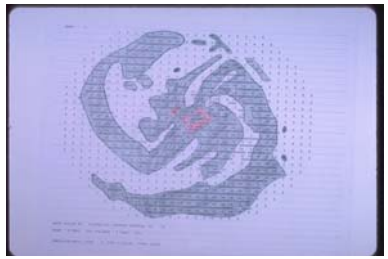
WRF Post-Processing



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

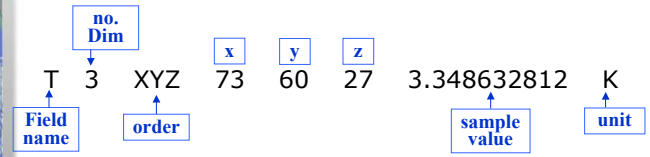
- **Advantages of using netCDF?**
  - Platform-independent (*big_endian / little_endian*)
  - A lot of software already exist which can be used to process netCDF data

netCDF utilities

- **ncdump**
  - reads a netCDF dataset and prints information from the dataset
    - ncdump –h file -- *print header (inc. variables in the file)*
    - ncdump –v VAR-name file -- *print values of the 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
  - Example



netCDF utilities

- **read_wrf_nc : Options**

-head	Prints header information
-m	Prints min and max values for each field
-M z	Prints min and max values for each field (values for 3d fields @ **z** level)
-s	Print list of fields available for each time, plus a sample value for each field
-S x y z	Print list of fields available for each time Sample value is at point **x y z** in domain
-t	Print only the times in the file
-v VAR	Print basic information about field **VAR**
-V VAR	Print 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

- **Simple calls to access the data**
- **For 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*
Native vertical coordinate	✓ *n/p/h*	✓ *n/p/h*	✓ *n/p/h*	✓ *n/h*
Model input & output	✓ *i/o*	✖ *i*	✓ *i/o/s*	✖ *i*
WRF I/O API	✖ *netCDF*	✖ *netCDF*	✖ *netCDF*	✖ *netCDF*
Real/Ideal	✓ *3D/2D*	✖	✓ *3D/2D/1D*	✖

NCL

Slides contributions from:
Bill Skamarock (NCAR/MMM)
Ethan Alpert (NCAR/SCD)
Wei Wang (NCAR/MMM)

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**
  - Precompiled versions exist for:
    - IBM RS6000, DEC Alpha, Sun Solaris, RedHat Linux, SGI IRIX, Alpha running RedHat Linux, and Mac running OSX
- **Set NCARG_ROOT environment variable:**
  - setenv NCARG_ROOT /usr/local/

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://ngwww.ucar.edu/ngdoc/ng/ref/ncl/Overview.html
- **Function and Procedure Reference**
  - http://ngwww.ucar.edu/ngdoc/ng/ref/ncl/NclFuncsAndProcs.html

using and learning NCL

- **Getting Started Using NCL (GSUN)**
  - http://ngwww.ucar.edu/ngdoc/ng/ug/ncl/gsun/
  - Intended for users with little or no NCL experience
  - Some programming language knowledge is assumed
  - Learning by example concept
  - Provides a set of simple functions written in NCL to be used by new users
  - The "Beyond the Basics" section covers incorporating FORTRAN into NCL

using and learning NCL

- **NCL users email list**
  - http://ngwww.ucar.edu/ncl-talk/
  - Email list devoted to NCL discussion
  - Read by NCL developers and support staff
- **Examples page**
  - http://ngwww.ucar.edu/ncl/examples.html
- **CCSM NCL page for additional examples**
  - http://www.cgd.ucar.edu/csm/support

NCL in WRF

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

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/mm5/WRF_post/NCL.htm**

NCL for WRF

README_FIRST

README_NCL

README files
- **"How to"**
- **About 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

NCL for WRF

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

NCL functions and procedures used by the plotting scripts

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

- 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

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.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

FORTRAN shared library

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

e.g.

```
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.alpha
   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

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

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_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

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_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**

a script

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


a = addfile("wrfout_01_000000.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
```

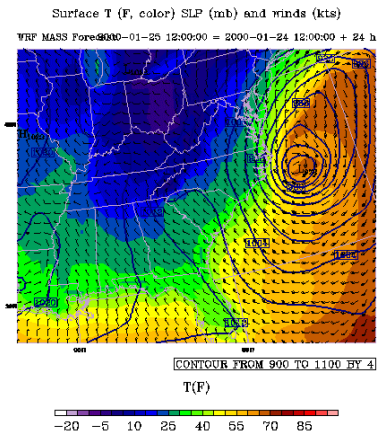

how to run NCL?

