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Climatology, Variability and Extrema of Ocean Waves – The Web-based KNMI/ERA-40 Wave Atlas

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- The quality of the ERA-40 waves
- The 100 year return wave height
- Statistical correction of wave heights
- The KNMI/ERA-40 Wave Atlas

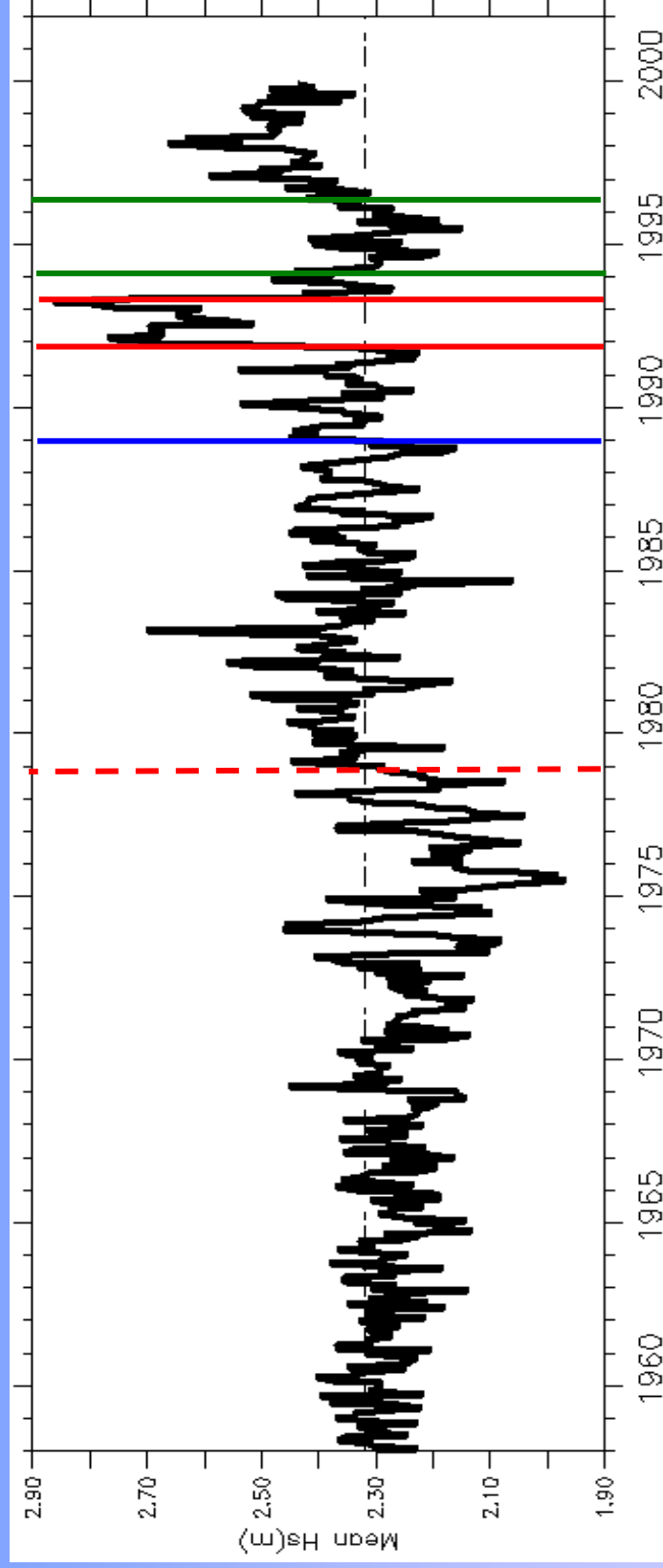


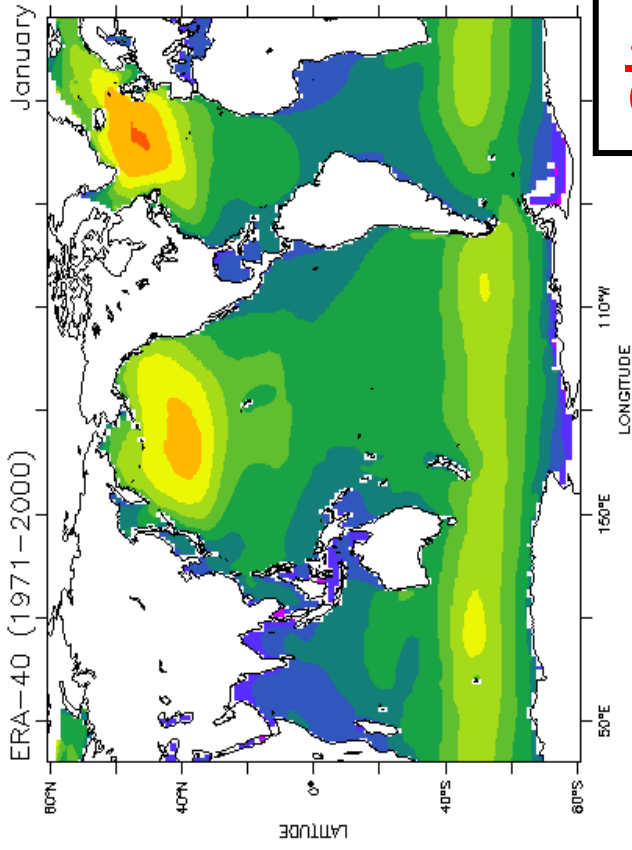
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ERA-40

- 45 year atmospheric reanalysis (09/1957 – 08/2002) from ECMWF
- **reanalysis**: model run constrained by observations
- interactive Charnock Parameter
- ==> coupled to WAM (1.5°)
- ==> **waves**

