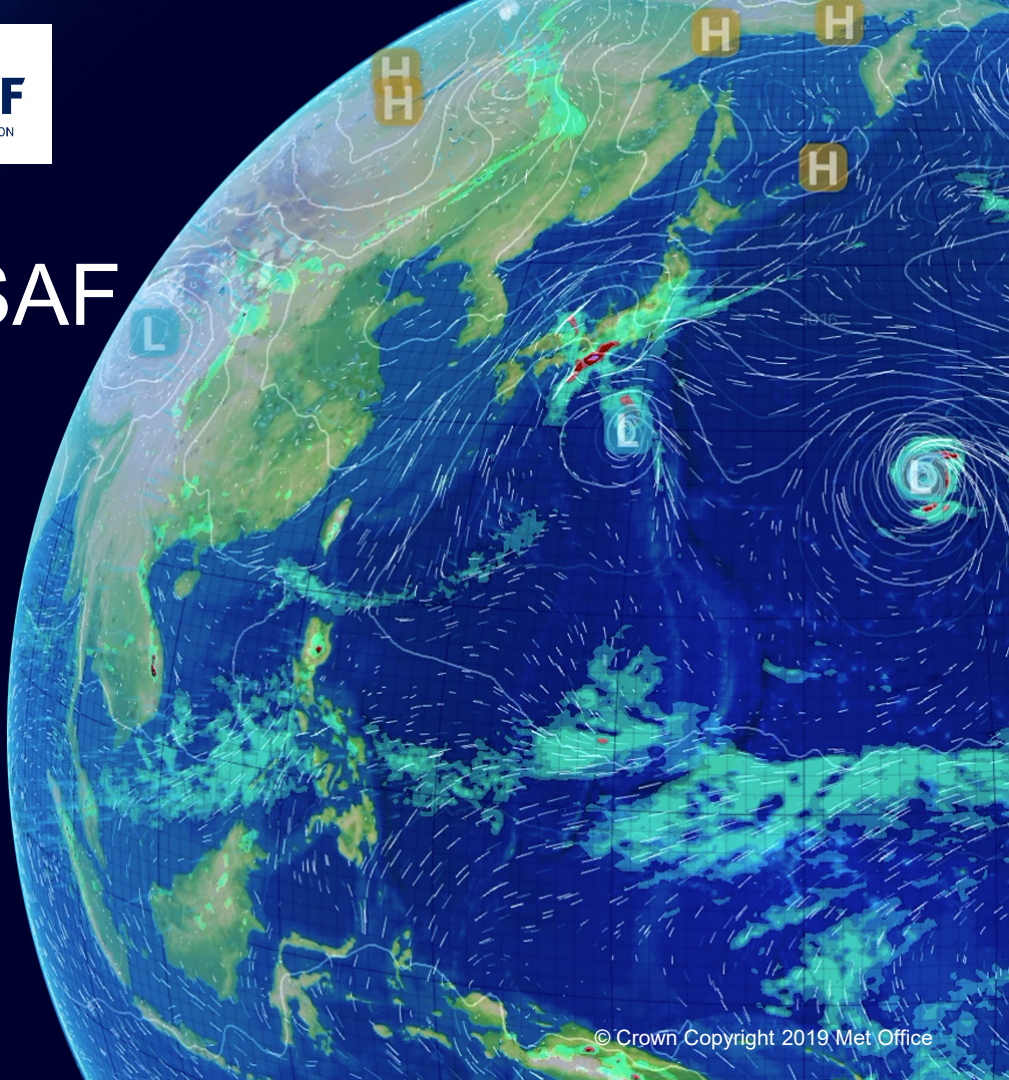


# 20 years of the NWP SAF

Nigel Atkinson

ITSC-22

31<sup>st</sup> October 2019




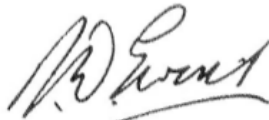
# Acknowledgements

To the many NWP SAF team leaders and developers who have worked on the project over the years, including:

John Eyre, Sam Pullen, James Hocking, Roger Saunders, Pascal Brunel, Pascale Roquet, Tiphaine Labrot, Philippe Marguinaud, Chiara Piccolo, Bryan Conway, Tony McNally, Jerome Vidot, Christina Köpken-Watts ... and many others

# The start of the NWP SAF

- The Satellite Application Facility on Numerical Weather Prediction (NWP SAF) was initiated in November 1998 (*so actually coming up to 21 years*)
- It was hosted by the Met Office, UK, and developed in co-operation with ECMWF, KNMI and Météo-France

In <u>Darmstadt</u>	In <u>Darmstadt</u>
on <u>25 November 1998</u>	on <u>25 November 1998</u>
for EUMETSAT	for The UKMO
	
..... Dr. Tillmann Mohr Director	..... Mr. Peter D. Ewins Chief Executive

# Why?

From the 1997 NWP SAF Proposal document:

- The quality of **NWP products** is crucial to the quality of forecasting services
- EUMETSAT Members have made, and are planning to make, **large investments in satellite systems**
- **Complex data processing systems** are needed to extract the meteorological information from the satellite data in a form suitable for use in NWP
- **Specialised R&D** is needed at a level beyond the resources of an individual NWP centre. A "network" is needed whereby the development work can be shared between European NWP centres and EUMETSAT.

The initiative was supported by EUMETSAT Council and STG

The proposal included a 1-year “definition” phase, followed by 4 years “development phase”. Follow-on phases were foreseen.

***Mission: to improve the interface between satellite data and NWP***

# Where were we in Nov 1998?

- NOAA-15 had been launched in May 1998 – lots of interest in the new AMSU-A!
- Radiance assimilation was becoming popular for TOVS/ATOVS, but retrievals still being used
- **AAPP** and **RTTOV** had already been developed outside the NWP SAF framework (more in next slides)
- Looking forward to the first Metop – especially IASI
  - Metop-A was eventually launched in 2006

# AAPP – early days

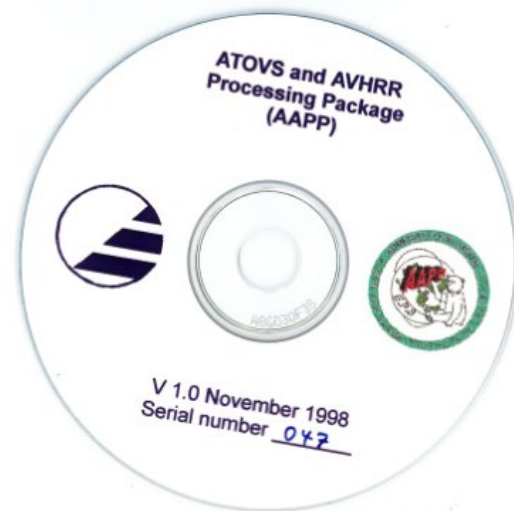
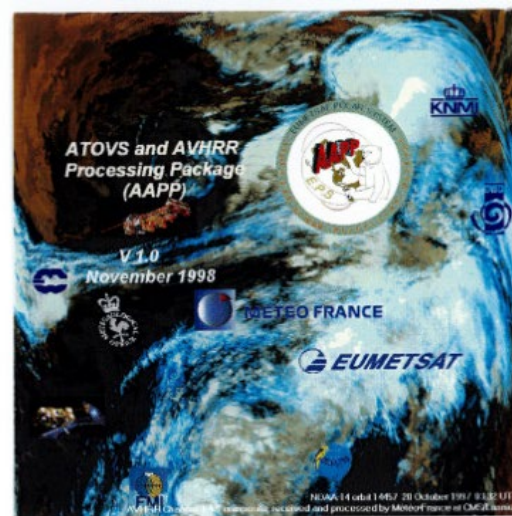
- Started as a EUMETSAT project around 1995
- Main aim: processing capability for the new generation of NOAA POES satellites: NOAA-15 and its successors
- Version 1.0 released in Nov 1998 by EUMETSAT
  - 6 months after launch of NOAA-15

