



NWS NWP models and their Potential Impact for Air Quality Prediction

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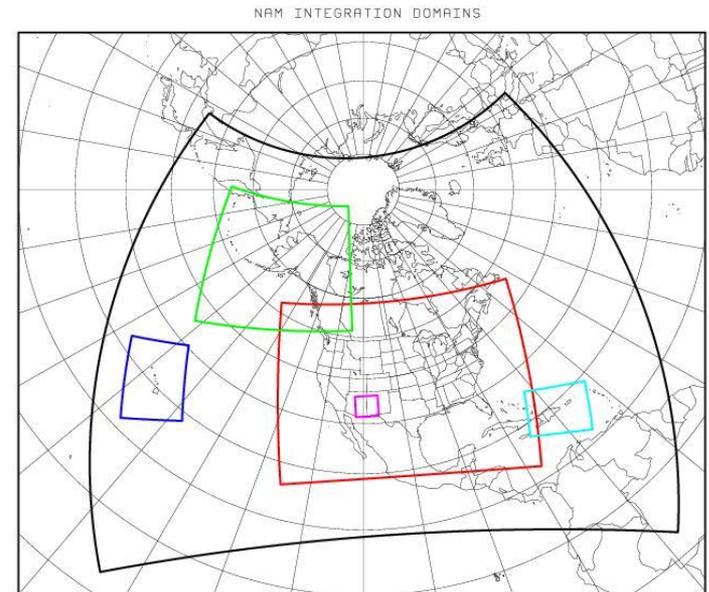


Questions

- Are the higher resolution operational NCEP NWP models mature enough to drive air quality ?
 - NAM Nests, HRRR, HREF
 - Value of capturing orographic flows vs. the uncertainty introduced from spurious cloud cover, convection and precipitation.
- How to evaluate NWP and AQ models ?
 - Small errors in location highly penalized by traditional metrics
- Should high resolution AQ models be coupled on-line with NWP systems ?
- NCEP moving to convection resolving regional ensemble (3 km NMMB/WRF-ARW) rather than one high resolution model.
 - Should we follow/leverage/take advantage of their capabilities ?

North American Model (NAM)

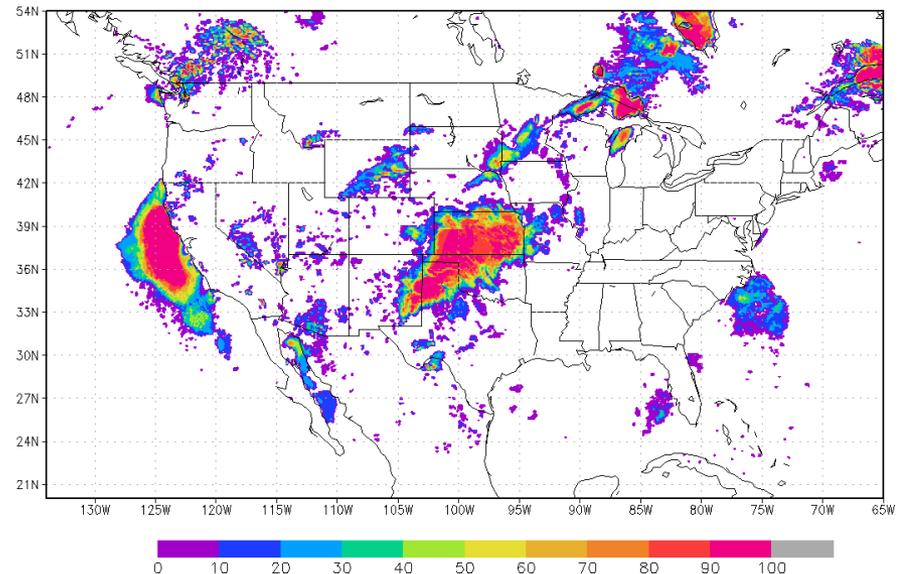
- Parent runs over continent at 12 km
- Runs out to 84 hr four times per day
- Model top is 2 mb with 60 vertical layers
- 60h 1-way interactive nests:
 - 4 km CONUS
 - 6 km Alaska
 - 3 km Hawaii and Puerto Rico,
- A placeable “Fire Weather” nest runs out to 36 hr at 1.33km when placed inside CONUS nest or at 1.5km when placed inside Alaska nest



Future: All regional guidance moving to ensemble basis

- The convection-allowing scale ensemble suite will be made up of smaller fixed-domain runs [possibly inline nested] **at ~3km** and will be called the High Resolution Ensemble Forecast [HREF see more [here](#)].
- HREF domains will include at least CONUS and Alaska with Hawaii and Puerto Rico

HREF: Prob of Wind Speed > 20 knots at 80m 03H FCST
from 00z Sep 01 2015. Validation Time: 03z 09/01/2015



- Probability of 80 m winds > 20 knots
- But for Air quality:
- Prob. Stagnation, stable conditions, thunderstorms, cloudiness....



NAM-CMAQ CB05/AERO-4

- Inclusion of latest EPA Carbon Bond 5 (CB05) chemical mechanism.
- Inclusion of AERO-4 aerosol chemistry.
- Modulate fugitive dust emission: suppress over ice/snow.
- Incorporate NESIDS HMS wild fire smoke. **CONUS**
- Incorporate real-time surface dust emissions (wind dependent). **CONUS**.
- **OPERATIONAL: January 29, 2015**
 - All emissions based on EPA 2011 Inventories
 - Increased vertical levels from 22 to 35
 - Using operational NEMS Global Aerosol Capability (NGAC) for dust lateral boundary conditions
 - Update BlueSky smoke emission system

