1. INTRODUCTION

The NOAA-K polar orbiting weather satellite, which has been launched in May 1998, has upgraded the NOAA/TIROS-N polar orbiting weather satellite system. The system still comprises two sun-synchronous polar orbiting spacecraft, one in the morning (AM) orbit, the other one in the afternoon (PM) orbit.

The Microwave Sounding Unit (MSU) flown on the NOAA/TIROS-N satellite series up to NOAA-14, was replaced on NOAA-K, after successful launch called NOAA-15, by Advanced Microwave Sounding Units (AMSU), providing 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) provides the continuity of the infrared sounding capability. The Stratospheric Sounding Unit (SSU) is no more embarked on NOAA-15.

The ATOVS (Advanced TIROS Operational Vertical Sounder) sounding package was 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 co-ordinated by EUMETSAT was focused towards a standard processing package for locally received HRPT (High Resolution Picture Transmission) ATOVS and AVHRR data. The development resulted in two sub-packages. They perform INGEST and PRE-PROCESSING, i.e. the reception of the data from the receiver hardware (direct read-out), the decommutation/demultiplexing of the sensor data, the calculation of calibration coefficients, and also the calculation of radiances and brightness temperatures, the identification and the treatment/adjustment of contamination effects to the ATOVS data and the mapping of the different sensor data to a common sensor grid. The pre-processing also includes the use of AVHRR data for the deduction of a cloud mask and their mapping to HIRS FOVs. The resulting processing package, the ATOVS and AVHRR Processing Package (AAPP) allows the processing of both TOVS and ATOVS. The AAPP is now available in Version 1.0 and is being tested at various sites.

A third processing step that follows AAPP is the RETRIEVAL/INVERSION. Interfaces to AAPP have been established for several retrieval packages for TOVS and have been tested by their developers.
2. AAPP DESIGN

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

FIGURE 1: Contributors to the EUMETSAT ATOVS Development

AAPP has a modular structure, which is depicted in the following Figure 2. The module HRPTDC inputs the HRPT data received by receiving equipment. The data processing chains for TOVS/ATOVS data and AVHRR are then activated.

2.1 ATOVS Processing

First the decommutation of the AIP (AMSU Information Processor) and/or TIP (TIROS Information Processor) data has to be performed, depending whether NOAA-15 or NOAA-14 and earlier has provided the data. Level 1a data (Note, that in this paper the level definition used by NESDIS is applied), i.e. counts from HIRS/3, AMSU-A and AMSU-B (or HIRS/2 and MSU), are the result. They are input to the Calibration and Earth location module within the Ingest module. This module performs the calibration, i.e. 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, forming the level 1b data set. In module ATOVIN the counts are transformed into radiances and subsequently the radiances into bright
ness temperatures. The processing includes quality control, e.g. checking of consistency in time, the viewing angles, brightness temperature boundaries, etc. The results of this step are the level 1c data.

Pre-Processing of ATOVS data is performed by ATOVPP. Pre-Processing means: 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). A further task is the mapping of one set of instrument data to the grid of another. 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 module in the Ingest module, the latter forming the entry point into the AVHRR processing. Navigation and the extraction of calibration parameters is performed (module AVHRCI), producing an AVHRR level 1b data set, i.e. AVHRR counts with appended calibration coefficients and earth location information.

Prior to the Pre-Processor step the calibration coefficients are applied to the AVHRR counts. The resulting data form directly the input to Pre-Processing of the AVHRR data, e.g. a cloud analysis. The calibration/Earth location step and also the Pre-Processor are considered as one processing bloc in Fig. 2. A cloud mask algorithm and a mapping algorithm (AVH2HIRS) are included into 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 the above mentioned modules has been 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. UNIX is available for nearly every possible platform, and should thus not form an obstacle for a wide spread use. The installation procedure is based on the IMAKE tool and was described at the last conference (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. Now AAPP is under test by about 80 Users throughout the world. The results have shown that successful installations can be made on the following platforms:

- SUN
- DEC alpha
- HP
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

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.

The current licence agreement covers the test of AAPP from June 1998 through 1999 and 2000 until January 2001. About 66 Users have signed a licence agreement and obtained AAPP V1.0. 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.

It is foreseen that users will be able to get a free licence for an unlimited time period for all types of use, except commercial redistribution. The distribution of the AAPP on these terms is awaiting the signature of an agreement between EUMETSAT and the Organisations who have filed the deposit for the Intellectual Property Rights.

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

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

6. REFERENCES


