Evaluation of the Source and Travel-time of wave Energy reaching a Local Area (ESTELA)

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INTRODUCTION

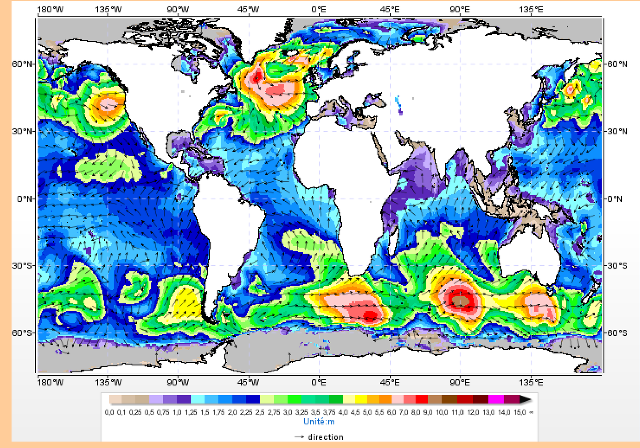
The description of wave conditions at a local scale is of paramount importance for off-shore and coastal engineering applications, e.g. maritime works, and harbours operability. However, wave characteristics at a specific location cannot be fully understood studying only information of such location. They are the integrated result of the dynamics of the ocean surface over an area of influence.

OBJECTIVE: Determination of the spatial domain of influence for any particular location in the world to automate the definition of the predictor area for statistical downscaling.

DATA

Global wave reanalysis from Ifremer
(Rascle et al. 2008, Rascle and Ardhuin 2012)

WaveWatch III v4.04 forced by CFSR winds
Spatial coverage: Global (0.5ºx0.5º)
Temporal coverage: 1993-2012 (3hourly)



CONCLUSIONS

- *Results show **important spatial patterns** that cannot be directly inferred from local met-ocean variables. **Robustness of the method** has been validated by comparison with other studies (e.g. Izaguirre et al., 2012; Alves et al., 2006)*
- *The proposed method evaluates the **spatial influence of local wave climate** in different temporal scales from hours (**extreme events**) to years (**climatologies**).*
- *The zones of **generation/dissipation** of energy can be located, helping us to **define the optimal predictor area** for statistical downscaling or a better definition of meshes for dynamical downscaling.*
- *ESTELA methodology provides valuable info for wave climate studies.*

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Acknowledgements

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IH cantabria INSTITUTO DE HIDRÁULICA AMBIENTAL UNIVERSIDAD DE CANTABRIA
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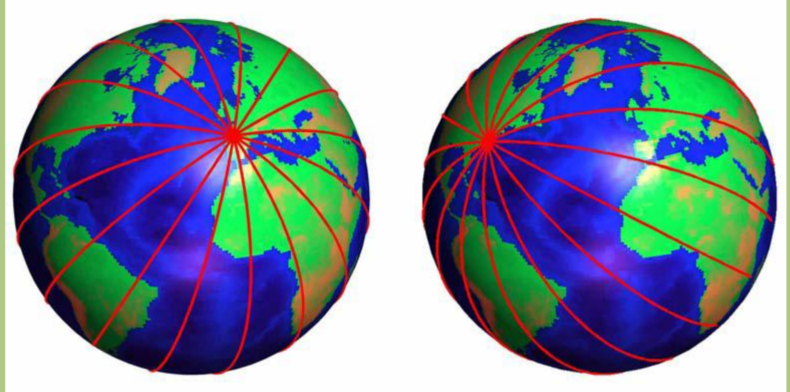
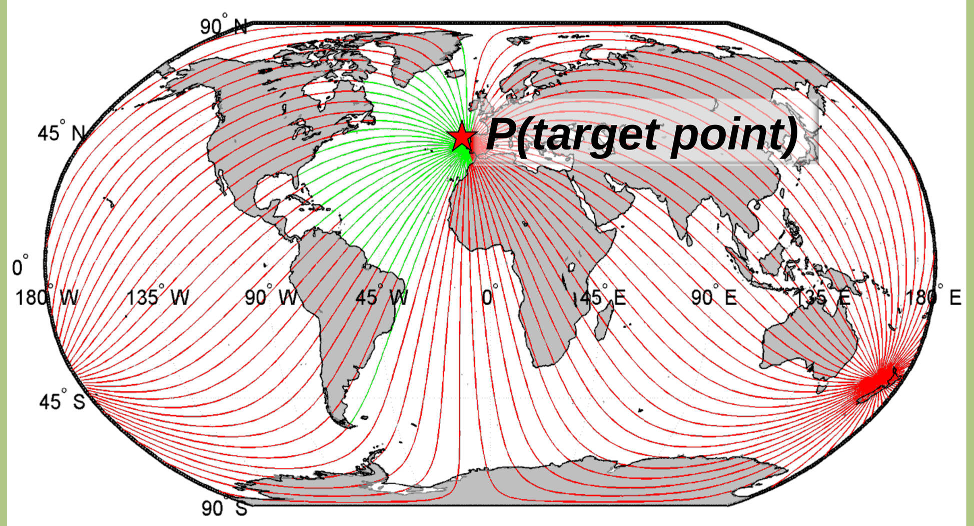
METHODOLOGY

1- GEOGRAPHICAL CRITERION:

First, we constrain the spatial domain to study.



