AQUARIUS:
Air Quality in the Western US

Workshop Goals: Ground Measurements

Kelley Barsanti
University of California-Riverside

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Measurements to Address Science Questions

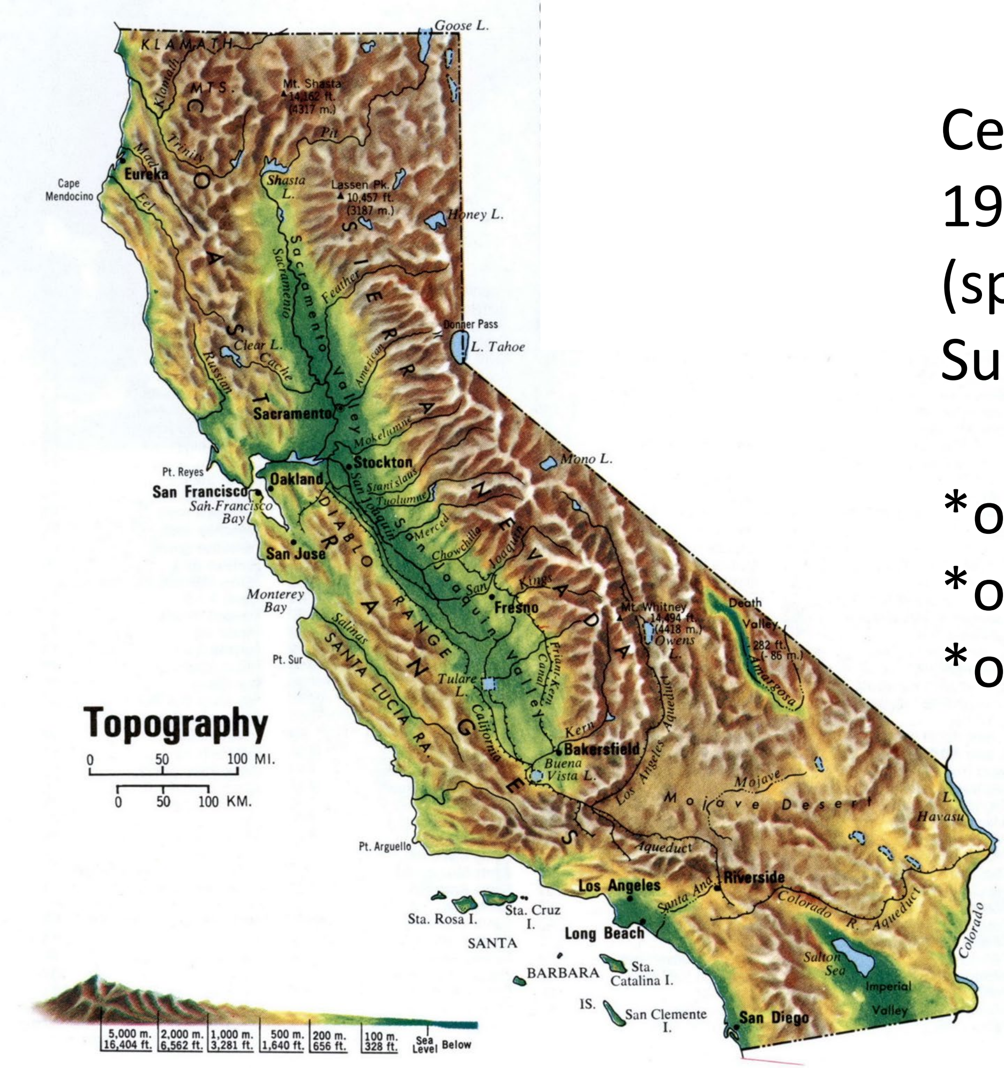
Measurements to identify and quantify:

1. urban GHG emissions
2. short-lived pollutants and their precursors
3. oxidant cycles, reactive nitrogen budgets
4. temperature and relative humidity cycles and gradients, fluxes, mixing, cold air pools (meteorology, thermodynamics)

Of particular importance:

1. spatial and temporal variability (vertical and horizontal gradients, temporal cycles, surfaces (fog, snow, ice)
2. platforms (ground, mobile, drone, aircraft, …); satellite data, long term air quality/met stations

Central Valley, CA

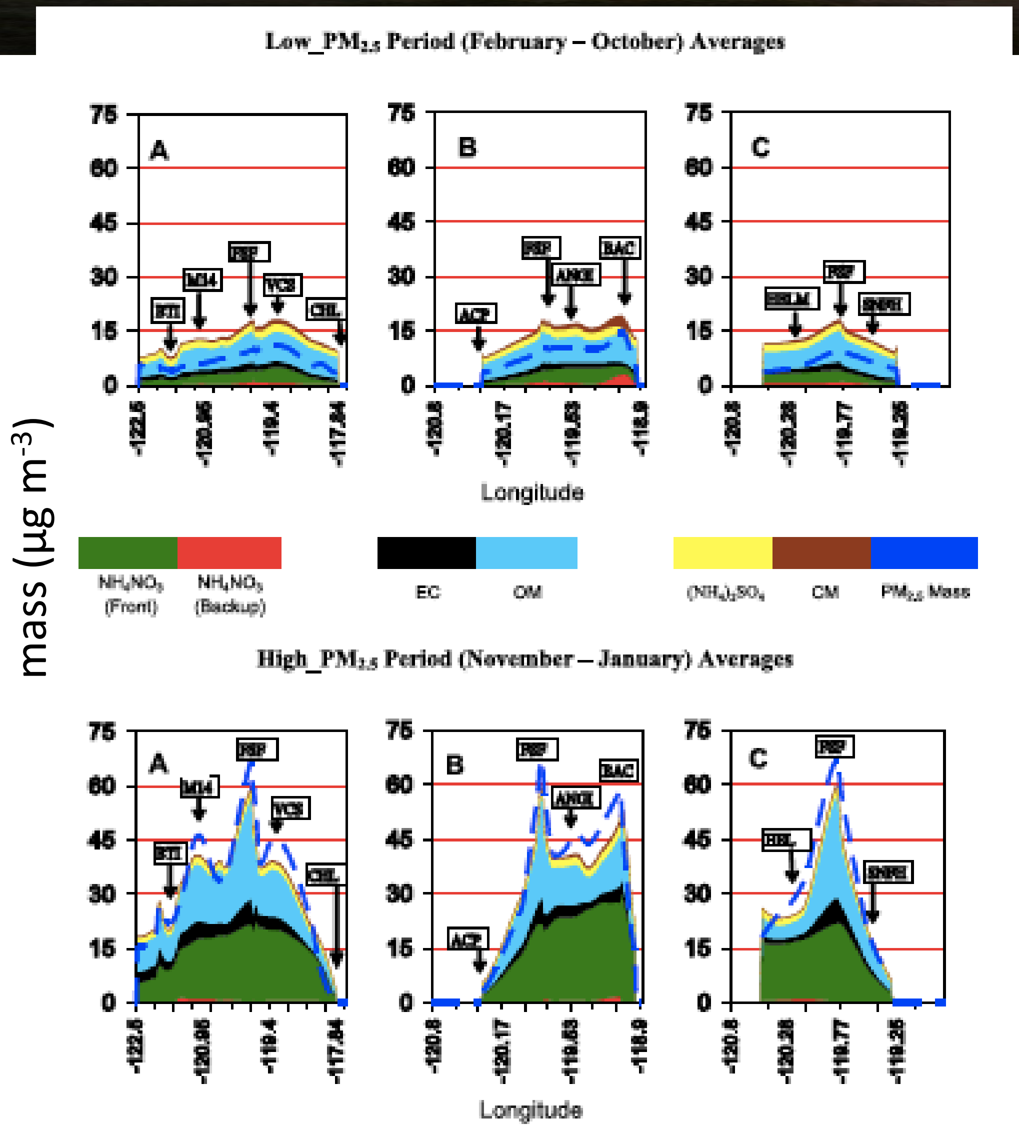


