Impact of GPS-Based Water Vapor Fields on Mesoscale Model Forecasts

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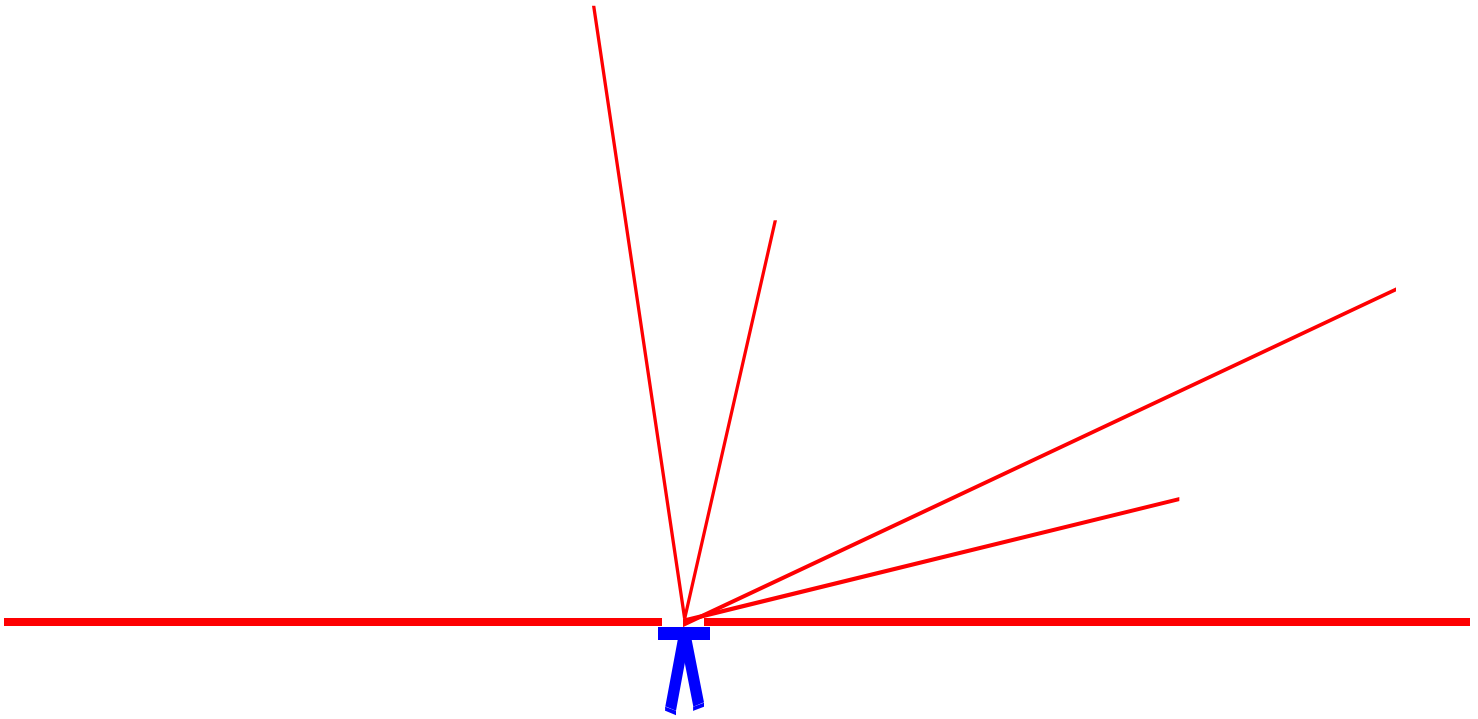
Presentation outline

- 3D water vapor analysis with GPS
  - GPS slant delays, simulated network
  - 3DVAR assumptions, results
  - Microwave profiler example
- Experiment design
  - Simulated slant GPS network
  - ARPS/ADAS assimilation
- Mesonet demonstration
- Summary

