# Evaluation of the Noah-MP Land Surface Model in WRFV3.4

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# Noah-MP – Experimental in WRFv3.4

- "Experimental" implies:
  - Not yet tested in a wide variety of situations and configurations
    - A short history of Noah-MP in WRF, as compared to 10+ years for Noah
  - Still finding and fixing bugs
    - Never-ending in the world of model development
  - Still investigating known issues and learning model behavior

- Results presented here reflect fixes and updates to the WRFv3.4 release
  - Updates planned for the summer 3.4.1 release
  - Related to treatment of radiation, vegetation fraction, vegetation density

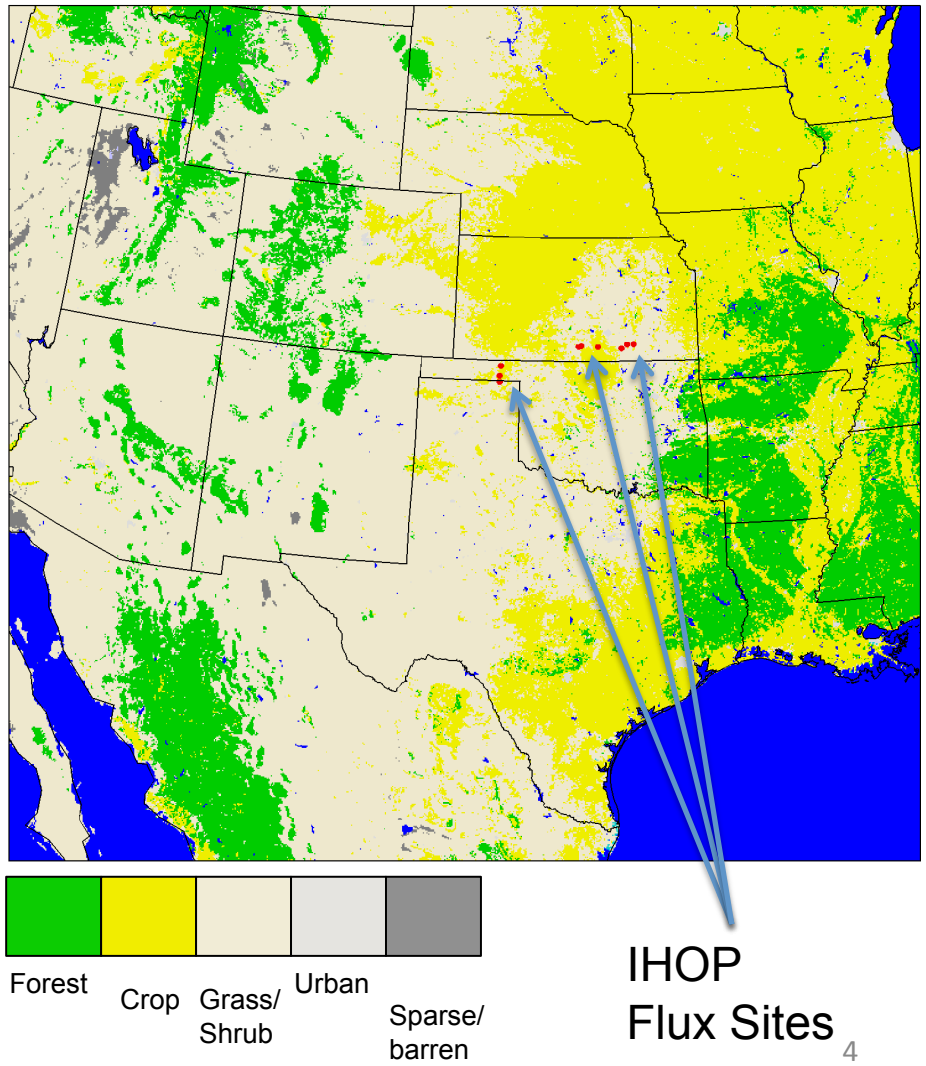
# Summer/Winter evaluations of Noah-MP in WRF

- Summertime convective situation – IHOP 2002

- Winter/Spring snowmelt situation – Spring 2008

# IHOP cases – June 2002

- Six successive 24-hour forecasts during a convectively active period
- 10 Jun 12Z through 16 Jun 12Z
- 3-km grid size; 800x750 points
- EDAS Initial and Boundary conditions
- Soil T and moisture initialized from 18-month Noah HRLDAS spin-up
- Noah-MP options:
  - dveg = 4
    - FVEG=Annual max; LAI from tables
  - opt_sfc = 1
    - Noah-MP Monin-Obukhov exchange coeff.
- Runtime with Noah-MP 2-3 % longer than with Noah



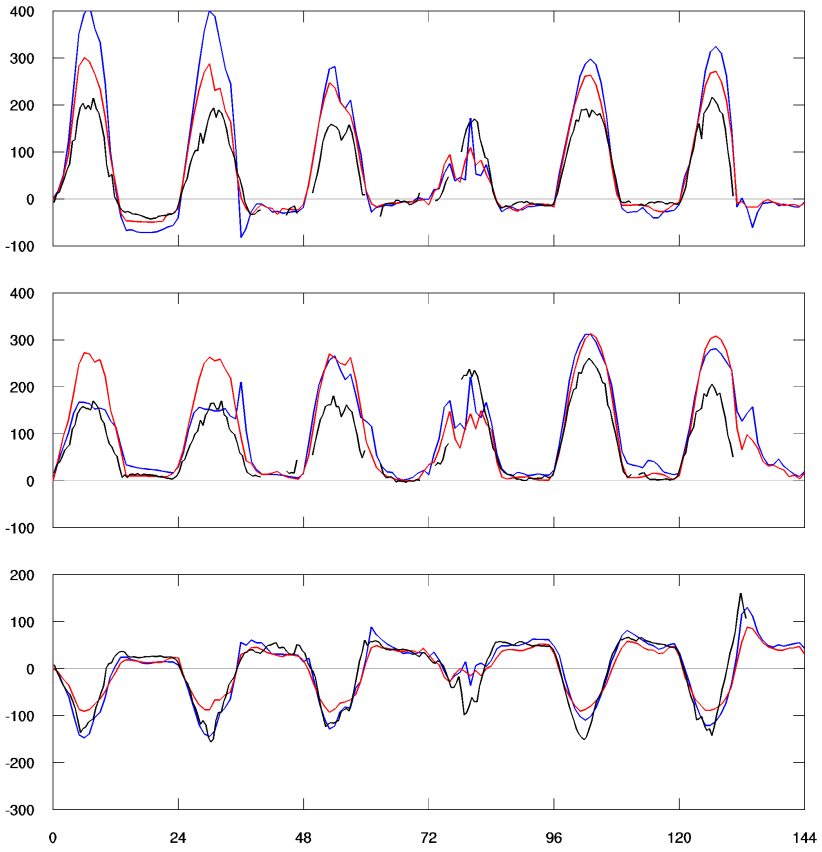
# IHOP Flux Station Statistics

*Average of 9 stations near KS/OK border*

Sensible Heat Flux (W $m^{-2}$)

Latent Heat Flux (W $m^{-2}$)

