ESTIMATION OF RETURN LEVELS OF EXTREME WAVES INCORPORATING NON-STATIONARITIES

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Non-stationarity

- **Seasonality**
- **Trends**

Wavelet Theory used to provide evidence

MLE to compute the parameters of the extreme value models

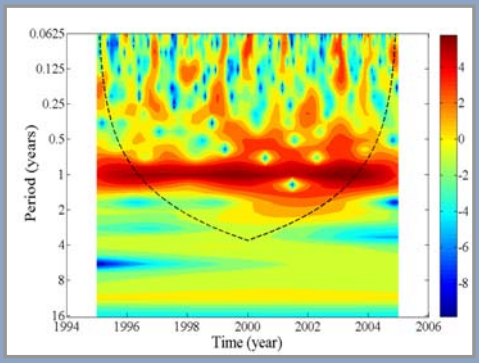
Estimation of return levels incorporating non-stationarities

Original series

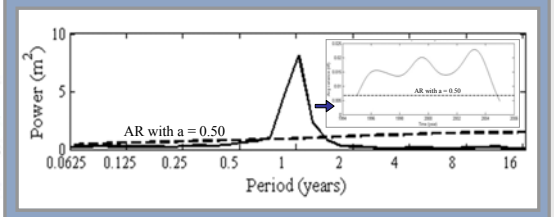
3-hourly wave height (1995-2004) of the WAM model

Data used

48-hourly maxima of wave height (1995-2004) to ensure independence of extreme observations



Wavelet Theory- Morlet wavelet



- **A 1-year "periodicity" is observed along the whole series**

Seasonality

- **This "periodicity" is proven to be statistically significant at a 5% significance level**
- **No evidence of significant trends**

Extreme Value Theory

Point process model with parameters μ, σ, ξ

$$\lambda_{\theta}(x) = \frac{1}{\sigma}\{1+\xi(\frac{x-\mu}{\sigma})\}_{+}^{-(\xi+1)/\xi}$$

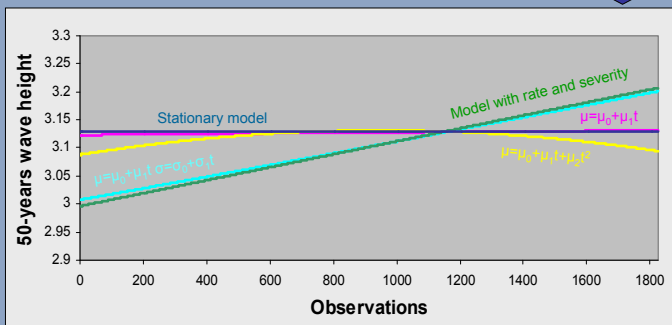
Threshold at 1.5 m

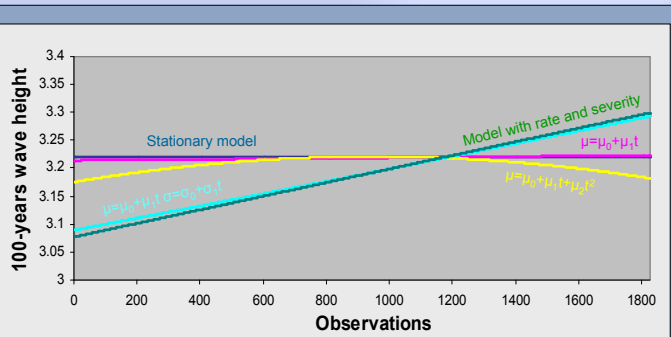
- **Periodicity in parameters μ and σ using a sinusoidal function**

Parameters are estimated using MLE

- **Trends are incorporated using**
  (a) polynomial functions
  (b) terms of the rate and severity of extreme events

Model for parameters to account for seasonality	Mean return level (m)	
	50-years	100-years
Stationary point process	3.13	3.22
$\mu=\mu_0+\mu_1*\cos(2\pi t)$	3.12	3.21
$\mu=\mu_0+\mu_1*\cos(2\pi t-\mu_2)$	3.05	3.14
$\mu=\mu_0+\mu_1*\cos(2\pi t-\mu_2)$ and $\sigma=\exp(\sigma_0+\sigma_1*\cos(2\pi t-\sigma_2))$	2.95	3.04





There appears to be a slight increase in rate and severity of extremes during the 10 years

All models do not present significant trends when judged in terms of the deviance statistic

Models $\mu=\mu_0+\mu_1 t$ $\sigma=\sigma_0+\sigma_1 t$ and the model in terms of rate and severity show similar results