The Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission and the PACE Postlaunch Airborne eXperiment

Kirk Knobelspiesse, Brian Cairns, Ivona Cetinić, Sean Foley, Meng Gao, Antonio Mannino, Chamara Rajapakshe, Andrew Sayer, Jeremy Werdell, NASA Goddard Space Flight Center;
Montserrat Pinol Sole, ESA
EarthCARE validation meeting, November 16th, 2023

PACE

PACE-PAX

pace.gsfc.nasa.gov

1. The NASA PACE Mission
2. The PACE-PAX validation field campaign
3. Potential PACE – EarthCARE synergy
4. Potential PACE – EarthCARE validation synergy

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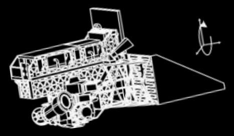
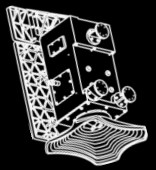


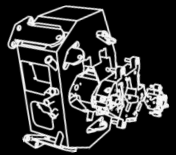
OCI

340-890 nm in 2.5 nm steps
7 discrete SWIR, 940-2260 nm
1-2 day coverage ±20° tilt, 1km



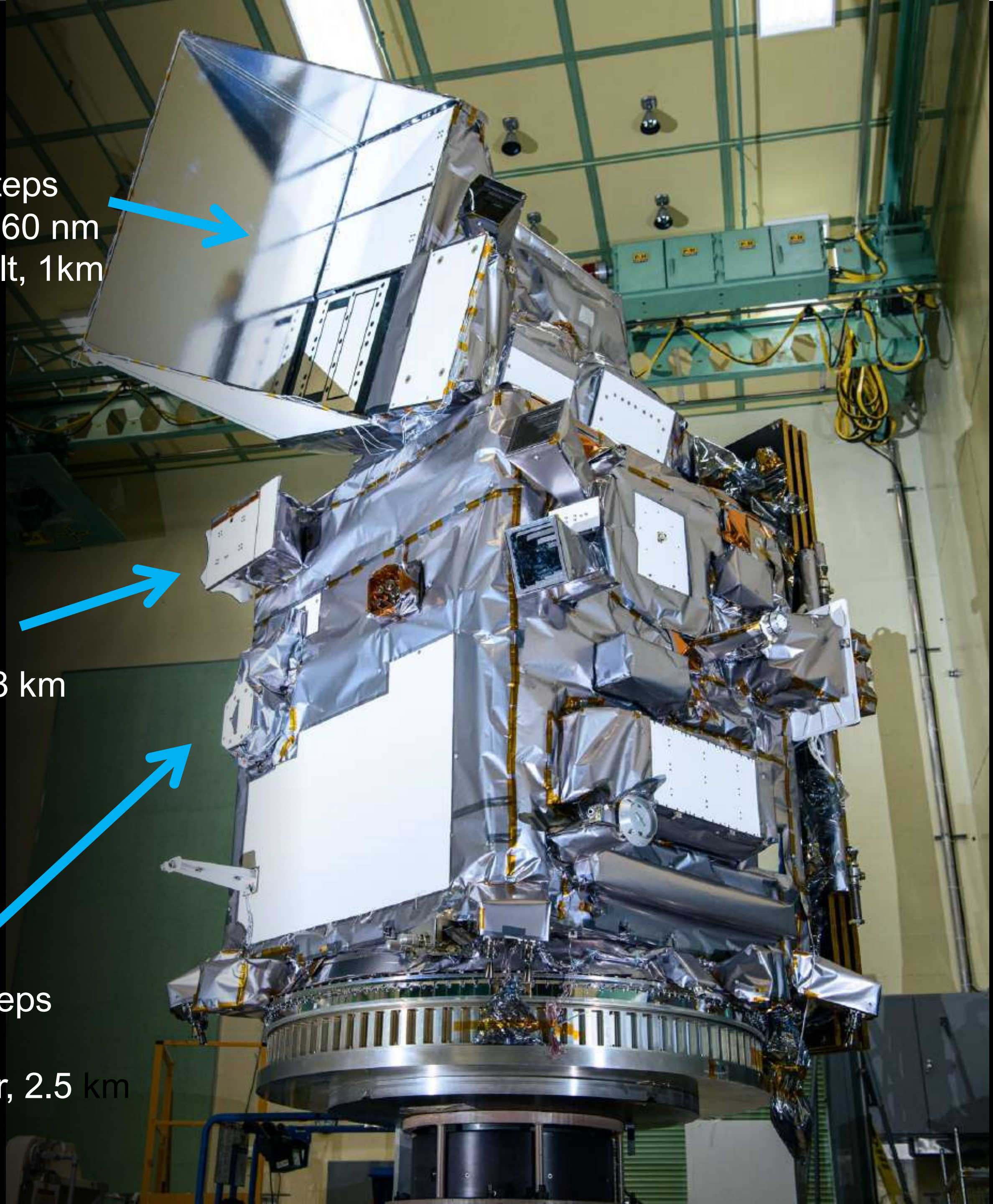
HARP2

440, 550, 670, 870 nm
10-60 viewing angles
wide swath polarimeter, 3 km



SPEXone

380-770 nm in 2-4 nm steps
5 viewing angles
narrow swath polarimeter, 2.5 km



NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission

PACE will extend key systematic ocean color, aerosol, & cloud climate data records, reveal the diversity of organisms fueling marine food webs, and introduce new methods to observe aerosols and clouds, the largest source of climate uncertainty.

Characteristics:

- ***January 2024 launch!***
- 676.5 km, polar, ascending orbit, 98°
- Sun synchronous, 13:00 Equatorial crossing
- Data to OB.DAAC (oceancolor.gsfc.nasa.gov)

After launch, there will be 60 days of on-orbit commissioning activities.

Official data distribution will follow, with heritage and required products first, followed by advanced and polarimetric products.

pace.gsfc.nasa.gov
@NASAOcean

PACE

PACE required products: OCI only

Ocean

Data Product	Baseline Uncertainty
Water-leaving reflectances centered on (±2.5 nm) 350, 360, and 385 nm (15 nm bandwidth)	0.0057 or 20%
Water-leaving reflectances centered on (±2.5 nm) 412, 425, 443, 460, 475, 490, 510, 532, 555, and 583 (15 nm bandwidth)	0.0020 or 5%
Water-leaving reflectances centered on (±2.5 nm) 617, 640, 655, 665 678, and 710 (15 nm bandwidth, except for 10 nm bandwidth for 665 and 678 nm)	0.0007 or 10%
Ocean Color Data Products to be Derived from Water-leaving Reflectances	
Concentration of chlorophyll-a	
Diffuse attenuation coefficients 400-600 nm	
Phytoplankton absorption 400-600 nm	
Non-algal particle plus dissolved organic matter absorption 400-600 nm	
Particulate backscattering coefficient 400-600 nm	
Fluorescence line height	

Atmosphere

Data Product	Range	Baseline Uncertainty
Total aerosol optical depth at 380 nm	0.0 to 5	0.06 or 40%
Total aerosol optical depth at 440, 500, 550 and 675 nm over land	0.0 to 5	0.06 or 20%
Total aerosol optical depth at 440, 500, 550 and 675 nm over oceans	0.0 to 5	0.04 or 15%
Fraction of visible aerosol optical depth from fine mode aerosols over oceans at 550 nm	0.0 to 1	±25%
Cloud layer detection for optical depth > 0.3	NA	40%
Cloud top pressure of opaque (optical depth > 3) clouds	100 to 1000 hPa	60 hPa
Optical thickness of liquid clouds	5 to 100	25%
Optical thickness of ice clouds	5 to 100	35%
Effective radius of liquid clouds	5 to 50 μm	25%
Effective radius of ice clouds	5 to 50 μm	35%
Atmospheric data products to be derived from the above		
Water path of liquid clouds		
Water path of ice clouds		

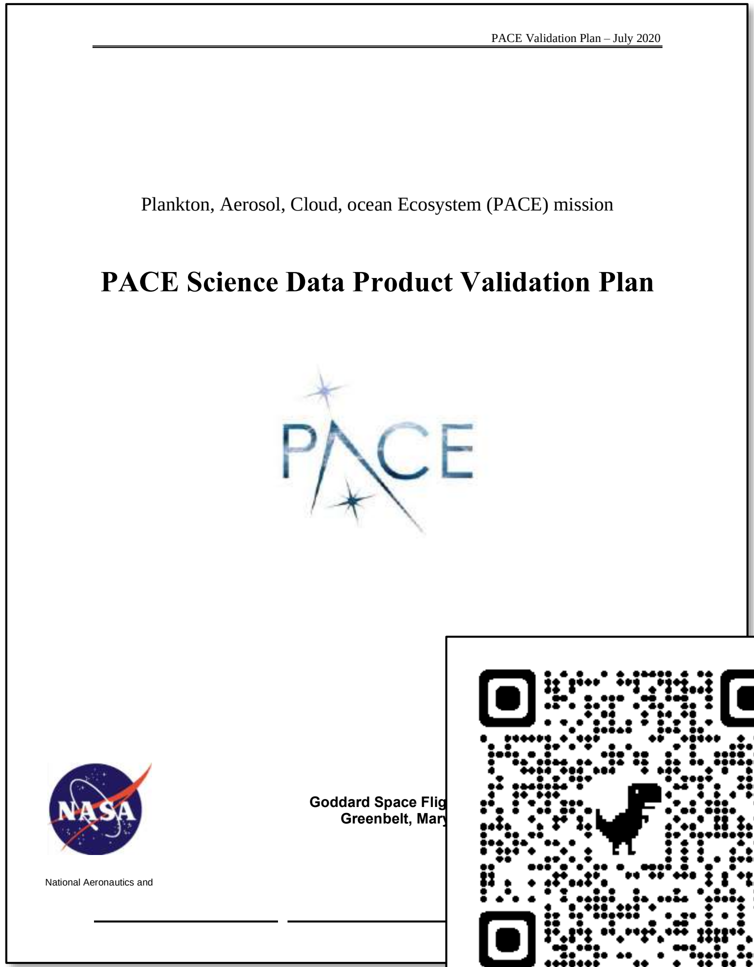
We must show we can successfully measure these products after launch

No required Level 2 products from the polarimeters, Level 1 at commissioning

The FULL list of products we will produce goes far beyond this. See:

https://pace.oceansciences.org/data_table.htm

PACE validation plan


PACE Validation Plan – July 2020

Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission

PACE Science Data Product Validation Plan

PACE

Goddard Space Flig
Greenbelt, Mary

National Aeronautics and

pace.oceansciences.org/documents.htm

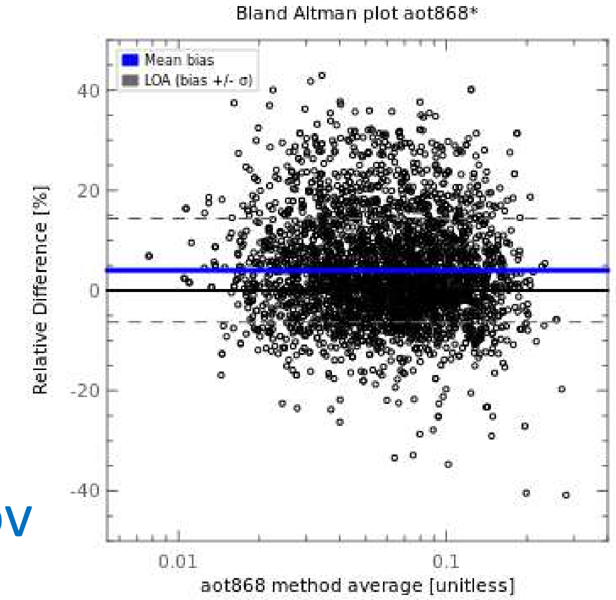
Validate of required and advanced products

This will utilize

- surface networks
- regular data collection from ships
- satellite data comparison
- a dedicated airborne field campaign

seabass.gsfc.nasa.gov

VIIRS SNPP AOT(868) vs. AERONET-OC



PACE Postlaunch Airborne eXperiment (PACE-PAX)

validation that can only be done with an airborne, multi-sensor field campaign

PACE-PAX

1. The NASA PACE Mission
2. The PACE-PAX validation field campaign
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4. Potential PACE – EarthCARE validation synergy

PACE-PAX

PACE Postlaunch Airborne EXperiment

An airborne field mission to validate the NASA PACE mission with coordinated observations

- California, 3-27 September 2024
- Remote sensing proxy observations from NASA ER-2
- In situ sampling with CIRPAS Twin Otter
- 60 flight hours for each aircraft
- Day trips from Santa Barbara with R/V Shearwater
- Coordinated observations under PACE
- Coordinated observations over surface sites & ship

Leadership team:

Kirk Knobelspiesse
Brian Cairns
Ivona Cetinić

PACE

pace.oceansciences.org/campaigns.htm

NASA Ames Earth Sciences · Goddard Earth Sciences · NPS · SRON Netherlands Institute for Space Research · JPL Jet Propulsion Laboratory California Institute of Technology · NOAA · UMBC · NASA Langley Research Center

