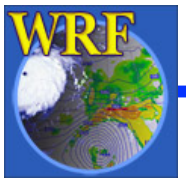
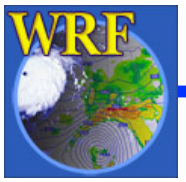

# Post-processing Tools: NCL

*Cindy Bruyère*

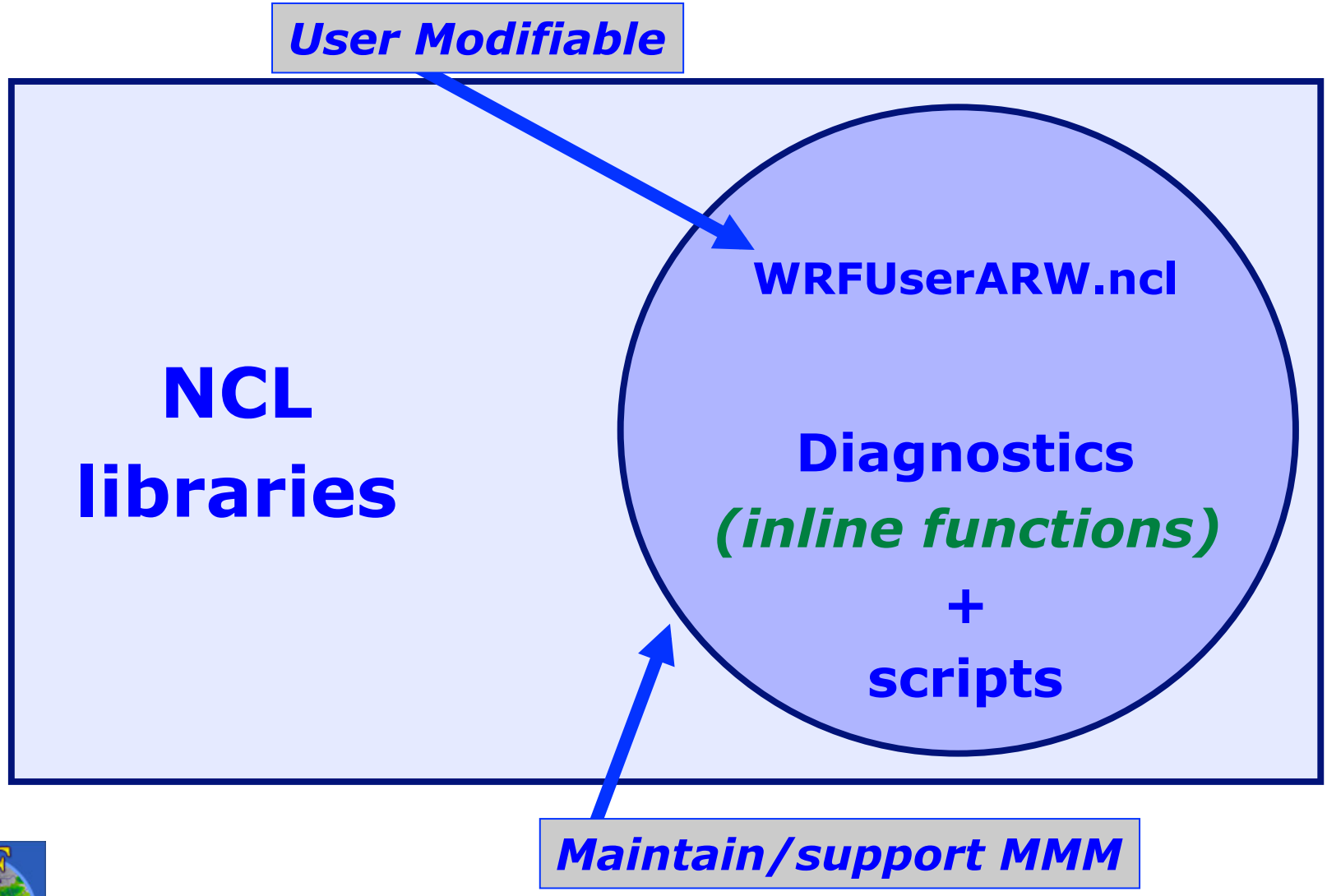


# NCL

- 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 5.1.1 or *later (current v6.1.0-beta)*
- NCARG_ROOT environment variable
  - setenv NCARG_ROOT /usr/local/ncl



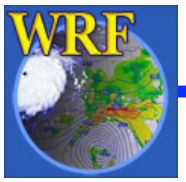
# NCL & WRF


User Modifiable
WRFUserARW.ncl
NCL
libraries
Diagnostics
(inline functions)
+
scripts
Maintain/support MMM

Home Directory → ~/.hluresfile ← Very Important

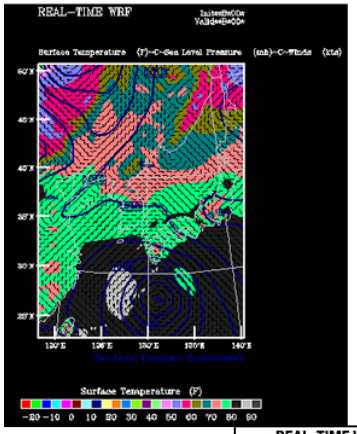
- Required by NCL libraries
- Must be in your "~/" directory *(home directory)*
- Control
  - color table ; font
  - white/black background
  - size of plot
  - control characters

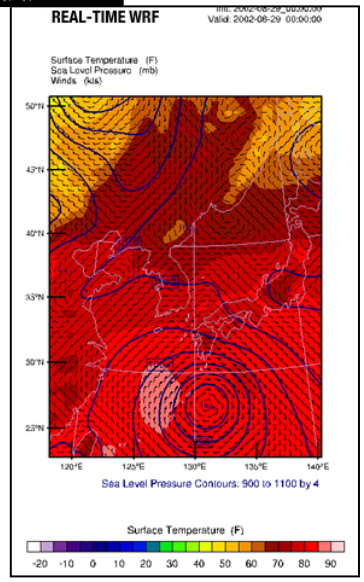
- http://www.ncl.ucar.edu/Document/Graphics/hlures.shtml



# ~/.hluresfile

```
*wkColorMap             : BlAqGrYeOrReVi200
*wkBackgroundColor      : white
*wkForegroundColor      : black
*FuncCode               : ~
*TextFuncCode           : ~
*Font                   : helvetica
*wkWidth                : 900
*wkHeight               : 900
```



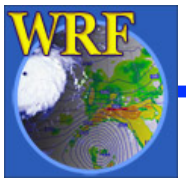




```
PLCHHQ - CHARACTER NUMBER 26 (.) IS NOT A LEGAL FUNCTION CODE
PLCHHQ - CHARACTER NUMBER 29 (t) IS NOT A LEGAL FUNCTION CODE
PLCHHQ - CHARACTER NUMBER 30 (o) IS NOT A LEGAL FUNCTION CODE
PLCHHQ - CHARACTER NUMBER 32 (.) IS NOT A LEGAL FUNCTION CODE
PLCHHQ - CHARACTER NUMBER 35 (b) IS NOT A LEGAL FUNCTION CODE
PLCHHQ - CHARACTER NUMBER 36 (y) IS NOT A LEGAL FUNCTION CODE
```

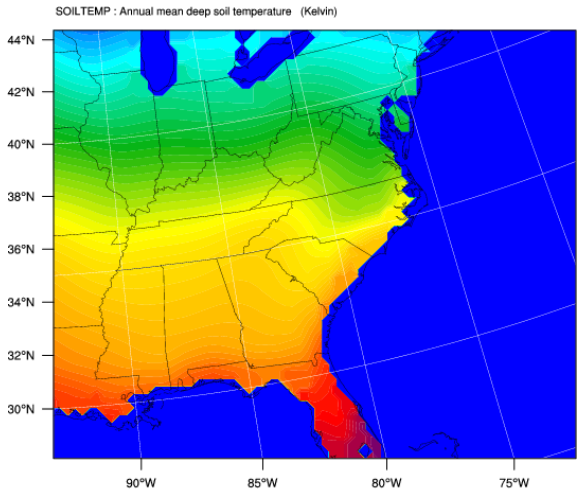
http://www.mmm.ucar.edu/wrf/OnLineTutorial/Graphics/NCL/.hluresfile

