

Objective Analysis Tool: Obsgrid

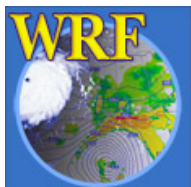
Objective Analysis (OBSGRID)

Cindy Bruyère

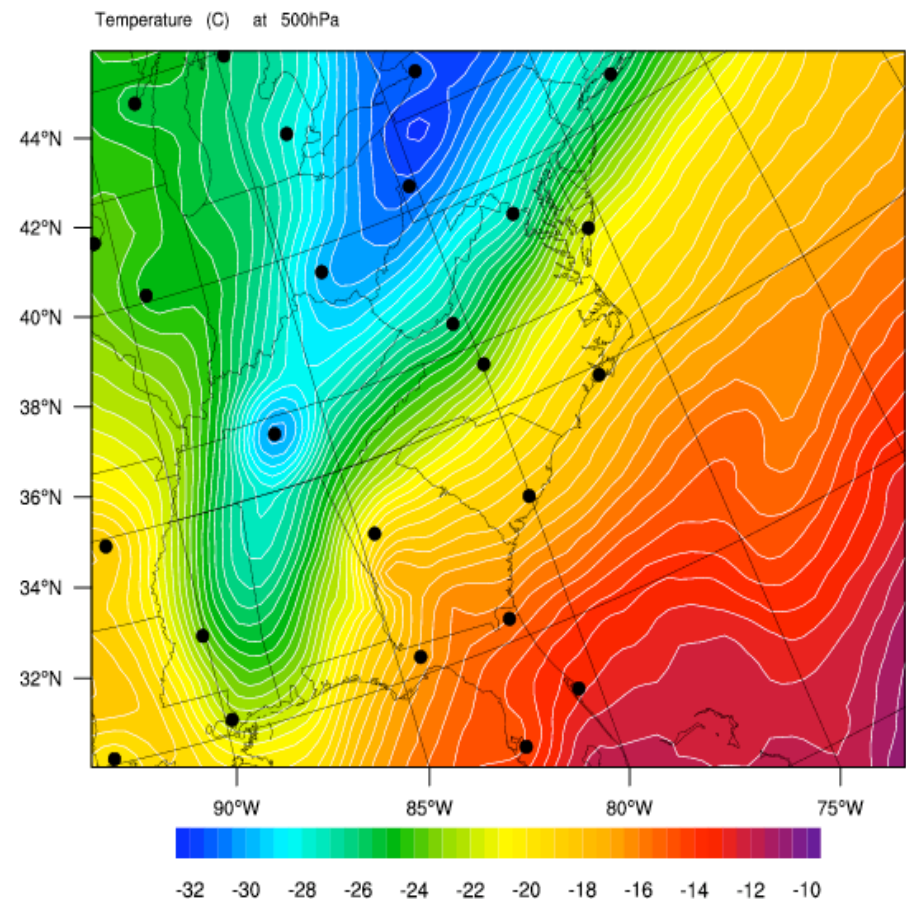
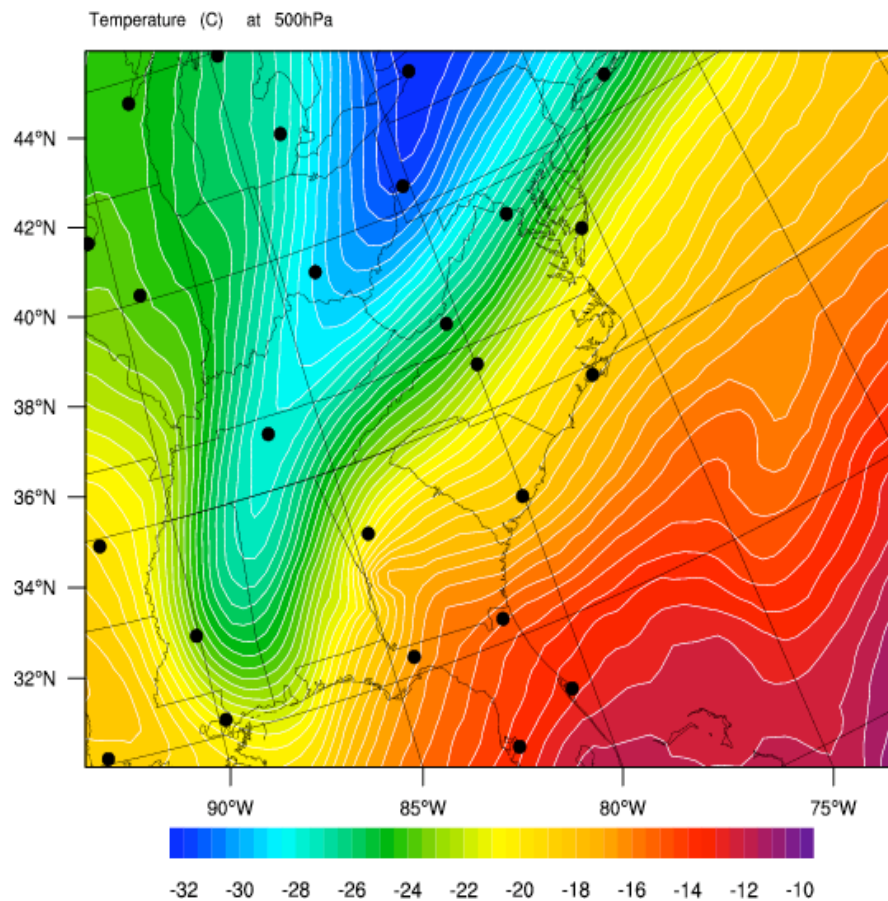


Objective Analysis

- To improve a *first-guess* gridded analysis by incorporating additional observational information
 - Traditionally, this first-guess analysis comes from low-resolution global analysis and forecast grids
 - These days, higher-resolution, regional scale analyses are more readily available
 - These high-resolution analyses mean that in many cases, the objective analysis step is not essential when running WRF



