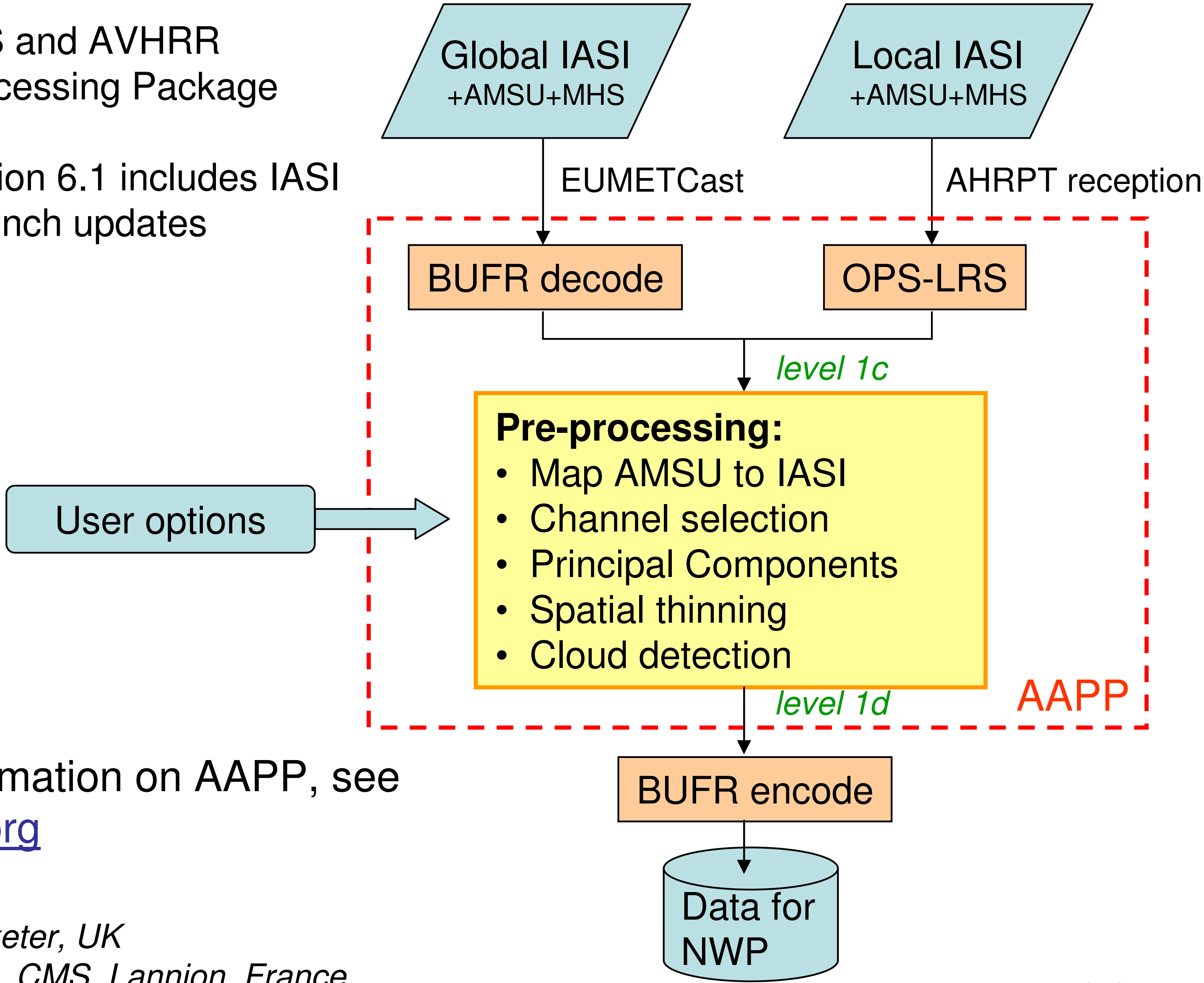
Pre-processing of IASI data for NWP using the AAPP software package

Nigel Atkinson[(1)], Fiona Hilton[(1)], Pascal Brunel[(2)] and Philippe Marguinaud[(2)]

AAPP = ATOVS and AVHRR Pre-processing Package

Oct 2006 – version 6.1 includes IASI
Several post-launch updates



For more information on AAPP, see
www.nwpsaf.org

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Introduction

The ATOVS and AVHRR Pre-processing Package (AAPP) is a software package maintained by the EUMETSAT NWP SAF. The package has recently been extended to accept IASI data – including both global Level 1c data in BUFR format (typically received via EUMETCast) and locally-received Level 0 data. The Level 0 data are processed to Level 1c using the OPS-LRS package, which is part of AAPP and is described elsewhere. This poster describes the options available at the pre-processing stage in order to prepare the data for input to NWP systems.

