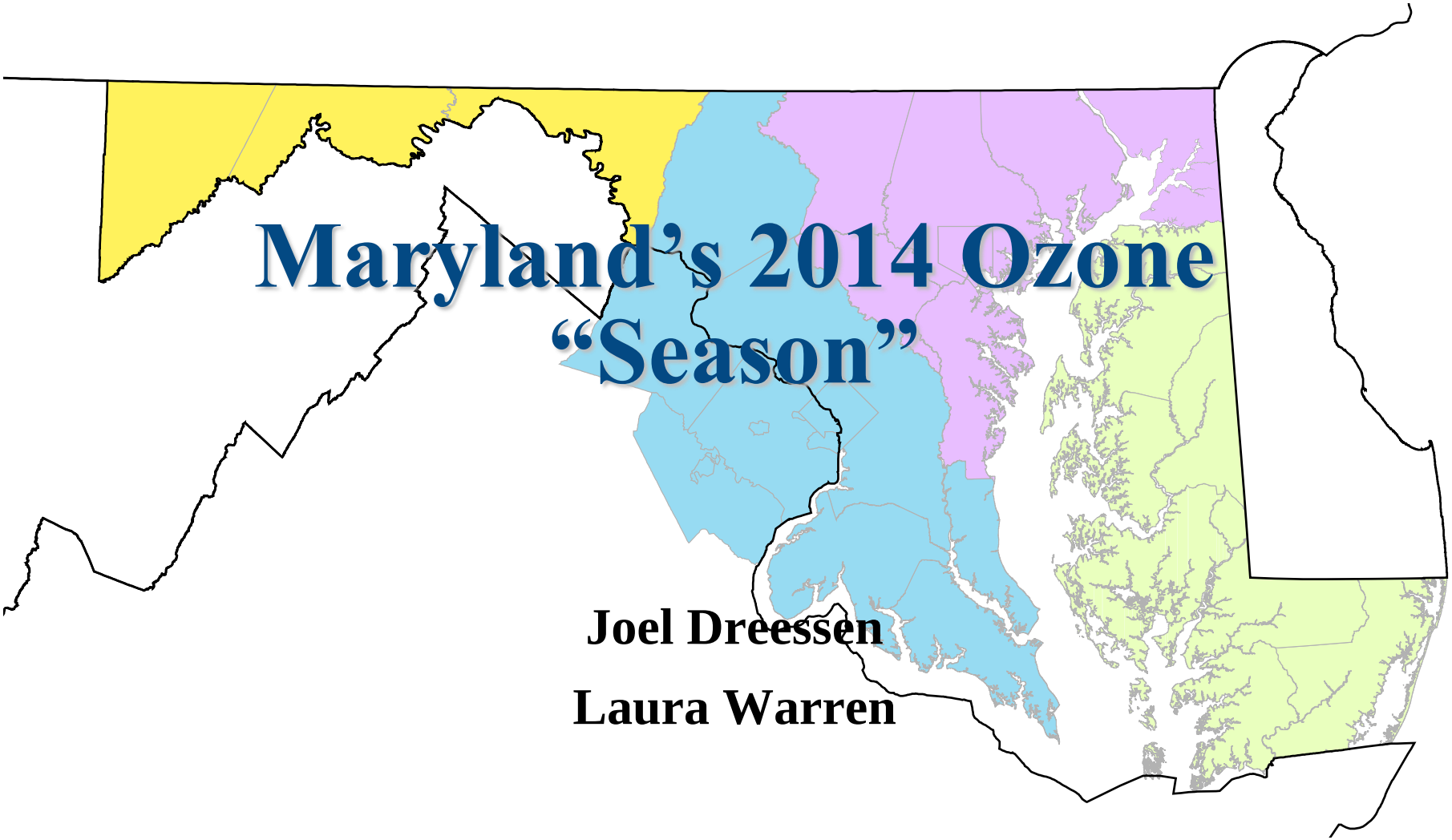
MARYLAND
DEPARTMENT OF THE ENVIRONMENT



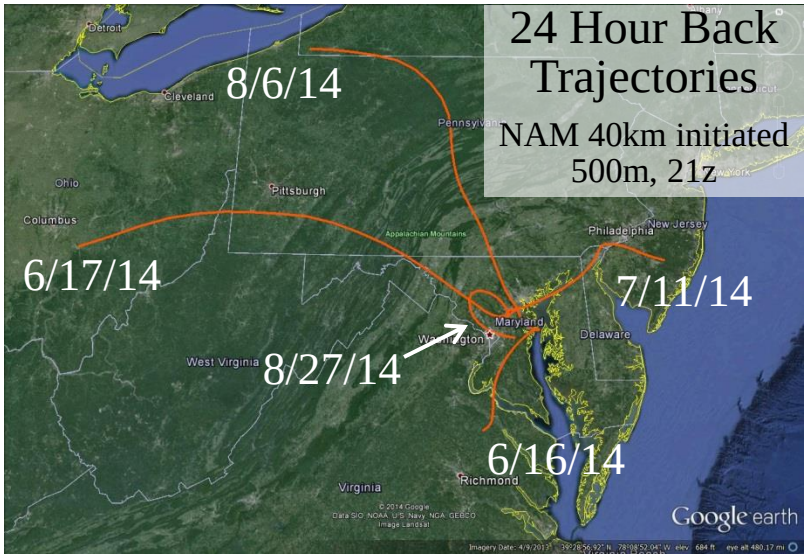
Maryland's 2014 Ozone "Season"

Joel Dreessen

Laura Warren

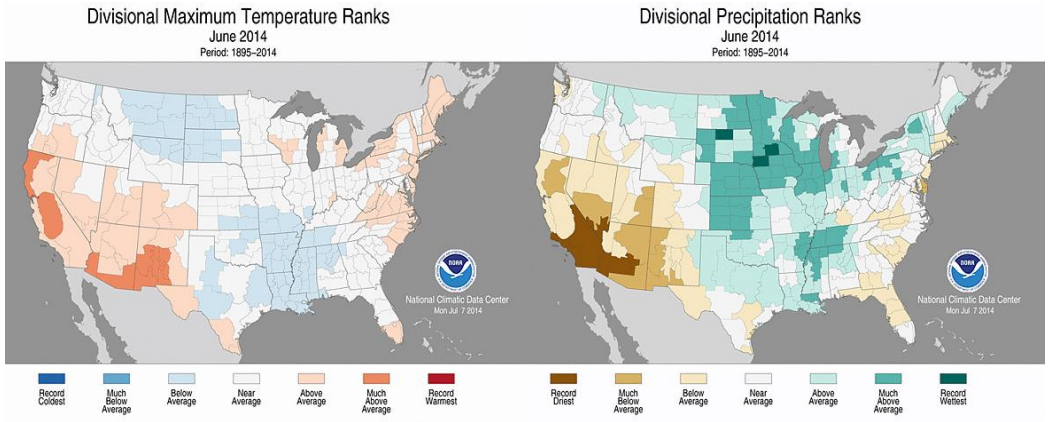
Ozone Season Summary

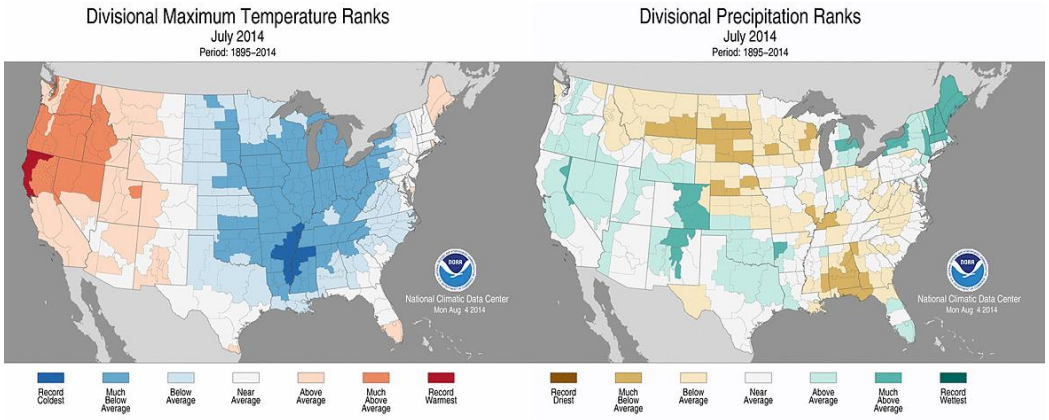
Date	Daily Max 8-Hr Ozone	MD Monitors > 75 ppb	Region
6/16/14	81 ppb	1	Metro Baltimore
6/17/14	80 ppb	1	Metro Baltimore
7/11/14	79 ppb	3	Metro Baltimore
8/6/14	77 ppb	1	Metro Washington
8/27/14	85 ppb	4	Metro Baltimore & Washington



