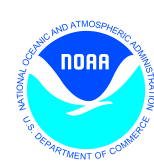


Ozone Prediction for Alaska and Hawaii: New Guidance in the National Air Quality Forecast Capability

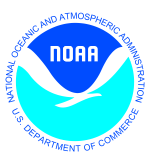
Operational Readiness Review
Tim McClung / Ivanka Stajner

August 31, 2010



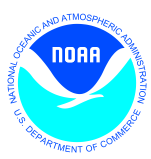
Purpose of Readiness Review

Obtain Corporate approval for operational deployment of ozone prediction for Alaska and Hawaii as new forecast guidance in the National Air Quality Forecast Capability

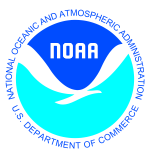


Outline

- **Background**
 - *Air Quality Forecast Program Goals, Planned Capabilities*
 - *Implementation Schedule*
- **Review operational readiness**
 - *Readiness Criteria (OST)*
 - *Objective Verification (NCEP)*
 - *Subjective Feedback (OCWWS)*
 - *Production Readiness (OCIO)*
 - *Summary (OST)*
- **Recommendation**



Background



National Air Quality Forecast Capability

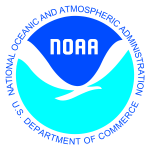
Vision and Strategy

Vision

National Air Quality Forecast Capability which provides the US with ozone, particulate matter and other pollutant forecasts with enough accuracy and advance notice to take action to prevent or reduce adverse effects

Strategy

Work with EPA, State and Local Air Quality agencies and private sector to develop an end-to-end air quality forecast capability for the Nation



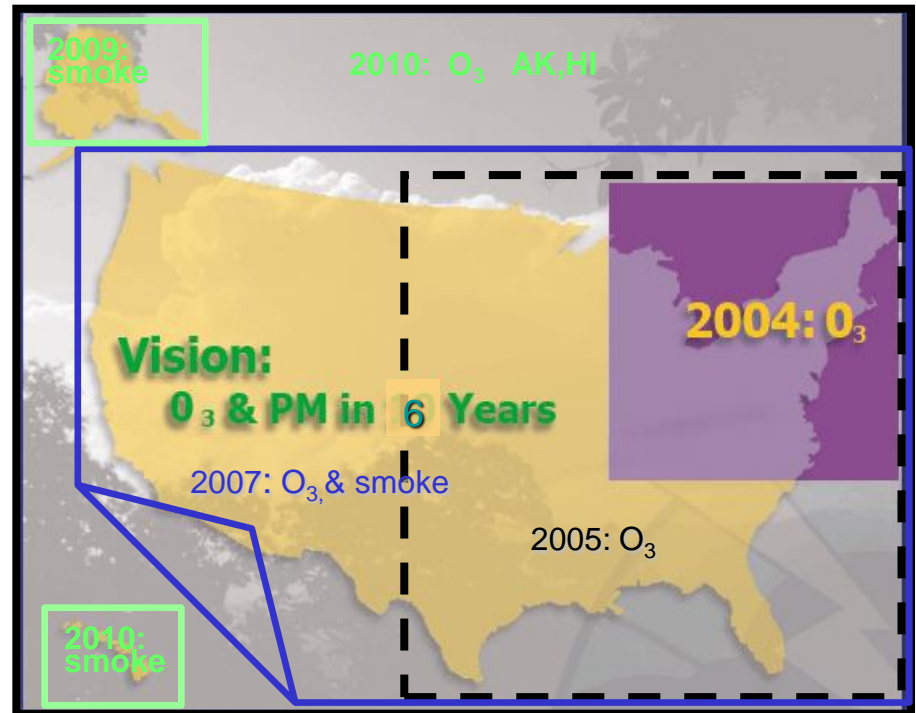
National Air Quality Forecast Capability

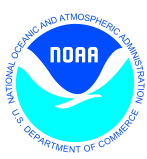
Current and Planned Capabilities, 8/10

- Improving the basis for AQ alerts
- Providing AQ information for people at risk

Prediction Capabilities:

- **Operations:**
 - Ozone implemented over CONUS (9/07)*
 - Smoke implemented over CONUS (3/07), AK (9/09) and HI (2/10)*
- **Experimental testing/products:**
 - Ozone upgrades*
 - Ozone over AK and HI*
- **Developmental testing:**
 - Components for particulate matter (PM) forecasts*





Ozone prediction for Alaska and Hawaii:

Expanding prediction to all 50 states



- ***Ozone a criteria pollutant, contributes to loss of life/property***
- ***Health effects***
 - Respiratory effects, especially in sensitive groups (children, elderly, those with respiratory problems)
- ***Accurate prediction is vital for prevention of adverse effects***
 - Hour-by-hour predictions
- ***Effectively leverages existing capabilities:***
 - NOAA/NWS NAM weather predictions
 - CMAQ model developed by NOAA scientists for EPA regulatory purposes
 - NOAA/OAR mapping and integration of emissions inventories from EPA over HI and AK, and Canadian inventories for Canadian portion of the AK domain
 - Verification at NOAA/NWS using AIRNow monitoring data
 - Expansion of linked numerical ozone prediction for CONUS at NCEP
- ***Adaptations:***
 - CMAQ4.6 (including CB-05 chemical mechanism); monthly boundary conditions; mapping and integration of emissions

Ozone Prediction for Alaska and Hawaii

End-to-End Capability

Model Components: Linked numerical prediction system

Operationally integrated on NCEP's supercomputer

- NCEP mesoscale NWP: WRF-NMM
- NOAA/EPA community model for AQ: CMAQ

Observational Input:

- NWS weather observations
- EPA emissions inventory

Gridded forecast guidance products

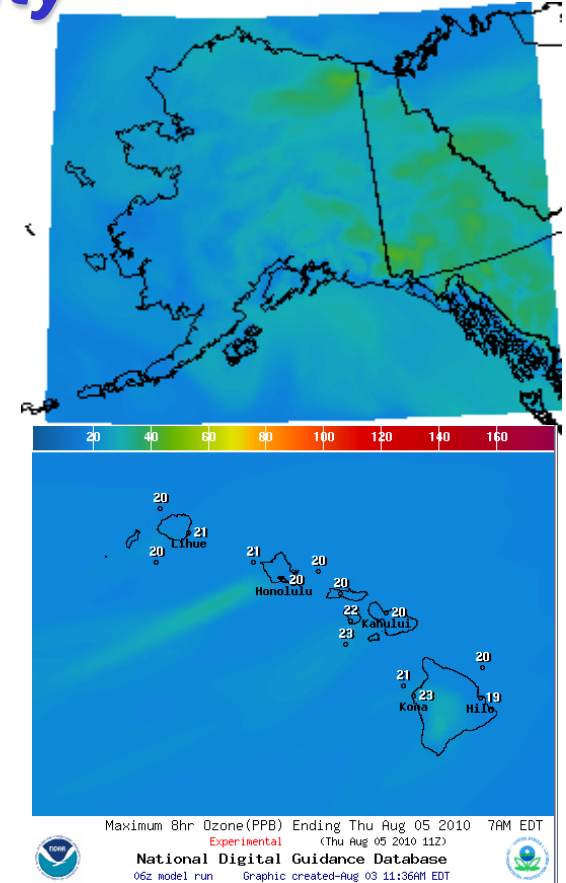
- On NWS servers: www.weather.gov/aq and ftp-servers
- Updated 2x daily

