Guidance on the provision of instrument performance monitoring from space agencies to users

Operational NWP centres and many other users rely on stable observation characteristics to enable exploitation of a wide variety of satellite observations. To aid with monitoring the stability of these observations, ITWG has long recommended that space agencies provide dedicated and publicly available websites that display the up-to-date evolution of key instrument and satellite parameters for all of their relevant instruments. The current document is intended to clarify which aspects are considered most useful from a user's perspective, and to provide guidance on which key parameters should be displayed.

1) Background and scope

At NWP centres, the stability of the observation characteristics is typically monitored through time-series of statistics of the differences between observations and model equivalents calculated from a short-range forecast ("background departures). When anomalies are detected in these background departure statistics, appropriate action needs to be taken to protect the quality of the forecast. Anomalies include, for instance, sudden changes in bias or instrument noise, slow drifts in these quantities, etc. When faced with such an anomaly, NWP centres will first cross-check departure statistics between different instruments or from different NWP centres in order to diagnose the potential origin (e.g., from https://nwp-saf.eumetsat.int/site/monitoring/nrt-monitoring/). But to further diagnose and analyse the issue, instrument diagnostics information can be key, and this is often not accessible to users with the disseminated data.

A wealth of information on the health and status of a given instrument is typically available with the level 0 data or in the data processing performed at space agencies. The instrument calibration, for instance, produces information on the gain or the instrument noise. Temperature information tends to be available from various parts of the instrument, such as from the calibration black body or the instrument's reflectors, etc. While it is not practical to disseminate all this information as part of the calibrated level 1 data, some space agencies display such information on dedicated websites in the form of time-series. One example is the ICVS monitoring provided by NOAA-Star (https://www.star.nesdis.noaa.gov/icvs/). CMA provide similar information for some of the FY-3C instruments (http://gsics.nsmc.org.cn/portal/en/fycv/ipm.html). Access to such diagnostic information via these websites has been found extremely helpful for users to analyse observation anomalies, to either confirm or rule out suspected issues for a given instrument.

Given the experience with instrument performance monitoring websites, ITWG has for some time recommended to all space agencies to provide similar monitoring information for their respective instruments on publicly available websites. Here, we aim to clarify which aspects are considered most useful from a user's perspective and

provide guidance on the key parameters to be displayed. The current document should be understood as a guide for a base-level implementation of such a website based on parameters that should already be routinely available in most cases, without being too prescriptive. It is recognised that the availability of some parameters will depend on the instrument and processing applied, so will need to be adapted to what is available.

2) High-level description of the content of an instrument performance monitoring website

Instrument performance monitoring websites display relevant instrument parameters in near-real-time per satellite and instrument, in a consistent way for all relevant instruments/satellites. An examples of a comprehensive website is the ICVS monitoring provided by NOAA-Star (https://www.star.nesdis.noaa.gov/icvs/). Note that the current document specifically covers the monitoring of instrument parameters. Some space agencies additionally provide statistics of observations minus model equivalents similar to what is available from monitoring of background departures at NWP centres, and these are not captured here.

The instrument and satellite parameters should be displayed as time-series (per channel where applicable), with optional temporal averaging as appropriate. Different plots should be provided for different lengths of time. These should cover as a minimum:

- In-orbit variations over the last few days,
- Orbital means over a year, and
- Orbital means over the lifetime of the instrument.

Ideally, the plots are updated in near-real-time, in step with the disseminated data, but less frequent updates are still considered useful (e.g. twice a day). Example plots for selected parameters are shown in Figure 1and Figure 2.

A non-exhaustive list of parameters to be displayed is given below, based on what users have found particularly useful in the past. The list of parameters provided is intended for guidance only, and it is recognised that actual information provided will depend on the availability of the parameters. Similarly, additional informative parameters may be available, and these could be included if instrument experts at the space agencies consider them useful.

