Office of Science
U.S. DEPARTMENT OF ENERGY

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Nighttime Aerosol-Oxidant Plume Experiment: Preliminary Results

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Battelle

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Overview

- Background and Motivation
- Experiment
- Preliminary Results
- Future Work

Participants

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- **Brookhaven National Laboratory**

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- **Brechtel Manufacturing, Inc.**

Fred Brechtel, Jr.

- **Boston College and Aerodyne Research, Inc.**

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- **UCLA**

Jochen Stutz, Andreas Geyer

- **Argonne National Laboratory**

Rich Coulter, Tim Martin

- **Hanscom AFB**

Lt. John Roadcap, Paul Tracy

- **NOAA and University of New Hampshire**

Background and Motivation

- Chemical interactions between oxidants and aerosols are poorly understood.
- Some of the proposed reactions are expected to be important at night, in the absence of photochemistry
- Need time-resolved measurements to understand these processes.

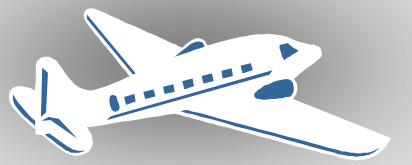
Objectives

- Make nighttime Lagrangian measurements of trace gases and aerosols in the Boston urban plume
- Look for evidence of heterogeneous chemistry

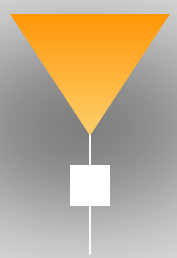
Measurement Platforms

- Ground Site (Boston College)

- G-1 Aircraft (Worcester)



- Constant-volume Tetroon (Nahant) (as Lagrangian markers)



