TAPIOWCA

long-Term Assessment, Proxies and Indicators of Ozone and Water vapour changes affecting Climate and Air quality

DURATION
1/09/2022 – 1/12/2025

BUDGET
285 672 €

PROJECT DESCRIPTION

Ozone and water vapour play fundamental roles in the Earth's atmosphere. They are deeply involved in major environmental concerns like air quality, climate change and ultraviolet radiation. Changes in the spatial distribution and the temporal cycles of ozone and water vapour are indicators of changes in their precursors, in global atmospheric transport, in the exchange between troposphere and stratosphere, and in the link between atmospheric composition and climate. Therefore, it is of particular scientific, political and societal importance to quantify and understand changes in tropospheric and stratospheric abundance of these constituents, at different temporal and spatial scales, and to discriminate their anthropogenic causes from natural processes.

Several international activities and projects supported by official bodies and programmes aim at improving the observational constraints on the present-day spatial distribution, interannual variability and long-term changes of ozone and water vapour; among them, the International Global Atmospheric Chemistry project (IGAC), Stratosphere-troposphere Processes And their Role in Climate activities (SPARC), the Committee on Earth Observation Satellites (CEOS), and the World Meteorological Organization (WMO). Despite these efforts, the latest international scientific assessments of the atmospheric environment (IGAC TOAR-I, 2019; SPARC LOTUS, 2019; IPCC, 2021; WMO/UNEP, 2022) conclude that the level of confidence in long-term trends of stratospheric water vapour (low), lower stratospheric ozone (medium) and tropospheric ozone (medium) is below par. Also currently lacking is a conclusive view on possible zonal patterns in climate variability and long-term trends of these constituents across the stratosphere.

The TAPIOWCA project aims to address several scientific questions by improving the constraints on the present-day global distribution, climate variability and long-term trend in water vapour and ozone across the troposphere and stratosphere. Fostering the integrated use of multiple satellite sensors, the project intends

1. to improve the agreement between tropospheric ozone Climate Data Records (CDR) by homogenising IASI satellite data, and, by applying a harmonisation scheme to all major satellite CDRs which corrects for differences in the vertical perception;
2. to characterise remaining differences between tropospheric ozone satellite CDRs and identify possible causes (Fig. 1);

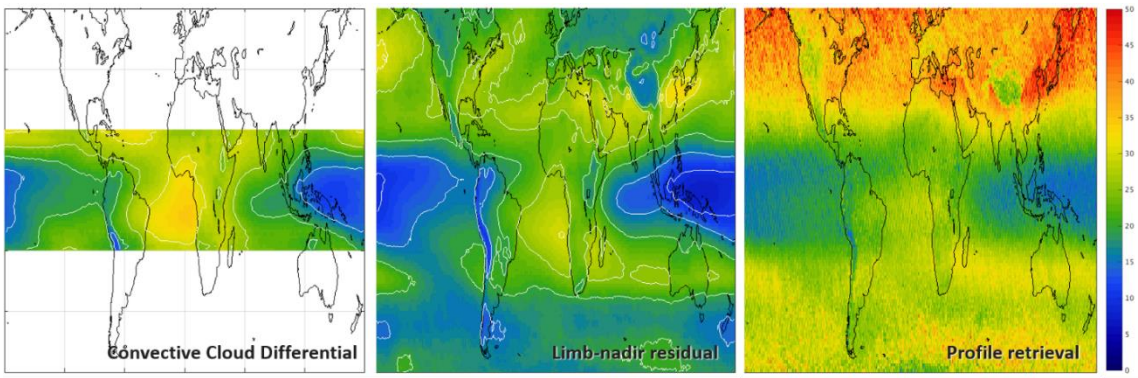

Figure 1 : Distribution of multi-annual mean tropospheric ozone column derived from satellite observations by the OMI sensor, obtained using three complementary measurement techniques and for different vertical ranges.

3. to investigate, using time series analysis techniques, whether changes in ozone precursor concentrations and in exchanges between stratosphere and troposphere can explain (part of) the trend in tropospheric ozone;
4. to improve the representation of interannual variability by optimising the time lag of the response of ozone and water vapour to natural processes, and to characterise its spatial structure and its impact on the regressed parameters and uncertainties;
5. to assess, based on multiple CDRs used widely in the community, the present-day global distribution, the interannual variations and the long-term trend of ozone in the troposphere and stratosphere, and, of water vapour in the upper troposphere and stratosphere (Fig. 2);
6. to study ozone and water vapour CDRs resolved in three spatial dimensions to reveal the full spatial structure of regressed parameters and link the global and regional perspectives, and to relate tropospheric and stratospheric patterns;
7. to adopt a systematic and comprehensive approach across the project, in order to reduce uncertainty and to maximise robustness of the project's assessments; this will be done by intercomparing different CDRs, in troposphere and stratosphere, and by exploring relations between ozone and water vapour.

TAPIOWCA aims to overcome several challenges, highlighted by recent international research activities, to improve the global monitoring and our understanding of changes in air quality, the ozone layer and the climate system, all of which are major concerns in the Earth system. We anticipate that the tropospheric ozone satellite data sets generated by TAPIOWCA, the harmonisation and time series analysis methods and the planned studies of ozone and water vapour hold the potential to have a great impact in several scientific assessments of our atmospheric environment carried out under the auspices of international bodies like IGAC TOAR, CEOS, SPARC and WMO/UNEP. Furthermore, the geophysical assessments could reveal unexpected distributions or rates of change of atmospheric constituents, which may require action by policy makers, industry and civil society as a whole.

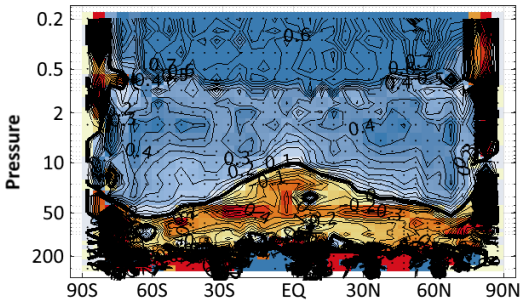

Figure 2 : The spatial distribution (latitude, air pressure) of the trend in water vapour concentrations between 1985 and 1997, obtained from a satellite Climate Data Record (CDR). A good understanding of the CDR and its uncertainties is required to properly interpret apparent changes of the trend (e.g., in the lower mesosphere around 0.7 hPa and in the polar regions).

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LINKS

https://tapiowca.aeronomie.be