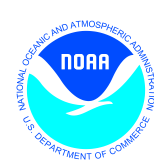


# **Ozone Prediction for Alaska and Hawaii: New Guidance in the National Air Quality Forecast Capability**

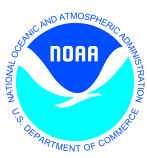
Operational Readiness Review  
Tim McClung / Ivanka Stajner

August 31, 2010



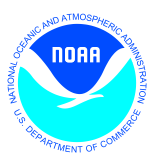
# Purpose of Readiness Review

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

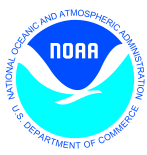


# Outline

- **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**

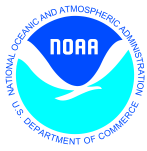
## ***Vision and Strategy***

### ***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***

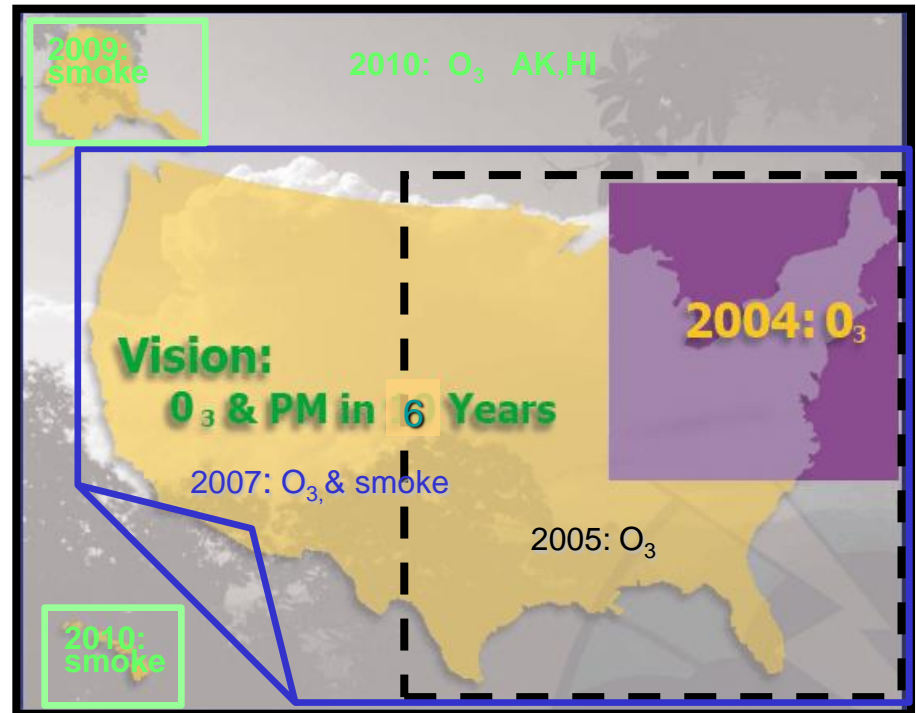


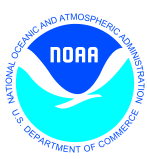
# National Air Quality Forecast Capability *Current and Planned Capabilities, 8/10*

- 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

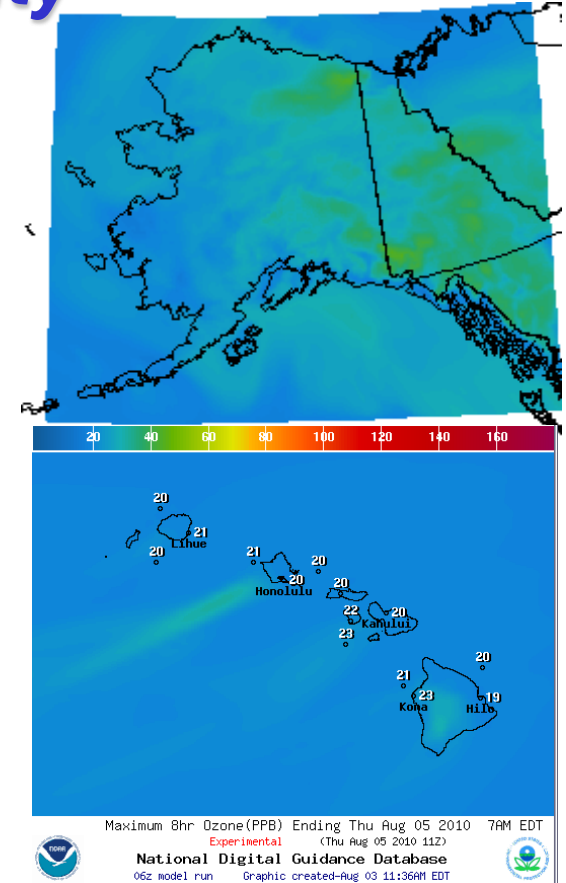
- *On NWS servers: [www.weather.gov/aq](http://www.weather.gov/aq) and ftp-servers*
- *Updated 2x daily*

### Verification basis, near-real time:

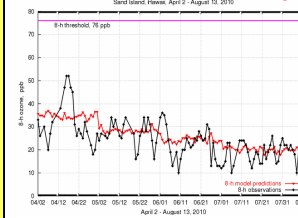
- *Ground-level AIRNow observations*

### Customer outreach/feedback

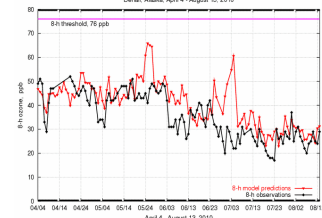
- *State & Local AQ forecasters coordinated with EPA*
- *Public and Private Sector AQ constituents*



