# AAPP status report and preparations for processing METOP data

***Nigel C Atkinson* [*], *Pascal Brunel* [†], *Philippe Marguinaud* [†] *and Tiphaine Labrot* [†]**

[*] *Met Office, Exeter, UK*
[†] *Météo-France, Centre de Météorologie Spatiale, Lannion, France*

## Introduction

The ATOVS and AVHRR Pre-processing Package (AAPP) is a software package maintained by the EUMETSAT Satellite Application Facility for Numerical Weather Prediction (NWP SAF). The host institute for the NWP SAF is the Met Office, with partners ECMWF, KNMI and Météo-France (see http://www.nwpsaf.org).

AAPP version 5 is in use routinely at many NWP and research centres worldwide. It processes direct readout (HRPT) data from the operational NOAA satellites, as well as global or regional data. There are currently 175 registered users of version 5. A new release, version 6, was released on 12th October 2006 and this includes a number of enhancements, the most important of which is the capability of processing data from METOP.

The paper describes the current status of version 5 and the new features to be found in version 6. Finally we consider the extension of AAPP to new satellites such as NPP and NPOESS.

## AAPP Version 5

Version 5.1 was released in July 2005, shortly after the launch of NOAA-N. Since then there have been 2 minor updates (mainly bug fixes), as detailed on the AAPP section of the NWP SAF web site. There have also been some updates to the AMSU-B coefficient file.

The reason for the AMSU-B coefficient updates is that on some channels, notably channels 18, 19 and 20 on NOAA-16, the output counts are found to drift downwards with time, necessitating changes to the gross limits. At the same time the gains are dropping and the NEΔTs are increasing, as shown in Fig. 1. Note the 50% decrease in gain over the last 3 years for these channels, and the 67% increase in NEΔT. The most likely cause is degradation in the receiver front-end (mixer or oscillator).

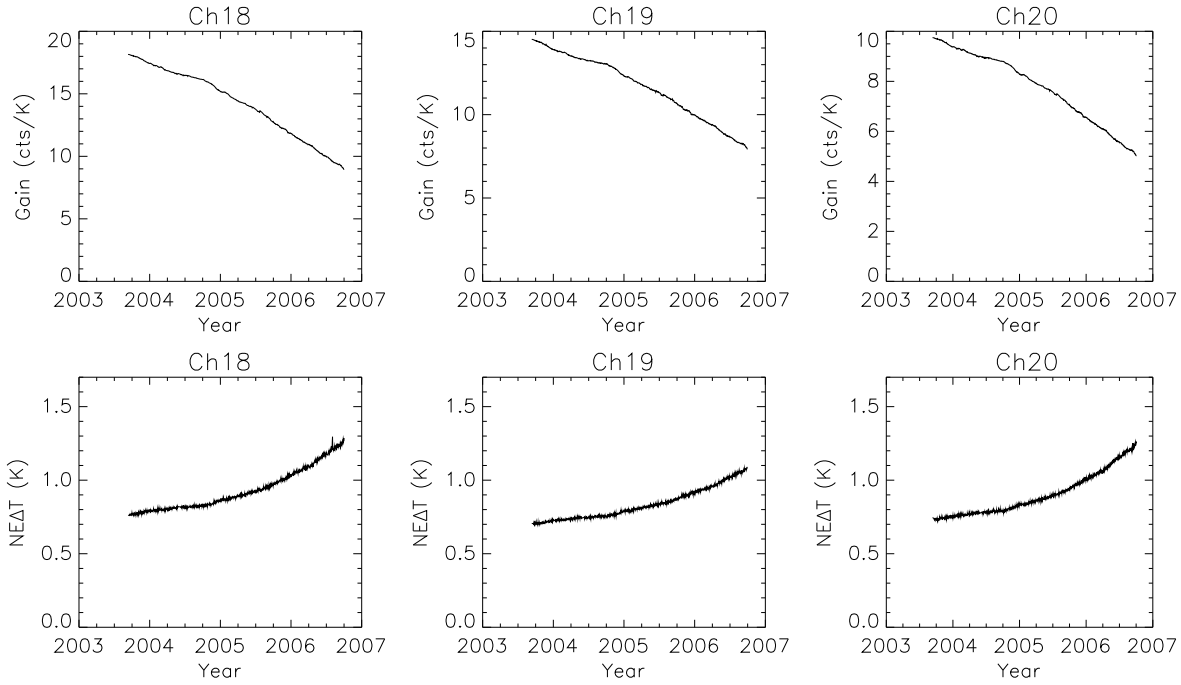



Fig. 1:Gain and NEΔT for NOAA-16 AMSU-B, channels 18-20 (183.31 GHz)