PACE-PAX

PACE Postlaunch Airborne EXperiment

NASA AMES EARTH SCIENCES

GODDARD EARTH SCIENCES

NPS PRAESTANTIA PER SCIENTIAM

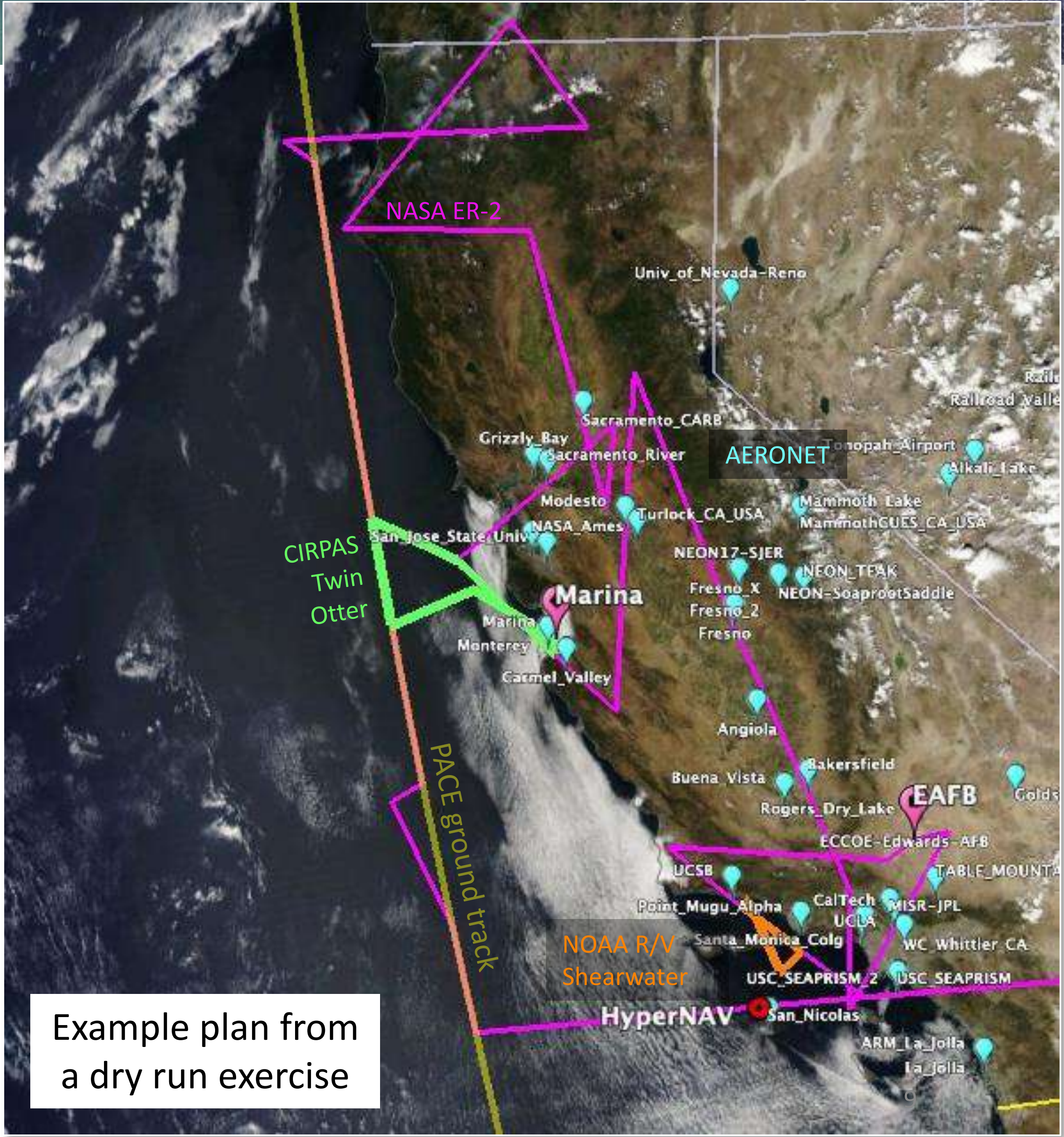
SRON Netherlands Institute for Space Research

JPL Jet Propulsion Laboratory California Institute of Technology

NOAA

UMBC

NASA Langley Research Center



Example plan from a dry run exercise

PACE-PAX instrumentation

Instrument	Platform	Role	Lead PI	Institution
AirHARP	ER-2	PACE/HARP2 polarimetry proxy	J. Vanderlei Martins	UMBC
PICARD	ER-2	PACE/OCI spectrometer proxy	J. Jacobson / K. Meyer	NASA ARC/GSFC
PRISM	ER-2	PACE/OCI spectrometer proxy	David R. Thompson	JPL
SPEX Airborne	ER-2	PACE/SPEXone polarimetry proxy	B. van Diedenhoven	SRON
HSRL-2	ER-2	Aerosol/cloud/ocean Lidar	T. Shingler / J. Hair	NASA LaRC
RSP	ER-2	Multi-angle polarimeter ref.	B. Cairns / K. Sinclair	NASA GISS
Facility instruments	Twin Otter	Aerosol/cloud in situ instruments	Anthony Bucholtz	NPS
LARGE	Twin Otter	Aerosol/cloud in situ instruments	Luke Ziemba	NASA LaRC
LI-Nephelometer	Twin Otter	Aerosol phase functions	Adam Ahern	NOAA
ISARA	Twin Otter	In situ data synergy activity	Snorre Stamnes	NASA LaRC
Ocean instruments*	RV Shearwater	Day cruises, instrumentation TBD	Mike Ondrusek	NOAA
HyperNAV*	Ocean floats	Radiometric calibration ocean floats	Andrew Barnard	OSU
AERONET, AERONET-OC*	Surface	Aerosol prop., water leaving radiance	P. Gupta / E. Lind	NASA GSFC

*externally supported activities

Validation objectives
1. Validate new retrieval properties
2. Assess spatial and temporal scale impact on validation
3. Validate in a narrow swath
4. Validate radiometric and polarimetric properties
5. Target specific geometries, season, and time of day
6. Focus on specific processes or phenomena

Our plan is based on a 'Validation Traceability Matrix' (VTM)

The VTM flows from top level objectives to the measurements needed to satisfy them and the requirements under which they are made

Validation objectives	ID	Measurement objectives	Importance, w	Objective total
1. Validate new retrieval properties	A	Land surface parameters	2	35
	B	Ocean radiometric parameters	2	
	C	Aerosol parameters over the ocean	10	
	D	Aerosol parameters over land	10	
	E	Cloud parameters	10	
	F	Ocean surface parameters	1	
2. Assess spatial and temporal scale impact on validation	A	Cloud parameters	8	16
	B	Aerosol parameters	8	
3. Validate in a narrow swath	A	Aerosol parameters over the ocean	10	25
	B	Aerosol parameters over land	10	
	C	Cloud parameters	5	
4. Validate radiometric and polarimetric properties	A	Validate large reflectances	3	12
	B	Validate large reflectances with high polarization	3	
	C	Validate large reflectances with low polarization	3	
	D	Overfly vicarious calibration sites	3	
5. Target specific geometries, season, and time of day	A	Aerosol over ocean retrieval geometry dependence	2	6
	B	Aerosol over land retrieval geometry dependence	2	
	C	Cloud property retrieval geometry dependence	2	
6. Focus on specific processes or phenomena	A	High aerosol loads over land	4	29
	B	High aerosol loads over ocean	4	
	C	Multiple aerosol layers	1	
	D	Aerosol under thin cirrus	2	
	E	Aerosol above liquid phase cloud	4	
	F	Broken clouds with complex structure	4	
	G	Dust aerosols over ocean	1	
	H	Aerosol and ocean parameters over turbid waters	2	
	I	Aerosol and ocean parameters over biologically productive waters	5	
	J	Aerosol and ocean parameters with and without reflected sunglint	1	
	K	Smoke aerosols over ocean	1	

Validation Traceability Matrix (VTM) based on PACE Science and Applications Team (SAT) input

“Importance” weighting helps prioritize observations, decision support in flight planning

Aggregate assessments can ‘score’ the value of an individual instrument, flight plan, etc. to the overall mission

“**Planning for PACE relevant field campaigns**” white paper and Validation Traceability Matrix (VTM)

NASA/TM–2023-219027/Vol. 11

PACE Technical Report Series, Volume 11

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The PACE Postlaunch Airborne eXperiment (PACE-PAX)

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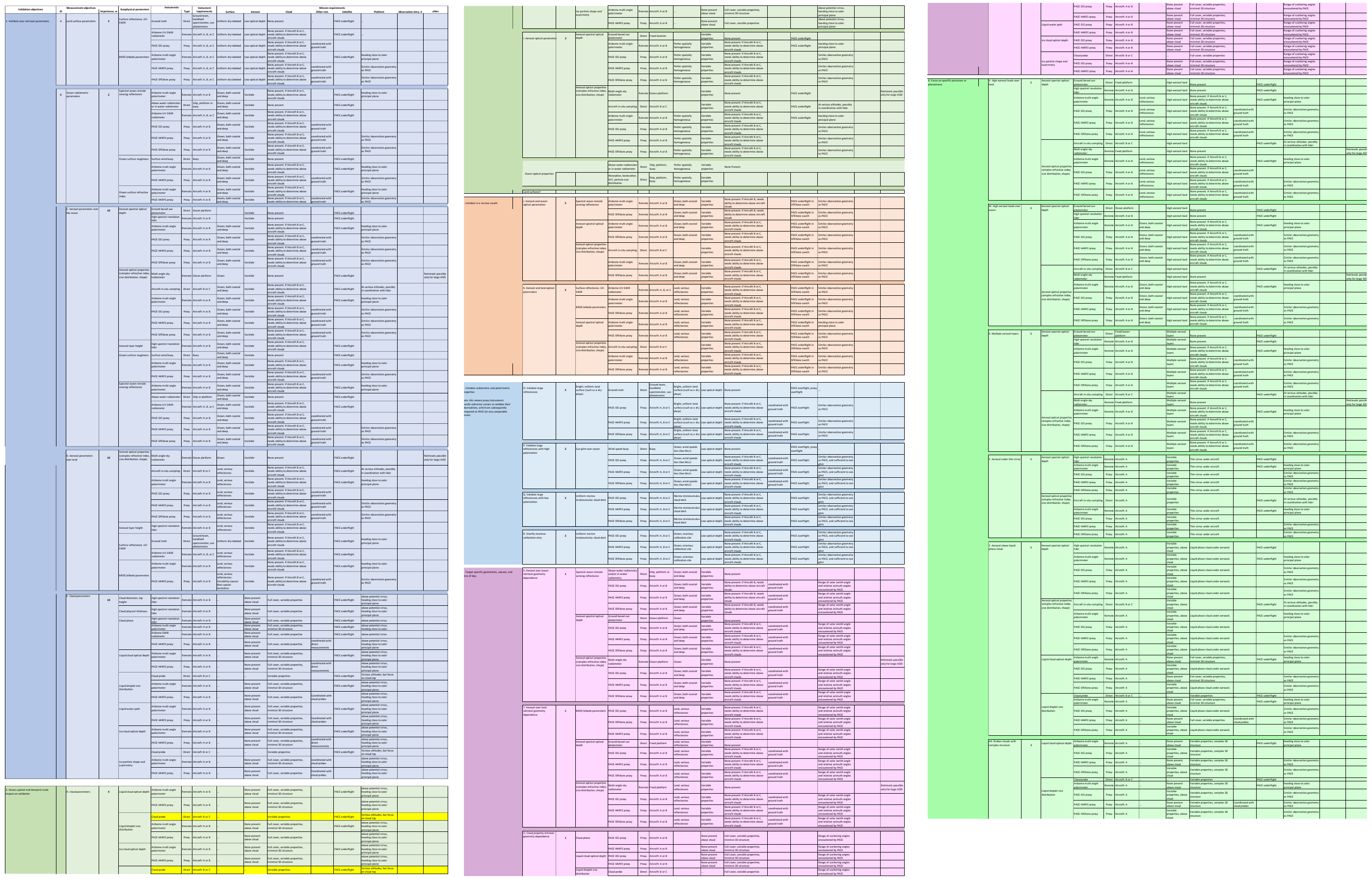
June 2023

Full Validation Traceability Matrix



Both of these are on the PACE website: https://pace.oceansciences.org/campaigns.htm

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	PACE	EarthCARE
Launch	January, 2024	May, 2024
Orbit	Polar ascending sun-sync 13:00	Polar descending sun-sync 14:00
Institutions	NASA; UMBC & SRON/Airbus	ESA & JAXA
Instruments	OCI UV-SWIR hyperspectral imager HARP2 multi-angle polarimeter SPEXone multi-angle polarimeter	ATLID HSRL UV lidar CPR Cloud profiling radar MSI multi-spectral imager BBR broad-band radiometer
Objectives (paraphrased)	1. Extend key ocean biology, cloud and aerosol climate data records 2. Make new ocean color measurements to better understanding of the carbon cycle 3. Make global aerosol and cloud measurements to reduce climate and radiative forcing uncertainty 4. Improve knowledge of atmospheric influence on the ocean and vice versa	Advance our understanding of the role that clouds and aerosols play in reflecting incident solar radiation back out to space and trapping infrared radiation emitted from Earth's surface
Validation plans	• Extensive collection and archive of ocean and atmosphere data (https://seabass.gsfc.nasa.gov/) • NASA HQ supported PACE Validation team • PACE-PAX for validation that can only happen with an airborne field campaign. Also, involvement with ARCSIX	Described in this meeting!