Verification basis, near-real time:

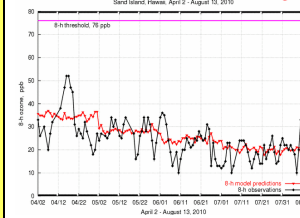
- Ground-level AIRNow observations

Customer outreach/feedback

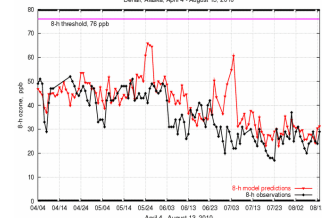
- State & Local AQ forecasters coordinated with EPA
- Public and Private Sector AQ constituents



HI: 8-hr max O₃

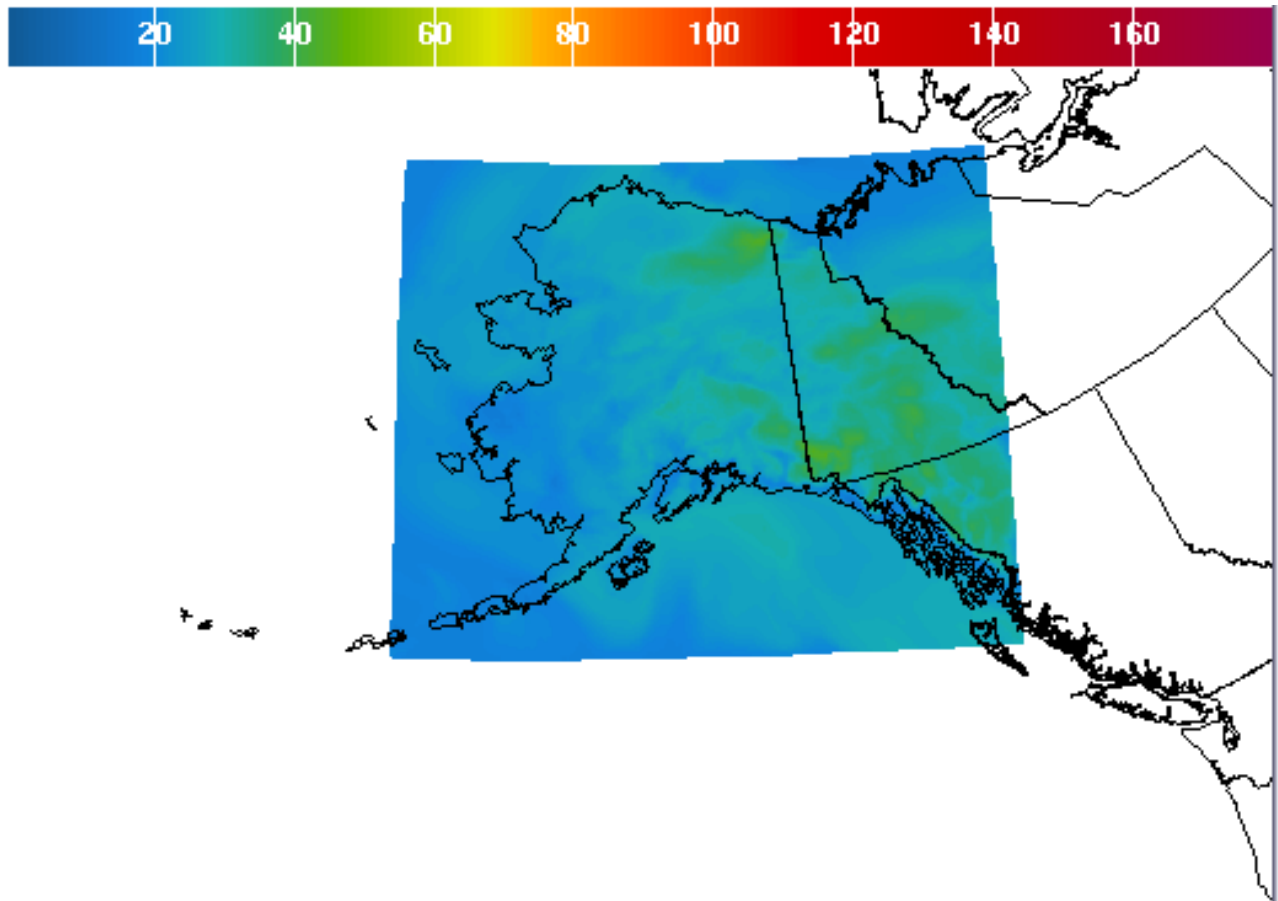


AK: 8-hr max O₃





Alaska ozone forecast guidance: *August 3, 2010*

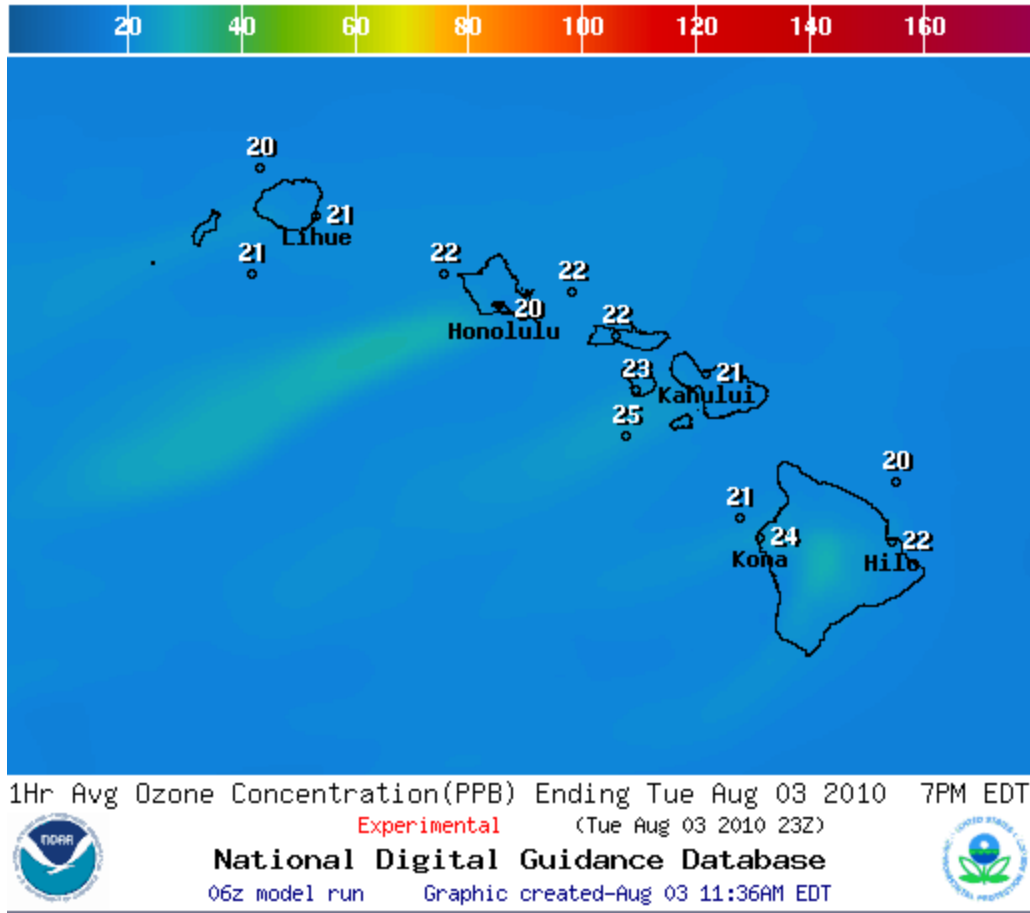


- Experimental testing: beginning 6/8/10
- Ground verification from AIRNow observations
- NCEP mesoscale data from WRF-NMM

8Hr Avg Ozone Concentration(PPB) Ending Tue Aug 03 2010 7PM EDT
 Experimental (Tue Aug 03 2010 23Z)
