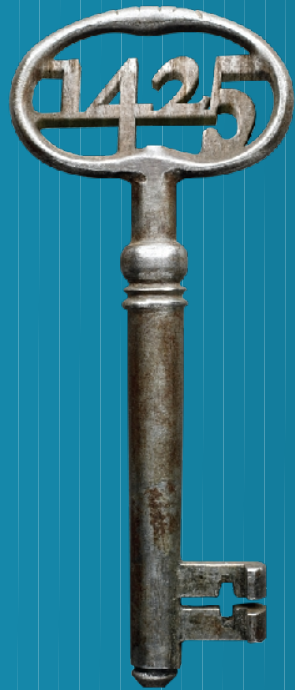




The role of spectral multimodality in wave climate design



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Motivation

Unimodal approach generates misinterpretation of real sea states



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Applied Stochastic models for ocean engineering, climate and safe transportation

<http://www.maths.lth.se/seamocs>



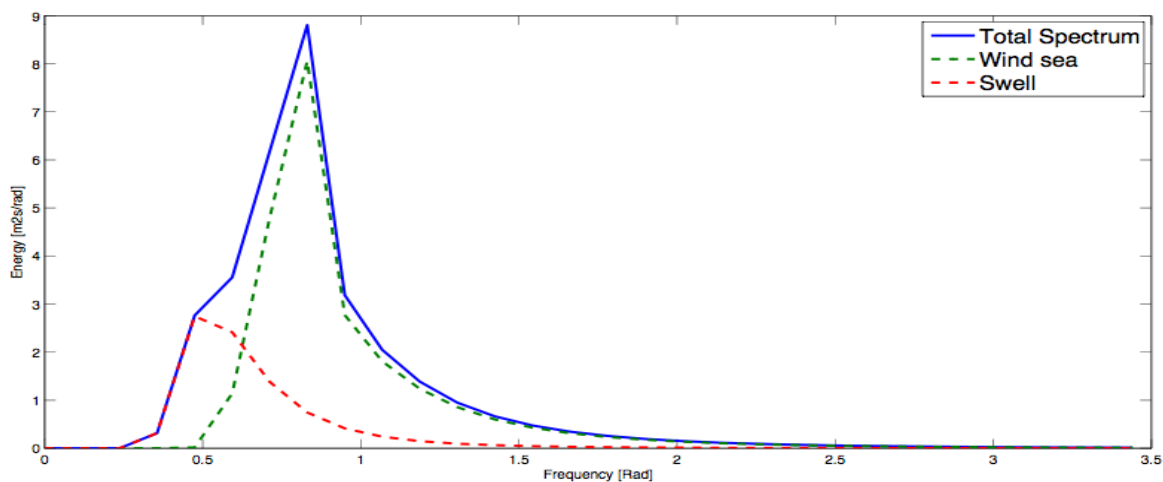
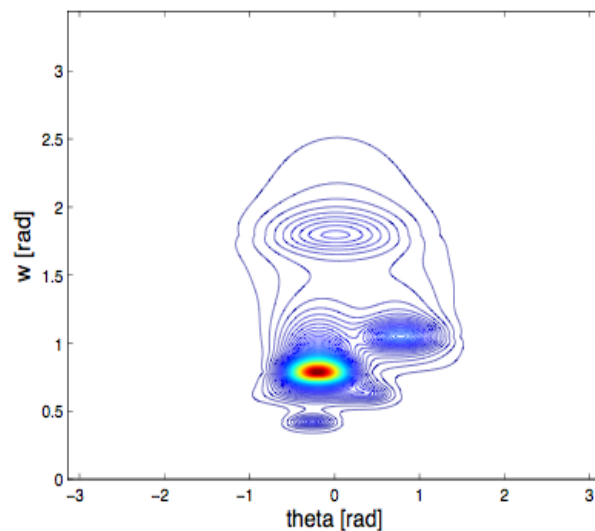
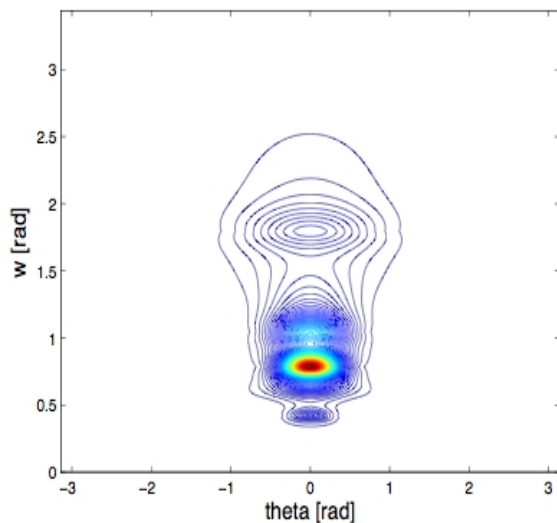
Summary

- Spectral partitioning scheme MuSeas
- Different assignment criteria lead to different wave system climates
- Additional criteria proposed (wave steepness, directional spreading, characteristic frequency)



MuSeas partitioning scheme 1/3

1- Identify the wave systems

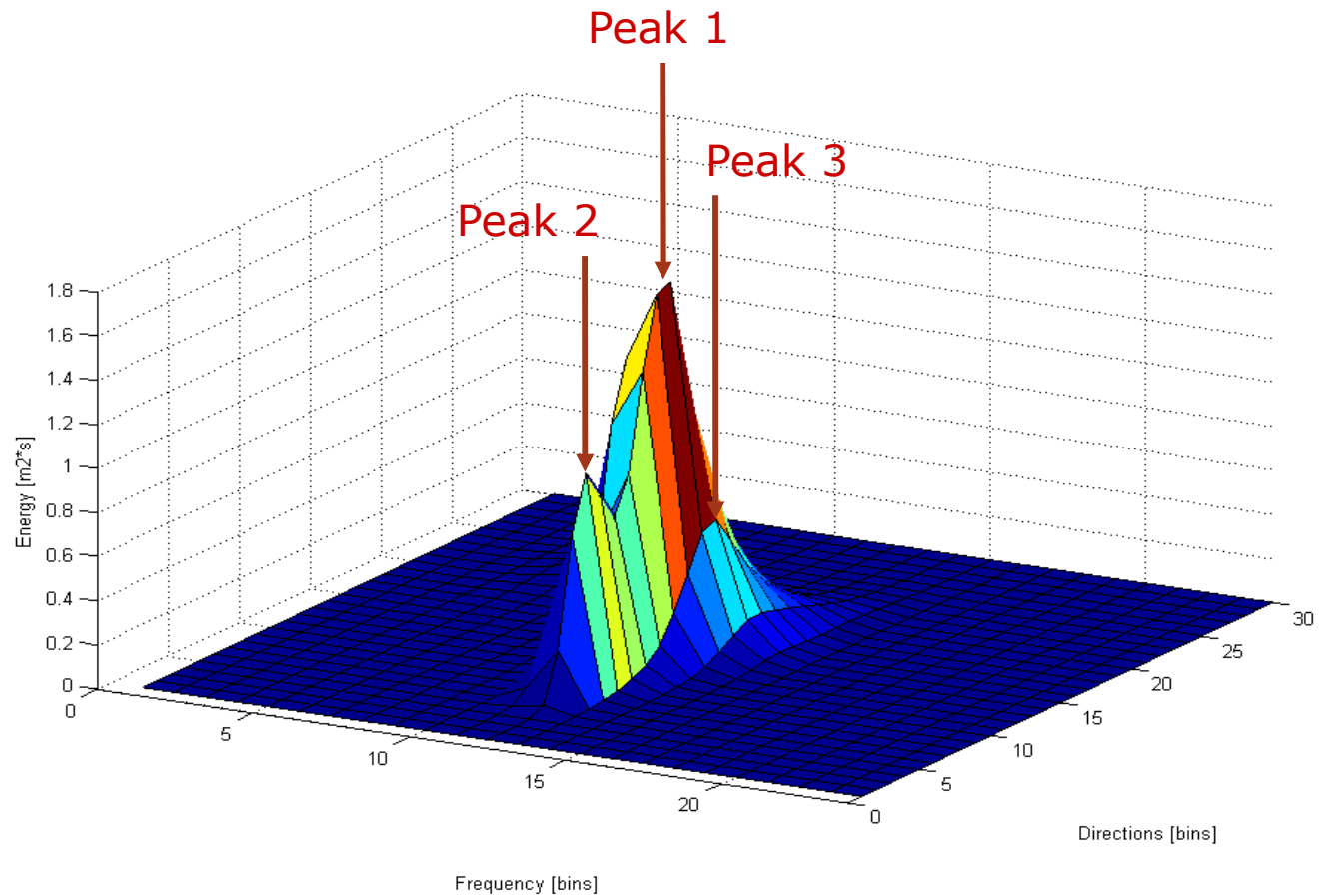


Hidden seas



MuSeas partitioning scheme 2/3

2- Combine the wave systems



MuSeas partitioning scheme 3/3

3- Assign wind sea and swell

Peak parameters $\left\{ \begin{array}{l} (1.3 \frac{U}{C_p} \cos(\theta_p - \theta_w) > 1) \\ \text{Hasselmann et al., 1996} \\ \text{[H96]} \end{array} \right.$

Mean parameters $\left\{ \begin{array}{l} (1.2 \frac{U}{C} \cos(\theta_m - \theta_w) > 1) \\ \text{Bidlot, 2001} \\ (1.5 \frac{U}{C} \cos(\theta_m - \theta_w) > 1) \\ \text{Hanson and Phillips, 2001} \end{array} \right.$

Data description

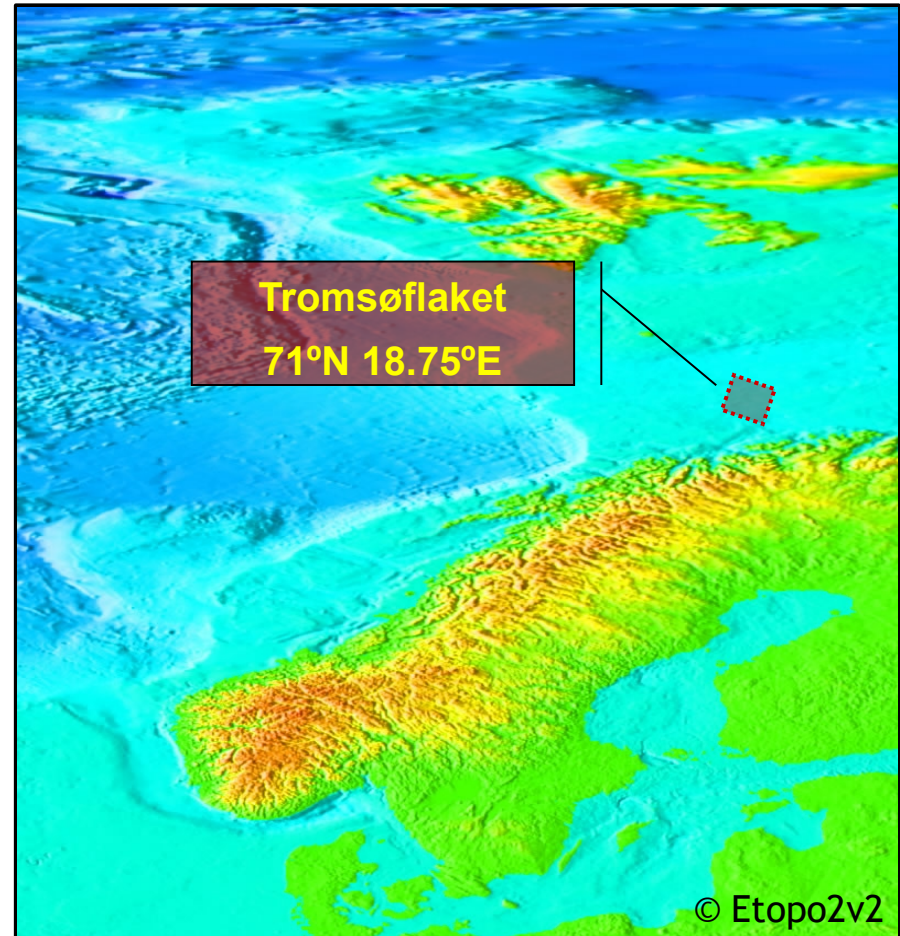
ERA-Interim 1989-2008

Grid Resolution: $1^{\circ} \times 1^{\circ}$

**Spectral Resolution: 30 frequencies x
24 directions**

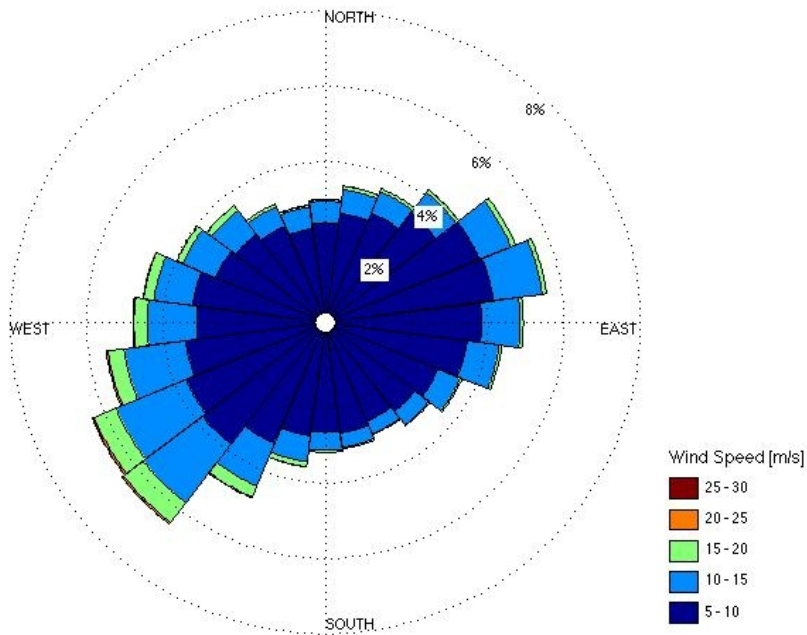
**Analysis times: 00 UTC, 06 UTC,
12 UTC, 18 UTC**

See Bidlot (2001) for more details

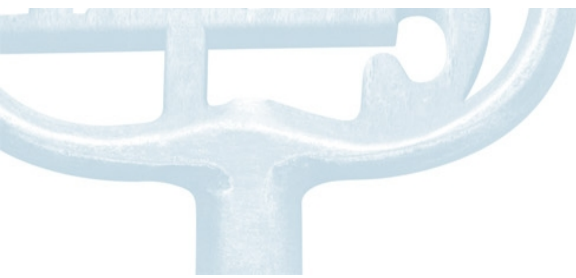
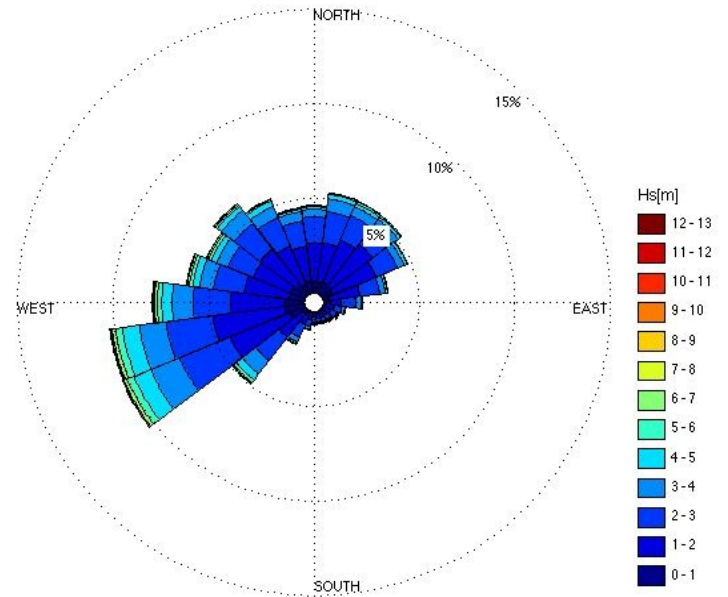


Unimodal wave climate

Wind distribution



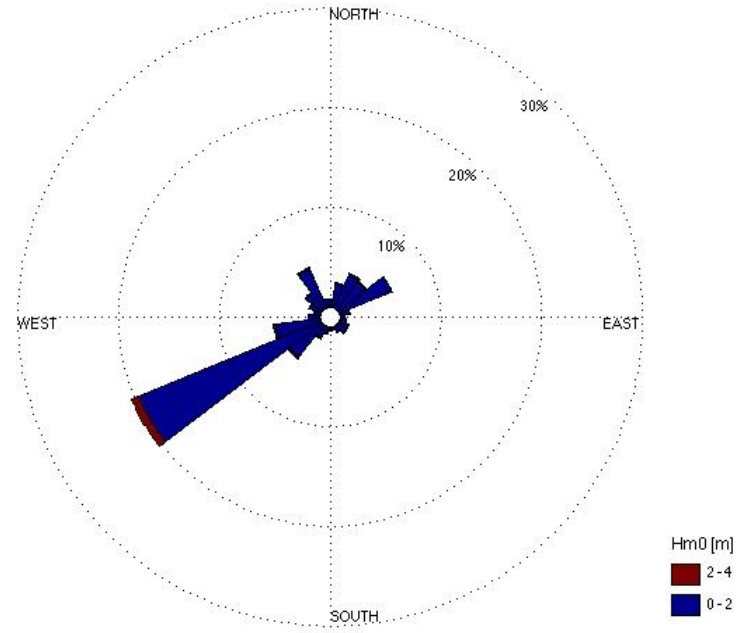
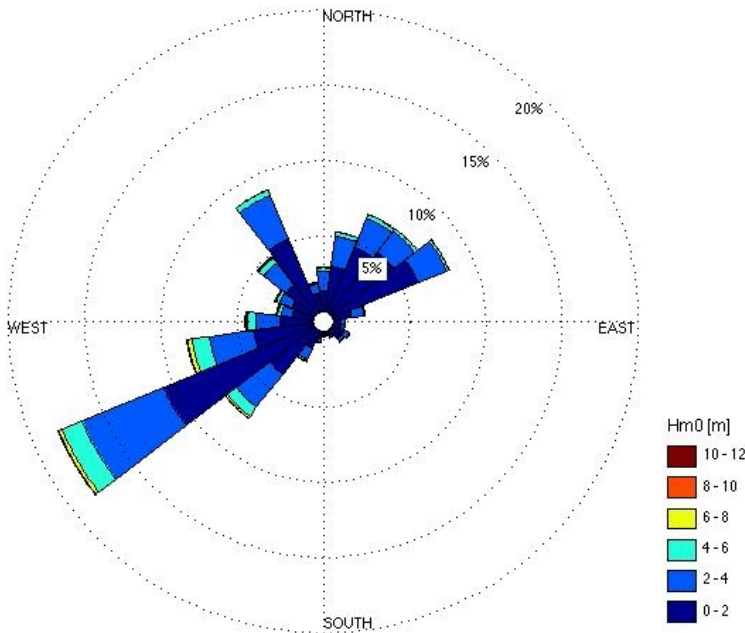
Hs distribution



