

A global network of Regional ATOVS Retransmission Services (RARS)

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Abstract

This paper first introduces the definition and purpose of the RARS network. One of the main benefits of a RARS, based on a selection of H RTP stations and a regional processing and dissemination centre, is to improve timeliness with respect to global ATOVS data. The global network of RARSs will allow near-global sounding data availability in NWP centres within 30 minutes instead of 2 or 3 hours.

Three RARS are currently operational or pre-operational. The first one is the EUMETSAT ATOVS Retransmission Service (EARS). It ensures coverage of a large part of the northern hemisphere. The Asia-Pacific RARS has started to operate and the South-America RARS is being established. By the end of 2007, the global RARS network is expected to cover most of the globe. Potential expansion is being considered for the retransmission of other data types (ASCAT, IASI and AVHRR).

Purpose and background

The World Meteorological Organization (WMO) Space Programme is a crosscutting WMO Programme with three main objectives:

- To collect and express requirements from WMO programmes for space-based observations and related services,
- To strive for the implementation of a space-based component of the Global Observing System satisfying these requirements through space agencies of its Members,
- And to enhance the ability of the users community to make a wide and meaningful use of space-based capabilities.

Facilitating efficient and timely access to data and products is an important task serving these objectives.

Initiated by WMO and building on the example given by EUMETSAT, the RARS project responds to regional and global requirements for improved availability and timeliness of polar-orbiting satellite soundings. Its principle is to take advantage of direct broadcast to ensure timeliness but to merge the data of several receiving stations in order to avoid the limitations of a single local acquisition area.

The current focus of RARS is on ATOVS data, i.e. AMSU-A, AMSU-B or MHS and HIRS complemented by low resolution AVHRR data for local cloud information. HRPT stations contributing to the RARS collect ATOVS data from polar orbiting satellites by direct readout and transmit it to a regional processing and distribution centre. Each regional centre performs overall monitoring, coordination, and makes the data available for use by NWP centres.

The EUMETSAT ATOVS Retransmission Service (EARS) has been operational since 2002. Building on EARS, WMO and the Coordination Group for Meteorological Satellites (CGMS) have set the goal to implement similar services for every region of the globe and adopted "RARS" as a generic name for these regional services. It is planned that RARS initiatives will be part of a global network ensuring coordination of efforts, mutual exchange of good practices, and data consistency. RARSs were subject to two recommendations of ITSC 14th requesting WMO to promote the implementation of a globally coordinated system of RARS. Three workshops have been held during 2004-2006 to support this goal and a RARS implementation group is being established.

RARS requirements and standards

Global and regional NWP requirements for sounding are defined through the Rolling Requirements Review process and are recorded in the CEOS/WMO Data Base on User Requirements and Observing Capabilities. They are recalled in Table 1. In this table, two values are indicated for each criteria: a threshold (or minimum performance) and a goal (or maximum performance). The timeliness goal in this Table is 1h for global NWP and ½ hour for Regional NWP. Noting that these figures are being reviewed by the relevant expert teams, it was decided that the RARS network should aim at a 30-minute timeliness.

A first version of RARS standards was established during the 2nd Global RARS workshop in December 2005. They are defined in three areas, the publication of service information, the maintenance and operations and the product processing and format. In the latter area, it was agreed to use a common pre-processing software to ensure global consistency, i.e. AAPP from the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF). Any products exchanged inter-regionally should be in BUFR format and at level 1c. Processing from level 1a to level 1c shall be done centrally in order to ensure better calibration result. Any products distributed shall include quality flags; the HRPT station identifier shall be defined in coordination with WMO.

Table 1. Global and regional NWP requirements for sounding

Products		Horizontal resolution	Vertical resolution	Observation Cycle	Accuracy	Delay	Confidence
Global NWP requirements							
Atmospheric temperature profiles	High Troposphere, stratosphere and mesosphere	50/500 km	1/3 km	1/12 h	0.5/5 K	1/ 4 h	Reasonable
	Lower stratosphere	50/500 km	1/3 km	1/12 h	0.5/3 K	1/ 4 h	Firm
	Lower troposphere	50/500 km	0.3/3 km	1/12 h	0.5/3 K	1/ 4 h	Firm
Specific Temperature profiles	High troposphere	50/250 km	1/3 km	1/12 h	5/20 %	1/ 4 h	Firm
	Low troposphere	50/250 km	0.4/2 km	1/12 h	5/20 %	1/ 4 h	Firm
	Total column	50/500 km	/	1/12 h	1/5 kg/m ²	1/ 4 h	Firm
Regional NWP requirements							
Atmospheric temperature profiles	Higher troposphere	10/500 km	1/3 km	0.5/12 h	0.5/3 K	0.5/2 h	Firm
	Lower stratosphere	10/500 km	1/3 km	0.5/12 h	0.5/3 K	0.5/2 h	Firm
	Lower troposphere	10/500 km	0.3/3 km	0.5/12 h	0.5/3 K	0.5/2 h	Firm
Specific Temperature profiles	High troposphere	10/100 km	1/3 km	0.5/12 h	5/20 %	0.5/ 2 h	Firm
	Low troposphere	10/100 km	0.4/2 km	0.5/12 h	5/20 %	0.5/ 2 h	Firm
	Total column	10/250 km	/	0.5/12 h	1/5 kg/m ²	0.5/ 2 h	Firm

