

PAPERS AND TALKS IN 1995

Hans von Storch

Max-Planck-Institut für Meteorologie

The WASA project:

**Changing Storm and Wave Climate
in the Northeast Atlantic and Adjacent seas?
by
the WASA group**

Clima Maritimo, Spain

Det Norske Meteorologisk Institutt, Norway

Max-Planck-Institut für Meteorologie, Germany

GKSS Forschungszentrum, Germany

Danmarks Meteorologiske Institute, Denmark

Sveriges Meteorologiska och Hydrologiska Institut, Sweden

Koninklijk Nederlands Meteorologisch Instituut, The Netherlands

Coordinator: Hans von Storch, MPI

The project is funded by the European Union's Environment program

Introduction

- **The analysis of the observational record**
 - the storm climate
 - the wave climate
- **Hindcast experiments with the WAM wave model**
- **Conclusions**

WASA aims:

- **Reconstruction of the storm and wave climate in the Northeast Atlantic and adjacent seas in the 20th century.**
- **Construction of the future perspectives of the storm and wave climate in the 21st century**

Two central questions:

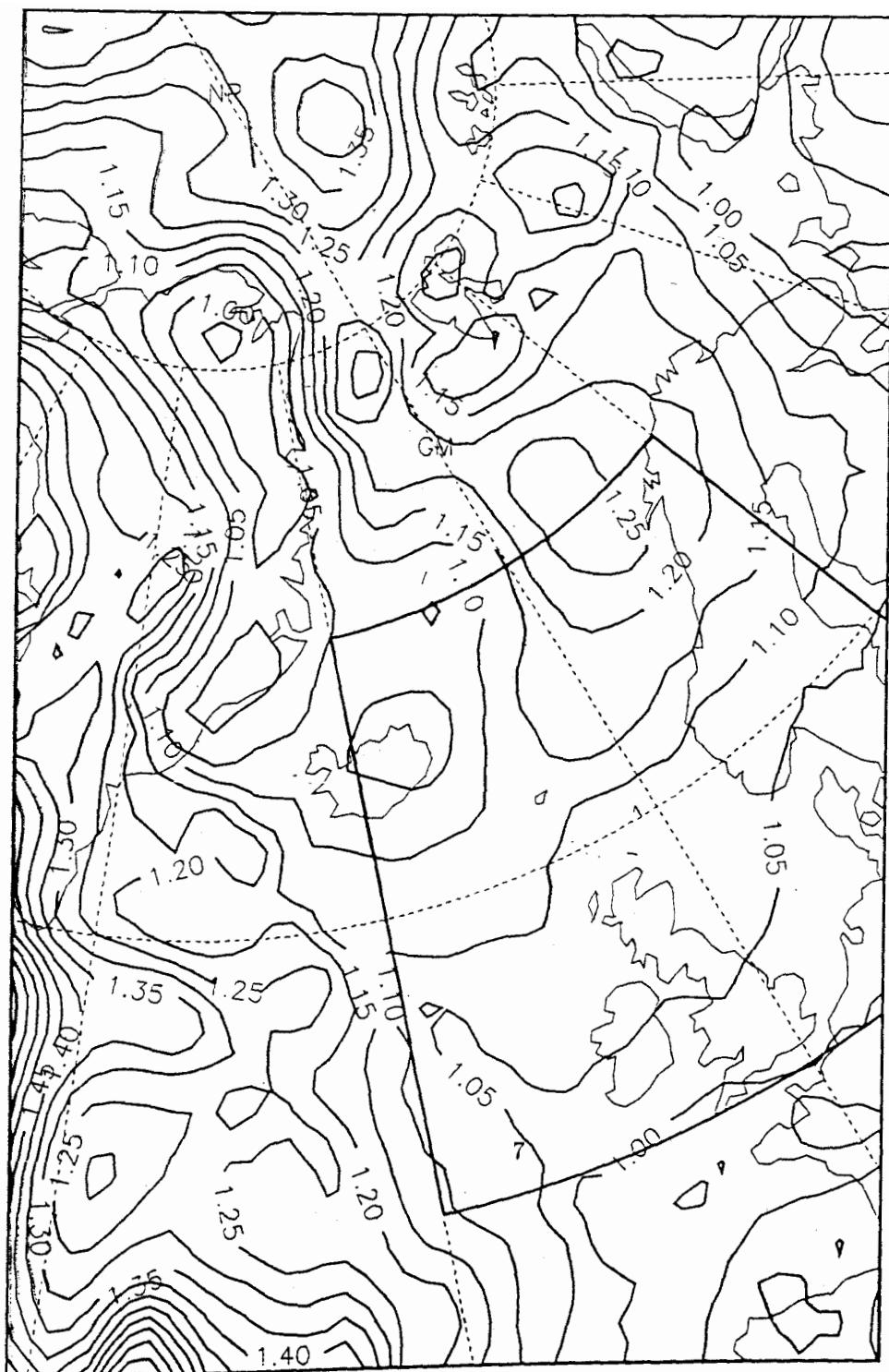
- Is the storm climate in the past 100 years consistent with the notion of intensifying or more frequently forming storms in the Northeast Atlantic and adjacent seas?
- How was / might be the response of the wave field and the storm surge statistics to the past / possible future changes in the storm climate and other atmospheric features?

Strategy:

- examine long, homogeneous observational data series
- analyse extended hindcast experiments with wave models
- use the output of climate change scenario experiments to prepare scenarios for possible future wave climates.

