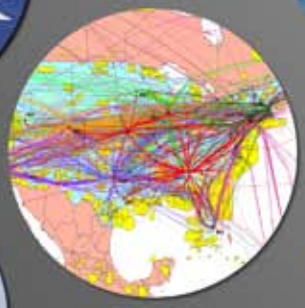
CAUAS

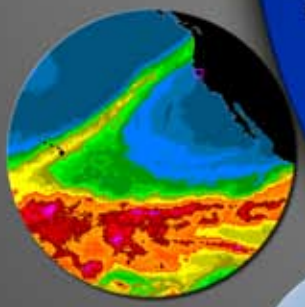
Civilian Applications of Unmanned Aircraft Systems

PRIORITIES FOR THE COMING DECADE











Initial UAS applications are showing tremendous benefits to science and homeland security; further development will likely bring even bigger rewards.

Betsy Weatherhead

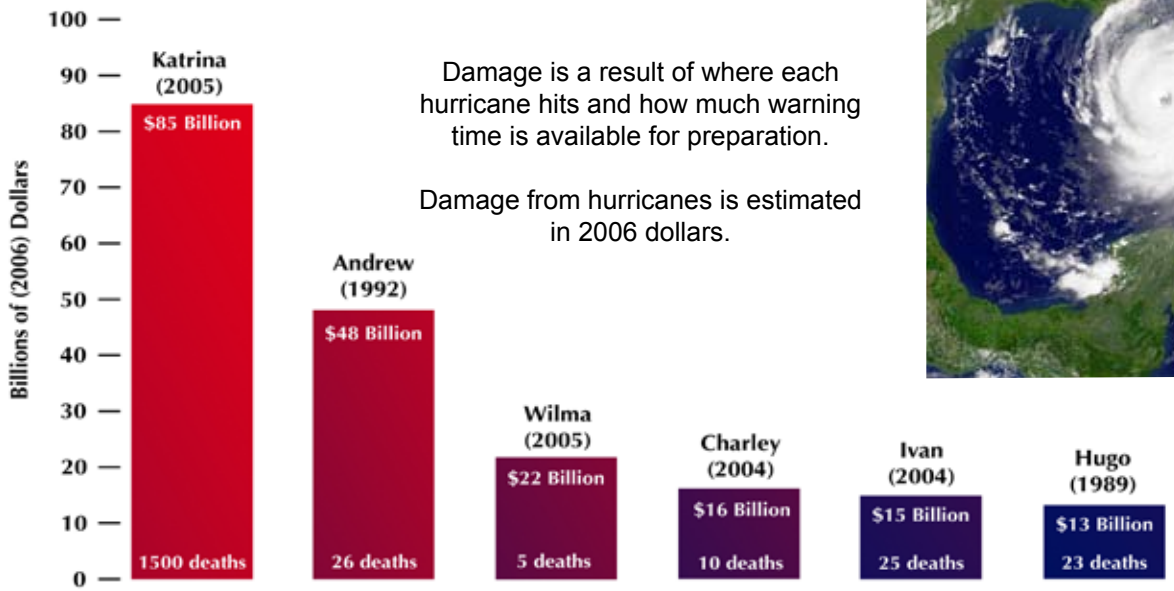
Flying unmanned aircraft safely in the US air space will be the challenge for this generation of American aeronautical engineers. Fortunately, we're up to the job.

Brian Argrow

Disaster Response

Unmanned Aircraft Systems (UAS) have already demonstrated their effectiveness for fire monitoring in six Western states. These preliminary flights helped fire-fighting efforts that saved lives, property and cost. UAS can also be used to survey disaster areas, providing immediate information for saving lives and property. Wider use of UAS after Hurricane Katrina could have expedited efforts to locate and rescue people stranded by floodwaters, and could have dramatically aided the disaster response.

