

# **PACE-PAX research report 2024/09/24**

**Compiled by Kirk Knobelspiesse, Brian Cairns  
2024/10/06**

**Reviewed by Samuel LeBlanc**

Operations for Twin Otter aircraft only, offshore cloud observations during PACE and EarthCARE overpasses. Spiral over Monterey bay at end of flight to provide vertical aerosol profile context for any retrievals of HABs in Monterey Bay made during PACE overpass.

## **ER-2**

No flight

## **Twin Otter**

Takeoff: 20:09

Landing: 23:14

Duration: 3.1 hours

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

## **R/V Shearwater**

No operations

## **PACE**

20:59, Offshore. Monterey Bay is in PACE-OH swath

## **EarthCARE**

22:33, offshore Northern California, orbit 1851

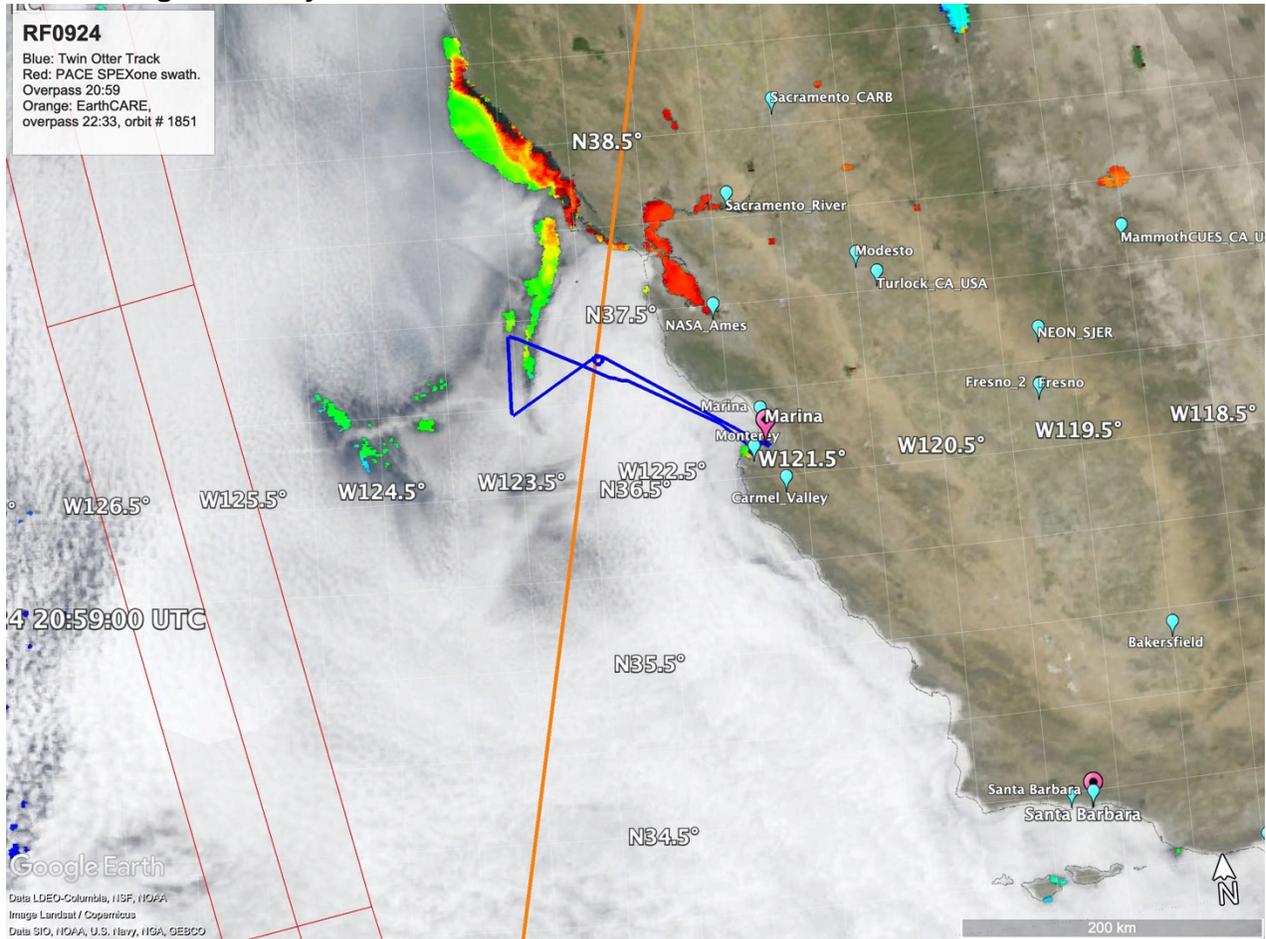
## **Gliders**

Operational

## **HyperNAV**

Operations concluded

## 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)	
20:09	TO		Twin Otter takeoff with low approach after take off at the Marina airport to characterize TO inlet
