Can We Detect the Decrease in Global Flight Activity over the North Atlantic during the Spring 2020 Covid-19 Lockdown from IASI Spectra?

Padraig Donnelly [1], Anni Määttänen [1], Lieven Clarisse [4], Simon Whitburn [3,4], Olivier Boucher [2], Robert Vautard[2], Sothea Has[1], Cathy Clerbaux[1]

[1] LATMOS/IPSL, Sorbonne Université, UVSQ Université Paris-Saclay, CNRS, Paris, France, address: Campus Pierre et Marie Curie BC102, 4 place Jussieu, 75005 Paris, France, E-mail: padraig.donnelly@latmos.ipsl.fr

[2] Institut Pierre-Simon Laplace, Sorbonne Université/CNRS, Paris, France address: Campus Pierre et Marie Curie BC99, 4 place Jussieu, 75005 Paris, France

[3] Royal Meteorological Institute of Belgium (RMIB), Atmospheric Composition, Measurements and Modelling (ACM2), address: Avenue Circulaire 3, 1180 Bruxelles, Belgique

[4] Spectroscopy, Quantum Chemistry and Atmospheric Remote Sensing, Université libre de Bruxelles (ULB), Brussels, Belgium address: Université Libre de Bruxelles, Av. Franklin Roosevelt 50, 1050 Bruxelles, Belgium

ABSTRACT

Introduction: This work investigates the radiative effects of ice crystals in the mid-infrared, and the degree to which cirrus and contrail effects can be resolved in the IASI spectra. The analysis covers the period of Spring 2020, marked by a significant reduction in air traffic due to the Covid-19 pandemic, resulting in a noticeable decrease in aviation-related cirrus clouds. This scenario provides a unique opportunity to observe the effects of reduced air traffic on outgoing longwave radiation (OLR) using IASI spectra. OLR is a critical component of the Earth's energy balance, influenced by emissions by the surface (land and oceans), atmospheric absorption and emission, interactions with clouds and aerosols. We study the spectrally integrated nadir IASI radiances (IIR) as a proxy for OLR through the spring 2020 period in the context of the long-term IASI data set.

Methodology: To isolate ice cloud effects in Level 1C IASI spectra, we focus on spectra co-located with positive detections of ice phase clouds (IASI Level 2 cloud product). To minimise IIR variability associated with the surface emission, we select measurements over the ocean (with small diurnal changes in sea surface temperature, SST). To minimise meteorological variability, we use the circulation analogues of Quaas et al. (2021, based geopotential at 500 mbar as a measure of atmospheric circulation) to construct a counterfactual spring 2020 period in the absence of the decrease in aviation cirrus.

Results: Building on Quaas et al. (2021), we use circulation analogues to compare the IIR during Spring 2020 to the prediction under similar meteorological conditions without the decrease in air traffic, to address the hypothesis that reduced aviation cirrus increases IIR. We are also exploring the use of machine learning (Extremely Boosted Trees) to regress IIR by training on ERA5 atmospheric fields, decomposing the statistical contribution of atmospheric fields and producing an alternative theoretical prediction of Spring 2020 IIR to compare with the primary result. Future work will expand this analysis to non-nadir measurements as well as observations of contrails both direct (visual imaging and LIDAR) and indirect (flight path reconstructions) to further separate the effects of natural cirrus and contrails.