SCILLA: Southern California Interactions of Low cloud and Land Aerosol

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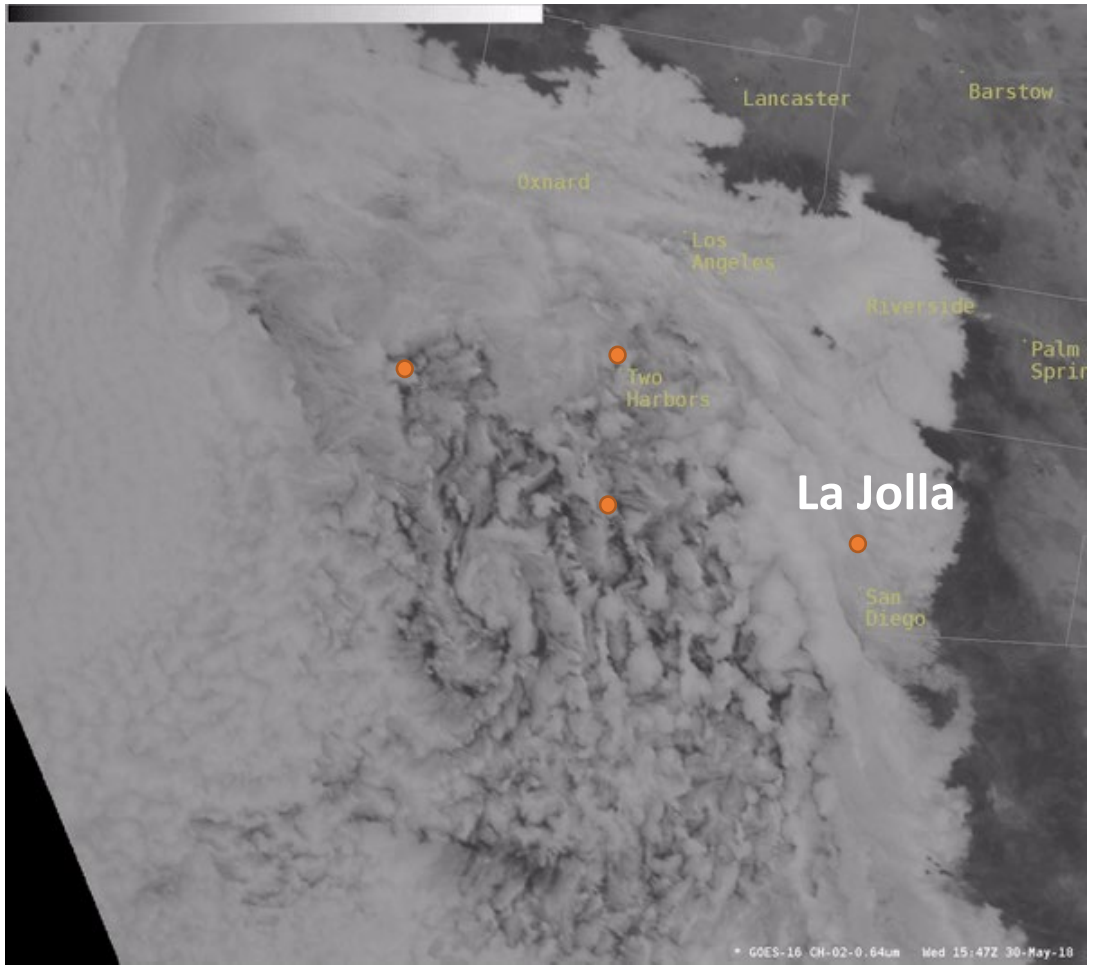
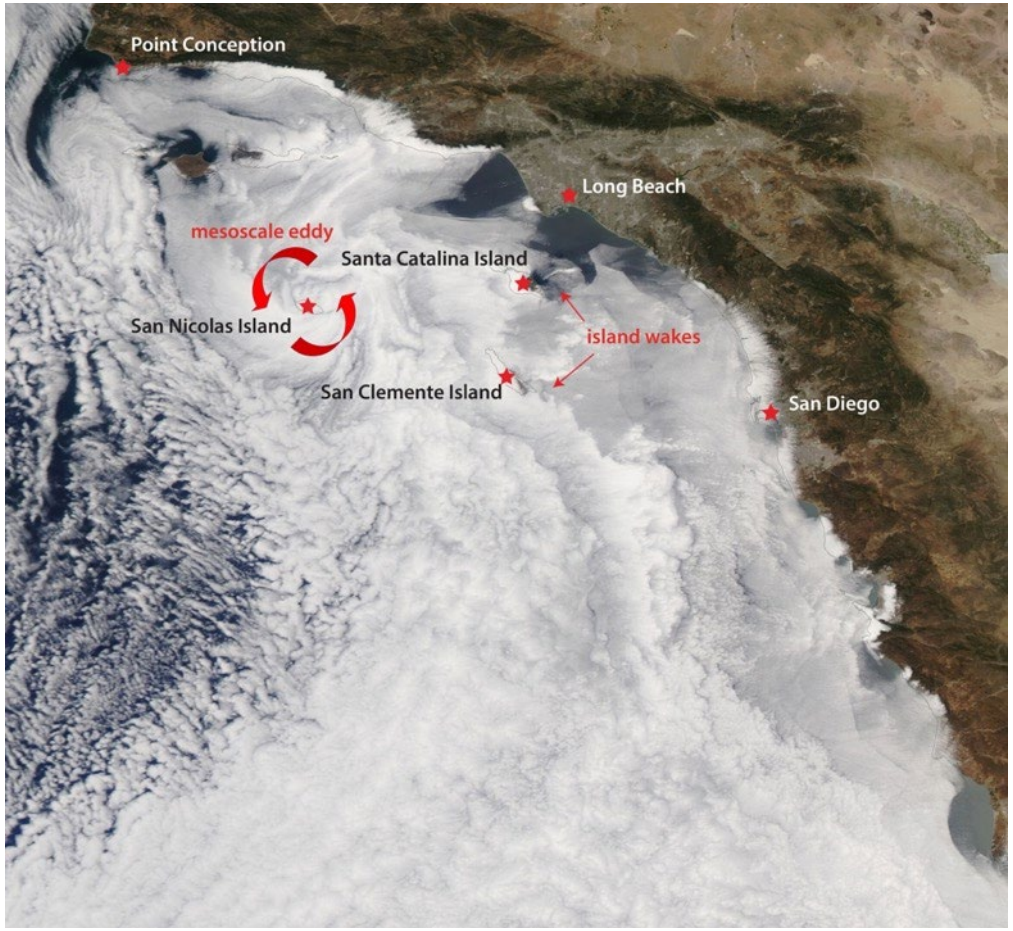
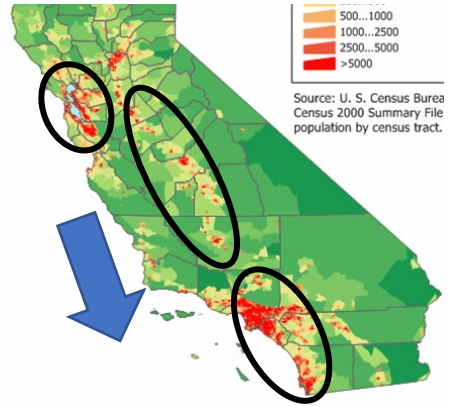


