Supporting the Present and Future of Observational Science

EOL Strategic Plan 2020

Vision

An end-to-end observational science enterprise.

Mission

To develop and deploy observing facilities and provide expertise and data services needed to advance scientific understanding of the Earth System.

Context

The ability to make observations of the atmosphere, Earth System, and Sun is fundamental to achieving the science goals of NSF, NCAR, and our scientific community. When established, NCAR was charged with providing observing facilities and services for the community of atmospheric scientists that are too large and expensive to be operated by a single university or a small group of universities and are thus best managed and operated centrally. This part of the NCAR charge now rests primarily with NCAR's Earth Observing Laboratory (EOL).

EOL manages the majority of NSF's Lower Atmosphere Observing Facilities (LAOF) and deploys them in support of observational field campaigns for researchers from universities, government agencies, and NCAR and also in support of education. We serve as the hub for the university research community and NCAR in the areas of technology of atmospheric measurements and observations, data services, and best practices in field campaign organization and conduct.

Goals of the EOL Strategic Plan 2020

This Strategic Plan presents direction for the Earth Observing Laboratory (EOL) over the next five years by outlining the Laboratory's programmatic priorities in response to the observational needs of our user community and our planned contributions to solving the challenges of the atmospheric and Earth System sciences. The plan presented in this document is described in terms of *Imperatives* and *Frontiers*.

Imperatives represent actions that EOL must do and continue to perform well in order to fulfill its mission as an NCAR laboratory and a provider of observations to our scientific community. Within each of the Imperatives, we have identified Frontiers as areas of emerging opportunities and new directions for evolution of our observational systems and services. The Frontiers reflect the alignment of science priorities with technological potential and opportunities and our anticipation of a substantial benefit from EOL's support of these areas to be incurred by a broader scientific community.

The EOL Strategic Plan 2020 is consistent with the broader plans and strategies for NCAR and NSF as presented in the corresponding Strategic Plans covering this same time period.

EOL Imperatives

Imperative 1: Deployment
Manage and Deploy Lower Atmosphere Observing Facilities

The Earth Observing Laboratory (EOL) plays a central and essential role in managing and deploying Lower Atmosphere Observing Facilities (LAOF). EOL-managed LAOF represent a collection of state-of-the-art observational research facilities and platforms that have been acquired through large investments by NSF and NCAR. The LAOF support the observing needs of a wide range of research programs at a level that serves the demands of the NSF-supported university community and NCAR researchers. Managing LAOF and making these observational assets available to the scientific community through field campaign deployments represent the fundamental part of EOL's mission. This Imperative encompasses a broad range of activities organized into the following priority areas: 1) LAOF management, 2) LAOF deployment in NSF-funded observational field campaigns, 3) management of the LAOF request and assessment process, and 4) cooperation with other organizations and agencies in support of observational science.

1) Manage LAOF

Maintaining our LAOF in the deployment-ready state calls for a rigorous observational asset management, including scheduled and unscheduled maintenance, pre- and post-campaign calibration, development of software, and detailed documentation of operating parameters and measurement characteristics of each instrument and platform that is necessary for successful scientific use of such cutting-edge instrumentation. This also necessitates regular upgrades, refinements, and improvements to the hardware, software, operating procedures, and documentation. Through maintaining excellence in prudent and efficient management of LAOF, we strive to ensure that the EOL-managed LAOF continue to meet the needs and expectations of the NSF-supported scientific community.

2) Deploy LAOF in NSF-funded Observational Field Campaigns

EOL deploys its facilities and instruments worldwide in a range of deployment modes that are custom designed to meet research needs of the NSF-funded investigators. EOL teams use their extensive expertise in all aspects of field deployments, from logistical to technical, to provide in-field services and facilitate remote operations and participation. Both prior to and after deployments, EOL offers a number of services to its facility users, including assisting in developing observing strategies, guidance in selecting instrumentation, providing technical expertise to certify and install user-provided equipment on the LAOF we manage, and delivering data that has been quality-controlled by instrument experts. Our objective is to maintain the existing high operational and safety standards of our LAOF deployments while striving to address unique logistical and technical needs of each of the programs we support.

