Warm Season Water Vapor Fluxes in the Intra-Americas Sea

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Introduction: Our goal is to explore the connection among the warm pool of the Intra-America Sea (IAS), its moisture budget, moisture transport from the IAS into North America, and warm-season precipitation over North America. Our approach is to diagnose the moisture budget variables in the IAS using different datasets.

Here we present preliminary results using twice-daily atmospheric sounding data around the IAS and Eta model regional analyses for the 2002 warm season including available Eta Model Output Location Time Series (MOLTS).

Soundings and Eta MOLTS: We estimated the water vapor fluxes for July 2002 using twice-daily (0 and 12Z) soundings at stations with available Eta MOLTS along an approximate boundary of the IAS. The selected sounding stations are shown in Figure 1 together with the Eta model grid, which has a resolution of about 32 km. At each of the selected sounding sites, we compared the vertical profiles of the moisture fluxes computed from the soundings and the Eta MOLTS and show a representative example for Miami in Figure 2. We found very good agreement for the mean vapor flux profiles at all levels. The standard deviations of the fluxes compare very well at levels above 800 hPa but there are some differences at lower levels. The rms difference of the moisture fluxes is of the same order of the mean at all levels. These uncertainties in the flux estimates are mostly due to uncertainties in the model simulated velocity fields because the Eta humidity simulations (not shown) agree quite well in the mean, standard deviation and rms difference with the observed humidity profiles at all levels.

Using the mean vapor flux profiles from soundings and Eta MOLTS we computed the vertically integrated fluxes at each sounding station for July 2002 (not shown). The resulting vertically integrated vector moisture fluxes from soundings and Eta MOLTS agree very well at all stations.

Vapor fluxes in the IAS region: The vertically integrated vector fluxes were used to estimate the net divergence of moisture in the IAS region represented by the polygon joining the sounding sites (thick solid line in Figure 1). The fluxes were assumed to vary linearly between sounding sites. The net divergence of moisture

over the IAS estimated from the soundings is 2.4 mm/day, which agrees very well with estimates from the Eta MOLTS (2.7 mm/day) (left two bars in Figure 4). This means that, neglecting the local storage term, during July 2002 evaporation in the IAS exceeded precipitation by that amount.

Uncertainties in the flux estimates due to the crude representation of the IAS region by the polygon of sounding sites and to the assumption of linearly varying fluxes between sites are estimated using the full resolution Eta model fields. The arrows in Figure 3 show the vertically integrated vector vapor fluxes for July 2002 from the Eta analysis, with vector magnitudes shown in color. The solid white line is a better estimate of the IAS region than the sounding sites polygon in Figure 1. Using both the new and old IAS polygons and the Eta analyses we estimated the respective vapor flux divergence to be 7.5 and 11.9 mm/day (right two bars in Figure 4). Using these two estimates one can infer the path error to be an overestimate of +4.4 mm/day. Similarly, using the smallest and largest red bars in Figure 4 one can infer the error due to assuming linear varying fluxes to be an underestimate of –9.2 mm/day. Therefore a larger error is introduced by assuming a linearly varying flux field between stations than by the rough approximation of the IAS boundary. Both of these errors combined give an underestimate in the IAS vapor flux divergence of –4.8 mm/day.

Vapor fluxes in the Gulf of Mexico and the Caribbean Sea: Using the Eta analysis fields for July 2002 we also estimated the vapor flux divergences in the Gulf of Mexico and the Caribbean Sea by dividing the IAS region in two along the dashed white line in Figure 3. The estimated Gulf of Mexico and Caribbean vapor flux divergences are 6.6 and 8 mm/day, respectively. Therefore, evaporation exceeds precipitation in both regions by these amouns. These estimates of vapor flux divergence are much larger than the ones of Hastenrath (1966) who used twice-daily (0 and 12 Z) sounding data for July 1960 and obtained 1 mm/day for the Gulf of Mexico and same value for the Caribbean.

Acknowledgments
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References

Hastenrath, S. L., 1966: The Flux of Atmospheric Water Vapor over the Caribbean Sea and the Gulf of Mexico. *J. Appl. Meteor.*, **5,** 778-788.

