

A FORUM simulator in the EC-Earth Climate Model: Implementation and Verification against IASI measurements





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The main objective of the work is to perform a strict climate model evaluation comparing the Far-Infrared (FIR) and Mid-Infrared (MIR) spectrally resolved radiances simulated by climate models with available instrumental measurements. In anticipation of FORUM mission, which will provide nadir-looking radiances at the top of the atmosphere in the FIR/MIR (from 100 to 1600 cm^{-1}), we compare the MIR (from 645 to 2760 cm^{-1}) existing observations from IASI to synthetic radiances extracted from the EC-Earth Global Climate Model.

INTRODUCTION

We firstly compare the observed and simulated Outgoing Longwave Radiation (OLR) fluxes integrated over the whole Earth emission spectrum

Models

Historical atmosphere-only simulations provided by 30 climate models partecipating the last intercomparison project (CMIP6).

Observations

CERES (Clouds and the Earth's Radiant Energy System) energy balanced and filled (EBAF) dataset constitutes a standard reference for evaluating simulations of Earth's radiative fluxes.

1. Global biases



2. Zonal biases

3. *Regional biases*



Global (1), Zonal (2) and Regional (3) OLR fluxes Seasonal means provided by a subset of CMIP6 models compared to CERES data over the period 2000 - 2014

ہٰ 25 Latitude(°)

MODELS (global mean) 238.3 \pm 2.8

CERES (global mean)240.0 \pm 2.0

Energy fluxes integrated over the whole Earth emission spectrum could be affected by compensation errors. In order to quantify compensating errors we need to validate spectral fluxes (not measured so far) i.e. to compare TOA spectral radiances (spectral measurements from IASI (MIR, 2007-to date) and in the future from FORUM (FIR, 2027-2033)) to simulation based on model atmospheres.

Latitude (°)

METHOD AND TOOLS

• EC-Earth Climate Model

Atmosphere:Integratedforecastsystem(IFS)ECMWFOceanNucleusforEuropeanModellingoftheOceanNEMO

• σ-FORUM Radiative Transfer Model

Fast parametric radiative transfer model with the capability to calculate high resolution radiances $(0.01 \ cm^{-1})$ in FIR and MIR

COSP

Instrument simulators like COSP map the model state into synthetic observations that can be compared to the real ones

CloudSat Instrument output CALIPSO Instrument output SCOPS ISCCP gridbox Instrument output COSP subgrid mean outputs MISR profiles Instrument outputs REC SCOPS MODIS Instrument outputs RTTOV Instrument outp

IASI Metop-A (Mid Infrared)

We collected 10 years of Level 1C data of IASI (Metop A) from 2007 to 2016 through the EUMETSAT EWC system Only nadir-view are selected (8 central Field of View) for each scan

• FORUM (Far-Infrared)

FORUM launch is planned for 2027

We have further developed the COSP package by implementing inside COSP the radiative transfer model σ -FORUM in order to extract simulated spectra from the EC-Earth climate model

1. Simulation with EC-Earth + COSP equipped with σ -*FORUM* in CLEAR-SKY condition is performed with prescribed sea-temperature and sea-ice extension over the period





compatible with IASI measurements.

- 2. IASI CLEAR SKY climatology constructed from observations
- Comparison of CLEAR-SKY zonal means radiances between model and observation over land/ocean and both.

Comparison of global (1) and zonal [30°N – 45° N] Clear sky simulated (ECE) and observed (IASI) BT for 2008

The comparison between nadir radiances simulated by the EC-Earth climate model and the climatology built from ten years of IASI observations represents a very high confidence test for the direct verification of the GCM. The same approach could be extended to other climate models, and, in the near future, it will involve FORUM measurements for a comprehensive analysis of the climate model ability in reproducing the whole Earth emission spectrum.

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