

**WRITTEN TESTIMONY OF
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE**

**HEARING ON
“UNMANNED AIRCRAFT SYSTEMS IN ALASKA AND THE PACIFIC: A
FRAMEWORK FOR THE NATION”**

**BEFORE THE
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE**

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Introduction

Thank you, Mr. Chairman and Members of the Committee, for inviting me here today to present testimony on the potential use of unmanned aircraft systems, or UAS, to improve oceanic and atmospheric observations. I am Vice Admiral Conrad Lautenbacher, Under Secretary of Commerce for Oceans and Atmosphere and Administrator of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce.

Many of you may be familiar with NOAA’s use of unmanned or autonomous underwater vehicles, but NOAA is also interested in Unmanned Aircraft Systems (UAS) as a tool to explore and gather data to help us reach new heights in our ability to understand and predict the world in which we live. Use of UAS could help NOAA achieve our mission goals to conserve and manage coastal and marine resources to meet the economic, social, and environmental needs of our nation.

NOAA constantly seeks better and more cost effective strategies to meet our mission goals and responsibilities, and this includes evaluating emerging technologies and the roles they could play in our work. UAS are an example of one emerging technology NOAA is exploring. My testimony today provides background on UAS as a potential platform for collecting data, and how they could be used to help NOAA accomplish its mission in Alaska and the Pacific, across the nation, and around the world as part of our global commitments.

Earth Observations: UAS Provide Complementary Data

The Global Earth Observation System of Systems (GEOSS) is an international effort that is working to link Earth observing systems from over 60 countries to improve global coverage. With benefits as broad as the planet itself, this U.S.-led initiative promises to make people and economies around the globe healthier, safer, and better equipped to

manage basic daily needs. UAS could be a valuable part of GEOSS by contributing more information and improving our observational capabilities and forecasts.

UAS have the potential to provide more comprehensive information on atmospheric conditions in the area between satellites and surface-based sensors. For example, UAS can perform functions that satellites cannot such as dropping specialized sensors (dropwindsondes) from high altitudes to obtain vertical profiles of crucial atmospheric variables. In other words, the dropwindsondes are able to take a series of measurements within a column of the atmosphere giving a “top-to-bottom” snapshot of conditions. These measurements include cloud properties, aerosols (small particulates), radiation (sun’s rays or sun’s energy), temperature, humidity, and winds. The complementary data that UAS provide could enable us to improve our weather and climate predictions.

UAS: Sentinels of the Sky

UAS are a developing segment of the aviation industry and are often used by U.S. military and intelligence agencies overseas. Civilian agencies, like NOAA, have only recently begun demonstration projects to test the mission-focused utility of these platforms. UAS could allow NOAA to carry instruments to remote locations too dangerous or impractical for manned flight, and provide unique capabilities for dirty, dull, and dangerous missions. Dirty, because they can fly into contaminated areas; dull, because they allow for long transit times and open new dimensions of persistent surveillance and tracking; and dangerous, because they can fly into hazardous areas minimizing the risk to human life.

Because UAS do not carry a human pilot, they function independently or remotely with ground-based operators. UAS launch from land, air, or ship-based platforms, and can carry internal or external payloads of scientific equipment. A typical UAS consists of the aircraft vehicle, a manned ground flight-control station, ground data retrieval and processing stations (including satellite communications links), and sometimes, the wheeled land-based vehicles that carry launch and recovery platforms. A comprehensive UAS base of operations also requires launch hangars and maintenance facilities.

UAS are highly sophisticated sensor platforms that can be selected, modified, and deployed to meet different missions. There are many different types of UAS; some have a wingspan as large as a Boeing 737 (93 to 112 feet), while others are the size of a model airplane (one foot). The payload capacities of UAS that NOAA has tested or examined can carry as little as one pound, or as much as 3,000 pounds of equipment. Flight endurance of UAS range up to more than 30 hours, and some can reach an altitude of almost 65,000 feet. Additionally, the instrument packages on UAS can be recalibrated or changed prior to each flight, providing a research platform that can be regularly altered to suit changing needs.

NOAA’s Interest in UAS

Over the past few years, NOAA has considered how to incorporate UAS technology into our scientific and operational missions. In July 2005, NOAA convened an internal Unmanned Aircraft Systems Steering Committee and Working Group. This body is

responsible for advising NOAA's line offices, goal teams, and programs on the potential application of UAS technology to meet mission goals. The Working Group has identified many diverse areas within NOAA that could benefit from the use of UAS, including:

- Climate and weather operations
- Oceanic and atmospheric research
- Monitoring and evaluating ecosystems
- Monitoring endangered species
- Mapping and charting
- Weather and climate satellite calibration and verification
- Monitoring fires
- Monitoring marine sanctuaries
- Fisheries enforcement

The Working Group has also identified common interests and coordinated collaborative activities with: the National Aeronautics and Space Administration (NASA); the Federal Aviation Administration; the Department of Energy; the National Science Foundation; the Department of Homeland Security including the U.S. Coast Guard; and academic institutions such as Scripps Institution of Oceanography and the Universities of Colorado, Alaska, Hawaii, and New Mexico. Since 2005, NOAA has worked with our partners to complete four successful UAS demonstration projects, and we have plans for more in the next few years.