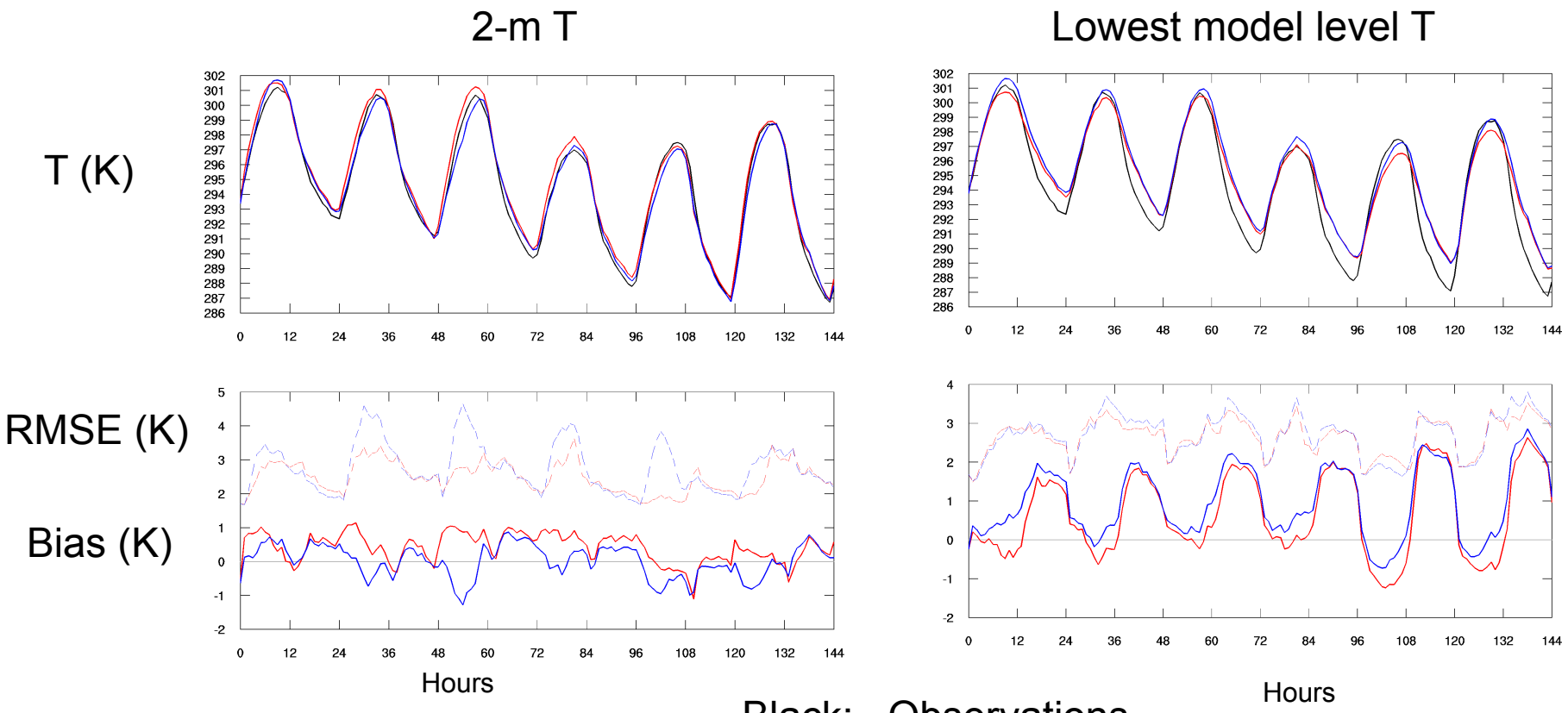
Soil Heat Flux (W $m^{-2}$)




Hours from 12 UTC, 10 Jun 2002

Black: Observations
Red: Noah
Blue: Noah-MP

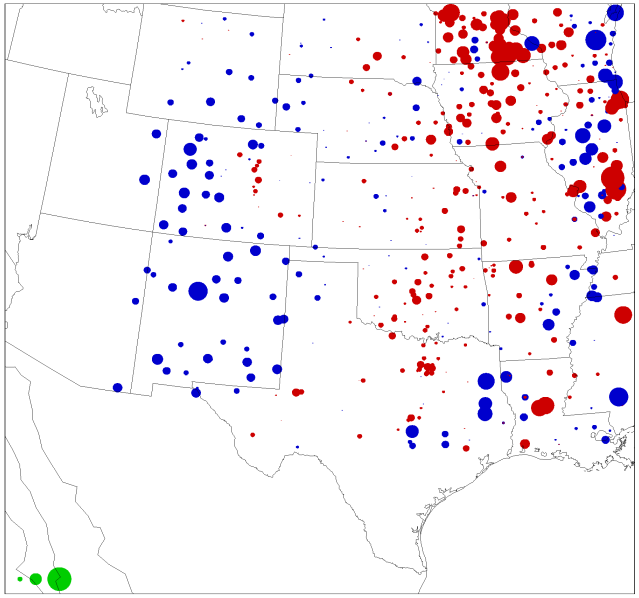
# Temperature Statistics for Six 24-hour forecasts as compared to approximately 400 NWS surface stations



