Statistical Correlation Between Jet Superpositions and Extreme Weather Events in the Winter/Cool Season

Investigators: Nathan Bailey, Jay Edelmon, James McAllister, Cal Watson; Mentor: Dr. Steven Cavallo.
School of Meteorology, University of Oklahoma; Norman, OK.

Introduction

Motivation:

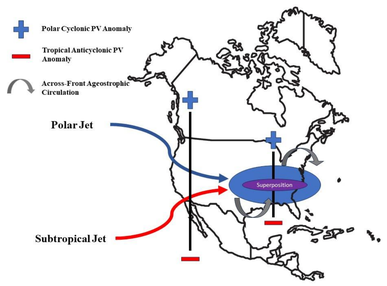
- Extreme weather events are recognized as a direct result of an ever-changing climate.
- There is growing concern among the scientific community that extreme weather events will have drastic socioeconomic reverberations through the end of the century.
- Previous studies have focused on jet superposition concepts independently and in a theoretical framework, but a systematic examination between these events had not been conducted.

Background:

- A jet superposition occurs when the latitudinal separation between the polar and subtropical jet vanishes (Winters et al. 2020b).
- Jet superposition development is preceded by a polar cyclonic potential vorticity (PV) anomaly or a tropical anticyclonic PV anomaly (Winters and Martin 2017).
  - Juxtaposed PV anomalies coupled with mesoscale processes in the near-jet environment act to restructure the tropopause and produce the deep layer associated with jet superpositions (Winters et al. 2020).
- Jet superpositions are characterized by the presence of stronger wind speeds and increased baroclinicity in horizontal and vertical circulations (Handlos and Martin 2016).
- Jet superpositions are known to lead to surface cyclogenesis, tropospheric frontogenesis, and restructuring of the tropopause, all precursors to high-impact weather events (Winters and Martin 2017).

Research Questions:

- Is there a statistical correlation between jet superpositions and extreme weather events in the North American cold season (November to March) from 1979-2010?
- During this time frame, what is the most dominant type of jet superposition, specifically polar dominant, subtropical dominant, or hybrid (Winters and Martin 2016; Winters et al. 2020a)?
- For the dominant type of jet superposition, what is the distance that extreme weather events can be separated from the superposition event?



Data and Methods

Data:

- National Centers for Environmental Prediction (NCEP) Jet Superposition Locations between 1979 and 2010 (November through March).
- National Centers for Environmental Information (NCEI) Storm Events Database Records for cold season weather events (November through March).

Methods:

- Identified the locations of extreme weather events in the North American cold season, using the NCEI Storm Events Database.
  - Events were synoptically-forced, including blizzards, extreme cold, heavy snow, ice storm, or winter weather, in general.
- Identified the most dominant type of jet superposition, using NCEP reanalysis data.
- Analyzed and compared the densities and locations of jet superpositions and extreme weather events, working backwards from the identification of extreme weather events.

Results

Extreme Weather Event Type	Number of Events
Winter Storm	73,754
Winter Weather	64,504
Heavy Snow	59,102
Ice Storm	11,534
TOTAL	**208,894**

Table 1: Number of Extreme Weather Events by Type

Dominant Jet Superposition Type	Number of Events
Subtropical	129
Hybrid	117
Polar	80
East Subtropical	76
West Subtropical	53
TOTAL	**455**