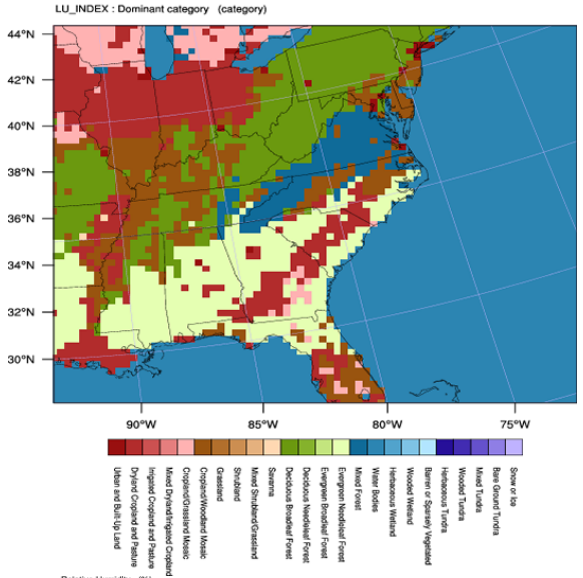
# Generate Plots with NCL

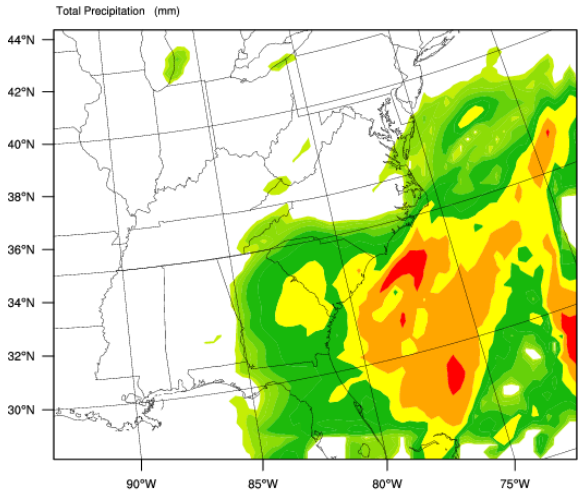
- Set NCARG_ROOT environment variable:
  - *setenv NCARG_ROOT /usr/local/ncl*
- Ensure you have an ~/.hluresfile file
- Create a script
  - *wrf_real.ncl*
    *(start with a sample script)*
    Most of the WRF script routines are called from
    "$NCARG_ROOT/lib/ncarg/nclscripts/wrf/WRFUserARW.ncl"
    *Feel free to add or change this script*
- Run NCL script
  - *ncl wrf_real.ncl*

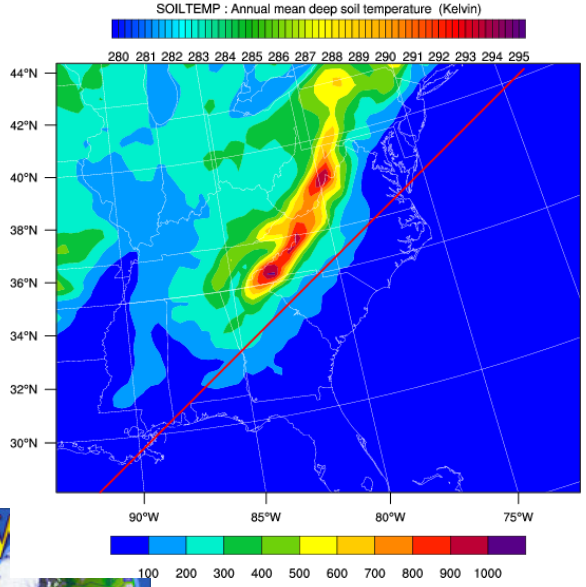


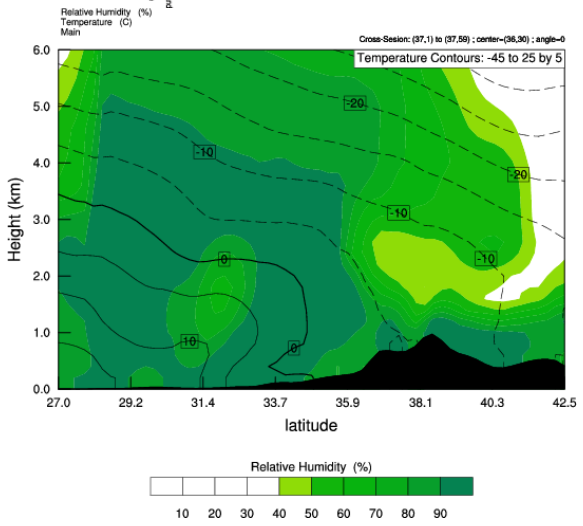
# Examples

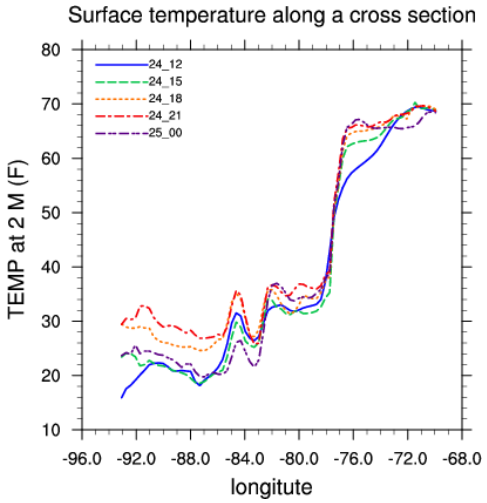

SOILTEMP : Annual mean deep soil temperature (Kelvin)
44°N
42°N
40°N
38°N
36°N
34°N
32°N
30°N
90°W
85°W
80°W
75°W


LU_INDEX : Dominant category (category)
44°N
42°N
40°N
38°N
36°N
34°N
32°N
30°N
90°W
85°W
80°W
75°W
Urban and Built-Up Land
Dryland Cropland and Pasture
Irrigated Cropland and Pasture
Mixed Dryland/Irrigated Cropland
Cropland/Woodland Mosaic
Cropland/Grassland Mosaic
Grassland
Shrubland
Mixed Shrubland/Grassland
Savanna
Deciduous Broadleaf Forest
Deciduous Needleleaf Forest
Evergreen Broadleaf Forest
Evergreen Needleleaf Forest
Mixed Forest
Water Bodies
Herbaceous Wetland
Wooded Wetland
Barren or Sparsely Vegetated
Herbaceous Tundra
Wooded Tundra
Mixed Tundra
Bare Ground Tundra
Snow or Ice

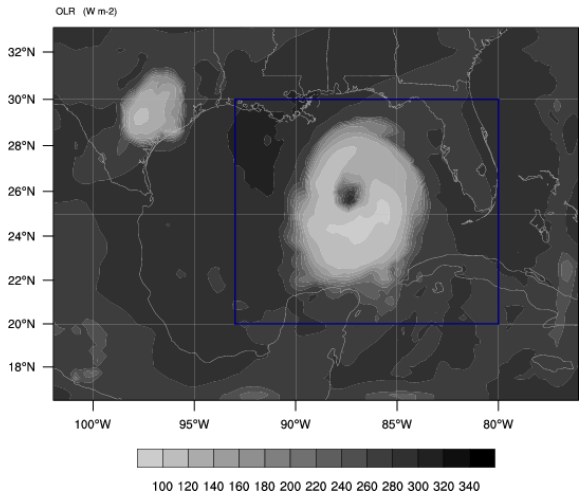

Total Precipitation (mm)
44°N
42°N
40°N
38°N
36°N
34°N
32°N
30°N
90°W
85°W
80°W
75°W
Total Precipitation (mm)
.1
.2
.4
.8
1.6
3.2
6.4
12.8
25.6
51.2
102.4

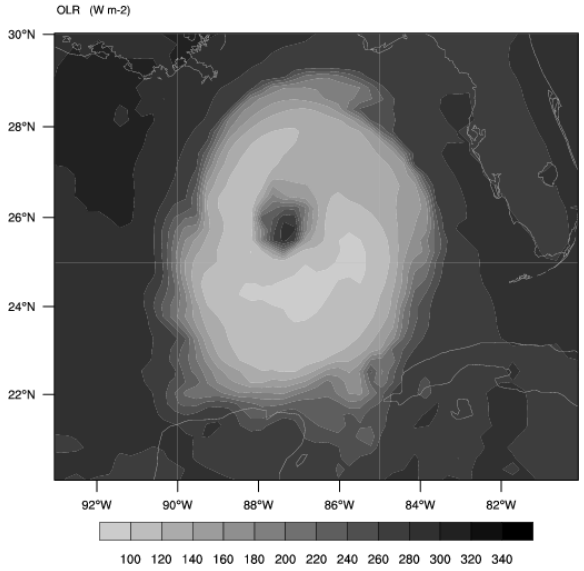

SOILTEMP : Annual mean deep soil temperature (Kelvin)
280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295
44°N
42°N
40°N
38°N
36°N
34°N
32°N
30°N
90°W
85°W
80°W
75°W
100 200 300 400 500 600 700 800 900 1000

