SENSITIVITY OF NEAR-SURFACE METEOROLOGICAL FIELDS IN WRF TO BOUNDARY/SURFACE-LAYER PARAMETERIZATIONS IN CONJUNCTION WITH HORIZONTAL GRID SPACING.

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Outline

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- Experimental Design
- Meteorological Cases
  - Results
- Summary

Motivation

- Atmospheric models using fine-scale grids with horizontal spacing of 1 to 4 km are increasingly popular in both research and operational applications.
- However, adequate modeling of atmospheric flow features within the corresponding scale ranges presents a problem because these features are often within the maximum energy-containing spectral interval, so they are neither explicitly resolved on the grid nor represented statistically as the subgrid motions.
- As a result, the ability of mesoscale models, such as the Weather Research and Forecasting (WRF) Model, to accurately reproduce atmospheric phenomena on such fine spatial scales is questionable, particularly in terms of near-surface flow, turbulence, and land-atmosphere interaction parameters.

Experimental Design

- In this study, WRF model (v3.0.1) output was compared with observational data and output from a University of Oklahoma large eddy simulation (OU-LES) code for meteorological conditions corresponding to a dry atmospheric convective boundary layer (CBL) developing over the Great Plains.
- OU-LES run in numerical domain of 51.1x51.1x4 km^3 with horizontal spacing of $\Delta x = \Delta y = 100m$ and vertical spacing of $\Delta z = 50m$.
- Three simulation domains for WRF employed horizontal grid spacings of $\Delta x = \Delta y = 1km$, 2km, and 4km with 41 vertical levels.
- Meteorological fields predicted by WRF over the OU-LES domain are extracted to enable a local comparison of near-surface atmospheric parameters.

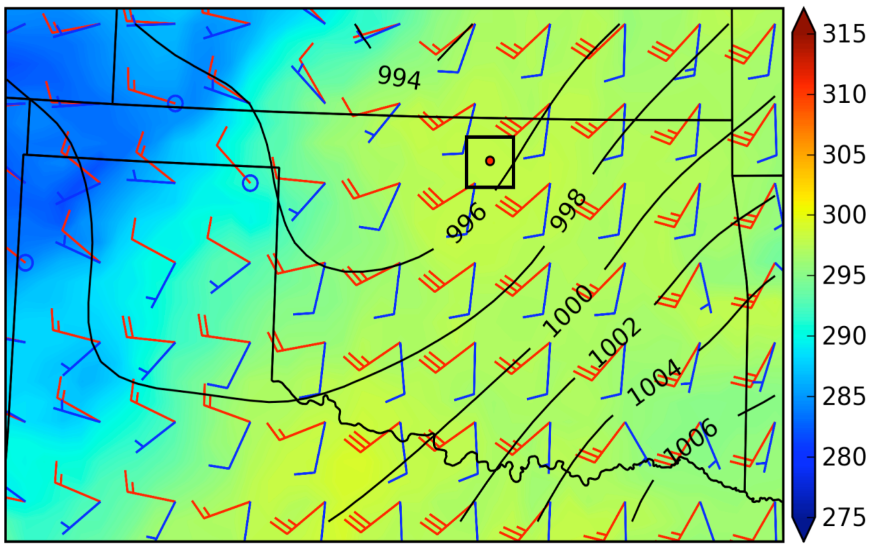
Experimental Design

- Horizontal means of each field were taken within the OU-LES domain and then temporally averaged to produce hourly means.
- WRF output and observational data were vertically interpolated to OU-LES grid.
- WRF model runs employed 12-hour warm start to account for spin-up.
- OU-LES solutions were nudged with RUC soundings using a simple force-restore method.

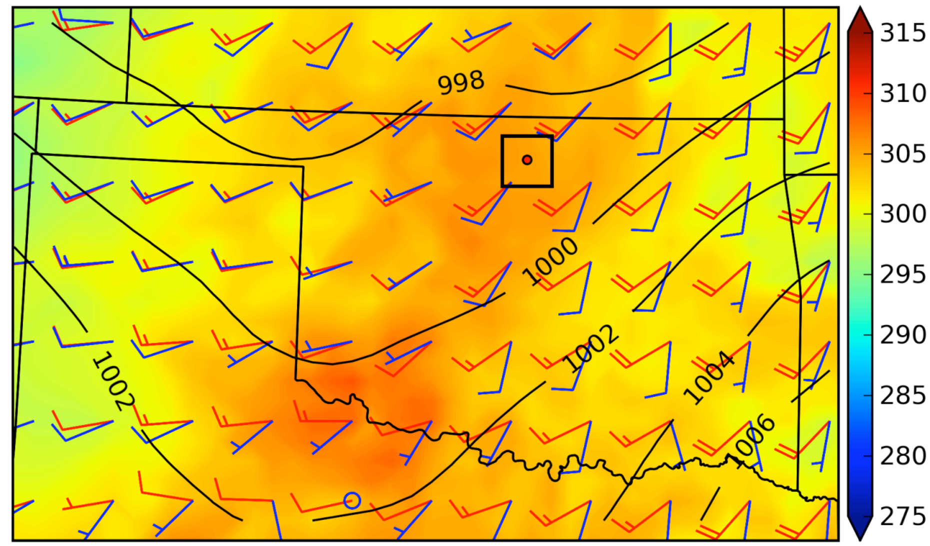
$$\left(\frac{\partial \varphi}{\partial t}\right)_{nudge} = -\left(\bar{\phi}_{LES(t-1)} - \bar{\phi}_{RUC(t-1)}\right)\Delta$$

