NWP SAF Support for Local Processing of Metop-SG A1

CSPP Users' Group Meeting
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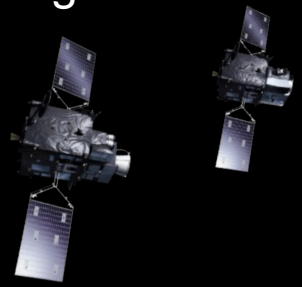
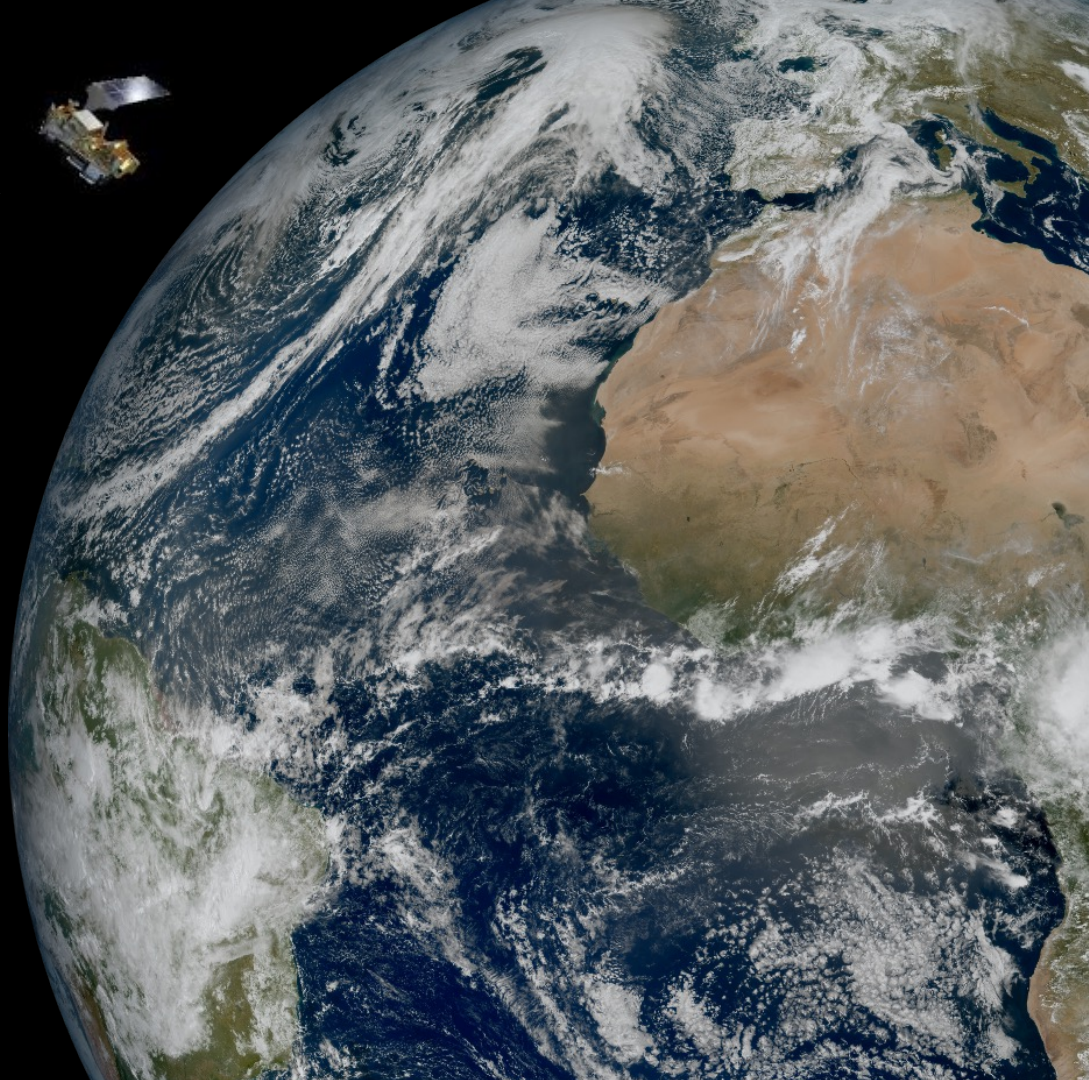




Metop-SG A1 (a.k.a. Metop-D)

- Satellite launched 13 Aug 2025
- Still in commissioning, but data now starting to flow
- Direct broadcast is ready for users!