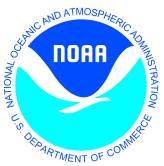
**HI: 8-hr max O<sub>3</sub>**



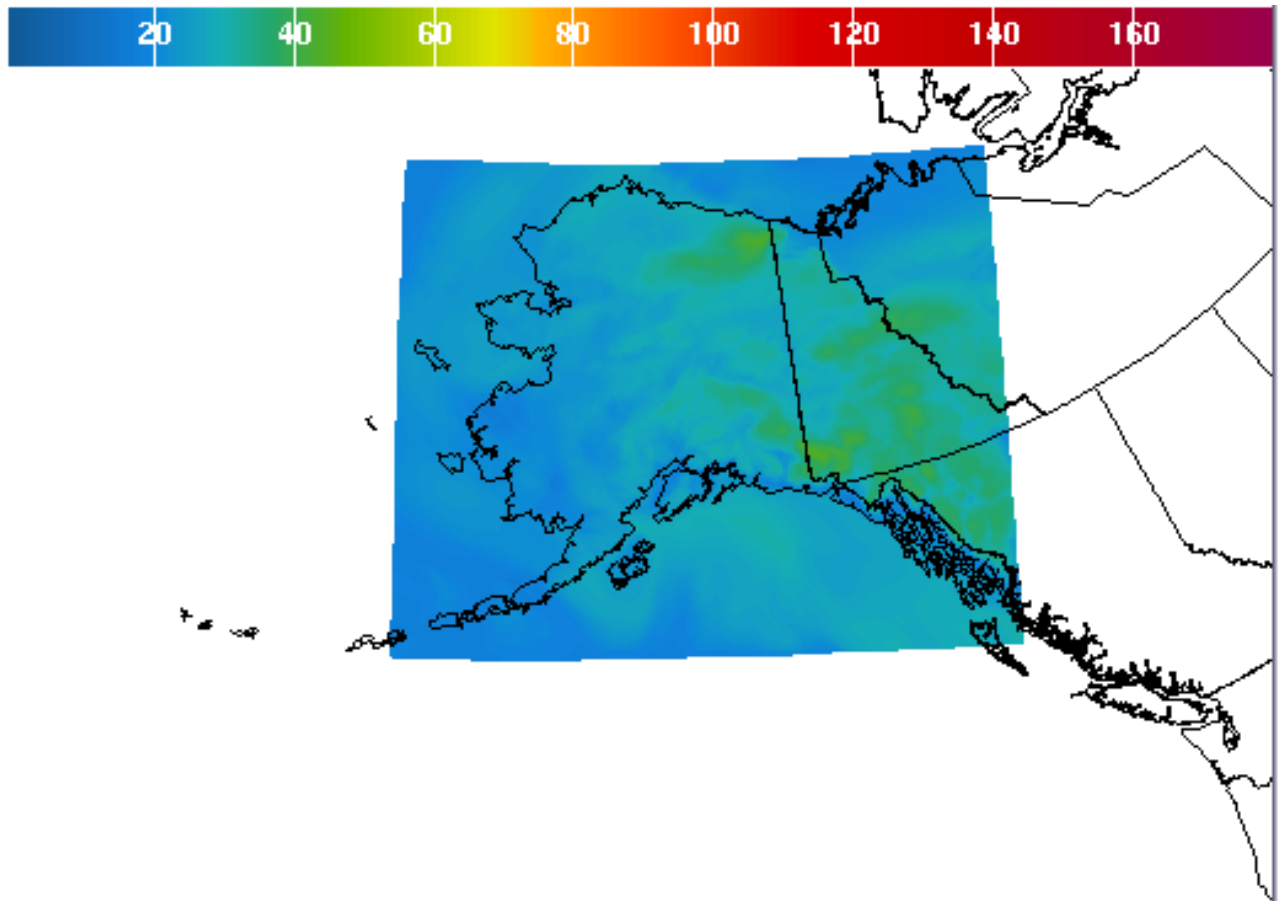
**AK: 8-hr max O<sub>3</sub>**







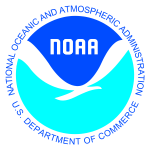
# Alaska ozone forecast guidance: *August 3, 2010*



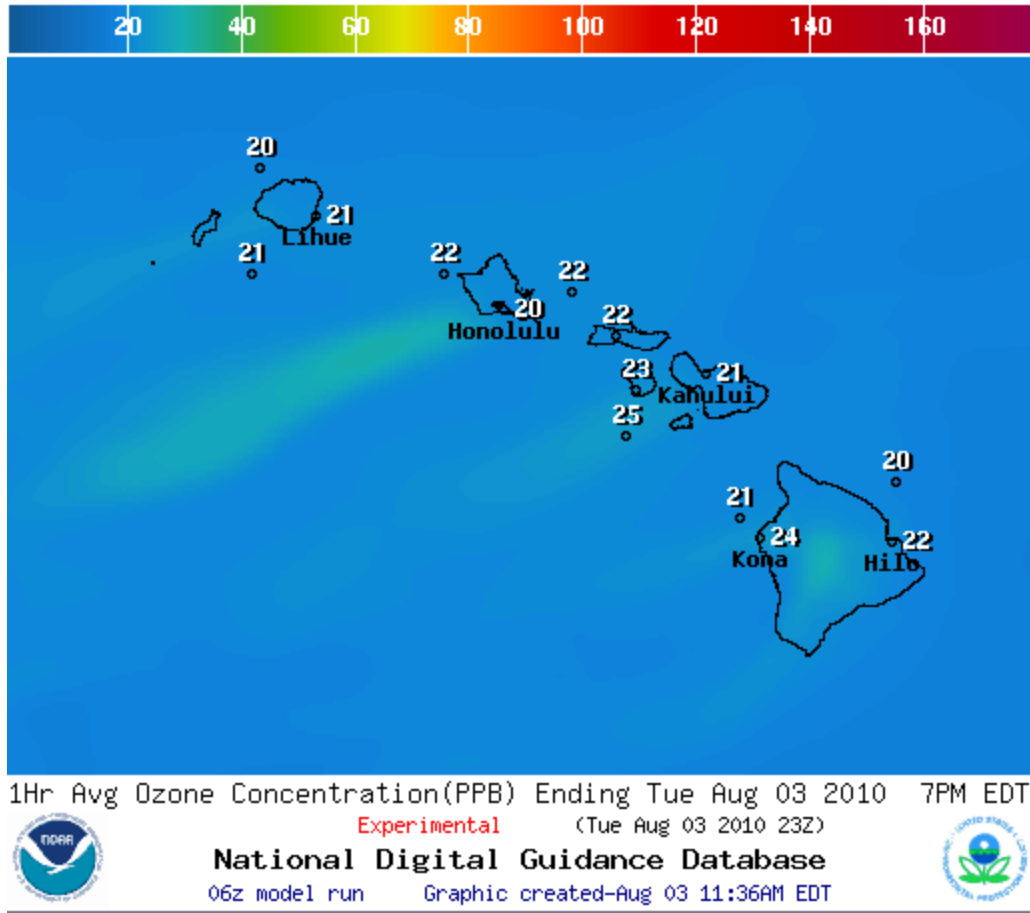
- Experimental testing: beginning 6/8/10
- Ground verification from AIRNow observations
- NCEP mesoscale data from WRF-NMM

