WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENTS AND METHODS
OF OBSERVATION

CIMO MANAGEMENT GROUP
Second session

Bucharest, Romania 2 – 3 May 2005

CIMO/MG-2/Doc.3.4.2
(6.IV.2005)

ITEM: 3.4

Original: ENGLISH ONLY

# "FLEXIBLE" UPPER-AIR SYSTEMS

**(Submitted by the Secretariat)**

---

**Summary and purpose of document**

This document provides background information on "flexible" upper-air systems in a support to the presentation of a demonstration test of a system in Dar Es Salaam, Tanzania, to be made by the vice-president of CIMO.

---

**Action proposed**

None

# "FLEXIBLE" UPPER-AIR SYSTEMS

## I. Background

1. Since the beginning of 2003, discussions were being made at various user and donor levels on (re)introducing more widely the so-called "universal" upper-air systems that can use GPS and non-GPS sondes. As this may have both positive and negative impacts on the global radiosonde network, the Expert Team on Upgrading the Global Radiosonde Network discussed this issue and recommended that further discussion of this issue is needed to develop a concept and assess its viability, in order to safeguard the best interests of the meteorological community.

## II. What is a "Flexible" upper-air system?

2. There are varieties of definitions of a "flexible" upper-air system (FUAS). In its universal sense a "flexible" upper-air system should be able to use different navigation and tracking systems and should provide an interface to wide range of radiosondes. Such a system could use both GPS and non-GPS radiosondes. It may use combination of different navigation and tracking systems, such as Radiotheodolite (RDF) systems and Global positioning system (GPS) or GPS and Hyperbolic navigation systems (LORAN-C). Through the radiosonde data converter, the system may be used with various radiosonde types and should allow for a real-time tracking and data processing of radiosondes operating on both 403 MHz and the 1680 MHz band. It should be an open and modular system.

3. Some definitions refer to dual- or multi-mode UAS, able to operate in more than one-mode, e.g. RDF and GPS wind finding (dual-mode) or 1680 MHz RDF/GPS and 403 MHz GPS.

4. The working definition of a "simple" FUAS refers to a one-mode upper-air ground system able to use radiosondes from multiple manufacturers.

## II. Potential benefits of using "Flexible" upper-air system

5. A FUAS provides opportunity, when appropriate and feasible, to limit the use of expensive GPS radiosonde to a necessary minimum and use cheaper non-GPS radiosondes. In the medium-term it would lead to a reduction of the operational cost of upper air sounding networks.

6. A FUAS also provides backup in case of failure or in case of low or bad reception or interference in certain bands. For example, in case of failure of radiotheodolite antenna the system may use the 403 MHz GPS sondes taking an advantage of the solid state UHF and GPS antennas with no moving parts. Similarly, in case of high interference in GPS the non-GPS sondes may be used.

7. Generally, ability of a simple FUAS to use radiosondes from multiple manufacturers provides a competitive environment with a positive influence on the price of radiosondes.

## III. Practical experience with "Flexible" upper-air systems

8. There is little experience in using FUAS, however some configurations are already in use or are commercially available.

9. Indian Meteorological Service installed 10 InterMet IMS 1500 radiotheodolite systems that are able to track Indian (MK4), InterMet (IMS 1680 MHz GPS and IMS 1680 MHz RDF), Sippican (MK2, MK2A and B-2) and Vaisala RS-80 radiosondes if they supply a decoder with their sonde. Meteorological Service purchased decoders for Indian MK4 and Sippican MK2, however, with the new IMS 1500 systems, they are initially using only Indian sondes.

10. Six Caribbean countries use InterMet IMS 1500C (version for warm climate), however only with Sippican B-2 sondes. These systems have performed quite well in the tropical region and have been more than adequate for wind determination where the winds are generally light to moderate throughout the year and radiosonde flight distances are significantly less than 200 km.

11. Norwegian army is using InterMet IMS 1600 system that combines 1680 MHz radiotheodolite wind finding and 403 MHz GPS wind finding with omnidirectional antenna. With this system the Sippican MK2 sonde for 1680 MHz RDF and Modem sonde for 403 MHz GPS are used. Again no detailed information is available.

12. The predecessor of IMS 1500 is being used in Cape Verde, Abu Dhabi.

13. Under the Radiosonde Replacement Programme in US NWS new ground system was designed by InterMet - IMS 2000. This system has bigger antenna than IMS 1500 and can track sondes to a bigger slant distance (250 km). IMS 2000 should work in 1680 MHz GPS and RDF or in 1680 MHz and 403 MHz dual mode. IMS 2000 should be used with Sippican and InterMet sondes.

14. VAISALA Radiotheodolite RT 20 equipped with MARWIN MW12 sounding processor is used in number of mostly European countries and mostly for military purposes. MW12 permits the redundant use of NAVAID technique, such as VLF-NAVAID, LORAN-C and GPS), New version RT20A connects directly to latest DigiCora III sounding system.

15. VAISALA also claims that it has a commercially available new DigiCora system equipped with both 1680 MHz RDF and 403 MHz GPS wind finding capability. No information is available on its possible use.

16. InterMet IMS 1600 Integrated Upper-air System was installed in Dar Es Salaam in October 2004, funded under GCOS project. This is a 1680 MHz RDF combined with 403 MHz GPS system. The Sippican and Modem radiosondes are used with the system. A demonstration test was performed by a joint UK Met Office and NOAA-NWS team on behalf of WMO/GCOS. The test revealed number of problems (see Annex), many of them already fixed by the manufacturer. (Two related presentations will be made during the TECO-2005). After most of the initial problems were solved, there are promising reports from the Tanzania Met Service on the operational use of IMS 1600 system.

17. Under projects funded by GCOS a system similar to Dar Es Salaam (however, without 403 MHz mode) was already purchased for Namibia and one system is planned for Zimbabwe.

**Annex**

**Demonstration test of IMS 1600 integrated UA system**
Dar Es Salaam, Tanzania, 18-30 October 2004
**Conclusions**
(by Dr. J. Nash)

1. The IMS 1600 system clearly needed more testing than had occurred before it was deployed in Tanzania. A lot of the system outputs were inconsistent within the various parts of the software.

2. The tracking of the radiotheodolite appeared good and able to meet user requirements for wind in the tropics, but the algorithms used for generating winds were not computing values at the resolution needed [or indicated by the software settings], i.e. 1 minute near the ground and 1 to 4 minutes in the stratosphere.

3. Mounting the radiotheodolite on the roof in Dar-es-Salaam hinders automatic tracking of the radiosonde at launch. Launch routines would be easier if the radiotheodolite were mounted on the ground [probably somewhere near the place here the old Vaisala radiotheodolite was stored.] Then, the person who launched the balloon could be responsible for checking that it was tracking on the main beam.

4. Correction procedures for Sippican and MODEM temperature measurements were not traceable by the test team. Neither radiosonde manufacturer appeared to have collaborated closely with IMS in ensuring that corrections applied were relevant to the radiosonde type provided for this demonstration.

5. IMS SIPPICAN measurements were fit for operational use, but the temperature correction procedures should not be used until the errors are rectified by IMS

6. IMS MODEM system measurements were unfit for operations because of a very large pressure computation error that corrupted all reported data, particularly in the upper troposphere and lower stratosphere.

7. IMS message generation was not appropriate for TEMP messages in Region I.

8. Further action is required to provide a more reliable method of communicating data from Dar-es-Salaam onto the GTS.

9. Re-establishing radiosonde measurements in a location such as Dar-es-Salaam where radiosonde ascents had not been made for more than 10 years requires a concerted training effort with staff present from both the manufacturer and from a National Meteorological Service with the necessary experience in radiosonde operations.

10. It would be beneficial if a suitable expert was sent to Tanzania to complete the training started during the demonstration test and to implement improved communications. This should be considered once IMS are ready to upgrade the system software.

11. The hydrogen generator installation worked well and is clearly capable of supporting the use of 800 or 1000g balloons on a regular basis. It is recommended that suitable funding be provided for the use of the large balloons at Dar-es-Salaam in the long term.