by Pat French

SENSORY PERCEPTION

Remote wireless sensor technology

The new generation of self-contained weather sensor systems improves the collection and transmission of remote weather data

Collection and transmission of local environmental data can play a major role in time-sensitive tactical aviation and Medevac operations. Volatile, rapidly changing weather systems at the site can create potentially dangerous conditions for these flight teams. Frequently, satellite images cannot provide forecasters and mission commanders with the reliable weather information they need to authorize a rescue attempt or conduct operations.

Accurate, local, and real-time weather information is vitally important in order to determine the level of risk for flight operations in remote areas. In many parts of the world, however, weather measurements are not collected at all or they are stored locally for future analysis. Historically, the cost and logistical challenges of installing weather monitoring stations in remote areas have been prohibitive. But, recent and continuing technological advances are breaking down this barrier, enabling wider tracking of environmental conditions around the world.

The scenario described above is one example of the value of a new generation of remote weather sensor technology. Reduced weight, simplified set-up procedures, two way communication capability, and self-contained power sources now allow sensors to be deployed in minutes on nearly any terrain in remote areas by a single person. This creates new value for decision makers in a variety of security, emergency, and meteorological settings.

The sensors were developed by Colorado-based company, Advanced Distributed Sensor Systems (ADSS), through a small business innovation research (SBIR) grant awarded by the Department of Defense (DoD). ADSS's Satellite SensorPod Network is a self-contained environmental monitoring system that collects and communicates this vital information from remote areas. The components are wireless and solar powered, so the system can be

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deployed almost anywhere regardless of local infrastructure.

The network includes miniature, specialized sensor pods that measure a variety of meteorological data, including wind speed, wind direction, barometric pressure, temperature, ambient light, rainfall, visibility, and cloud-ceiling height. The data can be collected in the field on any PC with a line-of-sight radio or transmitted through the Iridium Satellite Network to a distant command center. Communication is two-way so commands can be sent back to the sensors. Each component's batteries provide 30 days of service and a solar option can extend its life indefinitely. The weight of a multipod system is less than 50 lb and configuration is automatic. The units sense and orient to the other pods, when powered up, and when pods are added.

This technology was developed with national security and remote warzones in mind. But these systems can meet important domestic and scientific needs as well.

Plume monitoring and emergencies

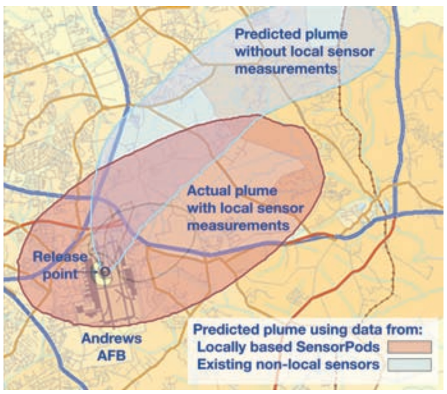
Dispersion of atmospheric plumes is directly related to weather conditions (such as wind speed and direction, temperature, and turbulence) and geographic features (including topography, hydrology, land use, and other factors). Effective response to a chemical, biological, radiation, or nuclear (CBRN) incident requires accurate plume predictions based on local weather measurements that augment regional weather-data sources.

Given the acquisition and deployment costs of portable weather stations, atmospheric plume modeling systems typically pull in data from meteorological stations far from the incident site that may not reflect the airflow and dispersion near the release. The SensorPod Network addresses this concern in that it is relatively inexpensive and can easily be placed in multiple locations near an area of interest.

The value of real time, localized weather data in a CBRN situation was demonstrated in a 2006 test underwritten by a grant from the Defense Threat Reduction Agency. ADSS's weather sensors were deployed around a military base facility for several months to determine the ideal number, placement, and types of sensors needed to monitor atmospheric plumes. After establishing the best regional configuration, a release was simulated and the data was analyzed. Compared to existing techniques, feeding local weather information into the model yielded drastically different results which, in an actual incident, would have provided better guidance to emergency responders. The accompanying illustration demonstrates the enhanced plume modeling accuracy when multiple onsite weather sensors are used.

