Influence of the Gulf Stream Sea Surface Temperature Front on the Evolution of Storms

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Background

There are complex dynamic and thermodynamic air-sea interactions in the Northern Hemisphere midlatitude western boundary currents, such as the Gulf Stream.

The sharp sea surface temperature (SST) gradients along the Gulf Stream strongly influence the atmosphere through enhanced latent and sensible heat fluxes. Furthermore, the lower tropospheric baroclinic zones associated with these SST fronts can play a significant role in the evolution of mid-latitude storms.

Data and Methodology

We focus on storms in the vicinity of the Gulf Stream SST front in the North-West Atlantic using 6-hourly data from ERA-Interim for the period 1979-2015.

The position of the North-West Atlantic SST front is defined by the location of the maximum meridional gradient of SST.

Storm tracks were compiled using a cyclone tracking algorithm for the same period.

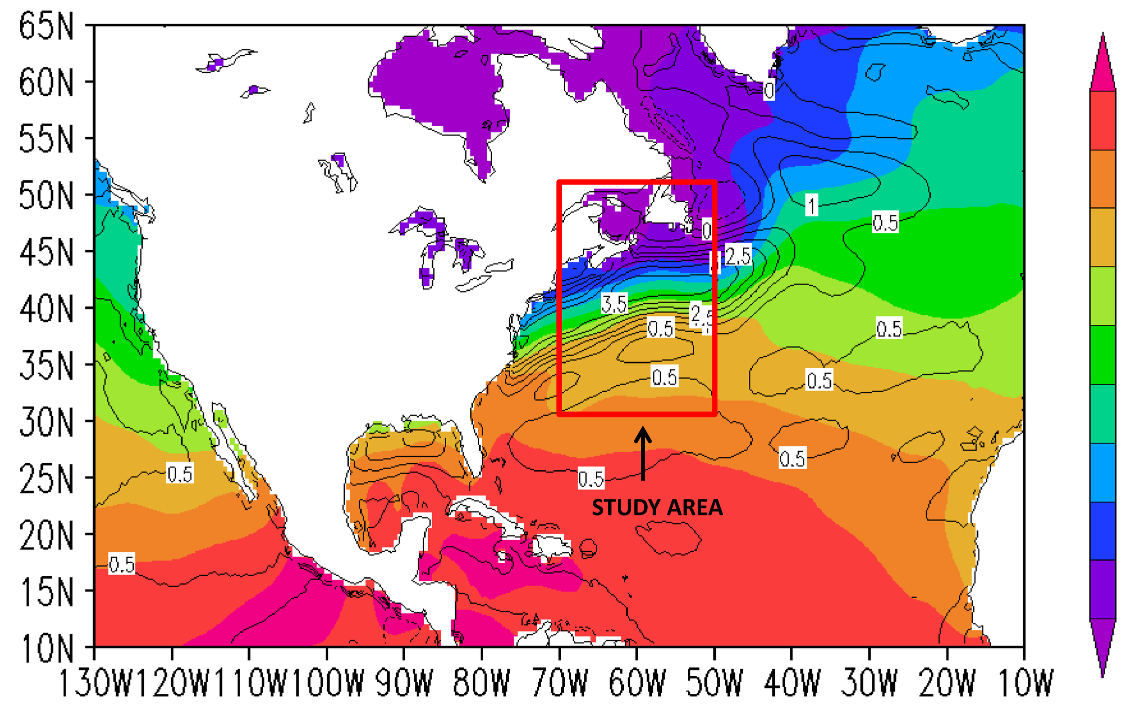

Figure 1. SST (shaded) and SST gradient(contour) for 16-01-90. The inner domain indicates the area of interest (North-West Atlantic), where the maximum values of the meridional SST gradient are identified.

Each storm track is classified by its trajectory with respect to the position of the SST front.

