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Three-dimensional distribution of biomass burning aerosols from Australianwildfires revealed by TROPOMI satellite observations

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The quantification of the abundance of particulate matter in the atmosphere has a great societal importance, as they directly impact the environment and Earth climate. Aerosols modify the radiative budget of the planet by scattering the sun radiation and preventing part of it from reaching the Earth surface . Depending on the vertical distribution of aerosols in the atmosphere, they may also modify precipitation rates since they act as cloud condensation nuclei. When located near the surface, aerosols are the most harmful air pollutants causing chronic diseases and premature deaths of millions of people everyyear around the world (WHO 2018). Aerosols can directly impact the economy by e.g., transport disruption or health care costs.

Satellite measurements offer a great potential for observing aerosol distribution in the atmosphere from the regional to the global scale. However, these measurements are mostly done in two dimensions (2D): horizontal distributions of aerosol optical depth (AOD) by passive sensors as MODIS or latitudinal transects of vertical profiles of aerosol backscatter spaced in longitude by about 2000 km as done by the CALIOP spaceborne lidar. Recently, horizontal maps of mean aerosol layer altitudes are also retrieved by analyzing the radiation spectra. However, the full 3D distribution of aerosols at daily scale has been only observed for coarse particles such as desert dust from the analysis of thermal infrared spectra from the IASI sensor (Cuesta et al., 2015, 2020). In the present work, we have extended the retrieval of the 3D distribution for fine aerosols for the first time, applying the approach on the biomass burning aerosol emitted from Australian major wildfires in December 2019. For this, we have analyzed the spectrum of reflectance at the oxygen A-band around 760 nm together with some part of the visible spectrum measured by the TROPOMI sensor onboard the Sentinel 5-Precursor satellite. Since these measurements are done in the near infrared and visible, they are sensible to fine aerosols and oxygen absorption in the A-band provides information on the vertical distribution of these particles. The retrieval is based on a Tikhonov-Philips altitude-dependent regularisation which adapts the constraints iteratively to each observed scene as done by Cuesta et al., (2015). In the current presentation, we will present the first retrievals of the 3D distribution of biomass burning aerosols for cloudfree conditions. We compare our TROPOMI-derived 3D distributions with MODIS 2D AOD maps, AERONET AOD retrievals and CALIOP vertical profile transects. Finally, we analyse the 3D pathways of transport followed by these biomass burning aerosols during these events, based on our new retrieval.