- Type the following to run

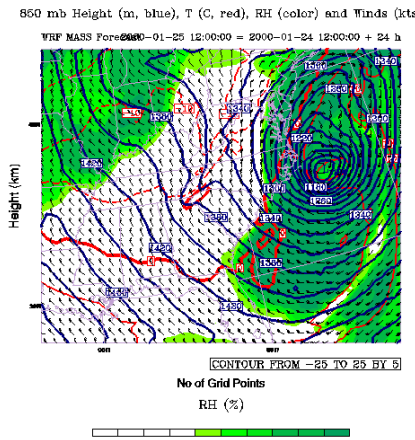
  ncl < *wrf_em_real.ncl*

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

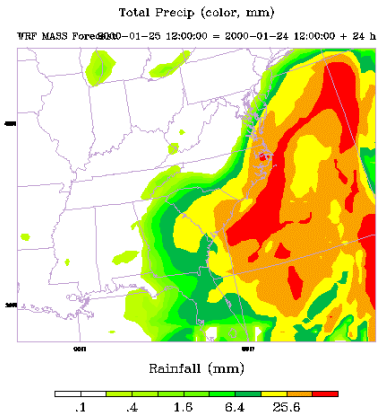
- Output from ncl can be in metacode, postscript, or on the screen



real data



real data



real data

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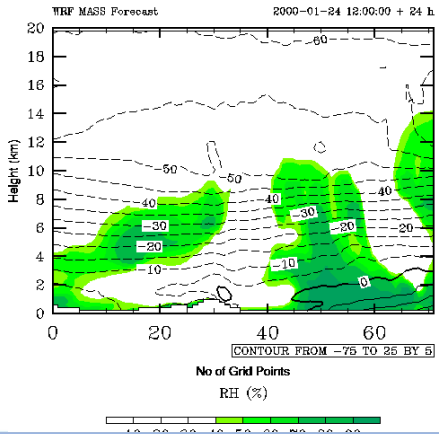
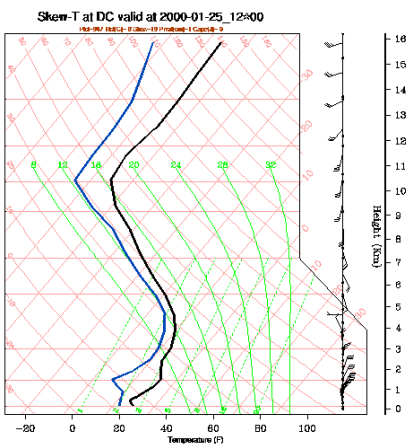


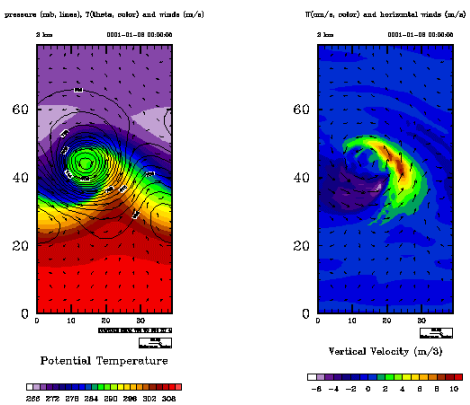
real data

Mesoscale & Microscale Meteorology Division of NCAR



real data

Mesoscale & Microscale Meteorology Division of NCAR



baroclinic wave

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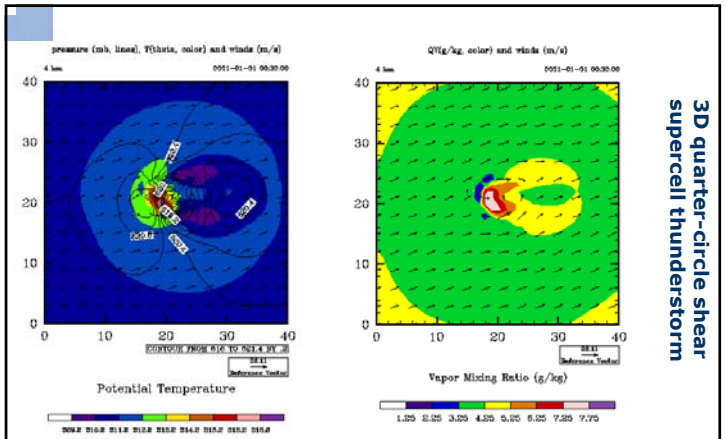

3D quarter-circle shear supercell thunderstorm

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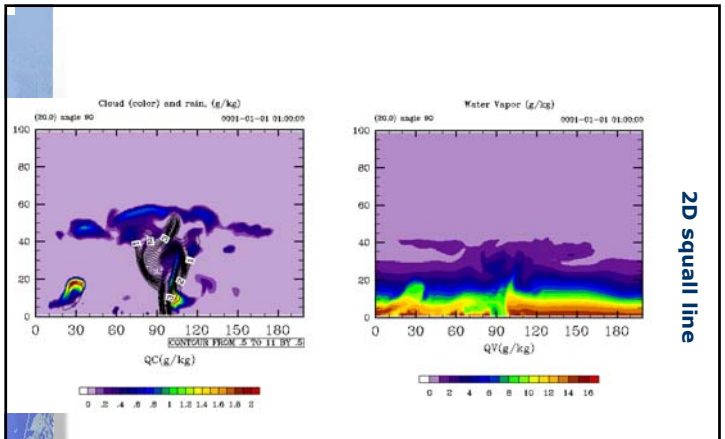

2D squall line

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RIP4

Read/Interpolate/Plot (Version 4)

Written by Mark Stoelinga
UW / NCAR

Mesoscale & Microscale Meteorology Division of NCAR

general

- **Requires NCAR Graphics low-level routines – freely available from http://ngwww.ucar.edu**
- **Documentation:**
  - In program tar file under the Doc/ directory
  - **http://www.mmm.ucar.edu/wrf/users/docs/ripug.htm**

