WRFDA Advanced Practice Sessions

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WRFDA Tutorial, August 2016, NCAR

WRFDA Advanced Practice Sessions

- WRFDA is a huge system. There are many capabilities that have only been briefly covered (or not covered at all)
- These advanced classroom exercises should give you some practice with these capabilities
  - Radar (and CLOUD_CV=1 compilation)
  - Precipitation
  - Cloudy radiance
  - Dual-resolution hybrid

Radar data assimilation

- Can assimilate radar velocity, reflectivity, or both
- Can be used with 3DVAR or 4DVAR
- Reads observation files in text-based format
- Radar information can be assimilated with any other combination of observations

```
&wrfvar4
use_radarobs  = true
use_radar_rv  = true
use_radar_rf  = true
use_radar_rhv = true
use_radar_rqv = true

&wrfvar7
cv_options         = 7
cloud_cv_options = 3
```

From Juanzhen Sun

Radar data assimilation

- Two methods of reflectivity DA:
  - `use_radar_rf = true`
    - Older method (Xiao et al. 2007)
    - Requires an observation operator to link the reflectivity with microphysics
    - No cloud control variables
    - Vertical velocity is diagnosed using the Richardson equation
    - Microphysics are diagnosed using a warm rain partition scheme
  - `use_radar_rhv = true`
    - Indirect assimilation of reflectivity (Wang et al. 2013)
    - Diagnose microphysics (qr, qs, qg) and humidity from reflectivity
    - Assimilate the diagnosed quantities
    - Cloud control variables and vertical velocity control variable
  - `use_radar_rqv=true`
    - Cloud analysis scheme (assimilate estimated water vapor)
    - Also described in (Wang et al. 2013)

From Juanzhen Sun

Radar data assimilation

- Conventional control variables
  - `cv_options = 7`
    - uses U and V as momentum control variables
    - developed for radar assimilation, useful for high resolutions
- Microphysics control variables
  - `cloud_cv_options = 3`
    - Extra cloud/moisture control variables
    - Must compile with CLOUD_CV=1
    - Uses extra memory due to the extra control variables

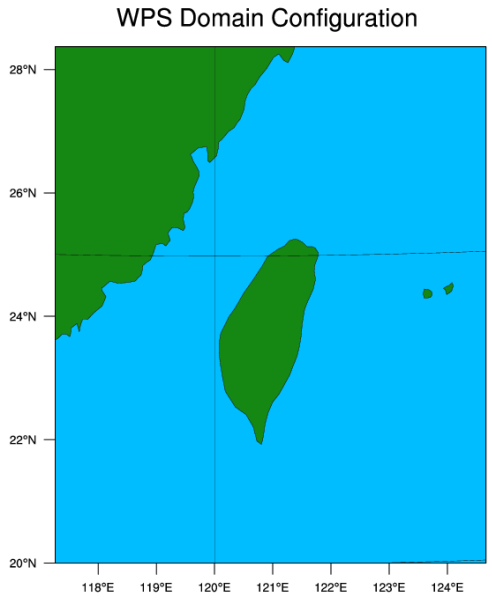
From Juanzhen Sun

Radar observation format

```
TOTAL NUMBER = 4
#-----------------#
#####
RADAR          RCCG 120.070    23.150      38.0  2010-09-19_00:06:13     6      5
#-------------------------------------------------------#

FM-128 RADAR   2010-09-19_00:06:13        22.498       118.089      38.0        1
         4600.5 -888888.000 -88 -888888.000         6.167   0       3.350
FM-128 RADAR   2010-09-19_00:06:13        22.543       118.089      38.0        1
         4545.0 -888888.000 -88 -888888.000         9.500   0       3.350
FM-128 RADAR   2010-09-19_00:06:13        23.802       121.122      38.0        5
         2121.3 -888888.000 -88 -888888.000         7.750   0       3.720
         4158.6     -51.550   0       2.556        37.375   0       1.303
         6424.2 -888888.000 -88 -888888.000   -888888.000 -88 -888888.000
         8693.2     -46.175   0       1.565        21.875   0       2.272
        10739.2     -45.050   0       0.688        16.000   0       8.268
FM-128 RADAR   2010-09-19_00:06:13        24.342       122.247      38.0        1
        10276.9 -888888.000 -88 -888888.000         7.500   0       1.333
FM-128 RADAR   2010-09-19_00:06:13        24.387       122.247      38.0        2
         6310.0 -888888.000 -88 -888888.000         9.625   0       1.438
        10419.8 -888888.000 -88 -888888.000         8.625   0       1.350
FM-128 RADAR   2010-09-19_00:06:13        24.432       122.247      38.0        1
        10567.3 -888888.000 -88 -888888.000         7.375   0       0.995

RADAR          RCKT 120.860    21.900      42.0  2010-09-19_00:06:13     5      7
#-------------------------------------------------------#

FM-128 RADAR   2010-09-19_00:06:13        19.944       118.655      42.0        1
         8578.5 -888888.000 -88 -888888.000        18.375   0       1.406
...
...
```