- 5 Maryland exceedance days, > 75 ppb 8-hour daily max
  - All Code Orange days, or Unhealthy for Sensitive Groups (USG)
  - Highest day on August 27th at 85 ppb
  - Cleanest Maryland ozone season on record
    - 2013 was the next cleanest season on record with 9 exceedance days
  - Forecast 4 Air Quality Alerts
    - 6/17/14, 8/4/14, 8/5/14, 8/27/14

Meteorological Trends

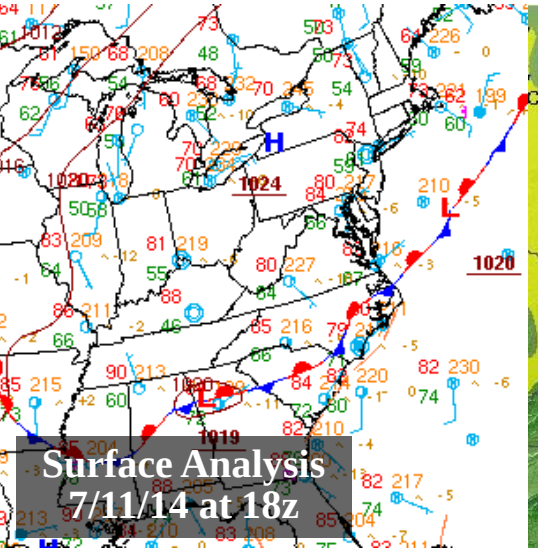


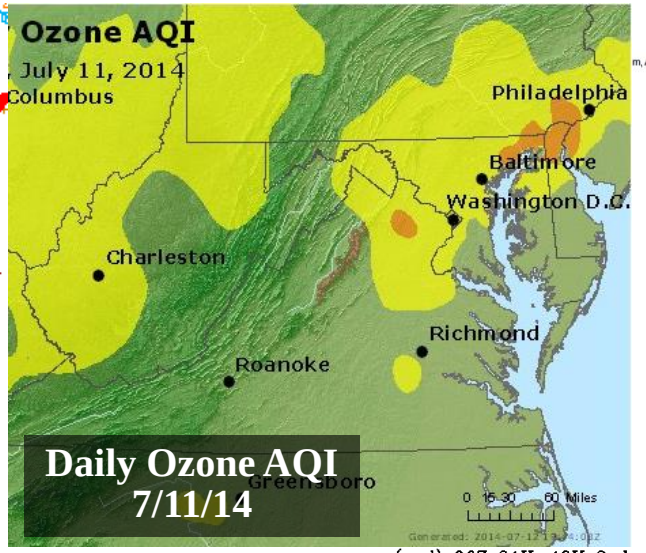


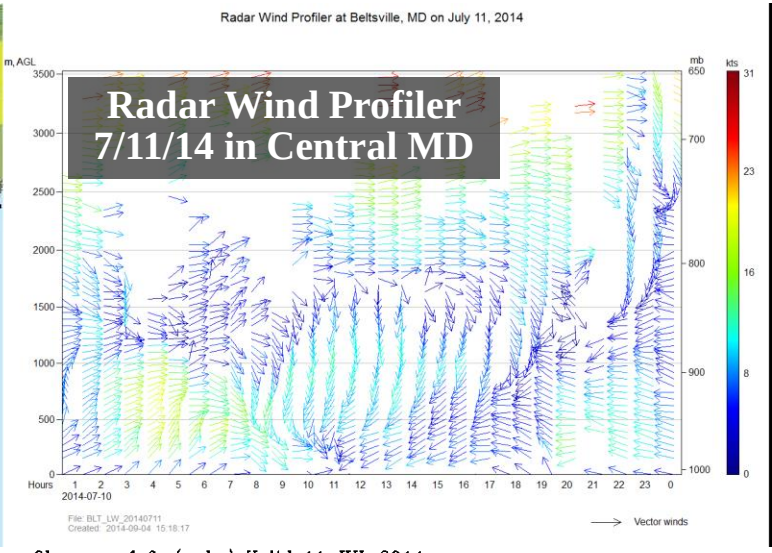
- At BWI, only 12 days* at or above 90˚F
  - Above average June precip in the central US
  - Below average July temperatures, especially in the central US
  - Winds seemed to be more often southerly to southeasterly similar to 2013

*As of 9/3/14, Source: NCDC

Case Study: July 11, 2014

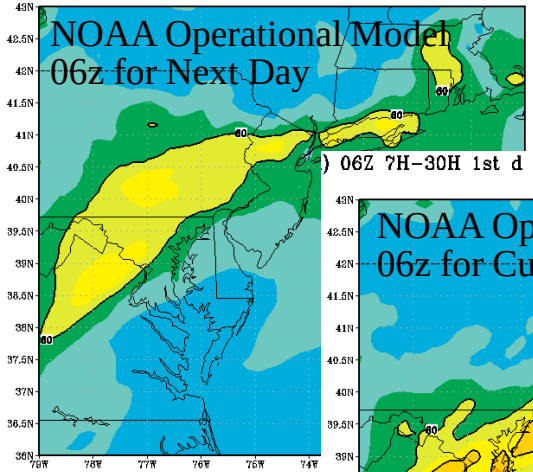




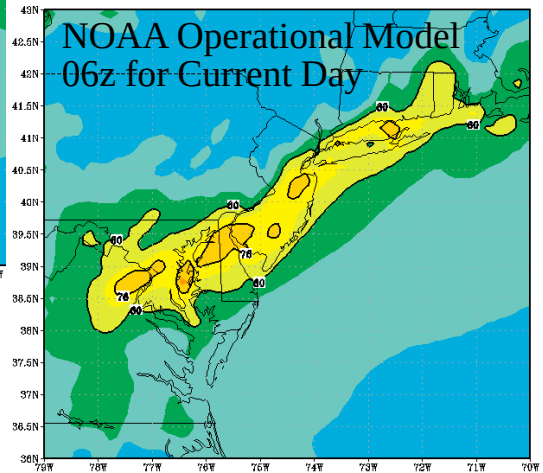


(prd) 06Z 31H-48H 2 day 8h max sf O_3 (ppbv) Valid 11 JUL 2014

- Ozone Conditions:
  - 3 MD monitors exceeded
  - 79 ppb 8-hour max at Fair Hill in NE MD
- Meteorology:
  - Reverse corridor flow
  - Surface high pressure centered to NW
  - Surface temperatures 86°F at BWI but ~ 90°F at PHL
- 06z NOAA operational model
  - No Orange in next day predictions, but some Orange on the current day