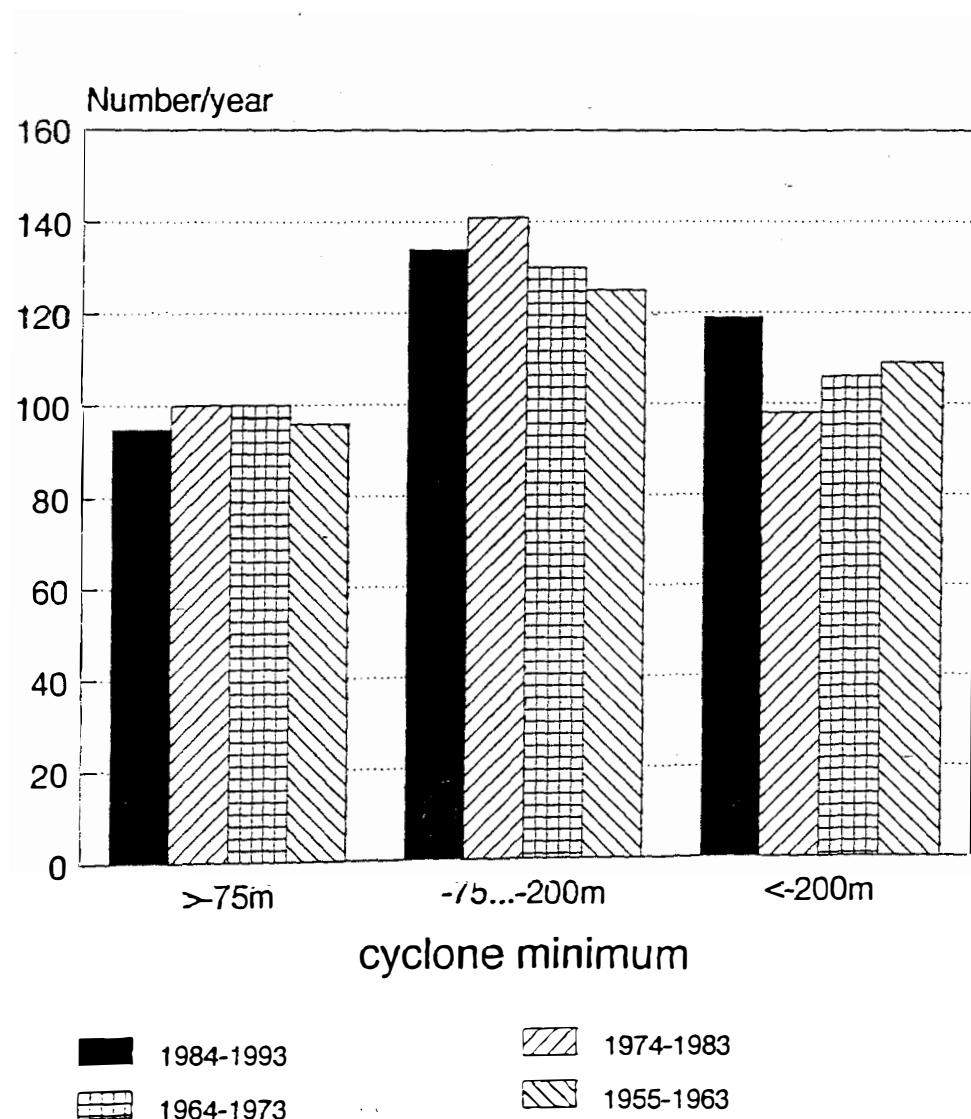
Figure 7: Ratio of synoptic scale standard deviation of air pressure variations in winter (DJF) as derived from DNMI analysis in the decade 1984-93 and in the decade 1964-73. The area "A" south of 70° N and east of 20° W is marked.

SLP STD ratio (band-pass filtered)



Data: DNMI 1984-93 vs. 1964-73, DJF

Figure 11: *Storm count in the area between 70°N to 50° N and east of 20° W (see Figure 7) in the DNMI data in DJF for different multi-year intervals. The storms are sorted after the core value z of the 1000 hPa level in meters. The pressure in mb is approximately $z/8 + 1000$.*



4

Figure 1: Time series of percentiles of geostrophic wind speed over Denmark. Units: m/s.
Percentiles of geostrophic wind speed over Denmark

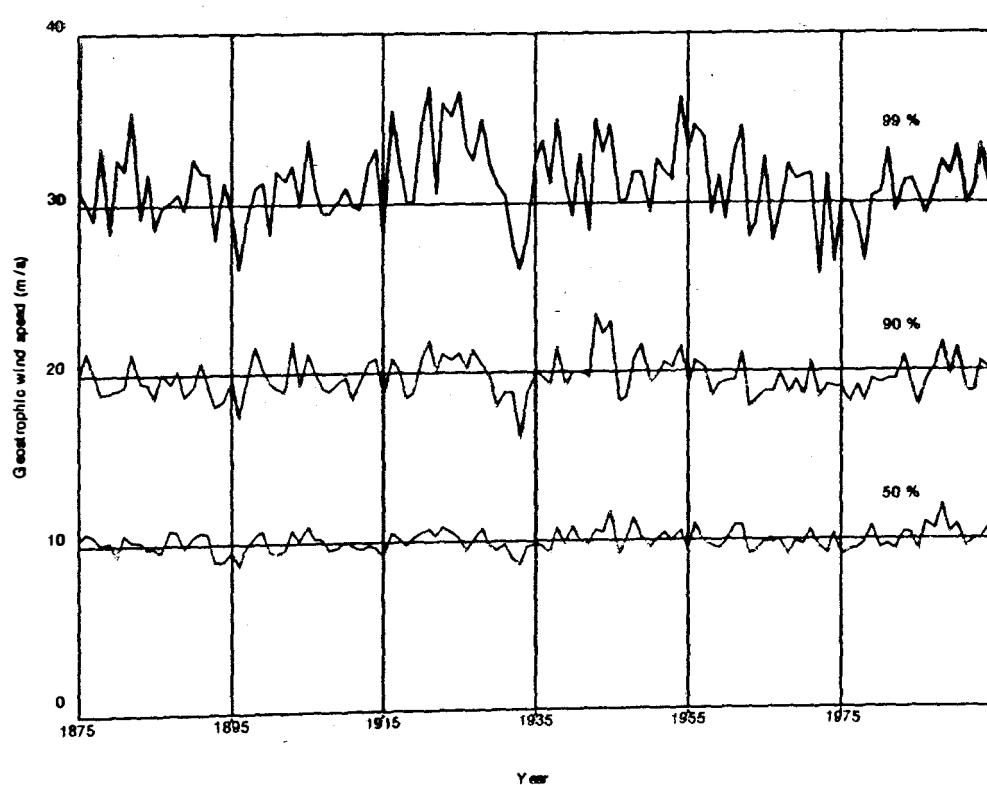


Figure 3: Time series of percentiles of 24-hour pressure tendencies over Denmark Units: 0.1 hPa/3 hrs.