Mesoscale & Microscale Meteorology Division of NCAR

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)
- Allow users to tailor the graphics
- Currently works for ***real-data*** simulation data only

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/mm5/WRF_post/RIP4.htm

RIP4 on your computer

set RIP_ROOT environment variable
- setenv RIP_ROOT /usr/$USER/RIP4

new
- Edit *src/Makefile* to define paths to netCDF library and include file on your computer:
  NETCDFLIB and *NETCDFINC*
- make <machine type> (*it'll make suggestions*)
  - make dec (*example*)
- RIP4 has 2 parts (RIPDP and RIP)

ripdp_mm5 ripdp_wrf

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] new \
  <model_data_name> [basic/all] \
  <input_file1 input_file2>

Example

ripdp_wrf -n ripdp_sample.in
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 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= .....
==========================================
feld= .....
feld= .....
==========================================
```
Frame specification group (FSG)

Plot specification line (PSL)

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

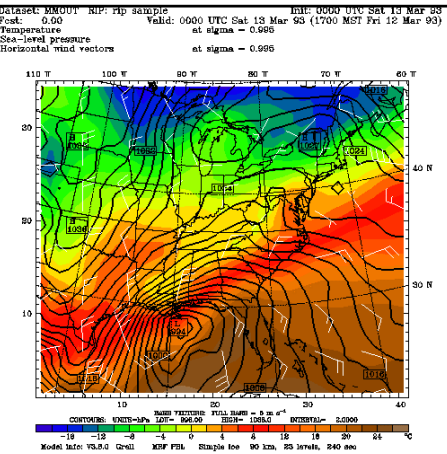
- idotitle – first part of first title line
- titlecolor – color of title lines
- ptimes, ptimeunits – times to process
- tacc – tolerance for processing data
- timezone –display of local time
- iusedaylightrule – 1 applied, 0 not applied
- iinittime – plotting of initial time
- ivalidtime – plotting 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

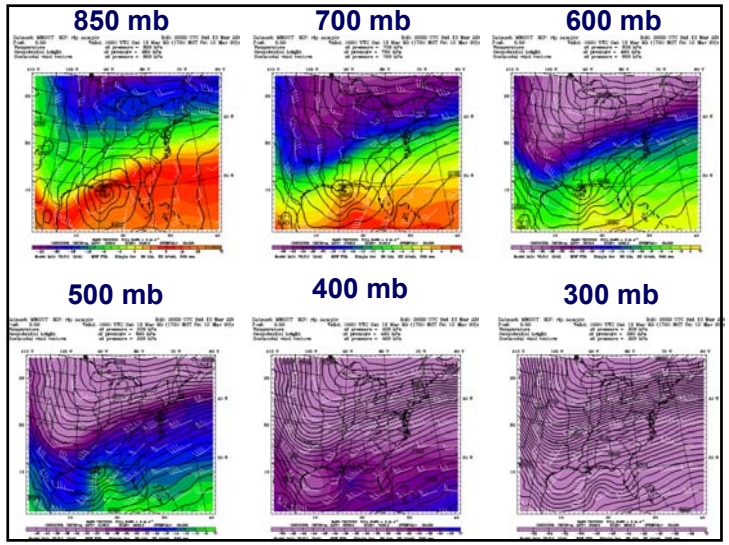
```
================================================
feld=tmc; ptyp=hc; vcor=s; levs=b1; cint=2; >
  cmth=fill ;cosq=-32,light.violet, >
  -16,blue,0,yellow, 16,orange, 32,light.gray
feld=slp; ptyp=hc; cint=2; linw=2
feld=uuu,vvv; ptyp=hv; vcmx=-1; >
  colr=white; intv=5
feld=map; ptyp=hb
feld=tic; ptyp=hb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

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
==========================================
```

Mesoscale & Microscale Meteorology Division of NCAR



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
=========================================
```

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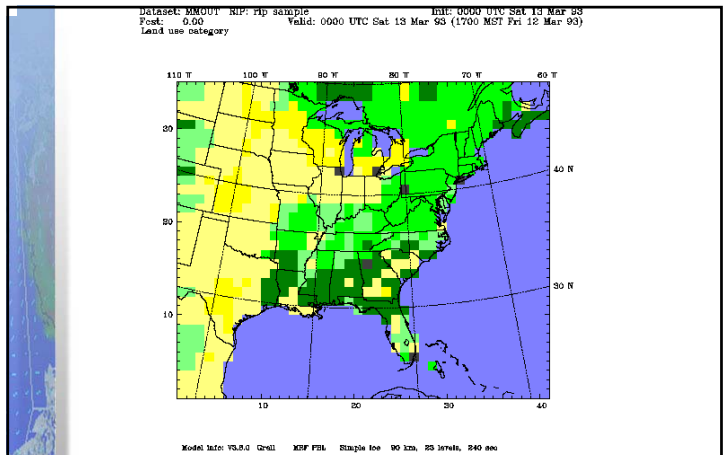

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example - cross section

```
=============================================
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
=============================================
```

