The Urban Atmosphere Research Program

Focus – To take our forecasts and analyses to where people live and work.

Issues --

For forecasting:

Dispersion	Floods
Fronts	Heat waves
Cold spells	Icing
Fires	**Air Quality**

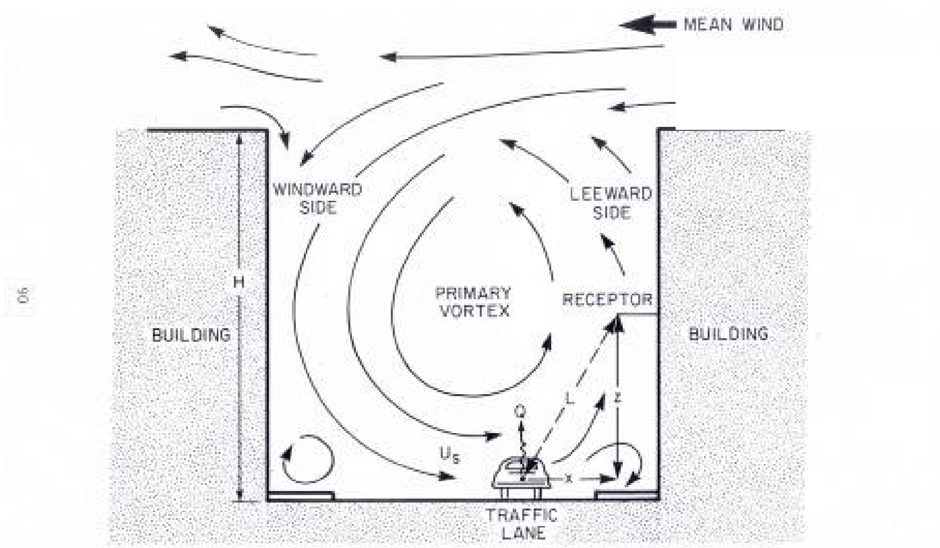
For data acquisition and analysis:

Climate	**Ecosystem loading**

Data requirements are different for the various issues. A central requirement is for an improved capability to predict the surface boundary layer accurately, and for data to support it.

Street canyons present great difficulty. What should we predict --
[C] or P([C] > [C_0])?

“Skimming flow” is driven by the meteorology aloft. The in-canopy environment is controlled by the configuration of streets and buildings, traffic patterns, etc.



Washington, DC, and New York illustrate two extremes

• Washington has broad streets and low buildings.

• New York has deep and sometimes narrow street canyons.

Physical models and computational fluid dynamics models are being used, in parallel.

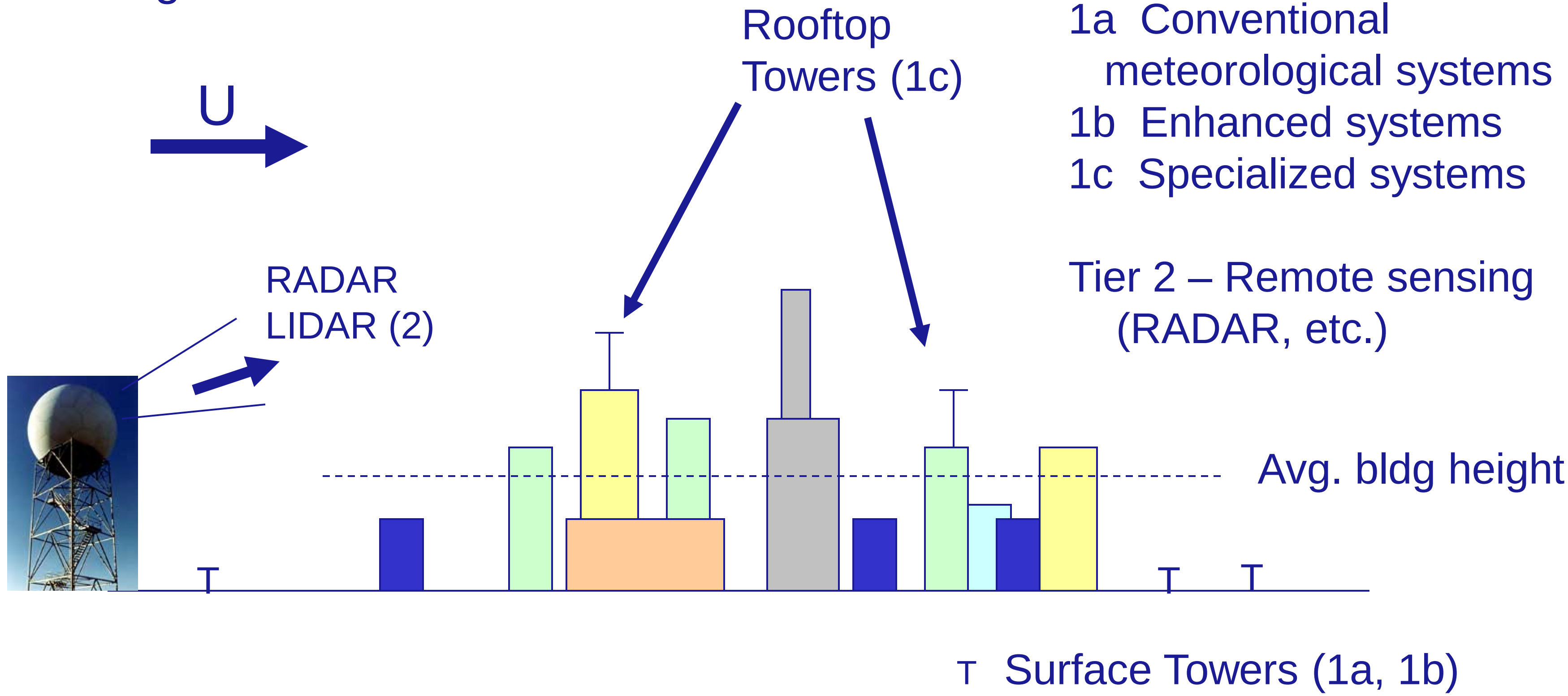
http://dcnet.atdd.noaa.gov/

A vision for measurements --

The proposed UrbaNet configuration

Tier 1 -- Surface towers
1a Conventional meteorological systems
1b Enhanced systems
1c Specialized systems

Tier 2 – Remote sensing (RADAR, etc.)



