

Seeking opportunities with perseverance: the example of the Sundowner Winds Experiment (SWEX)



April 1st – May 15, 2022

Santa Barbara County, California

NSF-AGS 1921595

Leila Carvalho, University of California, Santa Barbara

FARE User's workshop, NCAR, Boulder, September 19, 2023

Outline of this talk



Seeking
opportunities
and
encouragement



Learning
from
mistakes



Persevering
and
succeeding



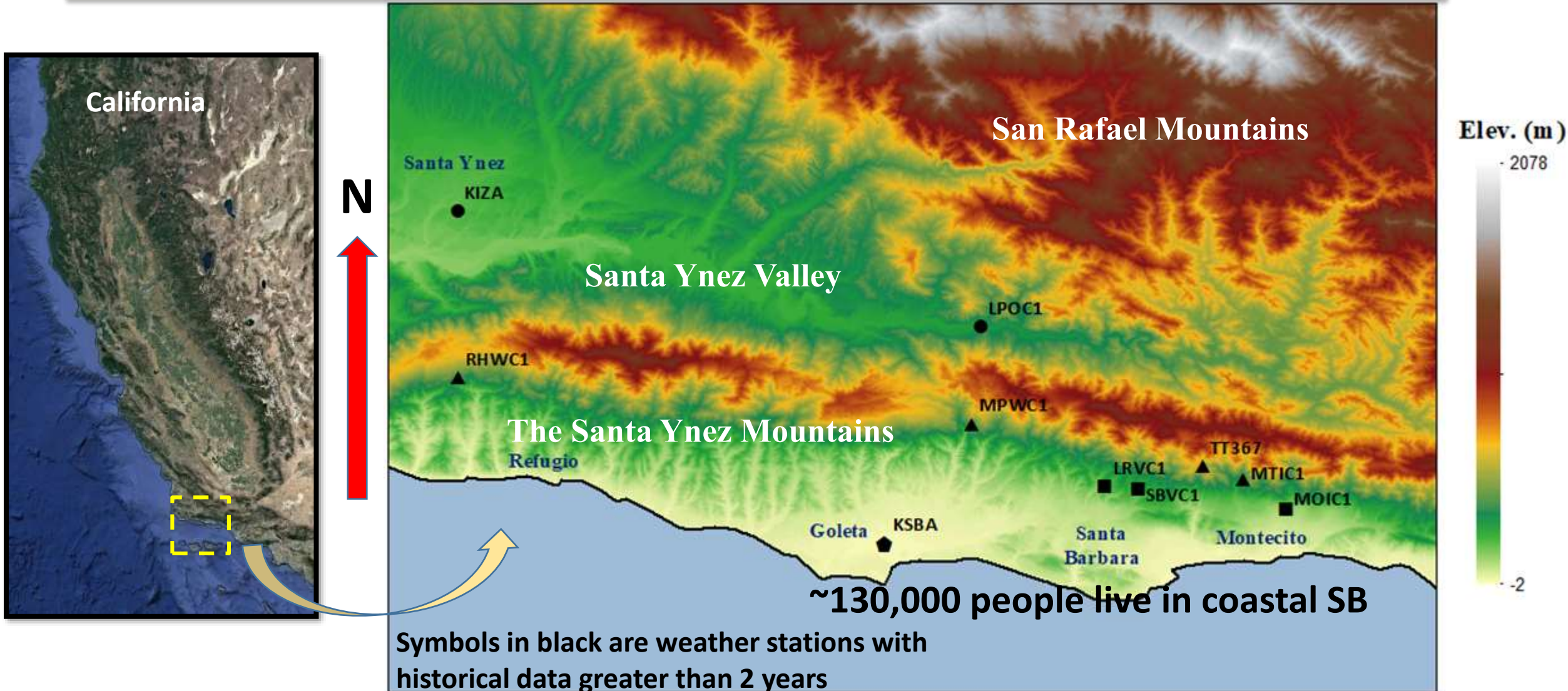
NCAR/EOL
support



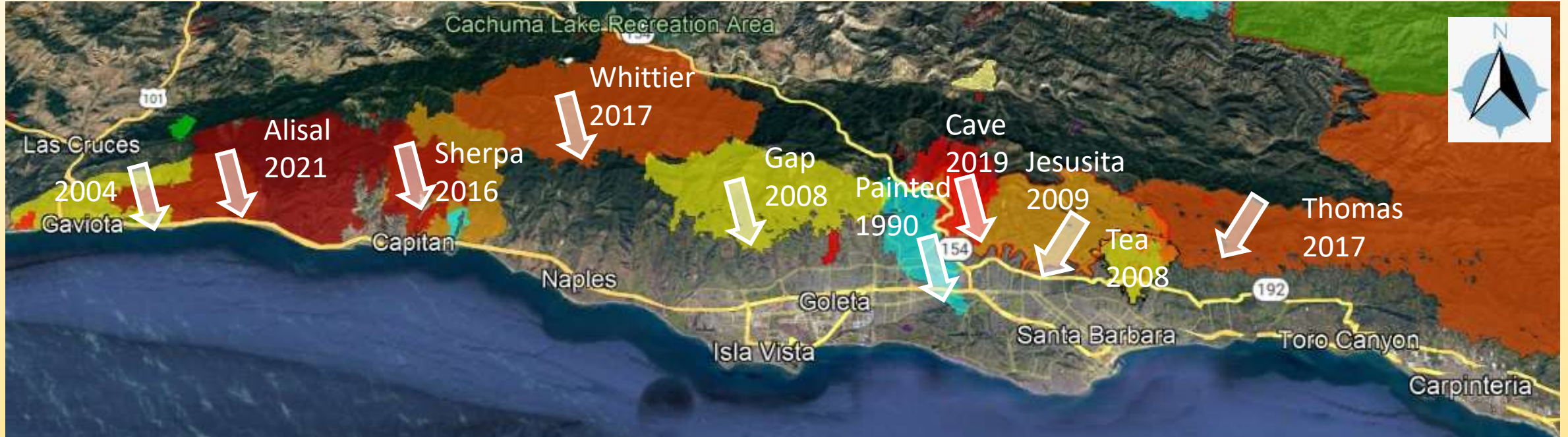
A few
highlights
about SWEX



Opportunity 1: the uniqueness



Opportunity 2: Scientific merit and Broader Impacts



- ✓ All major wildfires affecting coastal SB have been enhanced by strong downslope winds on the southern slopes of the Santa Ynez Mountains: “Sundowner Winds” (or Sundowners)
- ✓ Reason for the name: They tend to intensify after Sunset, and stay strong during the night causing significant drop in moisture.
- ✓ Critical need to understand mesoscale mechanisms and improve predictability

“All I know is that I know nothing ...”



➤ First message:
Do not be intimidated by the lack of knowledge or experience in field campaigns.

Why should I invest my time and energy in writing a complex proposal for a field campaign?

- 1) Problem is relevant and **observations are critical to test hypotheses.**
- 2) Uniqueness: past experiments did not answer similar questions; **measurements will help in building new theories.**
- 3) Broader impacts: **benefit society and the environment** (SWEX: improve forecast of the most important fire weather regime in SB).
- 4) **Contributes to other disciplines.**

Roll up your sleeves and start!



First step: SHARE:

- Find partners excited about your ideas and interested in a field campaign (experienced partners help).
- Seek advice: VISIT NCAR/EOL- Discuss your ideas with experienced EOL scientists (ISS, ISFS, discuss benefits of dropsondes (AVAPS) and all other resources.)
- Visit other facility providers (e.g, the University of Wyoming, King Air research aircraft)
- Do not be afraid of your “wishing list”.

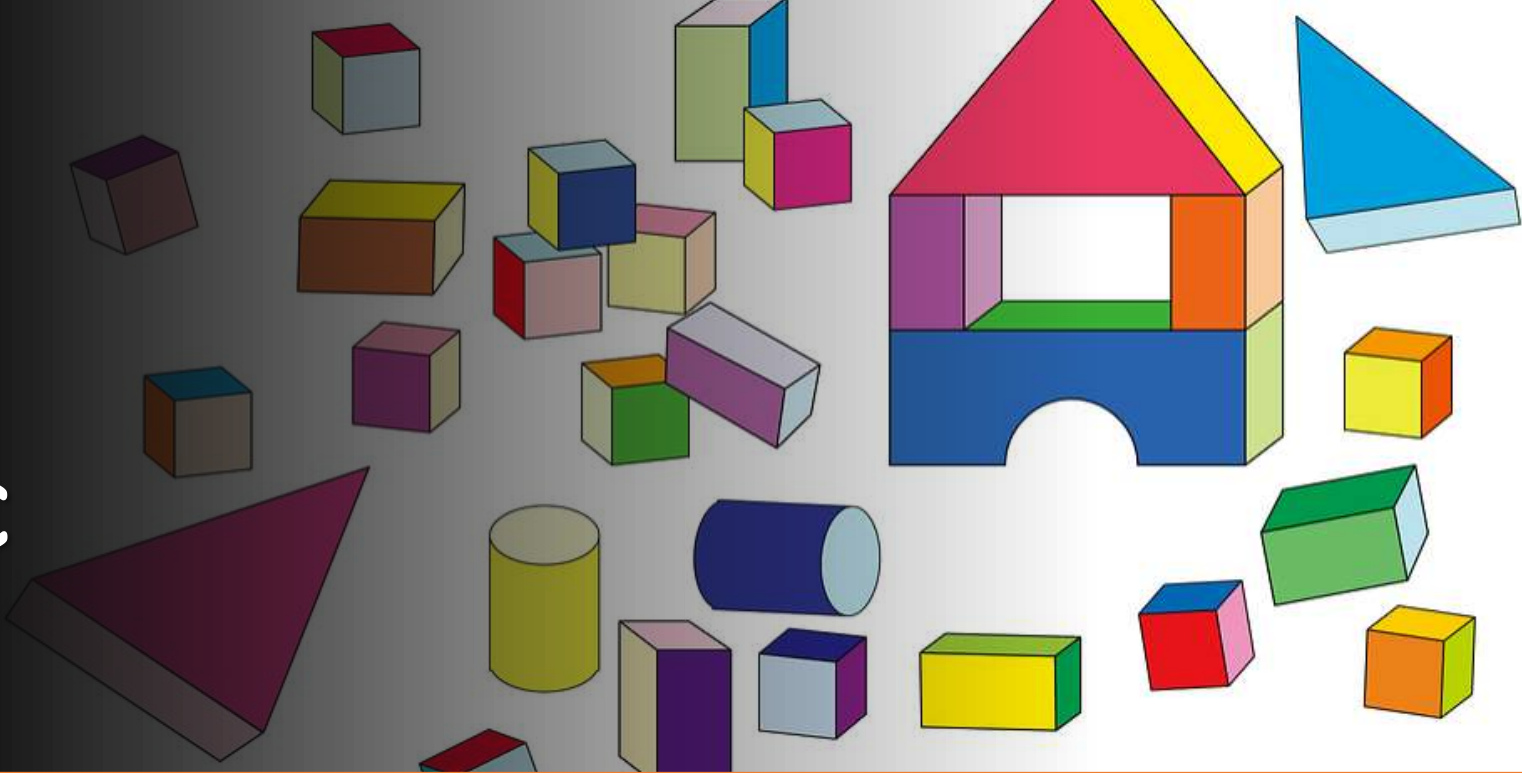
Leading a successful proposal



Engage local communities and governmental/public institutions

- SWEX: Support of the Santa Barbara county Fire Department (wildfires)
- National Weather Service (LA/Oxnard office): interested in improve forecast of Sundowners.
- Santa Barbara Fire Council

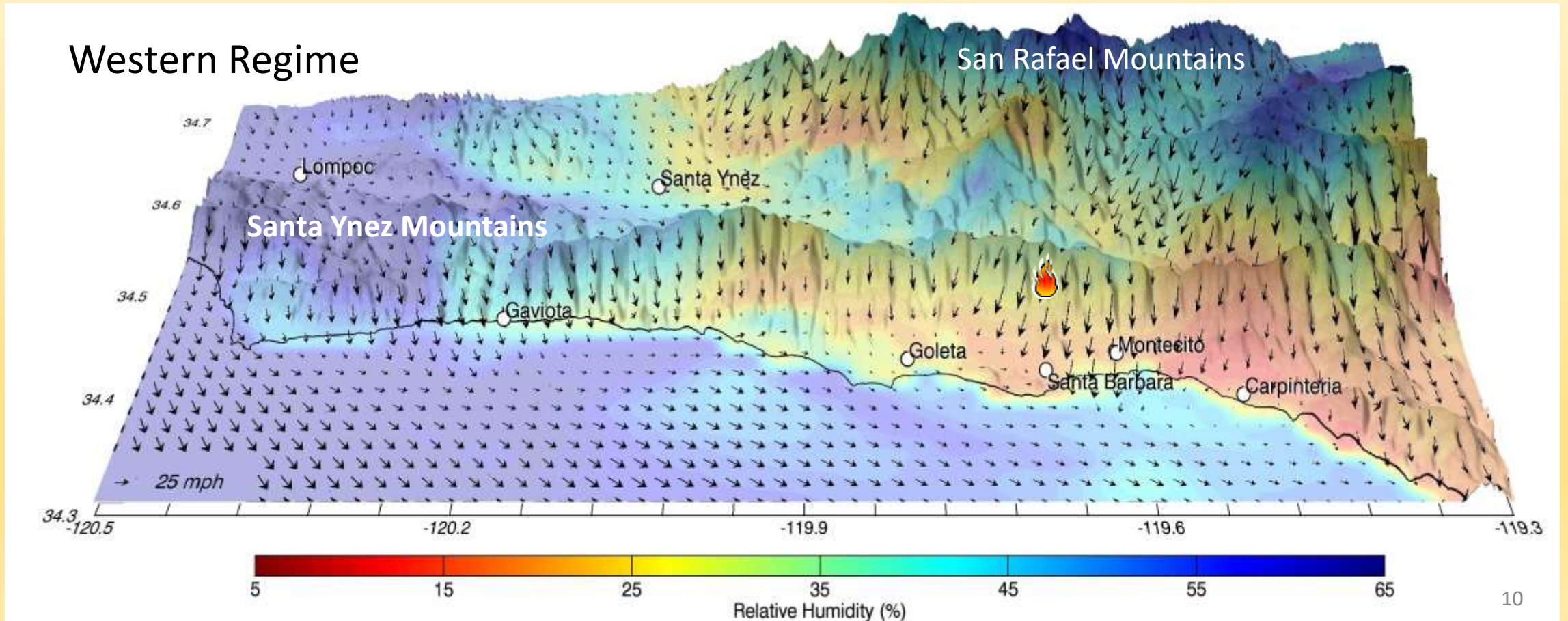
SWEX Scientific Building Blocks



Sundowner winds based on Simulations

Cannon et al. 2017

WRF (2km) Example Jesusita Fire: May 7th, 2009 - 6PM





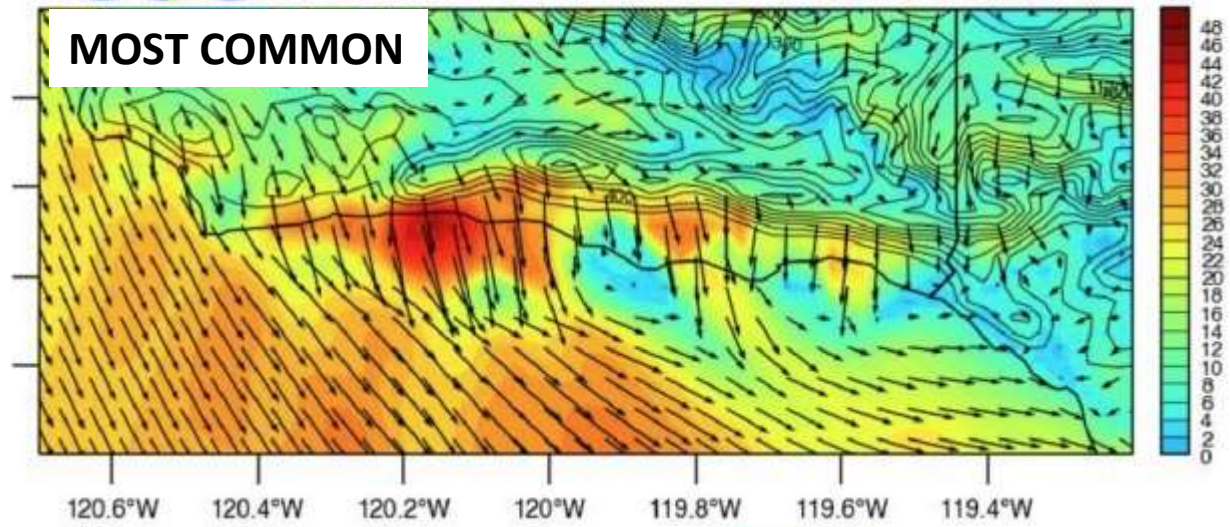
Sundowner Regimes (Jones et al. 2020)



