Migrating DW1 tidal variability during Northern and Southern Hemisphere SSWs

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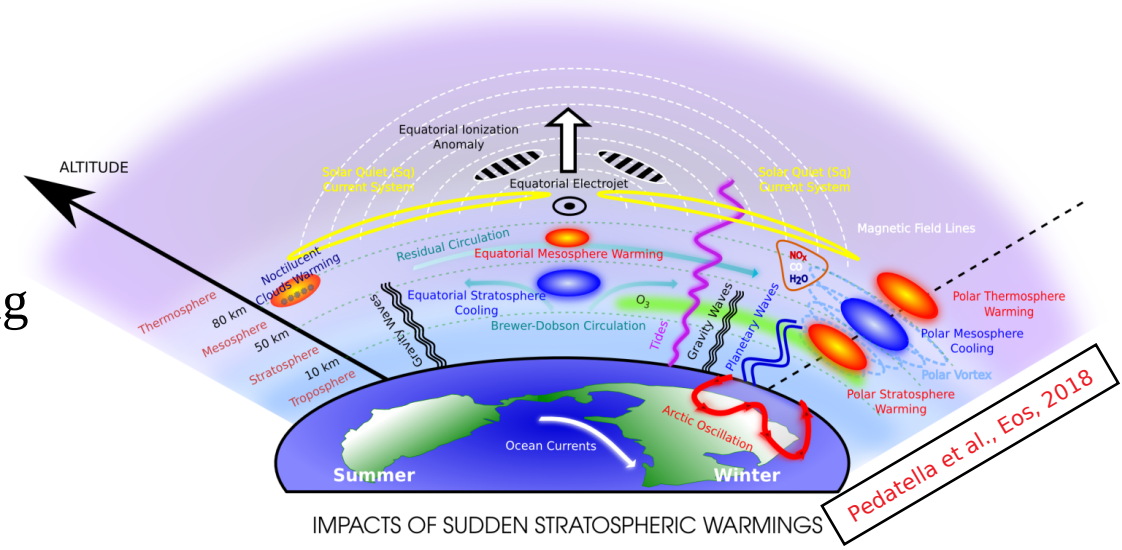
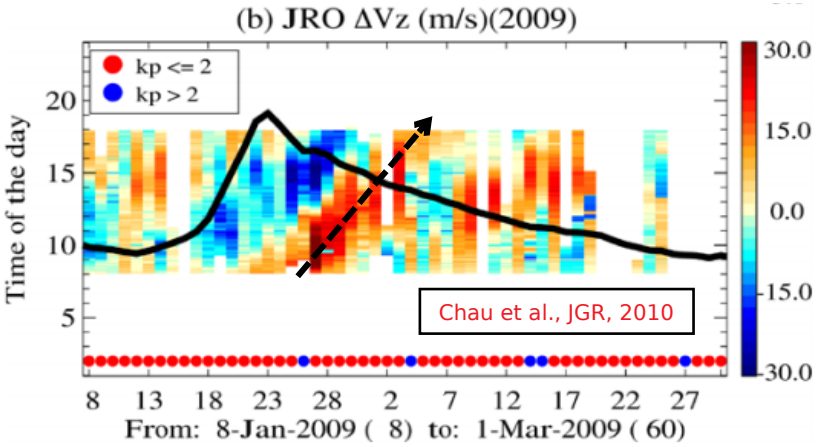
Background and Motivation

- The topic of variability in MLT and ionosphere during SSWs has received widespread attention in recent years.
- Changes in gravity wave and tidal forcing are assumed to be the major reasons for this variability in MLT and ionosphere during SSWs.
- The role of migrating semidiurnal solar (SW2) and lunar (M2) tides have also been found to be especially important in this regard.
- In this work, we investigate the variability of migrating solar diurnal (DW1) tide during NH and SH SSWs as this topic has not been explored in much detail.



