PACE-PAX research report 2024/09/22

Compiled by Kirk Knobelspiesse, Ivona Cetinić, Brian Cairns, Michael Ondrusek, 2024/09/28
Reviewed by Samuel LeBlanc

ER2 + Shearwater + HyperNAV in attempt to combine observations outside the Santa Barbara channel. Most likely unsuccessful due to clouds. This was the last chance at observations in the restricted flight area where the HyperNAV was located, which was why it was attempted (unsuccessfully) in potentially cloudy conditions. In the Central Valley, ER2 and Twin Otter coordinate for observations of smoke+dust, plus an overpass of Railroad Valley by the ER2.

ER-2
Take off: 16:30
Landing: 22:54
Pilot: Dean Neeley, mobile: Kirt Stallings

Twin Otter
Take off: 10:31:30 (17:31:30 UTC)
Landing: 13:59:17 (20:59:17 UTC)
Duration = 3.5 hrs.
Manifest: Bryce Kujat (pilot), Jeff Martin (pilot), Michael Shook (QNC), Ed Winstead (QNC), Francesca Gallo (QNC)
See end for full Twin Otter report

R/V Shearwater
Mission Scientist: Michael Ondrusek
Sailed out: 15:33 UTC
Back in port: 00:44 (09/22)UTC
See end for full R/V Shearwater report

R/V Blissfully
Operations concluded

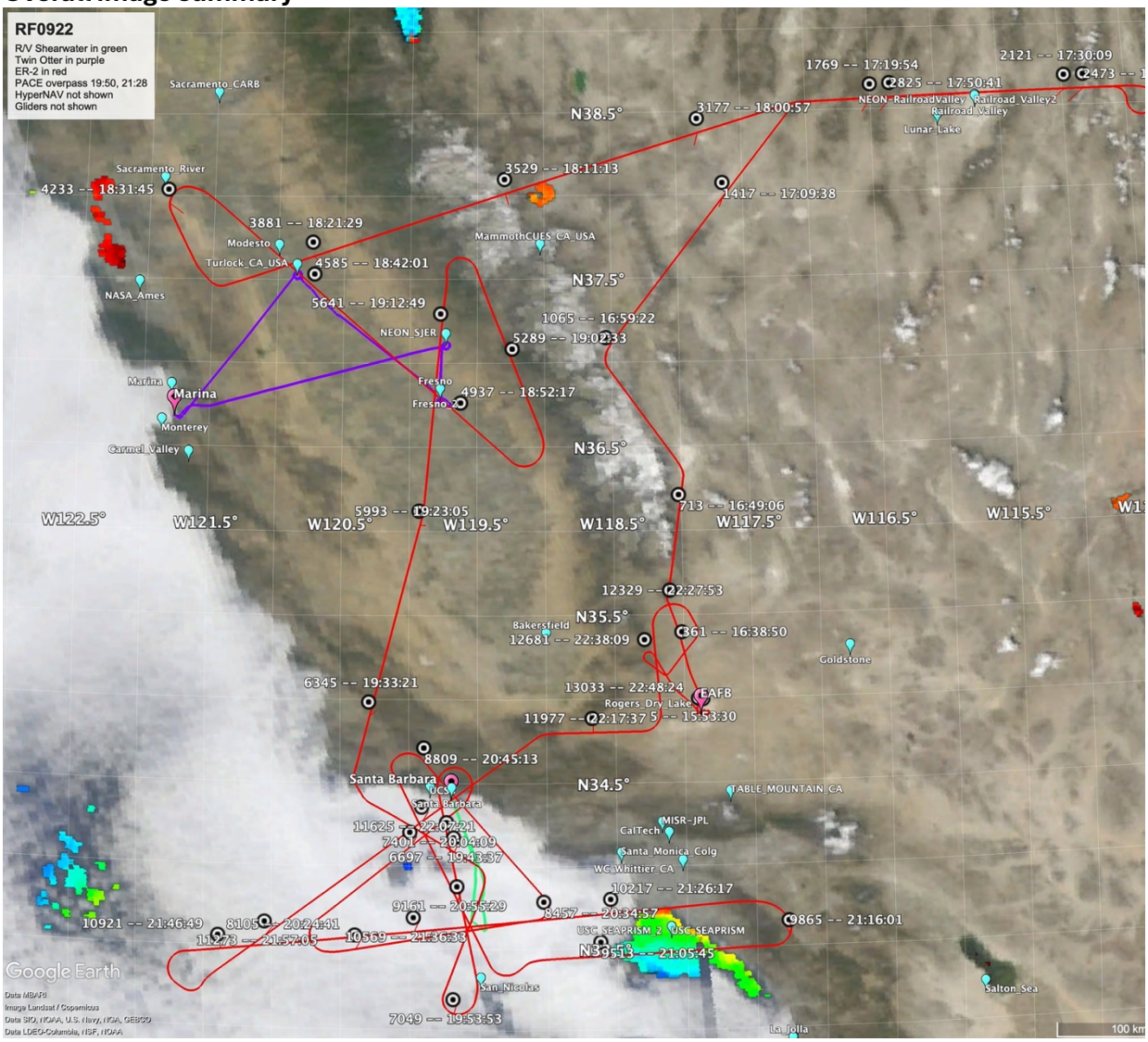
PACE
19:50, 21:28, OCI swath only

EarthCARE
Far from operations area and high surface winds, not targeted

Gliders
Operational

HyperNAV
Operational

Overall image summary



Note: not shown is the PACE tracks outside of range

Validation Traceability Matrix itemized objectives

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

Time UTC	Platform	VTM(hrs)	
15:33	RS		Shearwater departs
16:30	ER2		Takeoff. 15min delay
17:25	ER2	1a(0.5), 1d(0.5), 4a(0.5)	ER-2 over Railroad Valley. No Clouds. AERONET AOD(500)=0.055
17:31	TO		Takeoff
17:45	ER2	1a(0.5), 1d(0.5), 4a(0.5)	ER-2 over Railroad Valley. No Clouds. AERONET AOD(500)=0.056
18:09	TO, ER2	1d(1.5)	Begin spiral down over Turlock, ER2 overpass at 18:23. end at 18:31
18:03	ER2	1d(0.5)	ER-2 over Turlock AERONET site, AOD(500)=0.09

