IASI 1d-Var Retrievals Using PC Radiative Transfer

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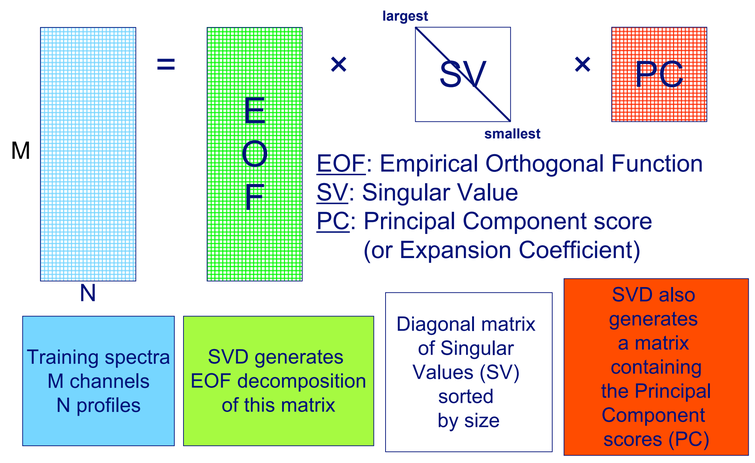
IASI data is widely used in NWP and has a positive impact on forecast skill. However, the data is conservatively used, only a few hundred channels are assimilated with most of these being temperature sounding channels. Furthermore, the assimilation of IASI data over land is restricted to channels that peak significantly above the surface. Operational centres are beginning to utilise some data in the presence of clouds but such use is still in its infancy and no attempt is being made operationally to utilise data within or below cirrus clouds. Here we present a principal component radiative transfer techniques that allow the fast forward modelling of all 8461 channels of IASI. We present results in clear skies using data gathered as part of the JAIVEX campaign. A second poster presents results of retrievals in the presence of clouds.

1. An introduction to principal component radiative transfer

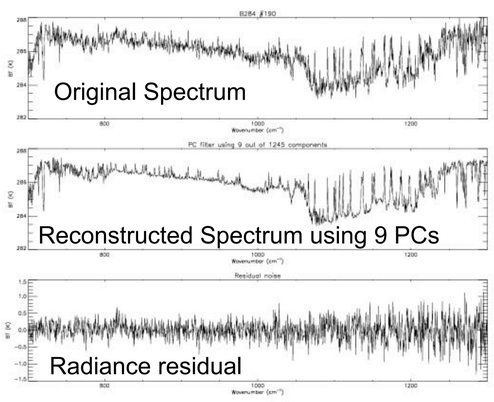
The Havemann-Taylor Fast Radiative Transfer (HT-FRTC) Code – key facts

- Wavelength range: 0.4 - 16.5 μm (to be extended)
- Spectral resolution currently down to 0.0025 cm^{-1}
- Atmospheric absorption by water vapour and atmospheric gases included
- Aerosol and clouds are included can represent full treatment of scattering in solar and thermal infrared
- Accuracy: Better than 0.1 K in Tb
- Speed: calculation time < 1s for calculating 8500 IASI satellite instrument channels
- Spectrally resolved surface emissivity (represented by 15 PCs)

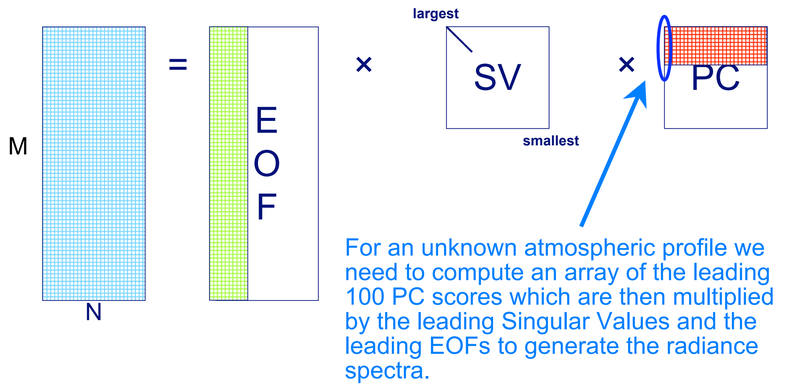
Offline calculations



PCs allow you to represent full spectral information in a compact manner

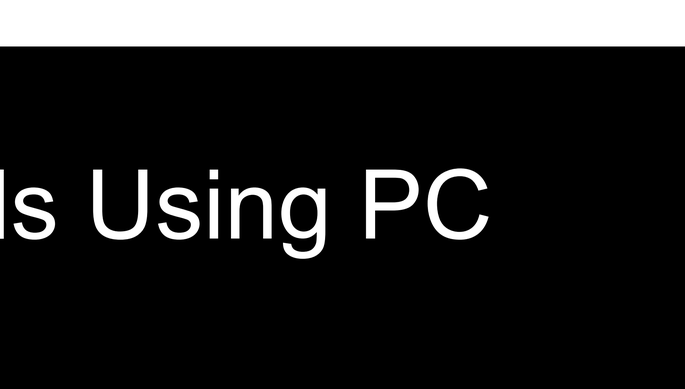


- The leading PCs contain all the useful information
- We find that 100 PCs are enough to represent all the information from an IASI spectrum of 8461 radiances
- If we can develop a radiative transfer model that predicts PCs instead of radiances then things will speed up considerably
- This is the basis behind the HT-FRTC

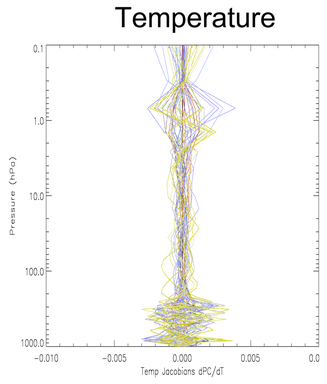


For an unknown atmospheric profile we need to compute an array of the leading 100 PC scores which are then multiplied by the leading Singular Values and the leading EOFs to generate the radiance spectra.

