Accounting for Uncertainties in NWPs using the Ensemble Approach for Inputs to ATD Models

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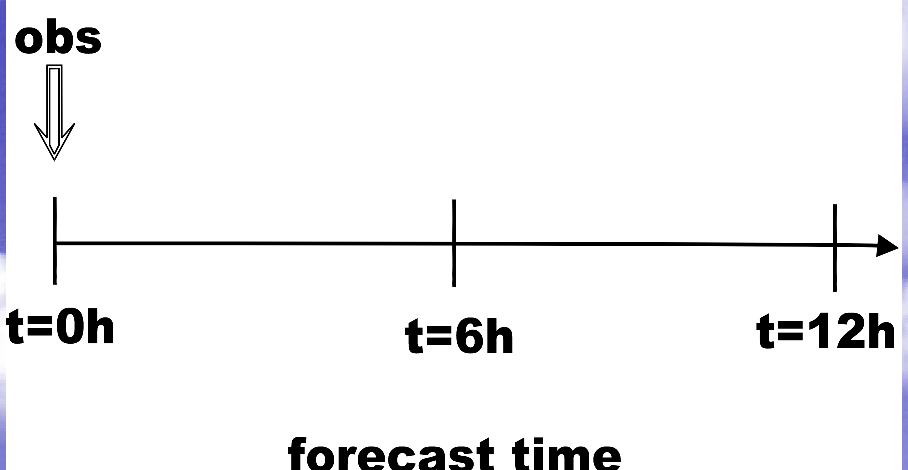
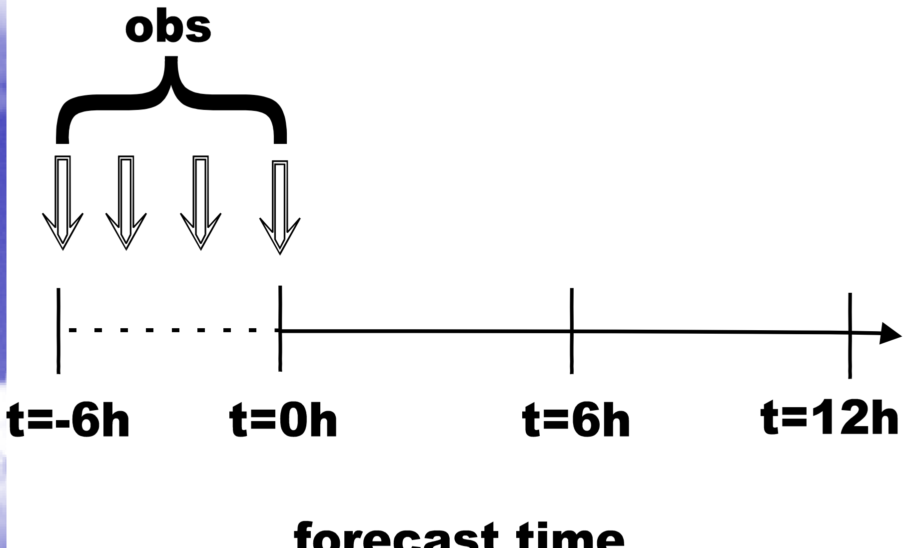
Model (Background) Errors

- Initial conditions / lateral boundary conditions (observation density and errors, data analysis, four-dimensional data assimilation (FDDA))
- Model numerics / resolution
- Model physics (especially subgrid processes which must be “parameterized”)

Cold Start - Static Initialization

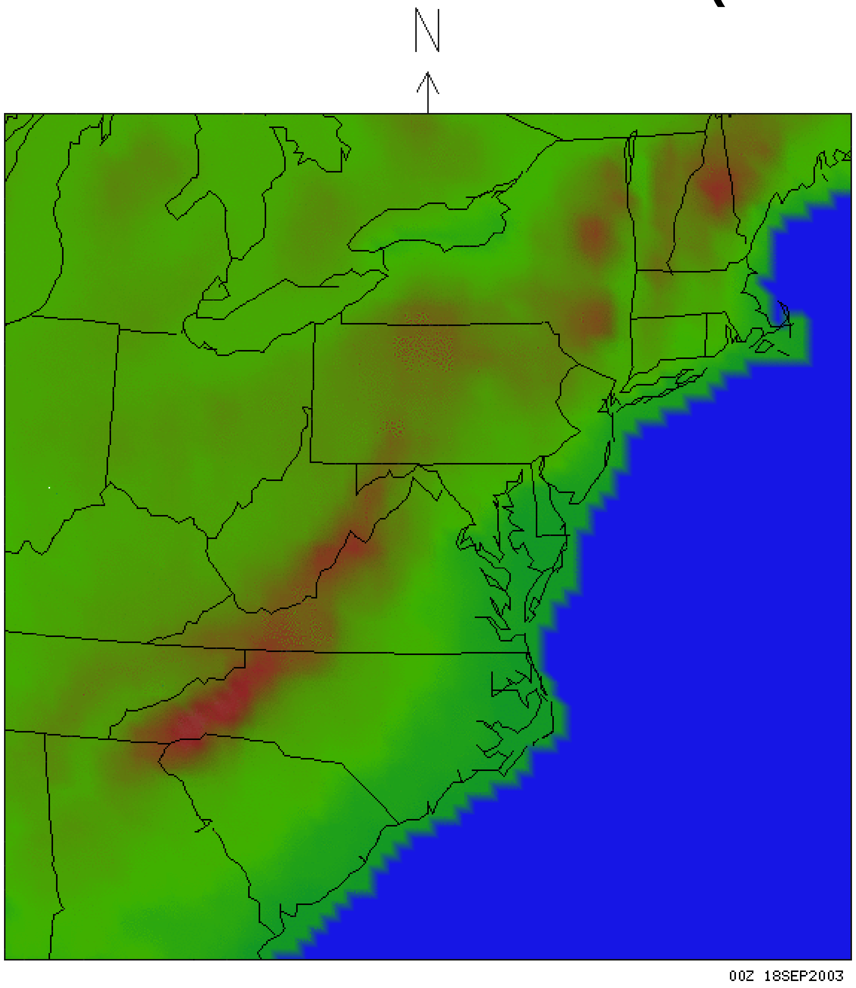


Running Start - Dynamic Initialization

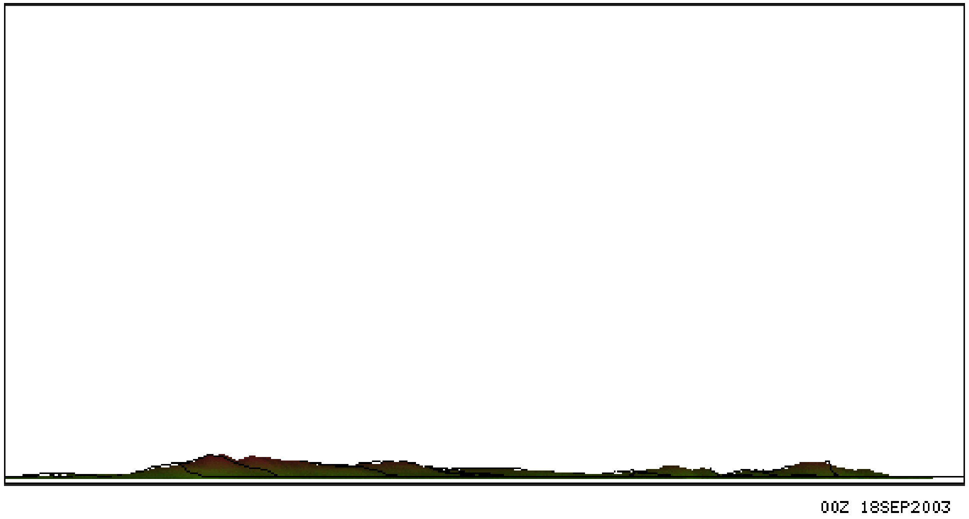


Animations of Cloud Water "Spin Up" from 00 UTC – 12 UTC 18 SEP 2003

(Hurricane Isabel)

