Meeting of the Working Group on Space-Based Lidar Winds

Destin, Florida, February 2 - 4, 2010

Tuesday, February 2

Co-chairs of the Working Group Michael Hardesty and Lars-Peter Riishojgaard presented "Introductory Remarks and Review of Action Items from Previous Meetings."

Session on Agency Perspectives

Mike Johnson presented "NWS/Office of Science and Technology Perspective on Future Enterprise Observing Systems," coauthored with M. Berchoff, P. Davidson, P. Roohr. Mike discussed a number of topics including Office of Systems Development (OSD) requirements process, Office of Science & Technology mission, and Science and Technology roadmap. The requirements process is used to define observation needs to meet strategic goals as defined by the S&T roadmap. The goals provide context for prioritizing weather and water goals. A restructuring of the OSD requirements process is underway. There are now only 4 focus areas for requirements. Weather and climate sensitive industries include nearly 30% of GDP. National needs and aviation weather are key considerations. Mike pointed out that about 70% of flight delays are weather related. The 2025 stretch goals and strategic themes in the S&T roadmap were discussed. Strategic themes included Integrated Environmental Modeling System, Atmospheric Models, Earth System Models, Next Generation Forecast and Decision Support System, interaction with end users, Weather Information Database, and Strategic priorities.

Steve Mango presented "Some Further Reflections on a Hybrid DWL, NPOESS 1st Generation Status & NPOESS 2nd Generation Considerations for an NWOS." Steve has retired from the government and is working as a consultant at NOAA. He described changes developing in the NPOESS program structure and pointed out that Stan Schneider is in PEO. There was extensive discussion following Steve's talk. Rich Fulton pointed out a need to make the business case for why Hybrid DWL is the right solution for wind observations and will do things that no other techniques will do (e.g. ocean vector winds, cloud motion vectors, water vapor motion vectors, hyperspectral, radiosondes, etc.). Rich also recommended analysis of the costs and benefits. Dave Emmitt pointed out the utility of OSSEs for answering questions about benefits and comparisons of instruments.

George Komar presented "NASA Headquarters Perspective on Space-based Global Wind Measurement." George reminded us again that the DWL mission is in Tier 3 of the Decadal Survey missions and that there are budget pressures, which together restrain the support

opportunities. George reviewed NASA's Earth Science Division budget projections, which show a significant increase beginning next year. He discussed missions in $800 M - $900 M categories, expanded Venture-class competitive PI-led missions, and climate modeling. There are 15 Earth-observing spacecraft in orbit. Glory, NPP, and Aquarius missions are preparing for launch. NASA will proceed toward completion and launch of foundational missions LDCM (6/13) and GPM (7/13). George discussed the possibility of getting instruments on the Space Station, although costs of integration and the ride up to the station are challenging. There is resistance to changing the order of the Decadal Survey missions in response to technology advances at this time. Many missions are using active sensing and lasers and NASA is making significant investments in lasers and optics, including coherent and direct detection lidars and other lasers. Current ESTO investments toward the Decadal Survey Missions include items toward enabling 3D winds. Winds are important to NASA and significant investments are being made to get ready for a winds mission. Stimulus funded technology development included Global Hawk instruments. Several other new investments were discussed including AITT, Earth Venture 1 (EV-1), IIP, EV-2, and R&A opportunities for demos and flight campaigns. Extensive discussion followed this talk. Wayman Baker suggested following up with the Air Force to seek support for a ride up to the Space Station for a DWL instrument, and this was included in the meeting Action Items (Note: Meeting scheduled for March 31 – April 1, 2010, at Kirtland AFB). Other partners, including international partners, were discussed. The space station environment was discussed.

Session on ADM/Aeolus

Erland Källen presented "The Need for a Doppler Wind Lidar in Space - ECMWF Impact Studies and Scientific Motivations," coauthored with D. Tan, C. Cardinali, P. Berrisford. Erland described ADM and its scientific motivation. Topics included present observation systems, sensitivity of forecast error to observations, re-analysis uncertainties, and ADM/Aeolus impact studies. Radiosonde observations have major impact on reducing error and DWL observations are expected to have comparable positive impact to the present radiosonde network. Wind data are lacking with the result that tropical analyses suffer and climate system re-analyses are uncertain in the tropics, polar regions, and the stratosphere.