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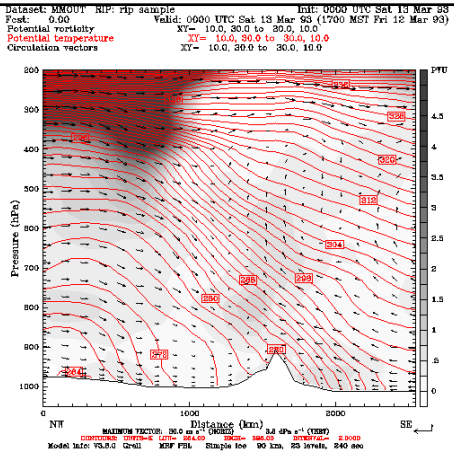

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example - skew-T

```
=============================================
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; sngdg
=============================================
```

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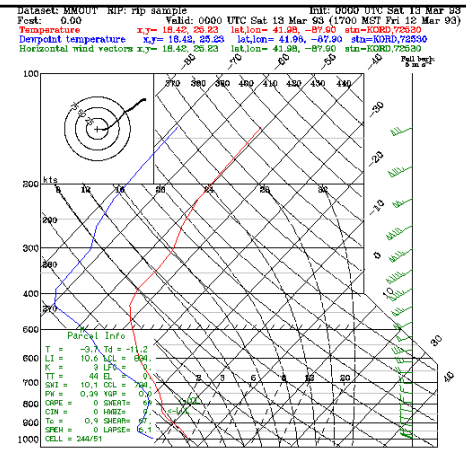

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WRF-to-GrADS

general

- Requires GrADS software – freely available from http://grads.iges.org/grads/grads.html
- Documentation:
  - http://grads.iges.org/grads/gadoc/index.html

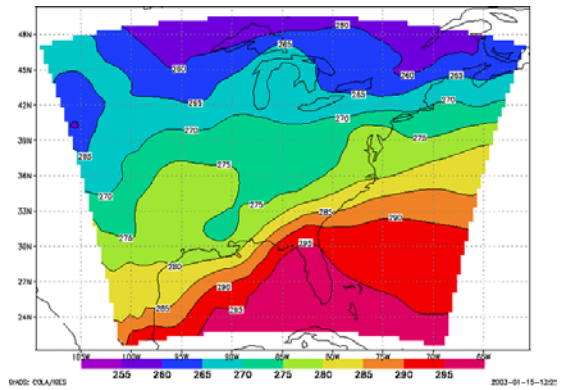
general

- 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

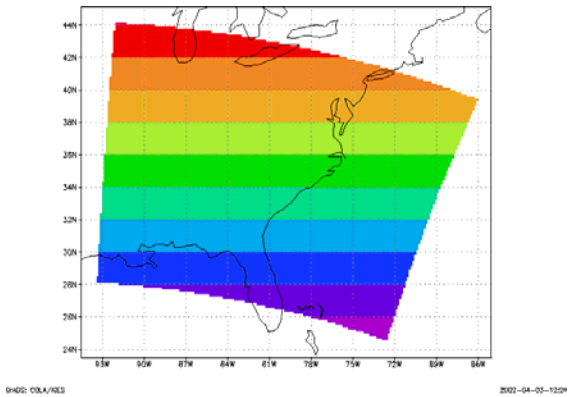
- Allow users to tailor the graphics
- Create large data files
- Interactive *(requires basic understanding of the GrADS software)*
- Adding diagnostics on the fly
- Animations (x,y,z,t)
- Zooming capability
- Multiple frames on one "page"
- Don't have to rerun to generate new images

projection



Mesoscale & Microscale Meteorology Division of NCAR

projection



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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

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staggering problem

```
    v     v     v     v
u   m u   m u   m u   m u
    v     v     v     v
u   m u   m u   m u   m u
    v     v     v     v
u   m u   m u   m u   m u
    v     v     v     v
u   m u   m u   m u   m u
    v     v     v     v
```

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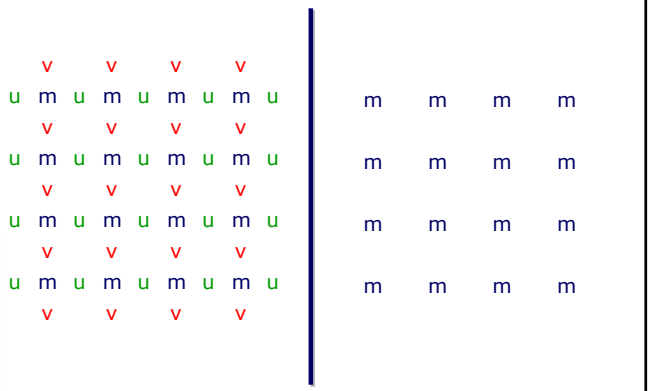
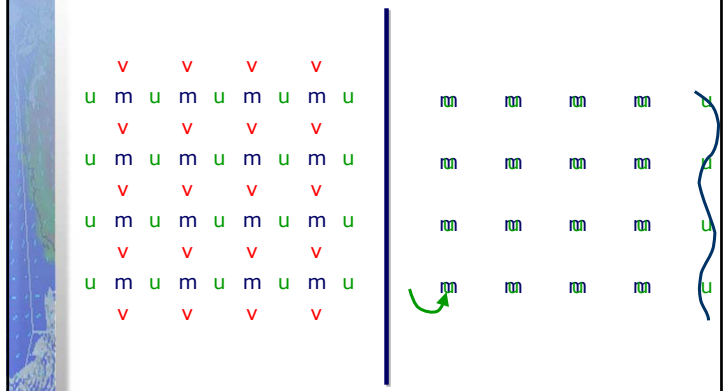
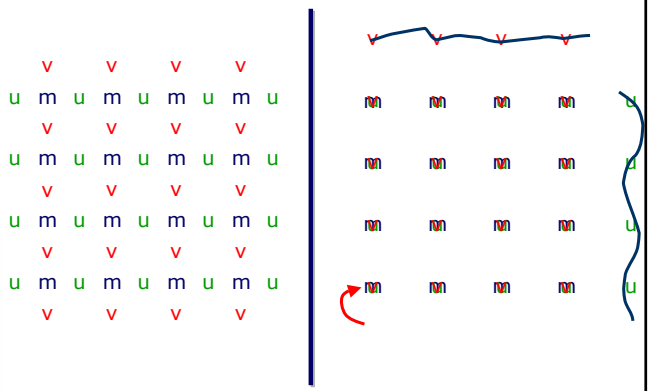
staggering problem



