OWLETS

Ozone Water-Land Environmental Transition Study

Overview of the 2017 OWLETS: Summary of Observations and Initial Results

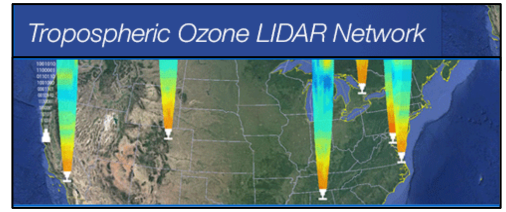
John Sullivan, (Co-I, ECF, NASA/GSFC), T. Berkoff (PI-NASA/LaRC), and extensive OWLETS team

5th Annual TOLNet/2018 NDACC LWG Meeting – UAH
8 May 2018

Additional Support

Ozone Water-Land Environmental Transition Study

LaRC Lidar team: Bill Carrion, Betsy Farris
GSFC Lidar team: Larry Twigg, Lance Nino
UAV/drone team: Eddie Adcock, Mark Motter, Ryan Hammit, Zak Johns, Ian Fenn, et al.
LaRC TEMPO student collaborators & volunteer: Lindsey Rodio, Jeremy Schroeder, Betsy Farris, Pablo Sanchez, Emily Gargulinski, Marlia Harnden
Chespeake Bay-Bridge Tunnel Authority: Ed Spencer, Tim Holloway
Hampton University: Bill Moore, student interns: Desorae Davis, Angela Atwater
GeoTASO team: Scott Janz, Jay Al-Saddi, Matt Kowalewski, Laura Judd
SERC/GSFC Research Vessel Team: Maria Tzortziou, Ryan Stauffer, Owen Parker, Julio Roman, Lena Shalaby, Cpt Mike Goodison, Belay Demoz
SARP/Sherpa team: Sally Pusede, Glenn Wolfe, James Flynn, Jessica Munyan, Thomas F Hanisco, Don Blake, Brenna Biggs, Reem Hannun, WFF Pilots and Crew
PANDORA team: Bob Swap, Maria Tzortiou, Nader Abuhassan, Alexander Cede, Si-Chee Tsay, Jay Herman,
GSFC AERONET team: Brent Holben et al.
LaRC Website and archive: Gao Chen, Ali Aknan
VA DEQ: Dan Salkovitz, Kristen Stumpf, Brian King, John Brandt, Chuck Turner
MDE: Joel Dreessen
Virginia Living Museum: Dan Summers
EPA: James Szykman



Background/Motivation

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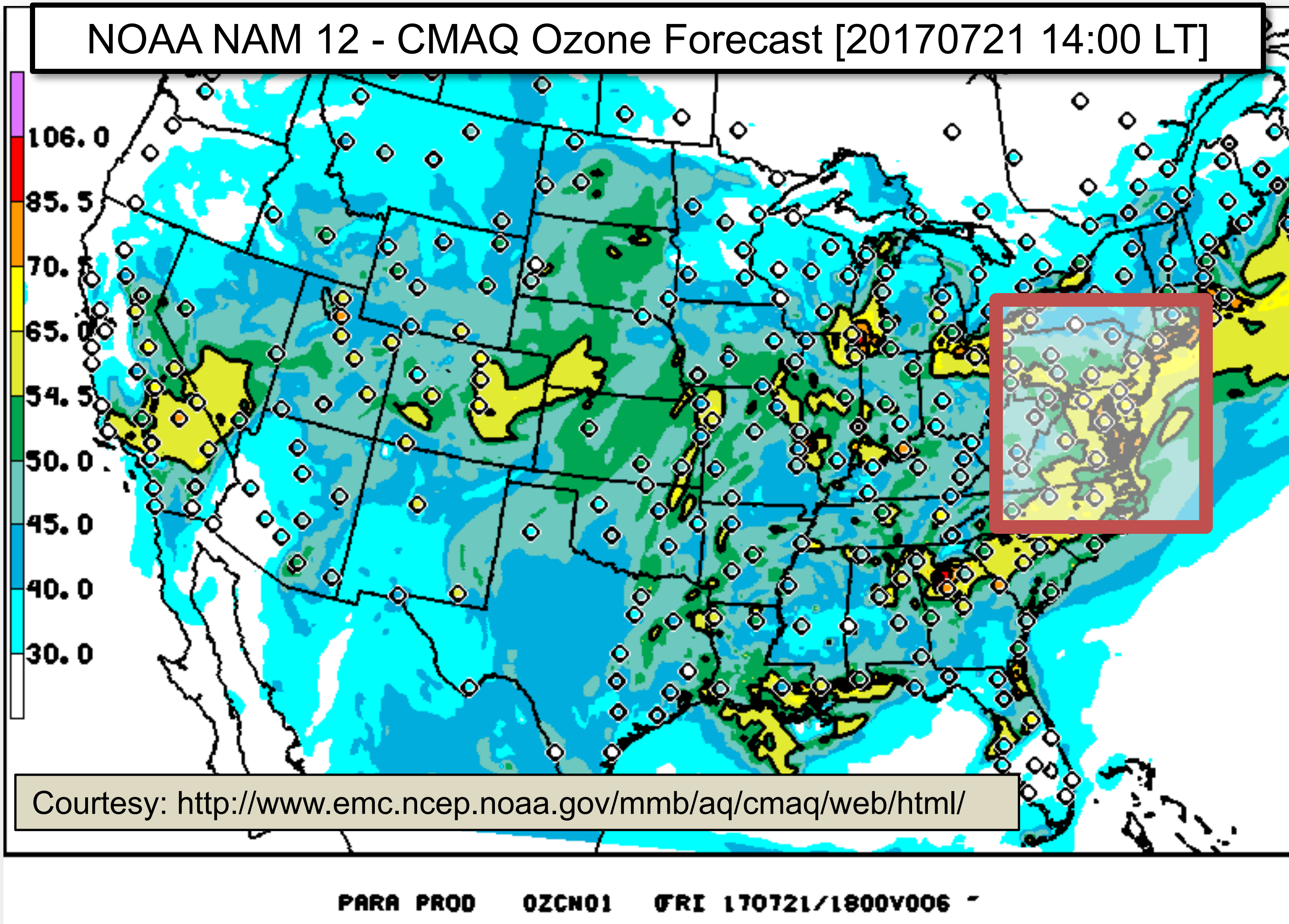
Ozone Water-Land Environmental Transition Study



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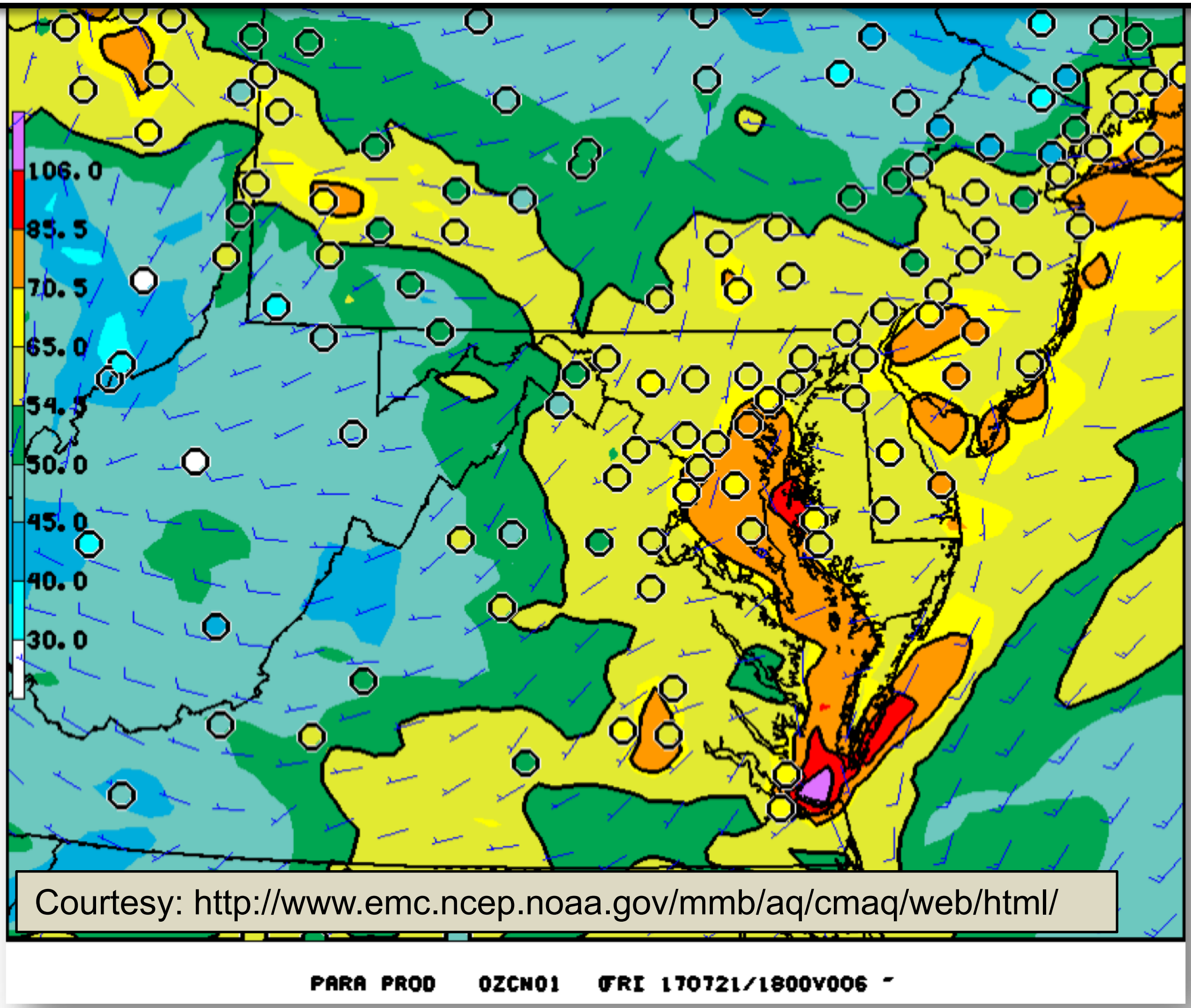
NOAA NAM 12 - CMAQ Ozone Forecast [20170721 14:00 LT]