Gif link: https://twitter.com/i/status/1001869430526218240

Motivation

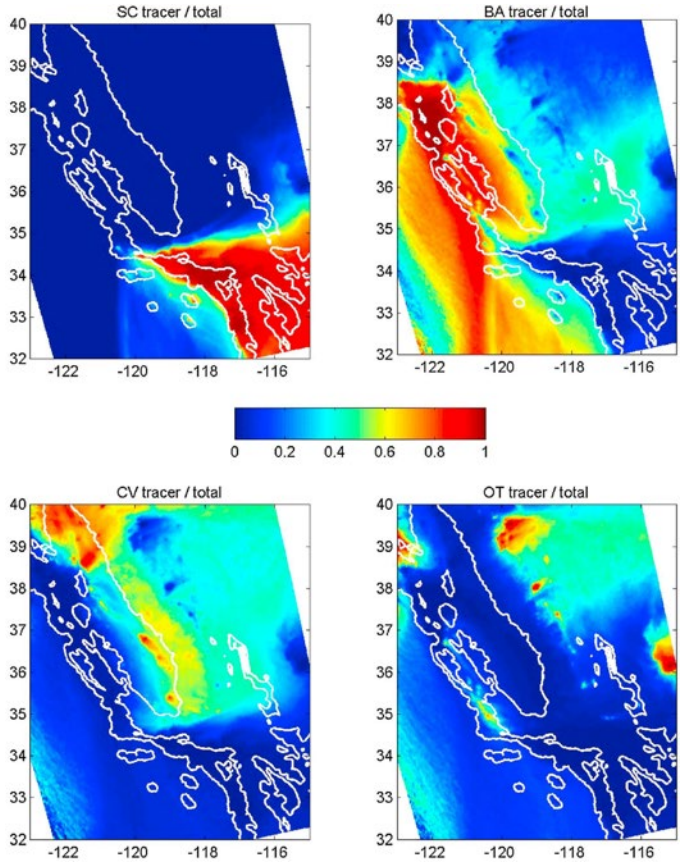
- Over the Southern California Bight, the lower troposphere has complicated dynamics with "action" at all scales, synoptic to micro:
  - Large-scale surface flow in spring typically NNW-ly
  - Flow and shape of coastline interact to form:
    - Hydraulic jump @ Point Conception
    - **Mesoscale "Catalina" 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.





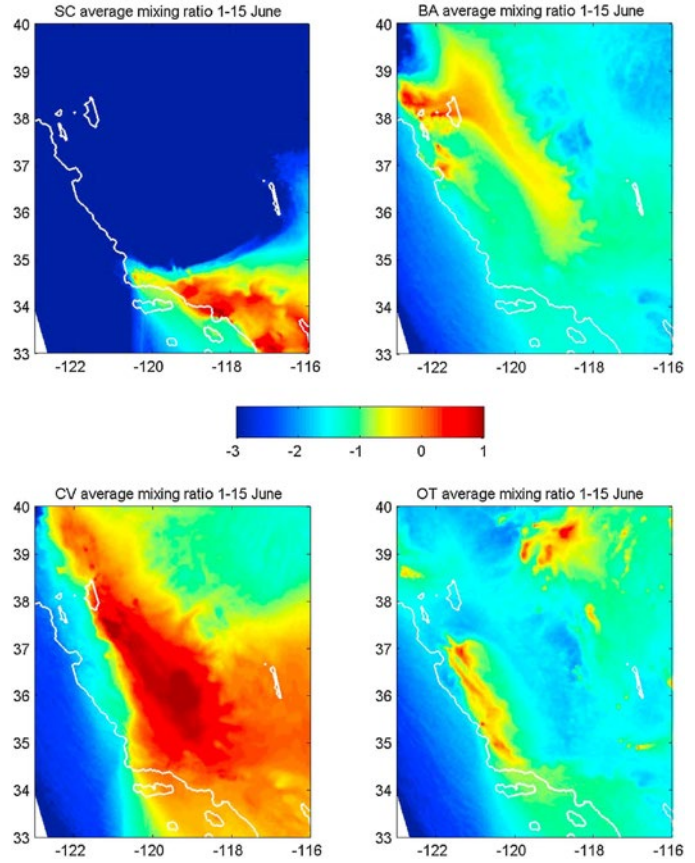
Multiple regions contribute to Bight pollution

CO (relative)

