ACEPOL overview

Mission Scientists: Kirk Knobelspiesse[1], Rich Ferrare[2], Otto Hasekamp[3], Felix Seidel[4]

NASA support: Hal Maring[4], Felix Seidel[4] , Arlindo da Silva[1]

Instrument Scientists: Carol Bruegge[6], Sharon Burton[2], Brian Cairns[7], David Diner[6], Rich Ferrare[2], Mike Garay[6], Otto Hasekamp[3], Olga Kalashnikova[6], J. Vanderlei Martins[5], Matthew McGill[1], John Yorks[1]

[1]NASA GSFC, [2]NASA LaRC, [3]SRON, [4]NASA HQ, [5]UMBC, [6]JPL, [7]NASA GISS

4th PACE science team meeting, Jan. 18, 2018

Aerosol Characterization from Polarimeter and Lidar (ACEPOL) Oct. 19 - Nov. 9, 2017

NASA and SRON (Netherlands) collaborated in the ACEPOL field campaign, based from AFRC, to acquire data with advanced active and passive remote sensors. These data will be used to develop and assess algorithms for retrieving profiles of aerosol optical and microphysical properties for various atmospheric applications. The measurements and algorithms are applicable to future satellite missions such as ACE, PACE, MAIA, METOP-SG, and EarthCare.

ER-2 instruments

- SPEX airborne
- RSP
- HSRL-2
- AirMSPI
- CPL
- AirHARP

Ground-based instruments

- AERONET
- GroundMSPI
- CARB AQ sites

Attempted coincident measurements with Navy CASPAR West mission

Objective: Provide a link between detailed microphysical/optical characterizations of column integrated and vertically-resolved aerosol properties.

Hypothesis: Polarimeter-Lidar combination would enable detailed characterization of several distinct aerosol layers (e.g. elevated dust/smoke and boundary layer smog).

Multi-angle Polarimeters (polarization sensitive channels in red)

AirHARP potential PACE contributed instrument

- Wide swath, 4 channel (440, 550, 670, 870nm), 20 view angles (60 for 670nm)
- Implementation on ER-2 requires targeting mode
- First time on ER-2

Multi-angle Polarimeters (polarization sensitive channels in red)

AirHARP potential PACE contributed instrument

- Wide swath, 4 channel (440, 550, 670, 870nm), 20 view angles (60 for 670nm)
- Implementation on ER-2 requires targeting mode
- First time on ER-2

AirMSPI prototype for MAIA

- High spatial resolution, 8 channel (355, 377, 443, 469, 553, 659, 863, 931nm)
- Gimbaled system requires targeting, various possible # view angels

Multi-angle Polarimeters (polarization sensitive channels in red)

AirHARP potential PACE contributed instrument

- Wide swath, 4 channel (440, 550, 670, 870nm), 20 view angles (60 for 670nm)
- Implementation on ER-2 requires targeting mode
- First time on ER-2

AirMSPI prototype for MAIA

- High spatial resolution, 8 channel (355, 377, 443, 469, 553, 659, 863, 931nm)
- Gimbaled system requires targeting, various possible # view angels

RSP high maturity polarimeter reference

- accurate along track scanner (not imager)
- 155 view angles, 9 channel (410, 470, 555, 670, 865, 960, 1590, 1880, 2250nm)

Multi-angle Polarimeters (polarization sensitive channels in red)

AirHARP potential PACE contributed instrument

- Wide swath, 4 channel (440, 550, 670, 870nm), 20 view angles (60 for 670nm)
- Implementation on ER-2 requires targeting mode
- First time on ER-2

AirMSPI prototype for MAIA

- High spatial resolution, 8 channel (355, 377, 443, 469, 553, 659, 863, 931nm)
- Gimbaled system requires targeting, various possible # view angels

RSP high maturity polarimeter reference

- accurate along track scanner (not imager)
- 155 view angles, 9 channel (410, 470, 555, 670, 865, 960, 1590, 1880, 2250nm)

SPEX airborne potential PACE contributed instrument

- Narrow swath, spectrometer ~385-770nm, 9 view angles, continuous scanning
- Second time on ER-2

Multi-angle Polarimeters (polarization sensitive channels in red)

AirHARP potential PACE contributed instrument

- Wide swath, 4 channel (440, 550, 670, 870nm), 20 view angles (60 for 670nm)
- Implementation on ER-2 requires targeting mode
- First time on ER-2

AirMSPI prototype for MAIA

- High spatial resolution, 8 channel (355, 377, 443, 469, 553, 659, 863, 931nm)
- Gimbaled system requires targeting, various possible # view angels