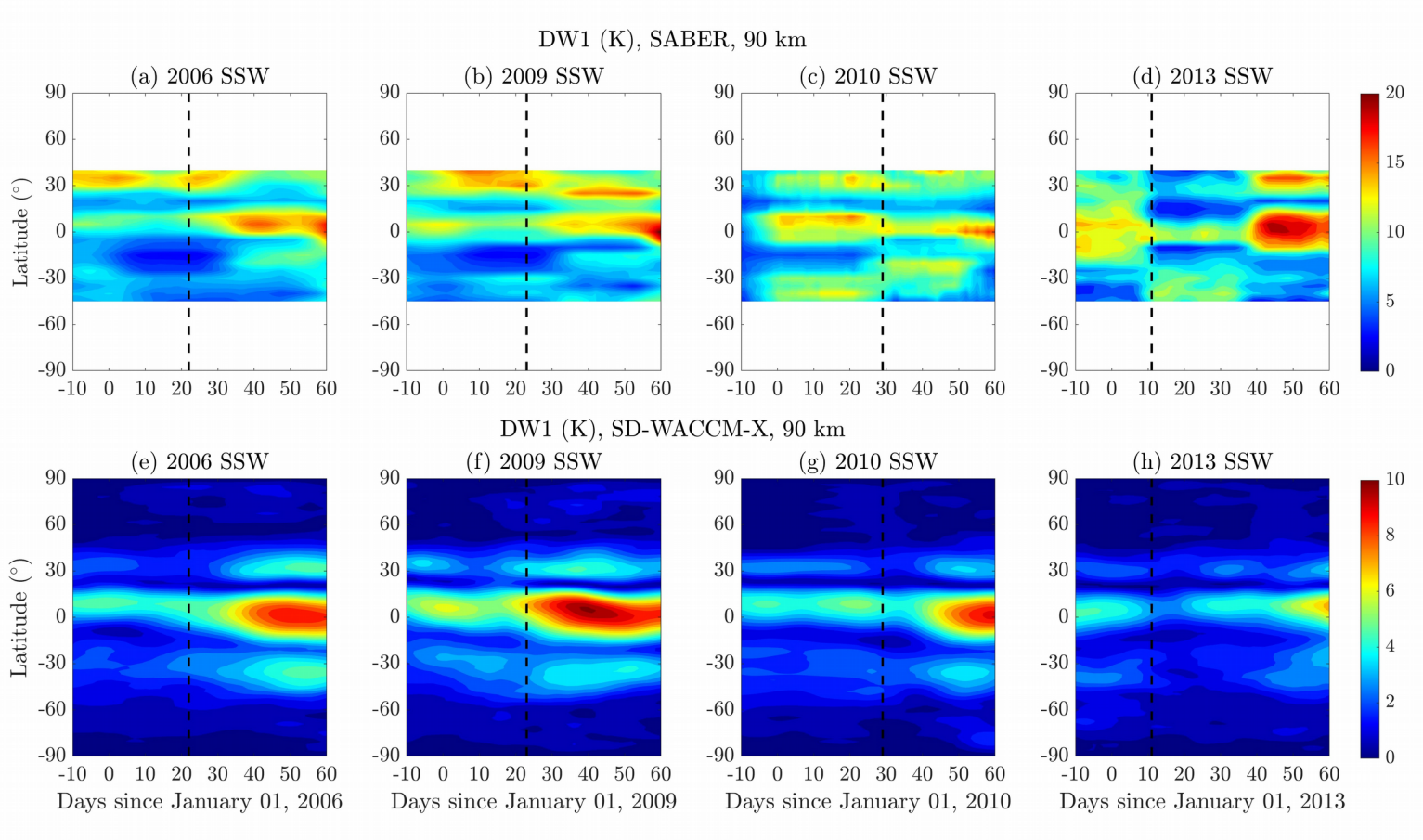
Jicamarca Vertical Drifts, 2009 SSW



MLT DW1 tide in SABER temperature observations are investigated during 4 major NH SSWs and compared with DW1 tides from SD-WACCM-X simulations

