Recommendations for Safe and Expeditious use of Unmanned Aircraft to Take Critical Environmental Measurements in the Arctic: Results of the Arctic Monitoring and Assessment Program Workshop of Scientists and Aviation Authorities from the Arctic Countries. Oslo, October, 2008.

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Arctic Monitoring and Assessment Programme (AMAP)

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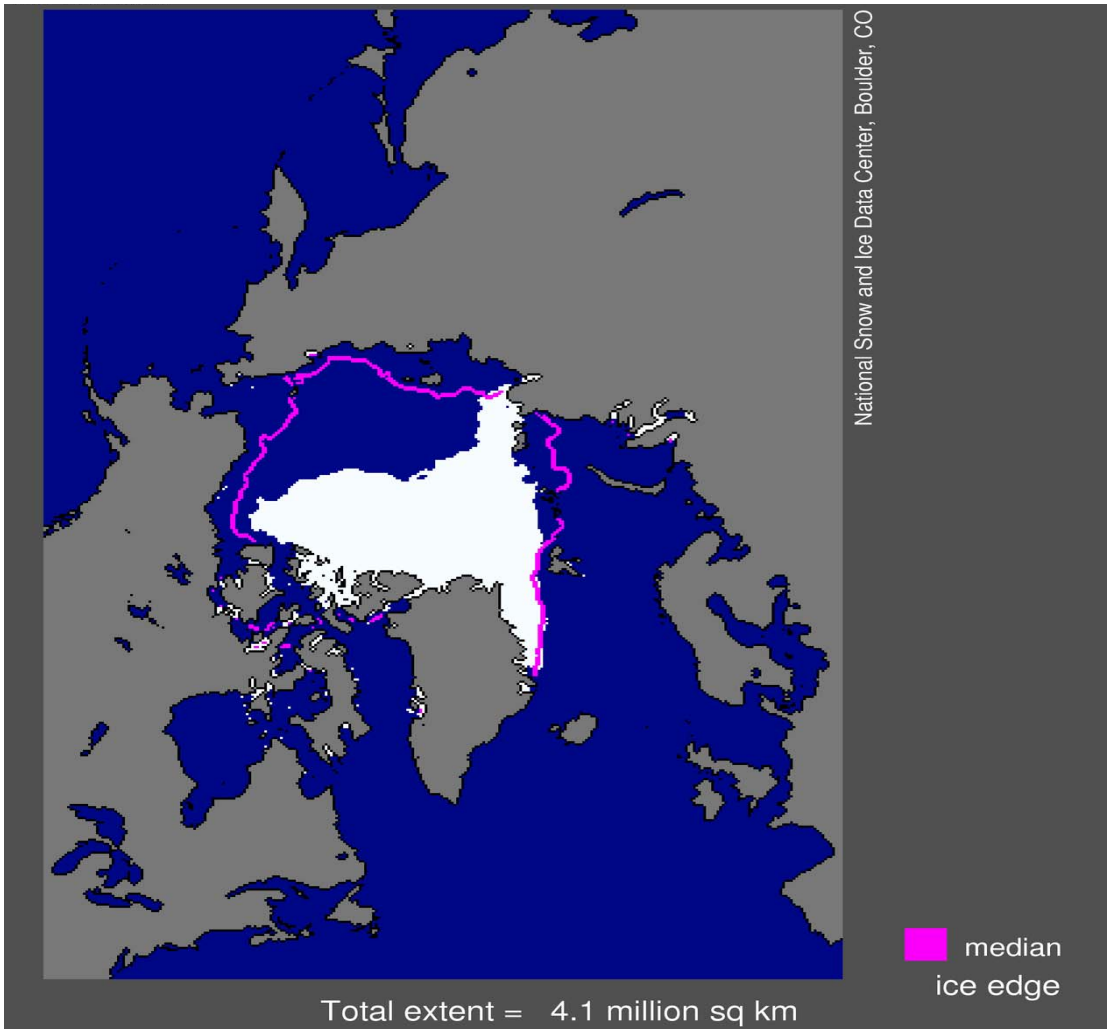
Unmanned aircraft have been in use for decades, making tremendous advancements over the past fifteen years. While primarily developed for other purposes, this technology can offer tremendous opportunities for gathering environmental data in the Arctic. Much of the area within the Arctic is not monitored because of the inability for current monitoring systems to accurately make measurements. A particular challenge is measuring within the lowest two kilometers in the atmosphere and monitoring sea ice and marine mammals. Satellites do not give accurate measurements in this region, and current buoy measurements give incomplete information. With the strong and ill-understood changes taking place in the Arctic, it is of great importance that scientists be empowered to use unmanned aircraft in the Arctic for important environmental measurements.