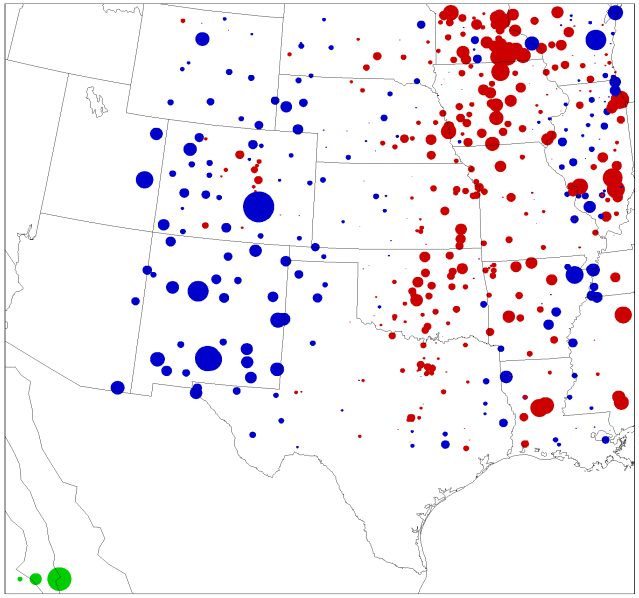

Black: Observations
Red: Noah
Blue: Noah-MP

# Daytime T2 errors – Example
# 20 UTC 10 June (8-hour forecast)
# Comparison to NWS surface observations

Noah



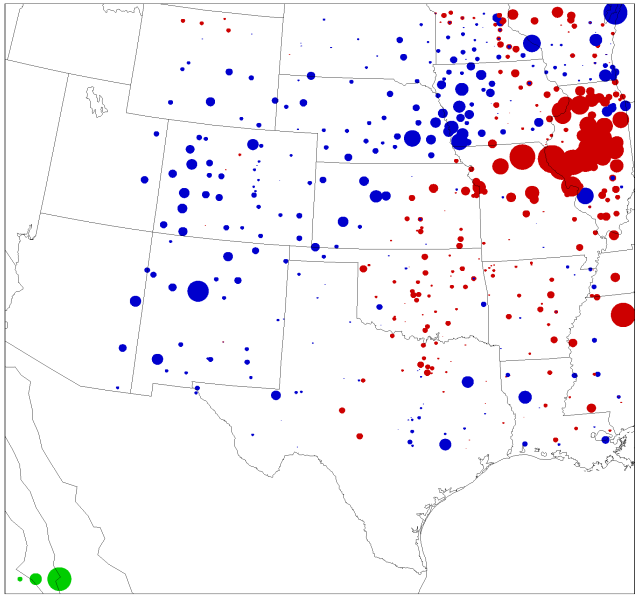
Noah-MP



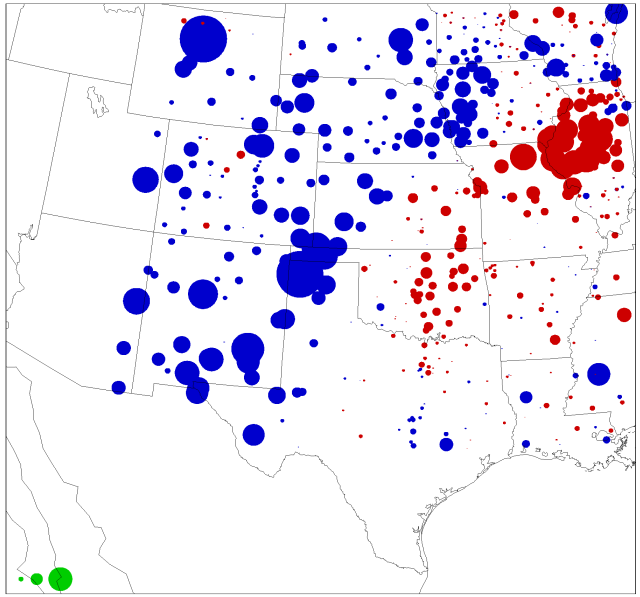
2,5,10 K

# Daytime T2 errors – Another Example
# 20 UTC 11 June (8-hour forecast)
# Comparison to NWS surface observations

Noah



Noah-MP

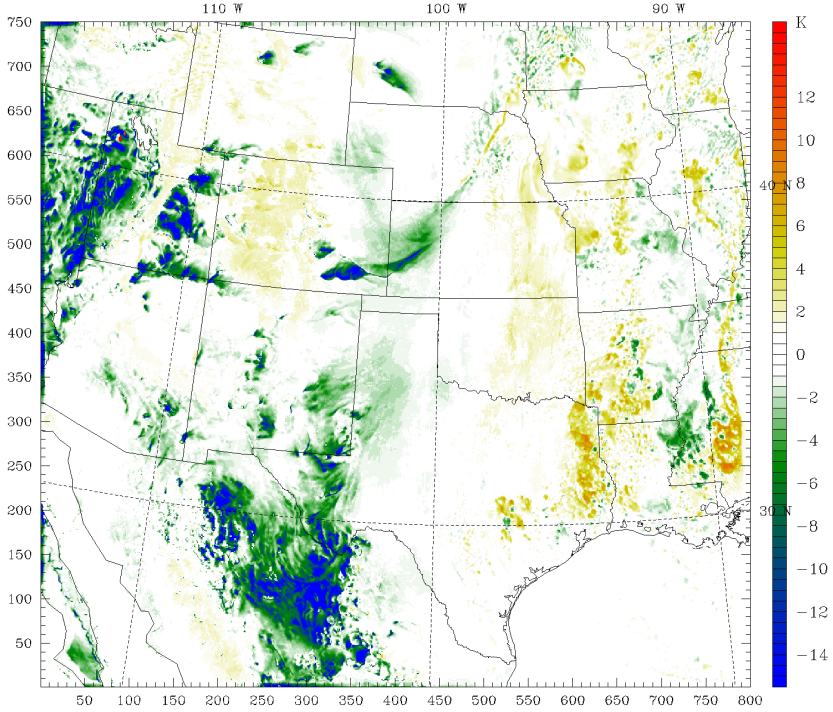


2,5,10 K

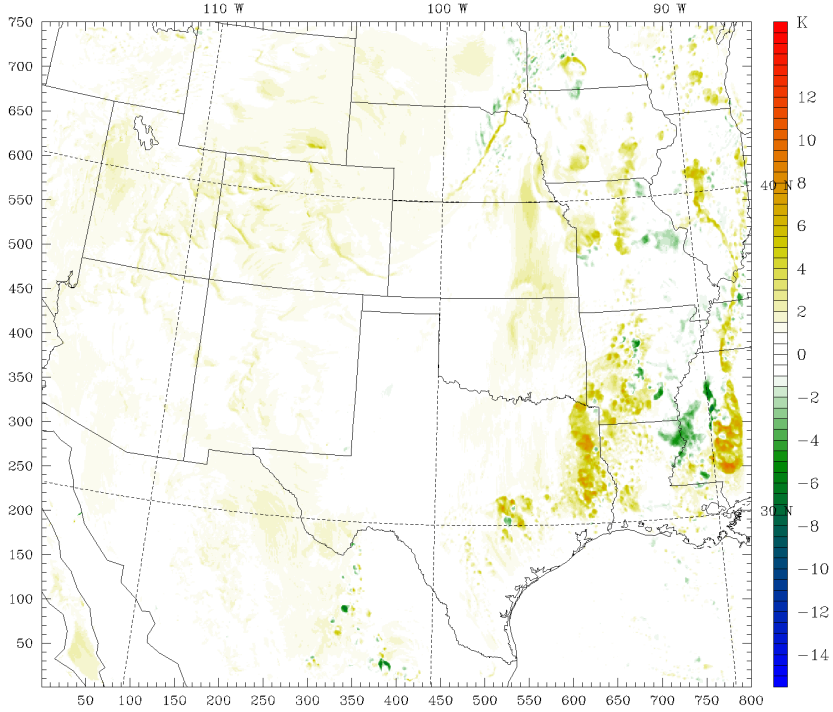
*Still some problems with the 2-m Temperature diagnostic in Noah-MP*

