![Met Office]
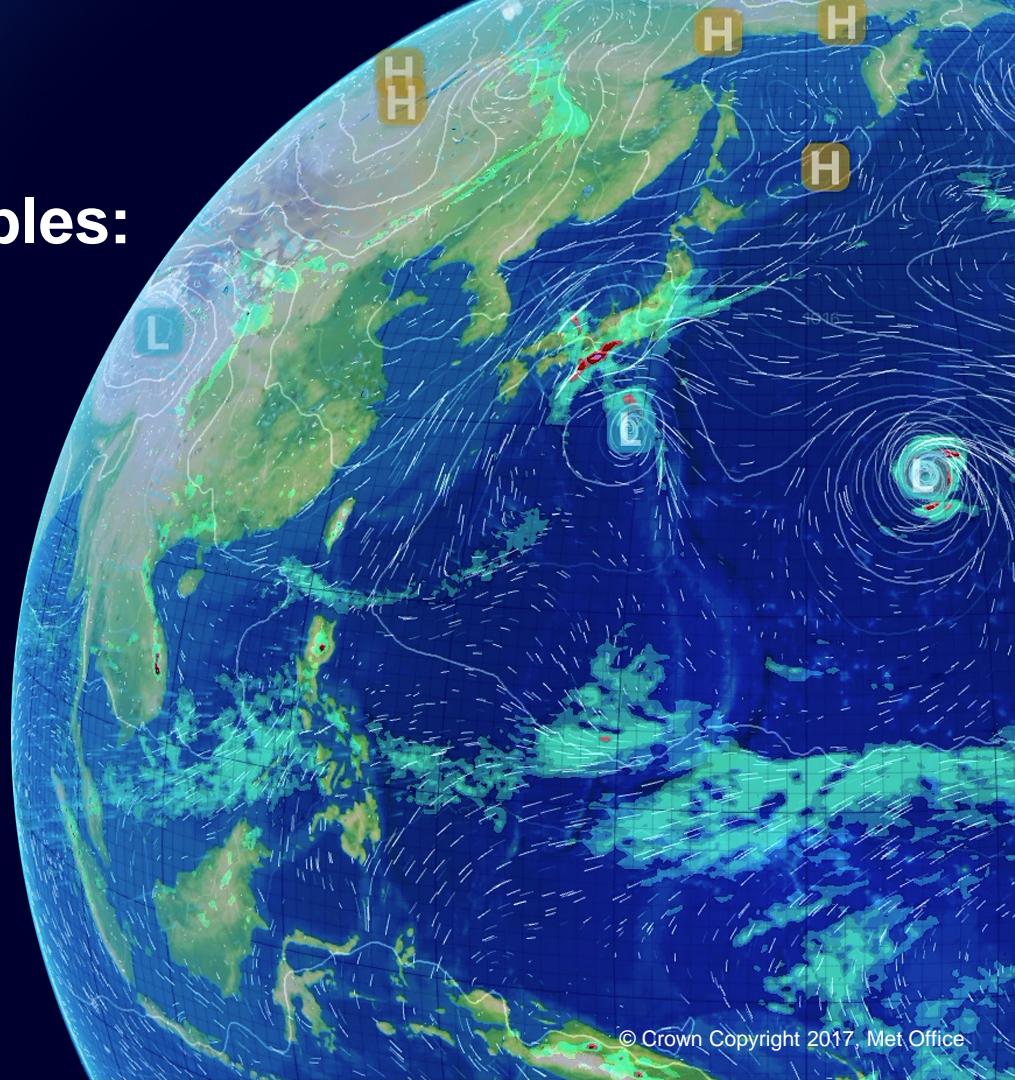
NWP SAF software deliverables: 2017 to 2022
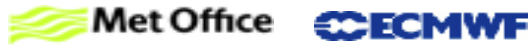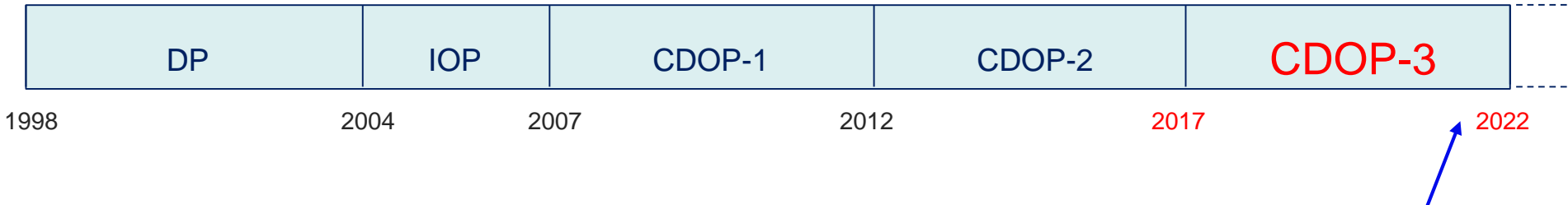
Nigel Atkinson

