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A "Special Effort" to Provide Improved Sounding and
Cloud-Motion Wind Data for FGGE

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This is an unreviewed manuscript, primarily
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1. Introduction

Beginning in late 1973 and continuing into 1976, NASA, in collaboration with NOAA, conducted a series of Data Systems Tests (DST), which were intended to be a precursor to U.S. participation in FGGE - The Global Weather Experiment. These tests proved to be extremely useful in evaluating the suitability of the projected FGGE observing systems, the data processing and distribution facilities, as well as our ability to use the resultant data in analysis and forecast models. The final two tests of the DST series produced the most complete sets of global meteorological data ever assembled.

Early attempts by the modelling community to use the DST data in achieving improved numerical forecasts were disappointing. We have since learned that part of the problem stems from the existence of a number of deficiencies in the processing and quality control procedures employed during the DST experiments. Contributing to these deficiencies was the fact that certain of the key data sets were produced in an isolated environment. That is, no ancillary data were used to quality check or guide the derivation of the final product. This was particularly true of the high density cloud motion winds and the research satellite soundings. In the case of the winds, their single most important deficiency was in the accuracy of the assigned cloud heights. Little effort was made to adjust the cloud motion heights using ancillary data such as satellite temperature soundings or forecast wind fields. An added difficulty in the case of the sounding data was that they were horizontally averaged so as to be

more compatible with the GARP grid size. This, together with the inherent lack of vertical resolution of satellite soundings contributed to the tendency of the analyses based on satellite sounding data to exhibit too little variance in the thermal structure of the atmosphere. This leads in turn to an underestimation of the amplitudes of weather systems.

As they were originally set up, the DST experiments were designed to simulate the data acquisition and processing environment of the Global Weather Experiment. Unfortunately, by the time the deficiencies in the data processing and quality control procedures were brought to light, it was too late to substantially alter existing plans for the operational processing of satellite data during FGGE. Thus, it became clear that FGGE itself would suffer from the same deficiencies unless some sort of special effort were made to circumvent these difficulties.

In January of this year, a panel of experts on quality control for FGGE recommended that a special effort be made to "enhance and edit" the satellite soundings and cloud motion winds. The panel, which consisted of both data producers and data users, stated that such an effort would be crucial for achieving the full impact of these observing systems. The panel recommended that an extensive effort be made to improve the cloud height determination, that the sounding data be processed with the highest possible horizontal resolution (particularly in meteorologically active areas), that data gaps be filled where possible, and that quality indicators be provided with the final data sets.

2. System Description

In February, representatives of NASA, NOAA and the University of Wisconsin met at NASA's Goddard Space Flight Center to discuss the

planning and implementation of the recommended special effort. A one-pass system was decided upon, wherein the initial editing and selection of areas for data enhancement would be conducted by the NOAA National Meteorological Center (NMC), the sounding and wind enhancement would be carried out under the direction of the GARP Project at Goddard, followed by a final editing and quality assessment by NOAA/NMC of the enhanced data.

A diagram outlining the proposed implementation plan is presented in Figure 1. Man-computer Interactive Data Access System (McIDAS) terminals developed by the University of Wisconsin will be used both for editing operations at NOAA/NMC and for data enhancement at NASA/Goddard. (McIDAS is a highly sophisticated hardware/software system developed for accessing, processing, and displaying data from high volume data sources such as meteorological satellite imaging systems.) The McIDAS operating system and applications software will be installed in the Amdahl computer system at Goddard's Laboratory for Atmospheric Sciences. The Goddard terminal will be co-located with the computer. The NMC terminal will be tied via land line to the Amdahl computer for direct access to the FGGE data sets. A third terminal will be available at the University of Wisconsin for software development and system maintenance.

The appropriate FGGE data sets will be acquired from NOAA and other sources. After the editing and enhancement procedures have been completed, the resultant data products will be forwarded to the World Data Centers and to the FGGE Level IIIb analysis centers as a supplement to the official FGGE data sets. (Level IIIb data are the final grid point analyses to be generated on a delayed basis from the full FGGE data sets - there are two official Level IIIb data producers: NOAA's Geophysical Fluid Dynamics Laboratory and the European Center for Medium Range Weather Forecasts.)

The development of a man-interactive capability on the Amdahl at Goddard, installation of a McIDAS terminal at NMC and the provision of training to NASA and NOAA scientists participating in the special effort will be the responsibility of the University of Wisconsin. The development of software and techniques to ingest the FGGE data, display it, edit erroneous data, and select meteorologically active regions or regions with data deficiencies will be the responsibility of both NOAA/NMC and NASA/Goddard.