Oliver Reitebuch presented "ADM-Aeolus Airborne Campaign over Iceland and Greenland" coauthored by C. Lemmerz, B. Witschas, U. Paffrath, I. Nikolaus, A. Dörnbrack, E. Nagel, U. Marksteiner, S. Rahm, Z. Li, et al. Oliver described instrument and ground campaigns results, UV sea surface reflectance from airborne observations, and other topics. He discussed pre-launch validation using A2D to validate the ADM instrument with atmospheric signals and instrument calibration in the atmosphere.

Lars-Peter Riishojgaard presented "US Ground Support for the ADM Mission." Lars-Peter discussed the ADM data policy to make data available to WMO GOS in real time, disseminated

by GTS. The baseline ground segment has a single receiving station at Svalbard. Near Real Time (NRT) level 1B data has 3 hour latency and are useful for global NWP. The low ADM orbit height causes some blind orbits. The WMO requirement for global NWP is 1 hour latency. The Quasi Real Time (QRT) data stream can be used for regional NWP, with 30 min or less latency. There is no southern hemisphere QRT data in the Svalbard-only scenario. Lars-Peter showed a map of where on the globe QRT data is available. The US is not covered. QRT is available for Europe but not for North America under the scenario that includes a receiving station at Troll as well as Svalbard, although this scenario is unlikely because of lack of funding. Lars Peter requested that ESA study implications of adding Wallops or Fairbanks as additional ground receiving stations. Fairbanks doesn't add much to Svalbard coverage, but Wallops fills in much of the gap. Wallops coverage was illustrated on a slide. NESDIS owns antennas at Wallops that are not fully utilized. Providing an antenna to ADM would guarantee QRT to North America. Lars-Peter has briefed Kathy Kelly (NOAA/NESDIS) and the Committee for Operational Processing Centers (COPC). Cost does not seem to be a problem. A formal request for NOAA ground support for ADM is being submitted by COPC. The technical requirements are being studied, a Memorandum of Understanding for ground support is being drafted by Jim Yoe, and there is an opportunity here for broader NOAA involvement in ADM and other wind lidar activities.

Oliver Reitebuch presented "Spontaneous Rayleigh-Brillouin Scattering Experiment of Nitrogen, Oxygen and Air", coauthored by B. Witschas, O. Vieitez, E.-J. Van Duijn, W. van de Water, W. Ubachs. Oliver described some unresolved questions about line shape for molecular scattering in air. Lidar measurements have very high spectral resolution so that the exact line shape in air becomes interesting. Line shape in air has not been validated, and neglecting line shape effects in ADM could result in up to 10% error in wind. An experiment at VU Amsterdam compared measurements and Tenti models at 1000 hPa for N2, O2, and Air. The Tenti models fit well. Experimental results were described.

Oliver Reitebuch presented "Rayleigh-Brillouin Scattering Experiment with Atmospheric Lidar from a Mountain Observatory," coauthored by B. Witschas, C. Lemmerz, E. Nagel. This presentation addressed direct measurement of Cabannes lineshape in the atmosphere. The measurement is challenging. The difference between Gaussian and actual is small. Line width is on the order 4 GHz to 6 GHz at 355 nm. Convolution of atmospheric and instrument functions was investigated. Measurements were made under low aerosol and homogeneous conditions at a mountain site in winter. The A2D instrument was used, pointed out a window. The instrument function is broad compared to atmospheric width, and samples of atmospheric line shape and instrument function were found. Oliver discussed how to compare the measurements with models.

Discussion – Exploring Synergisms and Interactions between the U. S.

Lidar Working Group and the ESA ADM

ADM accepted the proposal for Cal/Val support from the Lidar Working Group. The Working Group is looking for funding to support collaboration. Discussions addressed how to expand collaboration. There is no committed funding yet to support the proposal.

