      ; output to postscript
```

Not part of file name, but needs to be added inside the ncl script

Get Variables

Set options (i.e., line color / shading)

Overplay and draw graphic

how to run NCL?

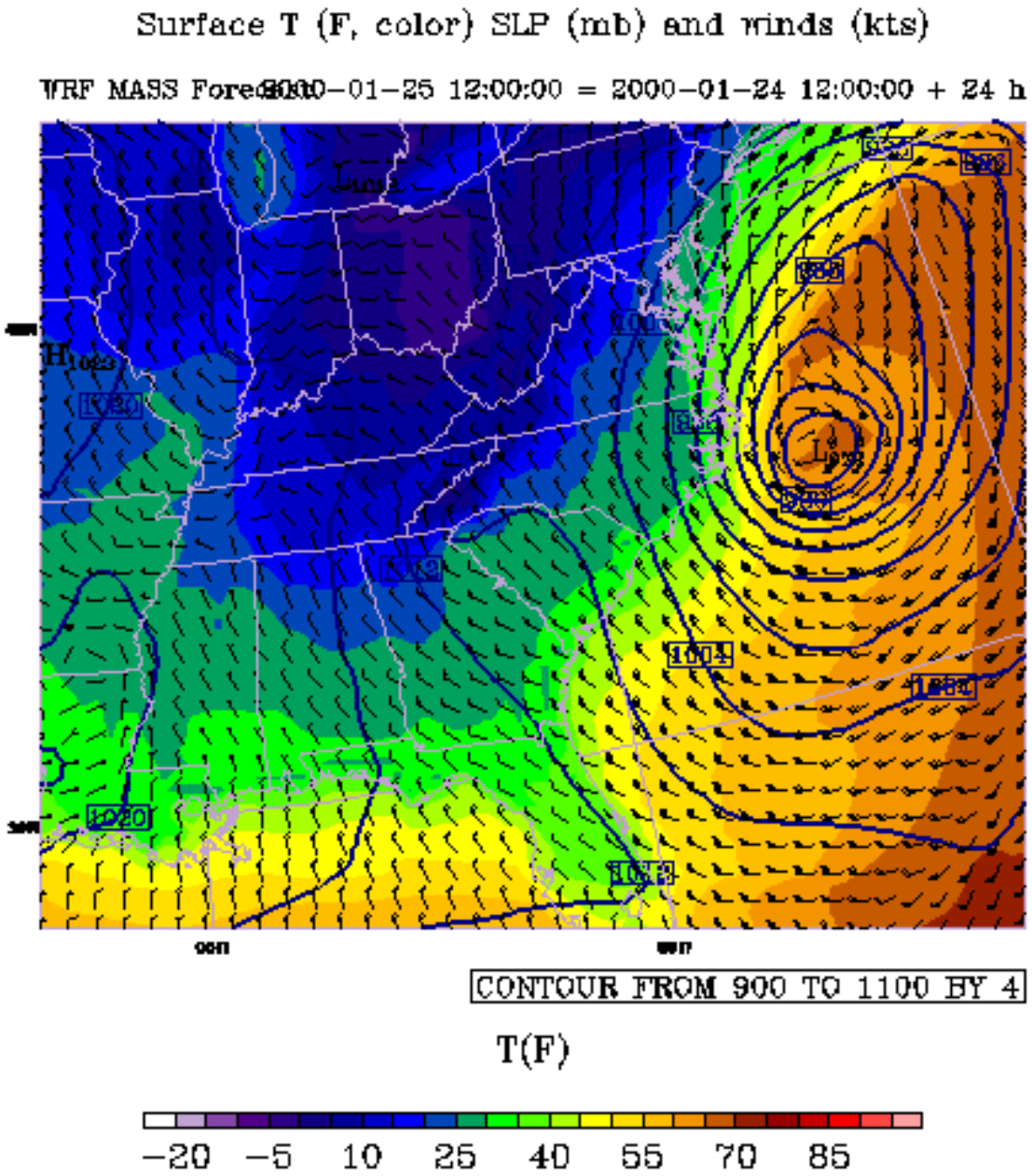
- **Type the following to run**

  ncl < *wrf_em_real.ncl*

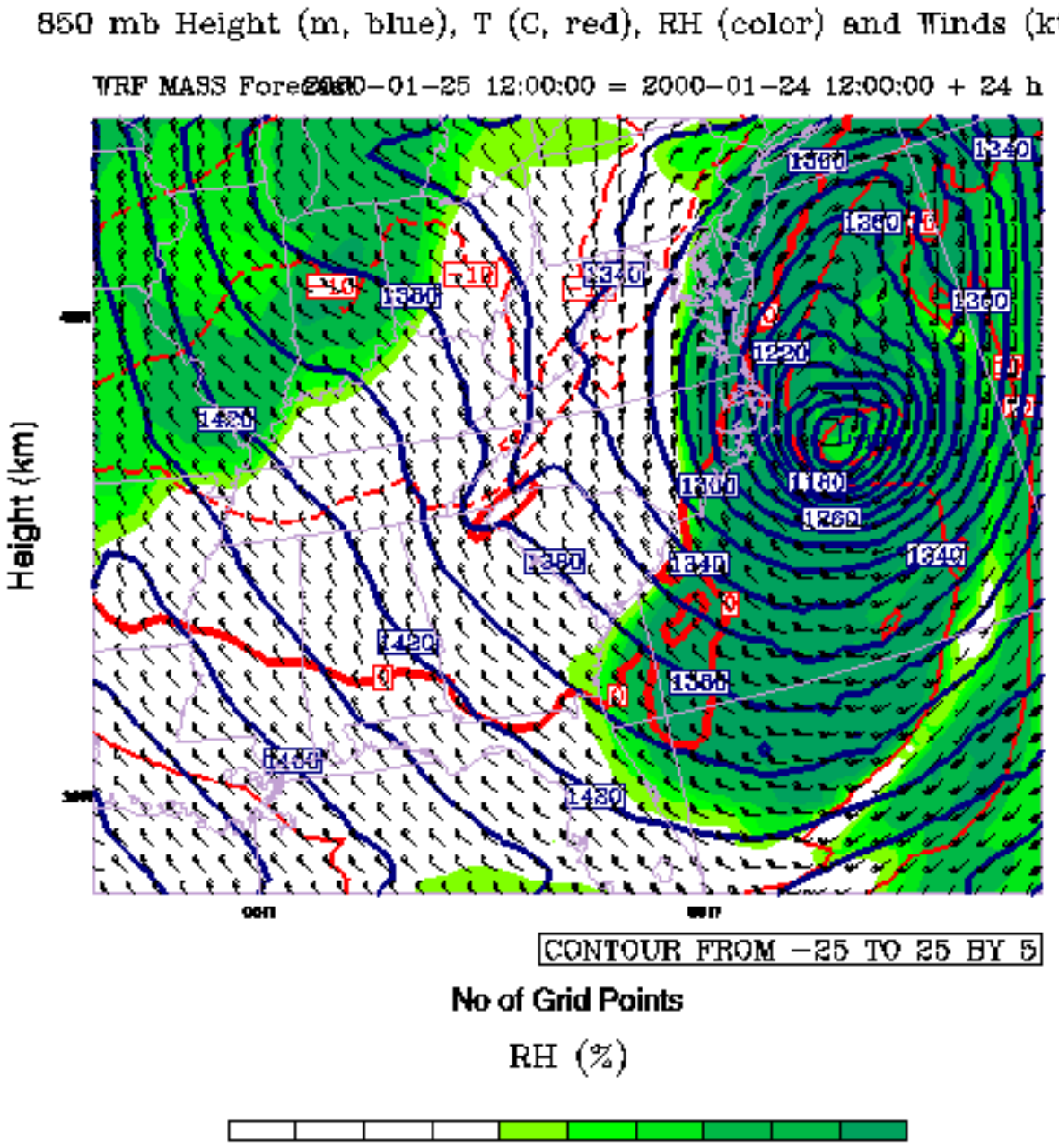
  ncl wrf_em_real.ncl (newer ncl versions)

- **Depending on output option, one can run NCL interactively or in 'batch' mode.**

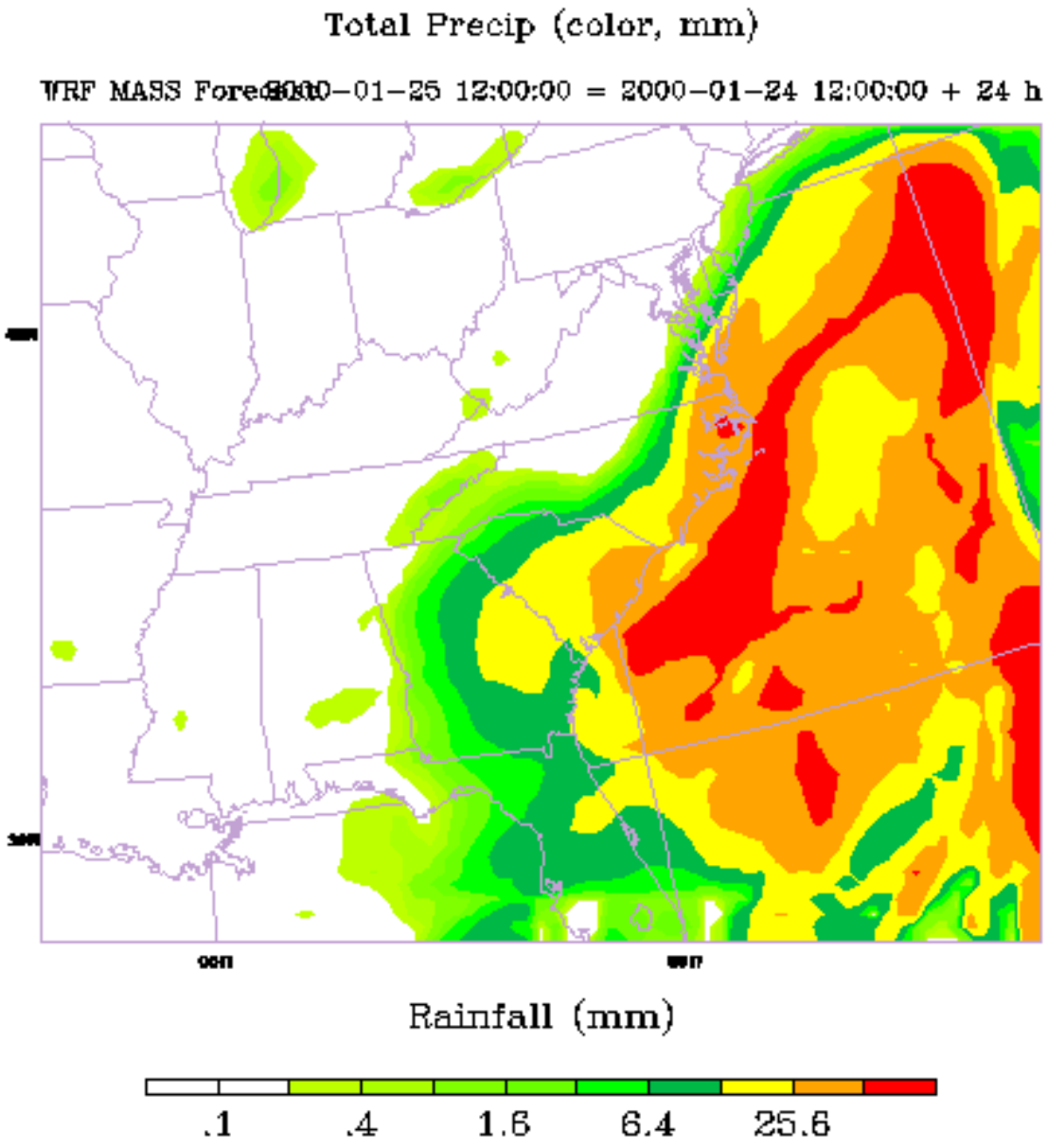
- **Output from ncl can be in metacode, postscript, pdf or on the screen**


Surface T (F, color) SLP (mb) and winds (kts)
WRF MASS Fore 2000-01-25 12:00:00 = 2000-01-24 12:00:00 + 24 h
CONTOUR FROM 900 TO 1100 BY 4
T(F)
-20 -5 10 25 40 55 70 85

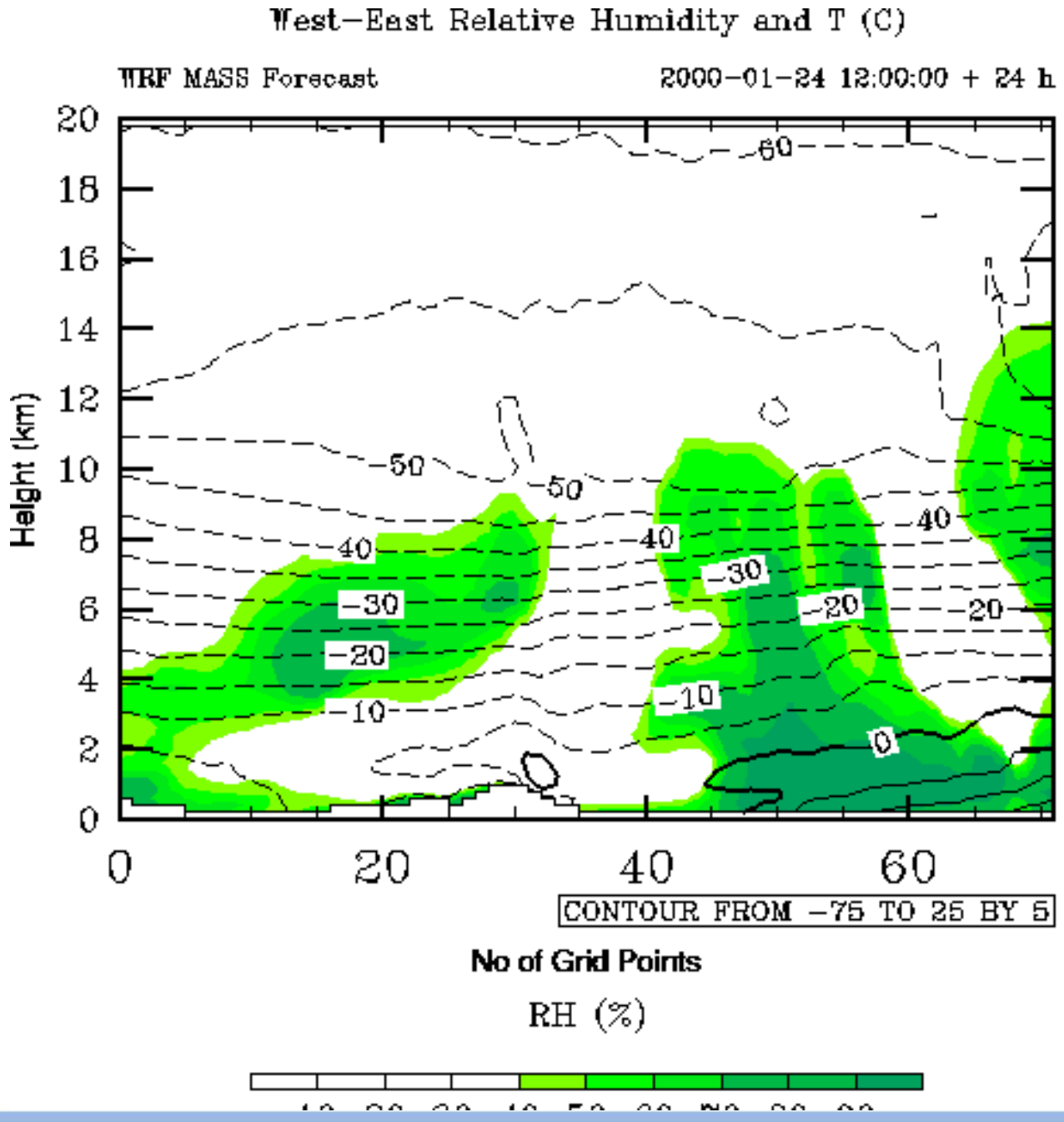
real data


850 mb Height (m, blue), T (C, red), RH (color) and Winds (kts)
WRF MASS Fore 2000-01-25 12:00:00 = 2000-01-24 12:00:00 + 24 h
Height (km)
CONTOUR FROM -25 TO 25 BY 5
No of Grid Points
RH (%)

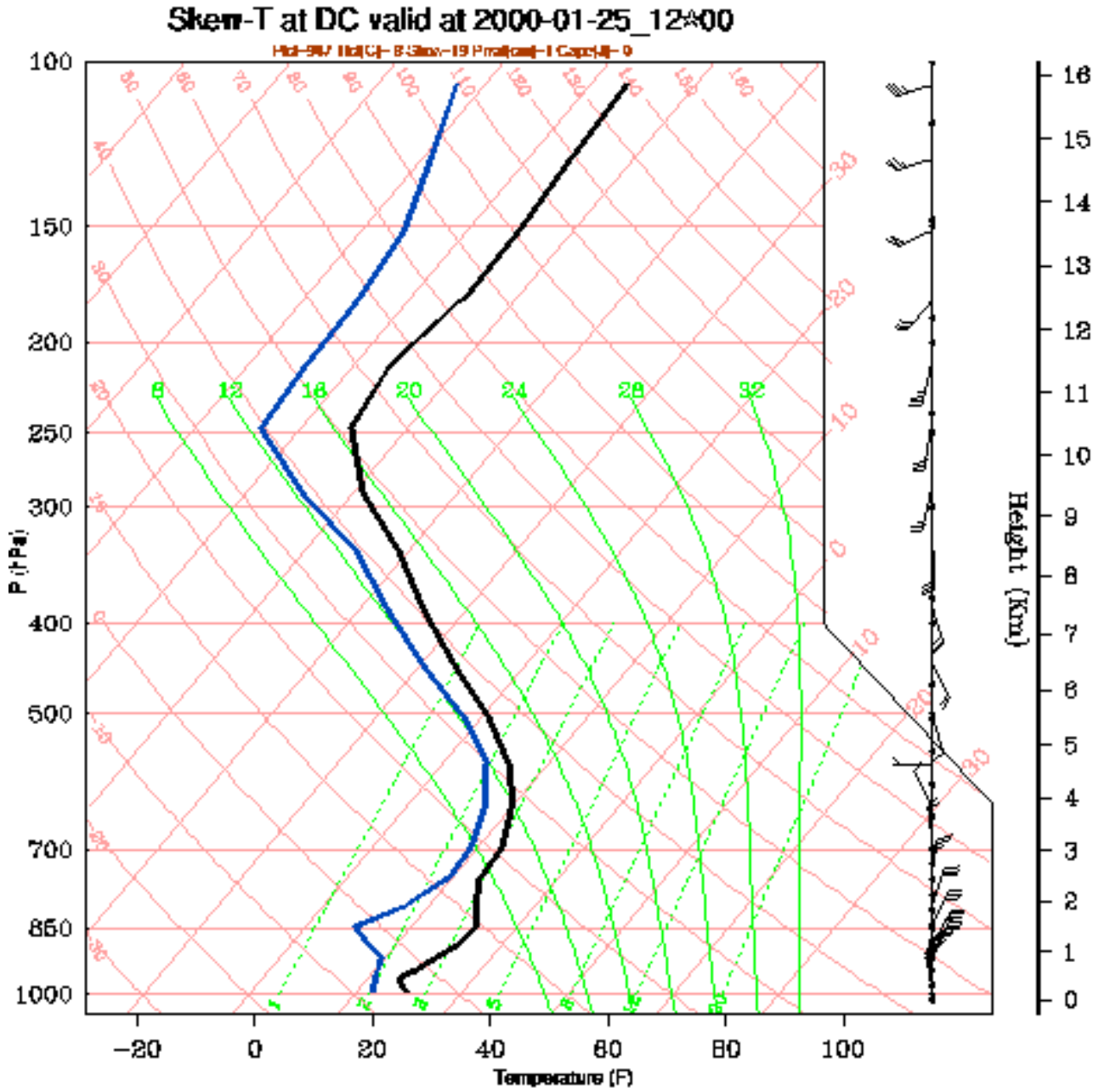
real data


Total Precip (color, mm)
WRF MASS Fore 2000-01-25 12:00:00 = 2000-01-24 12:00:00 + 24 h
Rainfall (mm)
.1
.4
1.6
6.4
25.6

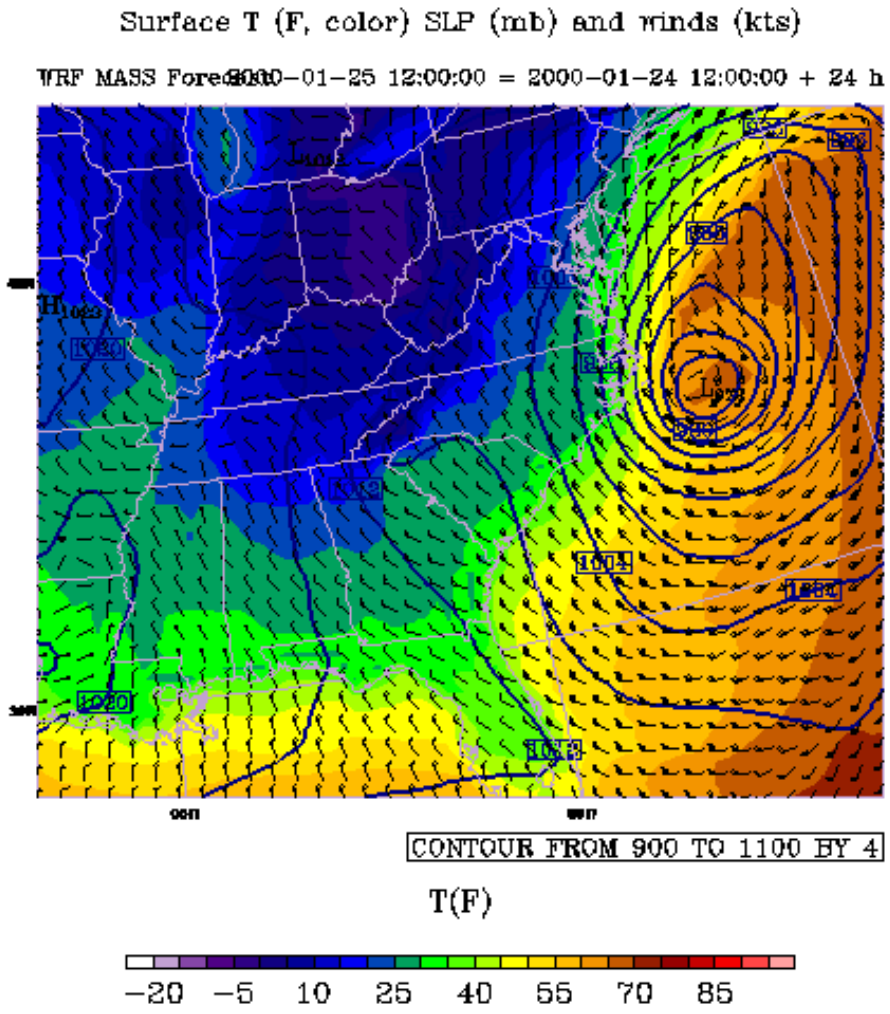
real data

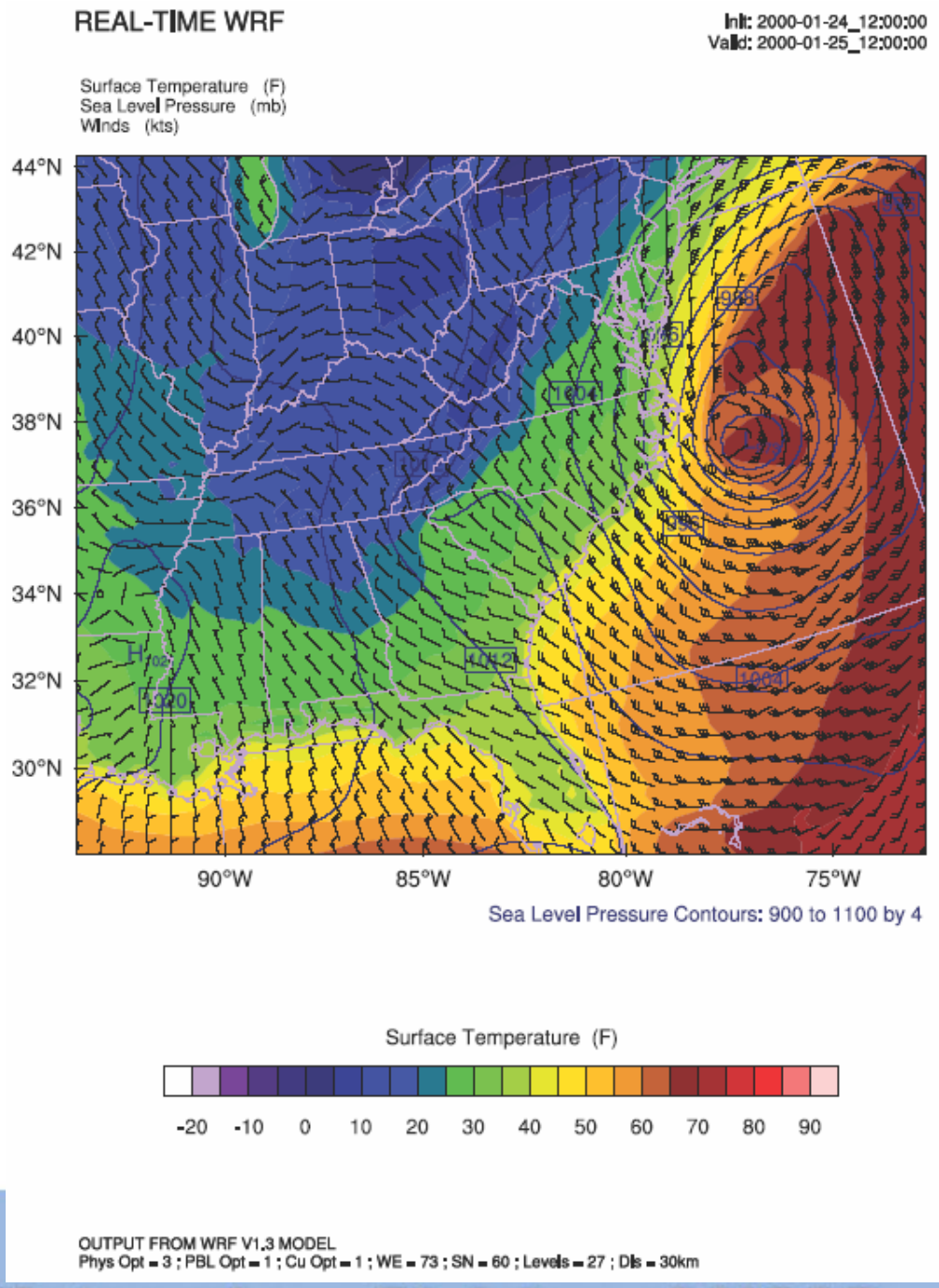

West–East Relative Humidity and T (C)
WRF MASS Forecast
2000-01-24 12:00:00 + 24 h
Height (km)
0
2
4
6
8
10
12
14
16
18
20
0
20
40
60
60
50
50
40
40
30
30
20
20
10
10
0
CONTOUR FROM -75 TO 25 BY 5
No of Grid Points
RH (%)

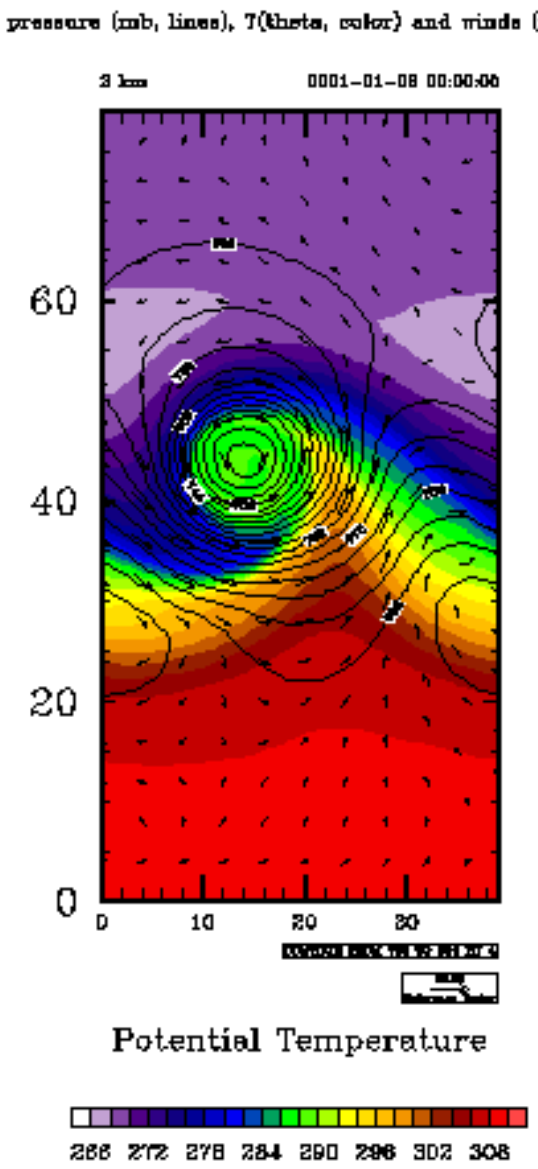
real data

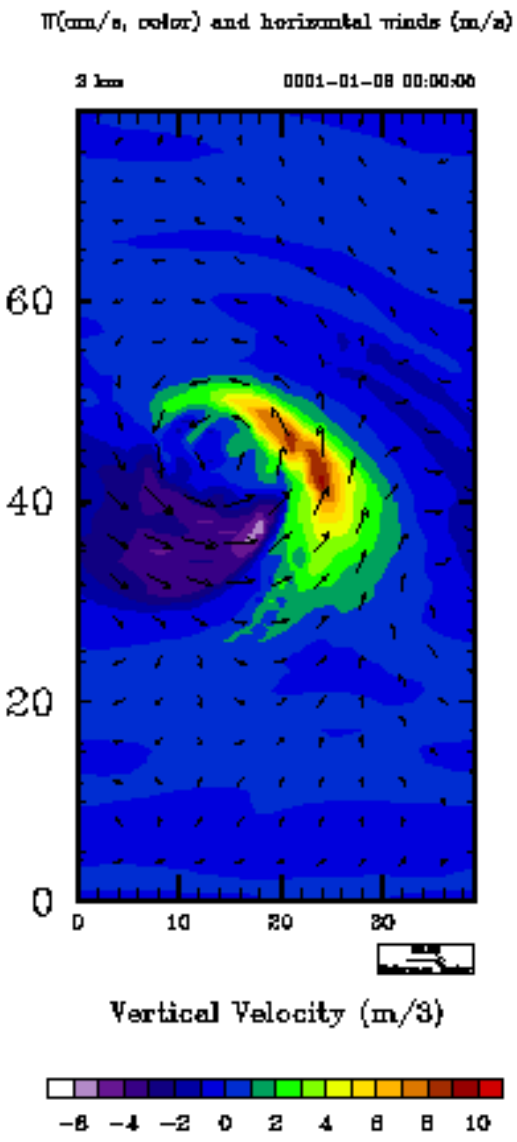

Skew-T at DC valid at 2000-01-25_12:00
P (hPa)
Temperature (F)
Height (Km)

real data


Surface T (F, color) SLP (mb) and winds (kts)
WRF MASS Fore 2000-01-25 12:00:00 = 2000-01-24 12:00:00 + 24 h
CONTOUR FROM 900 TO 1100 BY 4
T(F)
-20 -5 10 25 40 55 70 85

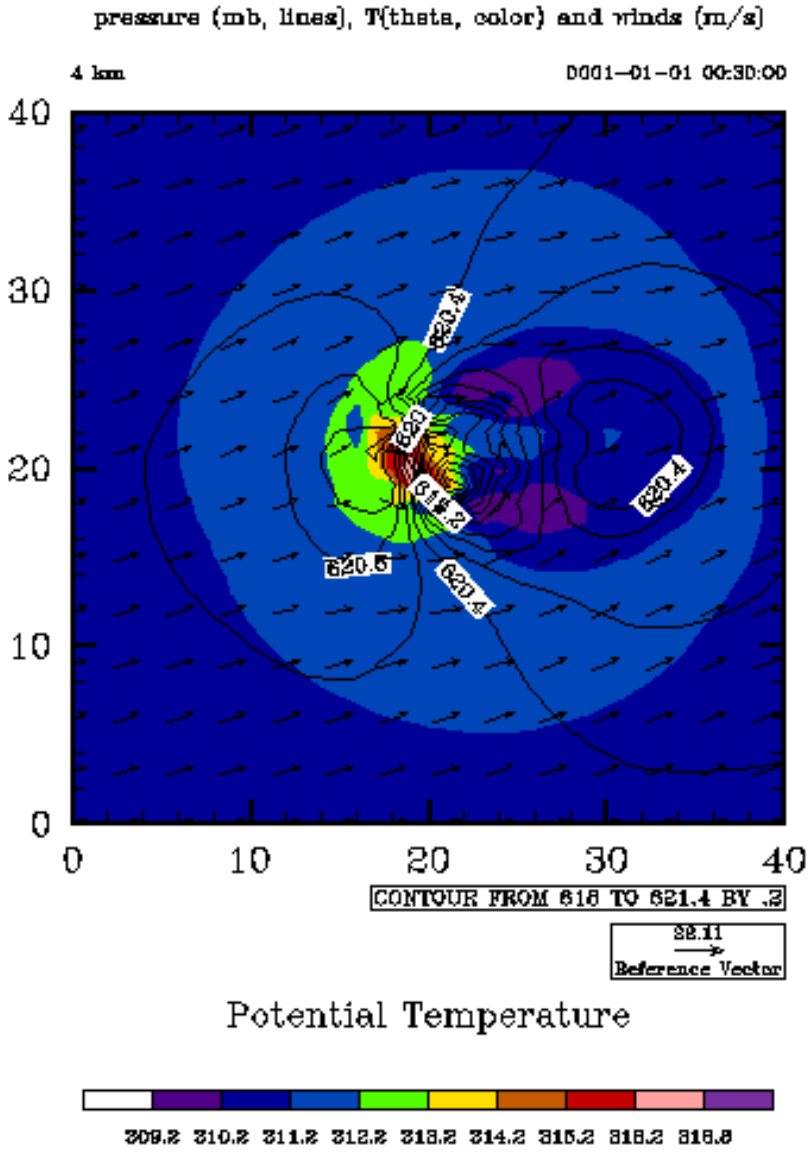

REAL-TIME WRF
Init: 2000-01-24_12:00:00
Valid: 2000-01-25_12:00:00
Surface Temperature (F)
Sea Level Pressure (mb)
Winds (kts)
44°N
42°N
40°N
38°N
36°N
34°N
32°N
30°N
90°W
85°W
80°W
75°W
Sea Level Pressure Contours: 900 to 1100 by 4
Surface Temperature (F)
-20 -10 0 10 20 30 40 50 60 70 80 90
OUTPUT FROM WRF V1.3 MODEL
Phys Opt = 3 ; PBL Opt = 1 ; Cu Opt = 1 ; WE = 73 ; SN = 60 ; Levels = 27 ; Dis = 30km

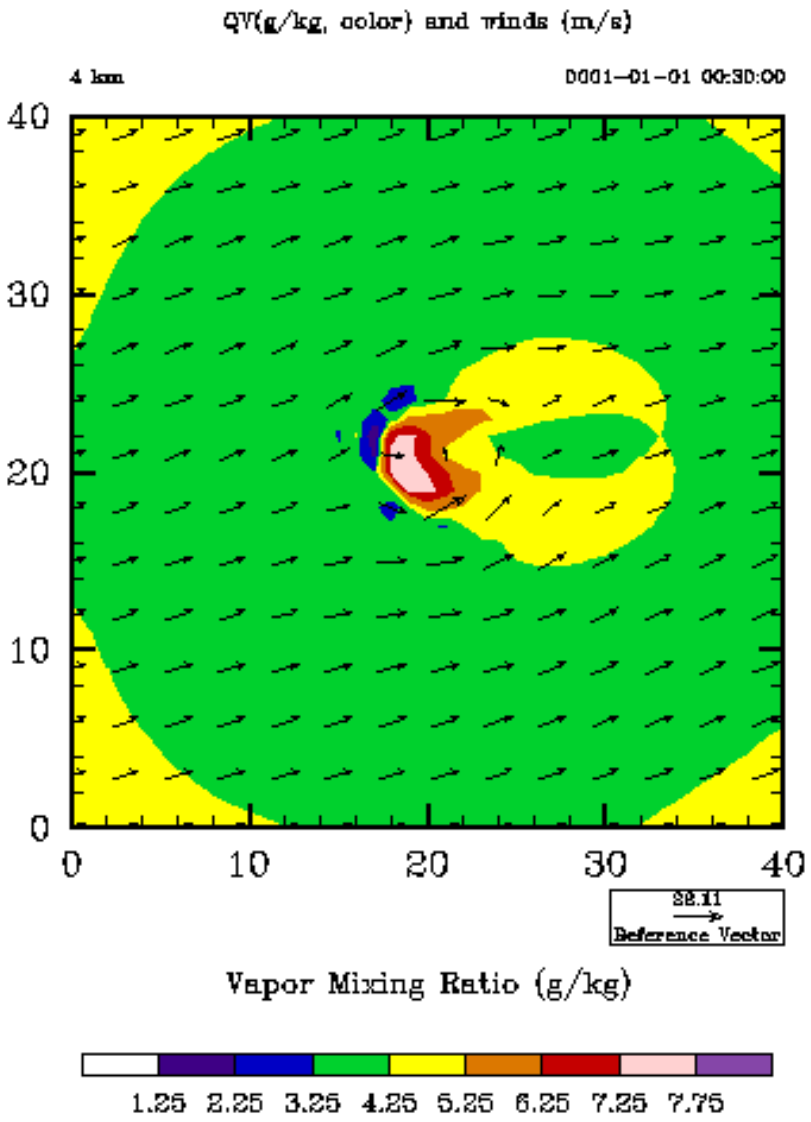


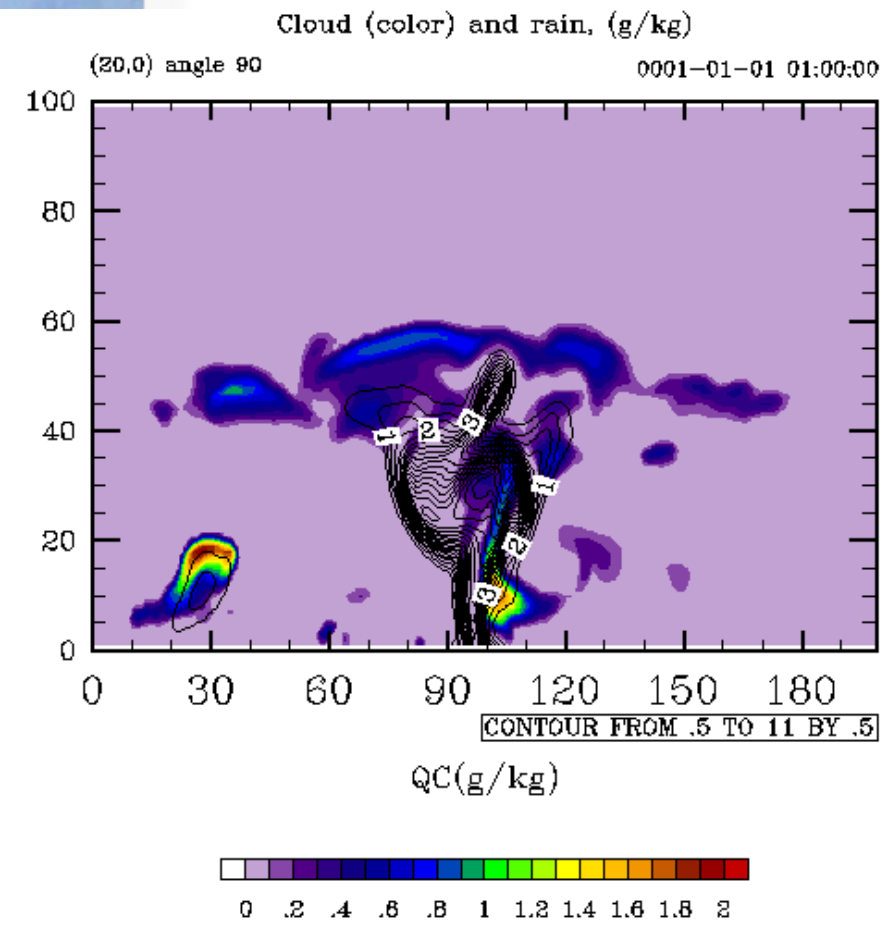


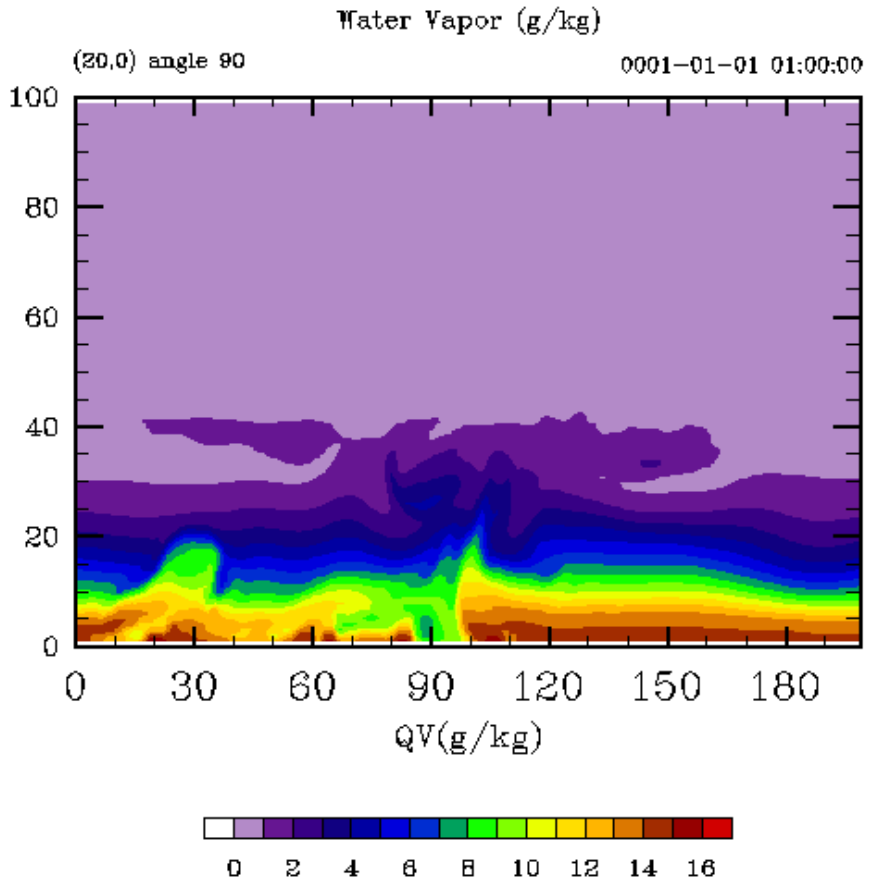
baroclinic wave

3D quarter-circle shear supercell thunderstorm









2D squall line

RIP4

Read/Interpolate/Plot (Version 4)

Written by Mark Stoelinga
UW / NCAR

general

- **Requires NCAR Graphics low-level routines**
  http://ngwww.ucar.edu

- **Documentation:**
  - In program tar file under the Doc/ directory
  - **http://www.mmm.ucar.edu/wrf/users/docs/ripug.htm**

general

- **Originally written for MM5 input and output, and recently rewritten and generalized to include WRF**
- **Horizontal plots** on σ, pressure, height, θ, θ_e, or PV surfaces
- **Vertical cross sections** on σ, pressure or log pressure, p, height, θ, θ_e, or PV as coordinate surface

general

- **Skew-T / log p soundings** specified at grid points or lat/lon, optional hodographs and sounding quantities
- **Forward and backward trajectories**
- **Generate input data for Vis5D**
- **Large number of diagnostic fields (> 100)**
- **Since version 4.1 – Works for *real* and *idealized data***

download RIP4 for WRF

- From wrf-model.org web site (*rip4.tar.gz*):

  http://www.mmm.ucar.edu/wrf/users/download/get_source.html

- "How to" and examples:

  http://www.mmm.ucar.edu/wrf/users/graphics/RIP4/RIP4.htm

RIP4 on your computer

- **set RIP_ROOT environment variable**

  setenv RIP_ROOT /usr/$USER/RIP4

- **Edit *Makefile* to define paths to netCDF library and include file on your computer:**

  new *NETCDFLIB* and *NETCDFINC*

- **make <machine type>** (*it'll make suggestions*)

  make dec (*example*)

- **RIP4 has 2 parts (RIPDP and RIP)**

ripdp_wrf

- **ripdp_wrf is *RIP Data Preparation for WRF***

- **RIP does not read WRF data directly**
- ***ripdp_wrf*** converts WRF netCDF data into RIP input format *(format described in the document)*
- **RIP puts each variable at each time into a separate file – LOTS of files**

mkdir storm_case

running ripdp_wrf

Optional
ripdp_sample.in

- **ripdp_wrf [-n namelist-file] **
  **<model_data_name> [basic/all] ** *new*
  <input_file1 input_file2>

Example

ripdp_wrf storm_case/test basic wrfout

use directory as part of the model_data_name

ripdp_wrf namelist