3) Manage the LAOF Request and Assessment Process

EOL manages all aspects of the LAOF request and facility request assessment process on behalf of NSF. This entails expert evaluation of facility requests and experimental designs of the proposed field campaigns with the aim of optimizing support of NSF-sponsored observational science and assuring that the scientific objectives of each campaign can be successfully accomplished. Aiding us in this effort is the Observing Facilities Assessment Panel (OFAP), an independent advisory body to EOL and the other NSF LAOF partner organizations, which is convened by EOL twice per year in spring and fall. Maintaining the transparency and existing high standards of the request and assessment process is essential for ensuring equal access to LAOF by all NSF-funded researchers and ensuring that allocations made by NSF result in safe and successful field deployments in which deployment facilities are well matched to the requestor needs.

4) Cooperate with Others on Support of Observational Science

EOL routinely enables and conducts multi-facility and multi-agency deployments that include instruments, resources, and collaborators from other U.S. agencies and other U.S. and foreign institutions. We also deploy EOL-managed LAOF occasionally in support of campaigns that are funded solely by other agencies. EOL fosters collaborations with outside groups in many areas, including some of the key measurements, instrument support, shared calibration and test equipment, studies related to the quality of measurements, expertise in meeting regulatory requirements, and software development. By maintaining current and developing new collaborations and cooperation, our objective is to enhance the overall scientific productivity and realization of research goals by a broad geosciences research community.

Imperative 2: Development
Support and Promote the Innovation Cycle

New science drivers and technological advances call for continued development of our facilities and services. As a nimble and flexible organization, EOL dynamically adjusts and evolves its observing capabilities and services to meet the evolving science needs. This evolution occurs both over short- and longer-term time scales and is informed through the Laboratory's processes for anticipating new needs and directions. Activities under this Imperative are categorized into the following priority areas: 1) agile development to meet current deployment needs, 2) advancement of priority developments to meet future needs, and 3) life-cycle-management and anticipation of new needs.

1) Sustain Agile Development to Meet Current Needs

Unique needs of individual field deployments drive targeted short-term developments of both measurement capabilities and data services within our existing suite of facilities and services. The ability to address unique measurement and support needs of individual field campaigns within a relatively short time frame, from their proposal to the execution stage, requires a development process agility that is made possible in EOL by close collaboration of teams of scientists, engineers, and software developers. Being a fundamental mode of development for the EOL Field Catalog and the key to our ability to integrate user-provided instrumentation into the LAOF suite, it is of vital importance for EOL to sustain this capability.

2) Advance Priority Developments to Meet Future Needs

As dictated by technological advancements and science needs of the communities we support, EOL also engages in longer-term developments of new cutting-edge observational systems. The current priority developments have emerged from a careful consideration of science drivers and critical needs of the communities we support, EOL's core skill areas and strengths, and the uniqueness of new systems designed to meet future needs. We will actively seek resources and strategic partnerships to advance the state of the following priority developments:

- ***Airborne Phased Array Radar (APAR)*** *– a new generation airborne Doppler radar to replace the pioneering ELDORA tail radar is envisioned as a dual-Doppler, dual-polarization, C-band radar with four flat-plate phased-array antennas mounted on the fuselage of the NSF/NCAR C-130 aircraft. APAR fills a critical need for an advanced airborne radar to enable new scientific discoveries on cloud dynamics and precipitation processes and their role in hazardous weather phenomena, such as hurricanes and winter storms, as well as cloud-related climate system processes in polar regions and other hard-to-reach locations over the vast expanses of world oceans.*

- ***Laser Air Motion Sensor (LAMS) –*** *a groundbreaking development that is designed to provide very accurate air motion measurements directly from aircraft and enable precise calibration of in-situ temperature and pressure measurements by aircraft indirectly. Extending the implementation of LAMS from the NSF/NCAR Gulfstream V (GV) to the NSF/NCAR C-130, we plan to bring to successful fruition our ability to measure both the mean and fluctuating air velocity* *components with unprecedented accuracy and enable more accurate measurements of vertical fluxes of momentum and scalars and other integral quantities.*

