We are very grateful to the two reviewers for the constructive comments on our manuscript, which greatly helped us to improve the quality of this manuscript. We have now revised the manuscript following your comments and suggestions. Our responses to your comments are listed below in red.

Reviewer #1

I have reviewed the manuscript 'Influence of Major Sudden Stratospheric Warming With Elevated Stratopause on the Hydroxyl in the Polar Middle Atmosphere' by Hu et al.. The authors present the composite response of the polar OH layer in the MLT to 10 ES-SSW events during 2004-2023 using SD-WACCM-X. During the stratospheric warming phase, the peak height of OH layer undergoes a distinct upward displacement, which is closely synchronized with changes in mesospheric temperature, atomic oxygen concentrations, and the vertical component of the residual circulation in the MLT region. GWs play a pivotal role, as the enhanced downward (upward) motion driven by GWs leads to mesospheric warming (cooling) and a corresponding increase (decrease) in atomic oxygen, which in turn facilitates an increase (decrease) in OH concentration. The manuscript is well-written, and the methodology is solid. I have a few comments. My only concern is that this study is mainly based on model results. Please see my major comment for details.

We thank the reviewer for the comment. In the revised manuscript, SABER OH observations for the 2009 SSW event have been added. The observed OH variations show a decrease in peak value and an upward shift, consistent with SD-WACCM-X simulations, which reinforces the robustness of our conclusions.

Major comment:

1.WACCM model has deficiencies in its treatment of GW forcing, which could lead to an underestimation of OH variation during ES-SSWs. I suggest that the authors validate the model results using SABER OH observations—perhaps for at least one SSW event.
Response: Thank you for your suggestion. Following your advice, we have compared the SD-WACCM-X with SABER OH observations for the 2009 SSW event, as shown in Figure R1d. The SABER results reveal a significant decrease in peak value and an upward shift of the OH layer during the stratospheric warming phase, which is consistent with the SD-WACCM-X simulation. This Figure is added in the revised manuscript.

It should be noted that the SABER OH airglow measurements originate from radiative emissions of vibrationally excited OH (v>0), whereas the SD-WACCM-X output reflects the OH concentration dominated by ground-state OH (v=0). Despite this difference, the simulated OH distribution from SD-WACCM-X exhibits a similar pattern to the SABER observation, because both share the same primary production mechanism. Moreover, the observed peak altitude of OH airglow (~87 km) lies slightly

above the simulated ground-state OH peak (~82km), which is consistent with known collisional quenching processes affecting vibrational levels. This result is added in the revised manuscript (see lines 265-271).