ITSC-21

29th November 2017

NWP SAF aim: To improve the benefits to NWP by exploitation of satellite data, enabling European NWP centres to realise more fully the benefits of the European satellite program

EUMETSAT
NWP SAF
NUMERICAL WEATHER PREDICTION

Met Office   ECMWF

METEO FRANCE   Deutscher Wetterdienst
Wetter und Klima aus einer Hand   DWD

What it produces: software modules, monitoring services, and training – functional interface between satellite data producers and use of the data in NWP systems

CDOP-3 –Third Continuous Development and Operations Phase (2017-2022)

DP	IOP	CDOP-1	CDOP-2	CDOP-3

1998   2004   2007   2012   2017   2022

First launches of MTG and EPS-SG in 2021

Satellite Data Pre-Processors   *MO, MF*

Pre-process satellite data to produce quality controlled BTs/radiances ready for use in NWP systems

AAPP: NOAA, Metop, FY-3, JPSS
- ➤Direct Broadcast processor - calibration, geolocation, QC
- ➤Maintain, develop – extension for EPS-SG

IRSPP: MTG-IRS geostationary hyperspectral
- ➤Pre-process for NWP ingest

MWIPP: Pre-processor for microwave imagers
- ➤BT averaging for noise reduction

Radiative Transfer Modelling   *MO, EC, MF, DWD*

RTTOV: Fast RT model for use in satellite radiance assimilation, and other applications
- ➤See talk 1.03 by James Hocking

Diverse profiles – only maintain dataset

Input on user requirements being sought

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NUMERICAL WEATHER PREDICTION

Software Deliverables (2)

Cloud and Aerosol Detection Software   *EC*

Cloud and aerosol detection for high spectral resolution IR sounders
  ➢Maintain, develop – extension for MTG-IRS, IASI-NG

R&D Software Tools   *MO*

1D-Var: Standalone – retrieval of atmospheric profiles from satellite radiances
  ➢Maintain, develop – RTTOV compatibility
  ➢RTTOV-SCATT, surface emissivity retrieval

Radiance Simulator: Standalone – simulation of microwave, IR radiances from NWP fields, particularly useful for mission studies
  ➢Maintain, develop – RTTOV compatibility
  ➢Extend for new instruments

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- AAPP version 7 being retired after 5 years … v8.1 about to be released

Feature	AAPP v7.15	AAPP v8.1
BUFR encode/decode	BUFRDC	BUFRDC or ecCodes
GRIB decode	GRIB_API	GRIB_API or ecCodes
Cloud mask	MAIA2.1 (AVHRR on HIRS grid) MAIA3 (AVHRR) MAIA4 (VIIRS)	MAIA4

ecCodes is a new software package from ECMWF.

It replaces the old GRIB-API and BUFRDC packages which are still supported by ECMWF but are being phased out.