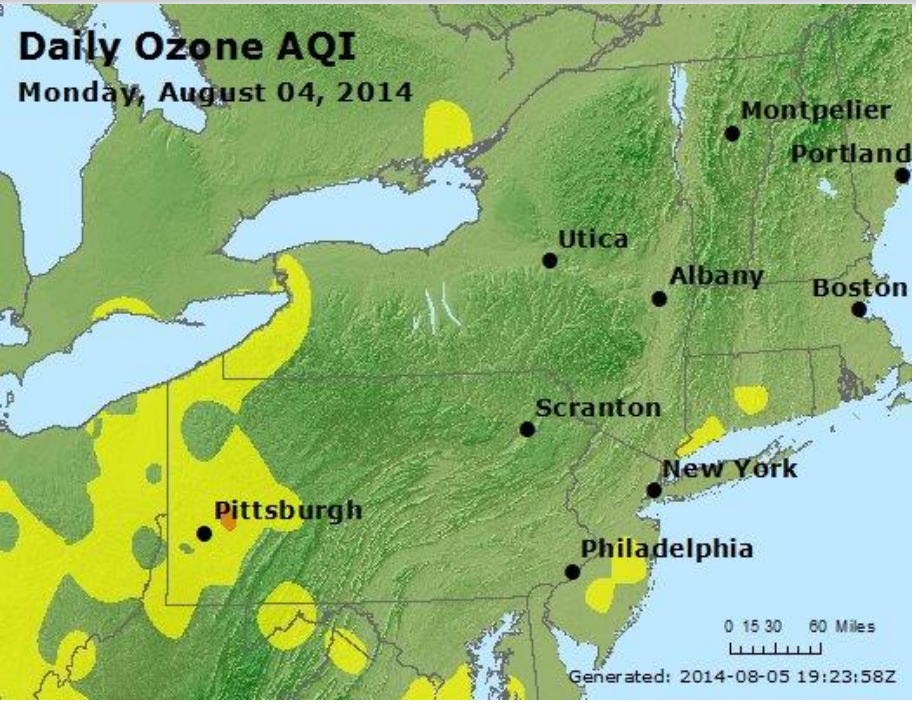


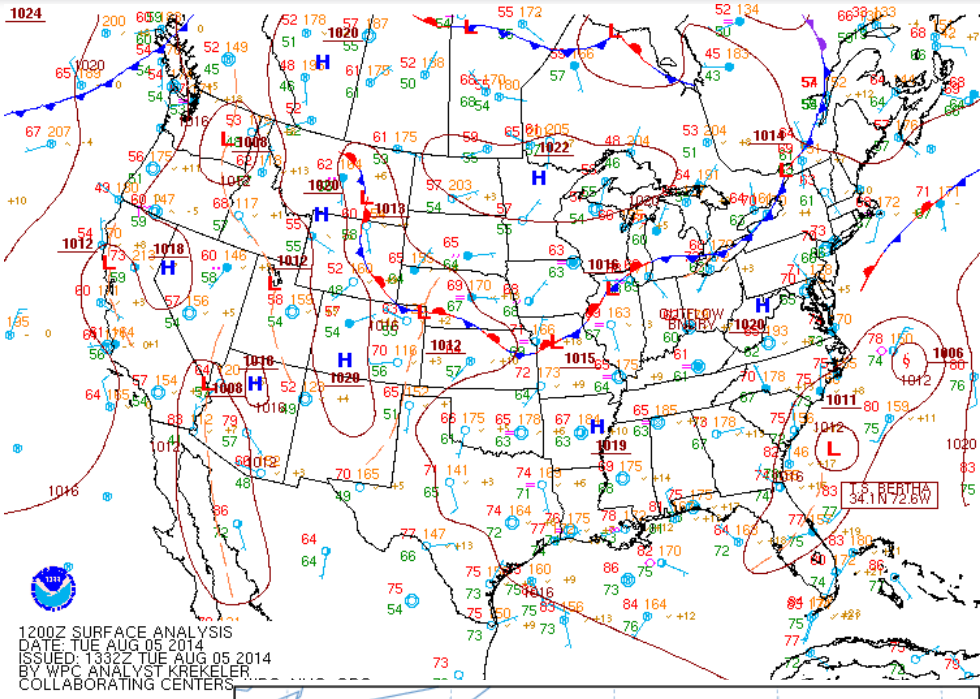
) 06Z 7H-30H 1st d 8h max sf O_3 (ppbv) Valid 11 JUL 2014

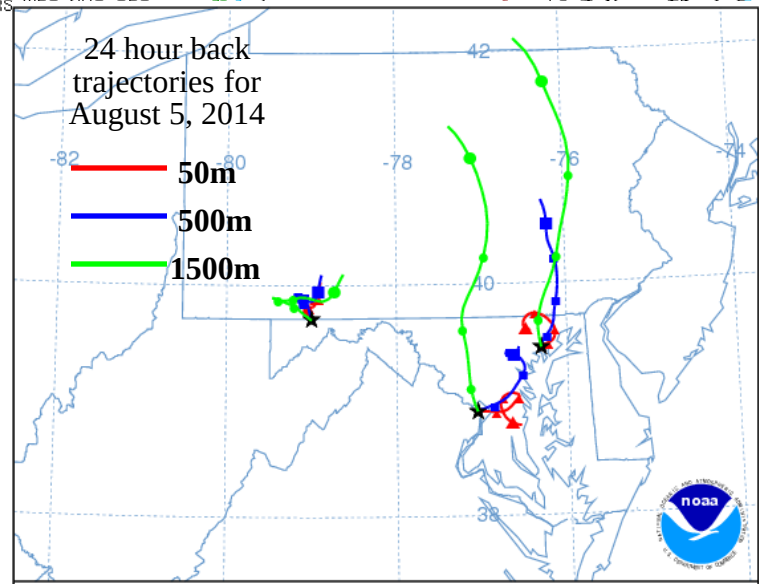


Source: AirNow, WPC, NAQFC

Case Study: August 4-6, 2014



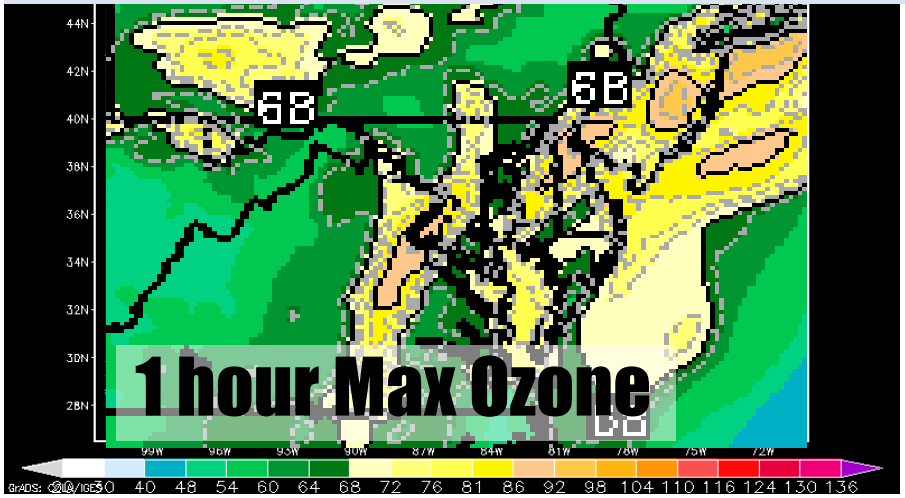


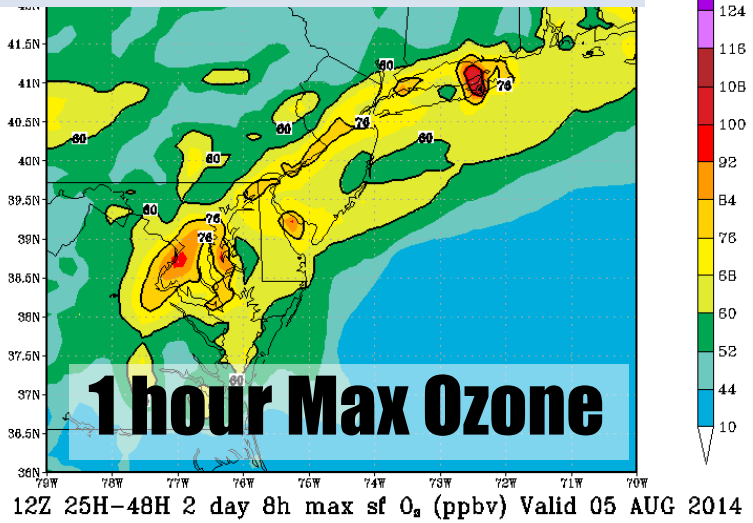


- High pressure over West Virginia and western Maryland created stagnant winds
- Surface temperatures were mid to upper 80s
- Monday August 4: transition day from lower 40s ppb on Sunday with clean northerly flow to threshold USG day for DC (71ppb)
- Tuesday, August 5 was thought to be a "slam dunk" USG forecast with temperatures ~90°F