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/mm5/WRF_post/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

WRF2GrADS

Makefile
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control_file_pressure

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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

Number of times to process &

Times to process

Negative : all times

```
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
```


control_file

3d variables to process

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

```
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
```

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

List of files to process

- **Indent to skip**
- **More than 1 input**
- **Must be in correct order**

```
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

List of levels

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

```
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
```


control_file

List of levels

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

```
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
```

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*)

Mesoscale & Microscale Meteorology Division of NCAR

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

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

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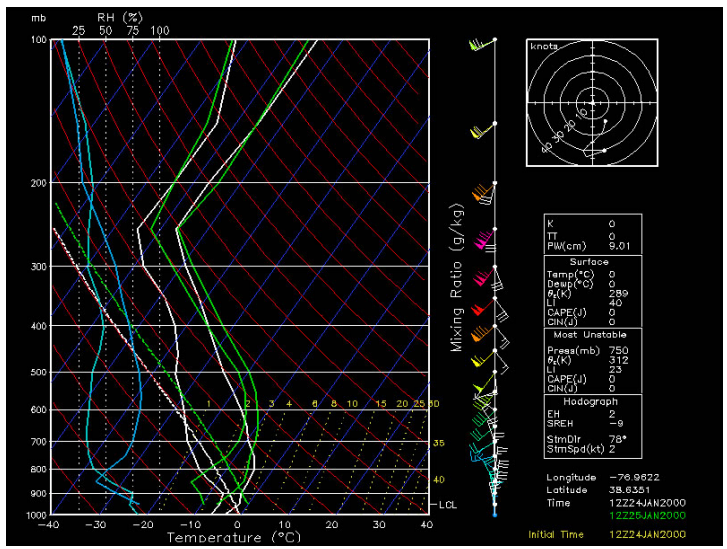
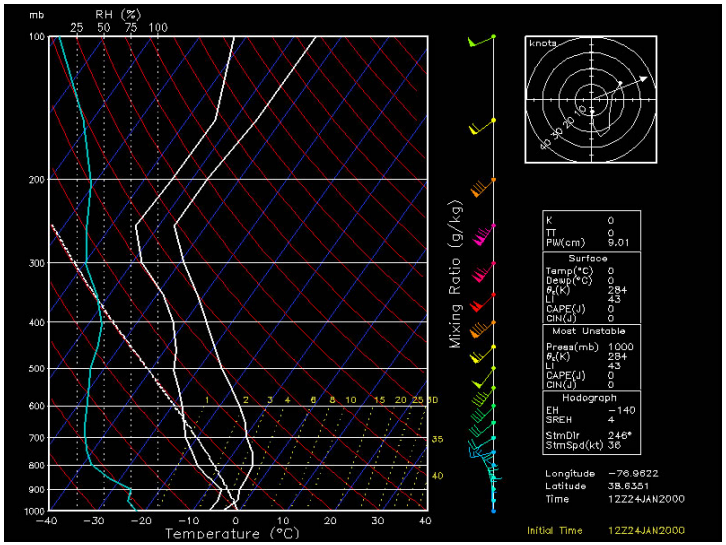
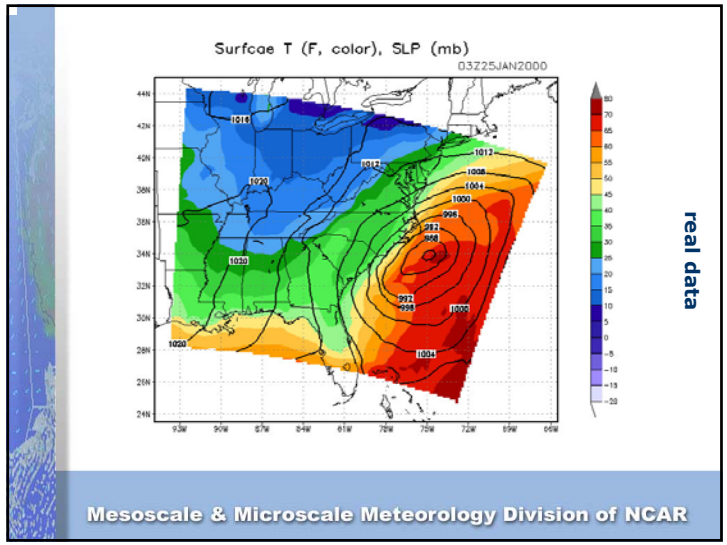
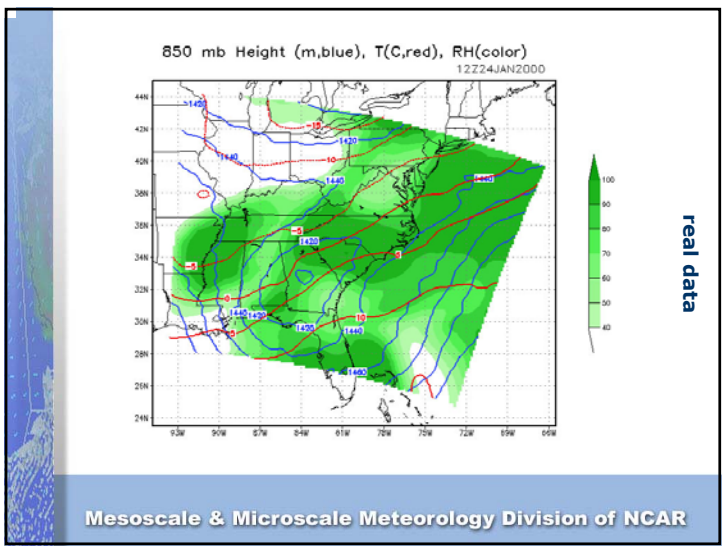
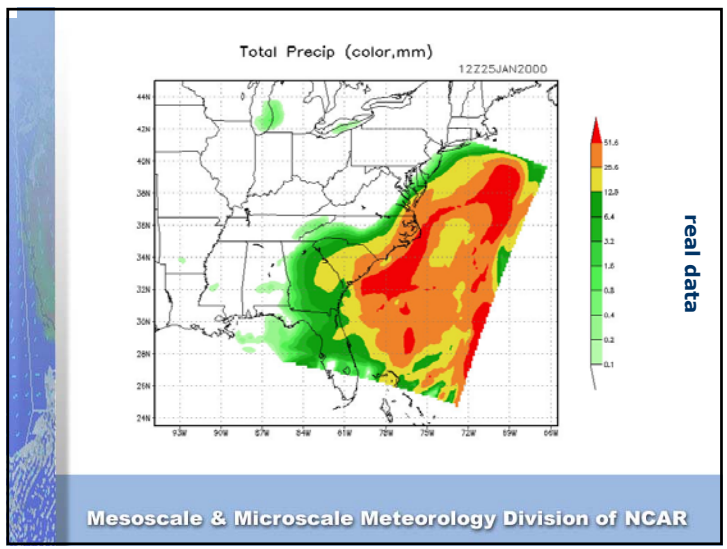
```
ga-> run skew