## THE EUROPEAN ATOVS AND AVHRR PROCESSING PACKAGE (AAPP) DEVELOPMENT

*ITSC-10 (Boulder)  
proceedings, 1999*

**K. Dieter Klaes and Rainer Schraidt**  
**EUMETSAT**  
**Darmstadt, Germany**

- Formal responsibility for licensing and distribution of AAPP passed to the NWP SAF in June 2004 (in the Initial Operational Phase)



# AAPP early contributors

**FIGURE 1 : Contributors to the EUMETSAT ATOVS Development**

*from Klaes and Schraidt, 1999*



*An early logo*

# RTTOV origins

- RTTOV-1 was developed at ECMWF and documented in ECMWF Tech Memo 176 (1991) by John Eyre. It built on earlier work:
  - McMillin L.M., Fleming H.E. and Hill M.L. 1979 Atmospheric transmittance of an absorbing gas. 3: A computationally fast and accurate transmittance model for absorbing gases with variable mixing ratios. Applied Optics 18 1600-1606
  - Eyre J.R. and Woolf H.M. 1988 Transmittance of atmospheric gases in the microwave region: a fast model. Applied Optics 27 3244-3249
- RTTOV-3 was used operationally at ECMWF (in 1D-Var) from 1992 to 1998.
- RTTOV-5 released in Aug 1999:
  - See ECMWF Tech Memo 282 by Roger Saunders, Marco Matricardi and Pascal Brunel

For a description of RTTOV history and current status, see

*Saunders et al., 2018: An update on the RTTOV fast radiative transfer model (currently at version 12), Geosci. Model Dev., 11, 2717–2737*



**Table 1.** Major enhancements to RTTOV since the initial versions developed at ECMWF in mid 1990s.

RTTOV version	Release date	Major enhancements
1–4	Mid1990s	– TOVS only on 40 atmospheric levels. Clear sky and black cloud. Surface emissivity provided by user.
5	1999 (pre-NWP SAF)	– ATOVS, METEOSAT, GOES imagers. Clear sky and grey cloud, 43 atmospheric layers
6	March 2000	– Revised water vapour transmittance calculation – More sensors supported (e.g. ATSR, GOES, AVHRR, MODIS, GMS, SSM/I) – Addition of SSIREM IR and FASTEM MW ocean surface emissivity models – Addition of MW cloud liquid water absorption (English et al., 2000)
7	January 2002	– New clear-air transmittance formulation introduced – Improved cloud simulations for multi-layers – FASTEM version 2 introduced
8	November 2005	– Revised transmittance calculations for more variable gases and separate continuum – FASTEM version 3 introduced to allow simulation of polarimetric radiometers – Addition of RTTOV-SCATT wrapper for MW scattering from hydrometeors
9	March 2008	– Addition of reflected solar radiation for SWIR channels – IR cloud and aerosol scattering added using parameterization from Chou et al. (1999) and maximum random cloud overlap – Radiative transfer computation possible on user input pressure levels – Coefficient files for advanced IR sounders provided on 100 levels – Internal profile interpolation added

