NAQFC update and impact of meteorological inputs

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Objectives

- To evaluate performance of O_3 and $PM_{2.5}$ predictions from an updated NAQFC system in winter and summer
- To evaluate meteorological inputs that are important for O_3 and $PM_{2.5}$ predictions

The National Air Quality Forecasting Capability

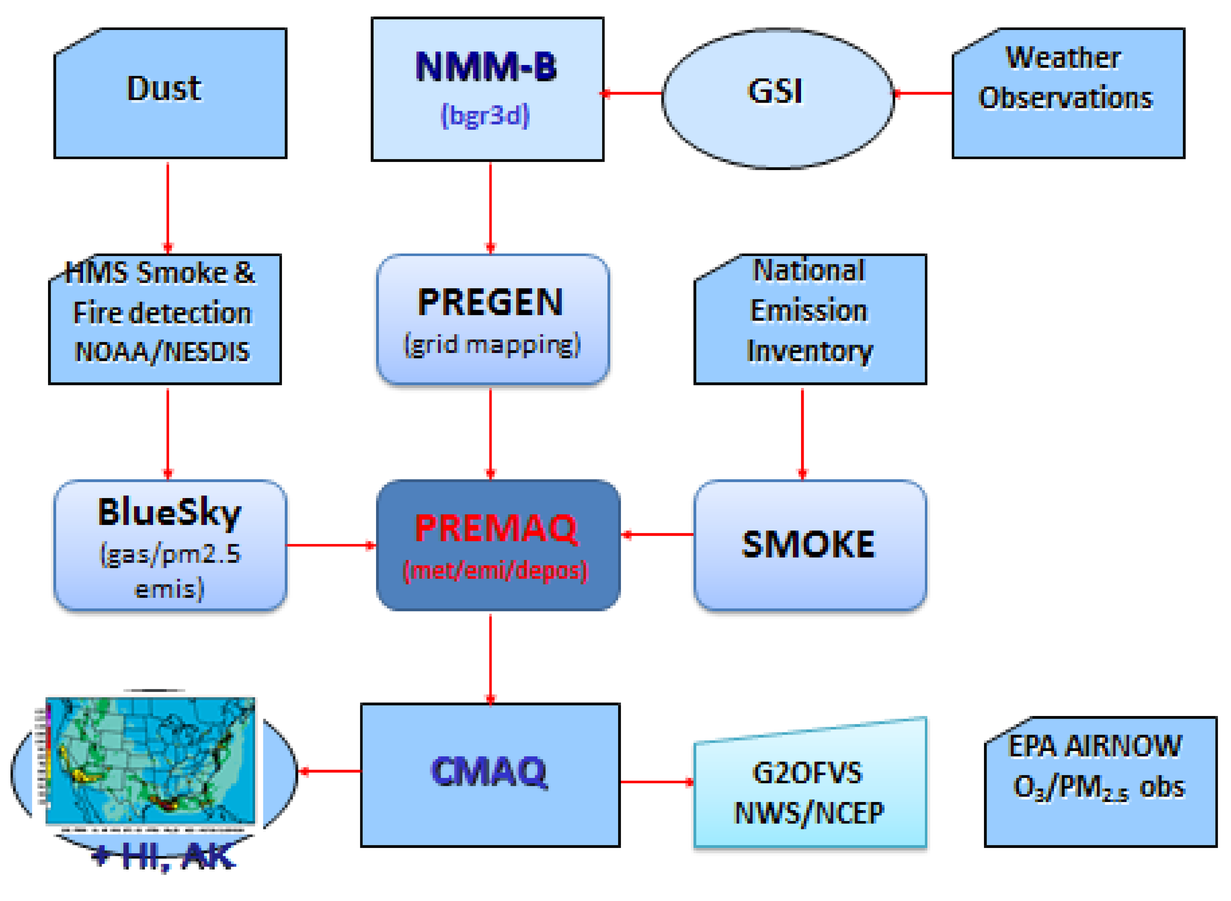

Fig.1 flow chart of NAQFC

Update of NAQFC

- Modulate fugitive dust emission: suppress over ice/snow
- Incorporate wild fire emission detected by NESDIS Hazard Mapping System and estimated by BlueSky Modeling Framework
- Implement a mechanism of faster removal of organic nitrate
- Include all changes in NMM-B (e.g., new radiation scheme, modified convection and microphysics schemes)
- Add wind blown dust emission