Status of the different RARS

- EUMETSAT Advanced Retransmission Service (EARS)

EARS has been the model for the implementation of the other RARS networks. It currently includes 10 HRPT stations (they are listed in Table 2), ensuring coverage over Northern Polar Regions, Europe, North Africa and North-America as described in Figure 1.

Data are distributed via the EUMETSAT multi-purpose multicast service EUMETCast and/or via the WMO point-to-point Global Telecommunication System (GTS) as shown in Table 3.

Furthermore, EUMETSAT has undertaken pilot activities to expand the scope of EARS, provisionally, on a subset of the EARS stations:

- 7 HRPT stations will ensure Metop/ASCAT data retransmission

- 5 HRPT stations will ensure AVHRR data retransmission. This is achieved within about 10 minutes thanks to the use of a 1-minute data segmentation process.
- Retransmission of IASI data from Metop is planned.

EARS was renamed “EUMETSAT Advanced Retransmission System” in order to reflect this wider scope that goes beyond ATOVS.

Table 2 - EARS HRPT stations

Regional Centre	HRTP station	Location (lat., long.)	HRTP station	Location (lat., long.)
Darmstadt	Athens	38.0°N, 23.44°E	Dartmouth	447.74°N, 63.67°W
	Edmonton	53.33°N, 113.5°W	Gilmore creek	64.97°N, 147.40°W
	Kangerlussuaq	66.98° N, 50.67°W	Lannion	48.75°N, 3.46°E
	Maspalomas	27.78°N, 15.63°W	Monterey	36.35°N, 121.55°W
	Svalbard	78.25°N, 14.4°W	Wallops	37.8°N, 75.3°W

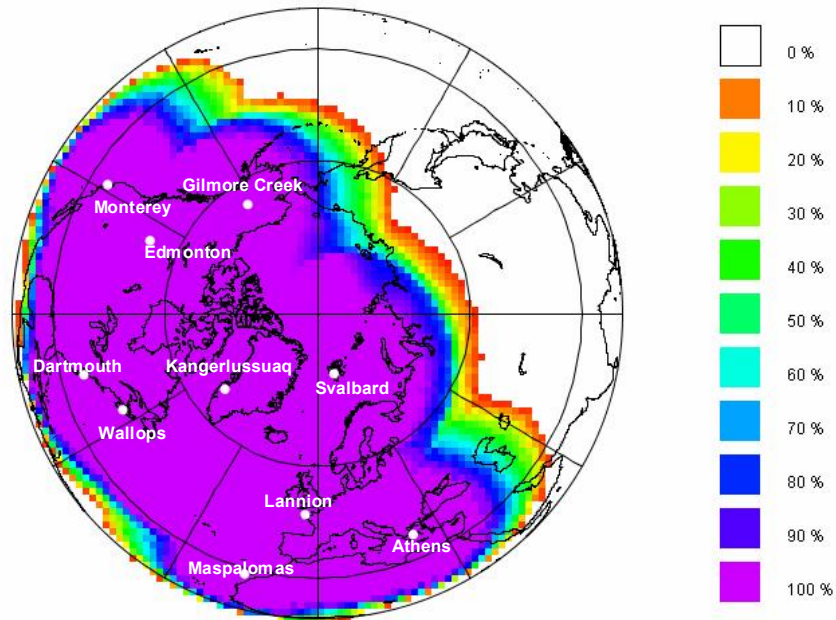


Figure 1. EARS coverage for ATOVS data in November 2006

Table 3 – EARS data content and distribution

	Products	Level and format
EUMETCast Ku-band Europe	ATOVS on original instrument grid	Level 1a, AAPP Level 1c, BUFR
	AVHRR derived cloud mask on HIRS grid	BUFR
GTS	ATOVS on original instrument grid	Level 1c, BUFR

- Asia-Pacific RARS (AP RARS)

The AP RARS currently includes 10 HRPT stations from China, Korea, Japan and Australia and two regional centres, one in Melbourne and one in Tokyo as described Table 4. It is coordinated by David Griersmith from Australian Bureau of Meteorology (AboM). Five stations are to be added by the end of 2006 thus allowing the AP RARS to provide wide coverage over Asia, Southern and Western Pacific.