EARTH OBSERVATION SYSTEM SUPPORT

EarthCARE vs PACE: Collocation Analysis

(Full analysis in backup slides)

Montserrat Pinol Sole

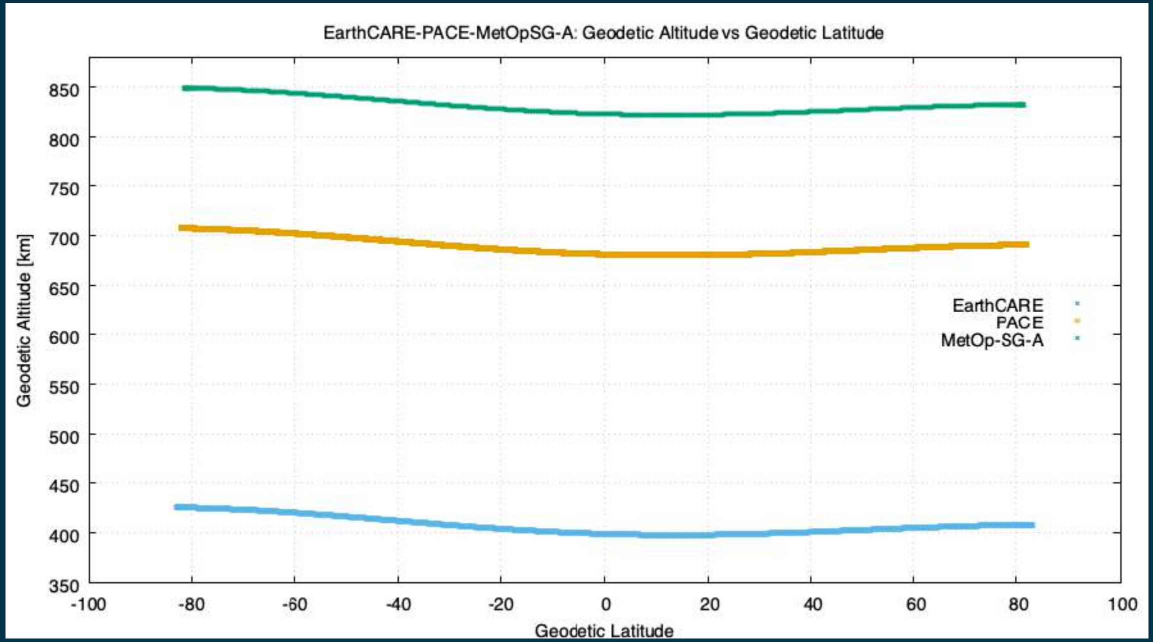
ESTEC / EOP-PES

24/Oct/2023

Ref. EOPPES-PTN-068 Issue 1

Orbit Characteristics

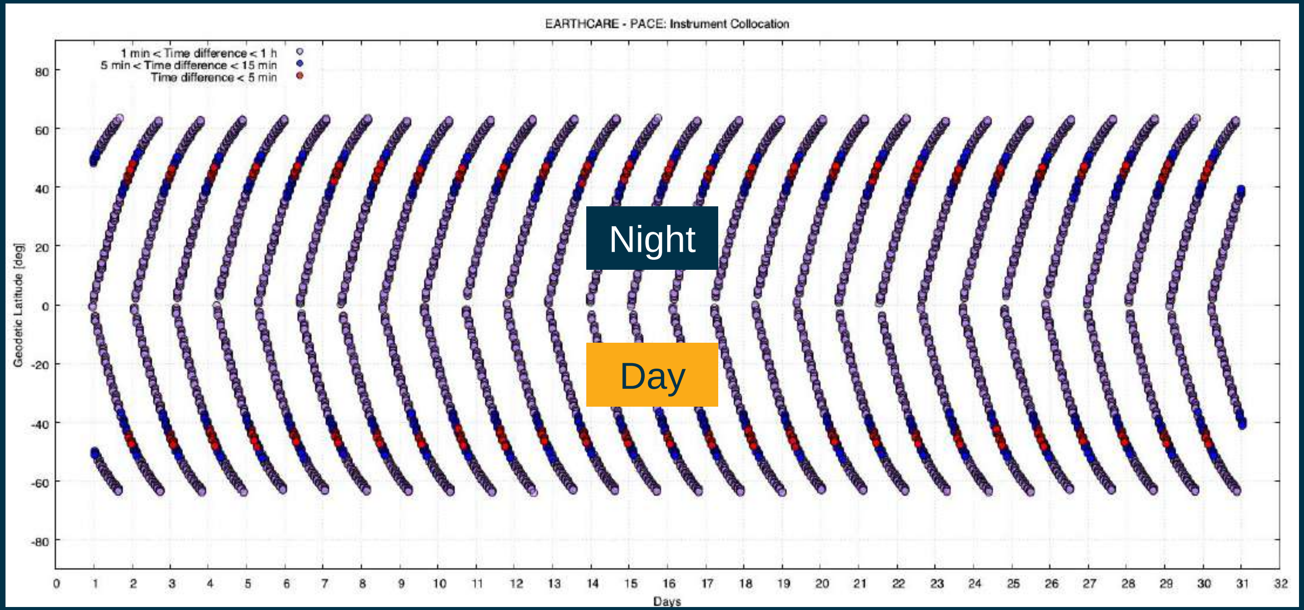
Satellite (LEO)	Repeat Cycle [days]/ Cycle Length [orbits]	Avg. Geodetic Altitude [km]	MLST at ANX [h]	Inclination [deg]
EarthCARE	22/325	408.3	14:00	97.03
PACE	11/161	690.6	13:00	98.11



- Similar MLST for PACE and EarthCARE → collocations distributed geographically in regions other than polar regions
- PACE is ~ 280 km higher than EarthCARE → satellites overtake each other after 1.08 days

EarthCARE Ground-Tracks vs PACE SPEXone

- 30 days simulated (01-Sep to 01-Oct).
- Collocation opportunities within 60 minutes (purple), 15 minutes (blue) and 5 minutes (red)



Daytime collocations within 5 minutes take place once per base period, around - 42°

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Validation campaign comparison

PACE-PAX

Location	Californal and nearby coastal areas
Dates	Sept 3-27, 2024
Leadership	Kirk Knobelspiesse, Brian Cairns, Ivona Cetinić
Documentation	https://pace.oceansciences.org/campaigns.htm
Archive	https://www-air.larc.nasa.gov/missions/pacepax
Platforms	ER-2 (air), Twin Otter (air), R/V Shearwater (ship)

Instrument	Platform	Role
AirHARP	ER-2	PACE/HARP2 polarimetry proxy
HSRL-2	ER-2	Aerosol/cloud/ocean lidar
PICARD	ER-2	PACE/OCI spectrometer proxy
PRISM	ER-2	PACE/OCI spectrometer proxy
RSP	ER-2	Multi-angle polarimeter reference
SPEX Airborne	ER-2	PACE/SPEXone polarimetry proxy
Facility inst.	Twin Otter	Aerosol/cloud in situ instruments
LARGE	Twin Otter	Aerosol/cloud in situ instruments
LI-Neph.	Twin Otter	Aerosol phase functions
Ship based obs.	Shearwater	Ocean optics
HyperNAV	Floats	Water leaving radiance

PERCUSSION

Location	Germany, Barbados, Cape Verde
Dates	June - October, 2024
Leadership	Bjorn Stevens (MPI-M) and Silke Groß
Documentation	https://halo-research.de/sience/future-missions/ec-tooc/
Archive	
Platforms	HALO (Aircraft)

Instrument	Platform	Role
WALES	HALO	Aerosol/cloud lidar
specMACS	HALO	Nadir VIS/NIR/SWIR cameras
HAMP Radar	HALO	Cloud radar 35.5 Ghz, nadir
HAMP Radiometer	HALO	MW Radiometer
SMART	HALO	UV-SWIR spectral irradiance, radiance
VELOX	HALO	IR camera
Dropsondes	HALO	

MAESTRO

Location	Cape Verde
Dates	Aug 10 - Sept 10, 2024
Leadership	Sandrine Bony (LMD) and Julien Delanoë (LATMOS)
Documentation	https://maestro.aeris-data.fr/
Archive	
Platforms	ATR-42 (Aircraft)

Instrument	Platform	Role
LNG	ATR-42	Aerosol/cloud lidar
Microphysics	ATR-42	Aerosol/cloud in situ instruments
NP-II	ATR-42	Phase functions
RASTA	ATR-42	W-band pulsed Doppler cloud radar
BASTA	ATR-42	Horizontal bistatic radar
AWALI	ATR-42	Horizontal lidar
CLIMAT	ATR-42	IR irradiance, sea surface temp.
Pyrg/Pyranometer	ATR-42	Broadband up/down radiative flux
Camera	ATR-42	VIS camera

Validation objectives	ID	Measurement objectives	Importance, w
1. Validate new retrieval properties	A	Land surface parameters	2
	B	Ocean radiometric parameters	2
	C	**Aerosol parameters over the ocean**	**10**
	D	Aerosol parameters over land	10
	E	**Cloud parameters**	**10**
	F	Ocean surface parameters	1
2. Assess spatial and temporal scale impact on validation	A	**Cloud parameters**	**8**
	B	**Aerosol parameters**	**8**
3. Validate in a narrow swath	A	**Aerosol parameters over the ocean**	**10**
	B	Aerosol parameters over land	10
	C	**Cloud parameters**	**5**
4. Validate radiometric and polarimetric properties	A	Validate large reflectances	3
	B	Validate large reflectances with high polarization	3
	C	Validate large reflectances with low polarization	3
	D	Overfly vicarious calibration sites	3
5. Target specific geometries, season, and time of day	A	**Aerosol over ocean retrieval geometry dependence**	**2**
	B	Aerosol over land retrieval geometry dependence	2
	C	**Cloud property retrieval geometry dependence**	**2**
6. Focus on specific processes or phenomena	A	High aerosol loads over land	4
	B	**High aerosol loads over ocean**	**4**
	C	**Multiple aerosol layers**	**1**
	D	Aerosol under thin cirrus	2
	E	**Aerosol above liquid phase cloud**	**4**
	F	**Broken clouds with complex structure**	**4**
	G	**Dust aerosols over ocean**	**1**
	H	Aerosol and ocean parameters over turbid waters	2
	I	Aerosol and ocean parameters over biologically productive waters	5
	J	**Aerosol and ocean parameters with and without reflected sunglint**	**1**
	K	Smoke aerosols over ocean	1

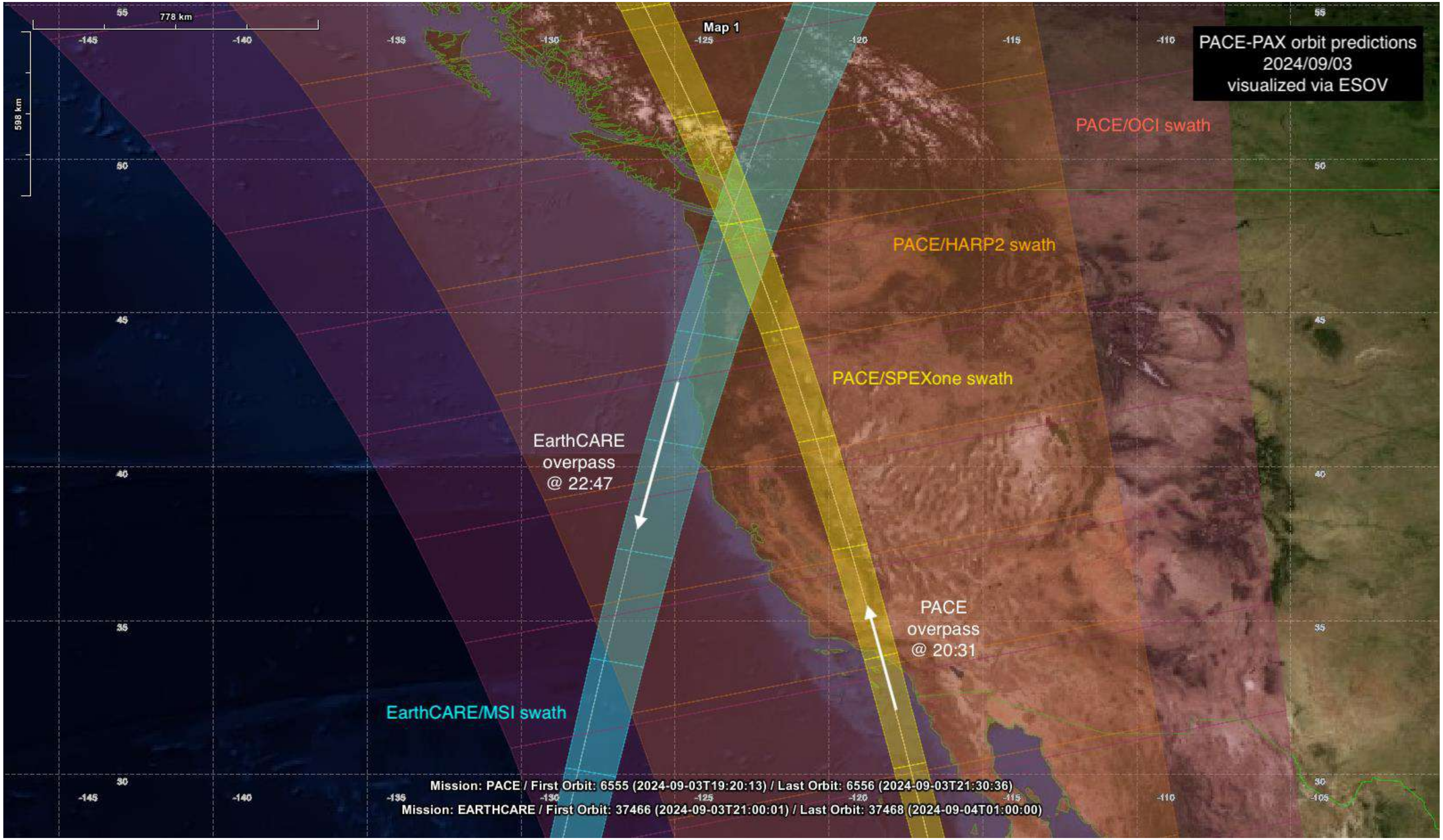
- EarthCARE validation campaigns can be useful for PACE validation
- Applies for aerosol products and especially cloud products
- EarthCARE campaigns do not have the equivalent of PACE proxy instruments, so validation would require observations during satellite overpass

