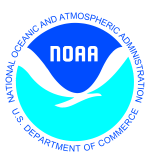


National Air Quality Forecast Capability: Progress in 2012

September 13, 2012

Ivanka Stajner



Outline



Background on NAQFC

Progress in 2012

- *Ozone*
- *Smoke*
- *Dust*
- *PM2.5*

Feedback and outreach

Summary

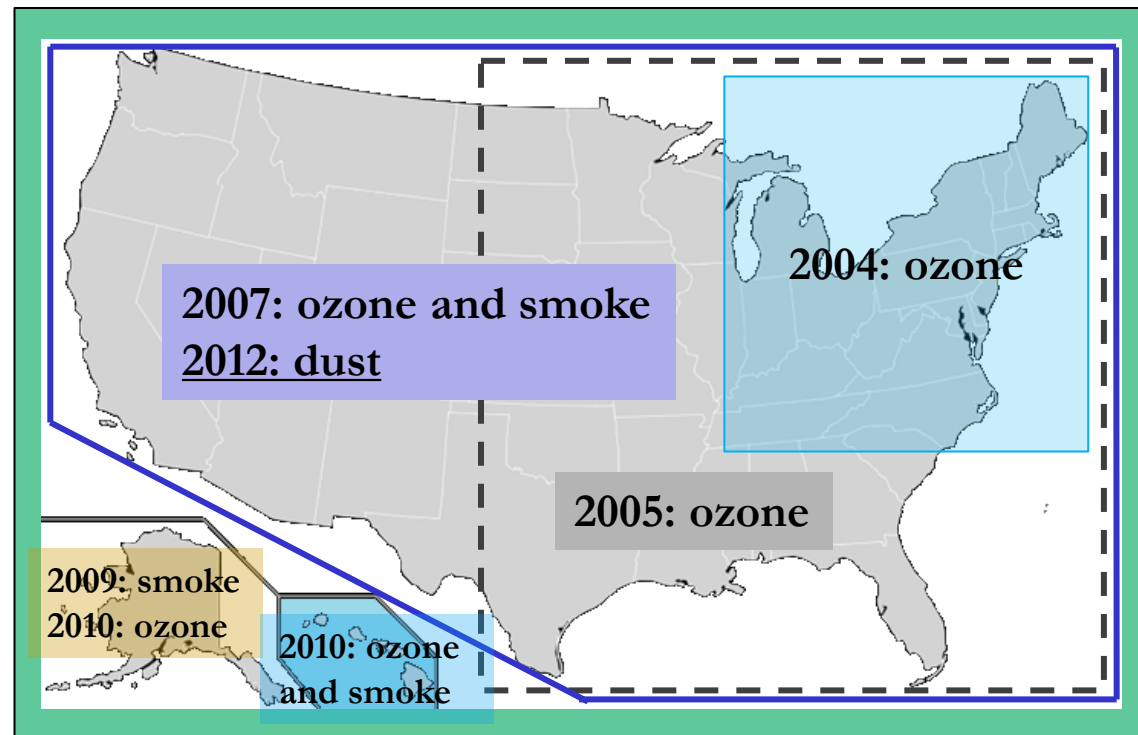
National Air Quality Forecast Capability

Current Capabilities, 9/2012

- Improving the basis for air quality alerts
- Providing air quality information for people at risk

Prediction Capabilities:

- **Operations:**
 - **Ozone nationwide:** expanded from EUS to CONUS (9/07), AK (9/10) and HI (9/10)
 - **Smoke nationwide:** implemented over CONUS (3/07), AK (9/09), and HI (2/10)
 - **Dust over CONUS:** (3/12)
- **Experimental testing:**
 - *Ozone predictions*
- **Developmental testing:**
 - *Components for particulate matter (PM) forecasts*



National Air Quality Forecast Capability

End-to-End Operational Capability

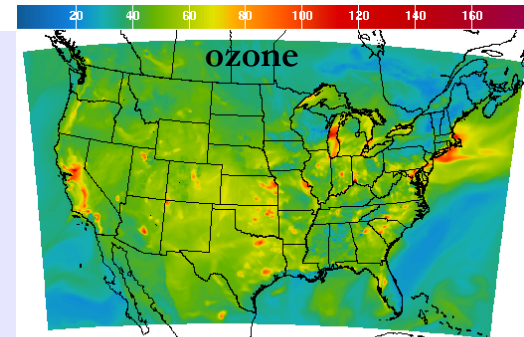
Model: *Linked numerical prediction system*

Operationally integrated on NCEP's supercomputer

- *NOAA NCEP mesoscale numerical weather prediction*
- *NOAA/EPA community model for air quality: CMAQ*
- *NOAA HYSPLIT model for smoke and dust prediction*

Observational Input:

- *NWS weather observations; NESDIS fire locations*
- *EPA emissions inventory*



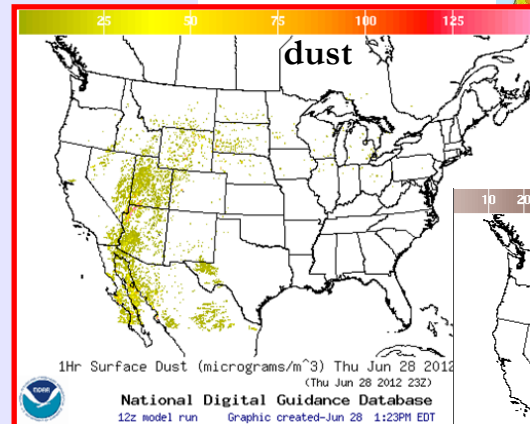
1Hr Avg Ozone Concentration (PPB) Ending Tue Jul 05 2011 7PM EDT
(Tue Jul 05 2011 23Z)
National Digital Guidance Database
12z model run Graphic created-Jul 05 1:42PM EDT



Generated: 2010-09-03 4:17 PST

Gridded forecast guidance products

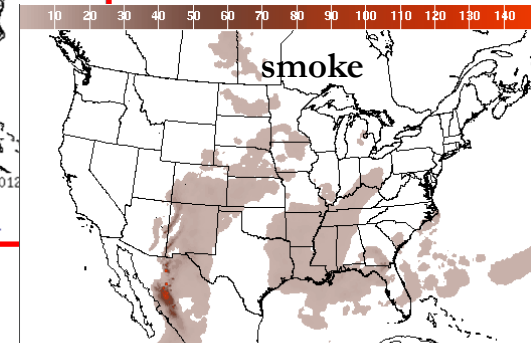
- *On NWS servers: airquality.weather.gov and ftp-servers*
- *On EPA servers*
- *Updated 2x daily*



1Hr Surface Dust (micrograms/m³) Thu Jun 28 2012
(Thu Jun 28 2012 23Z)
National Digital Guidance Database
12z model run Graphic created-Jun 28 1:23PM EDT

Verification basis, near-real time:

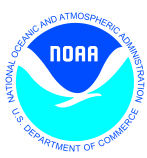
- *Ground-level AIRNow observations of surface ozone*
- *Satellite observations of smoke and dust*



1Hr Vertical Smoke (micrograms/m³) Sat Jun 04 2011 7PM EDT
(Sat Jun 04 2011 23Z)
National Digital Guidance Database
06z model run Graphic created-Jun 04 8:20AM EDT

Customer outreach/feedback

- *State & Local AQ forecasters coordinated with EPA*
- *Public and Private Sector AQ constituents*



Progress in 2012



North American Meteorological model was upgraded to Non-hydrostatic Multi-scale Model (NMMB)

- *These meteorological predictions are used for all air quality predictions (October 2011)*

Ozone Updates:

- *Substantial emission updates:*
 - *Mobile6 used for mobile emissions, but with emissions scaled by growth/reduction rate from 2005 to 2012*
 - *Non-road area sources use Cross State Rule Inventory*
 - *Canadian emissions use 2006 inventory*

Dust updates:

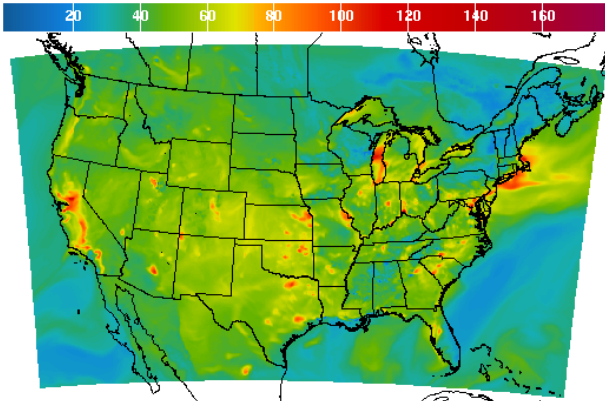
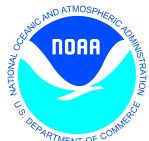
- ***Dust predictions implemented operationally in March 2012***
- *Dust emissions are modulated by real-time soil moisture*
- *Testing use of a longer time step to speed up dust predictions*

Smoke updates:

- *Testing of updates to plume rise and deposition parameters*

Operational Nationwide Ozone

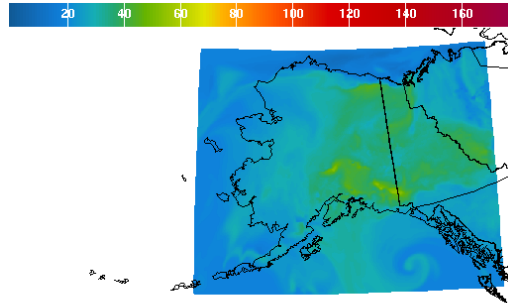
Operational predictions at <http://airquality.weather.gov>



1Hr Avg Ozone Concentration(PPB) Ending Tue Jul 05 2011 7PM EDT
 (Tue Jul 05 2011 23Z)
National Digital Guidance Database
 12z model run Graphic created-Jul 05 1:42PM EDT

1-Hr Average Ozone

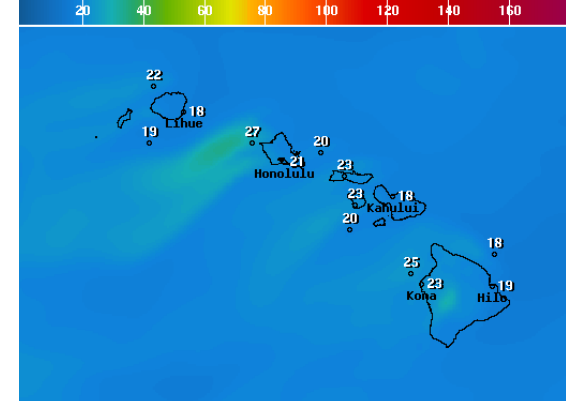
8-Hr Average Ozone



1Hr Avg Ozone Concentration(PPB) Ending Tue Jul 05 2011 7PM EDT
 (Tue Jul 05 2011 23Z)
National Digital Guidance Database
 12z model run Graphic created-Jul 05 12:20PM EDT

