Diagnosing Near-Surface Model Errors with FV3-LAM Physics Schemes for Multi-Physics RRFS Ensemble

CIWRO Workshop on Forecast Applications Improvements

September 30, 2022, 12pm

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Jerald Brotzge, Jacob R. Carley

5 physics suites in FV3-LAM for Rapid Refresh Forecasting System (RRFS) ensemble

Experiment names	Suite Characteristic	Microphysics	PBL	Surface Layer	LSM
CNTL	RRFS-control-like	Thompson	MYNN (Olson et al., 2019a; Olson et al., 2019b)	MYNN (Nakanishi & Niino, 2009)	NOAH (Chen & Zhang, 2009)
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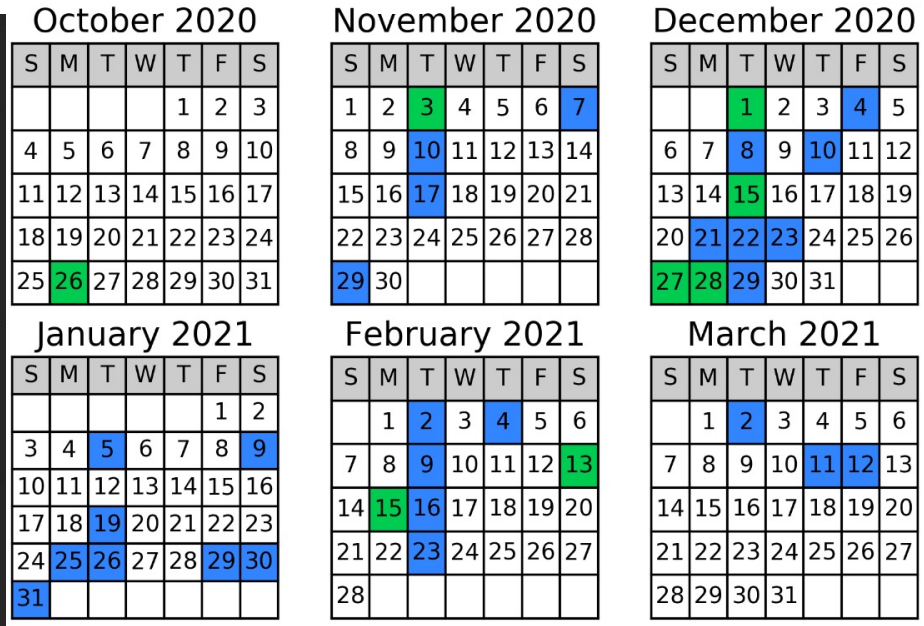
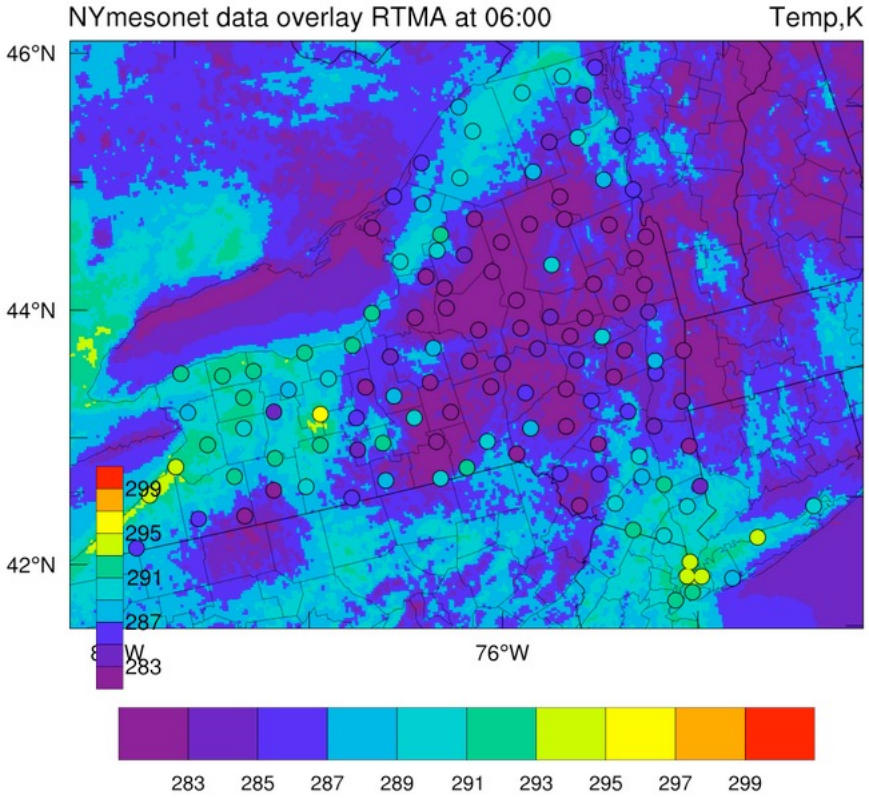


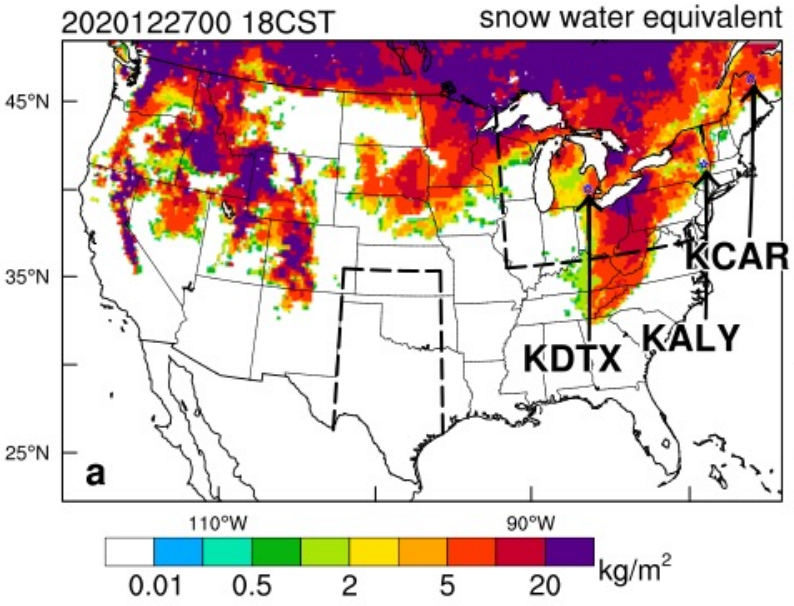
Hydrometeorology Testbed (HMT)
11th Winter Weather Experiment (2020-21)
Supinie et al. (2022, MWR)

