National Air Quality Forecast Capability:
Progress in 2012

September 13, 2012

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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
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

Gridded forecast guidance products
- On NWS servers: airquality.weather.gov and ftp-servers
- On EPA servers
- Updated 2x daily

Verification basis, near-real time:
- Ground-level AIRNow observations of surface ozone
- Satellite observations of smoke and dust

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
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
  - Date: 4/1/09, 5/1/09, 5/31/09, 6/30/09, 7/30/09, 8/29/09

- **2010**
  - Operational
  - CONUS, wrt 76 ppb Threshold
  - Date: 4/1/10, 5/1/10, 5/31/10, 6/30/10, 7/30/10, 8/29/10

- **2011**
  - Operational
  - CONUS, wrt 76 ppb Threshold
  - Date: 4/1/11, 5/1/11, 5/31/11, 6/30/11, 7/30/11

- **2012**
  - Operational
  - CONUS, wrt 76 ppb Threshold
  - Date: 4/1/12, 5/1/12, 5/31/12, 6/30/12, 7/30/12, 8/29/12

Maintaining prediction accuracy as the warning threshold was lowered and emissions of pollutants are changing.
Operational and experimental predictions show similar performance.

Ozone, Fraction Correct, Oper vs. Expr, 1200 UTC Cycle
Daily Maximum of 8-h avg, CONUS Domain, Th=76 ppb

Fraction correct with respect to 76ppb threshold
Operational Nationwide Smoke

Operational predictions at http://airquality.weather.gov
Colorado Springs – Waldo Canyon Fire

- Began on June 23, west of Colorado Springs\(^1\)
- 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 feet\(^2\)
- 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/](http://www.inciweb.org/incident/2929/)
\(^3\) AirNOW tech data, [www.airnowtech.org](http://www.airnowtech.org)
\(^4\) NWS Air Quality Predictions, [http://airquality.weather.gov](http://airquality.weather.gov)
Colorado Springs – Waldo Canyon Fire

Hourly PM2.5 (ug/m^3)

- Colorado Springs - USAF Academy
- Colorado Springs - Highway 24
- Colorado College

1Hr Surface Smoke (micrograms/m^3) Wed Jun 27 2012 8AM EDT
(Wed Jun 27 2012 12Z)
Verification of smoke predictions

Daily time series of FMS for smoke concentrations larger than 1μm/m³

- 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
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).
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
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.
Dust predictions

testing of longer time step

Surface concentration

Column average concentration

Operational predictions
6 minute time step

Predictions with a
10 minute time step

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 ($\mu g/m^3$)
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
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

![Graph showing average monthly bias: all regions 1 h avg aerosol predictions vs. EPA obs, Th-35 ug/m^3]
Partnering with AQ Forecasters

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*

http://www.epa.gov/airnow/airaware/
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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* Guest Contributors
Operational AQ forecast guidance

airquality.weather.gov

Ozone products
Nationwide since 2010

Smoke Products
Nationwide since 2010
Dust Products
Implemented 2012

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