

EPP-NO_x in the polar stratosphere: Background variability vs events?

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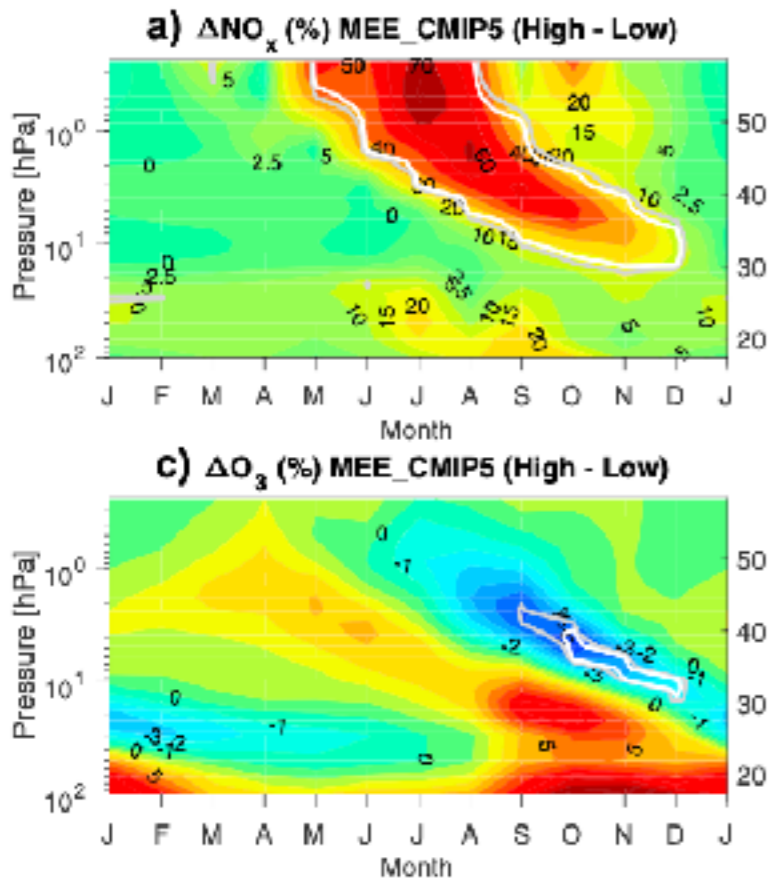
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EPP-NO_x contribution to stratospheric NO_x variability?

- Models: EPP-NO_x transported to stratosphere.
- Probably underestimating the amounts?
- Complex ozone response.



Andersson et al. (2018)
WACCM

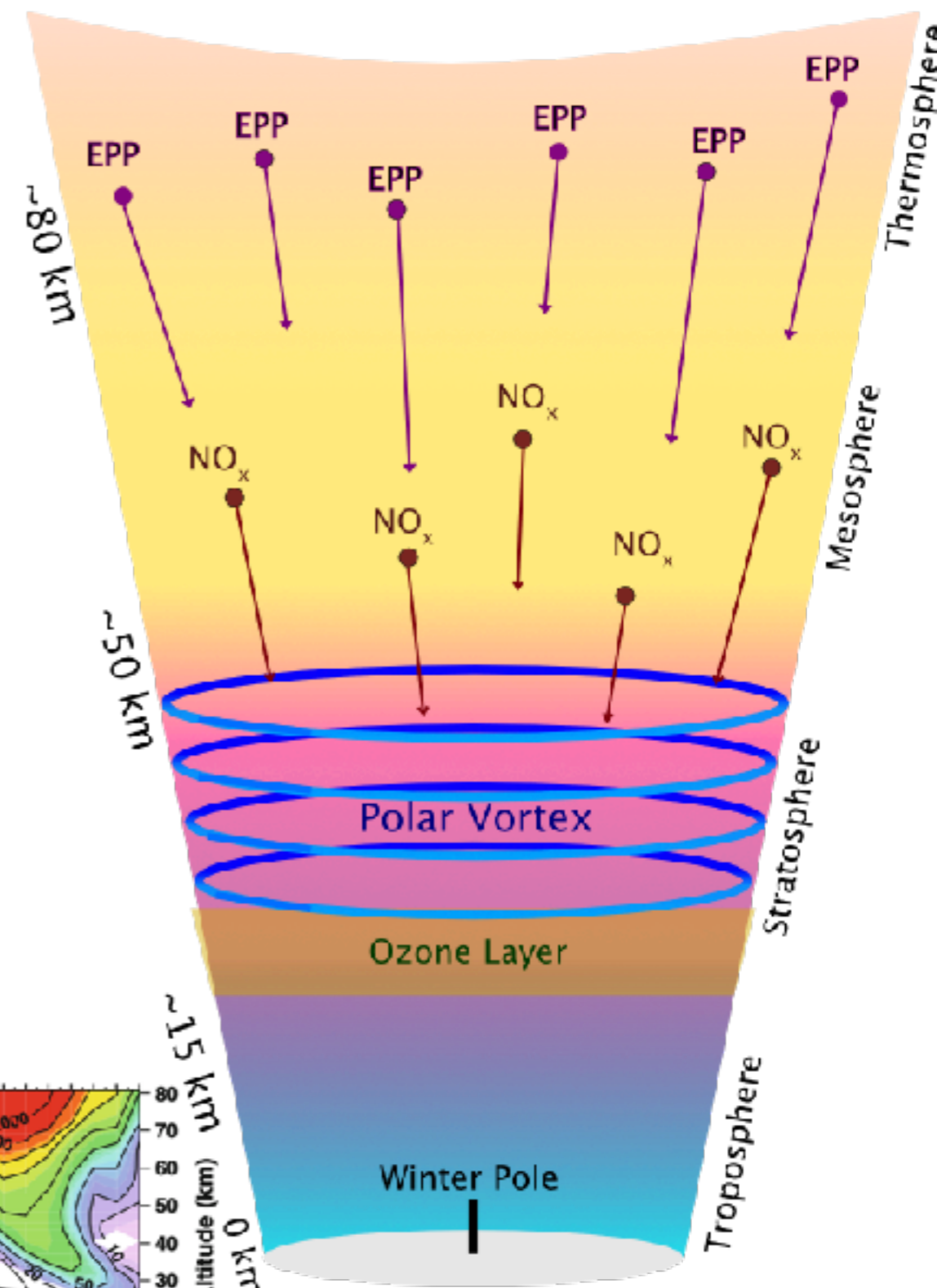
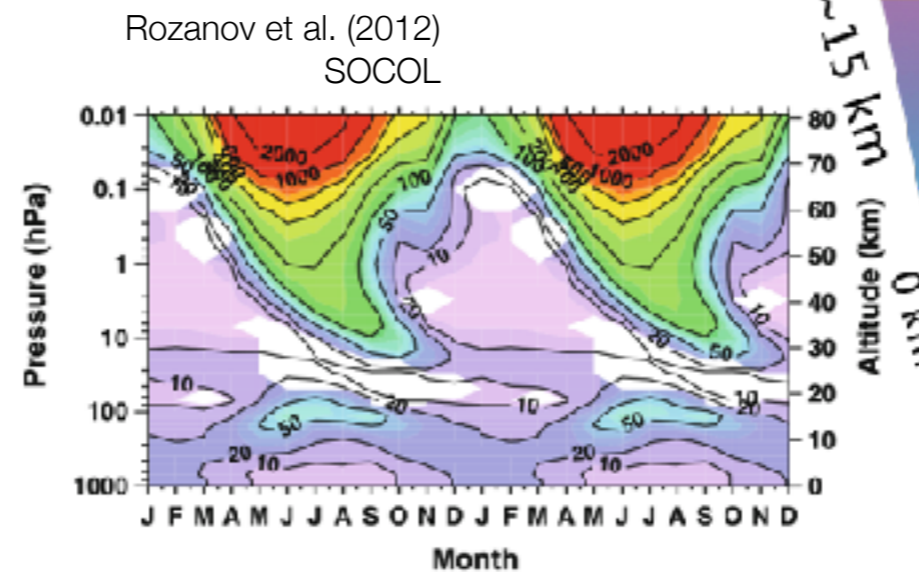