1-Hr Average Ozone

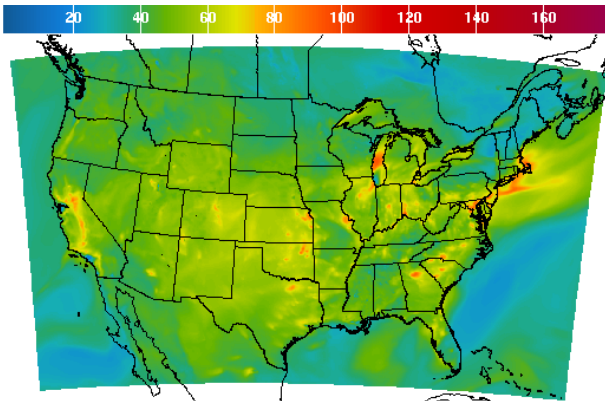
8-Hr Average Ozone



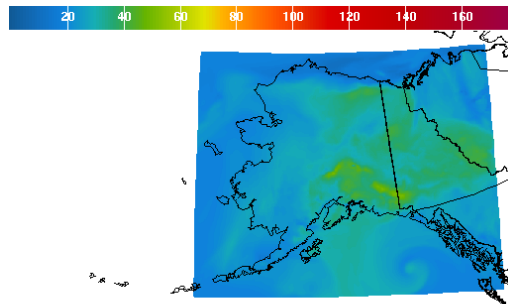
1Hr Avg Ozone Concentration(PPB) Ending Tue Jul 05 2011 7PM EDT
 (Tue Jul 05 2011 23Z)
National Digital Guidance Database
 12z model run Graphic created-Jul 05 11:20AM EDT

1-Hr Average Ozone

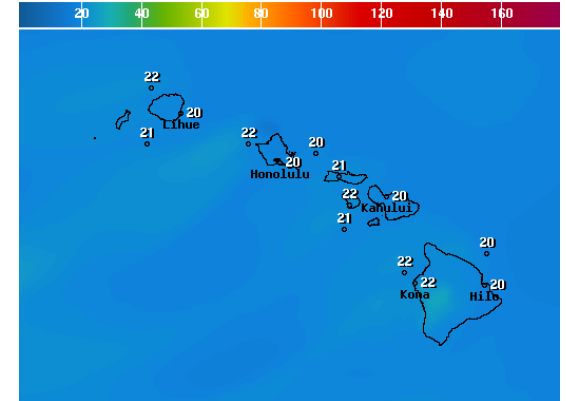
8-Hr Average Ozone



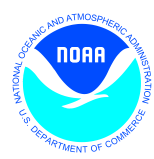
8Hr Avg Ozone Concentration(PPB) Ending Tue Jul 05 2011 7PM EDT
 (Tue Jul 05 2011 23Z)
National Digital Guidance Database
 12z model run Graphic created-Jul 05 1:43PM EDT



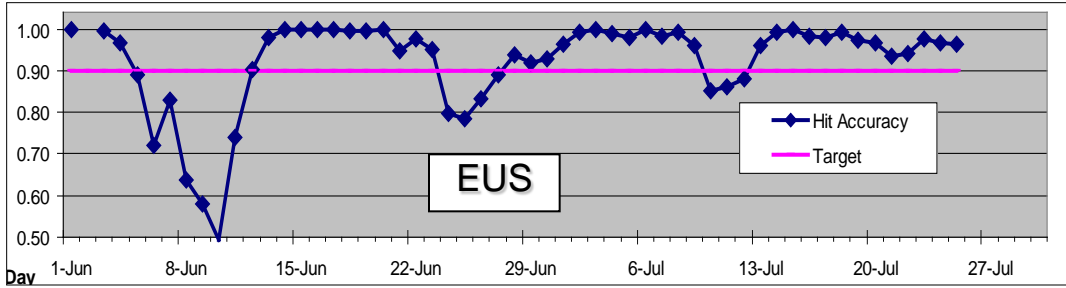
8Hr Avg Ozone Concentration(PPB) Ending Tue Jul 05 2011 7PM EDT
 (Tue Jul 05 2011 23Z)
National Digital Guidance Database
 12z model run Graphic created-Jul 05 12:20PM EDT



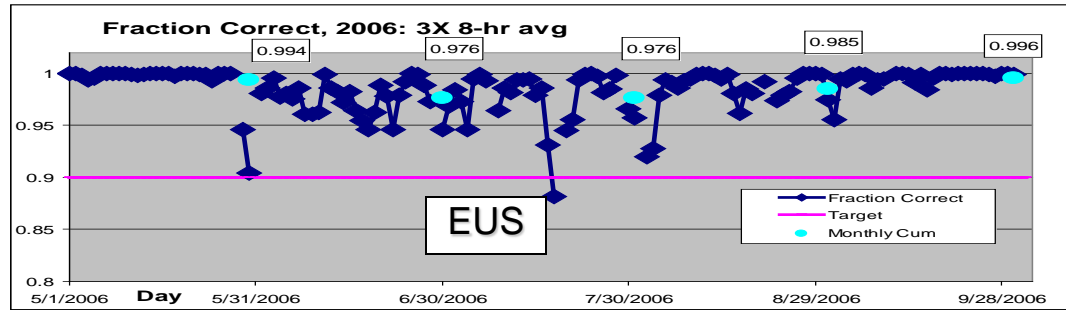
8Hr Avg Ozone Concentration(PPB) Ending Tue Jul 05 2011 7PM EDT
 (Tue Jul 05 2011 23Z)
National Digital Guidance Database
 12z model run Graphic created-Jul 05 11:20AM EDT



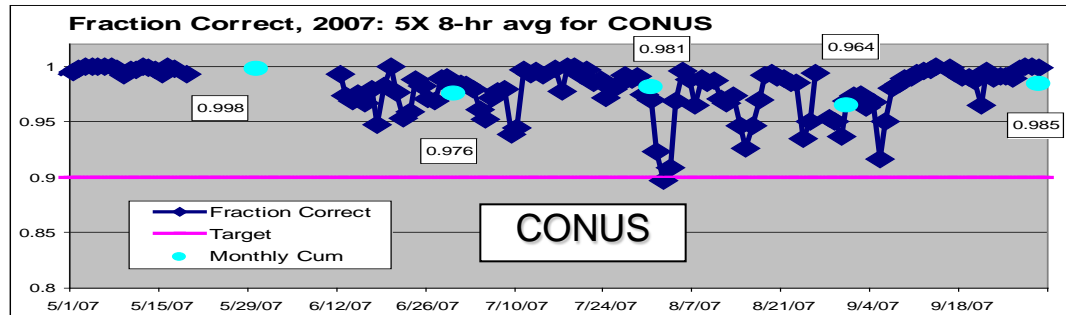
Progress from 2005 to 2008: Ozone Prediction Summary Verification



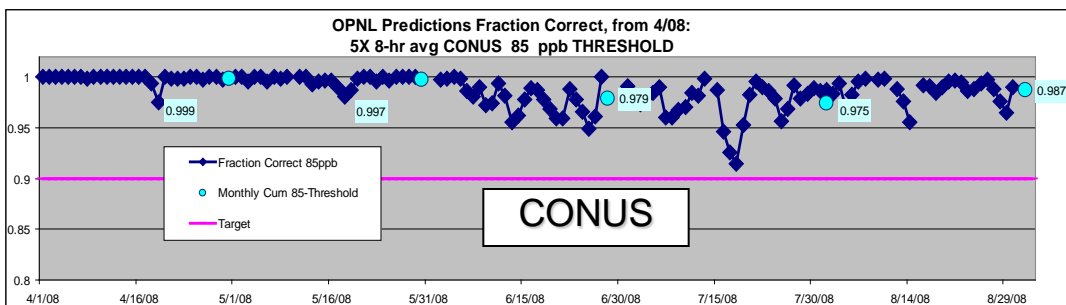
2005
Initial Operational Capability (IOC)
Operational, NE US Domain



2006 **Operational**
Operational, Eastern US

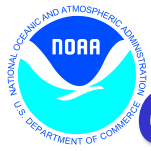


2007 **Experimental**
Experimental, Contiguous US
Approved 9/07 to replace Eastern US config in operations



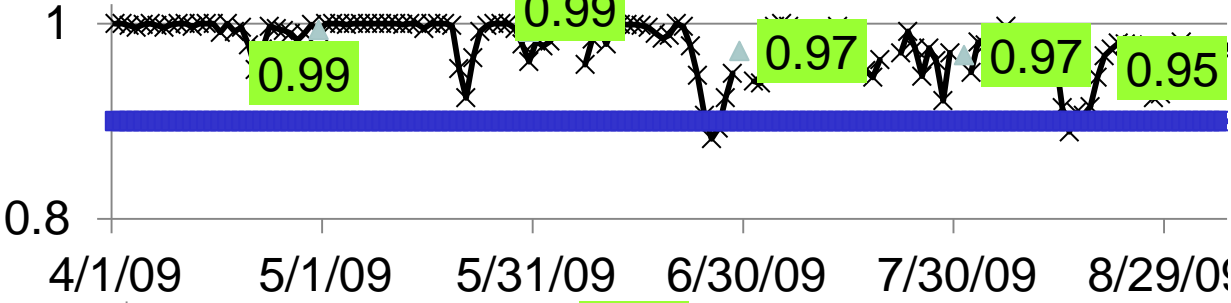
2008 **Operational**
CONUS, wrt 85ppb Threshold

Maintaining prediction accuracy as prediction domain expanded

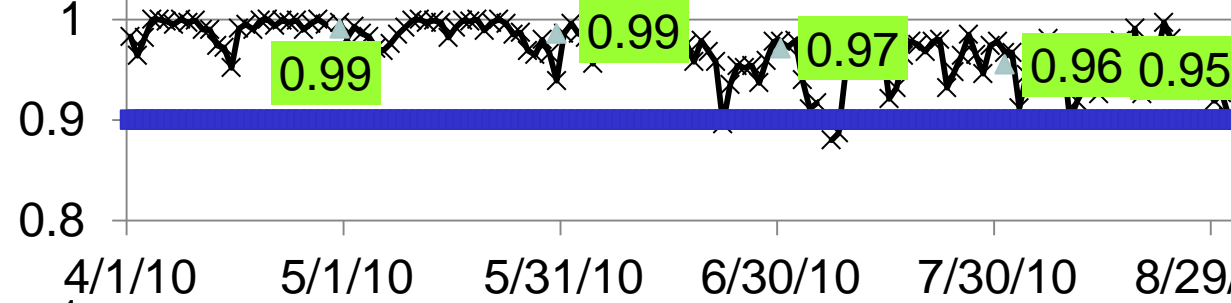


Progress from 2009 to 2012:

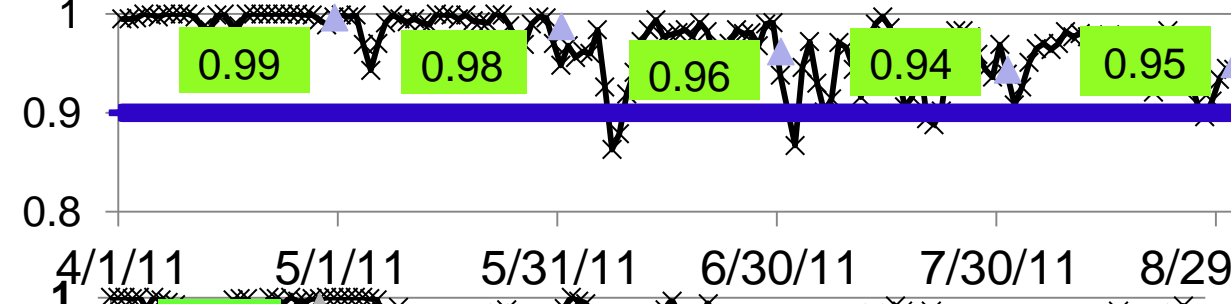
CONUS O₃ Prediction Summary Verification



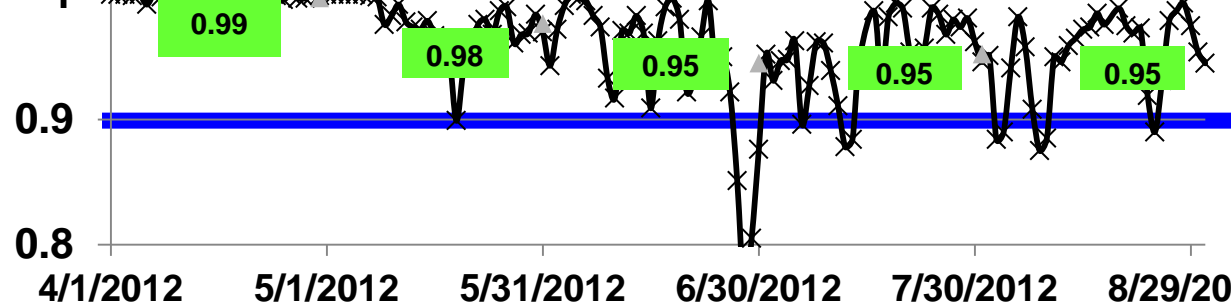
2009 **Operational**
CONUS, wrt 76ppb Threshold



2010 **Operational**
CONUS, wrt 76ppb Threshold

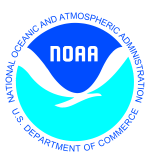


2011 **Operational**
CONUS, wrt 76 ppb Threshold

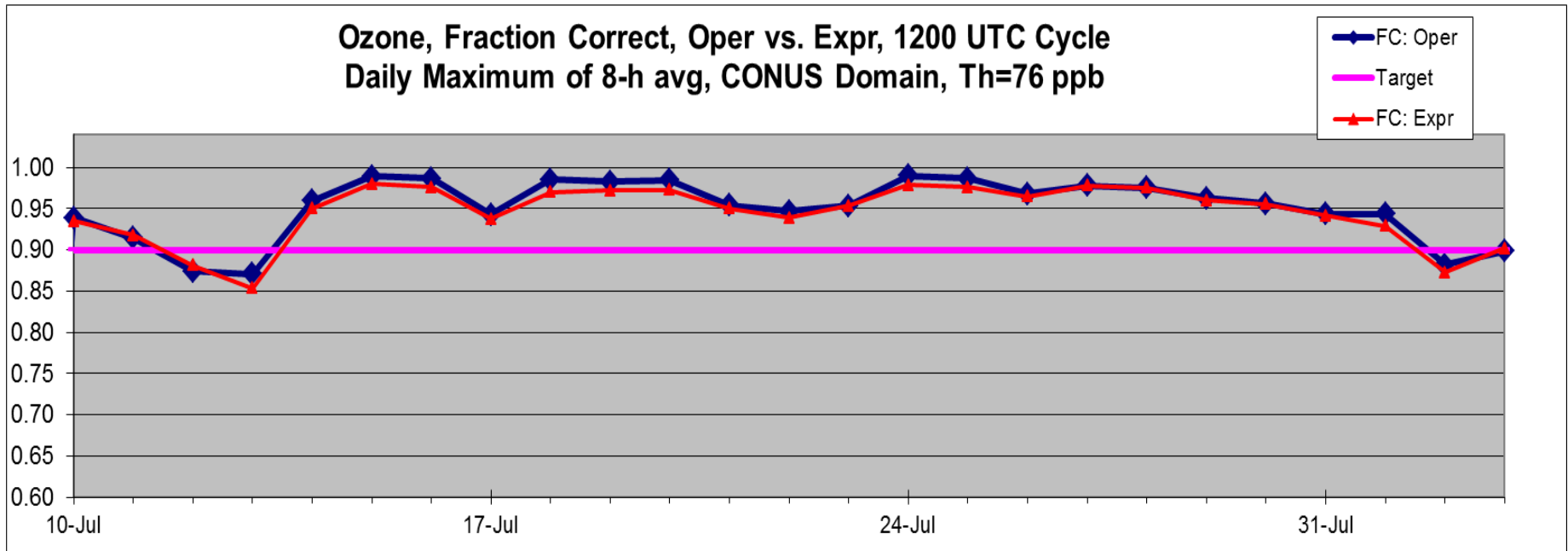


2012 **Operational**
CONUS, wrt 76 ppb Threshold

Maintaining prediction accuracy as the warning threshold was lowered and emissions of pollutants are changing



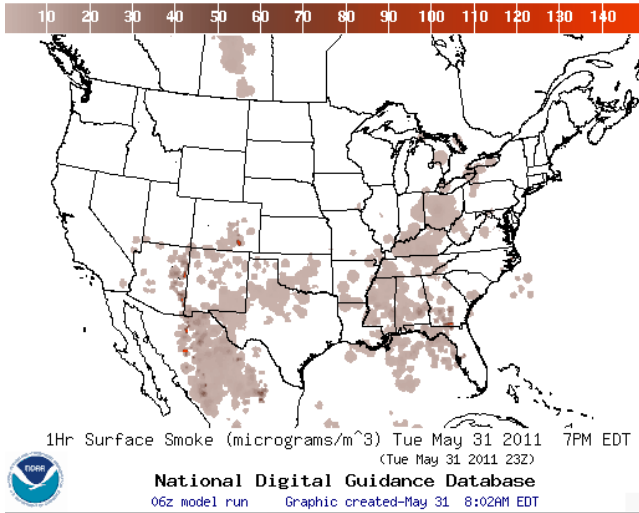
Operational and experimental predictions show similar performance



Fraction correct with respect to 76ppb threshold

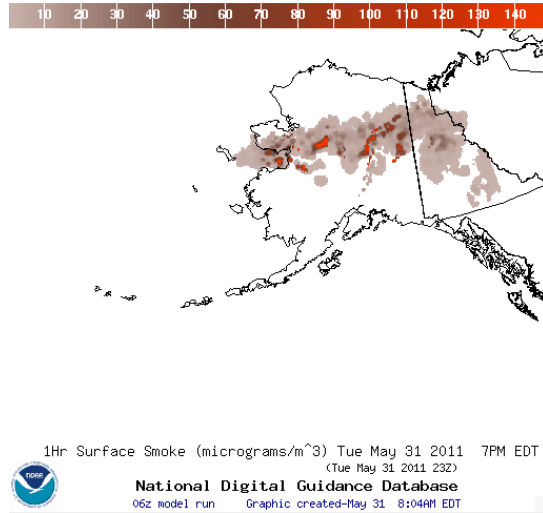
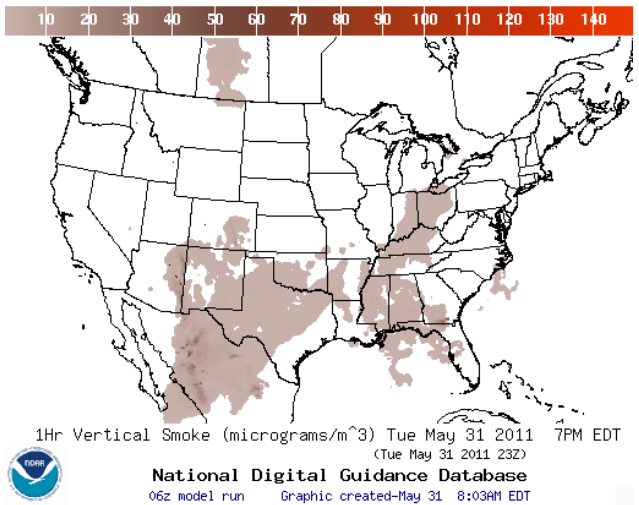
Operational Nationwide Smoke

Operational predictions at <http://airquality.weather.gov>



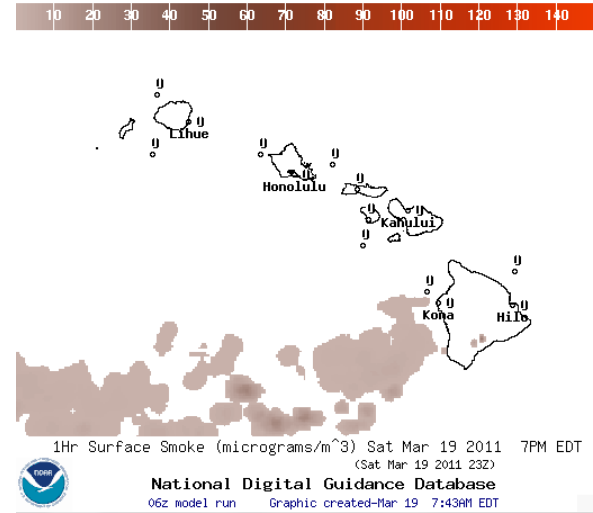
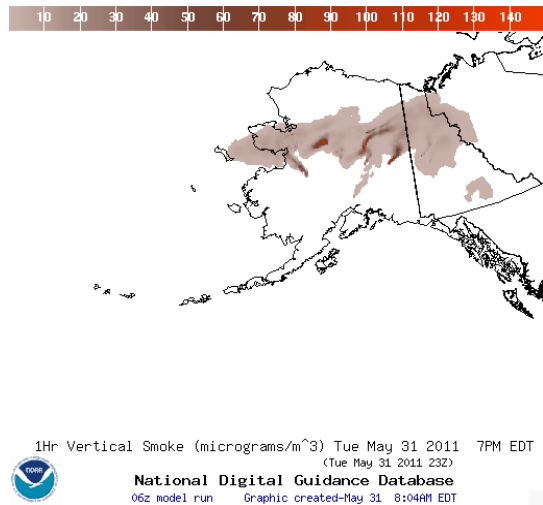
Surface Smoke