Processors for Metop-SG A1

- The NWP SAF supports two sets of processors for Metop-SG A1:-

1. Metop-SG Direct Broadcast software –
   - Level 0 processor to go from VCDU to level 0
   - Level 1 processor for each instrument – MWS, METimage (VII) and IASI-NG (IAS)
   - All outputs are netCDF

   Status: The MWS and VII processors have been released. See https://nwp-saf.eumetsat.int/site/metop-sg-direct-broadcast-software/. IAS to follow soon.

2. AAPP-SG (for sounders)
   - Ingests the MWS level 1b and IAS level 1c files, and converts to BUFR, as required for DBNet

   Status: The NWP SAF review process is underway. As AAPP-SG is a new package, this is quite time consuming.

Part 1 – Metop-SG-A1 Direct Broadcast software

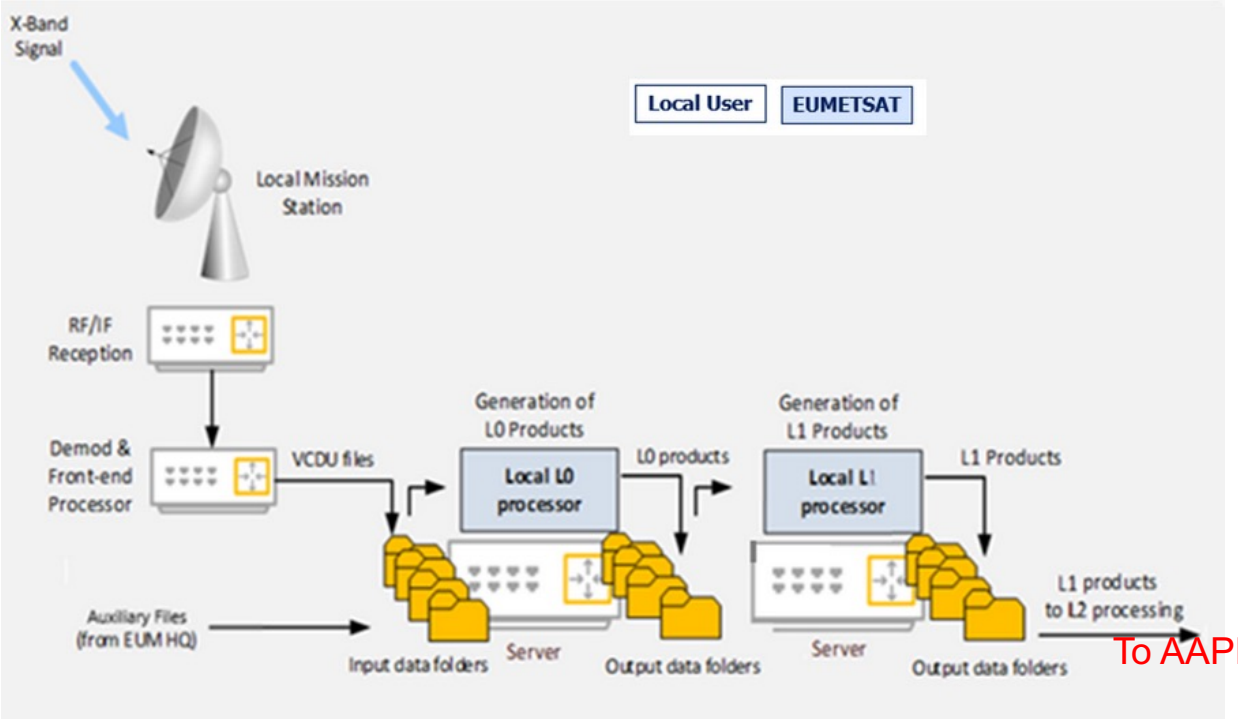
Responsibilities

- Overall responsibility – EUMETSAT
- “Re-engineering” of software for local mission use has been done by industry, under contract to EUMETSAT

