National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, MD 20771

June 11, 2019

Reply to Attn of: 427

RECORD OF ENVIRONMENTAL CONSIDERATION

Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) National Environmental Policy Act (NEPA) Compliance

1.0 Introduction

The NEPA of 1969, as amended (42 U.S.C. 4321, et seq.), requires Federal agencies to consider the project's environmental impacts in its decision making process. To comply with NEPA and associated regulations (the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA [40 CFR Parts 1500-1508] and NASA policy and procedures [14 CFR, Part 1216, Subpart 1216.3]), NASA prepared the, "Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles," dated November 2011. The 2011 NASA Routine Payload Environmental Assessment (NRPEA) assessed the environmental impacts of missions launched with spacecraft that are considered routine payloads from existing launch facilities at Cape Canaveral Air Force Station (CCAFS), Florida; Vandenberg Air Force Base (VAFB), California; the United States Army Kwajalein Atoll/Reagan Test Site (USAKA/RTS) in the Republic of the Marshall Islands; NASA's Wallops Flight Facility (WFF), Virginia; and the Kodiak Launch Complex (KLC), Alaska.

Spacecraft defined as routine payloads utilize materials, quantities of materials, launch vehicles, launch sites, and operational characteristics that are consistent with normal and routine spacecraft preparation and flight activities at VAFB, CCAFS, USAKA/RTS, WFF, KLC, and Kennedy Space Center. The environmental impacts of launching routine payloads from these sites fall within the range of routine, ongoing, and previously documented impacts that have been determined not to be significant. Spacecraft within the scope of this environmental assessment (EA) meet specific criteria ensuring that the spacecraft, its operation, and decommissioning do not present any new or substantial environmental or safety concerns.

Applicability of a routine payload classification for a mission is determined through an evaluation against the criteria defined in the EA using the routine payload checklist (RPC).

2.0 Mission Description

PACE is scheduled to launch in 2022 to 2023 and will extend and improve NASA's over 20-year record of satellite observations of global ocean biology, aerosols (tiny particles

suspended in the atmosphere), and clouds.

PACE will advance the assessment of ocean health by measuring the distribution of phytoplankton (tiny plants and algae that sustain the marine food web). It will also continue systematic records of key atmospheric variables associated with air quality and Earth's climate.

The science objectives of PACE are as follows:

- Extending key systematic ocean biological, ecological, and biogeochemical data records and cloud and aerosol data records;
- Making global measurements of ocean color data products that are essential for understanding the global carbon cycle and ocean ecosystem responses to a changing climate, as well as managing marine fisheries and water quality;
- Collecting global observations of aerosol and cloud properties, focusing on reducing the largest uncertainties in climate and radiative forcing models of the Earth system; and,
- Improving our understanding of how aerosols influence ocean ecosystems and biogeochemical cycles and how ocean biological and photochemical processes affect the atmosphere, as well as understanding air quality.

The primary science instrument planned for PACE is the Ocean Color Instrument (OCI), which will be capable of measuring the color of the ocean from ultraviolet to shortwave infrared. OCI will enable continuous measurement of light at finer wavelength resolution than previous NASA ocean color sensors, providing detailed information on our global ocean. The color of the ocean is determined by the interaction of sunlight with substances or particles present in seawater such as chlorophyll (a green photosynthetic pigment found in phytoplankton and land plants).

PACE will include two polarimeters. These instruments are used to measure how the oscillation of sunlight within a geometric plane, known as its polarization, is changed by passing through clouds, aerosols, and the ocean. Measuring polarization states of ultraviolet-to-shortwave light at various angles provides detailed information on the atmosphere and ocean, such as particle size and composition. The polarimeters onboard the PACE observatory are the Spectro-polarimeter for Planetary Exploration (SPEXone) and the Hyper Angular Research Polarimeter (HARP2). They will be contributed by a consortium based in the Netherlands and University of Maryland Baltimore County, respectively.

Combined, these instruments will be a major advance in satellite observing technology, allowing for new opportunities to monitor and respond to changes in our ecosystem, and the ways in which the atmosphere and ocean interact.

