Surface layer parameterization in the NCEP operational NAM/WRF-NMM

Michael Ek, Ken Mitchell,
Vince Wong, Youlong Xia, Zaviša Janjić

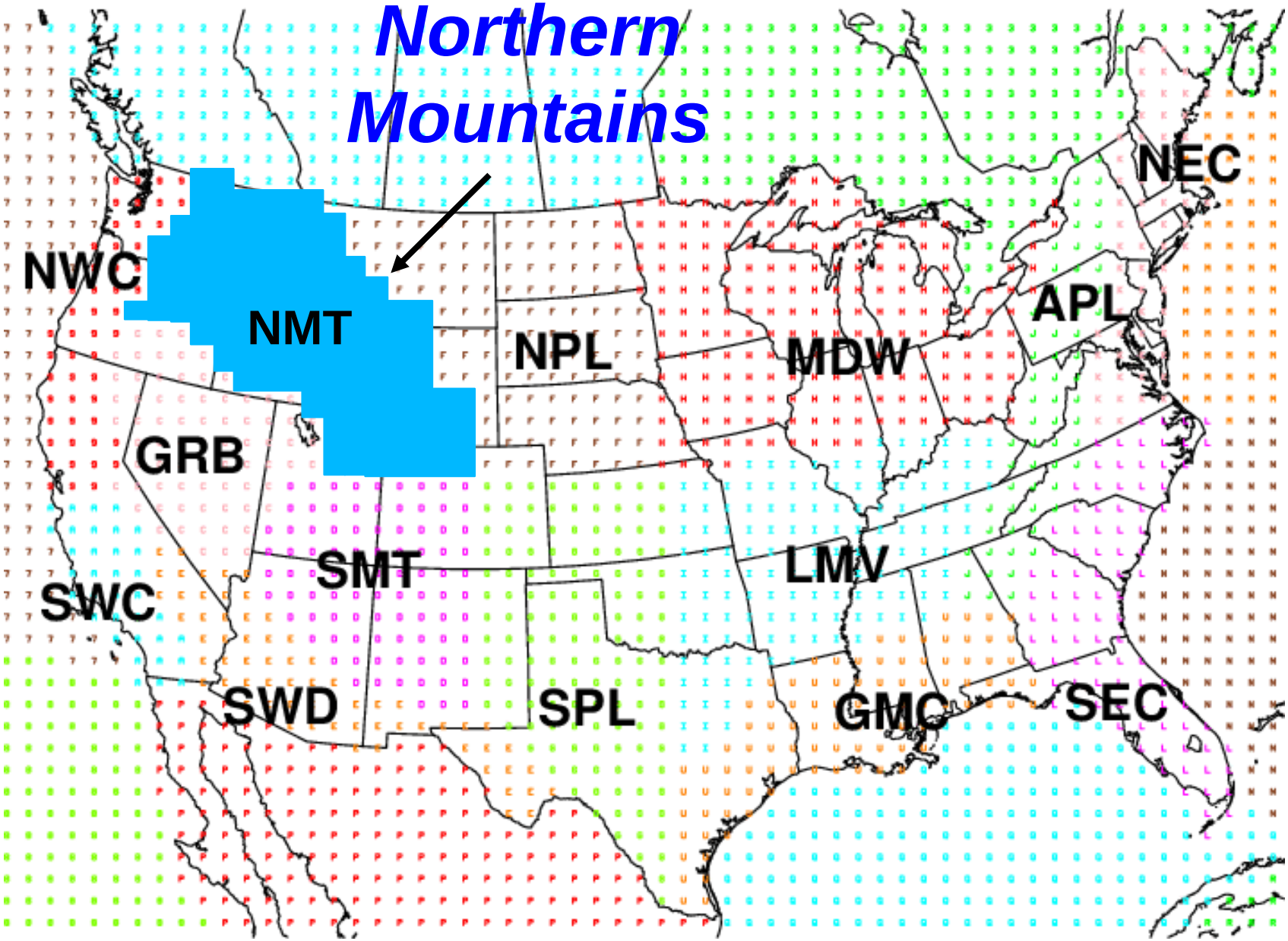
8th Annual WRF User's Workshop
11-15 June 2007, Boulder, Colorado, USA

To address a previous nighttime cold bias in NAM-Eta, roughness length for heat (z_{0T}) modified for stable conditions (used in NAM-WRF/NMM), so:

- z_{0T} smaller, plus nominally based on topography since higher-elevation regions in the West had strongest cold biases.
- less downward sensible heat flux & heat loss from atmosphere
- warmer 2-m air temperatures

