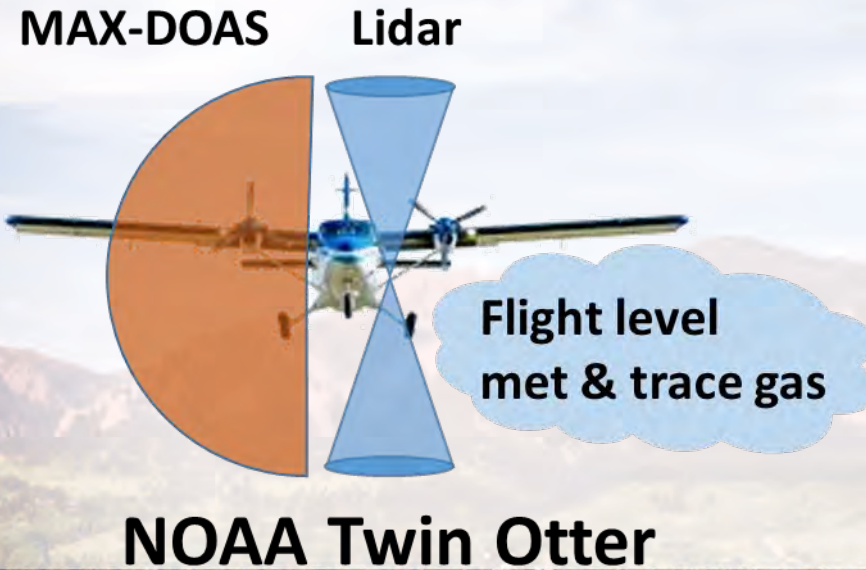




# CUPiDS: Coastal Urban Plume Dynamics Study

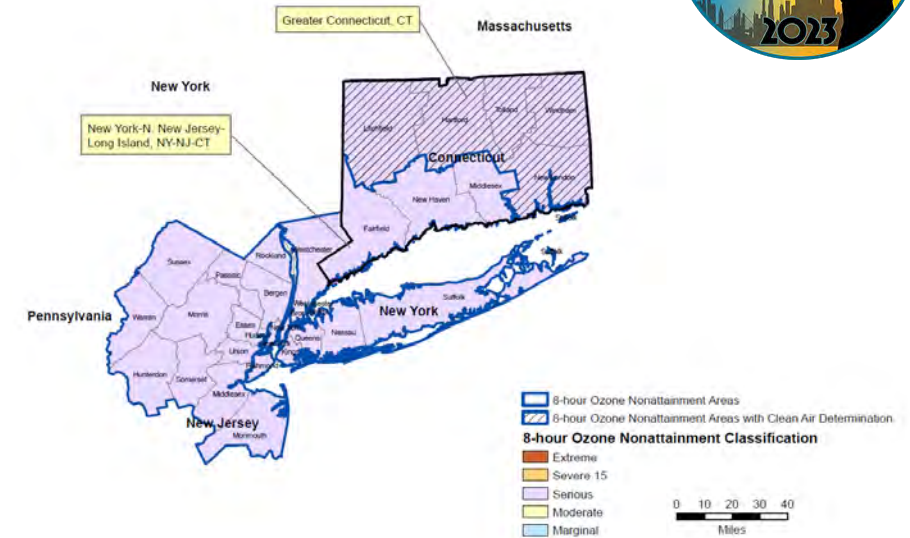
*Sunil Baidar and the CUPiDS team*



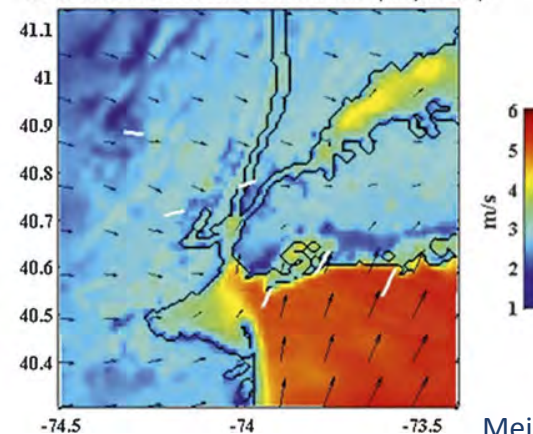
# Motivation



- Ground level  $O_3$  in the NJ-NY-CT metro area frequently exceed NAAQS.
  - Recently downgraded to serious.
- Pollution problem is amplified by complex interactions between flows over land and water
  - Not well understood
- LISTOS 2018: presence of low level jet just off the coast of CT during some high  $O_3$  events



1km COAMPS mean 10-m winds (July.2011)



Meir et al. (2013)