Waves move away along **great circle paths**

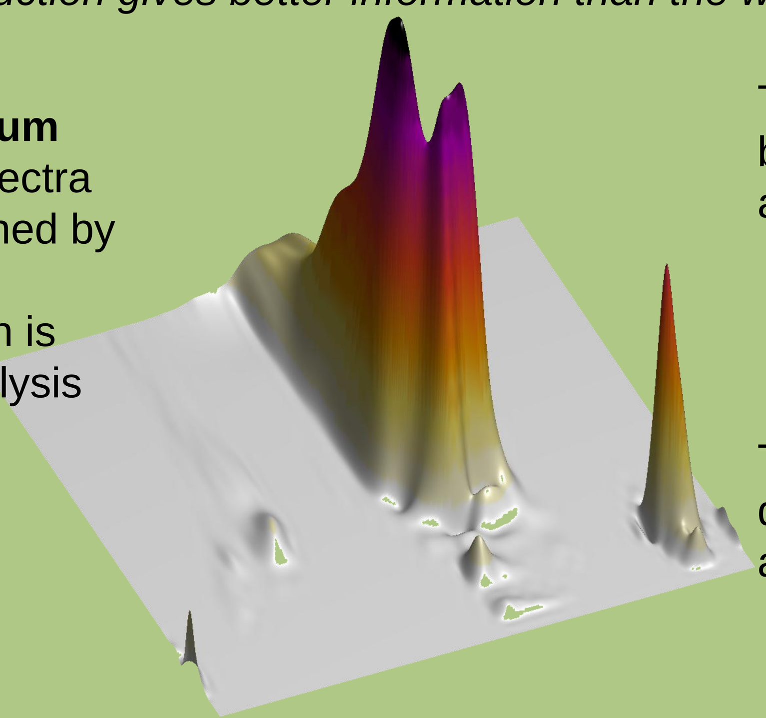


Grid points related to the reference point by a great circle that cross the coast are eliminated.

2- SPECTRUM RECONSTRUCTION:

Second, the spectral reconstruction gives better information than the wave parameters.

We use a **multimodal spectrum** composed by six unimodal spectra (one sea and five swells) defined by its parameters.
The spectrum of each partition is reconstructed from four reanalysis parameters:
•Significant wave height (**Hs**)
•Peak period (**Tp**)
•Mean direction (**θ_0**)
•Directional spread (**σ**)



The energy flux (Pw) is determined by the product of the energy (E) and the group celerity (Cg)

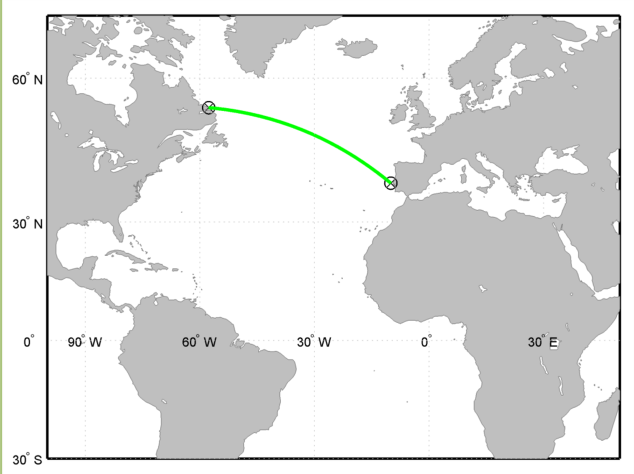
$$P_w = Ec_g = \frac{\rho g^2}{64\pi} T_p H_s^2$$