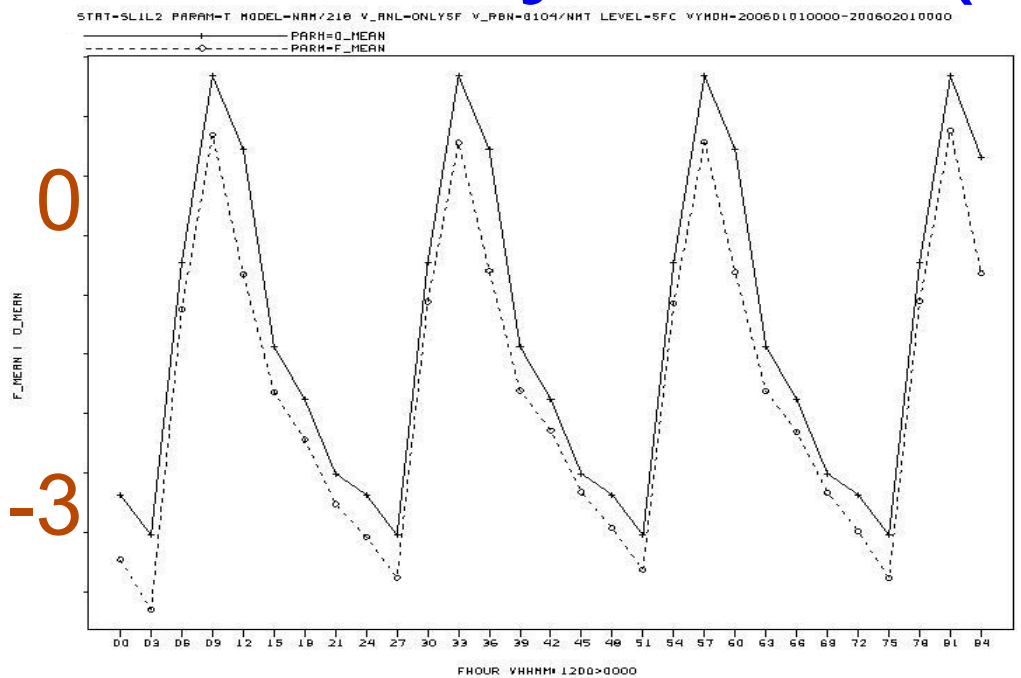
But now, nighttime temperatures too warm in mountainous regions.

NCEP forecast verification system regions



January **monthly mean** diurnal 2-m air temperature for NMT:

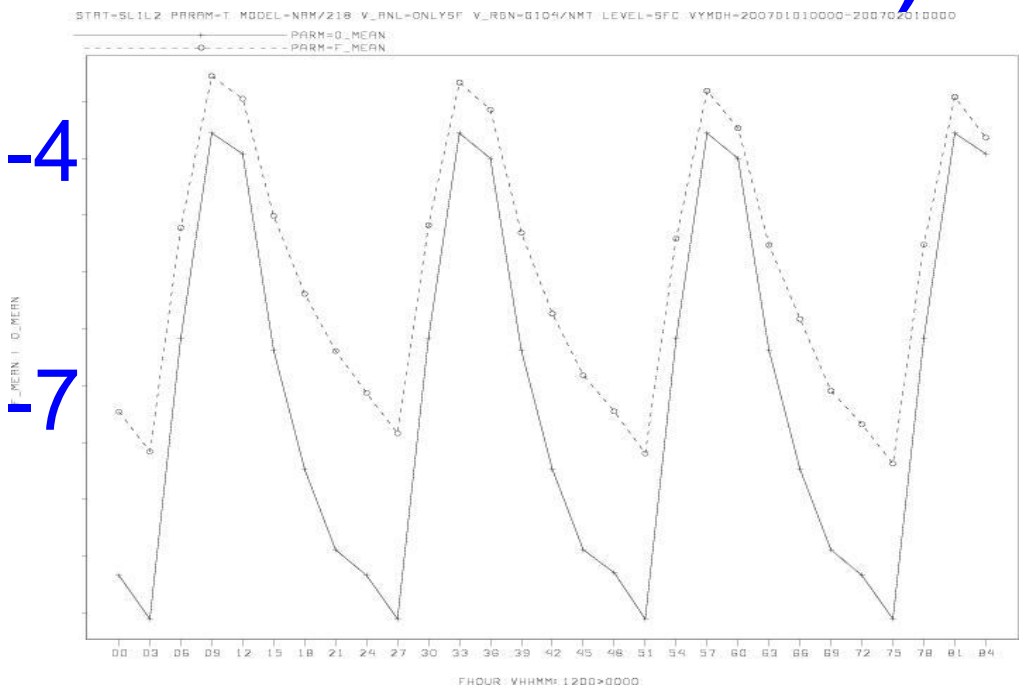
January 2006 (NAM-Eta) vs January 2007 (NAM-WRF/NMM)