Courtesy: http://www.emc.ncep.noaa.gov/mmb/aq/cmaq/web/html/

Background/Motivation

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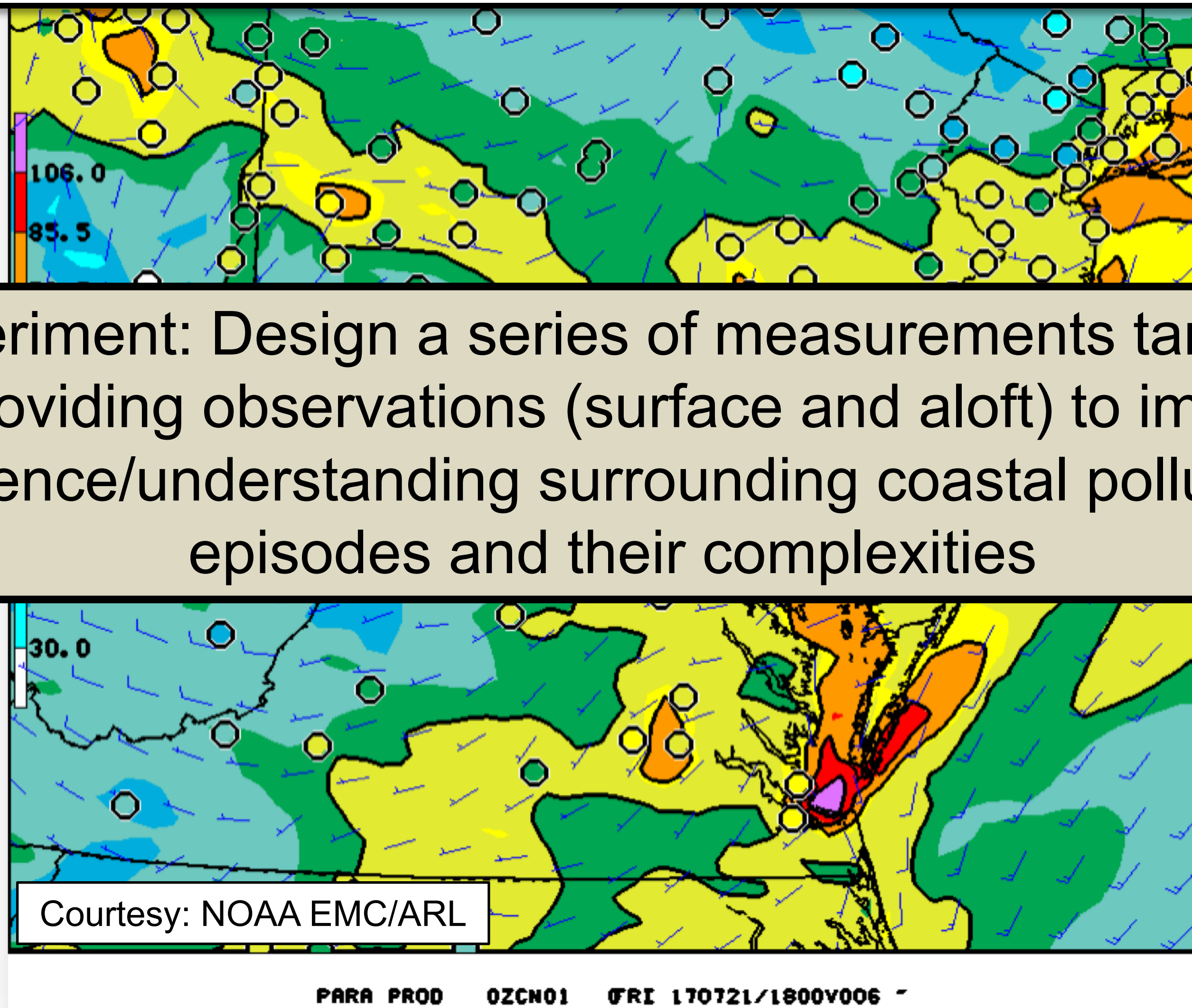
Environmental **T**ransition **S**tudy

NOAA NAM 12 - CMAQ Ozone Forecast [20170721 14:00 LT]



Experiment: Design a series of measurements targeted at providing observations (surface and aloft) to improve science/understanding surrounding coastal pollution episodes and their complexities

MODIS 08/01/2017

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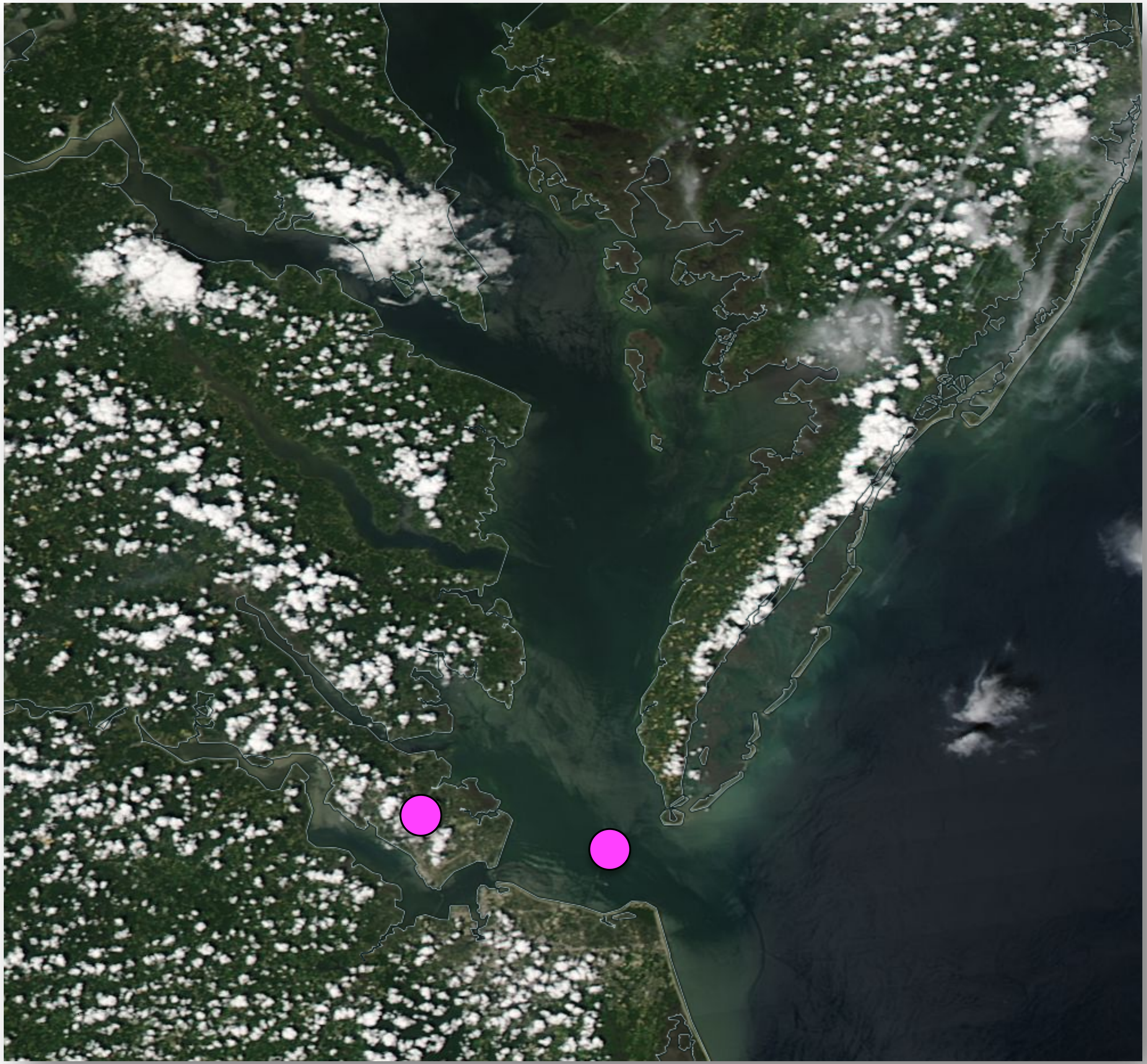
What causes ozone gradients near coastal transitions?

