Investigating Chemical Variation in Particulate Matter During the Polarimetric Cloud Analysis and Seeding Test (POLCAST) 2012 Campaign in Grand Forks, North Dakota

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Acknowledgments

Collaborative Efforts

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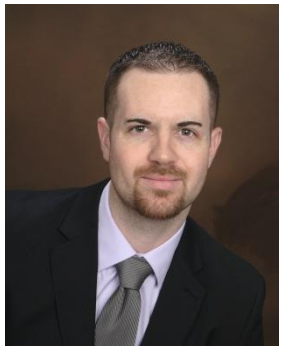

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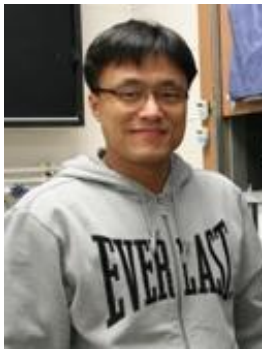

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UND AEROSPACE
UNIVERSITY OF NORTH DAKOTA
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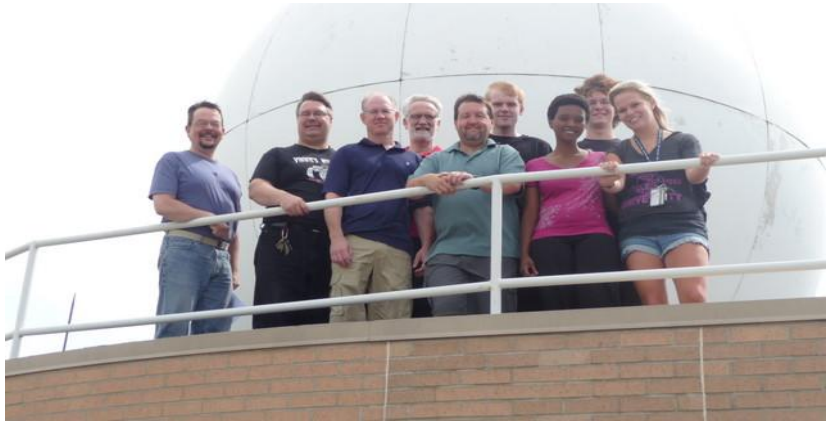

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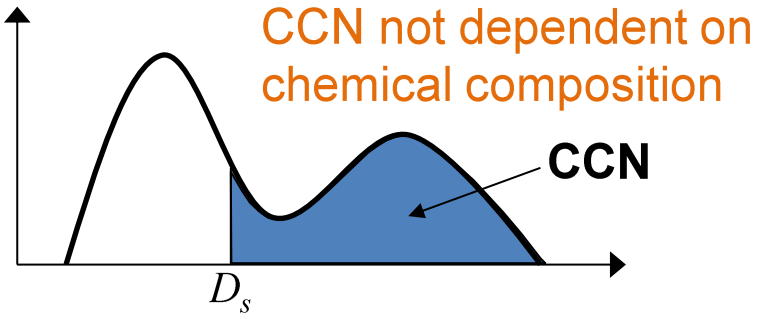
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

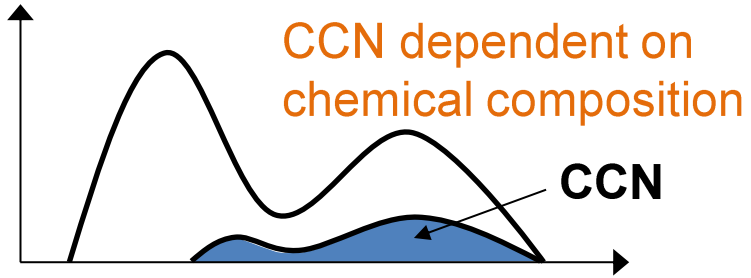
Sources of OA in North Dakota

Potential Contributors to Cloud Condensation Nuclei (CCN)

Mostly rural anthropogenic and natural sources of OA

How do these processes contribute to chemical variation in OA and ultimately in CCN concentrations?





Objectives of the POLCAST 2012 Campaign

Main goal of the POLCAST 2012 Campaign:

To better understand the effects of hygroscopic cloud seeding at cloud base on convective clouds in North Dakota.

- Characterization of hygroscopic seeding effects stratified by aerosol and CCN concentrations;
- Characterization of how aerosol and CCN concentration change between the surface and cloud base;
- Evaluate the changes in the chemical composition of aerosols between the summer and fall.
  - Determine it's effect on CCN concentrations
  - Influence of natural and anthropogenic events on chemical variation

Harvesting Impacts??

Instruments – Surface Measurements

Particle & Chemical Characterization

HVP – High Volume Pump
SMPS – Scanning Mobility Particle Sizer
TEOM – Tapered Element Oscillating Microbalance
CCNC – Cloud Condensation Nuclei Counter
CPC – Condensation Particle Counter

DMT – Droplet Measurement Technologies
UWyo – University of Wyoming
TSI – TSI Inc.
Thermo – Thermo Scientific Inc.

16.7 LPM 2.5 µm inlets

16.7 LPM 10 µm cyclone
(2.5 µm @ 92 LPM)

90 mm Filter Pack
(90 mm Quartz Filters)

Flow Controller
(@ 92 LPM)

HVP

TEOM
(Thermo)

SMPS
(TSI)

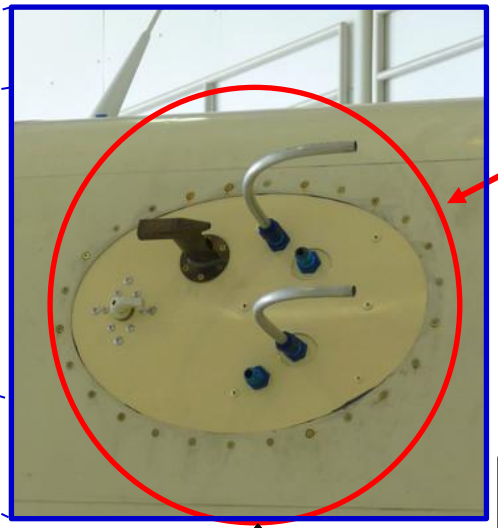
CPC
(TSI)

CCNC
(DMT)

CCNC
(UWyo)

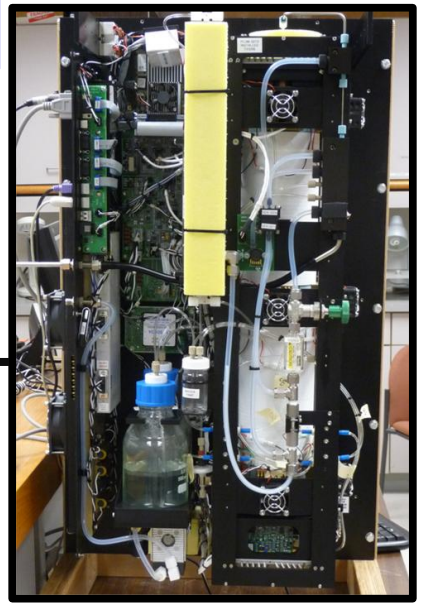
Cloud Base Measurements

CCN Measurements & Cloud Seeding Effects



CCNC Inlets

CCNC (DMT)

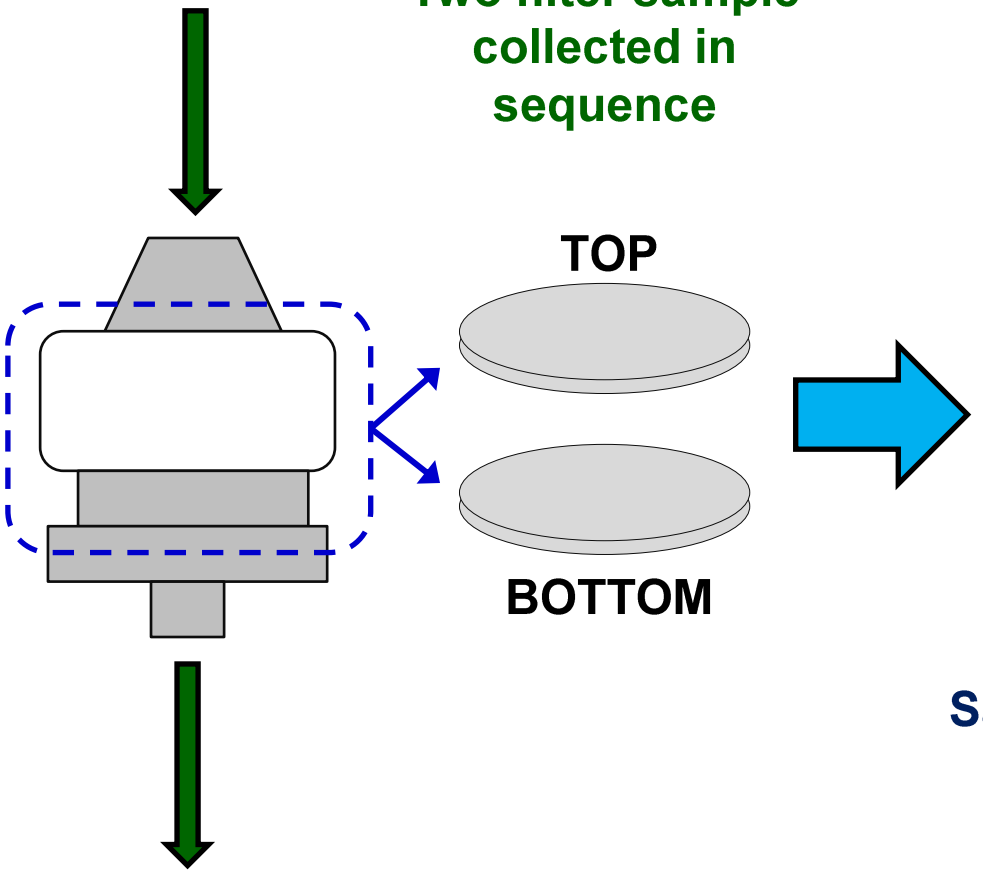


CCNC (UWyo)