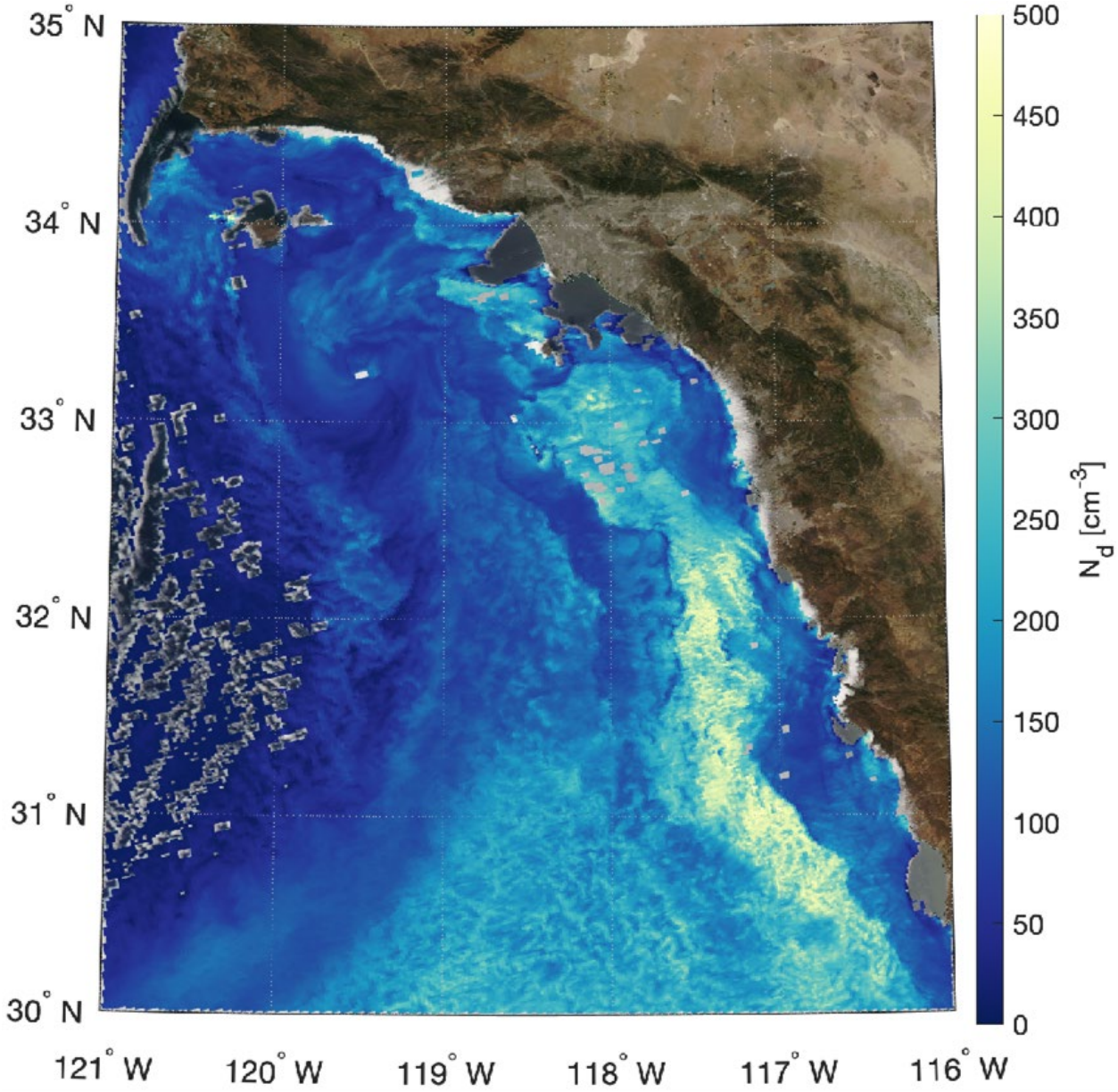


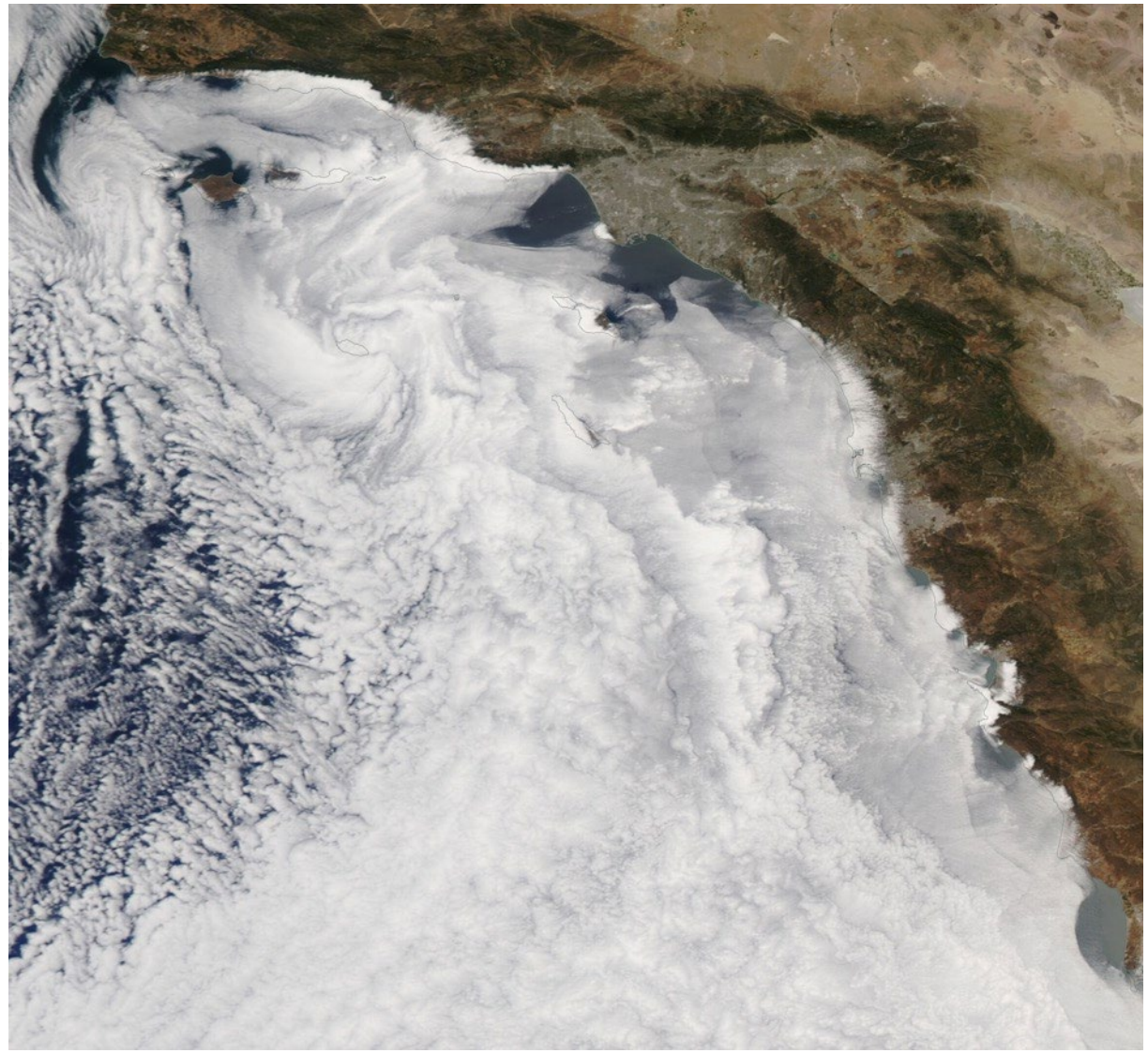
SC = SoCal
BA = Bay Area
CV = Central Valley
OT = Other