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*

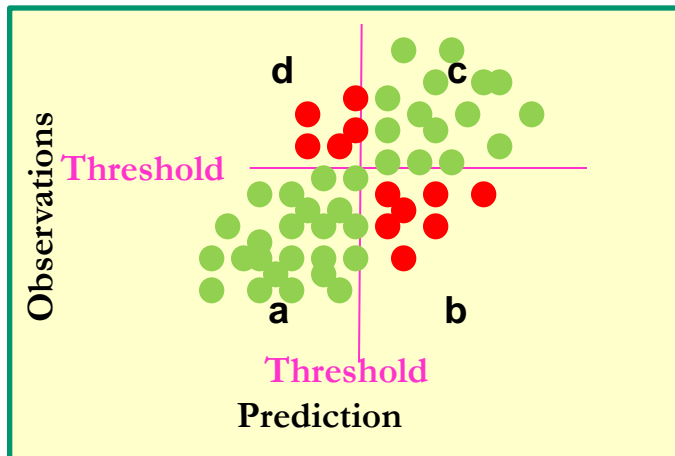


- Experimental testing beginning 3/31/10
- Ground verification from AIRNow observations
- NCEP mesoscale data from WRF-NMM

# Verification Approach: AK and HI Ozone

## Following verification approach for CONUS:

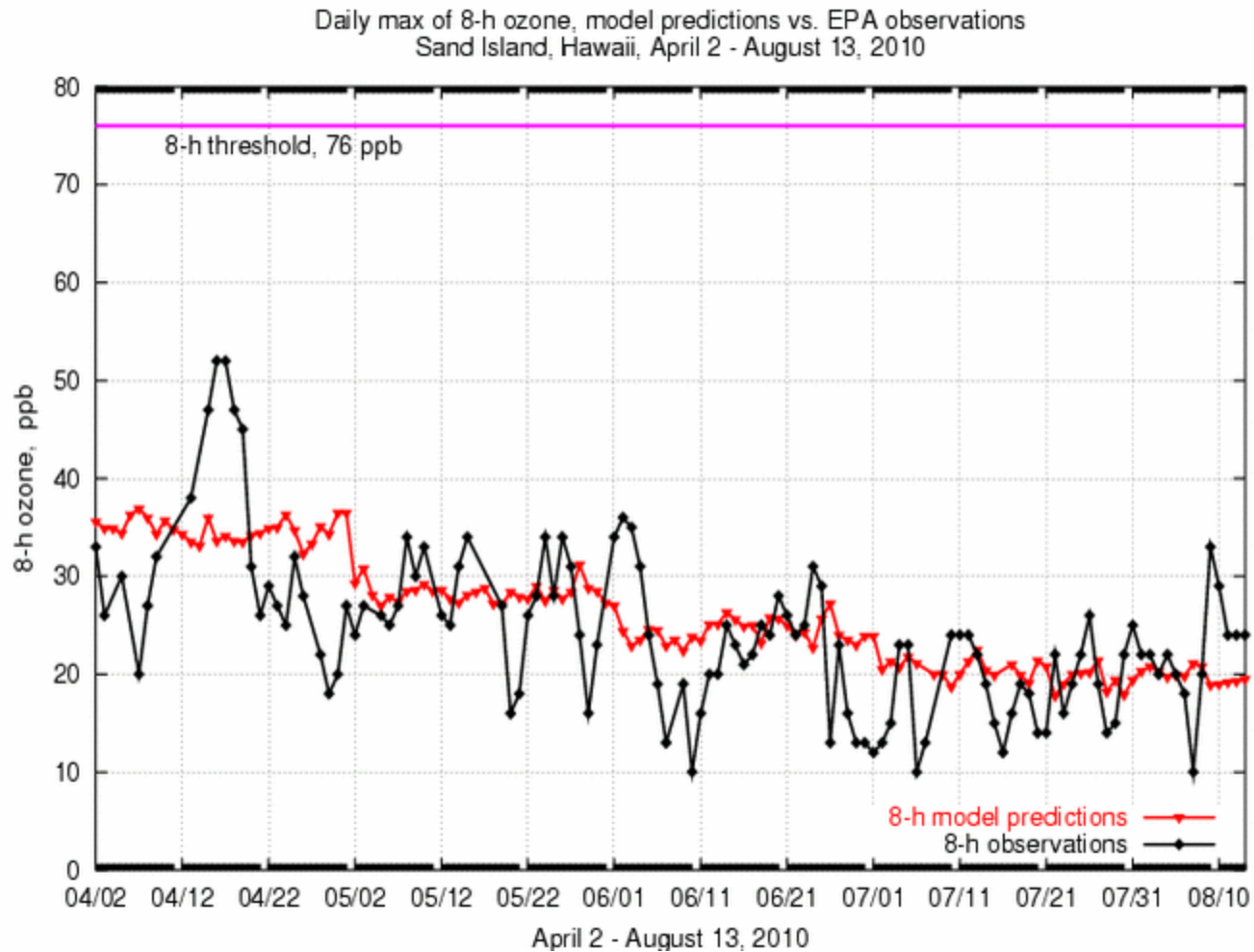
- Real-time verification of data
  - Comparing model with observed values from AIRNow ground level observations
- Daily maximum of 8-hour ozone
  - Metric is fraction correct with respect to 76 ppb threshold (alert level for air quality “code orange”)