Filter Analysis

OC/EC Measurements & Individual Chemical Speciation

Two filter sample collected in sequence



TOA Analysis

OC, EC & TC Distribution

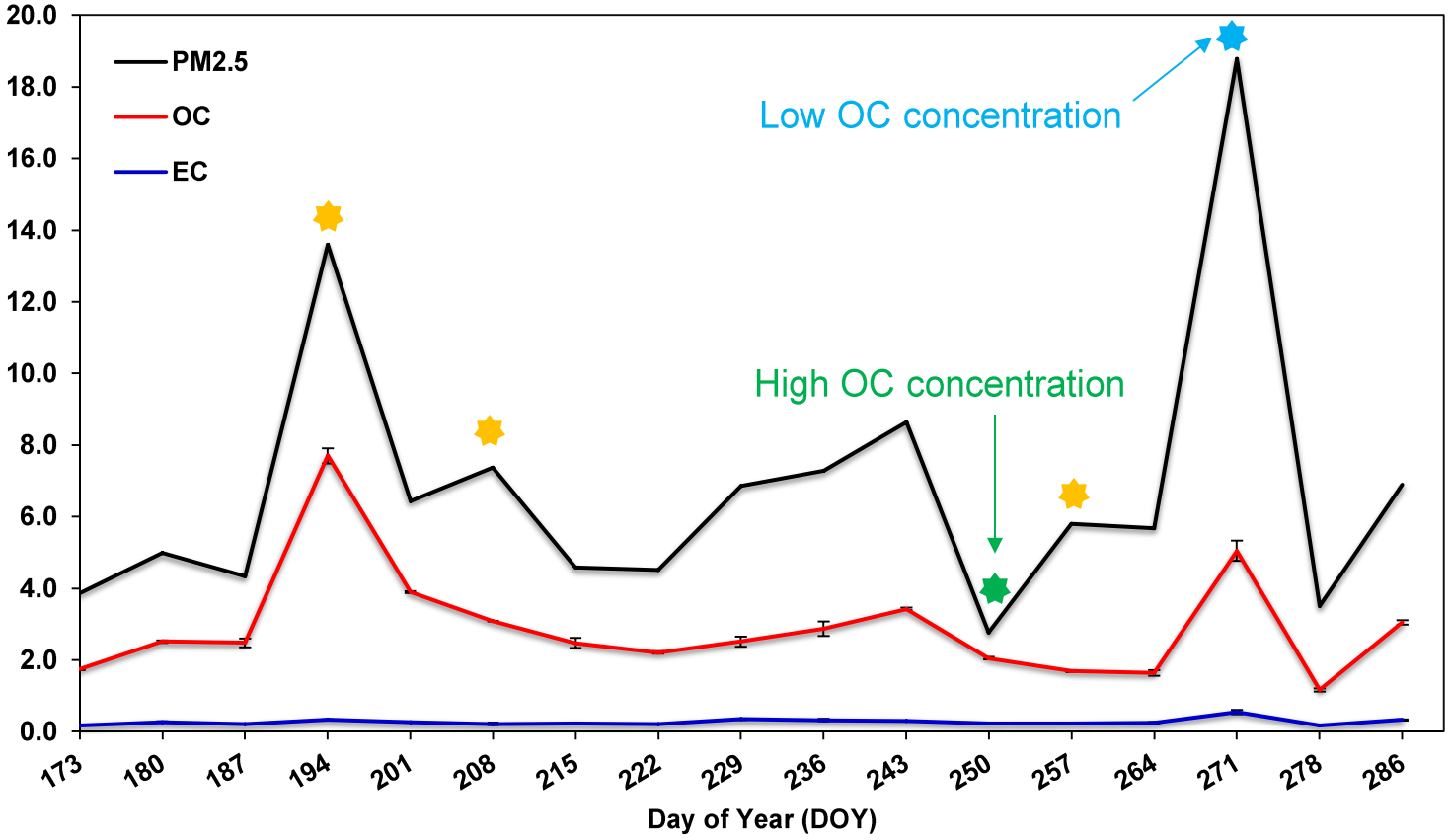
TD/Py-GC/MS Analysis

Chemical Speciation

Same temperature steps were used for both techniques

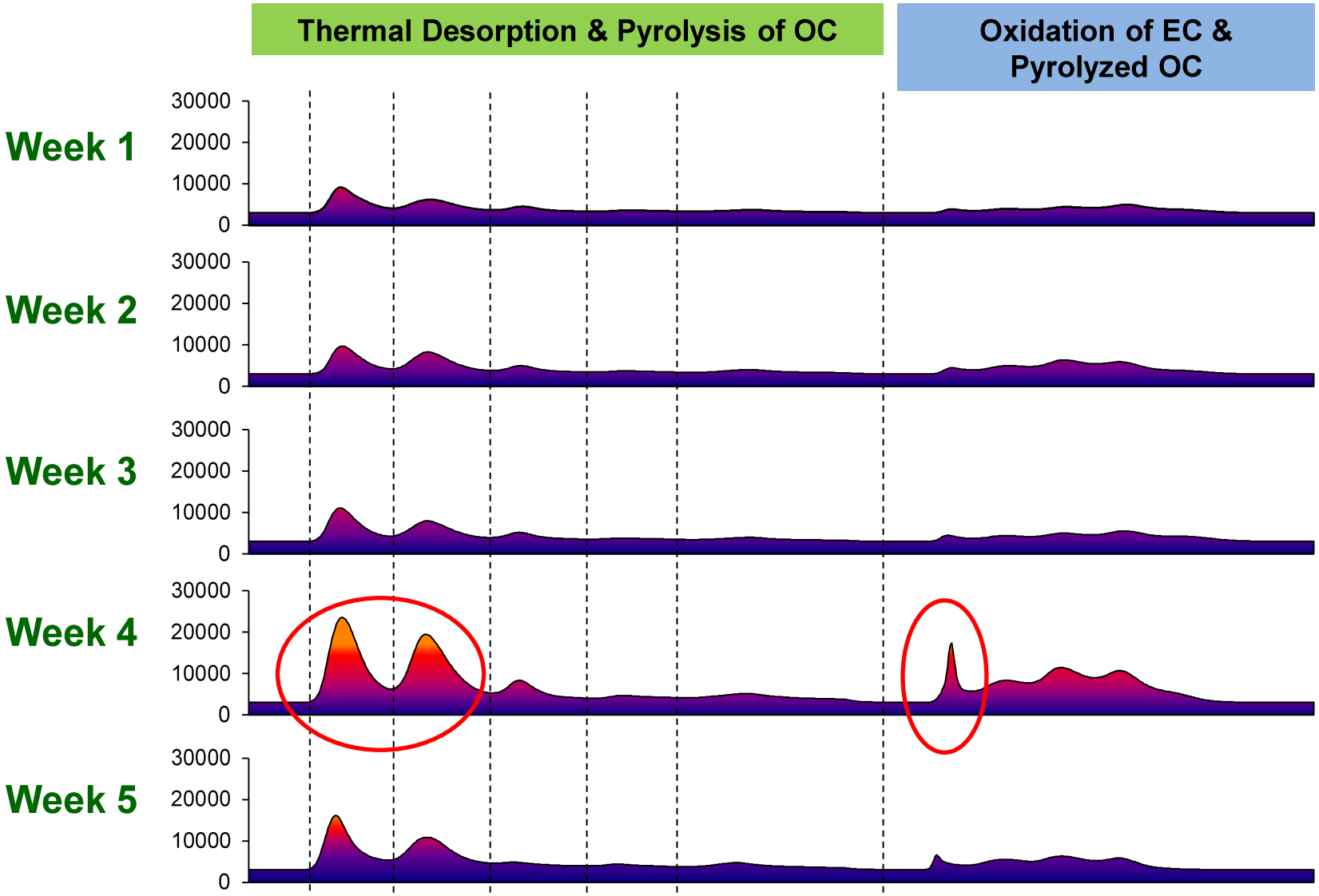
Mass Concentrations of the POLCAST 2012 Campaign

