

# Ocean/Atmosphere Links Using Spatial Variability: NAAMES-2 Clear Slot Case Study

Luke Ziemba and LARGE

NAAMES Science Team Meeting

6/17/2019

# NAAMES Science Objectives



## Overarching Science Goals

- *Goal #1:* Define environmental and ecological controls on plankton communities to improve predictions of their structure and function for a warmer future ocean
- *Goal #2:* Define linkages between ocean ecosystem properties and biogenic aerosols to improve predictions of marine aerosol-cloud-climate interactions for a warmer future ocean

## NAAMES Baseline Science Objectives

- *Objective #1:* Characterize plankton ecosystem properties during primary phases of the annual cycle in the North Atlantic and their dependence on environmental forcings
- *Objective #2:* Determine how primary phases of the North Atlantic annual plankton cycle interact to recreate each year the conditions for an annual bloom
- *Objective #3:* Resolve how remote marine aerosols and boundary layer clouds are influenced by plankton ecosystems in the North Atlantic



# Case Study Analysis Approach



## 1. Avoid Seasonality

- November: Minimal transport -- minimal biogenic activity
- May: Prevalent long-range transport -- bloom

## 2. Take advantage of aircraft strengths

- Co-located remote sensing and in-situ measurements
- Ability to cover large spatial gradients

*Hypothesis → Spatial gradients can be used to link ocean and aerosol properties*



# Challenges of Spatial Analysis



## 1. Advection

- Decouples ocean source from measurement location
- Introduces non-marine aerosol

## 2. Clouds obscure remote-sensing

## 3. Clouds change composition and concentration of aerosols:

- Wet removal by rain/drizzle
- Aqueous production and re-distribution
- Airmass history is very difficult to assess

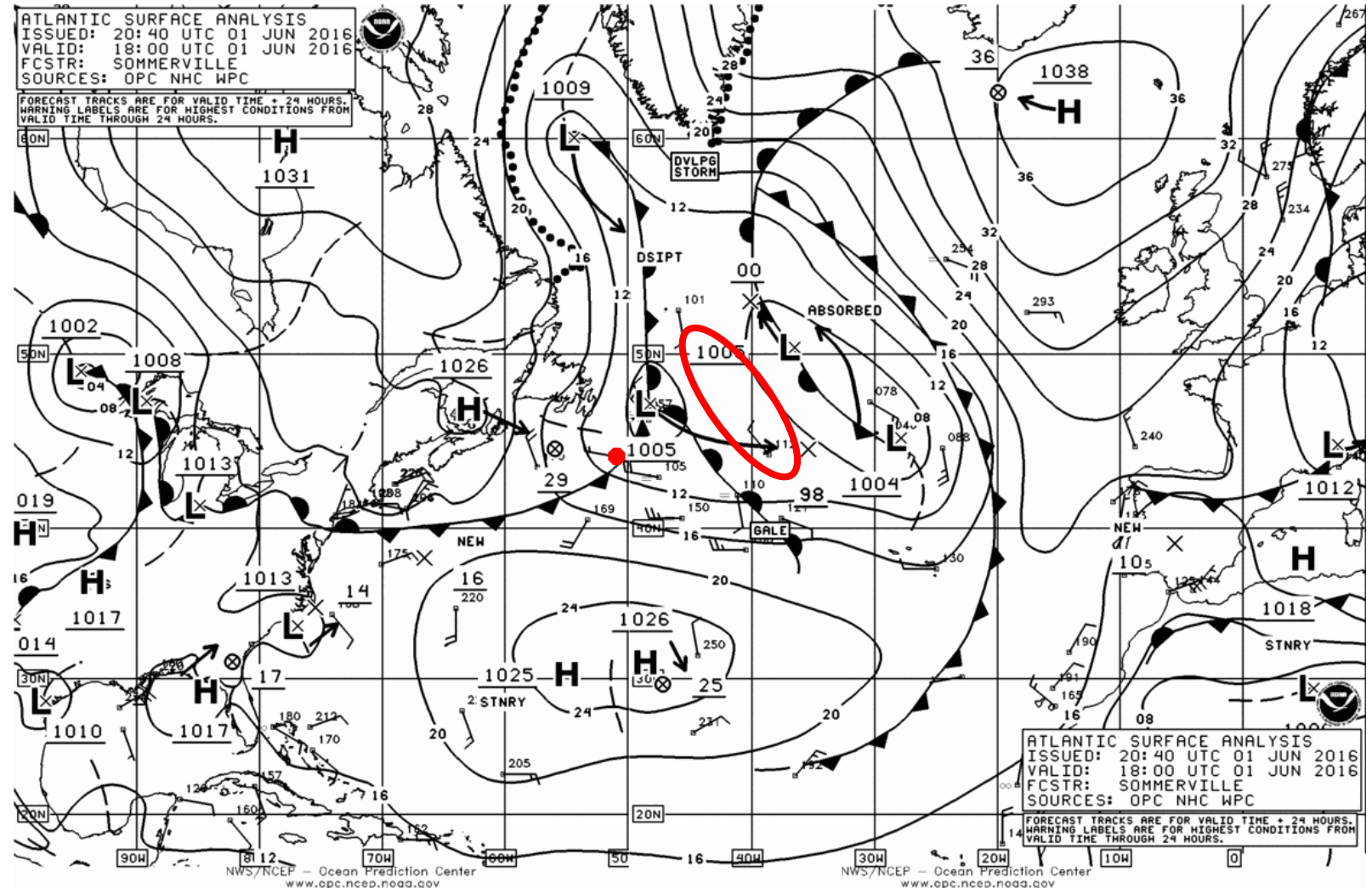
## 4. Meteorology is complicated



# 6/1/16: Meteorology



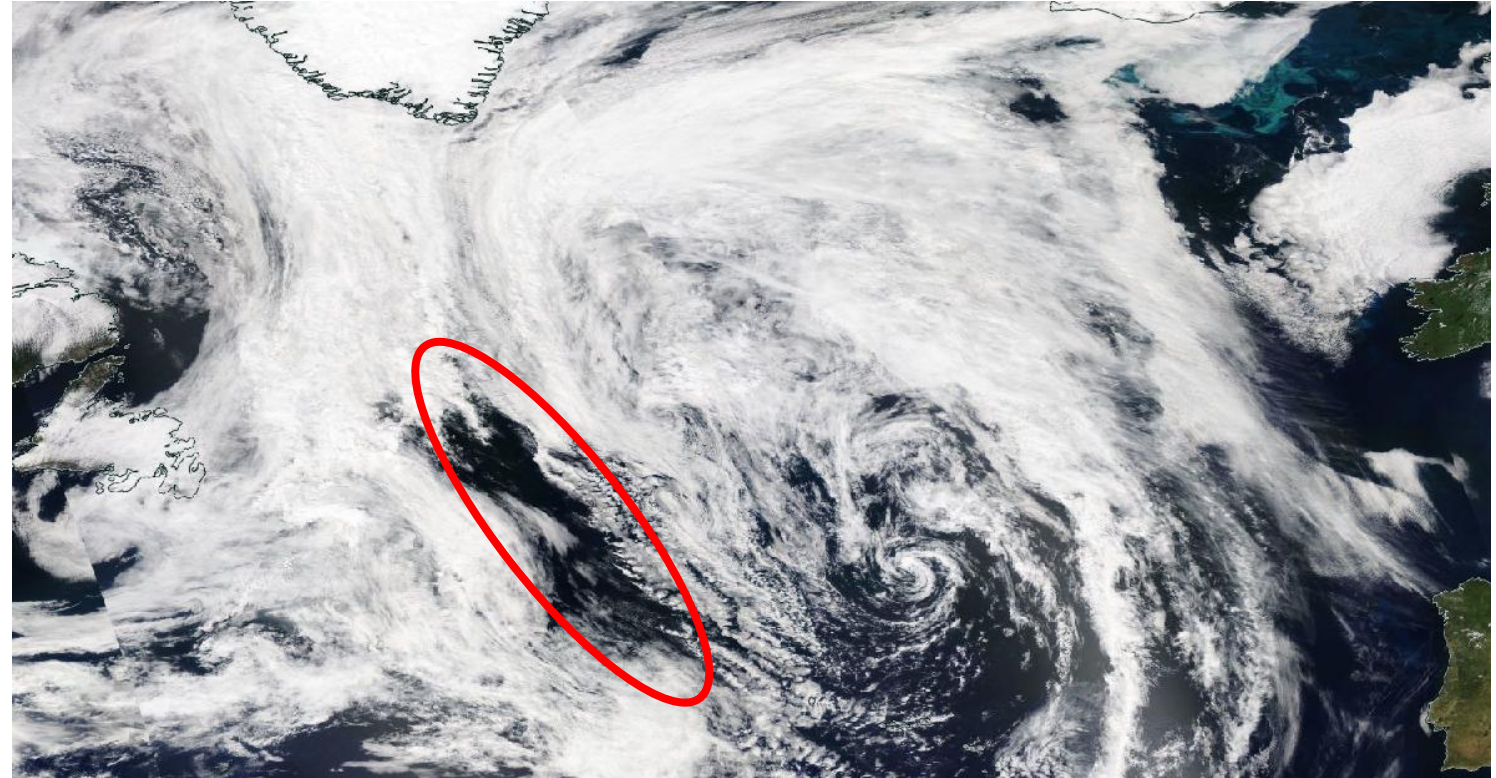
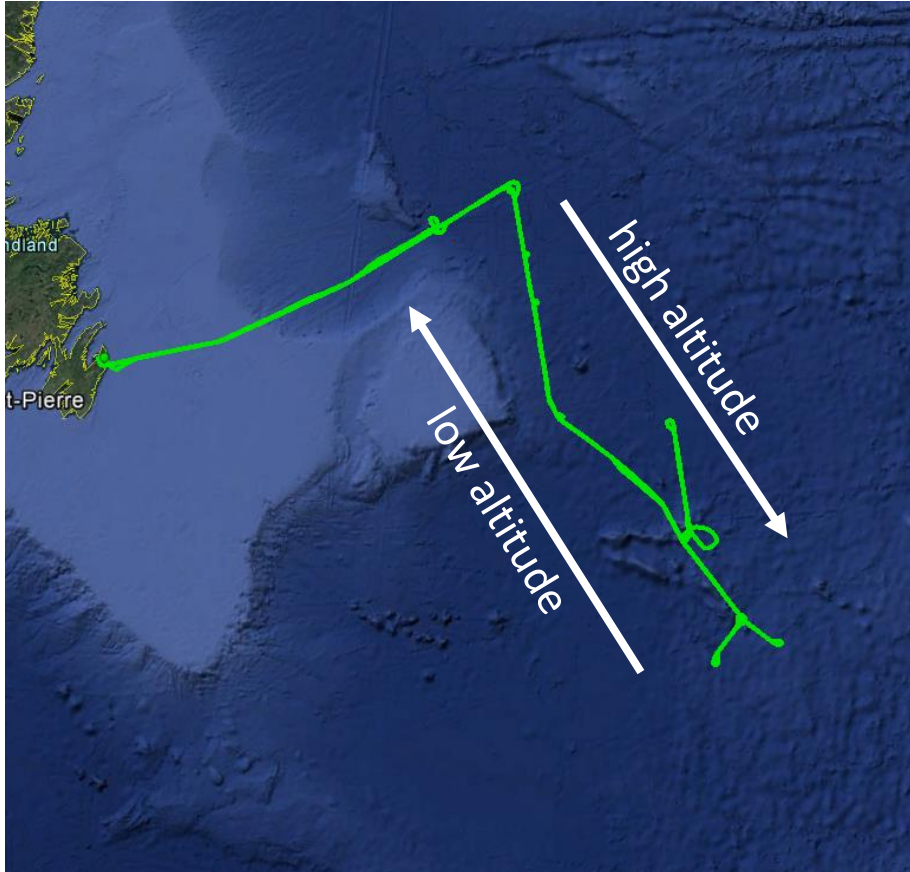
- COL! = Saddle point
- Low wind speeds
- Weak, varying transport
- Subsidence resulting suppressed clouds