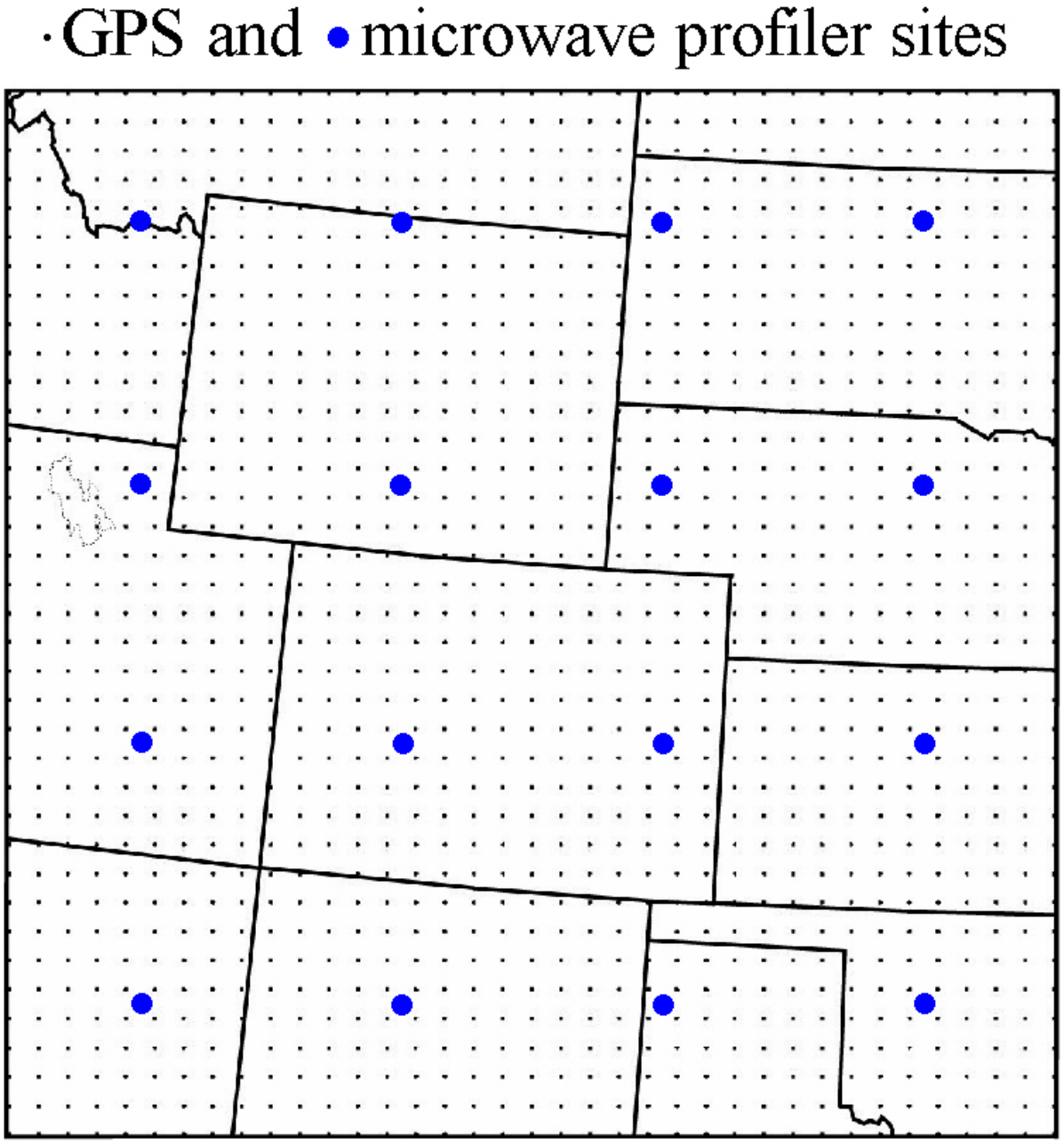
3D water vapor analysis with GPS

- GPS signals experience atmospheric delay
  - Dry atmospheric delay (temperature and pressure)
  - Wet atmospheric delay (water vapor)
- Slant path measurements
  - Delays for ~8 satellites in view
  - Provides strong horizontal constraint
- Humidity soundings
  - Needed for unique solution
  - Can be provided by microwave profilers

GPS slant delays



- Provide strong constraints on atmospheric temperature and humidity
- Low angle measurements simultaneously constrain many model cells

