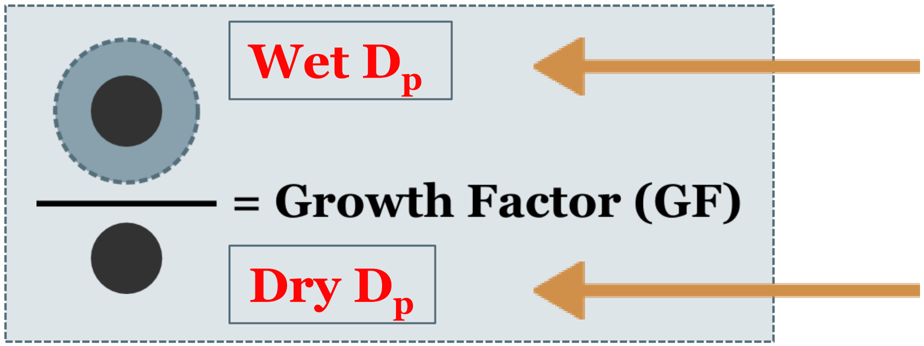
Characterization of size-resolved aerosol hygroscopicity on the NASA DC-8 during SEAC4RS

(U. Arizona) Taylor Shingler, Ewan Crosbie, Armin Sorooshian
Team LARGE, AMS, HD-SP2, PTR-MS
(Max Planck Inst., Germany) Manabu Shiraiwa
(McGill Univ.) Andi Zuend

30 April 2015
SEAC4RS Team Meeting (Pasadena, CA)

Motivation

- Aerosol hygroscopicity: The ability of particles to take up water
- How is aerosol hygroscopicity measured?



Equilibrium diameter of particle after being exposed to an elevated % RH

Diameter of dried particle (% RH < 20%)

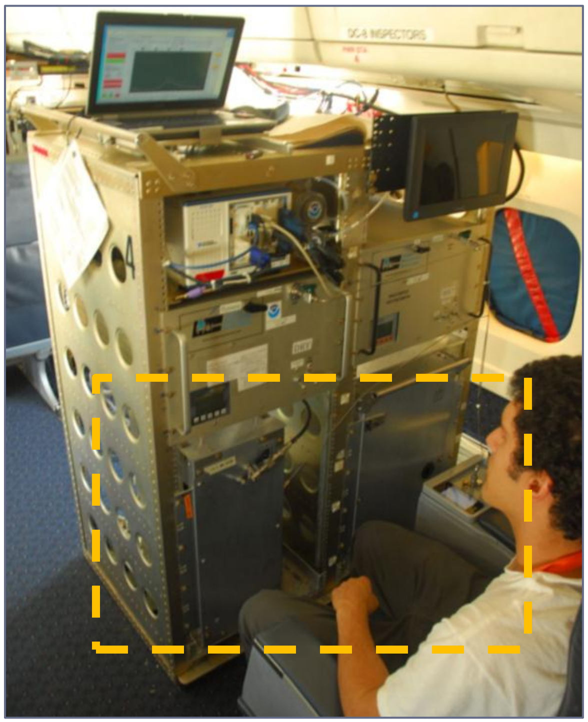
- Impacts: Radiative forcing and cloud properties; visibility; public health; remote sensing

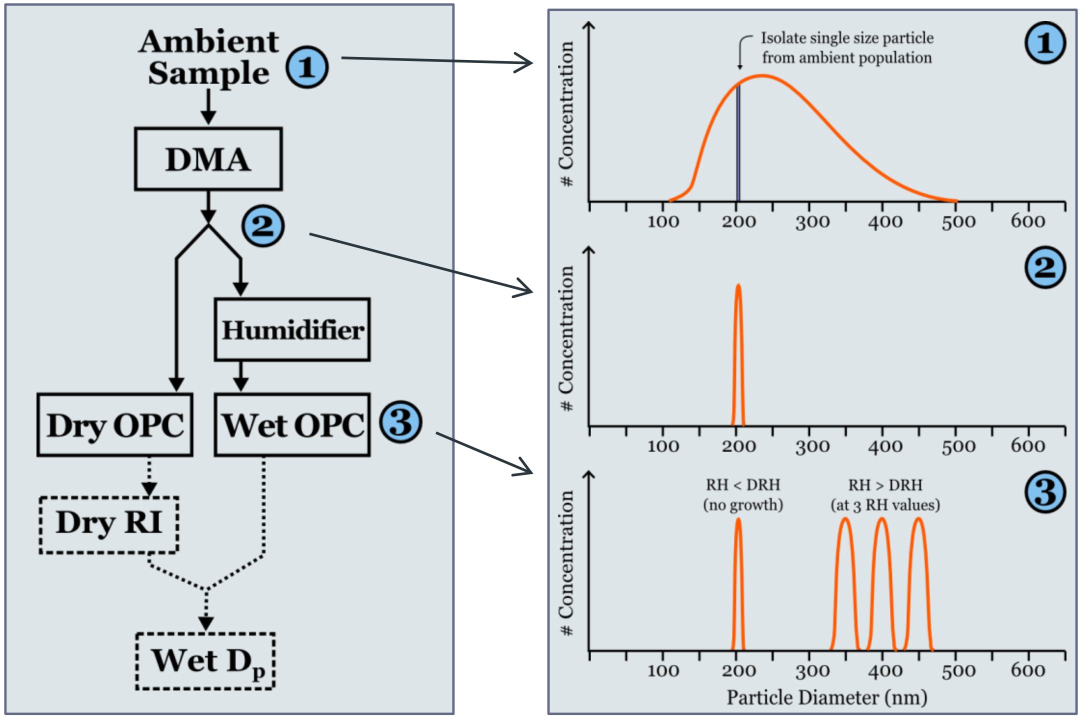
- Goal: Improve model parameterizations of hygroscopicity including connection between f(RH), GF, and kappa

