



NCEP Central Operations Change Control Board Upgrades on AQM

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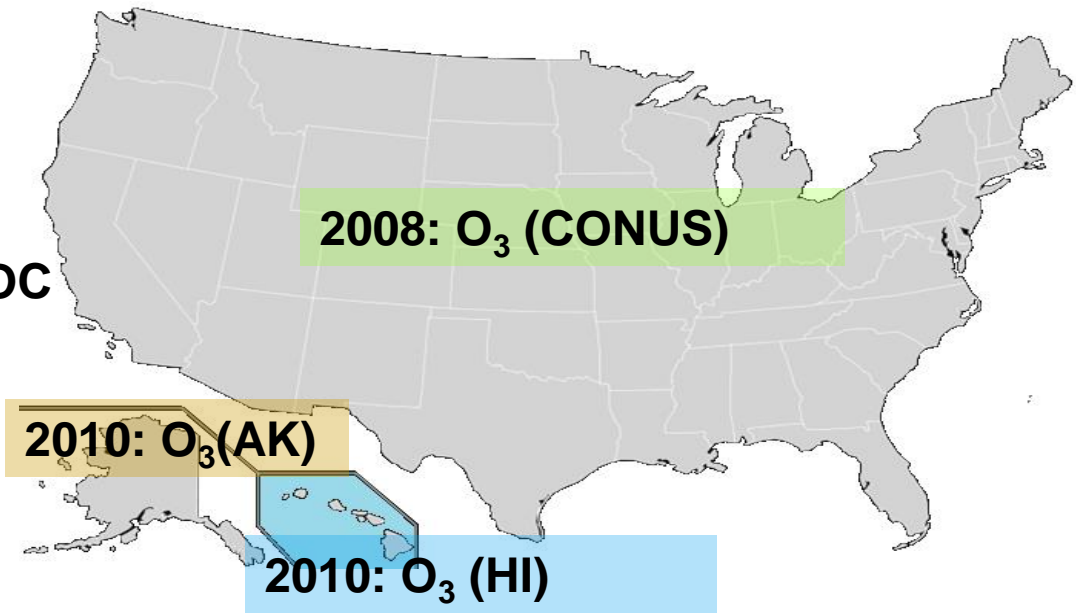


Current AQM: ops

Chemical Transport Model:

- **CMAQ4.5.2 for CONUS**
 - CBIV gas chemistry
 - LBC: Static from GEOS-CHEM
 - **O₃ product dissemination: TOC**

- **CMAQ4.6.2 for AK & HI**
 - CB05 gas chemistry
 - Aero4 aerosol chemistry
 - LBC: Static from GEOS-CHEM
 - **O₃ product dissemination: TOC**



O₃ Performance (FVS by NCO)::

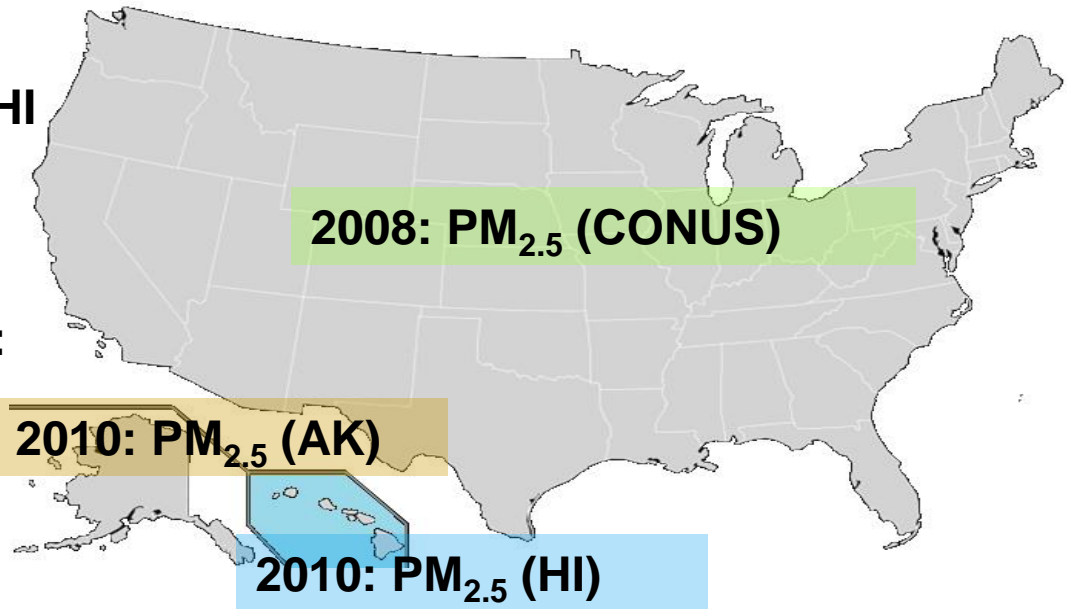
Max Daily 8h O₃ for domains above: Bias, RMSE, and % Hit Rate
Feed of EPA AIRNow O₃ and PM_{2.5} in Bufr format



Current AQM: dev

Chemical Transport Model:

- **CMAQ4.6.2 for CONUS, AK & HI**
- CB05 gas chemistry
- Aero4 aerosol chemistry
- LBC: Static from GEOS-CHEM
- **PM_{2.5} product dissemination:**
Graphics on web



PM_{2.5} Performance (Exceedance w.r.t 35 $\mu\text{g}/\text{m}^3$ by MDL & EMC):

24 h averaged PM_{2.5} for the above domains: Bias, RMSE, and % Hit Rate

Strong interest for NOAA PM_{2.5} forecast. E.g., **Fann et al., Risk Analysis 2011:** “Studies by American Cancer Society and National Mortality & Morbidity Air Pollution Study showed that **130,000 and 4,700 died of PM_{2.5} and O₃; respectively in 2005**”.



Proposed AQM Upgrades

Significant impact on O₃ forecast –CMAQ4.6.3

- Gas-phase chemistry: Carbon Bond 4 (CBIV) → CB05 for CONUS
- Faster removal of organic nitrate -- NTR (Saylor and Stein, GMD 2012)

Significant impact on PM_{2.5} forecast – CMAQ4.6.3

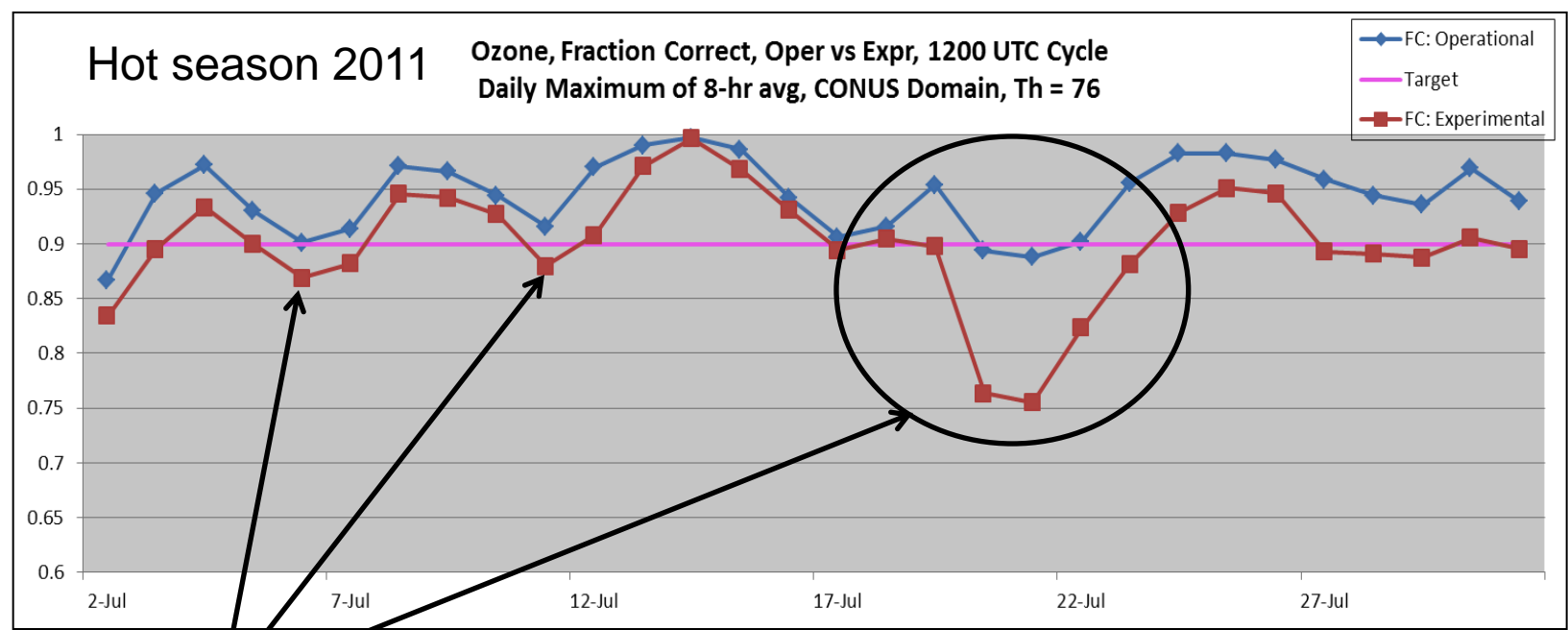
- Implement AERO-4 for CONUS
- Fugitive dust emissions modulated by snow – emission off if snow cover
- NESDIS Hazard Mapping System wild fires and fuel from USFS BlueSky
- Dynamic emission fluxes for windblown (Tong and Lee et al., ACP 2012)



