Storm-relative movements of mesoscale snow bands within coastal Northeast U.S. storms

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Introduction

Winter storms in the Northeast U.S. often develop elongated bands with locally higher snow rates. Weather forecasting models have difficulty predicting these enhanced snowfall bands since the processes governing band characteristics are poorly understood. Radar observations show that snow bands occur in two main modes, single bands and multi-bands. Single bands are defined as snow bands that are > 250 km in length and usually only occur one at a time during a storm. Multi-bands are sets of smaller bands, usually roughly parallel to each other that move as group. Sometimes multi-bands will converge with a larger single band. In other storms, multi-bands will move parallel to the storm motion and do not converge. This project seeks to better understand the conditions under which different types of snow bands occur.

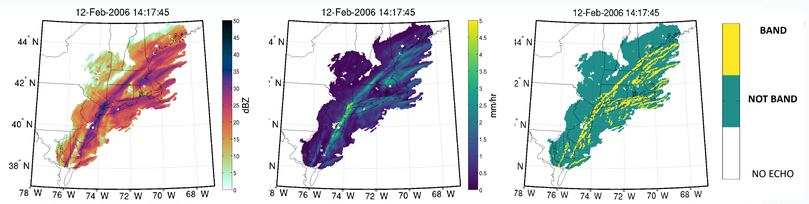
Methods

Dataset

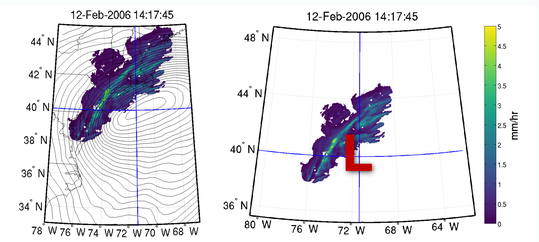
108 winter storms within the coastal Northeas United States region from 1996-2016 were analyzed. North American Regional Reanalysis and radar data from six National Weather Service operational radars (KOKX, KBOX, KDIX, KDOX, KENX, KGYX) was used in this project.

Materials

Using the methods described in Hoban (2016), the radar reflectivity is converted into snow rate which is then used to isolate the snow bands (yellow) from areas without bands (green).



12 Feb 2006 1417 UTC examples of reflectivity (left), snow rate (center), and convective stratiform (right)



12 Feb 2006 1417 UTC: snow rate with surface pressure contours (left), snow rate with low pressure center (right)

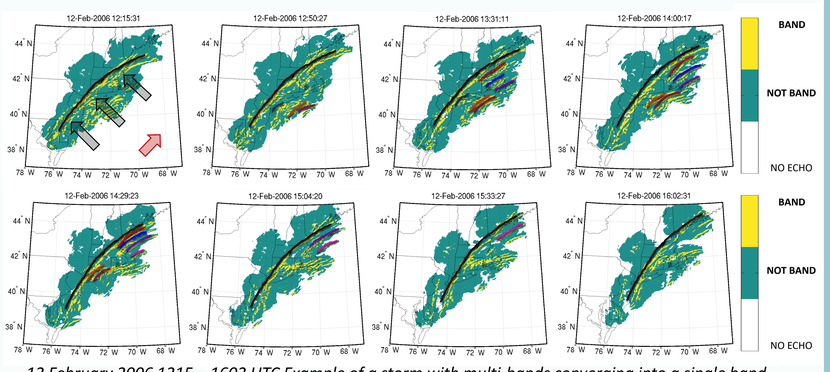
We use information on the track of the low pressure center to view the storm in a Lagrangian framework. This allows us to focus on the bands' motion relative to the low center. The blue lines divide the storm into quadrants.

Band Scenarios

Of the 108 storms that were studied, 79 storms were identified as banded storms (having a single band, multi-bands, or a combination of both present for a part of the storm duration). Of the 79 banded storms, 19 were identified with perpendicular-moving convergent bands, 21 were identified with parallel-moving bands, and the remaining 39 could not be classified as either perpendicular or parallel moving.

