

## ***Interactive comment on “Equatorial transport as diagnosed from nitrous oxide variability” by P. Ricaud et al.***

**Anonymous Referee #1**

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This paper uses 5 years of ODIN satellite measurements to study spatial and temporal variability of N<sub>2</sub>O in the tropics, and makes comparisons with results from 2 chemistry transport model simulations (SLIMCAT and MOCAGE). This is the first analysis of the ODIN N<sub>2</sub>O data that I have seen, and these results are novel and interesting. The data and models all show the well-known seasonal and QBO variations over ~20–50 km, with some noted differences between the observations and model results. However, the most interesting results and comparisons are in the altitude region near the tropopause, where neither model captures the observed seasonal or spatial variability. The authors document the behavior of the observations in this region, and make arguments about the importance of overshooting convection and transport for the lowermost stratosphere. Overall the paper is novel and interesting, and these new data

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will make an important contribution to understanding of the TTL region. However, I am not in agreement with all of the inferences regarding these observations, and I suggest the authors address the following points in revision.

1) The lack of seasonal variation in the models at 100 hPa is very interesting, but this could be due to a number of problems (such as N<sub>2</sub>O seasonality in the model upper troposphere and/or problems in model transport in the TTL). I agree with the logic that the vertical gradient in N<sub>2</sub>O is small, so that seasonal variations in vertical velocity probably do not completely explain the overall TTL seasonality (although the seasonal N<sub>2</sub>O maximum in NH winter is consistent with stronger upwelling in this season). However, I am not convinced that overshooting convection is a main contributor to the observed variability at 100 hPa. A key point is that the seasonality of the overshooting convection (above 14 km) in Fig. 7 (maximum in March-May) does not match the observed N<sub>2</sub>O minimum during May-July (Fig. 4), and results are not shown for the amount of overshooting for higher altitudes (the text suggests overshooting up to 500 K or 21 km; can TRMM results for these levels be shown?). I am unconvinced that the vertical profiles in Fig. 9 demonstrate injection of tropospheric air up to 500 K, but rather I see the largest gradient changes during May-July below 450 K (most pronounced in the Western Pacific); this is difficult to interpret given the poor knowledge of seasonal variability of N<sub>2</sub>O in the upper troposphere. Overall I do not think that there is convincing evidence that overshooting convection is a dominant process influencing seasonal or longitudinal structure in the TTL.

2) I would like to see a comparison of the vertical velocities used in the two model simulations (some time series at a couple of pressure levels). I am surprised at the substantial differences in the vertical structure of N<sub>2</sub>O between the two models in Fig. 9, and wonder if this is due to the imposed vertical velocity or some large differences in N<sub>2</sub>O photochemistry between the models. It would also be helpful to understand better the behavior of N<sub>2</sub>O in the upper troposphere in both of the models. Does SLIMCAT incorporate stratospheric ozone variations in its radiative calculations?

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3) I think there is some confusion regarding seasonal upwelling in the TTL. The seasonal cycle in upwelling is a dynamically forced phenomenon, with a resulting seasonal cycle in temperature and radiative heating (temperature responds to the upwelling, and the radiative heating is a response to the temperatures being out of equilibrium). Radiative heating is a response to the dynamically-forced upwelling; radiation is not a driver of the seasonal cycle. Similarly, the corresponding variations in TTL isentropes are a (diabatic) response to the dynamical upwelling, so that isentrope movements are not a useful explanation of constituent seasonal variability.

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Interactive comment on Atmos. Chem. Phys. Discuss., 9, 4899, 2009.

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