```
&userin
   ptimes=0,-72,1,ptimeunites='h',tacc=90.,
              discard='LANDMASK',H2SO4',
   iexpandedout=0
&end
```

- **Use namelist to add control**
  - ptimes – times for *ripdp_wrf* to process
    - *0,1,2*
    - *0,-72,1*
    - *0, 3,-24,3, 48*
  - discard fields if '*all*' is selected on the command line

rip

- **read the output generated by *ripdp_wrf***
- **read User Input File (UIF) *(rip_sample.in)***
  - **First** section is a list of general parameters *(namelist format)*
  - **Second** section is a series of plots in the Plot Specification Table (PST)
- **generate meta file**

running rip

- Edit the User Input File (UIF)
- setenv NCARG_ROOT /usr/local/ncarg
- setenv RIP_ROOT *your-rip-directory*

running rip

created by
ripdp_wrf

- **rip [-f] model-data-set-name **
  rip-execution-name

User Input File (UIF)

Example

rip -f storm_case/test rip_sample.in

use directory as part of the
model_data_set_name

output ; metacode

rip_sample.out
rip_sample.ncgm

rip UIF

&userin
.....
&end

Namelist controlling general parameters

&trajcalc
.....
&end

Namelist for trajectory calculations
Only used if itrajcalc=1, in userin namelist

==========

--------- Plot Specification Table ----------

==========

feld= .....
feld= .....

Frame specification group (FSG)

==========

feld= .....

Plot specification line (PSL)

feld= .....
feld= .....

==========

Plot Specification Table (PST)

rip namelist - userin

- **Use namelist to control**
  - processing times, intervals
  - title information
  - text quality on a plot
  - whether to do time series, trajectory, or to write output for Vis5D

- **Full explanation for namelist variables is available in the user document**

rip namelist - userin

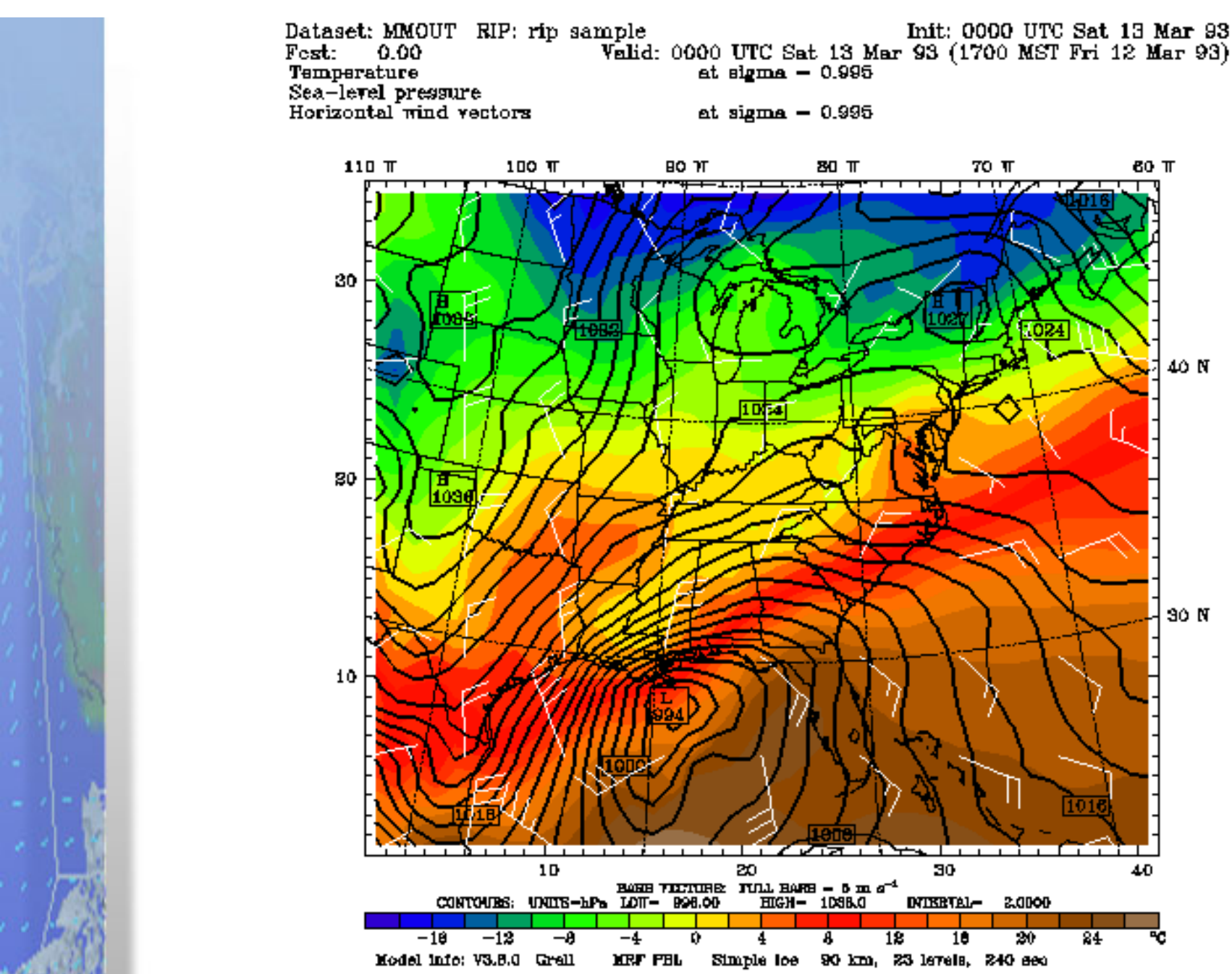
- idotitle – first part of first title line
- titlecolor – color of title lines
- ptimes, ptimeunits – times to process
- tacc – tolerance for processing data
- timezone –display of local time
- iusedaylightrule – 1 applied, 0 not applied
- iinittime – plotting of initial time
- ivalidtime – plotting of valid time
- inearsth – plot times as 2 / 4 digits
- flmin, frmax, fbmin, ftmax – frame size
- ntextq – text quality

rip namelist - userin

- ntextcd – text font
- fcoffset – 12 means hour 12 of the MM5 forecast is considered hour 0 by you
- idotser – generate time series output
- idescriptive – more descriptive titles
- icgmsplit – split metacode into several files
- maxfld – reserve memory for RIP (10-15)
- itrajcalc – 0, 1 ONLY when doing trajectory calculations *(use also namelist trajcalc)*
- imakev5d – 0, 1 generate Vis5D data

example

