AN INFLUENCE OF SOLAR VARIABILITY ON THE STRATOSPHERE AND TROPOSPHERE.

Abstract
EGS-AGU–EUG Joint Assembly. CL2.08 "Climate variability as problem of solar-terrestrial physics: detection of connection in the Sun-Earth system, modeling the underlying processes and predictions"
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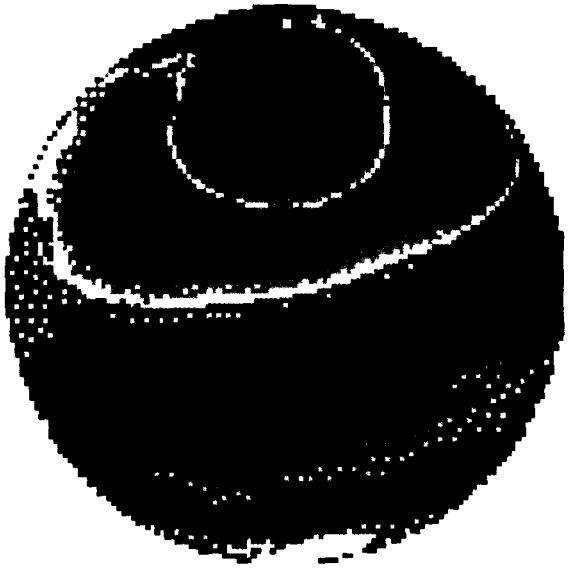
We have found that the excitation of the North Annular Mode (NAM) of the wintertime geopotential height anomalies between 10 hPa and 1000 hPa is influenced by solar cycle changes and the effect is highly statistically significant. Solar cycle changes of UV radiation were proxied by the 10.7 cm flux variations. These data were compared with the principle components of the NAM at 17 atmospheric levels throughout the stratosphere and troposphere obtained from the NCEP reanalysis (Baldwin and Dunkerton, 1999). The influence depends on the phase of the Quasi Biennial Oscillation (QBO). In the early winter for the west QBO and the late winter for the east QBO the solar changes affect the NAM in both the stratosphere and the troposphere almost equally. The NAM index was found to be systematically lower for low solar activity. The statistical significance of the results were tested by randomizing the solar data. The probability of obtaining these results by chance is less than one in a million. These results also imply that the NAM index in the troposphere was lowered during the Maunder Minimum in comparison with the current epoch.

North Annular Mode



- A recurrent pattern of wintertime climate anomalies with two major states, high (low) pressure at pole and a band of low (high) at somewhat lower latitudes.
- Account for 23% of variability

Thompson & Wallace (98)
Baldwin & Dunkerton (99)

What we did

- Compared North Annular Mode excitation at high and low solar UV fluxes
- Found that for early (late) winter west (east) QBO solar changes effect the NAM in both the stratosphere and troposphere almost equally

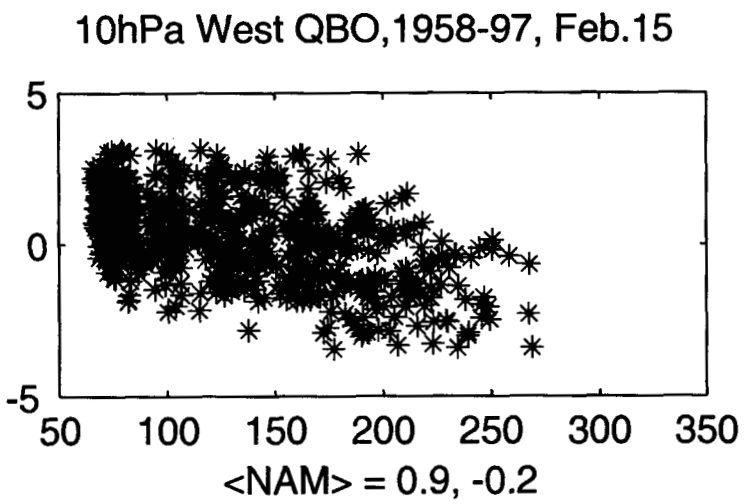
Data

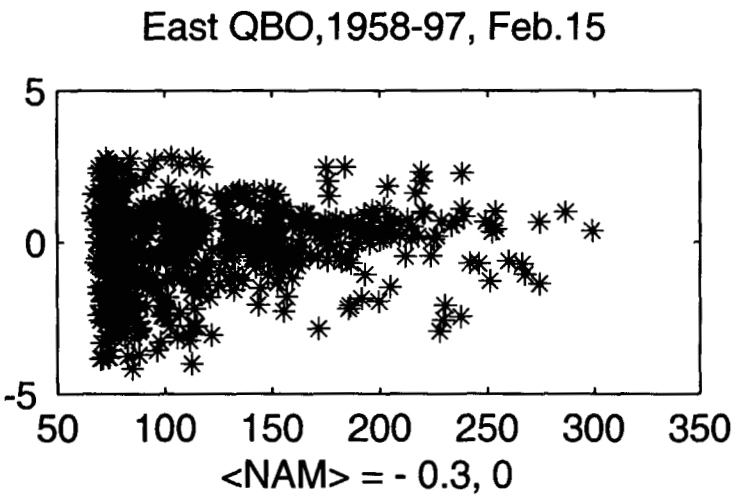
- NAM- first EOF of wintertime geopotential height anomalies