Currently, unmanned aircraft have been developed in a variety of shapes, sizes and capabilities. Sizes can range from less than one kilogram, to vehicles similar in size to a Boeing 737. Unmanned aircraft that have been used in the Arctic by scientists are generally less than 25 kilos, and often the aircraft have been much lighter. Despite their small size, unmanned aircraft have offered significantly improved data collection, often flying over 100 kilometers taking measurements in regions too difficult or risky for manned aircraft. UAS have been used to fly at low altitudes over Greenlandic glaciers taking detailed, systematic measurements of melt ponds, over sea ice to record detailed characteristics, and over seal and marine mammal populations to unobtrusively take systematic counts of existing mammals. These initial successful efforts of using unmanned aircraft to take environmental measurements have occurred in each of the eight Arctic countries.

In the next few years, several missions posed by scientists have been funded, but require assistance in order to secure safe use of airspace. One set of missions involves flights out of Svalbard, exploring airspace north of Svalbard and west of Svalbard toward Greenland. Scientists are actively interested in exploring the areas over and near Greenland as well as off the coast of Alaska and north of Canada and Russia. Many of these mission plans are well developed and funded, but require coordinated access to the airspace.

Proceeding safely within the complex airspace of the Arctic will require different approaches for the different aircraft and type of mission being flown. The scientific needs have focused on very low altitude flights, below the cloud deck (under 1000 feet) and high altitude flights with dropsonde capabilities over 50,000 feet. There is also a strong scientific need for unmanned aircraft that can travel within clouds; however this



Change in the Arctic environment can not be effectively examined by looking intensively in only one area of the Arctic. 2007's dramatic ice melt did not occur evenly throughout the Arctic, underlying the importance for Arctic environmental efforts to be coordinated. Unmanned aircraft have the ability fly long and low through larger areas of the Arctic that would be too remote and dangerous for manned aircraft.

capability is not well developed because of problems due to icing and the technical limitations of many unmanned aircraft.