- ***Water Vapor Differential Absorption Lidar (WV DIAL) –*** *a novel development that fills a major observational gap for accurate, high-resolution, continuous water vapor measurements in the lower troposphere. Conceived through partnership with Montana State University (MSU), this development aims at providing a small network of autonomous instruments, which would produce data on the concentration and spatial distribution of water vapor in the lower troposphere; this has been identified as a critical need for the improving both the physical understanding and numerical weather prediction of convection initiation.*

- ***Modular Wind Profiler –*** *a new generation EOL wind profiler operating at 449 MHz and utilizing an innovative modular antenna design that allows an easy reconfiguration and multiple-panel setups. High-resolution, both in space and time, accurate wind measurements represent the backbone of any boundary-layer study. We will continue this development toward the goal of assembling a sufficient number of antenna elements to be able to configure them into a small research network of boundary-layer wind profilers or into a single powerful full-tropospheric profiler.*

- ***Surface Flux System (CentNet)*** *– a new generation modular surface flux measurement system designed to provide observations at an optimal spatial density and over a wide range of spatial scales needed to understand processes at the atmosphere-land interface. We will continue to pursue this development in conjunction with our other ground-based network systems to enable research of complex processes near the Earth's surface that affect climate, air quality, atmospheric composition, surface hydrology, and ecological processes.*

3) Develop Life-Cycle-Management Plans and Anticipate New Needs

In a dynamic organization such as EOL, active life-cycle management is a critically important element of the innovation cycle. A dynamic life-cycle management entails processes at many different time scales and engages many stakeholders, from our own staff to other parts of NCAR, to the National Science Foundation and different science communities we support. In large part it is those internal-to-EOL life-cycle plans that drive us toward new and emerging technologies and prompt development and transition to new systems. The input from the science communities we serve is an equally important driver. To that end, we will continue to seek community input via general and targeted LAOF workshops, field-campaign-specific data workshops, and through a number of advisory committees serving the Laboratory, including the EOL External Advisory Committee. As important as it is for EOL to identify new technologies and needed developments, we also must also discern when our systems and software approach the end of their life cycle. Consequently, the continuous development and update of end-of-life plans and effective communication of those plans to all stakeholders is vitally important for the support and health of the innovation cycle in the Laboratory.

Imperative 3: Data
Provide Comprehensive Data Services and Long-Term Data Stewardship

Data has been and will continue to be the ultimate product from field campaigns EOL supports. As such, the data we provide must be of high quality and well managed and preserved. Furthermore, in view of the President's 2013 Open Data Executive Order for public access to data and NSF's increasing emphasis on multi-disciplinary science, EOL must ensure that its current and historical data is well documented, discoverable, and feed seamlessly into scientific analysis workflows. Imperative 3 describes our activities to meet these challenges, which are divided into three key areas: 1) acquisition, quality control, and data management; 2) standardization of data formats and distribution; and 3) data citation and metrics.

1) Sustain Efficient Acquisition, Quality Control, and Data Management
Data acquisition and processing technologies are changing at a rapid pace. In order to ensure sustained efficiency of our processes, we will continue to exploit advances in the software and hardware domains and incorporate a subset of those into our data acquisition and management processes. As the high quality of research data has been one of hallmarks of EOL, we will continue with our established practices of stringent quality control of field data and continue to place emphasis on assurance processes and algorithms. EOL will also continue its efforts in ensuring that our data holdings from field campaigns are well documented, readily available, and easily accessible. This also includes continued efforts to recover legacy data sets and to integrate those into EOL's data archives to facilitate "data re-use" and to expand data discovery. Given that the usefulness of data in the long-term is in large part determined by the quality of metadata, improving such quality following international standards is one of our top priorities in this area.

2) Standardize Data Formats and Distribution
In order to minimize efforts required to generate research quality data products, whenever possible, EOL will use and promote the use of standard data formats, such as netCDF, to enable streamlining of real-time and post-project data quality control, analysis, and visualization. In those instances when adhering to standardized formats might not be possible, we will adjust to the needs of individual investigators or a community of investigators yet strive to develop or implement already developed interactive format converters developed by others and apply them for ordering and downloading data. To meet the needs of real-time or near-real-time data distribution, in particular with increasing data volumes from remote sensors, we will advance the use of data subsetting for our platforms and datasets.

