

Dedicated Neural Networks Algorithms for Direct Estimation of Tropospheric Ozone from Satellite Measurements

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Topic of the research activity:

Development of a **fast** and **reliable** Neural Networks (NNs) algorithm for the direct retrieval of tropospheric ozone information (e.g., Tropospheric Column Ozone - TCO) from UV/VIS Earth's radiance spectra measured from satellite platform. ESA-Envisat SCIAMACHY were used as test sensor.

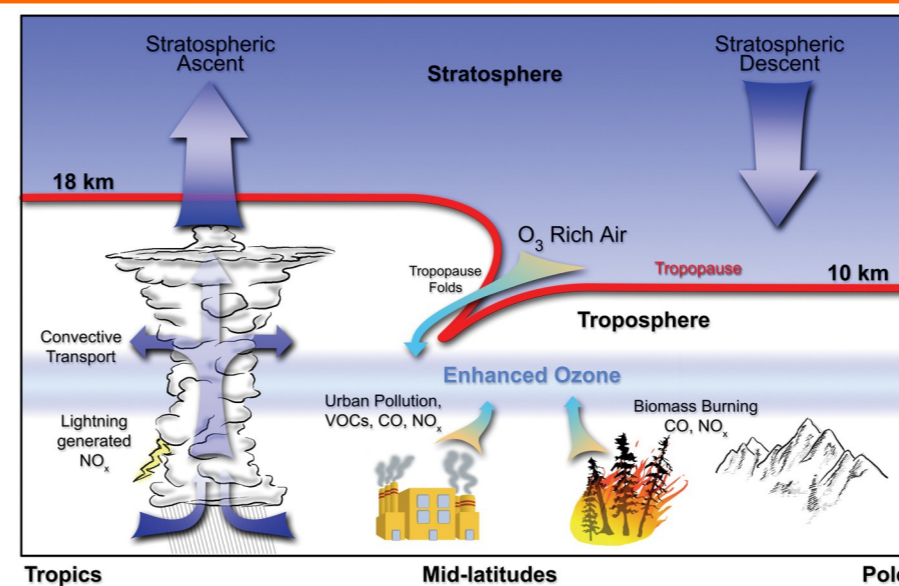


Image from: earthobservatory.nasa.gov

Operative steps:

- wavelength selection;
- topology definition;
- experimental dataset preparation;
- test and validation.