Stan Schneider (by Telecon) discussed "Status of NPOESS." Agencies will divide NPOESS by orbits into separate acquisitions. NOAA will pay for the afternoon orbit. It will be managed by a new division at GSFC, with the Program Office in Code 400 at GSFC. The bus will be similar to the NPP bus. DoD will support the morning orbit, the Joint Polar Satellite System (JPSS). JPSS contracting arrangements are uncertain. There has been no discussion of the Preplanned Product Improvement (P^3I) program, where we expected a DWL opportunity under earlier NPOESS plans. The Number1 unaccommodated EDR (global wind profiles) and a DWL instrument have not been discussed yet. The latest edition of the IORD was in 2001. Wind was placed in P^3I instead of being "accommodated" because in those days TRL was low. Now it's higher and could be accommodated in requirements. NASA and NOAA need to submit their requirements for global wind profiles..

Session on Space-based Lidar Studies

Dave Emmitt presented "Developing an OSSE Testbed at NASA/SIVO," coauthored with M. Seablom, R. Atlas (Telecon). Dave discussed development of a USWRP OSSE test bed, objectives, statement of work, and development of a Sensor Web Simulator to demonstrate sensor web for meteorological use cases, quantify cost savings and improvements in achieving science goals. A simulator will be built with functional elements to allow multiple "what if" scenarios and to use OSSEs to assess benefits. The Decadal Survey Doppler Wind Lidar mission scenario will be demonstrated, including GWOS with dynamic targeting with slewing. Future directions were described, including a polar orbiting scatterometer (XOVWM, DFS), GOES-R Advanced Baseline Imager, and geosynchronous microwave radiometer (PATH).

Lars-Peter Riishojgaard presented "Progress in Evaluation of Space Based DWL in Joint OSSEs," coauthored with M. Masutani, D. Emmitt, S. Greco., S. Wood., A. Stoffelen., G.-J.Marseille, and J. Woollen. This talk included extended discussion of how to use OSSEs. Quick OSSEs can be used to find directions, followed by full OSSEs for credibility. Steve Mango pointed out the need to assess impacts of OSSEs on past missions and suggested that OSSEs need to be funded as an organizational capability.

Dave Emmitt presented "Update on GWOS and Other Hybrid DWL Concepts." Dave presented an update on instrument and mission concept development, including GWOS conceptual design,

hybrid concepts, the coherent system ready to fly in GRIP, reduced risk, and the state-of-the-art of the technology. OSSEs are planned for data impact assessment, to test things such as adaptive targeting, hurricane track forecasts, and looking at specific phenomena in addition to anomaly correlation. Some current airborne activities include direct detection work with the ESA Falcon A2D and TWiLiTE and coherent detection work with TODWL, TPARC, GRIP, and NOAA P3DWL 2010.

Discussion – Preparing for a New DWL Venture Class Mission

George Komar – Winds Scientist at NASA. George pointed out that the winds mission doesn't fit into the NASA priority structure without a Winds Scientist. The winds mission is seen as being under the Weather area, but not top of Weather's list.

Wayman Baker –Space Station Mission. Wayman led a discussion addressing readiness for a Space Station mission. Discussion topics included:

- Should we focus on hybrid aircraft demonstrations first?
- What mission concept should be demonstrated?
    - Science focus – tropical cyclones, NWP, other?
    - Technology demonstration
    - Direct & coherent don't have to be fully integrated.
    - How important is it to have both hybrid (direct and coherent) vs. just one?
    - How important is biperspective in a Space Station demonstration?
    - Lots of tropical clouds under space station

Technology for Space Station accommodation must be mature. Power availability and management was discussed. It was pointed out that mission funding would require a partner to help support engineering and launch. The Air Force has expressed interest in partnering, possibly supporting launch. Other considerations include Japanese support on JEM, Russian launch support, university and industry support. It was recommended that we determine the extent of Air Force support for a mission. Wayman and George Komar will follow up on this. It was pointed out that universities have found funding for Space Station experiments. Technology readiness was discussed, including the status of TWiLiTE and GRIP aircraft flight. The Space Station environment was discussed, including pointing stability and vibration. Pointing and stabilization accommodation is used in other instruments. Accommodation, interfacing, and contamination were discussed. It was recommended that we support IDL and MDL studies for a Space Station mission. Some integration funds are available for Space Station utilization. The science value of the data needs emphasis as well as the technology demonstration value.

