Impact study of WRF changes

and

Sensitivity study on turbulent mixing of tracer species

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NWS/NCEP/EMC & NOAA/OAR/ARL - EPA

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WRF upgrades on June 19, 2007

- **Roughness length corrections: reduce warm bias in mountainous regions under stable conditions:** roughness length for heat modified for stable conditions *only* as a function of increasing stability (based on near-surface bulk Richardson number).
- **Increased the floor values of canopy resistance for evergreen needle-leaf and mixed forests to emulate a more realistic stomatal control in those categories: reduce high moisture bias in Pacific northwest, State of Oregon and Northern California.**

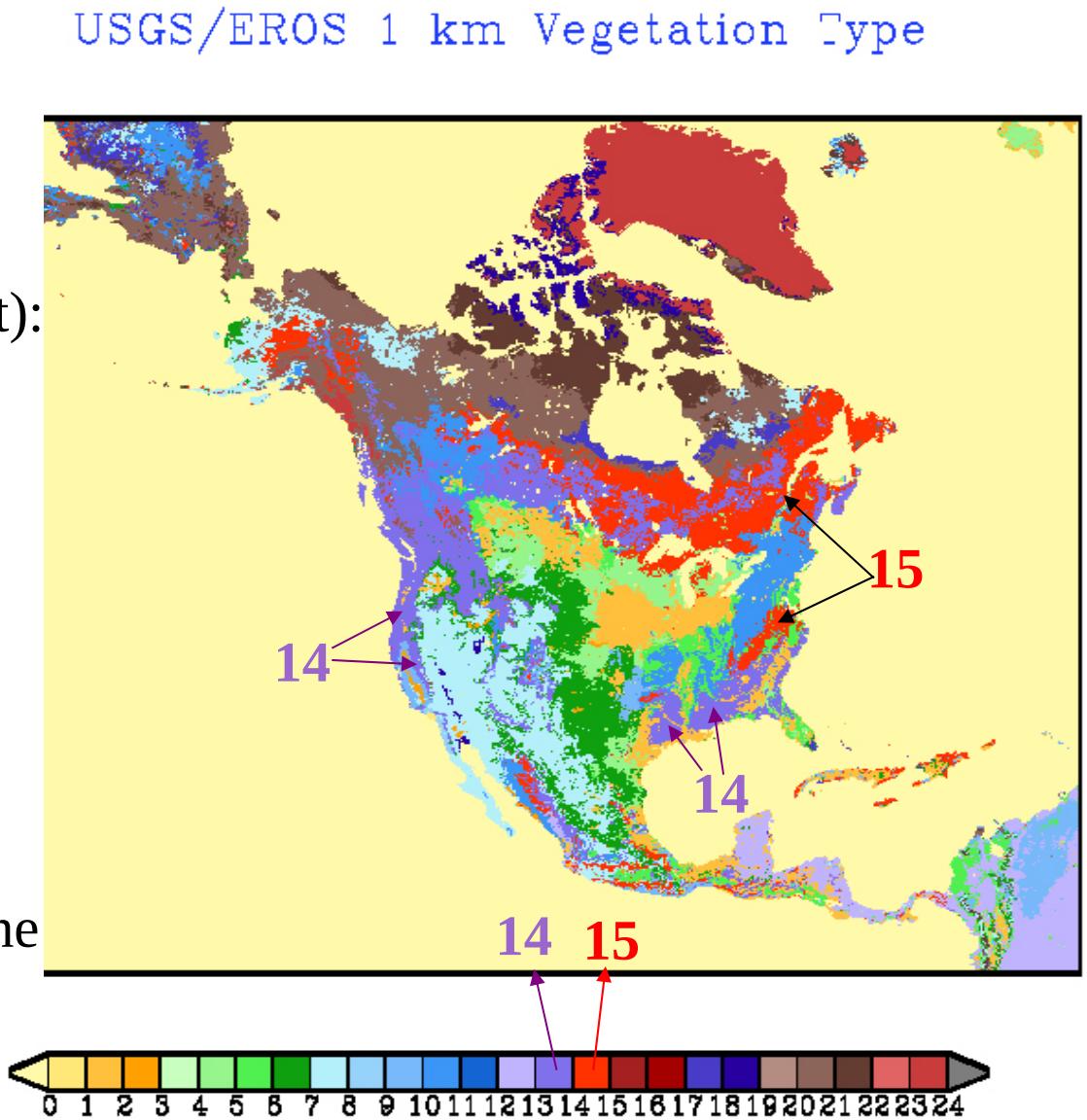
http://wwwt.emc.ncep.noaa.gov/mmb/mmbpll/eric.html

RSMIN (minimum canopy resistance) increases

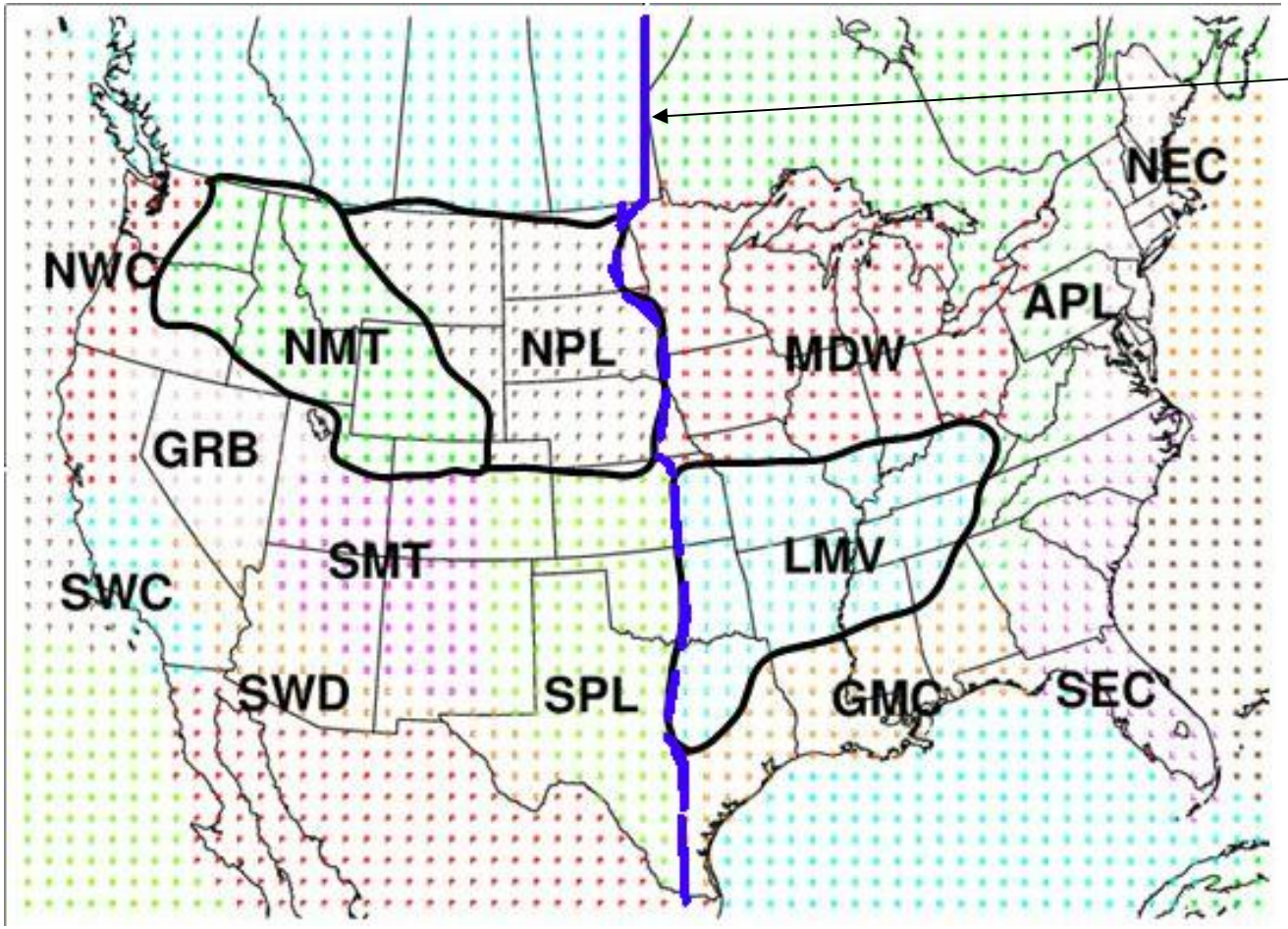
Category14 (evergreen forest): changed from 125 to 250 s/m

Category 15 (mixed forest): changed from 125 to 150 s/m

More dramatic reductions in midday latent heat flux (and 2-m dew point temperatures) over category 14 areas over the Pac NW and spots in SE US



