Northern Hemisphere Flow Regime Transitions, Blocking, and the Onset of Spring in the Central USA

Madeline A. Est

Samuel Mount

Anthony R. Lupo

Atmospheric Science Program

University of Missouri

Columbia, MO 65211

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Introduction

- The work of Klaus et al. (2020) demonstrated that Integrated Enstrophy (IE) reliably / skillfully identifies changes in the Northern Hemisphere flow regime as much as 10 days in advance when using an ensemble forecast model.

- Many studies have demonstrated that atmospheric blocking has a profound impact on weather and climate (temperature and precipitation) over very large portions of the globe.

Introduction

- For North America, blocking in the Gulf of Alaska region generally leads to colder conditions over the USA, this is especially true if coupled with an Atlantic blocking

- The weather and climate of the central USA during February and March 2019 were influenced by upstream blocking during this period of time, before the onset of a warmer spring flow regime over the central USA.

Motivation and Goal

- The cold weather during February and March 2019 was related to upstream and downstream blocking.

- The atmospheric flow regime changed abruptly and could be associated with IE maxima that were projected by the National Centers for Environmental Prediction (NCEP) North American Ensemble Forecast System (NAEFS)

- It will be demonstrated that blocking and IE can be associated with these changes including the onset of a warmer period following the cold outbreaks.

Data

- 500 hPa daily height fields (m) at 1200 UTC for February and March 2019 were used to calculate integrated enstrophy. These data are provided by the (NCEP/NCAR) reanalyses, on 2.5° by 2.5° latitude-longitude grids.

- Climatological Data were provided by the USA's National Weather Service (NWS). Teleconnection data were obtained from the Climate prediction center.

- The University of Missouri Blocking Archive provided the information for the blocking events.

Methods

- We calculated IE using the procedure found in Klaus et al. (2020)(Atmsophere) which used the 500 hPa heights and calculated geostrophic relative vorticity using finite differencing.

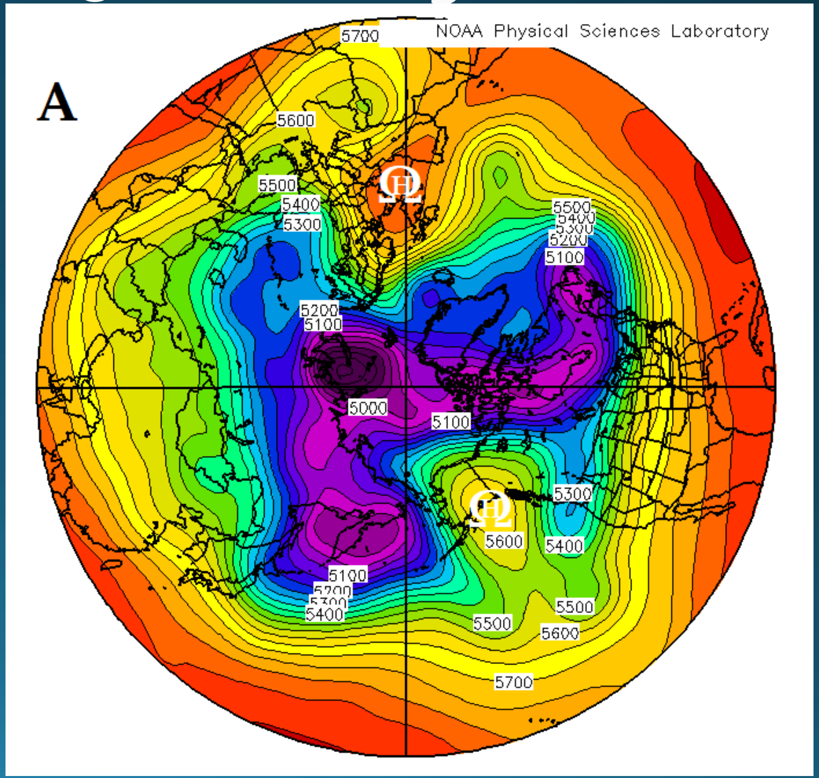
$$\mathrm{IE} = \sum_{i>0} \lambda_i \approx \int_A \zeta^2 dA$$

- Blocking events and characteristics are evaluated following Wiedenmann et al. (2002) (J. Climate). These included onset, duration and Block Intensity (BI).

Results

- Blocking occurred over the Atlantic from 20 February to 1 March 2019 over western Europe (BI = 5.16 – strong) and over the eastern Pacific from 23 February to 10 March (BI = 5.02 - strong) and 16 to 25 March 2019 (BI = 4.5 – strong).

