Integrated Remote and In-Situ Sensing (IRISS): Overview of Capabilities and Opportunities for Collaboration

Gijs de Boer, Brian Argrow, Eric Frew, Steve Borenstein, Laura Clayton, Michael Rhodes

University of Colorado Boulder

CIRES

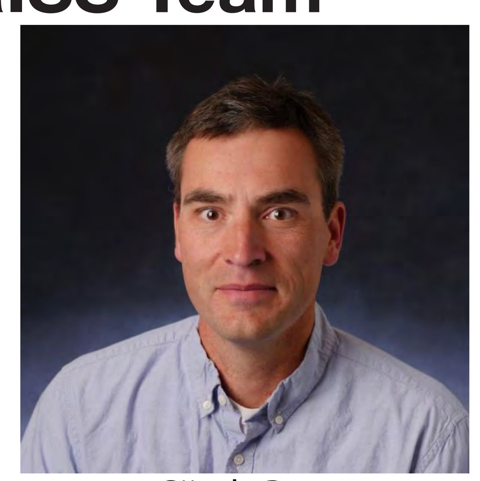
IRISS INTEGRATED REMOTE & IN SITU SENSING

Introduction

Nearly six years ago, a vision for a program leveraging aerospace systems to enhance data collection and support development of expanded visibility of the four-dimensionality of the ground-to-space column was born with the proposal of the Integrated Remote and In-Situ Sensing (IRISS) initiative. This initiative, part of the University of Colorado's Our Space, Our Future grand challenge, has accelerated and improved CU's ability to observe the Earth System and support communal understanding of our planet. Through IRISS, new observing systems have been developed and tested, diverse field campaigns have been supported, campus-wide science-engineering partnerships have developed, and students have been trained to support modern and innovative Earth System observing. To connect to a broad variety of scientific efforts and projects, IRISS supports development and deployment of various platforms and sensing systems, with a primary emphasis on uncrewed aircraft systems (UAS). Here, we provide an overview of IRISS capabilities, and offer examples of previous Earth science campaigns supported with systems developed and deployed by IRISS. Recent examples of such campaigns include ATOMIC, MOSAiC, Wisco-DISCO and TORUS. Additionally, we will highlight previous work with NOAA laboratories to develop task-specific systems and provide perspectives on opportunities for collaboration with the broader CIRES community.

Meet the Core IRISS Team


Brian Argrow
(IRISS Director)


Gijs de Boer
(Assoc. Director of Science)


Eric Frew
(Assoc. Director of Technology)

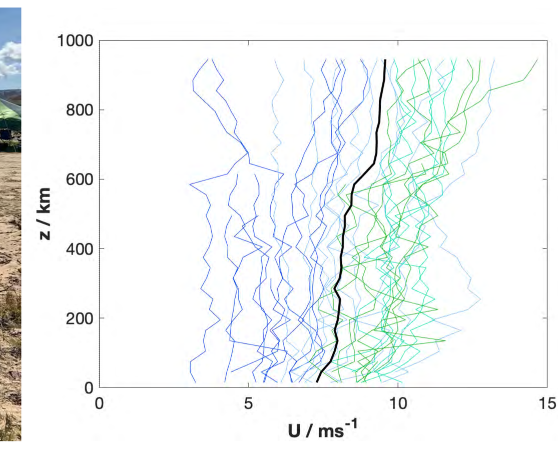

Steve Borenstein
(Chief Engineer)