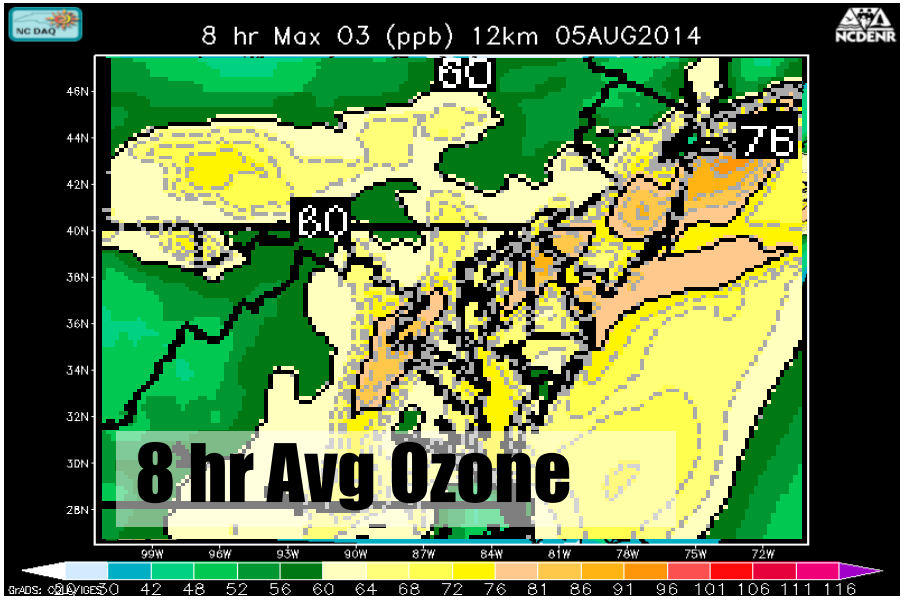
Case Study: August 4-6, 2014

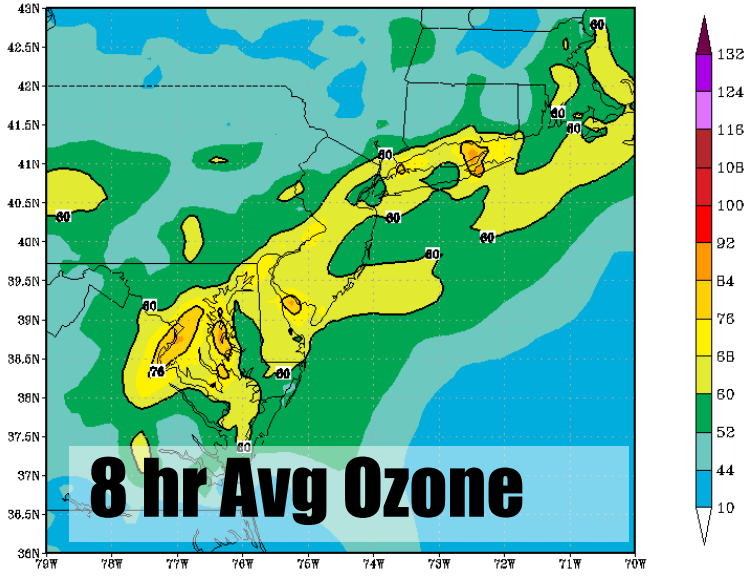
Day 2 Forecast for August 5





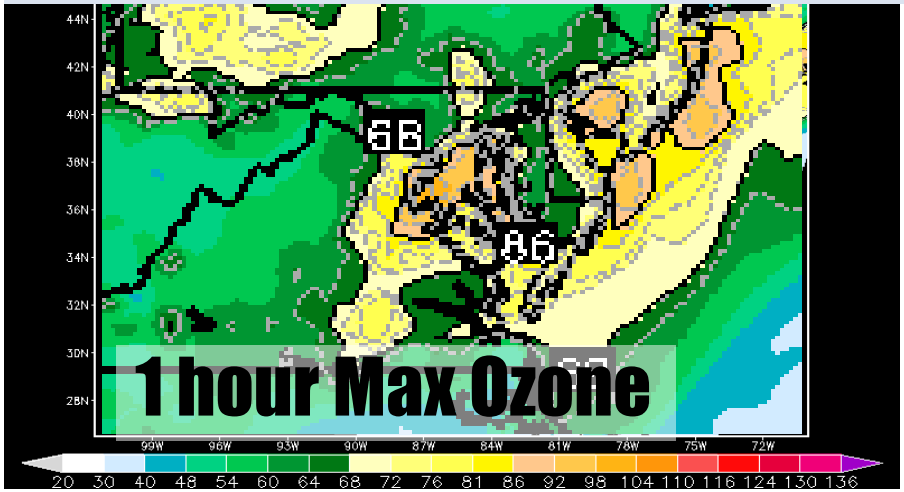
(prd) 12Z 25H-48H 2 day 8h max sf O_3 (ppbv) Valid 05 AUG 2014