RSP high maturity polarimeter reference

- accurate along track scanner (not imager)
- 155 view angles, 9 channel (410, 470, 555, 670, 865, 960, 1590, 1880, 2250nm)

SPEX airborne potential PACE contributed instrument

- Narrow swath, spectrometer ~385-770nm, 9 view angles, continuous scanning
- Second time on ER-2

Note only the 660/670nm channel is available for polarimetric comparison

Multi-angle Polarimeters (polarization sensitive channels in red)

AirHARP potential PACE contributed instrument

- Wide swath, 4 channel (440, 550, 670, 870nm), 20 view angles (60 for 670nm)
- Implementation on ER-2 requires targeting mode
- First time on ER-2

AirMSPI prototype for MAIA

- High spatial resolution, 8 channel (355, 377, 443, 469, 553, 659, 863, 931nm)
- Gimbaled system requires targeting, various possible # view angels

RSP high maturity polarimeter reference

- accurate along track scanner (not imager)
- 155 view angles, 9 channel (410, 470, 555, 670, 865, 960, 1590, 1880, 2250nm)

SPEX airborne potential PACE contributed instrument

- Narrow swath, spectrometer ~385-770nm, 9 view angles, continuous scanning
- Second time on ER-2

Lidars

CPL

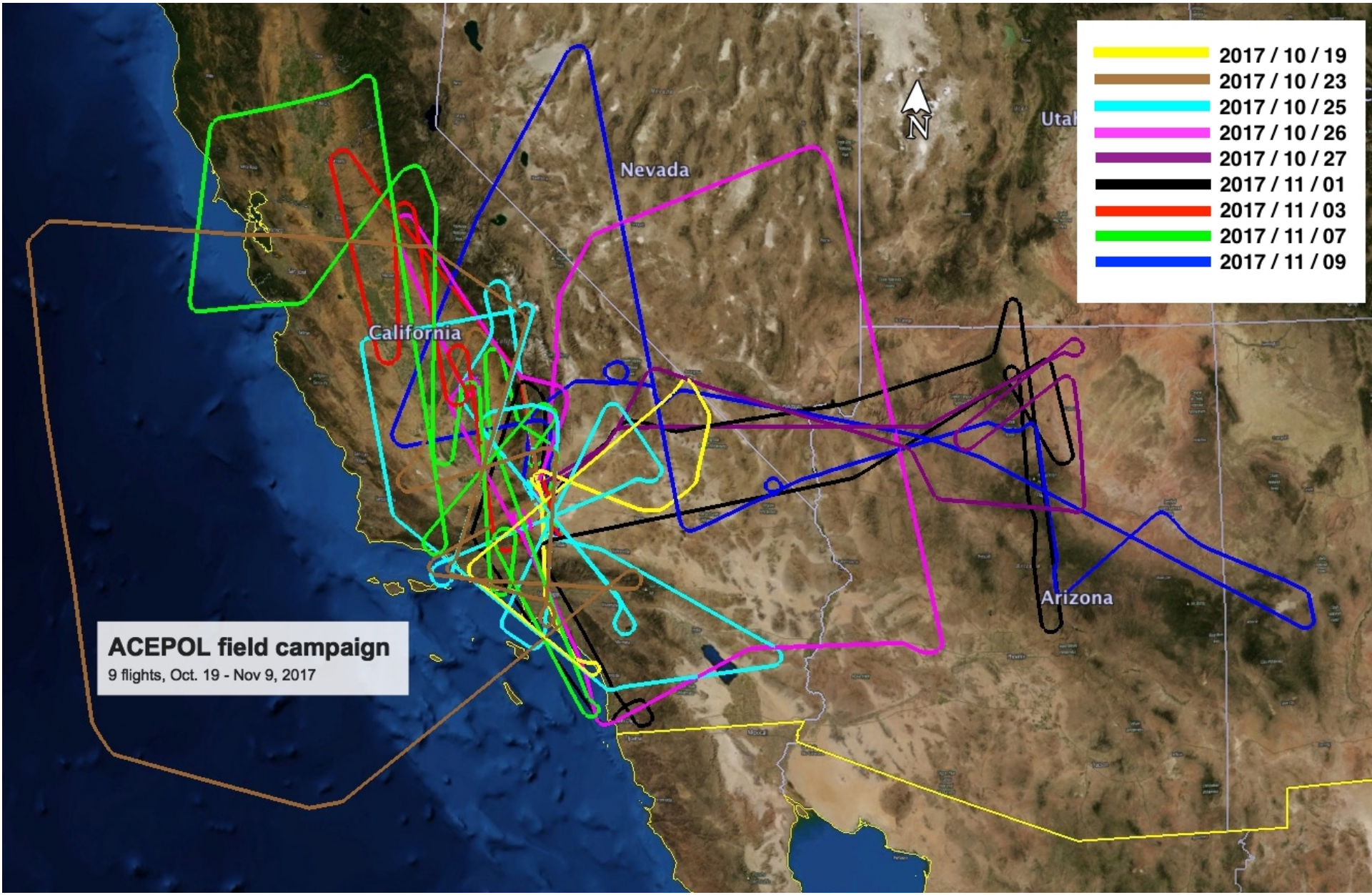
- Lidar with backscatter at 355, 532, 1064nm, depolarization at 1064nm

