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Neural network algorithms for height resolved ozone retrievals from OMI Level 1b data

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Abstract

Ozone is one of the most important trace gases in the Earth's atmosphere. It is mainly present in the stratosphere, with only about 10% of the total column amount in the troposphere. Despite the relatively small ozone abundance, the solar radiation at wavelengths below 310 nm does not reach the Earth surface because of the large ozone absorption and Rayleigh scattering. Anthropogenic releases of ozone depleting substances play a dramatic role in a possible increase of the surface UV radiation. Human activity is very likely to be responsible also for an increase in tropospheric ozone caused by the photochemical production from industrial emission of ozone precursors such as carbon monoxide, volatile organic compounds, and nitrogen oxides. The effect of these variations at lower altitudes, with respect to background values, have been estimated to be the third largest source of the greenhouse effect. Monitoring ozone concentrations and trends, especially in highly polluted locations, is a relevant topic in recent geosciences research. Obtaining height resolved information of ozone from satellite platform is an exciting task. Difficulties stem e.g. from the weak sensitivity of the Earth's radiances to variations of ozone at lower altitudes and from the relatively high horizontal resolution needed to resolve small scale features of regional air pollution, as well as for climatological issues. A daily global coverage may be required to continuously observe the air masses and check the air quality.

The Dutch-Finnish Ozone Monitoring Instrument (OMI) on board the NASA-Aura spacecraft matches these requirements by combining a satisfactory spatial resolution and a daily global coverage. From this point of view, the OMI can more satisfactorily provide useful data with respect to the Envisat SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) or the ERS-2 Global Ozone Monitoring Experiment (GOME). The OMI is an ESA third party mission.

Usually height resolved information about ozone is inferred from the satellite signal by means of Optimal Estimation (OE) inversion techniques. Recently, we proposed Neural Network (NN) based schemes to retrieve both ozone profiles and Tropospheric Ozone Column (TOC) from Earth's radiance UV/VIS nadir measurements. NN algorithms are particularly suited to solve complex non-linear problems like the inversion of satellite radiance measurements for atmospheric profiles retrieval. NNs are expected to be less sensitive to calibration uncertainties than the OE, and to work more reliably in aerosols/cloudy scenarios. The networks were trained using both simulated and experimental data. The input wavelengths were selected following an RTM-NN extended pruning method to objectively exploit the information budget of the satellite measurements and the role of ultraviolet and visible radiation was investigated.

In this work we report on the potential of NNs in the retrieval of atmospheric ozone concentration from NASA-Aura OMI Level 1b data. The results obtained with two NNs, one

for ozone pProfile retrievals and the second for a direct TOC retrievals, respectively, are shown and the different design issues addressed. Both data from ozone sondes and complementary satellite data, e.g. Aura Microwave Limb Sounder (MLS) measurements, are considered as the “true” outputs during the training phase. A comparison with operational OMI Level 2 tropospheric ozone and Level 2 ozone profiles products is also presented and the results are discussed. OMI, MLS and some correlative data were provided by the Aura Validation Data Center (AVDC).