```
==========================================
feld=tmc; ptyp=hc; vcor=s; levs=b1; cint=2; >
  cmth=fill ;cosq=-32,light.violet, >
  -16,blue,0,yellow, 16,orange, 32,light.gray
feld=slp; ptyp=hc; cint=2; linw=2
feld=uuu,vvv; ptyp=hv; vcmx=-1; >
  colr=white; intv=5
feld=map; ptyp=hb
feld=tic; ptyp=hb
==========================================
```



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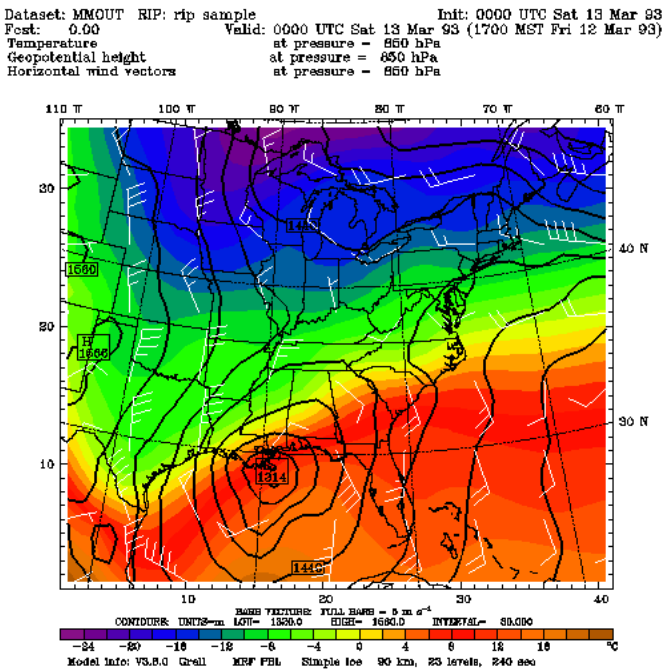
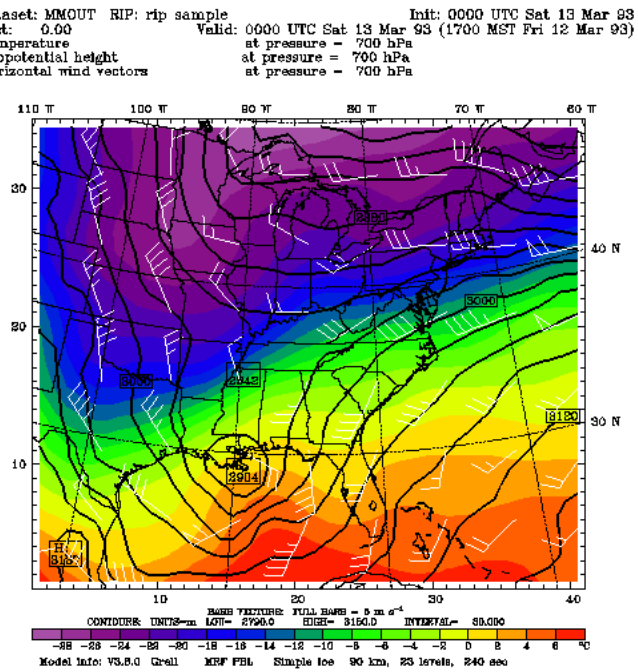
example

```
=========================================
feld=tmc; ptyp=hc; vcor=p; >
  levs=850,700,-300,100; cint=2; >
  cmth=fill ;cosq=-32,light.violet, >
  -16,blue,0,yellow, 16,orange, >
  32,light.gray
feld=ght; ptyp=hc; cint=30; linw=2
feld=uuu,vvv; ptyp=hv; vcmx=-1; >
  colr=white; intv=5
feld=map; ptyp=hb
feld=tic; ptyp=hb
=========================================
```

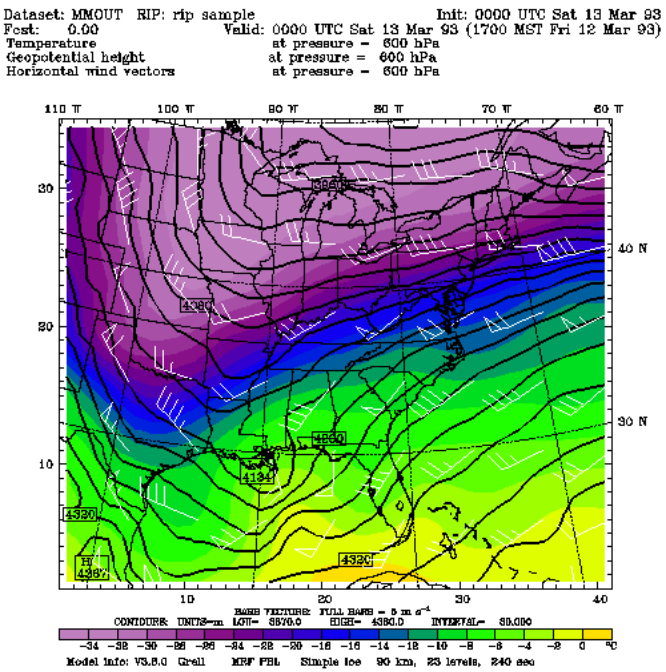
850 mb



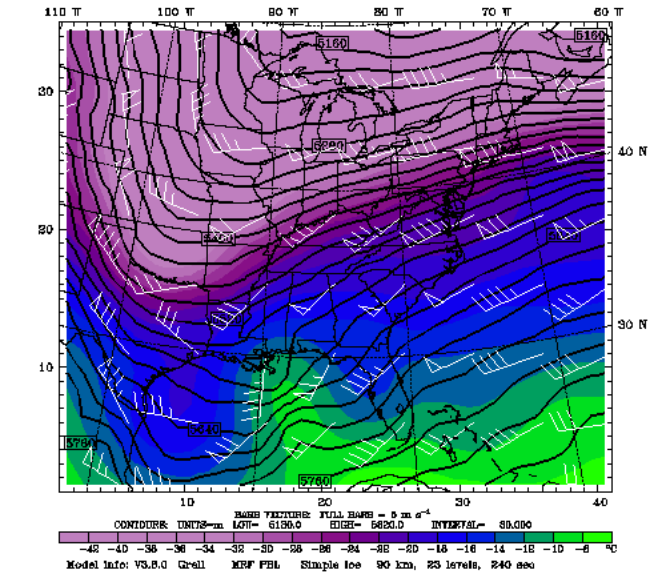
700 mb



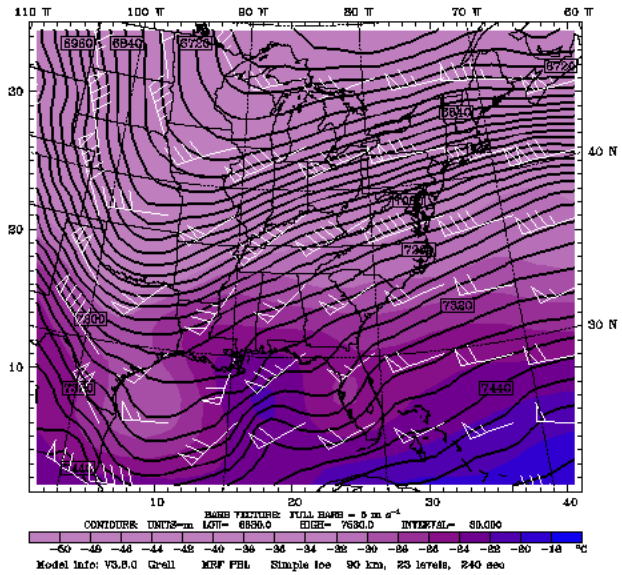
600 mb



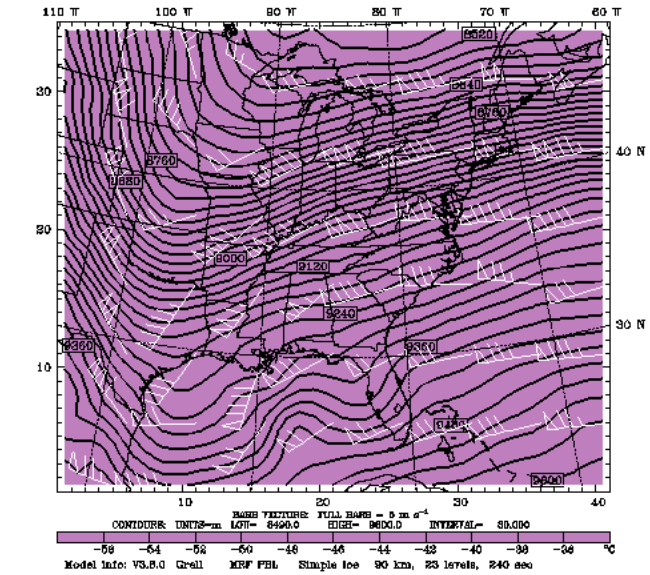
500 mb



400 mb



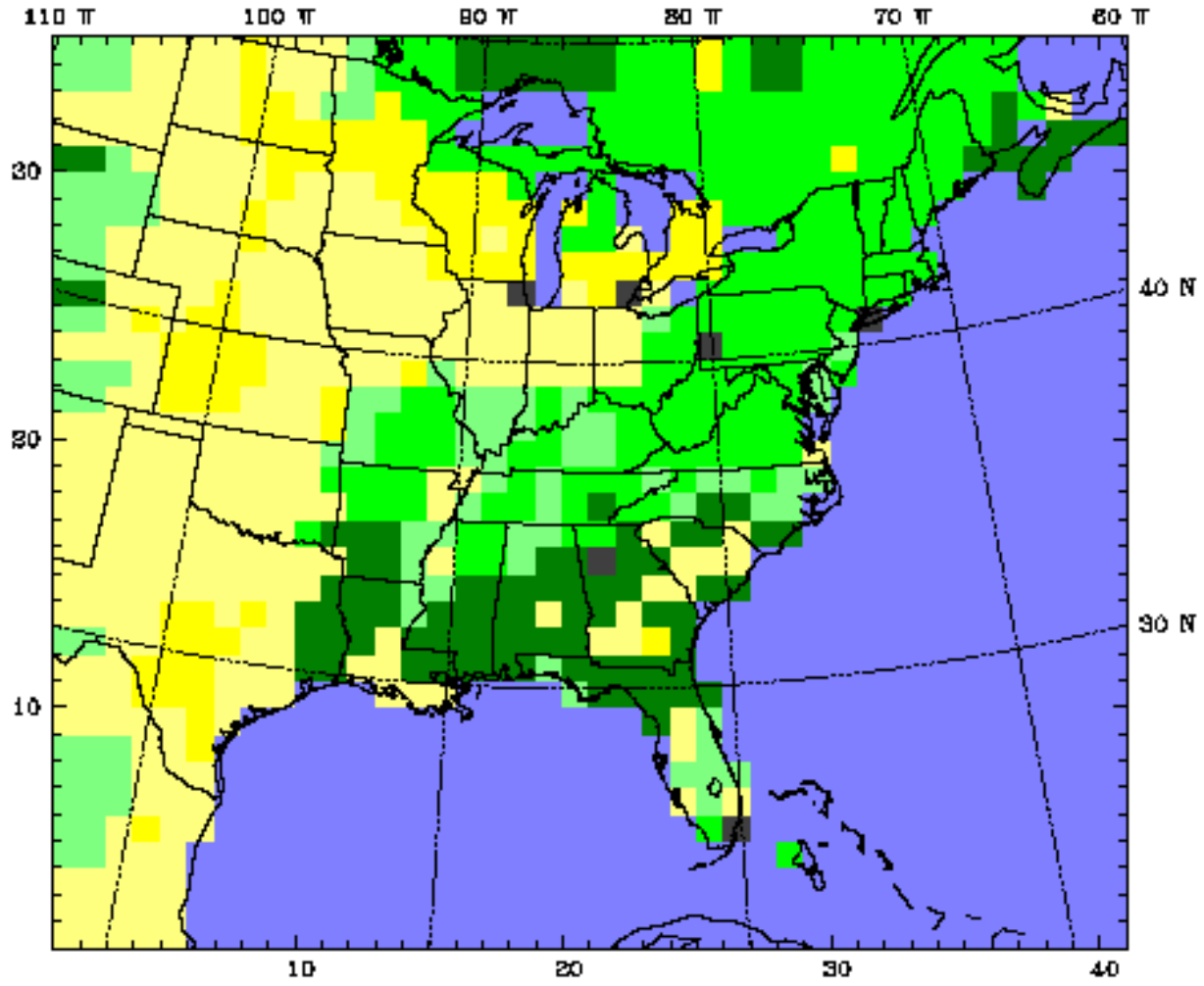
300 mb



example - different color fill