Proposed AQM-O₃ Upgrades

Significant impact on O₃ forecast –CMAQ4.6.3

➤ **Gas-phase chemistry: Carbon Bond 4 (CBIV) → CB05 for CONUS**



Courtesy: Ivanka Stajner

CB05 over-predicts surface O₃ considerably due to over-recycling of NTR (Saylor and Stein, GMD 2012)

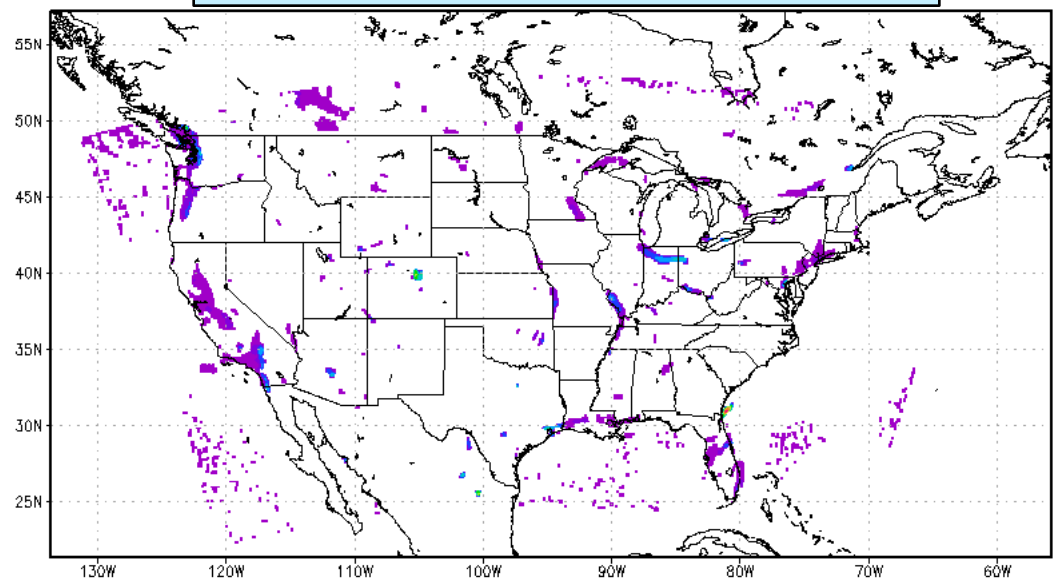
Proposed AQM-O₃ Upgrades

Significant impact on O₃ forecast –CMAQ4.6.3

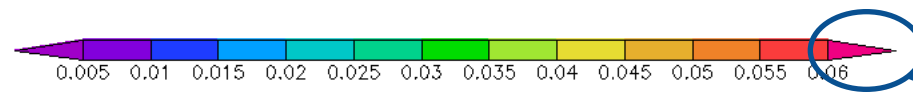
- Gas-phase chemistry: Carbon Bond 4 (CBIV) → CB05 for CONUS
- **Faster removal of organic nitrate -- NTR**

Hot season sensitivity cases: Same NMMB, initializations,

NTR modified minus Original NTR



12UTC cycle simulation
+6h Valid at 18UTC
July 15 2014,



~0.1ppb (small)

