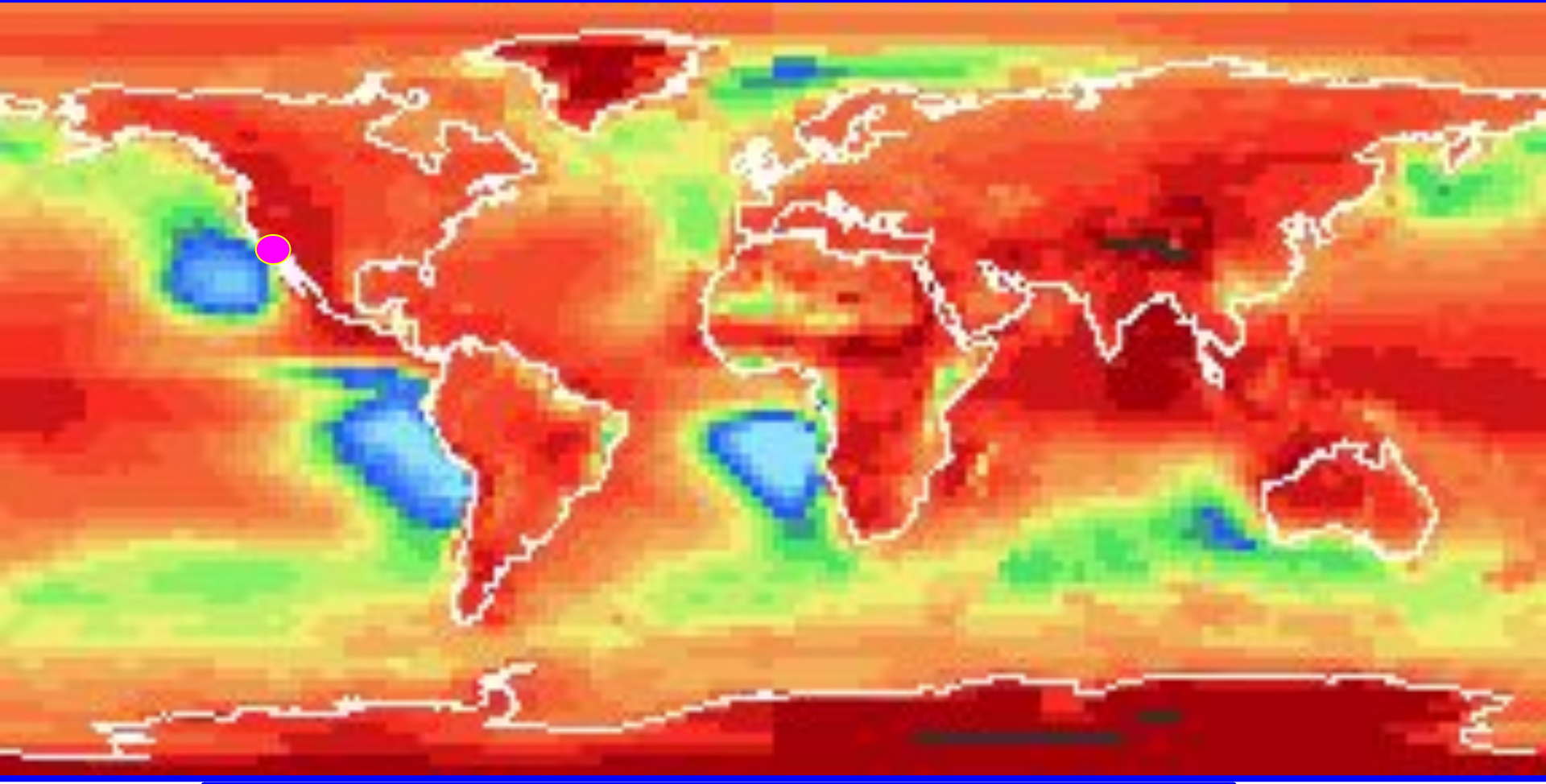
EPCAPE

Eastern Pacific Cloud Aerosol Precipitation Experiment
DOE ARM AMF1 Deployment: February 2023 - January 2024
La Jolla, California: Scripps Pier and Mt. Soledad
PI Lynn Russell: lmrussell@ucsd.edu