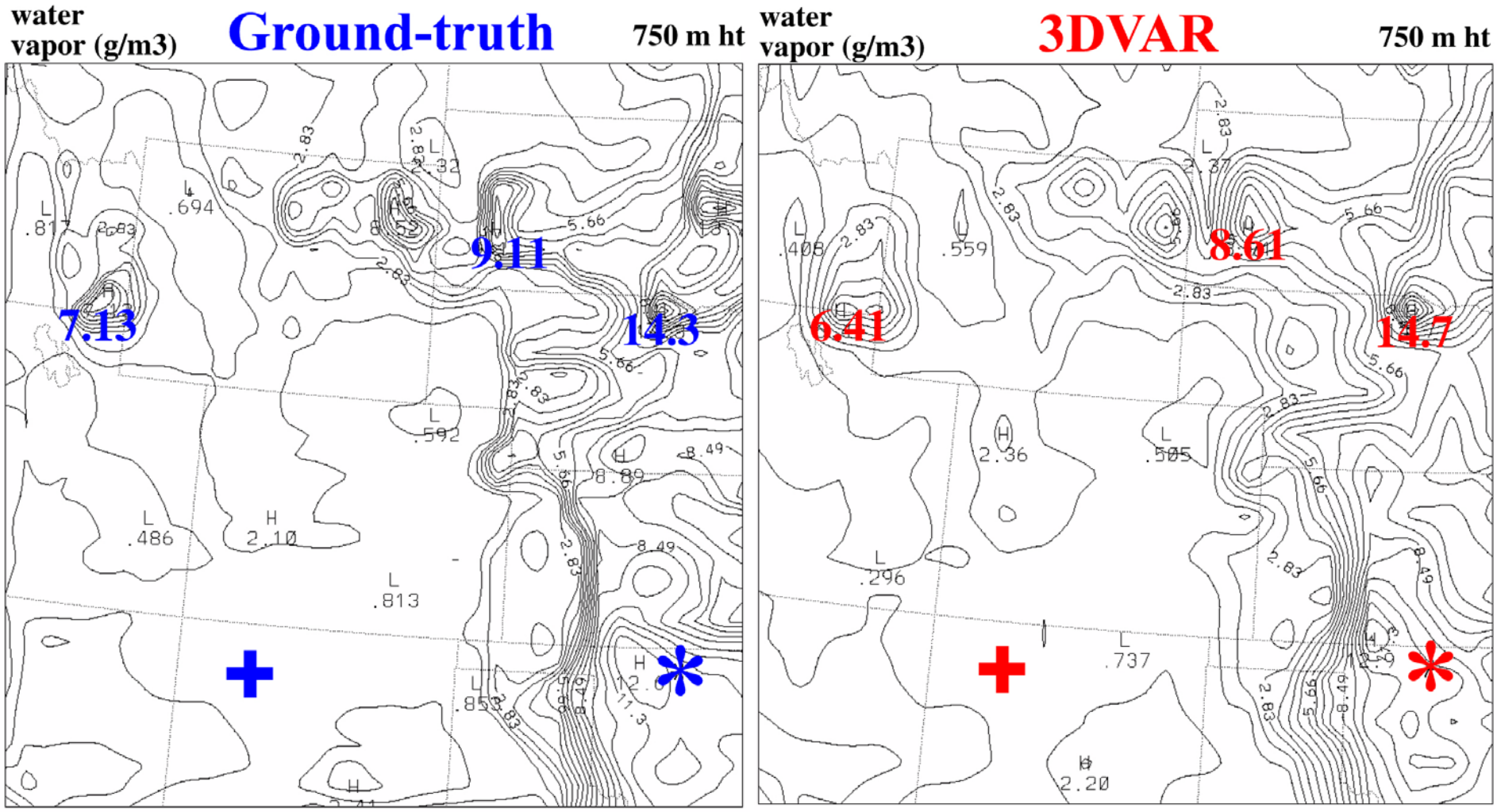


Simulated slant GPS network

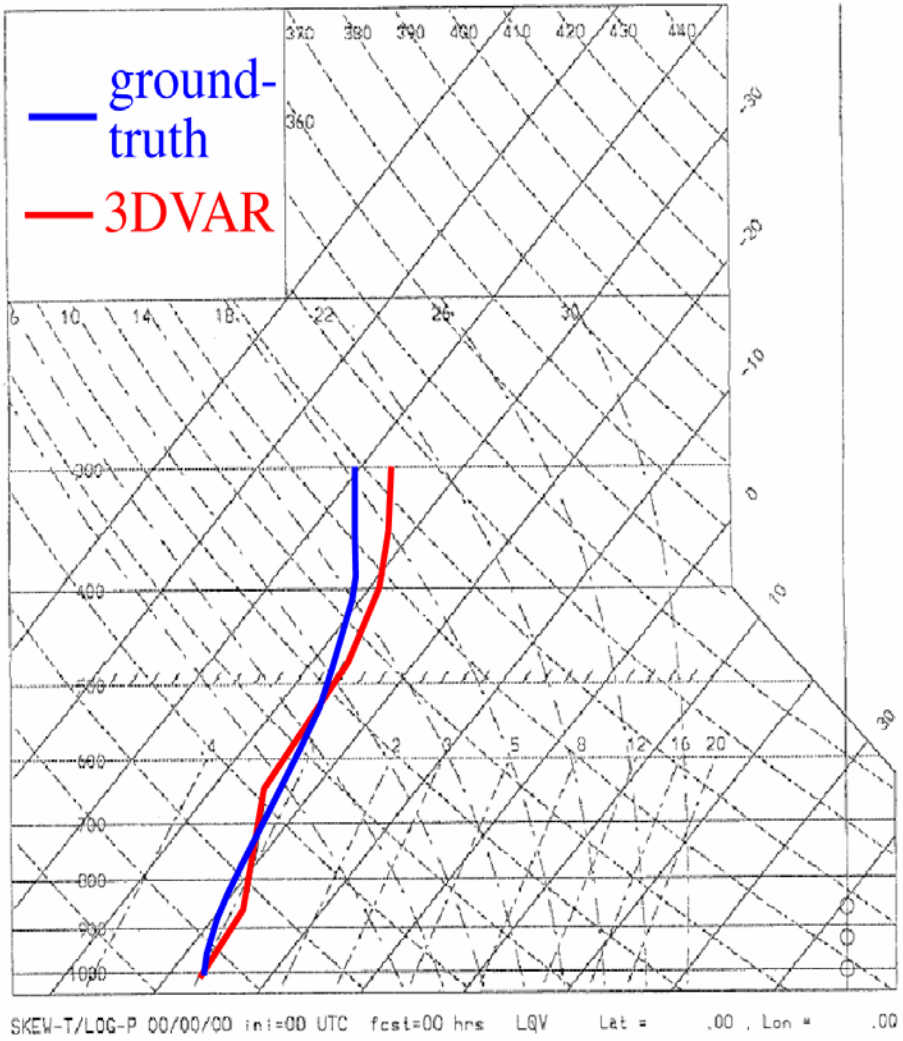
- resolution
  - 40 km horizontal
  - 500 m vertical
- domain
  - Rockies and high plains
  - surface to 8 km

