



We will begin momentarily at 2pm ET



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Have Questions?



“Why am I muted?”

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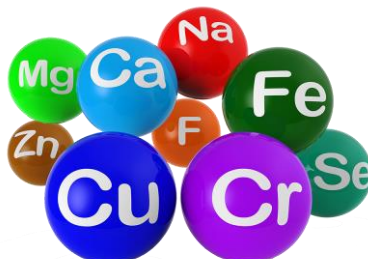
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Fan of the Week

Tina Bailey, Ph.D.
Professor and Chair Emerita
Department of Chemistry and Biochemistry California
Polytechnic State University



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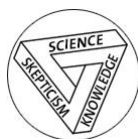


Thursday, April 30, 2015

"Picking the Right Screening Strategy"

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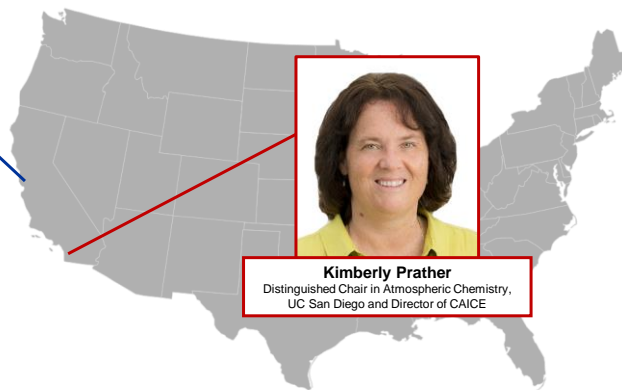
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"From Floods to Drought: How Aerosols Impact Our Climate"



Alexis Shusterman
PhD Candidate, UC Berkeley
and Chem Champs Winner



Kimberly Prather
Distinguished Chair in Atmospheric Chemistry,
UC San Diego and Director of CAICE

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From Floods to Drought: How Aerosols Impacts our Climate



CalWater (<http://atofms.ucsd.edu>)



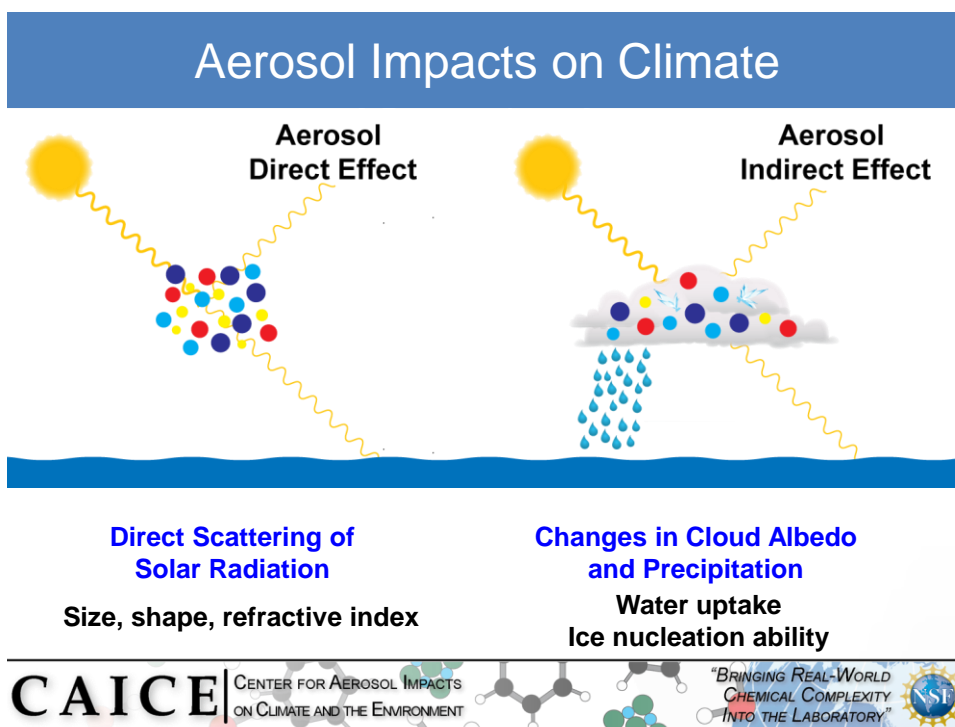
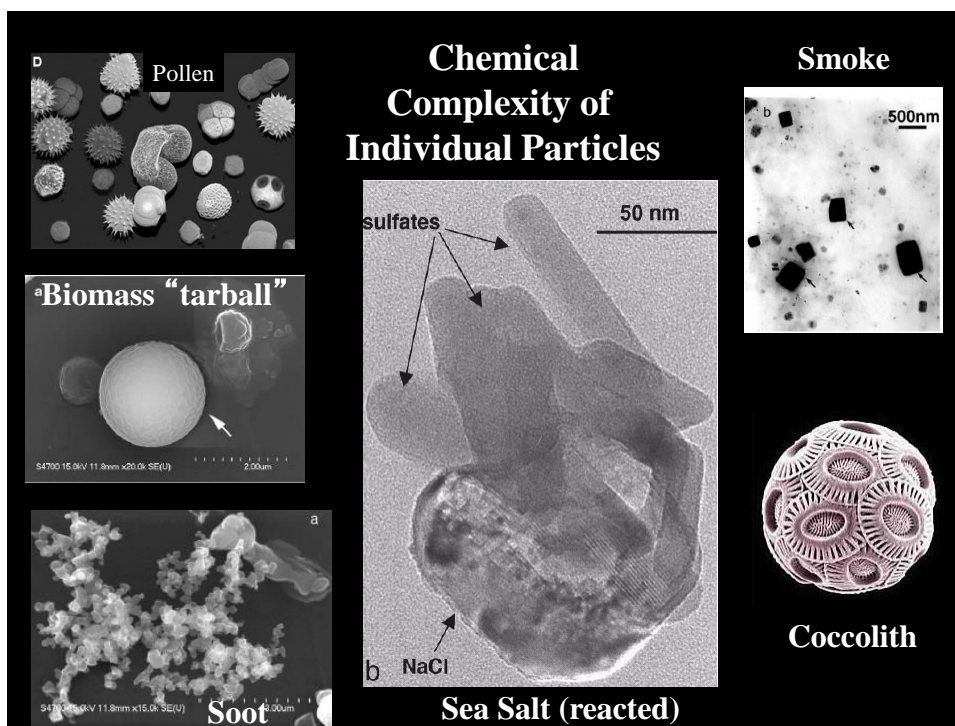
CAICE (<http://caice.ucsd.edu>)