Vertical Smoke



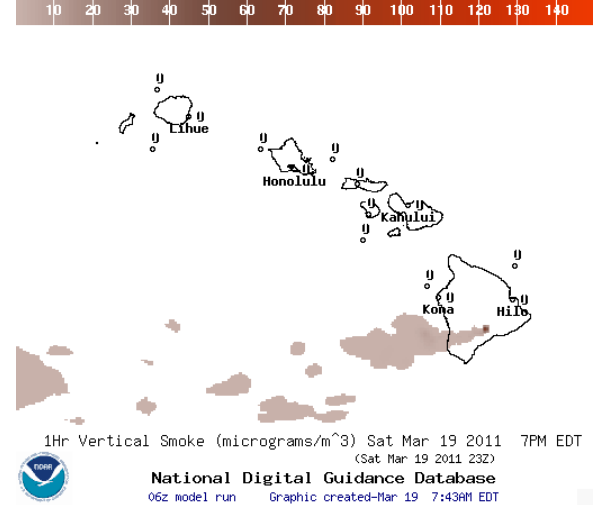
Surface Smoke

Vertical Smoke



Surface Smoke

Vertical Smoke



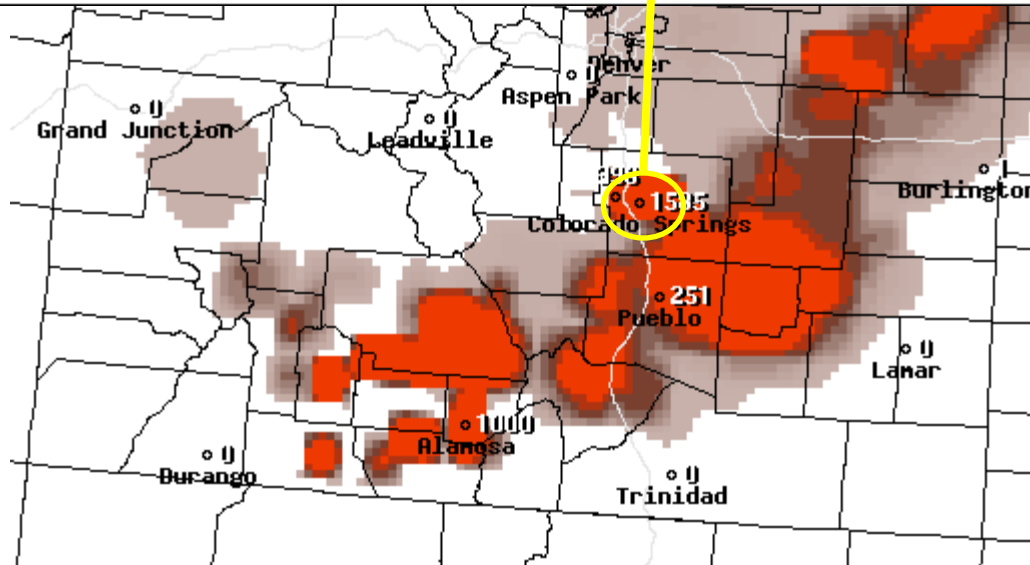
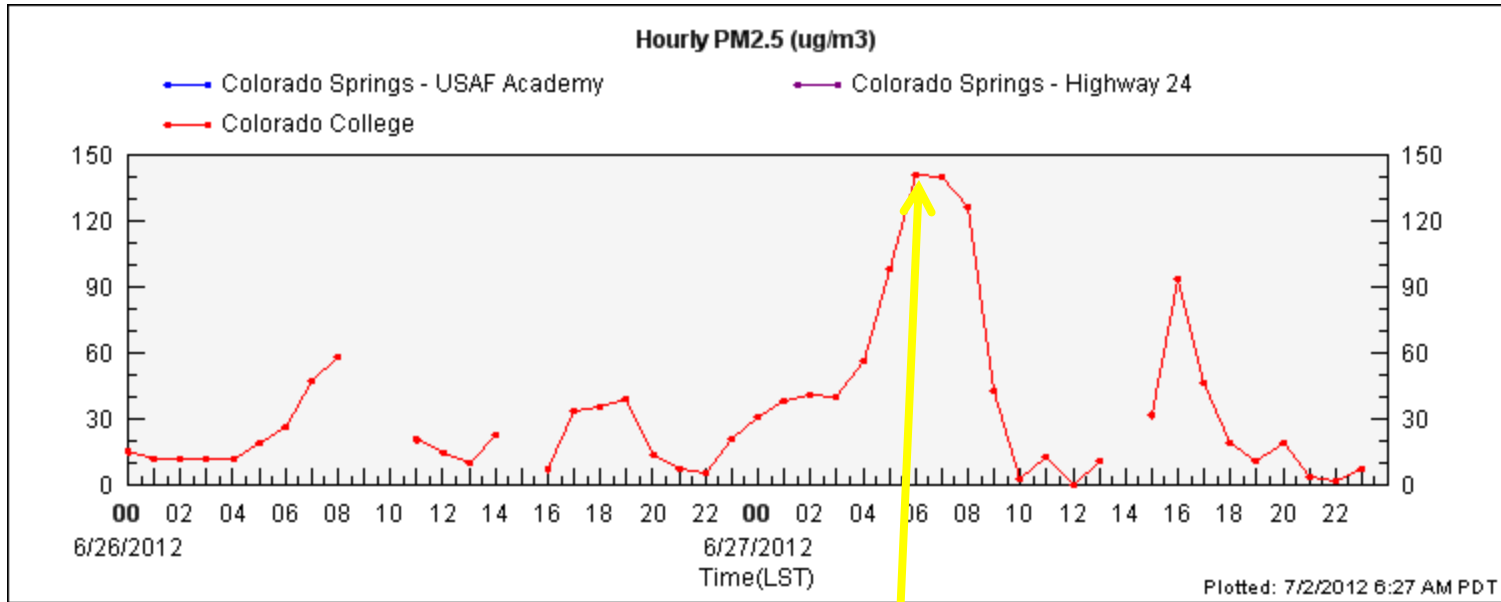
Colorado Springs – Waldo Canyon Fire

- ***Began on June 23, west of Colorado Springs¹***
- ***Moved eastward from winds, destroying 346 homes***
- ***Peak of fire June 26-27***
- ***Evacuations reached 32,000 on June 27***
- ***Over 17,000 acres destroyed***
- ***The cause of the fire is under investigation***
- ***Smoke plume reached heights of 20,000 feet²***
- ***High winds in region have fueled rapid spread of fire; dry conditions persistent; consecutive Red Flag Warning days***



1. ***Inciweb Reports, <http://www.inciweb.org/incident/2929/>***
2. ***Waldo Canyon fire reaches 'epic proportions', <http://www.csmonitor.com/USA/Latest-News-Wires/2012/0627/Waldo-Canyon-fire-reaches-epic-proportions-video>***
3. ***AirNOW tech data, www.airnowtech.org***
4. ***NWS Air Quality Predictions, <http://airquality.weather.gov>***

Colorado Springs – Waldo Canyon Fire

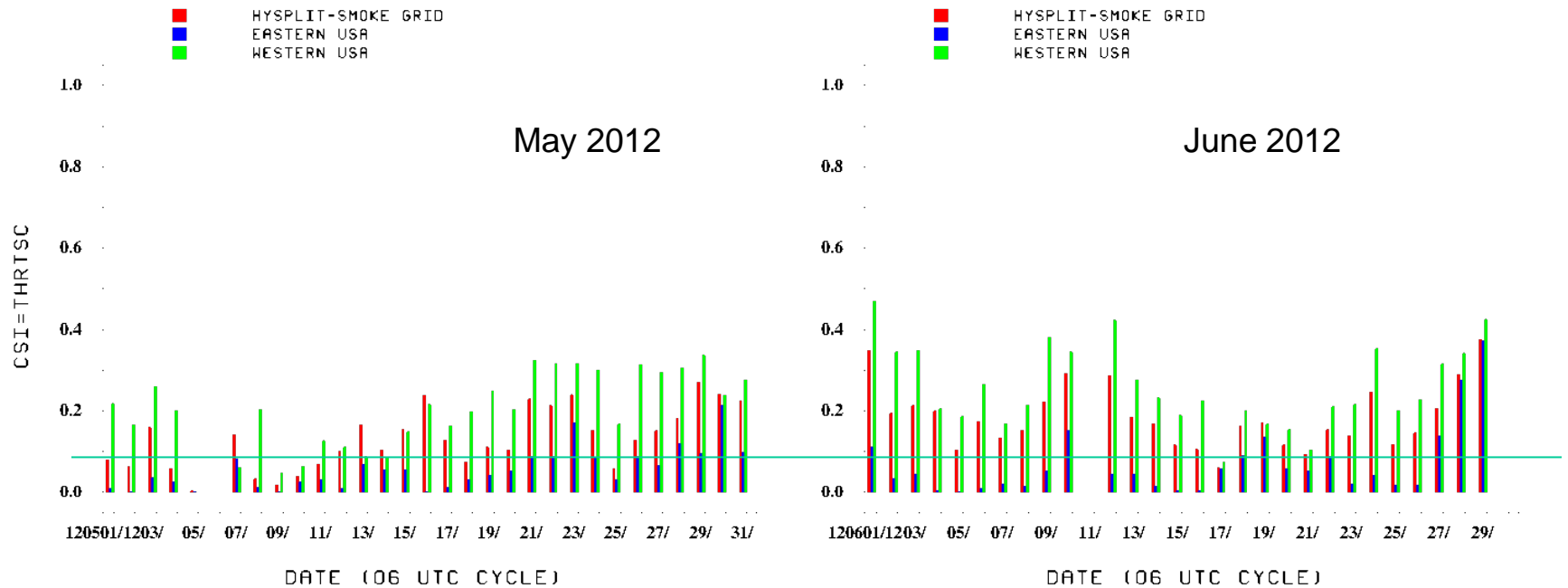


Verification of smoke predictions

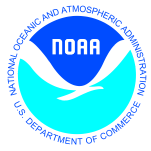
Daily time series of FMS for smoke concentrations larger than 1 $\mu\text{m}/\text{m}^3$