20:43	TO	6e(1.0*0.5) 1e(1.0*0.5)	Start of spiral at PIRAT to support potential aerosol above cloud retrievals in the PACE-OH swath. Spiral into clouds
<b>20:59</b>	<b>PACE</b>		<b>PACE Overpass</b>
21:00	TO		Spiral terminated at 500 ft due to the lack of visibility at that altitude
21:00-21:30	TO	1e(0.5*0.5)	Porpoising in PACE-OH cross track direction. Thick clouds with significant cloud top liquid water content ( $\sim 0.5 \text{ g/m}^3$ ) until 21:30.
21:30-21:46	TO	1e(0.5)	Porpoising on PACE-OH along satellite track direction with significantly different, thinner clouds ( $\sim 0.1 \text{ g/m}^3$ ) than previous leg.
<b>22:53</b>	<b>EarthCARE</b>		<b>EarthCARE overpass, orbit 1851</b>

23:40-22:54	TO	6h(1.5),6i(1.5)	EarthCARE overpass location was not workable because of low cloud tops so spiral was done in Monterey Bay at 36° 39'N, 121° 51.5'W starting at 23:40. Purpose: to provide evaluation of vertical profile in Monterey Bay where harmful algal blooms would have been observable during the PACE overpass.
23:14:40	TO		Landing at 23:14:40 after low approach at the Marina airport to characterize TO inlet.