Fig. 3 Monthly mean response of zonal mean NO_x (%) to GCR, SPE, and EEP averaged over 60°–90°S. Results are averaged from 1960 to 2005. *Solid contours* indicate positive changes. The *contours* are plotted for: 10, 20, 50, 100, 200, 400, 600, 1,000, and 2,000 %. *Color pattern* indicates the regions where the changes are judged statistically significant at or better than 10 % level. Twelve months of the monthly run climatology are repeated

Previous observations

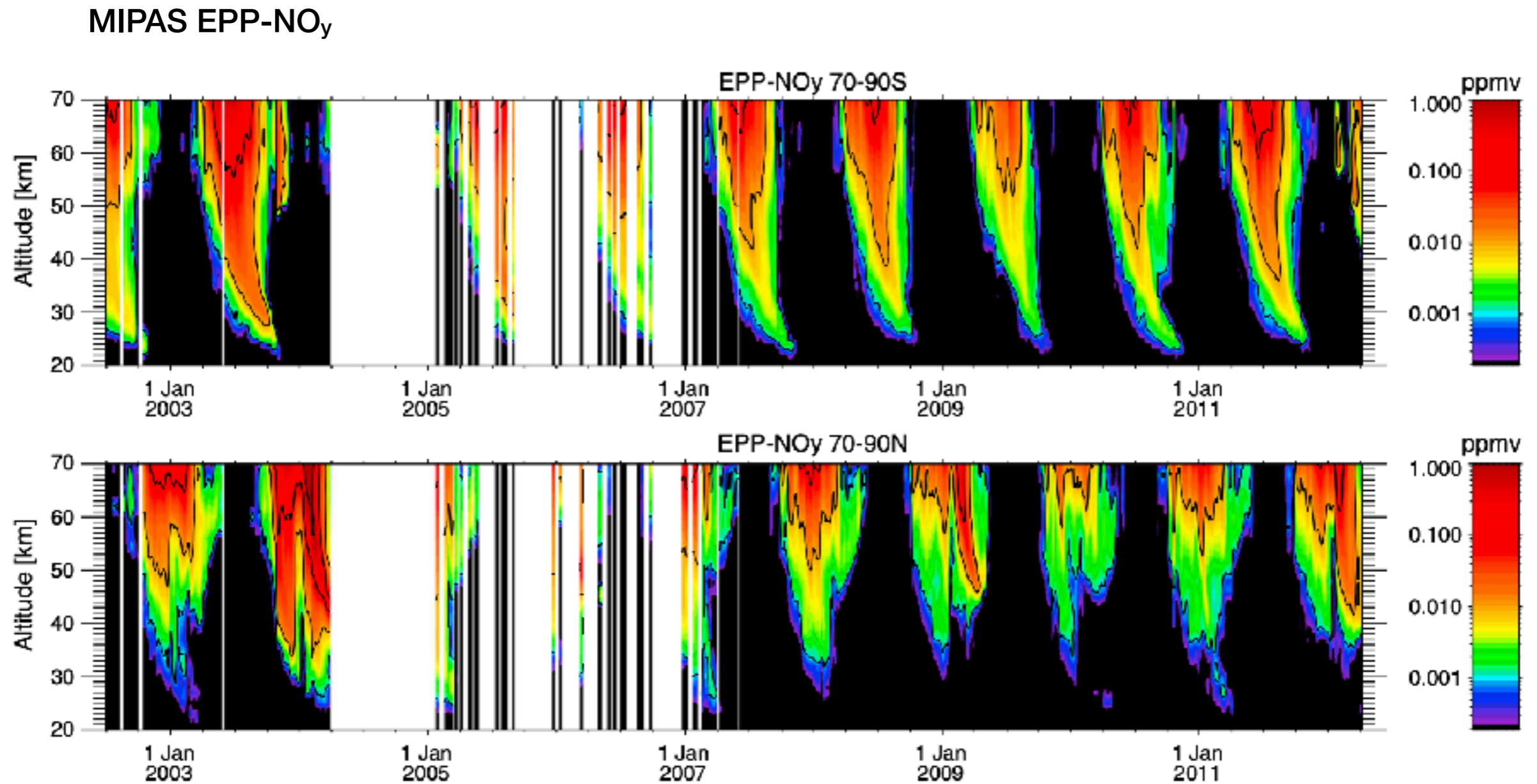
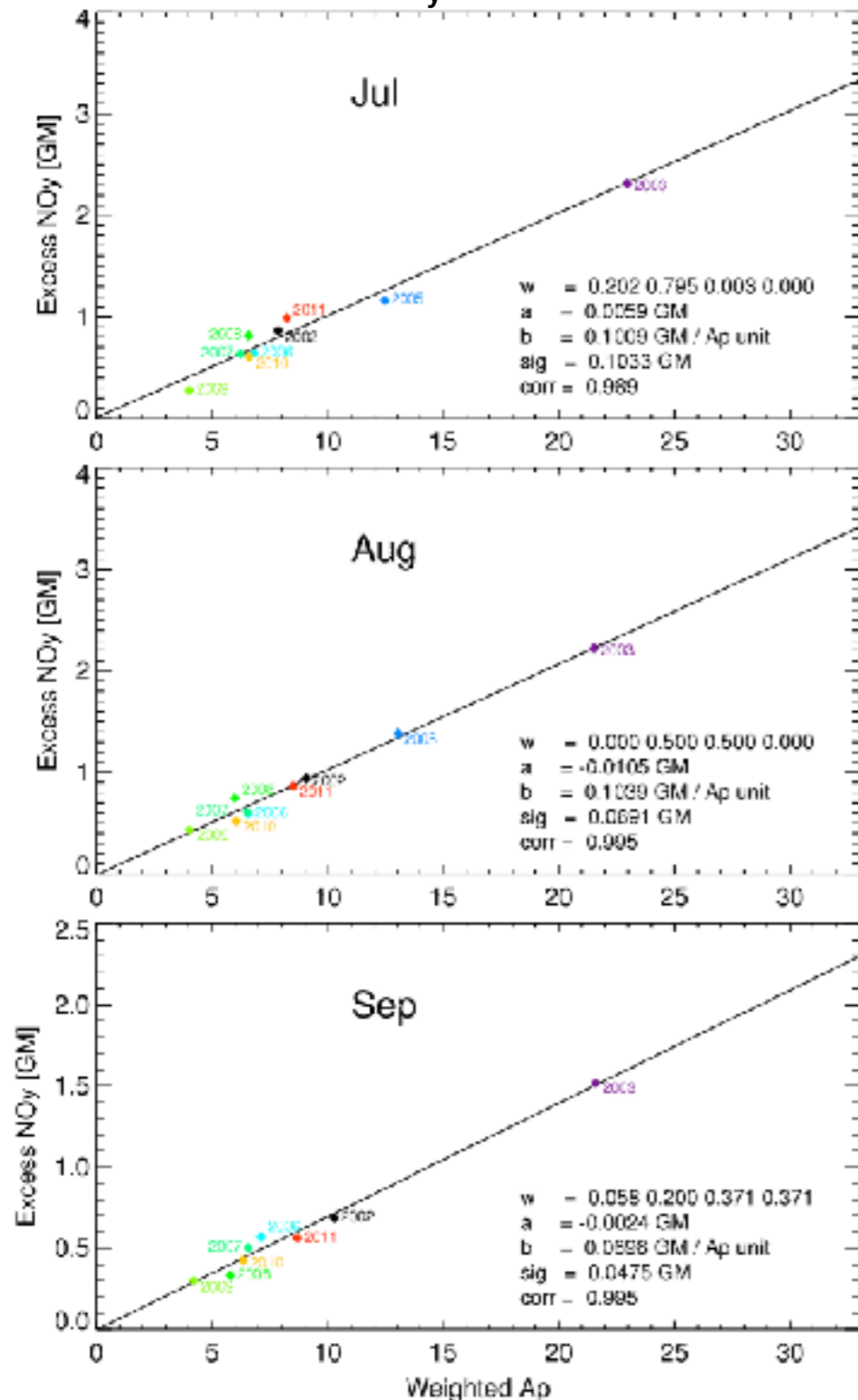