On an instrument level:

- Instrument temperature
- PRT temperatures from the internal calibration target

On a per-channel level:

- Noise-equivalent delta radiance (IR) or temperature (MW)
- Gain
- Space view count
- Warm load count

For MW instruments:

- Mixer/amplifier temperature
- Local oscillator temperature
- Reflector temperatures

For hyperspectral IR instruments:

- Temperature of the optics
- Scan mirror reflectivity
- Spectral calibration

On a space-craft level (as applicable, depending on orbit):

- Local Time Ascending Node
- Inclination
- Altitude
- Space-craft orientation

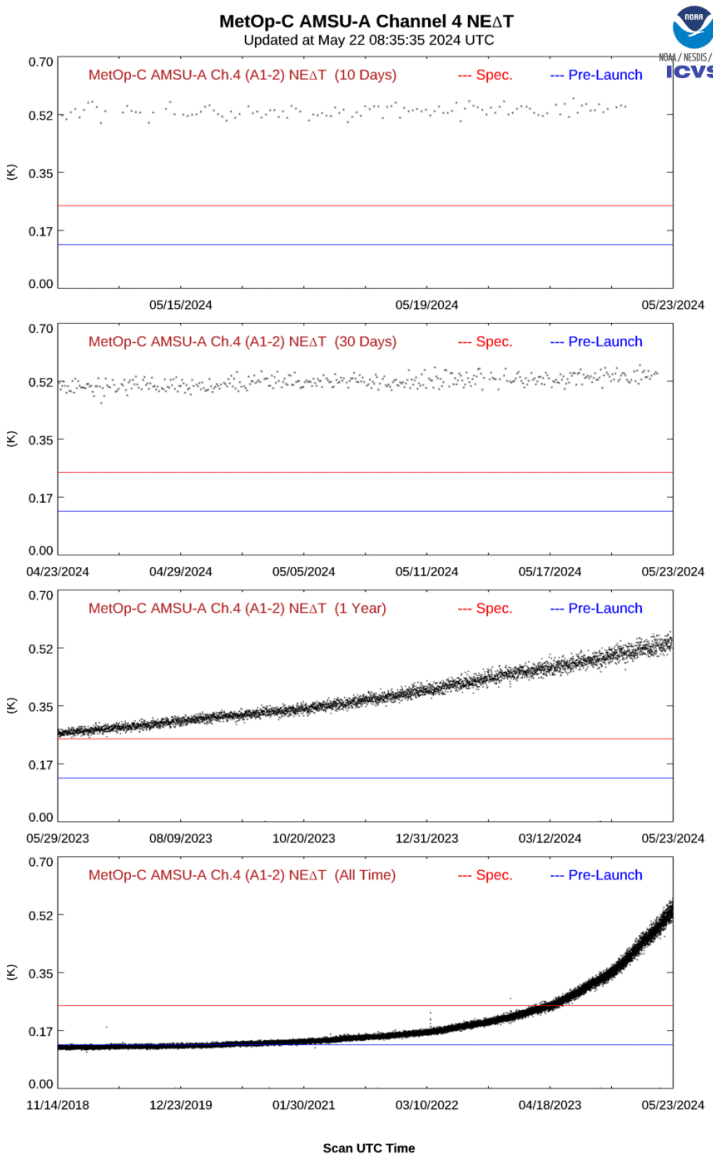

Figure 1: Example of NEDT monitoring for channel 4 of AMSU-A on Metop-C, curtesy of the ICVS monitoring website, showing a gradual increase in the instrument noise for this channel.