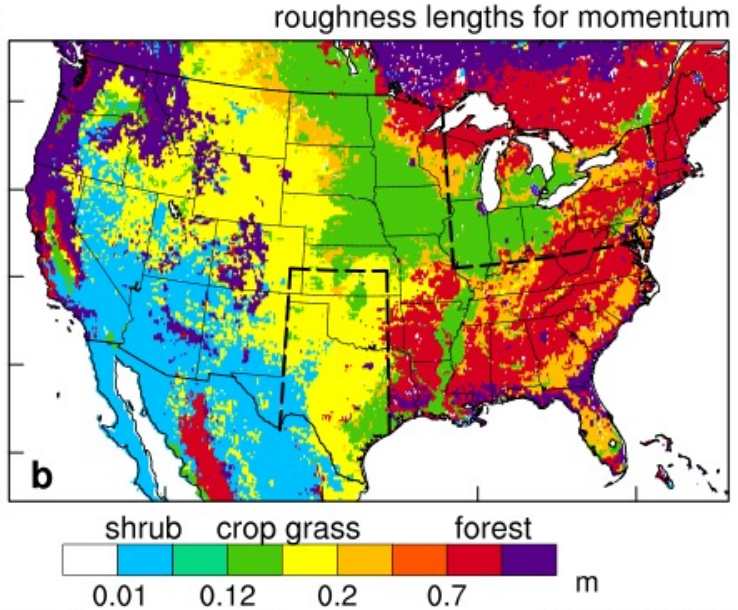
relatively-well understood and operationally hardened,
should thus be relatively easy to maintain in an operational setting.

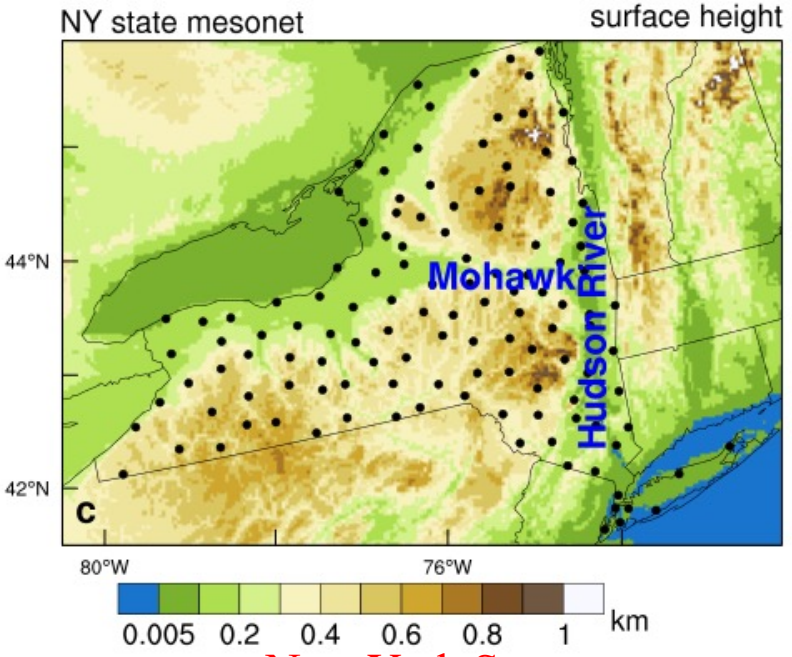
Observations for evaluation: URMA, Mesonet, Soundings



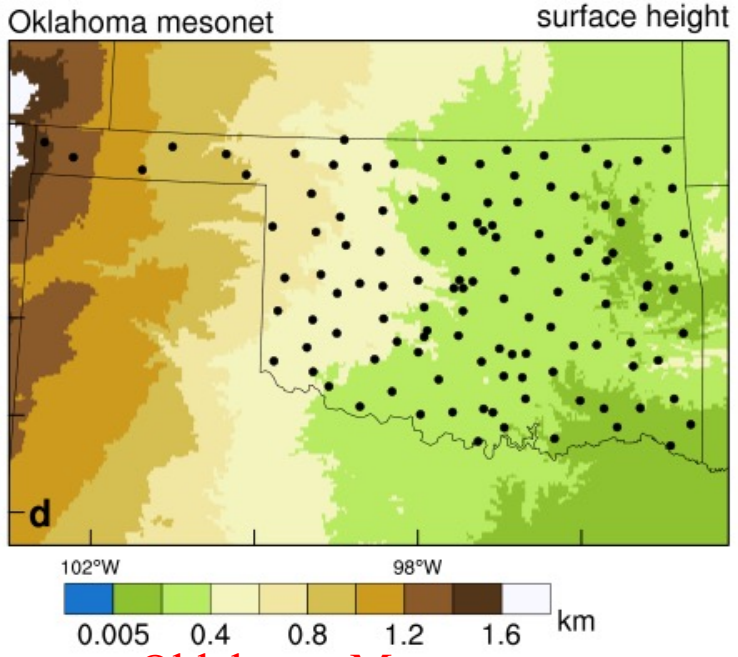
Unrestricted Mesoscale Analysis (URMA)