 National Digital Guidance Database
 12z model run Graphic created-Aug 03 12:39PM EDT



Hawaii ozone forecast guidance: *August 3, 2010*

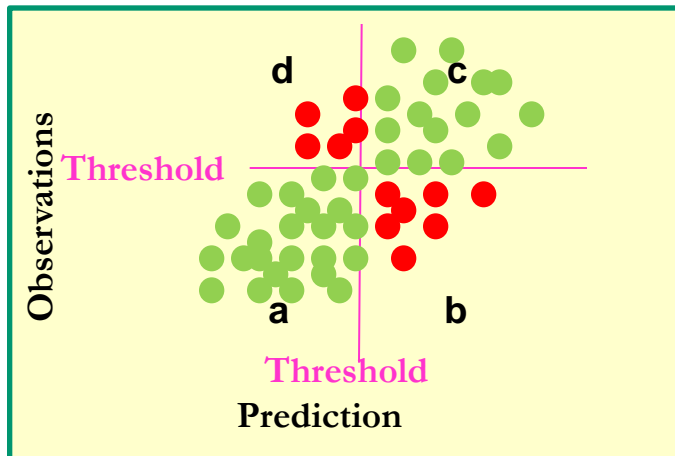


- Experimental testing beginning 3/31/10
- Ground verification from AIRNow observations
- NCEP mesoscale data from WRF-NMM

Verification Approach: AK and HI Ozone

Following verification approach for CONUS:

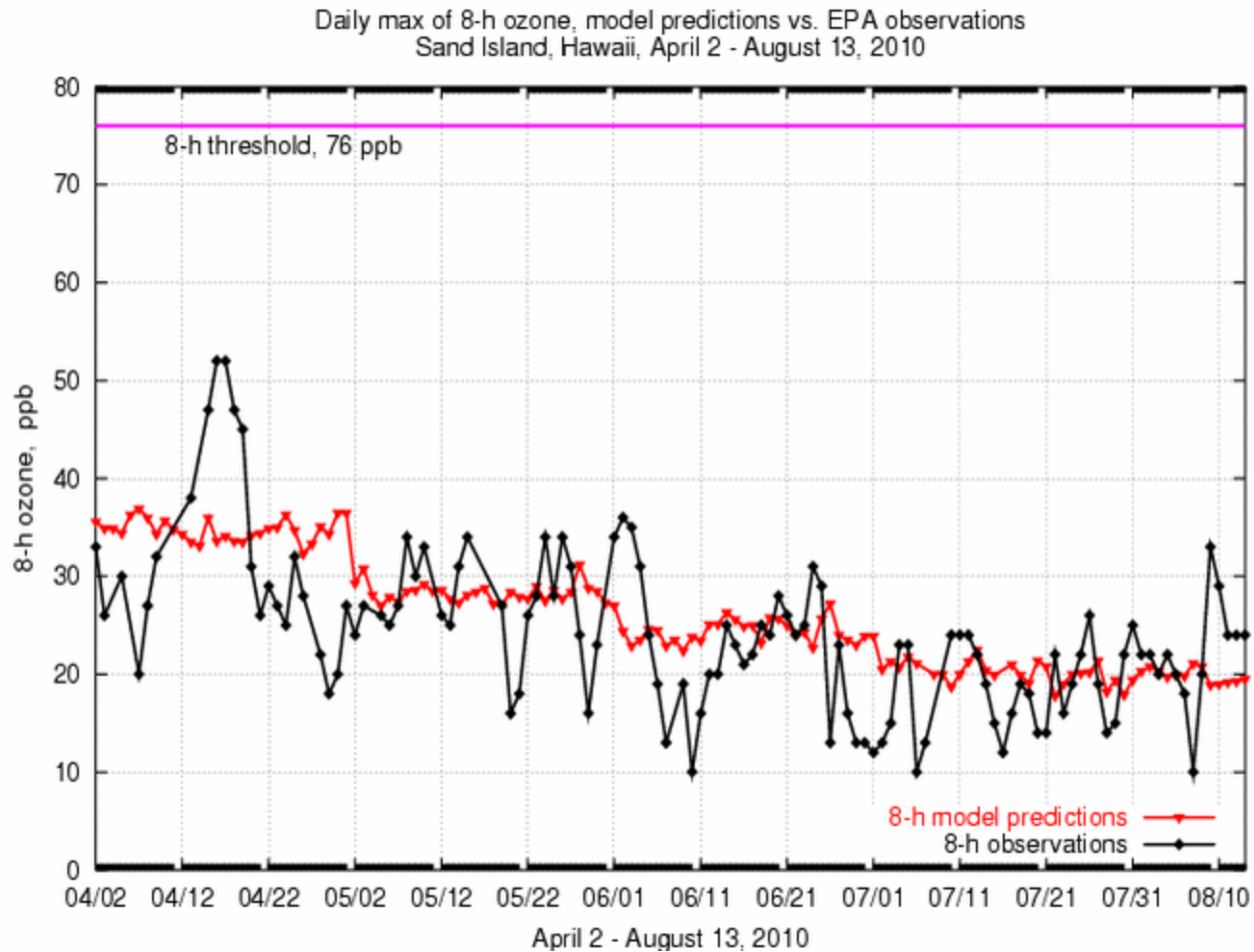
- Real-time verification of data
 - Comparing model with observed values from AIRNow ground level observations
- Daily maximum of 8-hour ozone
 - Metric is fraction correct with respect to 76 ppb threshold (alert level for air quality “code orange”)



