Calibration and Validation of Metop/ATOVS and AVHRR products

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Objectives

- Generate validated products in a timely manner to meet user requirements and achieve the overall mission objectives. . .
- AND. . . achieve state-of-the-art performance and accuracy from the EPS instruments and their generated data products.
- Meeting these objectives involves:
  - Converting raw instrument data into geo-located products expressed in terms of recognised physical units
  - testing and revision of processing algorithms and required databases
  - determination of the product quality, in terms of precision and accuracy
    - **guaranteed over the mission lifetime**
    - **assessed by multiple independent means**
    - **cross-checked against similar instruments**

Priorities (1): drivers

- **Criteria for prioritising Validation Activities:**
  - Objective activity selection criteria include **product priority**, **accuracy requirements**, **cost** and **feasibility**.
  - More “Subjective” criteria include **geographic coverage**, **temporal coverage** and **instrument type**.
- **Outputs**
  - quantitative error estimates, characterising the products
  - recommendations for
    - auxiliary data changes
    - processor changes
    - further (operational) monitoring/validation

EURD Product Priorities *(objective requirement)*

- **Priority 1**
  - Radiances / Brightness temperatures *(0.25K)*
  - Temperature sounding *(1K)*
  - Relative humidity sounding *(5%)*
  - Cloud cover *(5%)*
  - Cloud top temperature *(1K)*
- **Priority 2**
  - Cloud liquid water path *(0.01 mm)*
  - Cloud top height *(200m)*
- **Priority 3**
  - SST *(0.4K)*, NDVI, LST *(1K)*

Approach: Calibration

- **Most instruments are calibrated by viewing warm and cold targets.**
  - **Nonlinearity corrections are applied for some channels based upon pre-launch data.**
  - **Visible/near-infrared channels are calibrated based upon pre-launch values until sufficient surface data are collected (1+ years).**
  - **Aerosol retrievals may provide further information about the calibration of the vis/NIR channels.**
  - **Spectral calibration will initially be based upon pre-launch measurements, but post-launch data may be employed for adjustments once initial checks have been completed.**

Approach: Validation

- **Validation consists primarily of**
  - **assessment and monitoring of processing (thresholds, processing options, etc.), mostly through comparisons**
    - **focus on large, well-understood, operational datasets**
      - sondes,
      - buoys,
      - NWP,
      - AMDAR,
      - other satellites, etc.
    - **+ case studies using specialised instrumentation**
      - spectrometers,
      - radiometers,
      - aircraft,
      - ships,
      - stratospheric balloons, etc.

Calibration and Validation Facility

- **A Calibration and Validation Facility has been procured for Core Ground Segment product analyses.**
- **PCs with Linux / IDL and ENVI.**
- **Stores 1 month's Metop data, and has access to the EUMETSAT archive for retrieving archived data and reports.**
- **Customised functionality for reading formatted datasets, generating standardised displays, performing anticipated investigations (geolocation modelling, finding collocations, interpolations, etc.), scheduled reporting.**
- **Flexible and programmable to adapt to future needs.**

User Tools

- **EUMETSAT is eager to hear from the users about any issues that they may discover when using the products. To facilitate such analysis, a number of tools will be made available to the user community.**
  - **Tool and product format information is available at: http://www.eumetsat.int/en/area4/eps/user_information.html**
- **There are three classes of user tools:**
  - **IDL-based**
    - **The IDL tools can be run without a license using the IDL virtual machine (http://www.rsinc.com/idlvm/index.asp), but in this environment do not offer significantly more functionality than the standalone tool.**
  - **standalone**
  - **misc. related tools**

IDL tools

- **The EPS Product Reader**
  - Can read the whole EPS product into memory.
  - Can read specific product fields and store pointers to these records/fields in the product object.
  - Is needed for EPSMapper and EPSiPlotter.
- **EPSMapper**
  - Can visualise data onto a map projection selected by the user.
- **EPSiPlotter**
  - Provides predefined product-specific visualisations for the product to permit more detailed analyses.

