National Oceanic and Atmospheric Administration

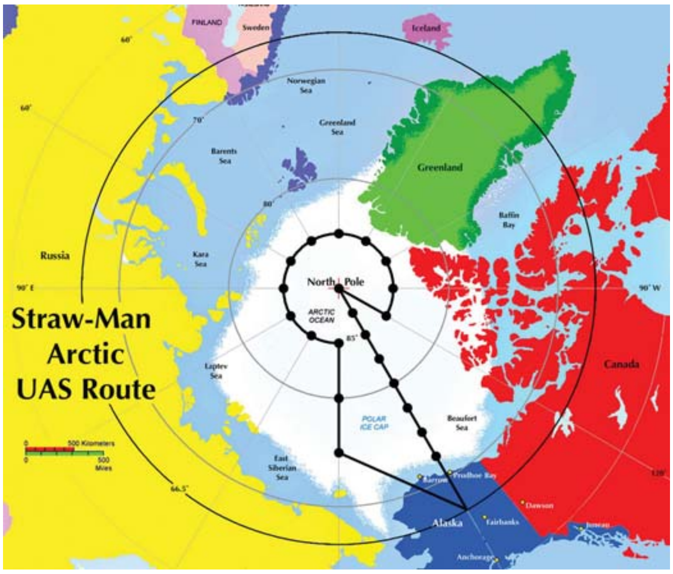
By Rene Eppi, Mridula Srinivasan, Sara Summers, Betsy Weatherhead

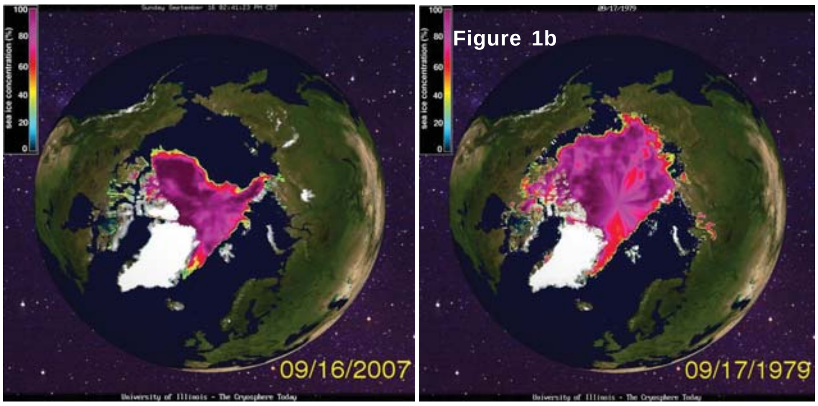
Unmanned Aircraft: Its Critical Role in the Arctic

The Arctic is a fragile and changing environment. In the past fifteen years, sea ice has melted significantly around the edges of Greenland and the Arctic, and marine mammals have been seriously threatened by the observed changes. Surprisingly, little is known about much of the Arctic because observations are scarce and satellites often perform poorly in the Arctic.

The present Arctic data gaps are large and can not be filled with current technologies. These data gaps are most prominent in understanding the cryosphere, biosphere, pollution, weather and climate. They include basic vertical measurements of temperature, humidity and wind over the Arctic Ocean, ice characteristics, and marine mammal inventories. These data gaps are critical for understanding and improving predictions for weather, climate, sea ice, and environmental change in general. For many of these issues, the data gaps should be addressed with a circum-Arctic approach in order to advance our current understanding of the mechanisms responsible for change. Unmanned Aircraft Systems (UAS) offer the possibility to fill these important gaps, in remote and harsh regions of the Arctic.

Figure 2 - A possible HALE flight over the Arctic Ocean could allow for a variety of environmental measurements to be gathered in a scientifically useful manner. Such a flight could originate in any of the Arctic countries, or even outside of the Arctic, and would require coordination and cooperation from all civil and military aviation authorities.





Figures 1a & 1b presented by Erland Källén, provided by Uni. of Illinois, show the loss of sea ice in the past decades. The loss is faster than predicted. Uncertainties about causes of ice loss are large, in part due to a lack of necessary measurements. With improved direct (in situ) measurements, short-term predictions as well as long-term predictions could allow for better planning by the Arctic countries.

UAS would augment and expand our current monitoring capabilities in the Arctic. UAS can help in satellite calibration, especially when carried out periodically over time. Some characteristics of the Arctic can not be measured with current satellite capabilities; both campaigns and routine UAS flights will be needed to fill these gaps. Campaigns using UAS can help clarify critical mechanisms for change in the Arctic, including change in sea ice, severe storms, marine mammal populations, deforestation, permafrost distributions, and glaciers. Routine UAS flights with direct vertical measurements at fixed locations around the Arctic can advance our understanding of weather, climate, the cryosphere and biosphere over the Arctic Ocean. The incorporation of such measurements into re-analysis efforts will assist both weather and climate studies for the Northern Hemisphere.