```
==========================================
feld=xlus; ptyp=hh; chfl; cosq=1,dark.gray,2,light.yellow, >
  3,light.green,4,yellow,5,yellow,6,light.green,>
  7,light.yellow,8,light.green,9,light.green,>
  10,light.yellow,11,green,12,dark.green,13,green,>
  14,dark.green,15,green, 16,blue,17,green,18,green,>
  19,light.gray,20,light.gray,21,dark.green, 22,light.gray,>
  23,light.gray,24,white
feld=map; ptyp=hb
feld=tic; ptyp=hb
time=0
==========================================
```

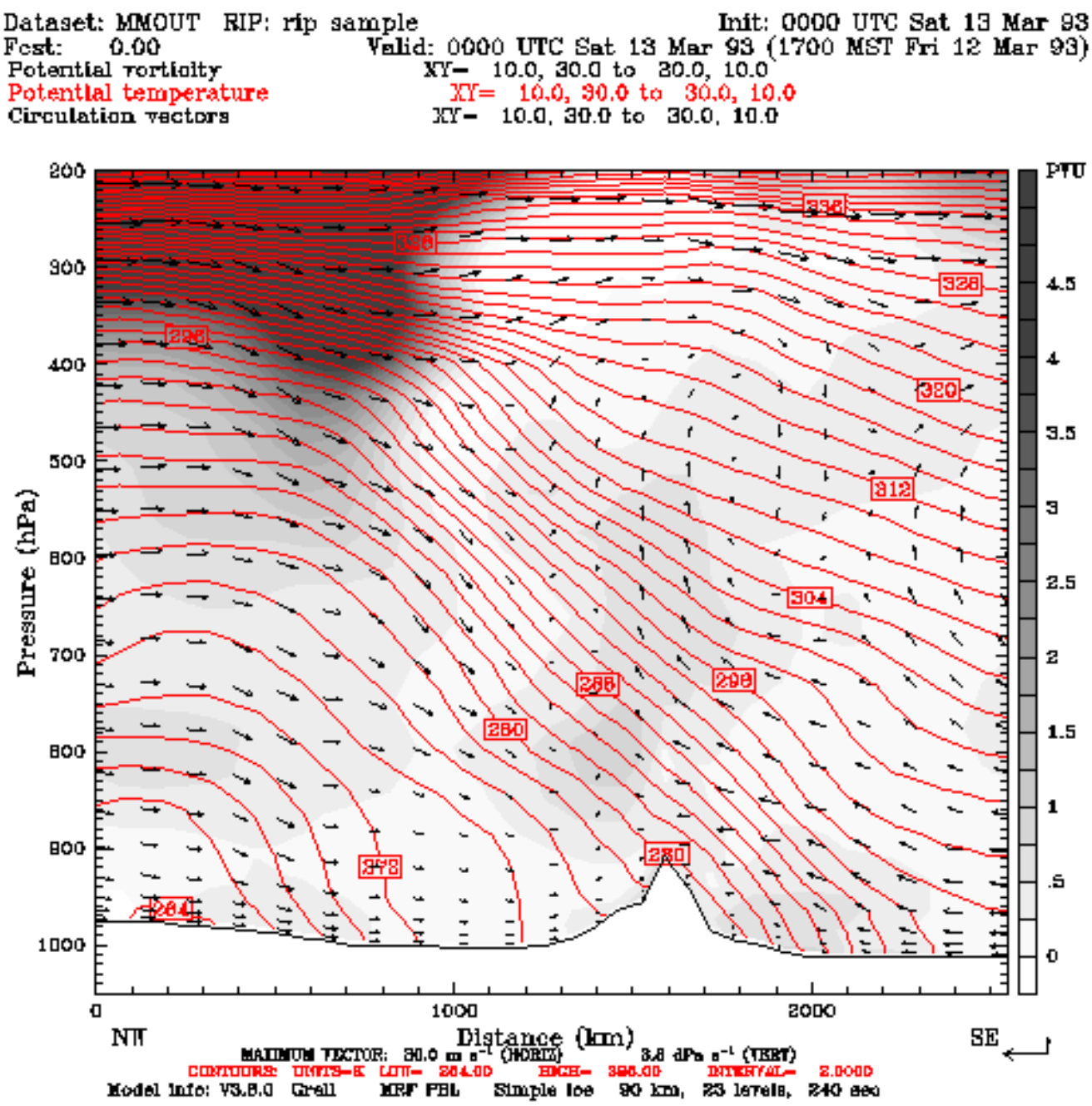
Dataset: MMOUT RIP: rip sample Init: 0000 UTC Sat 13 Mar 93
Fcst: 0.00 Valid: 0000 UTC Sat 13 Mar 93 (1700 MST Fri 12 Mar 93)
Land use category



Model Info: V3.5.0 Grell MRF PBL Simple Ice 90 km, 23 levels, 240 sec

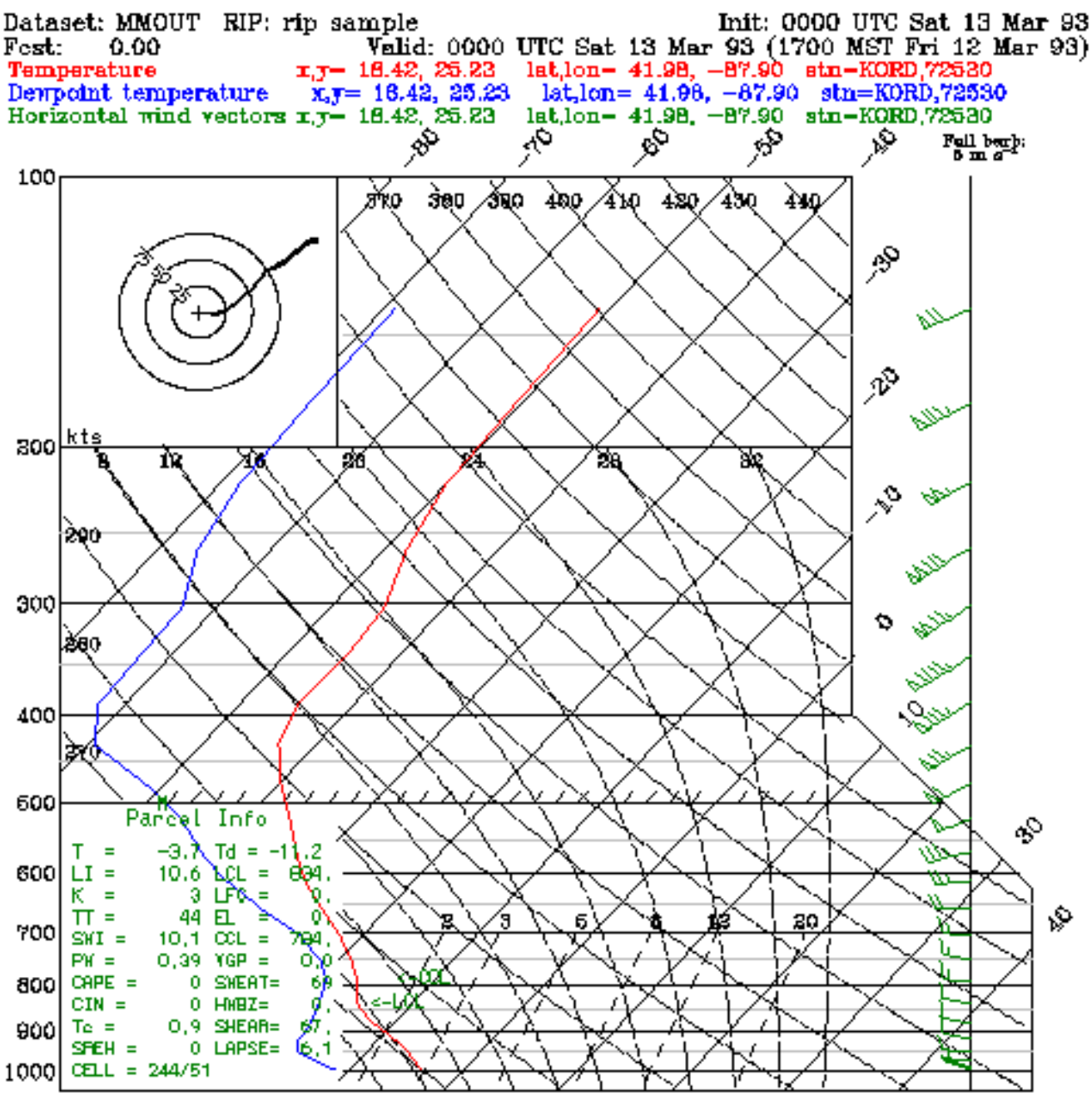
example - cross section

```
==========================================
feld=pvo; ptyp=vc; crsa=10,30; crsb=30,10;
  vcor=p; vwin=1050,200; cint=.25; >
  cmth=fill ;cosq=0,white,4,dark.gray;  >
  cbeg=0; cend=5
feld=the; ptyp=vc; cint=2; colr=red
feld=uuu,vvv,omg; ptyp=vv
feld=tic; ptyp=hb
==========================================
```


Dataset: MMOUT RIP: rip sample
Init: 0000 UTC Sat 13 Mar 93
Fcst: 0.00
Valid: 0000 UTC Sat 13 Mar 93 (1700 MST Fri 12 Mar 93)
Potential vorticity XY= 10.0, 30.0 to 30.0, 10.0
Potential temperature XY= 10.0, 90.0 to 30.0, 10.0
Circulation vectors XY= 10.0, 30.0 to 30.0, 10.0
Pressure (hPa)
Distance (km)
NW
SE
PVU
MAXIMUM VECTOR: 30.0 m s-1 (HORIZ) 3.8 dPa s-1 (VERT)
CONTOURS: UNITS=K LOW= 264.00 HIGH= 336.00 INTERVAL= 2.0000
Model Info: V3.5.0 Grell MRF PBL Simple Ice 90 km, 23 levels, 240 sec

example - skew-T