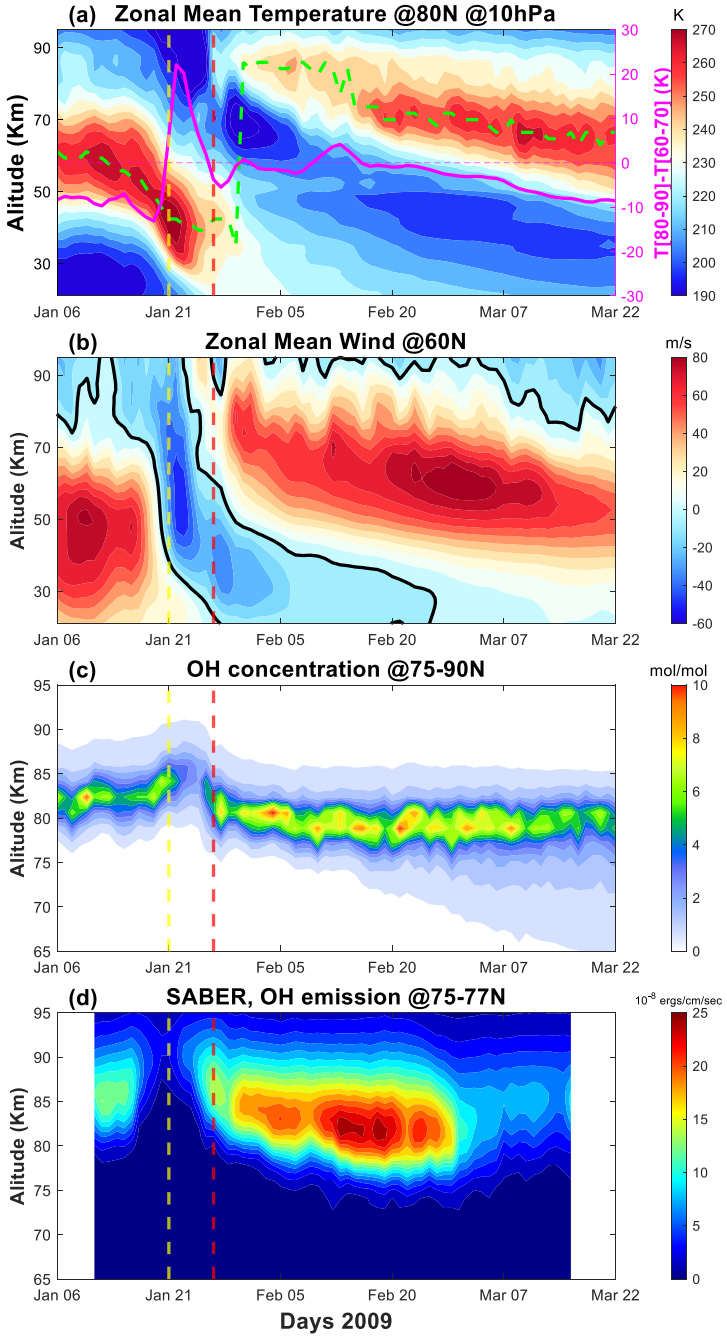

Figure R1. Time-altitude cross-section of SD-WACCM-X zonal-mean (a) temperature at 80°N, (b) zonal wind at 60°N, (c) OH concentration (in units of 10^{-9}), and SABER (d) OH emission during January 06-March 22, 2009. The solid pink line represents the temperature difference between 60°N and 90°N $(T[80^\circ - 90^\circ] - T[60^\circ - 70^\circ])$, and the dashed green line is the stratopause height. The black solid contour in (b) denotes the zero-wind line. Vertical dashed yellow and red lines are the onset of the stratosphere warming stage and the elevated stratopause stage, respectively.

Minor Comments:

1) Lines 190-192: 'In Figure 1a, the meridional temperature gradient (T[80−90]−T[60-70] K) is denoted by the pink solid line, and the height of the ES is indicated by the green dashed line.' How is the height of the ES defined? A sentence in the manuscript would be helpful.

Response: Sorry for the confusion. In the original manuscript, the term "height of the ES" was incorrectly used. In Figure 1a, the green dashed line indicates the stratopause height, which is defined as the altitude of maximum temperature within the 20–100 km vertical domain (Chandran et al., 2013). We correct it in the revised manuscript (see lines 221-224).

Reference:

Chandran, A., Collins, R. L., Garcia, R. R., Marsh, D. R., Harvey, V. L., Yue, J., and de la Torre, L.: A climatology of elevated stratopause events in the whole atmosphere community climate model, Journal of Geophysical Research-Atmospheres, 118, 1234–1246, https://doi.org/10.1002/jgrd.50123, 2013.

2) Figures 7-9 show latitude-altitude cross-sections of composite relative variation. How is the relative variation defined?

Response: Sorry for the confusion. The relative variation in this study is derived from this formula:

$$\text{Reletive variation} = \frac{X_{(i)} - \overline{X}}{\overline{X}} \times 100\% \quad (1)$$

in which $X_{(i)}$ represents the variable (OH, atomic oxygen, and temperature) for each ES-SSW event, and $\overline{X}$ stands for the background average obtained by averaging the same calendar dates over 2004–2023. The associated statements have been added to the revised manuscript (see lines 446-451).