# Noah-MP minus Noah
# Daytime temperature differences
# 8-hour forecast valid 20 UTC 10 Jun

2-m Temperature



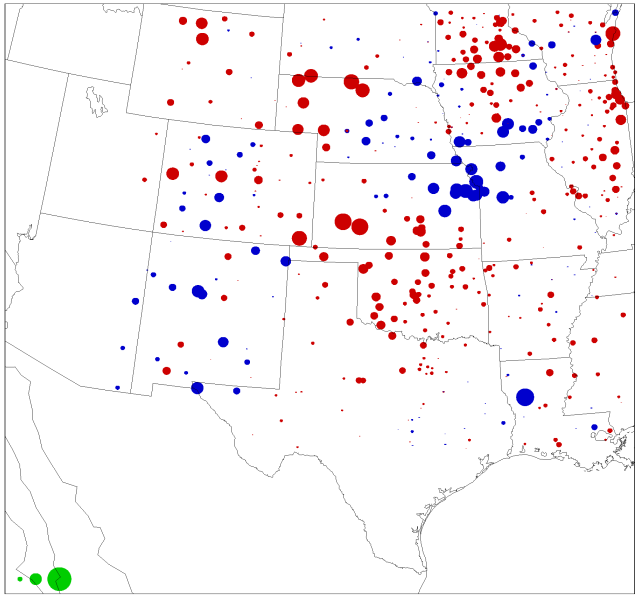

Lowest model level Temperature



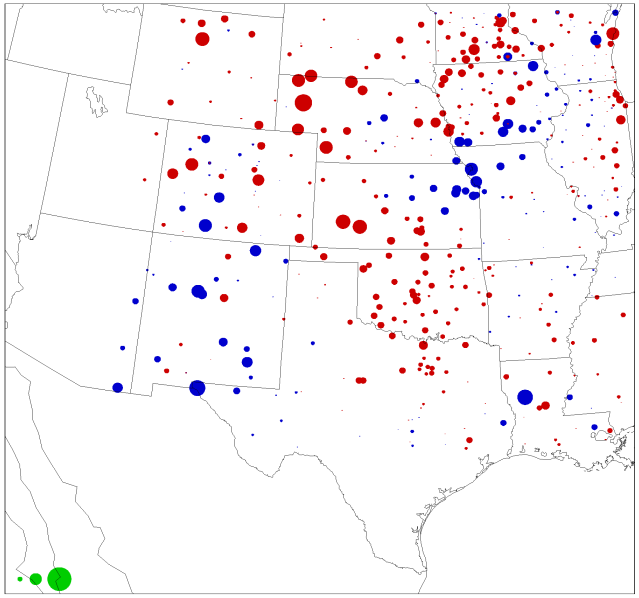

*Temperature problems strictly in the 2-m diagnostic field*

# Nighttime T2 errors – Example
# 08 UTC 11 Jun (20-hr forecast)
# Comparison to NWS surface observations

Noah

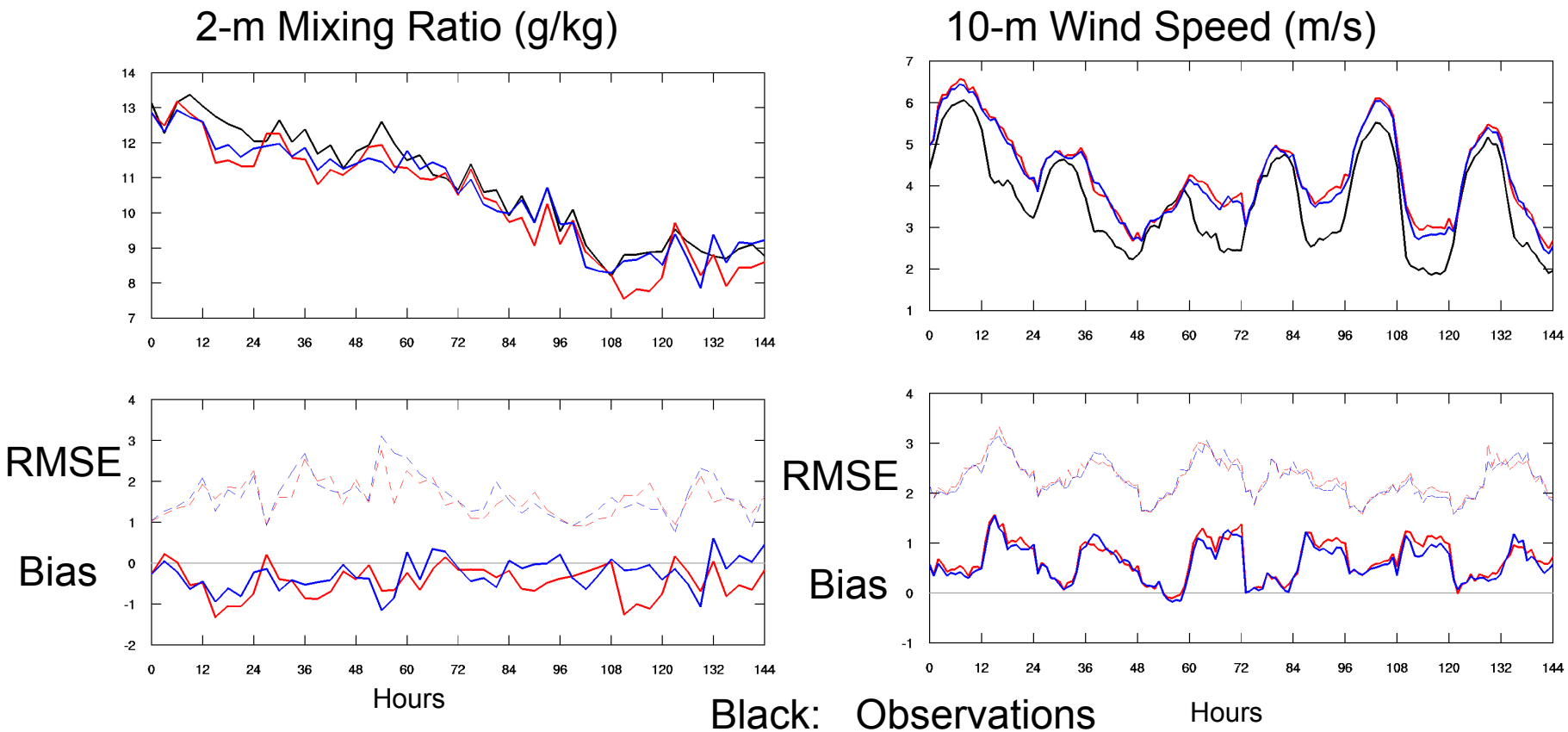


Noah-MP



2,5,10 K

# Humidity/Wind Statistics



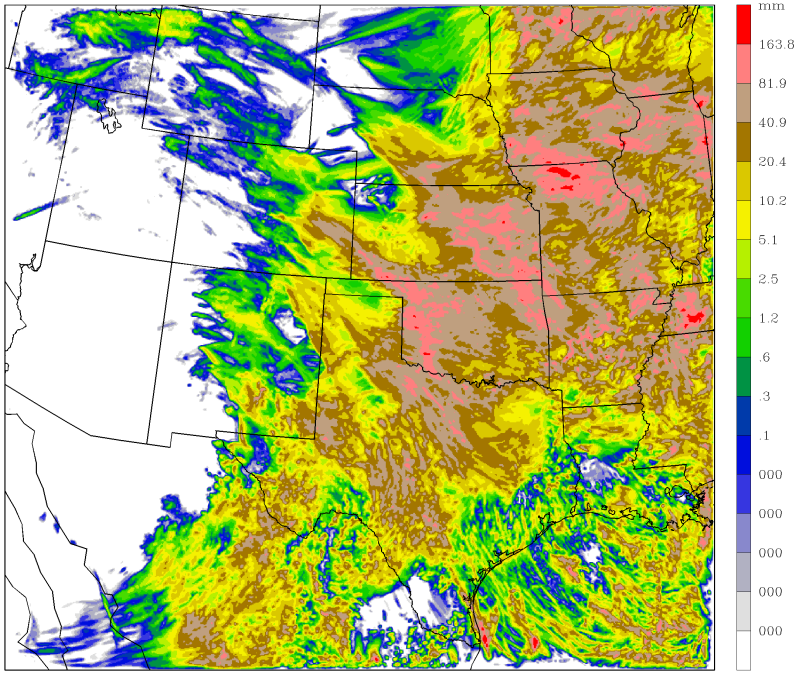

Black: Observations

Red: Noah

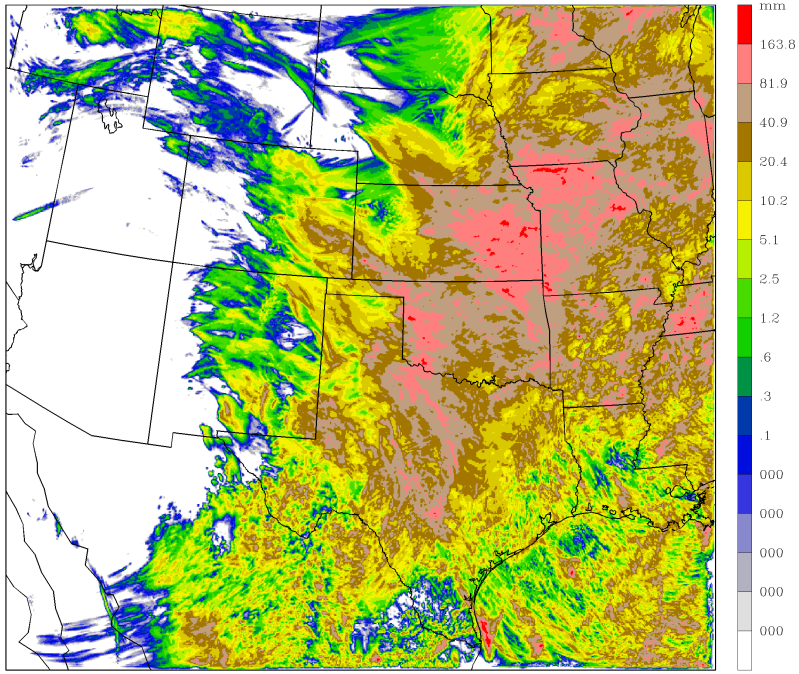
Blue: Noah-MP

# Precipitation Accumulations over six 24-hour forecasts

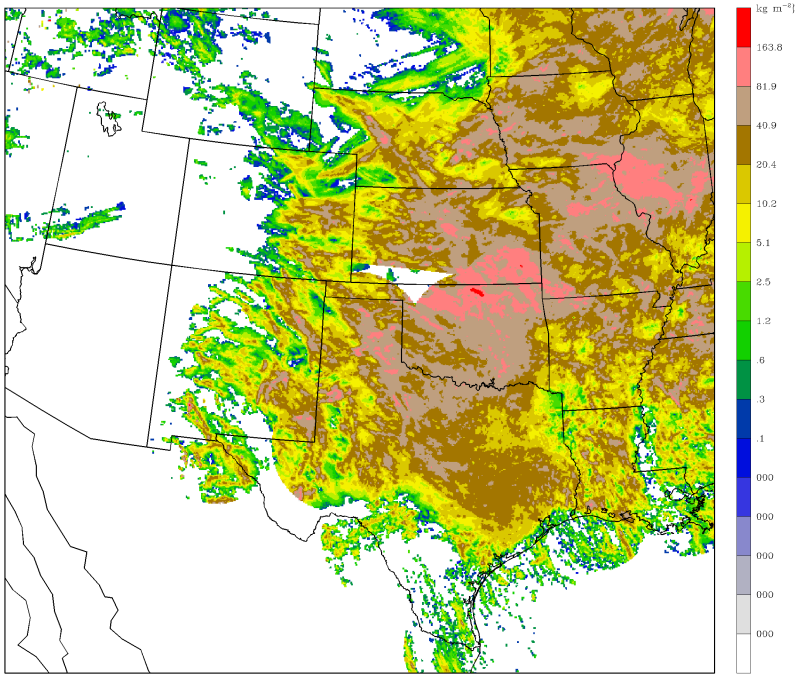
Noah-MP




Noah




Stage IV Analysis

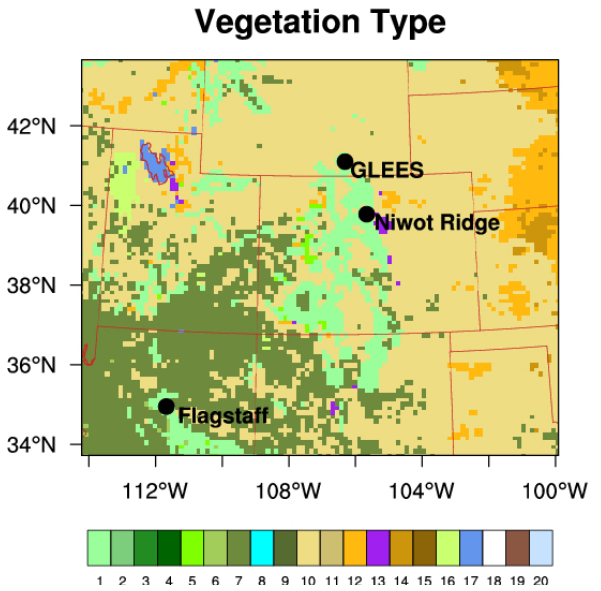


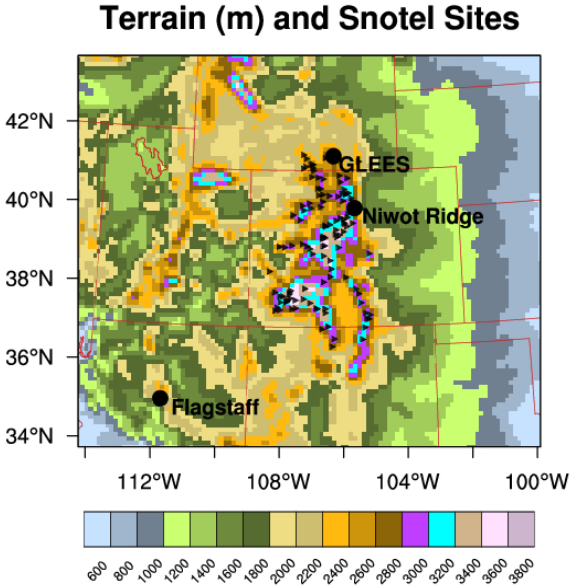
# WRF/Noah-MP and WRF/Noah Runs Winter/Spring 2008