Figure 10. Temporal evolution of the EPP-NO_y VMR at (top) 70–90°S and (bottom) 70–90°N during the Envisat mission lifetime (July 2002 to March 2012).

NO_y descent routinely down to 20-25km in SH
Tracer methods limited past Sept/Oct in SH spring.

More observations...

MIPAS EPP-NO_y in SH below 70 km



Funke et al. (2014)

HALOE stratospheric (45 km) EPP-NO_x

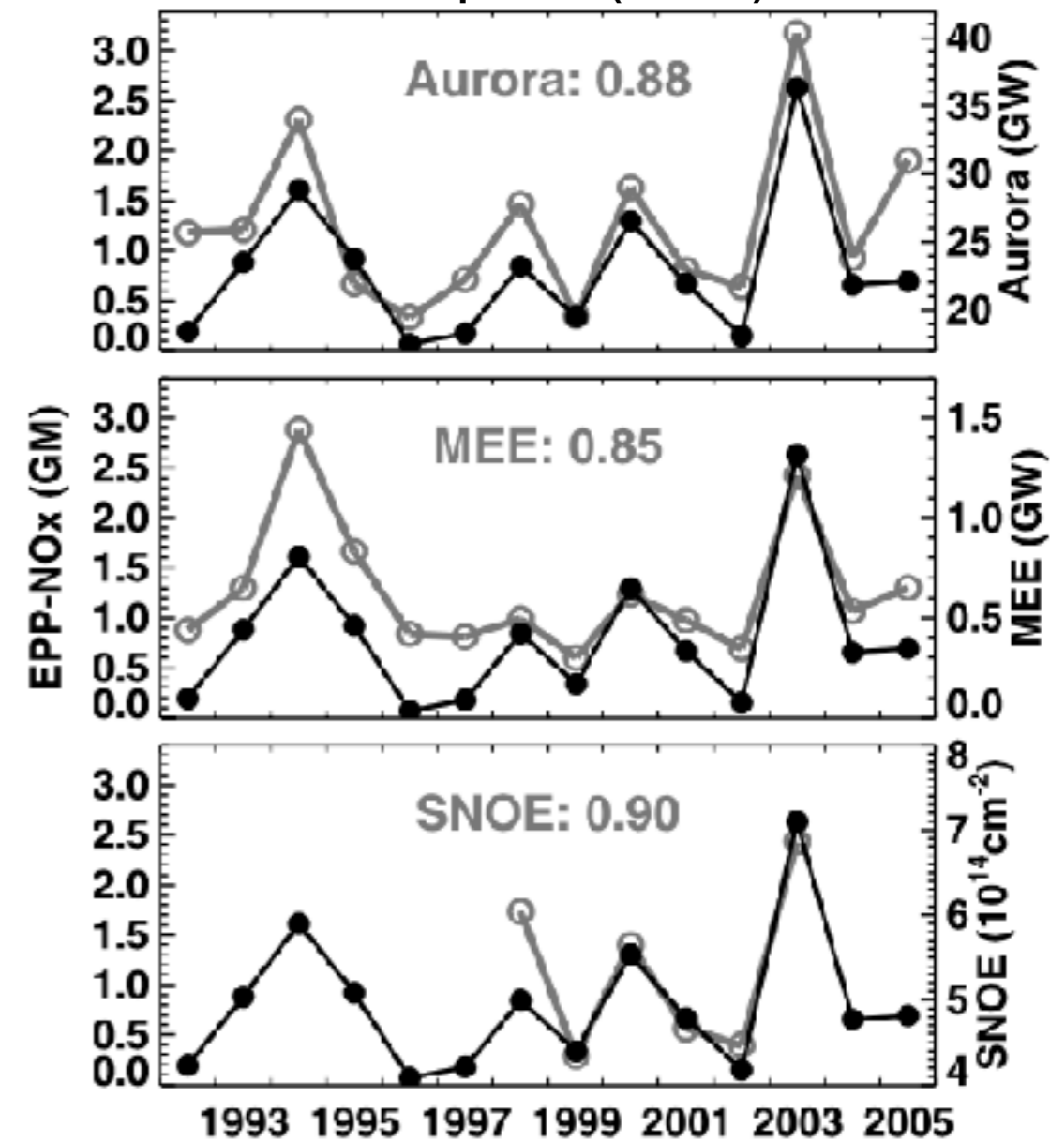
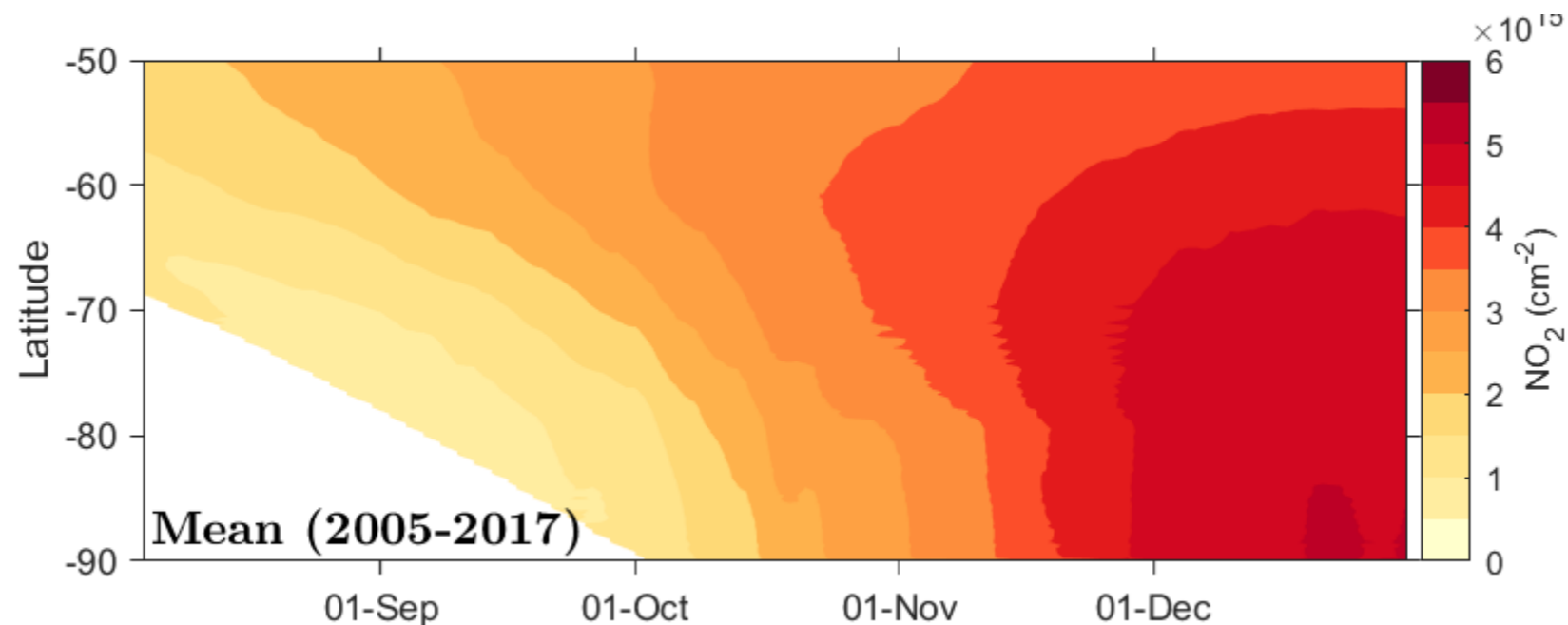


