

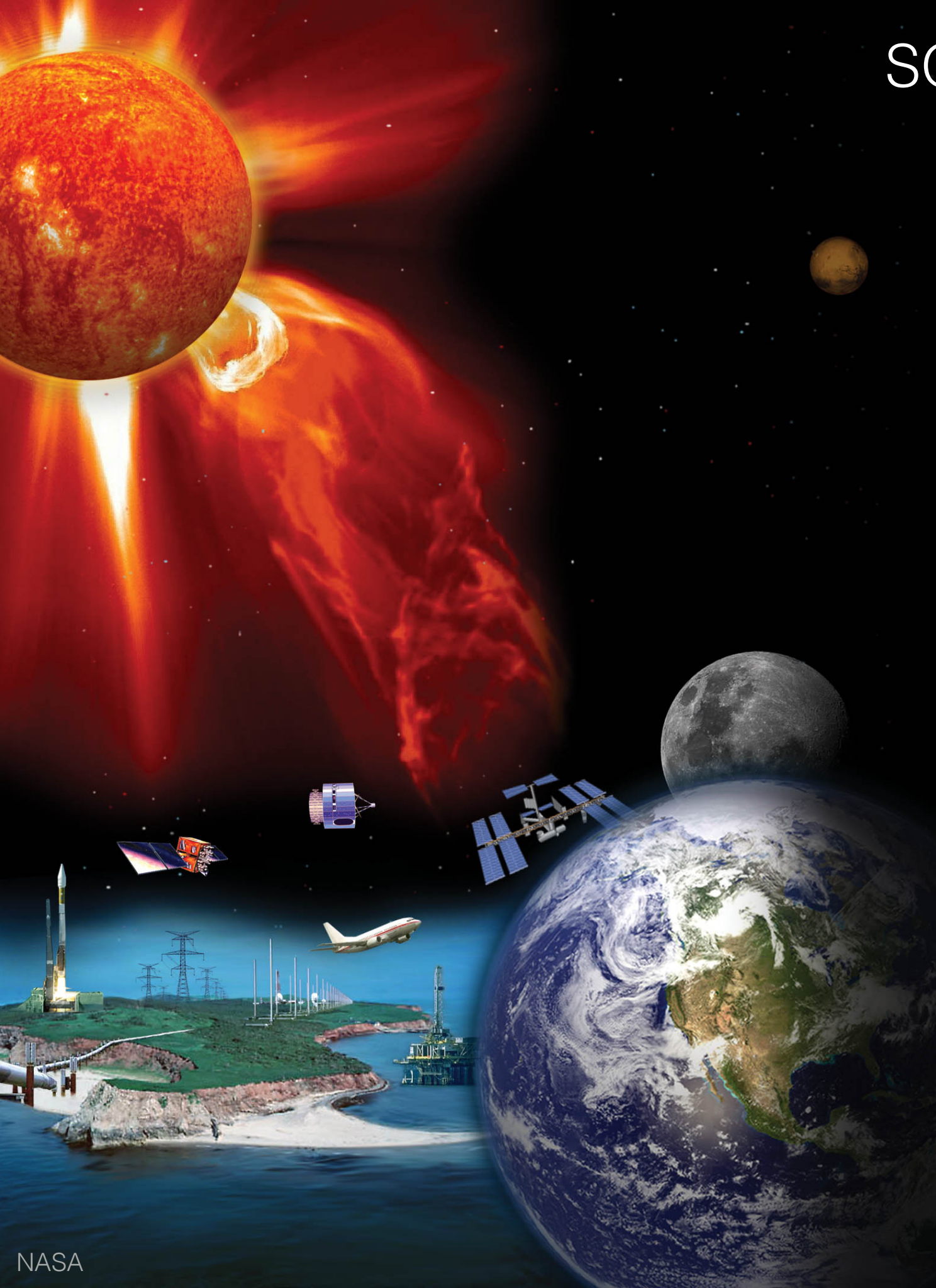


Observed effects of solar proton events and sudden stratospheric warmings on odd nitrogen and ozone in the polar middle atmosphere

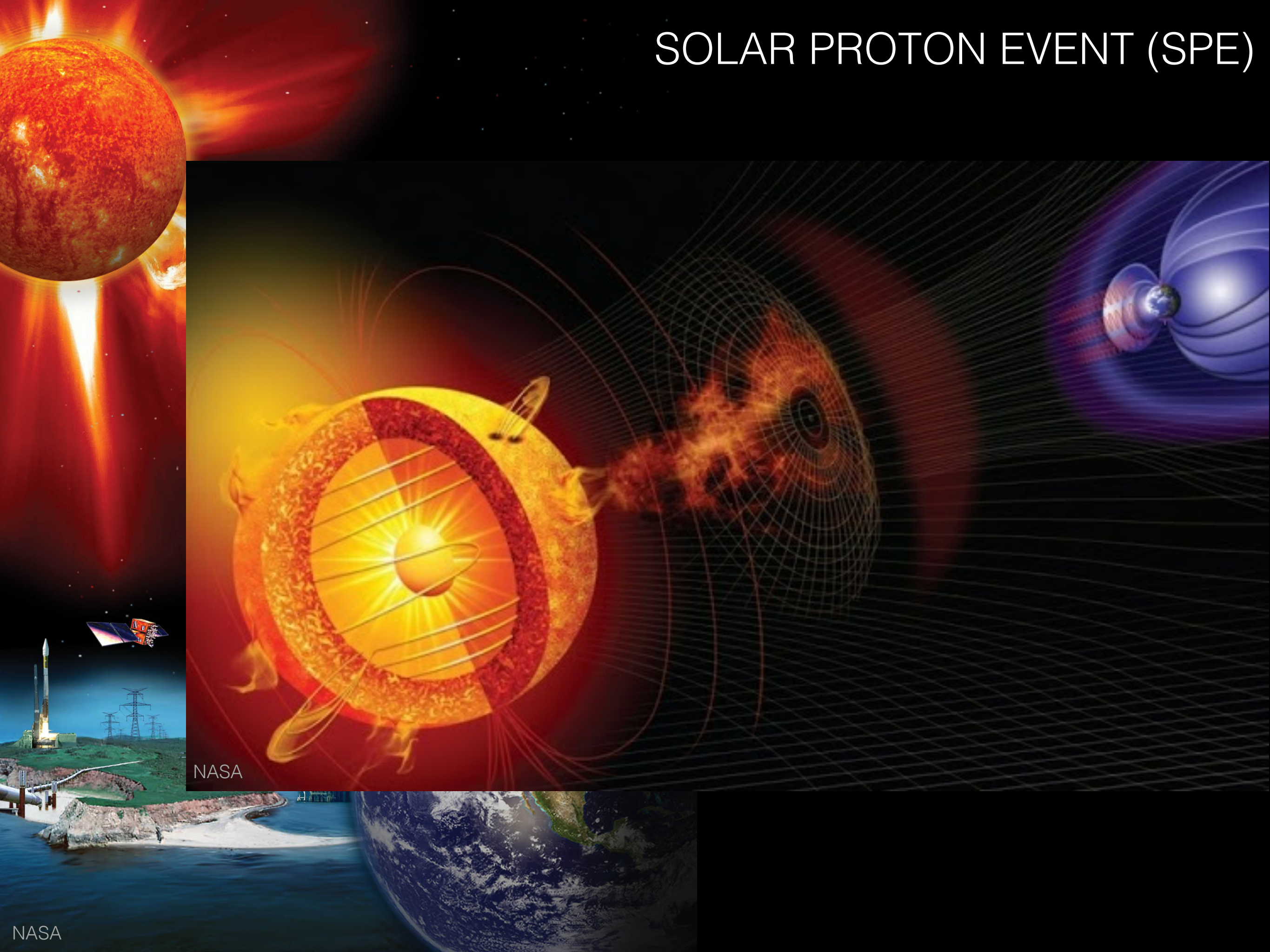
Sanna-Mari Päivärinta
Earth Observation
Finnish Meteorological Institute



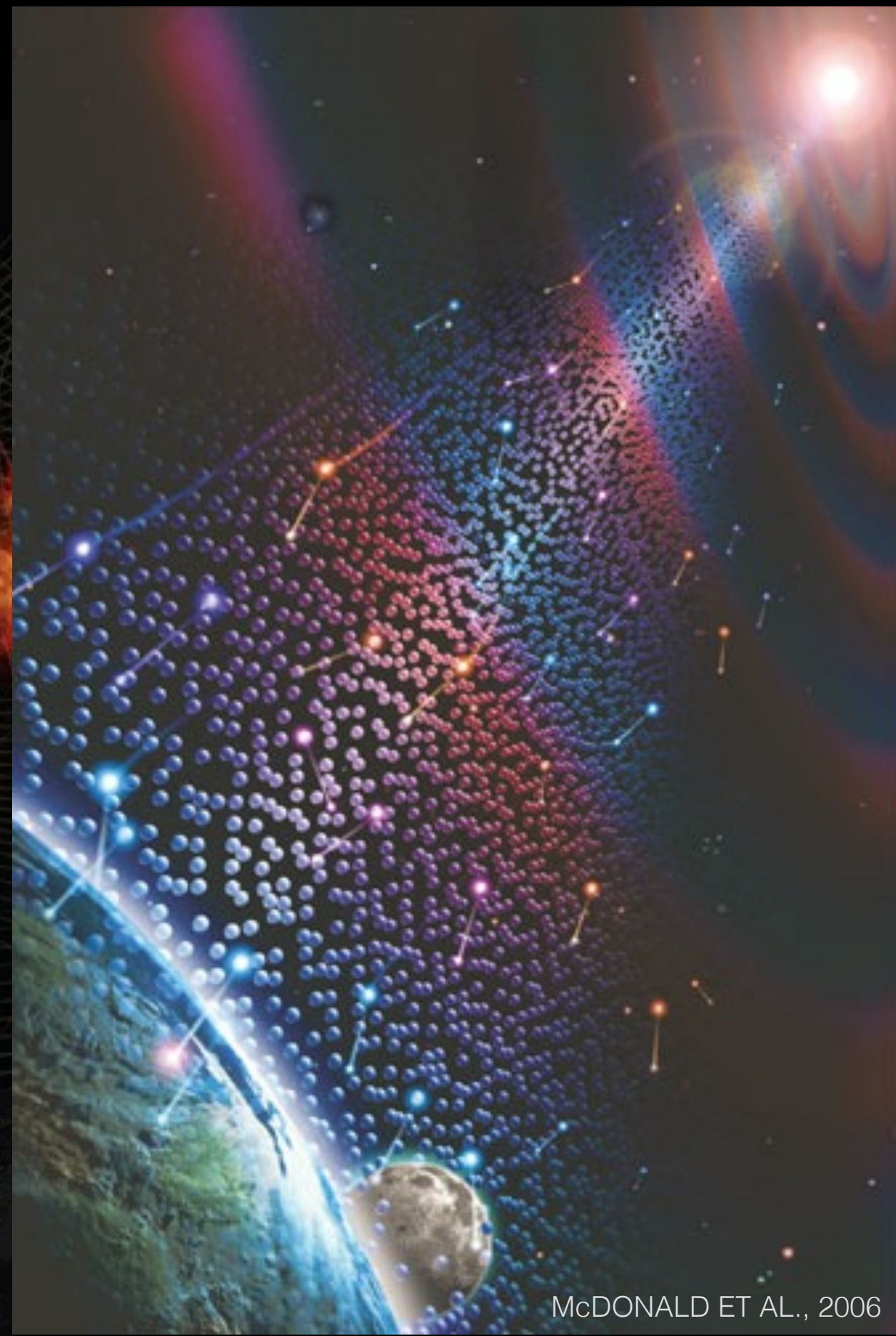
SOLAR PROTON EVENT (SPE)



