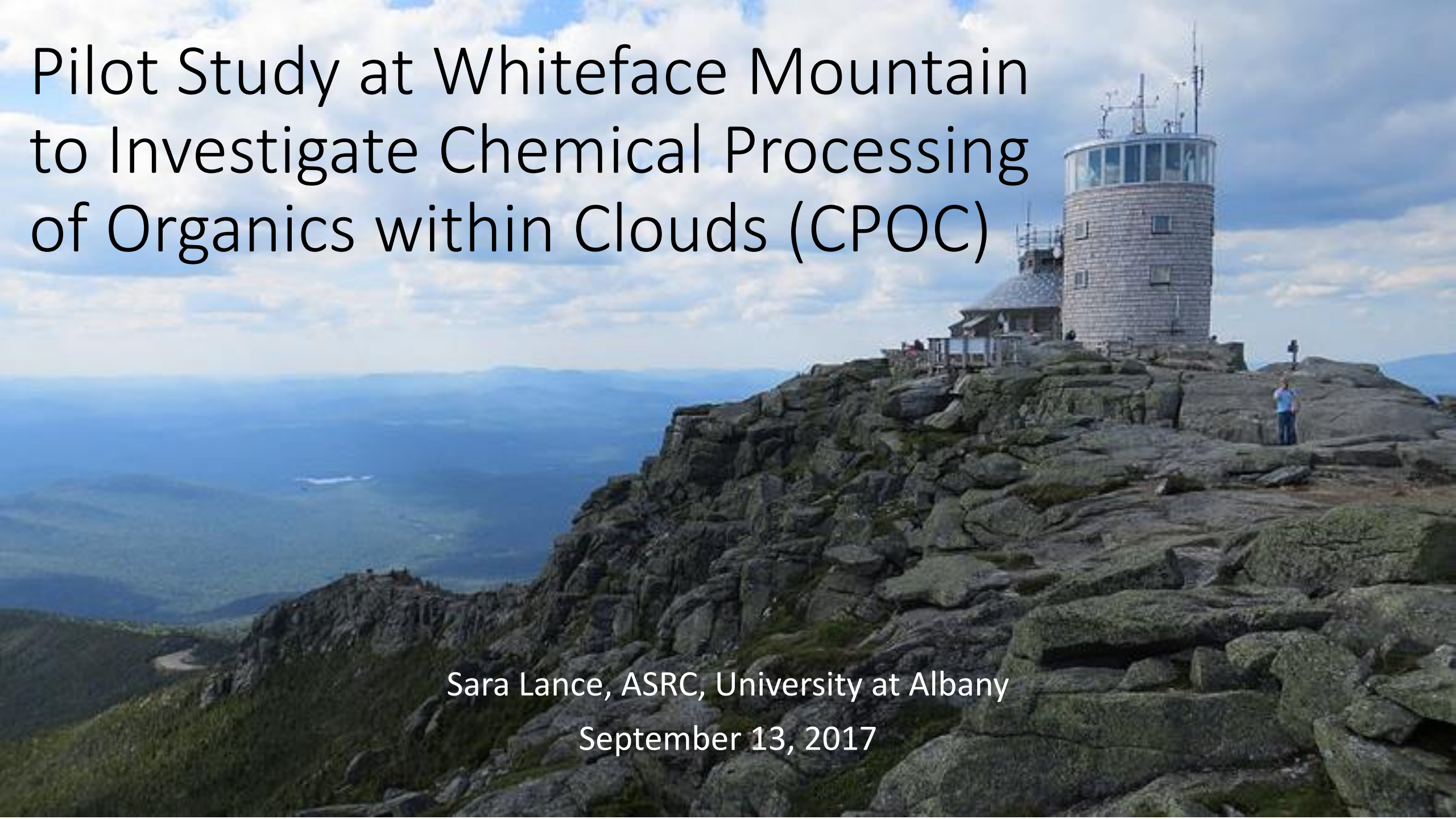
Pilot Study at Whiteface Mountain to Investigate Chemical Processing of Organics within Clouds (CPOC)



Sara Lance, ASRC, University at Albany

September 13, 2017

WFM Pilot Study Overview

1. Took place Aug 11-25, 2017
   https://www.asrc-research.com/cpoc

2. Substantial SUNY/ASRC involvement.
   7 Faculty, 6 Staff, Students

3. Lots of cloud, aerosol and meteorological data was obtained, pertinent to the chemical processing of organics within clouds

4. Data can be accessed at:
   http://atmoschem.asrc.cestm.albany.edu/~cpoc/

Biweekly CPOC data meetings will start Thurs Sep 28 at 3-4pm

- weather forecasts (LCL, rain, etc)
  Justin Minder, Matthew Brewer
- below-cloud aerosol measurements from the ASRC Sprinter Van (HR-TOF-AMS, CCN, SMPS, CPC)
  Jim Schwab, Sara Lance, Jie Zhang, Janie Schwab, Dan Orlowski (RPI), Matt Ninneman, Joe Marto, Richard Brandt
- summit aerosol measurements (CCN, SMPS)
  Sara Lance, Dan Orlowski (RPI) , Richard Brandt, Paul Casson
- summit trace gas and met data (wind direction, wind speed, T, RH, CO, NOy...)
- Jim Schwab, ALSC , Richard Brandt, Paul Casson
- summit cloud measurements (FFSSP, Parsivel disdrometer, LWC)
  Sara Lance, Dan Orlowski (RPI), Justin Minder, Matthew Brewer, ALSC, Richard Brandt
- radiosonde measurements (RH, Temperature, GPS location, Altitude)
  Justin Minder, Matthew Brewer, Janie Schwab, Dan Orlowski (RPI) , Richard Brandt
- Remote sensing: wind LIDAR, sun photometer (cloud base altitude, wind speed + direction, aerosol)
  Jeff Freedman, Bhupal Shrestha, Everette Joseph, Qilong Min, Richard Brandt
- met towers (RH, Temperature, wind speed + direction, pressure, solar irradiance)
  Dave Fitzjarrald, Matthew Brewer, Paul Casson
- ambient met sensors (RH, Temperature, GPS location, Altitude)
  Justin Minder, Matthew Brewer
- aerosol forecasts (trajectories, timeseries, chemical speciation)
  Sarah Lu, Jeongran Yun, Sheng-Po Chen
- cloud water analysis (ionic composition, organic content…)
  Paul Casson, Amy Christiansen (UC Irvine), AnnMarie Carlton (UC Irvine), ALSC, Jim Schwab, Sara Lance, Jie Zhang

AirBNB in Wilmington, NY

Stayed for the 2 week Intensive Operations Period:

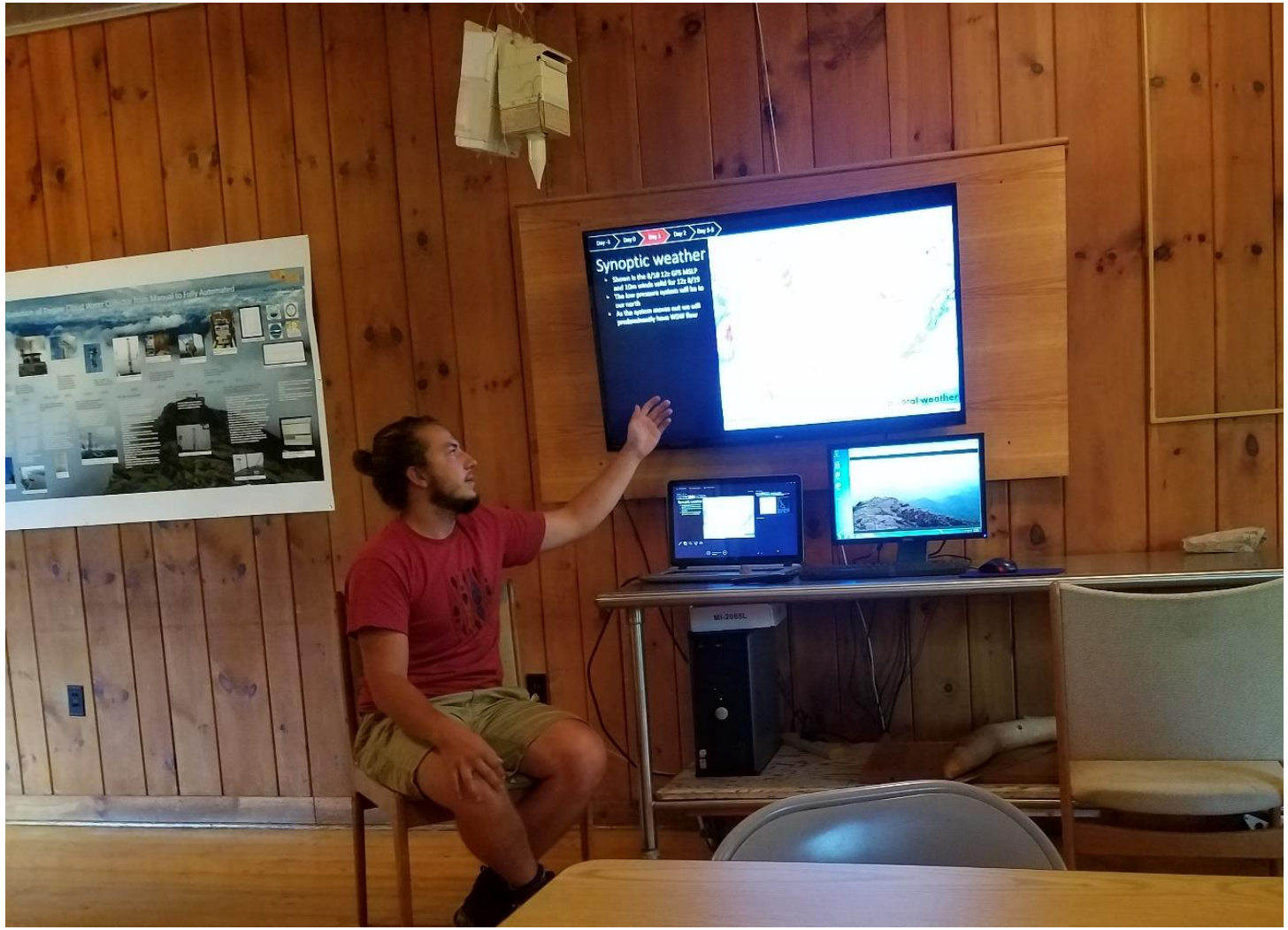
- Sara Lance
- Dan Orlowski
- Matthew Brewer
- Jie Zhang
- Amy Christiansen

Stayed for a few nights:

- Jim and Janie Schwab
- Justin Minder
- Dave Fitzjarrald
- Matt Ninneman
- Joe Marto

Student Involvement (grad and undergrad)

- Instrument Deployment
- Data Acquisition
- Weather Forecasting
- Balloon Launches
- Data Analysis
- Presentation of preliminary results



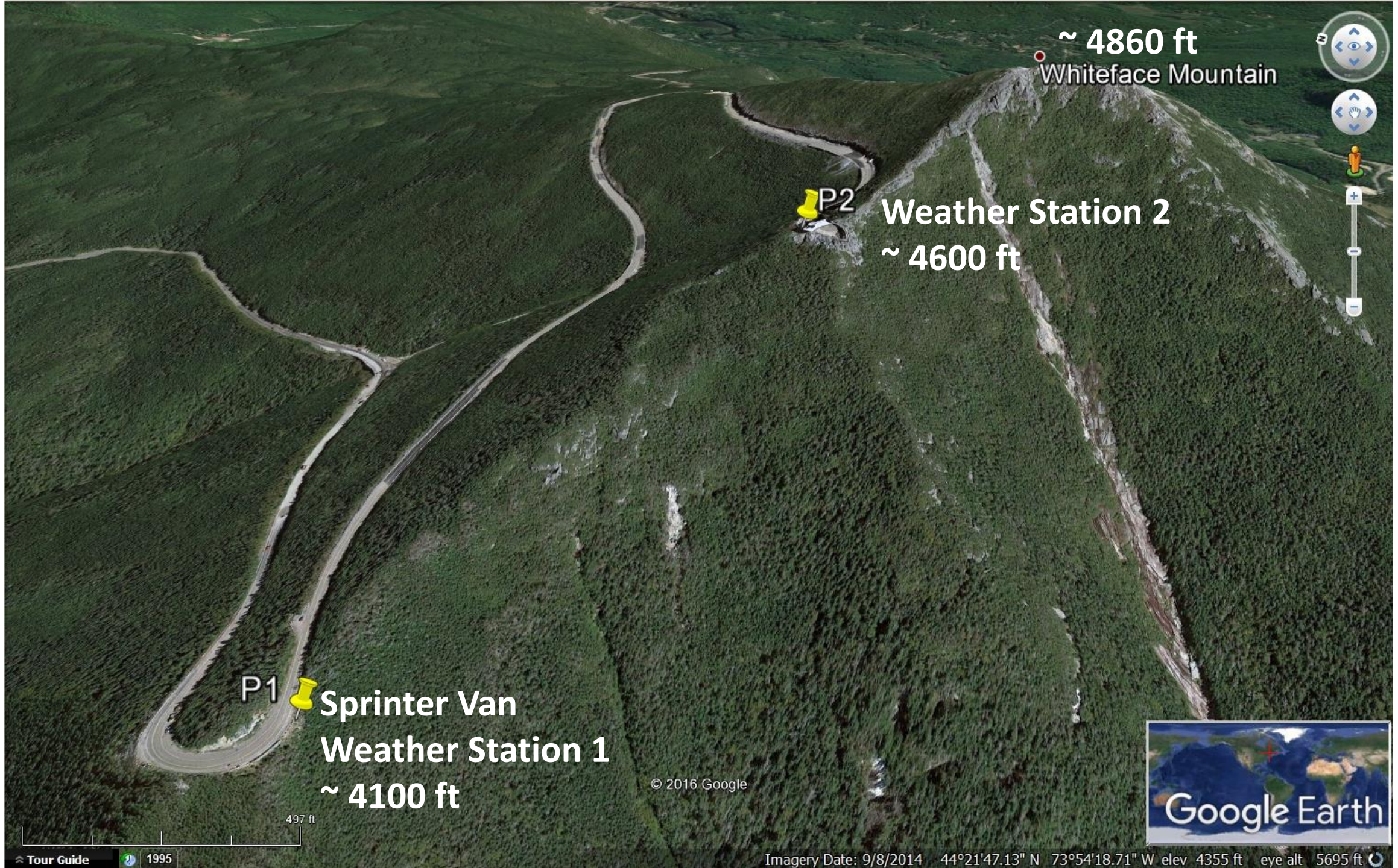
CPOC Pilot Study at WFM
Overview of Intensive Operations Period