18:17	RS, ER2	4c(0.5)	Shearwater on station #30 for first ER-2 overpass and PACE overpass (19:41). Station ends at 19:58. Fully cloudy, not scored.
18:44	TO, ER2	1d(1.5), 6c(1.5)	Long leg in central valley ,18:44 over Merced, with ER-2 overhead.
19:11	TO	1d(1.5), 6c(1.5)	Spiral up at Fresno, AOD(500)=0.12. Variable angstrom exponent.
19:13	ER2	1a(0.5), 1d(0.5)	ER-2 over NEON_SJER AERONET site, AOD(500)=0.11
19:41	ER2, gliders	4c(0.5)	ER-2 over gliders. Cloudy. Scored for cloud reference.
19:14	ER2, TO	1d(0.5)	ER-2 overflight of TO flight path (19:40) between Fresno and NEON_SJER (AOD~0.11) – agricultural dust
19:44	TO, PACE-O	1d(1.5), 6c(1.5)	Spiral down over NEON_SJER AERONET AOD(500)=0.11, site during PACE-O overpass.
19:50	**PACE**		**PACE overpass east of observed area**
19:50	ER2	1e(1.0)	ER2 over Shearwater, but fully cloudy. Scored for cloud retrievals because in PACE-O swath for overpass.
20:21	RS, ER2	4c(0.5)	Shearwater on station #31. HyperNAV surfaces nearby at 20:13. ER-2 overpass. Cloudy. Scored for cloud reference.
20:31	ER2	4c(0.5)	Another attempt at overpass of Shearwater, still cloudy .Scored for cloud reference.
20:55	ER2	4c(0.5)	Another attempt at overpass of Shearwater, still cloudy, Scored for cloud reference.
20:59	TO		Twin Otter lands.
21:10	ER2		ER-2 over USC_SeaPRISM in cloud free conditions, however, SeaPRISM is non-functional.
21:31	ER2	4c(0.5)	Another attempt at overpass of Shearwater, still cloudy. Scored for cloud reference.
21:42	RS		Returns
22:54	ER2		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:

- of objectives observed. Successful coordination between ER-2 and TO not scored highly because aerosol over land objectives have largely been met, however, the long run down the valley is a different version of this and useful. Many attempts at overflying HyperNAV and Shearwater, but clouds ruined the day. Salvaged somewhat in that those data can be used to validate bright surfaces, low polarization (4c)
- Top remaining objectives (score above 6.0): PACE aerosol in narrow swath (3a,b)

PACE-PAX progress tracking

Validation objectives	ID	Measurement objectives	Importance, w	Observation time, h (hours)	Total observed (hours)	Fractional success 9/16	Fractional success 9/17	Fractional success 9/18	Fractional success 9/19	Fractional success 9/20	Fractional success 9/21	Fractional success 9/22	Total success	Remaining score
1. Validate new retrieval properties	a	Land surface parameters	8	2.0	5.5	0.0%	39.3%	0.0%	0.0%	0.0%	0.0%	3.2%	0.971	0.2
	b	Ocean radiometric parameters	10	8.0	17.0	0.0%	2.6%	0.5%	0.4%	0.1%	0.0%	0.0%	0.995	0.0
	c	Aerosol parameters over the ocean	12	8.0	12.0	0.0%	4.1%	1.1%	1.2%	0.6%	0.0%	0.0%	0.980	0.2
	d	Aerosol parameters over land	12	8.0	12.5	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.999	0.0
	e	Cloud parameters	12	8.0	4.0	0.0%	0.0%	0.0%	0.0%	9.5%	0.0%	2.5%	0.815	2.2
	f	Ocean surface parameters	1	8.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.000	1.0
3. Validate in a narrow swath	a	Aerosol parameters over the ocean (PACE)	10	8.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.354	6.5
	b	Aerosol parameters over land (PACE)	10	8.0	2.0	0.0%	17.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.403	6.0
	c	Cloud parameters (PACE)	5	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.713	1.4
	d	Aerosol parameters (EarthCARE)	8	4.0	4.5	0.0%	28.2%	0.0%	7.9%	0.0%	0.0%	0.0%	0.826	1.4
	e	Cloud parameters (EarthCARE)	8	4.0	1.0	0.0%	19.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.313	5.5
4. Validate radiometric and polarimetric properties	a	Validate large reflectances	6	2.0	5.0	0.0%	49.3%	0.0%	0.0%	0.0%	0.0%	3.0%	0.953	0.3
	b	Validate large reflectances with high polarization	6	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.393	3.6
	c	Validate large reflectances with low polarization	6	2.0	2.5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.9%	0.936	0.4
	d	Overfly vicarious calibration sites	6	4.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.268	4.4
6. Focus on specific processes or phenomena	a	High aerosol loads over land	4	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.000	0.0
	b	High aerosol loads over ocean	4	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.393	2.4
	c	Multiple aerosol layers	1	2.0	4.5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.000	0.0
	d	Aerosol under thin cirrus	2	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.000	2.0
	e	Aerosol above liquid phase cloud	4	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.826	0.7
	f	Broken clouds with complex structure	4	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.528	1.9
	g	Dust aerosols over ocean	4	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.430	2.3
	h	Aerosol and ocean parameters over turbid waters	2	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.790	0.4
	i	Aerosol and ocean parameters over biologically productive waters	4	2.0	5.0	0.0%	86.5%	5.3%	0.0%	0.0%	0.0%	0.0%	0.918	0.3
	k	Smoke aerosols over ocean	1	2.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.713	0.3
		total:	150	98	75.5	0.0%	10.6%	0.3%	0.5%	0.8%	0.0%	1.1%	0.710	
														total
				ER-2 flight hours	15.8	0	0	0	0	0	0	0	0	15.8
				TO flight hours	11.2	0	0	0	0	0	0	0	0	11.2
				Shearwater days	4	0	0	0	0	0	0	0	0	4

PACE-PAX overall objectives satisfied: 0.710

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

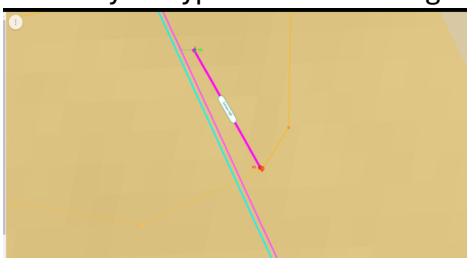
R/V Shearwater photos

Station #30 33 40.879', -119° 33.409' , arrival 18:17 UTC →departure 19:48 UTC
ER-2 overpass at 19:50, same as PACE first overpass
Just after departure another overpass at 19:58 UTC

Arrival photo:

Departure photo (departure location - 33° 37.427', -119° 29.292')

Station #31 33 37.301', 119° 28.080', arrival 20:21 UTC → departure 21:42 UTC
Proximity of HyperNAV – surfacing at 20:13:50.



