



## NASA P-3 Orion Airborne Science Laboratory



The P-3 in a typical mission configuration layout during a check flight.

# NASAfacts

### P-3 Orion Aircraft

The NASA P-3 Orion aircraft (BuNo 152735) is a former U.S. Navy patrol aircraft that has been extensively modified by NASA for use as an airborne science laboratory. It is owned by NASA and operated by the NASA Goddard Space Flight Center's Wallops Flight Facility Aircraft Office at Wallops Island, Virginia. The P-3 is a NASA Airborne Science Program supported platform. The aircraft can carry instrument payloads supporting scientific studies all over the globe.

The aircraft supports scientific investigations by NASA and visiting scientist from universities, other agencies, and organizations worldwide. Data gathered by the P-3 has been used for scientific studies in ecology, geography, hydrology, meteorology, oceanography, atmospheric chemistry, soil science, biology, cryospheric research, and satellite calibration/validation. The P-3 is also used as a technology test bed for new airborne and satellite instrumentation.

The P-3 is a four-engine turboprop aircraft and is in the 135,000-pound gross weight class. The aircraft is designed for endurance and range and is capable of long duration flights of 8-12 hours, large payloads up to 18,000 pounds, indicated airspeeds up to 405 knots, altitudes up to 32,000 feet, and requires a typical runway length of 7,000 feet. The aircraft is 117 feet long with a 100-foot wingspan and is 34 feet tall. It has many sensor ports, 4 feet of ground clearance for ease of access and calibration, and ample pressurized cabin space for user systems.

The aircraft was originally built in 1966, acquired by NASA in 1991 and had its wings replaced in 2016. NASA plans to operate the P-3 into the 2040's timeframe.

### Aircraft Modifications

The P-3 has been extensively modified to support airborne science-related activities. Some of the science features include zenith ports, three nadir ports (aft of the wings), and seven P-3 and DC-8 style windows to mount experiments, a tail cone, nose



radome and ten wing mounted locations.

Most of the fuselage ports are contained within the pressurized cabin environment along with dropsonde and sonobuoy launch tubes. The unpressurized bomb bay can be converted into experimenter ports via a custom fairing. This fairing creates two large nadir ports and several oblique ports for installation of large sensors and antennas.

A data system is available that provides aircraft navigation data, meteorological information, and flight videos to experimenters. This system is also connected to the IRIDIUM and INMARSAT satellite constellations, and provides real time uplink/downlink capability, internet access, flight tracking, and text messaging between aircraft and ground assets. Available experiment electrical power includes a total of 90KVA of 110V/60Hz AC, 110V/400Hz AC, and 28VDC.

### **Mission Support**

The P-3 is a self-sufficient global reaching aircraft that can operate from civilian and military airports to remote areas of the world. Experiment installations are installed on the aircraft at the NASA Wallops Flight Facility hangar, which has various spaces and support equipment available for researcher use. Wallops access to nearby restricted airspace allows for unique research to be conducted from the P-3 that normally cannot be conducted from other facilities. Wallops project managers, pilots, engineers, technicians, and aircraft mechanics provide an all-in-one comprehensive mission support team for all P-3 missions conducted locally or abroad.

### **Scientific Studies and Outreach**

The P-3's first mission in the early 1990's consisted of cryospheric research flights over the Arctic region. The aircraft flew to Greenland and other Arctic and Antarctic areas for the annual Operation IceBridge campaign. Operation IceBridge began in 2009 to fill the gap between the end of the IceSat I satellite and the beginning of the IceSat II satellite mission. The critical areas observed and measured during the Operation IceBridge 10-year campaign were coastal Greenland; in particular, the sub-glacial lakes and certain fast-moving glaciers, the southeast Alaskan glaciers, and Arctic sea ice thicknesses. The aircraft deployed to McMurdo Station, Antarctica in 2013 to perform Antarctic sea and land ice surveys. The P-3 was the first NASA aircraft to fly from the Antarctic continent utilizing a sea ice runway. The aircraft is well suited for the low altitude flights over sea and land ice to map the topography of the ice, bedrock, and sea floor beneath. The P-3 has been supported by the DC-8 and other aircraft in the Arctic and Antarctic regions in the past, but it remains the main NASA aircraft for performing cryospheric research.

The other major area of P-3 scientific flights has been in the atmospheric chemistry regime. The P-3 flew several global campaigns called Global Troposphere Experiment (GTE) during the late 1990's and early 2000's. These missions evolved over time to study specific atmospheric phenomena culminating in a return to the P-3 in 2008 for the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) campaign. In the spring of 2008, the P-3, along with several other NASA and other Agency aircraft, converged on Fairbanks, Alaska to study the effects of pollutants on the Arctic environment. The P-3 and DC-8 returned in the summer of 2008 to Yellowknife, Canada to study the specific effect of boreal forest fires on the Arctic environment. The P-3 continued its long history of atmospheric chemistry research in 2010 with a 4-year campaign called Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ). This campaign flew over several major U.S. cities to improve the use of satellites to monitor air quality for public health and environmental benefit. Following DISCOVER-AQ the P-3 supported another 4-year campaign called ObseRvations of Aerosols above Clouds and their intEractionS (ORACLES) to study key processes that determine the climate impact of African biomass burning by deploying from the countries of Namibia and Sao Tome and Principe and flying over the southern Atlantic Ocean.

The P-3 supported the Cloud, Aerosol and Monsoon Processes Philippines Experiment (CAMP<sup>2</sup>Ex) mission in the fall 2019 and between 2020-2023 supported the three-year Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) mission. IMPACTS flights took the P-3 into the heart of US East Coast and Midwest snowstorms to gather atmospheric samples to better improve weather forecast models.

Other notable scientific studies that the P-3 has conducted in the recent past include surface wind measurements for satellite validation from Goose Bay, Canada and soil moisture measurements conducted over Oklahoma and the Delmarva Peninsula. The P-3 has also support numerous instrument technology demonstration flights for various universities and NASA Centers over the years.

In addition to scientific research the P-3 supports educational outreach missions to inspire and train future scientist still in undergraduate and graduate schools. In 2012 the P-3 supported the Student Airborne Research Program (SARP) with student research flights flown over the US West Coast from Palmdale, CA. Following in the footsteps of SARP the P-3 also supported the Student Airborne Science Activation (SaSa) program in 2022 with student research flights flown over the US Mid-Atlantic from WFF.