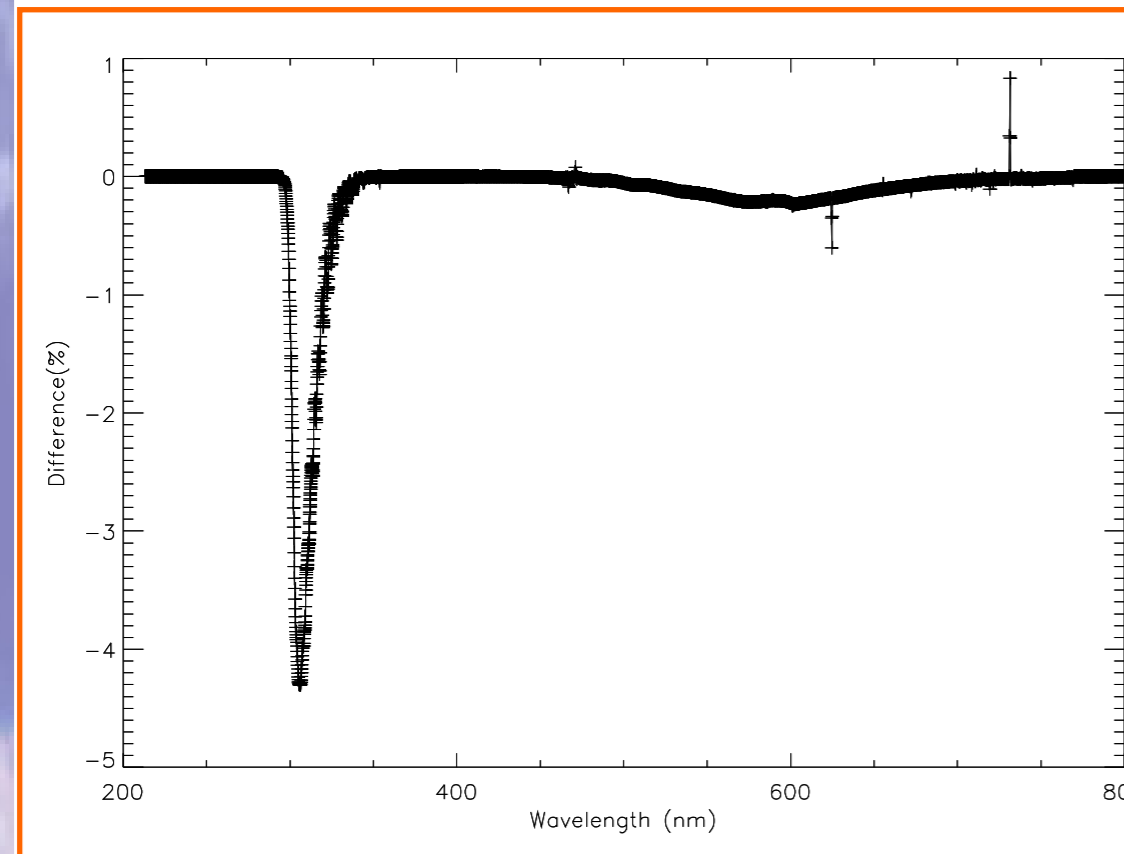
A) Wavelength selection:

Two step approach for dimensionality analysis of input radiance spectra:

- gross wavelength extraction by means of UVSPEC radiative transfer model (RTM) and LibRadtran suite;
- detailed wavelength selection by means of NN-extended pruning procedure.

