Variations in thermosphere composition and ionosphere total electron content under 'geomagnetically quiet' conditions at solar-minimum

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Background and Motivation

Ionosphere Q disturbance: variations of ionosphere parameters due to the Earth atmosphere itself (lower atmospheric forcing), not from outside of the Earth (geomagnetic activity and solar radiation)

Zevanika and Hill (1978) was the first to study Q disturbance by a ionosonde over San Jose, Brazil

Forbes et al., 2000; Kazimirovsky and Kokourov, 1991; Kazimirovsky et al., 2003; Khachikjan, 1987; Rishbeth and Mendillo, 2001, mostly based on ionosonde measurements

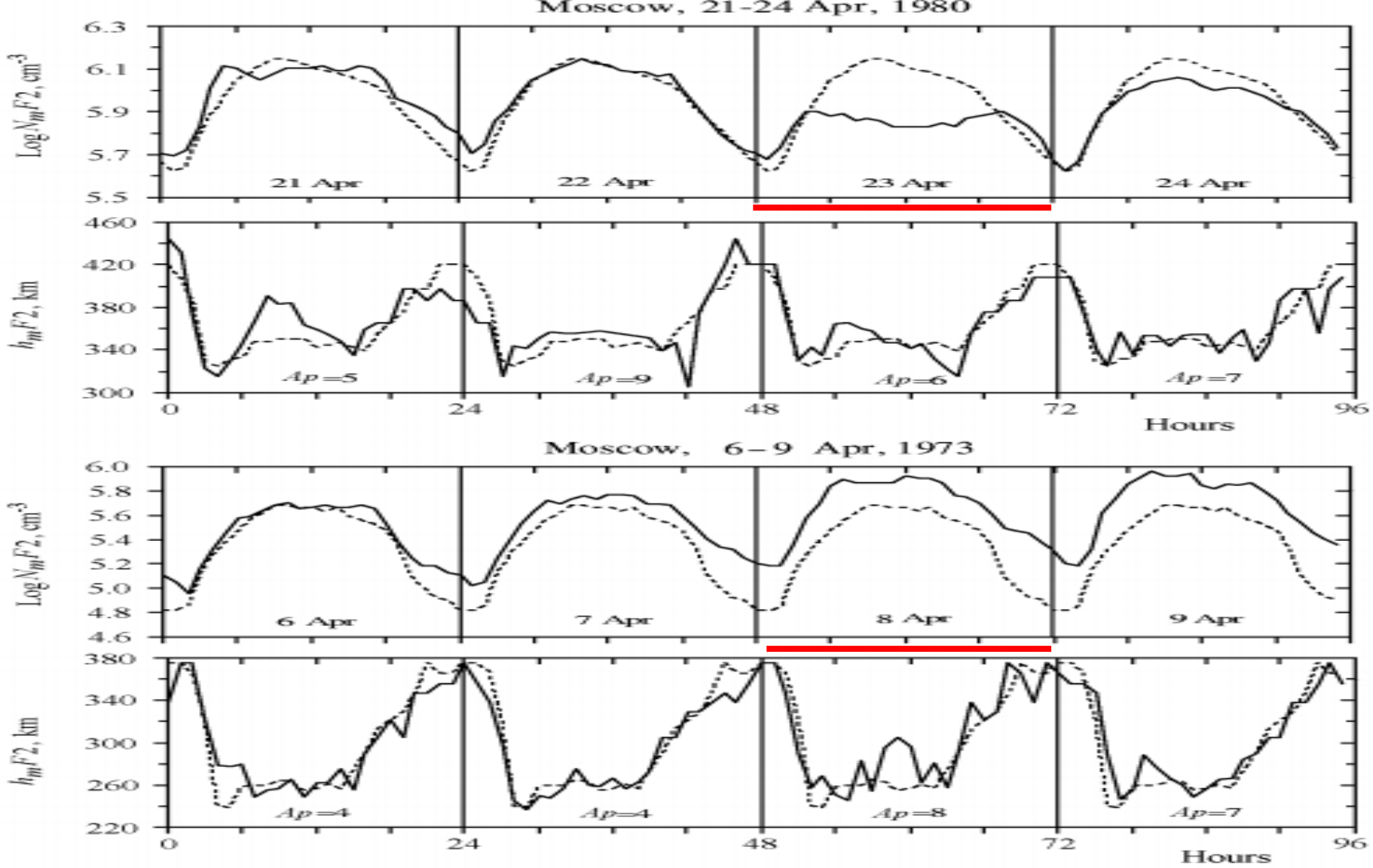
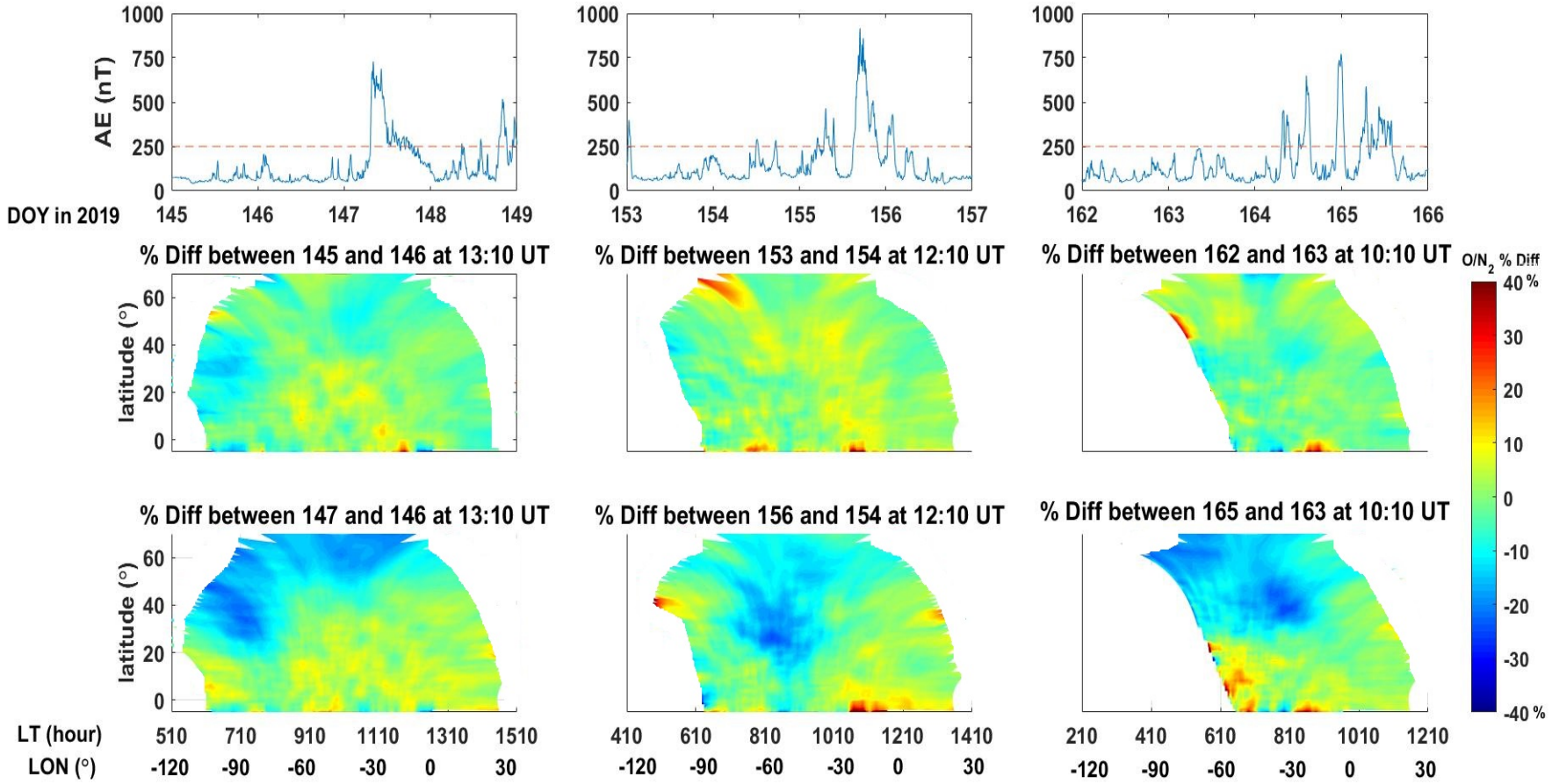


Figure 1. Examples of negative and positive daytime Q disturbances observed at Moscow (solid lines). A 27-day running median is given by dashed lines. Note that $h_m F2$ are close to median values during these events. Daily *Ap* indices are given.