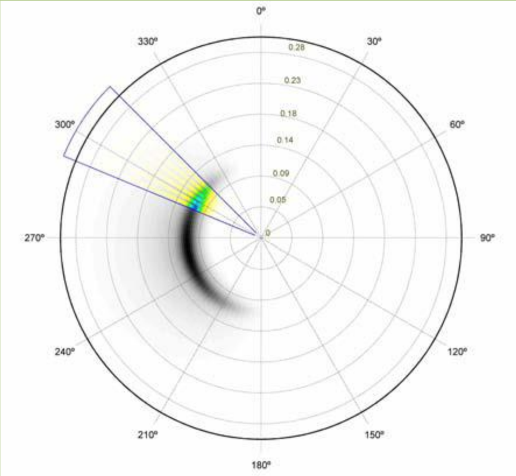
The directional distribution is determined by the mean direction and the directional spread.

$$D(\theta) = A_2 \cos^{2s}\left(\frac{\theta - \theta_0}{2}\right)$$

3- PHYSICAL CRITERION:

Third, only part of the energy flux of the source points influences the target point.





For a specific sea state in a source point, only the energy travelling towards the target point is considered. In addition, the amount of energy loss by **viscous dissipation** is sustracted. The result is the net energy flux (**F_i**).

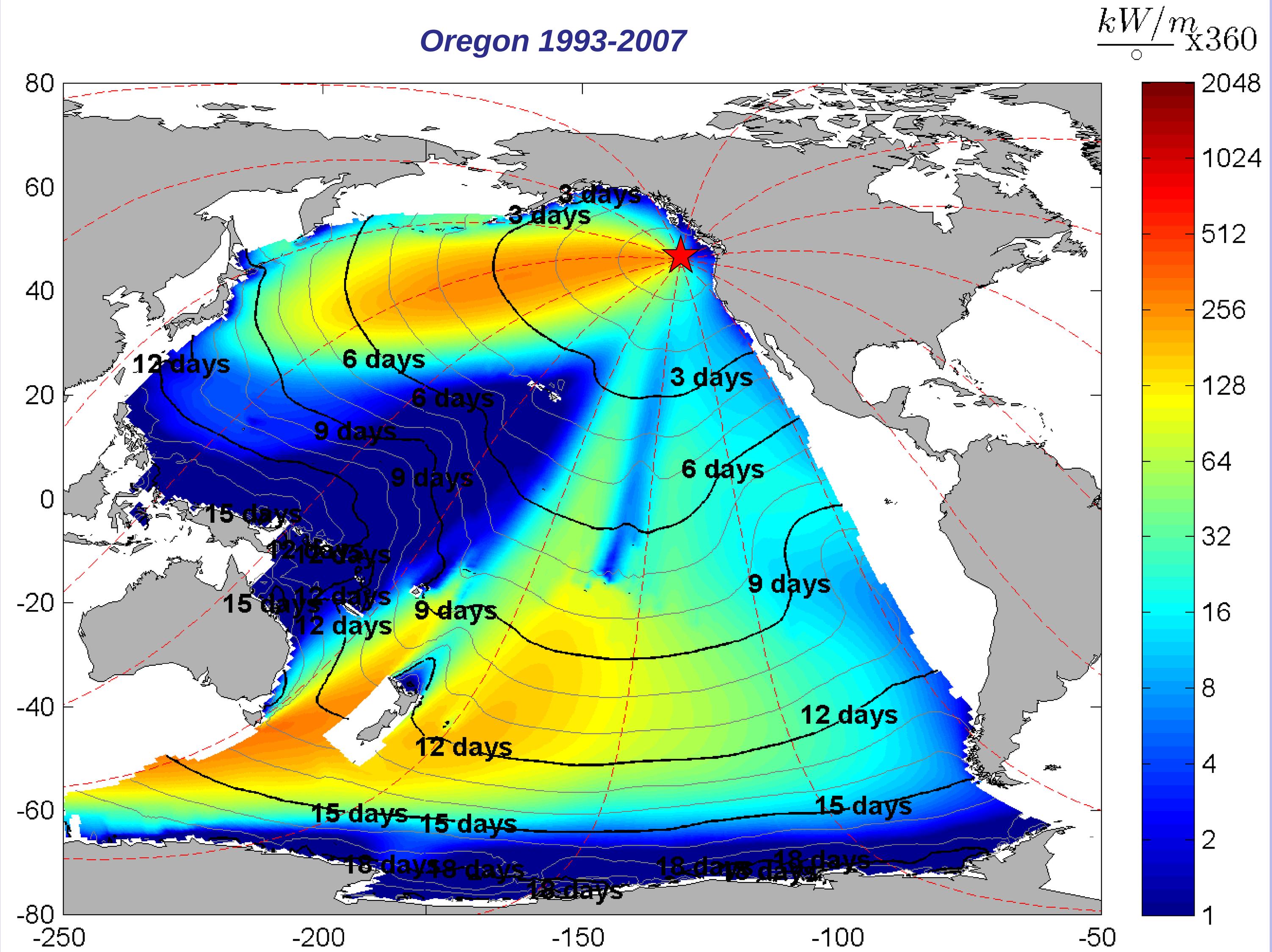
The net energy flux (F) and the travel time (T) over a temporal series of N sea states are obtained by using these formulas:

$$\overline{F} = \frac{\sum_{i=1}^{N} F_i}{N} \qquad \overline{T} = \frac{L}{\sum_{i=1}^{N} F_i c_g \Big/ \sum_{i=1}^{N} F_i}$$

In order to obtain the information on spatial maps, the physical criterion is applied to all the source points that satisfy the geographical criterion.

