Nitrogen Oxidants Mercury Aerosol Distributions Sources and Sinks (NOMADSS)

NOMADSS flux objectives:

SOAS

What are the magnitudes, variations, and controlling processes for biosphere-atmosphere fluxes of oxidants and reactive carbon and nitrogen across spatial scales relevant for regional models?

NAAMEX

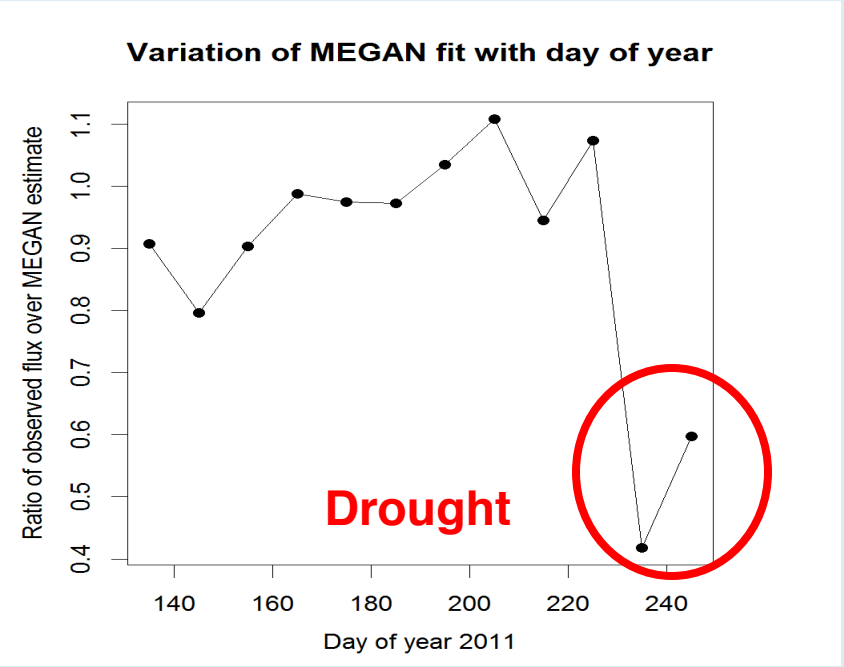
Constrain emissions of Hg from major source regions in the United States

TROPHONO

Constrain sources and sinks of reactive nitrogen in the troposphere

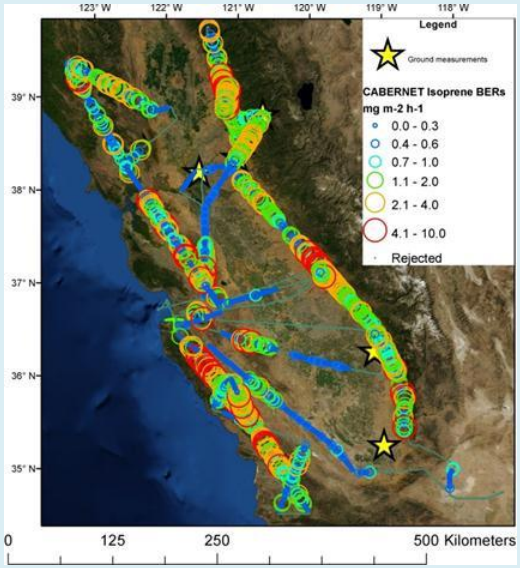
Surface and aircraft flux measurements components: VOC, Ozone, NOx

Surface flux tower: quantify diurnal (30 minutes) to seasonal (weekly) temporal variations



Potosnak et al. in prep

Aircraft fluxes: quantify local (km^2) to regional (1000 km^2) spatial variations