Figure 10. EPP-NO_x calculated from the maximum NO_x residuals as in Figure 9 (dots, solid line, left axis) compared to auroral hemispheric power (top), medium energy electron hemispheric power (middle), and SNOE column NO from 97 to 150 km averaged over the sunlit region poleward of 60°S (bottom). Energetic particle and SNOE data (gray) are averaged over the months of May-July and are referenced to the right vertical axes. Correlation coefficients are given in each panel.

Randall et al. (2007)

Can we use satellite observations to look at the springtime contribution?

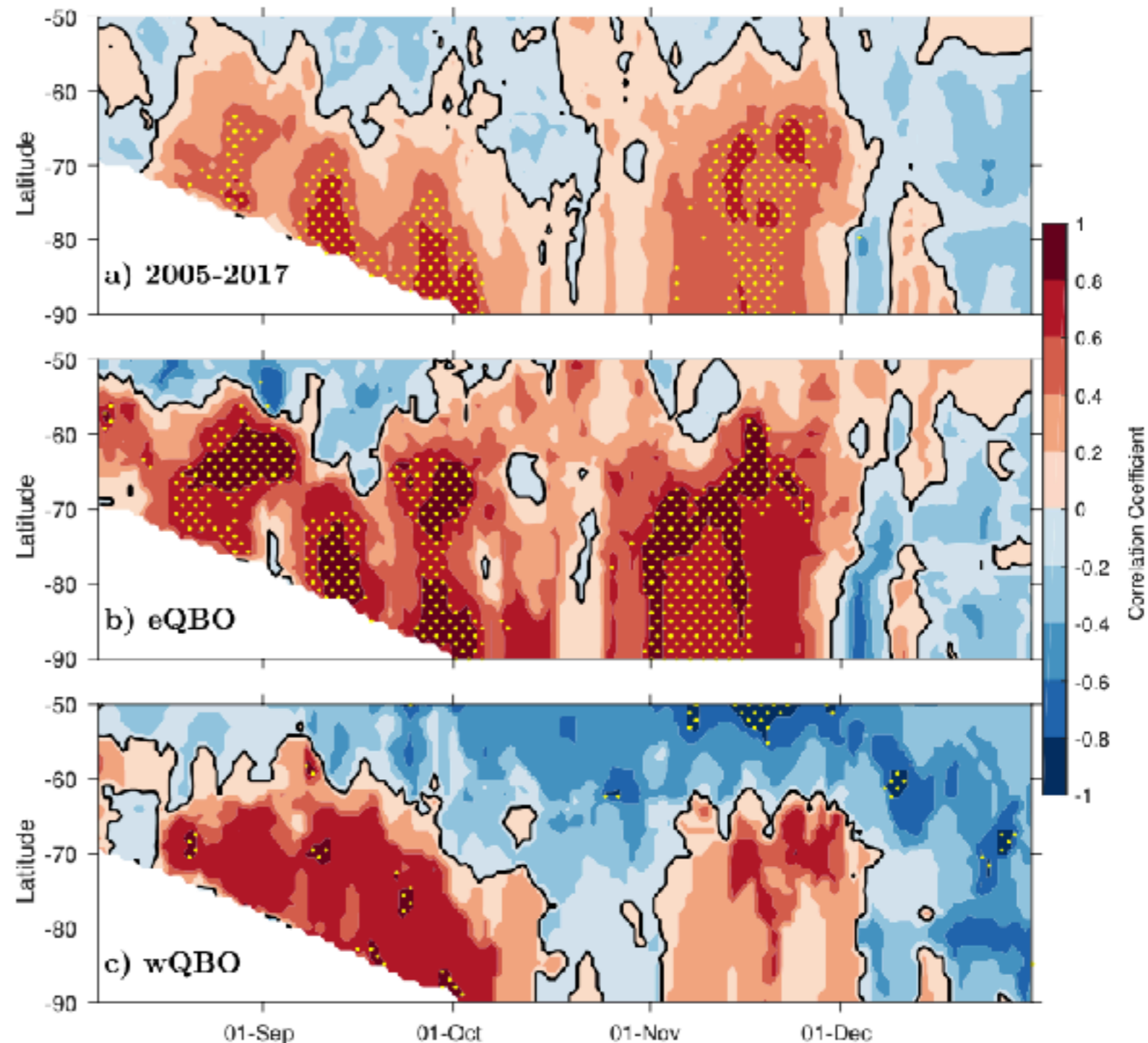
- Enter the *Ozone Monitoring Instrument* (OMI) on the Aura-satellite. Solar backscatter UV-Vis - no nighttime obs.
- Antarctic stratospheric NO₂ column, 2005-2017 (200,000 observations poleward of 60S in total). 0.25° × 0.25° horizontal resolution.