Separation wrt energy content

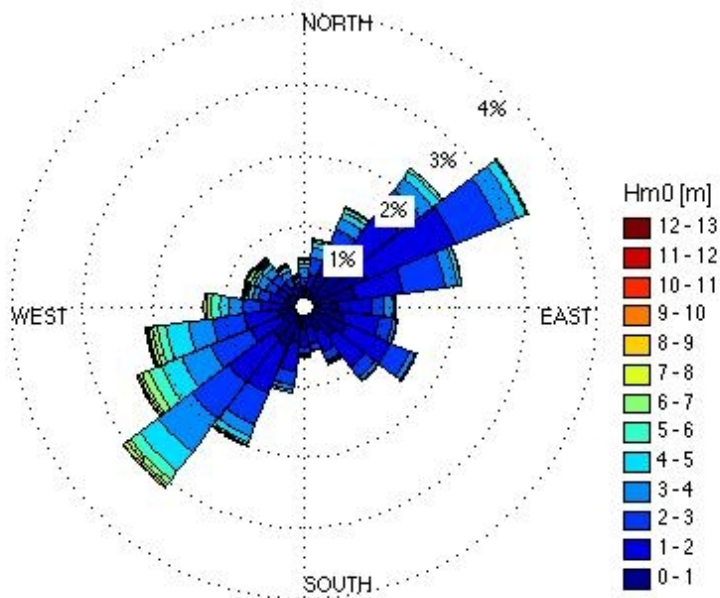
Hm0 1st wave system

Hm0 2nd wave system

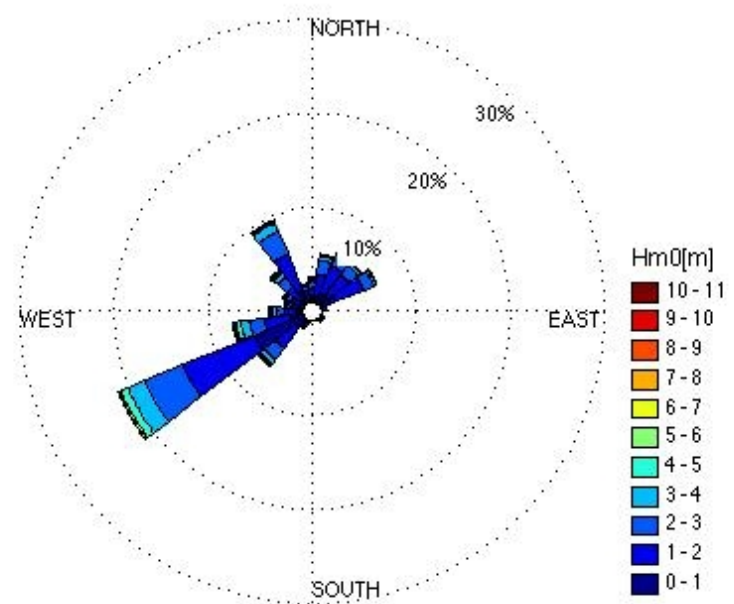


Separation with assignment (H96)

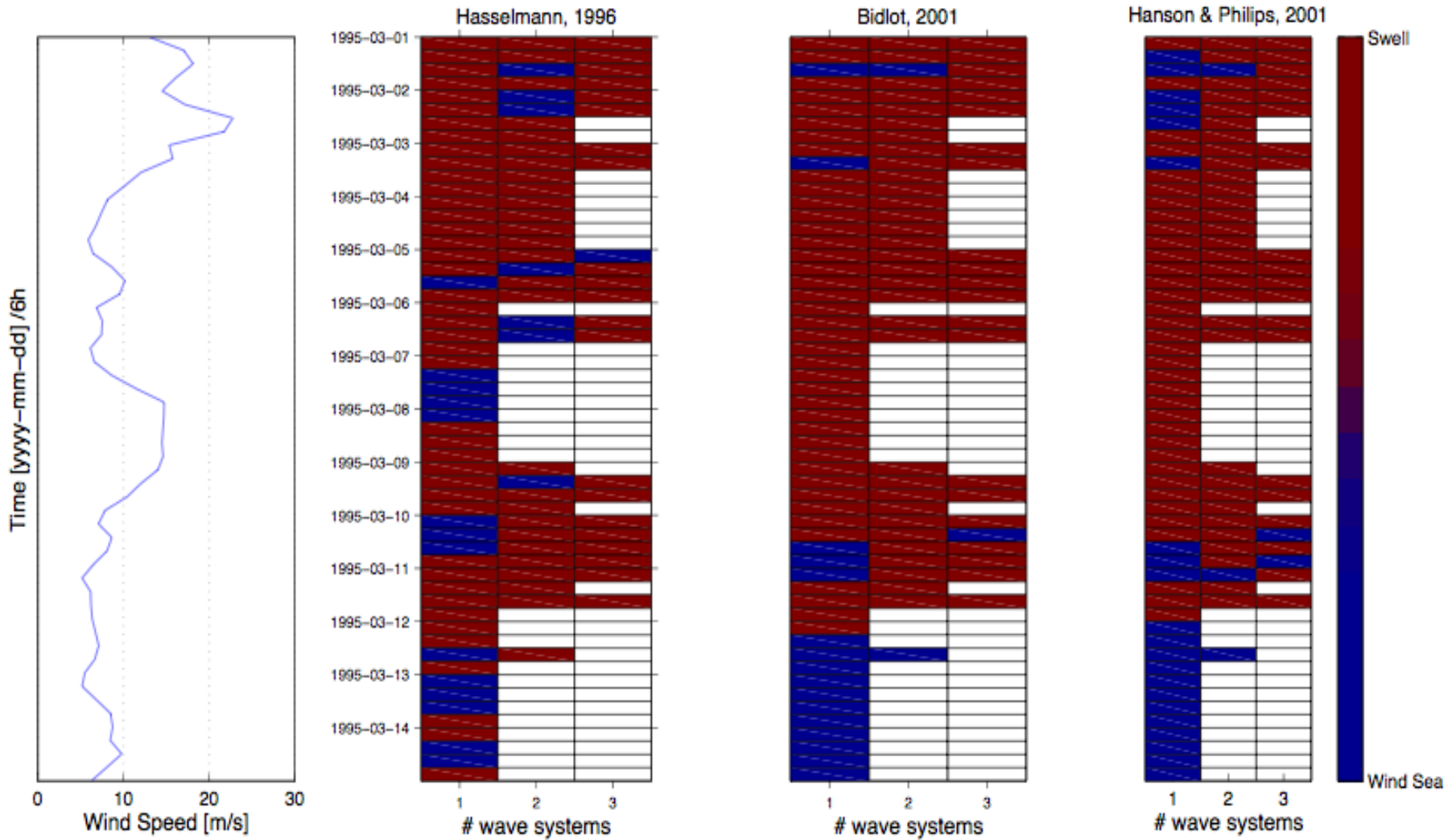
Hm0 Wind sea
(39.4%)



Hm0 Total swell
(60.6%)