## AAPP version 6 for METOP

The main changes in AAPP v6 compared with AAPP v5 are as follows:

1. Ability to ingest EPS level 0 files for METOP (from direct reception system), and to handle the "SPOT" navigation bulletins contained in the Admin files
2. Processing of IASI instrument to level 1c (via OPS-LRS – see below)
3. Ability to decode and encode BUFR level 1c formats (used for global/regional METOP data)
4. Pre-processing of IASI level 1c, including channel selection, generating Principal Component Scores and mapping AMSU/MHS to the IASI grid
5. An updated build system and directory structure

These changes are discussed below.

### *EPS Level 0 ingest*

AAPP assumes that the direct reception system will deliver METOP data in EPS Level 0 format, as defined by EUMETSAT. In this format the raw data for each instrument are provided in separate files, so there is no need for a "decommutation" task.

Instead, for the ATOVS and AVHRR instruments, AAPP contains front-end tools to convert the Level 0 file for each instrument to a conventional "AAPP level 1a" file. The 1a file can then be processed using the same modules as are used for NOAA data.

If the user's direct reception system does not deliver EPS Level 0 format, tools are available on the EUMETSAT web site to do the necessary conversion from raw HRPT. (Go to www.eumetsat.int and select *Access to Data > User Support > Useful Programs & Tools.* Then see the details on the *METOPizer* tool).

### *IASI level 1 processing*

The IASI level 0 to level 1c processor is called "Operational Software – Local Reception Station", or OPS-LRS. It is available as an optional component of AAPP v6. The software is based on the IASI OPS software delivered to EUMETSAT by CNES, in association with Thales-IS (Marguinaud, 2005).

OPS-LRS includes a perl script to process the data in *dump mode*, i.e. a single IASI L0 file is processed, together with its associated AVHRR files. The AVHRR is required in order to geolocate the IASI data.

Note that OPS-LRS is much more processor-intensive than the rest of AAPP, and makes use of multithreaded techniques (posix threads). A fairly powerful machine is required to run it.

### *BUFR decode and encode*

For some years, AAPP level 1c data have been encoded into BUFR (**B**inary **U**niversal **F**orm for the **R**epresentation of Meteorological data) by NWP centres and used as a format for international exchange of ATOVS data.

EUMETSAT intends to use BUFR for the distribution of METOP global data – for AMSU, MHS, HIRS and IASI.

AAPP v6 contains top-level routines that link with the ECMWF BUFR library. Users who wish to make use of these encode/decode routines will need to download the library from ECMWF (http://www.ecmwf.int/products/data/software/) and to install it before building AAPP.

### *IASI pre-processing*

Several new options will be provided in *atovpp*:

1. Map AMSU and MHS to the IASI grid
2. IASI channel sub-set, based on a pre-selected list of channels, in order to reduce data volume. AAPP includes a list of 300 channels, but users may change this selection if they wish.
3. Produce IASI Principal Component scores, i.e. the signal to noise ratio for the presence of certain pre-computed eigenvectors. The number of eigenvectors will be selectable by the user, but by default will be 300.
4. Spatial thinning, e.g. select 1 spot in 4, either a fixed spot or on the basis of a cloud test. Clear spots are generally preferred for NWP; climate users will prefer an unbiased selection.

For more details on these options, please see the AAPP Scientific Documentation (available on the AAPP web site).

### *Updated build system and directory structure*

During the lifetime of AAPP v5, several users had requested that the old build system (based on *imake,* together with a build script) should be updated. A new system has therefore been devised in which a consistent approach is used for both the new parts of AAPP (metop tools

and IASI tools) and the pre-existing parts (calibration, navigation, pre-processing, etc.). OPS-LRS is a separate component and is not part of this build system.

The new system works as follows:

- The user runs a *configure* script, in which he specifies his platform, preferred Fortran compiler, station name, external libraries, etc. (The script is written in perl). The script uses these settings, together with those in its platform-specific configuration files, to create a *Makefile.ARCH* file that is referenced by all the lower level makefiles
- The user then invokes *make* to build AAPP (or a component of AAPP)

A perl script is also available to automatically re-generate all makefiles, which is useful when creating new software modules.