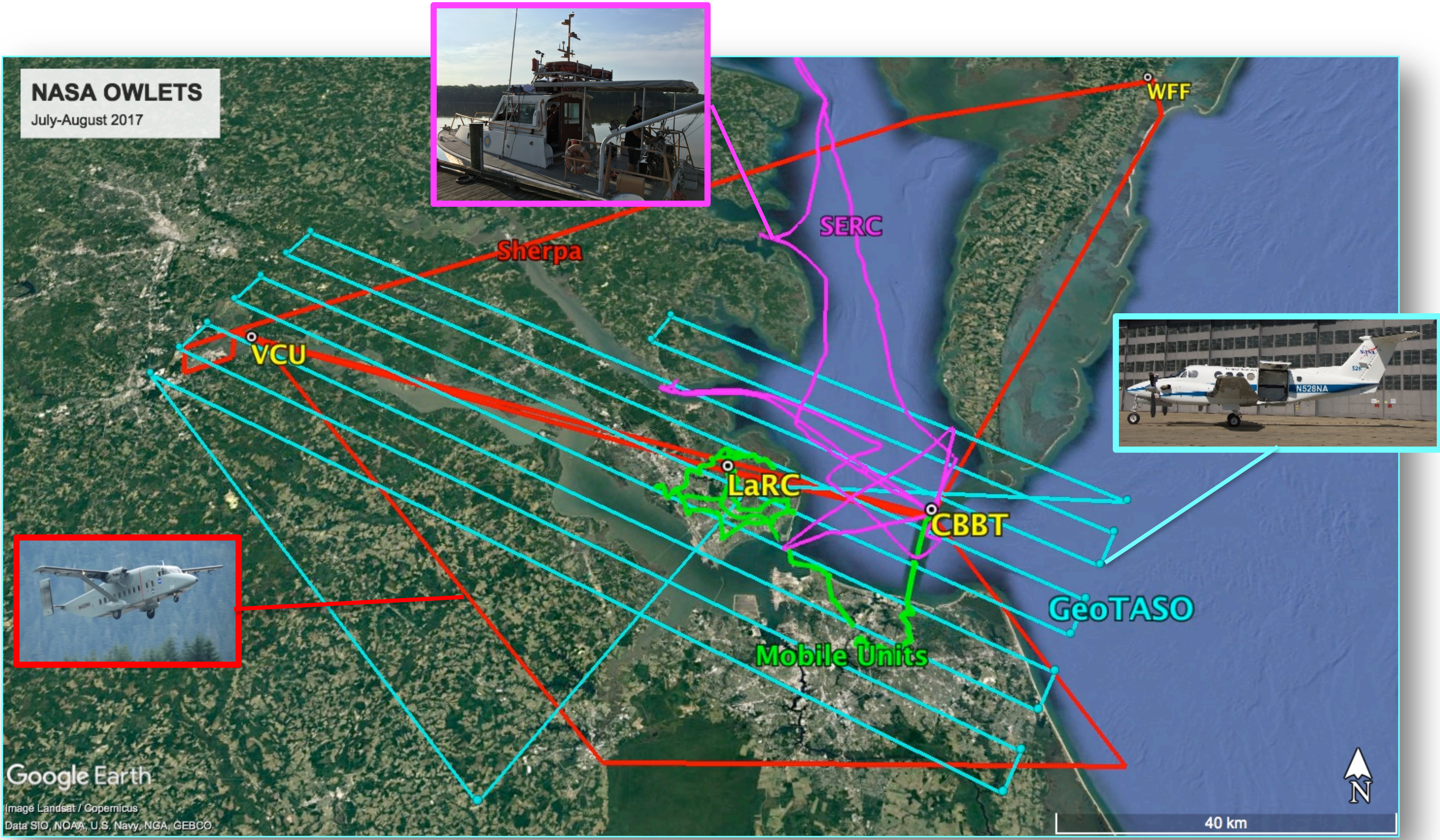
Differences in

- Cloud coverage
- Convective boundary layer depth
- Deposition velocity
- Emissions



Sampling Strategy

Ozone Water-Land Environmental Transition Study



12 days of measurements from July 7 to Aug 2, 2017

Measurement Table

Ozone Water-Land Environmental Transition Study

Instrument	Product	Reference	Site(s)/Platform
● **GSFC O_3 Lidar (TROPOZ)**	Tropospheric O_3 profiles	Sullivan *et al.*, 2014	LaRC
● **LaRC O_3 Lidar (LMOL)**	Tropospheric O_3 profiles	De Young *et al.*, 2017	CBBT
Ozonesondes	Profiles of O_3, RH, T, Wind	Thompson *et al*, 2015	CBBT, LaRC
Pandora Spectrometer	NO_2 and O_3 Total Column	https://gsfc.nasa.gov/Projects/Pandora/index.html	CBBT, LaRC, VCU, SERC-RV, WFF
AERONET Photometer	Aerosol Optical Properties	https://aeronet.gsfc.nasa.gov	LaRC, CBBT, Hampton U.
Micropulse Lidar	Aerosol Backscatter Profiles	Berkoff *et al.*, 2004	Hampton U.
GeoTASO	NO_2 slant/total columns	Nowlan *et al.*, 2016	NASA UC-12
Airborne In Situ Payload	CO_2, H_2O, CH_4	Wolfe *et al.*, 2017	NASA C-23 Sherpa
	HCHO	St. Clair *et al.*, 2017	
	NO_2, NO, O_3	Pollack et al., 2010; Ridley and Grahek, 1990; FEM Designation EQOA-0410-190.	
	CO, N_2O,		
	VOC		
● **Personal O_3 Monitor (POM)**	O_3	http://www.twobtech.com/	Mobile Units, UAV
Ceilometer (CL-51)	Aerosol Backscatter Profiles	http://www.vaisala.fi	CBBT, LaRC, VCU, SERC-RV
Hampton Roads/Richmond Regulatory Static Monitors	O_3, SO_2, CO, NO_2, *O_3	http://www.deq.virginia.gov *research analyzers provided by NASA	LaRC, Shirley Plantation,
	*O_3, *NO_2		CBBT, SERC-RV, VLM, TRO
	CO, SO_2, NO_2		Norfolk
	O_3		Tidewater, Suffolk, Hanover, Beach Rd
	O_3, SO_2, CO, PM		Richmond (Math &Sci. Center)

● Supported by NASA 2017 Science Innovation Fund Award

Measurement Groups

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Ridley

NASA C-23 Sherpa

and Grahek 1990:

Balloon-borne Sampling

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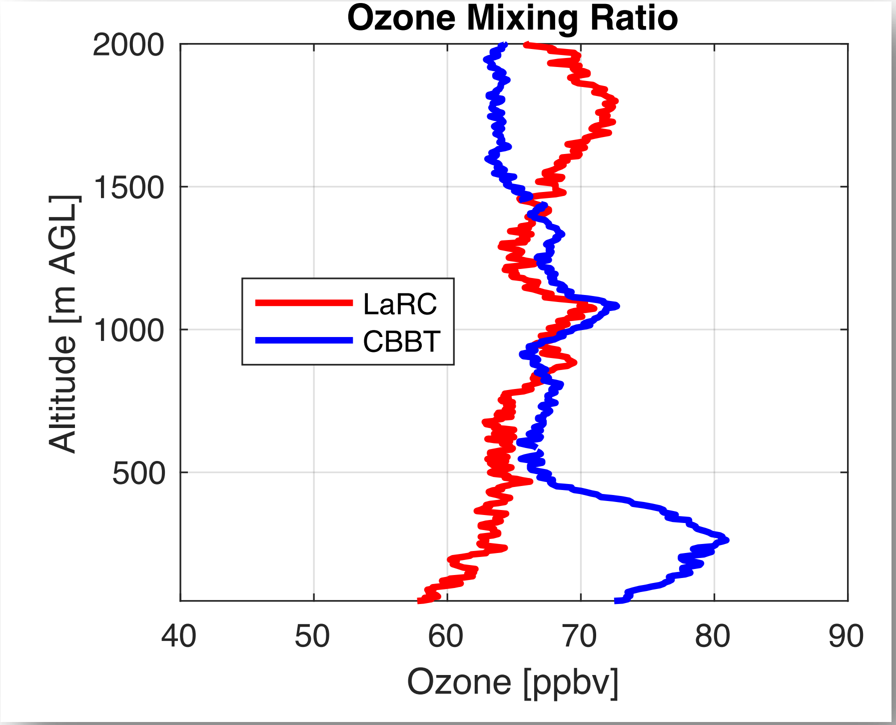
18 launches at each site, mostly within 30 minutes of each other
Below: Example for 20 June ~11:30 am



UAV Sampling

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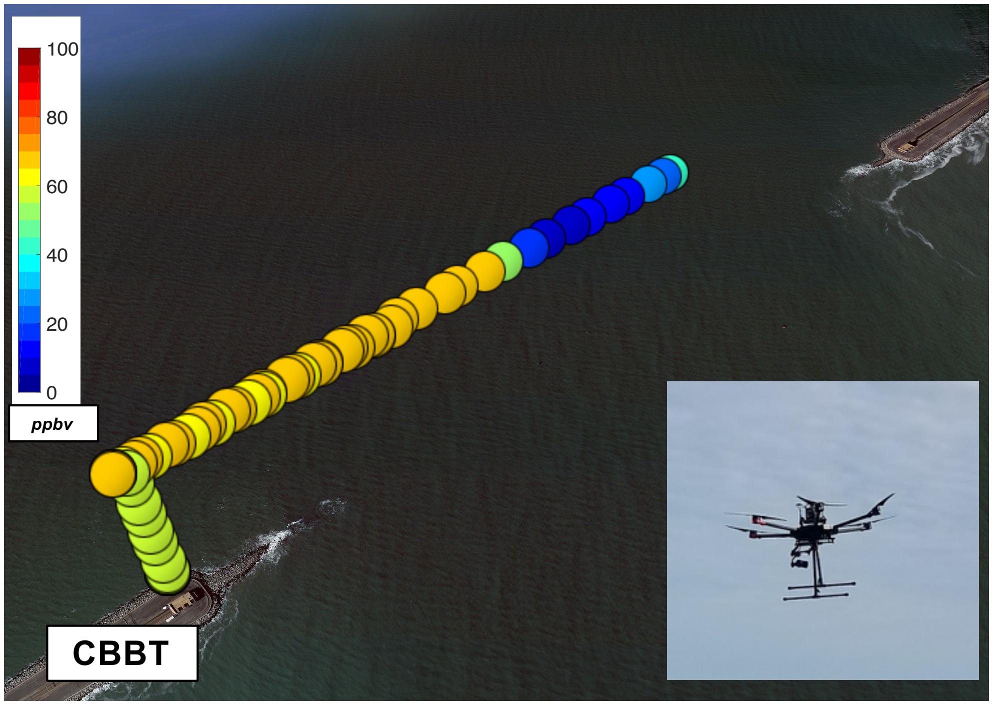
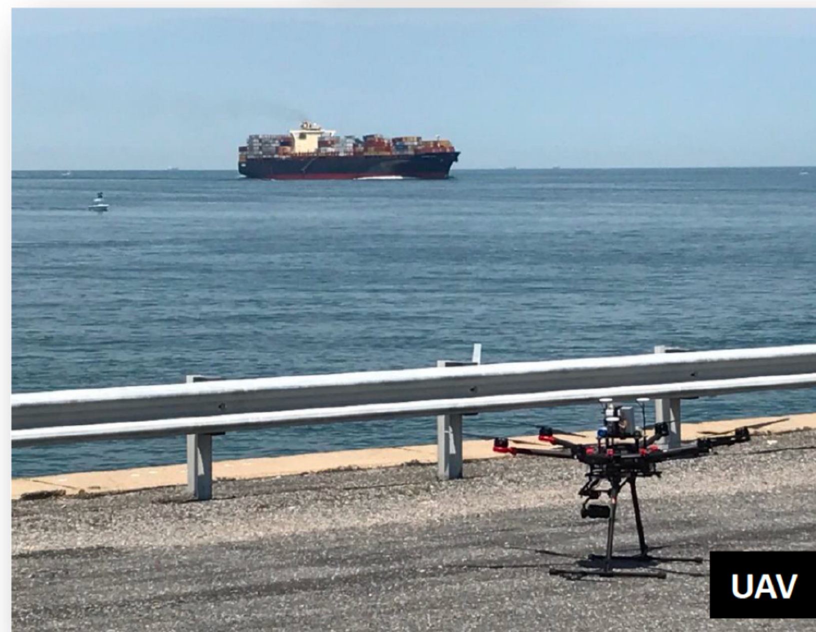
POM O_3 UAV Platform [01 Aug 2017 12:53-13:03 LT]



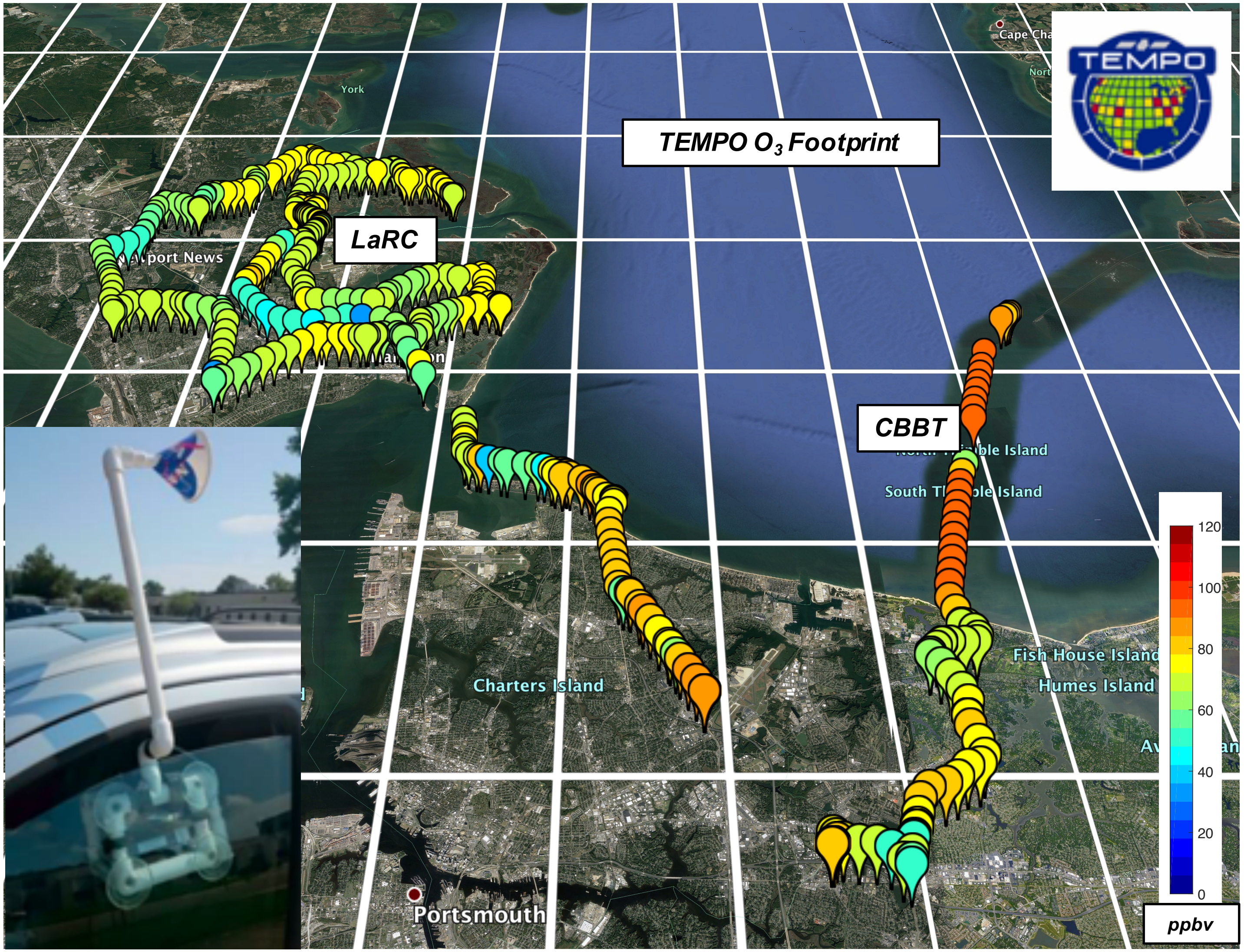


Science quality measurements for analyses and near-field lidar validation on UAV platform