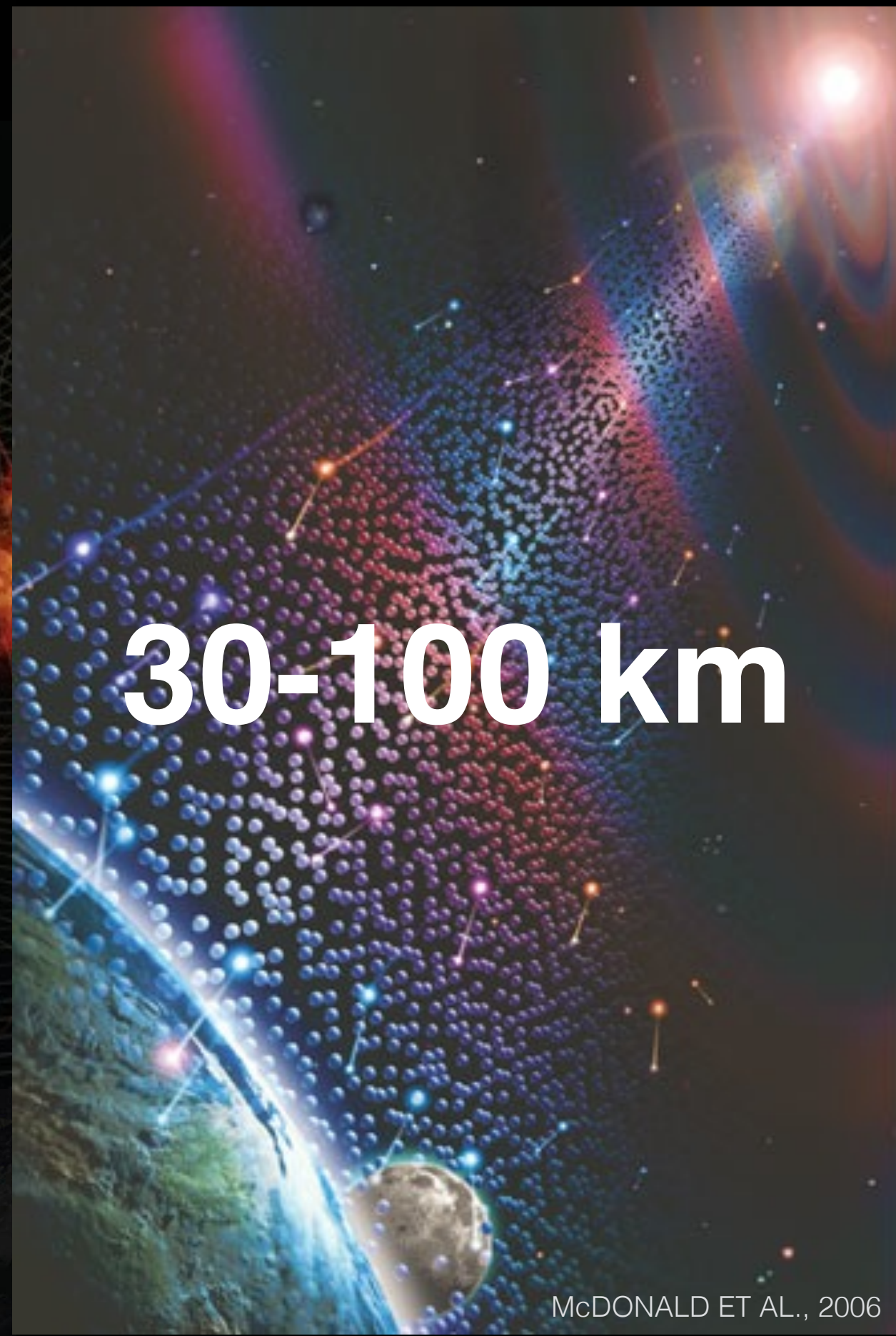
SOLAR PROTON EVENT (SPE)



SOLAR PROTON EVENT (SPE)



SOLAR PROTON EVENT (SPE)



30-100 km

SOLAR PROTON EVENT (SPE)

Energetic particle precipitation



Ionisation (30-100 km)