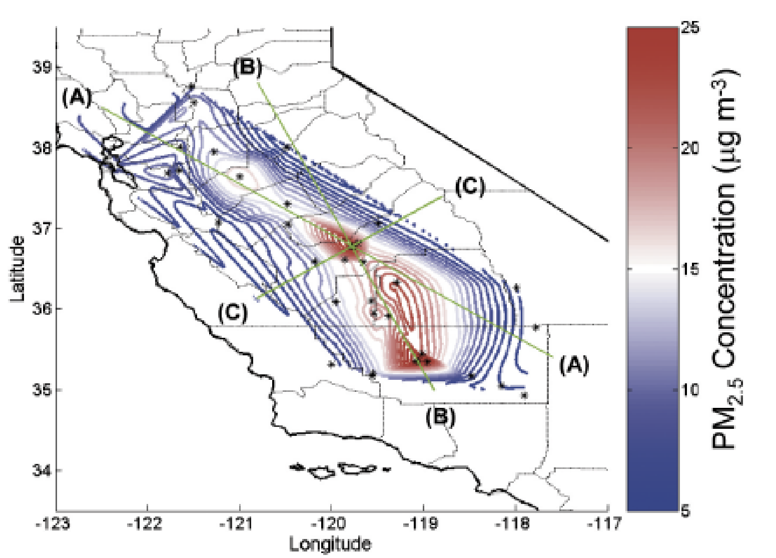
Central California Air Studies:
1999-2001: California Regional Particulate Air Quality Study (specifically focused on fall and winter PM)
Summer 2000: Central California Regional Ozone Study

*over 500 instruments
*over 100 monitoring locations
*over 600 parameters