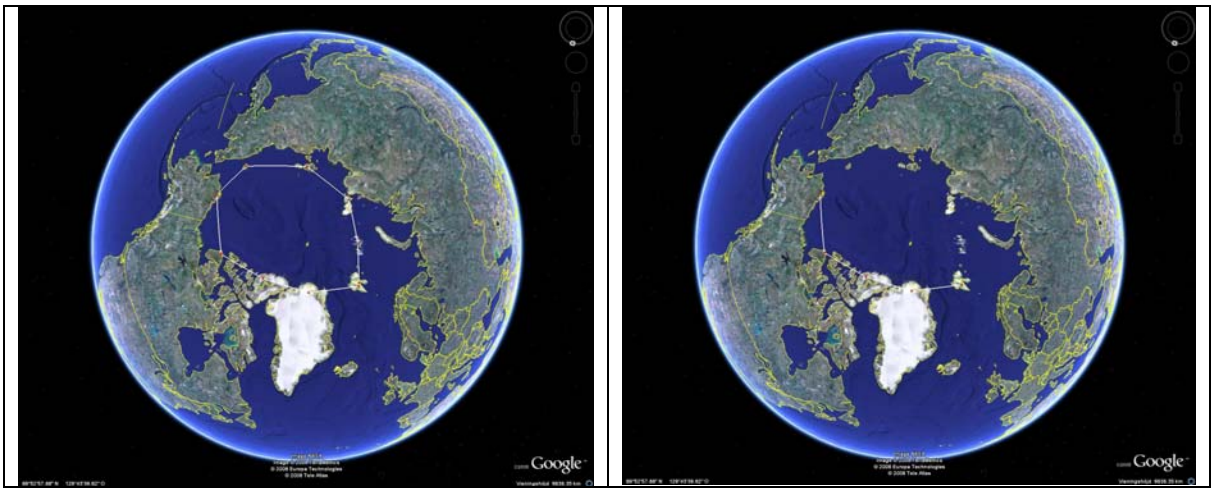
To date, there have been no serious accidents involving unmanned aircraft in the Arctic. This is due in part to the very low number of unmanned flights, the sparse density of air traffic in the Arctic and the careful planning by scientists and air traffic authorities. Continuation with unmanned aircraft in the Arctic will require additional coordination to assure the continued safety of the airspace, as well as the safety of the environment, people and property on the ground. As each country moves forward, the coordination across country and airspace boundaries will allow added benefit to the scientific questions being addressed. All parties agree that some risk is involved in introducing unmanned aircraft into the Arctic airspace. The primary risks in using unmanned aircraft over the Arctic are potential collisions with other aircraft or landing unexpectedly. The use of unmanned aircraft assures that these missions can be carried out without putting mission scientists and mission pilots on board at direct risk. The significant benefits to society of gaining the environmental measurements using unmanned aircraft are considered as plans proceed.

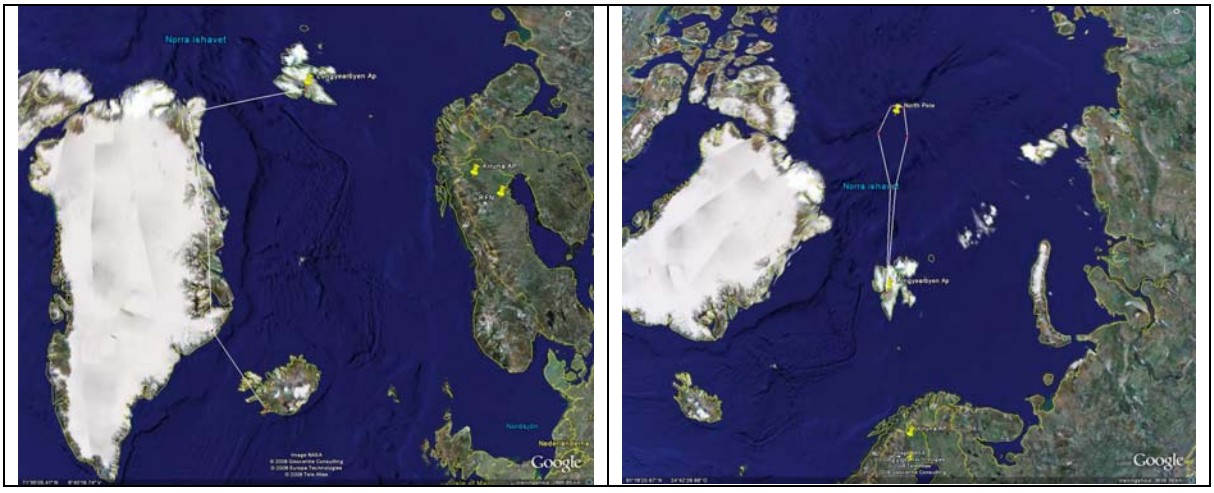
Unmanned aircraft systems pose technological, regulatory, workload, and coordination challenges that affect their ability to operate safely and routinely in the national airspace system. Unmanned aircraft cannot currently meet aviation safety requirements, such as seeing and avoiding other aircraft. The technological advances in unmanned aircraft required to allow them to fly safely in the airspace will take further efforts and are the focus of other organizations and industries. Air traffic regulations to appropriately integrate unmanned aircraft will likely take more than a decade as a variety of safety issues must be addressed. As a result of these challenges, routine access to the airspace for unmanned aircraft does not exist at this time.

