STEM

Covariation of Snowfall Patterns in the Northeastern United States with the Location of the Gulf Stream

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Why can winter snowfall for some locations vary so much from year to year? This project seeks to explore the relationship between interannual variability of seasonal snowfall in the Northeastern United States and the location of the Gulf Stream in the Atlantic Ocean. Along the northern edge of the Gulf Stream, a strong near-surface air temperature gradient exists with the sharp boundary separating warmer water to the south and cooler water to the north. This temperature gradient serves as the principal energy source for extratropical cyclones, which suggests that its location may have an effect on snowfall patterns in the region. We hypothesize that northward shifts in the Gulf Stream cause a corresponding northward shift in snowfall patterns.

We test our hypothesis in two simple manners. First, we regress snowfall onto Gulf Stream latitude. For snowfall, average latitude of a fixed amount of land-based snowfall is tested, as well as the full spatial distribution of snowfall at every grid point onto the time history of average Gulf Stream latitude. Second, we regress the latitude of historical storm tracks onto Gulf Stream latitude, because these provide the intermediate physical link between the Gulf Stream and snowfall patterns. For these analyses, snowfall

data are taken from the North American Regional Reanalysis, sea surface temperature data are from the National Oceanic and Atmospheric Administration's (NOAA) OI SST V2 High Resolution Dataset, and historical storm tracks are from NOAA NCEP.

The first analysis showed average snowfall latitude shifts northward with Gulf Stream latitude for the month of December, but not for the months of January, February, or March. This result was consistent across both one-dimensional and two-dimensional regressions of snowfall onto the Gulf Stream. The final approach examining storm tracks did not yield a positive correlation between mean storm track latitude and Gulf Stream latitude. This hypothesis may be further tested by studying how the results change under different El Niño conditions, or by running simulations in a controlled environment instead of using historical data.

Research advisor Dan Chavas writes: "Variability in winter precipitation in the Northeastern United States depends strongly on the location of the parent storm track relative to the coastline. The Gulf Stream creates a strong baroclinic zone that serves as an energy source for storms. Will's research is the first to test for spatial covariance among snowfall, storm tracks, and the Gulf Stream, which is the first step towards improved predictability on monthly-to-seasonal timescales."

Map showing how average latitudes of the Gulf Stream and storm tracks are computed.