New York State



Oklahoma Mesonet

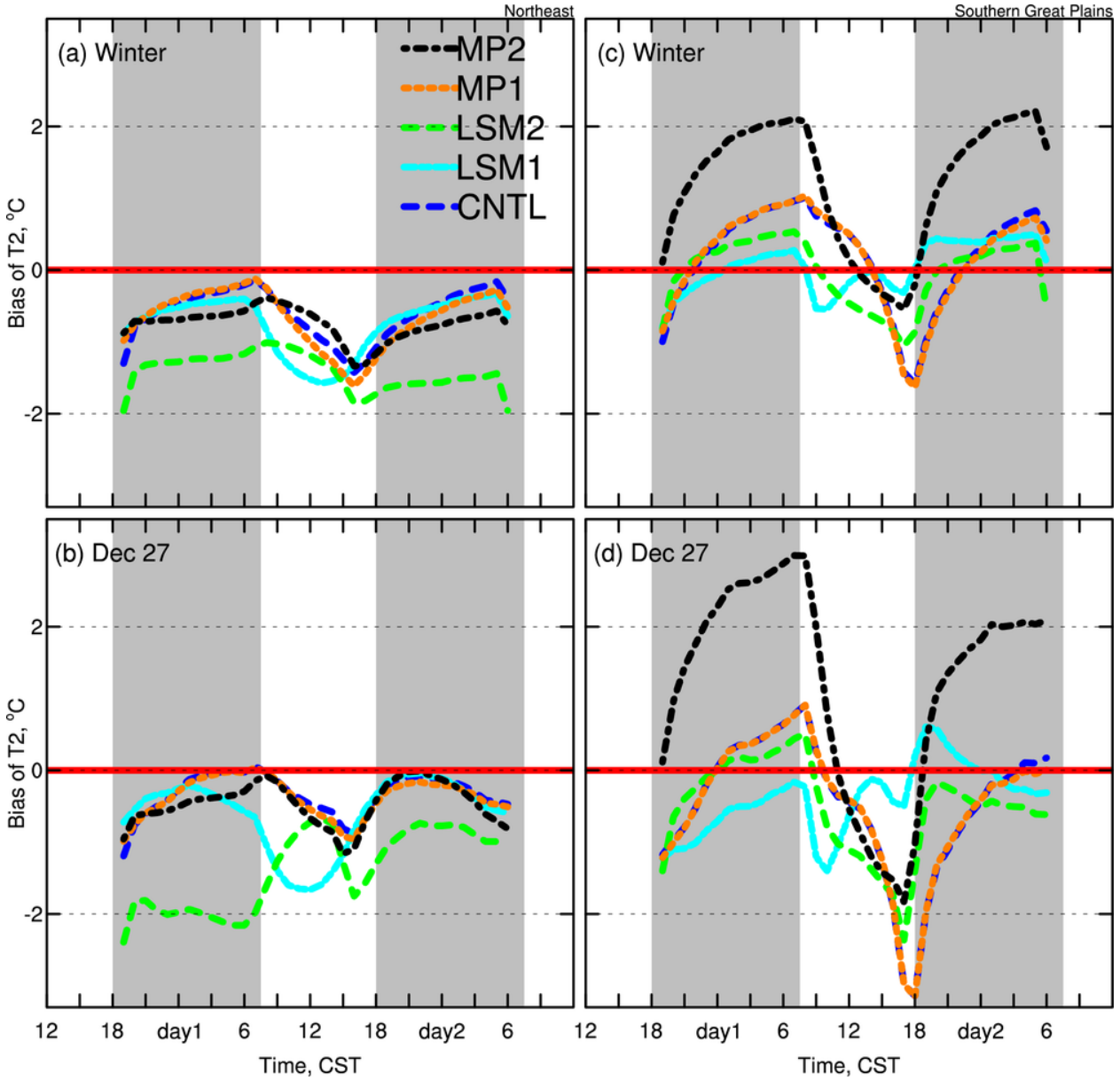
T2 bias against URMA

Northeast

Southern Great Plains

Whole winter

Case: Dec. 27



- Cold bias from LSM2 over Northeast
- Warm bias from MP2 over Southern Great Plains

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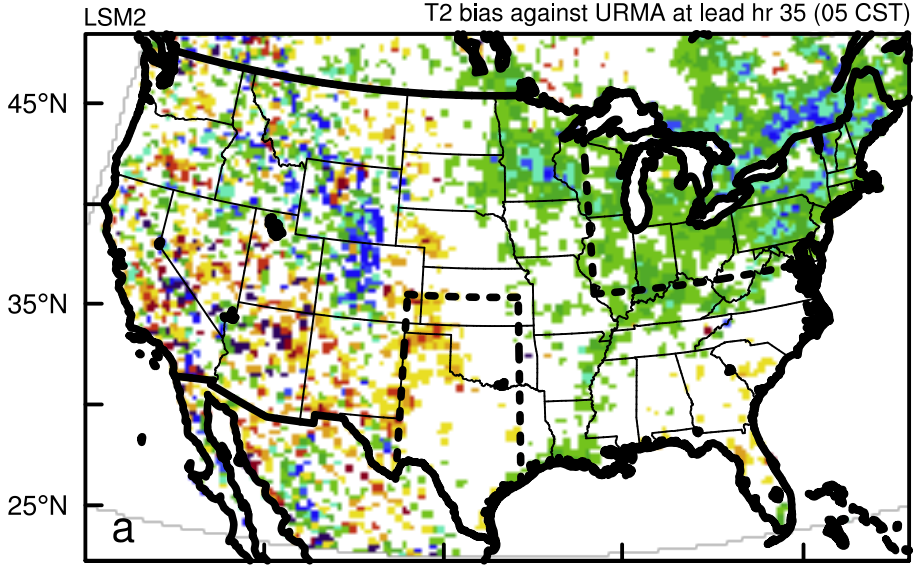
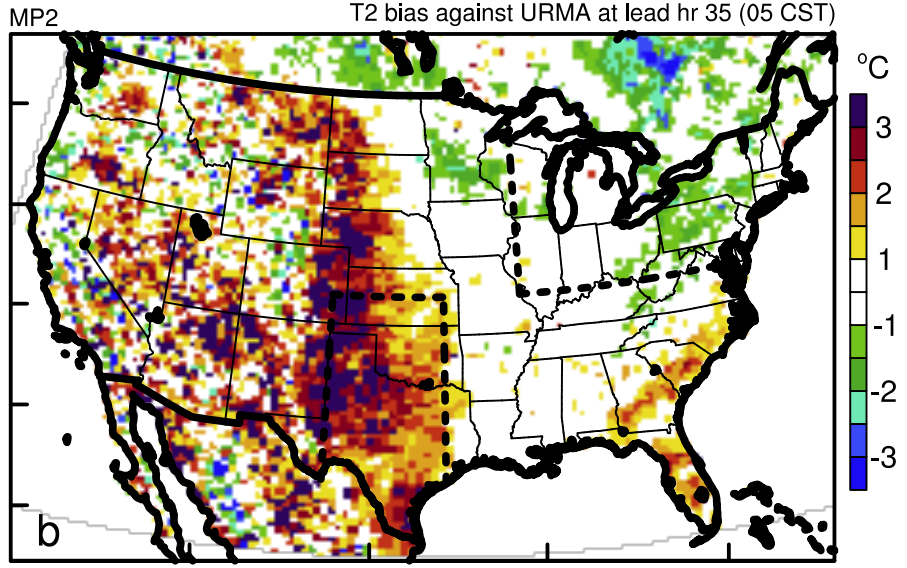
Spatial distribution of T2 bias against URMA