Production of NO_x and HO_x



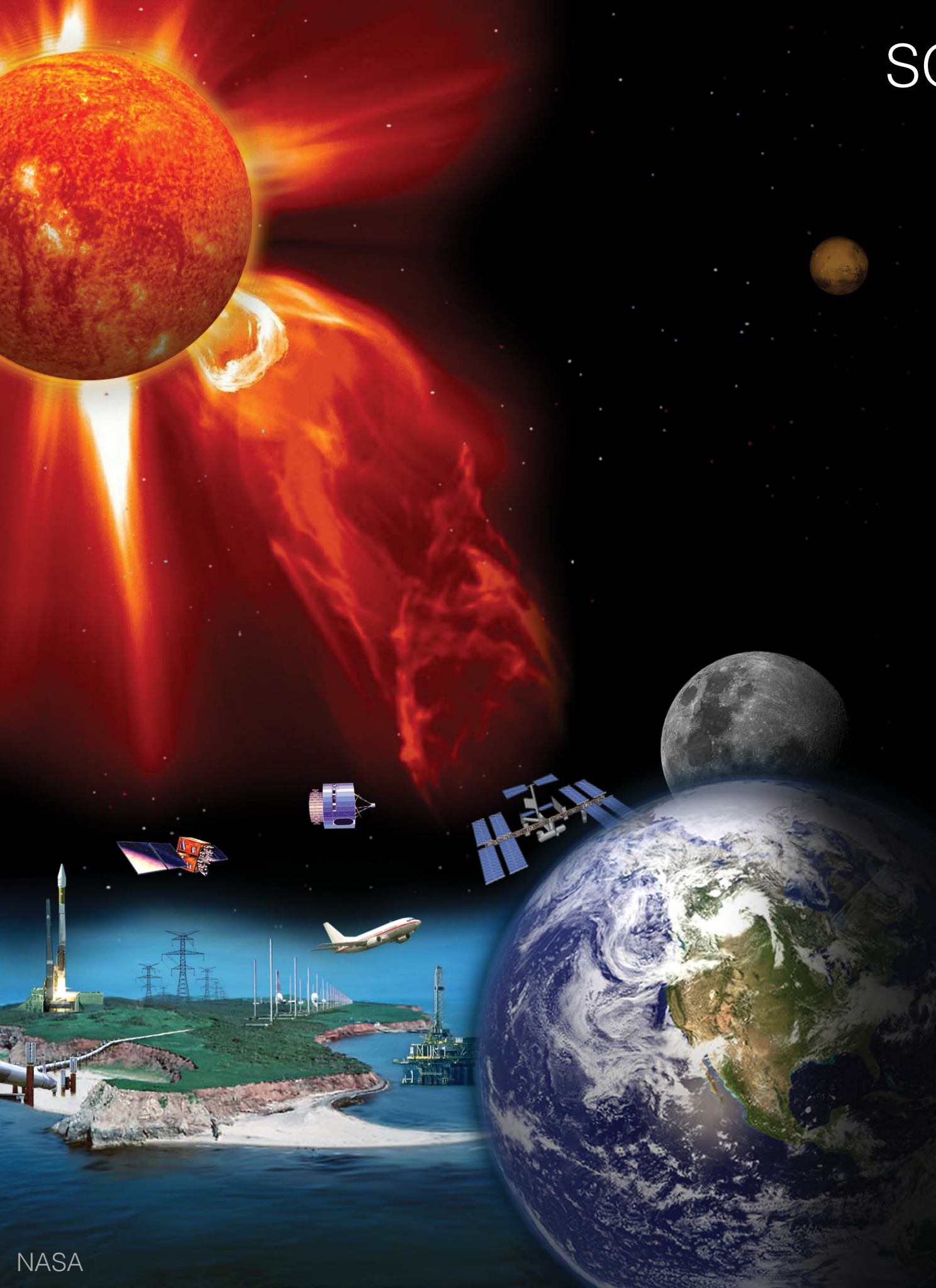
Catalytic ozone destruction



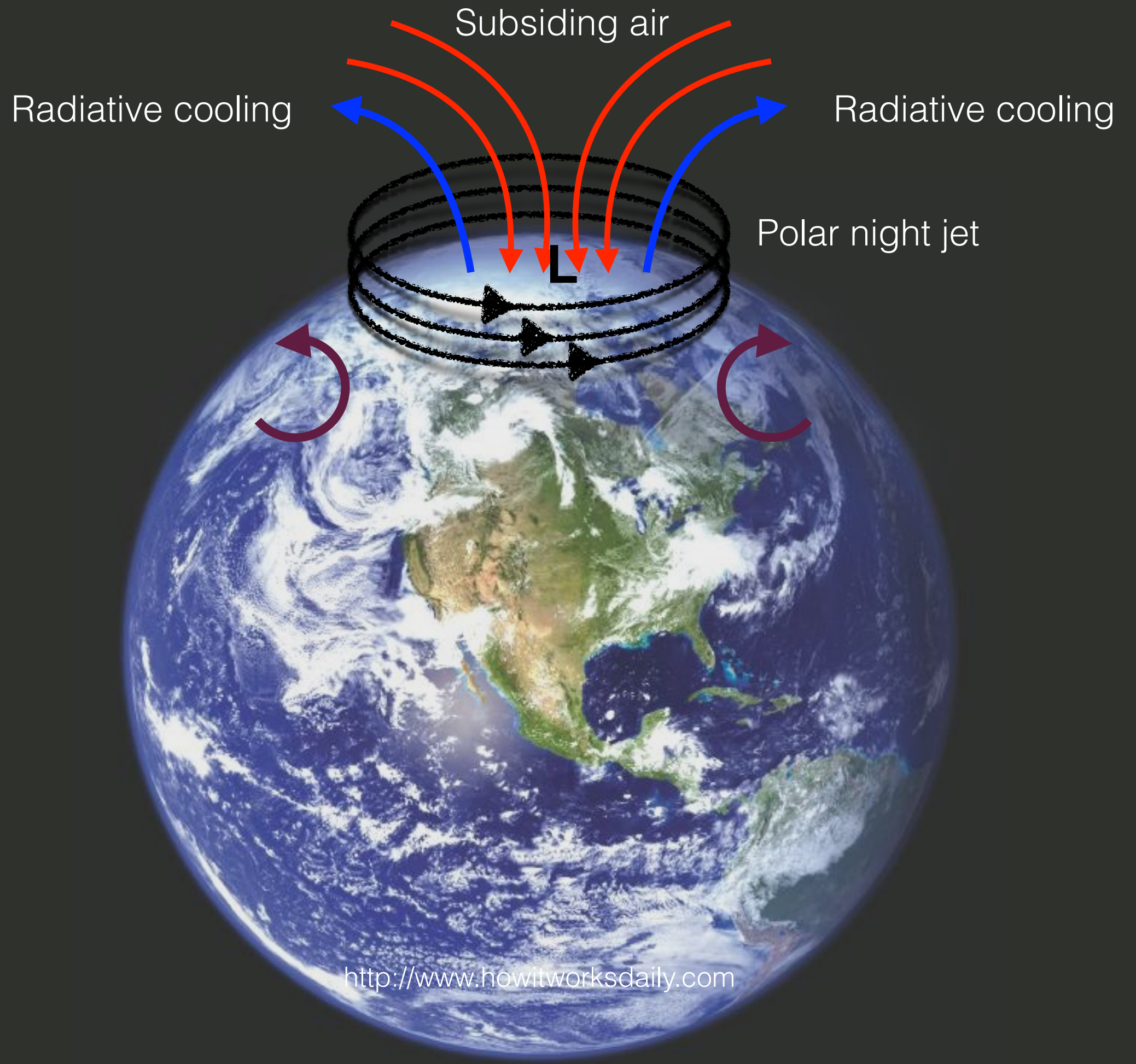
Temperature and dynamics



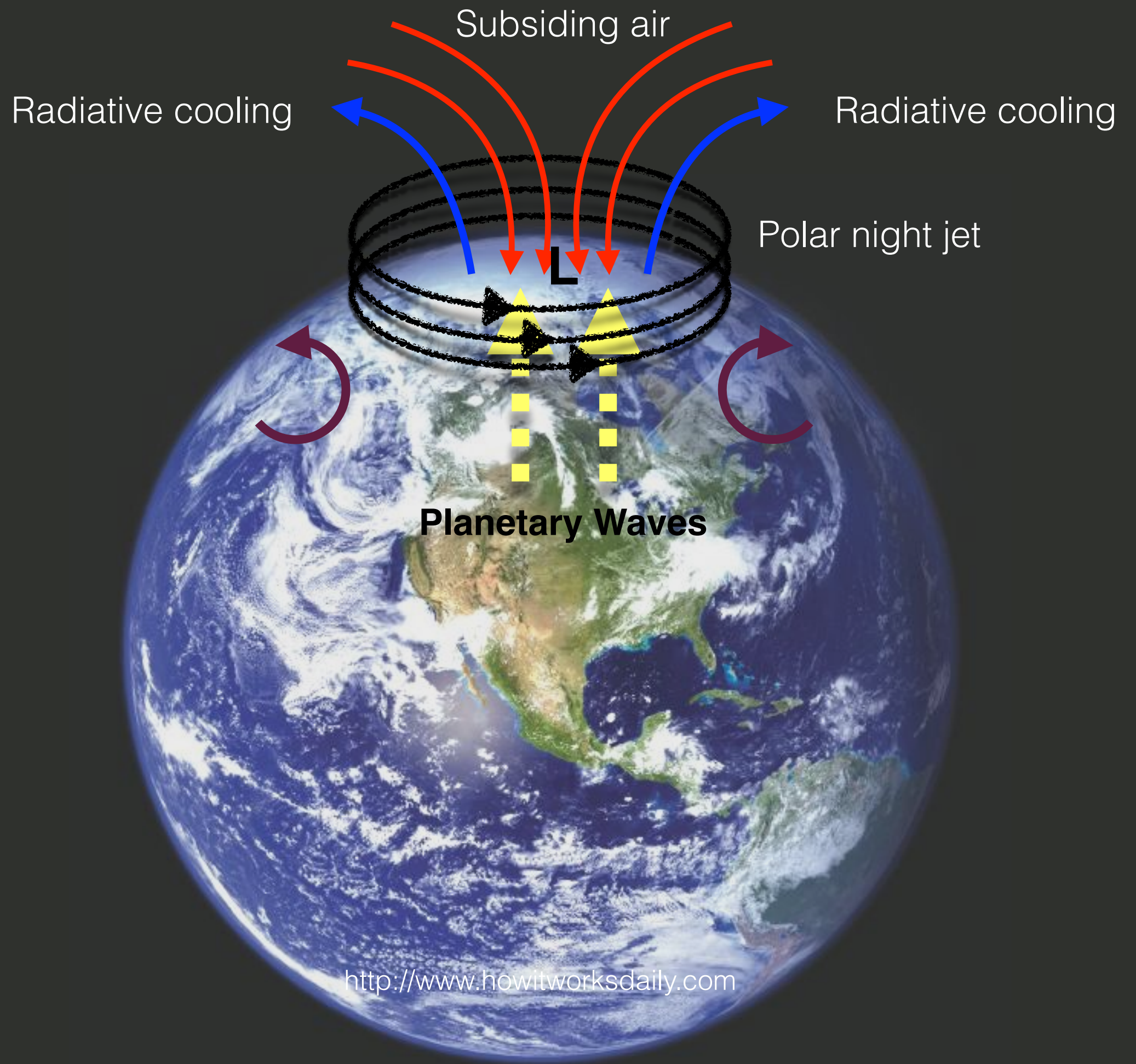
Effects on climate?



