North Atlantic Extratropical cyclones extreme waves from satellite altimetry observations.

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Why is it important the study of Extratropical Cyclones (ETCs)?

- Maritime safety, ship routing
- ETCs play a large role in determining wave conditions in western Europe
- Cyclone activity controls the synoptic variability

- Kita, Waseda and Webb (2018) [Ocean Dynamics]
- Ponce de León and Guedes Soares (2014) [Ocean Modeling]
- Mori (2012) [JGR]
- Rudeva and Gulev (2011) [MWR]
- Among many other authors
Introduction

Taken from:

Ponce de León and Guedes Soares (2014)

*Extreme wave parameters under North Atlantic extratropical cyclones*, Ocean Modelling 81, 78-88

[http://dx.doi.org/10.1016/j.ocemod.2014.07.005](http://dx.doi.org/10.1016/j.ocemod.2014.07.005)
Data and Methods

- The **Extratopical Cyclones (ETC) Database** consists of 58-year (1958 to 2016) record of daily ETC characteristics for the Northern Hemisphere. The ETC data is obtained by the *Serreze et al. (1997)* algorithm from the daily sea-level pressure (SLP) fields of the NCEP/NCAR reanalysis dataset.

- The **GLOBWAVE Database** of IFREMER, is a uniform and quality controlled, multi-sensor set of satellite wave data with a consistent characterization of errors and biases.

The data used in this study is the altimeter multimission **Hs** (*Significant Wave Height*) which is a merged global altimeter Hs data set from the six altimeter missions **ERS1&2, TOPEX-Poseidon, GEOSAT FollowON (GFO), Jason1** and **ENVISAT** (produced by **CERSAT/IFREMER**).
In the period 1998-2012 742 ETCs were selected (average 50 ETCs per year).

ETC=Extratropical cyclone

The track density of the selected ETC agrees with track density maps of several reanalysis ETC databases (review by Ulbrich et al., 2009).
For the period 1998-2012, ~22k data files were retrieved and processed.

<table>
<thead>
<tr>
<th>Mission</th>
<th># Data files</th>
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<tbody>
<tr>
<td>ENVISAT</td>
<td>4663</td>
</tr>
<tr>
<td>ERS-2</td>
<td>4475</td>
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<td>6789</td>
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<tr>
<td>JASON-2</td>
<td>2835</td>
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15 year ETC Hs composite maps
Hs composites vs intensity of the ETC

Q1 (weakest)  Q2  Q3  Q4  Q5 (strongest)

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The normalized PDFs show that **inside the cyclones the probability of large waves is higher than on the North Atlantic**.
Conclusions

- The Hs of North Atlantic extratropical cyclones considering a 15 year period of satellite altimetry data was studied.
- The composite of all ETCs shows higher Hs in the SE quadrant, but there is a high Hs variability due to individual cyclone differences.
- Stronger ETCs (Q5) have higher Hs in the NE and SE sectors; weaker ETCs (Q1,Q2) show higher Hs in the SW sector.
- During the maximum strength stage of ETCs, Hs averages can reach 5.5 m in the SE and SW sectors.
- ETC have higher probability of large wave occurrence and the most dangerous sector is the South East where the largest waves can be found.
Recommendations

- Invest in the development of data products directed to a specific need/process.
- As an example integration of sea surface and atmospheric data to study extratropical cyclones and their wind waves.
- If possible, carry this integration all the way to the satellite design.