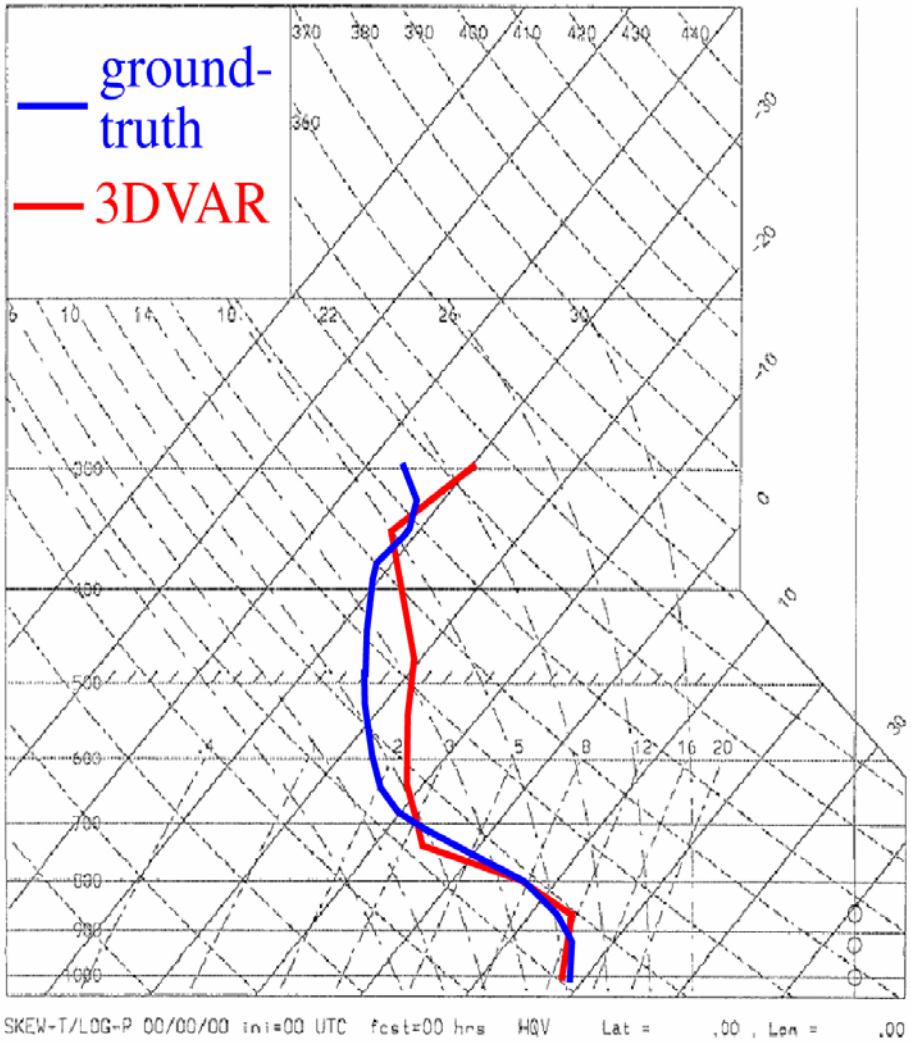
3DVAR assumptions

- 40-km GPS grid (~1300 sites)
- slant delays down to 1 degree elevation
  with 7% error
- 360-km microwave profiler grid (16 sites)
  with 8% error
- surface humidity measurements at GPS sites
  with 5% error