WESTERN - NNW

10m winds mph

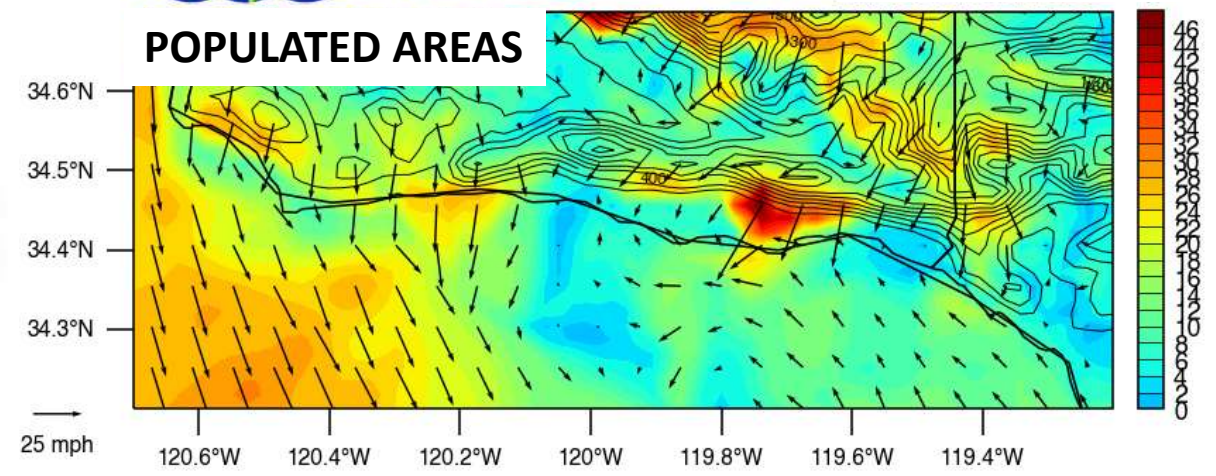
MOST COMMON



EASTERN - NNE

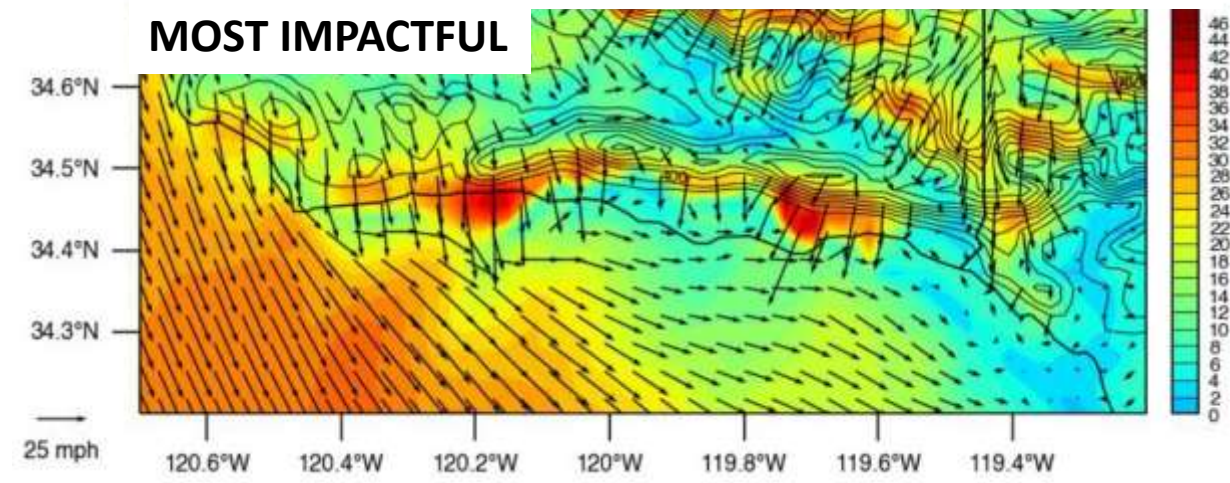
10m winds mph

POPULATED AREAS



***HYBRID (Santa Barbara)**

MOST IMPACTFUL



These conditions are related to strong temperature and humidity gradients



Scientific objectives & broader impacts:



Integrate multiple Sophisticated Instrumental platforms to:

- 1) Investigate how boundary layer structure and dynamics in the SYM and Santa Ynez Valley and SB channel influence Sundowner winds;
- 2) Examine mechanisms relating high amplitude mountain waves, critical layers, and surface wind intensity.
- 3) Investigate how variations in boundary layer structure and tropospheric stability impact the predictability of Sundowner winds.
- 4) Transfer our scientific results to decision makers.**
- 5) Educate the local community about fire weather risks in the SB county**

Recommendation: A low-budget “Pilot Study” (Sundowner during April 28/29, 2018) to warm-up, show “proof of concept” and feasibility

San Jose State University

CSU Mobile Atmospheric Profiling System

UC Santa Barbara

3-hourly radiosondes at one location during strong Sundowners.

Carvalho, et al. 2020: The Sundowner Winds Experiment (SWEX) Pilot Study: Understanding Downslope windstorms in the Santa Ynez Mountains, Santa Barbara, CA. *Monthly Weather Review*, 148(4), pp.1519-1539



Logistics: Santa Barbara County Fire Department



National Weather Service/Oxnard
FORECAST OF THE EVENT



THE
INAUGURAL
SUBMISSION
2017/2018



Need improvement

Leading your team to a successful proposal requires optimism, patience and perseverance!



“If your first (or second, or third...) submission is not successful, just persevere!” (Vanda Grubisic, former EOL director)

EOL STAFF PROVIDES HELPFUL CRITICISMS THAT ARE CRUCIAL FOR THE SUCCESS OF YOUR EXPERIMENT.

- “FAILING” THE FIRST SUBMISSION WAS A GREAT BENEFIT FOR SWEX!**

CRITICAL ISSUES THAT REQUIRE ATTENTION:

- ❑ Adjusting your scientific problems to a low budget does not guarantee success (in our case, we excluded an aircraft and this was obviously a mistake).
- ❑ A strong proposal should have reasonable requests but should not ignore critical instrumentation to answer the scientific questions.
- ❑ Properly address safety issues and inherent problems that can compromise your experiment or require attention (ex. wildfires, or environmental issues and restrictive laws, accessibility, risk of robbery and vandalism, exposure to violence, among others – EOL helps to address these issues, whenever possible).



THE SUCCESSFUL PROPOSAL (2019/2020):



NSF-AGS 1921595



Collaborative Project, 10 institutions



L. Carvalho,
C. Jones, GJ Duine



B. Brown, T. Hock
S. Oncley, H. Vomel

C. Clements



S. DeWekker



H. Fernando



D. Fitzjarrald
R. Fovell



Z. Wang



L. White



A. Bucholtz
D. Emmitt



M. Burkhart
M. Deng



Project Manager: Alison Rockwell (NCAR/EOL)



NCAR/EOL Project Manager (Alison Rockwell)

- Impossible to have decent experiment without the NCAR/EOL Project Manager

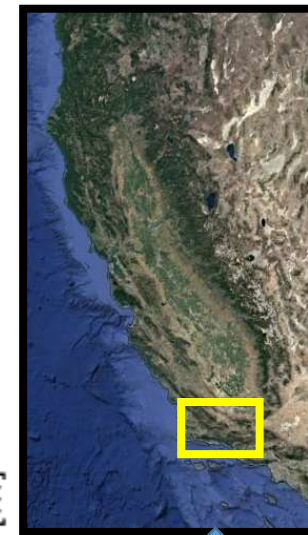
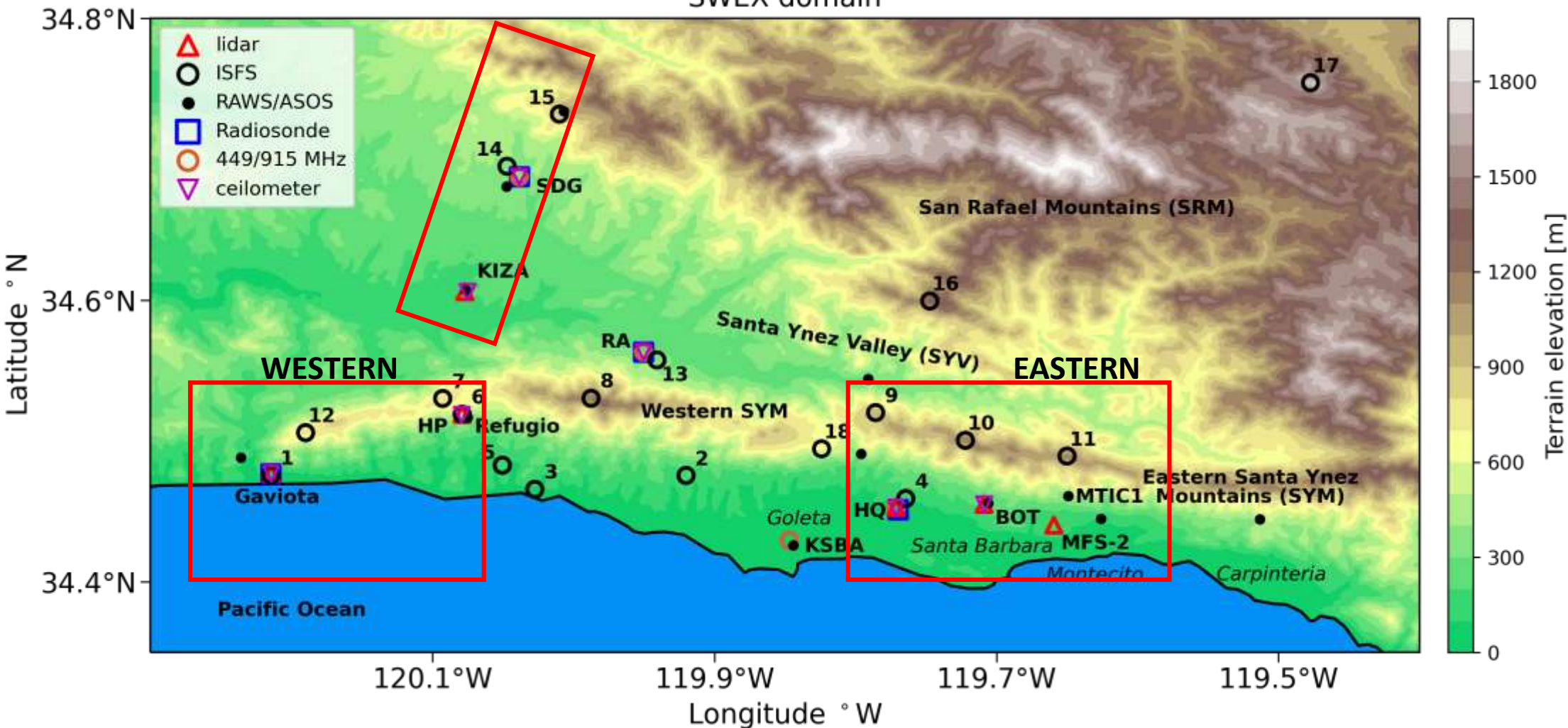
Assignments $\rightarrow \infty$:

- Deal with permits and logistics
- Help with the operation plan (the backbone of the experiment)
- Help with recruitment (in our case, for Radiosonde launches)
- Organize meetings, shared folders and all documents
- Weekly/daily support and guidance before, during and after the experiment



APRIL 01- MAY 15, 2022

SWEX domain



Ground Instruments (April 1-May 15)



20 Surface Flux towers:
18 EOL, 1UND, 1 SUNY
3 infrasound Detectors
(SLINY)



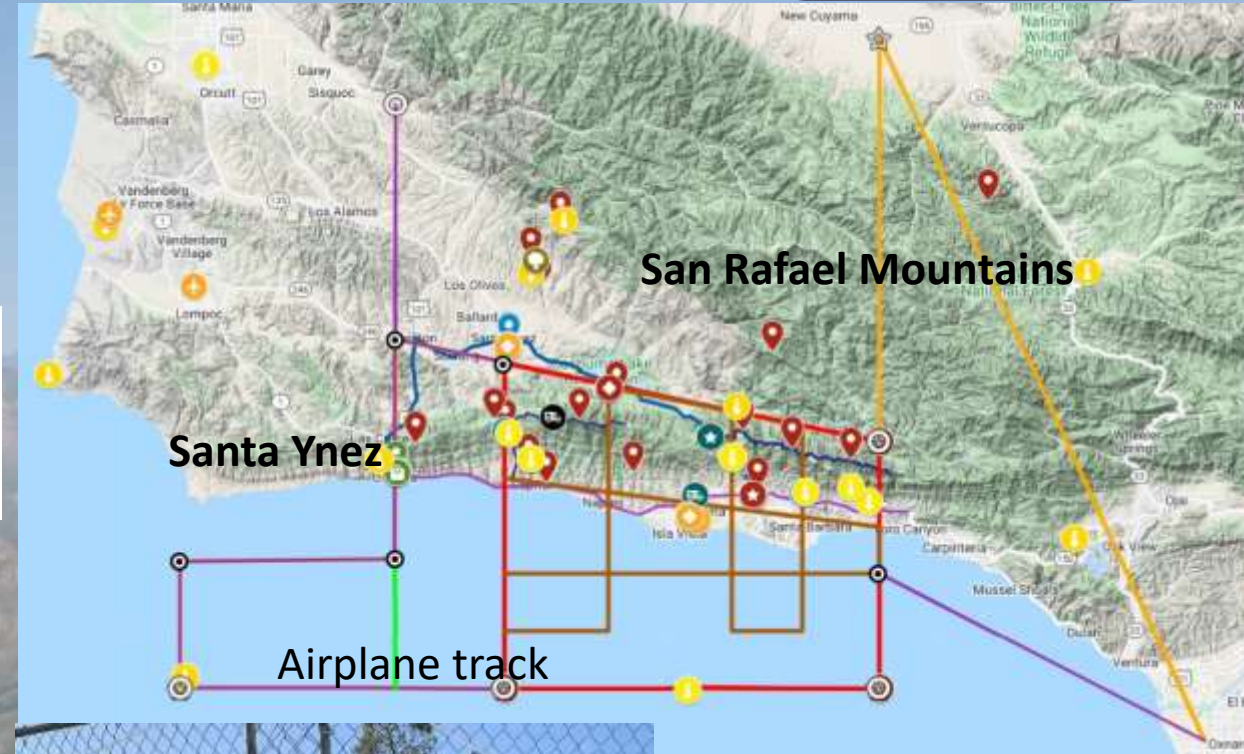
6 wind lidars (ground based), 5 ceilometers
(EOL, UND, SJSU, SUNY)