The main components of the directory structure for AAPP v6 are shown in Fig. 2.

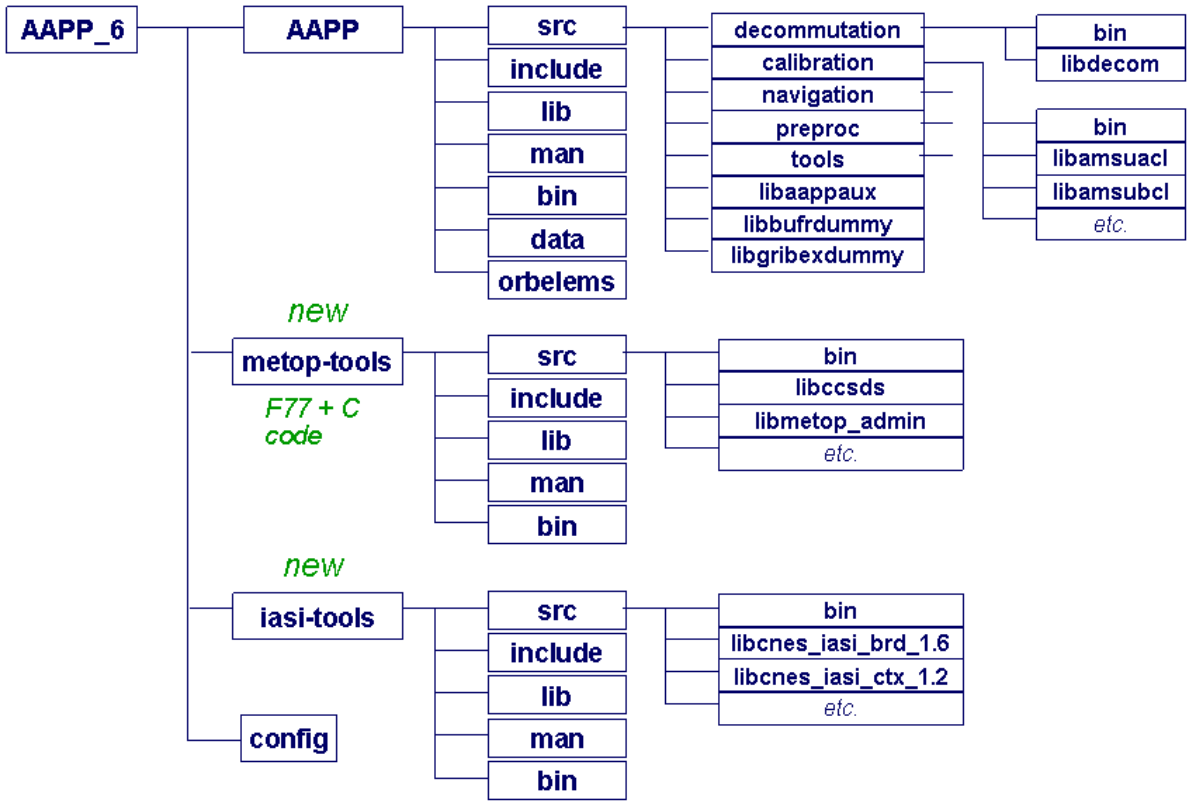



Fig. 2: Directory structure for AAPP v6 (excluding OPS-LRS)

## Overall functionality

The data flow when processing METOP AHRPT data is shown in Fig. 3. A script AAPP_RUN_METOP is provided which implements this data flow (starting from PFS level 0 files, 1 file per instrument per pass). It complements the AAPP_RUN_NOAA script which processes NOAA HRPT data.

Components of AAPP-6 may also be used to process global or regional data – for both NOAA and METOP satellites. Global and regional METOP data will be delivered to European users via EUMETCast. Typical data flows are given in Fig. 4; it is up to the user to write scripts to link together the various processing steps.

