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The Lifecycle of the North Atlantic Storm Track

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An intriguing feature of the North Atlantic lower-level eddy-driven jet is to exhibit latitudinal variability, with evidence of three preferred regimes: south (S), middle (M) and north (N). Understanding of the mechanisms controlling this variability and the transitions between the regimes, as well as the variability of the North Atlantic storm track (whose eddies drive the jet), is important for the predictability of this jet. However, these mechanisms are poorly understood. This study uses the ERA-40 reanalysis data to investigate the changes in the storm track characteristics (storm track intensity, baroclinic growth rate, eddy elongation, eddy tilting, PV distribution and E-vectors) during the three jet regimes, and proposes a mechanism by which enhanced storm track activity (as measured by upstream heat flux) is responsible for downstream latitudinal shifts in the jet. This mechanism is based on a nonlinear relationship between baroclinicity (which provides favorable conditions for eddy growth) and meridional high-frequency (period of shorter than 10 days) eddy heat flux. Enhanced baroclinicity enhances the heat flux, which in turn erodes baroclinicity until eddy growth is suppressed, at which point baroclinicity can be replenished by diabatic processes, causing the cycle to repeat. Existing literature suggests that such oscillations in baroclinicity would then induce different anisotropy and tilting of eddies which are associated with the dominant type of wave breaking and the direction in which the jet is deflected. The results of the present study support these suggestions, and imply that high heat flux is conducive to a more northward deflection of the jet, whereas low values are conducive to a more zonal jet. This study also demonstrates that the transition from an upstream baroclincic effect of the heat flux on the jet to a downstream barotropic influence is associated with the transition to lower-frequency timescales. The upstream influence of reducing the baroclinicity (and wind shear) therefore occurs at both short and long timescales, whereas the jet deflection operates mainly at longer timescales.