SABER

SD-WACCM-X



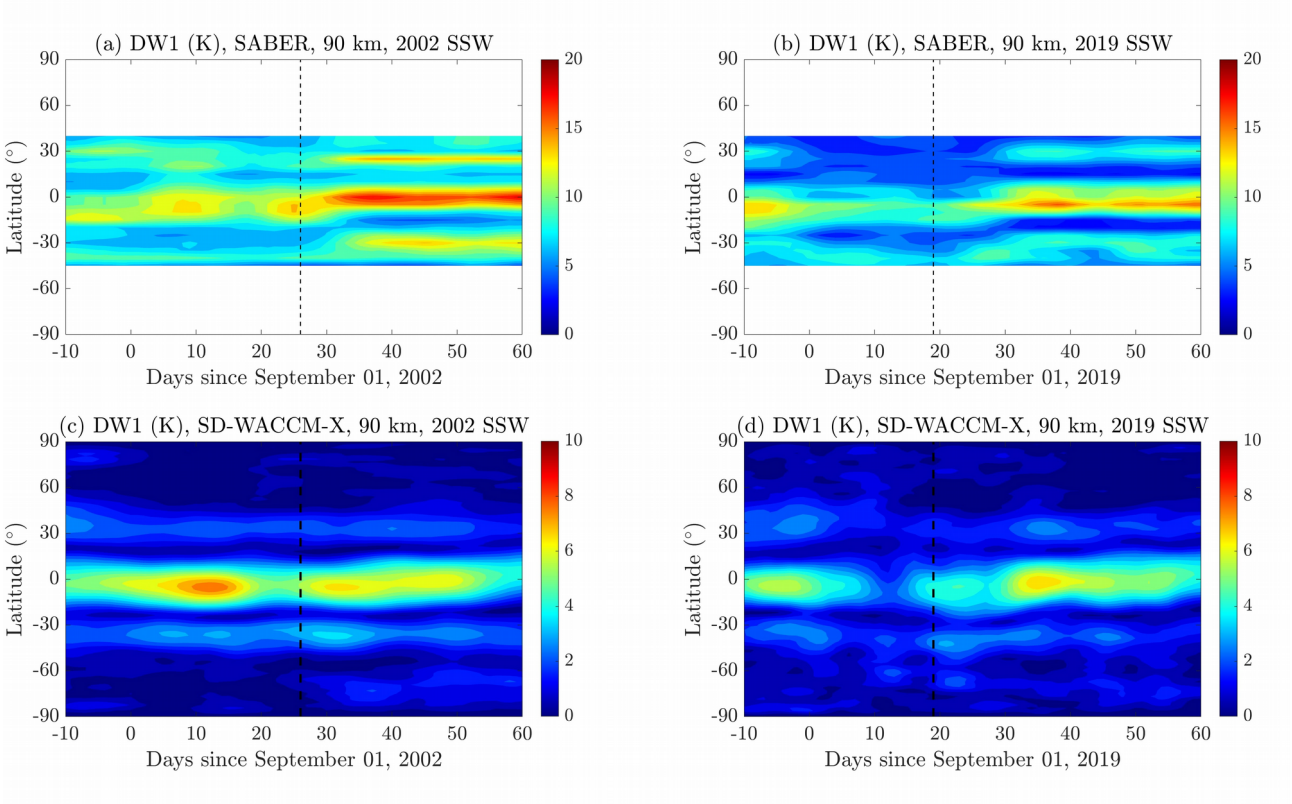
Case-studies of DW1 tidal variability during **2003**, **2006**, **2009** and **2013** NH SSWs

- Weakening of DW1 tidal amplitude is witnessed at low-latitudes close to the central day of these major SSWs.
- The SD-WACCM-X simulations reproduce the observations very well in qualitative terms.

