The EUMETSAT Network of Satellite Application Facilities

O3M SAF

Ozone and Atmospheric Chemistry Monitoring

FORLI-O_3

COMPLEMENT TO FORLI ATBD/ DESCRIPTIONS OF THE INPUTS TO FORLI-O3 v20151001

Prepared by	Daniel Hurtmans (ULB) Catherine Wespes (ULB) Pierre-François Coheur (ULB) Rosa Astoreca (ULB) Maya George (LATMOS) Cathy Clerbaux (LATMOS)	July 28 , 2016

<u>Reference documents</u>

- SAF/O3M/ULB/FORLI_ATBD
- SAF/O3M/ULB/FORLI_SFTIC

TABLE OF CONTENTS

1. INTRODUCTION

This document is a complement to the FORLI ATBD and describes the input parameters for FORLI-O_3 v20151001. These include the L1C measurements, meteorological data, ancillary data, input parameters for the Optimal Estimation method and the look-up tables.

2. INPUT PARAMETERS FOR V20151001

2.1 IASI radiances: L1C data

v20151001 uses the Level1C disseminated by EUMETCast. A subset of the spectral range, covering 1025-1075 cm $^{-1}$, is used for the retrieval.

2.2 Meteorological data from the Level 2 Product Processing Facility (PPF)

The IASI Level2 Product Processing Facility (IASI L2 PPF) has a modular structure, consisting of an operational processing chain, operational since 14/09/2010. It provides temperature and humidity profile information, the associated surface information and the retrieval of some trace gas species: CO, O_3, CH_4, N_2O and CO_2 (August et al., 2012).

2.2.1 Temperature and humidity profiles

Profiles of temperature and humidity are from the IASI L2 PPF (August et al., 2012). The atmospheric temperatures are kept fixed whereas the water profile is used as a priori and further adjusted to give the retrieval more freedom.

2.2.2 Surface temperature

Surface temperatures (land and sea) are from the IASI L2 PPF. Surface temperature is part of the parameters to be retrieved.

2.2.3 Cloud fraction

v20151001 uses the cloud fraction from the IASI L2 PPF. All pixels with a cloud fraction equal to or lower than 13 % are processed.

2.2.4 CO_2 profile

A constant vertical profile at 380 ppm is assumed for CO_2.

2.3 Surface properties

2.3.1 Orography

Orography is from the GTOPO30 global digital elevation model and is integrated in the entire IASI FOV (http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/gtopo30_info).

2.3.2 Emissivity

A wavenumber-dependent surface emissivity above continental surfaces is used while for ocean a single standard emissivity is considered. For continental surfaces it relies on the climatology of Zhou et al. (2011). In cases of missing values in the Zhou et al. climatology, the MODIS climatology of Wan (2008) is used. It is available on a finer 0.05° × 0.05° grid but is restricted to only 12 channels in the IASI spectral range. In order to deal with this, the spectrally resolved mean emissivity of the Zhou climatology is scaled to match as closely as possible the values in these 12 channels and it is this resulting emissivity that is considered. Finally when there is no correspondence between the IASI FOV and either climatologies, then the mean emissivity of the Zhou climatology is used.

2.4 Optimal Estimation

2.4.1 A priori profiles and variance-covariance matrix

The *a priori* covariance matrix $\mathbf{S}_a$ is constructed from the Mc Peters/Labow/Logan climatology of ozone profiles (McPeters et al., 2007), which combines long term satellite limb measurements (from the Stratospheric Aerosol and Gas Experiment II and the Microwave Limb Sounder) and measurements from ozone sondes. The *a priori* profile $\mathbf{x}_a$ is the mean of the ensemble. The resulting $\mathbf{x}_a$ (Fig. 1) has values slowly increasing from around 25 ppbv at the surface to 100 ppbv at 10 km, reaching a maximum of 7.3 ppmv in the middle stratosphere. The variability (taken here after as the square root of the variance, i.e. of the diagonal elements of $\mathbf{S}_a$) is below 30% in the boundary layer and the free troposphere; it is maximum in the upper troposphere–lower stratosphere, between 10 and 20 km, where it is of the order of 60%.

2.4.2 Retrieval noise

The value of the noise is wavenumber dependent in the spectral range used for the retrieval, varying around 2 x 10^{-8} W/(cm^2 cm^{-1} sr).