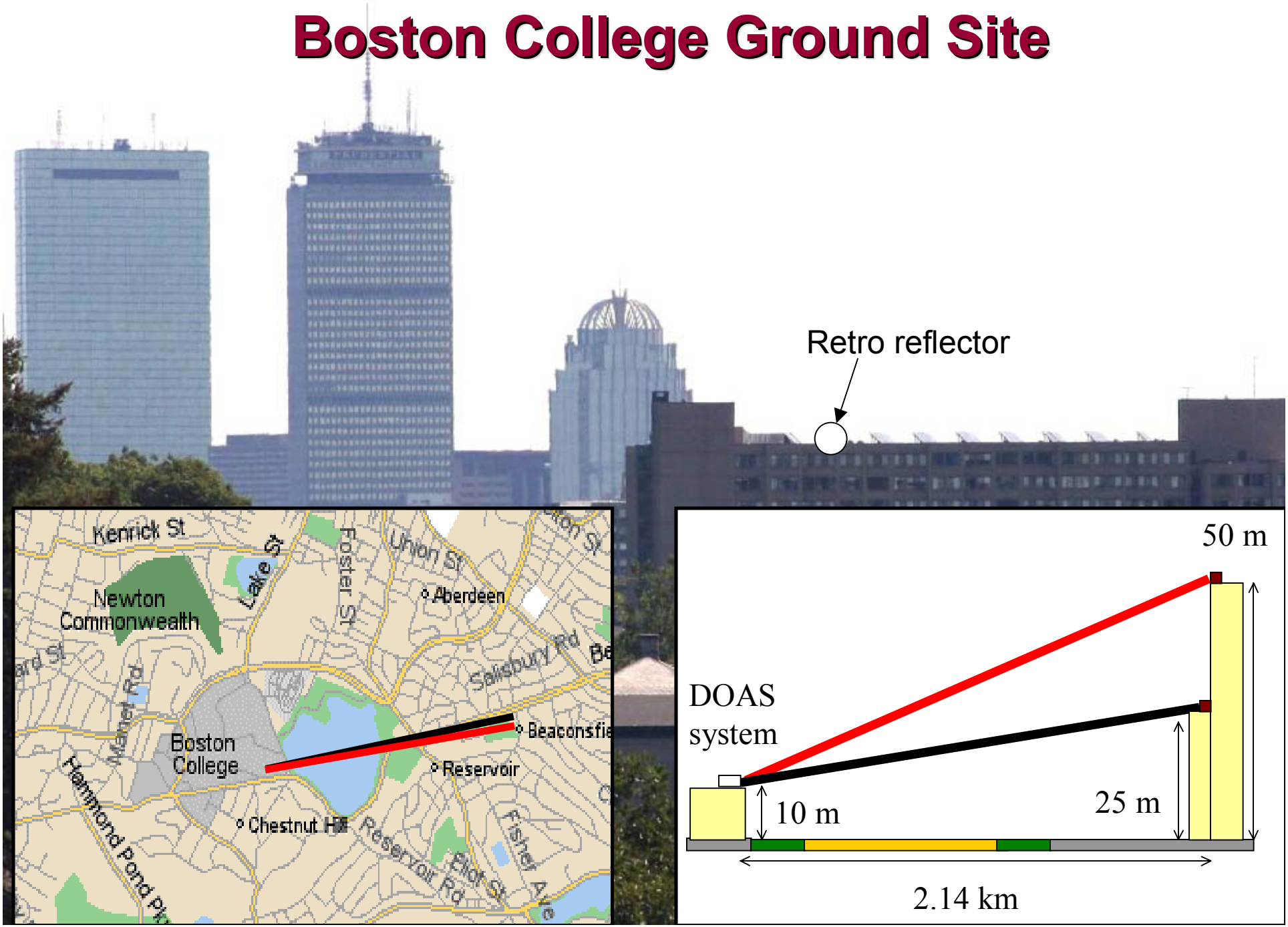
Site Map

20 NM
Logan Airport
Nahant
Worcester
Boston College
Boston Metro Area
93
495
95
100
435
590
90
50
395
295

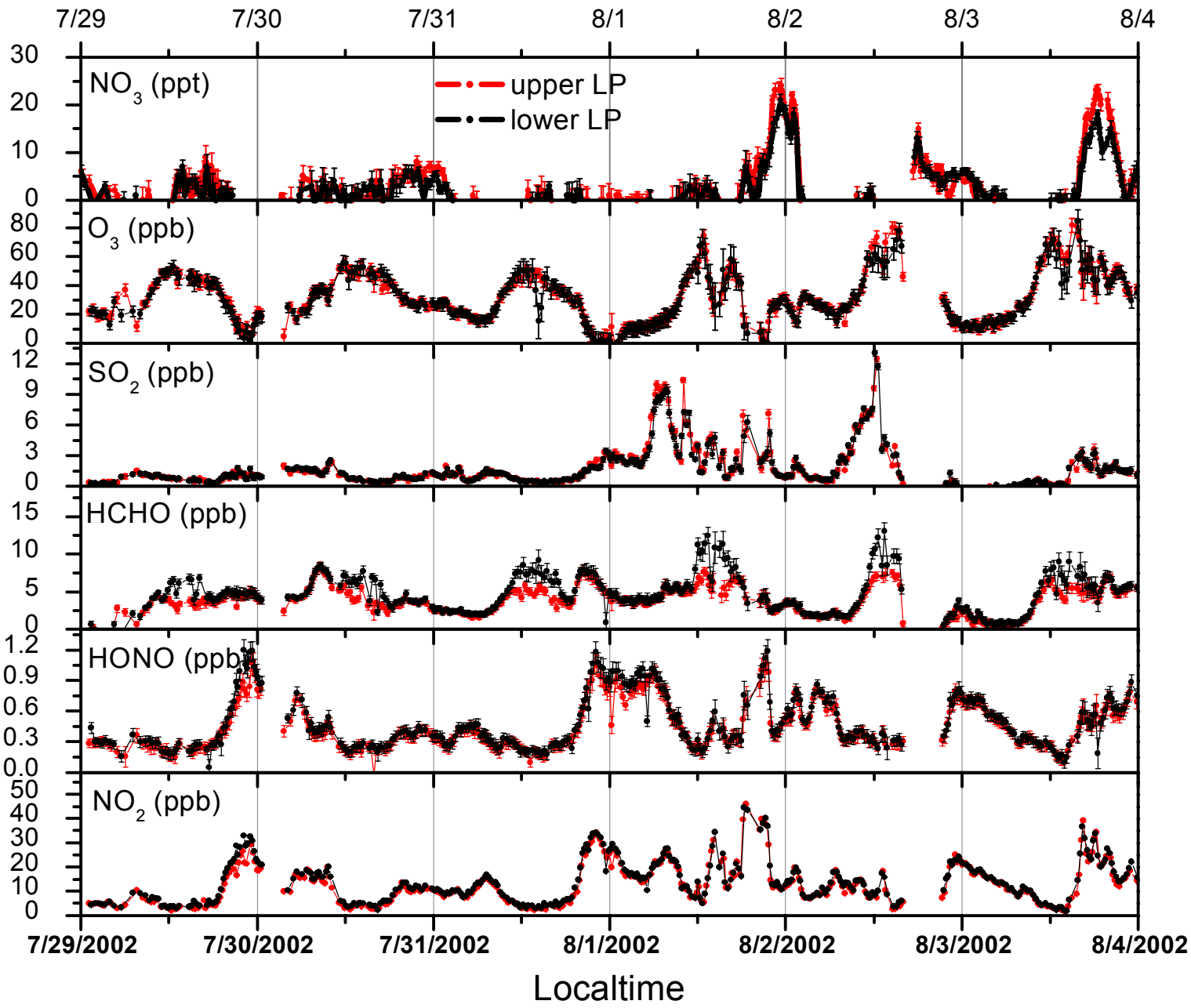
Ground Measurements

Measurement	Instrument	Groups
Aerosol Chemical Composition and Size Distribution	AMS	Boston College / Aerodyne
O_3, NO_2, SO_2, HCHO, HONO, NO_3, H_2O	DOAS	UCLA
NO, NH_3, CO	TDLS	Aerodyne
Met Data	Met Station / Sonic Anemometer	UCLA / PNNL
Temperature and Wind Profiles	Radiosondes Rawinsondes	ANL / UCLA / PNNL
JNO2	Filter radiometer	PNNL

Boston College Ground Site



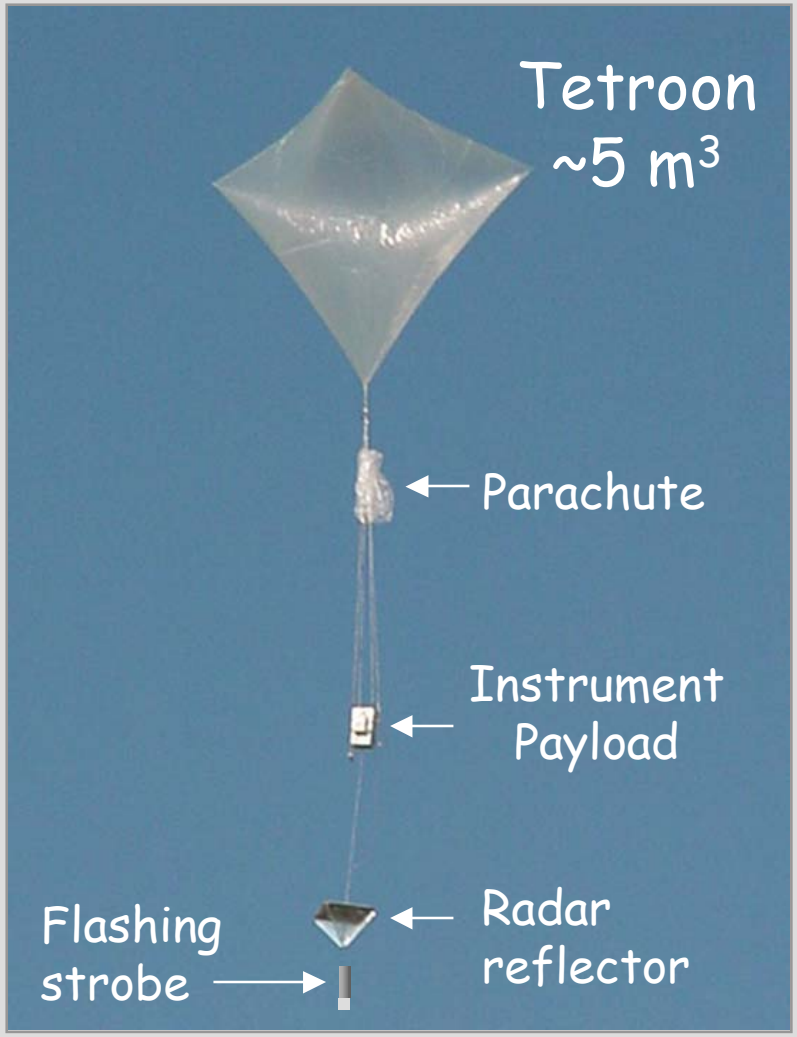
Summary of the DOAS Measurements



G-1 Aircraft Measurements

Measurement	Instrument	Groups
Aerosol Size Distribution	FSSP, PCASP, CPC TSEMS	PNNL Brechtel
Aerosol Composition	AMS PILS Single particle TRAC	Aerodyne BNL PNNL
Aerosol Optical Properties	Integrating Nephelometer Radiance PSAP	PNNL
Inorganic Gases	O_3, CO, SO_2 $NO/NO_2/NO_y$	PNNL & BNL BNL
VOC	Canister sampling system	York Univ.
Meteorology	T, P, RH, Dew Pt, Vector Winds (Gust Probe)	PNNL

