Full-physics inverse learning machine algorithm to retrieve geometry dependent surface reflectivity

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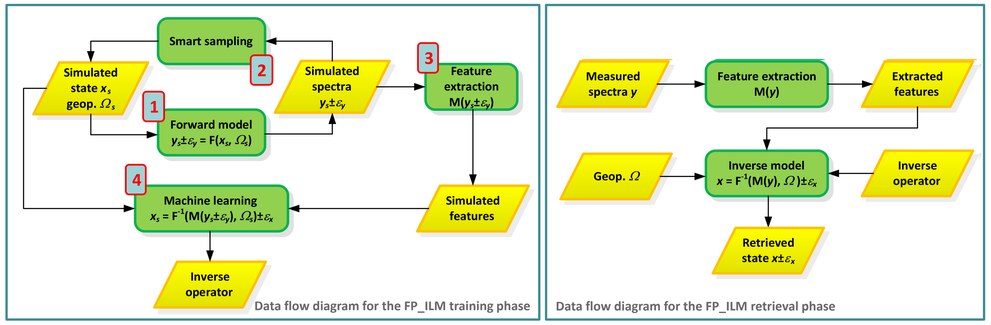
Abstract

The retrieval of trace gas, cloud and aerosol measurements from ultraviolet, visible and near-infrared (**UVN**) sensors requires precise information on the surface properties that are traditionally obtained from Lambertian equivalent reflectivity (**LER**) climatologies. In this work we present a novel algorithm for the retrieval of geometry-dependent effective Lambertian equivalent reflectivity (**GE_LER**) from **UVN sensors** based on the full-physics inverse learning machine (**FP_ILM**) retrieval. The radiances are simulated using a radiative transfer model that takes into account the satellite viewing geometry and the inverse problem is solved using machine learning techniques to obtain the **GE_LER** from satellite measurements [1].

The **GE_LER retrieval** is optimized for the trace gas retrievals using the DOAS algorithm and the large amount of data of the new atmospheric Sentinel satellite missions.

The **FP_ILM GE_LER** algorithm is applied to measurements of TROPOMI/S5P and it is being used for the operational retrieval of total ozone and cloud properties. The TROPOMI GE_LER/G3_LER results for the fitting windows corresponding to **O_3**, **NO_2**, **SO_2**, **HCHO**, **H_2O**, and **clouds** are presented and compared with climatological **GOME-2 LER** and **OMI LER** data.

FP_ILM algorithm for GE_LER retrieval



1 Forward model
2 Smart Sampling
3 Feature extraction
4 Machine Learning

GE_LER retrieval

Inputs: DOAS-fitted polynomial coefficients, fitting window slant column, SZA, VZA, RAA, SA, Z_e

Fitting windows

SO_2 [311-325] nm	NO_2 [405-465] nm
O_3 [325-335] nm	H_2O [430-466.5] nm
HCHO [328.5-346] nm	Cloud [755-771] nm

