

PACE-PAX research report 2024/09/26

Compiled by Kirk Knobelspiesse, Ivona Cetinić, Brian Cairns, Michael Ondrusek,
2024/10/06

Reviewed by Samuel LeBlanc

Last full coordination between ER-2, Twin Otter, Shearwater with PACE and EarthCARE overpasses. Generally cloud free with low aerosol optical depths. Twin Otter spirals above Shearwater and a potential red tide during PACE overpass.

ER-2

Take off: 17:01

Landing: 23:23

Duration: 6.4 hrs

Pilot: Kirt Stallings, mobile: Dean Neeley

All instruments operated successfully

Twin Otter

Take off: 17:25

Landing: 22:29

Duration = 5.1 hrs

Manifest: Bryce Kujat (pilot), Jeff Martin (pilot), Elizabeth Wilk (QNC), Adam Ahern (QNC), Edward Winstead (QNC)

[See end for full Twin Otter report](#)

R/V Shearwater

Mission Scientist: Michael Ondrusek

Sailed out: 15:54 UTC

Back in port: 22:15 UTC

[See end for full R/V Shearwater report](#)

PACE

20:31, California inland

EarthCARE

22:22, Lake Tahoe to California central coast. Orbit #1882

Gliders

Operational

Additionally at Reno: (from email Hans.Moosmuller@dri.edu)

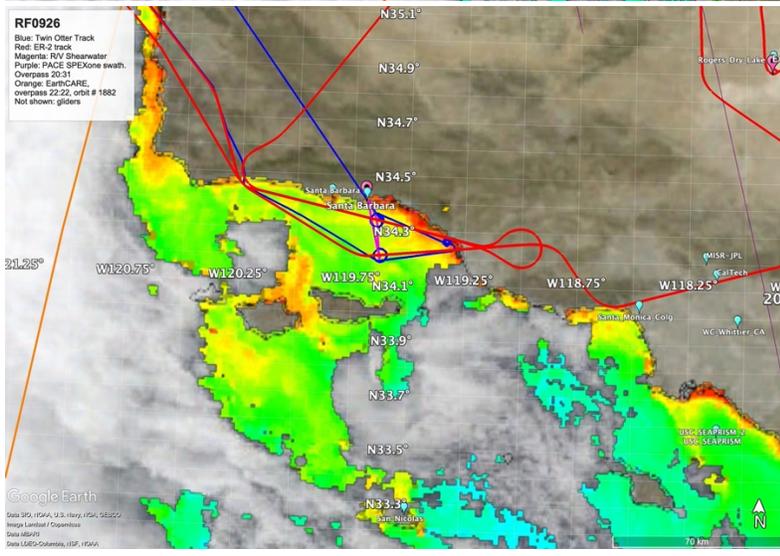
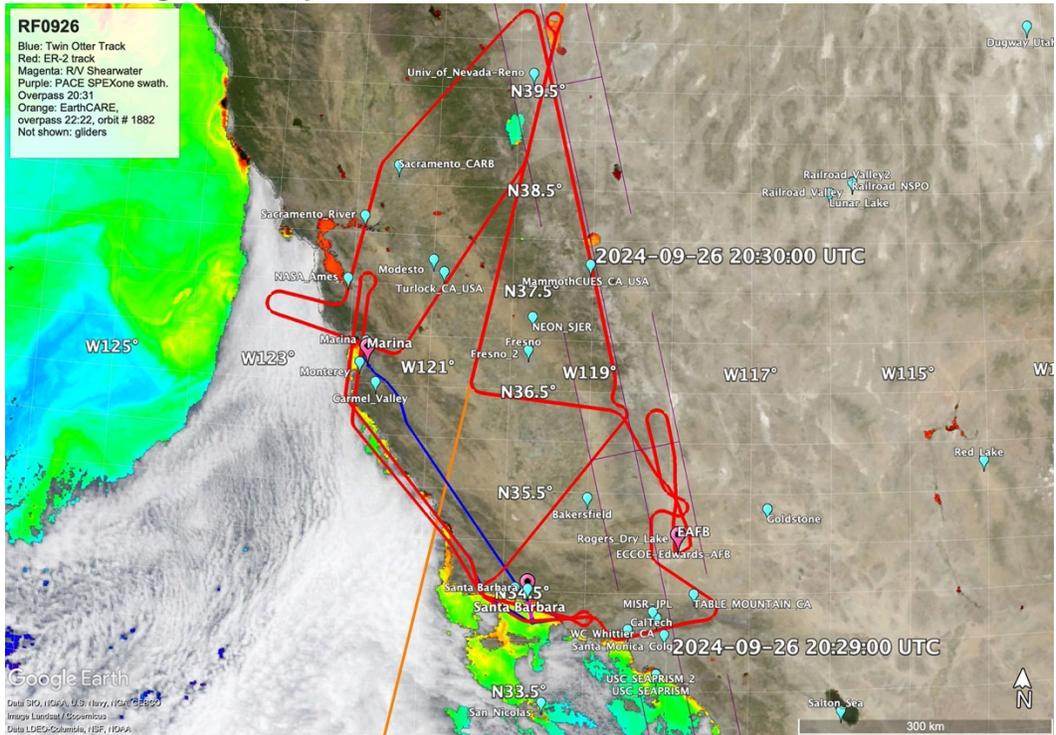
At UNR, Pat Arnott is running our AERONET station and in addition photoacoustic plus nephelometer measurements of aerosol absorption and scattering at 532 nm

(<https://www.patarnott.com/pas532/>). In addition, there are the Washoe County Air Monitoring stations (<https://www.nnph.org/programs-and-services/air-quality/air-monitoring-stations.php>)

with Reno4 at 1450 Stewart Street in Reno being the core station with the most instruments and data. The NWS Reno office (next to DRI, just north of Reno ~500' above valley floor) does the usual

twice a day met balloon soundings. Weather is calm and clear and predicted to stay this way with likely only a few ug/m³ of PM2.5.

Overall image summary



Validation Traceability Matrix itemized objectives

VTM elements in **black** satisfied, **blue** partially satisfied, **red** to be confirmed

Time UTC	Platform	VTM(hrs)	
15:54	RS		R/V Shearwater departs
16:36	RS		Station #38, departure 17:30. Mostly clear.
17:01	ER2		ER-2 takeoff
17:25	TO		Twin Otter takeoff