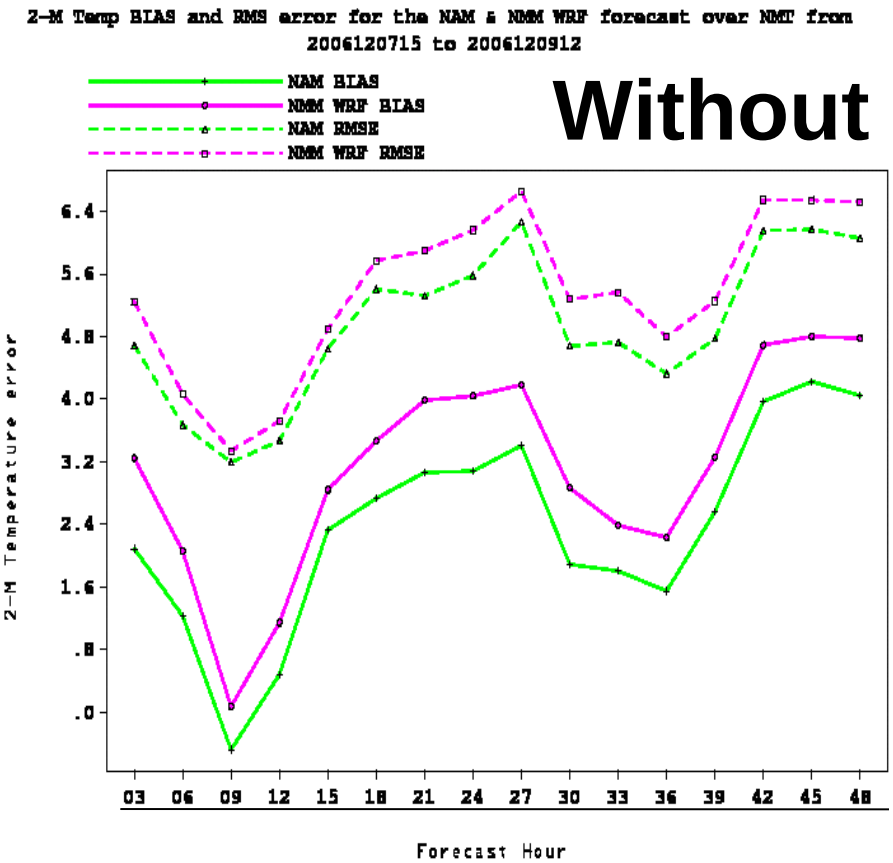
Verification system regions for meteorology

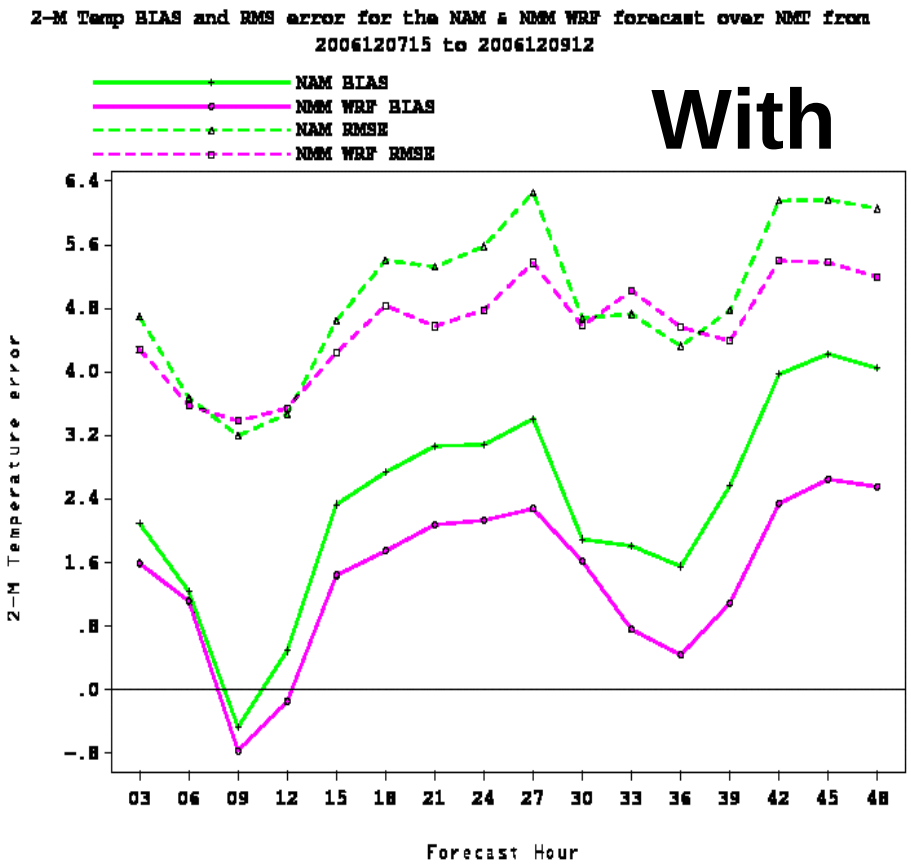


Dividing line between East and West

Impact test of Z_o correction:

2-m Temperature 8-Dec-2006/12z, 48-hr runs: NMT

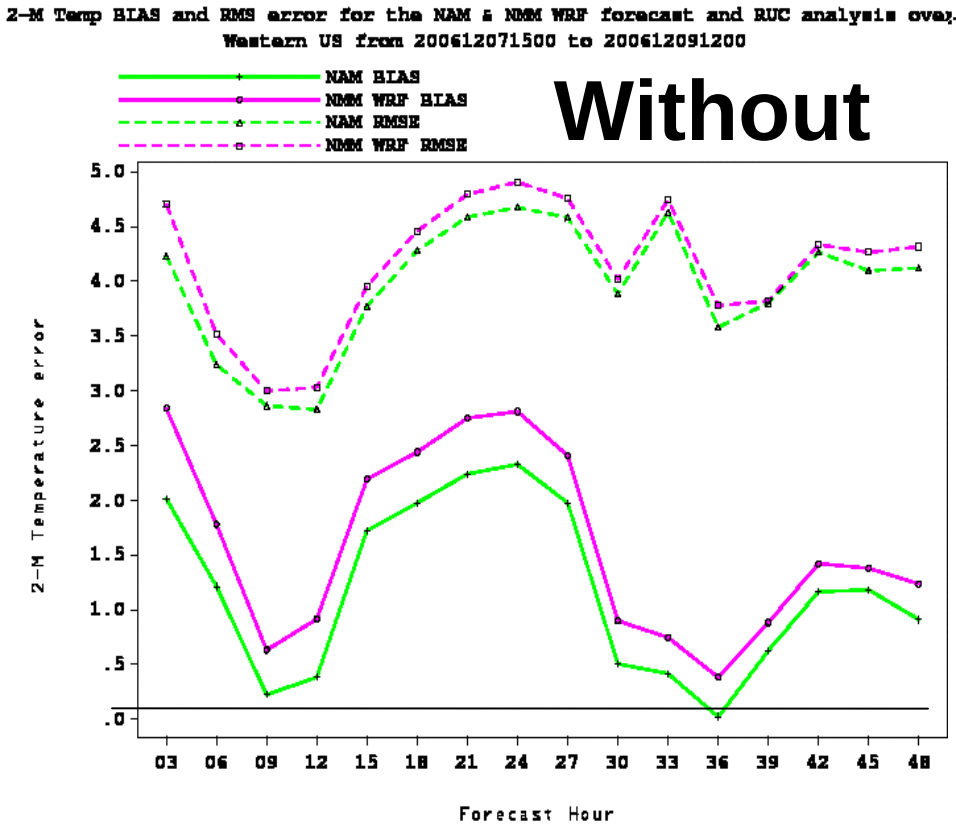


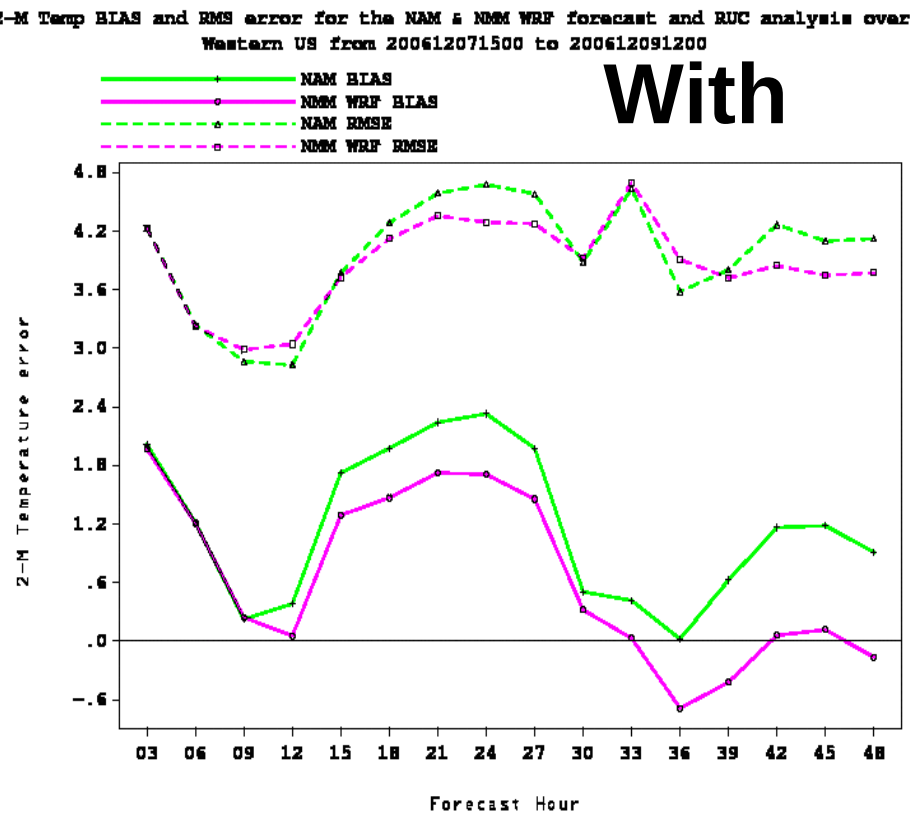


Correction achieved reductions in MB and RMSE for winter case

Impact test of Z_o correction:

2-m Temperature 8-Dec-2006/12z, 48-hr runs: West

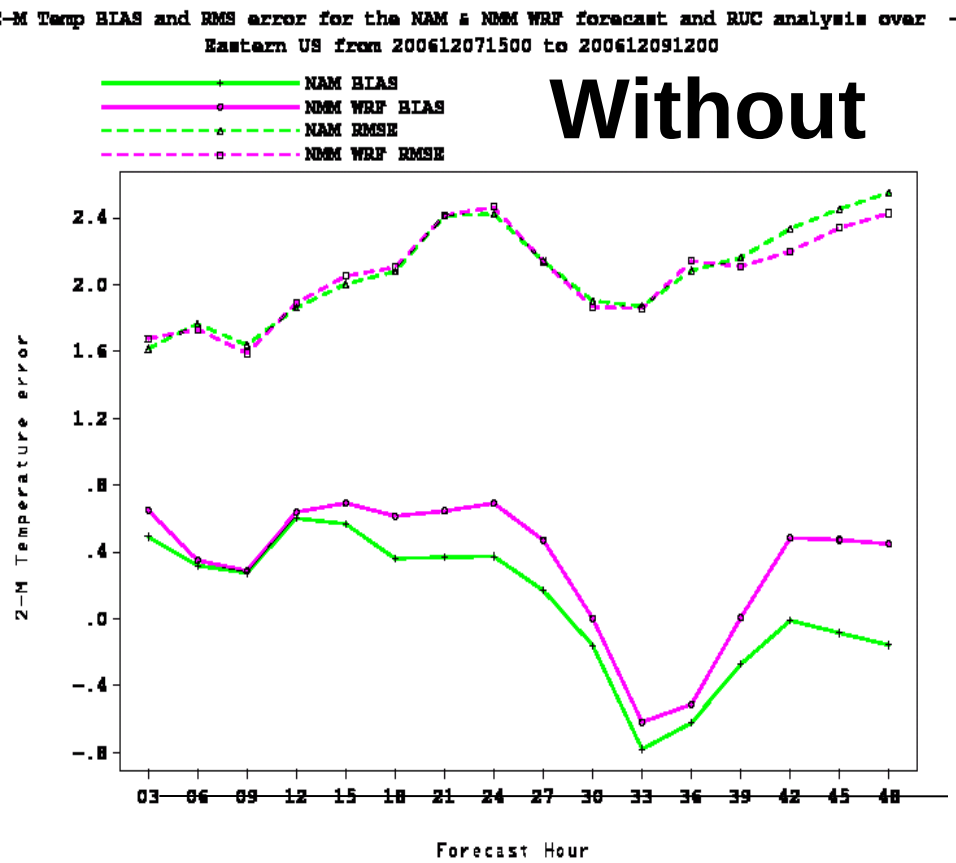


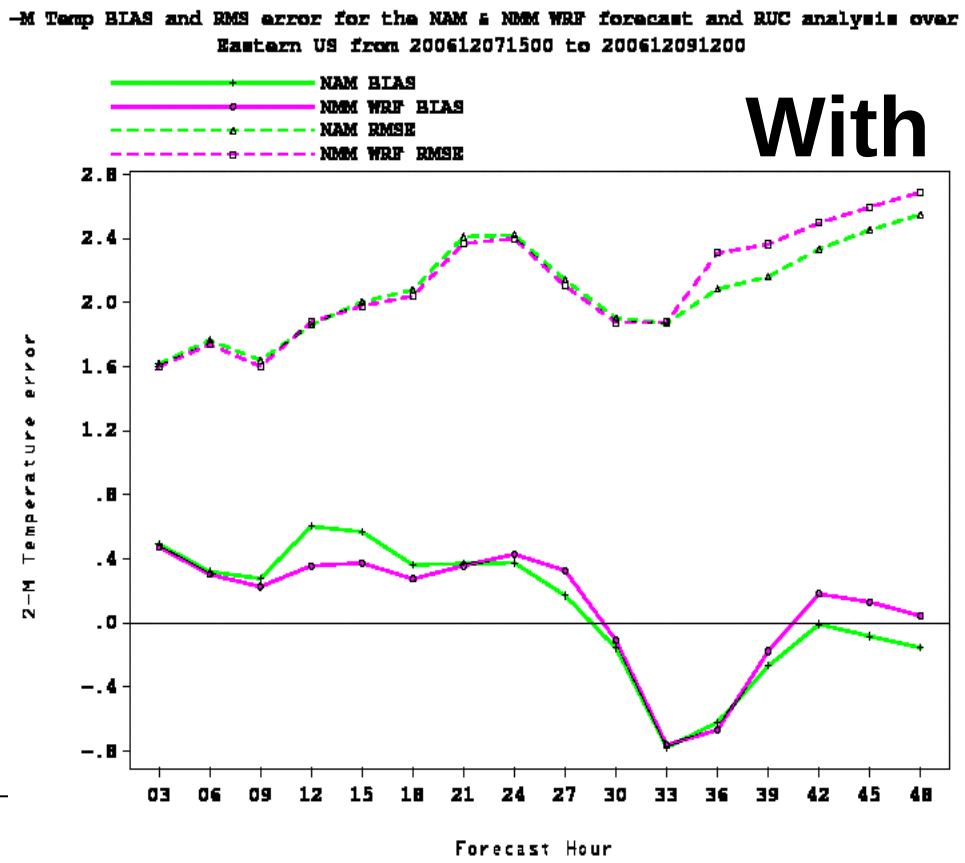


Correction achieved reductions in MB and RMSE for winter case

Impact test of Z_o correction:

2-m Temperature 8-Dec-2006/12z, 48-hr runs: East





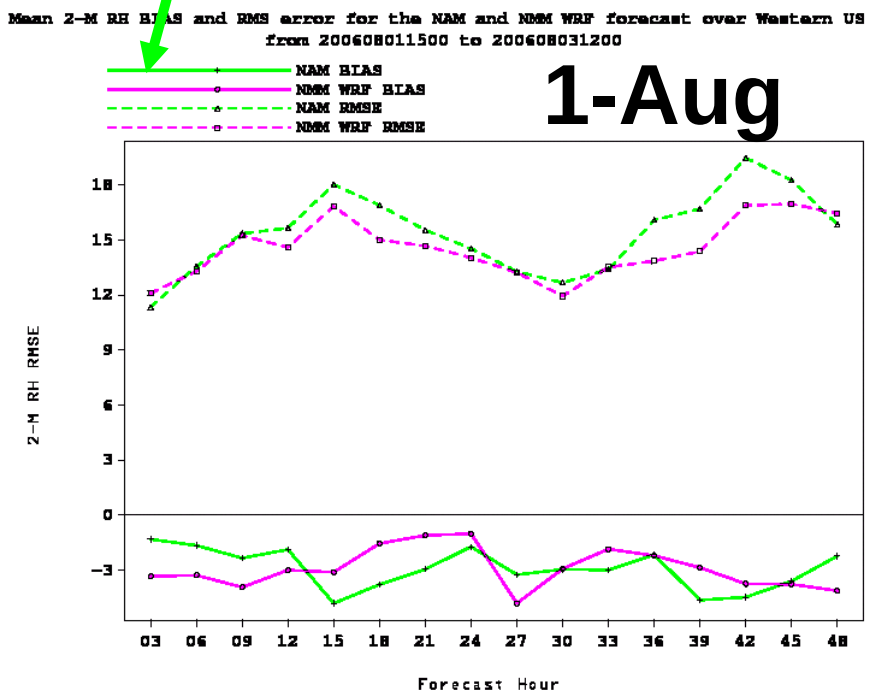
Correction aggravated MB and RMSE somewhat for eastern region