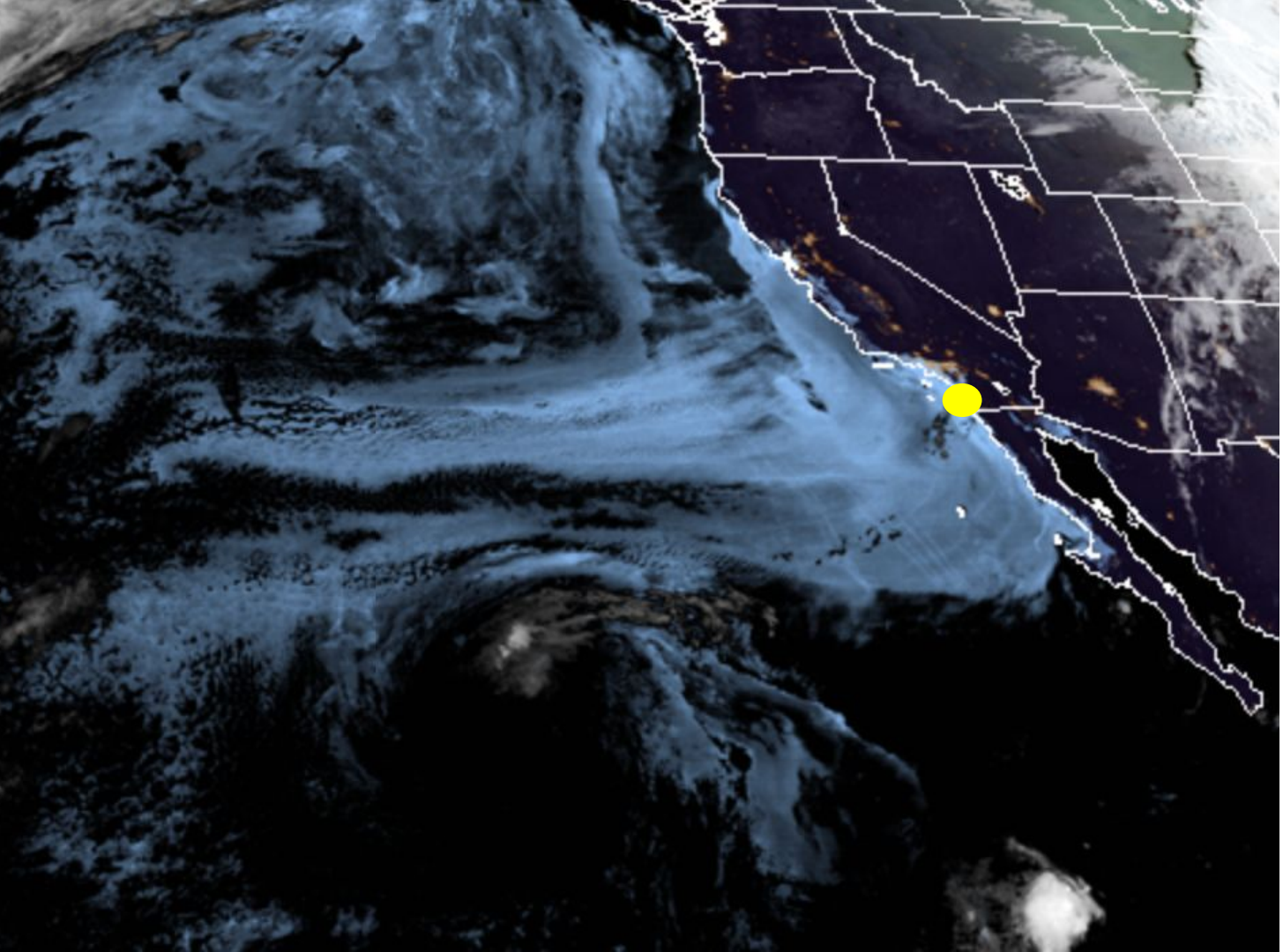
This session is being recorded and will be placed in public domain.