Differential Aerosol Sizing and Hygroscopicity Spectrometer Probe (DASH-SP; Sorooshian et al. (2008), Aerosol Sci. Tech.)

- Instrument developed for rapid measurements of size-resolved aerosol growth factor (GF) and real part of the dry particle refractive index (RI) at 532 nm

- Dry particle size (180–375 nm) and RH (up to 95%) changed rapidly during sampling





Data Analysis Objectives

- GF and f(RH) intercomparison
- Characterization of semivolatile losses during sampling on DC-8
- Predicting sub-saturated aerosol hygroscopic growth
- Compositing GF and RI data as a function of dry D_p, RH%, and airmass types

} Manuscript in preparation

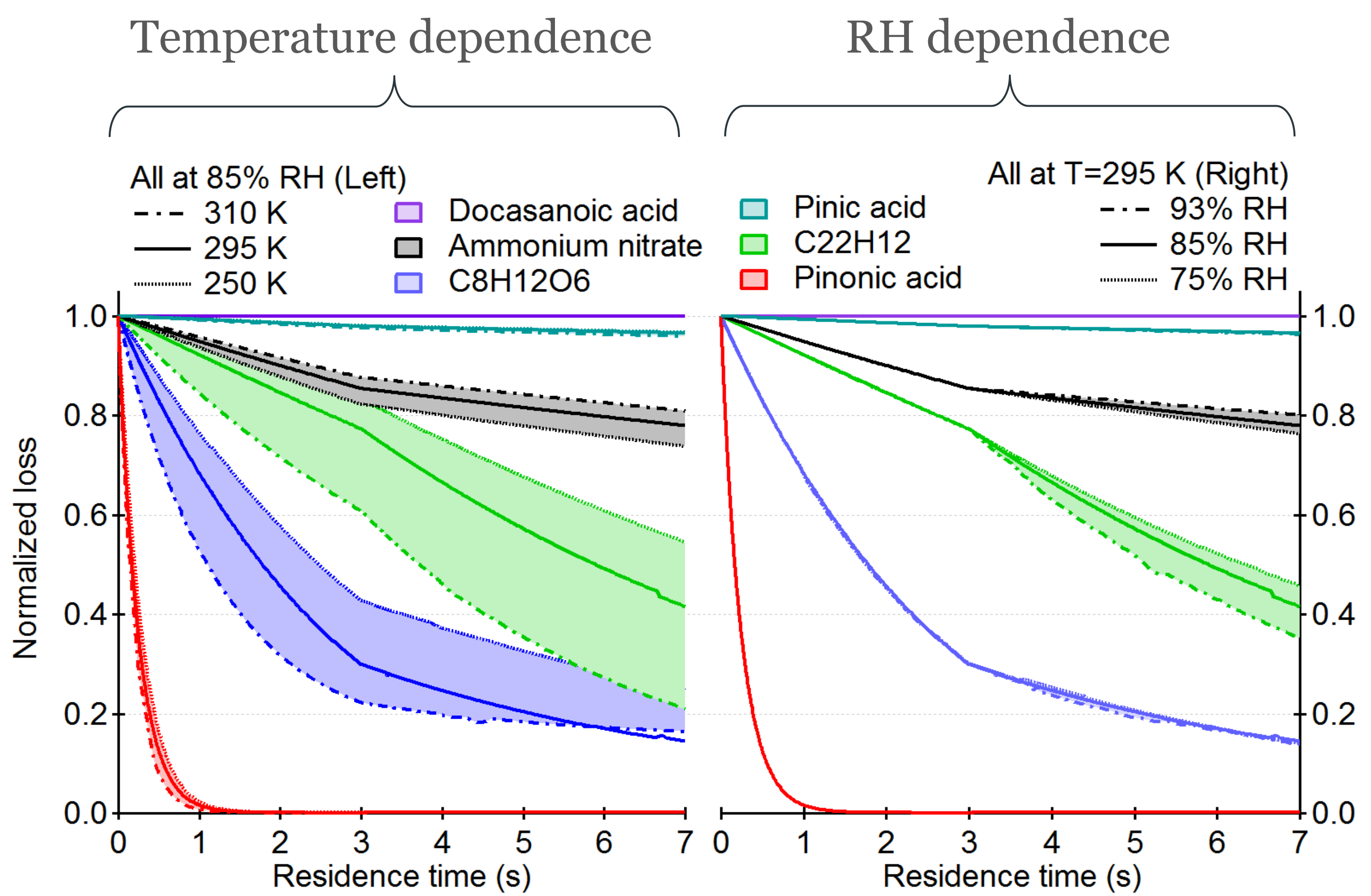
- Single parameter representation of water-uptake in sub- and super-saturated regimes

