AHW Post Processing

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Processing AHW data

- **ARW output**
  - Which packages can read this data
- **Moving nests**
  - How do we deal with moving nest data
- **Hurricane tracking**
  - Generating and plotting hurricane tracks
- **How to add diagnostics**

Graphical Packages

- **NCL** UG: 9-2
  - Graphical package
- **ARWpost** UG: 9-28
  - Converter (GrADS & vis5d)
- **RIP4** UG: 9-19
  - Converter and interface to graphical package NCAR Graphics
- **WPP** UG: 9-35
  - Converter (GrADS & GEMPAK)
- **VAPOR** UG: 9-50
  - Converter and graphical package
  - *Support: VAPOR*
- **IDV** unidata.ucar.edu
  - GRIB (from WPP)
  - GEMPAK (from wrf2gem)
  - vis5d (from ARWpost)
  - CF complaint data (from wrf_to_cf)
  - *Support: unidata*
- **GEMPAK**
  - Data from wrf2gem or WPP
  - *Support: unidata*

MatLab / IDL / R / ferret

NCL

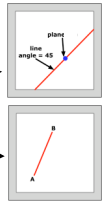
- **NCAR Command Language**
- **http://www.ncl.ucar.edu**
- **Read WRF-ARW data directly**
- **Generate a number of graphical plots**
  - Horizontal, cross-section, skewT, meteogram, panel
- **Download**
  - http://www.ncl.ucar.edu/Download
  - Fill out short registration form *(there is a short waiting period)*
  - Read and agree to OSI-based license
  - Get version 5.1.0 or later
- **NCARG_ROOT environment variable**
  - setenv NCARG_ROOT /usr/local/ncl

Generate Plots with NCL

- **Create a script**
  - *wrf_real.ncl*
    (start with a sample script)
- **Set NCARG_ROOT environment variable:**
  - *setenv NCARG_ROOT /usr/local/ncl*
- **Run NCL script**
  - *ncl wrf_real.ncl*

Special WRF NCL Functions

- **wrf_user_getvar**
  Get native and diagnostic variables
- **wrf_contour / wrf_vector**
  Create line/shaded & vector plots
- **wrf_map_overlays / wrf_overlays**
  Overlay plots created with wrf_contour and wrf_vector
- **wrf_user_intrp3d / wrf_user_intrp2d**
  Interpolate horizontally to a given pressure/height (3d data only)
  Interpolate vertically along a given line
- **wrf_user_ll_to_ij / wrf_user_ij_to_ll**
  Convert: lat/lon ⇔ ij
- **wrf_user_list_times**
  Get list if times available in input file
- **wrf_user_unstagger**
  Unstaggers an array



NCL and WRF_NCL

- **Combine strength of WRF_NCL specific and NCL general capabilities**

```
a = addfile("./wrfout.d01.nc","r")


t2 = a->T2(5,:,:)
t2 = wrf_user_getvar(a,"T2",5)


qv = a->QVAPOR(5,:,:,:)
qv =
wrf_user_getvar(a,"QVAPOR",5)


t2 = a->T2
t2 = wrf_user_getvar(a,"T2",-1)
```

```
res@cnLevelSelectionMode = \
     "ManualLevels"
res@cnMinLevelValF = 0.
res@cnMaxLevelValF = 1000.
res@cnLevelSpacingF = 50.
contour=wrf_contour(a,wks,ter,res)


res@ContourParameters = \
     (/0.,1000.,50./)
contour=wrf_contour(a,wks,ter,res)
```

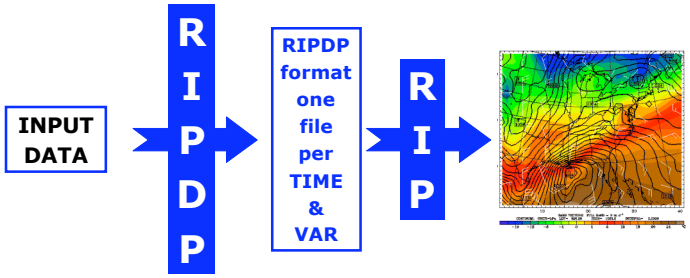
```
plot = wrf_map_overlays \
  (a,wks,(/contour/),pltres,mpres)


mpres@mpGridSpacingF = 45
 plot = wrf_map_overlays \
  (a,wks,(/contour/),pltres,mpres)
```