Kimberly A. Prather
Distinguished Chair in Atmospheric Chemistry
ACS Webinar
April 23, 2015

UC San Diego
Chemistry & Biochemistry

SCRIPPS INSTITUTION OF
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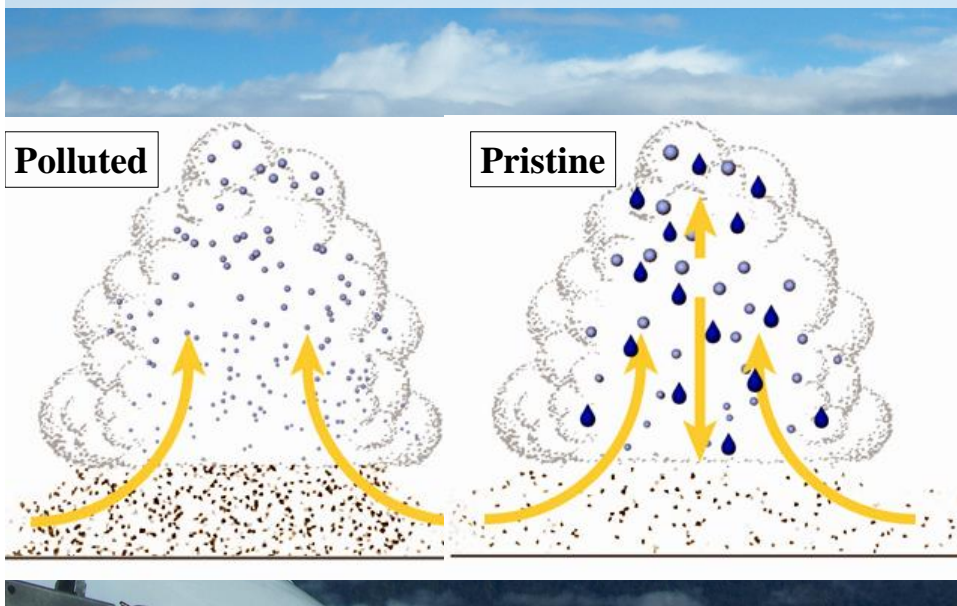




Aerosol Impacts on Clouds and Regional Climate

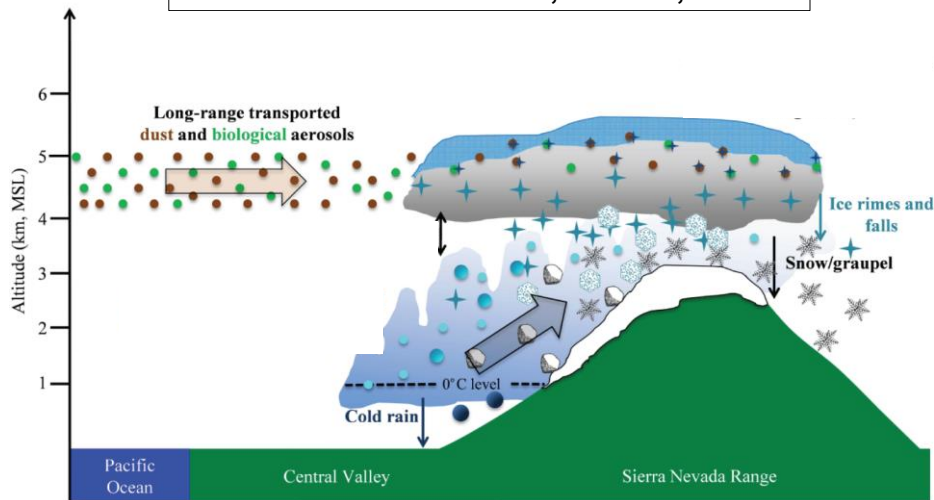


Aerosol Impacts on Clouds and Precipitation



Dust from Africa Affects Precipitation Over California

Prather and co-workers, *Science*, 2013



Some aerosols (dust and bioparticles) enhance snowfall
Others (air pollution) reduce precipitation

Audience Survey Question

ANSWER THE QUESTION ON SCREEN



On average, what fraction of atmospheric aerosol particles will form an ice nucleus?