Currently, most Arctic countries assess requests for using unmanned aircraft in the airspace as individual cases. Each country has the capability to allow unmanned aircraft to fly as an exception to existing regulations. The estimate of risk for each case is dependent on when and where the flights will take place as well as what type of aircraft will be used.

Discussions by the civil aviation authorities and air navigation service providers, as well as other experts, led to the conclusion that the best way to proceed safely during the coming decade is to establish special use airspace in the Arctic for environmental measurements. A variety of designations for airspace will allow for the separation and warning to the existing traffic in the Arctic. Each country has different mechanisms for declaring specific airspace as danger areas, and the process can be lengthy in some countries, requiring advanced planning. For the important Arctic flights that use more than one country's airspace, coordination of efforts is required in order to achieve the successful flights important to improving understanding of the Arctic.

As an example of a coordination issue that could prevent use of unmanned aircraft for environmental use, some of the Arctic countries, as well as a few international regulatory bodies have attempted to categorize unmanned aircraft by weight, kinetic energy, intended use, and operational capabilities. Scientists are responding to these categories by developing instrumentation and flight plans to work within their country's regulations. However, expanding these missions to the broader Arctic environment may run into difficulties if each country develops different standards. The needs of the scientific community and other potential civil users of Arctic airspace will best be met by a collaborative effort between the Arctic nations to harmonize regulatory standards and promote seamless unmanned aircraft operations in international airspace.