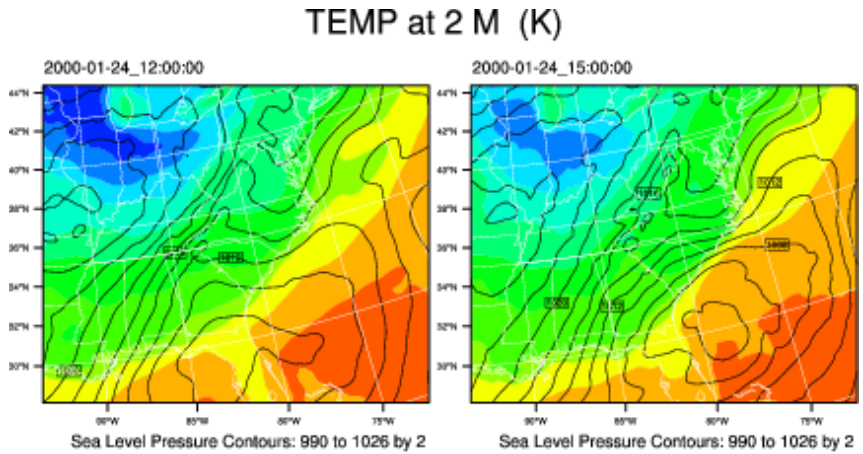

Relative Humidity (%)
Temperature (C)
Main
Cross-Section: (37,1) to (37,59) ; center=(36,30) ; angle=0
Temperature Contours: -45 to 25 by 5
Height (km)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
27.0
29.2
31.4
33.7
35.9
38.1
40.3
42.5
latitude
-20
-10
0
10
20
Relative Humidity (%)
10 20 30 40 50 60 70 80 90

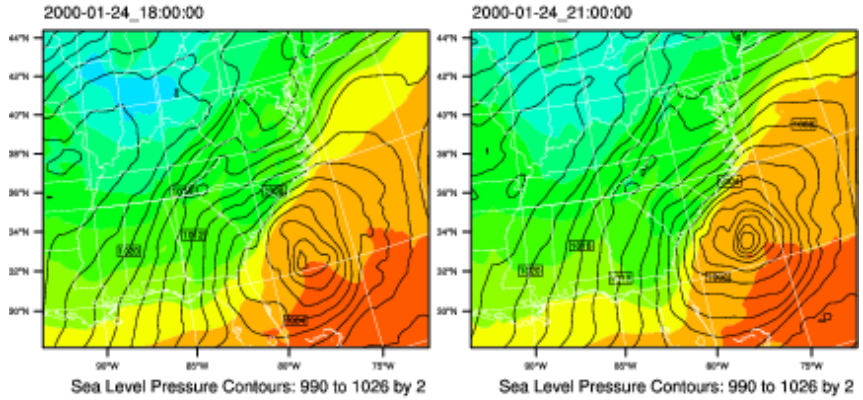

Surface temperature along a cross section
TEMP at 2 M (F)
80
70
60
50
40
30
20
10
-96.0
-92.0
-88.0
-84.0
-80.0
-76.0
-72.0
-68.0
longitude
24_12
24_15
24_18
24_21
25_00

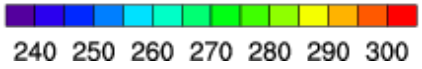
# Examples


OLR (W m-2)
32°N
30°N
28°N
26°N
24°N
22°N
20°N
18°N
100°W
95°W
90°W
85°W
80°W
100 120 140 160 180 200 220 240 260 280 300 320 340

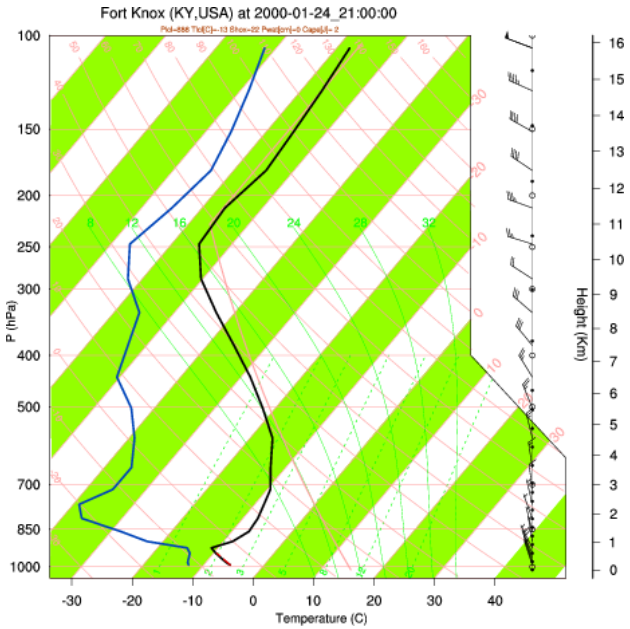

OLR (W m-2)
30°N
28°N
26°N
24°N
22°N
92°W
90°W
88°W
86°W
84°W
82°W
100 120 140 160 180 200 220 240 260 280 300 320 340

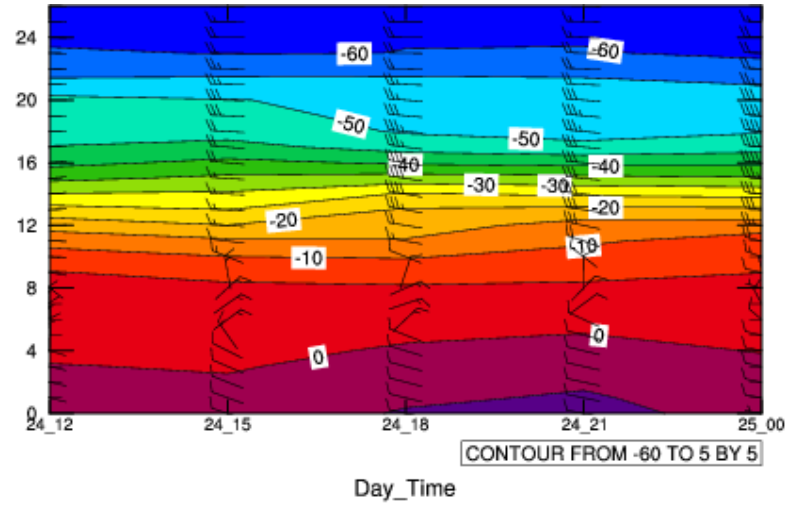

TEMP at 2 M (K)
2000-01-24_12:00:00
2000-01-24_15:00:00
Sea Level Pressure Contours: 990 to 1026 by 2
Sea Level Pressure Contours: 990 to 1026 by 2

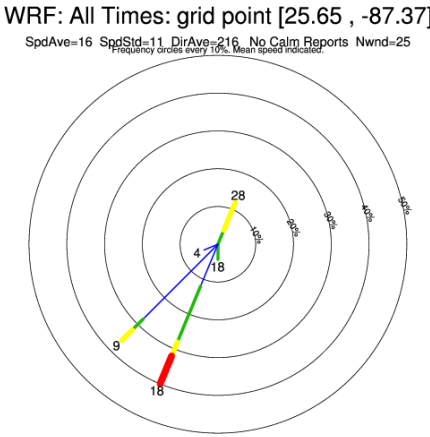

2000-01-24_18:00:00
2000-01-24_21:00:00
Sea Level Pressure Contours: 990 to 1026 by 2
Sea Level Pressure Contours: 990 to 1026 by 2