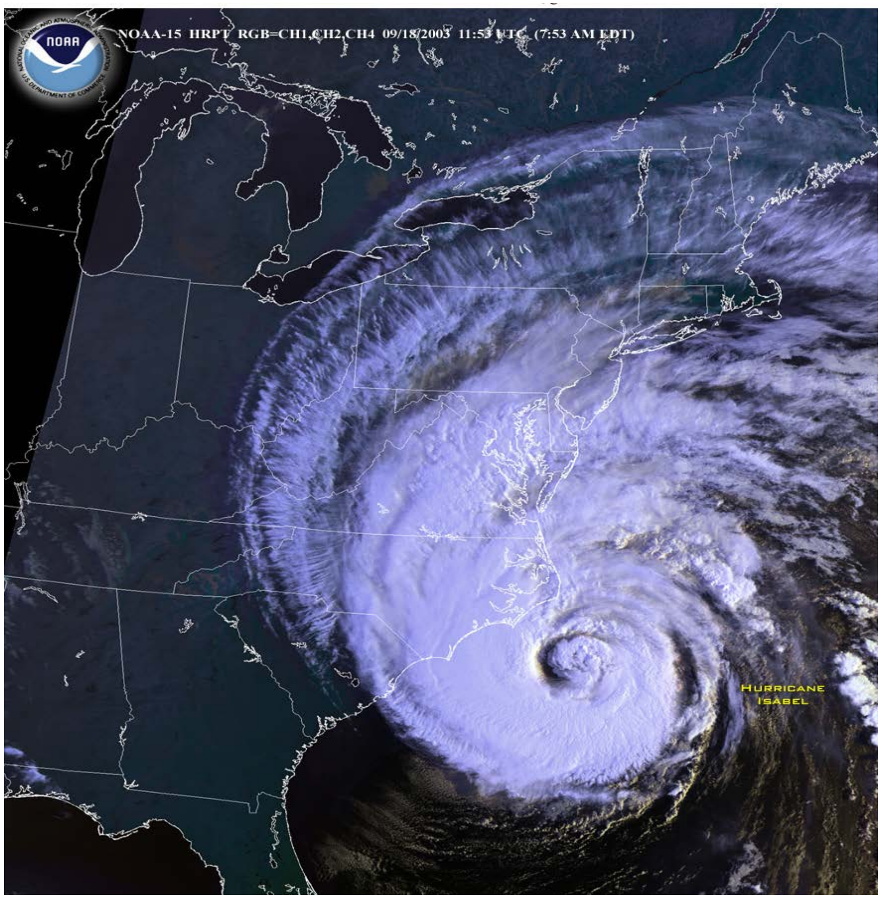


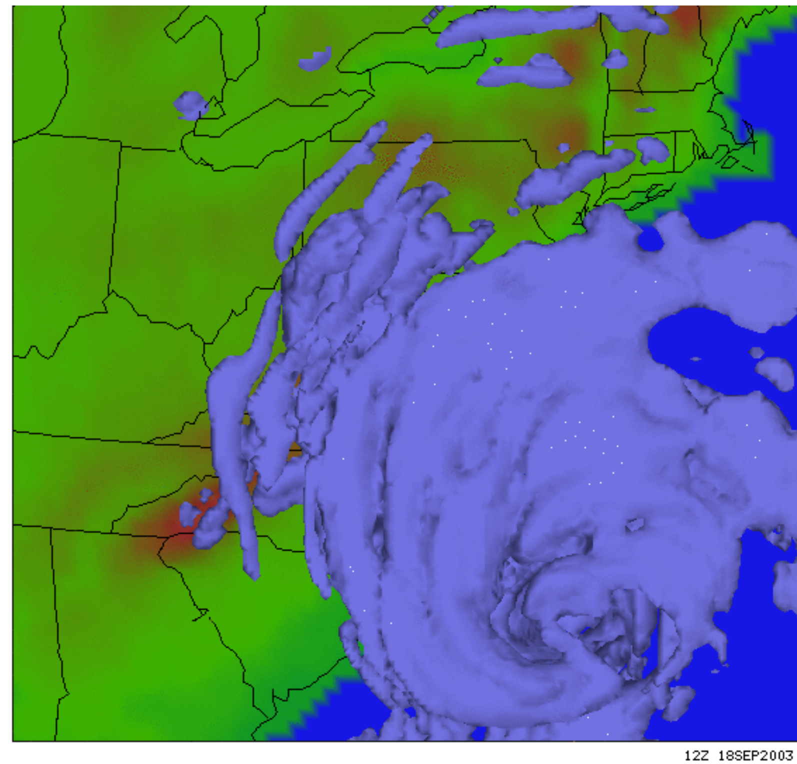
View from Above



View from the South

Observed and Simulated Cloud





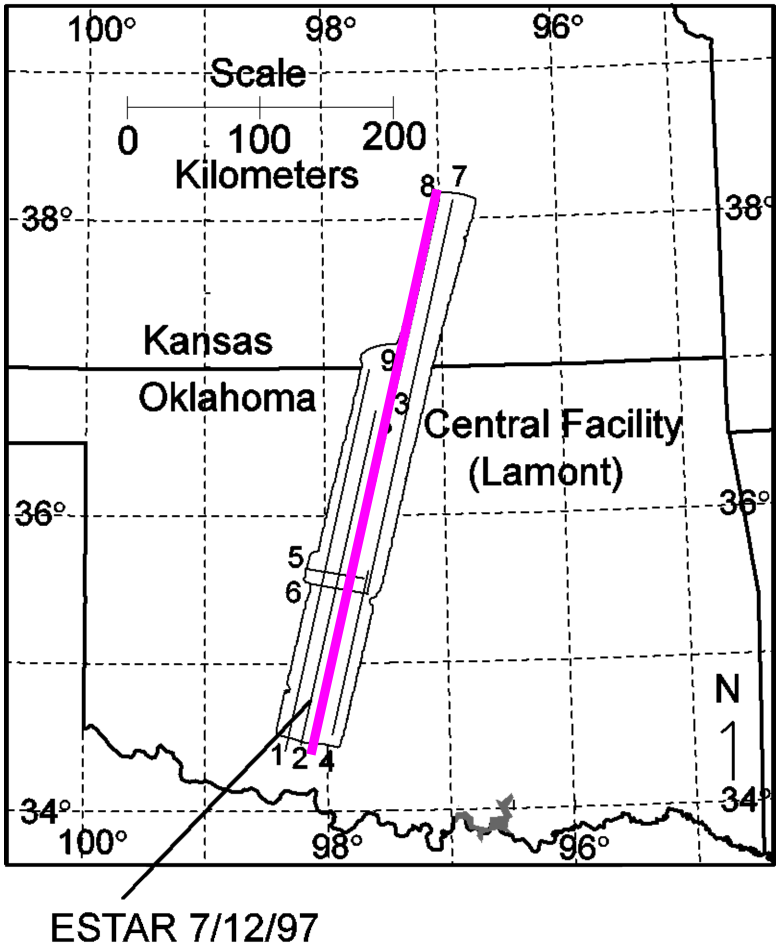
FDDA

Satellite Image Valid at 11:53Z

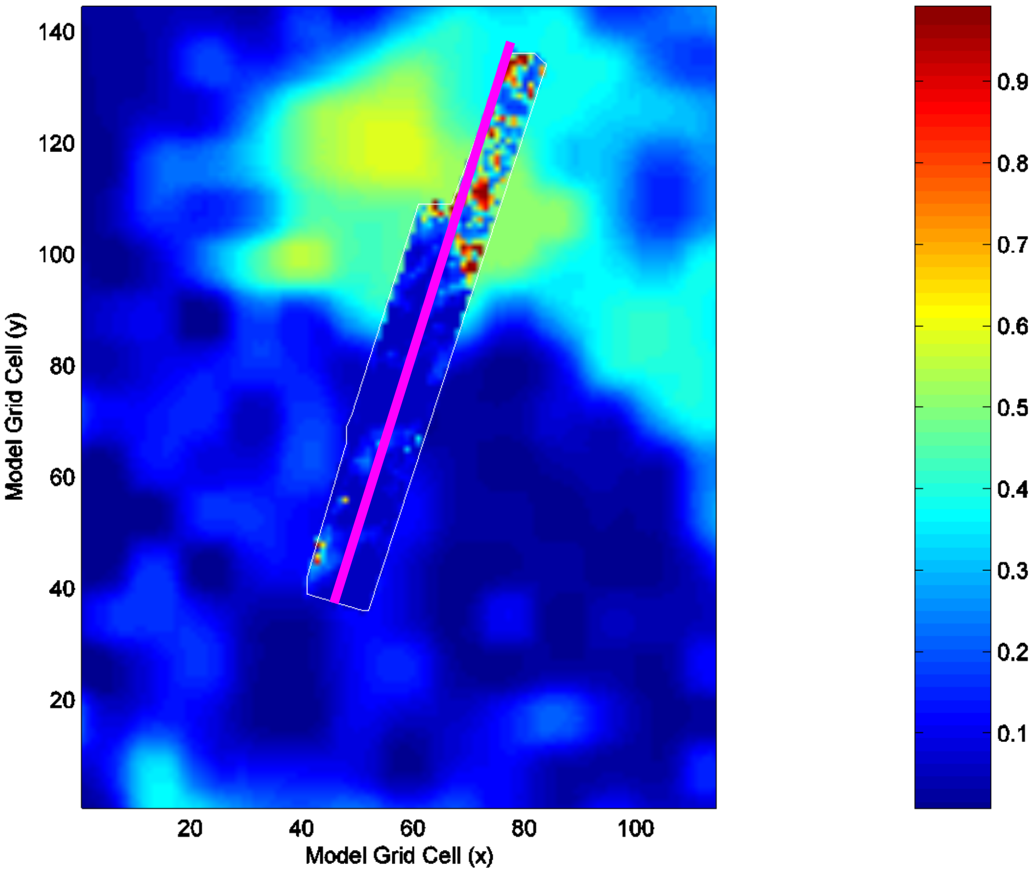
Cloud Water Isosurface Valid at 12:00Z

ATD – Boundary Layer Focus: Soil Moisture Heterogeneity

Areal coverage of 800-m ESTAR soil moisture data and aircraft transects on 12 July 1997 (SGP97).