POLAR VORTEX

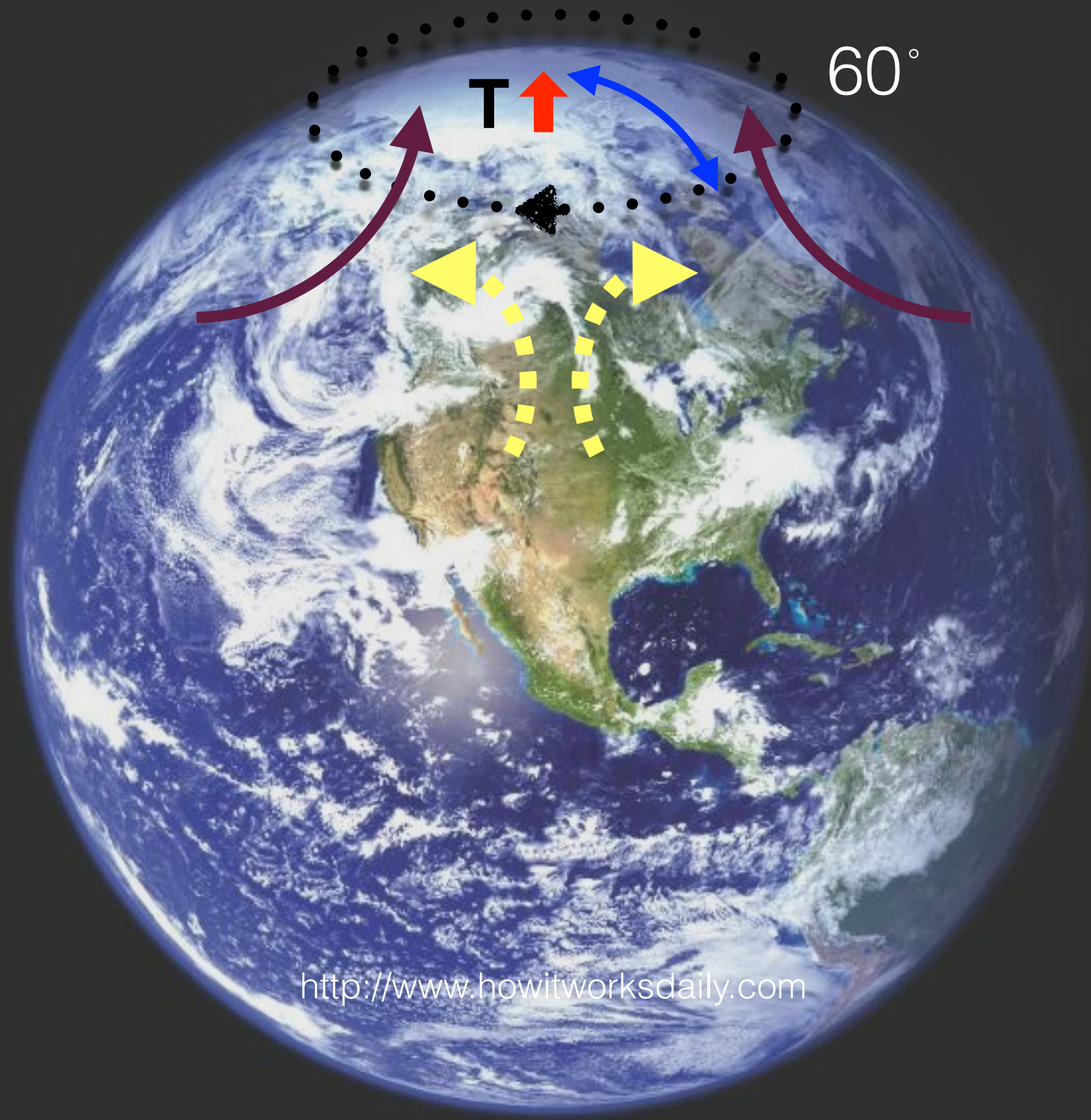


POLAR VORTEX



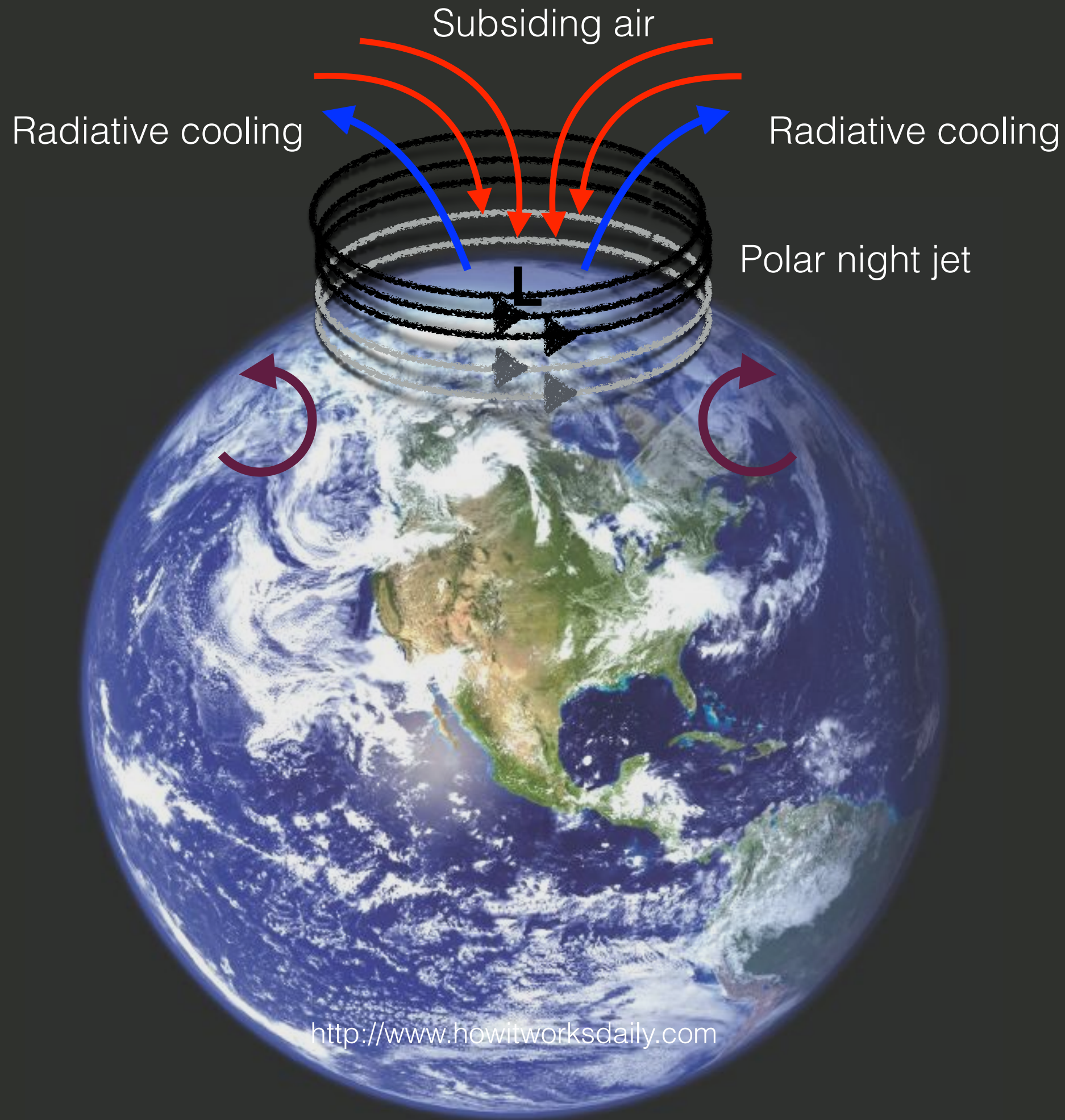
SUDDEN STRATOSPHERIC WARMING (major)

Reversal of zonal mean wind at 60° latitude and 10 hPa (~30 km) altitude



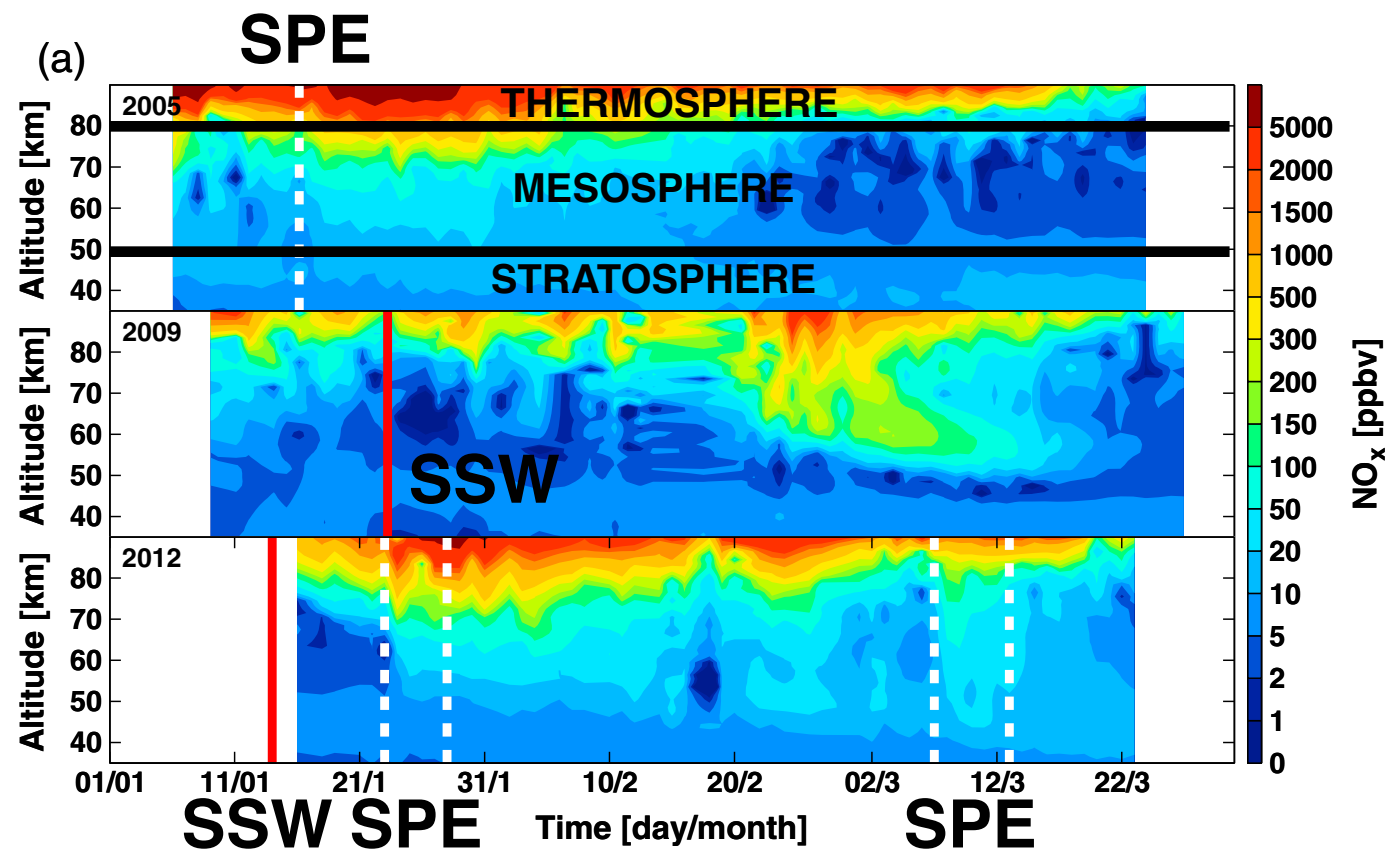
Positive poleward temperature gradient from 60° latitude to the pole
at or below 10 hPa