NAAMES

*Shook Surface Analysis*

# 6/1/16: Meteorology



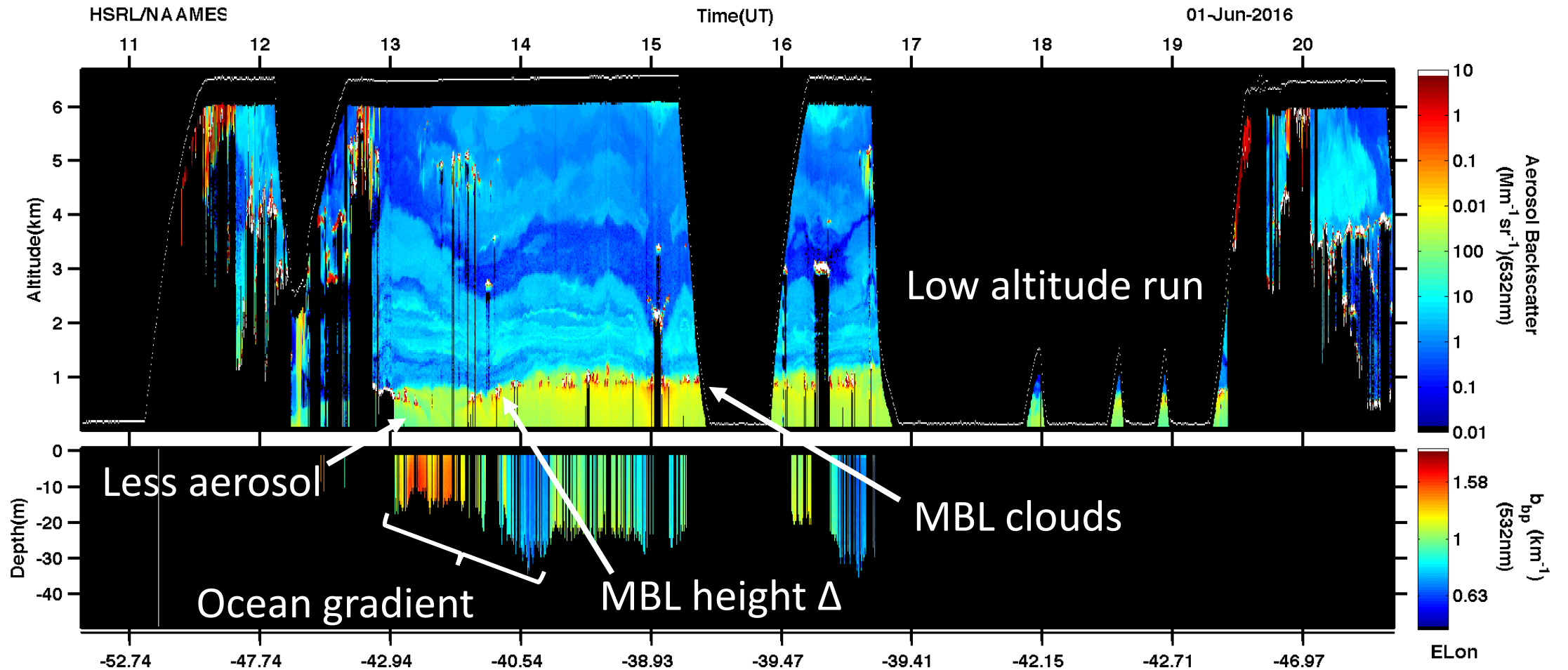
~460 nm (one-way)

