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Positive trends in Southern Hemisphere observations of carbonyl sulfide

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Carbonyl sulfide (OCS; lifetime of about 5.7 years) is the longest lived reduced sulfur-containing gas in the atmosphere. The primary source of OCS is the ocean, which is both a direct source (through OCS emission) and an indirect source (due to oxidation of carbon disulfide, CS2, and dimethyl sulfide). Other natural sources of OCS include volcanic outgassing and direct fluxes from wetland regions. The removal of OCS from the atmosphere is dominated by soil and vegetation uptake, with minor contributions from reactions with the hydroxyl radical. Small anthropogenic sources of OCS are coal combustion, biomass burning, and aluminum production. A dominant indirect source results from CS2 emissions from the rayon industry. Transport of tropospheric OCS to the stratosphere during volcanically quiescent periods has been suggested to contribute sulfur to the stratospheric aerosol layer which affects atmospheric radiative balance. If, however, production of stratospheric aerosols from OCS oxidation is smaller than typical estimates, this OCS contribution would be overestimated. The magnitude of the OCS flux to the stratosphere is currently not well quantified as is the relative contribution of OCS to background aerosol loading. While earlier model simulations indicate OCS fluxes into the atmosphere exceeding removal, past total column observations of OCS show no significant trend.

Analysis of tropospheric OCS columns at Arrival Heights (Antarctica) and Lauder (New Zealand) show strong positive trends from 2001-2008 followed by weaker trends to 2015, with unexpected temporal coherence. Since trends in ocean and land sources/sinks at these two sites, respectively, are unlikely to be similar, the coherence in trend structure likely results from changes in transport of OCS from the tropics to middle and high latitudes. Potential causes for OCS increases are (i) increases in tropical lower stratospheric OCS and/or (ii) strengthening of the large-scale circulation which transports OCS poleward. More atmospheric measurements and detailed transport model simulations are required to better understand the causes of the positive trend in OCS. This would more clearly differentiate whether stratospheric transport of OCS, or changes in local sources and sinks, is the main contributor to the observed trends.