

Introducing NASA's Pushbroom Imager for Cloud and Aerosol Research and Development (PICARD): a compact hyperspectral radiometer for ER-2 and G-III aircraft

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Abstract: The NASA Airborne Sensor Facility debuted the PICARD imager for science use during the PACE-PAX campaign in September 2024 with 50 hours recording data aboard a high-altitude aircraft. Calibrated spectral radiances are available for download.

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1. Summary

The Airborne Sensor Facility at NASA Ames Research Center partnered with Brandywine Photonics, LLC, to develop a compact hyperspectral radiometer named the Pushbroom Imager for Cloud and Aerosol Research and Development (PICARD). This dual Offner spectrometer and f/2.8 all-reflective 30 mm telescope provides 200+ channel imagery covering a wavelength range of 400 nm to 2400 nm at roughly 10 nm spacing and 15 nm FWHM spectral bands. Over 400 across-track samples, 50° field-of-view, 2.1 mrad instantaneous field-of-view, and 6.25 Hz frame rate combine to provide an 18 km wide swath and 30-40 m pixel spacing at 20 km altitude and 450 knots ground speed (e.g. on board the NASA ER-2).

PICARD has a silicon CCD at the VNIR focal plane and a HgCdTe hybrid sensor at the SWIR focal plane. Both have 14-bit digitization and use techniques unique to each detector to extend their dynamic ranges, providing an estimated SNR of 100 to 300 in the VNIR and 300 to 900 in the SWIR over moderately bright terrestrial targets at mid-latitudes. The SWIR detector is packaged in a Stirling-cooled Integrated Dewar-Cooler Assembly (IDCA), avoiding the need for liquid nitrogen in the field. The entire sensor mass is about 50 kg, allowing it to operate with multiple other instruments aboard high-altitude platforms such as the ER-2 and G-III aircraft in the NASA Airborne Science Program fleet. Following a series of engineering and validation flights in 2018 through 2023, PICARD was selected to participate in the PACE Postlaunch Airborne eXperiment (PACE-PAX).

PACE-PAX was a multi-platform, multi-sensor field campaign in September 2024 for validation of the Phytoplankton, Aerosol, Cloud, and ocean Ecosystem (PACE) satellite mission launched earlier in the year. The ER-2 high-altitude reconnaissance aircraft at NASA Armstrong Flight Research Center hosted airborne instrument proxies for the PACE instruments: the HARP2 and SPEXone polarimeters, and the Ocean Color Imager (OCI). During 14 sorties more than 50 hours of PICARD hyperspectral imagery were collected

above a variety of terrestrial and marine targets, and a variety of cloud, smoke, and atmospheric conditions.

Great care was taken during the PACE-PAX campaign to coordinate the ER-2 flight path with Navy/CIRPAS Twin Otter in-situ atmospheric sensors, many ocean radiometer and plankton sensors deployed on gliders and surface vessels, and with coincident PACE and EarthCARE satellite overpasses (Fig. 1). In addition to flying other PACE instrument proxies (UMBC's AirHARP, the Netherlands Institute for Space Research (SRON) SPEX airborne, and JPL's PRISM), the ER-2 hosted the NASA LaRC aerosol/cloud HSRL2 lidar and the NASA GISS multi-angle polarimeter (RSP). With the combination of different sensors used during the campaign, PICARD's participation in PACE-PAX offers a wealth of data to the scientific community and general public.

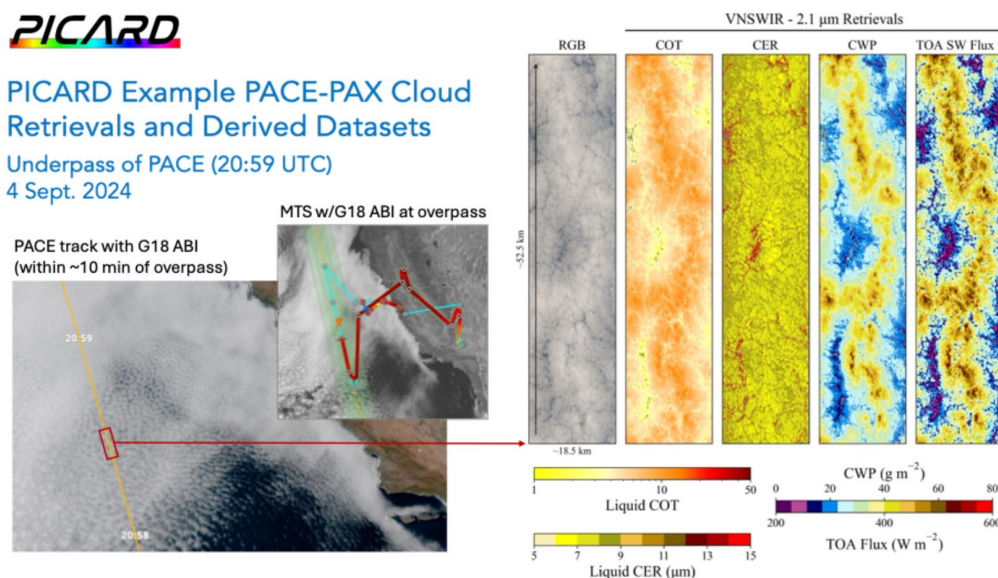


Fig. 1: Preliminary Level 2 cloud retrievals using PICARD radiance imagery of marine stratus during a PACE satellite overpass of the ER-2 at 20:59 UTC, 4 Sept. 2024. Lower left: PACE satellite track (orange) over GOES-18 Advanced Baseline Imager (G18 ABI). Center-left: ER-2 flight plan (cyan) and flight track at time of overpass (red). Center-right to right: PICARD true-color imagery (RGB), cloud optical thickness (COT), cloud effective radius (CER), cloud water path (CWP), and top-of-atmosphere shortwave flux (TOA SW Flux). Source: NASA

2. Data availability

PICARD quicklook imagery from the PACE-PAX airborne science campaign is available at: https://asapdata.arc.nasa.gov/picard/data/deploy_html/pace-pax.html.

Data from PACE-PAX, including PICARD Level 1B calibrated radiance imagery, are available in netCDF format at: <https://www-air.larc.nasa.gov/cgi-bin/ArcView/pacepax>. To create login credentials and access the data, contact Dr. Gao Chen at gao.chen@nasa.gov.

The Level-1 and Atmosphere Archive & Distribution System (LAADS) Distributed Active Archive Center (DAAC) will provide long-term hosting for public distribution of the PICARD L1B and L2 data sets (see <https://ladsweb.modaps.eosdis.nasa.gov>).

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