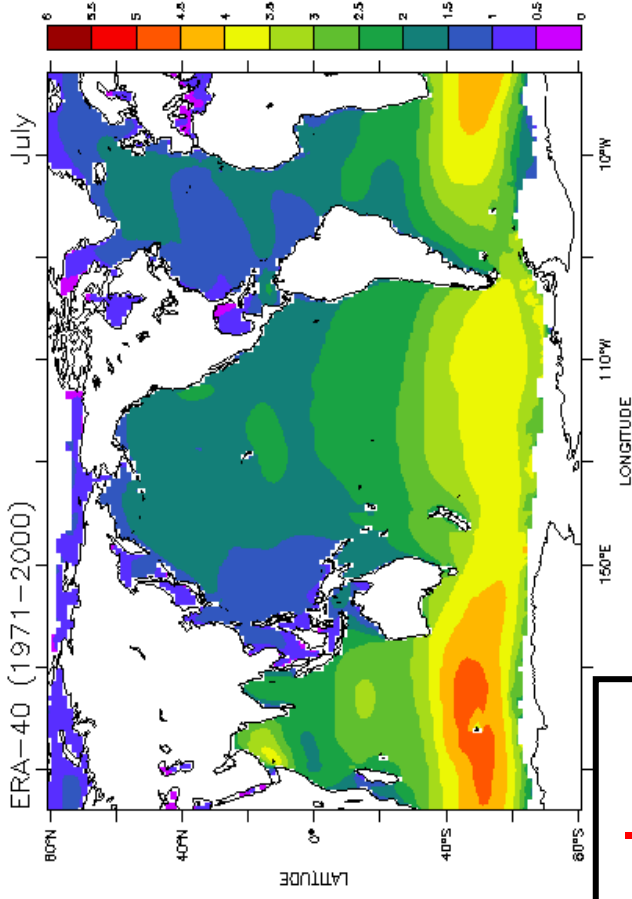


Global Mean Significant Wave Height



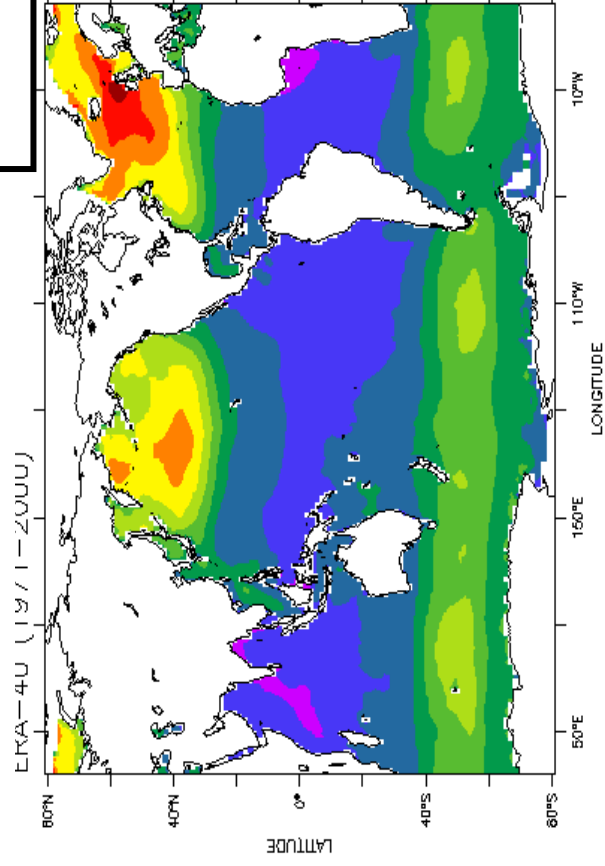


Climatology

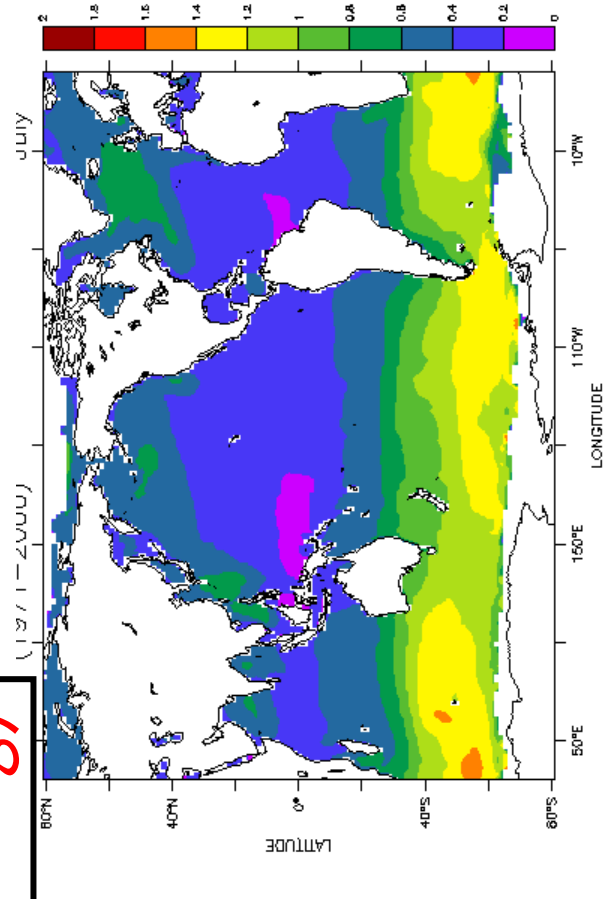


Significant wave height mean (m)

Significant wave height mean (m)



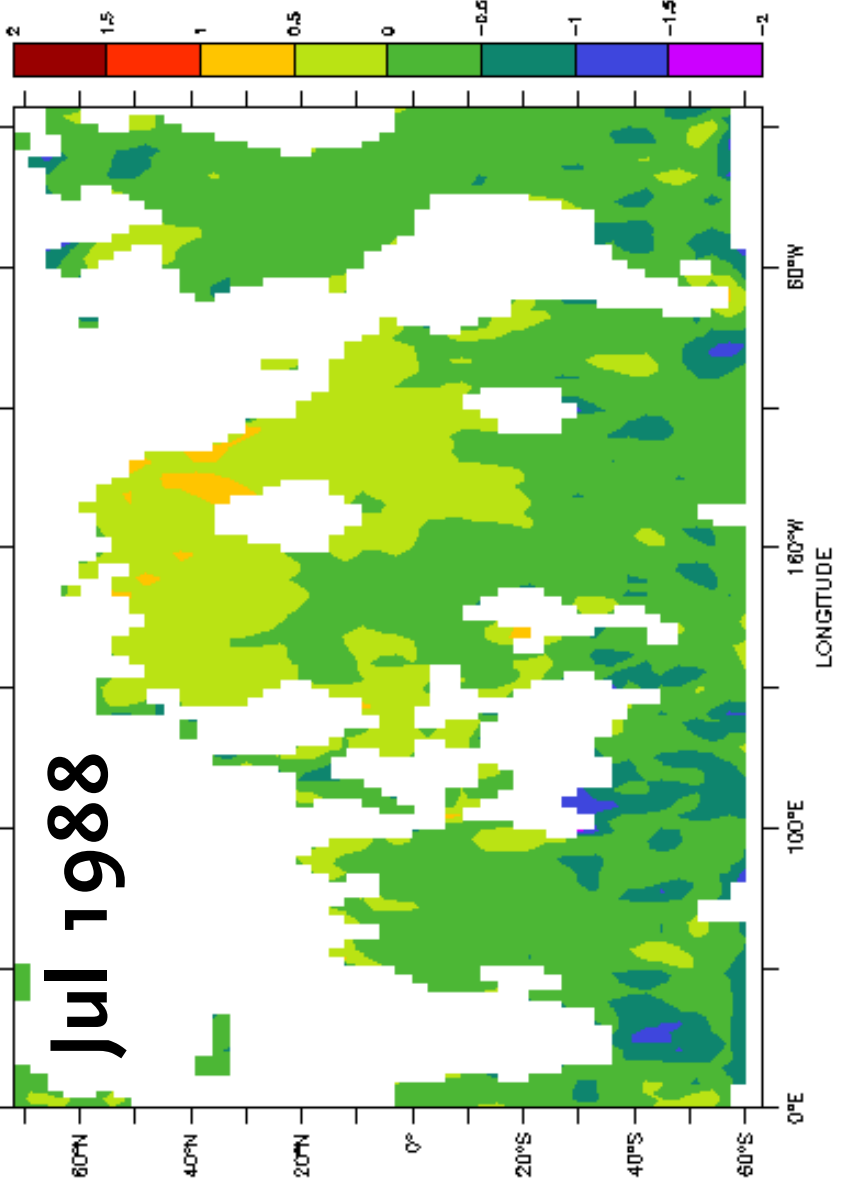
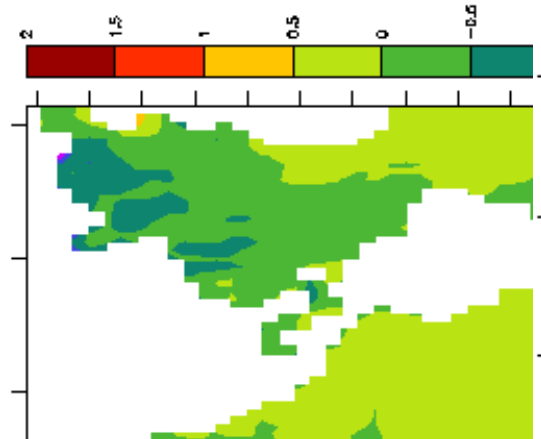
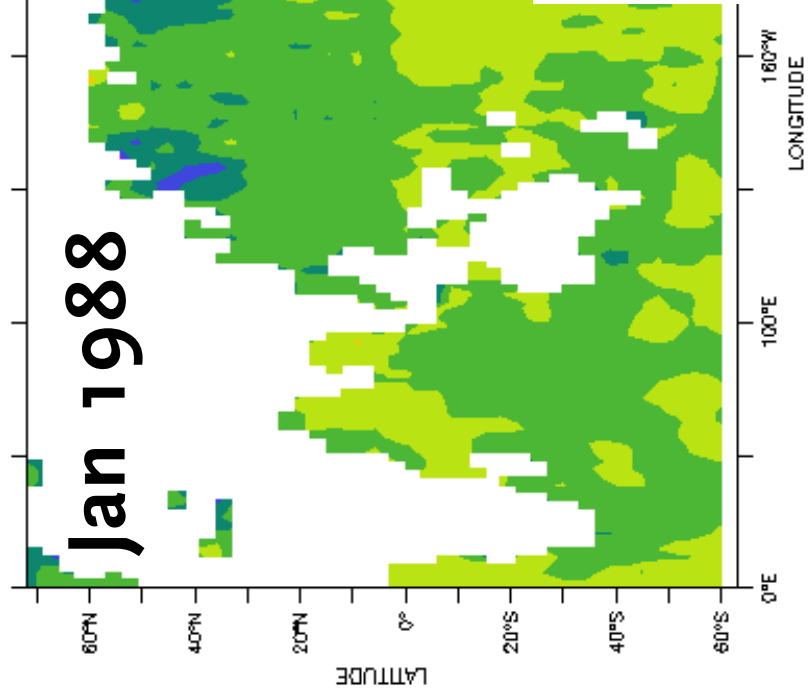
Significant wave height standard deviation (m)