Tetroon System



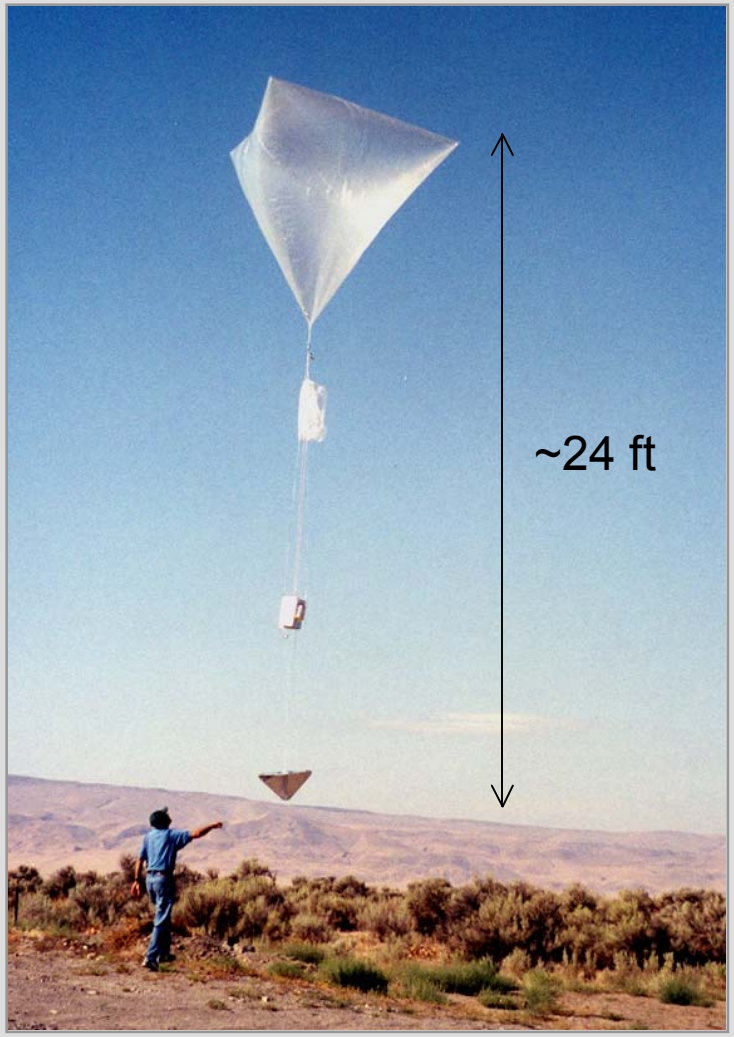
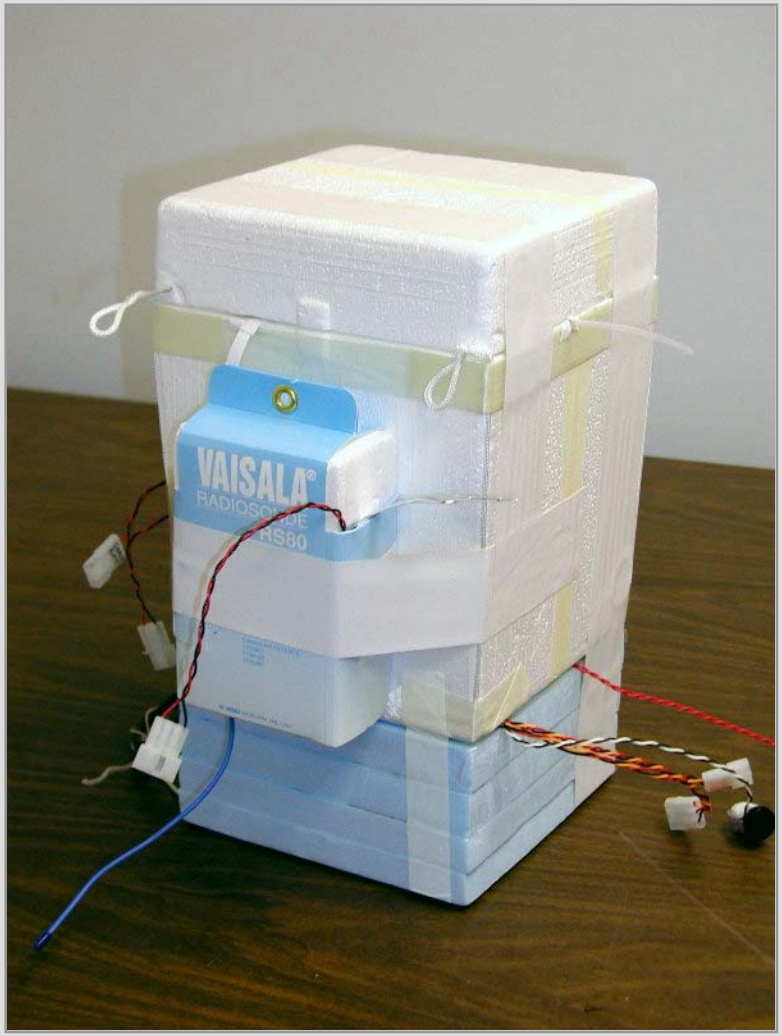