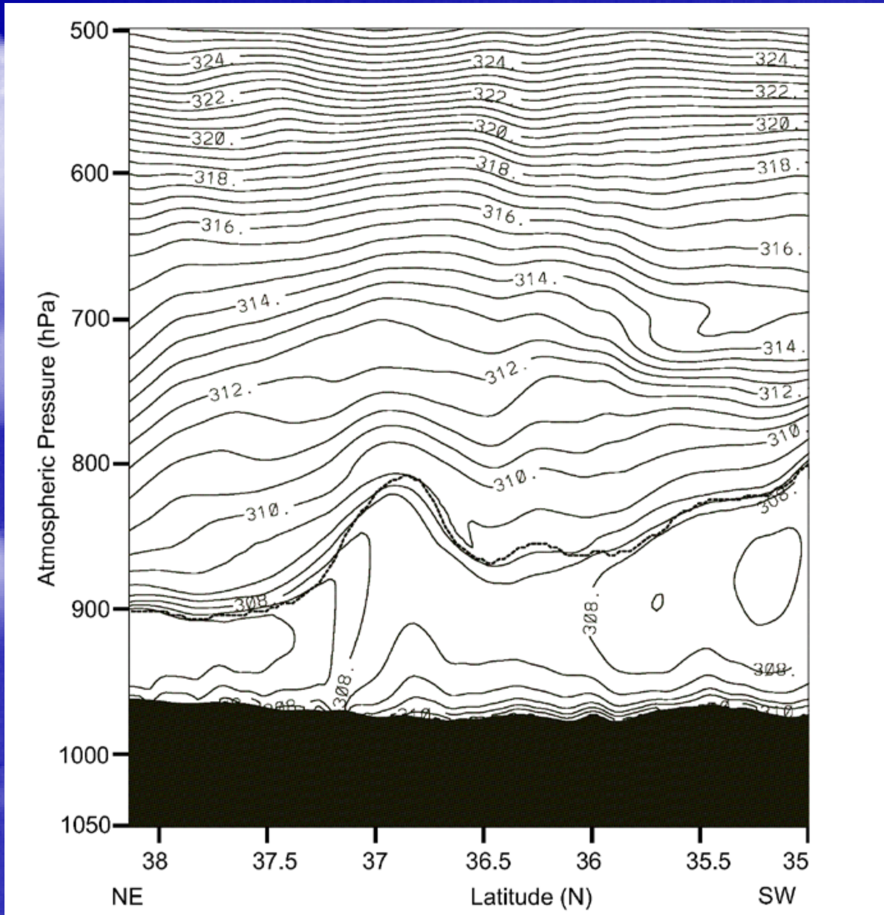


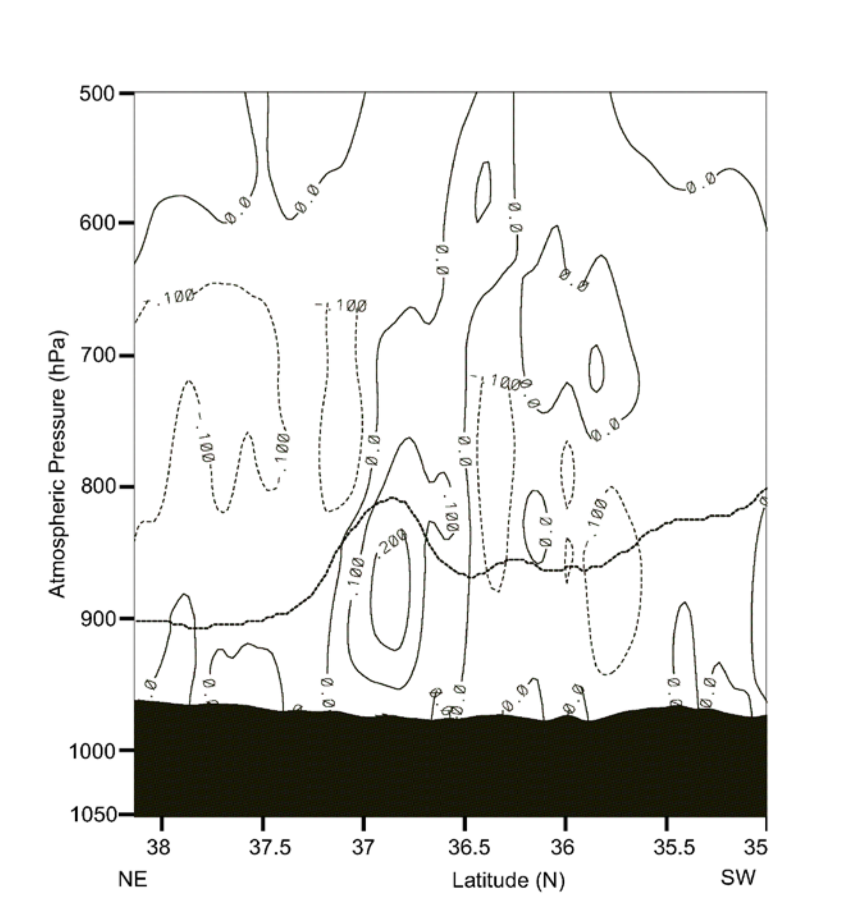
- **Soil moisture availability for the 4-km domain resulting from the use of ESTAR data (outlined region) and offline PLACE land-surface model (LSM) data.**



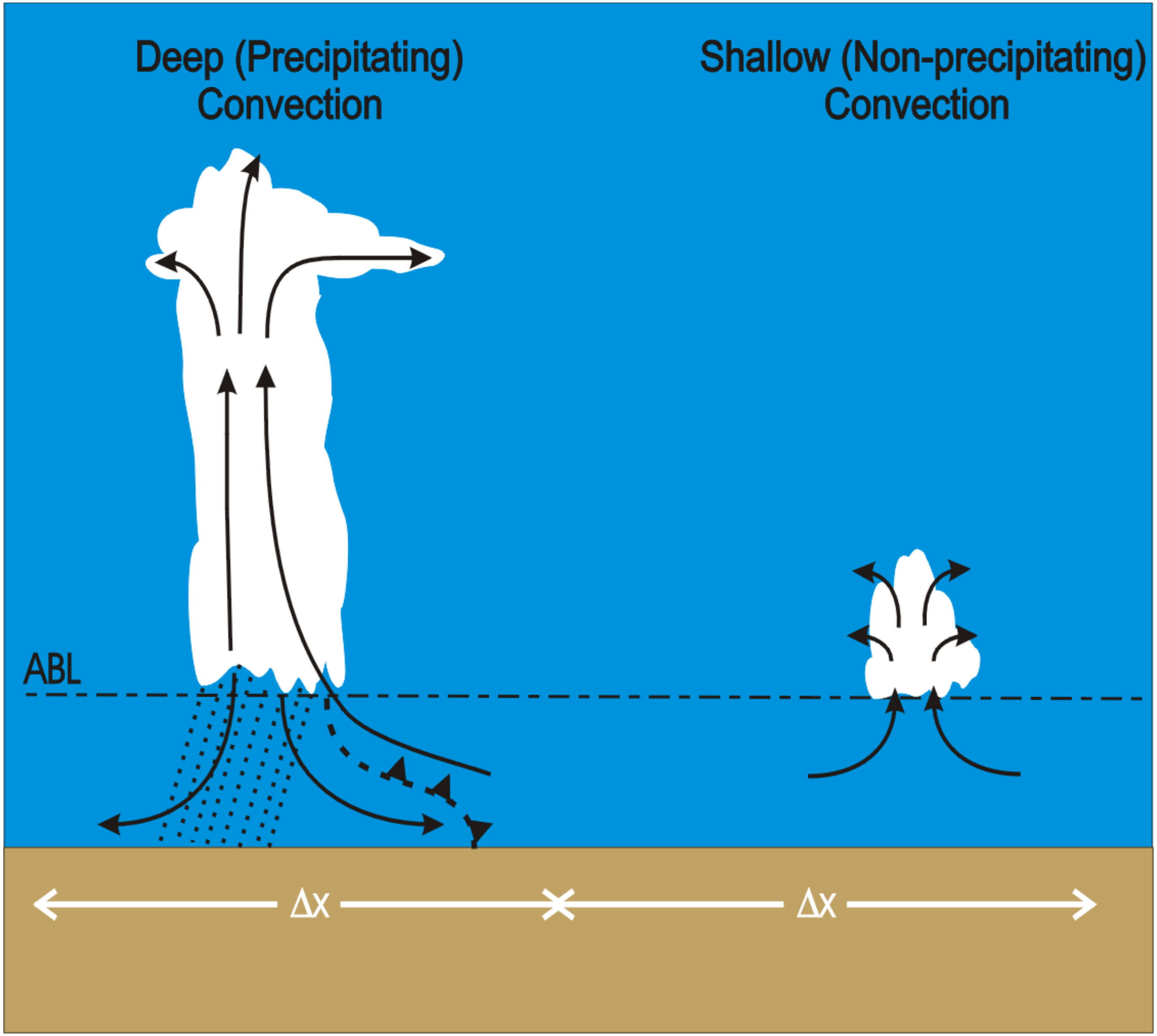
Model-Predicted Cross Section of ABL Structure: Potential Temperature (K) and Vertical Motion (ms^{-1}) (Using High-Resolution Soil Moisture)

Potential temperature (left) is depicted by solid contours (interval of 0.5 K), vertical motion (right) by solid / dashed contours (interval of 0.1 ms^{-1}), and top of the model-predicted ABL by the heavy contour in both figures.