LSM2



MP2



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Case study: Dec. 27, 2020

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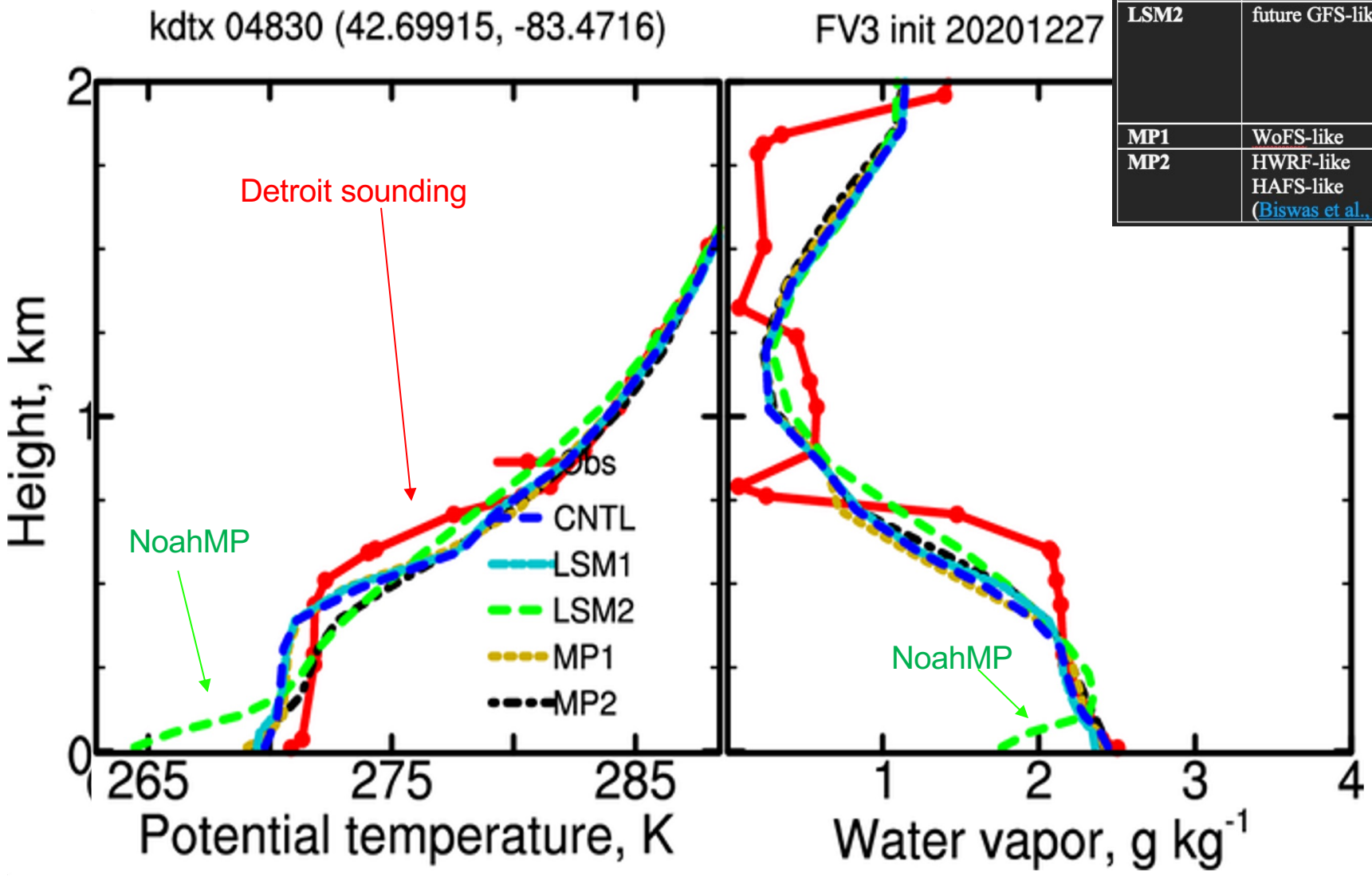