Model configurations

- **NMM-B**
  - B-grid, 12 km horizontal resolution, 60 hybrid (pressure-sigma) vertical layers
  - Physics schemes: RRTM radiation, BMJ convection, Ferrier-Aligo microphysics, MYJ PBL, Noah LSM
- **CMAQ** (operational version)
  - 12 km, 22 vertical layers
  - CB05 gas-phase chemistry mechanism & Aero-4 aerosol module
  - NEI 2005 base projected to 2012, BEIS V3 biogenic emissions

Model simulations

- Periods: January and July, 2014
- O_3: PROD (CB04), CMAQ4.6.2 (CB05) and CMAQ4.6.3 (CB05)
- $PM_{2.5}$: CMAQv4.6.2 and CMAQv4.6.3

Verification tool and observational data

- Grid2obs forecasting verification system (FVS)
- Meteorological observations: surface-based measurements
- Air quality observations: AIRNow data

O_3

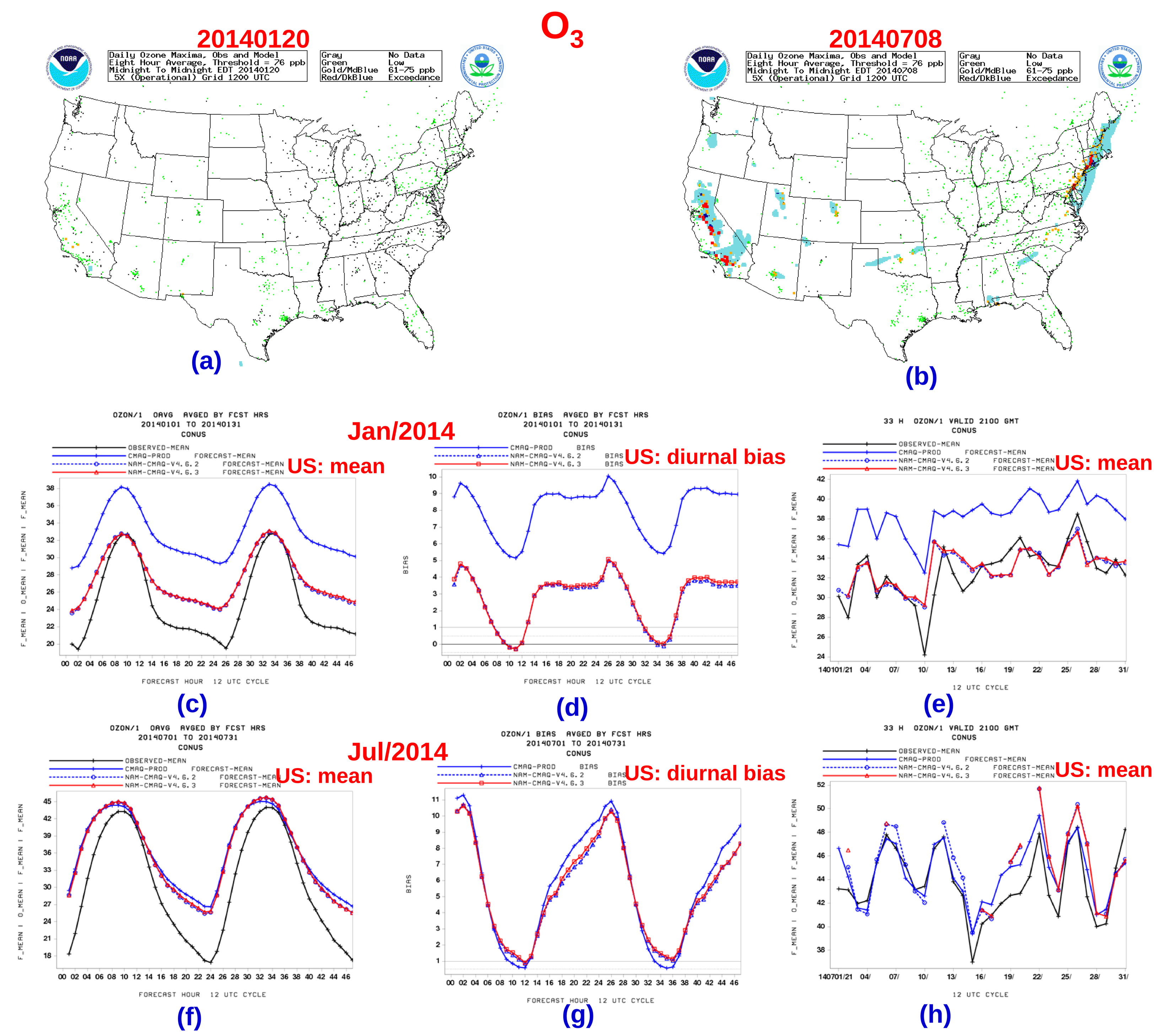

Fig.2 overlaid plots of O_3 in January (a) and July (b); diurnal variations in simulated and observed O_3 (c), forecast bias (d), and time series of simulated and observed O_3 at the 33th forecast hour (e) over CONUS in January 2014; (f), (g) and (h) are similar to (c), (d), and (e) but for July, 2014 (black: obs, solid blue: operation, dashed blue: v4.6.2, and red: v4.6.3).

