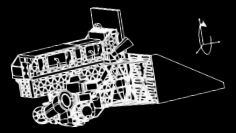
The PACE Postlaunch Airborne eXperiment

Kirk Knobelspiesse, Brian Cairns, Ivona Cetinić, Jeremy Werdell, NASA GSFC

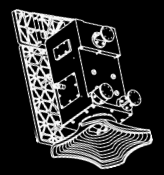
PACE-PAX

pace.gsfc.nasa.gov



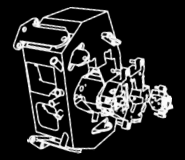
OCI

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



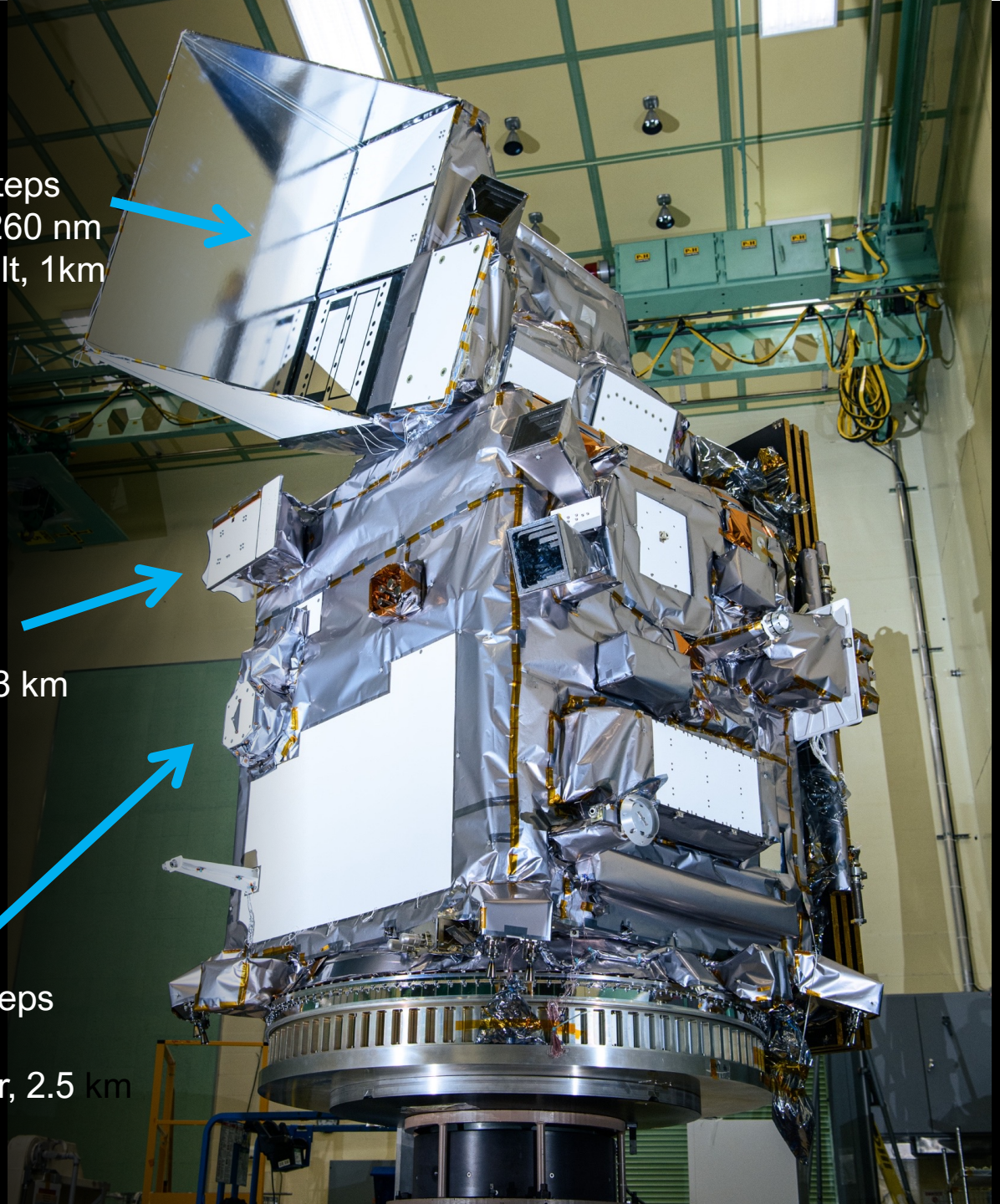
HARP2

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:

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

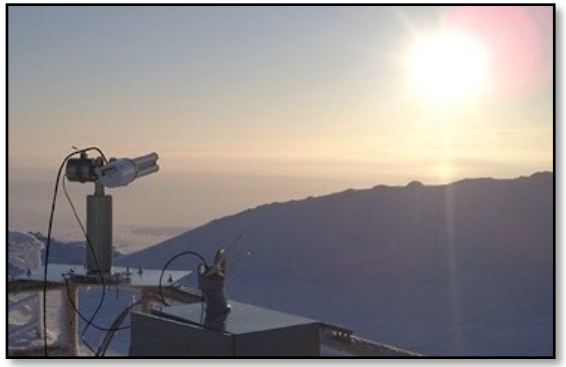
After launch, there will be 60 days of on-orbit commissioning activities.