Significant wave height standard deviation (m)

Assessment of ERA-40 waves

- other modelling efforts
- buoys (since 1978)
- altimeters (satellites)



ERA40 Hs(m) - Geosat Hs(m)

Koninklijk Nede

KNMI

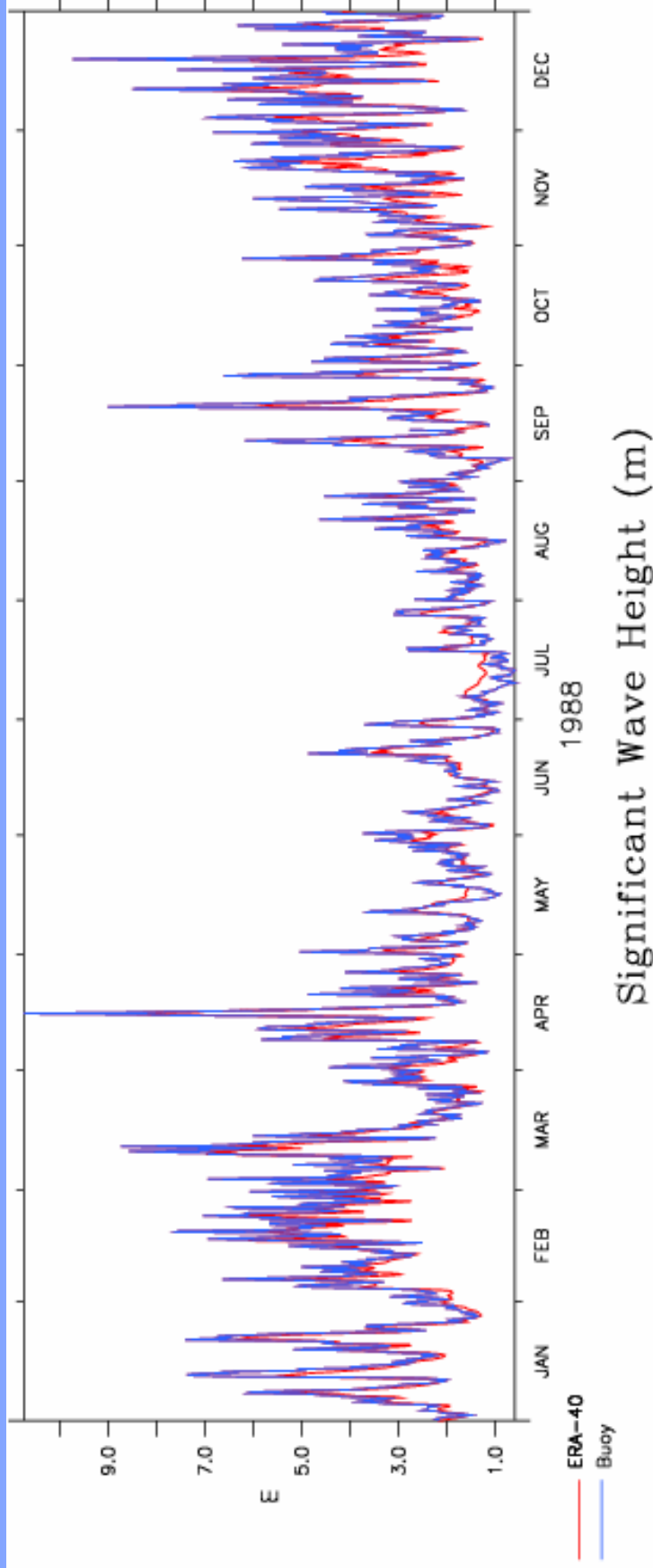
ERA40 Hs(m) - Geos

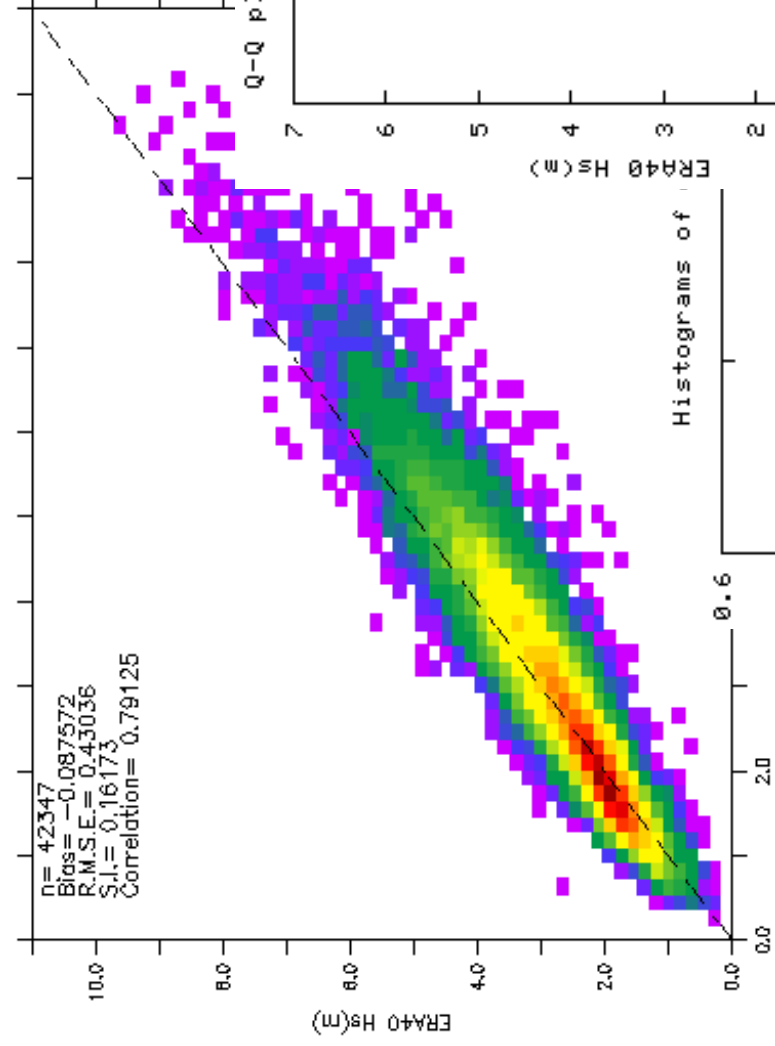
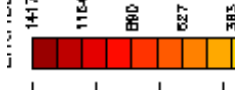
Monthly Means