Bob Hazard's Property

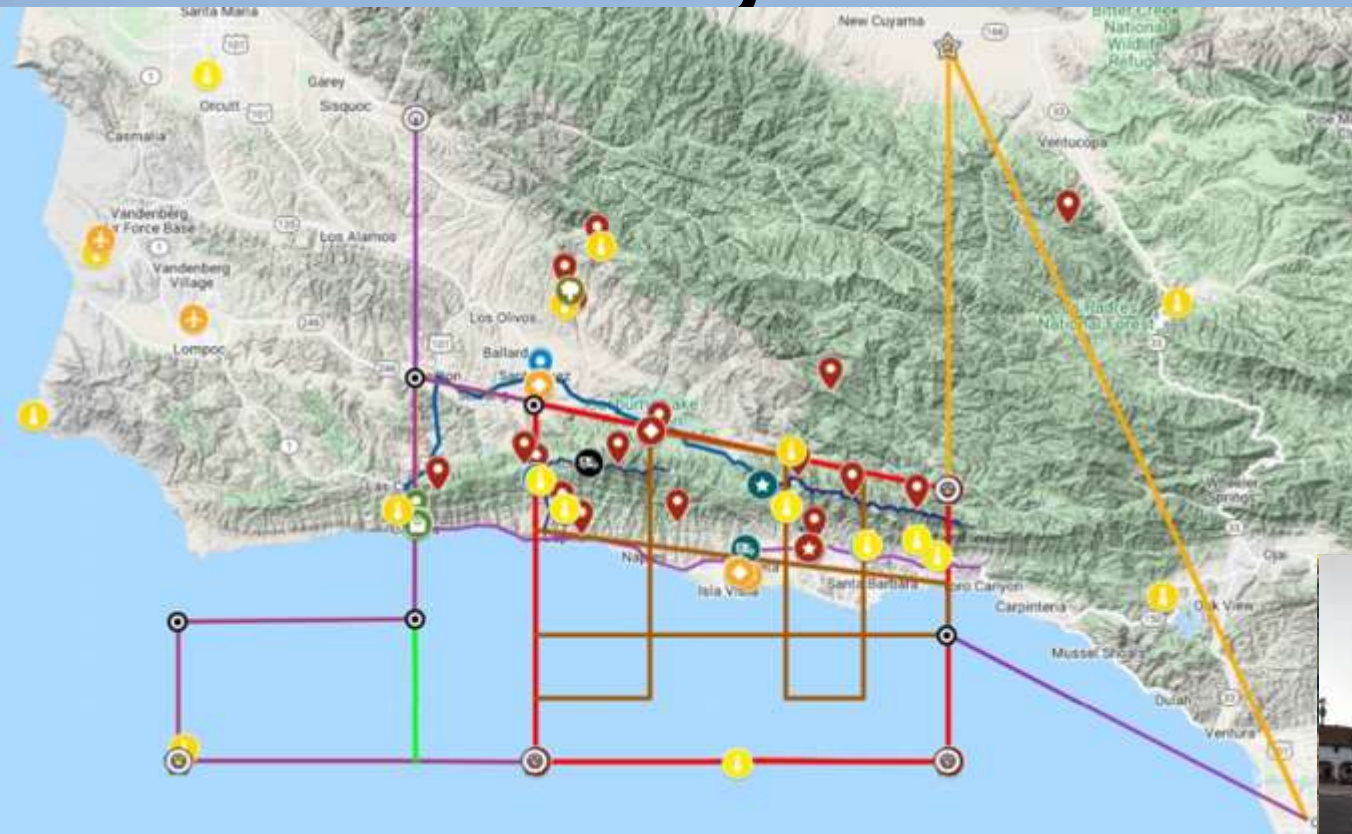
Ceilometer

Lidar



3 EOL Radar wind profilers (1 coast and 2 Santa Ynez Valley)
1 Microwave Radiometer, 2 Sodar-RASS (UND)

Mobile Platforms and Aircraft: 13 missions



UVA Lidar on Wheels –
measure winds below
1000m



JSU: Mobile
Meteorological unit:
near ground temperature
and humidity



IOPs/EOPs Radiosondes in 4 sites, every 3 hours 8 times a day

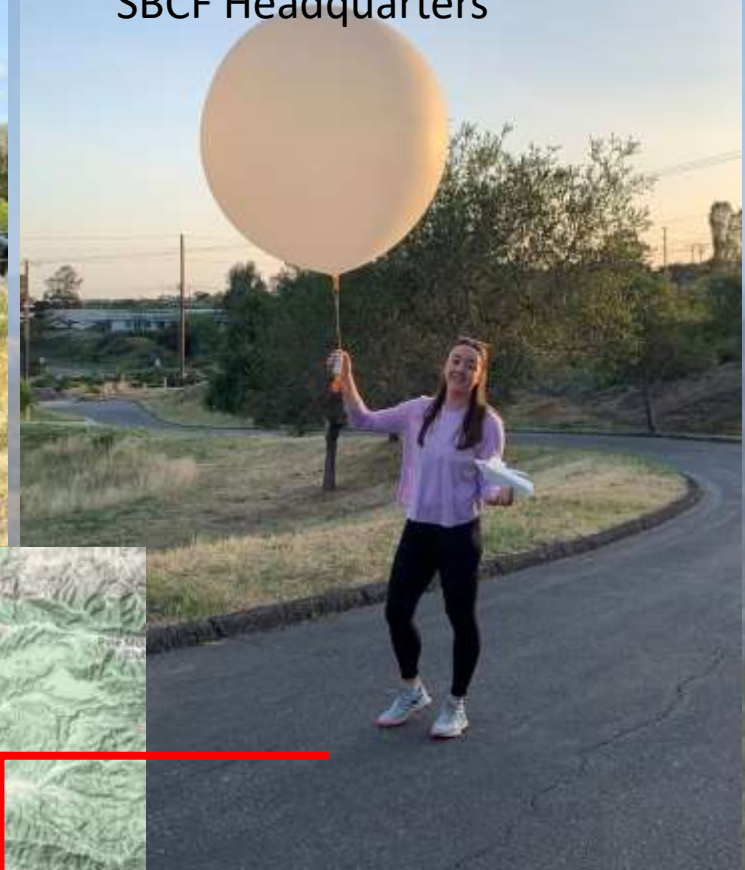
Day: 10:00, 13:00, 16:00, 19:00,
Night: 22:00, 01:00AM, 4:00AM, 7:00AM

16 Grad students, 8 undergraduates
4 Lab assistants, 2 postdocs
Total: 30 people (16 UCSB, 14 SJSU)

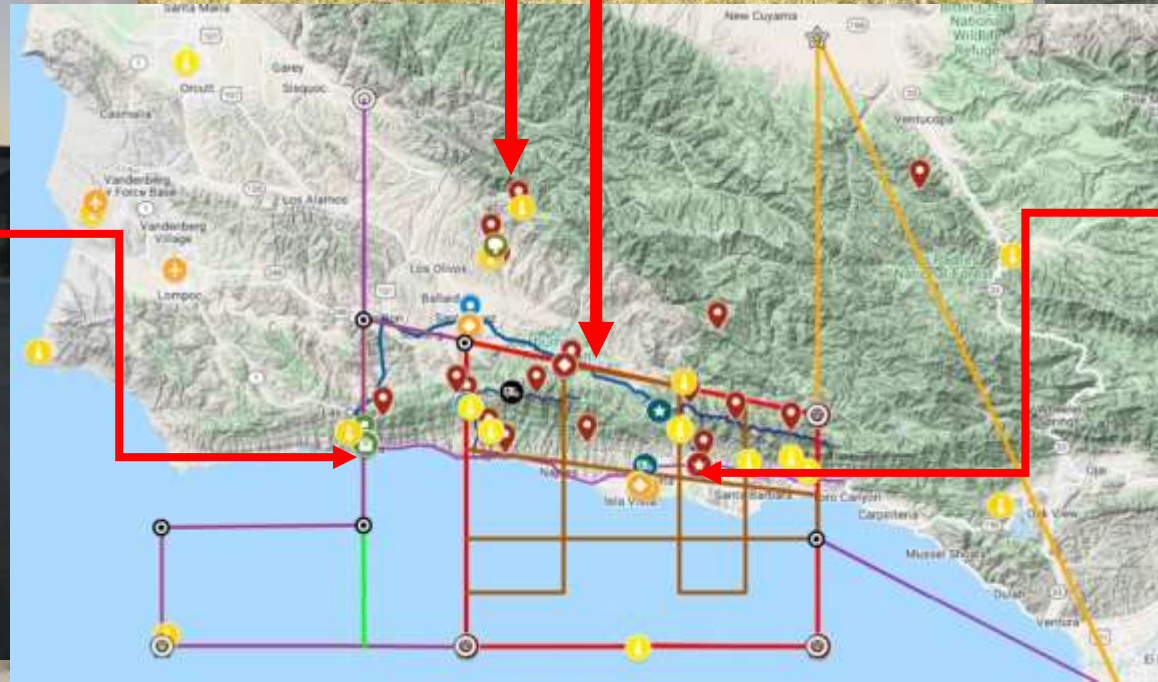
NCAR: Sedgwick reserve and Rancho Alegre



SJSU/UCSB:
SBCF Headquarters

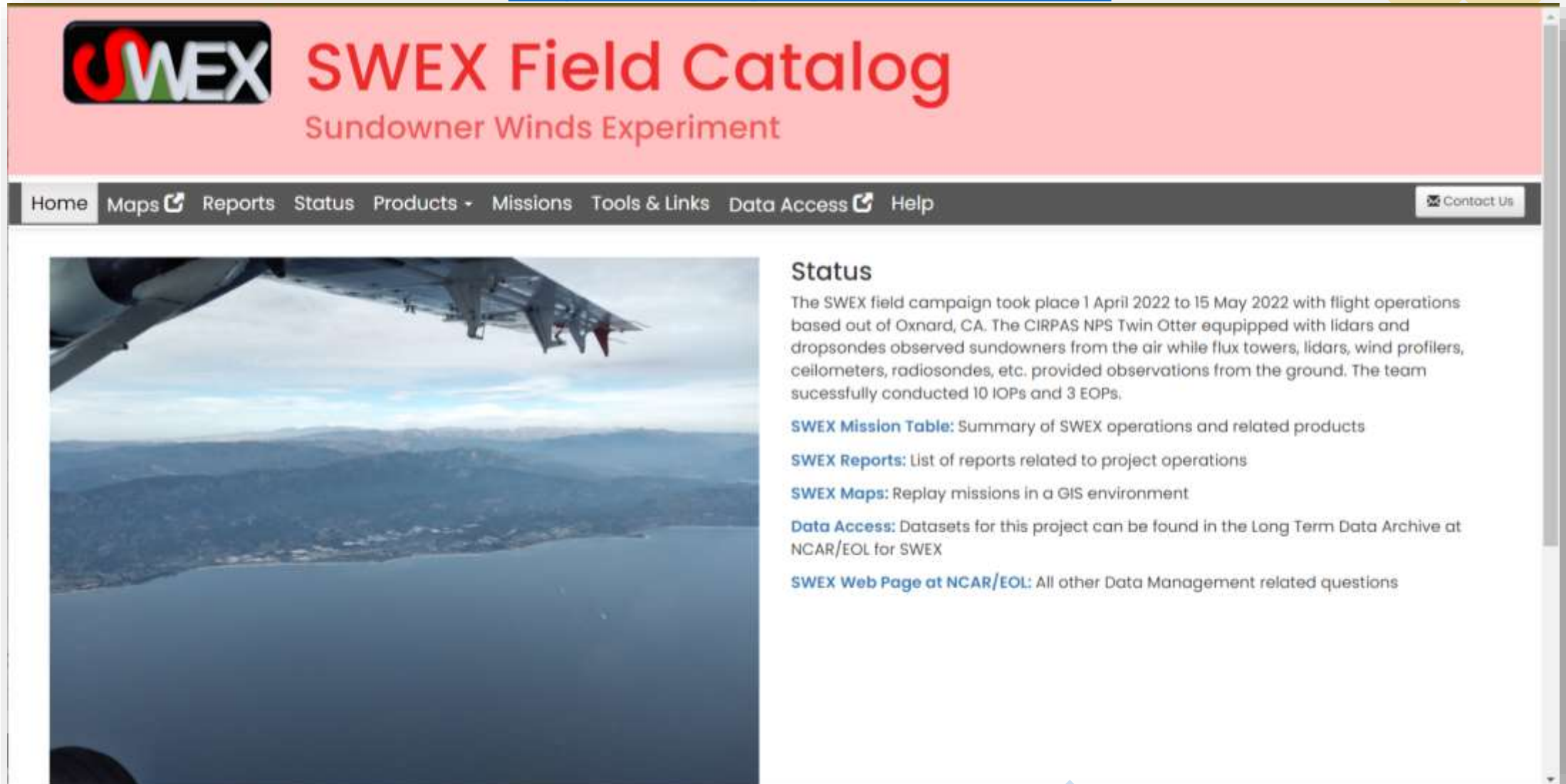


SJSU: Gaviota, Fire Station 38




SWEX : EOL/UCAR Field Catalog and data management (Carol Constanza, Linda Echo-Hawk)

<http://catalog.eol.ucar.edu/swex>



SWEX **SWEX Field Catalog**
Sundowner Winds Experiment

Home Maps Reports Status Products Missions Tools & Links Data Access Help Contact Us



Status

The SWEX field campaign took place 1 April 2022 to 15 May 2022 with flight operations based out of Oxnard, CA. The CIRPAS NPS Twin Otter equipped with lidars and dropsondes observed sundowners from the air while flux towers, lidars, wind profilers, cellometers, radiosondes, etc. provided observations from the ground. The team successfully conducted 10 IOPs and 3 EOPs.