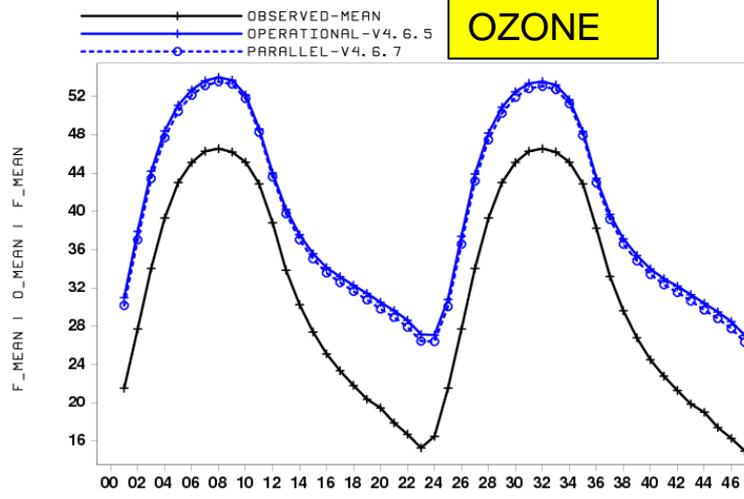


1 hour average Ozone & PM Predictions

August 2015

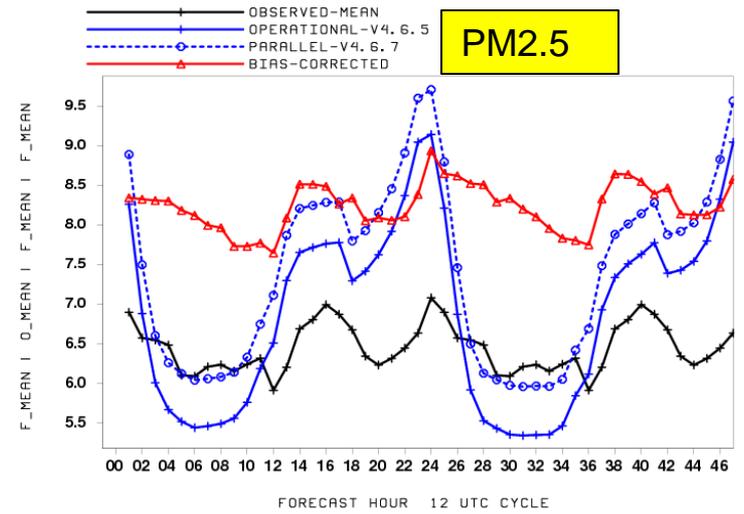


OZON/1 OAVG AVGED BY FCST HRS
20150801 TO 20150830
NORTHEAST

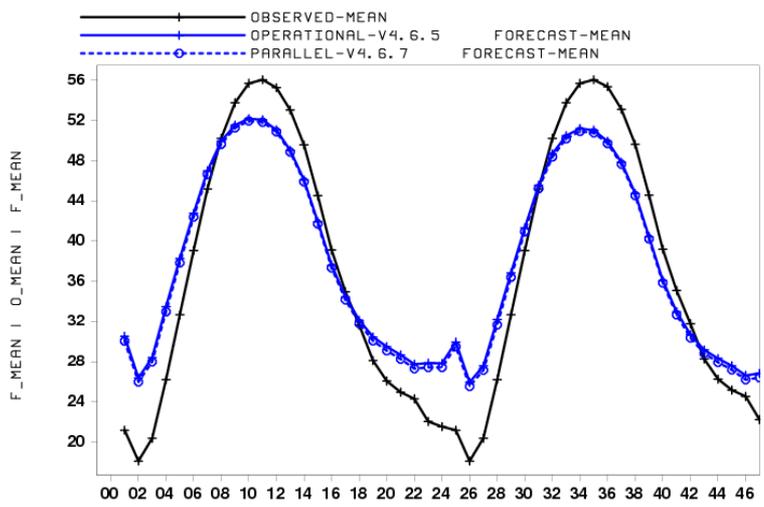


NE

PM25/1 OAVG AVGED BY FCST HRS
20150801 TO 20150830
NORTHEAST

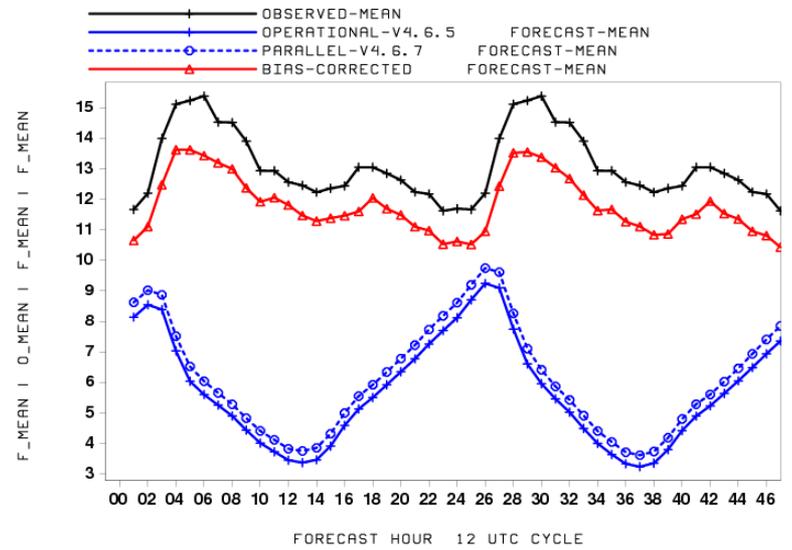


SWEST-COAST



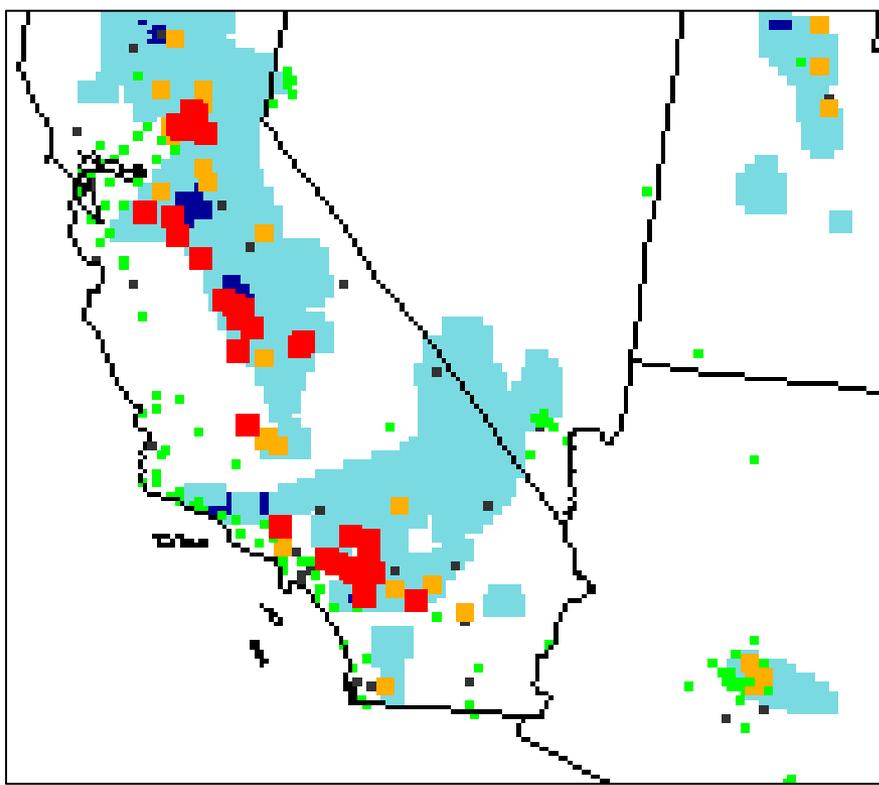
SW

SWEST-COAST

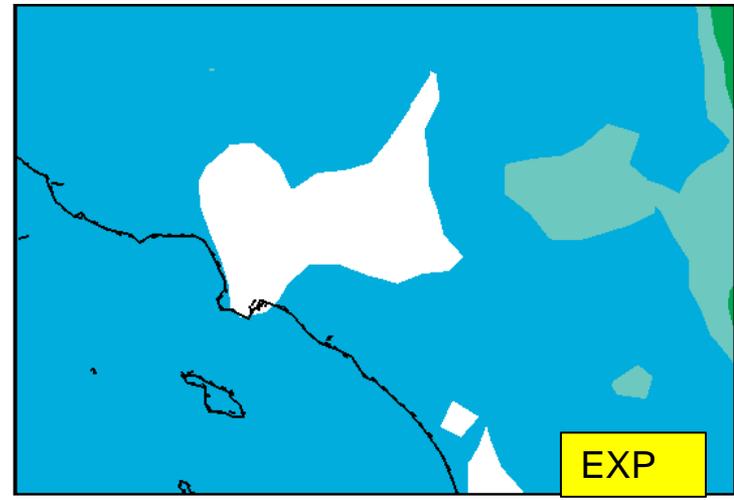
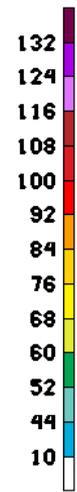




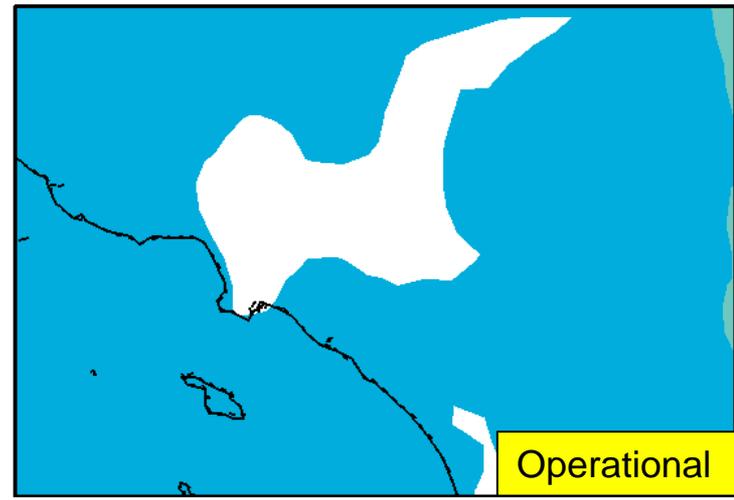
1 hour average Ozone Predictions July 08, 2014 Case



Experimental : V4.6.5 Ozone Daily max vs obs



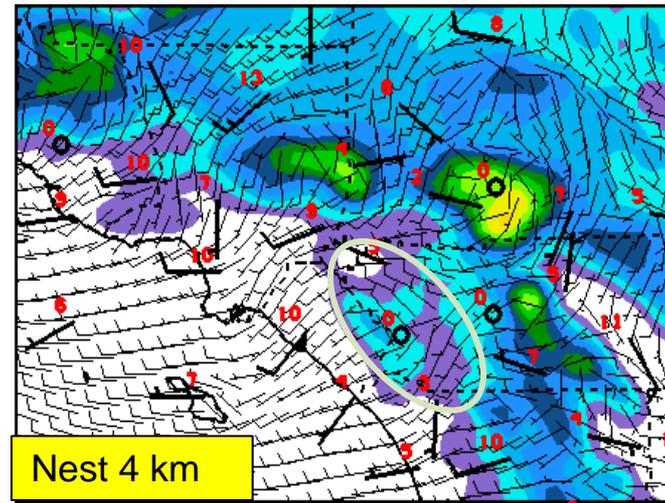
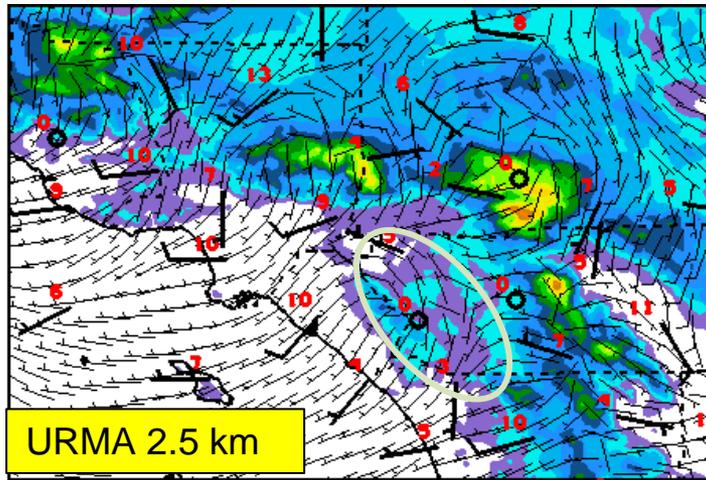
EMC EXP V4.6.32 AQM SFC OZCN01 140708/0900V021



OPER JEFF. MCQUEEN AQM SFC OZCN01 140708/0900V021

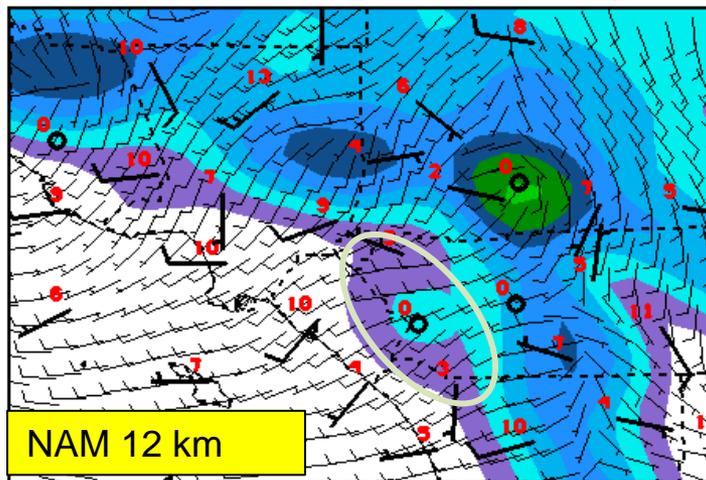
NAM Parent, Nest vs URMA Wind Vectors

July 8, 2014 21 UTC (33 h forecast)