17:35	RS		Station #39 (SHER1), departure 19:46. ER-2 and TO overpass (scored below). Clear skies
17:53	ER2	1d(0.5)	ER-2 over CalTech AERONET site possibly with remnant smoke and urban pollution. AOD(500)=0.13
18:05	ER2	1f(0.5), 4b(0.5)	ER-2 over sunglint
18:06	ER2, RS	1b(1.5), 1c(1.5)	ER-2 over Shearwater station #39 (SHER1) in clear skies
18:07	ER2, glider		ER-2 over gliders. Potentially cloudy?
18:33	ER2, TO	1d(1.0)	ER-2 over Monterey AERONET site, AOD(500)=0.07. Over line previously sampled by Twin Otter (roughly 50 min prior)
19:07	ER2, TO	1c(0.5)	ER2 overpass (at 19:17) of TO west of Santa Barbara, while TO is descending into boundary layer
19:25	TO, RS	1b(1.5), 1c(1.5)	TO spirals up from 100 to 10000ft over Shearwater at #39 (SHER1) at top 19:50
19:35	ER2,RS	1b(3.0), 1c(3.0), 1f(1.0), 4b(1.0)	ER-2 over Shearwater at station #40 (SHER2), at location for Twin Otter (also previously overflew this site at ~19:23). Some glint.
20:06	ER2, PACE-OHS	1d(1.0), 3b(1.0)	ER2 on PACE line over Sierra Nevada mountains up to Reno area. Overpass just south of Lake Tahoe. Line ends at 20:36. Cloud free, low AOD. Over MammothCUES_CA_USA AERONET station, AOD(500)=0.025 (20:15). Additional instrumentation at DRI/Reno, contact Hans Moosemueller
20:12	RS		Station #40 (SHER2) depart 21:39. Clear
20:00	TO	1b(1.5), 1c(1.5), 6i(1.5)	TO spirals over red tide offshore near Oxnard, CA.
20:20	TO	1b(1.5), 1c(1.5)	TO spirals up from 100 to 10000ft over Shearwater at #40 (SHER2) at top 20:59
20:31	PACE		PACE overpass, inland California
20:35	ER2, PACE-OHS	1c(0.25), 3a(0.25), 6h(0.25)	Over pyramid lake (turbid), under PACE-OHS, nearby Univ_of_Nevada-Reno AERONET AOD(500)=0.04
21:03	ER2	1b(0.5), 1c(0.5), 6h(0.5)	Over Sacramento_River AERONET-OC site. AOD(500)=0.03
21:10	ER2	1d(0.5)	Over NASA_Ames AERONET-OC site. AOD(500)=0.04
21:28	ER2	1d(0.5)	Over CEOBS site. AERONET not functional, but ground Lidar and other instruments ok
21:39	ER2	1d(0.5)	Over Turlock AERONET site. AOD(500)=0.05
22:09	ER2, EarthCARE	1d(2.0), 3d(2.0)	Start EarthCARE line, ends 22:40. Cloud free, low aerosol loads.
22:22	EarthCARE		EarthCARE overpass, Orbit #1882
23:23	ER2		ER-2 lands

PACE-O: within swath of PACE's OCI instrument

PACE-OH: within swath of PACE's OCI and HARP2 instruments

PACE-OHS: within swath of PACE's OCI, SPEXone and HARP2 instruments

TO: Twin Otter

RB: R/V Blissfully

RS: R/V Shearwater

Assessment:

- 0.021 of objectives observed. Successful coordination between ER-2 Shearwater and TO, underpasses of PACE and EarthCARE.
- Top remaining objective (score above 6.0): PACE aerosol in narrow swath over ocean (3a)

PACE-PAX progress tracking														
Validation objectives	ID	Measurement objectives	Importance, w	Observation time, h (hours)	Total observed (hours)	Fractional success 9/23	Fractional success 9/24	Fractional success 9/25	Fractional success 9/26	Fractional success 9/27	Fractional success 9/29	Fractional success 9/30	Total success	Remaining score
1. Validate new retrieval properties	a	Land surface parameters	8	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.971	0.2
	b	Ocean radiometric parameters	10	8.0	8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.958	0.0
	c	Aerosol parameters over the ocean	12	8.0	9.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.994	0.1
	d	Aerosol parameters over land	12	8.0	13.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.0
	e	Cloud parameters	12	8.0	4.8	0.058	0.025	0.000	0.000	0.000	0.000	0.000	0.898	1.2
	f	Ocean surface parameters	1	8.0	1.5	0.000	0.000	0.000	0.133	0.000	0.000	0.000	0.354	0.6
3. Validate in a narrow swath	a	Aerosol parameters over the ocean (PACE)	10	8.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.354	6.5
	b	Aerosol parameters over land (PACE)	10	8.0	4.0	0.132	0.000	0.000	0.103	0.000	0.000	0.000	0.638	3.6
	c	Cloud parameters (PACE)	5	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.713	1.4
	d	Aerosol parameters (EarthCARE)	8	4.0	3.0	0.038	0.000	0.000	0.053	0.000	0.000	0.000	0.918	0.7
	e	Cloud parameters (EarthCARE)	8	4.0	2.5	0.152	0.167	0.000	0.000	0.000	0.000	0.000	0.632	2.9
4. Validate radiometric and polarimetric properties	a	Validate large reflectances	6	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.953	0.3
	b	Validate large reflectances with high polarization	6	2.0	1.5	0.000	0.000	0.000	0.194	0.000	0.000	0.000	0.826	1.0
	c	Validate large reflectances with low polarization	6	2.0	1.5	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.970	0.2
	d	Overfly vicarious calibration sites	6	4.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.268	4.4
6. Focus on specific processes or phenomena	a	High aerosol loads over land	4	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.0
	b	High aerosol loads over ocean	4	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.393	2.4
	c	Multiple aerosol layers	1	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.0
	d	Aerosol under thin cirrus	2	2.0	3.5	0.826	0.000	0.000	0.000	0.000	0.000	0.000	0.826	0.3
	e	Aerosol above liquid phase cloud	4	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.826	0.7
	f	Broken clouds with complex structure	4	2.0	1.0	0.186	0.000	0.000	0.000	0.000	0.000	0.000	0.713	1.1
	g	Dust aerosols over ocean	4	2.0	0.0	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.430	2.3
	h	Aerosol and ocean parameters over turbid waters	2	2.0	0.5	0.000	0.000	0.000	0.046	0.000	0.000	0.000	0.837	0.3
	i	Aerosol and ocean parameters over biologically productive waters	4	2.0	1.5	0.000	0.000	0.000	0.043	0.000	0.000	0.000	0.961	0.2
	k	Smoke aerosols over ocean	1	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.713	0.3
	total:			150	98	55.8	0.041	0.011	0.000	0.021	0.000	0.000	0.000	0.793
				ER-2 flight hours		2.8	0	0	0	0	0	0	0	2.8
				TO flight hours		2.5	0	0	0	0	0	0	0	2.5
				Shearwater days		0	0	0	0	0	0	0	0	0
PACE-PAX overall objectives satisfied:			0.793											

Note: images and data presented in this report are preliminary, and not for publication, presentation, or scientific use. The PACE-PAX data archive is:

<https://www-air.larc.nasa.gov/missions/pacepax/index.html>

MVIS imagery

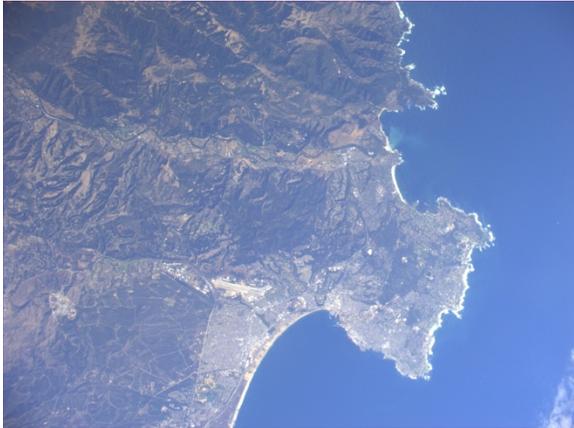
18:06 over R/V Shearwater



18:07 over glider



18:33 over Monterey AERONET site



19:35 over Shearwater, TO spiral location



20:31 PACE overpass (S. of Pyramid Lake)