[SWEX Mission Table](#): Summary of SWEX operations and related products

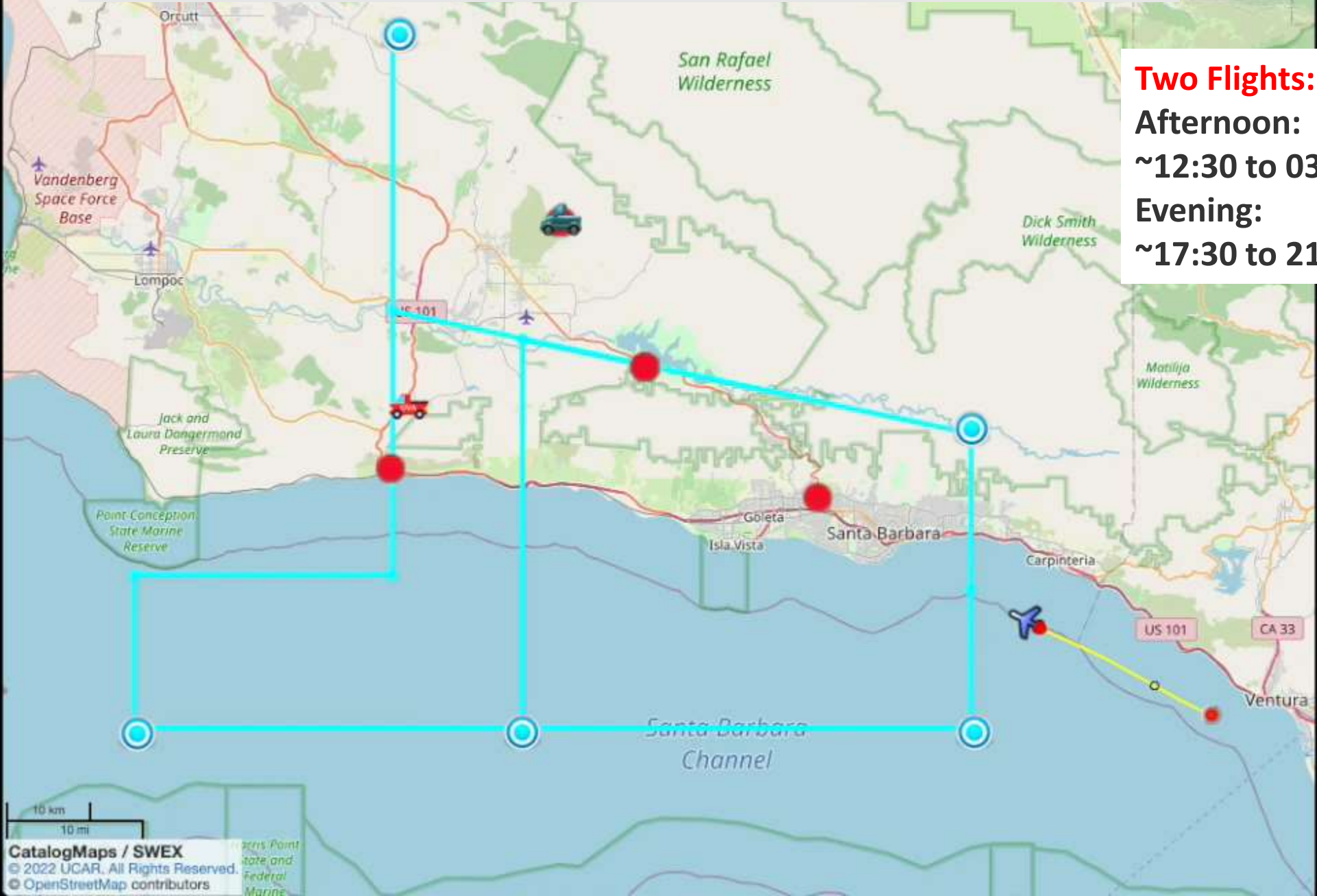
[SWEX Reports](#): List of reports related to project operations

[SWEX Maps](#): Replay missions in a GIS environment

[Data Access](#): Datasets for this project can be found in the Long Term Data Archive at NCAR/EOL for SWEX

[SWEX Web Page at NCAR/EOL](#): All other Data Management related questions

The SWEX catalog “map” feature allowed us to check all the mobile platforms in real time. Communication with the Twin-Otter was very efficient.



Two Flights:

Afternoon:

~12:30 to 03:30 PDT

Evening:

~17:30 to 21:00 PDT



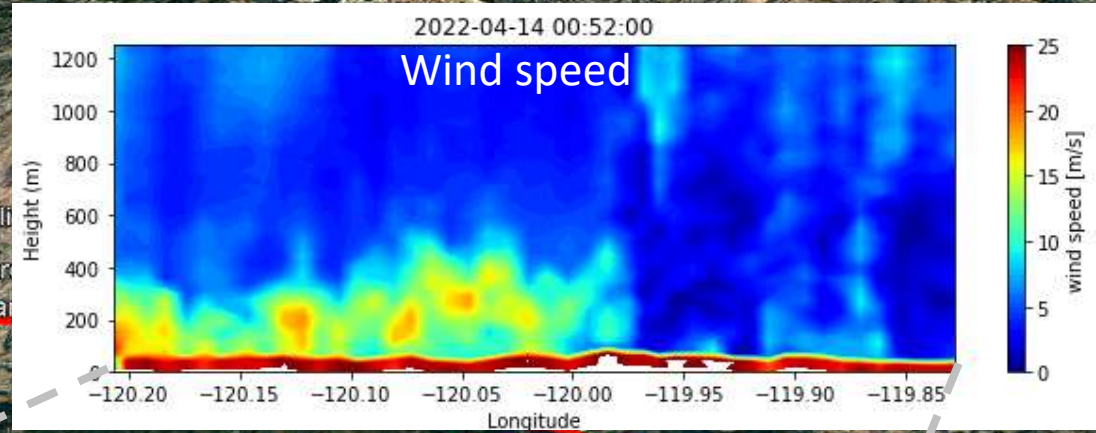
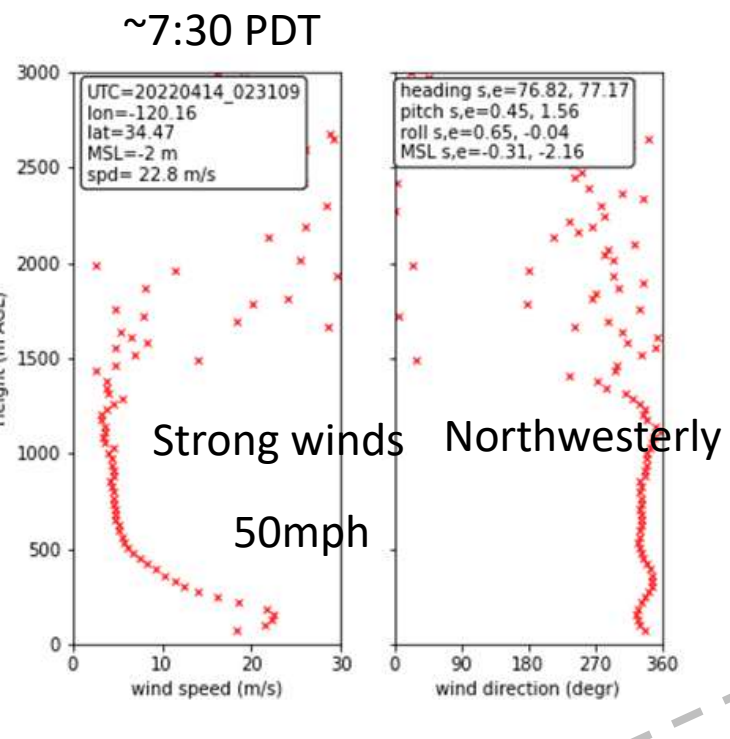
April 1st-May 15, 2022- Very active season

13 missions (2 more than initially proposed)

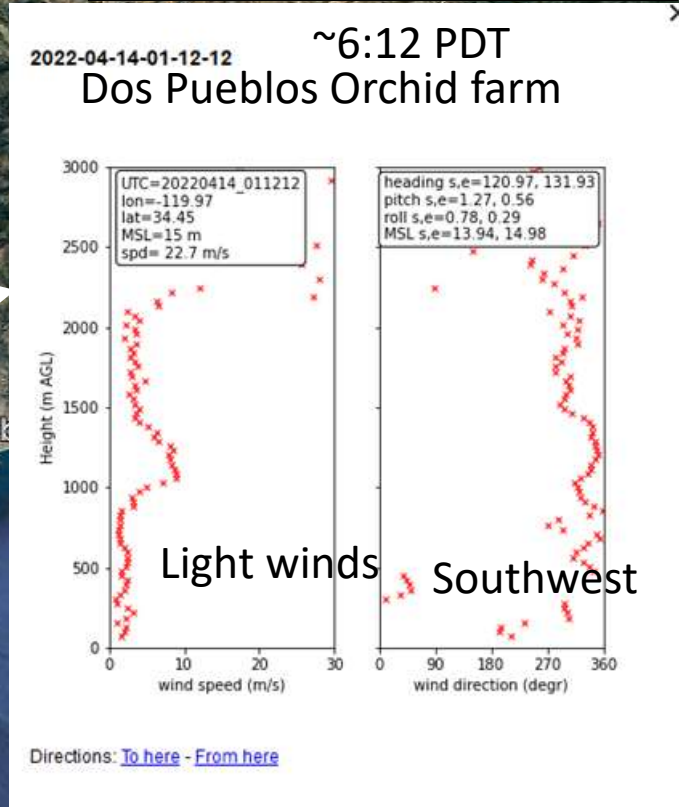
10 IOPs (disturbed: 4 Eastern, 6 western) and 3 EOPs (undisturbed)

Focus on a few exciting preliminary results

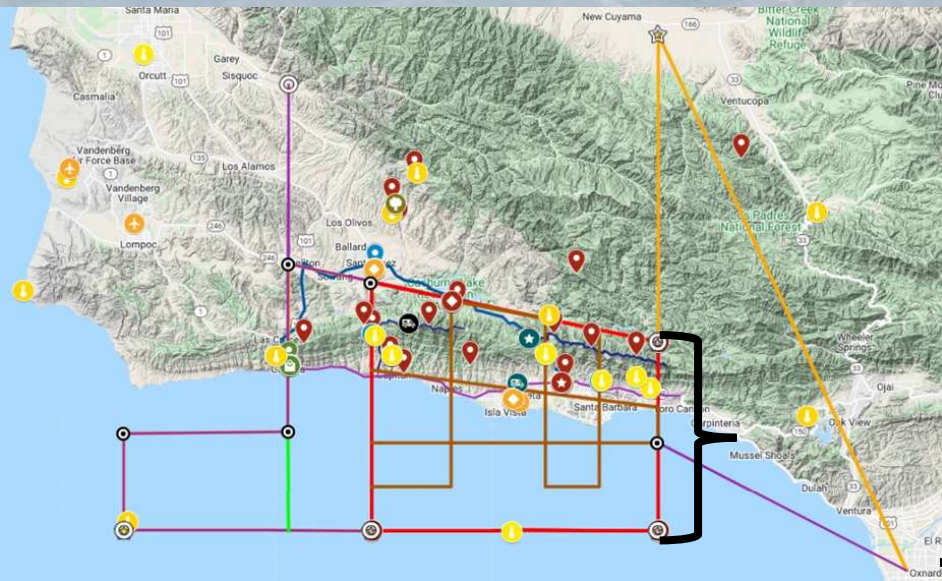
University of Virginia (UVA) Wind Observatory on Wheels (UWOW) – Mobile Doppler Lidar facility



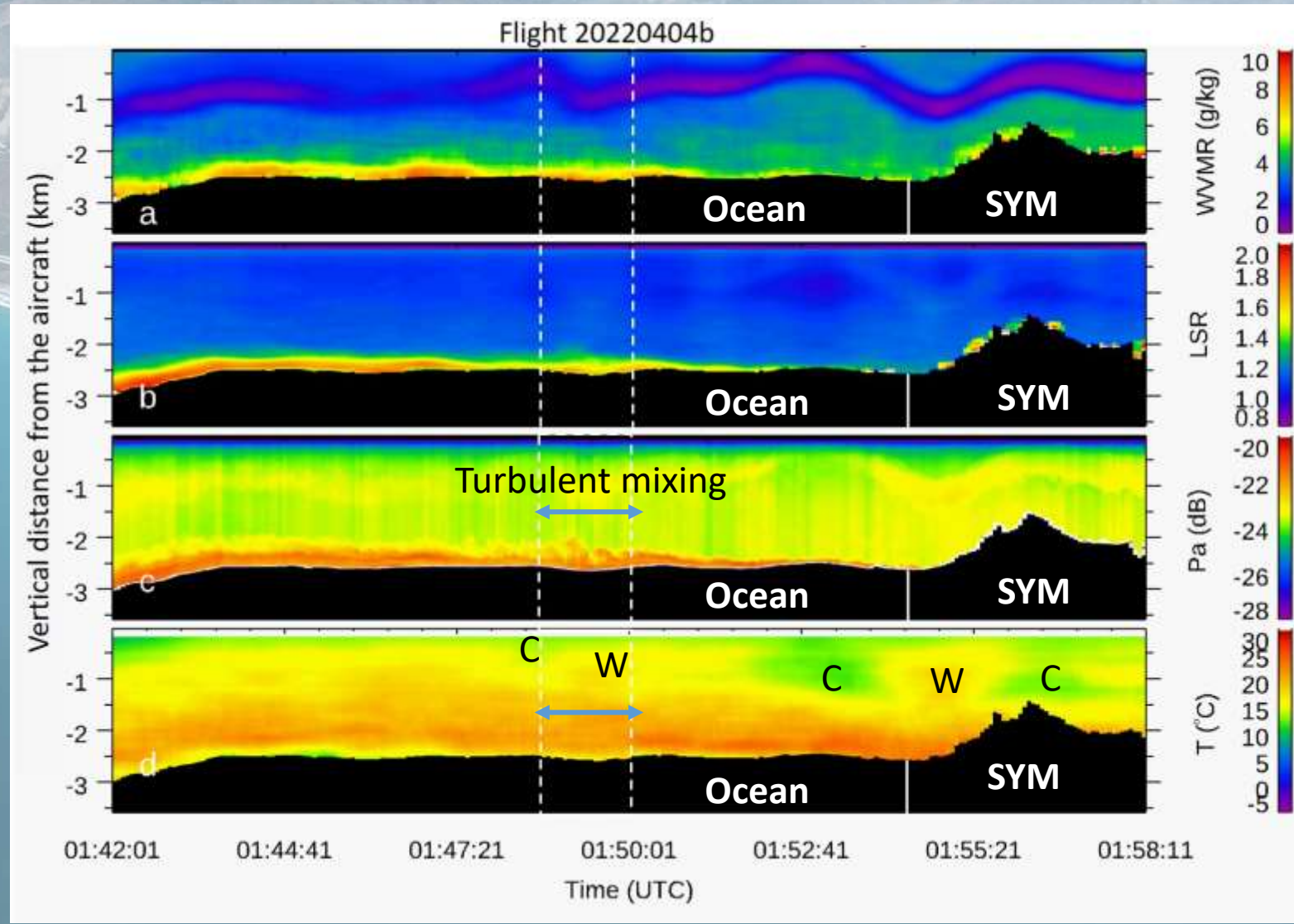
First deployment of UWOW
~4500 miles driven
~1 windprofile /km



TWIN Otter: CRL North-South Cross-section – eastern SB Montecito – Eastern Sundowner



Zhien Wang,
James Kasic





Conclusions

- SWEX was a very successful campaign (13 missions total).
- Large spectrum of events that will enhance our understanding about Sundowner winds, mountain waves and predictability of downslope winds in coastal regions.
- No reported covid cases, accidents or injuries from the mounting to the tear down period.
- Strong collaborations with the NWS
- Important Synergies with regional fire agencies
- Great community support

The SWEX Saga:



- 2018** → First submission: Needed Improvement! 🤔
- 2019** → Second Submission: Funded! 🙌
- 2020** → Pandemic: Aborted 2 weeks before starting 😭
- 2021** → Large uncertainty : Postponed again 😞
- 2022** → Finally Successful!! 🥰

Acknowledgements:

- NSF for the support and understanding
- Vanda Grubisic (NCAR/EOL) (Mentorship and encouragement)
- Alison Rockwell (NCAR/EOL) (Project Management and support)
- EOL staff, students and postdocs for their professionalism
- NWS office LA/Oxnard for the timely daily briefings
- SBC Fire Department and Montecito Fire Department for unconditional support



Thank you!