Photo credit: John Hubbe

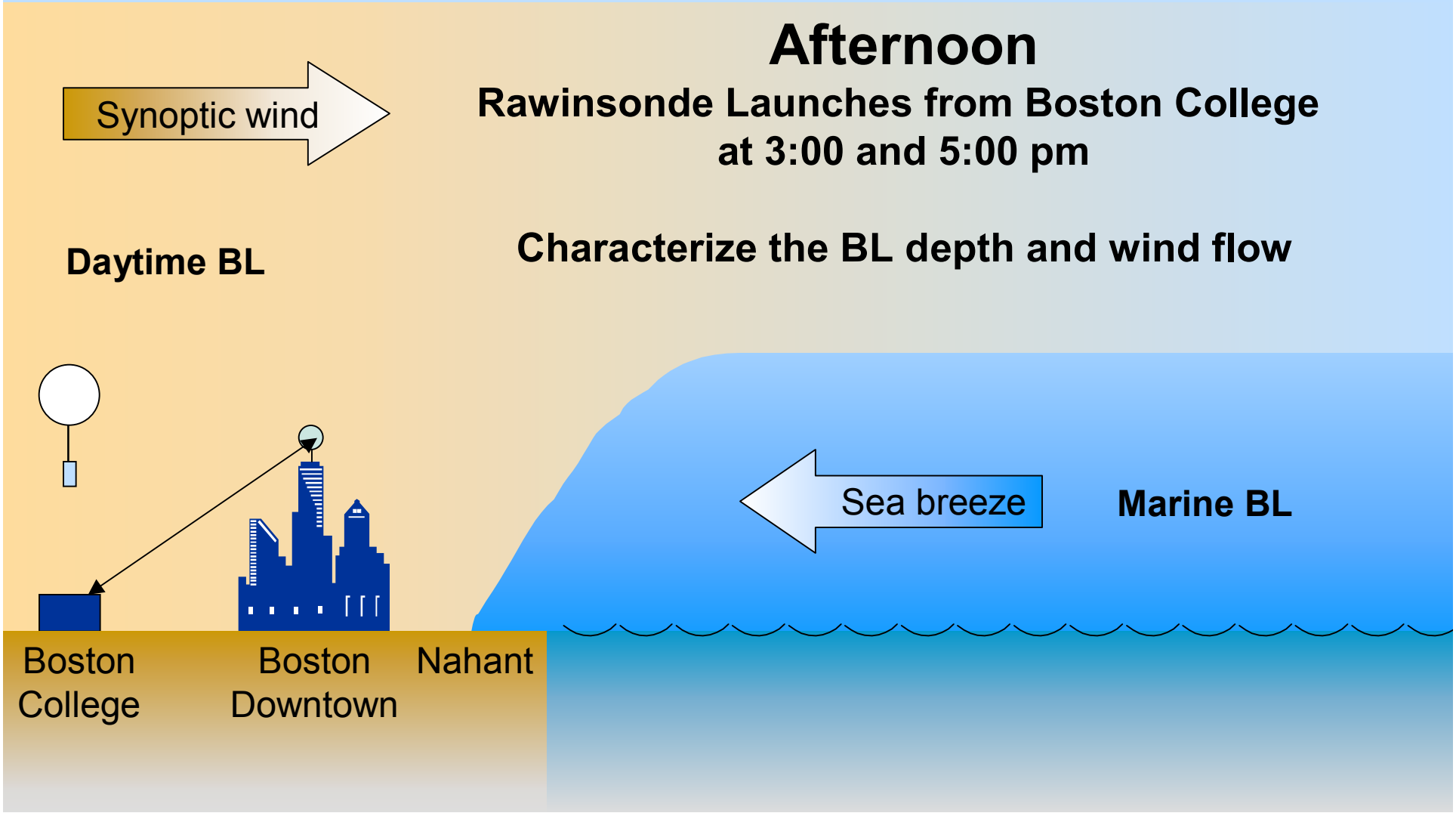
Tetroon Measurements



Instrument Payload

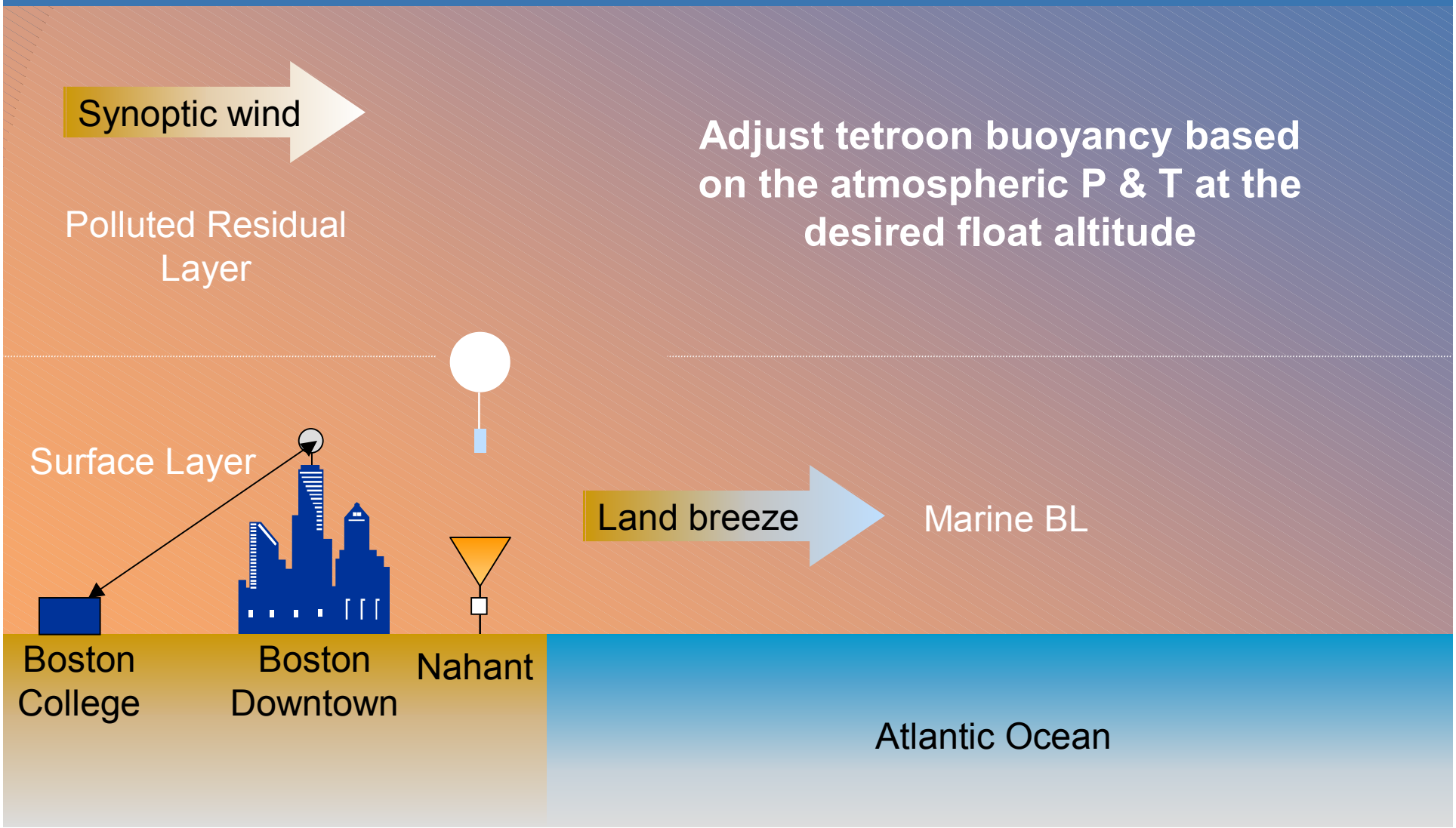
- Ozonesonde → O_3
- Radiosonde → P, T, RH
- GPS → Lat, Lon, Alt
  → wind speed & dir
- Timer-based terminator
- On-command terminator