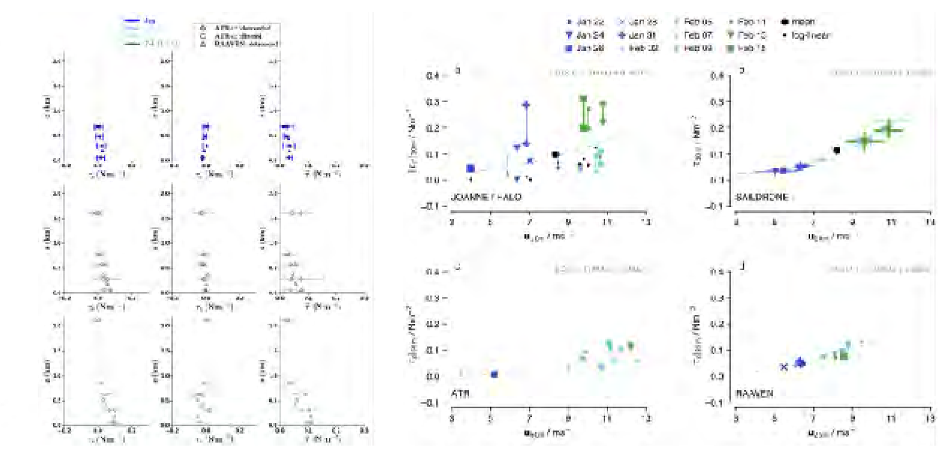

Laura Clayton
(Program Manager)


Michael Rhodes
(Laboratory Manager)

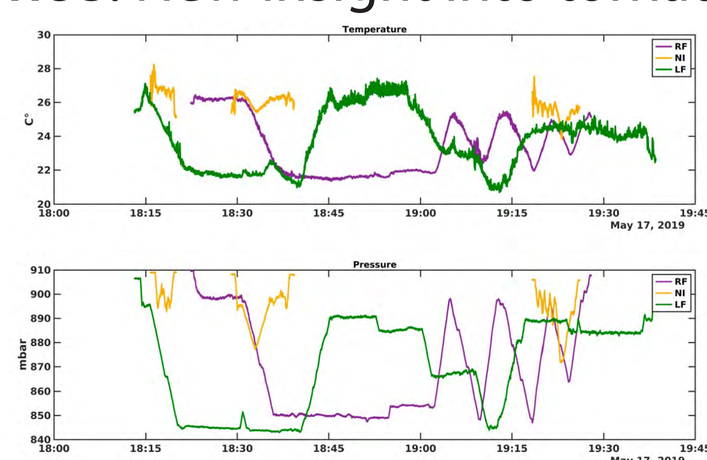
Examples of Recent Field Campaigns

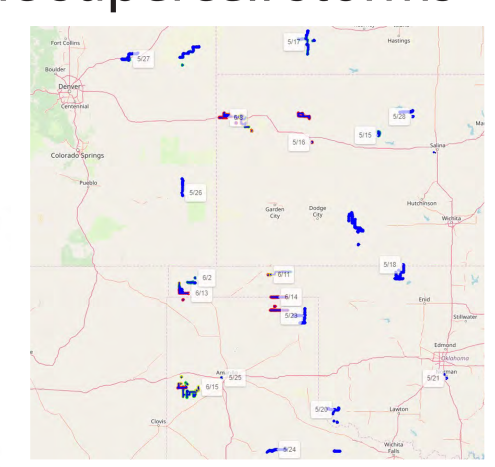
ATOMIC: Unlocking the secrets of tropical cumulus clouds



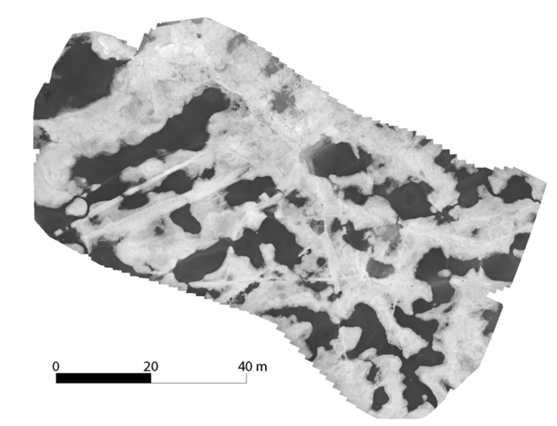


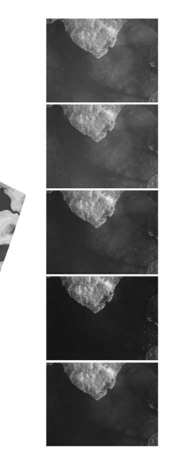
TORUS: New insight into tornadic supercell storms