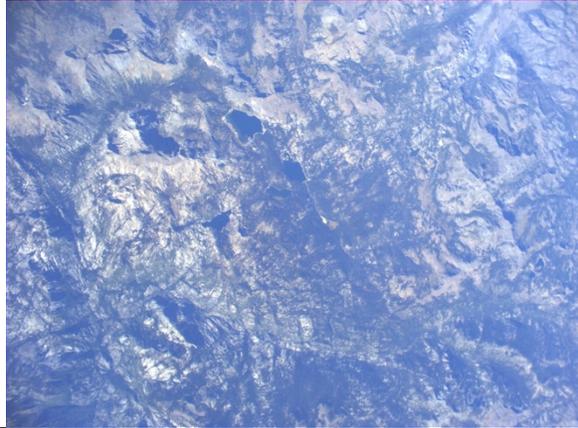
21:03:28 Sacramento_River AERONET-oc



21:28 CEOBS site



22:22 EarthCARE overpass



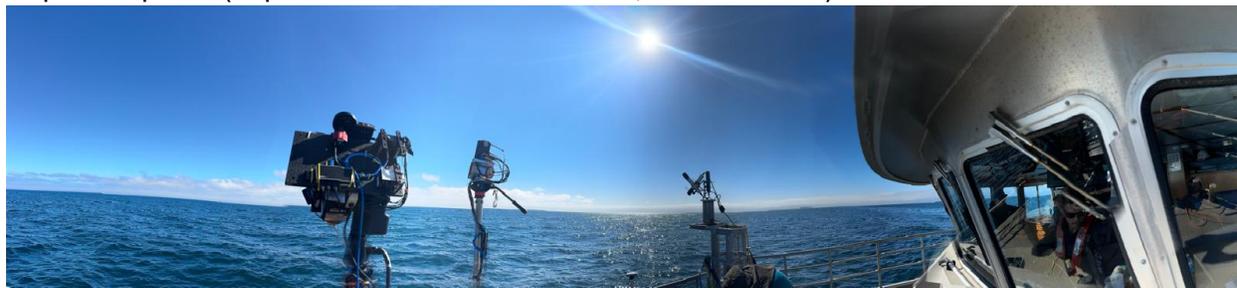
R/V Shearwater photos

Station #38 34° 11.308' N, -119° 37.773', arrival 16:36 UTC → departure 17:30 UTC

Arrival photo:



Departure photo (departure location - 34° 11.508', -119° 37.962')

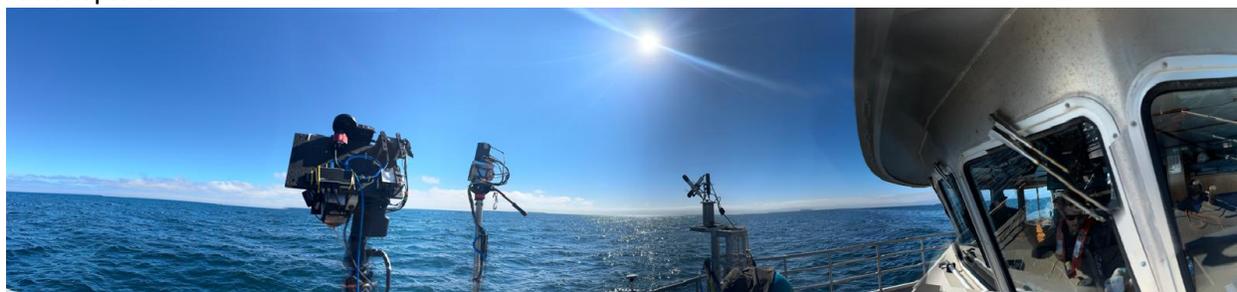


Station #39 (SHER1) 34° 12.461', -119° 37.559', arrival 17:35 UTC → departure 19:46 UTC

ER-2 overflight at 18:06

Twin otter spiral at 19:25

Arrival photo:



Departure photo: (34 12.897', -119° 37.947')



Station #40 (SHER2) 34 20.197', -119° 38.960' arrival 20:12 UTC → departure 21:39 UTC
ER-2 overpass prior to arrival to station @19:34 UTC
Twin otter spiral 13:22 start
PACE overpass at 13:29

Arrival photo:



Departure photo: (34 20.201', -119° 38.964')



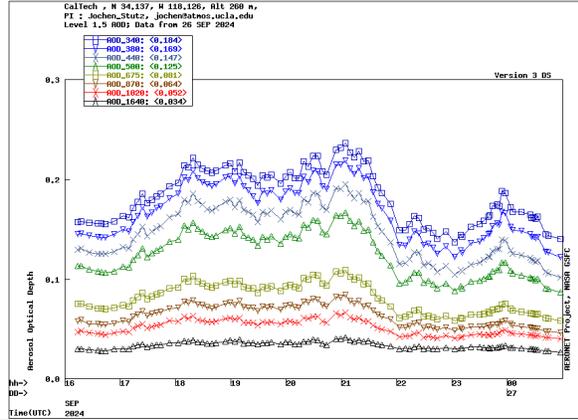
Twin Otter photos



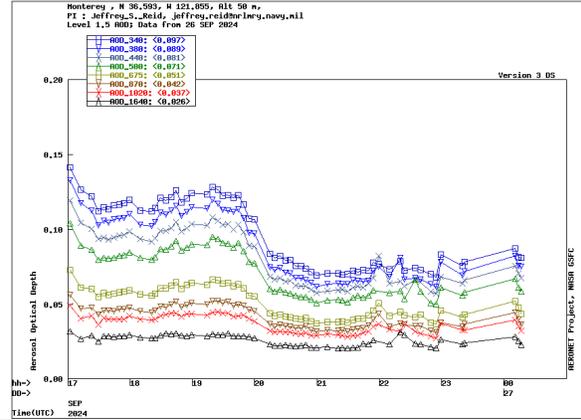
20:01:17 UTC – Spiral over red tide near Oxnard between RV Shearwater spirals 1 and 2. Photo Adam Ahern

AERONET plots

CalTech



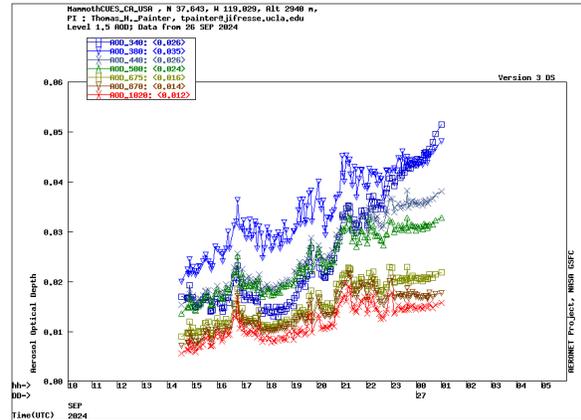
Monterey



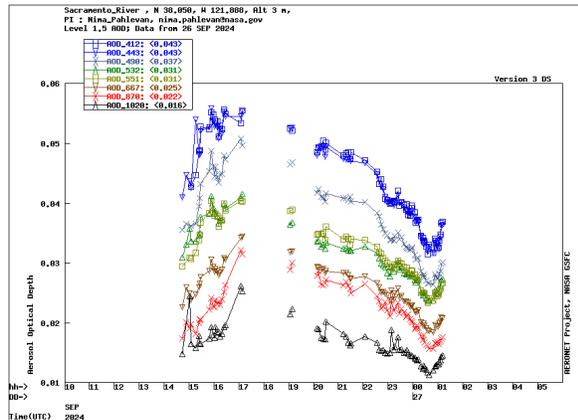
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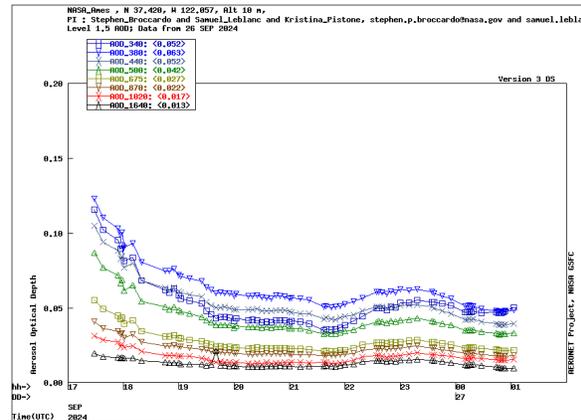
MammothCUES_CA_USA