NCL Resources

- **The special WRF functions have unique resources:**
  http://www.mmm.ucar.edu/wrf/OnLineTutorial/Graphics/NCL/NCL_functions.htm
- **All general NCL resources can also be used to control the plot:**
  http://www.ncl.ucar.edu/Document/Graphics/Resources

- am (annotation manager)
- app (app)
- ca (coordinate array)
- cn (contour)
- ct (coordinate array table)
- dc (data comm)
- err (error)
- gs (graphic style)
- gsn (gsn high-level interfaces)
- lb (label bar)
- lg (legends)
- mp (maps)
- pm (plot manager)
- pr (primitives)
- sf (scalar field)
- st (streamline)
- tf (transformation)
- ti (title)
- tm (tickmark)
- tr (irregular transformation)
- tx (text)
- vc (vectors)
- vf (vector field)
- vp (view port)
- wk (workstation)
- ws (workspace)
- xy (xy plots)

RIP4



RIP4: General

- **Requires NCL libraries:**
  - *http://www.ncl.ucar.edu*
- **Download Code:**
  - *http://www.mmm.ucar.edu/wrf/users/download/get_source.html*
  - *http://www.dtcenter.org/wrf-nmm/users/downloads/index.php*
- **Documentation:**
  - In program tar file under the Doc/ directory
  - *http://www.mmm.ucar.edu/wrf/users/docs/ripug.htm*
  - *http://www.dtcenter.org/wrf-nmm/users/docs/user_guide/RIP/ripug.htm*
- **Online Tutorial:**
  - *http://www.mmm.ucar.edu/wrf/users/graphics/RIP4/RIP4.htm*
  - *http://www.dtcenter.org/wrf-nmm/users/OnLineTutorial/NMM/RIP/index.php*

RIP4 on your computer

- **set environment variables**
  setenv RIP_ROOT /usr/$USER/RIP4 *(rip_root in namelist)*
  setenv NCARG_ROOT /usr/local/ncl
- **Configure**
  ./configure
  (check configure.rip to ensure netCDF paths are correct)
- **Compile**
  ./compile
- **RIP4 has 2 parts (RIPDP and RIP)**
  ripdp_mm5
  ripdp_wrfarw
  ripdp_wrfnmm

Running ripdp & rip

ripdp_wrf*xxx* [–n namelist-file] **<model_data_name>** \
[basic/all] <input_file(s)>

rip [-f] **<model_data_name> rip-execution-name**

Example:

ripdp_wrfarw RIPDP/arw all wrfout*
rip [-f] RIPDP/arw rip_sample.in

output
[rip_sample.out]
rip_sample.TYPE

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)

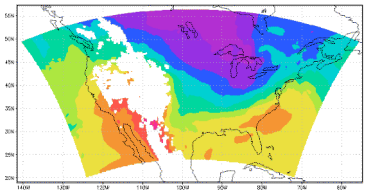
Plot Specification Table (PST)

ARWpost

- **Download Code** (http://www.mmm.ucar.edu/wrf/users)
- **Online Tutorial**
  http://www.mmm.ucar.edu/wrf/users/graphics/ARWpost/ARWpost.htm
- **MUST have WRF compiled *(similar to WPS)***
  ./configure & ./compile
- **For GrADS output**
  - GrADS libraries only needed to display data *(freely available)*
  - http://grads.iges.org/grads/grads.html
- **For vis5d output**
  - vis5d libraries needed for compilation *(freely available)*
  - http://www.ssec.wisc.edu/~billh/vis5d.html