- Two coupled WRF runs using WRFV3.4/Noah-MP, and WRFV3.4/Noah
- At 12km horizontal resolution:
  - e_we = 113,
  - e_sn = 95,
  - e_vert = 45,
- NARR data for initialization, Snow is initialized using SNODAS
- Model Runs start at 15 Feb 2008, 00 UTC; integrated for 2 months
- Noah-MP options:

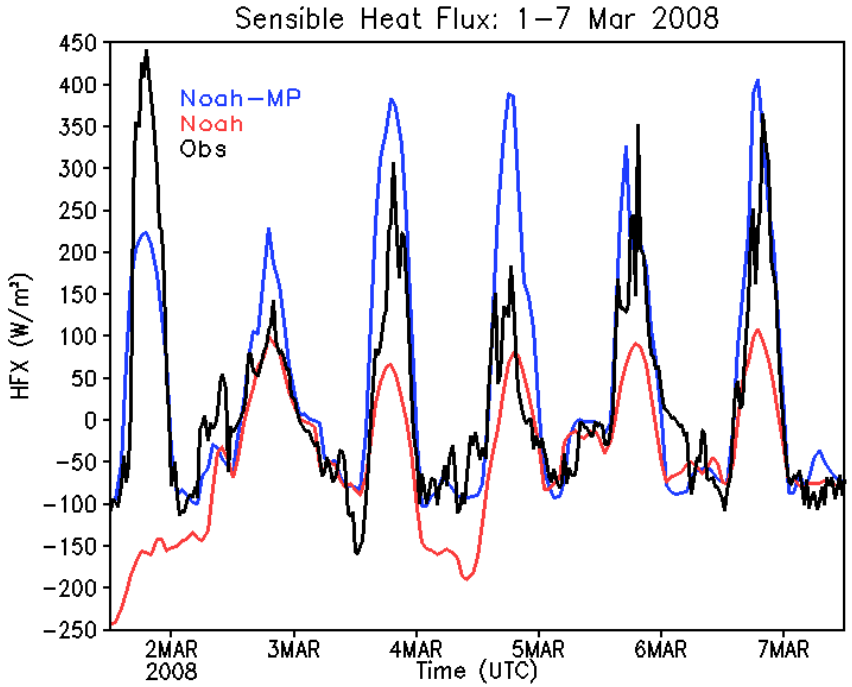
| | |
|---|---|
| dveg = 4 | opt_crs = 1 |
| opt_btr = 1 | opt_run = 1 |
| opt_sfc = 1 | opt_frz = 1 |
| opt_inf = 1 | opt_rad = 1 |
| opt_alb = 2 | opt_snf = 1 |
| opt_tbot = 2 | opt_stc = 1 |

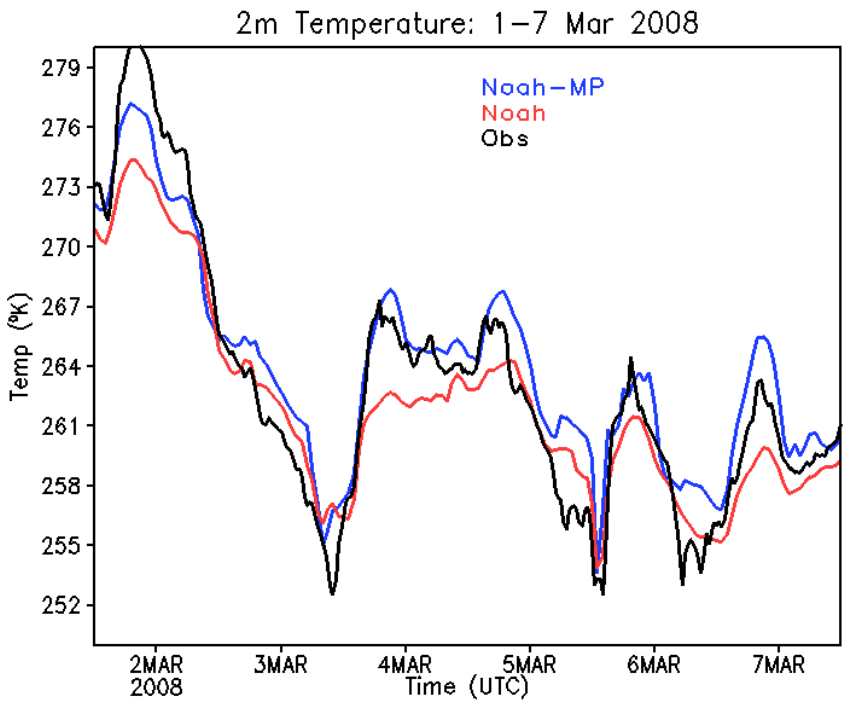
- Runtime with Noah-MP 5-6% longer than with Noah
- Model results compared to:
  SNOwpack TELemetry (SNOTEL) SWE and TEMP, Modis Land surface temperature, SNODAS (Snow Data Assimilation System) SWE, AMERIFLUX data, and WMO observations over the domain



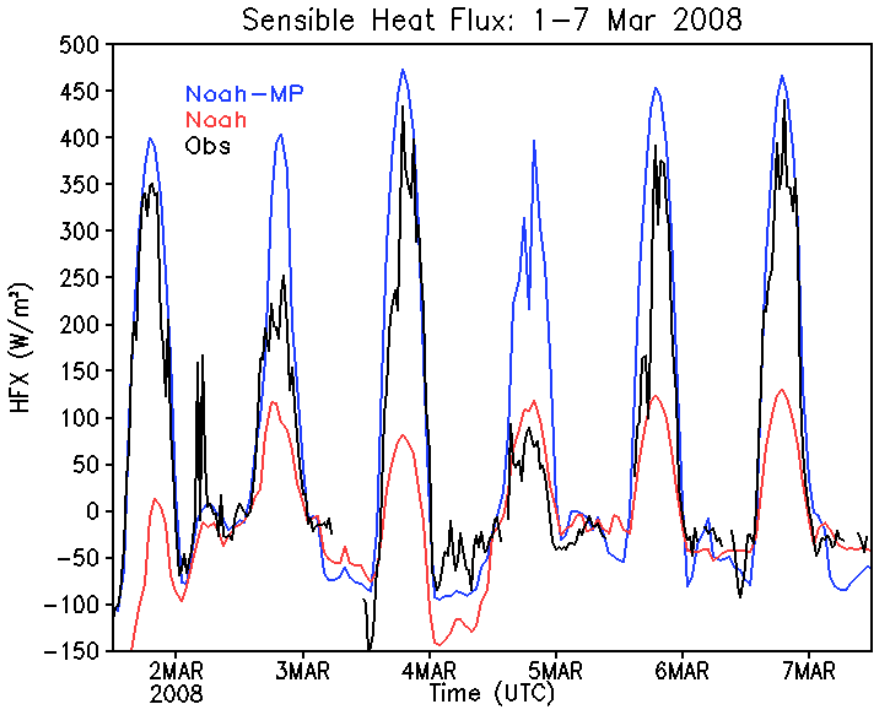
# Niwot Ridge: Sensible Heat Flux and 2m-Temperature 1-7 March 2008