# Science Goals

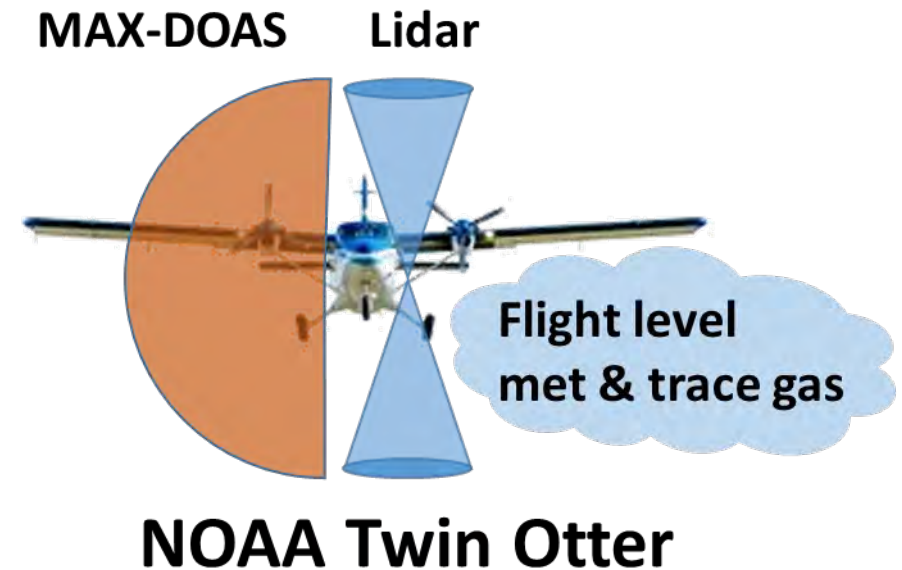


- Study spatial structure and temporal evolution of diurnal coastal flows and their role on pollution transport and mixing.
  - What are the kinematic characteristics of the boundary layer during high ozone events?
  - How does boundary layer evolve over land and water during these events?
  - What is the role of low-level jets in transporting pollutants into and out of the region?
- Determine reactive nitrogen emissions and O<sub>3</sub> production efficiency in the New York metro area
- Evaluation of TEMPO and TROPOMI products
  - NO<sub>2</sub>, HCHO, CHOCHO profiles/columns, wind profiles, surface albedo

# Instrumentation



- Scanning Doppler Lidar (CSL)
  - Wind, Turbulence and Aerosol profiles
  - Boundary Layer Depth
- MAX-DOAS (CU, AC4 supported)
  - NO<sub>2</sub>, Formaldehyde, Glyoxal column (profiles)
- NOxCaRD (CSL)
  - NO, NO<sub>2</sub>, NO<sub>y</sub>, O<sub>3</sub>
- Picarro (GML)
  - CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>O
- Radiometers (CSL, CU)
  - Multi spectral irradiance
  - Surface albedo
  - Surface temperature
  - jNO<sub>2</sub>
- AIMMS probe
  - Flight level temperature, pressure, winds



# Schedule



- 175 flight hours, 24 Jun – 8 Aug 2023,
- Based out of McArthur (KSIP) in Long Island
- Twin Otter: ~60 m/s & ~4 hour endurance
- 2 flights per day, repeat the same pattern

June						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

July						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Integration Lakeland
Test Flights Lakeland
Transit to NYC
NYC deployment
Transit to Lakeland
Deintegration Lakeland



# Scanning Doppler Lidar

- Compact and modular design; ability to look up or down
- Horizontal wind profiles
  - Scanning 30 deg/s, Beam rate 10 Hz
  - One sweep every 12s / 720 m along track resolution
  - 60 m vertical resolution
- Vertical wind profiles
  - 10 Hz Beam rate, 6m along track resolution
  - 60m vertical resolution
  - Motion stabilized