Instrument package	Contractor
MWS	Exprivia / isardSAT
VII	Exprivia / isardSAT
IASI-NG	CNES / Thales

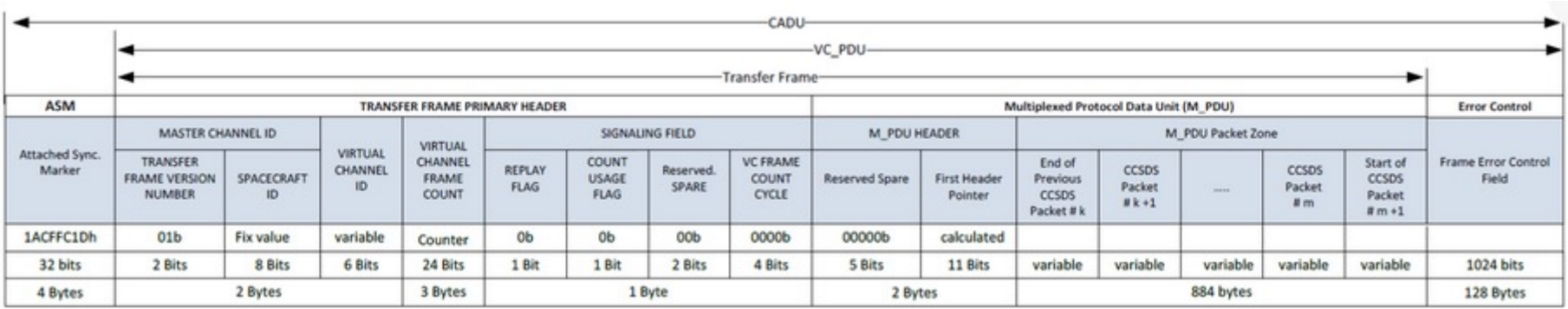
- Distribution and user support – NWP SAF