The END



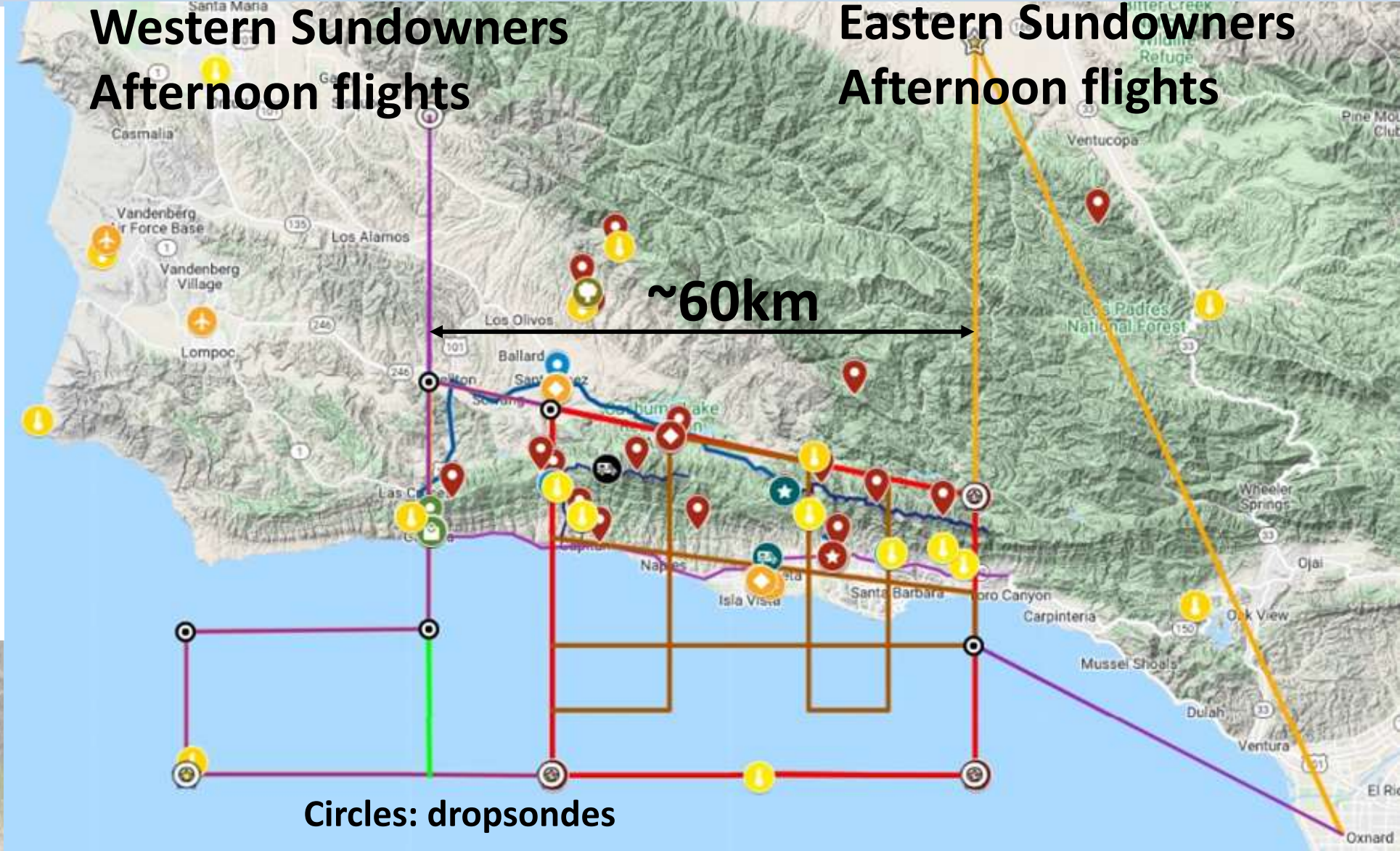
NPS Twin-Otter Fights during IOP/EOP missions

Two Flights:

Afternoon:
~12:30 to 03:30 PDT

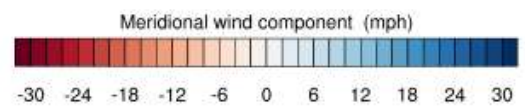
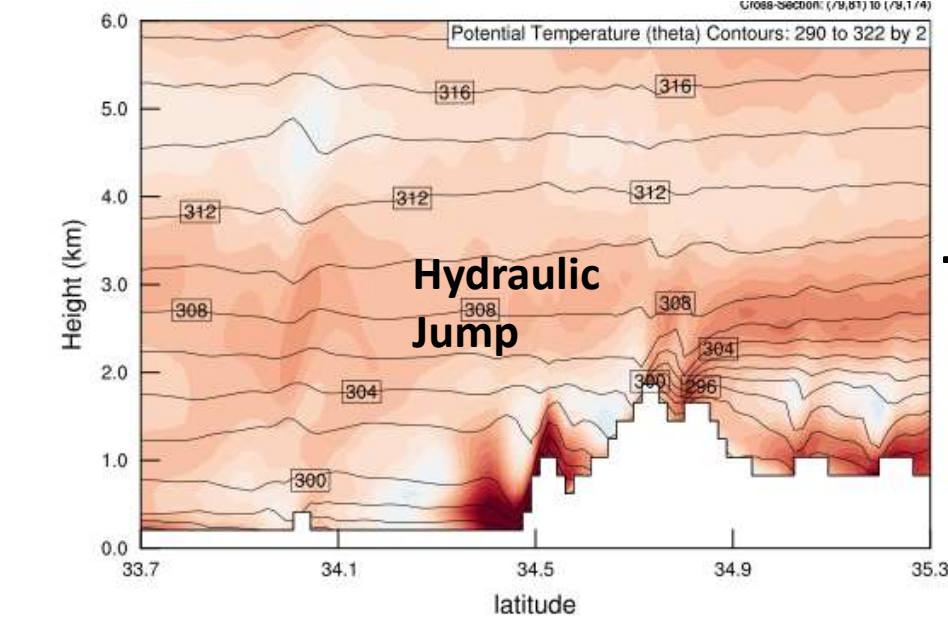
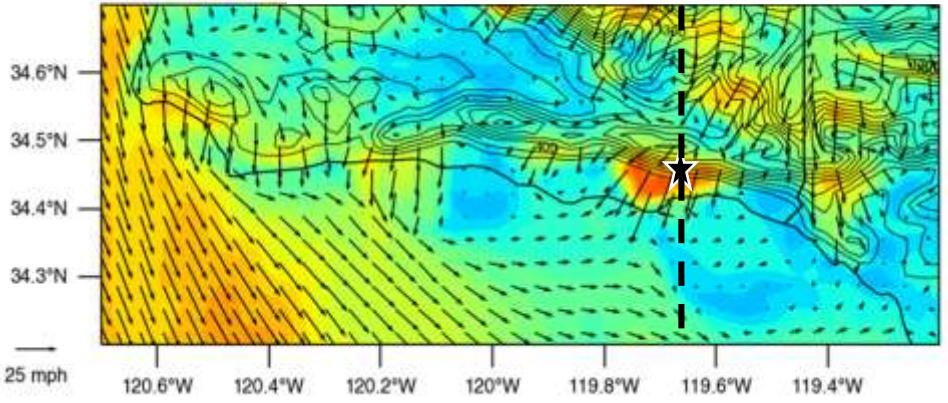
Evening:
~17:30 to 21:00 PDT