Alan  
Brewer



Amanda  
Makowiecki



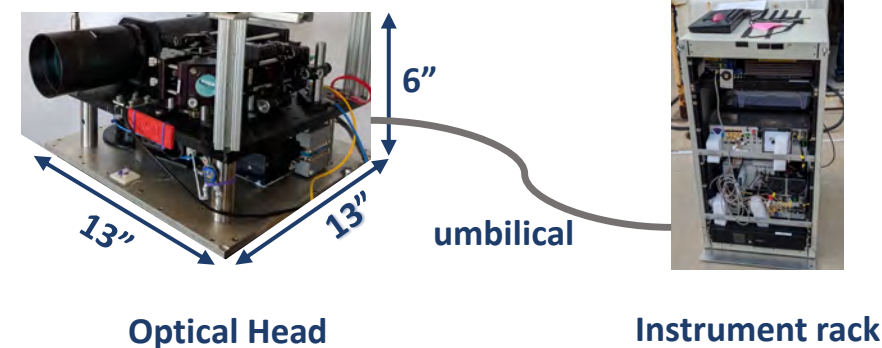
Max  
Holloway



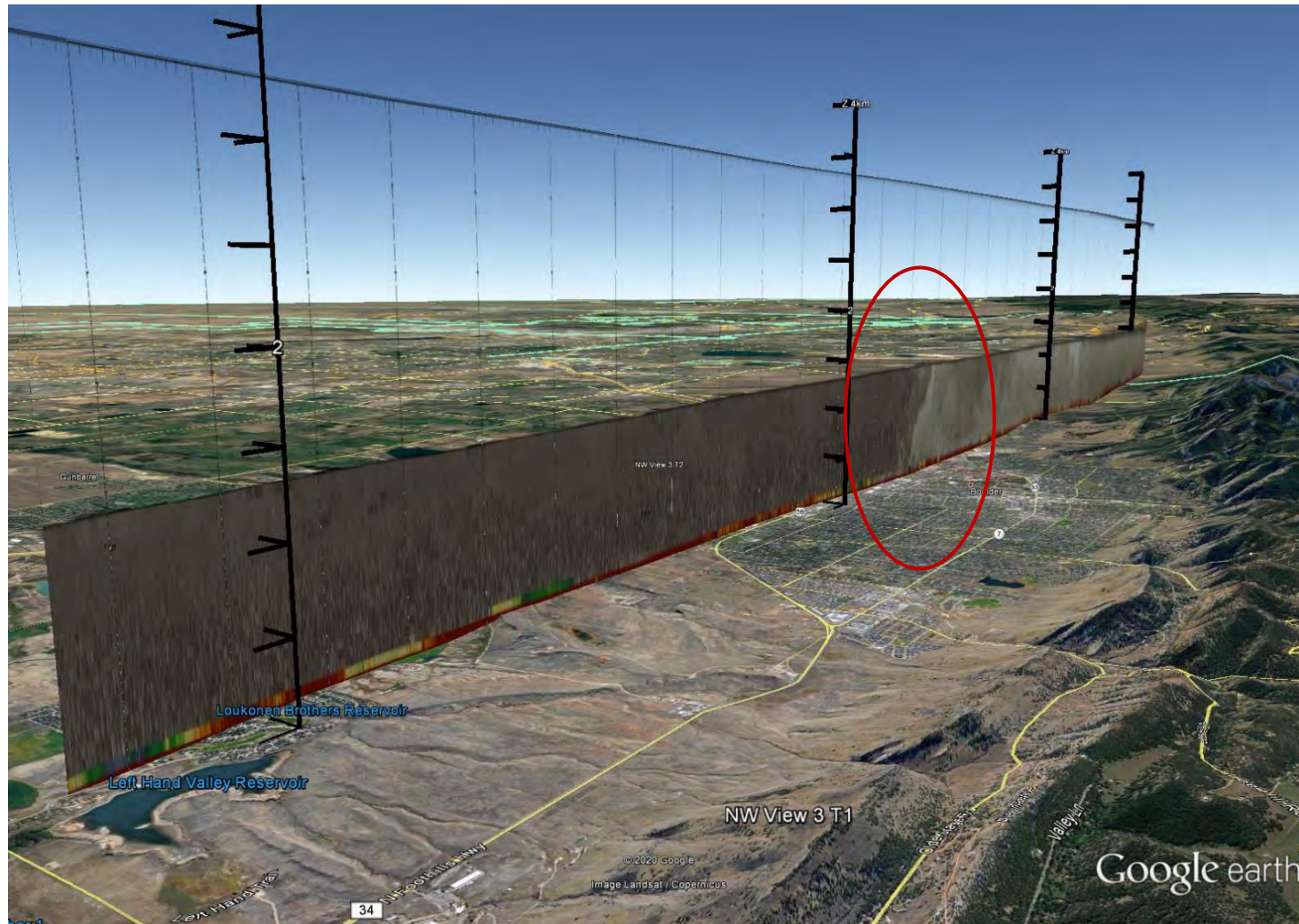
Mike  
Zucker



Rich  
Marchbanks

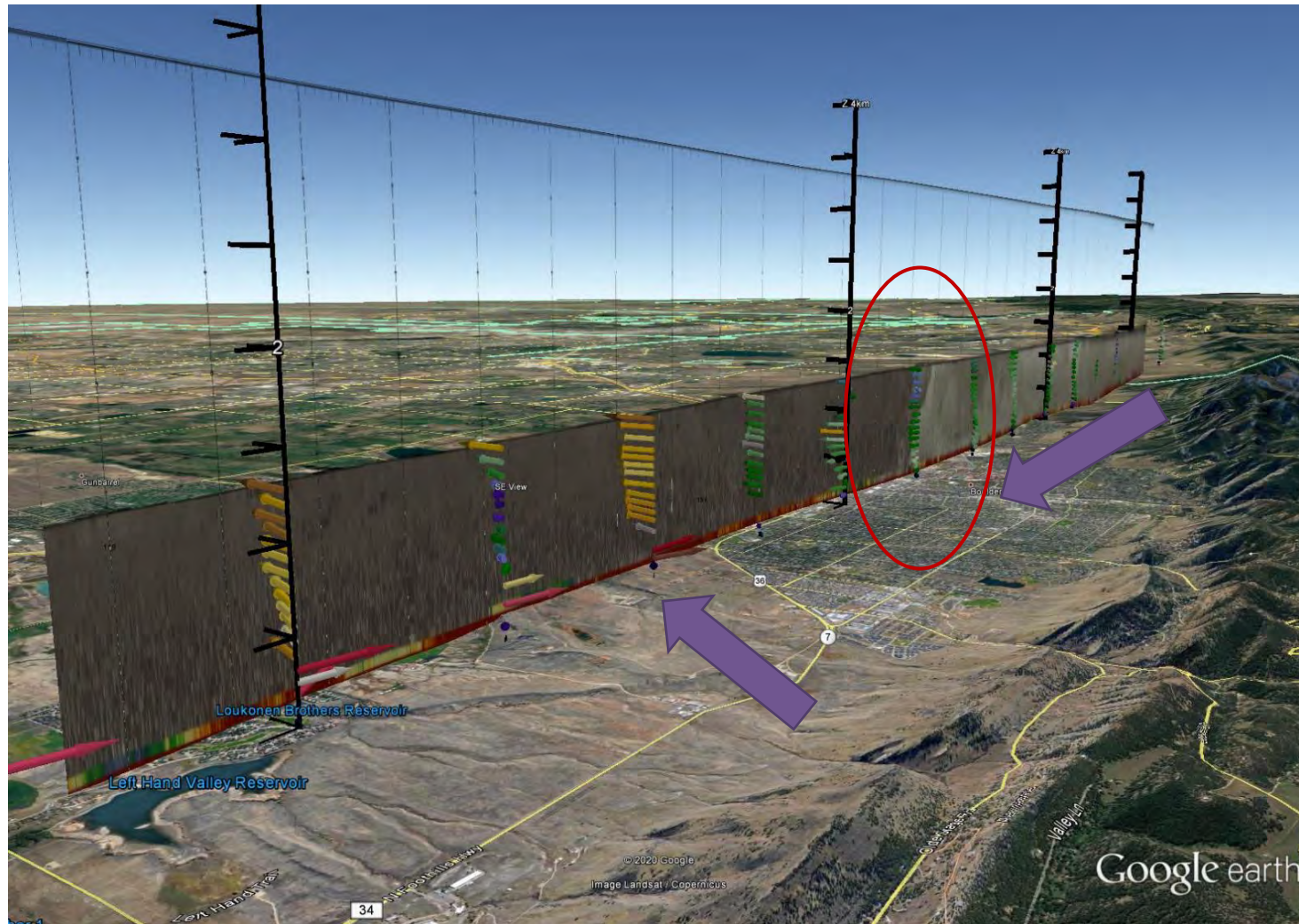