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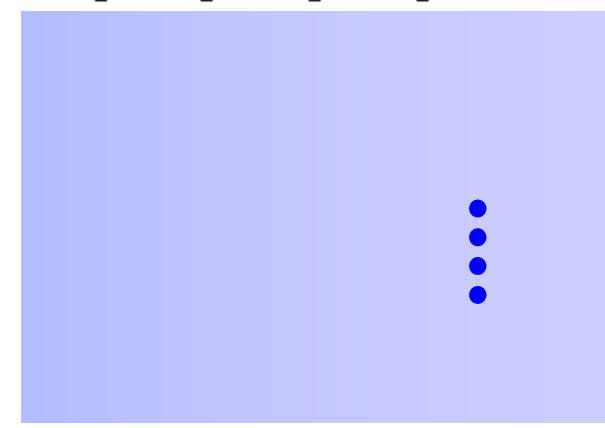
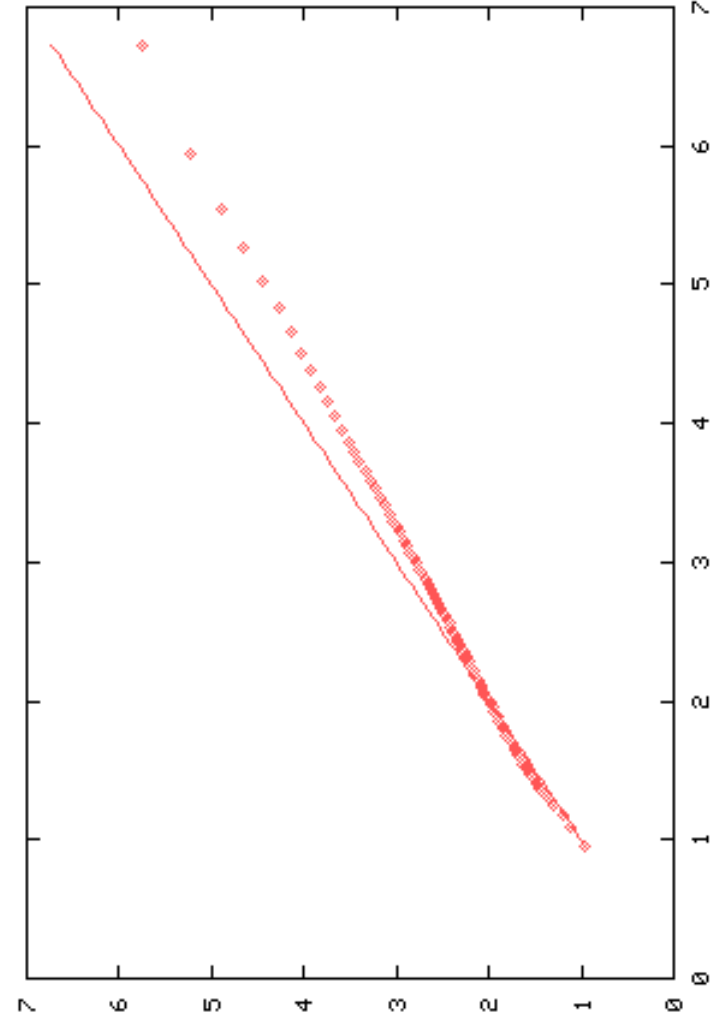
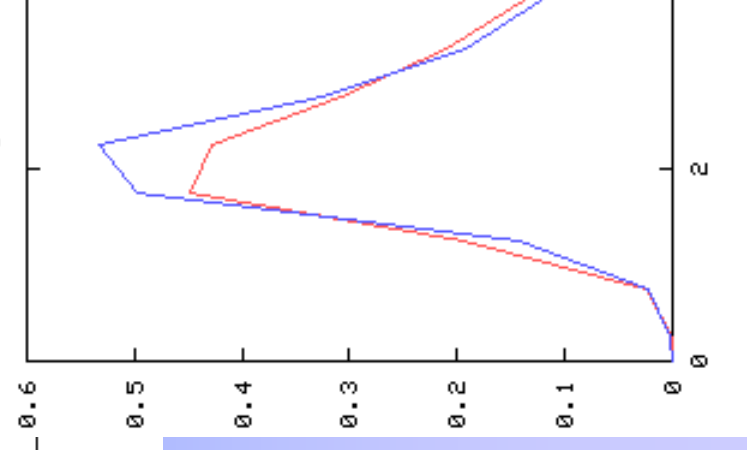
A.

Buoy 46001 (148.3°W, 56.3°N)