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

**Initial skill target for fraction correct  $\geq 0.9$ , as for CONUS**

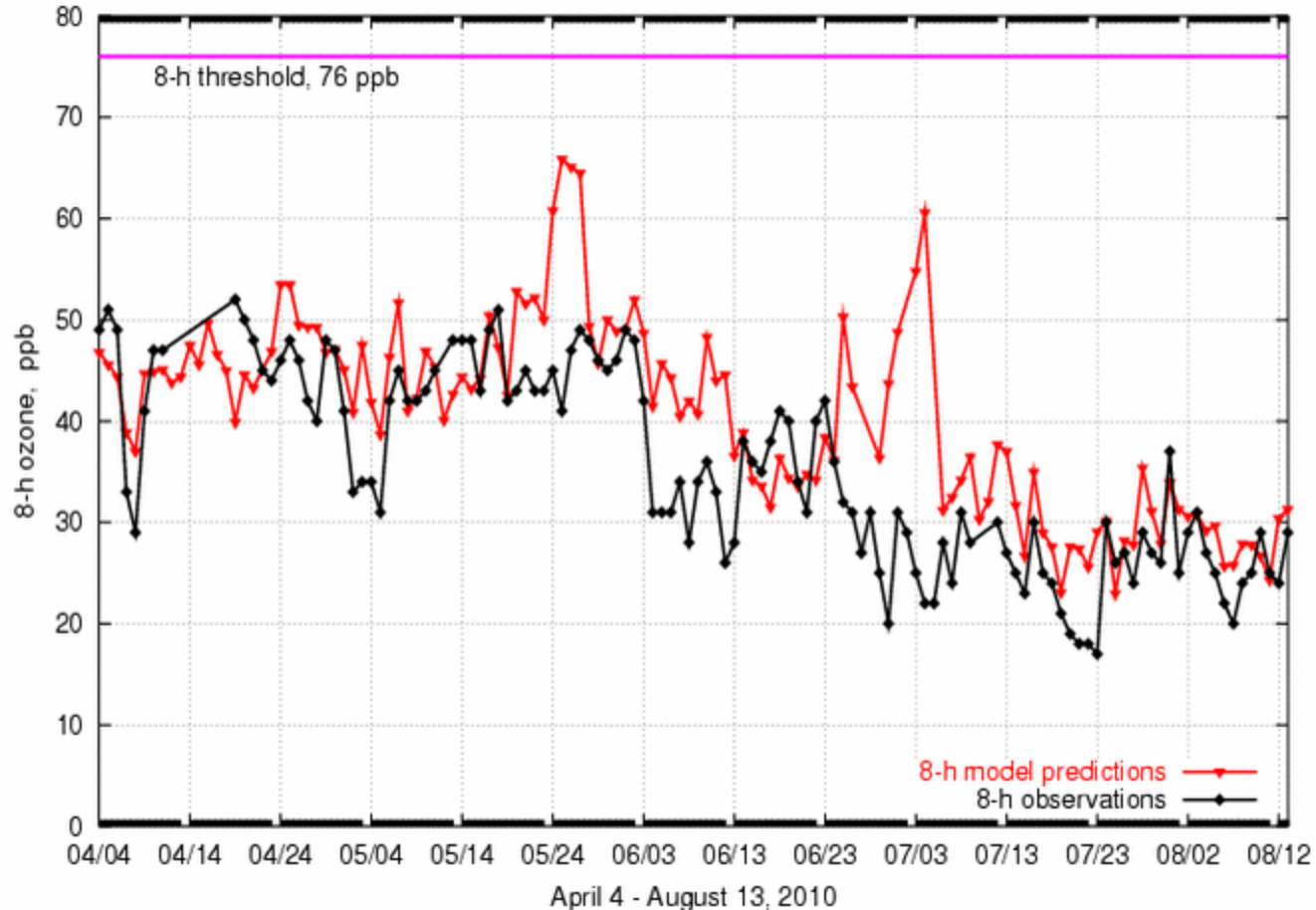
# Sample verification for Hawaii ozone



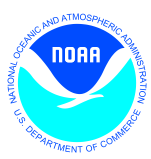
**Predictions and observations are both below the 76ppb threshold. Fraction correct  $\geq 0.9$**

# Sample verification for Alaska ozone

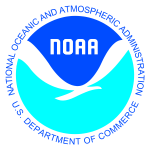
Daily max of 8-h ozone, model predictions vs. EPA observations  
Denali, Alaska, April 4 - August 13, 2010



Predictions and observations are both below the 76ppb threshold. Fraction correct  $\geq 0.9$