GrADS: COLA/IGES

2014-07-22-12:31



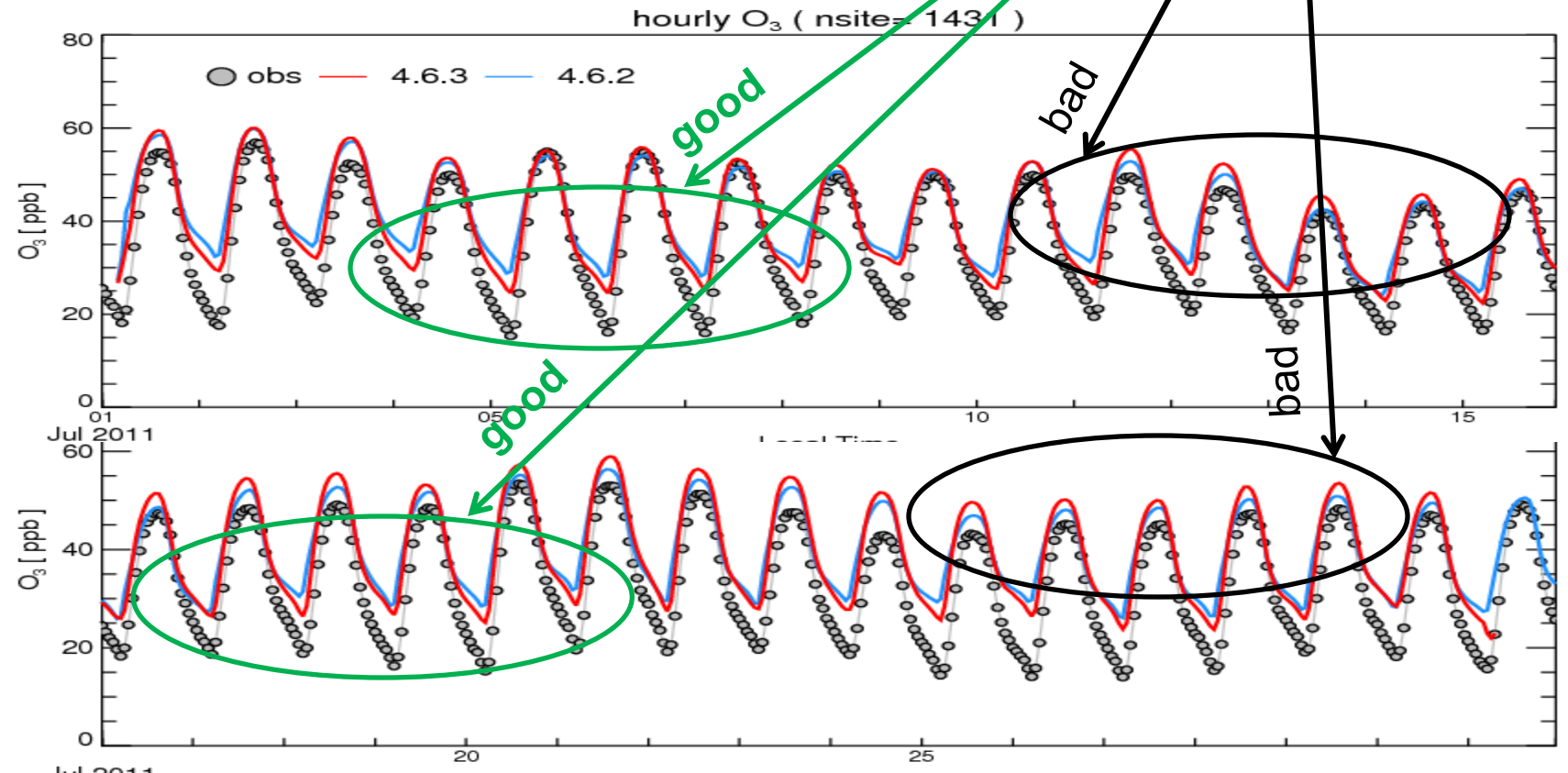
Proposed AQM-O₃ Upgrades

Mixed results over CONUS

Significant impact on O₃ forecast –CMAQ4.6.3

➤ **Faster removal of organic nitrate -- NTR**

Hot season sensitivity cases (July 2011): NMMB, one cycle/day,



Proposed AQM-O₃ Upgrades

Significant impact on O₃ forecast –CMAQ4.6.3

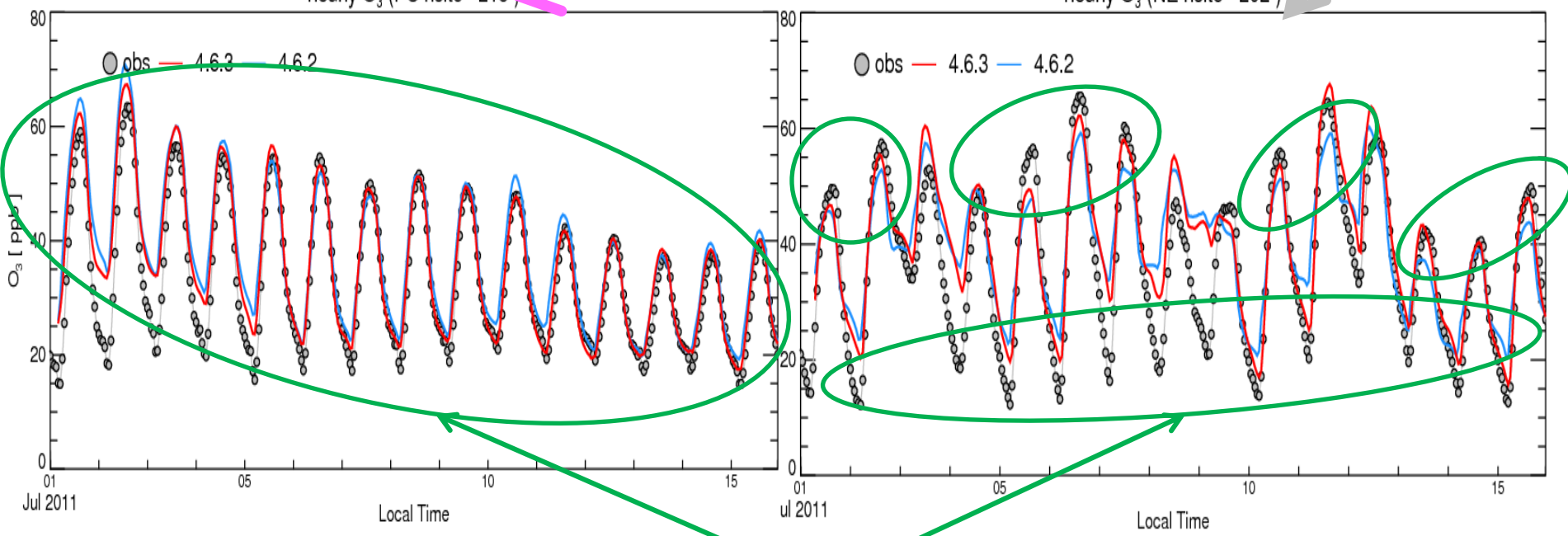
➤ **Faster removal of organic nitrate -- NTR**

Hot season sensitivity cases (July 2011): NIMMB, one cycle/day,



hourly O₃ (PC nsite= 213)

hourly O₃ (NE nsite= 202)



Improvement in PC and NE as monitors are predominantly over urban sites



Proposed AQM-PM Upgrades

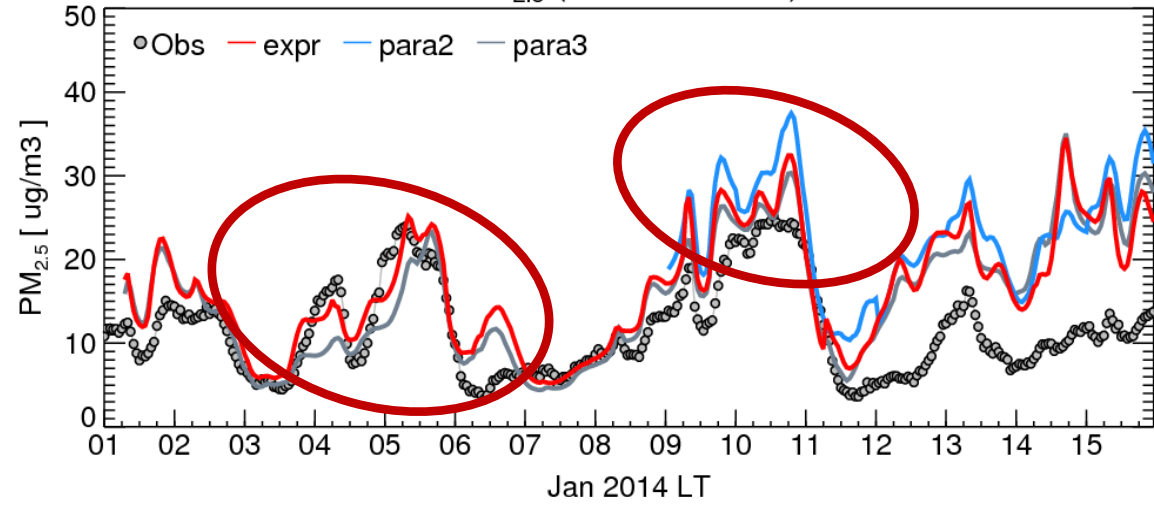
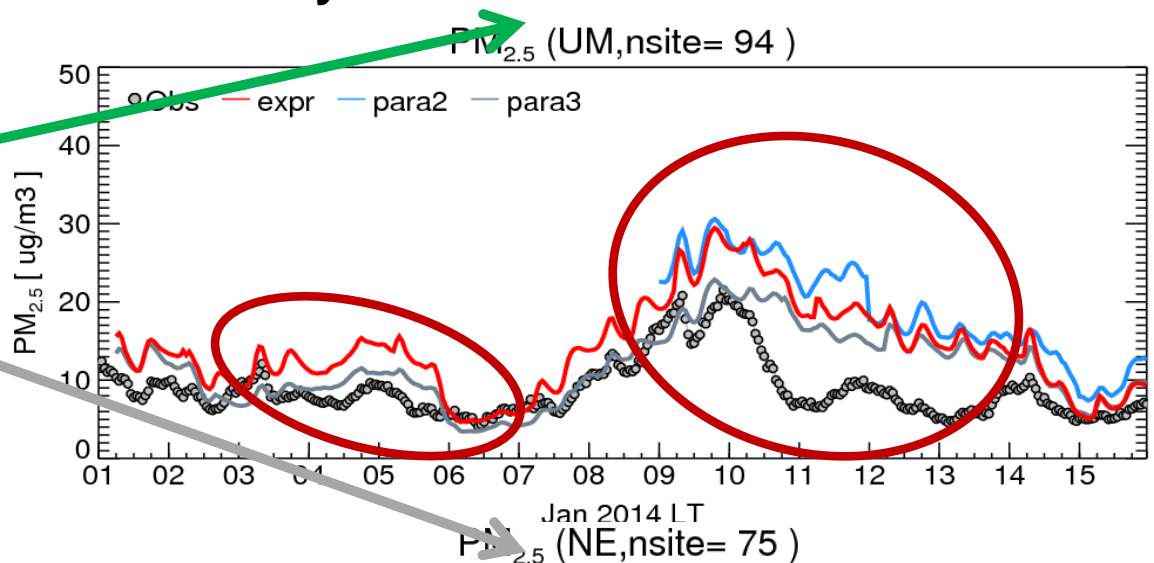
Significant impact on PM_{2.5} forecast – CMAQ4.6.3

- Implement AERO-4 for CONUS
- **Fugitive dust emissions modulated by snow** – emission off if snow cover