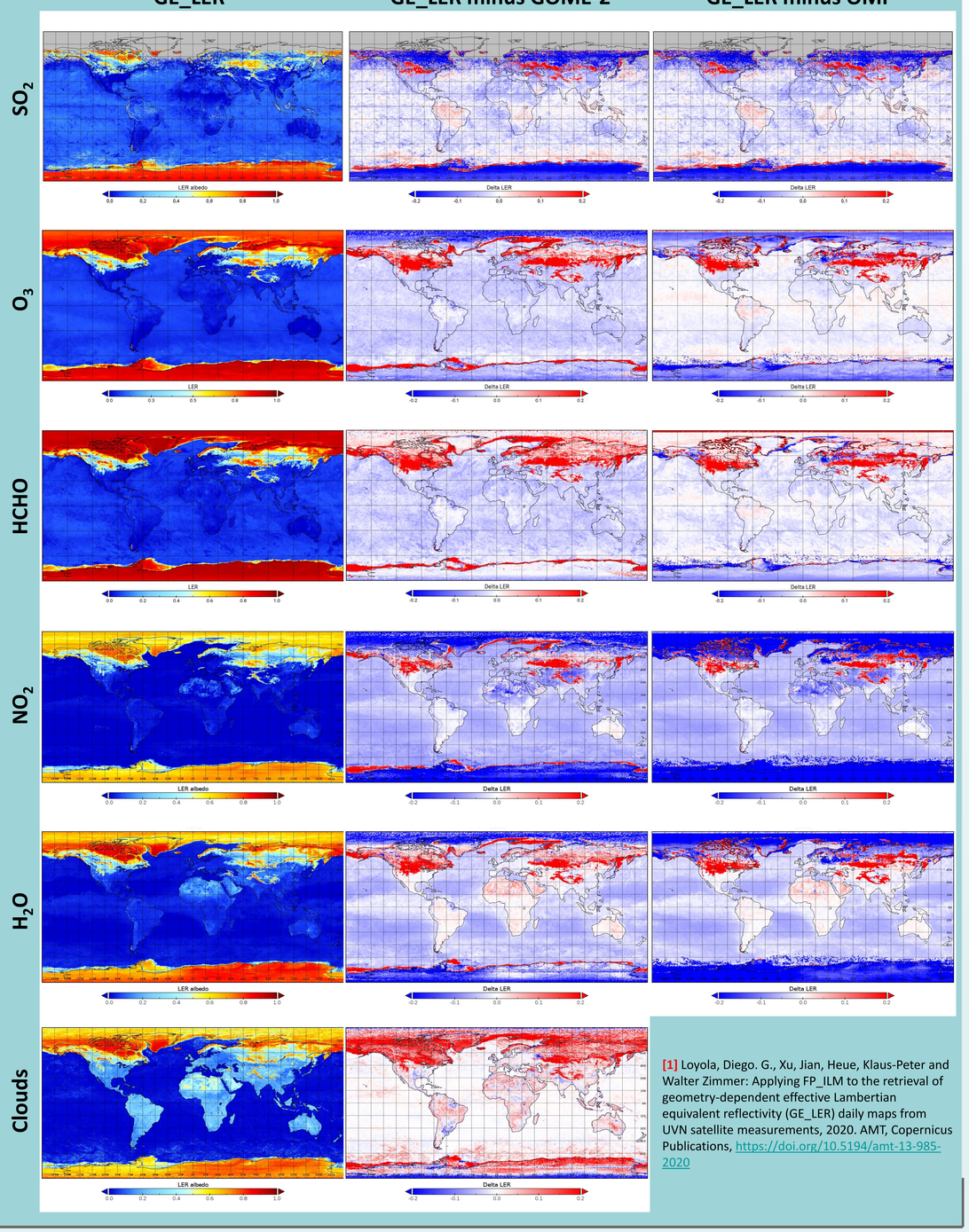
LER Climatologies

LER	Resolution	Climatology
GE_LER	0.1°	3 years
GOME-2	0.25°	6 years
OMI	0.5°	4 years

Conclusions

- The algorithm retrieves accurately **GE_LER** from **UVN** sensors based on **FP_ILM** technique. Monthly climatologies under clear sky conditions are created for the fitting windows: **SO_2**, **O_3**, **HCHO**, **NO_2**, **H_2O** and **clouds**
- The montly **GE_LER** maps (0.1° resolution) are superior to those based on **GOME-2** (0.25° resolution) and **OMI_LER** (0.5° resolution) climatologies
- **GE_LER** can be applied to any trace gas, cloud, and aerosol product retrieved in the UVN and is **accurate,** very **fast** and compatible with the **DOAS/AMF** settings used for the trace gas retrievals

GE_LER comparison GOME-2 and OMI LER



[1] Loyola, Diego. G., Xu, Jian, Heue, Klaus-Peter and Walter Zimmer: Applying FP_ILM to the retrieval of geometry-dependent effective Lambertian equivalent reflectivity (GE_LER) daily maps from UVN satellite measurements, 2020. AMT, Copernicus Publications, https://doi.org/10.5194/amt-13-985-2020

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