201205 SMOKE >1.0 ug/m3 Daily Avg Time Series Day 1 Fcst

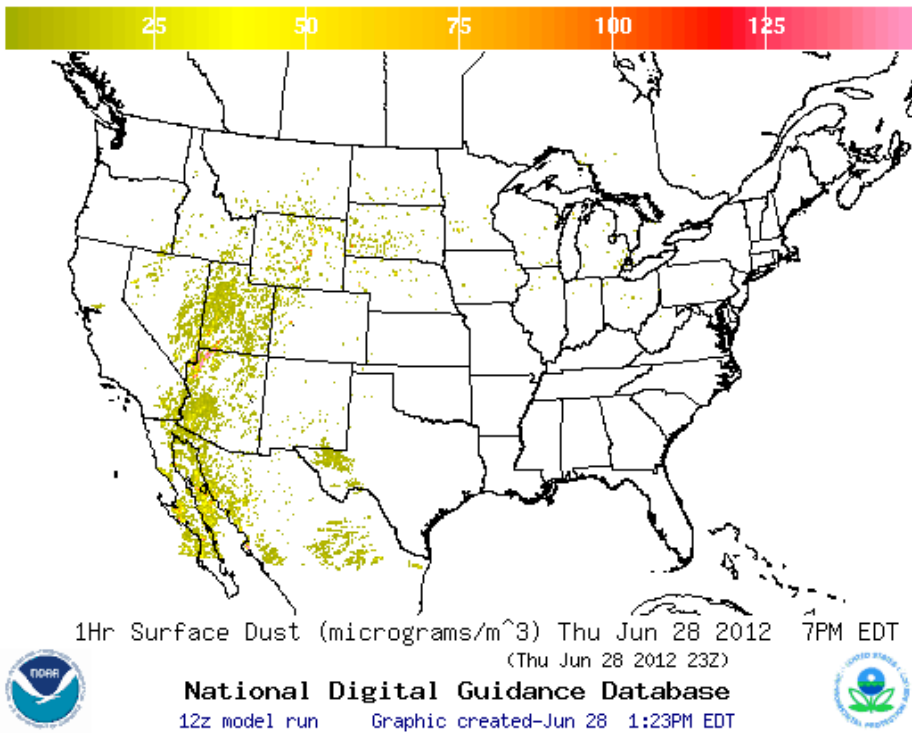
16 SMOKE >1.0 ug/m3 Daily Avg Time Series Day 1 Fcst



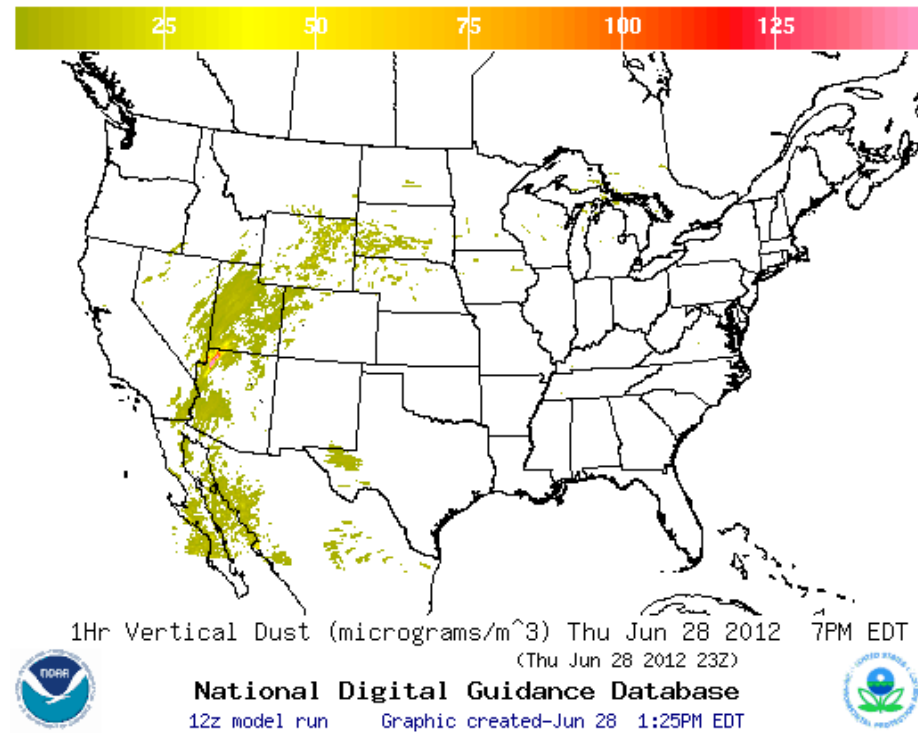
- Figure of merit in space (FMS), which is a fraction of overlap between predicted and observed smoke plumes, threshold is 0.08 marked by green line
- NESDIS GOES Aerosol/Smoke Product is used for verification



CONUS Dust Predictions

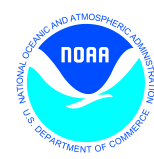


Surface Dust



Vertical Dust

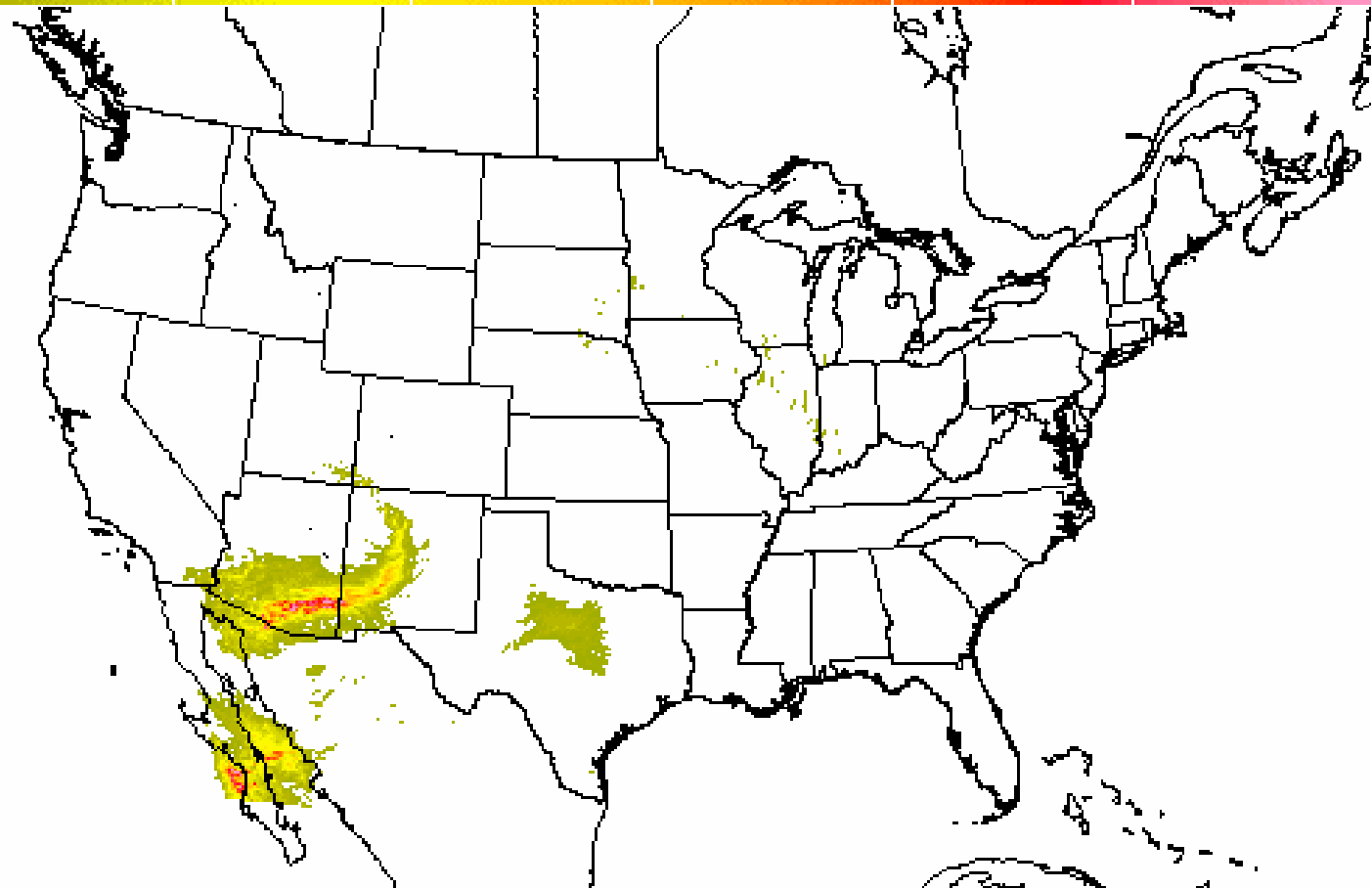
Predictions at <http://airquality.weather.gov>



CONUS Dust Predictions



Operational Predictions at <http://airquality.weather.gov/>



- Standalone prediction of airborne dust from dust storms:
- Wind-driven dust emitted where surface winds exceed thresholds over source regions
 - Source regions with emission potential estimated from monthly MODIS deep blue climatology (2003-2006).
 - HYSPLIT model for transport, dispersion and deposition (Draxler et al., JGR, 2010)
 - Emissions now modulated by real-time soil moisture.
 - Developed satellite product for verification (Zeng and Kondragunta)

1Hr Column Dust (micrograms/m³) Wed Mar 10 2010 2AM EST
(Wed Mar 10 2010 07Z)

National Digital Guidance Database
06z model run Graphic created-Mar 15 10:43AM EDT



Prediction of dust from dust storms over CONUS

End-to-End Capability

Model Components: Linked numerical prediction system

Operationally integrated on NCEP's supercomputer

NCEP mesoscale NWP: NAM (NMMB, 12km resolution)

NOAA/OAR HYSPLIT dispersion for dust transport

Observational Input:

NWS real-time weather observations assimilated in NAM

Gridded forecast guidance products

On NWS Telecommunications Gateway and NDGD

Updated 2 times per day: 6z and 12z

Routine verification basis

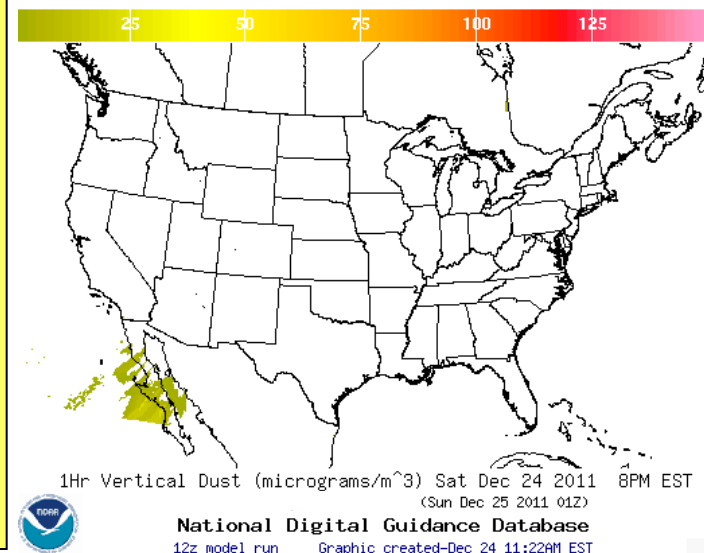
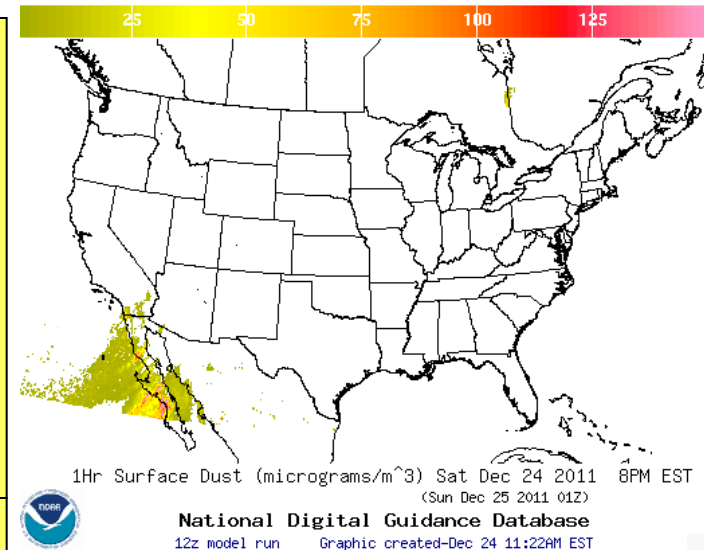
Near real-time NOAA/NESDIS dust-column product