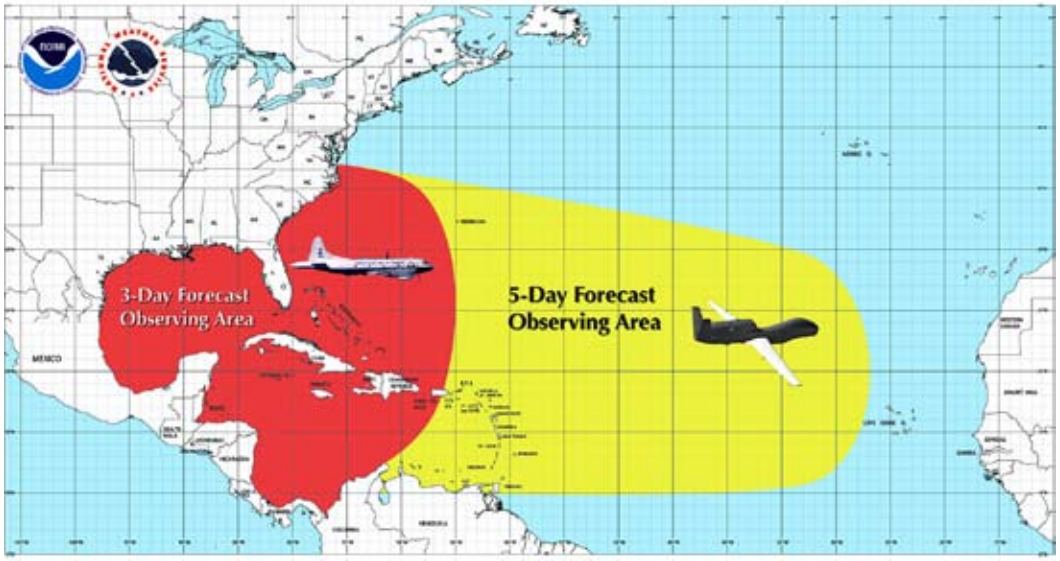
The first 24 hours are the most critical for rescue and recovery, but responders and disaster managers often have little information for the first 48 hours. Lives are lost or impaired, damage to the environment goes unabated, and resources are sent to the wrong locations due to insufficient information.



Damage is a result of where each hurricane hits and how much warning time is available for preparation.

Damage from hurricanes is estimated in 2006 dollars.

Extending Hurricane Prediction Lead Time



Unmanned aircraft can loiter for days over storms before they turn into hurricanes, taking measurements and observing development. These measurements can support earlier and better prediction of both the path and intensity of hurricanes.

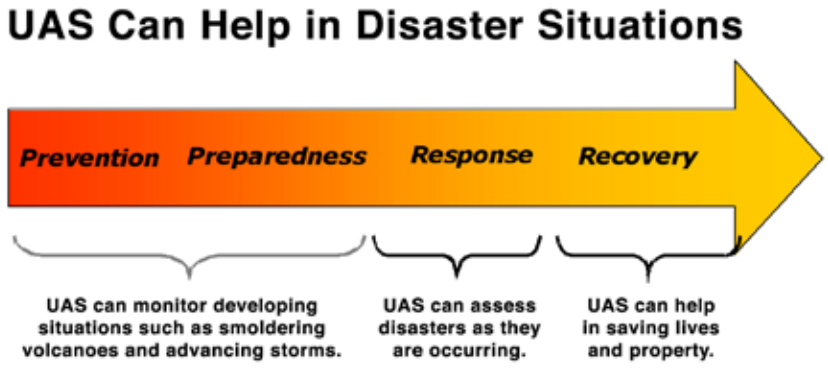
The first 24 hours is critical. Often, after that, we're looking for bodies.

Robin Murphy

The US spends $1.5 billion annually to fight forest fires. Unmanned aircraft can take measurements of the location and intensity of fires without risk to human pilots. In 2006, NASA's four UAS fire missions, lasting between 10 and 20 hours, assisted fire fighting efforts for 25 different fires in California, Idaho, Montana, Oregon, Washington and Wyoming. Future UAS could deliver direct lifesaving support.

