The sea spray parameterization relies on a white cap fraction based on Wu et al. (1984) and is a function of the wind speed to the power 3.4 ($W(U) = 3.8e^{-6}U^{3.4}$). This results in an areal coverage of 100% at 33 m $s^{-1}$ which is clearly not observed. This might introduce a lot more sea spray than needed in the high wind speed region. A study by Banner et al. (2001) derived a breaking probability of wind sea based on their spectral steepness. The spectral steepness is defined as the azimuthally-averaged spectral saturation :

$$\sigma = \int_0^{2x} \mathbf{k}^4 \Phi(\mathbf{k}, \theta)\, d\theta$$

(1)

where $\Phi$ is the wavenumber waveheight variance spectrum and $\mathbf{k}$ is the wavenumber vector. For seven central frequencies, fc, Banner et al. (2001) calculated a ratio fc/fp, where fp is the peak frequency of wind sea. The ratios are between $1 \leq$ fc/fp $\leq 2.48$ and each exhibits a different breaking threshold. As the ratio increases, so does the breaking threshold. We adapted this breaking probability to the hurricane environment by calculating a spectral steepness for each frequency of the spectrum. We find the peak frequency of wind sea and we then deduce the ratio of frequencies we are looking at for every frequency of the spectrum. We use a linear fit for the breaking probability as a function of the spectral steepness for each ratio. As there is no special trend of this linear fit as a function of the increasing ratio, we decided to use a linear fit in between each ratios and not just one for the entire range of ratios.On the other end if the breaking probability is more than the highest observed breaking probability for that ratio (or interpolated ratio) it is set to the maximum observed breaking probability (maximum breaking probability interpolated). So that the maximum breaking probability value will always be less or equal to 25%. Because we want to include principally the effect of the wind sea we weight our breaking by the energy spectrum between 0.7fp to the end of the spectrum such that our final breaking probability is :

$$F_{RWR} = \frac{\int_0^{2x} \int_{k_{minfp}}^{k_{25}} f_{RWR} \Phi(k, \theta)\, dk\, d\theta}{\int_0^{2x} \int_{k_{minfp}}^{k_{25}} \Phi(k, \theta)\, dk\, d\theta} \qquad (2)$$

where $k_{minfp}$ represents the wavenumber at which the frequency is equal to 0.7 times the minimum peak frequency in the whole WAVEWATCH III domain and $k_{25}$ represents the last wavenumber in the spectrum. This integration only takes places if 2fp is included in our frequency range. If not, the breaking probability is defined as non available. Figure 1 is an example of the breaking probability based on the wave spectrum for Hurricane Frances (2004) on August 31st at 1200 UTC.

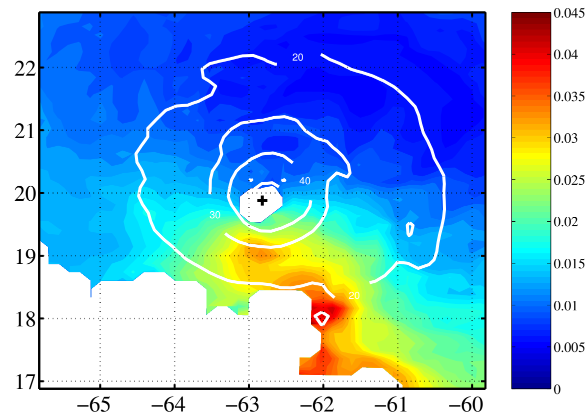


Figure 1: Wave breaking probability based on the spectral steepness.

The breaking probability is higher on the left, left-rear part of the storm (the storm has a west-northwest motion at that time). This corresponds to the area where the waves are really steep, young and most likely propagating against the wind. Because we cannot ignore the fact some breaking must also be occurring due to the high wind speeds we decided to combine this breaking information with a modified Wu parameterization. Below 20 m $s^{-1}$ and everywhere where our breaking probability is non-defined we actually consider that the Wu parameterization of white cap is divided by 2. Which based on several other observational studies (cf. sixth international workshop on tropical cyclones, Topic 1.b figure 10) is still an overestimate. Above 20 m $s^{-1}$ we consider that both phenomena are important and we give them different weight.

$$wb(u, F_{RWR}) = \begin{cases} (3.810^{-6}u^{3.4})/2, & u < 20 \\ (3.810^{-6}u^{3.4})/4 + 300/50F_{RWR}, & 20 \leq u < 40 \\ (3.810^{-6}u^{3.4})/20 + 300/14F_{RWR} & 40 \leq u \end{cases}$$

(3)

The number chosen to weight the importance of the wind speed and wave breaking are totally arbitrary.The subsequent white cap fraction obtained from those calculation is shown by fig. 2.