Wednesday, February 3

Session on Airborne Wind Measurements

Michael Kavaya presented "Airborne Lidar Development Status and Plans," coauthored with J. Beyon, G. Koch, M. Petros, P. Petzar, U. Singh, B. Trieu, J. Yu. The human-operated DAWN-AIR1 was discussed. Engineering flights are needed before the GRIP mission but these are not funded at present. It is planned for the autonomous DAWN-AIR2 to be accommodated on the DC-8 without WB-57 engineering flights. DAWN is funded thru DAWN-AIR1, AIR2 and GRIP. A Venture Class Science flight proposal was submitted with Bob Atlas as Principal Investigator. DAWN optics are in a cylindrical can with a rotating lens scanner and nadir angle 30^{o} to accommodate the aircraft structure. The DAWN transceiver is packaged and performing well at Howard University. High bandwidth data rate is 500 M samples / sec. INS/GPS is separated from the aircraft INS/GPS to decouple vibration. DAWN software is extensive. Michael reviewed the master wind equation. Additional financial support is needed to advance DAWN. There is no plan yet for hybrid flight with TWiLiTE since TWiLiTE wasn't selected for GRIP based on priority for flying a radar instrument. GRIP was justified on science, not as a technology demonstration.

Bruce Gentry presented "Status of the Tropospheric Wind Lidar Technology Experiment (TWiLiTE) IIP Project," coauthored with M. McGill, G. Schwemmer, M. Hardesty, A. Brewer, T. Wilkerson, R. Atlas, M. Sirota, S. Lindemann, F. Hovis. Bruce reviewed specs TWiLiTE specifications and showed a photograph of the TWiLiTE package for the ER-2 QBay. The GLOW DWL is still working at Howard University. TWiLiTE originally planned to fly in the GRIP DC8 but was not selected for GRIP. The ER2 was chosen for the next flights instead of the WB-57 as planned earlier, but TWiLiTE is still compatible with the WB57. The flight program is intended to get key technologies to TRL 5. The Holographic Optical Element (HOE) scanner will be demonstrated in the first flights. Photos of integration activities were presented. The flight results were discussed. A cooling pump failure limited the first flight activities. TWiLiTE worked till the laser cut off from heating. After redesign, the second engineering flights took place in September 2009. Some problems occurred again with the temperature environment. Flights over Boulder were coordinated with ground-based wind instruments for validation. The instrument was fully autonomous. There was no scanning in this test, with 26 hours flight time. Work is still needed on liquid cooling and auto alignment work. TWiLiTE IIP work is completed, components demonstrated, TRLs advanced. Flight data is being processing. Discussion followed Bruce's talk. The next flight opportunities are not defined, and it is not known when TWiLiTE and DAWN will fly together. There is no funded airborne work now.

Cathy Marx presented "Status of the Hybrid Doppler Wind Lidar Transceiver ACT Project," coauthored with B. Gentry, P. Jordan, M. Kavaya, and E. Faust. The GWOS IDL instrument design was the starting point of this project to build a compact 4-field of view transceiver for 2

micron and 355 nm DWLs, integrate it with lasers and receivers, and demonstrate shared optics on a NASA aircraft. The optics include 4 telescopes with 8" apertures, packaging and mechanical structure. Risks include precision for the coherent system, thermal, laser damage of coatings, and others. Cathy discussed plans for the next six months.

Dave Emmitt presented "Conducting 2010 hurricane season research using ONR's P3DWL on a NOAA P3," coauthored with D. Emmitt and F. Marks. Dave discussed the NOAA HFIP 2010 program, including flights with GRIP. The P3DWL was flown in an NRL P3 in 2008. ONR, ARL, NASA/LaRC, NOAA, and SWA participated in modifications, accommodation, and science support. The instrument has a bi-axial scanner. It was reduced in size from 4 racks to 1 rack. Region of regard, resolution, and accuracy were provided. P3 speed was 100 to 120 m/s. Data products were described, including vertical velocity, water surface elevation, depths of LAS, wave spectra, OLEs, mixed layer heights, aerosol pumping by cloud convection, and turbulence.