EPCAPE Co-Investigators (plus others are welcome -- *e.g.* AEROMMA)

Dan Lubin, Scripps Institution of Oceanography, UCSD
Israel Silber, Pennsylvania State University
Ed Eloranta, University of Wisconsin
Johannes Muelmenstaedt, Pacific Northwest National Laboratory
Susannah Burrows, Pacific Northwest National Laboratory
Allison Aiken, Los Alamos National Laboratory
Die Wang, Brookhaven National Laboratory
Markus Petters, North Carolina State University
Mark Miller, Rutgers University
Andy Ackerman, Goddard Institute of Space Studies
Ann Fridlind, Goddard Institute of Space Studies
Mikael Witte, Joint Institute for Regional Earth System Science and Engineering, UCLA
Matt Lebsock, Joint Institute for Regional Earth System Science and Engineering, UCLA
David Painemal, Langley Research Center
Rachel Chang, Dalhousie University
John Liggio, Environment and Climate Canada
Michael Wheeler, Environment and Climate Canada

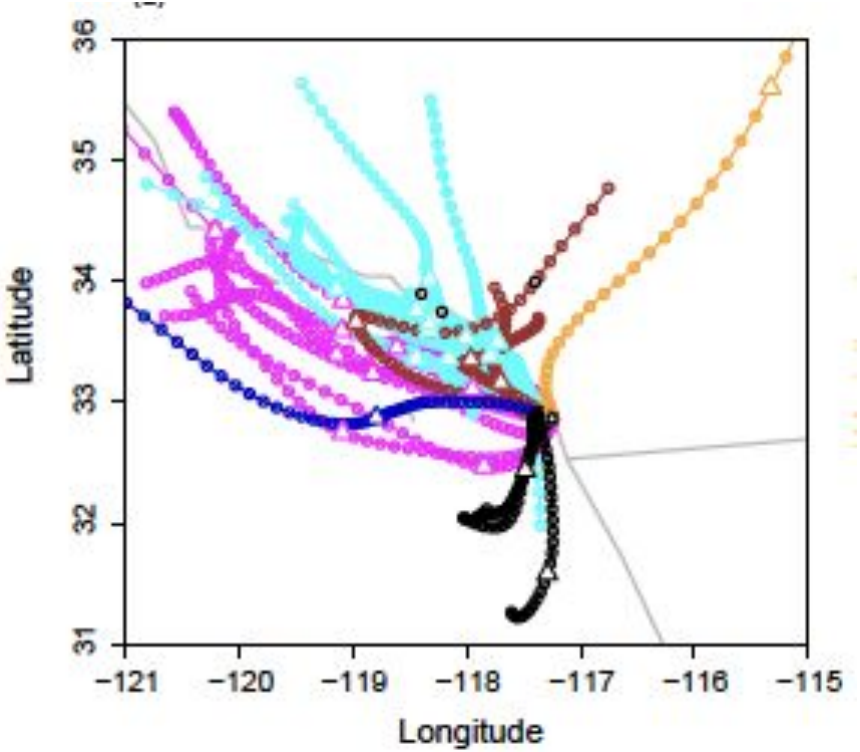


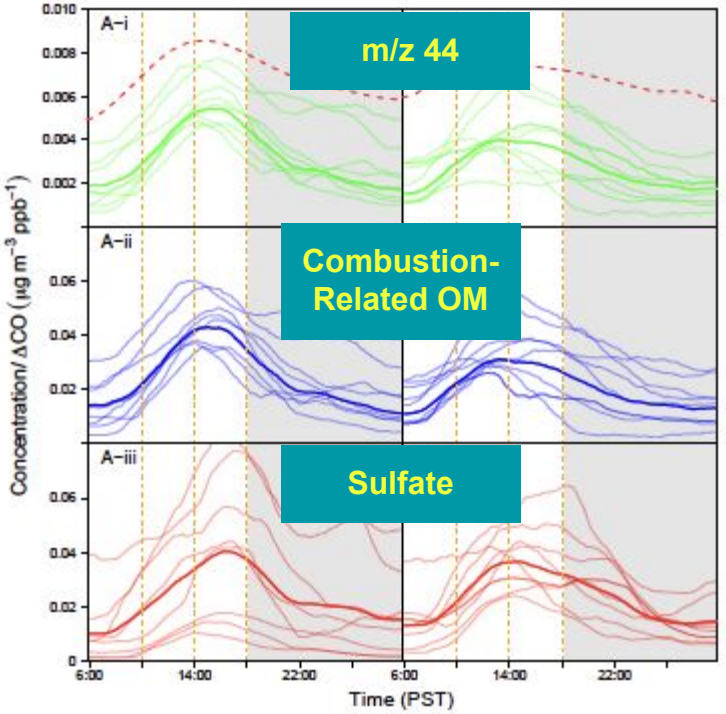
Russell et al., 2013



Persistent offshore stratocumulus interacting with coastal range provides more than 6 months of frequent cloud conditions.

