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

The Santa Ynez Mountains

San Rafael Mountains

Santa Ynez Valley

Symbols in black are weather stations with historical data greater than 2 years

~130,000 people live in coastal SB

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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 drops sondes (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)
- 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

Western Regime
Sundowner Regimes (Jones et al. 2020)

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.


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

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

- lidar
- ISFS
- RAW5/ASOS
- Radiosonde
- 449/915 MHz
- ceilometer

Western
- Gaviota
- Santa Ynez Valley (SYV)
- Western SYM
- Goleta
- Santa Barbara
- Montecito

Eastern
- Eastern Santa Ynez Mountains (SYM)
- Eastern SYM
- Eastern SYM

Terrain elevation [m]

Pacific Ocean
Ground Instruments (April 1-May 15)

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

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

3 EOL Radar windprofilers (1 coast and 2 Santa Ynez Valley)
1 Microwave Radiometer, 2 Sodar-RASS (UND)
Mobile Platforms and Aircraft: 13 missions

JSU: Mobile
Meteorological unit: near ground temperature and humidity

Meteorological unit:
near ground temperature
and humidity

2 Raman lidars (CU, UWy), 1 Doppler lidar (NPS), 1 AVAP dropsonde system (EOL)
Winds, Temperature, aerosols, and humidity profiles

NPS CIRPAS Twin-Otter
UVA Lidar on Wheels – measure winds below 1000m
**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: Gaviota, Fire Station 38**

**SJSU/UCSB: SBCF Headquarters**
SWEX : EOL/UCAR Field Catalog and data management
(Carol Constanza, Linda Echo-Hawk)
http://catalog.eol.ucar.edu/swex
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 wind profile / km

Stephan De Wekker

Strong winds
Northwesterly
50 mph

Light winds
Southwest
~6:12 PDT
Dos Pueblos Orchid farm

~38 km

Las Cruces
Gaviota
Capistrano
Naples
Goleta
TWIN Otter: CRL North-South Cross-section – eastern SB Montecito – Eastern Sundowner
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!!

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- 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.

Circles: dropsondes
IOP-10 Friday 13: Stationary UWOW in Montecito

WRF Forecast 10m winds  Friday 2:00 AM

- Hydraulic Jump
- Wave Breaking?
- 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

Montecito 051222

Eddie Dissipation Rate

Vertical Velocity

13:00 – 19:00  21:00

Vertical Velocity (m/s)

1-5:00AM

Horizontal Winds

1-5:00AM

Wind Direction

Horizontal wind speed (m/s)

Wind direction (degrees)
TWIN Otter: CRL North-South Cross-section – eastern SB Montecito – Western Sundowner

Zhien Wang, James Kasic

Preliminary Results

- 21:55-22:00 PDT
- 20:43-20:51 PDT Peak of the warming
- 19:12-20:18 PDT
- 18:07-18:12 PDT (Stratified layers)

(Stratified layers)

Zhien Wang, James Kasic
Driving down the slopes

April 13, 20:46-21:18 PDT

Elevation (going down)

Dew Point

Note the sharp decrease in humidity near foothills. Mountain waves to blame!

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

Loren White
Broad Impacts

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

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

Meridional Winds

Onset of Western Sundowners

Signal of enhanced Northerly winds Aloft in the valley

Vertical Velocity
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

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

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 Channel" 21:45:17 UTC (14:45:17 PDT)
Sundowner Regimes (Jones et al. 2020)