EPS Direct Readout and Processing Tools

Nigel Atkinson (Met Office, UK)
Who am I?

- I work for the Met Office in Exeter, UK
- I’ve been in Met Office since 1982 and involved in satellite instruments (specifically AMSU-B) since early 1990s
- AAPP co-ordinator since 2003
- You may have met me at conferences such as ITSC or NOAA Direct Broadcast, or corresponded via the NWP SAF Helpdesk
- http://www.metoffice.gov.uk/research/people/nigel-atkinson
Contents

• Introduction to direct readout
• Initial processing of the raw EPS signal
• AAPP software package and the NWP SAF
  • Processing Metop and NOAA satellite data
  • Processing IASI
  • AAPP cloud mask
  • Processing NPP data
• Use of direct broadcast data in regional re-transmissions
• Visualisation and products
Why direct readout?

- Timeliness – satellite broadcasts what it sees
- No reliance on external comms links – suitable for remote locations

Direct broadcast = what the satellite transmits

Direct readout = what the user receives
## Direct Readout

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Frequency</th>
<th>Data rate</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAA POES</td>
<td>VHF (APT), 137 MHz&lt;br&gt;L-band (HRPT), 1.7 GHz</td>
<td>0.04 Mbps&lt;br&gt;0.67 Mbps</td>
<td>AVHRR (2 channels)&lt;br&gt;AVHRR, AMSU, MHS, HIRS</td>
</tr>
<tr>
<td>Metop-A/B/C (EPS)</td>
<td>L-band (AHRPT), 1.7 GHz</td>
<td>3.5 Mbps</td>
<td>AVHRR, AMSU, MHS, HIRS, IASI</td>
</tr>
<tr>
<td>Terra/Aqua</td>
<td>X-band, 8.2 GHz</td>
<td>13.1 / 15 Mbps</td>
<td>Terra: MODIS&lt;br&gt;Aqua: MODIS, AIRS, AMSR</td>
</tr>
<tr>
<td>Suomi NPP</td>
<td>X-band, 7.8 GHz</td>
<td>15 Mbps</td>
<td>VIIRS, ATMS, CrIS</td>
</tr>
<tr>
<td>FY-3A/3B</td>
<td>L-band, 1.7 GHz&lt;br&gt;X-band, 7.8 GHz</td>
<td>4.2 Mbps&lt;br&gt;18.7 Mbps</td>
<td>VIRR, MWTS, MWHS, IRAS&lt;br&gt;MERSI</td>
</tr>
<tr>
<td>EPS-SG (2020+)</td>
<td>X-band</td>
<td></td>
<td>Imagers, sounders, etc., on 2 satellites</td>
</tr>
</tbody>
</table>
Direct Readout Reception

3m dish at Met Office, Exeter
Direct Readout Reception (2)

Installation of new 2.4m system, March 2012
Mobile systems are possible

Dartcom 1.3m active-stabilised marine antenna installed on the Swedish Maritime Administration icebreaker Oden
Initial processing