Most Arctic countries are moving forward with civil applications of UAS. Operations have been safe and have resulted in valuable contributions within each project.

In July 2008, NOAA and the University of Colorado conducted a successful test in Ilulissat, Greenland named The Arctic Multisensor Cryospheric Observation Experiment (MUSCOX). The goals of the experiment were to test the capability of the Manta to operate in the Arctic; and to acquire data that could help us understand the rapid increase in the movement and calving of the Greenland ice sheet which speeds glacial ice flows towards the ocean.

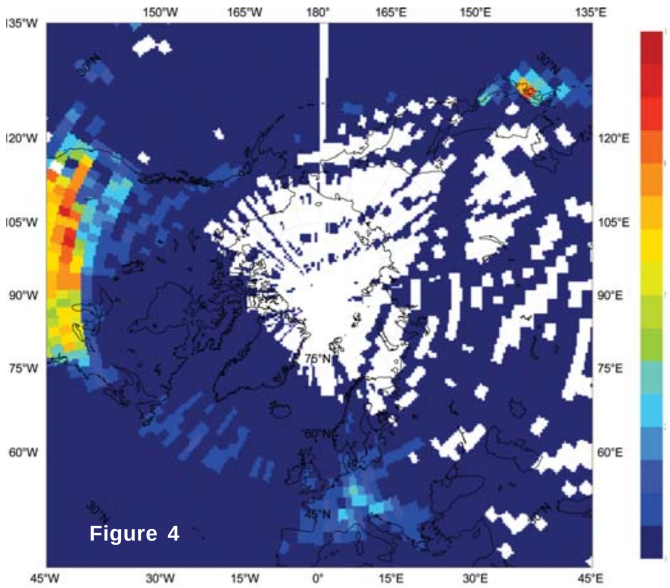
Figure 3 - July 8, 2008, Successful 35 minute Manta flight KangerlussuaqGreenland

Collaboration between all Arctic countries is required to support a comprehensive understanding of changes occurring in the Arctic environment. Bilateral meetings and discussions between the United States and other Arctic country representatives from Sweden, Norway, Russia, and Canada are underway to coordinate Arctic monitoring efforts, and regarding the potential use of UAS. However, circum-Arctic coordination will need to include communication across aviation authorities on issues of UAS in Arctic airspace. Circum-Arctic coordination is necessary to allow for an improved understanding of the current state of the Arctic. Environmental measurements from UAS should allow for advancements in scientific understanding that will assist in both short and long-term predictions for the Arctic. These improved predictions will be valuable for decisions regarding Arctic maritime transport for shipping, development, and ecosystem management.

Issues related to changes in the Arctic are important enough to warrant accelerated cooperation in environmental monitoring, in which UAS can play a unique and valuable role. Sustained monitoring capabilities will allow for this important problem to be addressed in the most accurate and consistent manner. The primary need is cooperation between the science communities and aviation regulatory bodies across country borders to develop and test UAS for key Arctic environmental research. The timing of these efforts is critically important to allow for data gathering as early as possible, while still maintaining safe operations in the Arctic.

In March 2008, scientists gathered in Stockholm, Sweden to discuss the use of UAS to take critical environmental measurements. The clear consensus of the group was that UAS allow for unprecedented capabilities in monitoring remote and harsh locations across the Arctic. In October 2008, civil aviation authorities met to discuss the possibilities of using UAS safely within the current airspace system. The conclusion at that time was that incorporation of UAS would be possible, but that further coordination and work would be necessary to allow for routine, safe flights.

Environmental change around the world has become one of the pressing issues of our day. The realization that problems in one part of the world can affect the entire planet is one of the most important changes in environmental monitoring during our lifetime. Examples from pollution emitted in a localized region finding its way to the most remote regions of the Antarctic to El Niño phenomena affecting African rains are reminders of the need for international collaboration and thoughtful stewardship of this planet. Timely information is key to all decisions related to weather, oceans, and the environment. Satellites, while developed for military and communication purposes, are one of our most powerful tools for understanding the Earth as a whole and making advanced five-day weather forecasts. Now, UAS emerge as a technology that can fill critical gaps in our ability to gather information about the environment in remote and data sparse regions.



This figure, presented by Erik Andersson of ECMWF, shows the availability of temperature and wind observations for the upper air (150-300hPa), from regular commercial aircraft during the month of July, 2006. The white areas are where no measurements were available for the entire month. Without balloon ascents, or data from airplanes, forecasting models have little direct measurements to assist in Northern Hemisphere weather prediction and climate re-analysis.