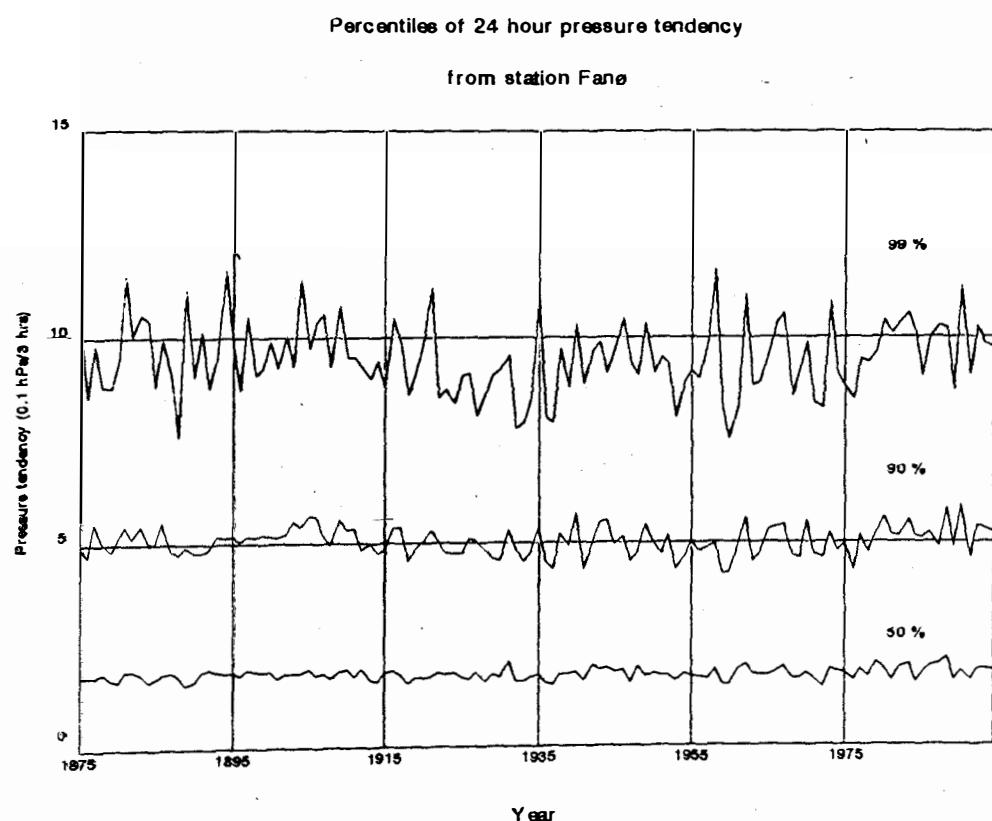


Figure 8: Scatterdiagram of station-mean wind speed and geostrophic wind speed over Denmark.

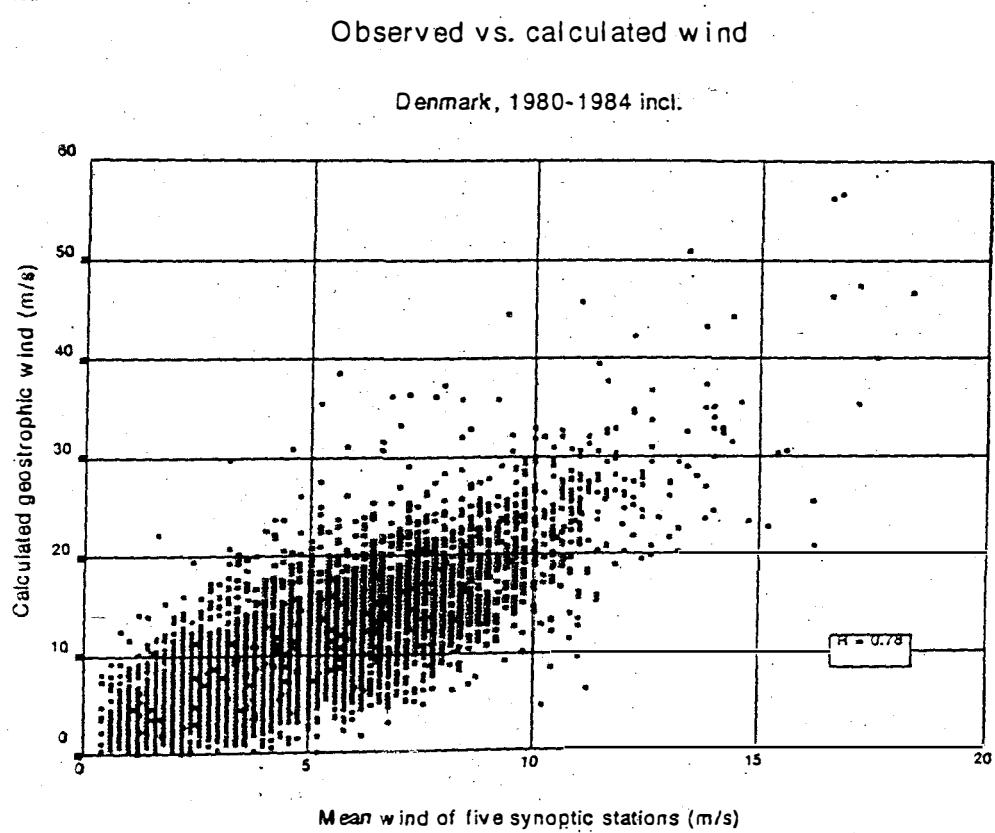


Figure 2: Time series of number of daily geostrophic wind speeds exceeding 25 m/s, derived from the triangle Göteborg-Visby-Lund in Southern Sweden. The solid line represents a low-pass filter.