From Mikhailov et al., 2004

However, many cases under so-called geomagnetic quiet time (Kp<=3) are actually still influenced by geomagnetic activity. The observed results are joint effort by the lower atmospheric forcing and geomagnetic activity.

As already been proved in Cai et al 2020 (GRL), weak geomagnetic activity can generate long and strong response in $\sum O/N_2$ in the mid-high latitude during solar minimum

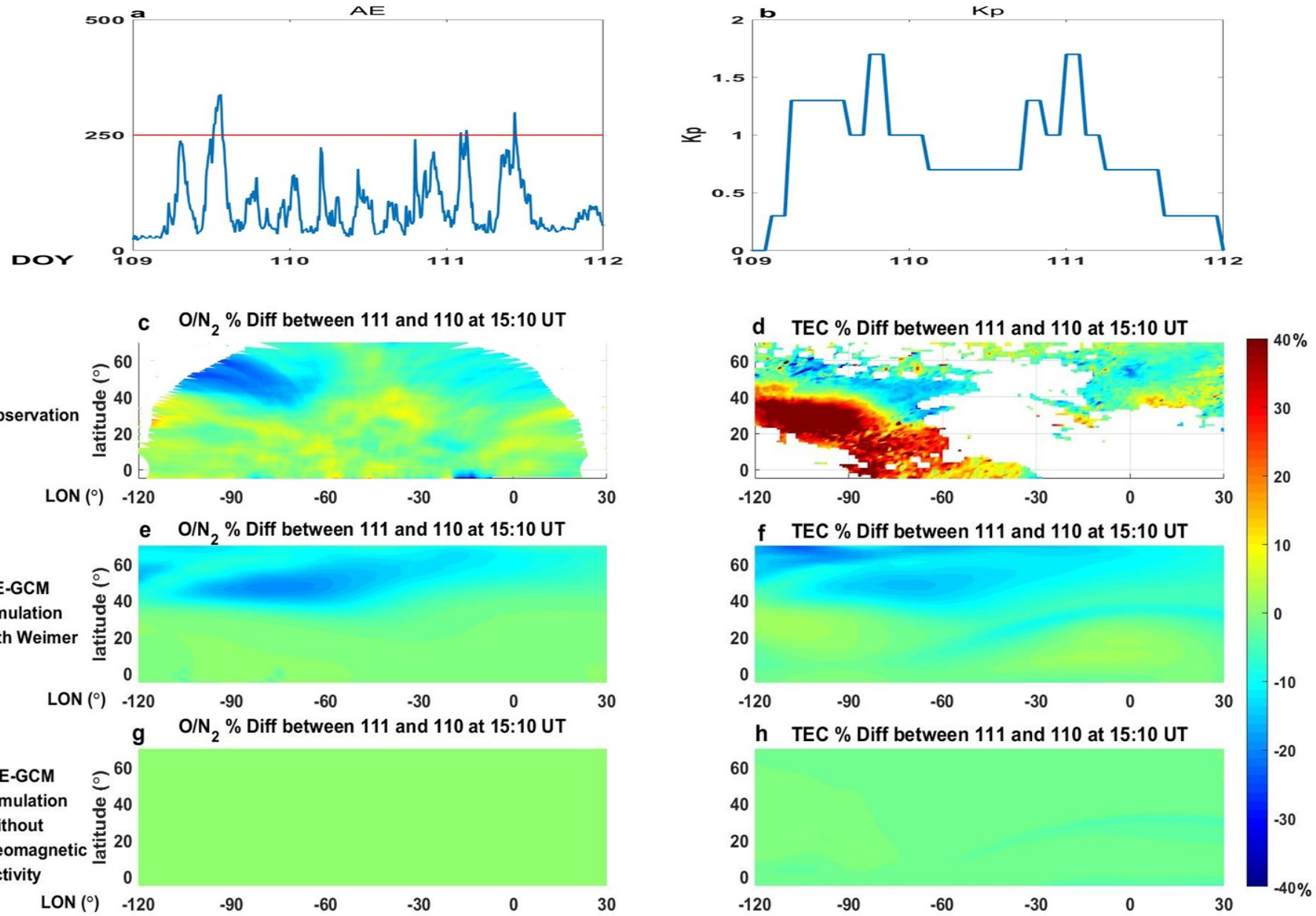


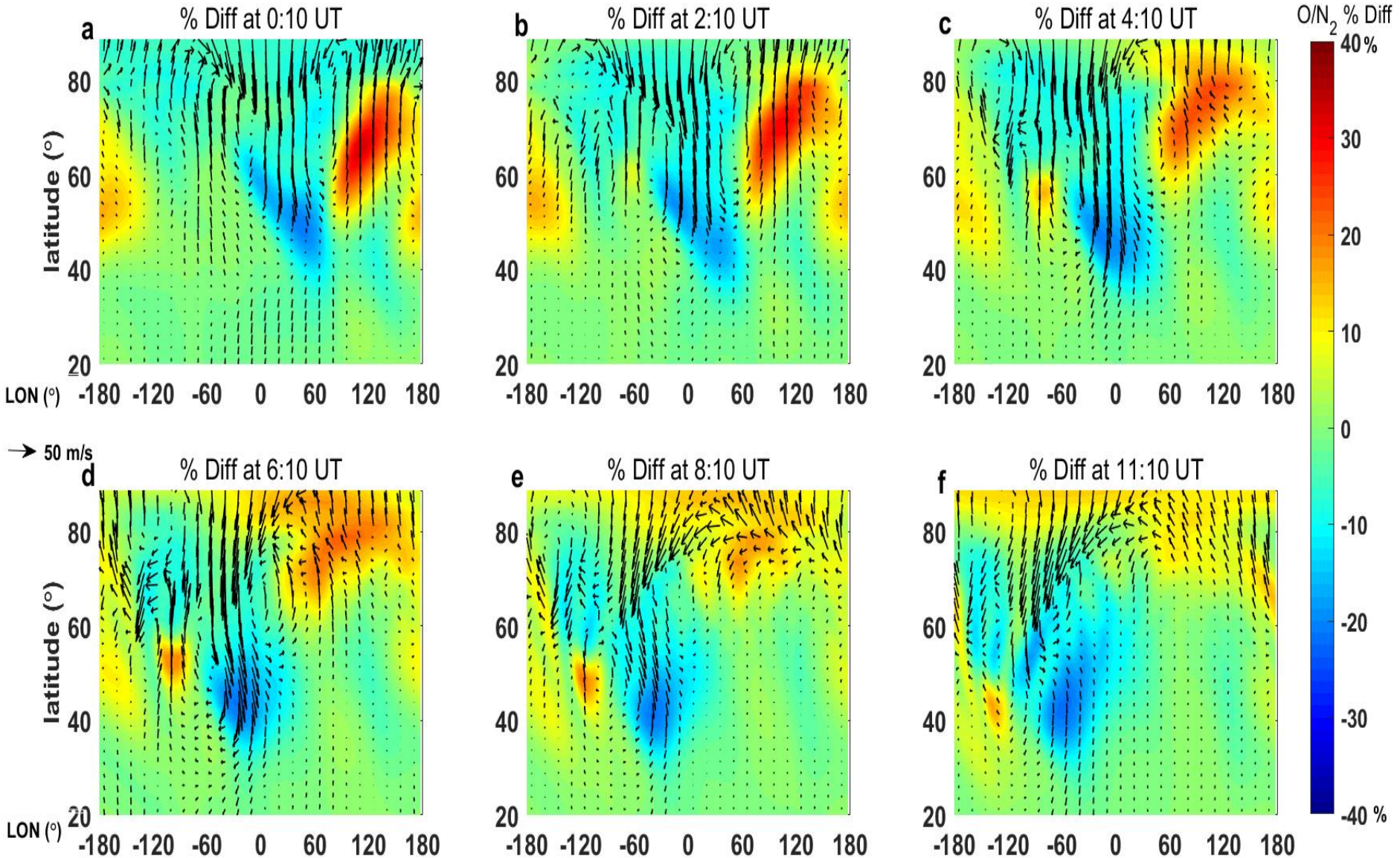
Weak geomagnetic activity 1<Kp<5 and AE>250 nT for at least 3 hours in a day