3) Develop Data Workflows and Citation Metrics
EOL must not only be the good steward of data collected in the field campaigns we support, but we must also maintain the algorithms and software used to process raw data into higher-level products. Our objective is to implement consistent standards and practices toward maintaining and improving our own data workflows. While the data is the ultimate product from field campaigns we support, the ultimate measure of the importance of EOL efforts are the results of scientific research enabled by the data we make available to the broad scientific community. In

order to allow simple citation and tracking of our data sets as well as the citation analysis of publications resulting from those data sets, our priority is to continue with our efforts in the implementation of Digital Object Identifiers (DOIs).

Imperative 4: Discovery
Nurture Intellectual Infrastructure for Scientific and Engineering Research

EOL scientists and engineers make new discoveries and developments that push the boundaries of observational and measurement science. Much of that is achieved through a vigorous set of internal and external collaborations and partnerships. Given a broad scope of its scientific and engineering activities, unique educational and training opportunities for the next generation of observational scientists and engineers lie in EOL. Our field campaigns provide opportunities to inform and excite the public worldwide about the importance of observational research and understanding the natural environment in which we all live. Imperative 4 is multifaceted and encompasses the following activities: 1) scientific and engineering research within EOL and in collaboration with our user community; 2) internships, new user training, and other educational efforts; and 3) outreach.

1) Foster Scientific and Engineering Research in EOL

Research by EOL scientists and engineers is closely related to the use of measurements from our current suite of observational assets and new instrumentation developments. EOL has extensive expertise in a number of observational science research areas ranging from micrometeorology and cloud and precipitation microphysics to boundary layer and mesoscale meteorology, remote sensing, and biogeochemistry. The broad existent engineering expertise in EOL is being strengthened by research elements in the area of optical engineering. The use of LAOF measurements by EOL scientists is not only important for advancing the state of observational research but also for identifying weaknesses and limitations of our instruments and platforms. Both the process-study research and the engineering research associated with technical developments serve to promote the innovation cycle in EOL and maintain our position as the provider of state-of-the-art measurements. Thus, it is vital for EOL that its scientists and engineers maintain a robust set of research efforts and a robust and dynamic set of interactions with investigators at universities and other major research organizations.

2) Promote Educational Efforts

Maintaining a vibrant user base, both for our instrumentation systems and data, is critical for EOL. We will therefore continue with concerted efforts on educating current and prospective new users on processing for requesting the Lower Atmosphere Observing Facilities (LAOF) and encourage and support new users in the facility request process. Establishing and sustaining partnerships with university faculty in both atmospheric science and engineering is of vital importance to EOL and serves multiple objectives: from bringing fresh perspectives and nurturing the future user base to broadening the applicant pools for internship programs and creating potential pipelines for future staffing. Sustaining both of our internship programs – the

Summer Undergraduate Program for Engineering Research (SUPER), which provides real-world engineering experience to undergraduate engineering students and the Technical Internship Program (TIP), which targets potential technical and support staff enrolled in local technical schools – is of high priority for EOL.

3) Support Outreach

EOL staff serve as our ambassadors and representatives in the local communities to which our deployments take us, many of which are located in remote areas of the world where few visitors are seen. EOL's objective is to sustain the culture of active engagement with local communities during our deployments by offering open houses and tours of our facilities, presenting to school groups, organizing teacher workshops, and leading discussions with civic groups. The use of cutting-edge communication platforms and tools is necessary for both interacting and engaging with broad audiences, and it is our priority to maintain a robust web and social media presence to collaborate, share, interact, and engage with audiences of all ages and from around the world and educate them about our work along with our science and engineering pursuits.