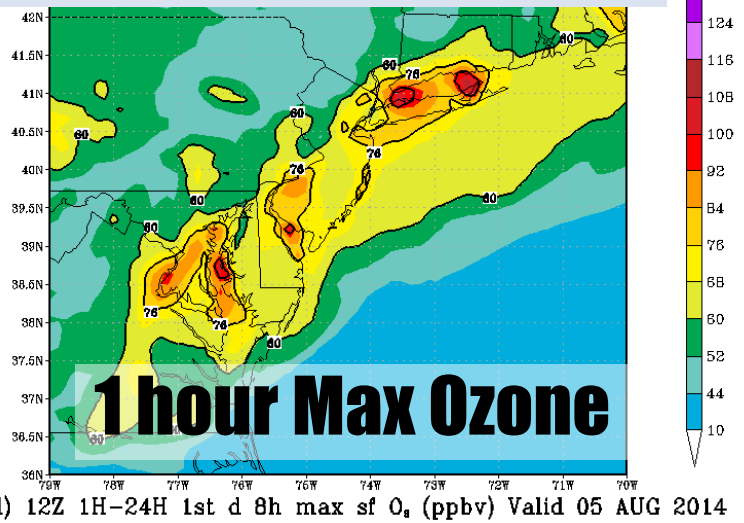


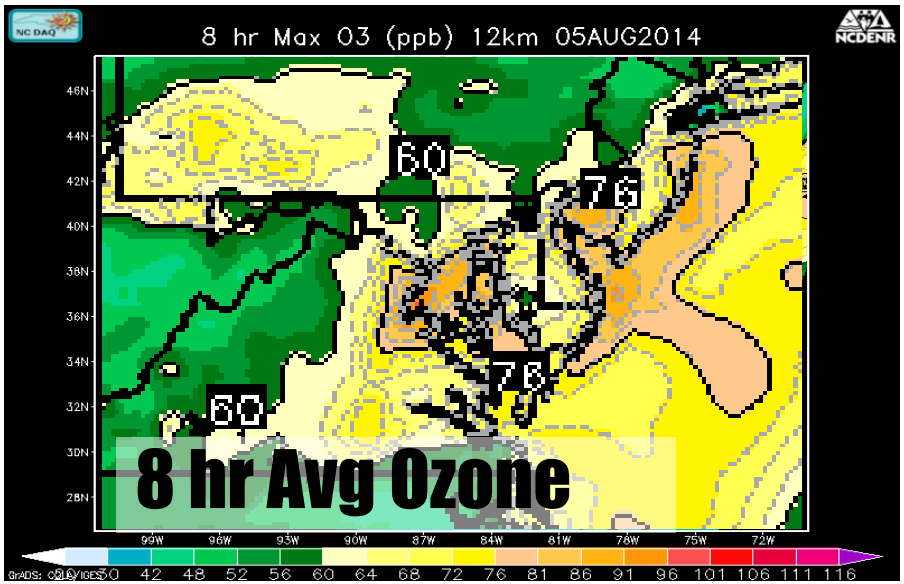


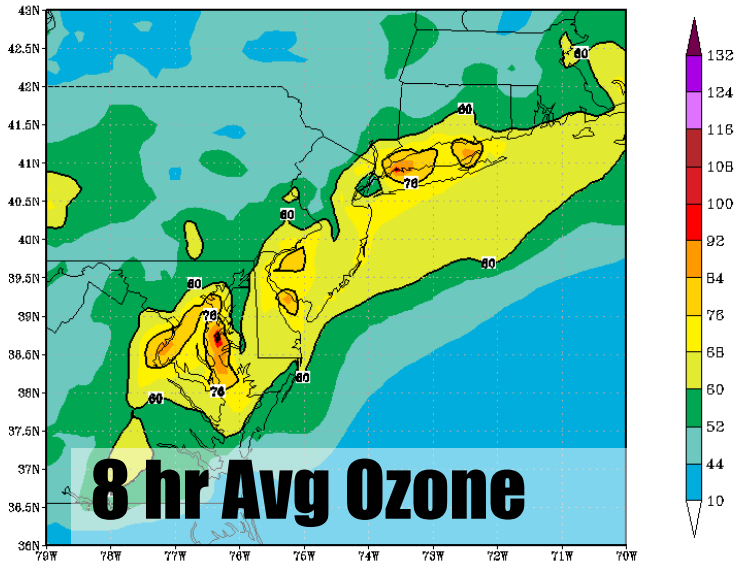
Case Study: August 4-6, 2014

Day 1 Forecast for August 5

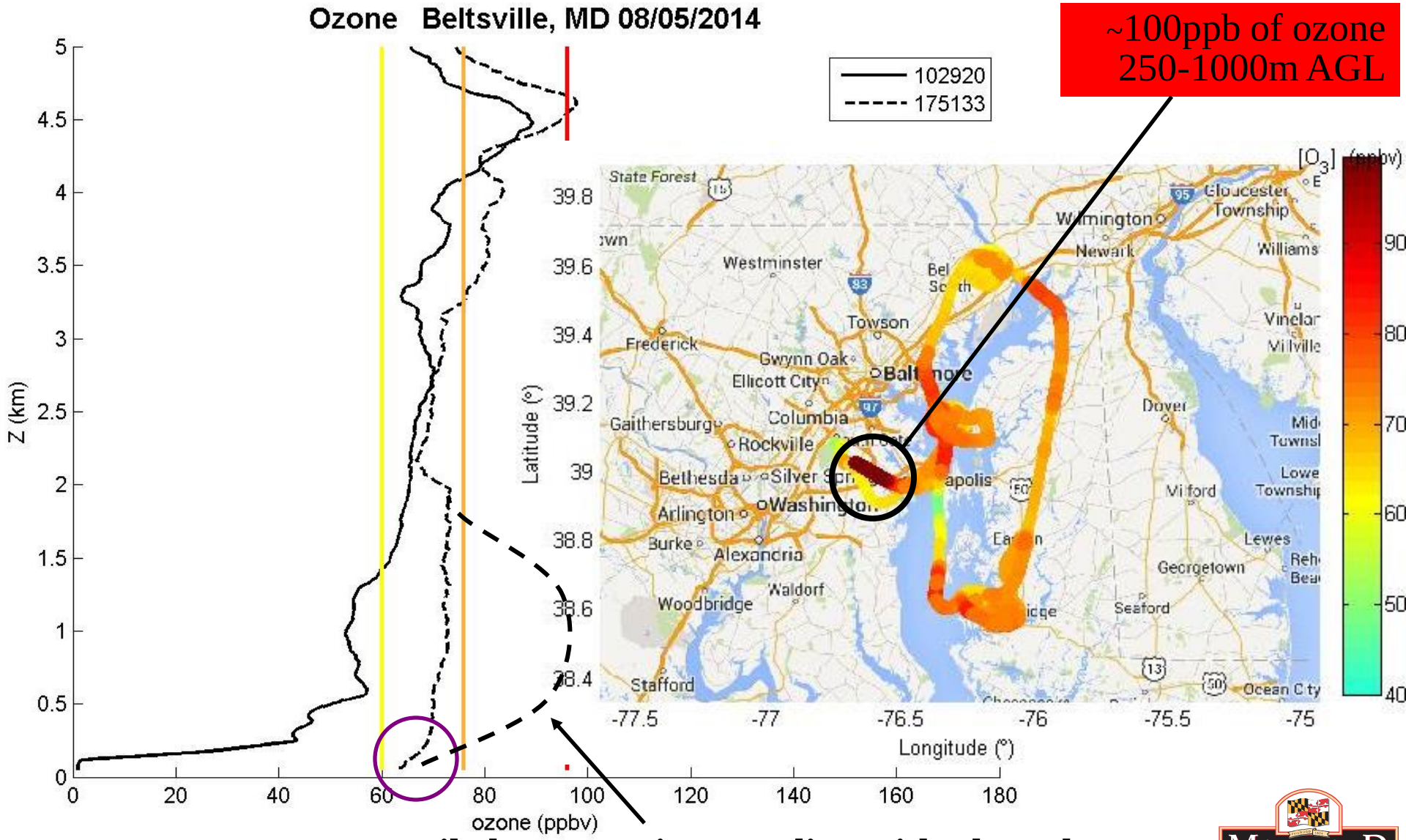




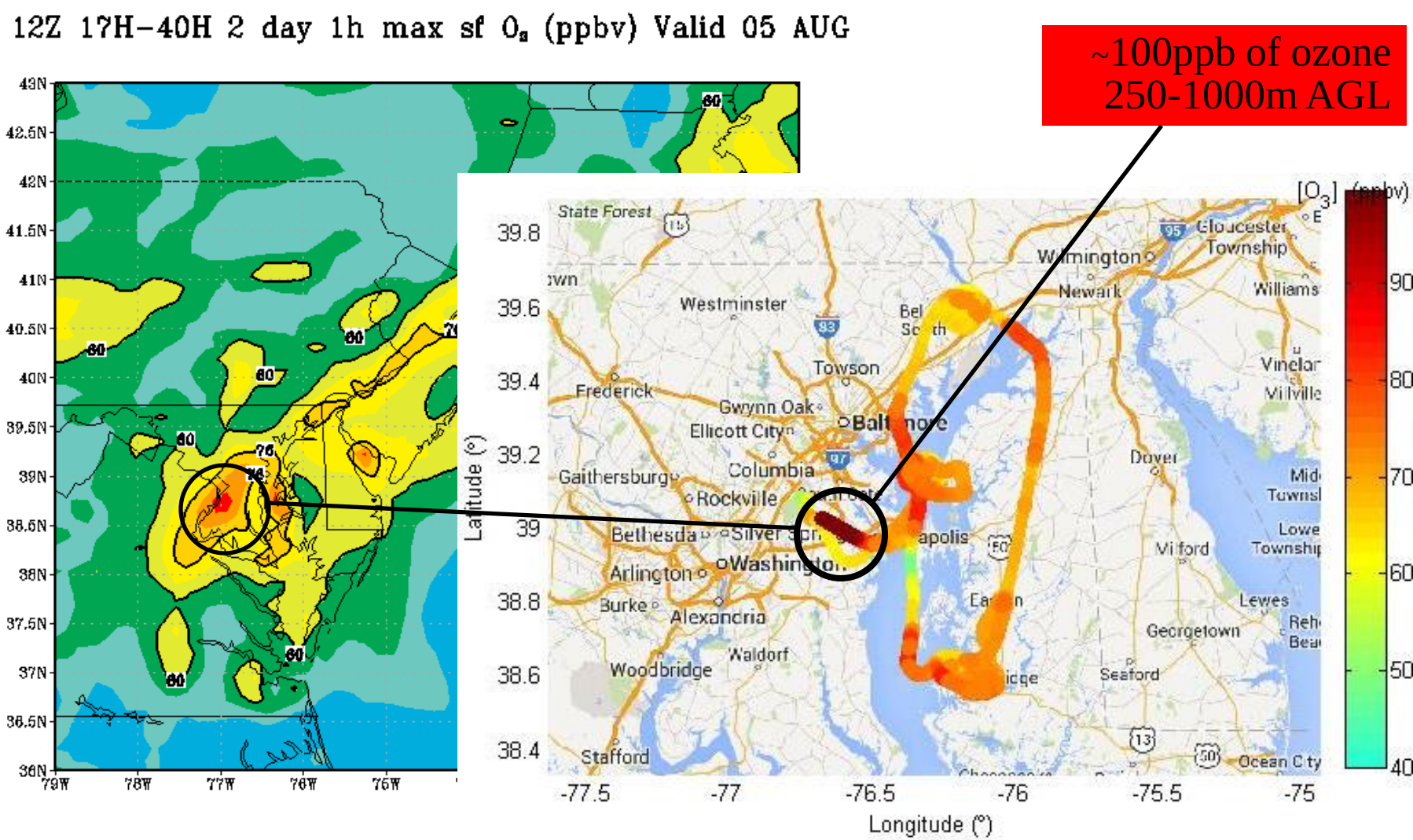




Case Study: August 4-6, 2014



Case Study: August 4-6, 2014



Model surface ozone forecast was excessive but seems correct when applied to the aloft ozone plume

