New Thrust—ARM LES Testbed (ALT)

Motivation:

--New high resolution radar and MWR observations

--Prospects of 3-D cloud characterizations (AVA)

--A framework for organizing observations

- ARM LES Evaluator (ALE)
  - Develop BL Data Sets—Single layered, uniform, cloud fields (stratocumulus; fair-weather cumulus)
  - BCs from ARM Obs, VAPS, NWP analyses…….
  - Evaluation/Tuning
    - Radar Doppler Spectra; LEO for LES
    - Liquid Water Path, Cloudbase, Surface Rad, 3-D cloud fields, e.g.
    - Establish Model Sensitivity to Forcing and Tunable Parameters
- ARM BLC Simulator (ABS) (20 kmx20 km domain?)
  - Near real time LES (1-hour statistics)
  - Assimilation/Nudging/Iteration/Neural Network Tuning?
  - Output --domain cloud, boundary layer, and radiation characteristics/statistics

ARM LES Testbed:
Multi-nested WRF Simulations of Boundary Layer Clouds

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1. Using multiple two-way nested WRF to simulate a spectrum of scales from large scale atmospheric flow, meso-scale organizations, to fine scale turbulent eddies in a unified system.

2. Using high resolution WRF simulation to provide initial and lateral boundary conditions for other LES models.

5 domains with 4 two-way nests.

Domain - 1: $121 \times 101 \times 54, \quad \Delta x = 8100\ \mathrm{m}$

Domain - 2: $103 \times 103 \times 54, \quad \Delta x = 2700\ \mathrm{m}$

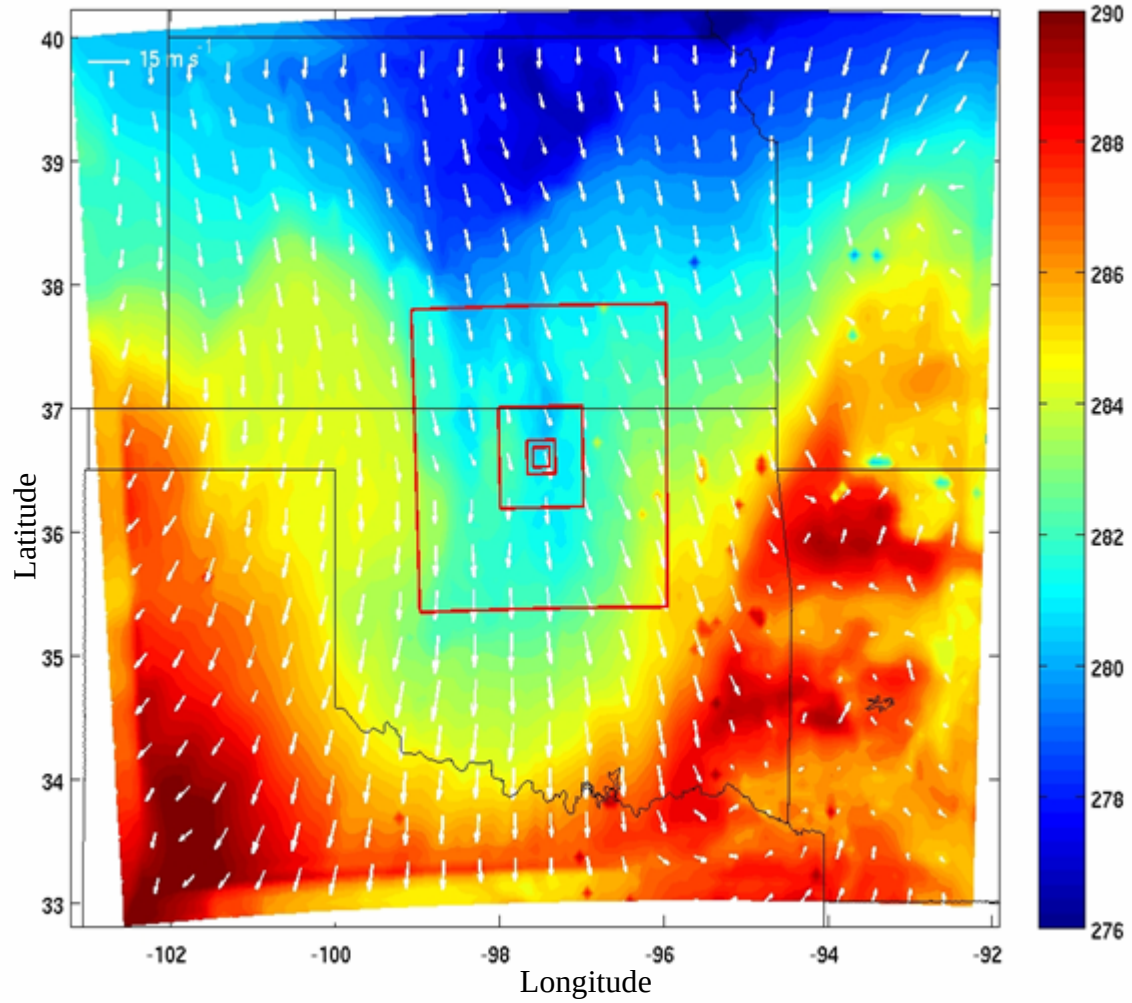
Domain - 3: $103 \times 103 \times 54, \quad \Delta x = 900\ \mathrm{m}$

Domain - 4: $103 \times 103 \times 54, \quad \Delta x = 300\ \mathrm{m}$

Domain - 5: $181 \times 181 \times 54, \quad \Delta x = 100\ \mathrm{m}$

Vertical resolution varying
from 24.0 m to 55.7 m below 1845 m.