ER-2 overflight at 20:59

Arrival photo:

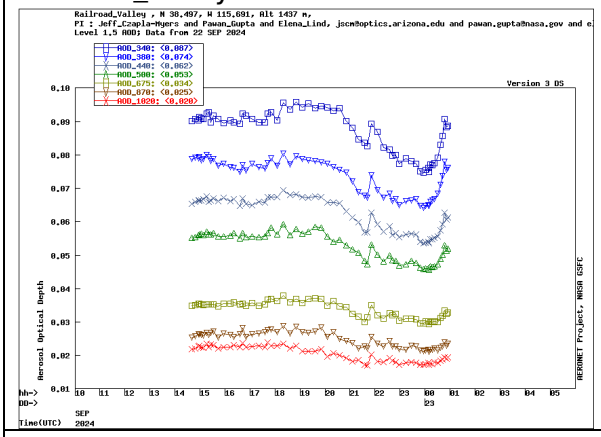
Departure photo: (33 37.176’, -119° 26.766’)

Twin Otter photos

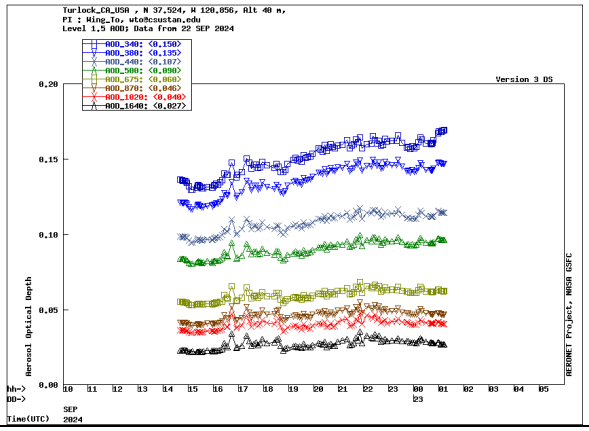
ER-2 co-ordination was extremely good and widespread dust was observed throughout the flight in the boundary layer. One source of dust was tree shaking operations, see photos in full report at end.