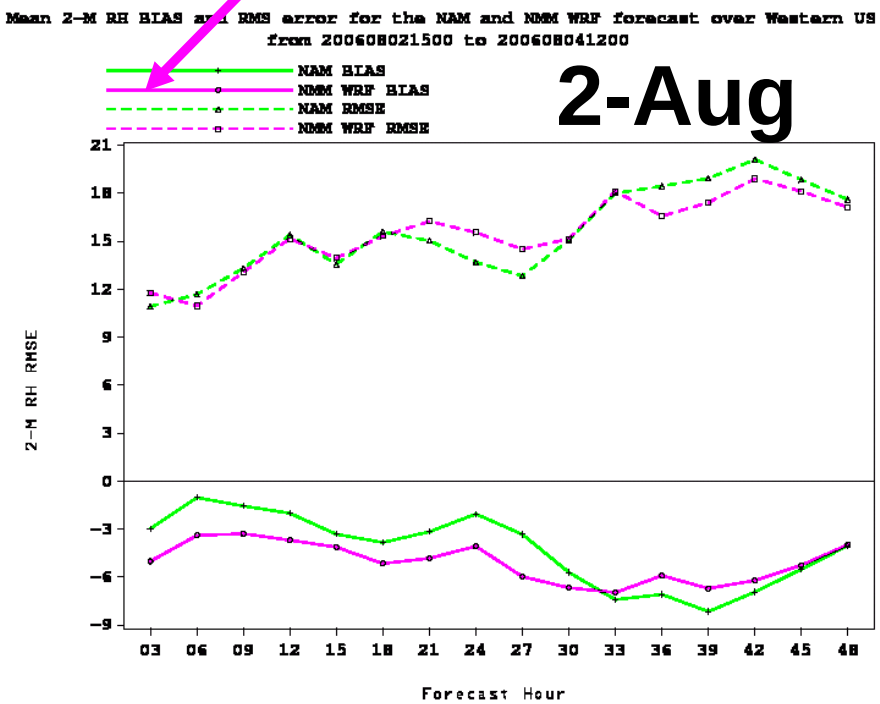
Impact test of Z_o and Rsmin corrections:

2-m Relative Humidity1/2-Aug-2006/12z, 48-hr runs: West

Green for without changes

Purple for with changes

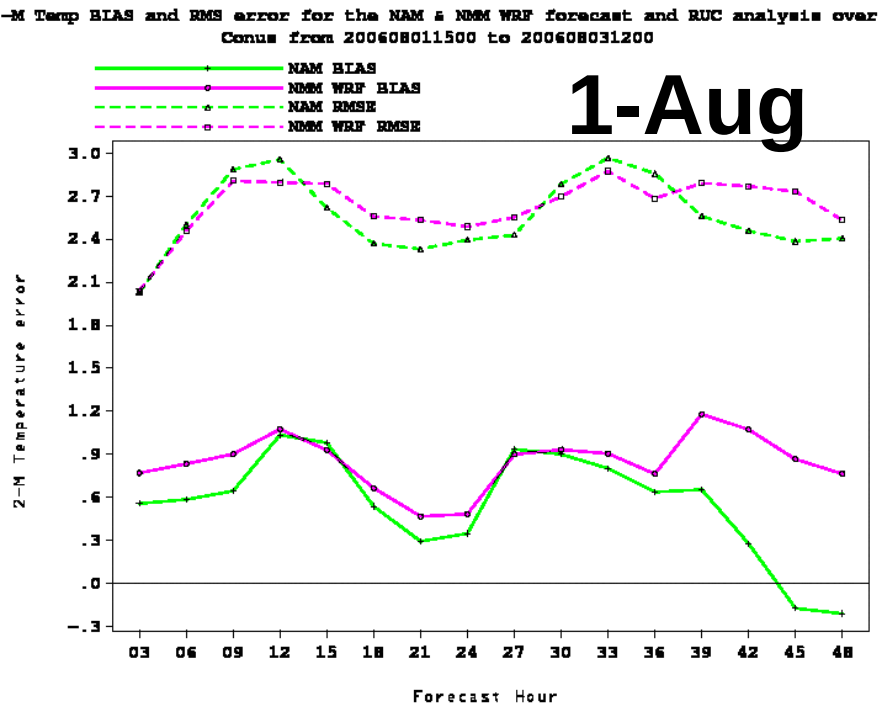


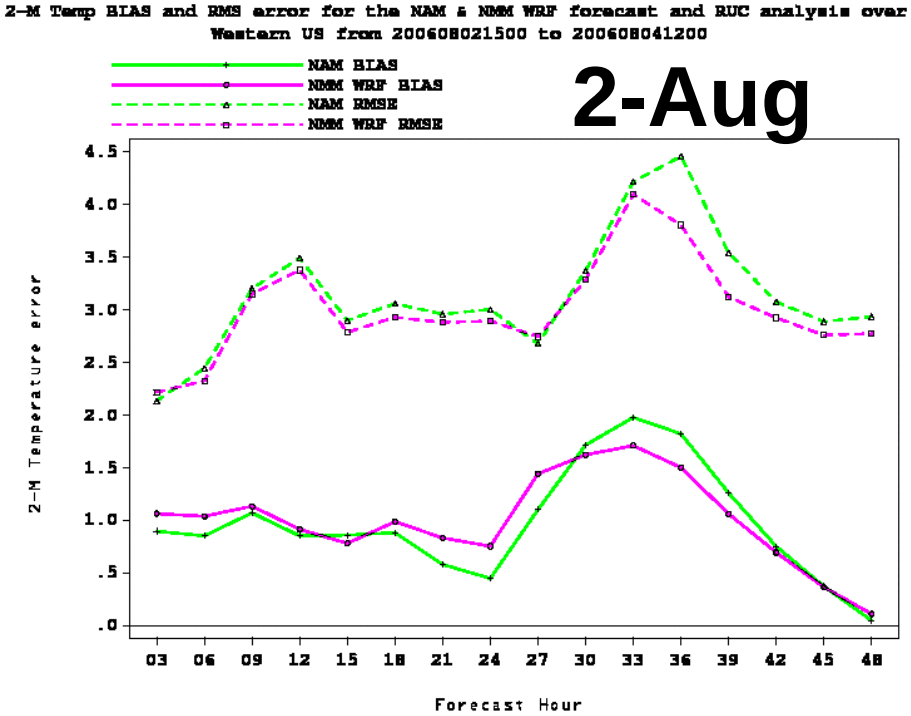


Corrections did not aggravate dry bias for western region for summer case

Impact test of Z_o and Rsmin corrections.