Diagnose cold bias from NoahMP

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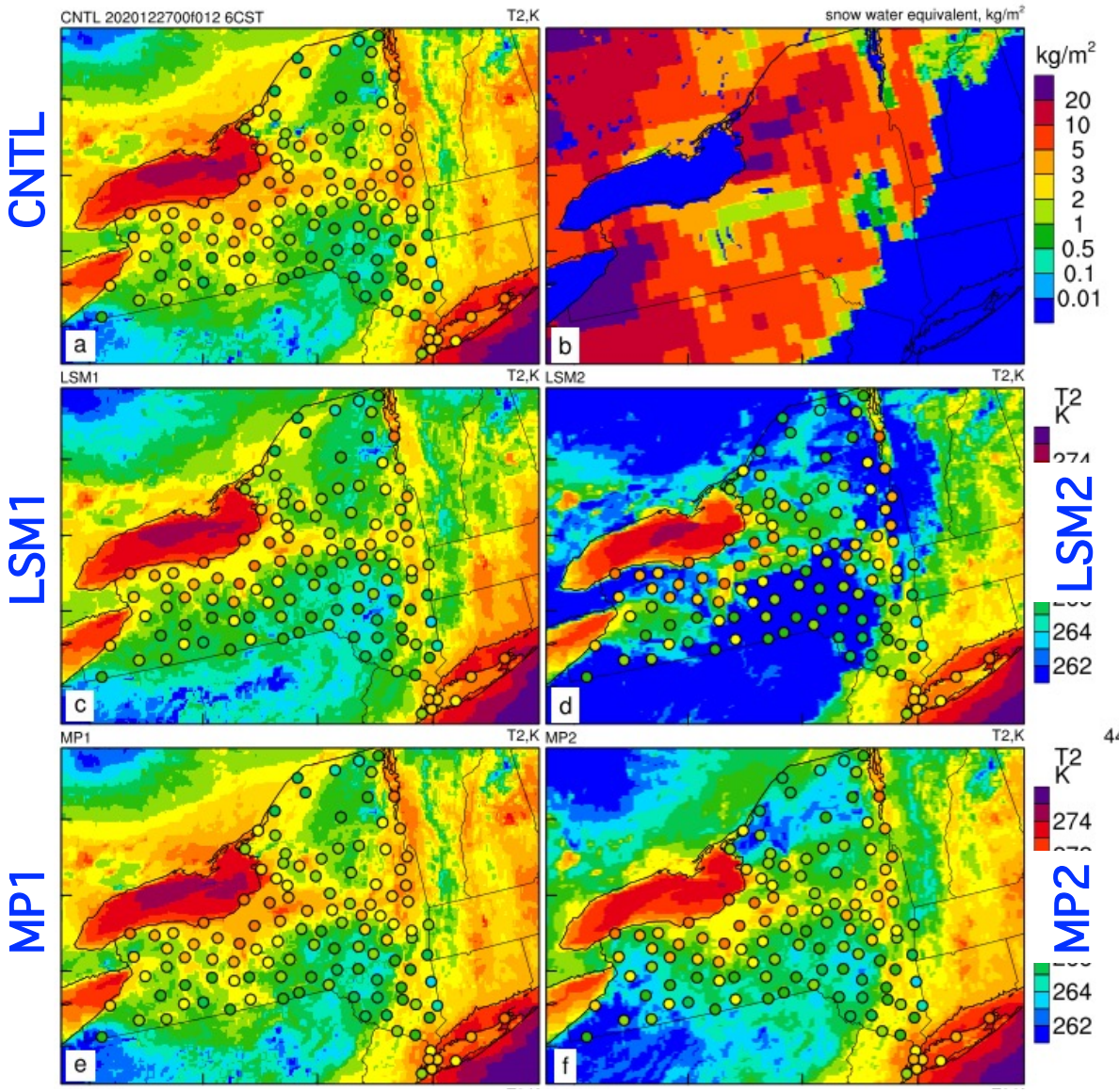
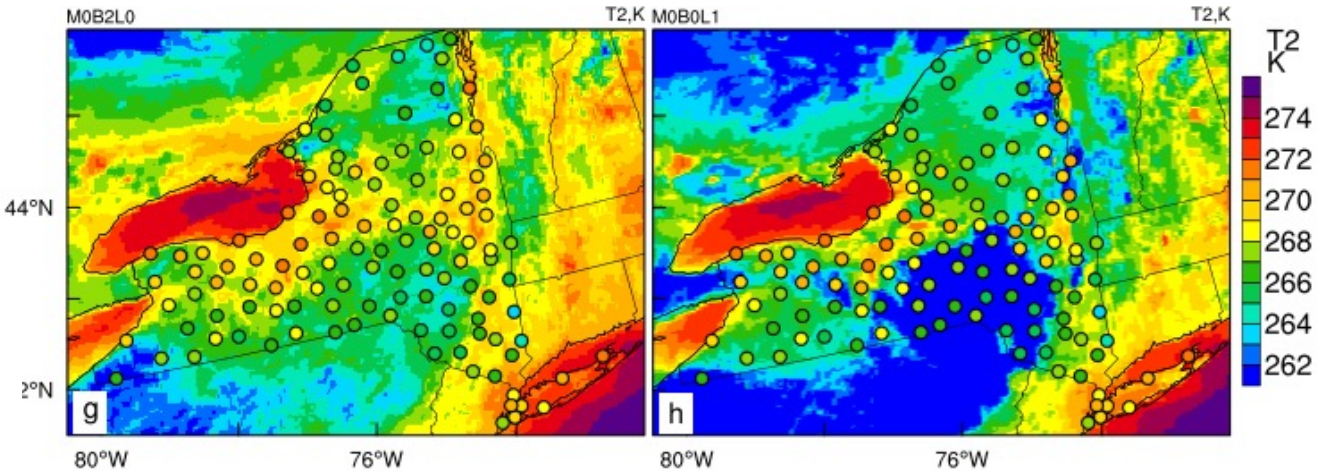


Circles: New York State Mesonet Measurements



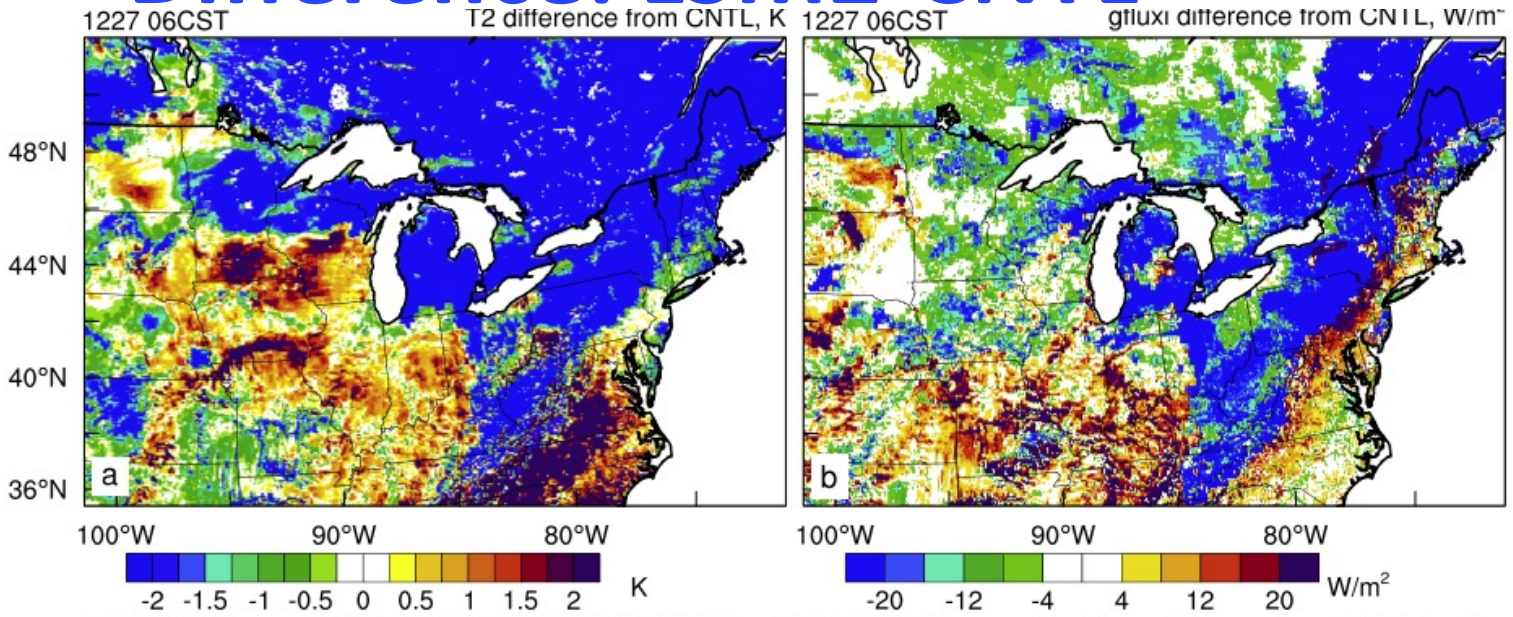
LSM2 but Noah

CNTL but NoahMP

NoahMP over snow???!!!!

