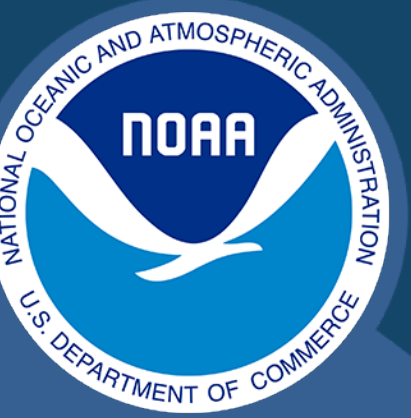


PMEL OCEAN CLIMATE STATIONS (OCS) AS REFERENCE TIME SERIES AND RESEARCH AGGREGATE DEVICES



PMEL
Pacific Marine Environmental Laboratory

Meghan F. Cronin¹, Nathan D. Anderson^{1,2}, Dongxiao Zhang^{1,2}, Patrick Berk^{1,2}, Samantha Wills^{1,2}, Yolande Serra², Catherine Kohlman³, Adrienne Sutton¹, Makio C. Honda⁴, Yoshimi Kawai⁴, Jie Yang⁵, Jim Thomson⁵, Noah Lawrence-Slavas¹, Jack Reeves Eyre⁶, and Christian Meinig⁷

¹ NOAA/Pacific Marine Environmental Laboratory (PMEL), Seattle, Washington

² University of Washington (UW) Cooperative Institute for Climate, Ocean, and Ecosystem Studies, Seattle, Washington

³ UW School of Oceanography, Seattle, Washington

⁴ JAMSTEC, Yokosuka, Japan

⁵ UW Applied Physics Laboratory, Seattle, Washington

⁶ NOAA/National Center for Environmental Research (NCEP) Climate Prediction Center, College Park, Maryland

⁷ DOE/Pacific Northwest National Laboratory (PNNL), Sequim, Washington

Abstract

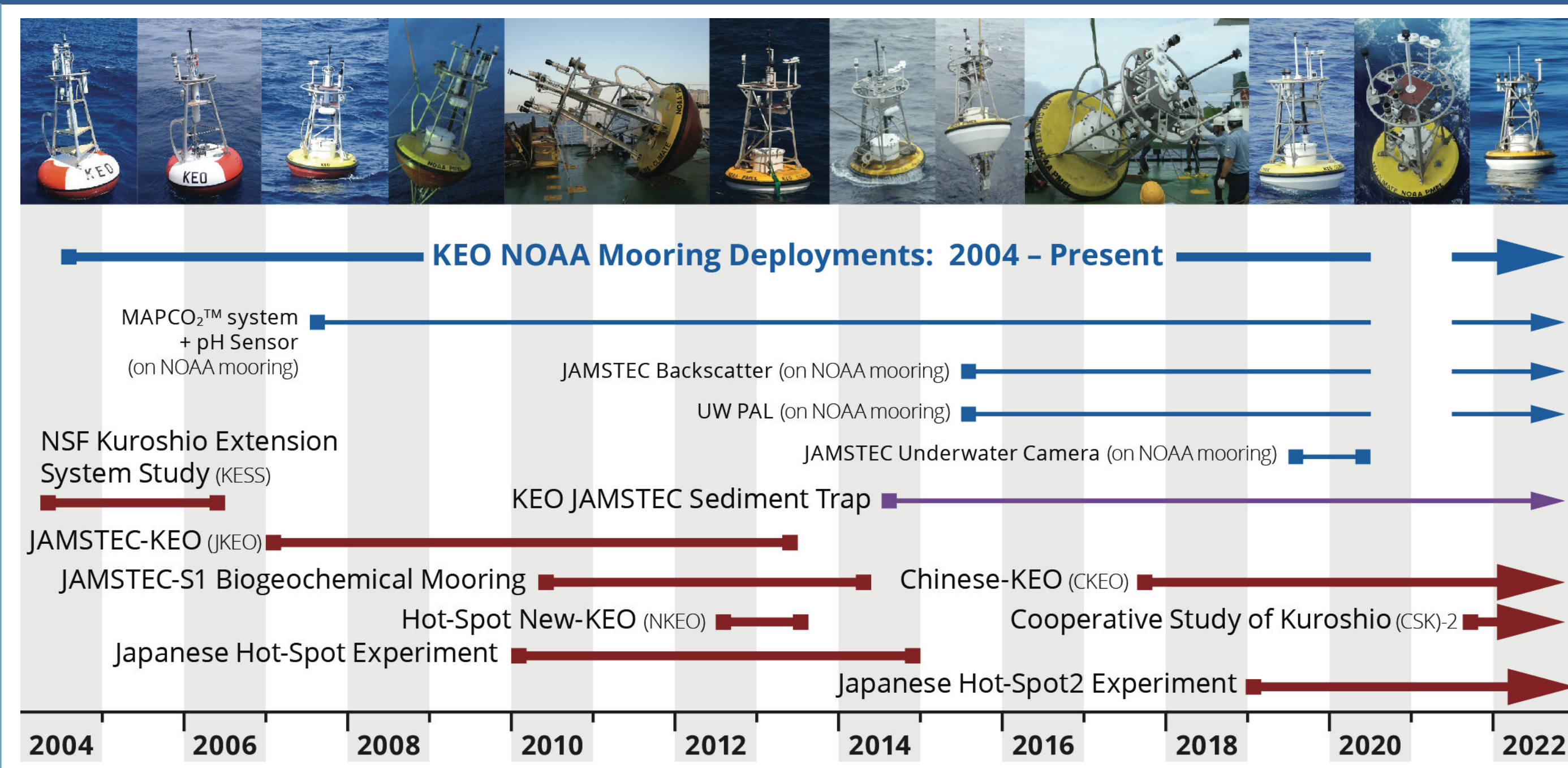
The NOAA Pacific Marine Environmental Laboratory (PMEL) Ocean Climate Stations (OCS) project provides in situ measurements for quantifying air-sea interactions that couple the ocean and atmosphere. The project maintains two OceanSITES surface moorings in the North Pacific, one at the Kuroshio Extension Observatory in the Northwest Pacific subtropical recirculation gyre and the other at Station Papa in the Northeast Pacific subpolar gyre. These time series are used as in situ references for assessing satellite and numerical weather prediction models, and OCS scientists have collected process-oriented observations of variability on diurnal, synoptic, seasonal, and interannual timescales associated with anthropogenic climate change.