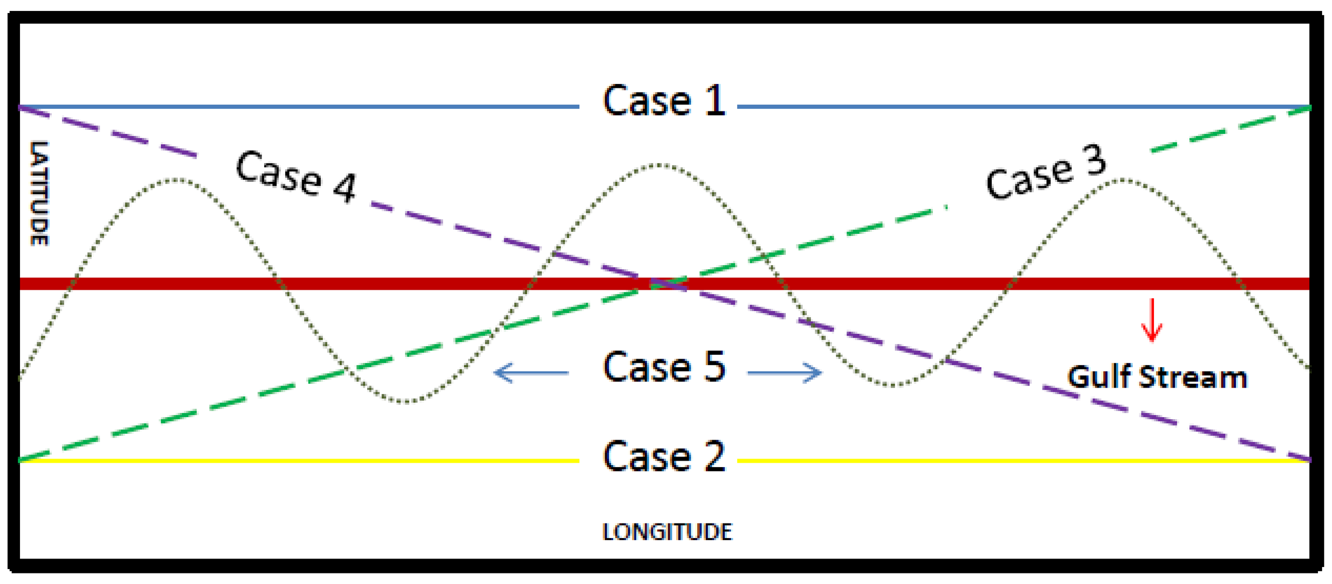

Figure 2. Different trajectories of storms

The majority of the storm tracks belong to the first three cases , as is depicted below (Figure 3)

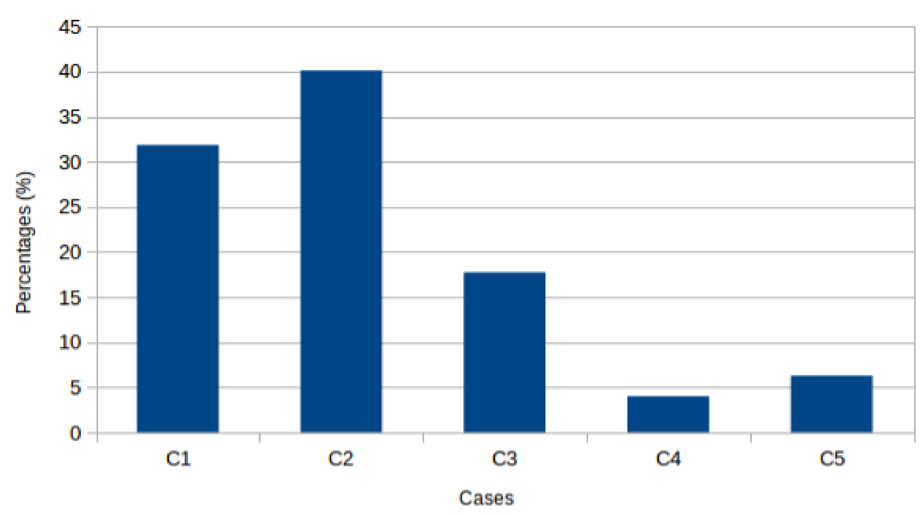

Figure 3. The frequency of the storm tracks in each case based on their trajectory and the position of the SST Front

Results

In the following figures (Figure 4-6) different parameters are presented for the first three cases, which are the dominant ones.