- About one tenth
- About half
- About 1 in 10^3
- About 1 in 10^6
- About 1 in 10^{10}

Audience Survey Question

ANSWER THE QUESTION ON SCREEN



On average, what fraction of atmospheric aerosol particles will form an ice nucleus?

- About one tenth
- About half
- About 1 in 10^3
- **About 1 in 10^6**
- About 1 in 10^{10}



Without ice nucleus, supercooled water droplets exist down to -38°C !

Ice nucleation is a chemically selective process!!

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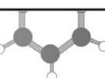
Center for Aerosol Impacts on Climate and the Environment
(<http://caice.ucsd.edu>)

UC San Diego



NSF Center for Chemical Innovation
<http://caice.ucsd.edu>

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Connecting Lab and Field Observations

Los Angeles Basin



- ~20 years of field observations and lab studies focusing on atmospheric aerosols

Sierra Nevada Mtns.



SIO Pier



- CAICE research aims to fill the gap between results from field and laboratory studies

Maldives (Indian Ocean)



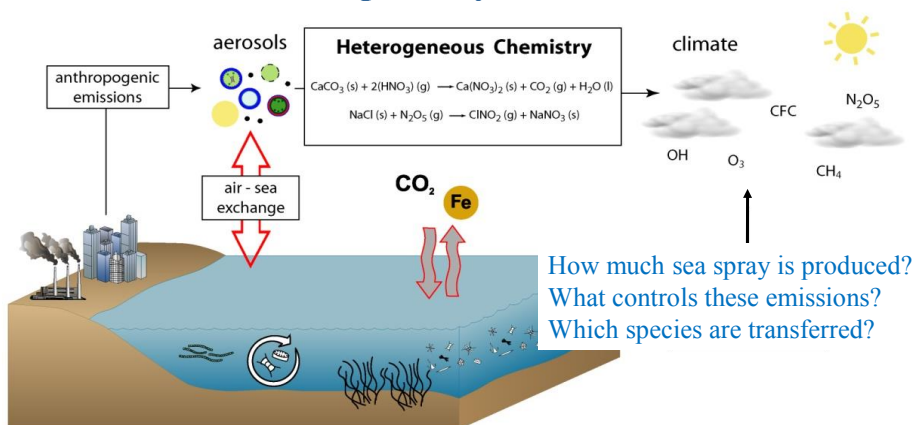
Caribbean Sea



Pacific Ocean



Can we reproduce (and control) the complexity of the real ocean-atmosphere system in the lab?



- Oceans cover 71% of our earth
- Field and lab studies have tried to address ocean impacts for decades
- CAICE scientists have developed new approach for studying this complex problem

Audience Survey Question

ANSWER THE QUESTION ON SCREEN



Which aerosols get ejected in sea spray?

- Sodium chloride (NaCl)
- Viruses
- Bacteria
- Proteins
- All of the above

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Audience Survey Question

ANSWER THE QUESTION ON SCREEN

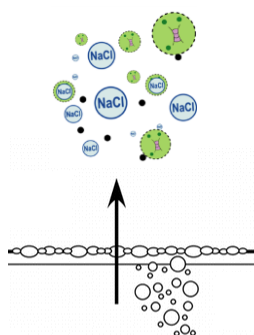


Which aerosols get ejected in sea spray?

- Sodium chloride (NaCl)
- Viruses
- Bacteria
- Proteins
- All of the above

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Chemical Complexity of Sea Spray



Sea spray aerosol particles are chemically diverse

Contain sea salt, bacteria, viruses, and complex organics (proteins, lipids, sugars, humic materials....)

Bubbles transfer organic material to the air-sea interface

Can ocean biochemistry affect aerosol how aerosols are produced and/or what molecules they contain?