00-hr 84-hr

~1C nighttime cold bias

Jan-2006



00-hr 84-hr

2C+ nighttime warm bias

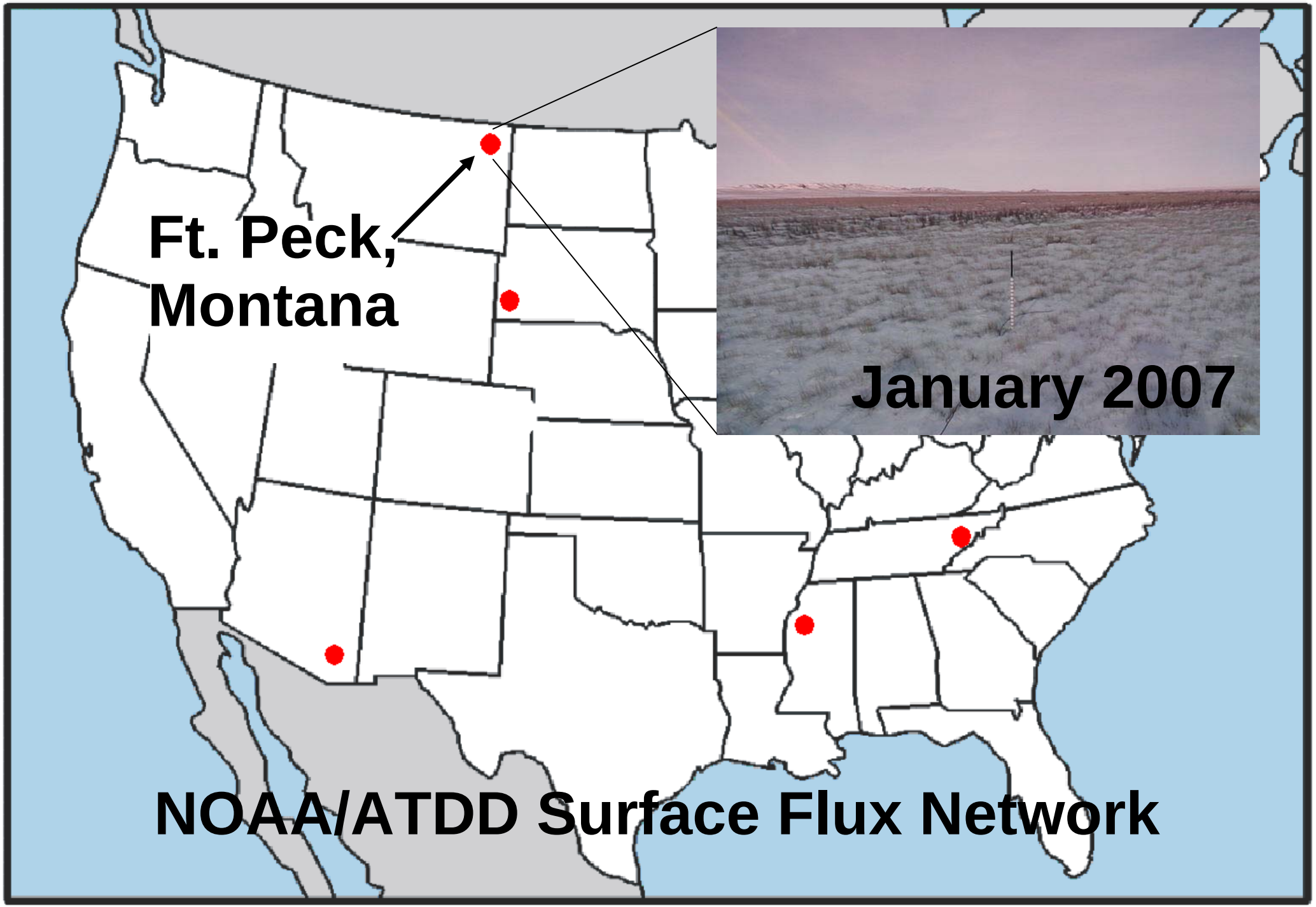
Jan-2007

Use surface flux observations to infer aerodynamic conductance

Sensible heat flux:

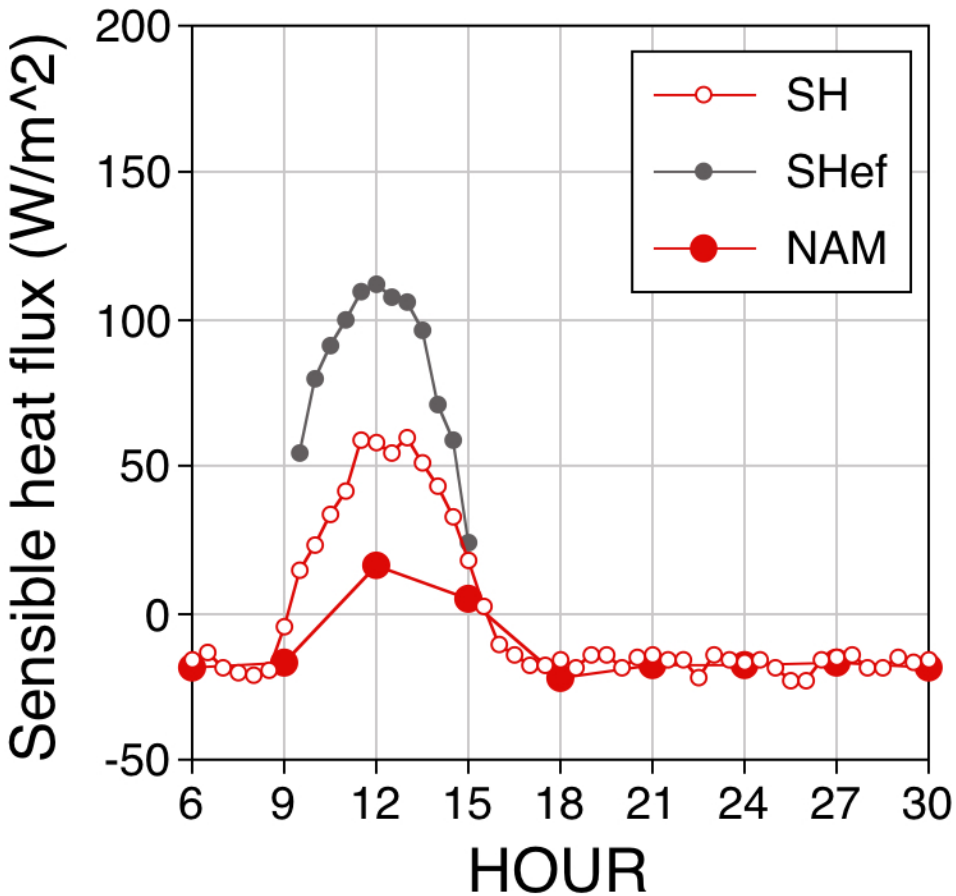
$$H = \rho\, c_p\, C_h\, U\, (T_{sfc} - T_{air})$$

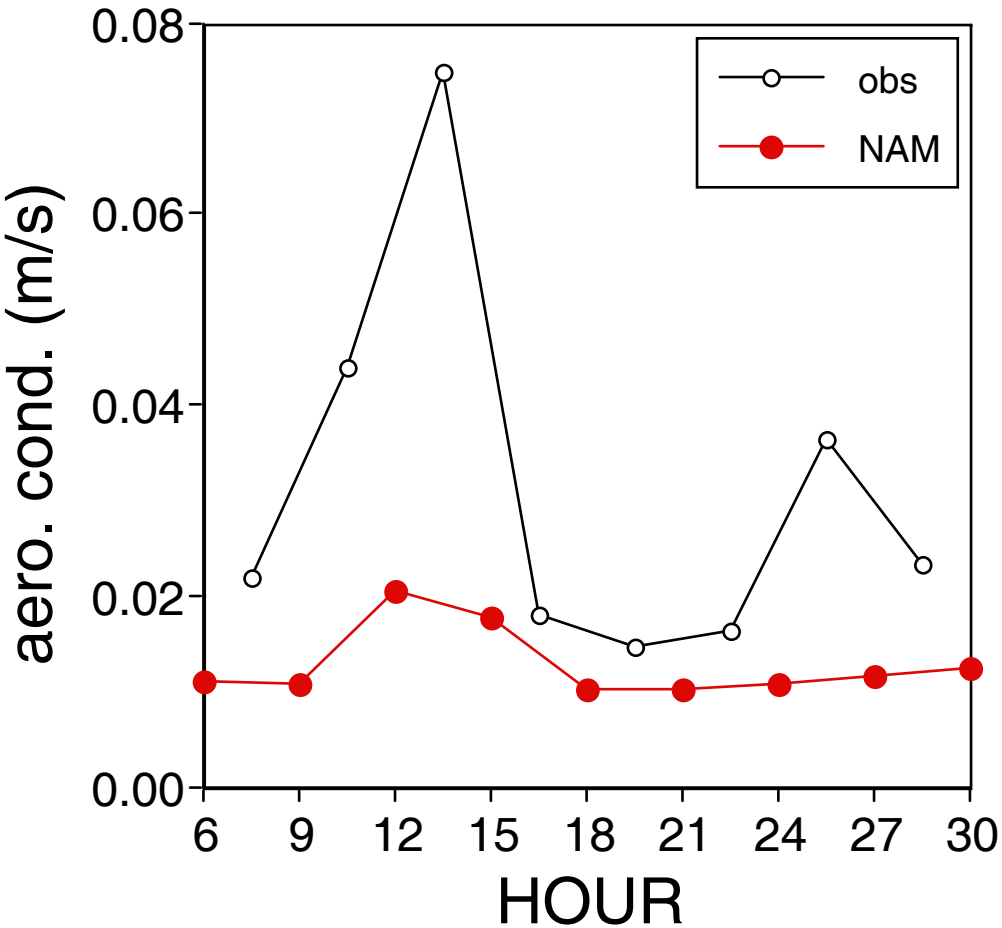
$C_h\, U$ = aerodynamic conductance [m/s] = surface exchange coefficient x wind speed