Table 2: Number of Jet Superpositions by Type

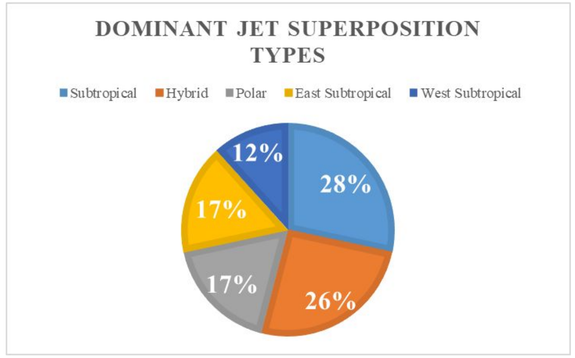


Chart 1: Percentage of Jet Superpositions by Type

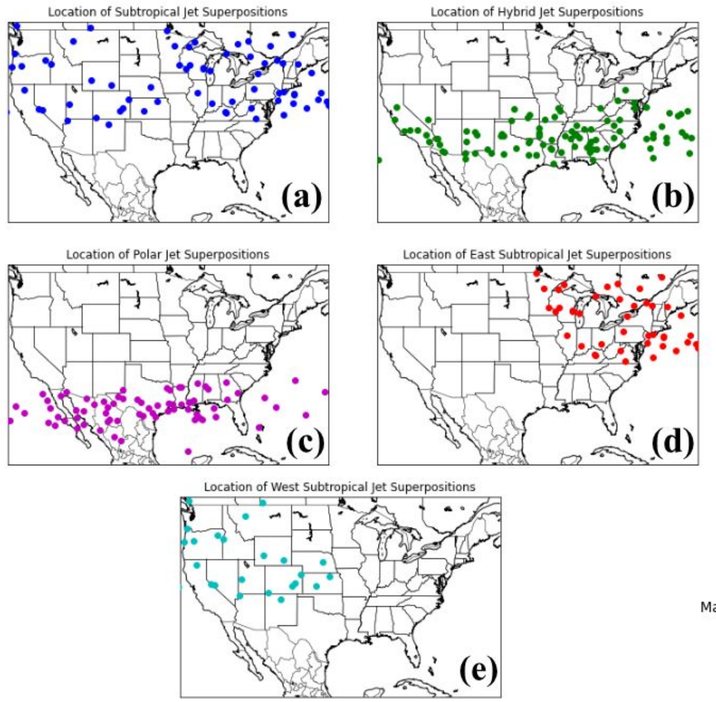


Figure 1 (a-e): Density Plots of the Locations of Jet Superpositions in the contiguous United States from 1979 to 2010, based on the five dominant types of superpositions: Subtropical, Hybrid, Polar, East Subtropical, and West Subtropical

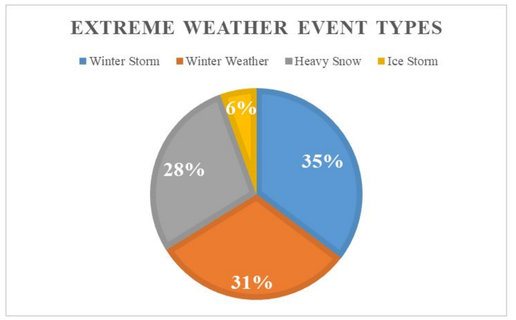


Chart 2: Percentage of Extreme Weather Events by Type

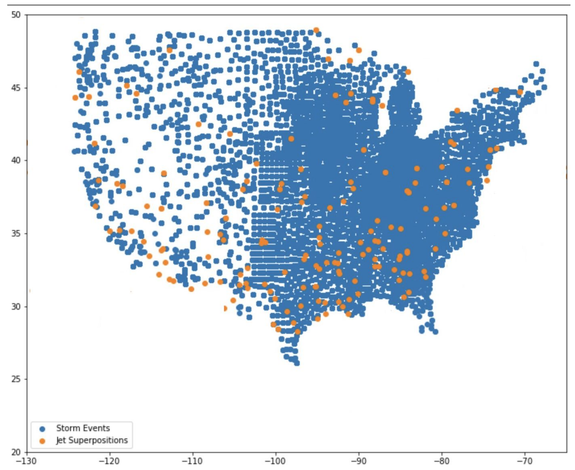


Figure 2: Density plot of Extreme Weather Events overlaid with Jet Superpositions in the contiguous United States from 1979 to 2010

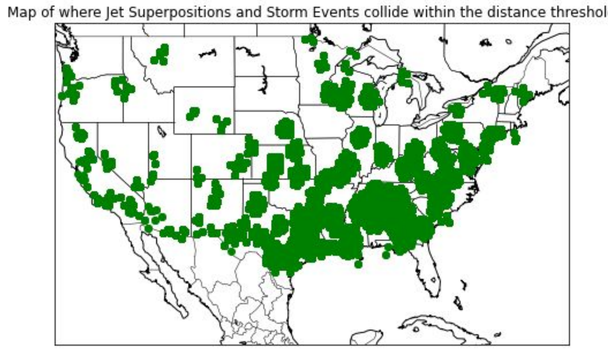


Figure 3: Plot of locations where Jet Superpositions and Extreme Weather Events were within 100 kilometers in the contiguous United States from 1979 to 2010

Conclusions and Discussion

- Over the 31 year period from 1979 from 2010, there were 208,894 extreme weather events in the cold season.
- Winter storms are the most common type of extreme weather events, comprising 35 percent of all events.
- 455 jet superposition events were identified from 1979 to 2010 in the United States.
- Subtropical (28.4 percent) and hybrid (25.7 percent) superposition types are identified as the most common types.
- Of the storm events identified, 135,531 occurred within 100 kilometers of a jet superposition event, or 61.12 percent of storm events.
- In random sampling, 4835 storm events occurred within 100 kilometers of a jet superposition, or 2.18 percent of storm events.
- From these results, it is concluded that 58.94 percent of storm events occurred within 100 kilometers of a jet superposition.

References and Acknowledgements

References:

Winters et al. (2016, 2017, 2020)

Handlos and Martin (2016)

Acknowledgements:

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