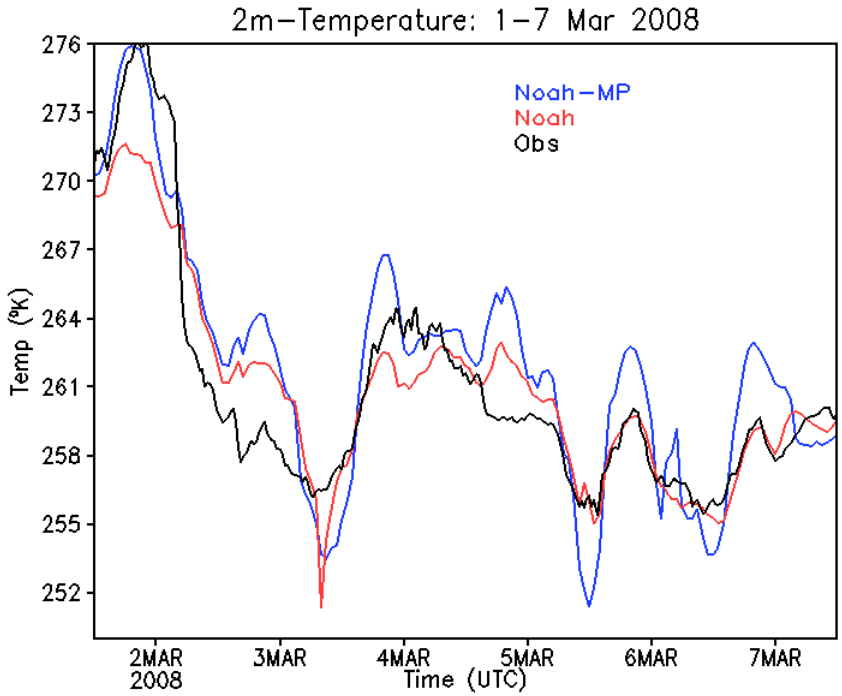


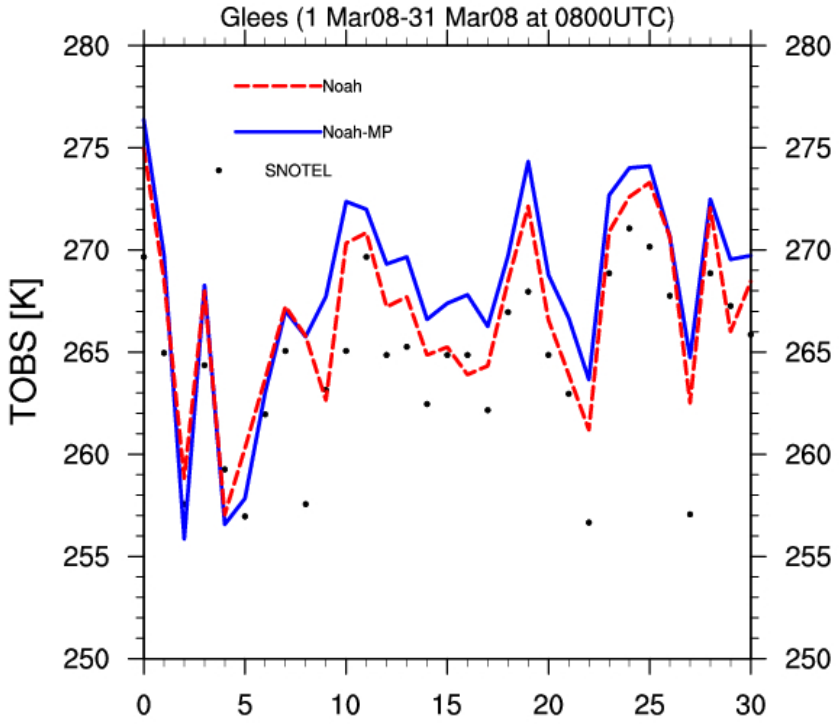

*Over snow-covered areas, Noah-MP produces lower surface albedo (closer to obs), higher sensible heating, and higher surface temperature than Noah*

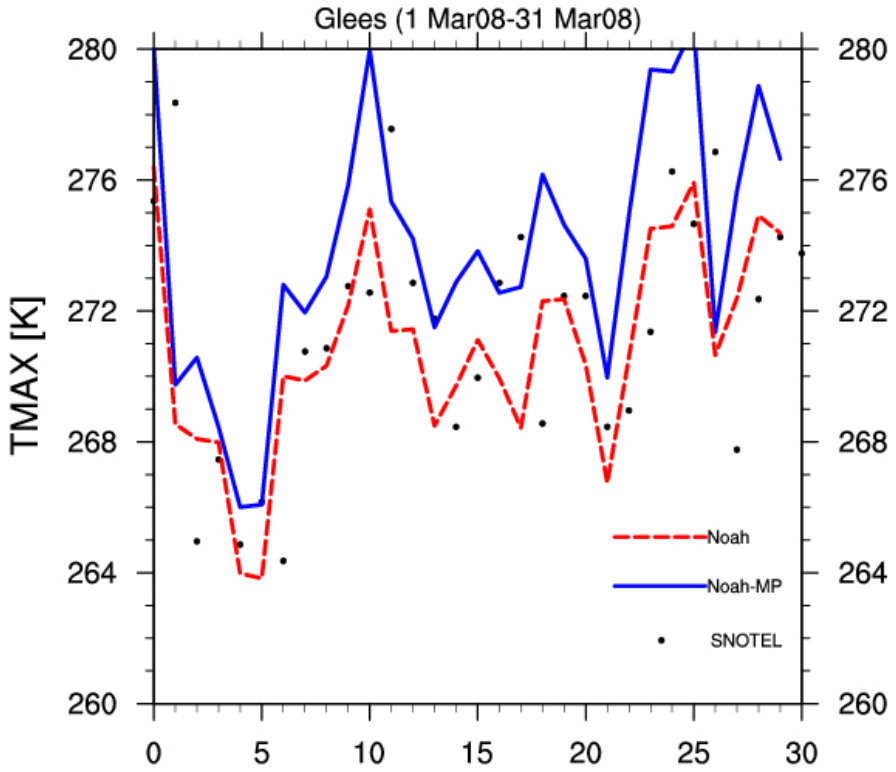
# GLEES: Sensible Heat Flux and 2m-Temperature
# 1-7 March 2008



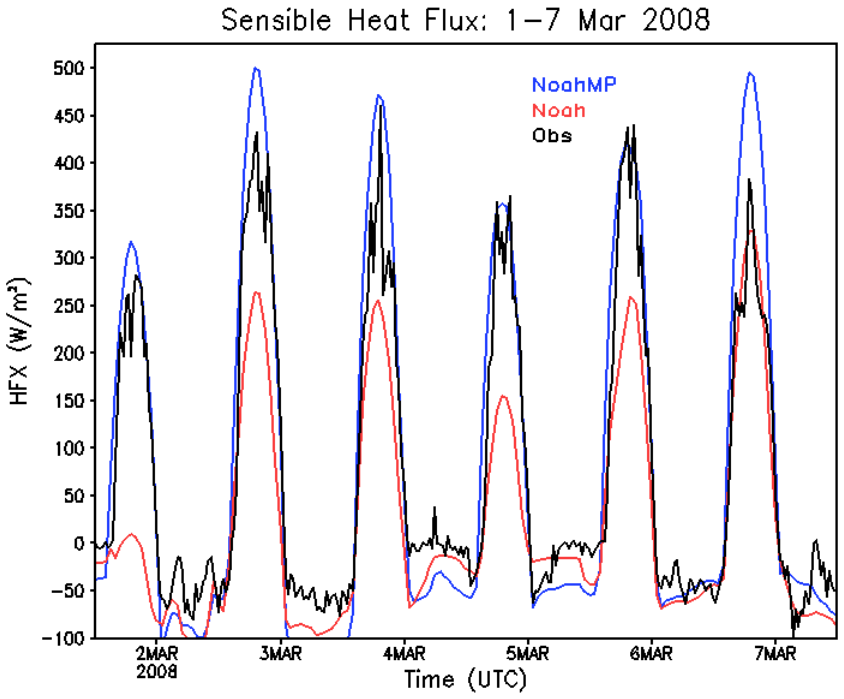



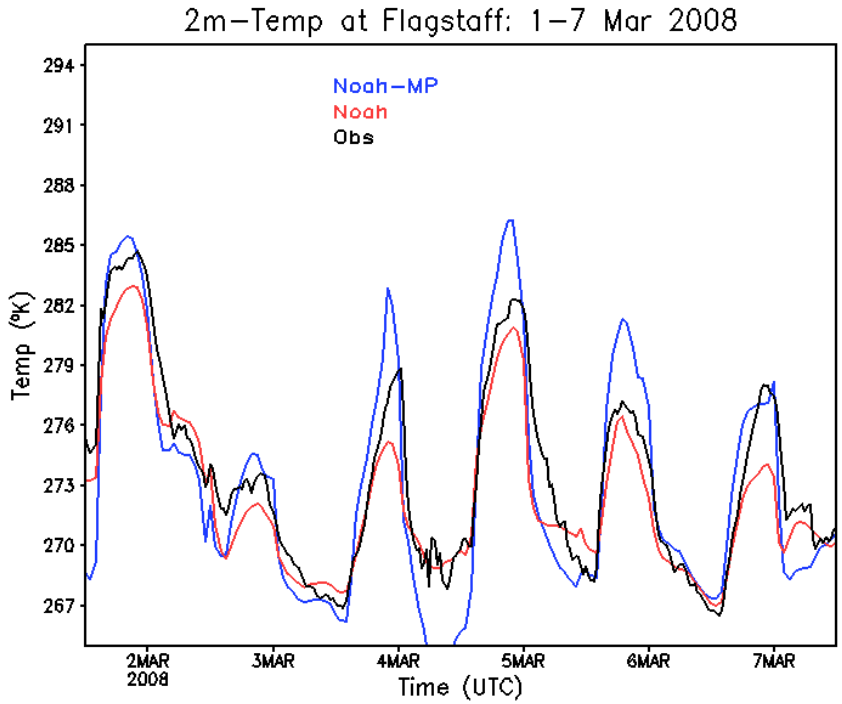
# GLEES Temperature comparison with SNOTEL



