

Source Signatures of Organic Compounds and Particle Growth in Bakersfield, CA

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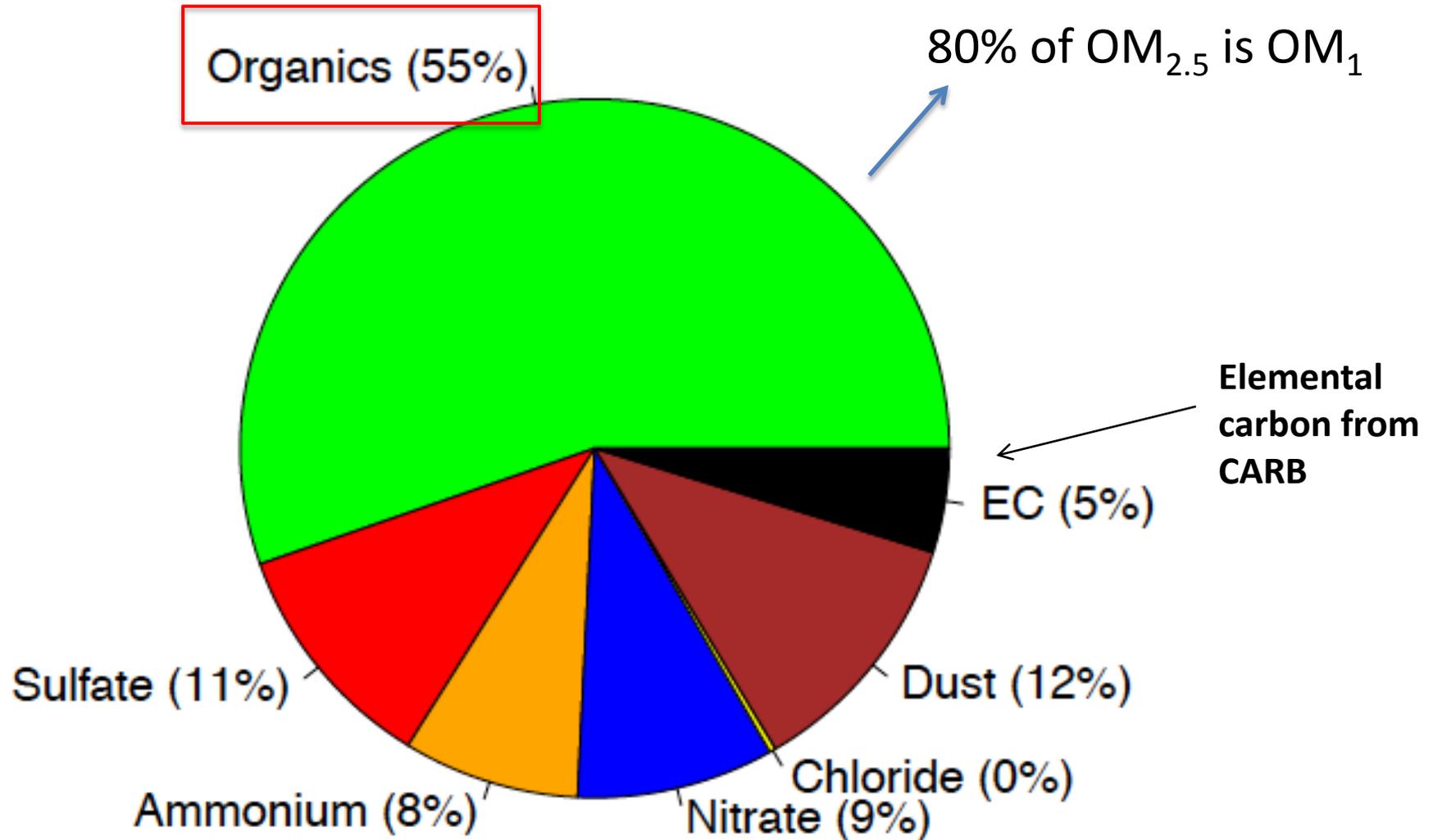
Main Questions to be Addressed

- What **sources** contribute to the **organic aerosol mass** in Bakersfield?
- What fractions of the organic aerosol mass are **HOA** and **OOA**?
- What processes control particle **number concentration**?
- What **vapors** contribute to **condensational growth** during the frequently observed growth events?