2-m Temperature 1/2-Aug-2006/12z, 48-hr runs: West

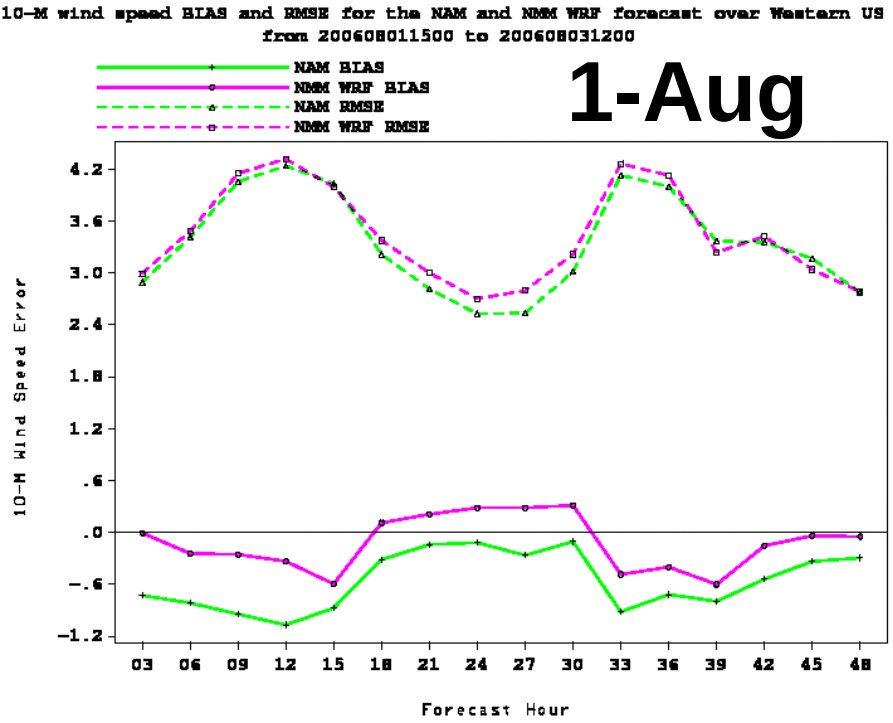


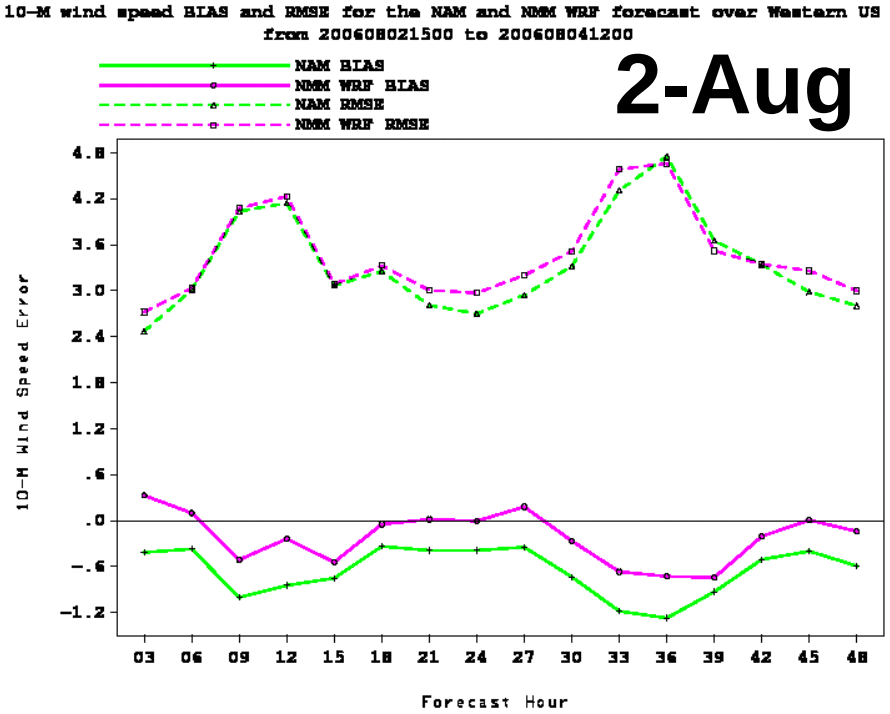


Corrections do not aggravate warm bias for western region for summer case

Impact test of Z_o and Rsmin corrections:

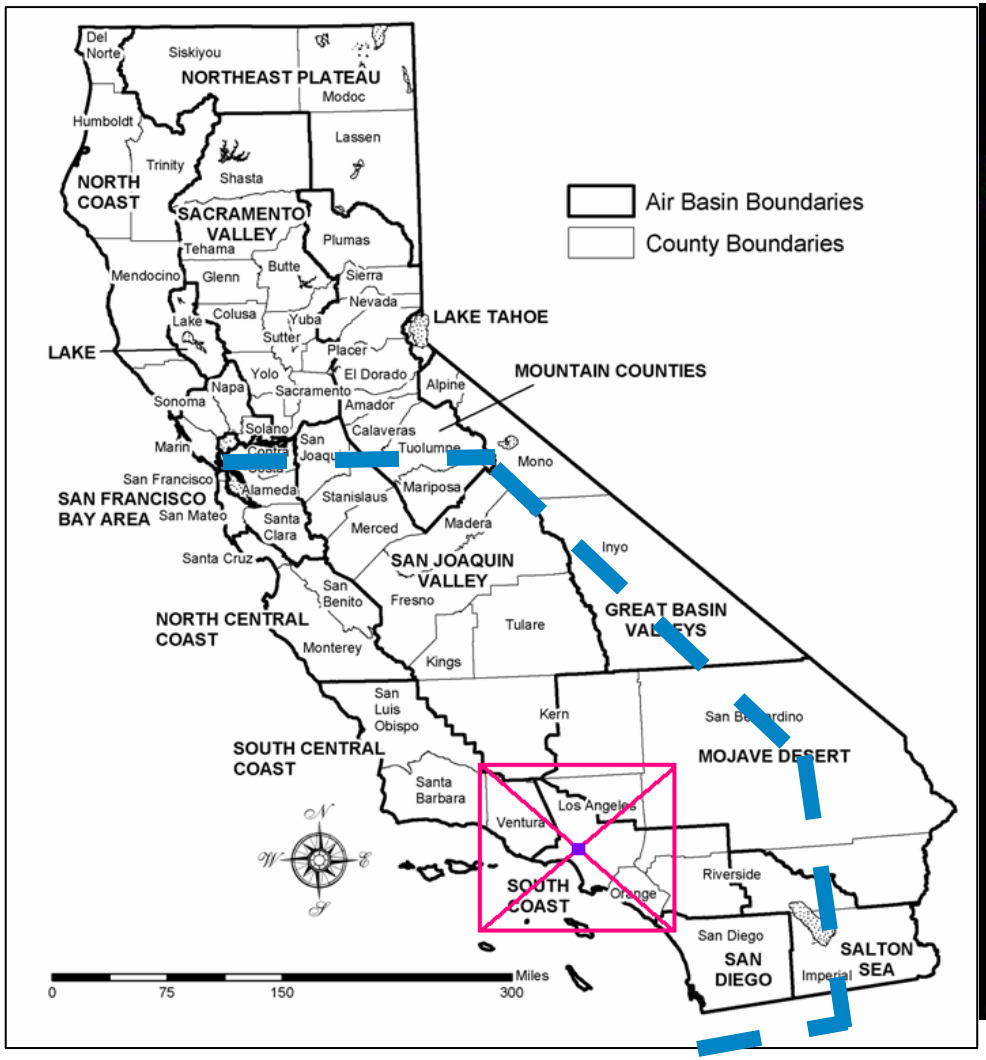
10-m Windspeed 1/2-Aug-2006/12z, 48-hr runs: West





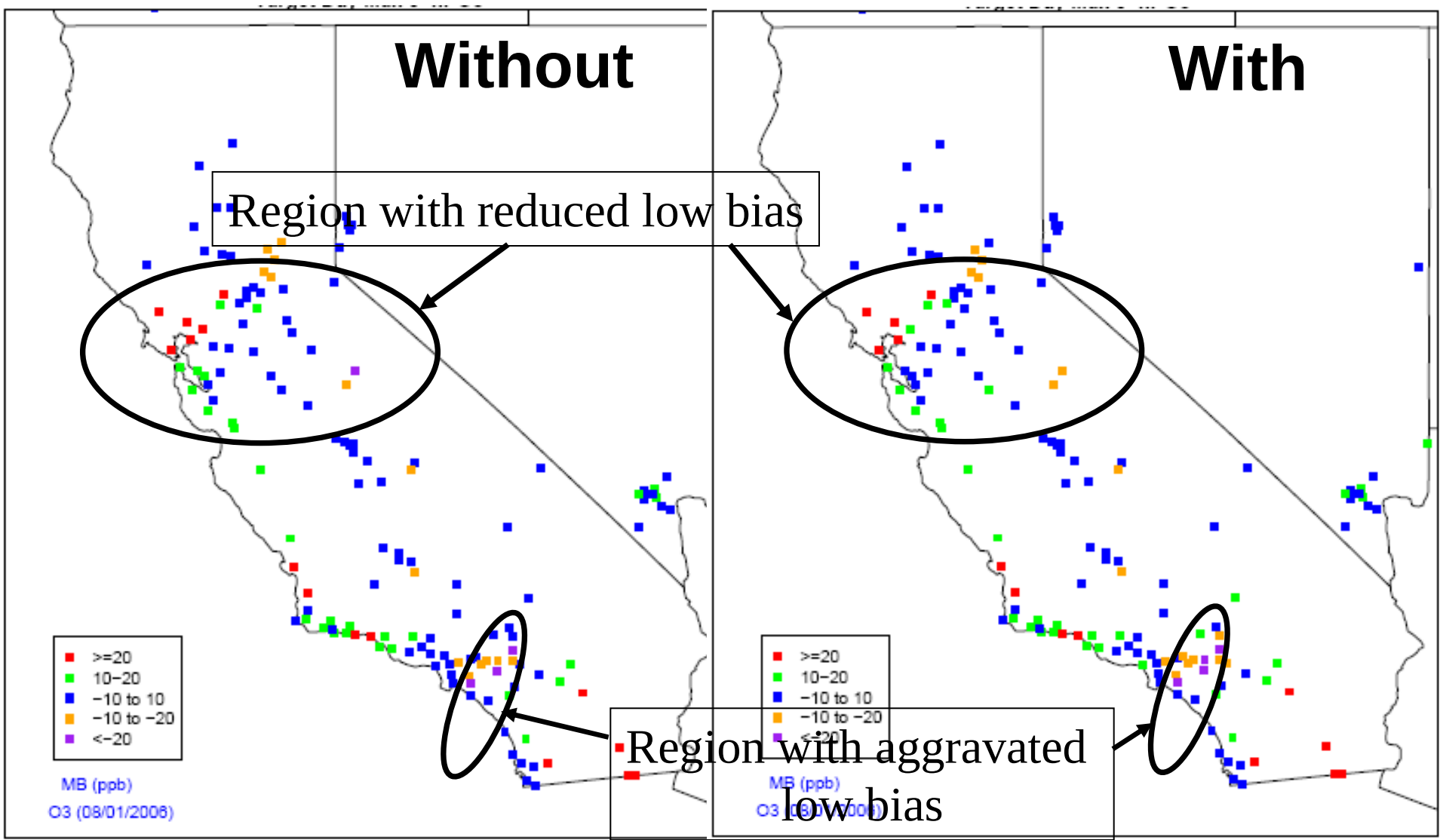
Corrections achieved significant improvement for Wind-speed forecast for western region for summer case