EOL Frontiers

Frontier 1: Deployment
Develop New Deployment Modes to Meet Evolving Science Needs

Frontier 1 buttresses the Deployment Imperative and focuses on areas of scientific discovery that are in need of unique observations and that come with unique observational challenges and requirements. Frontier 1 encompasses two of these scientific areas: 1) climate system science and 2) extreme and hazardous weather. Each of these comes with their attendant observational challenges that call on EOL to respond by creating new deployment modes.

1) Meet the Challenges of Climate System Science (CSS)

Atmospheric science research is increasingly dominated by the theme of change, especially as it relates to documenting and understanding the observed changes in Earth's climate and in our natural environment. Identifying underlying reasons for change calls for advancing the understanding of many of the climate system science (CSS) elements, such as hydrology, biogeoscience, and cryospheric science, as well as processes at the critical interfaces in the Earth System. The latter include the upper troposphere and lower stratosphere (UTLS), the atmosphere-land interface as well as remote regions near the poles where the seasonal and inter-annual variations have been pronounced. Exploration of CSS processes poses a challenge as it calls for new LAOF deployment paradigms and potentially new observing systems (cf. Frontier 2). For example, the seasonal nature of the exchange of many climate-relevant species has already seen deployments of NSF/NCAR aircraft with multiple campaigns at different times of year (i.e., HIAPER Pole-to-Pole Observations). It might also require surface deployments of our observing systems that are continuous over longer periods of time to quantify seasonal to inter-annual variability of different components of the climate system energy budget, such as precipitation and moisture fluxes. Furthermore, by increasing the accessibility of our field campaign data, EOL is in the position to enable more systematic exploration of historical data from past LAOF deployments to advance climate system models and the development of physical parameterizations in a range of numerical models, including the Earth System ones. We plan to address CSS deployment challenges by finding unique solutions to specific problems posed by the CSS community.

2) Meet the Challenges of Weather Hazard Research
Advancing the understanding and prediction of hazardous weather phenomena has received significant attention from the atmospheric science community due to high socio-economic impacts of hazardous weather events. Unique challenges are associated with observational documentation of extreme and hazardous events, which rarely occur repeatedly in the same location. In order to address these distinct observational challenges and decrease response time to these rare weather events based on predictions, we will aim, working in conjunction with NSF, at developing a rapid-deployment strategy. Potential elements of such a strategy are the identification of a basic suite of airborne facilities and instruments that could be deployed with minimal installation time (e.g., AVAPS, HCR), exploration of a standby mode for the NSF/NCAR GV and C-130 while not on field deployments, and enhanced remote or autonomous operation of airborne and ground-based instruments and platforms.

Frontier 2: Development
Adopt New Technologies and Techniques To Meet Future Science Needs

EOL maintains and deploys an impressive suite of observational facilities for support of the NSF observational research community. In order to be able to adapt to the evolving needs of the communities we support, EOL must remain at the forefront of measurement needs and technologies. Frontier 2 extends Imperative 2 and describes elements of our vision in meeting future science needs. This Frontier also complements Frontier 1 as elements presented here represent potential solutions to Frontier 1 challenges. Frontier 2 core areas are 1) technology frontiers and 2) measurement frontiers.

1) Expand Technology Frontiers
EOL technical and scientific staff continuously monitors technological developments and, when and where appropriate, adopts emerging and maturing technologies and applies them toward solutions to both current and new observational needs. These applications span both the improvements to the current LAOF suite – to expand the range of their operating modes and environments as described in Frontier 1 – and the development and adoption of new measurement technologies, such as unmanned aerial vehicles (UAVs).

Within the scope of this plan, we intend to investigate adopting several new technologies and technological solutions, including the following:

- ***Unmanned Aerial Vehicles (UAVs)*** *– we will partner with universities, private industry, or both to develop capabilities for coordinating, instrumenting, and integrating airborne observations from UAVs, operated by university or other providers, to provide needed measurements for CSS and other process studies and in remote and unforgiving regions.*

- ***Emerging Lidar Advances –*** *we plan to more broadly adopt advances in optical measurement technologies to benefit atmospheric measurement needs in high resolution profiling of temperature, aerosols, and trace gases.*