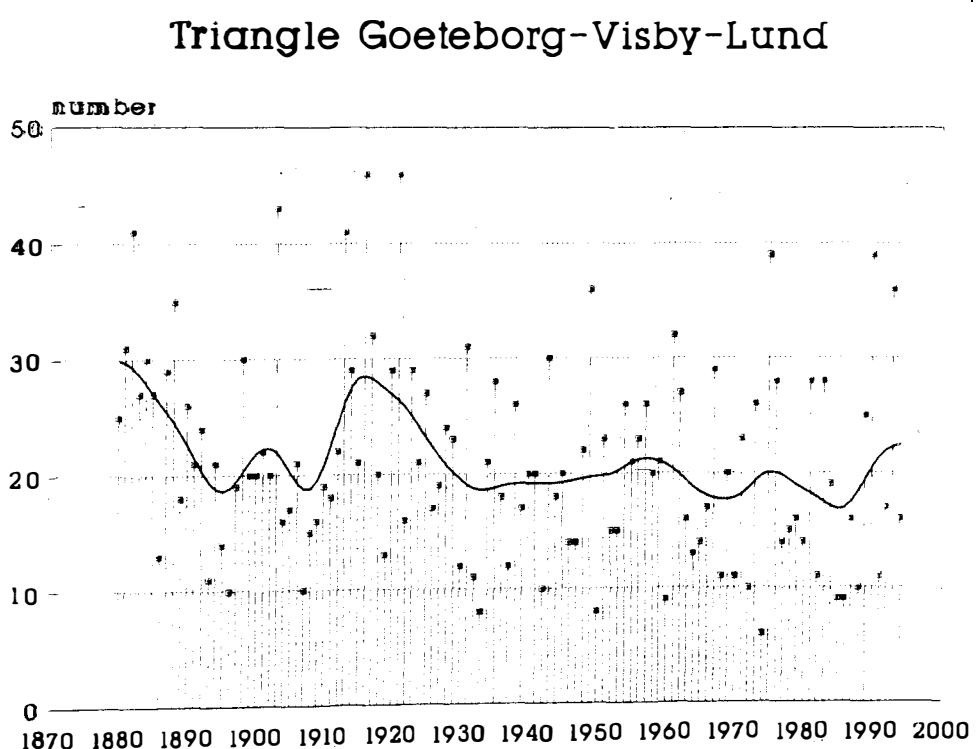


Figure 4: Time series of the annual mean of the sea level reported by the Cuxhaven (German Bight) tide gauge (top), and the time series of various percentiles (1%, 5%, 10%, 50%, 90%, 95%, 99% from bottom to top) of sea level relative to the annual mean (bottom). Units: cm

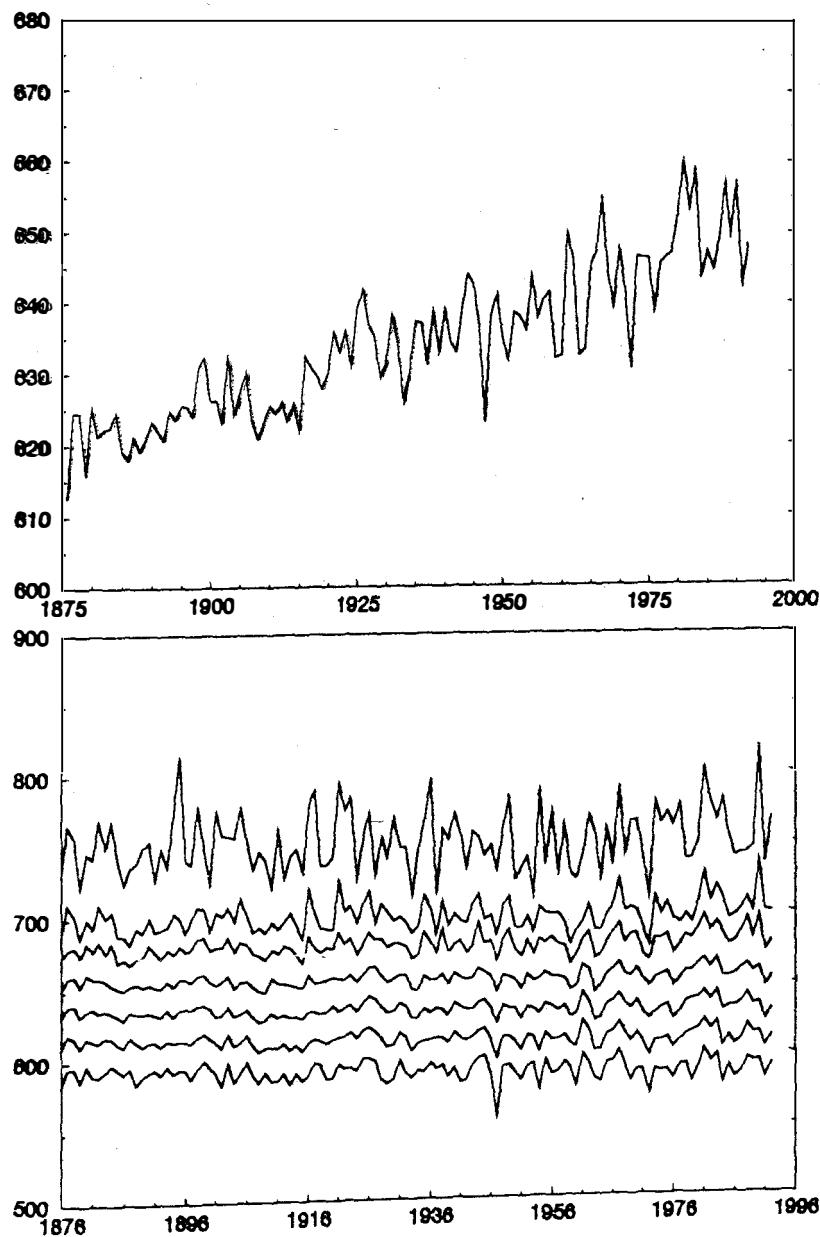


Figure 9: Percentile-percentile plot of station mean wind speed and geostrophic wind speed for the Danish triangle, derived from 5 years of daily data.