~6.3 hours between North points

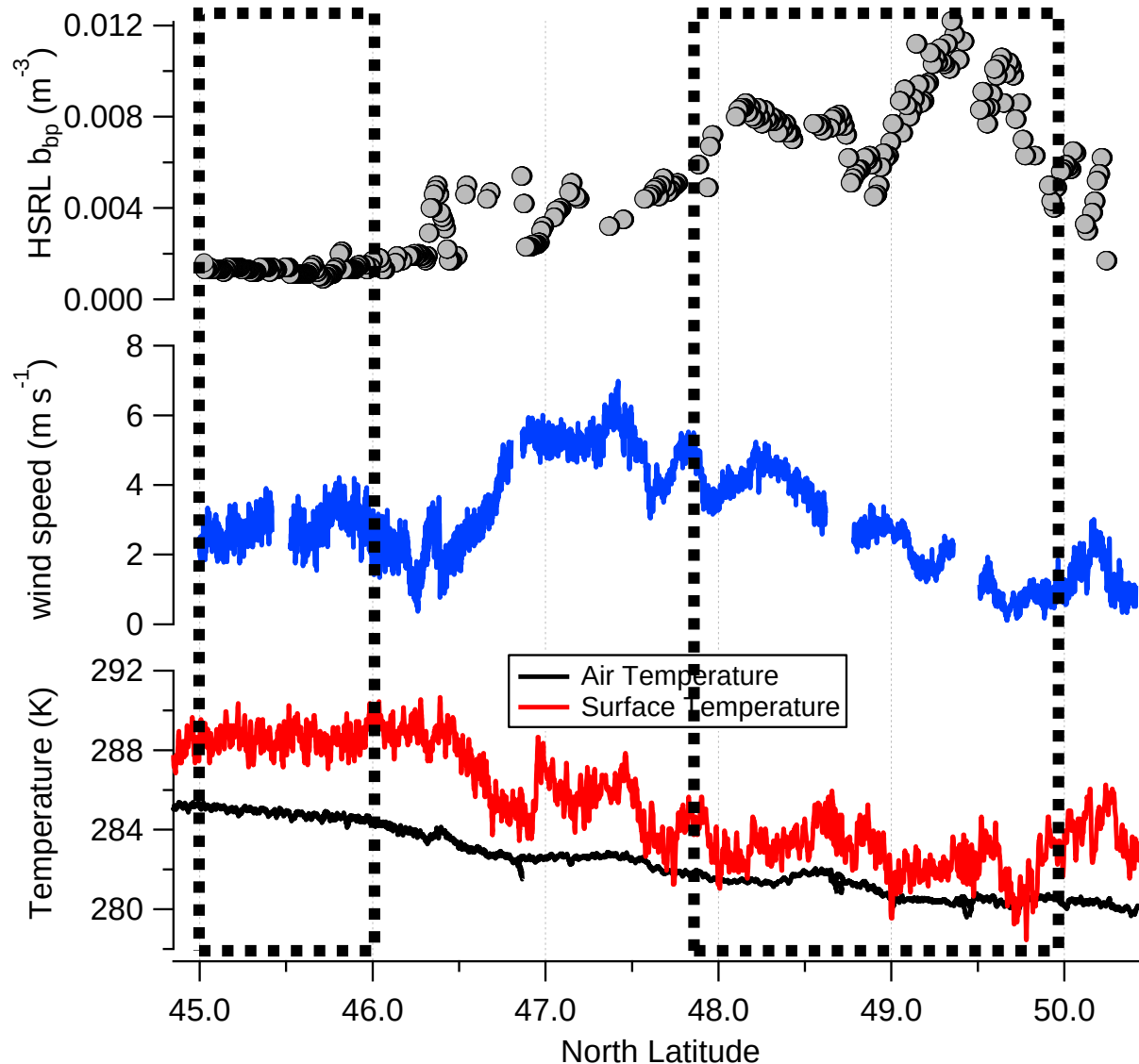


*MODIS-Aqua*

# 6/1/16: Flight Overview



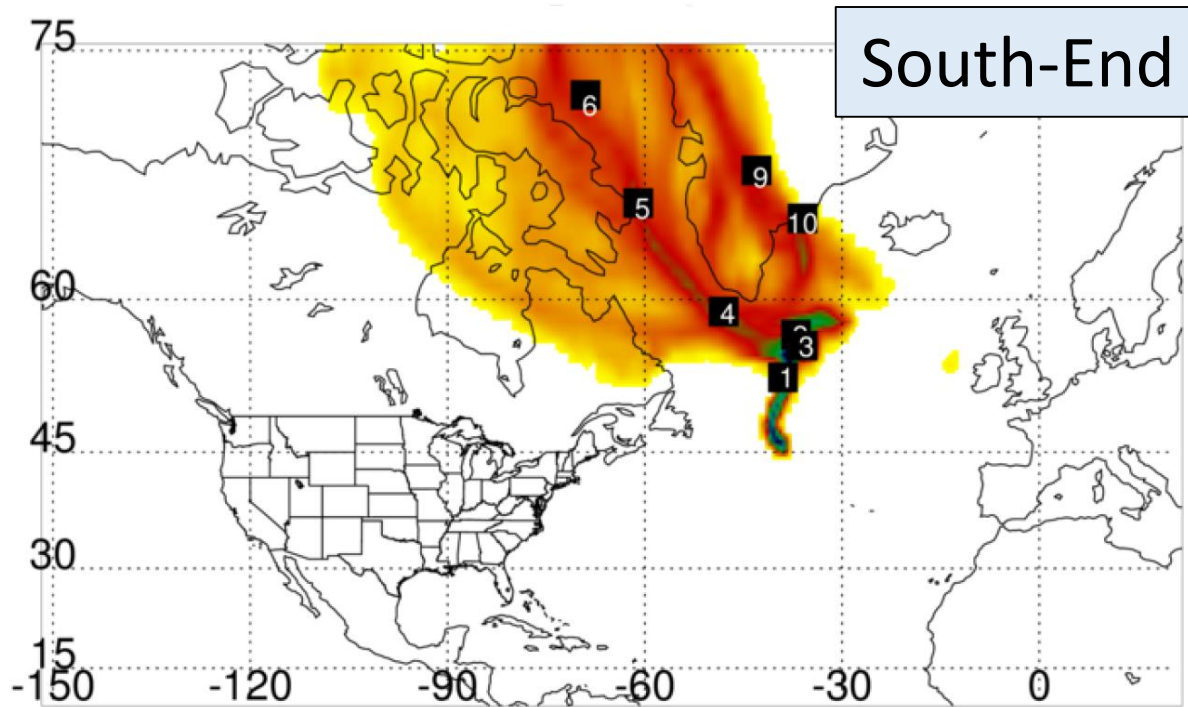
# 6/1/16: Spatial Variability



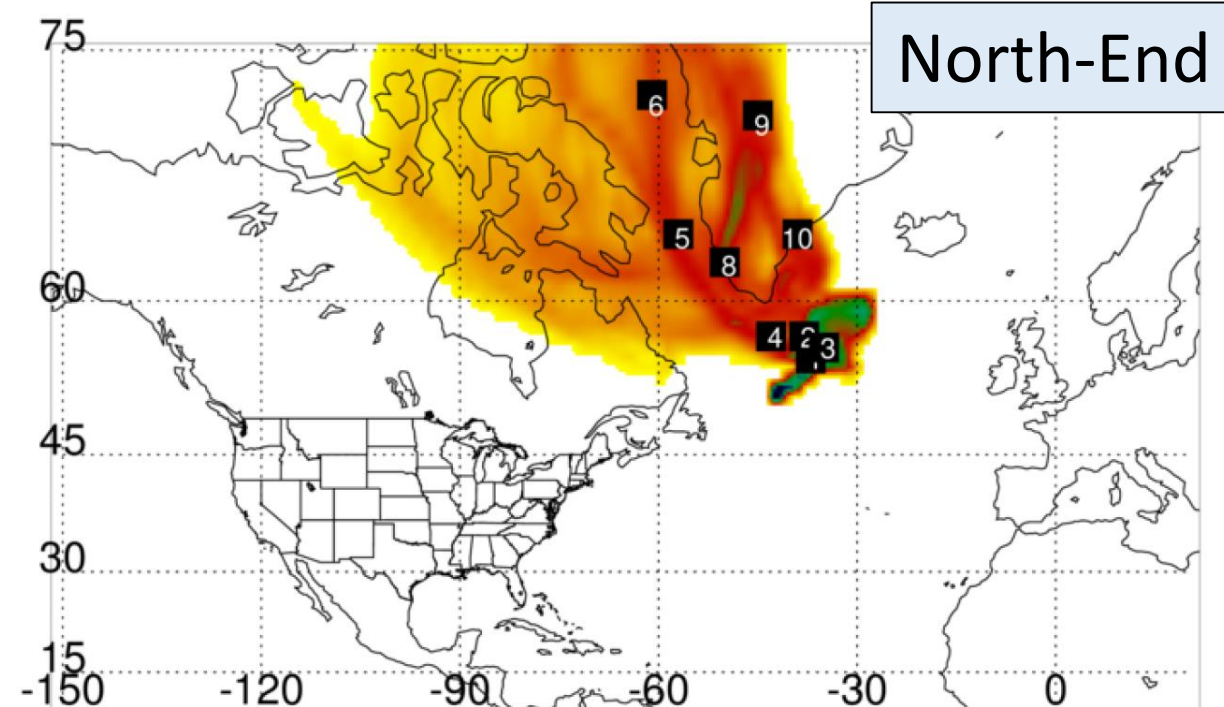
- High ocean- $b_{bp}$  at North end
- Lowest wind speeds at each end of track
- $4^\circ$  difference from N-to-S
- Co-variance from low wind speed?

- *In-situ data at 100m (300ft) AGL*  
- *Altitude changes removed*

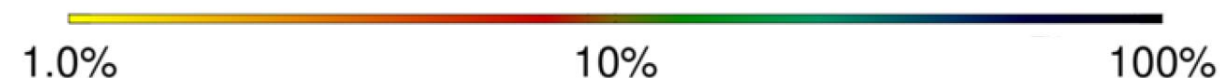
# 6/1/16: Airmass Origin



South-End



North-End

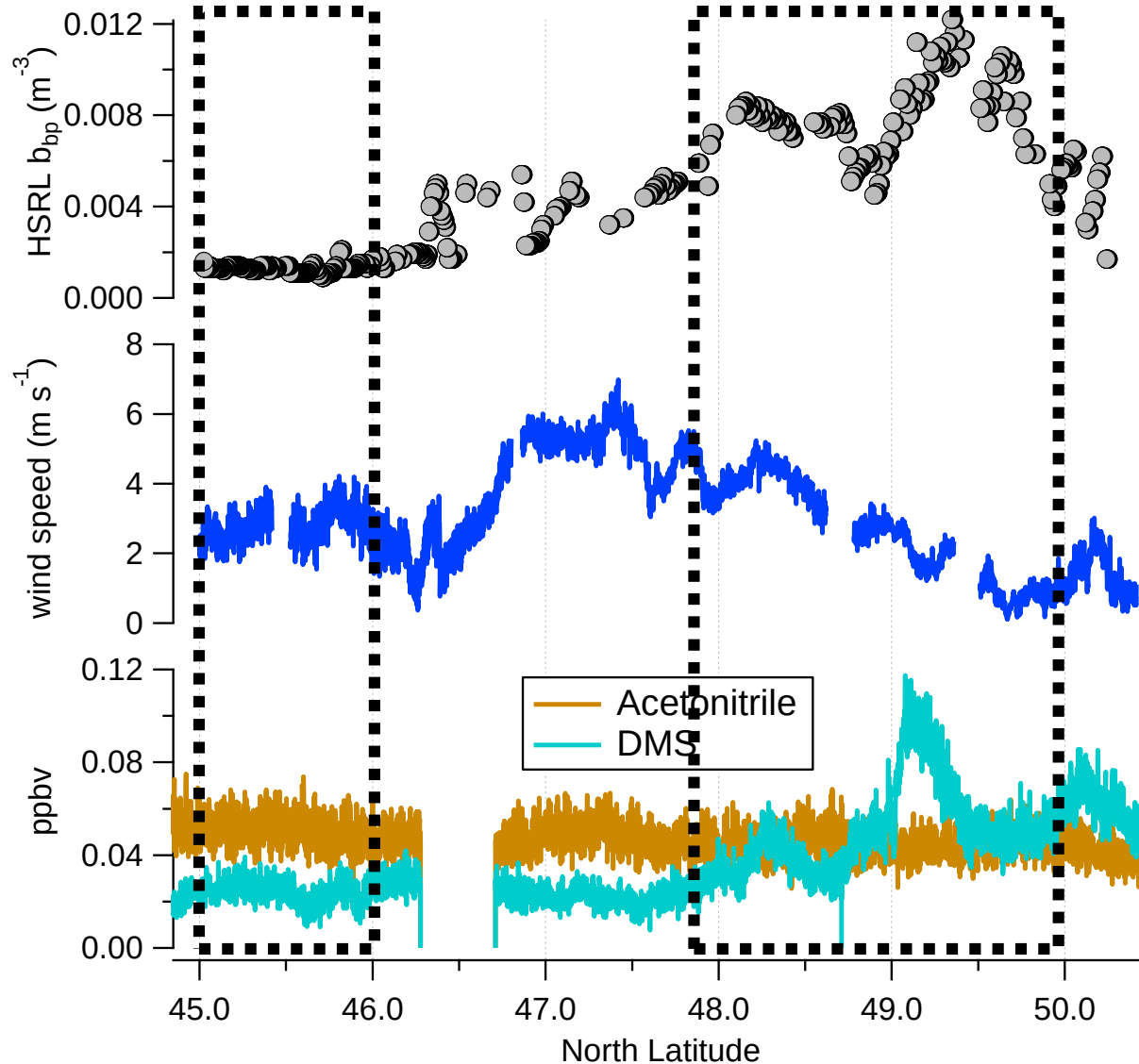


- Long-range source regions are Polar / “Clean”
- Especially for the North-end, transport was very slow for ~4 days



