Vision for a New Technology Development Facility in EOL: By Alan Fried

As indicated in its Strategic Plan, the Earth Observing Laboratory (EOL) will become more involved in the future with various studies that emphasize the upper troposphere and lower stratosphere (UT/LS) using platforms such as HIAPER, biocomplexity research, oceanic studies, polar programs and other fields contributing to an enhanced understanding of the earth system. As a consequence, it is important that the new Technology Development Facility (TDF) identify and foster the development of advanced technologies leading to an improved understanding in these various fields. Specifically, advanced technologies are needed to improve our understanding of: water vapor, trace chemical distributions and transformations, hydrometeor and aerosol compositions and distributions, as well as cloud formation and cloud-chemical processing, throughout the atmosphere. The new TDF will be involved in developing and employing a wide array of state-of-the-art sensing systems based on a variety of technologies to address many of these issues.

I envision the new TDF will initially be comprised of the following major areas: **Optical Sensing** (both in situ and remote); **Radio Sensing**, **In Situ Sensing** (trace and abundant gases and aerosols), **Flight Level Sensing,** and **Advances in Data Acquisition and Processing**. Since the scope of these areas spans a rather wide range of expertise, I plan to establish a strong team of sub-section heads to represent each discipline. Although I plan to provide strong leadership, cohesiveness, accountability, and overall direction, I will rely heavily on these sub-section heads to provide strong input and guidance in their respective disciplines. However, this team will be expected to operate much like the NCAR Associate Directorship team, in an open, productive, and unified manner for the greater common good of the entire facility rather than for the good of an individual discipline. As the ultimate success of the TDF directly depends upon the success of its individual components, I plan to be actively engaged in continuously assessing the cohesiveness of the group. I plan to conduct frequent open discussions in all areas of technology development. Specifically, I plan to meet with the entire group twice a month on a formal basis to discuss our coordinated strategy, apprise the entire group of new opportunities (funding and technology developments), disseminate information to and from EOL management, and assess progress in each development area. More extensive discussions on these and other areas will be carried out twice a year to further review: 1) progress, challenges, and new requirements for developments in each discipline; 2) prospects for continuation of developments and reassessment of time requirements; 3) prospects for transferring the developments into the field and/or into more routine operation by other operators; 4) prospects for deemphasizing a particular development and/or bringing on new developments; 5) new funding sources, opportunities, and the TDF budget; and 6) opportunities to bring new blood to the facility, either through visitors, graduate students and/or postdoctoral appointments, or through new hires. To foster career growth, all personnel in EOL will be given the opportunity to participate in development and deployment of technologies outside their immediate area of expertise.

Selected Specific Development Opportunities Because a comprehensive discussion of all specific development opportunities are simply too numerous to mention here, I illustrate below a cross section of activities spanning many of the disciplines discussed above. Each activity fits well with EOL's and NCAR's overall objective: to develop advanced technologies to improve our understanding of atmospheric processes and to transfer these to the broader community.

In situ Optical Sensing: It is important to continue the ongoing EOL effort in developing the next generation of laser-based in situ instruments for HIAPER employing difference frequency generation, including new high performance waveguide devices. This effort is important for our overall understanding of the chemistry in the UT/LS, particularly ozone production resulting from convective transport of ozone and its radical precursors. As new HIAPER-based sensors

employing quantum cascade and near-IR VCSEL lasers will be coming on line in the near future, it is important that EOL maintains a strong development effort with a wide array of IR laser sources and measurement technologies. One particularly promising new area involves collaborative research with NASA Langley employing open path absorption measurements on HIAPER. Initially this technology will provide a critical backup for water vapor measurements, but ultimately it will be used to measure very reactive halogen gases like HCl and HF, both important components of the UT/LS.

Remote Optical Sensing Using LIDARS: The REAL eye-safe lidar system has provided very impressive results of clouds and aerosols, but as of yet is limited to ground-based observations due to the nature of its laser source. Thus there is a need to develop solid state high power pulsed laser sources in the near and mid-IR spectral regions to utilize REAL's eye safe capabilities on airborne platforms and to extend its capabilities for trace gases such as CO_2, CO, and O_3 as examples. Such a new capability would have a strong synergy with in situ observations, very similar to the O_3 observations provided by NASA Langley's lidar. Such new high power sources would also open up new avenues for in situ observations; highly sensitive measurements by photoacoustic and cavity ring down spectroscopy would now become feasible. In addition, improved scanning water vapor differential absorption lidar (DIAL) systems are critical to improve our understanding of the weather, climate, the water cycle, biogeosciences, and the chemistry and dynamics of the UT/LS. As discussed in the EOL Strategic Plan, this is an enormous challenge since water can vary by more than 3 orders of magnitude, can exist in three phases, and generally requires an accuracy of ~ 1%. Continued emphasis will be given to EOL's ongoing partnerships with DLR and the University of Hoenheim in further developing such DIAL systems, and with our partnership with CU for our in situ water vapor measurements.

Radio Sensing: Development activities in this important technology have lagged somewhat in recent years within EOL compared to other technologies. Data processing of radar images is more than 8 years old, and high priority will be given to a dedicated effort with proper personnel support to build new hardware and software for real time image processing. In addition, millimeter wave radars are very capable of detecting and categorizing cloud-sized hydrometeor phase and particle types. As this information will be essential to many future HIAPER studies, including the upcoming Deep Cloud, Convection, and Chemistry study that is being planned, high priority will be given to this development activity.

In Situ Chemical Sensing: In addition to water vapor, a recent NASA workshop emphasized the need for higher accuracy of "routine" measurements such as O_3, and CO. Measurements of these gases on 4 different platforms differed by more than the mutual uncertainties, making it extremely difficult to carry out Lagrangian studies across the Atlantic Ocean. Improved accuracy in these and other "routine" observations will thus be one of many priorities for the new TDF.

The new TDF will rely heavily on strategic collaborations and partnerships with other groups, including commercial, university, and national laboratories. I envision that the new TDF will have a strong and vigorous Education and Outreach Program, similar to the program in the present APOL group. In summary, I envision an extremely active and productive TDF, which will represent the latest in technological advances across a wide range of fields. It is my goal that the new technologies thus developed will be more user-friendly, smaller, lighter weight, and more sensitive, than existing technologies, thus making them more accessible to a wider user base.