Dry Line Case

June 7 – 12 UTC



June 7 – 18 UTC



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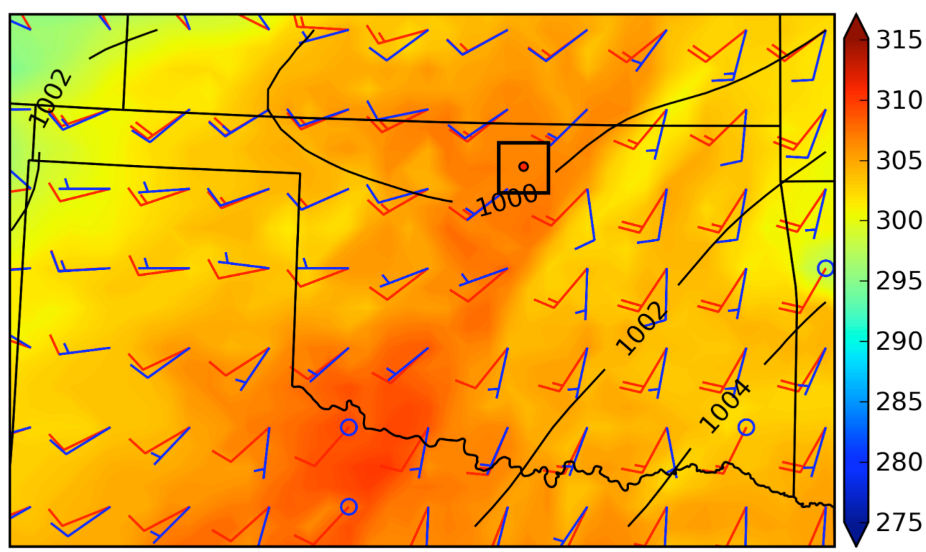

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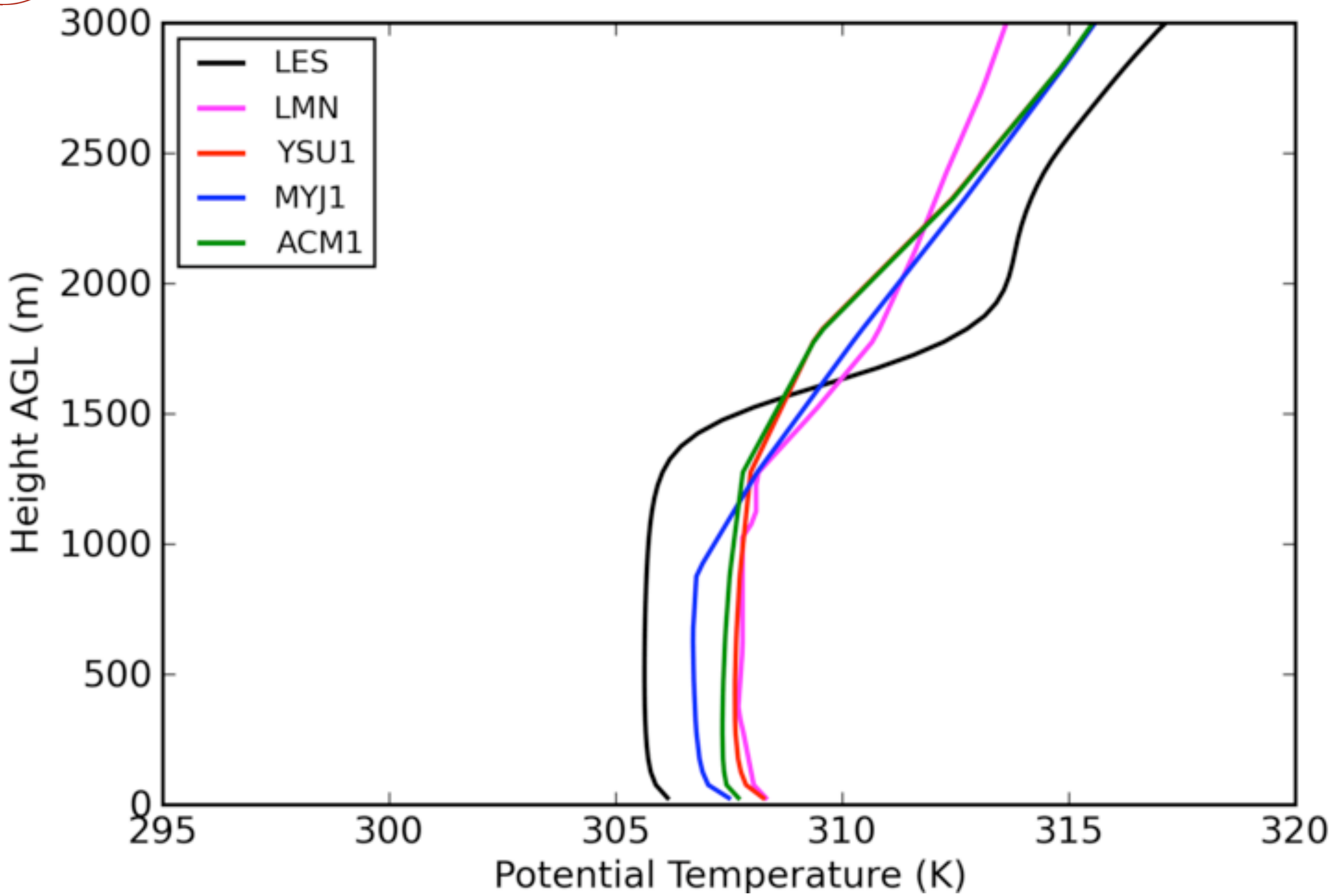