Experiment Schedule

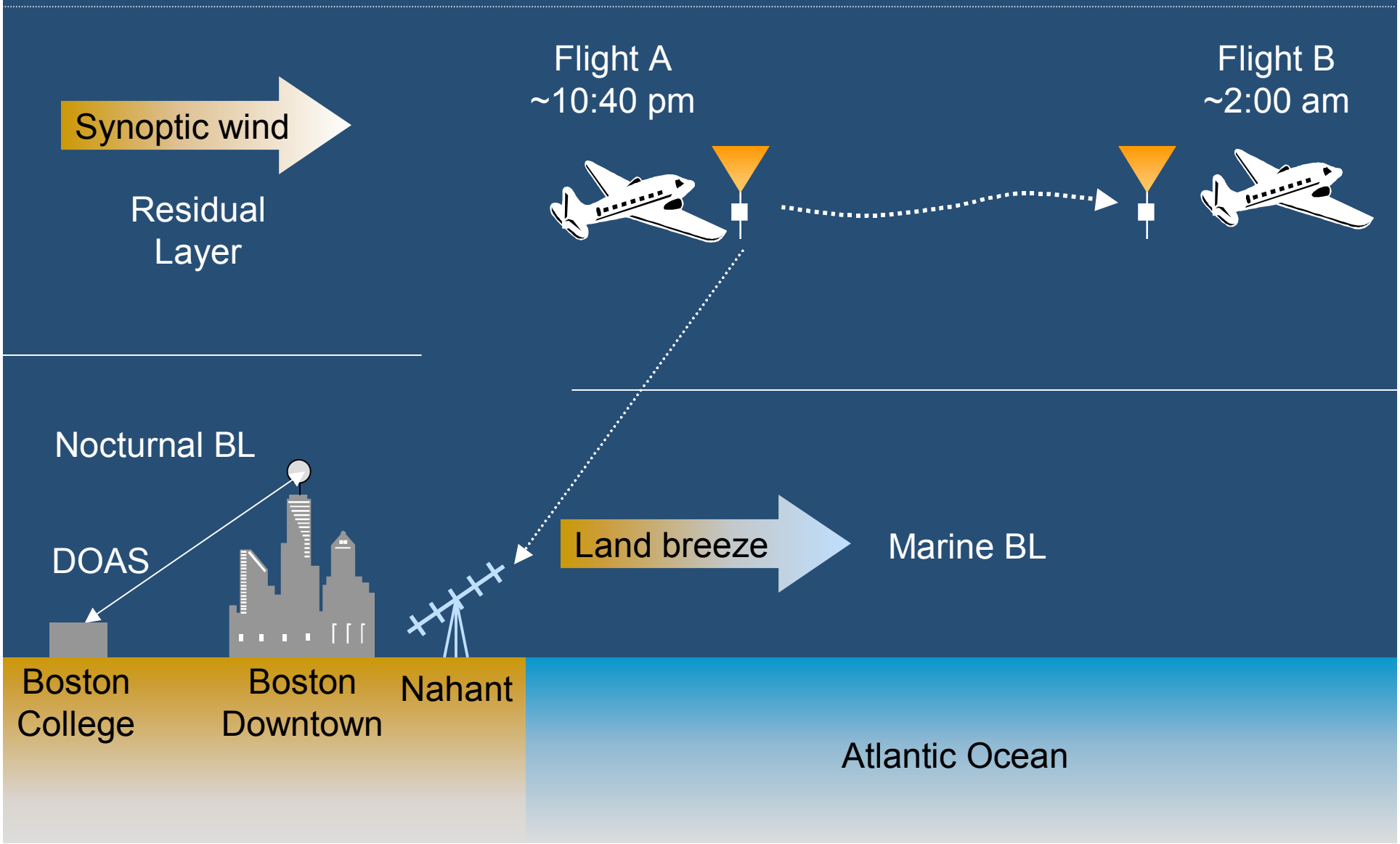


Evening

Rawinsonde Launches at 5:00 and 7:00 pm
Tetroon Inflation: 7:15 pm



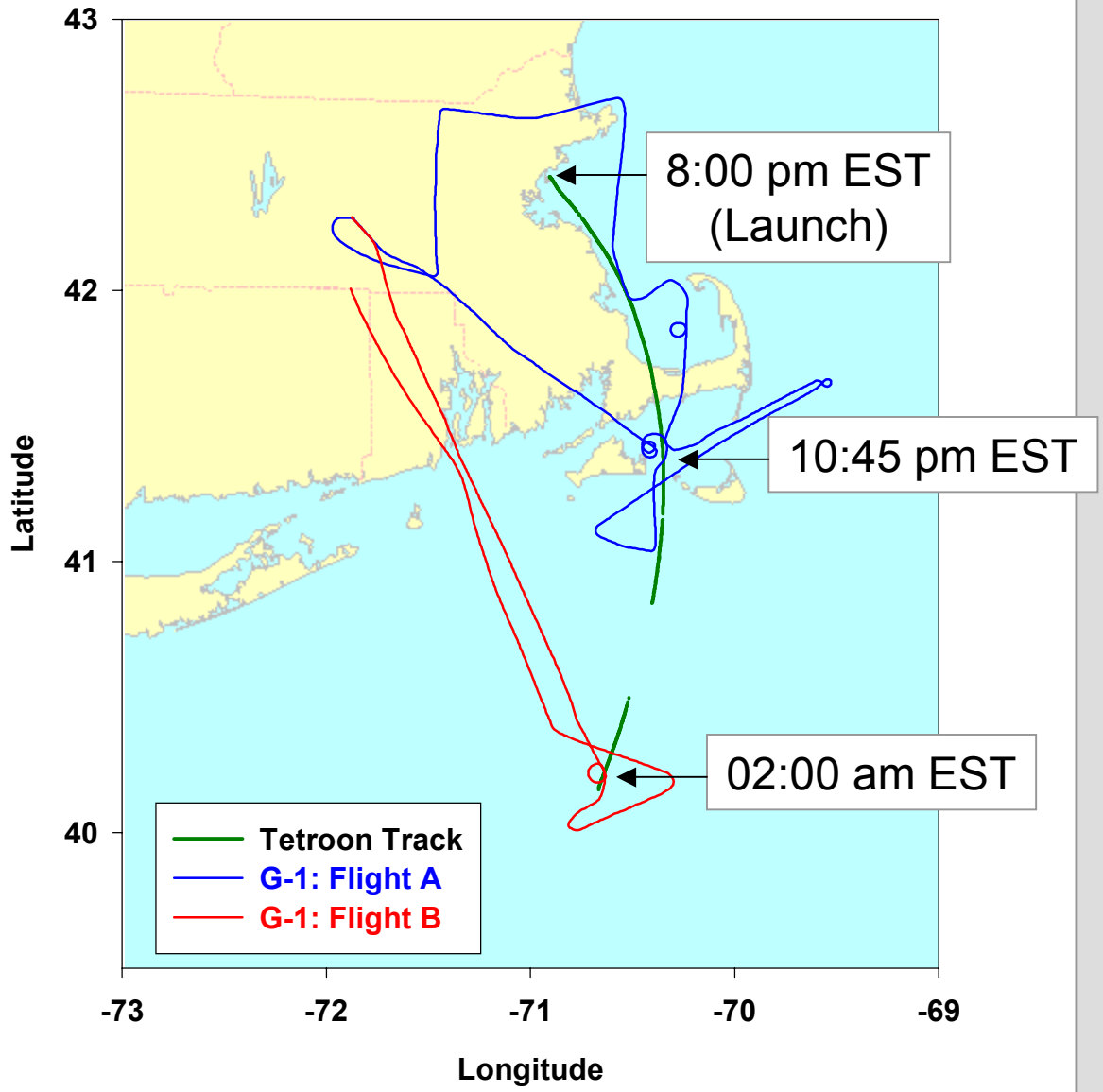
Lagrangian Sampling Strategy



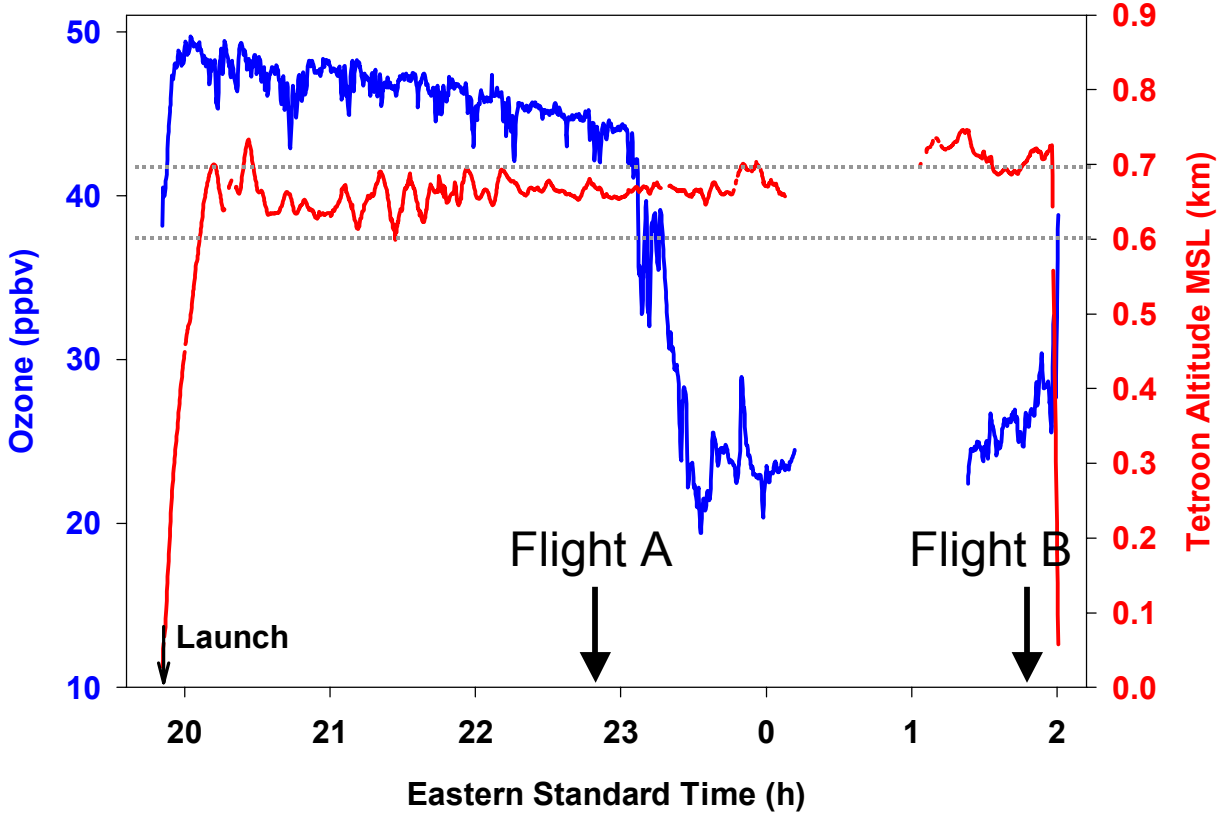
G-1 and Tetroon Flights

Days	Number of Flights	Tetroon Launch