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

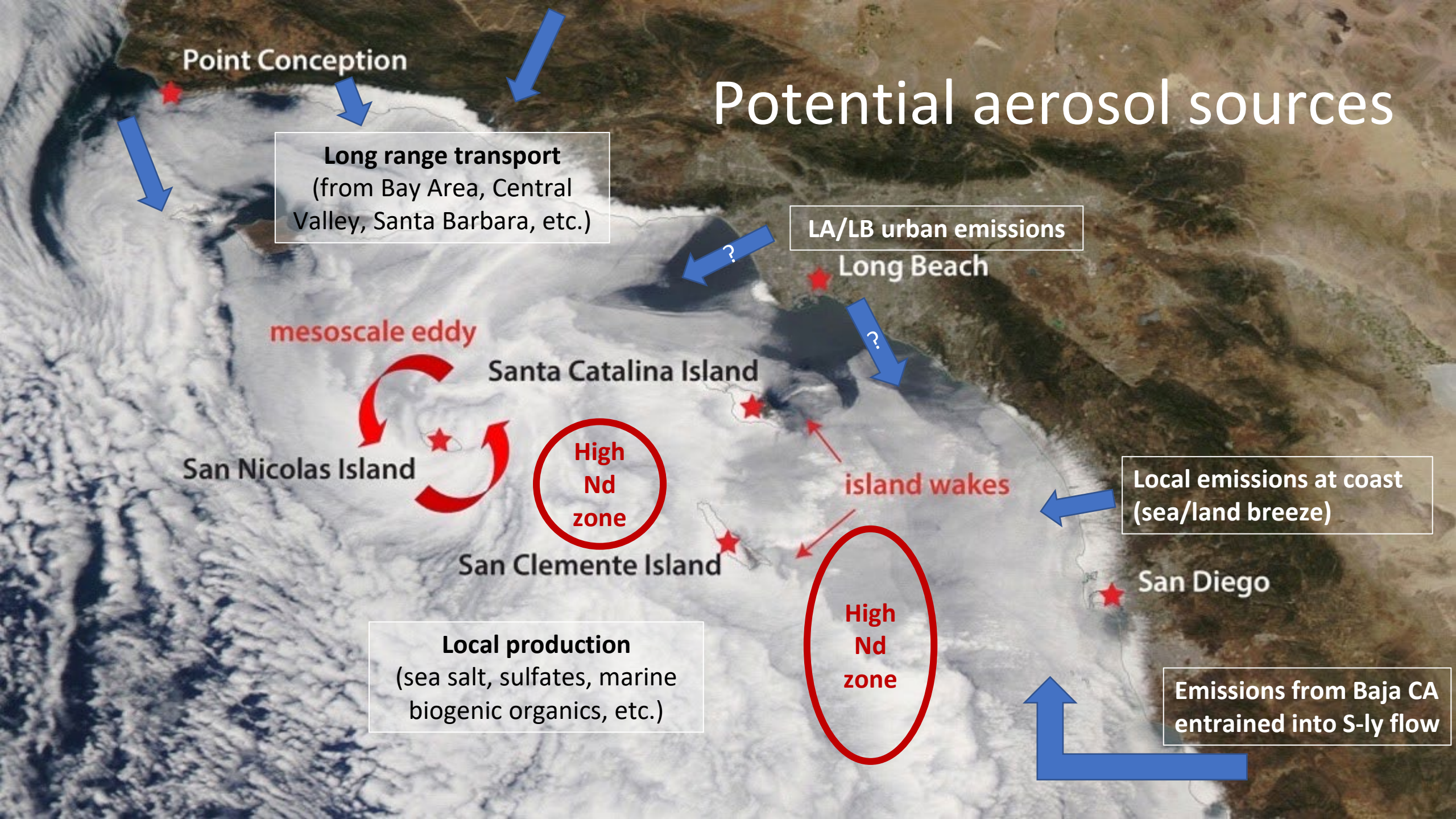
Measurement	Twin Otter
Aerosol concentration	
CN concentration	2 x CPC
CCN concentration	2 x CCN-100
Size distribution	SMPS + PCASP + PDI
Optical properties	
Light scattering	3-λ Nephelometer (dry)
Light absorption	1-λ PSAP
Black carbon	SP2
Aerosol composition	
Non-refractory	mAMS
Other	
Trace gases	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