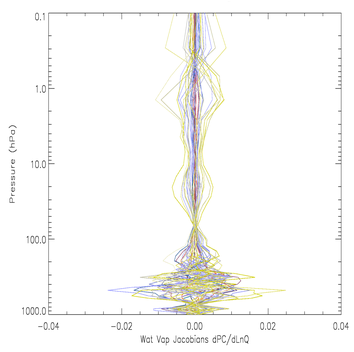
2. PC 1d-Var



Temperature

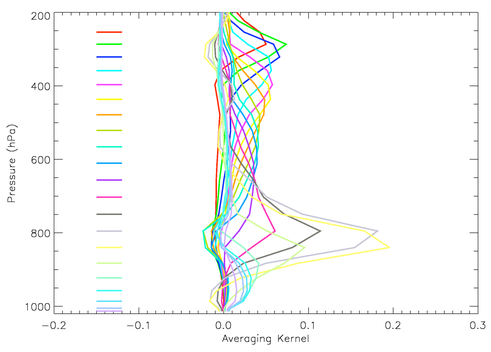


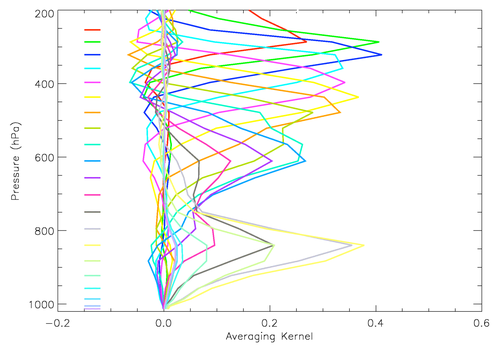
Water Vapour



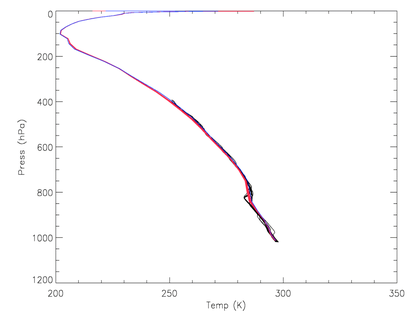
Jacobians have complex vertical structure – the Jacobian of each PC has information from many levels.

Averaging Kernels show that water vapour channels have lots of information about upper troposphere with reduced temperature sensitivity near the surface.



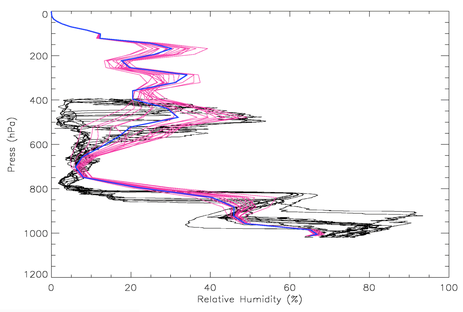


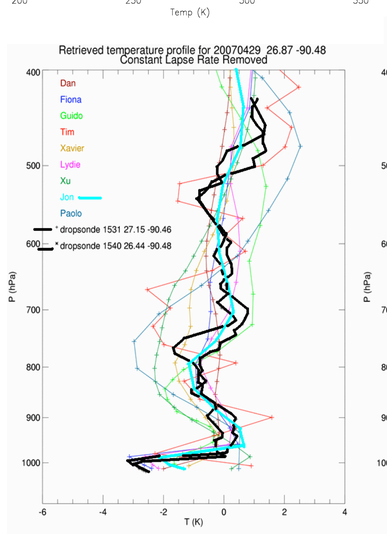
3. Results from JAIVEX – clear skies

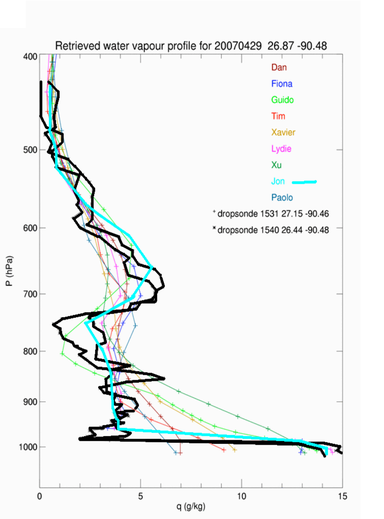


Example of retrieval over ARM site in Oklahoma

— Background
— Retrieval
— Dropsondes







Results using this PC 1D-Var approach (blue lines labelled "jon") compare favourably with other schemes.

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