Predicting the intensity and track of hurricanes is difficult with our current measurements. UAS allow us to observe the environment around and within these storms - places we can't get to with crewed aircraft.

Sandy MacDonald



Unmanned aircraft can monitor disaster prone areas before situations become critical, such as the development of a hurricane or an erupting volcano. Once a disaster has occurred, UAS can gather time-sensitive information to save lives and help with disaster response personnel.

Unmanned Aircraft Systems (UAS) will revolutionize this country's ability to address the most critical national environmental and security threats. These systems, where the pilot is not on board, accomplish tasks not currently possible with existing manned aircraft or satellite alternatives. The US currently has global leadership in this technology, thanks to decades of investment in defense applications, but active UAS program development in other countries now threatens this advantage. A national initiative is needed to accelerate the development of critical UAS technologies in the US. The nation will benefit from this initiative and the technological advances will support key national imperatives in disaster response, national security, as well as weather and climate. Strong national advocacy and support are needed to maintain the nation's competitive edge and reap the societal and economic benefits.

Unmanned aircraft systems will radically improve the ability to address three critical applications: disaster response, national security and climate change. Fledgling efforts in each of these applications have produced exciting results. Unmanned systems are highly flexible in their observing strategy, including going rapidly when and where needed without elaborate preparations. Their promise has barely begun to be realized.

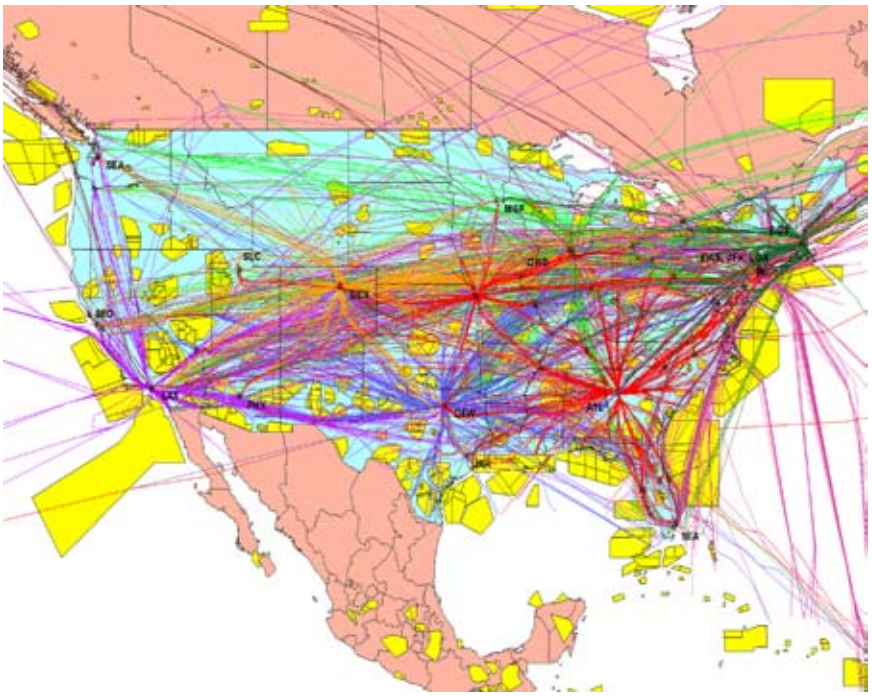
The initial efforts in civilian applications overwhelmingly illustrate the benefit of making further development of unmanned aircraft technology a national priority.

Major technological challenges must be addressed to safely and routinely operate UAS in the national airspace. These challenges cut across agencies and include reliable communication for controlling an aircraft and the ability to detect and avoid obstacles, including other aircraft, in the air and on the ground. New technologies are required to safely manage the increasingly crowded airspace. Many of these technologies are likely to come from investments in UAS. The technology to facilitate safe and routine access to the national airspace comparable to manned aviation does not yet exist and requires accelerated investment in research and development.

