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Tropical transition: Tropical cyclone formation from disturbances of extratropical origin

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Recent work on Atlantic tropical cyclones indicates that a substantial fraction (perhaps one third) is affected by disturbances of extratropical origin during their formation. Typically, these disturbances are associated with non-trivial baroclinity and vertical wind shear. These storms also frequently undergo extratropical transition and therefore accurate prediction of tropical transition can have practical implications for mid-latitude predictability.

Vertical shear has traditionally been viewed as detrimental to hurricane formation, and the occurrence of zero shear has at least tacitly been assumed optimal for development. Here, we summarize recent evidence that modest shear may actually be favorable for development because it helps organize convection. We investigate, in detail, the formation of hurricane Humberto (2001), primarily through the use of numerical simulations. We show how vertical shear was critical for the organization of convection that led to the mesoscale vortex seed of Humberto. The resulting MCS produced a mesoscale vortex and the vertical shear forced a persistent convection asymmetry on this vortex, with convection on the downshear side of the vortex (with respect to a synoptic-scale shear, not the total shear). Within the favored region of convection, intense convective cores occurred and these typically became associated with small-scale cyclonic vorticity anomalies that merged into the parent circulation. The budget of tangential wind confirms the importance of asymmetries to the intensification and contraction of the incipient storm circulation.

The effects of shear can be summarized as generally favorable in the earliest stages and having mixed results later on. In Humberto, the deep-layer, synoptic-scale shear persisted through much of the life-cycle of the storm, limiting the intensification. In

other cases, weakening of this shear following genesis allows greater ultimate intensity to be reached (all other factors being equal).