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ROSHYDROMET
Agenda Item:

CAL/VAL ACTIVITIES IN ROSHYDROMET

No actions required

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Roshydromet as an operational agency is responsible for the exploitation of existing Russian meteorological satellites. Along with this, Roshydromet and Roscosmos are developing the constellation of the next generation LEO, GEO, and HEO meteorological satellites. Thus there is a strong need for dedicated calibration and validation (CAL/VAL) activities with respect to satellite hydrometeorological data and Level 2 (L2) products. CAL/VAL of satellite data and products are critical for many applications. Roshydromet aims at using all available satellite hydrometeorological data for climate change studies, numerical weather prediction, etc.

In order to achieve this purpose Roshydromet has started the deployment of ground-based calibration/validation system for satellite data and L2 products in frame of Russian Federal Space Program 2006–2015. The system should include several CAL/VAL facilities based on Roshydromet observation network as well as on the measurement sites of other institutions, such as Russian Academy of Sciences (RAS), Saint Petersburg State University etc. An aircraft owned by Roshydromet is planned to be utilized in the future.

The main objective of CAL/VAL system:

- Post-launch calibration and characterization of in-orbit calibration performance for current and future Russian LEO, GEO, and HEO meteorological satellite instruments;
- Validation of L2 products.

The list of instruments for calibration monitoring includes: MSU-MR scanning radiometers, MSU-GS imager, IRFS-2 (IR) and MTVZA (MW) sounders (Meteor-M, Electro-L).

A lot of L2 products require validation, including vertical profiles of temperature and humidity, cloud cover analysis, sea and land surface temperature, characteristics of snow, ice and vegetation cover, atmospheric motion vectors, concentration of trace gases and aerosol, etc. Validation means the assessment of L2 products accuracy and reliability based on comparison with reference data (with known accuracy). It is performed to ensure user confidence in satellite-based products.

It has long been recognized that miscellaneous observations of atmosphere state parameters (ground- and aircraft-based) required for successful validation of L2 products. Because of this, several CAL/VAL facilities have to be established based on Roshydromet ground-based observation network, as well as on the other institutions' measurement sites. A brief overview of the proposed CAL/VAL facilities (in the vicinity of Saint-Petersburg) is given below.

A list of observations performed at Peterhof (Saint-Petersburg State University, 59°54´N, 29°48´E) and Voeikovo (Main Geophysical Observatory, 59°58´N, 30°18´E) is as follows:

- Measurements of the total column (TC) and vertical profiles of more than 20 gases – the spectroscopy of the direct solar IR radiation with a high spectral resolution;
- Measurements of O_3 and NO_2 TC – DOAS method;
- Microwave sounding of ozone profiles;

- Microwave sounding of temperature, humidity profiles and the cloud water content (0–15 km);
- Measurements of aerosol optical depth (AERONET);
- Lidar aerosol sounding;
- Measurements of near-surface concentrations of green-house and pollutant gases.
- Standard meteorological observations at weather station and actinometrical observations (direct solar, total, diffused radiations, radiation budget);
- Radio-sounding (vertical temperature profiles of the atmosphere, pressure, humidity, wind speed and direction);
- Meteorological radar observations of clouds and severe weather events;
- Microwave measurements at λ = 1.4 cm and λ = 0.8 cm for atmospheric water vapour and cloud liquid water content estimation;
- Observations of the total ozone column and UV-radiation;
- Total column measurements of greenhouse gases (CH_4, CO_2).

Other CAL/VAL facilities will include different measurement sites of Arctic and Antarctic Research Institute; Valdai branch of Russian State Hydrological Institute; P.Shirshov Institute of Oceanology RAS, Gelenjik site; V.Sukachev Institute of Forest, Siberian Branch of RAS, ZOTTO site.

Last part of WP addresses the development of inter-calibration technique for MSU-GS instrument (Electro-L basic payload).

Currently the different methods and techniques are used for post-launch calibration (stability monitoring, correction, quality assurance) of satellite sensors. Together with various versions of “vicarious calibration” the inter-calibration technique now is a rather efficient tool to provide reliable, accurate and consistent sensors during the lifetime of the mission. The development and implementation of inter-calibration techniques in national space agencies and remote sensing organizations is coordinated by GSICS.

In general, inter-calibration involves the comparison of observations from one **monitored instrument** to another, defined as the **reference instrument**, see (G. Chander et al, 2013, Overview of Inter-calibration of Satellite instruments. IEEE Trans. Geosci. Rem. Sens., v.51, №3). In our case the monitored instrument is imaging radiometer MSU-GS on board Electro-L geostationary satellite (IR channels). Several options are available as the reference instrument. The key features of any reference instrument are radiometric stability (it must be accurately calibrated and well characterized) and suitable spectral coverage allowing to cover the channels of monitored instrument (to provide full representation of the monitored instrument’s SRF). Along with this the satellite orbits of reference instrument must allow coverage of the same geographic areas ideally at the same time.

One of the options for reference instrument is SEVIRI/Meteosat-9 (-10), i.e. GEO-to-GEO inter-calibration scheme is realised. The main disadvantage of this scheme is that the same pixel is viewed from different angles by MSU-GS and SEVIRI instrument. There is no ray matching, so MSU-GS and SEVIRI pixel zenith angles have to be taken into account using so called Radiative Transfer Modelling method.

The second option is to follow GSICS recommendations and to use hyperspectral IR sounder (AIRS/EOS Aqua, IASI/Metop) as reference instrument. In this case GEO-to-LEO inter-calibration scheme is being realised.

To develop GEO-to-LEO inter-calibration tool, some preliminary experiments have been carried out with inter-calibration SEVIRI channel 9 and AIRS data. In order to minimize the influence of zenith angles difference the AIRS pixels have been selected with zenith angles close to zero. The criterion of suitable SEVIRI pixels choice is $\cos\theta > 0.995$, where θ is zenith angle. To eliminate uncertainties related to cloud contaminated data both measured and simulated (AIRS-based) brightness temperatures T_B in SEVIRI channel 9 have been sorted from minimum to maximum values. All the minimum and maximum values were discarded, so there were only ones utilised that represents cloud-free measurements.

Then an inter-comparison of measured and simulated T_B has been performed for 5 days in January 2013. The region of interest is the Gulf of Guinea. The mean difference between both T_B is found to be about 0.4K. It can be treated as SEVIRI calibration uncertainty.

This methodology is currently being extended to develop inter-calibration tool to inter-compare MSU-GS imager to AIRS and IASI data.