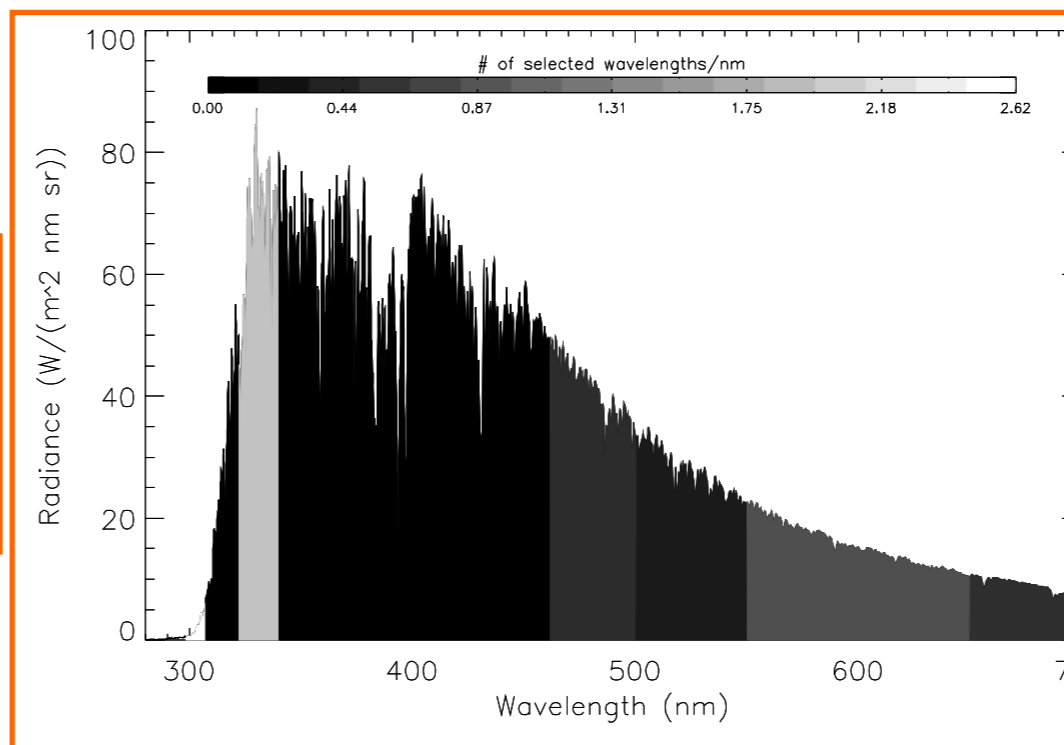
STEP 1 - HEIGHT RESOLVED RTM SENSITIVITY STUDY

Analysis of the variations in Earth's radiance resulting from changes in ozone concentration at 0-14 km. UVSPEC radiative transfer model and LibRadtran libraries used to represent a summer mid-latitude urban environment; atmospheric state set as in AFGL-MS climatological standard.



SCIAMACHY MEASUREMENTS SIMULATION