Sensitivity nomenclature

- expr = cmaq4.6.2**
- para2 = expr + new NMMB**
- para3 = para2 +ice/snow-modulation**





Proposed AQM-PM Upgrades

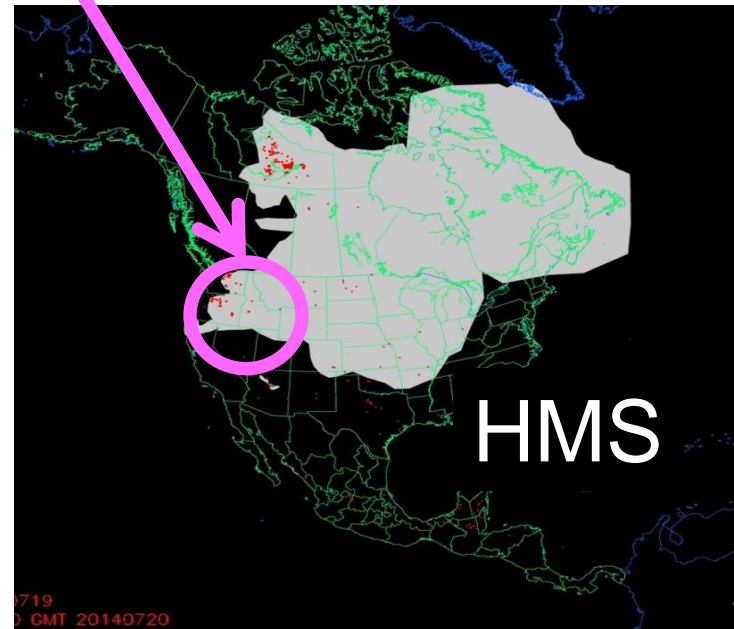
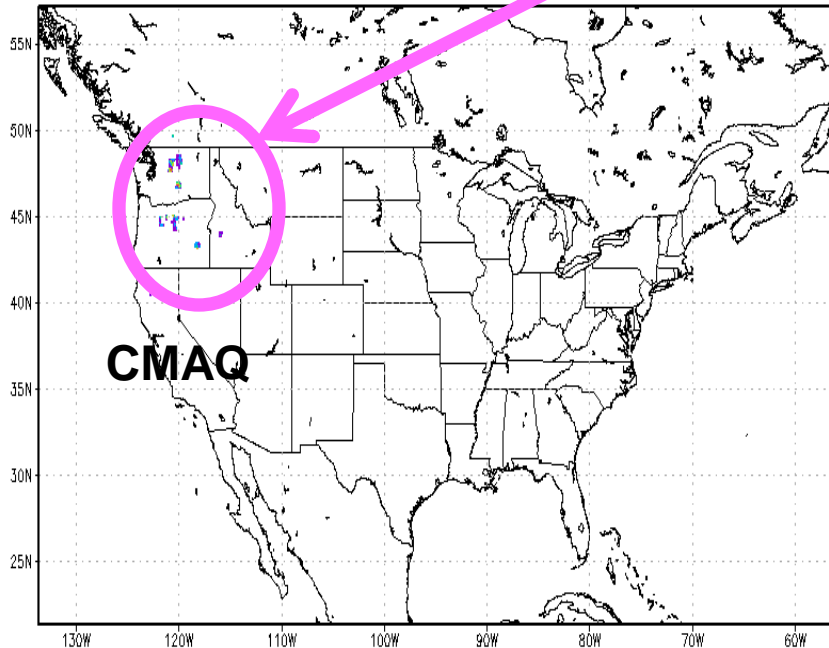
Significant impact on PM_{2.5} forecast – CMAQ4.6.3

➤ **NESDIS Hazard Mapping System** wild fires and fuel from USFS BlueSky

NESDIS TEXT on smoke plumes from wild fires on **July 19, 2014**

Smoke is visible ... Northwest Territories, northern Saskatchewan, Washington, and Oregon. .. much of central Canada recorded wildfire smoke plumes. In **U.S. wildfires in Washington/Oregon** are combining throughout northwestern and north-central U.S.