} Planned manuscript

- Growth factor measurements less than 1.0

} Planned manuscript

Semivolatile Species Losses During Sampling

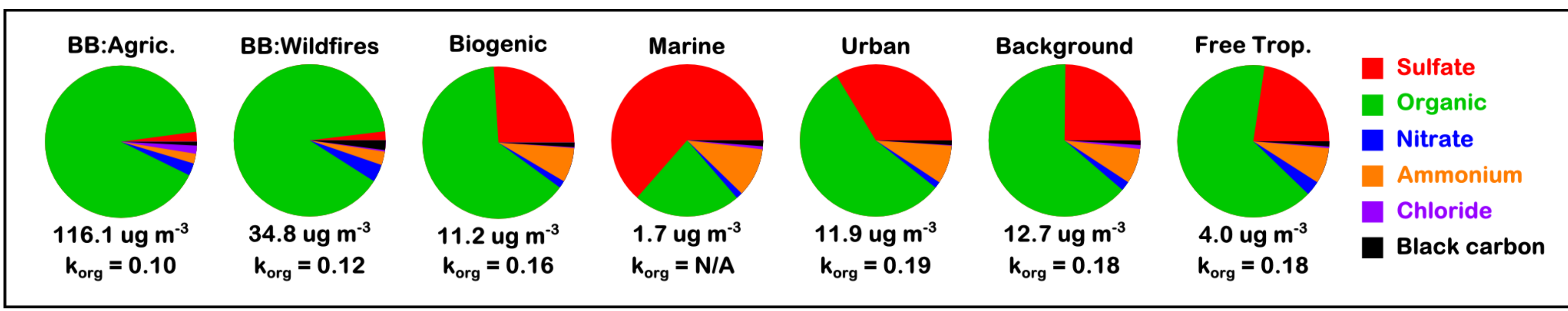


- ΔT has a greater impact on volatility than ΔRH

Shingler et al., in progress

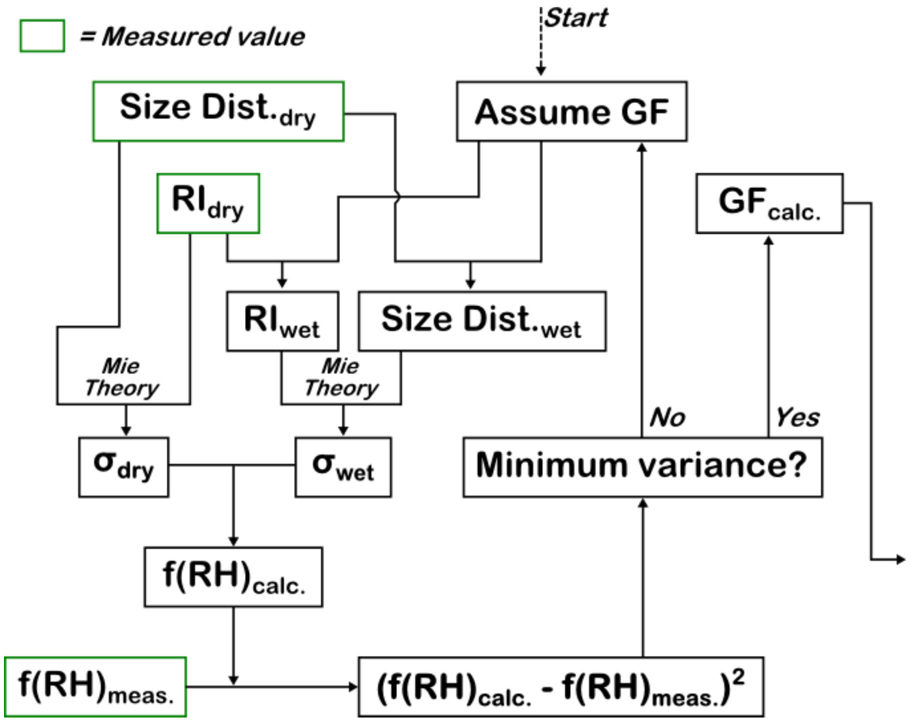
Compositing of GF and RI by Airmass Type