California Air Districts



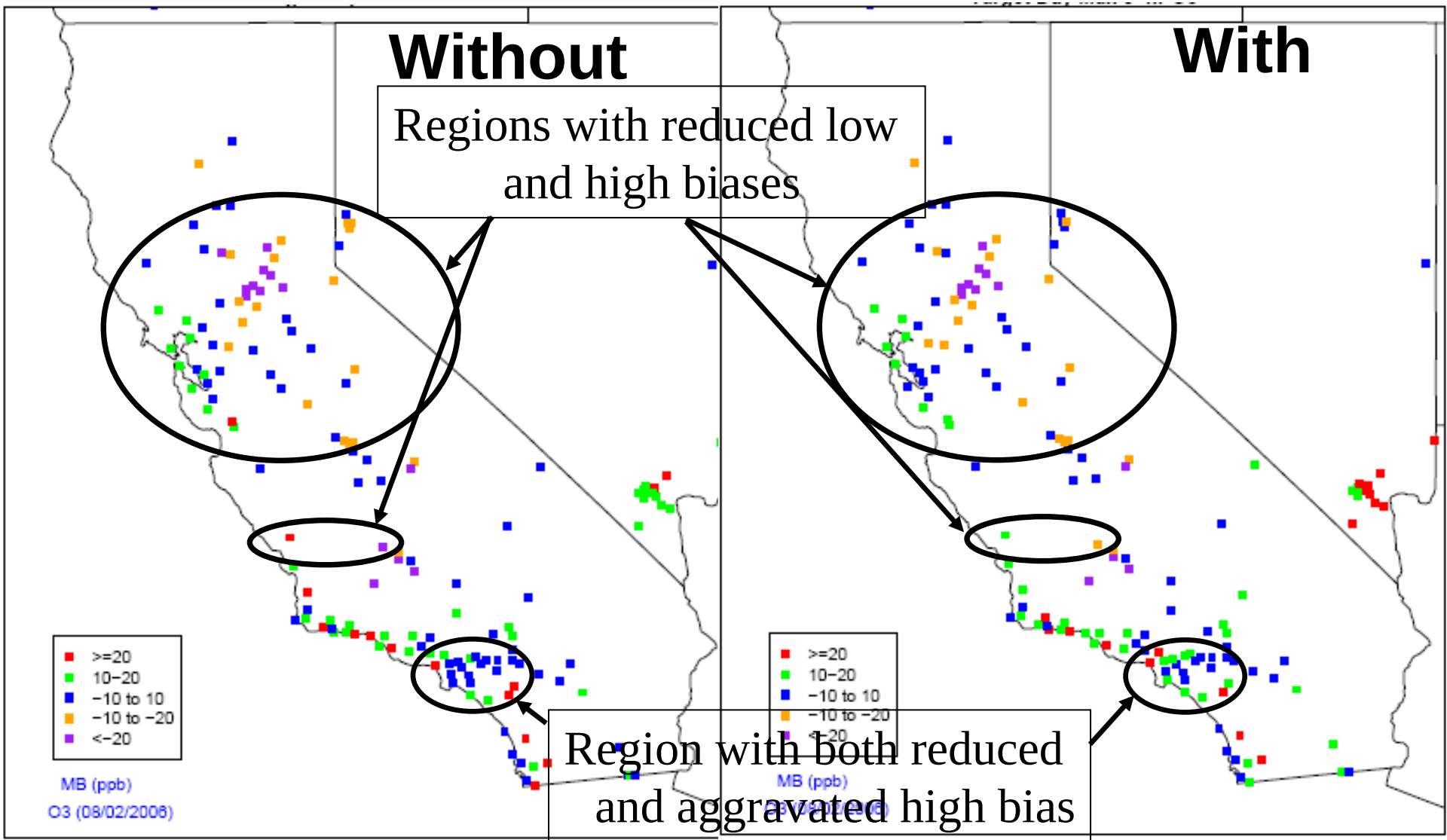
Impact of Z_o and Rsmin corrections in WRF

