

New constraints on terrestrial and oceanic sources of atmospheric methanol

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Abstract

We use a global 3-D chemical transport model (GEOS-Chem) to interpret new aircraft, surface, and oceanic observations of methanol in terms of the constraints that they place on the atmospheric methanol budget. Recent measurements of methanol concentrations in the ocean mixed layer (OML) imply that in situ biological production must be the main methanol source in the OML, dominating over uptake from the atmosphere. It follows that oceanic emission and uptake must be viewed as independent terms in the atmospheric methanol budget. We deduce that the marine biosphere is a large primary source (85 Tg y⁻¹) of methanol to the atmosphere and is also a large sink (101 Tg y⁻¹), comparable in magnitude to atmospheric oxidation by OH (88 Tg y⁻¹). The resulting atmospheric lifetime of methanol in the model is 4.7 days. Aircraft measurements in the North American boundary layer imply that terrestrial plants are a much weaker source than presently thought, likely reflecting an overestimate of broadleaf tree emissions, and this is also generally consistent with surface measurements. We deduce a terrestrial plant source of 80 Tg y⁻¹, comparable in magnitude to the ocean source. The aircraft measurements show a strong correlation with CO ($R^2=0.51-0.61$). We reproduce this correlation in the model with the reduced plant source, which also confirms that the anthropogenic source of methanol must be small. Our reduced plant source also provides a better simulation of methanol observations over tropical South America.