Large hemispheric difference in ultrafine aerosol concentrations in the lowermost stratosphere

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On the NASA Atmospheric Tomography Mission (ATom), we observed a sharp hemispheric contrast in the concentration of ultrafine aerosols (3-12 nm diameter) in the lowermost stratosphere that persisted through all four seasons. Exploring possible causes, we show that this is likely caused by aircraft, which emit both ultrafine aerosol and precursor gases for new particle formation (NPF) in quantities that agree well with our observations. While aircraft may emit a range of NPF precursors, we focus here on sulphur dioxide (a major source of atmospheric sulphuric acid), of which we have observations from the same mission. We observe the same hemispheric contrast in sulphur dioxide as ultrafine aerosol, and find that the observed concentrations are in alignment with inventoried aircraft emissions. We present box modeling and thermodynamic calculations that support the plausibility of NPF under the conditions and sulphur dioxide concentrations observed on ATom.

While the direct climate impact of ultrafine aerosol in the lowermost stratosphere (LMS) may currently be small, our observations show a definitive size distribution shift of the background aerosol distribution in the northern hemisphere. This is important for assessing aviation impacts, and the expected impacts of increased air-traffic. Furthermore, climate intervention via injection of sulphate or aerosols into the stratosphere is a current subject of research. Our study shows that NPF is possible and likely already happening in the LMS, which must be accounted for in models for stratospheric modification, and points out that we must consider that any intentional stratospheric modification will be applied to two very different hemispheres: a largely pristine southern hemisphere; and an already anthropogenically modified northern hemisphere.