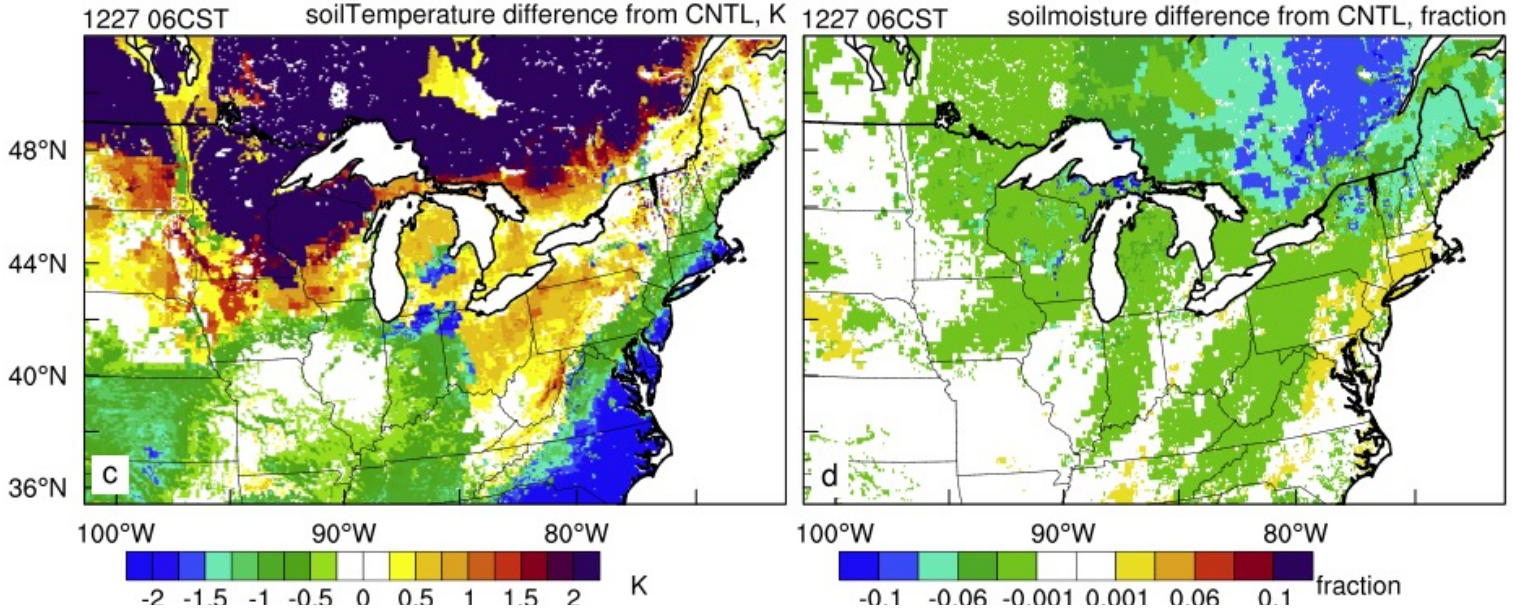
Difference: LSM2-CNTL

T2



Ground flux

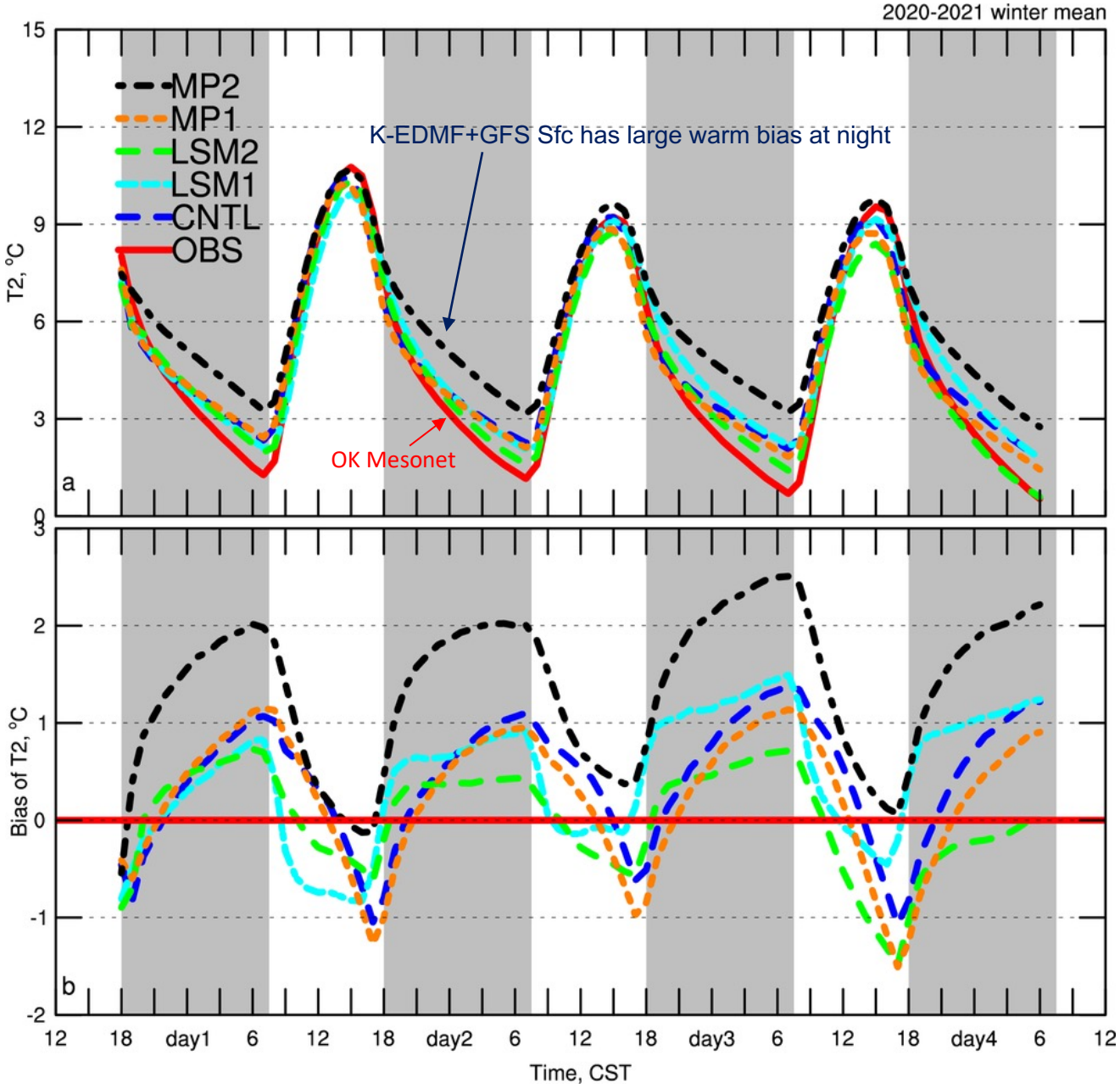
Tsoil



Soil moisture

NoahMP in LSM2: lower soil water =>lower conductivity=>lower upward ground flux=>too cold over snow