Kp>2 can generate apparent variations in $\sum O/N_2$ (-30% and >10-hour)

Now we make the rules stricter, to set 0<AE<250 nT for the whole day, and 0=<Kp<2, namely the real quiet (Q) conditions, to see what happen for the % Diff of $\sum O/N_2$ and TEC

Results and Discussion

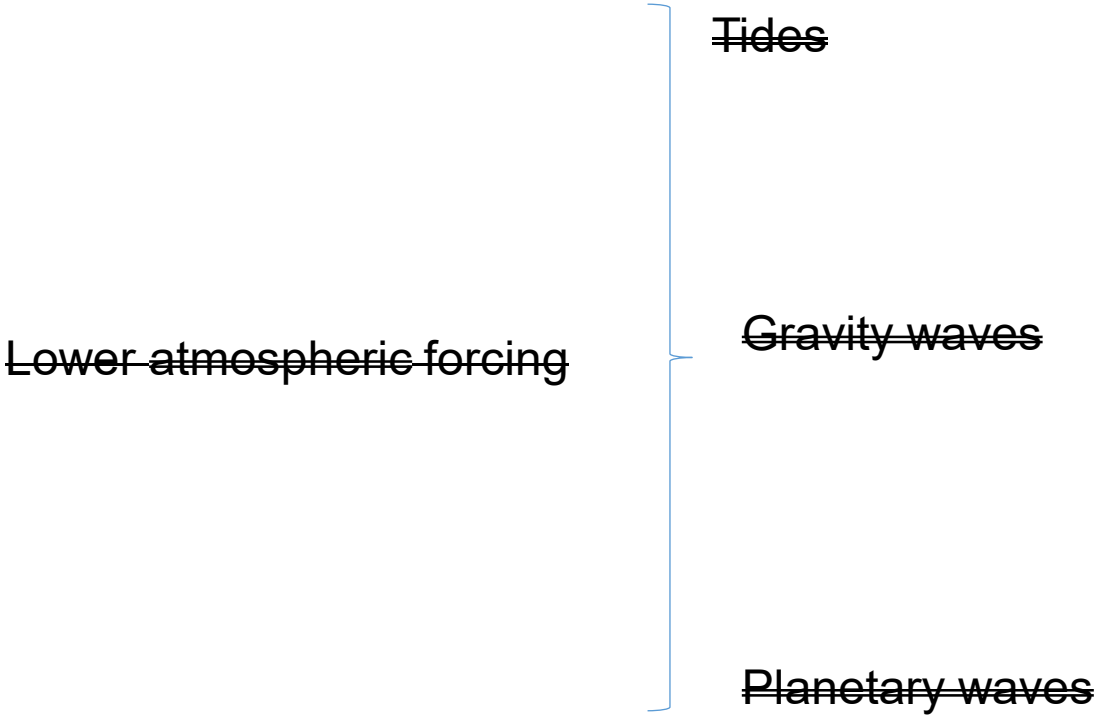




See more details in Cai et al., 2021 GRL
(https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2021GL093300)

Lower atmospheric forcing

- Tides — Most in the low-latitudes (He et al., 2010 and Zhang et al., 2010)
- Gravity waves — high-frequency (<=1-hour) (Vadas, 2007)
- Planetary waves — much weaker amplitude (~6%) Chang et al., 2014



Minor Geomagnetic activity (Most likely)

Summary

1 During some geomagnetically quiet periods (Kp<2), GOLD observed strong localized daytime $\sum O/N_2$ variations (~30% maximum and sustained ~10 hours) at mid-latitudes

2 Ionospheric TEC depletions are also seen in the region of $\sum O/N_2$ depletion

3 Model simulations show that the minor geomagnetic activity play crucial roles in these variations