Sacramento_River

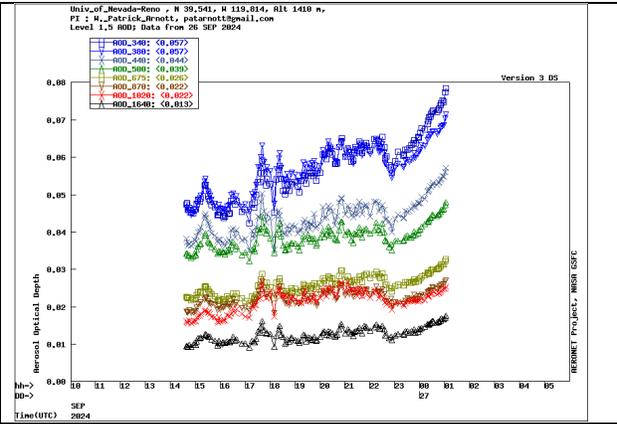
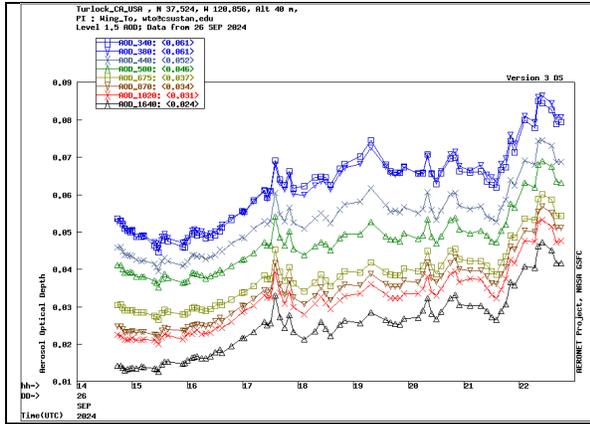