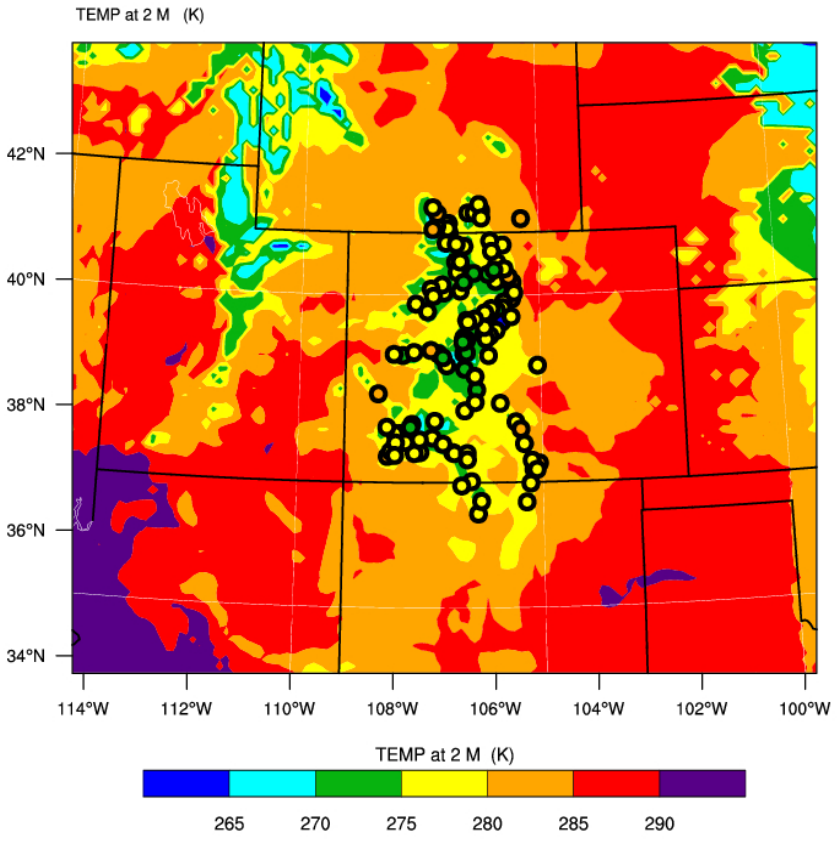
# Flagstaff: Sensible Heat Flux and 2m-Temperature 1-7 March 2008