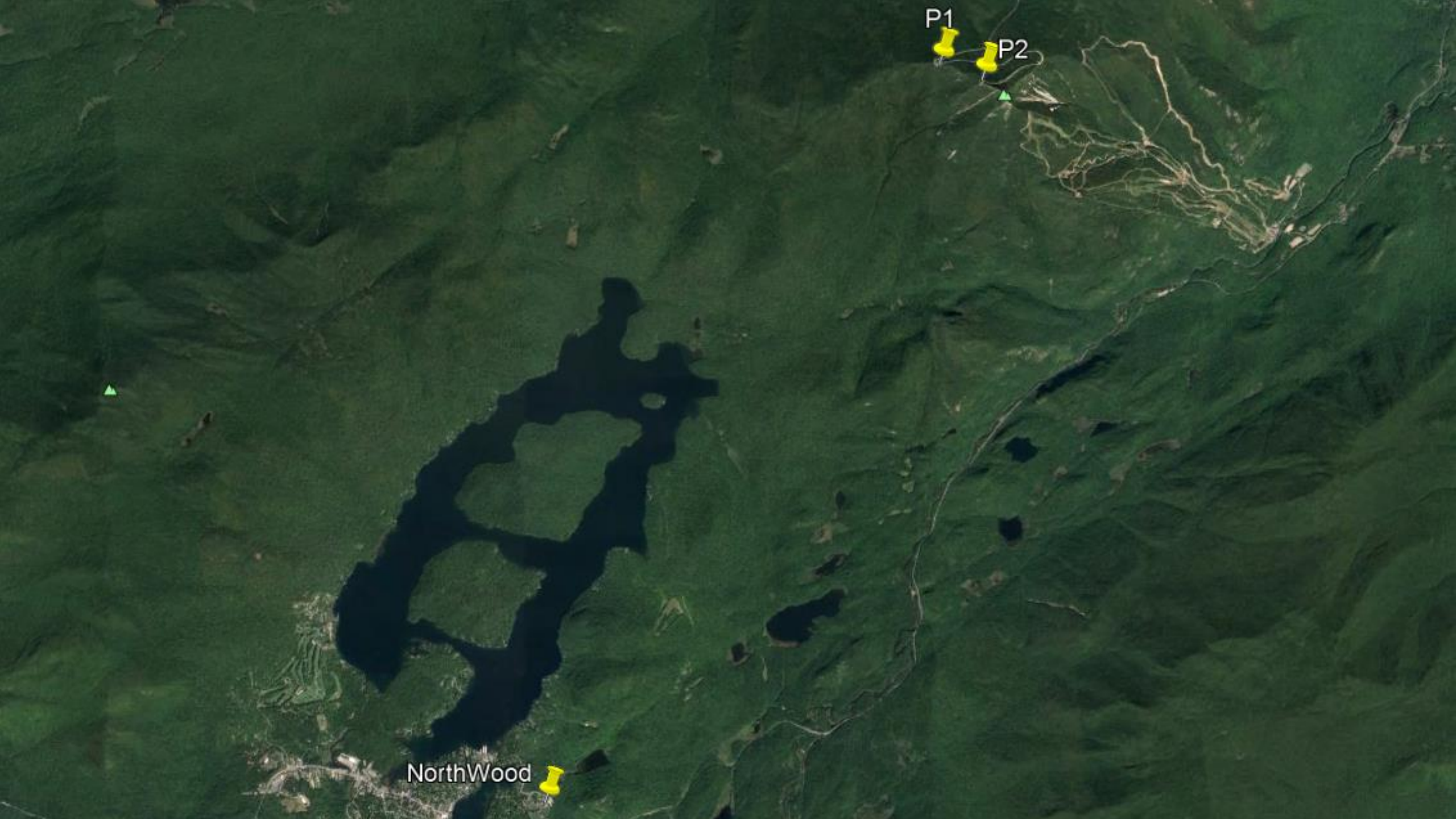
August 2017

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
31	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			