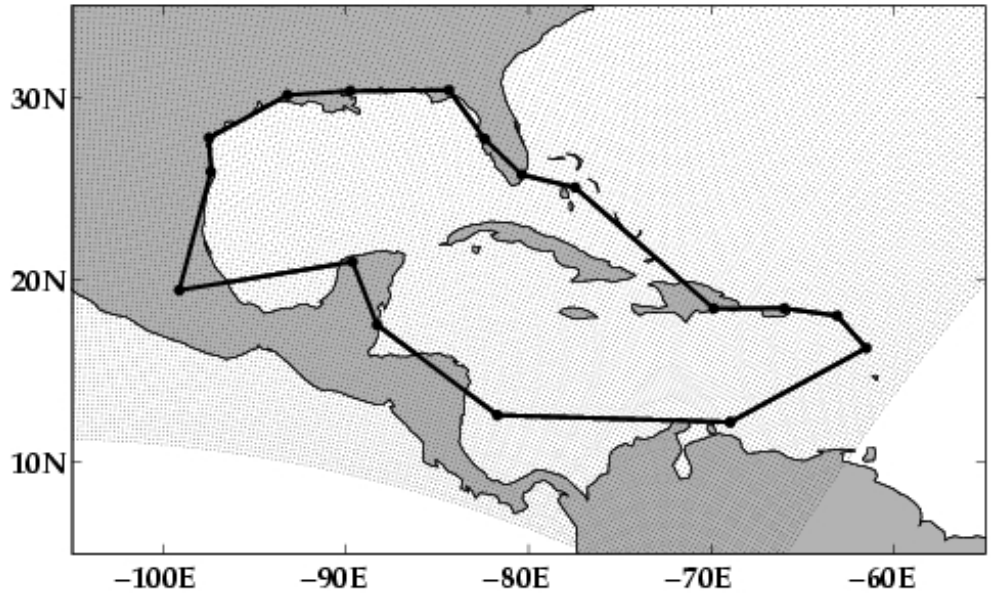

Figure 1. Sounding stations and sections used to estimate water vapor fluxes in the Intra-Americas Sea (IAS) region during July 2002. The gray shading indicate the Eta model grid points (about 32 km resolution).

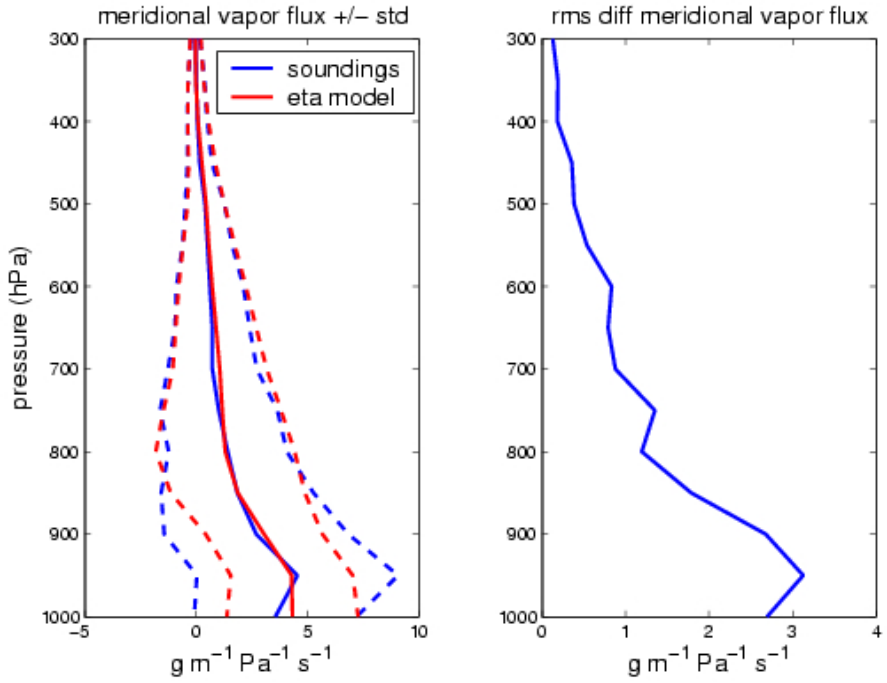

Figure 2. Left panel: mean ± 1 standard deviation comparison of meridional vapor fluxes from soundings (blue) and Eta MOLTS (red) in Miami during July 2002. Right panel: rms difference of the profiles used in the left panel.

