

PROJECT SUMMARY

Our ability to monitor, anticipate, and respond to changing circumstances and events is increasingly important, particularly with regard to our physical surroundings. Nowhere is this capability more vital to society, or the challenges associated with its practical implementation greater, than in the context of the atmosphere, where hazardous local weather, such as thunderstorms, tornadoes, microbursts, snow storms, and floods – as well as lofted radiological, chemical and biological agents – can, in a matter of minutes or hours, destroy or contaminate life and property over vast areas. Yet, the portion of the atmosphere that contains the bulk of both natural and man-made hazards – the lower troposphere and particularly the atmospheric boundary layer – is grossly undersampled by today's sensing technologies.

Our ERC proposes a revolutionary new paradigm in which transforming systems of distributed, collaborative, and adaptive sensing (DCAS) networks are deployed to overcome fundamental limitations of current approaches. Here, *distributed* refers to the use of large numbers of appropriately spaced sensors capable of high spatial and temporal resolution throughout the entire troposphere. These systems will operate *collaboratively* within a dynamic information technology infrastructure, *adapting* to changing conditions in a manner that meets competing end-user needs. These systems will achieve breakthrough improvements in sensitivity and resolution leading to significant reductions in tornado false-alarms, vastly improved precipitation estimates for flood prediction, fine-scale wind field imaging and thermodynamic state estimation for use in airborne hazard dispersion prediction and other applications.

Successful implementation of DCAS systems will require fundamental breakthroughs consistent with the *NSF Technical Merit Review Criteria*. Among these breakthroughs will be integration and sharing of knowledge across disciplines; design and fabrication of low-cost, multi-beam, solid-state radars; creation of a systems-based architecture to organize sensing, computing, and communications resources; development of two-way end-user interfaces that dynamically target system resources; deployment of integrative test beds to validate assumptions and understand emergent system behavior; implementation of cross-linked hierarchical data storage and processing; and improved understanding of small-scale atmospheric processes.

To achieve these breakthroughs, we have assembled leading engineering and computer science experts from the University of Massachusetts, Amherst. They will work in partnership with scientists and engineers from the University of Oklahoma, Colorado State University and the University of Puerto Rico, Mayaguez, and corporate partners including Raytheon, IBM, Vaisala, and federal and state government agencies to create the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA). We will create scalable prototype test beds to demonstrate the potential for DCAS to revolutionize our understanding, detection, and prediction of hazardous atmospheric phenomena—with end users involved from the outset.

CASA meets the NSF Broader Impacts Review Criteria through: comprehensive education and outreach programs that introduce systems-based engineering to K-12 students via the mandated engineering/technology curriculum in Massachusetts, and serves as the mechanism for expanding participation by under-represented groups in engineering and scientific endeavors at all levels. Further, it will engage first-responders and other end users through the provision of both technology and training. CASA will address the observation, prediction and response of weather, an issue that affects between 10 percent and 30 percent of the U.S. gross national product.

Our management structure has the flexibility to take advantage of our broad partnership. For example, CASA will collaborate with industry partners, who, in turn, will create new product lines and services based on our new paradigm for sensing, analyzing, predicting and responding to atmospheric hazards in the troposphere.