"UrbaNet" is DCNet in other areas (Tier 1c).

Some challenges for use of urban datasets for meteorological models (Courtesy Bruce Hicks)

Hard reality check #1

Meteorological models are constructed from the understanding of processes, each of which is represented as an average behavior.

If the models are essentially built from understanding of averages, they should not be expected to apply except on the average.

We are no longer interested solely in the average. We need to address specific instances. Hence, the requirement for more data is extreme.

Hard reality check #2 –

Meteorological models are becoming increasingly refined. However in daytime the convective process in the boundary layer is largely stochastic and hence deterministic models should not be expected to reproduce behaviors on the scale of convective updrafts, except on the average.

Hence, conventional mesoscale models should not agree well with observations taken over scales that are less than several kilometers, unless these observations are ensemble-averaged.

Hard reality check #3 –

In theory and in practice, micrometeorological descriptions of the surface apply above about ten times the roughness length (several m) above the zero plane (~ 80% of the average structure height).

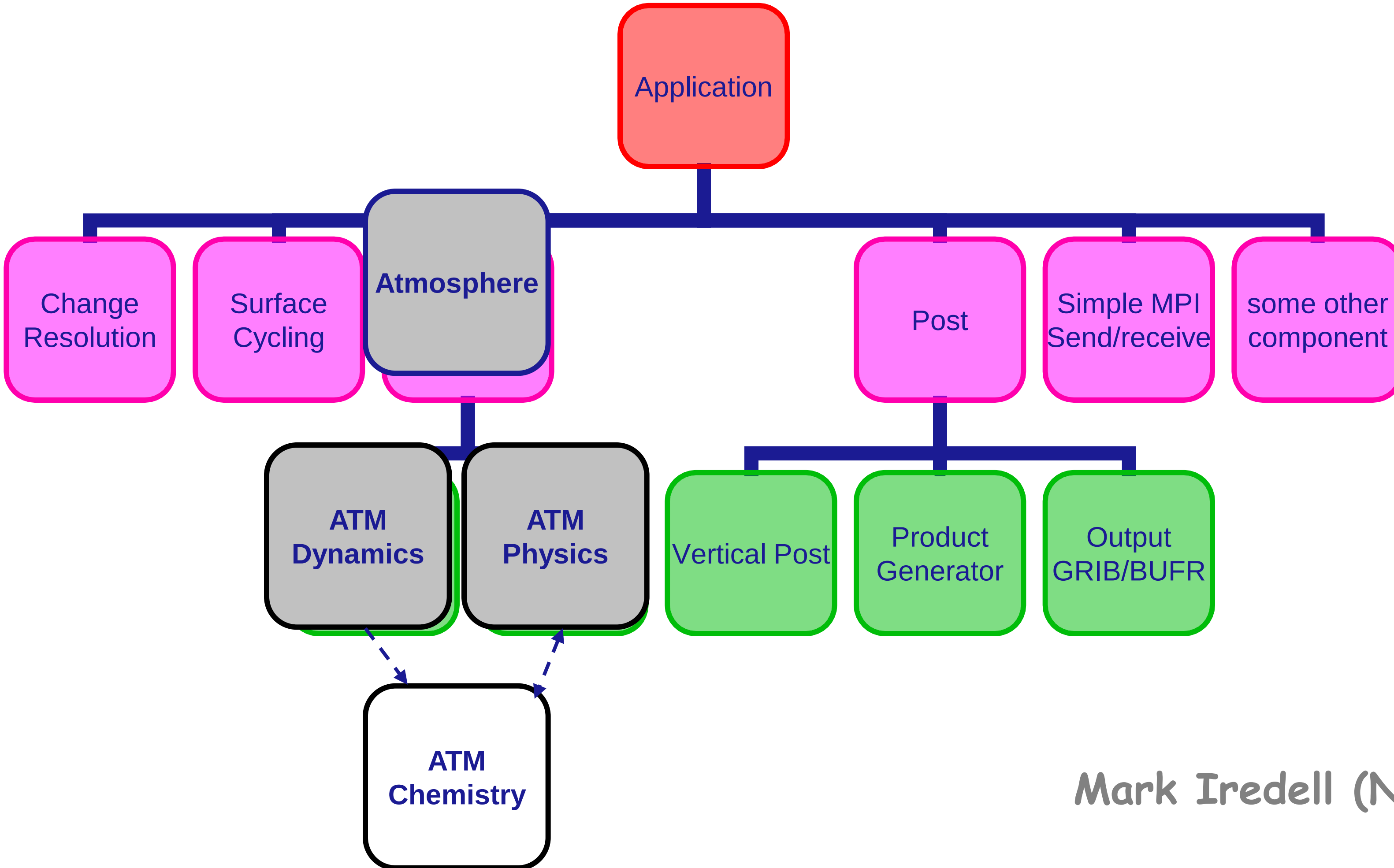
Typically – RADAR cannot look low enough, and towers are not high enough.

NOAA Modeling Applications

- Incorporate urban scale parameterizations in mesoscale models
- Focused evaluation of NWS non-hydrostatic model forecasts (~4 km) with urban datasets
  - WRF-NMM High Resolution Window nests (East/West/AK/HI/PR)
  - NEMS NMM-B 4 km CONUS Nest in NAM by 2010
  - Real Time Mesoscale Analysis (RTMA – 2.5 → 5 km)
  - Air Quality Forecasts
    - CMAQ: Ozone, fine particulate matter
    - HYSPLIT/GOCART: smoke, dust
  - Regional Reanalysis (1979-Present, North America 32 km)

