SERVICE EUMETSAT AS AN INTEGRATION INTO THE GEO SYSTEM IN KAZAKHSTAN

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Abstract

The GEO Office in Kazakhstan was created as a result of project “GEO Capacity Building Initiative in Central Asia” to study the best European practice and to develop strategic plans for the development of regional GEO capacities, as well as educational and research geo-environmental monitoring. The demands of Kazakhstan in the monitoring of Earth systems were estimated. The road map “National actions in the monitoring of Earth ecosystems” oriented on the possibility of its integration into the GEO system has been developed. Further international cooperation and exchange of the data of monitoring of Earth ecosystems will enable us to obtain additional information for scientific research based on the data of Earth observations.

Introduction

There is not a single system that could satisfy all requirements to observations necessary for understanding of the Earth system, monitoring of its state, analysis of changes in the state of atmosphere-surface system, in particular, climate changes on our planet and forecasting of such changes in the future. To fulfil all these requirements it is necessary to have contribution of different observation systems including satellites.

The specificity of measurements of atmospheric parameters is determined by the following factors:
- the necessity to measure a great number of characteristics of the atmosphere and surface;
- Measurements must cover a wide range of spatial scales of atmospheric processes and phenomena;
- Research and control of the state of the system must be carried out over large areas including global areas;
- It is necessary to monitor the external cosmic factors;
- It is necessary to take into account a huge range of time scales of studied phenomena and processes;
- It is necessary to carry out continuous long-term monitoring of the atmosphere- surface system and forecasts for different periods.

Satellite Observation System includes operational polar and geostationary satellites and a number of research satellites.

Polar satellites provide regular operational information on the vertical profiles of temperature and humidity, geostationary satellites register characteristics of wind fields in tropics and many other parameters. Geostationary satellites provide information about the state of the atmosphere and surface in the middle and tropical latitudes, with a high frequency (15-30 min).

In addition to the data from operational satellites, a significant amount of information is collected from a variety of scientific research satellites of different countries. Various devices on research satellites make it possible to determine different parameters of atmosphere and surface in scientific and research purposes. They determine various cloud properties, vertical profiles, concentrations of ozone and a number of trace gases, optical and microphysical properties of aerosols, water content of clouds, intensity of precipitations, etc.

Active methods of determining of vertical temperature profiles using the radio occultation by means of satellite navigation systems and specialized satellites are developed. This method uses artificial sources of electromagnetic radiation. Navigation systems not only determine routes for navigation but also enable scientists to carry out remote sensing of the earth's atmosphere to determine its parameters. This is possible because the speed of propagation of radio signals from GPS satellites decreases in the atmosphere because the refractive index of air n> 1. Furthermore, trajectories of radio rays get curved due to the exponential decrease in the density and refractive index of the atmosphere with height.

These two factors increase the propagation time of radio signals between the satellite and the GPS receiver in the atmosphere as compared with the same time in vacuum. In this connection, a new direction of research, sometimes called “GPS meteorology", appeared, the purpose of which is to extract useful information on atmospheric parameters from the specified time lag of GPS radio signals in the atmosphere.

There are two main directions in GPS Meteorology:
1) Satellite radio occultation of the atmosphere,
2) Ground-based GPS observations.

Satellite observations are carried out by the receivers installed on board of low-orbit (altitude of 200-1000 km) satellites. These receivers get signals from GPS satellites in geostationary tangent orbits, which are then used to determine the curvature of the trajectory and the deflection angle of the radio beam in the atmosphere. Under certain assumptions (for example, spherical symmetry), changes in the deflection angle of the radio beam with height can give information about the vertical profile of the refractive index, density and temperature in the middle atmosphere. In the stratosphere, where the effect of refraction of water vapour is very small, the vertical profile of temperature is determined. In the troposphere, if the temperature profile is known, the vertical humidity profile is determined.