Gordon, E., Seppälä, A., and Tamminen, J.: EPP-NO_x in Antarctic springtime stratospheric column: Evidence from observations and influence of the QBO, *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2019-1035>, in review, 2019.

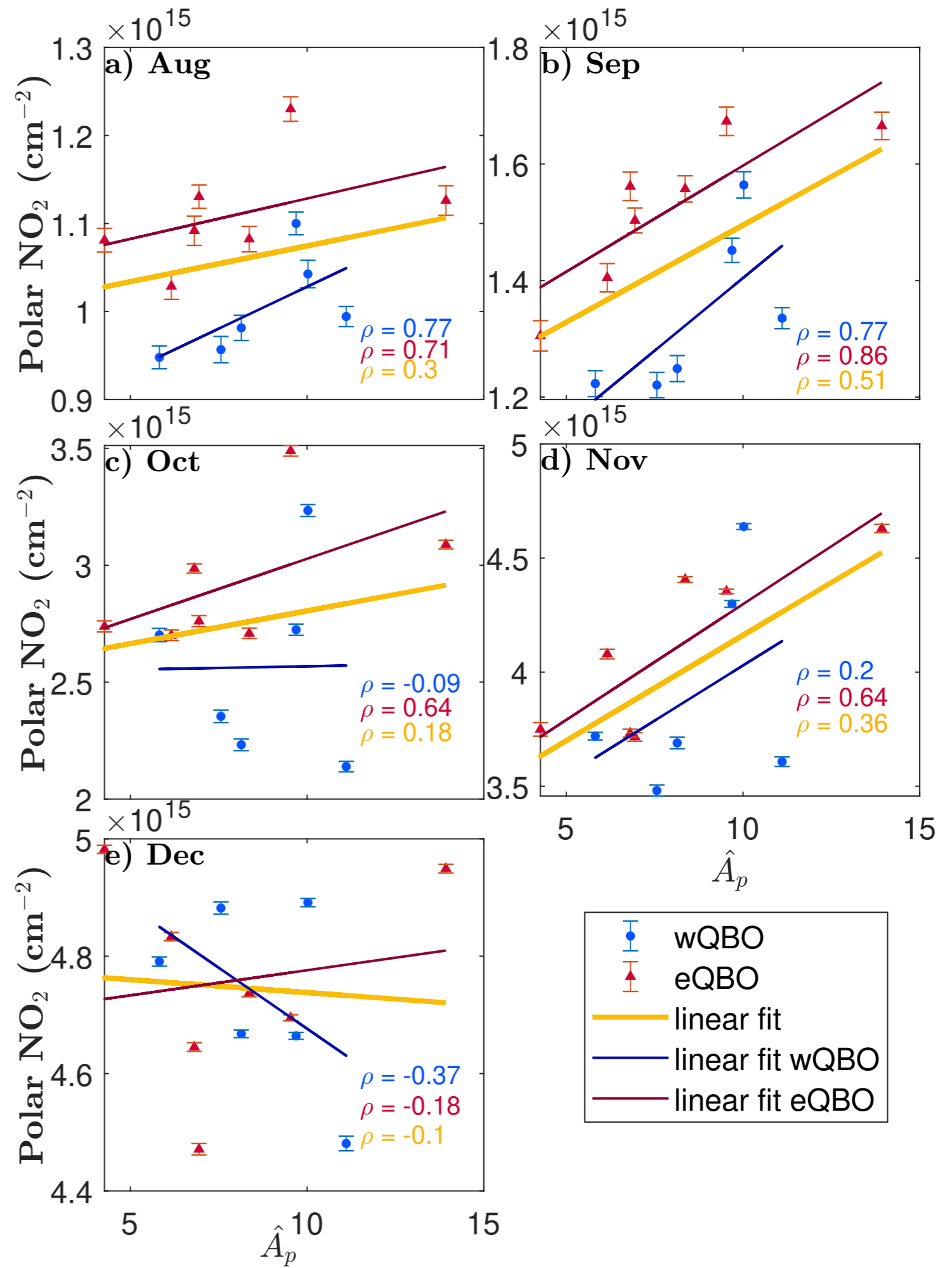
Correlate NO₂ column with EPP

- Use 4-month average (MJJA) wintertime A_p index as EPP proxy.
- Correlate with OMI NO₂ column.
- Spearman rank correlation, $\geq 95\%$ statistical significance shown with stippling.
- Note: we take the Quasi Biennial Oscillation (QBO) into account. Influences dynamics and the main (non-EPP) source of NO_x.