Customer outreach/feedback

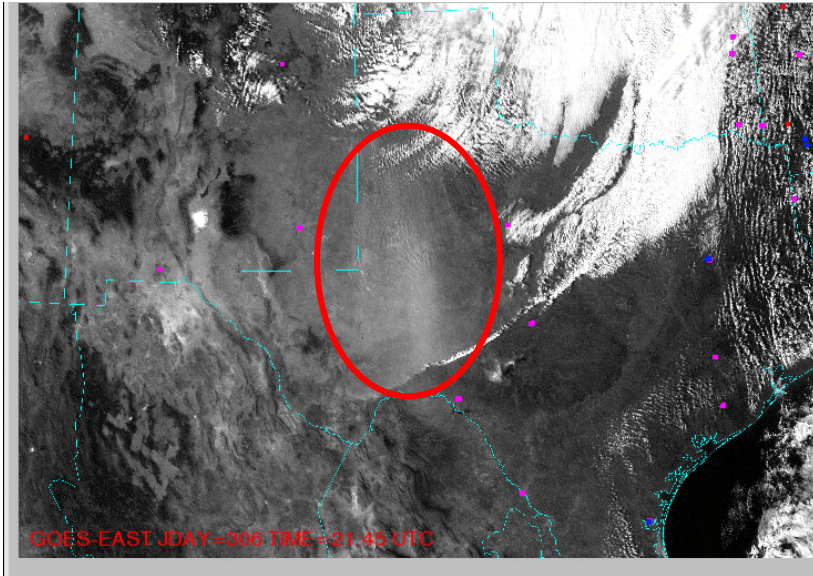
NOAA/NWS field forecasters

State & Local AQ forecasters, coordinated with EPA

Public and Private Sector AQ constituents

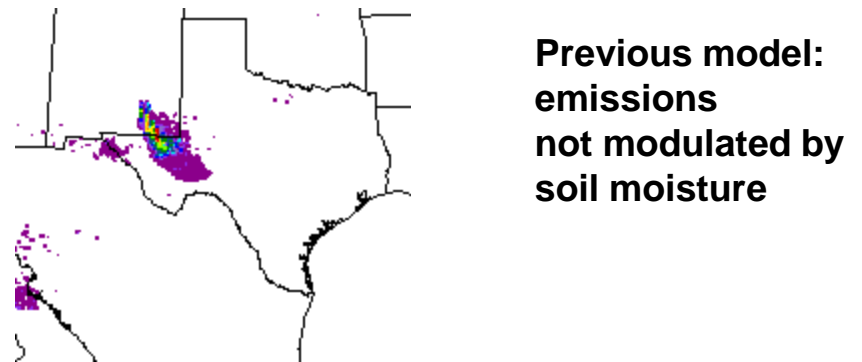
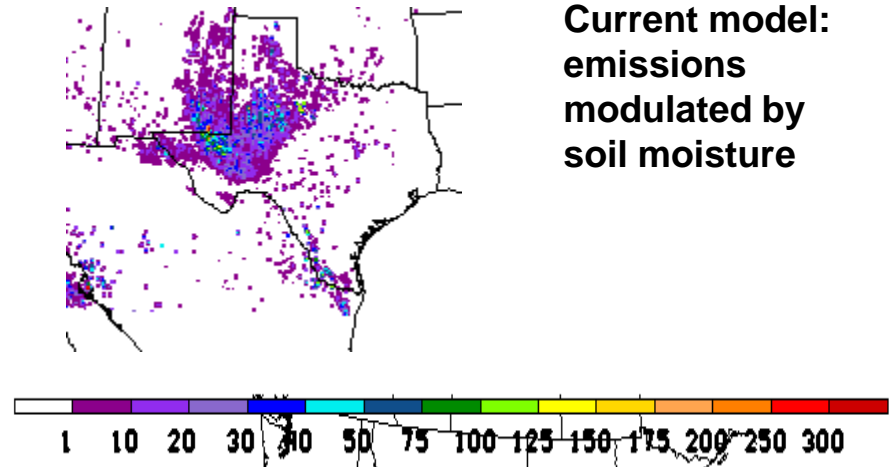


Texas dust event on November 2, 2011



A widespread dust event occurred on Nov 2 beginning around 18Z in west central Texas. This event was the result of ~25kt synoptic scale winds ahead of a cold front. Through 0Z (Nov 3) the dust blew south covering all of west Texas and parts of southeast New Mexico.

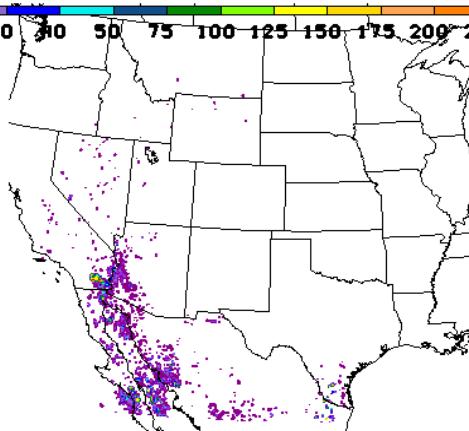
Predicted dust concentration (ug/m³) at the surface



Dust predictions testing of longer time step

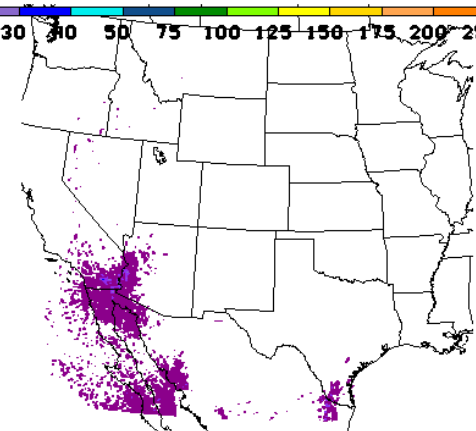
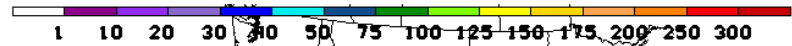
Operational predictions
6 minute time step