July 29:	1	Yes
July 30	2	Yes
Aug 3	1	No
Aug 4	1	No
Aug 6	2	Yes
Aug 8	1	No
Total: 6 days	8 flights	3 launches

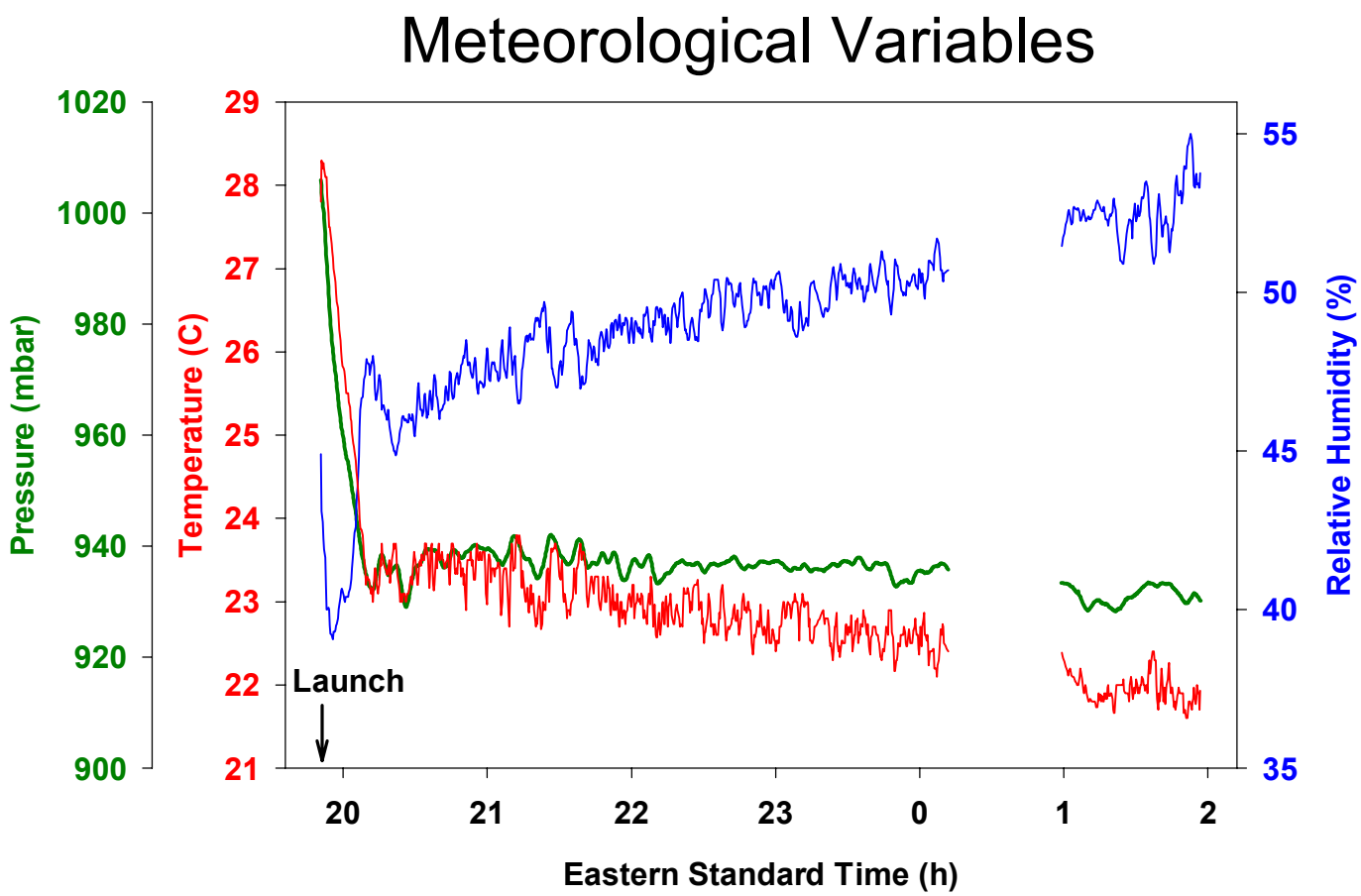
July 30 - 31


43
42
41
40
Latitude
-73
-72
-71
-70
-69
Longitude
8:00 pm EST
(Launch)
10:45 pm EST
02:00 am EST
Tetroon Track
G-1: Flight A
G-1: Flight B