- UV- proxied by 10.7 cm solar radio flux

- QBO- zonal wind anomalies at 40 hPa

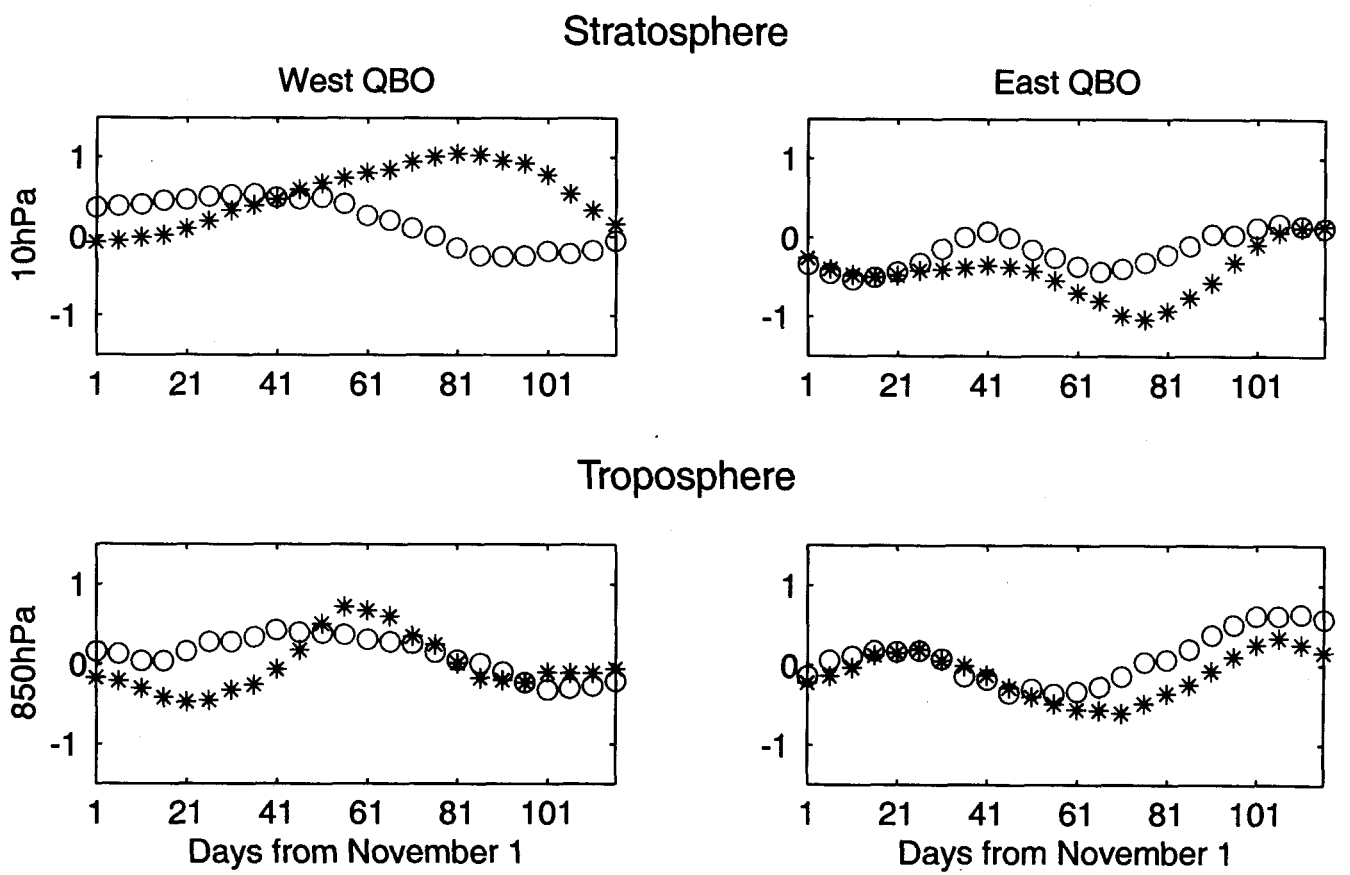
NAM index vs. 10.7 cm radio flux





- 30 days of data from each of 40 years
- Plotted in panel depending on direction of QBO