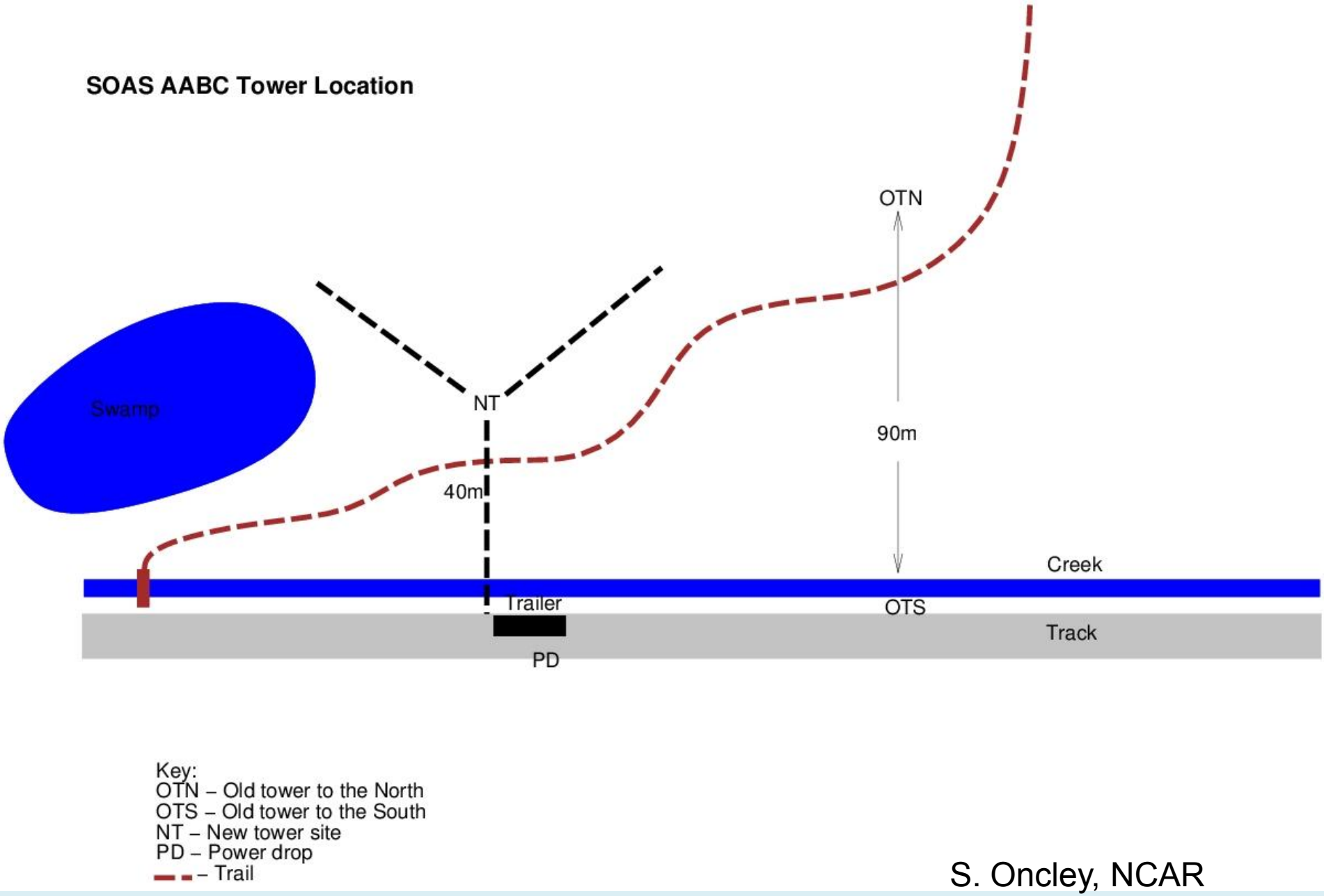


Misztal et al. in prep

Flux tower site in flat bottomland terrain along the Cahaba river. (Alabama state fish hatchery: AABC)

- Cahaba is the longest free flowing river in Alabama (194 miles).
- Cahaba's fish diversity (135 species) greater than any temperate river its size.
- World Wildlife Fund and the Nature Conservancy recognized the Cahaba River as being one of only eight Hotspots of Biodiversity in the world.

