# SCILLA: Southern California Interactions of Low cloud and Land Aerosol

Mikael Witte, Naval Postgraduate School

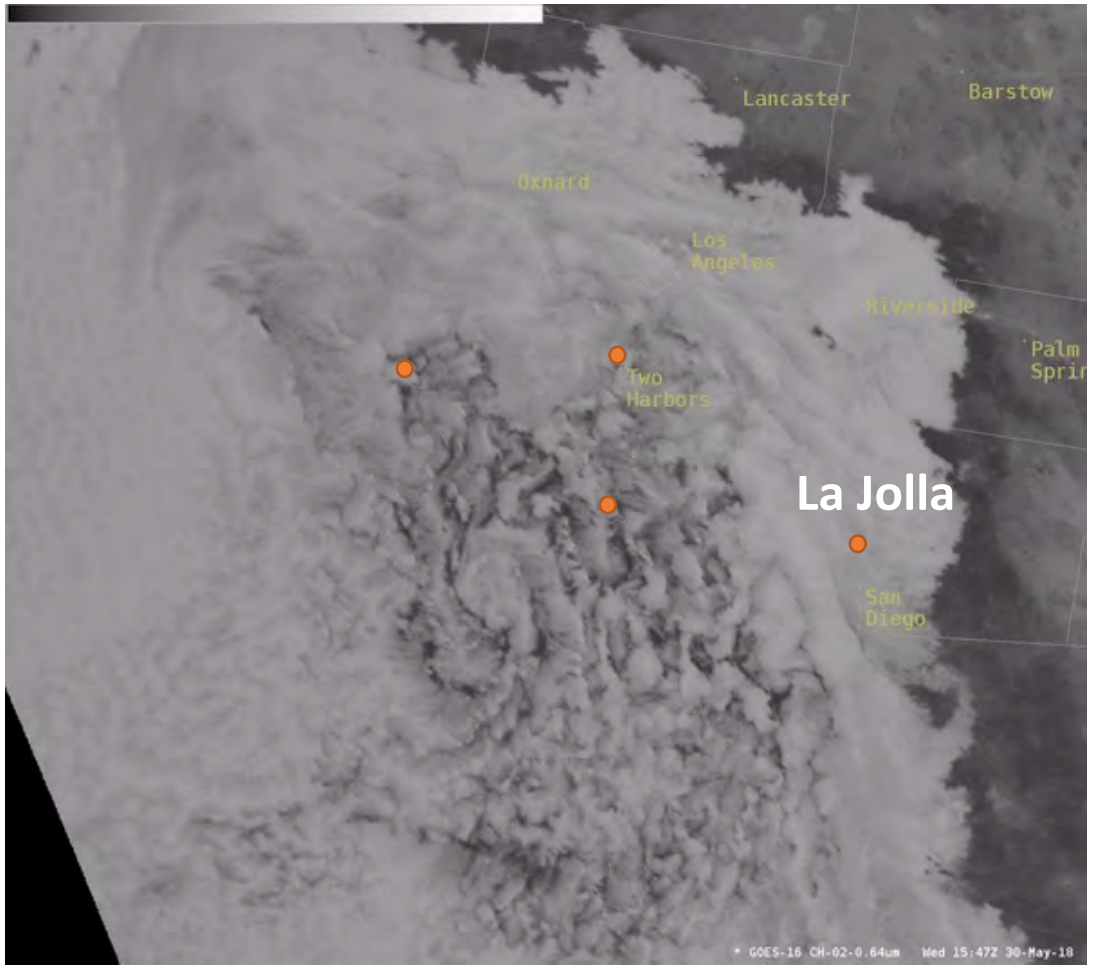
Don Collins, UC Riverside

Patrick Chuang, UC Santa Cruz

Roya Bahreini, UC Riverside

Andrew Metcalf, Clemson

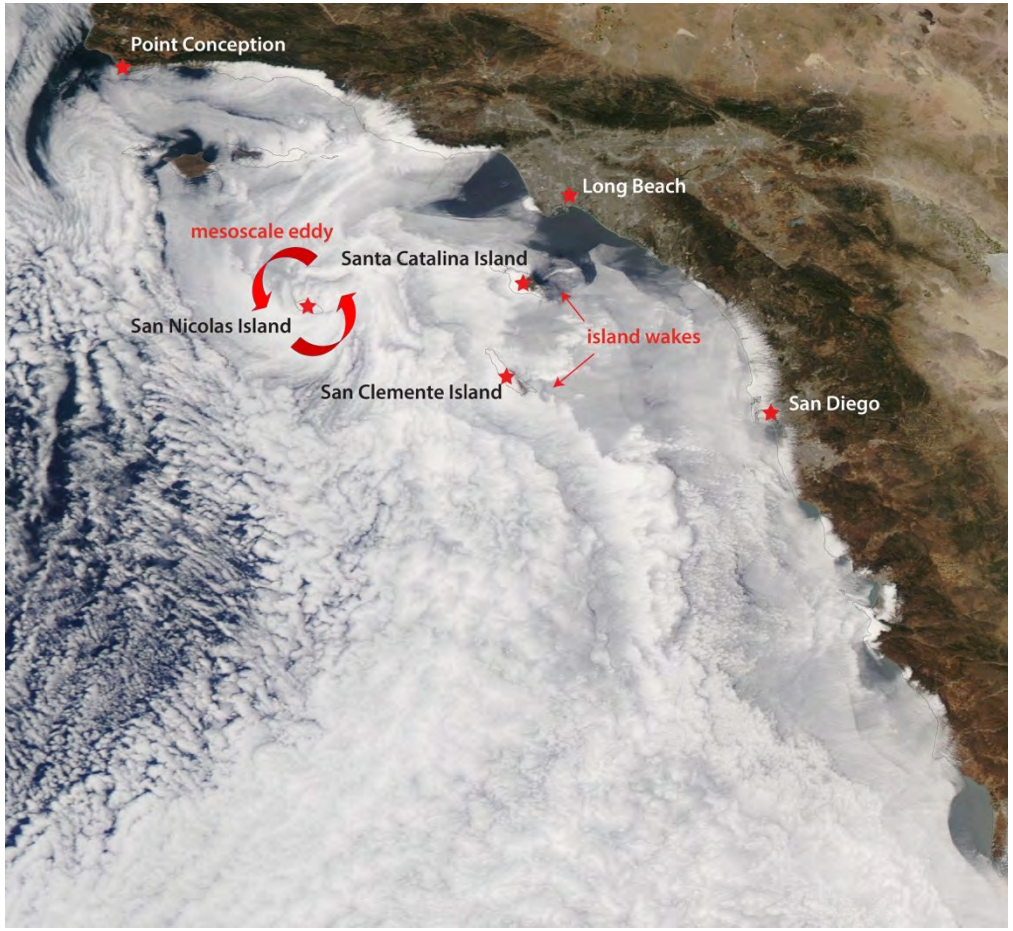
Joe Galewsky, U New Mexico

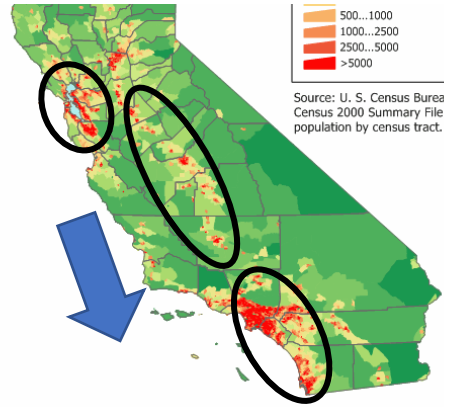



Gif link: https://twitter.com/i/status/1001869430526218240