MLT DW1 tide in SABER temperature observations are investigated during 2 SH SSWs and compared with DW1 tides from SD-WACCM-X simulations

SABER

SD-WACCM-X

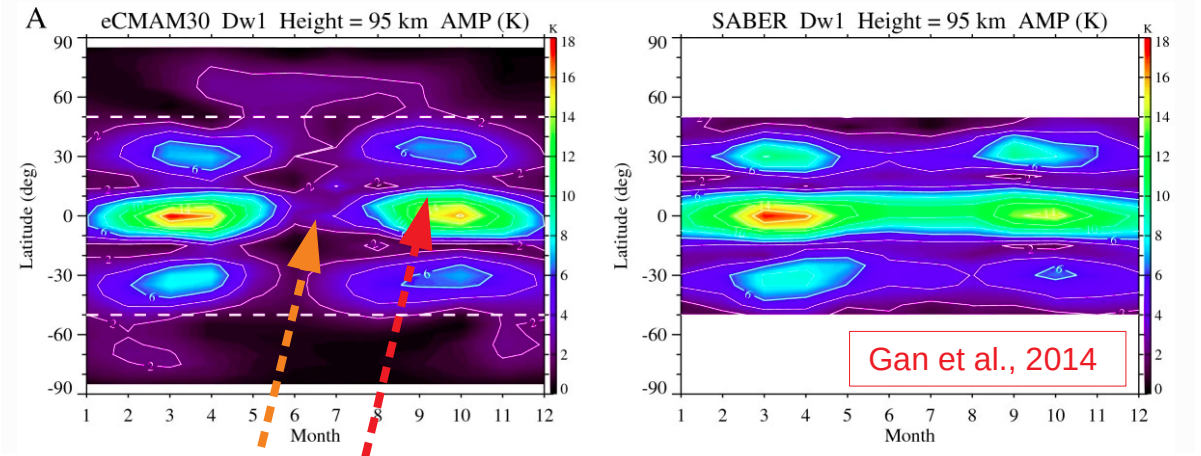


Case-studies of DW1 tidal variability during **2002** and **2019** SH SSWs

- Weakening of DW1 tidal amplitude is witnessed at low-latitudes close to the central day of SH SSWs as well.
- The SD-WACCM-X simulations reproduce the observations very well in qualitative terms.

MLT DW1 tide is known to be sensitive to changes in latitudinal shear of the MLT zonal-mean zonal winds. Could this mechanism explain the DW1 tidal weakening during SSWs?

Climatology of DW1 tide from eCMAM and SABER temperature data



Climatological behavior of DW1 tide shows its semiannual oscillation with strong amplitudes during equinoxes and weak amplitudes during solstices.

Mclandress, 2001

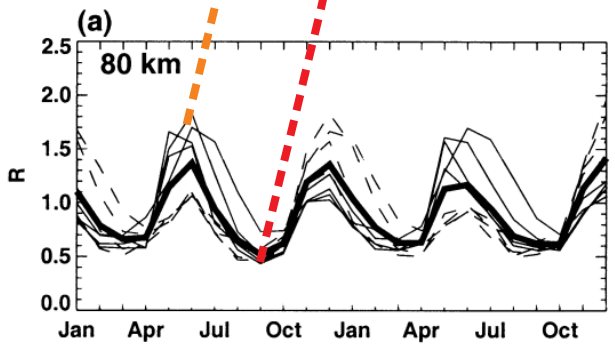
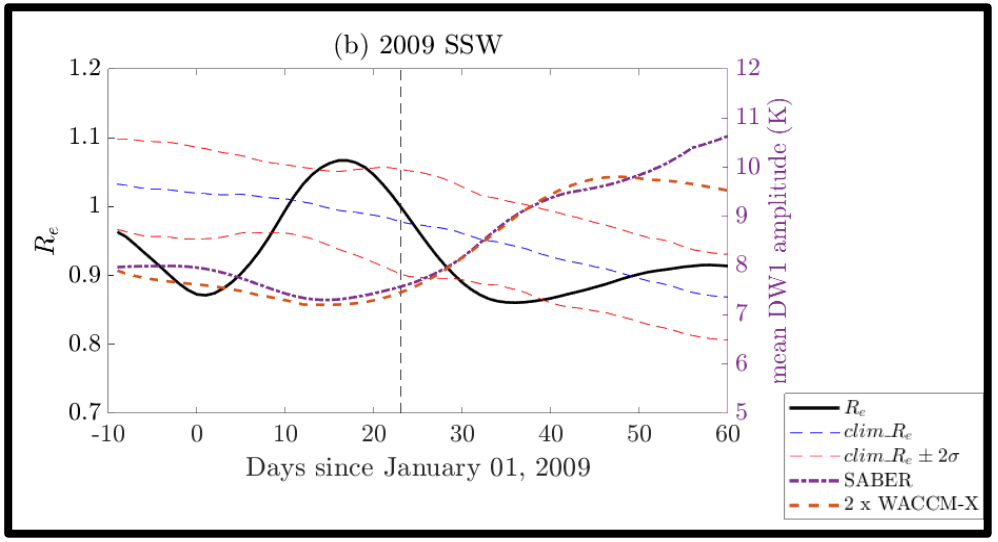