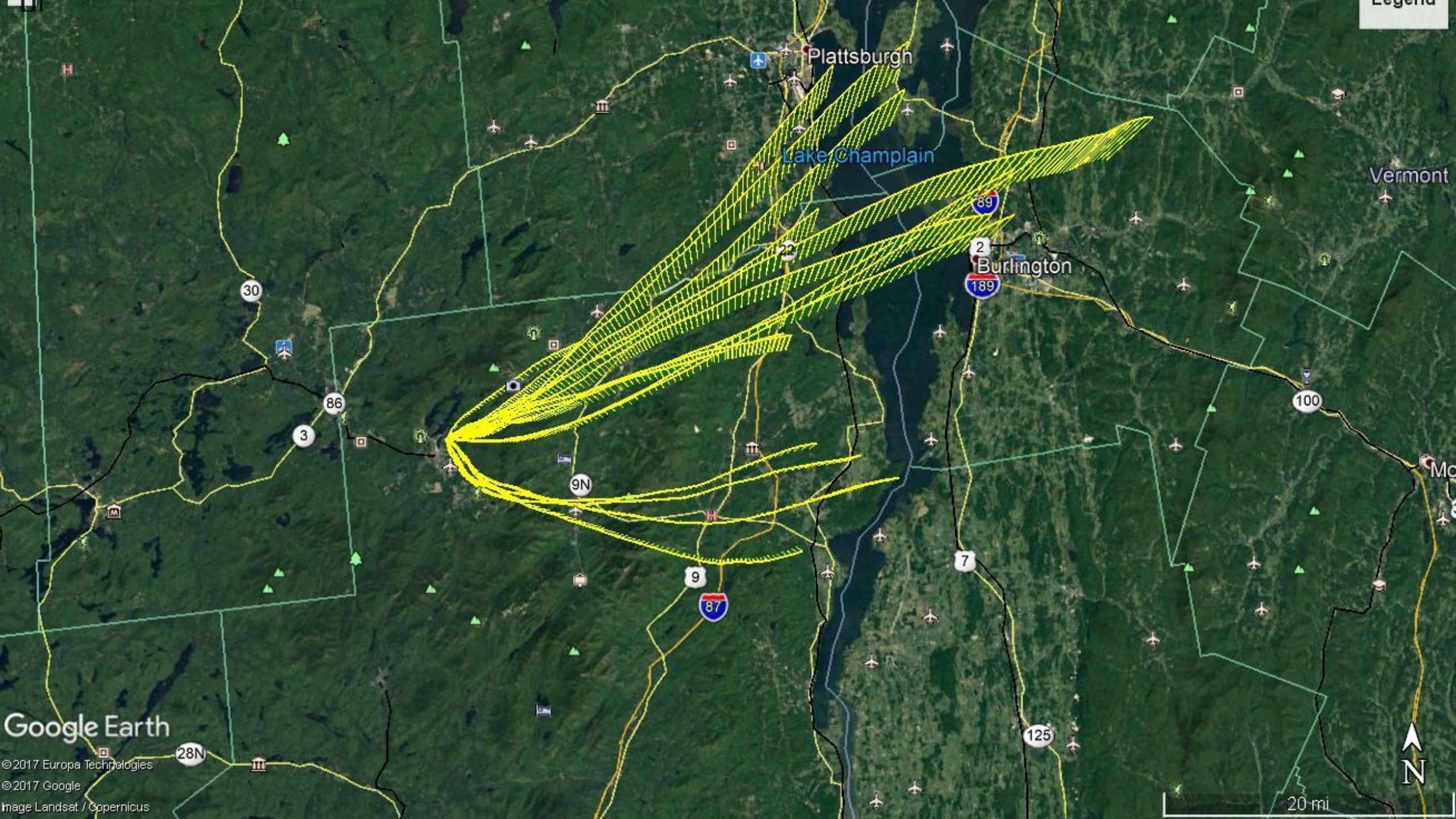
icalendars.net

- Soundings launched from Northwood School
- Sprinter Van deployed to the Lake Placid Turn
- Hourly cloud water samples taken at the WFM summit


~ 4860 ft
Whiteface Mountain
P2
Weather Station 2
~ 4600 ft
P1
Sprinter Van
Weather Station 1
~ 4100 ft
© 2016 Google
497 ft
Google Earth
Tour Guide
1995
Imagery Date: 9/8/2014 44°21'47.13" N 73°54'18.71" W elev 4355 ft eye alt 5695 ft


P1
P2
NorthWood

Northwood School, Lake Placid, NY


Legend
Plattsburgh
Lake Champlain
Vermont
Burlington
30
86
3
9N
9
87
89
2
189
100
7
125
28N
Google Earth
©2017 Europa Technologies
©2017 Google
Image Landsat / Copernicus
N
20 mi

“Lake Placid Turn” in the road up to WFM

“Lake Placid Turn”

The Summit!

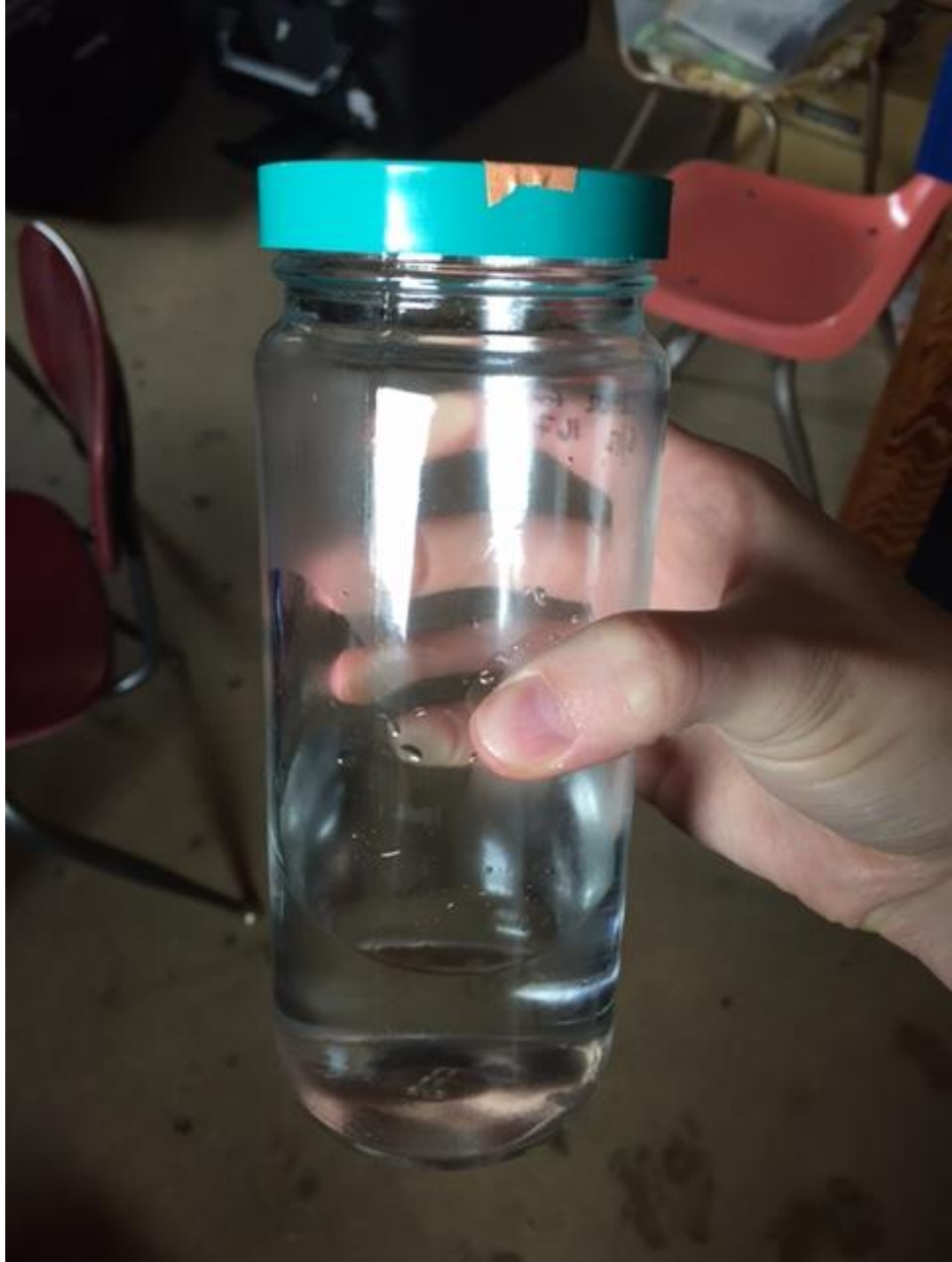
Summit of WFM

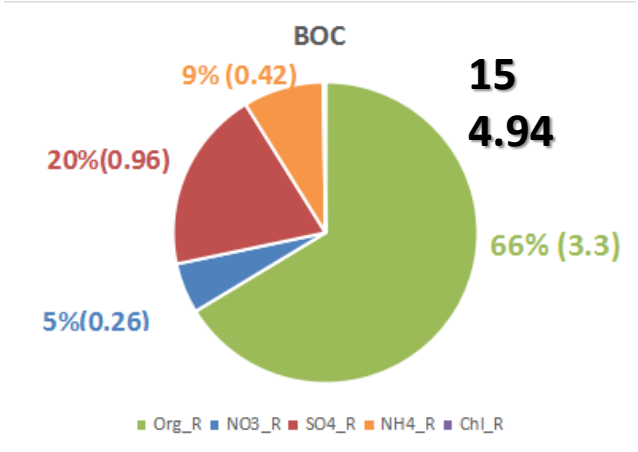
In-Situ Cloud measurements

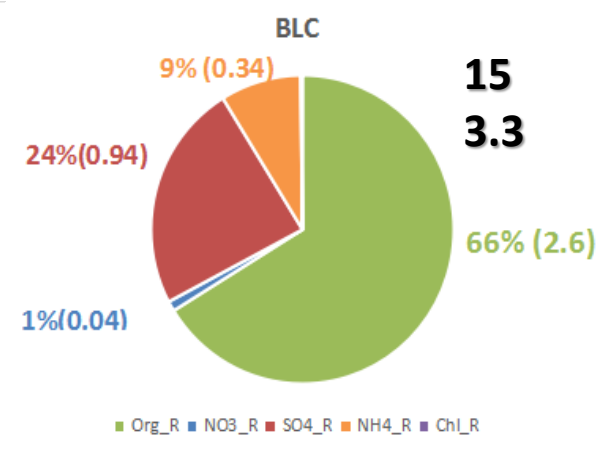
Aerosol Instruments installed at the WFM summit

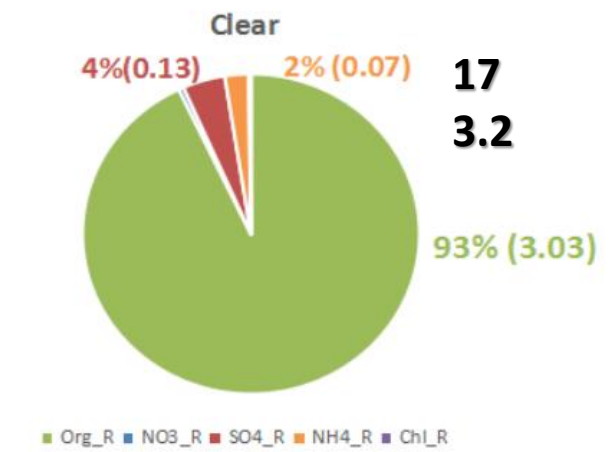
Cloud Water Chemical Analysis

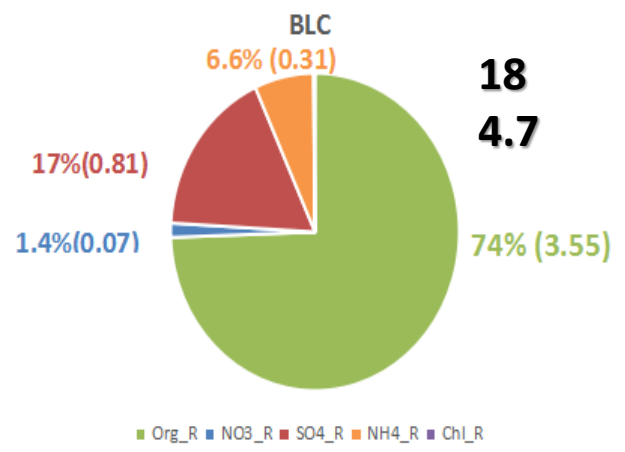
- Transition Metals (Fe, Cu, Mn)
  - UV-Vis Spectroscopy
  - High-resolution inductively-coupled plasma mass spectrometer
- Carboxylic acids
  - HPLC and IC
- Water soluble organo-nitrogen compounds
- Surface droplet tension
- TAG GC/MS
- HR-TOF-AMS