See “HRPT User Station Design Specification” on EUM web site

Data access → resources

CADU
Channel Access Data Unit

VCDU
Virtual Channel Data Unit

ISP
Instrument Source Packet

Level 0

FTP Server
L0 product

FTP Subsystem
L0 product

Archive
L0 product

Tape device

Receiver
CADU (I+O) Clock

Input Card

FEP Subsystem

Decryption files
PBK update

Local M&C
Adm Message

FTP Subsystem
Adm Message

ISP Handler
Adm Message

Quick Look Processor

Moving Window Display

Generate L0
ISP checked
ISP checked

Packet Error Control

Source Packet Reconstruct

Encrypted VCDU

Decrypted VCDU

Encrypted VCDU

Decrypted VCDU

ISP

KN + Seed

SKU

PBK update

Decryption files

Input Card

FEP Subsystem

FTP Subsystem

Archive

Tape device

L0 product

L0 product
Typical files

Metop-A pass received at Exeter

- **VCDU**

220347456 vcdu_M02_33780_2013-04-23T10:01:10.561_045

- **Level 0:**

520071 ADCS_HRP_00_M02_20130423100615Z_20130423101520Z_N_O_20130423100641Z
234119 AMSA_HRP_00_M02_20130423100615Z_20130423101528Z_N_O_20130423100635Z
2980639 ASCA_HRP_00_M02_20130423100621Z_20130423101541Z_N_O_20130423100625Z
43513607 AVHR_HRP_00_M02_20130423100622Z_20130423101541Z_N_O_20130423100625Z
27924231 GOME_HRP_00_M02_20130423100622Z_20130423101541Z_N_O_20130423100648Z
1384509 GRAS_HRP_00_M02_20130423100624Z_20130423101536Z_N_O_20130423101013Z
208023 HIRS_HRP_00_M02_20130423100613Z_20130423101524Z_N_O_20130423100633Z
472443 HKTM_HRP_00_M02_20130423100619Z_20130423101536Z_N_O_20130423100628Z
104218001 IASI_HRP_00_M02_20130423100621Z_20130423101541Z_N_O_20130423100625Z
280871 MHSx_HRP_00_M02_20130423100617Z_20130423101530Z_N_O_20130423100631Z
15095 SEMx_HRP_00_M02_20130423100607Z_20130423101440Z_N_O_20130423100718Z
Tools to generate L0

eumetsat.int → Data access → Software support and tools → Metopizer

• Useful if your station doesn’t already generate L0 files

• Metopizer includes:
  - `cadu_to_ccsds`
    - `cadu_to_tvcdcu`
    - `tvcdu_to_ccsds`
  - `ccsds_to_l0`
  - Various viewer tools

• L0 files ready for processing with AAPP
What is AAPP?

• ATOVS and AVHRR Pre-processing Package
• Software package for processing various types of polar orbiter data – imager and sounder
• Maintained by the EUMETSAT Satellite Application Facility for Numerical Weather Prediction (NWP SAF)
• Web site: http://www.nwpsaf.org
• Available free of charge (registration is required)
• Current version v7.4 (Dec 2012)
The NWP SAF  www.nwpsaf.org

• Range of tools, primarily for NWP users:
  ➢ ATOVS and AVHRR Pre-processing Package (AAPP)
    ▪ with capabilities for processing EPS direct readout
  ➢ Monitoring reports
  ➢ SSMIS processing package
  ➢ Scatterometer
  ➢ Radiative transfer (RTTOV)
  ➢ 1D-Var schemes
  ➢ Cloud detection

• Helpdesk for user support
Satellite Application Facility for Numerical Weather Prediction

The NWP SAF is a EUMETSAT-funded activity that exists to co-ordinate research and development efforts among the SAF partners to improve the interface between satellite data and NWP for the benefit of EUMETSAT member states. The NWP SAF is led by the Met Office, with partners ECMWF, KNMI and Météo-France. More about the aims of the NWP SAF.

NWP SAF overview from EUMETSAT's IMAGE newsletter (PDF file)

NWP SAF deliverables

The SAF is concerned with the NWP data assimilation process rather than with generating geophysical parameters. Its main deliverables are software packages and data monitoring reports.

- AAPP
- SSMIS_PP
- 1D-Var Schemes
- Scatterometer
- RTTOV & Profiles
- Monitoring reports
- Cloud Detection Software
- IASI PCA Compression

NWP SAF news

- AAPP update 7.2 and OPS-LRS version V6-0+P12 have been released. The AAPP update includes modifications to the processing of ATMS on Suomi-NPP and handling of the new EUMETSAT Multi-Mission Administration Messages (MMAM). The new version of OPS-LRS incorporates the latest updates from CNES. More information is available on the AAPP pages. 27 July 2012.
- Met Office 1D-Var v3.4 has been released. This new version adds support for the RTTOV v10 radiative transfer model and the addition of SSMIS liquid water retrieval capability. Further details can be found on the Met Office 1D-Var page. 11 May 2012.
- New monitoring pages showing plots of SSMIS and AIRS radiances vs Met Office global NWP are now available. Links to additional external monitoring sites have also been added to the monitoring links webpage. 18 April 2012.
- EUMETSAT has extended the duration of support services to licensees of NWP SAF software. For further details see the Software Request Forms page. 2 March 2012.

Further news items can be seen on the NWP SAF News page.