Since 2016, OCS worked to expand, test, and verify the observing capabilities of uncrewed surface vehicles, developing new observing strategies for integrating these unique, wind-powered observing platforms into the tropical Pacific and global ocean observing system. For more information about the project, visit:

<https://www.pmel.noaa.gov/ocs/>



OCS has also been at the center of the UN Decade of Ocean Sciences for Sustainable Development (2021–2030) effort to develop an Observing Air-Sea Interactions Strategy (OASIS) that links an expanded network of in situ air-sea interaction observations to optimized satellite observations, improved ocean and atmospheric coupling in Earth system models, and ultimately improved ocean information across an array of essential climate variables.



Kuroshio Extension

Fish Aggregate Devices

- OCS formed in 2003 as an offshoot of PMEL's Tropical Atmosphere and Ocean group (TAO)
- Cronin led the Eastern Pacific Investigation of Climate (EPIC) process study, enhancing existing moorings along 95°W.
- Biofouling became an issue, attracting fish, then international fishing fleet vandalism.
- At the conclusion of EPIC, equipment was redistributed, and the Kuroshio Extension Observatory (KEO) was established June 2004.

Research Aggregate Devices

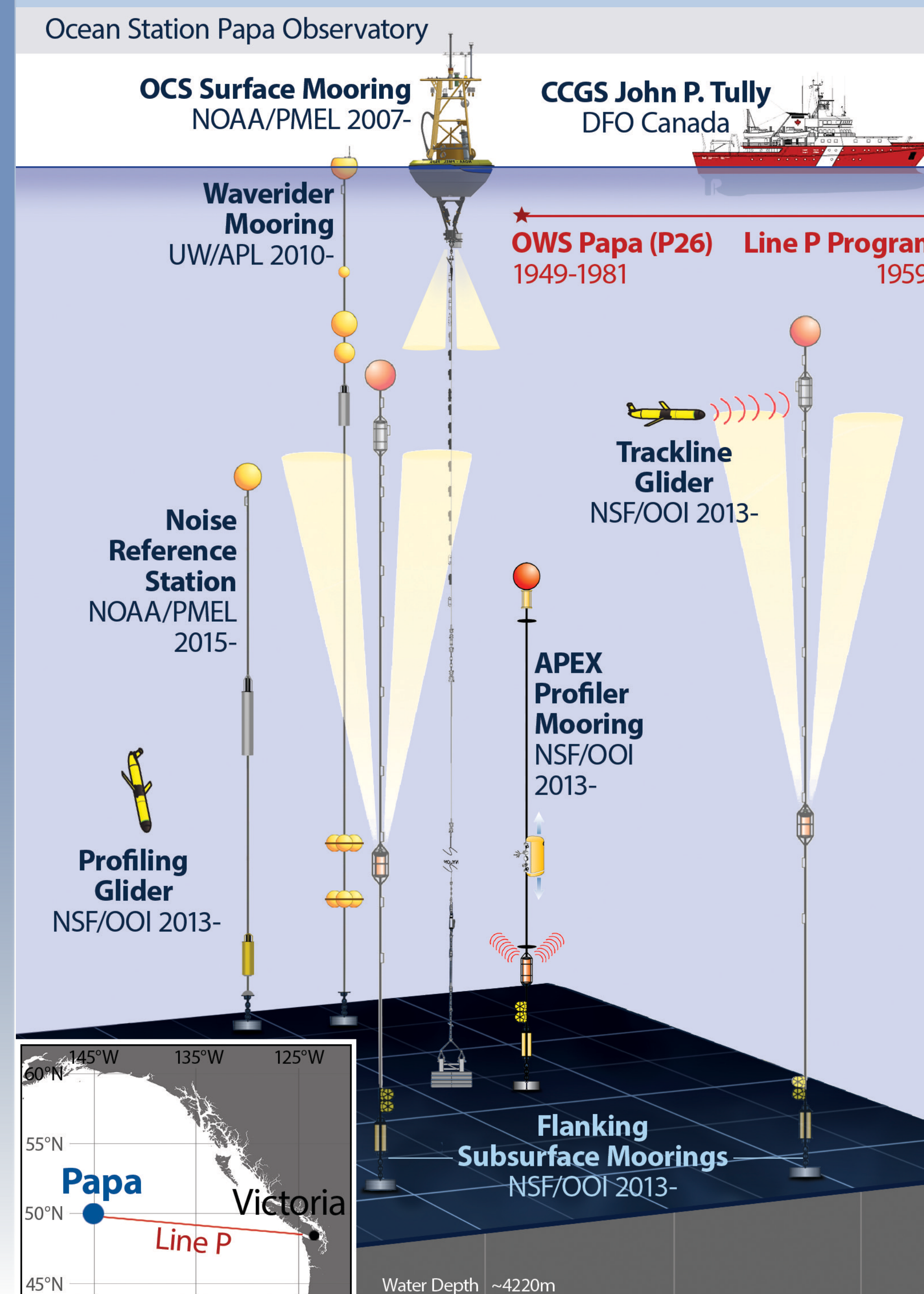
- OCS moorings attract international researchers, partner programs, experiments (e.g. Hot-Spot, CSK, CSK-2) and supplemental moorings (e.g. JAMSTEC sediment trap)
- JAMSTEC established J-KEO north of the Kuroshio Extension in 2005, and China deployed a set of C-KEO moorings north and south of the KE jet.
- Both KEO (top) and Papa (at right) draw upon international collaboration and benefit from partners who have built up the station or region into an observational array.

