Quantification of Hurricane Sandy's Impact on the Midlatitude Flow

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It is unquestioned that Sandy was the most destructive Hurricane at the North American East Coast in 2012 and during the last years. Interestingly, landfall and the most devastating impacts occurred when the tropical cyclone interacted with an upstream midlatitude trough, transitioned into an extratropical cyclone (extratropical transition - ET), and unusually tracked westward inland.

In this study it is explored whether and how Sandy contributed in

1. maintaining a blocking anticyclone to the North that hindered the usual northeastward propagation of ET systems,
2. establishing a midlatitude environment that was supportive for extratropical development and reintensification,
3. modifying the upper-level midlatitude flow with potential impacts downstream over the North Atlantic and Europe.

The impact of Sandy on the midlatitude large-scale flow is quantified in sensitivity experiments with and without the tropical cyclone using a PV-based TC removal technique (Grams et al. 2013).
Four key phases for the midlatitude impact of Sandy are found. Preconditioning: strong WCB activity with an explosive extratropical cyclogenesis over eastern North America lifts the tropopause and initially builds a ridge to the North of Sandy. Trough amplification: in the subsequent days Sandy's TC outflow becomes directed poleward and the vertical convective ascent in the TC core gradually transitions in more warm conveyor belt (WCB)-like slantwise ascent. Diabatic PV reduction and isentropic transport of low-PV air to jet level by mixed TC-WCB-outflow leads to a further elevation of the tropopause and very intense ridgebuilding to the North of Sandy. Likewise the upstream trough is strongly amplified which increases the midlatitude baroclinic forcing for extratropical development. Reintensification: Sandy then interacts with the upstream trough and explosively reintensifies while tracking onshore. The ongoing WCB-outflow deepens and extends the strong ridge to the North. Downstream impact: When merging with the upstream trough Sandy rapidly decays and the low-PV air in the ridge to the North is advected isentropically downstream over the Atlantic eventually shifting southward a zonally aligned PV streamer off the coast of Europe. The quantification reveals that Sandy significantly contributes to the last three phases but not to the preconditioning. Thus Sandy effectively created its own environment for strong extratropical reintensification. Lagrangian diagnostics confirm the diabatic PV reduction in WCB-like airstreams as one of the key physical processes that determine the modification of the upper-tropospheric midlatitude flow during ET. It also emerges that WCBs associated with Sandy are much more intense than usual extratropical WCBs, as reflected in the altitude of the outflow and diabatic heating rates.

C. M. Grams, S.C. Jones, C.A. Davis, P.A. Harr, M. Weissmann, 2013: The impact of Typhoon Jangmi (2008) on the midlatitude flow. Part I: upper-level ridgebuilding and modification of the jet. *Quarterly Journal of the Royal Meteorological Society*, in press, doi:10.1002/qj.2091.