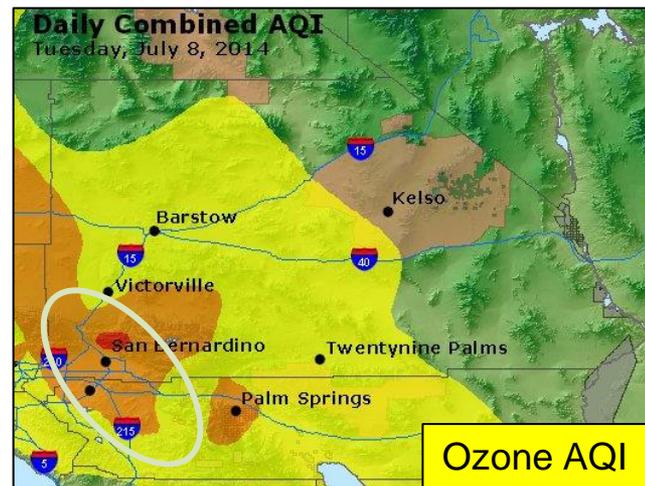


MESO URMA2P5 SFC HGHT (M) ANALYSIS CNO** 140708/210

100 CONUSNEST NAM SFC HGHT (M) CNO** 140708/21001



PROD 12 NAM SFC HGHT



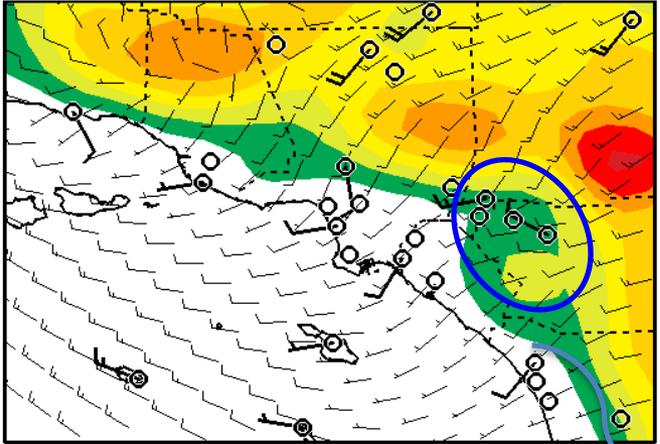
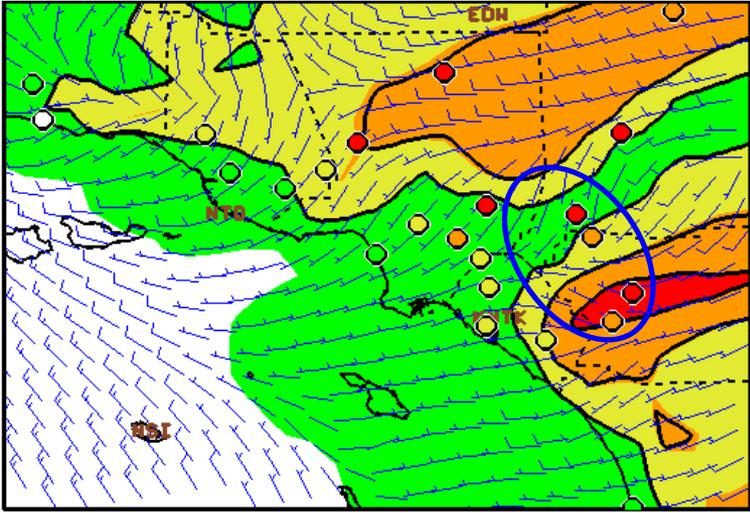
- Complex flow fields delineated by URMA
- Turning and slowing of winds around high terrain near San Bernadino not captured by NAM 12 km

NAM/CMAQ Parent vs Nest

June 16, 2015 LA Basin

1 hr avg max ozone

10 m winds/topo

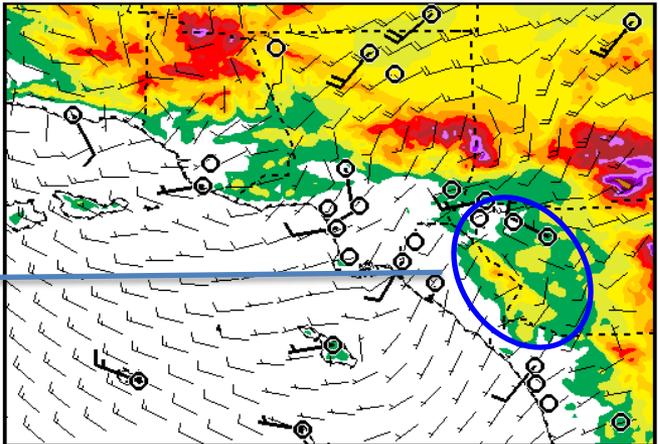
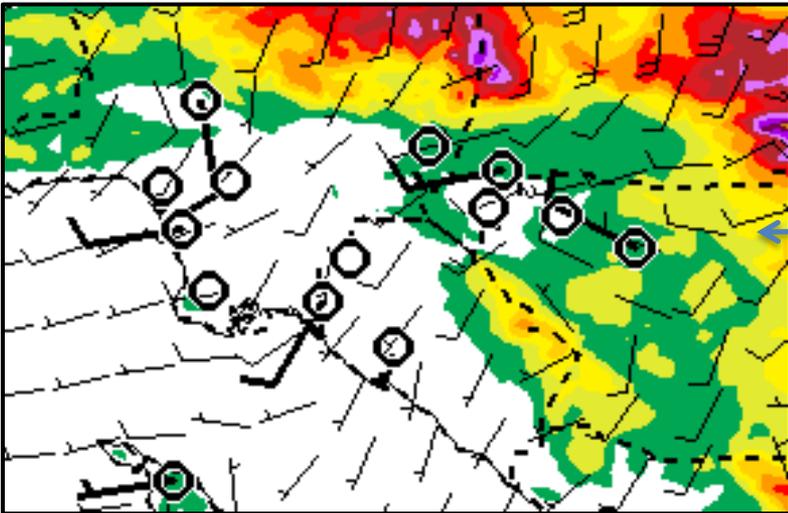


116
96
75

1750
1500
1250
1000
750
500
250

PARA1 AQM SFC DAY1 OZHX01 20150616 12Z CYCLE

NCO PROD 12 NAM SFC HGHT (M) LAX** 150617/0000V0:2



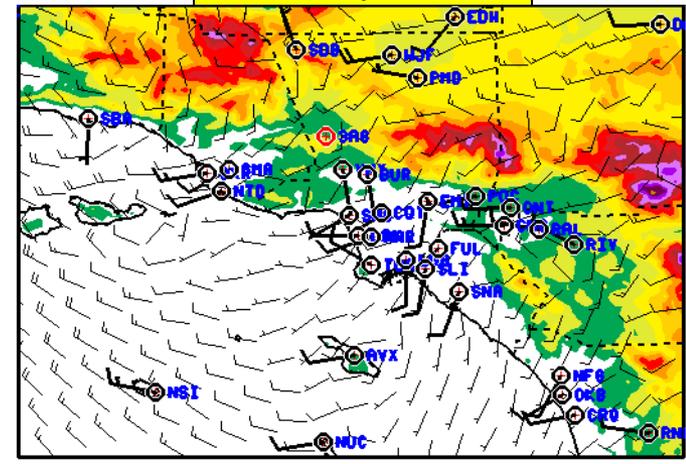
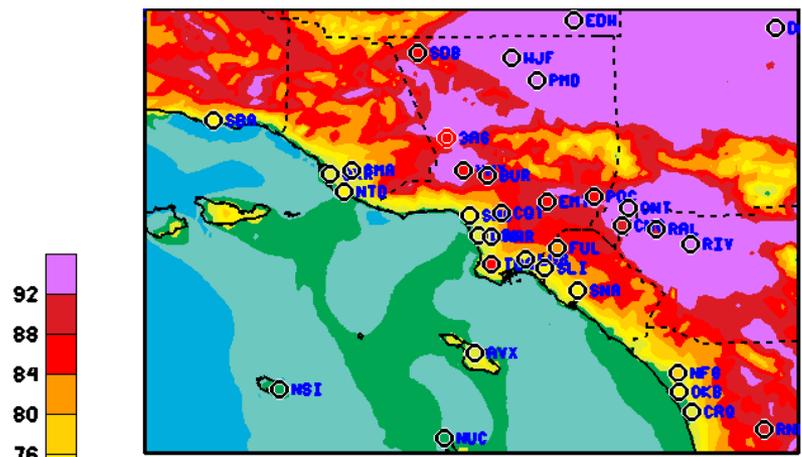
NCO PROD CONUS2P5 SHART SFC HGHT (M) LAX** 150617/0000V0:1

