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Research Using High (and Higher) Resolution Radiosonde Data

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High vertical resolution radiosonde data (HVRRD), which began to become available in the early 1990s, have had value in gravity wave and tropical wave studies [*Hamilton and Vincent*, 1995]. For example, routine analysis of upper troposphere–lower stratosphere temperature and wind has led to better understanding of seasonal and geographic variations in gravity wave activity and spectral characteristics

Since then, HVRRD have been exploited for much broader research applications in fields where HVRRD provide the highest resolution available for observational parameters. With recent upgrades to the National Oceanic Atmospheric Administration's (NOAA) network of U.S. upper air stations providing yet higher vertical resolution, new research applications of operational sounding data are emerging. A repository of long-term, routine, very high resolution in situ observations of fundamental atmospheric parameters, including temperature, water vapor, and wind velocity, is now available, for which the full research potential has yet to be realized.

High Vertical Resolution Radiosonde Data

Many of the studies that have applied HVRRD utilized data from U.S. stations made publicly available through the Stratospheric Processes and their Role in Climate (SPARC) Data Center (http://www.sparc.sunysb.edu) at Stony Brook University. These data have 6-second resolution, corresponding to roughly 30-meter vertical resolution assuming a balloon ascent rate of 5 meters per second. The data were purchased from NOAA using funding from the National Science Foundation (NSF) for research conducted at Stony Brook and are freely available from the NASA-funded SPARC Data Center.

The Stony Brook group has used these data to study spatial and temporal variations of gravity waves and their spectral characteristics, with recent efforts focused on characterizing the distribution of gravity wave momentum flux to constrain gravity wave parameterizations in general circulation models (GCMs). Recently, other groups have extended the analysis period as the dataset has been updated from year to year and have begun investigating planetary waves in addition to gravity waves.

Shortly after these data were made available, other groups utilized the data from tropical stations to investigate tropical convection in relation to the mass flux and water vapor budget, troposphere-stratosphere transport, and validation of associated parameterizations for GCMs. Studies have also been made of the fine-scale structure of the tropical and extratropical tropopause on climatological and regional bases with subsequent analysis of the abilities of GCMs to reproduce these features.

Further applications have included validation of satellite observation techniques, studies of pyrocumulonimbus (fire-driven storm cloud) processes, studies of polar regions, and studies of the effects of geomagnetic storms on the lower atmosphere. A list of references covering some of the studies published in these fields that have used the data available at the SPARC Data Center is provided as an electronic supplement to this brief report (http://www.agu.org/journals/eo/v093/i035/2012EO350001/2012EO350001_brr.pdf).

Higher Vertical Resolution Radiosonde Data

Beginning in 2005, NOAA began transitioning from the MicroART radiosonde system, which used radiolocation, to the Radiosonde Replacement System (RRS), which uses GPS location. The data from this new system are recorded at 1-second resolution, which corresponds to 5-meter vertical resolution, permitting analysis of even smaller-scale atmospheric structure and processes.

One of the new applications facilitated by the increase to 1-second resolution is the derivation of clear air turbulence parameters describing the transfer of energy from large- to small-scale motions and identifying potential hazards for aircraft, using Thorpe scale

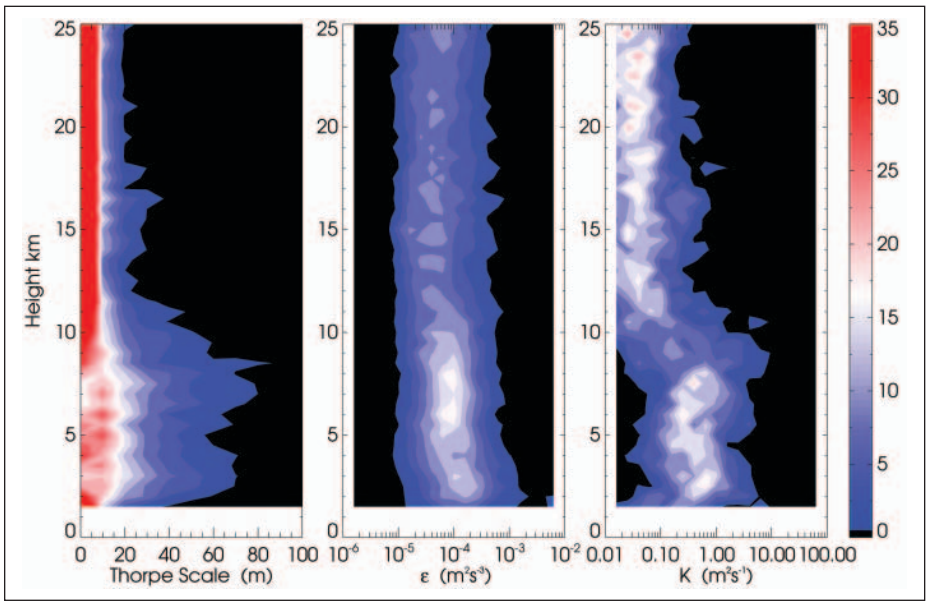

Fig. 1. Probability densities (in percent) of turbulence parameters derived from 3 months of 1-second resolution radiosonde soundings at Riverton, Wyo., in winter 2007. (left) The Thorpe scale (m), which provides a measure of the length scale of turbulent fluctuations, calculated from the potential temperature profile, which is taken to be proportional to the Ozmidov scale, a characteristic length scale above which overturning is inhibited by buoyancy; (middle) eddy dissipation rate; and (right) eddy diffusivity.

analysis, which was previously developed in studies of oceanic turbulence. While not the first application of this technique to atmospheric soundings, the availability of the new operational data yields the potential for routine observational analysis of clear air turbulence. This represents a significant improvement from previous studies that could utilize only highly limited campaign data and complements aircraft observations, which are the only other semiregular source of in situ turbulence observations. Research on this application continues at Stony Brook too, where efforts are under way to produce a climatology of turbulence parameters to be made publicly available. Figure 1 shows an example of the kind of data that will be made available.

Potential research applications of the 1-second resolution data have yet to be realized in two respects. First, there are potential applications that have not yet been explored, for example, the 1-second resolution data could be particularly useful for studies of the boundary layer, which could help improve understanding of surface-atmosphere exchange processes and dispersion of pollutants. Second, improved access to the data, potentially at a collective repository, could facilitate the move from regional analysis using databases from individual meteorological organizations to global analysis.

Data Availability and Upcoming Workshop

Currently, the SPARC Data Center holds a database of HVRRD from the more than 90 U.S. upper air stations operated by NOAA for the period of 1998–2008. The database can be accessed at http://www.sparc.sunysb.edu/html/hres.html. At the time of writing, it is anticipated that data for 2009–2011 will also be available soon. While a few stations have come in and out of service, the record for most stations is continuous for this period. The transition to RRS and the associated change from 6-second to 1-second resolution have taken place gradually from 2005–2012. Data are provided at their native resolution, and for convenience, the 1-second data have also been reformatted to provide a unified 11-year archive in the 6-second format.

Using NSF and SPARC funding, the SPARC Data Center will host a workshop on research applications of HVRRD on 27–29 May 2013 at Stony Brook University, in New York. The workshop will cover issues such as new applications made possible by the increase to 1-second resolution; means of improving existing analysis techniques, uncertainties, and limitations; and collaborations for intercomparison of regional analyses and possibly global studies. Also up for discussion will be the logistics of compiling a collective repository of international data, covering details of acquisition, location and storage requirements, and format. More information about the database and possibilities for contributing to an expanded database or about the workshop and limited funding to subsidize travel to the workshop is available by contacting the authors of this brief report.

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Reference

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