Changes in Blocking Characteristics During the First Part of the 21st Century

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Introduction

- Atmospheric blocking is a phenomenon that may occur relatively rarely (compared to **smaller** scale phenomenon), but may dominate a region's weather for a whole season.

- Summer 2010 was an example as blocking dominated Russia's weather from May to mid-August.

Introduction

- There is not one set definition widely used, but there is general consensus that blocking results in the reversal of equator-to-pole gradients, or a persistent anomaly.

- A generic definition may be: a long-lived, mid-latitude, mid-tropospheric, quasi-stationary, positive geopotential anomaly.

Motivation

- Wiedenmann et al. (2002) published a 30 –year blocking climatology (1970-1999) that included such characteristics Block Intensity

- We are now 17 years beyond this work.

Methodology

- Lupo and Smith (1995) - intensity index for blocking (BI) and is proportional to the strength of mid-latitude height gradients. This index was refined by Wiedenmann et al. (2002)

- BI = 100*(Zm/RC -1.0)
  - RC = (Zu + 2*Zm +Zd) / 4 (large-scale)
  - NH: 3.04 Units SH : 2.80 Units (~1970 – present)

Methodology

- Data: Used the NCAR/NCEP re-analyses 500 hPa height fields (resolution 2 degrees lat/lon grid).

- All blocking events are archived at: http://weather.Missouri.edu/gcc (NH 1 July 1968 – present / SH 1 January 1970 – present)

Occurrence (1970 – present)

- Northern Hemisphere – about 35 per year
  - Mean duration 9 days
- Southern Hemisphere – 10 – 15 per year
  - Mean duration 8 days
- Typically at the end of the storm tracks
  - NH – Pacific, Atlantic, and Eurasia
  - SH – Pacific (SPCZ)

Climatological Results

- Wiedenmann et al. (2002) showed that blocking was more frequent and intense during La Niña (El Niño) years in the Northern (Southern) Hemisphere. This result could be linked to cyclone variability.

- Lupo, Oglesby, and Mokhov (1997) proposed that blocking characteristics may change in an increased CO_2 and warmer world (become more persistent, occur more often, but weaker overall)

Climatological Results

- Wiedenmann (2002) demonstrated that up until 1999, the long term trend in the SH was for fewer blocking events, and this could be related to the increasingly zonal SH flow in the mid-latitudes.

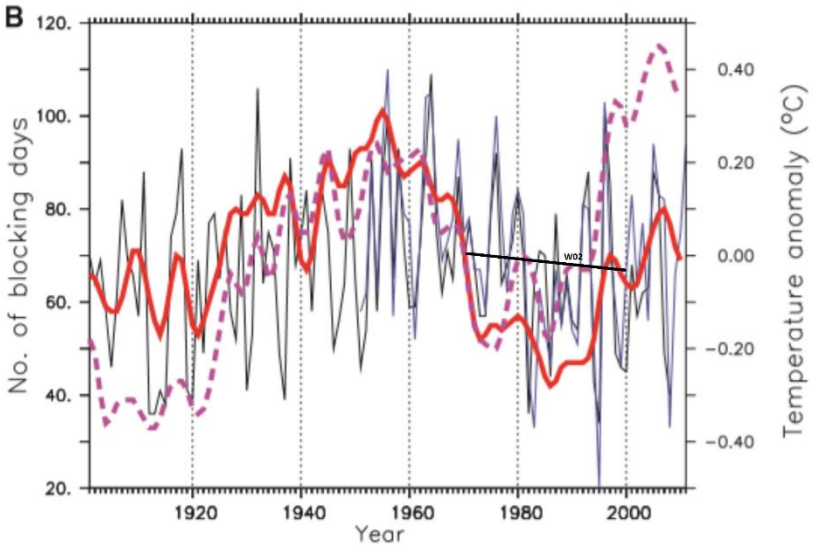
- New analysis shows blocking to be on the increase again globally and this may be related to natural variability or climate change.