Flux tower and trailer



S. Oncley, NCAR

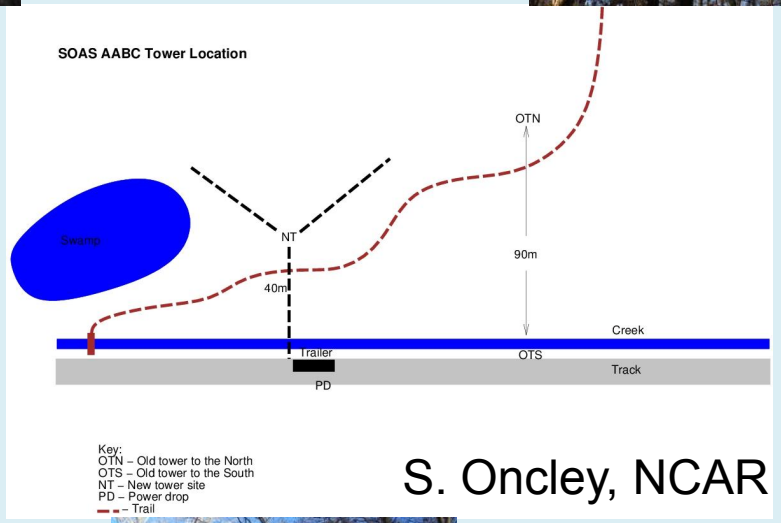
SOAS AABC Tower Site

NW Guy

NE Guy

Adjacent Oak

Adjacent Swamp



S. Oncley, NCAR

Straight Up

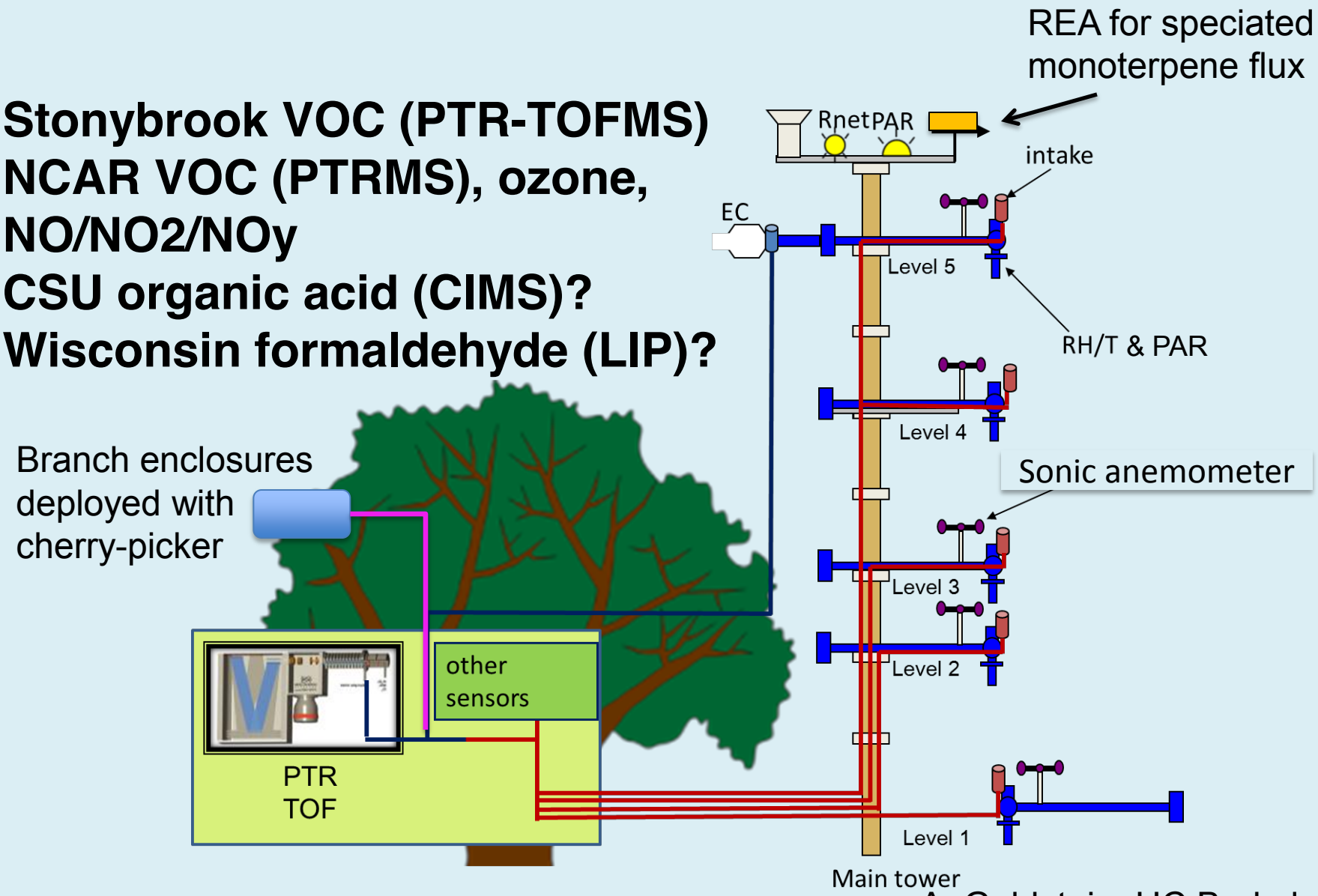
Nice Bench (+Verizon)!

South Guy

Trailer site

Tower flux and gradient (~6 levels) measurements

- **Stonybrook VOC (PTR-TOFMS)**
- **NCAR VOC (PTRMS), ozone, NO/NO2/NOy**
- **CSU organic acid (CIMS)?**
- **Wisconsin formaldehyde (LIP)?**



A. Goldstein, UC Berkeley

1D Canopy-chemistry Modeling

Allison Steiner (UMich) and Serena Chung (WSU)

- CACHE 1D Model (Bryan et al. 2012: CABINEX)

