



*Supporting Elected Officials  
and the Public on Climate Issues*

The Honorable Diane Feinstein  
United States Senate  
10 April 2020

Subject: Response to Terminate or Decrease fy 2021 Funding for NASA Climate Related Projects

Dear Senator Feinstein,

The President's budget proposes to terminate as detailed in the NASA budget (atoms/files/fy 2021 congressional justification.pdf) 3 projects that will advanced capabilities to measure the health of our oceans, to improve climate models that identify climate modifications decades into the future, and to assess greenhouse gas emissions from forests, forest fires, farming practices, and other natural carbon stocks in part to make informed decisions in managing our forests and farm lands.

These programs will provide for our nation's security in detecting and preparing for the effects of a changing global environment: providing data that supports our military, infrastructure, areas of commerce, and the ability to feed this nation

Sincerely,  
Stanley Farkas, PhD

Philip Russell, PhD

Gary Latshaw, PhD

Anthony Strawa, PhD

Steven Zornetzer, PhD

## **NASA EARTH SCIENCE (NES) PROGRAM**

### **Terminate Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) mission and Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder missions**

*Consistent with the FY 2018 and FY 2019 Budget Request, this budget provides no funding for the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) and the Climate Absolute Radiance and Refractivity Observatory Pathfinder (CLARREO Pathfinder) missions. Existing and planned missions from other NASA, National Oceanic and Atmospheric Administration (NOAA), and international partner satellite fleets are providing or will provide measurements to enable similar science. The PACE and CLARREO Pathfinder missions are in the early stages of implementation and are eliminated to achieve cost savings.*

**For clarity:** The measurements provided by existing and known planned missions may support similar science but not the specific science that PACE and CLARREO were designed for, per addressed below.

NOTE: Congress approved funding for; both PACE and CLARREO Missions in 2018 and 2019.

[atoms/files/fy\\_2020\\_congressional\\_justification.pdf](#)

### **Terminate Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) mission (-\$110M)**

*PACE would have incorporated selected ocean color and atmospheric aerosol measurement capabilities ensuring continuity and additional capability in the measurement record, particularly for ocean color.*

- **Response to Terminate PACE:** PACE is a critical component of our fleet of climate instruments that will provide a better understanding of the overall health of our oceans, coastal waters, air quality and to better prepare for the effects of climate change. In January 2018, the National Academies Second Decadal Survey for Earth Science and Applications from Space provided recommendations for the next decade (2017 - 2027) to complete the program of record, including maintaining the Venture Class program and completing missions currently in formulation and development: PACE is a Venture Class high priority mission. Onboard will be a new unique instrument with high spectral resolution that will allow scientists to distinguish the species and determine the distribution of the microscopic phytoplankton (bottom of the food chain and producing much of the oxygen we breath) flourishing in different regions of the globe at different times: providing more details of ocean life than ever from previous missions. The fishing

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industry is directly dependent upon the health and abundance of the ocean's phytoplankton providing 1.6M US jobs and valued at \$208B. Two additional polarimeter instruments will act in synergy with the radiometer to provide a dataset for air quality applications and making significant breakthroughs in aerosol-cloud-ocean research.

PACE will provide high quality data for the next 3-10 yrs to monitor the health of our oceans and air quality: unmatched by current or planned future missions. The information recorded will be used by the Navy, NOAA, the commercial fishing industry, earth scientists, and potentially by the aviation sector:

- Better understand the overall health of our oceans and coastal waters
  - Deep ocean probes of the BioArgo Program measure several parameters (including O<sub>2</sub> and CO<sub>2</sub>) from the surface to 2000m complementing measurements from PACE for a comprehensive evaluation of the health of our oceans.
- Provide volcanic ash data: avoid catastrophic risk of airplane engine failure by monitoring ash clouds from volcanic eruptions to recalculate aircraft flight plan.
- Forecast Harmful Algal Bloom
- Track water resources
- Fill critical data gaps in regions that lack ground-based air or water quality measurements
- Aid in understanding key ecosystems that sustain our economy
- Support oil spill monitoring and response
- Improve forecasting air quality.

Technically: The PACE instrument vs. existing instruments is like comparing a modern 4K digital TV set with an outdated color cathode-ray tube (CRT) from 1960's. You can watch television on either system, but the spatial resolution and color rendition is much better on today's TV. The PACE's hyperspectral radiometer instrument is being designed and built by NASA Godard Space Flight Center and will gather data on 4 ocean colors between 340 and 890 nanometres (infrared, visible, and ultraviolet) using 120 band widths at 5 nanometers resolution and record at high signal-to-noise ratios. Previous missions provided only slices of the light spectrum whereas PACE will look at the whole of this spectral range.