TC, OC and EC Concentrations



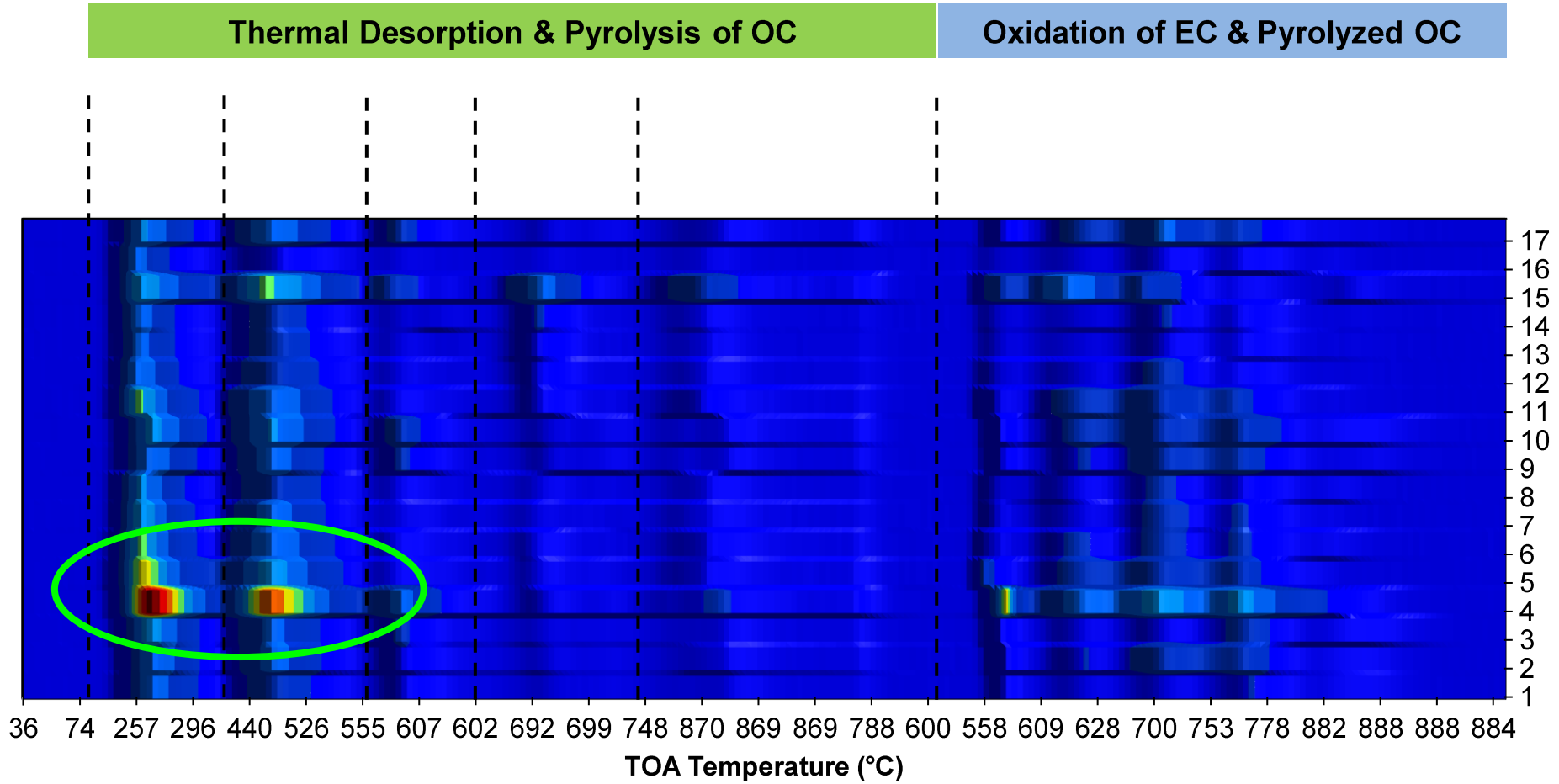
OC and EC Distribution – Weeks 1–5

Thermal Fractionation with TOA



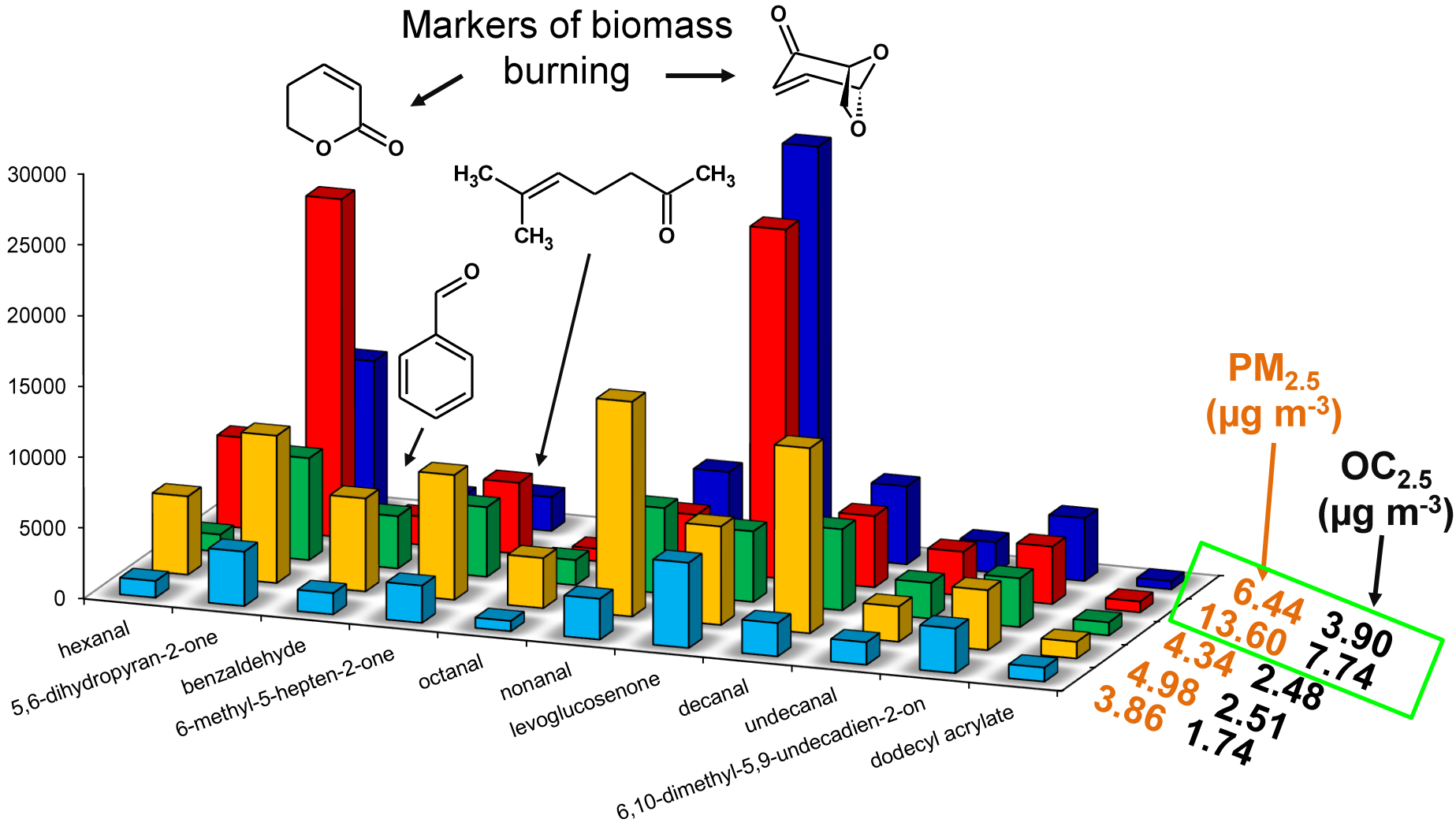
OC and EC Distribution

