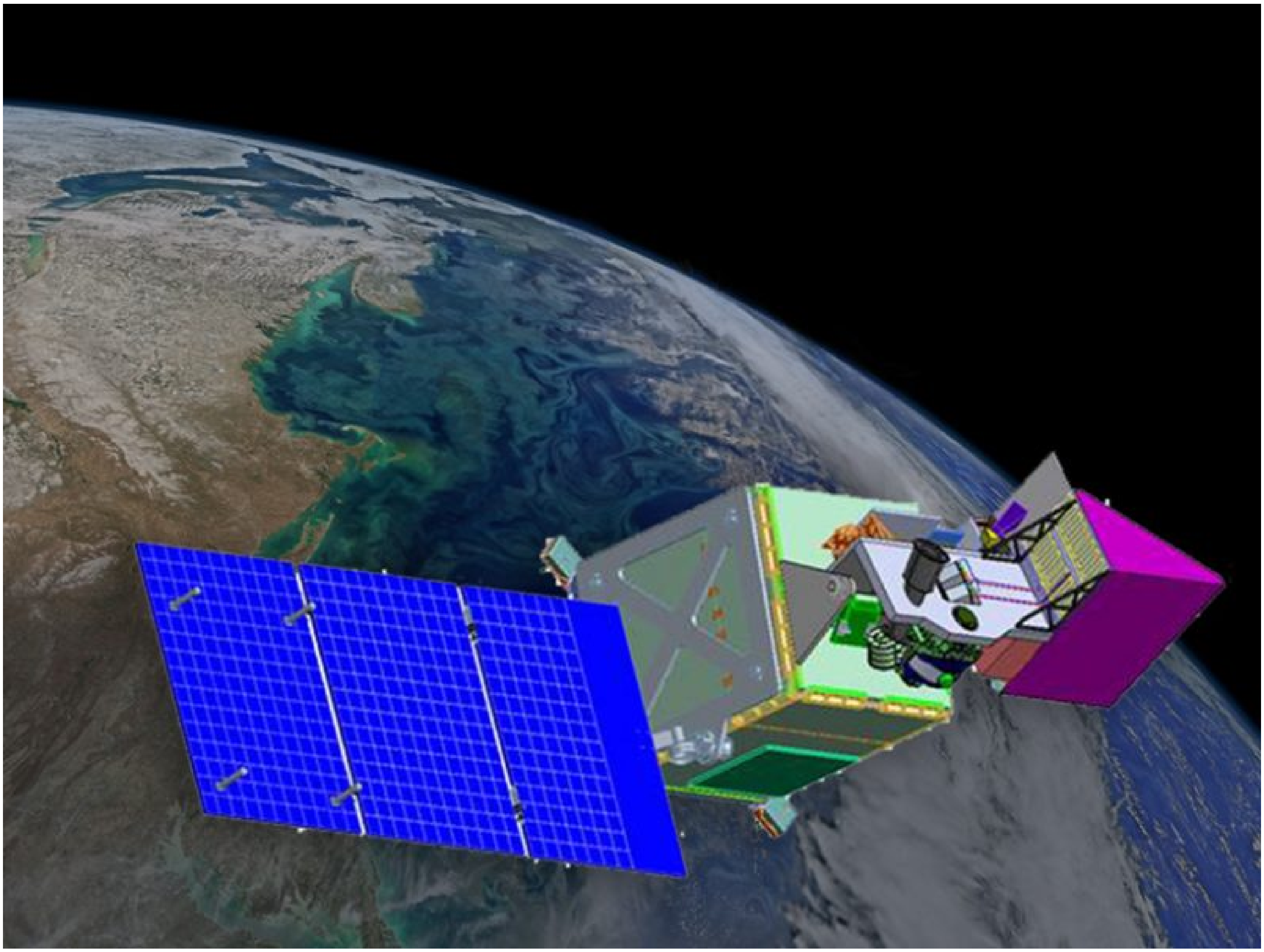
A Novel Approach to a Satellite Mission's Science Team

NASA's Plankton, Aerosol, Cloud, Ocean Ecosystem satellite mission, still in planning stages, operates with a framework that could serve as an example for science support of future missions.



An artist's rendering of the proposed NASA PACE satellite. PACE is expected to significantly contribute to better understanding of the functioning of the atmosphere and oceans. Credit: G. V. Gasto, PACE Project, NASA GSFC

By Emmanuel Boss and Lorraine A. Remer 12 mins ago

The NASA Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) mission, with a target launch within the next 5 years, aims to make measurements that will advance ocean and atmospheric science and facilitate interdisciplinary studies involving the interaction of the atmosphere with ocean biological systems. Unique to this Earth science satellite project was the formation of a science team charged with a dual role: performing principal investigator (PI)-led peer-reviewed science relevant to specific aspects of PACE, as well as supporting the mission's overall formulation as a unified team.

This science team is serving a limited term of 3 years, and recompetition for membership is expected later this year. Overall, the cooperative, consensus-building approach of the first PACE Science Team has been a constructive and scientifically productive contribution for the new satellite mission. This approach can serve as a model for all future satellite missions.