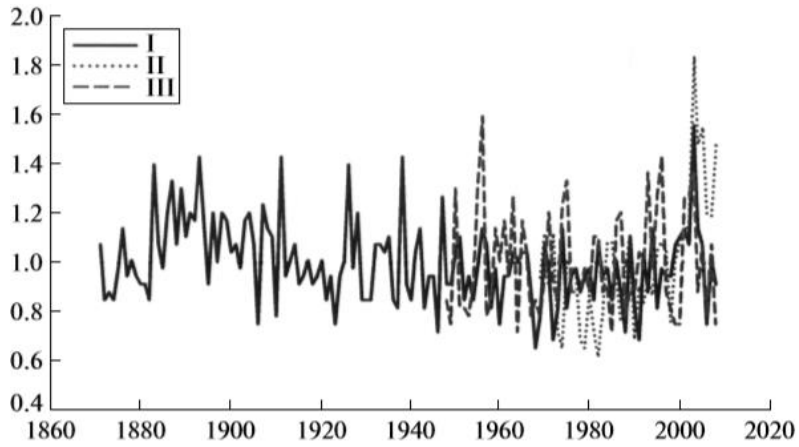
New Results

- Northern Hemisphere
- Wiedenmann et. al. vs. 2000-2016
- Events: 25 vs. 38 - 56% increase
- Duration: 8.2 vs. 9.5 days (12% increase)
- Intensity: 3.21 vs. 3.02 (BI) – (6% decrease)

New Results

- Recent Increase in block occurrence (NH)
  - Hakkinen et al 2011
  - Mokhov et al 2013





New Results

- Northern Hemisphere – table comparing seasonal results the last 19 years with Wiedenmann et al. 2002

	Summer	***Fall***	***Winter***	***Spring***
Occurrence	***7.9 / +51***	***8.3 / +53***	***10.1 / +42***	***11.2 / +53***
Duration	***10.0 / +31***	***9.7 / +20***	***9.7 / +9***	***9.7 / +23***
Intensity	***2.90 / +5***	***3.24 / -12***	***3.56 / -9***	***2.53 / -9***

New Results

- Northern Hemisphere – table comparing interannual and interdecadal results the last 19 years and Wiedenmann et al. 2002.

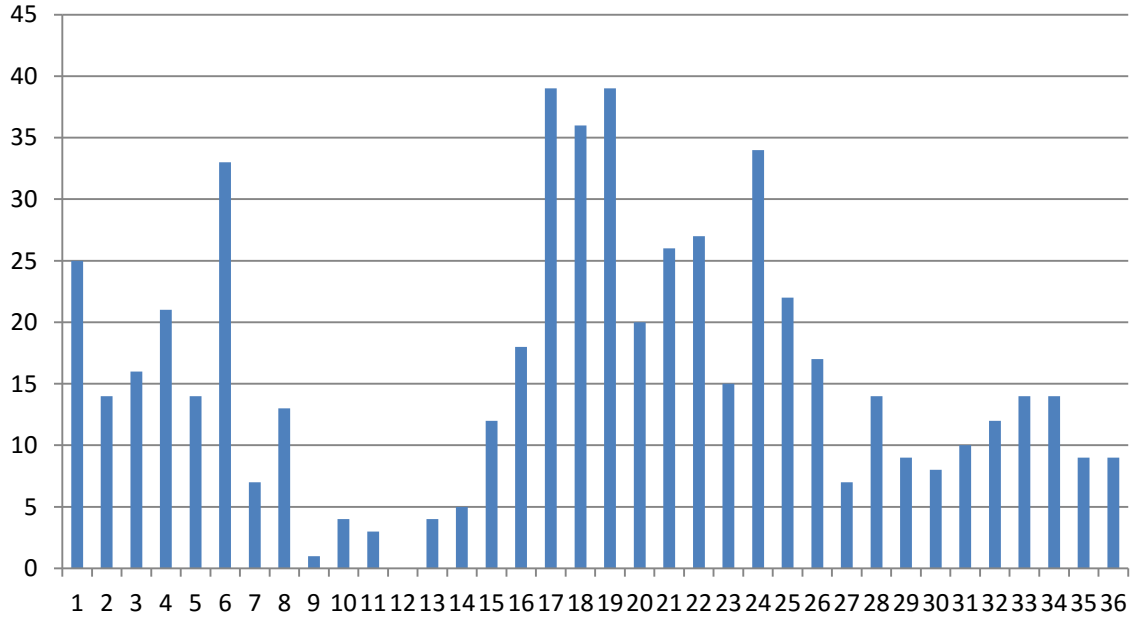
PDO +	***El Nino(6)***	***Neutral(15)***	***La Nina(2)***
Occurrence	**24**	***24***	***31***
Duration	***8.1***	**8.2**	**8.3**
Intensity	***3.06***	**2.86**	**3.11**

PDO -	***El Nino(8)***	***Neutral(9)***	***La Nina(7)***
Occurrence	**37**	**36**	**29**
Duration	**9.6**	**10.0**	**8.4**
Intensity	**3.13**	**3.01**	**3.08**

New Results

- Wiedenmann et al. NH (1970-1999) found:
  - Pacific (140^{o} E – 120^{o} W – peaks 150^{o} E and 150^{0} W)
  - Atlantic (near 0^{o}) Land (50^{o}E – 90^{o} E)

- Now: (similar!)