Large dynamic range of aerosol sources, including frequent transport from LA/LB ports after 12-24 hr transit over ocean, provides a variety of aerosol conditions for investigating aerosol cloud interactions.



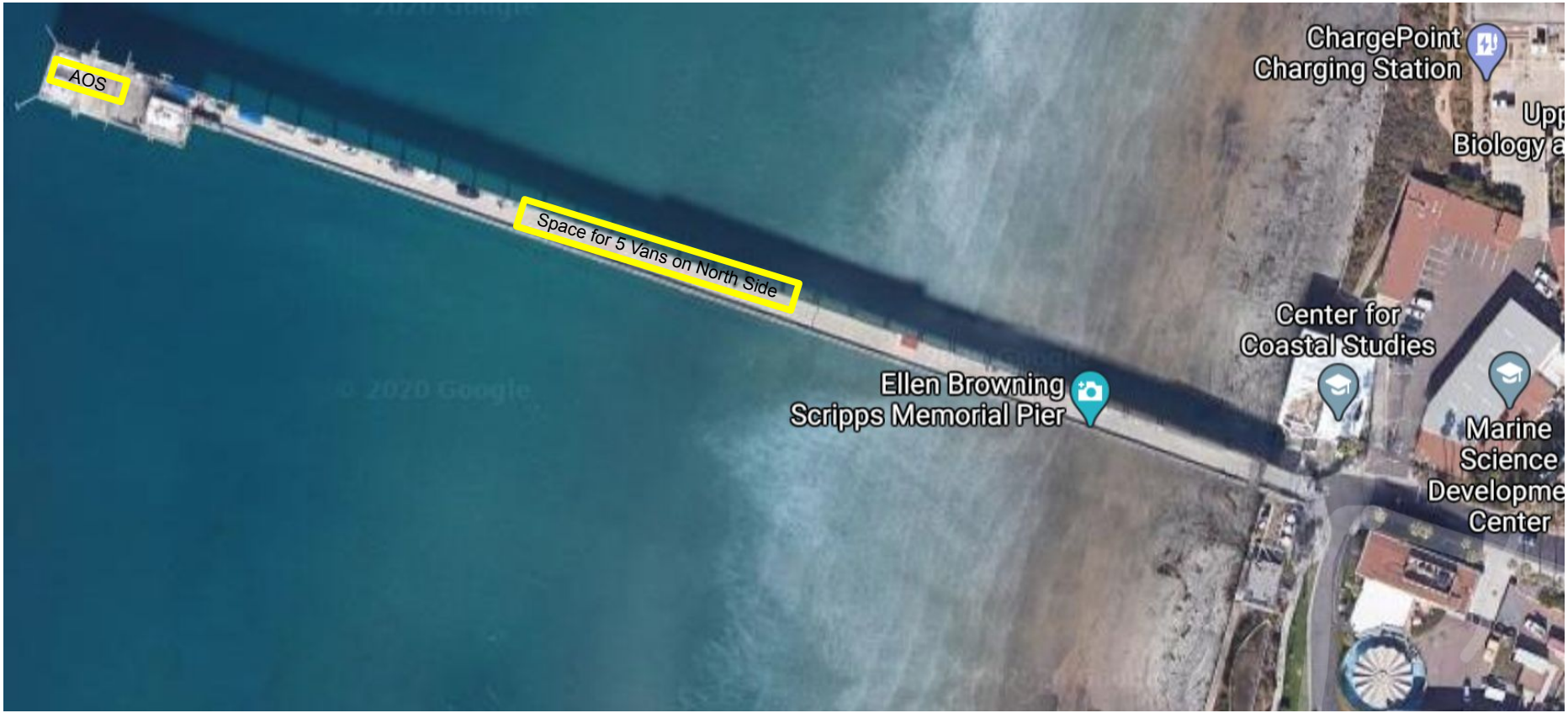


INTENSIVE EPCAPE-Radiation July-September: Strong photochemical signal in aerosol and frequent higher cloud cover.