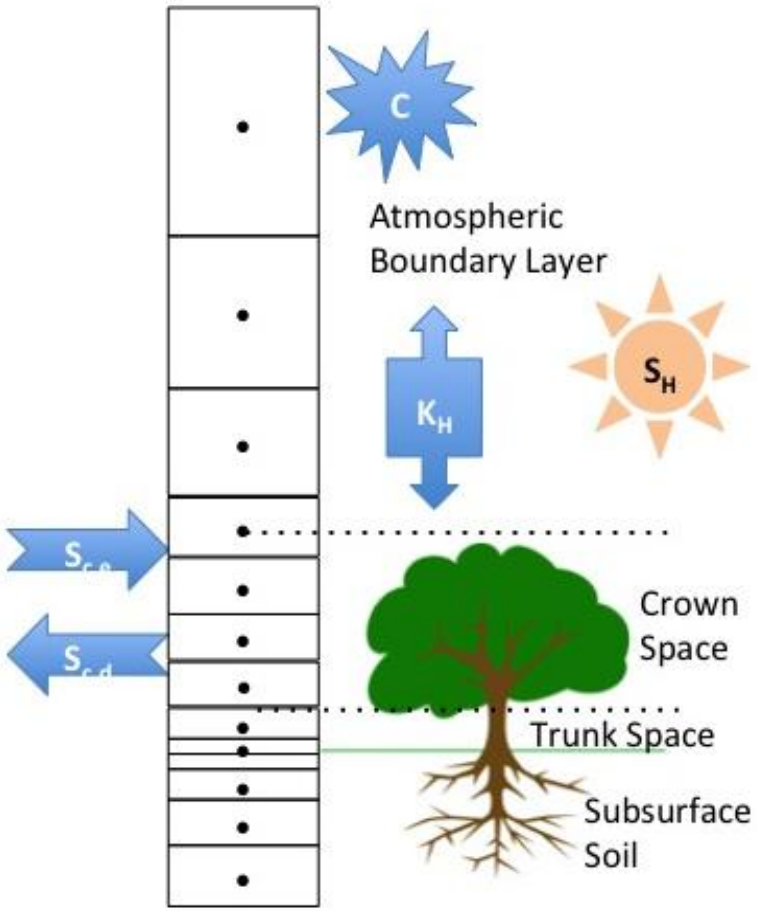


Figure 2. One dimensional model (CACHE) schematic.

Data Needs (Flux tower site)

- Top of canopy PAR
- Wind direction/speed at TOC
- Micromet in/above canopy

Science Questions

- HOx recycling at northern forests
- BVOC contribution to SOA
- Role of anthropogenic NOx

Proposed work

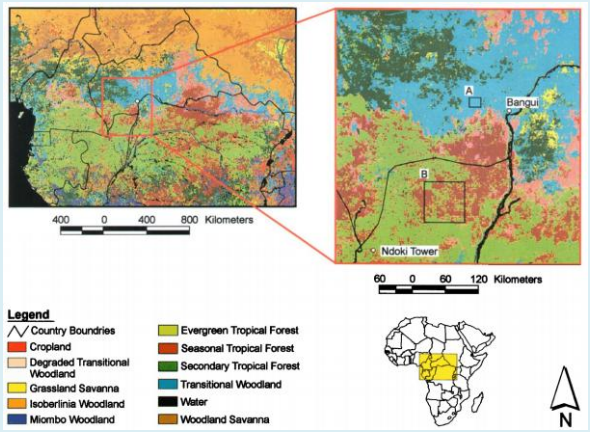
- CACHE Development to include SOA
- Multi-site comparison

- CELTIC (2003), BEARPEX (2008), BEACHON (2010), CABINEX (2009), Harvard Forest, SOAS

Some of the airborne flux study hypotheses:

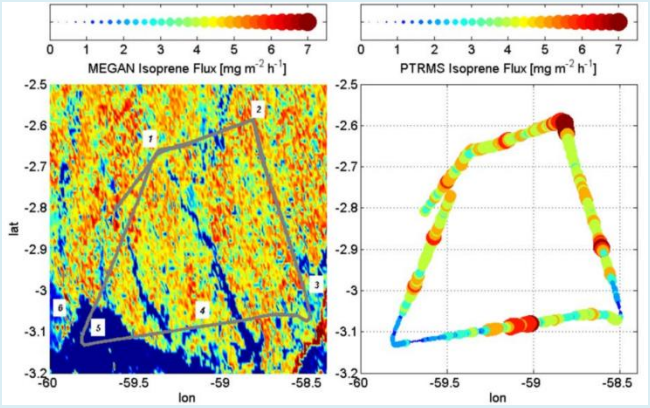
- **Emission models do not include all sources of biogenic VOC (BVOC) and NO.**
- **Monoterpene and methanol emissions are highly correlated with foliage (LAI) but not isoprene.**
- **Bottom-up isoprene emission estimates can be reconciled with top-down (satellite) estimates if we quantify OH loss rates and vertical transport dynamics.**
- **Better understanding of atmospheric chemistry will improve top-down bottom-up diffusion functions used to estimate isoprene fluxes from mixed layer gradients.**