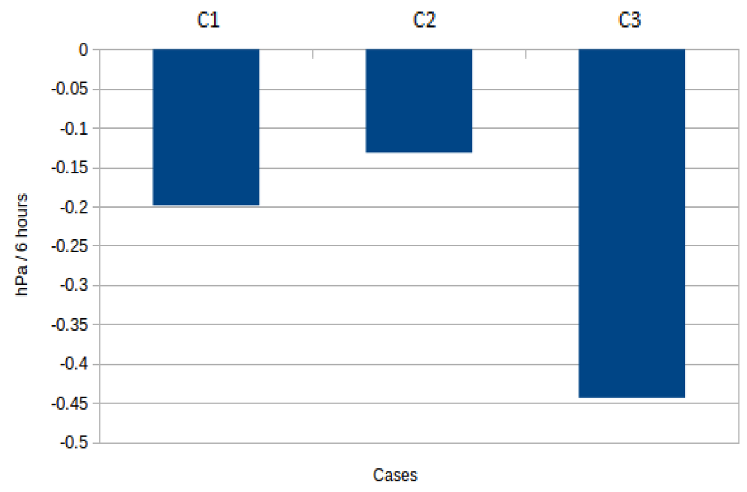

Figure 4. Rate of pressure for the first three cases

In case 3, in which each storm is crossing the Gulf Stream from the south to the north (Figure 2) has the biggest decreasing rate of pressure

To know the precipitation that is associated with one storm we define an area around it by using a radius of 200km from the storm center each time. As it is shown below (Figure 5) case 2 is associated with the most of precipitation(both the large scale and convective one).

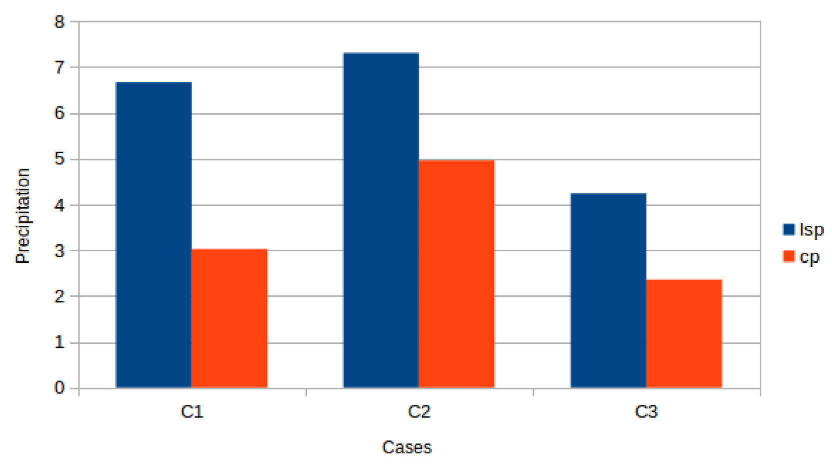

Figure 5. Large scale and convective precipitation for the first 3 cases

Large scale precipitation is more than the convective one for both three cases.As is shown in Figure 5, case 2 is associated with the most of precipitation (both the large scale and convective one).