Michael Kavaya presented "Modifying the 3-D Winds Space Concept for Aircraft Science Campaign Wind Measurements." Michael discussed the space concept and the GRIP Airborne concepts. Differences include smaller range to surface, port and starboard separation too small for a second line of observations, can observe vertical wind as well as horizontal. He identified pulsed coherent lidar trades and discussed the equation for trades, with fixed E, PRF, D, nadir angle, then hold constant a formula with variable horizontal resolution, vertical resolution, aerosol sensitivity, number of azimuths, a/c speed, a/c height and other variables. Space parameters were compared to GRIP in a dB table. Total gain over the space mission is factor of 69, or 18.4 dB.

Jim Ryan presented "BalloonWinds – GroundWinds Project Summary." Jim reviewed the history of GroundWinds technical demonstrations with locations in Bartlett NH (532 nm 5 watt – decommissioned) and Mauna Loa (355 nm 5 watt, mostly molecular backscatter, mothballed, but can be restarted). He reviewed the history of BalloonWinds with flights planned at Holloman AFB, Alamogordo. The instrument and gondola weighed 2700 kg (3 tons). It used 1300 W provided by 20 Li Ion batteries. Thermal control was implemented with ice and electric heaters. The telescope was ½ meter diameter. There were two direct detection receivers (aerosol and molecular). The gondola dimensions were 82 x 82 x 122 inches. Objectives included downlooking observation of the atmosphere, validation of the instrument performance model, and learning about the space environment. The balloon launch failed because of mechanical problems and funds were insufficient for a retry. After the failed launch, the team analyzed up-looking data and the instrument performance model and made comparisons of the data to the model. The instrument performance model includes over 50 parameters to describe all subsystems. Results can be used to predict signal strength and measurement uncertainty in new environments. The aerosol channel wasn't used in the end. The model was used to extrapolate

from balloon instrument parameters to space instrument parameters at a 200 km orbit. Parameters for the space instrument vs. the balloon included

- 20 W laser emission vs. 3W
- 1.5 m telescope vs. .5 m
- 80% quantum efficiency vs. 40%
- Improved transmissions and detector properties

A Final Report has been submitted to NOAA. Two working systems are available for redeployment, the Mauna Loa GroundWinds instrument and the BalloonWinds instrument.

Dave Emmitt presented "Comparisons of TPARC P3DWL Wind Profiles with Dropsondes in the Presence of Clouds," coauthored with K. Godwin and S. Greco. Flight data included 4 typhoons, with 170 hours of data for the whole campaign. Data were acquired in spite of visible clouds 80% of the time. Hurricane data were discussed. Lidar data agreed well with sonde data. This activity showed that airborne DWL state-of-the-art has moved beyond technical demonstration to the science applications stage. They made unique and critical mass observations available. Airborne DWL investigations for 2010 will focus on tropical cyclones.

Dave Emmitt presented "Impact of Airborne DWL Observations on Numerical Simulations of Formation of Typhoon Nuri: (2008)," coauthored by Z. Pu, D. L. Zhang. P3 DWL data were compared to dropsonde data at several points around typhoon Nuri and wind speed observations had high correlation. DWL showed a positive impact on numerical simulation and forecasting of tropical cyclones. Greater information content is present in DWL data than in dropsonde data which is important for the data assimiulation. Dave discussed results using 4DVAR and 3DVAR data assimilation approaches. In the discussion following the talk, Oliver Reitebuch pointed out that information from dropsondes was not as effective as DWL, consistent with Reitebuch's presentation at an earlier Working Group meeting. Similar work by Weissman and Cardinali with Falcon data was also mentioned.

Mike Hardesty presented "Evaluating a Compact Commercial Lidar for ADM Validation and Boundary Layer Research," coauthored with S. Tucker, G. Pearson, F. Davies. Mike discussed a high prf, low pulse energy, Doppler lidar for airborne pollution transport measurements. The instrument can be co-deployed with an ozone lidar and AMAX DOAS on an aircraft for air quality forecasting. It will measure horizontal wind flux and pollution concentrations. DOAS measures NO2 in column. There is not enough room for HRDL on Twin Otter. The instrument is produced by Halo Photonics. It has been compared with HRDL. The plan is to install it on the Twin Otter. Wavelength 1.6 micron, prf is 20,000 vs. 200 for HRDL. Pulse energy is uJ vs. mJ in HRDL. When operated side by side, the devices see pretty much the same, although there is some variance between instrument measurements. Halo is more precise at low altitude, but drops out at 1500 m because of low power. Space on the plane is very limited. A port will be shared with the ozone lidar. Mike described flight tests, including the measurement track from flight

test, and wind, ozone, and ozone transport plots. Mike discussed the CALNEX project configuration, including a wedge scanner, 3 point scan, 3-d wind vector, 500 m horizontal and 50 m vertical resolution. The instrument worked well in the aircraft environment. The next step is to measure 3-d winds and ozone fluxes over Southern California in summer 2010.