$$\text{Fraction Correct} = (a+c)/(a+b+c+d)$$

Initial skill target for fraction correct ≥ 0.9 , as for CONUS

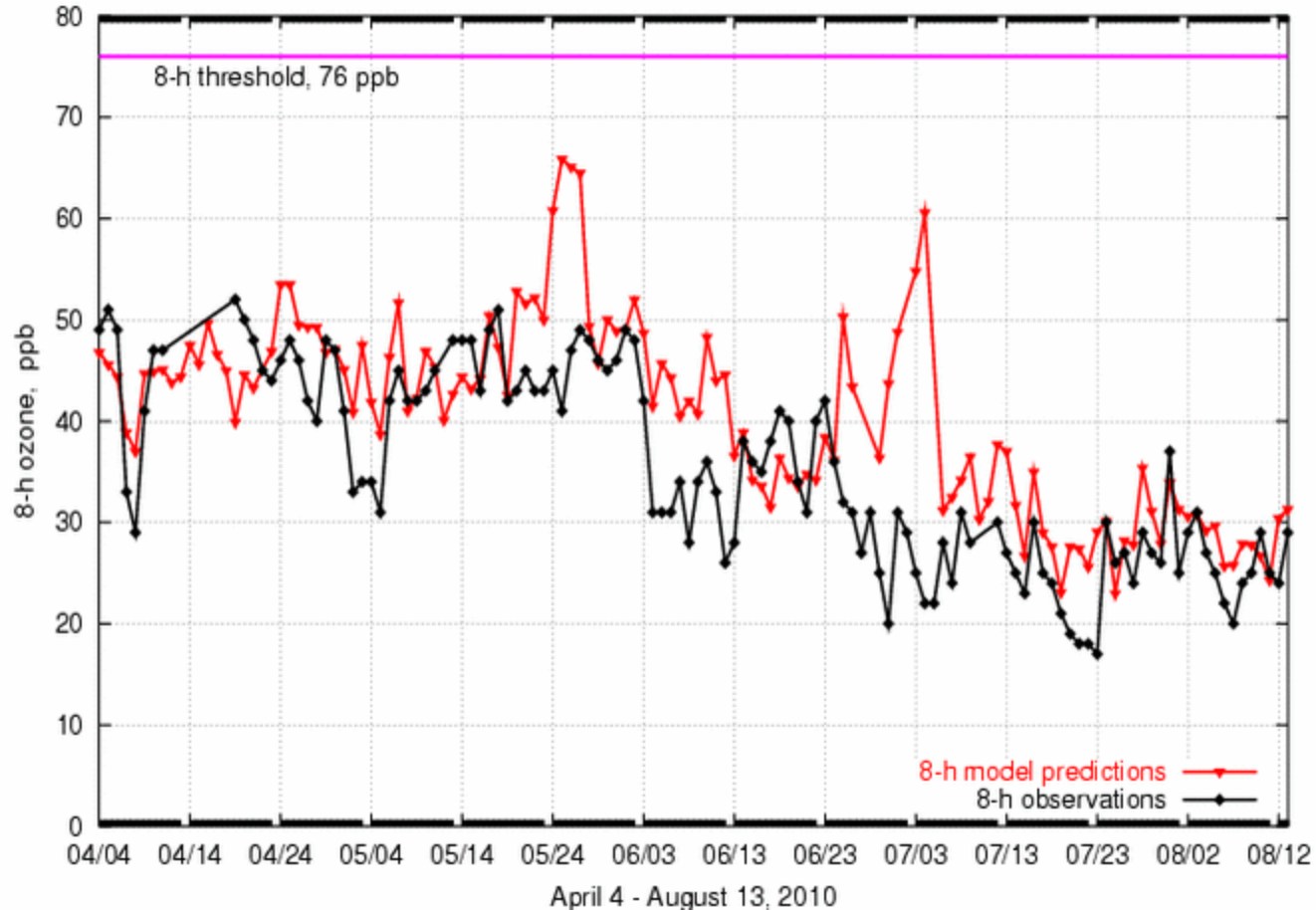
Sample verification for Hawaii ozone



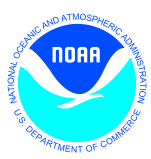
Predictions and observations are both below the 76ppb threshold. Fraction correct ≥ 0.9

Sample verification for Alaska ozone

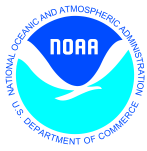
Daily max of 8-h ozone, model predictions vs. EPA observations
Denali, Alaska, April 4 - August 13, 2010



Predictions and observations are both below the 76ppb threshold. Fraction correct ≥ 0.9



Review of Operational Readiness



Ozone Forecast Tool: Alaska and Hawaii

Operational Readiness Criteria Summary

Criterion	Lead	Metric	AK Dates	HI dates	Status <i>8/10</i>
Objective Evaluation: Accuracy	NCEP	> 90 %	6/8/10-8/30/10	3/31/10-8/30/10	C
Subjective Feedback	OCWWS	Positive on balance	6/8/10 – 8/30/10	3/31/10 – 8/30/10	C
Production Readiness	OCIO, NCEP				C
On-time delivery		>95 % AK: ~98% HI: ~97%	7/6/10 – 8/30/10	3/31/10 – 8/30/10	C
Back-up		In place	6/8/10	3/31/10	C
Data retention		In place	6/8/10	3/31/10	C
Near-real time verification	NCEP	In place	8/20/10	3/31/10	C
Final go/no go decision	NWS		Review date		G

Key **Complete** **On schedule** **At risk** **Remedial Action Required**

Objective Verification (NCEP, MDL)

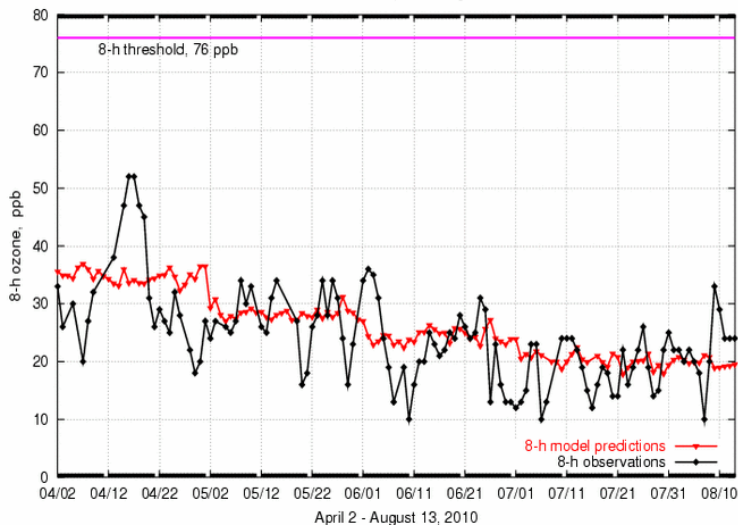
Criterion	Metric	Dates	Status
Objective Evaluation: Accuracy	Fraction correct of daily maximum of 8h average ozone with respect to 76ppb threshold ≥ 0.9	4/2/10-8/8/10	C

