STATUS AND PLANS FOR AAPP

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1. INTRODUCTION

The NOAA-15 polar orbiting weather satellite represents an upgrade the NOAA/TIROS-N polar orbiting weather satellite system, which comprises two sun-synchronous polar orbiting spacecraft, one in the morning (AM) orbit, the other one in the afternoon (PM) orbit.

Advanced Microwave Sounding Units (AMSU) replaced on NOAA-15 the Microwave Sounding Unit (MSU) on the NOAA/TIROS-N satellite series up to NOAA-14. They provide improved microwave sounding capability for temperature (AMSU-A) and humidity (AMSU-B) profiles. An improved version of the High Resolution Infrared Radiation Sounder (HIRS/3) continues to provide the infrared sounding capability. The Stratospheric Sounding Unit (SSU) is no more embarked on NOAA-15.

The payload is complemented by a new version of the Advanced Very High-Resolution Radiometer (AVHRR/3) multi-spectral imager.

The AAPP (ATOVS and AVHRR Processing Package) software development initiative was co-ordinated by EUMETSAT. A standard processing package for locally received HRPT (High-Resolution Picture Transmission) ATOVS and AVHRR data was the goal. The development focused on two sub-packages. They include INGEST and PRE-PROCESSING:

- the reception of the data from the receiver (direct read-out)
- the decommutation/demultiplexing of the instrument data
- the calculation of calibration coefficients
- the calculation of radiances and brightness temperatures
- the identification and the treatment/adjustment of contamination effects to the ATOVS data
- the mapping of the sensor data to a common sensor grid.

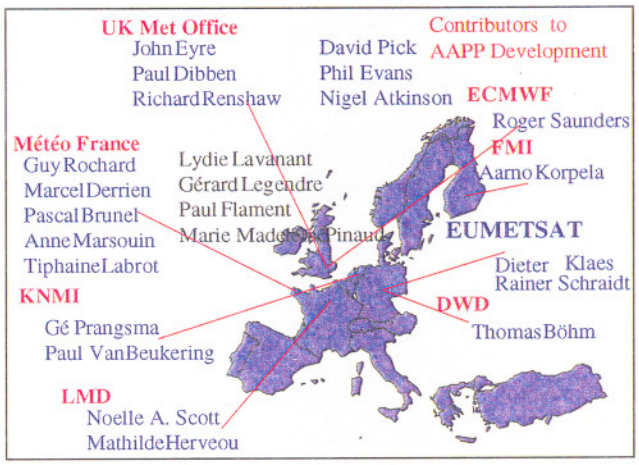
Pre-processing also includes the deduction of a cloud mask from AVHRR data and its mapping to HIRS FOVs. The resulting software package, the ATOVS and AVHRR Processing Package (AAPP) allows the processing of both TOVS and ATOVS. AAPP is presently available in Version 1.3 and is being used at various sites.

A subsequent processing step to AAPP is the RETRIEVAL/INVERSION. Interfaces to AAPP have been established for several retrieval packages for TOVS and ATOVS and have been tested by their developers.

2. AAPP DESIGN

A group of European Organisations has designed and developed AAPP (see Fig. 1). AVHRR processing as part of AAPP is kept as a separate chain. This design allows keeping the processing as flexible as possible and the separation of the (data intensive) AVHRR processor from the remaining data. The AAPP software includes modules for orbit predict, clock correction and navigation.

FIGURE 1 : Contributors to the EUMETSAT AAPP Development



AAPP has a modular structure, outlined in Figure 2. The module HRPTDC accepts and processes the HRPT raw data received by receiving equipment. The data processing chains for TOVS/ATOVS data and AVHRR are then activated.

2.1 ATOVS Processing

Decommutation of the AIP (AMSU Information Processor) and/or TIP (TIROS Information Processor) data is done, depending whether NOAA-15 or NOAA-14 and earlier is the origin of the data. The level 1a product (Note, that in AAPP the level definition used by NESDIS is applied), i.e. counts from HIRS/3, AMSU-A and AMSU-B (or HIRS/2 and MSU), is the output. It is input to the Calibration and Earth location module within the Ingest module. This module performs the extraction and calculation of calibration coefficients, and the navigation (earth location) of the data. The calibration coefficients and Earth location parameters are

appended to the counts, composing the level 1b product. ATOVIN transforms the counts into radiances and subsequently the radiances into bright