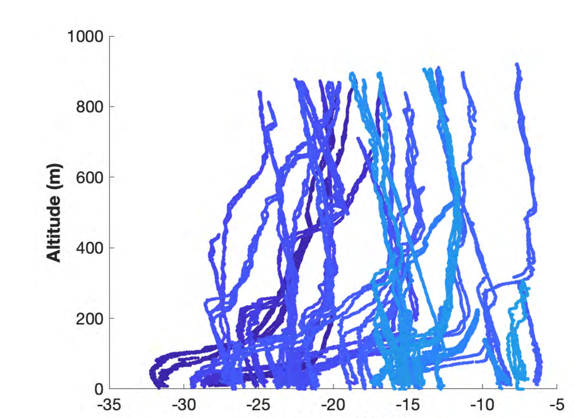




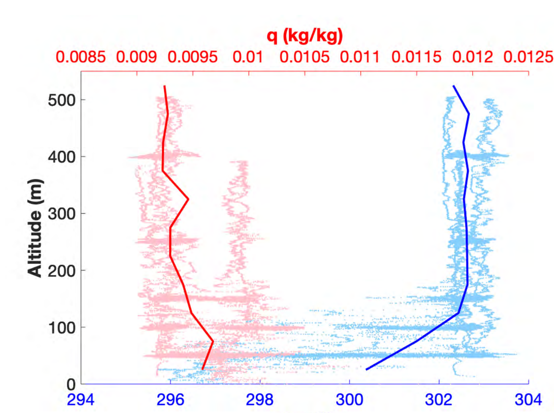
MOSAiC: Understanding spatial variability in the high Arctic