Mobile Sampling

<u>O</u>zone <u>W</u>ater-<u>L</u>and <u>E</u>nvironmental <u>T</u>ransition <u>S</u>tudy

POM O_3 Mobile Platform [21 Jul 2017 13:20-16:45 LT]



Research Vessel Sampling

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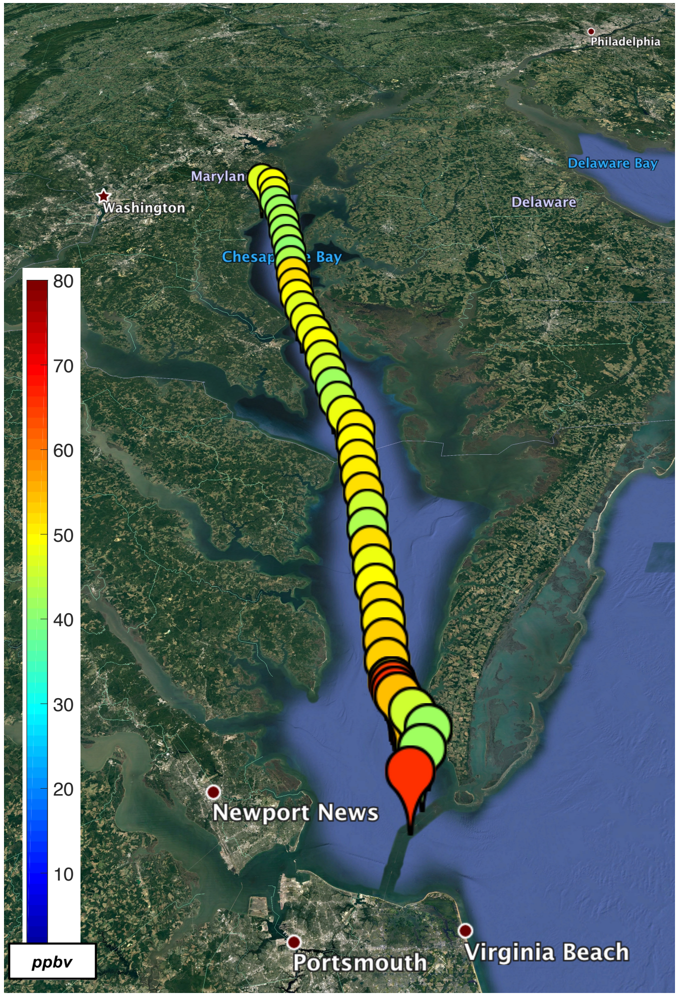
R/V SERC O_3 [17 July 2017 09:45-15:35 LT]



In situ measurements of 'over-water' pollution with the Smithsonian Environmental Research Center (SERC) Research Vessel (17-18 July)
UMBC Ceilometer onboard

Airborne Chemical Sampling

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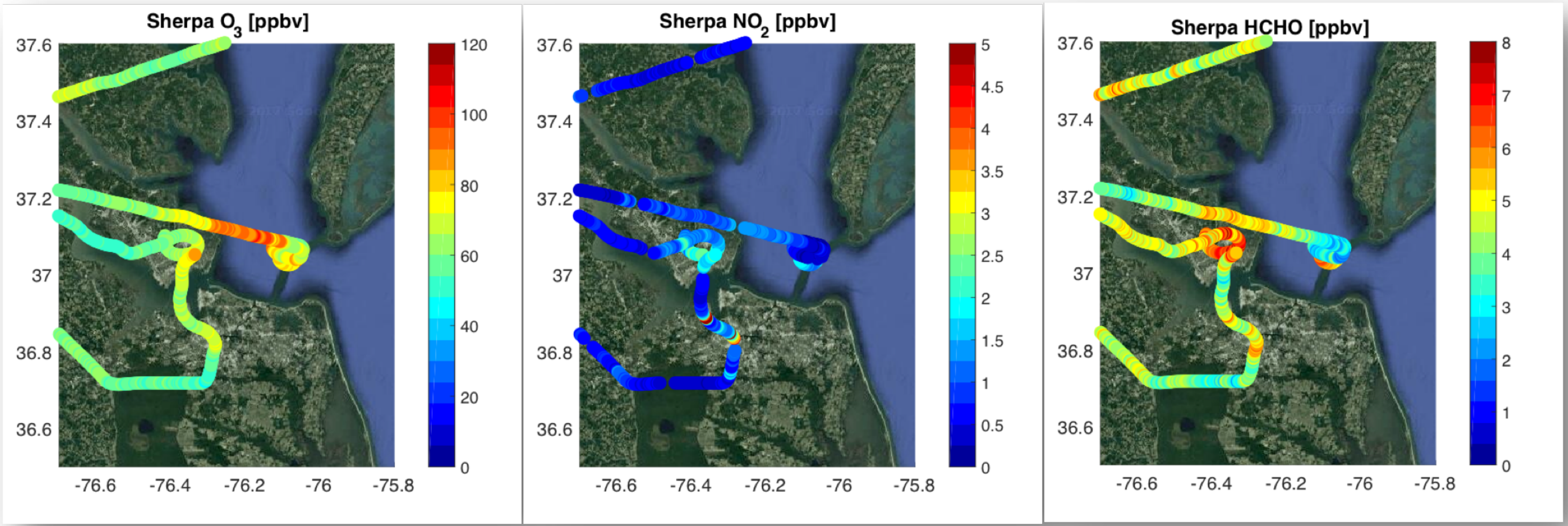

Data <500m (July 20)

Payload	PI, Institution
HCHO	Hanisco/St. Clair, GSFC
NO_x/O_3	Pusede/Flynn, UVA/UH
$CO/N_2O/H_2O$	Pusede, UVA
VOC	Blake, UCI
$CH_4/CO_2/H_2O$	Hanisco/Wolfe, GSFC

