*Reply (in italics) to comments of Reviewer 2:*

This technical note uses methane (CH4) profile data from the Halogen Occultation Experiment (HALOE) to diagnose changes in the Brewer-Dobson Circulation (BDC). The author analyzes CH4 trends for three 5-year time spans from 1992 to 2005 and finds significant changes in CH4 trends, particularly in the Northern Hemisphere (NH) near 30 hPa, which is a transition layer between the shallow and deep branches of the BDC.

The author finds that CH4 changes were positive and large in the shallow branch following the eruption of Mount Pinatubo, but they then decreased and agreed with tropospheric trends in the late 1990s and early 2000s. In the upper part of the deep branch, CH4 decreased from 1992 to 1997, following the Pinatubo eruption. CH4 continued to decrease in the deep branch in the late 1990s, but then increased in the early 2000s, although the changes were small compared with the seasonal and interannual variations of CH4.

The author concludes that these multi-year changes in CH4 trends were due, in part, to wave forcings during the El Niño Southern Oscillation (ENSO) of 1997-1998 and beyond, and to episodic sudden stratospheric warming (SSW) events during both time spans. The author also concludes that time series of HALOE CH4 provide effective tracer diagnostics for studies of the nature of the BDC from 1992 to 2005.

Overall, this is a well-written and informative manuscript. I recommend it for publication, with the following suggestions:

1. Limitations of using multi-variate regression model to detect short-term trends

The author should highlight the limitations of using a multivariate regression model to detect short-term trends in CH4. A major limitation is that multivariate regression models can be sensitive to the choice of explanatory variables and the model structure. Additionally, short-term trends can be difficult to distinguish from interannual variability. Authors should also mention that overall tropsopheric CH4 trends are non-linear (hiatus and then rapid increase).

*At the suggestion of Reviewer 1, I altered the QBO term in my model for the latitude and pressure level of Fig. 1a and found only very minor differences of the analyzed trend coefficient. While there may be other regressors, I did examine the MLR time series residuals for each pressure level and latitude zone but did not find any significant periodic structure in them.*

2. Role of OH chemistry in CH4 loss

The author should discuss the role of OH chemistry in controlling CH4 loss rates. Changes in OH concentrations can have a significant impact on CH4 trends. For example, the eruption of Mount Pinatubo injected sulfur dioxide into the stratosphere, which led to the formation of sulfuric acid aerosols altering OH concentrations (e.g Branda et al., 2014). Authors should also discuss importance of this pathway.

Bândă et al., (2015), The effect of stratospheric sulfur from Mount Pinatubo on tropospheric oxidizing capacity and methane, J. Geophys. Res. Atmos., 120, 1202–1220, doi:10.1002/2014JD022137.

*The effects of $SO_2$ and aerosols on the production of OH and the loss of tropospheric CH4 appear to be secondary, especially when compared with the lower stratosphere trends of $CH_4$ in Figure 3. In addition, those secondary effects do not extend past 1992.*

3. Comparison with gap-free data

The author could compare the results from the raw HALOE data with the gap-free stratospheric CH4 profile data constructed by Dhomse and Chipperfield (2023). This comparison would provide additional insights into the accuracy and reliability of the results.

Dhomse Sandip S. (2022). TCOM-CH4: TOMCAT CTM and Occultation Measurements based daily zonal stratospheric methane profile dataset [1991-2021] constructed using machine-learning (1.0) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.7293740

*Dhomse and Chipperfield report that their gap-free, zonal mean $CH_4$ profiles agree to within ~10% with those of the original HALOE dataset. It is very unlikely then that separate analyses of their gap-free dataset using my same regressors will yield trends that are qualitatively different from what I am showing. Therefore, I do not wish to expand my Note to include additional analysis results for my three, 5-yr time spans. Others may want to consider those gap-free HALOE data and to extend their analyses to 2012 and to the present day using the MIPAS and ACE data, respectively.*

Minor comments:

Line 147: Change "July 1996" to "July 1997".

*The year 2996 in the sub-head is a typo and should be 1996; the second, 5-yr time span has a one-year overlap with that of 1992-1997 of Figure 3.*