3.0 NASA Routine Payload Determination

The components utilized in the PACE spacecraft are made of materials normally encountered in the space industry. The PACE mission will not utilize radioactive sources, will not carry

any pathogenic organisms, and will not return samples to Earth. PACE will implement a controlled re-entry.

The PACE mission has been evaluated against the 2011 NRPEA, using the RPC (see enclosed evaluation recommendation package). The evaluation indicates that the mission meets the criteria for a routine payload and falls within the scope of the reference EA. The launch vehicle has yet to be selected; however, the candidate launch vehicle/launch site combinations all fall within the scope of the EA. The site-specific impacts of these combinations are addressed in the EA.

The PACE mission does not present any unique or unusual circumstances that could result in new or substantial environmental impacts. Based on the foregoing and the analyses set forth in the 2011 NRPEA, Goddard Space Flight Center has determined that the environmental impacts associated with the PACE mission will not individually or cumulatively have a significant impact on the quality of the human environment and that a routine payload classification for the mission is applicable. No additional NEPA action or documentation is required at this time. Once launch vehicle selection has occurred, the mission will be reviewed to ensure that a routine payload classification is still valid.

for David F. Mitchell
Director, Flight Projects

6/4/19
Date

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
Flight Project Environmental Checklist

Enclosure

NASA Goddard Space Flight Center
RECORD OF ENVIRONMENTAL CONSIDERATION (REC)

PROJECT NAME: PACE

1. **Description of proposed action:** PACE will extend the high quality observation on ocean ecology, biogeochemical cycling, and ocean productivity begun by NASA in the late 1990s with the SeaWiFS and MODIS Instruments. The mission will also extend the data record on aerosols and clouds..

Date and/or Duration of project: Launch - November 2022

2. It has been determined that the above action:

☒ a. Is adequately covered in an existing EA or EIS.
Title: *Environmental Assessment for Launch of NASA Routine Payloads*
Date: November 2011

☐ b. Qualifies for Categorical Exclusion and has no extraordinary circumstances per 14 CFR 1216.304 (c) which would suggest a need for an Environmental Assessment.

Categorical Exclusion: _____

☐ c. Has no significant environmental impacts as indicated by the results of an environmental checklist and/or detailed environmental analysis.

☐ d. Is exempt from NEPA requirements under the provisions of: _____

☐ e. Will require the preparation of an Environmental Assessment.

☐ f. Will require the preparation of an Environmental Impact Statement.

☐ g. Is addressed under EO12114.
- ☐ Is exempt from EO12114 requirements under the provisions of: _____
- ☐ Action not included under EO12114: _____
- ☐ Qualifies for an EO12114 categorical exclusion: _____
- ☐ Is adequately covered in existing documentation: _____
- ☐ Requires an environmental summary document: _____
- ☐ Requires EO documentation IAW 2-4. (a) i, ii, iii: _____

☐ h. Is not federalized sufficiently to qualify as a major federal action.

LIZABETH MONTGOMERY Digitally signed by LIZABETH MONTGOMERY Date: 2019.05.09 15:32:51 -04'00'

Beth Montgomery NEPA Manager, Code 250 Date

ANDRE DRESS Digitally signed by ANDRE DRESS Date: 2019.06.04 14:50:34 -04'00'

Andre Dress Project Manager, Code 427 Date

NASA Routine Payload Evaluation and Determination Process and Checklist

After a proposed spacecraft mission is sufficiently well formulated (usually the Phase B design study), the Sponsoring Entity, in coordination with the local Environmental Management Office (EMO), will prepare an environmental evaluation. An environmental evaluation is a preliminary review that determines what aspects of the proposal are of potential environmental concern. The environmental evaluation also assists in determining the appropriate level of National Environmental Policy Act (NEPA) documentation (i.e., environmental assessment [EA], or environmental impact statement [IEIS]) for the proposal. The local EMO uses a comprehensive checklist to provide a level of rigor to this early evaluation of the proposal, helping to ensure that pertinent considerations are not overlooked. Local EMO review of the Routine Payload Checklist (RPC, below) forms the basis for evaluating the applicability of a NASA Routine Payload (NRP) spacecraft classification for a proposed mission.

