Impact Between Two Vestige Atlantic Tropical Cyclones with Mid-latitude Cyclonic Storm Over Mediterranean

E.A. Smith (1), A. Mehta (2), A. Mugnai (3) and G. J. Tripoli (4)

(1) NASA/Goddard Space Flight Center, Laboratory for Atmospheres (Code 613.1), Greenbelt, MD 20771, USA [301-614-6286 / eric.a.smith@nasa.gov], (2) Univ. of Maryland in Baltimore County/JCET @ NASA/GSFC, Laboratory for Atmospheres (Code 613.1), Greenbelt, MD 20771, USA [301-614-6270 / amita@radar.gsfc.nasa.gov], (3) Institute of Atmospheric Science & Climate (ISAC), National Research Council (CNR), Rome 00133, ITALY [+3906-4993-4575 / a.mugnai@isac.cnr.it], (4) Dept. of Atmospheric & Oceanic Sciences, Univ. of Wisconsin, Madison, WI 53706, USA [608-262-3700 / tripoli@aos.wisc.edu]

One of the more interesting tropical-mid-latitude interactions is one that has important effects on precipitation within the Mediterranean Basin. This interaction consists of an Atlantic tropical cyclone vestige whose original disturbance has either (a) traveled westward across the Atlantic Basin later recurving northeastward into extratropical latitudes migrating back across the Atlantic, or (b) developed incipiently within the Gulf of Mexico-Caribbean Basin and similarly has migrated eastward as it moves to higher latitudes – in either case, intermingling with a mid-latitude cyclone entering southern Europe and/or the western Mediterranean Sea. Given the period of the Atlantic Hurricane season, June to November, and the onset of the Mediterranean Basin's cyclone season in mid-September, the associated interaction period takes place from mid-September through November. If the tropical cyclone and its vestige is able to make the complete eastward Atlantic transit within the low to mid-levels or if an upper level potential vorticity perturbation emitted by an active Hurricane in the west or central Atlantic basin is able to propagate eastward into the region of the western Mediterranean Sea (MED), then there is the prospect for the tropical cyclone remnant to produce a major modification of the mid-latitude cyclone preparing to affect the region. For such an occurrence to take place, it is generally necessary for an amplifying baroclinic perturbation, situated in the westerly Rossby wave train, to already be in place in or near the west-MED storm entrance region.

Various recent studies have shown how vestige tropical storms can affect cyclonic storms in the MED through the process of advecting high concentration moist air masses into the circulation region of the baroclinic disturbance. These studies have used backward trajectory analysis to demonstrate how moist air parcels carried to the eastern Atlantic by the vestige vortex are advected into the MED cyclone. These few studies have been effective in making the case that Atlantic tropical cyclones are very much part of the Mediterranean basin's hydrological cycle. Just how much hydrological difference these eddy-eddy interactions can produce has yet to be investigated.

We make this advance through use of a high resolution regional model to estimate the potential impact that such an interaction might have on the MED's precipitation distribution.

The Algiers City flood of 9-10 November 2001, which killed some 700 people, was produced by a Mediterranean cyclone that had been influenced by two vestige Atlantic tropical cyclones, Lorenzo and Michelle. A published modeling study involving various of this study's authors has already described the dynamical development of the Algiers storm as it amplified into its flood period, then lingered in the western MED as a semi-intense warm core cyclone. The precipitation (P) distribution produced by this cyclone was complex, created by (a) small-scale, low level, orographically-induced P fields created over both the Iberian Peninsula and North Africa, (b) a synoptic scale P field caused by the coupling of upper-level, high theta-e air in the amplifying baroclinic trough with lower-level, high theta-e air produced by surface sensible heat fluxes, and (c) tropical storm-like P bands and outer vortex generated by the final stage of the warm-core cyclone.

In this preliminary study, we first remove the dynamical and moisture features of the two vestigial tropical cyclones from the large scale meteorological fields used to initialize the Mediterranean cyclone simulation. This is done by energetically destroying the latter stages of the eastward traveling tropical cyclones by lowering the underlying sea surface temperatures. The moisture front produced by the two tropical cyclones is depleted by relaxing the moisture back to suppressed East Atlantic conditions. A P-distribution impact experiment is then run by initializing with the customized large-scale fields. The final P-impact field is described by differencing the "impact" run from the "control" run – defined as the original simulation which intrinsically includes the effects of the two vestigial tropical cyclones.