Solar Influence on the North Annular Mode



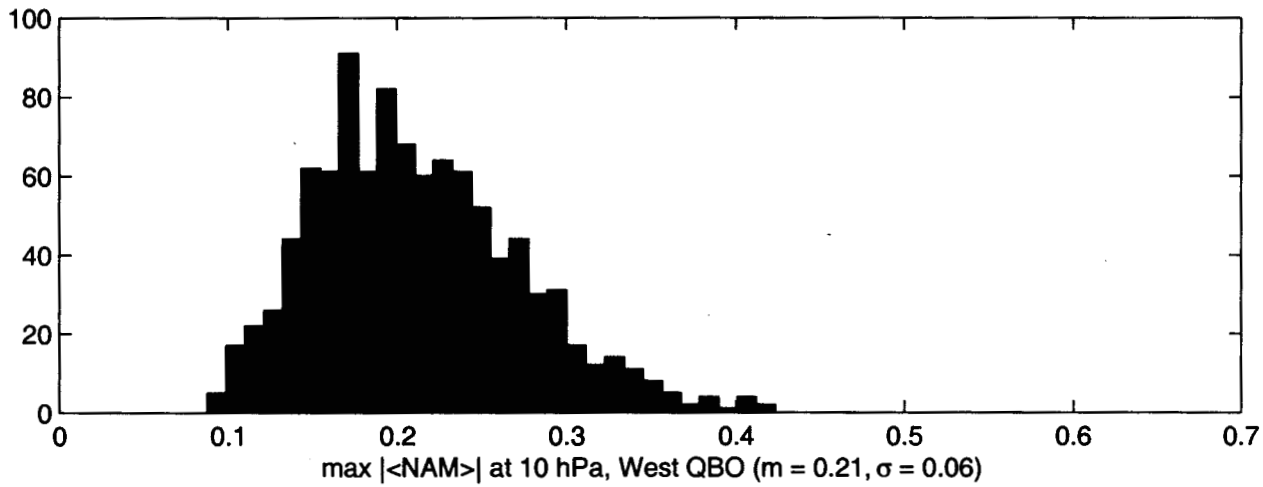
High UV flux - circles, Low UV flux - asterisks

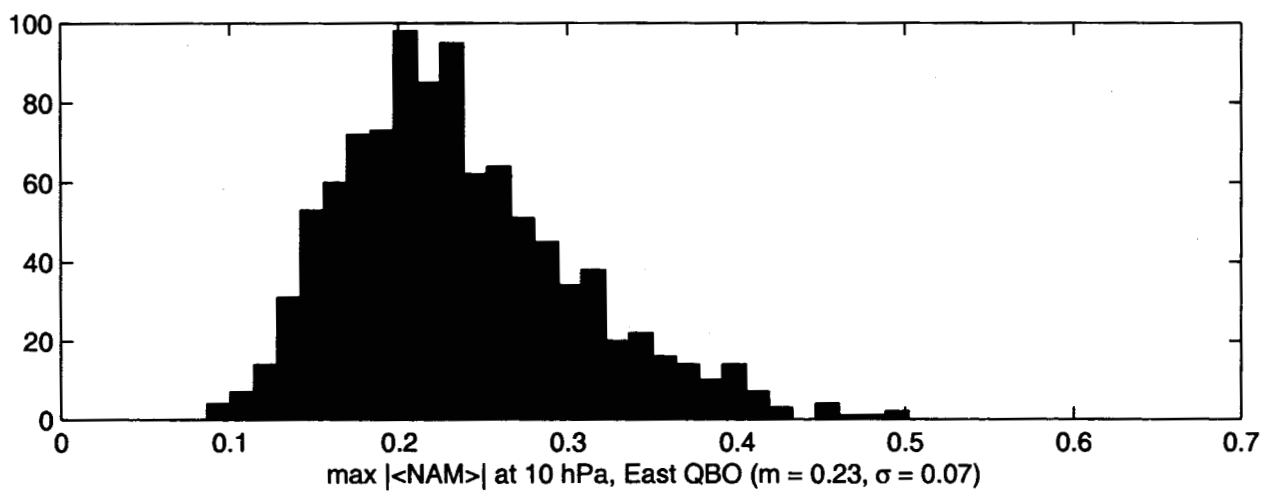
In early (late) winter for West (East) QBO UV effect on NAM is not damped between 10hPa and 850hPa

NAM index is persistently low in troposphere during Maunder Minimum

Ruzmaikin & Feynman(02)