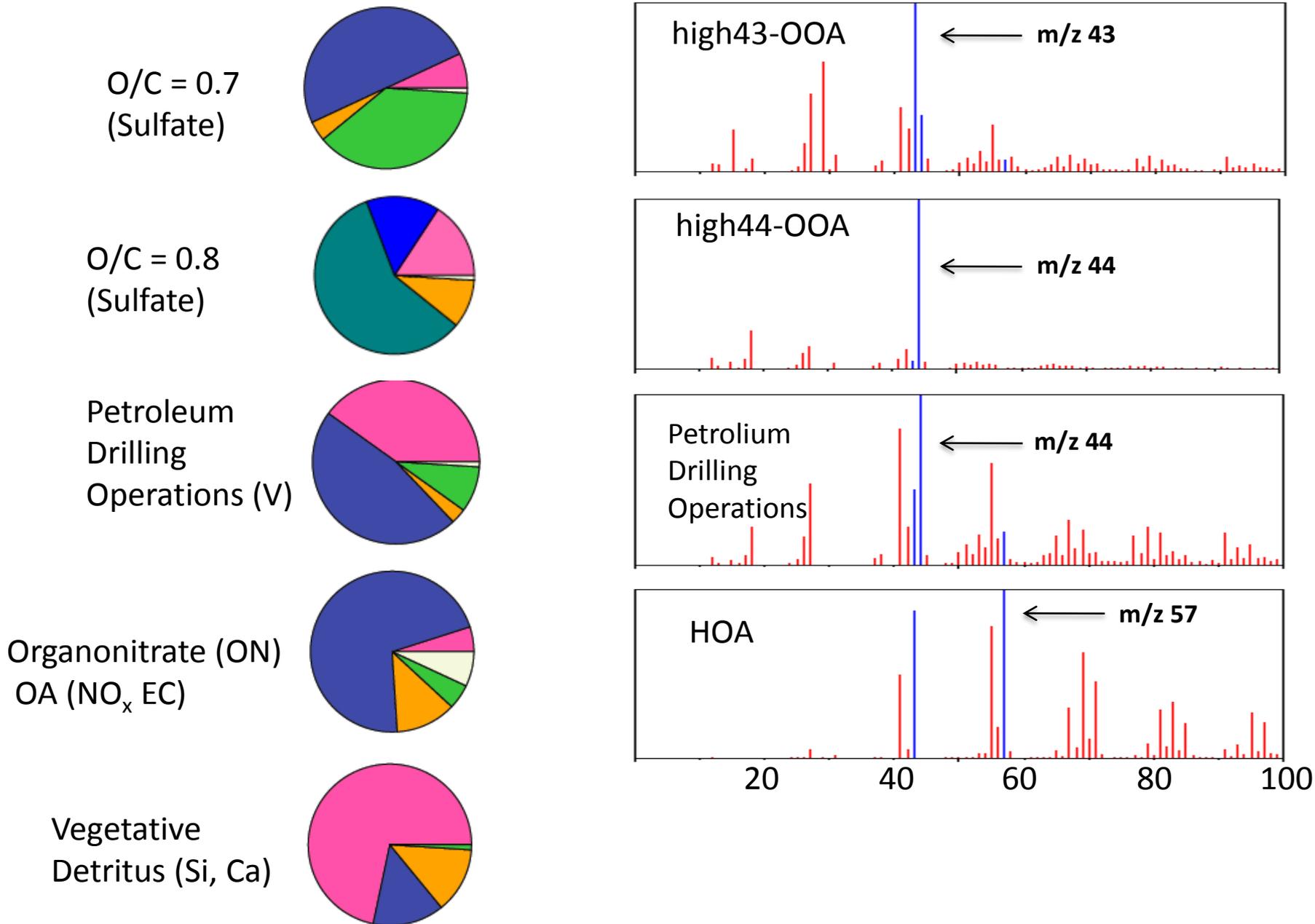
Particle Measurements at Bakersfield

- **FTIR: organic functional groups**
 - OM₁: 3-6 hour filter samples, 5 samples a day
 - OM_{2.5}: 23 hour filter sample, 1 sample a day
- **HR-AMS: non-refractory organics, sulfate, nitrate, ammonium, and chloride**
 - online measurement with 2 min resolution
- **SMPS: particle number size distribution**
 - online measurement with 10 min resolution
- **XRF: elemental concentration**
 - XRF measurements were conducted on PM₁ and PM_{2.5} filters