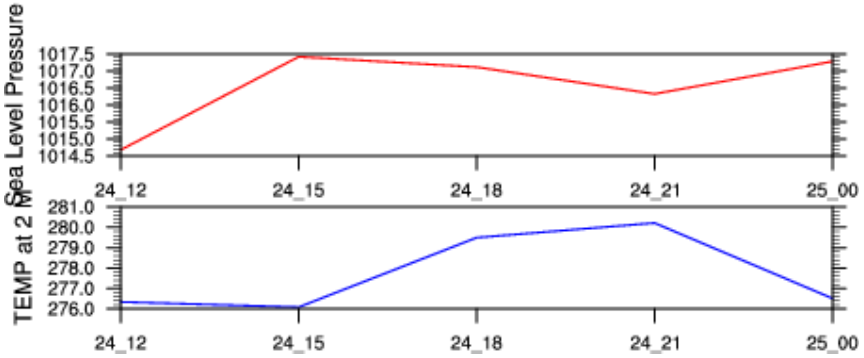

240 250 260 270 280 290 300

# Examples

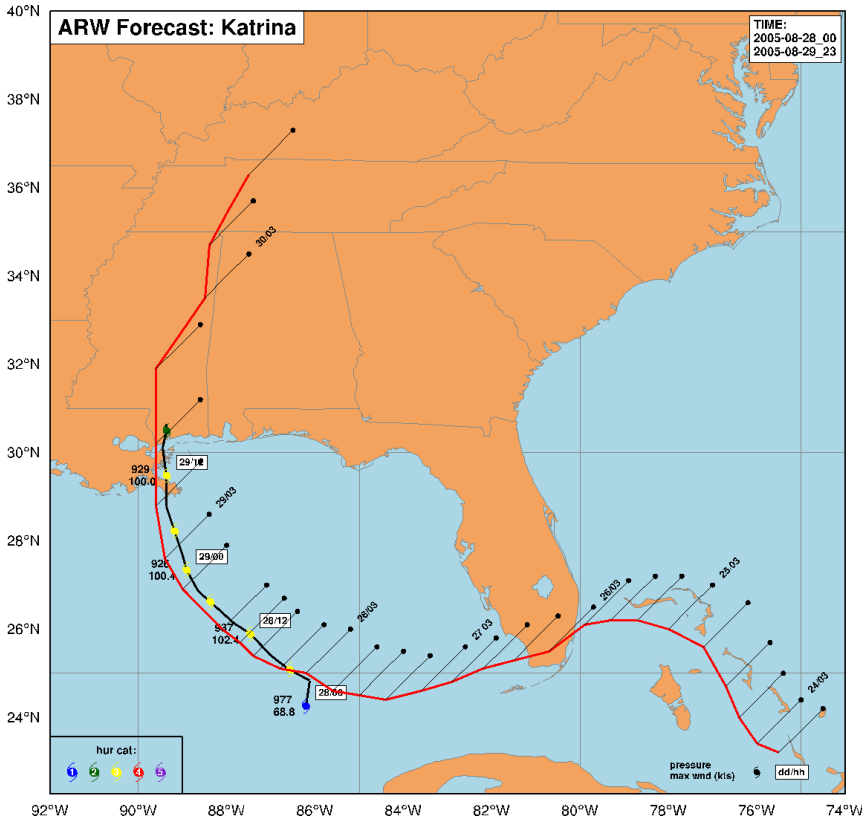

Fort Knox (KY,USA) at 2000-01-24_21:00:00
P (hPa)
Height (Km)
Temperature (C)

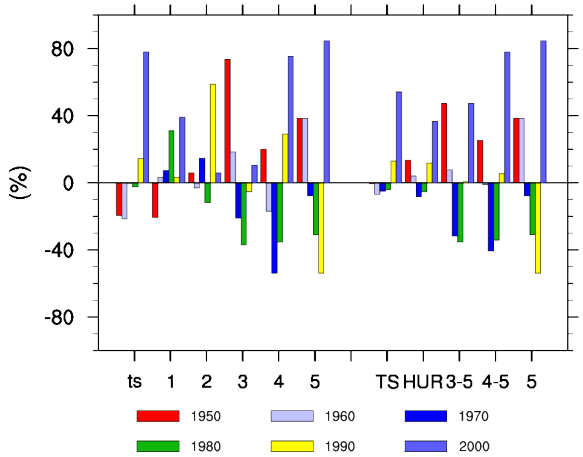

-60
-50
-40
-30
-20
-10
0
24_12
24_15
24_18
24_21
25_00
CONTOUR FROM -60 TO 5 BY 5
Day_Time

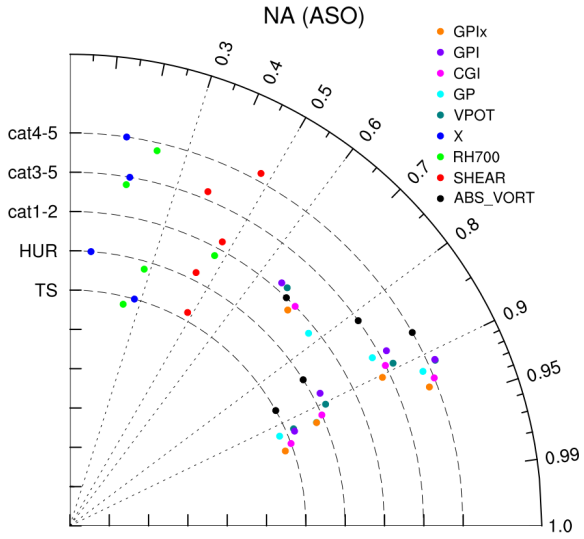

WRF: All Times: grid point [25.65 , -87.37]
SpdAve=16 SpdStd=11 DirAve=216 No Calm Reports Nwnd=25
Frequency circles every 10%. Mean speed indicated.


Sea Level Pressure
TEMP at 2 M
24_12
24_15
24_18
24_21
25_00

# Examples

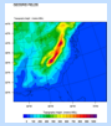

ARW Forecast: Katrina
TIME:
2005-08-28_00
2005-08-29_23
40°N
38°N
36°N
34°N
32°N
30°N
28°N
26°N
24°N
92°W
90°W
88°W
86°W
84°W
82°W
80°W
78°W
76°W
74°W
hur cat:
pressure
max wnd (kts)
dd/hh


80
40
0
-40
-80
(%)
ts
1
2
3
4
5
TS HUR 3-5
4-5
5
1950
1960
1970
1980
1990
2000


NA (ASO)
GPIx
GPI
CGI
GP
VPOT
X
RH700
SHEAR
ABS_VORT
cat4-5
cat3-5
cat1-2
HUR
TS
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0.95
0.99
1.0

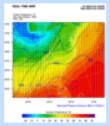
# Generate Plots: *A good start - OnLine Tutorial*

**Basic Plots**



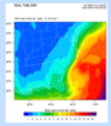
Basic Plot Setup
*(This series of examples takes users though same basic steps in generating plotting scripts.)*
Get and plot a single field
Multiple input files
Plot all fields in a file

**Basic Surface Plots**



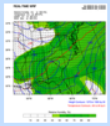
Surface 1
Surface 3
Surface 2
Surface with multiple input files

**Plots on Model Levels**



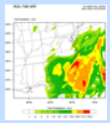
Clouds
Levels from wrfout files
Levels from metgrid files

**Plots on Interpolated Levels**



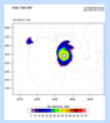
Height Levels
Pressure Levels

**Plotting Precipitation**



Precipitation

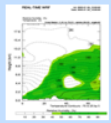
**Diagnostics**



CAPE
dBZ
PW
Vorticity
helicity
updraft_helicity

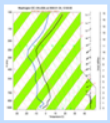
*(More diagnostics are available, shown are only some newer/special diagnostics)*

**Cross-section Plots**



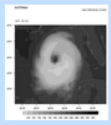
Height - Through a Pivot Point
Height - Point A to Point B
Pressure
Limited Vertical Extent
For 2D fields
Smooth terrain

**Skew_T Plots**



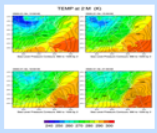
Skew_T

**Overlay and Zoom**



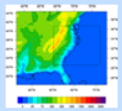
Overlay
Zoom
Overlay & Zoom

**Panel Plots**



Panel 1
Panel 2

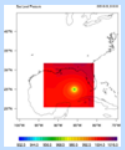
**Overlay Domains**



Overlay 2 domains

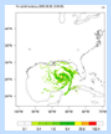
[http://www.mmm.ucar.edu/wrf/OnLineTutorial/Graphics/NCL/index.html](http://www.mmm.ucar.edu/wrf/OnLineTutorial/Graphics/NCL/index.html)

**Moving Nest**



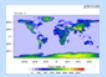
Moving Nest
*Keeping a fixed background for moving nest domain*

**Moving Nest**



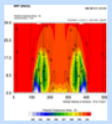
Precip Tendencies for a Moving Nest
*Keeping a fixed background for moving nest domain, and plotting rainfall tendencies in the overlapping regions*
Domain 1 and 2 Precip Tendencies on a single plot (domain 2 is a moving nest)

**Global WRF**



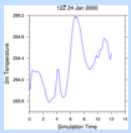
gWRF_merc

**Idealized cases**



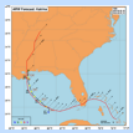
wrf_Grav2x
wrf_Hill2d
wrf_Squall_2d_x
wrf_Squall_2d_y
wrf_Seabreeze2x
wrf_BWave
wrf_QSS

**Time Slice Plots**



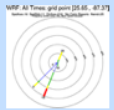
Meteograms
WRF Time Series data

**Track Cyclone**



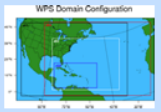
Plot Cyclone Vortex

**Wind Roses**

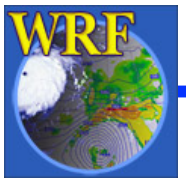


Create a wind rose

**Preview Domain**

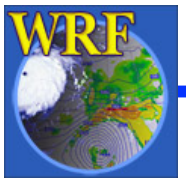


Preview
*Note: This example script makes use to the WPS namelist directly*



# Creating a Plot : NCL script

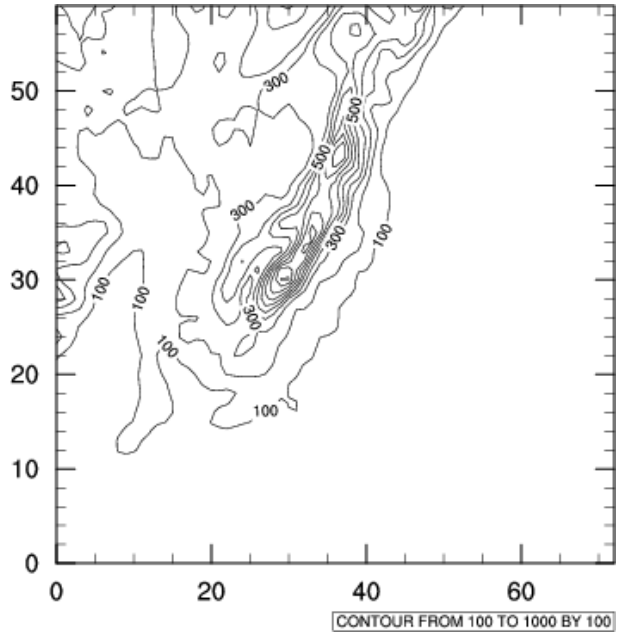
```
load ncl library scripts

begin

  ; Open graphical output
  ; Open input file(s)

  ; Read variables

  ; Set up plot resources & Create plots
  ; Output graphics

end
```