# Scanning Doppler Lidar



- Aerosol backscatter intensity

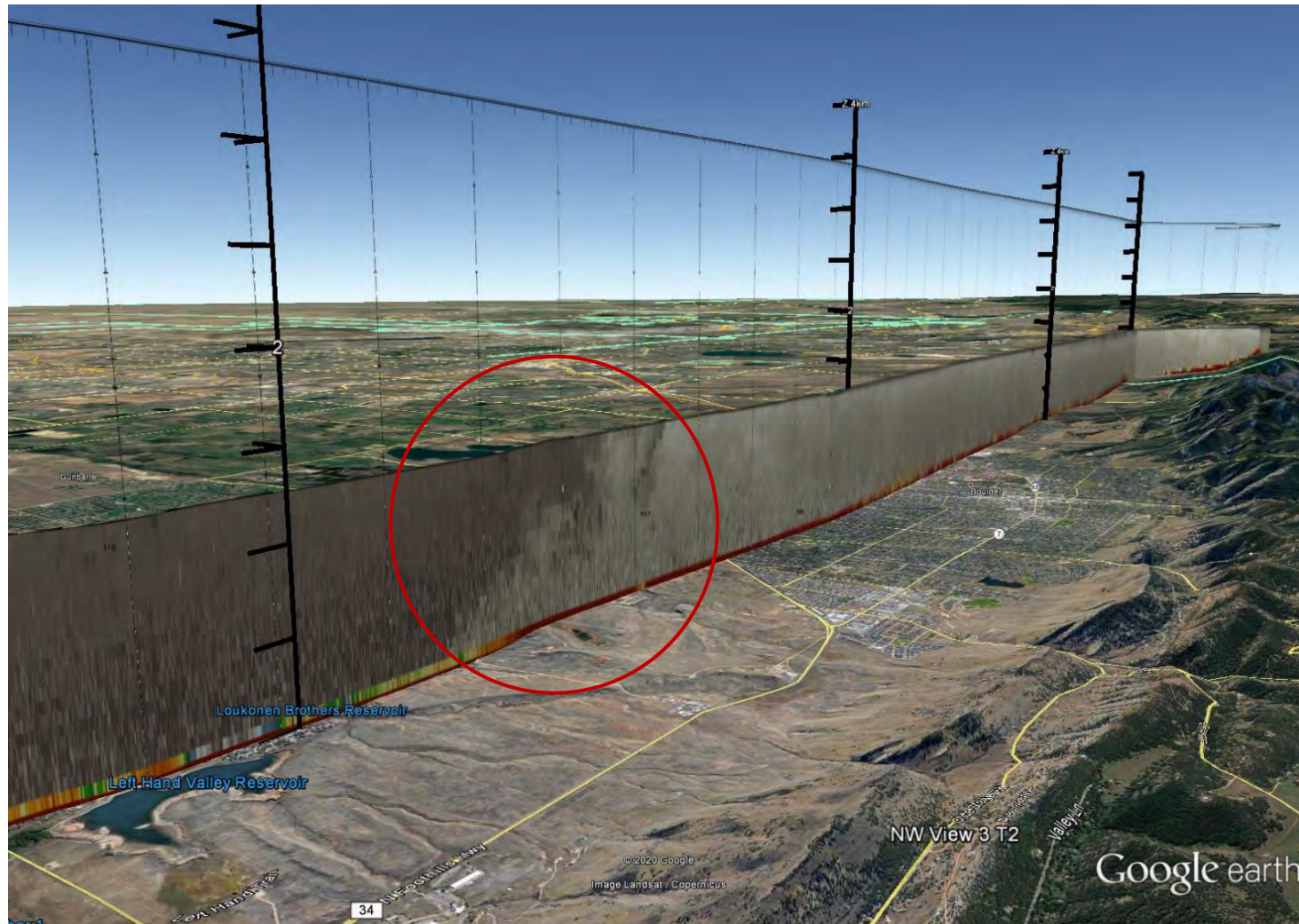
# Scanning Doppler Lidar



- Winds and aerosol backscatter intensity

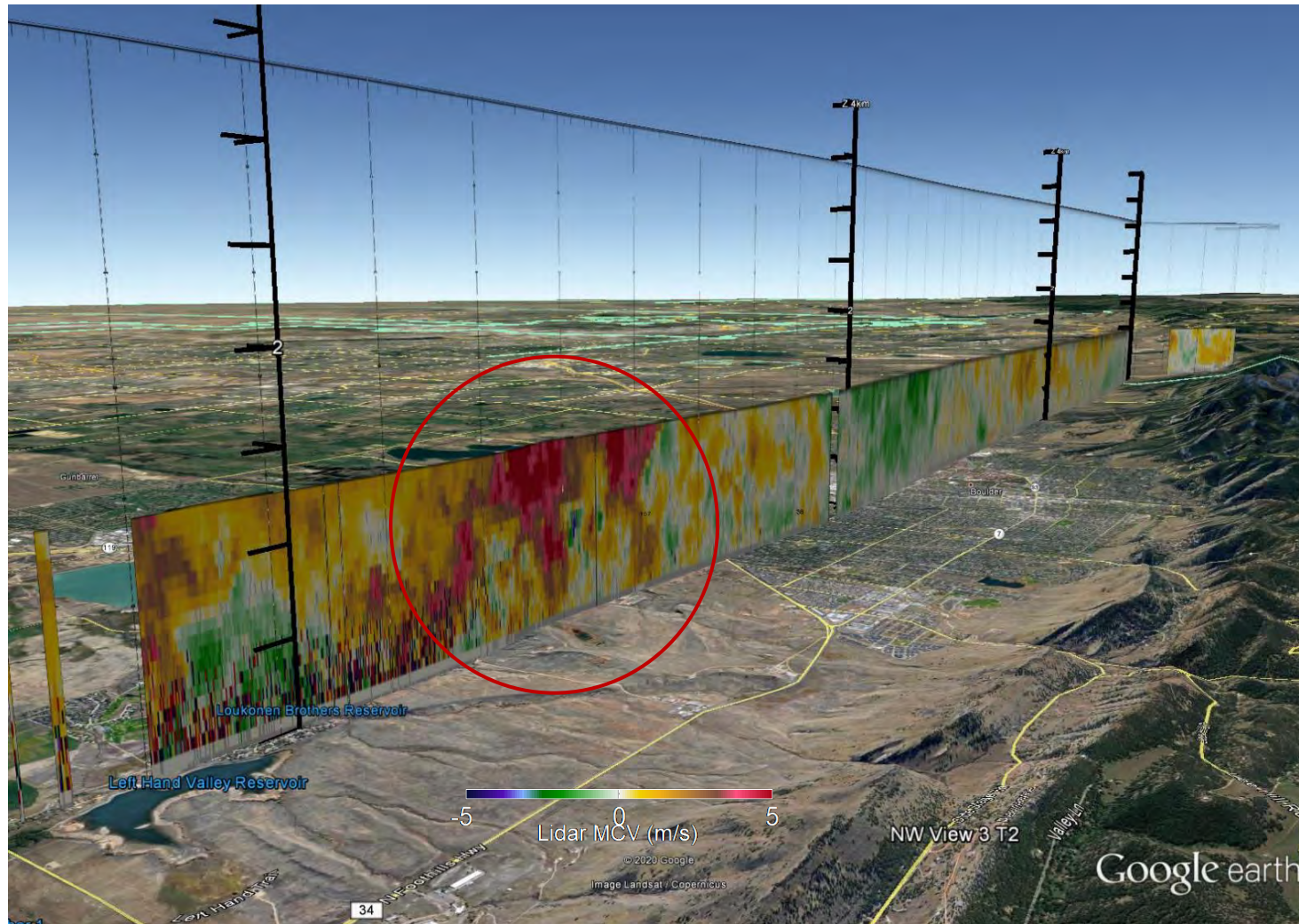