on Mean Bias of daily 8h avg max surface O_3
Valid 4Z-Aug2 to 3Z-Aug3, 2006



Impact of Z_o and Rsmin corrections in WRF

on Mean Bias of daily 8h avg max surface O_3
Valid 4Z-Aug3 to 3Z-Aug4, 2006

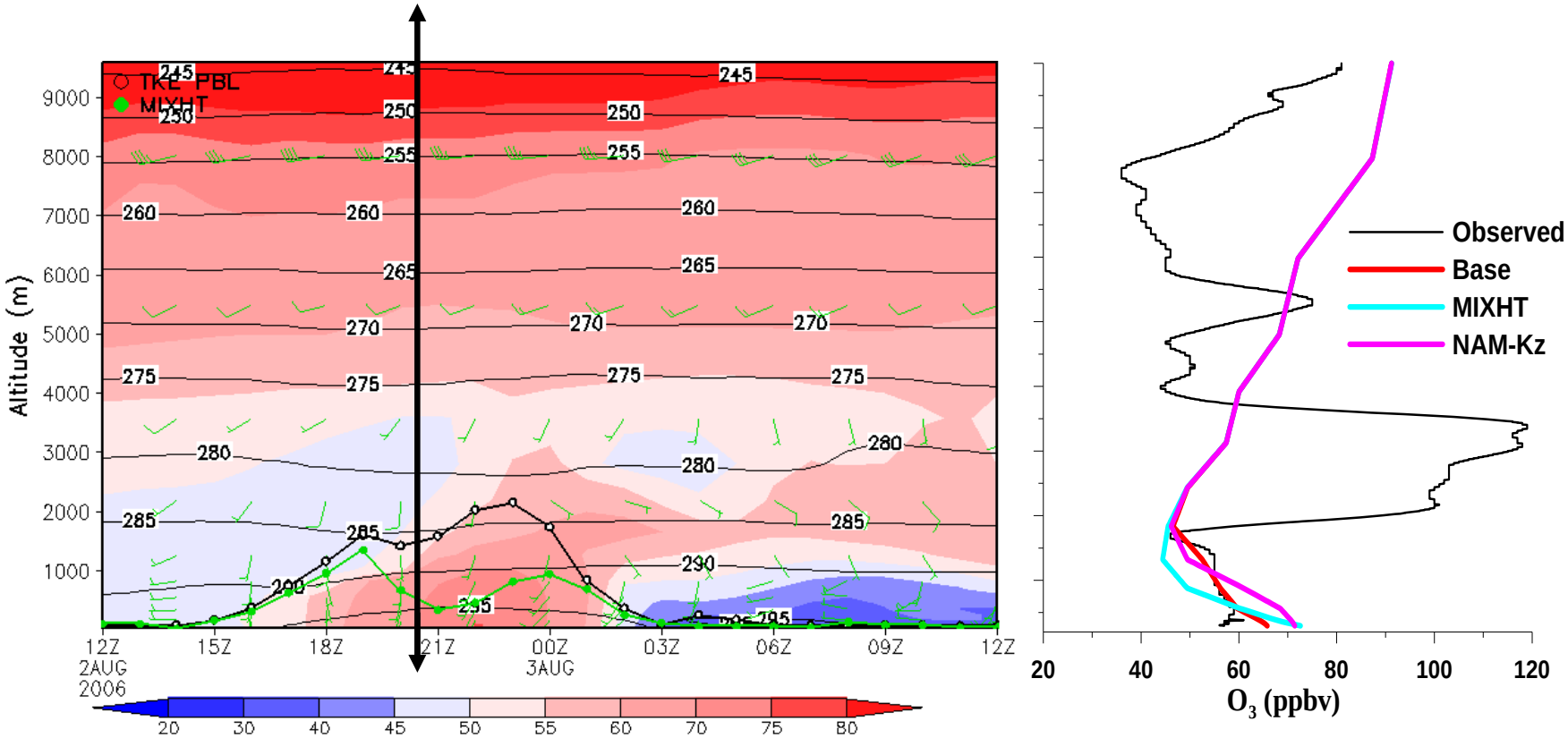


Sensitivity study of alternative vertical mixing schemes in CMAQ

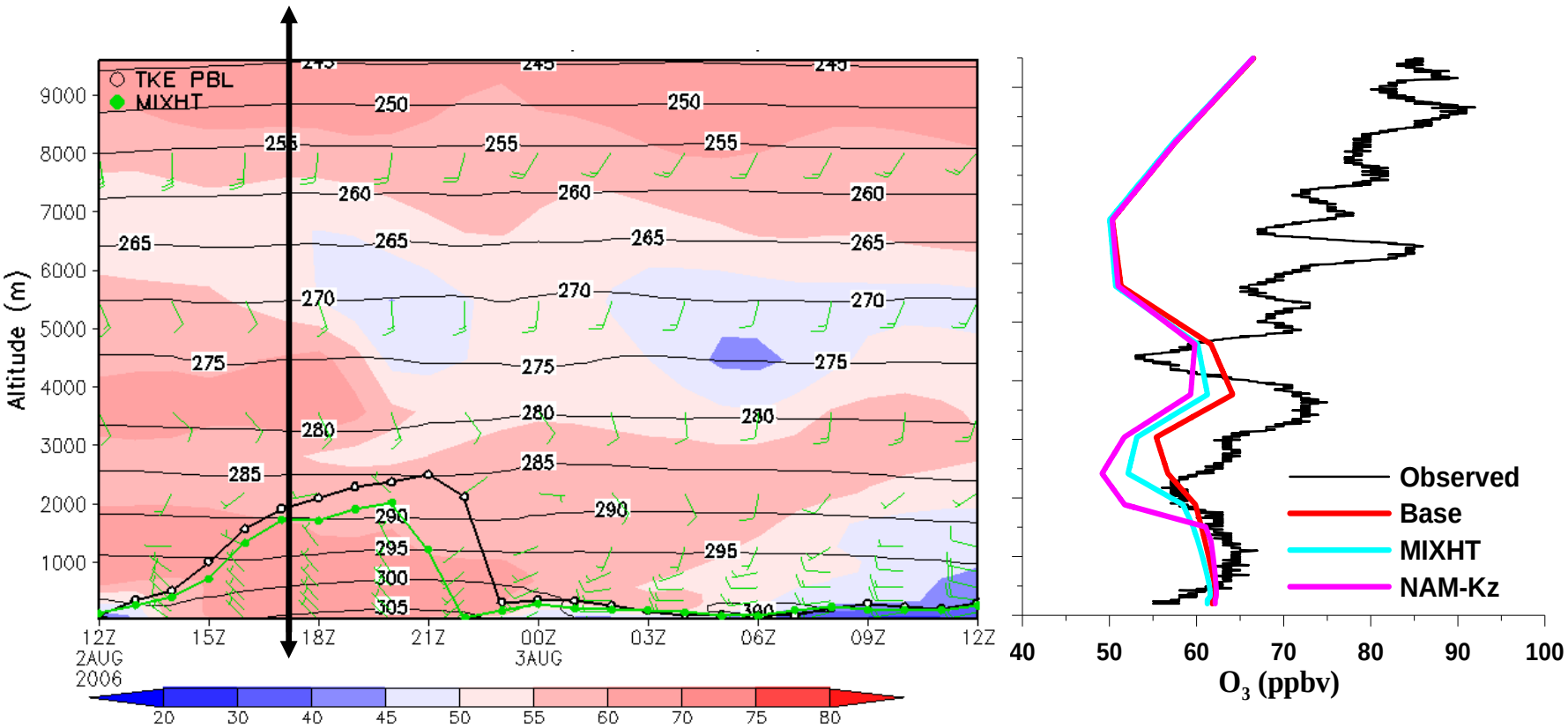
Case	**Vertical mixing scheme**
Base	CMAQ's default K-theory based *Kz*% formulation using NAM TKE-based *h**
MIXHT	Same as above but uses NAM predicted MIXHT as *h*
NAM-Kz	Use NAM predicted *Kz* directly

%*Kz* is vertical eddy diffusivity; **h* is planetary layer height

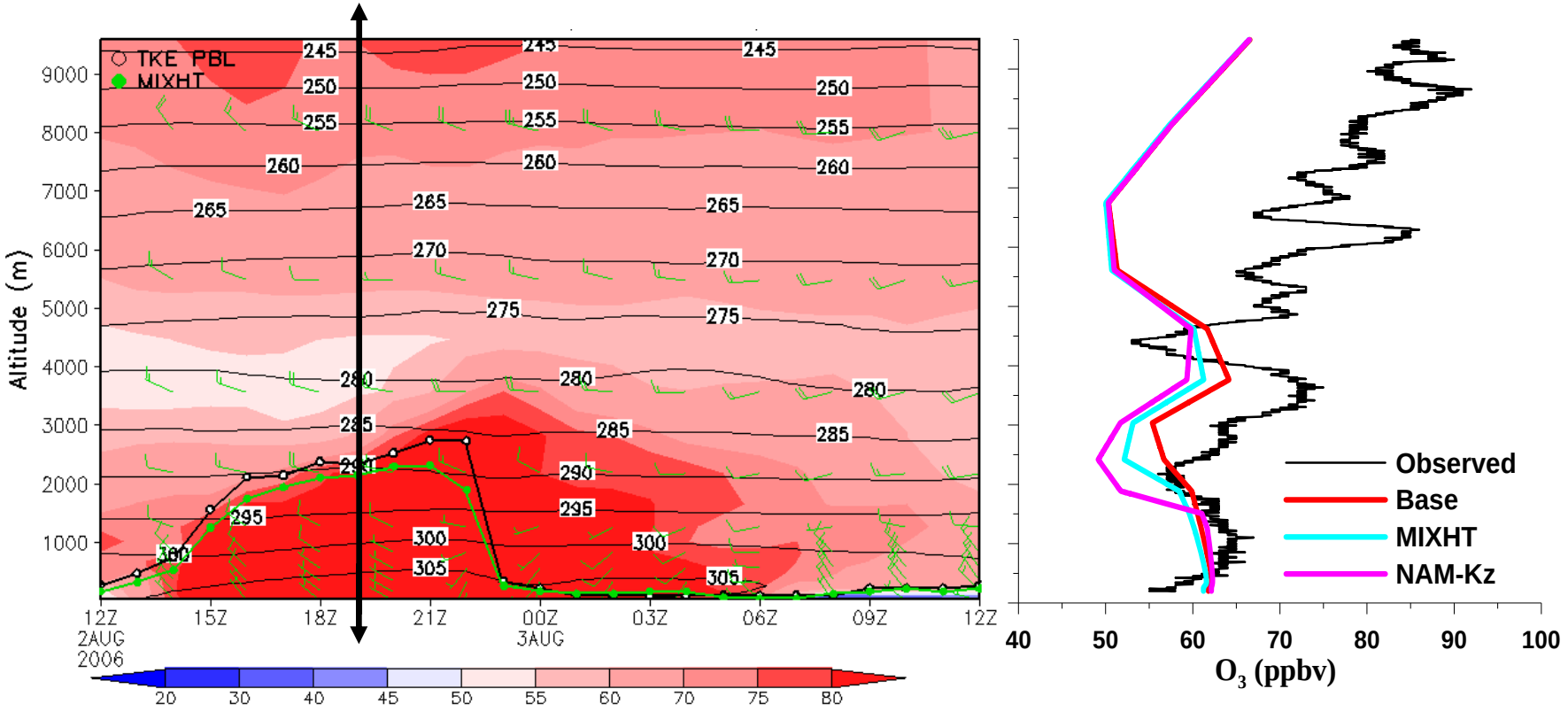
Time cross section of predicted O_3 and PBL height over Table-mount,CA (117.7W, 34.4N) Ozone-sonde was launched at 20:45Z August 2, 2006.



