NEURAL NETWORK ALGORITHMS FOR TROPOSPHERIC OZONE RETRIEVAL FROM
ESA-ENVISAT SCIAMACHY AND NASA-AURA OMI SATELLITE DATA

Pasquale Sellitto, Fabio Del Frate and Domenico Solimini

Earth Observation Laboratory, Department of Computer, Systems and Industrial Engineering,
Tor Vergata University of Rome,
DISP Building DT-09, Via del Politecnico 1, 00133, Rome, Italy
Email contact: sellitto@disp.uniroma2.it; Tel : +39 0672597711

The ozone in troposphere is a direct greenhouse gas [1] and its importance, both from a radiative point of view and
concerning its interaction with the biosphere, is outlined in several scientific papers. Monitoring its trends, especially in
highly polluted locations, is a relevant topic in recent geo-sciences research. Obtaining information about ozone in the lower
atmospheric levels from space is an arduous and exciting task. Difficulties stem both from the weak sensitivity of the Earth’s
radiances to tropospheric ozone variations and from the relatively high horizontal resolution needed to resolve small scale
features of regional air pollution. The maximum pixel dimension for monitoring air pollution from space has been estimated
to be about 15 km [2]. A global daily coverage can be required to continuously observe the air masses and check the air
quality.

Recently, we proposed a Neural Networks (NN) based scheme to retrieve the Tropospheric Ozone Column (TOC) from
Earth’s radiance UV/VIS nadir measurements [3]. Neural Network algorithms are particularly suited to solve complex non-
linear problems like the inversion of satellite radiance measurements for atmospheric profiles retrieval. The net was trained
using both simulated and experimental data. The considered simulation tool was a synthetic ozone profile dataset combined
with the UVSPEC Radiative Transfer Model (RTM). The experimental sample pairs were formed by several thousands
matching ESA-Envisat SCIAMACHY spectra and ozonesondes concentrations from the World Ozone and Ultraviolet
Radiation Data Centre (WOUDC) and from the Southern Hemisphere ADditional OZonesondes (SHADOZ). The input
wavelengths were selected following an RTM-NN extended pruning method to objectively exploit the information budget of
the SCIAMACHY measurements and the role of ultraviolet and visible radiation was investigated. The results of a validation
exercise carried out on a mid-latitude target area were encouraging.

Our present contribution first reports on the results obtained by several case studies in different situations and climatologies
to systematically test our Neural Net algorithm and to assess its wide applicability to the SCIAMACHY data. In addition,
some experiments on NASA-Aura OMI data are reported and the obtained results are discussed. Indeed, the enhanced
horizontal resolution of this latter sensor is more satisfactory with respect to the needed spatial resolution as indicated in [2].
In addition, the global daily coverage of the OMI sensor can help in a reliable monitoring of tropospheric ozone levels.
Unfortunately, the availability of ozonesonde systematic data for use in our OMI Neural Network algorithm is strongly
limited, given the observed recent decreasing trend of the sounding routine activity [4]. To overcome this difficulty, we
consider different solutions, including matching of OMI nadir measurements with commonly used satellite data. In particular,
the use of data from sounders like the Atmospheric InfraRed Sounder (AIRS) [5] flying on the NASA-Aqua spacecraft, and
the Tropospheric Emission Spectrometer (TES) [6] on the NASA-Aura spacecraft, has been considered. Both TES [7] and
AIRS [8] data were validated against ozonesondes measurements. The applied procedure is described and the attained results
are critically evaluated. A comparison with operating Level 2 tropospheric ozone OMI data is also presented and the results
discussed.

REFERENCES