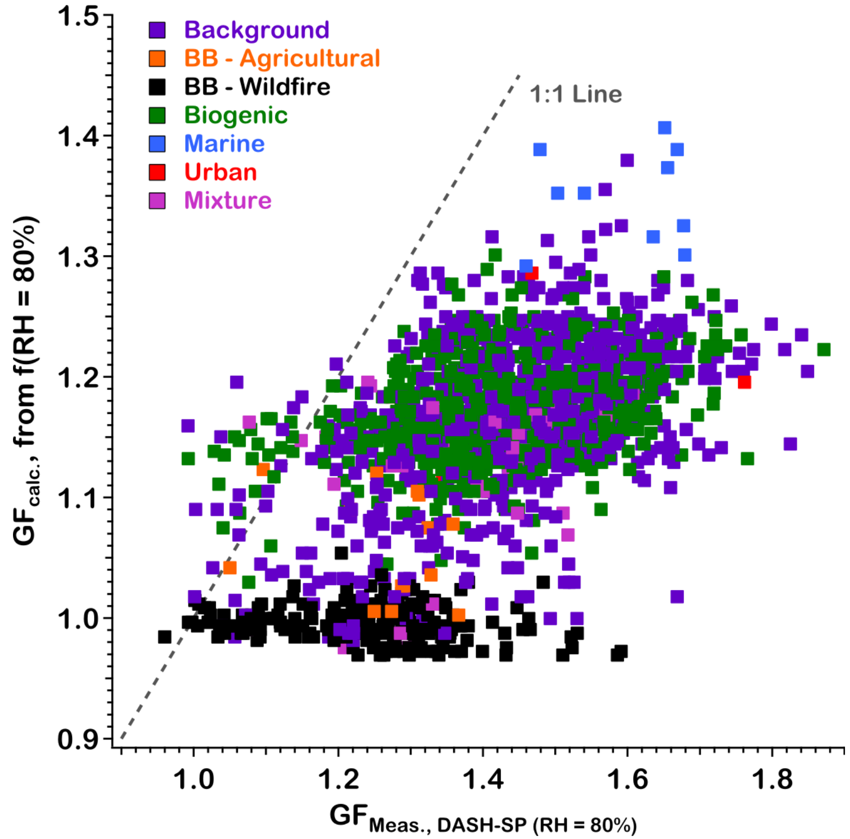
	Average Growth Factors							
Relative Humidity	75%	80%	85%	90%	95%	κ (from GF)	Dry RI	f(RH = 80%)
Dry Diameter (nm)	200-300 nm	200-300 nm	200-300 nm	200-300 nm	200-300 nm	200-300 nm	200-300 nm	Bulk
Airmass Type								
BB - Agricultural	1.09 (.08)	1.08 (.09)	1.22 (.14)	1.35 (.11)		0.14 (0.11)	1.55 (.01)	1.09 (.13)
BB - Wildfire	1.09 (.09)	1.13 (.10)	1.15 (.12)	1.22 (.11)	1.31 (.09)	0.15 (0.14)	1.56 (.01)	1.00 (.06)
Biogenic	1.27 (.11)	1.35 (.10)	1.41 (.09)	1.51 (.10)	1.55 (.10)	0.33 (0.11)	1.54 (.01)	1.41 (.13)
Marine	1.28 (.19)	1.39 (.19)	1.47 (.20)	1.75 (.16)	1.67 (.06)	0.56 (0.19)	1.55 (.02)	1.63 (.46)
Urban	1.35 (.10)	1.42 (.09)	1.52 (.11)	1.51 (.17)		0.43 (0.16)	1.55 (.02)	1.64 (.21)
Background	1.29 (.14)	1.37 (.12)	1.45 (.13)	1.52 (.13)	1.55 (.11)	0.37 (0.16)	1.54 (.01)	1.41 (.20)
Free Troposphere	1.24 (.10)	1.36 (.14)	1.45 (.12)	1.52 (.13)	1.57 (.17)	0.39 (0.18)	1.54 (.02)	1.33 (.27)