```
=========================================
feld=tic; ptyp=sb; sloc=KORD; hodo; sngdg
feld=tmc; ptyp=sc; colr=red
feld=tdp; ptyp=sc; colr=blue
feld=uuu,vvv; ptyp=sv; colr=dark.green >
  hodo; sndg
=========================================
```



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WRF-to-GrADS

general

- **Requires GrADS software**
  freely available from
  http://grads.iges.org/grads/grads.html

- **Documentation:**
  http://grads.iges.org/grads/gadoc/index.html

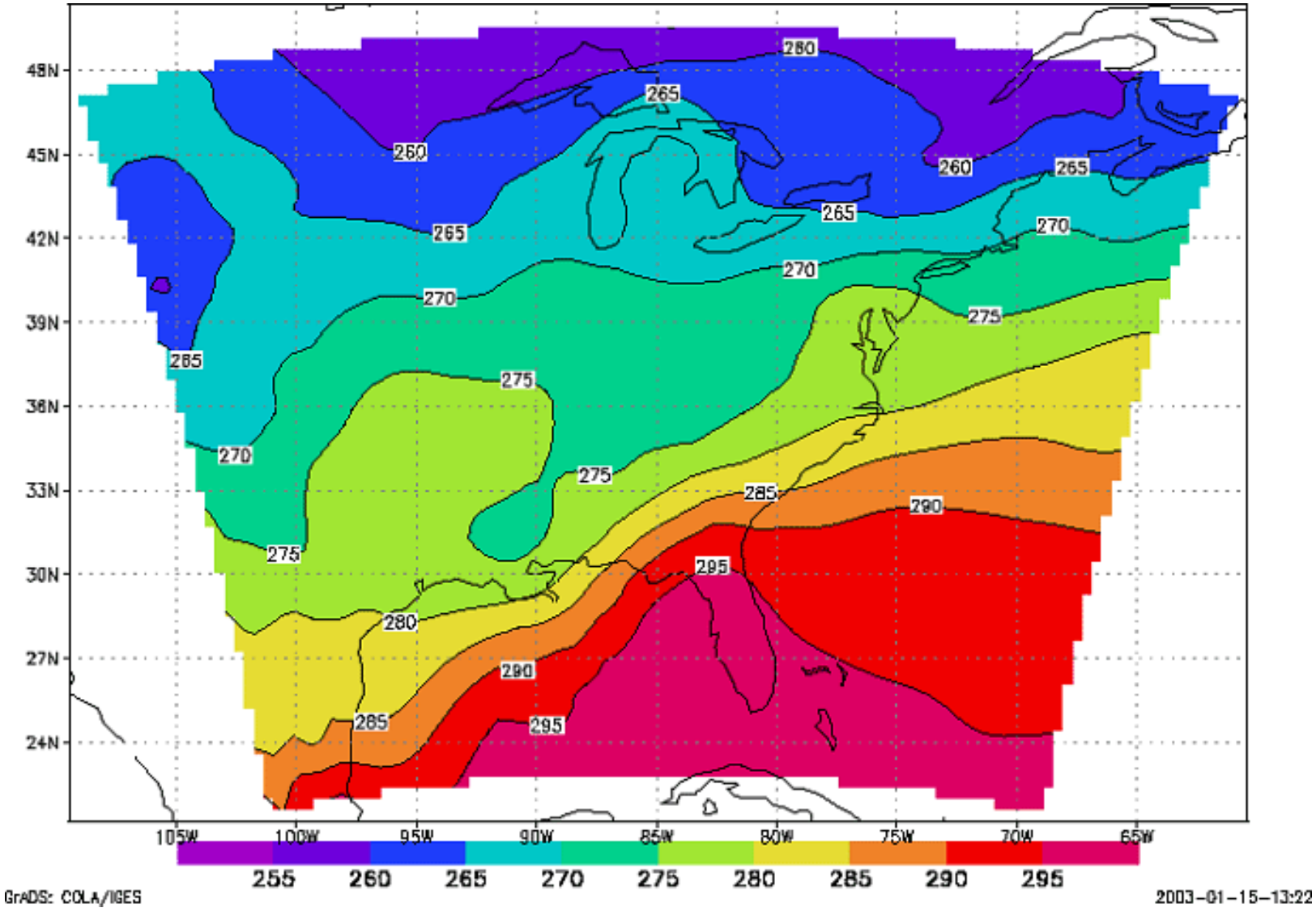
general

- **Converter** creates GrADS file ***(.dat***) and the corresponding control file ***(.ctl***)
- **Horizontal plots** on model, height or pressure surfaces
- **Vertical cross sections** model, height or pressure surfaces
- **Skew-T/log p soundings** specified at grid points (*lat/lon*), hodographs and sounding quantities
- **Works for *real-data* , *idealized data* and *static data***

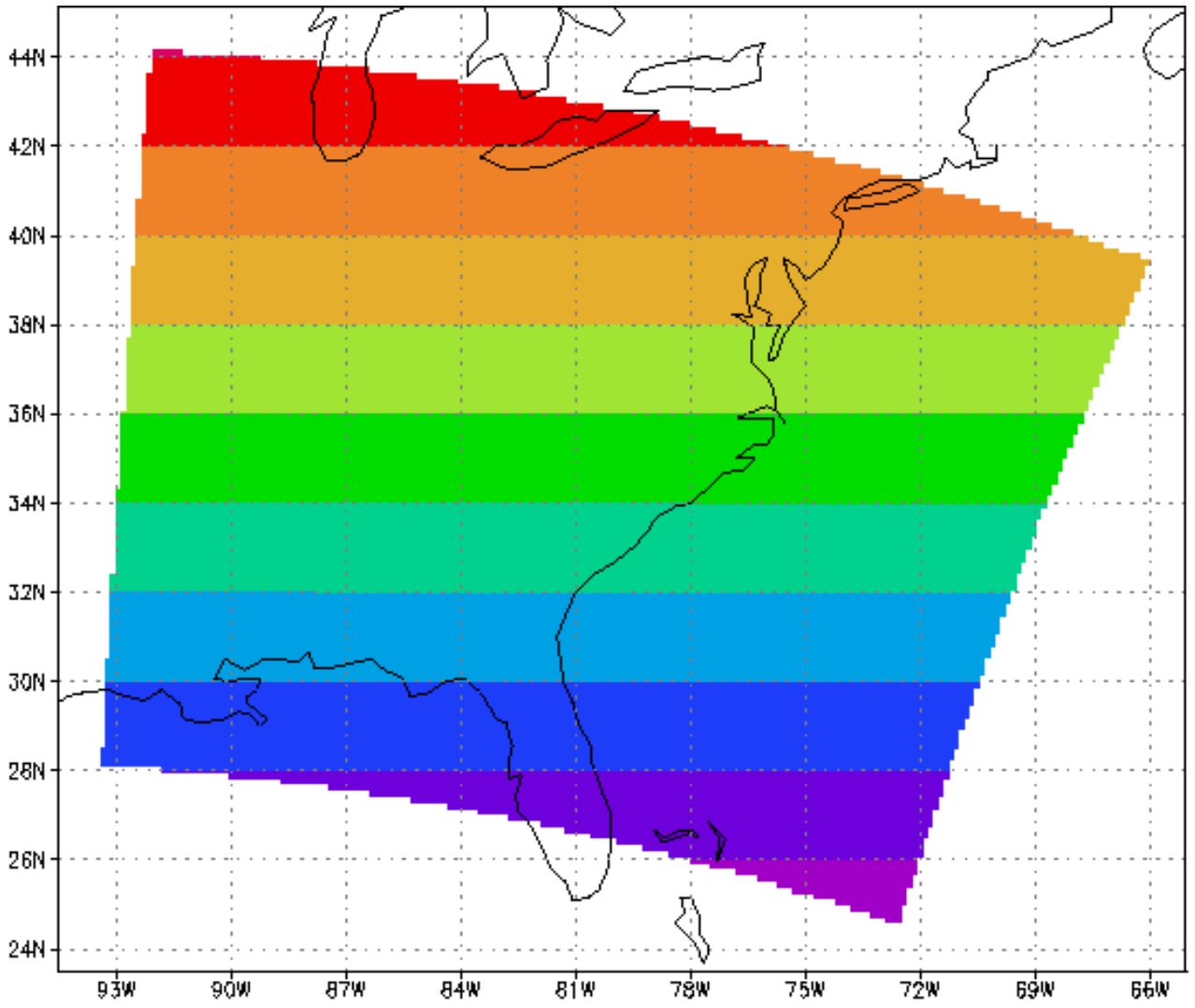
general

- **Allow users to tailor the graphics**
- **Create large data files**
- **Interactive** *(requires basic understanding of the GrADS software)*
- **Adding diagnostics on the fly**
- **Animations (x,y,z,t)**
- **Zooming capability**
- **Multiple frames on one “page”**
- **Don’t have to rerun to generate new images**

projection


48N
45N
42N
39N
36N
33N
30N
27N
24N
105W
100W
95W
90W
85W
80W
75W
70W
65W
255
260
265
270
275
280
285
290
295
GrADS: COLA/IGES
2003-01-15-13:22

projection



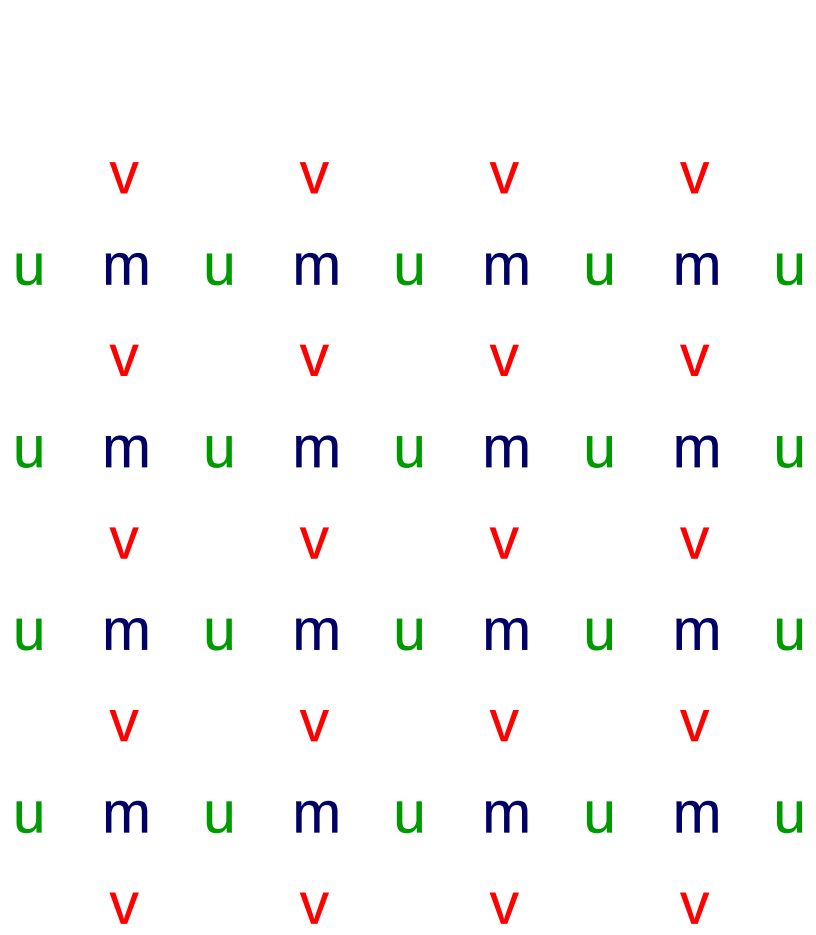
GrADS: COLA/IGES

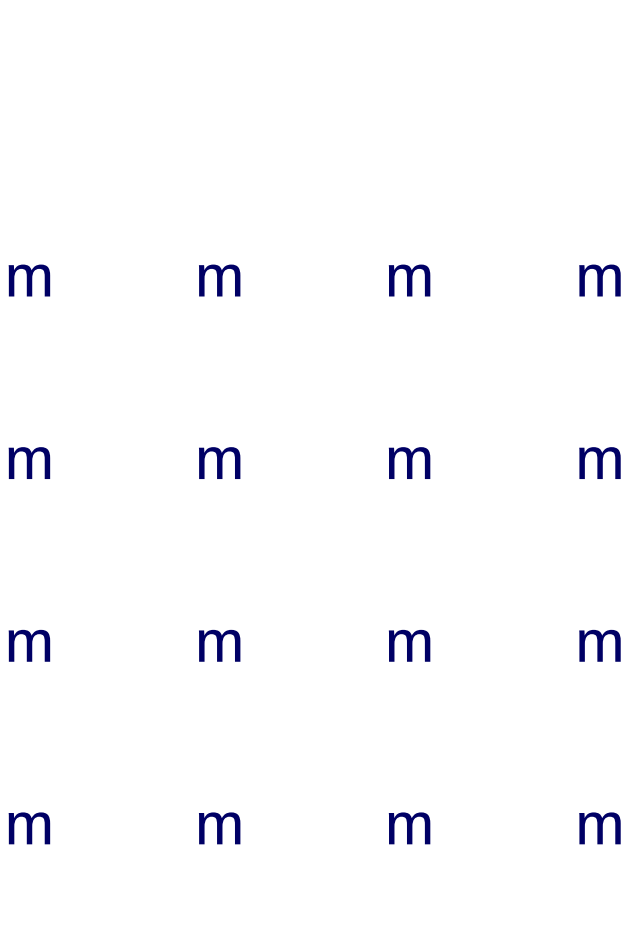
2002-04-03-12:20

question

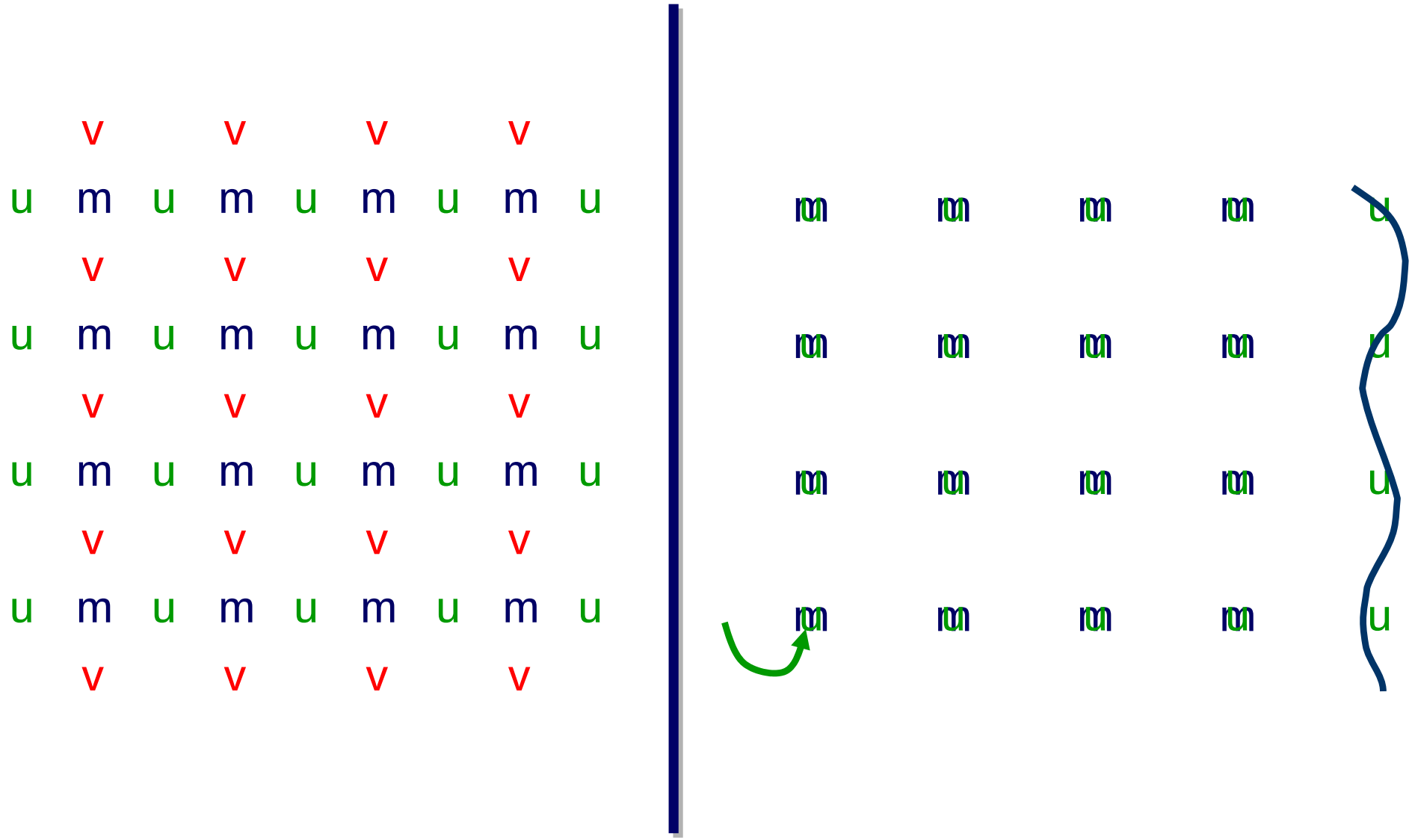
- **Why is a converter needed if GrADS can display netCDF files?**
  - Can only display model surface coordinates
  - Cannot interpolate to height or pressure levels
  - All diagnostics must be added via GrADS script files
  - Staggering creates a problem
  - *(GRIB1 model output can also be read directly by GrADS, but above issues are still valid)*

staggering problem

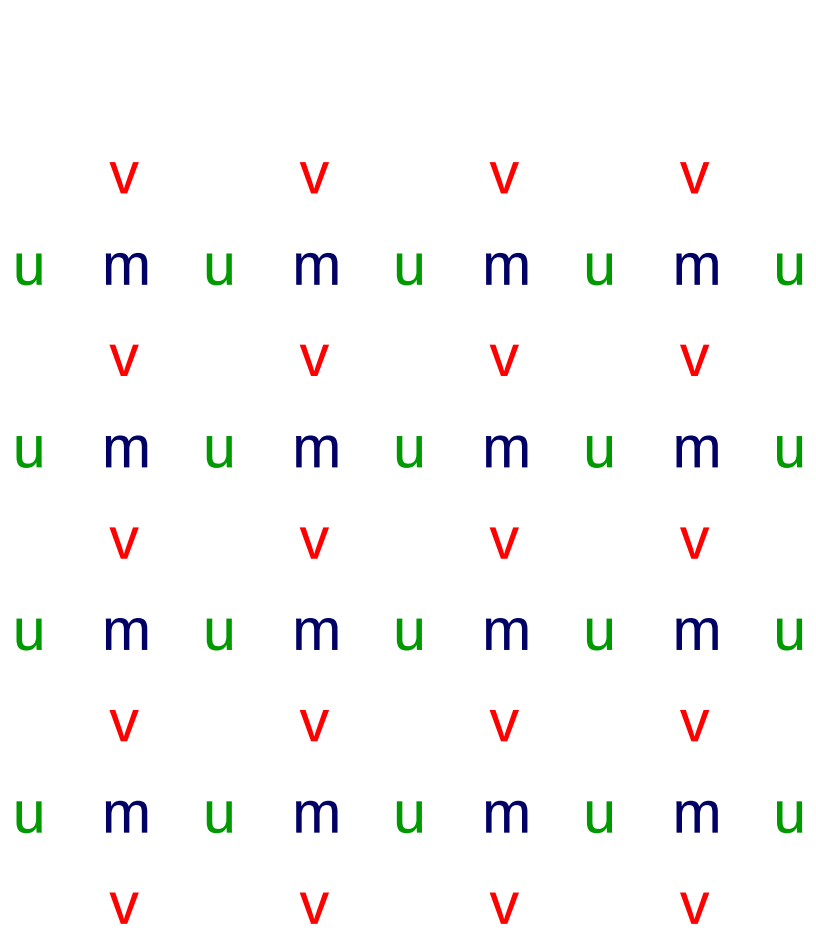


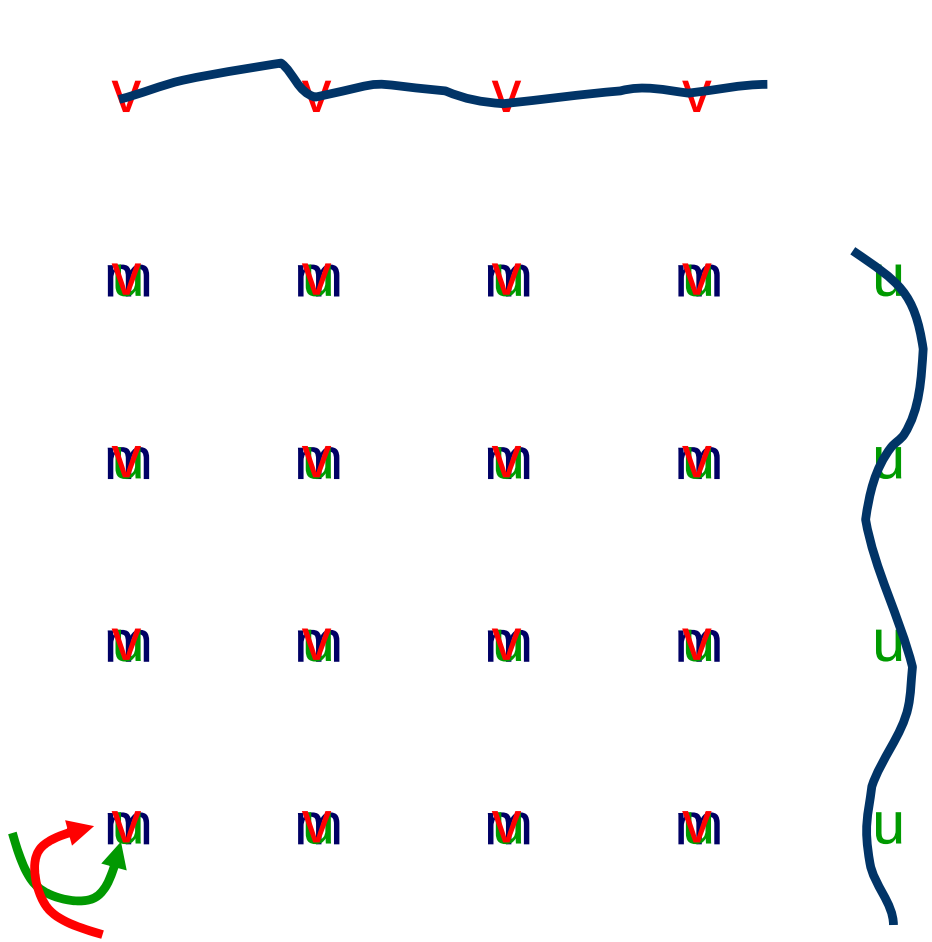


staggering problem



staggering problem





download WRF2GrADS

- From wrf-model.org web site (*wrf2grads.tar.gz*):

  http://www.mmm.ucar.edu/wrf/users/download/get_source.html

- "How to" and examples:

  http://www.mmm.ucar.edu/wrf/users/graphics/WRF2GrADS/GrADS.htm

WRF2GrADS

Makefile
README

Edit:

- Computer
- netCDF libraries

control_file
control_file_height
control_file_pressure

module_wrf_to_grads_netcdf.F
module_wrf_to_grads_util.F
wrf_to_grads.F

wrf_to_grads

cbar.gs
rgbset.gs

skew.gs
real_surf.gs
plevels.gs
rain.gs
cross_z.gs
zlevels.gs
input.gs
bwave.gs
grav2d.gs
hill2d.gs
qss.gs
sqx.gs
sqy.gs

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module_wrf_to_grads_util.F
wrf_to_grads.F

cbar.gs
rgbset.gs

skew.gs
real_surf.gs
plevels.gs
rain.gs
cross_z.gs
zlevels.gs
input.gs
bwave.gs
grav2d.gs
hill2d.gs
qss.gs
sqx.gs
sqy.gs

control_file

```
2
2000-01-24_12:00:00
2000-01-24_18:00:00
2000-01-25_00:00:00
end_of_time_list
U                ! U  wind
V                ! V  wind
  UMET           ! U wind - rotated
  VMET           ! V wind - rotated
W                ! W  wind
TC               ! Temperature in C
TKE              ! TKE
P                ! Pressure (hPa)
  Z              ! Height (m)
QVAPOR           ! Vapor
QCLOUD           ! Cloud Water
TSLB             ! soil Temp
  SMOIS          ! soil moisture
end_of_3dvar_list
```

Time

- Number of times to process

-Times to process

Negative : all times

control_file

```
2
2000-01-24_12:00:00
2000-01-24_18:00:00
2000-01-25_00:00:00
end_of_time_list
U                ! U  wind
V                ! V  wind
 UMET            ! U wind - rotated
 VMET            ! V wind - rotated
W                ! W  wind
TC               ! Temperature in C
TKE              ! TKE
P                ! Pressure (hPa)
  Z              ! Height (m)
QVAPOR           ! Vapor
QCLOUD           ! Cloud Water
TSLB             ! soil Temp
  SMOIS          ! soil moisture
end_of_3dvar_list
```

3d variables to process

- Also soil
- Indent to skip
- Need description
- Add if in netCDF
- Unknown will be skipped
- Diagnostics

control_file

2d variables to process

- Indent to skip
- Need description
- Add if in netCDF
- Unknown will be skipped
- Diagnostics

```
RAINC          ! total PRECIP
RAINNC         ! grid PRECIP
slvl           ! sea level pressure
T2             ! TEMP at 2 M
U10            ! U at 10 M
  U10M         ! U 10 M - rotated
V10            ! V at 10 M
  V10M         ! V 10 M - rotated
XLAT           ! LATITUDE
XLONG          ! LONGITUDE
XLAND          ! LAND MASK
end_of_2dvar_list
    /DATA/real/wrfinput_d01
wrfout_d01_2000-01-24_12
wrfout_d01_2000-01-25_00
  /b_wave/wrfout_d01
  /hill2d_x/wrfout_d01
end_of_file_list
```

control_file

```
RAINC           ! total PRECIP
RAINNC          ! grid PRECIP
slvl            ! sea level pressure
T2              ! TEMP at 2 M
U10             ! U at 10 M
  U10M          ! U 10 M - rotated
V10             ! V at 10 M
  V10M          ! V 10 M - rotated
XLAT            ! LATITUDE
XLONG           ! LONGITUDE
XLAND           ! LAND MASK
end_of_2dvar_list
    /DATA/real/wrfinput_d01
wrfout_d01_2000-01-24_12
wrfout_d01_2000-01-25_00
  /b_wave/wrfout_d01
  /hill2d_x/wrfout_d01
end_of_file_list
```

List of files to process

- Indent to skip
- More than 1 input (must be for same type)
- Must be in correct order
- Must have at least one input file

control_file

```
real        ! real / ideal / static
1           ! map background
0           ! specify vertical grid
            ! 0=Cartesian,
            ! -1=interp lowest z
            ! 1 list levels
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
```

control_file

```
real        ! real / ideal / static
1           ! map background
1           ! specify vertical grid
! 0=Cartesian,
! -1=interp lowest z
! 1 list levels
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
```

List of levels

- Indent have **NO** effect
- Pressure (mb) / Height (km)
- Bottom to top
- No need to number levels

control_file