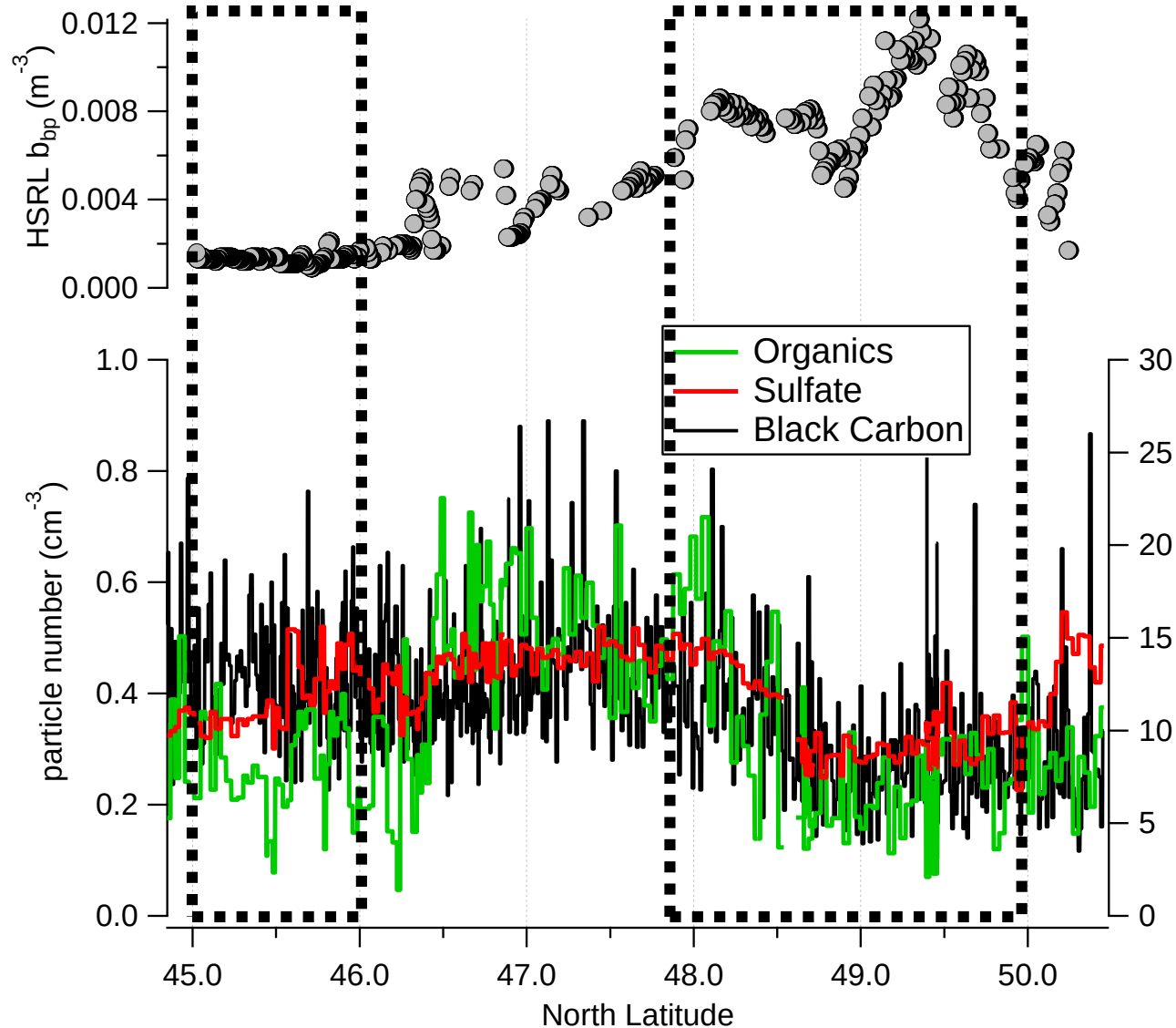
*FLEXPART runs by Bo Zhang*

# 6/1/16: Spatial Variability



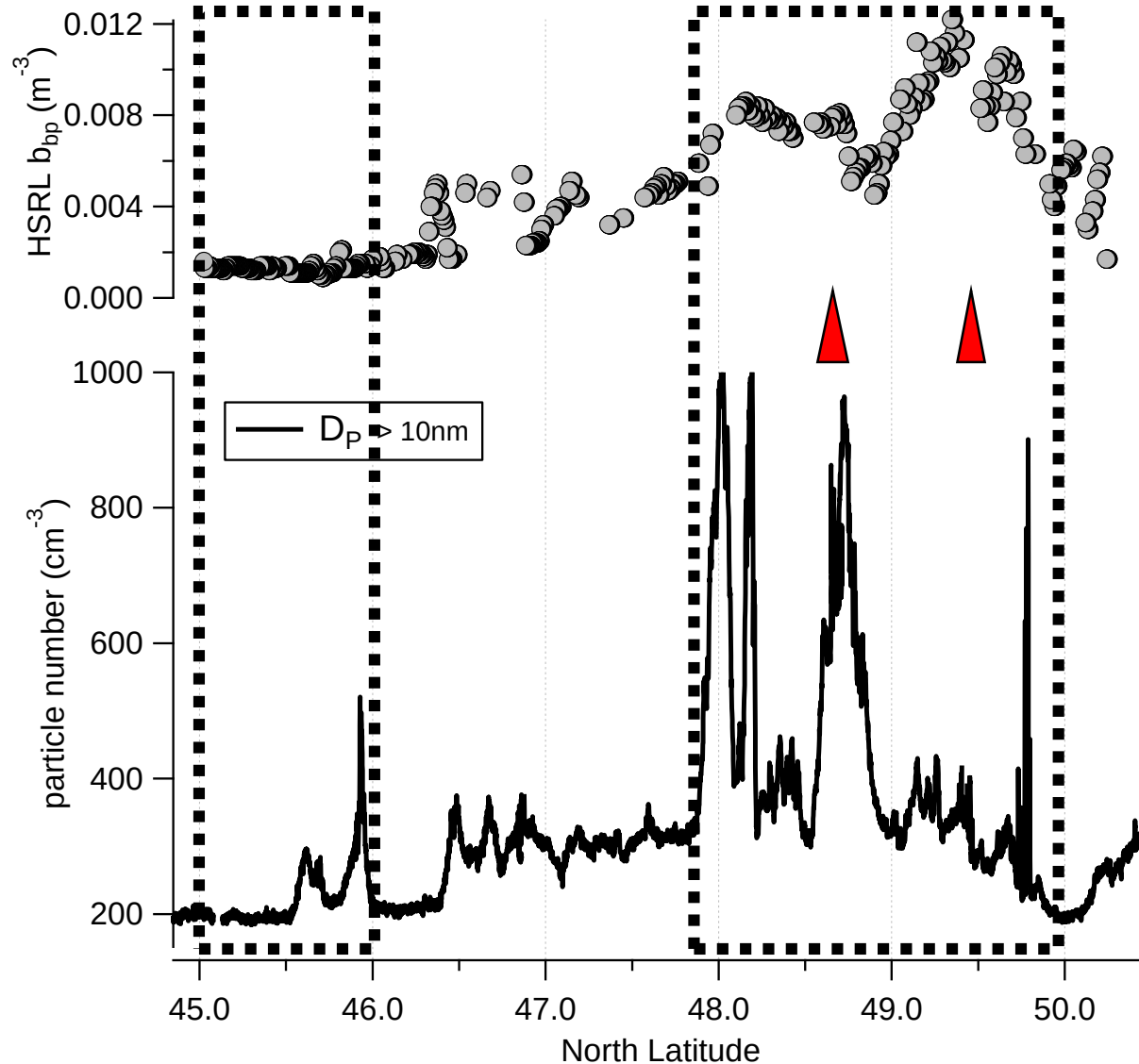
- High ocean- $b_{bp}$  at North end
- Lowest wind speeds at each end of track
- Acetonitrile shows unlikely influence from smoke in MBL
- DMS elevated with  $b_{bp}$  !

# 6/1/16: Spatial Variability



- High ocean- $b_{bp}$  at North end
- Organics + sulfate + BC are well correlated
- Highest  $b_{bp} \rightarrow$  lowest mass
- Suggests organics are NOT likely of primary-marine origin

# 6/1/16: Spatial Variability



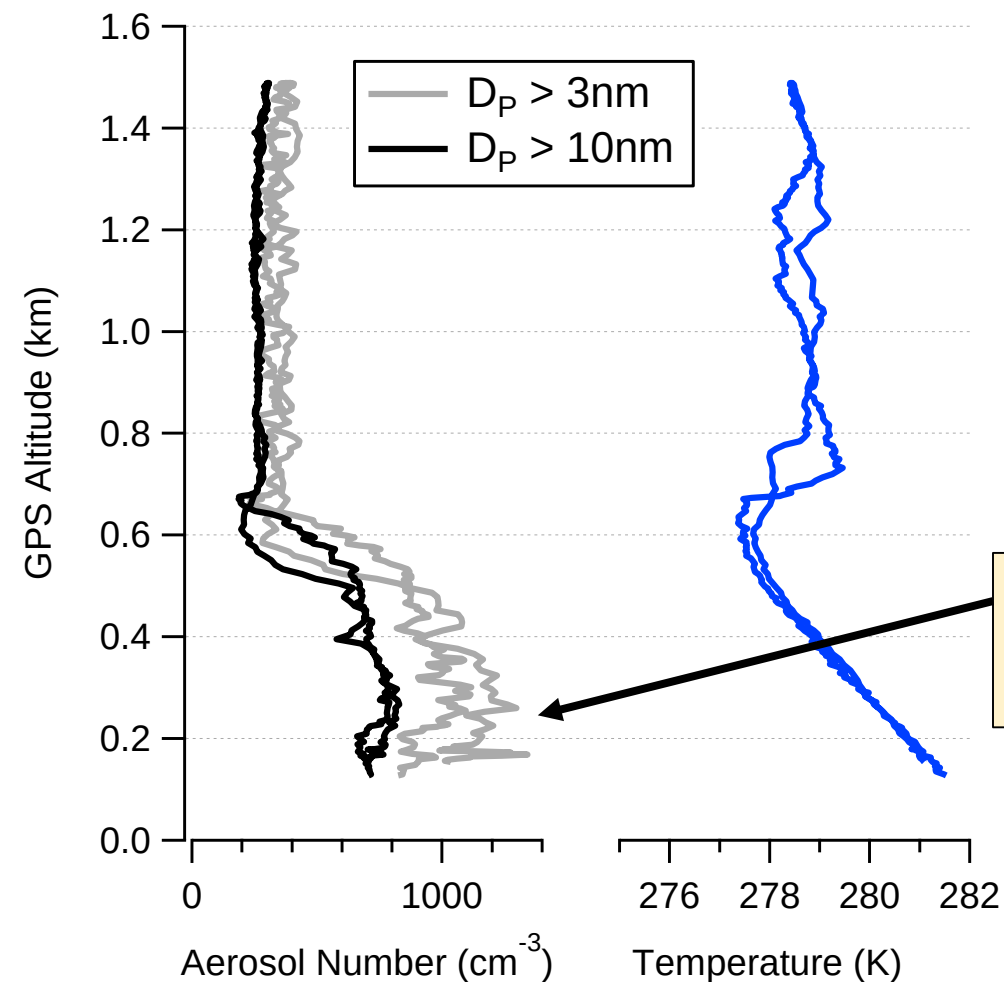
- High ocean- $b_{bp}$  at North end
- “total” particle concentrations
- Filtered for clouds
- Baseline similar to  $b_{bp}$ , increase of  $\sim 150 \text{ cm}^{-3}$  in “bloom”  
**(primary?)**
- Numbers up to  $10^3 \text{ cm}^{-3}$  sustained for  $\sim 5$  mins (17miles)  
**(secondary?)**