NAM 3 km vs HRRR 3 km

June 22, 2015 LA Basin

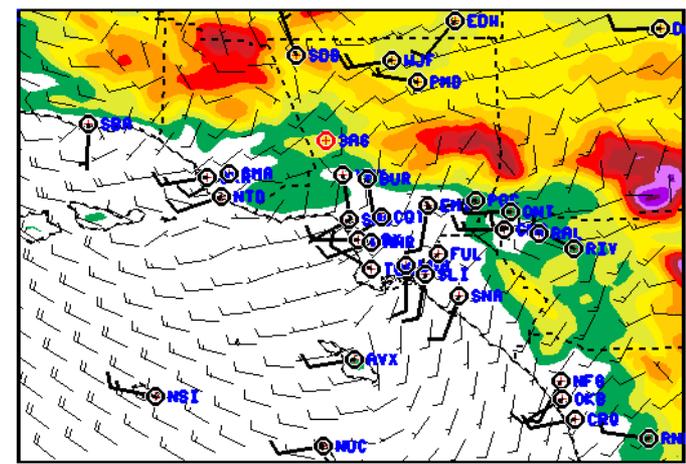
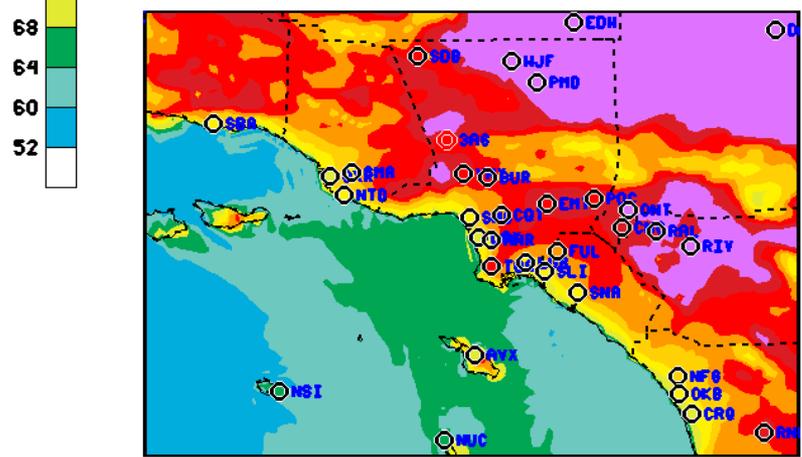
2 m temperature

Winds/topo



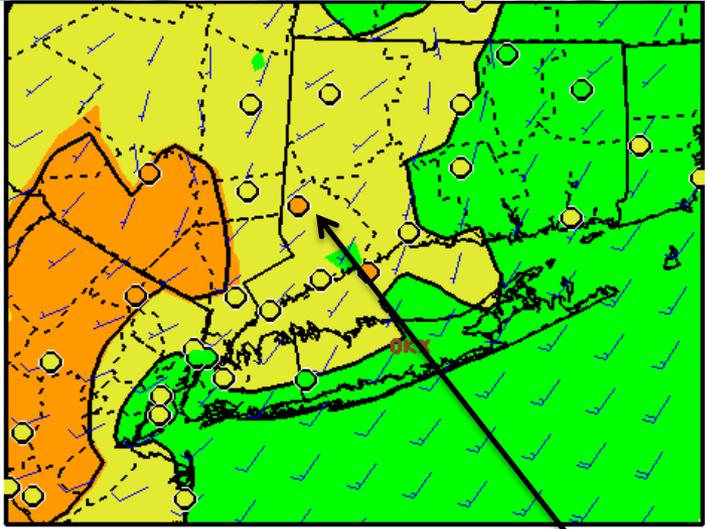
COM2 PROD CONUSNEST HRRR 2 M TMPF LAX** 150622/2100V009

COM2 PROD CONUSNEST HRRR SFC HGT (M) LAX**

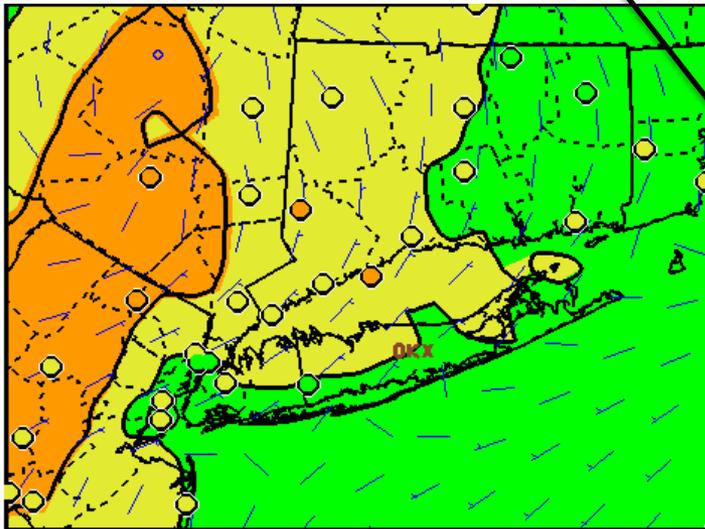


MES02 ERIC. ROGERS PARA CONUSNEST NAM 2 M TMPF LAX** 150622/2100V009 MES02 ERIC. ROGERS PARA CONUSNEST NAM SFC HGT (M) LAX** 150622/211

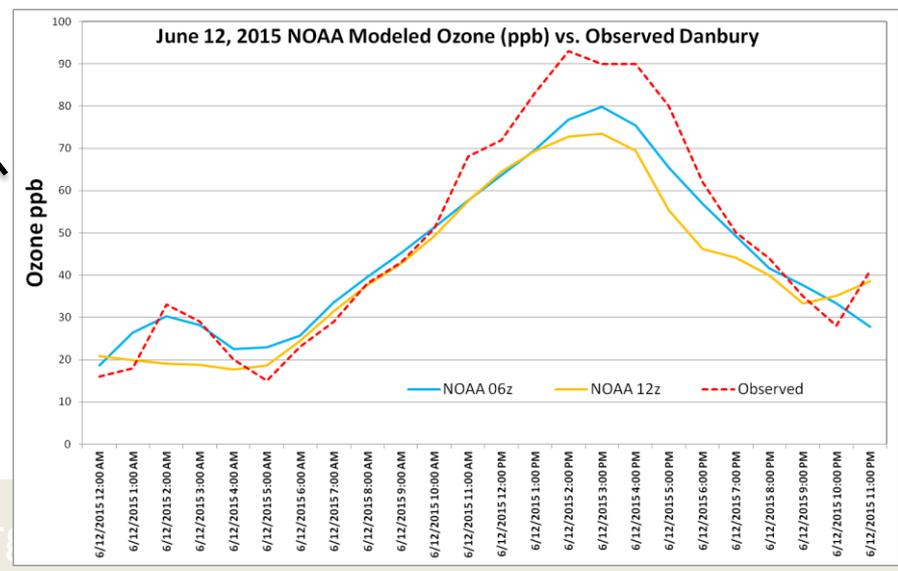
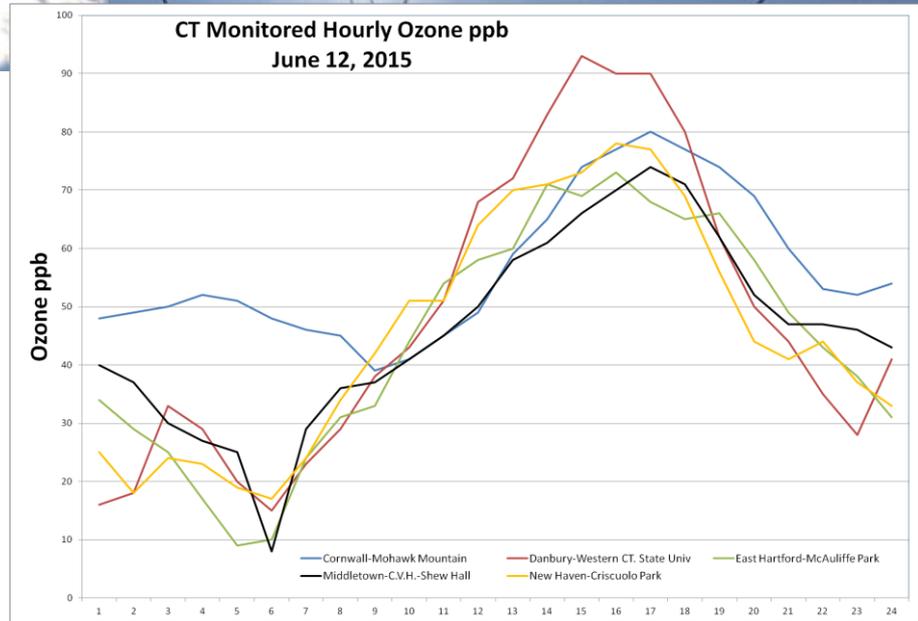
under-prediction



PARAL AQM SFC DAY1 OZMX08 20150612 06Z CYCLE



PARAL AQM SFC DAY1 OZMX08 20150612 12Z CYCLE



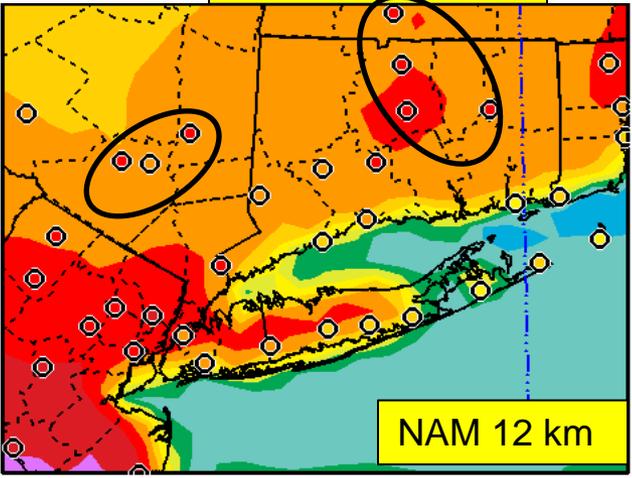


NAM Parent, Nest vs Obs Temperatures

June 12, 2015 18 UTC (12 H forecast)

