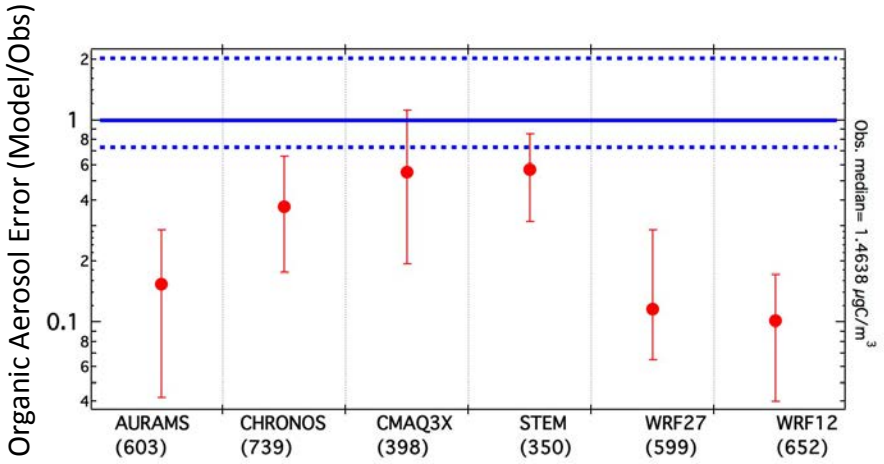
State of understanding of secondary organic aerosol sources

Joost de Gouw

- Aerosols are important for air quality, visibility and climate
- A large fraction (~50%) of aerosol is organic
- A large fraction of organic aerosol is formed in the atmosphere from gas-phase precursors (secondary organic aerosol or SOA)

Forecast models underestimate organic aerosol in NE U.S. [*McKeen*, JGR 2007]



At the time of previous CSD review, SOA formation was poorly understood. Since then:

- CSD-led studies in Los Angeles and over Gulf of Mexico oil spill highlighted the importance of **intermediate volatile organic compounds (IVOCs)** as precursors
- CSD conducted the SENEX field mission in the Southeast U.S. to study the role of **natural hydrocarbons** as precursors

CSD Approach: Studied SOA formation in different regions with completely different emissions using measurements and models

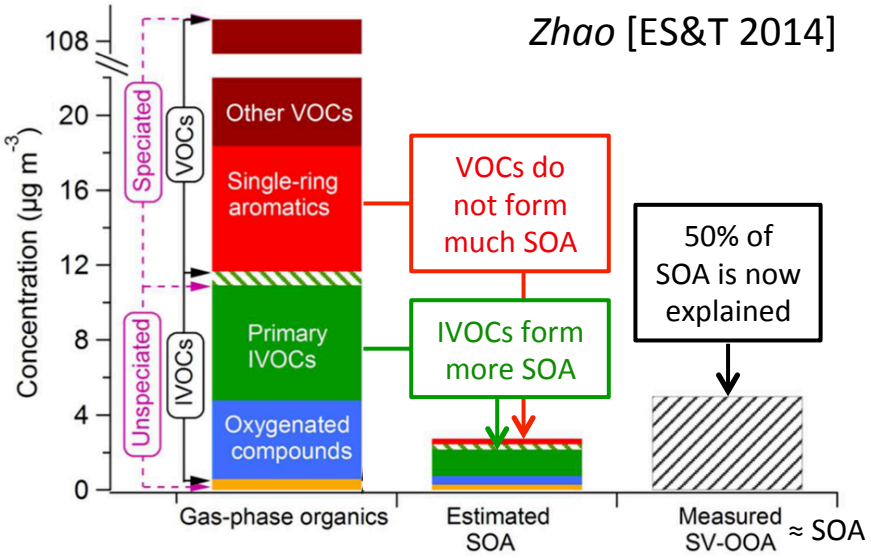
Case 1: Los Angeles (High anthropogenic emissions)

- Organic aerosol formation in urban air cannot be explained from commonly considered precursors
- CSD led a detailed study of organic aerosol formation at an urban site during CalNex

Findings from CalNex:

- Volatile organic compounds (VOCs) do not form much SOA
- Much more of the SOA in urban air is formed from intermediate volatile organic compounds (IVOCs) that are not commonly measured
- The emission sources of IVOCs (Diesel vs. gasoline) remain unclear: see poster

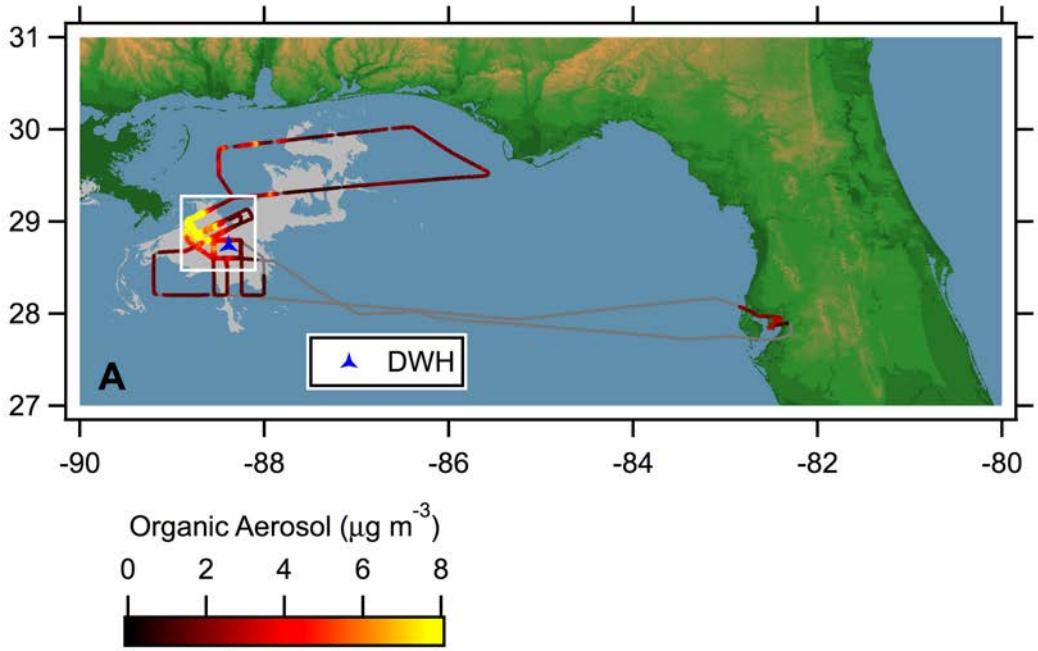
Zhao [ES&T 2014]