WRF nested domain over SGP site
Stratocumulus case, March 25, 2005



Background: 2 m high potential temperature with 10 m high wind vectors at 11:30 UTC

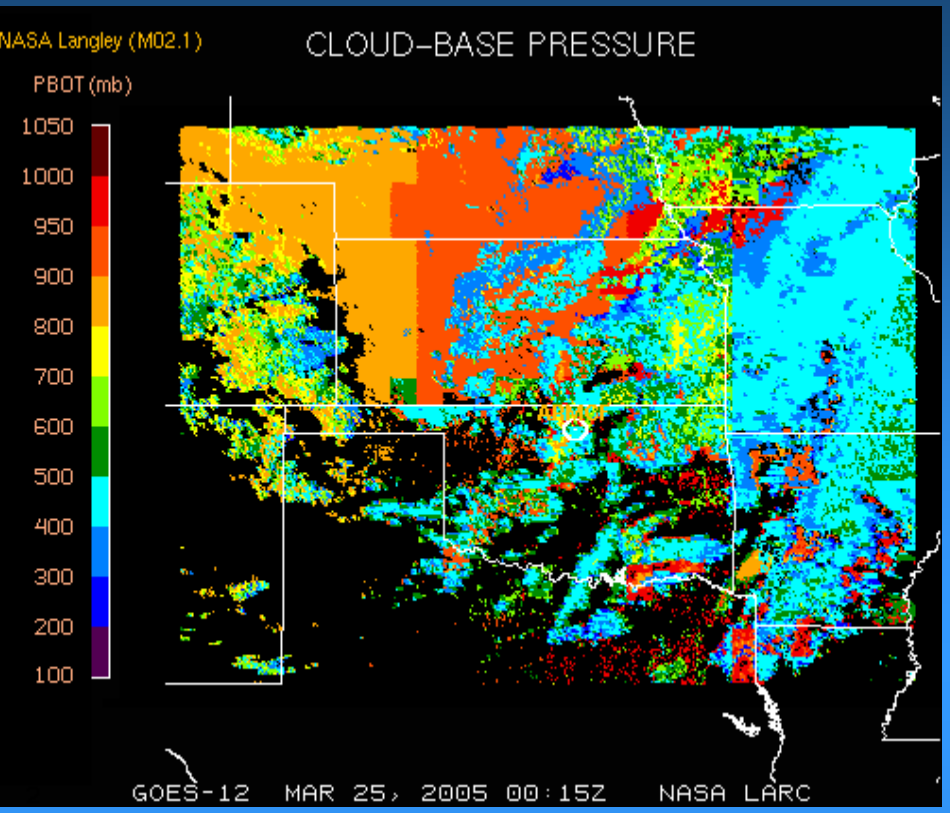
WRF-LES vs LES

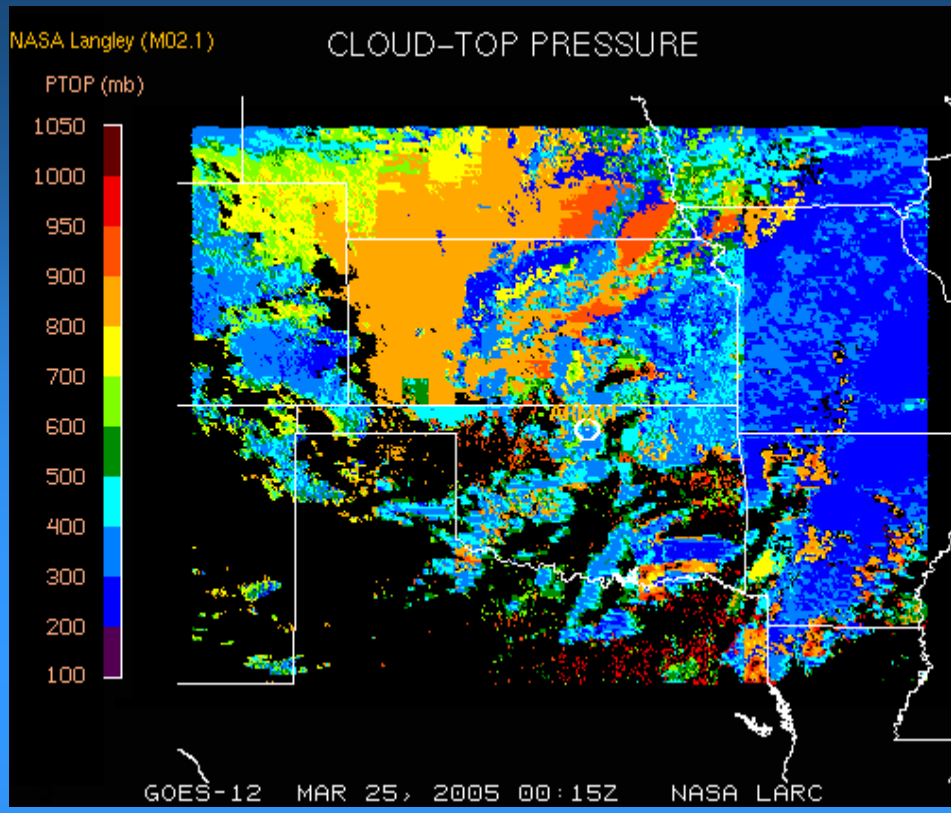
LES:
1. horizontal homogeneous.
2. idealized vertical profiles.
3. certain surface & large-scale forcing.

