WMO Space Programme data access challenges

Update on the RARS initiative

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***Abstract*—The paper highlights current challenges of ensuring timely access worldwide to environmental satellite data and products for WMO programmes in meteorology, climate, related applications and space weather. New initiatives are required to meet evolving needs. An update is provided on the Regional ATOVS Retransmission Service (RARS) as an example of cost-efficient trade-off between timeliness and completeness to acquire data from Low-Erath Orbit satellites.**

Keywords: data accessibility, timeliness, RARS

I. INTRODUCTION

The World Meteorological Organization Space Programme aims to expand the space-based observing system for weather, climate and related environmental issues, and to facilitate the access to, and use of satellite data and products worldwide. This activity is now expanding to space weather.

User surveys are regularly pointing to data access as a major limiting factor to the optimal use of satellite data and products. This issue is addressed at different levels: (i) organizing the user community to express precise requirements and engage in a dialogue with data providers; (ii) setting up portals to facilitate the discovery of available data and products and inform on data access mechanisms; (iii) supporting standardization of data and metadata formats and transmission protocols for data exchange; (iv) encouraging data retransmission satellites via Digital Video Broadcast (DVB) systems; and more generally (iv) reviewing the overall data dissemination concept in order to adapt to various and evolving user needs and technical capabilities.

II. DATA ACCESS CHALLENGES

A. Data explosion

The evolution of Earth observation satellite capabilities over the current decades results in an exponential increase of satellite raw data rates and of the amount of data the users have the potential to exploit. A parallel evolution of information and telecommunication technology offers ever improving solutions to acquire, manage, distribute and store these data. Although it is always a challenge to reach out to users in developing countries, data dissemination is greatly facilitated by cost-efficient means such as re-broadcast by telecommunication satellites in DVB-S/S2 standard, or ftp access to data or products from data centres. However, the new paradigm of Earth Observation satellite data access reveals new challenges.

B. Sustainable data management

First of all, data and metadata standardization has become a prerequisite, e.g. in the WMO Information System (WIS), in order to ensure efficient data discovery and interoperability. Furthermore, there is an increasing perception that it would not be a sustainable goal for all potential users to systematically acquire and process all the raw data; instead, a widely accessible set of raw data should be supplemented by high level products generated by specialized centres and made available to the community, hence the importance of rigorously documenting these products and demonstrating their quality. Finally, the increasing societal demand for climate monitoring and climate services reinforces the importance of following best practices for data stewardship and long-term data preservation.

C. Direct Broadcast

An essential feature of meteorological satellites since the 1960's is their Direct Broadcast capability by which observation data acquired by the spacecraft are continuously transmitted in a publicly accessible data stream, thus allowing a user with a direct readout station to receive these data in real time when the satellite is in his area of visibility, which often is the primary area of interest. As data rates have evolved from a few kb/s to almost 100 Mb/s, larger bandwidths and higher frequency bands are required, moving from the old VHF to L-Band and X-Band. While the use of X-Band is necessary to accommodate high data rates, the L-Band allocated to meteorological satellite services remains highly needed because it is less affected by rain than X-Band, which is of primary importance for meteorological systems.

III. AN EXAMPLE: RARS

A. Access to Low-Earth Orbit satellite data

The near-real time access to data from non-geostationary satellites, such as the constellation of sun-synchronous polar-orbiting meteorological satellites, poses a particular technical challenge because of the necessary trade-off between coverage and timeliness. On one hand, acquiring data by a direct readout stations enables real-time access but its coverage is limited to data in the acquisition area of the station, typically two of four times a day during 10-15 minutes. On the other hand, acquiring full-orbit data recorded aboard the satellite enables access to the whole global data set, but with the drawback of data storage until it can be dumped to a ground station, which increases data latency by up to 100 minutes.