- ***Remote Control and Operation –*** *we will intensify our efforts at developing and adapting remote control and communication technologies to our instrumentation in order to enable deployment and operation at remote and hard-to-reach sites. In conjunction with these efforts, we will also work on hardening and adapting our systems (e.g., flux-measuring CentNet stations) to enable their use for seasonal to inter-annual terrestrial deployments in remote regions, such as Arctic sea ice and permafrost.*

2) Expand Measurement Frontiers

In order to remain the center of excellence for atmospheric measurements, EOL must expand measurement frontiers and continuously evolve our measurement capabilities to meet the support needs for research areas that are growing in importance. The following are three examples of areas in which investment of our efforts and resources would generate appreciable benefits:

- ***Integrated Suite of Ground-Based Measurements for Boundary-Layer Research –*** *an integrated suite that consists of the lower-tropospheric electromagnetic profilers for wind (UHF), water vapor, and temperature (IR, DIAL) and is deployed together with CentNet surface flux stations and other auxiliary ground-based remote sensors. This suite lies at the core of the Lower Troposphere Observing System (LOTOS) concept – a system that would allow for a more holistic three-dimensional sensing of the lower troposphere.*

- ***Integrated Suite of Airborne Measurements for Research on Clouds and Weather Hazards –*** *an integrated suite of airborne instrumentation on the NSF/NCAR C-130 that is complementary to and works in conjunction with the Airborne Phased Array Radar to enable advanced research on weather hazards (e.g., hurricanes), mixed-phase clouds in polar regions, intense moist convection over oceans, and aerosols and their direct and indirect effects.*

- ***High-Precision Airborne Measurements of Trace Gases and Aerosols –*** *a suite of coordinated measurements of a number of gas phase and aerosol species, including the primary greenhouse gases, related isotopes and tracers, and of organic and black carbon aerosols, in order to determine their sources and fate. Advancing the state of these measurements is best achieved in collaboration with the NCAR Atmospheric Chemistry Observation and Modeling (ACOM) Laboratory and the community through the Atmospheric Chemistry Center for Observational and Research Data (ACCORD) initiative.*

- ***Measurements to Advance Water Cycle Research*** ***–*** *needed at many different temporal and spatial scales, at high and low altitudes, reaching into the ground, and across all three water phases (gas, liquid, and solid) in order to advance understanding of certain types of extreme weather and climate events, such as floods and droughts.*

Frontier 3: Data
Improve Data Quality and Develop New Data Tools

The landscape of observational data continues to evolve, and our response to that challenge is contained in Frontier 3. This Frontier extends Data Imperative and focuses on 1) improving data quality through measurement characterization and instrument calibration and 2) creating new data tools and software to increase scientific productivity.

1) Improve Measurement Characterization and Data Quality
The value of scientific data is intrinsically dependent on measurement characterization and calibration. The expertise of EOL scientists, engineers, and technical staff is critically important for production of high-quality data sets via characterization of measurements from the instruments and systems we manage and operate. Consequently, EOL plans to continue evaluation of existing data algorithms and development of new algorithms as well as the systematic development of formal uncertainty analysis for the full suite of EOL instruments and attendant guidelines for publishing measurement uncertainty. The systematic use of calibration facilities is an important facet of measurement characterization, and EOL's plan is to expand our calibration facilities as resources allow and to broaden their use to as many EOL instruments and sensors as possible.

2) Develop New Data Tools to Increase Scientific Productivity
In conjunction with the development of new observing systems, EOL has recognized the need to develop a new generation of software and data tools. EOL has also recognized the need to adopt open source paradigm and open source frameworks in the development of this new generation of tools. Through our engagement with the NSF EarthCube effort, we expect to make contributions to shaping up the future of geoscience data management and data tools. One of those potential new developments is the Lidar Radar Open Software Environment (LROSE) that builds on 25 years of NCAR radar data analysis software and tools, which have served as the golden standard for the weather radar research community. Envisioned as an open software framework that makes use of common exchange data formats, LROSE is to be built through strong collaborations and partnerships with agencies, universities, and end users. EOL also plans to continue development and provision of web-based tools for real-time situational awareness and decision making in the field to support integration with modeling during field projects, for enabling data assimilation into the models, and for making targeted observations as driven by model predictions.