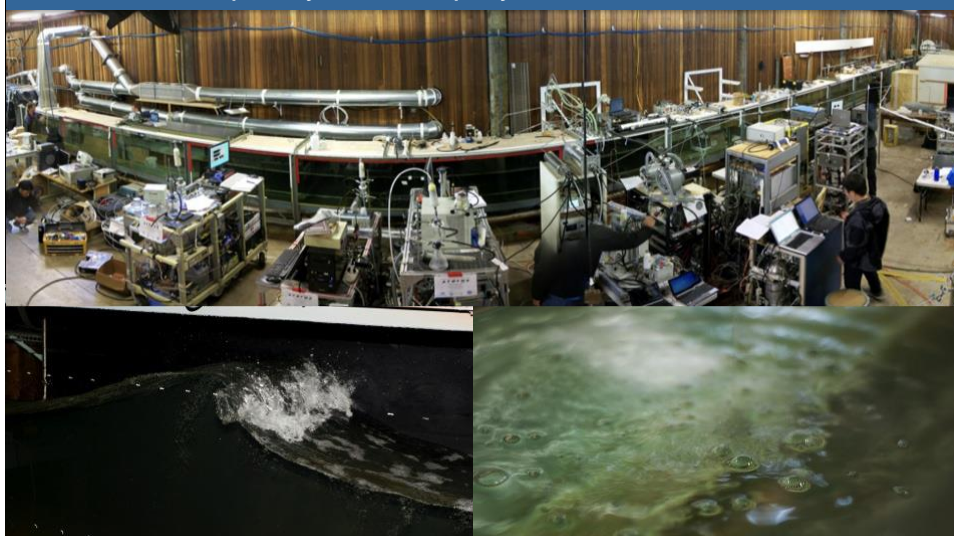


Biological processes change the chemical composition of the ocean

Photosynthesis in the ocean converts *55 billion tons of carbon* from CO₂ to organic every year

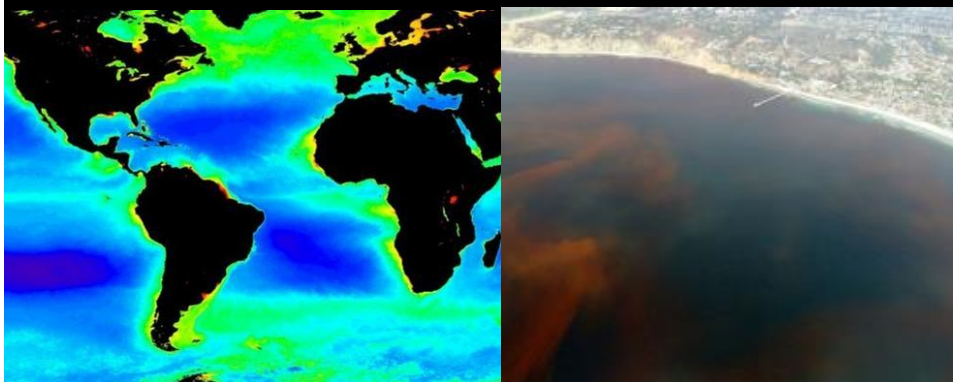


Successfully Transferred Real World Complexity of Sea Spray Aerosol Into the Lab



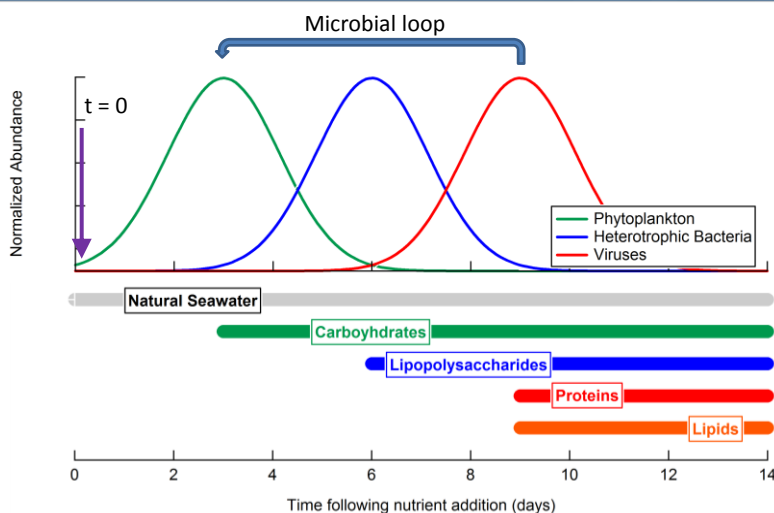
Demonstrated sea spray aerosols are comprised of vast array of chemically complex individual particles (Prather et al PNAS, 2013)

Controlling Chemical Complexity Phytoplankton Blooms Traditional Metric: [chlorophyll-a]



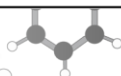
What is the link between changes in seawater chemistry and cloud properties?

How does evolving seawater composition impact SSA composition and physicochemical properties?