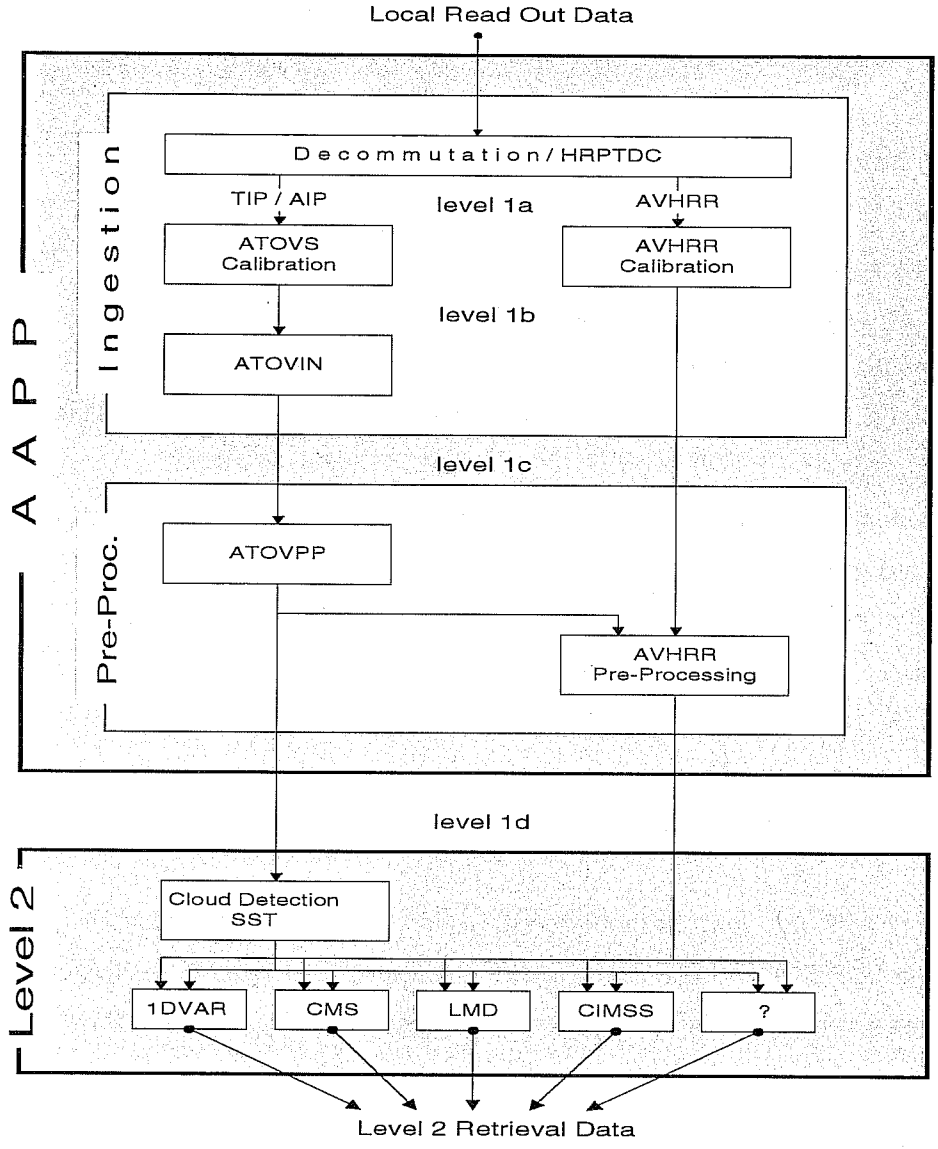


FIGURE 2 : AAPP Structure and potential use of retrieval packages.

ness temperatures. Quality control, e.g. checking of consistency in time, the viewing angles, brightness temperature boundaries, etc., is included in the processing. The result of this step is the level 1c product.

Subsequently Pre-Processing of ATOVS data is performed.: examining the data for effects (e.g. precipitation contamination, contamination by large cloud ice particles etc.) which deem them unsuitable for subsequent processing (e.g. retrieval). The mapping of one set of instrument data to the grid of another is a further task. The mapping from any grid to any other grid is possible. The output of AAPP version 1.0 is instrument

brightness temperatures, mapped onto HIRS FOVs, with optional other instrument combinations on the AMSU-A or AMSU-B grid. Pre-Processing flags and Pre-Processing information is added to the data, and also mapped to the target grid. The resulting data format is called level 1d and is one interface of AAPP towards further subsequent processing.

2.2 AVHRR Processing

Fig. 2 depicts in its right part the AVHRR processing, which is performed in a similar way. AVHRR data are decommutated and demultiplexed within the Ingest module. Navigation and the extraction of calibration parameters is subsequently done (module AVHRCL), resulting in the AVHRR level 1b product which contains AVHRR counts with appended calibration coefficients and earth location information.

Subsequently the calibration coefficients are applied to the AVHRR counts. The resulting data are input to the Pre-Processing step of the AVHRR data, which includes e.g. a cloud analysis. A cloud mask algorithm and a mapping algorithm (AVH2HIRS) are provided with AAPP. The resulting mapped cloud mask and averaged AVHRR data per HIRS FOV are included into the AAPP level 1d file.

3. DEVELOPMENT, INTEGRATION and TESTING

The development of AAPP was done by the involved institutions from 1995 through begin of 1998. The modules are coded in FORTRAN77, with some agreed extensions. The package is developed for a UNIX environment, assuring a wide spread use. The installation procedure is based on the IMAKE tool and was described earlier (Klaes, 1997).