WRF-LES:
1. up-scale and down-scale interactions across scales.
2. operational mode.

Real time data: GFS, ETA, AVN, etc

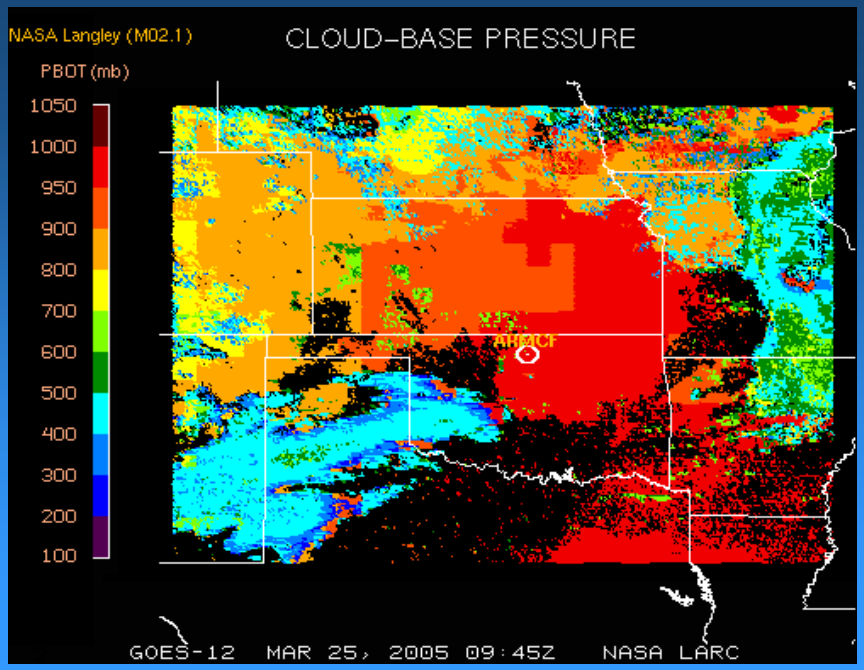
NCEP reanalysis data

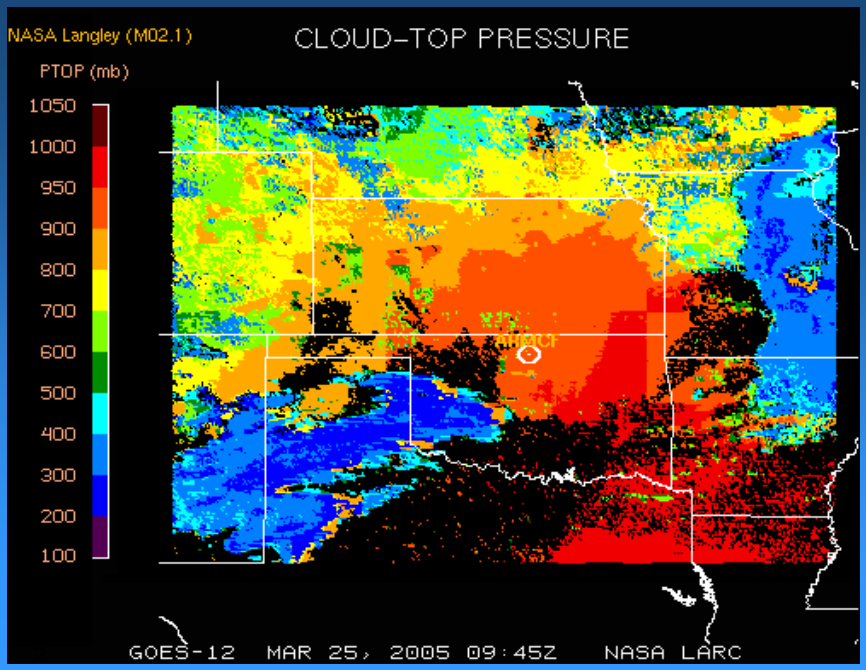




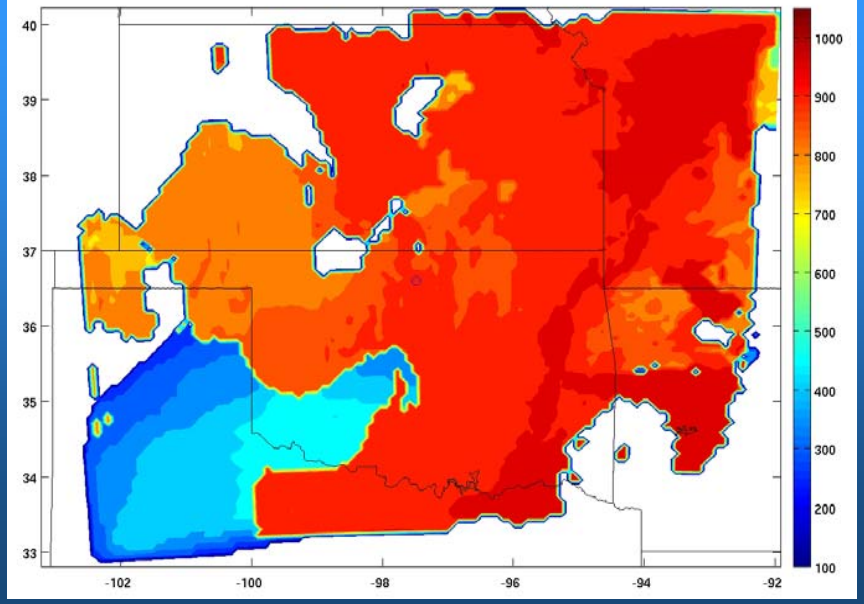
NCEP Global Tropospheric Analyses 1 X 1.

24-hour simulation starting at 0 UTC March 25th in Domain 1..
The four two-way nested domains were activiated 6 hour later.