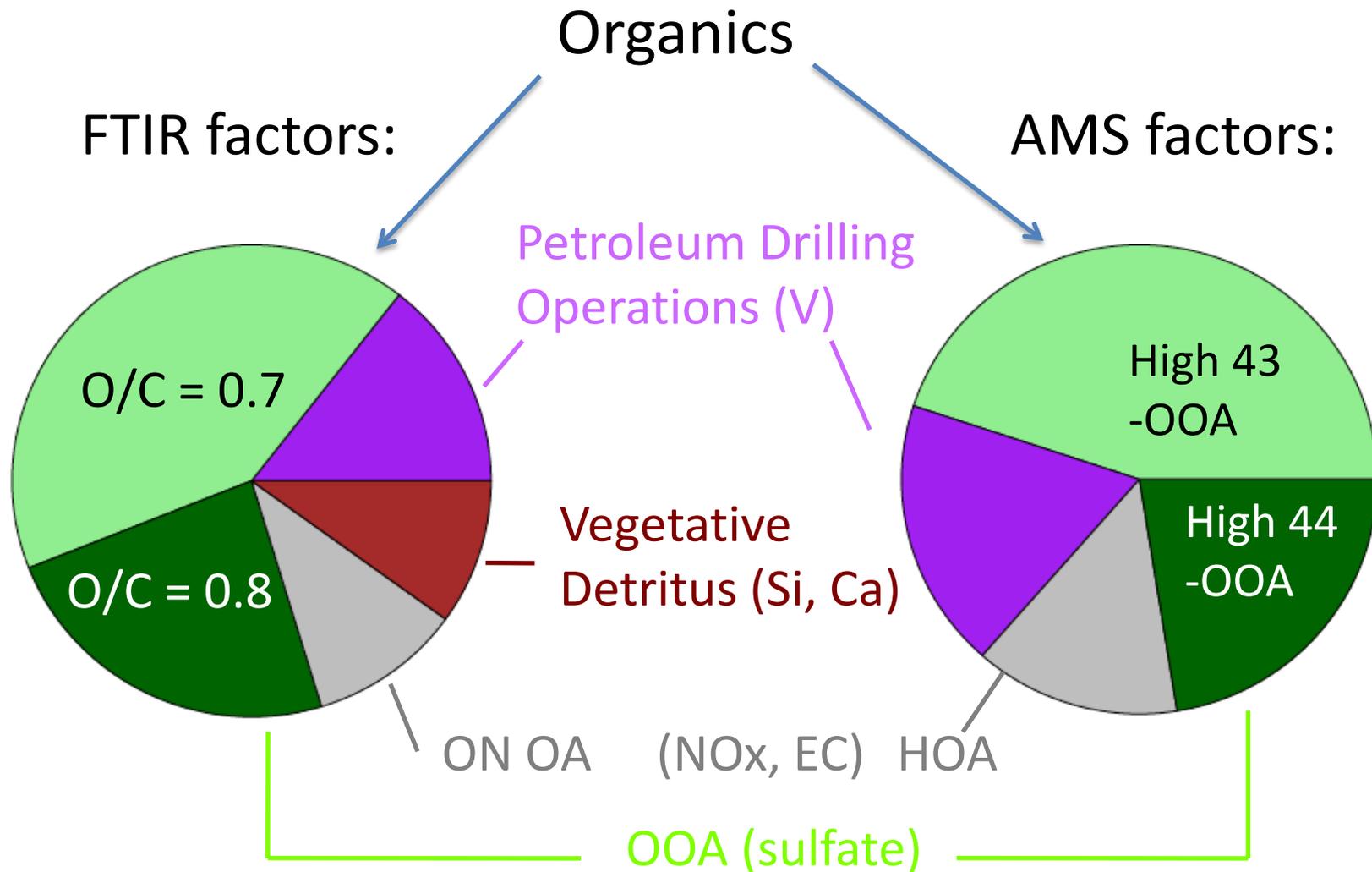
Chemical Composition of Submicron Particles