Airborne Chemical Sampling

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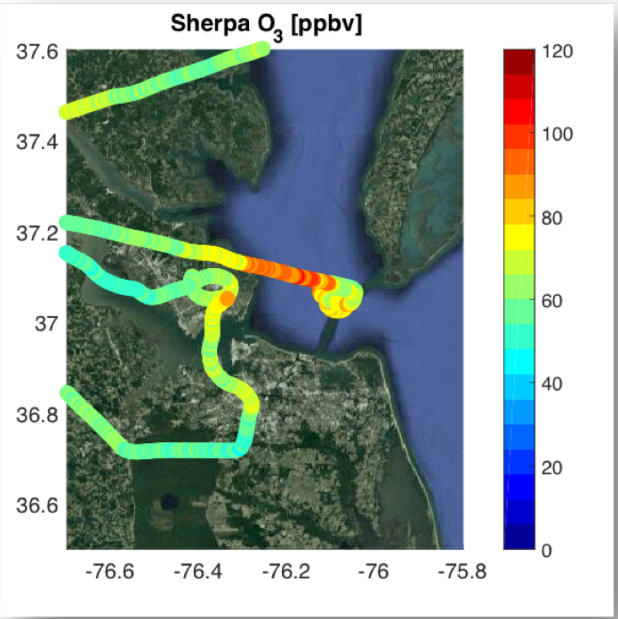
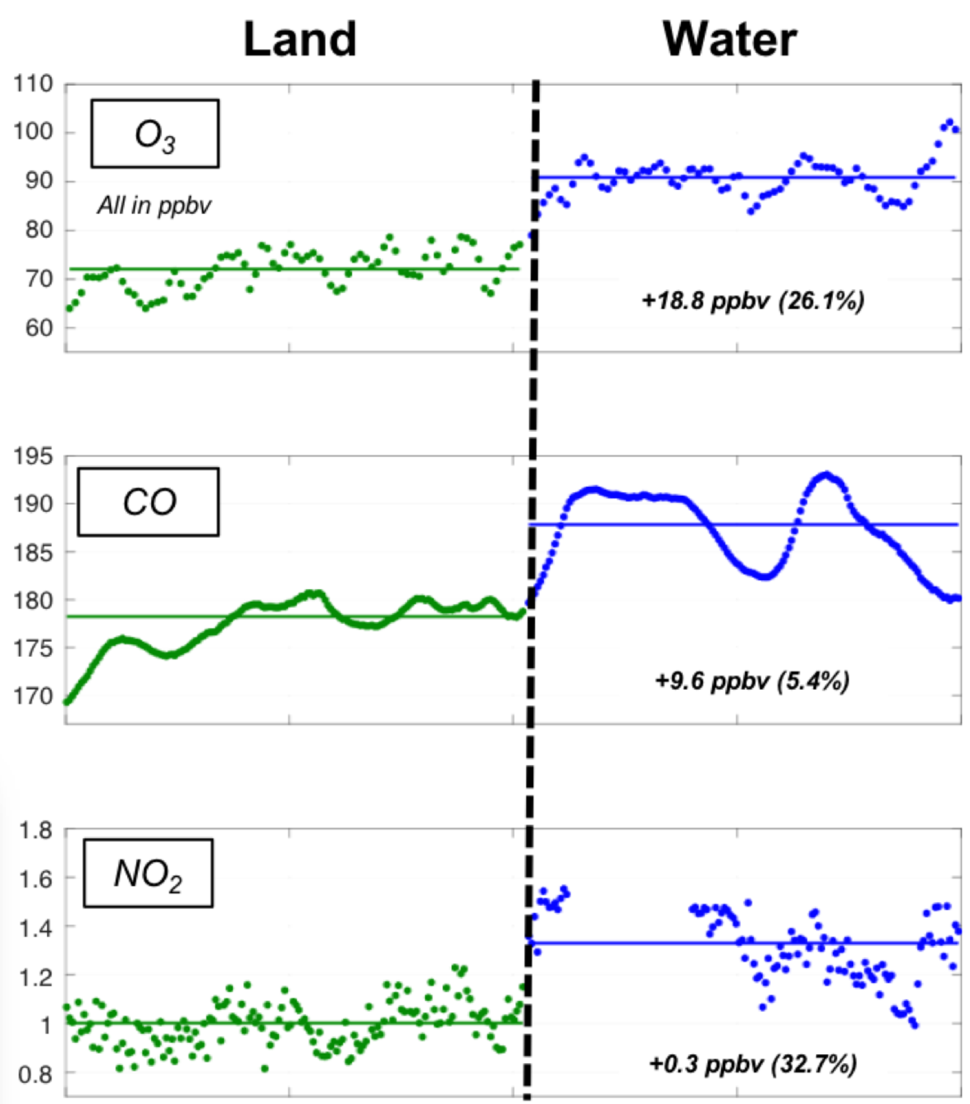


Data <500m (July 20)



Lidar Analyses

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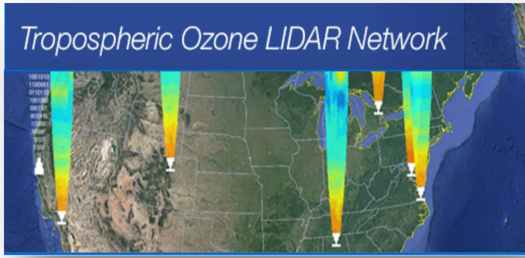

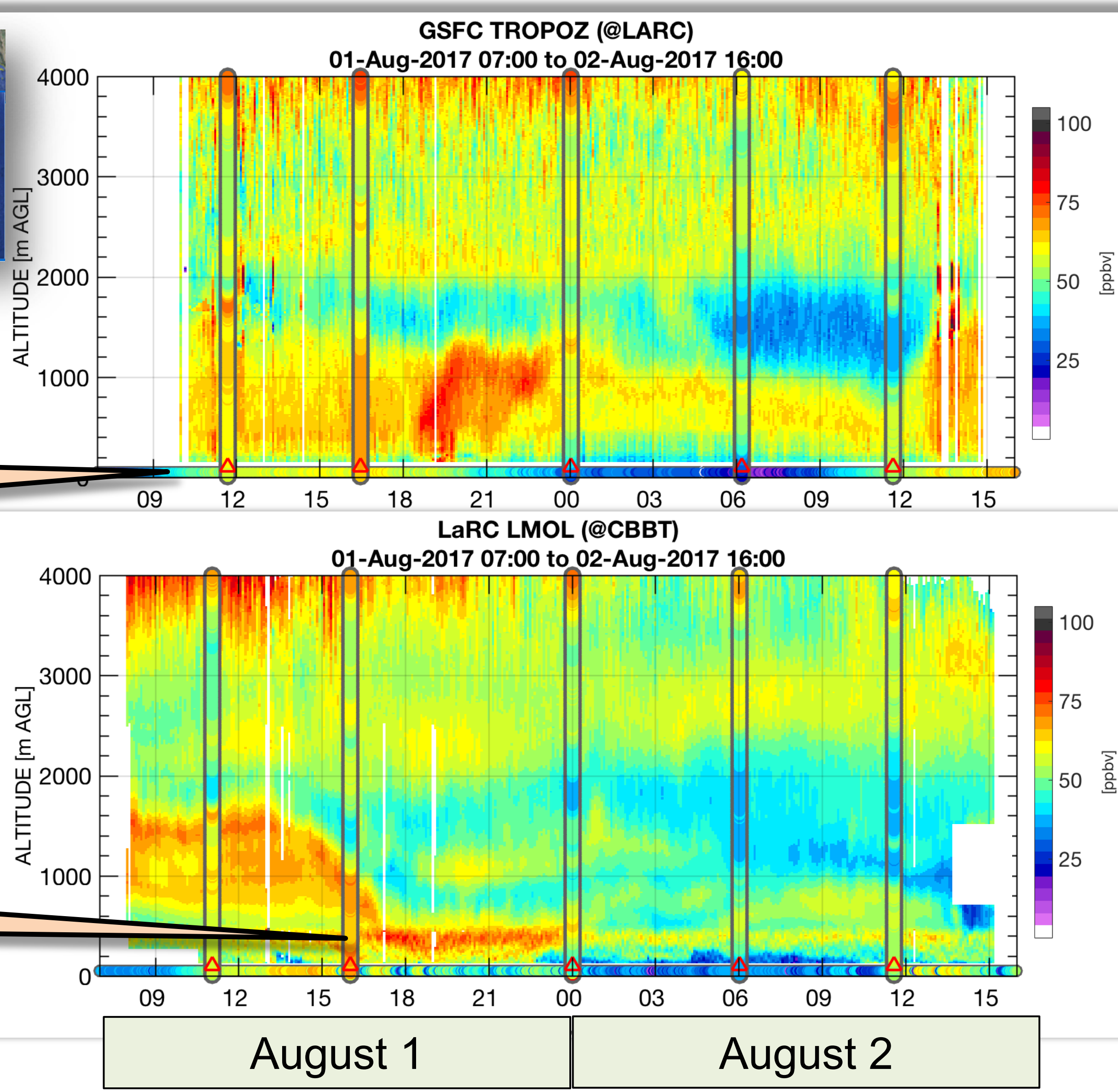

Lidar Analyses (Differences)