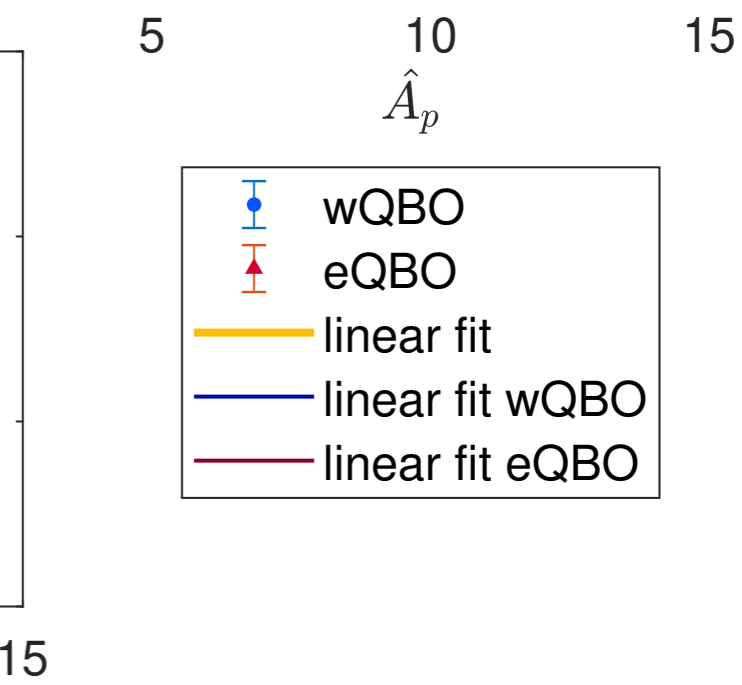
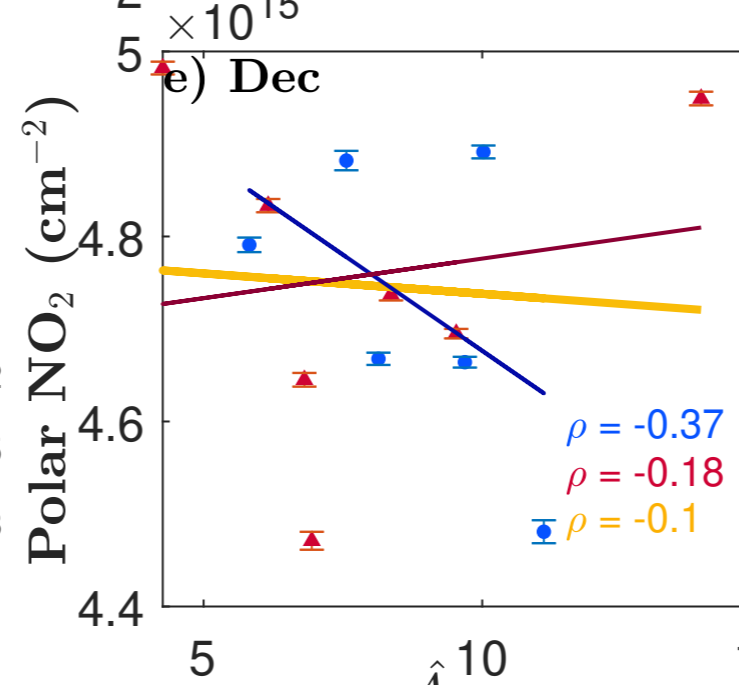
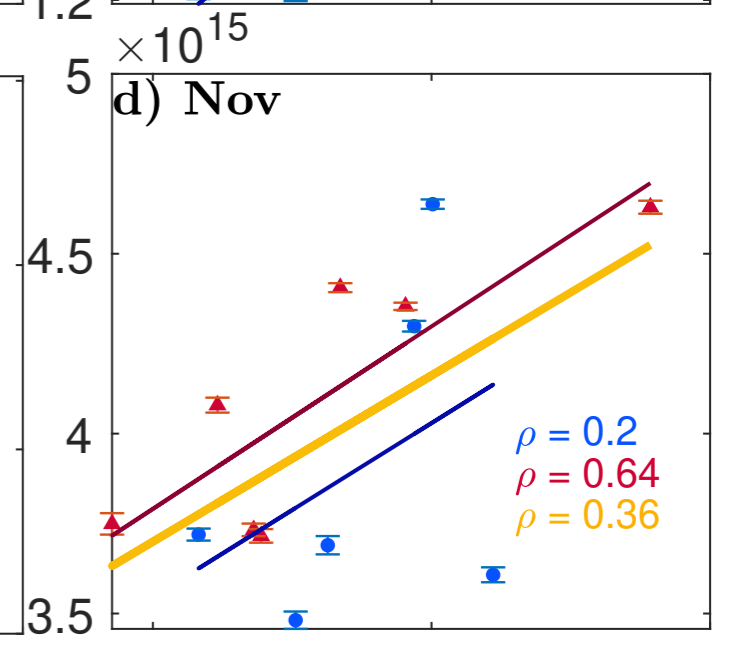
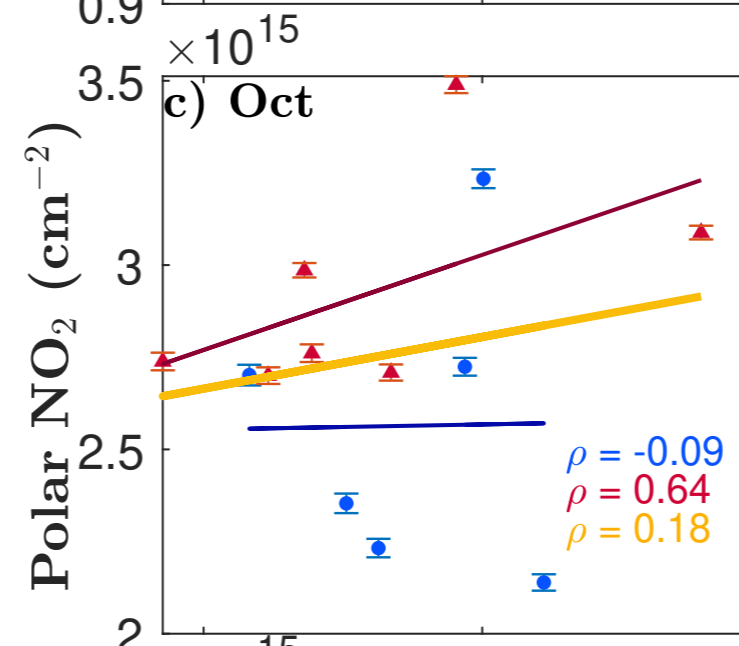
