Characterizing changes in bird migration signals in time and scale domains

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A more complete characterization of the signal of bird migration observed throughout the migratory season may improve our understanding of how changing environmental conditions affect the phenology of bird migration. We here adopt a signal processing perspective and characterize autumn migration signals of passerine species at two Norwegian bird observatories as a function of time and observation scale. Variability between years in the pattern of occurrence is comparable in magnitude to the variability between species. Wavelet analysis shows that this also applies to the partitioning of the signal's variance into scale components, though almost all species-year combinations showed decreasing variance with increasing observation scale. A significant effect of migratory status (long-distance, short-distance or partial migrant) on the relative amount of small-scale variance was found at Jomfruland bird observatory, which recruits autumn migrants from the south-eastern parts of Norway. Small-scale variance was for all groups less prominent at Lista bird observatory, which recruits autumn migrants from the weather-exposed western parts of Norway. While partial migrants showed the highest relative amount of small-scale variance at both observatories, long-distance migrants at Lista exhibited a significantly lower ratio than the other two groups. Though no overall trends were found for the period 1990-2004, quantile regression showed a significant increase in small-scale variability at Jomfruland for the upper quartile of the distribution. At Lista, the lower quartile showed a negative relationship with the NAO Aug-Oct index, suggesting an effect of inclement migration weather. There was little consistency between years in the assignment of species to quartiles. Yet, environmental forcing does not appear to effectively synchronize the co-occurrence of species, since complex wavelet analysis revealed that phases were poorly correlated over the entire range of scales. Synchronization was consistently lower at Lista, where migration seems likely to be more affected by inclement weather.