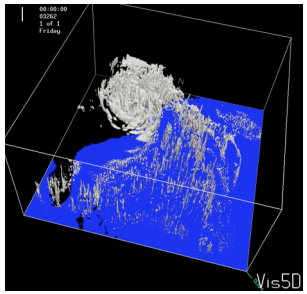
GrADS - .ctl file

```
dset ^test.dat
options byteswapped
undef 1.e37
title  OUTPUT FROM WRF V2.2 MODEL
pdef  259 163 lcc  40.000  -98.000  130.000   82.000
60.00000  30.00000  -98.00000  22000.000  22000.000
xdef  877 linear -141.49254   0.09909910
ydef  389 linear   18.88639   0.09909910
```



vis5d

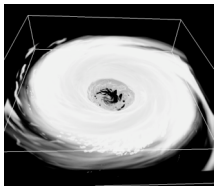
- **vis5d is a three-dimensional visualization software**
- **vis5d is free and can be downloaded from:**
  http://www.ssec.wisc.edu/~billh/vis5d.html
- **Run**
  vis5d output_root_name.v5d
- **Graphical Interface**

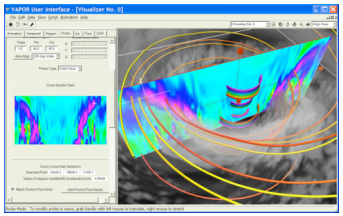


VAPOR

Computational and Information Systems Laboratory
National Center for Atmospheric Research

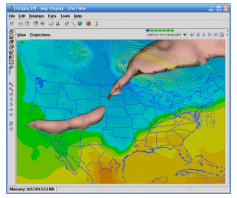
- http://www.vapor.ucar.edu
- http://www.vapor.ucar.edu/doc/WRFsupport.pdf

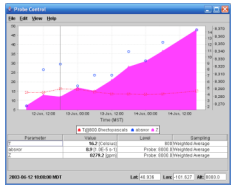




Integrated Data Viewer (IDV)

- **Integrated Data Viewer homepage**
  - http://www.unidata.ucar.edu/software/idv
- **RAMADDA homepage**
  - http://www.unidata.ucar.edu/software/ramadda/
- **VisAD homepage**
  - http://www.ssec.wisc.edu/~billh/visad.html
- **All IDV questions/comments**
  - support-idv@unidata.ucar.edu



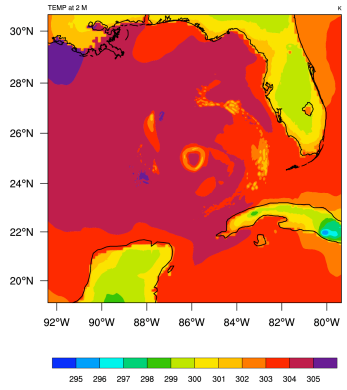


Moving Nest

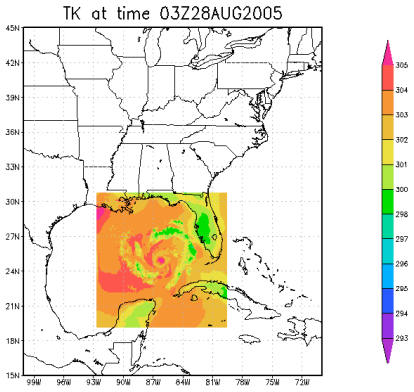
- **One file per time**
- **Process each time separately**
- **Issues**
  - Can plot any variable as per normal, but the background will move
    - *NCL, and to some extend Grads, can use fix backgrounds with moving domains*
  - Rain fields are accumulative, so just plotting the field is not much use
    - *At the moment only NCL can plot the tendencies correctly*

Moving Nests

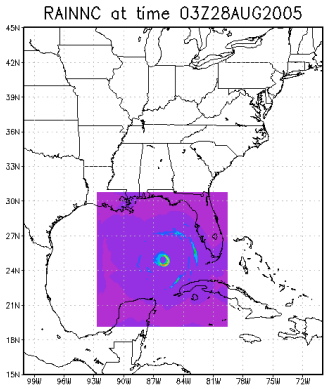
- **Just plotting each field will result in the background moving**
  - RIP4 *(no alternative)*
  - Grads & NCL
    Both have the ability to control the map background, so that the map is stationary and the data is projected onto the right location of the map.