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

### Assessment:

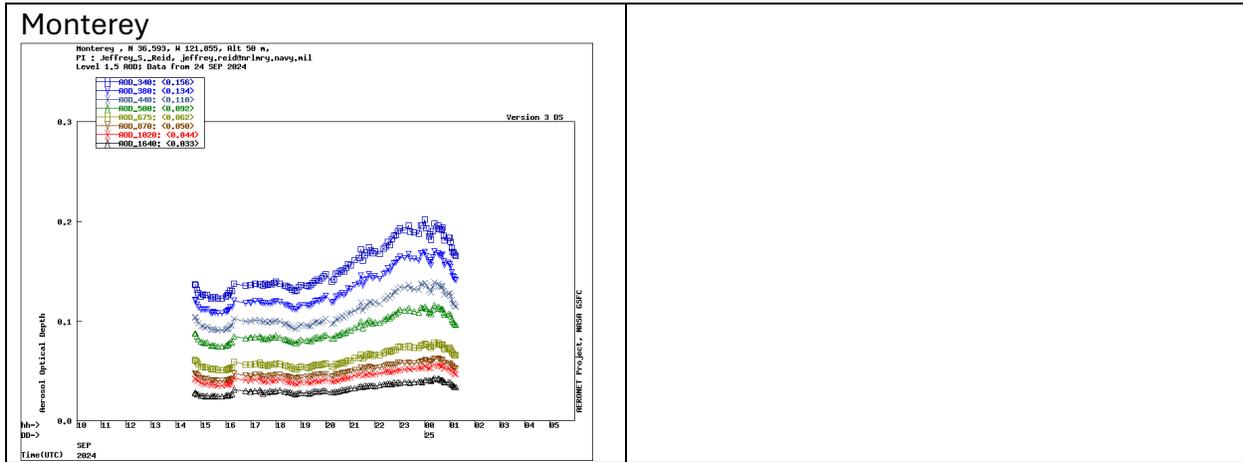
- 0.005 objectives observed. Successful underpasses of PACE-OH and EarthCARE in cloudy conditions. Aerosol above clouds present during first spiral at PACE overpass, but not very opaque aerosol layers. Data during second spiral probably not useable by EarthCARE radar team because cloud tops are too low (within the first range bin of the surface).
- 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	3.0	0.000	0.000	0.000	0.000	0.000	0.015	0.007	0.994	0.1
	b	Ocean radiometric parameters	10	8.0	18.0	0.000	0.000	0.000	0.003	0.001	0.000	0.000	0.999	0.0
	c	Aerosol parameters over the ocean	12	8.0	20.5	0.000	0.000	0.000	0.014	0.003	0.001	0.001	0.998	0.0
	d	Aerosol parameters over land	12	8.0	22.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.0
	e	Cloud parameters	12	8.0	6.8	0.058	0.011	0.000	0.000	0.026	0.000	0.011	0.929	1.0
	f	Ocean surface parameters	1	8.0	1.5	0.000	0.000	0.000	0.133	0.076	0.000	0.000	0.354	0.6
3. Validate in a narrow swath	a	Aerosol parameters over the ocean (PACE)	10	8.0	3.0	0.000	0.000	0.000	0.103	0.113	0.023	0.126	0.751	2.5
	b	Aerosol parameters over land (PACE)	10	8.0	7.0	0.132	0.000	0.000	0.000	0.000	0.000	0.000	0.918	0.4
	c	Cloud parameters (PACE)	5	2.0	2.5	0.000	0.000	0.000	0.053	0.000	0.000	0.038	0.956	0.4
	d	Aerosol parameters (EarthCARE)	8	4.0	5.5	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.465	4.3
	e	Cloud parameters (EarthCARE)	8	4.0	1.0	0.152	0.000	0.000	0.000	0.000	0.000	0.000	0.827	0.2
4. Validate radiometric and polarimetric properties	a	Validate large reflectances	6	2.0	1.0	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.972	0.2
	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	2.5	0.034	0.000	0.000	0.000	0.000	0.000	0.012	0.982	0.1
	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	0.5	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	0.5	0.000	0.038	0.000	0.000	0.000	0.000	0.000	0.865	0.5
	f	Broken clouds with complex structure	4	2.0	3.0	0.186	0.000	0.000	0.000	0.181	0.000	0.000	0.895	0.4
	g	Dual aerosols over ocean	4	2.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.410	2.3
	h	Aerosol and ocean parameters over turbid waters	2	2.0	3.8	0.000	0.111	0.000	0.022	0.017	0.013	0.015	0.968	0.1
	i	Aerosol and ocean parameters over biologically productive waters	4	2.0	6.8	0.000	0.043	0.000	0.020	0.013	0.002	0.000	0.997	0.0
	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
	<b>total:</b>			<b>150</b>	<b>98</b>	<b>113.8</b>	<b>0.041</b>	<b>0.005</b>	<b>0.000</b>	<b>0.021</b>	<b>0.019</b>	<b>0.009</b>	<b>0.014</b>	<b>0.827</b>
				ER-2 flight hours		6.2	0	0	6.4	6.5	6.7	6.5	0	32.3
				TO flight hours		4.1	3.1	0	5.1	3.1	0	0	0	15.4
				Shearwater days		0	0	0	0	0	0	0	0	0
				<b>PACE-PAX overall objectives satisfied:</b>		<b>0.827</b>								