... and many more developments up to the current v12

Now supports 50 satellites and 90 instruments

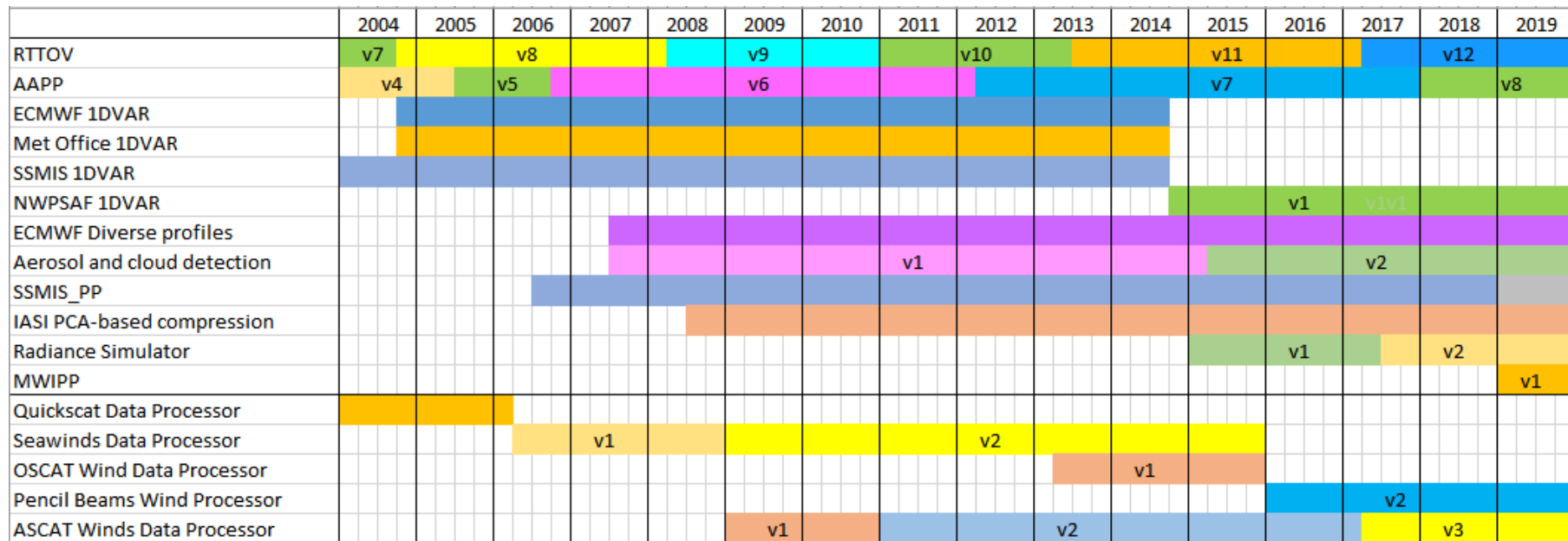
# Key events in the NWP SAF

- Nov 1998: start of the **Development Phase** – cooperation agreement signed
- March 2004: start of the **Initial Operational Phase (IOP)**; **Helpdesk** launched
- March 2007: start of **Continuous Development and Operations Phase (CDOP-1)**
  - Each phase lasts 5 years
  - We are now into CDOP-3



SAF logos past and present

# Deliverables timeline since IOP



Note that OSI SAF have taken over responsibility for the scatterometer deliverables since March 2017, but NWPSAF still distributes them