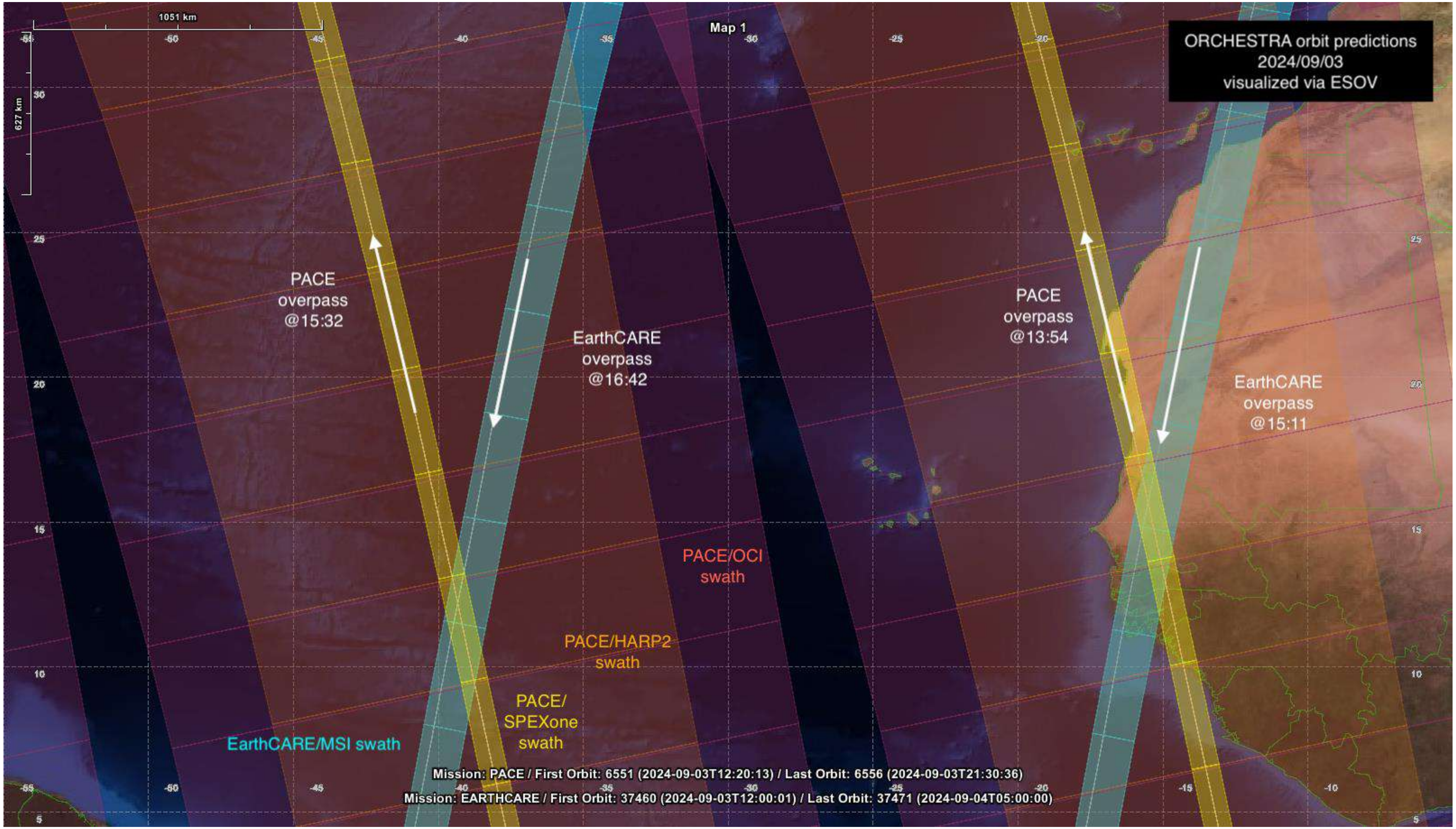
PACE-PAX

Satellite overpasses on first planned day of PACE-PAX

PACE overpass at 13:31 PDT

EarthCARE overpass at 15:47 PDT





Same day, ORCHESTRA region

PACE overpass at
12:54 CVT (East)
14:32 CVT (West)

EarthCARE overpass at
13:11 CVT (East)
15:42 CVT (West)

Conclusions

- PACE-PAX will be in September, 2024 in California. Two aircraft, a ship and other ground assets will be used to validate PACE's ocean, aerosol and cloud products.
- PACE and EarthCARE will have once daily coincident daytime observations in the Southern Hemisphere. These observations can be used for product intercomparison and validation.
- PACE-PAX and ORCHESTRA will have both PACE and EarthCARE satellite overpasses which will be valuable for validation of products from both missions. Coordination of activities will be mutually beneficial.

Thank you!

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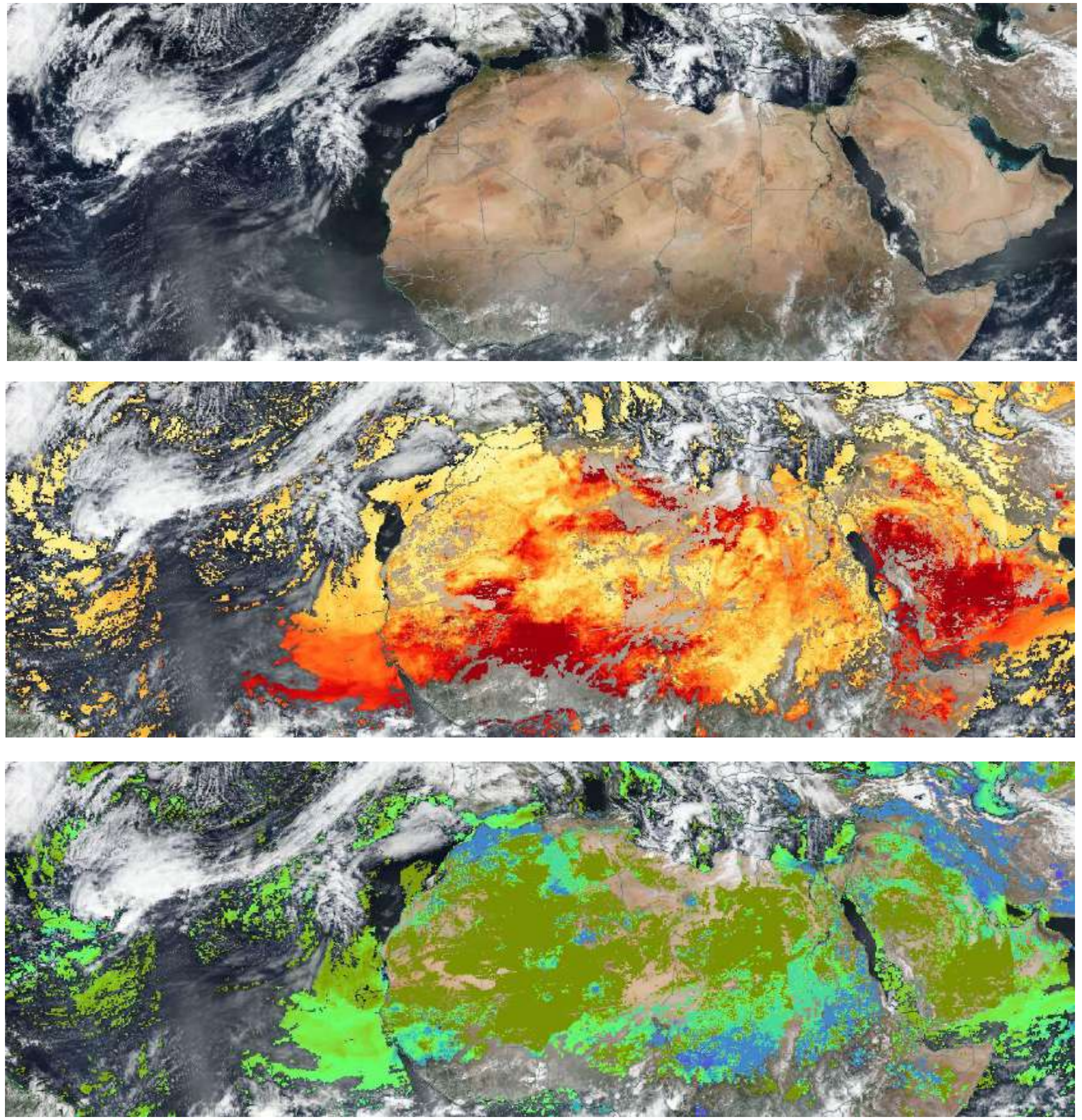
Brian Cairns, PACE-PAX Deputy Mission Scientist, Brian.Cairns@nasa.gov
Ivona Cetinić, PACE-PAX Deputy Mission Scientist, Ivona.cetinic@nasa.gov

Interested in learning more about PACE? See our Community of Practice in the Applications section here: pace.gsfc.nasa.gov

Backup slides

At-launch PACE/OCI aerosol algorithms include heritage Deep Blue and Dark Target

- **Deep Blue** (DB) and **Dark Target** (DT) implemented
  - Based on VIIRS versions of code
  - Output at full (~1 km) resolution
  - Available with <1 day latency from spring 2024
- Post-launch candidates:
  - Remer *et al.* “Unified Aerosol Algorithm” combining DB, DT, and OMAERUV, code delivered, in testing
  - Lyapustin *et al.* MAIAC, code to be delivered



VIIRS
04 Mar 2020

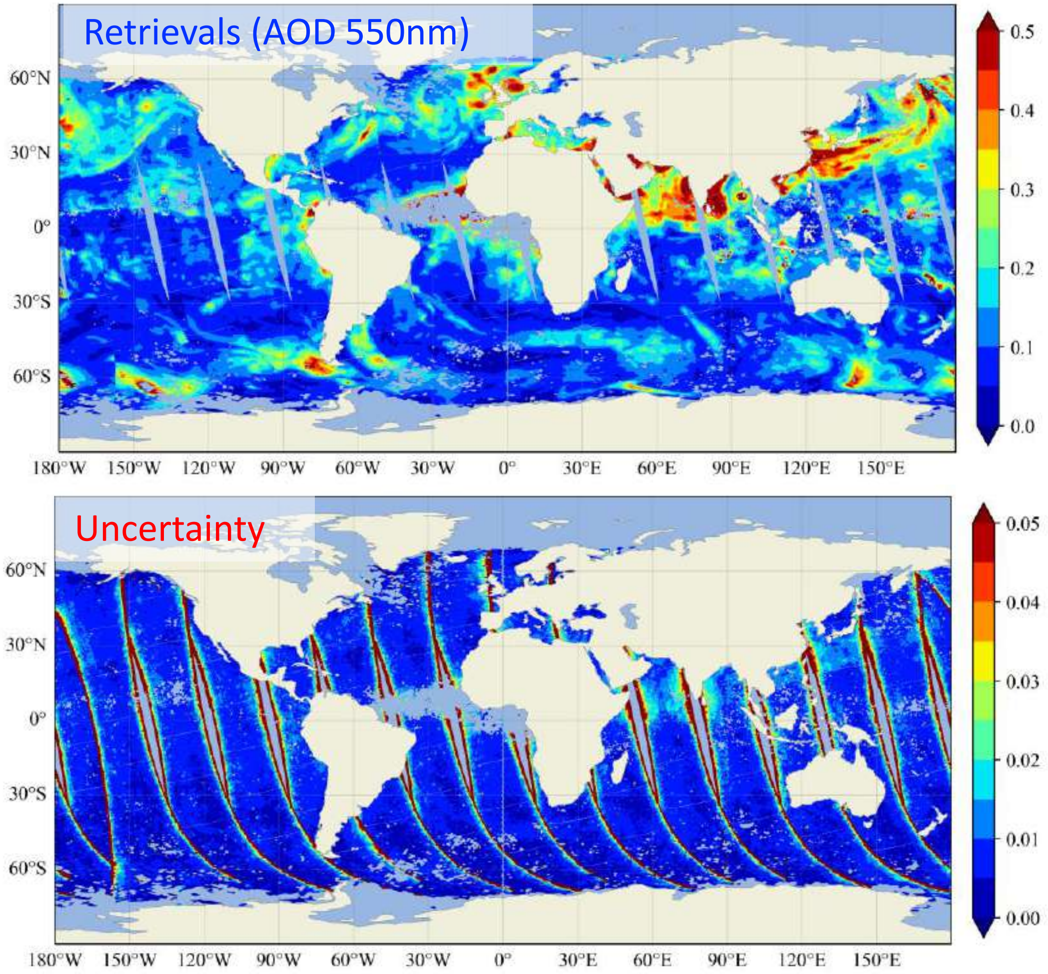
AOD
low high

AE
low high

We have in-house polarimetric retrievals implemented…

FastMAPOL

- Lead: Meng Gao
- Joint aerosol and ocean retrieval
- Fast neural network radiative transfer forward model
- Reasonable pixel-level uncertainty estimates for all quantities
- Validated with AirHARP and synthetic global HARP2 data
- Updates for spheroidal dust and land surfaces in the works



Main products

Complex refractive index (fine/coarse)