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

pace.gsfc.nasa.gov
@NASAOcean

PACE

PACE 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 (e.g. Railroad Valley, AERONET) & R/V Shearwater
- Final data to Langley airborne archive by March 31, 2025

Leadership team:
Kirk Knobelspiesse
Brian Cairns
Ivona Cetinić

pace.oceansciences.org/campaigns.htm

PACE-PAX

PACE Postlaunch Airborne EXperiment

GODDARD EARTH SCIENCES

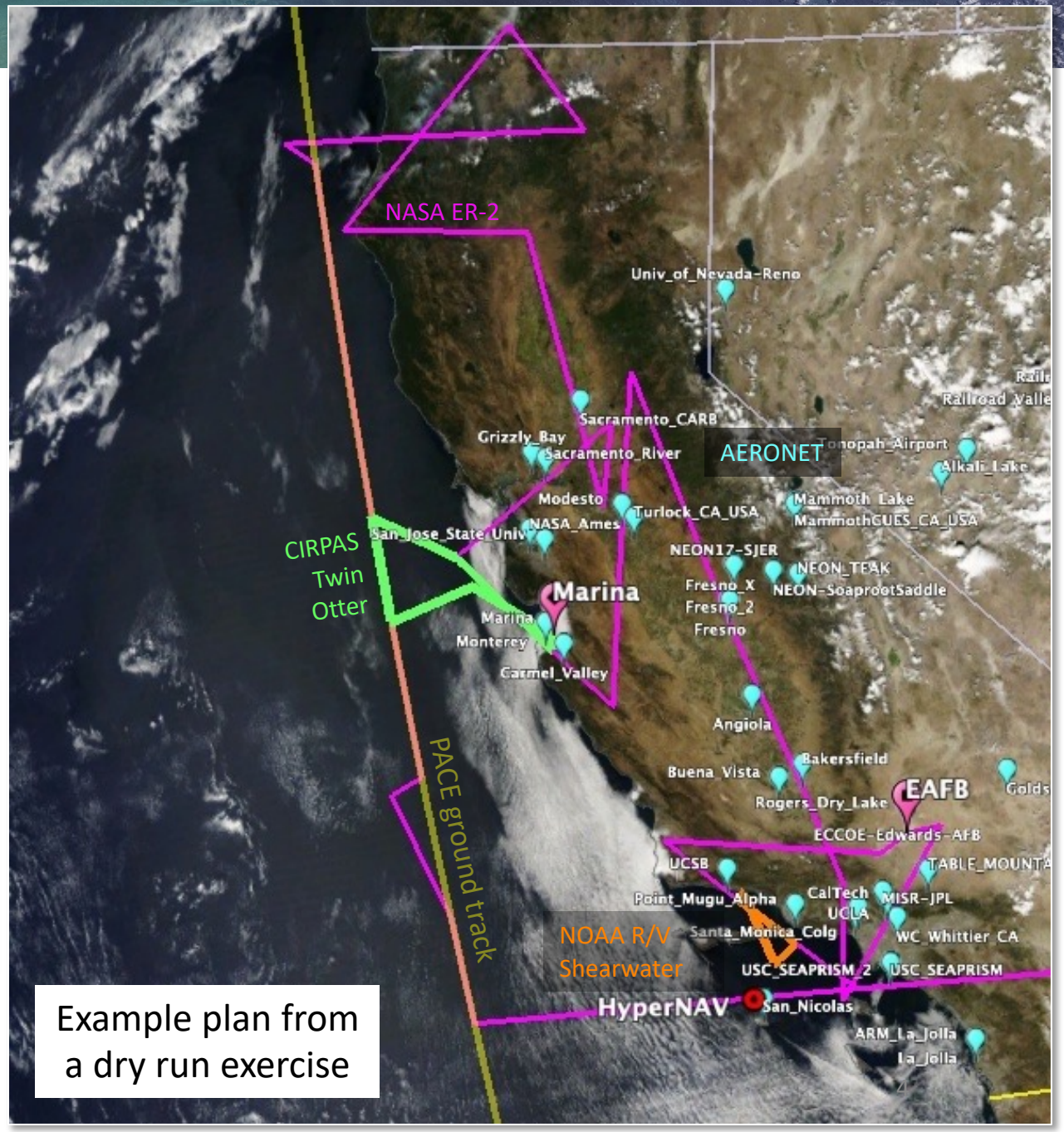
SRON Netherlands Institute for Space Research