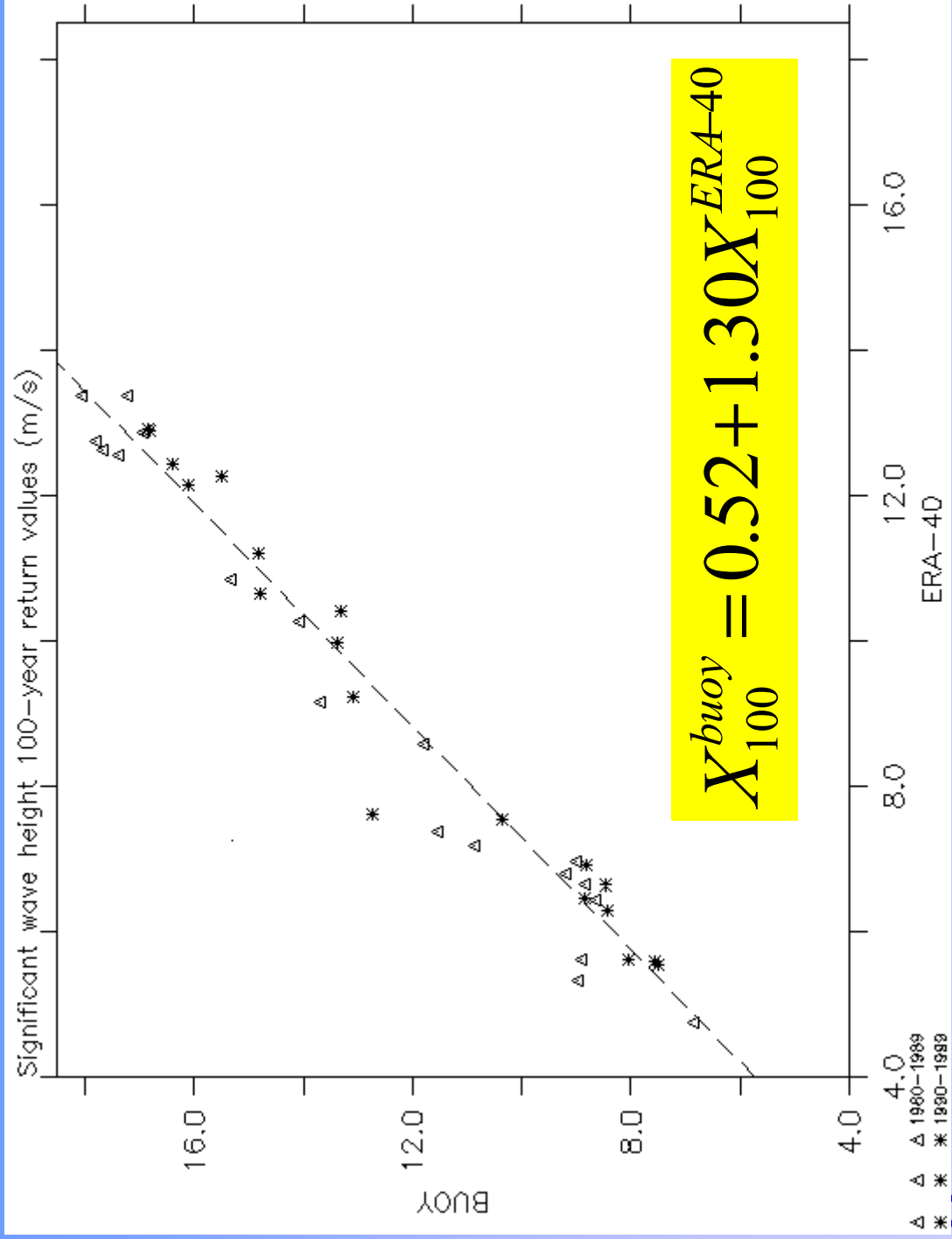
Histograms of

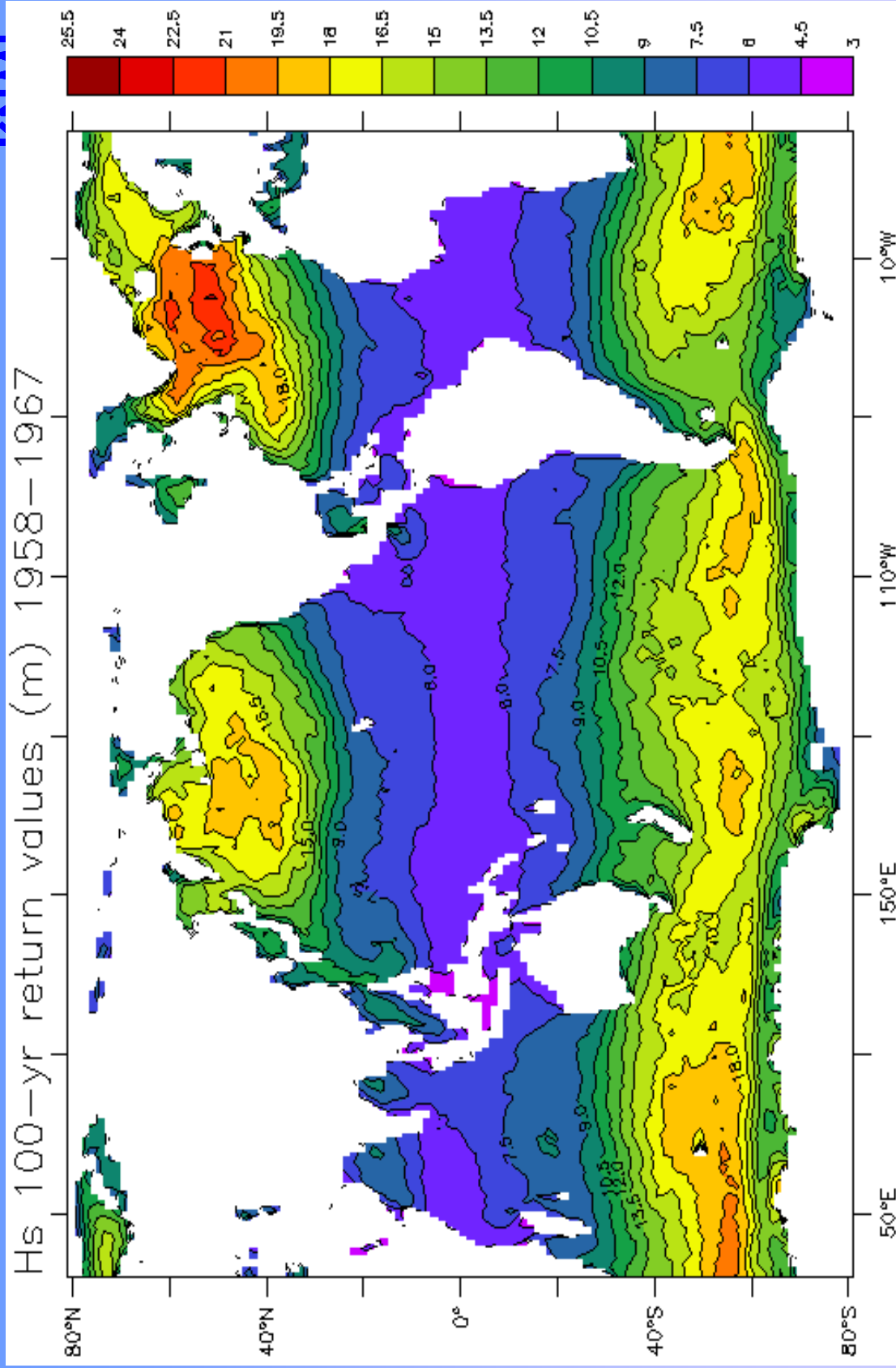


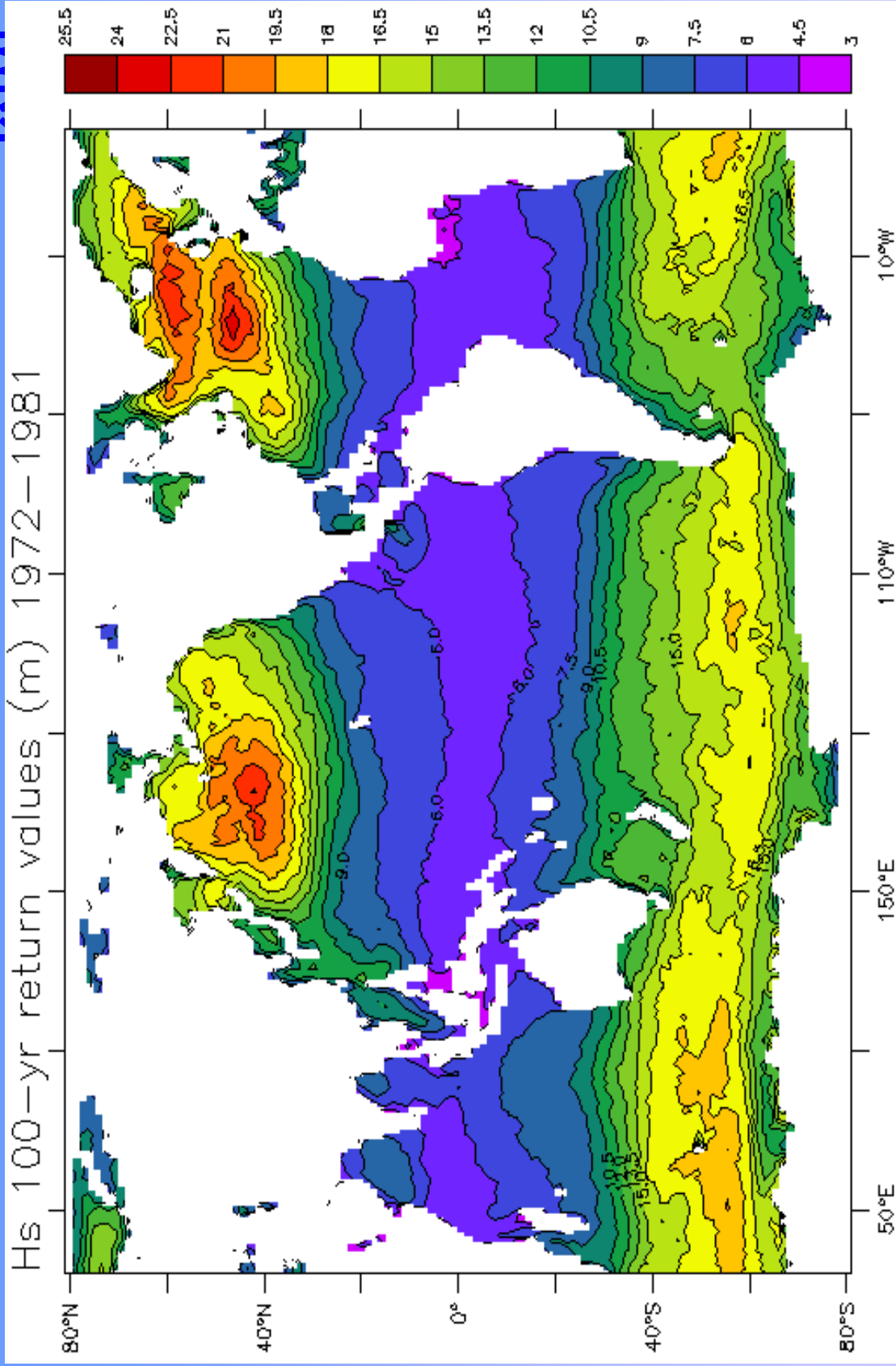
The “100 year return” wave height

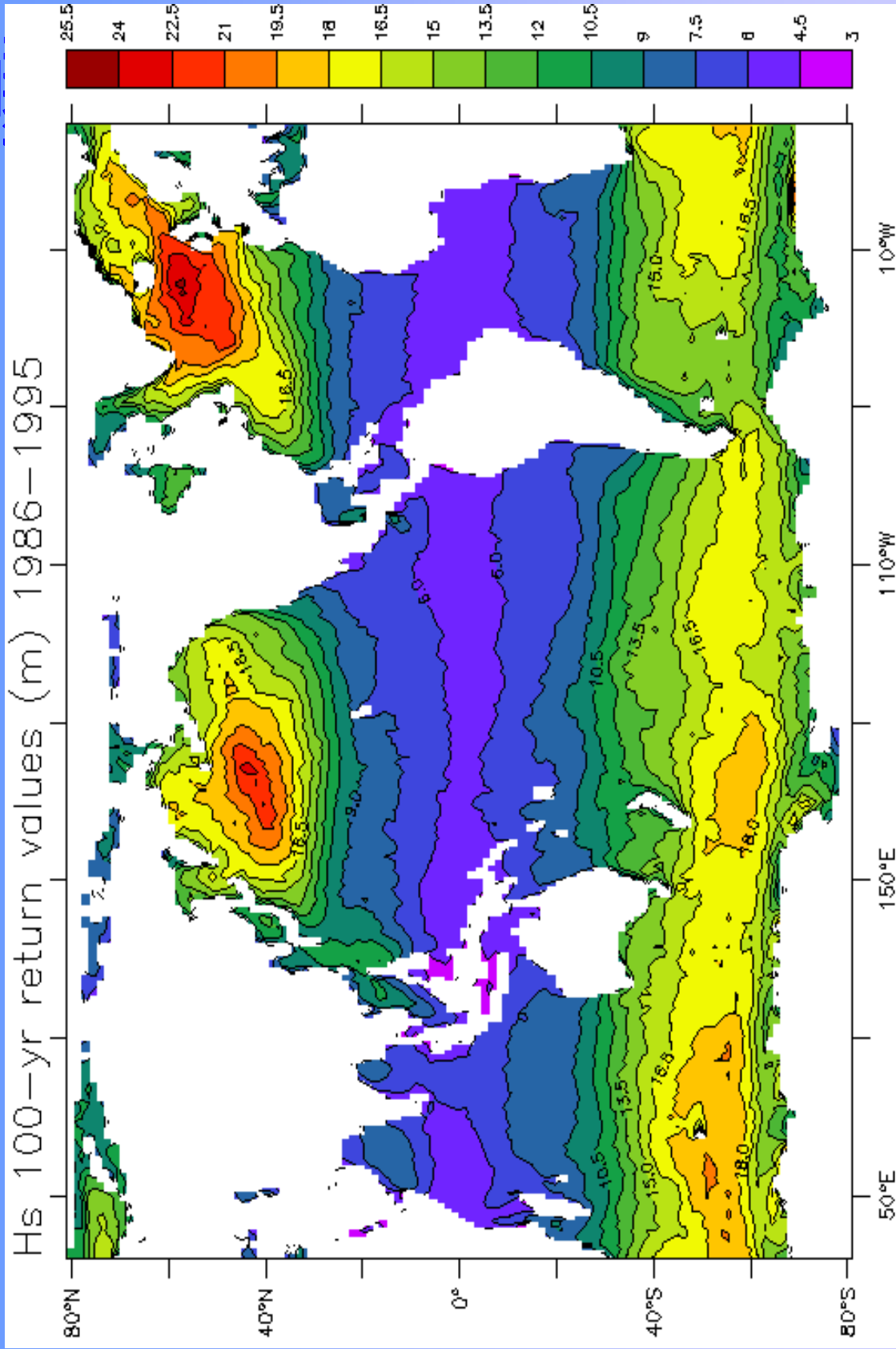
- **Peak-Over-Threshold (POT) method**
- **Both for ERA-40 and buoy**