 = Profile locations

# 6/1/16: Perfect Porpoise Profiles



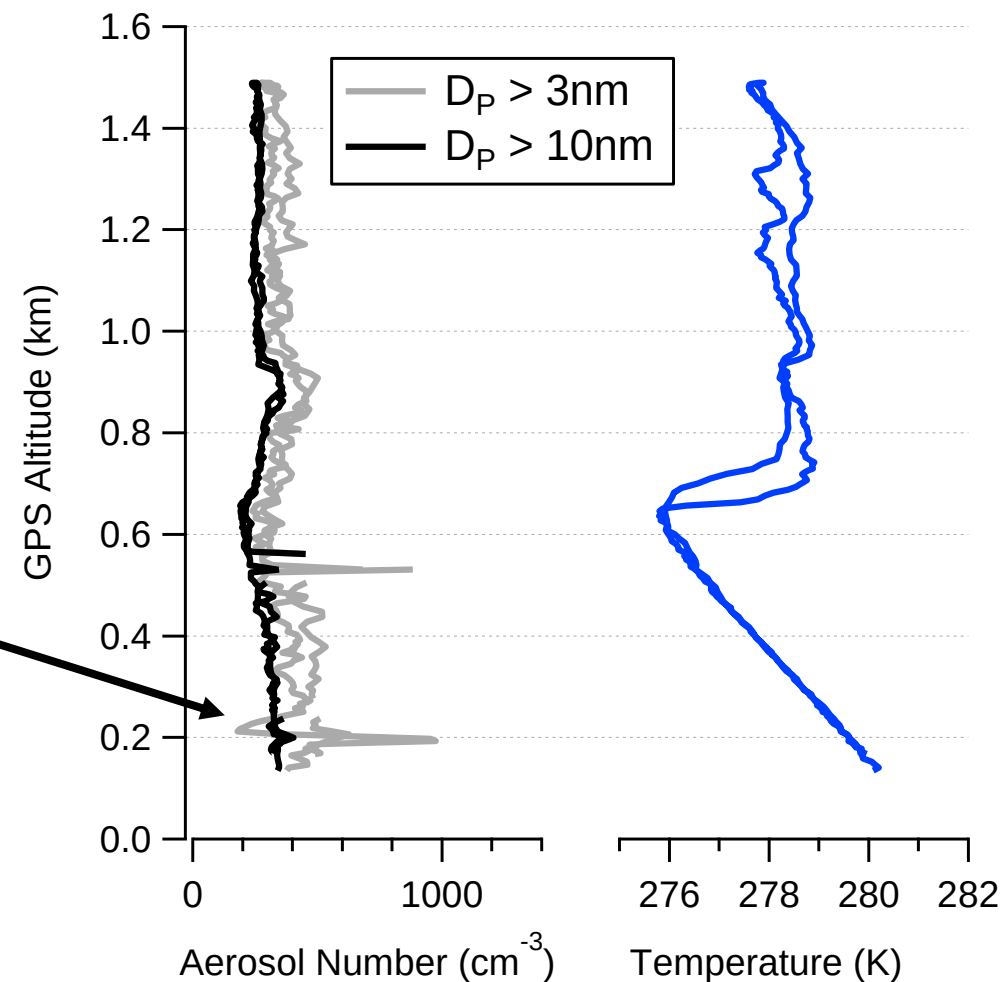
Latitude = 48.7N



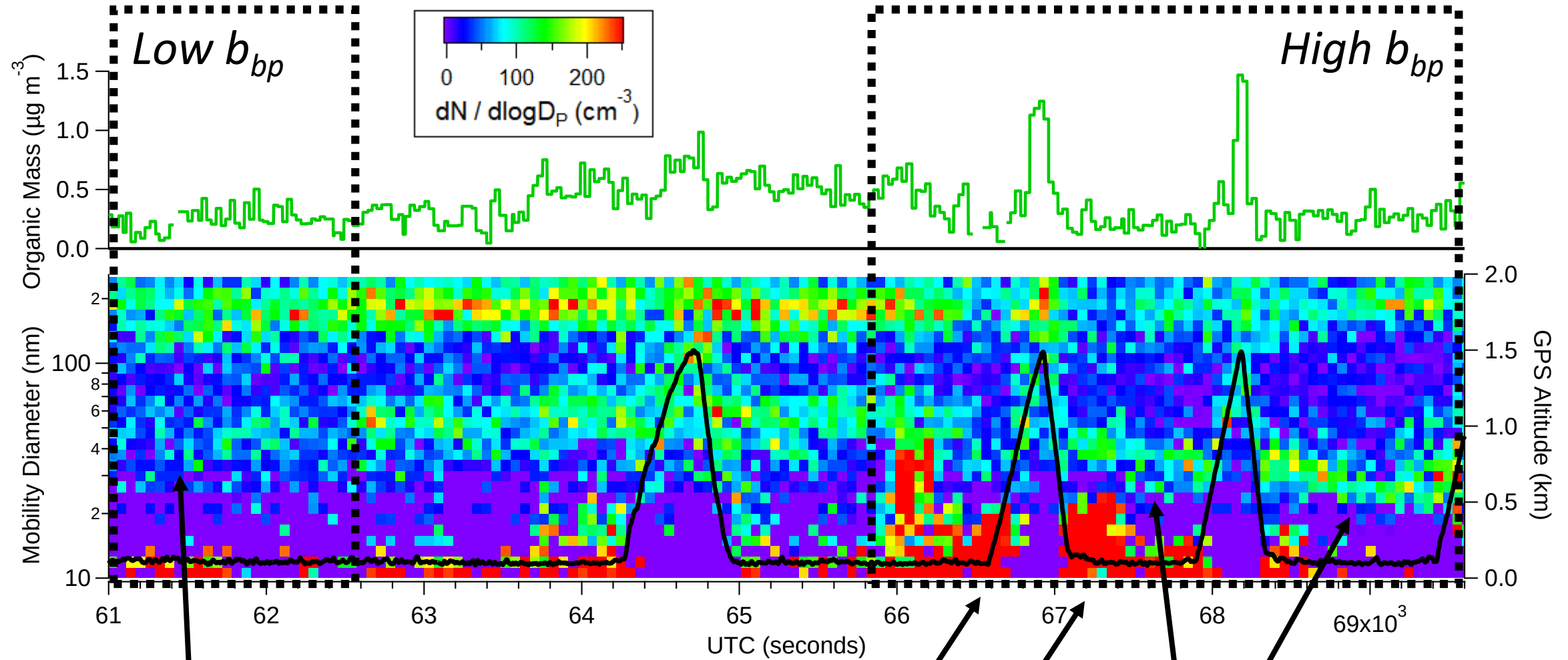
Cause of variability?