```
real        ! real / ideal / static
1           ! map background
1           ! specify vertical grid
! 0=Cartesian,
! -1=interp lowest z
! 1 list levels
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
```

List of levels

- Indent have **NO** effect
- Pressure (mb) / Height (km)
- Bottom to top
- No need to number levels

running WRF2GrADS

- Edit **Makefile**
- **make**
- Edit **control_file**
- **Run**

  wrf_to_grads control_file MyOutput *[-options]*

  MyOutput.dat & MyOutput.ctl

  – There are 3 debug levels (options) available:

  None : Only basic information

  -v : Debug option low

  -V : Debug option high (*lots of output*)

WRF2GrADS

Makefile
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module_wrf_to_grads_netcdf.F
module_wrf_to_grads_util.F
wrf_to_grads.F

cbar.gs
rgbset.gs

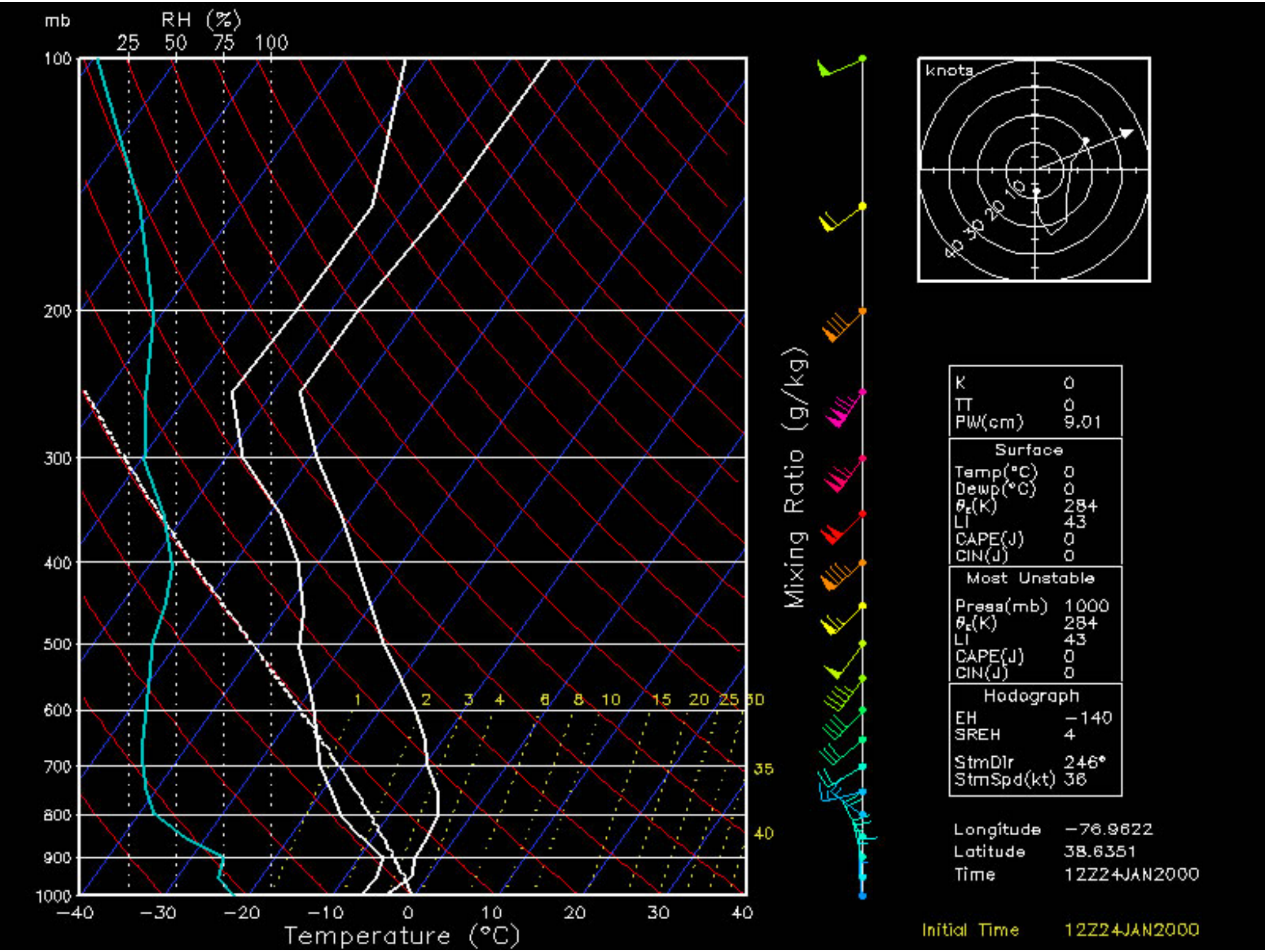
skew.gs
real_surf.gs
plevels.gs
rain.gs
cross_z.gs
zlevels.gs
input.gs

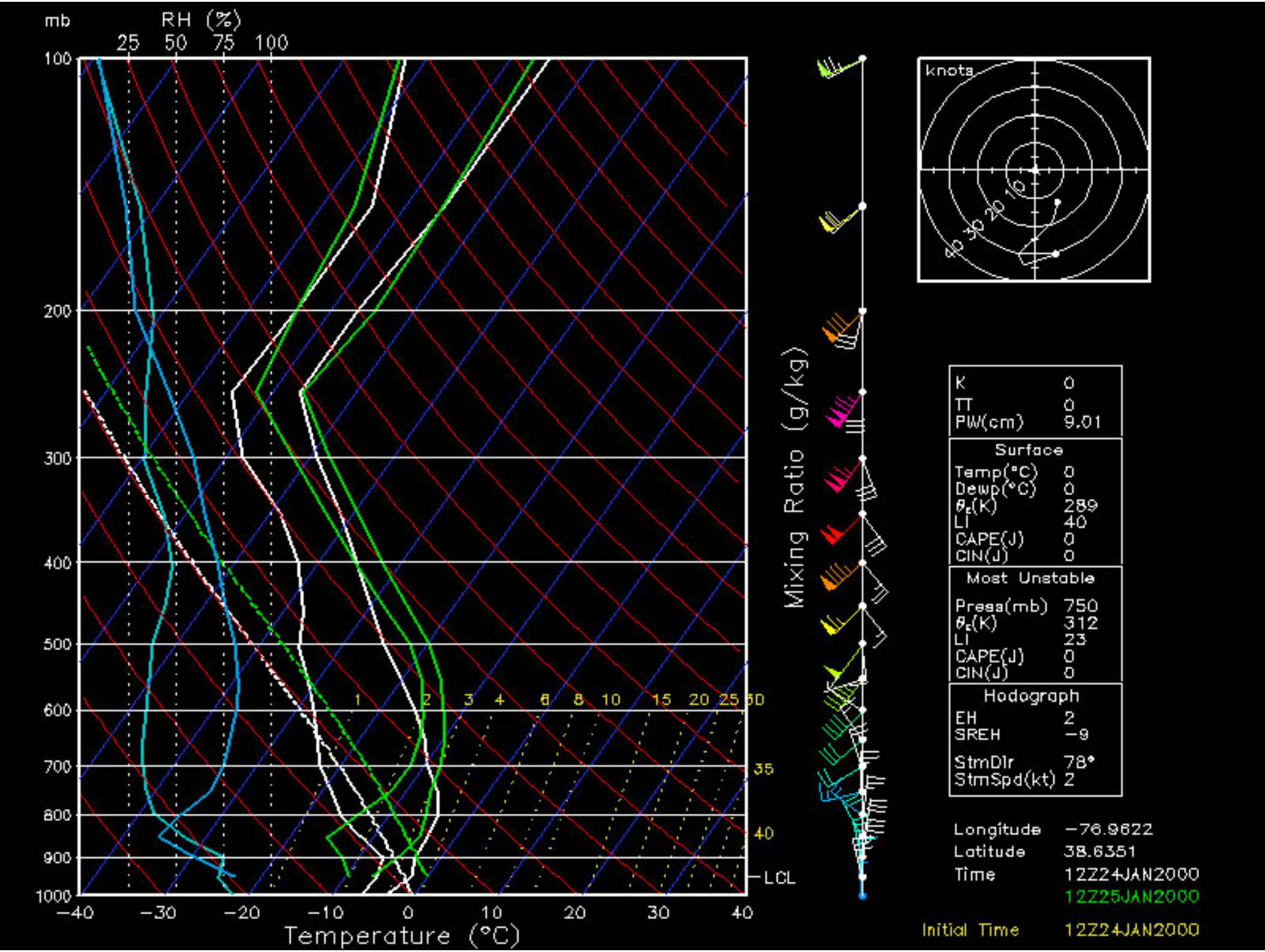
real

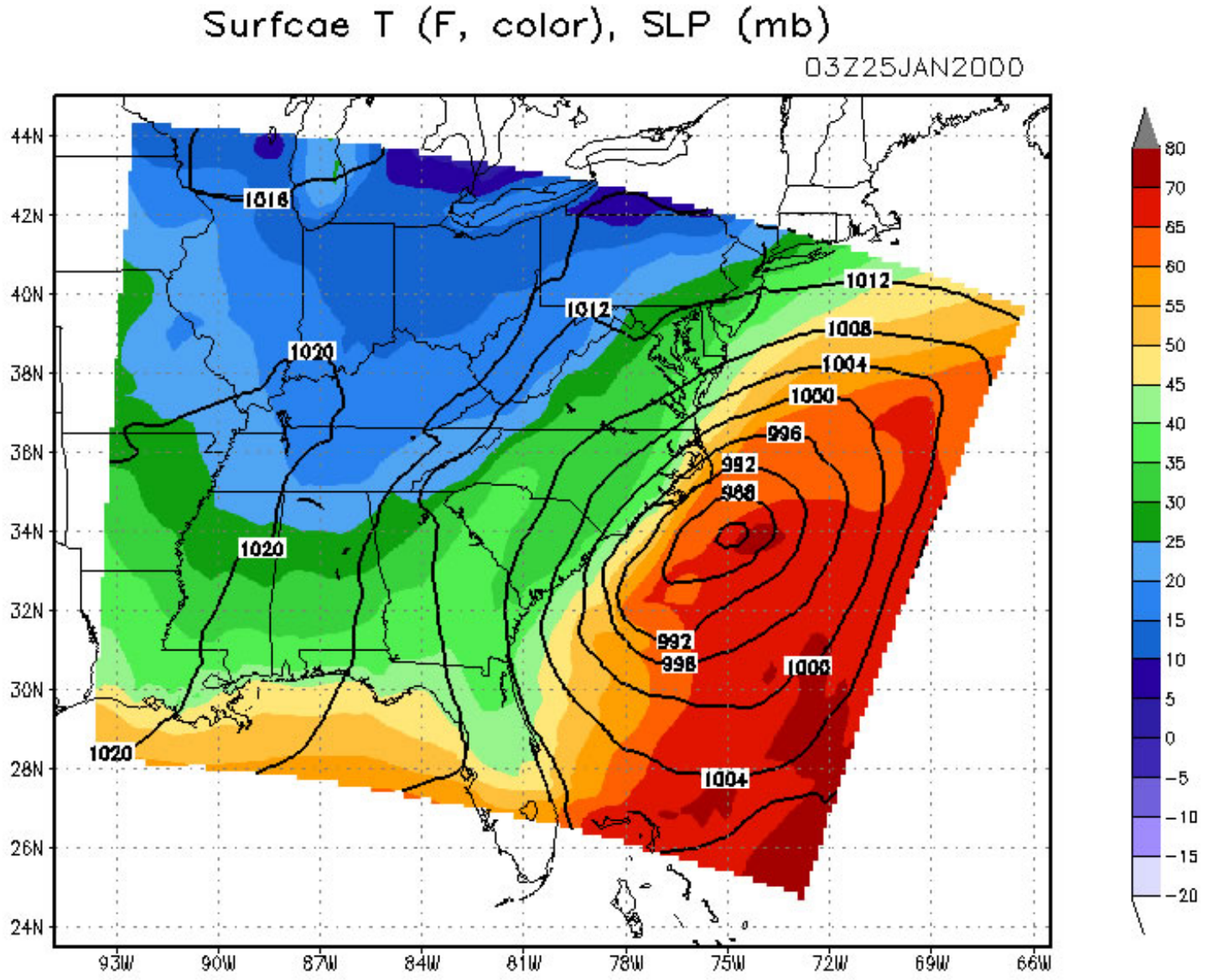
bwave.gs
grav2d.gs
hill2d.gs
qss.gs
sqx.gs
sqy.gs

ideal

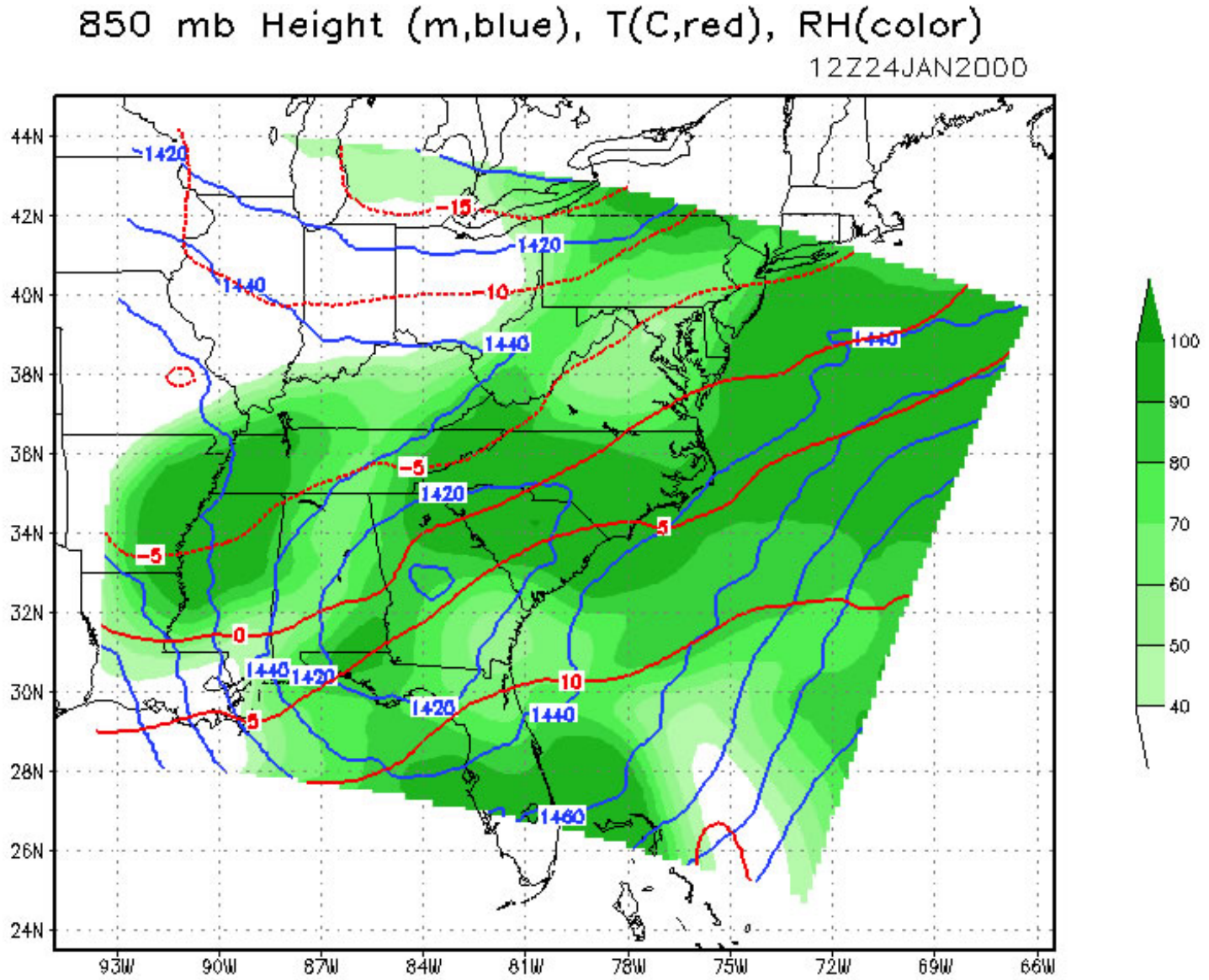
```
ga-> run skew

 Initial Time is 12Z24JAN2000
 Create gif images as well (1=yes ; 0=no)                    1

 Please enter coordinated for sounding
 Latitude values between: 23.5 and 44.9865
 Enter Latitude                                          38.58

 Longitude values between: -94.8 and -65.4757
 Enter Longitude                                        -77.0

 Overlay two time periods 1=yes ; 0=no                       1

 Please enter time to plot
 Available times: 1 to 9                                     1
 Drawing .....
 Done.

 Please enter time to plot
 Available times: 1 to 9                                     9
 Drawing.....
 Done.