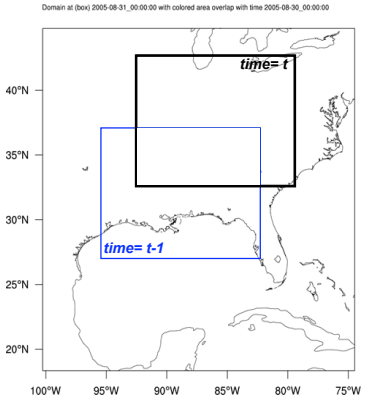
Moving Nests



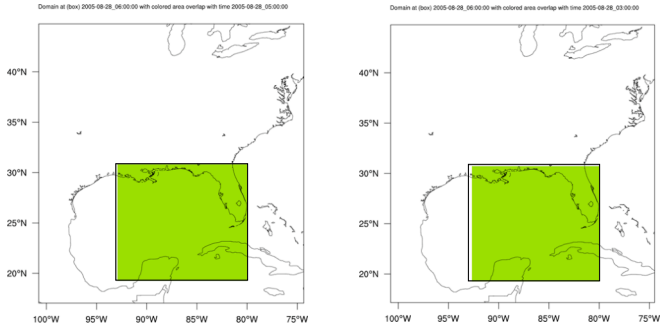
Moving Nests



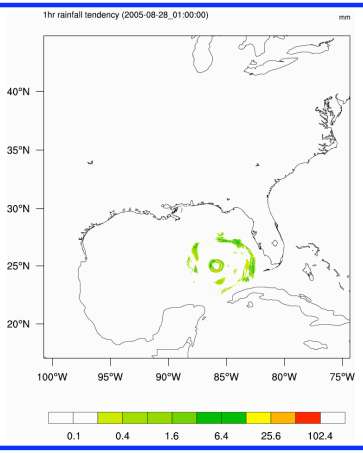
Moving Nest : *Precip Tendencies*



Moving Nest : *Precip Tendencies*



Moving Nests



Hurricane Tracking

- **How to track a storm**
  - AHW will output data at run time
    text output in the rsl.out.0000 file

```
ATCF 2005-08-26_00:00:00  25.79  -80.39  990.3  50.4
ATCF 2005-08-26_00:15:00  25.83  -80.41  994.3  52.9
```

  - Output from WPP can be used in the TRACKER program
    more in a later talk

Hurricane Tracking

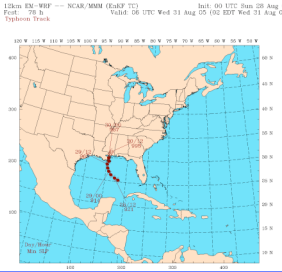
- **How to track a storm**
  - Run RIP4 *(Does NOT work for moving nest)*

```
&userin
 ptimes=0,
/
=================================================================
-----------------    Plot Specification Table    ----------------
=================================================================
feld=map; ptyp=hb; ouds=solid; oulw=2; cint=10.; >
       mllm=land; mfco=light.cerulean,peach
feld=map; ptyp=hb; ouds=solid; oulw=2; cint=10.; mllm=land
feld=track; ptyp=hb; colr=dark.red; tslb=.014; tynt=6.
feld=tic; ptyp=hb; axlg=0.; axtg=0.
=================================================================
```


Hurricane Tracking

- **How to track a storm**
  - Run RIP4 *(Does NOT work for moving nest)*

```
lat   lon     y       x       t     SLP     wind  xmax    ymax
24.93 -85.97 130.12 222.62 0.00 964.08 47.44 223.00 134.00
25.13 -86.16 131.87 221.12 1.00 957.02 57.38 222.00 134.00
```