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
```

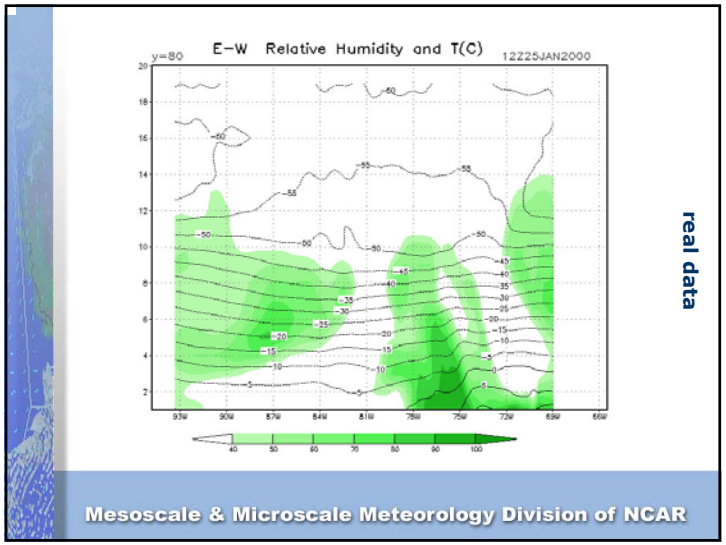


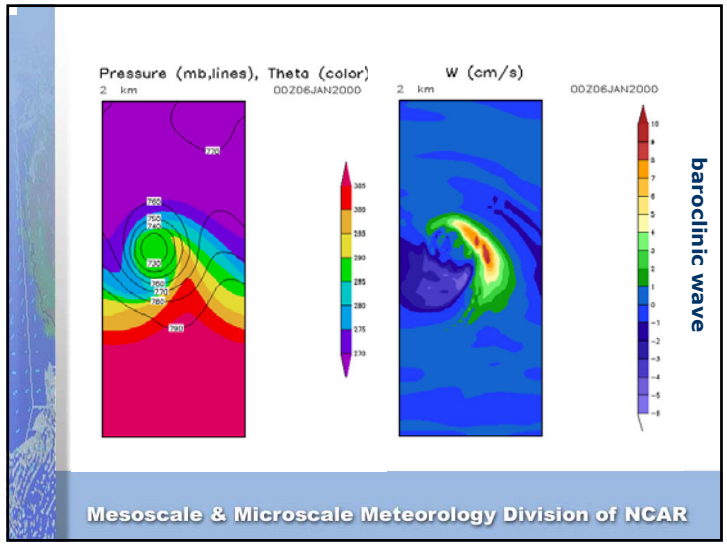

mb
RH (%)
25 50 75 100
Temperature (°C)
Mixing Ratio (g/kg)
knots
K 0
TT 0
PW(cm) 9.01
Surface
Temp(°C) 0
Dewp(°C) 0
θe(K) 284
LI 43
CAPE(J) 0
CIN(J) 0
Most Unstable
Presa(mb) 1000
θe(K) 284
LI 43
CAPE(J) 0
CIN(J) 0
Hodograph
EH -140
SREH 4
StmDir 246°
StmSpd(kt) 36
Longitude -76.9822
Latitude 38.6351
Time 12Z24JAN2000
Initial Time 12Z24JAN2000

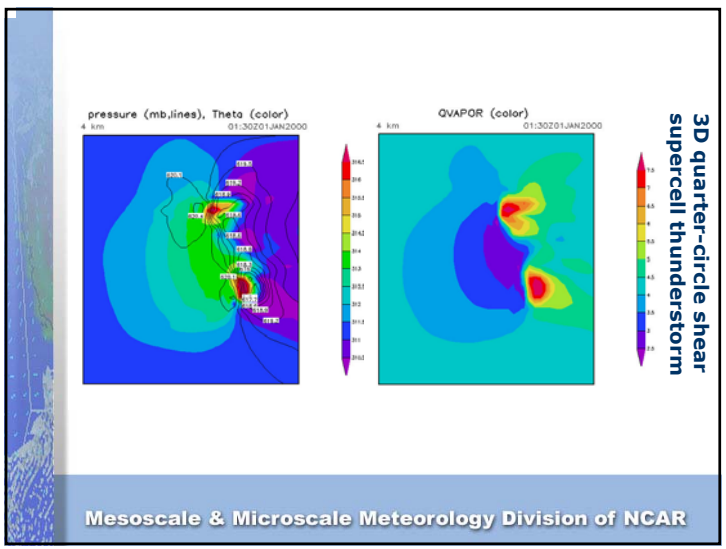

Surface T (F, color), SLP (mb)
03Z25JAN2000
real data
Mesoscale & Microscale Meteorology Division of NCAR

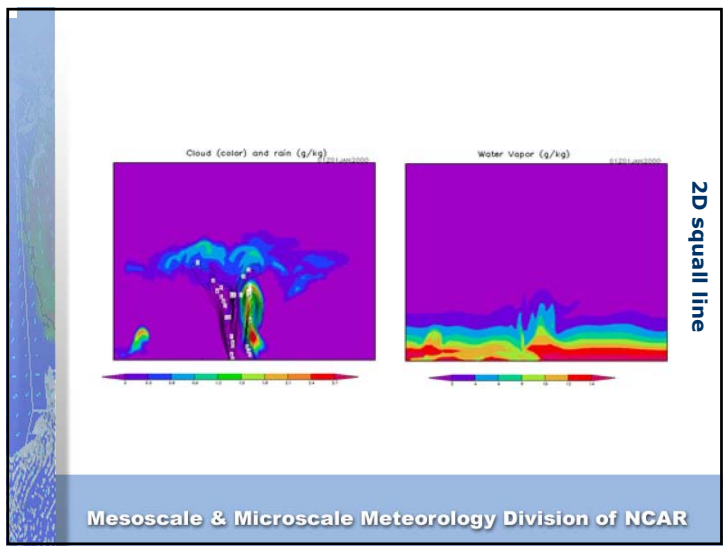

850 mb Height (m,blue), T(C,red), RH(color)
12Z24JAN2000
real data
Mesoscale & Microscale Meteorology Division of NCAR


Total Precip (color,mm)
12Z25JAN2000
real data
Mesoscale & Microscale Meteorology Division of NCAR


E–W Relative Humidity and T(C)
y=80
12Z25JAN2000
real data
Mesoscale & Microscale Meteorology Division of NCAR


Pressure (mb,lines), Theta (color)