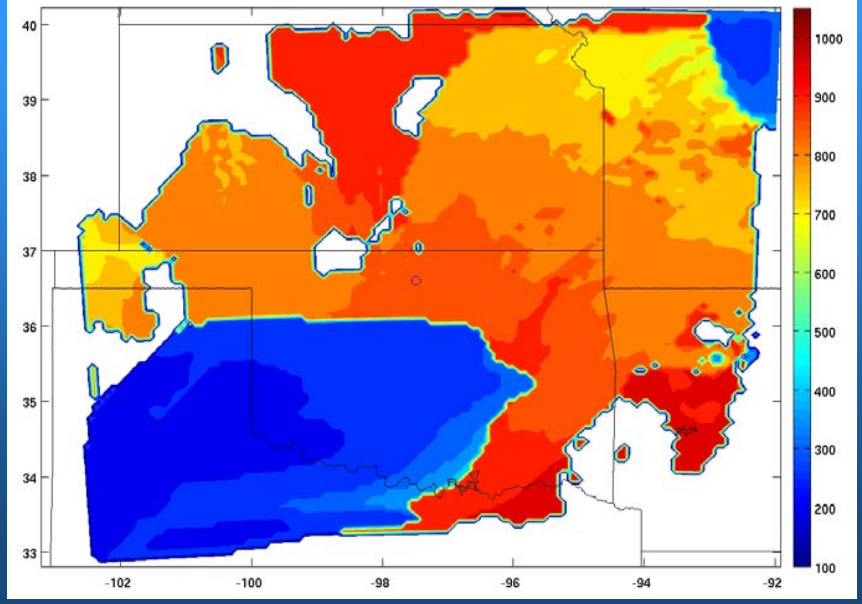


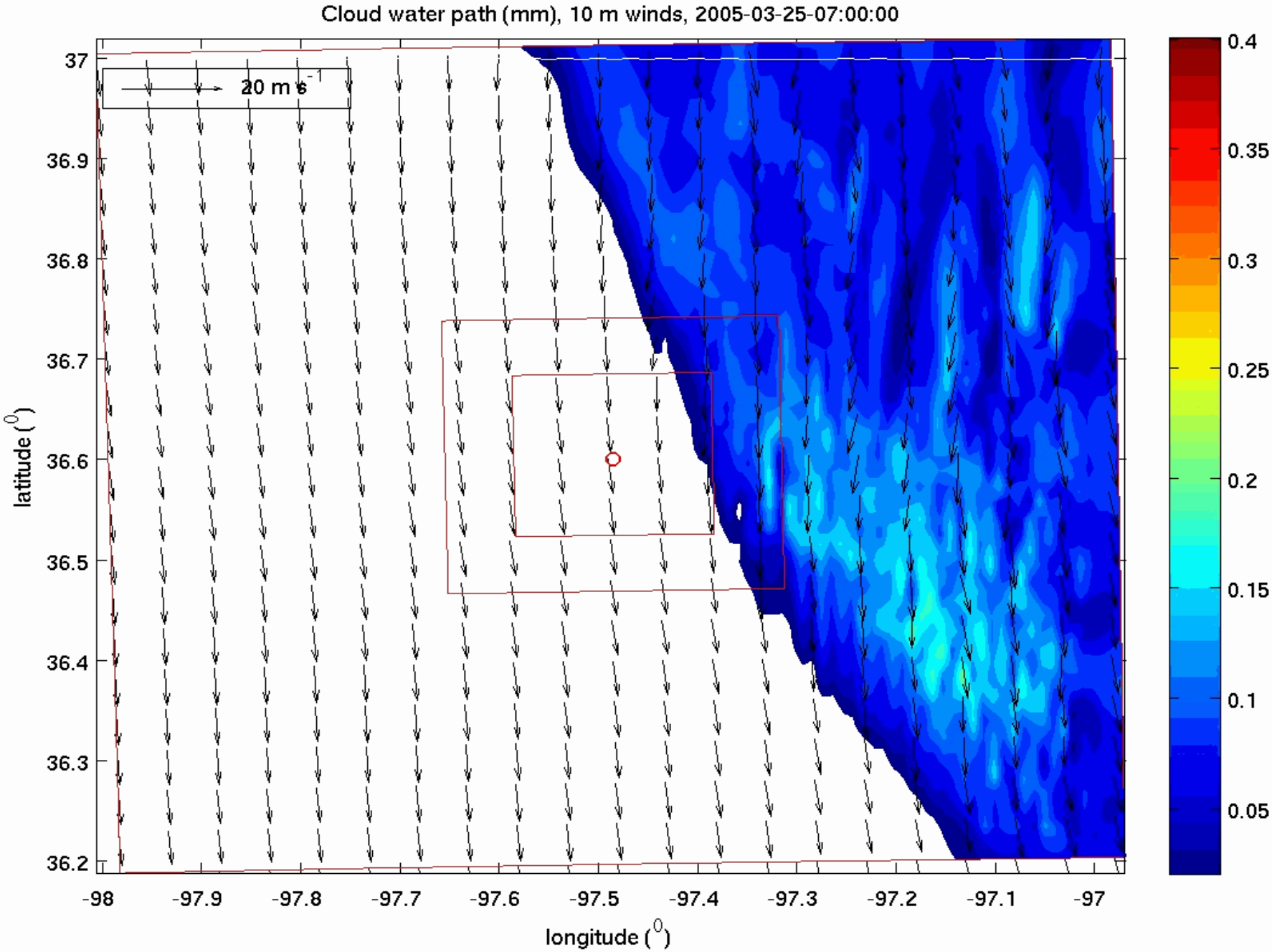


SIMULATED DOMAIN-1 CLOUD-BASE PRESSURE MAR 25 09:45Z

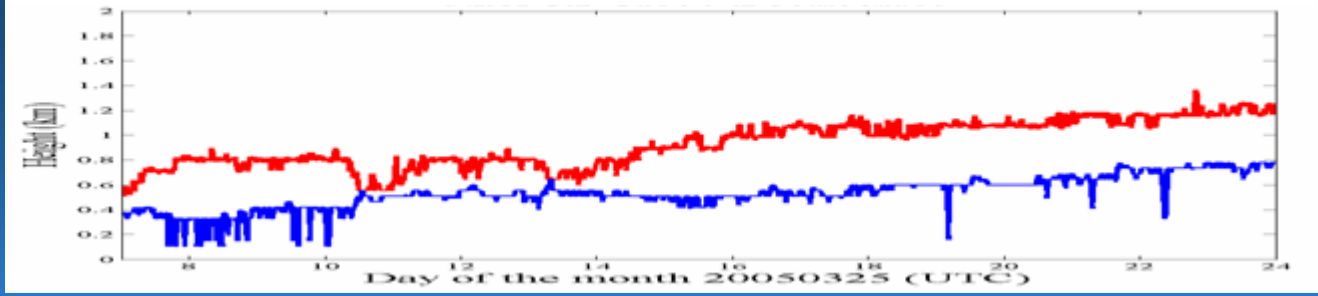


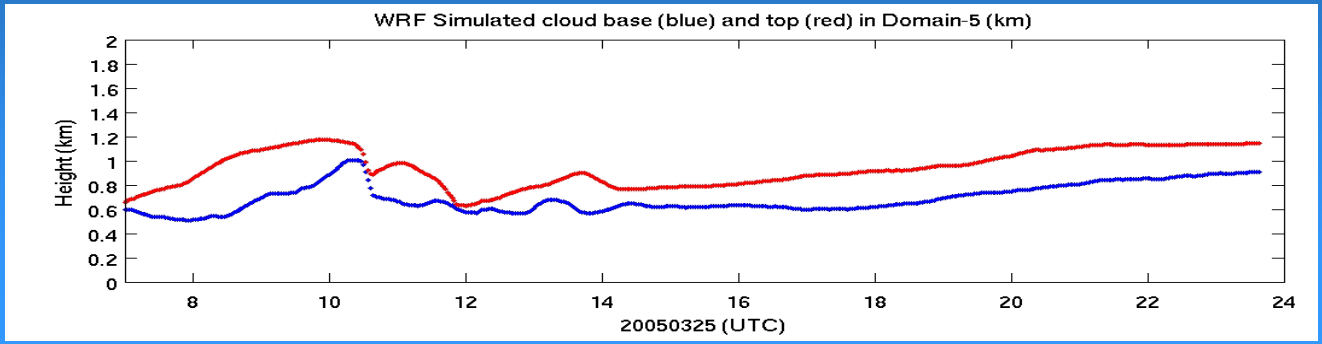
SIMULATED DOMAIN-1 CLOUD-TOP PRESSURE MAR 25 09:45Z

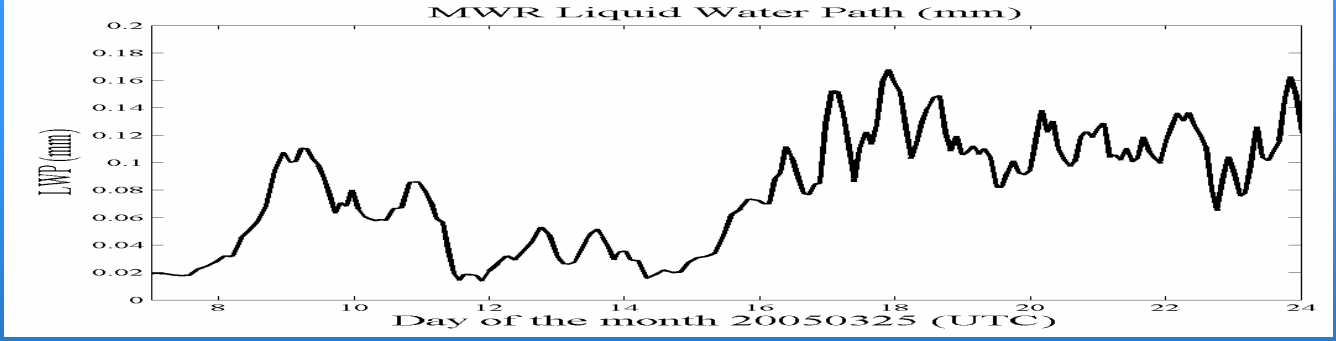