Ft. Peck,
Montana
January 2007
NOAA/ATDD Surface Flux Network

January 2007 average diurnal cycle of sensible heat flux and aerodynamic conductance

Ft. Peck,MT obs & NAM 12-36h fcst



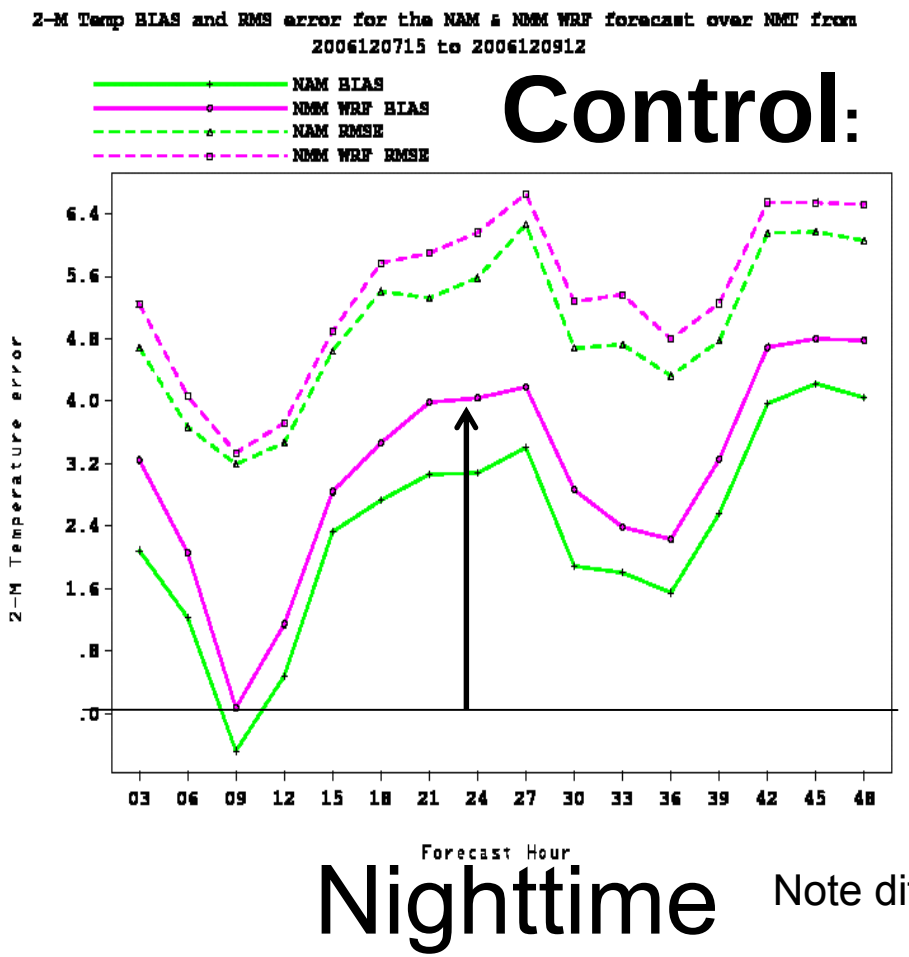


Change surface layer treatment so roughness length for heat modified for stable conditions *only* as a function of increasing stability (based on near-surface bulk Richardson number).