Summary Performance for daily maximum 8h average ozone, 4/2/10 – 8/8/10

- Fraction correct ≥ 0.9

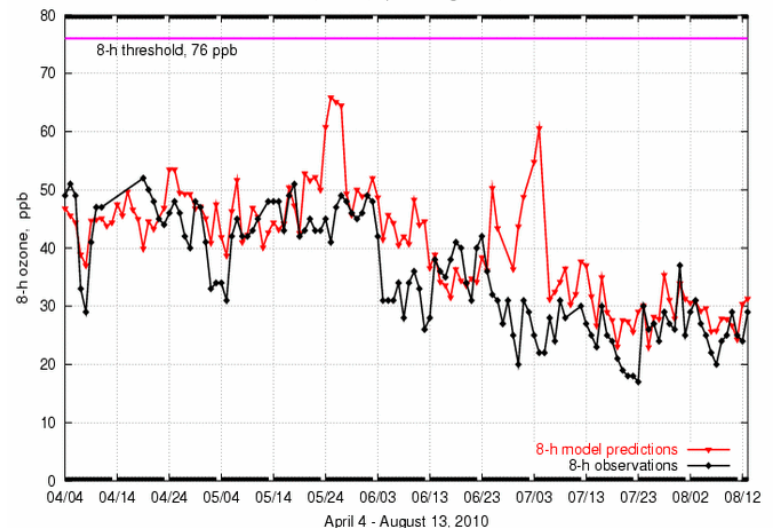
Hawaii: predictions and observations are below the threshold, fraction correct=1

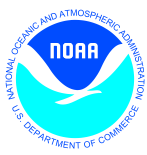
Daily max of 8-h ozone, model predictions vs. EPA observations
Sand Island, Hawaii, April 2 - August 13, 2010



Alaska: predictions and observations are below the threshold, fraction correct=1

Daily max of 8-h ozone, model predictions vs. EPA observations
Denali, Alaska, April 4 - August 13, 2010





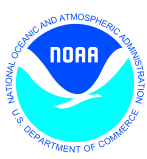
Subjective Feedback (AR, PR, OCWWS)



Criterion	Metric	Dates	Status
Subjective Feedback	<i>External feedback from State/Local AQ forecasters support product as helpful.</i> <i>Other feedback: internal, constituent, general public: On Balance, positive</i>	6/1/10 – 8/30/10	C

Feedback Sources:

- Feedback link from NDGD
- State and Local AQ forecasters
- NWS field forecasters
- Constituent group
- Other responses/comments on experimental products



Subjective Feedback:

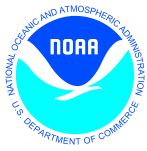
Other responses/comments on experimental products

Responders represented a mix of public, AQ forecasters, and researchers including AR and PR.

Sample Comments:

- ***“I do like your forecasting page... The visualizations are an accurate way to describe the air quality.” (HI)***
- ***“The ozone predictions look fine.” (HI)***
- ***“Ozone monitoring is a relatively new pollutant in Alaska - the only places that have data are Denali National Park which is run by the Park Service, and the Municipality of Anchorage just started monitoring this past spring... If the Muni starts seeing values above background, or once the NCORE site is up in Fairbanks and they monitor, maybe we would have more use of the predictions once they could be validated with real data.”***

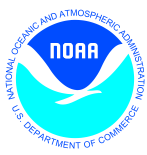
No negative comments received



Production Readiness



Criterion	Lead	Metric	AK Dates	HI Dates	Status 8/10
On-time delivery	OCIO	<i>Forecast guidance available by 1730 UTC (primary) and by 13 UTC (updated) > 95%</i>	6/8/10-8/30/10	3/31/10–8/30/10	C
Ftpserver	OCIO	<i>In place in TOC</i>	6/8/10-8/30/10	3/31/10–8/30/10	C
NDGD server	OCIO, MDL	<i>In place in TOC</i>	6/8/10-8/30/10	3/31/10–8/30/10	C
Guidance availability on NDGD		<i>Forecast guidance available on NDGD by 1300 UTC and 17:35 UTC > 95%</i>	6/8/10-8/30/10	3/31/10-8/30/10	C
Guidance backup		<i>NCEP backs up as part of NCEP model backup</i>	6/8/10	3/31/10	C
IT infrastructure backup		<i>CCS, TOC and interfacility communications links fully backed up. Reliability of comms links > 99.99%</i>	6/8/10	6/8/10	C
Back-up	OCIO	<i>In place</i>	6/8/10	3/31/10	C
Product archiving	OCIO	<i>In place</i>	6/8/10	3/31/10	C
Near-real time verification	NCEP	<i>In place</i>	8/20/10	3/31/10	C

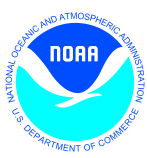


Experimental Ozone Data Availability

- **Monitored Data Flow Receipt from the TOC To NWS Web Farm**
 - *Data flow for AK tracked from 6/8/10-8/30/10*
 - *Data flow for HI tracked from 3/31/10-8/30/10*
 - *Reviewed forecast guidance availability from system logs, graphical interface displays*
- **Availability must meet program criteria: Forecast guidance available by 1300 and 1735 UTC > 95%**

STATUS

- *Availability at TOC FTP Server: **GREEN***
- *Data Archive at NCDC: **GREEN***
- *Guidance Availability at NDGD: **GREEN***
- *Timely Display on the NWS Web Farm: **GREEN***

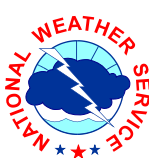
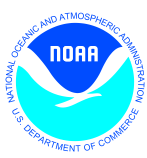


Production Readiness (NCEP)

Near-real time verification




Criterion	Metric	AK	HI	Status
Near-real time verification	<i>Daily; for 24-hour forecast interval 0700-0600 UTC by 48 hours after end of forecast interval</i>	8/20/10	3/31/10	

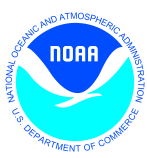
- **Verification Statistics:** *Compiled and maintained by NCEP. Updated daily*
- **Availability:** *Model developer group*
- **Seasonal summary:** *Available on AQ program web site (public)*
- **Weekly verification:** *Reports on operational performance measures provided by NCEP to OST PM*
- **AIRNow:** *Report ground level observations of ozone*



Summary:

Experimental Production of AQ forecast guidance for IOC

- **September 2010 Status:**general...
 - *Generally performing well... AK and HI under alert threshold*
- **Objective verification:** 
 - *Accuracy performance targets achieved*
- **Subjective feedback:** 
 - *Feedback received and ongoing for AK and HI*
- **Production readiness:** 
 - *Forecast guidance available on time*
 - *Backup, data retention and verification demonstrated*



Future Science Infusion



NOAA planning for improvements to the ozone capability

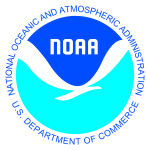
- CMAQ being coupled with NMM-B
- Canadian emissions to be updated – currently using 2000 inventory, planning to transition to 2005 inventory

Continuing R&D required

- Currently using climatological fire emissions, testing use of time dependent emissions based on observed fires