Airborne BVOC flux measurements



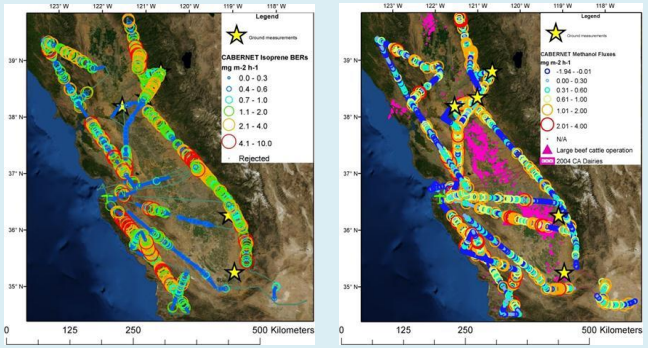
EXPRESSO: Central Africa 1996
REA (Greenberg et al. 1999)

~20 flight hours to get 2 fluxes:
tropical forest and savanna



TROFFEE: Amazon 2004
PTRMS variance (Karl et al. 2007)

~8 flight hours to get 7 fluxes:
primary tropical forest, secondary forest, mixed crops, soybean, pasture, urban, water

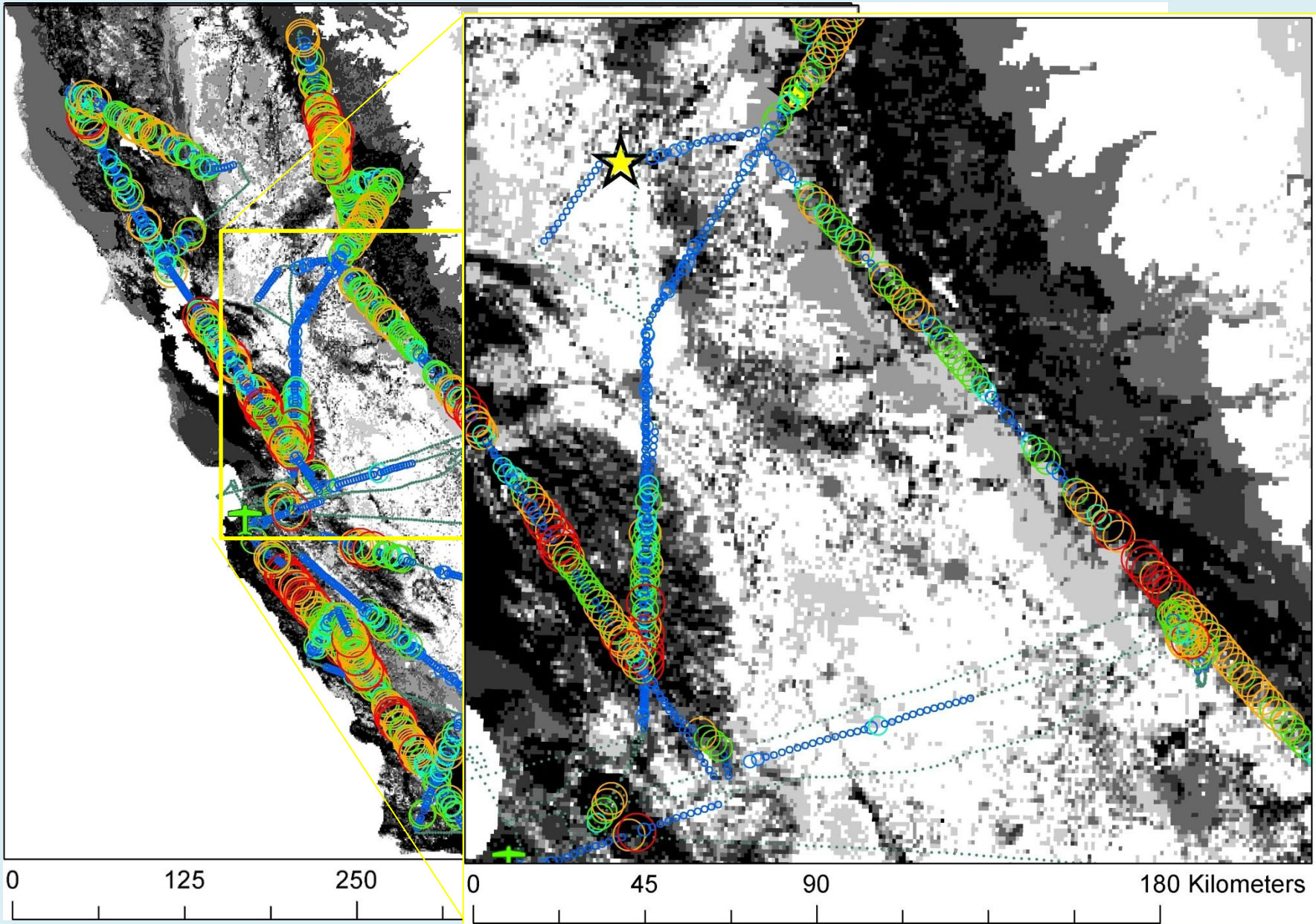


CABERNET: California 2011
PTRMS eddy covariance (Karl et al. submitted; Misztal et al. in prep)