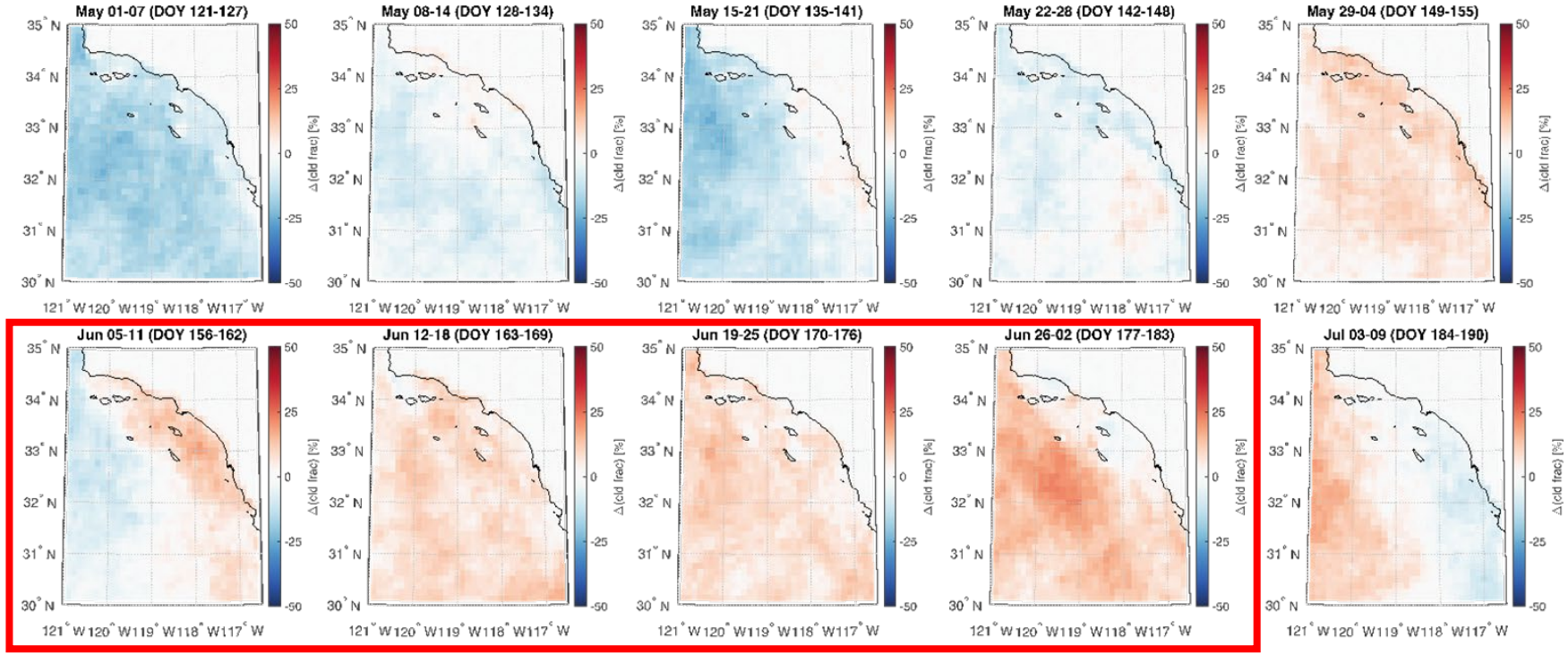
- Investigate the dynamical controls on aerosol transport into, and distribution within, the SoCal Bight
- Quantify the impact of aerosol-cloud interactions on PBL structure and evolution
- Characterize gradients in atmospheric properties across the inversion to constrain mixing/turbulent transport hypotheses


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

Sampling objectives

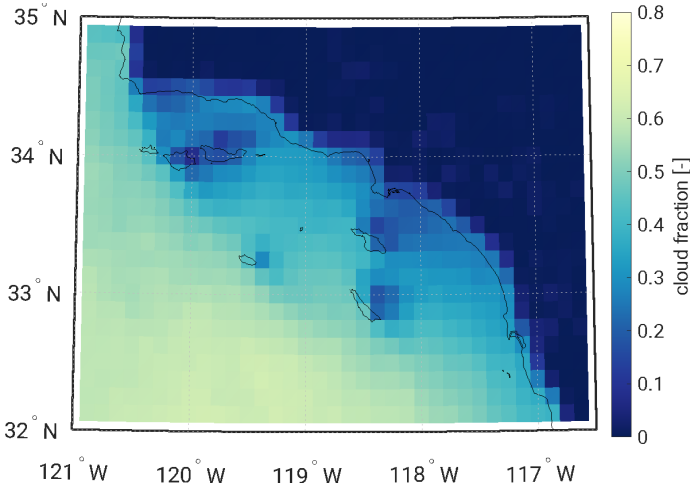
- Characterize vertical and horizontal structure of PBL (dynamics, thermodynamics, microphysics, aerosol, trace gases…)
- Quantify aerosol/drop size distribution, composition, proxies for processing/aging
- Establish “end members” for mixing analysis (primarily surface vs. free troposphere, limited ability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