# Motivation

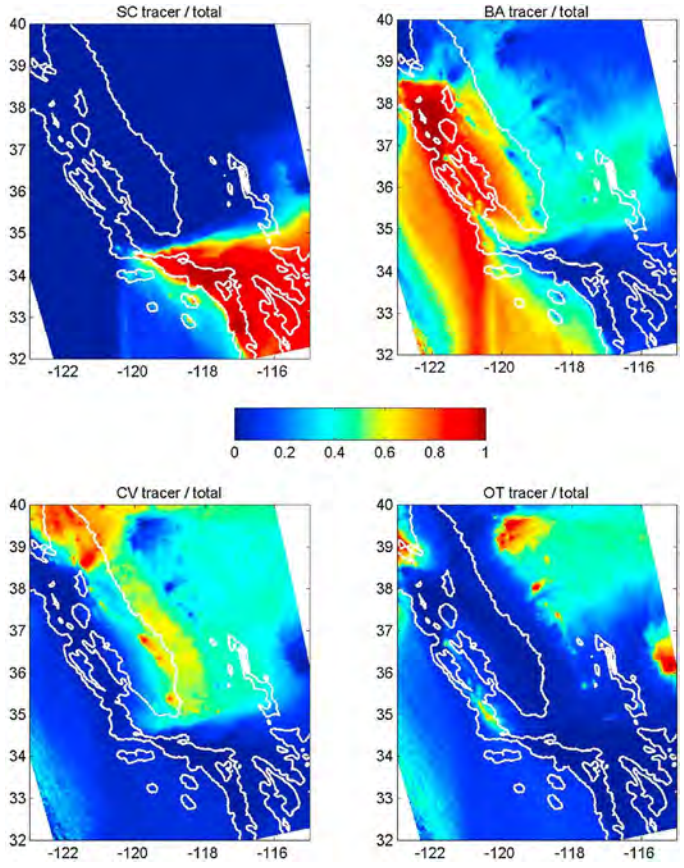
- Above the Southern California Bight, the lower troposphere has complicated dynamics with “action” at all scales, synoptic to micro:
  - Large-scale surface flow in spring typically NNW-ly
  - Flow and shape of coastline interact to form:
    - Hydraulic jump @ Point Conception
    - **Mesoscale “Catalina” eddies over Bight**
      **– Highly correlated with onshore clouds**