Assuring quality with science peer reviews:

- Design review of major system upgrades (initial, yearly upgrades)
- Diagnostic evaluations with field campaigns and evaluations
- Publication of T&E in peer-reviewed literature
 - *Otte et al. Weather and Forecasting, 20, 367-385 (2005)*
 - *Mckeen et al., J. Geophys. Res. 110, D21307 (2005)*
 - *Lee et al., J Applied Meteorology and Climatology (2007)*
 - *Yu, et al. , J. Geophys. Res. (2007)*
 - *Lee et al., Environmental Fluid Mechanics, 9 (1), 23-42, doi:10.1007/s10652-008-9089-0 (2009)*
 - *Tang et al., Environmental Fluid Mechanics, 9 (1), 43-58, doi:10.1007/s10652-008-9092-5 (2009)*



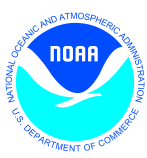
Ozone Forecast Tool: Alaska and Hawaii

Operational Readiness Criteria Summary



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Subjective Feedback	OCWWS	Positive on balance	6/8/10 – 8/30/10	3/31/10 – 8/30/10	C
Production Readiness	OCIO, NCEP				C
On-time delivery		> 95 %	6/8/10 – 8/30/10	3/31/10 – 8/30/10	C
Back-up		In place	6/8/10	3/31/10	C
Data retention		In place	6/8/10	3/31/10	C
Near-real time verification	NCEP	In place	8/20/10	3/31/10	C
Final go/no go decision	NWS		Review date	Review date	G

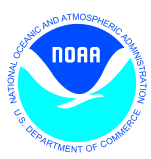
Key **Complete** **On schedule** **At risk** **Remedial Action Required**



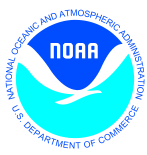
Deployment Recommendation

Recommend:

NWS deploy ozone forecast guidance for Alaska and Hawaii as a new air quality component of the operational product suite



Backup



Lateral Boundary Conditions (LBCs)



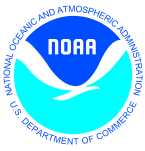
Ozone LBCs for Hawaii:

Monthly ozone sonde climatology computed from Hilo, HI ozone sondes launched during 1982-2007.

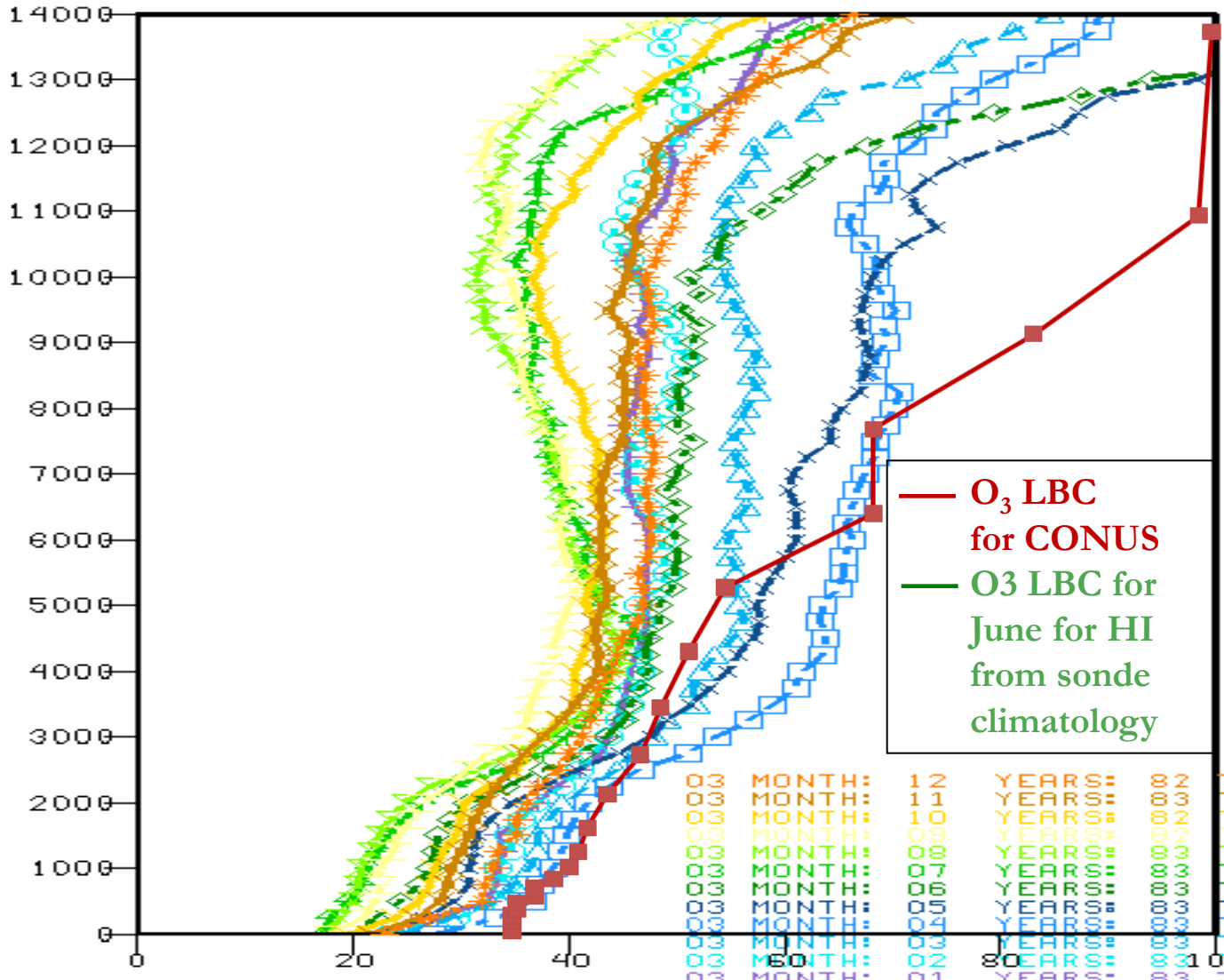
Monthly varying LBCs for 40 other chemical species from GEOS-Chem, a global 3-D tropospheric chemistry model simulation for year 2002 (Harvard group, Bey et al., 2001) are used for Hawaii and Alaska.