Aerosol effective radius & variance

Layer height

AOD

SSA

Wind speed

Chlorophyll a

Research products

Multi-angle cloud mask

Multi-angle water leaving signal

https://doi.org/10.5194/egusphere-2023-1843

PACE-PAX org chart

PACE Project Scientist: Jeremy Werdell
PACE Deputy Project Scientists: Brian Cairns, Antonio Mannino
PACE Program Scientist: Laura Lorenzoni
PACE Deputy Program Scientist: Hal Maring
PACE Applied Sciences: Woody Turner

Leadership:
Kirk Knobelspiesse
Brian Cairns
Ivona Cetinić

Project Management:
Sommer Nicholas
Judy Alfter

Weather and flight planning:
Rei Ueyama

- Flight planning: Samuel LeBlanc
- Forecasting: Mijeong Park
- IT Support: Ju-Mee Ryoo
- Satellite support: Louis Nguyen

ER-2:
Kirk Knobelspiesse

Aircraft management:
Samuel Choi
John McGrath
Fran Becker

Science instruments:
- AirHARP: J. Vanderlei Martins
- HSRL-2: John Hair; Taylor Shingler
- PICARD: James Jacobson, Kerry Meyer
- PRISM: David Thompson
- RSP: Ken Sinclair; Brian Cairns
- SPEX Airborne: Otto Hasekamp

Twin Otter:
Brian Cairns

Aircraft management:
Anthony Bucholtz

Science Instruments:
- Facility: Anthony Bucholtz
- LI Nephelometer: Adam Ahern
- LARGE: Luke Ziemba

R/V Shearwater:
Ivona Cetinić

Ship management:
Michael Ondrusek

Science Instruments:
- HyperNAV: Andrew Barnard
- Others TBD

Data archive:
Gao Chen,
Michael Shook

In-Situ Aerosol Retrieval Algorithm (ISARA)

	Instrument
Facility instruments	Navigation
	Meteorology
	Wind
	Ultra-Fine 3025A particle counter
	Magic200 CPC particle counter
	TSI Scattering Nephelometer
	Particle soot absorption photometer (PSAP)
	PMS PCASP
	DMT Cloud Imaging Probe (CIP)
	DMT Cloud and Aerosol Spectrometer (CAS)
	DMT Hotwire Liquid Water Content (LWC)
LARGE	DMT Ultra-High Sensitivity Aerosol Spectrometer
	TSI-3321 Aerodynamic Particle Sizer (APS)
	TSI-3563 Scattering Nephelometer, Dry
	TSI-3563 Scattering Nephelometer, Humidified
	Aerodyne CAPS-PM_{SSA} at RH < 40%
NOAA	Laser Imaging Nephelometer (LiNeph)

Validation relevant aerosol and cloud parameters

Snorre Stamnes, Joe Schlosser

High Spectral Resolution Lidar (HSRL-2) products

John Hair, Taylor Shingler, Brian Collister and others

Atmospheric products

Parameter	Wavelength (nm)	Approximate Precision	Horizontal Resolution	Vertical Resolution
Aerosol Backscatter	355/532/1064	0.2 $Mm^{-1}sr^{-1}$	2 km	30 m
Aerosol Extinction	355/532	0.01 km^{-1}	12 km	300 m
Depolarization	355/532/1064	0.01	2 km	30 m
Aerosol Optical Depth	355/532	0.01	12 km	
Aerosol Type (e.g., marine, dust, smoke)	N/A	Qualitative	12 km	300 m
Cloud Top Height (upper layer)	532	15 m	100 m	15 m

New! Ocean products

Parameter	Wavelength (nm)	Approximate Precision	Horizontal Resolution	Vertical Resolution
Particulate Backscatter	355/532	2E-7 $m^{-1}sr^{-1}$	2 km	1 m
Extinction	355/532	1E-5 m^{-1}	2 km	5 m
Remote Sensing Reflectance	355/532	*1E-6 sr^{-1}	2 km	N/A

*estimate based on propagation of errors from backscatter and extinction above

Meteorological forecasting and flight planning

Team lead by Rei Ueyama, NASA Ames Research Center

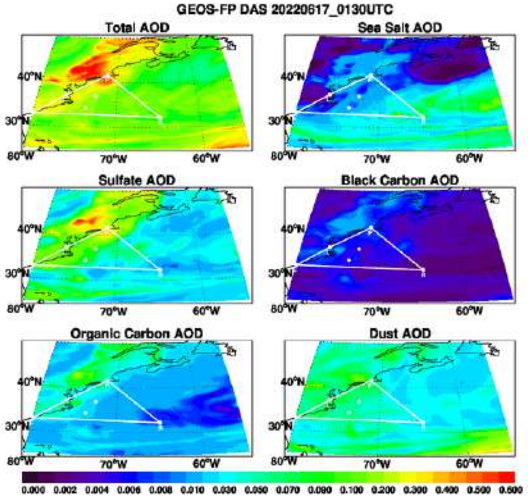
Flight planning by Samuel LeBlanc

Additional support from NASA GMAO and for geostationary datasets

https://bocachica.arc.nasa.gov/PACE-PAX/

Global Modeling and Assimilation Office GMAO

https://gmao.gsfc.nasa.gov/field_campaigns/



Project management Earth Science Project Office (ESPO) at NASA Ames

ESPO is a group of success-oriented individuals providing a long history of outstanding field project management for NASA's Science Mission Directorate. We provide support in all facets of field project management.

ESPO oversees mission planning, including but not limited to conducting site visits to potential deployment sites, working with project teams to plan the details of the field operations, and setting up deployment locations.

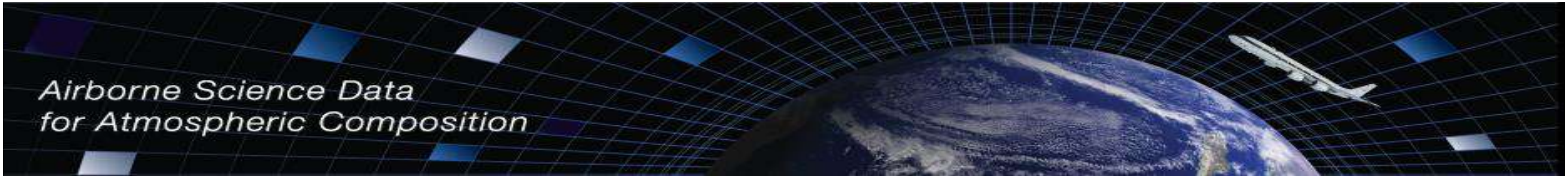
<u>**ESPO Responsibilities:**</u>

Management – Schedule, Planning, Budget, Reviews, Coordination
Travel Requirements – Site Surveys, Deployment Operations, Science Meetings
Logistics – Operations Website, List Serves, Lodging, Transportation**,** Shipping
Facilities – Setup Lab/Office/Hangar, Rentals, Badging/Access, Ground Sites
Mission Supplies – Office Supplies, Printers, Gases/Cryogens
Communications – Network, Phone
Mission Closeout – Contracts, Accounts
External Support – PAO

Sommer Nicholas and Erin Czech

https://espo.nasa.gov/pace-pax

Data Management Gao Chen and Michael Shook at NASA Langley



Support during ongoing campaign

- Similar to ACEPOL data repository at www-air.larc.nasa.gov
- Team file sharing capability
- ICARTT file naming convention or CF compliant netCDF files
- Script-based batch upload and download option available via fixed IPs
- File scanning to enhance F.A.I.R.ness

Later migration of data to long term DAAC (archive) TBD

Overall paper to *Earth System Science Data* or similar

Final data are to be archived within six months of the field campaign conclusion (March 31, 2025)

EarthCARE and MetOpSG-A vs PACE: Collocation Analysis

Montserrat Pinol Sole

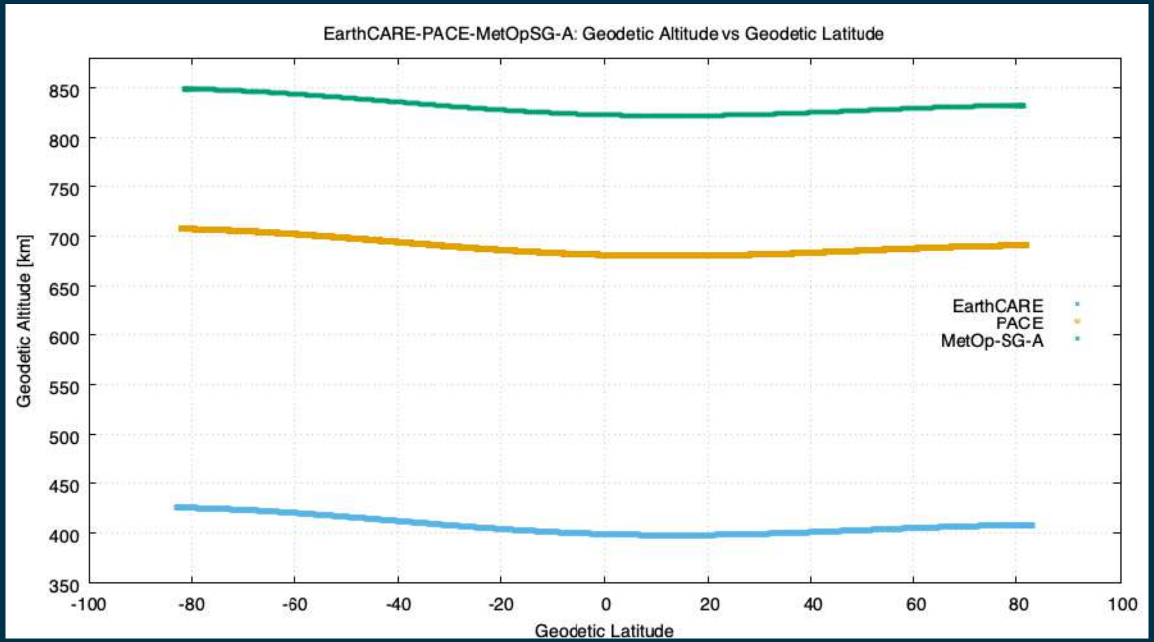
ESTEC / EOP-PES

24/Oct/2023

Ref. EOPPES-PTN-068 Issue 1

Orbit Characteristics

Satellite (LEO)	Repeat Cycle [days]/ Cycle Length [orbits]	Avg. Geodetic Altitude [km]	MLST at ANX [h]	Inclination [deg]
EarthCARE	22/325	408.3	14:00	97.03
PACE	11/161	690.6	13:00	98.11
Metop-SG-A	29/412	832.2	21:30	98.7



- Similar MLST for PACE and EarthCARE → collocations distributed geographically in regions other than polar regions
- Large MLST difference between PACE and MetOpSG-A → collocations distributed geographically in polar regions

- PACE is ~ 280 km higher than EarthCARE → satellites overtake each other after 1.08 days
- Metop-SG-A is ~ 140 km higher than PACE → satellites overtake each other after 2.3 days

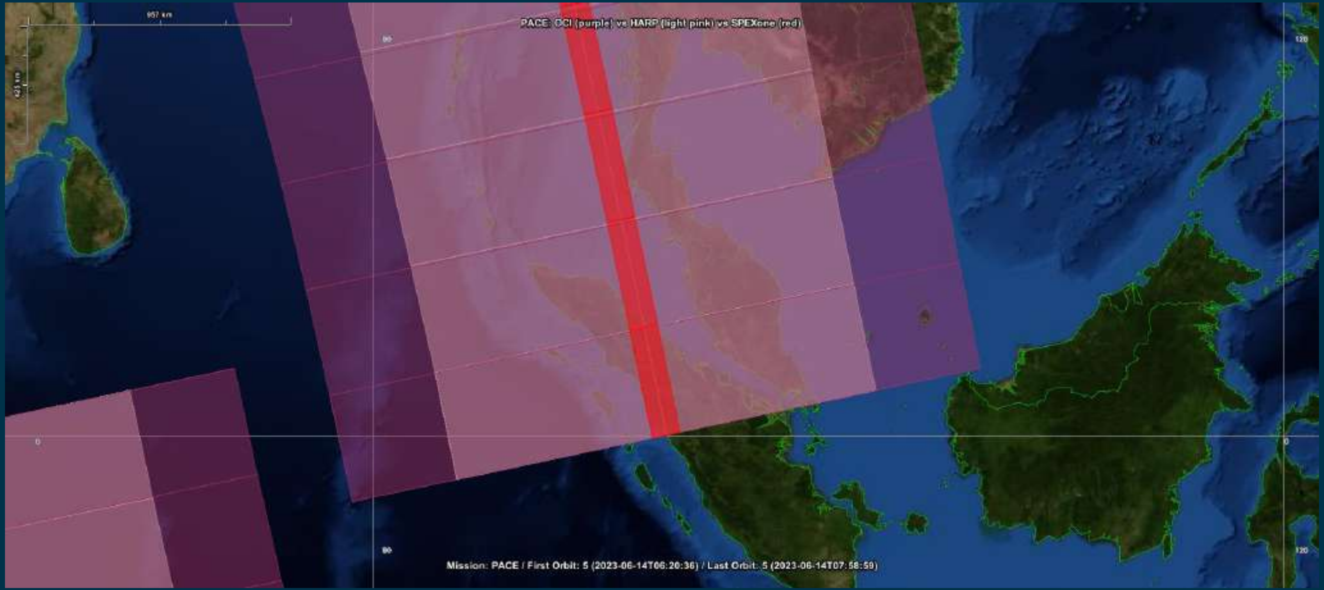
Swath Characteristics

Satellite (LEO)	Instrument	Field-of-View [deg]	Swath Width [km]
EarthCARE	Ground-Track	Nadir	-

