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Analysis of seasonal and regional variability in double tropopause activity investigated using HIRDLS observations and re-analysis data

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The Upper Troposphere Lower Stratosphere (UTLS) region in the Earth's atmosphere plays a critical role in the climate system. The tropopause draws the boundary between the troposphere and stratosphere. The thermal definition of the tropopause usually shows a break during the winter at the subtropical jet and forms a double tropopause (DT) when the tropical and polar tropopause overlap. This break has been connected to an increase in ozone concentration, thus indicating a connection between DTs and air mass exchange. Examining the climatology of the DT is important for understanding how the definition, location, and strength of this feature changes Stratosphere-Troposphere Exchange (STE) in the UTLS region.

This study expands upon previous climatological research by utilizing both high vertical and along track resolution of the HIRDLS instrument to examine the distribution and variability of the DT from 2005-2007. First, the spatial distribution of DT frequency is examined for all seasons with a focus on the extratropics. Analysis of the winter/spring seasons for the northern hemisphere reveals a high concentration of DTs along the jet stream with a decrease of 10% over the eastern Pacific and mid Atlantic. These two breaks occur in regions of poleward wave breaking and weak zonal flow. This pattern is also seen in the analysis of DT depth, i.e. altitude difference between the polar and tropical tropopause. Additionally, an analysis of HIRDLS profiles along each orbit track shows a larger latitude range and northward extension of the DT in regions of wave breaking. For the first time, DT duration is investigated utilizing a Hovmueller Diagram of DT frequencies. This representation of the DT reveals lifetimes of approximately 5 days in the northern hemisphere extratropics. Lastly, some of these results are compared to ERA-Interim analyses to examine how well these can reproduce fine scale structures, such as the DT, in the UTLS region.