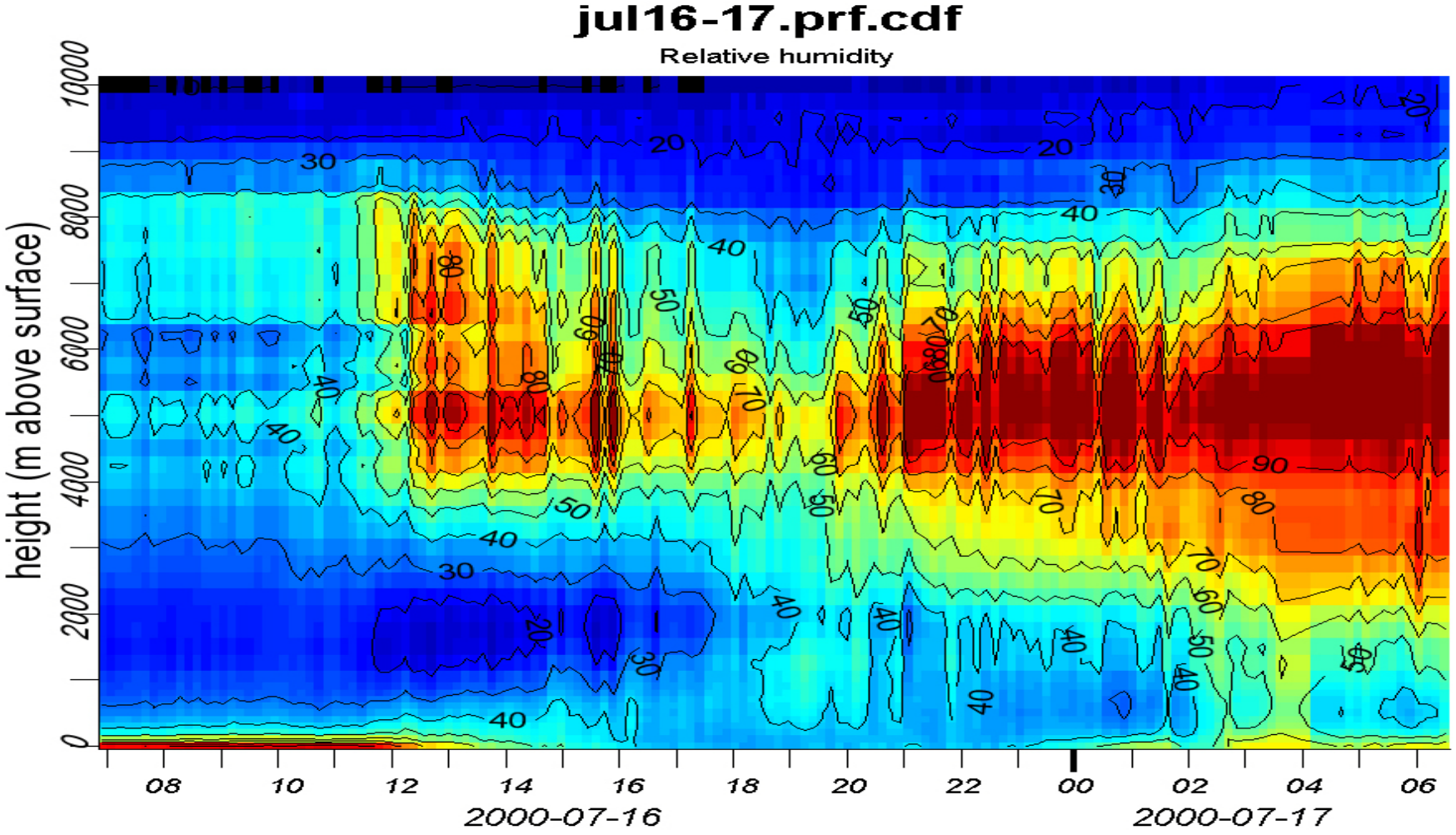
Humidity fields at 750 m height. Size and location of the major convective features are similar. Humidity soundings are compared at dry (+) and moist (*) locations.