Full POLCAST 2012 Campaign



Distribution of Major Chemical Markers

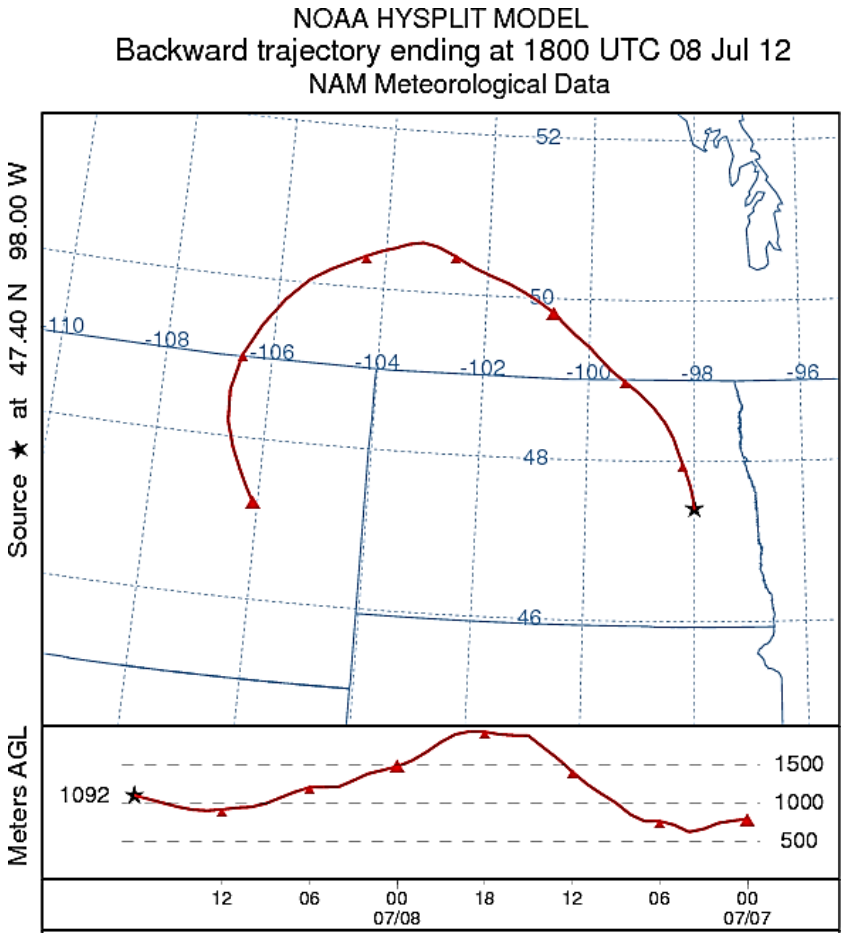
300 °C Thermal Fraction; Weeks 1–5



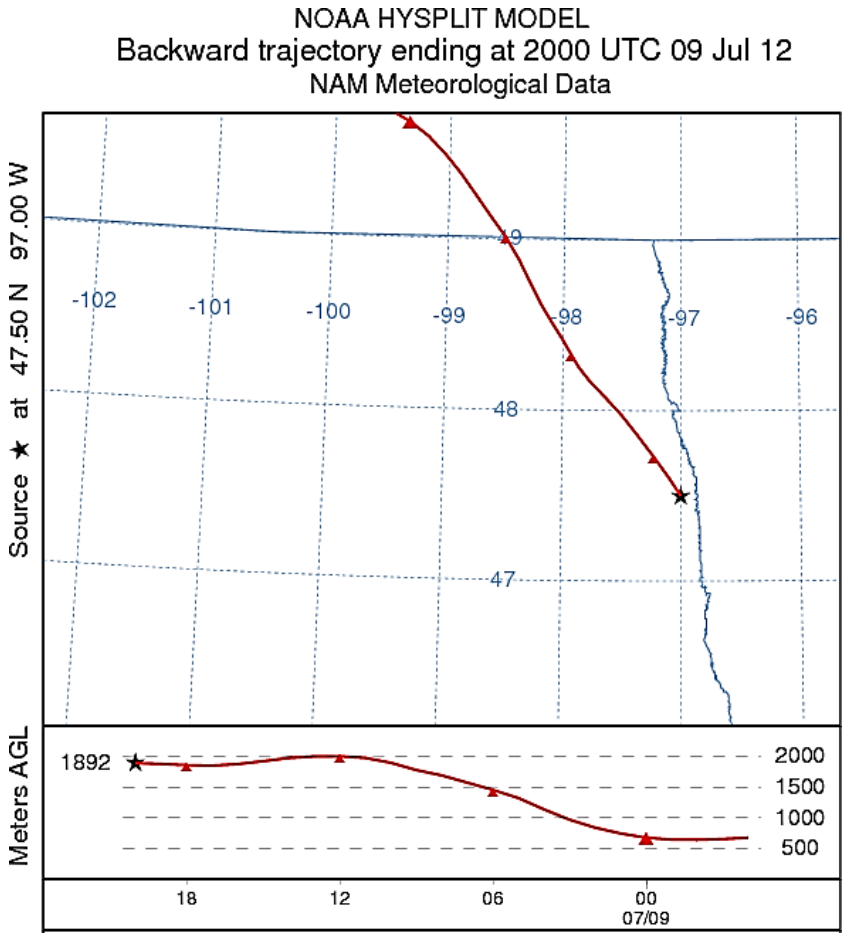
Backward Trajectories for July 8 & 9, 2012