Dave Emmitt presented "Advanced Signal Processing for Airborne Data in Severe Weather," coauthored with K. Godwin and S. Greco. There are lots of commercial DWLs working now. Issues with severe weather airborne DWL include platform motion, strong horizontal wind gradients (need to hurry scanner to make an average), and difficulties with automating extraction of surface level returns over water. Potential information includes wind speed, wave motion, presence of foam, presence of sprays, and turbulent kinetic energy. Dave described lidar parameters and processing tools (threading, sliding range gates, contextual movies, and intensity filtering.

Chris Grund presented "OAWL IIP Development Status: Year 2," coauthored with J. Howell, M. Ostaszewski, R. Pierce, S. Tucker. Chris reported on OAWL specifications and on development and testing status. The NASA IIP includes plans to fly on a WB57 in 2010, to raise TRL to 5 demonstrate flight and radiometric performance. Vibration testing results are good, ground testing is scheduled in March 2010. Chris described the flight plan out of Houston, around wind profilers, up to Boulder and ground validation there in Fall 2010. In the following discussion, it was suggested that a second lidar be flown with OAWL on the test flights.

Session on Ground-based Measurements

Huailin Chen presented "Goddard Lidar Observatory for Winds (GLOW) Wind Profiling from the Howard University Beltsville Research Facility," coauthored with B. Gentry, T. Bacha, B. Demoz, D. Venable. Huailin reviewed the goals including understanding and operating GLOW, developing a seasonal winds database, conducting intercomparisons of direct and coherent DWLs, and comparing with other sensors, e.g. Profiler, radiosonde, ACARS. He described upgrades to GLOW, 2009 wind measurements, and ongoing work.

Dave Emmitt presented "Preparing for VORTEX2 Using TWOLF with Phased Array Radar," coauthored with H. Bluestein. The VORTEX2 NSF/NOAA field program will investigate severe weather. CIRPAS will provide the platform with radar and DWL instruments. The P3DWL goal is to investigate PBL circulations in tornados. Dave reviewed some science questions about tornados including how and when and why they form, what is their structure, how strong are winds near ground, and how to forecast tornados. Current warnings have only 13 minutes average. TWOLF is a truck mounted observing lab with Xband phased array radar and DWL. It was tested in Boulder.

Alan Marchant presented "ValidWind: Improved Techniques and Results for Ground-Based Remote Sensing of Low Altitude Wind Profiles," coauthored with T. Wilkerson, T. Apedaile, B. Bradford, D. Scholes. This project developed a small balloon tracer. The balloon has retroreflector tape. The instrument includes laser rangefinder, inclinometer, compass, and Bluetooth data link. The measurement traces the balloon's 3D trajectory. Alan described analysis software. The product has high accuracy for flights of 5 to 10 minutes. Applications include wind turbine siting, measuring terrain-induced wind fields, and air quality studies looking at stuff coming off treatment facilities. Alan described the balloon aerodynamics characteristics of lift, loft, drag, and terminal velocity (~2 m/sec rate of rise). The instrument was compared with miniMOPA at Boulder, showing fair correlation sometimes, other times very different. ValidWind enhancements in automatic tracking and realtime data processing are underway. The scanner was about $20,000, the rest of equipment was inexpensive.

Session on Alternative Space-based Wind Measurement Techniques

Bob Brown was unable to attend to present "Uses of Scatterometer Data and Implications for Doppler Lidar Data for PBL Research."