AERONET plots

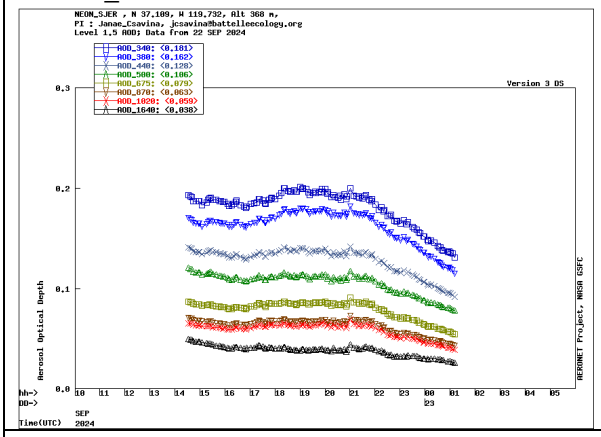
Railroad_Valley



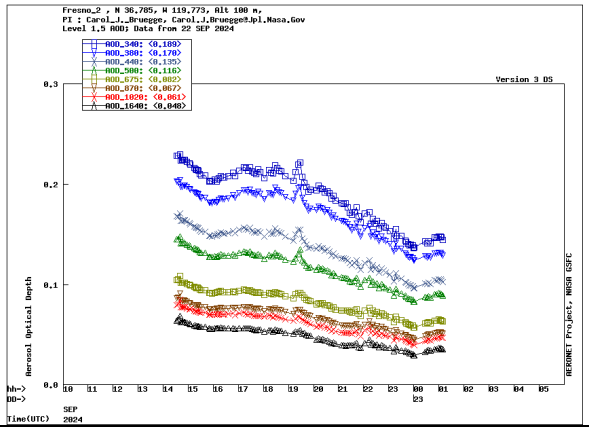
Turlock



NEON_SJER

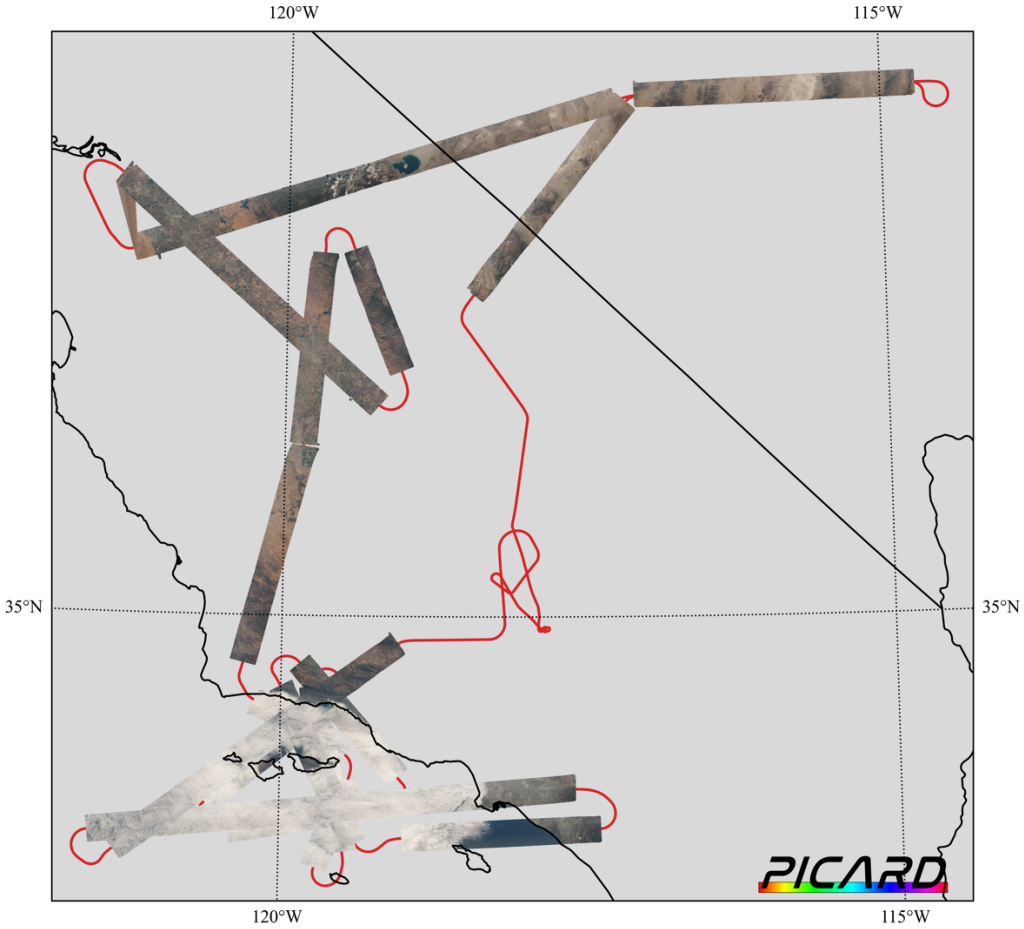


Fresno_2



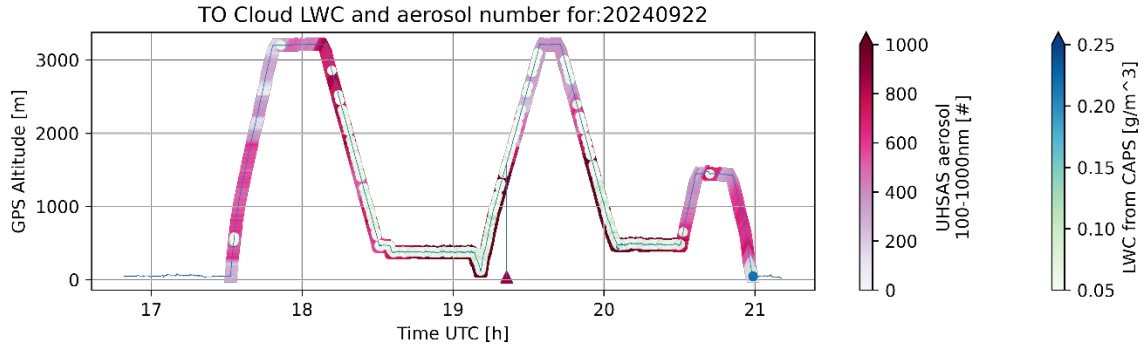
USC_SeaPRISM
Not operational

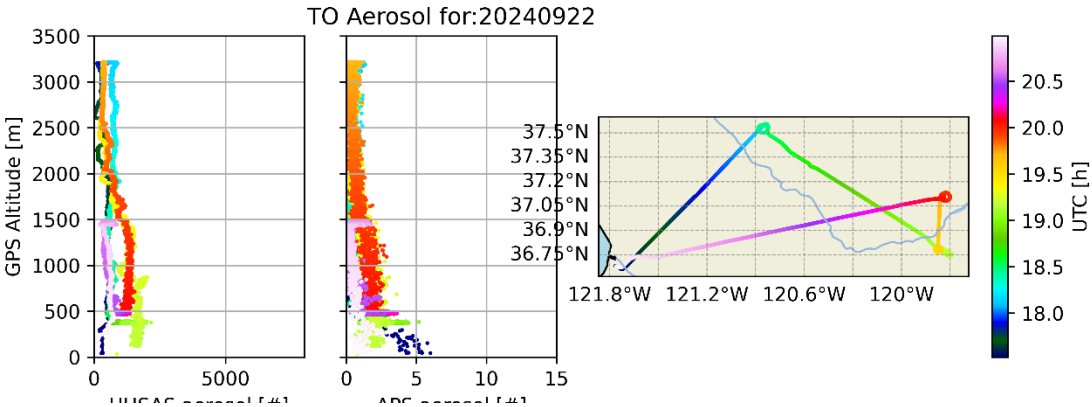
PICARD quicklooks



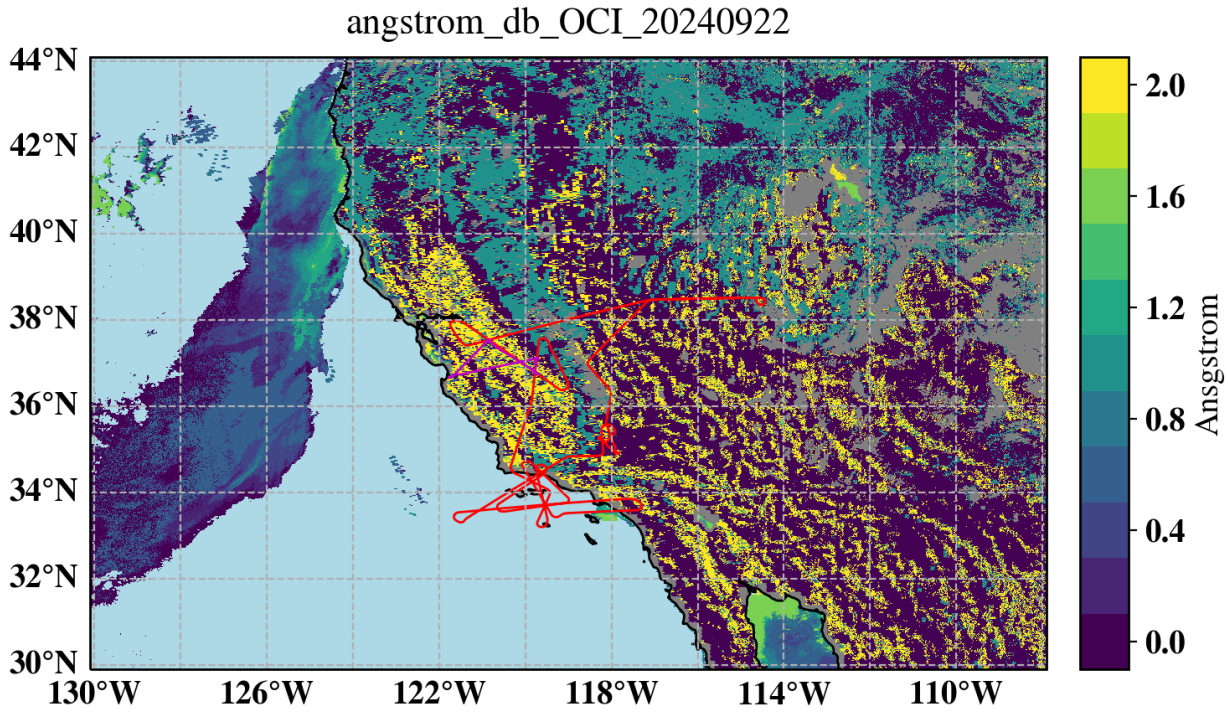
Pushbroom Imager for Cloud and Aerosol Research and Development
PACE-PAX, NASA Armstrong Flight Research Center
22 September 2024