 Continue with another sounding 1=yes ; 0=no                 0
```


mb
RH (%)
25 50 75 100
100
200
300
400
500
600
700
800
900
1000
−40 −30 −20 −10 0 10 20 30 40
Temperature (°C)
1 2 3 4 6 8 10 15 20 25 30
35
40
Mixing Ratio (g/kg)
knots
10 20 30
K 0
TT 0
PW(cm) 9.01
Surface
Temp(°C) 0
Dewp(°C) 0
θe(K) 284
LI 43
CAPE(J) 0
CIN(J) 0
Most Unstable
Press(mb) 1000
θe(K) 284
LI 43
CAPE(J) 0
CIN(J) 0
Hodograph
EH −140
SREH 4
StmDir 246°
StmSpd(kt) 36
Longitude −76.9622
Latitude 38.6351
Time 12Z24JAN2000
Initial Time 12Z24JAN2000


mb
RH (%)
25 50 75 100
100
200
300
400
500
600
700
800
900
1000
−40 −30 −20 −10 0 10 20 30 40
Temperature (°C)
1 2 3 4 6 8 10 15 20 25 30
35
40
LCL
Mixing Ratio (g/kg)
knots
10 20 30
K 0
TT 0
PW(cm) 9.01
Surface
Temp(°C) 0
Dewp(°C) 0
θe(K) 289
LI 40
CAPE(J) 0
CIN(J) 0
Most Unstable
Press(mb) 750
θe(K) 312
LI 23
CAPE(J) 0
CIN(J) 0
Hodograph
EH 2
SREH −9
StmDir 78°
StmSpd(kt) 2
Longitude −76.9622
Latitude 38.6351
Time 12Z24JAN2000
12Z25JAN2000
Initial Time 12Z24JAN2000


Surfcae T (F, color), SLP (mb)
03Z25JAN2000
44N
42N
40N
38N
36N
34N
32N
30N
28N
26N
24N
93W
90W
87W
84W
81W
78W
75W
72W
69W
66W
1016
1012
1020
1008
1004
1000
996
992
988
1020
992
996
1008
1020
1004
80
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
−5
−10
−15
−20

real data



real data

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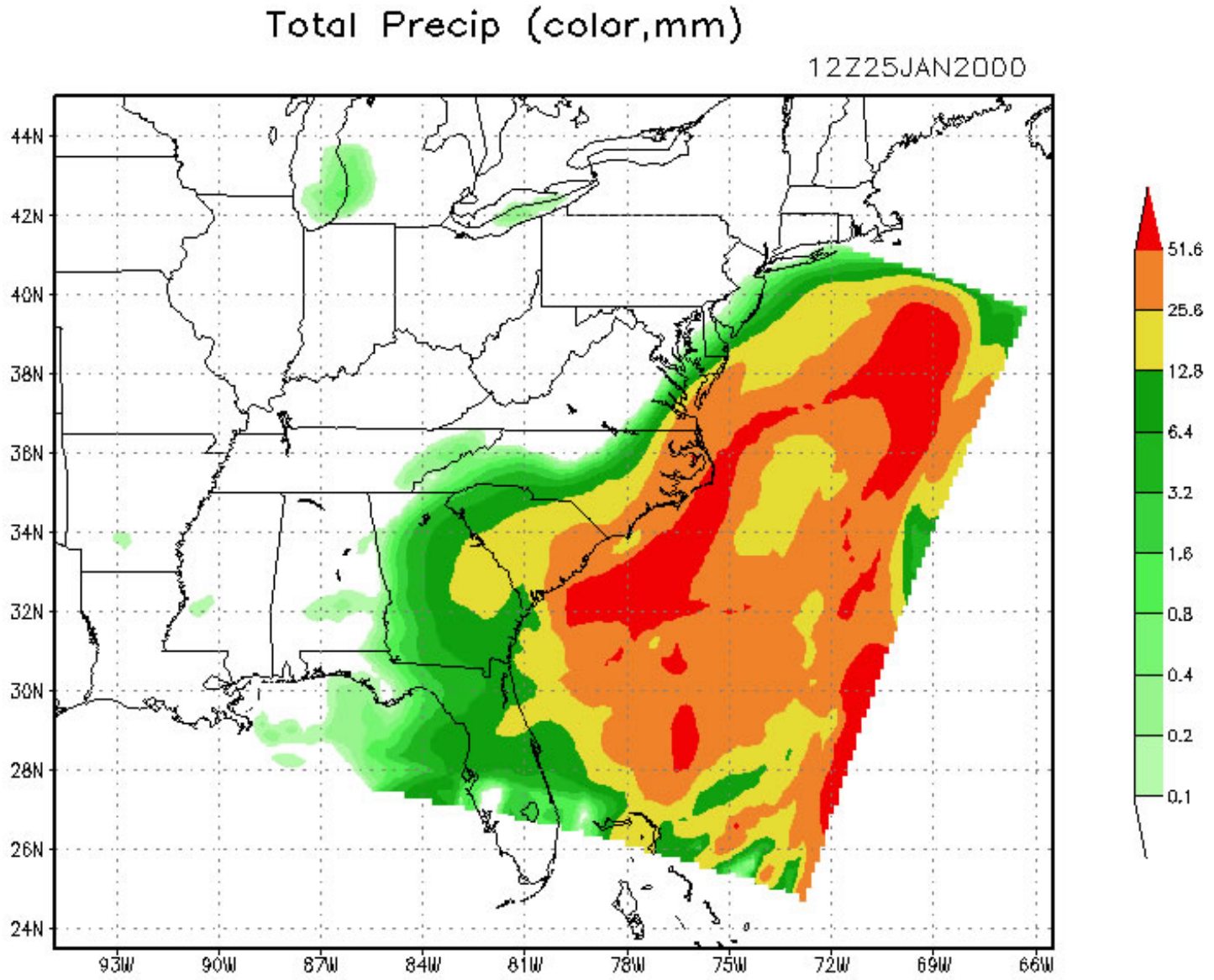
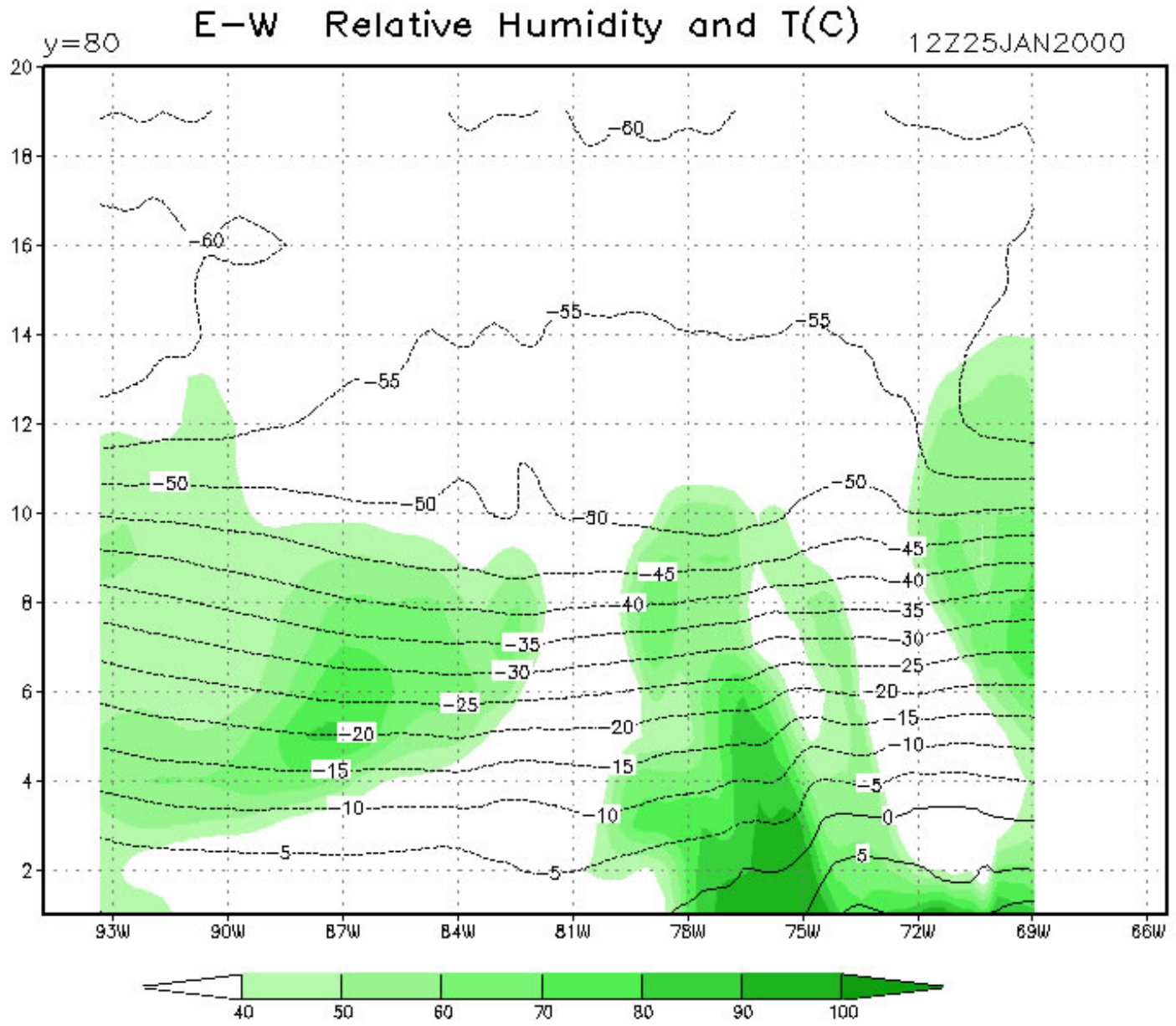

Total Precip (color,mm)
12Z25JAN2000
44N
42N
40N
38N
36N
34N
32N
30N
28N
26N
24N
93W
90W
87W
84W
81W
78W
75W
72W
69W
66W
51.6
25.6
12.8
6.4
3.2
1.6
0.8
0.4
0.2
0.1

real data



real data

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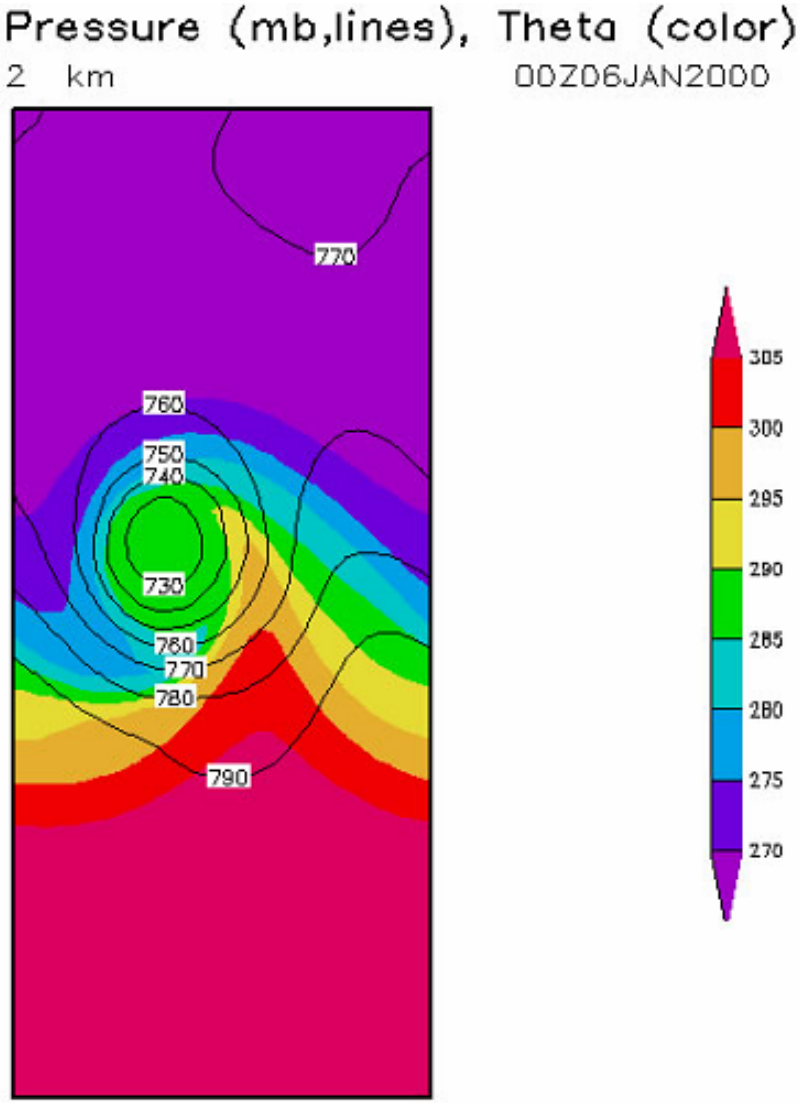
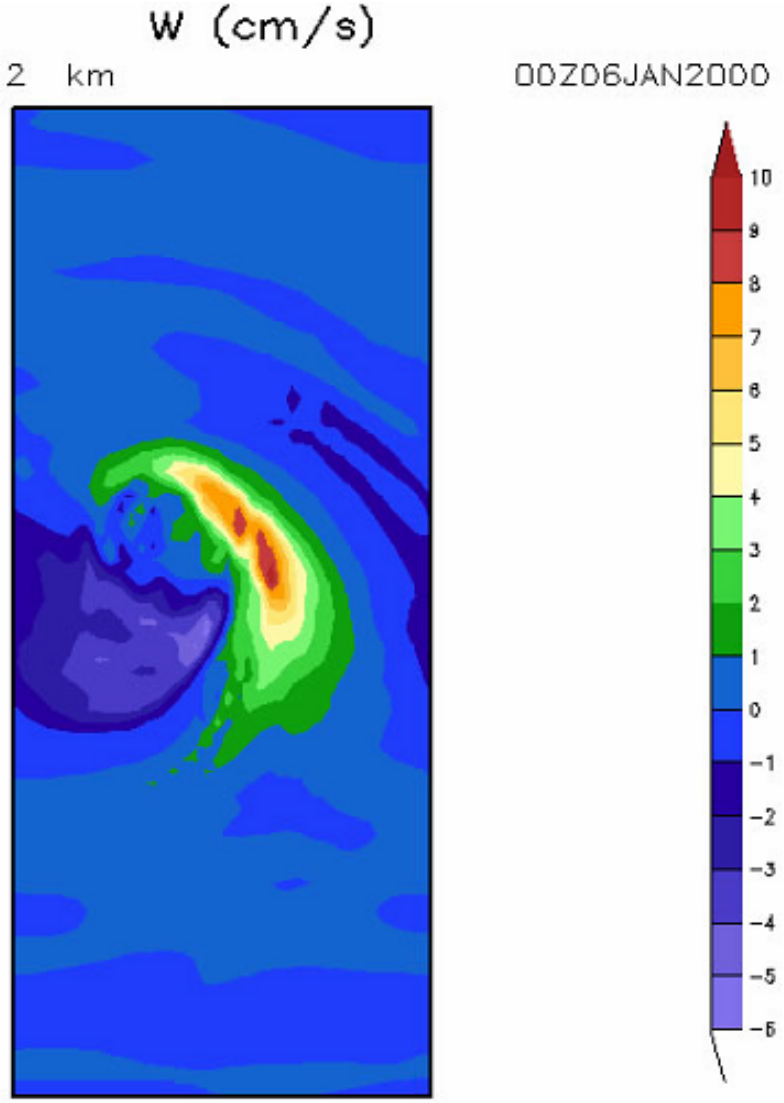
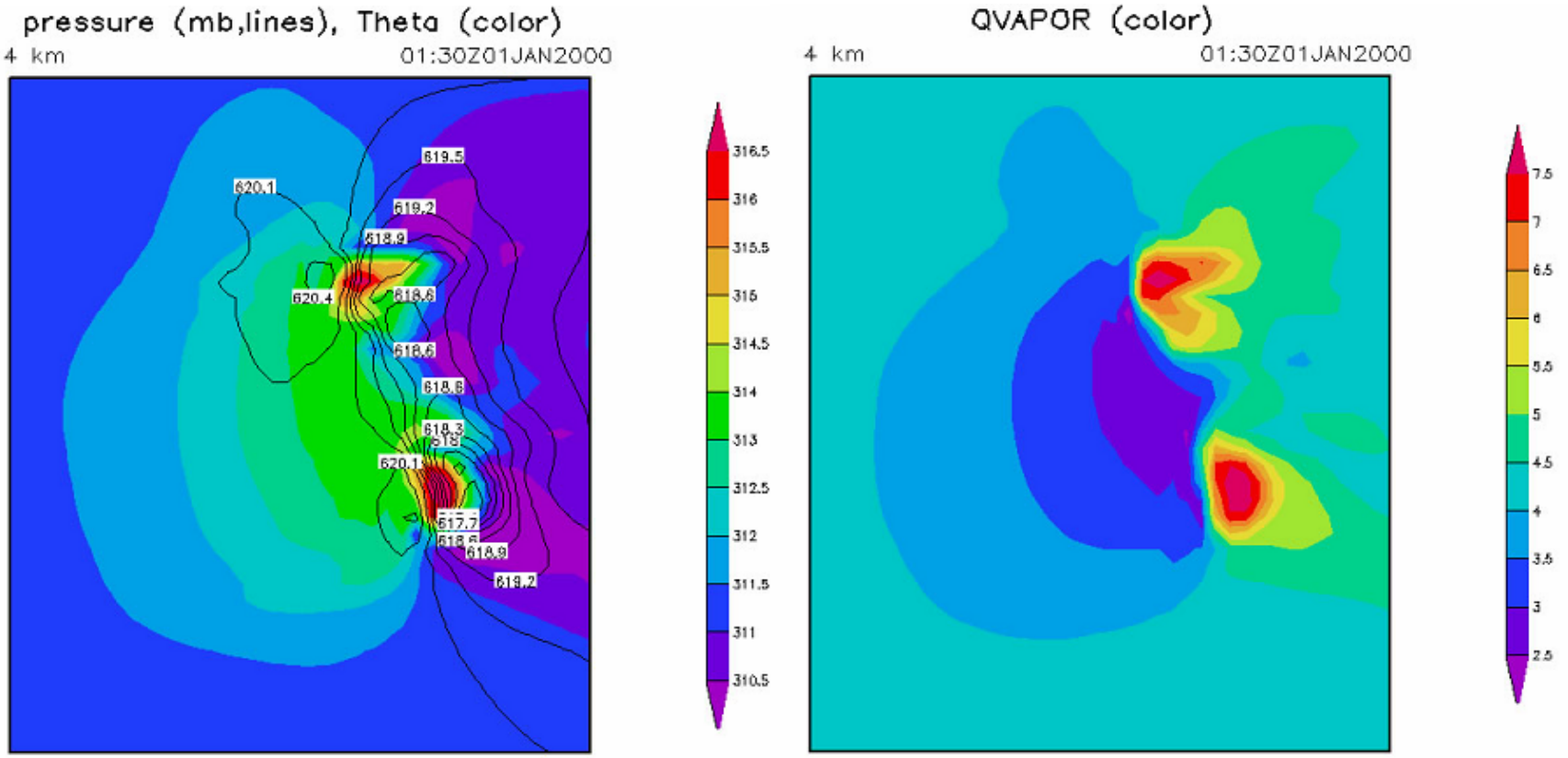


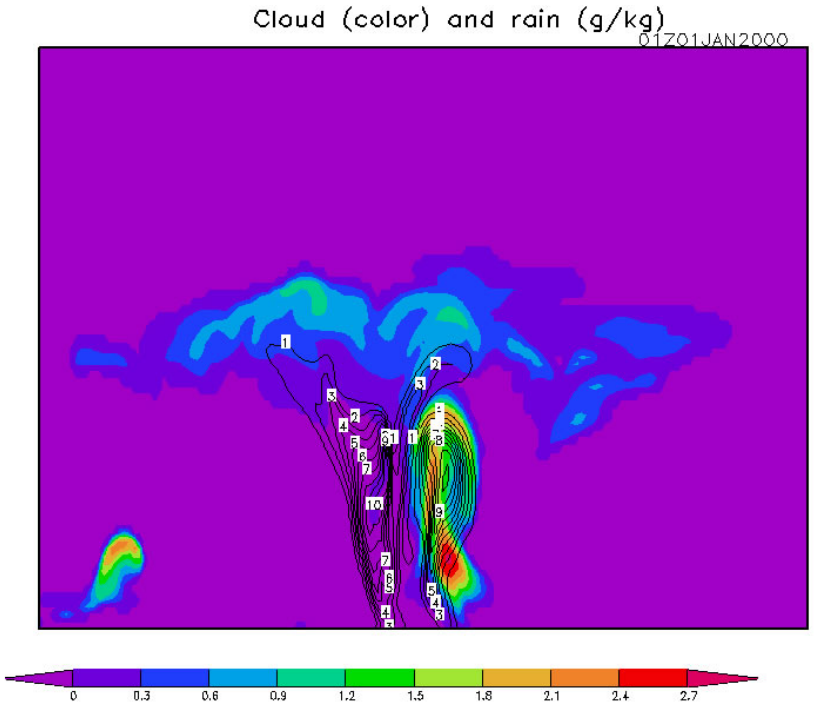


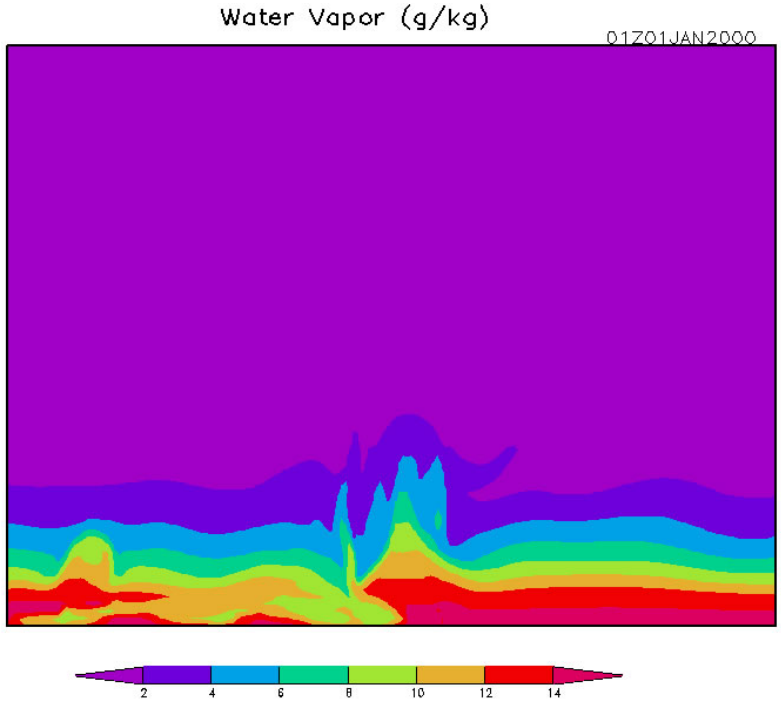
baroclinic wave

3D quarter-circle shear supercell thunderstorm



2D squall line





WRF-to-VIS5D

general

- **Convert WRF model output data in netCDF to Vis5D format.**
- **Vis5D is a three-dimensional visualization software**
- **Vis5D is free and can be downloaded from: http://www.ssec.wisc.edu/~billh/vis5d.html**
- **Currently works for *real-data* simulation data only**

download WRF2VIS5D

- From wrf-model.org web site (*wrf2vis5d.tar.gz*):

  http://www.mmm.ucar.edu/wrf/users/download/get_source.html

- "How to" and examples:

  http://www.mmm.ucar.edu/wrf/users/graphics/WRF2VIS5D/VIS5D.htm

WRF2VIS5D

Makefile
README

Edit:

- Computer
- netCDF libraries
- Vis5d libraries

wrf_v5d_input

module_map_utils.F
module_wrf_to_vis5d_netcdf.F
module_wrf_to_vis5d_util.F
wrf_to_vis5d.F

wrf_to_vis5d

WRF2VIS5D

Makefile
README

Edit:

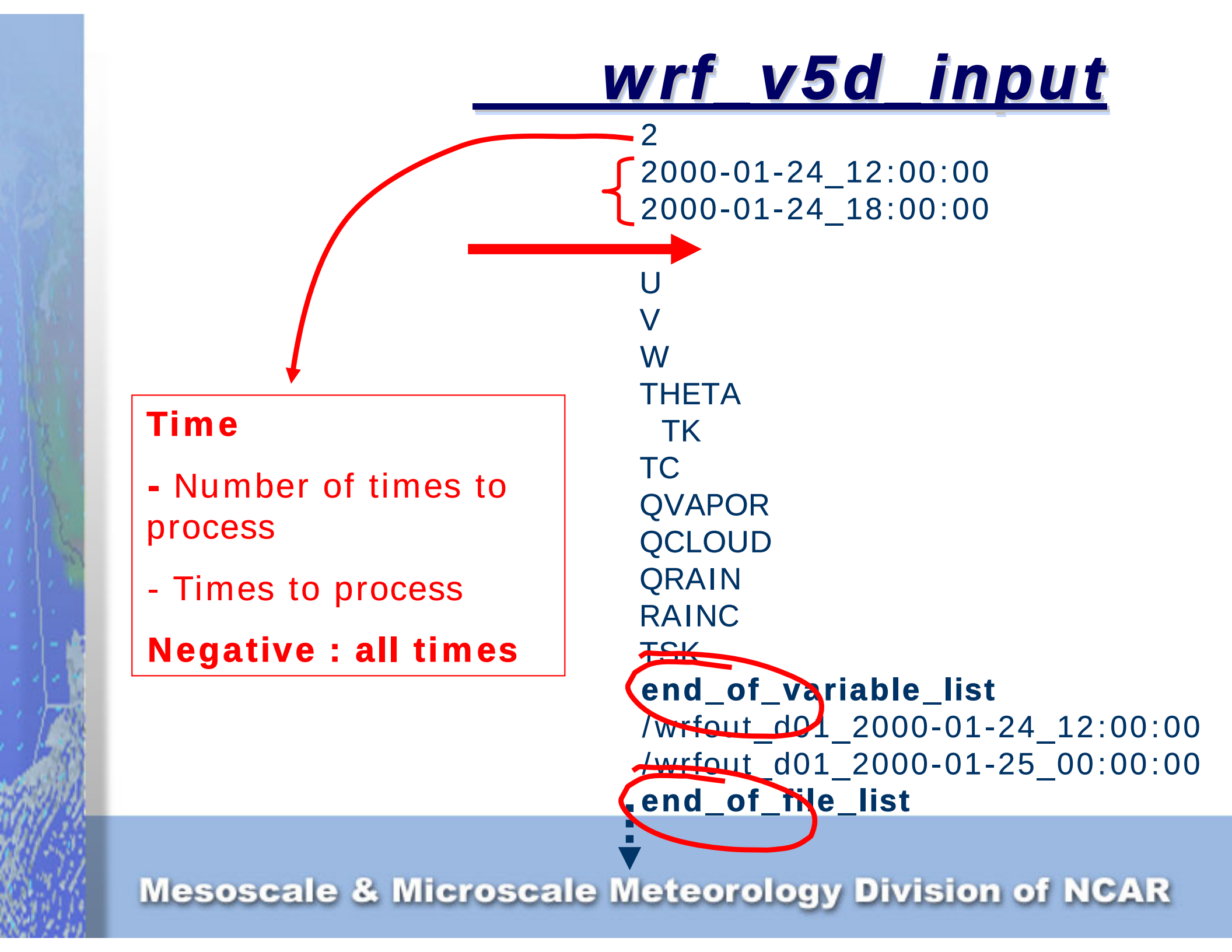
- Computer
- netCDF libraries
- Vis5d libraries

wrf_v5d_input

! Similar to GrADS control_file, but important differences !

module_map_utils.F
module_wrf_to_vis5d_netcdf.F
module_wrf_to_vis5d_util.F
wrf_to_vis5d.F

wrf_v5d_input



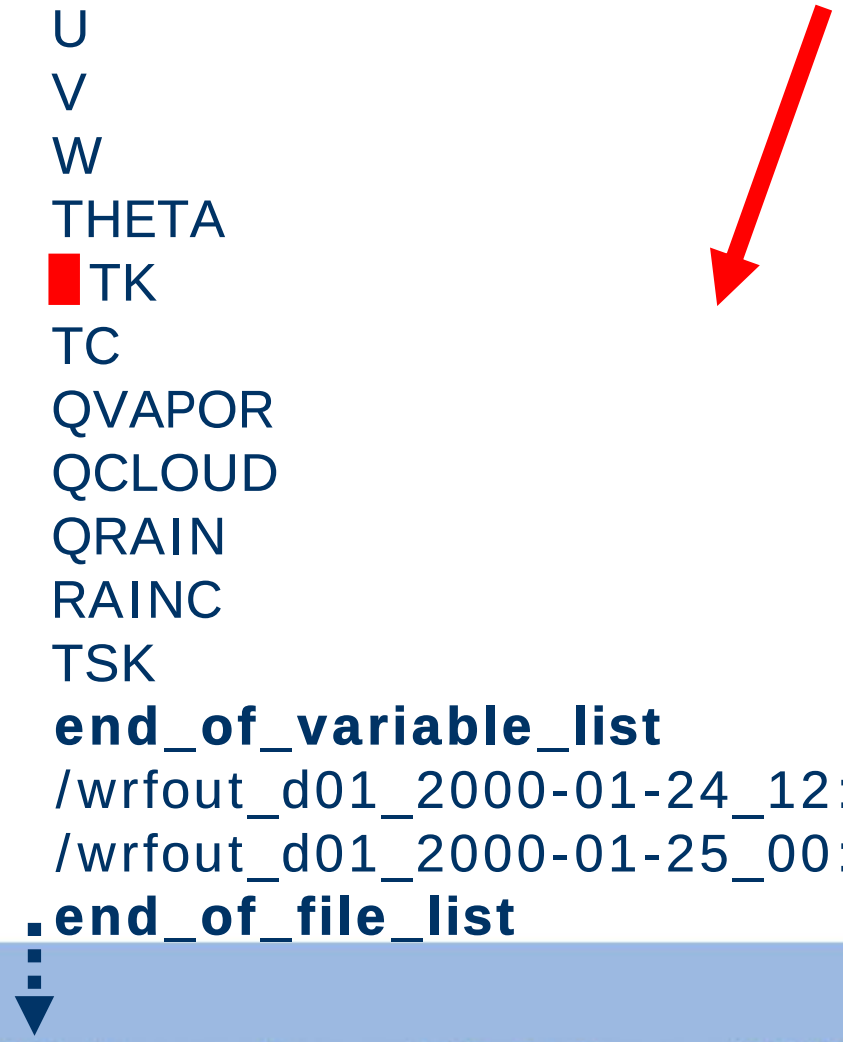
wrf_v5d_input

2
2000-01-24_12:00:00
2000-01-24_18:00:00

ALL variables to process

- Indent to skip
- NO description
- Add if in netCDF
- Unknown will result in error
- Diagnostics

U
V
W
THETA
TK
TC
QVAPOR
QCLOUD
QRAIN
RAINC
TSK
end_of_variable_list
/wrfout_d01_2000-01-24_12:00:00
/wrfout_d01_2000-01-25_00:00:00
end_of_file_list



wrf_v5d_input