(a) Wu's white cap fraction (b) Modified Wu's white cap fraction

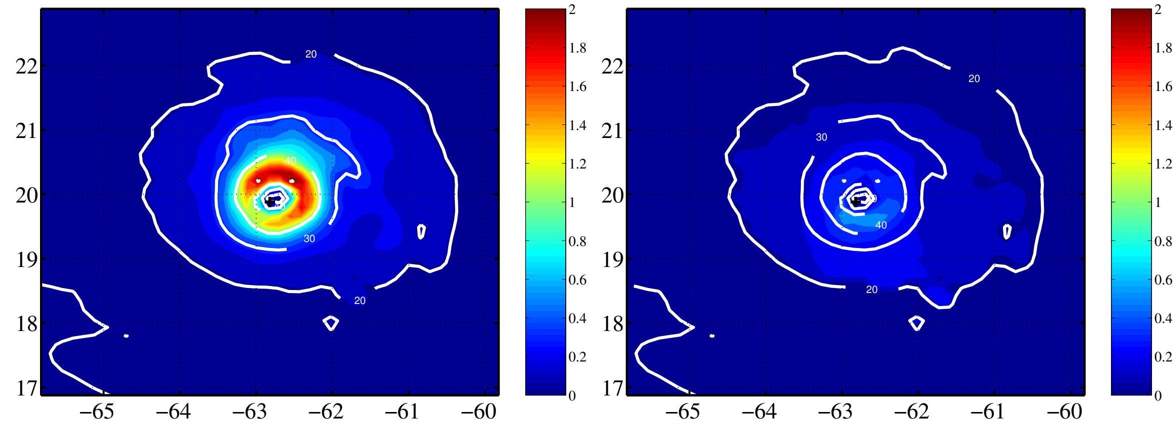


Figure 2: White cap fraction

The white cap fraction is now considerably reduced. The maximum white cap fraction is still in the eyewall with a maximum in the rear left part of the storm where we expect more breaking to occur. The net enthalpy flux from the sea spray mediated fluxes is however keeping its main features cf. fig. 3. This might be due to the fact that later on in the parameterization the droplet mediated flux is also highly dependent on the significant wave height which also shows some asymmetries and might therefore compensate the asymmetries introduced in the white cap coverage.

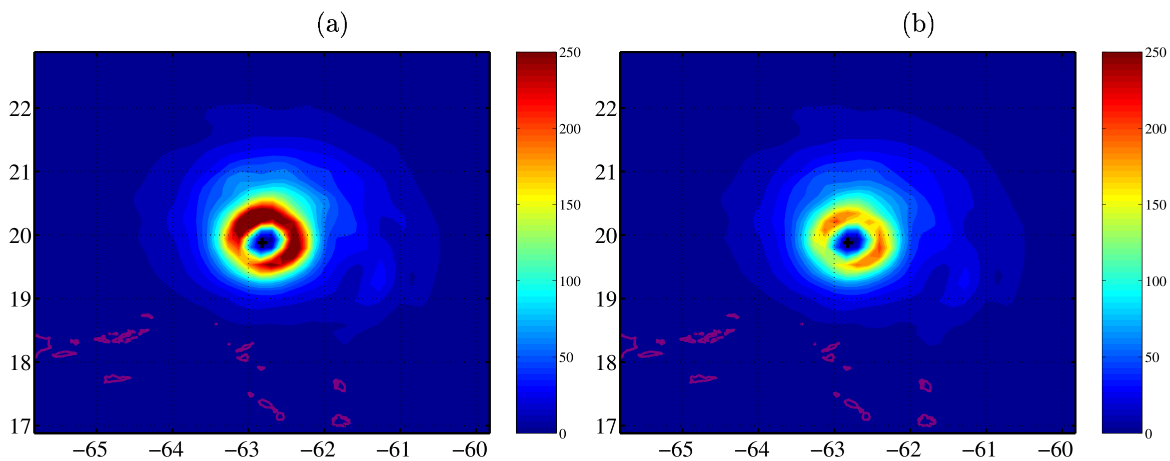


Figure 3: Net enthalpy flux due to sea spray : a)Net enthalpy flux due to sea spray with Wu's white cap coverage, b)Net enthalpy flux due to sea spray with Wu's modified white cap coverage