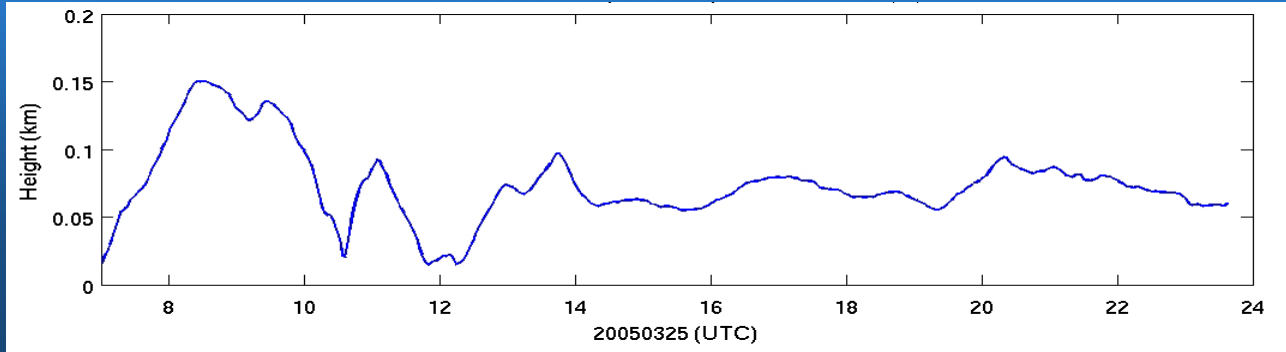

Cloud water path (mm), 10 m winds, 2005-03-25-07:00:00
20 m s-1
37
36.9
36.8
36.7
36.6
36.5
36.4
36.3
36.2
latitude (0)
-98
-97.9
-97.8
-97.7
-97.6
-97.5
-97.4
-97.3
-97.2
-97.1
-97
longitude (0)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05