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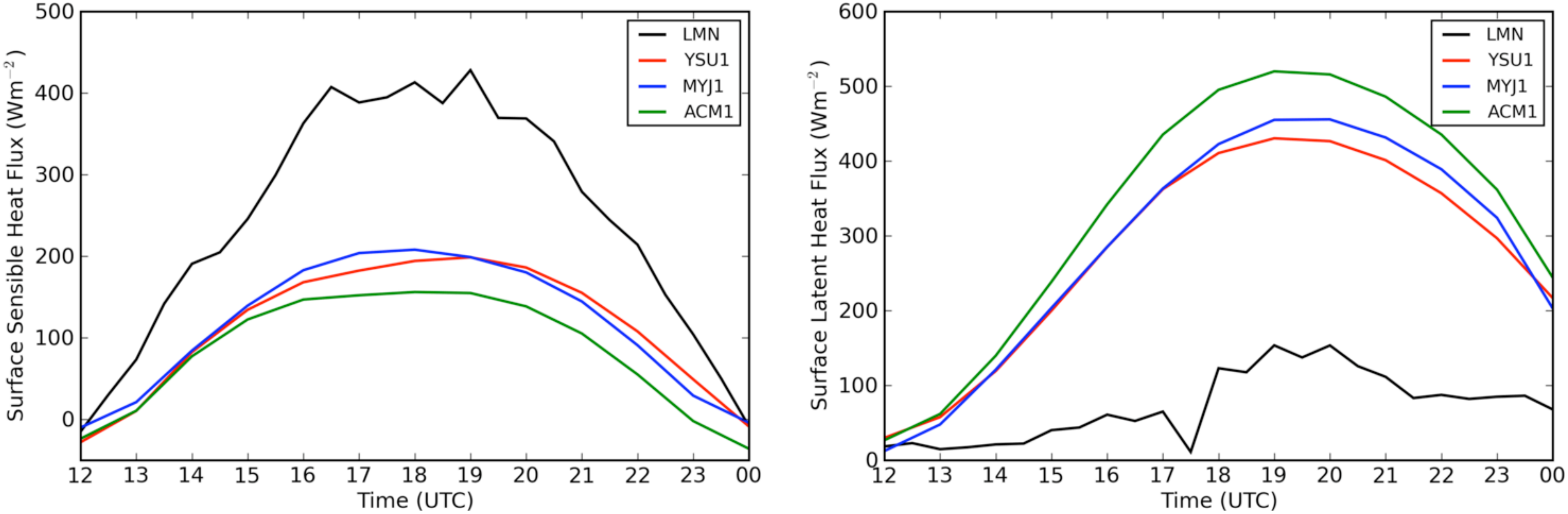

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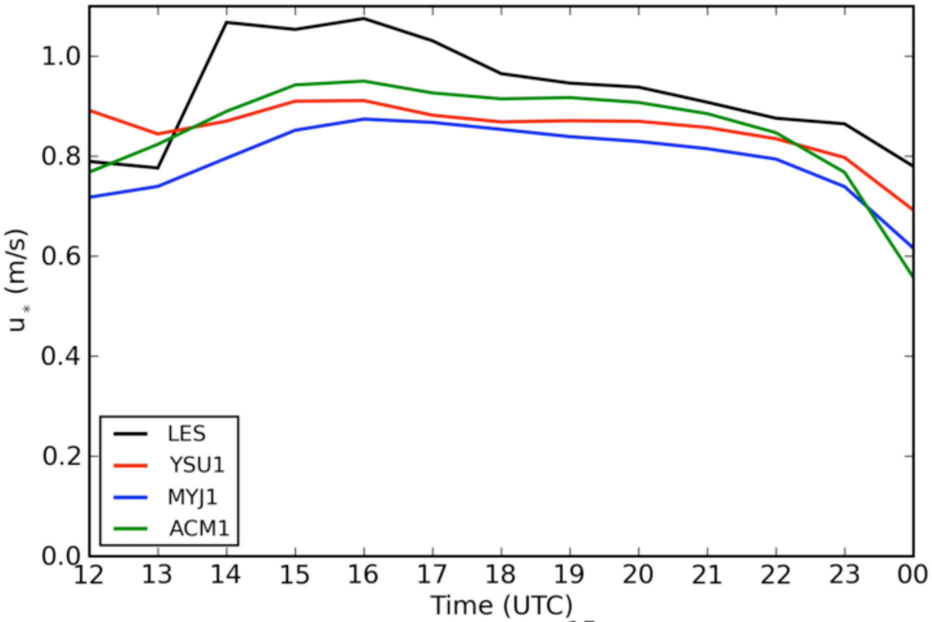