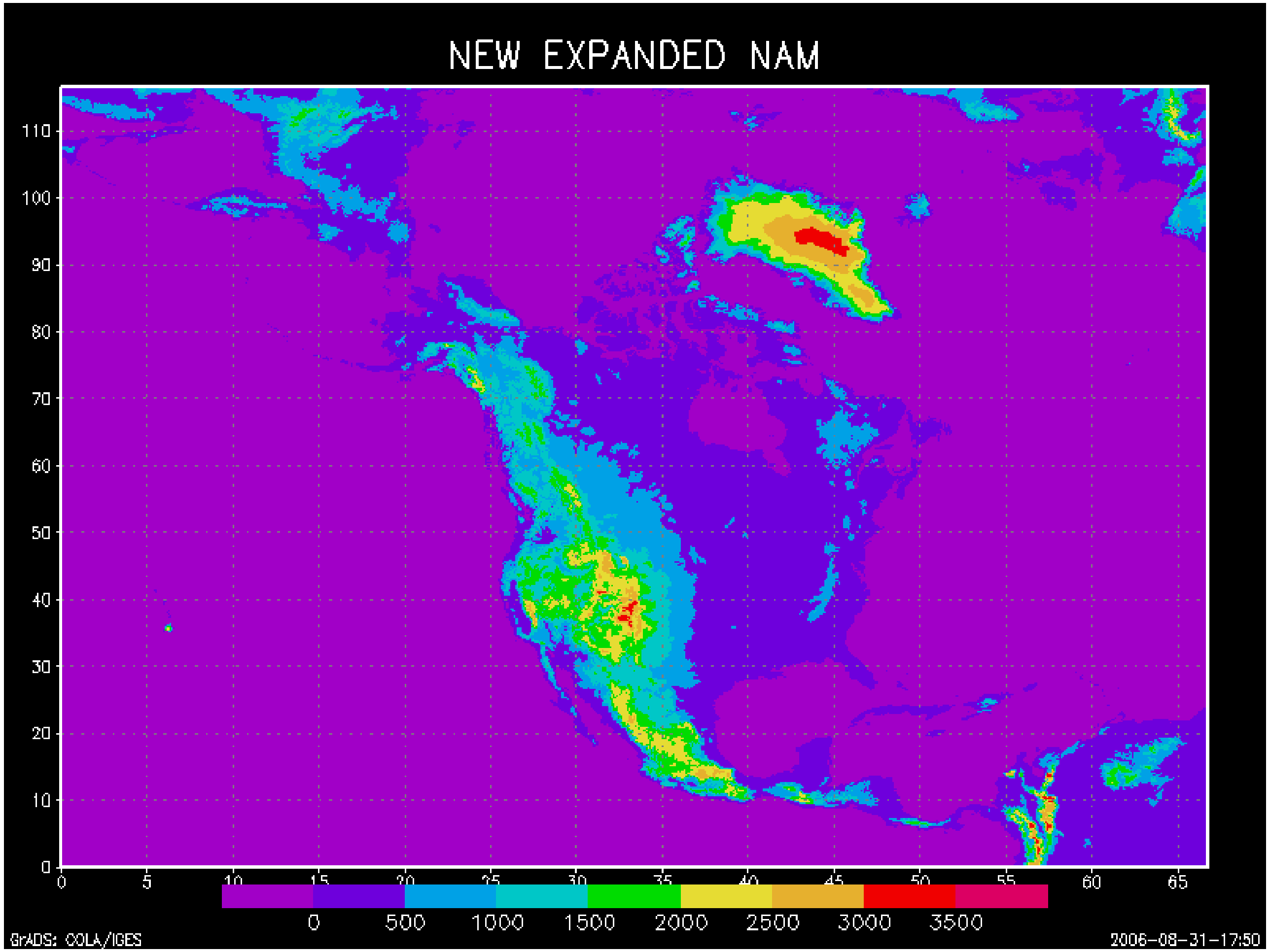
- Provide high resolution meteorological uncertainties using ensemble techniques
  - SREF : 32 km, 4x/day 84 hour forecasts
  - GENS : 1 degree, 4x/day, 16 forecasts
  - HREF experimental 12 km forecasts for Eastern U.S. & Beijing Olympics
- Explore mesoscale data assimilation techniques with urban datasets
  - GSI 3-D VAR

ESMF Component Framework: National Environmental Modeling System (NEMS – NMMB, GFS, FIM, ARW…)



Mark Iredell (NCEP)