```
2
2000-01-24_12:00:00
2000-01-24_18:00:00

U
V
W
THETA
  TK
TC
QVAPOR
QCLOUD
QRAIN
RAINC
TSK
end_of_variable_list
/wrfout_d01_2000-01-24_12:00:00
/wrfout_d01_2000-01-25_00:00:00
end_of_file_list
```

List of files to process

- NO extra files
- More than 1 input
- Must be in correct order

wrf_v5d_input

```
-1      ! specify vertical grid
        ! 0=Cartesian,
        ! -1=interp lowest z
        ! >1 list levels
1 1.
2 2.
3 3.
4 4.
5 5.
6 6.
7 7.
8 8.
9 9.
10 10.
11 11.
12 12.
13 13.
```

wrf_v5d_input

```
13      ! specify vertical grid
        ! 0=Cartesian,
        ! -1=interp lowest z
        ! >1 list levels
1 1.
2 2.
3 3.
4 4.
5 5.
6 6.
7 7.
8 8.
9 9.
10 10.
11 11.
12 12.
13 13.
```

List of levels

- Indent have NO effect
- Height (km)
- Bottom to top
- Must number levels

running WRF2VIS5D

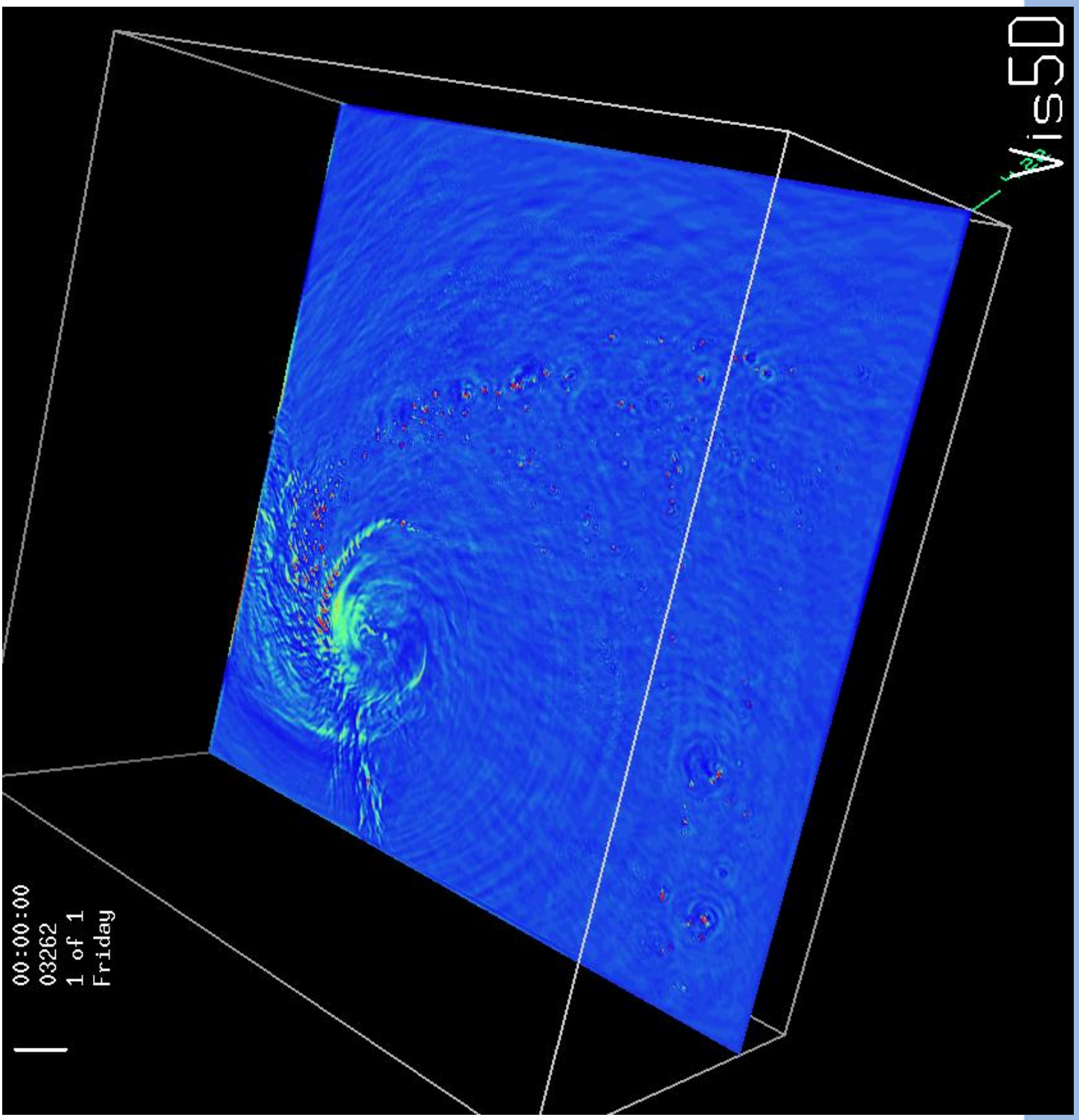
- Edit **Makefile**
- **make**
- Edit **wrf_v5d_input**
- **Run**

```
wrf_to_vis5d  wrf_v5d_input  MyOutput
```

MyOutput

Horizontal slice of w-coordinate

Tim Scheitlin (NCAR/SCD)



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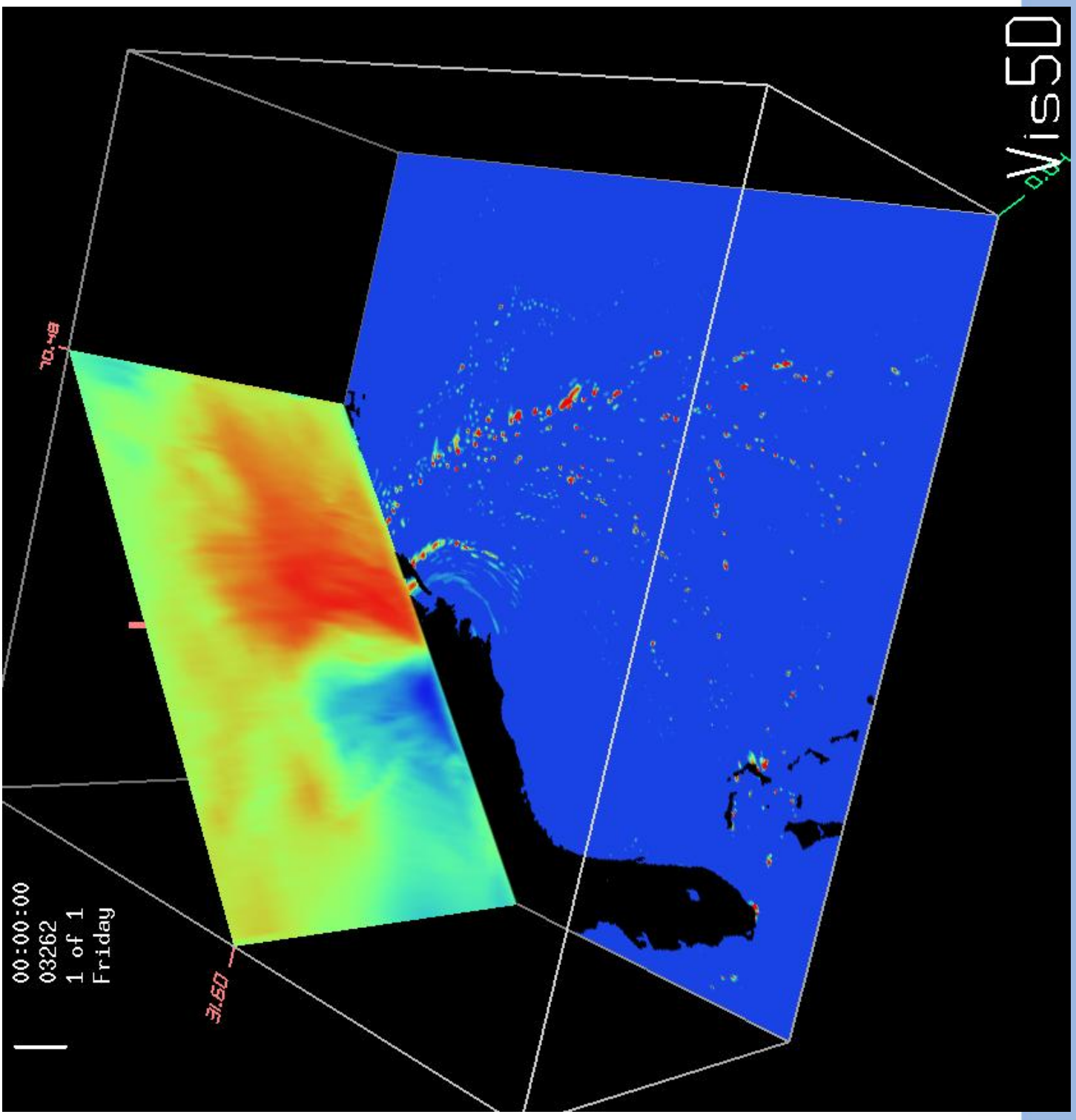
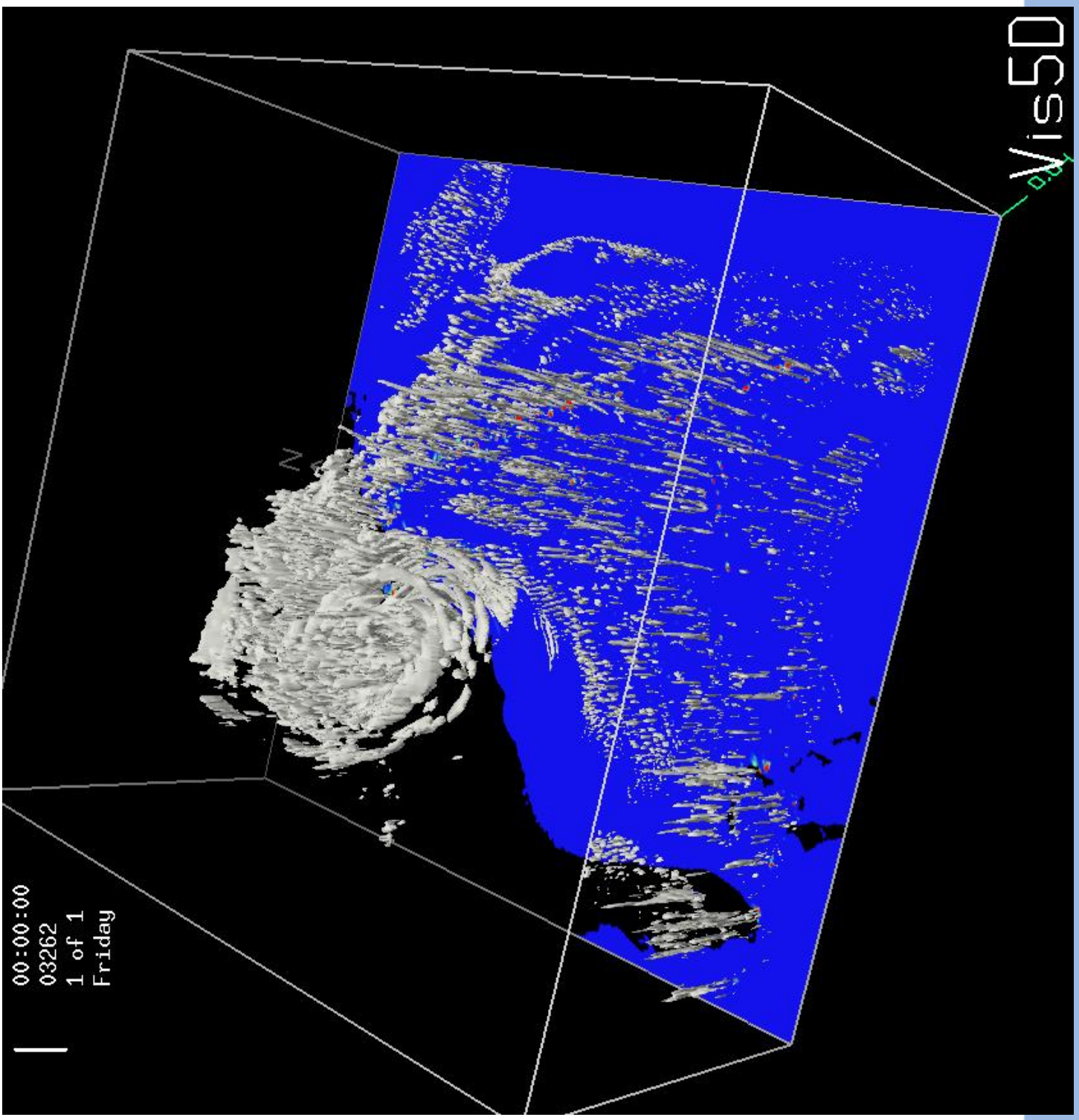
Vertical slice of v-coordinate

Tim Scheitlin (NCAR/SCD)



Clouds around hurricane

Tim Scheitlin (NCAR/SCD)



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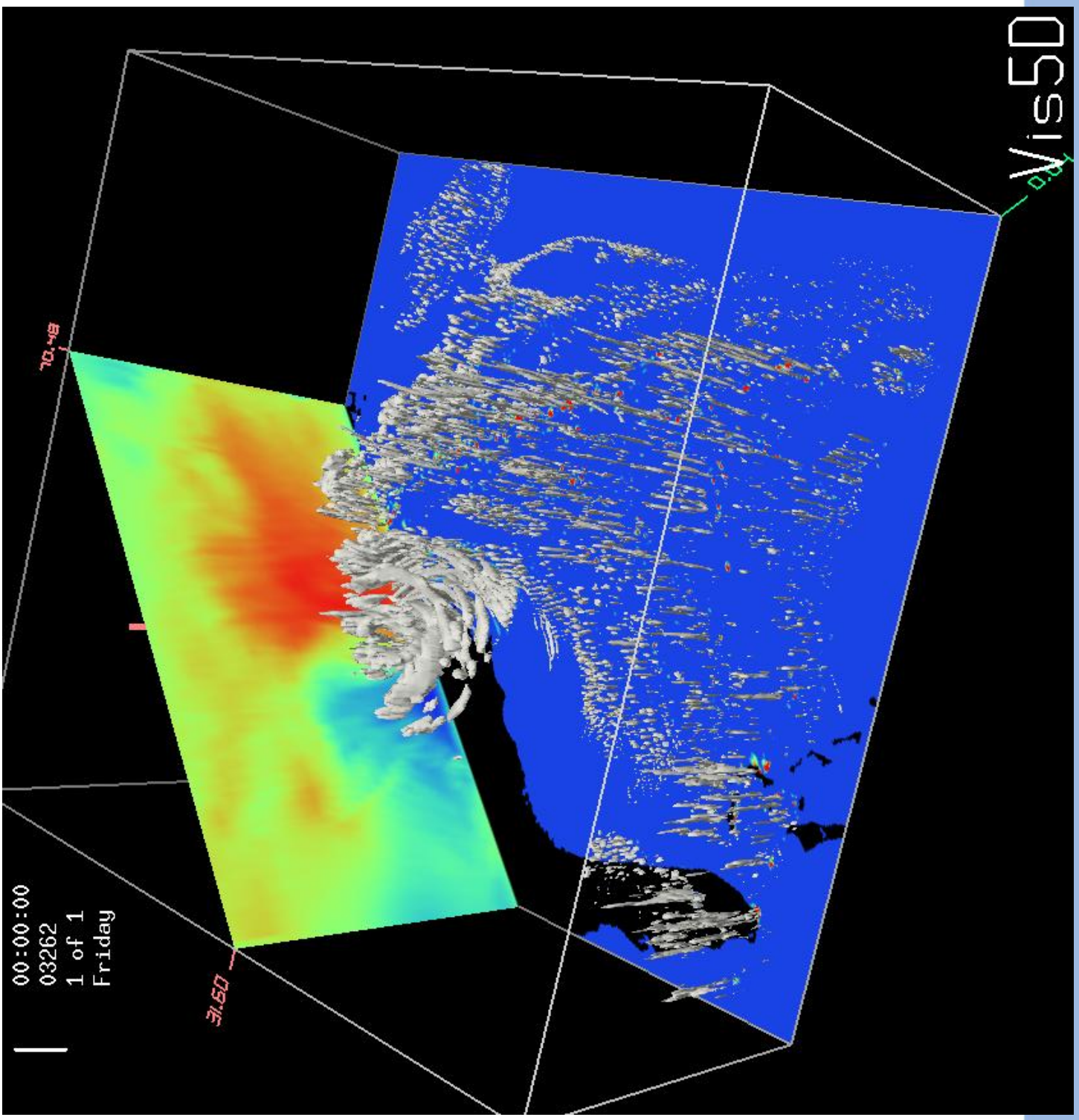
Clouds around hurricane +
Vertical slice of v-coordinate

Tim Scheitlin (NCAR/SCD)



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