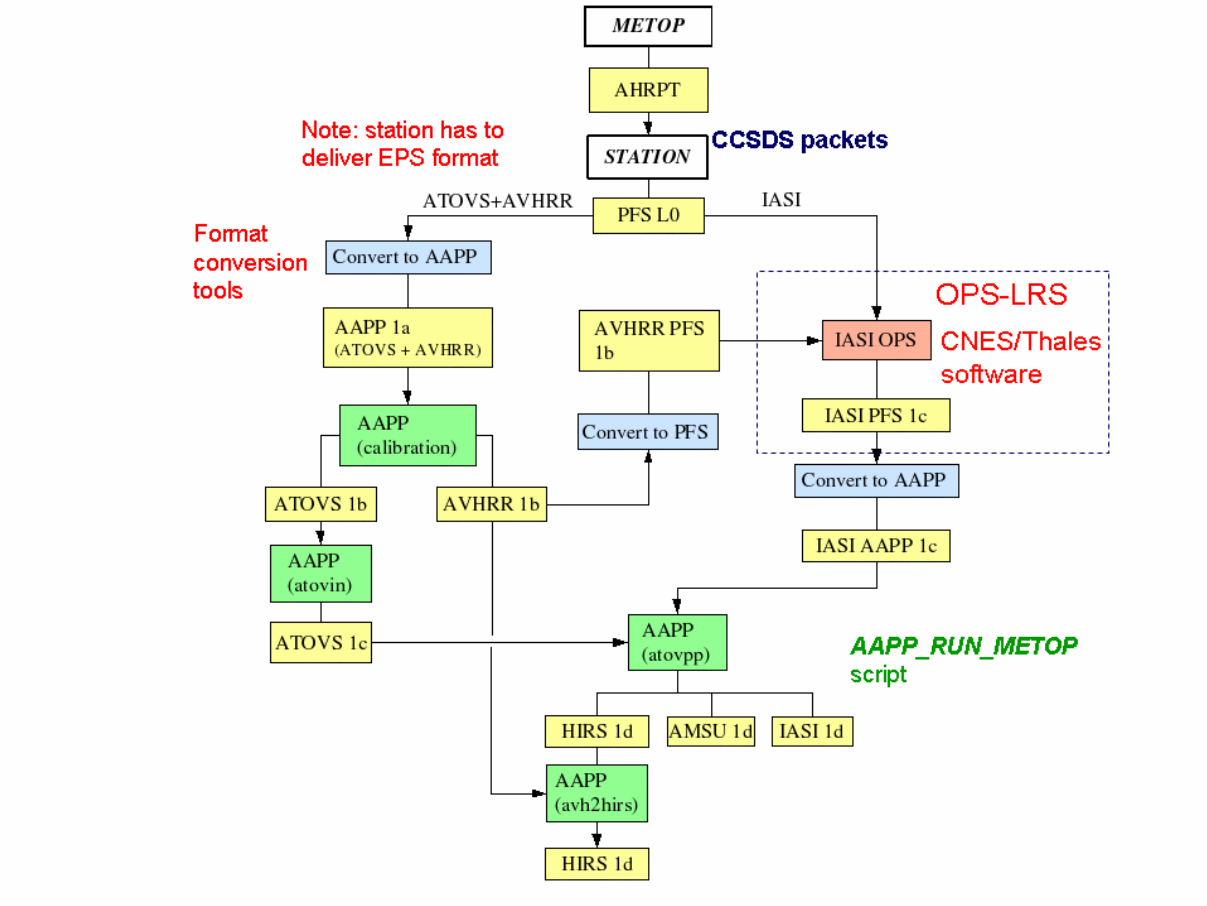



Fig. 3: Data flows for processing METOP direct readout data

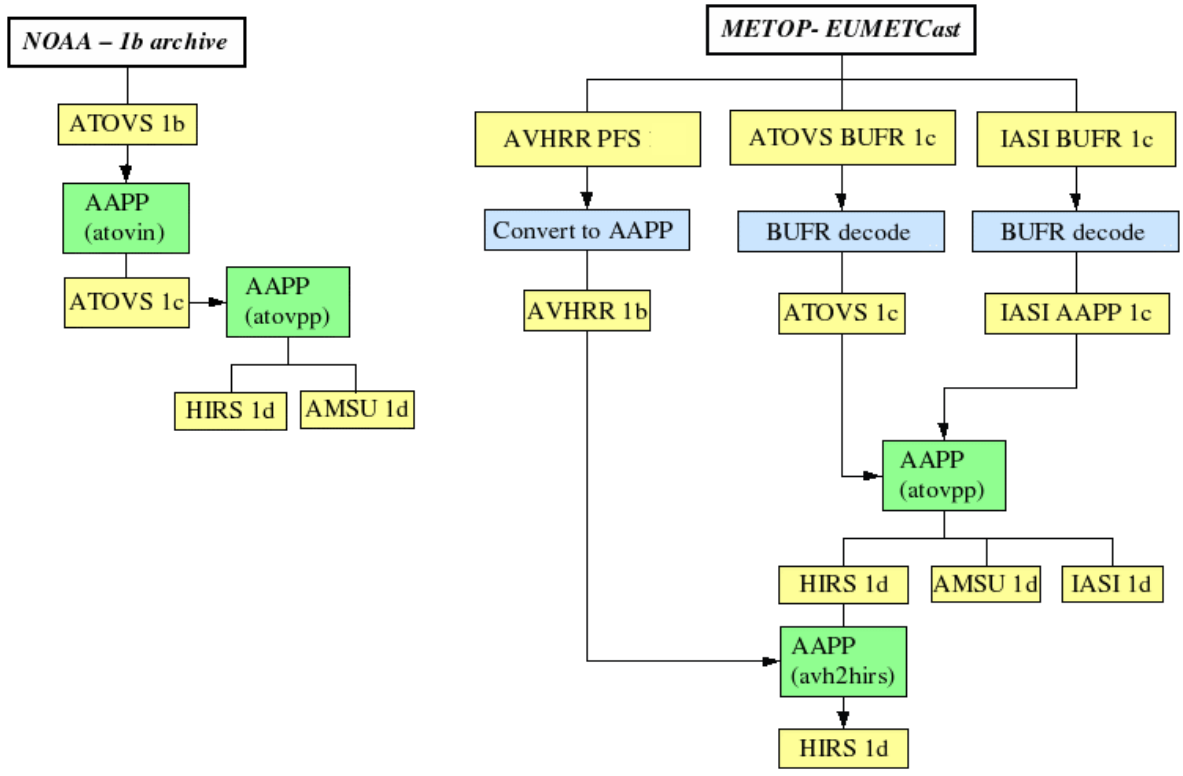



Fig. 4: Data flows for processing global and regional data. (Note that METOP AVHRR processing will initially only be available for regional data, not global).

## NPP and NPOESS

NPP (with a launch scheduled for 2009) will contain a new suite of instruments, including CrIS, ATMS and VIIRS. It is planned to extend AAPP to accept data from these instruments – i.e. to develop 1d products for ATMS and CrIS that are analogous to the 1d products for AMSU/MHS and IASI.

AAPP will not process the direct broadcast data directly but the intention is that AAPP will be able to ingest the level 1 radiances generated by the *International Polar Orbiter Processing Package (IPOPP)*, being prepared jointly by IPO, NASA and the University of Wisconsin (Overton, 2005). These data are expected to be in HDF-5 format.

AAPP will also be able to ingest the BUFR format radiances that NOAA intends to distribute.