Number of publications since CRPAQs: shorter campaigns, long term measurements, other regions

Key Findings -CRPAQS





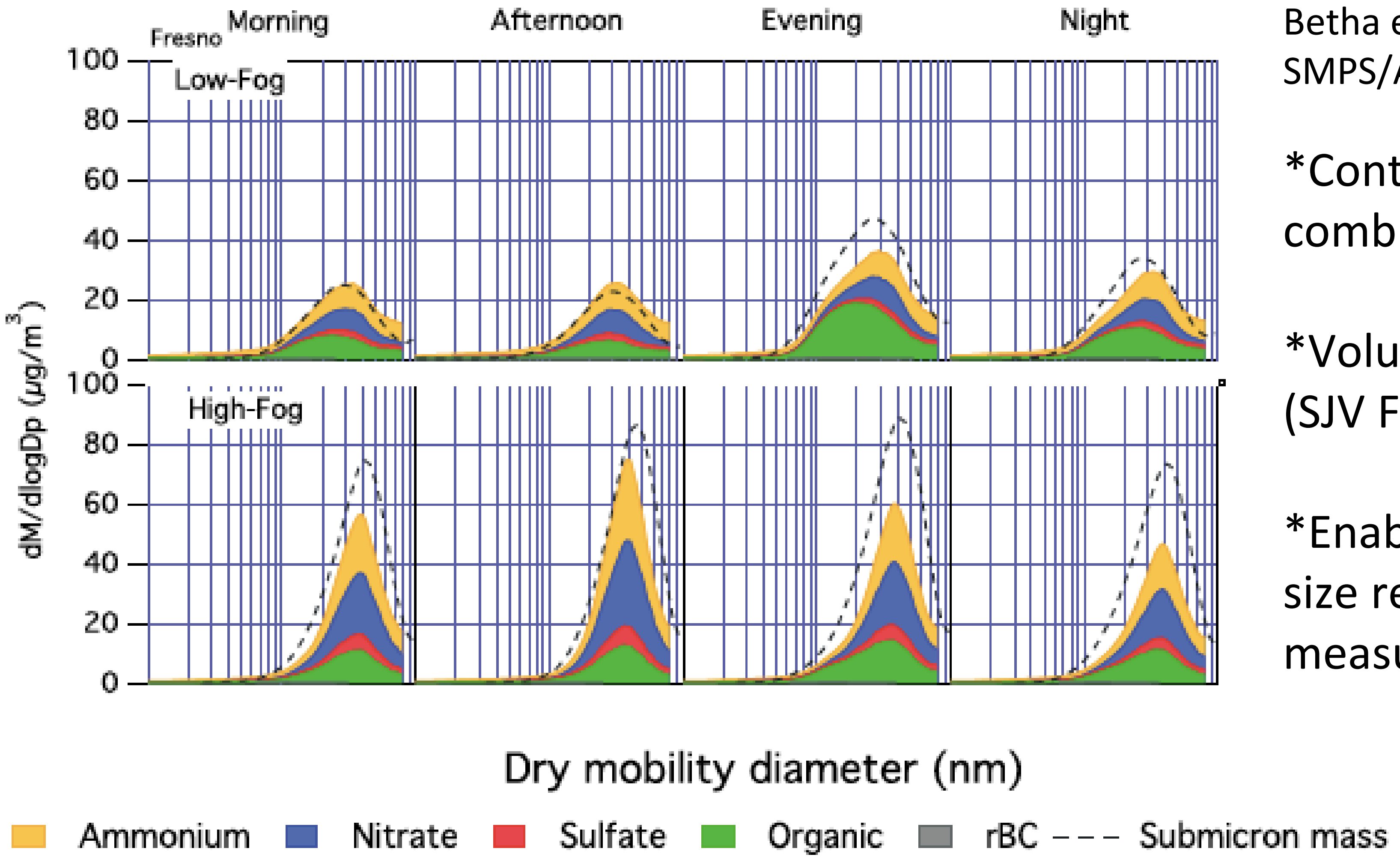
*$PM_{2.5}$ elevated in winter:
urban areas enhanced organic/elemental carbon
non-urban areas enhanced ammonium nitrate (NH_4NO_3)

