The Revolution Is Here

The Integrated Weather Observation System Compared to Traditional Weather Stations

An Intellisense Systems Guide

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Introduction

To achieve its mission of air combat superiority, the United States Air Force relies on an array of environmental-sensing instruments to capture accurate weather data in the world's most remote areas. This data ensures the safety and success of military operations in isolated, denied, or otherwise inaccessible regions where mission planners need to make critical decisions. These tools need to not only transmit essential environmental parameters like visibility, wind speed/direction, and cloud layers, but also report this key data autonomously with a solar-powered system and satellite communications.

Tech. Sgt. Richard Kienzle reviews a read out from the automatic remote weather station employed by the USAF over the last 30 years. (Photo Credit: Staff Sgt. Christopher Boitz)

Unfortunately, those capabilities are not typically present in traditional weather stations. For the last 30 years, the Air Force has deployed numerous weather-sensing systems to fulfill this need. Their primary solution, which was designed for autonomous weather observations at remote airfields, consisted of up to 80 separate pieces and weighed approximately 100 lb. Another solution attempted to consolidate this functionality into only four pieces of equipment, but the program was terminated in 2010 without a permanent replacement.[1]

That same year, the Department of Defense (DoD) issued a request for proposal to develop a portable weather station that could supply vital weather data in a hand-held solution for rapid response and greater ease-of-use. Through the DoD's Small Business Innovation Research (SBIR) initiative, Intellisense Systems, Inc. was awarded multi-phase contracts to develop the Micro Weather Station (MWS®), which is now deployed for both military and commercial operations all over the world.

But the engineers at Intellisense Systems were not content with just improved portability. They sought to design a mobile weather station that was competitive with larger, permanent environmental-monitoring systems in terms of range, resolution, and accuracy. With that goal in mind, they developed the **Integrated Weather Observation System (IWOS)**, pictured right, to meet the requirements put forth by the Air Force and consolidate many weather-observation systems into one unit. This revolutionary weather-sensing product integrates over a dozen key sensors with integrated data processing, logging, and communications, enabling it to report over a dozen parameters from a single package that fits into a single case and weighs just 25 lb.

So how did they do it? **This guide examines how Intellisense Systems revolutionized the weather-monitoring system and fulfilled every one of the Air Force's needs.** It looks at the IWOS's enhancements by detailing six key improvements that sets the system apart from traditional solutions:

- System Size
- Cloud Layer Measurements
- Installation/Operation
- Visual Imagery
- Communications
- Cost

System Size

In defining a new generation of environmental-sensing systems, the Air Force's first requirement was a drastic reduction in size. Traditional weather-monitoring systems required 2-3 team members to transport, install, and disassemble the station, making fast and clandestine deployments challenging and very labor intensive.[2] Weather operators requested a much smaller solution that could be transported and installed by one person.

Intellisense achieved the compact design of the IWOS by developing new ultrasonic, RF-, and LIDAR-based environmental-sensing modules that combined the latest component technologies with intelligent data processing. This packaging helps maximize data transmission and minimize power consumption. The IWOS can integrate up to eight sensing modules into a package that is just 20 in. tall and 5 in. deep. Mission planners can easily reconfigure the stack for different mission needs with no wiring or special software configuration required. Three of these sensor modules are highlighted below:

Wind Speed/Direction

While traditional weather stations employ a cup anemometer and rotating wind vane, the wind sensor on the IWOS (pictured left) uses ultrasonic technology with high-speed processing for accurate wind sensing in areas of erratic or high-intensity weather. These sensors not only determine wind speed and direction with comparable accuracy to legacy systems in more compact packaging, but they are also more reliable; because they do not have any moving parts, they do not need to be replaced like traditional rotating anemometers. This feature enables maintenance-free operation for longer periods of time.

Visibility and Present Weather

A similar strategy was implemented for the IWOS's visibility and present weather detector module. The Air Force's current systems incorporate a traditional forward scatter sensor, which is relatively large but accurate across a wide spectrum of atmospheric obscurants like rain, fog, and snow. In general, these sensors require a laser and receiver to be positioned at opposed angles and at relatively large distance from each other, which makes the weather station more conspicuous for concealed operations. A backscatter visibility sensor would be more discreet, but it can be less accurate than a forward scatter sensor.