From April to November 2005, NOAA and NASA successfully completed a series of high altitude, long endurance (HALE) Altair UAS flights off the coast of California and Oregon. The Altair UAS was initially built to support NASA's Earth science research needs. The Altair demonstration included five flights totaling 45 flight hours, including an 18-hour 45,000-foot high flight over the Pacific Ocean, carrying instruments for measuring ocean color, atmospheric moisture and chemical composition, and temperature, as well as a surface imaging and surveillance system. This project demonstrated the possibility of using a HALE UAS to support of NOAA's research operational needs for mapping, monitoring and surveillance.

In September, 2005, NOAA, NASA and industry partners successfully flew an Aerosonde UAS into Tropical Storm Ophelia. At the time, Ophelia was a 55-knot tropical storm located off the North Carolina coast, and this marked the first time a UAS had flown into a tropical storm. This mission used the unique capabilities of UAS to document areas of the tropical storm environment near the surface of the ocean that have historically been either impossible, or impractical, to routinely observe by either NOAA or U.S. Air Force Reserve hurricane hunter aircraft. This demonstration showed the ability of UAS to obtain continuous low-level observations. These observations may be useful in improving future forecasts of hurricane intensity change when the information collected by these aircraft are incorporated into NOAA computer models used to predict hurricane track and intensity.

In February, 2006, NOAA participated in a field demonstration of the aerial survey capabilities of the Silver Fox UAS over the Hawaiian Islands Humpback Whale National Marine Sanctuary. The Silver Fox is a small, low altitude, short endurance UAS that was

developed with Office of Naval Research funding to function primarily as an expendable, over the horizon, surveillance tool that could be launched from ships or from land. At the demonstration, the Silver Fox UAS was used to observe surface ocean features, living resources, and vessels, and demonstrated the potential of UAS for monitoring threatened and endangered species like whales, as well as illegal, unregulated and unreported fishing activities.

During a demonstration project in February and March, 2006, NOAA's Climate Program supported the use of three Manta UAS based out of Hanimaddhoo Island in the Maldives. The UAS were equipped with radiation and aerosol sensors to detect anthropogenic smog from India. The flights also coordinated with the ground-based measurements made at the Maldives Climate Observatory, part of NOAA's Earth System Research Laboratory Global Monitoring Division. This project demonstrated the ability of UAS to obtain new information about how aerosols and clouds regulate planetary albedo (light reflection), which can affect our weather and climate.

Potential Roles for UAS in Alaska

The demonstration projects outlined above show the potential utility of UAS in providing additional observational data to assist NOAA in meeting our mission goals. Alaska's location, size, and extensive coastline make it a unique setting to evaluate the potential contributions UAS can make toward achieving NOAA's mission.

Climate and Ecosystem Monitoring

NOAA is observing climate and ecosystem changes in many parts of the world, including Alaska and the Arctic region. UAS could provide additional climate observations lacking from the Arctic due to the physical and geographic challenges we face there. Long-term atmospheric measurements repeatedly taken from the same place are the "gold standard" for climate change detection. The Arctic Ocean — covered by sea ice most of the year — is a particularly difficult area to take long-term measurements because sea ice drifts, and the entire ice shield rotates clockwise. This means that stations established on the ice move, and repeated measurements cannot be taken from the same location. Long-term detailed measurements of temperature, solar radiation, clouds, and aerosols from fixed points over the Arctic Ocean would be helpful in advancing our understanding of the region and the extent of change that is occurring. UAS may be an effective platform to obtain these measurements because of their ability to go on long flights to remote areas, and because they can potentially deploy the sensors needed to take high-resolution measurements of critical atmospheric properties at fixed locations on a routine basis.

Operational Sea Ice Monitoring

As part of NOAA's mission to provide weather and climate information to enable safe transportation, NOAA's National Weather Service Weather Forecast Office in Anchorage, Alaska forecasts sea ice year round. NOAA partners with the United States Navy and United States Coast Guard to operate the National Ice Center, which provides global ice analysis and forecasts including strategic and tactical ice services tailored to meet the operational requirements of U.S. military. Sea ice is a major marine hazard in Alaska's Bering, Chukchi, and Beaufort Seas, and can trap and even crush a ship. Ship

operators require precise up-to-date information on the location of ice edges, leads and open water, and the type and concentration of ice along their vessel's route. Anticipating sea ice formation is critical for maintaining navigational safety, and is essential for supporting Alaska's marine fisheries. Dropwindsonde and monitoring sensors released by a UAS could further NOAA's efforts in sea ice forecasting by providing timely information on the conditions that foretell rapid sea ice formation in the Arctic. This information could potentially assist in the dissemination of more timely and accurate navigation warnings.