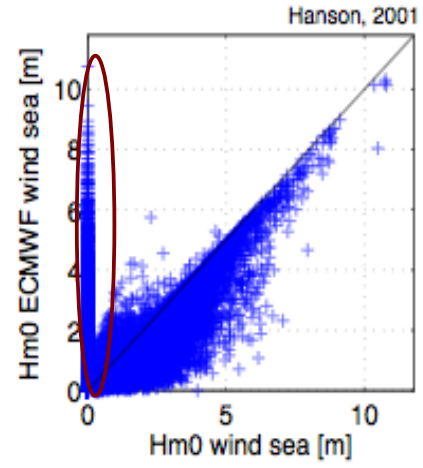
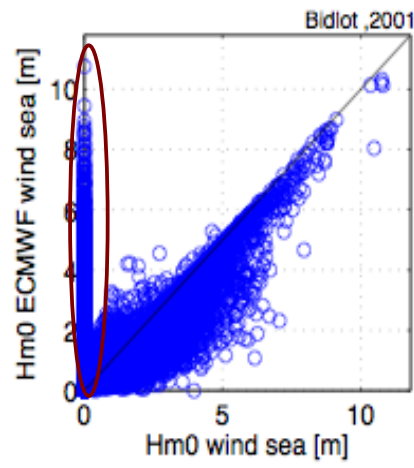
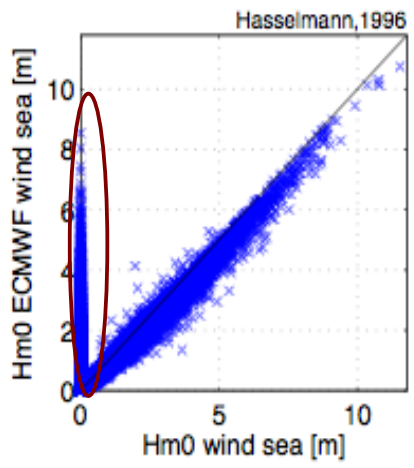


Assignment with 3 formulations

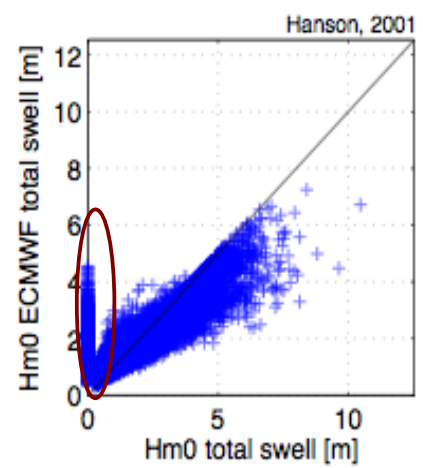
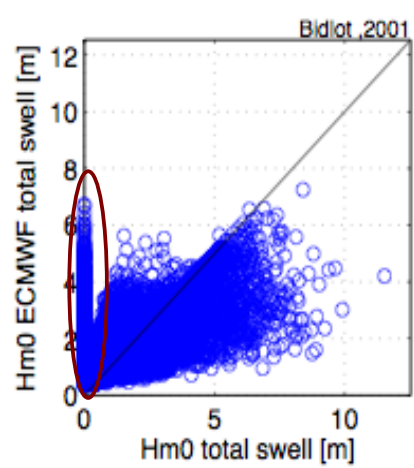
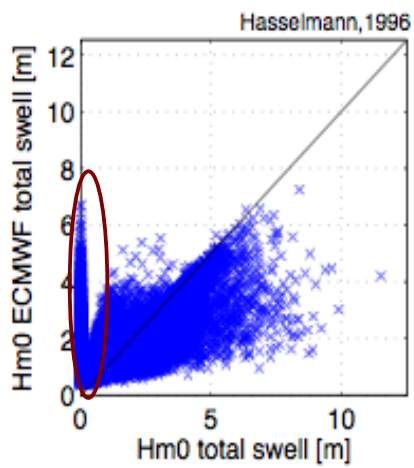