JPL Jet Propulsion Laboratory California Institute of Technology

NOAA

UMBC

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, # still under negotiation

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

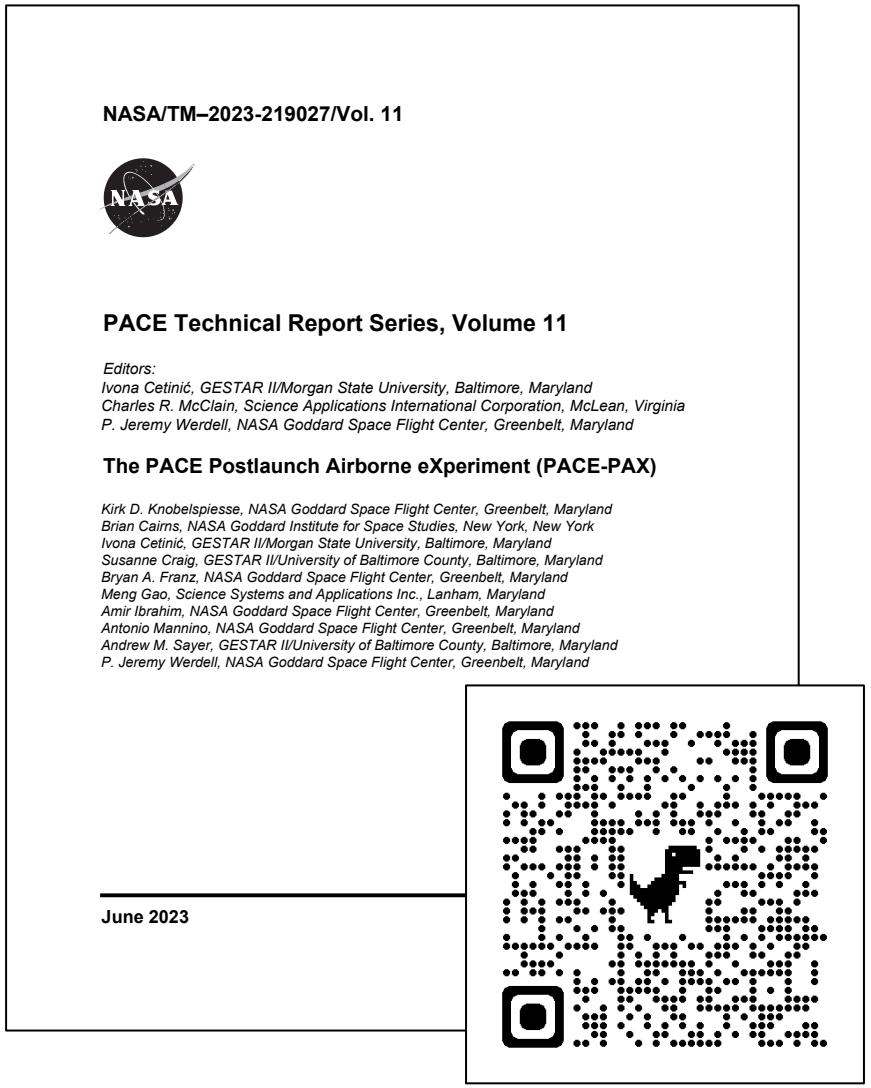
Validation objectives	ID	Measurement objectives	Importance, w	Objective total
1. Validate new retrieval properties	A	Land surface parameters	2	35
	B	Ocean radiometric parameters	2	
	C	Aerosol parameters over the ocean	10	
	D	Aerosol parameters over land	10	
	E	Cloud parameters	10	
	F	Ocean surface parameters	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