      – Also results in tilt in PBL, deeper toward coast
  - Island wakes
  - Land-sea breeze circulation at coast
- Major pollution sources in close vicinity (LA/LB, SD, points inland) and farther afield (Bay Area, Central Valley)
- Important area for air quality control, visibility impacts on maritime & aviation operations, coastal solar forecasting, etc.



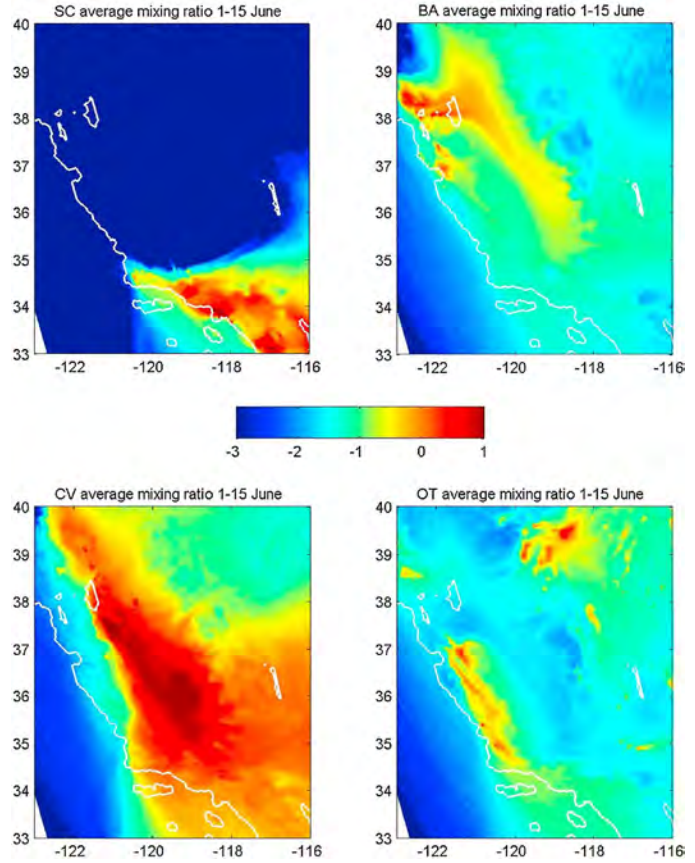
# Simulated pollutant dispersion over the Bight

CO (relative)