Shingler et al., in progress

Comparison of GF to f(RH)



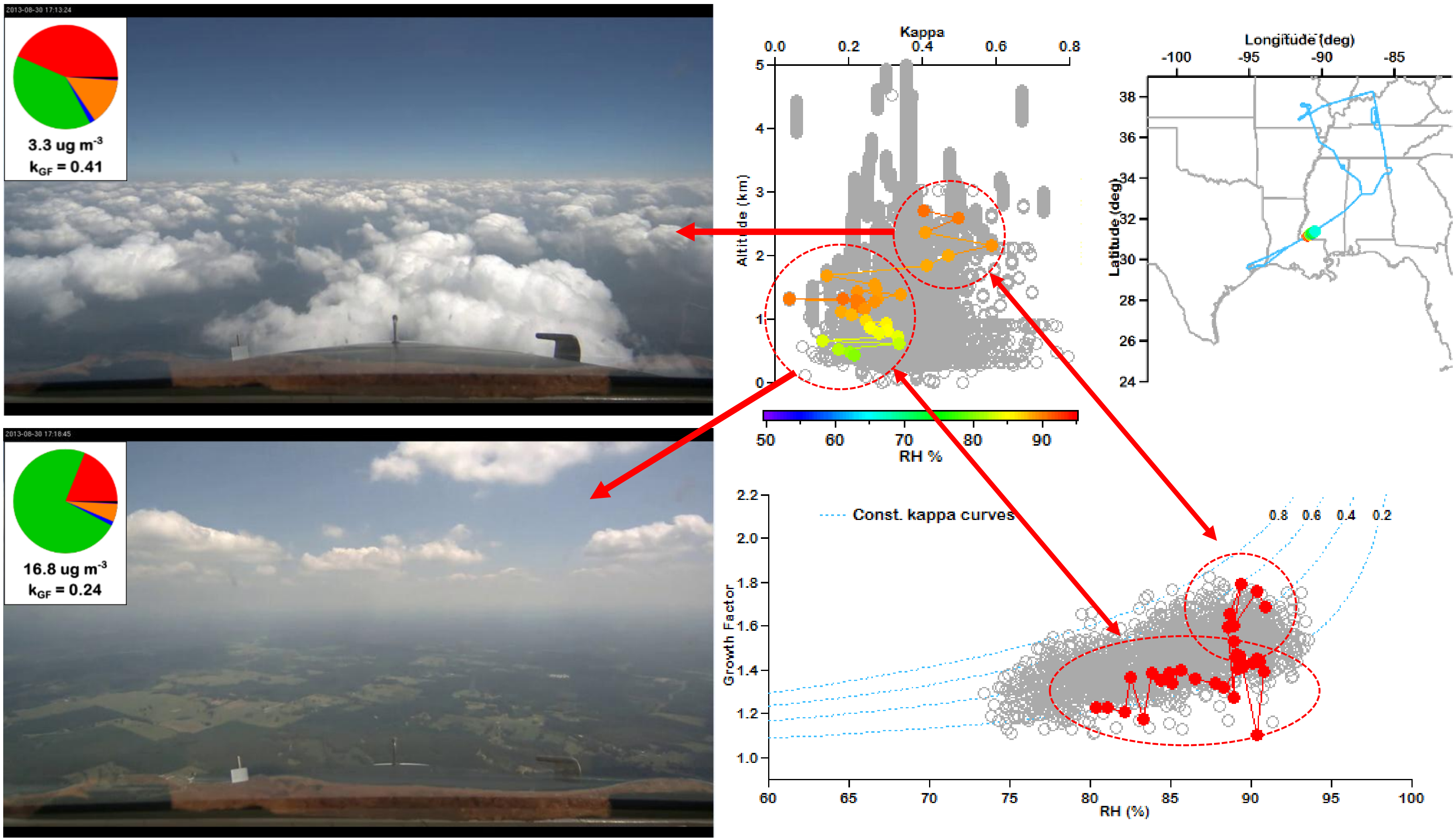


All measurements limited to:

- Coincident 80% RH sampling conditions
- Only submicron populations

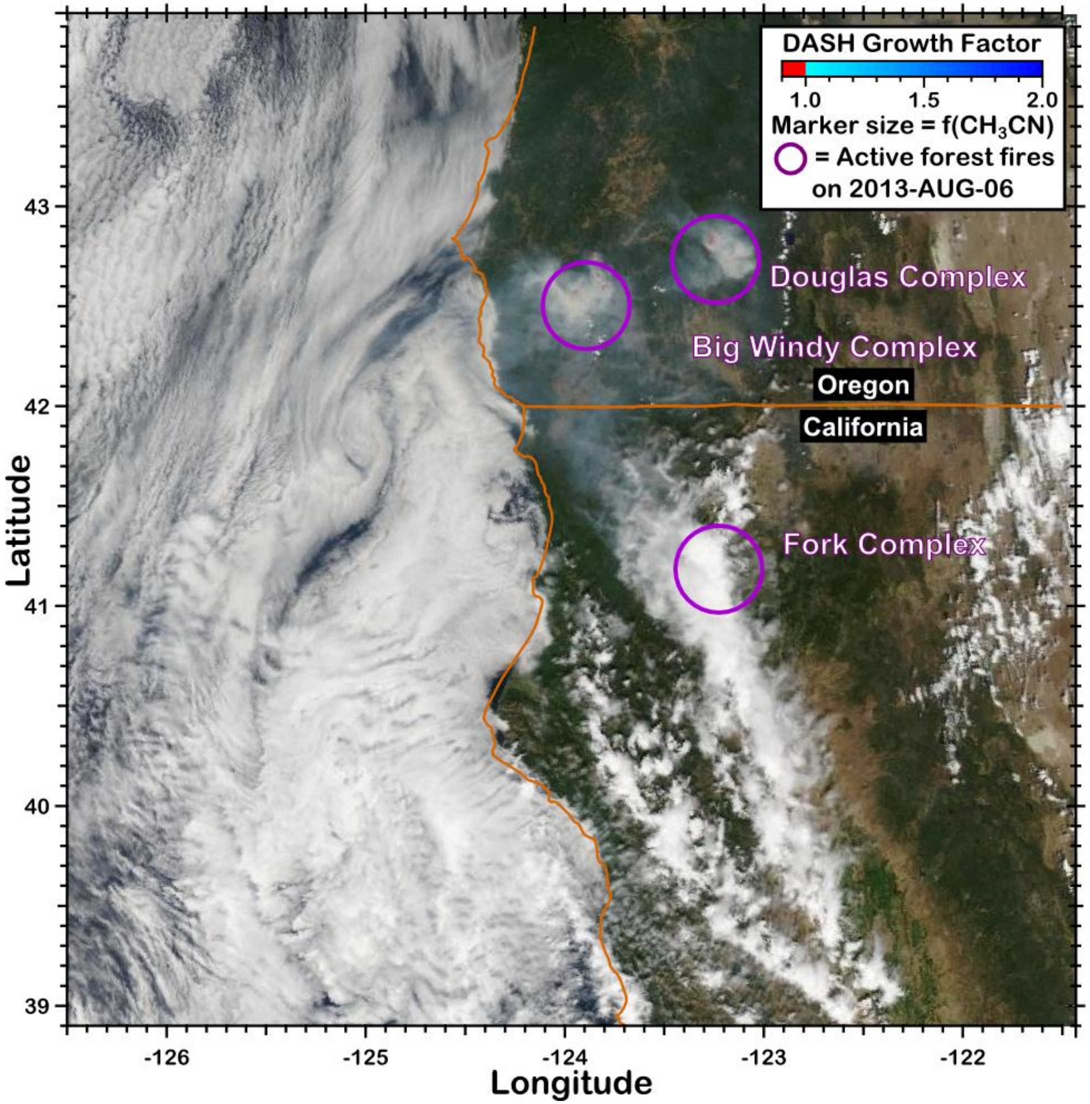
Shingler et al., in progress

Case Flight Analysis: Impact of Clouds



Shingler et al., in progress

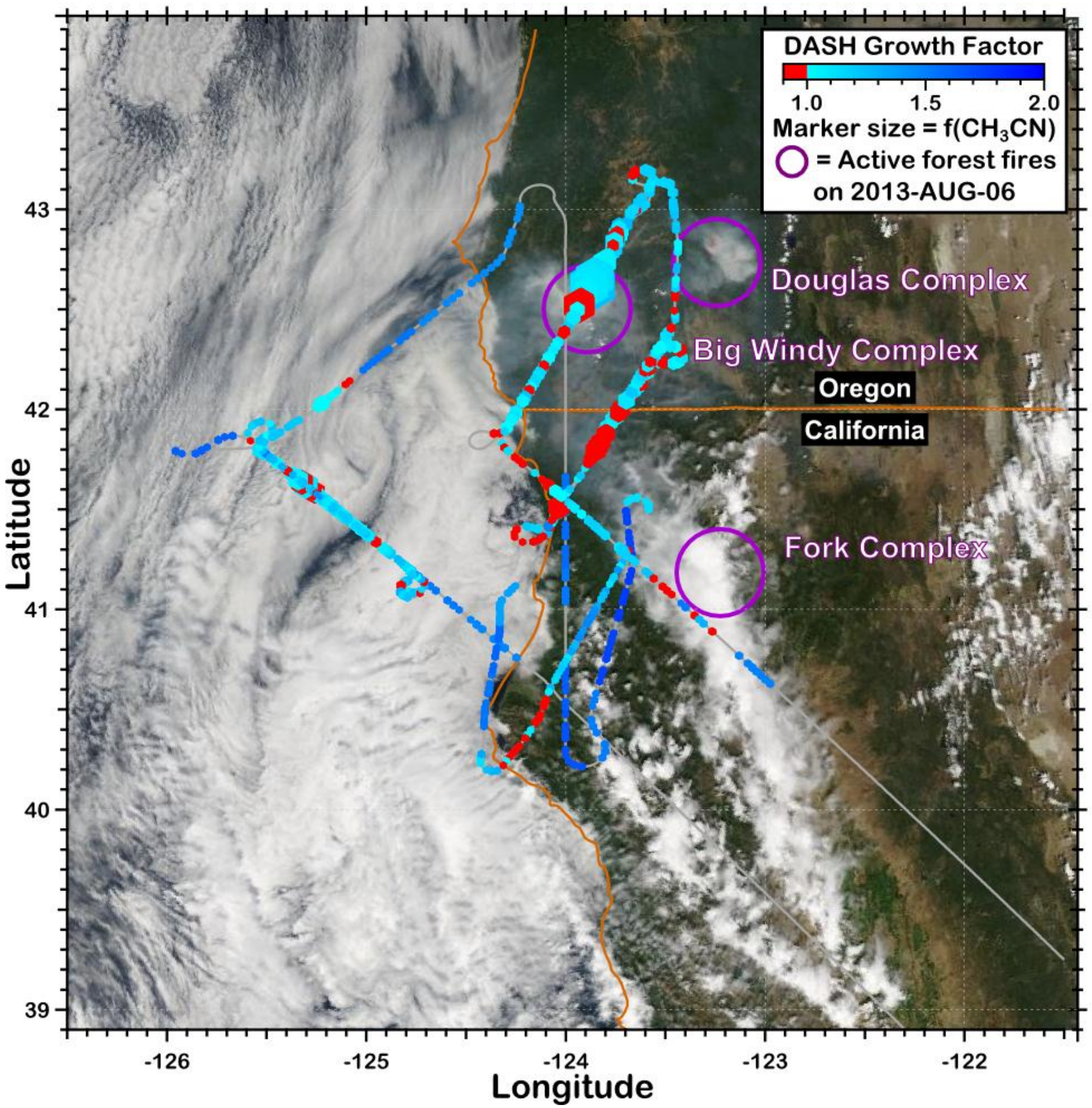
Case Flight Analysis: Impact of Biomass Burning



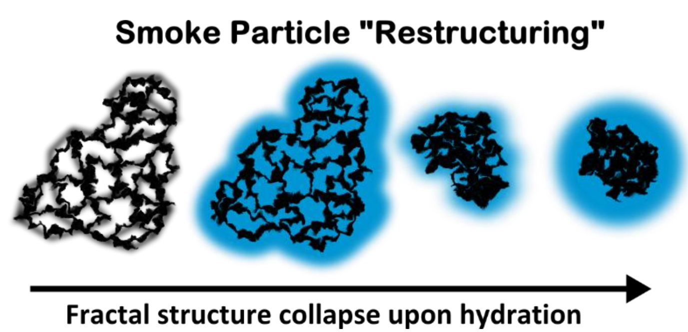
- Three major forest fires along the Oregon/California border on 2013-AUG-6
- Numerous cases of sub-1.0 GF and f(RH) values