## Conclusions

AAPP version 6 has recently been released by the NWP SAF, to support processing of the ATOVS and IASI data from METOP.

In the near future, it is planned to extend AAPP to handle the sounding data from NPP and NPOESS – in conjunction with direct readout packages developed elsewhere.

## Acknowledgements

Thanks to the AAPP v6 beta testers from DMI, DWD, FMI, SMHI, JMA, CIMSS and EUMETSAT for their helpful feedback. Thanks also to the NWP-SAF helpdesk team for their support in dealing with enquiries and distributing the software.

## References

Marguinaud, P., 2005: The IASI L1 processing software and its integration within AAPP, ITSC-14, Beijing, China, http://cimss.ssec.wisc.edu/itwg/itsc/itsc14/presentations/session10/10_3_marguinaud.pdf

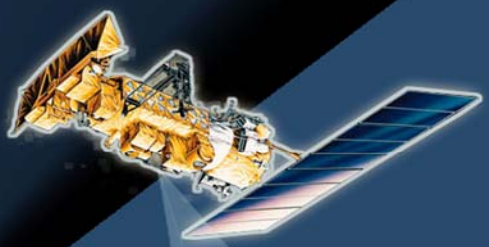
Overton, J., 2005: The National Polar-Orbiting Operational Environmental Satellite System (NPOESS) and NPOESS Preparatory Project (NPP) Access to Data: A Partnership. International EOS/NPP Direct Readout Meeting 2005, Benevento, Italy, http://dbmeeting.gsfc.nasa.gov/files/IPOPPDBMeeting.ppt