Objective Analysis



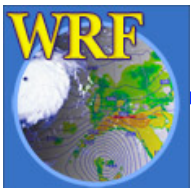
Objective Analysis in WRF

- **Traditional methods**

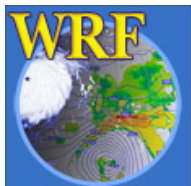
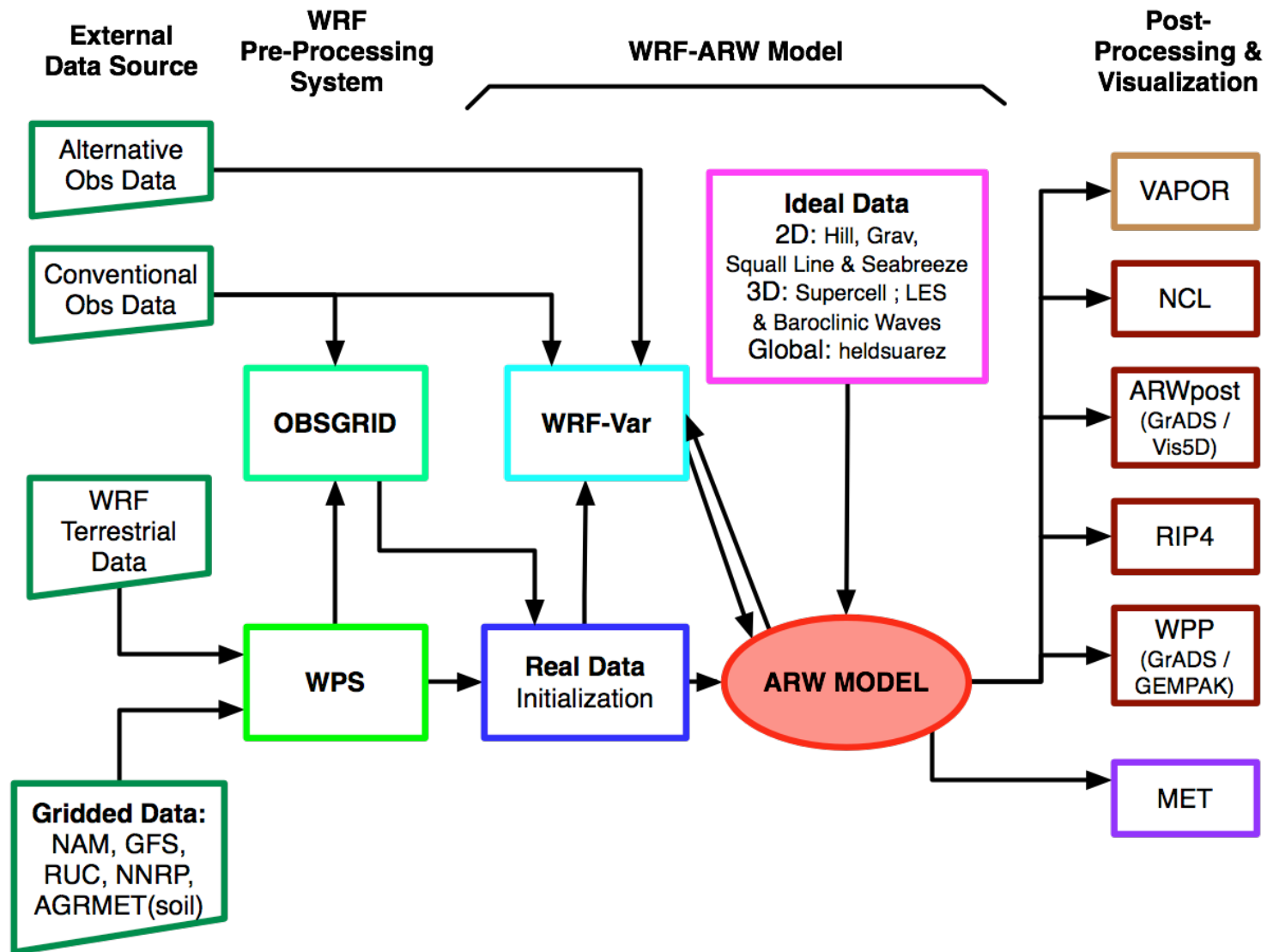
- Direct observations of T, U, V, RH at surface and on pressure levels (*conventional observations*)

- **Variational Analysis**

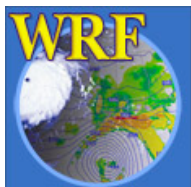
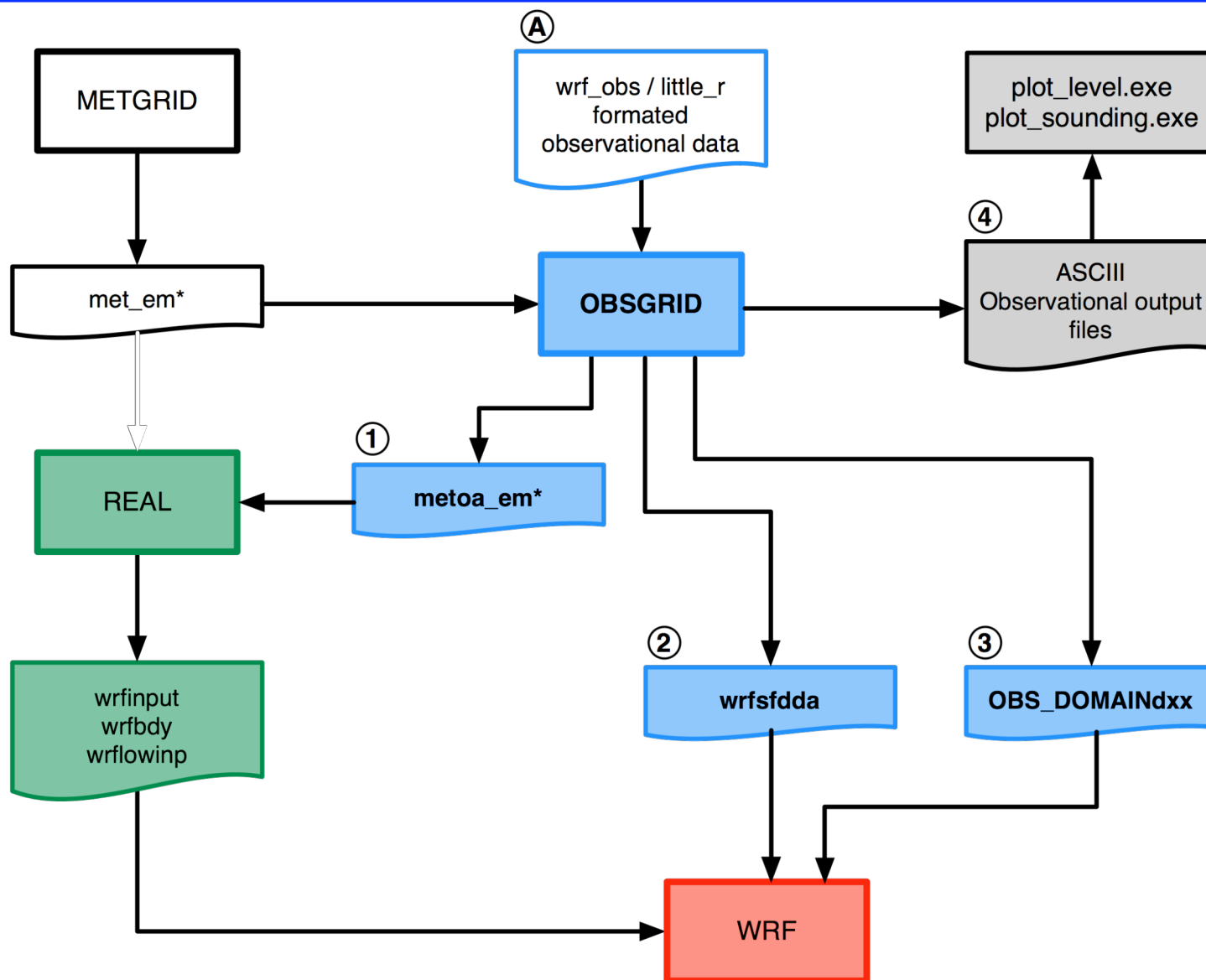
- Direct and indirect observations on model levels (*conventional + alternative observations*)