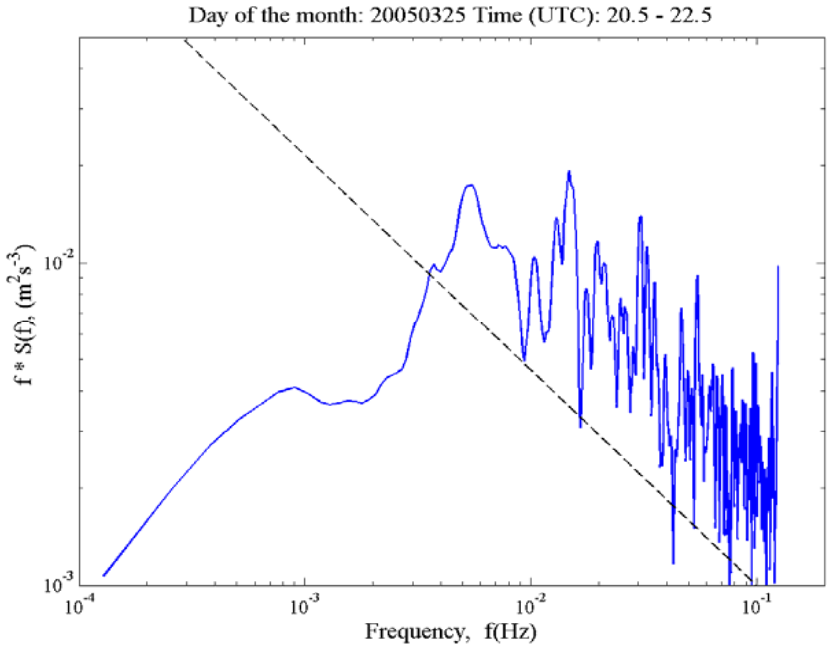
ARSCL Cloud Bounaries

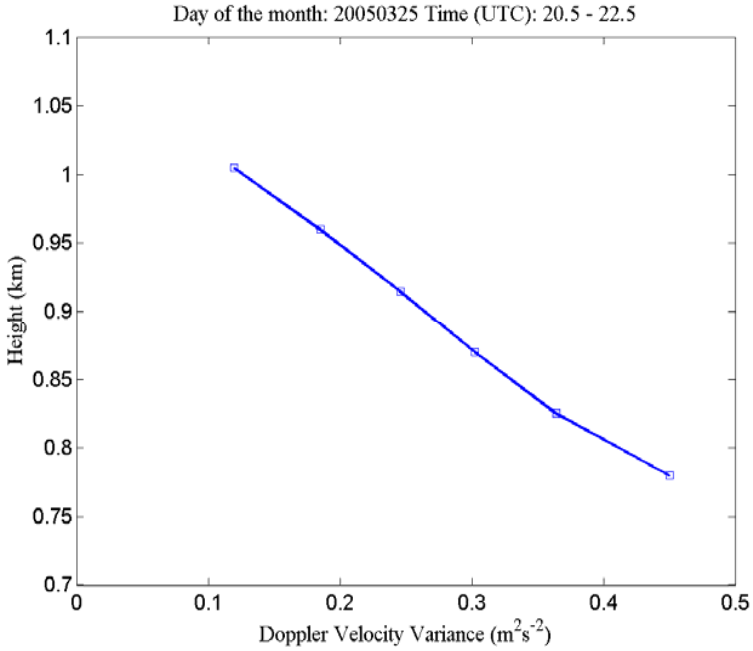


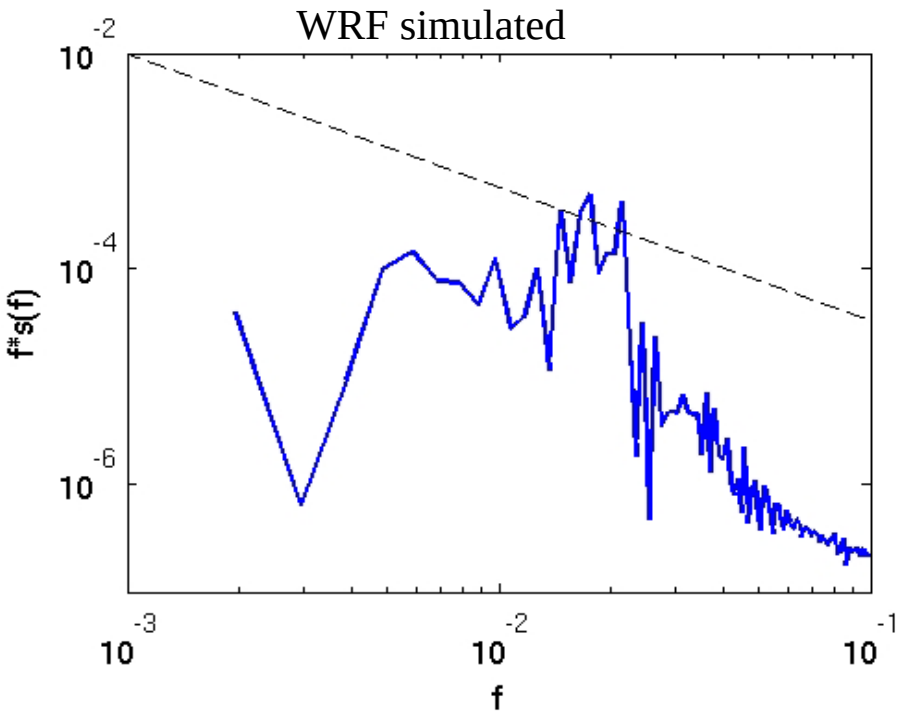