Contact

Questions for other users and developers can be posted on the RTTOV or AAPP Forums. To contact us with other enquiries, please use the NWP SAF Helpdesk link, or use a software request form to request a software deliverable.

Visiting scientists

A visiting scientist programme allows scientists from institutions that are not SAF members to participate in the activities of the SAF. More about visiting scientists.

Members' site

This area of the site is restricted to the NWP SAF Development Team.
Main purposes of AAPP

• To prepare polar-orbiter data for use in NWP
  ➢ radiances from sounder instruments – microwave and I/R
  ➢ major contributor to forecast accuracy

• To prepare data for retrieval packages
  ➢ such as IAPP (Univ. Wisconsin) for HIRS+AMSU

• As a step to creating images
  ➢ AVHRR
  ➢ cloud mask

• For creating climate products
Data inputs

• Raw data from satellite direct broadcast – complete level 1 processing
  ➢ NOAA-15-19, Metop-A/B, (FY-1D)

• Outputs from other DB packages
  ➢ e.g. Sensor Data Records from NPP (from University of Wisconsin’s CSPP)

• Level 1B data from NOAA or EUMETSAT
  ➢ near-real-time or archived (e.g. NOAA CLASS)

*Level 1B = raw counts (or radiances) on original instrument grid, with geolocation*
Requirements

To run AAPP, you need

• Linux or unix system, e.g.
  - e.g. Linux PC, Sun Solaris, IBM AIX

• A suitable Fortran compiler
  - e.g. gfortran, g95, ifort, pgf90, xlf, ….
  - Most parts of AAPP will also work with a fortran77 compiler, e.g. g77

• C compiler

• Korn shell, perl, make, etc.

• For IASI level 1 processing you also need C++, multi-threading support and at least 2Gb memory

• External libraries are used for some parts of the processing (e.g. hdf5, BUFR, GRIB) – see Installation Guide for details

Not Windows!
Example: NOAA-19 direct readout

*(one of the test cases supplied with AAPP)*

• Inputs

  ➢ HRPT file: hrpt_noaa19_20110906_0206_13280.hrp (113Mb for 14 minute pass)
  
  ➢ Orbital elements (spacecraft position information): tle_20110906_0255.txt
    
    ▪ these can be obtained by the user from celestrak.com or www.space-track.org.
    
    ▪ normally save them in AAPP directory AAPP/orbelems/tle_tb/2011-09

• AAPP command

  AAPP_RUN_NOAA -i "AMSU-A MHS HIRS AVHRR" -g HIRS \ hrpt_noaa19_20110906_0206_13280.hrp

• Outputs

  amsual1b_noaa19_20110906_0206_13280.l1b
  amsual1c_noaa19_20110906_0206_13280.l1c
  hirsl1b_noaa19_20110906_0206_13280.l1b
  hirsl1c_noaa19_20110906_0206_13280.l1c
  hirsl1d_noaa19_20110906_0206_13280.l1d
  hrpt_noaa19_20110906_0206_13280.l1b
  mhsl1b_noaa19_20110906_0206_13280.l1b
  mhsl1c_noaa19_20110906_0206_13280.l1c

  } AMSU-A

  } HIRS

  } AVHRR

  } MHS

  Binary files, with header record, and 1 data record per scan

  Takes a few seconds on a modern linux system
Outputs rendered as images

MHS

AMSU

HIRS

AVHRR

Used IDL for these images

Many possibilities
Example 2: Metop-A direct readout

- **Inputs**
  - Level 0 files:
    - AMSA_HRP_00_M02_20100128104249Z_20100128105130Z_N_O_20100128104314Z
    - AVHR_HRP_00_M02_20100128104259Z_20100128105149Z_N_O_20100128104305Z
    - HIRS_HRP_00_M02_20100128104253Z_20100128105138Z_N_O_20100128104316Z
    - HKTM_HRP_00_M02_20100128104256Z_20100128105143Z_N_O_20100128104310Z
    - IASI_HRP_00_M02_20100128104259Z_20100128105148Z_N_O_20100128104303Z
    - MHSx_HRP_00_M02_20100128104252Z_20100128105138Z_N_O_20100128104310Z
  - Orbital elements: as before, or get TLEs from HKTM
  - For IASI processing, need auxiliary files (available on AAPP ftp site)