PACE

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The PACE satellite, as envisioned, would carry multiple sensors into space as early as 2022. These instruments include a radiometer that will span the ultraviolet to the near infrared (NIR) with high spectral resolution (<5 nanometers). This radiometer will also scan individual bands from the NIR to the shortwave infrared. In addition, the instrument suite would include two different CubeSat polarimeters. These devices are radiometers that separate different polarization states of light over several viewing angles and spectral bands.

Measurements from these sensors would be used to derive properties of atmospheric aerosols, clouds, and oceanic constituents. Derived products could lead to better understanding of the processes involved in determining sources, distributions, sinks, and interactions of these variables with critical applications including Earth's radiative balance (https://eos.org/research-spotlights/new-evidence-challenges-prevailing-views-on-marine-carbon-flux), ocean carbon uptake (https://eos.org/research-spotlights/oceans-may-produce-twice-as-much-organic-matter-as-usually-measured), sustainable fisheries (https://eos.org/research-spotlights/how-will-climate-change-affect-the-california-current-upwelling), and more (https://eos.org/research-spotlights/can-we-predict-the-future-of-ocean-carbon-dioxide-uptake).

The PACE Science Team

To help map out the scope of the PACE mission, NASA first established a science definition team that provided a report (https://pace.oceansciences.org/docs/pace_sdt_report_final.pdf) on the desired characteristics of PACE in 2012. Following that report and just before the decision to fund PACE was made, in 2014 NASA published a call for proposals for participants in the first PACE Science Team.

The scientists funded under this call and selected for the science team were partitioned into two subject areas: One focused on atmospheric correction and atmospheric products, and the other addressed the retrieval of inherent optical properties of the ocean. The team was enhanced with NASA personnel with specific portfolios in two areas: data processing and applications for societal relevance.

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NASA's solicitation (https://sites.nationalacademies.org/cs/groups/ssbsite/documents/webpage/ssb_160751.pdf) specified "the ultimate goal for each of the two measurement suite teams is to achieve consensus and develop community-endorsed paths forward for the PACE sensor(s) for the full spectrum of components within the measurement suite. The goal is to replace individual ST [science team] member recommendations for measurement, algorithm, and retrieval approaches (historically based on the individual expertise and interests of ST members) with consensus recommendations toward common goals."

This new framework differed from past NASA science teams in that PIs not only proposed their own science objectives and coordinated their own research but were also expected to contribute to common goals as well.

Science Team Activities

Soon after forming, the science team identified several issues or subject areas of common concern and formed subgroups to address these individual concerns. These areas included construction of novel data sets for algorithm development (both in situ and synthetic data sets), cross comparison and benchmarking of coupled ocean-atmosphere radiative transfer codes, and cross comparison of instruments in the field (https://eos.org/project-updates/bringing-biogeochemistry-into-the-argo-age) to assess and constrain uncertainties in the measurements of oceanic particle absorption.

The science team was also asked by NASA to assess the designs of the PACE radiometer and polarimeter and to determine the value of adding a high spatial resolution coastal camera. An ad hoc subgroup was formed to produce a stand-alone report on the advantages and requirements for polarimetry for atmospheric correction, aerosol characterization, and oceanic retrievals. The team contributed to both the design and content of the PACE website (http://pace.gsfc.nasa.gov).

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The PACE science team also developed an alternative style for their last two annual meetings that emphasized discussion and interaction. To improve the efficiency of the PACE science team's workshops, a "flipped meeting" format was adopted in which team members prerecorded their individual presentations in advance and posted these recordings to an internal site. Science team members were able to view and listen to the recordings at their leisure and arrived at the meeting itself readied with questions and discussion points for the presenters. This meeting strategy was successful and led to invigorating two-way discussions.

Enhanced Collaborations

The PACE science team is in the last phase of the 3-year term. Several consensus reports are being finalized to provide NASA with input and recommendations about the most likely paths forward for PACE atmospheric correction, atmospheric products, and oceanic optical properties [e.g., *Werdell et al.*, 2018].

PACE has set itself up to be a model for interdisciplinary collaboration. Early fruits of this can be seen in the multiple collaborations that have sprouted up between ocean and atmospheric scientists, whose vocabulary and culture were initially vastly different. Collaborative products range from published papers that build realistic radiative transfer models from within the ocean to the top of the atmosphere to the assembly of novel databases that contain ocean and atmospheric measurements useful to develop novel algorithms.

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We hope these collaborations will result in increased cooperation in PACE's future and on future missions. In particular, we're hopeful that collaborations will lead to enhanced study of processes at the air-sea interface, a complex domain that is relatively unknown, where a holistic and interdisciplinary approach will lead to better understanding of the functioning of our planet.

PACE's future is currently uncertain (it is in Congress's continuing resolutions but was one of the missions the current administration did not support). Although we hope that the mission keeps its funding, we note that the cooperative, consensus-building approach of the first PACE science team was a constructive and scientifically productive contribution to the path forward for a new satellite mission. We expect that this framework to support mission activities will be adopted in future NASA missions to maximize their utility across disciplines.

References

Werdell, P. J., et al. (2018), An overview of approaches and challenges for retrieving marine inherent optical properties from ocean color remote sensing, *Prog. Oceanogr.*, in press, https://doi.org/10.1016/j.pocean.2018.01.001 (https://doi.org/10.1016/j.pocean.2018.01.001).

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