$PM_{2.5}$

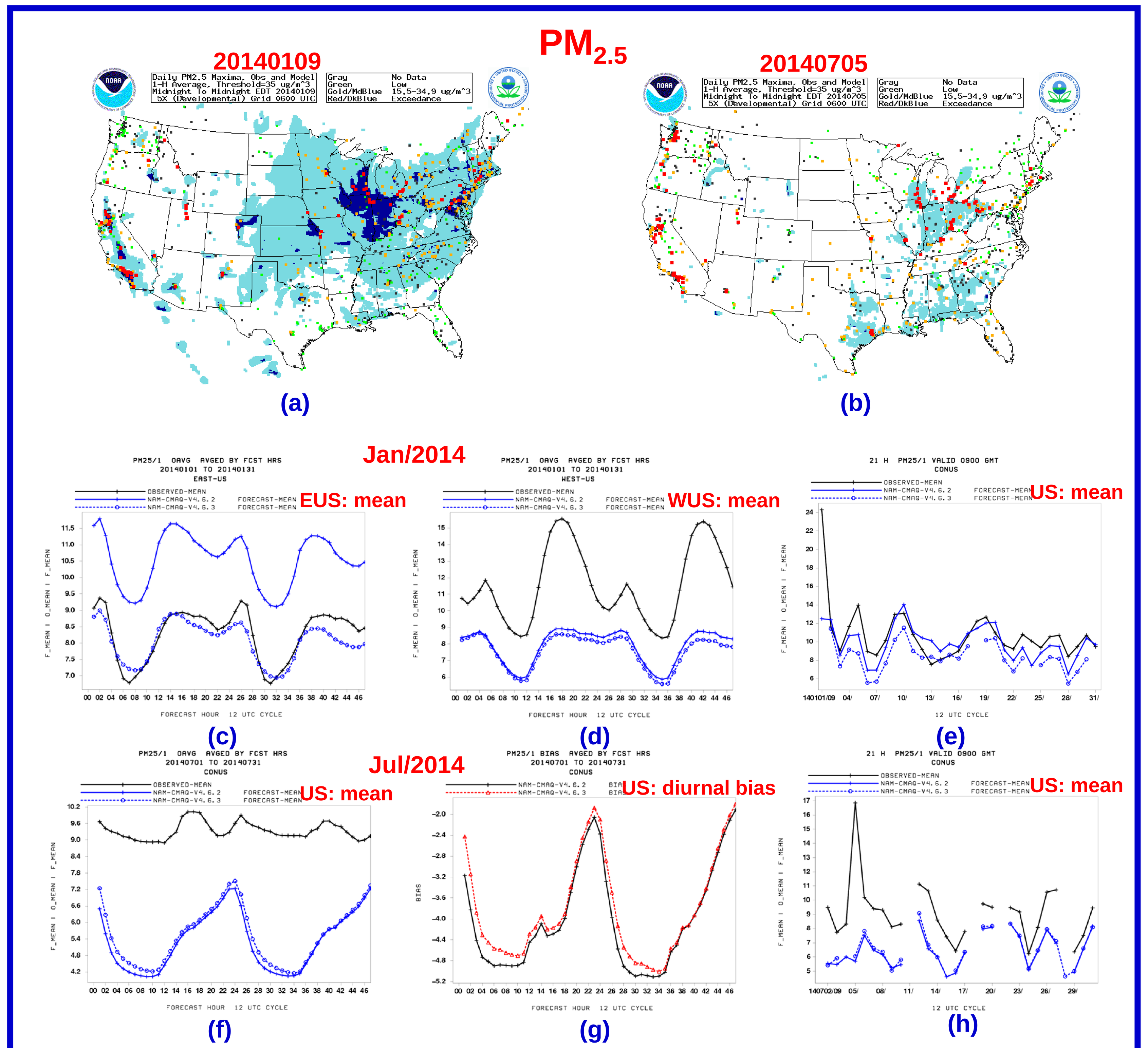

Fig.3 overlaid plots of $PM_{2.5}$ in January (a) and July (b); diurnal variations in simulated and observed $PM_{2.5}$ over eastern US (c) and western US (d), and time series of simulated and observed $PM_{2.5}$ at the 21st forecast hour (e) over CONUS in January, 2014; (f), (g), and (h) represents diurnal mean, diurnal bias, and time series of $PM_{2.5}$ at the 21st hour over CONUS in July, 2014, respectively. (black: obs, solid blue: operation, dashed blue: v4.6.2, and red: v4.6.3).