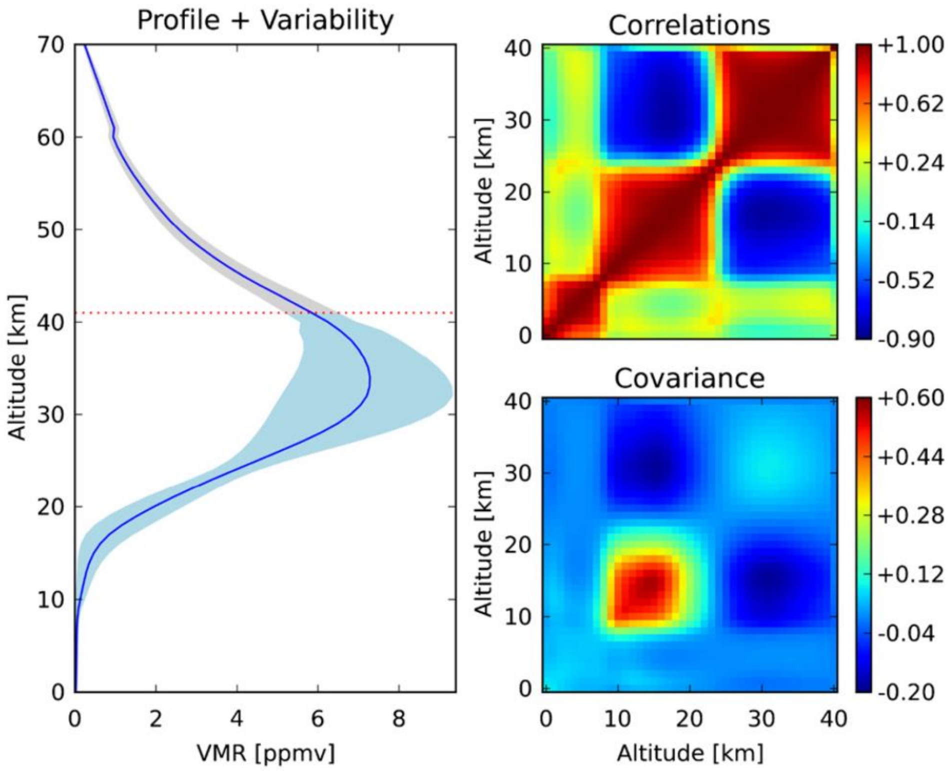

Figure 1. Left: $\mathbf{x}_a$ (ppmv, blue line) and associated variance (shaded blue) for the FORLI-O_3. The dashed red line indicates the top altitude of the last retrieved layer. Right: correlations and $\mathbf{S}_a$ variance–covariance matrices in multiplication factor (from Hurtmans et al. 2012)

2.5 Look-up-tables

Tabulated absorption cross-sections at various pressures and temperatures are used to speed up the radiative transfer calculation. The spectral range for the LUTs used in v20151001 is 960-1075 cm^{-1} and the spectral oversampling is 100. The absorption cross-sections are computed on a logarithmic grid for pressure from 4.5×10^{-5} to 1 atm with a grid step of 0.2 for the logarithm of pressure, and on a linear grid for temperature (162.8–322.6 K with a grid step of 5K). Relative humidity is also introduced in the LUT, varying linearly between 0 and 100%, by steps of 10%.

2.6 Spectroscopy

Line integrated absorption cross section, air broadening, self-broadening, line shifting and absorption cross section data are taken from the widely used HITRAN spectroscopic database online version (hitran.org). Continuum formulations are taken from MT-CKD (Clough et al., 2005).

REFERENCES

August, T., Klaes, D., Schlüssel, P., Hultberg, T., Crapeau, M., Arriaga, A., O'Carroll, A., Coppens, D., Munro, R. & Calbet, X. IASI on Metop-A: Operational Level 2 retrievals after five years in orbit. *J. Quant. Spectrosc. Radiat. Transfer, 113*, 1340-1371, 2012.

Clough, S, Shephard, M, Mlawer, E, Delamere, J, Iacono, M, Cady-Pereira K, Boukabara, S., Brown, P.D., Atmospheric Radiative Transfer Modeling: a Summary of the AER Codes, *J. Quant. Spectrosc. Radiat. Transfer*, 91, 233-244, 2005

Hurtmans, D.; Coheur, P.; Wespes, C.; Clarisse, L.; Scharf, O.; Clerbaux, C.; Hadji-Lazaro, J.; George, M. & Turquety, S. FORLI radiative transfer and retrieval code for IASI. *J. Quant. Spectrosc. Radiat. Transfer, 113*, 1391-1408, 2012.

McPeters RD, Labow GJ, Logan JA. Ozone climatological profiles for satellite retrieval algorithms. J Geophys Res (Atmos);112(D5). doi:10.1029/2005JD006823, 2007.

Wan Z. New refinements and validation of the MODIS Land-Surface Temperature/Emissivity products. *Remote Sens. Environ.*, 112(1):59-74, 2008.

Zhou, D. K.; Larar, A. M.; Liu, X.; Smith, W. L.; Strow, L. L.; Yang, P.; Schluessel, P. & Calbet, X. Global Land Surface Emissivity Retrieved From Satellite Ultraspectral IR Measurements. *IEEE Trans. Geosci. Remote Sens.*, 49(4):1277-1290, 2011.