Local processors - overview



- This figure from the EUMETSAT *Metop-SG Direct Readout guide*

VCDU definition

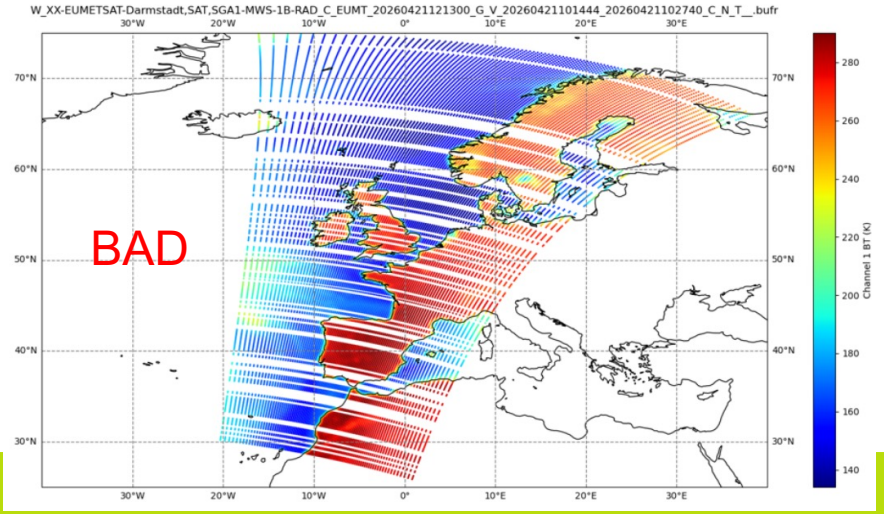


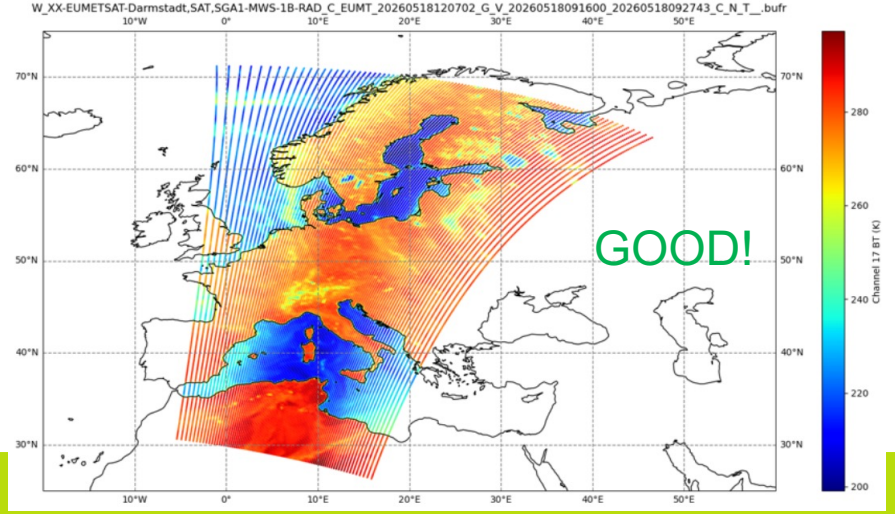
ASM	TRANSFER FRAME PRIMARY HEADER								Multiplexed Protocol Data Unit (M_PDU)							Error Control
Attached Sync. Marker	MASTER CHANNEL ID		VIRTUAL CHANNEL ID	VIRTUAL CHANNEL FRAME COUNT	SIGNALING FIELD				M_PDU HEADER		M_PDU Packet Zone					Frame Error Control Field
	TRANSFER FRAME VERSION NUMBER	SPACECRAFT ID			REPLAY FLAG	COUNT USAGE FLAG	Reserved. SPARE	VC FRAME COUNT CYCLE	Reserved Spare	First Header Pointer	End of Previous CCSDS Packet # k	CCSDS Packet # k +1	.....	CCSDS Packet # m	Start of CCSDS Packet # m +1	
1ACFFC1Dh	01b	Fix value	variable	Counter	0b	0b	00b	0000b	00000b	calculated						
32 bits	2 Bits	8 Bits	6 Bits	24 Bits	1 Bit	1 Bit	2 Bits	4 Bits	5 Bits	11 Bits	variable	variable	variable	variable	variable	1024 bits
4 Bytes	2 Bytes			3 Bytes	1 Byte				2 Bytes		884 bytes					128 Bytes

- The raw data stream comes encoded (Reed Solomon) and pseudo randomized, so the sync marker is not visible. It can be decoded with RT-STPS. This is typically done in real-time on the front-end (but can be done off-line if necessary).
- The required VCDU, or “Transfer Frame” can be found straight after the sync marker. It is 892 bytes in length.
- For efficiency, it is important to configure RT-STPS such that the *instrument streams are separated*. (Config file available on request).

Running RT-STPS

- Ideally, RT-STPS should be run on the front end while the acquisition is in progress – to save time
- But for some systems this causes problems (see images)
- At Exeter, we are now running RT-STPS after the “raw” file has been generated (thanks to SSEC for the suggestion)





Virtual channel numbers

We need the data for the following VCIDs:

- VCID9 – NAVATT
- VCID12 – IASI-NG
- VCID13 – MWS
- VCID16 – METimage

Our scripts assume that the “VCIDnn” string is present in the file name. If it isn’t then you should add it. There is no standard file name convention for VCDUs.

The local processors

- All details are in the User Guide linked from https://nwp-saf.eumetsat.int/site/metop-sg-direct-broadcast-software/
- Package files are available on the NWP SAF web site in the usual way, from the “software downloads” button. You have to tick the box for each processor that you require (for usage monitoring purposes).
- Package files available now:

Table 1: Package files and their sizes. The IASI-NG package will be added at a future date.

Package file	Size (bytes)
L0_v3.1.0.tar.bz2	8671158
MWS_v2.5.0.tar.bz2	27511348
VII_v4.2.4.tar.bz2	36433130
NWPSAF_EPSSG_wrappers_v1.0.0.tar.bz2	54542687

Selecting packages …

Click here to change Software Preferences.