FIG. 3. Time series of the ratio of the absolute and planetary vorticity, $R = (f + \overline{\zeta})/f$, computed from $\overline{u}$ shown in Fig. 1. The thin solid and dashed lines denote R in the Northern Hemisphere (from 13.8°N to 30.5°N) and Southern Hemisphere (from 13.8°S to 30.5°S), respectively. The thick solid line denotes the average of all eight latitudes. In the absence of mean winds, $\overline{\zeta} = 0$ and $R = 1$.

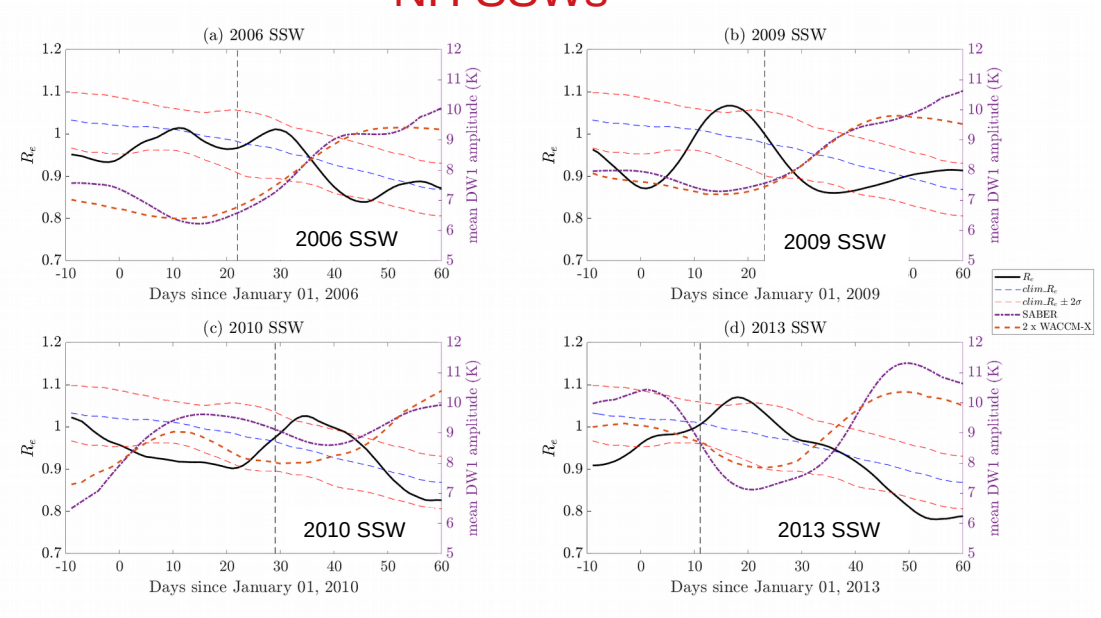
- The latitudinal shear in the zonal-mean zonal winds introduces a zonal-mean vorticity (ζ), which at low-latitudes can be large enough to be comparable to the Coriolis parameter (f).
- It is found that ζ could affect the DW1 tide indirectly by changing the absolute zonal-mean vorticity (η = f + ζ) of the background atmosphere.