# Scanning Doppler Lidar



- Aerosol backscatter intensity
- ~30 minutes later

# Scanning Doppler Lidar



- Vertical velocity
- ~30 minutes later

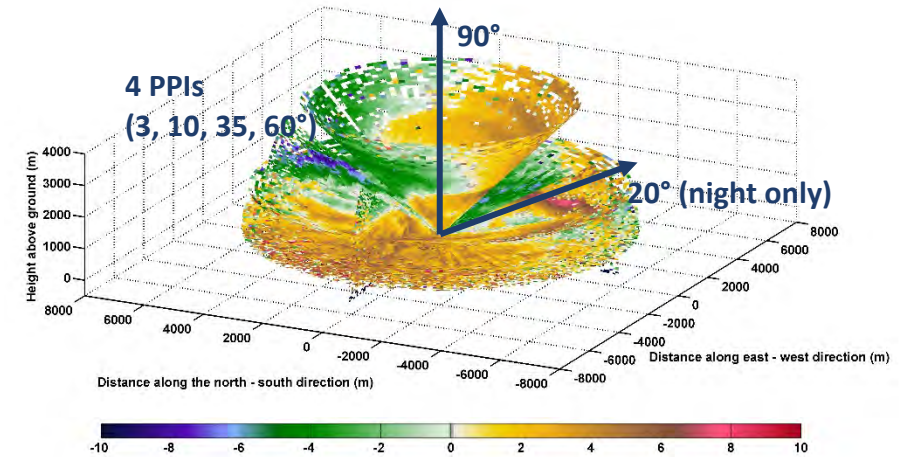
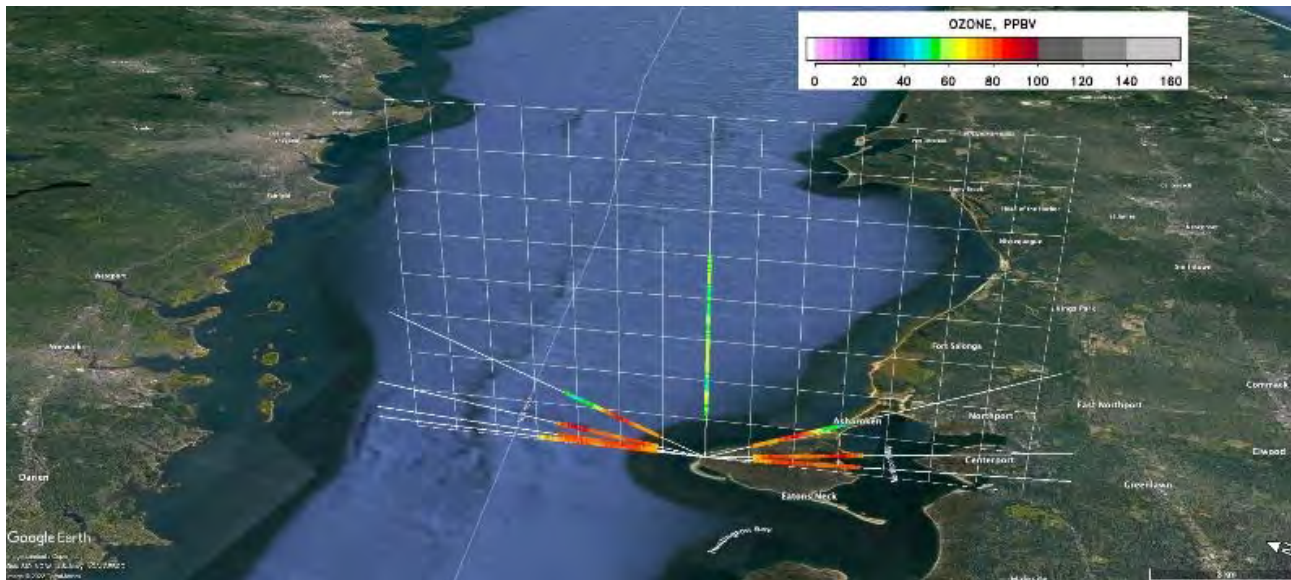
