Preferred Atmospheric Patterns for Autumnal and Vernal Bird Migration Using the Plymouth, New Hampshire NOAA-ESRL Snow-Level Radar

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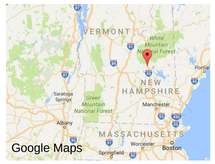
Background

- Large populations of northeastern songbirds travel up and down the Pemigewasset River Valley during Spring and Autumn nocturnal migration periods
- Atmospheric triggers such as wind and precipitation affect migration timing (La Sorte et al. 2015; Alerstam 1990; Richardson 1990)
- Spring-time migration is known to have a more pressing time constraint than fall migration (McNamara, Welham and Houston 1998)

Black-and-white Warbler

Canada Warbler



Objectives

- Utilize snow-level radar on Plymouth State University campus in New Hampshire to study peak bird migrations
- Identify preferential atmospheric conditions for birds during these migration periods

Snow Level Radar (SLR)

- NOAA/ESRL Physical Science Division (PSD) snow-level radar
- Bi-static, Frequency-Modulated Continuous Wave (FM-CW) radar with 5.9° beam width
- S-band wavelength 10.6 cm (2.835 GHz)
- Ideal for detecting target objects from ground-level up to 7.5 km
- Primarily used to detect Bright Band Height (BBH), or level at which snow melts to rain

Plymouth State University's Snow-Level Radar

Data and Methodology

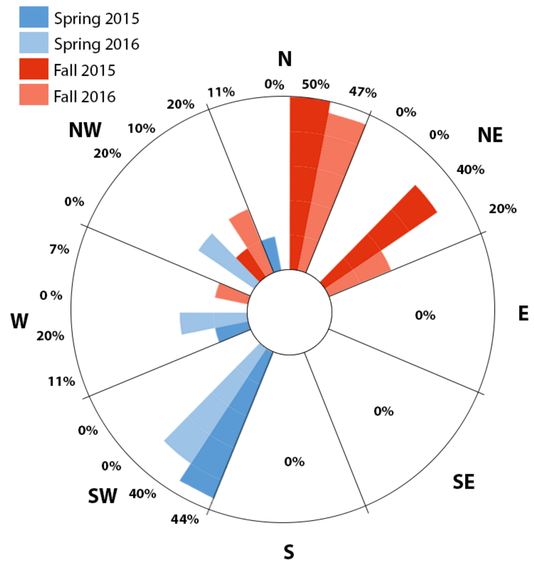
- Upper-air sounding data archives from NWS Gray, ME to determine wind direction and speed at flight altitudes
- WPC surface analysis charts to analyze synoptic pattern at time of peak pulse event
- Created subjectively defined reflectivity rankings to distinguish peak migration events
  - Required continuous returns from sunset to sunrise
- Identified 39 peak pulse events

Average Reflectivity Return Rankings

Ranking	Pulse Event Intensity	dB value
1	No detectable returns	< 60 dB
2	Weak	60-70 dB
3	Moderate	70-75 dB
4	Moderately high	75-85 dB
5	High	> 85 dB

Reflectivity ranking values for peak pulse events. Boxed in area highlights threshold values considered for this study.

Results



Wind rose plot displaying frequency of occurrence of wind direction favored for corresponding migration season.

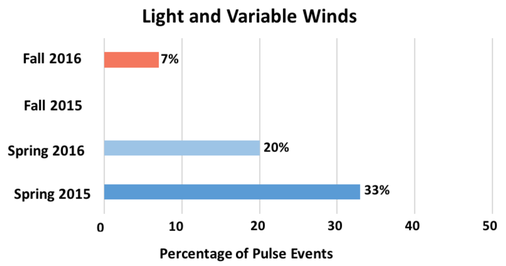
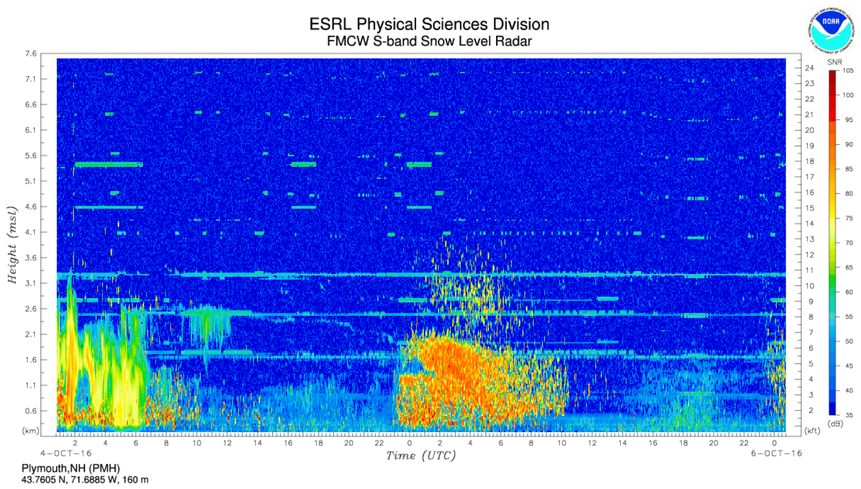


Table displaying frequency of light and variable winds for each migration period.

SLR Imagery



Non-meteorological echoes from birds. On the left-hand side, birds can be seen within falling precipitation. In the middle of the image, birds can be seen without obstruction by precipitation. Only nights where birds were not obstructed by precipitation were considered.

- SLR imagery can be found online at NOAA/ESRL PSD's website: https://www.esrl.noaa.gov/psd/data/obs/datadisplay/

Conclusions

- A seasonal dependence for wind direction was found for corresponding migration periods
  - 92% of Fall peak pulse events favored N/NE winds
  - Only 43% of Spring peak pulse events occurred ahead of a frontal boundary (stationary or warm) with SW winds
  - Greater preference for light and variable winds during Spring migration compared to Fall
- Approximately 40% of both Fall/Spring peak pulse events occurred with high pressure over New England

Future Work

- Perform quantitative analysis of results found in this study
- Analyze weather patterns associated with bird altitude wave patterns
- Analyze atmospheric conditions during nights where birds are not flying

Acknowledgments

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References

Johnston, P.E., D.A. Carter, 2009: A New Snow-Level Detection Radar. Cooperative Institute for Research in Environmental Sciences and NOAA Earth System Research Laboratory, P14.13.

La Sorte, F.A., and Coauthors, 2015: Migration timing and its determinants for nocturnal migratory birds during autumn migration. *Journal of Animal Ecology*, **84**, 1202-1212, doi: 10.1111/1365-2656.12376.

Larkin, R.P., R.H. Diehl, 2012: Radar techniques for wildlife research. T*echniques for Wildlife Investigations and Management*, 7th edition, C.E. Braun, Ed., Wildlife Society, pp. 448–464.

McNamara, J.M., R.K. Welham, and A.I. Houston, 1998: The timing of migration within the context of an annual routine. *Journal of Avian Biology*, **29**, 416.