3. Implementation

The special effort will be conducted only for the two Special Observing Periods of FGGE (Jan/Feb 1979 and May/June 1979). Its primary objectives will be the production of high quality, edited and enhanced, sounding and cloud motion wind sets. Neither the editing nor the enhancement efforts will be compromised in quality in the interest of satisfying particular time constraints, although every effort will be made to have the data available in time for use by the Level IIIb analysis centers (nominally six months after data acquisition).

While a review of potential data problems will begin much earlier, the formal editing task will not begin until at least three months after the data observation date so as to allow the use of as broad a data base as possible. Data input would include:

- o Global operational data received by NOAA/NMC
- o Operational satellite sounding and wind data sets generated by the NOAA National Environmental Satellite Service (NESS)
- o Wisconsin wind data at the FGGE scale from the Indian Ocean satellite

- o Wisconsin tropical mesoscale wind data from all three U.S. geostationary satellites
- o Special aircraft dropwindsonde data
- o Commercial aircraft data

The data and derived products will be displayed via a McIDAS terminal to an experienced meteorologist at NMC for subjective evaluation. The data will be evaluated on the basis of synoptic reasonableness, vertical, horizontal, and temporal consistency, consistency with other data, etc. Primary emphasis will be placed on the soundings and cloud motion winds obtained from U.S. satellite systems. Suspect data will be designated with a code number describing the reasons for questioning its validity. These quality indicators will be supplied in addition to those already provided by the data producer. None of the original data will be changed or discarded - only graded as to quality. Regions of special interest such as meteorologically active areas, data voids and areas of questionable data quality will be identified as areas where enhancement efforts should be concentrated.

The sounding data enhancement process at Goddard will consist of supplementing the operational satellite sounding data set with higher resolution soundings in meteorologically active regions, and with new soundings in data voids or areas of questionable quality. Upon selection of the regions of interest, the operator will access, via the McIDAS terminal, the raw radiance data for use in producing new high resolution soundings. These new soundings will be generated using new retrieval schemes developed in conjunction with man-interactive processing techniques by NOAA/NESS.

The cloud motion wind enhancement process will consist of the rederivation of cloud heights in suspect areas using new techniques developed by NESS and the University of Wisconsin which make use of

sounding radiance data. In areas of significant data voids, it may be possible for Wisconsin to generate additional winds at some prescribed density. For both winds and soundings, the enhanced data sets will be identified as such, appended to the original operational products and turned over to NMC for final editing.

At NMC a synoptician will then evaluate these new data and assign coded quality indicators that will describe the validity of various observations. In addition, NMC will gather information on the basic characteristics and systematic errors of the data, together with descriptions of the nature and possible source of errors. After this last editing step, the final data package including the edited and enhanced soundings and cloud motion winds as well as the edited portions of the original operational products will be forwarded by NASA to the World Data Centers and to the FGGE Level IIIb centers.

4. Summary and Conclusion

The United States pre-FGGE experiment known as the Data Systems Tests clearly indicated a need for a special effort to edit data and enhance the quality of satellite soundings and cloud motion winds during FGGE. A panel of experts on FGGE quality control has proposed that the U.S. make a special effort to edit and enhance the satellite soundings and cloud motion winds obtained during the Global Weather Experiment. In response to that request, a formal program to carry out the editing and enhancement tasks has been established jointly by NASA, NOAA and the University of Wisconsin. This program will be funded by the GARP Project at NASA and by the U.S. FGGE Project Office. The GARP Project at NASA will have the overall responsibility for the successful completion of the special effort.

In its original proposal that a special effort for editing and data enhancement be undertaken, the panel of experts on quality control went on record stating that ". . . this effort is crucial for achieving full impact of non-conventional observing systems." In addition to greatly improving the value of the space-based data, a significant added benefit will be that in the process of equipping and training groups in both NASA and NOAA to accomplish this task, an enormous amount of highly useful technological transfer will occur from the research community to the key user groups. The special effort represents an opportunity to take a significant step forward in improving the usefulness of satellite data in numerical weather prediction. For the first time the concepts of enhanced resolution in areas of greater meteorological interest, man/machine interactive processing, and internal data consistency (data source to data source) will be simultaneously brought into play.

PROPOSED SPECIAL EFFORT IMPLEMENTATION