The US has the unique opportunity at this time to leverage the expertise and technologies developed by the Department of Defense over the past decade to utilize UAS for critical, non-military applications. Operations in Asia and the Middle East have provided experience using manned and unmanned aircraft together in high stress environments. A narrow window of opportunity exists for leveraging the expertise of the returning veterans from these campaigns while transitioning the technology to domestic applications in support of national needs.

Unmanned aircraft have been used extensively in Iraq and Afghanistan with great success. Returning military personnel have developed invaluable skills at operating UAS safely. Transitioning this technology to civilian applications will take advantage of our skilled veterans and allow the US to move forward with the highest safety.

The US national airspace is the busiest and most complicated airspace in the world, with private, commercial and public aircraft of various capabilities sharing the same facilities. The FAA is responsible for the safety of the airspace and has designated specific airspace for certain users. UAS will need to be able to share limited airspace safely with existing users before they can be integrated into all of the airspace.



National Security

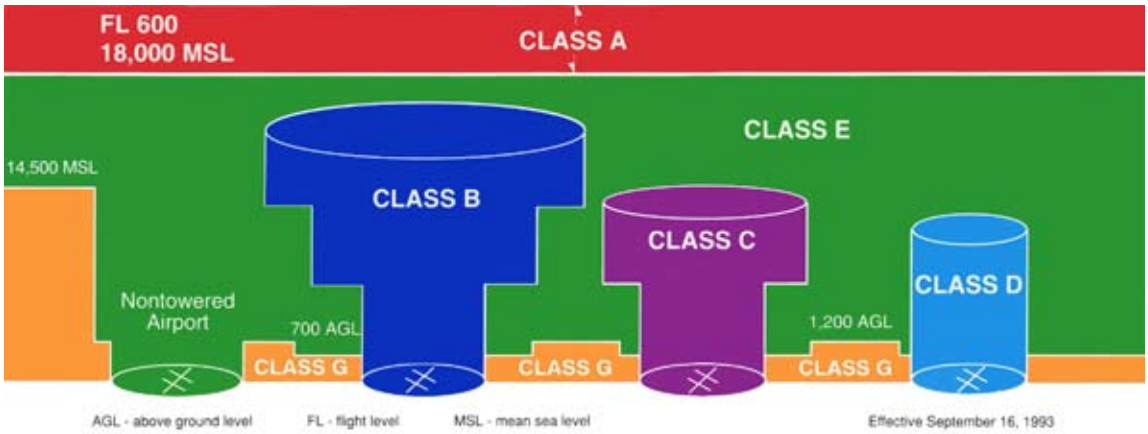
UAS are becoming increasingly important in protecting the homeland, helping Customs and Border Protection streamline routine and event-driven operations along the country's borders. These systems have contributed to the apprehension of more than 3,400 undocumented aliens crossing the US - Mexican Border.

Using unmanned aircraft in our complex airspace will require advanced engineering solutions and thorough testing. Investing in these solutions is investing in American competitiveness.
Steve Hottman

The Department of Homeland Security's UAS program is an integral part of their border protection plan. Due to this success, DHS has significantly increased its investment in UAS.

The development of engineering solutions for unmanned aircraft systems will result in technologies that will make the national airspace safer for all aircraft.
Doug Marshall

FAA evaluates unmanned aircraft systems based on a variety of scenarios. Engineering solutions need to be developed, tested and proven to ensure the safety of our national airspace.



Climate Change

Unmanned aircraft systems can fill an important gap not covered by existing systems. The observations would revolutionize the monitoring and scientific understanding of weather and climate. UAS have successfully penetrated a hurricane, and provided real time observations of dangerous winds. These observations could be used operationally in storm forecasting and storm track prediction. UAS can also help measure carbon emissions, providing necessary information for carbon trading.

This cover shows a montage of three unmanned aircraft flying in synchronized formation. These aircraft were able to fly above, through and below clouds to determine how much heating and cooling were produced by different cloud types. Such work would be too dangerous and too imprecise with manned aircraft.