# Review of Operational Readiness



# Ozone Forecast Tool: Alaska and Hawaii

## Operational Readiness Criteria Summary

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

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

# Objective Verification (NCEP, MDL)

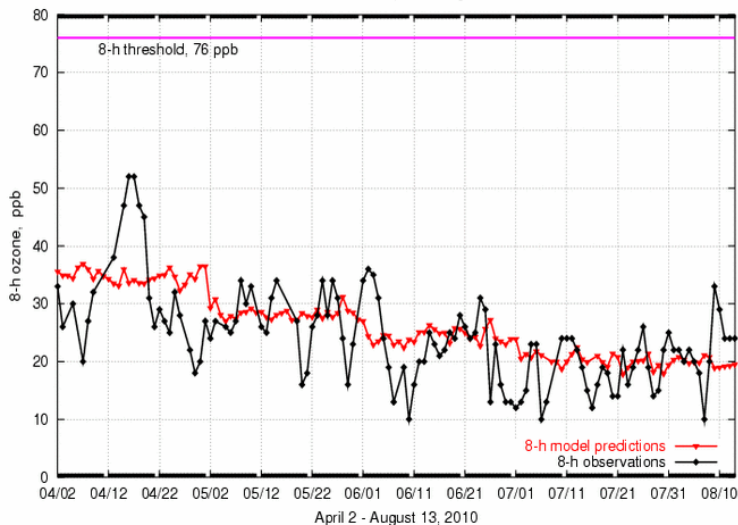
Criterion	Metric	Dates	Status
Objective Evaluation: Accuracy	Fraction correct of daily maximum of 8h average ozone with respect to 76ppb threshold $\geq 0.9$	4/2/10-8/8/10	C

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

- Fraction correct  $\geq 0.9$

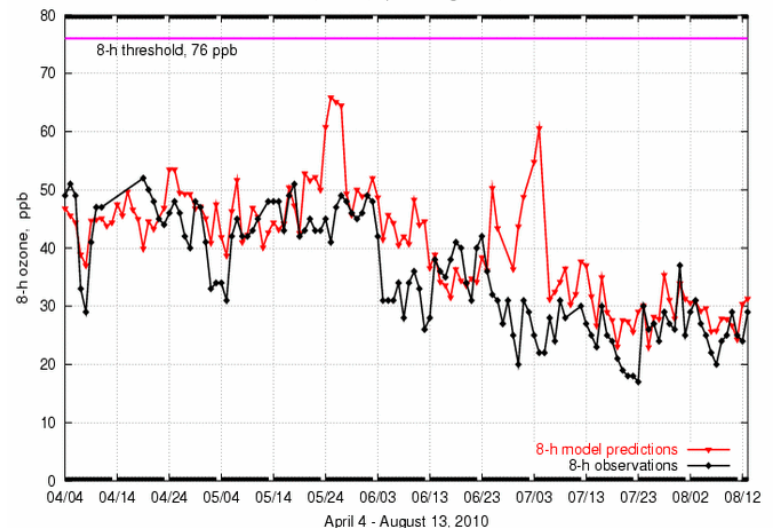
**Hawaii: predictions and observations are below the threshold, fraction correct=1**

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

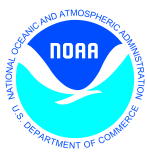


**Alaska: predictions and observations are below the threshold, fraction correct=1**

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







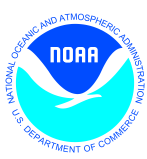
# Subjective Feedback (AR, PR, OCWWS)



<b>Criterion</b>	<b>Metric</b>	<b>Dates</b>	<b>Status</b>
<b>Subjective Feedback</b>	<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:

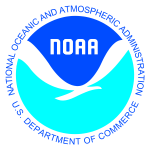
## *Other responses/comments on experimental products*

**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.”***

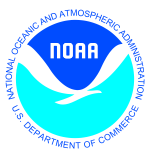
***No negative comments received***



# Production Readiness



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

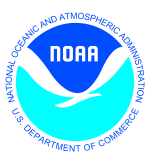


# Experimental Ozone Data Availability

- **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***

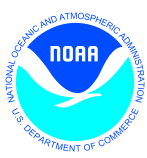


# Production Readiness (NCEP)

## Near-real time verification




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

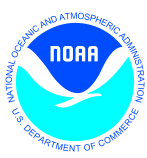
- **Verification Statistics:** *Compiled and maintained by NCEP. Updated daily*
- **Availability:** *Model developer group*
- **Seasonal summary:** *Available on AQ program web site (public)*
- **Weekly verification:** *Reports on operational performance measures provided by NCEP to OST PM*
- **AIRNow:**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

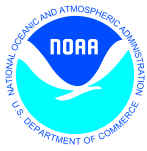
- CMAQ being coupled with NMM-B
- Canadian emissions to be updated – currently using 2000 inventory, planning to transition to 2005 inventory

## ***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

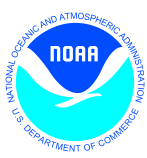
## Operational Readiness Criteria Summary



