Radically Shifted Atmospheric Circulation and Intensified Anticyclones: Causes of Recent Extreme Cold Weather Events in Eurasia

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#### • Drastic declining sea ice over the Atlantic Arctic Ocean





Atlantic Arctic Ocean: Barents Sea, Kara Sea, and Laptev Sea

## • <u>Surface air temperature increase pattern has shifted: Amplified</u> warming over the Arctic but cooling over Eurasia



# **Scientific Question:**

What has driven the temperature increase pattern shift along

with the rapid declining Arctic sea ice?

**Hypothesis:** 

It is a change in the atmospheric circulation.

### • Spatial pattern change in the atmospheric circulation



## • Accelerated poleward shift unprecedented invasion into the Barents Sea of the polar center of action

**Running EOF/PC (Rn-EOF/PC) analysis:** 

- 30-winter-month running window
- EOF/PC analysis seeks spatiallyand temporally-coordinated pattern that explains maximum variance and identifies centers of action



Zhang et al., 2008

# • Atmospheric circulation pattern shift and the Arctic Rapid change Pattern (ARP)



#### <u>ARP has not only orchestrated rapid changes in the Arctic climate</u> system but also played driving role in midlatitude climate

![](_page_7_Figure_1.jpeg)

# <u>Monthly or seasonal mean temperature cannot reflect extreme cold</u> <u>events</u>

Time	Station	Coldest Daily Minimum SAT	Monthly Mean Daily Minimum SAT
Jan 2006	TARKO-SALE (235520)	-54.2	-29.1
Jan 2008	NJURBA (246390)	-55.5	-40.4
Dec 2009	NJURBA (246390)	-50.3	-37.6
Jan 2010	SUNTAR (247380)	-51.5	-38.2
Feb 2012	UST-MAJA (249660)	-51.0	-40.8

Eurasian cyclones has weakened and anticyclones has intensified

![](_page_9_Figure_1.jpeg)

<u>Zhang et al. (2012)</u>

![](_page_10_Figure_0.jpeg)

# **Summary**

• The atmospheric circulation pattern drastically shifted since the mid-1990s.

• The extremely shifted atmospheric circulation pattern (ARP) has enhanced Arctic-global climate interactions:

1. It built up a shortcut for warm air/water inflow into the Arctic, amplifying Arctic warming and sea ice melting.

2. It redistributed polar cold air to Eurasian midlatitude, causing cold weather events there.

• Anticyclone activities have intensified over Eurasia, playing a fundamental role in causing daily-based extreme cold weather events.