Evaluation of meteorological inputs

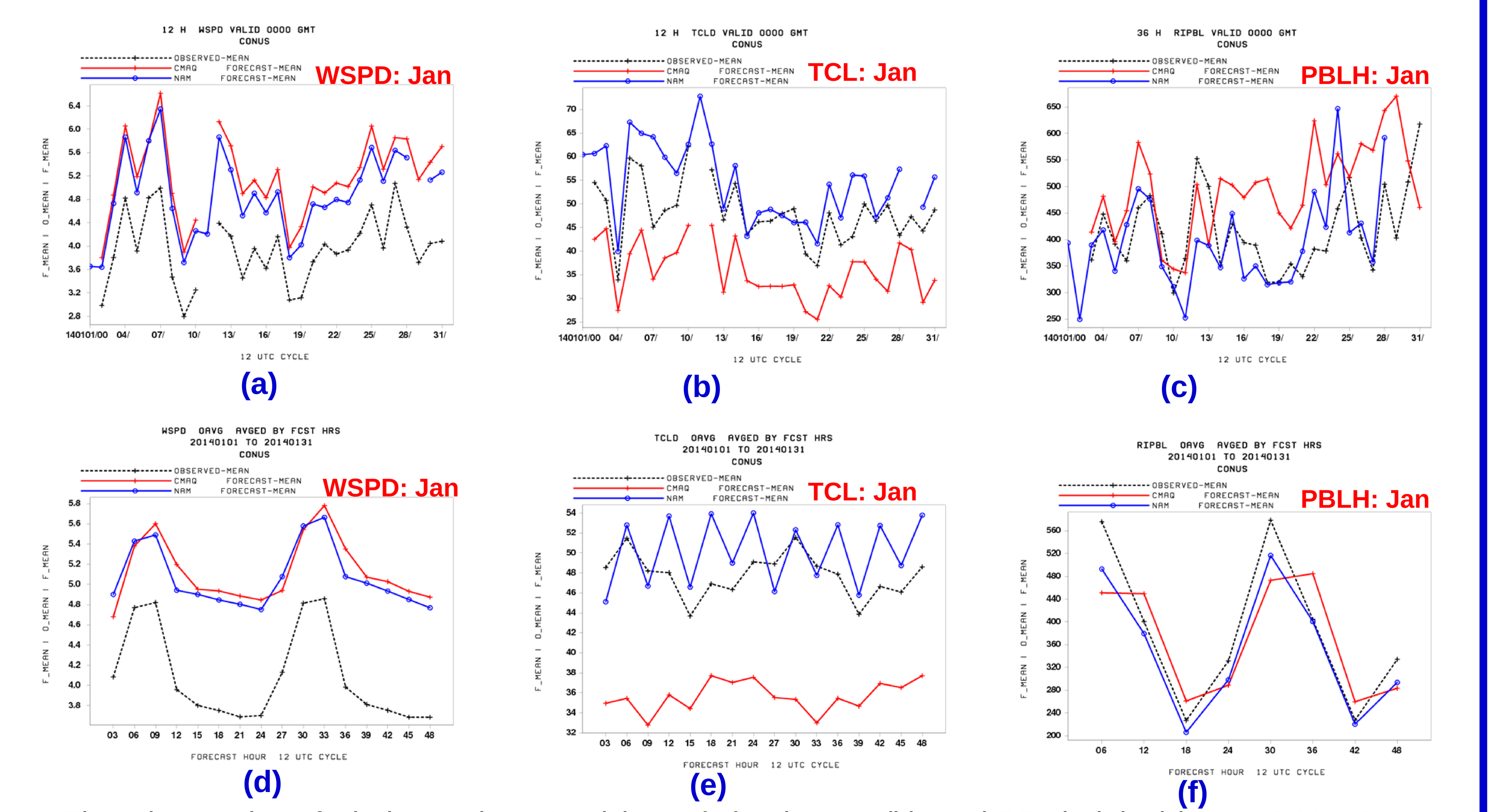

Fig.4 time series of wind speed at 10m (a), total cloud cover (b), and PBL height (c) over CONUS in January; (d), (e) and (f) are similar to (a), (b), and (c) but for diurnal variations (black: obs., blue: NAM (i.e., NMM-B), and red: CMAQ input).