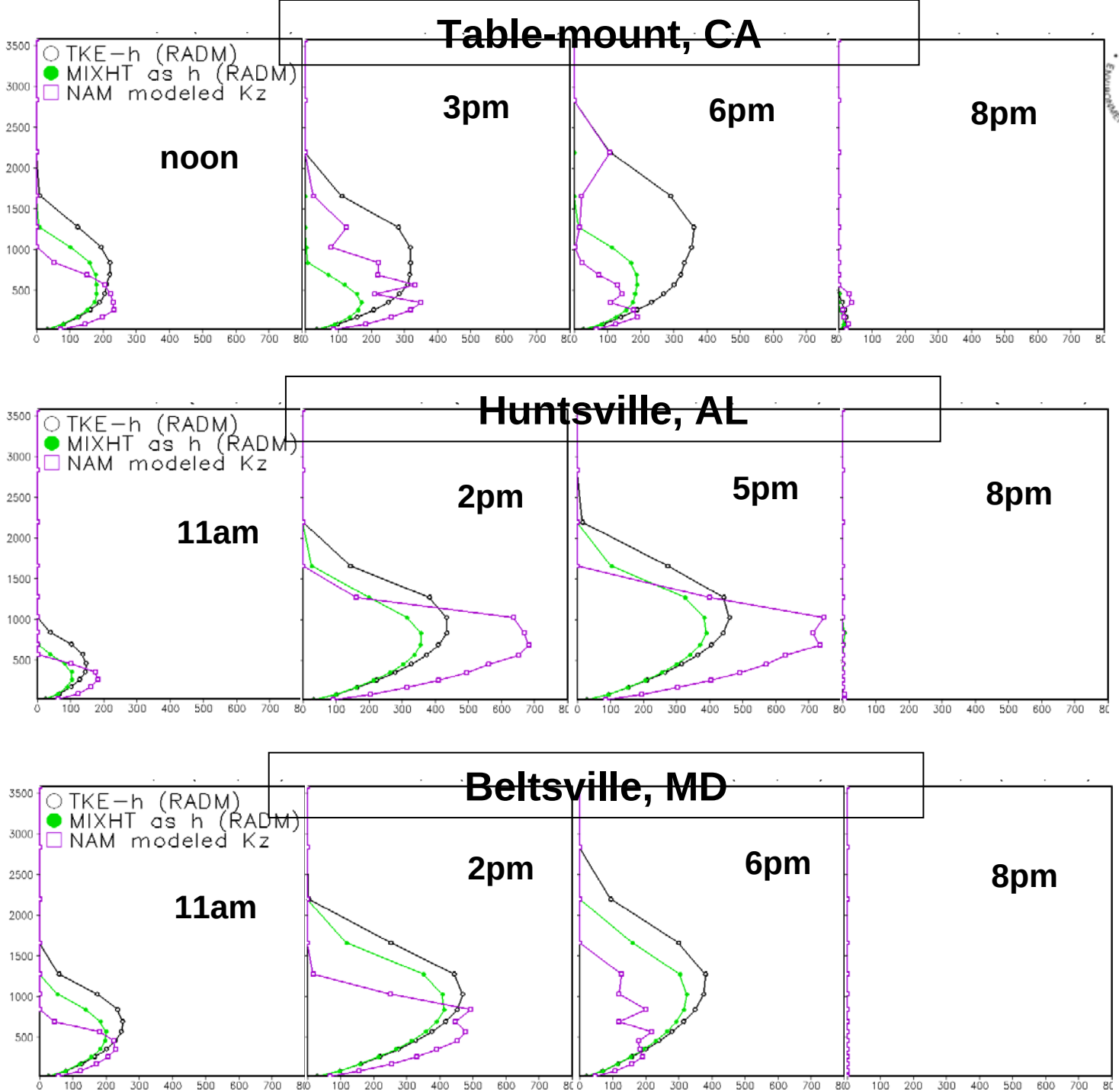
Time cross section of predicted O_3 and PBL height over Huntsville, AL (86.5W, 34.7N) Ozone-sonde was launched at 17:36Z August 2, 2006.



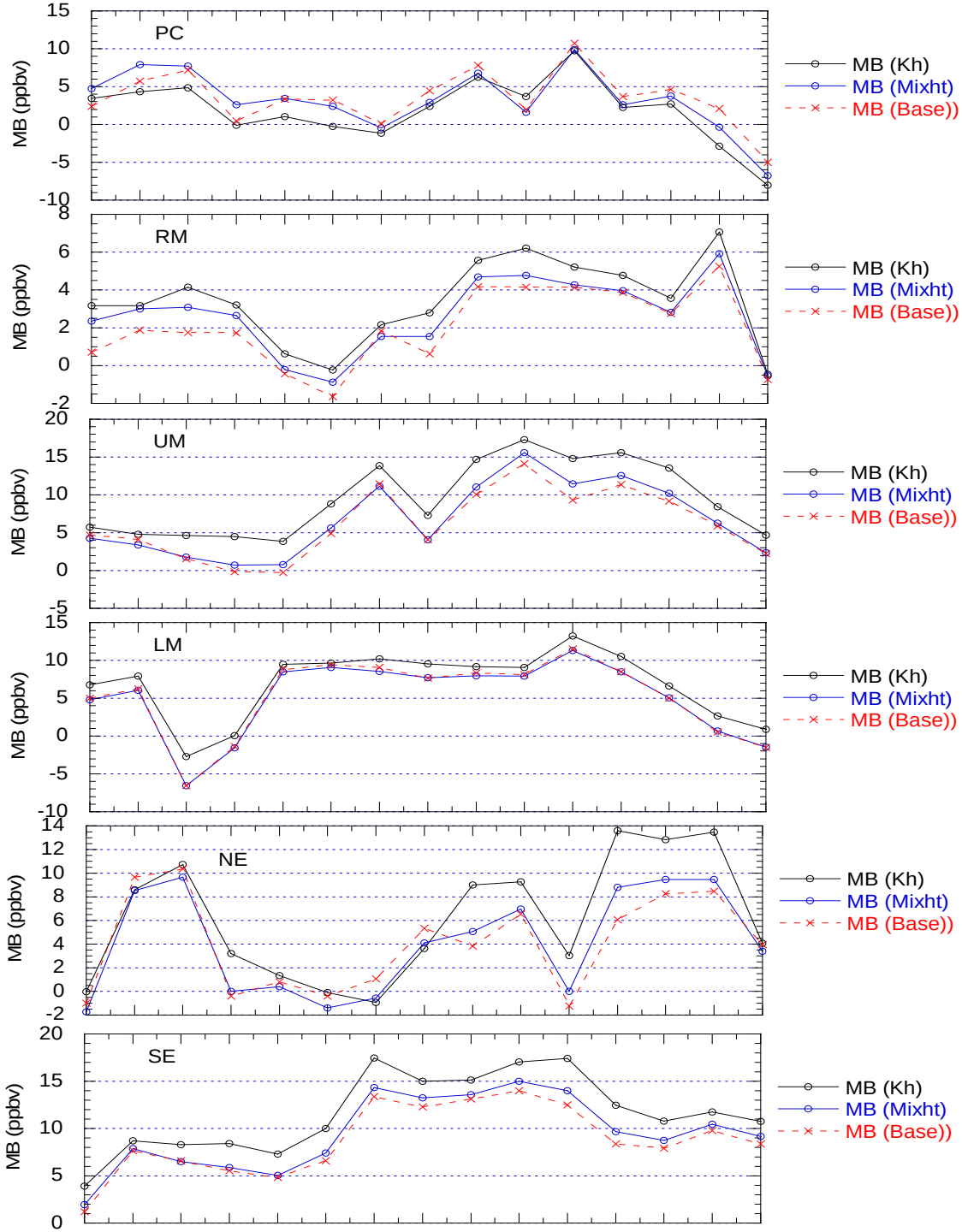
Time cross section of predicted O_3 and PBL height over Beltsville, MD (76.5W, 39.0N) Ozone-sonde was launched at 19:18Z August 2, 2006.



Modeled 2nd day Kz, valid on August 2, 2006.



Time series of mean bias in ppb between July 21 and August 4, 2006.



Summary

- ***Impact study of WRF changes: Z_o correction and Rsmin's increase***
  - *Winter time warm biases at low levels have been reduced for Pacific Northwest, State of Oregon, and Northern California.*
  - *Moist biases in the season over the aforementioned regions have also been reduced.*
  - *The perennial warm and dry biases in western regions was not aggravated significantly neither for winter nor summer situations due to the changes.*
  - *Low level wind speed forecast has achieved significant improvement.*
  - *Surface O3 forecast over California has been improved over the Sacramental Valley area but mixed results were obtained over the LA basin.*
- ***Sensitivity Study for Vertical mixing schemes.***
  - *Aim to couple WRF and CMAQ tighter in terms of package commonality*
  - *A two week period retrospectively study with various schemes showed that using WRF modeled mixed layer depth as the capping level of convective mixing in the K-theory parameterization of CMAQ can be an attractive alternative*
  - *Using WRF modeled Kz is not as attractive at this time. Time averaging and hour centering techniques of this field should be considered to generate a more realistic representation of distribution of the mixing intensities.*

Acknowledgements

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Mike Ek – PBL Model development

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