Perturbation MODIS low cloud fraction from 15-year gridded mean

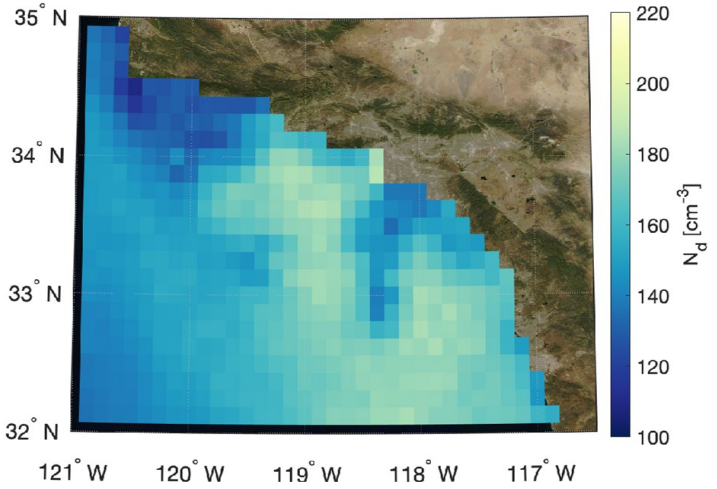


Planned deployment period:
5 June - 3 July 2023

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



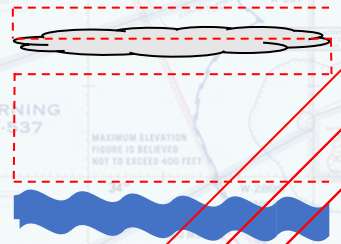
Aqua MODIS mean N_d, 1/8°, May 1-July 15, 2008-2022



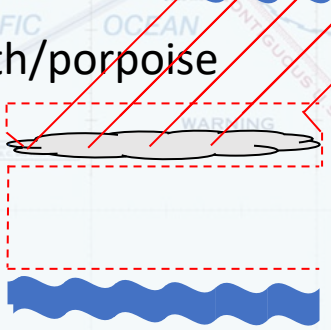

EPCAPE
MYF
(TO base)
PACIFIC OCEAN
CONTIGUOUS U.S. ADIZ
WARNING W-537
WARNING W-532S
WARNING W-289S
WARNING W-289N
WARNING W-289W
WARNING W-412
WARNING W-292E
WARNING W-292W
WARNING W-291E
MAXIMUM ELEVATION FIGURE IS BELIEVED NOT TO EXCEED 400 FEET
5500 MSL
1200 AGL
SANTA BARBARA CLASS C
NOAA REGULATED NATIONAL MARINE SANCTUARY DESIGNATED AREAS
EXAMPLES OF CLASS B ALTITUDES
MEXICO FIR MMFR

Vertical sampling strategies:

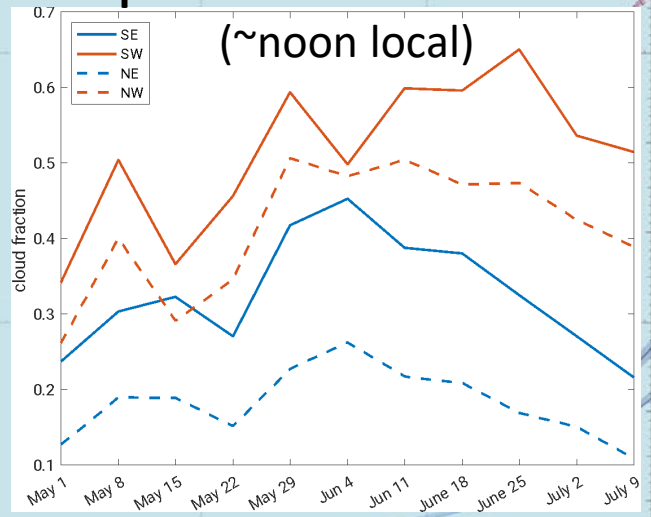
- Level legs



- Slow sawtooth/porpoise



Aqua MODIS cloud fraction



1
2
3
4
5

EPCAPE

MYF (TO base)

Thank you!

- SCILLA flights are planned for 5 June-3 July 2023 and will investigate dynamical controls on aerosol transport into, and distribution within, the SoCal Bight
- Sampling focus will be on aerosol, cloud and turbulence properties in and directly above the PBL toward the southern half of the CA Bight, likely between ~10-100 nm of the coast
- Science payload on Twin Otter is maxed out (sorry!)
- Interested in coordinating? Drop me a line: mikael.witte@nps.edu

GOES Loops: June 2020

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

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