3.1 Package Testing

The final integration to Version 1.0 has been performed in summer 1998 in EUMETSAT. Testing has been done at the developer sites with version 1.0 for TOVS and ATOVS data after the launch of NOAA-15. With the release of the versions subsequent to AAPP 1.0, the update mechanism via the AAPP homepage and the EUMETSAT ftp-server had been successfully tested. An electronic user forum was established where information and feedback can be exchanged. On the EUMETSAT server, after more than one year of testing, an extensive list of known bugs and fixes is available. All these bugs are fixed in the subsequent releases. The distribution mechanism via the home page (http://www.eumetsat.de/en/area4) and registration against a signed licence form works well. Currently

- 102 Users from 40 countries have obtained V1.3; they include the agreed beta-testers and the members of the Development Group;
- 33 more have registered, but have not yet signed a license.

The versions 1.2 and 1.3 of AAPP include a correction, provided by the UKMO, for the AMSU-B interference problem,. Since the AMSU-B bias is drifting, updates of the corrections needed to be done every two months.

NESDIS have switched the NOAA-HRPT frequency from 1698.0 MHz to 1702.5 MHz. This is seems to provide a consistent HRPT data stream and seems to end the variable biases that have contaminated the AMSU-B instrument data (Further testing is required to consolidate this view). This change works with the existing correction scheme for AMSU-B.

The testing has demonstrated that successful installations can be made on the following platforms:

- SUN
- DEC alpha
- HP
- SGI
- IBM RISC
- Linux PC
- PC under Windows

No major problems have been reported so far.

3.2 Year 2000 compliance

During the development and integration phase the year 2000 compliance of all modules and of AAPP at package level had been tested at the developers' sites and also in EUMETSAT. The processing of 21st century (e.g. data from 2000) data in the 21st century (e.g. 2001 machine time) does not cause a problem for AAPP.

4. DISTRIBUTION AND FEEDBACK

A deposit of the intellectual property-rights to the AAPP software has been filed in the names of Météo-France, the UK Met Office and KNMI with the "Agence pour la Protection des Programmes" in Paris. Consequently the AAPP package is distributed against the signature of a licence agreement.

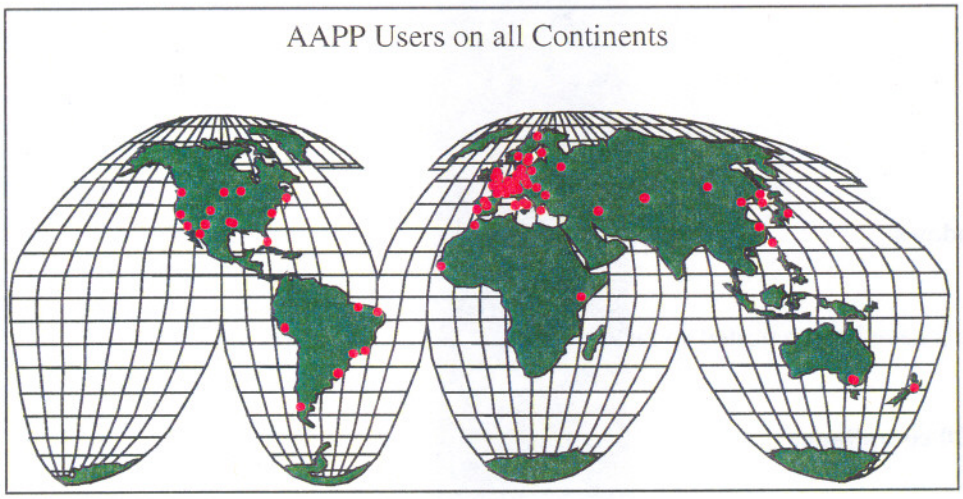
A Licence Agreement between EUMETSAT and the AAPP Development Partners has been signed, allowing EUMETSAT to distribute the AAPP free of charge to all interested Users and to persons,

organisations and companies who wish to redistribute the AAPP alone or as an integrated part of their other products.

Possibility of feedback exists through the EUMETSAT AAPP Home Page (http://www.eumetsat.de/en/area4/aapp/index.html) and through a list server, which has been established to ease the exchange of information between testers. Commercial use of AAPP is not permitted.

The following Figure 3 provides an overview on the current distribution of AAPP.

FIGURE 3 : AAPP Users October 1999.



5. OUTLOOK

The integration of retrieval/inversion code into AAPP would complete the full end-to-end processing chain. Within the development group, the structure of a retrieval file has been defined. Thus, together with the file definitions in the AAPP the interfaces are defined. For the 3I, ICI and ITPP retrieval packages interface modules have been developed and these retrieval packages were successfully tested with AAPP for both TOVS and ATOVS data. The Satellite Application Facility for Numerical Weather Prediction (NWP SAF) plans to perform the maintenance of AAPP from 2000 onwards.

With retrieval modules a full processing chain for the processing of the HRPT direct readout data from the NOAA/TIROS-N and NOAA-K, L, M spacecraft is available.

6. REFERENCES

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