- **These tools are designed for users familiar with IDL programming.**

Standalone tool

- **The EPSView tool**
  - Can generate two-dimensional or geolocated images of product parameters
  - It provides for a tree-like drill-down into the full product
  - The product can be viewed down to the bit level, if desired.

- **EPSView was designed to operate in a standalone mode (Java-based) and to be easy to use.**

- **All of these tools are or will be shortly available on the EUMETSAT external website before launch.**

Additional Related tools

- **noaa2eps**
  - Convert NOAA L1b products into EPS format products. If people need additional EPS format ATOVS products prior to launch they can use this tool to generate them.

- **Kai**
  - Can be used to combine PDUs into full products, e.g. in an NRT terminal.

- **Eugene**
  - Can be used as a command line product reader, or built as a library to access EPS products from C++ and Python.

Activities (I)

- **The initial instrument checkout will be completed by ESA before Cal/Val begins (6 weeks).**
- **An initial product checkout will be carried out against range limits, looking for visual anomalies, etc.**
- **Trending of instrument characteristics and product parameters will be carried out for monitoring purposes.**
- **NWP data will be employed for monitoring purposes.**
- **Outliers will be flagged for visual inspection on a daily basis to identify sudden changes in the products (or validation datasets).**

Activities (II)

- **A campaign will be carried out using extra radiosonde launches timed to coincide with Metop overpasses.**
  - **The sites have not yet been selected, but preference will be given to those with nearby correlative measurements.**
- **Globally distributed measurements from operational networks (radiosondes, buoys and aircraft) will be matched against the products.**
- **Additional analyses will be carried out using smaller high quality and high resolution datasets to improve confidence in the data, and to validate remaining products.**
- **Results from the Research Announcement of Opportunity will also be analysed.**

Product Example: Temperature sounding

- **Radiosondes will provide the primary validation.**
  - Operational network
  - Additional launches
- **NWP will be used to monitor the product for changes.**
- **NOAA measurements will be compared**
- **Aircraft/balloon**
  - FAAM (TBC Opportunistic)
  - IASI balloon
  - dropsondes/SDLA (TBC Opportunistic)
- **Other satellites**
  - AIRS
  - TES, etc. . .?

Method Example: NWP

- **NWP provide a global, well understood dataset that will be analysed daily.**
  - **Radiances (RTTOV-7)**
  - **Temperature and humidity soundings**
  - **SST, LST**
- **12 hour forecasts will be employed.**
- **NWP to be interpolated to measurement space.**
- **Preference given to NWP in the vicinity of sondes.**

