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# Using ACE-FTS to assess mixing barrier strength in nudged chemistry-climate models

Methane is a potent greenhouse gas with an increasing trend in the atmosphere due to rising emissions. Aside from its climate impacts, it is important to monitor methane because of its long lifetime of about ten years, which makes it a useful tracer of atmospheric transport. Modelled methane fields can therefore be compared with observations to evaluate transport in atmospheric models. Several methods have been proposed for assessing the strength of the subtropical mixing barrier and the polar vortex edge using long-lived tracers, but most require high data density. In addition, it is difficult to separate the effects of mixing from those of chemical production and destruction or from other aspects of atmospheric transport. In this study, we explore various methods of using methane probability density functions and time series to quantify the strength of the subtropical mixing barrier and the polar vortex edge through comparisons with relatively sparse satellite measurements from the Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS). ACE-FTS is a solar occultation instrument with near-global coverage and 3–4 km vertical resolution, spanning the upper troposphere to the lower mesosphere. The focus of the comparisons is on a specified dynamics run of the Canadian Middle Atmosphere Model (CMAM39-SD) for the 2004-2018 period. In general, we find that the modelled subtropical mixing barrier is too weak in the lower stratosphere and too strong in the upper stratosphere. In contrast, CMAM39-SD reproduces methane variability near the polar vortex edge very well. To provide context, we also compare ACE-FTS with the air quality model GEM-MACH, the Earth system model MRI-ESM2, and the chemical transport model GEOS-Chem.

## Topic

Atmospheric composition (Earth and planets), chemistry and transport

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