FTIR and AMS factors from PMF

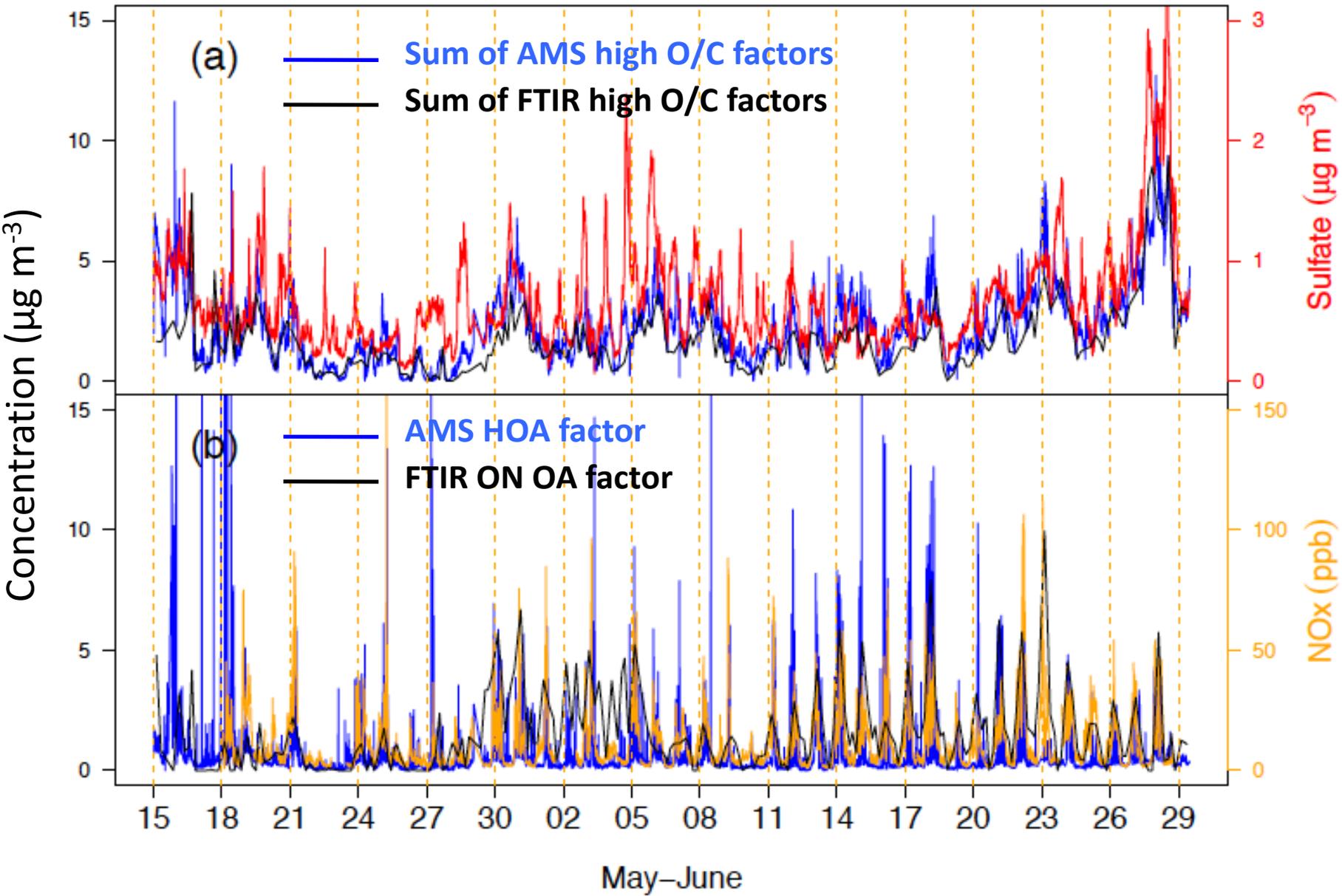


Types and Sources of Organic Aerosol at Bakersfield