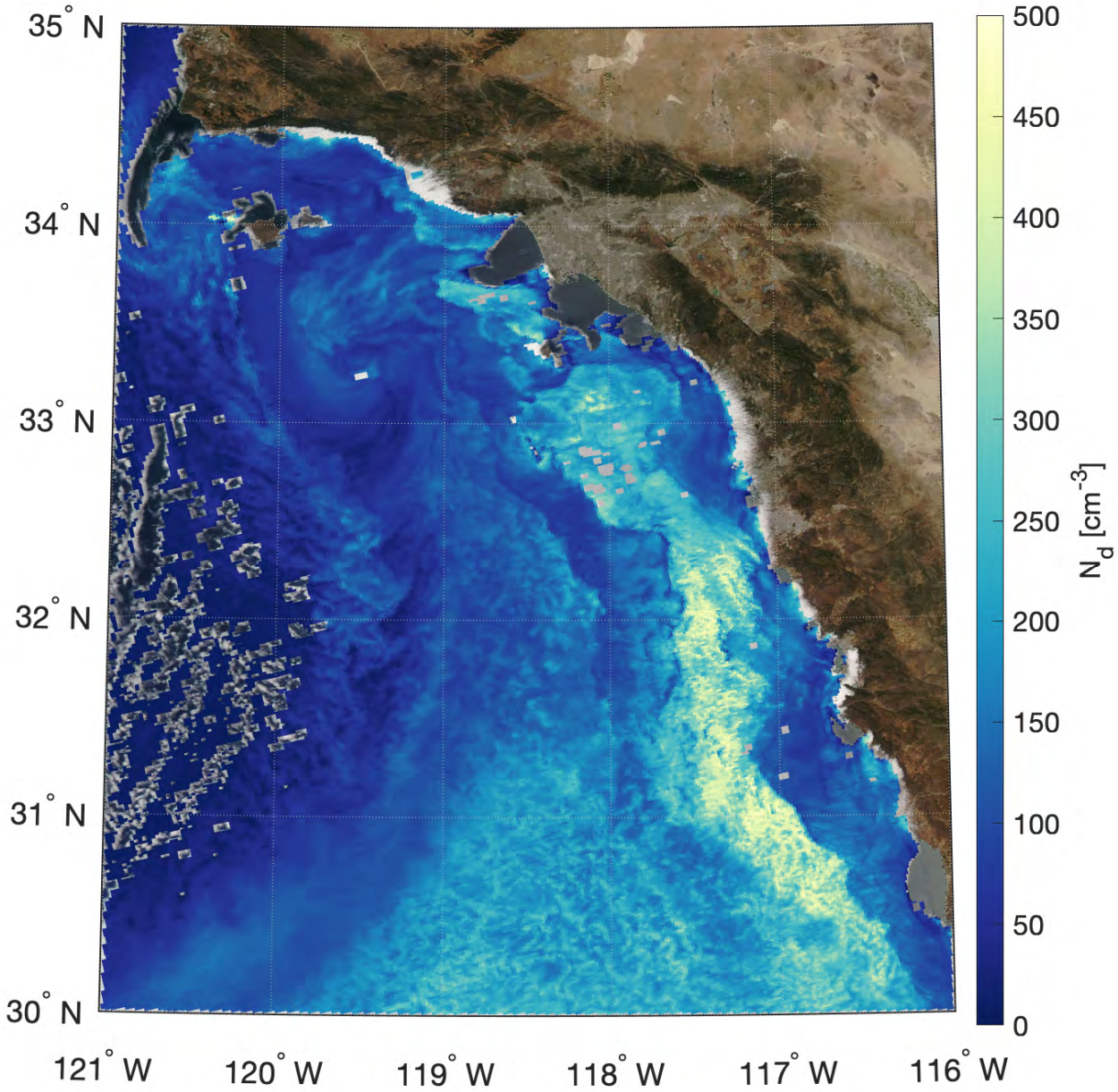



SC = SoCal
BA = Bay Area
CV = Central Valley
OT = Other

NH3 ($log_{10}$(ppb))




Angevine et al. 2013


35° N
34° N
33° N
32° N
31° N
30° N
121° W
120° W
119° W
118° W
117° W
116° W
500
450
400
350
300
250
200
150
100
50
0
$N_d$ [$cm^{-3}$]

# Platform and instrumentation

- Naval Postgraduate School (formerly CIRPAS) Twin Otter aircraft
  - Facility director: Anthony Bucholtz