# Generate Plots

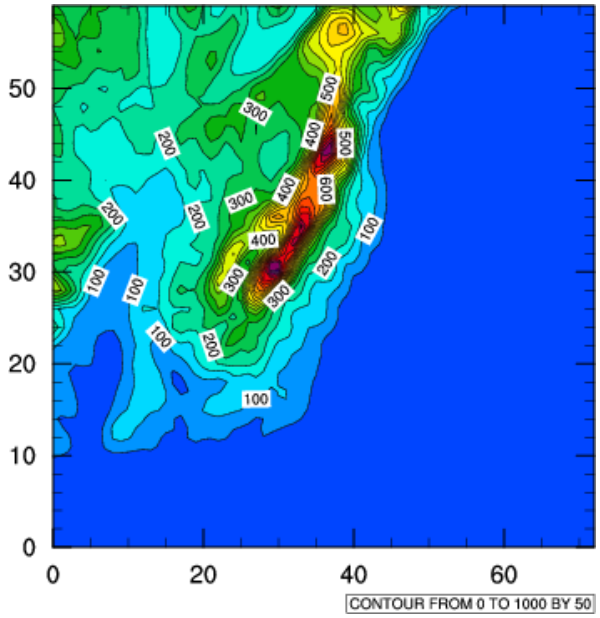
```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"

begin
  a = addfile("./geo_em.d01.nc","r")
  wks = gsn_open_wks("pdf","plt_ter1")
  ter = a->HGT_M(0,:,:)
  plot = gsn_contour(wks,ter,True)
end
```

```
> ls wrfout*
  wrfout_d01_2005-10-08_00:00:00

a = addfile("./
wrfout_d01_2005-10-08_00:00:00.nc","r")
```



# Generate Plots

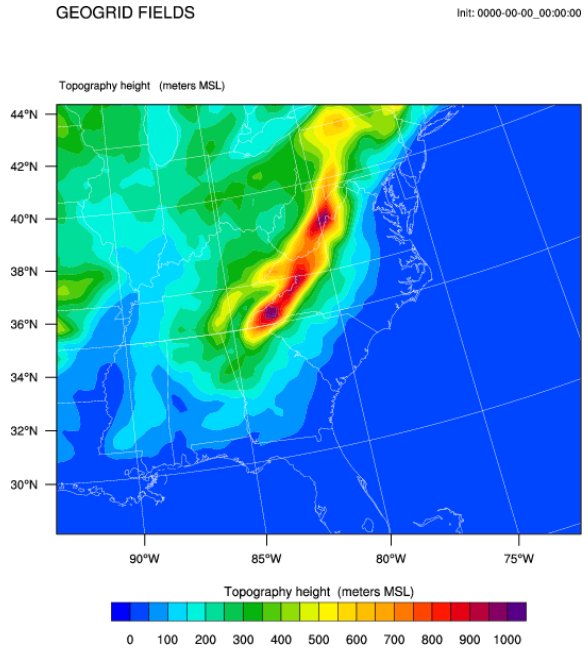
```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"

begin
  a = addfile("./geo_em.d01.nc","r")
  wks = gsn_open_wks("pdf","plt_ter1")
  ter = a->HGT_M(0,:,:)
  res = True
  res@cnFillOn = True
  res@gsnSpreadColors = True
  res@cnLevelSelectionMode = \
     "ManualLevels"
  res@cnMinLevelValF = 0.
  res@cnMaxLevelValF = 1000.
  res@cnLevelSpacingF = 50.
  plot = gsn_contour(wks,ter,res)
end
```




**Basic NCL resources - *there are over 1400 controlling contours, labelbars, legends, maps, etc.***

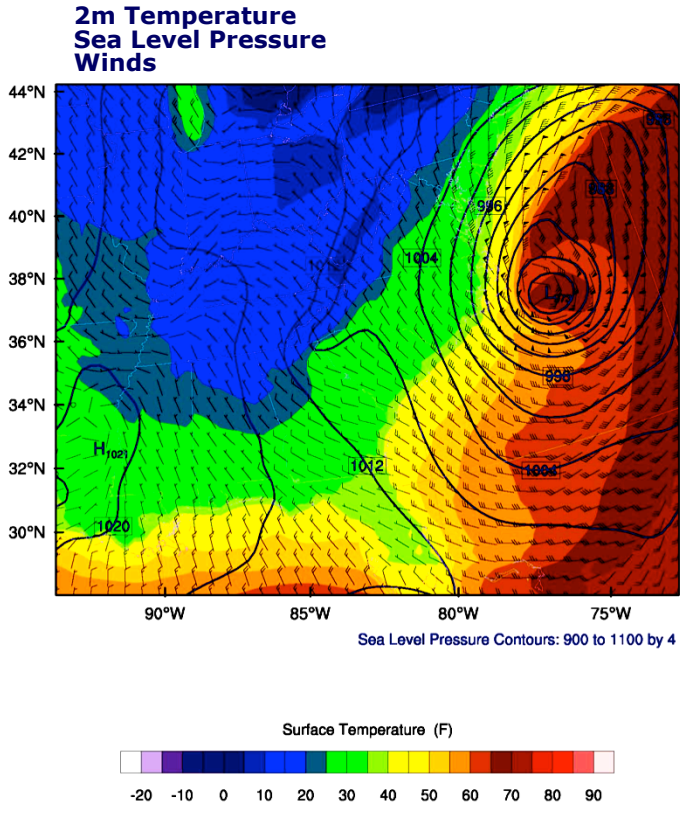
# Generate Plots

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

begin
  a = addfile("./geo_em.d01.nc","r")
  wks = gsn_open_wks("pdf","plt_ter1")
  ter = a->HGT_M(0,:,:)

  res = True
  res@MainTitle = "GEOGRID FIELDS"
  res@cnFillOn = True
  res@ContourParameters = (/0.,1000.,50./)
  contour = wrf_contour(a,wks,ter,res)
  pltres = True
  mpres = True
  plot = wrf_map_overlays(a,wks,(/contour/),\
    pltres,mpres)
end
```



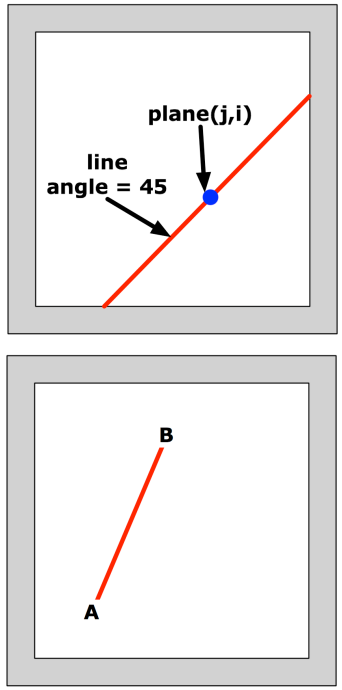
# Generate Plots