POLAR VORTEX

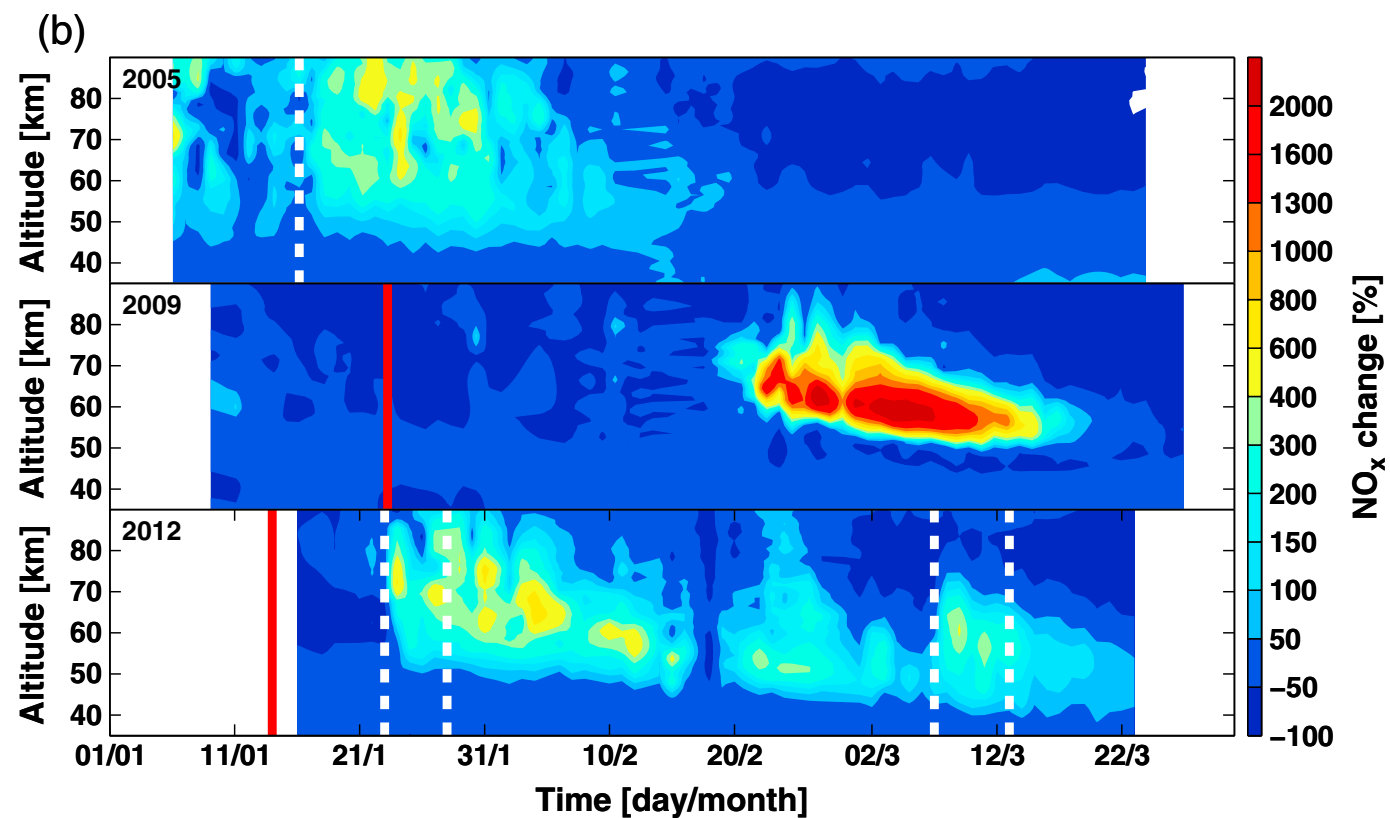


Effects on NO_x

mixing ratio in ppbv

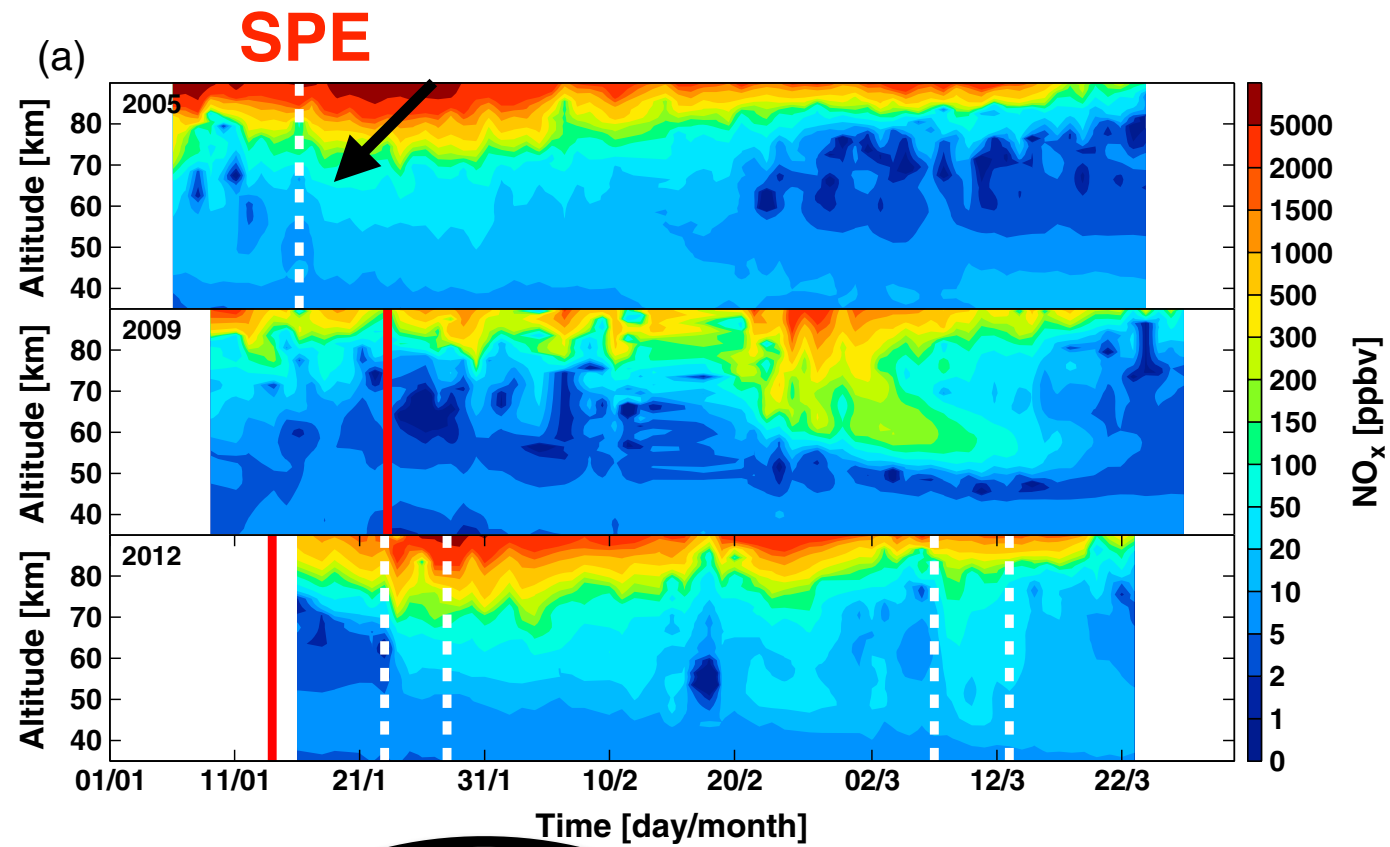


relative change (%)