*Importance of lateral transport of NH_4NO_3; limited vertical mixing (pollutants decrease rapidly with elevation-ground based measurements)

*Various degrees of spatial heterogeneity

Chow et al., J. Geophys. Res., 2006
sequential filter sampler

Key Findings - San Joaquin/South Coast



Betha et al., J. Geophys. Res., 2018
SMPS/AMS

*Contribution of residential wood combustion

*Volume-limited aqueous production (SJV Fresno, winter)

*Enabled by temporally, spatially, and size resolved composition measurements

Cache/Salt Lake/Utah Valleys, UT

Eric H. Christiansen-Utah to Salt Lake Valley

Observations (e.g., Silva et al. 2007; Kelly et al. 2013; Kuprov et al. 2014; Baasandorj et al. 2017):

*Multi-day pollution episodes

*$PM_{2.5}$ levels build over days and then plateau

*$PM_{2.5}$ reaches tens ug m^{-3} (up to one hundred)

*$PM_{2.5}$ largely composed of ammonium nitrate during events

Persistent Cold Air Pool Study (PCAPS)

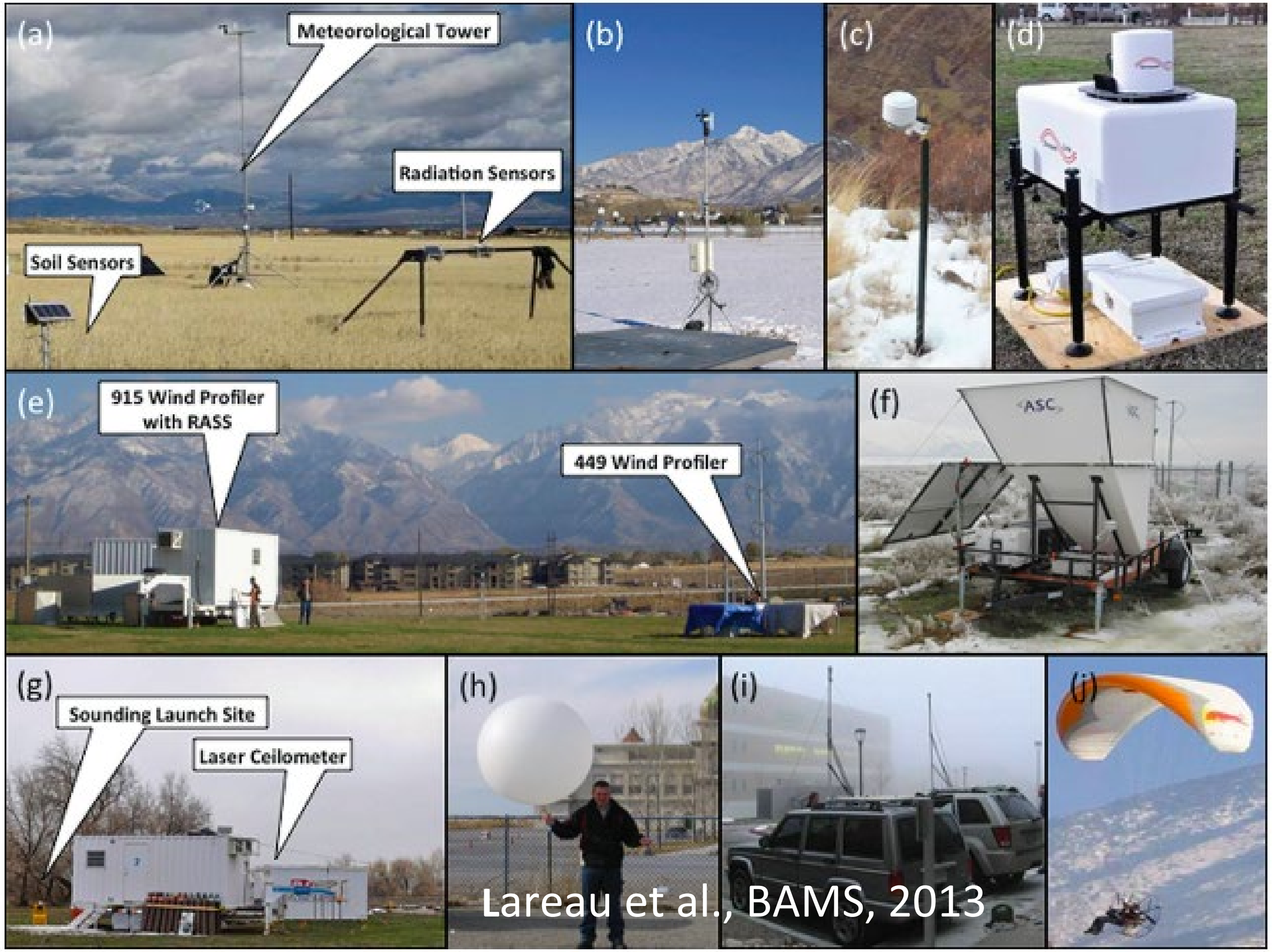
Questions:

Is event-driven $PM_{2.5}$ limited by NH_3 or HNO_3?

What is the contribution of residential wood smoke combustion?

How do meteorological events (venting, mixing) affect precursors?

Key Findings -P C A P S



Lareau et al., BAMS, 2013

PCAPS instrumentation (SLV): includes Integrated surface flux station, Doppler lidar, mini-SODAR, radiosondes, instrumented paraglider!