Flights were adjusted according to the event forecast



IOP-10 Friday 13: Stationary UWOW in Montecito

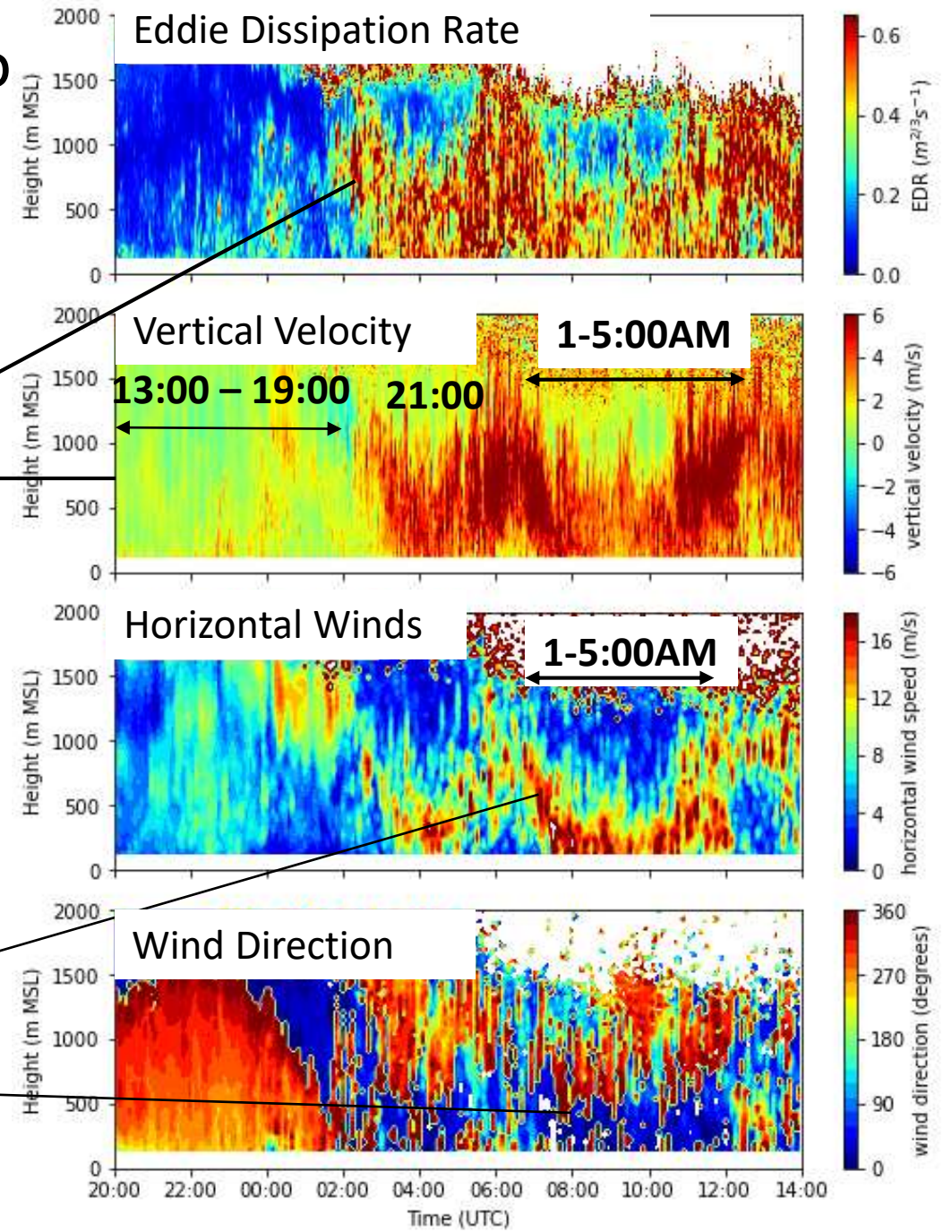
WRF Forecast 10m winds Friday 2:00 AM



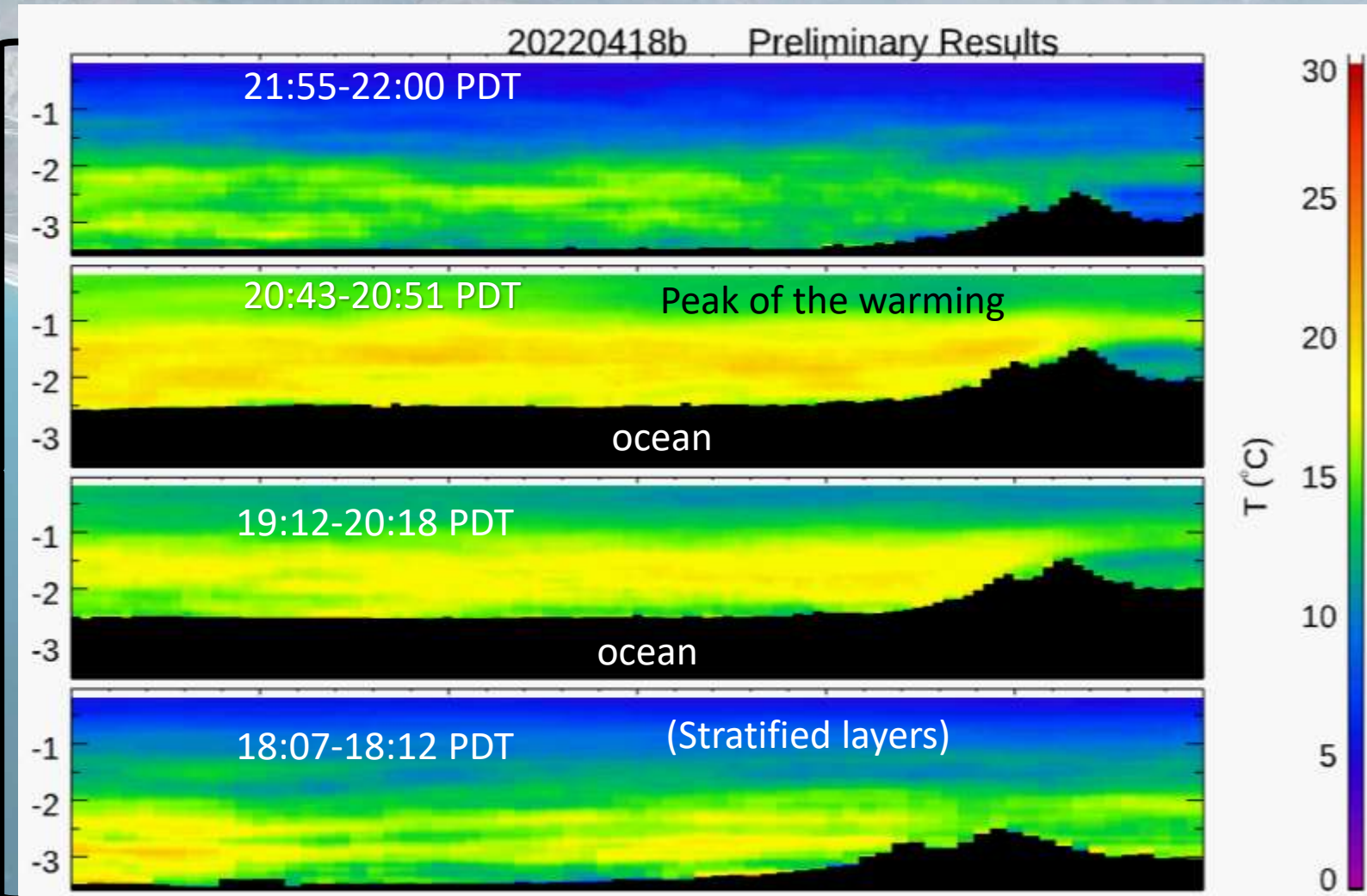
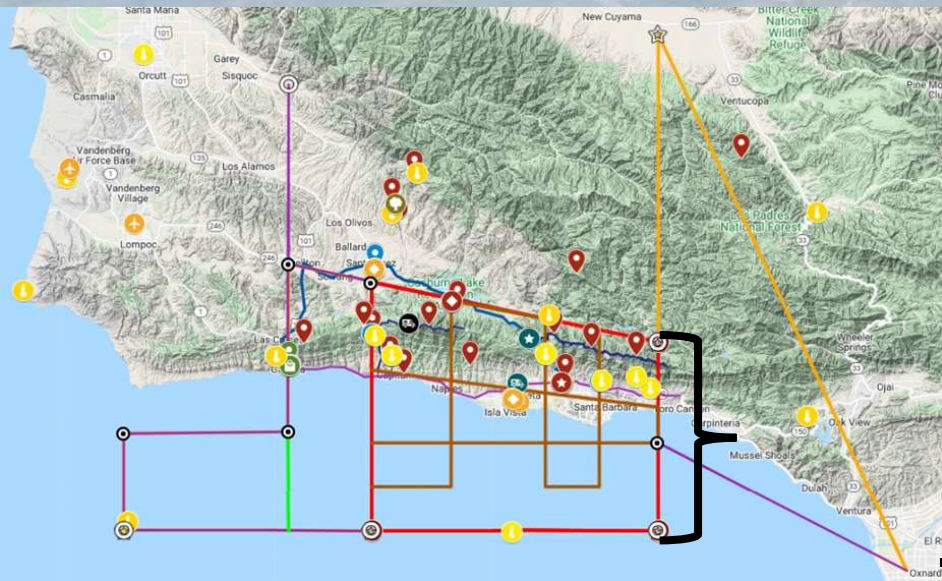
WRF Cross-section
Meridional Wind
Component
Across Montecito
(MCT1)
at 2:00 PDT

Peak of the NE winds
Near ground level
~1-3:00 AM

Hydraulic Jump
Wave Breaking?



TWIN Otter: CRL North-South Cross-section – eastern SB Montecito – Western Sundowner



Zhien Wang,
James Kasic

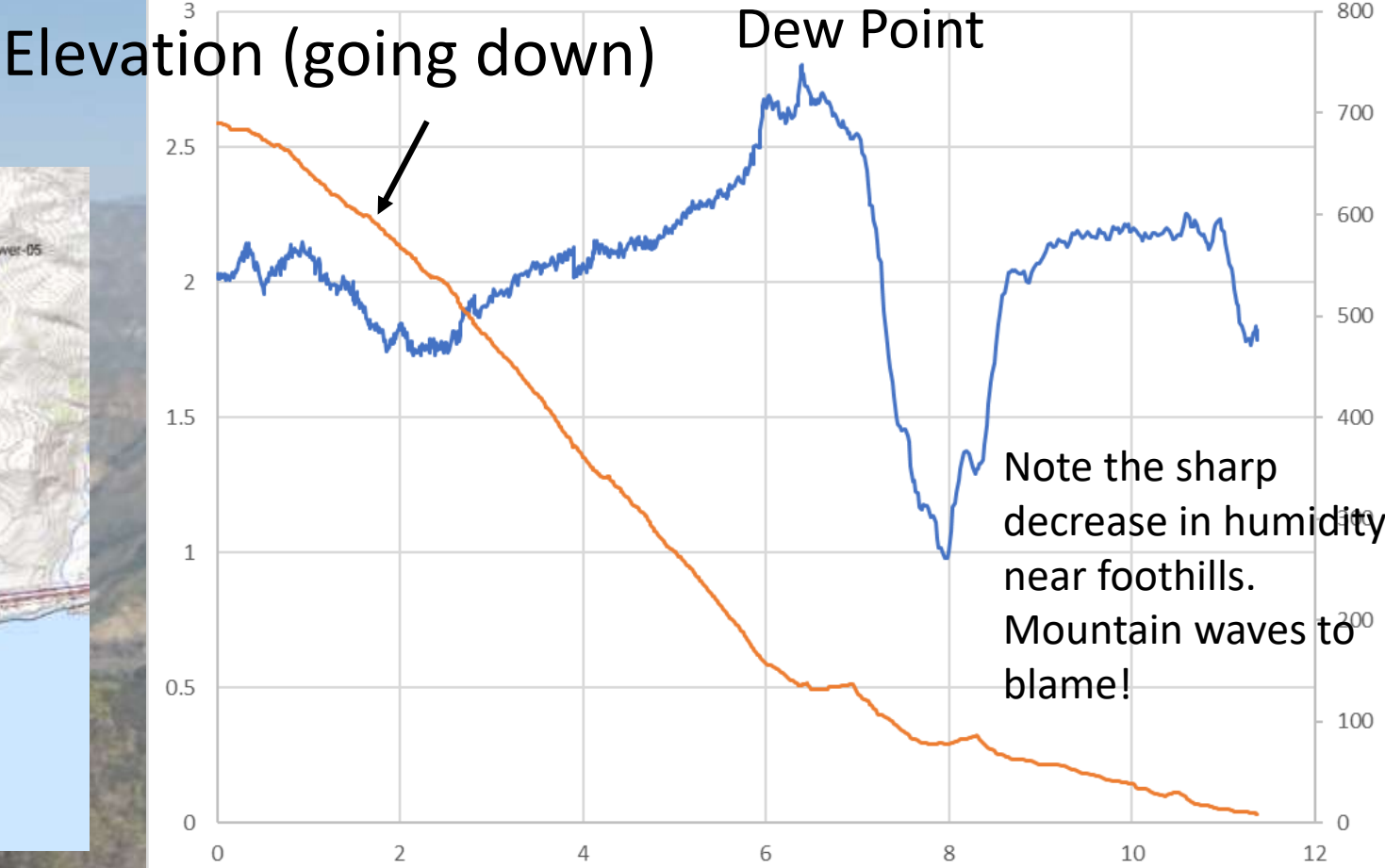


Driving down the slopes

April 13, 20:46-21:18 PDT



Water-Vapor Mixing ratio near Refugio Beach around 12:30 PDT



Loren White



Broad Impacts

- Strong and fruitful collaboration with the NWS/LA Oxnard ->



UCSB Real-time WRF forecasts

near-time numerical weather forecasts for Southern California are performed with the **Weather Research and Forecasting (WRF)** model. WRF configuration includes **two nested domains** with 6 km and 2 km horizontal grid spacings and 55 vertical levels.

Current runs:

- * **00UTC run:** Initial and boundary conditions from **NCEP NAM** 12 km forecasts, 84 hour forecasts
 - * Physical parameterizations: mp_physics=6, ra_lw_physics=4, ra_sw_physics=4, sf_sfclay_physics=5, sf_surface_physics=4, bl_pbl_physics=5, cu_physics=6 (6 km grid only), sst=update=1 (every 6 hr)
- For more information, please contact **Professor Charles Jones**

WRF 2 km products - 00 UTC Initial Condition - 84-hour forecasts

Model run status (click)

- Surface fields
- Skew-T profiles
- Meteograms
- Time x Height
- Cross sections
- Hovmoller

2 km Full domain	2 km Full domain	2 km zoom over Santa Barbara	2 km zoom over Santa Barbara
Winds (10 m)	Precipitation	Winds (10 m)	
Specific Humidity (2m)	Clouds: < 120m	Temperature (2 m)	
Temperature (2m)	Clouds: [120m,2km]	Relative Humidity (2 m)	
Relative Humidity (2m)	Clouds: [2km,5km]	Specific Humidity (2 m)	

Sundowner Wind Metrics

MEAN SEA LEVEL PRESSURE DIFFERENCES AMONG SANTA BARBARA, SANTA MARIA AND BAKERSFIELD AIRPORTS

WESTERN AND EASTERN SUNDOWNER WIND REGIMES: PC1 AND PC2 FORECASTS

84hs WRF Forecasts and products (2km resolution)
Products have been incorporated in their daily operations

Santa Barbara County and Montecito Fire Departments: Strong interest in the research we develop

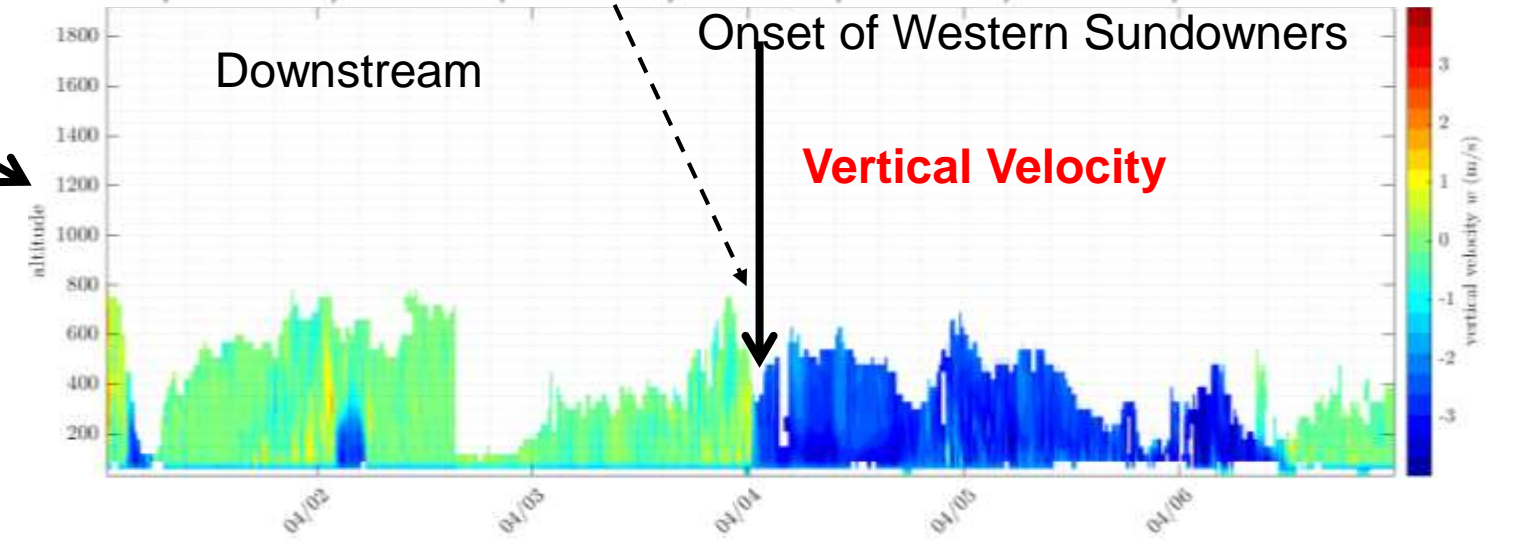
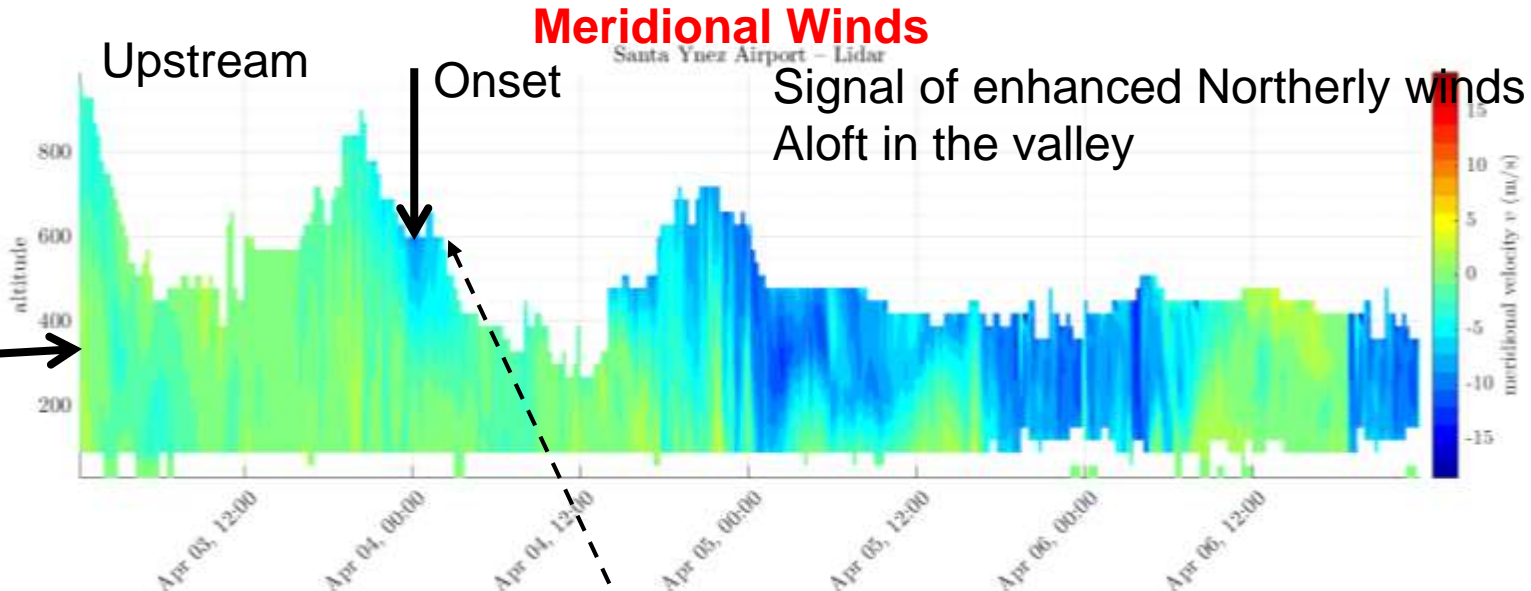
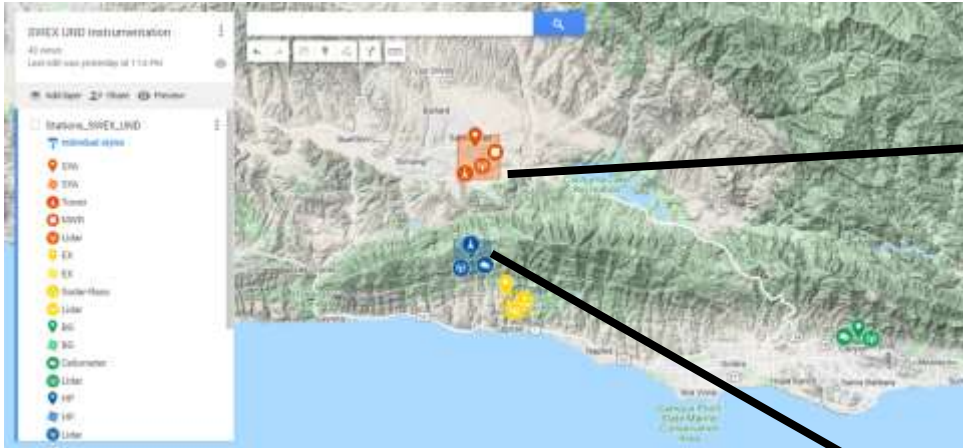