**PI operated instrumentation**

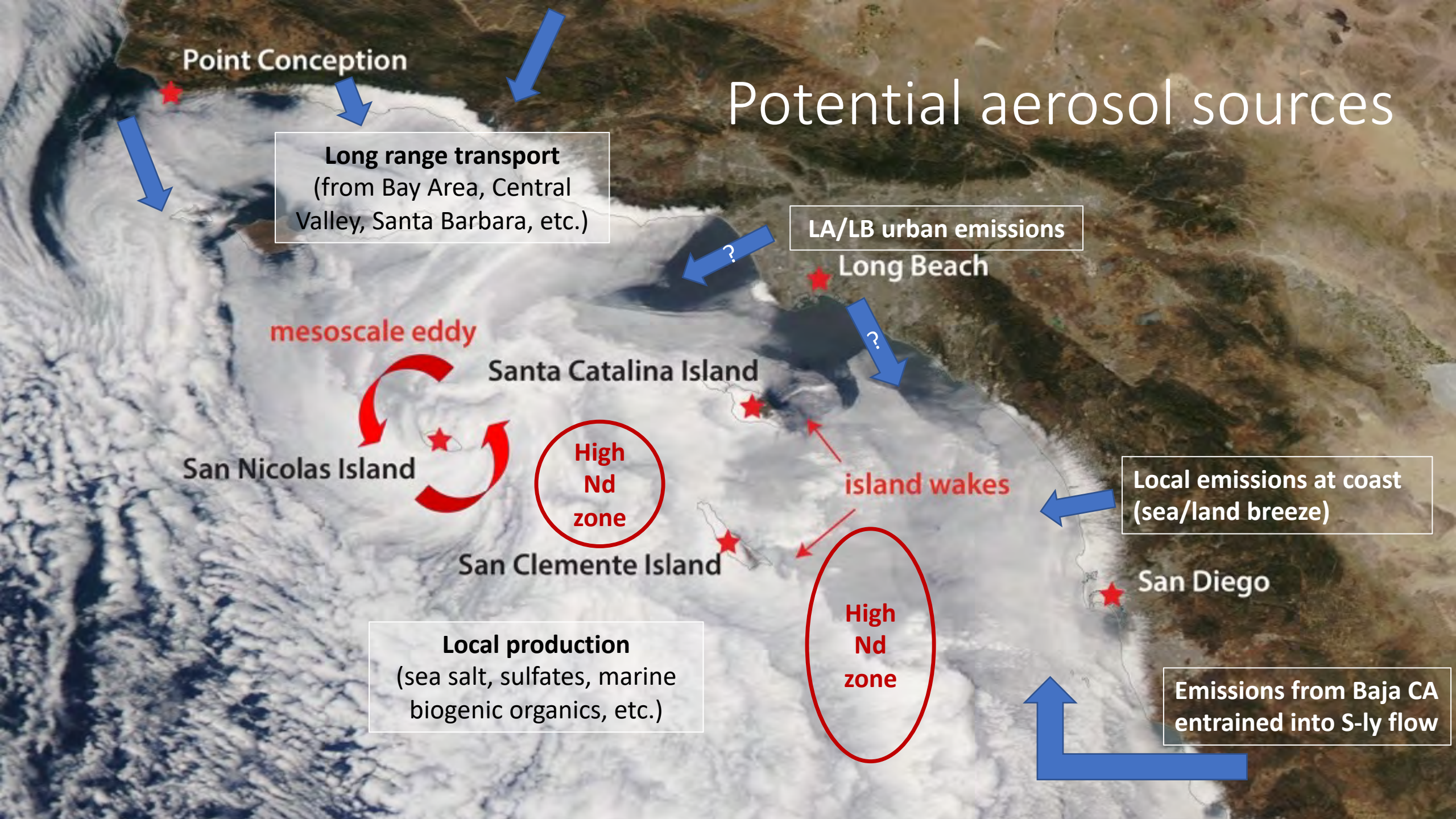
| Measurement | Twin Otter |
|---|---|
| **Aerosol concentration** | |
| CN concentration | 2 x CPC |
| CCN concentration | 2 x CCN-100 |
| Size distribution | SMPS + PCASP + PDI |
| **Optical properties** | |
| Light scattering | 3-λ Nephelometer (dry) |
| Light absorption | 1-λ PSAP |
| Black carbon | SP2 |
| **Aerosol composition** | |
| Non-refractory | mAMS |
| **Other** | |
| Trace gases | $O_3$, CO, $NO_X$, $CO_2$, isotopes of $H_2O^*$ |
| OH chemistry | Oxidation flow reactor |
| Droplet size distribution | PDI (2µm-1mm) + CDP |
| Cloud droplet residuals | CVI |