Comparison of dry (left) and moist (right) ground-truth and 3DVAR humidity soundings

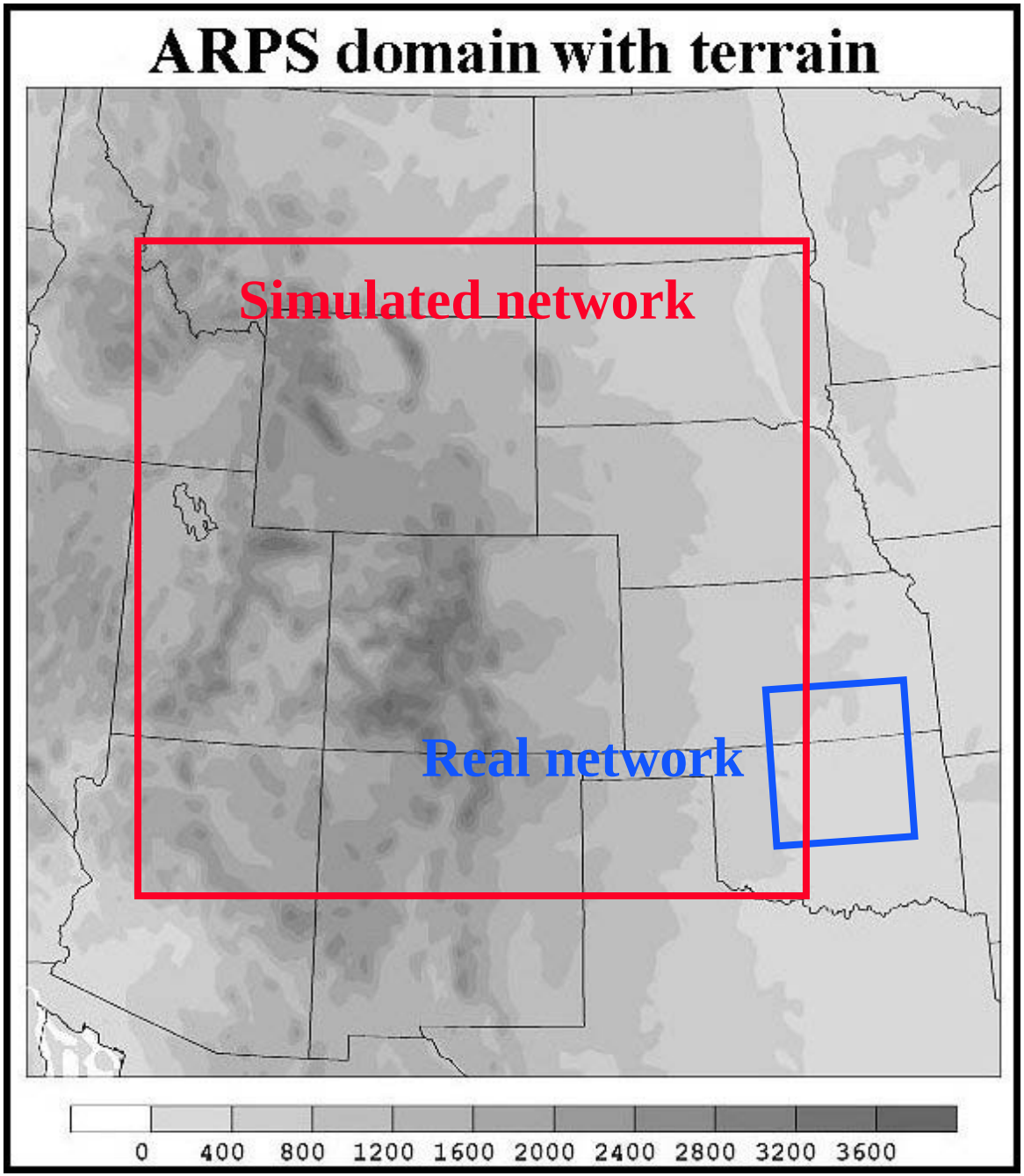
Example microwave profiler sounding



Microwave profiler observations near Lamont OK by DOE of a dry line passage (around noon on 16 July)