NASA_Ames

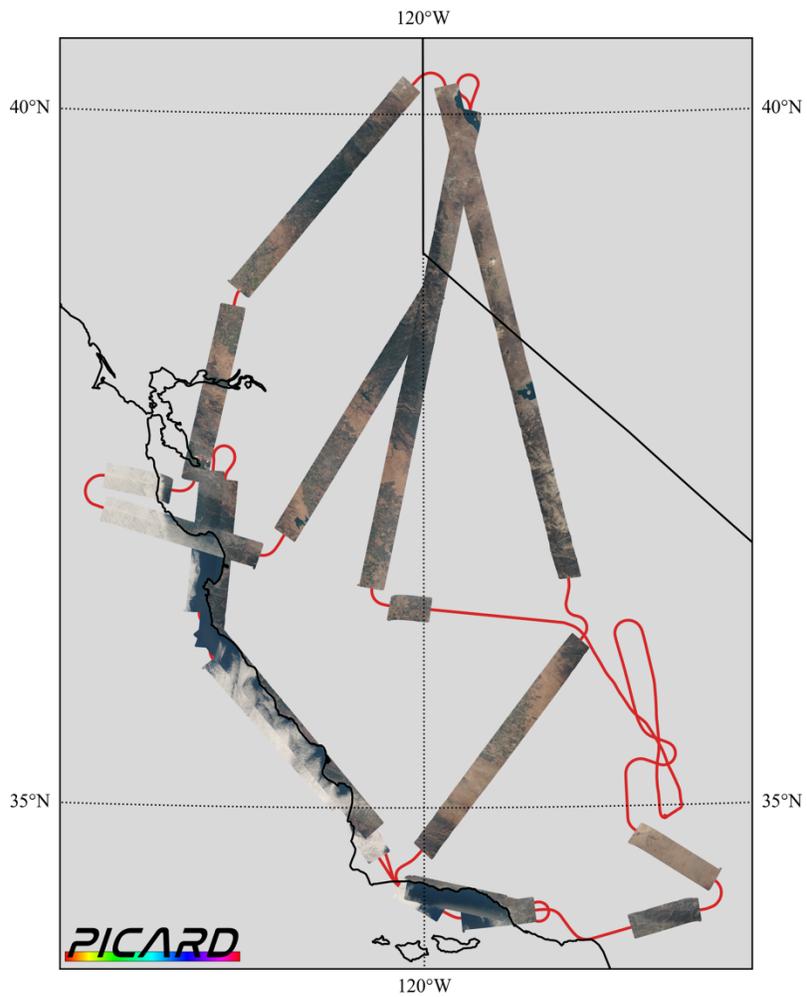


Turlock_CA_USA

Univ_of_Nevada-Reno

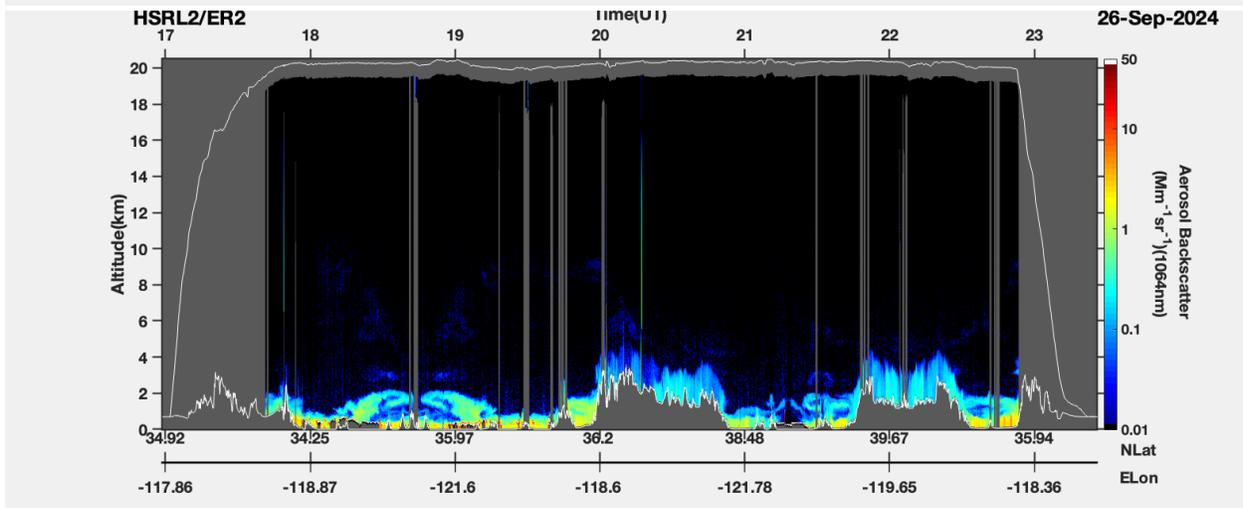
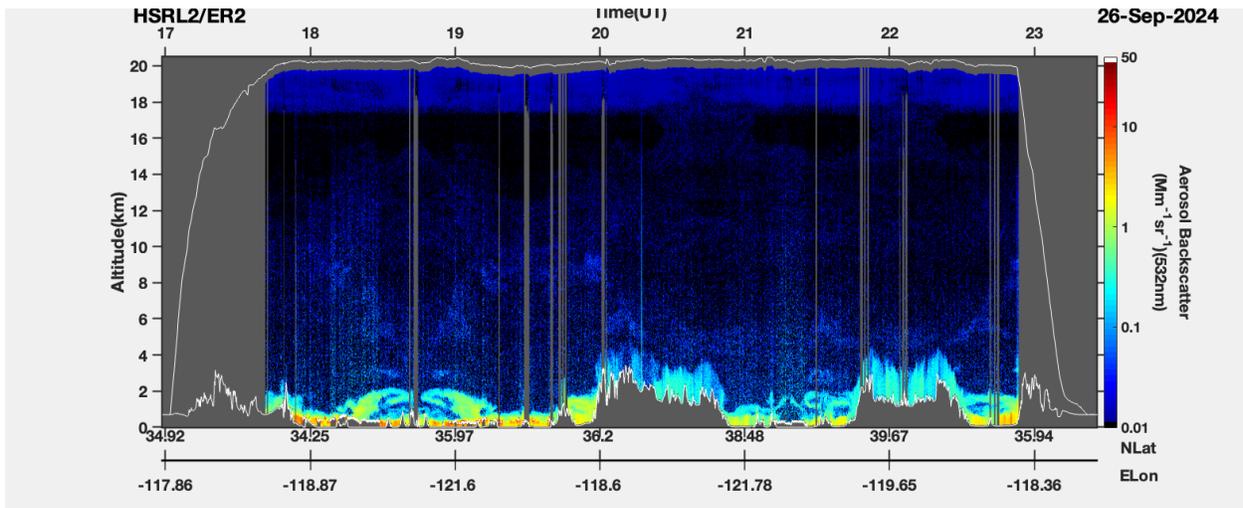
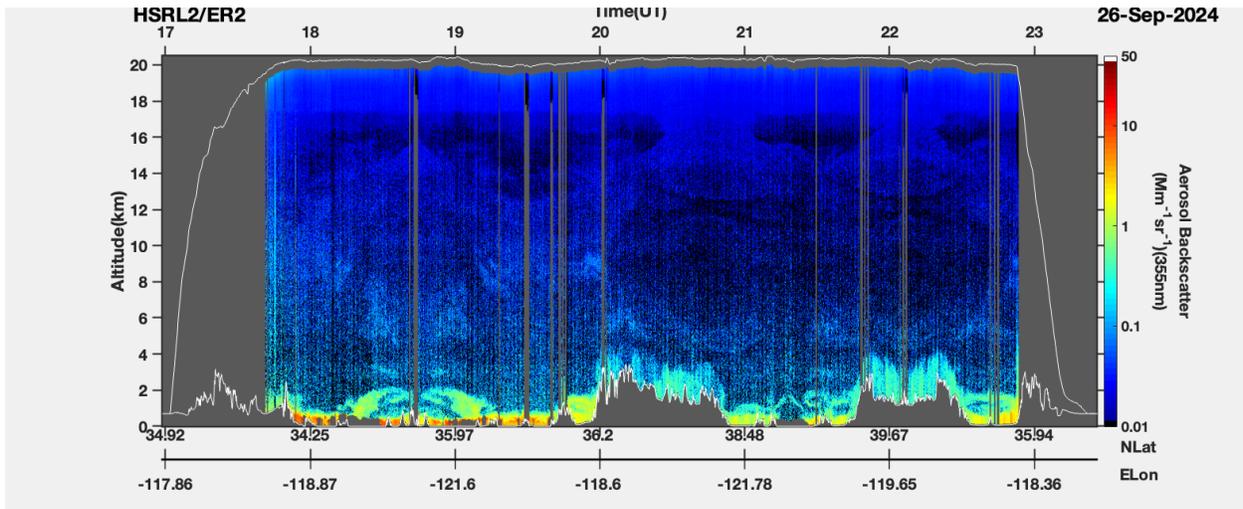


PICARD quicklooks

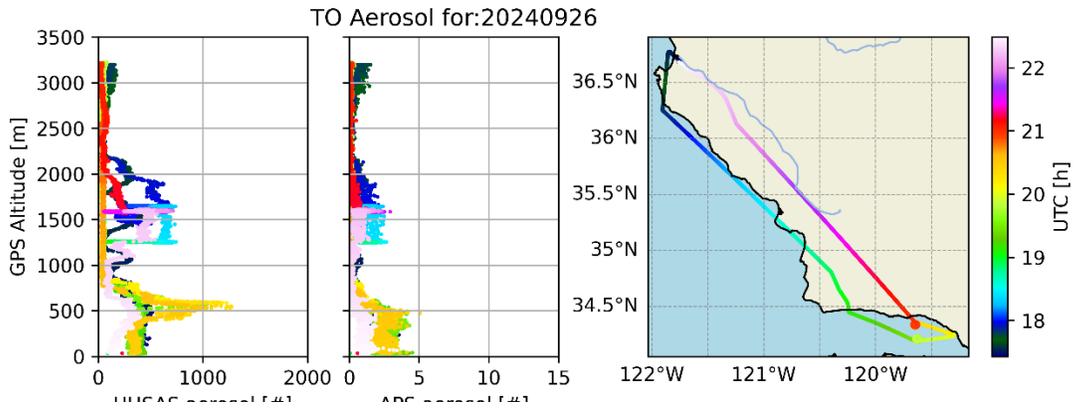
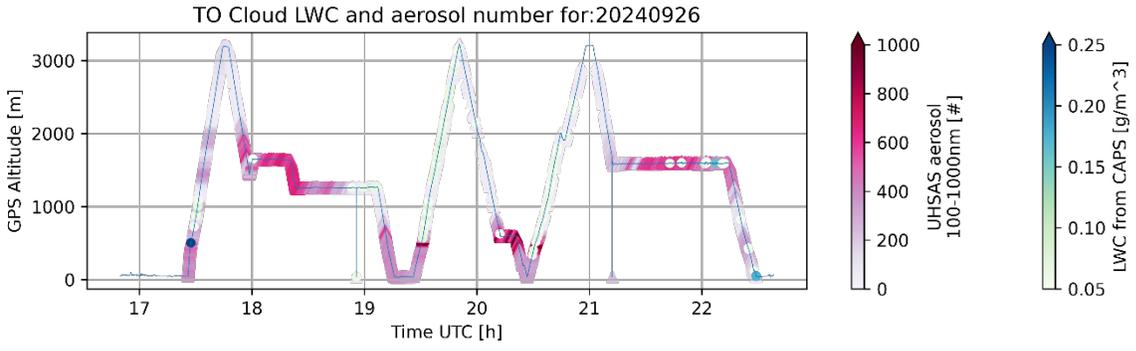


Pushbroom Imager for Cloud and Aerosol Research and Development
PACE-PAX, NASA Armstrong Flight Research Center
26 September 2024

