UW King Air Strategic Plan

2022 - 2027

Introduction

The University of Wyoming King Air (UWKA) together with associated instruments including the Wyoming Cloud Radar (WCR) and Lidars (WCL) is one of the three aircraft facilities supported by NSF-AGS as *Lower Atmospheric Observing Facilities* (LAOF) through the *Facilities for Atmospheric Research and Education* (FARE) *Program* (https://beta.nsf.gov/funding/opportunities/facilities-atmospheric-research-and-education-fare). The other two are NSF-owned aircraft managed by the National Center for Atmospheric Research (NCAR): the Gulfstream V (GV) and the C-130. Two recent NSF-sponsored workshop reports (Smith et al. 2013 and Geerts et al. 2018) emphasize the need for continued, long-term availability of the LAOF fleet to the NSF-funded community. Several recent national reports have mentioned *the importance of novel airborne measurements in the study of the climate system, the water cycle, extreme weather, and air quality*. For instance, the 2018 National Academies report on 2017-2027 decadal strategies (NASEM 2018) calls for "a comprehensive observing strategy for the spatial distribution [of aerosol and trace gases] within the boundary layer and lower free troposphere … using a combination of space-based observations, and expansion of aircraft and ground-based observations" (p. 329). The 2021 NASA PBL Incubation Study (Teixeira et al. 2021) calls for more manned and unmanned airborne measurements of the PBL with in situ and remote sensors, in order to better predict weather and air quality, and to advance climate models.

The UWKA has its own well-defined niche in the LAOF fleet (see Appendix A), and has operated in this framework through FARE, and its predecessor, the LAOF Program, since 1987 (Avallone and Baeuerle 2017), funded through a series of Cooperative Agreements (CA). This Strategic Plan builds on the current agreement, CA8 (Sept '2019 – Aug '2024), and is written as a 5 year plan (2022-2027) to extend into the period that will be proposed for CA9. The current aircraft (tail number N2UW), a twin turbo-prop model 200T, will be retired in 2022. In 2020, the University of Wyoming (UW) purchased a new aircraft, a slightly larger, more capable King Air 350i (serial number FL-862), hereafter referred to as UWKA-2. This aircraft will serve as the next-generation UWKA (UWKA-2). The aircraft currently is being modified/certified into a research facility through an NSF Mid-Scale Research Infrastructure 1 (MSRI-1) implementation award entitled *The Next Generation Wyoming King Air Atmospheric Research Aircraft* (Oct '2019 – Sept '2024). The UWKA-2 is targeted to become available for NSF-funded deployments at the end of 2023/beginning of 2024 and will become the aircraft supported through the remainder of CA8 and that proposed for CA9.

This Strategic Plan builds on objectives both within CA8 and the MSRI Awards.

Mission and Strategic Objectives

The mission of the UWKA as a national facility, together with its in situ instruments and the Wyoming Cloud Radar (WCR) and Wyoming Cloud Lidar (WCL), is summarized as follows:

> *Provide the NSF-funded community with a world-class mission-ready airborne atmospheric research facility that enables new discoveries*

As a LAOF in the FARE Program, the UWKA/WCR/WCL facility supports science and outreach supported through NSF-AGS Physical and Dynamic Meteorology, Atmospheric Chemistry, and other related units. This includes measurements related to aerosol/clouds/radiation/precipitation, air quality/chemistry, boundary layers/turbulence and interdisciplinary and/or cross-cutting applications. In order to ensure that we meet our mission, we focus our efforts on achieving five specific objectives outlined below:

1. Provide an airborne platform that fills the well-defined 'niche' of the UWKA within the LAOF fleet (see Appendix A) and remains nimble and flexible enough to continue to accelerate atmospheric research for decades to come.
2. Advance a suite of in situ and remote airborne instruments that enable new perspectives and discoveries.
3. Ensure superb user support and the collection of high-quality scientific data sets.
4. Become the premier facility for educating and training airborne-measurement-focused atmospheric scientists.
5. Ensure the facility's accessibility to the scientific community, its relevance to cutting-edge atmospheric science, and positive visibility to the public.

The following sections describe each of the specific objectives listed above and strategies that the facility will employ to meet those goals. The goals and strategies were developed and informed by our current Cooperative Agreement and MSRI Award. In addition to serving as a roadmap to meeting our award goals, the timing of this Strategic Plan also serves to guide the facility in the development of its next CA proposal in 2024.

Specific Objective #1: Provide an airborne platform that fills the well-defined 'niche' of the UWKA within the LAOF fleet and remains nimble and flexible enough to continue to accelerate atmospheric research for decades to come.

A short summary of the UWKA's role within the LAOF fleet is provided in Appendix A. The UWKA and its replacement, the UWKA-2, seek to remain within this niche that is defined by a mid-sized, agile platform with slower flight speeds. The platform must be configurable and capable of an array of atmospheric science missions while remaining relatively low cost and therefore suitable for supporting single-PI and smaller projects and educational initiatives.