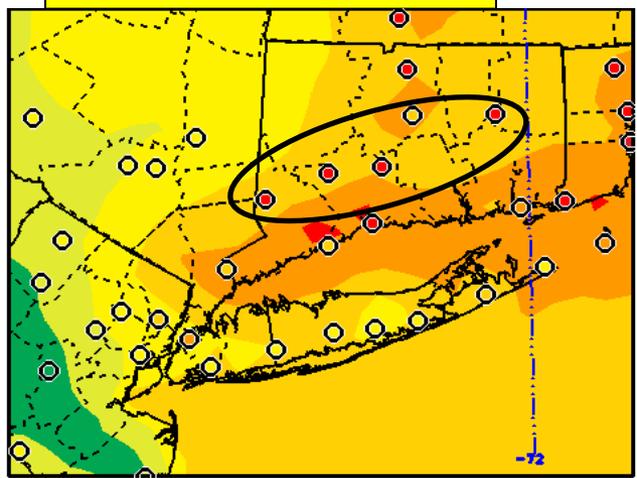


2 m Temperature

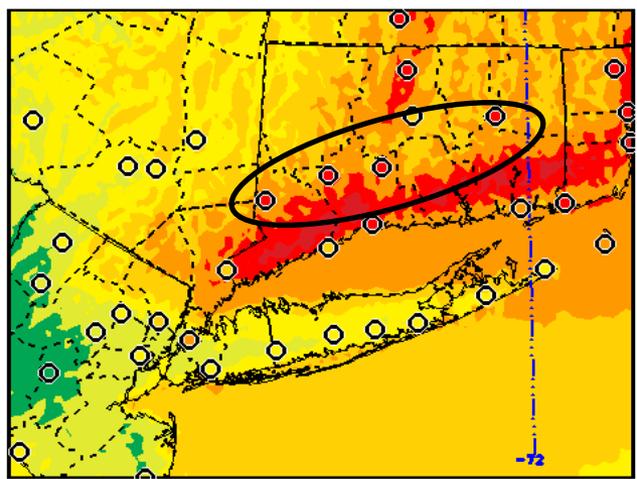
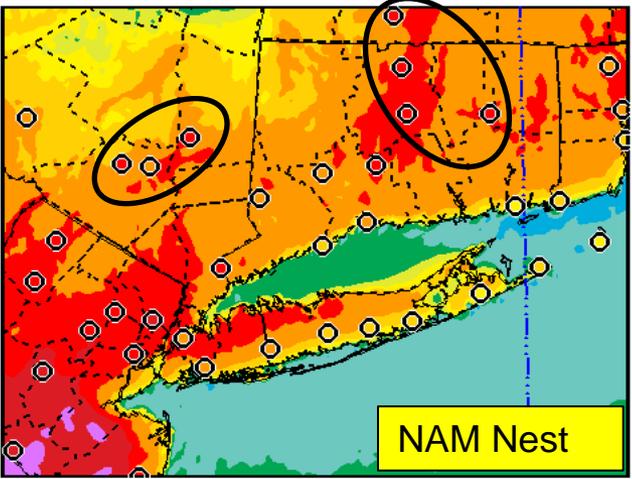


NCO PROD 12 NAM 2 H TMPF BDR** 150612/1800V012

Dew Point Temperature



NCO PROD 12 NAM 2 H DHPF BDR** 150612/1800V012



NAM-12: Temps ~ 2-4 ° cooler & 4-8 ° moister in Upstate NY/CT
 Can contribute to lack of ozone production
 Nest: Better inland predictions, Strong drying near the coast : downward mixing ?

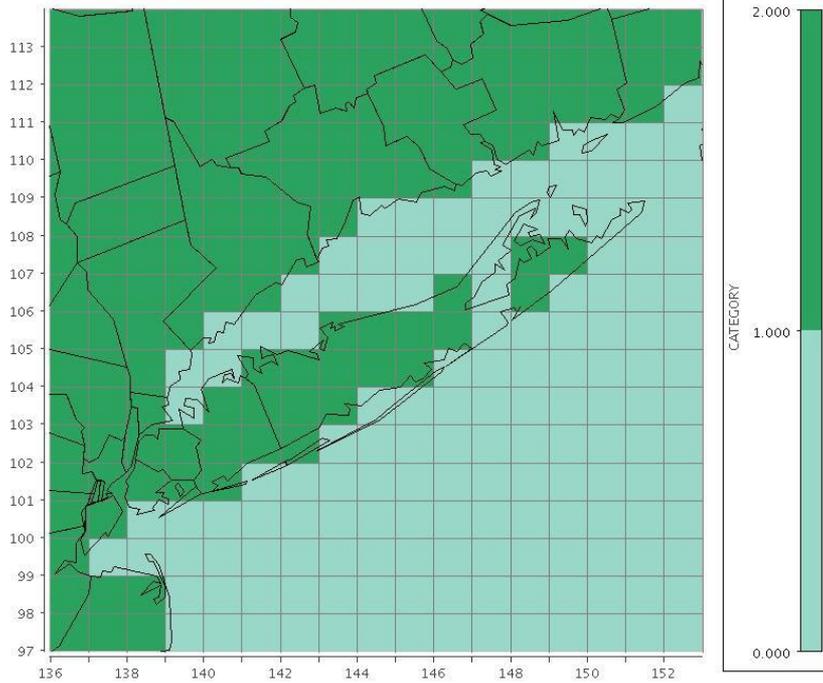
150612/1800V01



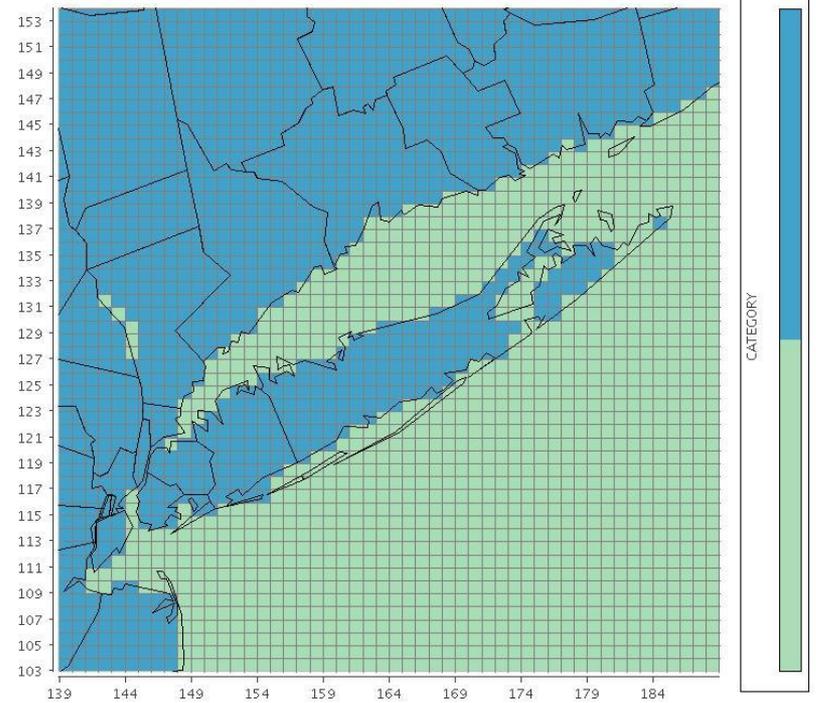
12 vs 4 km Land Surface Grid



Layer 1 LWMASK[1]



Layer 1 LWMASK[1]



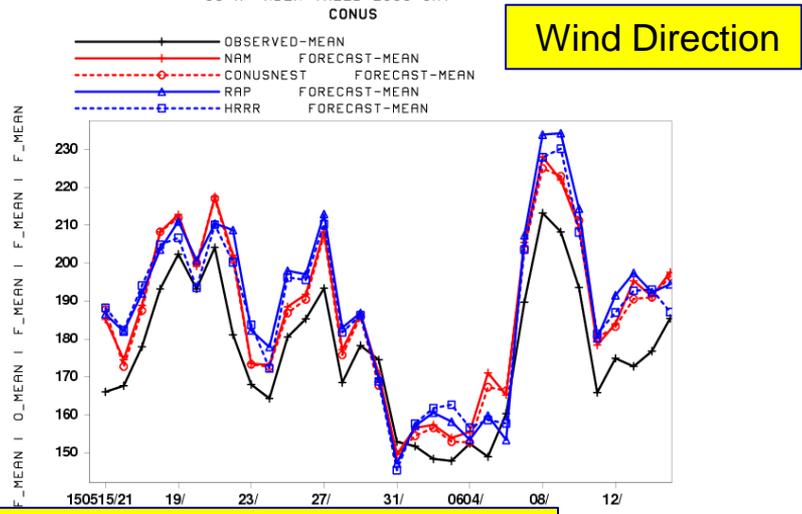
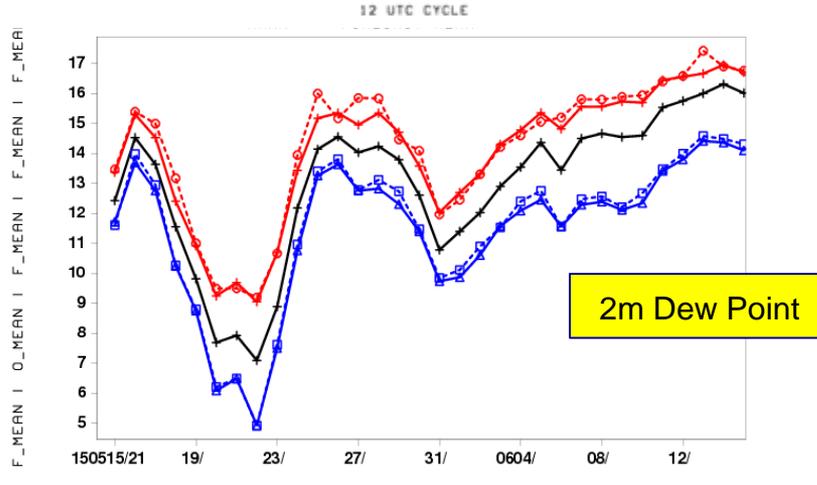
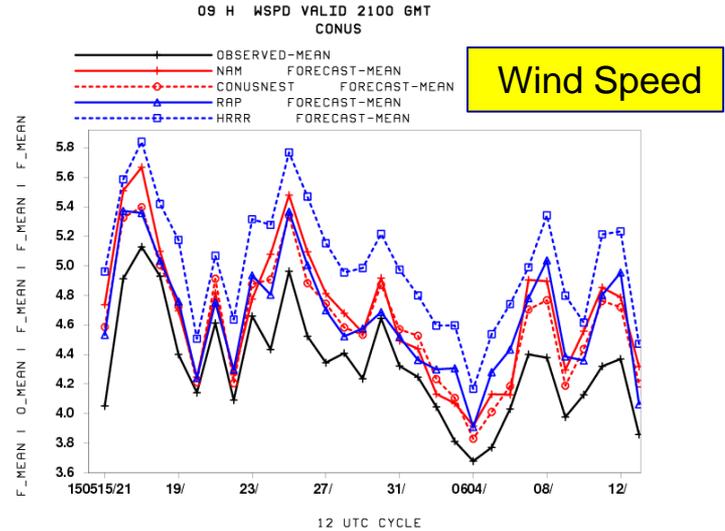
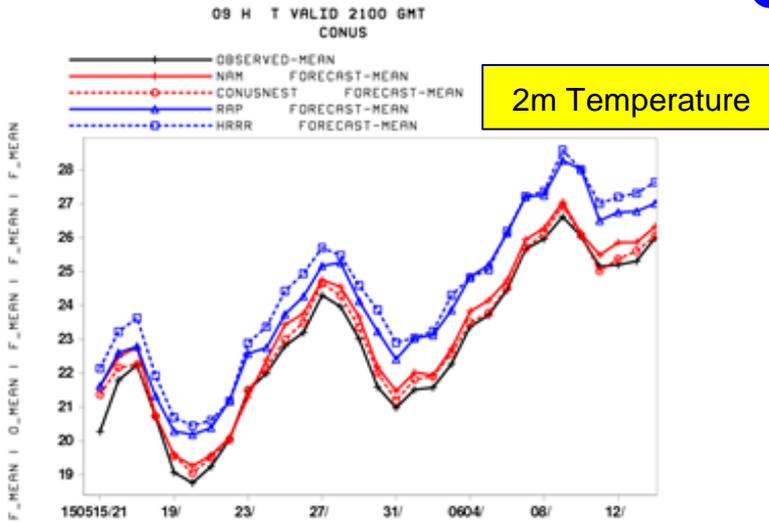