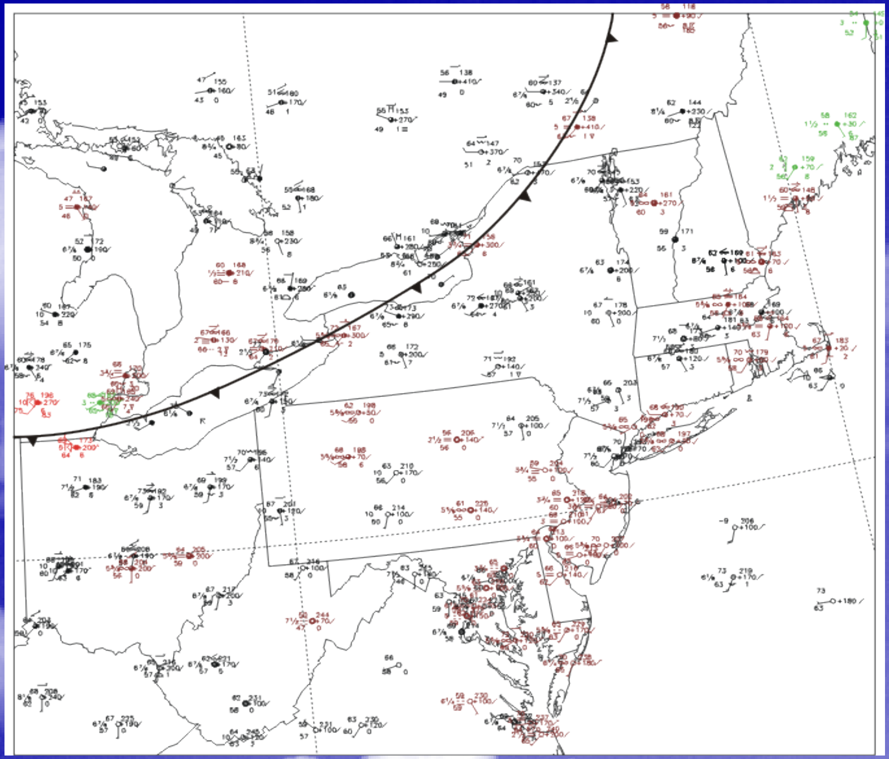
ΔX=>0: To parameterize or not to parameterize?

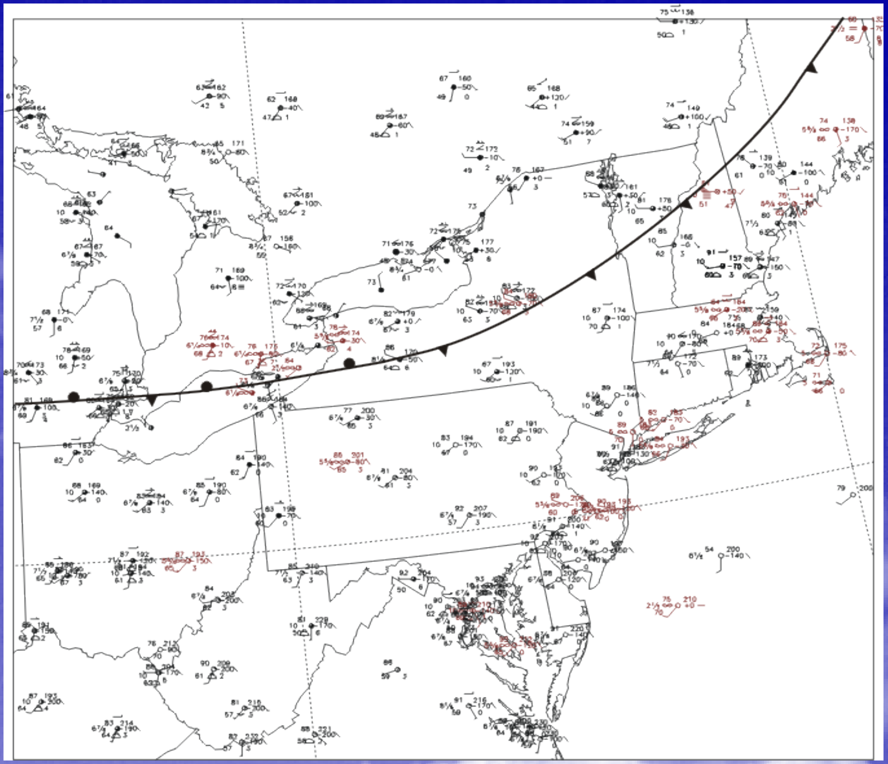


Stauffer and Deng (2004)

Observed Surface Conditions

12 UTC, 19 Sept. 1983 (24 h) 18 UTC, 19 Sept. 1983 (30 h)

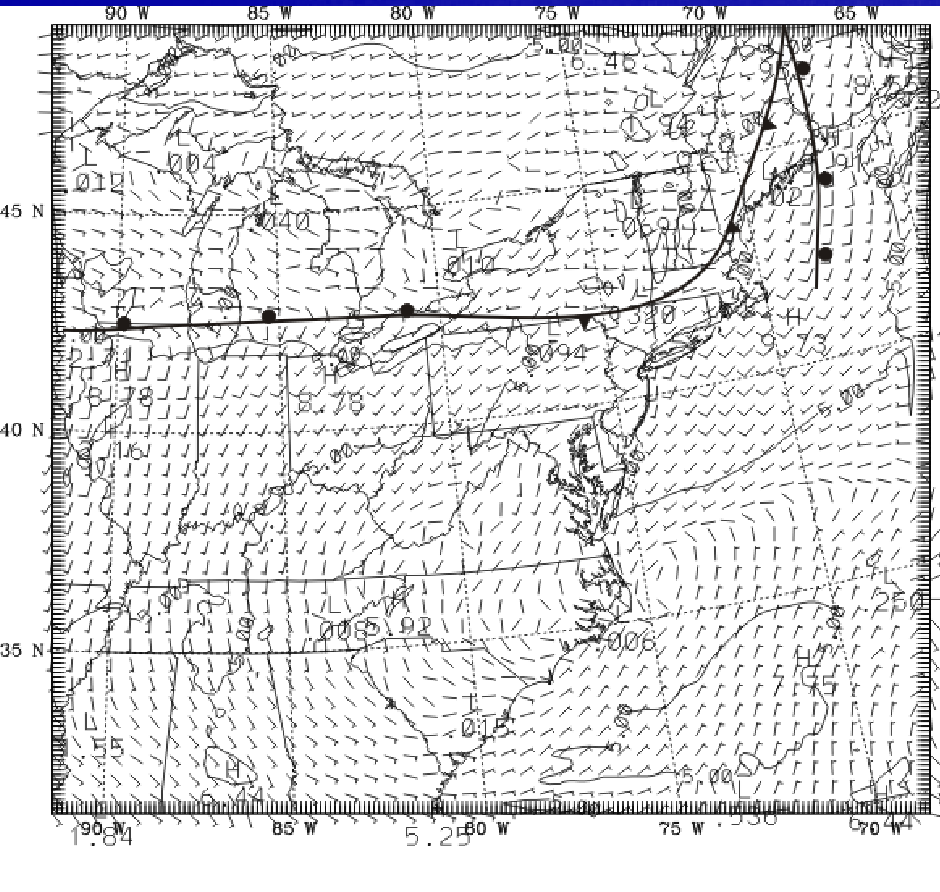




MM5-Simulated Surface Wind Fields at 1800 UTC, September 19, 1983 (30 h)