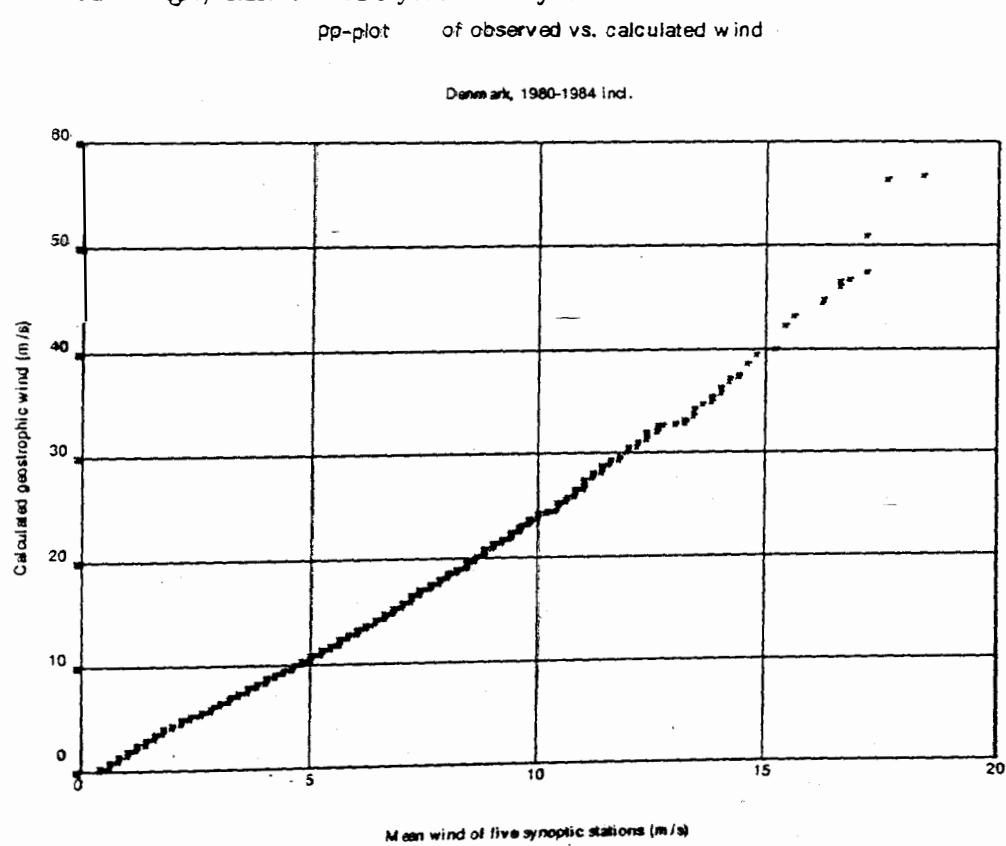


Figure 5: Time series of 1%, 5%, 10%, 25% and 50% percentiles of the annual wave height distribution at Ocean Weather Station M. Units: m.
Updated from WASA (1994).

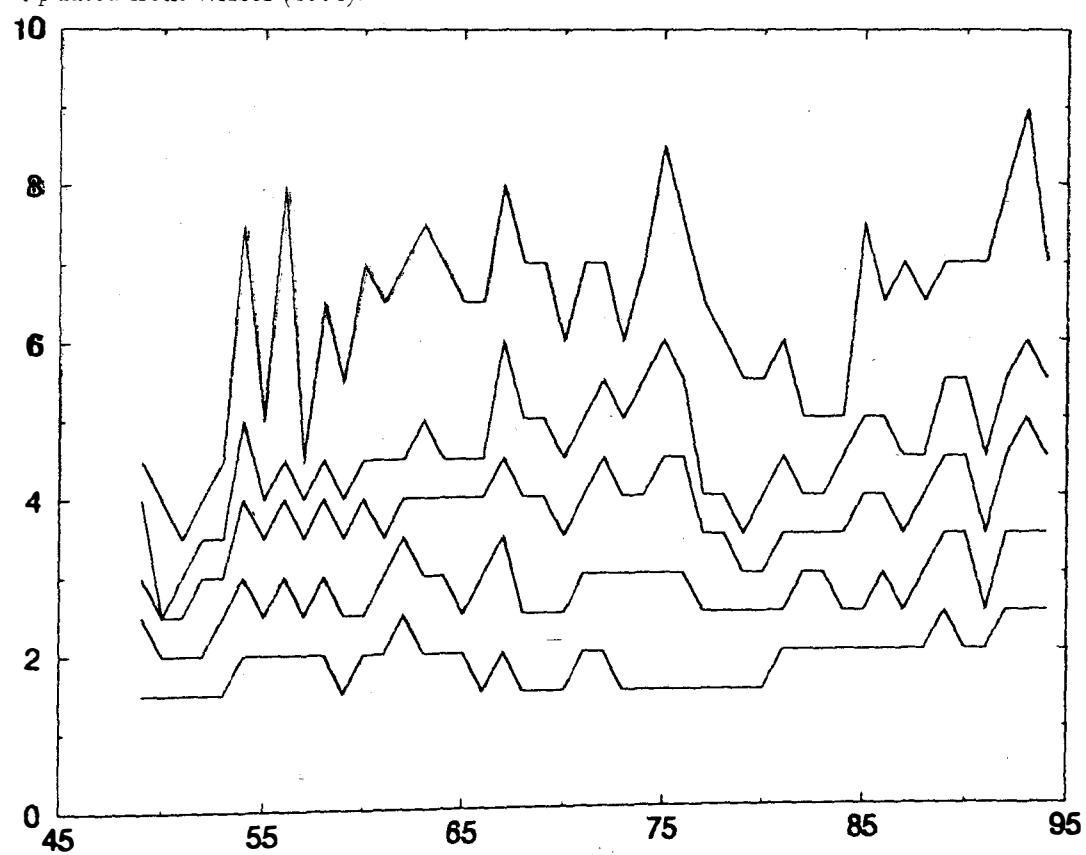


Figure 6: Time series of 1%, 10% and 50% percentiles of the annual wave height distribution in an area west of Ireland (10° - 20° W, 50° - 55° N) derived from operational shiprouting maps prepared by KNMI. Units: m.