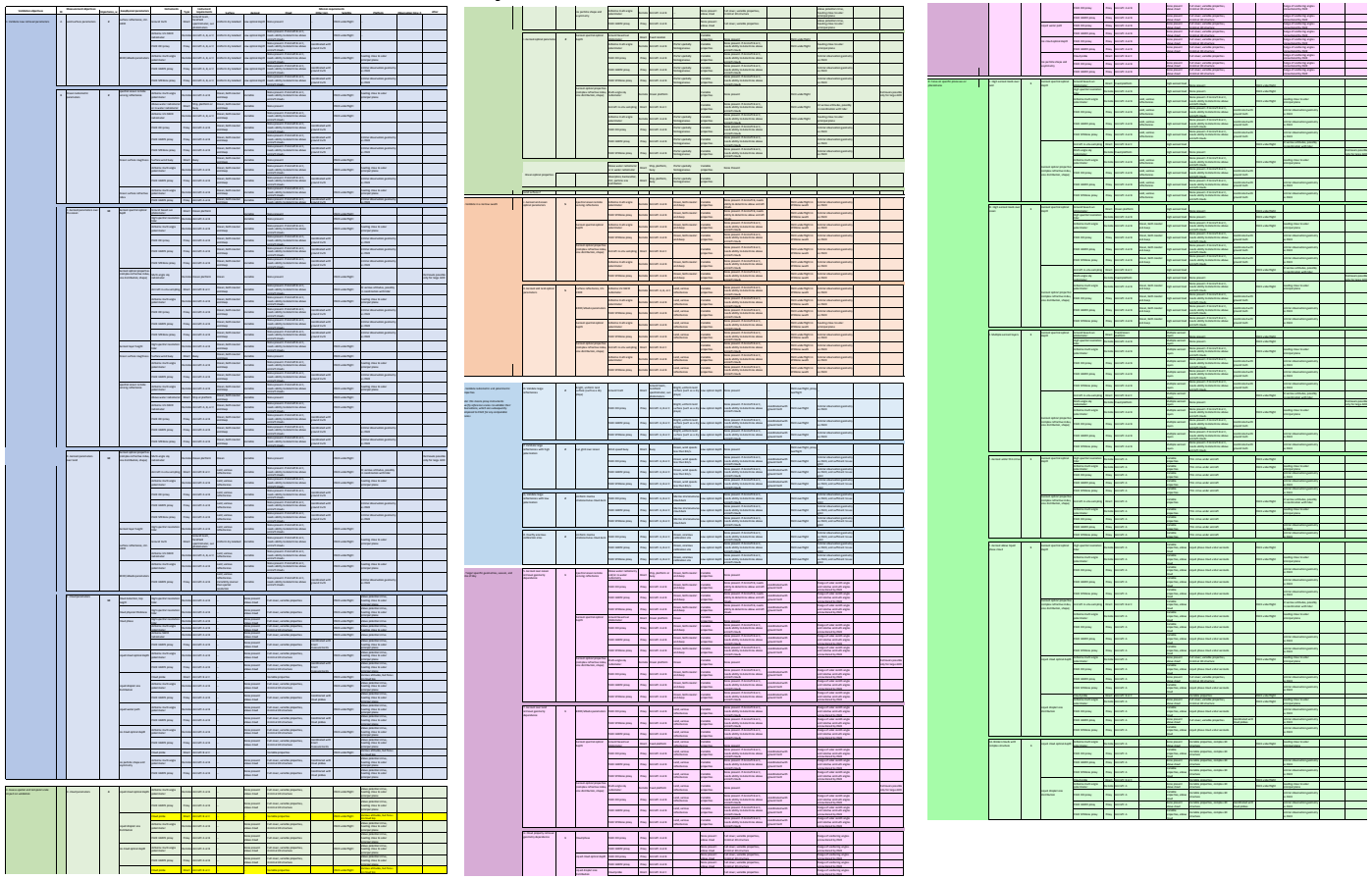
Editors:
Ivona Cetinić, GESTAR II/Morgan State University, Baltimore, Maryland
Charles R. McClain, Science Applications International Corporation, McLean, Virginia
P. Jeremy Werdell, NASA Goddard Space Flight Center, Greenbelt, Maryland

The PACE Postlaunch Airborne eXperiment (PACE-PAX)

Kirk D. Knobelspiesse, NASA Goddard Space Flight Center, Greenbelt, Maryland
Brian Cairns, NASA Goddard Institute for Space Studies, New York, New York
Ivona Cetinić, GESTAR II/Morgan State University, Baltimore, Maryland
Susanne Craig, GESTAR II/University of Baltimore County, Baltimore, Maryland
Bryan A. Franz, NASA Goddard Space Flight Center, Greenbelt, Maryland
Meng Gao, Science Systems and Applications Inc., Lanham, Maryland
Amir Ibrahim, NASA Goddard Space Flight Center, Greenbelt, Maryland
Antonio Mannino, NASA Goddard Space Flight Center, Greenbelt, Maryland
Andrew M. Sayer, GESTAR II/University of Baltimore County, Baltimore, Maryland
P. Jeremy Werdell, NASA Goddard Space Flight Center, Greenbelt, Maryland

June 2023

Full Validation Traceability Matrix



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

Thank you!

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

PACE-PAX

pace.gsfc.nasa.gov

pace.oceansciences.org/campaigns.htm