Convergent bands

Some snow bands move perpendicular relative to the storm motion. Below is a sequence of images every ~30 minutes that illustrates the convergence of multi-bands into a single band. In the first image below, the direction of the band movement is represented by the black arrows and the overall storm direction is represented by the red arrow. This convergence may in effect 'fuel' the single band.

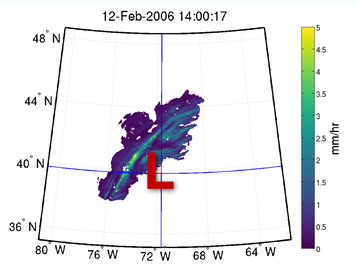


12 February 2006 1215 – 1602 UTC Example of a storm with multi-bands converging into a single band

The single band is highlighted with a black line and the colored lines show various multi-bands in the storm. Highlighted multi-bands of the same color correspond to the same multi-band in the previous frame. Each of the highlighted multi-bands moves closer to the single band. Some of these multi-bands apparently disappear once they reach the single band.

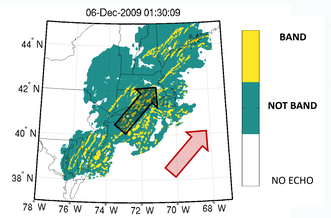
Converging bands occurred in the northeast and northwest quadrants relative to the low pressure center, Illustrated by the image on the right.

Please note that **movies** of these storms can be accessed online by scanning the QR code in the upper right of this poster.



12 February 2006 1400 UTC Example of band-convergent storm location relative to low

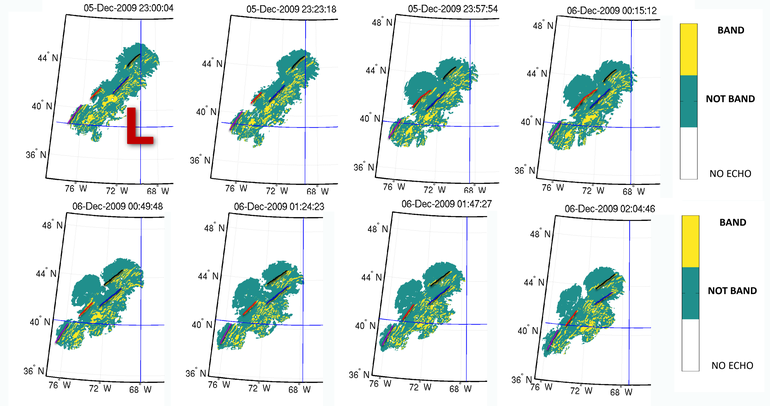
Parallel-moving bands



6 December 2009 0130 UTC Example of storm with parallel-moving bands

Some snow bands move parallel to the storm motion. The multi-bands moving in these storms do not converge into a single band. The black arrow overlaid on the storm in the image on the left represents the direction of the band motion and the red arrow represents the overall direction of the storm.

The images below are another sequence of images showing the features of a storm with parallel-moving bands. In this case, we remove storm motion by using a grid with the center of the low pressure system at the origin. The bands are highlighted with black, red, blue, and purple lines. The multi-bands stay in roughly the same area and do not move relative to the storm or each other. The bands are in the northwest quadrant relative to the low which is a common feature of storms with parallel-moving multi-bands.



5 December 2009 2300 – 6 December 2009 0200 UTC, Example of parallel-moving multi-bands

Summary

- Multi-bands within winter storms can move roughly perpendicular or parallel relative to the overall storm motion.
- Multi-bands which move perpendicular can converge into single bands and in effect fuel the single band.
- Convergent bands are situated in the northeast and northwest quadrants relative to the low pressure center.
- Parallel-moving bands do not converge and do not move much relative to the storm or each other.
- Parallel-moving bands generally occur to the northwest of the low center.

Reference: Hoban, N.P., 2016: Observed Characteristics of Mesoscale Banding in Coastal Northeast U.S. Snow Storms, M.S. Thesis, Dept. of Marine, Earth, and Atmospheric Sciences, North Carolina State University.

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