Frontier 4: Discovery
Expand Research Directions to Enable Future of Observational Research

The scientific and engineering research in EOL is foundational in furthering our expertise in new research areas that strengthen our ability to respond to the community needs. The activities in Frontier 4 ensure that EOL scientific advances and engineering developments will continue to be at the forefront of our field and that the research community we support will remain robust and vital for decades to come.

1) Strengthen the Links between Measurements and Modeling

Enhanced synergy between measurements and modeling has led to transformative changes and acceleration of research on physical process studies over the past decade. In order to meet the current and future needs of a broad spectrum of NSF-supported researchers, EOL must understand a wide-ranging set of requirements demanded by such research and formulate changes to our instrumentation design and our deployment and support modes. For example, a growing demand for acquiring measurements at higher spatial and temporal resolutions to verify high-resolution models drives the design of instruments and networks of instruments. Likewise, the presence of modeling groups providing predictions via their high-resolution research models that exceed the resolution of model forecasts from operational centers has become a regular feature of field campaign operations. EOL will seek innovative ways to stimulate and promote stronger collaboration between these groups by, for example, supporting sabbaticals by EOL scientists to collaborate closely with modeling groups, bringing into the EOL fold as visitors or affiliate scientists those whose research lies at the interface of observations and modeling, and entraining new users of observational facilities from the modeling communities.

2) Meet the Challenges of Predictability and Data Assimilation Research

Determining the limits of inherent predictability and explicitly quantifying the uncertainty of the Sun-Earth system predictions for weather, climate, air quality, and space weather applications is currently one of the leading topics of basic research in atmospheric sciences. Part of that research is directed at determining the impact of initial conditions via targeted high-resolution observations and the assimilation of those into numerical models in real time or near real time. Furthermore, the recent trend in assimilating operational remote sensor observations and products sets a new standard for research quality data from EOL instruments and provides an excellent opportunity for EOL to work with the data assimilation researchers on defining standards for quality of measurements and scientific products. To meet the future needs of data assimilation research, EOL needs to devote increased attention to the characterization of observations we collect by focusing on topics such as correlation times and distances and correlations among uncertainties in the measured quantities.

EOL Team and Core Values

EOL's organizational structure features five facilities and three centralized groups. The five facilities include three research platform facilities (aircraft, remote sensing, and in situ sensing) and two service facilities that provide centralized support for design and fabrication, and data and software support. The project management, system administration and the administrative groups reside centrally and provide support for management of field campaigns and technical developments, computing infrastructure, and administrative needs of the Laboratory. Each of these organizational components has a history of significant accomplishment harkening back to when we were called the Atmospheric Technology Division (prior to 2005), and continuing up to today.

EOL core values represent the foundation and pillars of our organization. EOL maintains the core values of:

Excellence – permeating all areas of our activities – scientific, technical, and organizational – the tradition of excellence is reflected not only in our skills and procedures but also in the dedication and professionalism of our staff.

Leadership – by continually identifying emerging technologies and new ideas and, by integrating them with the established practices and services, leading in a broader adoption of technological advances by the community we serve.

Teamwork – known for our collaborative and can-do spirit, we seek and embrace ideas and contributions from within and outside of our organization, and rise to challenges and deliver on our promises by working together in project teams tightly woven by interpersonal trust.

Agility – by fostering innovation, creativity and flexibility, we adapt to change quickly while striving to preserve organizational balances and sustain a motivating and positive work environment for our staff.

Accountability – rooted in a deep understanding of our role as the provider and developer of research facilities and service for the atmospheric science community, we carry our dual role of stewardship and leadership with integrity, transparency, and the highest standards of professionalism.