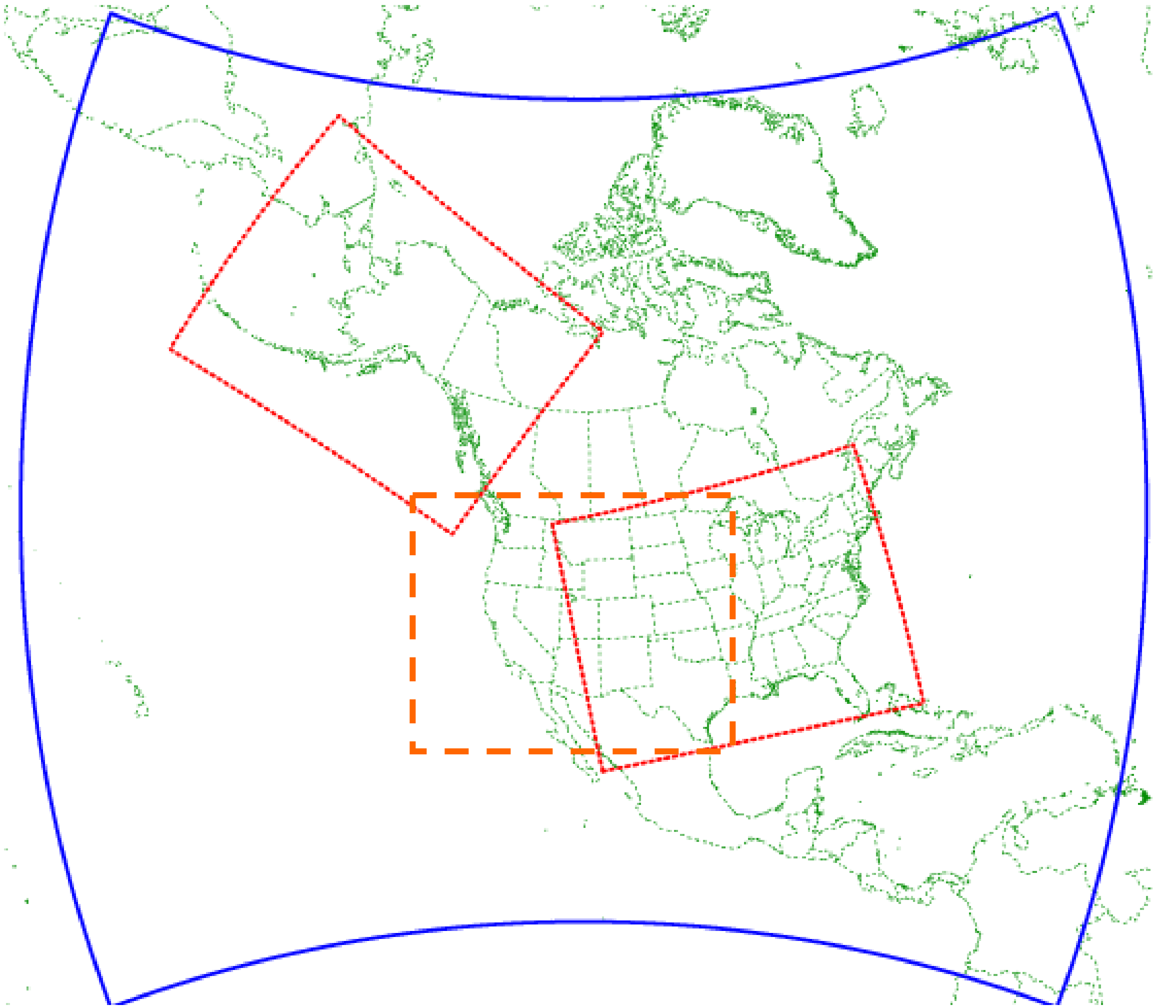
North American Model



North American Model (NAM) WRF run 4x/day at 12 km to 84 hours

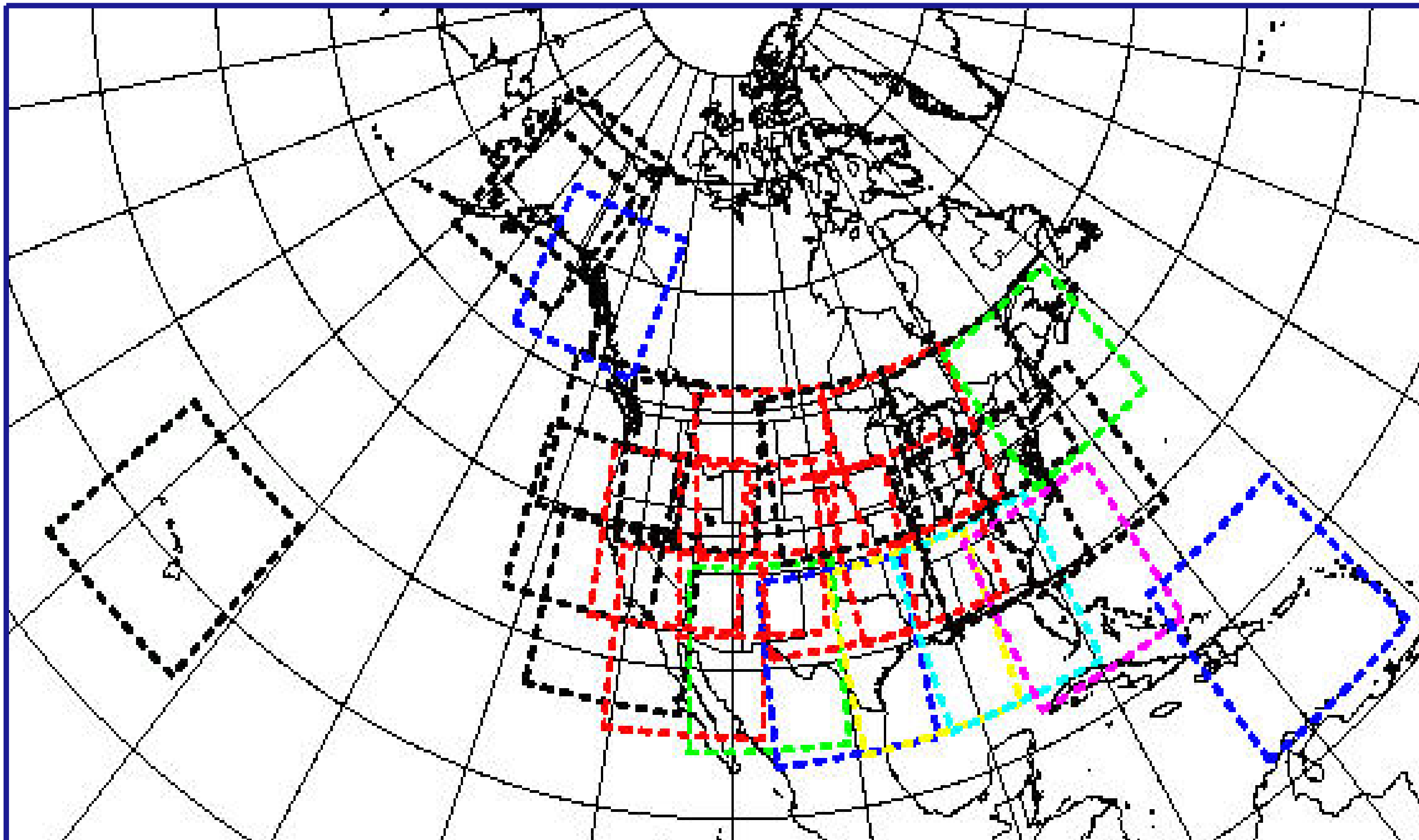
HiRes Window Fixed-Domain 4 km Runs

- FOUR routine runs made at the same time every day
- 00Z : ECentral & Hawaii
- 06Z : Alaska & Puerto Rico
- 12Z : ECentral & Hawaii
- 18Z : WCentral & Puerto Rico
- Everyone gets daily high resolution runs ***if & only if*** hurricane runs are not needed
- implemented in Q4FY07