To address this issue, Intellisense engineers devised a new approach to visibility sensing for the IWOS with a hybrid forward and backscatter sensing module (pictured right). Thanks to this innovation, the laser and the receiver can be packaged into a smaller form factor. The compact size and relatively large sampling volume coupled with novel sampling techniques and algorithms make this module ideal for remote, dynamic, or covert operations. The new IWOS visibility and present weather detector module provides excellent performance with unprecedented size, weight, and power specifications.

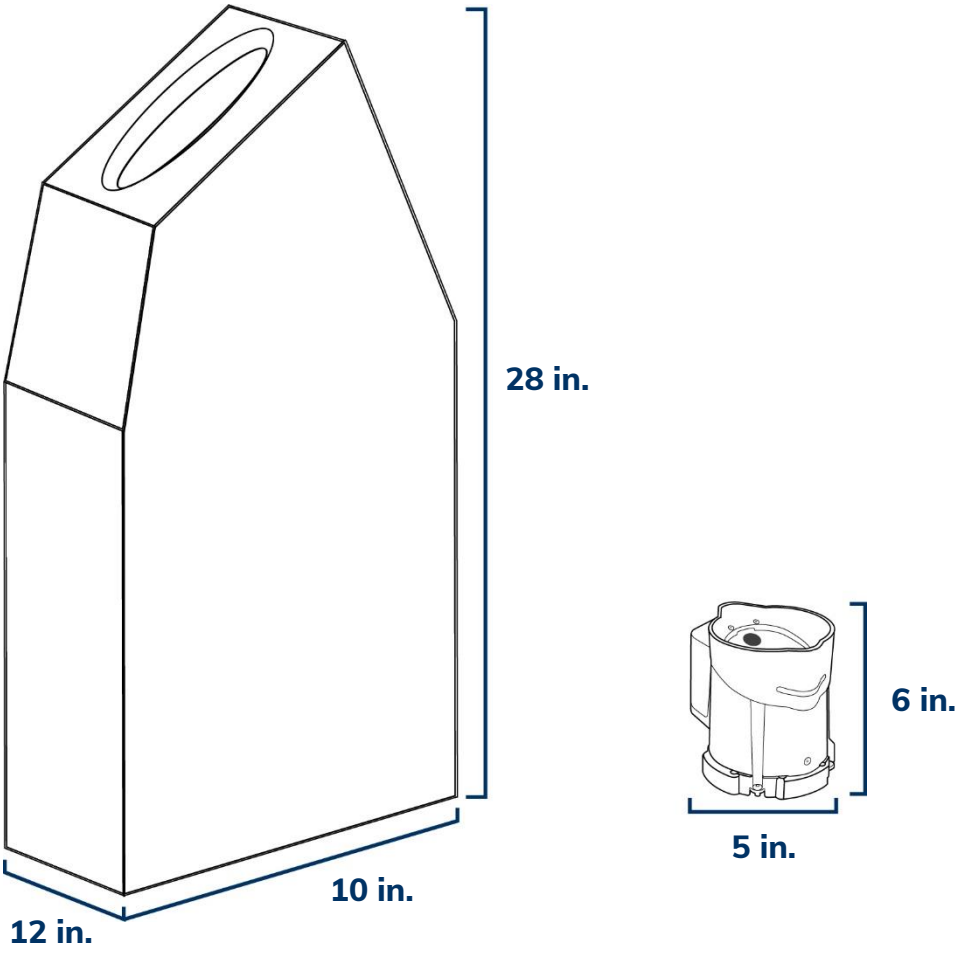
Cloud Layer Measurements

Both traditional weather stations and the IWOS use a LIDAR-based ceilometer to determine cloud layer heights up to 25,000 ft. The ceilometer emits a vertical laser that is bounced back from the cloud and into the instrument to calculate cloud base and cloud ceiling. These parameters provide mission planners with a better understanding of visibility and precipitation conditions for flight operations.

Operators typically deploy ceilometers that weigh over 30 lb and resemble a large box, making it difficult to transport and not ideal for concealed operations. For the cloud height module on the IWOS (pictured right), the engineers at Intellisense developed and integrated the world's smallest LIDAR ceilometer with intelligent obscurant detection into a 6-in. tall cylinder. The intelligent obscurant detection helps clear the optics for persistent operation and reliable cloud layer readings even in adverse weather. Operators are now able to obtain cloud bases and ceilings using a single instrument that weighs less than 2 lb and can easily fit inside a backpack.

Ceilometer Size Comparison

While each of these instruments can measure cloud layers up to 25,000 ft high, the ceilometer module on the IWOS (right) is just 6 in. tall and weighs less than 2 lb.