WRF-ARW Modeling System Flow Chart



Program Flow



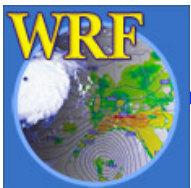
OA Techniques in OBSGRID

- **Cressman-based analysis**

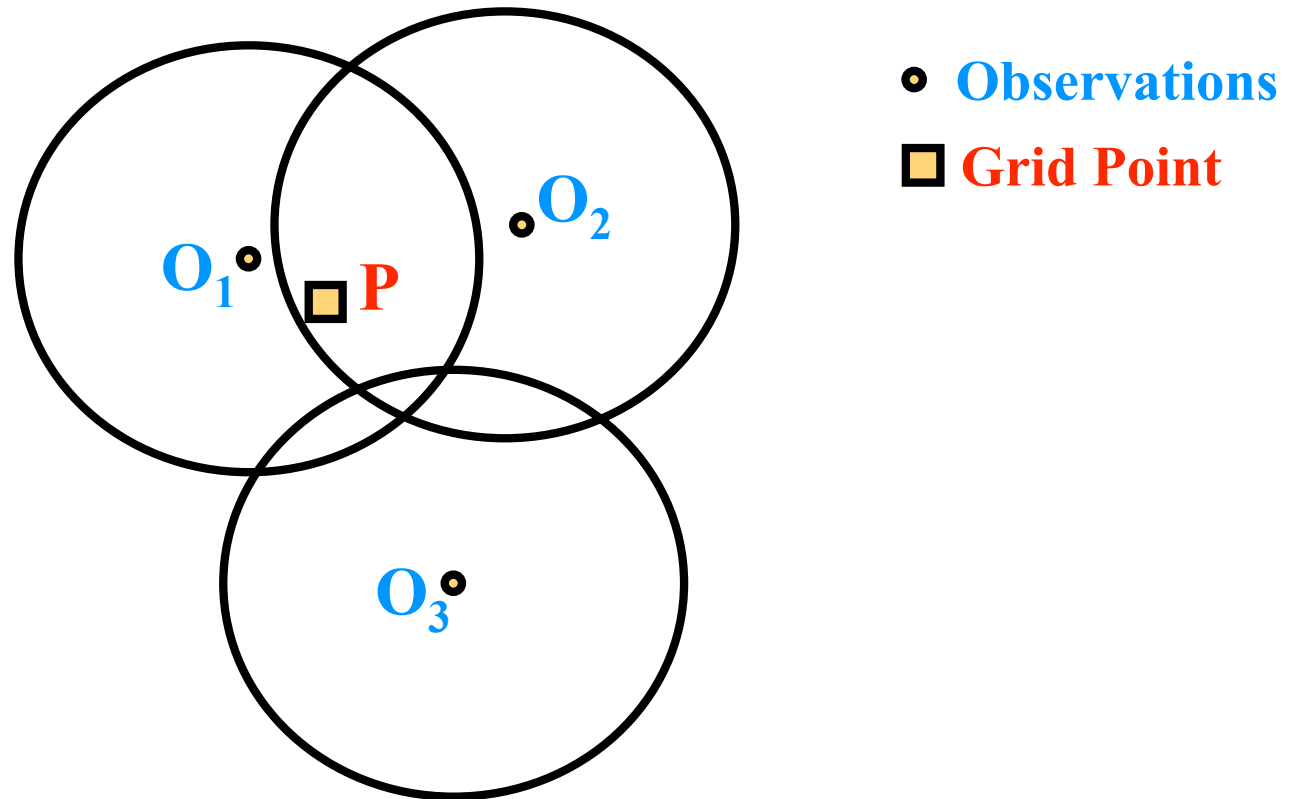
- Impact of observation within radius of influence only
- Multiple scans
- With ellipse and banana extensions

- **Multi-Quadric analysis**

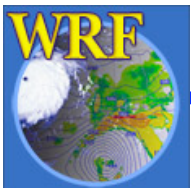
- Impact of observations are over the entire model domain
- Scheme is sensitive to the data density distribution



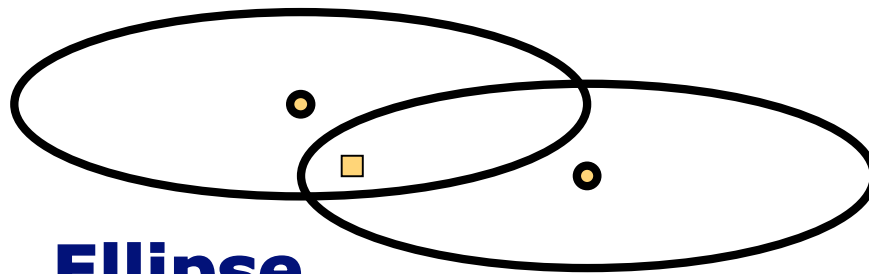
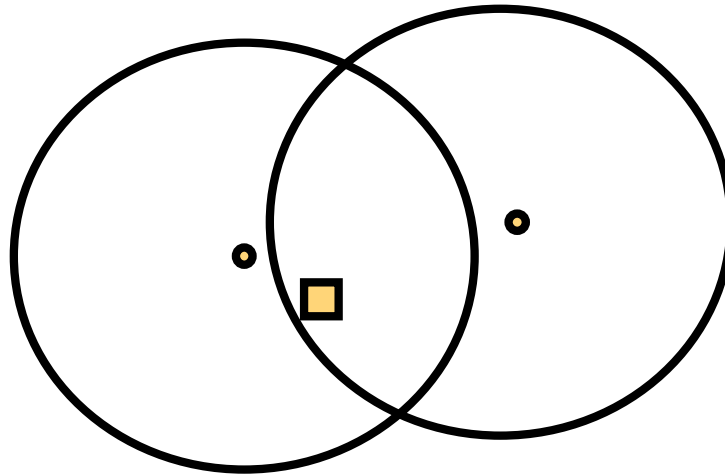
Cressman Scheme



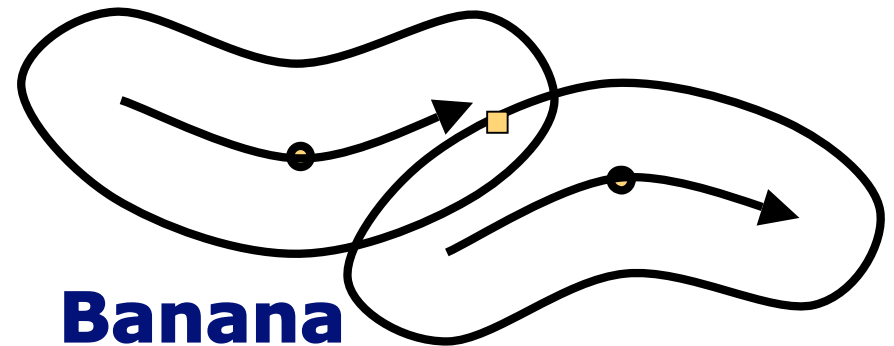
Observations O_1 and O_2 influences grid point P , O_3 does not