Software Packages – current version

- [ ] RTTOV v14
- [x] OPS-LRS v8
- [ ] Radiance Simulator v4
- [ ] ASCAT Winds Data Processor (AWDP) v3
- [ ] CWDP Scatterometer Data Processor v1.0
- [x] SSMIS PP
- [ ] RTTOV-gb v1
- [x] EPS-SG Level 0
- [x] EPS-SG METimage level 1
- [x] IRSPP v1
- [x] AAPP v8
- [ ] 1DVAR v2
- [ ] Cloud and Aerosol Detection Software v3
- [ ] PenWP Scatterometer Data Processor v4
- [x] IASI PCA-based Compression Package v1
- [x] SSMIS UPP Averaging Module
- [x] MWIPP v1
- [x] EPS-SG MWS level 1
- [x] EPS-SG NWP SAF wrappers for DB packages

Ancillary files and test data

- Download these from https://nwp-saf.eumetsat.int/downloads/epssg_db_ancillary_files/

Table 2: Ancillary files, test files and documentation package

Package file	Size (bytes)	Comment
LM_SGA1_fullchain-run_tds.tar.bz2	5620050267	VCDU test data and ancillaries
Local_L0_CADU_split_VC.tgz	2329472720	Optional CADU test data
SG_____AUX_RD09___S20070101000000Z_Exxxxxxx xxxxxxxZ_G20210201120000Z_CALV_OPE_OPER.SIP.tgz	2918568630	Used for VII and IAS
SG_____AUX_LSM____S20070101000000Z_Exxxxxxx xxxxxxxZ_G20230508000000Z_CALV_VAL_TEST_T.SIP.tgz	28854654	Used for VII and IAS
'Consolidated documentation package LM V1.zip'	18909537	Optional documentation package from EUMETSAT

Real-time ancillary files

- Near-real-time ancillary files (notably predicted orbit files) will need to be downloaded from the EUMETSAT Data Store
- You will need to set up an account for the EUMETSAT User Portal and to install the ***eumdac*** software. For details, see https://user.eumetsat.int/data-access/data-store
- The NWP SAF scripts assume that *eumdac* is available in your PATH.
- Predicted orbit file is checked daily.

Pre-built binaries

- The packages were pre-built by EUMETSAT on RHEL9
- The necessary dynamic libraries are included with the *NWPSAF_EPSSG_wrappers*
- As well as running natively on RHEL9 we were also able to run them on our (rather old) RHEL7 servers via Rocky Linux 9 environment in Apptainer:

```
apptainer build --sandbox rocky9/ docker://rockylinux:9
apptainer shell rocky9
```

Alternatively, source code is included for L0, MWS and IAS, but if you need source code for METimage you should contact EUMETSAT Helpdesk due to Export Control restrictions.

Installation

- There is an installation script in the *NWPSAF_EPSSG_wrappers* package. The script unpacks each rpm file and installs into a directory of your choice – referred to by environment variable **EPSSG_INSTALL**. No admin privilege is needed.

```
${EPS_SG_INSTALL}/
├── opt/
│   ├── EOCFI-CPP-4.xx/
│   │   └── [subdirectories]/
│   ├── L0-READER-1.x/
│   │   └── [subdirectories]/
│   ├── facilities/
│   │   └── epssg/
│   │       └── VII-L1B-LP/
│   │           ├── bin/          # Contains VII_L1B_LP
│   │           └── lib/
│   └── mws/
│       └── eps-sg-mws-l1-lp-2.4.0/
│           ├── bin/              # Contains mws_l1_lp.bin
│           ├── lib/
│           └── schemas/
├── usr/
│   ├── bin/                      # Contains execute_L0processor.py
│   ├── lib/
│   ├── lib64/
│   └── share/
└── IAS/                          # Contains L1clopLocalLauncher.sh
    ├── conf/
    ├── java/
    ├── lib/
    └── licenses/
```

Computing resources

- MWS – can be run on a single core
- METimage (VII) – at least 16 cores recommended
- IASI-NG – at least 64 cores and 128GB memory recommended. It will run with fewer, but will be slow

We recommend that you start with MWS as that is easy and quick to run

Note also that IASI-NG processing requires VII to have been first processed to level 1b.