*MBL DMS  
~30 ppt*

Latitude = 49.4N



# 6/1/16: Aerosol Size Distribution

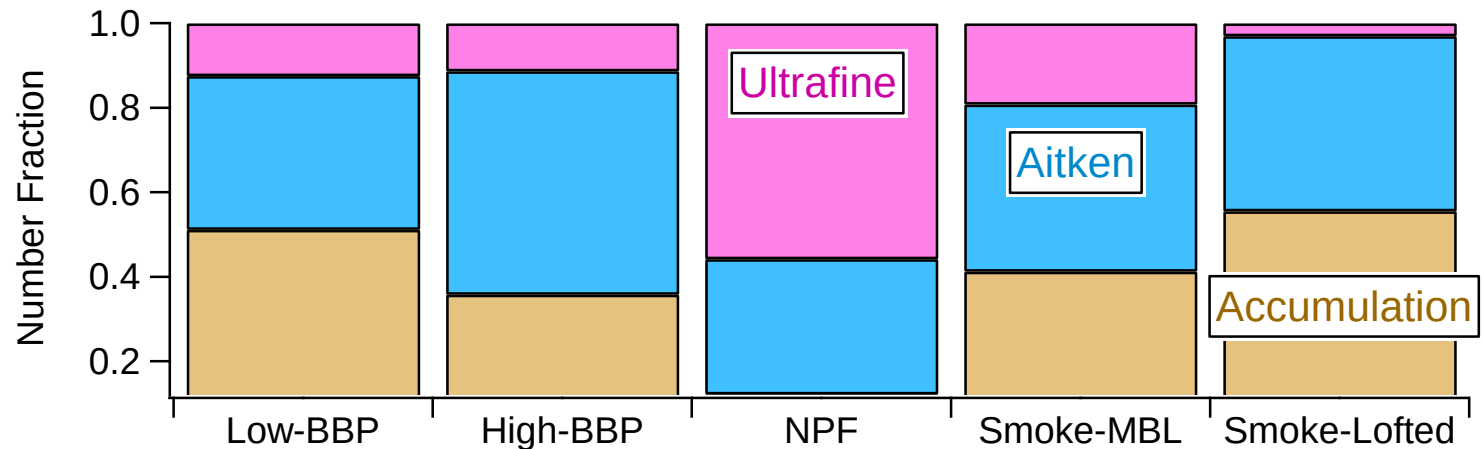
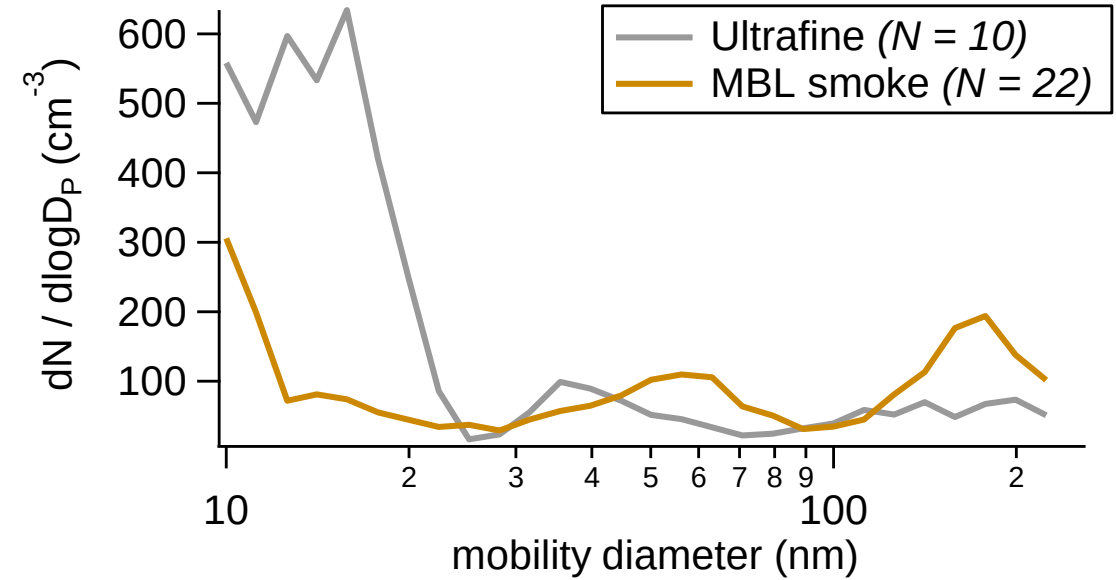
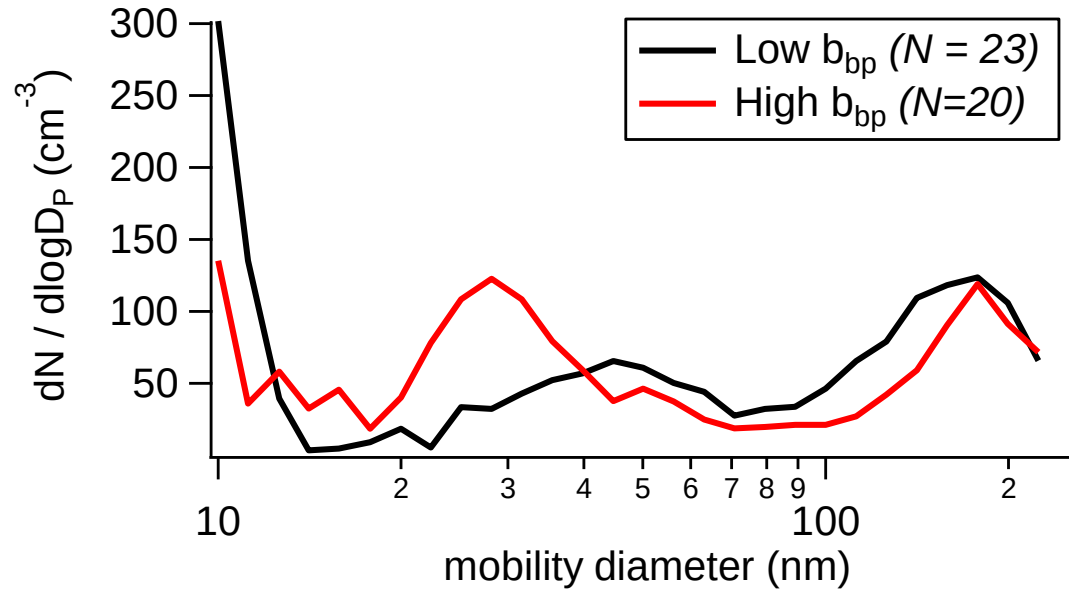


Aitken mode less apparent in low  $b_{bp}$  region

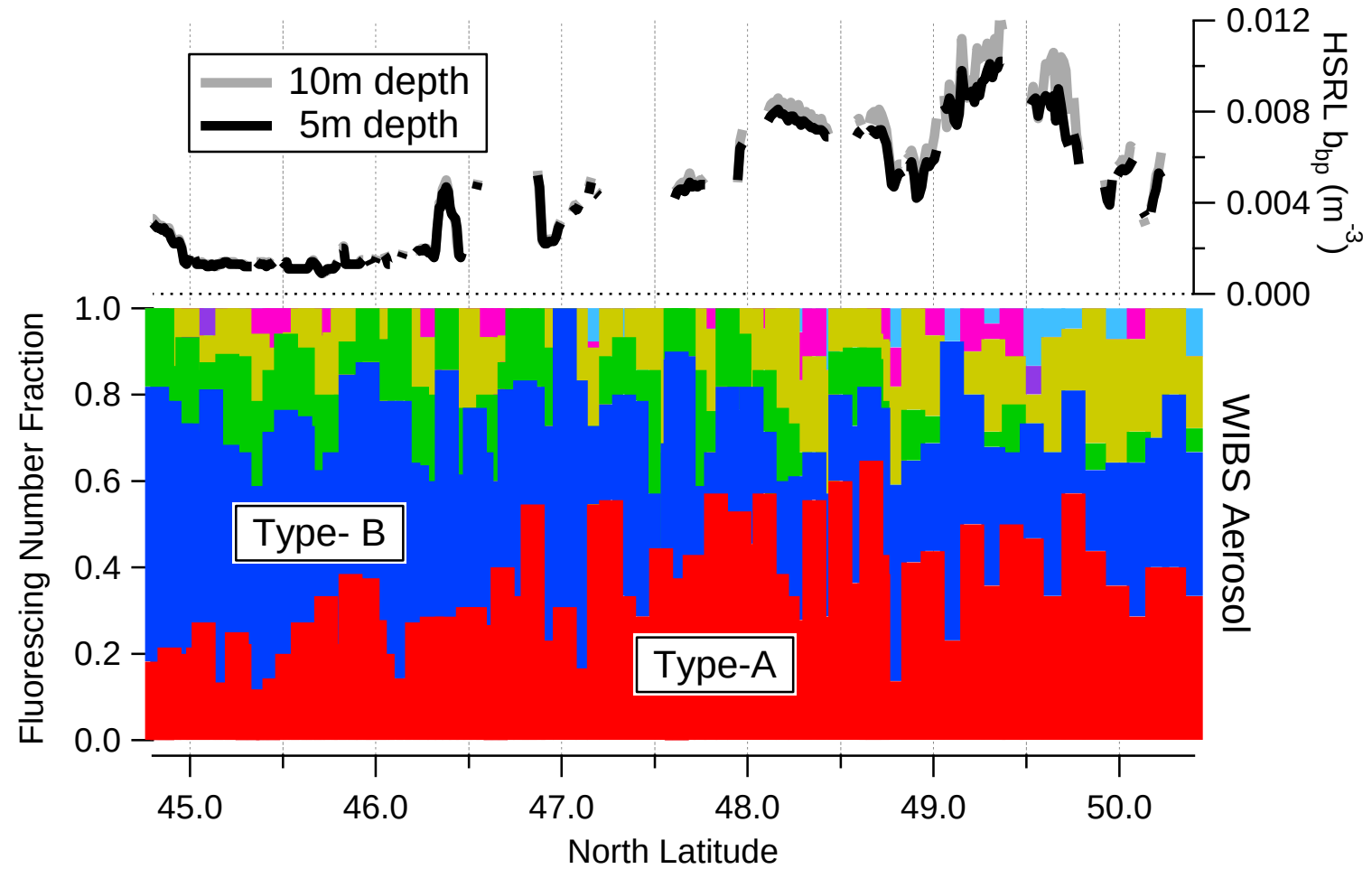
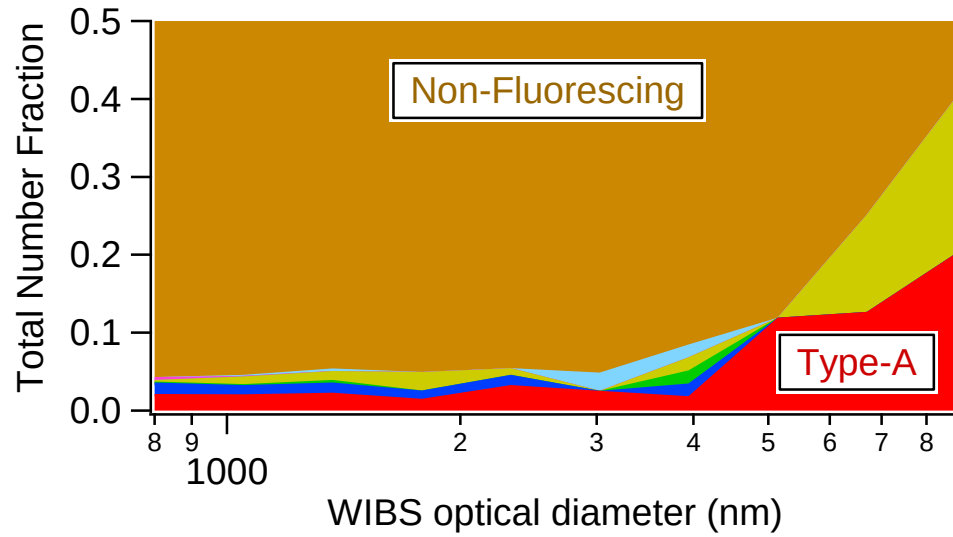
Ultrafine particles in MBL when accumulation-mode is absent

Aitken mode size shifts to smaller  $D_p$  in high  $b_{bp}$  region

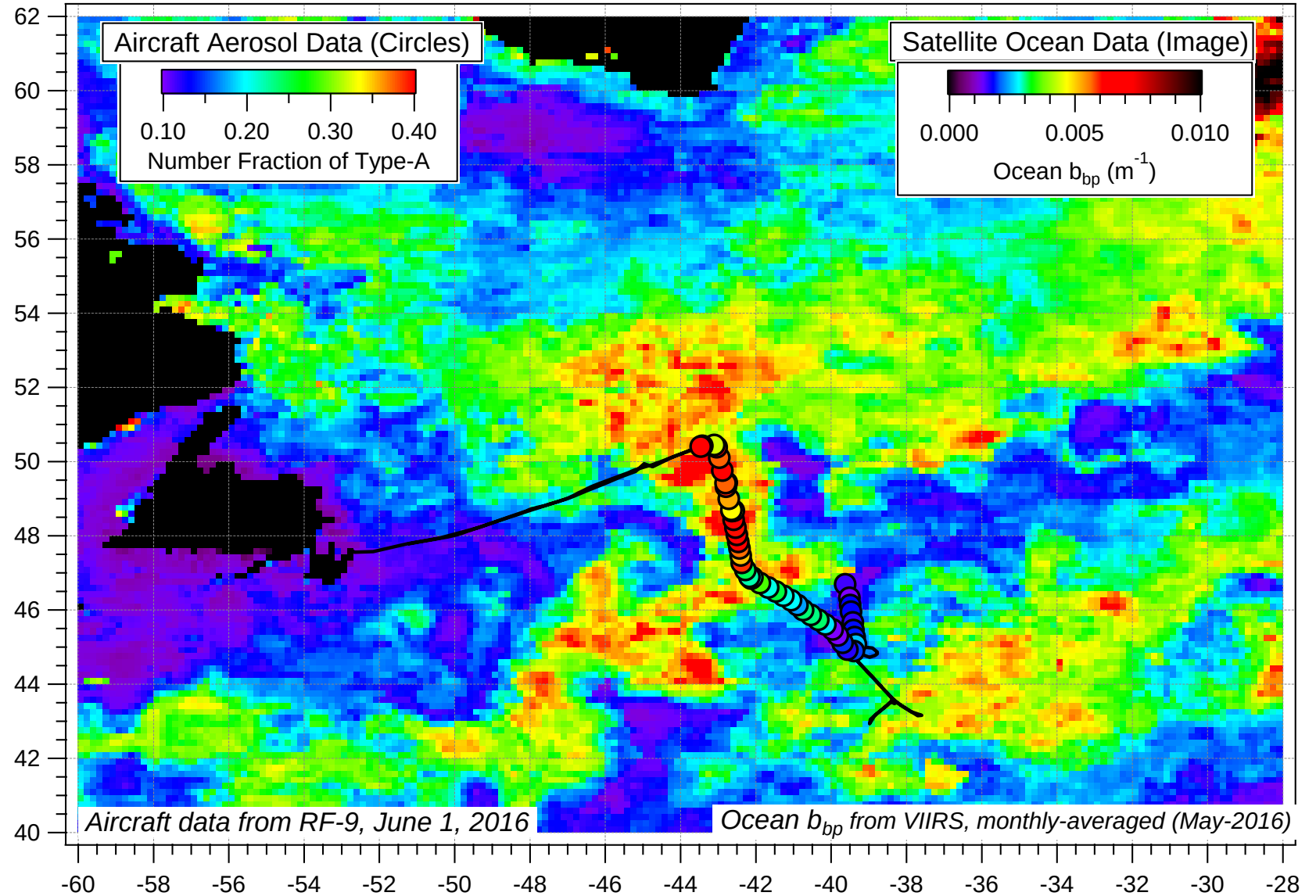
# 6/1/16: Aerosol Size Distribution



# 6/1/16: Bioaerosol Variability



# 6/1/16: Mapping to Ocean $b_{BP}$



NAAMES

# Summary and Conclusions

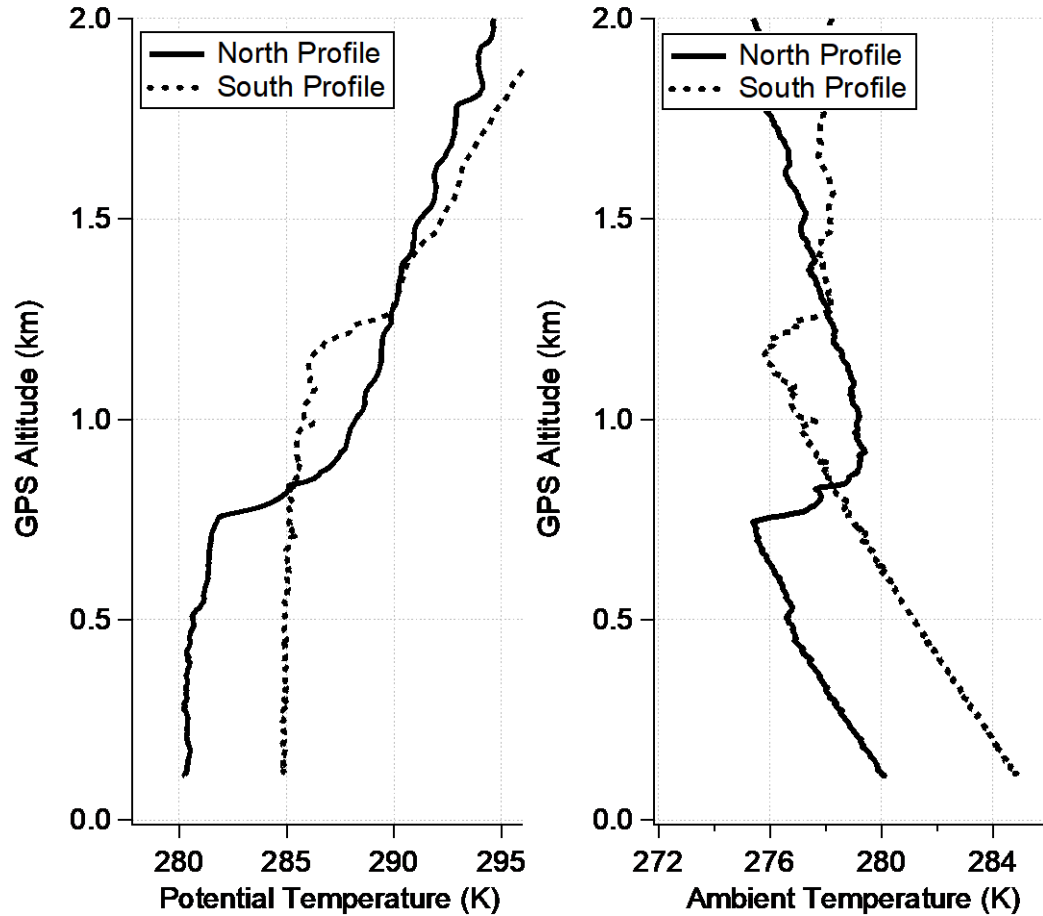


# Backup

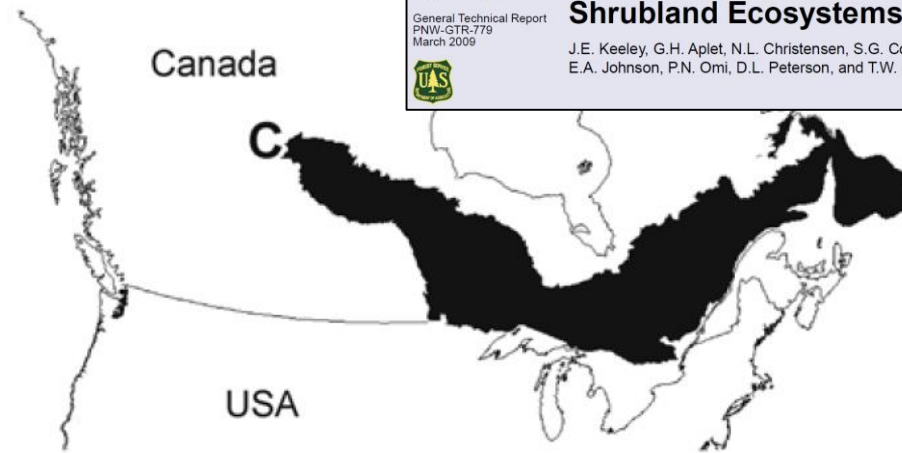
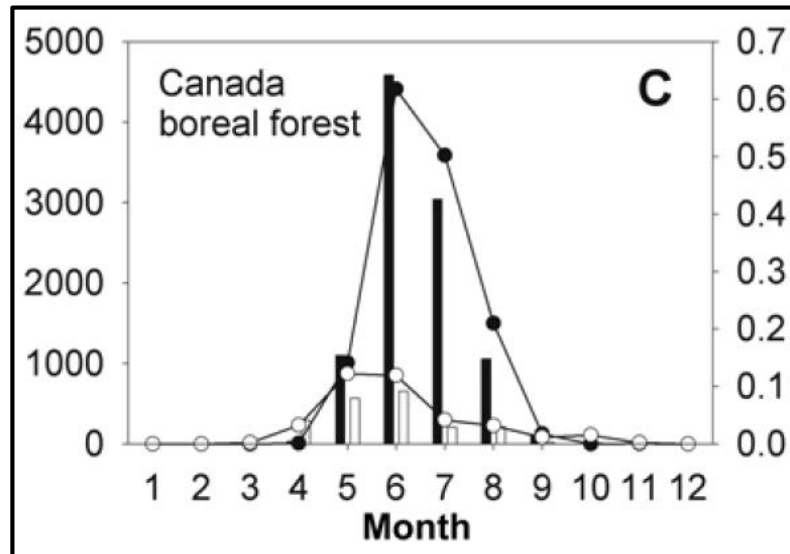