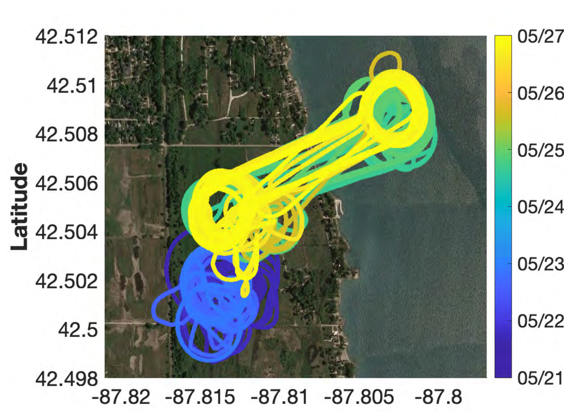


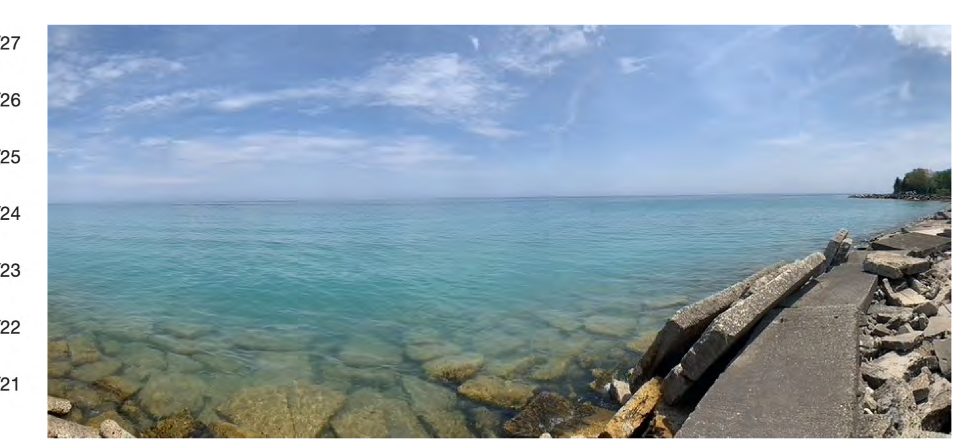




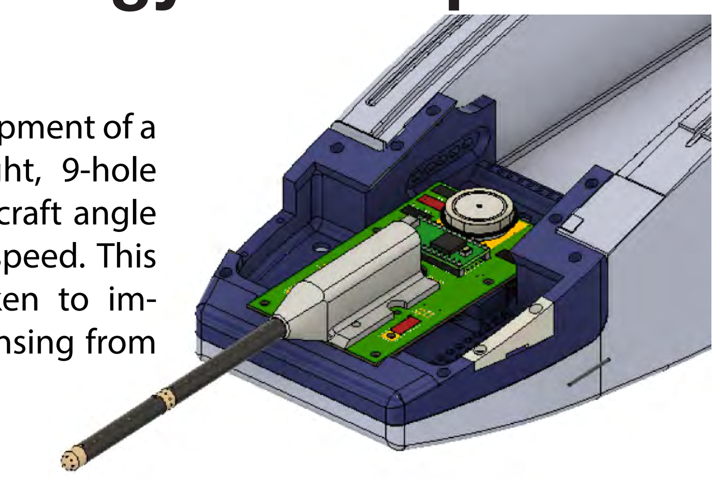
Wisco-DISCO: Observing coastal circulations and their impacts



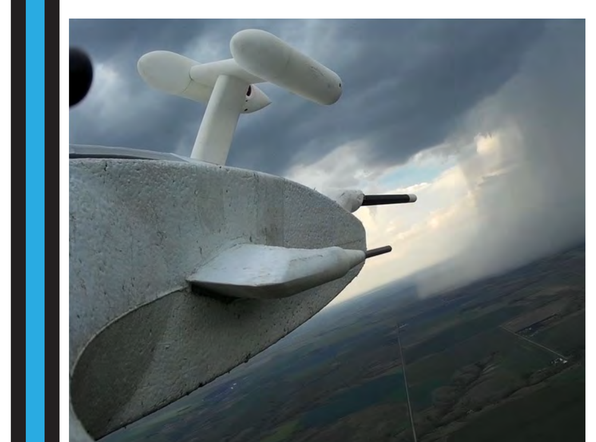




Recent Technology Development

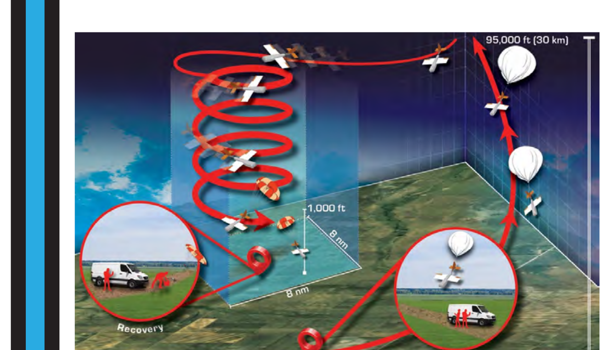


Sensor Advancement: Development of a new, low-cost and light-weight, 9-hole pressure probe to measure aircraft angle of attack, sideslip angle and airspeed. This effort was primarily undertaken to improve wind and turbulence sensing from the RAAVEN aircraft.



Sensor Suite Integration: Through a project supported by the UAE Rain Enhancement Program, IRISS integrated a suite of sensors, including a DMT Cloud Droplet Probe and NOAA/Handix POPS instrument, into a larger version of the RAAVEN to better understand aerosol-cloud interactions and cloud and precipitation modification. Additionally, IRISS has worked with NOAA to develop and advance the miniFlux sensor suite, which can be integrated on to a variety of UAS platforms to provide consistent observations across platforms.

Pushing Boundaries: Environmental science related deployment of UAS requires that aircraft are hardened to withstand a variety of conditions. This includes operation in extreme temperatures, various modes of clouds and precipitation, at extreme altitudes (both low and high) and through in corrosive environments. IRISS has worked with scientists to advance systems to ensure reliable performance of aircraft and sensors in a range of operating environments.