The access to information from geostationary and low-orbit satellites specified is available for us through the GEO office located in Alma-Ata. In the Environment Programme of the European grant SEOCA “GEO Capacity Building Initiative in Central Asia” of the VII Framework Program of the European Community aimed at studying of the best European experience, development of the strategic plans of the regional GEO facilities, training and carrying out of GEO-ecological monitoring of the environment and creation of the terminal providing access to the ecological data on the base of the European GEONETCast distribution/exchange system we created Account on Earth Observation Portal EUMETSAT. We were granted licenses by EUMETSAT, (the period of their validity is 31/12/2014), and got access to the following subscribed services.

1. Geostationary Image Data Services:
1.1. Meteosat Rapid Scanning Service 9.5 degrees East,
1.2. High Resolution Image Indian Ocean (1/2-hourly data transmissions).
2. EUMETSAT Application Ground Segment.
2.1. Central EUMETSAT Products: Meteosat Rapid Scanning Meteorological Products 9.5 degrees East, EUMETSAT Metop ASCAT Surface Soil Moisture, AVHRR Polar Winds.
2.2. EUMETSAT Satellite Application Facilities Products: Land Surface Analysis Applications, Ozone & Atmospheric Chemistry Applications
3. Global Data Service: Metop AVHRR, NOAA AVHRR, NPP ATMS, NPP CrIS
4. Third Party Data: MODIS thinned level 1 products, MODIS Global Fire products, MODIS Total Precipitable Water products, NASA-SERVIR.

The terminal provides access to satellite information based on the European System of dissemination/exchange of meteorological data. The portal organization EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) for Earth Observation has an account providing the right for getting information through the channel of satellite communication, as shown in Figure 1.