Hurricane Tracking

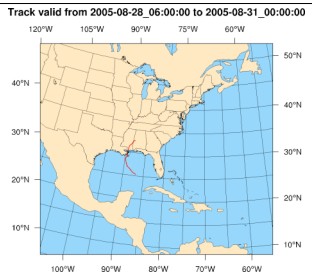
- **How to track a storm**
  - Run NCL tracking program *(Does NOT work for moving nest)*
  - Based on same tracking algorithms as RIP4
  - Requires a test input file **tcdat**

```
Date of storm
Number of storms
name      lat1    lon1    lat2    lon2    SLP     rad     wind    -1


Eg.
05082800
1
KATRINA   24.8N   85.9W   11.5N   56.6W   941MB   300KM   51M/S   -1KM
```


Hurricane Tracking

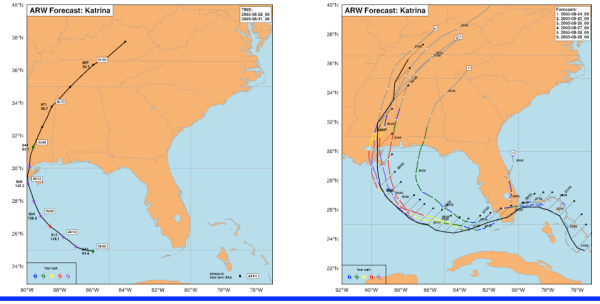
- **How to track a storm**
  - Run NCL tracking program *(Does NOT work for moving nest)*

```
lat    lon     t     SLP     wind
24.93 -85.97 0.00 964.08 47.44
25.13 -86.16 1.00 957.02 57.38
```



Hurricane Tracking

- **How to plot a storm track**
  - RIP4 and NCL - *generate basic plots at run time*
  - RIP4, NCL and WRF generated tracks output data can be used in NCL track plotting script ***(CreateTracks.ncl)***



How to add diagnostics

- **RIP4**
  - Create a subroutine (note RIP4 expects the code to be in "j/l/-k" orientation)
  - Add links to the RIP4/src/fields.f routine
  - Add new subroutine to RIP4/src/Makefile
- **ARWpost**
  - Create a subroutine
  - Add links to ARWpost/src/module_diagnostics.f90
  - Add new subroutine to ARWpost/src/Makefile
- **NCL**
  - Create an NCL script and load/call from other NCL scripts
  - Link in a FORTRAN / C program into an NCL script

Calling FORTRAN code from NCL

- **Easier to use F77 code, but works with F90 code**
- **Need to isolate definition of input variables and wrap it with special comment statements:**

```
C NCLFORTSTART
C NCLEND
```

- **Use a tool called `WRAPIT` to create a `*.so` file**
- **Load `*.so` file in NCL script with "`external`" statement**
- **Call Fortran function with special "`::`" syntax**
- **Must pre-allocate arrays!**

myTK.f

```
C NCLFORTSTART
    subroutine compute_tk (tk,pressure,theta, nx, ny, nz)
      implicit none
      integer nx,ny,nz
      real    pi, tk(nx,ny,nz)
      real    pressure(nx,ny,nz), theta(nx,ny,nz)
C NCLEND
     integer i,j,k

      do k=1,nz
        do j=1,ny
        do i=1,nx
           pi=(pressure(i,j,k) / 1000.)**(287./1004.)
           tk(i,j,k) = pi*theta(i,j,k)
        enddo
        enddo
      enddo

      end
```

myTK.so - *Create & use in NCL script*

```
% WRAPIT myTK.f
```

This will create a "`myTK.so`" file

```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "$NCARG_ROOT/lib/ncarg/nclscripts/wrf/WRFUserARW.ncl"
external myTK "./myTK.so"

begin
    t = wrf_user_getvar(a,"T",5)
    t = t + 300
    p = wrf_user_getvar(a,"pressure",5)

    ; Must preallocate space for output arrays
    dim = dimsizes(t)
    tk = new( dimsizes(t), typeof(t) )

    ; Remember, Fortran/NCL arrays are ordered differently
       myTK :: compute_tk (tk,p,t,dim(2),dim(1),dim(0))
end
```

FORTRAN 90 code

- **Can use simple FORTRAN 90 code**
- **Your FORTRAN 90 program may not contain any of the following features:**
  - pointers or structures as arguments,
  - missing/optional arguments,
  - keyword arguments, or
  - recursive procedure.