Sensitivity of easterly QBO's boreal winter teleconnections and surface impacts to sudden stratospheric warmings (SSWs)

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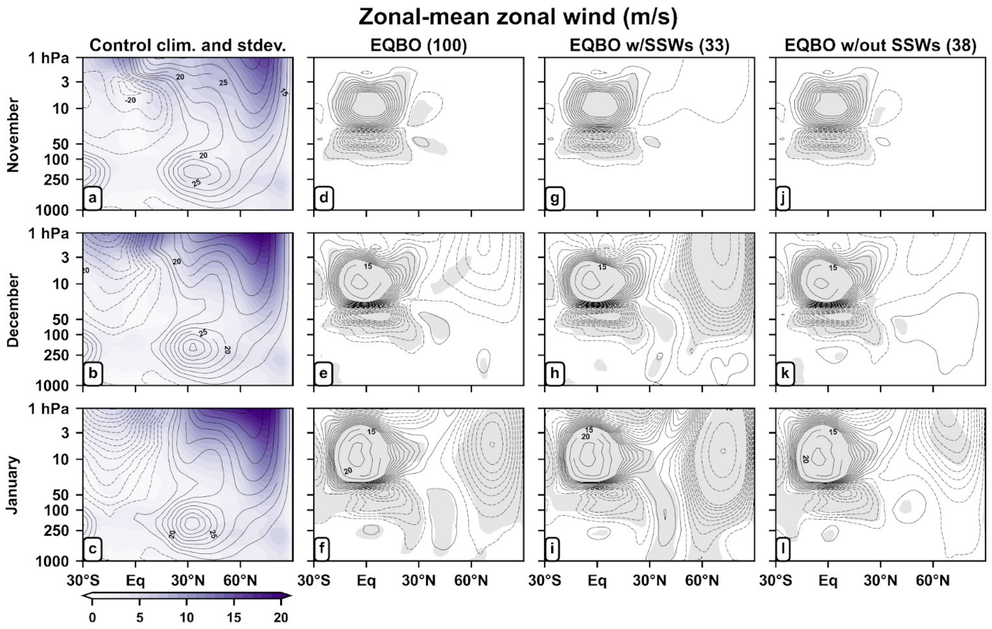
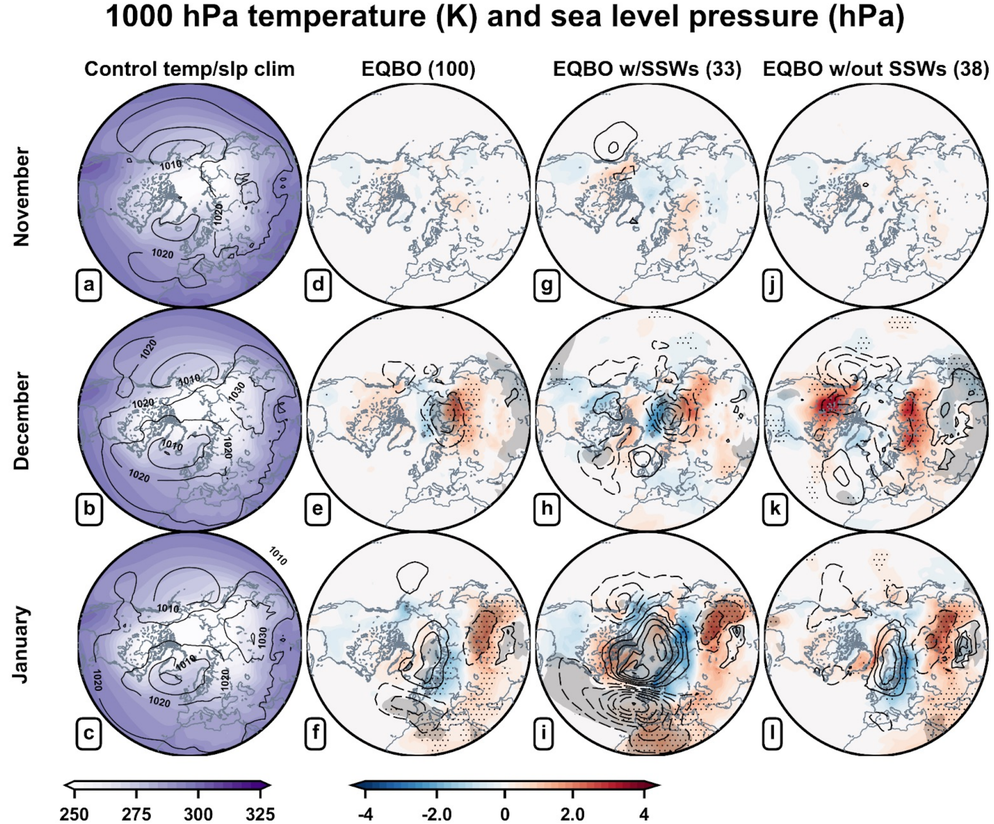
- The stratospheric Quasi-Biennial Oscillation (QBO) is thought to impact surface weather over Asia, the North Atlantic, and Europe, but we are not sure if these responses are robust or how exactly they happen
- SSWs are major perturbations to the winter polar vortex that also initiate persistent surface weather impacts
- SSWs are more common during EQBO; from 1950-2021, the 24 easterly QBO (EQBO) winters have had 20 SSWs while the 39 westerly QBO (WQBO) winters have also had 20 SSWs
- **Question:** Does the QBO initiate its surface impacts by modulating the frequency of SSWs or does it use other means to influence surface weather?