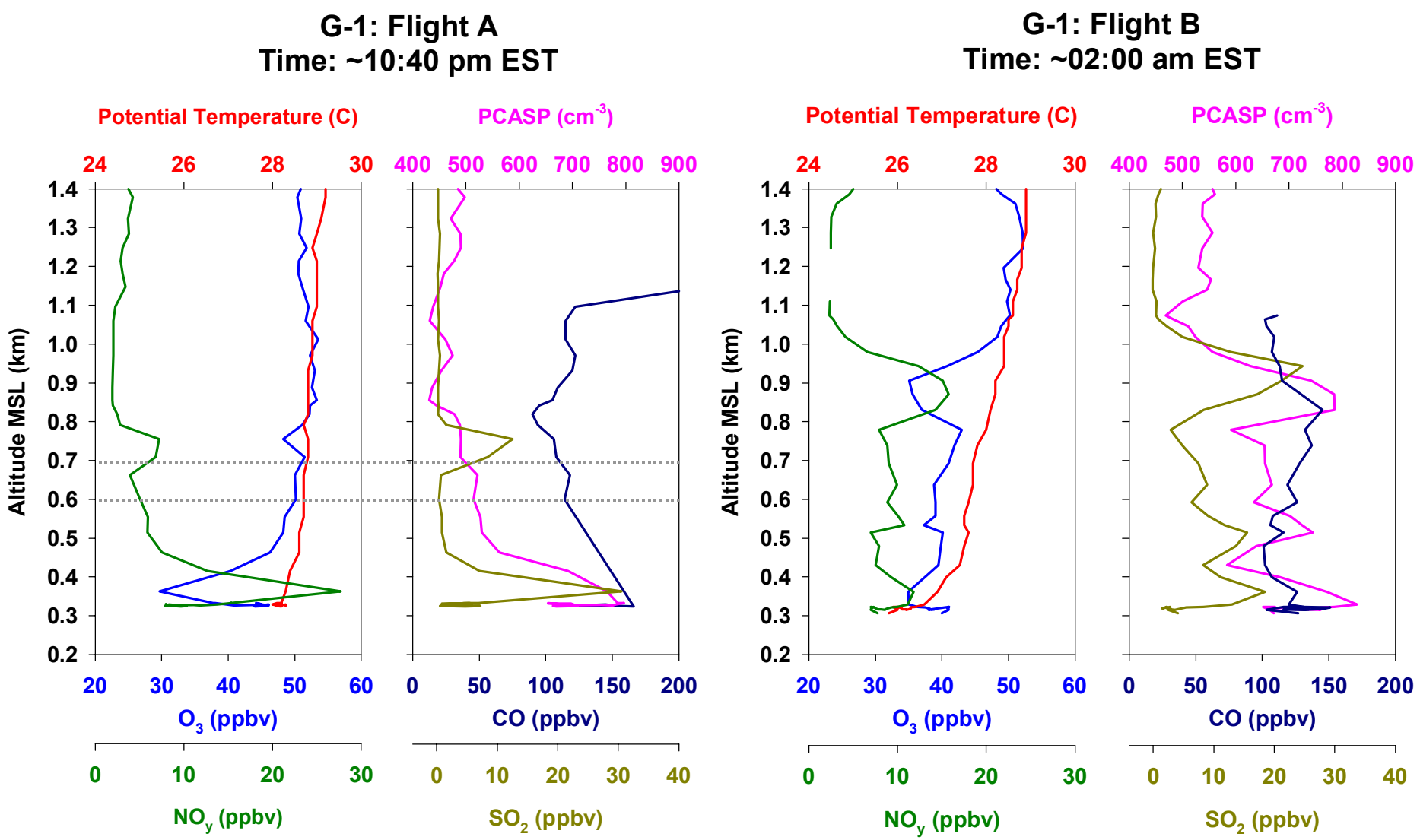
Tetroon Data



Tetroon Data

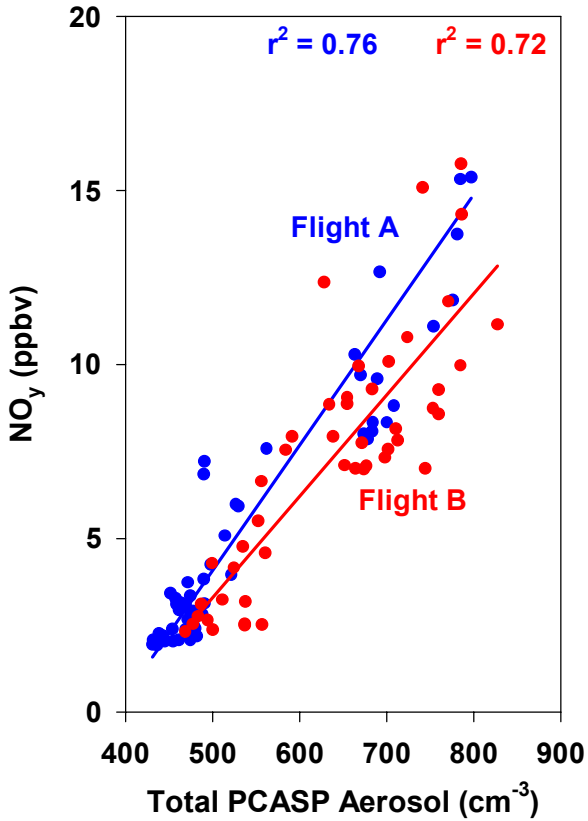


G-1 Vertical Profiles

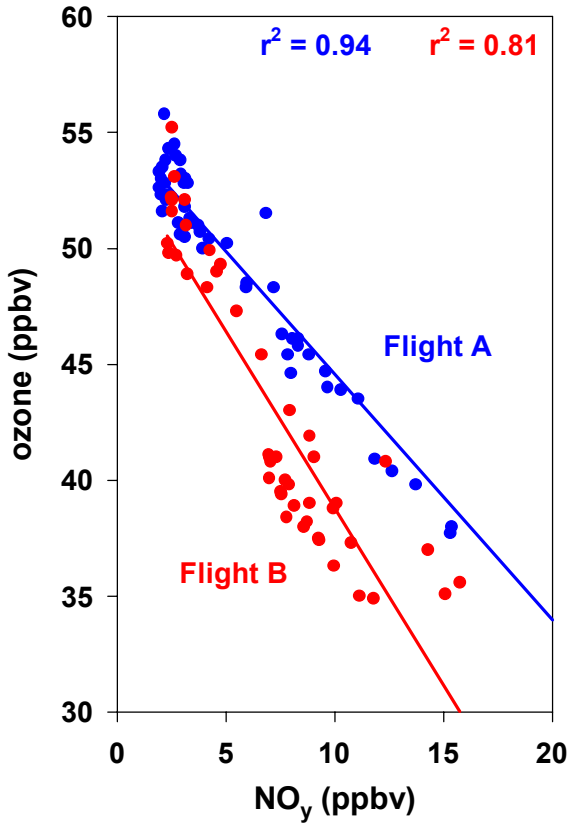


Correlations in Vertical Profiles

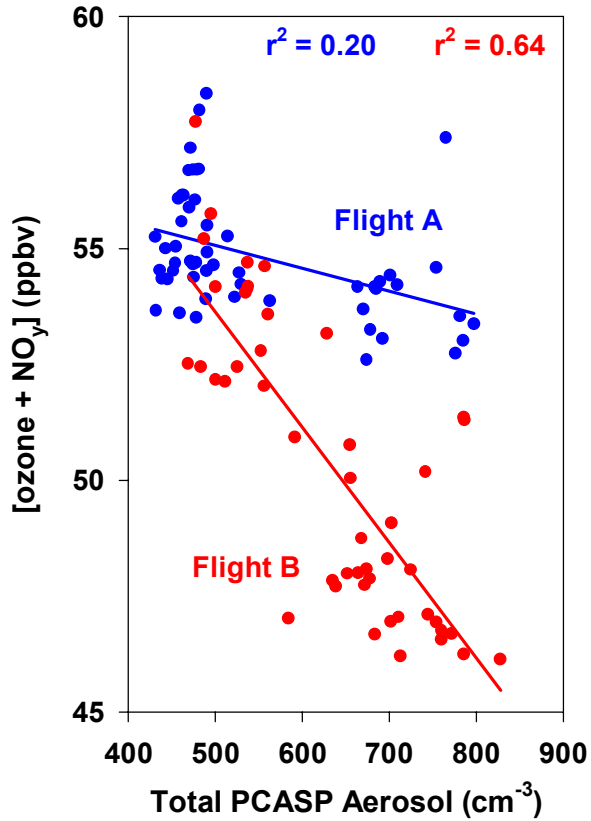
✓ as expected



✓ as expected

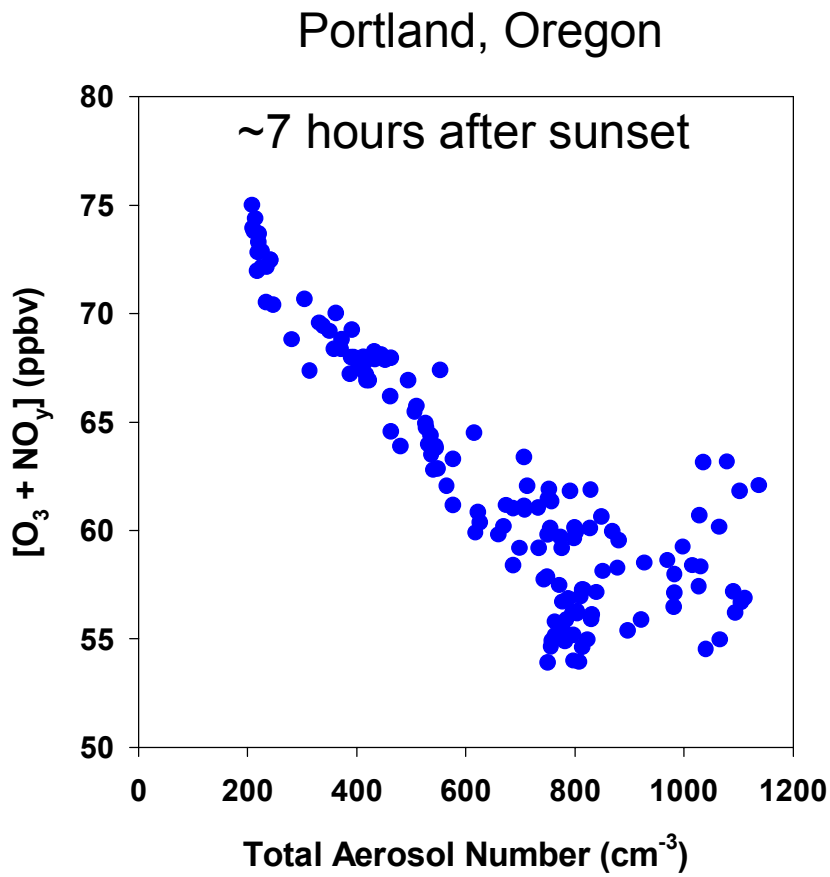


? intriguing ?



Since [O_3 + NO_y] should be conserved at night, it is intriguing to see them anti-correlated, especially later in the night.

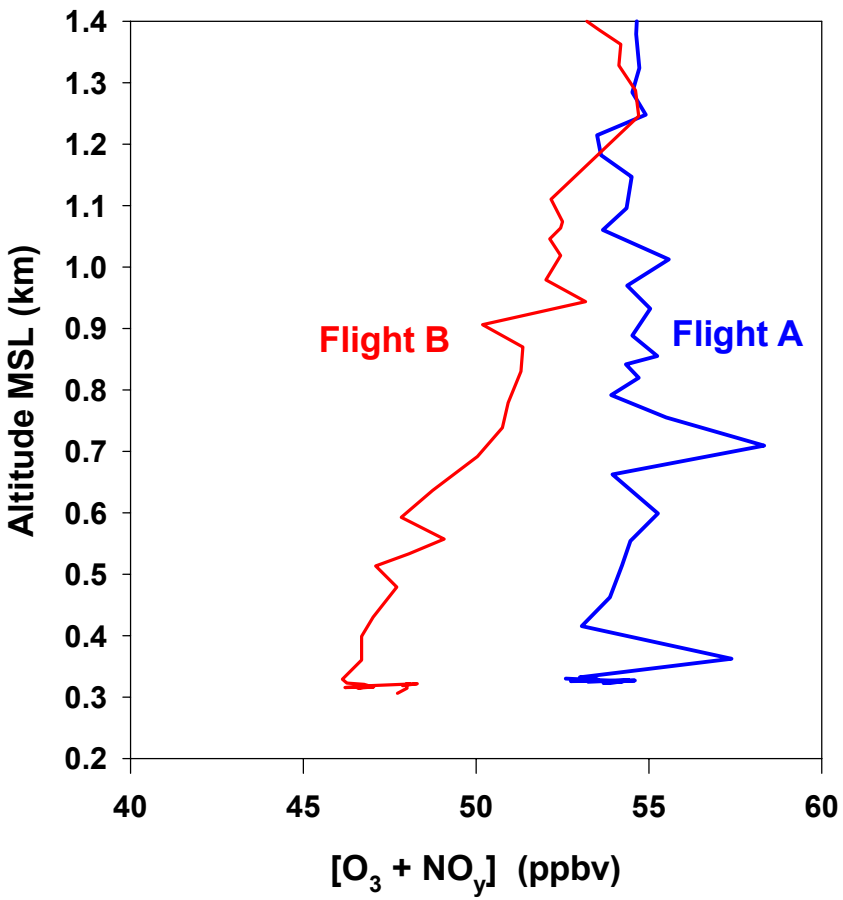
Déjà vu!



We have seen such anti-correlations before elsewhere!

Reference:
Berkowitz et al., Aircraft observations of Aerosols, O_3, and NO_y in a nighttime Urban plume. Atmos. Environ., 35, 2395-2404, 2001

Ozone Loss?



Potential Hypotheses

- Wind shear and/or mixing?
- Gas chemistry (O_3 + alkenes)?
- Heterogeneous chemistry?
- Combinations of the above?

Future Work

- Continue data analysis
- Test various hypotheses against the observed ozone depletion
- Improve the Lagrangian measurement strategy for future field campaigns

Acknowledgements

- Alex Pszenny (UNH), Chester Suchecki, Katie Shaver, and Paul Tracy
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