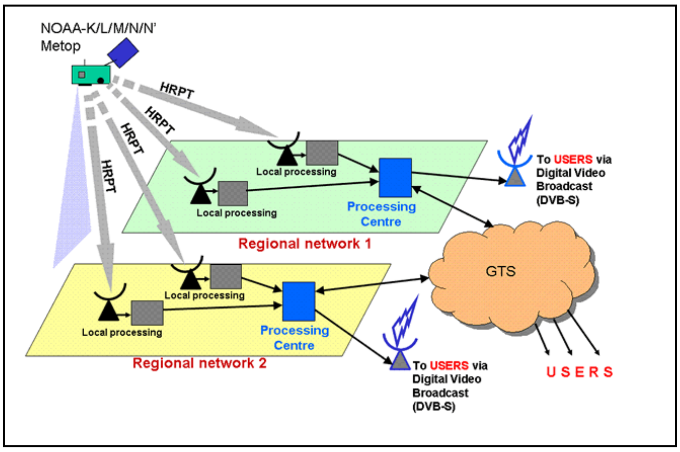

Fig. 1. Schematic diagram of the RARS network

B. *RARS concept*

Several approaches have been developed to find the best trade-off between these two options, either through adding additional ground stations to reduce on-board data latency, or through sharing data from a network of direct readout stations operating in a coordinated manner and redistributing the data through different means. The latter is the option taken in the so-called Regional ATOVS Retransmission Service (RARS) concept illustrated in Fig.1, whose initial objective is to deliver satellite atmospheric sounding data from at least 90% of the globe, within 30 minutes from acquisition for ingesting into for Numerical Weather Prediction models.

C. *RARS status*

The global RARS network is comprised of three components:

- The EUMETSAT Advanced Retransmission System (EARS) managed by EUMETSAT covers mainly the European, central Asian and Atlantic areas and involves 18 stations from Canada, Denmark, France, Greece, Norway, Oman, Russian Federation, Spain and the USA;

- The Asia-Pacific RARS coordinated by the Bureau of Meteorology, Australia, with one telecommunications node in Melbourne and another in Tokyo, involves 16 stations from Australia, China, Japan, Republic of Korea, New Zealand and Singapore;

- The South America RARS with one coordination node in Argentina and another in Brazil, involves 6 stations from Argentina, Brazil, and Chile.

Interoperability of the data sets from these different stations is ensured through the adoption of standard practices regarding data formats, coding, and pre-processing software. A global monitoring is performed to check the timeliness, integrity and consistency of the datasets. Different means are available to make RARS data globally available, either using rebroadcast by telecommunication satellite beams, or point-to-point telecommunication within the WMO Information System, and/or FTP transfer from regional nodes to major user centres.

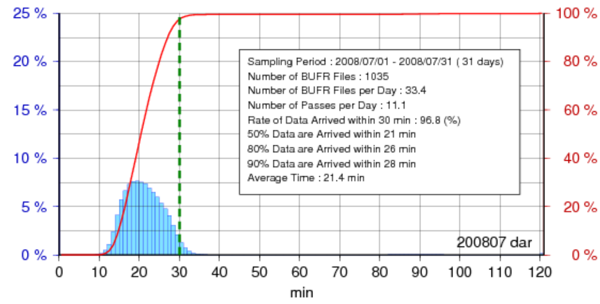

Fig. 2. Time period between observation and receipt of each data set

Currently, the RARS system involves more than 40 direct readout stations which altogether enable the acquisition of satellite sounding data from around 80 % of the globe with a target of maximum 30-minute data latency. Additional stations are being considered in order to fill residual gaps in the South Pacific and South Atlantic areas. The RARS initiative has nearly completed its first objective, in terms of both timeliness (Fig.2) and quasi-global coverage (Table 1).

TABLE I. CURRENT AND PLANNED NETWORK STATUS

Regional component	**Number of stations current (planned)**	**Fraction of global coverage**
Europe/Atlantic	18 (19)	40% (41%)
Asia-Pacific	16 (19)	30% (36%)
South America	8 (9)	14% (17%)
Overall network	**42 (47)**	**77% (84%)**

D. *Perspectives*

The main ongoing development is to extend the RARS initiative to the collection and retransmission of additional sensor data, in particular advanced hyperspectral infrared sounders. Since data volumes are orders of magnitude higher than for traditional sounders the network operation must be optimized by selecting stations with minimum overlap with each other, and by sampling the data through channel selection, data reduction and compression.

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