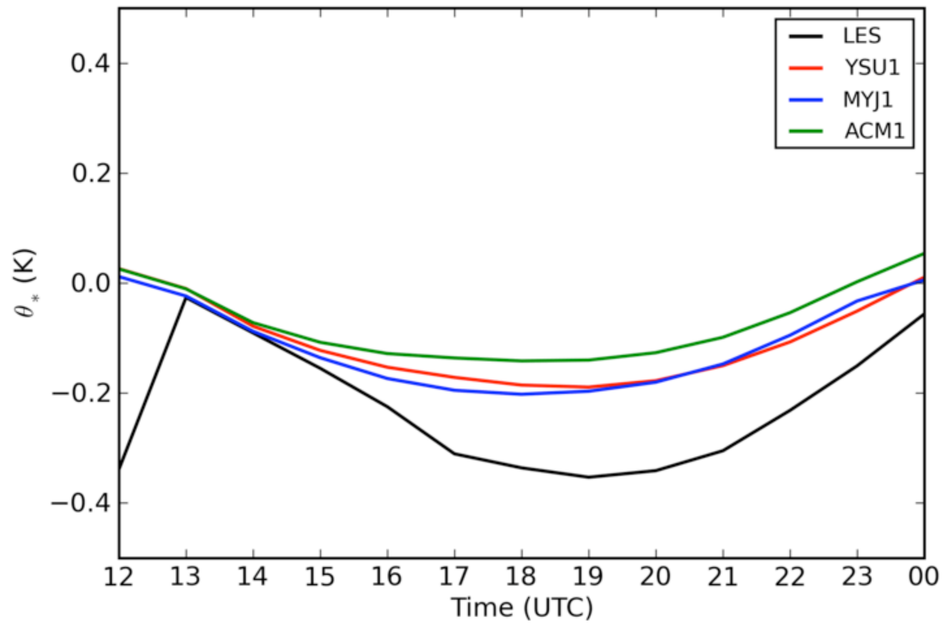

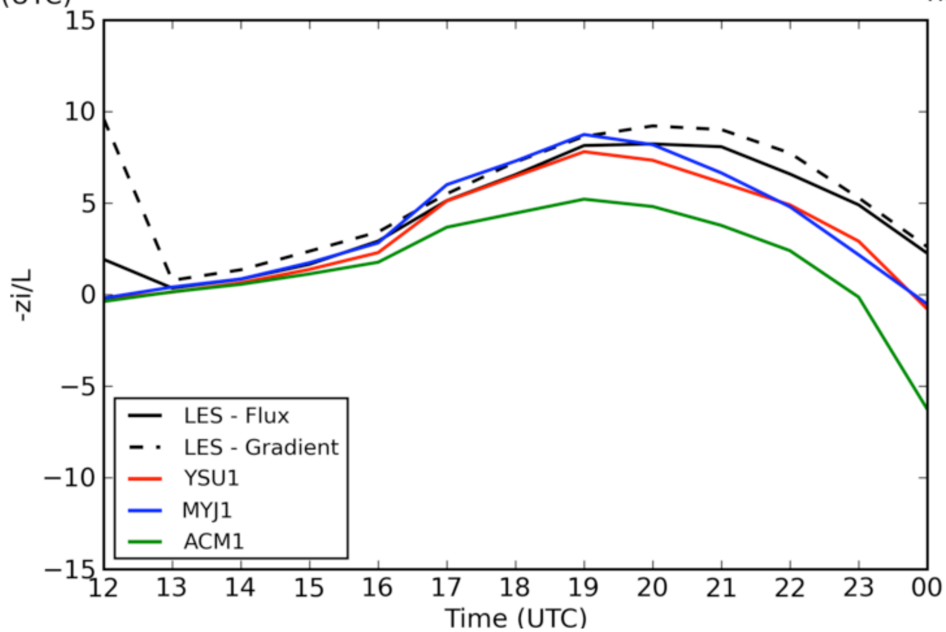

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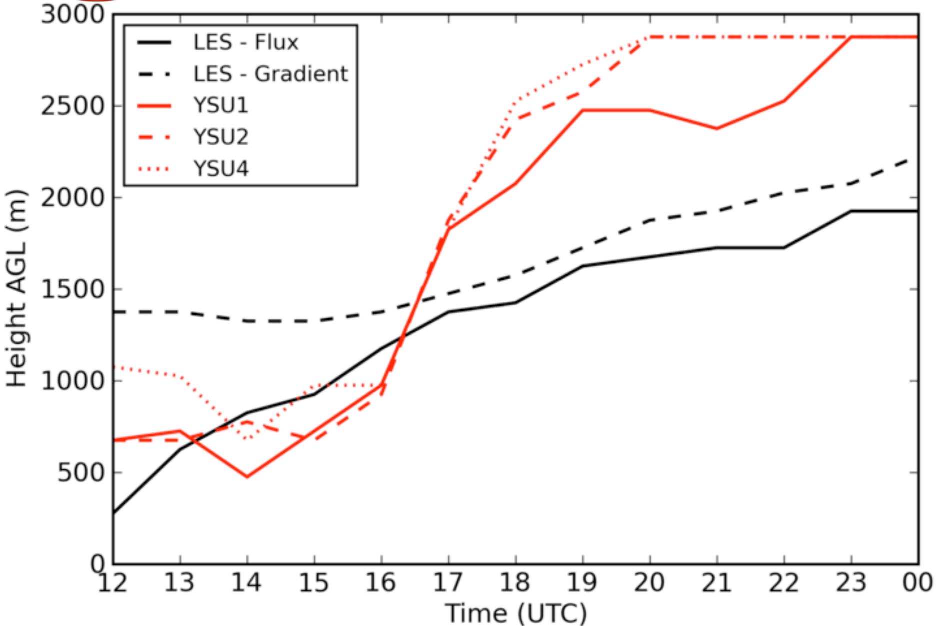
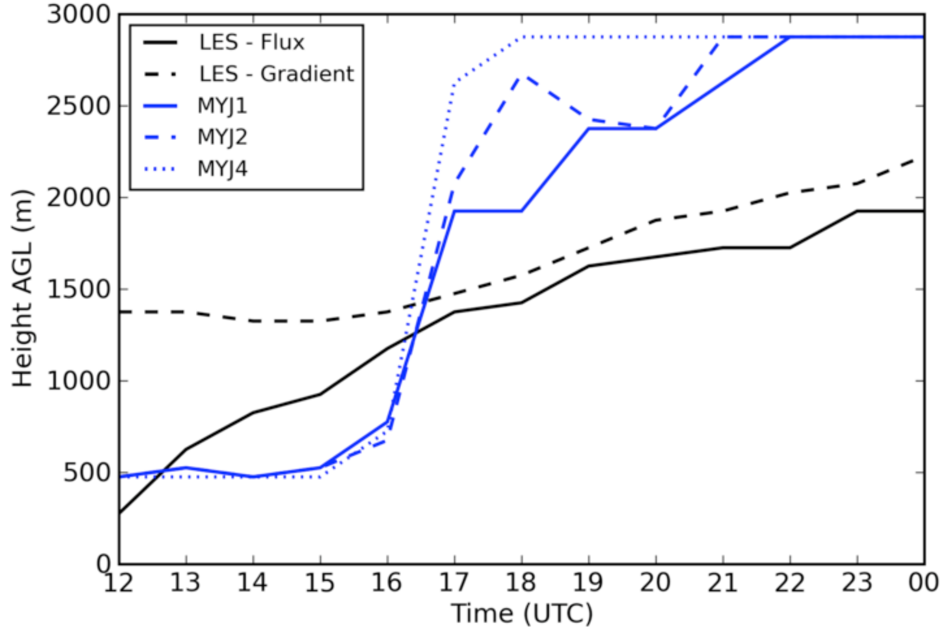