12 km

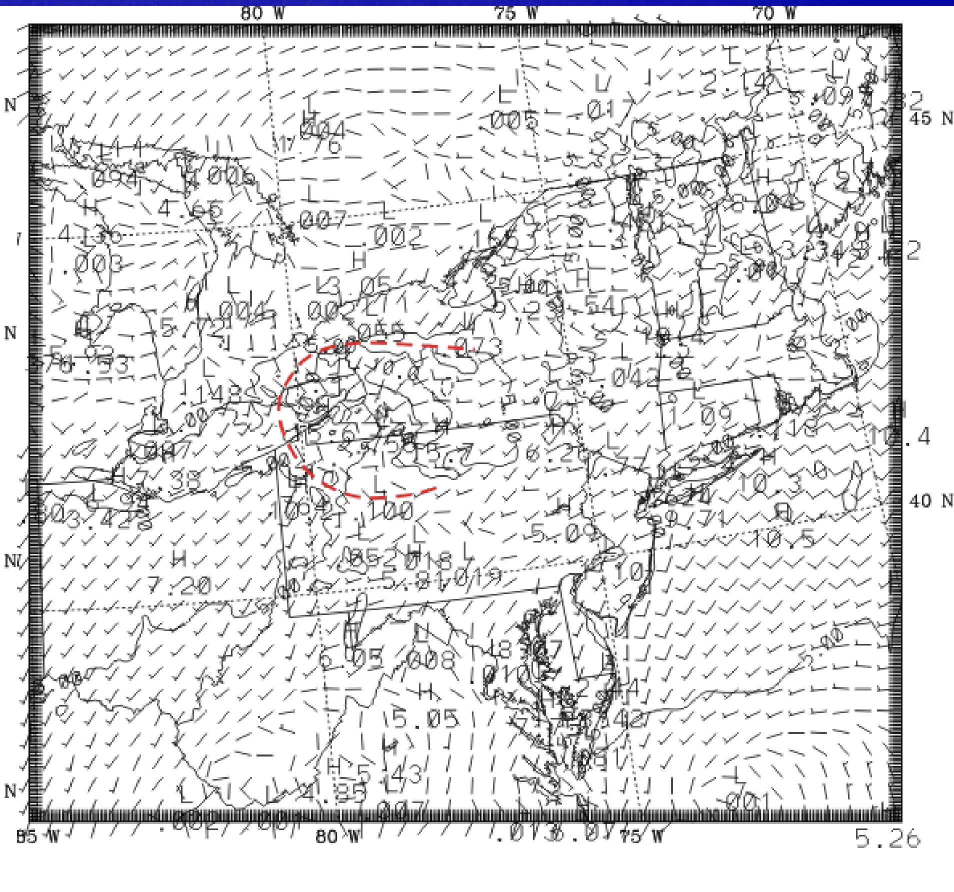
(Convective Parameterization)



MM5V3−CAPTEX EXP2D, 12km, KF, FDDA

4 km

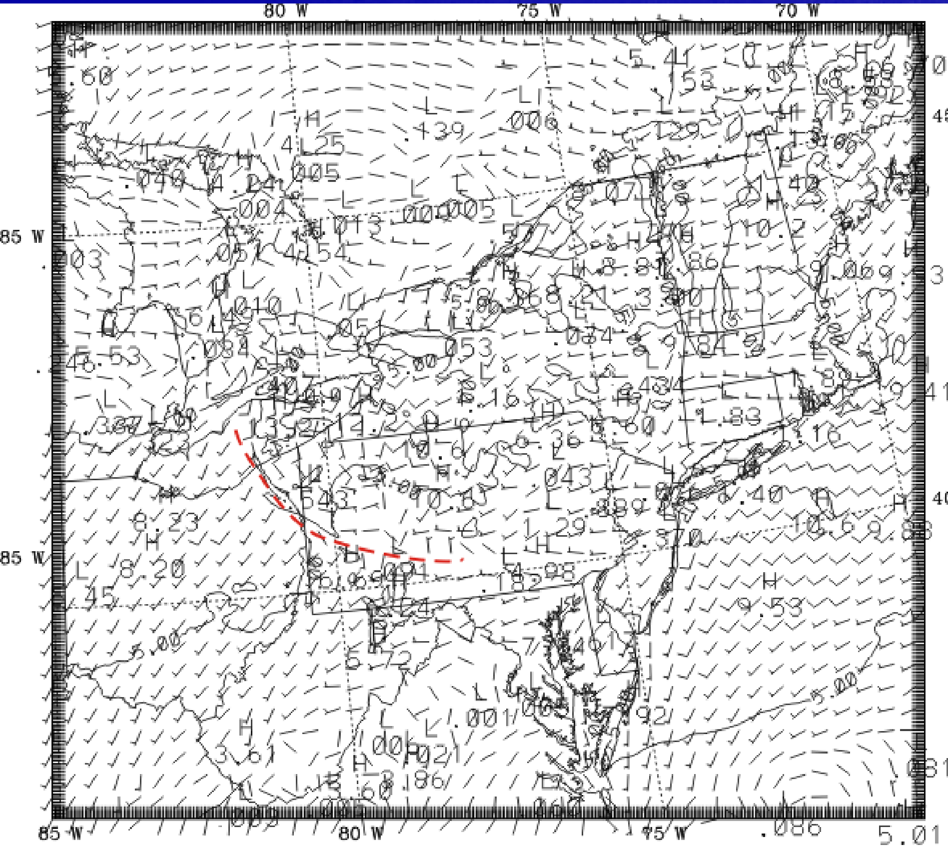
(No Convective Parameterization)