Ozone LBCs for Alaska:

Monthly varying from GEOS-Chem simulation for year 2002

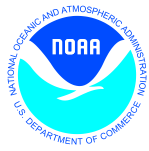


Monthly O₃ lateral boundary conditions for Hawaii



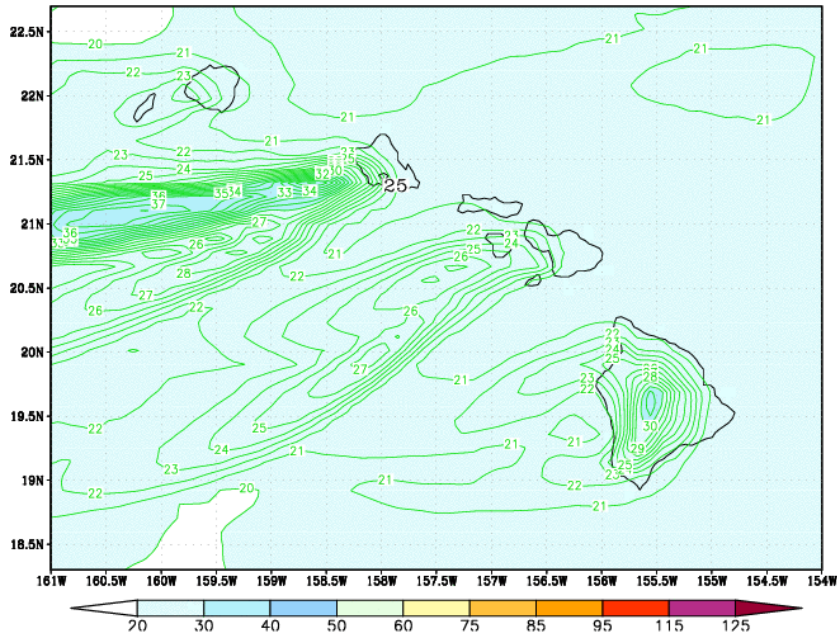
Ozone LBCs for HI are lower than the CONUS LBC, especially near the surface and in the upper troposphere