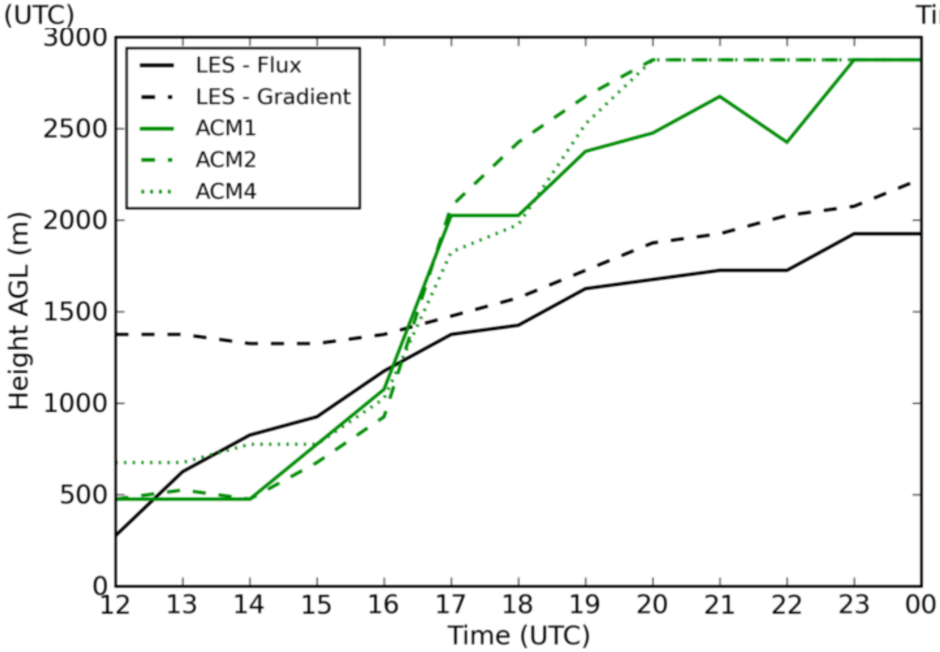
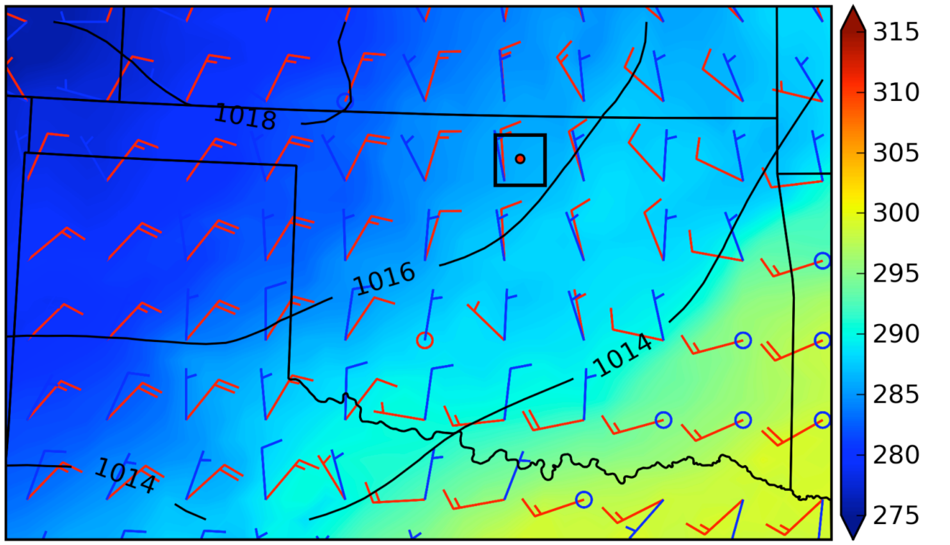






Post Cold Front Case

June 8 - 12UTC



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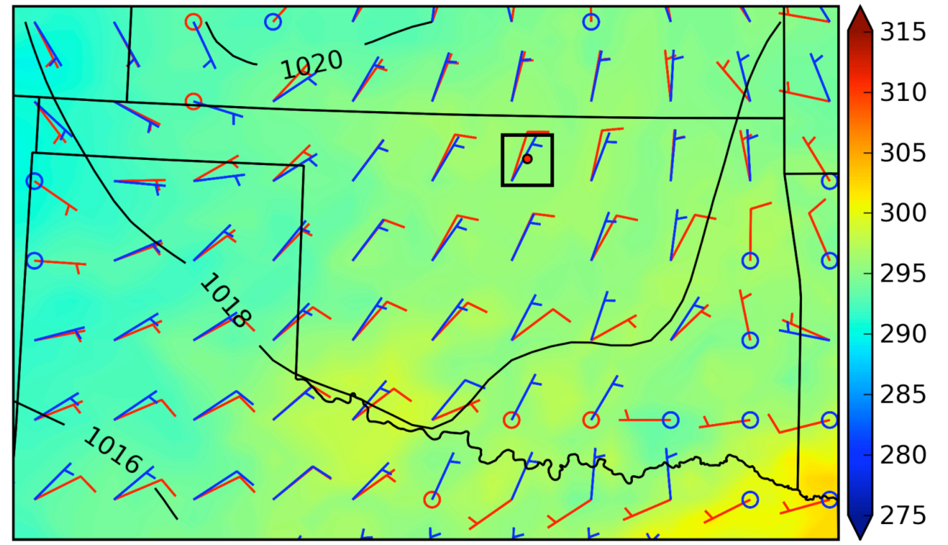