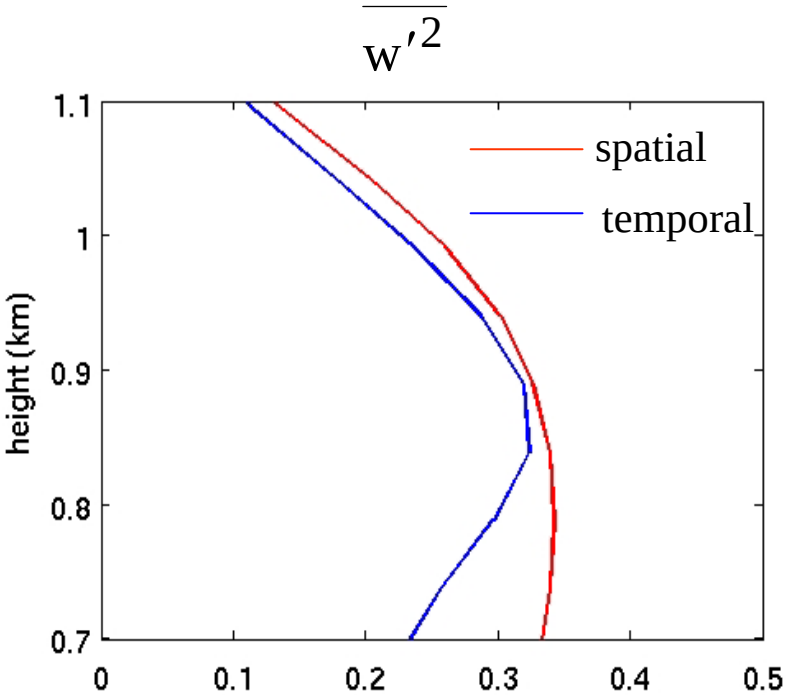





Day of the month: 20050325 Time (UTC): 20.5 - 22.5
f * S(f), (m²s⁻³)
Frequency, f(Hz)