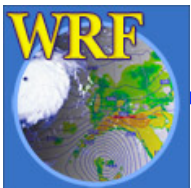
Cressman Scheme



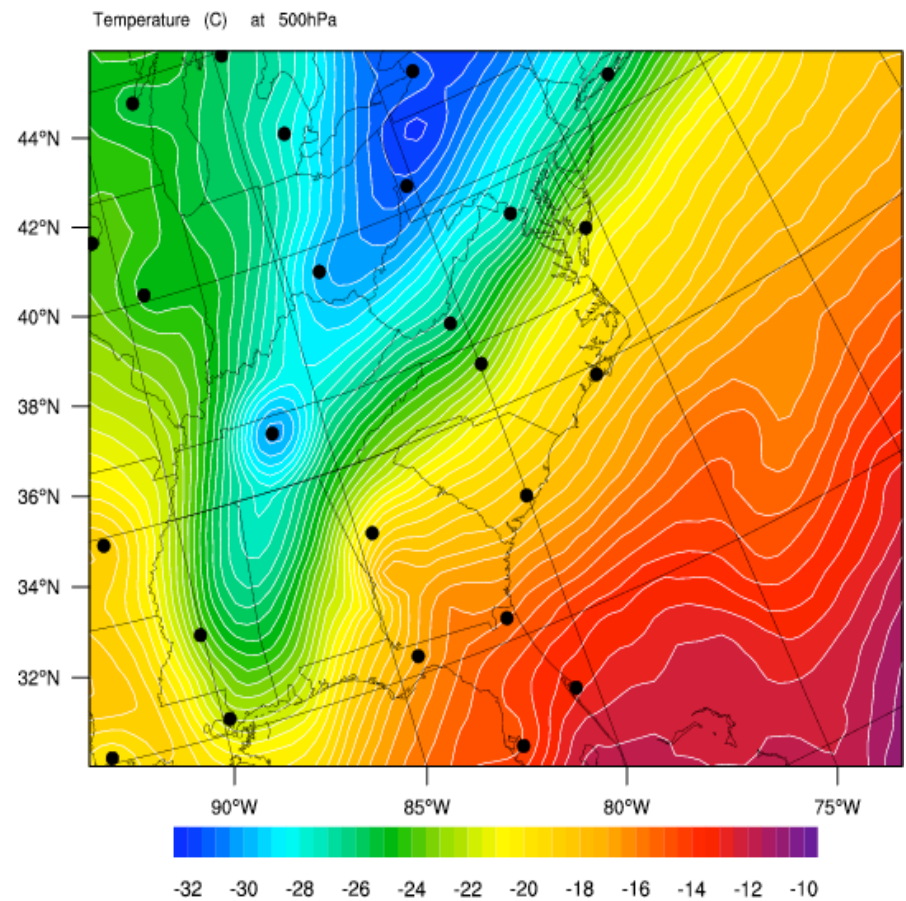
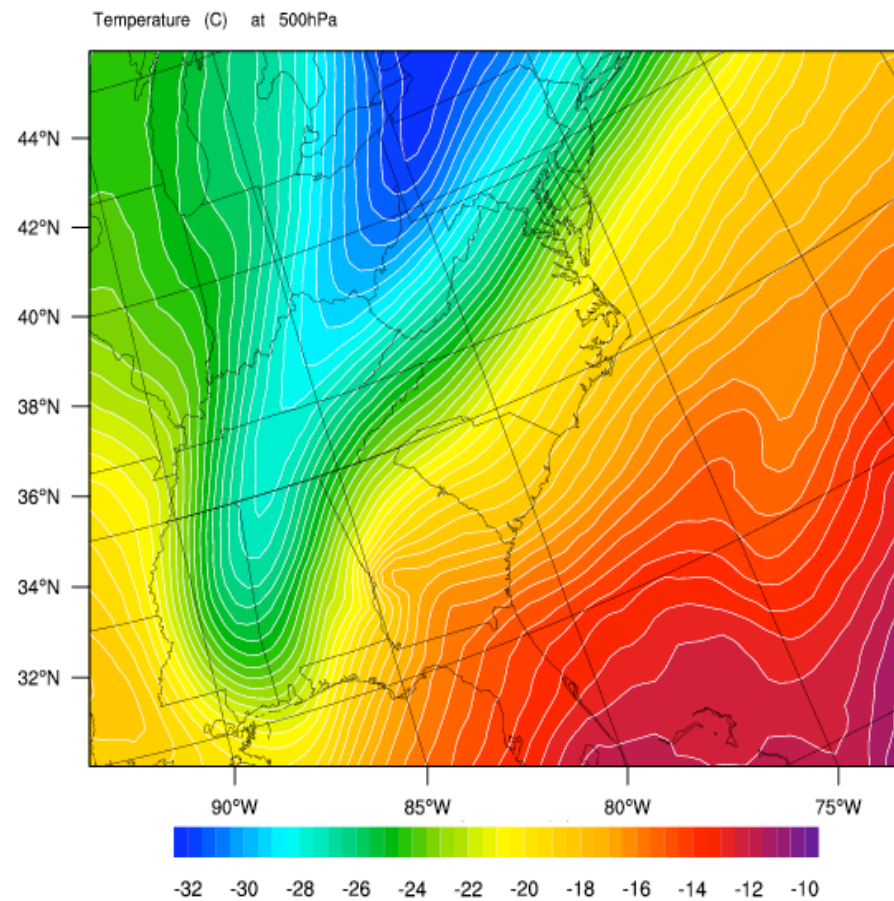
Ellipse