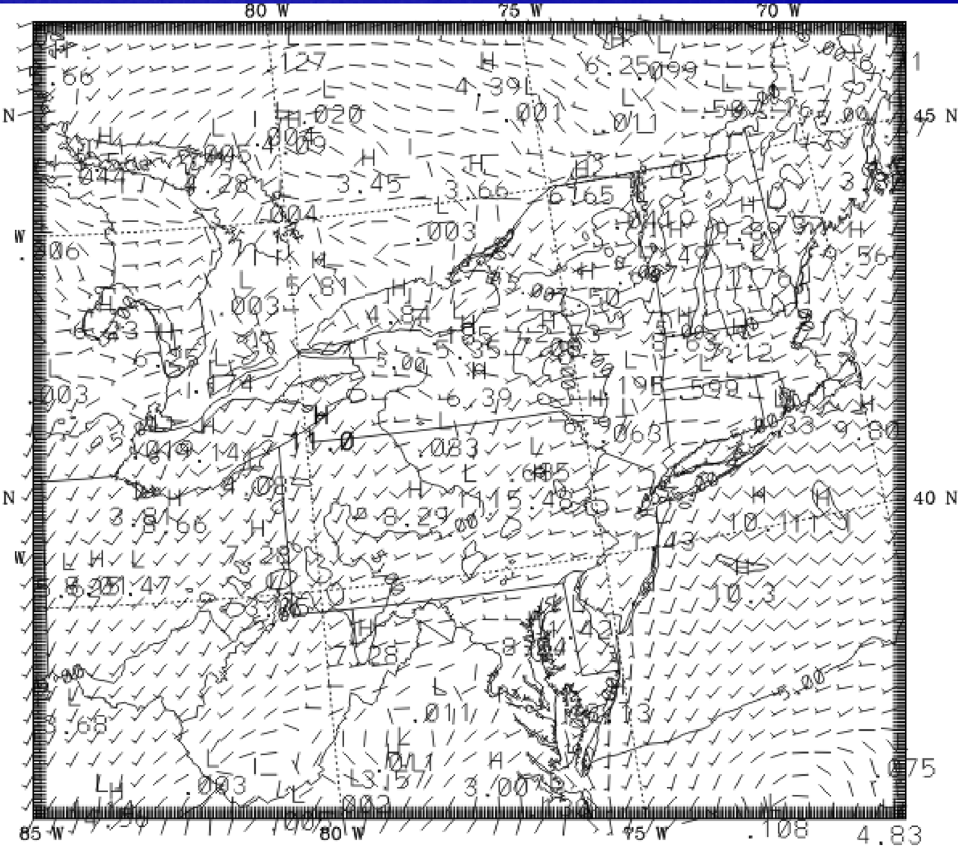
MM5V3−CAPTEX, EXP 3A, 4km

MM5-Simulated Surface Wind (m/s) on the 4-km Domain at 1800 UTC, September 19, 1983 (30 h)