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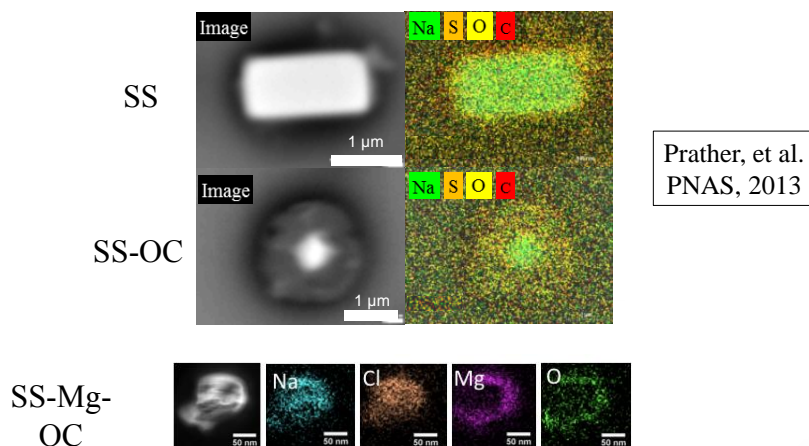
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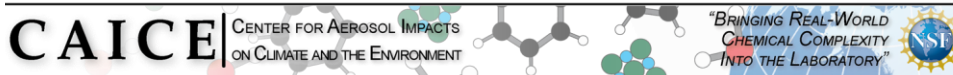
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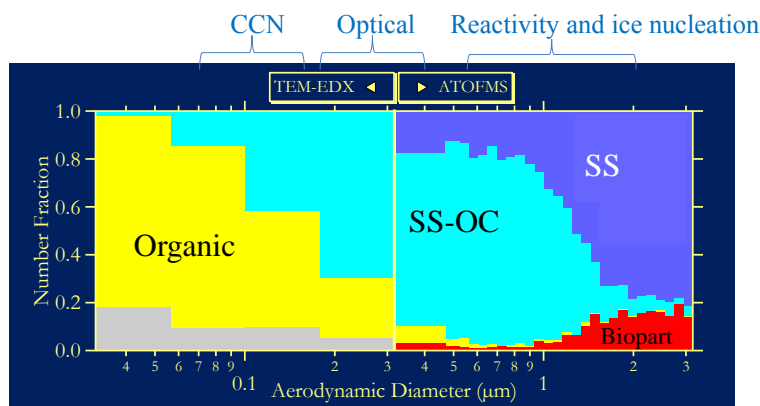
Sea Spray Aerosol: Chemically Complex



Surface composition different from bulk



Size-Resolved SSA Mixing State

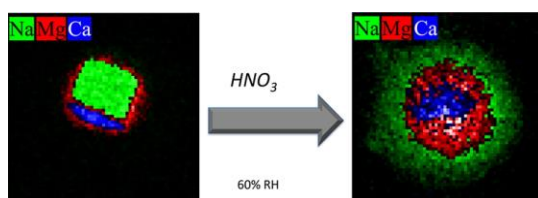
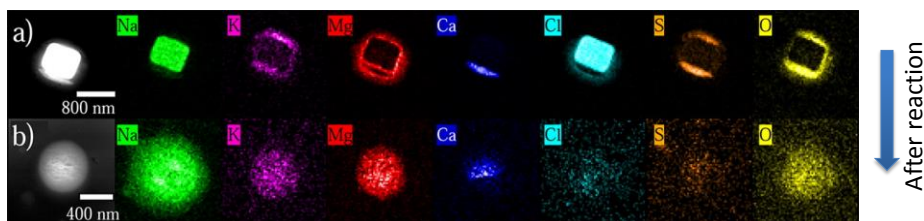


Single particle ATOFMS measurements show chemically distinct particle types

Climate properties impacted by different size ranges

Prather, et al. PNAS (2013)

Chemical Complexity



Chemical complexity leads to structural rearrangement after reactions with gases
Ault, et al. JACS, 2013

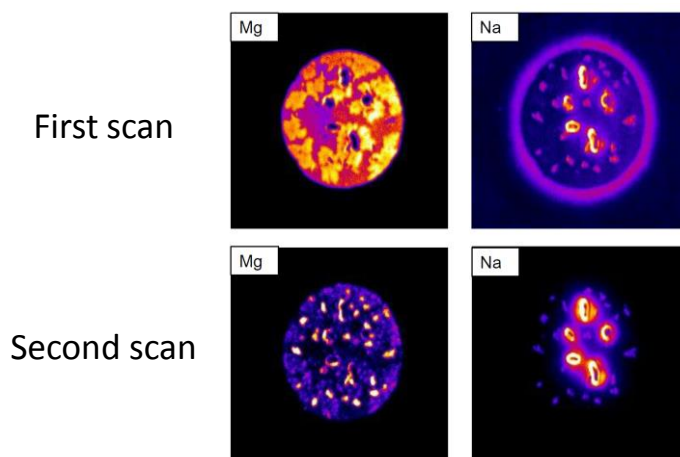
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Depth Profiling: Nano-SIMS



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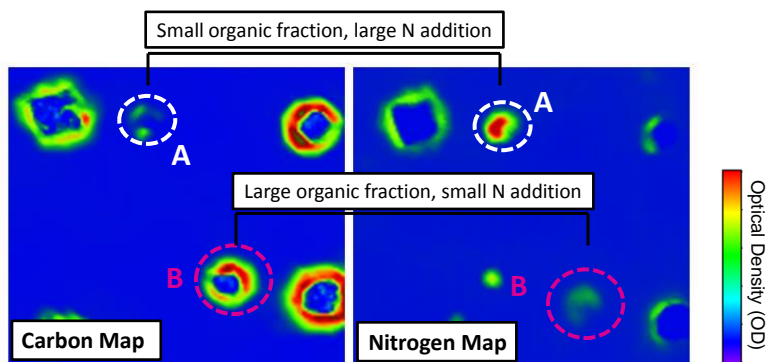
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CAICE: N_2O_5 Reactions on Single Particles

Large particulate organic mass fractions appear to suppress N_2O_5 reactive uptake.
Significant particle-particle variability in N_2O_5 reactivity.