Liu et al. 2011

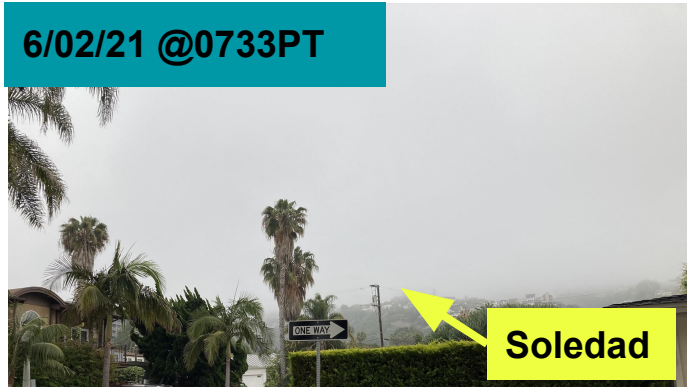
EPCAPE Science Questions

1) **Cloud and Aerosol Climatology**: What are the seasonal and diurnal cycles of marine stratocumulus cloud and aerosol properties on the northeastern Pacific coast?
2) **Cloud Radiative Fluxes**: How do cloud properties, including the ratio of direct-to-diffuse radiation, change as coastal clouds are advected inland?
3) **Aerosol-Cloud Interactions**: Will retrieved cloud properties reflect the regional signatures of aerosol?