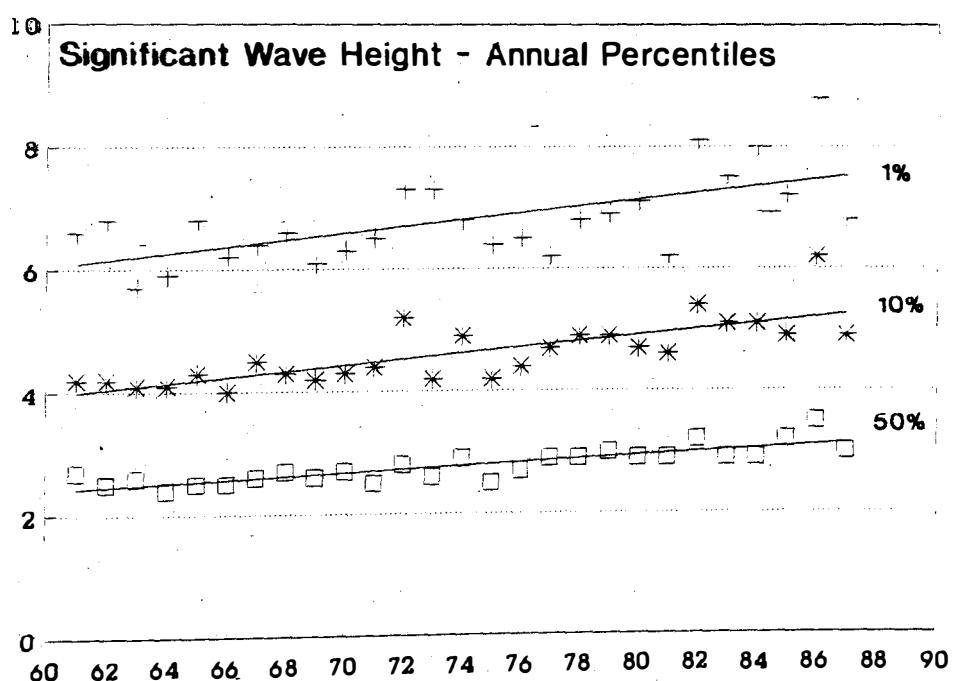


Figure 10: An example of a FNOC wind field.

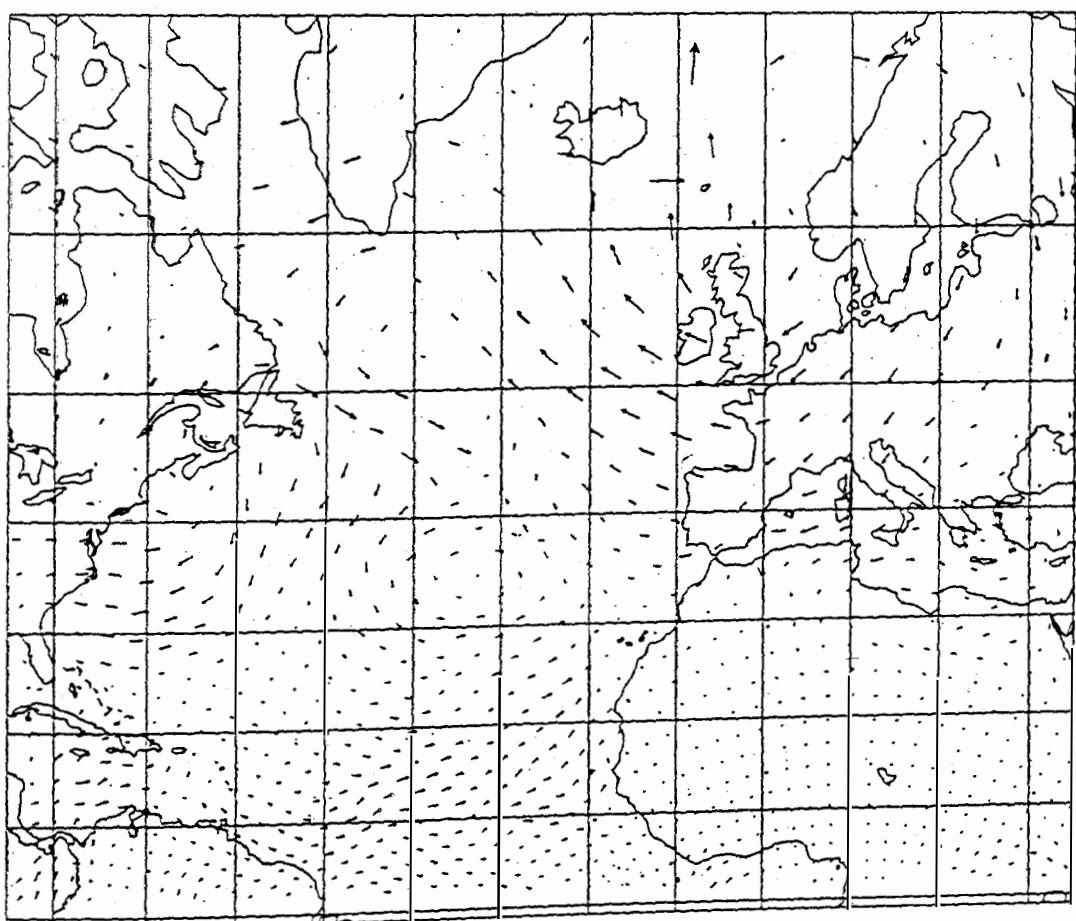
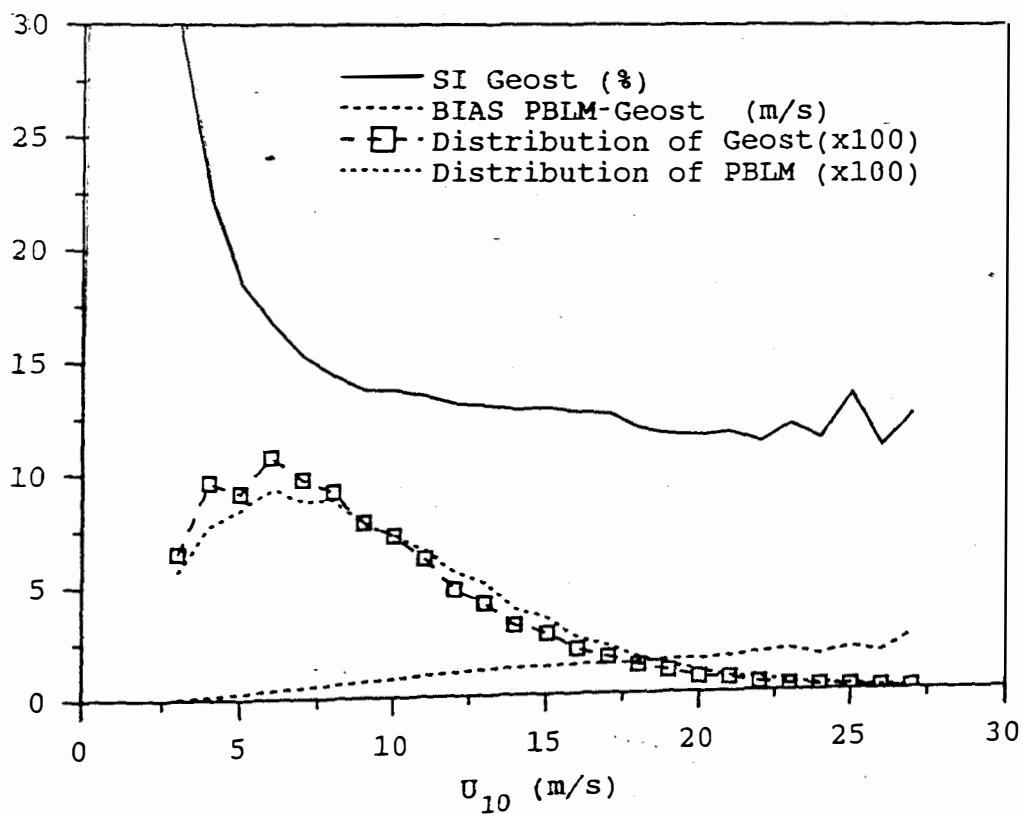
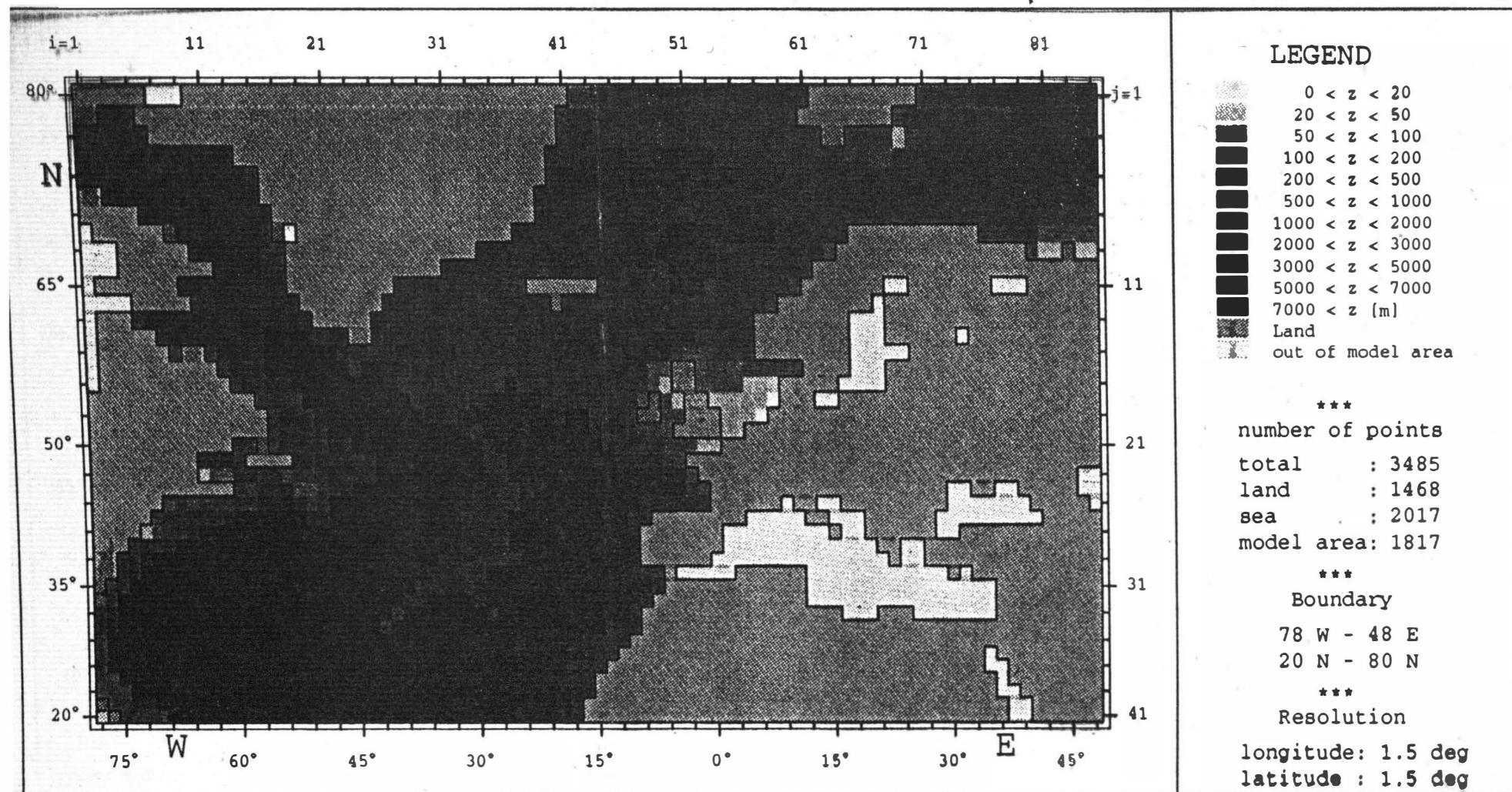