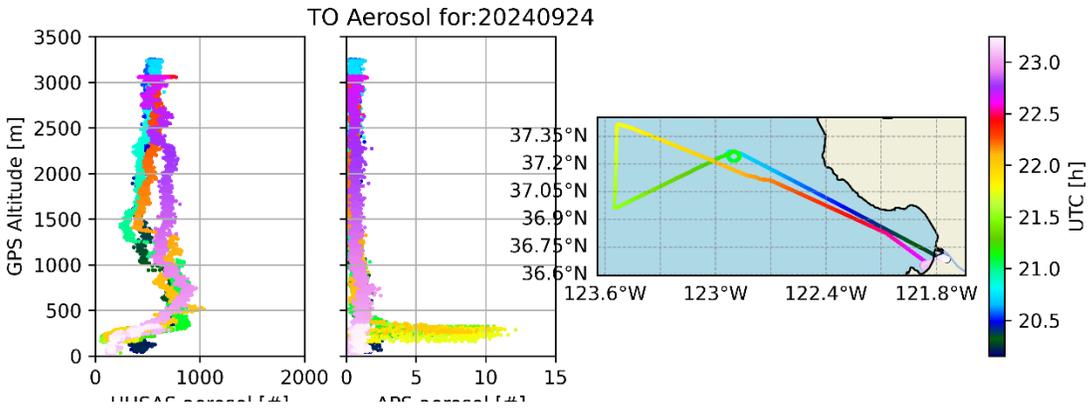
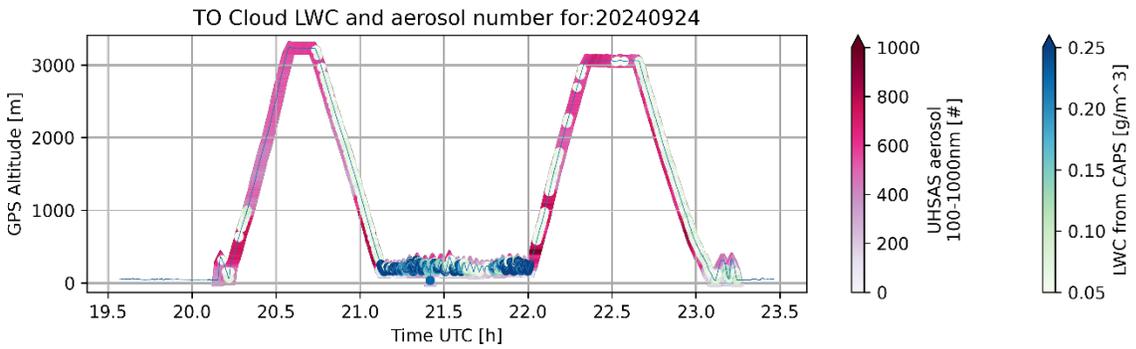
Note: images and data presented in this report are preliminary, and not for publication, presentation, or scientific use. The PACE-PAX data archive is:

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

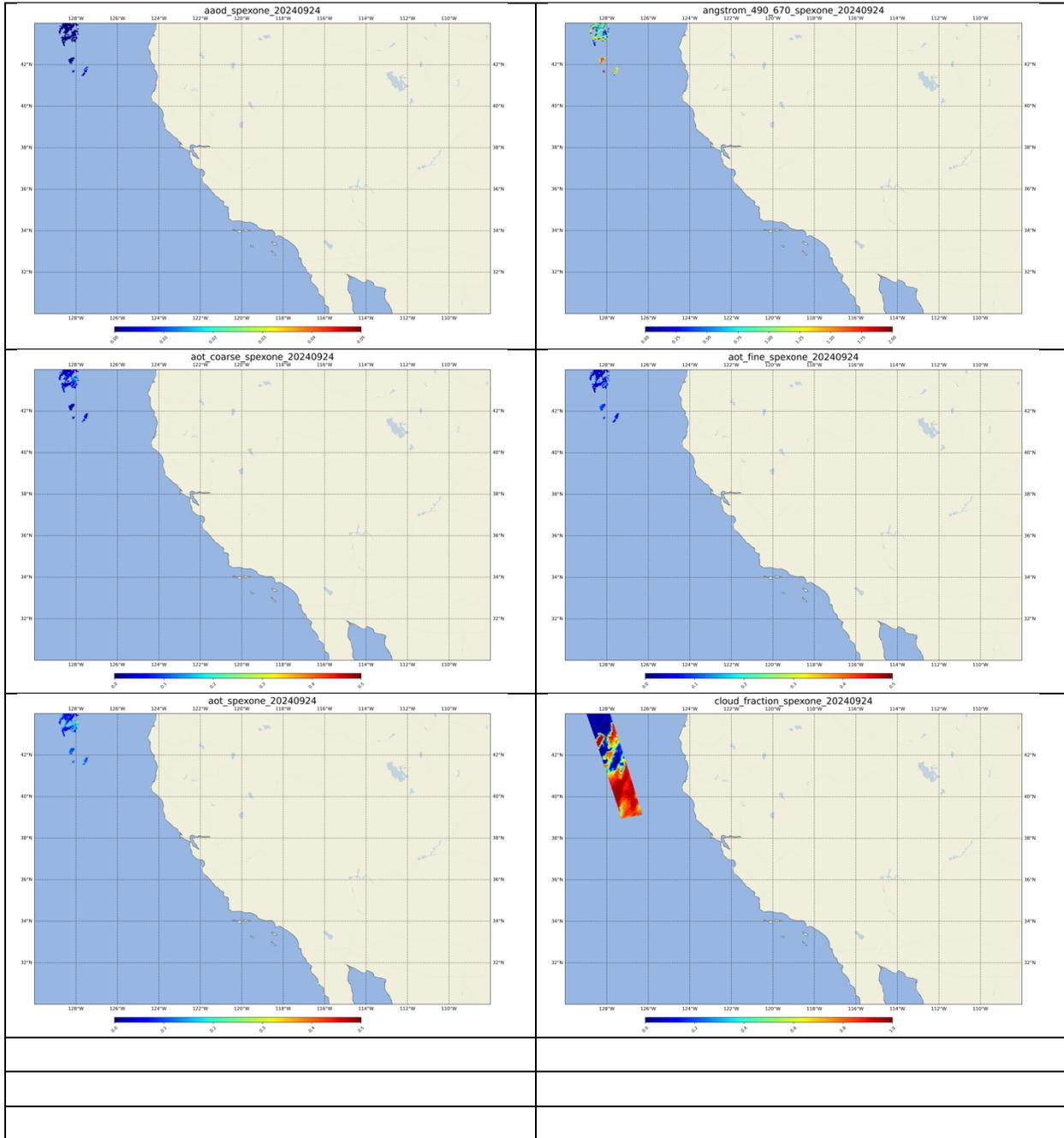
# AERONET plots



# TO Quicklooks



# PACE quicklooks



## Twin Otter full report

# PACE-PAX Research Flight report 2024-09-24

Manifest:

Bryce Kujat (pilot)

Jeff Martin (pilot)

Michael Shook (QNC)

Elizabeth Wilk (QNC)

Edward Winstead (QNC)

Note: The ER-2 did not fly this day.

Take off: 13:09:13 (20:09:13 UTC) Marina Airport (OAR)

Landing: 16:14:40 (23:14:40 UTC) Marina Airport (OAR)

Duration = 3.1 hrs

**Objectives:** In-line ascent to PIRAT, then spiral down beneath PACE at 21:00 UTC. Porpoise in cloud along and perpendicular to PACE swath west of the ADIZ line. Spiral up under EarthCARE at 22:23 UTC in clouds with tops at least 1000-1200 ft if available OR spiral in clear air over the Monterey Bay in the vicinity of the algae bloom (if there are no suitable clouds under the EarthCARE line and there is a spot clear of clouds in the bay). If possible, perform low approaches at Marina after takeoff and prior to landing.

**Summary:** After taking off, we performed a low approach at the Marina airport. Green scattering coefficient was  $\sim 15\text{Mm}^{-1}$ , and some coarse mode particles were measured by the APS. Cloud tops in the bay were estimated at less than 1000 ft. As we climbed towards PIRAT, we experienced unusual turbulence and shear at about 3300 ft at 20:19 UTC; the temperature profile indicated that this coincided with a second inversion above the boundary layer. By 20:21 UTC (above the second inversion), scattering coefficient had dropped to  $8\text{Mm}^{-1}$ . We reached the top of the PIRAT spiral at 20:43 UTC, where scattering coefficient was still  $8\text{Mm}^{-1}$  and some super-micron particles were detected. By 20:58 UTC, the scattering coefficient had decreased to  $4\text{Mm}^{-1}$ . At the PACE overpass