T2 evaluation against Oklahoma Mesonet



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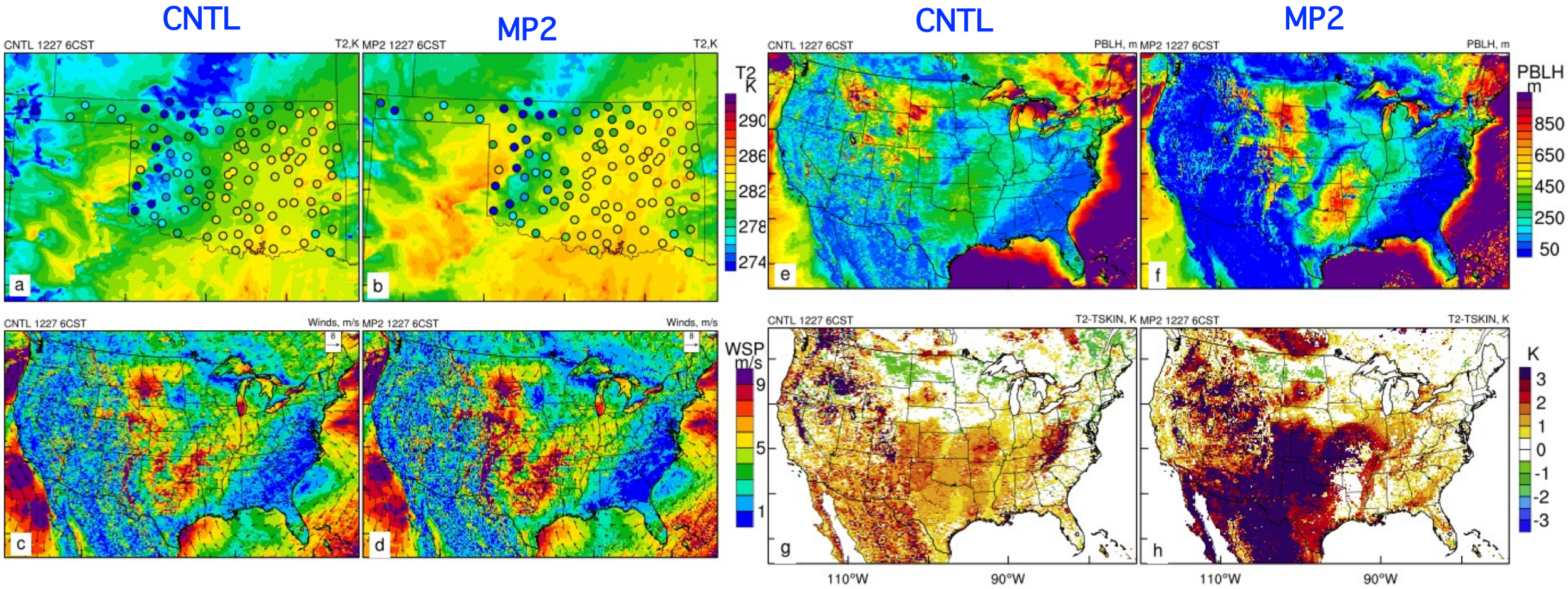
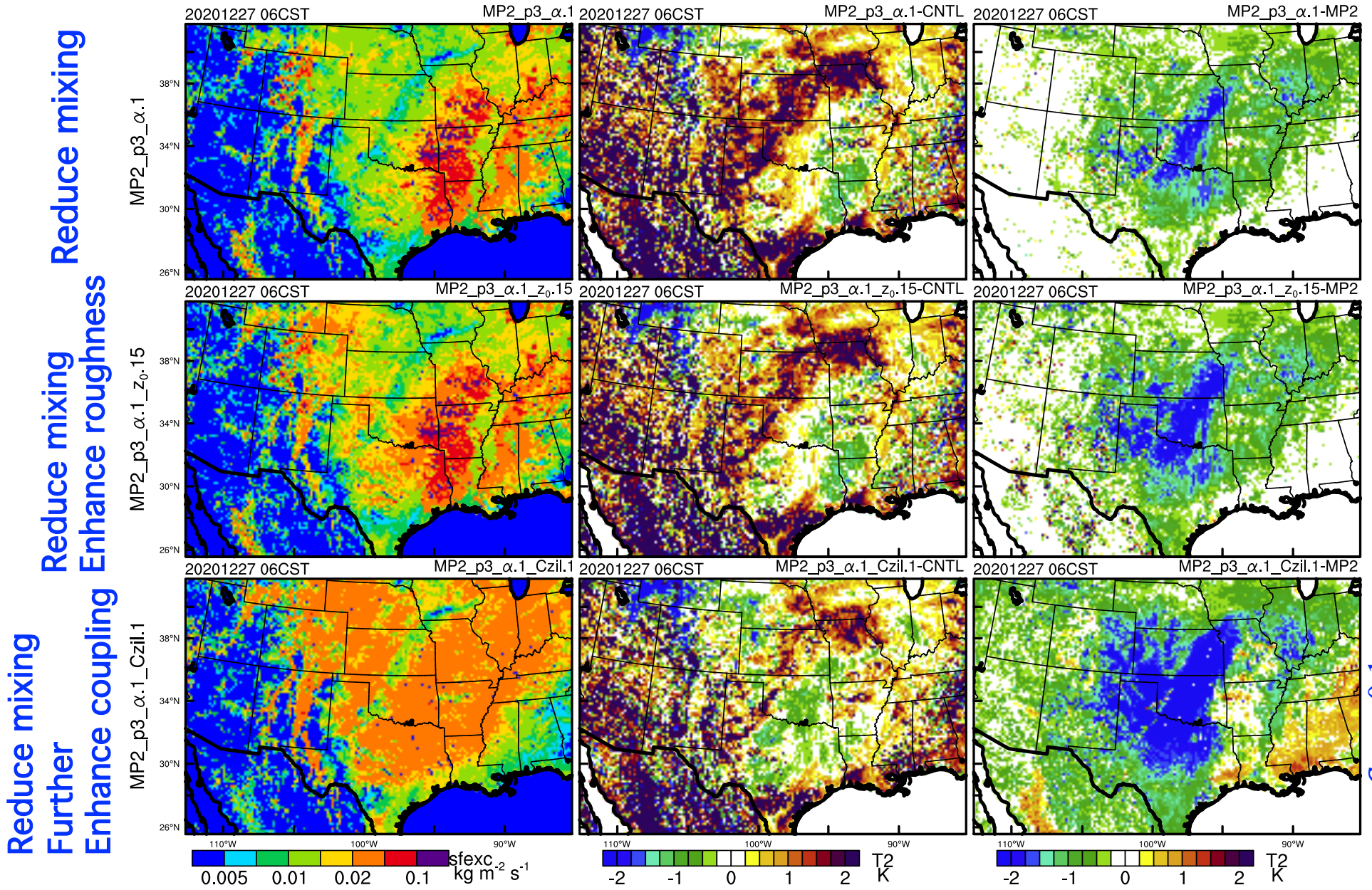
Nighttime warm bias over the southern Great Plains from MP2 with K-EDMF and GFS surface layer scheme