Summary: August 4-6, 2014

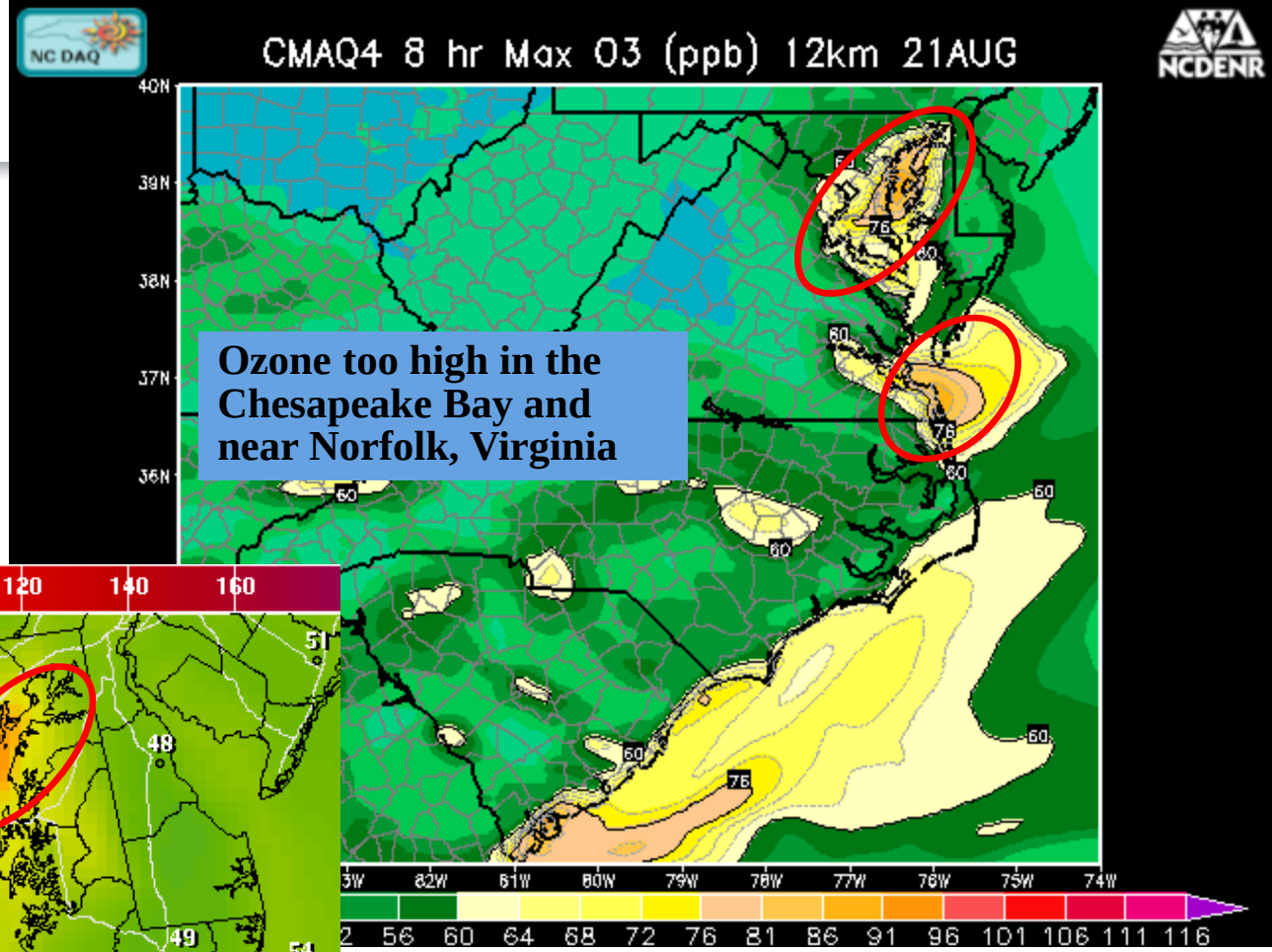
- Monday, August 4
  - **84°**F High Temperature; 2.8mph average wind speed
  - 71ppb 8-hr max ozone (Model recovered a bit too fast in this forecast from previous day's mid 40s ppb ozone)
- Tuesday, August 5
  - **89°**F High Temperature; 1.8mph average wind speed
  - 72ppb 8-hr max surface ozone ***(But ~100ppb ozone observed just ~500m above surface sites observing 65-74ppb hourly ozone values)***
  - 6 to 13ppb greater ozone observed just 8m higher between two Beltsville sites!!!
- Wednesday, August 6
  - 77ppb 8-hr Max Ozone (Exceedance Day)
  - "Hole in Clouds" and convergence along cold front (Meteorology Issue)

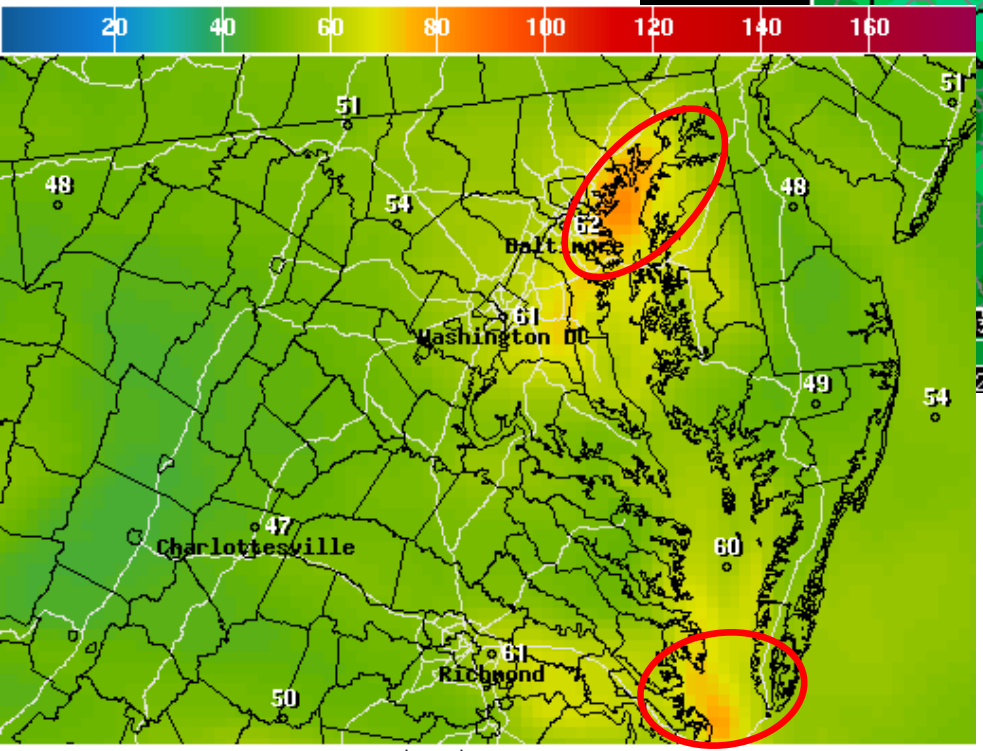
Why is there an over-prediction of the surface? Model "correct" but at the wrong height.