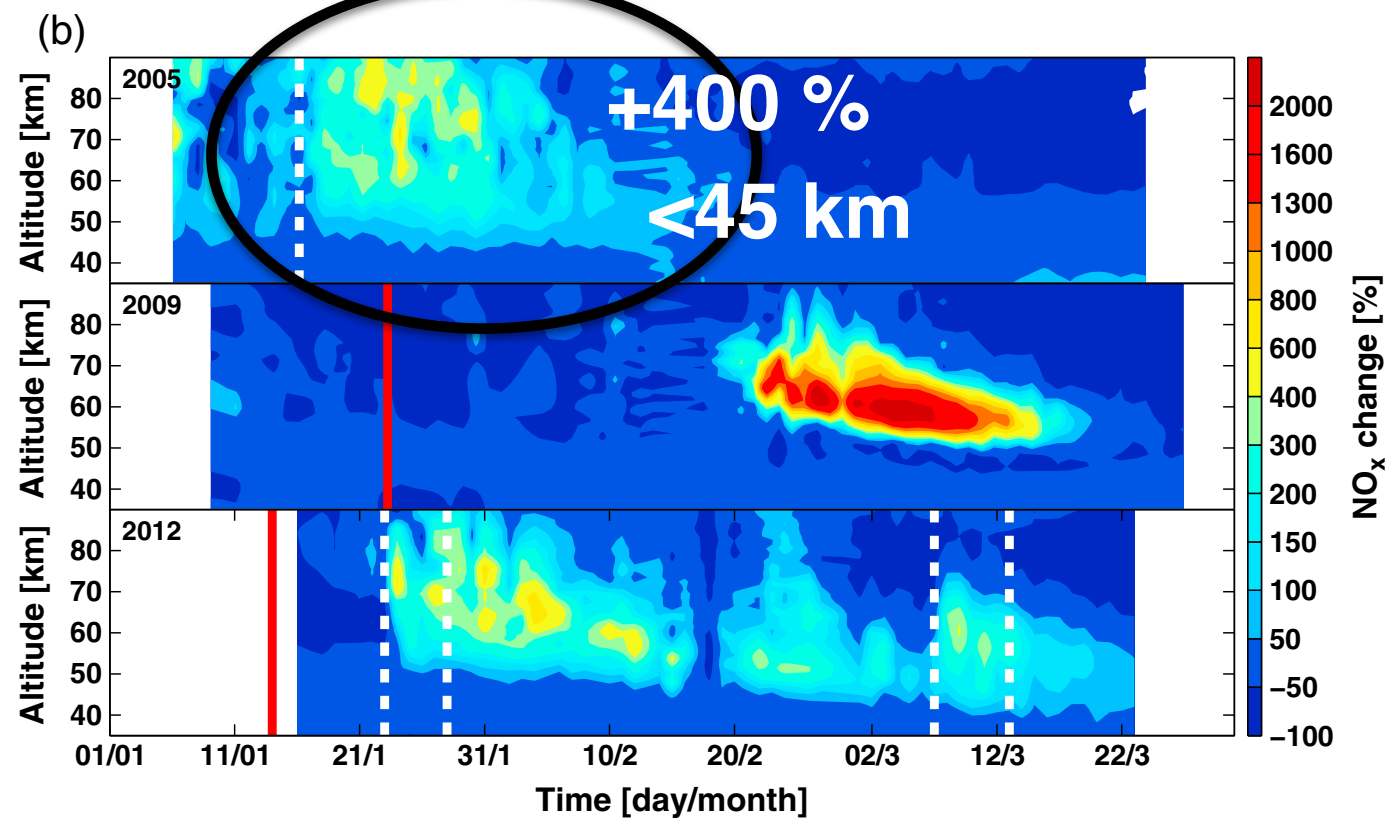


Effects on NO_x

mixing ratio in ppbv

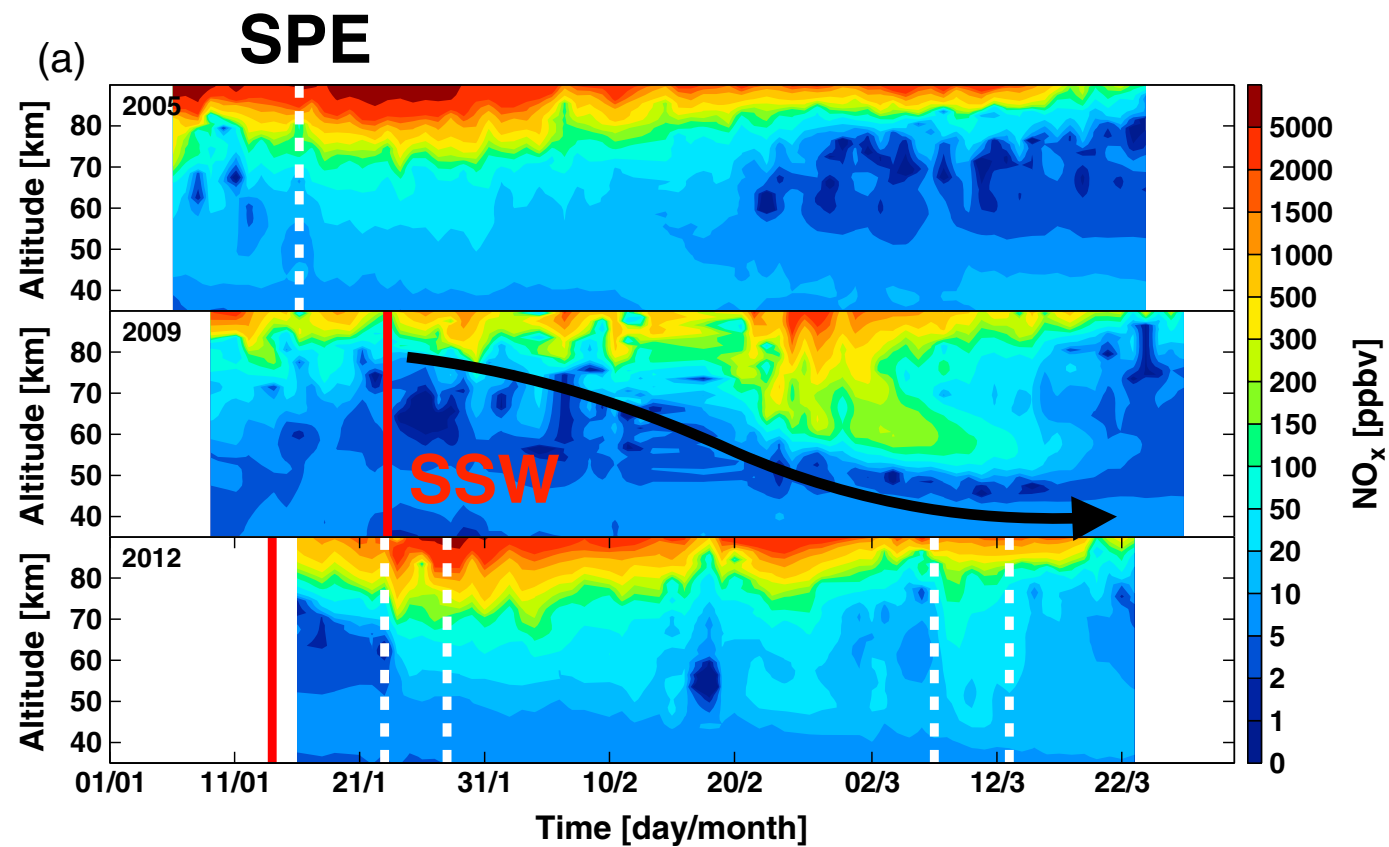


relative change (%)



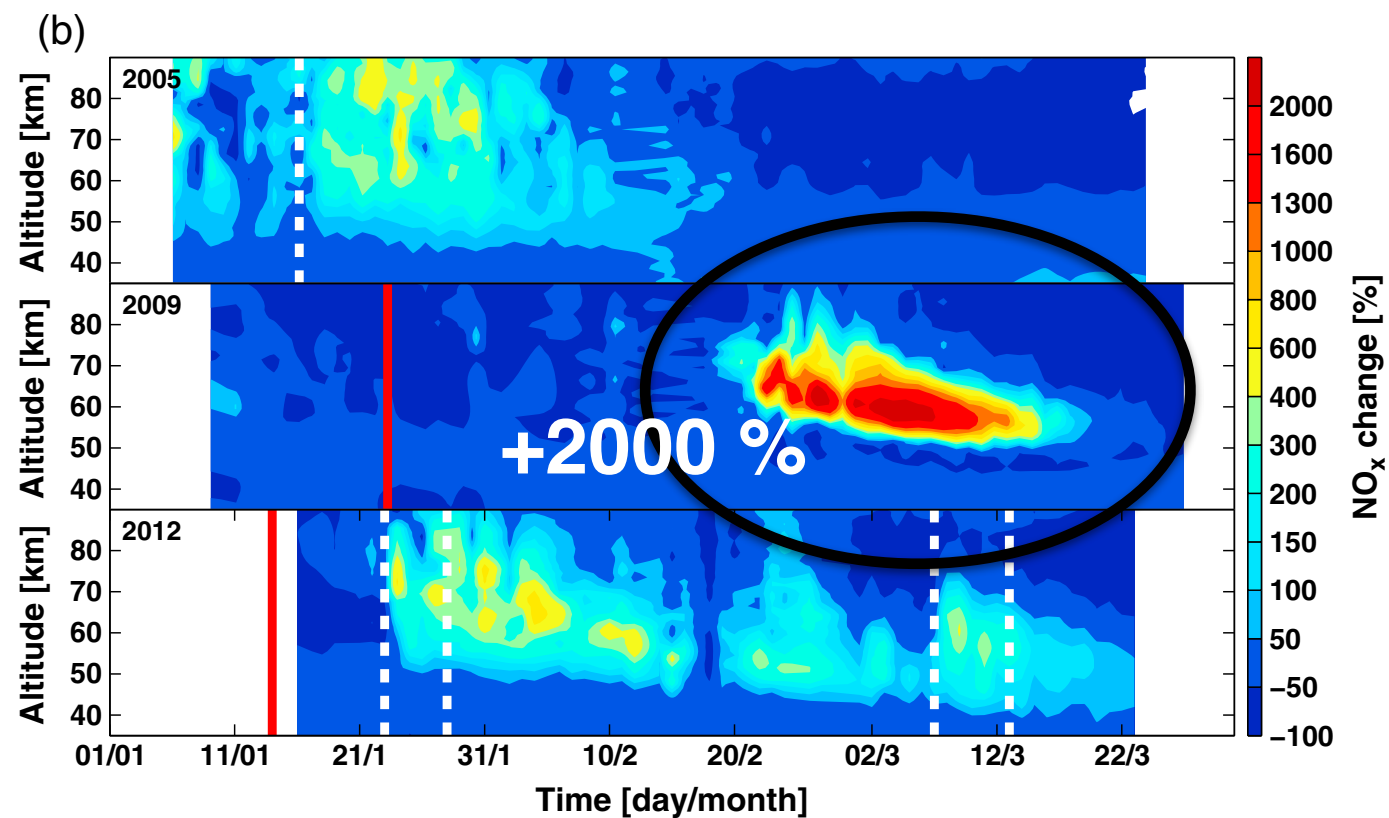
Effects on NO_x

mixing ratio in ppbv



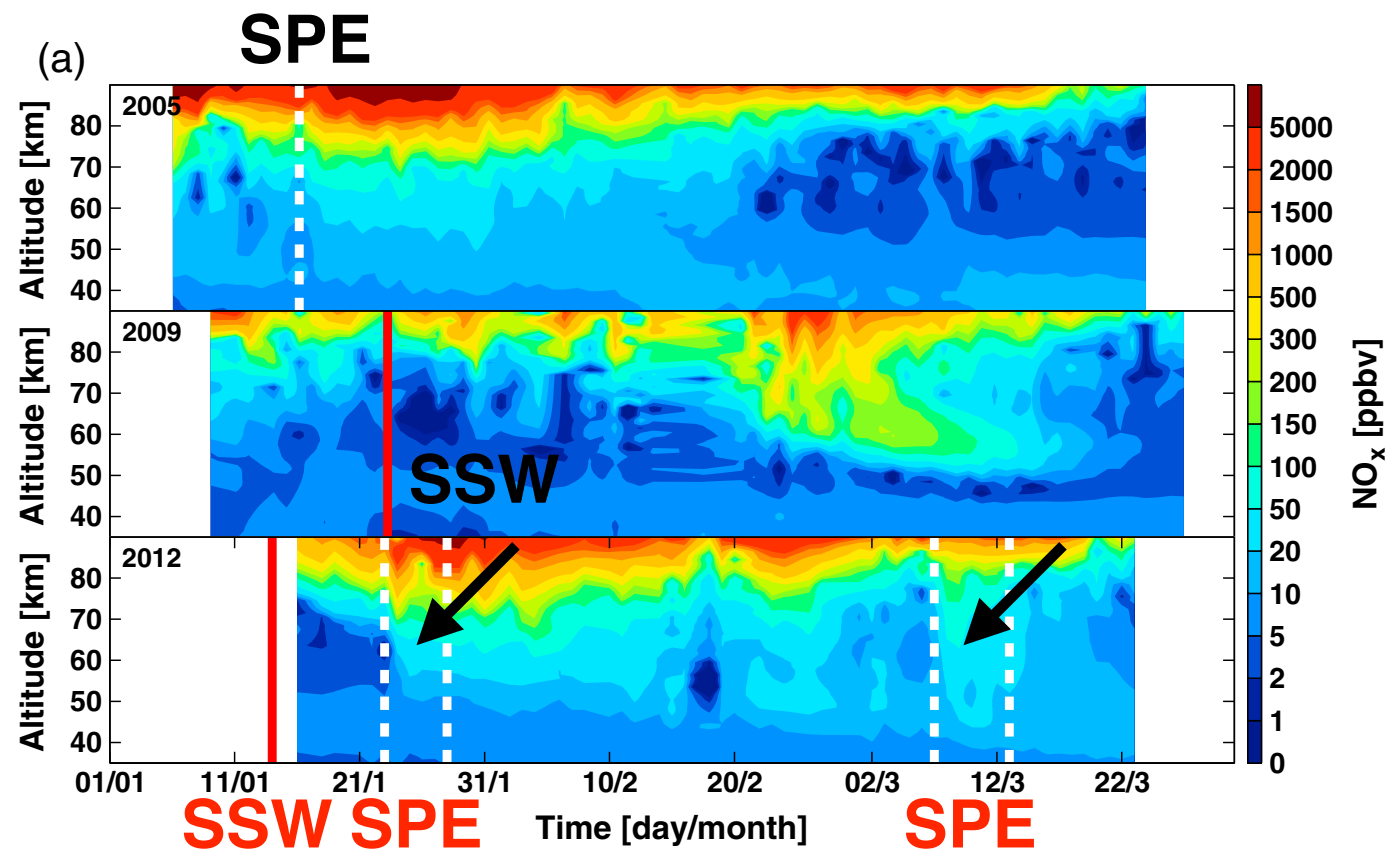
80→50 km
570m/d

relative change (%)