Improvements with High Res Met ?

May 15-June 15, 2015 33 h forecast (21:00 UTC)



CONUS



RAP/HRRR: Warm, dry bias, Winds too strong
NAM/Nest: Warm bias reduced, Moist Bias, Winds over-predicted



Improvements with High Res Met ?

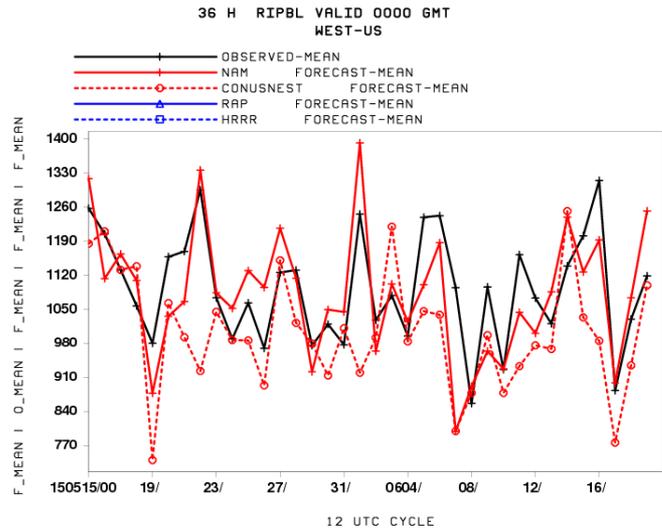
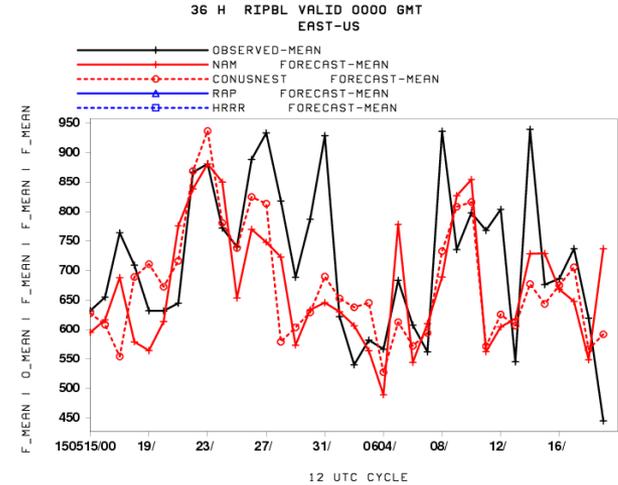
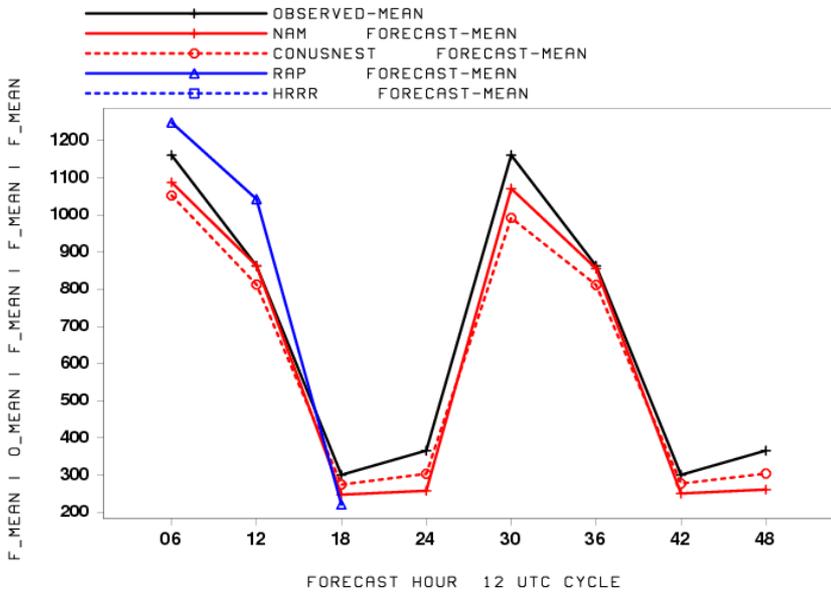
May 15 –June 15, 2015 PBL Height



CONUS

East

RIPBL OAVG AVGED BY FCST HRS
20150515 TO 20150619
CONUS



NAM/Nest:



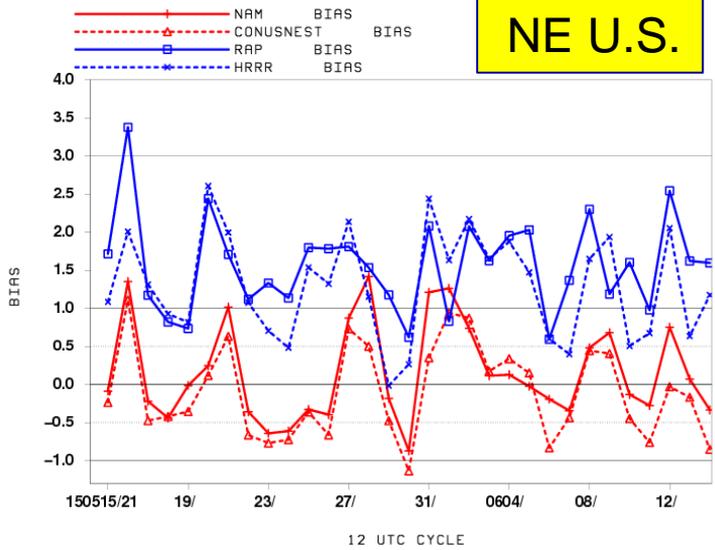
Improvements with High Res Met ?

May 15 –June 15, 2015 9h forecast (21:00 UTC)



09 H T BIAS VALID 2100 GMT
NORTHEAST

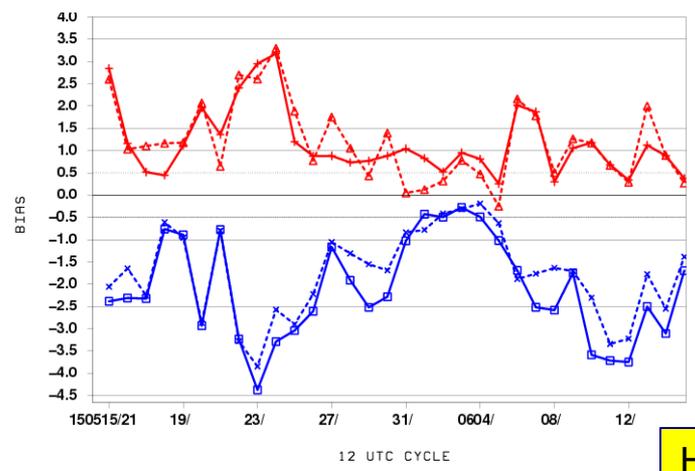
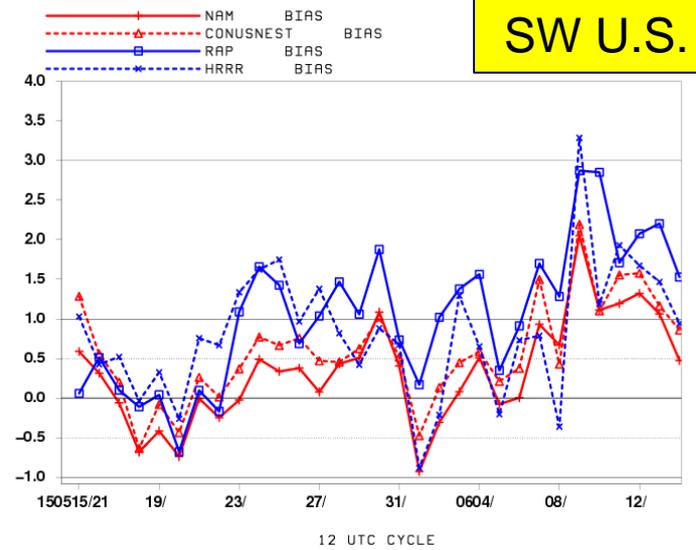
NE U.S.