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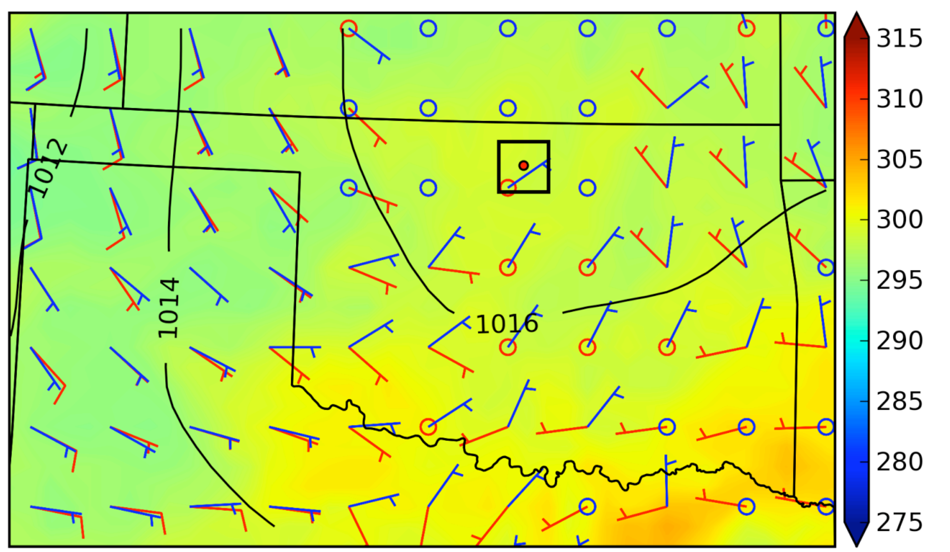

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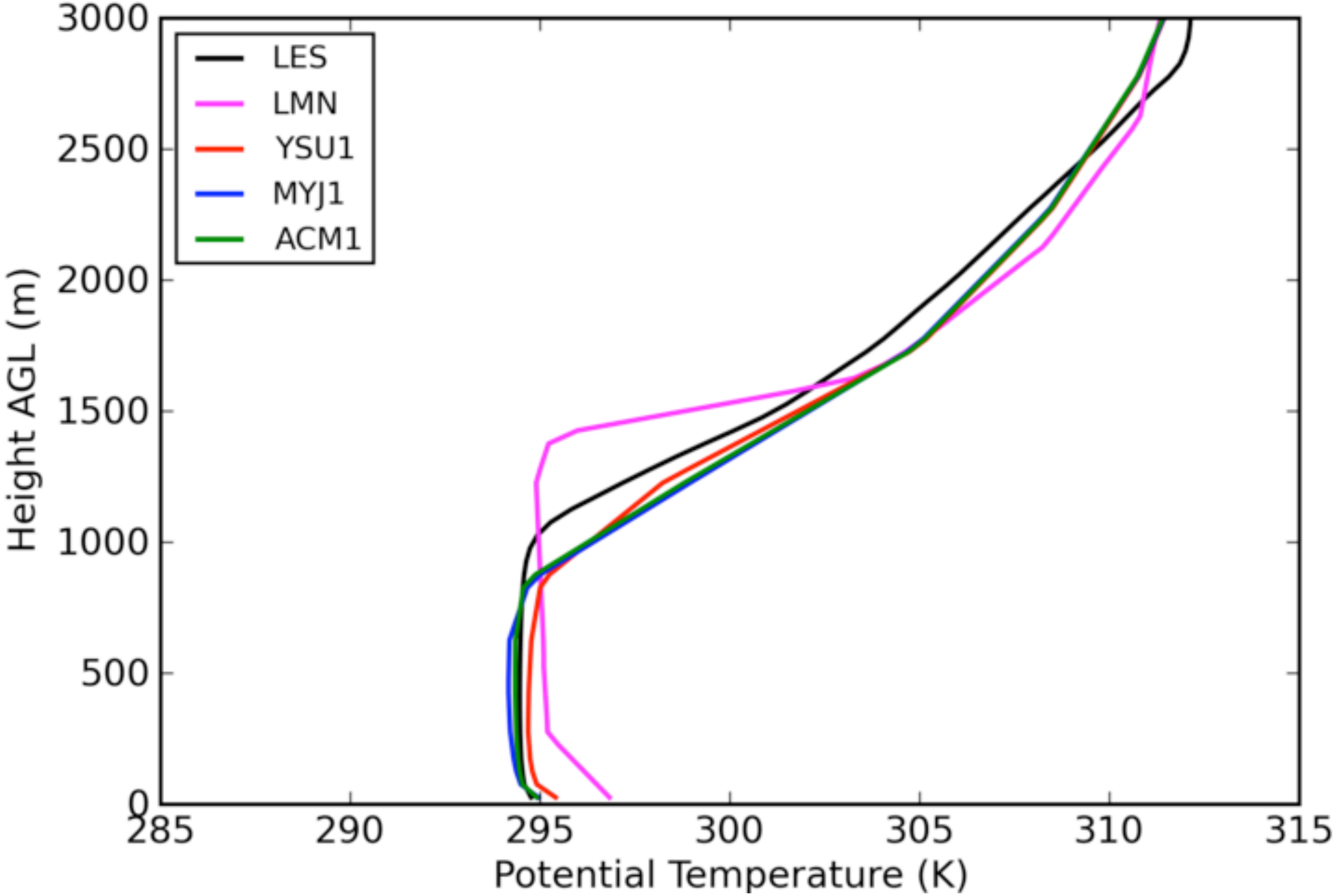