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

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

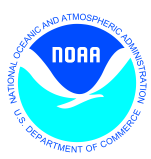




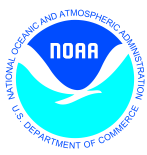
# Deployment Recommendation

***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)



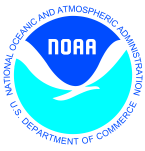
## **Ozone LBCs for Hawaii:**

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

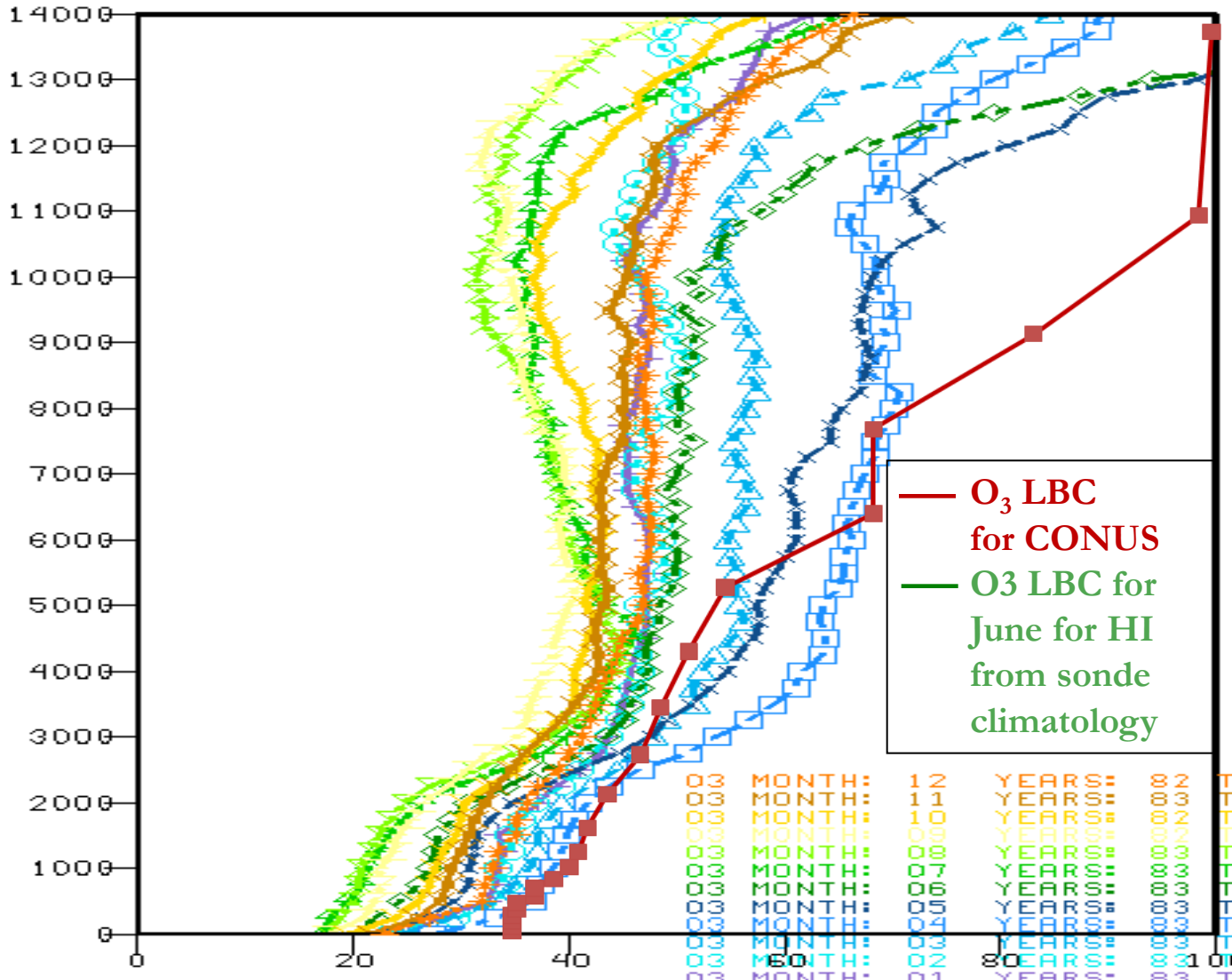
**Monthly varying LBCs for 40 other chemical species from GEOS-Chem, a global 3-D tropospheric chemistry model simulation for year 2002 (Harvard group, Bey et al., 2001) are used for Hawaii and Alaska.**

## **Ozone LBCs for Alaska:**

**Monthly varying from GEOS-Chem simulation for year 2002**

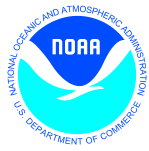


# Monthly O<sub>3</sub> lateral boundary conditions for Hawaii



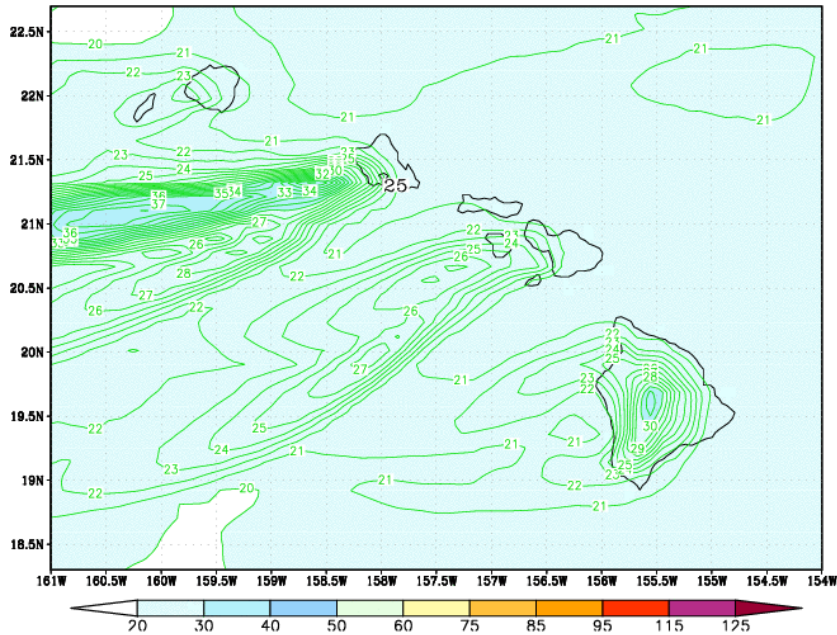
Ozone LBCs for HI are lower than the CONUS LBC, especially near the surface and in the upper troposphere