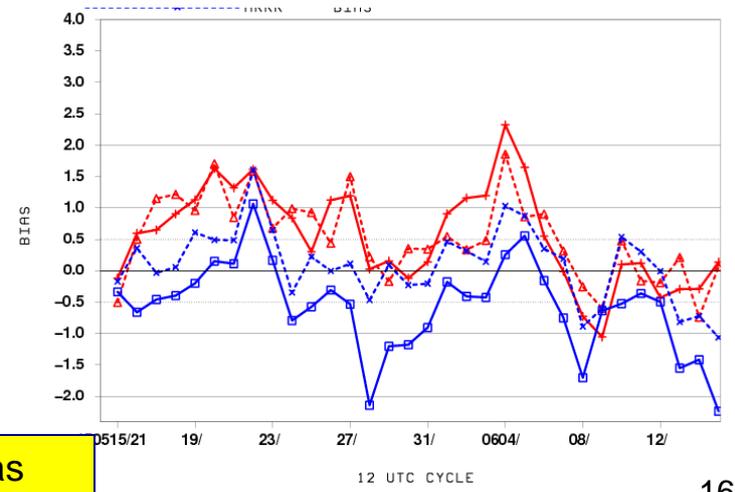
**2m Temperature
BIAS**

09 H T BIAS VALID 2100 GMT
SWEST-COAST

SW U.S.



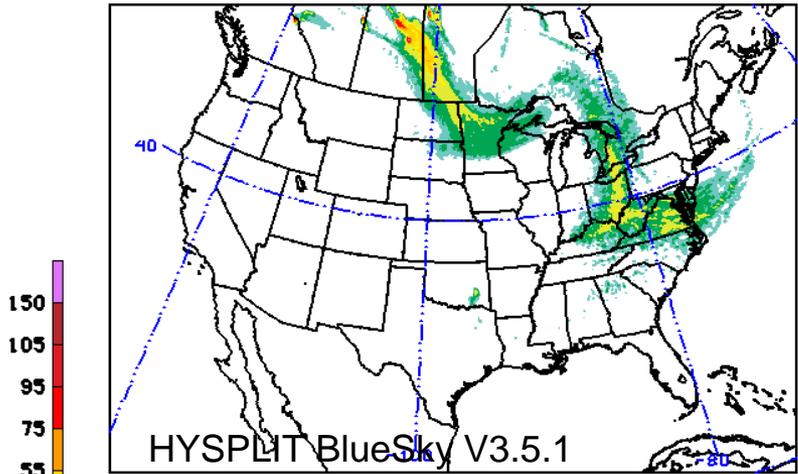
**Dew point T
BIAS**



**HRRR: Warm/Dry bias
NAM/Nest: Moist bias**

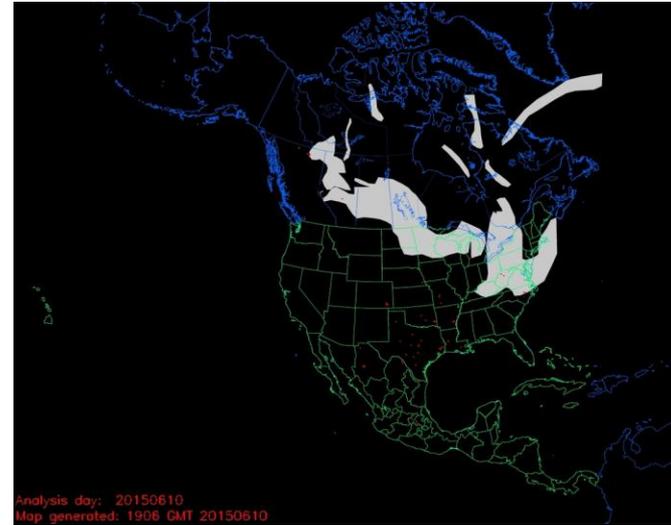
Canadian Smoke over E. U.S.

June 10, 2015

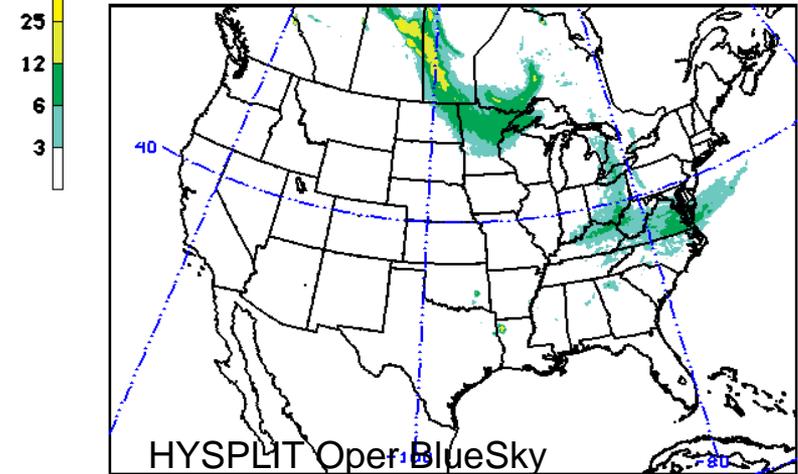


HYSPLIT BlueSky V3.5.1

EMC EXPERIMENTAL hyspl11 pbl smoke forecast CONUS

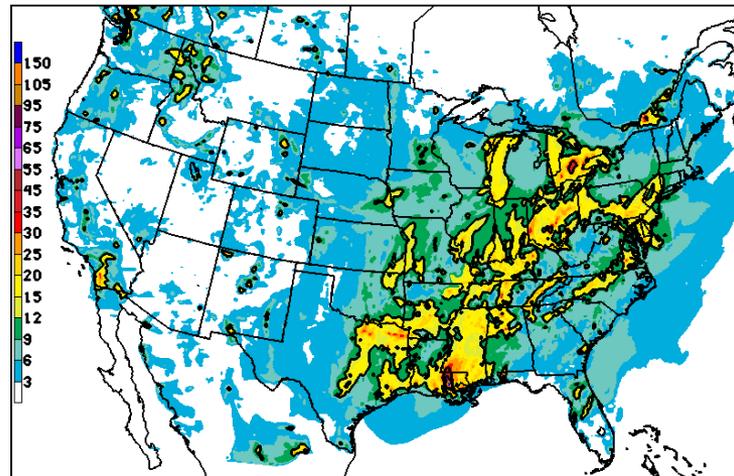


Analysis day: 20150610
Map generated: 1906 GMT 20150610



HYSPLIT Oper:BlueSky

OPERATIONAL PROD hyspl11 pbl smoke forecast CONUS 150610/0900V003 "