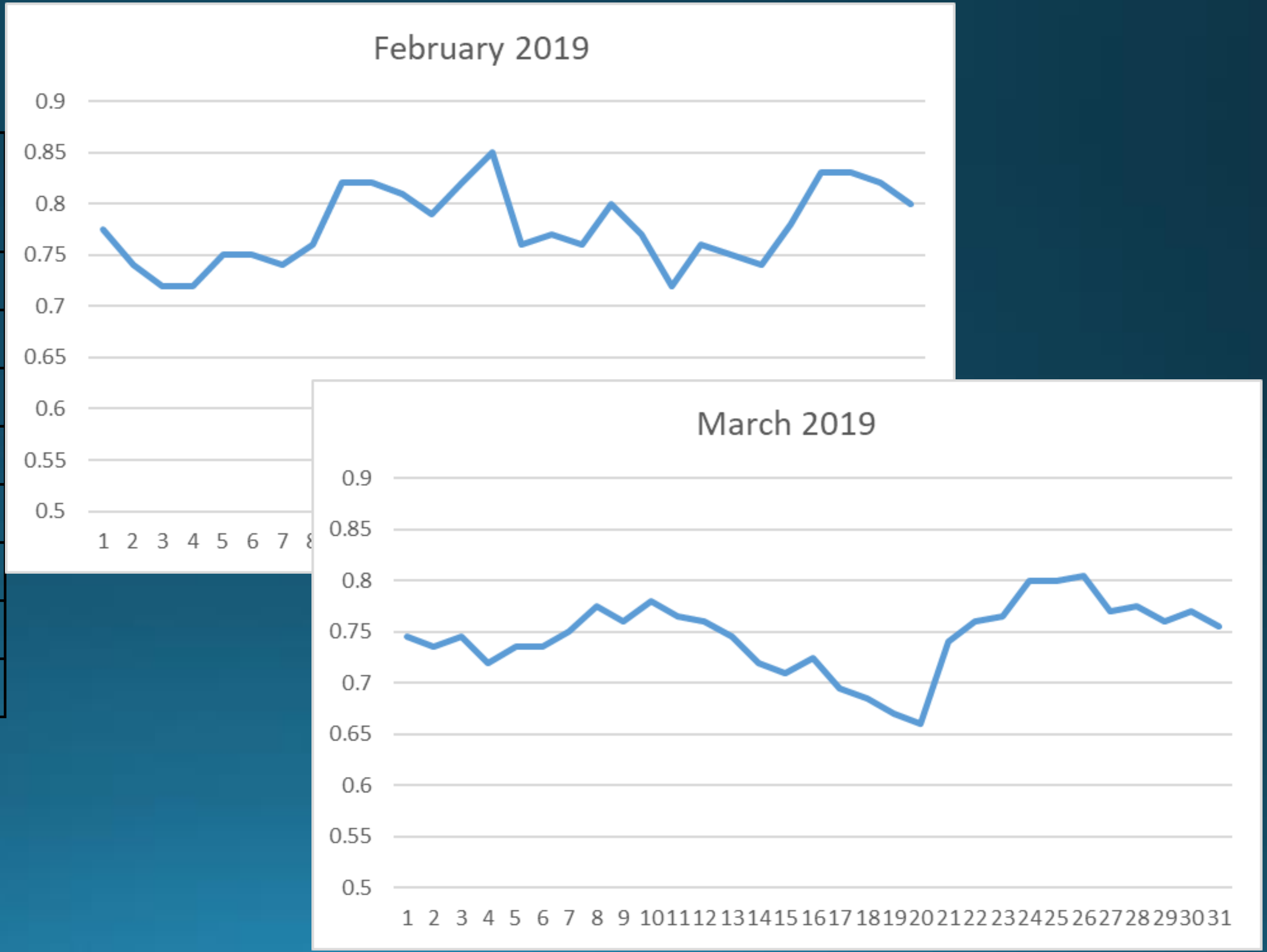
- Example: 1200 UTC 26 February 2019



Results

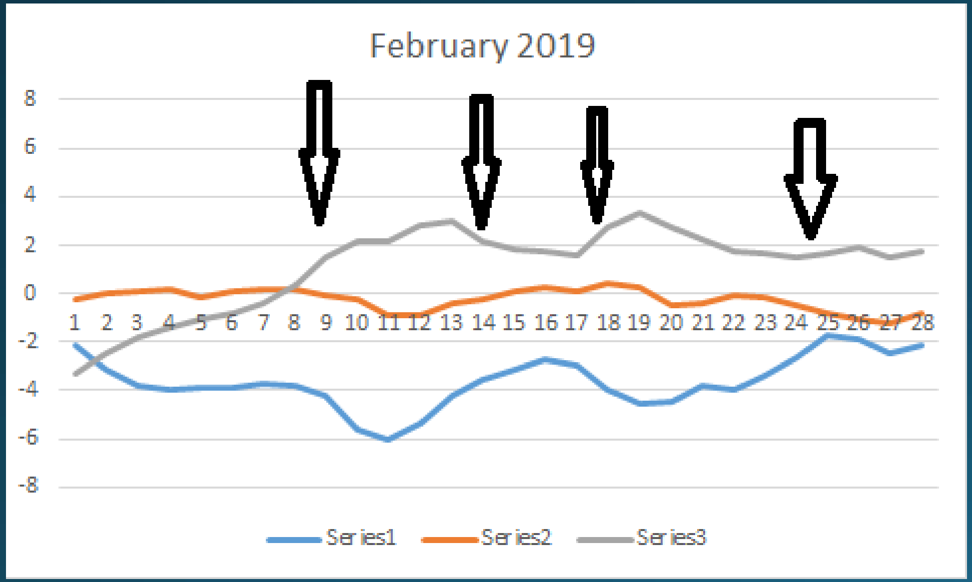
- Integrated Enstrophy Maxima during February and March 2019.