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

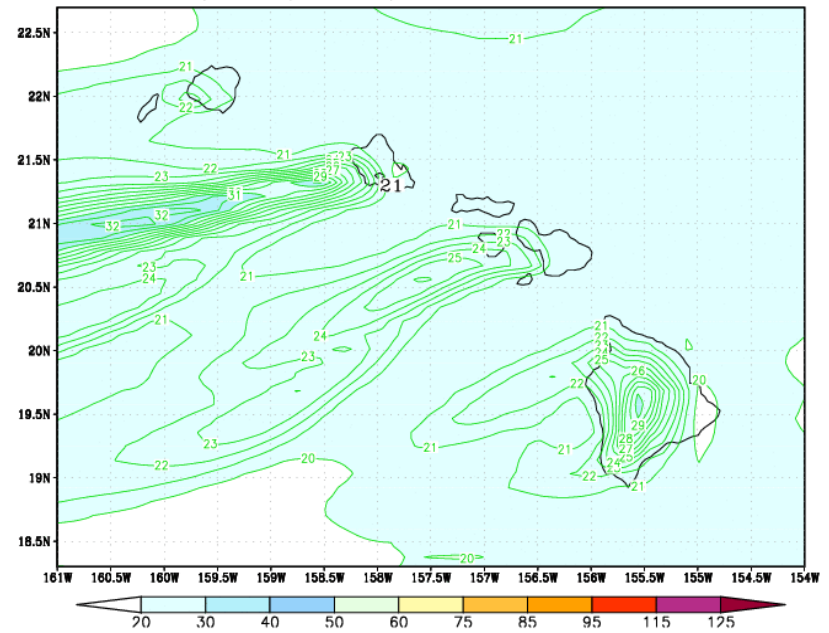


# Hawaii Spatial Verification Maps August 24, 2010

HI (Developmental) 1-hr max 24AUG2010



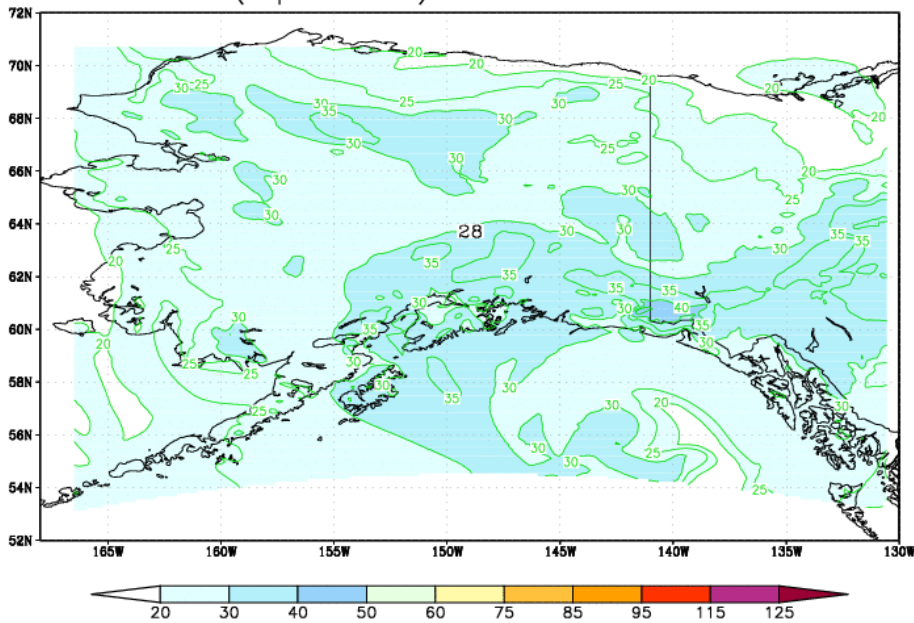
HI (Developmental) 8-hr max 24AUG2010



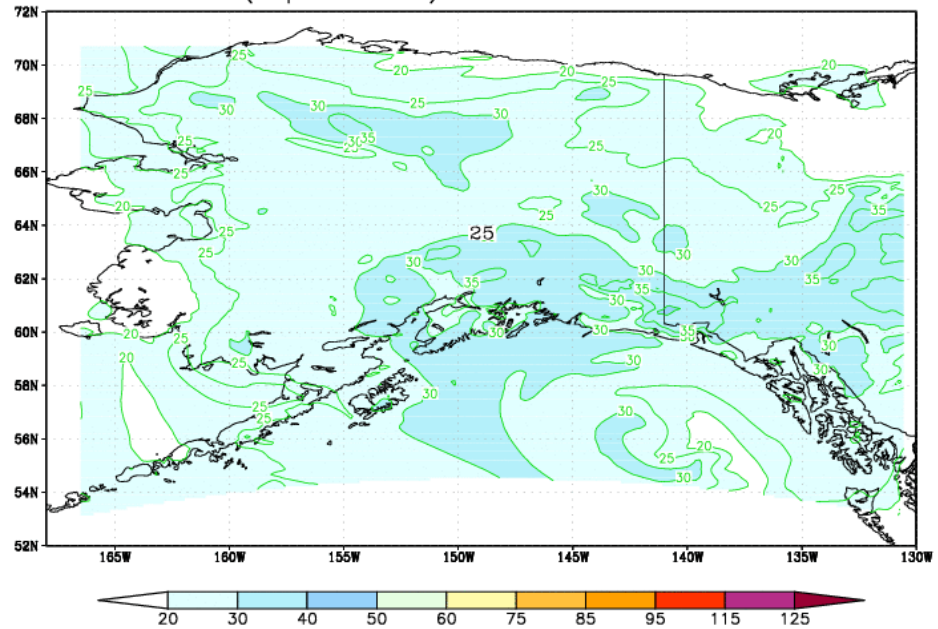
# Alaska Spatial Verification Maps

## August 24, 2010

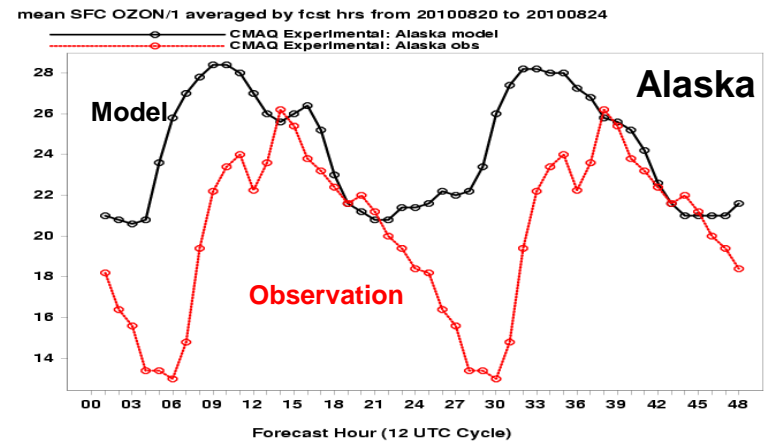