Surface concentration



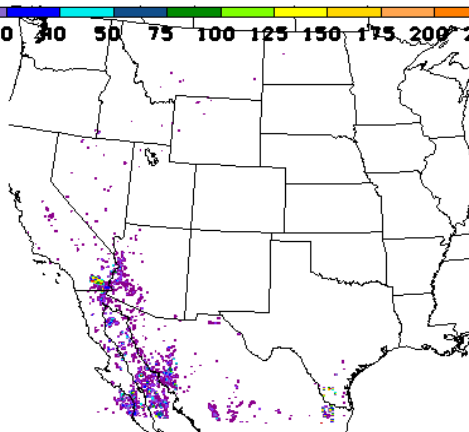
120711/1500V033 33-HR SFC DUST OPS RUN

Column average concentration

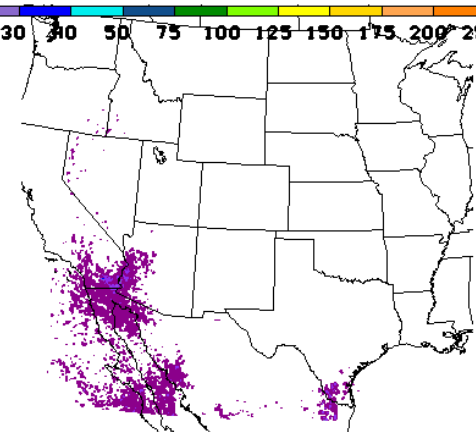


120711/1500V033 33-HR COLUMN DUST OPS RUN

Predictions with a
10 minute time step

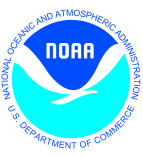


120711/1500V033 33-HR SFC DUST PARA RUN

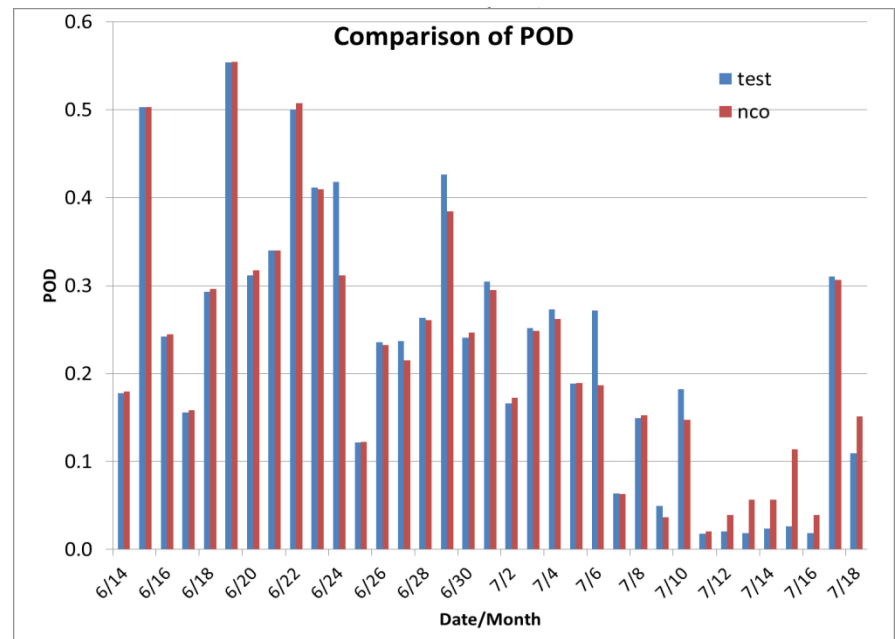
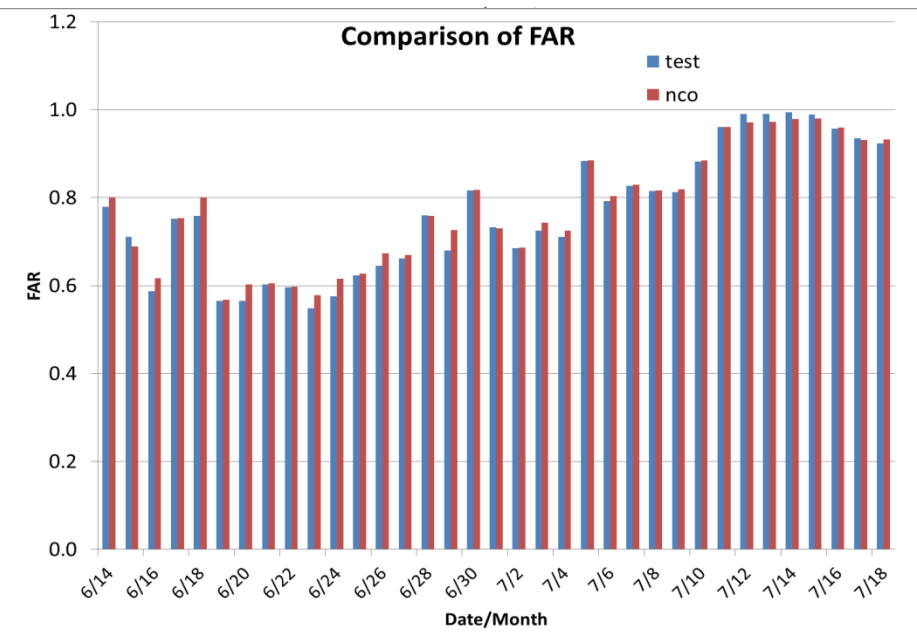
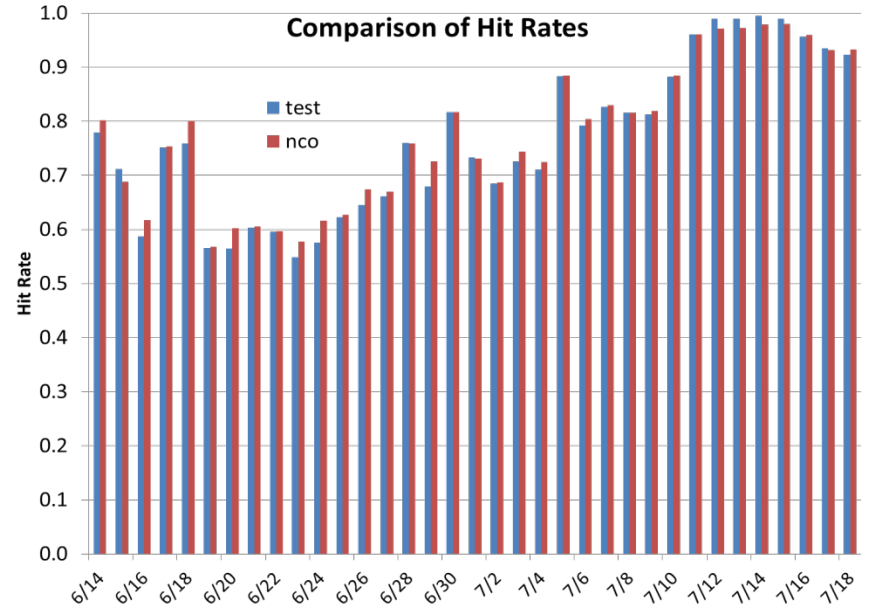
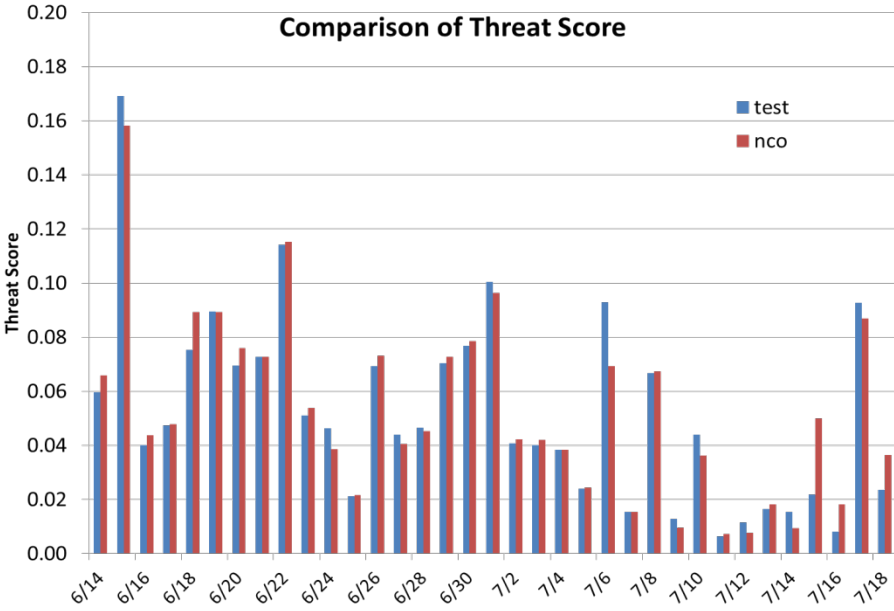


120711/1500V033 33-HR COLUMN DUST PARA RUN

Longer time step reduces prediction run time by over 30%

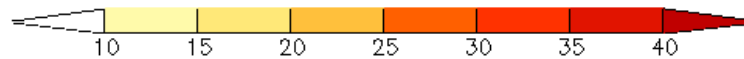
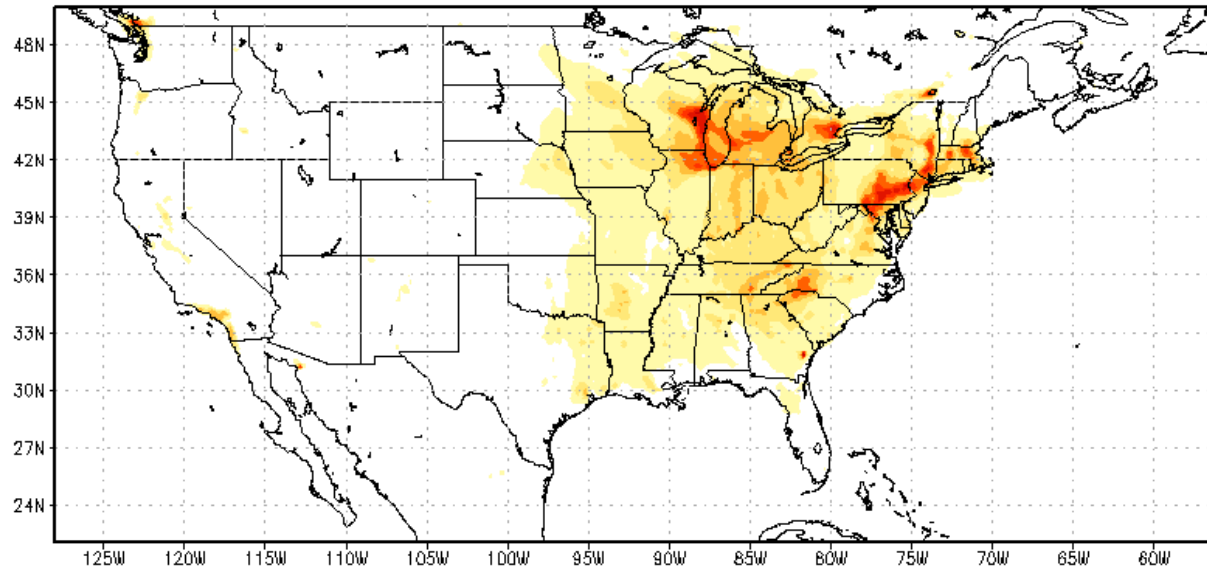


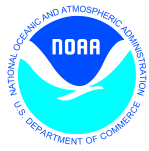
Verification of dust predictions with 10 min and 6 min time step



PM2.5 Developmental Predictions

(dev) 24h sfc pm2.5 22Z31AUG2011-21Z01SEP2011 ($\mu\text{g}/\text{m}^3$)





Developmental predictions, Summer 2012

Focus group access only, real-time as resources permit

Aerosols over CONUS

From NEI sources only

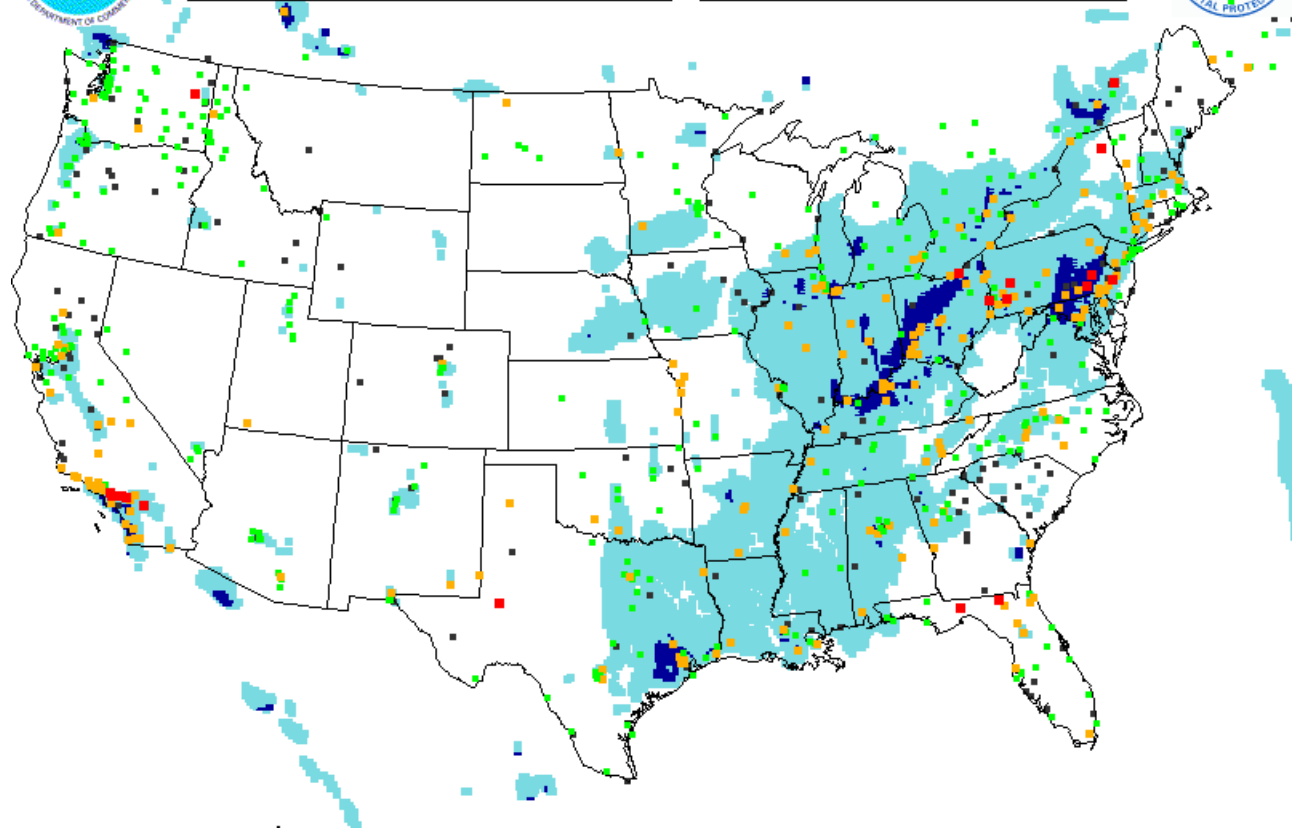
- CMAQ: CB05 gases, AERO-4 aerosols
- Sea salt emissions and reactions