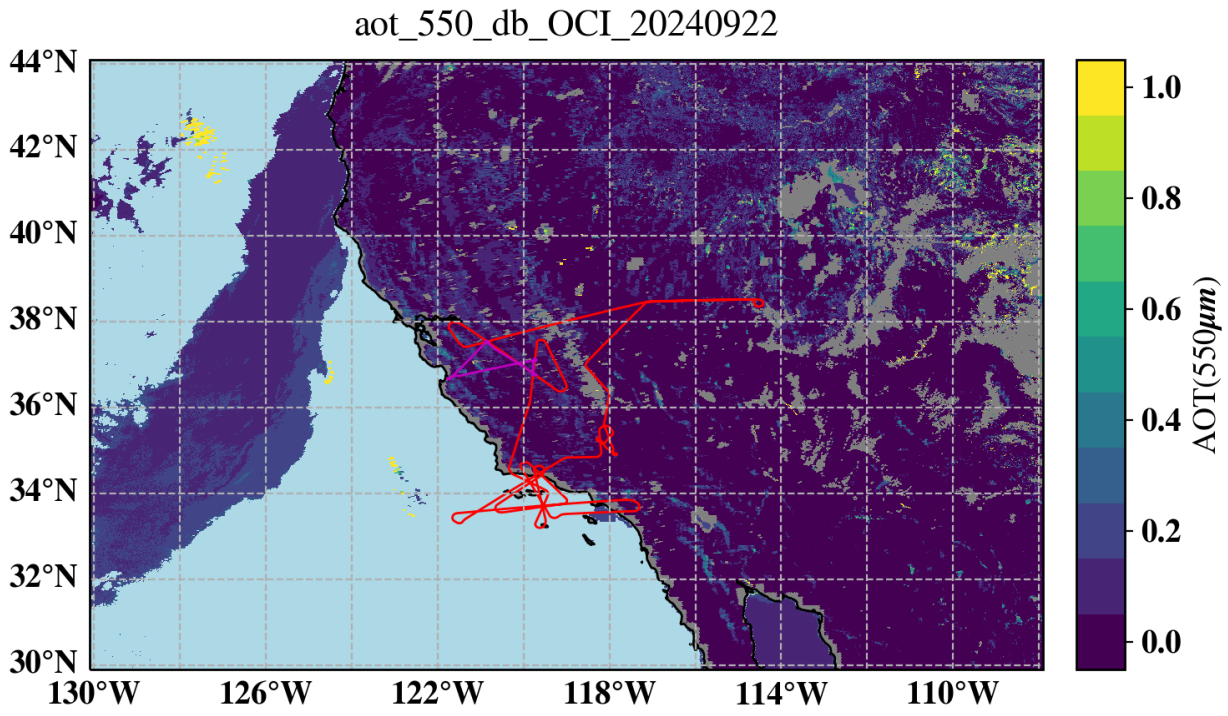
TO quicklooks



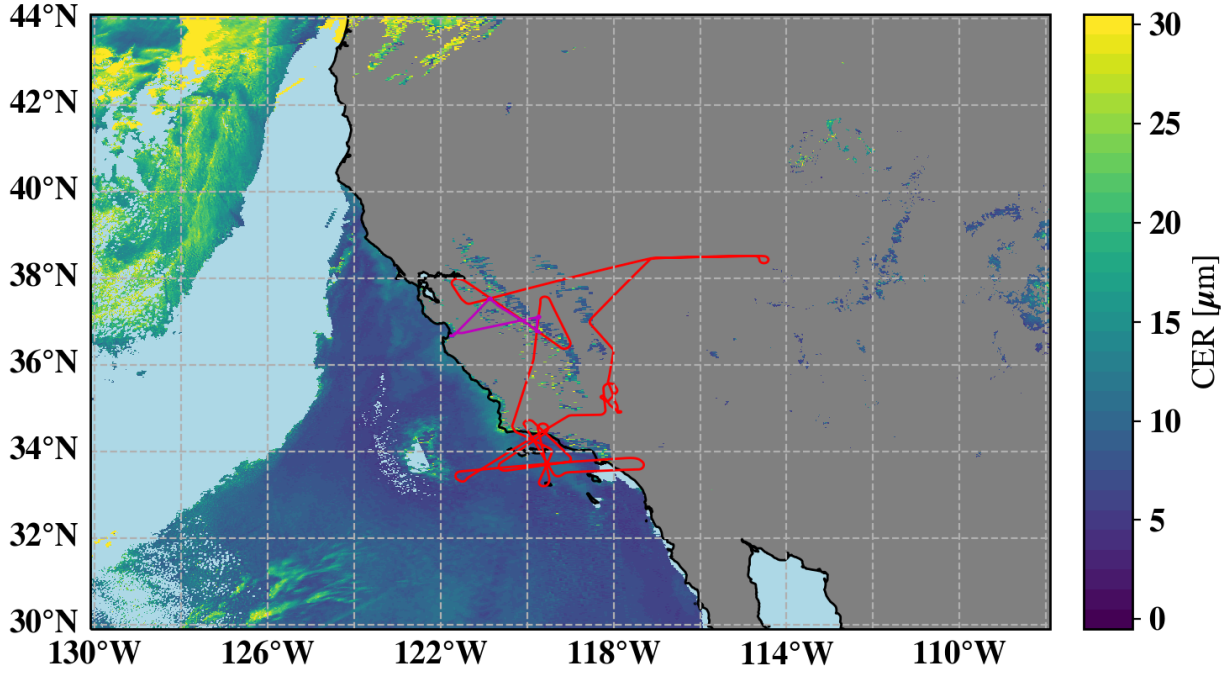


PACE quicklooks

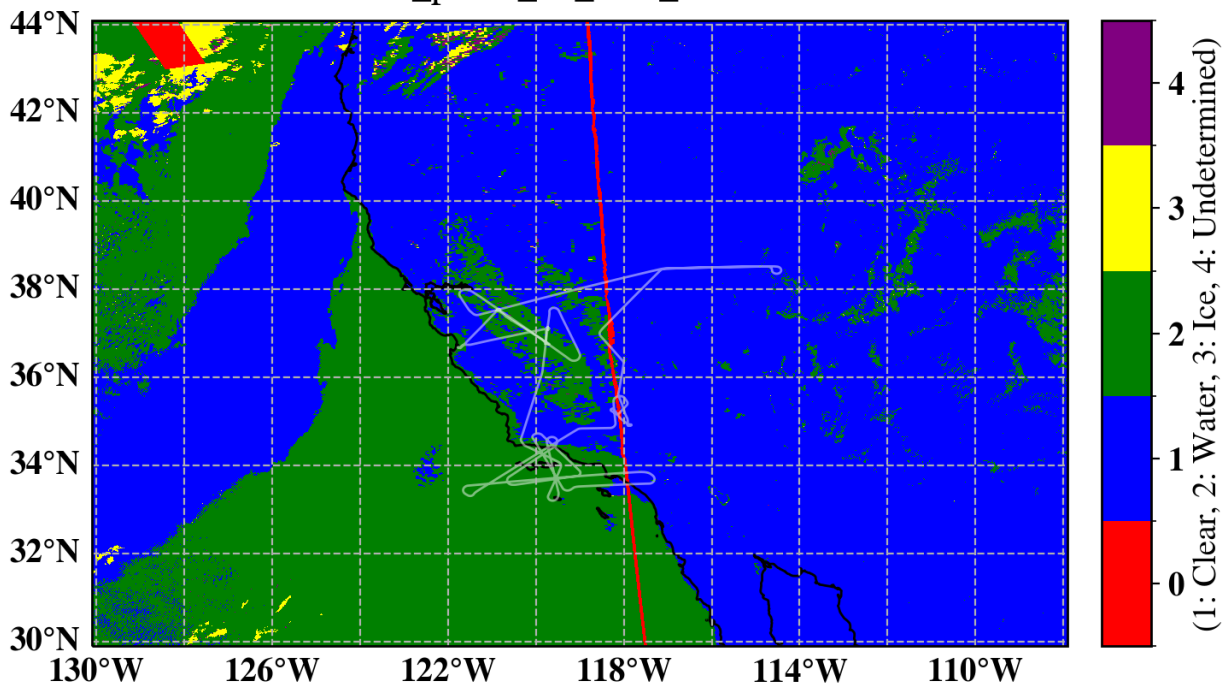


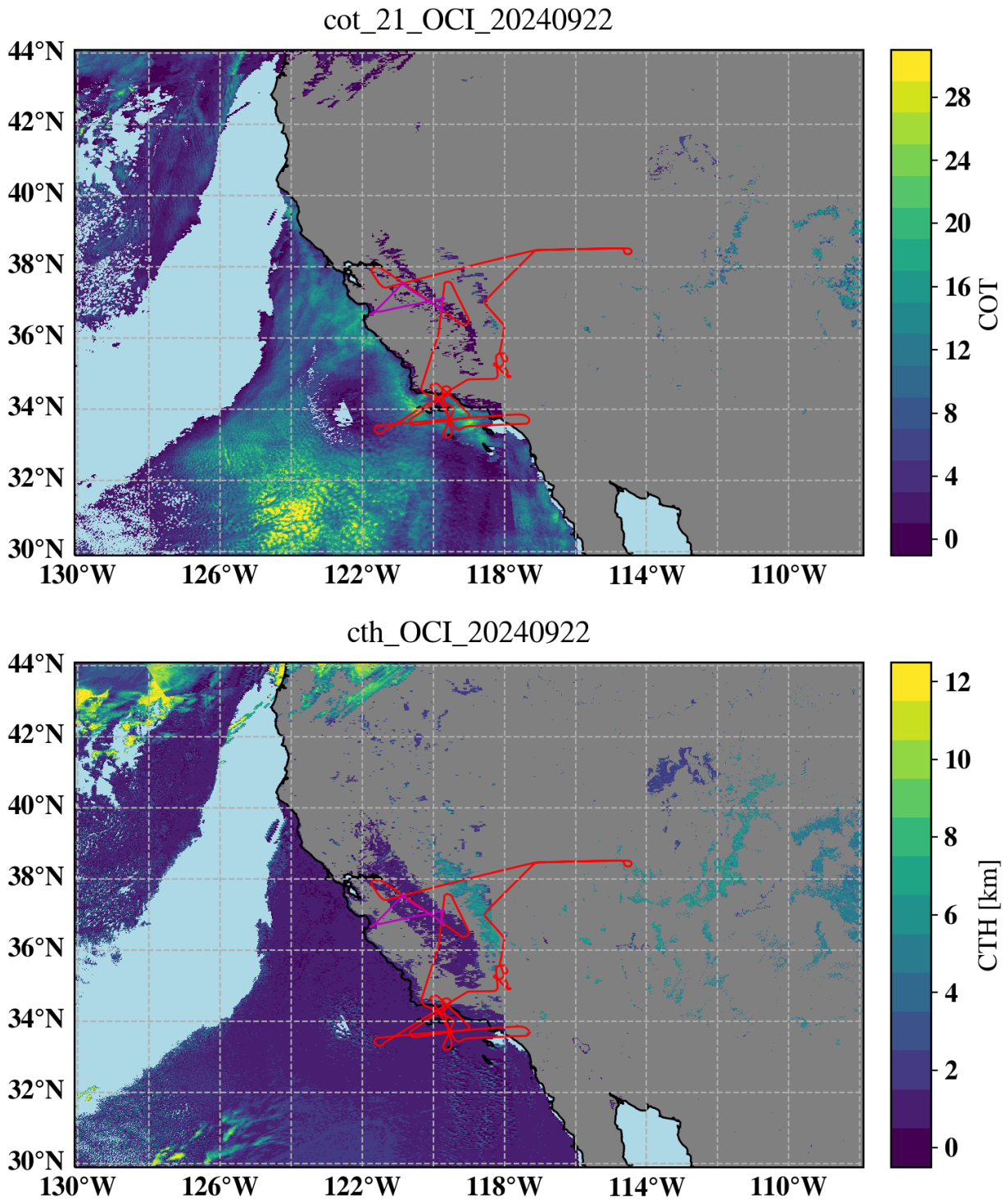


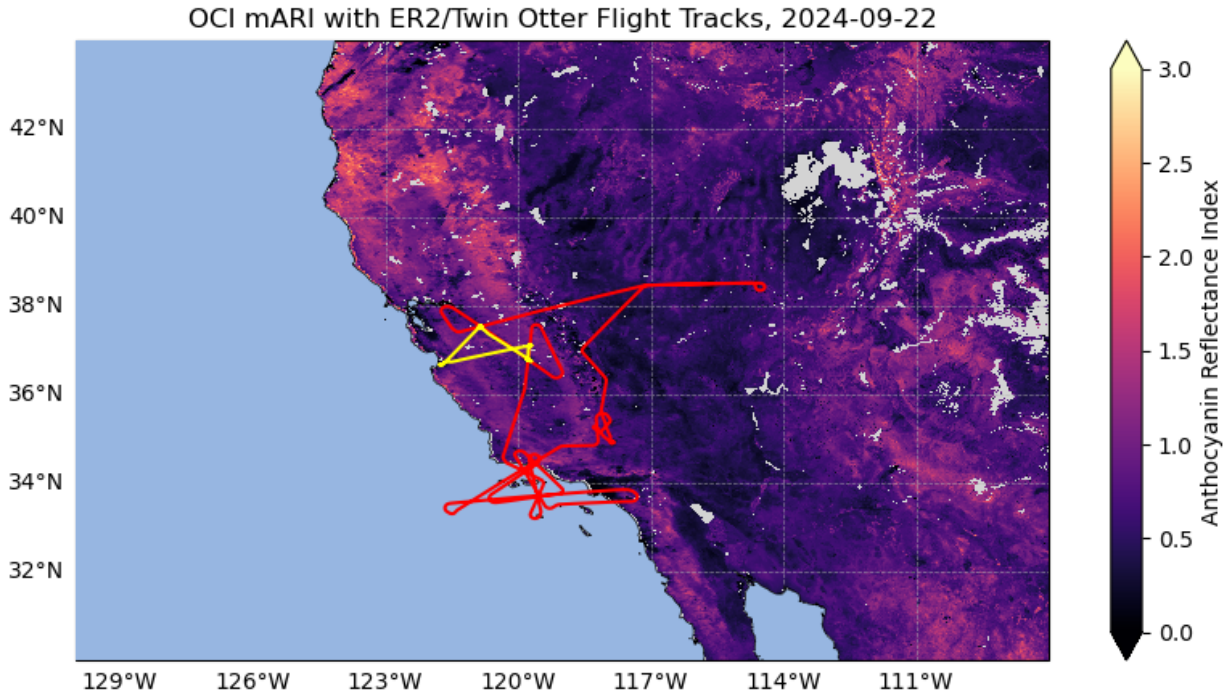
cer_21_OCI_20240922