Impact test of surface layer changes 8-Dec-2006/12z, 48-hr runs: NMT

Green lines: existing operational NAM-WRF/NMM in both panels

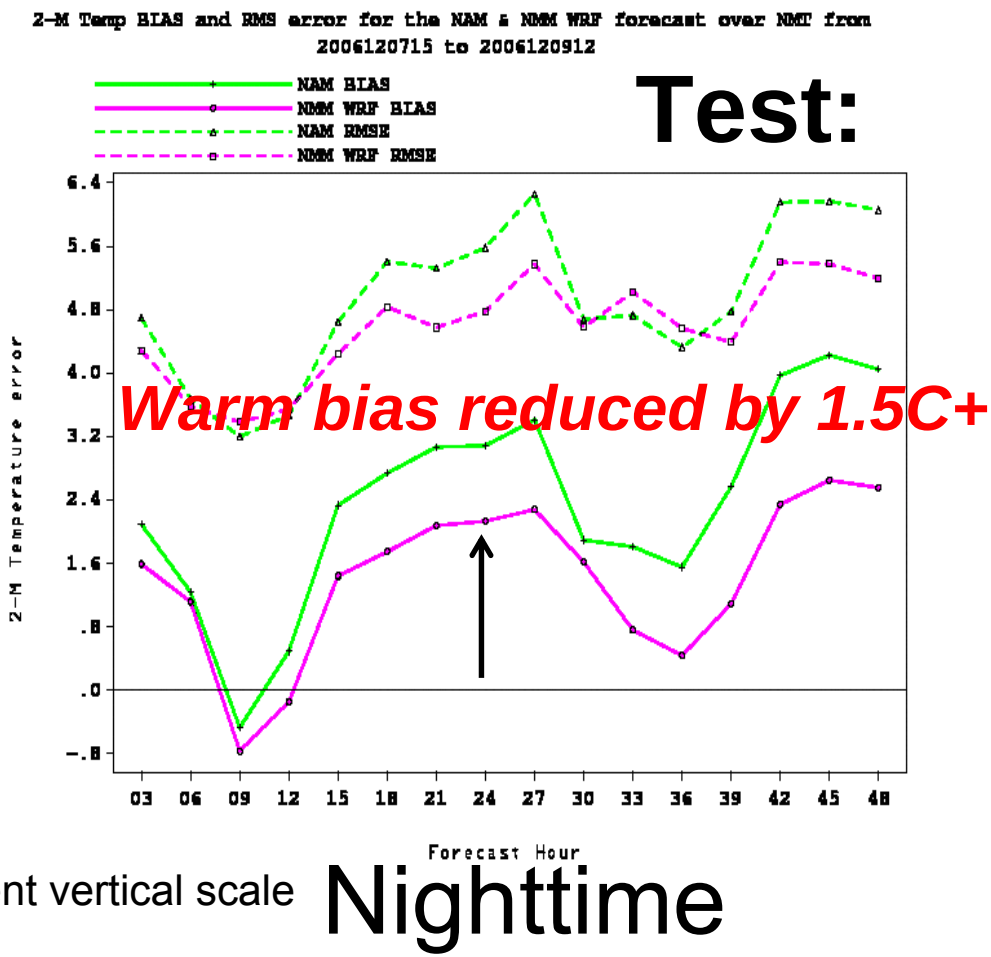
Purple lines: control (L) and test (R) runs



Control:

Nighttime

Note different vertical scale



Test:

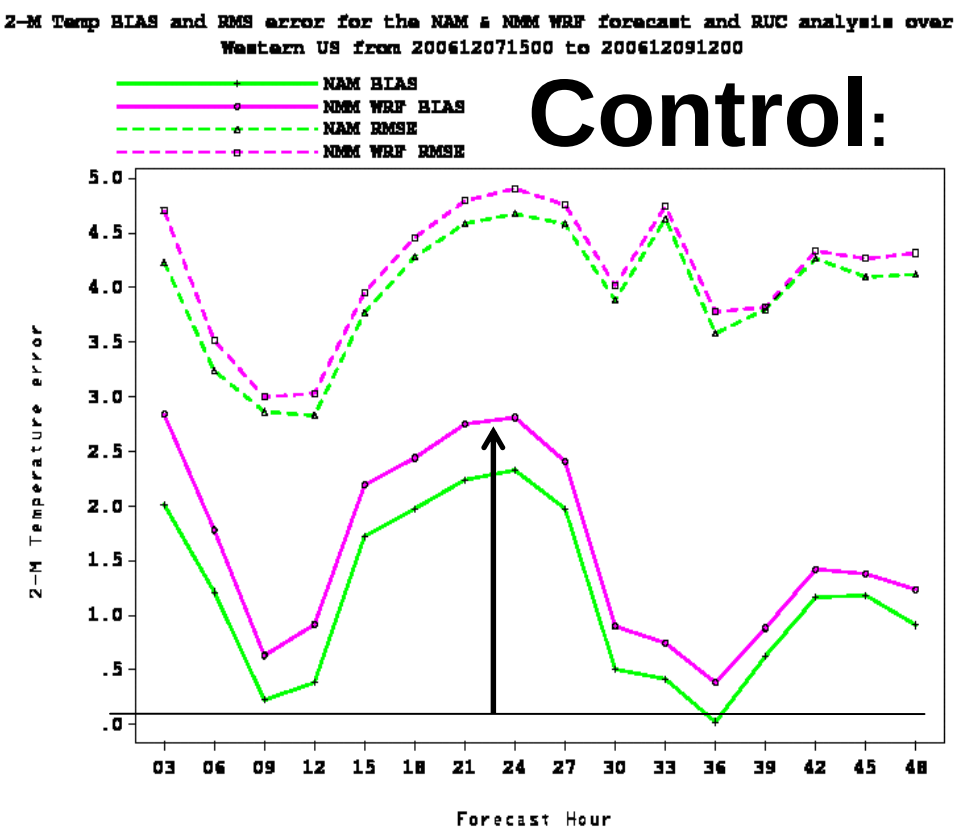
Warm bias reduced by 1.5C+

Nighttime

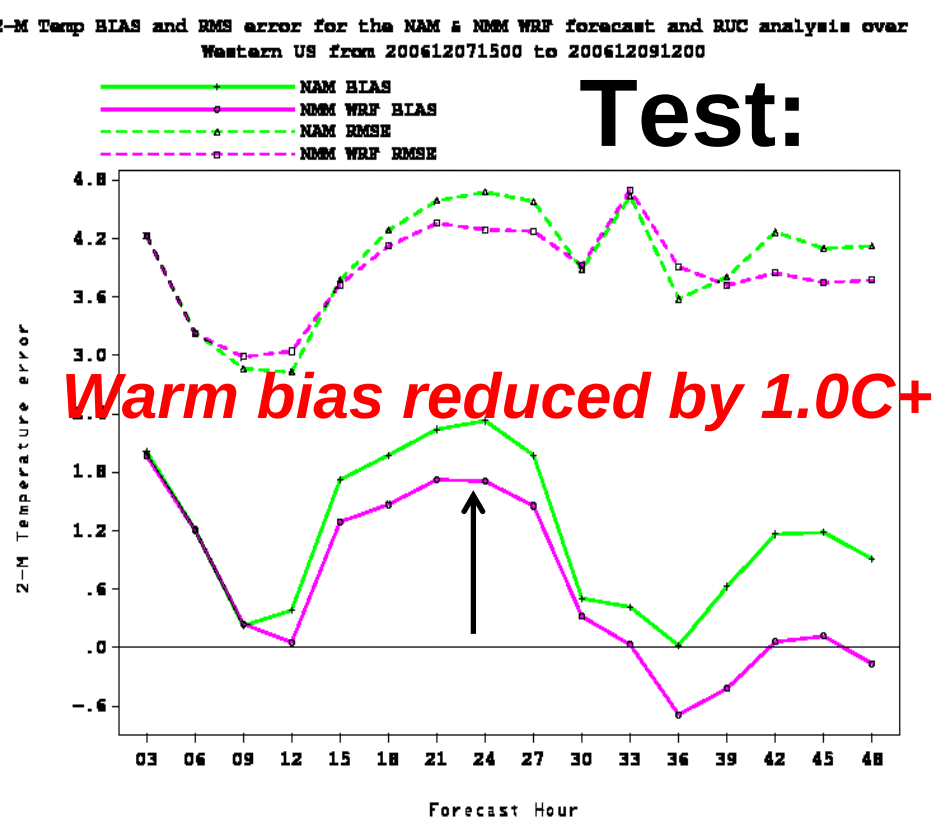
Impact test of surface layer changes 8-Dec-2006/12z, 48-hr runs: WEST

Green lines: existing operational NAM-WRF/NMM in both panels

Purple lines: control (L) and test (R) runs



Control:



Test:

Warm bias reduced by 1.0C+

Nighttime

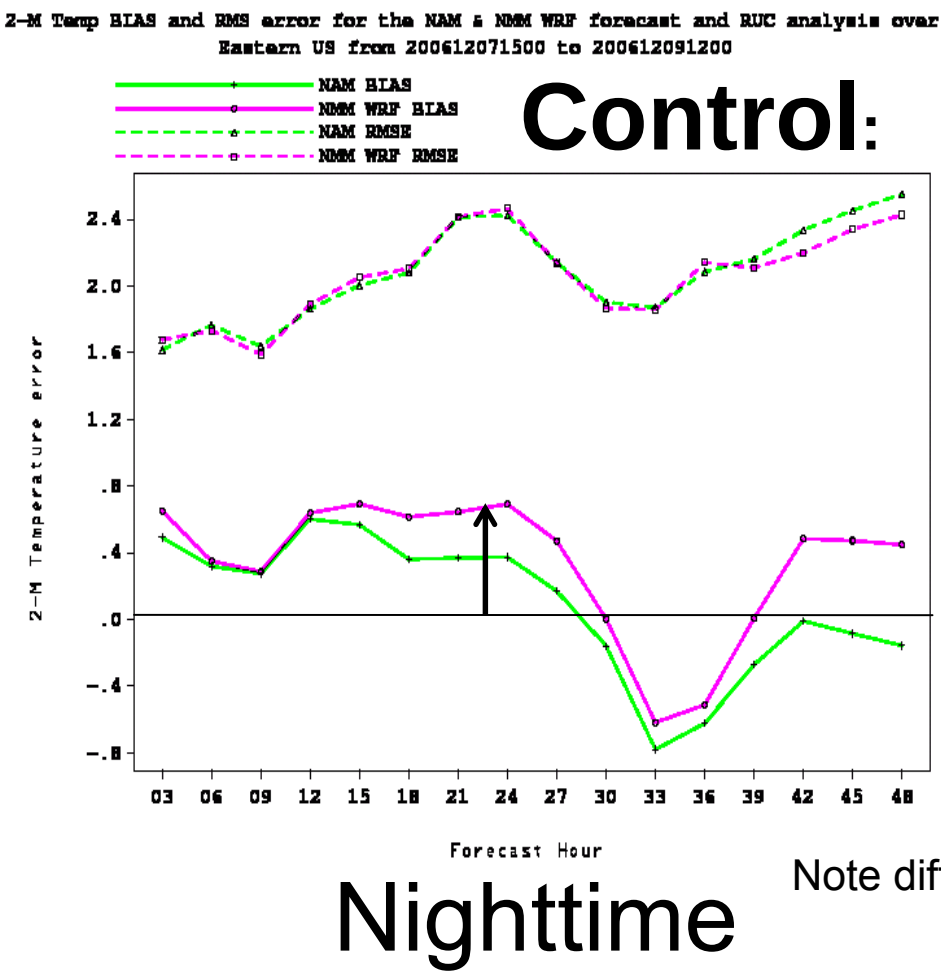
Note different vertical scale

Nighttime

Impact test of surface layer changes 8-Dec-2006/12z, 48-hr runs: EAST

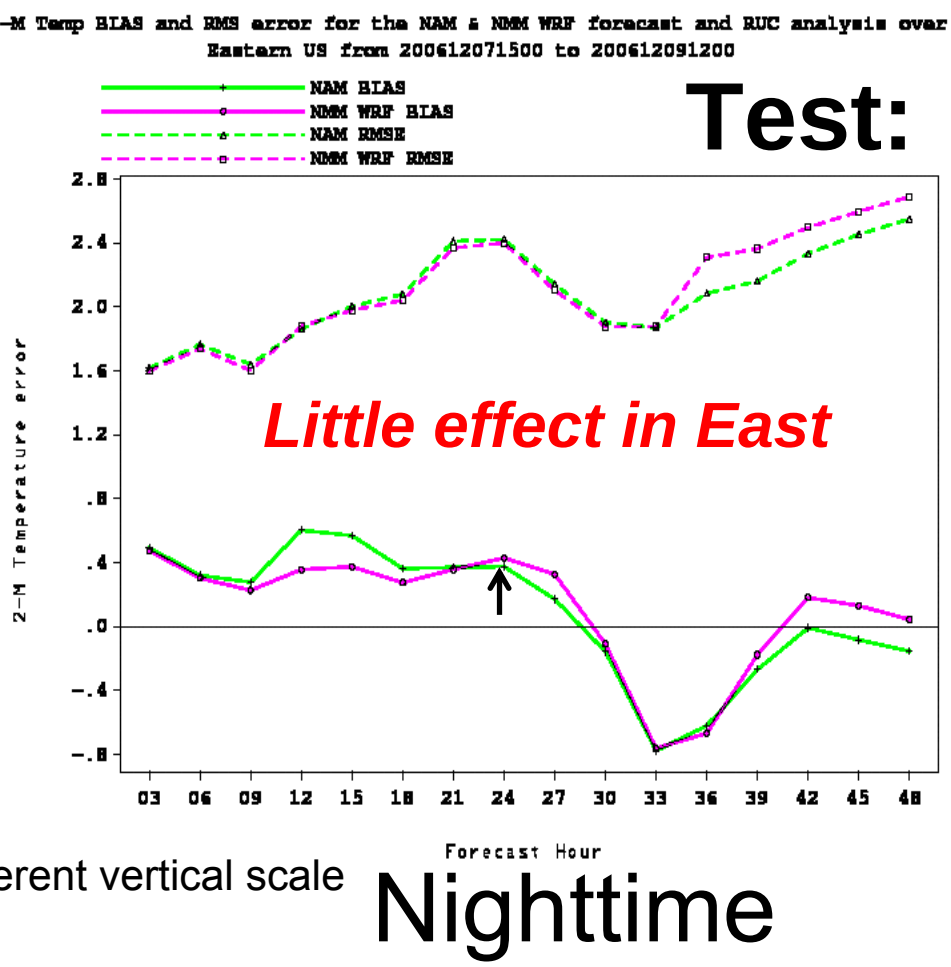
Green lines: existing operational NAM-WRF/NMM in both panels

Purple lines: control (L) and test (R) runs



Control:

Nighttime



Test:

Nighttime

Note different vertical scale

Summary & Future

For stable conditions, modify z_{0T} such that downward flux to surface increased -> reduces warm bias in low-level air temp.

Check consistency with PBL physics.

More analysis of observations, other sites/ times to determine aero. conductance, Tskin, roughness lengths for heat/moisture & momentum, other (e.g. canopy conductance).

More model runs and analysis of output, further aero. cond., Tskin, etc verif., extend to other case studies, retrospective runs (cycled).


End