# Deliverables in 2019

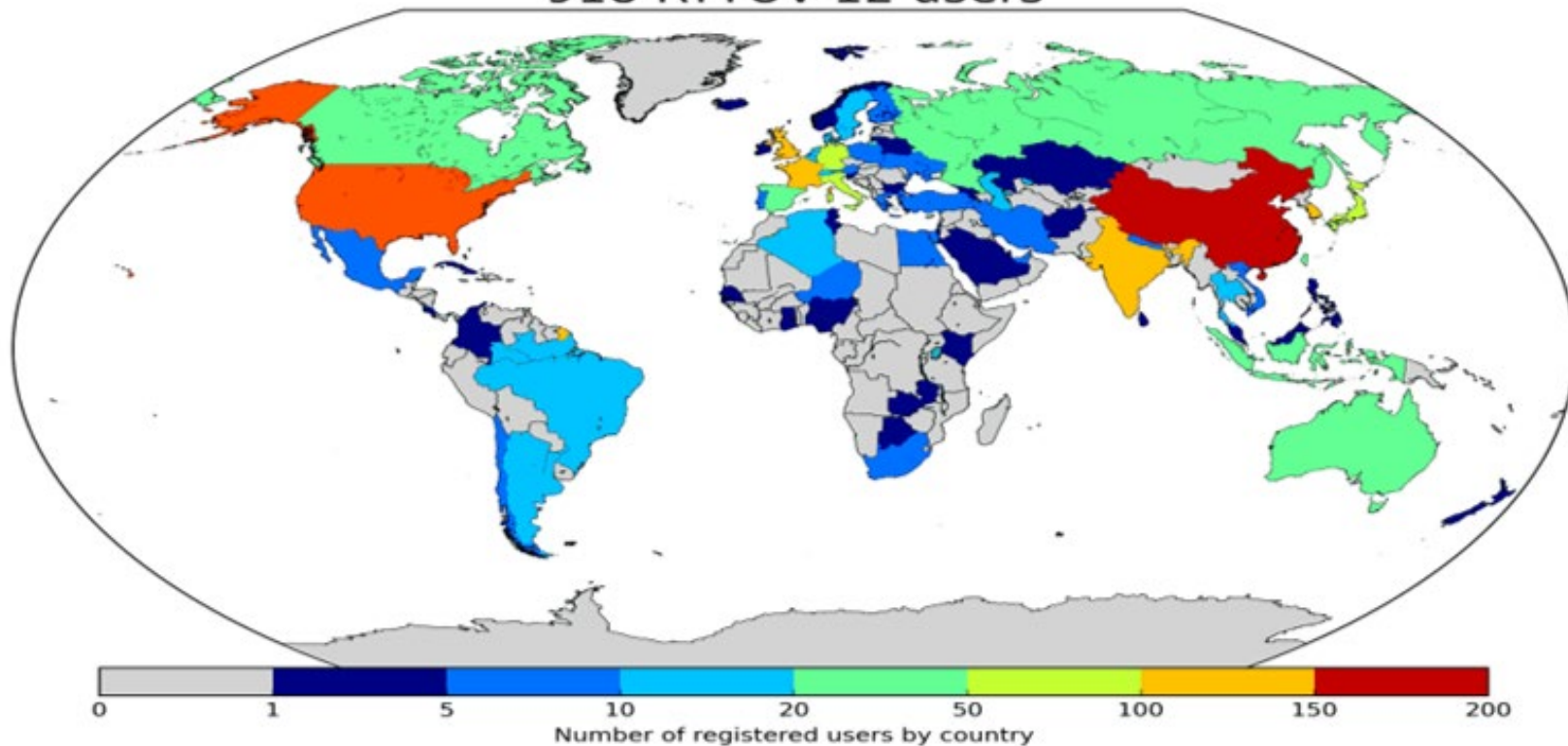
Deliverable	New registrations 1.1.19-30.6.19	Total registrations up to 30.6.19
AAPP v8	104	209
AWDP v3*	59	186
CADS v2	59	425
CWDP v0.9*	0	17
IASI PCA-based compression package	45	222
MWIPP v1	13	13
NWPSAF 1D-Var v1	64	375
OPS-LRS v8	51	100
PenWP v2*	31	167
RADSIM v2	78	232
RTTOV v11	0	1054
RTTOV v12	326	978
SSMIS PP v1	33	198
<b>Total</b>	<b>863</b>	<b>4176</b>

Most popular packages:

- ← 2. Cloud/aerosol (CADS)
- ← 3. 1D-Var
- ← 1. RTTOV

# RTTOV users

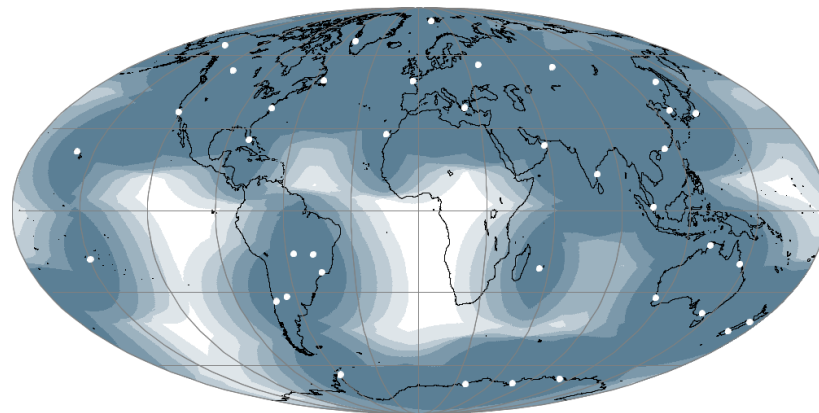
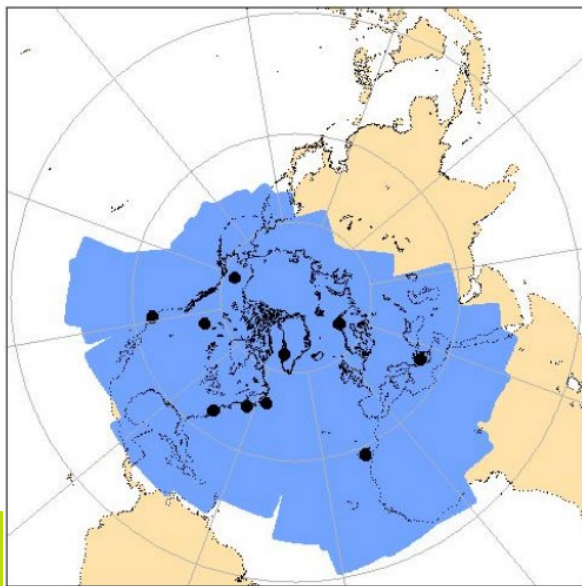
918 RTTOV-12 users



# EARS, RARS and DBNet

- Jan 2005: Start of operational monitoring of **EARS** data (then known as the EUMETSAT ATOVS Retransmission Service)
- Nov 2007: the EARS monitoring was extended to cover the new **RARS** ATOVS service, at the request of WMO
- Re-branded DBNet in 2015 – recognising that it is now more than just ATOVS

**EARS**  
coverage  
in 2004



**DBNet ATOVS** coverage in 2019

# Monitoring activities

Have greatly expanded over the years.

Now includes:

- NRT availability (led by DWD)
- NRT quality (led by ECMWF)
- auto-alert system
- DBNet
- DFS diagnostics
- AMV and Scatterometer wind monthly monitoring
- Radiance quality assessments

The AMV Analysis Reports are produced every 2 years ahead of IWWG meetings – major contribution to the satellite DA community

# Radiance monitoring against NWP

- Radiances from 21 instruments are covered
- Plus some level-2 products

NWP SAF Monitoring			
	<a href="#">ECMWF</a>	<a href="#">Met Office</a>	<a href="#">Meteo France</a>
<b>Microwave radiances</b>			
AMSR-2	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
ATMS	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
AMSU-A	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
AMSU-B/MHS	<a href="#">plots</a>		<a href="#">plots</a>
MWHS	<a href="#">plots</a>	<a href="#">plots</a>	
MWHS-2	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
GMI	<a href="#">plots</a>	<a href="#">plots</a> (high freq) <a href="#">plots</a> (low freq)	<a href="#">plots</a>
MWRI	<a href="#">plots</a>		
SAPHIR	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
SMOS	<a href="#">plots</a>		
SSM/I	<a href="#">plots</a>		
SSMIS	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
WindSat	<a href="#">plots</a>		
<b>Infrared radiances</b>			
AIRS	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
CrIS	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
HIRS	<a href="#">plots</a>		
IASI	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
<b>Geostationary radiances</b>			
GOES-15/GOES Imager	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
GOES-16/ABI	<a href="#">plots</a>		<a href="#">plots</a>
Himawari-8/AHI	<a href="#">plots</a>	<a href="#">plots</a>	<a href="#">plots</a>
SEVIRI	<a href="#">plots</a> Meteosat-8 <a href="#">plots</a> Meteosat-11	<a href="#">plots</a>	<a href="#">plots</a>
<b>Level 2 Products</b>			



# Web site

- New website in 2014 – independent from the old Met Office web site that was previously used
- A new feature was the automatic system for registering for deliverables
  - No longer necessary to print, sign and scan the License Agreements!



The NWP SAF aims to improve and support the interface between satellite data/products and European activities in NWP.