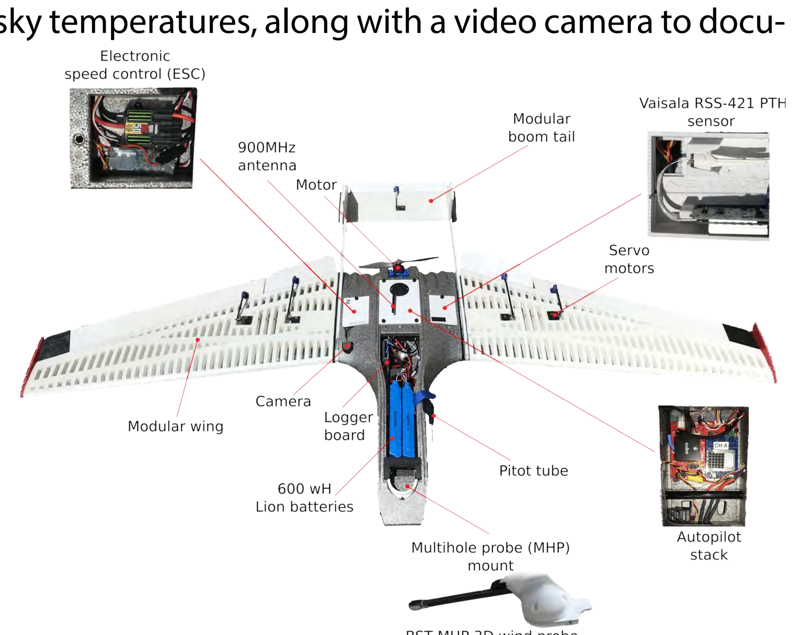


Autonomous and Coordinated Flight Capabilities: IRISS is working to advance aircraft control and coordination systems to support different sampling modes, including high-altitude sampling as done with the NOAA GML HORUS platform. This includes enhancing onboard decision making to allow aircraft to autonomously optimize sampling of features of interest, and to support "swarming", or coordinated flight of a fleet of aircraft.

Primary Observing Systems and Infrastructure

RAAVEN

The RAAVEN is IRISS"s primary fixed-wing UAS platform. Propelled by an electric motor, this aircraft can stay airborne for over two hours at a time, resulting in the ability to capture extended datasets of phenomena of interest. Stretching approximately 2 meters from wing-to-wing, the aircraft's base configuration includes instrumentation to measure winds, thermodynamic structure, turbulence and surface/sky temperatures, along with a video camera to document conditions.



HELiX

Originally developed for MOSAiC, the HELiX platform is designed to conduct low-altitude flights over a variety of surfaces to document surface and lower atmospheric conditions. The platform is equipped with stablized up- and downward looking pyranometers to measure incoming and reflected broadband shortwave irradiance, allowing it to map out surface albedo. It is additionally equipped with a downward-looking multispectral camera to document and classify surface types that it overflies. It has additionally been instrumented to measure pressure, temperature and moisture, allowing to serve as a virtual tower. The HELiX takes off and lands vertically, allowing for operations from tight spaces (e.g. research vessels). It is currently deployed for the NOAA SPLASH campaign to track changes in Colorado snowpack.

Ground Vehicles

IRISS operations are conducted by operators on the ground surface. These operations are conducted from mobile command centers. This includes the Mobile Unmanned Research Collaboratory (MURC), a modified Sprinter van with a 50 foot met mast, onboard servers, a multi-display command/control center, and lots of space for aircraft maintenance and preparation. It also includes multiple "Tracker" vehicles -- modified SUVs that are set up to serve as a surface control center. These vehicles are often used for "follow-me" flight operations, where a team of operators fly the aircraft from a moving vehicle to support flights over extended distances. These platforms also have pneumatic launchers integrated on the roof of the vehicles, allowing for rapid deployment of platforms when required.

Additional Information

Please check out IRISS online: **https://www.colorado.edu/iriss/**

We want to foster new collaborations with CIRES scientists! To discuss potential opportunities for scientific collaboration, please contact Gijs de Boer (gijs.deboer@colorado.edu)

Acknowledgments

Funding for IRISS and recent and future field campaigns has come from a variety of sources, including:

NOAA · NSF · Department of Energy · Air Force Office of Scientific Research · University of Colorado Boulder · DARPA · UAE Research Program for Rain Enhancement Science · KAIST