Satellite (LEO)	Instrument	Field-of-View [deg]	Swath Width [km]
PACE	Ground-Track	Nadir	-
	OCI	+/-56.0	~ 2100
	HARP2	+/-47.0	~ 1500
	SPEXone	+/-4.314	~ 100

Satellite (LEO)	Instrument	Field-of-View [deg]	Swath Width [km]
MetOp-SG-A	3MI	Nadir	-

PACE Instrument Swath Visualisation



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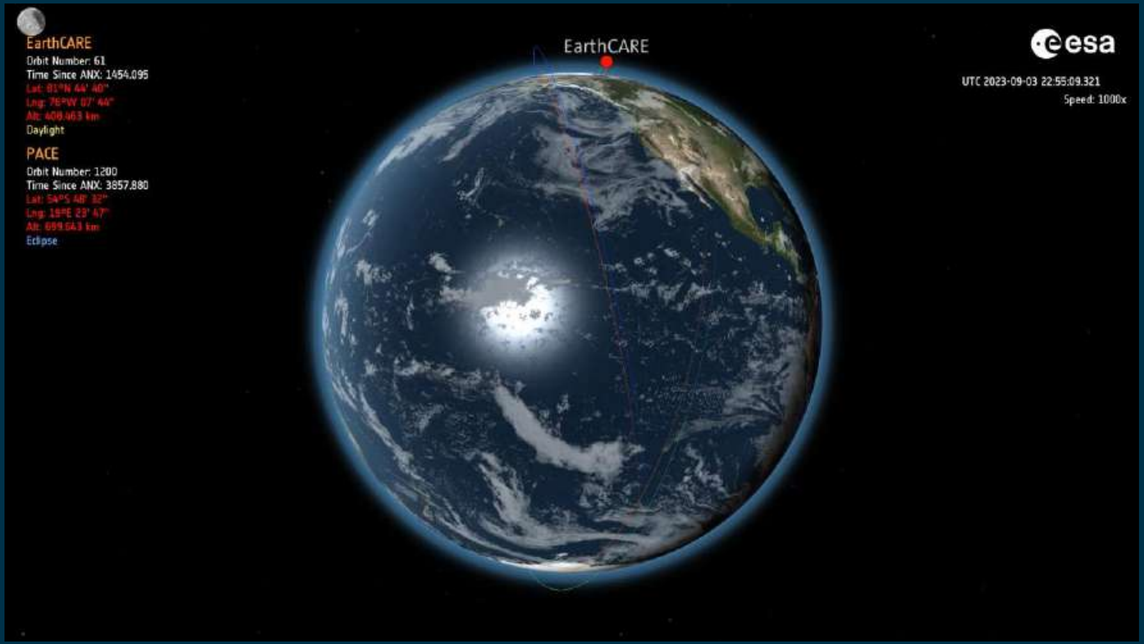
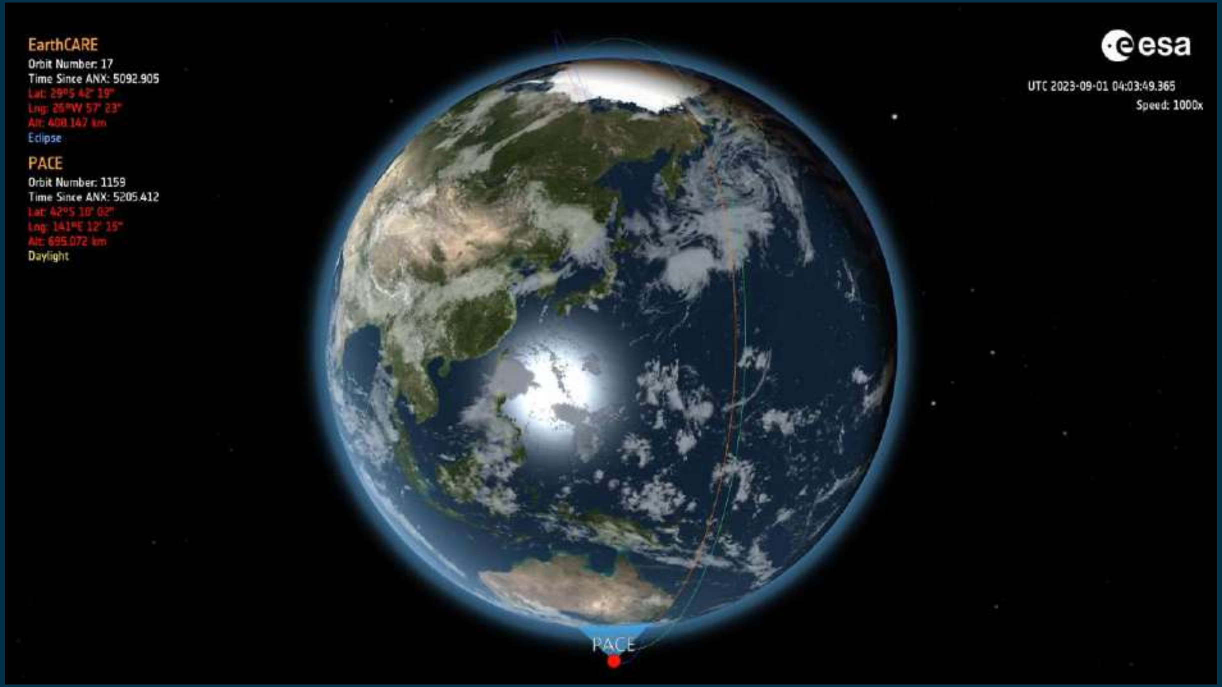
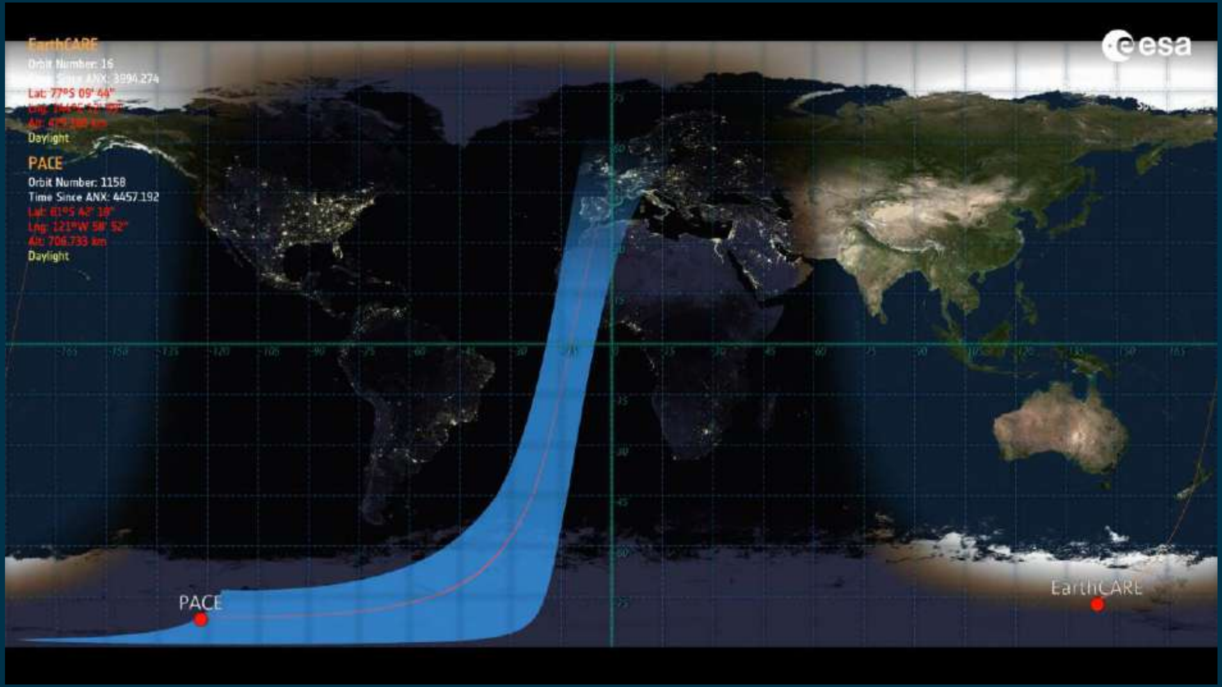


- SAMI

EARTHCARE-PACE: Relative geometry

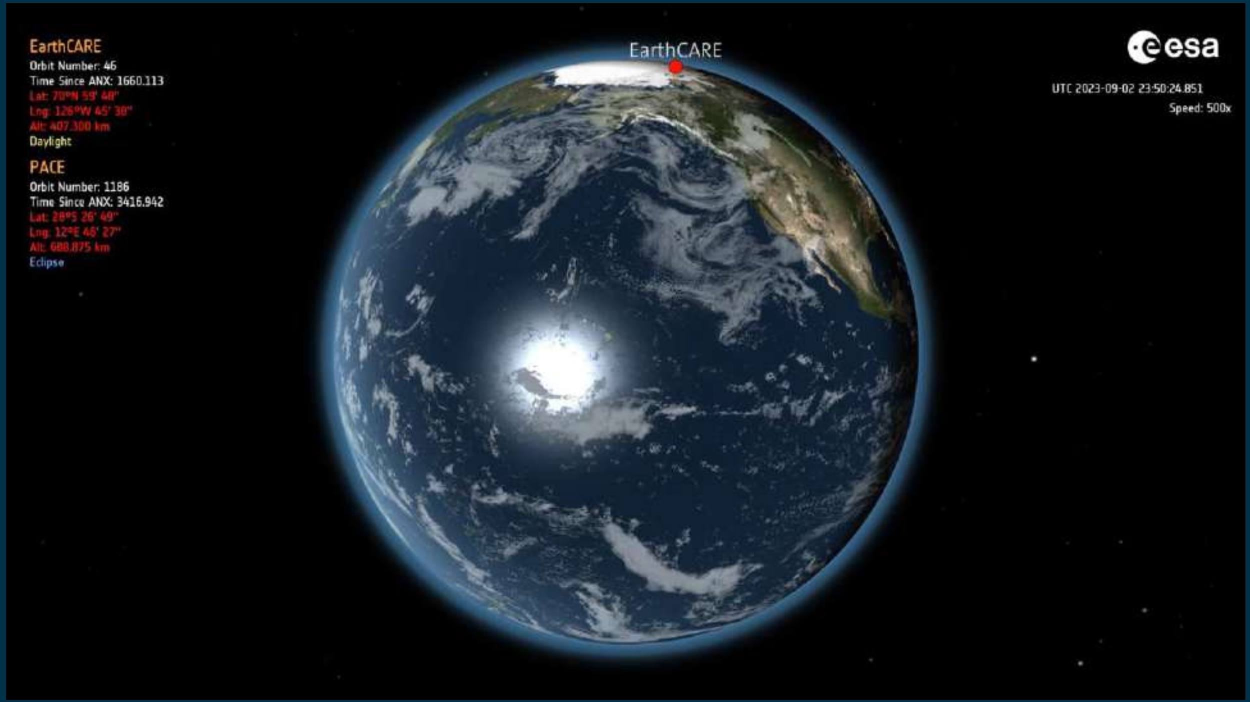
- Satellites overtake each other with a base period of 1.08 days





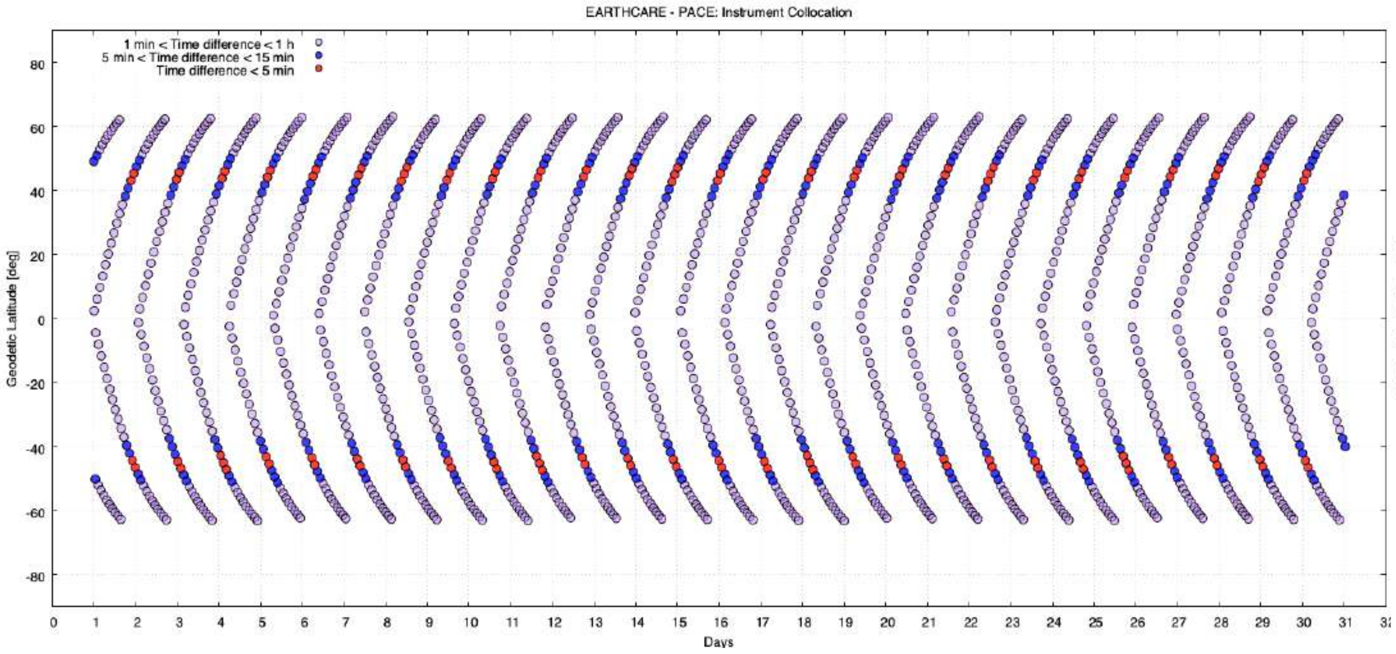
- The combined cycle of EarthCARE and PACE would be 25x11=275 days