MS2 (Enhanced Kz) **MS5 (KF Convective Parameterization)**

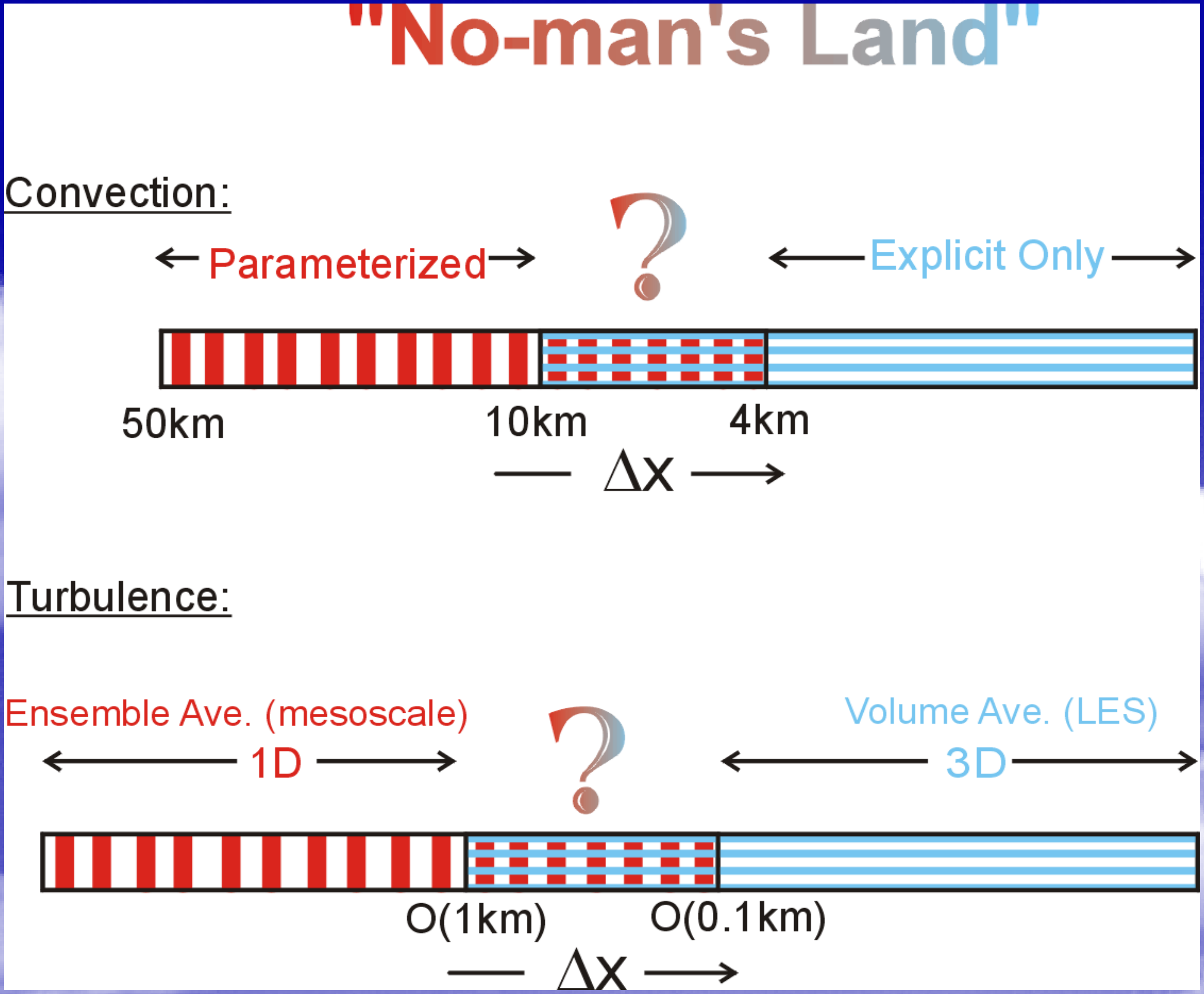


MM5V3-CAPTEX ms2, 4km, 2k

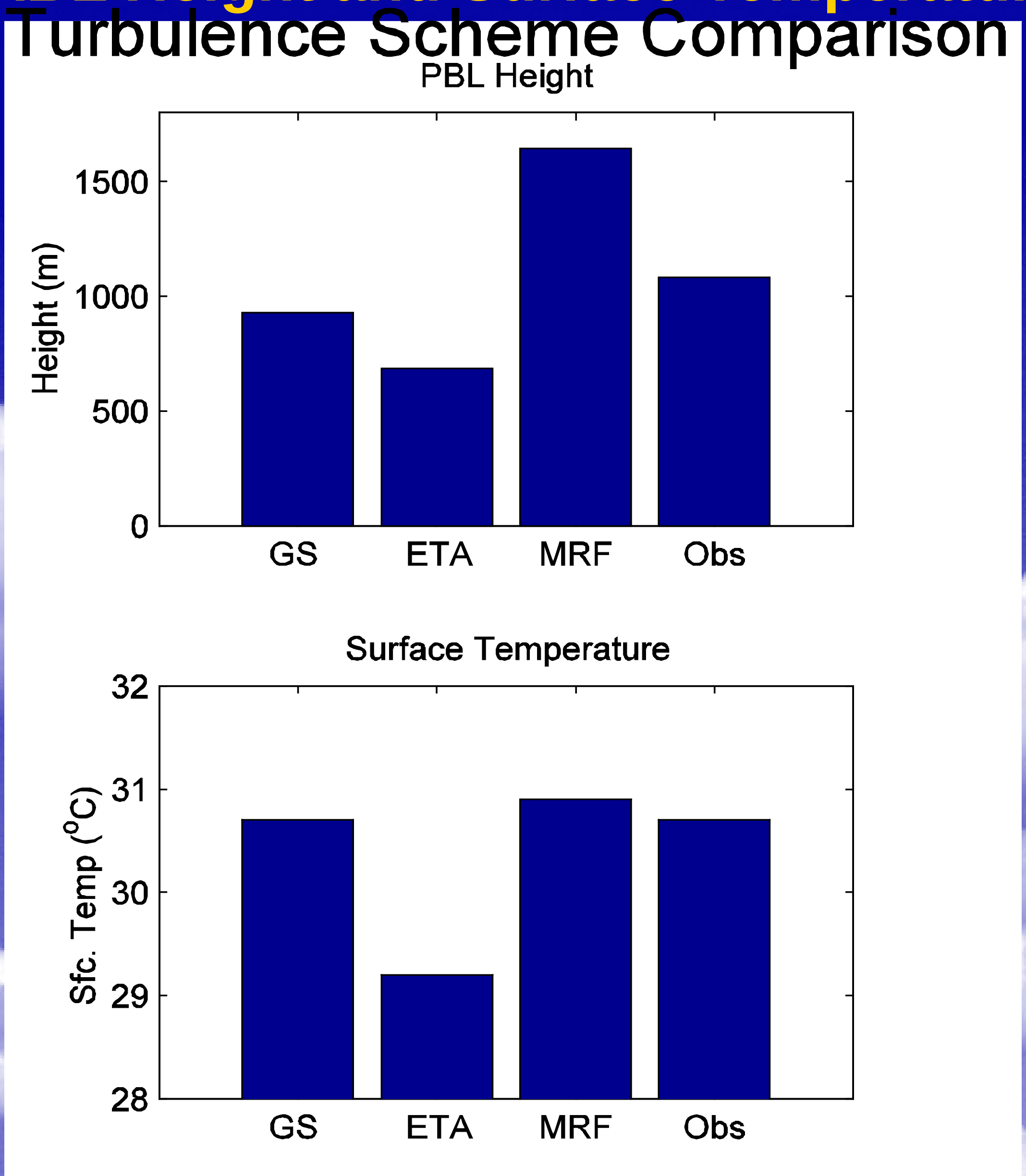


MM5V3-CAPTEX ms5, 4km, 2K, KF2

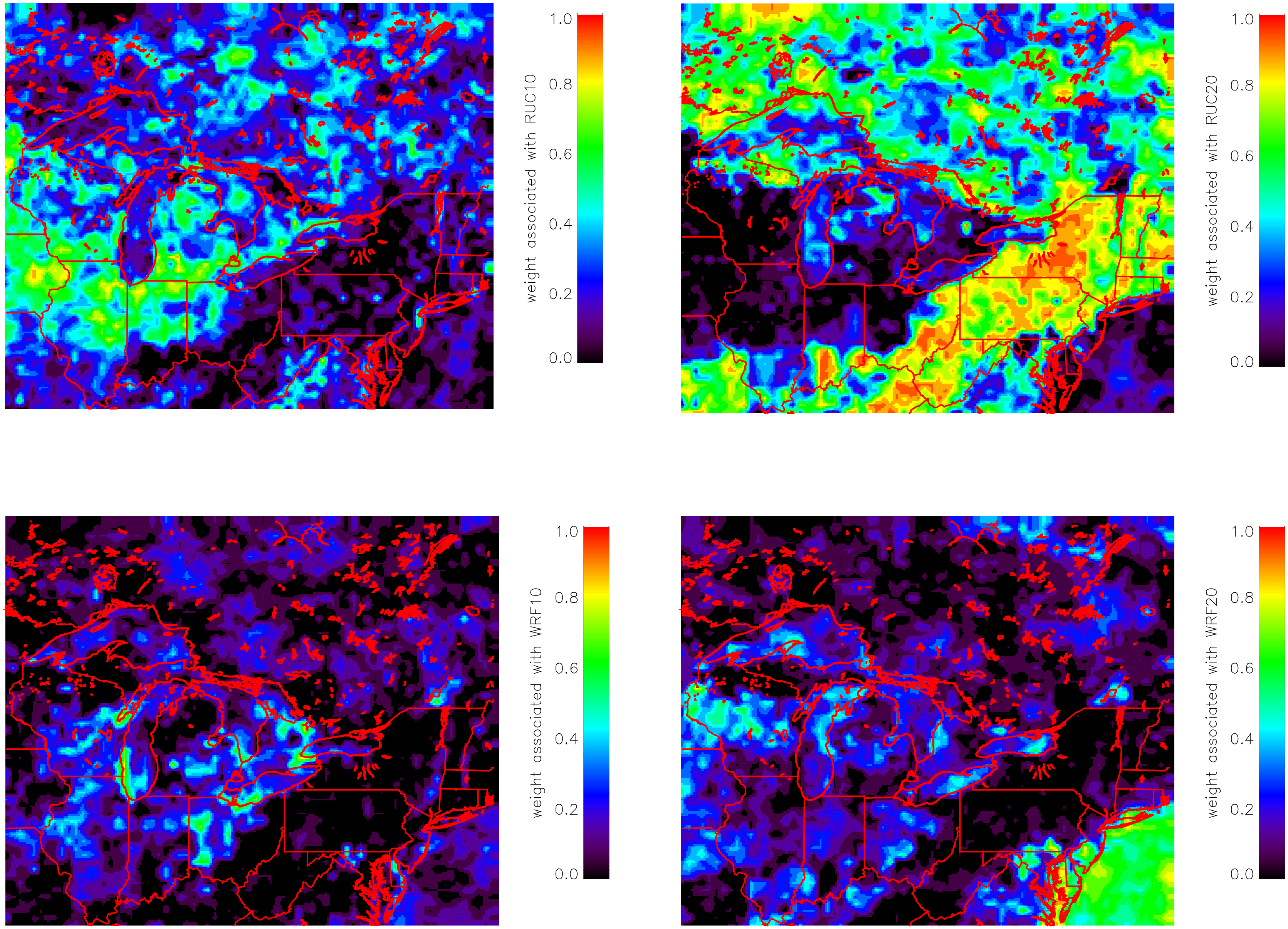
Physics Parameterization



Ensemble Approach: Initial Condition / Physics Diversity
Turbulence Parameterizations
(ABL Height and Surface Temperature)



Bayesian Model Averaging: Calibrated Ensemble (See 6.6)



Weights for 10 meter wind (U,V components)

SUMMARY

- MET model uncertainties are caused by errors in model initialization / spinup, model numerics / resolution and model physics / parameterizations

- MET model grid resolutions should be chosen carefully to avoid those scale ranges where problems exist with the underlying assumptions for parameterized convection and turbulence. New hybrid approaches are required in these scale ranges.

- ATD models must make more effective use of 1) the MET model outputs (minimize interpolation errors, apply temporal averaging to remove transients, use MET model consistent physics / MET model turbulence profiles) and 2) MET model uncertainty information (ensemble-based large scale variances, length scales)

- MET model ensembles / statistical methods (e.g., Bayesian Model Averaging) are an effective means of quantifying the MET uncertainties for ATD models, but they must focus on the boundary layer.