# TOPAZ O<sub>3</sub> lidar



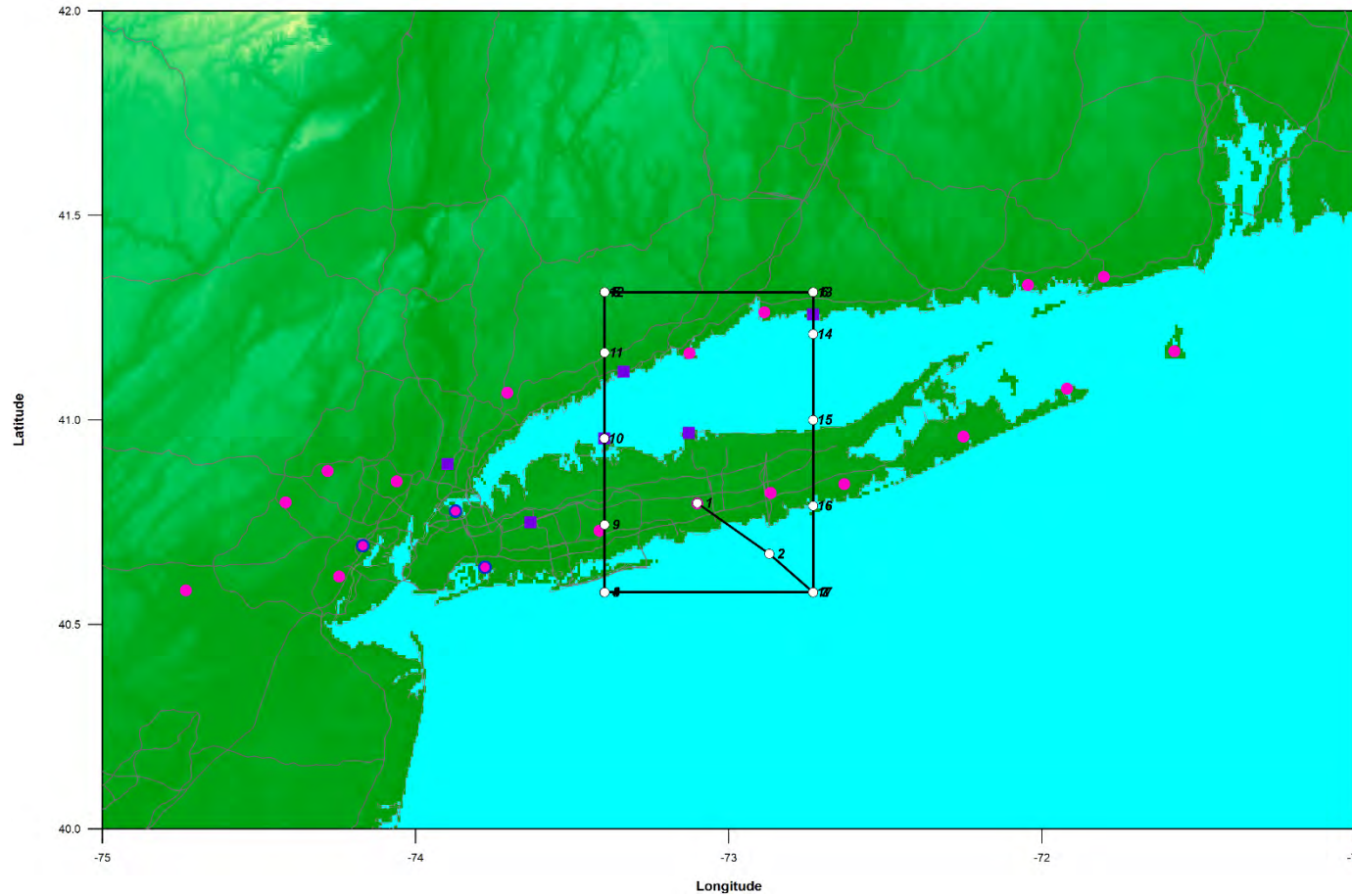
- Planned deployment at Eaton's Neck (50 km/ ~ 3 hours downwind)
- Co-deployed with a scanning Doppler lidar
- Scanning O<sub>3</sub> and aerosol profile over sound and land