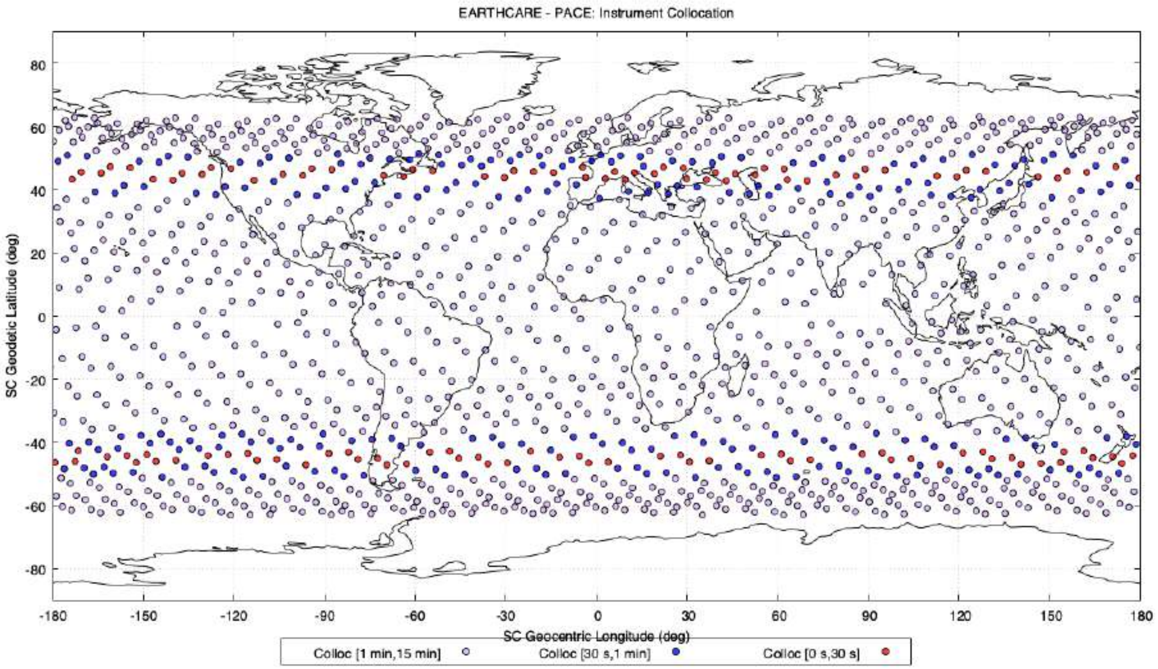
EARTHCARE-PACE : Collocation < 5 minutes



EarthCARE-PACE: Collocation Opportunities
Ground-Tracks Only

- A time interval of 30 days has been simulated (01-Sep to 01-Oct).
- Collocation opportunities within 60 minutes (purple), 15 minutes (blue) and 5 minutes (red)
- The collocations below 5 minutes take place once per base period, around +/-42 deg latitude
- A time interval of 30 days has been simulated (01-Sep to 01-Oct).

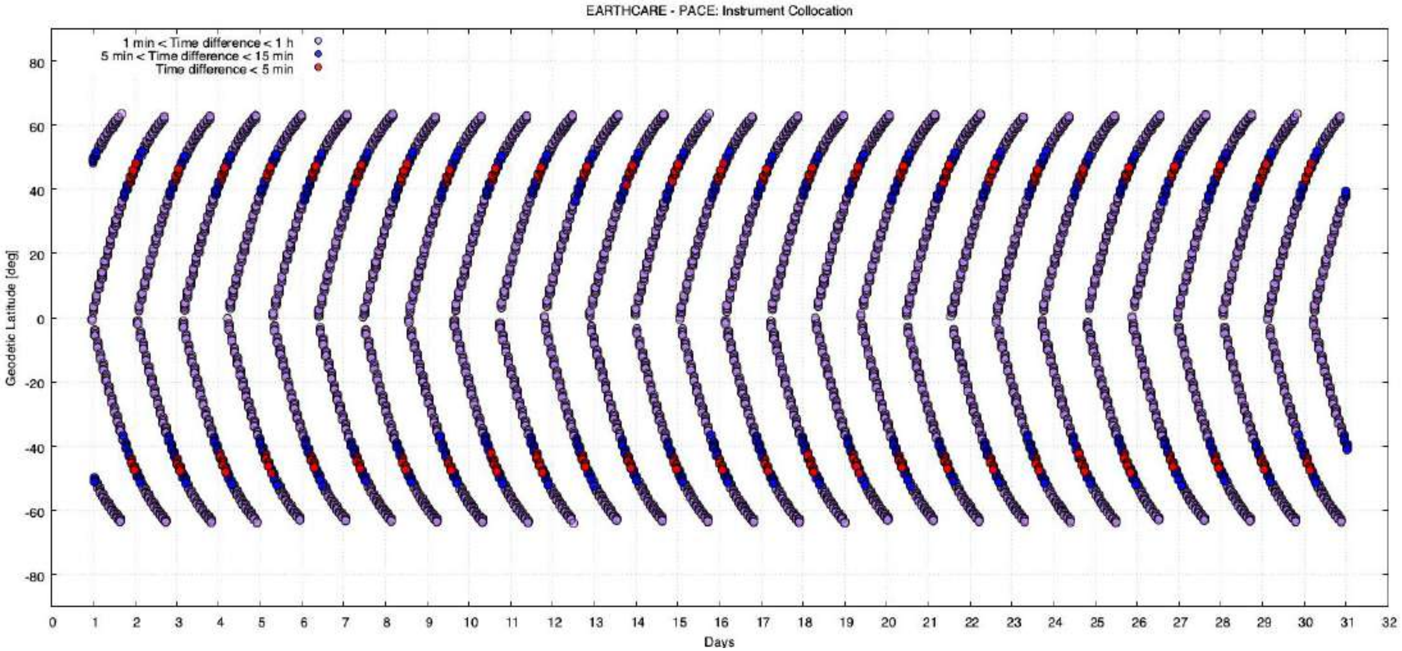


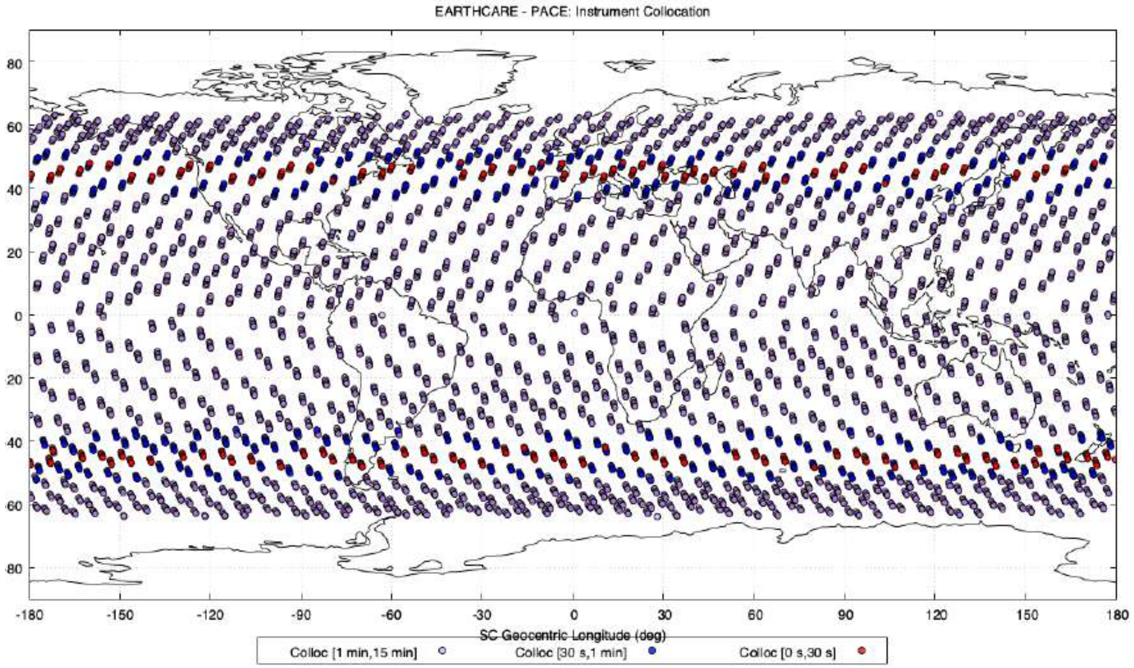


EarthCARE-PACE: Collocation Opportunities

EC Ground-Tracks vs PACE SPEXone

- A time interval of 30 days has been simulated (01-Sep to 01-Oct).
- Collocation opportunities within 60 minutes (purple), 15 minutes (blue) and 5 minutes (red)
- The collocations below 5 minutes take place once per base period, around +/-42 deg latitude
- A time interval of 30 days has been simulated (01-Sep to 01-Oct).