Localized: Nature of the game now; widespread exceedance rare in 2013/2014

MDE

Operational models tend to over predict surface ozone





Recent information obtained regarding marine emissions in the Bay areas could be causing over prediction of surface ozone, especially in light of lower than actual PBLH. <u>All boat emissions in the bay are ingested at level zero (0),</u> or on the ground in the off-the-shelf NEI. This would cause a spike in NOx at the surface and potentially lead to ozone overestimation.

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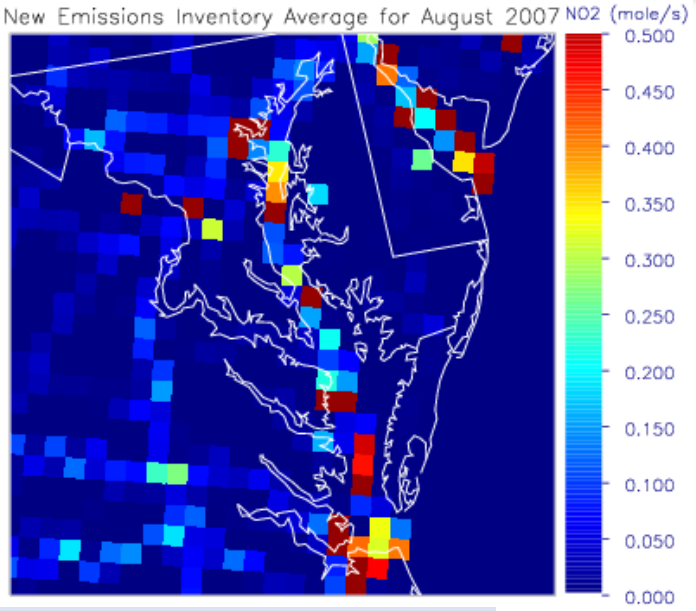
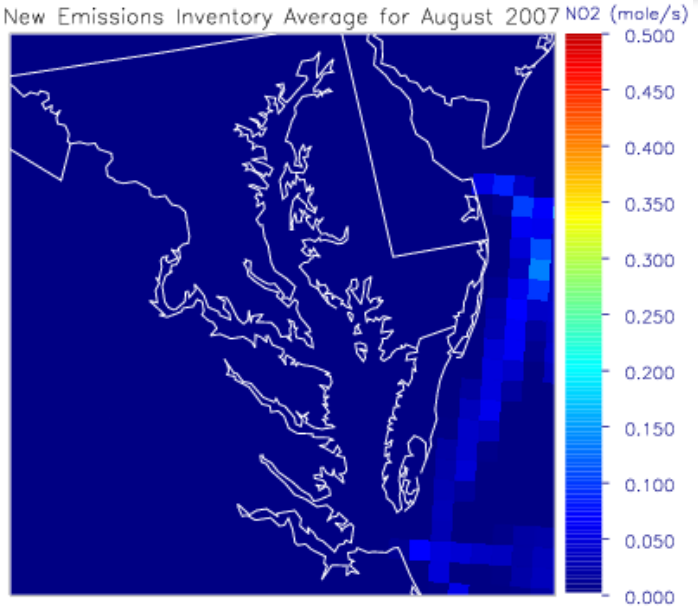
Ship Emissions: MARAMA 2007



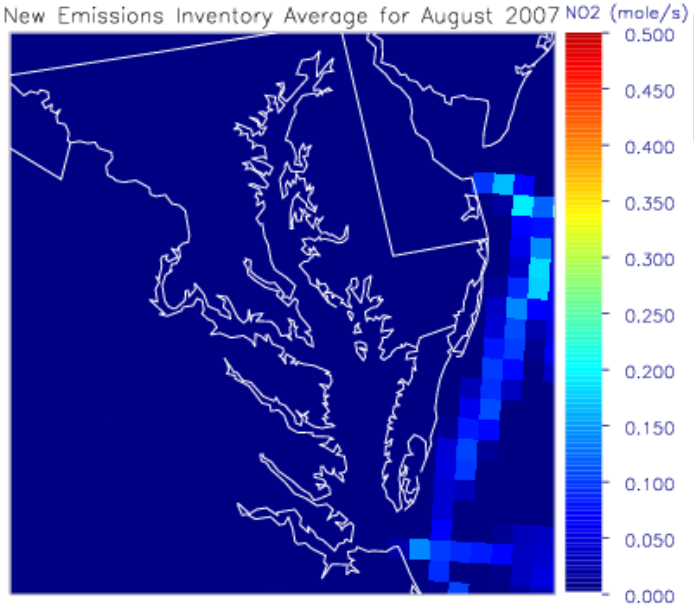
Level zero (0) emissions

NOx

Emissions



Non-level zero (0) emissions



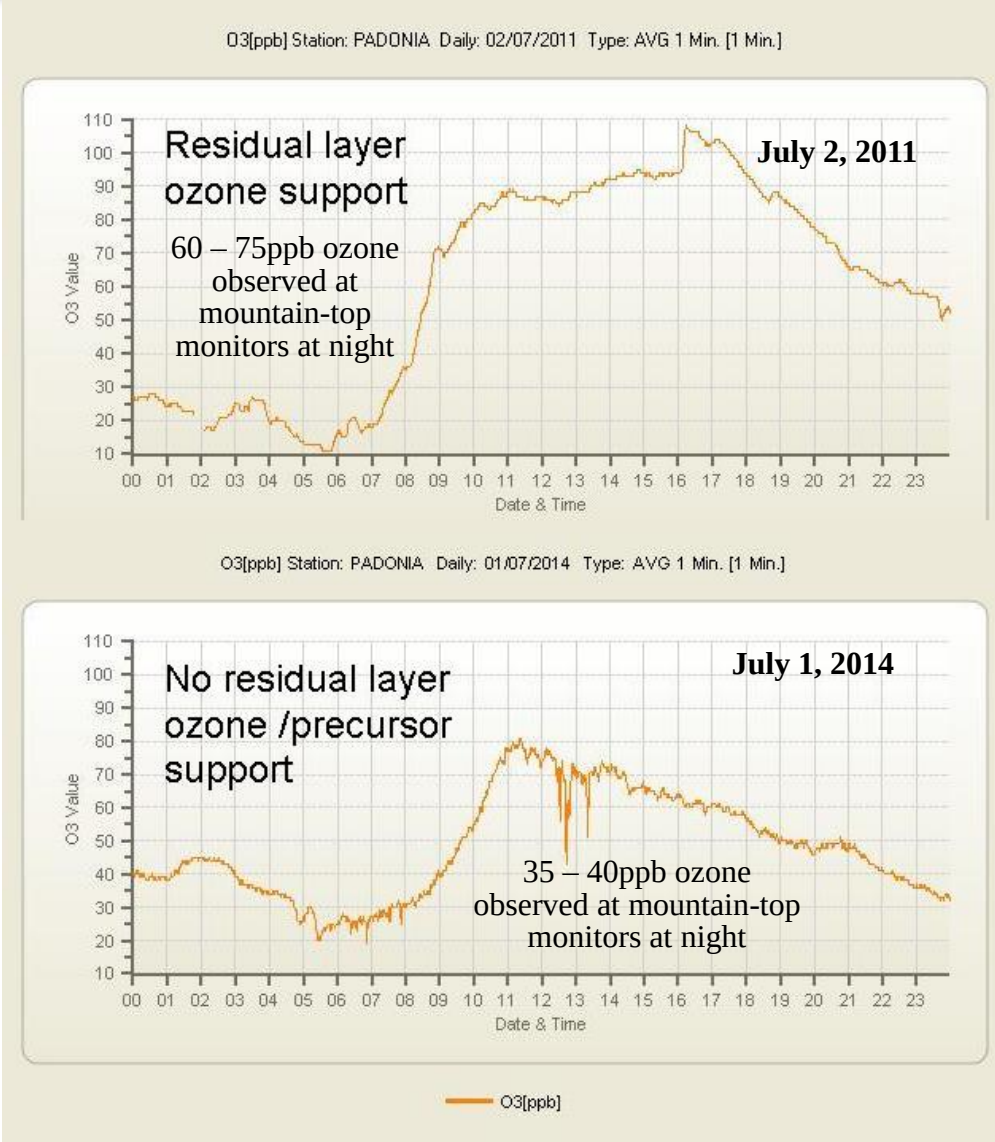
Is the emissions inventory correct?

