

Process analysis of GHGs seasonal variability in the UT/LS region on account of emissions, dynamics and atmospheric chemistry

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The seasonal variability of four important greenhouse-gases (GHGs): carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and sulphur hexafluoride (SF₆), has been studied in the upper troposphere and lower stratosphere (UT/LS) region. The dynamical and chemical processes involved in distribution of the long-lived GHGs are elucidated using MIROC4 (Model for Interdisciplinary Research On Climate Earth System Model version 4) atmospheric chemistry transport model (ACTM) and CONTRAIL (Comprehensive Observation Network for Trace gases by AirLiner) aircraft observations. The GHGs concentration has been analysed over western pacific in multiple latitude bands (between equator and 30°N) and over the Eurasian continent (50°N-70°N). The observed seasonality in GHGs at different latitude and longitude bands have been discussed comprehensively by emphasising the role of emissions, dynamics, and atmospheric chemistry with the help of MIROC4-ACTM. For an example, we are able to distinguish the predominant role of OH chemistry in the CH₄ seasonal cycle in the tropical low latitude bands in upper troposphere, while, over high latitude the role of both OH loss and emission prevailed. Further, the dynamical components associated with GHGs seasonality has been studied by segregating the contribution from convection and advection tendencies as modelled in the ACTM. The zonally averaged transect of age of air and GHGs simulations from MIROC4-ACTM make it easier to explain the GHGs variability in the lower troposphere (Figure 1).

Figure 1: Zonal averaged age of air (AoA) from MIROC4-ACTM for (a) January 2014; arrow indicates the fast-downward movement of stratospheric air due to deeper branch of Brewer-Dobson circulation and (b) July 2014; arrow indicates diffusion of air with younger age towards extratropical tropopause by the shallower branch of Brewer-Dobson circulation. The zonal averaged CH₄ concentration has been also shown for (c) CH₄ January 2014 (d) CH₄ July 2014. The black and white asterisk indicate the approximate altitude at $\Delta \theta > 50.0\text{K}$ and $\Delta \theta = 37.5 - 50.0\text{K}$ respectively.

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