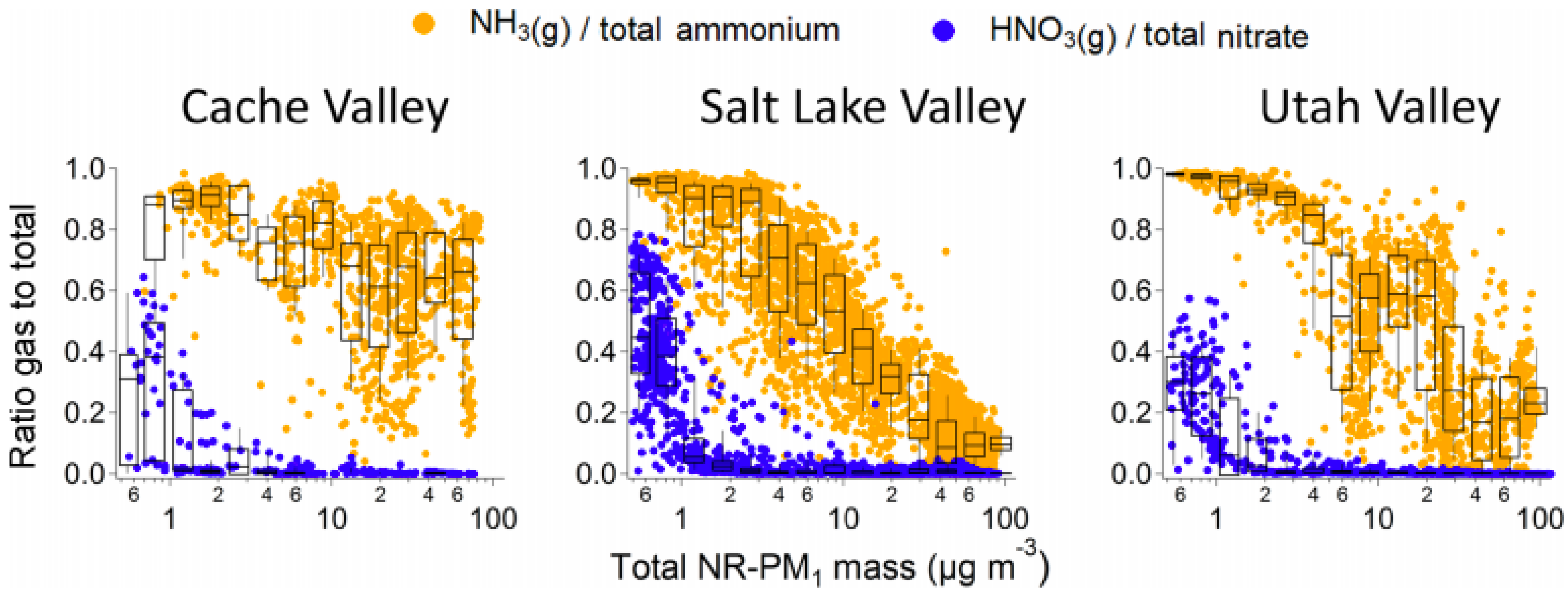
*Strength and duration affect $PM_{2.5}$ (altitude too, Silcox et al. 2012)

*Complexity: in thermodynamic profiles (temperature, dew point, wind direction) and CAP evolution

*PM exhibited vertical and temporal diurnal variability

Key Findings - UW F P S

*$NHNO_3$ appears to be nitrate limited, but exhibits spatial and temporal dependencies
*Salt Lake Valley appears to be near equivalence point, approaches NH_3 limiting as event persists
*NH_3 inventories need improvement



Franchin et al., Atmos. Chem. Phys., 2018; McDuffie et al., Atmos. Chem. Phys., 2019

Key Uncertainties/Unknowns

- What is the fraction of NO_3 produced by day vs. night pathways? (nocturnal production in residual layer appears to dominate, e.g., McDuffie et al., 2019)
- What is the role of gaseous organic compounds (I/VOCs) in modifying oxidant cycles and NO_3 production?
- What is the contribution of residential wood combustion to $PM_{2.5}$? What about other sources (e.g., agriculture, industrial, transportation)? (may be particularly important at basin/sub-basin scales)
- How do PCAPS affect deposition of short-lived pollutants/precursors and greenhouse gases?
- What is the relationship between short-lived pollutants/precursors and GHGs? Can we use covariance to better differentiate chemical and transport processes (e.g., Bares et al., 2018)?

Measurement Needs

What are the core measurements needed….

To identify and quantify:

1. urban GHG emissions; short-lived pollutants and their precursors ; oxidant cycles, reactive nitrogen budgets; temperature and relative humidity cycles and gradients, fluxes, mixing, cold air pools (meteorology, thermodynamics)

To address (this list will grow this week):

1. NO_3 production
2. sources and identities of I/VOCs, role in photochemistry, contributions to $PM_{2.5}$
3. evolution of PCAPS, deposition during PCAP/CAP events
4. relationships between GHGs, short-lived pollutants and precursors

Considering:

1. spatial and temporal variability (vertical and horizontal gradients, temporal cycles, surfaces (fog, snow, ice)
2. platforms (ground, mobile, drone, aircraft, …); satellite data, long term air quality/met stations