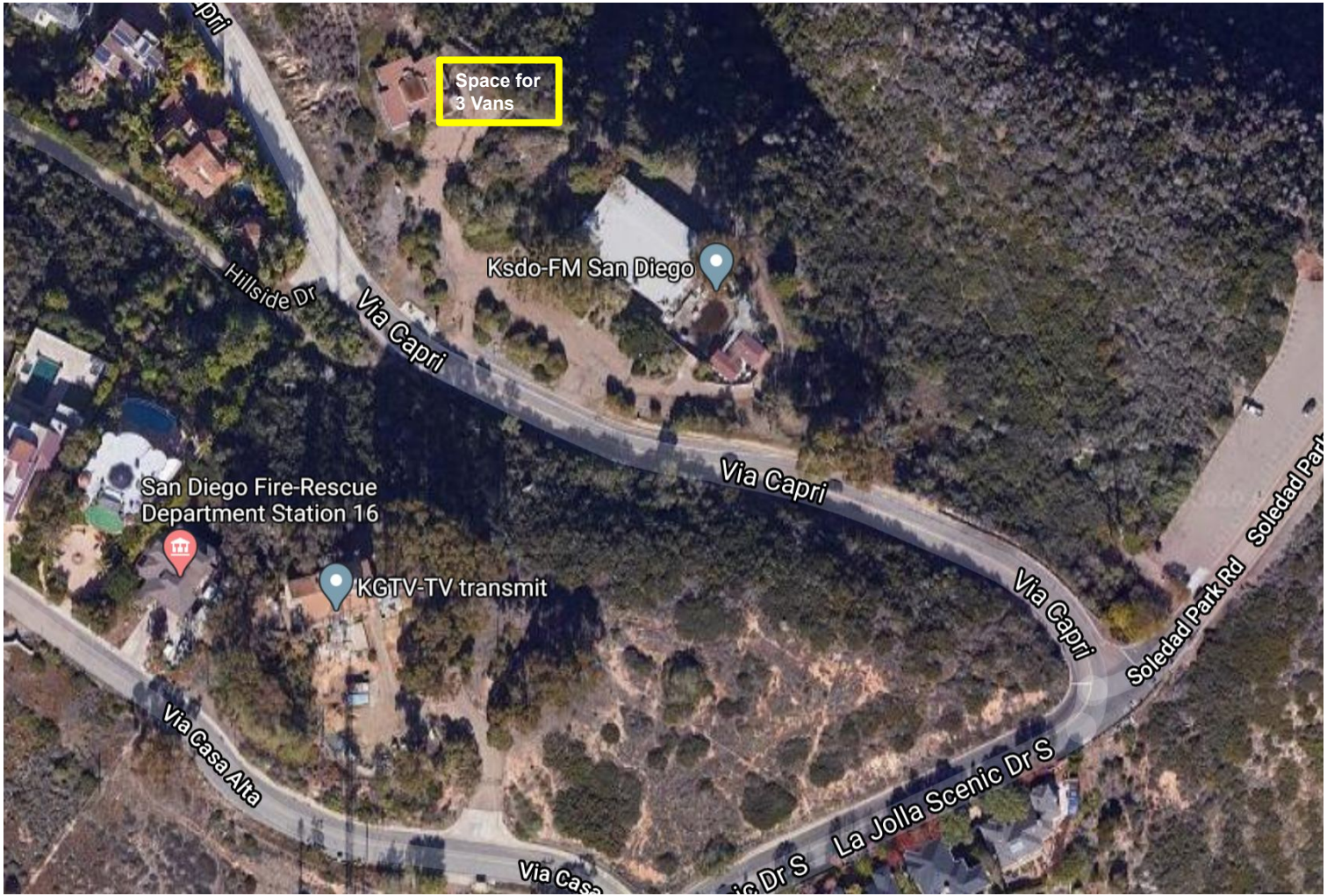


Most AMF1 instruments will be at pier. Downward-pointing radiometers and E-CORR can be boom-mounted on NW side.

Two sites provide the ability to capture different advantages for aerosol and cloud sampling.



INTENSIVE EPCAPE-Chem April-June: Mt. Soledad site is frequently in cloud in May-June, allowing sampling of droplets and interstitial aerosol.



Soledad site has clear field of view to north and west for SACR and is sometimes in cloud for drop measure-ments.

Science Highlight Talks

Cloud and Aerosol Climatology

12:05 Susannah Burrows
Opportunities to Better Understand E3SM Aerosol and CCN Simulation Biases using EPCAPE Observations

Seasonal Cycles

- What is the variability in cloud fraction and rain and drizzle frequency and intensity in the marine stratocu… at the Eastern Pacific coast on seasonal time scales?
- What are the key controlling factors and properties associated with meteorological conditions for marin… ulus clouds at the coast?
- How does the contribution of turbulence to coastal stratocumulus clouds change across different seas…
- How well do different models represent coastal stratocumulus cloud evolution and properties?
- What is the seasonal frequency and relative contribution of aerosols from LA/LB to Scripps pier?
- How do the contributions of photochemical oxidation and cloud processing to the aerosol size distribution change with season?
- How does the warming contribution of absorbing aerosols from LA/LB port activities change with season?
- How much do giant CCN and turbulence contribute to droplet spectral broadening? [*Graham Feingold et al.*, 2002; *Witte et al.*, 2019]
- How well do large-scale models (*e.g.* E3SM) predict aerosol properties relevant to CCN activation (aerosol amount, size distribution, composition, and hygroscopicity) and their associations with different air masses in this region?
- How large are the biases in the modeled CCN activation spectra that are caused by biases or limitations in the modeled aerosol (including structural limitations), and how sensitive (or insensitive) are simulated clouds to any model biases in activation spectra? In other words, what are the main model weaknesses when it comes to simulating aerosol, and how much do they actually matter?

11:45 Allison Aiken
Aerosol Sources and Mixed-Phase Chemistry in the Coastal Marine Environment

Diurnal Cycles

- What is the diurnal cycle of coastal marine stratocumulus clouds, precip…
- How does the diurnal cycle of coastal stratocumulus clouds modulate the … radiative cooling versus surface turbulent fluxes?
- Is the diurnal cycle of coastal stratocumulus cloud properties mainly controlled by meteorological conditions (*e.g.* LWP) or do other factors, like a… a role?
- Are the differential heating rates of the land-sea boundaries characterized well enough to accurately predict modulation of climate change in coastal a…as?
- What does the diurnal cycle of the aerosol size distribution show us about the frequency and importance of photochemically-induced particle growth?
- Is there evidence for new particle formation associated with entrainment from above the marine boundary layer?
- How does the recirculation of aerosol from alternating onshore and offshore flow affect the size of accumulation-mode particles and their ability to serve as CCN?