Strategy 1.a: Design and develop UWKA-2 with infrastructure and modifications suitable for supporting a range of instrumentation while maintaining the flight and operational characteristics of the UWKA.

Strategy 1.b: Complete the development and certification of UWKA-2, bringing the new aircraft online by Quarter 1 of 2024

Strategy 1.c: Provide a 'mission-ready' aircraft with the complete complement of measurement capabilities of the current aircraft

Strategy 1.d: Ensure that the UWKA-2 remains requestable and deployable through the Track 1 and Track 3 FIRP solicitation.

Strategy 1.e: Ensure adequate infrastructure and proper human capital to support all aspects of aircraft maintenance and operations

Strategy 1.f: Recruit and retain a high-quality team, composed of engineers, technicians, pilots, and maintenance personnel capable of supporting aircraft operations and field deployments.

Strategy 1.g: Maintain a culture of safety at all times

Specific Objective #2: Advance a suite of in situ and remote airborne instruments that enable new perspectives and discoveries.

The UWKA/WCR/WCL facility provides a suite of state-of-the-art airborne scientific instrumentation that may be requested by the NSF-funded user community. Facility personnel are responsible for ensuring proper calibration, installation, and operation on the UWKA and other NSF aircraft. The facility is continually exploring opportunities for the acquisition and/or development of new instruments and measurement capabilities to meet evolving scientific needs.

Strategy 2.a: Maintain an array of reliable, high-quality, well-characterized in situ and remote sensing instruments

Strategy 2.b: Engage UW Atmospheric Science faculty in all aspects of the facility, including research, instrument development and data products

Strategy 2.c: Evaluate existing and promising capabilities to ensure that measurements are available to address relevant scientific questions

Strategy 2.d: Continue to develop and advance radar capabilities of the facility for cloud and precipitation research

Strategy 2.e: Define the role of lidar remote sensing and future development in the facility and determine the resources required

Strategy 2.f: Grow the aerosol and trace gas measurement capabilities of the facility

Specific Objective #3: Ensure superb user support and the collection of high-quality scientific data sets.

The long-term success of the UWKA/WCR/WCL facility is rooted in its continued ability to provide outstanding support to its users from project inception, through deployment and operations, to the high-quality data that are produced and delivered. Support begins by working closely with potential users during proposal and facility request preparation and pre-project planning. It continues during the project execution while the aircraft is deployed to ensure the best possible methodologies to acquire the needed data. This support extends well after the data are delivered to ensure their usability and relevance.

Strategy 3.a: Recruit and retain a diverse team of high-quality scientists, engineers, and software developers

Strategy 3.b: Grow relationships with instrument developers, organizations that support advanced atmospheric observations, private industry, and data scientists

Strategy 3.c: Maintain an effective IT infrastructure

Strategy 3.d: Implement data processing, archival, perusal, visualization, and distribution that is responsive to community needs

Strategy 3.e: Ensure accessibility and transparency through documentation, open-source software, interface drawings, etc.

Strategy 3.f: Continue to provide un-paralleled support to users for integration of non-facility instruments and ensure their interoperability with facility equipment

Specific Objective #4: Become the premier facility for educating and training airborne-measurement-focused atmospheric scientists.

The UWKA is the only LAOF located at a university. Having the facility housed within an organization whose primary mission is to educate provides exceptional opportunities for education and training. The relatively small size of the UWKA presents challenges, but also results in a more cost-effective and personalized platform for teaching and training.

Strategy 4.a: Leverage the unique relationship between the facility and the University of Wyoming to enhance educational opportunities

Strategy 4.b: Ensure engagement of DAS faculty in the facility, and foster the inclusion of airborne atmospheric measurements in curricula

Strategy 4.c: Provide outstanding hands-on and interactive training opportunities for students and early-career professionals

Strategy 4.d: Identify and develop opportunities for engagement with undergraduate and graduate students with institutions nationwide

Strategy 4.e: Encourage participation in the facility by diverse communities through outreach to minority serving institutions

Strategy 3.f: Develop opportunities for remote real-time participation in airborne research

Specific Objective #5: Ensure the facility's accessibility to the scientific community, its relevance to cutting-edge atmospheric science, and positive visibility to the public

Understanding of the facility resources and limitations, and of the facility request and proposal process, requires regular communication with prospective investigators and educators. Working with and educating existing and potential users will provide opportunities to grow our user base and reduce barriers to the scientific community.