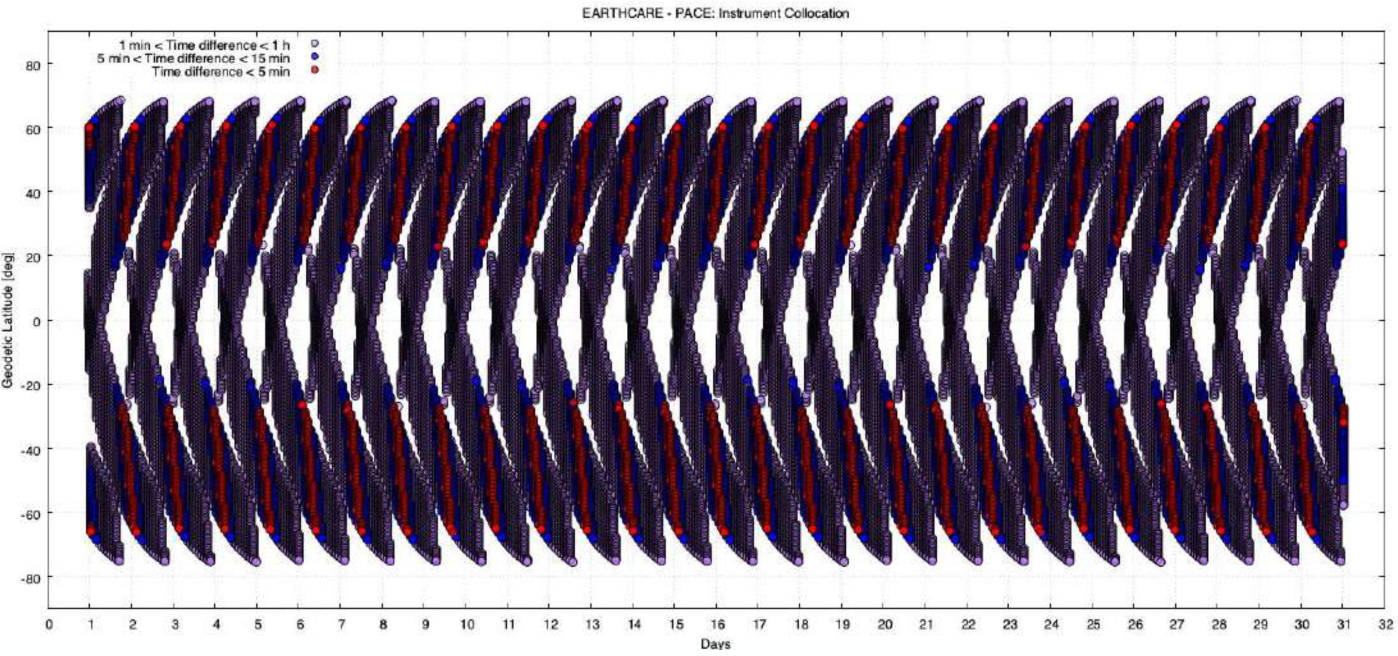


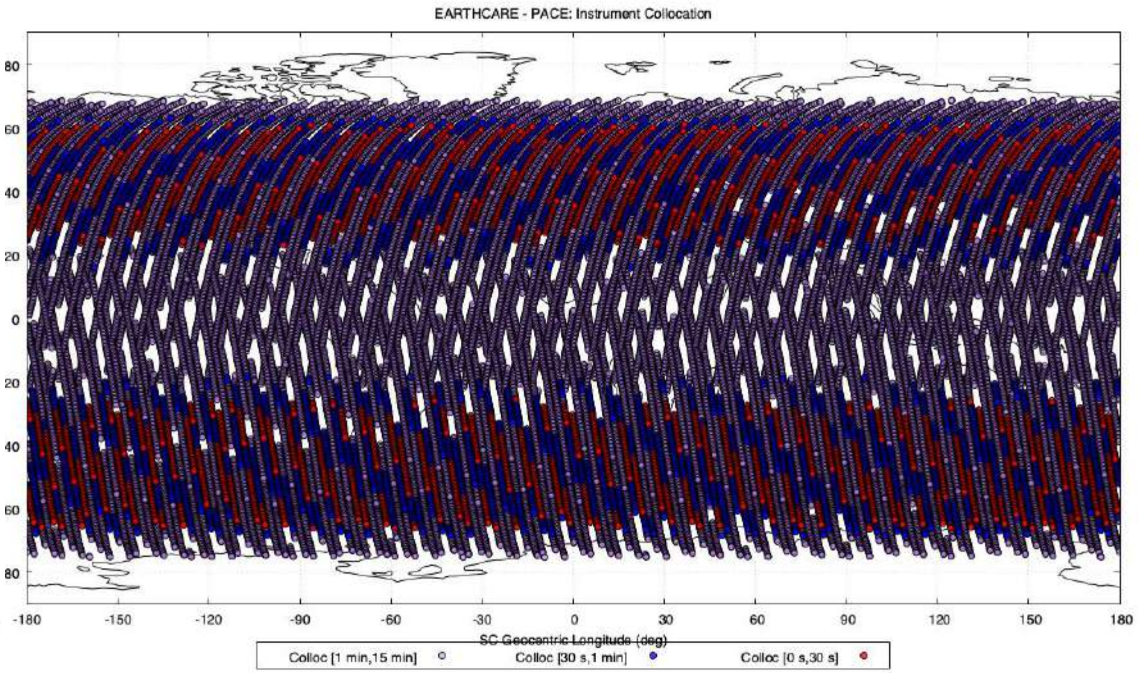


EarthCARE-PACE: Collocation Opportunities

EC Ground-Track vs PACE HARP2

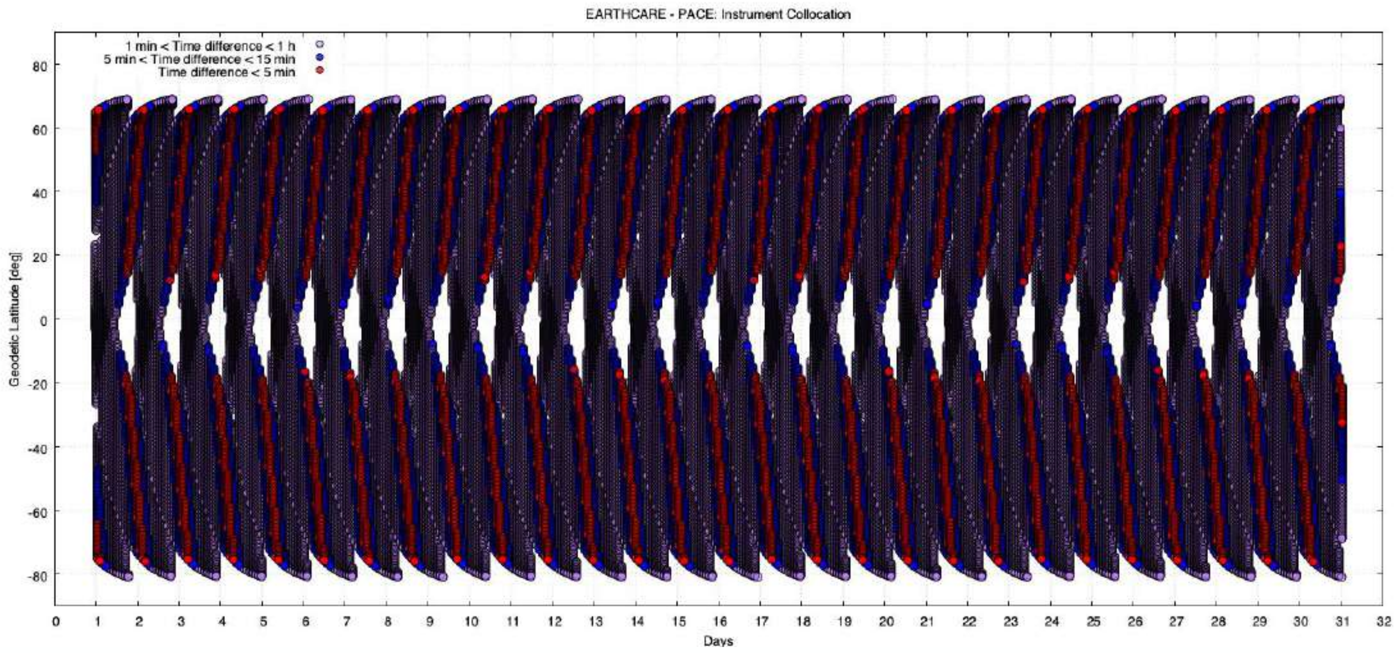
- A time interval of 30 days has been simulated (01-Sep to 01-Oct).
- Collocation opportunities within 60 minutes (purple), 15 minutes (blue) and 5 minutes (red)
- The collocations below 5 minutes take place once per base period, around [20,60] and [-60,-20] deg latitude bands
- A time interval of 30 days has been simulated (01-Sep to 01-Oct).

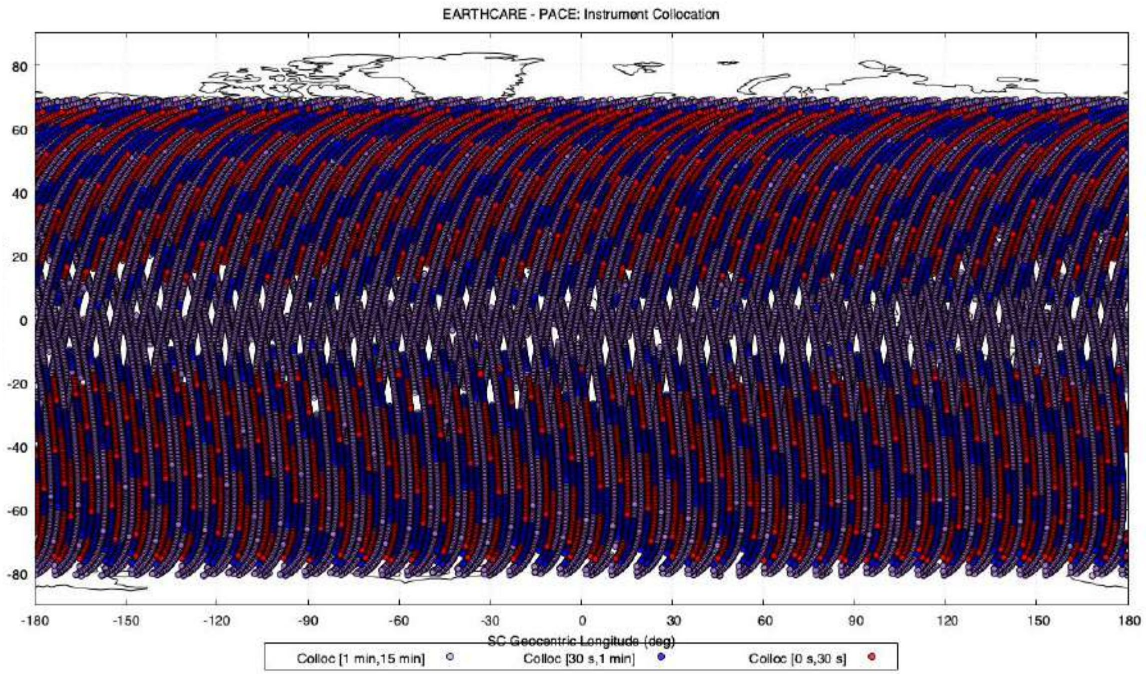




EarthCARE-PACE: Collocation Opportunities
EC Ground-Track vs PACE OCI

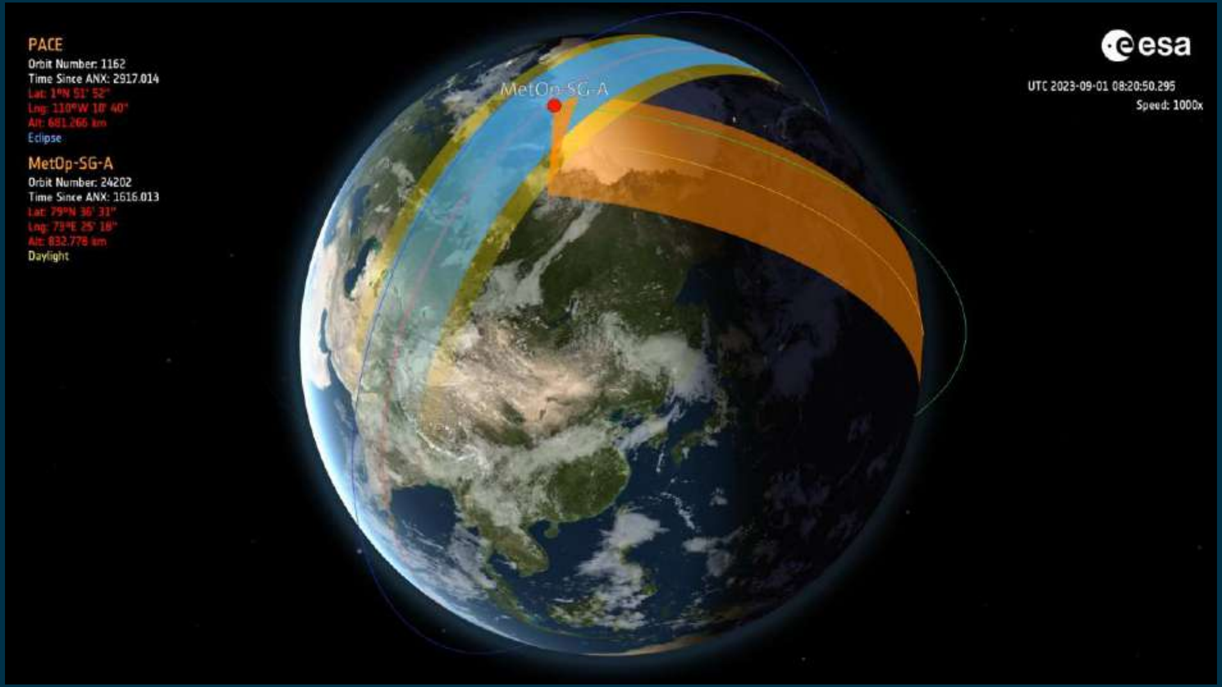
- A time interval of 30 days has been simulated (01-Sep to 01-Oct).
- Collocation opportunities within 60 minutes (purple), 15 minutes (blue) and 5 minutes (red)
- The collocations below 5 minutes take place once per base period, around [10,80] and [-80,-10] deg latitude bands
- A time interval of 30 days has been simulated (01-Sep to 01-Oct).

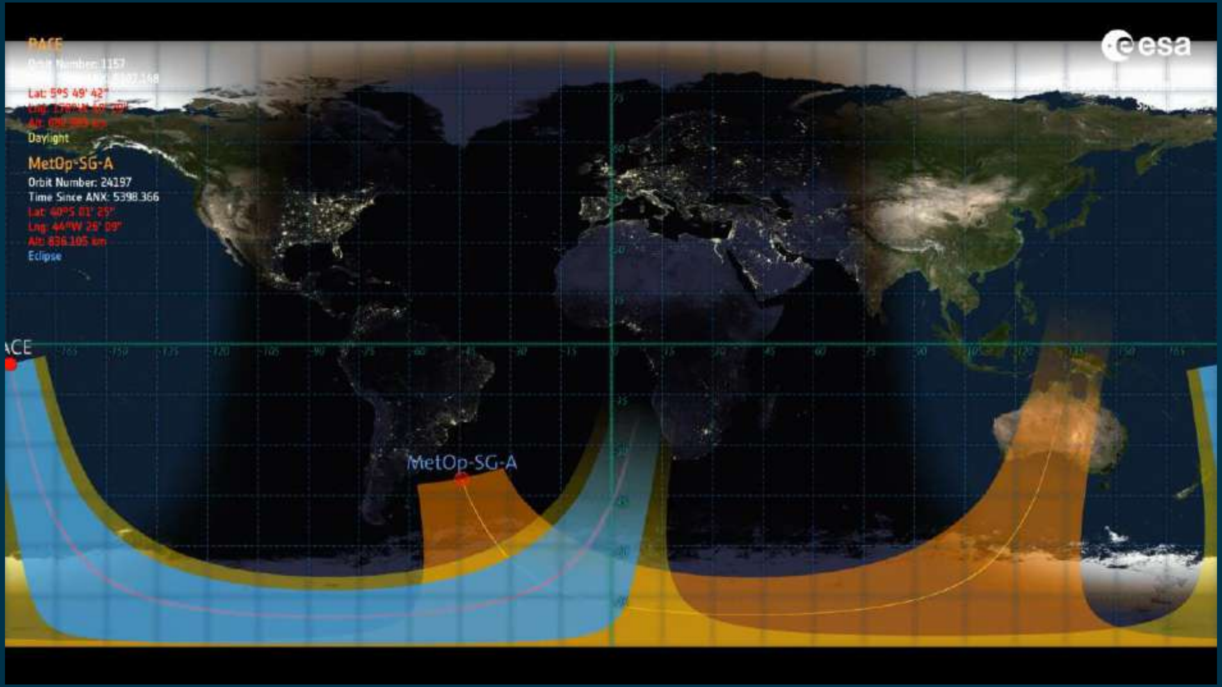




MetOpSG-A vs PACE: Relative geometry

- Satellites overtake each other with a base period of 2.3 days





- The combined cycle of EarthCARE and PACE would be 29x11 =319 days

MetOp-SG-A vs PACE: Collocation Opportunities
MetOp-SG 3MI vs PACE SPEXone

- A time interval of 30 days has been simulated (01-Sep to 01-Oct).
- Collocation opportunities within 60 minutes (purple), 15 minutes (blue) and 5 minutes (red)
- The collocations below 5 minutes take place once per base period, around polar regions
- A time interval of 30 days has been simulated (01-Sep to 01-Oct).