CO emis from fires in CMAQ4.6.3 on July 19, 2014



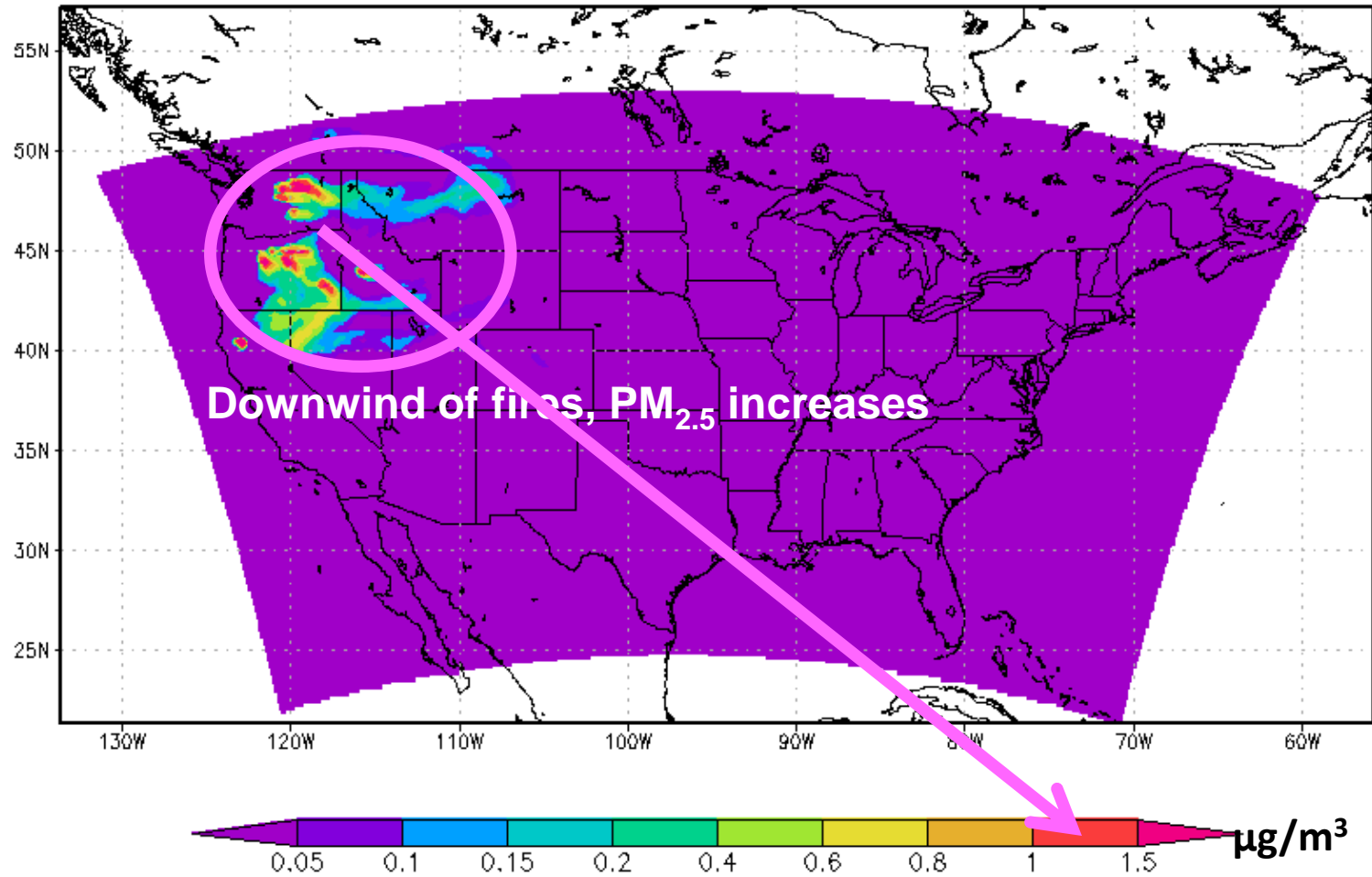


Proposed AQM-PM Upgrades

Significant impact on PM_{2.5} forecast – CMAQ4.6.3

- NESDIS Hazard Mapping System wild fires and fuel from **USFS BlueSky**

cmaq4.6.3_EC – cmaq4.6.2_EC on July 19, 2014



GrADS: COLA/IGES

2014-07-22-19:30

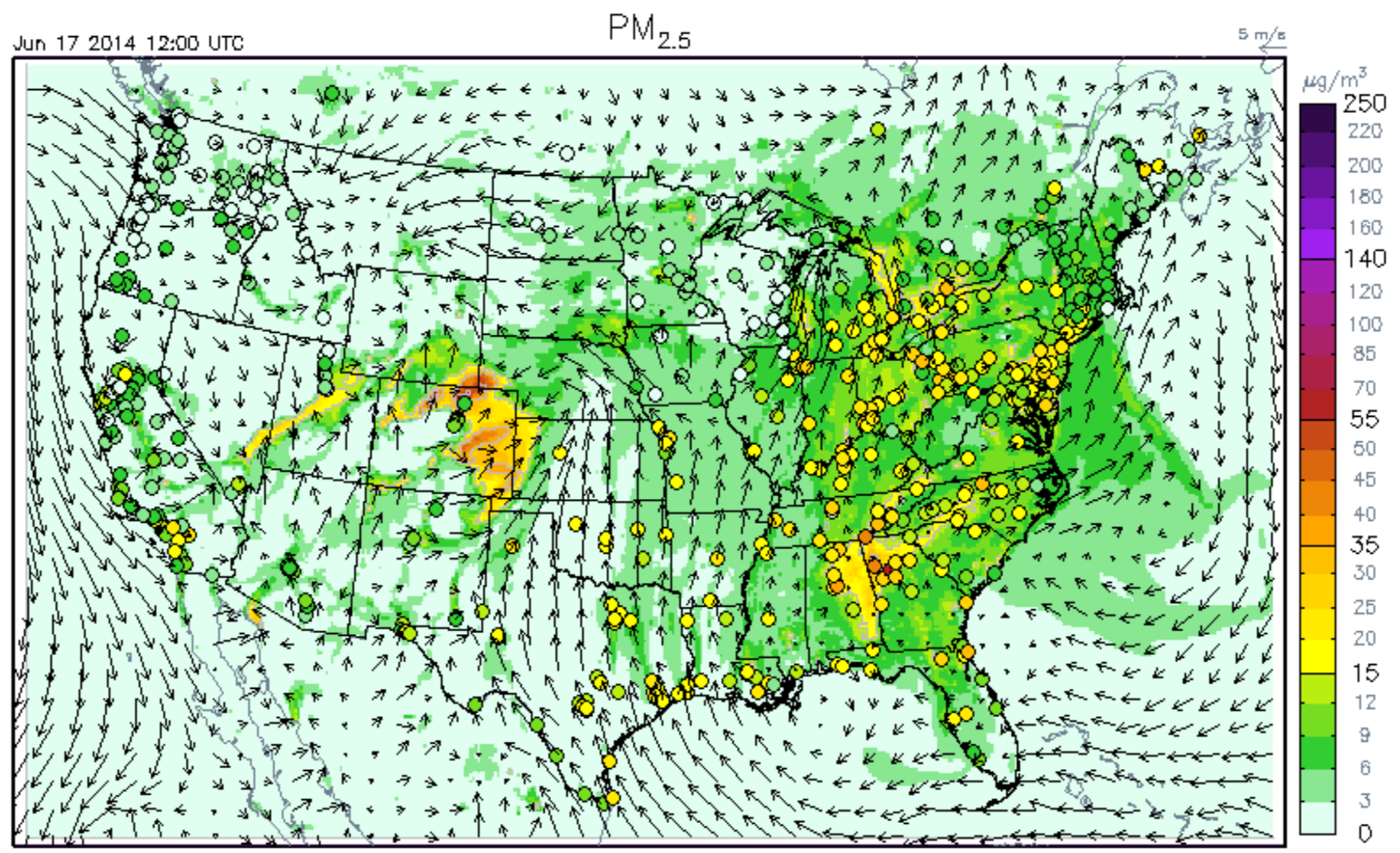


Proposed AQM-PM Upgrades

Significant impact on PM_{2.5} forecast – CMAQ4.6.3

- **Dynamic windblown dust emission** (Tong and Lee et al., ACP 2012)

Dust Movie on 6/17-19 2014





Proposed AQM-PM Upgrades

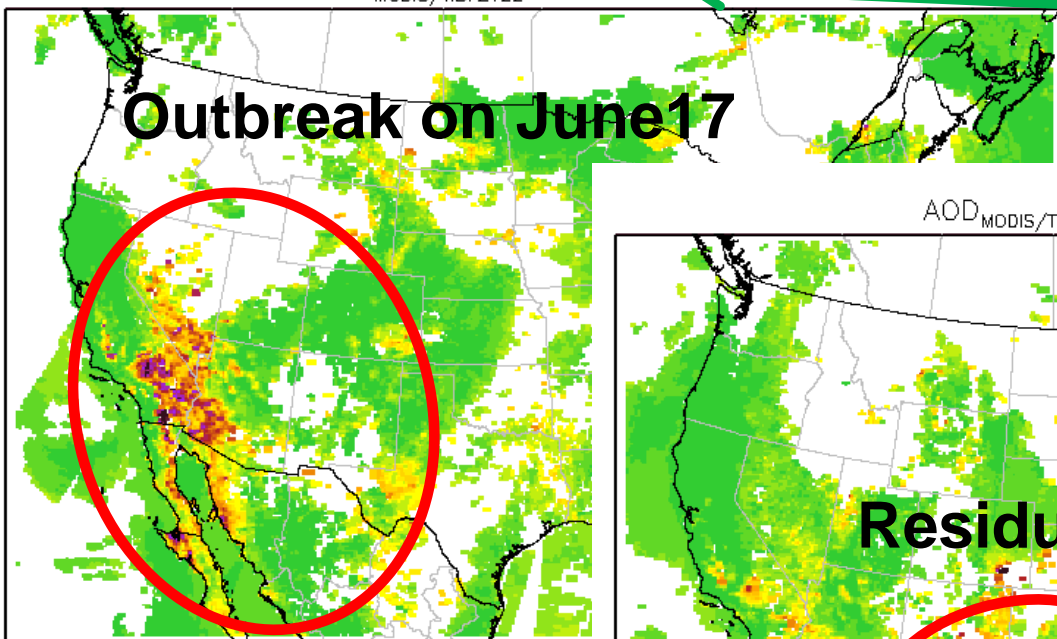
Significant impact on PM_{2.5} forecast – CMAQ4.6.3

➤ **Dynamic windblown dust emission**

NESDIS TEXT June 19 2014: A large cyclone ..thin dust and sand covers much of AZ into SE UT, W CO and far NW NM.

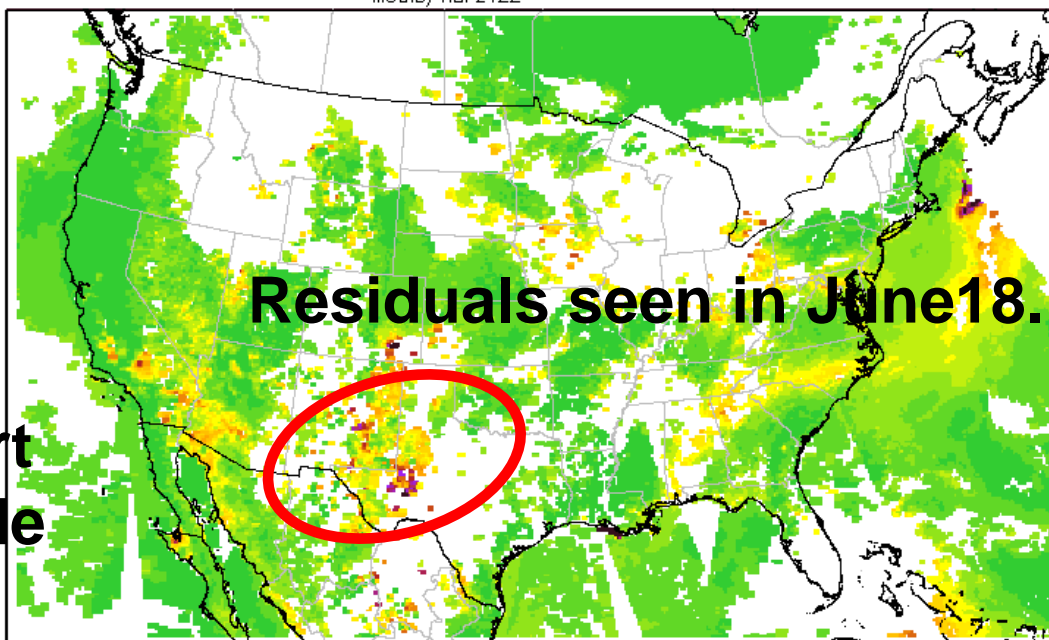
**MODIS imageries
Confirmed dust event**