Cronin, M.F., N.D. Anderson, D. Zhang, P. Berk, S.M. Wills, Y. Serra, C. Kohlman, A.J. Sutton, M.C. Honda, Y. Kawai, J. Yang, J. Thomson, N. Lawrence-Slavas, J. Reeves Eyre, and C. Meinig. 2023. PMEL Ocean Climate Stations as reference time series and research aggregate devices. *Oceanography*, <https://doi.org/10.5670/oceanog.2023.224>.

Station Papa Observatory

Historic Time-Series

- Observations began in 1949, with a Canadian ocean weather ship stationed at Papa.
- Recurring ship-based hydrographic sections of "Line P" (Vancouver Island to 50°N 145°W) have been conducted since 1956.
- NOAA mooring established in 2007.



Saildrone

Autonomous Vehicles

- Wind-powered navigation and solar-powered equipment = low carbon footprint.
- Collaboration with Saildrone Inc. led to the first OCS Saildrone mission in 2017.
- Recurring Tropical Pacific Observing System (TPOS) missions have explored a range of scientific interests across the central and eastern Pacific:

- Abrupt Fronts, Cold Pools, Boundary Layers
- Tropical Instability Waves and Mesoscale Eddies
- Air-sea Interactions and Energy Budgets
- Tropical Storm Pre-Conditions and the ITCZ

Challenges

Anticipating Conditions

- Open-ocean environments & biofouling can cause system and instrument failures.
- Broken mooring lines set buoys adrift (e.g. eddies, vandalism, extreme weather, etc.).
- Acquiring shiptime for turnaround cruises.
- Developing a culture of mentorship and partnership for succession planning, cruise staffing, and training of early career scientists.

The Future

- Long time series will grow in importance as anthropogenic warming raises the heat content of the ocean and alters its chemistry.
- Observing the oceans with a lower carbon footprint will become increasingly necessary.