NOAA HYSPLIT Model Trajectories

July 8, 2012
DOY 190 – Case 1

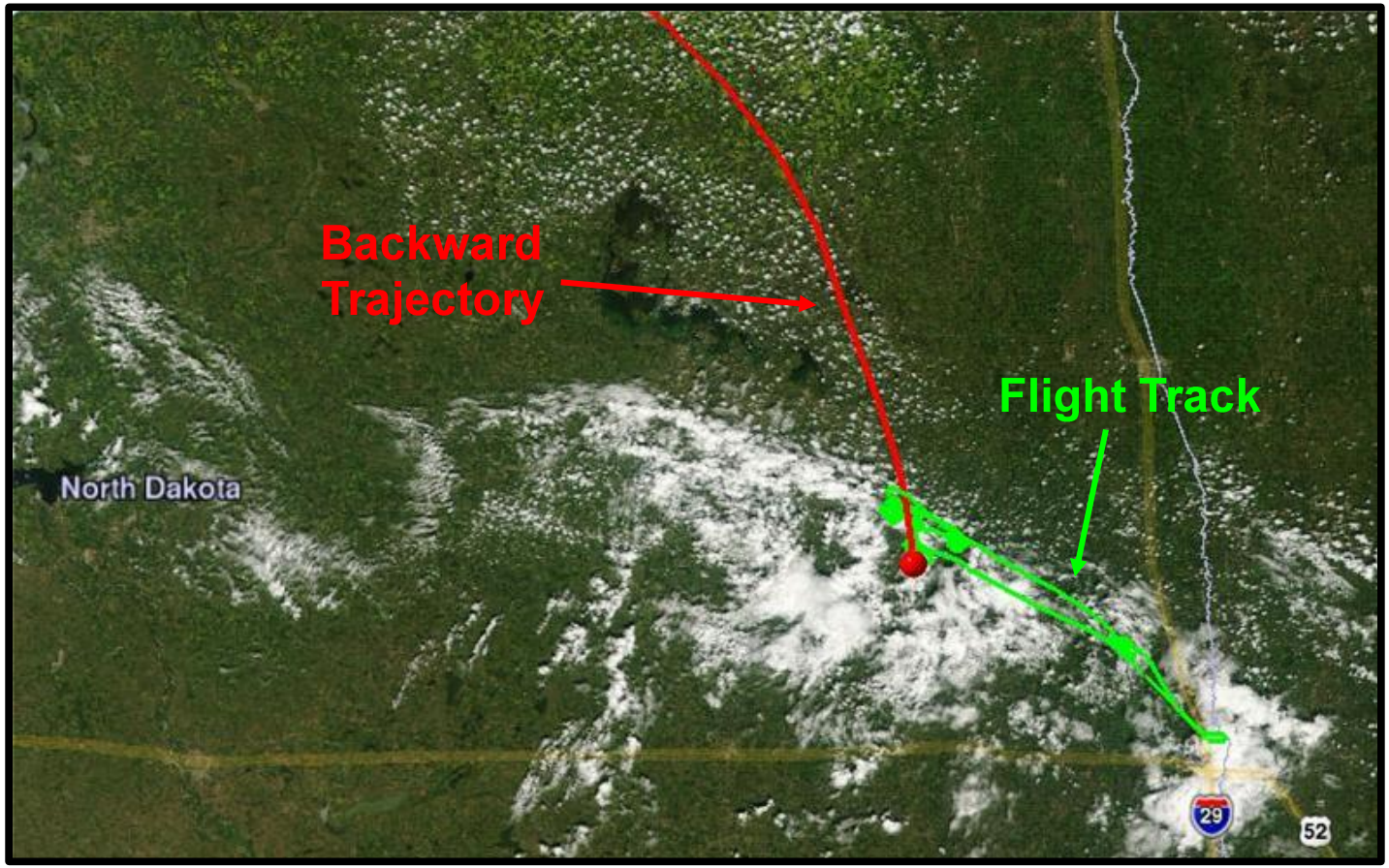


July 9, 2012
DOY 191 – Case 1



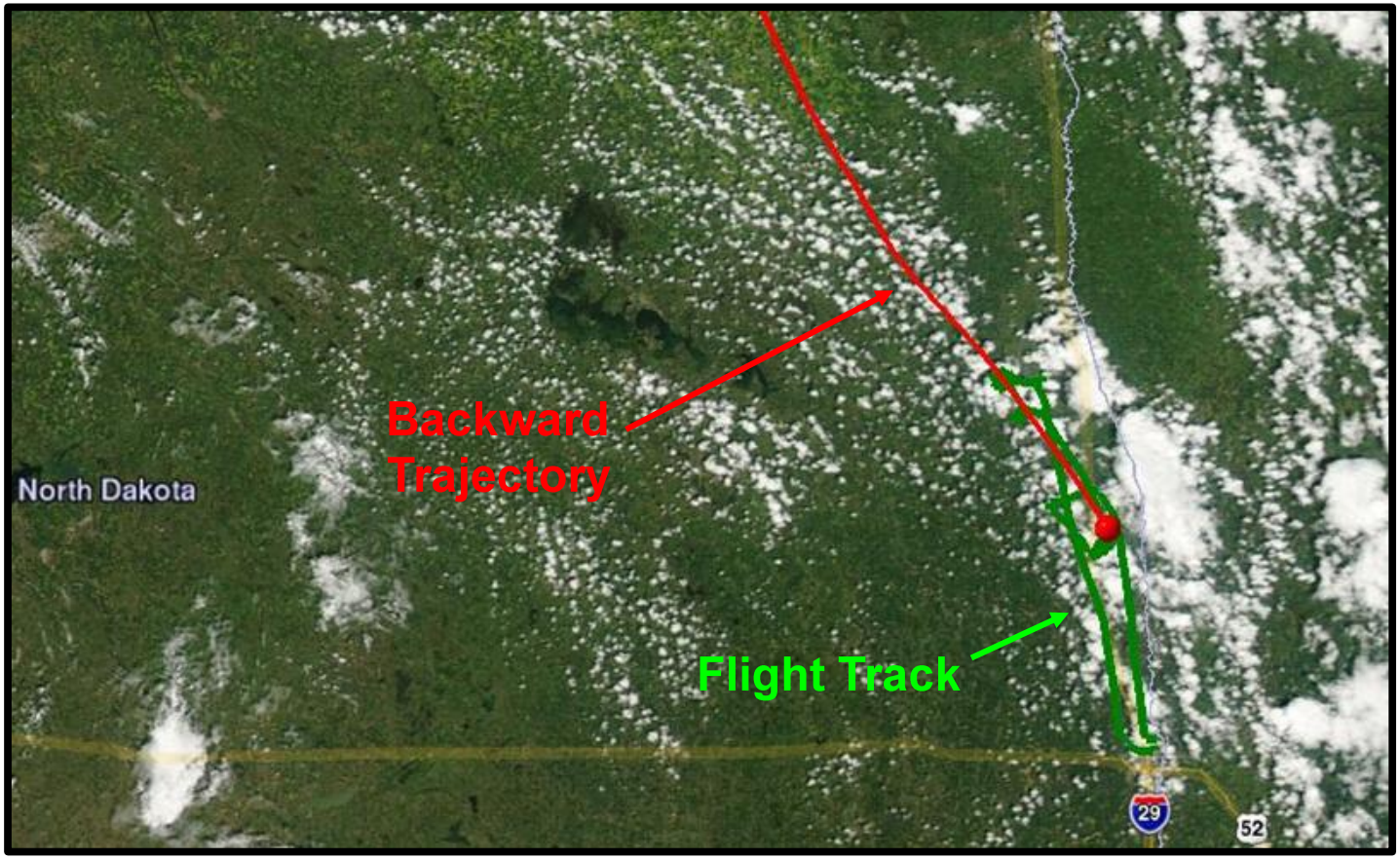
Cloud Base Measurements – July 8 (DOY 190)

MODIS Terra Visible Image
July 8, 2012 (DOY 190) – Case 1



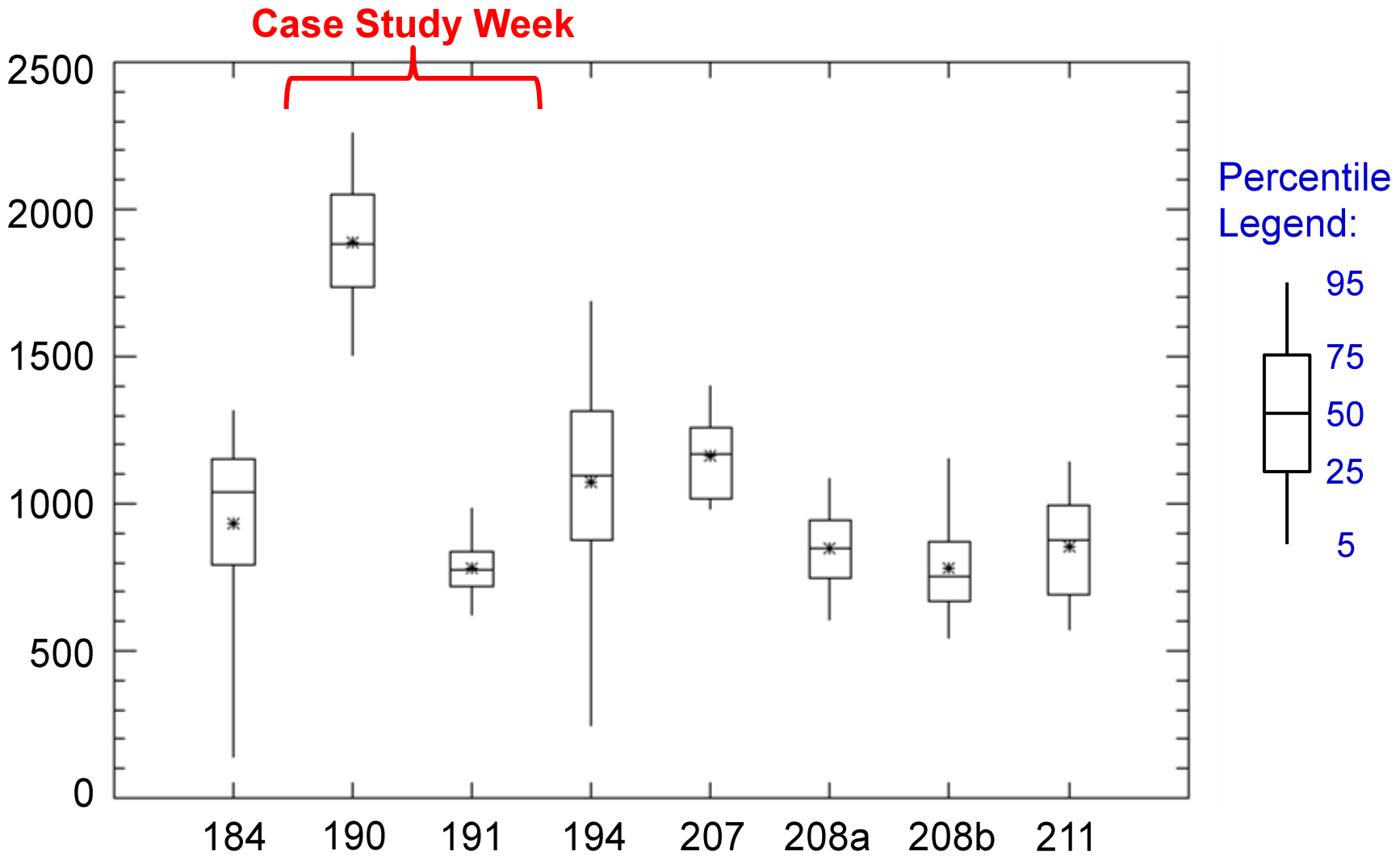
Cloud Base Measurements – July 9 (DOY 191)