- **AAPP command**
  
  ```
  export PATH_OPS=...; export DIR_IASI_CONFIG=...
  AAPP_RUN_METOP -i "AMSU-A MHS HIRS AVHRR" -g HIRS
  AAPP_RUN_METOP -i "AMSU-A MHS AVHRR IASI" -g IASI
  ```

- **Outputs**
  - AMSU-A
  - HIRS
  - AVHRR
  - IASI
  - MHS
  
  IASI 1d:
  - mapped AMSU
  - channel selection
  - PCs if requested
Main components of AAPP

- **Decommutation**
  - NOAA sats – convert raw data to level 1a
  - Metop – convert EPS level 0 to level 1a

- **Calibration**
  - amsuacl, mhscl, hirscl, avhrcl

- **Navigation**
  - Performed when you run the calibration

- **Pre-processing**
  - atovin – convert from counts to BT
  - atovpp – re-mapping, etc.

- **Cloud mask**
  - MAIA 2.1 (HIRS grid), MAIA3 (AVHRR) and MAIA4 (VIIRS)

- **Tools**
  - BUFR and HDF5 conversion tools
  - Orbital elements handling
IASI level 1 processor

• The IASI level 1 processor is called OPS-LRS: Operational Software – Local Reception Station

• Optional addition to the core AAPP

• Based on CNES/Thales code used in EUMETSAT ground segment

• Adapted by NWP SAF for portability and to make it easier to install/run
  ➢ though not very user-friendly if something goes wrong!

• See OPS-LRS User Manual (on AAPP web page)

With the recent launch of Metop-B, we expect interest in IASI from HRPT stations that are unable to receive Metop-A (e.g. South America)
Running OPS-LRS

• Can be called from AAPP_RUN_METOP – specify IASI and AVHRR in the list of instruments)

• or call the `ops_process` script, e.g.

```bash
ops_process --satellite=M01 --processing=DUMP \ $IASIfile $AVHRR1bfile
```

• At the Met Office, takes ~3.5 min for a 13 minute pass, using 8 threads.
IASI level 1c
## IASI 1c product dissemination

<table>
<thead>
<tr>
<th></th>
<th>EUMETCast</th>
<th>GTS</th>
<th>EUM Data Centre</th>
<th>NOAA CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8461 channels, global</strong></td>
<td>BUFR (340007)</td>
<td></td>
<td>Native, BUFR, netCDF, HDF5EPS</td>
<td>Native, netCDF</td>
</tr>
<tr>
<td><strong>366 channels, global</strong></td>
<td>BUFR (340008)</td>
<td>BUFR (340008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>300 PCs, global</strong></td>
<td>BUFR (340008)</td>
<td>BUFR (340008)</td>
<td>Native</td>
<td></td>
</tr>
<tr>
<td><strong>300 PCs + 366 channels, regional (EARS – direct readout)</strong></td>
<td>BUFR (340008)</td>
<td>BUFR (340008)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AAPP has tools to ingest BUFR and Native formats, or use the EUMETSAT EPS tools on their web site (Support Software & Tools)
AVHRR cloud mask

- This is another optional part of AAPP
- Cloud mask “MAIA3” developed by Météo-France (Lydie Lavanant), introduced Feb 2010.
- MAIA4 (VIIRS capability) coming soon.
- It makes use of NWP forecast fields (GRIB), or climatology if these are not available.
- Command:
  `MAIA3_RUN hrpt_noaa19_20110906_0206_13280.l1b`
- Outputs
  `avh_noaa19_20110906_0206_13280.l1c` - radiances
  `avh_noaa19_20110906_0206_13280.l1d` - radiances + cloud mask
  and optionally plots like this one …
## What about DB from other polar satellites?

