ALL-SKY RADIATIVE TRANSFER CALCULATIONS FOR IASI AND IASI-NG: THE σ-IASI-as CODE

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Introduction and motivations

In order to give continuity in the service offered by IASI interferometers, EUMETSAT has scheduled the operativity of a new generation of interferometers, named IASI-NG (IASI New Generation). IASI-NG is a key payload element of the MetOp-SG (Second Generation), a series of European meteorological polar-orbit satellites.

IASI-NG is intended to pursue not only a continuity with IASI monitoring capabilities, but also to provide more advanced technical performances, as far as spectral resolution and signal-to-noise ratio are concerned. Such new challenging requirements, together with the scientific perspective and monitoring capabilities offered by this new instrument, make of crucial importance the availability of a new, complete radiative transfer model to simulate the radiance as it is observed by IASI-NG.

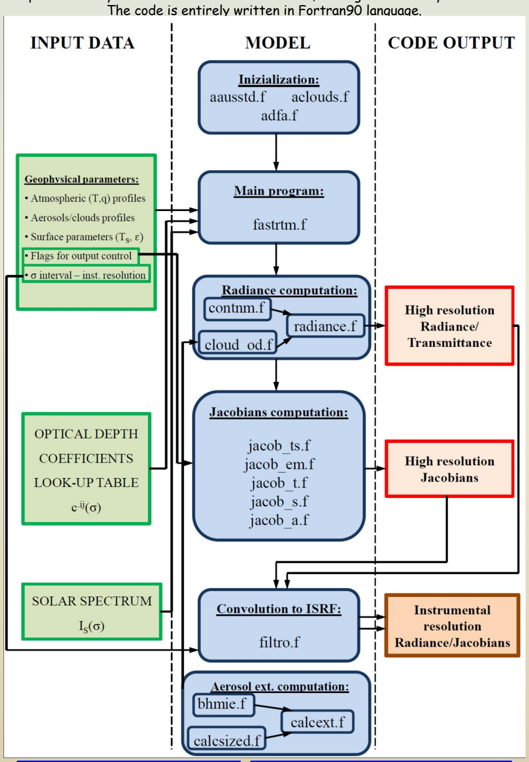
In this context, we present the new **σ-IASI-as** ('as' standing for **all-sky**) radiative transfer code. Like its predecessor σ-IASI, the code is able to calculate both clear and cloudy sky radiances, as well as their Jacobians (i.e. derivatives) with respect to any desired geophysical parameter. In addition, σ- IASI-as can simulate the **extinction effect** of the most common types of atmospheric aerosols and of clouds via **ab-initio Mie calculations**, without dramatically affecting the code performances, and can also simulate the contribution due to **solar irradiance**.
The new model is already available for IASI and IASI-NG, for both operational, sensitivity studies, and research purposes.

σ-IASI-as CODE STRUCTURE

The radiative transfer code we have built is capable to compute the radiance as it is observed by **any instrument working from the far-infrared to the mid-near infrared** (3-100 µm). In addition, the code can compute analytical Jacobians of the radiance with respect to surface temperature and emissivity, and atmospheric temperature and gases or aerosols/cloud particles concentrations.

Calculations fastness is ensured by the polynomial parameterization of optical depths, which preserves the accuracy and generality of a line-by-line approach. All the radiative transfer is performed at high resolution, and the convolution to the specific ISRF is performed by a dedicated module of the code, making it extremely feasible.

The code is entirely written in Fortran90 language.



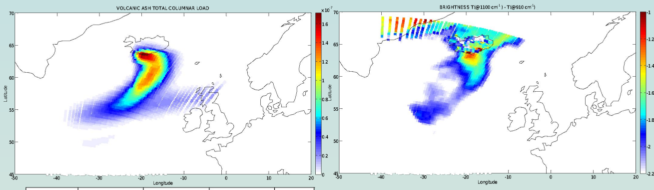
GASES:

- H_2O
- CH_4
- CO_2
- SO_2
- O_3
- HNO_3
- N_2O
- NH_3
- CO
- OCS
- HDO
- CF_4

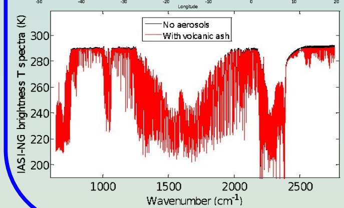
AEROSOLS:

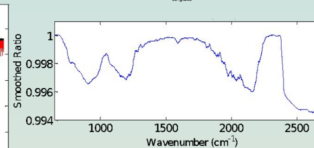
- SEA SALT
- DESERT DUST
- BLACK CARBONS
- ORGANIC HAZE
- METEORIC DUST
- H_2SO_4 DROPLETS
- AMMONIUM SULFATE
- HEMATITE DUST

SAMPLE CALCULATIONS AT IASI-NG RESOLUTION



Here we show some sample spectra computed at the resolution of IASI-NG, in order to see how the code deals with the new generation of infrared sensors, in different sky conditions. We also put in evidence the possibility to work with different aerosols.

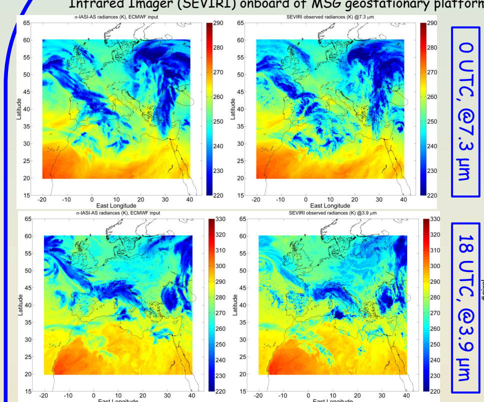




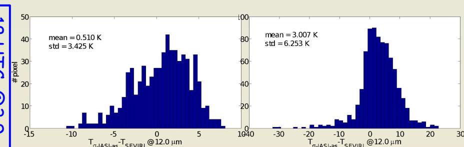
EXAMPLE: VOLCANIC ASH

RTM CONSISTENCY with SEVIRI AND AIRS

Here we show a direct comparison between the radiance computed by the code and that observed by the Spinning Enhanced Visible and Infrared Imager (SEVIRI) onboard of MSG geostationary platform. Input profiles are from ECMWF reanalyses of 1st April 2013.



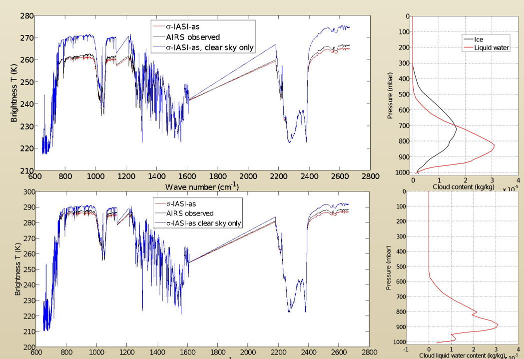
Time to compute...	σ-IASI-as	LBLRTM
20 channels radiance	0.003 s	~0.25 s
IASI-NG spectrum (0.25 cm^{-1})	0.9 s	~120 s
IASI-NG spectrum + Jacobians	~5.0 s	-----
Europe scene radiances	~13 hrs	~40 day



CLOUDY RADIANCES BIAS

The code is able to effectively simulate the observed radiance in every sky condition. The bias in computing cloudy radiance is typically below 5 K for thick clouds, and below 8 K for thin, low-altitude clouds. A consistent part of this bias may be ascribed to the lack of information about the dimensional distribution of water/ice particles.

Other discrepancies can be observed in the simulated cloudy radiance during daytime, but it is due to the fact that this version of the RTM does not include the radiance contribution due to the reflection of solar radiation by the top of the cloud.



Here we show a direct comparison between radiances as observed from the Atmospheric InfraRed Sounder (AIRS) and those computed with the RTM and convolved to AIRS ISRF.

The first plot shows the comparison (average between 800 AIRS spectra) with calculations in presence of both water and ice clouds.

The second plot involves the average between 100 AIRS spectra, that corresponds only to water clouds.

Such data give a proof of the accuracy of radiative transfer in different sky conditions.

References

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