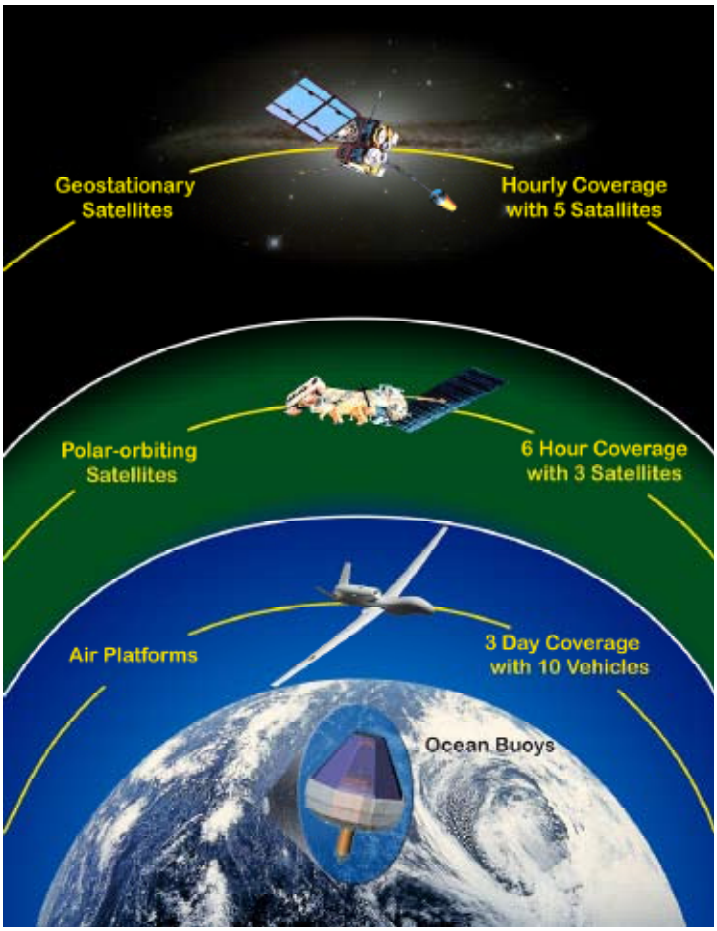
Unmanned aircraft are revolutionizing the way we can do science. Answers to questions on air pollution and climate change that we couldn't address before are now within our grasp.

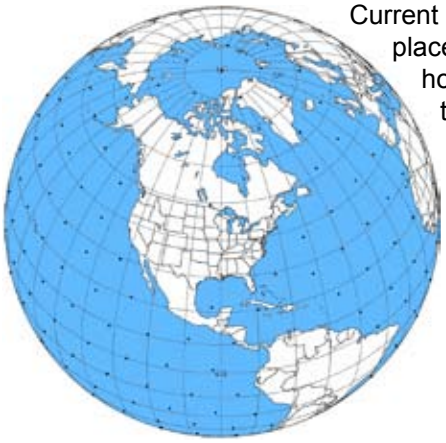
V. Ramanathan

In climate research, we've pushed manned aircraft and satellites to the max, yet huge gaps remain; to fill those gaps, we need UAS.

Warren Wiscombe

Monitoring the Earth requires a variety of approaches from satellites and aircraft to buoys and surface measurements. Aircraft information is currently limited because of the cost and risk to pilots. UAS could supply the missing information that would add value to, and fill gaps in, the existing measurement systems.





Current monitoring of the atmosphere takes place on all continents around the world; however, measurements are lacking over the oceans. To improve predictions of both weather and climate, unmanned aircraft can safely supply routine measurements.

Many ecosystems, including seal populations, are in danger as the Arctic sea ice disappears off of Alaska.

Unmanned aircraft can allow for monitoring of the dependent ecosystems in remote areas without risk to human lives.

Why **Unmanned** Aircraft Systems?

Unmanned aircraft can fly much longer missions - and into more dangerous situations (fires, hurricanes, volcanoes) - than manned aircraft.

