The Ozone Water-Land Environmental Transition Study (OWLETS): Overview and Highlights

Land-Water Interface: Major Efforts

OWLETS
June – July, 2018

OWLETS-2
June – July, 2018

LISTOS
July - Sep, 2018

LMOS
May – June, 2017
Core OWLETS Science Objectives

What is the spatial and vertical extent of the ozone (and ozone precursors) within complex orographic/geographic terrain?

TOLNet lidars (with additional measurements) during OWLETS answer these questions within the complex coastline of the Chesapeake Bay.

Can we properly evaluate photochemical transport models?

TOLNet lidars during OWLETS have been reliably used to show model biases, such as the over-prediction of ozone concentrations in and around the Chesapeake Bay. Lidar, balloon-borne and surface observations are directly aimed at better understanding photochemical models by providing boundary layer height, chemical composition, and flow pattern differences between land and water.

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)?

During OWLETS, TOLNet observations provided a detailed characterization of both upwind and downwind chemical composition that can be used to directly quantify pollution transport entering the urban region as compared to locally produced pollution.
OWLETS-1 Strategy

THE OZONE WATER–LAND ENVIRONMENTAL TRANSITION STUDY
An Innovative Strategy for Understanding Chesapeake Bay Pollution Events

See Dacic et al., Berkoff et al., Santos et al., Kotsakis et al., BAMS 2019
OWLETS Research Teams

2017 & 2018

2017: T. Berkoff, PI
2018: J. Sullivan, PI

NASA
Tropospheric Ozone LIDAR Network

UMBC
JCEL
NASA-GSFC

NASA SPACE FLIGHT CENTER

Goddard

HARVARD UNIVERSITY

NASA POSTDOCTORAL PROGRAM

THE SCIENCE DIRECTORATE
AT NASA S LANGLEY RESEARCH CENTER

UMD

COLUMBIA UNIVERSITY

HAMPDEN-SYDNEY UNIVERSITY

TEMPO

JOHNS HOPKINS UNIVERSITY

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UNIVERSITY OF VIRGINIA
SSAI
COLUMBIA UNIVERSITY
ARL
Air Resources Laboratory
Conducting research and development in the fields of air quality, atmospheric dispersion, and climate
CHESAPEAKE BAY BRIDGE-TUNNEL
DEQ
Virginia Department of Environmental Quality
IVING VIRGINIA LIVING MUSEUM
U OF MARYLAND
HOWARD UNIVERSITY
JOHNS HOPKINS UNIVERSITY
Understanding Ozone Variability


**UAV**

Tzortziou et al., (in prep)

Data: Pippin et al., NASA/LaRC

TEMPO O$_3$ Footprint
Learning from CTM Evaluation

How can measurements be better utilized (in conjunction with chemical transport models) to connect ground level pollutants to satellites in the upcoming framework of the NASA TEMPO instrument?

Repeated high-resolution TOLNet measurements during OWLETS under a variety of atmospheric conditions will help provide the atmospheric science community with the tools to better evaluate chemical transport models that will feed into TEMPO a priori.
Airborne Pollution Mapping

6/30 09:00-12:20 LT

[NO₂] (ppbv)

6/30 14:50-18:00 LT

[O₃] (ppbv)

Spatially correlated with CO

Data: X. Ren, R. Dickerson
Complex Coastal Terrain

Sat. 6/30 ~15:30 LT

Hart Miller Island

- Weak Synoptic Forcing
- Local recirculation patterns
- Differences in Cloud Coverage
- Boundary Layer Depth
- Deposition Velocity
- Emissions (land and ship-based)
Ozone Lidar Analyses

4+ days of continuous data!
16 ozonesondes!

On-Land

Over-Water
Lidar observations are consistent with OWLETS aircraft/sondes and provide unprecedented context for understanding chemical and dynamical processes impacting ozone gradients. Ex: Polluted Return Flow
More Info and Data

STM Presentations and final data from both OWLETS1/2 missions now archived

Over 80 people attended in person or remotely from the OWLETS and TOLNet groups

35 abstracts related to OWLETS presented at national meetings in 2018/2019

https://www-air.larc.nasa.gov/missions/owlets/
https://www-air.larc.nasa.gov/missions/TOLNet/
Linking OWLETS to TEMPO

• **What have we learned for TEMPO validation?**
  – Significant chemical gradients often occur directly at the coastal interface, therefore it will be critical to understand evolving shorelines and emission sources. *(Sullivan et al., BAMS, 2019)*
  – CTMs (such as GEOS-FP or NOAA NAQFC) that can be better evaluated with ozone lidars and have the ability to reproduce localized recirculation flows *(Dacic et al., (in prep))*
  – Ship-related emissions (including pleasure craft) can be substantially in the columnar products and need to be considered in emissions inventories *(Gronoff et al., Atmos. Env., 2019)*

• **How would TEMPO have been used to support the campaigns?**
  – Mapping NOx sources (e.g. early morning) to understand vehicular/stationary emissions, coupled with ozone/aerosol vertical profiles, can add critical information in scientific interpretation and evaluation

• **How do we design special TEMPO observations for focused field campaigns?**
  – Need to make the connection with local DEQ to maximize policy relevant science