The portable and rapidly deployable nature of the network provides additional advantages. As a plume spreads, sensor networks can be deployed and re-deployed quickly, giving emergency responders the up-to-date, accurate information they need. An airborne release might be in or near an urban area, but power sources and

Below: Diagram showing actual toxic plume cloud versus predicted plume cloud from Andrew's AFB using sensors



The VOS system includes 4,000 commercial ships which collate data within standard meteorological parameters

communications channels could prove unreliable in these scenarios, so the self-contained nature of the sensor network would be essential.

Chemical sensors can be 'trained' to detect a large number of toxic industrial compounds (TICs) or volatile organic compounds (VOCs), even in the presence of common background interference from diesel fumes, exhaust fumes, and common cleaners. Therefore, a sensor pod network can be deployed permanently in high-risk areas such as the fence-lines of chemical and other plants to help comply with monitoring requirements and provide early warning to emergency responders.

Oceanic monitoring

There is a desperate need for improved ocean-surface weather data collection to enhance weather forecasting and modeling, monitor severe meteorological events, and contribute to global climate change research. The National Oceanic and Atmospheric Administration (NOAA) relies in part on two National Weather Service programs the Voluntary Observing Ship (VOS) Project and the National Data Buoy Center (NDBC) data collection system.

The VOS system includes crews from approximately 4,000 commercial ships worldwide (roughly 800 from the USA) who voluntarily collect standard meteorological parameters while at sea. Unfortunately, the VOS program faces significant challenges. The number of participating vessels has been steadily declining. Weather measurements are normally collected by the crew through personal observation and then encoded and transmitted, leaving room for human error. And there are many data-scarce regions, especially in the southern hemisphere, since VOS data collection is focused on the primary shipping lanes.

The new weather sensor network technology can fill the need for a reliable, low-cost weather monitoring system widely deployed on VOS and research vessels, commercial ships, NDBC sites, day markers, channel markers, and at fixed coastal locations. These systems would include standard weather measurement pods as well as sensors for atmospheric constituents and water quality measurements.

Because of the challenges faced in monitoring oceanographic weather, ADSS was awarded an NOAA grant to test the SensorPod Network on ocean-going ships and demonstrate the feasibility of adoption within the VOS program. Before being deployed at sea, accelerated lifecycle tests were performed on the network components in a condensed salt water atmosphere to ensure they were durable and well-sealed. Then several ships were fitted with both the ADSS technology and the current 'gold standard' sensors for comparison. Over a three month period, the systems collected data for further review.

Lightweight sensor networks can be deployed easily to collect data from forest fires and fire-prone areas

ADSS has created an accurate atmospheric dispersion modeling technique using its Plume Modeling Toolkit and SensorPod

Utilizing batteries and solar power, combined with wireless radios, the ADSS system proved easy to install and required no modification to the ships' infrastructures. Minimal maintenance and interaction was required of the crew. In the end, the pilot program demonstrated the system's ability to report automated measurements in a hostile marine environment with the desired accuracy.

Forest fire prediction

The new generation of sensors can track humidity levels, temperature, sunlight, wind direction and velocity, and even lightning strikes, which are all indicators of forest fire risk. Fires themselves create weather patterns, and localized tracking is the most reliable way to detect these rapidly evolving conditions in real time.

The US Forest Service has stated that an improved understanding of 'core fire science', including 'fire weather', is a priority research area. It also acknowledged that current fire behavior models, 'do not accurately reflect, fire and atmosphere interactions'.

As remote weather tracking technology evolves, the new lightweight, inexpensive, and easily-deployed sensor networks can fill the need for enhanced data collection near forest fires and in fire-prone areas. Based on better data and improved modeling, land managers will be able to make better-informed decisions on fire and fuel management on remote, vulnerable tracts of land.

Real-time, detailed meteorological data from remote locations or urban hotspots is easier and less expensive to collect than ever before. The new generation of self-contained weather sensor technology has been successfully tested and deployed in a variety of conditions from remote warzones to the high seas. Initially developed for the DoD, these sensor networks will continue to revolutionize weather modeling, enhancing our ability to protect the civilian population, and the environment. ∎

Pat French is the chief scientist at Advanced Distributed Sensor Systems Inc. He was assisted by Brian Leugs of Business Communication Support LLC