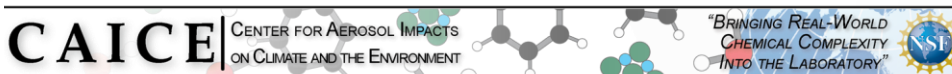
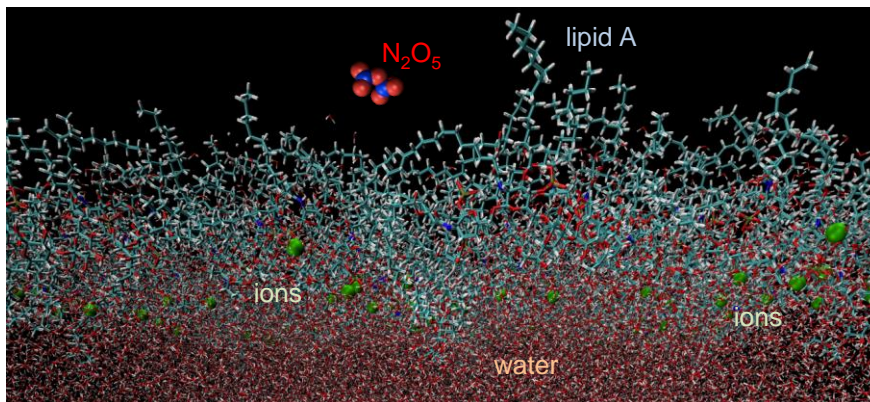
Single Particle Elemental Maps (STXM, post reaction) (Bertram, Ryder, Andreae)

Sea spray aerosol generated from real seawater post reaction with N_2O_5



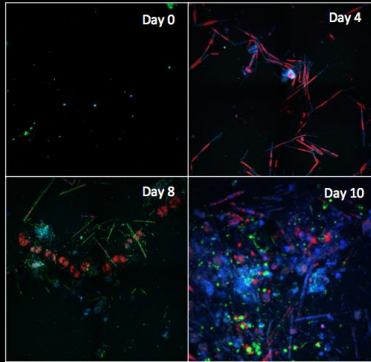
Theoretical Investigations: Reactive Uptake on Chemically Complex Aerosol Surfaces

Measurements being compared against theoretical predictions
Theory being developed (F. Paesani (UCSD), V. Molinero (Utah))



Investigation into Marine Particle Chemistry and Transfer Science (IMPACTS-2014)

Challenge: Induce the World's Largest Indoor Phytoplankton Bloom



Evolving Complexity of Seawater



IMPACTS-2014



SIO Hydraulics Laboratory

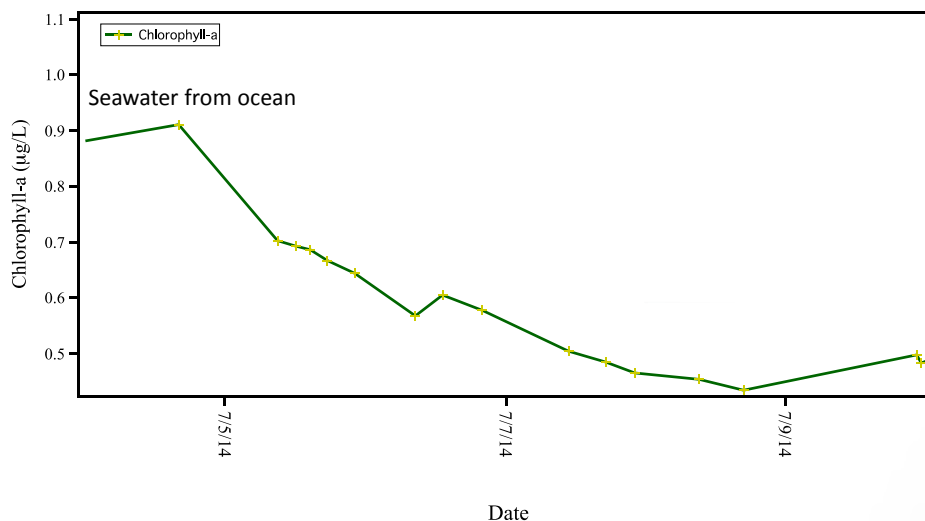
July 3rd – August 8th 2014

33 m glass channel w/ breaking waves

3,400 gallons of seawater

11 research institutions
7th grade up to postdocs
15 research groups
22 grad students
54 researchers!