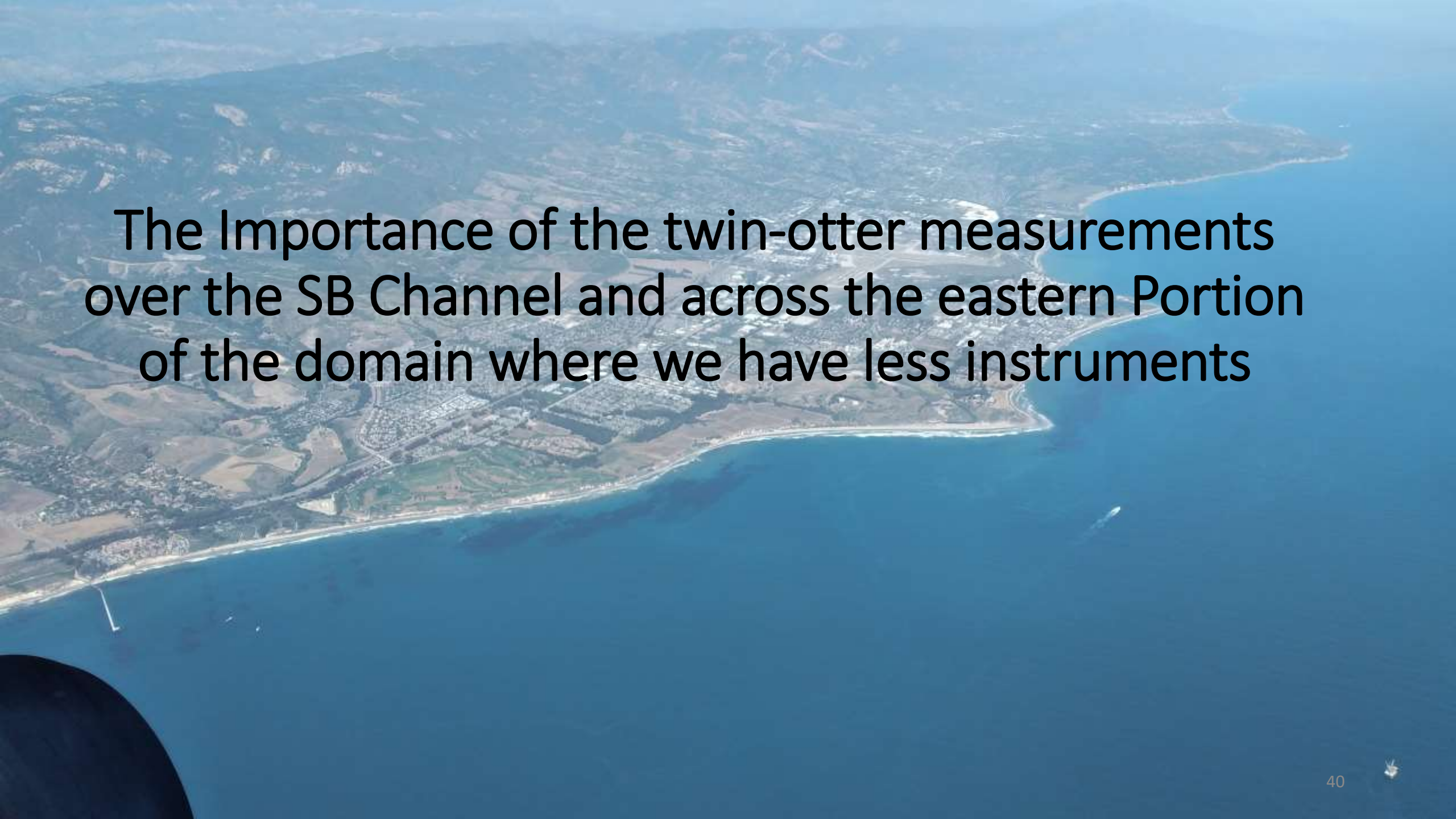
Decision making



- *Daily (10:00 PDT) briefings with the NWS/LA Oxnard office (LOX)*
- *Final decisions: 24h in advance*
- *Eastern or Western regimes (usually based on pressure gradient proxies and 84h UCSB 2km WRF simulations provided daily to the NWS - LOX)*
- *Avoided two consecutive days in the field*

Doppler lidar data upstream and downstream



An aerial photograph showing a coastal area. In the foreground, there is a large, deep blue body of water. A narrow strip of land with a sandy beach and some buildings runs along the coast. Behind the beach, there is a dense urban area with many buildings. The background consists of rolling hills and mountains under a clear sky. The text is overlaid on the middle of the image.

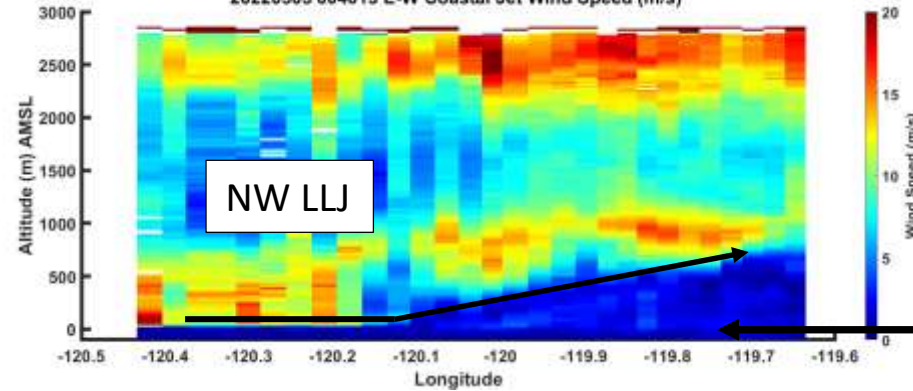
The Importance of the twin-otter measurements
over the SB Channel and across the eastern Portion
of the domain where we have less instruments

CIRPAS Doppler Lidar-Augmentation flights



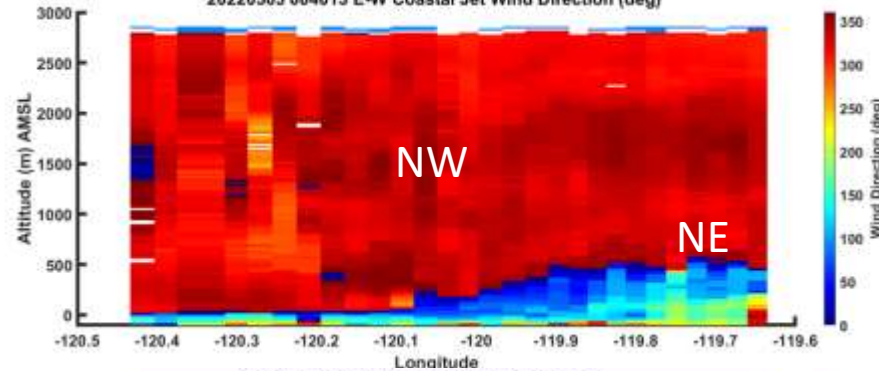
May 03, 17:40-18:00 PDT

20220503 004013 E-W Coastal Jet Wind Speed (m/s)

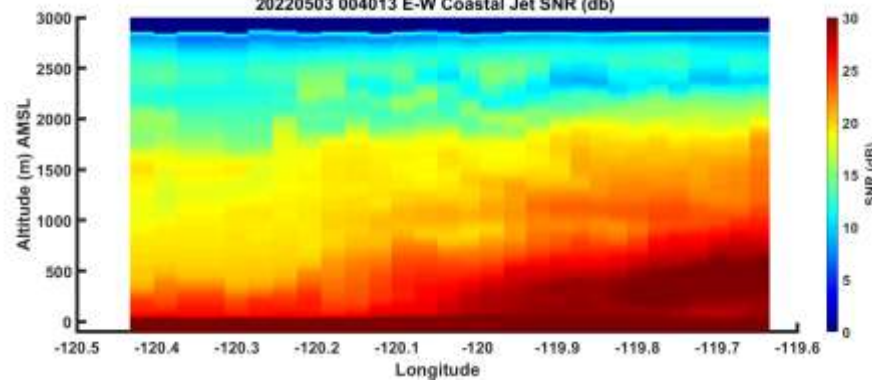


NE downslope flow from land to water undercuts and lifts the LLJ over the Santa Barbara Channel

20220503 004013 E-W Coastal Jet Wind Direction (deg)



20220503 004013 E-W Coastal Jet SNR (db)



Higher aerosol content in the down slope flow than that in the LLJ over the water.



Education and Outreach

- **Education**

- Training of 30 students (18 grad, 8 undergraduate, 4 lab assistants)
- Two postdocs, 1 Project Scientist



- **Outreach**

- EOL – instrumental demonstration to K-12 at Rancho Alegre
- Interview to the local TV-News
- Invitation to talk about SWEX at the SB County Fire Council
- Invitation to participate in a panel and record a video during the Wildfire Preparedness Exposition (at Direct Relief)
- Informal visit of Firefighters and the public in general during balloon Launching
- Invitation to talk about SWEX to Senator Dianne Feinstein staff at Sedgwick Reserve



Safety, Respect and Collegiality

- **Safety:** we were very serious about the safety of the team and students.
- Our strategies (working in shifts, same group of people in sites) have demonstrated to be successful
- No case of COVID, no injury or accident reported during mounting, teardown and throughout the 45 days of the campaign.
- Communication among participants using Slack was very efficient and worked during night and day.
- The SWEX catalog “map” feature allowed us to check all the mobile platforms in real time. Communication with the Twin-Otter was very efficient.
- Collegiality and respectful behavior among students, researchers and the community permeated all aspects of the field campaign.

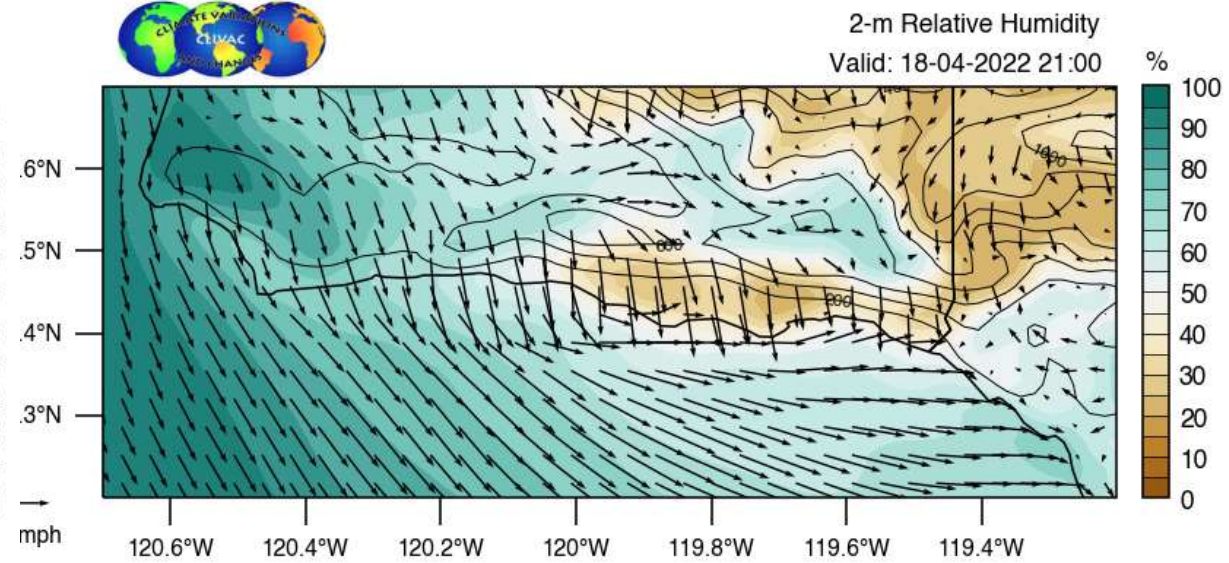
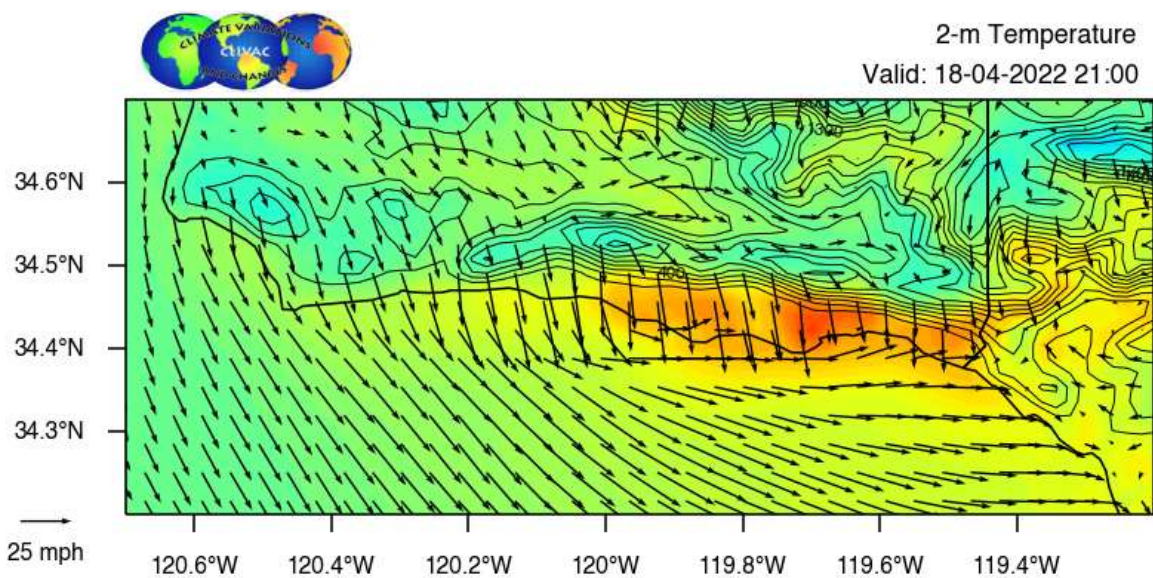
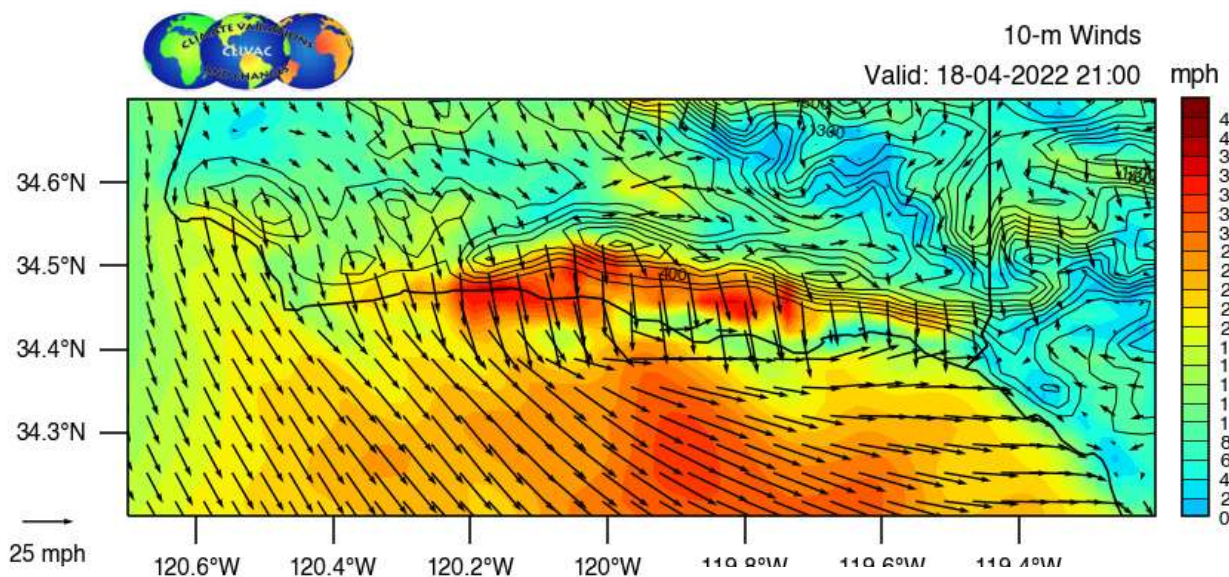