Cloud Radiative Fluxes

11:35 Mark Miller
Perspectives on Turbulence and Drizzle in Coastal Stratocumulus

Predicting Inland Cloud Cover

- How does inland cloud cover depend on turbulence, cloud microphysical, and cloud radiative properties?
- How might multilayer cloud scenarios impact cloud presence and persistence?
- Do aerosols, decoupling, and sedimentation effects provide important additional controls on cloud dissipation?
- Are there net feedback effects of cloud optical properties on surface upwelling?
- How does the coastline modulate the turbulent kinetic energy (TKE) when the flow is onshore?
- What is the balance between cloud top radiative properties and changes in the sub-cloud drizzle evaporation rate (and its stabilizing impact on the TKE profile)?

Quantifying Cloud Radiative Properties

- How does the direct-to-diffuse ratio change as clouds move inland along the southern California coastline?
- How do boundary layer structure, aerosol properties, and local circulation modulate the evolution of the direct-to-diffusion ratio?
- What are the implications of cloud evolution on solar photovoltaic arrays along the southern California coastline and beyond, a[illegible]w does this evolution mesh with the energy demand profile?
- To what degree and on what time scale do aerosol interactions affect solar resources?

12:15 Dan Lubin
Southern California Cloud Radiative Properties

Aerosol-Cloud Interactions

Aerosol Effects on Cloud Brightening and Surface Temperature

- Which aspects of model errors in aerosol simulation matter most to the cloud properties that are most important [illegible] the coastal transition region?
- Can changes in aerosol properties (size, composition, hygroscopicity) be related to changes in cloud properties?
- Are there sufficient ranges of aerosol sources to distinguish between sources?
- How are aerosols processed in a cloud and what is the role of entrainment and detrainment? If above-cloud particles are detrained droplets, then comparing measurements at the pier to Mt. Soledad can provide insights on the chemical and physical processes that take place. Do these processes feed back onto the cloud properties?
- Do ACI metrics change as a function of deepening and shoaling boundary layer [*Possner et al.*, 2020]?
- Can we separate the roles of aerosol and meteorology in determining cloud properties (including cloud droplet number, liquid water path, precipitation rate, boundary layer depth, decoupling, diurnal cycle)?
- Can retrieved sub-cloud turbulence and activation theory accurately predict observed [illegible] meteorological forcing [*Sena et al.*, 2016]? This type of closure study can be difficult to [illegible] other proposed in-cloud instrumentation for Mt. Soledad will enhance our ability to address th[illegible]

Aerosol Effects on Cloud Lifetime and Water Budget

- Is it possible to disentangle the covariability of meteorology and aerosol perturbation? Do pollute[illegible] northeastern Pacific coast? [*Atwood et al.*, 2019]
- How does aerosol mediate the diurnal cycle of precipitation? Does this vary depending on either aerosol amount or CCN spectrum (activation curve as a function of supersaturation) associated with different airmass regimes?
- What is the role of aerosol in controlling drizzle fluxes from the cloud layer and how does the drizzle [illegible]
- Do models initialized with the measured aerosol properties reproduce the observed ACI evolution[illegible] [*Christensen et al.*, 2020]?

11:25 Markus Petters
Exploration of Cloud Chemistry Questions during EPCAPE-CCC

11:15 Matt Christensen
Lagrangian Perspective on the Indirect Radiative Effect of Aerosols

11:55 Mikael Witte
Lagrangian Observations of Interactions of Aerosol, Clouds and Near-Coastal Circulations

Questions and contributions are welcome!