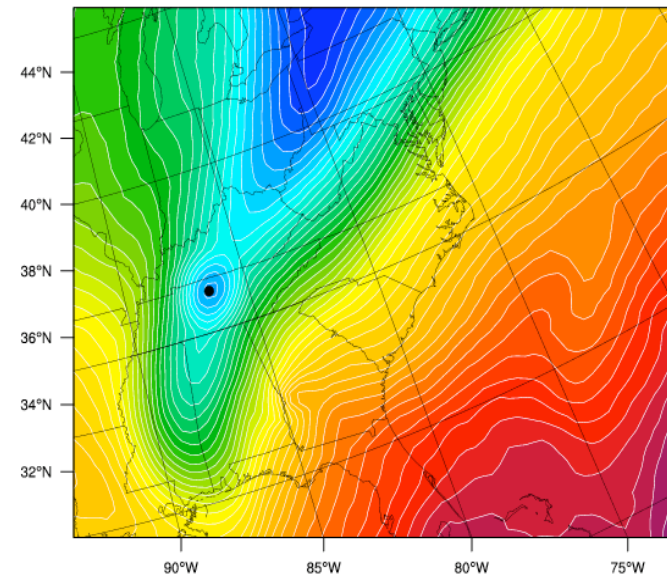
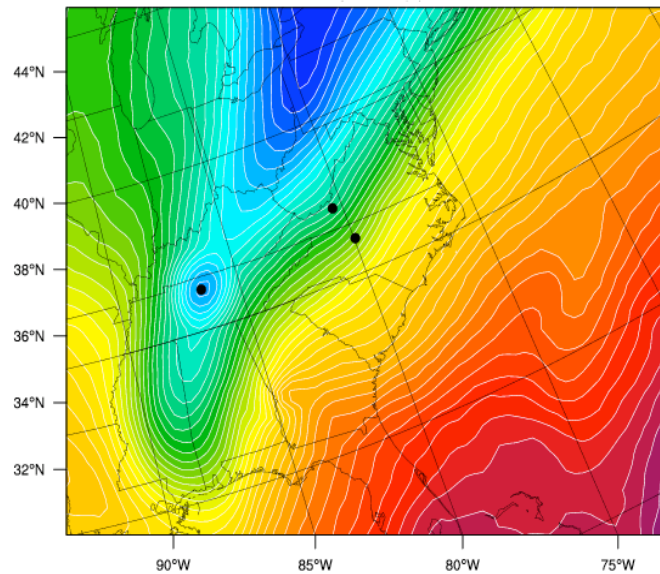
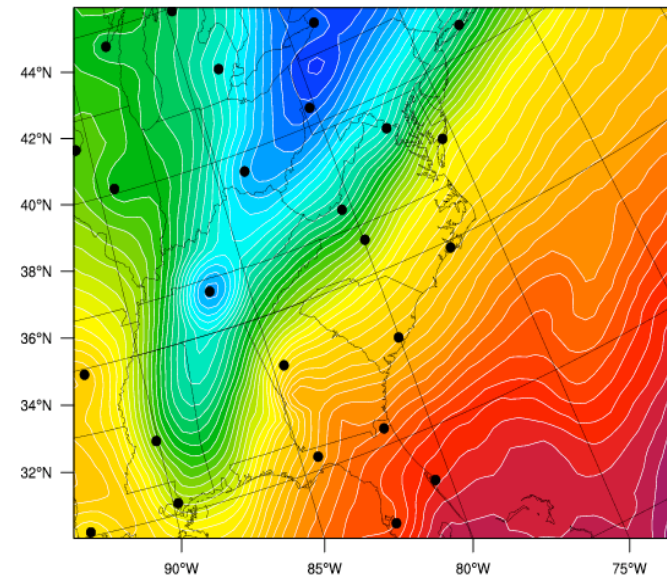
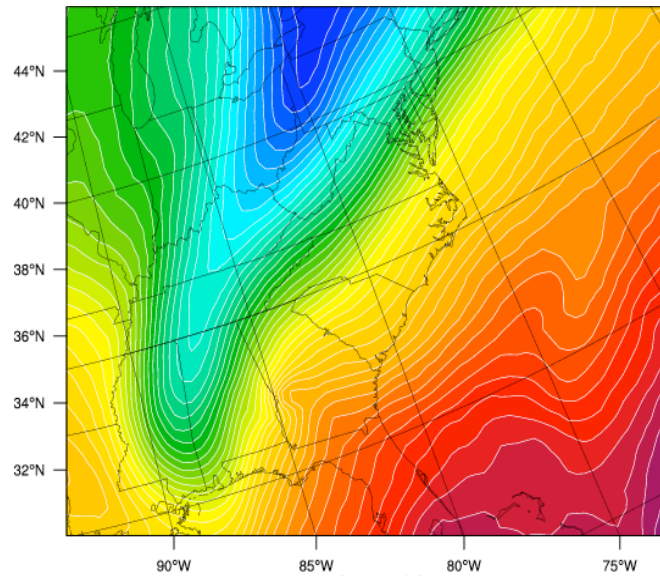
Banana



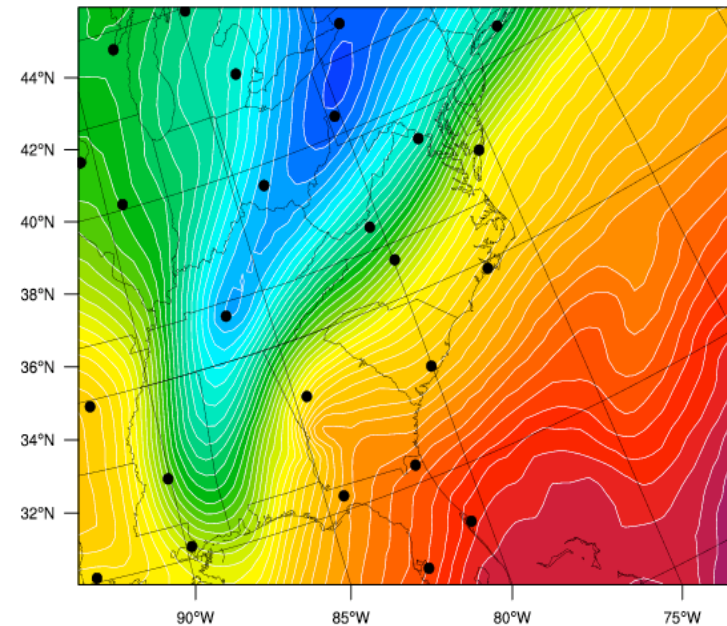
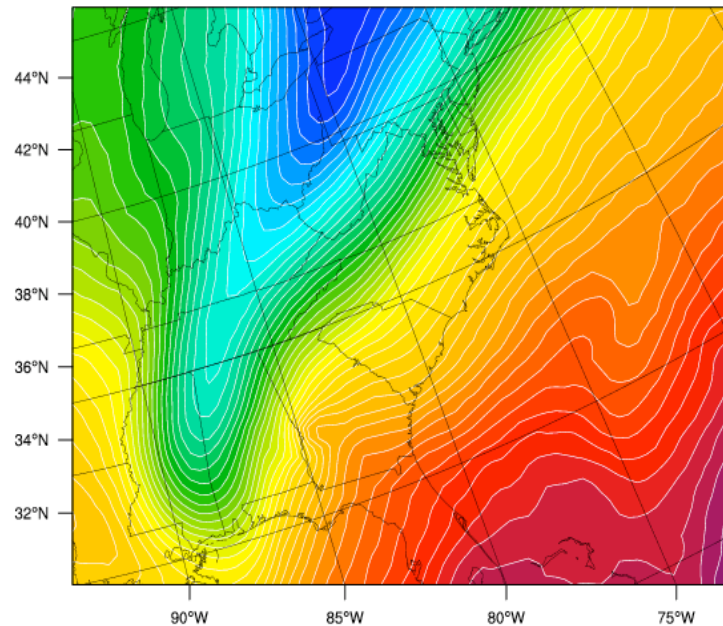
Cressman Scheme



