Introduction

Areas that reside in the high-latitudes such as the northern United States can experience hazardous conditions during the winter months due to snowstorms. When strong winds exist with falling or freshly fallen snow, blizzard conditions can cause significant personal, societal, and economic impacts for the Northern Plains. A blizzard is defined as an event with “sustained wind or frequent gusts of 16 meters per second or greater, accompanied by falling and/or blowing snow, frequently reducing visibility to less than 400 meters for 3 hours or longer.” While the climatology for these extreme snowstorms is known, the frequency and intensity of how these events may change in a warming climate is not certain.

Goal: Identify atmospheric patterns associated with blizzards and investigate the frequency of these patterns in past and future climates simulations

Northern Plains Blizzards Climatology

- Northern Plains is the blizzard capital of the continental United States (Coleman and Schwartz, 2017) (Fig. 1).
- Grand Forks National Weather Service (NWS) office maintained a database of historical blizzard cases. The blizzard events were also archived in the National Center for Environmental Information (NCEI) Storm Events Database.

Blizzards in the Northern Plains generally occur due to one of three distinct patterns: Colorado Lows, Alberta Clippers, and Arctic Fronts (Fig. 2). There are also types that have characteristics between the three patterns, called Hybrids.

Methodology

- Created a SOM using the North American Regional Reanalysis (NARR, Mesinger et al., 2006).
- To directly compare the NARR to the Global climate model (GCM), the NARR data were averaged to a 16x16, 0.5° (latitude) by 1.25° (longitude) grid, matching the GCM.
- To avoid any biases between models, surface temperature and MSLP anomalies were used to classify patterns.
- To determine how the frequency of blizzard patterns change in the future, the Community Earth System Model (CESM) Mother of All Runs (MOAR) was used.

Results: 4x2 Blizzard SOM

- The 4x2 blizzard SOM demonstrates that it can segregate between many of the patterns (Fig. 4). Hybrid classes occur across a number of patterns; this is expected considering subjective classification defines these events as having characteristics of multiple patterns.

Results: Objectively Classified Patterns

- Created a SOM based of all historical patterns of MSLP anomalies using the NARR (every 12 hours for the past 35 years)
- Blizzard patterns were isolated within all climatological patterns within the SOM
- Blizzard patterns were identified by classes that matches historical blizzard patterns, but were more specific.
- The automated blizzard pattern identifies more events than observed blizzards (Fig. 7 & 8).
- These results are expected, as surface conditions and precipitation are not considered, and have a large role in determining whether or not a blizzard pattern actually results in a blizzard.

Results: Blizzard Patterns in CESM

- Average number of blizzard patterns per year
  - CESM Historical: 16
  - CESM RCP4.5: 13
  - CESM RCP8.5: 14
- RCP4.5 has a 18.5% decrease in blizzard frequency, while RCP8.5 has a 13.3% decrease compared to the historical run

Future Work

- Refine automated blizzard pattern recognition to maximize probability of detection and minimize false alarm ratio
- Verify automated monthly number of blizzards by type matches what is observed
- Determine reasoning for the decrease in blizzard patterns in CESM future projections
- Are certain patterns not occurring as often?

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