1. Data inputs

The characteristics of the incoming IASI level 1c data are as follows:

	Global (EUMETCast)	Locally received (OPS-LRS)
Format	BUFR	PFS
Typical granule size	3 minutes	Up to full pass (16 minutes)
Data volume	660 Mbyte per hour	Up to 280 Mbyte per pass
Spectral channels	8461	
Number of spectra	120 spectra per 8 second scan	

AAPP first converts the incoming data to an internal flat-binary format, similar to the formats used for AMSU, MHS and HIRS.

For NWP use the data must be thinned – spectrally and spatially – and screened for cloud. These tasks are done by the "atovpp" module. The user can control the various options via a data file.

2. Channel selection

The AAPP user can select any combination of IASI channels. By default the selection of 300 channels provided by Collard (ECMWF Tech. Mem. 532, 2007) is used, together with 14 additional monitoring channels chosen by CNES.

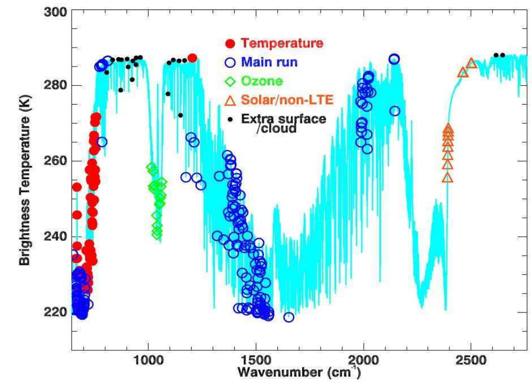

***Figure 1**: Selection of 300 IASI channels (from Collard, 2007)*

3. Principal Components scores

Principal Component scores, **c**, computed from a set of pre-computed eigenvectors, **U**, and noise-normalised radiance spectrum, **y**. Typically use 100 to 300 eigenvectors.

$$\mathbf{c} = \mathbf{U}^T \mathbf{y}$$

The eigenvectors are computed off-line from a Singular Value Decomposition of a set of reference spectra, **Y** (several thousand spectra). This is external to AAPP; the eigenvector file is supplied to users.

$$\mathbf{Y} = \mathbf{U}\ \mathbf{w}\ \mathbf{V}^T$$

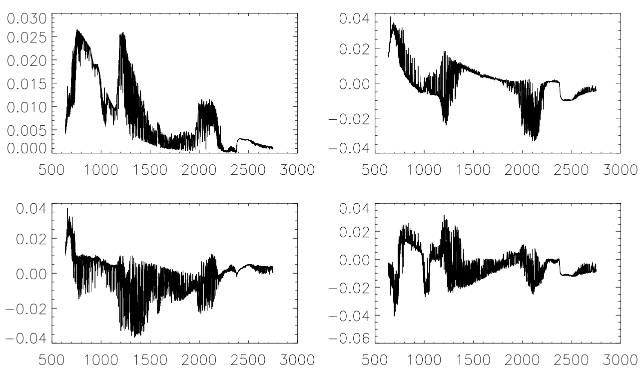

***Figure 2**: First four eigenvectors*

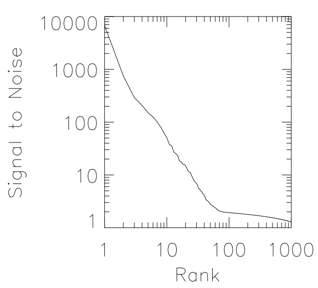

***Figure 3**: Eigenvalues, expressed as signal to noise*

Note most of the useful information is in the first ~100 eigenvectors.

4. De-apodisation

For a limited spectral region, instrument noise is 'white' in the interferogram domain and in the level 1b (raw) spectra. However, the level 1c spectra are gaussian-apodised (red curve in Fig 4) – the noise is no longer white.