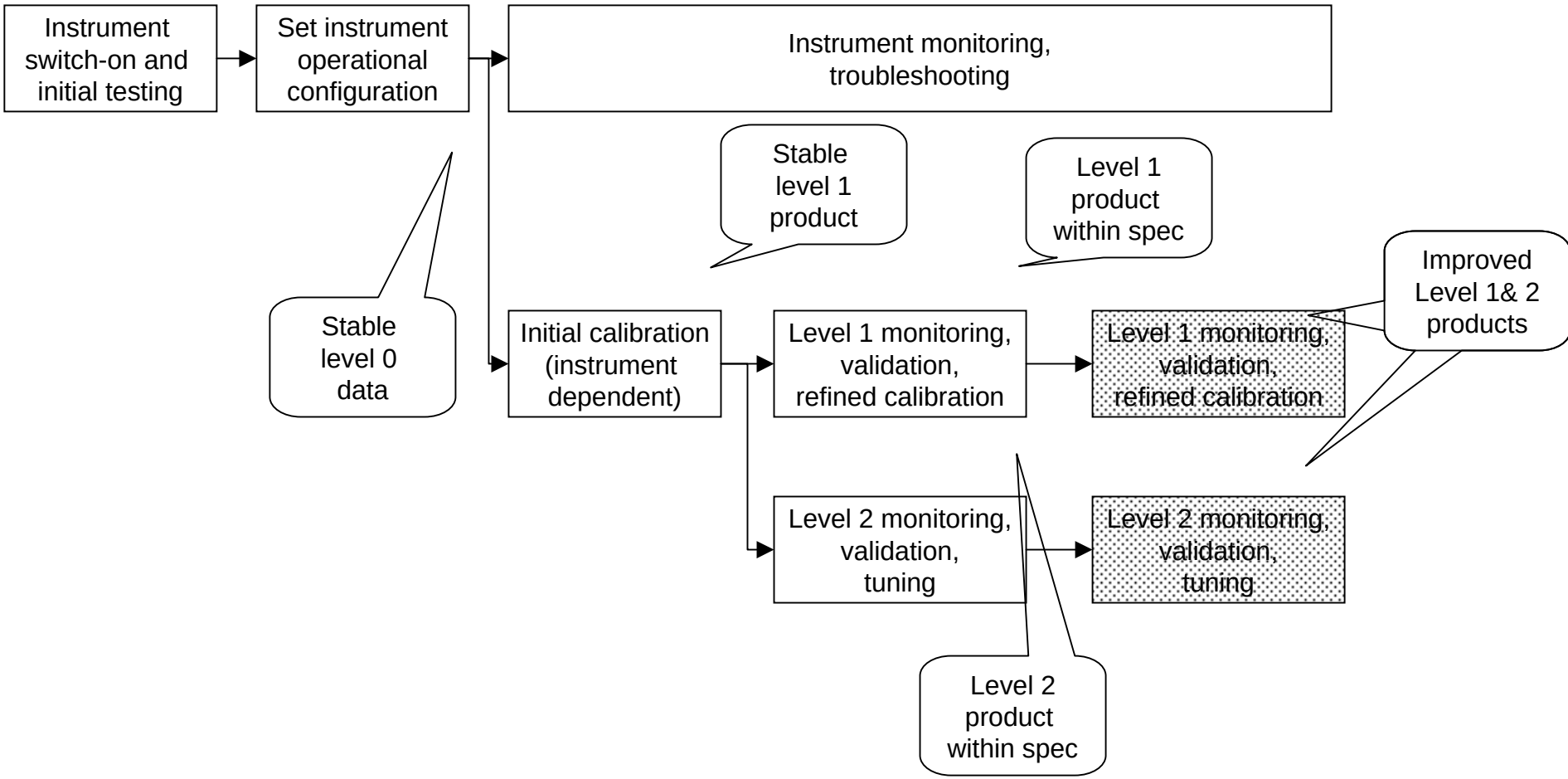
Day-2 activities

- **After initial product behaviour has been established, a more rigorous analysis may be applied to resolve uncertainties inherent in comparing retrieved quantities (Rodgers and Connor 2002).**
- **Spectral response profiles may be shifted in response to post-launch modelling efforts.**
- **Once validated, IASI data will be employed for additional comparisons of radiances and geophysical products.**

ATOVS Schedule

- **AVHRR is critical to subsequent validation activities.**
  - AVHRR Geolocation will be validated first,
  - then AVHRR Cloud mask
  - then geolocation and collocation of ATOVS instruments
- **Temperature and water vapour profiles are of highest priority for validation.**
  - Radiosondes
  - NWP
  - NOAA platform instruments
  - other datasets as secondary priority
    - ground-, water-, air-, and space-based
- **Dry runs will be carried out before launch for Mandatory and Important activities using NOAA data.**

Generic Sequencing



Summary

- **The EUMETSAT Cal/Val Facility has been procured to calibrate and validate EPS products.**
- **The commissioning phase is currently scheduled to last the first 6 months following the launch.**
- **Validation will rely heavily on the use of large, well understood datasets, complemented by more detailed analyses where practical.**
- **Tools are available to the user community for independent analyses, and additional input has been solicited through the RAO mechanism.**