```
slp = wrf_user_getvar(a,"slp",5)
t2  = wrf_user_getvar(a,"T2",5)
u10 = wrf_user_getvar(a,"U10",5)
v10 = wrf_user_getvar(a,"V10",5)


os@cnLineColor = "NavyBlue"
c_slp = wrf_contour(a,wks,slp,os)
ot@cnFillOn = True
c_tc = wrf_contour(a,wks,t2,ot)
ov@NumVectors = 47
vec = wrf_vector(a,wks,u10,v10,ov)

plot = wrf_map_overlays(a, wks, \
       (/c_tc,c_slp,vec/), pltres, mpres)
```



# 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_unstagger**
  *Unstaggers an array*



# Special WRF NCL Functions

- **wrf_user_getvar**
  Get fields from input file

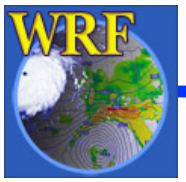
```
ter = wrf_user_getvar(a,"HGT",0)      {ter=a->HGT(0,:,:)}
t2  = wrf_user_getvar(a,"T2",-1)      {t2=a->T2}
slp = wrf_user_getvar(a,"slp",1)
```

avo/pvo: Absolute/Potential Vorticity, eth: Equivalent Potential Temperature,
cape_2d: 2D mcape/mcin/lcl/lfc, cape_3d: 3D cape/cin,
dbz/mdbz: Reflectivity (3D and max),
geopt/geopotential: Geopotential,
helicity/updraft_helicity: Storm Relative Helicity/Updraft helicity,
p/pres/pressure: Pressure, pw: Precipitable Water,
rh/rh2: Relative Humidity (3D and 2m),
slp: Sea Level Pressure, times: Time as a string [*(TIMES: Time as characters)*],
td/td2: Dew Point Temperature (3D and 2m),
tc/tk: Temperature (C and F), th/theta: Potential Temperature,
z/height: Height, ua/va/wa: wind on mass points,
uvmet/uvmet10: wind rotated to earth coordinates (3D and 10m)

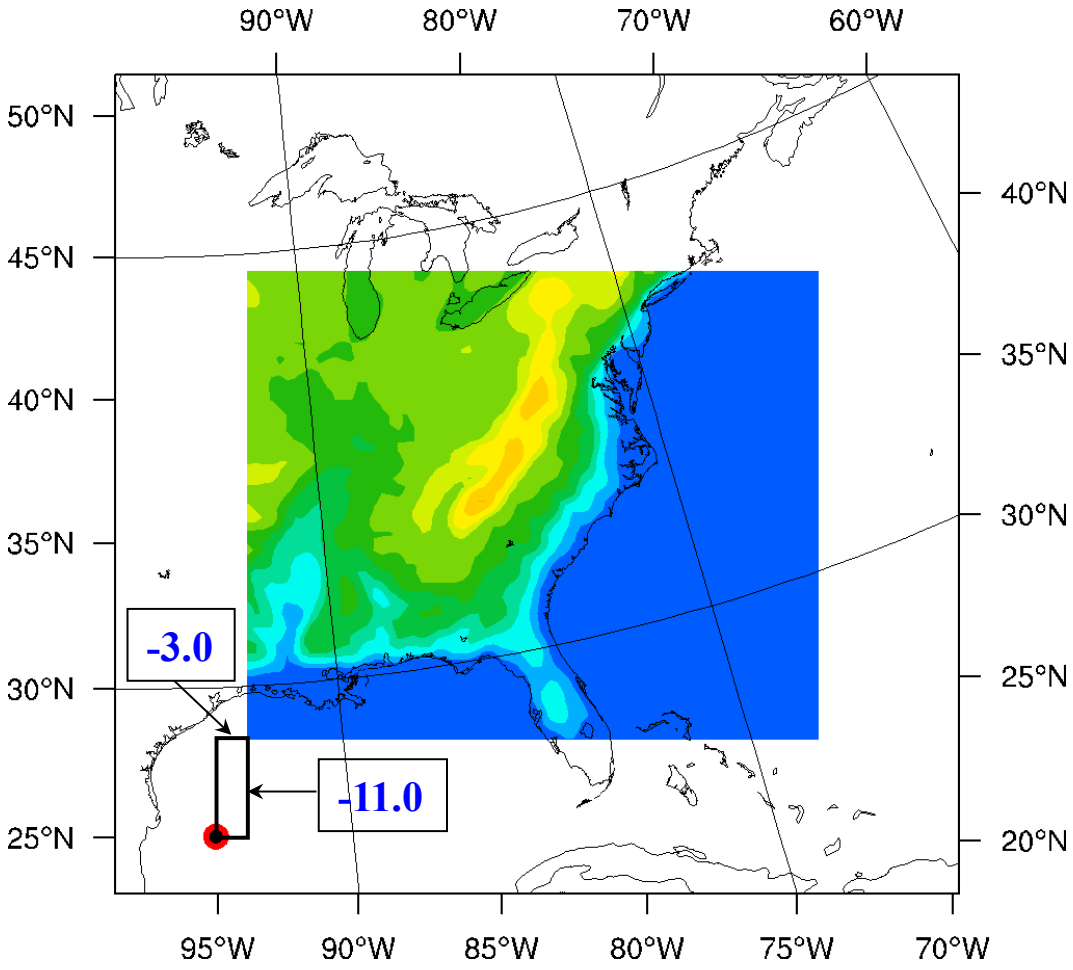
# Diagnostics

```
PH      = nc_file->PH(5,:,:,:)
PHB     = nc_file->PHB(5,:,:,:)
   PH    = ( PH + PHB ) / 9.81
   z = wrf_user_unstagger(PH,PH@stagger)

P       = nc_file->P(5,:,:,:)
PB      = nc_file->PB(5,:,:,:)
   P = P + PB

T       = nc_file->T(5,:,:,:)
   T = T + 300.
   tk = wrf_tk( P , T )

QVAPOR = nc_file->QVAPOR(5,:,:,:)
   QVAPOR = QVAPOR > 0.000


slp = wrf_slp( z, tk, P, QVAPOR )
```

```
slp = wrf_user_getvar(nc_file,"slp",5)
```

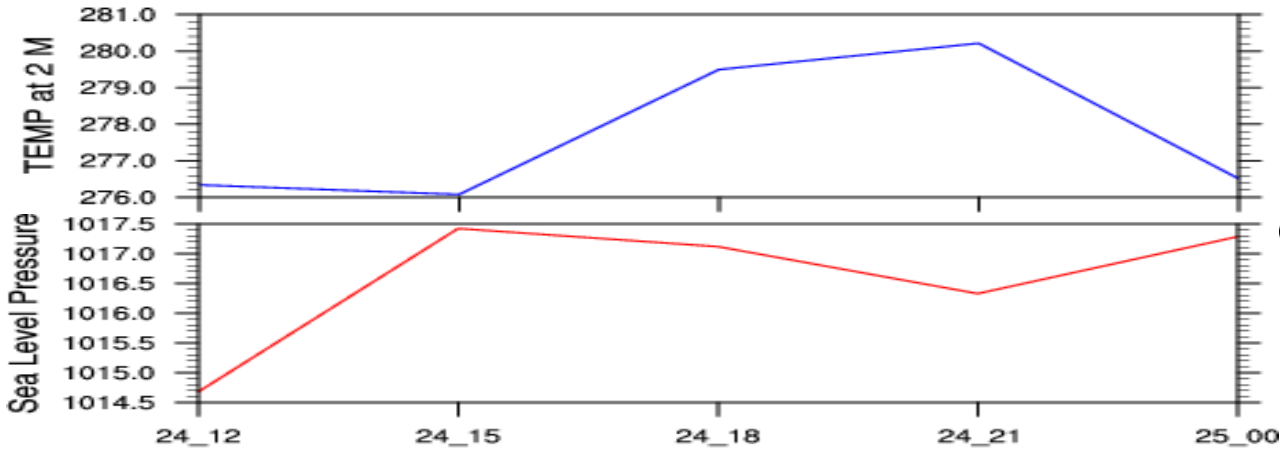


# wrf_user_ll_to_ij



# Time Series

```
locij = wrf_user_ll_to_ij(a, -87., 32.5, llres)
locij = locij - 1
locX = locij(0)
locY = locij(1)

t2_point  = a->T2(:,locY,locX)
t2_plot   = gsn_csm_xy(wks,taus,t2_point,t2_res)

slp   = wrf_user_getvar(a,"slp",-1)
slp_point  = slp(:,locY,locX)
slp_plot  = gsn_csm_xy(wks,taus,slp_point,t2_res)
```



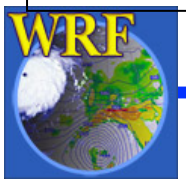
# NCL and WRF_NCL

- 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)

t2 = wrf_user_getvar(a,"T2",
(/0,10,2/))
t2 = wrf_user_getvar(a,"T2",
(/1,2,3,4,5/))
```

```
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)
```