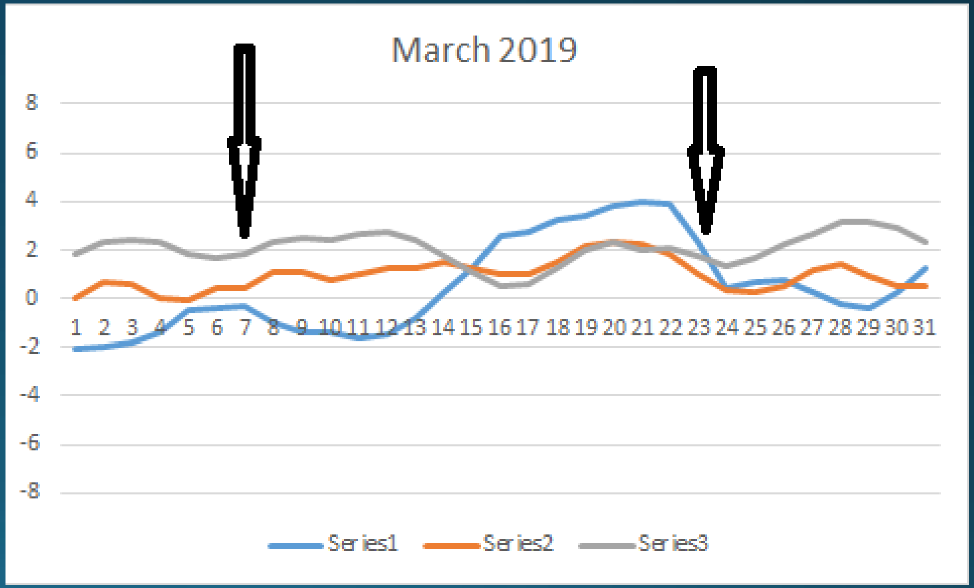
Date	Forecast out 10 days	Forecast Peak Intensity
1 February	No	7 Days
9 February	Yes	7 Days
14 February	Yes	7 Days
18 February	No	7 Days
25 February	Yes	7 Days
7 March	Yes	10 Days
24 March	Yes	6 Days



Results

- Teleconnections (Blue = PNA Orange = NAO   Gray = AO)





Results

- The Map of the USA (star = study site)

Results

- Temperature Anomalies (°C) and precipitation totals (mm) presented for:
- Pre blocking: 1 – 19 February
- Double Blocking: 20 February – 9 March (roughly lines up with 18 February to 7 March IE maxima)
- Interblock: 10 March – 15 March
- Second block: 16 March – 25 March

Results

- The table (The period 14 February – 28 February 2019 was accompanied by 30 cm to 8 cm of snow in the northern part of the state from west (EAX) to east (STL).
- Table showing temperature anomalies (left – °C) and precipitation (right - mm)

Period	COU	EAX	STL	SGF	DFW
Pre-block	-0.7 / 46.5	-2.0 / 35.8	-0.4 / 80.3	0.7 / 66.5	1.5 / 30.0
Blocking (double)	-4.6 / 39.9	-6.7 / 34.8	-4.1 / 48.3	-3.3 / 34.3	-3.3 / 12.2
Interblock	1.5/ 30.7	1.0 / 17.8	1.4 / 27.2	0.4 / 34.8	0.3 / 41.4
2nd block	1.0 / 1.3	1.3 / 6.4	-0.3 / 16.0	0.4 / 6.9	0.6 / 0.0

Summary and Conclusions

- This study examined the influence of flow regime changes and the correspondence to blocking over the Missouri Region of the USA. The second author's home is DFW in Texas and this was examined to determine how far south the cold outbreak reached.

- The northern hemisphere flow changed strongly on 14 February and blocking was established in the Pacific on 20 February and in the Atlantic on 23 February. Blocking lasted until 10 March. Daily temperatures were as much as 20° C below normal

Summary and Conclusions

- The northern hemisphere flow switched abruptly again on 7 March and the temperature s rebounded rapidly to just above seasonal normal.
- In the pre-block environment, the temperature ranged between -2° C below normal north and west to 1.5° C south. Then during the blocking events, the temperature ranged from -6.7° C below normal to -3.3° C below normal. Following the blocking events, the temperatures were generally near normal to above normal.

Summary and Conclusions

- The temperature anomalies are more severe (not shown) if the 14 February to 7 March IE maxima are used as benchmarks. Early February and late March were warm with respect to normal.

- IE maxima which are anticipated well in an operational ensemble model, can signal drastic changes in regional weather conditions.

Summary and Conclusions

- Questions?
- Comments?
- Criticisms?
- mae4yx@mail.missouri.edu samuelmount@mail.Missouri.edu lupoa@missouri.edu