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Transport mechanisms for synoptic, seasonal and interannual SF_6 variations and "age" of air in troposphere

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Abstract. We use an atmospheric general circulation model (AGCM) driven chemistry-transport model (ACTM) to simulate the evolution of sulfur hexafluoride (SF_6) in the troposphere. The model results are compared with continuous measurements at 6 sites over 71° N–90° S. These comparisons demonstrate that the ACTM simulations lie within the measurement uncertainty over the analysis period (1999–2006) and capture salient features of synoptic, seasonal and interannual SF_6 variability. To understand transport timescales of SF_6 within the troposphere, transport times of air parcels from the surface to different regions of the troposphere ("age") are estimated from a simulation of an idealized tracer. The age estimation error and its sensitivity to the selection of reanalysis meteorology for ACTM nudging or the tracer transport by deep cumulus convection as represented in the model are discussed. Monthly-mean, 2-box model exchange times (τ_{ex}) are calculated from both the observed and simulated SF_6 time series at the 6 observing sites and show favorable agreement, suggesting that the ACTM adequately represents large-scale interhemispheric transport. The simulated SF_6 variability is further investigated through decomposition of the mixing ratio time-tendency into advective, convective, and vertical diffusive components. The transport component analysis illustrates the role of each process in SF_6 synoptic variability at the site level and provides insight into the seasonality of τ_{ex}.

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