HSRL-2

- Lidar with backscatter at 355, 532, 1064nm, extinction at 355, 532nm, depolarization at 355, 532, 1064nm

Note only the 660/670nm channel is available for polarimetric comparison

ACEPOL: 9 flights, 41.3 hours



ACEPOL targets

Ranked by priority, where 1 is highest, 10 lowest

Targets we achieved:

1a: Calibration over ocean with no clouds or aerosols

1b: Calibration over land with no clouds or aerosols

1d: Geolocation images of coastlines with no clouds

1e: Coordinated CALIPSO or CATS underflights

2b: Validation with AERONET with low aerosol loading

3a: Satellite intercomparison for aerosol retrievals

3b: Satellite intercomparison for cloud retrievals

4b: Target of opportunity: high aerosol loads over land

9: Targets of opportunity: low clouds over land

10: Targets of opportunity: Cirrus clouds

Targets we partially achieved:

1c: Calibration over spatially uniform cloud deck

2a: Validation with AERONET with medium to high aerosol loading

Targets we did not achieve:

2c: Validation against CASPER field campaign

4a: Targets of opportunity: high aerosol loads over ocean

4c: Targets of opportunity: multiple aerosol layers

5: Targets of opportunity: aerosol above cloud

6: Targets of opportunity: high aerosol loads over urban surfaces

7: Targets of opportunity: marine stratocumulus clouds far from land

8: Targets of opportunity: broken clouds far from land

ACEPOL targets

Ranked by priority, where 1 is highest, 10 lowest

Targets we achieved:

1a: Calibration over ocean with no clouds or aerosols

1b: Calibration over land with no clouds or aerosols

1d: Geolocation images of coastlines with no clouds

1e: Coordinated CALIPSO or CATS underflights

2b: Validation with AERONET with low aerosol loading

3a: Satellite intercomparison for aerosol retrievals

3b: Satellite inte… retrievals

4b: Target of op… over land

9: Targets of opportunity: low clouds over land

10: Targets of opportunity: Cirrus clouds

Targets we partially achieved:

1c: Calibration over spatially uniform cloud deck

2a: Validation with AERONET with medium to high aerosol loading

Targets we did not achieve:

2c: Validation against CASPER field campaign

4a: Targets of opportunity: high aerosol loads over ocean

4c: Targets of opportunity: multiple aerosol layers

…e cloud

…loads over

…ocumulus

8: Targets of opportunity: broken clouds far from land

We were (mostly) successful observing our primary targets

ACEPOL targets

Ranked by priority, where 1 is highest, 10 lowest

Targets we achieved:

1a: Calibration over ocean with no clouds or aerosols

1b: Calibration over land with no clouds or aerosols

1d: Geolocation images of coastlines with no clouds

1e: Coordinated CALIPSO or CATS underflights

2b: Validation with AERONET with low aerosol loading

3a: Satellite intercomparison for aerosol retrievals

3b: Satellite intercomparison for cloud retrievals

4b: Target of opportunity: high aerosol loads over land

9: Targets of opportunity: low clouds over land

10: Targets of opportunity: Cirrus clouds

2017/10/25

18:00 4-5-6 first Rosamond leg

18:30 7-8-9 Turn 180 deg and go back across Rosamond

18:30 10-11-12 next Rosamond leg with close approaches to Cal Tech and USC Seaprism AERONETS

18:58 13-14-15 next Rosamond leg

19:31 16-17-18 next Rosamond leg notes tailwind and pitch surfing

Carol Bruegge and team on site at Rosamond dry lake with GroundMSPI & other equipment, location 34.85636 N, 118.07649 W.