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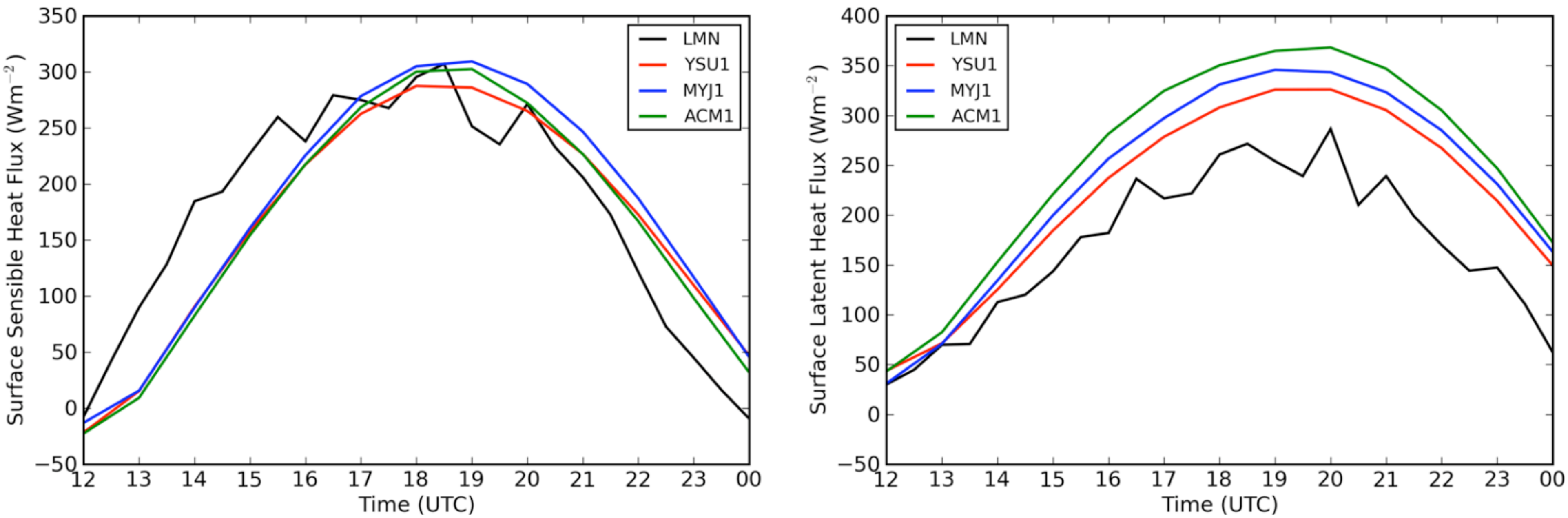

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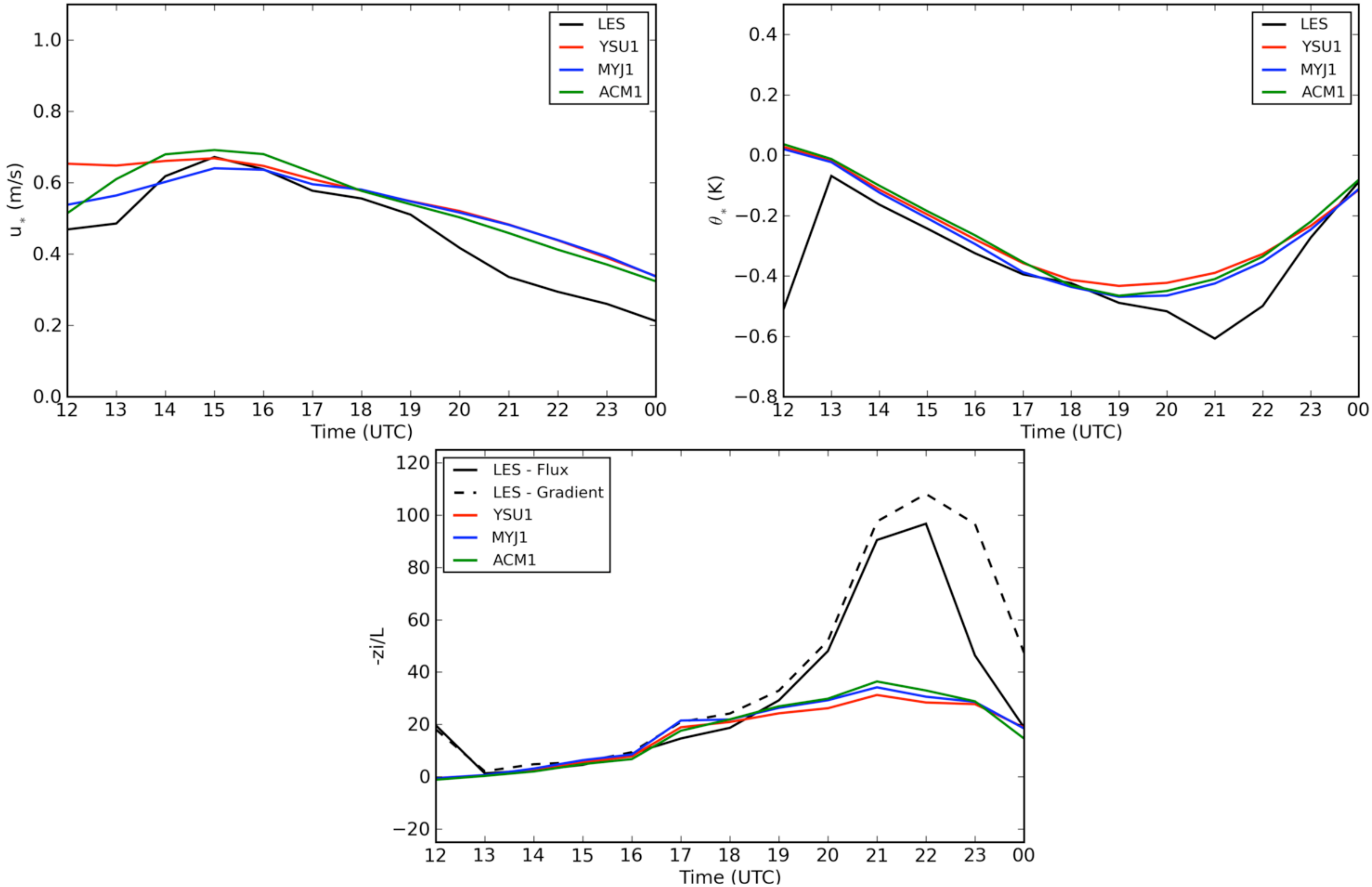