Wildfire smoke emissions not included



Daily PM2.5 Maxima, Obs and Model
 1-H Average, Threshold=35 ug/m³
 Midnight To Midnight EDT 20120419
 5X (Developmental) Grid 0600 UTC

Gray	No Data
Green	Low
Gold/MdBlue	15.5–34.9 ug/m ³
Red/DkBlue	Exceedance

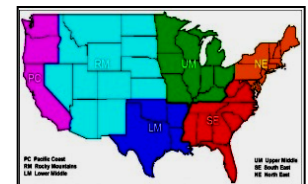
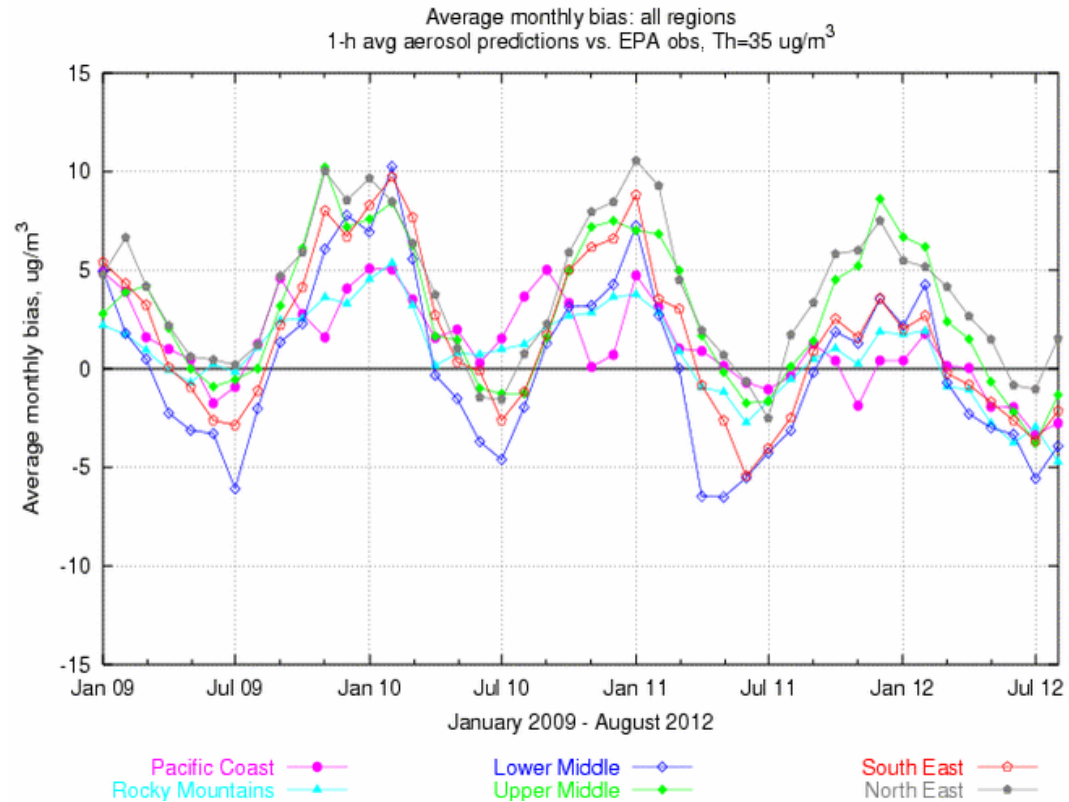


NWS/OST/MDL 2010

Quantitative PM performance

Forecast challenges

- *Aerosol simulation using emission inventories:*
- Show seasonal bias-- winter, overprediction; summer, underprediction
- *Intermittent sources*
- *Chemical boundary conditions/trans-boundary inputs*



Partnering with AQ Forecasters

<http://www.epa.gov/airnow/airaware/>

Focus group, State/local AQ forecasters:

- Participate in real-time developmental testing of new capabilities, e.g. aerosol predictions
- Provide feedback on reliability, utility of test products
- Local episodes/case studies emphasis
- Regular meetings; working together with EPA's AIRNow and NOAA
- **Feedback is essential for refining/improving coordination**

Air Quality Awareness Week

Learn more about the AQI
Learn more about the School Flag Program

[AirNow.gov](#) | [Tools for Teachers](#) | [Tools for Weathercasters](#) | [State & Local Activities](#) | [State & Local Resources](#)

Sign-up for EnviroFlash | Facebook | Twitter

Healthy Air. Healthy You.
Learn how air quality affects your health during Air Quality Awareness Week, April 30-May 4.

Monday: It's Not Just Ozone, Particulate Pollution Matters, Too

You probably heard that ground-level ozone is bad for you. But did you know that there's another common pollutant that can harm your lungs and your heart? [More](#)

Tuesday: Know When You Can Breathe Easy

Today is World Asthma Day. If you have asthma, you're among the millions of people more at risk from both particulate pollution and ozone. Here's why: particulate pollution can penetrate deep into the lungs, aggravating lung disease, triggering asthma attacks and bronchitis, and increasing susceptibility to respiratory infections. Ozone can inflame the airways, reduce lung function and make people more sensitive to allergens – all of which can be problems for people with asthma. [More](#)

Wednesday: Heads Up: Particulate Pollution Can Harm Your Heart

You're doing a lot of things to keep your heart healthy. You eat right. You exercise. You don't smoke. Are you paying attention to air quality? If not, today's the day to start. [More](#)

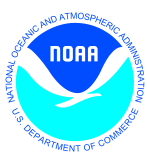
Thursday: Where There's Smoke ... There's Particulate Pollution!

If you've ever been near a forest fire, you know how thick the smoke can get. But did you know that means particle levels may be extremely high? [More](#)

Friday: You Can Help Keep the Air Cleaner and Your Family Healthier

Because particle sources include vehicles and power plants, you can help reduce particle pollution by driving less, keeping your car well-maintained, and using less energy. Also, avoid using gas-powered lawn and garden equipment when particle levels are forecast to be high. [More](#)

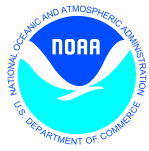
School Flag PROGRAM



Summary

Current US national AQ forecasting capability status:

- **Ozone** prediction nationwide (AK and HI since September 2010)
- **Smoke** prediction nationwide (HI since February 2010)
- **Dust** prediction for CONUS sources (operational since March 2012)
- Developmental testing of CMAQ **aerosol** predictions with NEI sources



Acknowledgments:

AQF Implementation Team Members



Special thanks to Paula Davidson, OST chief scientist and former NAQFC Manager and to Jim Meager former NOAA AQ Matrix Manager

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AQF model interface development, testing, & integration
Global dust aerosol and feedback testing
NAM coordination

Smoke and dust product testing and integration
NCO transition and systems testing
HPC coordination and AQF webdrawer

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CMAQ development, adaptation of AQ simulations for AQF

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HYSPLIT adaptations
Smoke and dust verification product development

NESDIS/OSDPD *Liqun Ma, Mark Ruminski*

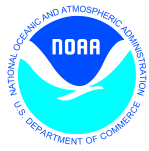
Production of smoke and dust verification products,
HMS product integration with smoke forecast tool

EPA/OAQPS *partners:*

Chet Wayland, Phil Dickerson, Brad Johns, John White

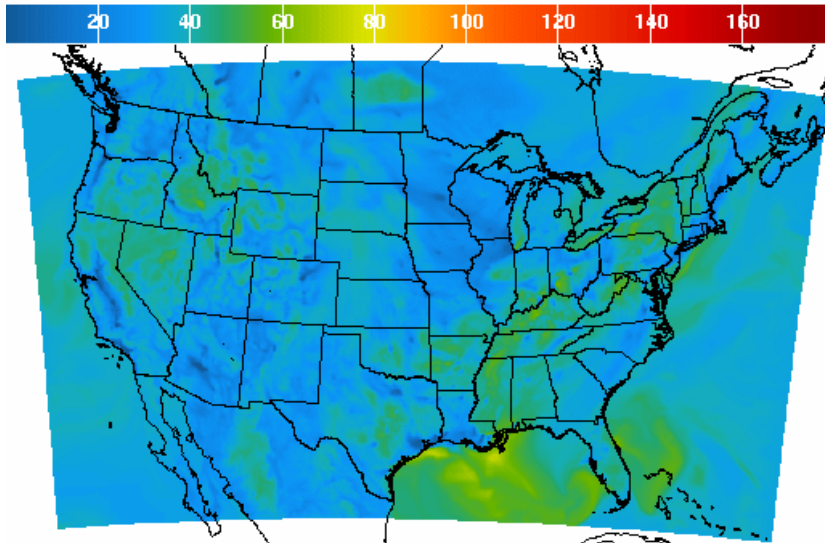
AIRNow development, coordination with NAQFC

* Guest Contributors



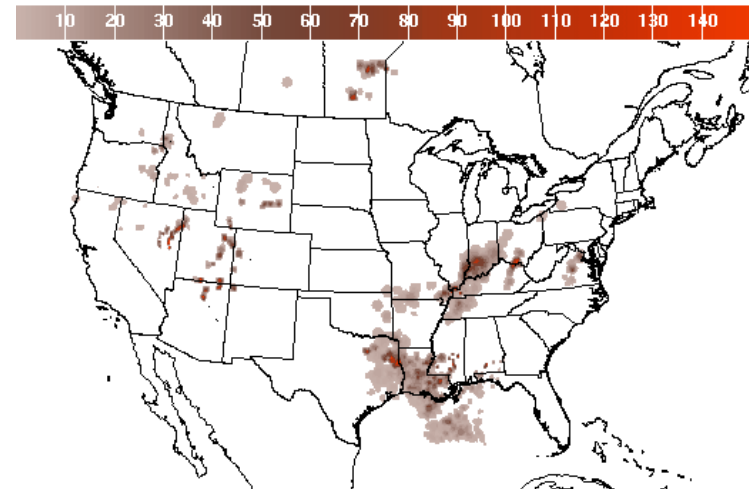
Operational AQ forecast guidance

airquality.weather.gov



1Hr Avg Ozone Concentration(PPB) Ending Thu Sep 20 2007 10AM EDT
(Thu Sep 20 2007 14Z)
National Digital Guidance Database
06z model run Graphic created-Sep 20 7:23AM EDT

Ozone products Nationwide since 2010



1Hr Surface Smoke (micrograms/m³) Thu Sep 20 2007 9AM EDT
(Thu Sep 20 2007 13Z)
National Digital Guidance Database
6z model run Graphic created-Sep 20 8:24AM EDT

Smoke Products
Nationwide since 2010
Dust Products
Implemented 2012

Further information: www.nws.noaa.gov/ost/air_quality