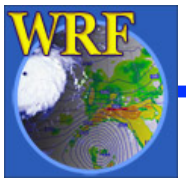


# Resources

- 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

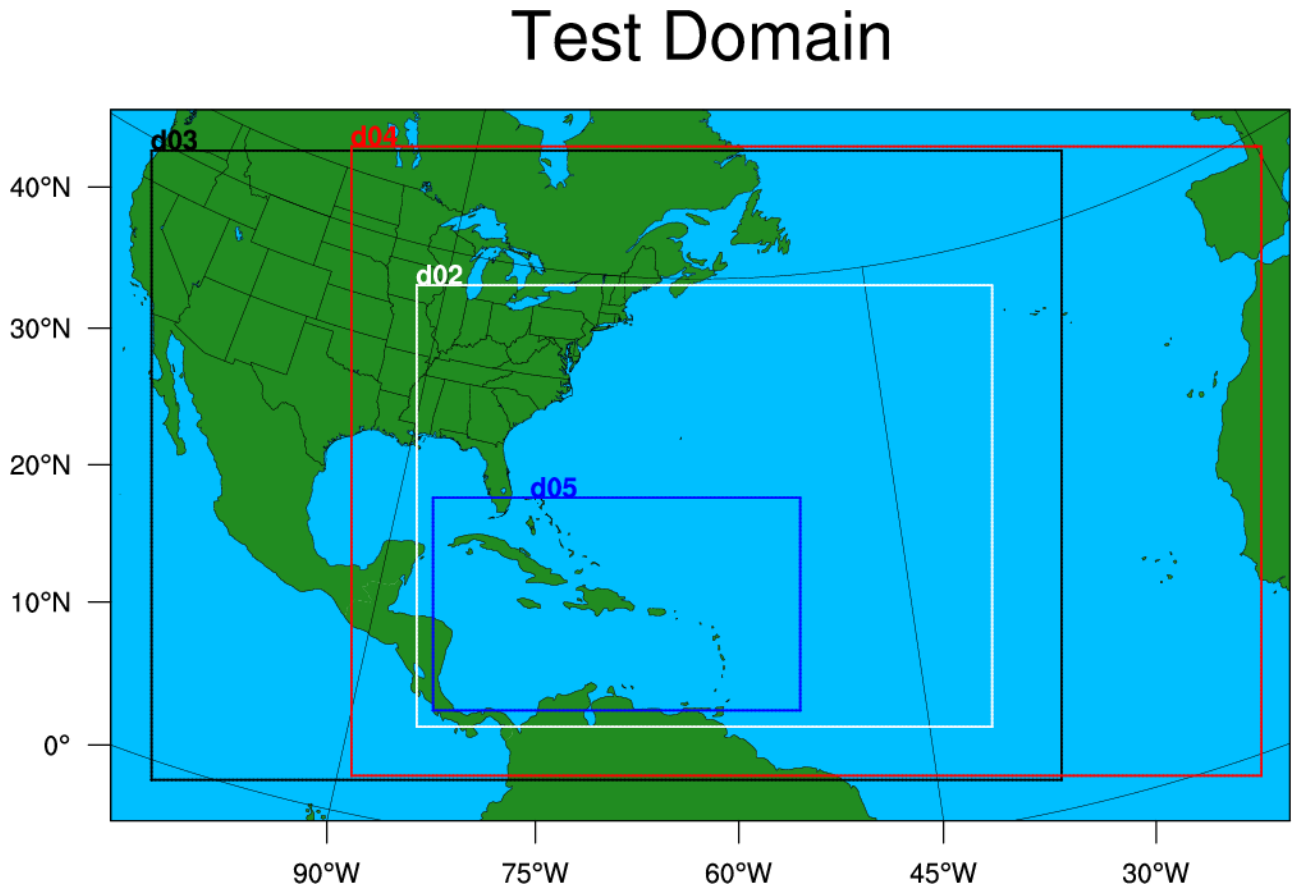
  - am (annotation manager)
  - app (app)
  - ca (coordinate array)
  - cn (contour)
  - ct (coordinate array table)
  - dc (data comm)
  - err (error)
  - gs (graphic style)
  - gsn (gsn high-level interfaces)
  - lb (label bar)
  - lg (legends)
  - mp (maps)
  - pm (plot manager)
  - pr (primitives)
  - 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)



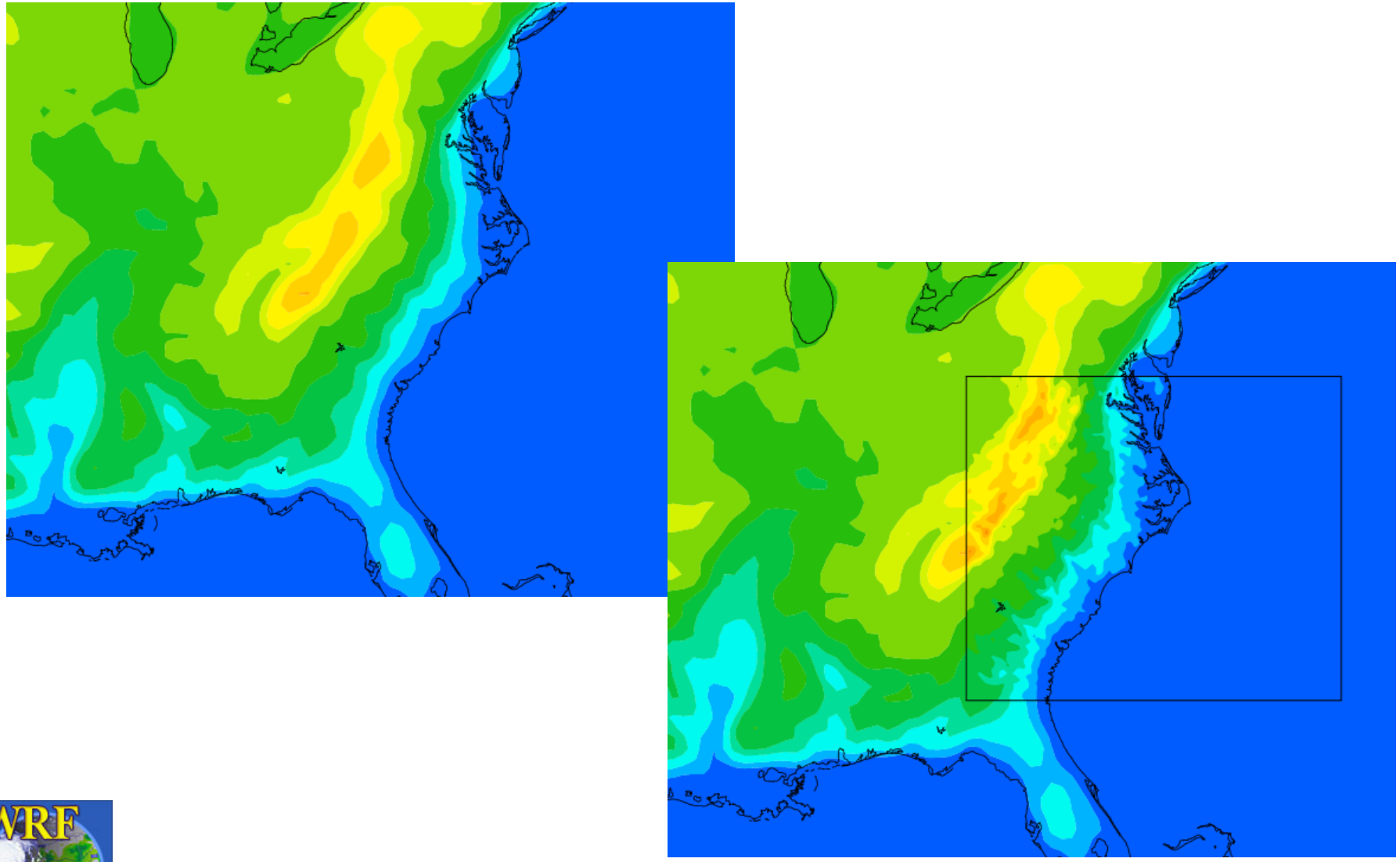
# Domain Design

mp = wrf_wps_dom (wks, mpres, lnres, txres)