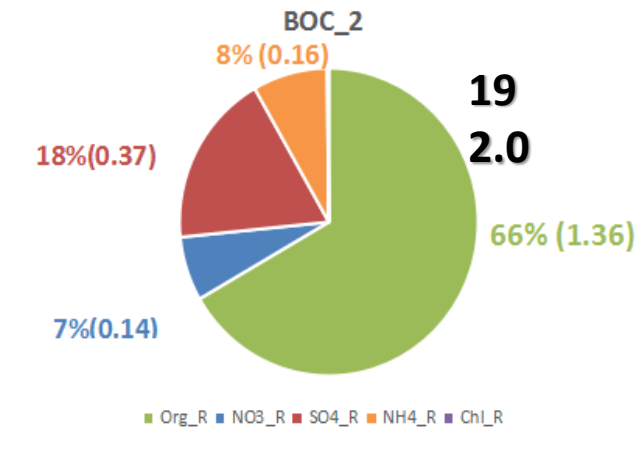


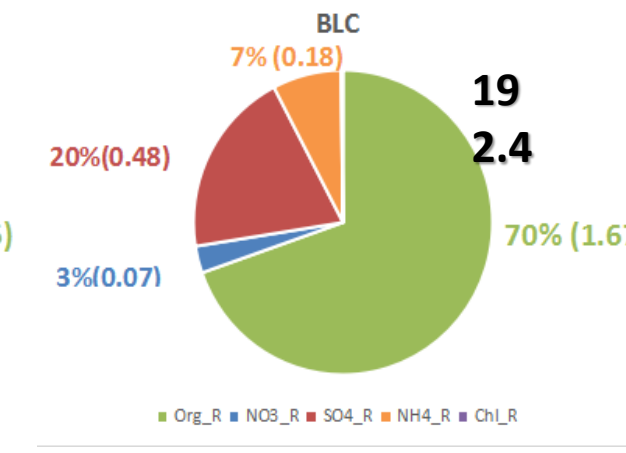

BOC
9% (0.42)
20%(0.96)
5%(0.26)
66% (3.3)
15
4.94
Org_R NO3_R SO4_R NH4_R Chl_R

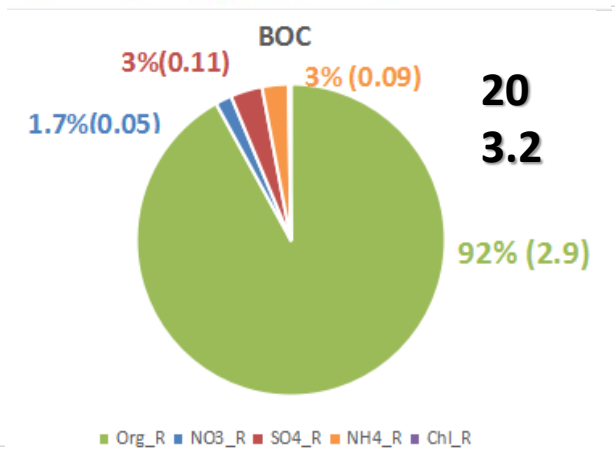

BLC
9% (0.34)
24%(0.94)
1%(0.04)
66% (2.6)
15
3.3
Org_R NO3_R SO4_R NH4_R Chl_R

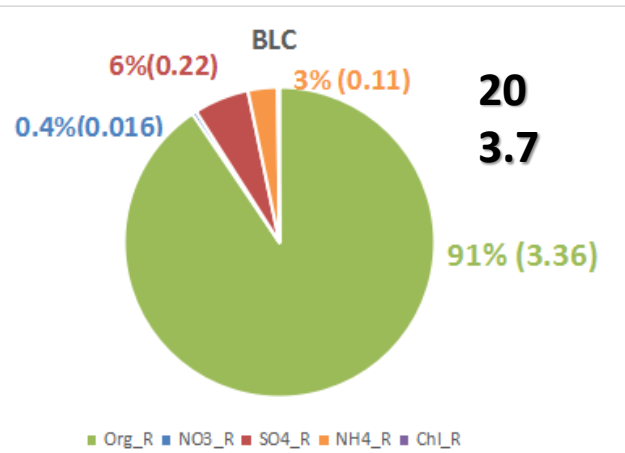

Clear
4%(0.13)
2% (0.07)
93% (3.03)
17
3.2
Org_R NO3_R SO4_R NH4_R Chl_R

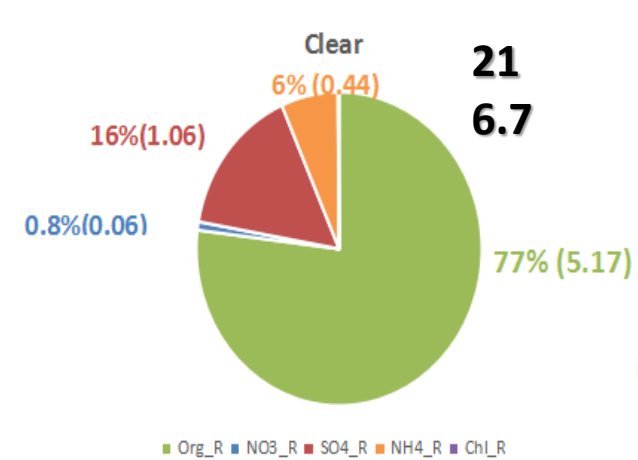

BLC
6.6% (0.31)
17%(0.81)
1.4%(0.07)
74% (3.55)
18
4.7
Org_R NO3_R SO4_R NH4_R Chl_R

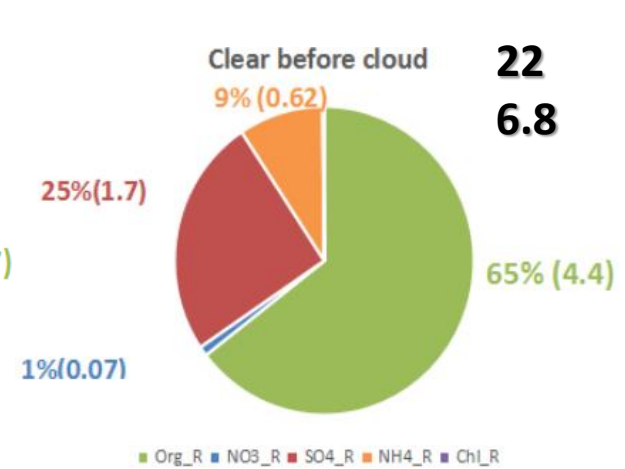

BOC_2
8% (0.16)
18%(0.37)
7%(0.14)
66% (1.36)
19
2.0
Org_R NO3_R SO4_R NH4_R Chl_R

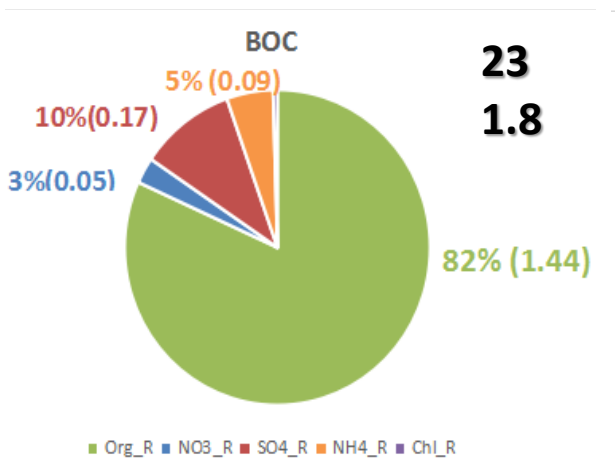

BLC
7% (0.18)
20%(0.48)
3%(0.07)
70% (1.67)
19
2.4
Org_R NO3_R SO4_R NH4_R Chl_R

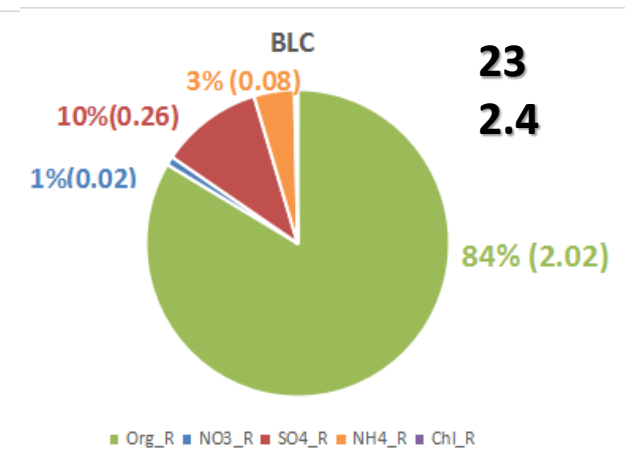

BOC
3%(0.11)
3% (0.09)
1.7%(0.05)
92% (2.9)
20
3.2
Org_R NO3_R SO4_R NH4_R Chl_R


BLC
6%(0.22)
3% (0.11)
0.4%(0.016)
91% (3.36)
20
3.7
Org_R NO3_R SO4_R NH4_R Chl_R