AOD_{MODIS/T1B2122} 20140617



Outbreak on June 17

AOD_{MODIS/T1B2122} 20140618 Wed



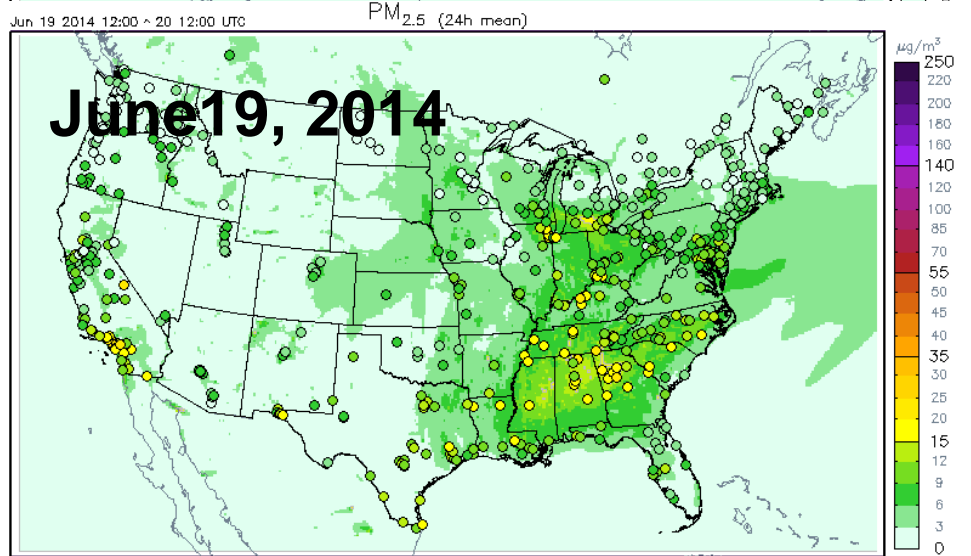
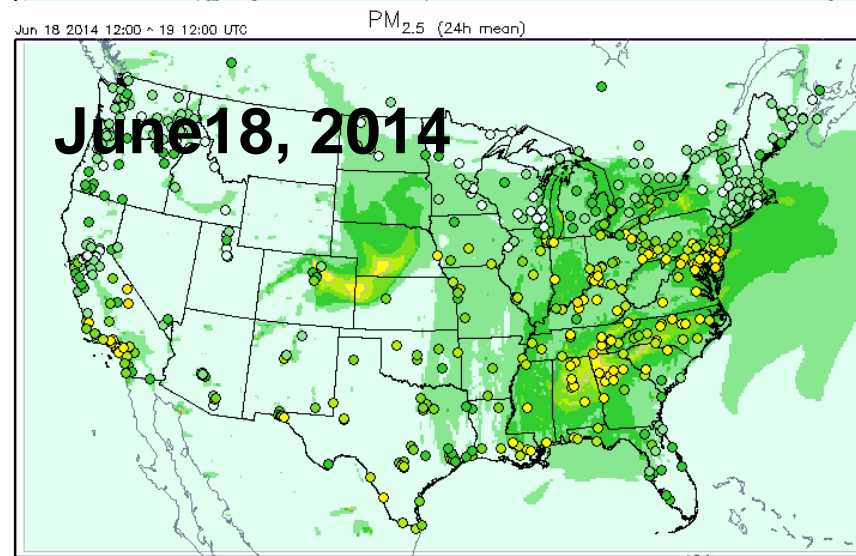
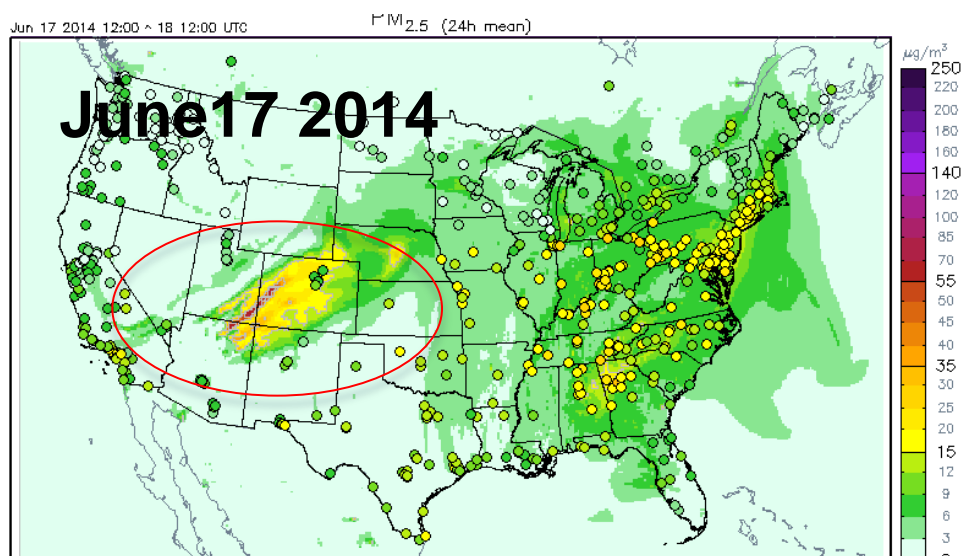
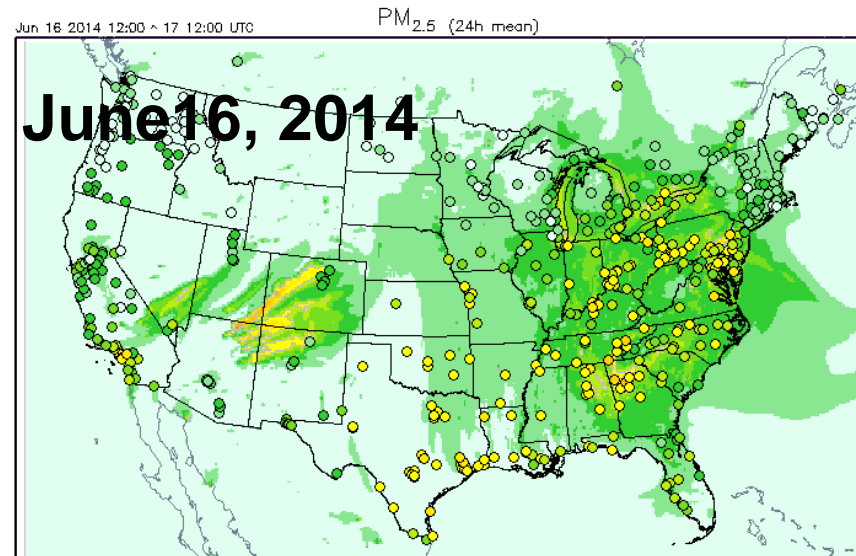
Residuals seen in June 18.

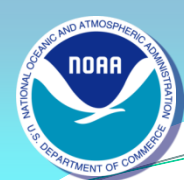
High AOD over desert regions, thin and wide plume over the SW.