The local EMO uses the completed RPC (and required attachments) to evaluate the proposed mission against the NRP EA criteria. If the EMO evaluation of the RPC indicates that a NRP categorization may be appropriate, the Sponsoring Entity documents this in an Evaluation Recommendation Package (ERP). The ERP is then processed for review and approval in accordance with established National Aeronautics and Space Administration (NASA) procedures and guidelines. If approved, the ERP would be attached to a Record of Environmental Consideration (REC).

The Sponsoring Entity can then proceed with the proposal while monitoring the project activities, for changes or circumstances during implementation that could affect classification of the proposed mission as a NRP spacecraft. If a NRP spacecraft categorization is determined to be inappropriate, the local EMO will initiate plans for preparation of additional NEPA documentation.

NASA Routine Payload Checklist

Project Name:		Date of Launch:
PACE Project - Plankton, Aerosol, Cloud, and ocean Ecosystem		11/2022
Project Contact: Andre Dress	**Phone Number:** 6-6321	**Mailstop:** 427
Project Start Date:	**Project Location:** NASA / GSFC	

Project Description:
o extend the high quality observation on ocean ecology, biogeochemical cycling, and ocean productivity begun by NASA in the late 1990s with the SeaWiFS and MODIS Instruments. The mission will also extend the data record on aerosols and clouds.

A. Sample Return:	Yes	No
1. Would the candidate mission return a sample from an extraterrestrial body?	☐	☒
B. Radioactive Materials:	Yes	No
1. Would the candidate spacecraft carry radioactive materials in quantities that produce an A2 mission multiple value of 10 or more?	☐	☒
Provide a copy of the Radioactive Materials On Board Report as per NPR 8715.3 with the ERP submittal.	Attachment	
C. Launch and Launch Vehicles:	Yes	No
1. Would the candidate spacecraft be launched on a vehicle and launch site combination other than those indicated in Table C-1 on Page 2?	☐	☒
2. Would the proposed mission exceed the approved or permitted annual launch rate for the particular launch vehicle or launch site?	☐	☒
Comments:		
D. Facilities:	Yes	No
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?	☐	☒
Provide a brief description of the construction or modification required, including whether ground disturbance and/or excavation would occur.		
E. Health and Safety:	Yes	No
1. Would the candidate spacecraft utilize batteries, ordnance, hazardous propellant, radiofrequency transmitter power, or other subsystem components in quantities or levels exceeding the EPC's in Table C-2 below?	☐	☒
2. Would the expected risk of human casualty from spacecraft planned orbital reentry exceed the criteria specified by NASA Standard 8719.14?	☐	☒
3. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the Envelope Payload Characteristics?	☐	☒
4. Would the candidate mission, under nominal conditions, release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?	☐	☒
5. Are there changes in the preparation, launch or operation of the candidate spacecraft from the standard practices described in Chapter 3 of this EA?	☐	☒
6. Would the candidate spacecraft utilize an Earth-pointing laser system that does not meet the requirements for safe operation (ANSI Z136.1-2007 and ANSI Z136.6-2005)?	☐	☒
7. Would the candidate spacecraft contain, by design (e.g., a scientific payload) pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health or the environment beyond Biosafety Level 1 (BSL 1)[1]?	☐	☒
Comments:		

The use of biological agents on payloads is limited to materials with a safety rating of "Biosafety Level 1." This classification includes defined and characterized strains of viable microorganisms not known to consistently cause disease in healthy human adults. Personnel working with Biosafety Level 1 agents follow standard microbiological practices including the use of mechanical pipetting devices, no eating, drinking, or smoking in the laboratory, and required hand-washing after working with agents or leaving a lab where agents are stored. Personal protective equipment such as gloves and eye protection is also recommended when working with biological agents.