IMPACTS-2014 (Week 1)



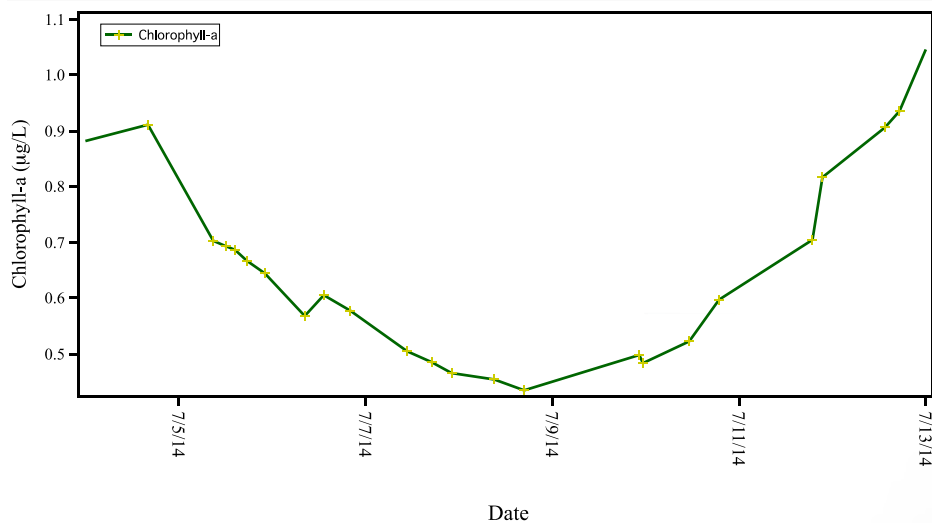
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IMPACTS-2014 (Bloom?)



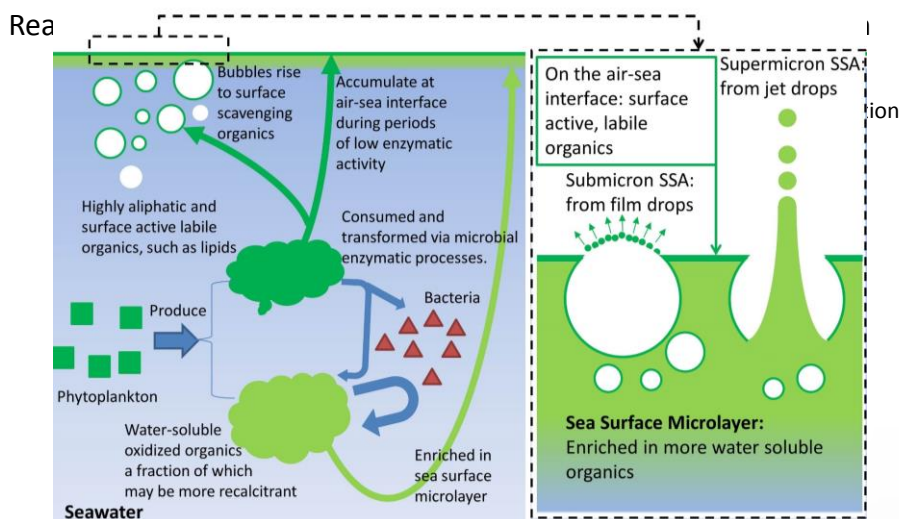
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A Tale of Two Blooms



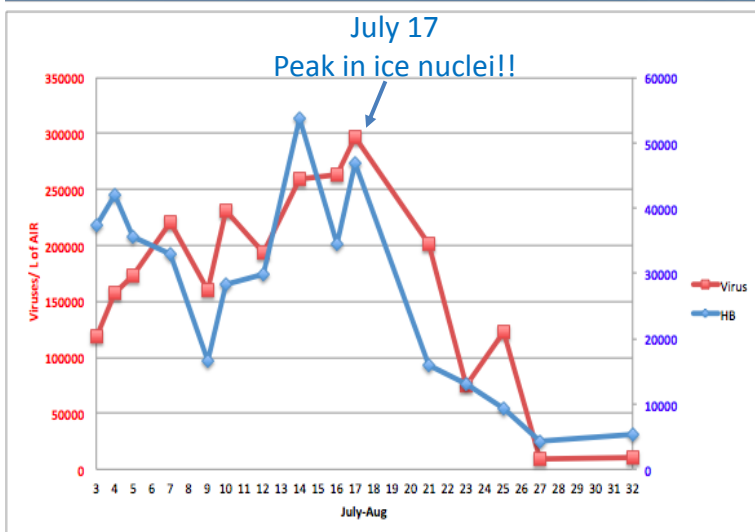
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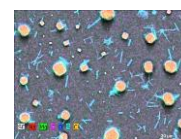
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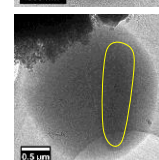
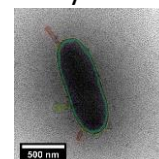
Bacteria and Viruses in Sea Spray Aerosols



AFM



Cryo-EM



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Audience Survey Question

ANSWER THE QUESTION ON SCREEN



How are aerosols impacting our climate?