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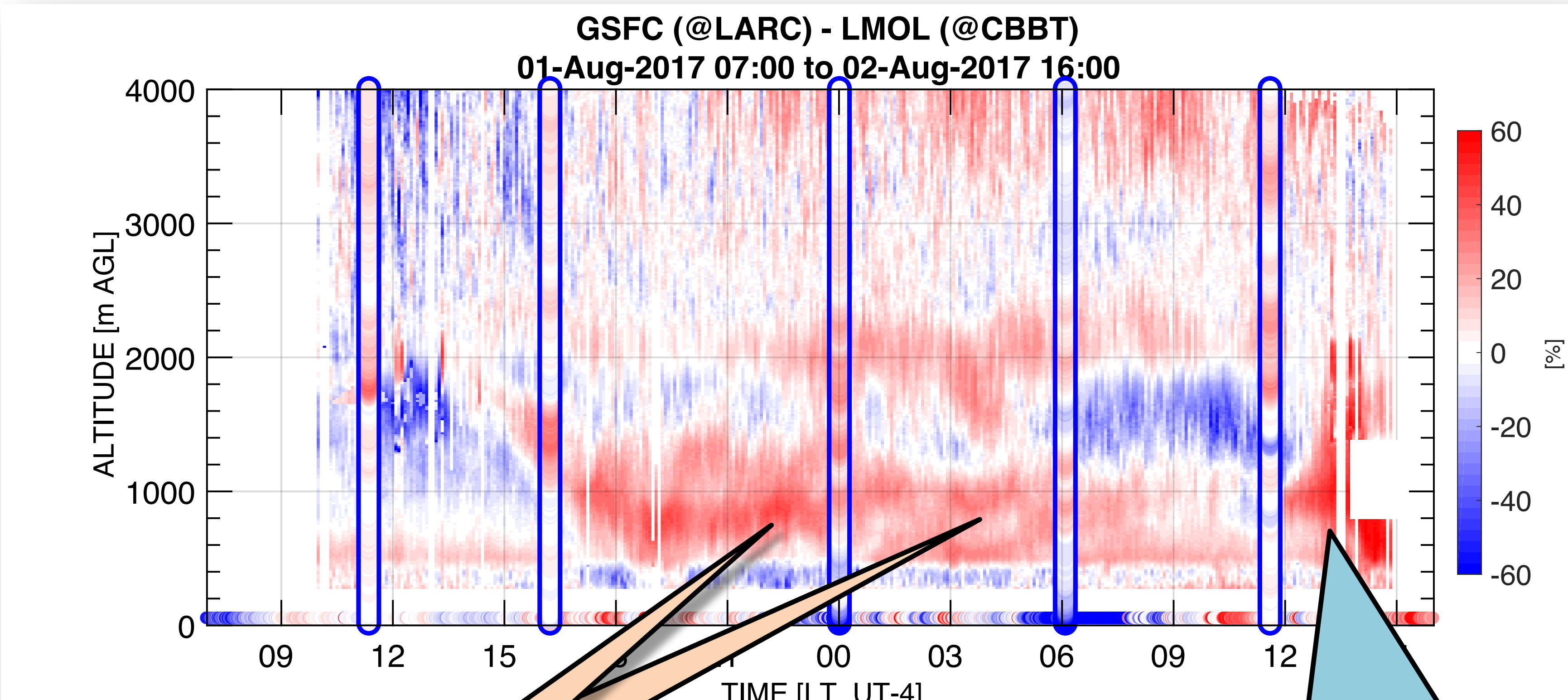
Difference (Land – Water) / Land



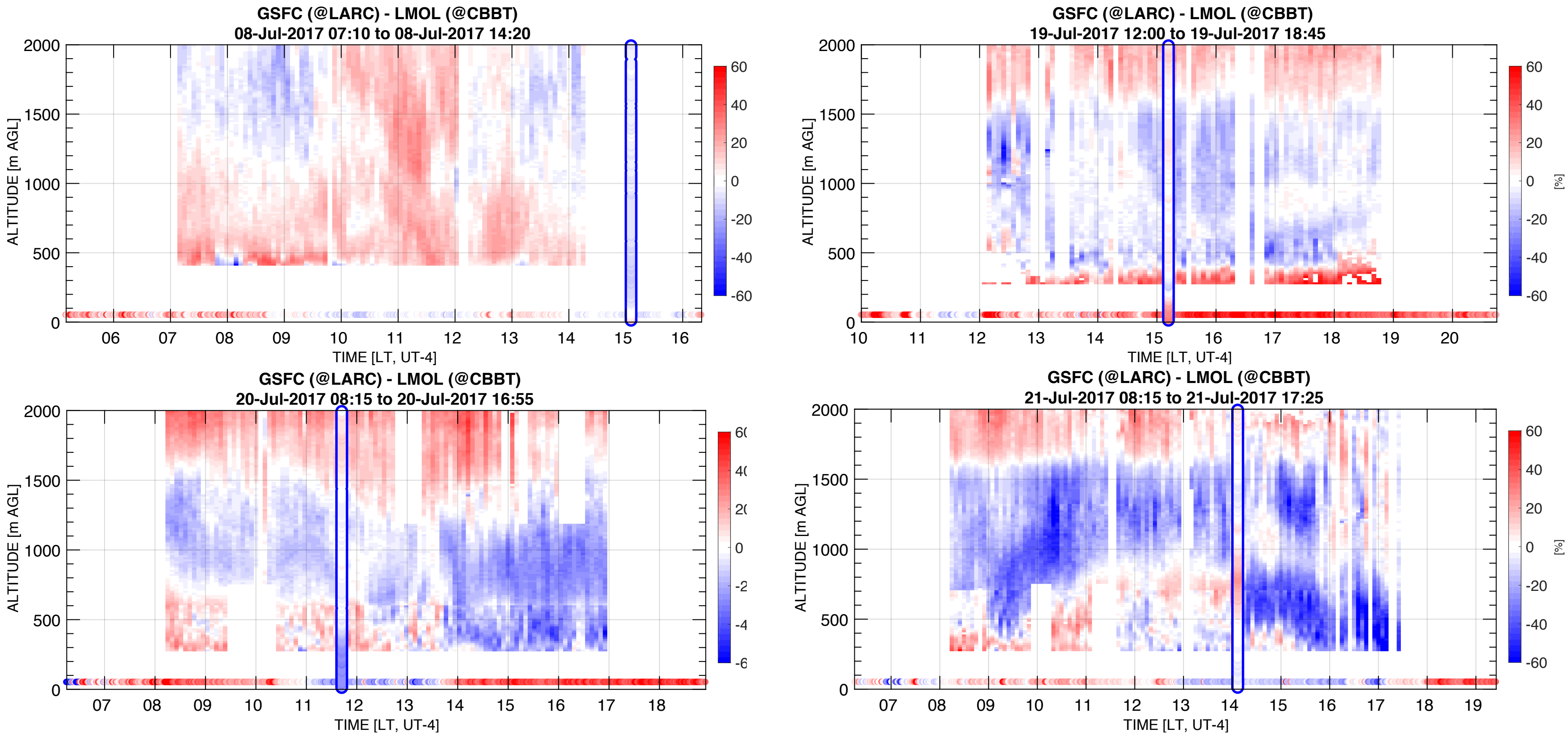
Nocturnal Residual O_3 Layering

Entrainment, enhanced O_3 boundary layer as compared to over water

Lidar Analyses (Differences)

Ozone Water-Land Environmental Transition Study

Difference (Land – Water) / Land



Future Work: Understanding physical and chemical differences between lidars

Summary and Outlook

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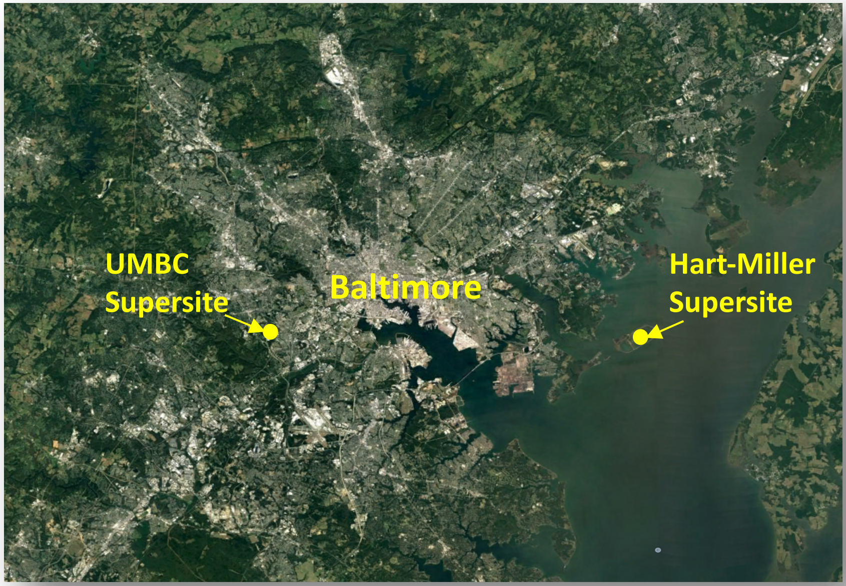
- Aloft differences in ozone (upwards of 30-40 ppbv) were sampled during OWLETS at the 'over-water' vs. continental sites
- Chemical gradients can occur directly at the land-water interface
  - Supported by Lidar, UAV, Sonde, Mobile, Shipborne and Aircraft observations
  - Could not have been done without student intern and university involvement