Proposed AQM-PM Upgrades

➤ Dynamic windblown dust emission: Outbreak captured

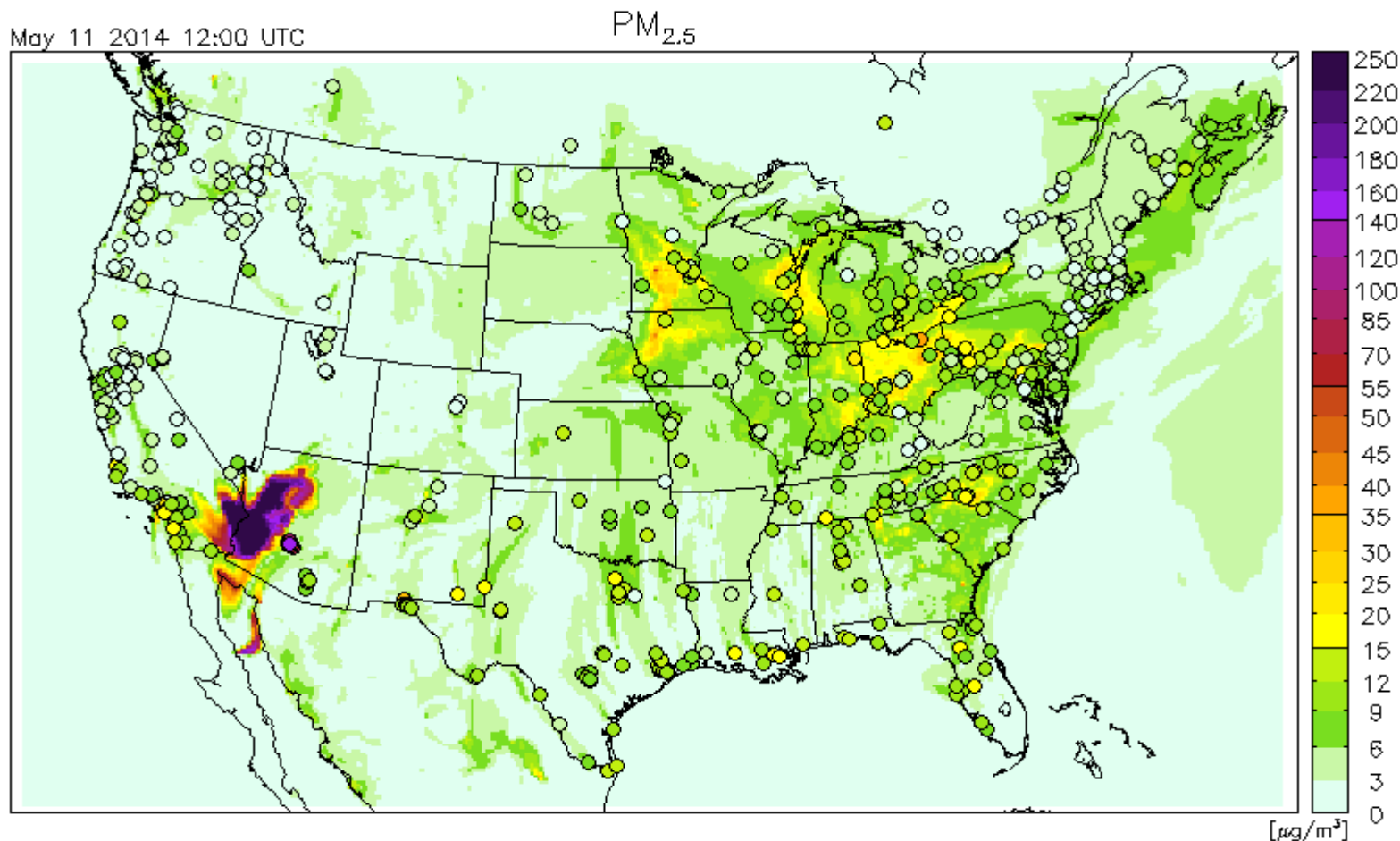




Proposed AQM-PM Upgrades

- **Real-time testing: May 11 2014:** Event was near monitors

NESDIS TEXT May 11 2014: Moderate windblown dust was visible across Northern Baja (CA & AZ) into Western NM.



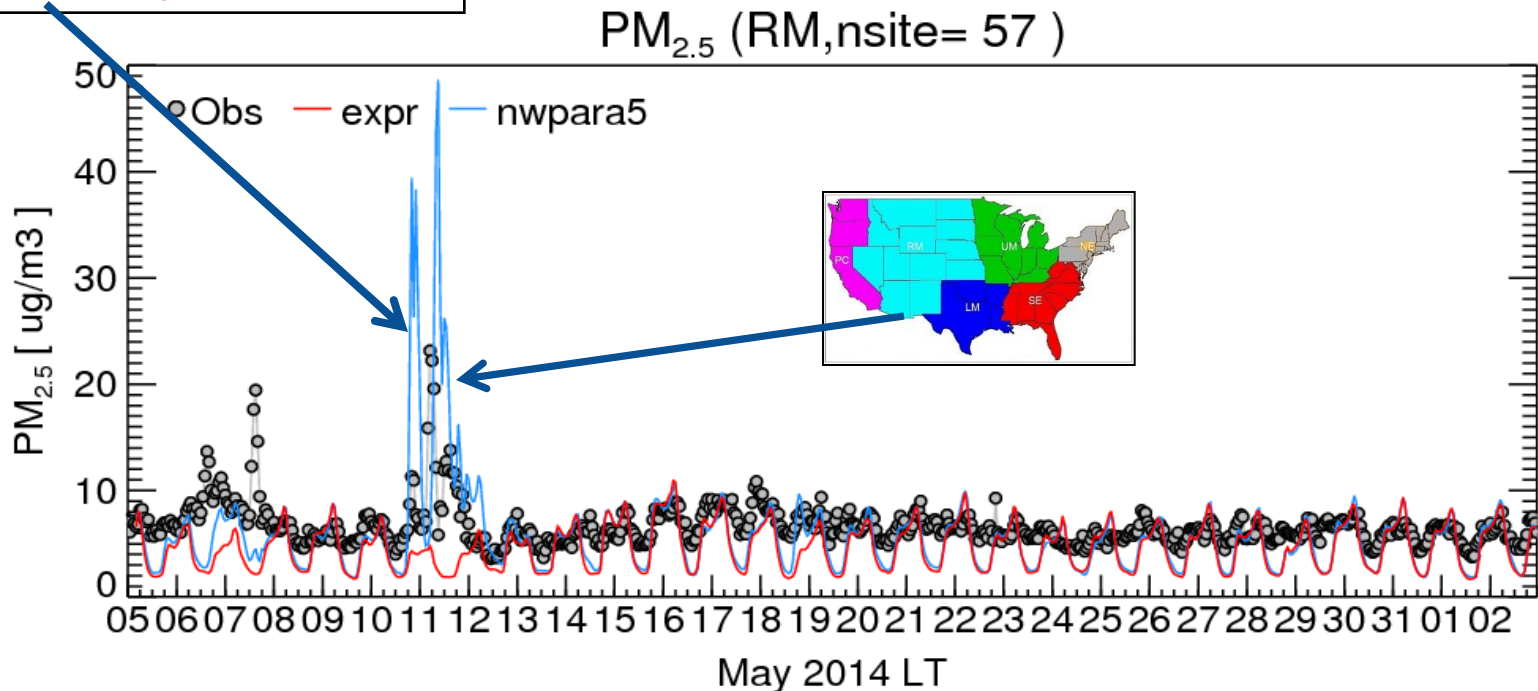


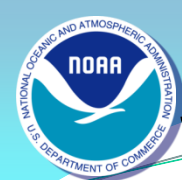
Proposed AQM-PM Upgrades

- **Real-time testing: May 11 2014:** Event was near monitors

NESDIS TEXT May 11 2014: Moderate windblown dust was visible across Northern Baja (CA & AZ) into Western NM.