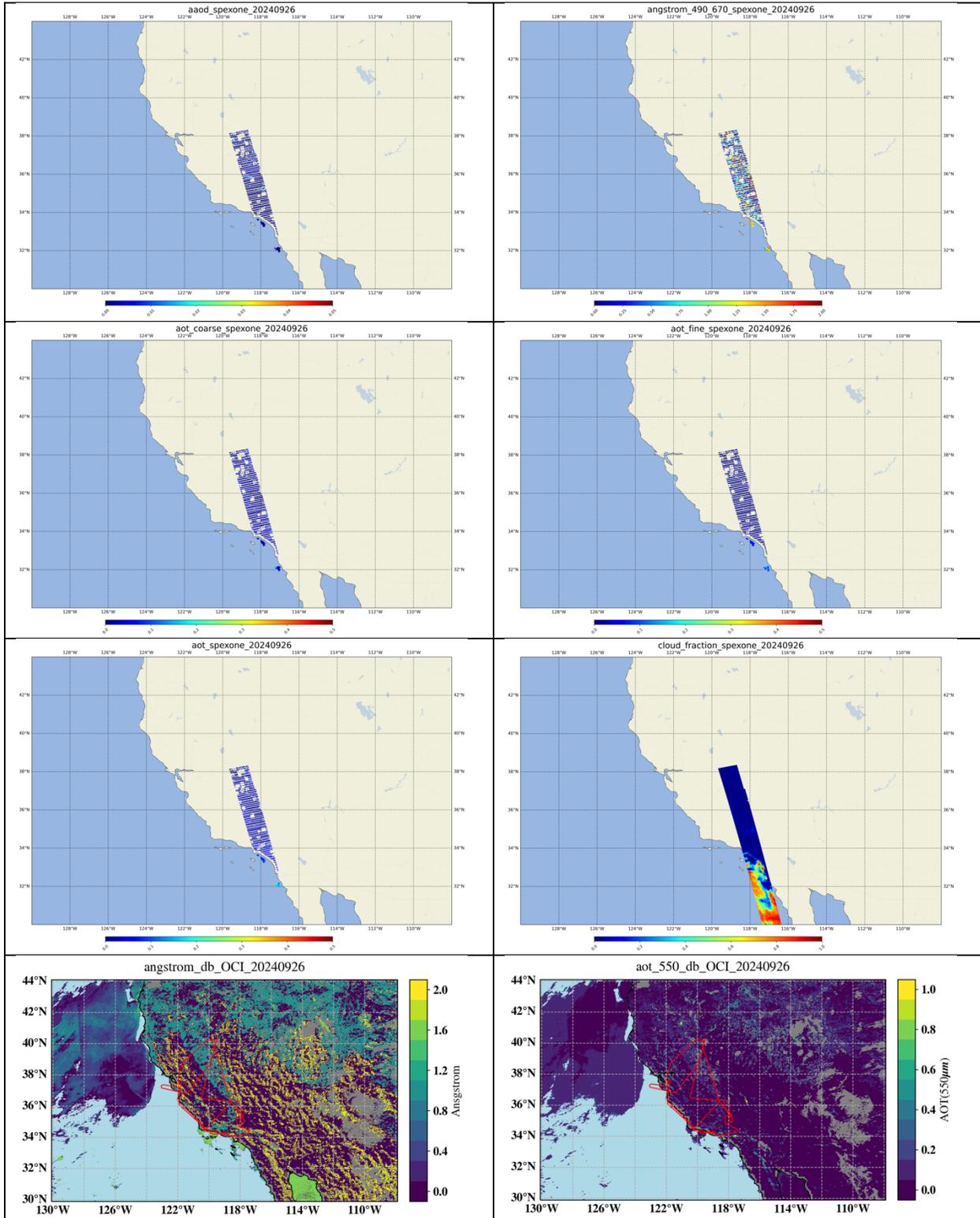
HSRL quicklooks

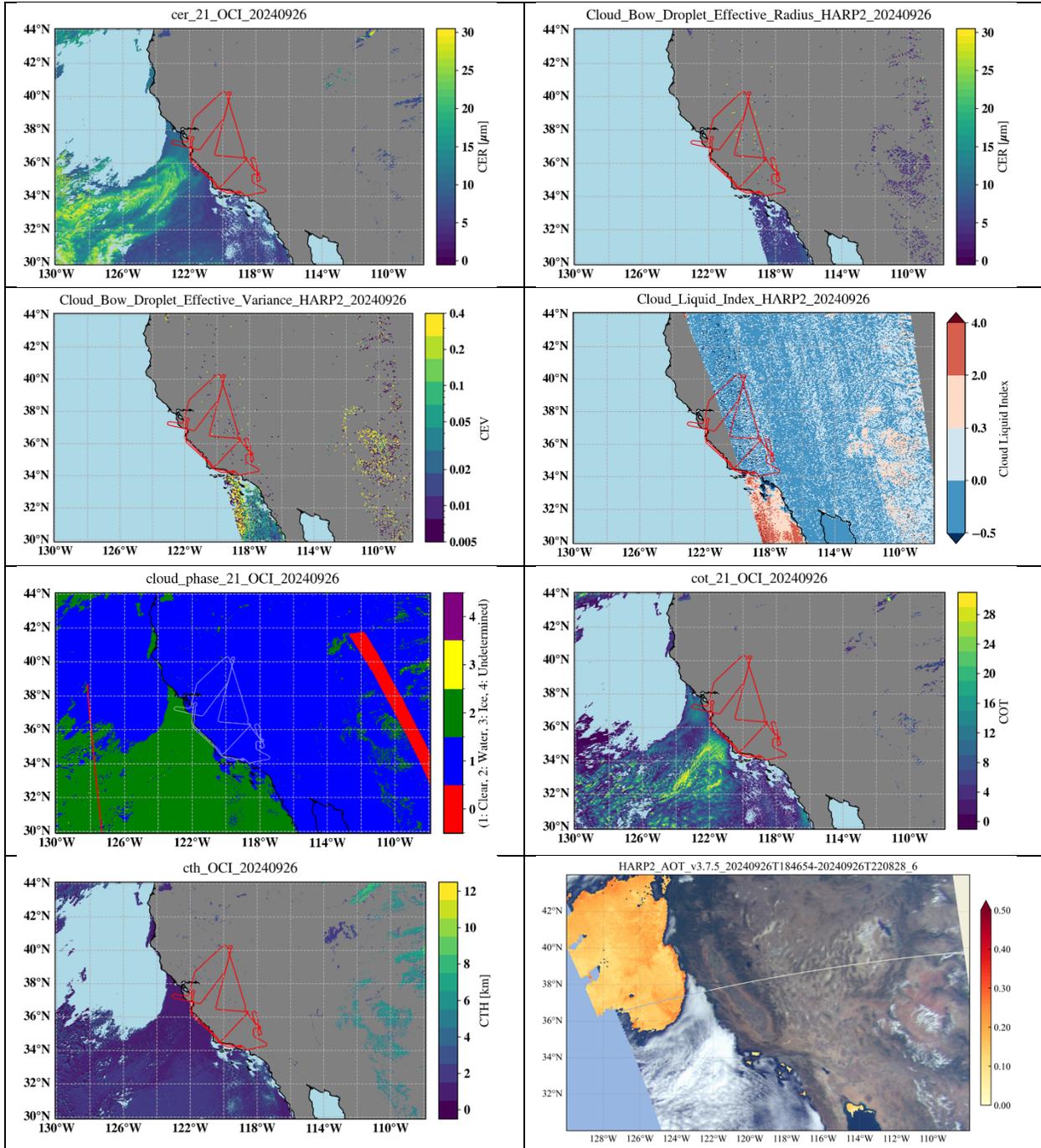


TO Quicklooks



PACE quicklooks





Twin Otter flight report

PACE-PAX Research Flight report 2024-09-26

Twin Otter Flight

Manifest:

Bryce Kujat (pilot)

Jeff Martin (pilot)

Elizabeth Wilk (QNC)

Adam Ahern (QNC)

Edward Winstead (QNC)

Note: This flight had coordination with the ER-2 and RV Shearwater.

