



Recommendation ITU-R RS.1165-3
(12/2018)

**Technical characteristics and performance
criteria for systems in the meteorological
aids service in the 403 MHz
and 1 680 MHz bands**

RS Series
Remote sensing systems



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Foreword

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SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
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SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R RS.1165-3

Technical characteristics and performance criteria for systems in the meteorological aids service in the 403 MHz and 1 680 MHz bands

(1995-1997-2006-2018)

Scope

This Recommendation gives the technical characteristics and performance criteria for systems in the meteorological aids service in the 403 MHz and 1 680 MHz bands. All the various MetAids systems are covered: radiosondes, dropsondes and rocketsondes.

Related ITU-R Recommendations, Reports

Recommendation ITU-R RS.1263-1 – Interference criteria for meteorological aids operated in the 400.15-406 MHz and 1668.4-1700 MHz bands

Recommendation ITU-R P.528 – Propagation curves for aeronautical mobile and radionavigation services using the VHF, UHF and SHF bands

Recommendation ITU-R SA.1021 – Methodology for determining performance objectives for systems in the Earth exploration-satellite and meteorological-satellite services

Keywords

MetAids, radiosonde, rocketsonde, dropsonde

Abbreviations/Glossary

AFC	Automatic frequency control
AXBT	Airborne expendable bathythermograph
FM	Frequency modulation
GDPS	Global data-processing system
GFSK	Gaussian frequency shift keying
GMSK	Gaussian minimum shift keying
GOS	Global observing system
GTS	Global telecommunications system
OECD	Organization for Economic Co-operation and Development
PTU	Pressure, temperature and relative humidity
QAM	Quadrature amplitude modulation
RDF	Radio direction finding
RNSS	Radionavigation satellite service
RR	Radio Regulations
WMO	World Meteorological Organization

The ITU Radiocommunication Assembly,

considering

- a) that upper-air meteorological measurements carried out by radiosondes are an essential element of the World Weather Watch Programme of the World Meteorological Organization (WMO);
- b) that many defence services deploy radiosonde systems in order to support a variety of operations, independent of the World Weather Watch Programme;
- c) that many radiosonde systems are used for local and regional monitoring of atmospheric pollution conditions and also for tracking the trajectories of hazardous discharges from natural or man-made disasters;
- d) that radiosonde systems operating in the meteorological aids (MetAids) service have unique radiocommunication requirements;
- e) that radiosonde, dropsonde, and rocketsonde systems under MetAids service mainly operate in the frequency bands 400.15-406 MHz (called the 403 MHz frequency band) and 1 668.4 1 700 MHz (called the 1 680 MHz frequency band) with limitations as per the provision No. **5.379E** of the Radio Regulations (RR);
- f) that radiosondes in the MetAids service are carried by ascending balloons launched from land stations or ships, dropsondes deployed from aircraft and carried by a parachute, and rocketsondes lifted into the atmosphere by rockets;
- g) that performance objectives for transmissions to and from radiosondes must be consistent with the attendant functional requirements and with the performance limitations associated with the systems and frequency bands in which the requirements will be fulfilled;
- h) that performance objectives for representative systems operating in the MetAids service are intended to provide guidelines for the development of actual systems that must operate in a frequency sharing environment;
- i) that performance objectives for particular systems may be determined using the methodology similar to that described in Recommendation ITU-R SA.1021;
- j) that performance objectives are a prerequisite for the determination of interference criteria;
- k) that Recommendation ITU-R RS.1263 provides the interference criteria for systems of the meteorological aids service operating in the 403 MHz and 1 680 MHz frequency bands;
- l) that Resolution **205 (Rev.WRC-15)** deals with the protection of the systems operating in the mobile-satellite service in the frequency band 406-406.1 MHz,

recommends

- 1** that the technical and operational characteristics in Annex 1 should be considered as typical for meteorological aids in the 403 and 1 680 MHz frequency bands;
- 2** that the performance criteria specified in Table 3 of Annex 1 should be considered when developing interference criteria and conducting sharing studies with other services.

Annex 1

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1 Introduction

1.1 Daily meteorological operations

Meteorological aids¹ are mainly used for *in situ* upper air measurements of meteorological variables (pressure, temperature, relative humidity, windspeed and direction) in the atmosphere up to an altitude of 36 km. The measurements are vital to national weather forecasting capability (and hence severe weather warning services for the public involving protection of life and property). The meteorological aids and associated tracking systems provide simultaneous measurements of the vertical structure of temperature, relative humidity and wind speed and direction over the full height range required. The variation of these meteorological variables in the vertical contains the majority of the critical information for weather forecasting. The MetAids systems are the only meteorological observing systems able to regularly provide the vertical resolution that meteorologists need for all four variables. Identification of the heights where sudden changes in a variable occur is vital. Thus, it is essential that continuity of reliable measurements is sustained throughout the ascent of the radiosonde.

The MetAids observations are produced by radiosondes carried by ascending balloons launched from land stations or ships, dropsondes deployed from aircraft and carried by a parachute, and rocketsondes lifted into the atmosphere by rocket and descend under a parachute during data collection. Radiosonde observations are carried out routinely by almost all countries, two to four times a day. The observation data are then circulated immediately to all other countries within a few hours via the WMO Global Telecommunications System (GTS). The observing systems and data dissemination are all organized under the framework of the World Weather Watch Programme of the WMO.

The radiosonde network provides the primary global source of real-time *in situ* measurements. WMO Regulations (Manual on the Global Data-Processing System (GDPS)) require that radiosonde measurements should be made and circulated to all GDPS centres worldwide at national, regional and global levels for numerical weather prediction. The observation stations are required, worldwide, at a horizontal spacing of less than or equal to 250 km, during the first decade of the twenty-first century, with a frequency of observation of from one to four times per day. However,

¹ This Recommendation addresses radiosondes, dropsondes, and rocketsondes operated in the meteorological aids (MetAids) service. The term MetAids is used when the discussion applies to all three types of systems. The specific system name (radiosonde, dropsonde and rocketsonde) is used when the discussion applies to one or two of the specific types of systems.

the numerical weather prediction models for small scale meteorological phenomena (e.g. thunderstorm, local winds, tornadoes) and environmental emergencies will actually require local upper air observations every one to three hours at a horizontal resolution from 50 to 100 km. Observations are to be provided from a variety of observing systems, chosen according to the needs of the national administration, including MetAids measurements, wind profiler radar measurements or satellite measurements.

The radiosonde observations are essential to maintain stability in the WMO Global Observing System (GOS). Remotely sensed measurements from satellites do not have the vertical resolution that is available from radiosondes. Successful derivation of vertical temperature structure from these satellite measurements usually requires a computation initialized either directly from radiosonde statistics or from the numerical weather forecast itself. In the latter case, the radiosonde measurements ensure that the vertical structure in these forecasts remains accurate and stable with time. In addition, the radiosonde measurements are used to calibrate satellite observations by a variety of techniques. Radiosonde observations are thus seen to remain absolutely necessary for meteorological operations for the foreseeable future.

1.2 Monitoring climate change

Changes in atmospheric temperature and ozone have been observed over the past 20 years, many of the largest changes taking place at heights between 12 and 30 km above the surface of the Earth. Routine daily radiosonde observations to heights above 30 km identify the distribution in the vertical of the changes that occur and hence allow the causes of the changes to be evaluated. Ozonesonde measurements to similar heights determine the vertical distribution of the ozone depletion that now appears to be occurring in both Southern and Northern Hemisphere winter and spring. Many countries fly ozonesondes at least three times per week during these seasons to monitor developments.

Successful sampling of changes in climate requires the use of radiosondes with established systematic error characteristics. The requirement for continuity in the time series of upper air measurements worldwide means that new radiosonde designs are only introduced into operation after several years of intensive testing, that occurs both in the laboratory and in the free atmosphere.

1.3 Other users

Other MetAids systems may be deployed independently of the main civilian meteorological organization by national research institutes and other users. Specific investigations will include environmental pollution, hydrology, radioactivity in the free atmosphere, significant weather phenomena (e.g. winter storms, hurricanes, thunderstorms, etc.) and investigation of a range of physical and chemical properties of the atmosphere. This use is not decreasing with time, since with modern automation it is now much easier to successfully operate mobile systems and shipboard systems without highly skilled operators and a large amount of supporting equipment. MetAids operations have to accommodate these users, and this expands the radio-frequency spectrum required for MetAids operations. This is particularly critical when launch sites of these other users are within 150 km of the meteorological organization launch sites.

2 Characteristics of radiosonde operation

While many radiosonde operations are normally conducted on a specific schedule, operations can be conducted at any time of the day or night in response to specific operational requirements, atmospheric conditions, or testing requirements. Synoptic radiosonde observations are carried out worldwide to provide the observations necessary for daily weather forecasting. The standard observations are nominally performed at 0000 and 1200 UTC, but the actual launch times vary

according to national practice and in some cases will be at least three-quarters of an hour earlier than the nominal time. The launch may also be up to two hours later than nominal if there are problems with preparation of the radiosonde prior to flight, if local air traffic regulations limit launch times or if there is a malfunction during the initial flight. Intermediate observations at 0600 and 1800 UTC are also performed routinely in several countries. Additional radiosondes and dropsondes are launched periodically by synoptic operators, often from temporary sites using mobile systems, in response to abnormal weather or requirements for testing. Non-synoptic flights are scheduled to meet operational requirements.

The radiosonde networks are implemented and operated by national meteorological services in compliance with recommended practices and procedures internationally agreed upon by WMO. The current number of radiosonde stations reporting regularly is about 650. About 500 000 radiosondes are routinely launched in a year in association with the WMO network and it is estimated that about another 350 000 radiosondes are used for defense use and specialized applications.

3 Radio-frequency spectrum used in operations for WMO reporting

3.1 Results from WMO survey

Table 1 presents estimates of the radio frequency use at synoptic radiosonde stations reporting information daily for WMO meteorological data exchange. This information is based on the WMO Catalogue of Radiosondes and Upperwind Systems in use by Members. The survey results are grouped into regions to illustrate the variation in use worldwide. More detailed information is available from the WMO Catalogue of Radiosondes and Upperwind Systems in use by Members. Proposals for band segmentation would have to take account of the fact that frequency bands internationally allocated to MetAids on a primary basis are not available to this service in all countries. For instance, in Australia, at least half of the 403 MHz frequency band is currently not available for MetAids operations.

Use of the two main frequency bands allocated to MetAids (403 and 1 680 MHz frequency bands) varies widely in different parts of the world. Systems operating in the 1 680 MHz frequency band have been operated in the United States of America but are being replaced by 403 MHz systems. 1 680 MHz systems are operated primarily in Japan and China. These systems are providing synoptic data to the WMO GTS. Within these countries other users primarily use the 403 MHz frequency band for non-synoptic operations. Within Europe, the 403 MHz frequency band is used heavily to support synoptic radiosonde operations. Russia and some countries with cooperating arrangements use frequencies around 1 780 MHz for radiosonde operations. Many of the countries using 1 780 MHz radiosondes have transferred their operations to one of the two main allocated frequency bands in order to take advantage of commercially available equipment.

TABLE 1

Summary of radio frequency use for radiosondes for daily synoptic operations²

Region	Total number of sites	Total number of active sites	Number of silent sites ⁽¹⁾	Number of active sites using 400 MHz	Number of active sites using 1 680 MHz	Number of active sites using 1 780 MHz ⁽²⁾
Europe and Western Russia	192	154	38	112	28	14
Asia and Eastern Russia	471	288	183	95	158	35
Africa	237	60	177	58	2	0
North America	277	148	129	58	90	0
South America and Antarctica	114	86	28	84	0	2
Australia and Oceania	191	90	101	81	9	0
Ship systems	166	70	96	67	3	0
Overall	1648	636	752	555	290	51

⁽¹⁾ Silent sites are locations where operations have been suspended, but the site may become operational again in the future.

⁽²⁾ The 1 780 MHz band (1 774-1 790 MHz) is used in a few countries around the world but is not allocated to the meteorological aids service in the RR.

3.2 Radio-frequency spectrum used in Western and Northern Europe

In Western and Northern European areas the radiosonde network is dense, with stations operated for routine meteorological operations, environmental monitoring and a variety of defence operations. Most of the radiosondes are operating in the 403 MHz frequency band. Although some analog systems are still in use the majority of these radiosondes are now digital. In the near future it is expected that the analog systems that are still in use will be replaced by digital systems. Harmonized European standards covering the essential requirements for spectral mask and transmission power have been developed for all digital radiosondes used in Europe. There is no harmonized standard for analogue radiosondes and their use is based on national approval.

3.3 Radio-frequency spectrum used in North and South America

The civilian weather service in the United States of America had been the main user of the 1680 MHz frequency band but is moving radiosonde operations to the 400.15 to 406 MHz frequency band. Other users within the United States of America also utilize the 403 MHz frequency band. In addition large numbers of 403 MHz systems are deployed by the non-synoptic users. Additional systems are used by universities or other United States agencies.

² Data for this table were extracted from the WMO VOLA Legacy Report dated 05-18-2016.