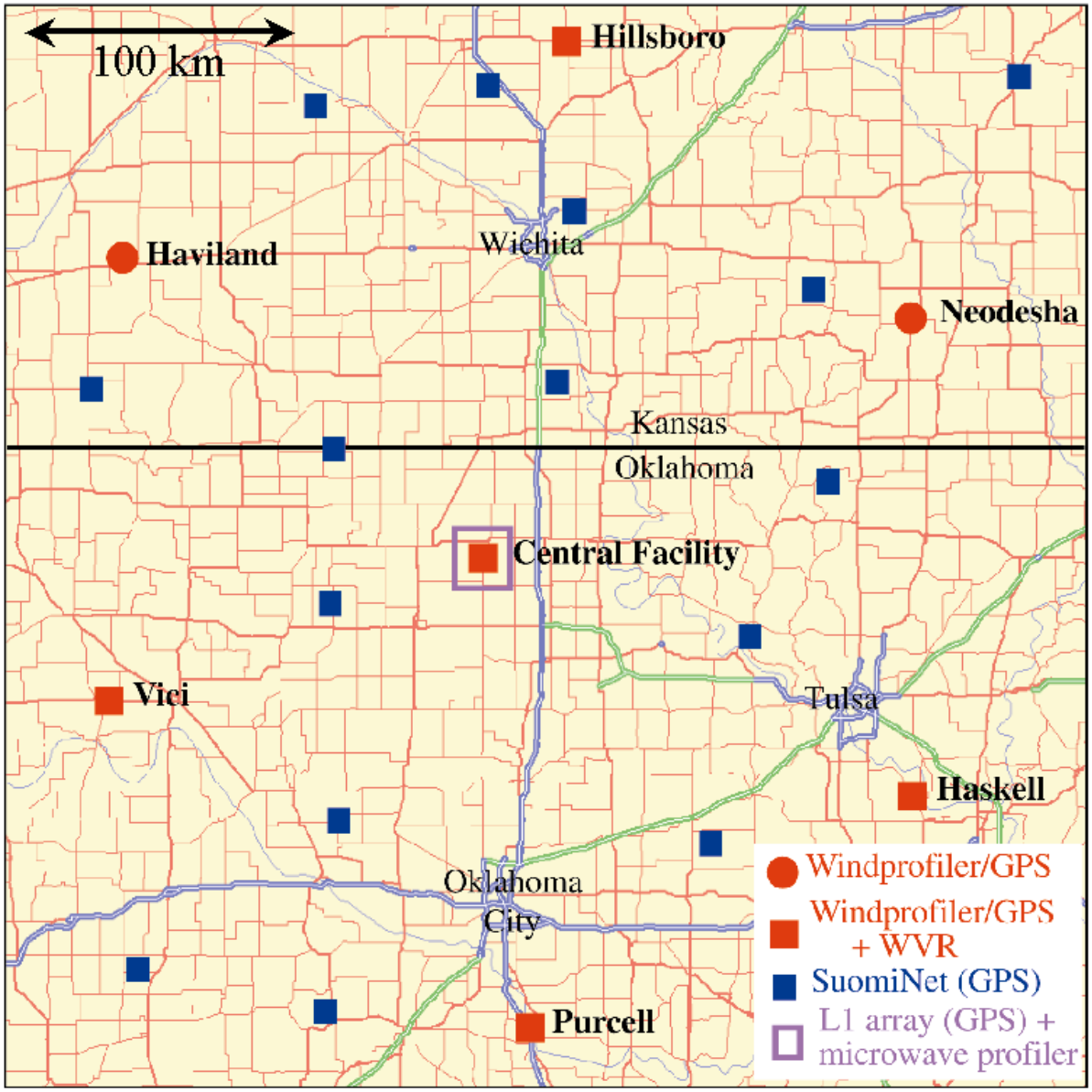
Experiment design

- Purpose
  - Assimilate GPS slant delay data into mesoscale model
  - Evaluate impact on forecast
- Part I
  - Analyze high resolution humidity field using 3DVAR and simulated GPS slant and tropospheric profile data
  - Evaluate impact of these data on forecasts using the Advanced Regional Prediction System (ARPS)
  - Initialize model using ARPS Data Analysis System (ADAS)
- Part II
  - Repeat experiment using real GPS and tropospheric profile data
  - Evaluate impact of real GPS slant data on forecast



ARPS/ADAS assimilation

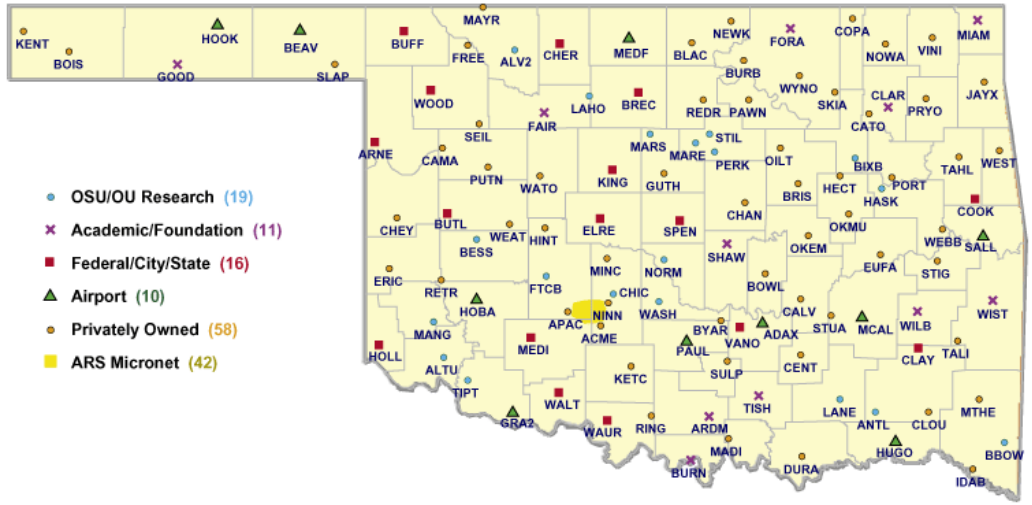
- resolution
  - 10 km horizontal
  - 412.5 m vertical (average)
  - Stretched vertical coordinate
- domain
  - Rockies and plains
  - surface to 16.5 km