Current monitoring of ecosystems, such as these scientists looking for alligator eggs in this Florida Everglades photograph, is often dangerous. Scientists and pilots have lost their lives trying to do research that could be more safely carried out with unmanned aircraft.

As the current leader in UAS technologies, the US is in a key position to implement these technologies for civilian use and must move forward now. If this country does not seize this opportunity, other countries will take the lead. To move forward efficiently, a focused organization comprised of government, academia and industry is needed to achieve these objectives. These groups convened for the first time in October 2007 at the Symposium for Civilian Applications of Unmanned Aircraft Systems (CAUAS) to survey UAS capabilities, discuss applications, identify key opportunities and obstacles, and strategize a way forward for the next decade.

To support the next steps, the community calls for a national initiative to accelerate the development of critical UAS technologies. These technologies will allow the user community to serve society by completing tasks not feasible using other platforms and will be applicable to multiple agencies. Realizing the full potential of UAS technologies requires substantial investment. Given the beneficial capability of UAS in addressing national needs, the time to undertake this investment is now. The timeliness and value of UAS technology and its civilian applications are detailed in the full report.

CAUAS Steering Committee Executives

Brian M. Argrow is Associate Dean for Education, Look Professor of Aerospace Engineering Sciences at the University of Colorado, cofounder and Director of the Research and Engineering Center for Unmanned Vehicles, and a member of the US Air Force Scientific Advisory Board. He conducts research on the design and deployment of small UAS.

Betsy Weatherhead is a senior research scientist at the University of Colorado at Boulder. She serves on a number of advisory boards for WMO, DOE and NSF and her research has been featured in *Nature*, *Scientific American* and *Discover Magazine*. She is a world-recognized expert in detecting trends and designing systems to monitor Earth's change and is a lead author on two major assessments of climate change in the Arctic.

Susan Avery is a Professor and Fellow of CIRES. A past president of the American Meteorological Society, she has served on numerous advisory boards and professional committees. She is author on over 80 journal articles and has received numerous awards for her contributions to science and engineering. Previously Vice Chancellor for Research, Dean of the Graduate School and Provost at the University of Colorado at Boulder, she has recently accepted the post of President and Director of the Woods Hole Oceanographic Institution in Massachusetts.

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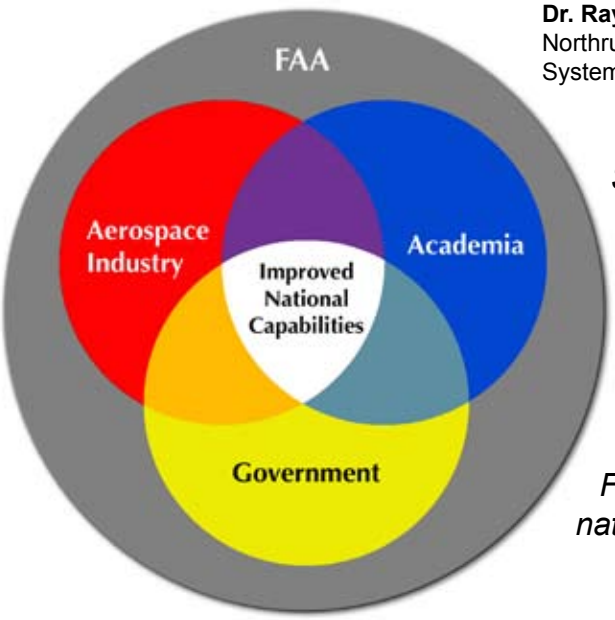

Successful implementation of unmanned aircraft systems will greatly increase our national capabilities in the areas of disaster response, national security and climate change. Active collaboration between industry, government and academia is necessary to preserve the United States' current technological advantage and reap the societal benefits that unmanned aircraft can offer. All development will take place in cooperation with the Federal Aviation Agency as the regulatory agency for our national air space system.

http://cauas.colorado.edu