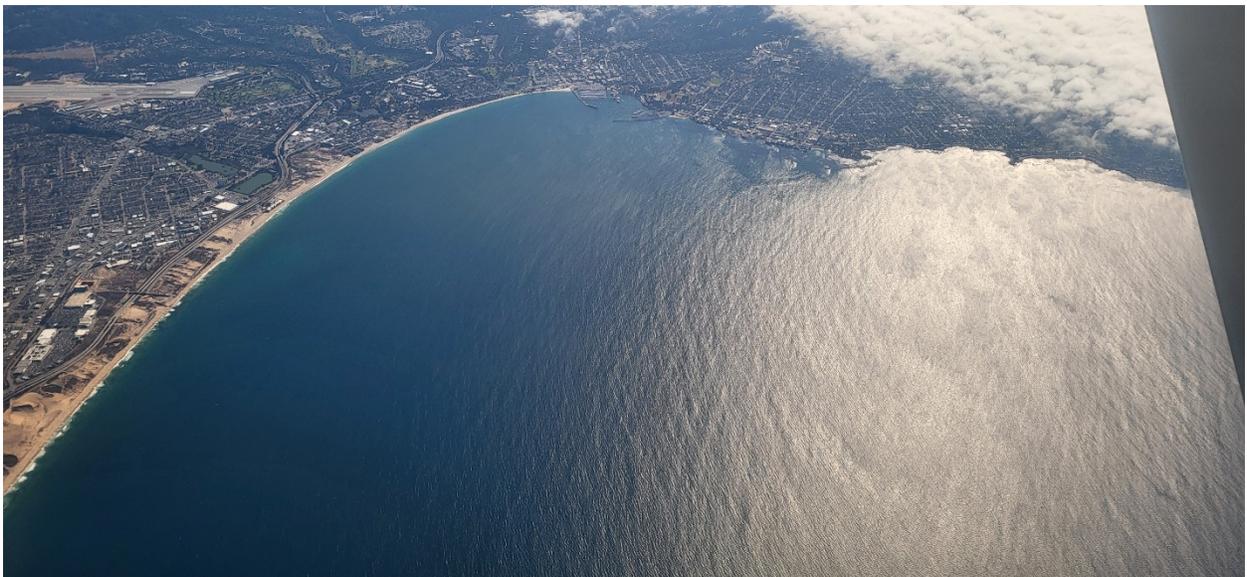
time of 21:00 UTC, scattering coefficient had increased again to  $\sim 10 \text{Mm}^{-1}$ , with  $f(\text{RH}) \sim 1.3$ ; an inversion was present at about 2200 ft. Cloud top was about 850 ft, and we were unable to descend below 500 ft due to the lack of visibility at that altitude. We began profiling (descending to 500 ft, ascending above the cloud, and remaining level above cloud top for  $\sim 10$  seconds before descending again) west along the cross-track line, and cloud tops increased from  $\sim 700$  ft to 900-1000 ft. Scattering coefficient above cloud top varied from  $15\text{-}30 \text{Mm}^{-1}$ , and Liquid Water Content (LWC) at cloud top was about  $0.40\text{-}0.48 \text{g/m}^3$ .

At about 21:30 UTC, we transitioned into a clearly different cloud deck. Cloud tops dropped by about 200 ft, and cloud top LWC dropped to about  $0.25 \text{g/m}^3$ . It was also significantly hazier above the cloud, making it hard to determine where cloud top was. About this time, we turned north to begin the along-track leg. LWC continued to decrease to about  $0.08 \text{g/m}^3$ . At our northernmost point (21:46 UTC), the cloud had thinned to barely 200 ft thick, and the surface was visible at 500 ft. However, as we headed southeast towards the ADIZ line, the cloud thickened again with tops around 700-800 ft, and LWC around  $0.28 \text{g/m}^3$ . Around 21:51 UTC, we transitioned back into the cloud deck with tops around 900-1000 ft and LWC  $0.4\text{-}0.5 \text{g/m}^3$ .