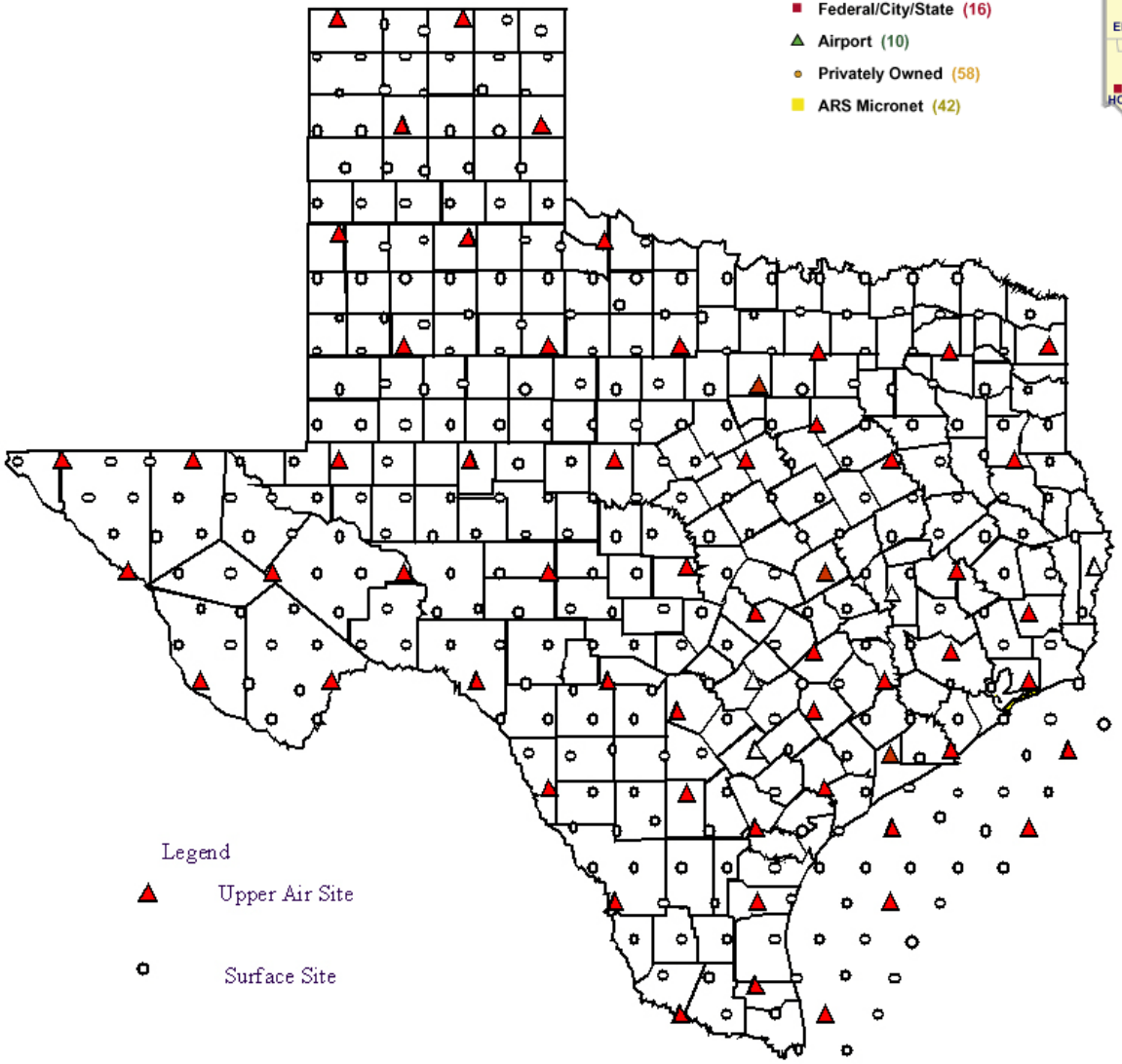


Slant GPS test bed

- slant GPS (22)
- wind radars (7)
- microwave profiler (1)
- water vapor radiometers (5)

Mesonet demonstration





If forecast impact is large, regional mesonets could be instrumented

Summary

- Simulations show that GPS slant data can be used for high resolution humidity analysis
- We plan to assimilate simulated and real data to determine the impact on mesoscale forecasts
- If the impact is significant, regional mesonets could be instrumented for demonstration experiments

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