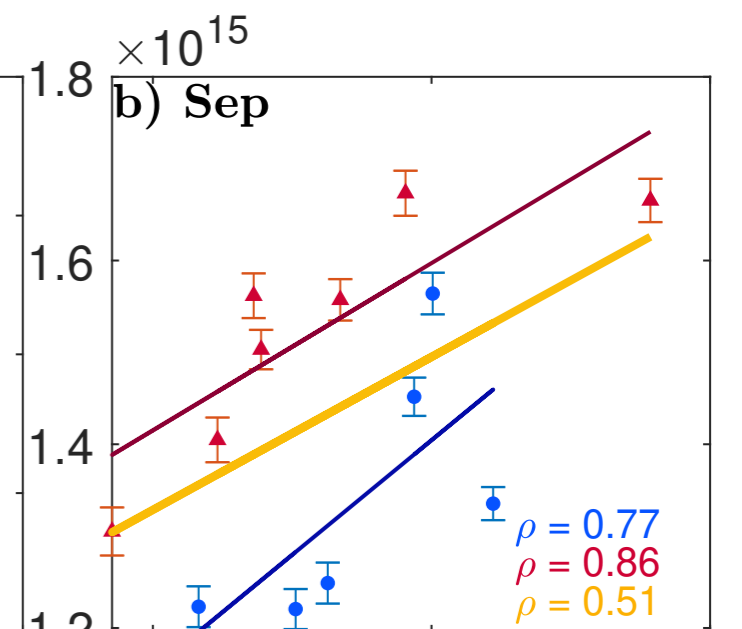
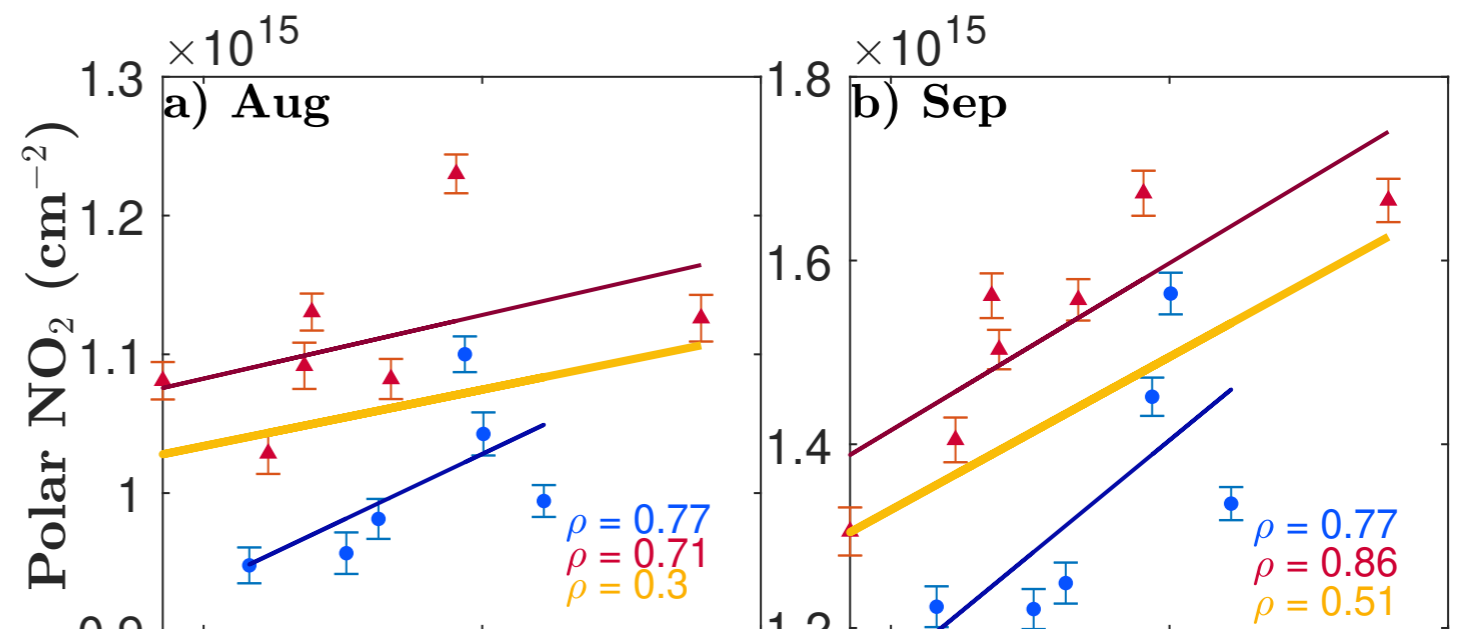
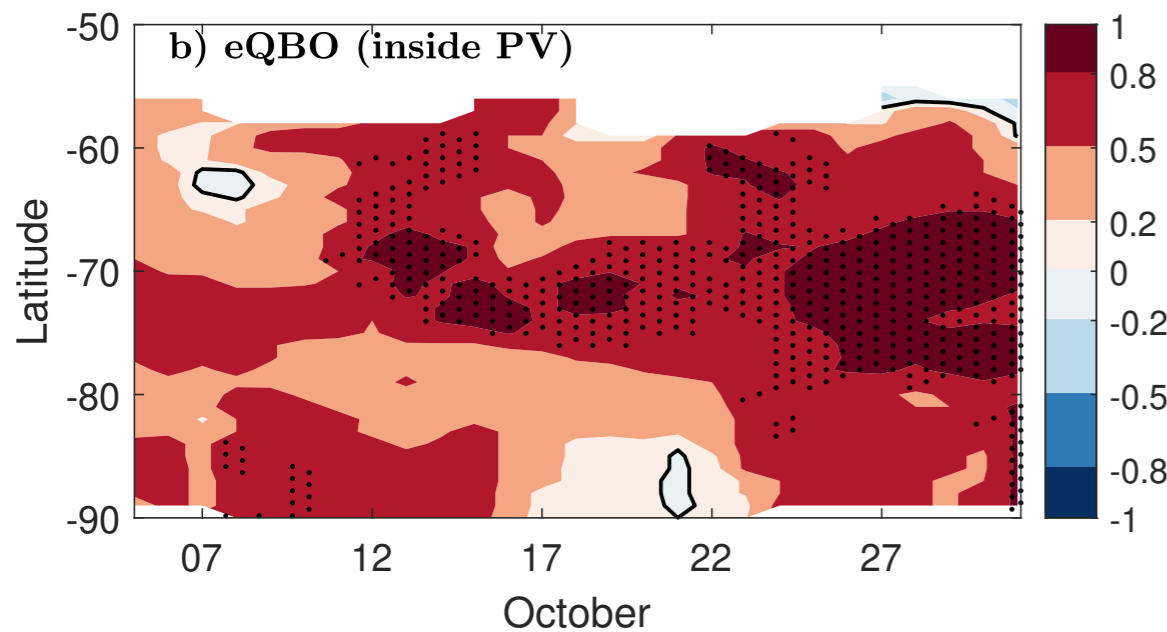
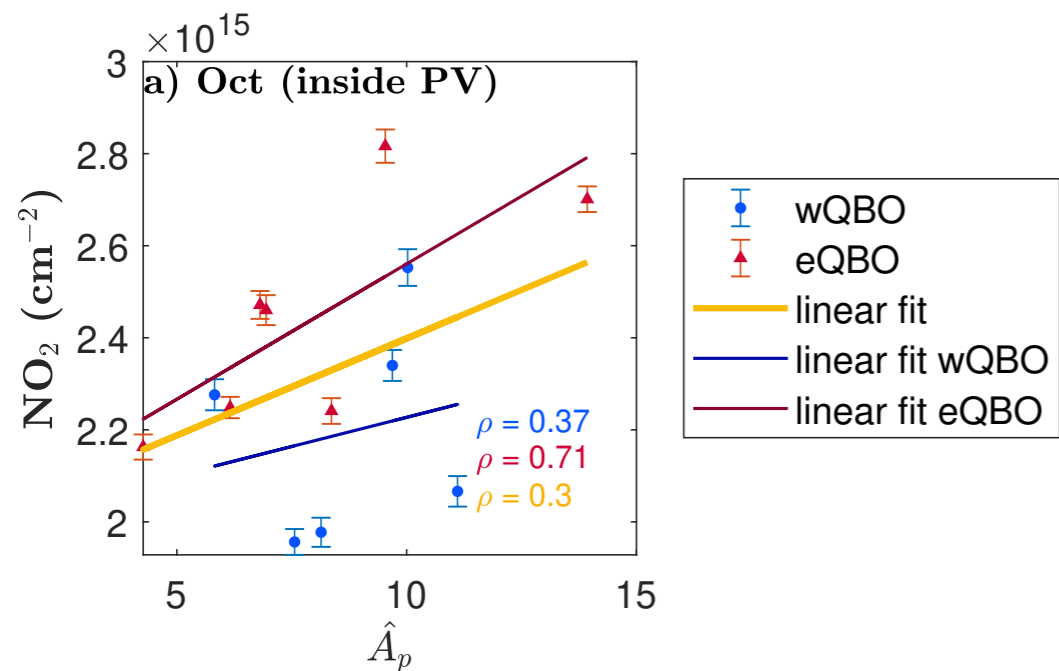
Contribution to polar NO_x