The shear mechanism is explored to understand the MLT DW1 tidal variability at low-latitudes during NH and SH SSWs

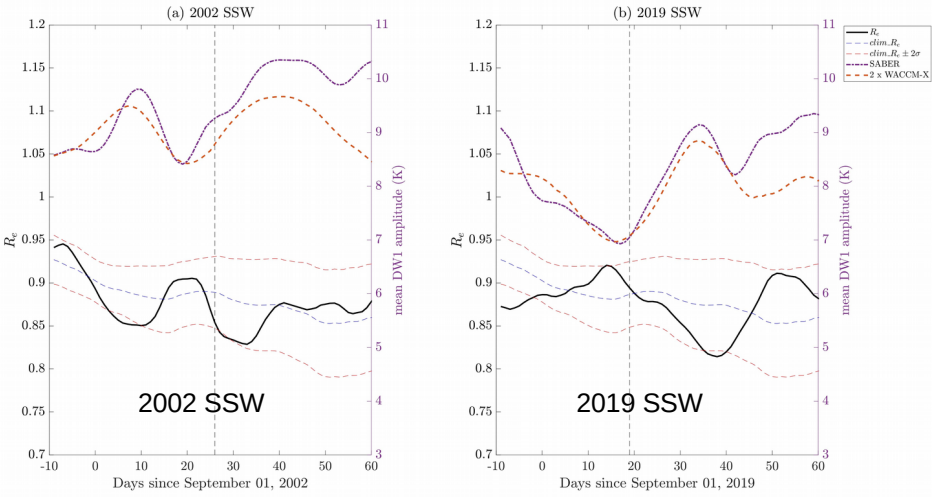


- Higher and lower R_e values are associated with weakening and amplification of DW1 tidal amplitudes during SSWs.
- In both NH and SH SSWs, this shear mechanism seems to explain the variability of MLT DW1 tidal amplitudes.

NH SSWs

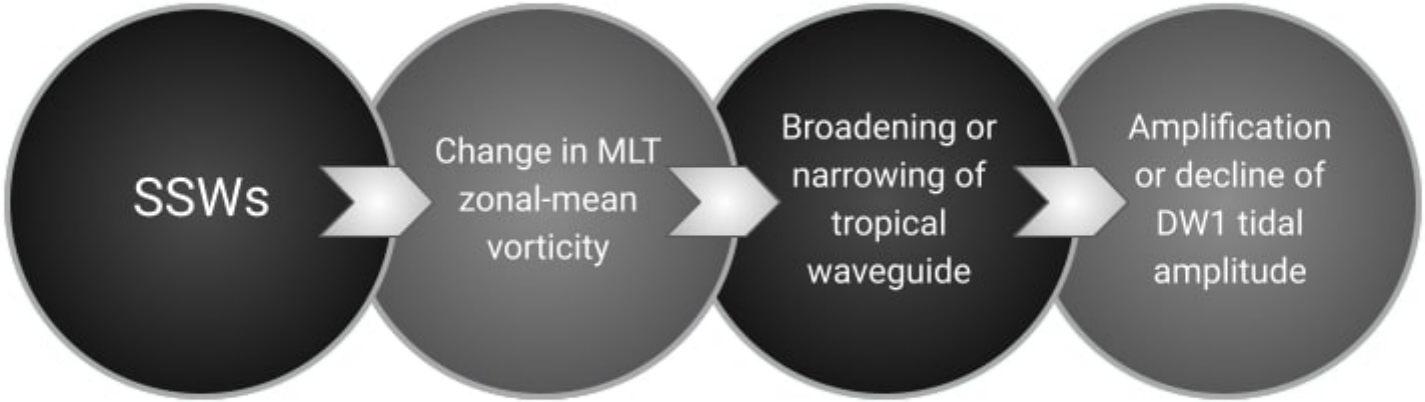


SH SSWs



Conclusions

- Weakening of MLT DW1 tide is observed close to the central day of both NH and SH SSWs.
- This weakening can be explained by the SSW-associated changes in the latitudinal shear of the zonal-mean zonal winds. (see schematic below)



- Manuscript is under review. Preprint available at 10.21203/rs.3.rs-1365756/v1