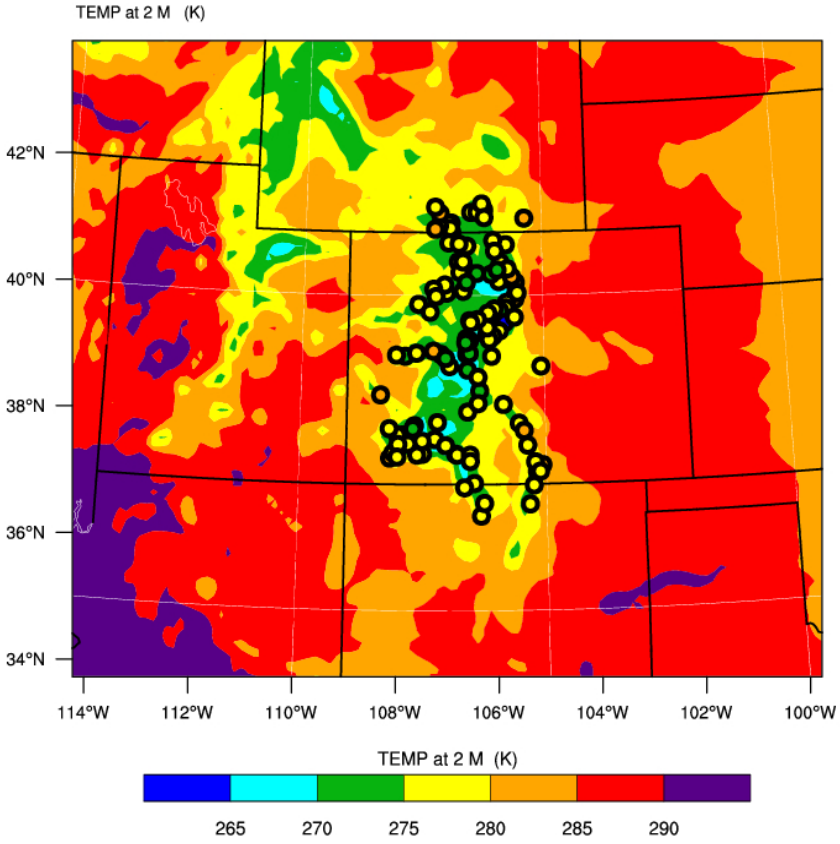



# Comparison with SNOTEL Temp: 15 Apr 2008

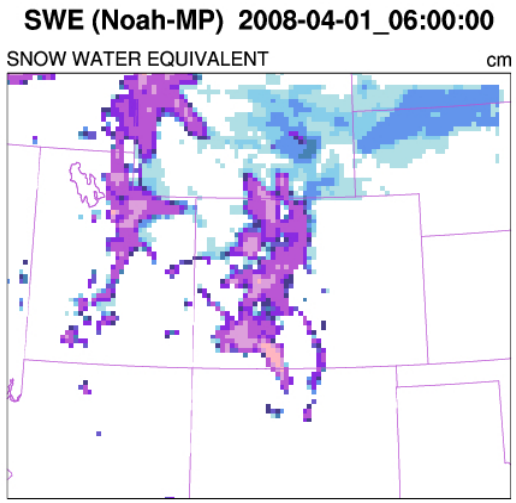
WRF/Noah-MP
24-hr Avg Temp

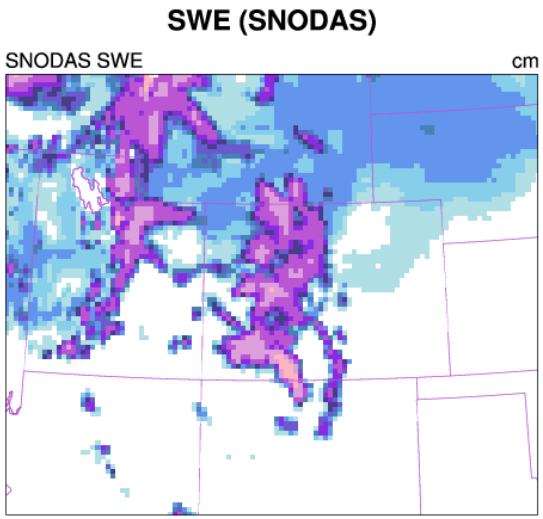


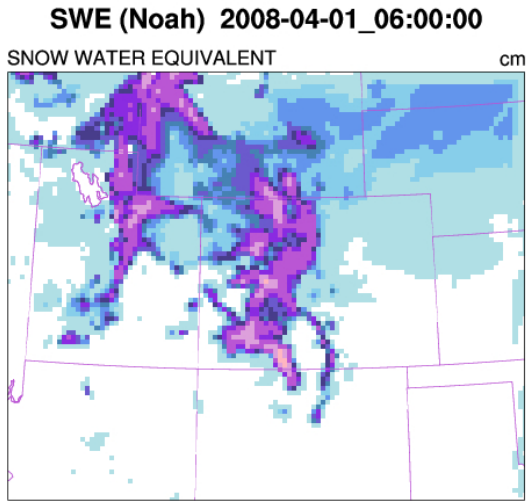

WRF/Noah
24-hr Avg Temp

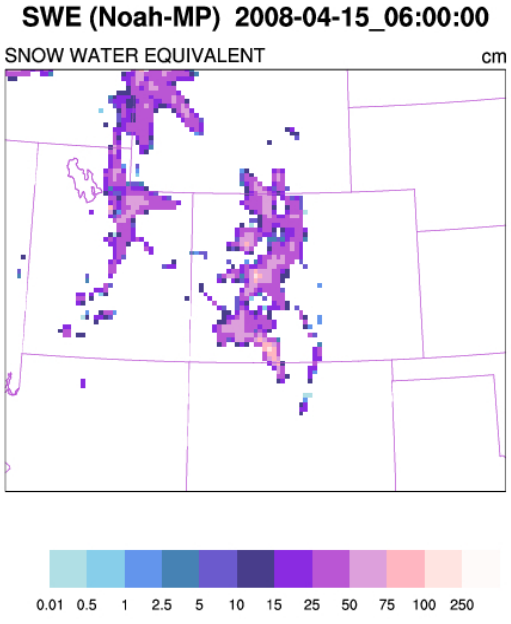


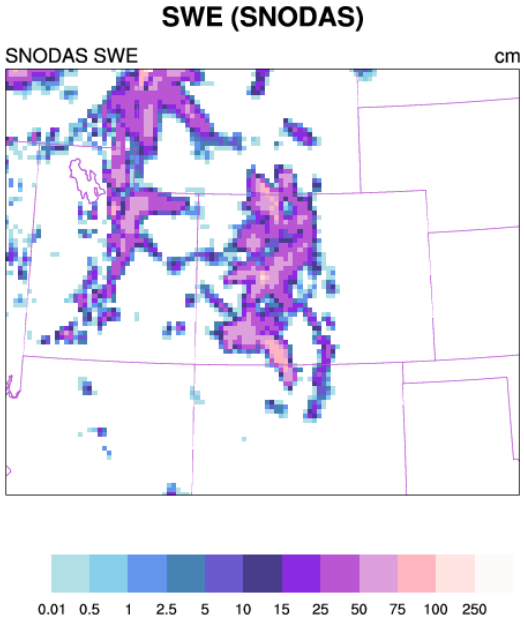
# SWE comparison with SNODAS
# 1 Apr & 15 Apr 2008 06UTC

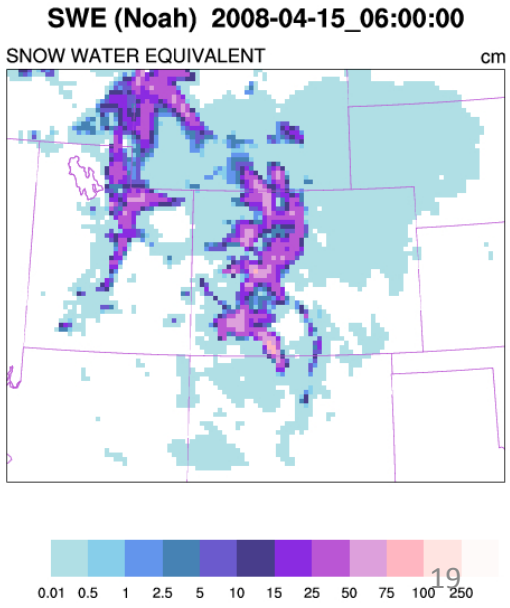


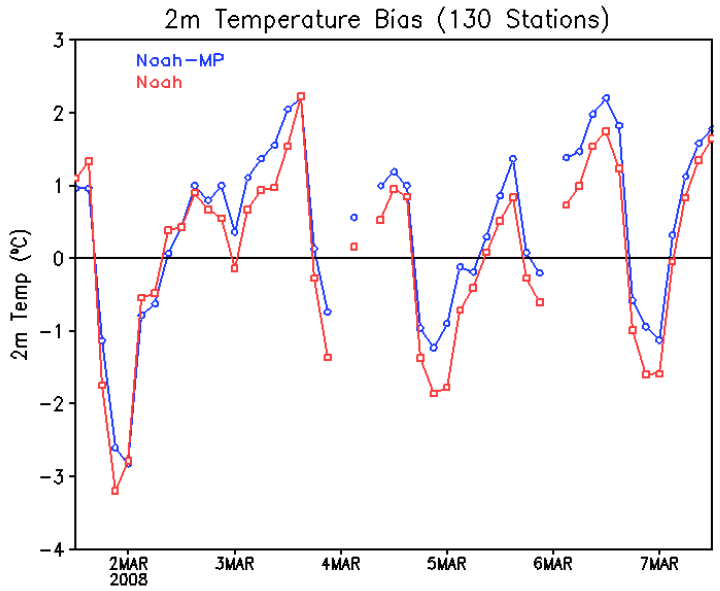



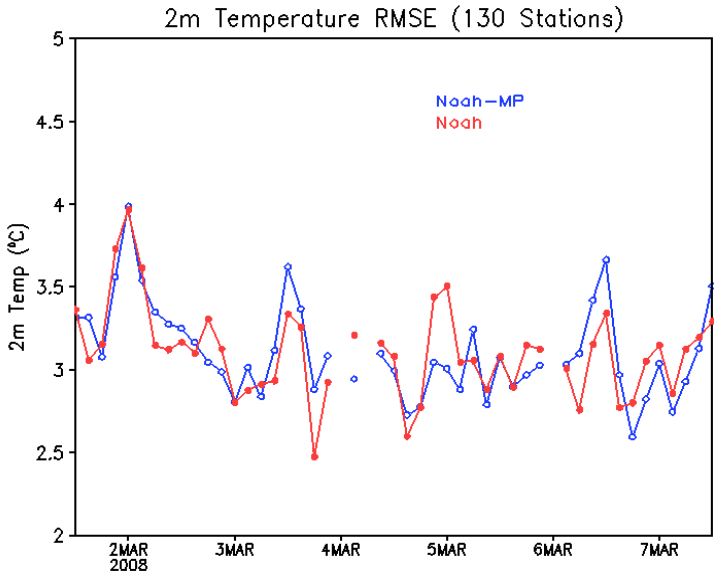



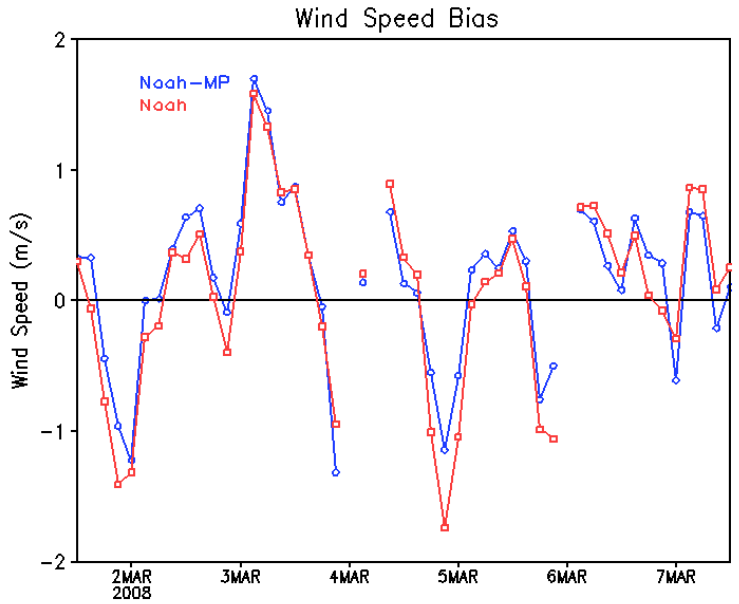



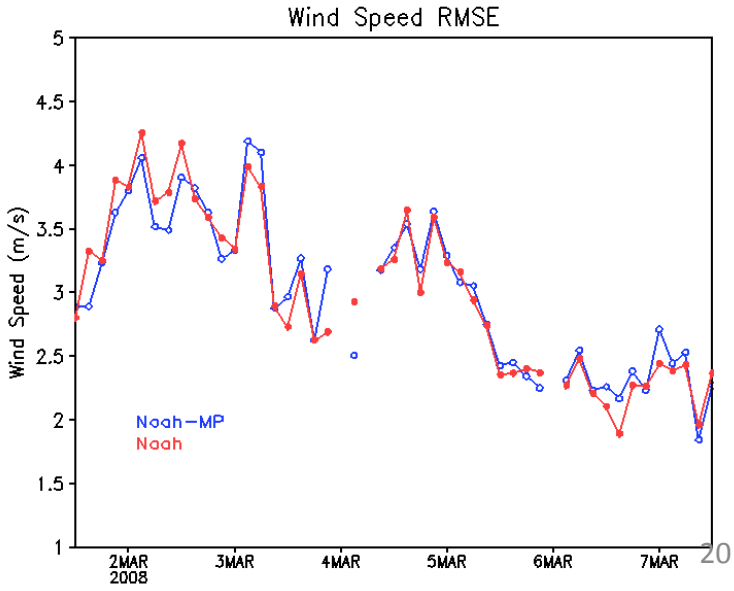



# 2m-T and 10-m Wind Bias and RMSE over the Domain 1-7 March 2008 (~140 Stations)



# Summary

- New Noah-MP LSM introduced into WRF Version 3.4
- Evaluations in summer and winter situations show overall good results as compared to Noah and to observations
  - Sensible and Latent heat fluxes reasonable in both summer and winter
  - Snow cover shows good melt-season behavior and higher temperatures
- Outstanding issues
  - Daytime T2 calculations in summer
  - Consistency between Noah-MP canopy radiation and turbulence with WRF physics
- Updates will be available with WRF 3.4.1 release