- Average all NO_2 over polar region: 60S-90S
- Taking QBO into account shows the difference in the background level with eQBO resulting in highest correlations.
- October?



Contribution to polar NO_x

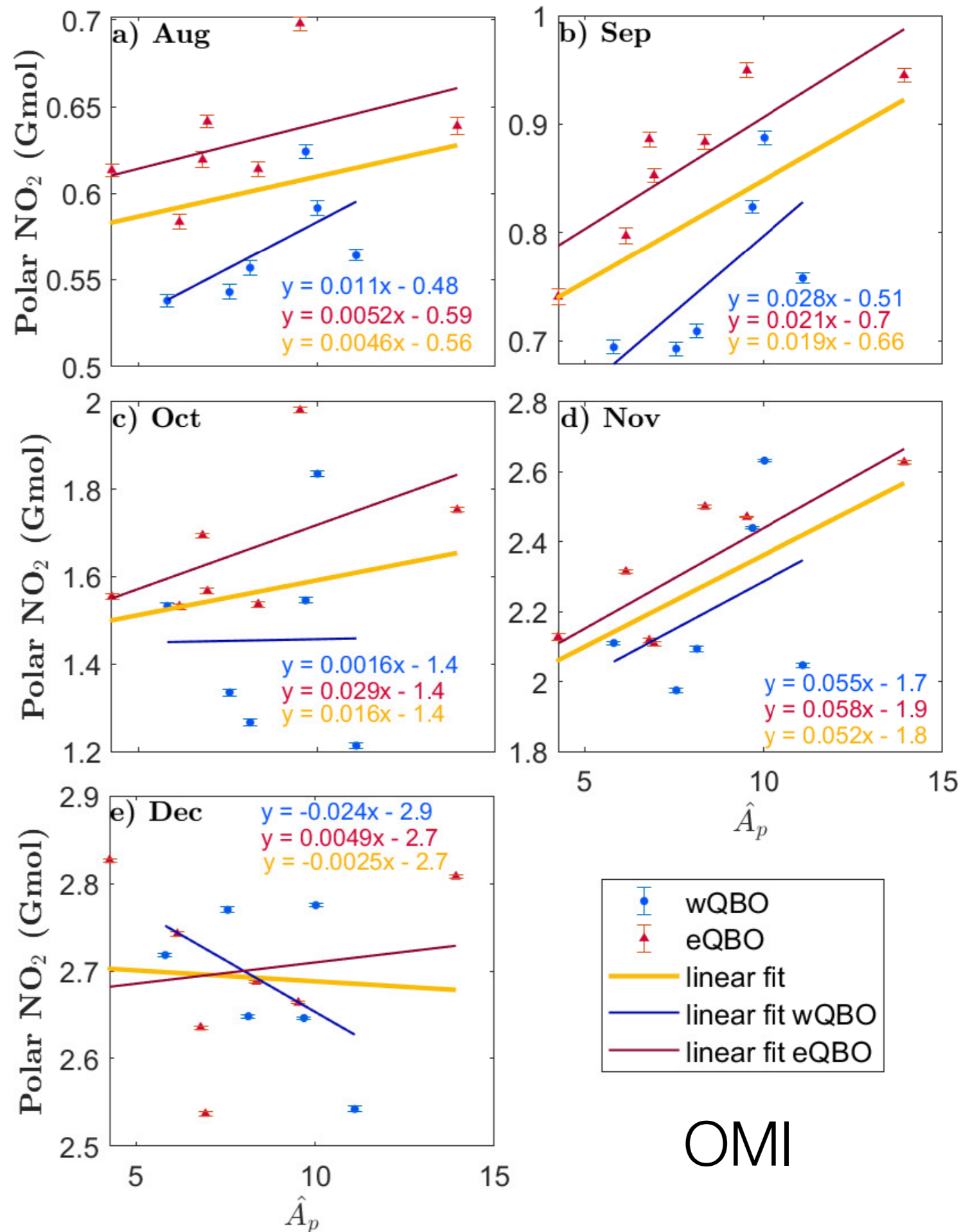
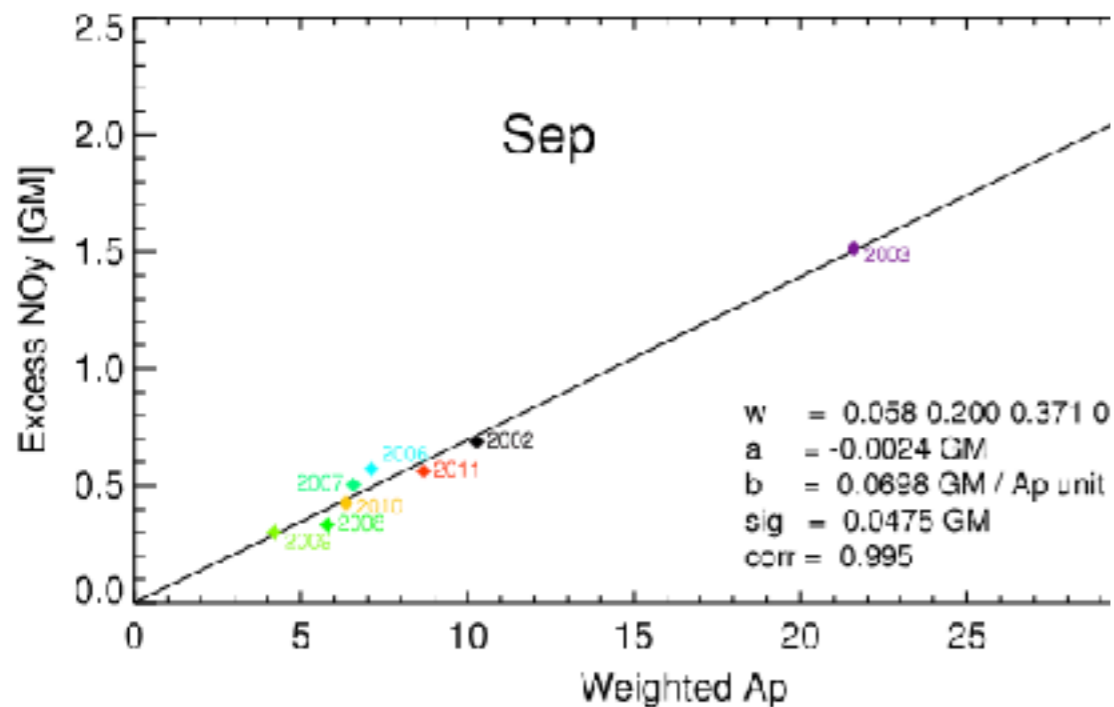
- October? Take inside vortex observations only:



Contribution to polar NO_x

- MIPAS: 0.0698 **Gmol** of EPP-NO_y/A_p unit in the SH in September.
- Does that still hang around later?
 - OMI: Nov: 0.058 Gmol NO₂/A_p unit

MIPAS



OMI