The real-time run better captured May 11-12 dust in Rocky Mountains

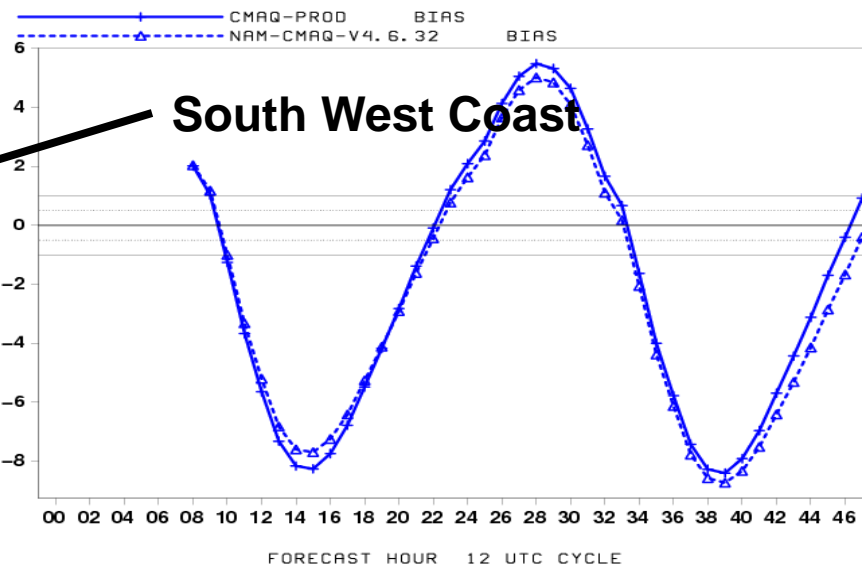
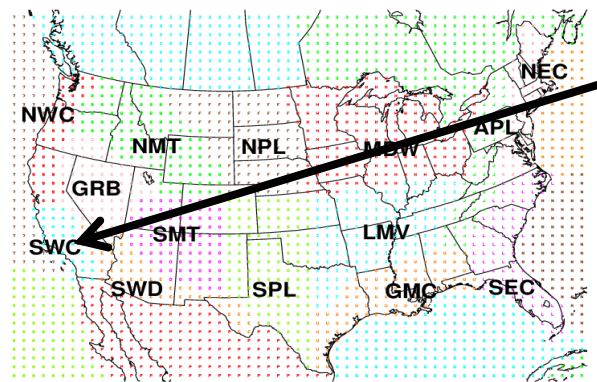
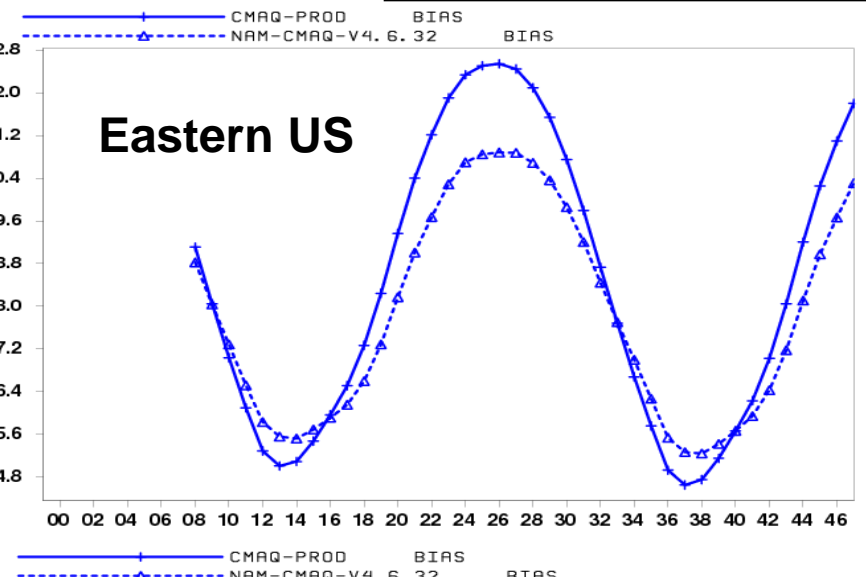
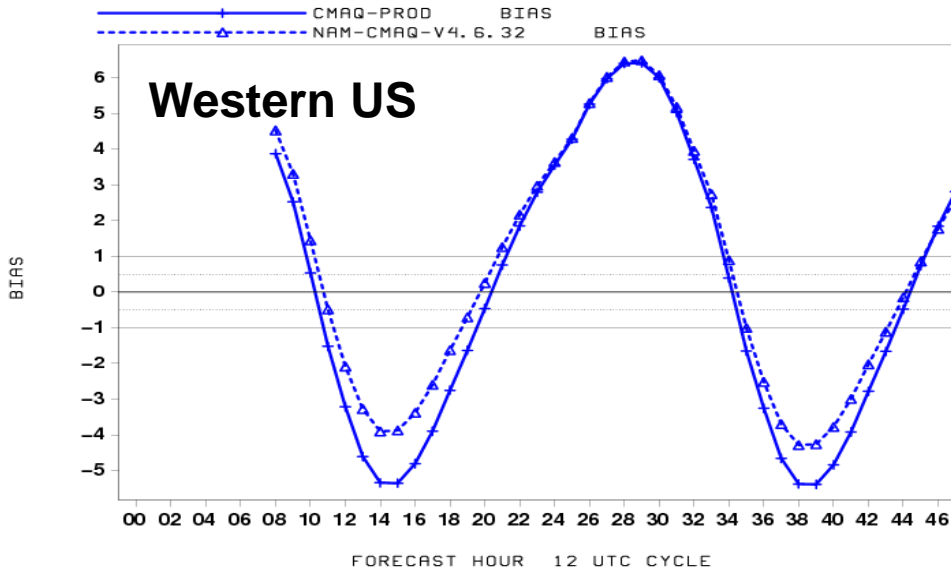




Science Impact: O₃ performance: CMAQ4.6.3 v. ops

FVS: Between July 15 – August 20, 2014

No degradation Of performance





Resource Impact: lib,fd,fix,I/O: CMAQ4.6.3 v. ops

new	# added / major changes	Description	Remarks
Library	3	libaqm_fileset.a, libaqm_edsstools.a, libaqm_smoke.a	consistent mxvar
Source codes (fd) (total 14)	9 SMOKE	aqm_emmod.fd, aqm_emutil.fd, aqm_emqa.fd, aqm_smkinven.fd, aqm_point.fd, aqm_temporal.fd, aqm_grdmat.fd, aqm_spcmat.fd, aqm_smkmerge.fd	sequential process
	3 fengsha	aqm_snowdust.fd, aqm_fengsha.fd, aqm_fengsha_merge.fd	wind gust
	2 posts	post1, post3	pm25
Fixed files	44	land texture and soil-type,...etc	fengsha
Intermediate files	264	SMOKE's temporalization & spatialization	QA and logs
Output	328	aqm.cycle.pm25.grib2	pm & fire



Resource Impact: memory & CPU: CMAQ4.6.3 v. ops

Disk Usage	Current Production	Expected New Production	Timing Increase
IBM Disk (/tmpnwprd, One 48 h run)	PREPHY: 45 GB PREMAQ: 19.4 GB CMAQ: 24 GB POST: 3 GB	PREPHY: same PREMAQ: 29.5 GB CMAQ: 52.7 GB POST: 18.5 GB	Same +25 mins +25 mins +5 mins
IBM Tape		+25 GB/cycle (pm files)	-
NCEP FTP Server (/com)	115 GB/day	303 GB/day	-
NWS FTP Server	similar minimal	No change	-



Summary

- **Propose upgrade AQM to CMAQ4.6.3**

- **Include 6 science upgrades: with 2 deal with O₃, 4 deal with PM_{2.5}**

Significant impact on O₃ forecast

- Gas-phase chemistry: Carbon Bond 4 (CBIV) → **CB05** for CONUS
- **Faster removal of organic nitrate – NTR**

Significant impact on PM_{2.5} forecast – CMAQ4.6.3

- Implement **AERO-4** for CONUS
- Fugitive dust **emissions modulated by snow** – emission off if snow cover
- NESDIS Hazard Mapping System **wild fires** and fuel from USFS BlueSky
- Dynamic **windblown dust** emission

No degradation in O₃ forecast performance

Reasonably good PM_{2.5} forecast as a new release



BACKUP SLIDES

Emission configurations considered for 2014 emission

Source		Option 1	Option 2	Option 3	Used
Mobile Source		2005 MOVES	2012 MOVES	2005 MOBILE6	2005 MOBILE6 + '05 to '12 Projections
Point Sources		2012 CEM + 2014 Energy Outlook			2012 CEM + 2014 DoE Energy Outlook
Area Source	Nonroad	2005aa	2005cs	2012cs	2012 Cross-state Rule Projection
	Other sectors	2005aa	2005cs		2005 cs
Biogenic Emissions		BEIS 3.11 (PREMAQ)	BEIS3.13 (CMAQ inline)		BEIS3.13
Canadian Emissions (Area, Mobile, and Point)		2000 EI	2006 EI/New Surrogates		2006 EI