- Making it warmer
- Making it cooler
- By forming clouds
- By scattering and absorbing sunlight
- All of the above

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Audience Survey Question

ANSWER THE QUESTION ON SCREEN



How are aerosols impacting our climate?

- Making it warmer
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Take Away Messages

- Atmospheric aerosol particles are chemically complex—comprised of millions of different species
 - Keep our planet cooler than it would be otherwise
 - Can warm or cool our climate depending on particle composition
 - Affect how much precipitation we get and where it falls (i.e. re-distributing water resources)
 - Control atmospheric composition through reactions (heterogeneous, aqueous)
- CAICE has developed a new approach for studying real-world chemistry in a controlled lab environment
- Interfacial chemistry is different and critical to controlling reactivity and cloud formation
- Must develop and implement more fundamental chemistry tools to explain the behavior of chemically complex systems
- Please contact us at CAICE if interested in these topics!



Resources

Prather KA, et al. (2013) Bringing the ocean into the laboratory to probe the chemical complexity of sea spray aerosol. PNAS 110(19):7550–7555.

NSF Center for Aerosol Impacts on Climate and the Environment (<http://caice.ucsd.edu>)

How do clouds form?

Search “CAICE media” on YouTube



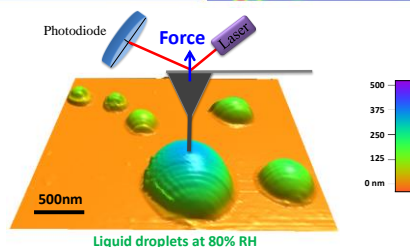
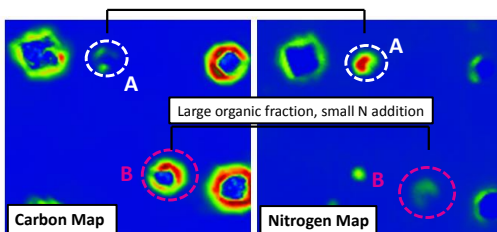
CAICE Chemistry and Climate Toolkit

<http://caice.ucsd.edu/index.php/education/learning-materials/>

Prather Research Group: <http://atofms.ucsd.edu>

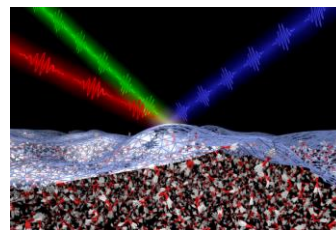
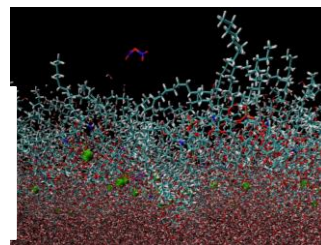
Thank you!

Sensitive Surface Probes (N_2O_5 reactivity)



Nanoscale Chemical Properties

Predictive Theoretical Tools



Interfacial Chemistry

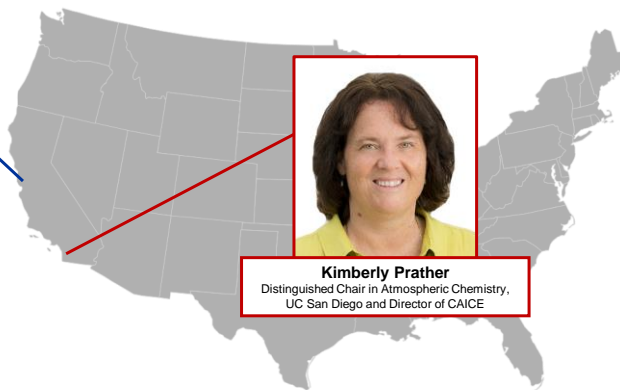
New Insights into the behavior of complex chemical systems



"From Floods to Drought: How Aerosols Impact Our Climate"



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Distinguished Chair in Atmospheric Chemistry,
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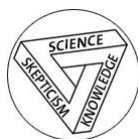


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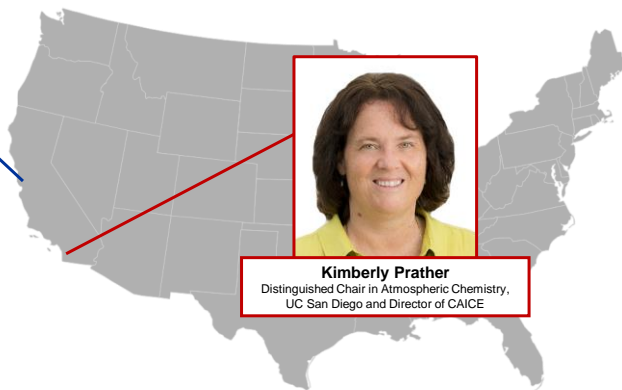
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Tina Bailey, Ph.D.
Professor and Chair Emerita
Department of Chemistry and Biochemistry California
Polytechnic State University

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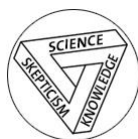


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