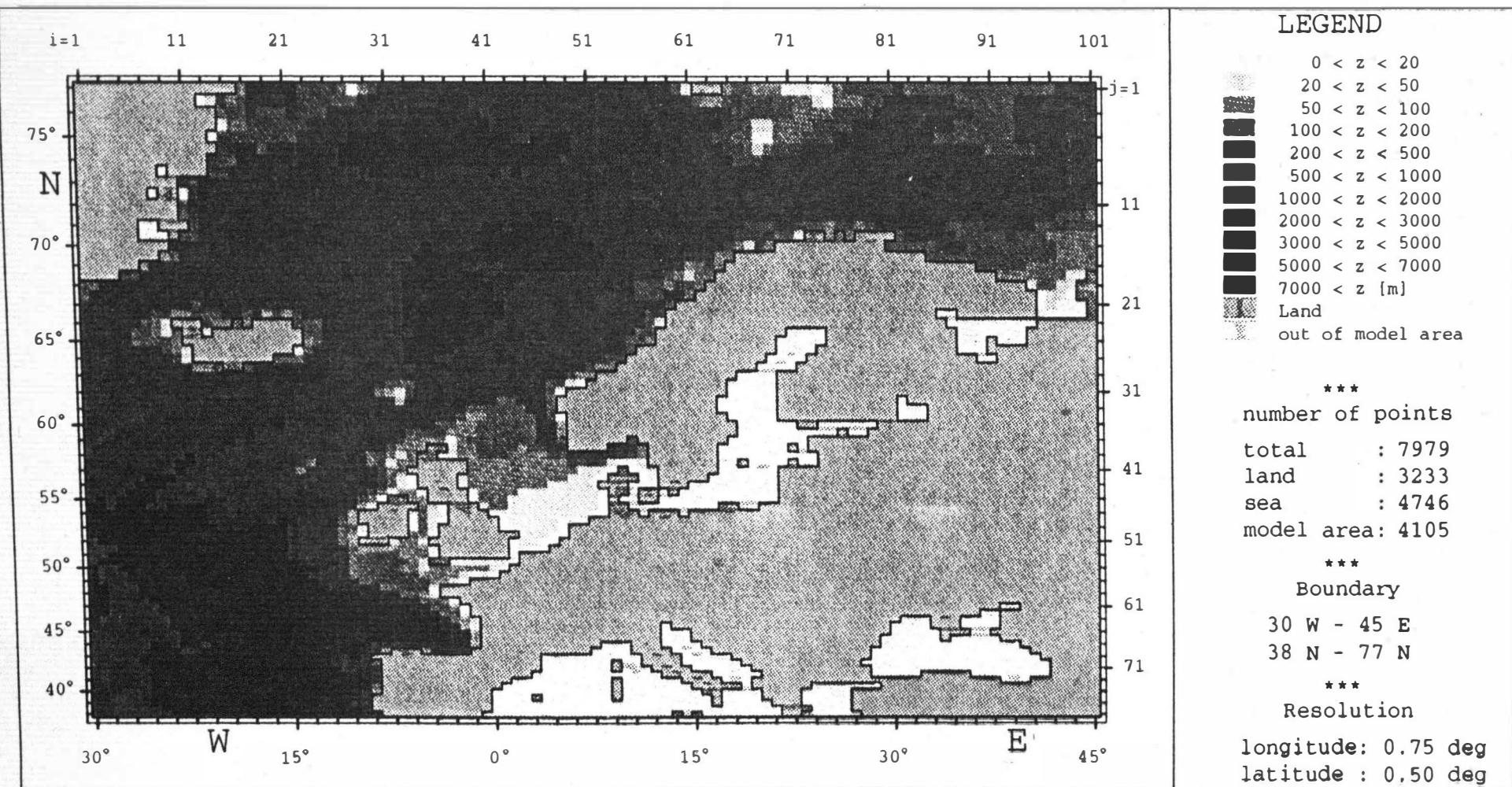
Figure 13: Analysis of paired observations of geostrophically derived wind speeds and PBLM-generated winds. The frequency distribution for the geostrophically derived wind speeds and for the PBLM derived winds are labelled "distribution of". The "bias" is the difference between the mean geostrophically derived wind speed, conditional upon a PBLM wind speed given at the horizontal axis, and the specified PBLM wind speed. "SI" is the (conditional) coefficient of variation (standard deviation divided by the mean).