Chris Grund presented "Progress Toward Achieving Full-time Lidar Winds from Geostationary Orbit," coauthored with J. Eraker, B. Donley, and M. Stephens. A geostationary orbit permits a wind lidar instrument to integrate for a long time, which helps to overcome the high orbital altitude in making measurements. Chris described an approach promising 64 independently targetable profiles from GEO at 20 minute intervals, with 1 to 2 m/s accuracy. The approach would use a 3 meter telescope for operations, and a 0.5 m telescope for demonstration. It would gather 4608 wind profiles per day with 20 – 60 minute averaging. Some investment has already been made to investigate the method. GEO would provide regional, 24/7 views for nowcasting, short term predictions, cyclogenesis/ cyclolosis, support for wind farm power generation, and other applications. Characteristics included 355 nm wavelength, 0.5 to 1 Joule / pulse, 100 Hz, beam forming telescope without moving parts, 3 m telescope 3^o x 3^o, and an OAWL receiver. Questions were discussed regarding the effect of the nearly vertical perspective on horizontal wind measurement.

Open Discussion on Future Directions

The first topic was the need for an airborne hybrid mission. The possibility of a Venture class airborne mission was discussed. There is a goal to increase the frequency of Venture class missions with additional funding, an AITT solicitation was mentioned in spring.

The DC8 aircraft could accommodate both systems.

There are no flights of opportunity in sight for TWiLiTE. Chris Grund has flights scheduled in 2010, and the question arose as to whether Bruce Gentry and TWiLiTE could fly with AOWL.

Michael Kavaya is planning for DAWN to fly in GRIP this summer.

There was discussion of focusing hybrid airborne flights around ADM cal/val activities and whether NOAA would sponsor this. A possible request scenario included George Komar support for technology development and Ramesh Kakar for science. It was suggested to get this concept onto appropriate agendas in NASA and NOAA. A science proposal should be made that includes ADM underflight to corroborate ADM and to show that hybrid data adds information to ADM data.

George Komar, Dave Emmitt, and Wayman Baker agreed to seek a meeting at Kirtland to validate Air Force partnering opportunities (Note: Meeting scheduled for March 31 – April 1).

A conceptual design study at NASA GSFC Instrument Design Laboratory was recommended for a Space Station mission instrument concept.

Thursday, February 4

<u>Continue Discussions on Future Directions and other topics</u>

Discussion topics included the following.

1. Information content and measures of information content in observations.
2. Space Station office looking for instruments and experiments. Challenges with the manned environment and power were discussed. Space Station limitations make it less desirable than a free flyer for a full demonstration mission, but it could provide significant results at a lower cost.
3. Cost of Space Station instrument. There was discussion of whether an ISS HDWL instrument could be made for $150 M. Comparisons were made with SPARCLE and Zephyr costs for ISS deployment. The general consensus was that it would be challenging to do it for $150 M.
4. A partner outside NASA or another instrument to hitch-hike with will be required to get on a free flyer any time soon.
5. The Working Group should prepare for a possible mid-term update of Decadal Survey recommendations. The first step is to update the mission white paper submitted to the NRC in the original survey. Wayman Baker is working on this update. It would be

advantageous to have an airborne hybrid capability to demonstrate advanced TRLs before any new survey.

6. New OSSEs are needed. Lars-Peter and Dave Emmitt are working on OSSE for GWOS and will have more information at the next meeting.
7. Outreach to atmospheric science should be reemphasized.
8. GRIP mission.
9. Next Instrument Design Laboratory conceptual designs.
10. Mission cost concepts. Costs of ICESat/GLAS & CALIPSO provide some idea of demonstration mission cost ballpark.

Wayman Baker led a session on "Preparation of a Doppler Wind Lidar article for BAMS." The last BAMS article was published in 1995 and an update is needed for the scientific community. Wayman reviewed his abstract and outline. A lot is new since 1995, including ADM, LaRC and GSFC advances, GWOS and NWOS, airborne systems, new DWL configurations, OSSEs, value of data, and impact studies with actual data. We need to let scientists know about inadequacies of model winds used in transport studies. A number of suggestions were provided in the review of the outline. (Was not sure what this was about).

Subcommittee Reports and Recommendations, Review Action Items, Next Meeting

There were a number of technical discussions.

The next meeting will be August 24-26. Alternative sites include Washington State, Portsmouth NH, or Bar Harbor.

The meeting was adjourned.