<http://sites.nationalacademies.org/DEPS/ESAS2017/index.htm>

<https://pace.oceansciences.org/mission.htm>

<http://sites.nationalacademies.org/DEPS/ESAS2017/index.htm>

<https://www.nap.edu/catalog/24938/thriving-on-our-changing-planet-a-decadal-strategy-for-earth>

<https://spacenews.com/bridenstine-offers-senators-reassurances-on-nasa-programs/>

<https://www.spiedigitallibrary.org/journals/Journal-of-Applied-Remote-Sensing/volume-12/issue-04/042608/Plankton-Aerosol-Cloud-ocean-Ecosystem-mission--atmosphere-measurements-for/10.1117/1.JRS.12.042608.full?SSO=1>

<http://ioccg.org/>

<https://www.noaa.gov/media-release/us-fishing-generated-more-than-200b-in-sales-in-2015-two-stocks-rebuilt-in-2016>

<http://biogeochemical-argo.org/>

**Terminate Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder missions (-\$17M)**

*The CLARREO Pathfinder mission would have demonstrated measurement technologies for a larger, more expensive future mission recommended in the 2007 decadal survey focused on improving detection of climate trends.*

**Response to Terminate CLARREO:** CLARREO is a critical component of our fleet of climate instruments that will provide for our nation's security in detecting and preparing for the effects of climate change. In January 2018, the National Academies Second Decadal Survey for Earth Science and Applications from Space provided recommendations for the next decade (2017 - 2027) to complete the program of record, including maintaining the Venture Class program and completing missions currently in formulation and development: CLARREO is a Venture Class high priority mission.

CLARREO is designed to improve climate models to detect climate change trends decades into the future by providing highly accurate measurements of reflective solar energy from the Earth: 4-10X more accurate than any current or known planned mission. The CLARREO mission accomplishes this critical objective through accurate decadal observations that are sensitive to many of the key climate parameters such as radiative forcings (difference between radiation absorbed and radiation reflected by the Earth), climate responses, and feedbacks. Uncertainties in these parameters drive uncertainty in current climate model projections: measurements from CLARREO will help diminish these uncertainties.

- Provides data for climate projections to make informed decisions in responding to rising sea levels, rising global temperatures, and declining air quality.
- Provides data for coastal communities and DoD for planning Naval Bases
- A key goal is to make observations traceable to international standards (specifically, SI, or *Système International d'Unités* (International System of Units))
- Provides data to calibrate current missions (CERES, VIIRS) that measure reflective solar energy from the Earth

<http://sites.nationalacademies.org/DEPS/ESAS2017/index.htm>

<https://clarreo.larc.nasa.gov/>

[https://clarreo.larc.nasa.gov/pdf/CLARREO\\_Pathfinder\\_Report.pdf](https://clarreo.larc.nasa.gov/pdf/CLARREO_Pathfinder_Report.pdf)

**No Mention of Carbon Monitoring System (CMS) awards in Presidents Budget (2020 budget stated elimination by \$10M)**

*NASA's Carbon Monitoring System (CMS) was begun by congressional mandate in 2010 to develop methods for assessing the greenhouse gas emissions from forests and other natural carbon stocks. Although much of the work is focused on the United States, it also*

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*supports pilot technologies for eventual use in countries such as Colombia, Cambodia, Mexico, and Peru. Consistent with the 2019 Budget, the request eliminates funding for new Carbon Monitoring System (CMS) awards and continues the funding for 2018 and 2019 awards. The funding for the continued CMS awards is in the Earth Science R&A project. Missions that monitor carbon such as Orbiting Carbon Conservatory-2 (OCO-2)*

*will continue operations and Orbiting Carbon Conservatory -3 (OCO-3) will launch later in FY 2019.*

**Response for continuation of funding for new (CMS) awards:** NASA's Carbon Monitoring System (CMS) began by a congressional mandate in 2010 to develop methods for assessing the greenhouse gas emissions from forests and other natural carbon stocks.

The CMS will provide knowledge of the interactions of global biogeochemical cycles and terrestrial and aquatic ecosystems with global environmental change and the implications for Earth's climate, productivity, and natural resources. This information will be used to detect and predict changes in Earth's ecosystems and biogeochemical cycles, including land cover, biological diversity, and the global carbon cycle. The US and the selected countries above rely on this collaboration and knowledge in order to monitor their forests better. CMS currently supports airborne measures of Alaska's interior forests, prototype methane monitors for California regulators, satellite-based assessments of farming emissions, and studies of forest fires in the Amazon basin. The program will use the full range of NASA satellite observations and modeling/analysis capabilities to establish the accuracy, quantitative uncertainties, and utility of products for supporting national and international policy, regulatory, and management activities. The CMS will maintain a global emphasis while providing finer scale regional information, utilizing space-based and surface-based data and will rapidly initiate generation and distribution of products both for user evaluation and to inform near-term policy development and planning.

NOTE: Congress approved funding for CMS in 2018 and 2019.

<https://www.sciencemag.org/news/2017/05/what-s-trump-s-2018-budget-request-science>

<https://eos.org/articles/new-budget-bill-rescues-nasas-carbon-monitoring-system>

[https://daac.ornl.gov/cgi-bin/dataset\\_list.pl?p=33](https://daac.ornl.gov/cgi-bin/dataset_list.pl?p=33)

<https://carbon.nasa.gov/index.html?>

<https://cce.nasa.gov/cce/about.htm>