http://www.emc.ncep.noaa.gov/mmb/mmbpll/nestpage/

HRW Homeland Security/Fire Wx Nests (26)
WRF-NMM Model @ 2.66 km



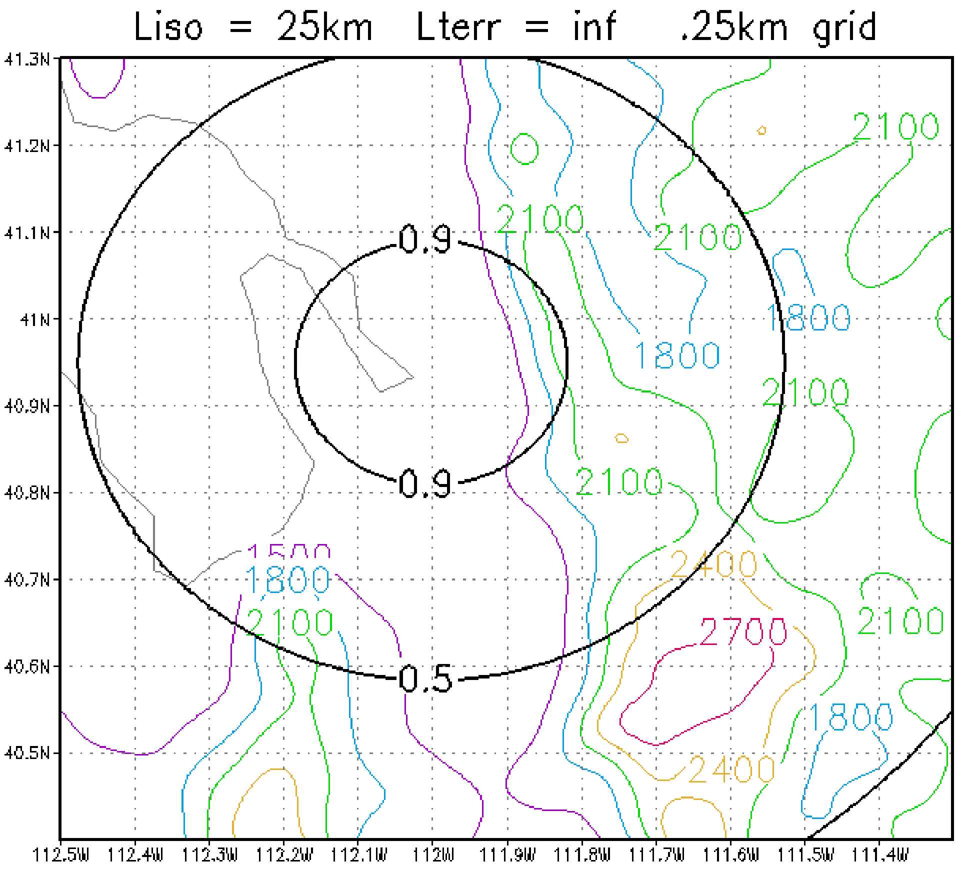
Real Time Mesoscale Analysis (RTMA)

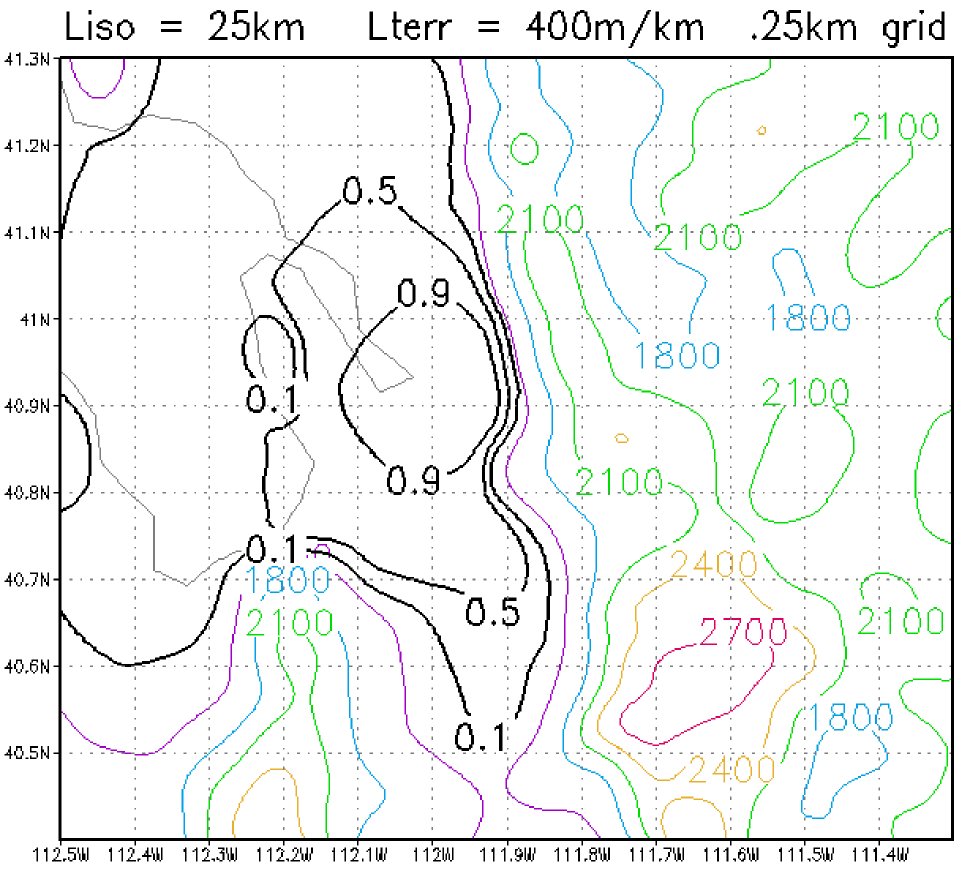
- Temperature & dew point at 2 m & wind at 10 m
  - RUC forecast/analysis (13 km) is downscaled to 5 km NDFD grid
  - Downscaled RUC used as first-guess in NCEP's 2DVar analysis of ALL surface observations
  - Estimate of analysis error/uncertainty
- Precipitation – NCEP Stage II analysis
- Sky cover – NESDIS GOES sounder effective cloud amount
- *Currrently adding a Planetary Boundary Layer Analysis into RTMA: Radiosondes, ACARS, MPLNET, GPS-RO*

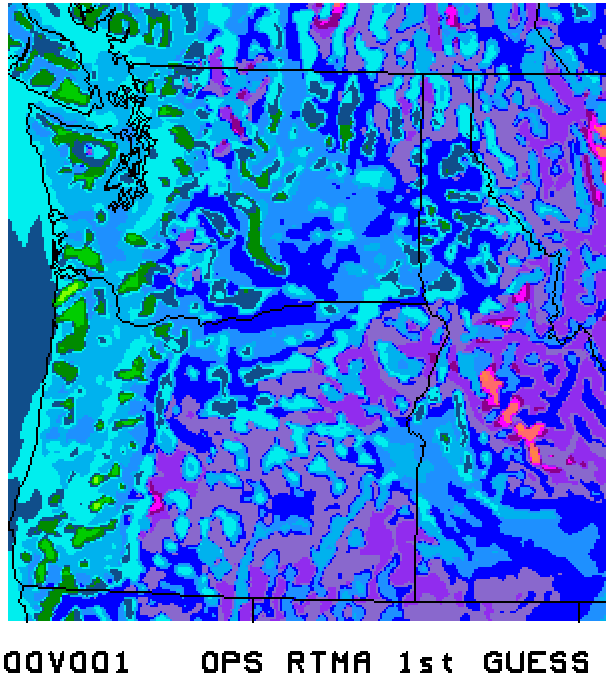
Error Correlations for Valley Ob (SLC) Location Plotted Over Utah Topography

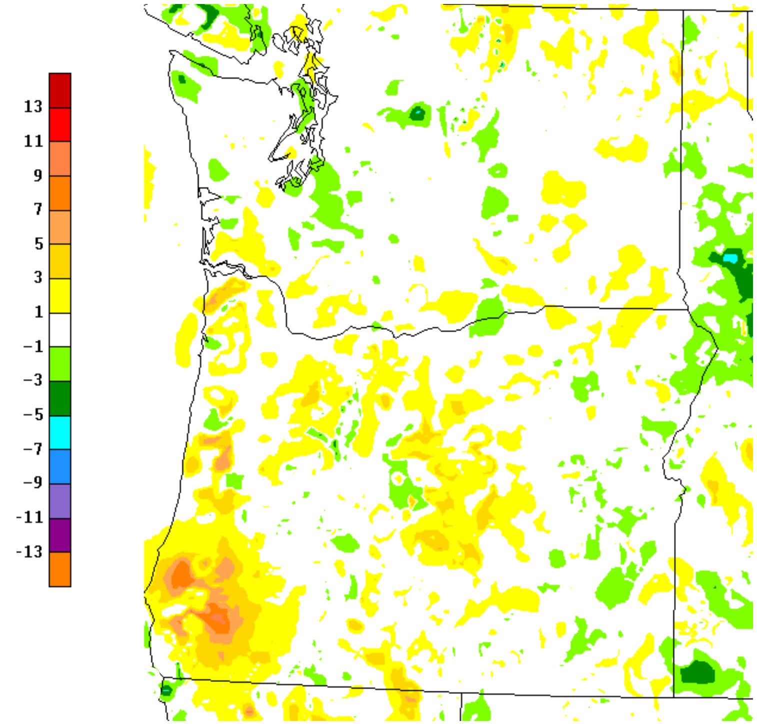
Isotropic Correlation: obs' influence extends up mountain slope

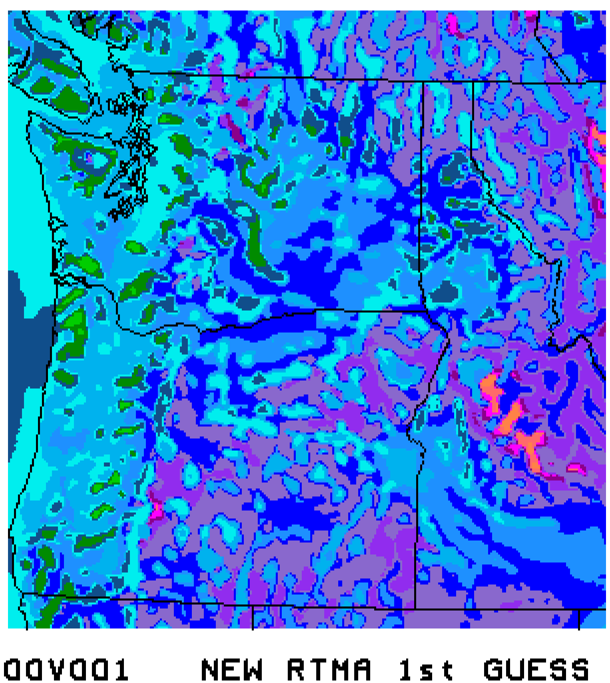
Anisotropic Correlation: obs' influence restricted to areas of similar elevation







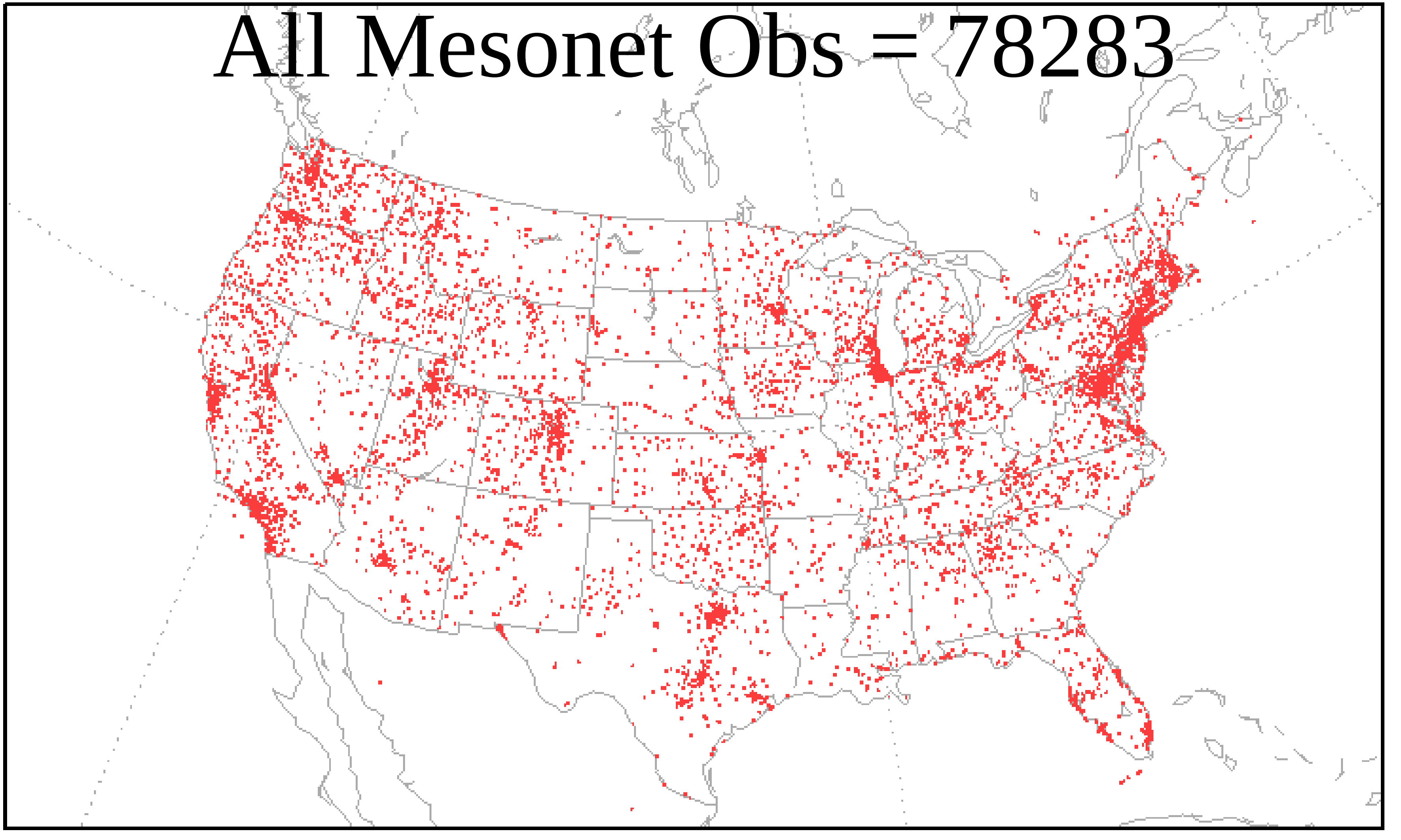




Example of revision in RTMA-RUC downscaling based on 2006 review

Revised code to generate downscaled NDFD 1st guess constrains the upward extrapolation that previously led to too warm 2-m temps over high terrain during early morning inversions

2005092600 NAM Mesonet Data Dump Distribution over CONUS

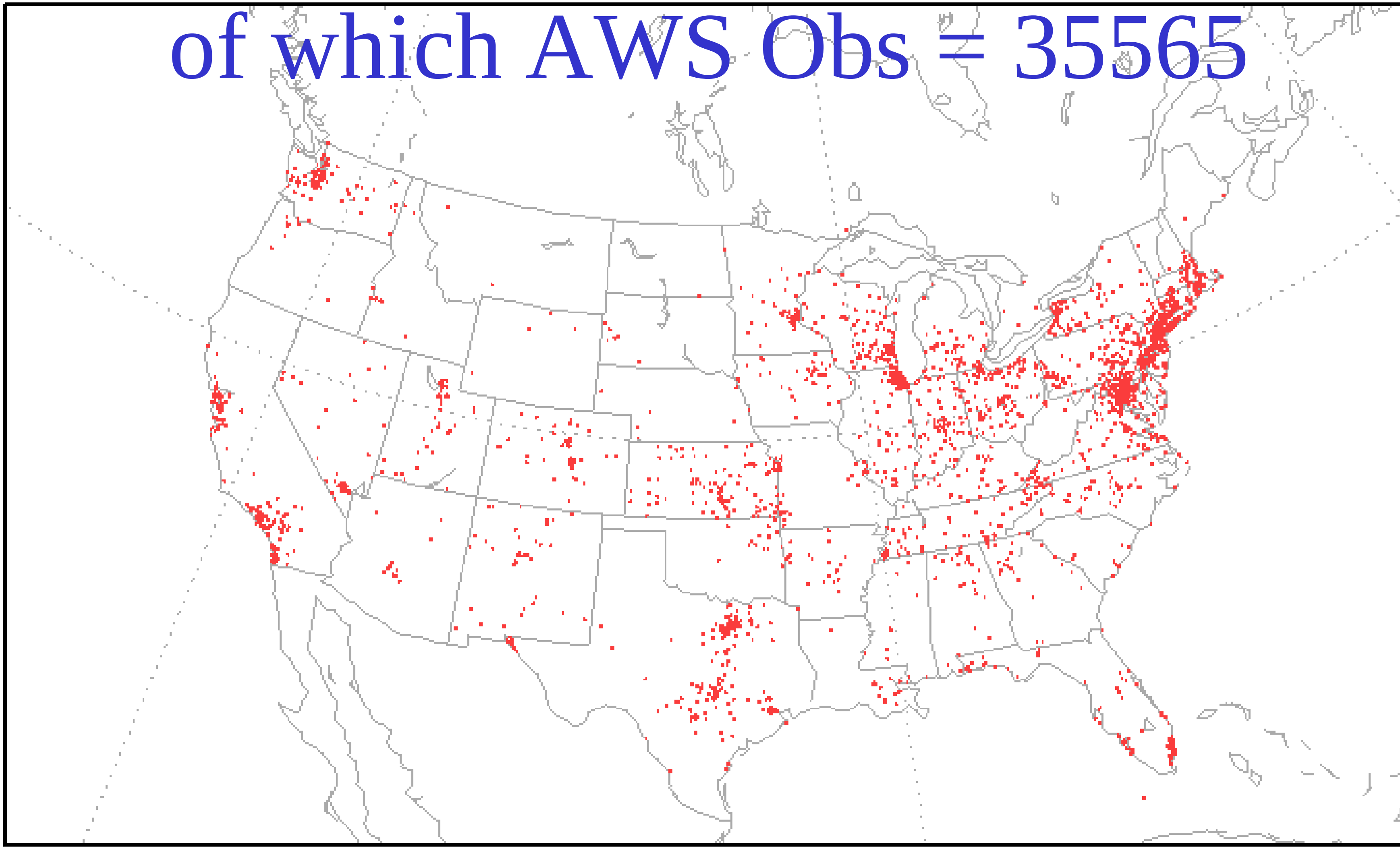


(all Mesonet data, including AWS)

DOC/NOAA/NWS/NCEP/EMC/MMB

REPORT COUNT: 78283

2005092600 NAM Mesonet Data Dump Distribution over CONUS



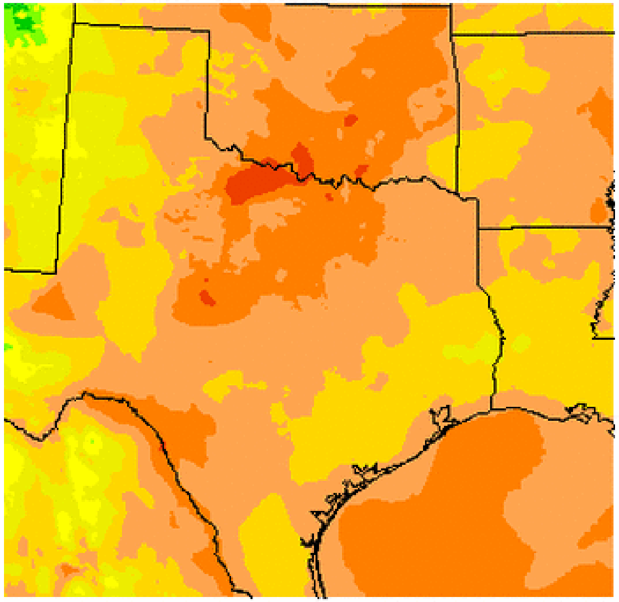
(AWS only)