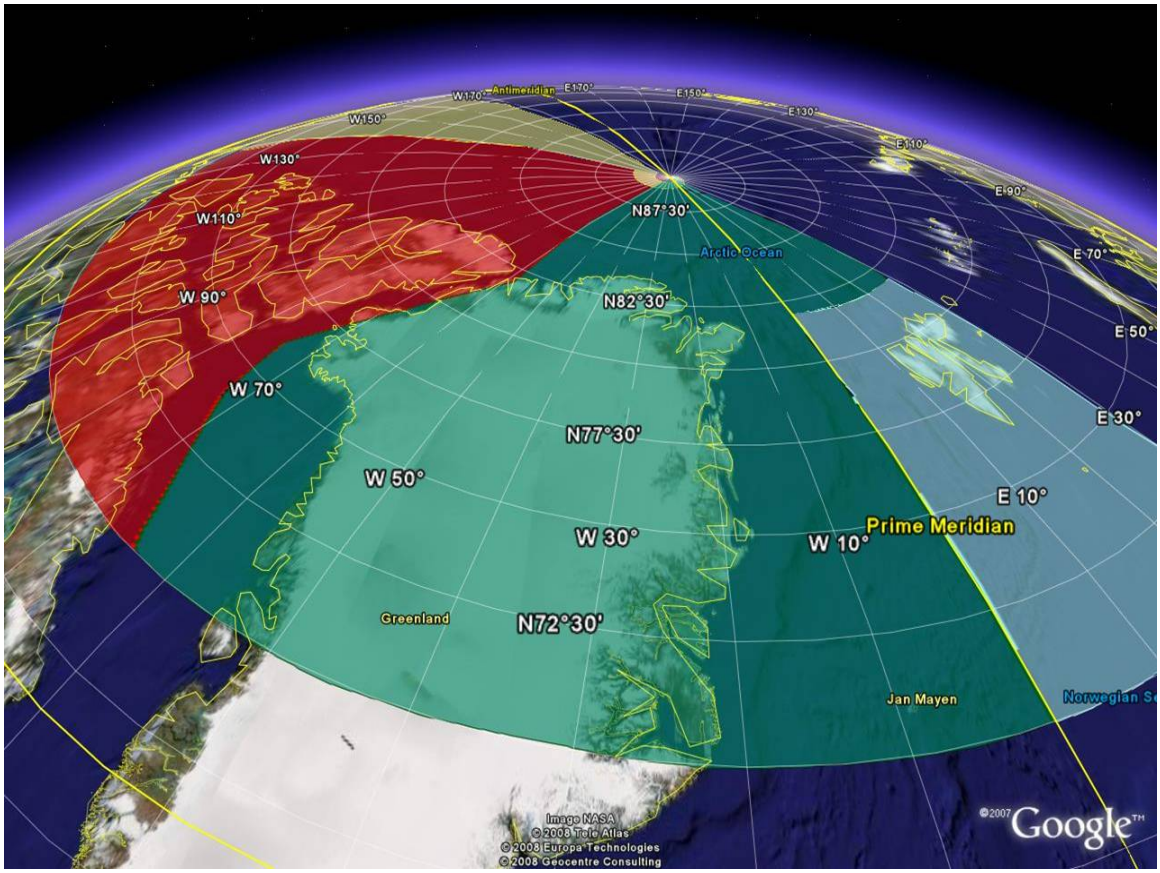




Potential flights in the Arctic would allow scientists to take critical measurements of the Arctic environment. All of these flights would involve coordinating with multiple countries and the air navigation service providers who are responsible for the areas.

Some of the flights that may be considered in the future are illustrated above. In order to coordinate these flights and maintain safety of the airspace, the Arctic Council is asked to request that the appropriate aviation authorities within each country coordinate efforts to approve requests for flights with unmanned aircraft for the purpose of taking environmental measurements. The representatives from the aviation authorities and air navigation service providers that met in Oslo felt the meeting was highly valuable and necessary for coordinated progress in this area. Despite the success of this meeting, it was pointed out that involvement with representatives from all of the Arctic countries was extremely important in order to advance unmanned aircraft flights in a safe manner. AMAP is a likely and appropriate organization for continued coordination of this working group.

While safety is of highest importance when considering unmanned aircraft use in the Arctic, other factors must also be considered. Concerns about privacy, preservation of pristine environments, and leaving wildlife undisturbed, particularly during breeding periods must also be considered. To proceed appropriately with unmanned aircraft, each country must examine and communicate such sensitivities through the AMAP working group.



A number of countries currently coordinate aircraft flights through the Arctic. Coordinating with each of these countries will be necessary to fly safely in the Arctic and gather critical environmental data that can not be collected any other way.

As scientists and aviation authorities move forward with unmanned aircraft within the Arctic a number of principles for good behavior have been identified and agreed on by the groups meeting in Stockholm and Oslo. These principles include such principles as sharing of data, and being clear about mission objectives. Further development of these principles of best practices will likely improve both safety efforts and scientific advances as unmanned aircraft progress in the coming years. The identification and dissemination of principles of best practice will be part of the goal of the AMAP working group proposed by the experts gathered in both Oslo and Stockholm.

Unmanned aircraft systems (UAS) offer a genuine breakthrough in our ability to monitor and gather environmental data over the Arctic and can be a significant contribution to the Sustaining of Arctic Observibng Networks (SAON). Scientists and air authorities in each of the Arctic countries are currently involved in some level of use of this new technology. The safe and efficient progress in this area requires close collaboration within and between countries at this time. The Arctic Council is respectfully requested to assist in this coordination through the following actions:

1) An expert group should be established under AMAP to coordinate and facilitate unmanned aircraft missions for environmental research, monitoring, and assessment of the Arctic.

2) Each Arctic country is requested to nominate an individual who is responsible for coordination of unmanned aircraft operations and will communicate through the AMAP expert group.

3) It is requested that each Arctic country, when safety and regulations allow, permit and support unmanned aircraft flights for the purpose of environmental measurements.