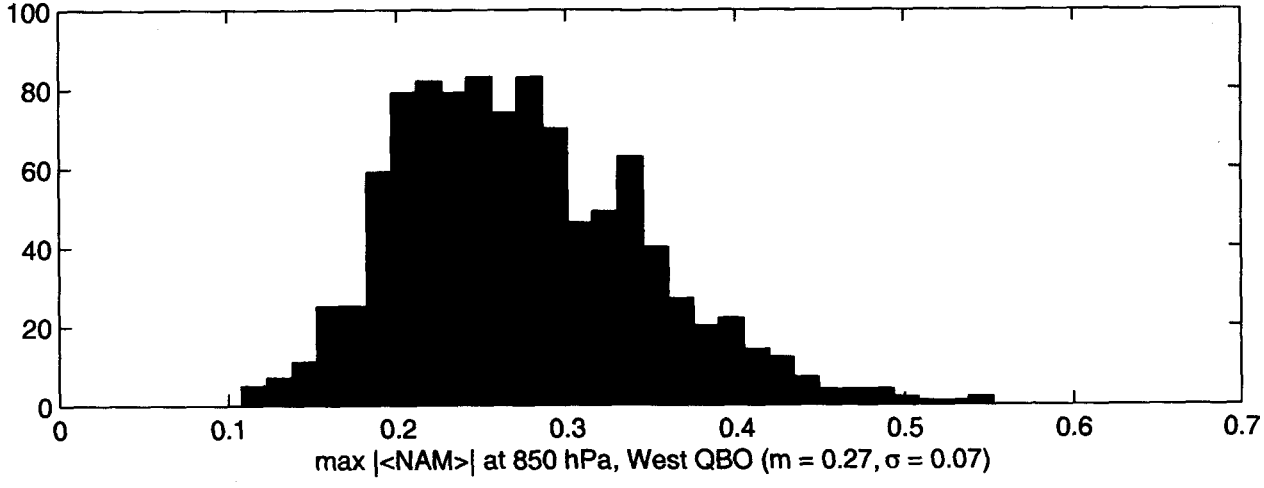
Test of statistical significance (stratosphere)

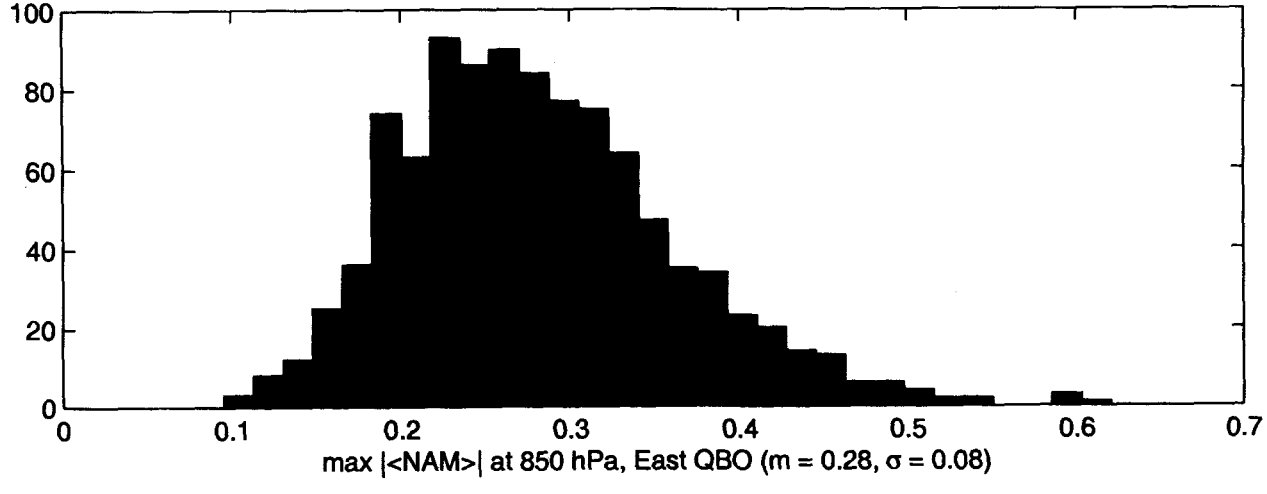




Distribution of 1,000 realizations of max |< NAM >| for West and East QBO and random UV flux at 10 hPa

Test of statistical significance (troposphere)





Distribution of 1,000 realizations of max |< NAM >| for West and East QBO and random UV flux at 850 hPa

Table of significance

	West QBO	**East QBO**
	Nov-Dec	Jan-Feb-March
10 hPa	0.45 (3 σ)	0.72 (4 σ)
850 hPa	0.73 (6 σ)	0.52 (3.5σ)

Chances all four trials exceed 3σ by chance is $<<1 \times 10^{-7}$

Conclusions for Troposphere

- Solar UV variation affects NAM in troposphere for early (late) winter for west (east) QBO.
- The statistical significance of this effect is extremely large.
- Solar UV variation does not affect the NAM in troposphere in late (early) winter for west (east)QBO