Running test cases

- EUMETSAT have supplied test VCDU files. You can process these using the NWP SAF script ***run_EPSSG_test_data.sh***
- For example, to process MWS to level 1b:

```
cd scripts
export EPSSG_INSTALL=[installation directory]
export EPSSG_DATA=[data directory]
./run_EPSSG_test_data.sh MWS
```

- The script automatically copies all the fixed ancillary data from the package files into the data directory, the first time it is run.

A new test case will be posted soon, to support IASI-NG

Running your own real-time data

- The main wrapper script is called ***run_EPSSG.sh***. See the User Manual for details.
- Remember that Metop-SG-A1 is still in commissioning and configuration files etc. may change at short notice. We will endeavour to post relevant information on the web page https://nwp-saf.eumetsat.int/site/metop-sg-direct-broadcast-software/

IASI-NG cloud mask

- The IASI-NG L1C output includes an optional cloud mask derived from METimage
- To generate the cloud mask, the NWCSAF's ***PPS*** package is used
- This complicates the processing flow … but you can run it without the cloud mask if you prefer.

- See details in the User Manual.

Run times

MWS is fast but IASI-NG takes significant time even without the cloud mask.

Potential speed-up if VII can be processed while the acquisition is in progress.

These figures are on the Met Office's Microsoft Azure facility.

We have also procured new on-premises servers, but they are not built yet. Will test the packages on these servers ASAP.

Table 5: MWS processing chain with 4 threads and 16 GB memory

Process	Run time (s)
L0 NAV	[8]
L0 MWS	8
L1 MWS	7

Table 8: IAS and VII processing chain, configuration 2, with 120 threads and 240 GB memory

Process	Run time (s)
L0 NAV	[8]
L0 VII	261
L0 IAS	[56]
L1 VII	221
L1 IAS (no cloud mask)	926
Total	**1408 (=23.5 minutes)**

RT-STPS run times not included!

Part 2 – AAPP-SG

AAPP-SG

- AAPP-SG should be released late May 2026.
- AAPP-SG includes facilities for processing MWS and IASI-NG (input netCDF files from the L1 processors)
- MWS:
  - Provision for spatial filtering and cloud/surface parameters
  - Or you can just run the BUFR encoding, to match EUMETSAT global product
- IASI-NG
  - Includes the option of converting from level 1c (raw spectra) to level 1d (PC scores) – subject to availability of conversion matrices (EUMETSAT responsibility)
  - Noting that IASI-NG is still in commissioning – level 1c spectra are stable but EUM are not yet in a position to disseminate level 1d.

AAPP-SG code

- Written in Fortran90 – like other packages such as IRSPP and MWIPP
- Prerequisites: ecCodes, netCDF (with Fortran interface), hdf5
- A build script is provided

Status of BUFR sequences

- MWS: The level 1b BUFR sequence is finalised and EUMETSAT are already distributing BUFR data to cal/val partners
- IASI-NG: Whilst the IASI-NG level 1c BUFR sequence is fairly stable (though not finalised), the level 1d (PC scores) is not. AAPP-SG includes our best guess, to be updated later.

Other packages relevant to Metop-SG

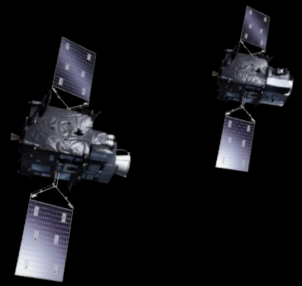
- Satpy (Pytroll) – for creating METimage imagery
- NWC/PPS – includes METimage cloud mask
- NWC/PPS-MW – in preparation by the NWCSAF
- And others ...

Conclusion

- Direct broadcast processors for MWS and METimage are available
- IASI-NG coming soon.
- Users should give it a try!
- The NWP SAF welcomes feedback on your experiences

Met Office

Thank you



EUMETSAT NWP SAF NUMERICAL WEATHER PREDICTION

www.metoffice.gov.uk