ACEPOL targets

Ranked by priority, where 1 is highest, 10 lowest

Targets we achieved:

1a: Calibration over ocean with no clouds or aerosols

1b: Calibration over land with no clouds or aerosols

1d: Geolocation images of coastlines with no clouds

1e: Coordinated CALIPSO or CATS underflights

2b: Validation with AERONET with low aerosol loading

3a: Satellite intercomparison for aerosol retrievals

3b: Satellite intercomparison for cloud retrievals

4b: Target of opportunity: high aerosol loads over land

9: Targets of opportunity: low clouds over land

10: Targets of opportunity: Cirrus clouds

10/23 Channel Islands

18:30 10-11 Pt. Mugu

20:13 19-20-21 Ocean leg, mostly cloud free

20:53 22-23-24 Second ocean leg, different heading, mostly cloud free?

21:34 25-26-27 Ocean leg including SeaPrism AERONET

10/25 SoCal coast

18:30 10-11-12 next Rosamond leg with close approaches to Cal Tech and USC Seaprism AERONETS

20:39 25-26-27 coastal leg

21:07 28-29-30 USC Sea Prism AERONET leg

21:24 31-32-33 Salton Sea leg

10/26 Central Valley, Salton Sea

18:58 4-5-6 Fresno AERONET

19:19 7-8-9 Bakersfield AERONET

20:01 16-17-18 Salton Sea Leg

10/27 Lake Powell

19:26 12-13-14 Las Vegas target

11/7 Channel Islands, LA coast

18:35 6-7-8 Target: USC_SeaPRISM 15˚ from SPP (some low marine)

11/9 Las Vegas, Lake Powell

17:57 3-4-5 Target: Las Vegas

…and probably more

ACEPOL targets

Ranked by priority, where 1 is highest, 10 lowest

Targets we achieved:

1a: Calibration over ocean with no clouds or aerosols

1b: Calibration over land with no clouds or aerosols

1d: Geolocation images of coastlines with no clouds

1e: Coordinated CALIPSO or CATS underflights

2b: Validation with AERONET with low aerosol loading

3a: Satellite intercomparison for aerosol retrievals

3b: Satellite intercomparison for cloud retrievals

4b: Target of opportunity: high aerosol loads over land

9: Targets of opportunity: low clouds over land

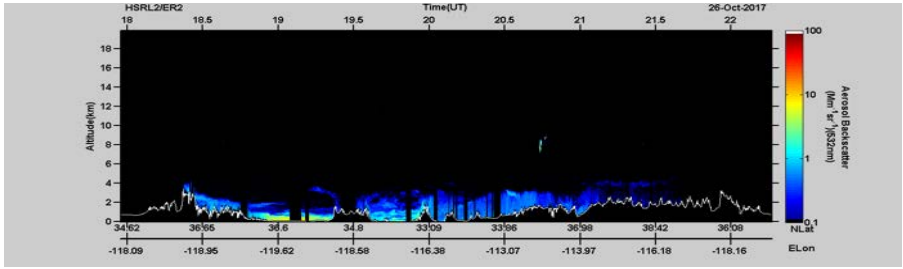
10: Targets of opportunity: Cirrus clouds

10/19: CATS 17:23z short duration

17:32 6-7-8 CATS underpass. Start near Death Valley Junction and end at Ventura/Oxnard with overflight of Mojave at ~ 90° to the solar principal plane (SPP). Some clouds at the end of the leg near the coast. No cloud bows

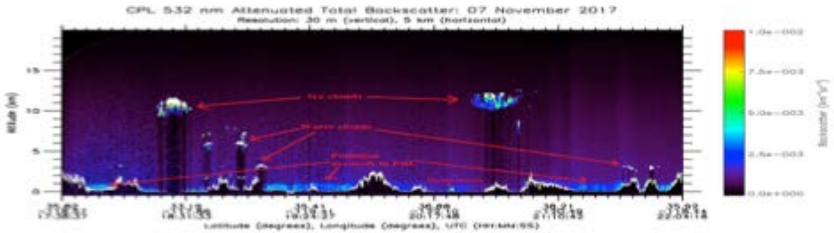
10/26 CALIPSO 10:54z low AOD

20:44 22-23-24-25 CALIPSO leg (overpass at 20:54 UT)



11/7 CALIPSO 21:07z

21:05 22-23-24 Target: CALIPSO track, 21:18 (no AirHARP)



11/9 CALIPSO 21:07 cirrus transitioning to clear

20:45 18 be here @ 20:45 +/- 10min

20:53 19 Target: CALIPSO track

21:07 20 CALIPSO overpass 21:07

21:21 21 Target: CALIPSO track

ACEPOL targets

Ranked by priority, where 1 is highest, 10 lowest

10/19 Cirrus over land and ocean

17:51 9-10-11 SeaPrism AERONET

6 Over water from Point Mugu to Oceanside with land at Rancho Verde. 160° from SPP. Quite a lot of cirrus over some water clouds below: Leg 2017-10-19 17:51:26

7 Over land with substantial cirrus coverage. 1° from SPP with specular artifacts that may be oriented cirrus ice crystals. Starts at Laguna Beach and ends at Santa Fe Springs (in LA): Leg 2017-10-19 18:11:40

11/01 off LA, first and second legs

HSRL not operating.