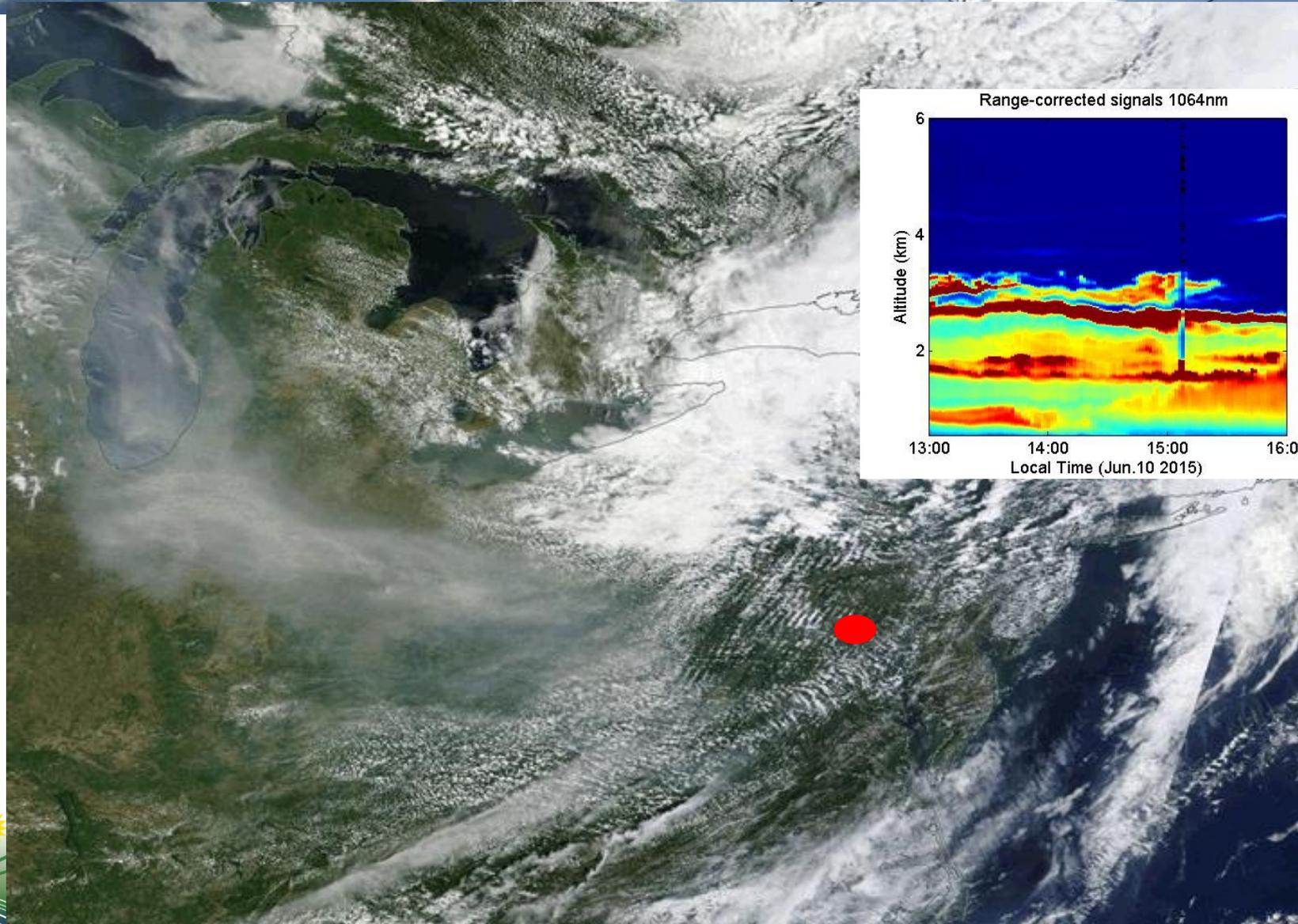


PROD AQH SFC DAT1 PMH01 20150610 06Z CYCLE "

Total Column smoke Concentration (ug/m3)

CMAQ Oper Sfc PM2.5 Prediction

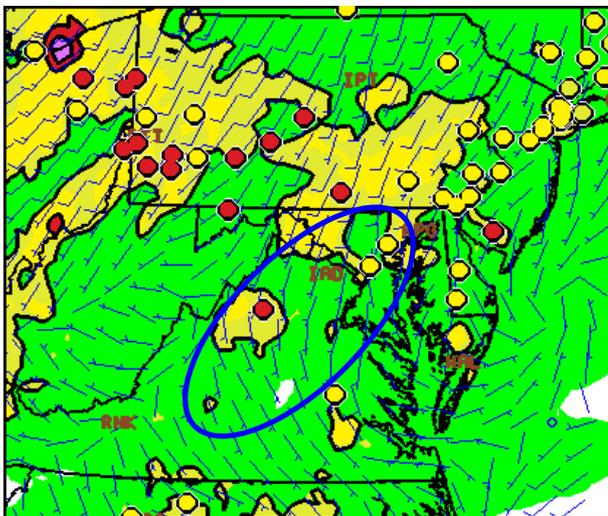
Aqua/Terra Images from June 9- June 11



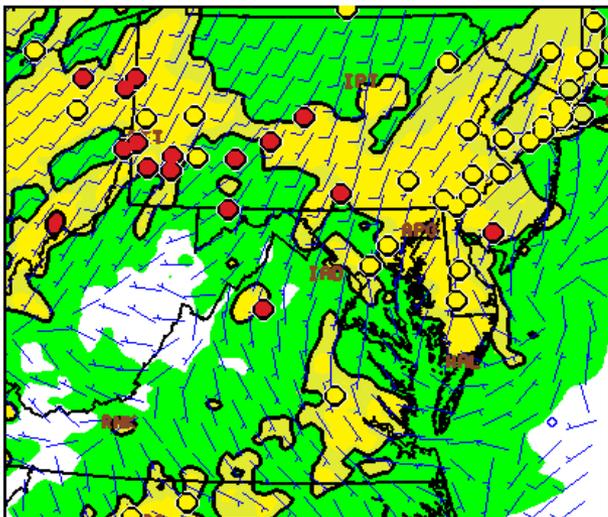


Canadian Fire smoke over DMV

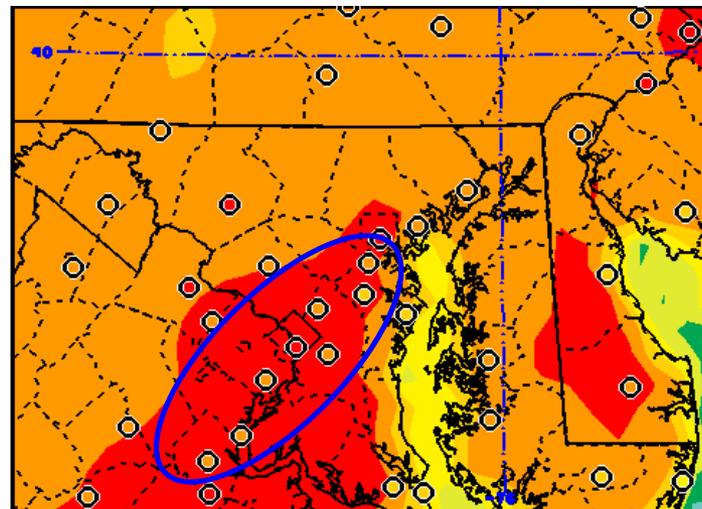
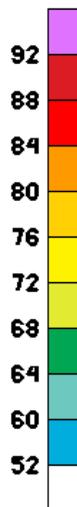
June 10, 2015



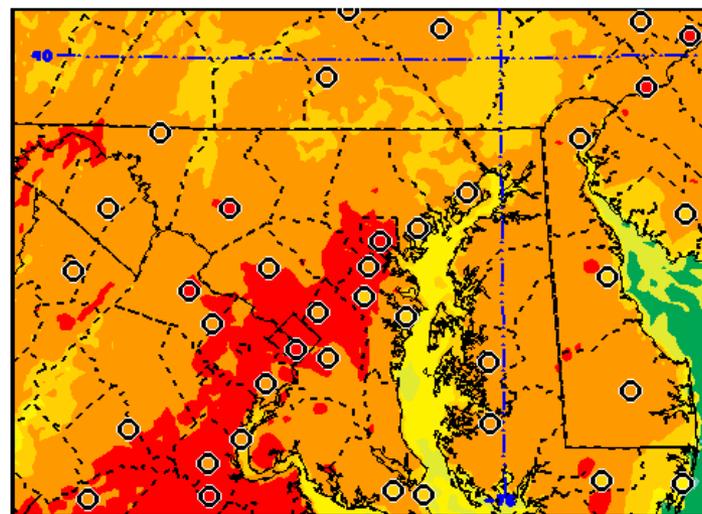
PARA1 AQM SFC DAY1 PMX01 20150610 12Z CYCLE



PROD AQM SFC DAY1 PMX01 20150610 12Z CYCLE -



NC0 PROD 12 NAM 2 H TMPF BHI** 150610/2100V015



NC0 PROD CONUS2P5 SMART SFC TMPF BHI** 150610/2100V0



Summary

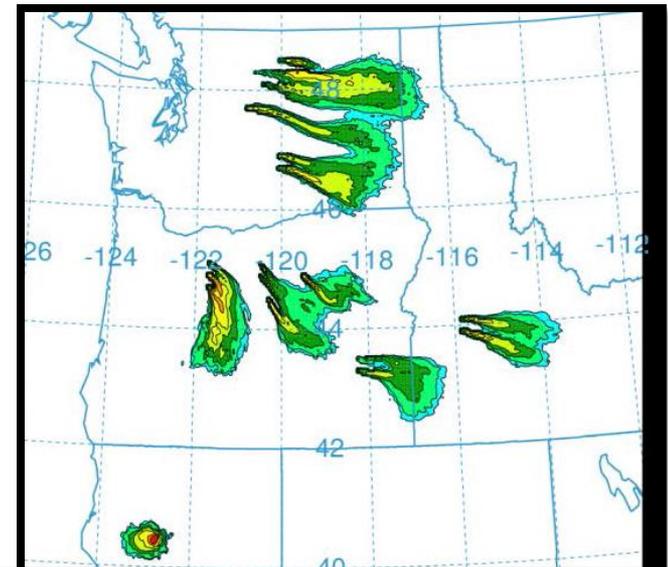


Smoke, dust, ozone, anthropogenic PM : **unified system** using CMAQ V4.6.5

- **Ozone predictions improved** with latest changes to V4.6.5
 - Although strong under-prediction in California still evident
- PM predictions:
 - positive impact from updated emissions and NGAC LBCs (V4.6.7)
 - Better emissions from wild fire smoke (H-C Huang)
- NWS **Un-Restricted Mesoscale Analysis** (2.5 km) proved useful for evaluating NAM 12 and 4 km predictions
- High Res Met useful for identifying processes not resolved with 12 km NAM
 - 4 km nest captured blocking flow in San Bernadino Valley, California
 - 4 km nest performance of AQ sensitive weather fields best so far (what about fire wx nest ?)
- What is the impact of smoke/dust on Meteorology ?
 - possible impact for June 9-11
- Met performance should be carefully evaluated while proceeding to address other system errors
 - Concern that we are **making changes to chem/emissions that mask 1st order met errors**

Short-term Future plans

- Include NGAC real-time full aerosol boundary conditions
- Improve smoke emissions
 - Update USFS BlueSky emissions
 - (forest load, consumption, spread emissions)
 - Smart fire behavior using real-time met
 - Evaluate plume rise (additional met constraints)
- Include ESRL bias correction for O3/PM
 - At stations
 - spreading technique to grid
- Short-range High Resolution prediction
 - smoke (HRRR-smoke ?)
- Partial Inline NWP - CMAQ V5.1
 - Dust first (ARL USWRP project)
 - Impact on weather
 - Highly optimized



HYSPLIT smoke driven with NAM 4 km
July 19, 2014