Cressman Scheme



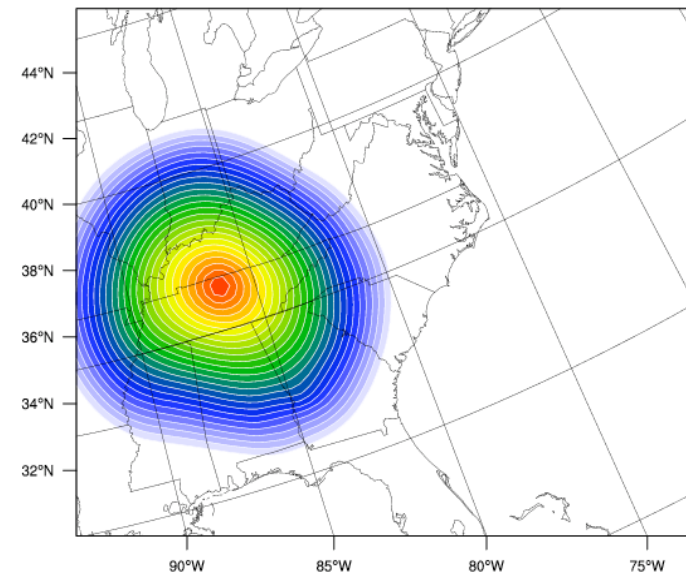
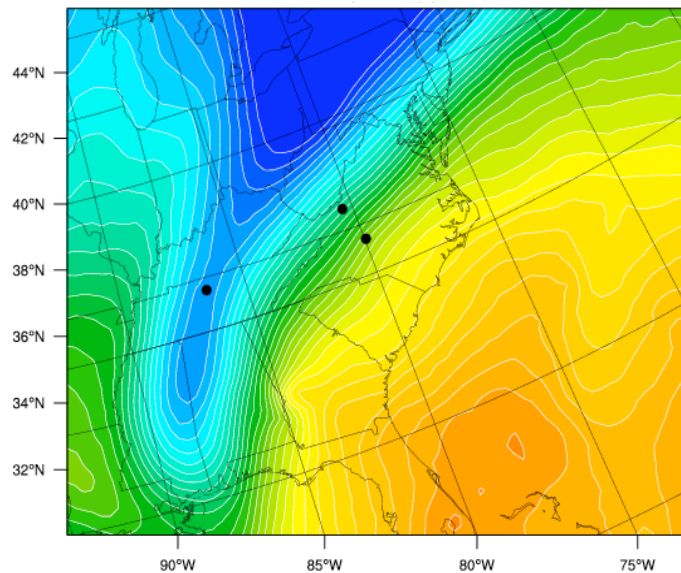
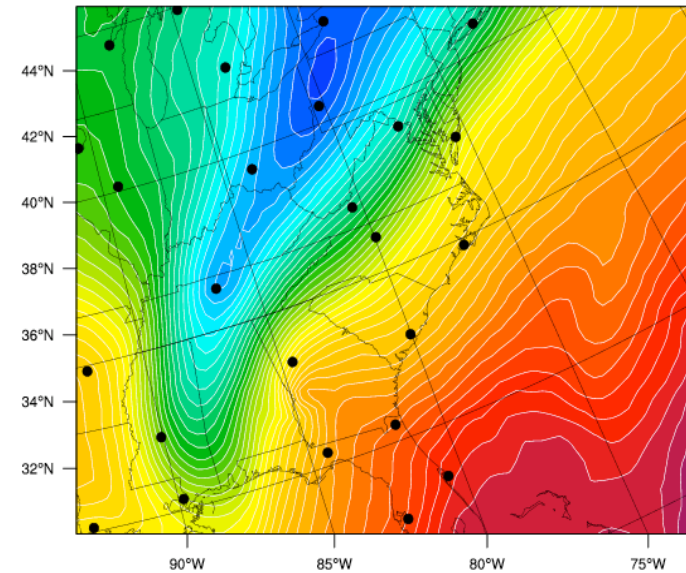
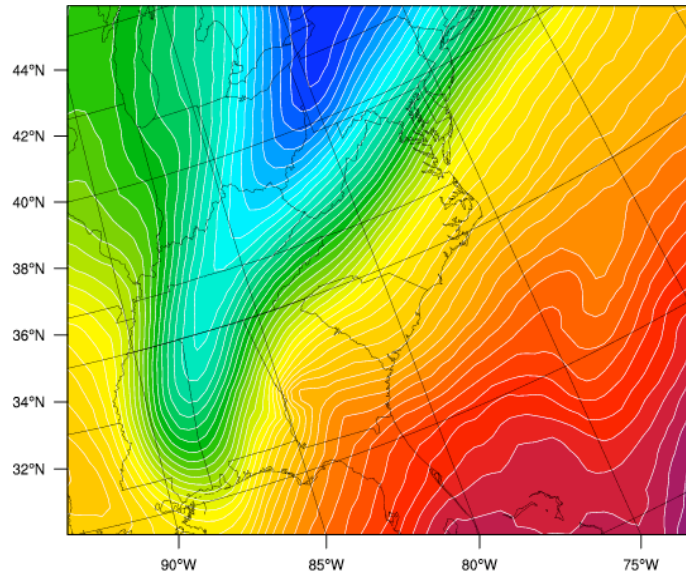
Multi-Quadric Scheme



Makes use of hyperboloid radial basis functions to interpolate observation corrections onto model grid



Multi-Quadric Scheme

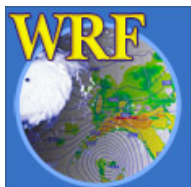
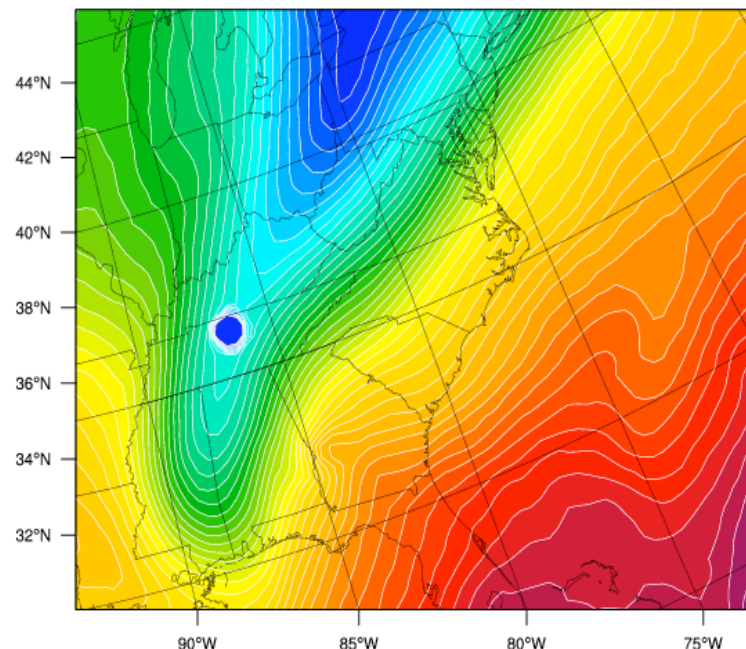