**Facility standard instrumentation**

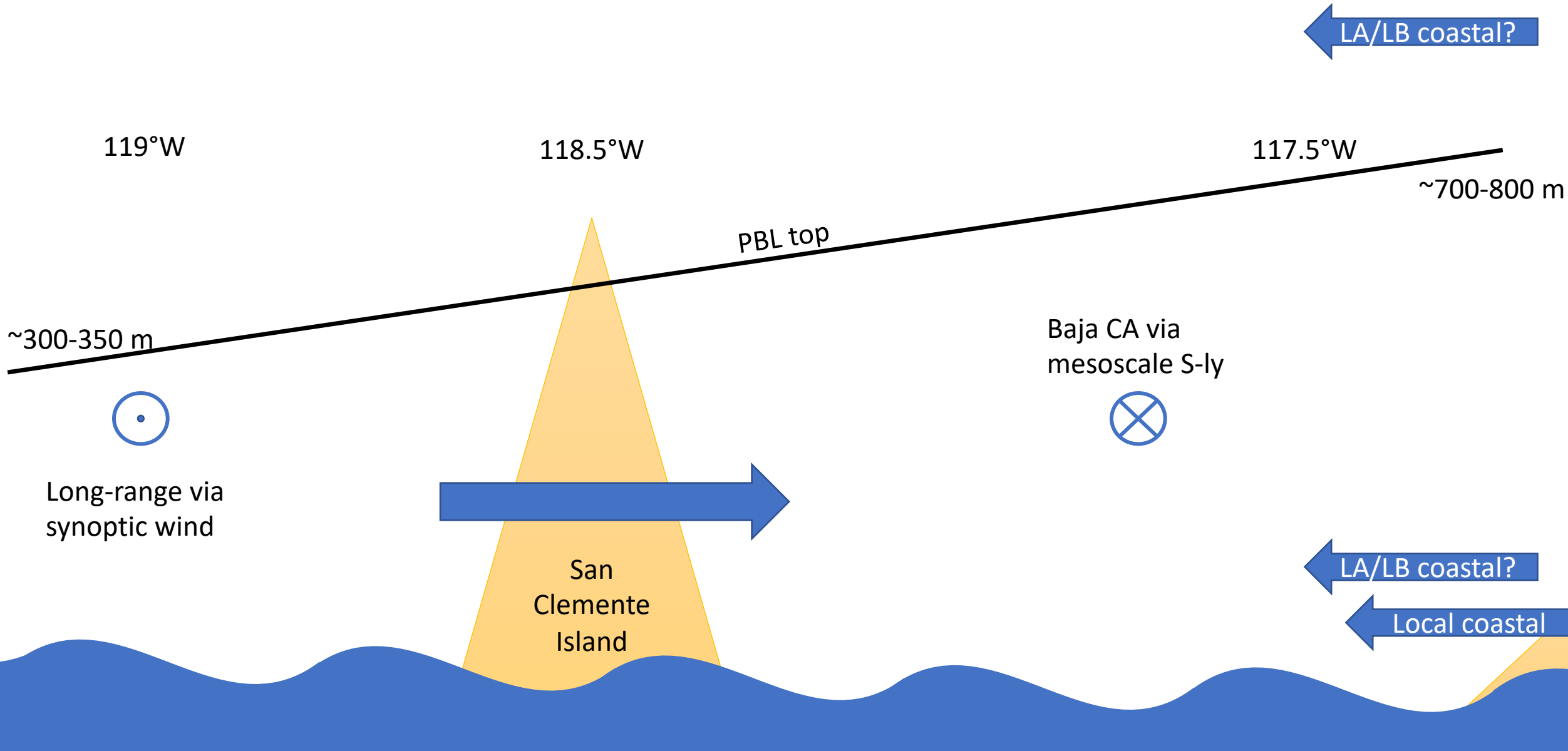
| Instrument | Measurement |
|---|---|
| Thermometer | Temperature |
| Chilled mirror | Dew point temperature |
| Pressure transducers | Atmospheric pressure |
| Radome & flow angle probe | Winds |
| Particulate volume monitor | Bulk cloud liquid water content |
| Pyrometer | Sea surface temperature |
| Pyranometer | Solar irradiance (upwelling & downwelling) |
| Pyrgeometer | Infrared irradiance (upwelling & downwelling) |

# Scientific Objectives

- Investigate the dynamical controls on aerosol transport into, and distribution within, the SoCal Bight
- Quantify the impact of aerosol-cloud interactions on PBL structure and evolution
- Characterize gradients in atmospheric properties across the inversion to constrain mixing/turbulent transport hypotheses


Potential aerosol sources
Point Conception
Long range transport
(from Bay Area, Central Valley, Santa Barbara, etc.)
LA/LB urban emissions
Long Beach
?
?
mesoscale eddy
Santa Catalina Island
San Nicolas Island
High Nd zone
island wakes
Local emissions at coast (sea/land breeze)
San Clemente Island
San Diego
High Nd zone
Local production
(sea salt, sulfates, marine biogenic organics, etc.)
Emissions from Baja CA entrained into S-ly flow