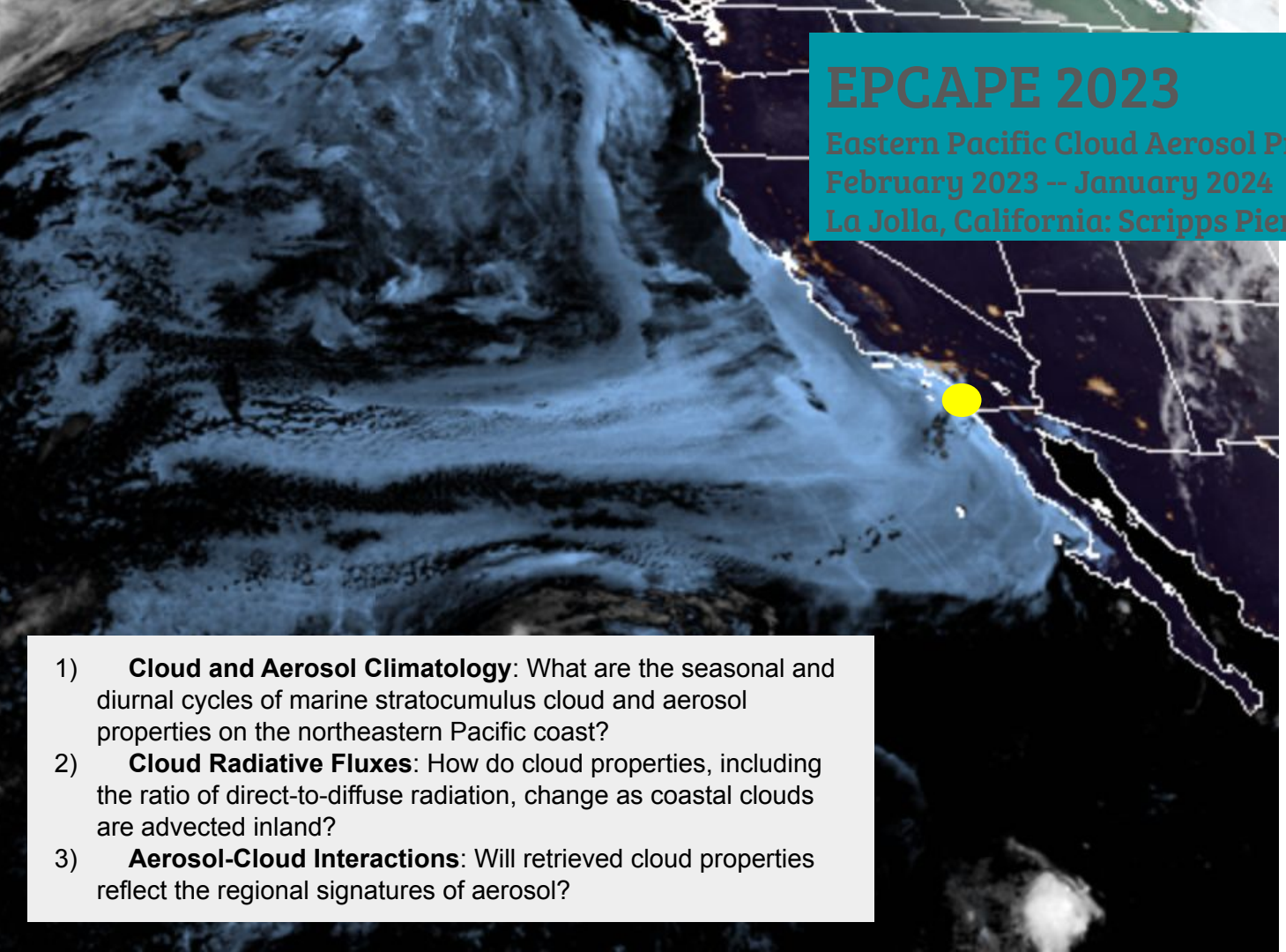
Send me (lmrussell@ucsd.edu):

- More questions if we don't get to them today.
- Requests to join EPCAPE mailing list.
- Updates on EPCAPE (monthly Zoom 1st Th @11PT -- ask me for link).
- Interest in collaborations for EPCAPE measurements and analysis.

Places with more information

- Use our Slack channel for questions: breakout-session1-epcape.
- Slides from this presentation.
- Also see poster presentation by David Chu.
- Draft of Science Plan: EPCAPESciencePlan.

EXTRA SLIDES



EPCAPE 2023

Eastern Pacific Cloud Aerosol Precipitation Experiment

February 2023 -- January 2024

La Jolla, California: Scripps Pier and Mt. Soledad

1) **Cloud and Aerosol Climatology**: What are the seasonal and diurnal cycles of marine stratocumulus cloud and aerosol properties on the northeastern Pacific coast?
2) **Cloud Radiative Fluxes**: How do cloud properties, including the ratio of direct-to-diffuse radiation, change as coastal clouds are advected inland?
3) **Aerosol-Cloud Interactions**: Will retrieved cloud properties reflect the regional signatures of aerosol?

Persistent offshore stratocumulus interacting with coastal range provides more than 6 months of frequent cloud conditions.