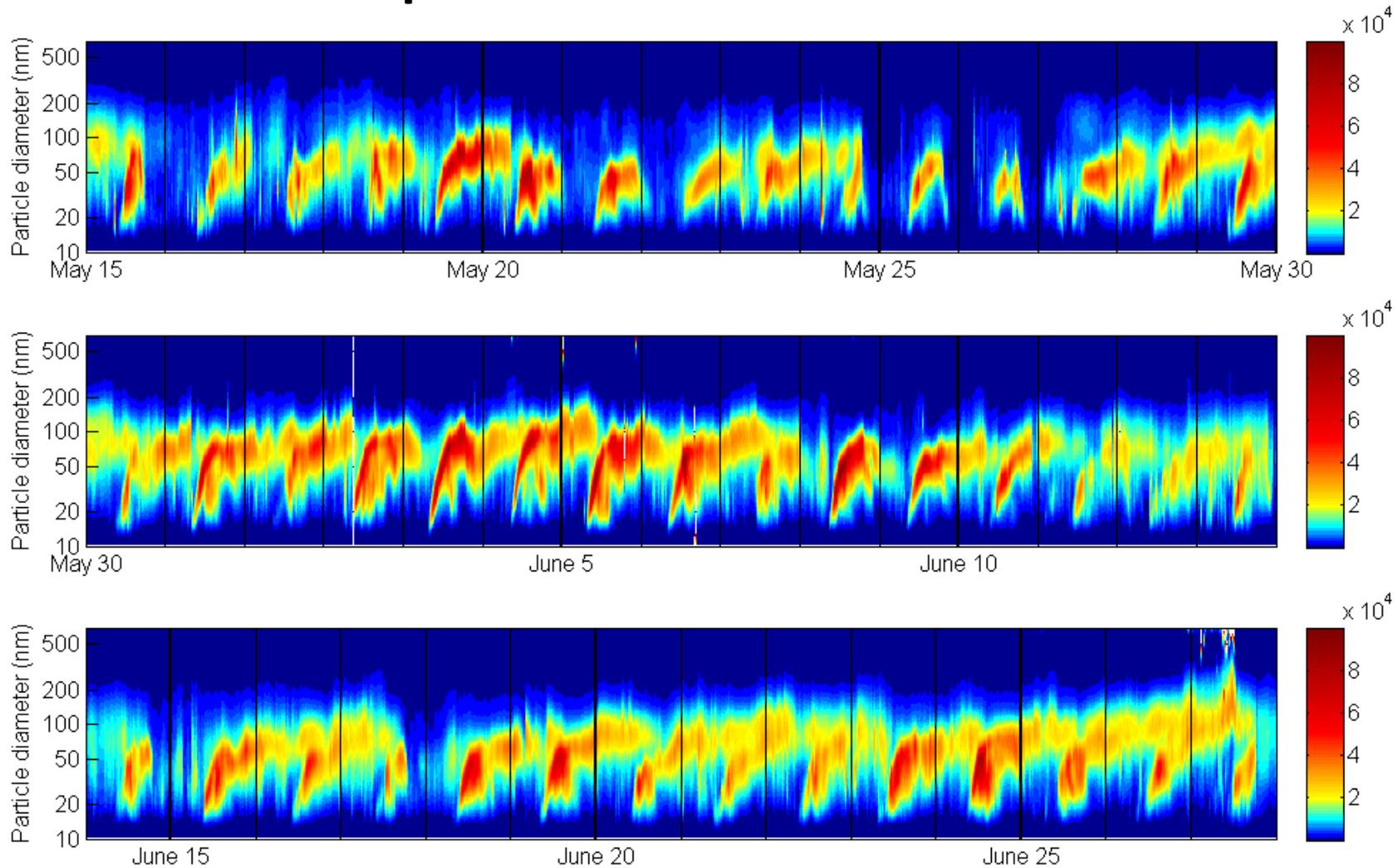


Both show 65% of OM is OOA and 11-14% of OM is HOA.