MODIS Terra Visible Image
July 9, 2012 (DOY 191) – Case 1



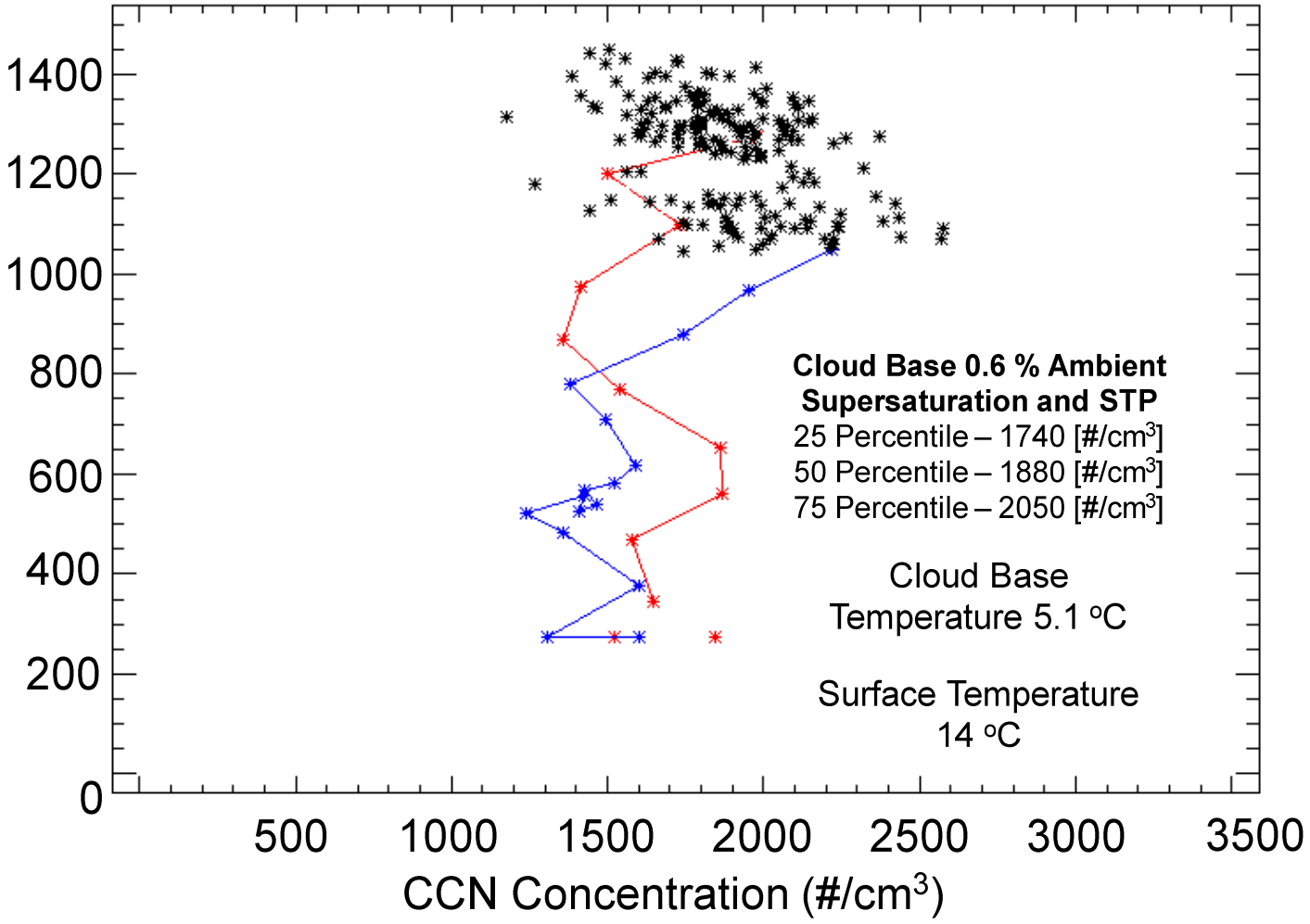
Cloud Base CCN Measurements – POLCAST 2012

CCN Concentrations at 1000–1500 m



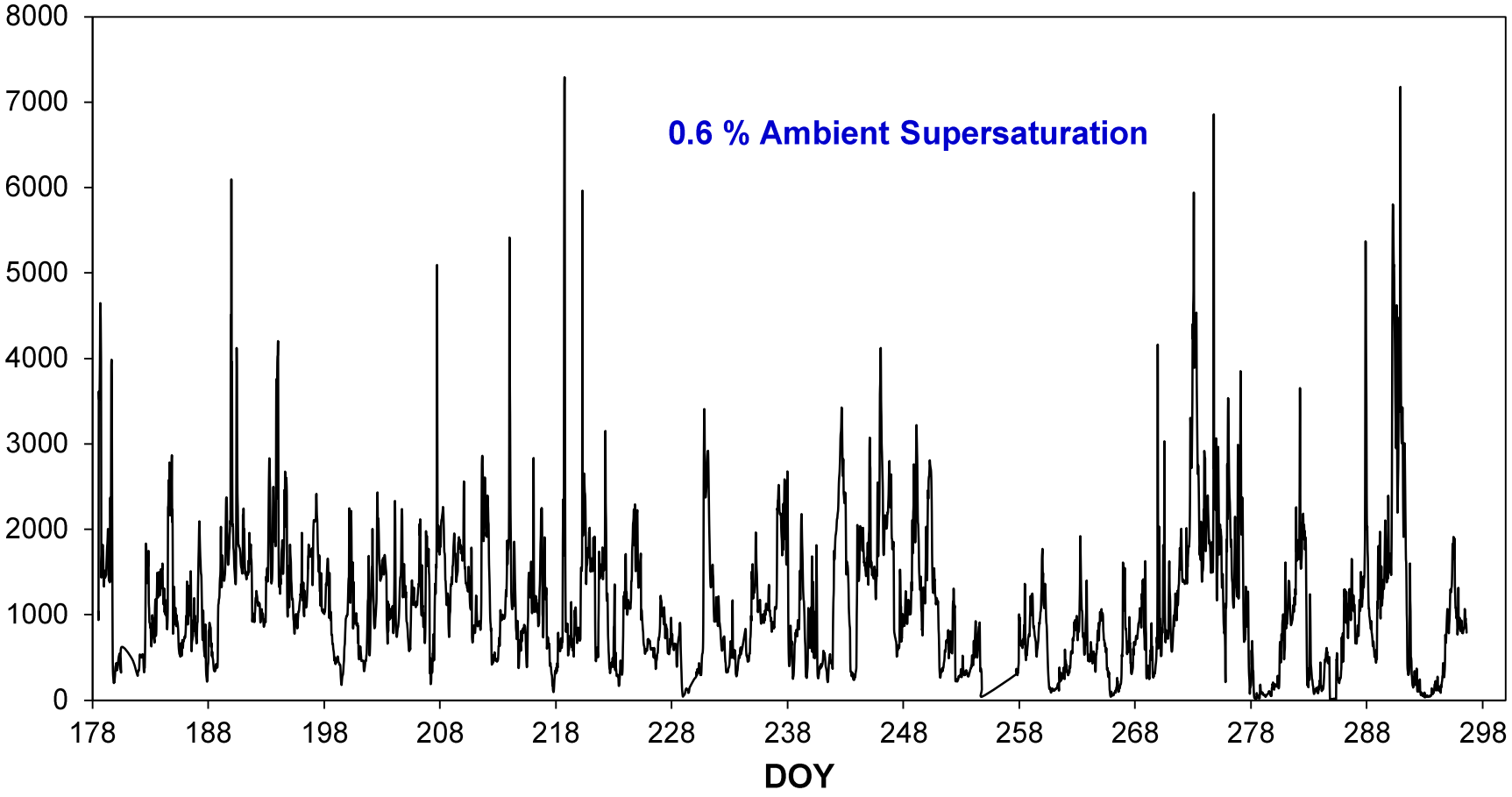
Cloud Base CCN Measurements – POLCAST 2012

Variations with Altitude



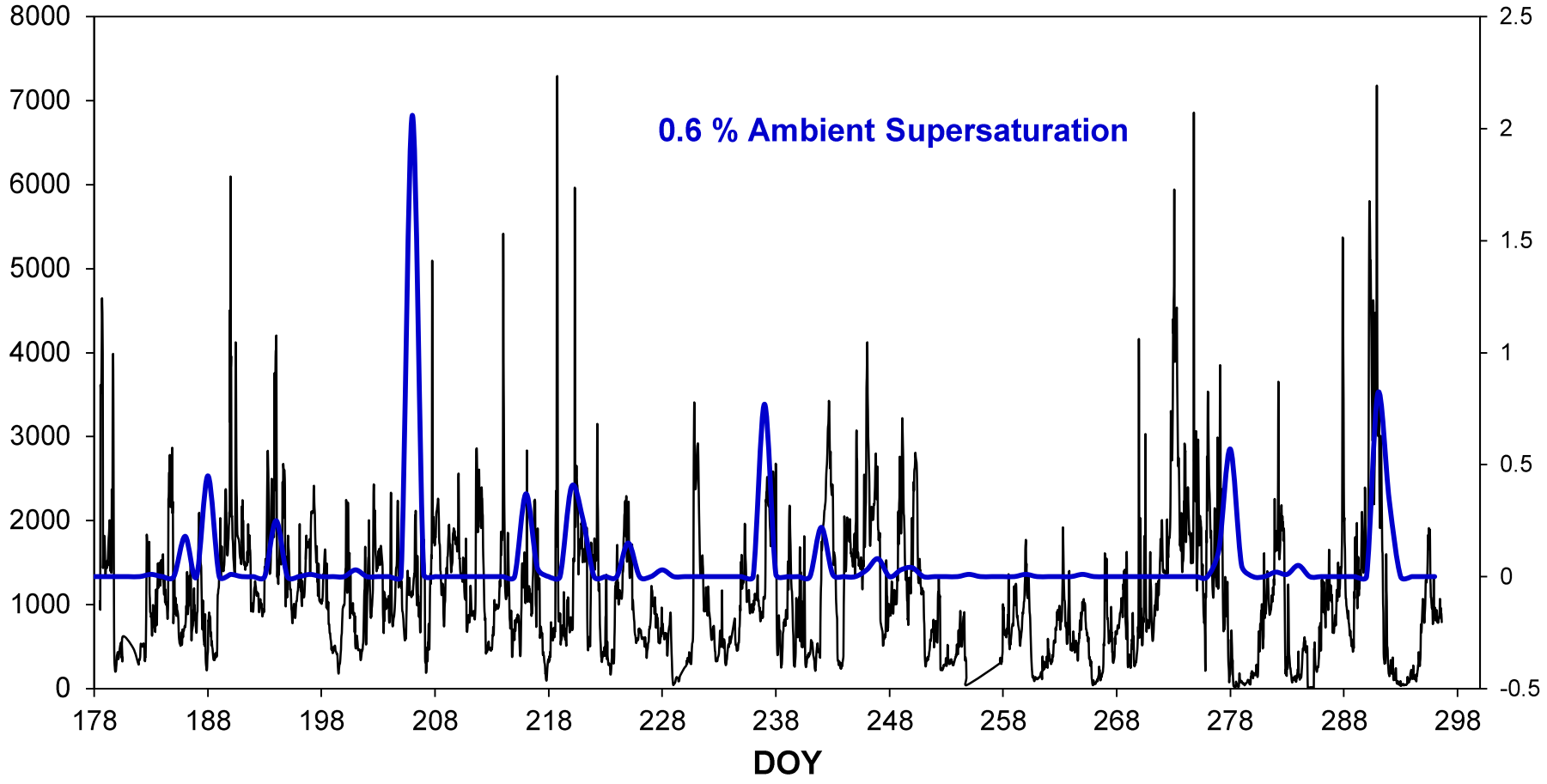
Surface Based CCN Measurements – POLCAST 2012