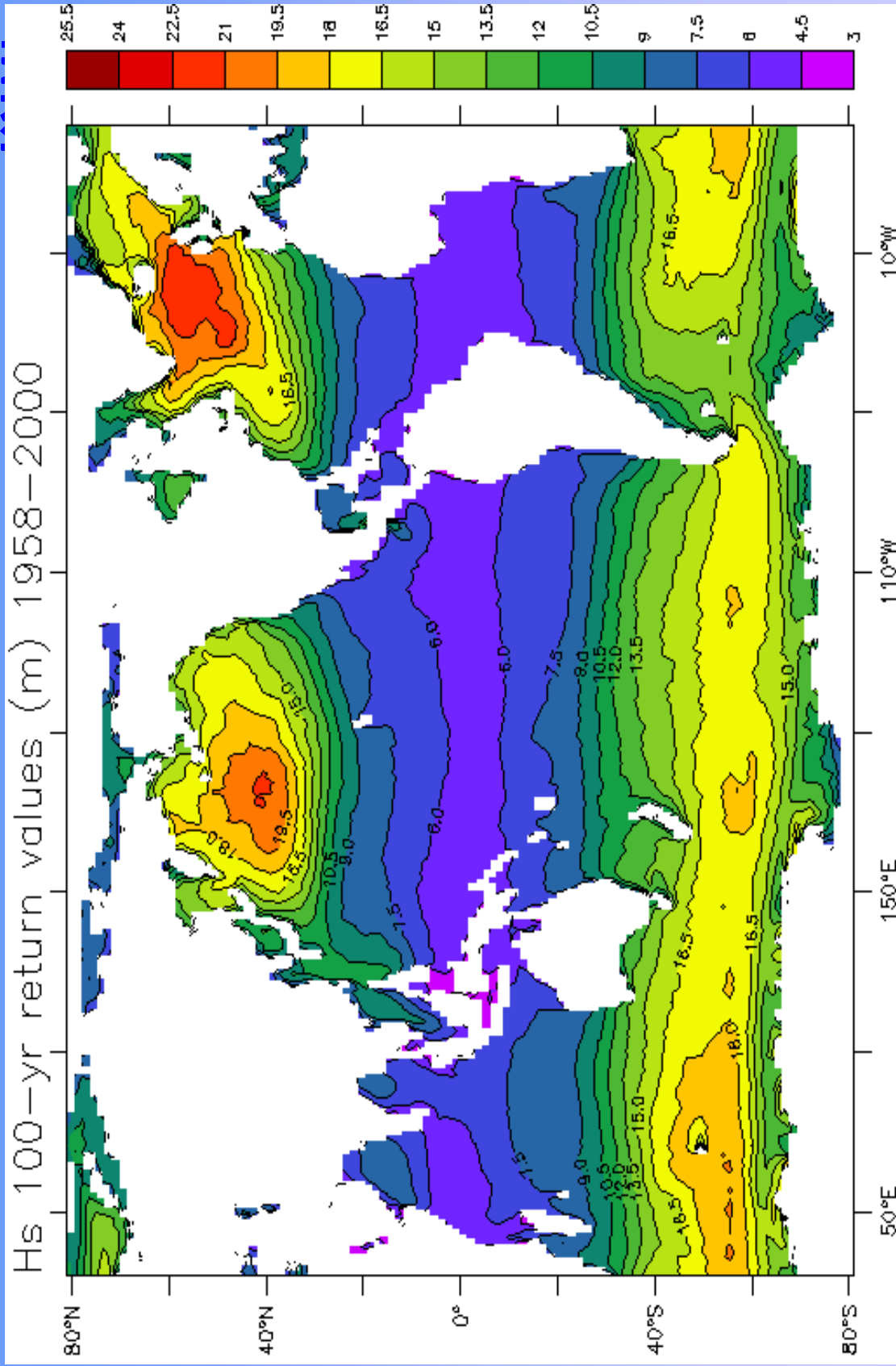
ERA-40 vs buoy data







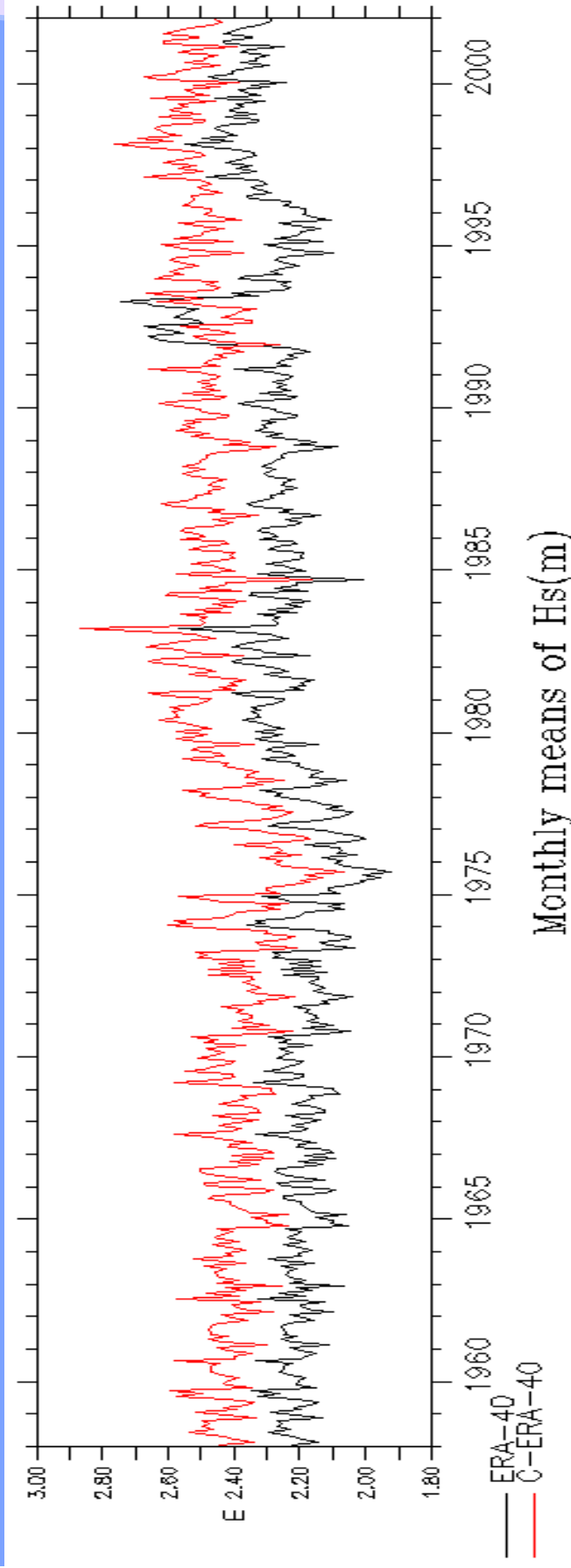




Statistical correction of wave heights

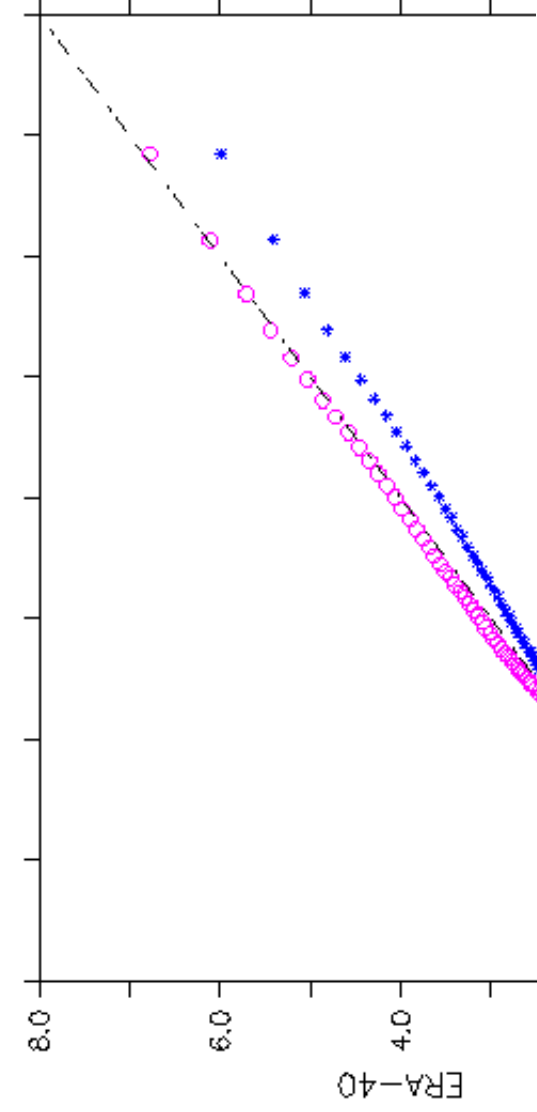
- **obs:** bias similar in similar situations
- **similar:** last three H_s close together
- identify “similar” situations
- compare with “learning data” ...
- ... obtained from altimeters (“truth”)
- correct data

Global mean H_s

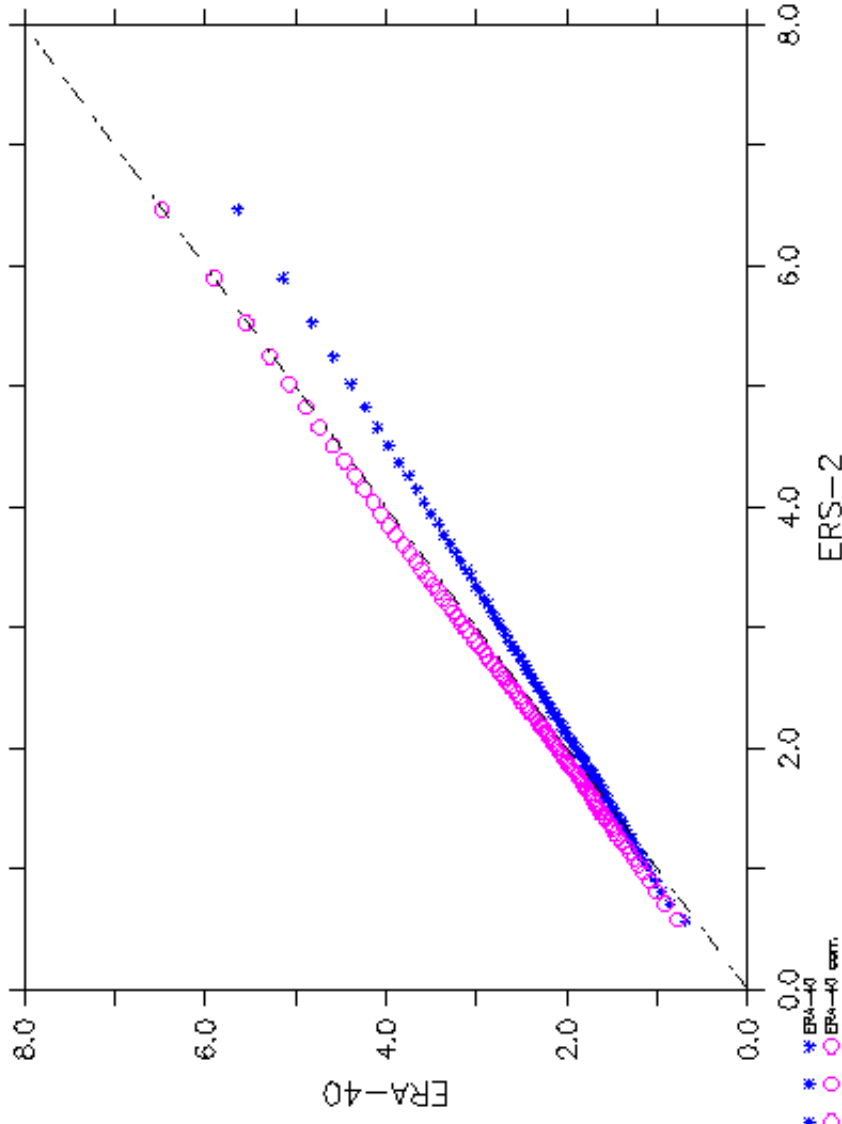
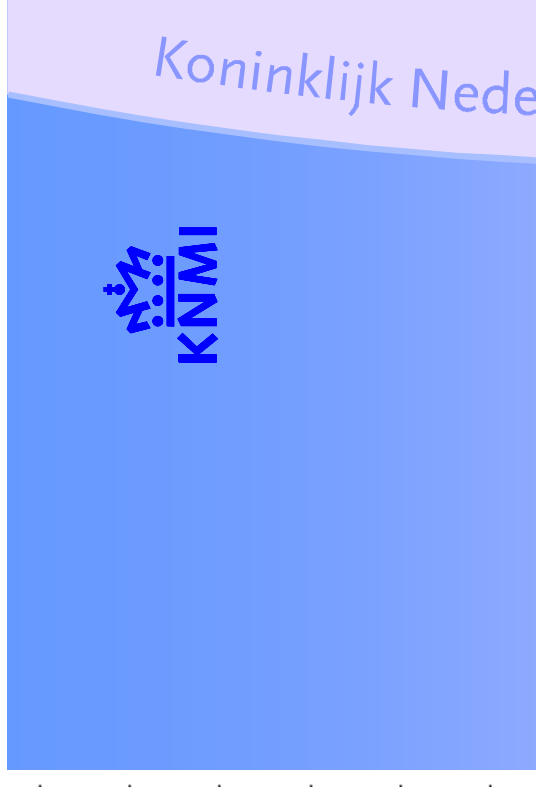
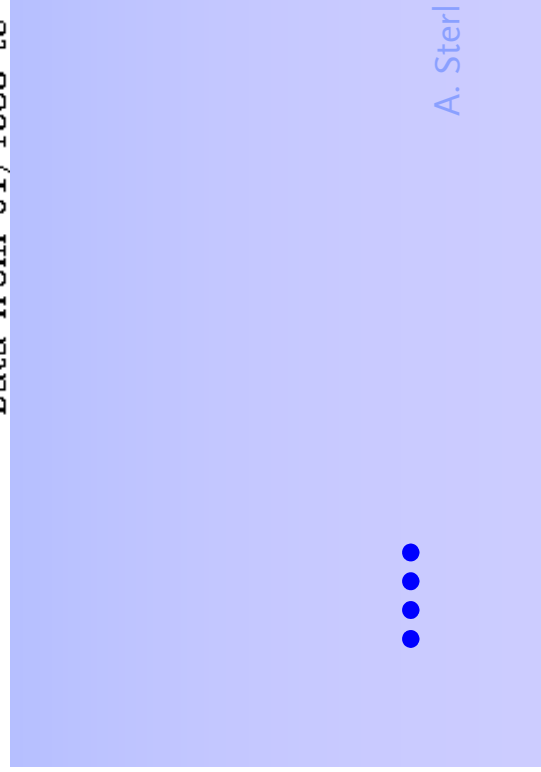


- wave height generally increased (bias ≈ 0)
- no more inhomogeneities





Data from 01/1988 to



Data from 06/1995 to 05/1996

The KNMI/ERA-40

Wave Atlas

1. Introduction
2. Description of data sources
3. Validation of wind and waves
4. Description of wind and wave climate (means, exceedences, quantiles, extremes, bivariate histograms)
5. Description of wind and wave climate variability

Click [here](#) for a no frames version of this page.

The KNMI/ERA-40 WAVE ATLAS derived from 45-years of ECMWF reanalysis data

Thanks to



for the raw ERA-40 data.