Quality Control for Observations

- **A critically important step**

Bad observations = Bad objective analysis

- **Even a single bad observation can ruin initial conditions**
- **Default namelist settings should in most cases prevent this from happening**
- **Tests performed in OBSGRID**
 - Tests on individual reports
 - ERRMAX test
 - Buddy test



Tests on individual reports

- **Gross error checks**
- **Remove spikes from temperature and wind profiles** (*optional, not recommended*)
- **Adjust temperature profiles to remove superadiabatic layers** (*optional, not recommended*)
- **No comparisons to other soundings or to first-guess field**



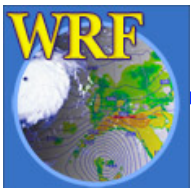
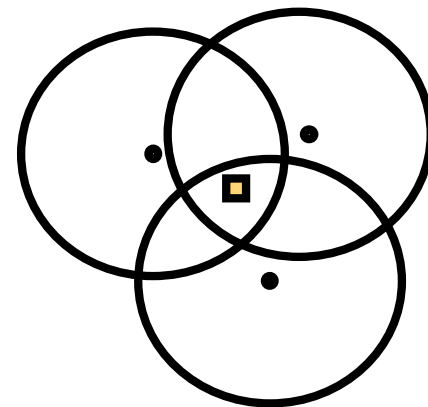
ERRMAX test

- **Limited user control over data removal**
- **Observations are compared to first-guess field**
- **If the difference between the observation and the first-guess exceeds a threshold, the observation is discarded**
- **Threshold varies depending on field, level, time of day**
- **Works well with good first-guess field**



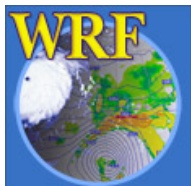
Buddy test

- Limited user control over data removal
- Observations are compared to the first guess and to nearby observations
- If an observation deviates from the first guess in a manner inconsistent with the deviations of surrounding stations from the first guess, then that observation is discarded
- Works well in regions of good data density



How to run OBSGRID

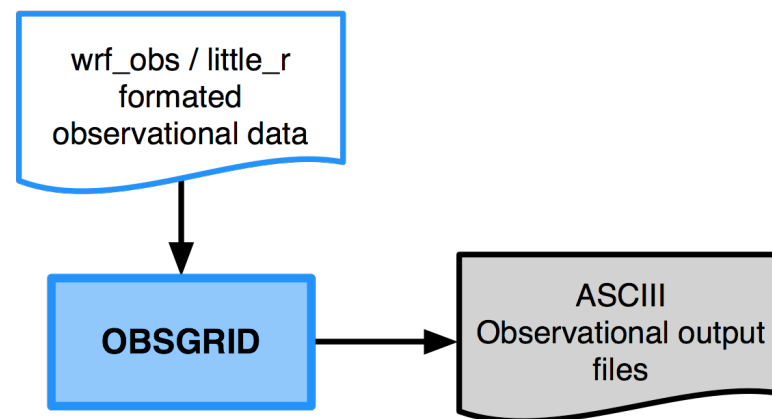
- Get the source code
- Compile (*./configure & ./compile*)
- Prepare observations files
 - Users need to generate this file (*some sample programs are available*)
- Edit the namelist
- Run the program
- Check your output



Observations

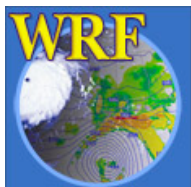
UG: 7-13

- **ASCII text files (*wrf_obs / little_r* format)**
 - One entry per observation (*sfc or upper-air*)
 - Header ; Data ; End
- **Each time period is stored in a separate file**
- **OBSGRID combines reports, removes duplicates, interpolates to analysis levels**



Observations Format

header {
station_latitude, station_longitude, station_id,
station_name, type_of_observation, observation_source,
station_elevation, num_valid_fields, num_errors,
num_warnings, report_number, number_of_report_duplicates,
is_this_a_sounding, is_this_a_bogus_observation,
discard_the_report, time_of_report, julian_day,
report_time, slp, slp_qc, ref_pres, rpres_qc, ground_t,
t_qc, sst, sst_qc, psfc, psfc_qc, precip, precip_qc,
t_max, t_max_qc, t_min, t_min_qc, t_min_night,
t_min_night_qc, p_tend03, tend03_qc, p_tend24, tend24_qc,
cloud_cvr, cloud_qc, ceiling, ceiling_qc
end data {
pressure, p_qc, height, z_qc, temperature, t_qc,
dew_point, td_qc, speed, spd_qc, direction, dir_qc, u,
u_qc, v, v_qc, rh, rh_qc, thickness, tn_qc
num_valid_fields, num_errors, num_warnings



Observations Format

44.08000 -103.2100072662		RAPID CITY WFO, SD. / UNITED STATES OF AFM-35 TEMP										GTS (ATEC)	
UEUS05 KWBC 190000		1029.00000		20	-888888	-888888	446	-888888	T	F	F	-888888	-888888
20080119000000-888888.00000		0-888888.00000		0-888888.00000	0-888888.00000		0-888888.00000		0-888888.00000		0-888888.00000		0-
888888.00000		0-888888.00000		0-888888.00000	0-888888.00000		0-888888.00000		0-888888.00000		0		
100000.00000	0	249.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
92500.00000	0	852.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
90400.00000	0	1029.00000	0	260.65000	0	255.65000	0	6.18557	0	335.00000	0-888888.00000	0-888888.00000	0
90300.00000	0-888888.00000	0	261.25000	0	252.25000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
89600.00000	0-888888.00000	0	261.05000	0	252.05000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
88900.00000	0-888888.00000	0	260.85000	0	247.85000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
85000.00000	0	1496.00000	0	257.65000	0	246.65000	0	15.46392	0	315.00000	0-888888.00000	0-888888.00000	0
79500.00000	0-888888.00000	0	253.05000	0	244.05000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
78000.00000	0-888888.00000	0	252.45000	0	243.45000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
73100.00000	0-888888.00000	0	249.65000	0	245.05000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
72100.00000	0-888888.00000	0	250.65000	0	246.15000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
70000.00000	0	2931.00000	0	249.25000	0	244.25000	0	23.71134	0	330.00000	0-888888.00000	0-888888.00000	0
69400.00000	0-888888.00000	0	249.05000	0	243.05000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
62300.00000	0-888888.00000	0	243.65000	0	233.65000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
55700.00000	0-888888.00000	0	237.85000	0	226.85000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
50700.00000	0-888888.00000	0	232.05000	0	223.05000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
50300.00000	0-888888.00000	0	231.65000	0	222.65000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
50000.00000	0	5300.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
46100.00000	0-888888.00000	0	227.85000	0	217.85000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
3100.00000	0-888888.00000	0	214.45000	0	213.65000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
-777777.00000	0-777777.00000	0	20.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
20	0	0											