- radiation transfer equation solved at operating SCIAMACHY wavelengths;
- simulation of sensor's spectral resolution;
- 1% level noise addition to the radiances.



✓ Maximum sensitivity in 302-307 nm range.

✓ Little but not-neglectable sensitivity in VIS Chappuis band.

✓ UV sub-band 298-307 nm most informative;

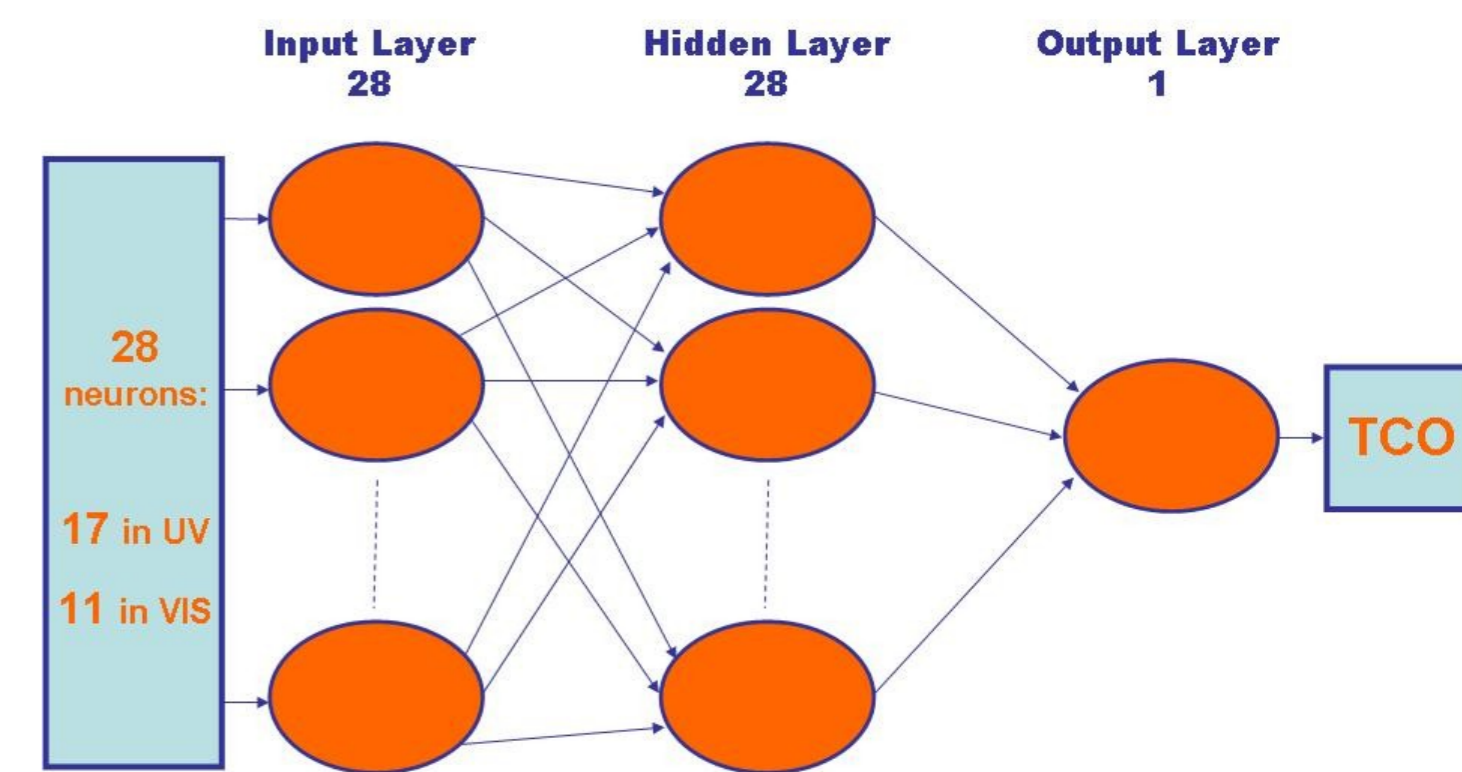
✓ VIS density of selected wavelengths consistent with Chappuis ozone bands structure.