AirHARP targeting mode wrong for first leg. AirMSPI disk failure after first leg.

17:30 3-4-5: AERONET USC_Seaprism in SPP (solar principal plane). Marine stratocumulus clouds

18:03 6-7-8: Stratocumulus target over land (LA region). Less uniform.

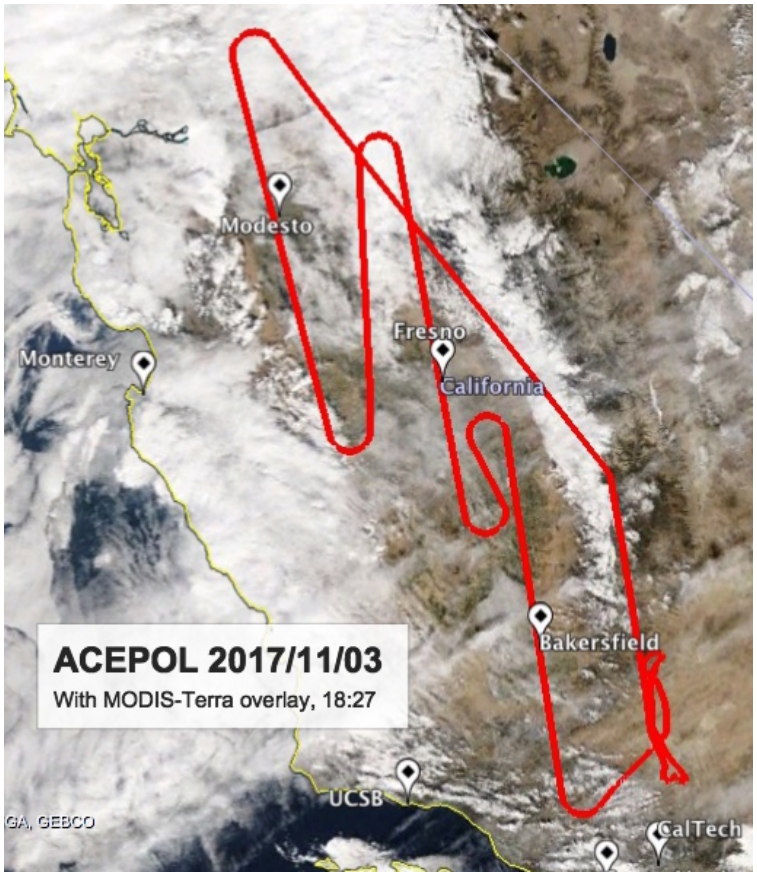
11/03 was primarily cloudy, but need to verify all instruments targeted together at right locations. Modesto best target?

20:08 3-4-5: Target AERONET Modesto (scattered broken clouds)

Targets we partially achieved:

1c: Calibration over spatially uniform cloud deck

2a: Validation with AERONET with medium to high aerosol loading



ACEPOL scenes relevant to MAIA

Central valley AERONET sites were co-located with CARB air quality sensors in the Central Valley. The most instrumented site was in Fresno, followed by Modesto. Bakersfield AERONET and CARB sites are not co-located. Sites were targeted 10+ times.

Scenes with low aerosol load

10/23 Bakersfield

17:56 4-5-6 Bakersfield AERONET

18:45 12-13-14 MISR leg (near Bakersfield?)