OWLETS-2 plans are underway for the Baltimore metropolitan area Summer 2018



For website quick look reports and archive:

www-air.larc.nasa.gov/missions/owlets/

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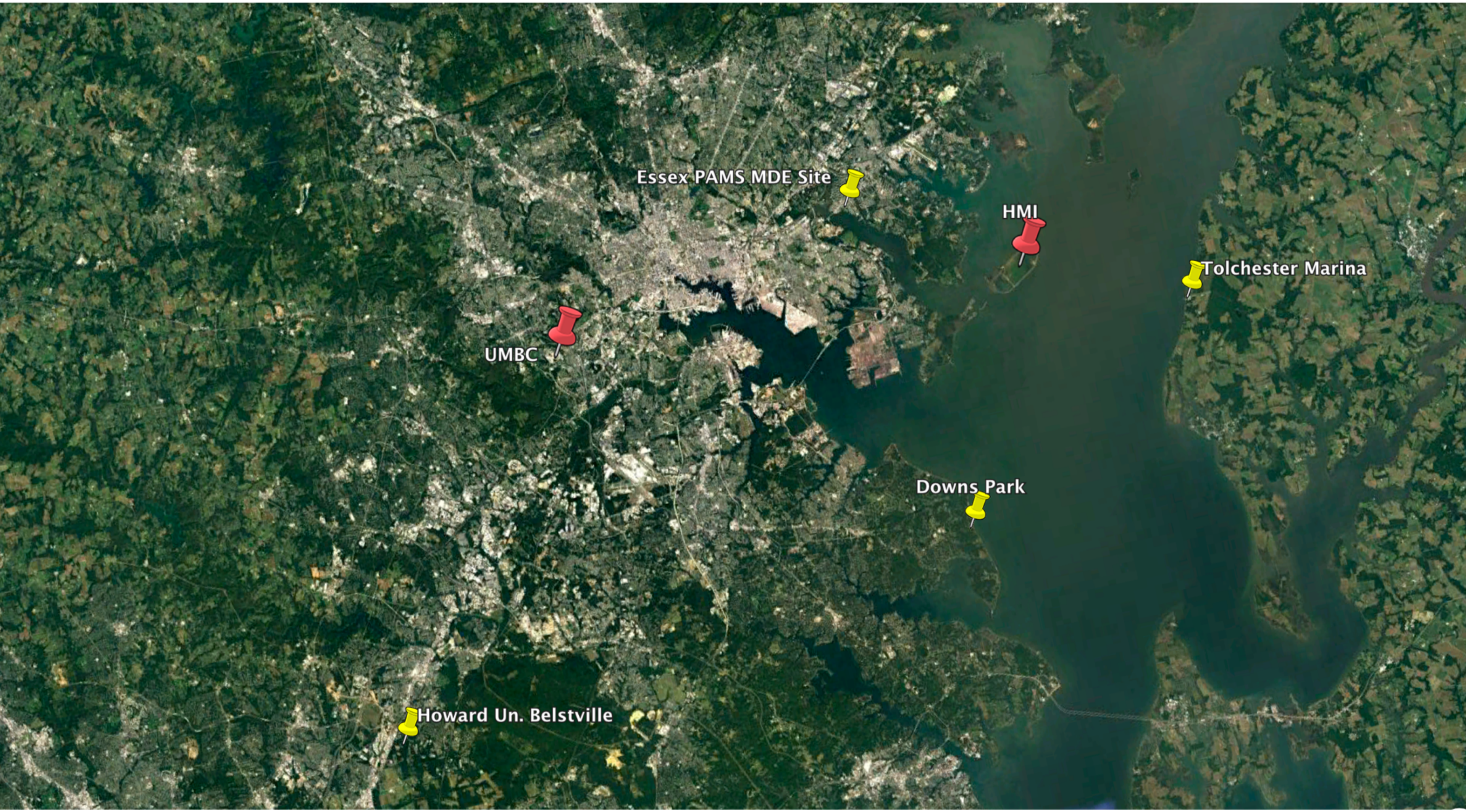
OWLETS-2 Topics

Ozone Water-Land Environmental Transition Study

1. What is the spatial and vertical extent of the ozone (and ozone precursors) in and around the Chesapeake Bay?
2. What are the mechanisms (low boundary layer, chemistry, weather) that produce high ozone over the Chesapeake Bay and lead to high ozone at locations on land near the Chesapeake Bay?
3. How much of the ozone (ozone precursors) is a result of local sources (EGUs, mobile, ship, boat, etc) and/or pollutant transport (westerly, nocturnal low level jet) into Maryland?
   - ***Current (2017) DV is 76ppb at Fair Hill & Edgewood, would be 84 ppbv at HMI***
4. Why do the photochemical models appear to over-predict ozone concentrations in and around the Chesapeake Bay? ***(Measurements would be used to answer this question, so what pollutant measurements are needed to help improve the modeling?)***
5. What source groups and in what locations do policy makers need to focus on to reduce ozone over the Chesapeake Bay?

OWLETS-2 Sites

Ozone Water-Land Environmental Transition Study



OWLETS-2 TOLNet Sites

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Site	Type	Latitude	Longitude	Instruments	Contact/PI	Product	24-7	R/F
UMBC	Research	39.254336°	-76.709578°	Ozone Lidar	john.t.sullivan@nasa.gov	Tropospheric O3 Profiles		X
				Surface Trace Gases	john.t.sullivan@nasa.gov	Surface O3, NO2, HCHO	X	
				Surface Met	john.t.sullivan@nasa.gov	RH,T,WS,WD,	X	
				Ozonesondes (20 Launches)	john.t.sullivan@nasa.gov	O3, RH,T,WS,WD, Profiles		X
				Surface PM 2.5	delgado@umbc.edu	Surface PM 2.5	X	
				Doppler Wind Lidar	delgado@umbc.edu	3D Wind profiles	X	
				Microwave Radiometer	delgado@umbc.edu	T, RH, H20 mixing ratio profiles	X	
				Ceilometer	delgado@umbc.edu	Aerosol Backscatter, Mixing Layer Heights	X	
				Pandora	robert.swap@nasa.gov	Total Column NO2, O3	X	
				Aeronet	delgado@umbc.gov	Total Column Aerosol Properties	X	
				VOC Grab Canisters	joel.dreessen@maryland.gov	VOCs,		X
HMI	Research	39.241710°	-76.363328°	Ozone Lidar	timothy.a.berkoff@nasa.gov	Tropospheric O3 Profiles		X
				Surface Trace Gases	timothy.a.berkoff@nasa.gov	O3	X	
				Surface Met	timothy.a.berkoff@nasa.gov	RH,T,WS,WD,	X	
				Ozonesondes (20 Launches)	delgado@umbc.edu	O3, RH,T,WS,WD, Profiles		X
				Surface PM 2.5	delgado@umbc.edu	Surface PM 2.5	X	
				Doppler Wind Lidar	delgado@umbc.edu	3D Wind profiles	X	
				Microwave Radiometer	delgado@umbc.edu	T, RH, H20 mixing ratio profiles	X	
				Ceilometer	delgado@umbc.edu	Aerosol Backscatter, Mixing Layer Heights	X	
				Pandora	robert.swap@nasa.gov	Total Column NO2, O3	X	
				Aeronet	brent.holben@nasa.gov	Total Column Aerosol Properties	X	
				Surface Trace Gases	ren@umd.edu	O3/SO2/CO/NO/NO2/NOy/Hg(0) .	X	
				PILS/OC/EC/Trace Gases	hennigan@umbc.edu	PILS, IC, NH3 (gas phase), OC, EC,	X	
				VOC Grab Canisters	joel.dreessen@maryland.gov	VOCs,		X

UMD Cessna, Small Sensors (JHU), more extensive regulatory sites, TROPOMI

OWLETS (Sci. Team. Meeting)

Ozone **W**ater-**L**and **E**nvironmental **T**ransition **S**tudy

Over 40 attendees from NASA/GSFC, NASA/LARC, MDE, UMBC, UMD, Argonne Nat. Lab, NOAA ARL

Acknowledgments

- (see previous slides for extensive list of supporting partners/institutions)
- NASA 2017 Science Innovation Fund
- NASA Tropospheric Chemistry Program
- NASA Pandora/AERONet/TOLNet
- EPA’s Air, Climate, and Energy Research Program.
- NOAA Environmental Modeling Center and Air Resources Laboratory
- Maryland Department of Environment (MDE)