To compute signal-to-noise ratios the spectra are first de-apodised. AAPP uses the method proposed by Lee (2004, EUMETSAT contract). This is computationally fast.

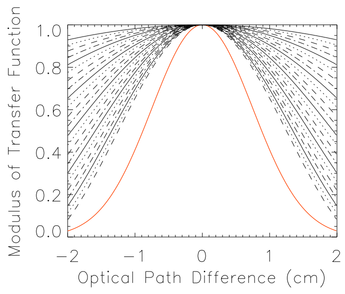

***Figure 4**: Transfer function from 600-2800 cm^{-1} at intervals of 100 cm-1. Red: Gaussian apodisation used at level 1c.*

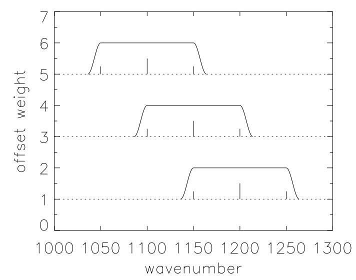

***Figure 5**: Overlapping spectral windows of 512 points.*

5. Reconstruction scores

Reconstruction score is defined as RMS difference between input radiance (noise-normalised) and reconstructed radiance. The reconstruction error should be mostly noise, i.e. the log of the score ~0.

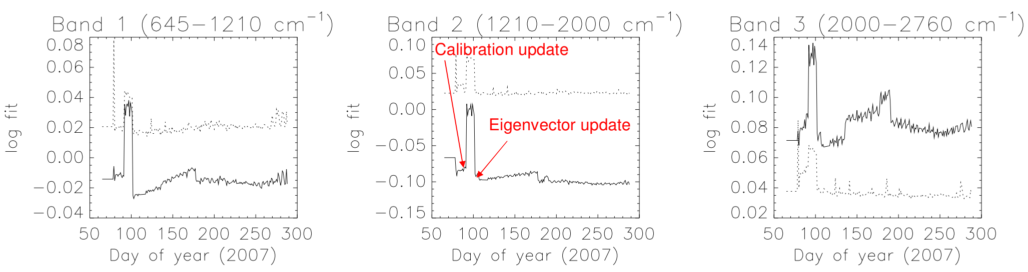

***Figure 6**: log reconstruction score for the 3 IASI bands, from global data. Solid: mean, dotted: std dev*

Mean scores are within 25% of nominal (based on pre-launch noise), and show little variation with time.

6. Cloud detection and spatial thinning

To thin the data, AAPP allows users to choose one of the 4 IASI spectra per scan position. There are several choices:

- Fixed detector (unbiased dataset for climate)
- FOV with minimum AVHRR variability (used operationally at Met Office)
- FOV with warmest AVHRR (or IASI) radiance
- Minimum AVHRR variability in polar regions, otherwise warmest AVHRR (noting that low cloud over ice can have a warmer BT than cloud-free)

For cloud detection, AAPP currently implements the method of Cheng et. al. (ITSC-15, poster A17):

- Likely to be cloudy if standard deviation of 4 IASI FOVs at 2390 cm^{-1} exceeds 3×NEΔT
- Use AMSU channels 4,5,6 to predict IASI radiance at 2390 cm-1, and flag if AMSU minus IASI is >2K
- These checks are NWP-independent – useful 'first guess'

Please feed your favourite IASI cloud detection methods back to the NWP SAF Helpdesk (www.nwpsaf.org), and we will endeavour to add them to AAPP.

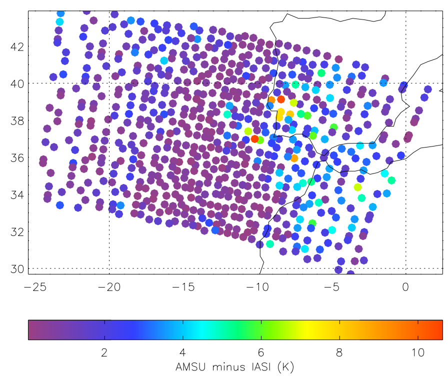

***Figure 7**: Cloud detection using AMSU. Data for 15 Oct 2007, 1044-1047 Z.*

Summary

- AAPP is used as a pre-processor for both global and locally-received IASI
- Contains a range of user options for channel selection, Principal Components compression, spatial thinning and cloud detection
- We welcome scientific input from users

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