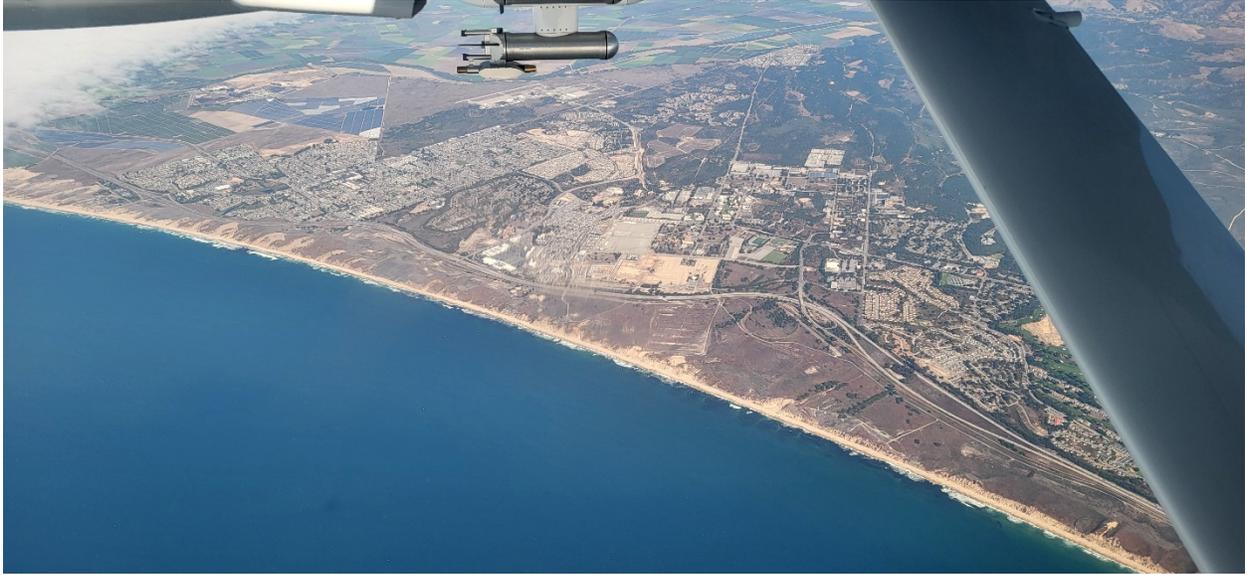
At 22:00 UTC, we determined that cloud tops were too low for a useful EarthCARE spiral, so we stopped porpoising and ascended to cross the ADIZ line. Scattering coefficient was  $\sim 30 \text{Mm}^{-1}$  right above cloud top as we climbed, with a particle size mode in the APS. Scattering dropped as we climbed to about  $8 \text{Mm}^{-1}$ . We leveled off at 9500 ft at 22:21 UTC and saw  $1800 \text{particles/cm}^3$ . We were able to find a small area of clear air in the Monterey Bay, so we began spiraling down to 100 ft at 22:40 UTC. The spiral was centered roughly at  $36^\circ 39' \text{N}$ ,  $121^\circ 51.5' \text{W}$ , just off the coast of Monterey; the spiral location did not appear to be above any algae bloom, which we observed the previous flight farther north in the bay. The first temperature inversion in the profile was at about 3500 ft, and clouds to the west of the profile were estimated to have tops at 700 ft and bases at 300 ft or lower. Once we descended to/below the level of the clouds at 23:08 UTC, scattering coefficient dropped to  $5 \text{Mm}^{-1}$ . Finally, we transited to the Marina airport and did one low approach, where scattering coefficient was about  $7 \text{Mm}^{-1}$ .



Low clouds in Monterey Bay just after takeoff; photo by Eddie Winstead



Monterey and Seaside, CA coastline at 22:39 UTC; photo by Michael Shook



Marina, CA coastline at 22:41; photo by Michael Shook



Missed approach at Marina airport with marine layer that extended over CEOBS in the background; photo by Brian Cairns