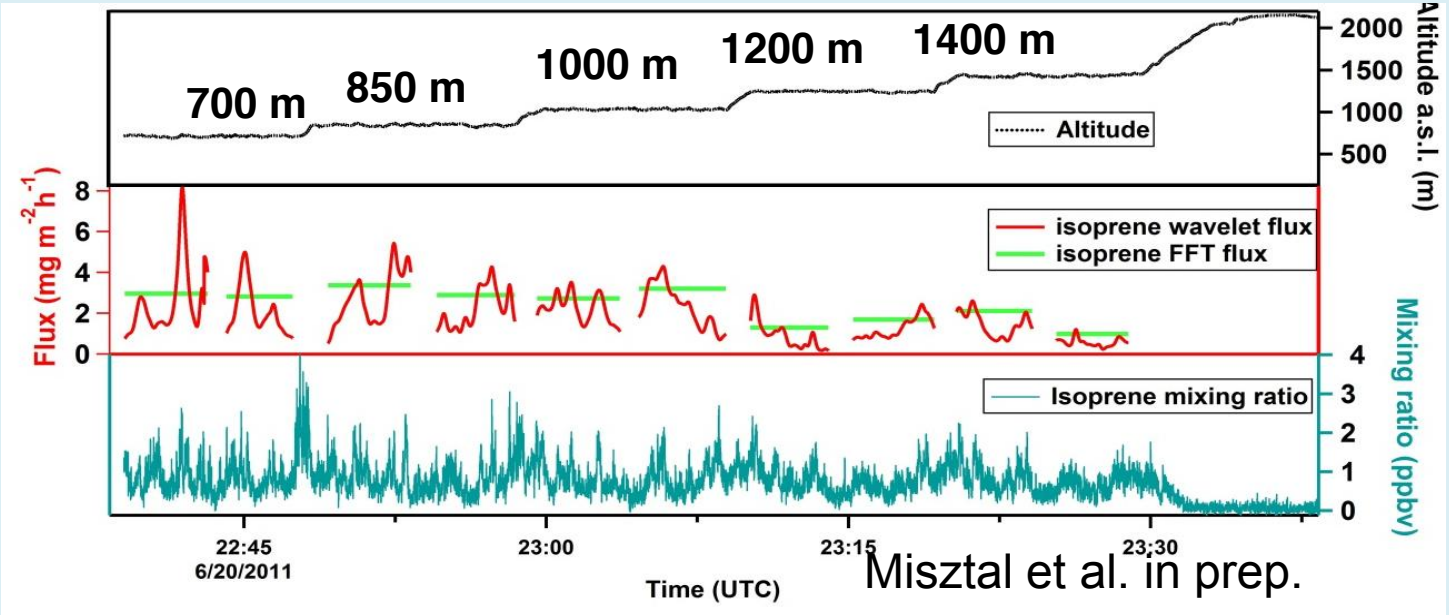
~40 flight hours to get >1000 fluxes:
Oak woodlands, pine forest, shrublands, grasslands, agriculture

MEGAN Landcover 2.2 vs CABERNET

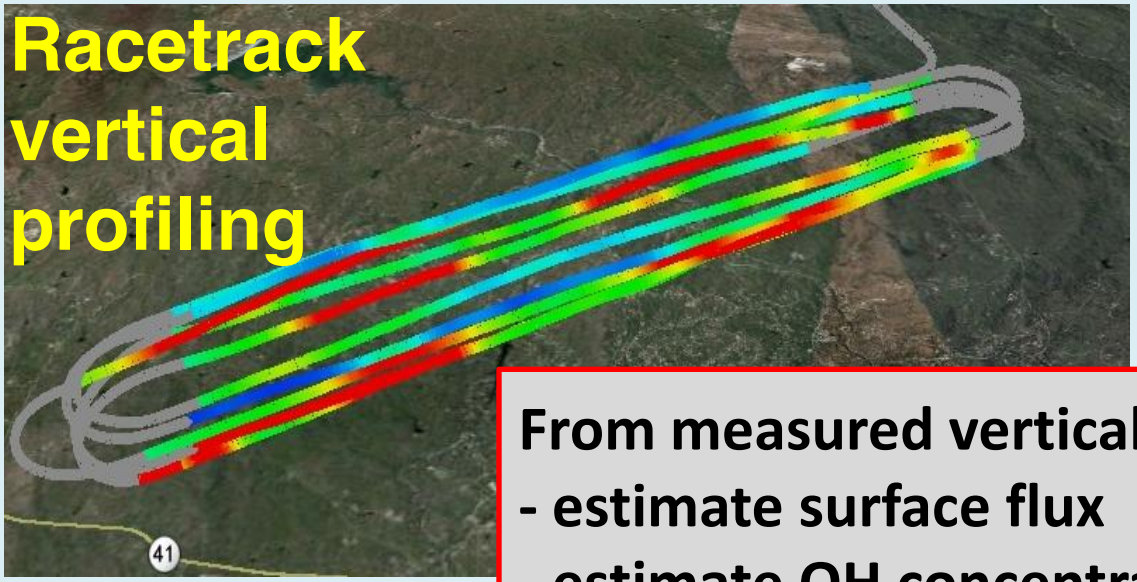
Misztal et al. in preparation



Wavelet technique provides high spatial resolution



Misztal et al. in prep.