New Results

- Southern Hemisphere (17 years)
- Wiedenmann et. al. vs. 2000-2016
- Events: 10 vs. 16 – 60% increase*
- Duration: 7.3 vs. 8.0 days (11% increase)
- Intensity: 2.83 vs. 2.86 - no change

New Results

- Southern Hemisphere – Table comparing the last 17 years seasonally with Wiedenmann et al. 2002

	Summer	***Fall***	***Winter***	***Spring***
Occurrence	***1.9 / +53***	***5.1 / +47***	***5.4 / +66***	***3.2 / +80***
Duration	***7.0 / +9***	***8.2 / +9***	***8.5 / +11***	***7.5 / +10***
Intensity	***2.90 / +12***	***2.90 / -1***	***2.88 / -1***	***2.41 / -11***

New Results

- Southern Hemisphere – Table comparing the last 17 years interannually and interdecadally including Wiedenmann et al. 2002

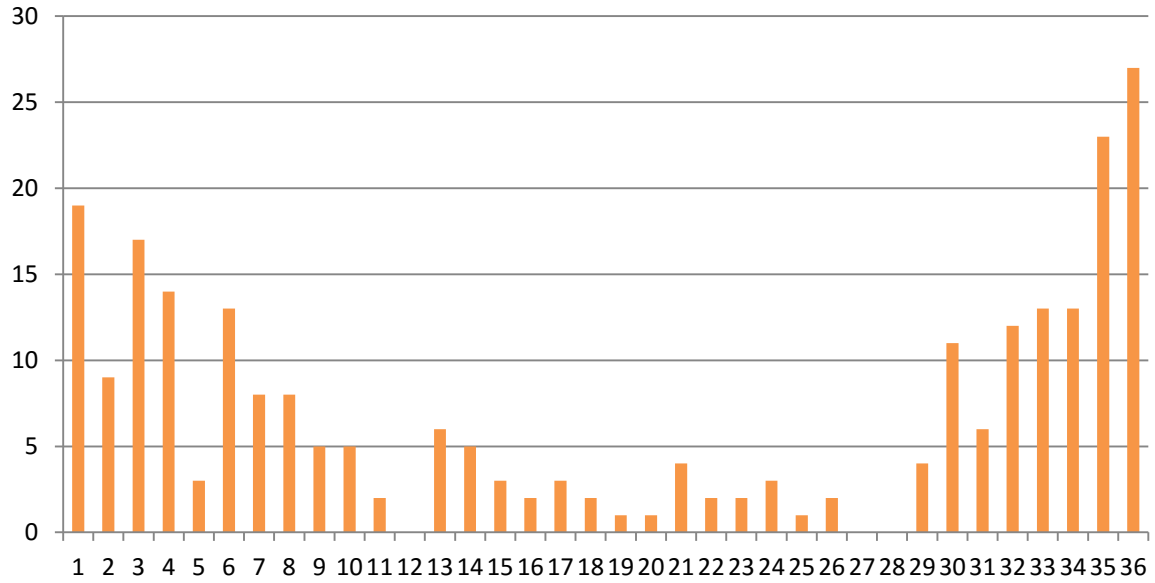
PDO +	***El Nino(5)***	***Neutral(15)***	***La Nina(2)****
Occurrence	**9.0**	**9.5**	**6.0**
Duration	**7.0**	**7.1**	**6.7**
Intensity	**3.02**	**2.76**	**1.87**

PDO -	***El Nino(8)***	***Neutral(9)***	***La Nina(8)****
Occurrence	***14.8***	**16.0**	**12.0**
Duration	***8.4***	***7.8***	***7.6***
Intensity	***2.96***	***2.80***	***2.75***

New Results

- Wiedenmann et al. SH (1970-1999) found:
  - Pacific (140^{o} E – 120^{o} W – peak 170^{o} E)
  - Atlantic (near 50^{o} W) Indian void (50^{o}E – 70^{o} E)

- Now: (similar)



Summary and Conclusions

- In this study, we examined the statistical character of blocking over the entire globe for the 17 years beyond Wiedenmann et al. (2002) .

- The occurrence of blocking has increased significantly in the Northern Hemisphere, and this increase occurred in all but the winter season, and the Atlantic Region.

Summary and Conclusions

- In the Southern Hemisphere, the occurrence of blocking increased significantly only in the winter and spring seasons, and in the Atlantic and Indian Ocean basins.

- There were no notable changes in where block onsets occur in either hemisphere, or any significant changes in intensity (although blocking is weaker across the NH).

Summary and Conclusions

- Blocking events are longer lived across all regions and seasons, however, none of these increases are significant.

- The variability (as measured using standard deviation) has increased for blocking occurrence and duration, but has not changed for the intensity (decreased) for SH (NH) blocking.