10/25 Bakersfield, Fresno

19:58 19-20-21 Bakersfield AERONET leg

20:23 22-23-24 Fresno AERONET leg

10/26 Bakersfield

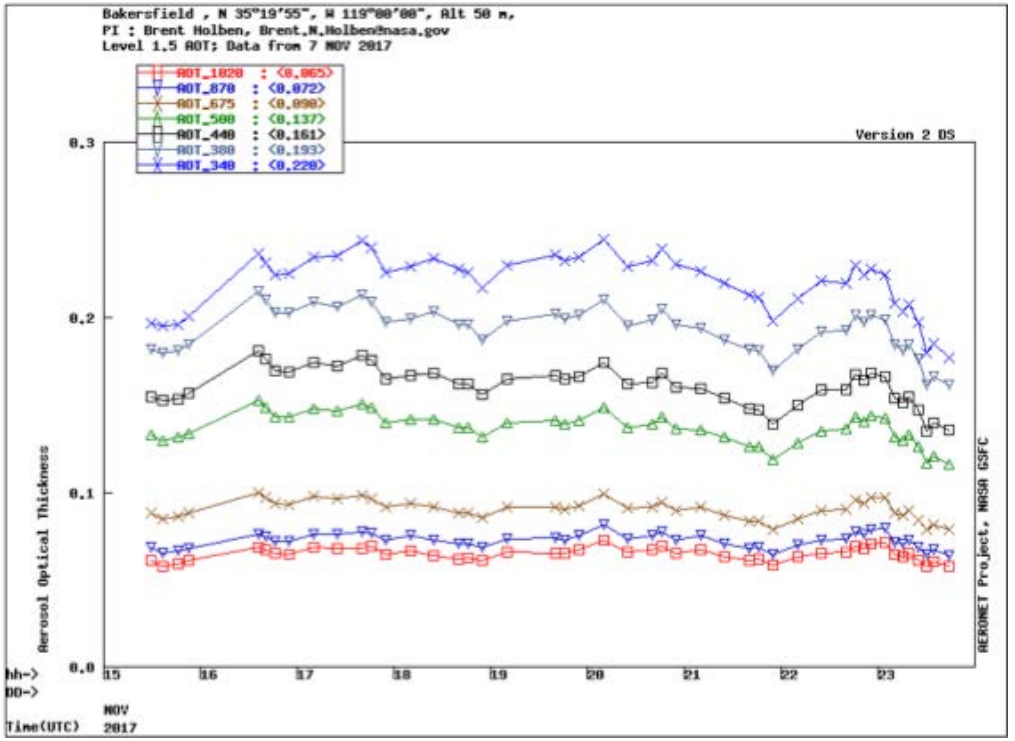
19:19 7-8-9 Bakersfield AERONET

11/07 Modesto

20:05 15-16-17 Target: Modesto (no cloud)

11/09 Fresno

22:02 23-24-25 Target: Fresno



Scenes with moderate aerosol load

10/26 Fresno AOD=0.13

18:58 4-5-6 Fresno AERONET

11/1 Bakersfield ~ 0.25, flew nearby but not all instruments targeting?

Prior to first targets, flew near Bakersfield AERONET site which measured AOT ~0.25

11/7 Bakersfield AOD(500)=0.14 (twice) + Fresno 0.12 + GroundMSPI in Fresno

19:07 9-10-11 Target: Bakersfield in SPP (no cloud)

19:39 12-13-14 Target: Fresno near SPP (no cloud)

21:57 25-26-27 Target: Bakersfield in SPP

ACEPOL targets

Ranked by priority, where 1 is highest, 10 lowest

Targets we achieved:

1a: Calibration over ocean with no clouds or aerosols

1b: Calibration over land with no clouds or aerosols

1d: Geolocation images of coastlines with no clouds

1e: Coordinated CALIPSO or CATS underflights

2b: Validation with AERONET with low aerosol loading

3a: Satellite intercomparison for aerosol retrievals

3b: Satellite intercomparison for cloud retrievals

4b: Target of opportunity: high aerosol loads over land

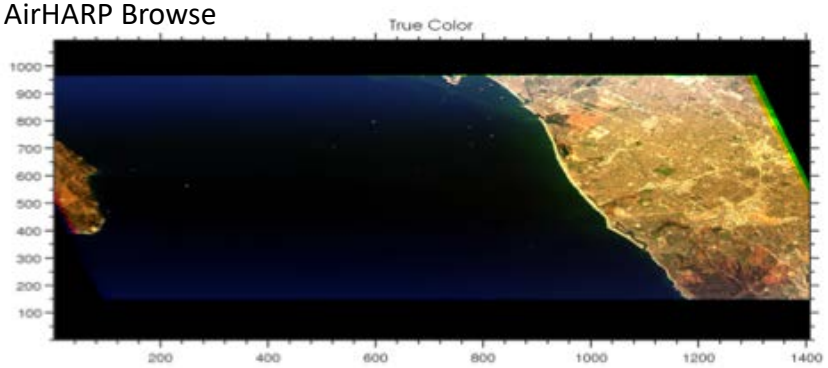
9: Targets of opportunity: low clouds over land

10: Targets of opportunity: Cirrus clouds

2017/10/23

Long leg over Catalina and the SeaPrism site close to SPP with strong glint and solar zenith close to Brester's angle. RSP 2260 nm band shows peak polarization of 99.7%: Leg 2017-10-23 21:07:50

AirHARP Browse



2017/10/25

18:30 10-11-12 next Rosamond leg with close approaches to Cal Tech and USC Seaprism AERONETS

Running along coast and over water by LA from Santa Maria to Carlsbad at -96°: Leg 2017-10-25 20:49:09

ACEPOL scenes relevant to PACE

AirHARP and SPEX airborne both represent potential multi-angle polarimeter contributions to the PACE Mission. Overall ACEPOL objectives therefore coincide with that of PACE. Scenes of interest are ocean observations of the AERONET SeaPRISM site, which observes both aerosol optical thickness and normalized water leaving radiance.