Day of the month: 20050325 Time (UTC): 20.5 - 22.5
Height (km)
Doppler Velocity Variance (m²s⁻²)


WRF simulated
f*s(f)
f


$\overline{w'^2}$
spatial
temporal
height (km)

Multiple two-way nested WRF : ARM LES Test-bed modeling platform

1. WRF-LES
2. Providing forcing data to drive various LES models.

Data assimilation of ARM observations.

1. WRF_SI
2. WRF_3DVAR

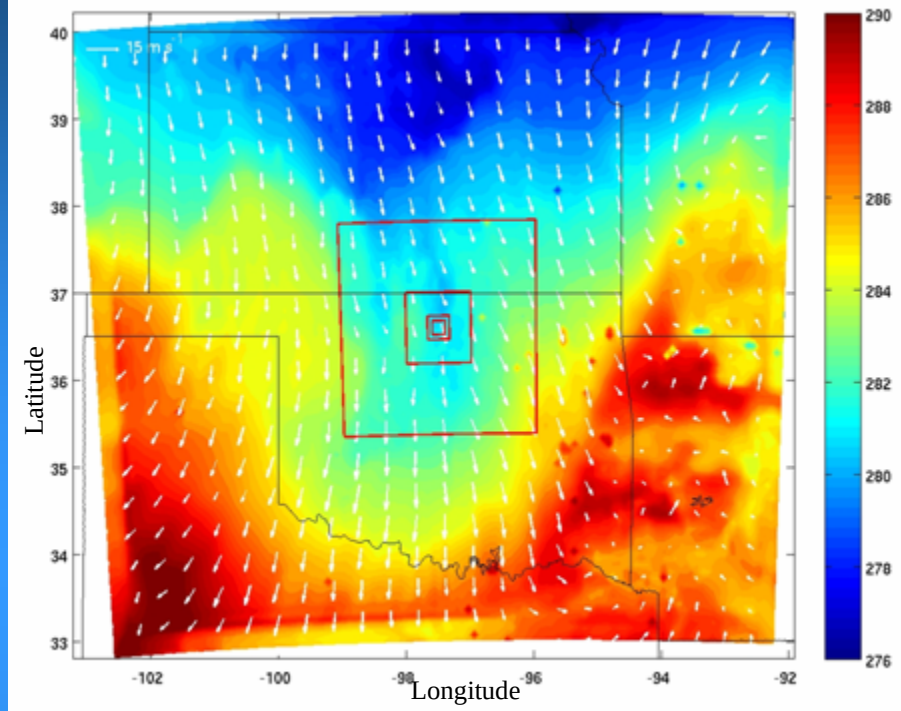
Data can be assimilated:

1. sounding data
2. surface observations
3. radar radial velocities
4. radar reflectivity

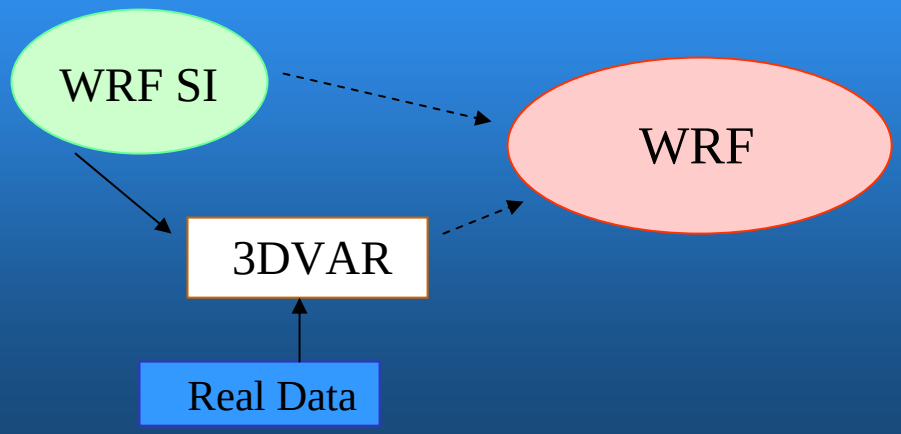
Improvement of 3DVAR

1. radiance assimilation?
2. wind profile data assimilation?

WRF nested domain over SGP site



2 m high potential temperature with 10 m high wind vectors at 11:30 UTC



Model physics

- Microphysics: Thompson et al. (2004) graupel scheme.
- Radiation: RRTM (Rapid Radiative Transfer Model) longwave scheme,
  Dudhia shortwave scheme.
- Boundary layer: Mellor-Yamada-Janjic TKE scheme, Monin-Obukhov scheme.
- Cumulus: Kain-Fritsch scheme (domains 1 and 2).
- Soil model: Noah land-surface model, thermal diffusion scheme for temp only.