Strategy 5.a: Participate in and facilitate community workshops to showcase the platform and instruments, to share insights about the proposal process and designing airborne experiments, and to learn about measurement priorities

Strategy 5.b: Continue to collaborate with and seek feedback from an external advisory panel

Strategy 5.c: Maintain a high level of visibility for the facility through presentations at national and international conferences and public engagement

Strategy 5.d: Continue to improve the public facing aspects of the facility (e.g., webpage, documentation)

Strategy 5.e: Value and encourage scientific and professional development of facility personnel

Strategy 5.f: Value, encourage, and support proposals for facility usage and/or new instrument development

Strategy 5.g: Leverage facility research to impact change for societal and environmental challenges

References

Avallone, L.M. and B. Baeuerle, 2017: A 20-Year History of NSF-Supported Atmospheric Science Field Campaigns: Statistics and Demographics. *Bull. Amer. Meteor. Soc.*, **98**, 1333–1339, https://doi.org/10.1175/BAMS-D-15-00222.1

Geerts, B., and Co-authors, 2018: Recommendations for in situ and remote sensing capabilities in atmospheric convection and turbulence. *Bull. Amer. Meteor. Soc.*, **99**, 2463-2470. https://doi.org/10.1175/BAMS-D-17-0310.1

National Academies of Sciences, Engineering, and Medicine (NASEM) 2018: *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24938

Smith, R. B., 2013: *The Lower Atmospheric Observing Facilities Workshop: Meeting the Challenges of Climate System Science*. Final Report. UCAR/NCAR Earth Observing Laboratory. Available at https://www.eol.ucar.edu/system/files/LAOF_Workshop_Report_FINAL_06112013.pdf

Teixeira, J., and Co-authors, 2021: Toward a Global Planetary Boundary Layer Observing System: The NASA PBL Incubation Study Team Report. NASA PBL Incubation Study Team. 134 pp.

Appendix A: The Wyoming King Air in the LAOF fleet

The three aircraft in the LAOF fleet have unique and complementary capabilities. The UWKA occupies a well-defined niche in this triad, enabling research that would be otherwise difficult or impractical with either the NCAR C-130 or GV. Three key features of the operation of the UWKA that distinguish it from the other two LAOF aircraft are:

(a) Relatively low cost resulting in more scientific opportunities. Of the three platforms, the UWKA is several times less expensive per flight hour and deployment because of lower operational costs associated with aircraft size coupled with a smaller number of support crew necessary for project support. For this reason, the UWKA facility is well-suited for smaller projects, projects with highly focused objectives, and educational initiatives. Despite what may *appear to be* less capability, because of a smaller range and payload capacity, the UWKA enables science that may otherwise be difficult to justify and support financially.

(b) Agility in flight. Because of its smaller size and slower flight speeds, the UWKA is well-suited for missions that require maneuverability, such as repeated sampling of cumulus clouds or emission sources, or flight near terrain or in the boundary layer; and sampling strategies that require tight patterns, such as in-cloud spirals or investigations of phenomena that are transient and/or highly spatially dependent.

(c) Flexible flight planning and rapid adjustments in flight. Flight planning can be more flexible with the UWKA since it often operates lower in the troposphere and away from flight routes. The weight category of the UWKA also allows it to be operated single pilot, allowing the PI (mission scientist) to occupy the right side (co-pilot) cockpit seat. This provides an environment that enables direct (face to face) interaction between the pilot and the scientist, while at the same time the PI has access to both meteorological information (current and recent in situ measurements, time-height transects of radar reflectivity, etc.) and information that the pilot uses for real-time decision-making and air traffic control (ATC) requests. Phenomenological atmospheric research (focusing on a specific atmospheric phenomenon, such as a wildfire or a convergence zone) almost always requires real-time in-flight adjustment to flight plans. With the scientist sitting next to the pilot in the cockpit and two additional scientists (and/or students) in the seat(s) right behind the cockpit seats, there is often a lively conversation about real-time weather and interpretation of measurements from scientific instruments. Such interaction amongst the entire crew allows for evolving missions and changing flight patterns that can readily adapt to the phenomena being studied.

There is one other important distinction: while the two other aircraft are operated by a national research center (NCAR), the UWKA is operated by a university, offering a graduate program in Atmospheric Science. This makes the UWKA a platform of choice *for the training of the next generation of airborne atmospheric scientists.* While the vast majority of graduate students in weather and climate research use numerical models as their primary tool, there is a need for graduate students to use and understand advanced observational atmospheric technology, which often is less readily accessible. There continues to be great value in "hands-on" experience with the facility and instruments in the field, in training future atmospheric scientists in using and interpreting data from highly complex instrumentation (Hallett et al. 1990). This explains the existence of an Education and Outreach channel (Track 1) within the NSF Facility and Instrumentation Request Process (FIRP). Any of the three LAOF aircraft can be requested for a Track 1 proposal, but the UWKA should be the primary platform, given its lower operational cost. The UWKA is the only aircraft that can be requested for a purely educational campaign (i.e., not piggybacking on a research field campaign).

Finally, the UWKA serves as a unique asset for UW Atmospheric Science faculty to advance their research portfolio. *The relationship between UW faculty and the UWKA (as a national facility) has been and remains strong, and is essential for the facility's sustainability and growth as leader in airborne atmospheric research*.

None of these essential distinctions will change in the transition to UWKA-2, i.e., *the new aircraft will occupy the same niche in the LAOF fleet, and will retain the a strong focus on faculty involvement and student training*.