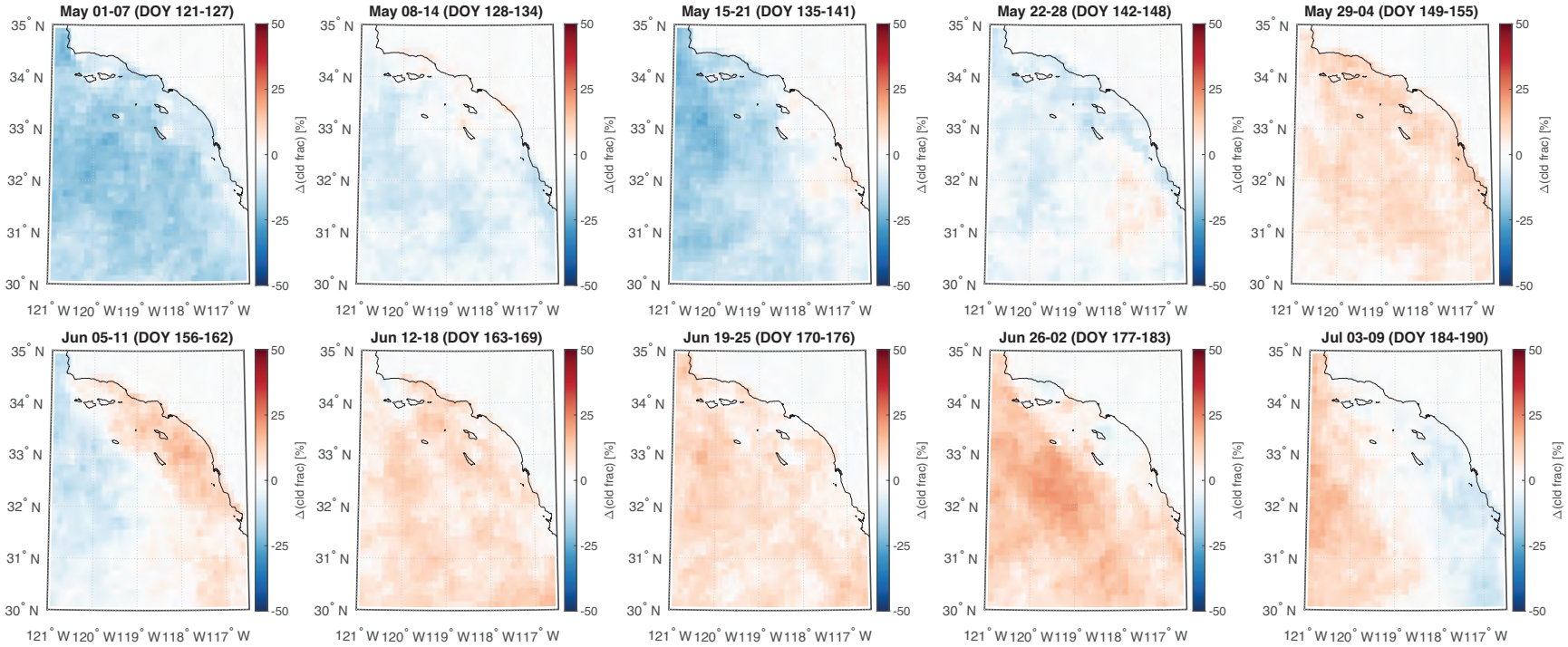
# Transect along ~33°N during a Catalina eddy viewed from the south



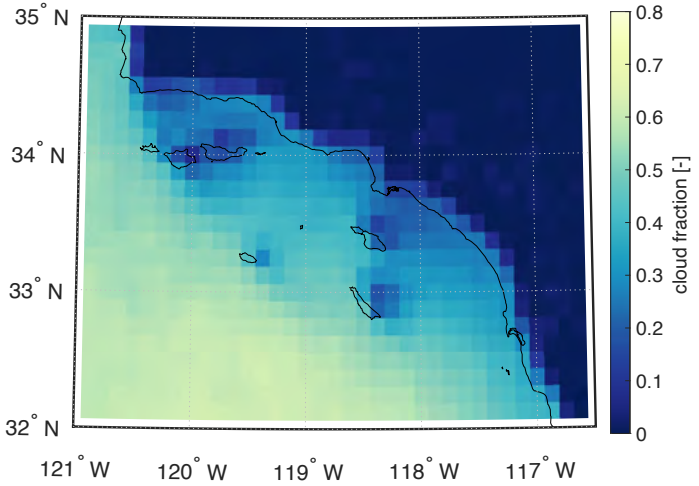
# Sampling objectives

- Characterize vertical and horizontal structure of PBL (dynamics, thermodynamics, microphysics, aerosol, trace gases…)
- Quantify aerosol/drop size distribution, composition, proxies for processing/aging
- Establish “end members” for mixing analysis (i.e., surface vs. free troposphere)