STEP 2 - EXTENDED PRUNING PROCEDURE

Applied to determine the most informative wavelengths for TOC retrieval. RTM results considered as first screening for NN-EP procedure, to reduce the processing time of EP.

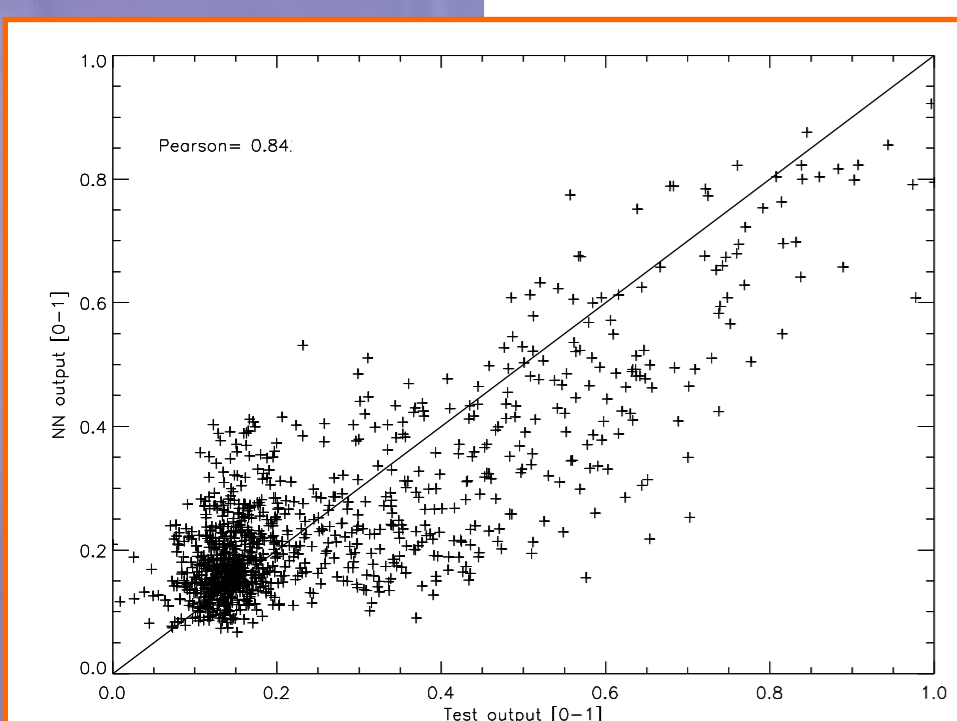
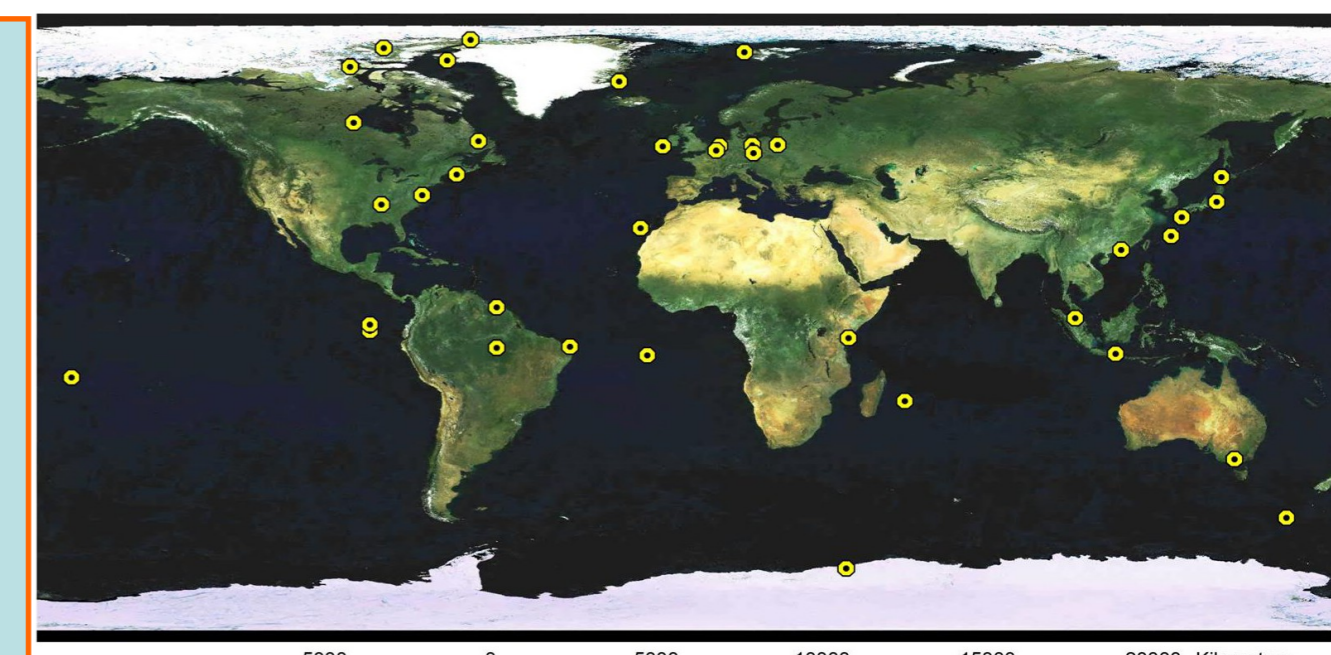
B) Topology definition:

- Input layer of 28 units, following the combined RTM-EP wavelength selection procedure;
- hidden layer dimensionality of 28 units, selected by means of an analysis of retrieval error variation vs hidden units;
- monodimensional output layer to infer TCO as integration of ozone concentrations at 0-14 km.



C) Experimental dataset definition:

- set of measured radiances extracted from **SCIAMACHY Level 1b** data;
- satellite data matched with ozonesondes measurements from **WOUDC** and **SHADOZ** databases;
- matching distance selected as 150 km (poles) and non-linearly varying with latitude until 400 km (equator);
- matching time distance 12 h;
- only northern mid-latitudes stations (30°N-60°N).



D) Test and validation:

- ✓ independent test dataset to verify NN's reliability on simulated data: UV/VIS NN improve of over 10% the retrieval capability in terms of Pearson coefficient;
- ✓ retrieved TCOs follow time trend of reference ozonesondes data at some reference mid-latitudes sites.