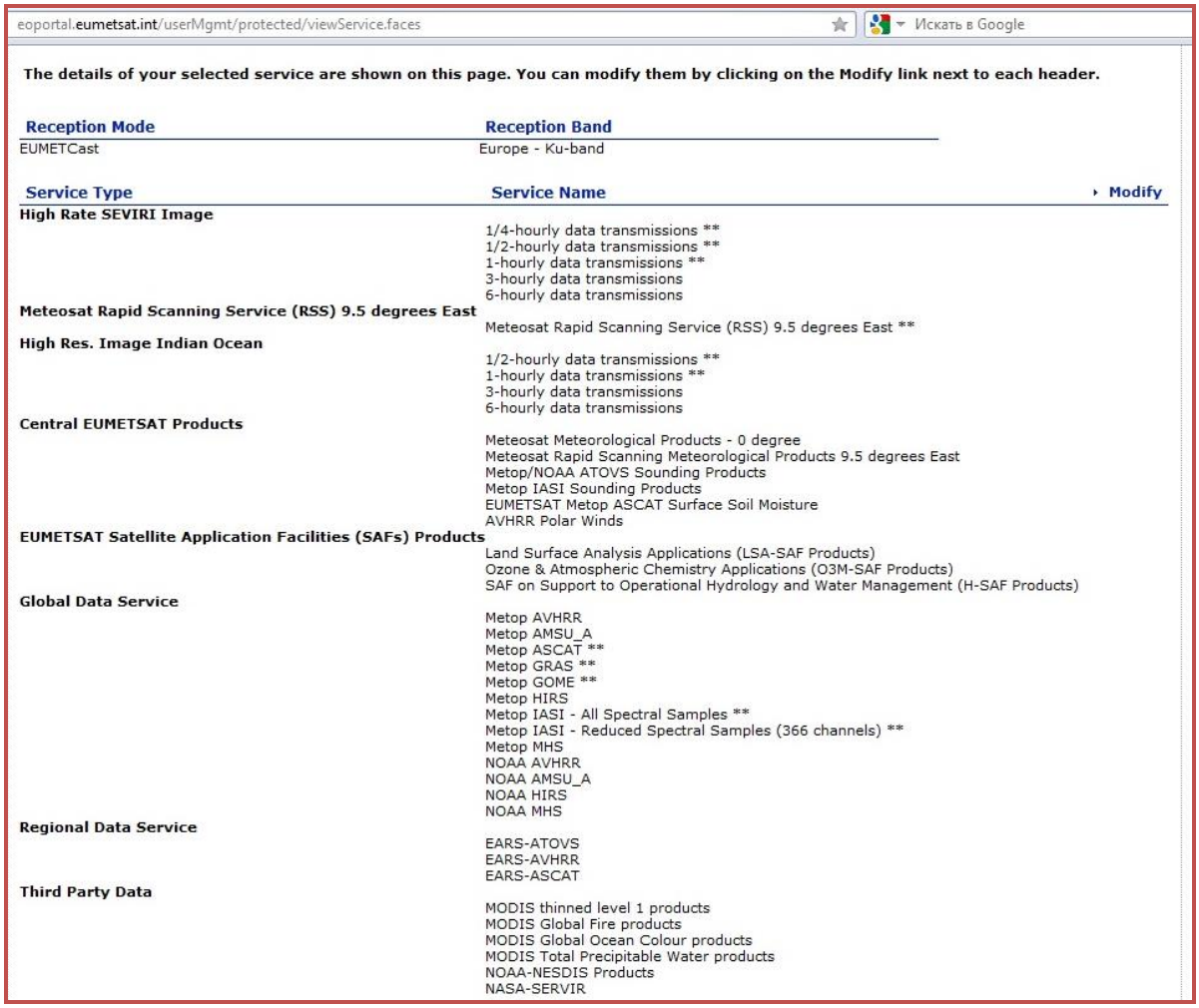

Figure 1: **Site Eumetsat, inlay "Services".**

Available Services are set to receive channels of the station as shown in Figure 2.

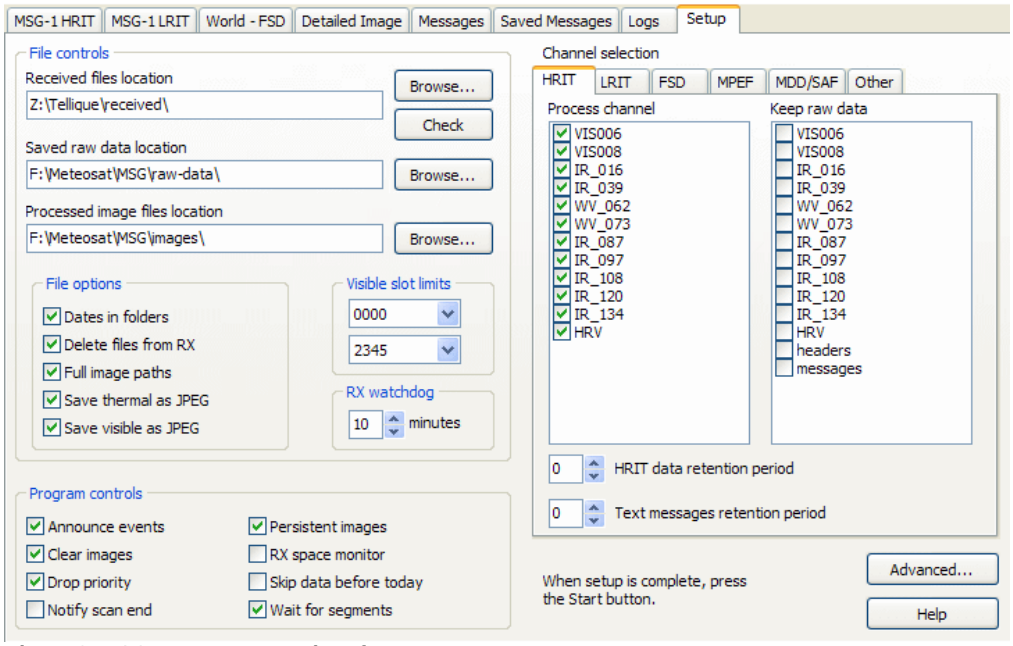

Figure 2: **MSG Data Managaer interface .**

Reduced and uncharged images of radio-brightness temperature in Kelvin obtained as a result of information processing of ATMS radiometer and CRIS spectrometer data for October 13, 2013, are presented in Figures 3 and 4, respectively.