NASA Routine Payload Checklist (continuation)

Project Name: PACE Project - Plankton, Aerosol, Cloud, and ocean Ecosystem		Date of Launch 11/2022
Project Contact: Andre Dress	Phone Number: 6-6321	Mailstop: 427
Project Start Date:	Project Location: NASA / GSFC	

Project Description:
o extend the high quality observation on ocean ecology, biogeochemical cycling, and ocean productivity begun by NASA in the late 1990s with the SeaWiFS and MODIS Instruments. The mission will also extend the data record on aerosols and clouds.

F. Other Environmental Issues:	Yes	No
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?	☐	☒
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?	☐	☒
3. Would any aspect of the candidate spacecraft that is not addressed by the EPCs have the potential for substantial effects on the environment (i.e., previously unused materials, configurations or material not included in the checklist)?	☐	☒

Comments:

Table C-1. Launch Vehicles and Launch Sites

Launch Vehicle and Launch Vehicle Family	Space Launch Complexes and Pads				
	Eastern Range (CCAFS)	Western Range (VAFB)	USAKA/RTS	WFF	KLC
Athena I, IIc, III[a]	LC-46	CA Spaceport (SLC-8)	NA	Pad 0	LP-1[a]
Atlas V Family	LC-41	SLC-3	NA	NA	NA
Delta II Family	LC-17	SLC-2	NA	NA	NA
Delta IV Family	LC-37	SLC-6	NA	NA	NA
Falcon I/Ie	LC-36	SLC-4W	Omelek Island	Pad 0	LP-3[b]
Falcon 9	LC-40	SLC-4E	Omelek	Pad 0	LP-1
Minotaur I	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur II-III	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur IV[c]	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur V	LC-20 and/or LC-46	SLC-8	NA	Pad 0	NA
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB Airfield	Kwajalein Island	WFF Airfield	NA
Taurus	LC-20 and/or LC-46	SLC-576E	NA	Pad 0	LP-1
Taurus II	NA	NA	NA	Pad 0	LP-3[b]
Any other launch vehicle/launch site combination for which NASA has completed or cooperated on the NEPA compliance.					

a
Athena III is currently under design.
b
LP-3 is currently under design.
c
While not explicitly listed in this table, the Minotaur IV includes all configurations of this launch vehicle, including the Minotaur IV+, which is a Minotaur IV with a Star 48V 4th stage.

Key: CA = California; CCAFS = Cape Canaveral Air Force Station; KSC = Kennedy Space Center; LC = Launch Complex; LP = Launch Pad; MARS = Mid-Atlantic Regional Spaceport; SLC = Space Launch Complex; SLF = Shuttle Landing Facility; USAKA/RTS = United States Army Kwajalein Atoll/Reagan Test Site; VAFB = Vandenberg Air Force Base; WFF = Wallops Flight Facility.

Table C-2. Summary of Envelope Payload Characteristics by Spacecraft Subsystems

Structure	• Unlimited: aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion[a]	• Liquid propellant(s); 3,200 kg (7,055 lb) combined hydrazine, monomethyhydrazine and/or nitrogen tetroxide. • Solid Rocket Motor (SRM) propellant; 3,000 kg (6,614 lb) Ammonium Perchlorate (AP)-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.)
Communications	• Various 10-100 Watt (RF) transmitters
Power	• Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH_2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Nickel-hydrogen (NiH_2) battery.
Science Instruments	• 10 kilowatt radar • American National Standards Institute safe lasers (see Section 4.1.2.1)
Other	• U. S. Department of Transportation (DoT) Class 1.4 Electro-Explosive Devices (EEDs) for mechanical systems deployment • Radioactive materials in quantities that produce an A2 mission multiple value of less than 10 • Propulsion system exhaust and inert gas venting • Sample returns are considered outside of the scope of this environmental assessment

[a] Propellant limits are subject to range safety requirements.

Key: kg=kilograms; lb=pounds.