Table 4. Implementation of the Asia-Pacific RARS

Processing/ Dissemination Centre	HRPT stations providing ATOVS data			
	Available in September 2006		To be added by December 2006	
Tokyo	Tokyo-Kiyose	35.77°N, 139.53°E		
	Syowa (Antarctica)	69°S, 39.58°E		
	Seoul	37.48°N, 126.92°E		
	Beijing	39.93°N, 116.28°E		
	Guangzhou	23.13°N, 113.3°E		
	Urumuqi	43.78°N, 87.6°E		
Melbourne	Melbourne-Crib Point (2 stations)	37.88°S, 144.96°E	Singapore	1.3°N, 103.83°W
			New Zealand	41.3°S, 174.5°E
			Hong Kong	22.15°N, 114.10°E
	Perth	31.95°S, 115.89°E	Vladivostok	43.08°N, 131.54°E
	Darwin	12.46°S, 130.84°E	Honolulu	21°S, 157.5°E

Some preliminary feedback of positive impact have been provided by NWP centres. Around 85 % of the data collected by the HRPT stations are retransmitted through RARS network and available for assimilation by NWP centres within less than 30 minutes.

- South American RARS (SA RARS)

The SA RARS is still in development and testing phase. Work is being done on the implementation of the AAPP pre-processing software and the optimization of communication means to concentrate the data from HRPT stations in Regional Centres and to distribute the data from Regional Centres to NWP Centres. In its first phase of implementation, the SA RARS will include 7 HRPT stations and two centres of retransmission as described Table 5.

Table 5. Implementation of the South-American RARS

Processing/ Dissemination Centre	HRPT stations providing ATOVS data			
	Planned in first stage		Considered expansion	
INPE/CPTEC (Brazil)	Fortaleza	3.47°S, 38.32°W	Peru Chile (TBC) Central-America	
	Natal	5.5°S, 35.15°W		
	Cachoeira Paulista	22.68°S, 45°W		
	Brasilia	15.45° s, 47.57°W		
	Manaus	3.09°S, 59.56°W		
	Cuiaba	15.55°S, 56.07°W		
Cordoba Argentina	Cordoba	33.38°S, 70.78°W	Marambio (Antarctica)	64.23°S, 56.72°W

- Resulting coverage

EARS ensures coverage over a large part of the Northern Hemisphere. AP RARS is starting to operate and covers most of the Asia-Pacific region except Eastern Pacific. The SA RARS will cover South-America and the South-West Atlantic, and has become the new priority. By the end of 2007, the overall coverage of the RARS network is expected to be as described in Figure 2.

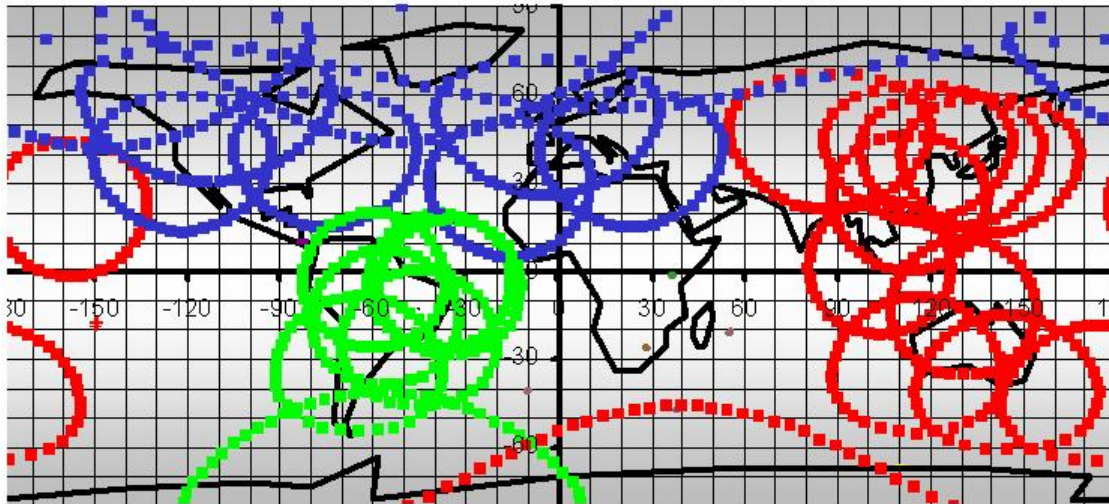


Figure 2. Expected coverage of the global RARS network by the end of 2007.
In red, the AP RARS; in green the SA RARS and in blue EARS