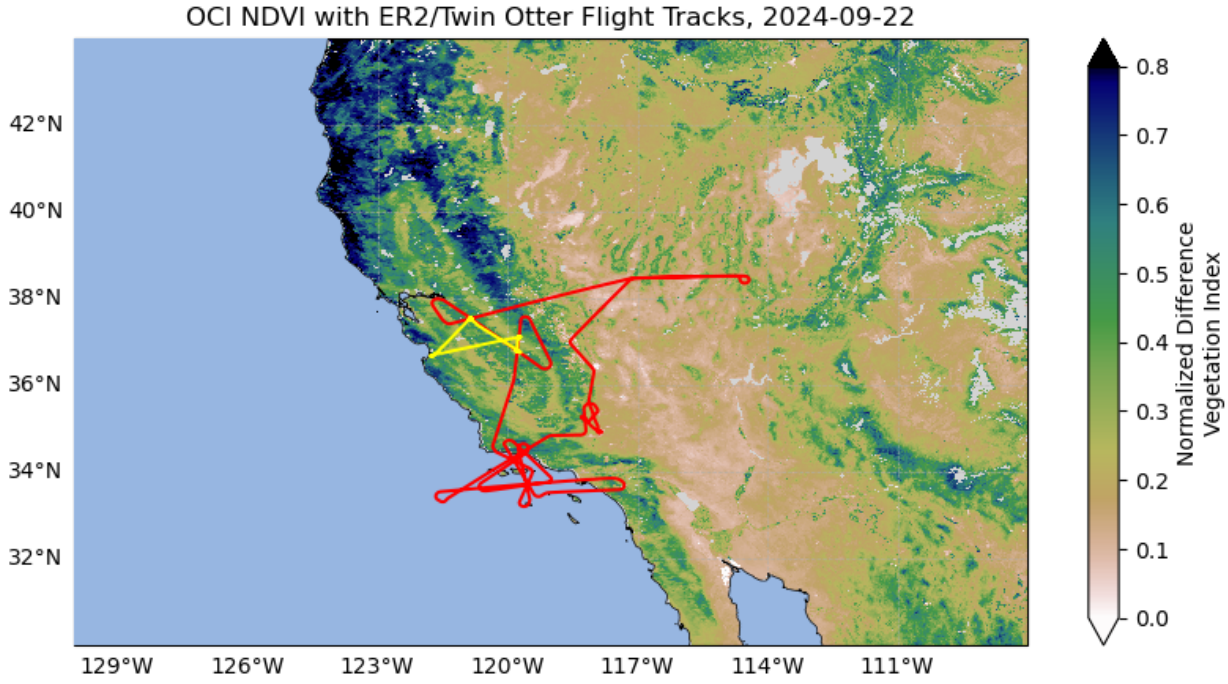


cloud_phase_21_OCI_20240922

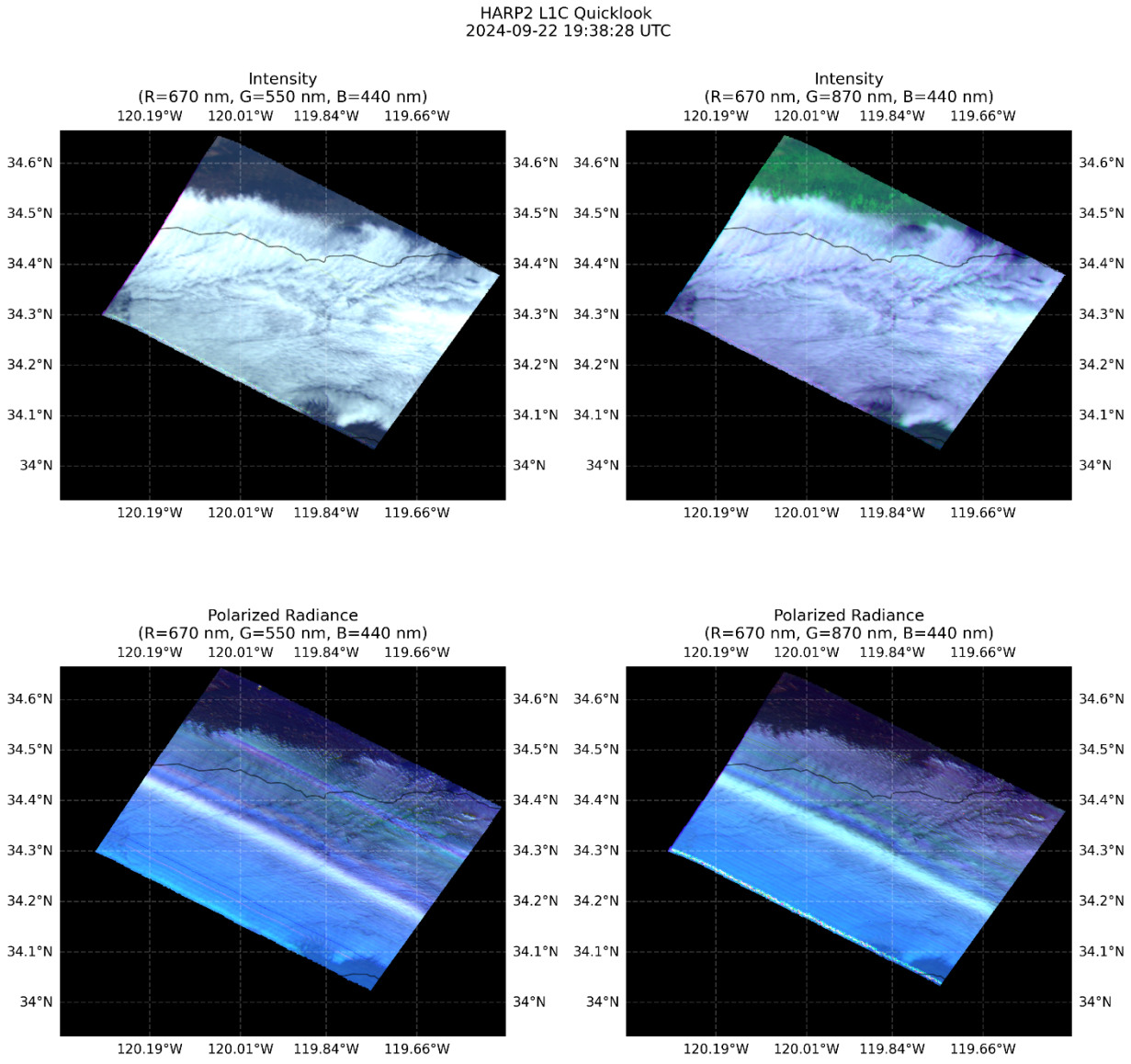



cot_21_OCI_20240922
44°N
42°N
40°N
38°N
36°N
34°N
32°N
30°N
130°W
126°W
122°W
118°W
114°W
110°W
28
24
20
16
12
8
4
0
COT
cth_OCI_20240922
44°N
42°N
40°N
38°N
36°N
34°N
32°N
30°N
130°W
126°W
122°W
118°W
114°W
110°W
12
10
8
6
4
2
0
CTH [km]


OCI mARI with ER2/Twin Otter Flight Tracks, 2024-09-22
42°N
40°N
38°N
36°N
34°N
32°N
129°W
126°W
123°W
120°W
117°W
114°W
111°W
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Anthocyanin Reflectance Index