WACCM Experiments	SST/SIC forcing years	GHG/solar forcing years	Has a QBO?	# of years	# SSWs
Control	1979-2008	2000	No	100	29 (20-38)
EQBO branching	1979-2008	2000	Yes	100	47

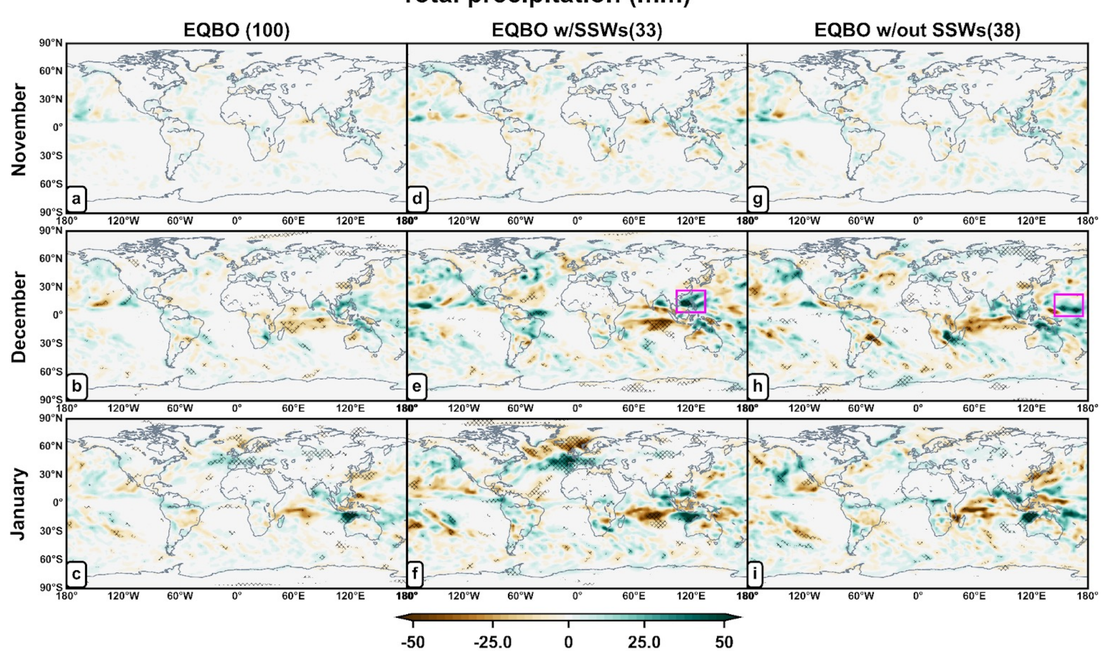
Details: We "branch" off of every November 1st from the control and nudge the stratospheric zonal winds so that they contain an easterly QBO (EQBO), allowing us to diagnose the transient atmospheric response to EQBO. The simulations run for 3 months (Nov 1 – Jan 31). To ascertain what EQBO does to the surface vs. what the increased frequency of SSWs does to the surface, we then bin the responses based on when EQBO has an SSW vs when EQBO occurs without an SSW.



- EQBO accelerates the tropical upper tropospheric wind, pushes the subtropical jet-stream poleward, and weakens the polar vortex
- These are three "observed" pathways the QBO uses to interact with troposphere/surface
- The subtropical jet response and the polar vortex response are primarily associated with the QBO influencing the number of SSWs



- EQBO warms surface Asia, consistent with observational studies
- EQBO also promotes negative North Atlantic Oscillation (NAO) conditions, thereby cooling Europe, warming North Africa, and Greenland
- The –NAO response develops because the QBO modulate the frequency of SSWs
- The Asia warming develops independently of SSWs. It likely results from EQBO interacting with the subtropical jet-stream



- The –NAO response associated with higher frequency of SSWs during EQBO also shows up in the January precipitation response where we see that precipitation shifts south across Europe
- EQBO generally reduces precipitation over the Indian Ocean and increases it over the South China Sea and the Maritime Continent. This is important because these response stimulate upper tropospheric Rossby waves that propagate into the extratropics and influence extratropical regional weather