Clear
6% (0.44)
16%(1.06)
0.8%(0.06)
77% (5.17)
21
6.7
Org_R NO3_R SO4_R NH4_R Chl_R


Clear before cloud
9% (0.62)
25%(1.7)
1%(0.07)
65% (4.4)
22
6.8
Org_R NO3_R SO4_R NH4_R Chl_R


BOC
5% (0.09)
10%(0.17)
3%(0.05)
82% (1.44)
23
1.8
Org_R NO3_R SO4_R NH4_R Chl_R


BLC
3% (0.08)
10%(0.26)
1%(0.02)
84% (2.02)
23
2.4
Org_R NO3_R SO4_R NH4_R Chl_R

Science Question 3:
Cloud Processing Impacts on Aerosol

How does liquid-cloud-water-mediated processing modify

- particle size distribution
- organic/inorganic mass loading
- oxidation state
- brown carbon or OA-metal ligands (e.g. iron oxalate) concentrations
- toxicity (ROS, reactive oxygen species)
- O:C ratio
- mixing state
- hygroscopicity
- volatility
- morphology
- optical properties of atmospheric aerosols

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Science Question 3:
Cloud Processing Impacts on Aerosol

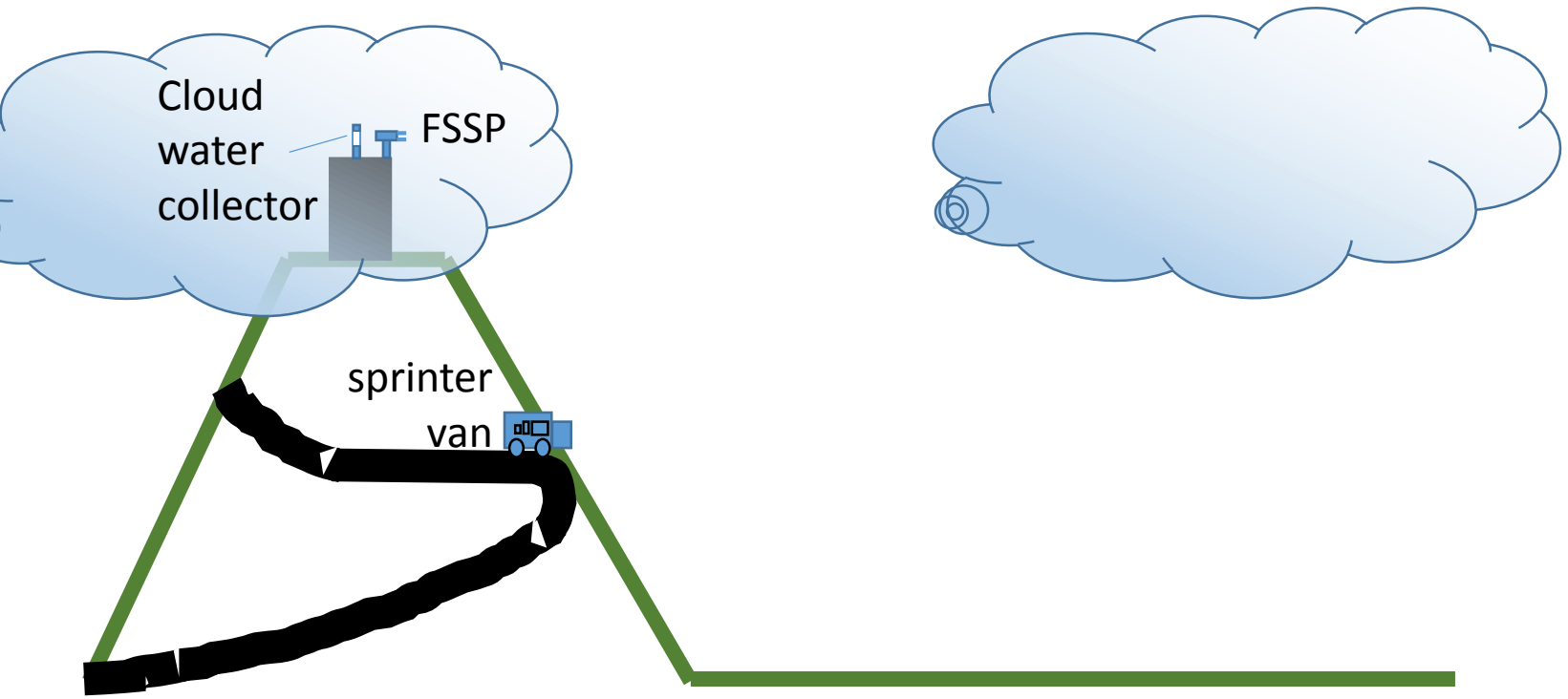
What sort of coupling occurs between organics/inorganics during cloud processing?

What is the mixing state of transition metal-containing particles (like mineral dust) relative to the cloud water?

What is the contribution of biomass burning/ residential and recreational pellet stove/wood burning emissions to the WFM during the warmer seasons when cloud water is sampled at WFM?

Can we add more constraints to counteract ambiguity of complex terrain (possibly no clear in-and-out trajectory for the aerosol, but instead a continual recycling of the aerosols below cloud and possibly at cloud edges/top)?

