12th International Workshop on Wave Hindcasting and Forecasting and 3rd Coastal Hazards Symposium

High resolution coastal wave climate in a semi-enclosed sea: the SW Mediterranean



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Waves from N Atlantic

Wave generation in the Mediterranean

Complex Wind fields

Refraction + Shoaling

Local wave generation

Multimodal directional spectra







Dynamic Downscaling

Menendez, M., García-Diez, M., Fita, L., Fernandez, J., Mendez, F.J., Gutierrez, J.M. (2011) High-resolution sea wind hindcasts over the Mediterranean area, submitted to *Climate Dynamics*

Global Wave reanalysis & Calibration

Reguero, B., Menendez, M., Mendez, F.,J., Minguez, R., Losada, I.J., (2011) A Global Ocean Wave (GOW) Calibrated Wave Reanalysis from 1948 onwards, submitted to *Coastal Engineering*

Minguez, R., Espejo, A., Tomas, A., Méndez, F.J., Losada, I.J. (2011) Directional Calibration of Wave Reanalysis Databases using Instrumental Data, *Journal of Atmospheric and Oceanic Technology*, doi: 10.1175/JTECH-D-11-00008.1

Minguez, R., Reguero, B.G., Luceño, A., Méndez, F.J. (2011) Regression Models for Outlier Identification (Hurricanes and Typhoons) in Wave Hindcast Databases, *Journal of Atmospheric and Oceanic Technology*, in press.

Downscaling wave climate to coastal areas

Camus, P., Méndez, F.J., Medina, R., Cofiño, A.(2011) Analysis of clustering and selection algorithms for the study of multivariate wave climate, *Coastal Engineering*, doi:10.1016/j.coastaleng.2011.02.003

Camus, P., Méndez, F.J., Medina, R. (2011) A hybrid efficient method to downscale wave climate to coastal areas, *Coastal Engineering*, doi:10.1016/j.coastaleng.2011.05.007

Camus, P, Cofiño, A.S., Méndez, F.J., Medina, R.(2011) Multivariate wave climate using self-organizing maps, *Journal of Atmospheric and Oceanic Technology*, doi: 10.1175/JTECH-D-11-00027.1



mean(estadisticos.Hs.mean.anual) 1948-2008





Almeria Alternativa Nº1. H₉₅ (m)



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Atmospheric Reanalysis (LR)



Menendez et al (submitted to Climate Dynamics)





Grid WRF-Model downscaled from NCEP/NCAR





20 ^l

-30

-20

-10











Model vs Satellite data, Bias (m/s)



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Atmospheric Reanalysis (LR)



Reguero et al (submitted to Coastal Engineering & Poster P21) Minguez et al (2011, Journal of Atmospheric and Oceanic Technology



Regional Wave Reanalysis GOW1.1





Point-to-point validation (reanalysis vs buoy data)











Spatial validation (reanalysis vs buoy and satellite data)

Calibration procedure Minguez et al (2011)

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Wave climate

Camus et al (2011a, 2011b, Coastal Engineering)

1.5

2.5

CANTABRIA CAMPUS INTERNACIONAL

0.5

aua y Energía

IHcantabria

Nearshore processes:

- Refraction
- Shoaling
- Wave breaking
- Spatial scale of interest=100 m

Maximum Dissimilarity Algorithm

 $D_{j} = \left\{ H_{j}^{D}, T_{j}^{D}, \theta_{j}^{D}, W_{j}^{D}, \beta_{j}^{D} \right\}; j = 1, ..., M$

Selection

↓ <u>Vali</u>dation

Reconstruction

Wave climate

Radial Basis Functions

$$RBF\left(X_{i}\right) = p\left(X_{i}\right) + \sum_{j=1}^{M} a_{j} \Phi\left(\left\|X_{i} - D_{j}\right\|\right)$$
$$p\left(X_{i}\right) = b_{0} + b_{1}H_{i} + b_{2}T_{i} + b_{3}\theta_{i} + b_{4}W_{i} + b_{5}\beta_{i}$$
$$\Phi\left(\left\|X_{i} - D_{j}\right\|\right) = \exp\left(-\frac{\left\|X_{i} - D_{j}\right\|^{2}}{2c^{2}}\right)$$

Point P1

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Atmospheric Reanalysis (LR)

Synthesis of the work Wind forcing Large-scale wave reanalysis The problem of downscaling (nearshore propagation) Downscaled Ocean Waves Conclusions

High Resolution grids: 200 m spatial resolution

mean(estadisticos.Hs.mean.anual) 1948-2008

Almeria Alternativa Nº1. H₉₅ (m)

95% percentile of SWH

0.5

High resolution coastal wave climate in a semi-enclosed sea: the SW Mediterranean

- 1. Synthesis of the work
- 2. Wind forcing
- 3. Large-scale wave reanalysis
- 4. The problem of downscaling (nearshore propagation)
- 5. Downscaled Ocean Waves
- 6. Conclusions

- Coastal wave climate requires a more detailed spatial resolution (say, 100 m) in order to correctly evaluate different coastal processes
- A combination of atmospheric dynamic donwscaling and wave generation models using nested grids is presented
- A hybrid methodology is proposed to downscale wave climate to coastal areas
- M=100-500 high-resolution wave propagations are adequate
- In a 60 years hourly shallow water wave reanalysis... 1000X CPU

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Forzamiento NCEP 1948-2008 1.8° 6 h Modelo WW3 0.1° + 1 hora Parámetros espectrales + espectros direccionales

44.4

43.4

42.5

-5.1

V

Selection

Propagation

SWAN model Variable boundaries: Directional wave spectra

Library of the *M*=500 propagated cases