Advantages of MAIA4:
- Consistency between the different cloud masks
- Ability to use GFS forecast files as background – freely available via internet

(Disadvantage – takes longer to run that the old MAIA2.1)

Met Office

Other features of AAPP v8:

- JPSS-1 support (including new channel selection for CrIS FSR)

- Download is via NWPSAF web site - no longer using the old ftp site

- Have a look at the example build script *install_aapp8.sh*, linked from the Installation Guide https://www.nwpsaf.eu/site/software/aapp/documentation/aapp-v8-installation-guide/
  - ➤ Can use it to build the various external libraries (BUFRDC, ecCodes, hdf5, xerces, fftw, etc.) as well as AAPP and OPS-LRS.
  - ➤ Customise as required

- Now supporting macOS – but so far only limited testing has been possible. Let us know your experiences!

- JPSS-1 requires testing

- Support FY-3D (launched Nov 2017)

  ➢ In particular the new hyperspectral sounder *HIRAS*. Treatment expected to be similar to CrIS, i.e. AAPP ingests SDR files generated externally

- Support Metop-C *AMSU*, *IASI*, *AVHRR* (Oct 2018 launch)

- Support the sounders and imager on Metop-SG-A1 (2021)

  ➢ *MWS*, *IASI-NG*, *MetImage*

For Metop-SG, the plan is that EUMETSAT will procure level 1 processors (as was done for IASI). The NWPSAF will ensure compatibility with Direct Broadcast applications.

IRSPP – processing for the MTG-IRS

First launch: 2023

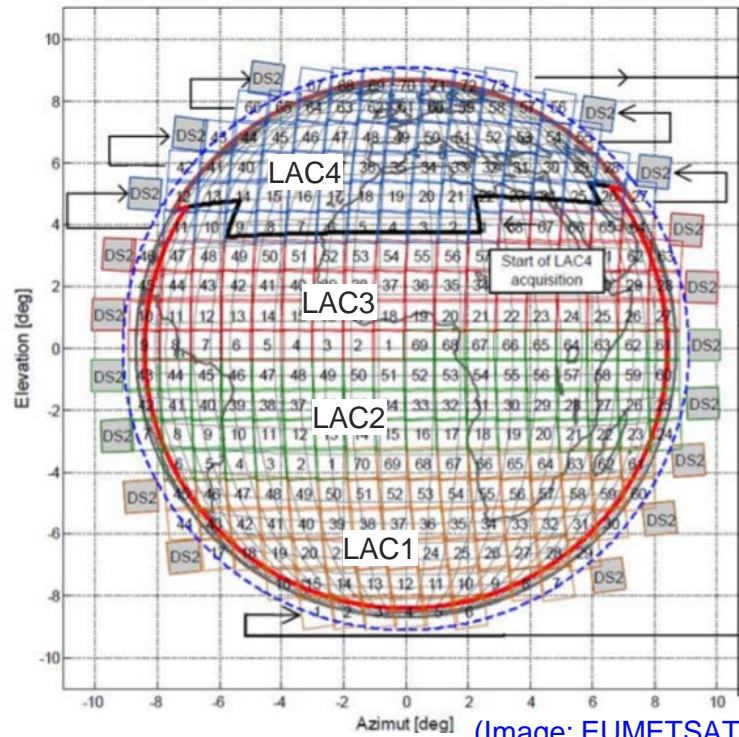Input: netCDF4 files, Principal Component (PC) compressed

Output: BUFR or netCDF4

Main processing steps:

- Generation of reconstructed radiances (for specified channels)
- or transformation to other PC basis sets (EUMETSAT's PCs are designed for effective *dissemination*; users might want something different).
- Changing the apodisation of the eigenvectors (next slide)
- Spatial thinning and/or averaging. Full resolution is 4-10km depending on position.