GSFC Flight Project Environmental Checklist

1. Project/Program	Date:
PACE Project - Plankton, Aerosol, Cloud, and ocean Ecosystem	02/01/2019

2. Schedule

PDR/CDR:	Launch Date:
PDR-6/2019, CDR-1/2020	11/2022

3. Current Status

Phase B

4. Project Description

a. Purpose:
To extend the high quality observation on ocean ecology, biogeochemical cycling, and ocean productivity begun by NASA in the late 1990s with the SeaWiFS and MODIS Instruments. The mission will also extend the data record on aerosols and clouds.

b. Spacecraft:
The spacecraft is comprised of two instruments, an Ocean Color Instrument (OCI) and a Polarimeter. OCI is designed to measure ocean color. Polarimeter is designed to measure and will extend the data records on aerosols and clouds. This spacecraft is being developed and integrated at GSFC.

c. Instruments:
(OCI) Ocean Color Instrument
Polarimeter (2) - HARP2 and SPEX One

d. Launch Vehicle:
TBD

e. Launch Site:
VAFB, California USA

f. NASAs Involvement/Responsibility: (include other NASA Centers)
Satellite development, launch and operations

g. Participants/Locations:
HARP2 - provided by UMBC (University of Maryland Baltimore County)
SPEX One – provided by the Netherlands

h. End-of-Mission Plan: Planned Re-entry (controlled/uncontrolled?)
Controlled Re-entry

5. Is there anything controversial or unique about the mission, spacecraft or instruments? If yes, Explain. Yes ☐ No ☒

6. Is the mission compliant with NASA requirements for limiting orbital debris (NPR 8715.6, and NASA Standard 8719.14? Explain non-compliances. Yes ☒ No ☐

7. During any phase, does the mission/project include or involve: Check yes for all that apply. If uncertain, check the corresponding box. For all that apply, provide an explanation	Yes	No	Uncertain
A. Fuels	☒	☐	☐
B. Ionizing Radiation Devices/Sources	☐	☒	☐
C. Explosives	☒	☐	☐
D. Hazardous Materials/Substances/Chemicals	☒	☐	☐
E. Lasers (Class, Earth Pointing)	☐	☒	☐
F. Disease Producing Pathogenic Microorganisms/Biological Agents	☐	☒	☐
G. Discharges/Venting of any Substances into Air, Water, or Soil	☐	☒	☐
H. Hazardous Waste Generation	☐	☐	☒
I. High Noise Levels	☐	☒	☐
J. Sample Return to Earth	☐	☒	☐
K. Radio Frequency Communications	☒	☐	☐
L. Construction/Modification/Demolition of a Facility/Lab (onsite - offsite)	☐	☒	☐
M. Land Disturbance, Tree Clearing, Removal of Vegetation	☐	☒	☐
N. Impact on Threatened or Endangered Species	☐	☒	☐
O. Impact/Destruction of Sensitive Wildlife Habitat	☐	☒	☐
P. Impact on Cultural Resources	☐	☒	☐
Q. Impact on Local Social or Economic Conditions (Increase in Traffic, Employment, etc.)	☐	☒	☐
R. Impact on Minority or Low Income Populations	☐	☒	☐
S. New or Foreign Launch Vehicle	☐	☒	☐
T. Other Issues of Potential Environmental Impact	☐	☒	☐
U. Environmental Permits	☐	☒	☐

Additional Information:
Launch vehicle would have small separation charges (explosives)
Hazardous chemicals used to clean prop lines, etc.
Fuel for spacecraft - Hydrazine ~220 kg
NOTE: As design matures, more information will become available

8. What Safety Hazards are associated with the mission?

TBD

9. Summary of Subsystem Components

Propulsion (Include fuel type, amount, tank size, materials, dimensions	Hydrazine fuel / Size, material, dimensions TBD
Communications	RF and S-band
Structural Materials	Aluminum Honeycomb / TBD
Power	Lithion-Ion battery / TBD
Science Instruments	OCI / Polarimeter
Hazardous components (radioactive materials, lasers, chemicals, etc.)	TBD
Other (include dimensions and weight of s/c)	TBD

GSFC Flight Project Environmental Checklist

Project Manager Printed Name:	Signature Field		
Andre Dress	ANDRE DRESS Digitally signed by ANDRE DRESS Date: 2019.05.06 16:15:50 -04'00'		
Project Name:	**Date:**	**Phone Number:**	**Org Code:**
PACE Project	02/01/2019	6-6321	427

Comments: