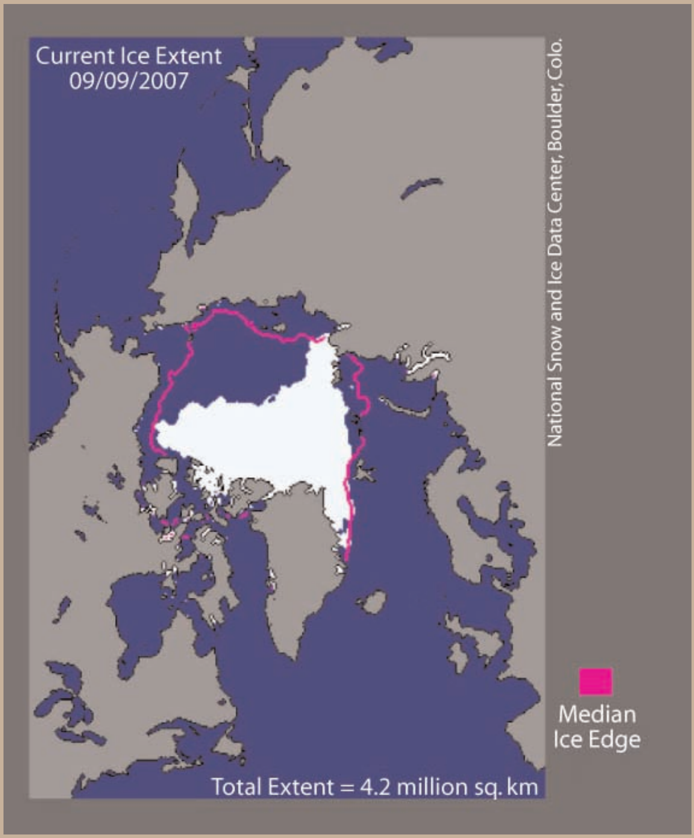
NOAA's ARCPAC Field Mission

Aerosol, Radiation, and Cloud Processes affecting Arctic Climate

As a part of the International Polar Year, NOAA scientists and their U.S. and international colleagues are conducting the Aerosol, Radiation, and Cloud Processes affecting Arctic Climate (ARCPAC) field study. ARCPAC is an airborne research activity to investigate the climate-changing characteristics of pollution in the Arctic. The ARCPAC work is a part of the international POLARCAT (Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport) research activity.

The Warming Arctic

Observations from the ground, from balloons, and from satellites all show that the Arctic is warming faster than the average across the globe. Sea ice cover in summertime has decreased in extent by about 40% relative to the 1979-2000 average, and the sea ice is also thinning. ARCPAC is investigating the connections between pollution such as atmospheric fine particles (aerosol, the "Arctic Haze"), clouds, and the melting of polar ice in the region.



Map of sea ice extent for September 9, 2007, near its minimum for that year. The magenta line shows the median September monthly extent based on data from 1979 to 2000. (Figure courtesy of the National Snow and Ice Data Center.)

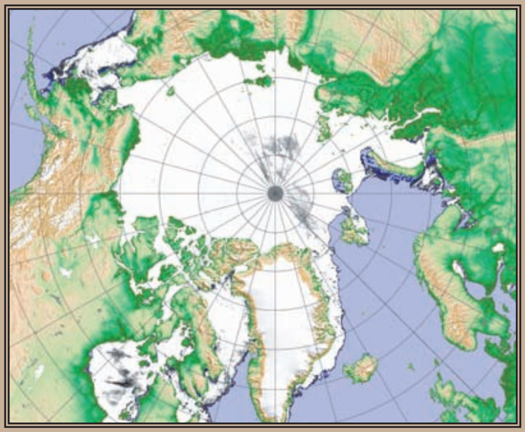
Arctic Air Pollution and Climate Change

Pollutants from North America, Europe, and western Asia are carried to the Arctic and contribute to the so-called Arctic Haze, a phenomenon that recurs every winter and spring. Ozone and some aerosols (small particles floating in air) are produced in the atmosphere when pollutants mix and react in the presence of sunlight. The climate impact of the aerosols can be quite different over the Arctic ice sheet compared to elsewhere. The Earth/atmosphere system is heated more when a haze layer is above a highly reflective surface such as white snow or ice. Aerosol particles may change the radiative characteristics of clouds in the Arctic and make them more effective insulators. And since some haze particles are deposited to the surface and darken the snow, the surface absorbs more of the incident sunlight and is warmed. Taken together, haze may warm both the atmosphere and the surface when the sun rises in springtime.

Clear and hazy conditions in spring near Ny Ålesund, Norway. Photos by Ann-Christine Engvall.

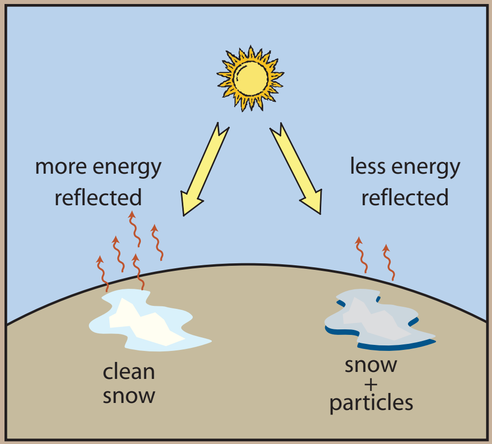
What is Happening During ARCPAC?

One of NOAA's premier research aircraft, a WP-3D Orion (the "P-3"), is carrying out a series of flights in the Arctic during spring 2008. Scientists have outfitted the aircraft with 26 instruments to transform it into a "flying chemical laboratory" that can measure physical and chemical properties of aerosol fine particles comprising Arctic Haze, cloud properties, and radiation, along with ozone, nitrogen oxides, volatile organic compounds, and other trace gases that affect climate in the Arctic.



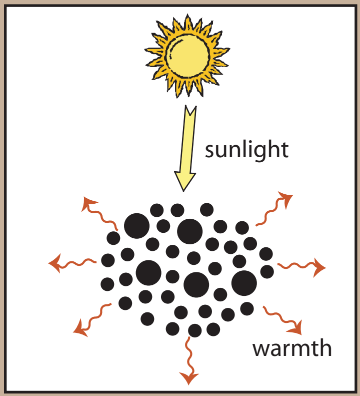
- Flights based out of Fairbanks, Alaska
- Far northern base with hangar, good runways, safe aircraft operations
- First 3 weeks of April 2008
- Haze present at ground level and aloft
- Sun is up (radiative heating)
- Comparisons to NOAA and DOE long-term ground sites at Barrow
- Contrast with NOAA ship study of fresh emissions in European Arctic

Arctic Haze Climate Processes

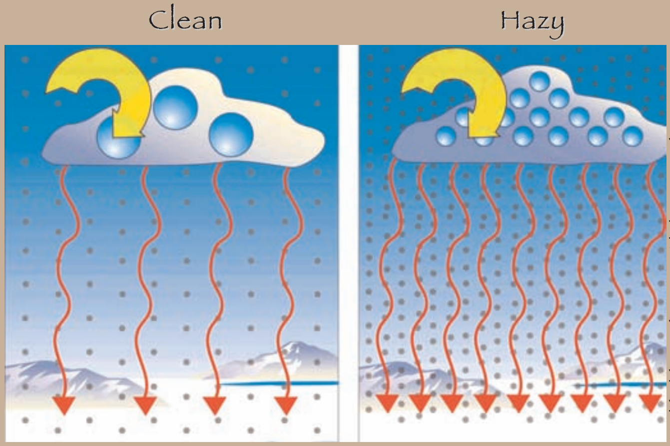


- Haze particles deposited on snow absorb more sunlight and warm the surface.

- Pollution causes more ozone to form (a greenhouse gas).



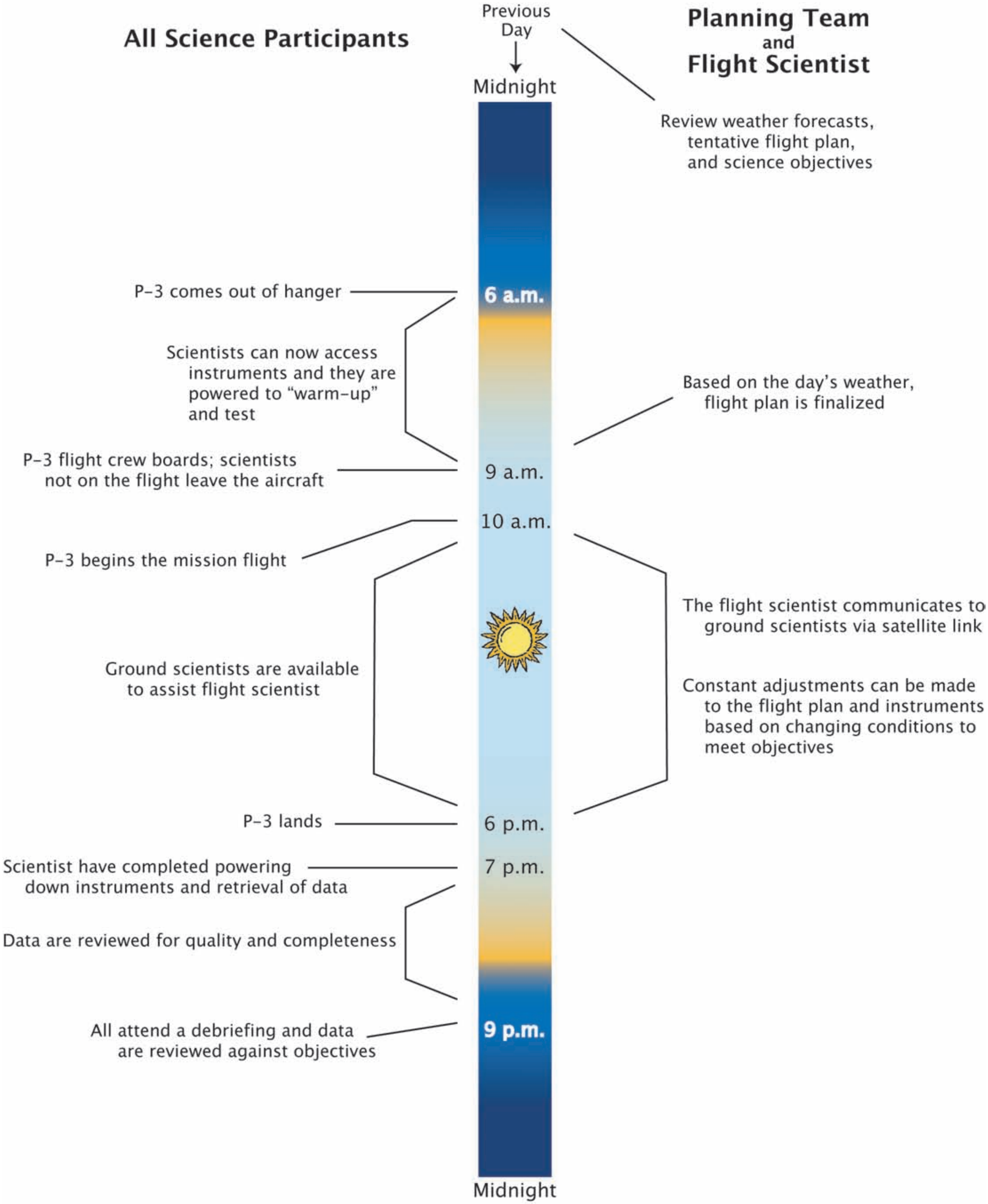
- Dark haze particles absorb sunlight and warm the atmosphere.



Modified from a figure provided courtesy of Brookhaven National Laboratory

- Arctic Haze causes clouds to have more and smaller droplets that radiate more warmth downward.

A day in the life of a flight:
Example of a flight day timeline



About Us

Earth System Research Laboratory (ESRL), located in Boulder, Colorado, is an atmospheric research laboratory in the National Oceanic and Atmospheric Administration (NOAA) / Office of Oceanic and Atmospheric Research (OAR). A group of the ESRL staff are engaged in research that provides a sound scientific basis for decisions made in industry and government related to climate change understanding, air quality improvement, and ozone layer protection. Within that group, many of the staff are employees of NOAA's Joint Institute with the University of Colorado, the Cooperative Institute for Research in Environmental Sciences (CIRES). That ESRL staff conducts scientific research aimed at discovering, understanding, and quantifying the processes that govern the chemical reactions of Earth's atmosphere that are needed to improve the capability to predict its behavior. Chemical reactions and radiative processes (heating, cooling, and reactions) drive atmospheric change. Their identification and characterization are a fundamental necessity for building better models of the atmosphere and predicting the behavior of regional and global phenomena, which is at the heart of NOAA's mission.

ESRL scientists are the lead investigators for NOAA's ARCPAC Field Mission. We are also collaborating with scientists from The Georgia Institute of Technology and the University of Colorado.

For more information on ESRL, go to http://www.esrl.noaa.gov

More on the P-3

Two of the world's premier research aircraft, the renowned NOAA WP-3D Orions, participate in a wide variety of national and international meteorological, oceanographic and environmental research programs in addition to their widely known use in hurricane research and reconnaissance. These versatile turboprop aircraft are equipped with an unprecedented variety of scientific instrumentation, radars, and recording systems for both in-situ and remote sensing measurements of the atmosphere, the earth, and its environment. Obtained as new aircraft from the Lockheed production line in the mid-70's, these aircraft have led NOAA's continuing effort to monitor and study hurricanes and other severe storms, the quality of the atmosphere, the state of the ocean and its fish population, and climate trends.

The P-3s are excellent aircraft for the research work they do. The structural design enables them to carry a wide variety of instrumentation. Besides locating instruments inside the aircraft, instrumentation can be hung in pods from the P-3's wings and fuselage. A typical flight will carry 5-7 flight crew members and five scientists and a payload of over 20 instruments for studying atmospheric chemistry and meteorology.

For more information go to website http://www.aoc.noaa.gov/