Shingler et al., in progress

Case Flight Analysis: Impact of Biomass Burning

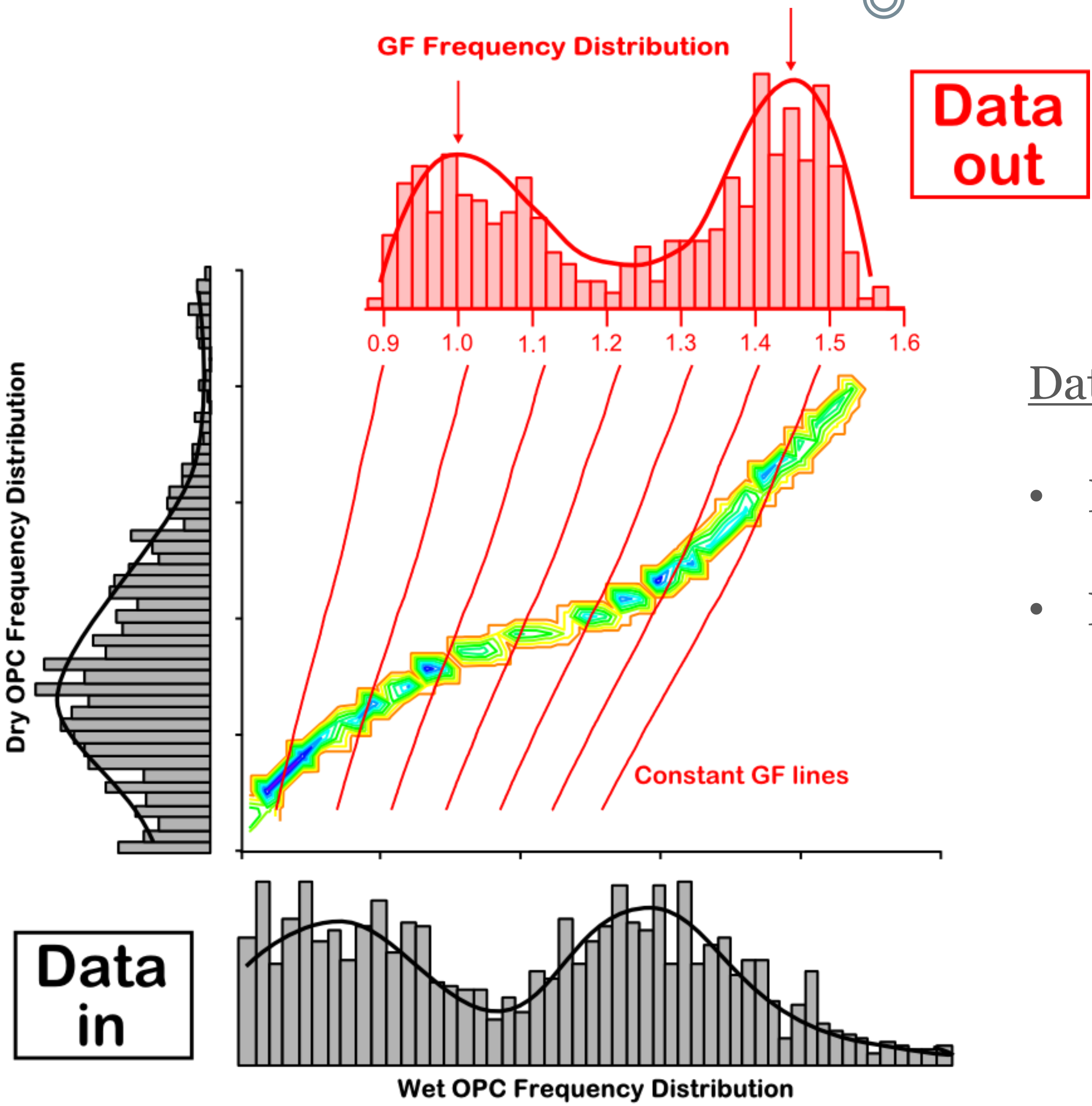


- Three major forest fires along the Oregon/California border on 2013-AUG-6
- Numerous cases of sub-1.0 GF and f(RH) values
- This "restructuring" (particle shrinking upon hydration) is being investigated in the laboratory



Shingler et al., in progress

Added Data Analysis Capabilities



Data Processing Methods

- Distribution data vs. mean
- Identify external mixtures

Shingler et al., in progress

Acknowledgements

- Funding from NASA Earth and Space Science Fellowship (NNX14AK79H), and grants NNX12AC10G and NNX14AP75G.
- All SEAC4RS personnel

- Brechtel Manufacturing Inc.
  - Fred J. Brechtel
  - Stephen Dey
  - Andy Corless