Ozone near the surface over Hilo is lowest in August and highest in April

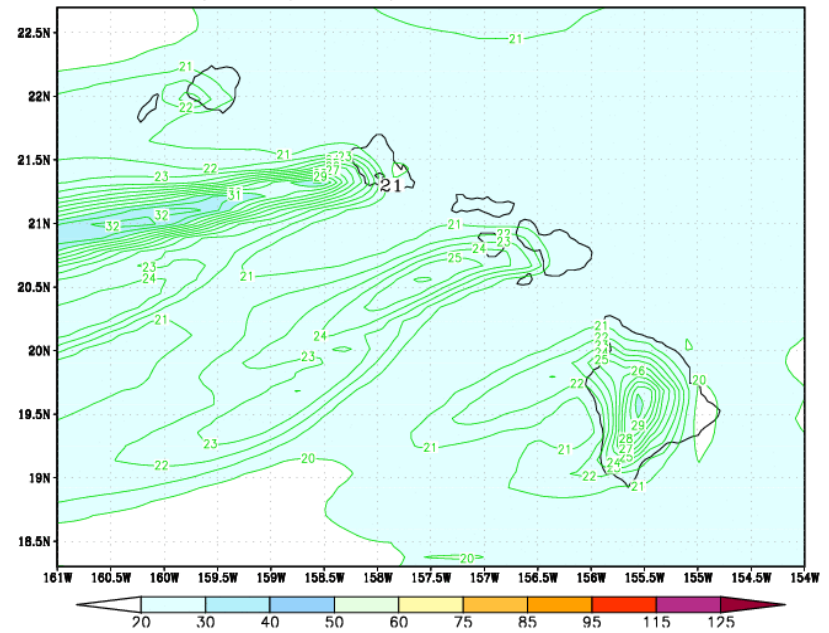


Hawaii Spatial Verification Maps August 24, 2010

HI (Developmental) 1-hr max 24AUG2010



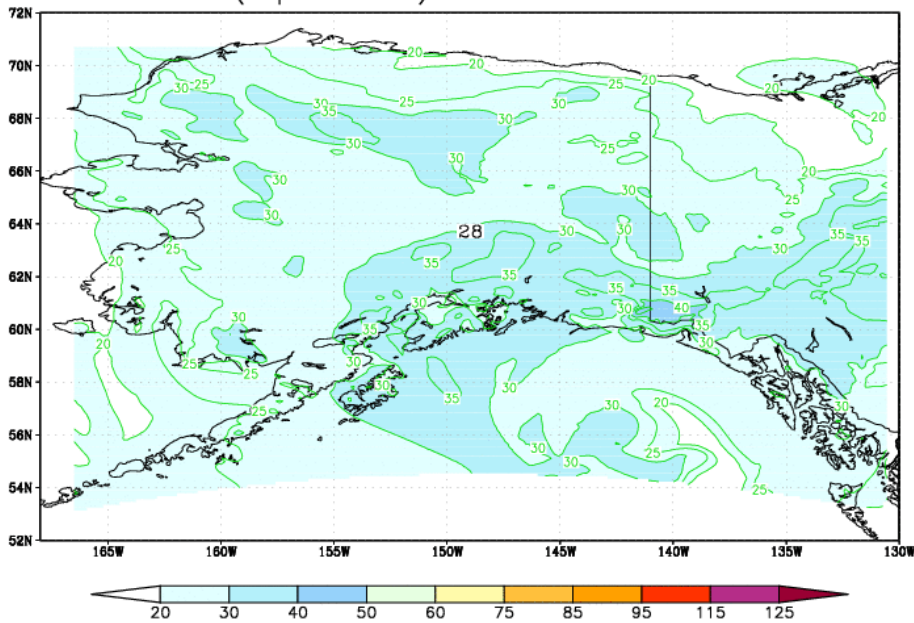
HI (Developmental) 8-hr max 24AUG2010



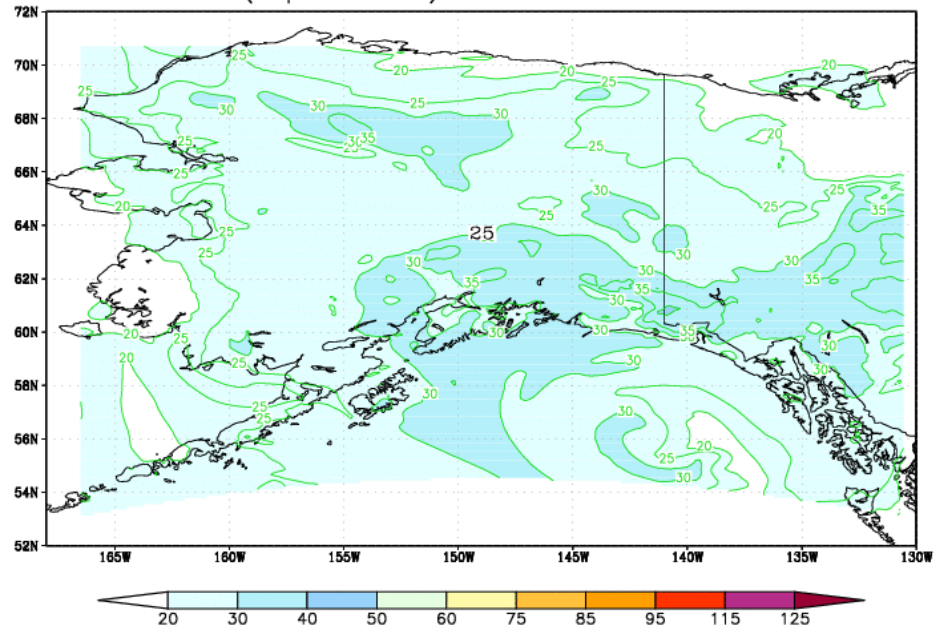
Alaska Spatial Verification Maps

August 24, 2010

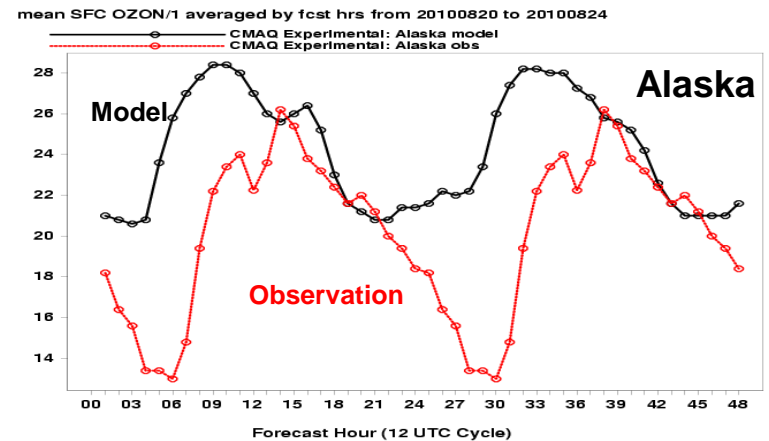
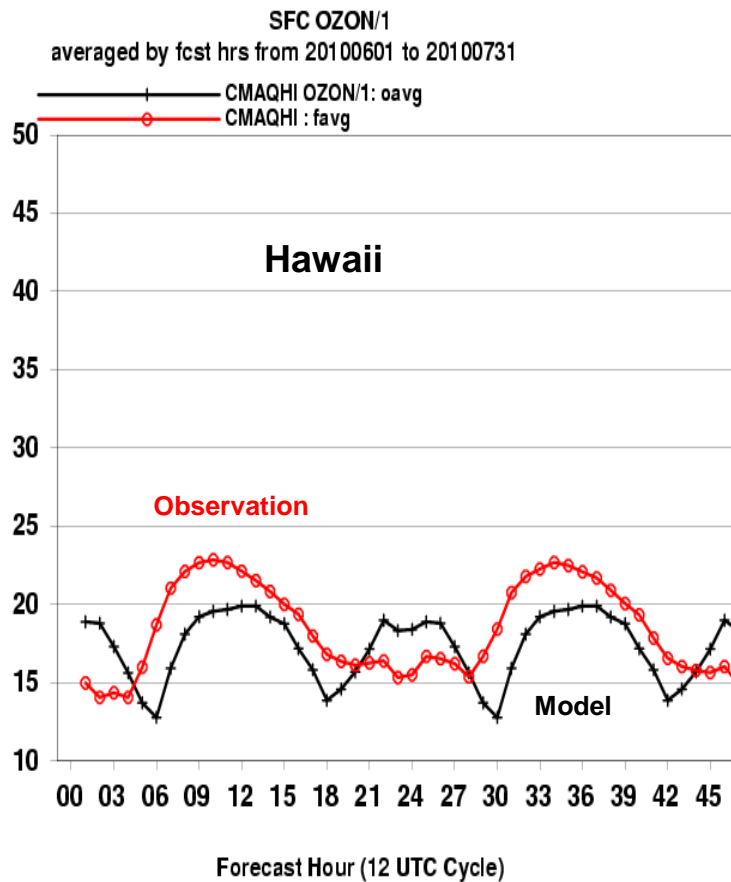
AK (Experimental) 1-hr max 24AUG2010



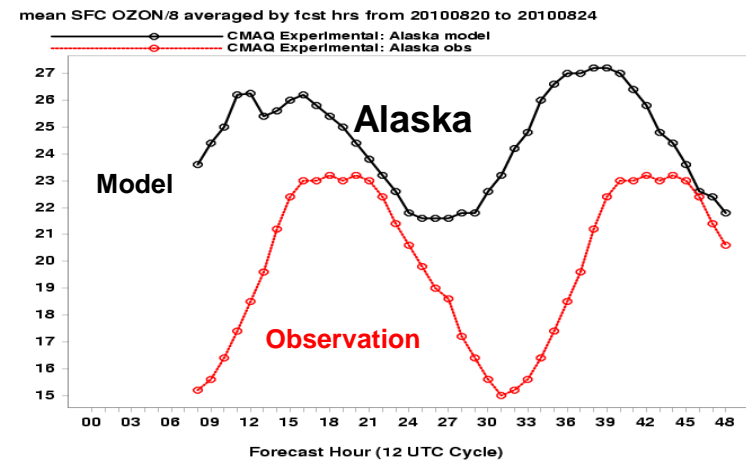
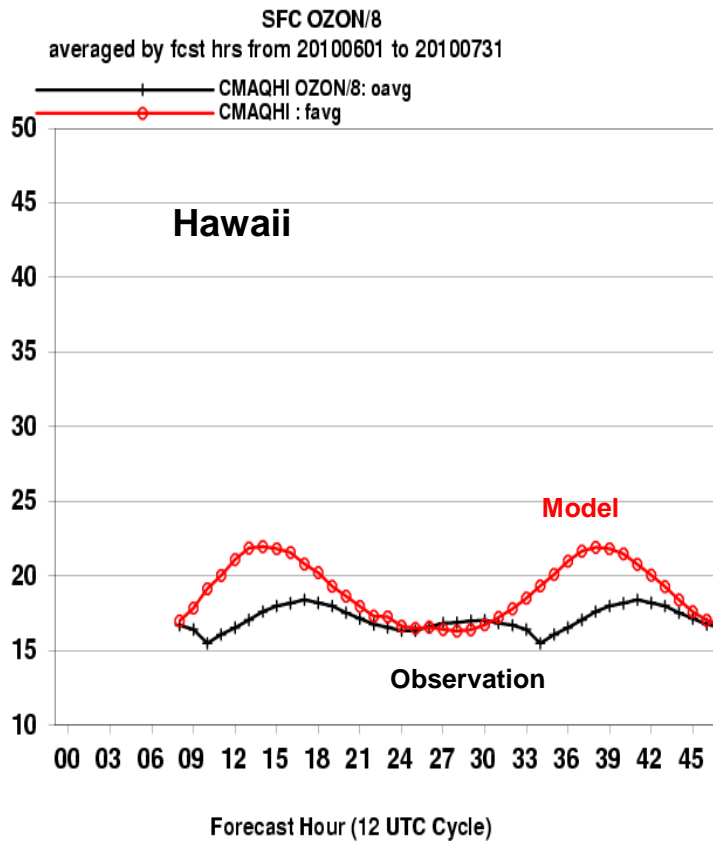
AK (Experimental) 8-hr max 24AUG2010



Verification of 1-hr Ozone: Diurnal variability



Verification of 8-hr ozone: Diurnal variability



Ozone Forecast Tool for AK and HI

Major Components

