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Fundamental Coupling Processes in the Mesosphere, Lower Thermosphere (MLT) Using Enhanced Na Wind-temperature Lidar Measurements at the Atmospheric Lidar Observatory

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USU Data Management Plan

To provide the scientific community easy access to the lidar data, the USU will maintain a Data Center as described in detail in sections 3.2 and 4.2 in the Project Description. The Data Center will serve as a central location for data archiving and distribution for USU lidar observatory, along with collaborations with other NSF Na lidar observatories at ALO and PFRR. The current Madrigal database at CSU will be moved to USU for easier management. Detailed lidar data will be collected and organized in a standardized format for easy access. The Data Center will work with the other two observatories to optimize and standardize the lidar data retrieval algorithms to ensure high quality and consistent data products. Madrigal (www.openmadrigal.org/) is an upper atmospheric science data base used by groups throughout the world and is a robust, web-based system capable of managing and serving archival and real-time data. Data at each Madrigal site is locally controlled and can be updated at any time, but shared metadata among Madrigal sites allow searching of all Madrigal sites at once. Updates to Madrigal 3.0 in June, 2016, allow users to generate a script command to download a whole series of files with a few clicks. At the moment, there are Madrigal sites in the USA including NCAR, Millstone Hill, SRI International, Cornell University, as well as EISCAT, Sweden, Arecibo, Puerto Rico, Jicamarca, Peru, the Institute of Solar-Terrestrial Physics, Russia, and Wuhan Ionospheric Observatory, the Chinese Academy of Sciences. Since its initiation in 1980 at the MIT Haystack Observatory, the Madrigal system has been time-tested and has a number of programs to facilitate the installation of Madrigal and the creation and editing of Madrigal data files thereby reducing the time for successful implementation. The lidar data on Madrigal are in CEDAR Madrigal HDF5 (Hierarchical Data Format version 5) format, but one can access the data in Network Common Data Format version 4 (netCDF4) or ASCII format. NetCDF4 is a modern, supported, self-describing, machine-independent file format and is used extensively by the climate and weather community, by the NASA TIMED mission data of interest to the CEDAR community, by the HAO/NCAR upper atmosphere modeling community (WACCM, TIEGCM, TIMEGCM, CMIT).The netCDF format and tools are available through the NCAR Unidata website at www.unidata.ucar.edu/software/netcdf/. NetCDF4 includes support for variable-length records, and has extensive interchange capabilities with the HDF5 format. Application program interfaces for Madrigal are available for MatLab, Python, and IDL programmers from any computer on the internet using any platform (Unix/Linux, Windows, Mac). Standard Na lidar datasets include hourly altitude profiles of temperatures, horizontal winds and sodium densities with a vertical resolution of 2 km for night-time data and 4 km for day-time data. Data access and archiving will be through both the Madrigal and CEDAR databases Researchers from outside who are interested in other data products for their research, for example, tidal amplitudes and phases, Brunt-Väisälä frequencies, Richardson numbers, momentum fluxes, or products at other space/time resolutions will be encouraged to contact the PI to ensure a full understanding of the constraints and limitations of the data products. The Data Center will assist researchers from the other organizations to obtain data products that are not produced routinely but are necessary to extract additional science results. Consistent with other Madrigal sites, access to the data will require users to give their name, email address, and affiliation. No password is required. The following will be included on the USU Madrigal site: "Use of the Madrigal Database is generally subject to the CEDAR Database Rules-of-the- Road. Prior permission to access the data is not

required. However, the user is required to establish early contact with any organization whose data are involved in the project to discuss the intended usage. Data are often subject to limitations which are not immediately evident to new users. Before they are formally submitted, draft copies of all reports and publications must be sent to the contact scientist at all data-supplying organizations along with an offer of co-authorship to scientists who have provided data. This offer may be declined. The Database and the organizations that contributed data must be acknowledged in all reports and publications, and whenever this data is made available through another database. If you have any questions about appropriate use of these data, contact david.krueger@colostate.edu."