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The Vorticity Budgets of North Atlantic Winter Extratropical Cyclones Development

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A partitioned technique is used to combine Zwack-Okossi development equation with the generalized omega equation. The combination provides a possibility to partition the adiabatic term in the Z-O equation into its different forcing mechanisms. Thus, both the direct effect of the dynamic and thermodynamic forcing and their indirect effect on the adiabatic term can be calculated to provide the total effect (direct + indirect) on the near surface (900 hPa) geostrophic vorticity tendency. The methodology is used on 100 most intense cyclones in the development phase over North Atlantic during the period 1979-2009.
The composite results show that the vorticity advection term is the largest contributor to the development of the cyclones. The total positive effect of both the temperature advection and latent heating terms is smaller owing to the induced adiabatic cooling which reduces the positive direct contributions. The direct and indirect parts of ageostrophic tendency and friction terms support each other, resulting in significant total positive contributions at the low center.
During the genesis, the production of cyclonic geostrophic vorticity is associated with upper level cyclonic vorticity advection and warm advection. The end of the development is however dominated by mid-tropospheric contribution by vorticity advection term and low level warm advection. The former is due to both the mid-level cyclonic vorticity advections and induced adiabatic warming over the composite low center.