2 km
00Z06JAN2000
W (cm/s)
2 km
00Z06JAN2000
baroclinic wave
Mesoscale & Microscale Meteorology Division of NCAR


pressure (mb,lines), Theta (color)
4 km
01:30Z01JAN2000
QVAPOR (color)
4 km
01:30Z01JAN2000
3D quarter-circle shear supercell thunderstorm
Mesoscale & Microscale Meteorology Division of NCAR


Cloud (color) and rain (g/kg)
Water Vapor (g/kg)
2D squall line
Mesoscale & Microscale Meteorology Division of NCAR

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/mm5/WRF_post/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

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wrf_v5d_input

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

Number of times to process &
Times to process
Negative : all times

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

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wrf_v5d_input

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

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

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wrf_v5d_input

List of files to process
- NO extra files
- More than 1 input
- Must be in correct order

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

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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

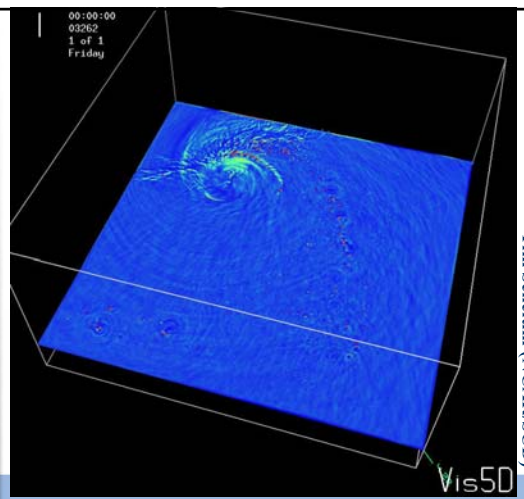
- **Indent have NO effect**
- **Height (km)**
- **Bottom to top**
- **Must number levels**

running WRF2VIS5D

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

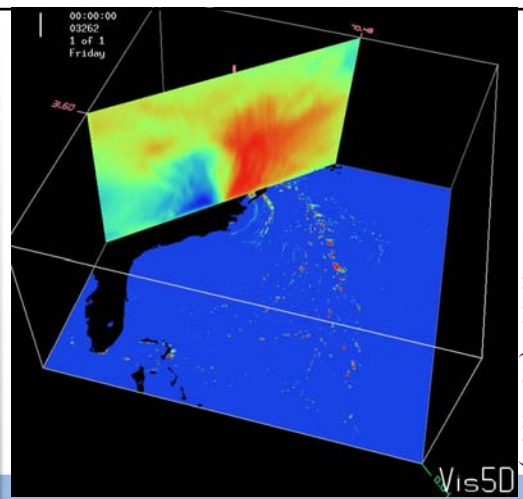
```
wrf_to_vis5d  wrf_v5d_input  MyOutput
```

  - MyOutput



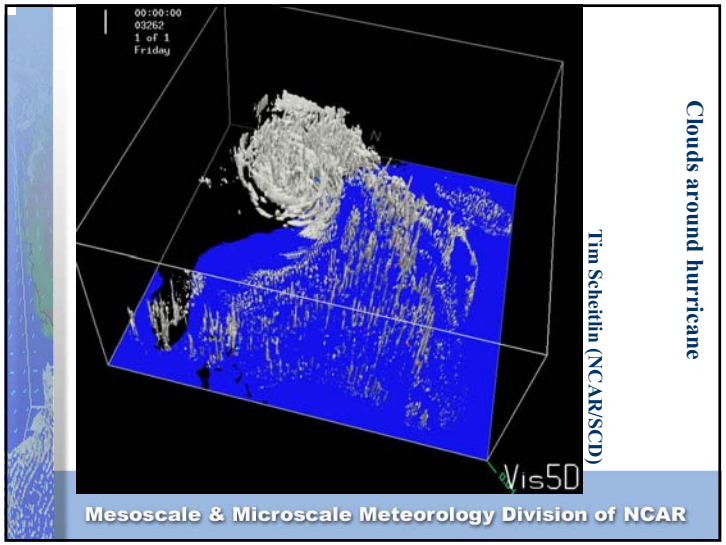
Horizontal slice of w-coordinate

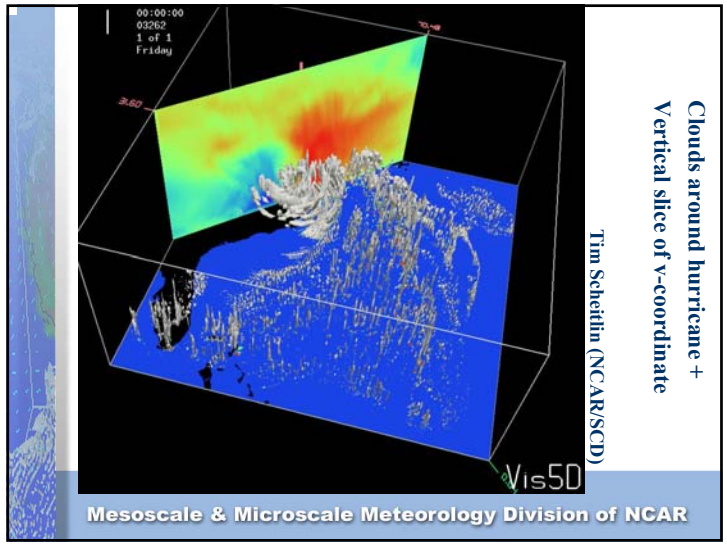
Tim Scheitlin (NCAR/SCD)



Vertical slice of v-coordinate

Tim Scheitlin (NCAR/SCD)


Clouds around hurricane
Tim Scheitlin (NCAR/SCD)
00:00:00
03262
1 of 1
Friday
Vis5D
Mesoscale & Microscale Meteorology Division of NCAR


Clouds around hurricane +
Vertical slice of v-coordinate
Tim Scheitlin (NCAR/SCD)
00:00:00
03262
1 of 1
Friday
Vis5D
Mesoscale & Microscale Meteorology Division of NCAR