INTERNATIONAL ATOVS WORKING GROUP

*Sharing ideas, plans and techniques*

*to study the earth's weather*

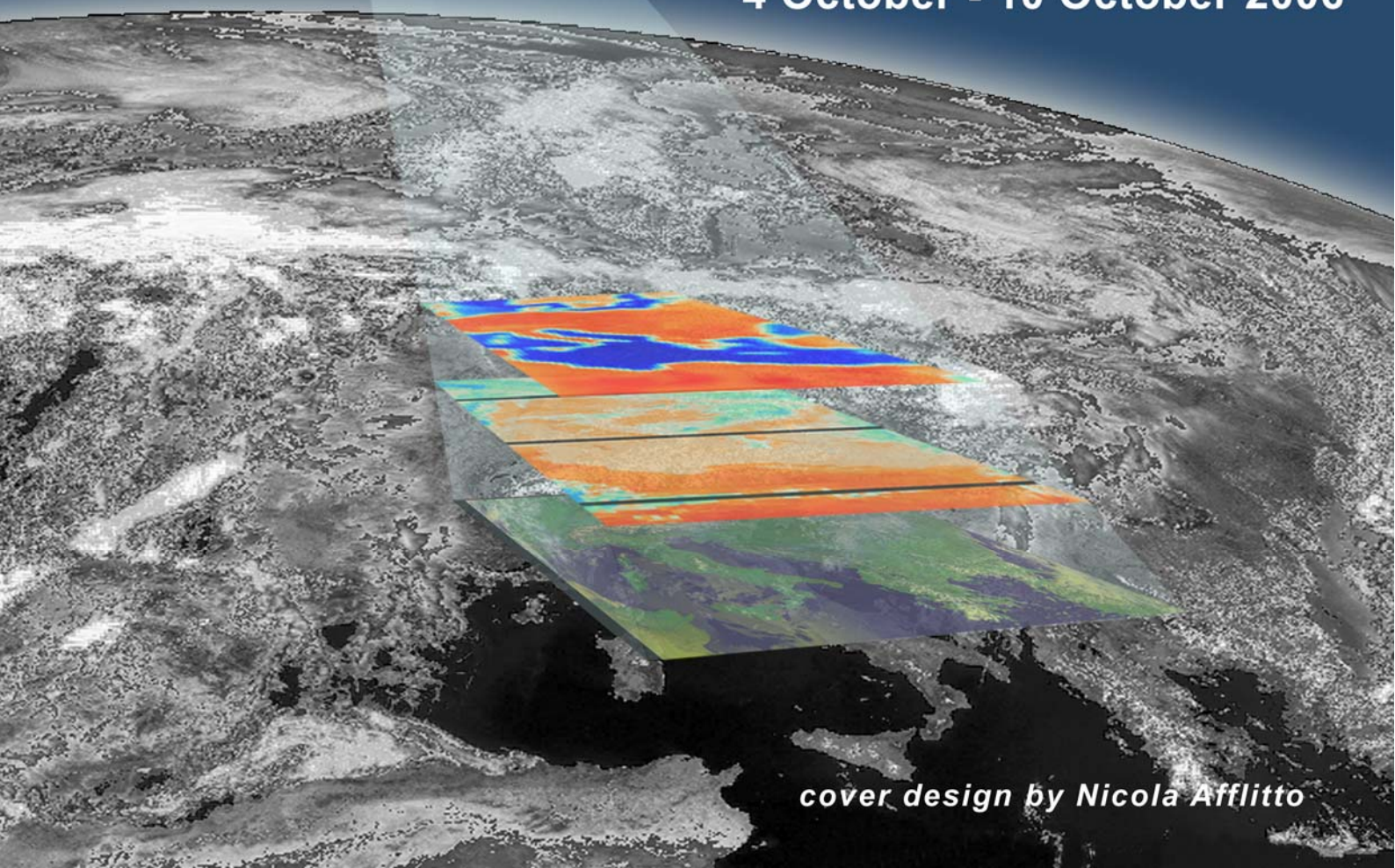
*using space-based observations*



# *Proceedings of the Fifteenth International TOVS Study Conference*

**Maratea, Italy**

**4 October - 10 October 2006**



*cover design by Nicola Afflitto*