Weather Observations and Predictions

Beyond the short term (six to 12 hours), weather forecasts are primarily based on Numerical Weather Prediction (NWP) models. NWP model forecasts depend on the amount and quality of observational data regarding the current state of the atmosphere, land, and ocean surface conditions. Alaska lacks the conventional observational coverage present in the continental United States, and UAS could provide additional observations to improve weather forecasts and warnings. The potential improvements would not only benefit Alaska, but the nation, due to the prevailing storm track that steers many weather systems from the Gulf of Alaska and North Pacific toward the continental United States.

In addition to the NWP uses of UAS data, this real-time data could contribute to the database from which the National Weather Service (NWS) develops forecasts, watches and warnings. All of the NWS forecast and warning programs (public, marine, fire weather, aviation, and hydrologic) could directly benefit from these observations.

Fire Prediction and Surveying

The 2004 and 2005 fire seasons in Alaska were the worst since records began more than 50 years ago, with 6.6 million and 4.4 million acres burned respectively. There are several major advantages of using UAS for fire weather forecasting and fire prediction and surveying over Alaska, including its long-flight endurance and its capability of high-risk flights over dangerous or remote regions. UAS with the capability of flying for long periods could survey existing wild fires, detect hot spots, and help predict the weather conditions around wild fires and fire's future track.

NOAA's National Weather Service Weather Forecast Offices provide spot weather forecasts to enhance our land management partners' decision-making process. This assists with advanced mitigation planning and safe mobilization of fire crews during wild fire suppression activities in Alaska and around the Nation. These forecasts account for the potential influence of forest fires on local weather conditions and provide vital, localized detail on wind conditions and the impact to fire behavior. UAS are a potential tool for gathering site specific data on fire weather conditions to further improve NOAA's spot weather forecasts. In addition, UAS could provide valuable information on hot spots within a fire which could benefit fire weather forecasters and those responsible for coordinate firefighting resources. The long flight time of UAS would be particularly well-suited to surveying fires that occur in remote areas of Alaska. In addition to helping to forecast fire weather, UAS could help with predicting the threat of fires. NOAA

scientists in Alaska analyze meteorological and soil moisture data to predict forest fire potential and issue fire warnings. UAS could potentially play a role in fire prediction by providing more meteorological data to validate fire advisory models.

Forest fires also impact air quality in Alaska and throughout the nation. Emissions of gases (carbon monoxide, ozone, oxides of nitrogen and sulfur) and aerosols from fire degrade the local air quality. Observations of these pollutants by UAS could improve our air quality models and extend the NWS Air Quality Forecast Guidance for ozone concentration averages across the country. In addition, emissions of trace gases and aerosols from forest fires and subsequent deforestation can affect climate change. The use of UAS to collect data on these emissions from remote areas has the potential to impact NOAA's efforts to better understand climate.

Volcanic Monitoring and Forecasting

Volcanic ash is hazardous to aircraft flying over Alaska and the entire North Pacific Region, as well as the maritime community and general public. The national and international aviation communities have taken action to help aircraft avoid such dangerous environments. In the mid-1990s, the International Civil Aviation Organization (ICAO) and NOAA reached an agreement whereby NOAA monitors satellite imagery and data to detect volcanic eruptions and, in the event of an ash eruption, issues advisories and warnings for the aviation community. NOAA also runs computer simulations to forecast the dispersion of volcanic ash. NOAA, the U.S. Geological Survey (USGS), and the Federal Aviation Administration (FAA) work in a strong partnership to monitor and mitigate the effects of volcanoes on aviation.

There are over 100 historically active volcanoes across Alaska, the Kamchatka territory of Russia, and the Northern Kurile Islands that can affect U.S. air space. Enhanced remote sensing systems, such as UAS, could be used to closely monitor these volcanoes and collect higher resolution real-time data in order to improve plume position forecasting. UAS could be useful in helping researchers and forecasters obtain data on the extent, composition, and density of ash plumes in Alaska. Ash extent data captured by sensors on UAS could be integrated into the operational forecast process and used to verify current volcanic ash detection techniques. Knowing ash density and composition would help improve ash fallout and dispersion forecasting and warnings. Sensors could also be released en-route to acquire wind speed and direction information.