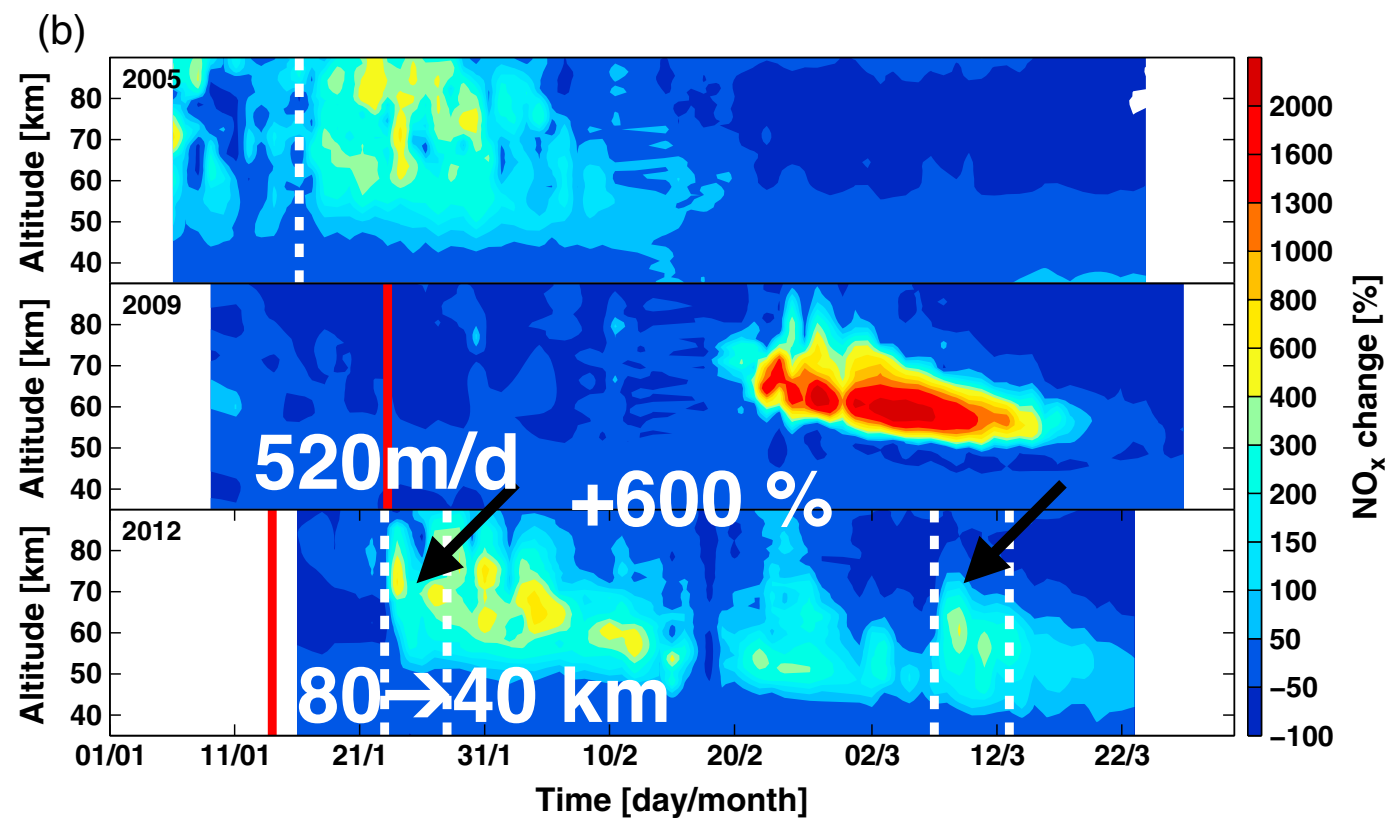


Effects on NO_x

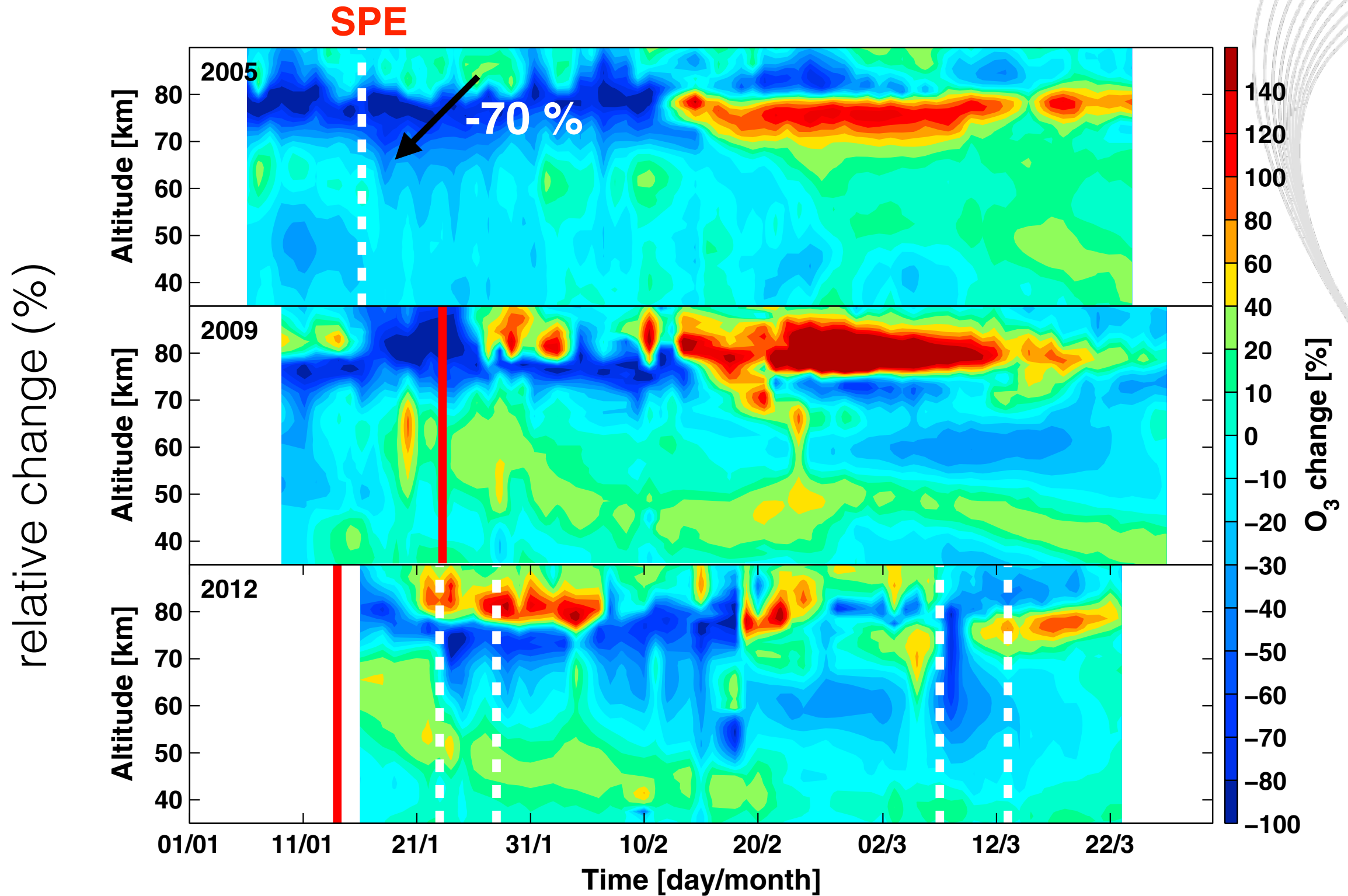
mixing ratio in ppbv



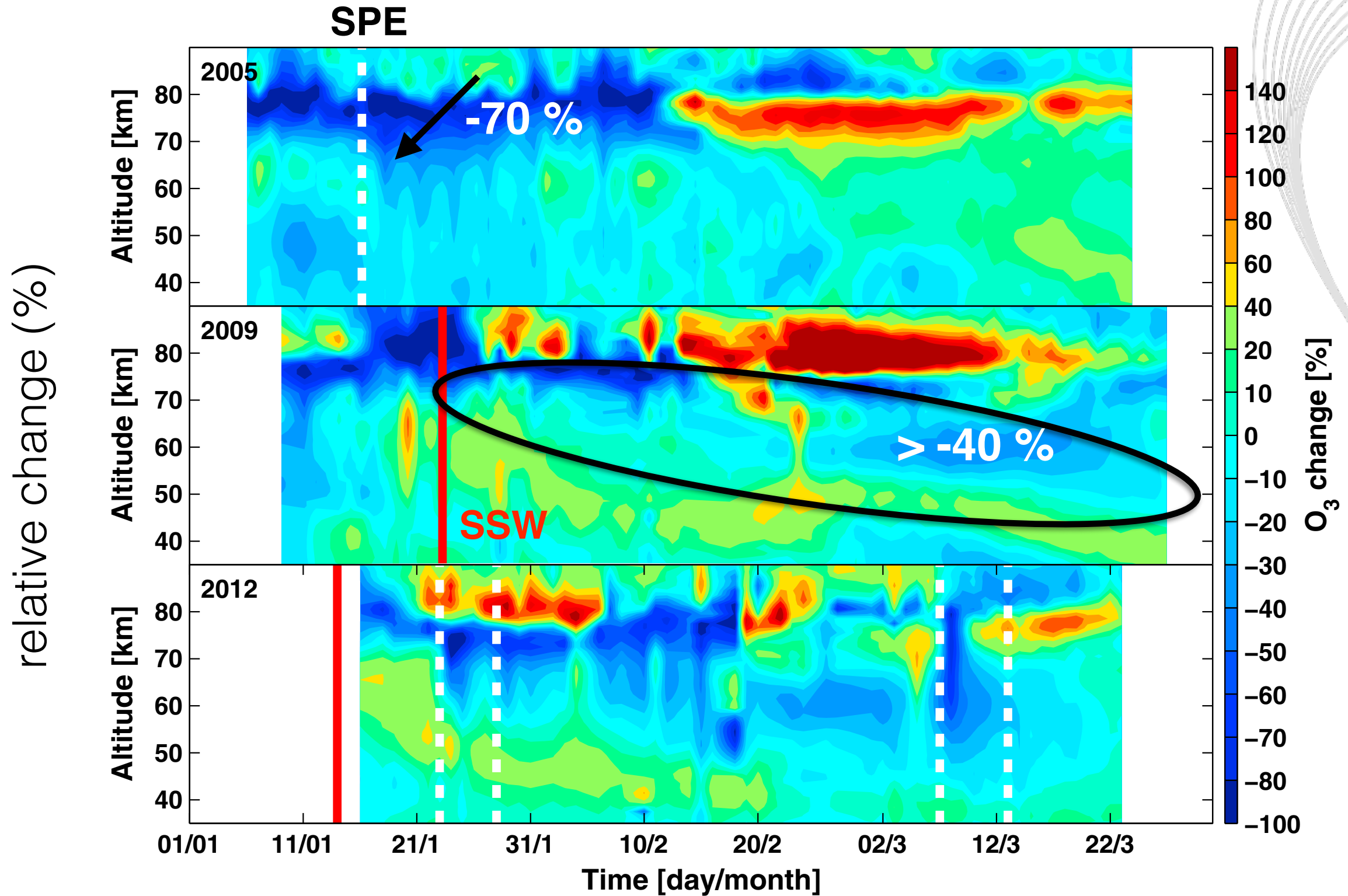
relative change (%)