Comparison with ECMWF assignment

Wind sea



Total swell



Additional criteria

Wave steepness and directional spreading correlation

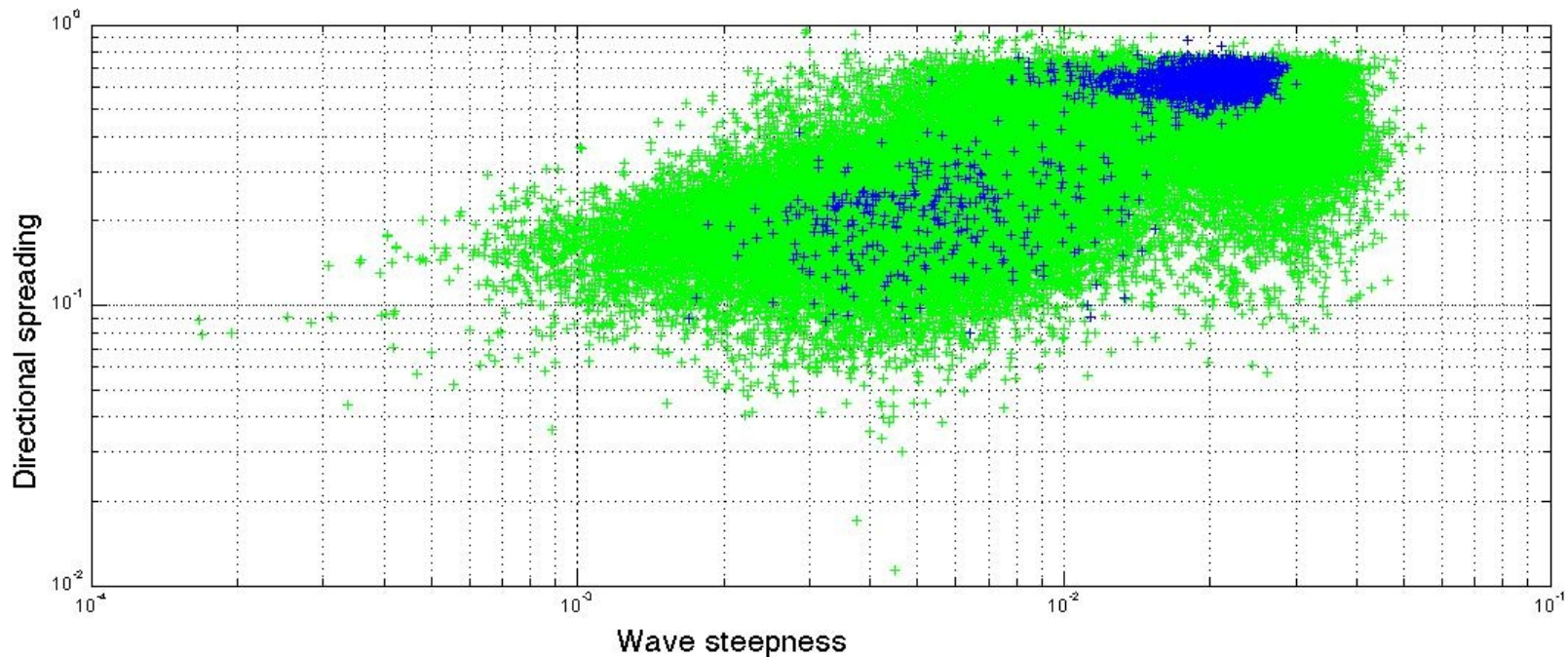
Is this wind sea?

■ All spectra

■ Extracted spectra (H96)



1725/29220

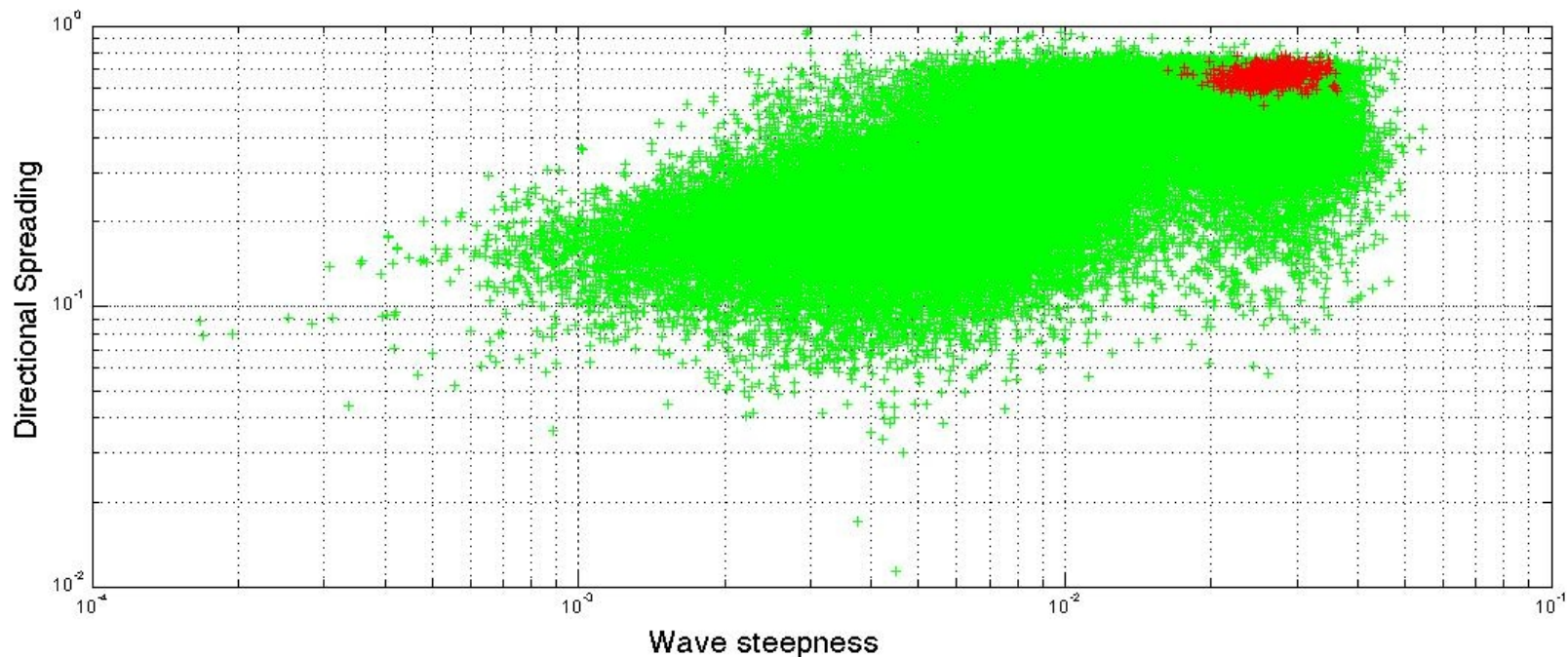


Additional criteria

Wave steepness and directional spreading correlation

Is this Swell?

