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**CBS MANAGEMENT GROUP**

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**OPAG on Integrated Observing Systems**

**Workshop to Improve the Usefulness of  
Operational Radiosonde Data**

*(Submitted by the Secretariat)*

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**Summary and purpose of document**

This document provides a summary of results developed during the Workshop to Improve the Usefulness of Operational Radiosonde Data held in Asheville, North Carolina, USA, from 11 to 13 March 2003.

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## DISCUSSION

1. The Workshop to Improve the Usefulness of Operational Radiosonde Data was held at the NOAA National Climatic Data Center (NCDC) in Asheville, North Carolina, USA, from 11 to 13 March, 2003. The workshop was attended by 30 participants including users of global radiosonde data in numerical weather prediction, climate, and satellite data applications, along with a number of experts concerned with radiosonde instrument development, validation, and operational programmes. WMO was represented by Dr John Nash (UK), Chair of CIMO Expert Team on Upper-Air Systems Intercomparisons. The report of the workshop, which contained a number of recommendations relevant to CBS, CIMO and GCOS activities, is being submitted to the Bulletin of the American Meteorological Society. The contact person for the workshop and its deliberations is:

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2. This document provides a summary of findings and recommendations developed by the workshop specifically related to CBS activities in the areas of (1) sampling strategies for various applications; and (2) exchange of and response to information on radiosonde data and metadata.

3. Regarding **Spatial sampling**, the workshop specifically recommended the following:

- CBS should consider means for enhancing the atmospheric sounding capabilities of research vessels (and possibly other ships) in order to provide improved data coverage of remote ocean areas.
- GCOS should reiterate to providers the importance of continuing soundings in the tropics given their importance in the climate change science context.
- Interested groups and committees should consider the potential benefits and pitfalls of large trans-national procurements of radiosondes and ground equipment. Such large procurements could significantly reduce equipment costs.

4. Regarding **Consolidation of sampling strategies**, the workshop noted that there is a need for a definition, rationalization, and consolidation of sampling strategies to reduce existing ambiguities and recommended that CBS Implementation/Coordination Team on Integrated Observing Systems and other relevant bodies should consider how to most efficiently rationalize the overall system of sampling strategies.

5. When considering **Selective collocation of radiosonde and satellite observations**, the workshop noted that a continuous, robust and traceable sample of global, radiosonde observations that are coincident with satellite overpass times is required for the validation of the measurements, processing algorithms, and derived products from operational and R&D satellites. In this connection, the workshop recommended that relevant working groups (e.g., the CBS Expert Team on Observational Data Requirements and Redesign of the GOS) consider establishing a sampling strategy and requirements for a geographically diverse subset of sites where well-characterized radiosondes will be launched at satellite overpass times. This sub-network should include observations from small islands and ships, selected Atmospheric Radiation Measurement (ARM) sites, all primary Network for the Detection of Stratospheric Change (NDSC) sites, operational observing stations, and a selection of sites where additional surface-based observing systems (e.g., ground-based

GPS precipitable water sounders, ship-based microwave radiometers, ozonesondes, and rocketsondes are deployed. Site selection must also consider existing climate and numerical weather prediction (NWP) strategies.

6. Regarding **Targeted launches**, the workshop stressed that the ability to undertake weather-sensitive targeted launches (globally) at short notice from current observing sites would greatly enhance the usefulness of radiosondes to NWP. In particular, the workshop supported efforts of THORpex to implement the concept of targeting, whereby “observations are utilized and/or supplemented where and when their impact on the quality of the analyses and forecasts is largest”.

7. With regard to **Multi-sensor platforms**, the workshop recommended that appropriate CBS working groups consider the experimental installation of other surface-based sounding equipment coincident with a selection of land and ship-based radiosonde sounding sites, taking into account the potential for synergy not just with radiosondes, but also with satellite observations. For example, high-quality ground-based GPS receivers at selected upper-air sites as well as ship-based microwave radiometers would provide surface-based constraints on the column precipitable water.

8. The workshop noted that there is a growing requirement for a better **sampling of the middle to upper stratosphere** for both climate and satellite operations and recommended that appropriate sampling strategies concerning the vertical resolution and extent of radiosonde observations in the middle to upper stratosphere need to be defined by consultation between relevant user groups and committees. It is also recommended that the sampling strategies should include a specification of the minimum percentage of flights that will be required to reach a specified minimum height (e.g., 5 hPa).

9. Regarding **00/12 Universal Coordinated Time (UTC) observations**, the workshop noted that both weather prediction and climate monitoring require 00 and 12 UTC soundings to (begin to) sample the diurnal cycle and to maintain continuity with the historical record. It recommends that, as certain sites are selected for radiosonde launches coincident with satellite overpass times, a 00 / 12 UTC sampling approach be maintained wherever possible. This is most important for GUAN stations and other stations with long records used for climate monitoring.

#### ***Exchange of and response to information on radiosonde data and metadata.***

Under this topic the workshop expressed the following views and recommendations.

#### ***Metadata***

10. Station history information is contained in databases residing at various data centers, as well as in WMO-maintained lists and catalogues such as Publication 9, Volume A. There exists a need to fill in and frequently update records of upper-air station history information, as well as to reconcile the metadata records maintained by various centers. Efforts are currently underway to obtain up-to-date station history information through a web-based survey of WMO member countries.

#### **Recommendations:**

- Designated centers (e.g., NCDC and the Hadley Centre) should undertake a concerted, cooperative programme for resolving problems with historical metadata, particularly focusing on pinning down the timing of changes. They should also provide high resolution metadata in the future using data held in coded radiosonde messages to complement research-quality radiosonde datasets. The resulting historical and real-time metadata should be made widely available to users in a number of easily accessible forms.

- Station lists such as WMO Publication 9, Volume A, be updated consistently for all parts of the world and made available on the Internet in a timely manner to accurately reflect recent changes in station location, instrumentation, corrections applied operationally, and other metadata.

### ***Content of radiosonde messages***

11. The current coded message includes space for the actual launch time, radiation bias code, wind finding equipment used, and other metadata, but this information is not provided by all stations. Once messages are transmitted in binary universal form for representing meteorological data (BUFR), the possibility also exists for including additional information that cannot be transmitted in the current message format.

#### Recommendations

The proper WMO working group should provide guidance to operators that encourage them to include as much information as possible in the message to make the data more useful to a large range of applications. In their upcoming meeting to finalize BUFR content, the WMO should consider that the following are deemed to be highly desirable for inclusion in future BUFR-formatted messages:

- station name;
- latitude, longitude, and time at every level;
- height of the surface level;
- relative humidity at all levels;
- pre-launch data;
- high-resolution data rather than solely mandatory and significant levels;
- elapsed time.

### ***Reversibility and traceability***

12. There is a need for reversibility and traceability. Experiences of some users have pointed towards the presence of errors in, for example, operationally applied radiation correction factors, which can, in theory, easily be corrected. Increased traceability and reversibility would simplify the implementation of such back-corrections.

#### Recommendations

Data processing centers should be encouraged to keep data that are not quality-controlled as well as, if possible, undecoded radiosonde messages. The proper WMO working group should consider whether it is feasible for sites to transmit or otherwise retain both uncorrected and radiation-corrected data.

### ***Quality control***

13. The potential exists for increased communication among relevant groups and individuals regarding decoding and quality-control (QC) issues.

#### Recommendations

A process should be established for exchanging decoding and QC methods and tools. That process should consist of:

- a common web site including test data sets, sharable code, and plots of soundings in which data values were rejected that could serve as feedback to the site operators;
- a workshop to exchange methods;

- a formal intercomparison of QC systems similar to existing model intercomparison projects.

This exchange could lead to the development of automated QC analysis indicators that could provide further feedback between monitoring centers and sites and assist in removing discrepancies between the blacklists maintained by the various centers.

### ***Information exchange***

14. There are some weaknesses and inefficiencies in the current system management of information exchanges among users, monitoring centers, and operational sites.

#### Recommendations

- There should be a larger number of regional radiosonde workshops that provide training to the operators and managers of radiosonde sites. Attempts should be made to raise awareness of the importance of radiosonde data and metadata. Operators should discuss options for incentives to encourage high performance of all individual radiosonde sites, learning from the experiences of the NWS. The designation of a station for specific network processes (e.g., GUAN) may also act as an incentive to station operators.
- Expert WMO groups should improve the process of resolving deficiencies in the global radiosonde network and provide a clearer mechanism for input to those processes from customers and the scientific community.
- The Commission for Basic Systems should consider establishing an Expert Team focused on radiosondes.
- WMO and analysis centres should consider, through consultation with the user community, how to make the crucial information more accessible.

15. In conclusion, the workshop recognized that the implementation of the above recommendations hinges upon actions by numerous groups. It urged CBS and CIMO to make a review of accuracy requirements and sampling strategies as a matter of priority. It further encouraged interested scientists to pursue the research questions posed by several of the recommendations and funding agencies to provide the resources for such research.

16. The MG is invited to consider the above information and decide on how to best incorporate recommendations of the Workshop in the OPAG/IOS, OPAG/ISS and OPAG/DPFS activities.

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