Comparison of HOA and OOA Factors from FTIR and AMS PMF analyses



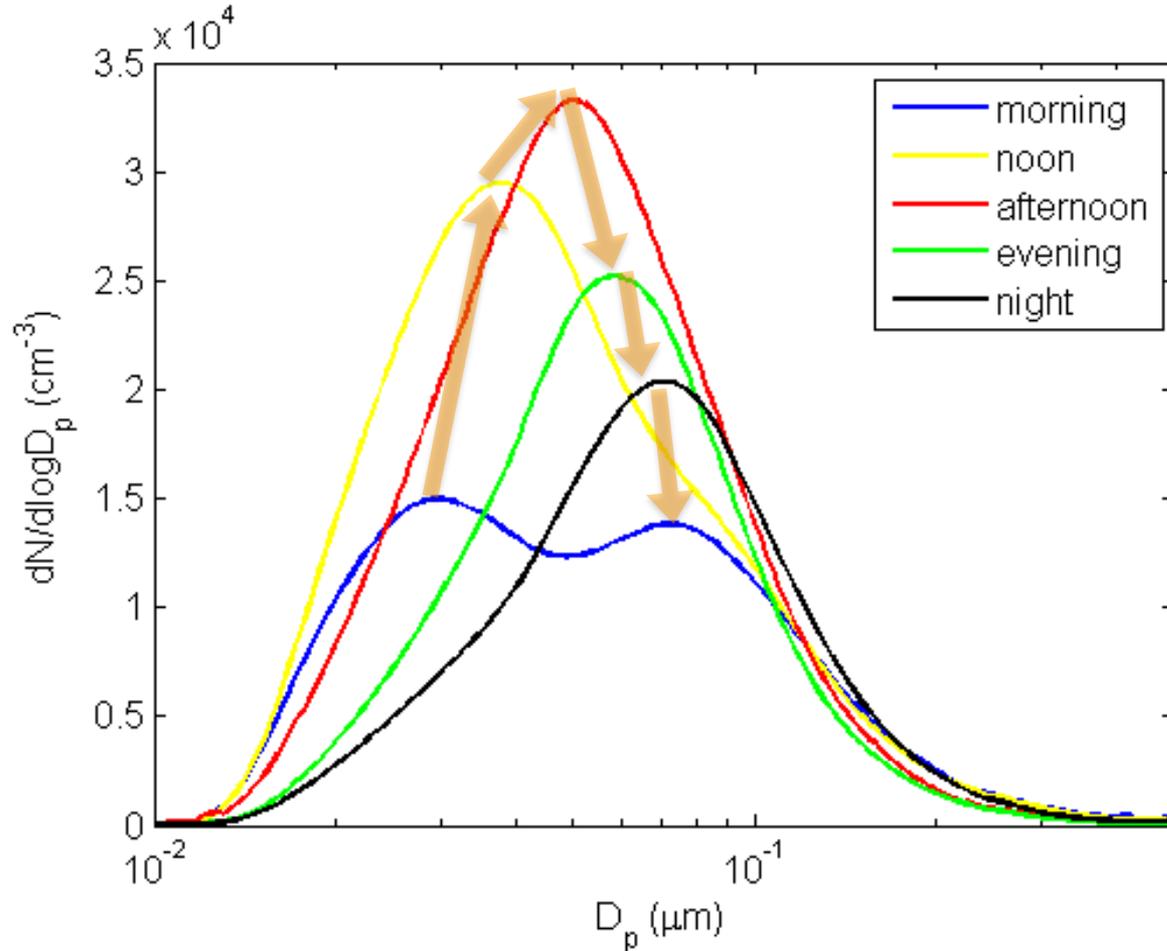
Time series of the particle number size distribution in Bakersfield



Growth of 10-20 nm diameter particles up to 40-100 nm occurred on most days.

The growth could be followed from early morning to at least 7pm on 31 of the 46 days – regional events over horizontal scales of at least 100 km.

Average diurnal variations in particle number size distribution



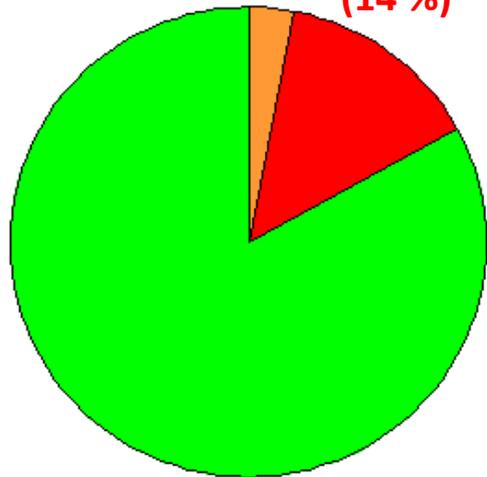
The growth was in general linear with time until around $1 \mu\text{m}$ but decreased in rate during afternoon and evening.

The average growth rate was 7.3 nm hr^{-1} with a standard deviation of 2.6 nm hr^{-1} (within the range of what has been observed in for instance Atlanta, Mexico City and Leipzig).