- Global monitoring

It is planned to receive support from the EUMETSAT SAF on NWP operated by the UK Met Office for monitoring data quality and overall consistency across the global RARS network.

Potential future developments

- Geographical expansion

Current plans still leave a gap over Africa and Eastern Pacific. Some investigations had been initiated with Météo-France and South Africa on the possible use of data from Reunion, Gough and Marion Islands and Pretoria HRPT stations. If these considerations could be confirmed, it would result in the coverage presented on Figure 3 and partly fill the gap over Africa.

As for Eastern Pacific, some potentialities need to be further investigated.

- New data sets

Following the example given by EUMETSAT with EARS, it is considered to extend the RARS concept beyond ATOVS data, especially for advanced sounders (IASI) data and scatterometer (ASCAT) data.

It might also be considered to include AVHRR imagery depending on the requirements and on the impact on telecommunications bandwidth and cost. This would be an attractive and cost-effective solution for many users. It should be furthermore noted that RARS can provide full resolution near-global AVHRR data from NOAA/POES, which are not available within the global “stored mission data”, since they are not stored aboard the satellite at full resolution for the entire globe, but only at reduced resolution through the Global Area Coverage (GAC) mission.

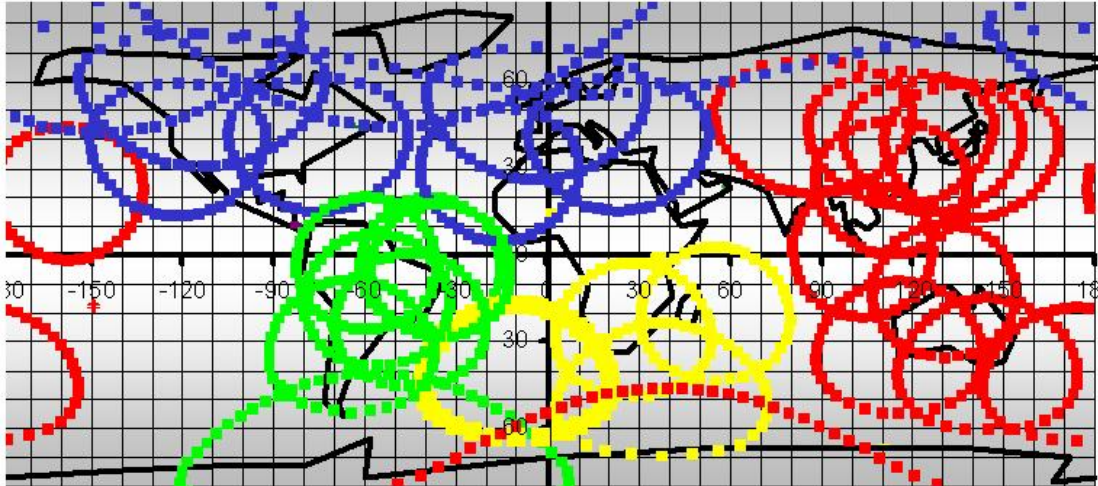


Figure 3. Expected coverage of the global RARS including the potential expansion to Africa in yellow

Conclusion

The global RARS network will provide a valuable trade-off between timeliness and coverage as it will ensure near global data availability within 30 minutes. It is particularly cost-efficient since a limited number of HRPT stations are needed to ensure near global coverage and since low cost dissemination and communication means can be used.

By the end of 2007, RARSs are expected to ensure quasi-global coverage, improved timeliness and improved data consistency. The WMO RARS website, planned for 2007, will enhance user information.

Thanks to the worldwide coordination of activities, the RARS network will allow enhancing the benefit from polar-orbiting satellites, in particular as concerns their sounding missions.

Acknowledgements

EARS: EUMETSAT, DMI, HNMS, INTA, KSAT, Météo-France, MSC/CMC, NOAA

AP RARS: ABoM, CMA, JMA, KMA

SA RARS: CONAE, INMET, INPE/CPTEC, SMN

Monitoring : NWP SAF and UK Met Office

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