S. Cabres, A. Sterf, G. Komen and V. Swail.

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 - Buoy measurements
 - Altimeter measurements
- 2.3 Corrected ERA-40 significant wave height data

Chapter 3 - Validation of winds and waves

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- 3.2 Comparisons with altimeter data

Chapter 4 - Description of wind and wave climate

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 - Significant wave height (original ERA-40): means and standard deviations, 90% quantiles, 99% quantiles
 - Significant wave height (corrected ERA-40): Means and standard deviations, 90% quantiles, 99% quantiles
 - Mean wave period: Means and standard deviations
 - Wind speed: Means and standard deviations, 90% quantiles, 99% quantiles
 - Annual statistics: Significant wave height (original ERA-40):

Global Wave Climatology Atlas
derived from 45-years of ECMWF reanalysis data

This tech-based atlas describes wave climate and variability for use in:
- System engineering applications
- Detailed strategic planning of shipping routes
- Scientific areas such as climate research

Contents highlights:
- Climate means, standard deviations and percentiles.
- Maps of extreme statistics.
- Wave histograms, period and direction tabular.
- Description of wind and wave climate variability.

Developed by
S. Cabres, A. Sterf,
G. Komen and V. Swail

Bookmark:
<http://www.knmi.nl/waveatlas>.

<http://www.knmi.nl/waveatlas>

Summary

- Inhomogeneities due to changing data
- Good monthly means
- Low waves (slightly) too high
- High waves (much) too low
- Possibility of statistical correction
- H_{100} highly variable
- Free **KNMI/ERA-40 Wave Atlas**

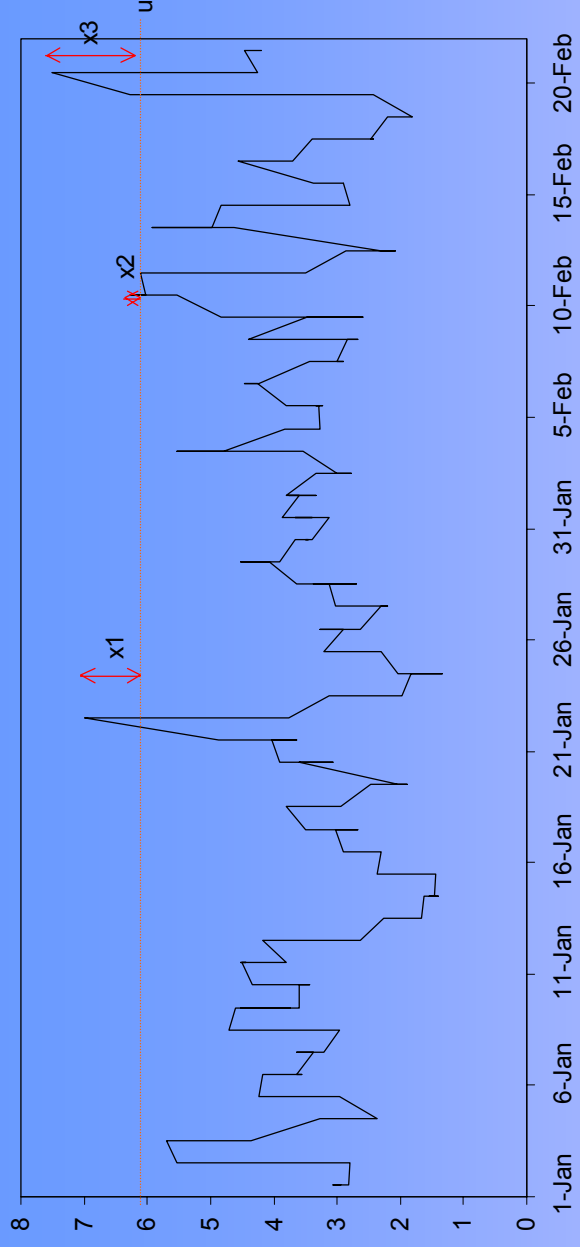


Enjoy

<http://www.knmi.nl/waveatlas>



Peaks-over-threshold method



Peak excesses over a high threshold u occur according to a Poisson process with rate λ_u and are independently distributed with a **Generalized Pareto Distribution**

$$F_u(x) = \begin{cases} 1 - (1 - \kappa x / \alpha)^{1/\kappa} & \kappa \neq 0 \\ 1 - \exp(-x / \alpha) & \kappa = 0 \end{cases}$$

m-year return value

$$x_m^{(u)} = \begin{cases} u + \alpha / \kappa \log(1 - (\lambda_u m)^{-\kappa}) & \kappa \neq 0 \\ u + \alpha \log(\lambda_u m) & \kappa = 0 \end{cases}$$

A. Sterf & S. Gajda, CMAE2006, Hamburg, 06.06.2006



Estimation method: maximum likelihood

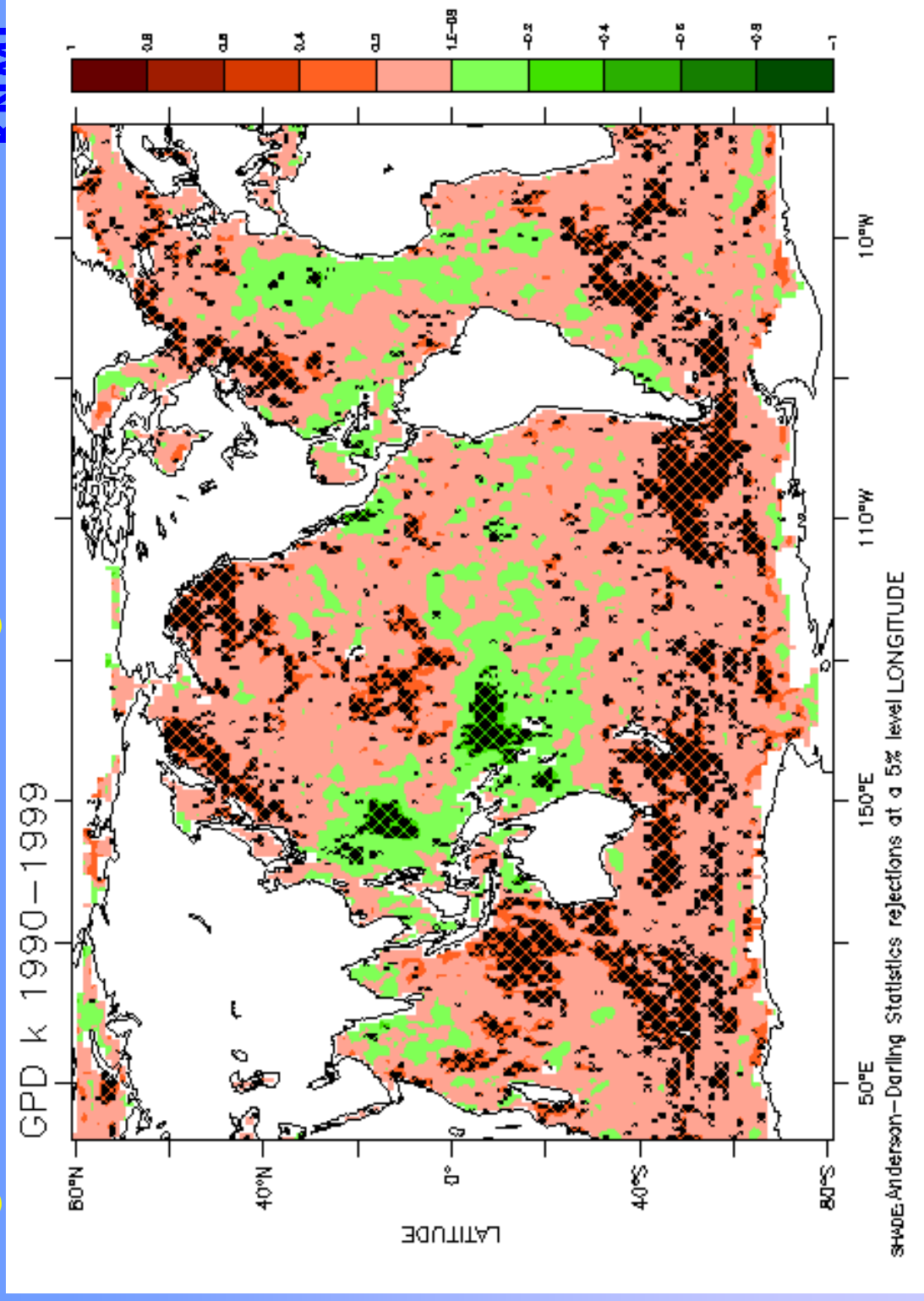
Unknowns: u, λ, α, K

Assumptions

- $K = 0$ (data is exponential)
- $u = h_{0.93}$



The exponentiality of the data was tested • using the Anderson-Darling statistic



Learning