10/23 20:00z SeaPRISM

20:13 19-20-21 Ocean leg, mostly cloud free

20:53 22-23-24 Second ocean leg, different heading, mostly cloud free?

21:34 25-26-27 Ocean leg including SeaPrism AERONET

This day observed glint with high polarization

10/25 SeaPRISM

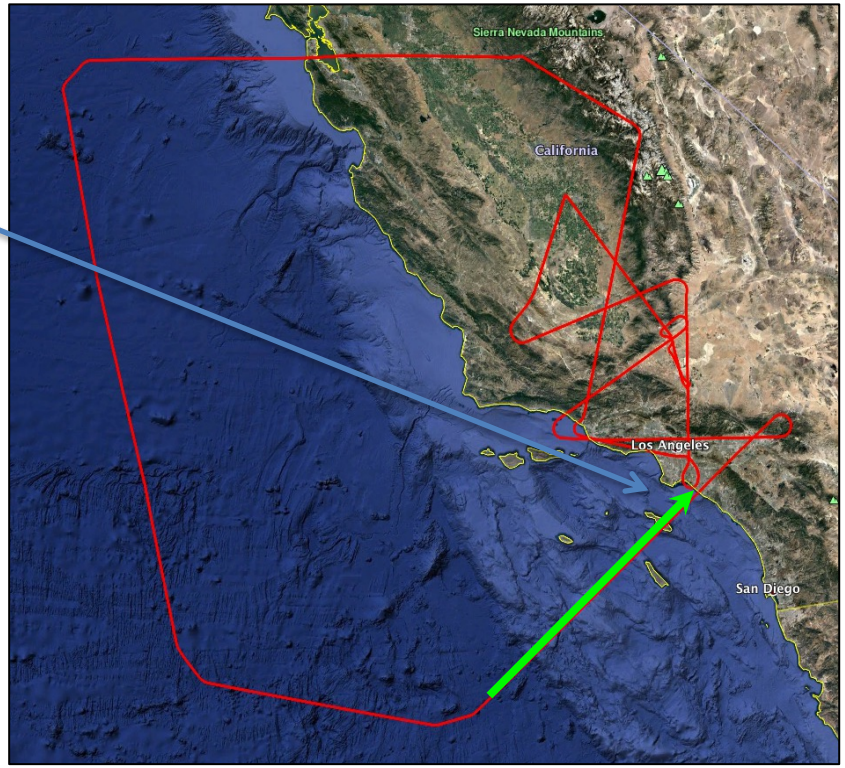
18:30 10-11-12 next Rosamond leg with close approaches to Cal Tech and USC Seaprism AERONETS

10 Relatively short leg but stable attitude between Catalina and the mainland 38° from SPP: Leg 2017-10-25 18:43:04

17 Running along coast and over water by LA from Santa Maria to Carlsbad at -96°: Leg 2017-10-25 20:49:09

11/7 off Northern California

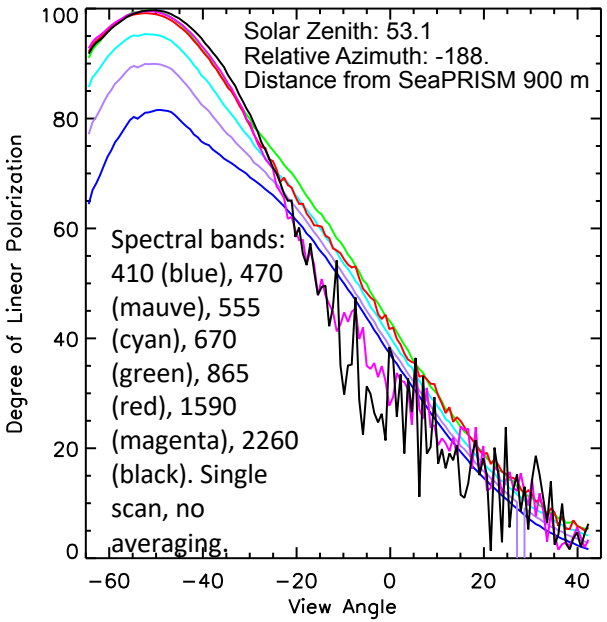
11 Short leg out over water just south of Santa Cruz to set up for next targeted leg. 107° from SPP: Leg 2017-11-07 20:14:15