Case study: Dec. 27, 2020



Too high PBL, and too strong near-surface temperature gradient from MP2 with K-EDMF and GFS surface layer scheme indicating model errors in vertical mixing and land-atmospheric coupling

MP2 sensitivity runs with different vertical mixing and land-atmospheric coupling

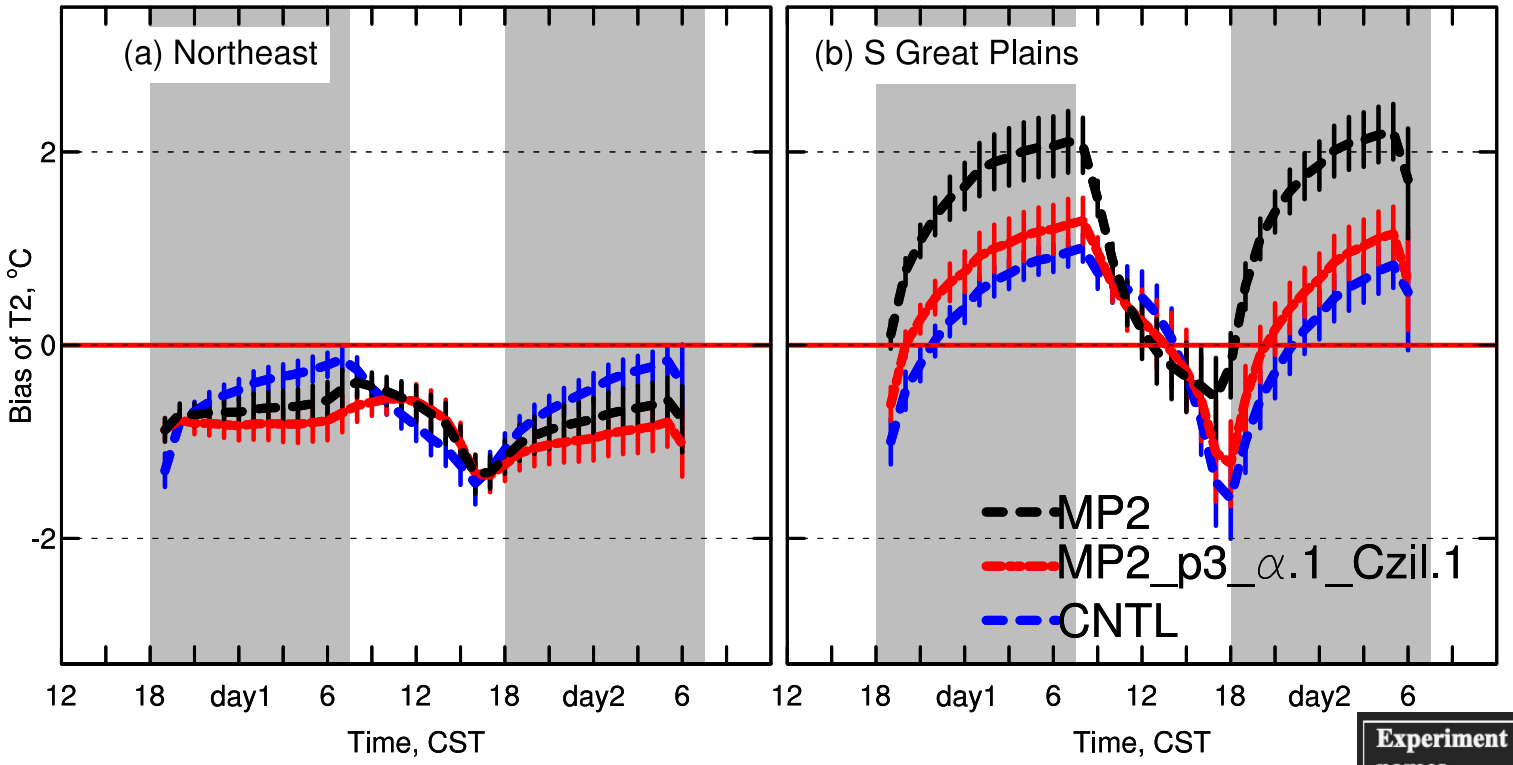


$C_{zil} = 10^{(-0.4h)}$

$C_{zil} = 0.1$

Too strong mixing by K-EDMF & too weak land-atmospheric coupling by GFS surface layer lead to nighttime warm bias over grassland

MP2 sensitivity runs with different vertical mixing and land-atmospheric coupling



winter of 2020-2021 evaluated against URMA

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Conclusions

- Noah-MP simulates lower soil water content, and thus lower thermal conductivity, leading to smaller upward ground flux during nighttime and consequently lower surface temperature over snow.
- Overestimated vertical mixing strength from the K-EDMF PBL scheme and insufficient land-atmospheric coupling from the GFS surface layer scheme over short vegetation lead to nighttime warm bias in the Southern Great Plains.

Hu, X.-M., J. Park, T. Supinie, N. A. Snook, M. Xue, K. Brewster, J. Brotzge, J. R. Carley (2022), **Diagnosing Near-Surface Model Errors with Candidate Physics Parameterization Schemes for Multi-Physics Rapid Refresh Forecasting System (RRFS) Ensemble during Winter over the Northeastern US and Southern Great Plains**, *Mon. Wea. Rev.*, doi:10.1175/MWR-D-22-0085.1