Challenges:
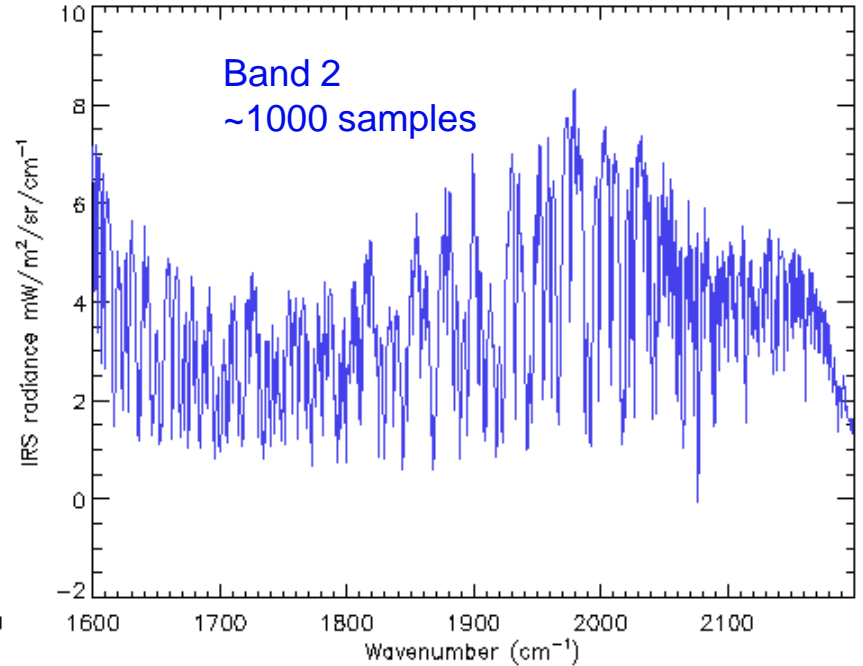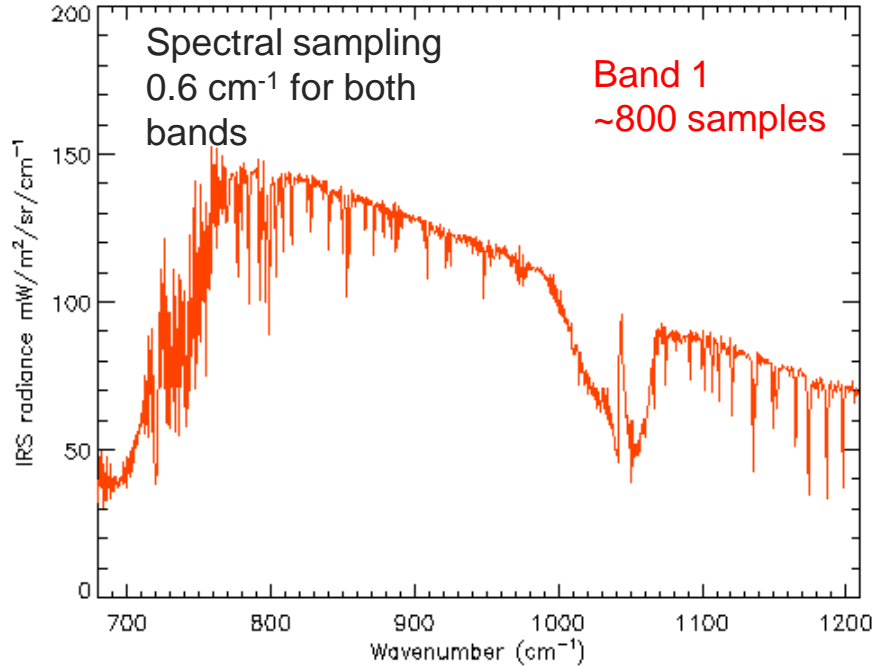
- Handling the large data volume in a timely manner