NAAMES

# 6/1/16: Meteorology

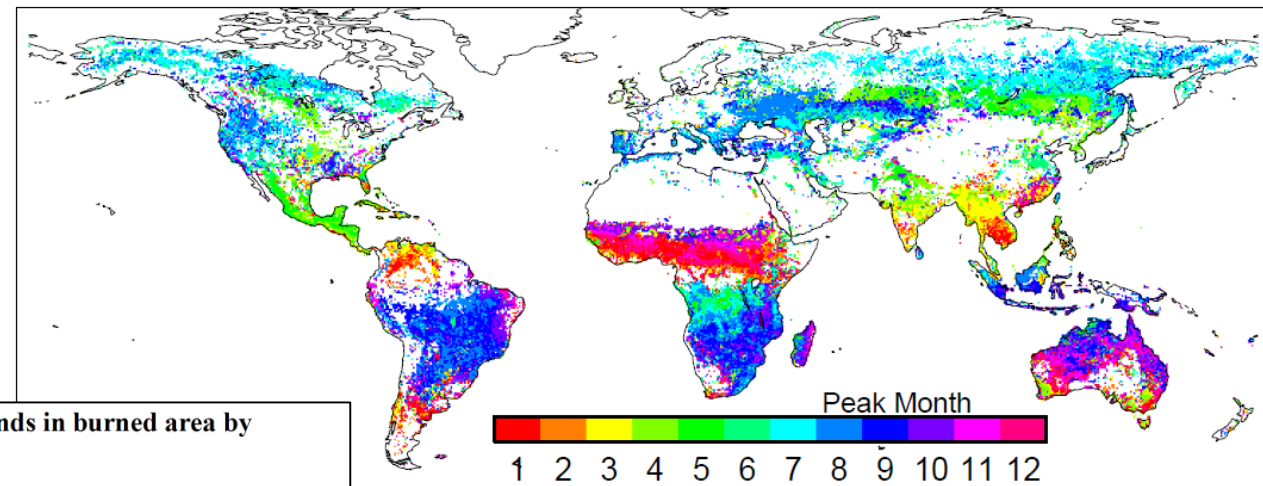


# Complications to Seasonality: Similarity to Biomass Burning



  
 United States  
 Department of  
 Agriculture  
 Forest Service  
 Pacific Northwest  
 Research Station  
 General Technical Report  
 PNW-GTR-779  
 March 2009  


**Ecological Foundations for  
 Fire Management in North  
 American Forest and  
 Shrubland Ecosystems**  
 J.E. Keeley, G.H. Aplet, N.L. Christensen, S.G. Conard,  
 E.A. Johnson, P.N. Omi, D.L. Peterson, and T.W. Swetnam

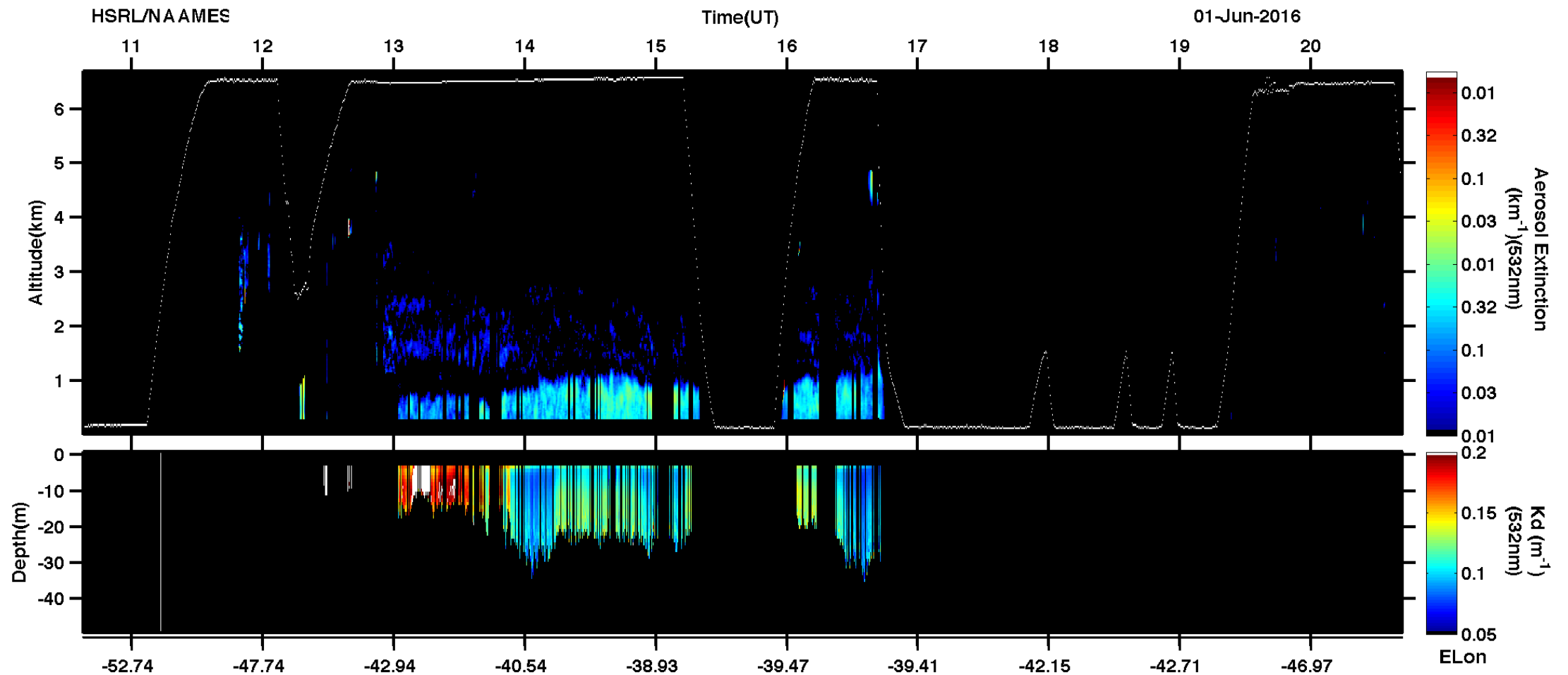


**Assessing variability and long-term trends in burned area by  
 merging multiple satellite fire products**

L. Giglio<sup>1,2</sup>, J. T. Randerson<sup>3</sup>, G. R. van der Werf<sup>4</sup>, P. S. Kasibhatla<sup>5</sup>, G. J. Collatz<sup>1</sup>, D. C. Morton<sup>1</sup>, and R. S. DeFries<sup>6</sup>

NAAMES

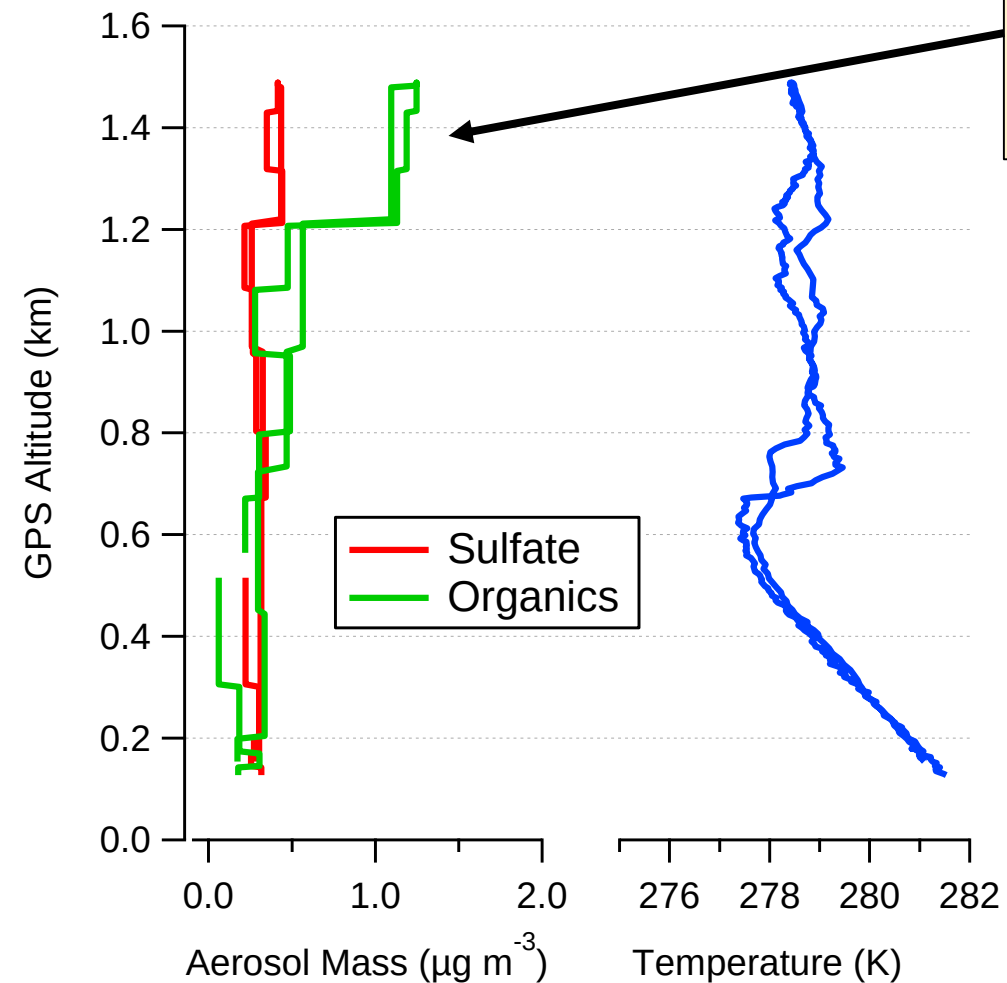
# 6/1/16: Flight Overview



# 6/1/16: Perfect Porpoise Profiles



Latitude = 48.7N



*Acetonitrile*  
*140-150 ppt*

Latitude = 49.4N