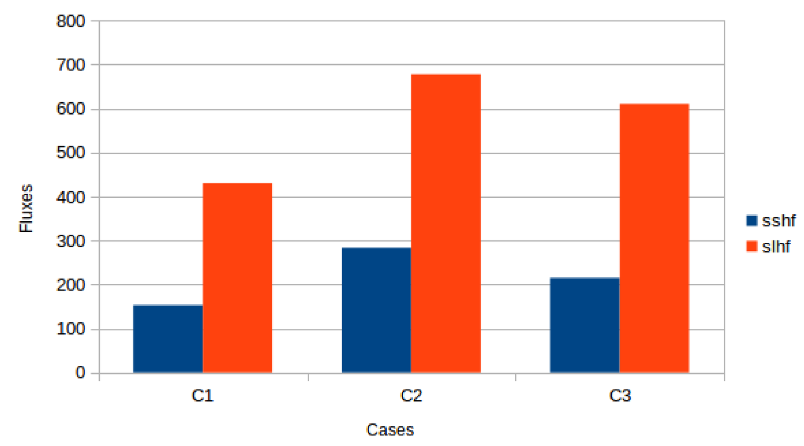

Figure 6. Typical values of sensible and latent heat Fluxes associated with each eddy of the 3 different cases.

Latent heat fluxes are more than the sensibles ones for each of the 3 cases.
Case 2, which was the case with the most of precipitation (Figure 5) is also connected with the highest sensible and latent heat fluxes.

Future Work

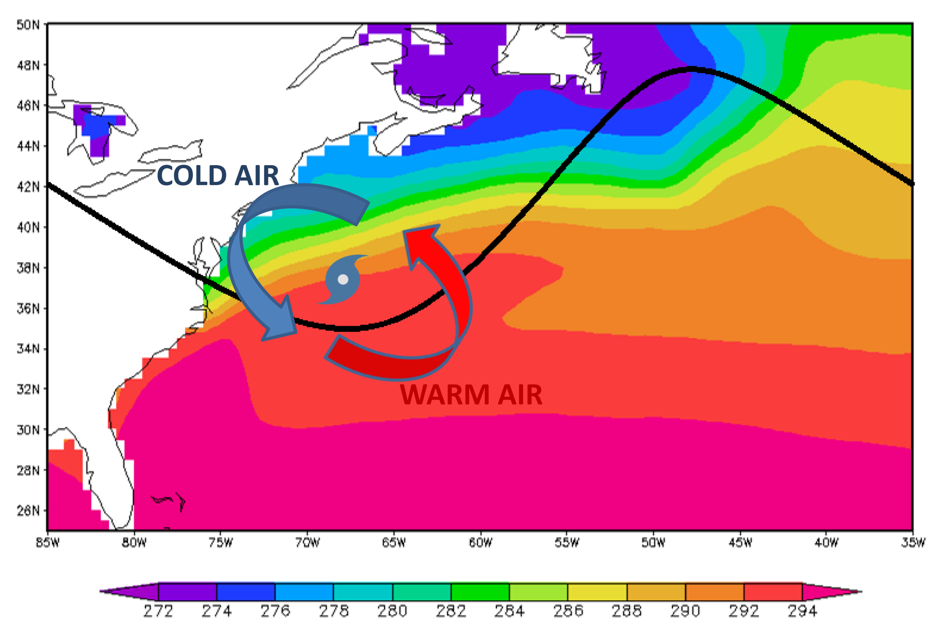

Figure 7. Schematic of wintertime situation describing the potential role of Jet Stream on the evolution of Storms. The climatology of SST is depicted with shade and the position of the Jet Stream with line.

But what really happens when a cyclone is crossing the Jet Stream?

Except from the role of the SST in the Gulf Stream it will be intriguing enough to understand the role of the Jet Stream to the evolution of Storms. For this process a detection scheme for upper-tropospheric jets will be used (Spensberger et al., 2017).

Conclusion

• Storm trajectories have different characteristics depending on its path relative to the SST Front and play a major role for storm intensification. Case 2 shows a clear relationship between the amounts of latent heat fluxes (Figure 6) and the amount of the precipitation (Figure 5).

• Case 3 (Figure 2) shows a rapid decreasing rate of pressure (Figure 4), which makes it an interesting case for further analysis.

Reference

Spensberger et al. Monthly Weather Review **145, 2363 -2374,(2017)**