Fisheries, Marine Mammals, and Sanctuaries Observations and Enforcement

NOAA's Office for Law Enforcement (OLE) helps protect and conserve our nation's marine resources and their natural habitats along our coasts and within the U.S. Exclusive Economic Zone (EEZ). Our EEZ is the largest in the world spanning over 12,300 miles of coastline and contains 3.4 million square nautical miles of ocean — larger than the combined land mass of all 50 states. Alaska's coastlines alone are over 6,600 miles, and the task of monitoring and protecting this vast area is daunting.

OLE also provides direct enforcement support to a number of critical programs involving fisheries, endangered and threatened species, marine mammals, international commerce,

and many other areas. For example, OLE and other federal agencies protect the U.S. domestic fisheries industry, which has a national value added close to \$44.7 billion a year. Of this national total, one third represents Alaska's fisheries.

Traditional enforcement methods in Alaska involve deploying aircraft for surveillance and using various vessels for at-sea coverage. NOAA currently relies on significant support from the U.S. Coast Guard for these methods of surveillance, and UAS could supplement these resources in the execution of our regional enforcement strategies.

River Flood Monitoring and Forecasting

The mission of NOAA's Alaska River Forecast Center (AKRFC), part of the NWS, is to provide watches and warnings for flooding along all streams in Alaska. In addition to floods caused by rainfall or snowmelt, a common cause of flooding in Alaska is the breakup ice jams. The AKRFC has monitored the breakup of rivers throughout Alaska for over two decades using field reconnaissance (including traditional aircraft) and observational networks (including satellites). While useful, these methodologies have their limitations. For example, given the vast size of Alaska, it is not possible to cover the entire territory using traditional aircraft surveys. Satellite-based information sometimes has to be scheduled two weeks ahead of time and requires clear skies. UAS could enhance NOAA's field reconnaissance capability, because of their increased flight autonomy and ability to directly downlink remote sense information.

Potential Roles of UAS in Hawaii

NOAA's work reaches to every corner of our nation, and the application of a UAS program could also extend to the Hawaiian Islands.

As an example, on June 15th, President Bush designated the Northwestern Hawaiian Islands as a marine national monument. Encompassing nearly 140,000 square miles, the monument covers an area larger than all of our national parks put together. The creation of the largest marine conservation area in the world is an exciting achievement and recognizes the value of marine resources to our nation.

The monument is one of the least accessible of our national treasures and presents ongoing challenges to ensure its monitoring, conservation, and protection. UAS based in Hawaii could take measurements of the monument and other Pacific Island regions that are too remote for most sustained manned aircraft observations. UAS have potential to address a number of additional issues in the Pacific including detection of marine debris, monitoring coral reef bleaching, and supplementing our national climate and weather prediction models.

The Challenges Ahead

NOAA has learned a great deal about the potential uses of UAS, their capabilities, and the ways in which they could help us meet challenges, create solutions, and produce results. Despite the potential for expanded observational capability that UAS represent in Alaska and other parts of the nation, a number of significant challenges remain, including platform cost and how best to integrate UAS into existing systems.

By virtue of development of UAS for military purposes, the United States has a commanding lead in UAS technology. As the technological maturity of UAS continues to increase, UAS have the potential to become a lower cost alternative to traditional research and operational missions. We will continue to explore the most cost effective strategies to meet our mission goals and responsibilities.

The costs of purchasing a UAS range from less than fifty thousand dollars to tens of millions of dollars depending upon the desired aircraft performance requirements, such as range, duration, payload, altitude, and the sensors onboard. As described in a recent NASA report to Congress (*Potential Use of Unmanned Aircraft Systems (UAS) for NASA Science Missions*), the 2004 NASA commissioned study, *Cost and Business Model Analysis for Civilian UAS Missions*, found that “for the foreseeable future, the cost-per-hour-per-pound-of-payload will be at least an order of magnitude larger for a UAS when compared to a conventional manned aircraft.” This additional cost may be reasonable, if the platform gathers data not otherwise accessible by manned aircraft because of safety concerns or aircraft performance limitations. UAS-based missions are not likely to replace traditional manned aircraft missions in the near future, but will instead complement and enhance them by providing unique datasets.

Concluding Remarks

NOAA constantly seeks better and more cost effective ways to accomplish its mission for the nation as we work to understand and predict changes in the Earth’s environment. Through our NOAA Observing Systems Council and other related NOAA Councils, we continue to work towards coordinating observational and data management activities across NOAA; proposing priorities and investment strategies for observation related initiatives; and identifying programs that might benefit most from integration. UAS are an example of the emerging technologies NOAA is exploring that have the potential to alter how we monitor and respond to changes in the Earth’s environment, much like radar and satellites did in the 1950s and 60s. NOAA will continue to examine how UAS, and other emerging technologies, could assist us as we develop our daily weather forecasts, manage our nation’s marine resources, and research the changes occurring in our climate.

Mr. Chairman, I am happy to answer any questions that you, or other Members of the Committee, may have.