8×10^6 spectra received per hour (1 "LAC" per 15 min)
160×160 spectra per "dwell" (numbered boxes)
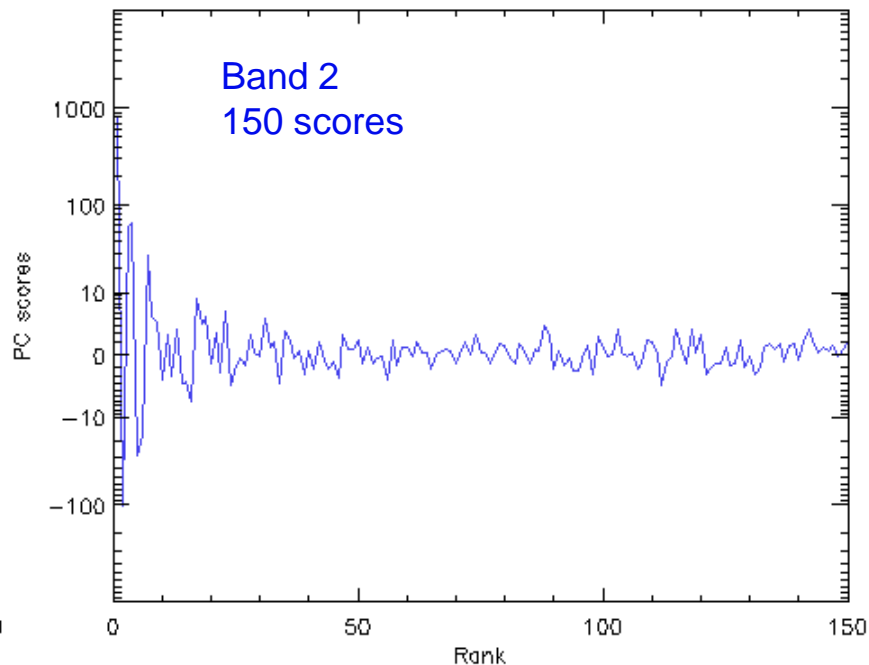

(Image: EUMETSAT)

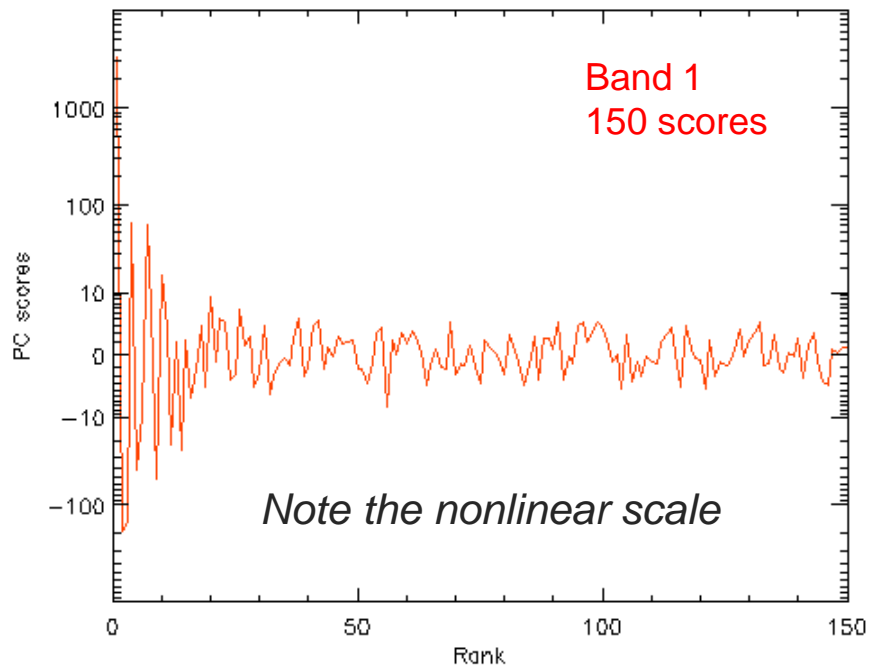Spectral sampling 0.6 cm^{-1} for both bands