Radar practice session

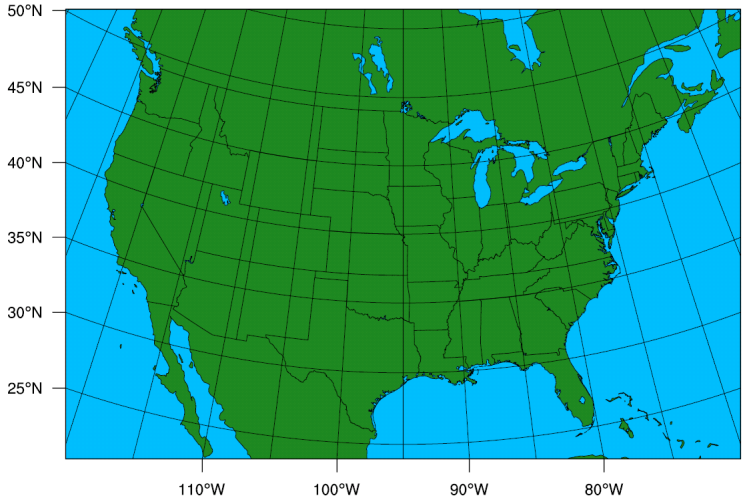
- Simple Typhoon case
  - Typhoon Fanapi, September 19, 2010
  - 61x51x54 grid points, 15 km resolution
  - Data for both 3DVAR and 4DVAR exercises



Precipitation data assimilation

- Can assimilate accumulated precipitation data
  - 4DVAR only!
  - reads observation files in text-based format
  - Converter provided for NCEP Stage IV data: see User's Guide
  - Classroom exercise is same test case as for 3DVAR, GENBE practice

```
&wrfvar1
var4d=true,
var4d_bin=3600,
var4d_bin_rain=21600,

&wrfvar4
use_rainobs=true,
thin_rainobs=true,
```



Precipitation observation format

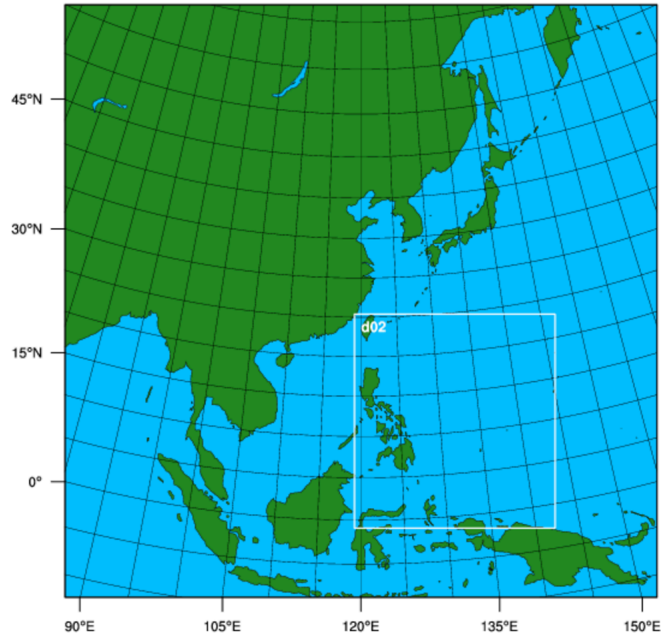
```
TOTAL = 987601,MISS. =-888888.,
INFO  = PLATFORM, DATE, LEVELS, LATITUDE, LONGITUDE, ELEVATION, ID.
EACH  = HEIGHT, RAINFALL DATA, QC, ERROR
#-------------------------------------------------------------------------#
FM-129 RAIN  2008-02-05_17:59:59      1      23.117      -119.022  -88888.0 xxxxx
 -888888.000 -888888.000  88       2.000
...
...
FM-129 RAIN  2008-02-05_17:59:59      1      25.119      -104.076  -88888.0 xxxxx
 -888888.000       0.000  88       2.000
FM-129 RAIN  2008-02-05_17:59:59      1      25.118      -104.040  -88888.0 xxxxx
 -888888.000       0.000  88       2.000
...
...
FM-129 RAIN  2008-02-05_17:59:59      1      30.639      -102.559  -88888.0 xxxxx
 -888888.000       0.250  88       2.000
FM-129 RAIN  2008-02-05_17:59:59      1      30.637      -102.519  -88888.0 xxxxx
 -888888.000       0.130  88       2.000
...
...
```

Cloudy radiance

- Information available in WRF Workshop presentation: http://www2.mmm.ucar.edu/wrf/users/workshops/WS2016/oral_presentations/5b.1.pdf
- Not yet available in released code, but can be downloaded as a beta release
  - http://www2.mmm.ucar.edu/wrf/users/wrfda/beta.html
- For now, only available with CRTM for AMSR2 observations
- &wrfvar14
  crtm_cloud=true,

Dual-resolution hybrid

- Covered a bit in Craig's hybrid talk
- Two domains:
  - 181x181x45, 45km
  - 184x196x45, 15km
- Analysis is produced for inner, high-resolution domain
- Ensemble statistics are derived from outer, low-resolution domain



Some notes about data

- After you leave, you will be able to download the data used for the classroom exercises here: http://www2.mmm.ucar.edu/wrf/users/wrfda/Tutorials/2016_Aug/class/wrfda_testdata.html
- We will send out a follow-up email with this info after you leave