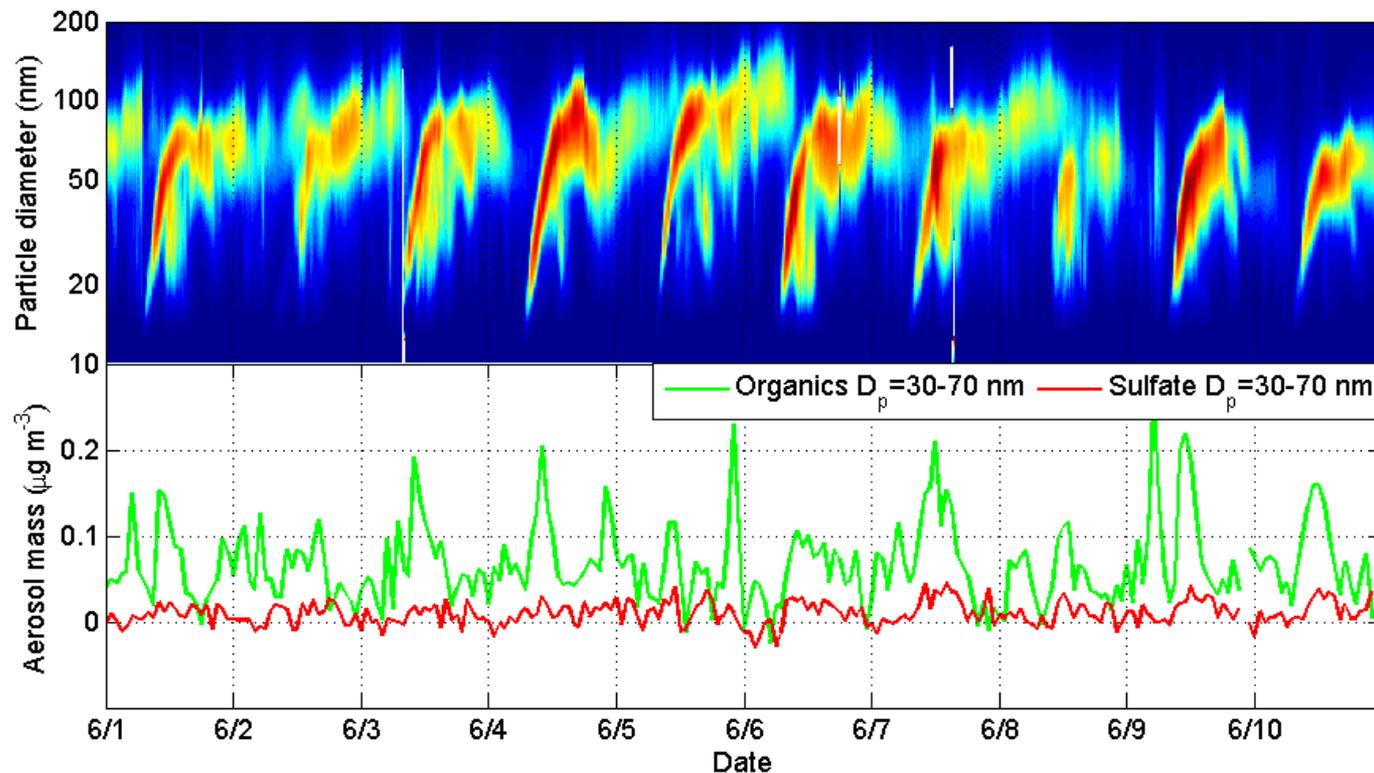
Chemical compounds contributing to ultrafine ($D_p < 100\text{nm}$) mass and particle growth