51.48000 -0.4500003772		ICAO EGLL London / Heathrow Airport UnitFM-15 METAR										GTS (ATEC)	
SAUK31 KWBC 190020 CCA		24.00000		10	-888888	-888888	525	-888888	F	F	F	-888888	-888888
20080119002000-888888.00000		0-888888.00000		0-888888.00000	0-888888.00000		0 101200.00000		0-888888.00000		0-888888.00000		0-
888888.00000		0-888888.00000		0-888888.00000	0-888888.00000		0-888888.00000		0				
-888888.00000	0	24.00000	0	286.15000	0	284.15000	0	8.76289	0	230.00000	0-888888.00000	0-888888.00000	0
-777777.00000	0-777777.00000	0	1.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0-888888.00000	0
10	0	0											



Quality-Control Flags

- Binary flags indicating which warning and error conditions have been met

Pressure interpolated from first-guess height	2**1	2
Temperature and dewpoint both 0	2**4	16
Wind speed and direction both 0	2**5	32
Wind speed negative	2**6	64
Wind direction < 0 or > 360	2**7	128
Level vertically interpolated	2**8	256
Value vertically extrapolated from a single level	2**9	512
Sign of temperature reversed	2**10	1012
Superadiabatic level detected	2**11	2048
Vertical spike in wind speed or direction	2**12	4096
Convective adjustment applied to temperature field	2**13	8192
No neighboring observations for buddy check	2**14	16384
Error maximum test failed	2**15	32768
Buddy test failed	2**16	65536
Observation outside domain	2**17	131072



Namelist

UG: 7-15

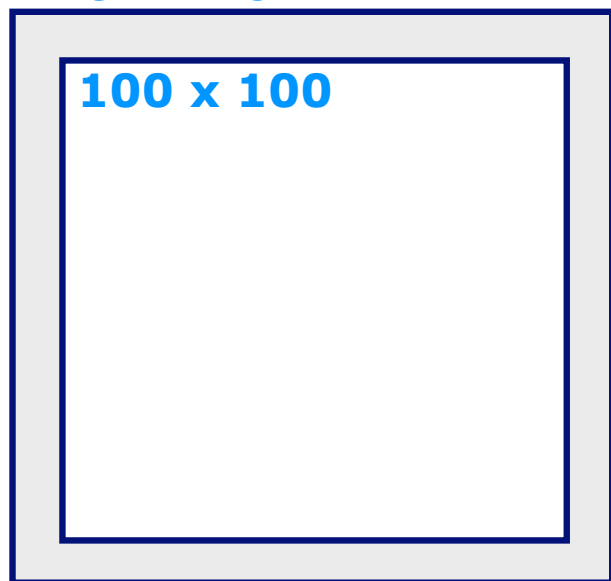
start _year _month _day _hour	Start date
end _year _month _day _hour	End date
interval	Interval between analysis times (sec)
f4d	Turn on / off the creation of the surface analysis file (<i>wrfsfdda_d0x</i>)
intf4d	Time interval (<i>sec</i>) for surface analyses (<i>typically smaller than interval between analysis</i>)
obs_filename	Root file name (<i>may include directory information</i>) of the observational files. All input files must have the format obs_filename:<YYYY-MM-DD_HH> One file per time period Also used when doing surface fdda (<i>F4D=.TRUE.</i>)



Namelist

<code>domain_id</code>	ID of domain to process
<code>trim_domain</code>	Set to <code>.TRUE.</code> if this domain must be cut down on output
<code>trim_value</code>	Value by which the domain will be cut down in each direction

110 x 110



- **Why do this:**

This allows observations just outside the desired grid box of 100x100 grid points to be included in the OA

- ***geogrid* and *metgrid* run with a domain size of 110x110**

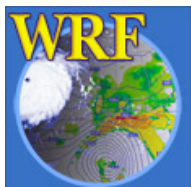
- **`trim_domain = .TRUE.`**

- **`trim_value = 5`**



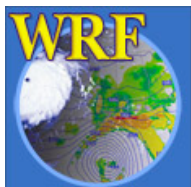
Namelist

<code>qc_test_error_max</code>	Turn on error-max test (T/F)
<code>max_error _t _uv _rh _p</code>	Max difference in T, uv, RH & SLP allowed for error-max test
<code>qc_test_buddy</code>	Turn on buddy test (T/F)
<code>max_buddy _t _uv _rh _p</code>	Threshold for T, uv, RH & SLP allowed for buddy test
<code>buddy_weight</code>	Scaling for buddy thresholds
<code>qc_test_vert_consistency</code>	Turn on vertical tests (T/F)
<code>remove_data_above_qc_flag</code>	Data with qc flags higher than this will not be output to OBS_DOMAINdxx (32768)
<code>remove_unverified_data</code>	Unverified data will not be output to OBS_DOMAINdxx



Namelist

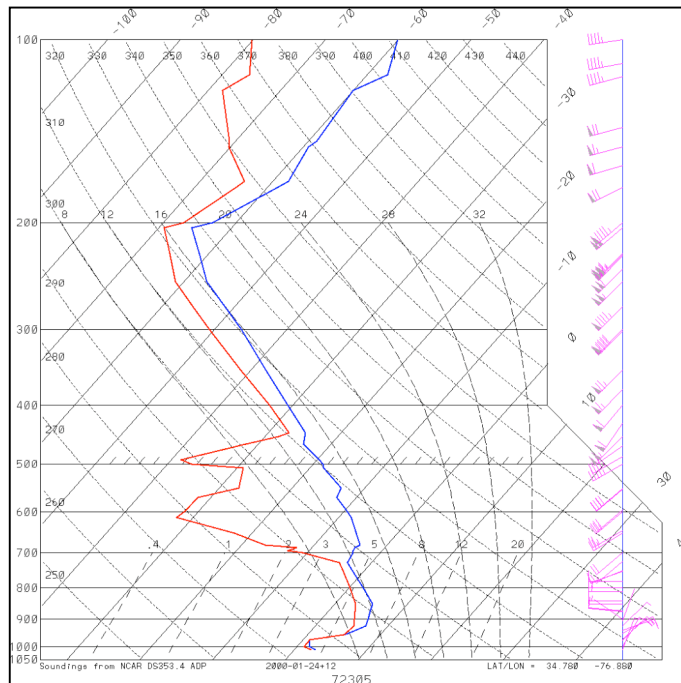
OA_type	"MQD" or "Cressman"
radius_influence	Radius of influence for Cressman
MQD_minimum_num_obs	Minimum number of obs for MQD
OA_min_switch (T/F)	Switch to Cressman if too few obs for MQD
MQD_maximum_num_obs	Maximum number of obs for MQD
OA_max_switch (T/F)	Switch to Cressman if too many obs for MQD



Utilities

- **plot_sound**

- Plot sounding from the 'raw' or 'used' wrf_obs / little_r output files
- Namelist control: **&record1, &record2, &plot_sounding**



- **plot_level**

- Plot data used on all levels
- Namelist control: **&record1, &record2**