Are ship/train/plane emissions processed correctly?

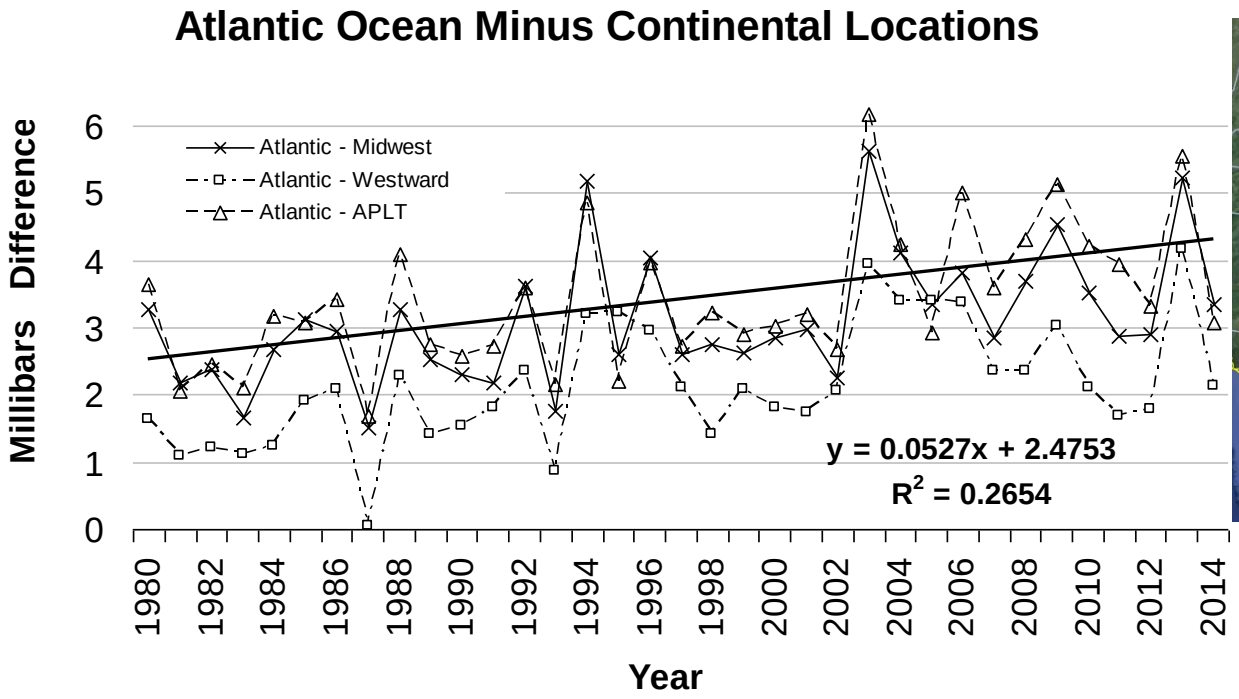
Source: University of Maryland

Ozone Trends

- Diurnal Profiles
  - Without the support of a dirty residual layer from upwind, daily ozone peaks around or just after noon and steadily decreases.
  - Not necessarily captured in model
- Localized vs Regional Exceedances
  - Most exceedances now (2013/2014) occur when localized plumes encounter a monitor
  - Regional exceedances are far less common without widespread poor transport

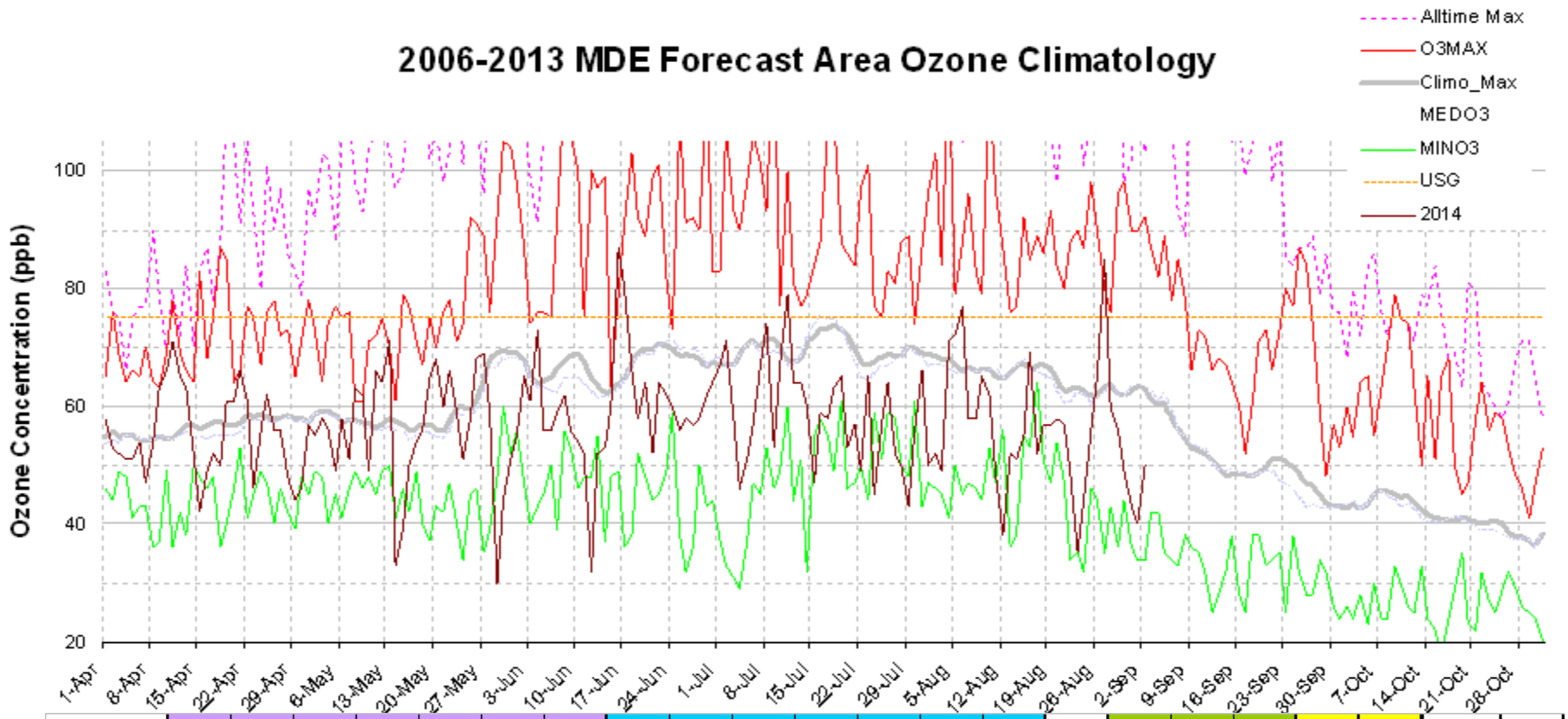


Ozone Trends: Bermuda High



- The pressure gradient between the Midwest and Atlantic(~35°N) has been steadily increasing since at least 1980.
  - South and southeast wind component has been steadily growing
  - Is there an implication on air quality trends in the future?

Appendix: MD Ozone Summary



As of Sept. 3*

	Aldino	Davidsonville	Edgewood	Essex	Furley ES, Baltimore	Padonia	So. Carroll	Calvert Cnty.	PG County Equest. Ctr.	Frederick County	HU-Beltsville	Beltsville (BEL116)*	Rockville	So. Maryland	Fair Hill	Blackwater NWR (BWR139) **	Millington	Horn Point	Hagerstown	Piney Run		
2013 Design Value	78	81	85	78	72	78	74	77	81	74	76	NA	74	77	82	NA	80	77	71	70		
06/16/2014						**81**															**81**	1
06/17/2014			**80**																		**80**	1
07/11/2014	76		**78**												**79**						**79**	3
08/06/2014														**77**							**77**	1
08/27/2014	**79**	**80**							**76**						**85**						**85**	4