Andy Langford    Chris Senff    Scott Sandberg    Raul Alvarez



# Flight Patterns and Measurement Strategy

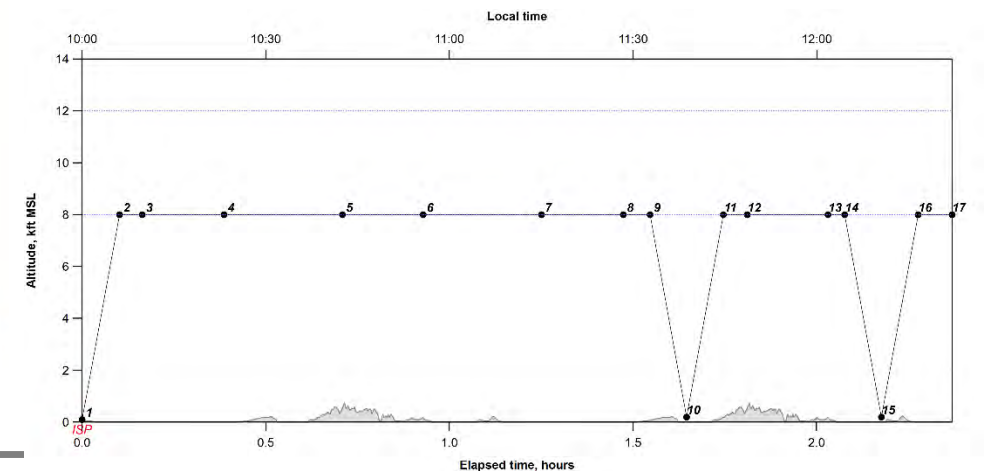


## Objectives:

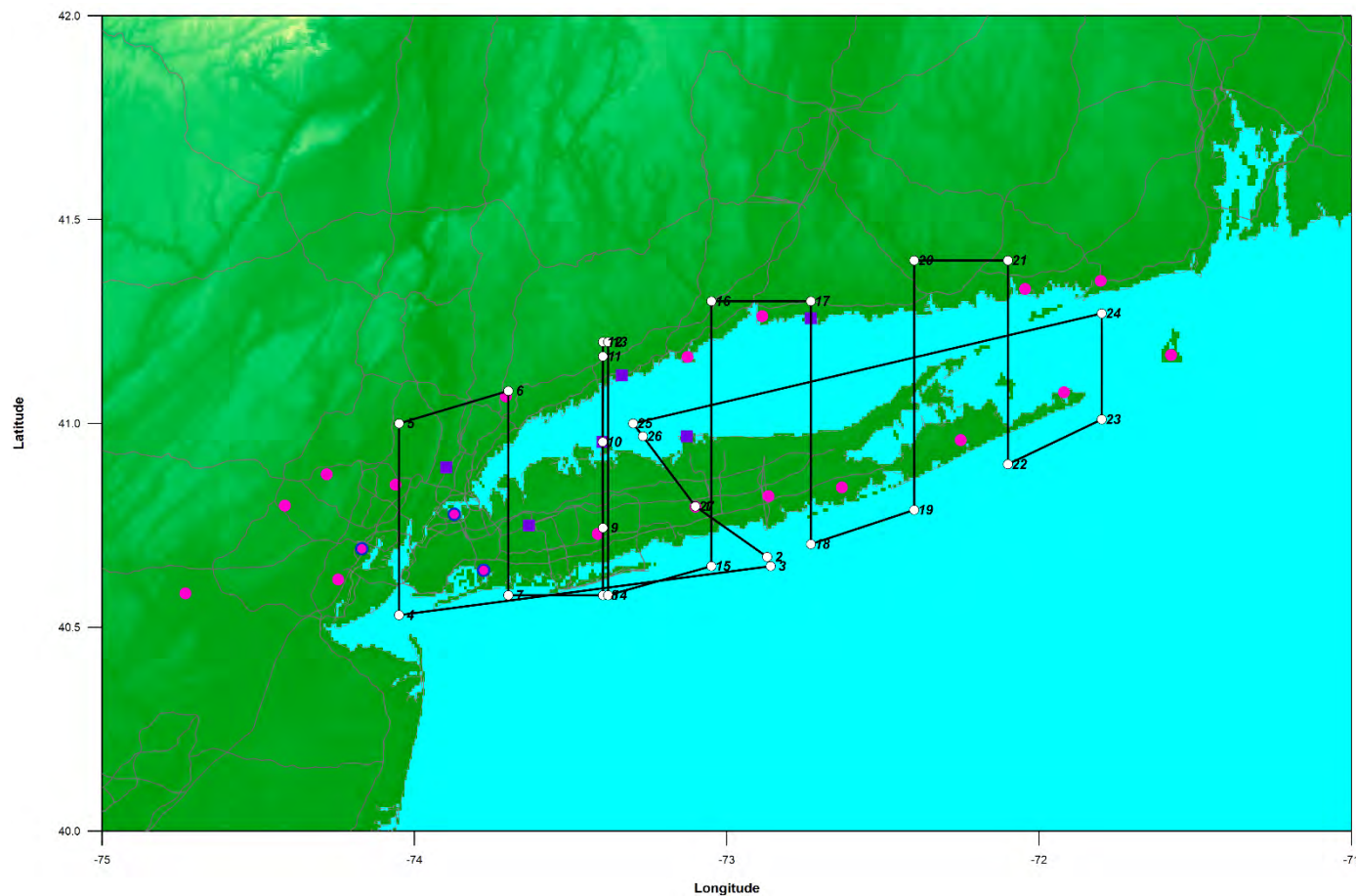
- Temporal evolution of sea/bay breeze

## Features:

- Repeat cycle: 1 hour
- Profile over water at TOPAZ and ground site every other loop.
- ~4 loops per flight
- Flight altitude: ~500 m above BL



# Flight Patterns and Measurement Strategy

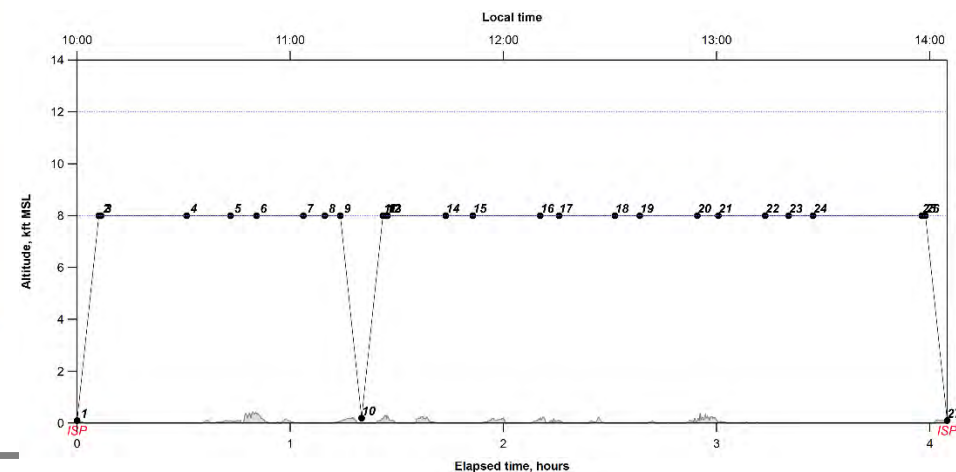


## Objectives:

- Spatial variation of sea breeze
- Spatial distribution of pollutants

