(Solar Variability, Earth's Climate and the Space Environment; Bozeman, Montana, June 2008)

Influences of the 11-year sunspot cycle on the stratosphere – and the importance of the QBO

Karin Labitzke,

Institute for Meteorology, F.U. Berlin

Germany

(Labitzke and van Loon, numerous papers, 1987 – 2006) ¹

The topics of my lecture today are:

1) Variability of the Arctic Winters -- the Sun and the QBO

2) Solar Signals in Summer



1956 – 2008: trend = - 0.01 K/dec; sigma = 9.2K (after 2001 = ECMWF)





February

red = warm event

~ El Nino

blue = cold event SO

no correlation with 11 year solar cycle r = 0.22 (n = 67)

Tropical volcanoes W: Agung March 1963 E: Chichon March 1982 E: Pinatubo June 1993

SO	Cold event	cold and strong	(Labitzke and
	Warm event	warm and weak	van Loon, 1987)
QBO	Westphase Eastphase	cold and strong warm and weak	(Holton and Tan, 1980; 1963-1978, n = 18)
SUN	Solar min Solar max	like QBO opposite to Q	(Labitzke + van Loon, BO 1987 – 2006)
AO	High index (+) Low index (-)	cold and strong warm and weak,	(Baldwin and Dunkerton, 2001)

Different forcings influencing the stratospheric polar vortex during the northern winters ⁶



The Quasi - Biennial Oscillation (1988 – 2007)

QBO-definition: 40+50hPa in Jan+Feb)/4

North Pole February 30hPa Heights FU-Berlin







Detrended Temperature, February, NCEP/NCAR, 1948-2006



5 strongest MMWs in east min

nodal point lines: ~ 30S and ~ 55N in both cases

5 coldest winters in west min

Deviations of the zonal mean temperatures (K) in (Jan+Feb)/2 from the long-term mean (1968 through 2002); (shading larger than 1 (2) standard deviations)

Teleconnections, i.e. Correlations between the Arctic and the Tropics



12

Teleconnections – QBO – Solar Cycle

(in the middle stratosphere/ upper troposphere)





July, Northern Summer,

the dynamically least disturbed season



Correlations between the solar flux and the detrended 30-hPa temperatures in July (1968 -2007); red = corr. > 0.4; blue is temp. diff. ¹/₉ 1K



near Nagasaki (1968 - 2007, n = 40)all r = 0.57 east r = 0.84 west r = 0.39

17

ALL: correlations



Zonal mean temperatures in July, 1968-2007

(NCEP/NCAR): left: correlations with 10.7cm solar flux; right: temperature differences (K) between solar max and solar min.

July, 1968 – 2005: Detrended Temperature Correlations (NCEP/NCAR)





Temperature Differences, (solar max – min) standardized: July, 1968 – 2007, n = 40



21

30-hPa Heights, solar max – solar min, bi-monthly through the year



30-hPa heights, solar max – solar min, (Jul + Aug)/2

anomalous wind from the west in solar max, i.e. weaker QBO/East in solar max



anomalous wind from the east in solar max, again weaker QBO/West in solar max





The Constructed Annual Mean Differences, (solar max - solar min), separately for QBO east and west

Temperature differences (K)

Height differences (m)



Weaker QBO in Solar Max

<u>solar min:</u> (H+T)

- QBO east is **stronger**
- and
- polar vortex is
- warmer/weaker

QBO west is stronger and polar vortex is stronger/ colder

But:

<u>solar max:</u>

QBO east <u>and</u> west are weaker in max and the condition of the polar vortex is opposite to solar min (and to H+T) Thank you for your attention



WELCOME TO BERLIN: **STP-12 Symposium 12th-16th July, 2010** (SCOSTEP/ First Announcement; http://www.scostep.ucar.edu)



North Pole February 30 – hPa Heights, NCEP/NCAR + Rec.

22 years later and 16 years back; filled symbols = MMWs; n = 67

6.5 solar cycles; WE in red, CE in blue; van Loon and Labitzke (1994), updated)





 $r = 0.84, T_{diff} = 2.1 K$ $r = 0.39, T_{diff} = 0.8 K$

(sigma = 1K) (near Nagasaki)

(Chichon = March 82/ east; Pinatubo = June 91/east)

Scatter diagrams of the zonal wind (m/s) over the equator at (40+50 hPa)/2 in July (absolute values) against the 10.7 cm solar flux. Period: 1953 – 2007 (n = 55, r = 0.07, Data set Fu-Berlin) Left: years in the east phase of the QBO (n = 25). Right: west phase

The QBO is weaker in solar max and stronger in solar min!