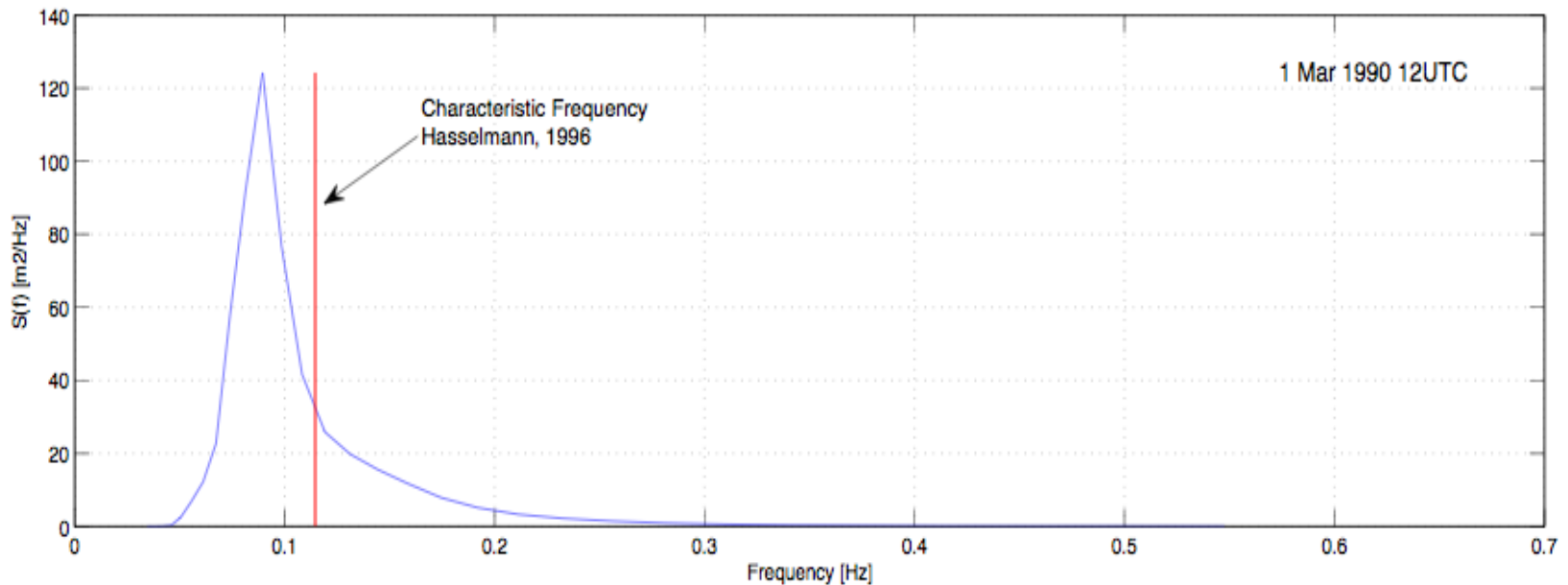
- All spectra
 - Extracted spectra (H96)
- ↙ 731/29220



Additional criteria

Characteristic frequency

$$F_{ch} = \frac{g}{2.4 \pi u \cos(\theta_p - \theta_w)}$$

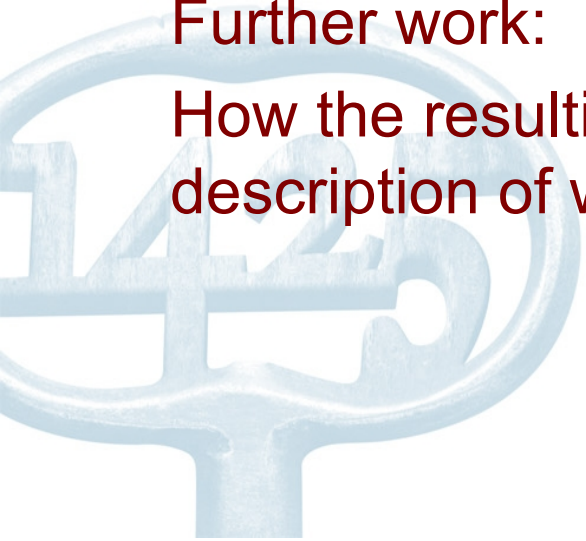


Summary

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Further work:

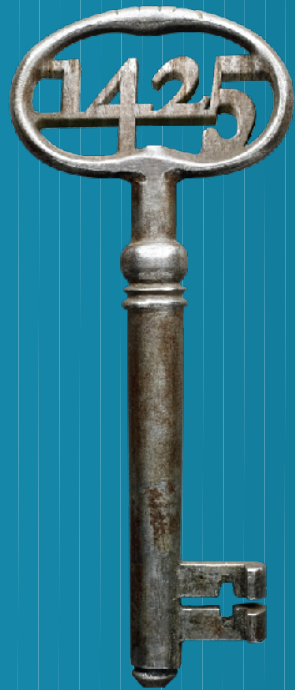
How the resulting wave climates will affect the joint description of wind sea and swell components?



References

- Bidlot, J. R., 2001: ECMWF wave-modelproducts, ECMWF Newsletter No. 91.
- Hanson, J. L. and O. M. Phillips, 2001: Automated analysis of ocean surface directional wave spectra. *J. Atmos. Oceanic Technol.*, **18**, 277-293.
- Hasselmann, S., C. Bruening, K. Hasselmann and P. Heimbach, 1996: An improved algorithm for retrieval of ocean wave spectra from synthetic aperture radar image spectra. *J. Geoph. Res.*, **101(C7)**, 16615-16629.





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