## Features:

- Profile over water at TOPAZ
- Flight legs parallel to wind direction (S)
- Flight altitude: ~500 m above BL



# CUPiDS Team

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Alan  
Brewer

Amanda  
Makowiecki

Max  
Holloway

Mike  
Zucker

Rich  
Marchbanks

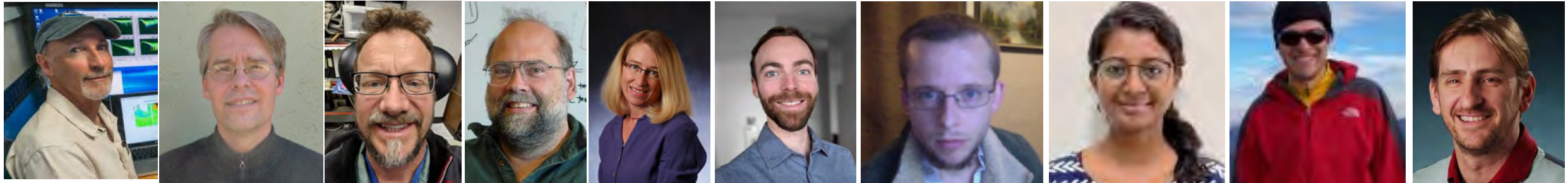
Sunil  
Baidar

Steve  
Brown

Kristen  
Zuraski

Jeff  
Peischl

Colm  
Sweeney



Andy  
Langford

Chris  
Senff

Scott  
Sandberg

Raul  
Alvarez

Brandi  
McCarty

Brian  
Carroll

Edward  
Strobach

Swlaeha  
Inamdar

Kyle  
Zarzana

Rainer  
Volkamer