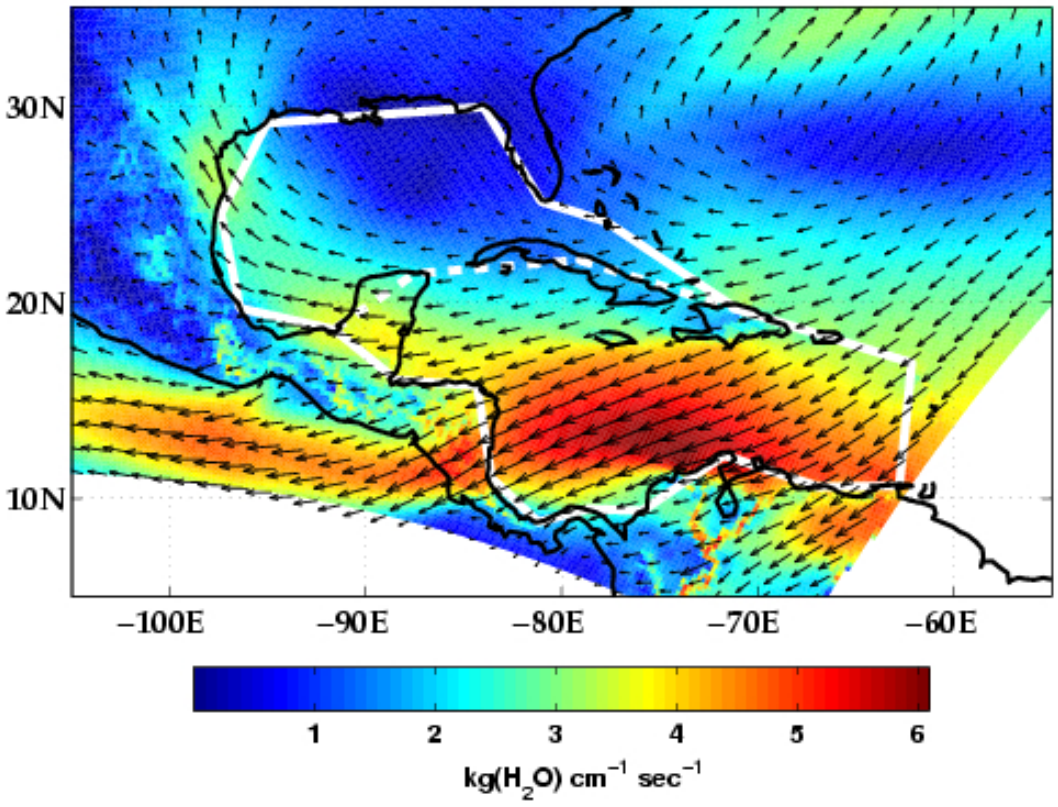

Figure 3. Mean vertically integrated vapor fluxes from Eta analysis fields for July 2002. The white solid lines indicate the IAS region used for estimating vapor flux divergence and the white dashed lines the boundary between the Gulf of Mexico and the Caribbean Sea.

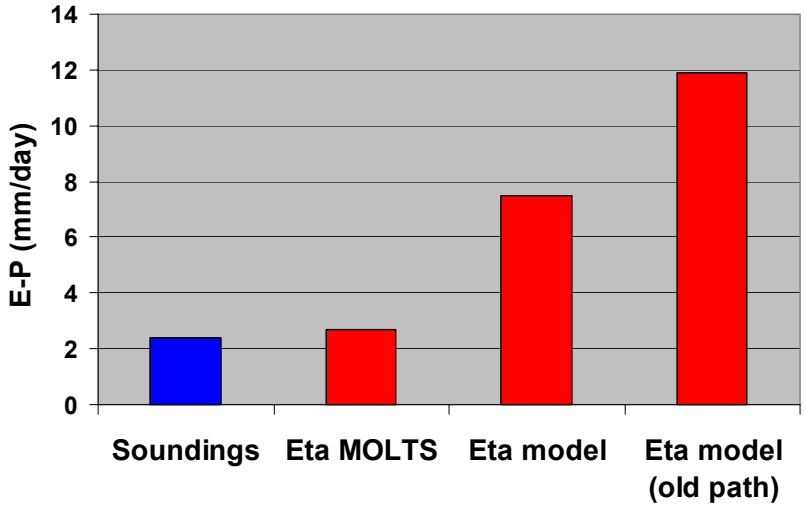

Figure 4. From left to right: Moisture flux divergences (mm/day) estimated from soundings in the IAS region shown in Fig. 1, from Eta molts with IAS region shown in Fig. 1, Eta analyses with IAS region shown in Fig. 3, and Eta analyses with IAS region shown in Fig. 1.