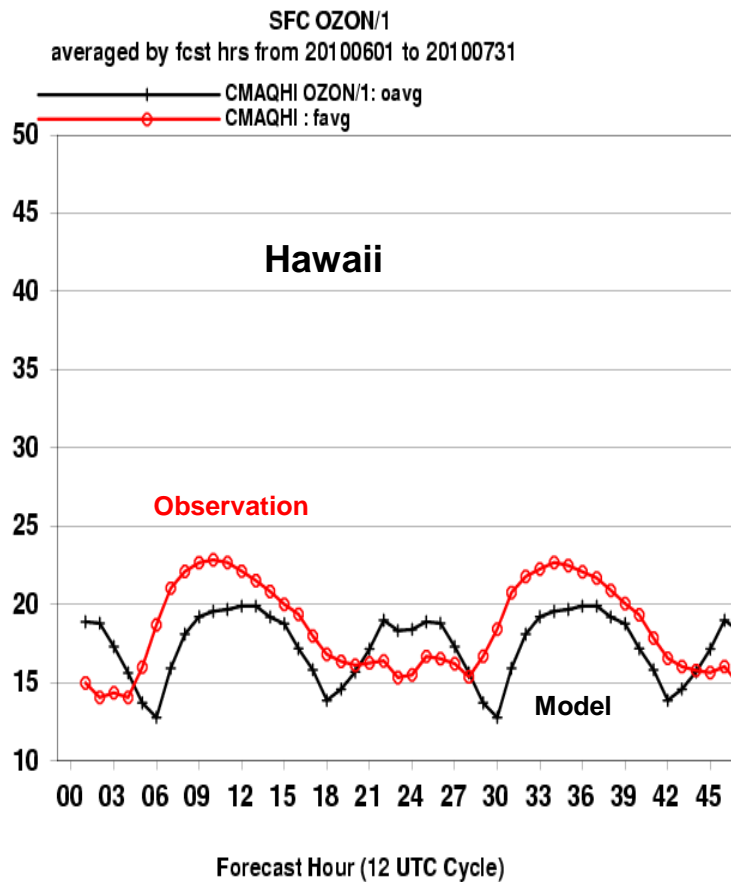
AK (Experimental) 1-hr max 24AUG2010



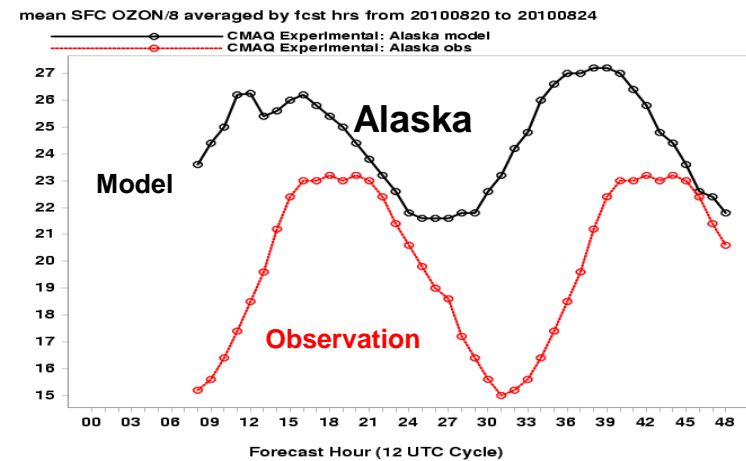
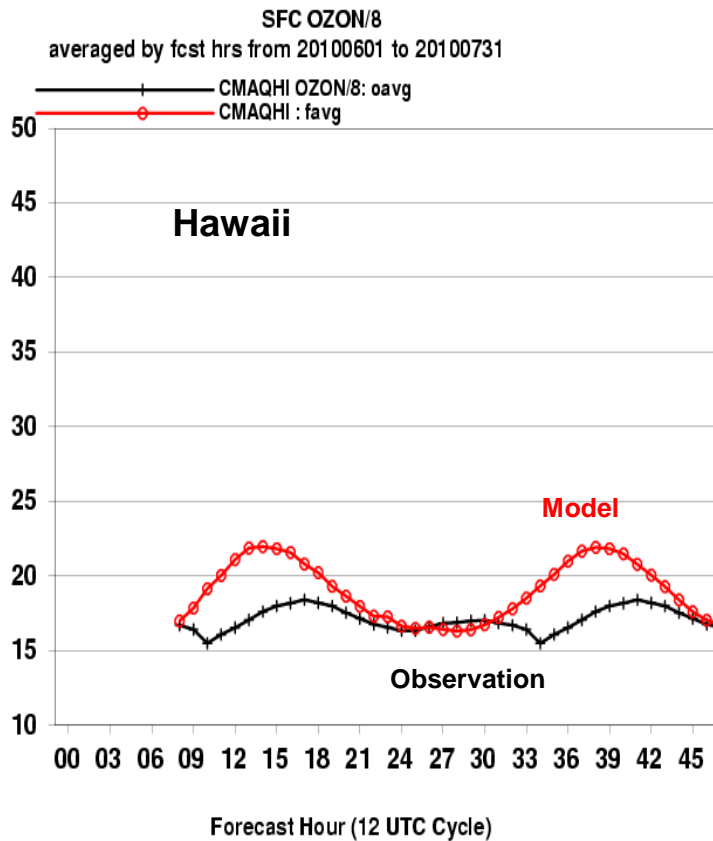
AK (Experimental) 8-hr max 24AUG2010



# Verification of 1-hr Ozone: Diurnal variability



# Verification of 8-hr ozone: Diurnal variability





# Ozone Forecast Tool for AK and HI

## Major Components