Take off: 10:25:52 (17:25:52 UTC) Marina Airport (OAR)

Landing: 15:29:03 (22:29:03 UTC) Marina Airport (OAR)

Duration = 5.1 hrs

Spiral 1 – Over RV Shearwater (SHER1, revised) from 100 ft (19:25 UTC) to 10000 ft (19:50 UTC)

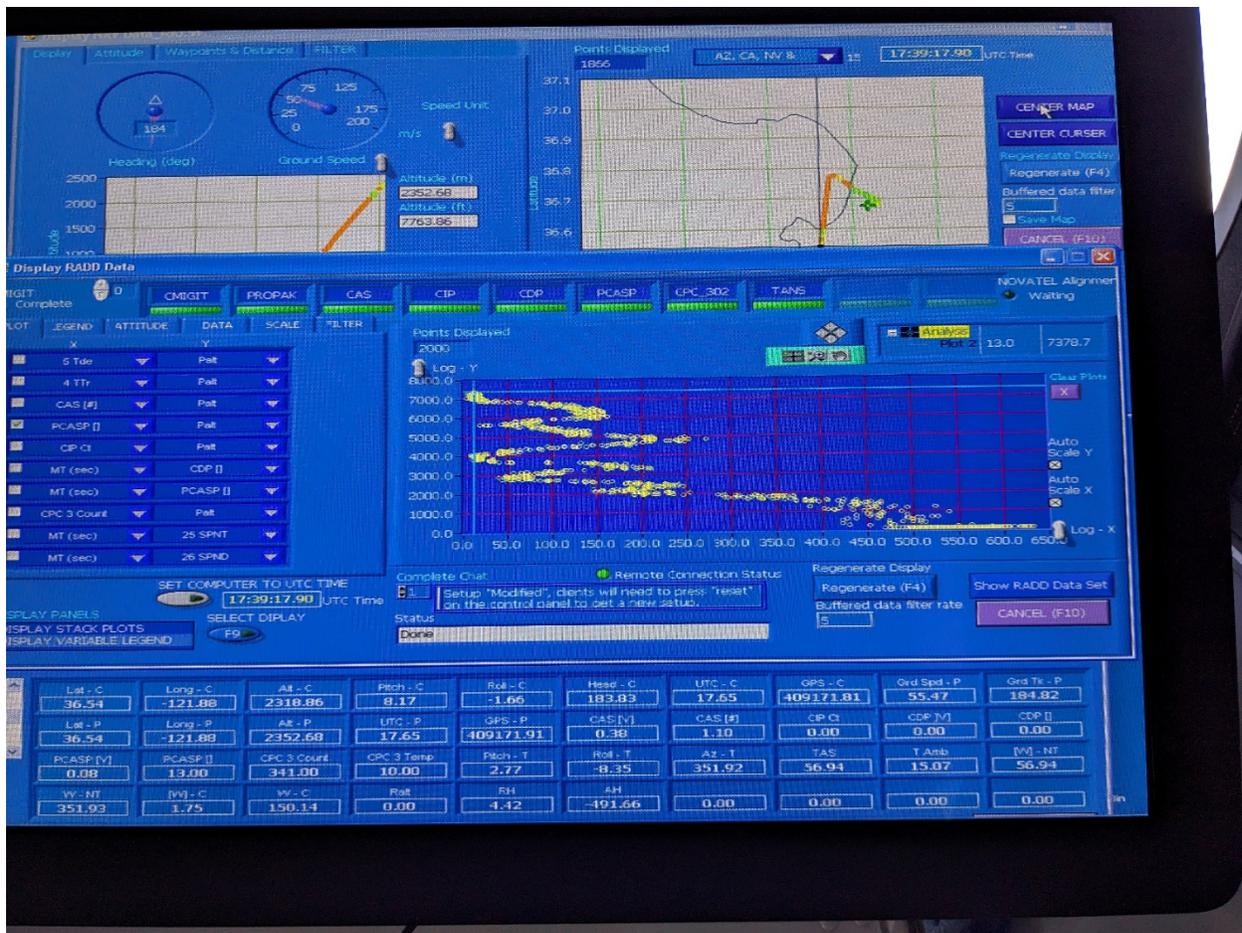
Spiral 2 – Over Red Tide near Oxnard CA

Spiral 3 – Over RV Shearwater (SHER2, revised) from 100 ft (20:20) to 10000 ft (20:59 UTC)

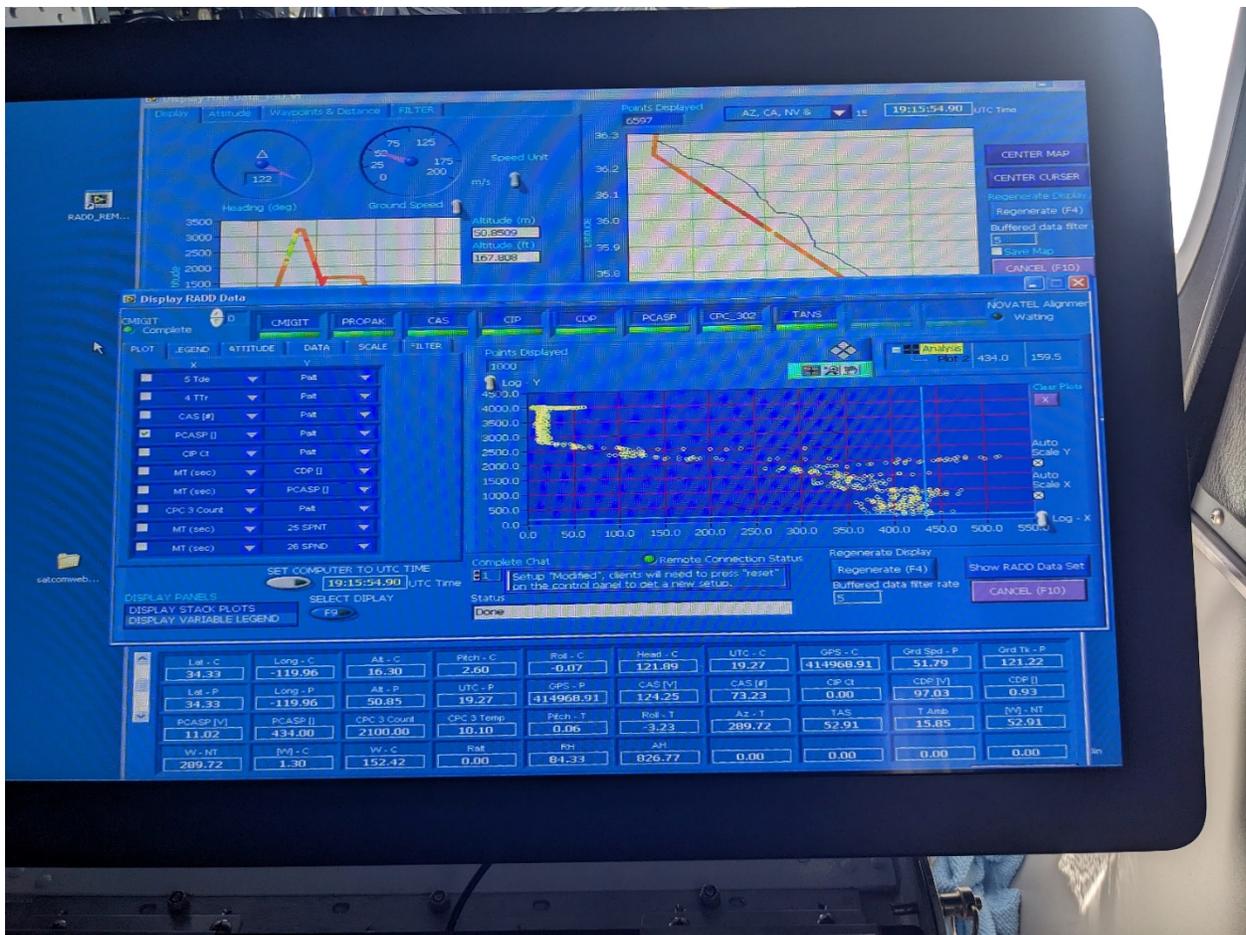
Objectives: The Twin Otter was targeting air masses predicted to contain optically thin levels of aerosols over water 1) under the ER-2's future flight path over water and 2) in spirals over the RV Shearwater off the coast of Santa Barbara. PACE overpass will occur during a spiral over the RV Shearwater at 20:29 UTC inside the HARP2 swath but outside the SPEXone swath. Missed approaches at the Marina tower are a target of opportunity.