DOC/NOAA/NWS/NCEP/EMC/MMB

REPORT COUNT: 35563

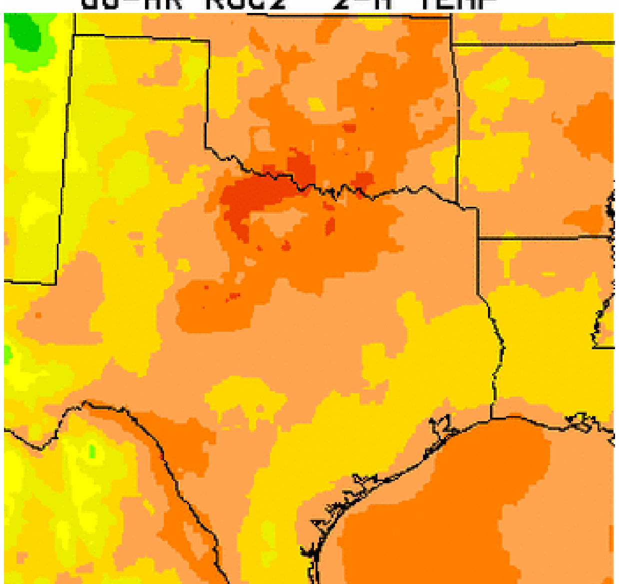
TX 2 m Temperature Analysis

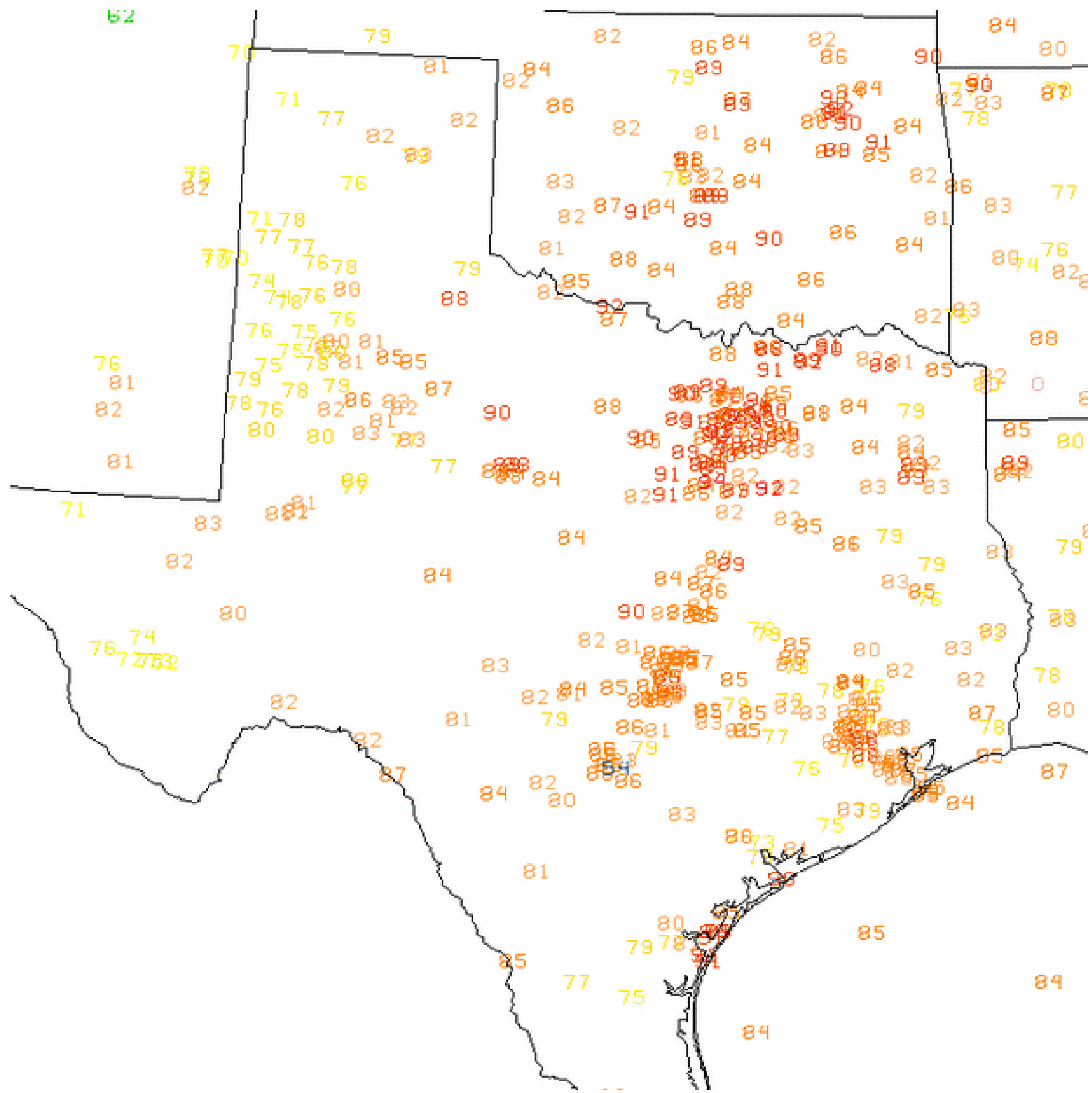
00-HR RTMA 2-M TEMP



ANALYSIS VALID 06Z 08/09

00-HR RUC2 2-M TEMP





TEMPERATURE OBSERVATIONS

Questions for this Group

- What data are needed for:
  - Meteorological evaluation and data assimilation
  - To drive and evaluate dispersion models
- Spatial and temporal resolution ?
  - Winds, temperature, moisture
  - Mixing depth
  - Sigma u,v, θ; TKE
  - Tracer releases
- Vertical Profiles vs surface observations