<table>
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<tr>
<th>Satellite</th>
<th>Software</th>
<th>Available from</th>
<th>Interface with AAPP?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqua/Terra</td>
<td>MODISL1DB (SeaDAS)</td>
<td><a href="http://seadas.gsfc.nasa.gov/">http://seadas.gsfc.nasa.gov/</a></td>
<td>No requirement</td>
</tr>
<tr>
<td></td>
<td>IMAPP</td>
<td><a href="http://cimss.ssec.wisc.edu/imapp/">http://cimss.ssec.wisc.edu/imapp/</a></td>
<td>(There is an IMAPP tool to generate AMSU-A BUFR files)</td>
</tr>
<tr>
<td></td>
<td>MODIS level 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AIRS level 1 &amp; 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AMSR-E level 1 &amp; 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPP</td>
<td>RT-STPS (raw → RDR) and CSPP (RDR → SDR)</td>
<td><a href="http://cimss.ssec.wisc.edu/cspp/">http://cimss.ssec.wisc.edu/cspp/</a></td>
<td>Yes. AAPP can ingest the SDR files (hdf5 format)</td>
</tr>
<tr>
<td></td>
<td>IPOPPP (NASA Direct Readout Lab)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY-1D (“Feng Yun”)</td>
<td>AAPP</td>
<td>NWP SAF</td>
<td>(Satellite no longer working)</td>
</tr>
<tr>
<td>FY-3A and FY-3B</td>
<td>FY3L0pp and FY3L1pp</td>
<td><a href="http://www.nsmc.cma.gov.cn/NewSite/NSMC_EN">http://www.nsmc.cma.gov.cn/NewSite/NSMC_EN</a></td>
<td>Yes. AAPP can ingest the SDR files for sounder instruments (hdf5 format)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training → FAQs</td>
<td></td>
</tr>
<tr>
<td>DMSP (U.S. military)</td>
<td>No</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Meteor-3M (Russia)</td>
<td>No</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
Recent launches

Suomi NPP: 28th Oct 2011

Metop-B: 17th Sept 2012
Metop-B

L0 data from Judd Taylor, Orbital Systems, 16/10/2012

- Operational status from 24th April 2013
- See NWP SAF Forum “AAPP Announcements” for code updates, etc.: [www nwpsaf eu forum](http://www.nwpsaf.eu/forum)
## NWP SAF forums

The NWP SAF is a EUMETSAT-funded activity that exists to co-ordinate research and development efforts among the SAF partners to improve the interface between satellite data and NWP for the benefit of EUMETSAT member states.

The NWP SAF website can be found at [http://nwpsaf.org](http://nwpsaf.org)

### Board index

- **User Control Panel** (0 new messages) • View your posts
- **FAQ** • **Members** • **Logout** [nigel.atkinson]

It is currently Thu Oct 18, 2012 9:16 am

[ Moderator Control Panel ]

Last visit was: Wed Oct 17, 2012 1:59 pm

View unanswered posts • View unread posts • View new posts • View active topics

### Mark forums read

#### RTTOV

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<tr>
<th>Version</th>
<th>Topics</th>
<th>Posts</th>
<th>Last Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTTOV 10</td>
<td>35</td>
<td>74</td>
<td>by james.hocking (Wed Sep 19, 2012 2:33 pm)</td>
</tr>
<tr>
<td>RTTOV 9</td>
<td>13</td>
<td>20</td>
<td>by james.hocking (Wed Sep 19, 2012 2:34 pm)</td>
</tr>
<tr>
<td>Older versions</td>
<td>1</td>
<td>1</td>
<td>by roger.saunders (Mon Feb 07, 2011 9:02 pm)</td>
</tr>
</tbody>
</table>

#### AAPP

<table>
<thead>
<tr>
<th>Topic</th>
<th>Topics</th>
<th>Posts</th>
<th>Last Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAPP Announcements</td>
<td>15</td>
<td>20</td>
<td>by nigel.atkinson (Wed Oct 17, 2012 9:21 am)</td>
</tr>
<tr>
<td>AAPP General Discussion</td>
<td>7</td>
<td>13</td>
<td>by nigel.atkinson (Thu Oct 11, 2012 9:15 am)</td>
</tr>
</tbody>
</table>

### WHO IS ONLINE

In total there are 4 users online: 3 registered, 0 hidden and 1 guest (based on users active over the past 5 minutes)

Most users ever online was 11 on Thu May 31, 2012 10:05 am
AAPP support for Suomi NPP
from AAPP v7.1 (Feb 2012)

AAPP ingests the SDR files – hdf5 or BUFR.
Stores in “AAPP-format level 1c”

**ATMS**
- Spatial filtering (noise reduction and channel matching) – FFT technique
- Spatial thinning
- Map to CrIS
- BUFR encoding

**CrIS**
- Channel selection
- Spatial thinning
- BUFR encoding

**VIIRS**
- Cloud mask coming soon

More info: see AAPP document on ATMS and CrIS processing at
http://www.nwpsaf.org
VIIRS cloud classification (MAIA4) is being added to AAPP.