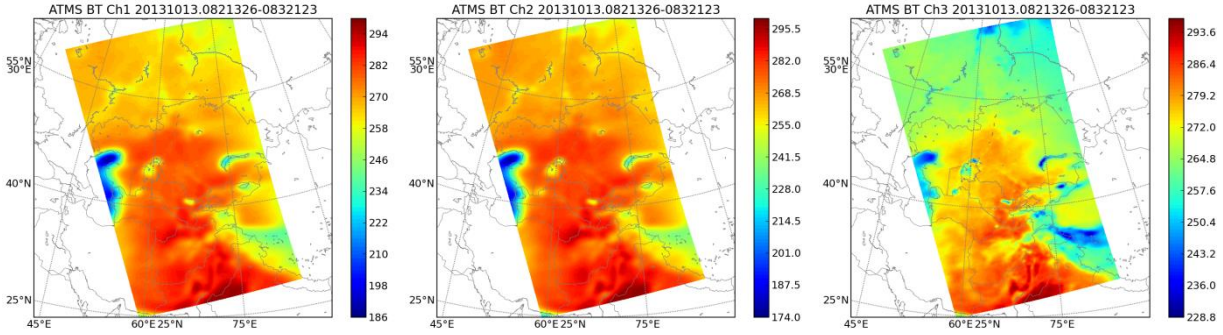

Figure 3: **Images of ATMS 1-3 channels in brightness temperature.**

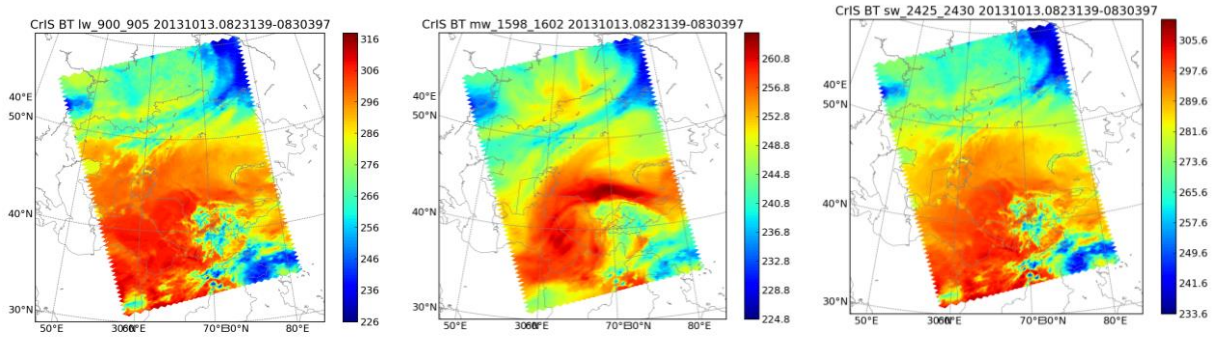

Figure 4: **CRIS data (lw, mw, sw) in brightness temperature.**

The combined use of different methods of measurements of atmospheric parameters, having their own advantages and disadvantages, make it possible to satisfy requirements to measurements of atmospheric parameters and to solve the numerous scientific and applied problems.

This is particularly important in connection with the problems of climate change and the destruction of the Earth's ozone layer of our planet. The consequences of these processes are difficult to predict with reasonable certainty, but they can lead to undesirable environmental, economic and social consequences (changes in temperature, precipitation, sea level rise, increased ultraviolet illumination of the earth surface, etc.).