Band 1 ~800 samples

Band 2 ~1000 samples

At 4-10km spatial resolution, data volume would be prohibitive, so …

Band 1
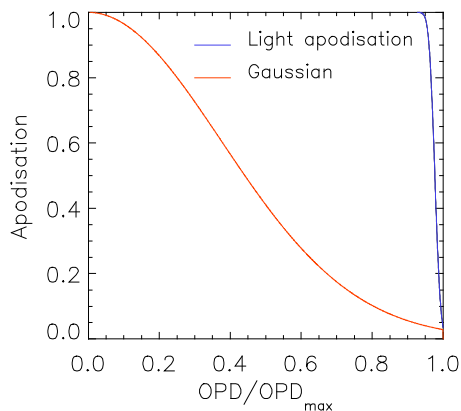150 scores

Note the nonlinear scale

Band 2
150 scores

- The main NRT dissemination will be *PC scores*
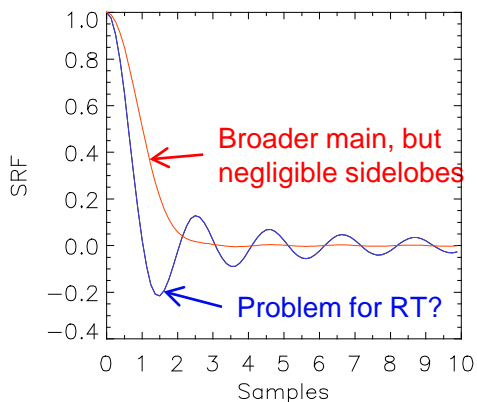
- User can reconstruct the radiances

IRSPP – changing the apodisation

PC scores will be generated at EUMETSAT on the basis of "lightly apodised" spectra – this is good because it preserves the information content, but can be difficult for radiative transfer (negative transmittances)
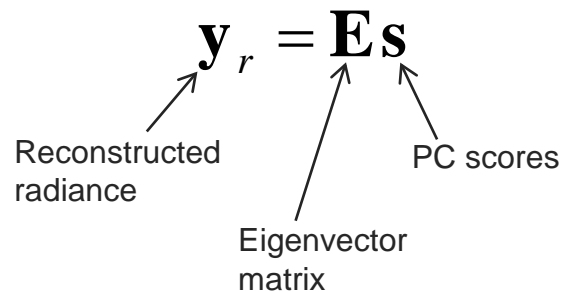
It is easy for the user to change the apodisation just by using a different set of eigenvectors. No computational overhead! Provision for this in IRSPP.

Interferogram domain

Spectral Response Function

$$\mathbf{y}_r = \mathbf{E}\,\mathbf{s}$$

Reconstructed radiance

Eigenvector matrix

PC scores

Broader main, but negligible sidelobes

Problem for RT?

Questions on IRSPP for the Working Groups
(NWP, Advanced Sounder)

Which of the following would you like to see implemented in IRSPP?

- Ingest of the NetCDF4 input files (obviously this has to be done)
- Generation of RRs for specified channels
- Conversion to some other PC basis set – different from the one used by EUMETSAT
- Output in BUFR for the RRs and/or PC scores?
- Output in NetCDF4 (or some other format?) for the RRs
- Spatial sub-sampling
- Ability to change the apodisation (e.g. light to heavy)
- Options to use, or not to use any "extra PCs" that might be generated dynamically by EUMETSAT
- Ability to generate eigenvectors from *full-spectrum* datasets. This will in any case be done by EUMETSAT, but do users want to do it themselves also? *Note: only worthwhile if you will have access to EUMETCast-terrestrial, because of the huge data volume*
- Produce modular code that can be integrated into NWP Centre's own software
- Anything else?

MWIPP – for microwave imagers

We are planning an updated version of the current **SSMIS_PP** package

What does SSMIS_PP currently do?

- Ingest incoming BUFR files
- *Mapping between SSMIS channels with different feedhorns – so that all channels are co-located*
- *Instrument corrections (spillover, intrusion flagging, etc.)*
- Spatial averaging, for noise reduction
- Create output BUFR

Functions in *grey* are no longer needed because they are done in NRL's *Unified Pre-processor*

But may be needed for future instruments (next slide)