From Lydie Lavanant
Use of AAPP in regional ATOVS data distribution

- Each RARS node is a direct broadcast reception station
- AAPP is run at each RARS node – products in BUFR
- ATOVS data available within 30 minutes (normally via GTS)
- IASI and ATMS/CrIS coming soon

See WMO RARS page

RARS = Regional ATOVS Retransmission Service
EUMETSAT’s EARS services

http://www.eumetsat.int/Home/Main/Satellites/GroundNetwork/EARSSystem/index.htm?l=en

ATOVS

All based on DB data

ATOVS and IASI use AAPP

AVHRR, ASCAT, Nowcasting

IASI
EUMETSAT’s initial EARS-NPP network

ATMS – all channels & spots, BUFR
CrIS – 399 channels, BUFR
VIIRS – M-band, HDF5
Processing tools for EARS-AVHRR and EARS-NWC

• AVHRR files arrive in 1 minute granules (level 0)
  - User can concatenate them (unix "cat") and use AAPP to process to level 1b or 1c.

• Nowcasting products are generated using the Nowcasting SAF’s “PPS” package
  - Tools are available for handling and display: see http://pytroll.org/
EARS-NWC cloud mask

Interesting to compare with MAIA?
Visualisation

• Visualisation tools are not officially part of AAPP
  ➢ AAPP is primarily targetted at NWP

• But visualisation of the microwave and I/R data can be very useful for
  ➢ nowcasting, verification, diagnostics, meteorological analysis, etc.

• Many possibilities, some free, some commercial, e.g.
  ➢ IDL, Python, Matlab, McIDAS-V, GMT, IDV, VisAD, Hydra, Metview, Visual Weather, ERDAS IMAGINE, etc.
  ➢ Any others?

• Met Office has some IDL tools that we can supply on request (best effort basis)
Example: Pytroll

http://pytroll.org/ 

• Developed by SMHI and DMI

• Lots of supported satellites:

  ➢ Meteosat series (tested with 7, 8, 9)
  ➢ GOES series, in HRIT/LRIT format (tested with 11, 12, 13, 15)
  ➢ MTSAT series, in HRIT/LRIT format (tested with 1R, 2)
  ➢ Electro L, in HRIT/LRIT format (tested with N1)
  ➢ NOAA series, in AAPP format (tested with 15, 16, 17, 18, 19)
  ➢ Metop-A/B, in EPS 1a and 1b format
  ➢ Aqua and Terra, in hdf-eos format
  ➢ Suomi NPP, in SDR hdf5 format (VIIRS)
AVHRR example from the Pytroll web site
MHS imagery of Hurricane Isaac
28 Aug 2012, 03Z (Metop-A) – generated using IDL

Strong ice scattering signal

89 GHz

157 GHz

190 GHz

AVHRR chan 4

© Crown copyright   Met Office
Scattering index (AAPP) + geo I/R

These images are used by Met Office forecasters

Local reception, EARS and global
ITWG activities

• The International TOVS Working Group (ITWG) covers many aspects of satellite sounder science

• *Products Working Group* has a particular focus on direct readout

• Next meeting: 26 March - 1 April 2014 in Jeju Island, South Korea

• [http://cimss.ssec.wisc.edu/itwg/itsc/](http://cimss.ssec.wisc.edu/itwg/itsc/)
Summary

• Direct broadcast available on L-band for EPS

• Trend is to move to X band for future satellites (including EPS-SG)

• Processing packages are available
  ➢ AAPP for Metop and NOAA

• Regional retransmission services provide access to regional DB data.
  ➢ RARS = WMO co-ordination of several networks
  ➢ EARS = EUMETSAT network

• Many possibilities for products and methods of display
Thank you for listening!

Visit http://www.nwpsaf.org for more information

Questions?

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