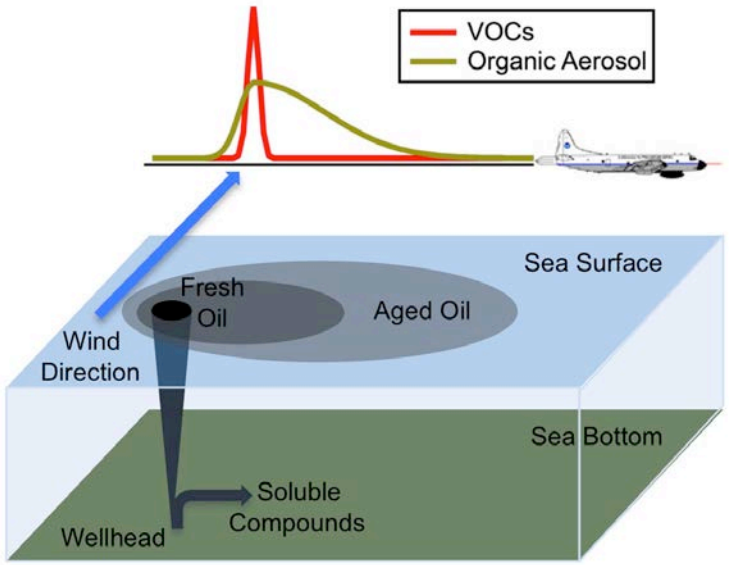
Why are these findings important?

Policy makers (California Air Resources Board) need to know which emissions to reduce to improve urban air quality

Case 2: Gulf of Mexico oil spill (Crude oil vapors)



Strong organic aerosol formation was observed downwind from the oil spill [*de Gouw*, Science 2011]



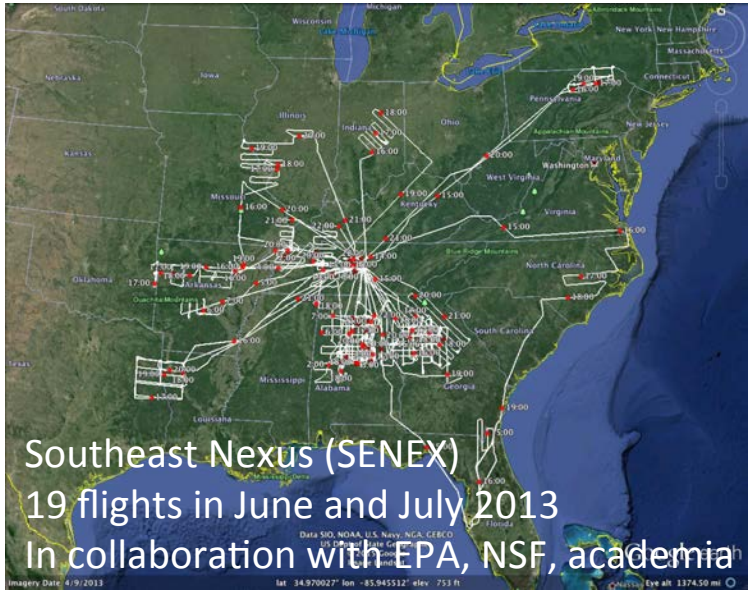
Organic aerosol was formed from intermediate volatile organic compounds (IVOCs) that took longer to evaporate

Why are these findings important?

- Strong evidence that IVOCs can be efficient aerosol precursors
- Quantify impact of future oil spills

Case 3: Southeast U.S. (High biogenic emissions)

- Vegetation in the Southeast emits large quantities of hydrocarbons
- Laboratory studies have shown that these compounds are efficient organic aerosol precursors



How do biogenic and anthropogenic emissions combine to form organic aerosol?

First papers are coming out

Why is this study important?

- **Air quality:** policy makers need to know how much of the haze can be reduced
- **Climate:** aerosol forcing is determined by anthropogenic component

  N.B.: Southeast has not warmed like rest of the U.S. [*Portmann*, poster 1-6]

Future: Emissions from Wildfires

- Wildfire emissions are a large driver of reduced air quality in the western U.S.
- Previous studies have shown a large variability in the formation of secondary organic aerosol in smoke

CSD-led NOAA FIREX Study
2015-2019

- Emissions characterization
  (U.S. Forest Service Fire Sciences Laboratory)
- Laboratory simulation
  (CIRES environmental chamber)
- Field study
  (research aircraft, mobile laboratories, ground site)
- Satellite measurements
  (e.g. TropOMI, CrIS)
- Modeling

Cover page of the FIREX White Paper