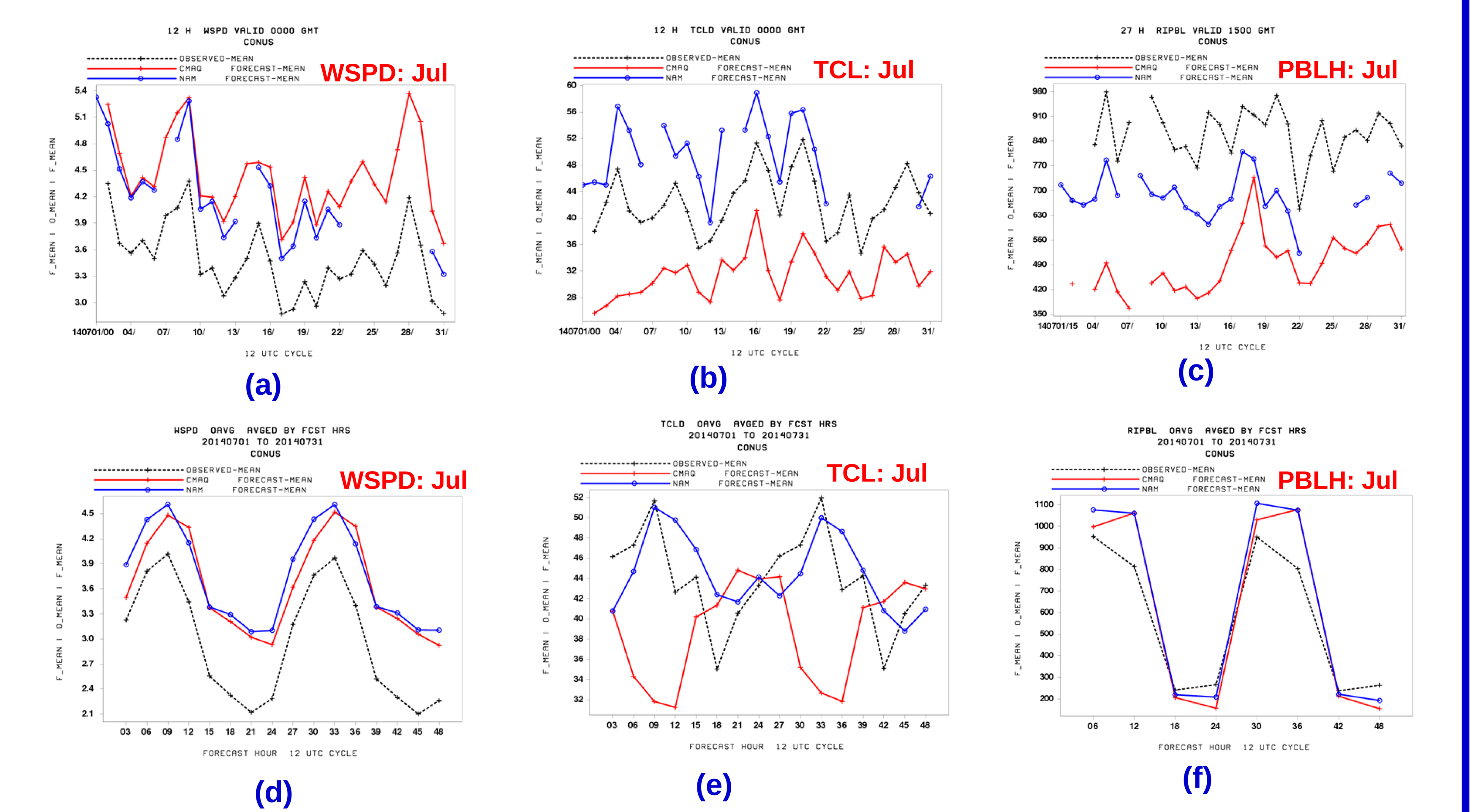

Fig.5 Similar to Fig.4 but for July, 2014

Summary and conclusions

- With the updated NMMB-CMAQ, surface O_3 prediction has been improved significantly in January 2014, but not in July 2014. The forecast bias shows clear diurnal variation with peak bias at 14z (around early morning). The bias variation pattern is persistent even when the forecasting system is improved.
- FVS verification indicates a large improvement in testing of $PM_{2.5}$ predictions over eastern US and in winter, but very little change in other regions and other seasons. Significant under-predictions are still seen over western US and in summer.
- Total cloud cover is under-estimated significantly by PREMAQ (i.e., MCIP) in both January and July, and its diurnal variation differs from the observed. It could partly account for the over-predictions of surface O_3. This is the reason that we do not use this information for photolysis and other related calculations in our system. Meanwhile, under-estimated PBL height is another reason causing O_3 over-predictions in the ozone season.
- This study suggests that the offline coupling system like NMMB-CMAQ should use direct met model outputs instead of re-diagnosed meteorological fields.