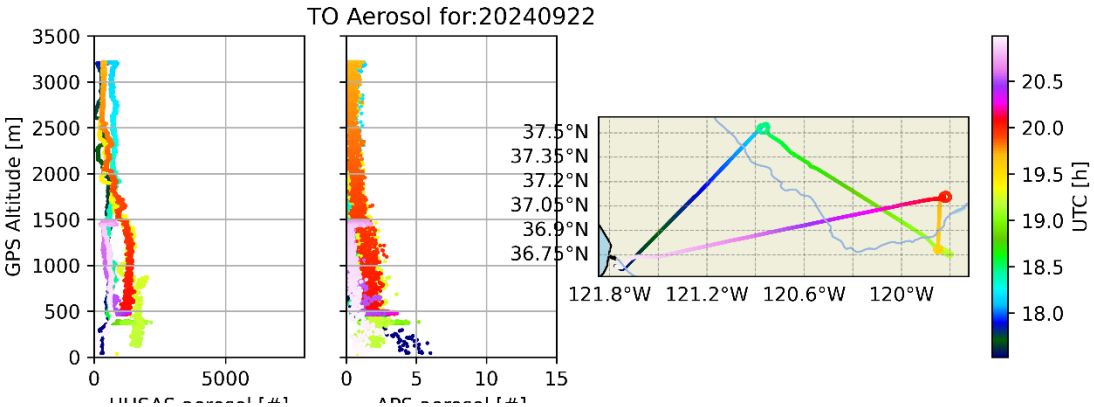

OCI NDVI with ER2/Twin Otter Flight Tracks, 2024-09-22
42°N
40°N
38°N
36°N
34°N
32°N
129°W
126°W
123°W
120°W
117°W
114°W
111°W
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Normalized Difference Vegetation Index

AirHARP Quicklooks



(Showing high polarization and white background for the 18:17 UTC

TO aerosol vertical profile



Twin Otter full report

PACE-PAX Research Flight report 2024/09/22

Twin Otter Flight

Manifest:

Bryce Kujat (pilot)

Jeff Martin (pilot)

Michael Shook (QNC)

Ed Winstead (QNC)

Francesca Gallo (QNC)

Take off: 10:31:30 (17:31:30 UTC)

Landing: 13:59:17 (20:59:17 UTC)

Duration = 3.5 hrs.

Objectives: Profiles of aerosol scattering and absorption coefficients and size distributions together with scattering (polarized) phase functions using spiral ascents and descents over Turlock, Fresno and the San Joaquin Experimental range (SJER) field site located approximately 40 km (25 mi.) north of Fresno, CA. Spirals over Turlock and Fresno to be coordinated with ER-2 overpasses, and the SJER spiral to be coordinated with a PACE overpass.

Summary: Climb to 10 kft after takeoff en route to Turlock. During cruise at 10 kft it was quite clean with a scattering coefficient of 2 Mm^{-1}. The Turlock spiral down began at 11:09 local (18:09 UTC) with the ER-2 about 6 minutes away and seen by the Twin Otter on ADSB. Spiraling down green scattering coefficient was relatively constant (~10/12 Mm^{-1}). The HSRL2 on the ER-2 was showing a lower aerosol layer at 1 kft. ER-2 overpass took place at about 18:23 during the spiral. A second ER-2 overpass took place near Merced, which had to be avoided because of air traffic. Scattering coefficient during ER2 overpass at 18:44UTC was ~20 Mm^{-1}, and up to 25 Mm^{-1} over Merced. Descended to 1.2 kft during transit from Turlock to Fresno to get in the boundary layer with scattering coefficients of ~ 25 Mm^{-1} observed. A lot of agricultural activity was observed during the

transit with scattering coefficients of 20-35 Mm-1 observed during set up for low approach at Fresno. Aerosol Optical Depth (AOD) at Fresno was ~ 0.14 with the Angstrom coefficient being “all over the place and centered about unity”. Low approach at Fresno was completed at 12:11 local (19:11 UTC) with scattering coefficients consistent throughout the approach at 35 Mm^{-1}. Spiral up near Fresno with boundary layer top at 3 kft and ER-2 overpass during the spiral. Scattering coefficient dropped from 35 Mm-1 to 20-25 Mm-1 as we left the boundary layer, and decrease with increase in altitude (~10 Mm^{-1} at 5 kft, ~5Mm^{-1} at 7 kft). Spiral at Fresno was completed at 12:35 local (19:35 UTC) with scattering coefficient of 4 Mm^{-1} and particle number concentrations of 1000 cc^{-1} at 10 kft during transit to SJER. Spiral down at SJER began at 12:44 local (19:44 UTC). Satcom lost at 12:53 local (19:53 UTC) and restored at 12:55 (19:55 UTC) after power cycle. SJER spiral was completed at 13:04 local (20:04 UTC) at 1.5 kft with scattering coefficients of 25 Mm^{-1} and particle concentrations of 5000 cc^{-1}. Climbed to 4.5 kft to avoid terrain during transit back to Marina (scattering coefficient ~3/4 Mm^{-1} at 4.5 kft). No low approaches were done prior to landing because of poor weather conditions. Landed at Marina at 13:59:17 local (20:59:17 UTC).

ER-2 co-ordination was extremely good and widespread dust was observed throughout the flight in the boundary layer. One source of dust was tree shaking operations, see photo below.

Dust devil southeast of Turlock at 18:41 UTC; photo taken by Michael Shook

Dust generated by tree shaking activities in the Central Valley; photo taken by Francesca Gallo.

Missed approach at Fresno; photo taken by Francesca Gallo.

San Joaquin Experimental range taken from 9 kft; photo taken by Francesca Gallo.

Landing at Marina Airport at 20:59:17 UTC; photo taken by Francesca Gallo.

R/V Shearwater full report

Date: 09/22/2024

Creator: Michael Ondrusek

Cruise ID: RF0922-RS

Sailed out: 15:33 UTC

Back in port: UTC (09/23/2024)

Today, the ship occupied 2 stations in proximity of HyperNAV

Station #30 33 40.879', -119° 33.409' , arrival 18:17 UTC →departure 19:48 UTC

ER-2 overpass at 19:50, same as PACE first overpass

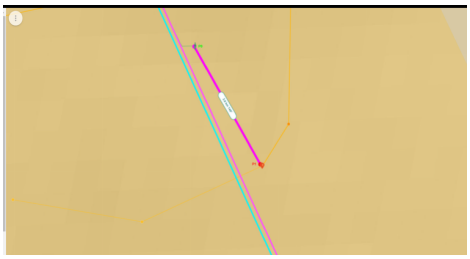
Just after departure another overpass at 19:58 UTC

Arrival photo:

Departure photo (departure location - 33° 37.427', -119° 29.292')

Station #31 33 37.301', 119° 28.080', arrival 20:21 UTC → departure 21:42 UTC

Proximity of HyperNAV – surfacing at 20:13:50.



ER-2 overflight at 20:59

Arrival photo:

Departure photo: (33 37.176’, -119° 26.766’)

Tomorrow, RV Shearwater will

Ship plans through the next 3 days…

System Status…

All good

Group Status…

All great