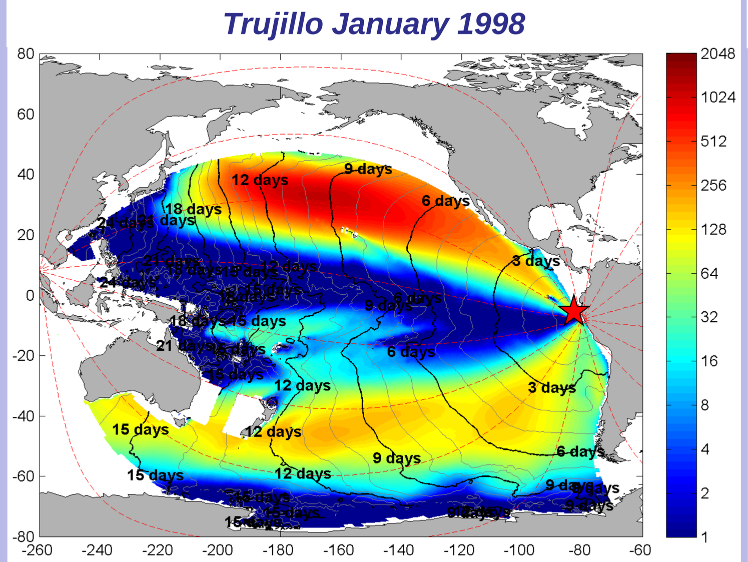
RESULTS

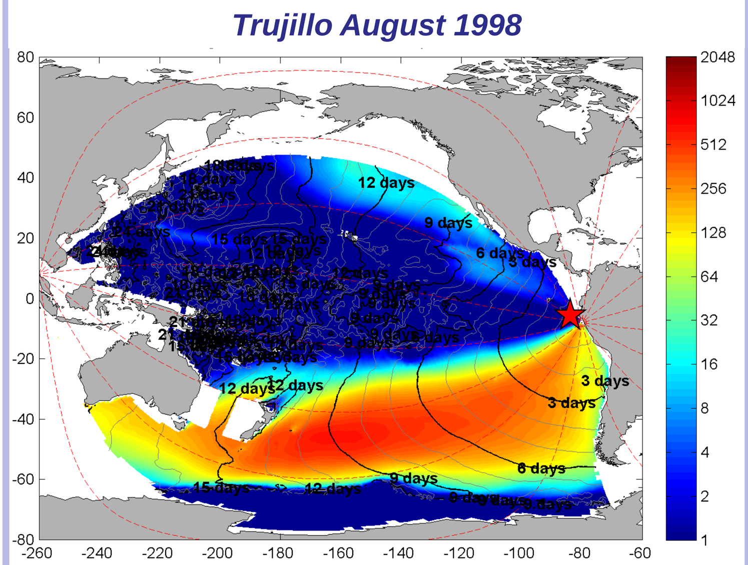
Here we show the spatial representation of the results for a target point in Oregon. Red lines are great circles that define sixteen directional sectors, and gray and black lines represent the travel time in days. We represent the effective energy flux in the source points in a logarithmic scale from blue (lowest energy) to red (highest energy)



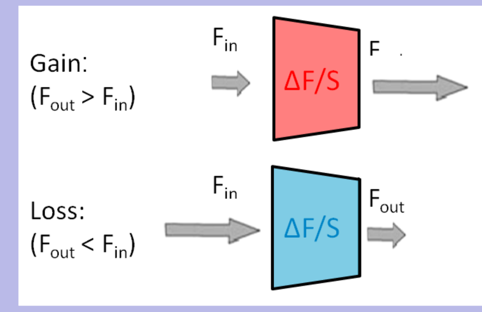
CLIMATE VARIABILITY:

Here we show January and August of 1998 for a target point in Trujillo. The seasonality and the effect of ENSO phenomenon are easily noticeable.





GAIN/LOSS OF ENERGY:



We can observe that energy growth is produced over a large area for Galicia (Spain) and it is very local for New York (USA).