mg m^{-2} h^{-1}

- >3.00
- 2.25
- 1.50
- 0.75
- 0.00
- rejected

From measured vertical flux divergence:

- estimate surface flux

- estimate OH concentration

NOMADSS airborne fluxes

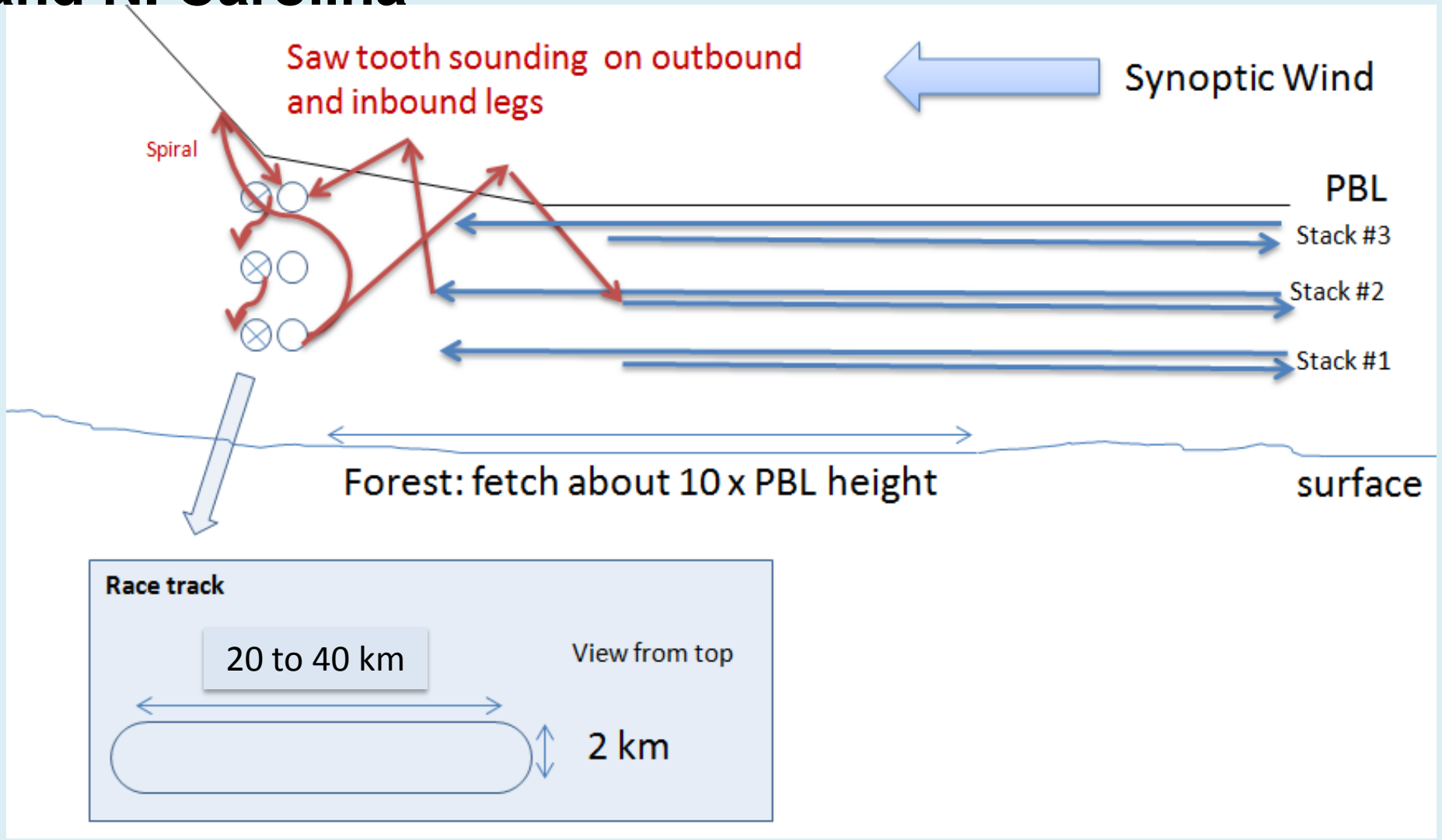
Note that fluxes will be estimated from both natural and built landscapes