These core values define our organization whose true strength lies in its people and the diversity of their expertise, skill sets, gender, age, cultural backgrounds, views, and opinions. Maintaining a diverse staff and investing our resources wisely in realizing the full potential of our staff are the key areas of investment within the scope of this Strategic Plan. Four areas of investment rise to the top:

1) Employ and Train an Appropriately Balanced Staff
Development, maintenance and operation of complex EOL research platforms and instruments requires teams of qualified staff that possess a wide spectrum of engineering and science skills and training. Our imperative is to maintain an appropriately balanced, diversified and well-trained workforce through strategic hires; also, to offer opportunities for advancement and cross training to the existing staff. Succession planning and knowledge transfer are an integral part of our strategy to successfully manage an evolving workforce and to ensure that we continue to lead by welcoming new ideas and talents while preserving necessary existing expertise.

2) Develop and Promote Careers of EOL Scientists and Engineers
Scientists and engineers in EOL have many roles. One of their key roles is to serve as information conduits between EOL and its scientific user communities, keeping the Laboratory abreast of new developments, new needs and developing technologies, in order to enable development of informed positions on priorities and scientific directions. To be effective in this role, EOL scientists and engineers need to be leaders in their respective fields and to achieve external recognition. Thus, developing the careers of its scientists and engineers is vital for the Laboratory. EOL will continue to provide opportunities and support its scientists and engineers in pursuit of excellence in their scientific and technical contributions, leadership and professional service to their respective communities.

3) Adopt and Apply Project Management Practices
Whether it is the support of field campaigns or the delivery on technical developments, working together in project teams has been a trademark of EOL. In order to achieve greater efficiencies of our operations and mitigate risks, our objective over the period of this Strategic Plan will be to foster adoption of disciplined project management, uniformly and consistently across EOL. The Laboratory will invest in formal project management training of its staff and encourage unique adaptation of formal project management practices to suite specific EOL needs. Through the formation of formal project teams and adoption of project management practices we aim to minimize ambiguities, increase effective and efficient communication and improve management of risk and budgets, and accelerate knowledge sharing across the Laboratory. The success of this objective will be measured by sustained and expanded project management practices and their systematic adoption in everyday EOL operations.

4) Establish and Foster Culture of Partnerships
EOL has a diverse technical talent whose expertise is well matched to the current facilities and services the Laboratory provides. With the rapid pace of developments in measurement, communication, and information technologies, as well as the size and complexity of new developments described in this plan, it is not feasible for EOL to plan on obtaining expertise in all areas needed to deliver on this plan. Thus, it is of paramount importance for EOL to develop and foster internal and external partnerships with other NCAR laboratories, universities, private companies as well as other national research laboratories. We will invest our resources and efforts to build a broadened collaborative and partnership network through increasing a number of affiliate scientists and longer-term visitors, post-doctoral researchers and fellows,

joint research programs, Memoranda of Agreement and Understanding, as well as formal partnerships and staff exchanges with other major research organizations.

Acronyms

ACCORD	Atmospheric Chemistry Center for Observational and Research Data
AGU	American Geophysical Union
AMS	American Meteorological Society
APAR	Airborne Phased Array Radar
AVAPS	Advanced Airborne Profiling System
CDS	Computing and Data Services
CSS	Climate System Science
DFS	Design and Fabrication Services (EOL Facility)
DOI	Digital Object Identifier
EOL	Earth Observing Laboratory
ESIP	Earth Science Information Partners
HCR	HIAPER Cloud Radar
HSRL	High Spectral Resolution Lidar
ISF	In Situ Sensing Facility (EOL Facility)
ISFS	Integrated Surface Flux System
ISS	Integrated Sounding System
LAOF	Lower Atmosphere Observing Facilities
LROSE	Lidar Radar Open Software Environment
MSU	Montana State University
NCAR	National Center for Atmospheric Research
NSF	National Science Foundation
OFAP	Observing Facilities Assessment Panel
OSSE	Observing System Simulation Experiment
PMO	Project Management Office
RAF	Research Aviation Facility (EOL Facility)
RSF	Remote Sensing Facility (EOL Facility)
SUPER	Summer Undergraduate Program for Engineering Research
TIP	Technical Internship Program
UTLS	Upper Troposphere Lower Stratosphere
UAV	Unmanned Aerial Vehicle
WMO	World Meteorological Organization
WV DIAL	Water Vapor Differential Absorption Lidar