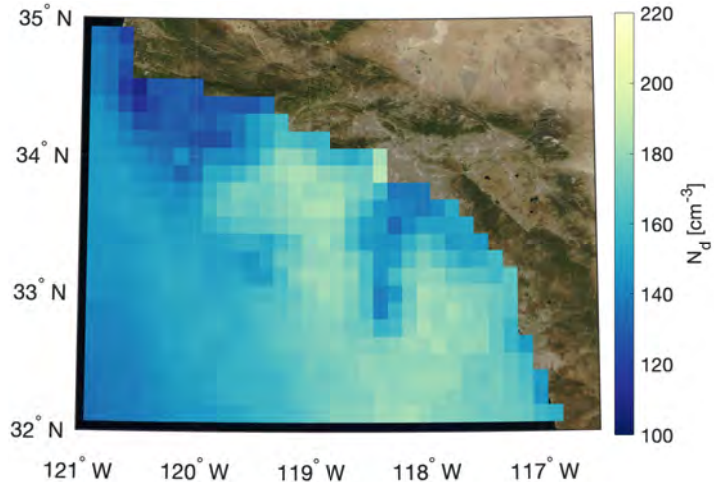
## Perturbation MODIS low cloud fraction from 15-year gridded mean




## Aqua MODIS mean cloud fraction, 1/8°, May 1-July 15, 2008-2022



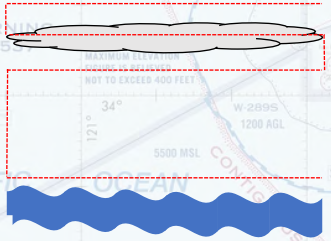

## Aqua MODIS mean $N_d$, 1/8°, May 1-July 15, 2008-2022



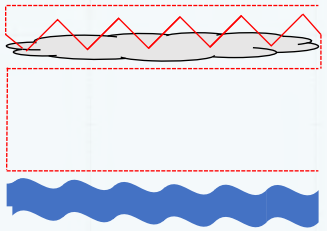
PACIFIC OCEAN
CONTIGUOUS U.S. ADIZ
WARNING W-532S
WARNING W-537
WARNING W-289S
WARNING W-289N
WARNING W-412
WARNING W-269W
WARNING W-289S
WARNING W-292E
WARNING W-291E
WARNING W-292W
WARNING W-291E
MAXIMUM ELEVATION FIGURE IS BELIEVED NOT TO EXCEED 400 FEET
5500 MSL
1200 AGL
SANTA BARBARA CLASS C
NOAA REGULATED NATIONAL MARINE SANCTUARY DESIGNATED AREAS
EXAMPLES OF CLASS B ALTITUDES
LOS ANGELES BASIN
SAN DIEGO TERMINAL AREA
CONTROL AREA PACIFIC LOW
MEXICO FIR MMFR
MAZATLAN CTA SECTOR I

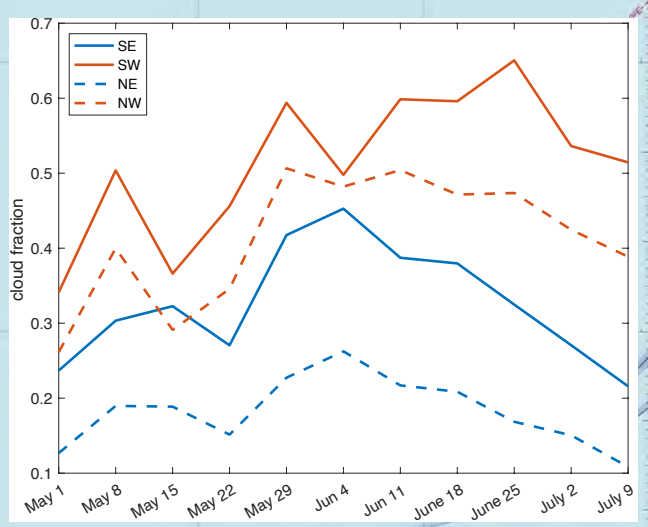
Vertical sampling strategies:

- Level legs



- Slow sawtooth/porpoise





# GOES Loops: June 2020

- Day/night cloud cover only: https://youtu.be/lRcKVmFAo9M
- With microphysical retrievals: https://youtu.be/d-rWFFjdRfA

# Thank you!

- Interested in coordinating? Drop me a line: mikael.witte@nps.edu