ACEPOL scenes relevant to PACE

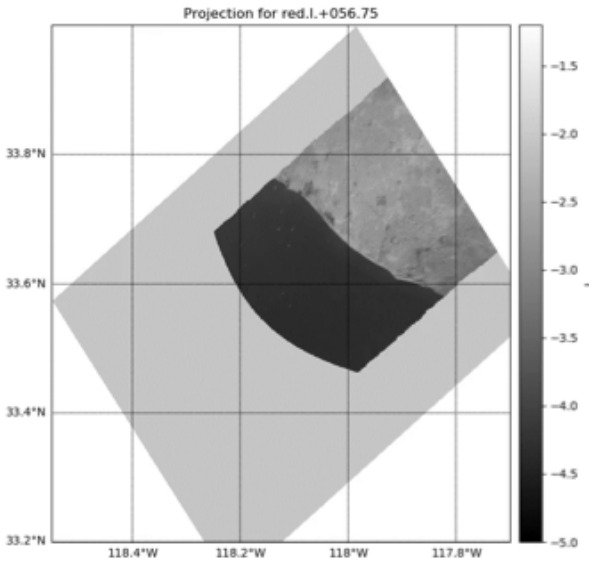
Preliminary!

RSP: note highly polarizing sunglint

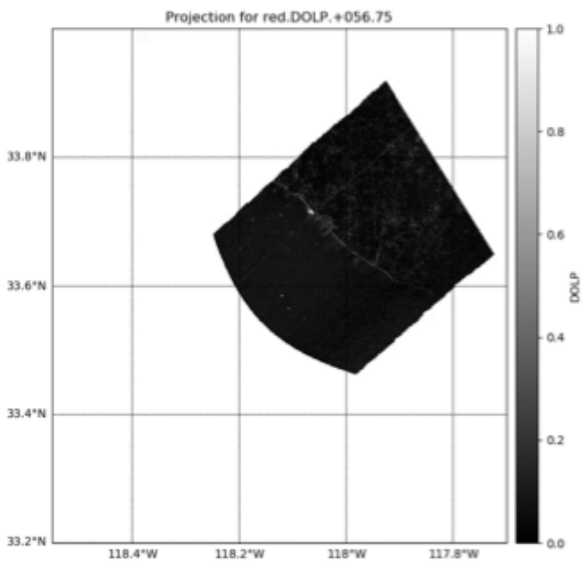


AirHARP 670nm

Radiance



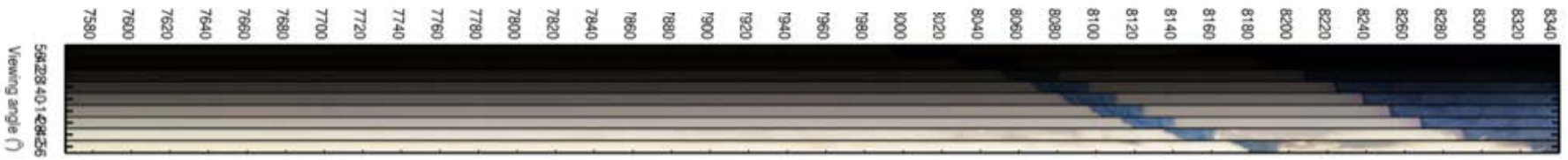
DoLP



SPEX Airborne

Radiance

DoLP



All results are preliminary browse data from experimental instruments. More info:

https://www-air.larc.nasa.gov/missions/acepol/index.html ← archive

https://www.nwo.nl/en/research-and-results/research-projects/i/77/27477.html

When data become available they will also be here:

- SPEX airborne: https://www-air.larc.nasa.gov/missions/acepol/index.html
- AirHARP: https://sites.google.com/view/airharp-acepol
- RSP: https://data.giss.nasa.gov/pub/rsp/ACEPOL/
- AirMSPI: https://eosweb.larc.nasa.gov/project/airmspi/airmspi_table
- CPL: https://cpl.gsfc.nasa.gov/
- HSRL: https://www-air.larc.nasa.gov/missions/acepol/index.html

ACE meeting first week of May, followed by ACEPOL meeting first version of L1 data to be ready by then (subject to confirmation)

Do we need PACE field campaigns?

-validation of aerosol & cloud products

-validation of polarimeters, atmospheric correction, etc.

Existing data notes: https://goo.gl/bN85PD