UAS
ENV
LAS
IMA
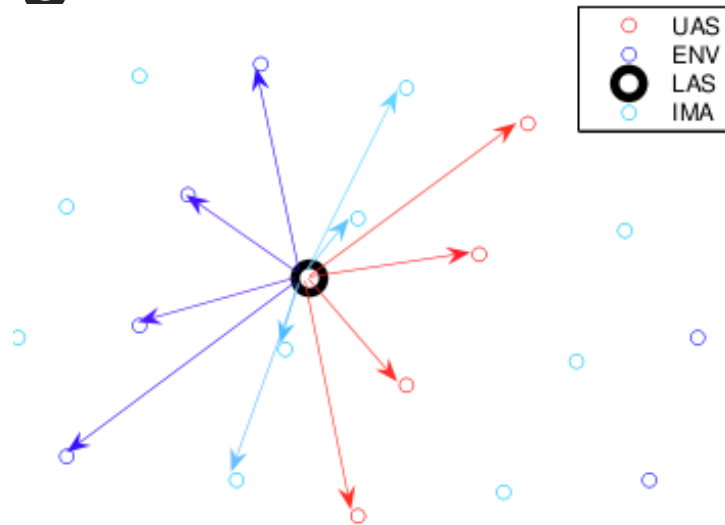
Re-mapping in SSMIS_PP
(from SSMIS Scientific Description)

MWIPP (2)

Candidate instruments for inclusion (highest priority **bold**):

- **SSMIS** (DMSP)

- AMSR-2 (GCOM-W series)

- MWRI (FY-3 series)

- GMI (GPM-Core)

- **MWI** and **ICI** (Metop-SG-B, 2022+)

As well as re-mapping and averaging, consider handling different formats:

- BUFR formats already exist for several of the above (e.g. defined by EUMETSAT)

- **Native format (HDF5) to BUFR** converters are possible – and are relatively easy to make using *ecCodes* (ECMWF software). Contact the NWPSAF to see a prototype for AMSR-2

MWI

ICI

Satellite B

Metop-SG-B satellite
(Image: ESA)
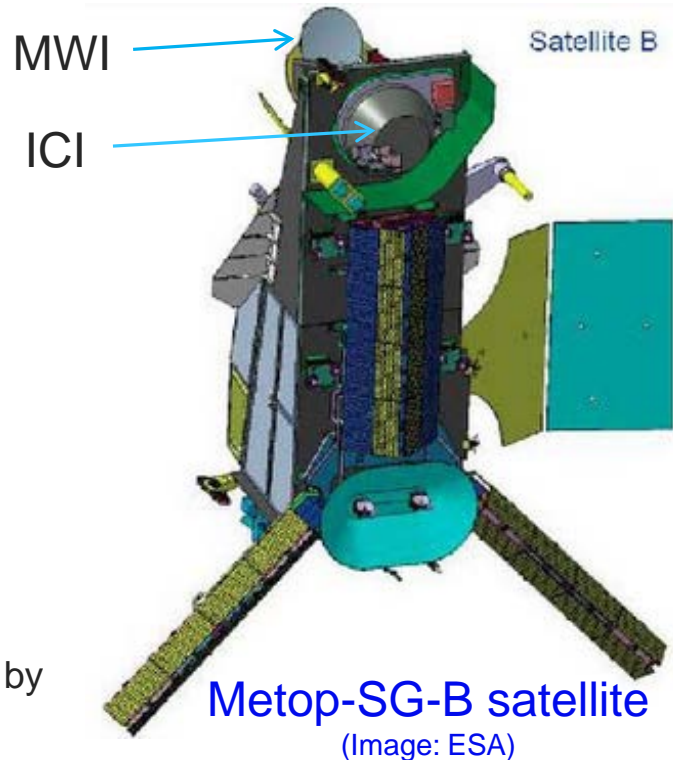
Questions on MWIPP for the Working Groups

Which of the following would you like to see implemented in MWIPP?

- Continued support for the SSMIS Averaging Module (works with UPP BUFR files)

- Averaging facilities for other imagers (as currently done for SSMIS)?

- Format conversion, e.g. hdf5/NetCDF4 to BUFR? If so, for which instruments?

  ➢ AMSR-2, GMI, MWRI, MWI, ICI ?

- Mapping between MWI and ICI? (Different instruments on the same satellite)

- Any other generic pre-processing?

For more information on current activities, or to obtain software, please visit

nwp-saf.eumetsat.int

We look forward to your feedback!