Installation/Operation

Consisting of nearly 80 separate pieces, the Air Force's legacy weather station requires multiple team members to transport, install, and set up in remote or denied locations.[3] It also needs dozens of wires to connect multiple weather-sensing components with a separate data processor and communications unit. This operation is slow and, depending on the perils of the area, can put the lives of mission planners in danger.

The IWOS addresses these concerns by integrating up to eight environmental-sensing modules with communications and advanced data processing so that users do not have to transport separate pieces of equipment into denied locations. The controls on the IWOS are also simplified to include just one power switch and an automated configuration process that boots up every integrated module within 60 seconds of powering the system on. And thanks to local tablet viewing or remote, cloud-based system operation, the IWOS can connect to a multitude of user-friendly devices.

Members of the 455th Expeditionary Operations Support Squadron inspect their traditional weather station at Bagram Airfield, Afghanistan. (Photo Credit: Senior Airman Justyn M. Freeman)

A single airman installs the Integrated Weather Observation System during an exercise in Fort Hood, Texas. (Photo Credit: Combat Weather Program Manager Everett Eugenio)

The siting of environmental-sensing equipment can have a tremendous impact on its accuracy and reporting to industry observation standards, which is why the Air Force's current solution includes many poles and attachments to ensure each instrument is at the proper height for data collection. While the integrated design of the IWOS provides the most compact feature set for rapid deployment, the modular architecture also enables the discrete modules to be placed at industry-standard heights for accurate data collection. In addition, the system is designed to provide full weather observations on the hour for up to 72 hours of solar-free conditions in the event that it is disconnected from AC or solar power. This capability guarantees the reliable transmission of accurate environmental data so that operators can focus on greater mission challenges.

Visual Imagery

Because the military operates in the world's most remote and inaccessible regions, the need for "eyes on the ground" imagery of the site to confirm meteorological conditions is another key requirement. Earlier weather stations employed by the Air Force were not designed to include a camera sensor, and attempts to integrate imagery required more wires and greater power consumption. Intellisense engineers have developed a 360° panoramic camera module for the IWOS that transmits four wide-angle color images over an Iridium satellite or cellular connection to greatly improve operators' situational awareness in isolated locations.

Communications

The IWOS can collect and report over a dozen environmental parameters and provide 360° panoramic imagery from anywhere on the planet thanks to the Iridium satellite constellation. The use of this constellation has greatly reduced costs associated with prior weather-sensing solutions.[3] In addition, the antenna on the IWOS's communications module (right) is ruggedized in a hard-plastic casing, making it more resilient to environmental hazards. The IWOS can also be equipped with cellular, wired, or radio communications to accommodate any application. Onboard data logging is standard and can also be automatically off-loaded to cloud- or network-based storage.

Cost

The IWOS greatly reduces the lifecycle cost burden of a traditional weather station by leveraging smaller, purpose-built components and a more efficient deployment strategy, reducing clutter and minimizing the risk of equipment damage. A standard, preconfigured stack can be deployed in a single case, which not only minimizes the amount of assembly time in the field, but also reduces the logistical burden and potential loss of equipment. Automated built-in testing and a simplified calibration process also lessens labor cost and time needed for specialty training. Finally, the modularity enables the easy integration of new sensing capabilities, including the attachment of third-party sensors through auxiliary ports. This capability future-proofs the system and provides a more cost-effective, longer term solution than legacy weather stations.

Conclusions

The IWOS represents a new generation of integrated and automated weather stations to meet the needs of the U.S. military, as well as commercial markets. For mobile and clandestine operations, the smaller size and simplified operation significantly reduces the amount of time required to install and operate in the field, greatly improving mission safety and success. The rugged design lends itself to tactical operations in austere environments or, alternatively, permanent operations at remote airfields. The greater power efficiency and communication options also makes the IWOS far more versatile and cost-effective than traditional weather stations, and the modular, stackable packaging enables countless configurations and expandability for the world's most demanding applications.

The IWOS is the revolutionary new weather sensing system capable of reporting over a dozen parameters with integrated data processing and communications in a lightweight, rugged, and customizable package.

To learn more about this latest innovation in weather sensing technology, please contact Intellisense Systems by phone at 310-320-1827 or by email at Info@intellisenseinc.com.

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Phone: 310-320-1827
Email: Info@intellisenseinc.com
www.intellisenseinc.com

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