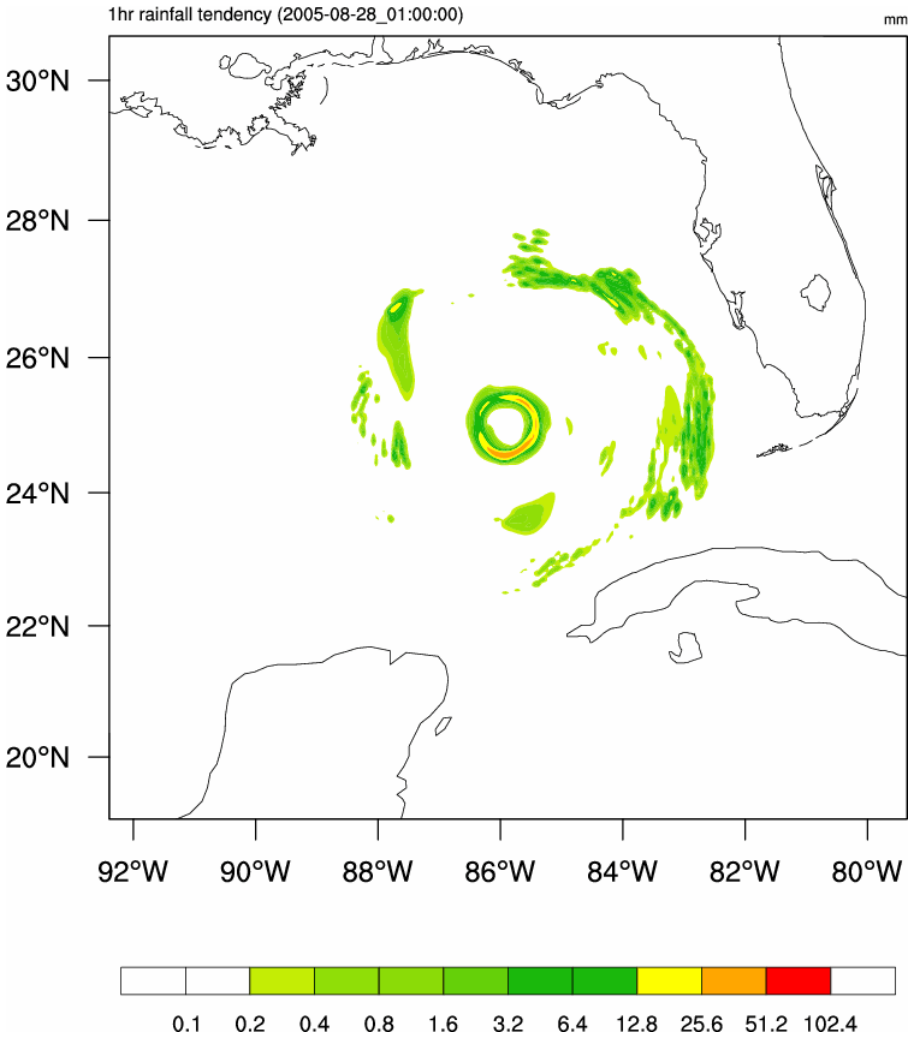
**WPS/util/plotgrids.ncl**



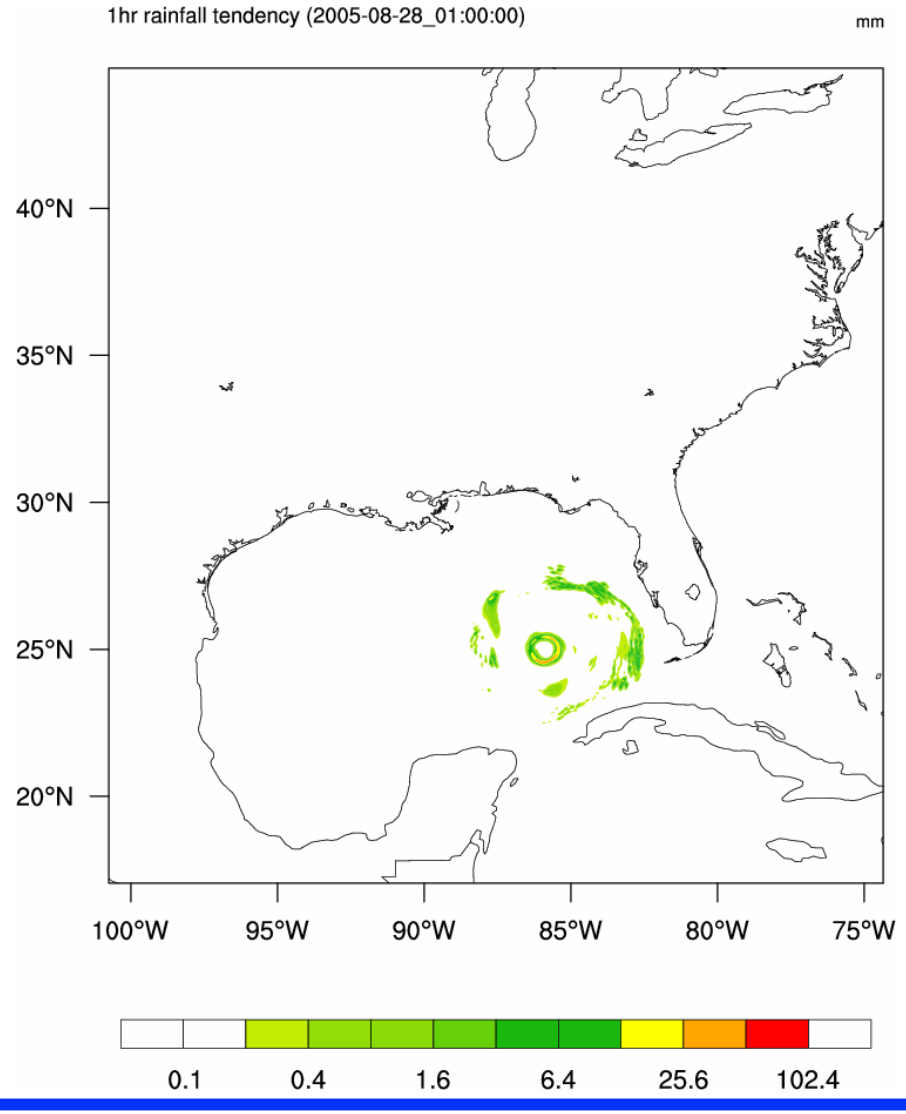
# Over Domains



# Moving Nests



# Moving Nests

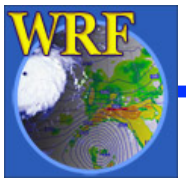


# Calling FORTRAN code from NCL

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

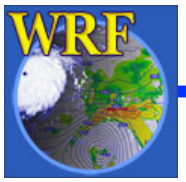
```
C NCLFORTSTART
C NCLEND
```

- 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
```

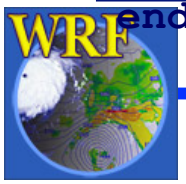


# myTK.so - *Create & use in NCL script*

```
% WRAPIT myTK.f
```

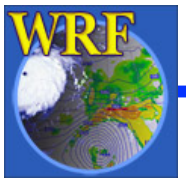
This will create a "myTK.so" file

```
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.



# Compiling with ncl

*ncl myscript.ncl*

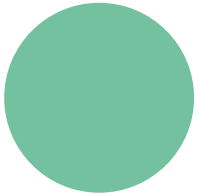
**NCARG_ROOT**

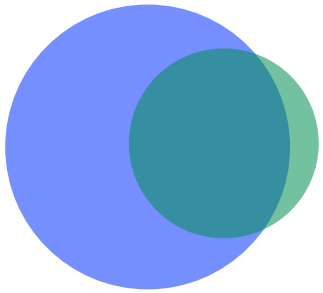
/usr/local/ncl

*compile <util>*

**NCARG_ROOT**

/usr/local/ncarg





*ncl myscript.ncl*

*compile <util>*

**NCARG_ROOT**

/usr/local/ncl

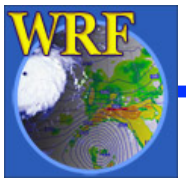
# Compiling with ncl

```
In function `write_png':
  undefined reference to `png_create_write_struct'
  undefined reference to `png_create_info_struct'
  undefined reference to `png_destroy_write_struct'
  undefined reference to `png_destroy_write_struct'
```

**-L<path_to_png_lib> -lpng -L<path_to_z_lib> -lz**

```
/usr/local/ncl/lib/libncarg.a(agcurv.o): In function `agcurv_':
agcurv.f:(.text+0x69): undefined reference to `_gfortran_copy_string'
/usr/local/ncl/lib/libncarg.a(aggtch.o): In function `aggtch_':
aggtch.f:(.text+0x3e): undefined reference to `_gfortran_copy_string'
aggtch.f:(.text+0x7b): undefined reference to `_gfortran_copy_string'
```

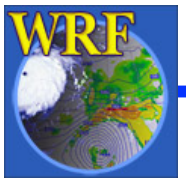
**-L<path_to_gfortran_lib> -lgfortran**



# FORTRAN 90 code

myTK.f90

```
subroutine compute_tk (tk, pres, theta, nx, ny, nz)
  implicit none
  integer :: nx,ny,nz, i,j,k
  real (nx,ny,nz) :: tk, pres, theta
  real ::    pi


  pi(:,:,:)=(pres(:,:,:)/1000.)**(287./1004.)
  tk(i,j,k) = pi(:,:,:)*theta(i,j,k)

end subroutine compute_tk
```



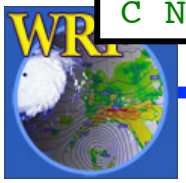
# FORTRAN 90 code

myTK.f90

```
subroutine compute_tk (tk, pres, theta, nx, ny, nz)
  implicit none
  integer :: nx,ny,nz, i,j,k
  real (nx,ny,nz) :: tk, pres, theta
  real ::    pi


  pi(:,:,:)=(pres(:,:,:)/1000.)**(287./1004.)
  tk(i,j,k) = pi(:,:,:)*theta(i,j,k)

end subroutine compute_tk
```

myTK90.stub

```
C NCLFORTSTART
   subroutine compute_tk (tk, pres, theta, nx, ny, nz)
   implicit none
   integer nx,ny,nz
   real    tk(nx,ny,nz)
   real    pres(nx,ny,nz), theta(nx,ny,nz)
C NCLEND
```



# myTK90.so - *Create & use in NCL script*

```
% WRAPIT myTK90.stub  myTK.f90
```

This will create a "myTK90.so" file

```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "$NCARG_ROOT/lib/ncarg/nclscripts/wrf/WRFUserARW.ncl"
external myTK90 "./myTK90.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
       myTK90 :: compute_tk (tk,p,t,dim(2),dim(1),dim(0))
end
```