17 Week Measurement Period



Surface Based CCN Measurements – POLCAST 2012

Rain Events – Major Sink of CCN



Conclusions

Future Work & Directions

Initial experiments of Weeks 1–5 exhibit:

- Variations in OC distributions ($OC_{Wk\,4}$ >> $OC_{Wk1–3}$)
- Changes in concentrations for source markers

Back-trajectories show source of Week 4 OC may be from Canada and/or western North Dakota or eastern Montana

- High response of biomass burning markers

CCN measurements show connections to rain events being a major sink of CCN

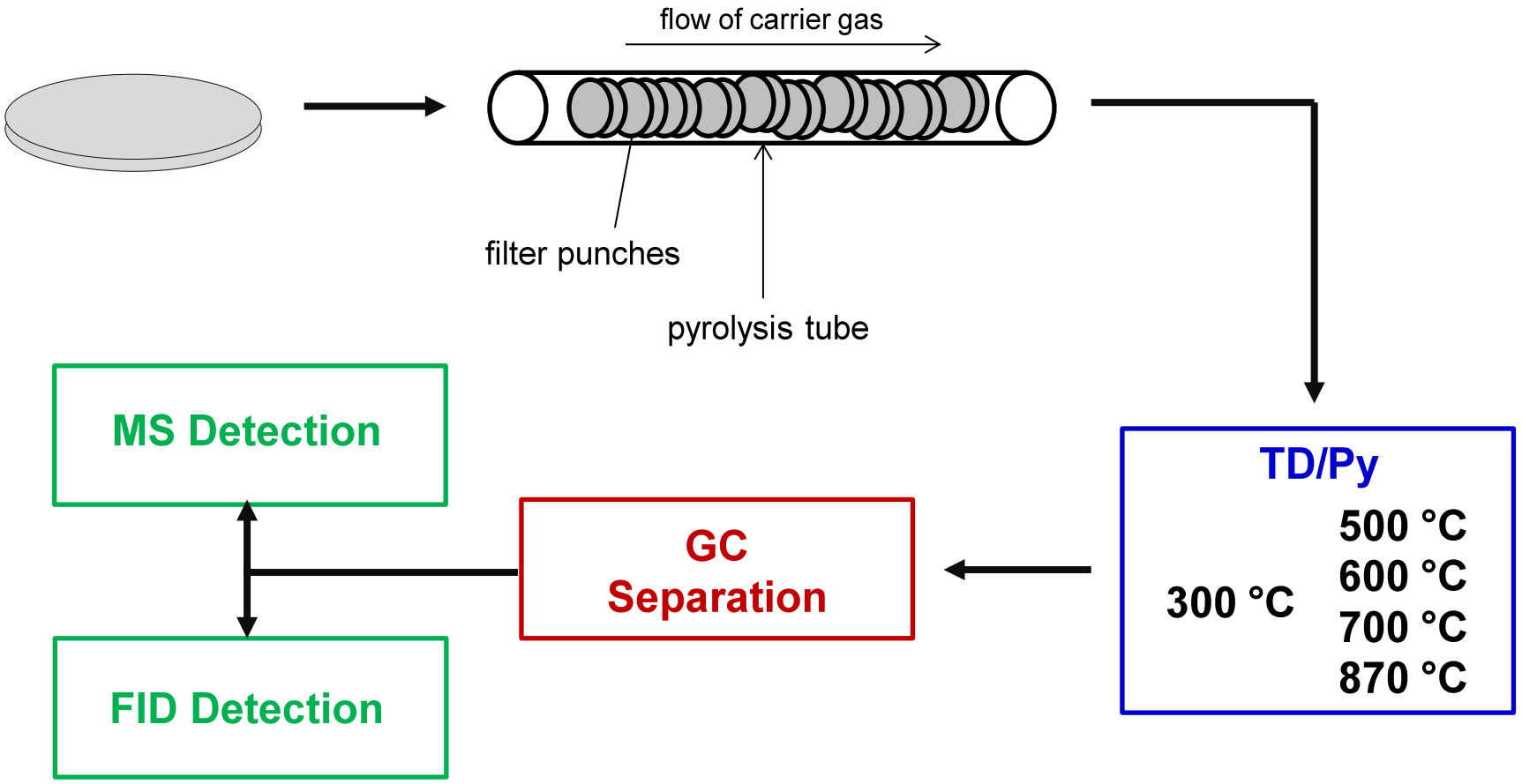
Future Plans

- Complete the speciation of the remaining weeks of the POLCAST campaign
- Evaluate trends correlating CCN concentrations to aerosol chemical composition
- Determine the possible (if any) contributions from harvesting activities
- Observe fluctuations in CCN/CN ratios

Filter Analysis – Chemical Speciation

TD/Py-GC/MS/FID Analysis Method

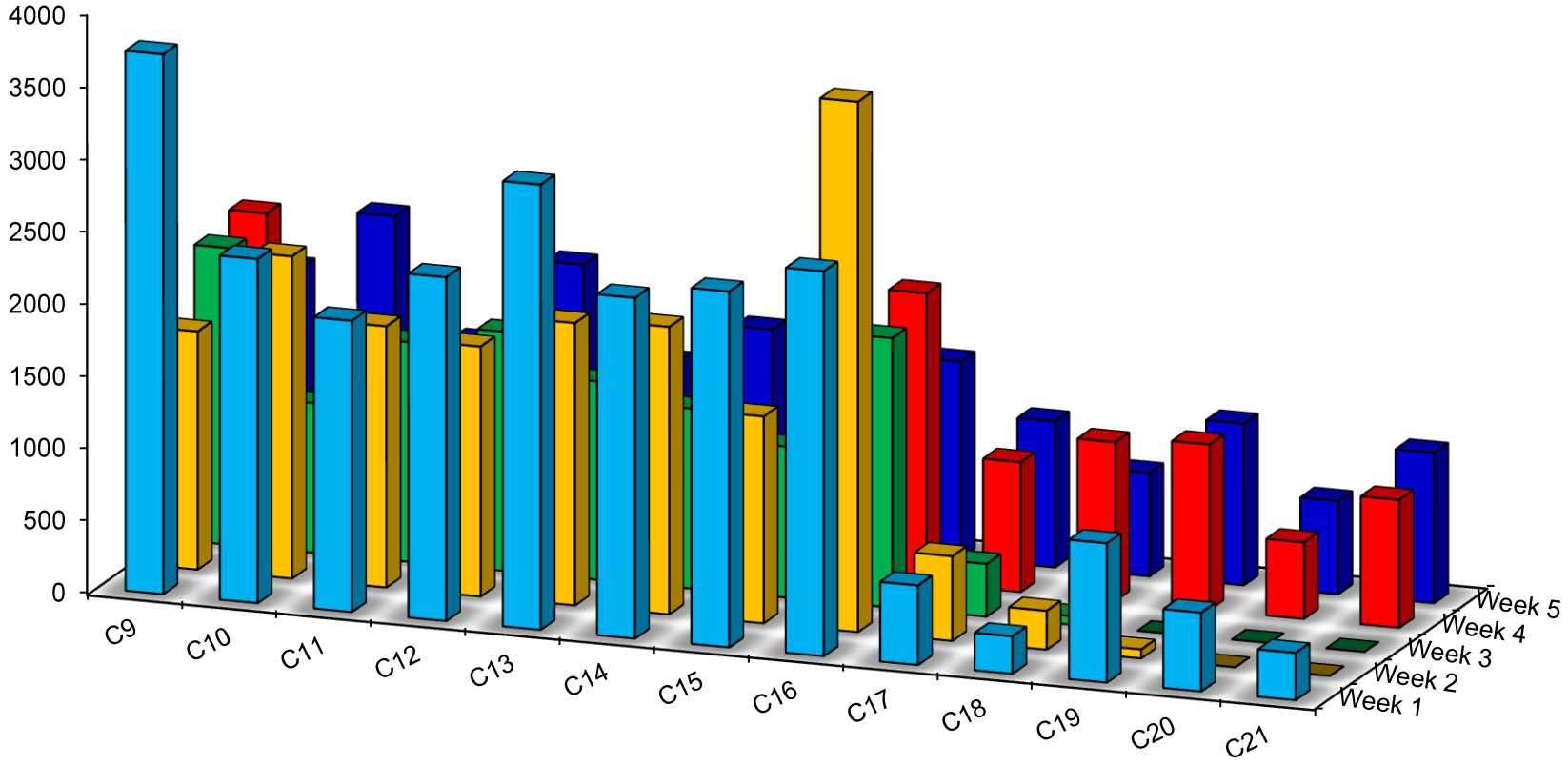
Thermal Desorption/Pyrolysis with Gas Chromatohraphy separation and Mass Spectrometry/Flame Ionization Detection (TD/Py-GC/MS/FID)