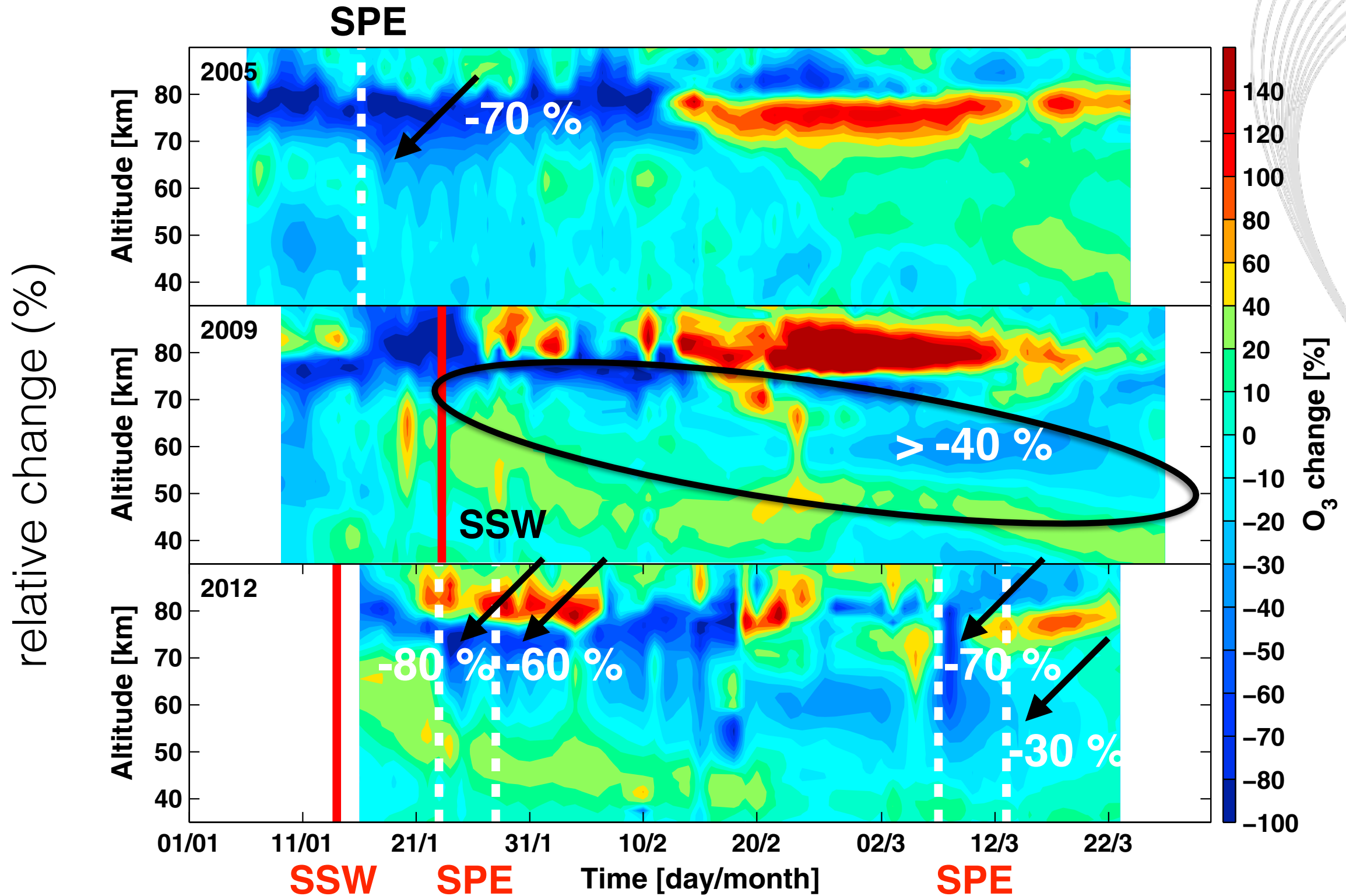
Effects on O₃



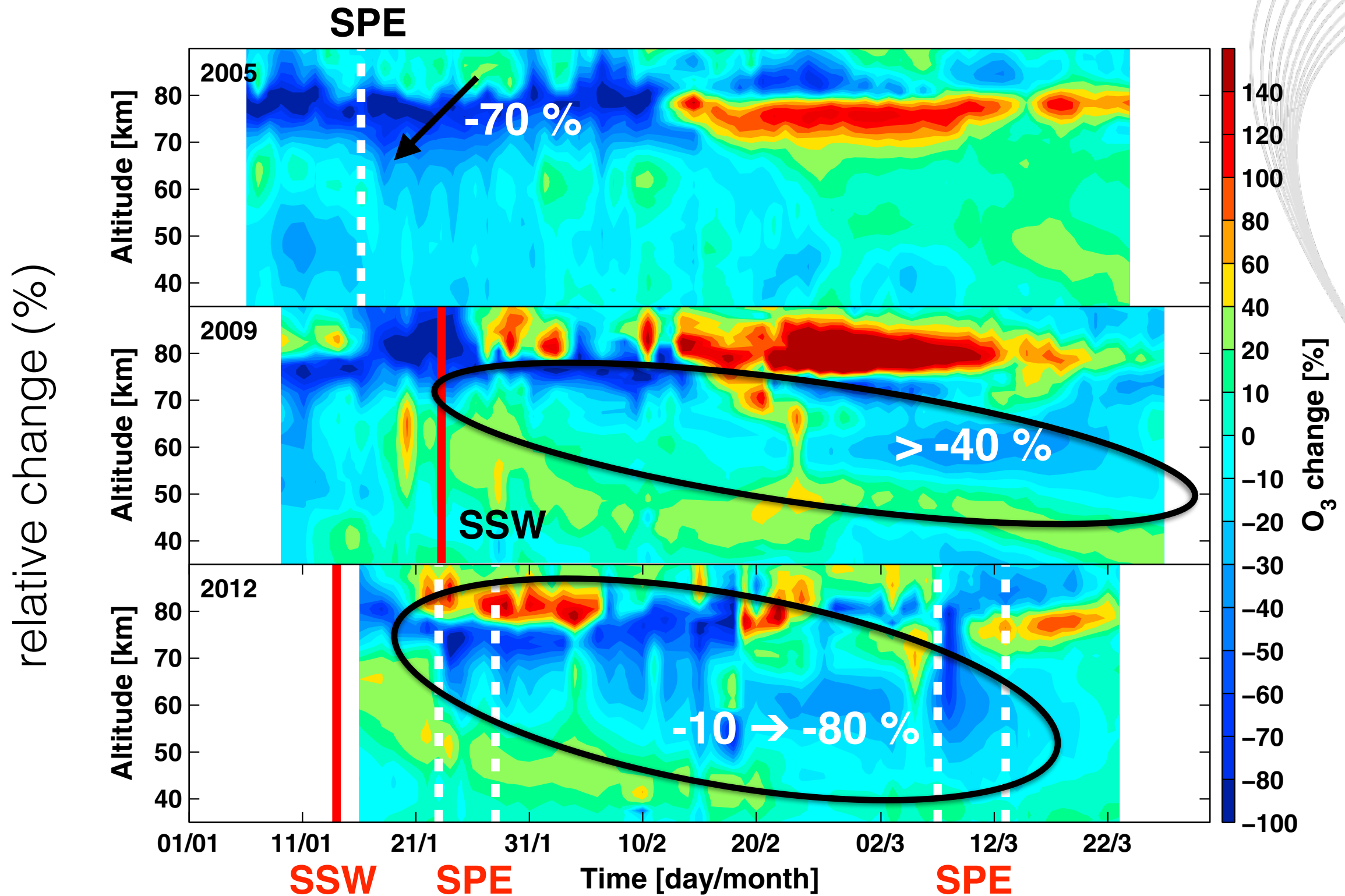
Effects on O₃



Effects on O₃



Effects on O₃



Conclusions

- SPEs and SSWs both have effects on the upper and middle atmospheres (40-90 km)
 - the amount of NO_x was increased by a factor of 1-25
 - both short-term and long-term ozone losses of the order of 10-90 % were observed
- largest mesospheric NO_x changes were observed in 2009 (SSW)
- largest stratospheric NO_x changes in 2012 (SPEs + SSW)
- optimal conditions (dynamics + production) \neq NO_x -dominated effect on ozone
- measurements during periods of active Sun

Päivärinta et al., 2013: Observed effects of solar proton events and sudden stratospheric warmings on odd nitrogen and ozone in the polar middle atmosphere, *J. Geophys. Res. Atmos.*, 118, 6837–6848, doi:10.1002/jgrd.50486



beforeitsnews.com

©2017 PEARL HARBOR NEWS