Ultrafine mass distribution

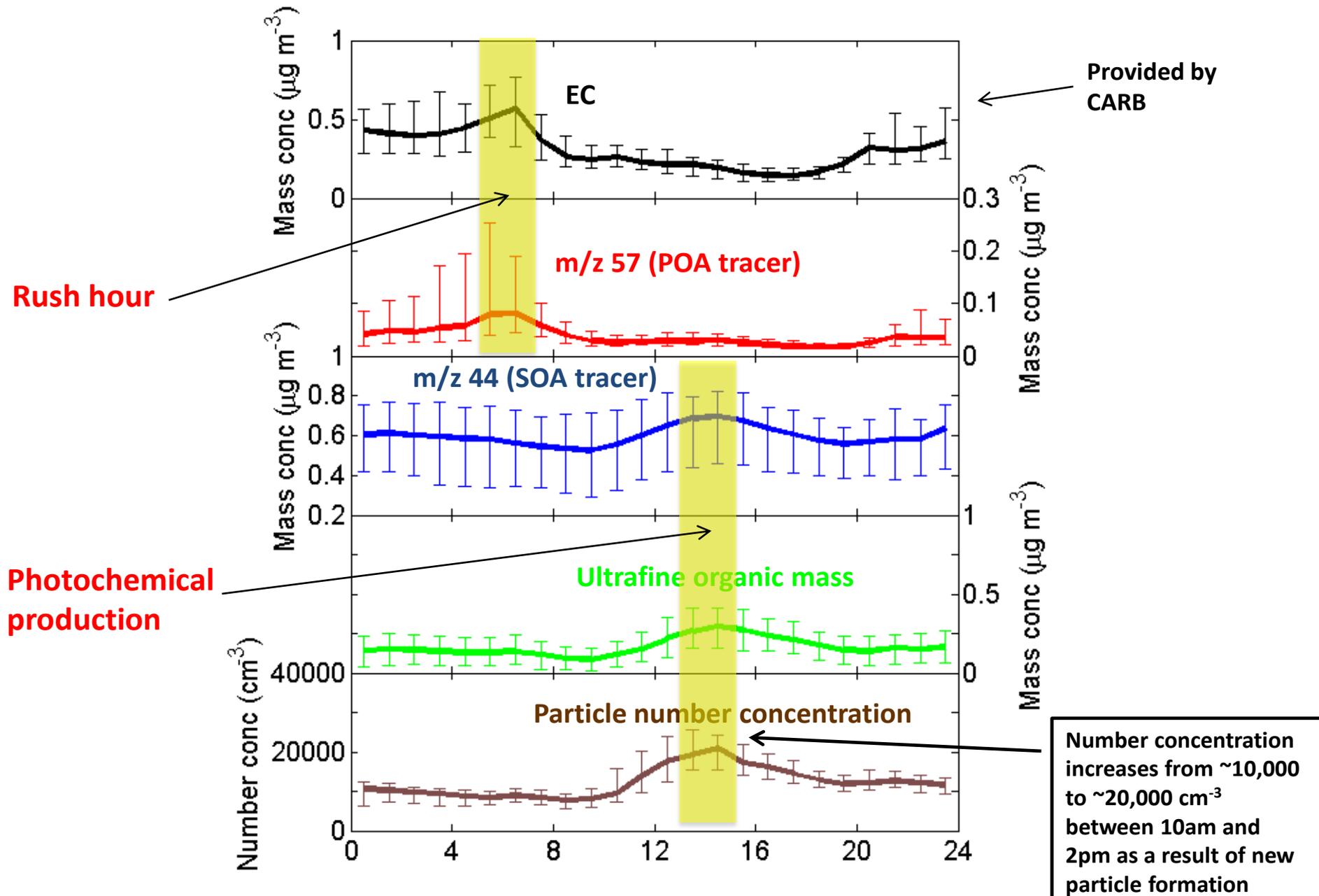
Ammonium
(3%) Sulfate
(14%)



Organics (83%)



Median diurnal cycles of mass and number concentrations



How does the ultrafine mass during growth events correlate with other parameters?

- The correlation between ultrafine mass and **OH** concentration ($R=0.56$) was better than the the corresponding correlation with **ozone** ($R=0.29$) during the growth events.
- Some correlation also with **UV radiation** ($R=0.52$).
- No clear correlation between ultrafine mass and **SO₂** ($R=0.16$) or biogenic VOCs such as **isoprene** ($R=-0.03$) and **alpha-pinene** ($R=0.08$) during the events.
- The best correlations were found for gas-phase **formaldehyde** ($R=0.80$), **oxalic acid** ($R=0.70$), **formic acid** ($R=0.68$), **glyoxal** ($R=0.61$).

**SO₂, oxalic acid and formic acid from
Jennifer Murphy's group**

**OH data from William Brune's
group**

Main conclusions

- Traffic emissions, petroleum operations and vegetative detritus contribute to organic mass at Bakersfield.
- FTIR and AMS measurements agree that the OOA fraction of OM₁ is 55-63 %.
- New particle formation was the dominating source of particle number at the site.
- Ultrafine particles grew primarily through condensation of organic vapors.

Acknowledgement

- We would like to thank Jennifer Murphy and her group at University of Toronto for providing data of SO₂, formic acid and oxalic acid, William Brune's group at Pennsylvania State University for OH-data and CARB for providing data of elemental carbon.