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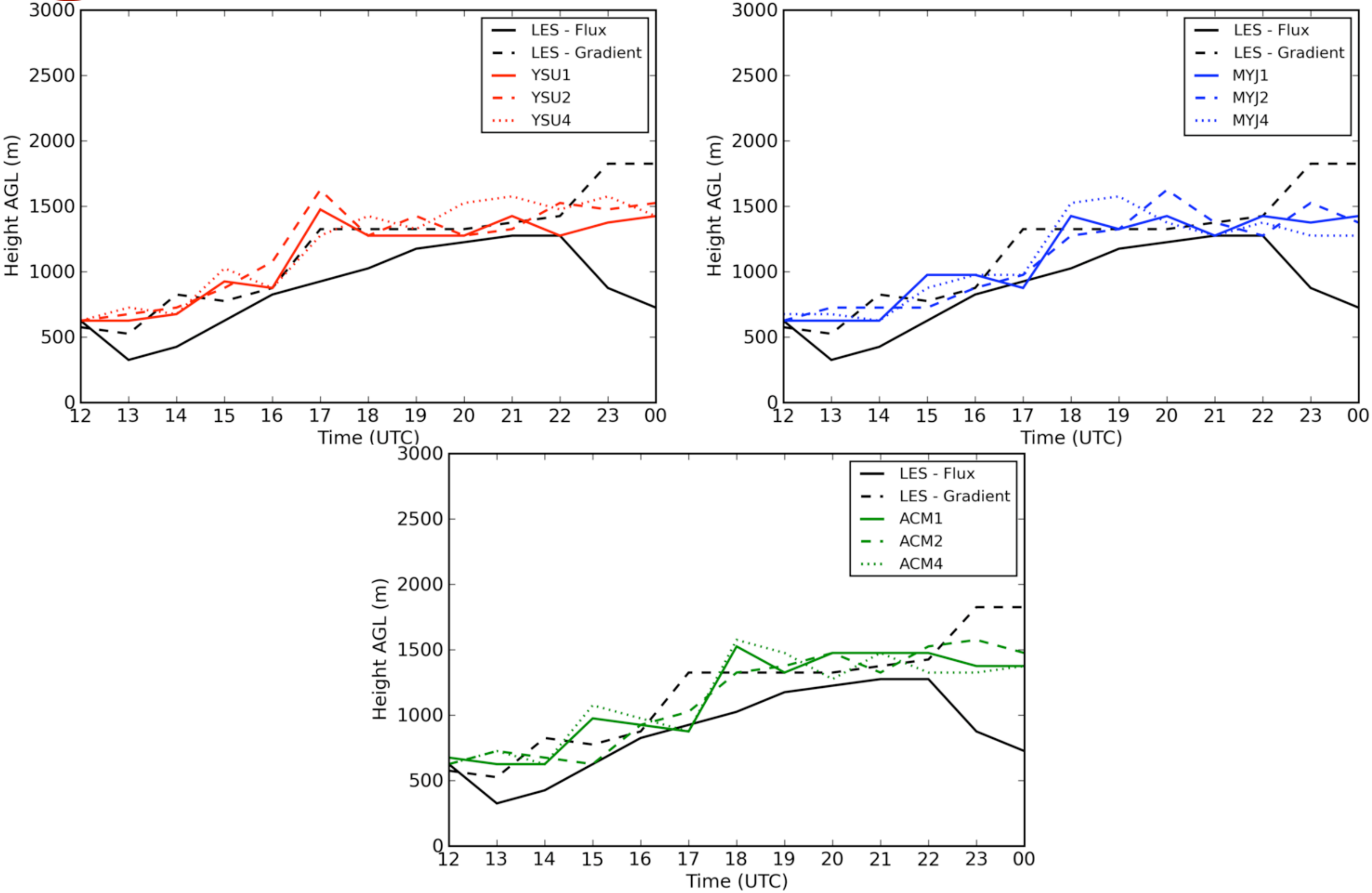

Summary

- For conditions when PBL was driven primarily by buoyancy forcing, WRF predicted near-surface turbulence parameters reasonably well.
- However, for conditions when shear production played a larger role, WRF under-predicted these parameters.
- In general, MYJ produced weaker mixing than either YSU or ACM2, however, differences between predictions for near-surface turbulence scales by all schemes were generally minor.
- Overall, finer grid spacing produced more realistic PBL depth values.
- There are indications that all three tested schemes do not represent ensemble of motions at 1km grid spacing for the studied CBL cases.

References

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Thank You

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- Questions/Suggestions?

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