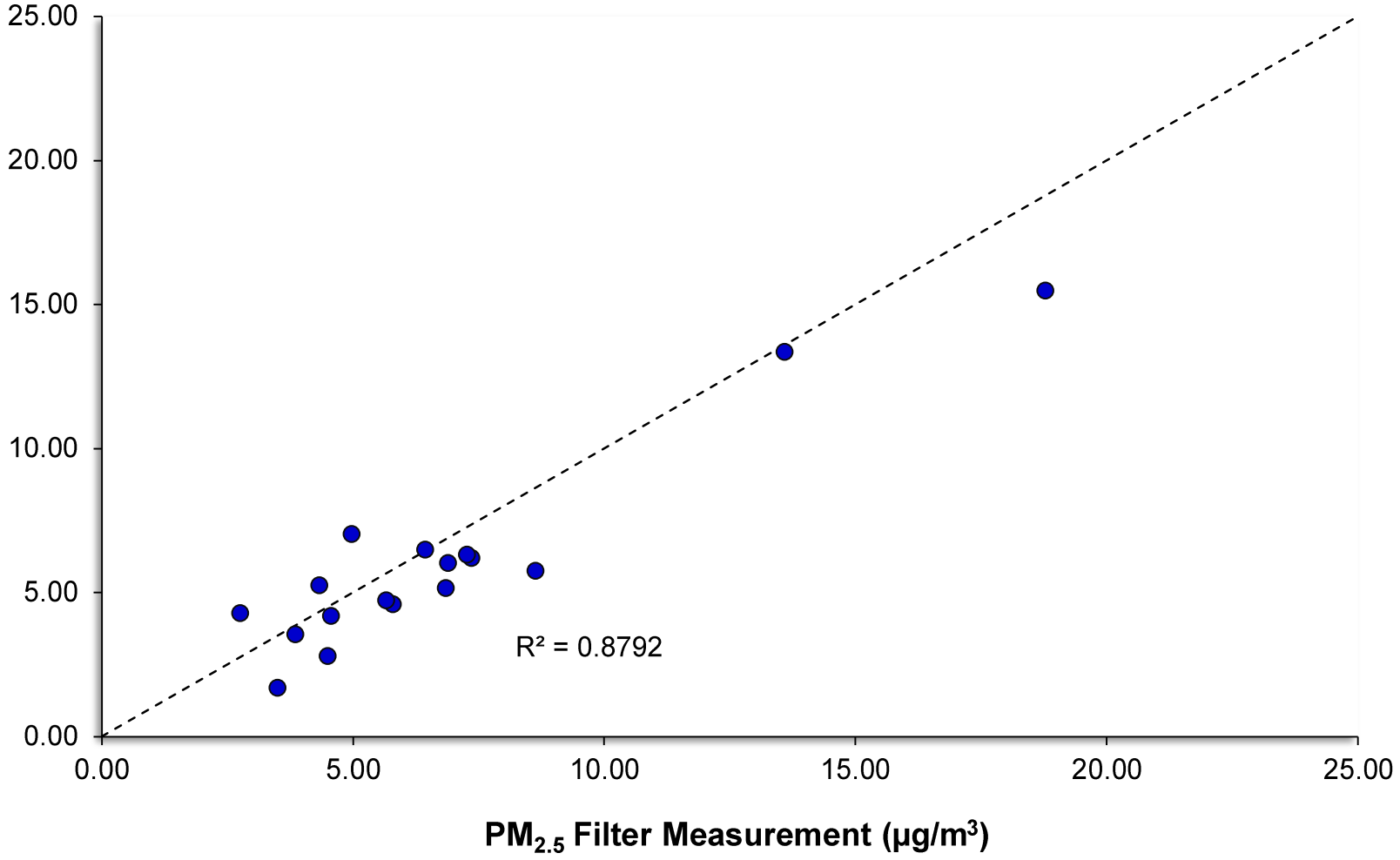
Distribution of Major Chemical Markers

500 °C Thermal Fraction; Weeks 1–5

High relative abundance of alkene TD or pyrolysis products



Comparing TEOM and Filter Weight Measurements



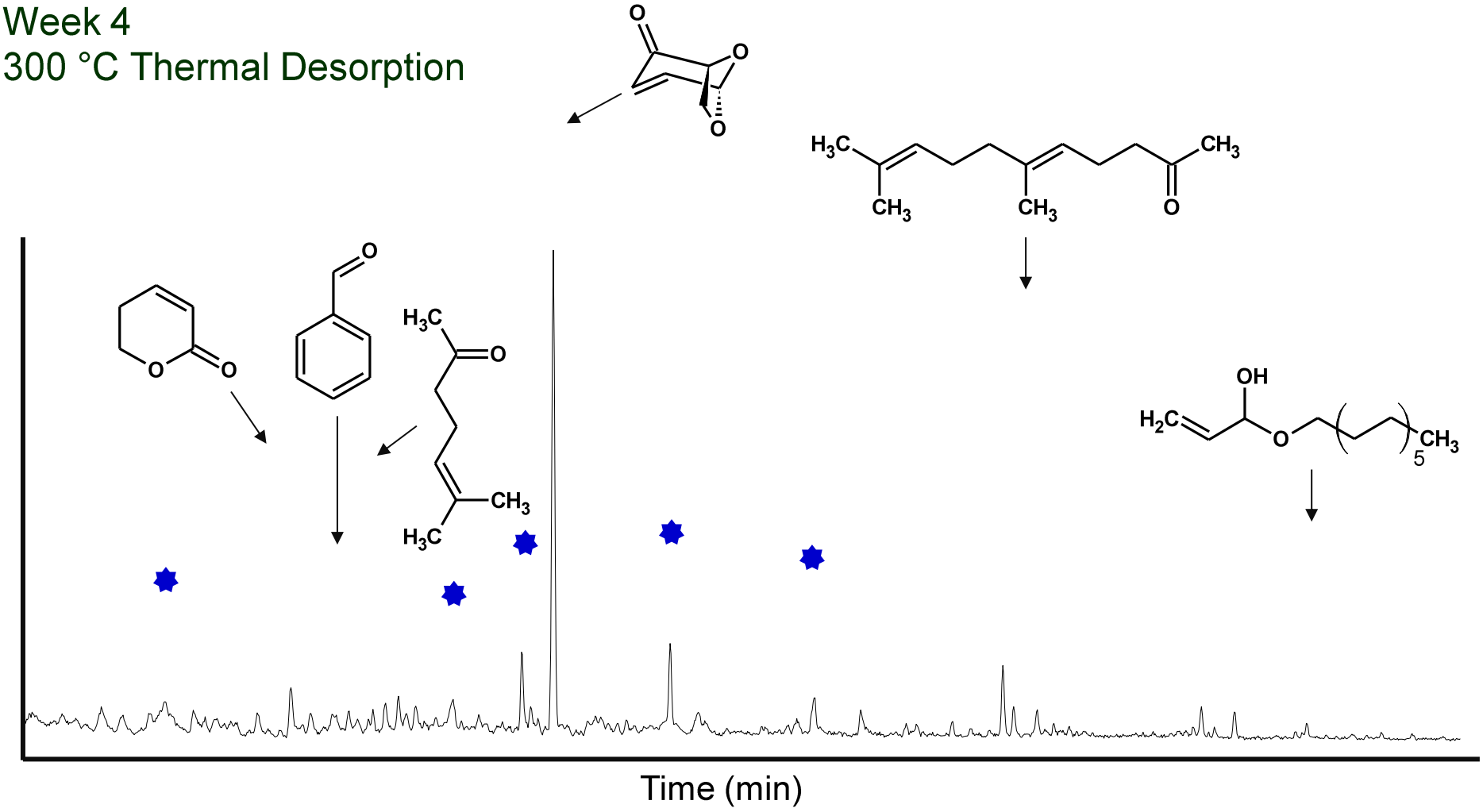
Chemical Speciation - Organics

GC-MS Analysis of Quartz Fiber Filters

Sample Chromatogram

Week 4

300 °C Thermal Desorption



Reproducibility of TD/Py-GC/MS Method

Relative Standard Deviations of Triplicate Measurements