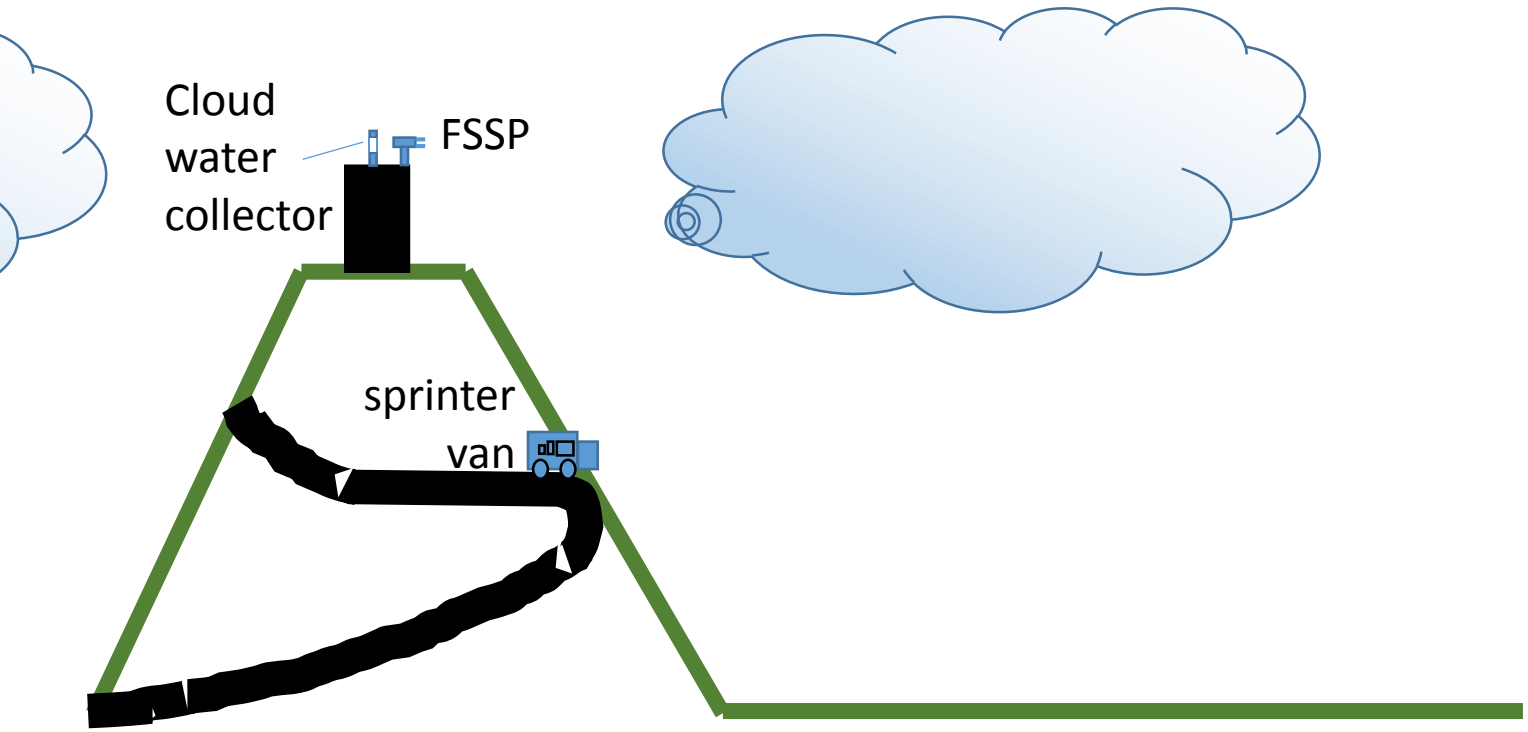
Pilot Study Deployment Plan



1. In-situ observations at Summit
   - Cloud droplet size distribution, cloud water chemistry, LWC
   - "Between-cloud" aerosol characterization (size distribution, CCN activity)

2. Below-cloud aerosol characterization (from the Sprinter Van)
   - Aerosol composition, size distribution, CCN activity

Pilot Study Deployment Plan



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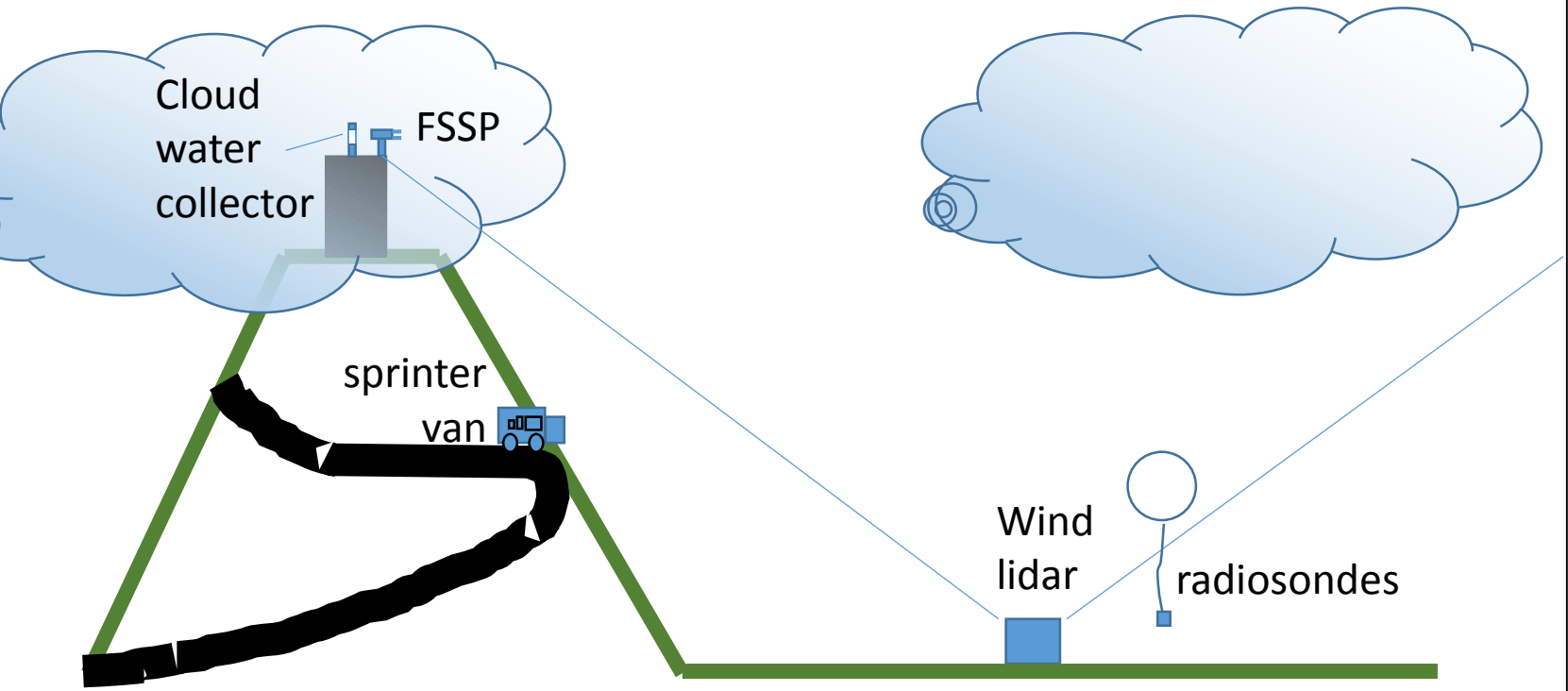
   - “Between-cloud” aerosol characterization (size distribution, CCN activity)

2. Below-cloud aerosol characterization (from the Sprinter Van)
   - Aerosol composition, size distribution, CCN activity, Ozone

Pilot Study Deployment Plan



3. Doppler lidar – 3D wind profile, cloud base
   - Deployed now at ASRC
   - Upwind location desired (less important than proximity to the summit – tradeoff is lack of cloud base observations at summit. Would only have Wild Center camera for estimating that)

4. Radiosondes – vertical profile of RH, T, winds
   - 4-8 per day on “golden days”