The NWP SAF is one of several EUMETSAT SAFs (Satellite Application Facilities). Utilising specialist expertise from the Member States, SAFs are dedicated centres of excellence for processing satellite data and form an integral part of the distributed EUMETSAT Application Ground Segment. Further information about SAFs is available on the [EUMETSAT web site](#).

The SAF for NWP interacts, where appropriate, with related work in other SAFs and in other EUMETSAT activities in order to enhance collaboration and to minimise duplication of effort.

## Recent News and Updates

- [Radiance Simulator v2.2 released](#) - September 26, 2019  
Radiance Simulator v2.2 has been released. The main new features are: support for RTTOV v12.3, simulations for all solar-affected channels supported by RTTOV including use of the BRDF atlas and the MFASIS fast visible cloud parameterisation, clear-sky simulations using the Principal Components-based models PC-RTTOV and HTFRTC, ingest of DWD ICON model fields in GRIB format, ingest of ECMWF data in netCDF format, and the ability to modify the background CO<sub>2</sub> profile used in the simulations.

## News Feature



### Removing the influence of Arctic snow from satellite microwave observations of the atmosphere

Find out how Dr. Melody Sandells is using the NWP SAF Radiance Simulator in a project aiming to improve the exploitation of surface-affected microwave sounding data in NWP. [Read More...](#)

# Focus in the coming years

- Metop-SG

- Direct broadcast software will be provided, but exactly what it will look like is unclear
  - Likely to be via industry-supplied packages, procured by EUMETSAT and distributed by the NWP SAF
- New instruments to be added to AAPP and MWIPP
- Extend the spectral range of RTTOV to cover new instruments

- MTG

- Development of IRSP – includes handling of the PC score NRT product. Preliminary Product Specification is on the NWP SAF web site

- Continued maintenance and user support – for all deliverables

- Continued training activities

- CDOP-4

- Starting to prepare proposals for 2022-2027
- Please let us know your requirements, and discuss them in the Working Groups!

# Competition challenge for ITSC-22:

*Which bug has survived undetected in code for longest?*

My submission from AAPP:

Antenna correction coefficients for AMSU-B and MHS on NOAA-15,16,17,18

- Channels 3-5 are supposed to be the same, since they are derived from 1 set of pre-launch measurements
- Discovered that channels 4 and 5 are based on channels 1 and 2 respectively – same error was copied for 4 satellites!
- Uncovered in FIDUCEO report (Hans et al, 2019, Remote Sensing)
- **Undetected for 20 years!**

NWP SAF web page: <http://nwpsaf.eu>

Thank you for your attention



# Backup slides

# Deliverables in the first year of IOP (2004-5)

<b>Deliverable</b>	<b>Total licences</b>	<b>pre-IOP</b>
AAPP v4	228	187
ECMWF 1D-Var v2	2	0
Met Office 1D-Var v3	11	0
QDP v1	5	5
RTTOV v7	94	94
RTTOV v8	57	0
SSMIS 1D-Var v2	8	6
ICI v3	23	23

QDP = QuikScat Data Processor

ICI = Inversion Coupled with Imager (Météo-France). Not an NWPSAF deliverable, but existing users were supported

## New satellite series relevant to NWPSAF deliverables

- Aug 2002: [Meteosat-8](#) (SEVIRI)
- Oct 2003: [DMSP F16](#) (first SSMIS)
- Oct 2006: [Metop-A](#) (first IASI)
- May 2008: [FY-3A](#) (MWHS, MWTS)
- Oct 2011: [Suomi-NPP](#) (ATMS, CrIS, VIIRS)
- 2021: [MTG-I1](#) (FCI, LI, DCS, GEOS&R)
- 2022: [EPS-SG-A1](#) (MWS, IASI-NG, MetImage, 3MI, Sentinel-5, RO)
- 2023: [Metop-SG-B1](#) (MWI, ICI, SCA, A-DCS, RO)
- 2023: [MTG-S1](#) (IRS, Sentinel-4, DCS, GEOS&R)