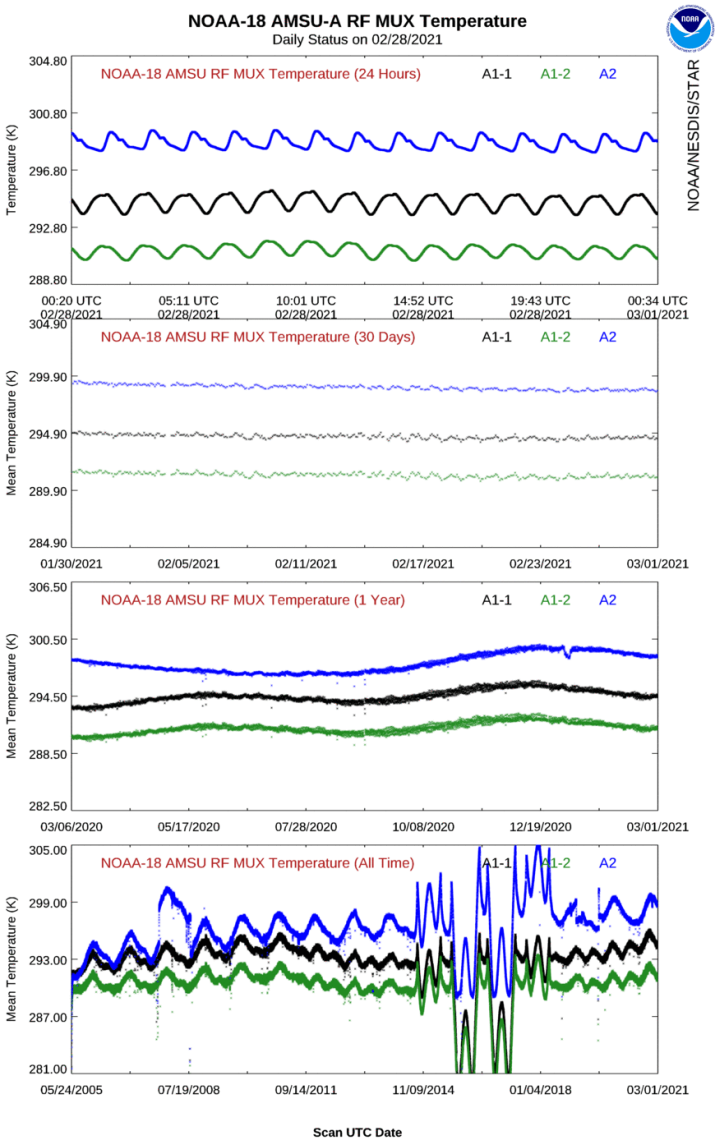

Figure 2: An example of instrument-temperature monitoring for AMSU-A on NOAA-18 from the ICVS website. The changes in instrument temperature between mid-2015 and mid-2017 can be linked to changes in the bias seen in the monitoring against NWP in Figure 3.

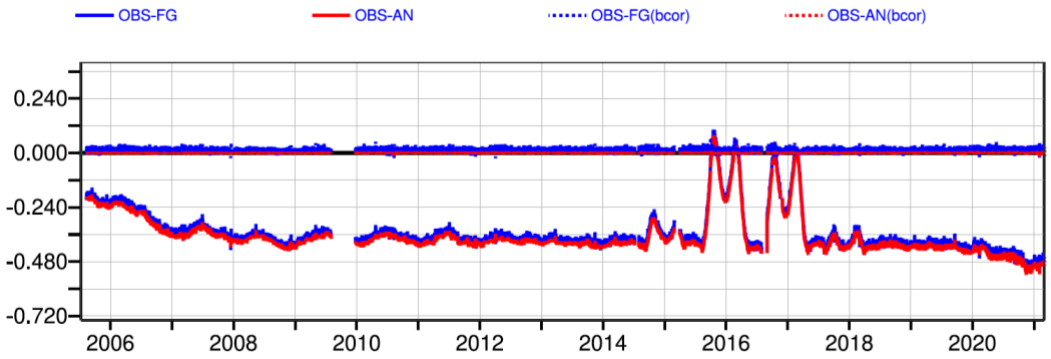

Figure 3: Monitoring of the bias in channel 6 of AMSU-A on NOAA-18 against the ECMWF background (blue) and analysis (red) before (solid) and after bias correction (dotted), taken from ERA-5. Plots from the ICVS website like the one shown in Figure 2 helped to diagnose likely origins of the bias changes in mid-2015 to mid-2017, and contributed to the decision to continue the operational use of this channel at ECMWF at the time.