Atmos. Chem. Phys. Discuss., 10, C13099–C13103, 2011
www.atmos-chem-phys-discuss.net/10/C13099/2011/


Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Middle atmosphere response to the solar cycle in irradiance and ionizing particle precipitation" *by* K. Semeniuk et al.

**K. Semeniuk et al.**

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Response to Referee # 5

We disagree with the contention of the referee that the paper is not acceptable for publication in its current form. The following is a list of points raised by the referee and our reply:

1) Robustness of the dynamical response to EPP:

The dynamical response to EPP in the individual EEP type runs (Figs. 4 and 8) cannot be clearly separated from variability and we make no claim that there is any separation. This is why we conduct ensemble runs in addition to the individual runs. The ensemble runs paint the same picture, specifically for the southern hemisphere. That one ensemble member, only for the ensemble without solar variability, does not agree with the other two highlights that variability is an important factor but does not make the impact of EPP nil. The compositional impact of EPP is systematic and has a discernible effect on the dynamics. There is no disagreement between ensemble members when solar variability is included which indicates that the solar cycle may be enhancing the EPP response. The referee ignores the solar variability ensemble completely in his comments.

2) Does austral winter jet weakening due to auroral EPP manifest itself on a yearly basis:

Comparing on a yearly basis is not possible due to dynamical variability. Figure 1 in this reply shows differences between the auroral EPP run from the reference run in zonal mean zonal wind and total column ozone for successive seven year periods. The SH polar vortex is disturbed in all periods and in spite of significant variability there is SH ozone depletion compared to the reference run during most of the run period. Periods when the SH ozone loss exhibits significant longitudinal variation (1979-1985 and 2000-2006) have some vortex strengthening at high SH latitudes which reflects deviation from axial symmetry in the polar vortex.

3) The role of source terms in the mean meridional circulation:

The diabatic heating does not drive any persistent circulation in the middle atmosphere, unlike the EP flux divergence (Haynes et al., 1991). On a seasonal timescale the evolution is quasi-steady, especially in the southern hemisphere winter with its stable vortex,



ACPD
10, C13099–C13103, 2011





so any change in the Brewer-Dobson circulation is mechanically driven and not due to a change in the radiative equilibrium state due to ozone changes. We have looked at EP flux divergence differences in association with the zonal wind, temperature and diabatic circulation differences but did not include these figures except the new figure in response to referee comments in section 5 (see highlighted manuscript in the included supplement). The EP flux divergence fields were consistent with the dynamical response being maintained by wave drag changes.

Haynes, P. H., Marks, C. J., McIntyre, M. E., Shepherd, T. G., Shine, K. P., 1991: On the "downward control" of extratropical diabatic circulations by eddy-induced mean zonal forces. J. Atmos. Sci., 48, 651–678.

4) Weak response of SPEs in the NH winter:

The referee's statement is difficult to understand. SPEs do have an impact in the NH but the long term impact is weaker than in the SH due to the higher dynamical variability in the NH induced by inter-hemispheric differences in orography and hence wave forcing. SPEs $NO_x$ is lost through photochemical conversion into $N_2$ much more readily in the NH winter compared to the SH winter. We make this clear in the paper.

5) Number of figures and paper length.

Many referees requested additional analysis which would make the paper even longer. The amount of text reflects the content level we cover in this paper and is not excessive in this regard. Since the number of figures is large we could not present all the EP flux divergence figures, basic state figures and other interesting plots we wanted.

6) Table of runs.



ACPD
10, C13099–C13103, 2011

We have added a table in section 2 summarizing the various runs.

7) Figure layout and abstract.

The figures can be read clearly aside from any subjective aesthetic judgments. We were not aware that there was an order constraint on abstracts. As long as the abstract presents the main results in a readable fashion then that is sufficient.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/10/C13099/2011/acpd-10-C13099-2011-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 24853, 2010.





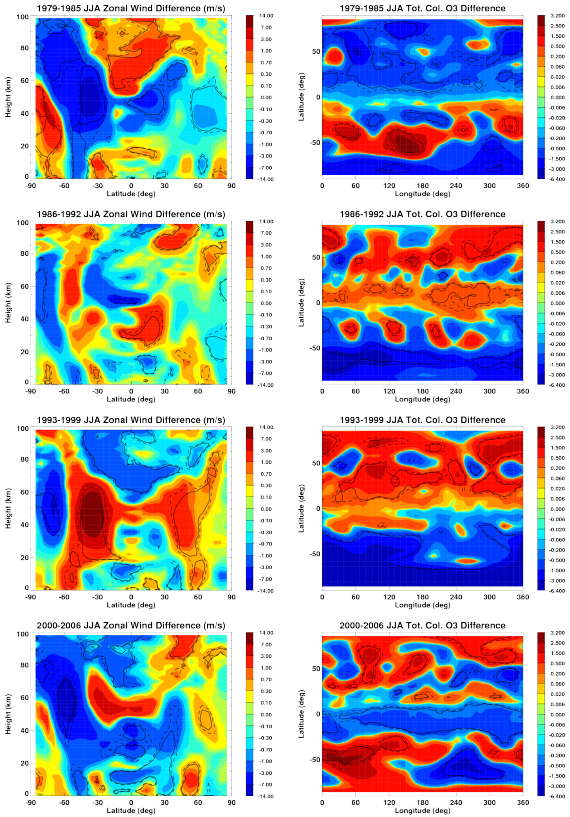


**Fig. 1.** Left: June-August zonal wind difference of auroral EPP run from reference run. Right: June-August total column O$_3$ difference.



ACPD

10, C13099–C13103, 2011

Interactive Comment