B01-P03

THE GREENLAND BLOCKING INDEX 1948-2014: A KEY INDICATOR OF ARCTIC-MID LATITUDE WEATHER/CLIMATE COUPLING?

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At the regional level, the AO and NAO are strongly related to the incidence and intensity of blocking high pressure over Greenland, which has recently been defined the Greenland Blocking Index (GBI; Fang 2004, Hanna et al. 2013 & 2014, Woollings et al. 2010). We relate GBI changes to changes in hemispheric wave numbers and patterns (marking the dynamic forcing of polar jet-stream flow by Greenland blocking), Greenland temperature trends (depicting the thermodynamic signal of geopotential height/GBI changes) (Rajewicz & Marshall 2014), and anomalous SST patterns in the western tropical Pacific (Ding et al. 2014): by synthesising and extending recent analyses, we'll therefore resolve the relative importance of these processes as a measure of Arctic-mid latitude climate connectivity. The present analysis is based on NCEP/NCAR Reanalysis data spanning 1948- 2014.

Most monthly GBI series show little overall long-term trend. The two most notable exceptions are in June and especially October where significant increases are seen. Likewise, there are no significant overall annual and seasonal GBI trends, except for autumn (OND) which shows an increase. However, since 1981 GBI shows a significantly increasing trend for most seasons. Four of the five highest June GBI values occurred in years since 2007 inclusive - indeed all of the five highest GBI summers, JJA, were during 2007-2012 - and three of the five highest December GBI values were in the 2000s.

GBI has also become more variable in the last few decades in December, in line with significantly increased NAO variability in that month (Hanna et al. 2014). There has been a significant clustering of extreme December GBI values since 2004, including the two highest (2010 & 2009) and two of the five lowest (2011 & 2004) GBI values. Other months/seasons which have shown a significant recent clustering of extreme GBI values are June and summer (record high GBI values only), and spring (record high and low GBI values).

Regression coefficients were calculated between the GBI and NAO monthly time series to quantify how much they co-vary. Regression analysis was then used to subtract that part of GBI that is linearly related to the NAO, in order to examine a residual quantity of the GBI that is uncorrelated with the NAO. We then correlated this 'residual' GBI series with Composite Greenland Temperature (CGT3; Hanna et al. 2012), to examine the co-variation between the two. In this way, we attempt to resolve the relative dynamical (NAO) and thermodynamical components of the GBI.

The significant GBI increases in October/autumn and in June are likely to have intensified episodic blocking of prevailing westerly winds, with a greater influence of Greenland in setting up Rossby waves in the jet-stream flow, and led to more meridional airflow in those months/seasons in the northern North Atlantic. The recently more variable Greenland Blocking conditions in December may signify a destabilisation of the polar jet stream flow, possibly partly in response to dramatically reduced Arctic sea-ice cover in late summer/early autumn and its subsequently delayed seasonal growth in late autumn/early winter.