<u>NSF/NCAR C130</u>

- **Eddy covariance flux measurements of isoprene, monoterpenes, methanol (PTR-cTOFMS), Ozone?, NO?**

- Flux-gradient estimates: many VOC (Fast-GCMS), many compounds (DOAS), particles (SMPS), HONO, Hg, CO

C130 stacked “racetrack” vertical flux profiling:
-repeated profiling near SOAS site in AL
-also flights near flux towers in Missouri, Indiana, and N. Carolina



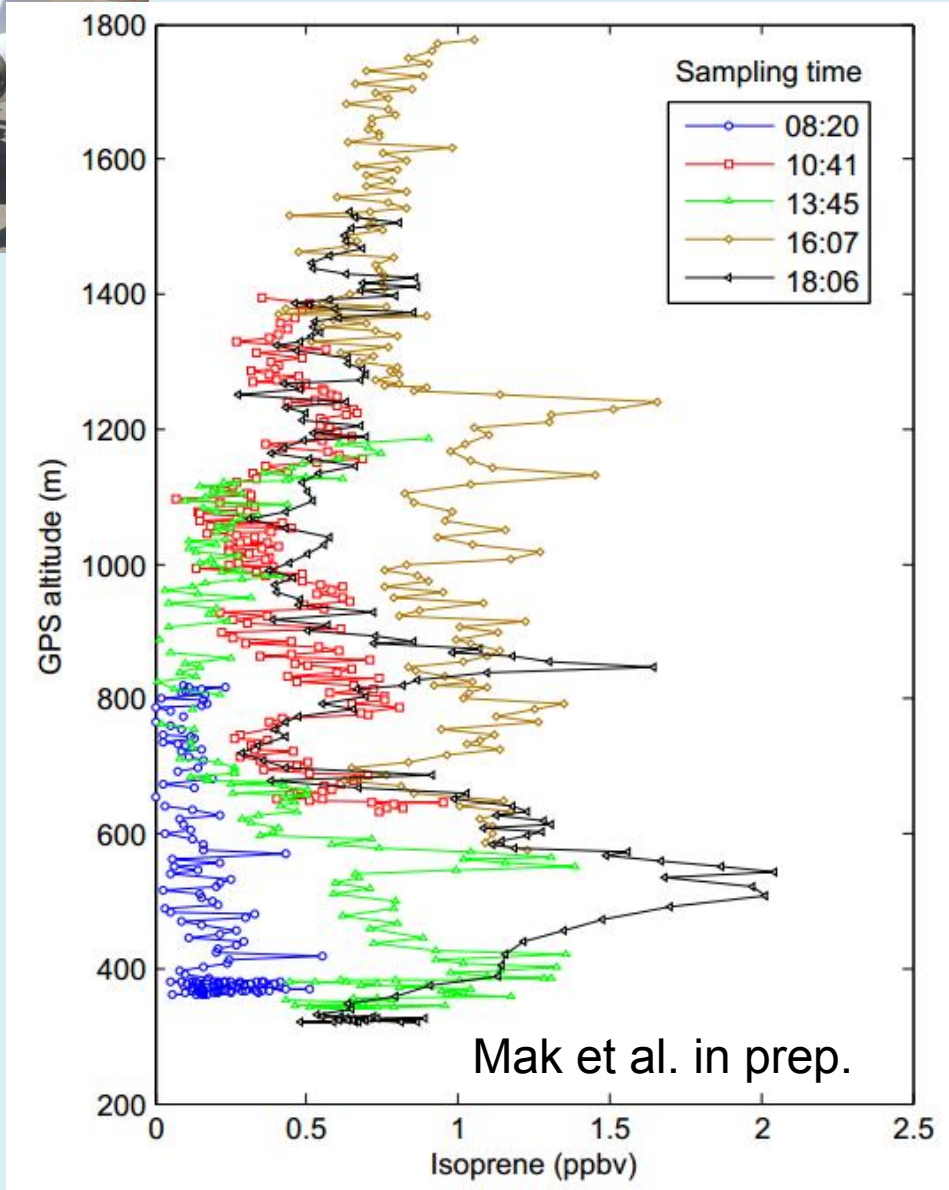
NOMADSS airborne fluxes

John Mak's Long EZ

- REA flux measurements of isoprene/MT
- Vertical profiles of isoprene and products using WASP and analyzed by PTR-TOFMS

Paul Shepson's Duchess

- Vertical profiles of VOC using canister sampling



Summary

- **Coordinated ground (flux tower) and aircraft measurements (C130 and other aircraft)**

- **VOC fluxes and possibly other compounds by direct Eddy Covariance (EC) and Relaxed Eddy Accumulation (REA) will improve understanding of the process controlling diurnal to seasonal variations (tower) and local to regional variations (aircraft)**

- **May be able to estimate fluxes of other compounds using mixed layer gradients (constrain reactive nitrogen, oxidants, mercury, and aerosol sources and sinks).**