Challenges and Opportunities

- The onset of the Pandemic in 2020, two weeks before the starting of the SWEX campaign and all the uncertainties in the next 2 years were the major challenge of the project
- Thanks to a cohesive and respectful team, and the understanding and support of the NSF program managers, we overcame these obstacles.
- Set backs: Graduate Student support and time to degree; the unavailability of the UWy King Air in 2022
- Opportunities:
 - 1) data collected by the UND lidar was used for a dissertation and to create a framework for a new proposal.
 - 2) Inclusion of CIRPAS Twin-Otter equipped with a Doppler lidar
 - 3) Improve UCSB weather products to forecast Sundowners

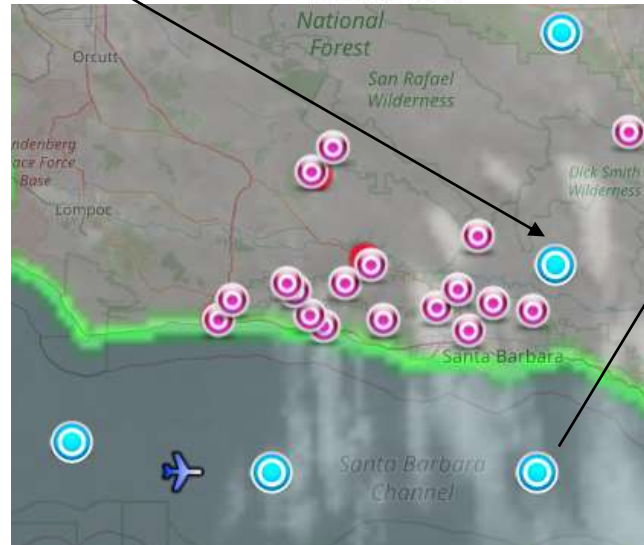
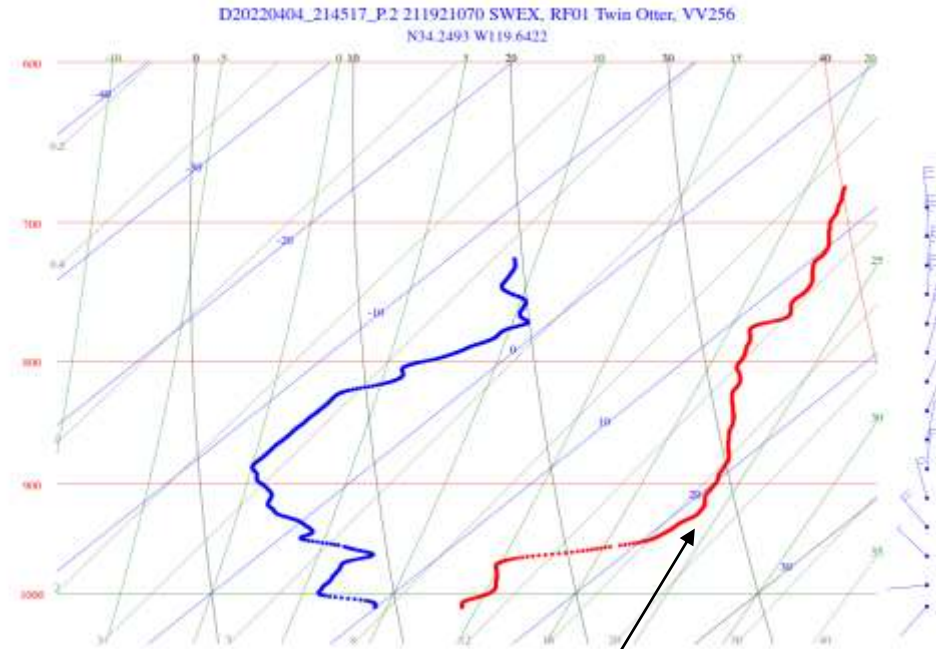
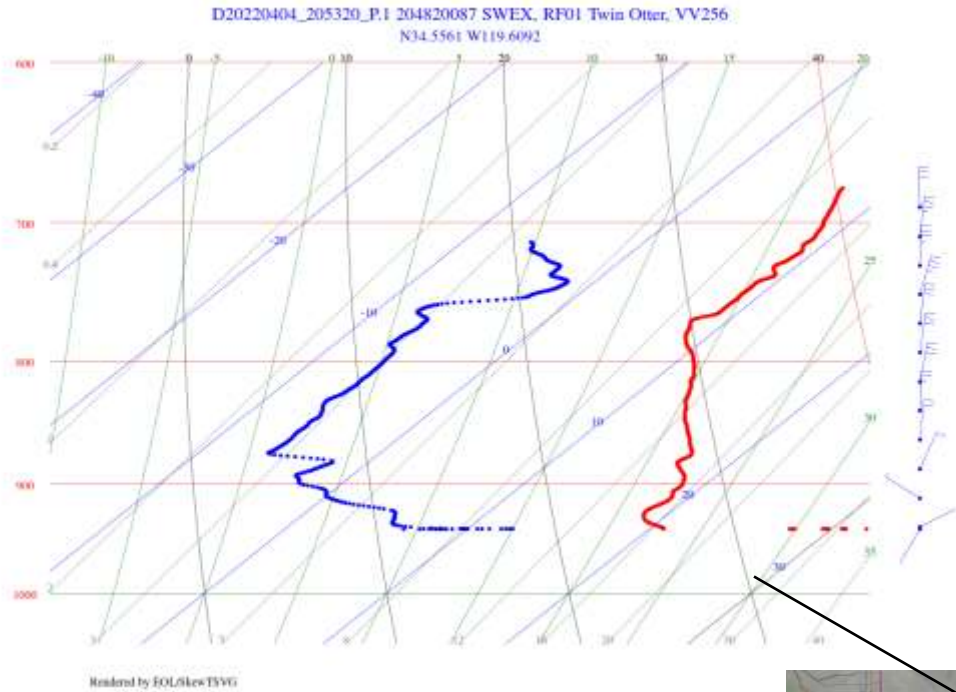


Remarkable thermodynamic contrasts



East Valley: 20:53:20 UTC- 13:53:20 PDT

East Channel" 21:45:17 UTC (14:45:17 PDT)



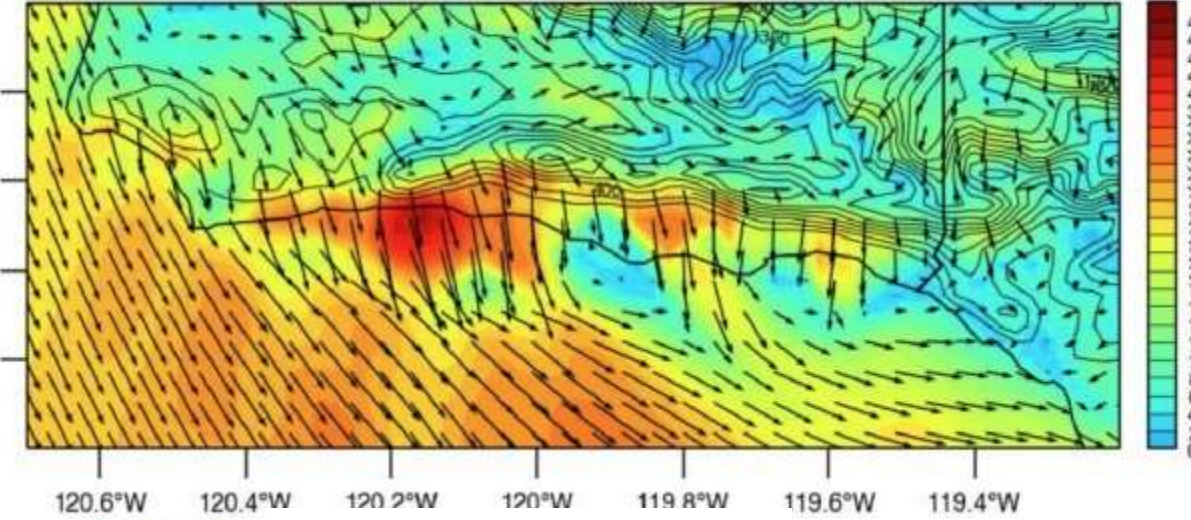


Sundowner Regimes (Jones et al. 2020)



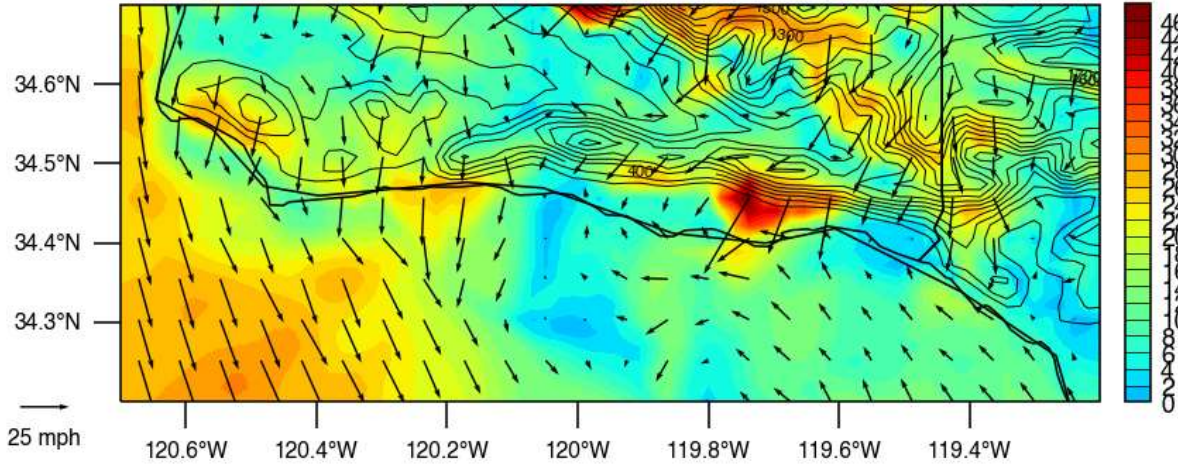
WESTERN - NNW

10-m Winds
Valid: 13-04-2022 22:00 mph



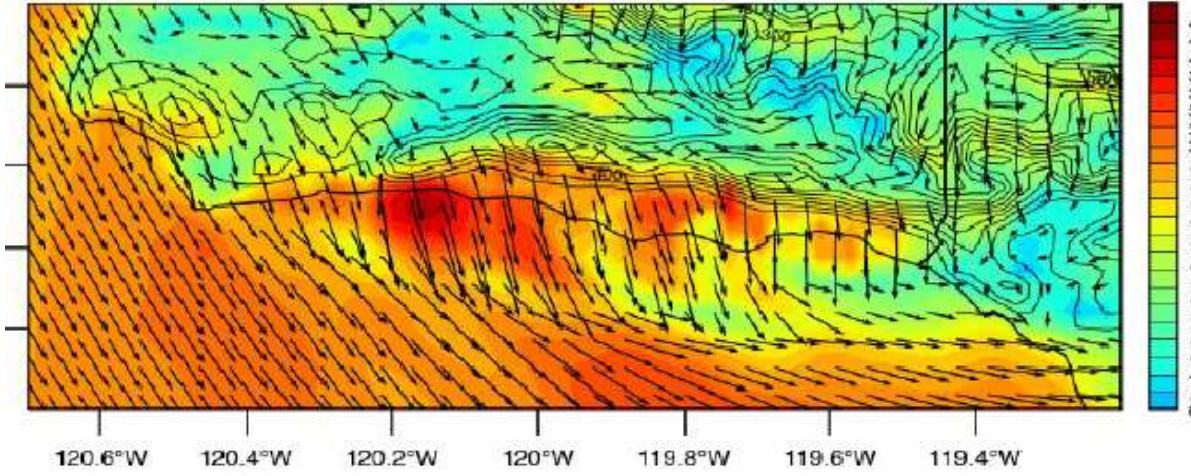
EASTERN - NNE

10-m Winds
Valid: 05-04-2022 23:00 mph



SANTA BARBARA -

10-m Winds
Valid: 10-05-2022 22:00 mph



*HYBRID

10-m Winds
Valid: 29-04-2022 01:00 mph