Summary: Prior to and during takeoff, a large mode ($D_{opt} \sim 300$ nm) was observed with a scattering coefficient of 40 Mm^{-1} at 550 nm. After takeoff, we observed this layer to an altitude of 1600 ft. We continued to climb and turn towards the coast, observing several thin layers up to 7000 ft, see CIRPAS quickplot below. En route to the rendezvous with the RV Shearwater at SHER1, we tried to sample the aerosol layer observed at 5100' with an observed scattering coefficient of 15 Mm^{-1} . At the same time, the ER-2 was on an offset flight path to the west of the Twin Otter and observed a thick aerosol layer at 4000'. We descended to 4000' but did not see any increase from 15 Mm^{-1} of aerosol scattering. When we crossed overland the aerosol layer dissipated.

We descended in-line towards the RV Shearwater, reaching an altitude of 100 ft. During the first spiral over the RV Shearwater, we observed a thick layer up to 3000 ft, with a maximum scattering coefficient of 30 Mm^{-1} at 1960 ft and 19:31 UTC. The ER2 overflew us during the spiral. Very little aerosol was observed from 3000 ft up to 10000 ft. We descended inline towards Oxnard airport and identified a red tide (toxic algal bloom) off the shore. We spiraled down above it before continuing to the 2nd Shearwater coordination point at 2000' measuring scattering coefficients of $\sim 25 \text{ Mm}^{-1}$. When we reached the RV Shearwater we descended to 100 ft and began our spiral up, which showed a profile consistent with that observed in the first spiral. We climbed all the way to 10000 ft then headed back towards KOAR. We had to hold at 6000 ft for a few minutes during the spiral due to traffic. We were in the spiral in the aerosol layer over the RV Shearwater during the PACE overpass at 20:30 UTC. We returned to KOAR at 5000 ft and measured on average a scattering coefficient of 10 Mm^{-1} . Missed approaches weren't possible due to weather at KOAR.



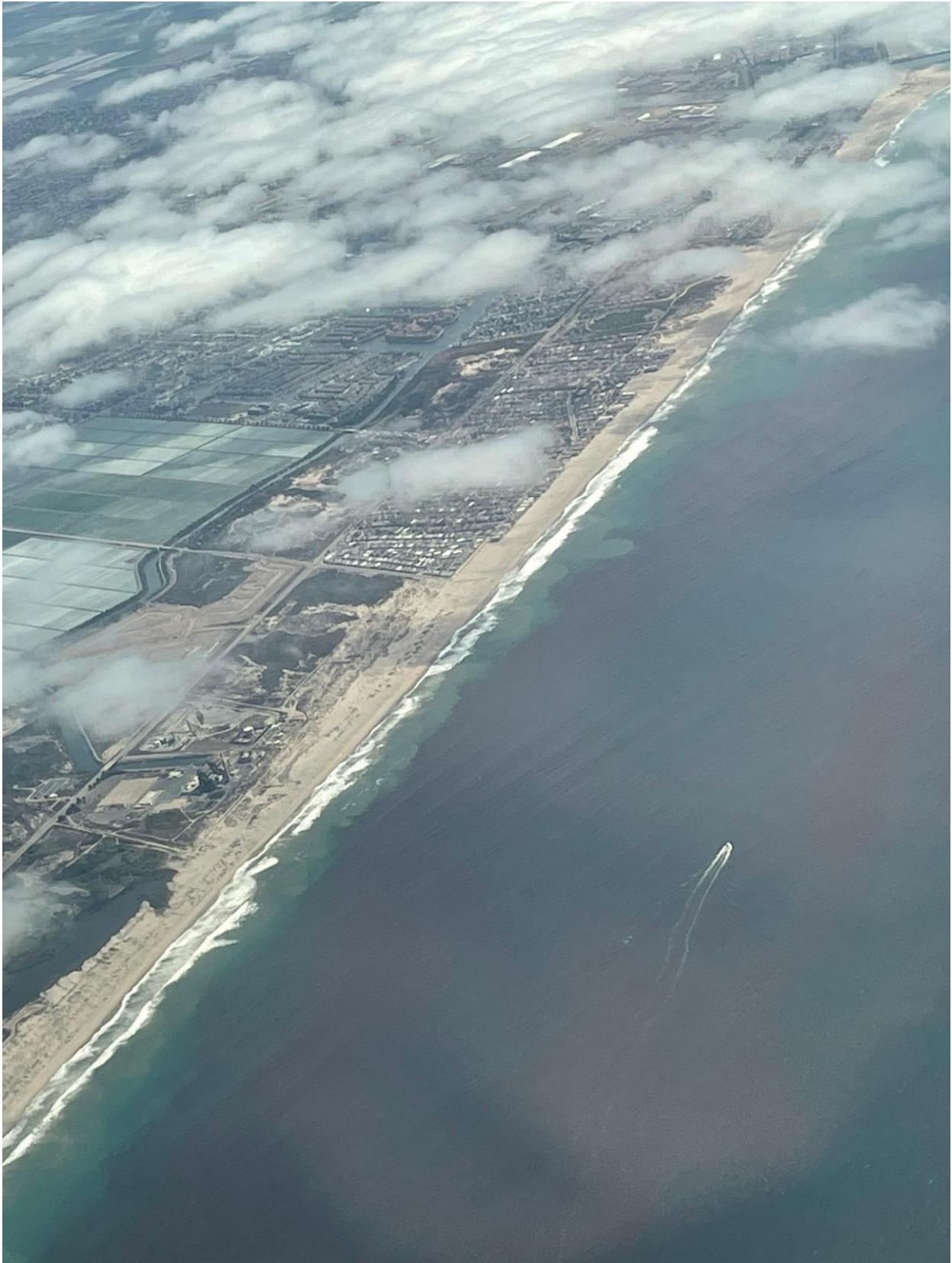
17:39:17 UTC – Climb and turn from KOAR - Layer of larger particles below 1600', with layers of optically thinner aerosol above were observed.



19:15:54 UTC – Descending in-line towards RV Shearwater shows a well mixed aerosol layer below 2600 ft.



20:01:17 UTC – Spiral over red tide near Oxnard between RV Shearwater spirals 1 and 2. Photo Adam Ahern



20:16 UTC – Another picture of the red tide near Oxnard; photo taken by Eddie Winstead.

R/V Shearwater report

Date: 09/26/2024

Creator: Michael Ondrusek

Cruise ID: RF0926-RS

Sailed out: 15:54 UTC

Back in port: 22:15 UTC

Today, the ship occupied 3 stations in clear skies!!!

Station #38 34° 11.308' N, -119° 37.773', arrival 16:36 UTC → departure 17:30 UTC

Arrival photo:



Departure photo (departure location - 34° 11.508', -119° 37.962')



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ER-2 overpass prior to arrival to station @19:34 UTC

Twin otter spiral 13:22 start

PACE overpass at 13:29

Arrival photo:



Departure photo: (34 20.201', -119° 38.964')



Tomorrow, RV Shearwater will demob and pack.

Ship plans through the next 3 days... No plans – demob end of the cruise.

System Status...

All good

Group Status...

All great