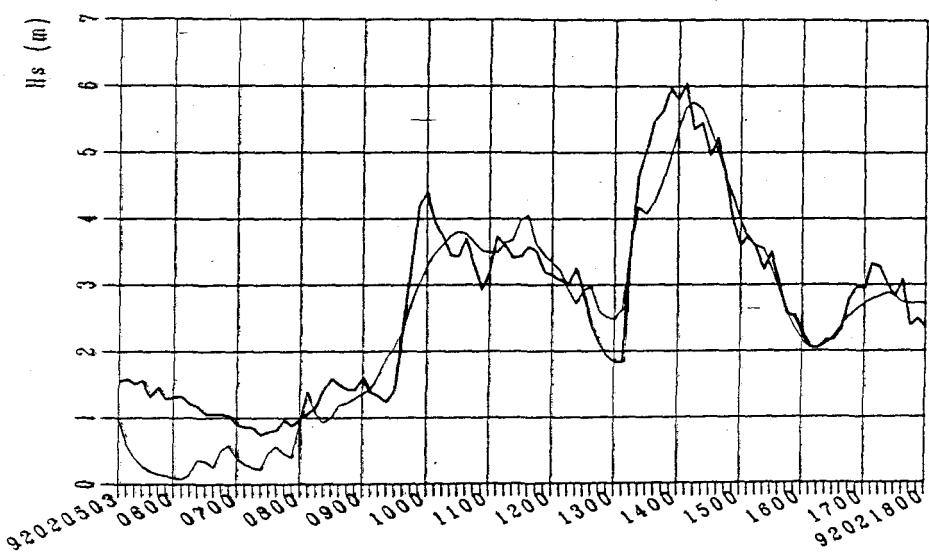
WASA coarse grid



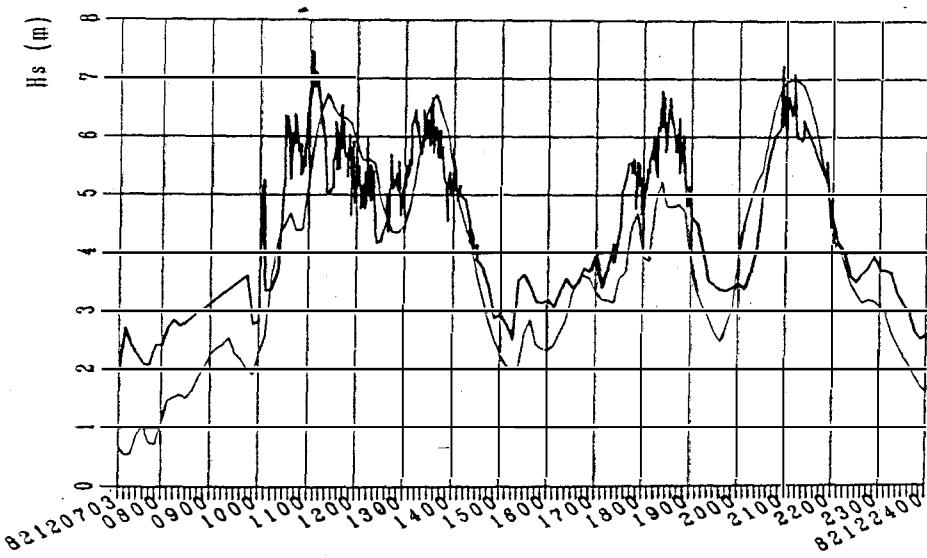
WASA fine grid



WAM/FNOC PBLM winds: BILBAO, Hs(m)
THIN LINE: MODEL / GROSS LINE: BUOY



WAM/FNOC PBLM winds: BILBAO, Hs(m)
THIN LINE: MODEL / GROSS LINE: BUOY



WAM/FNOC PBLW winds: CANARIAS. Hs(m)
THIN LINE: MODEL / GROSS LINE: BUOY

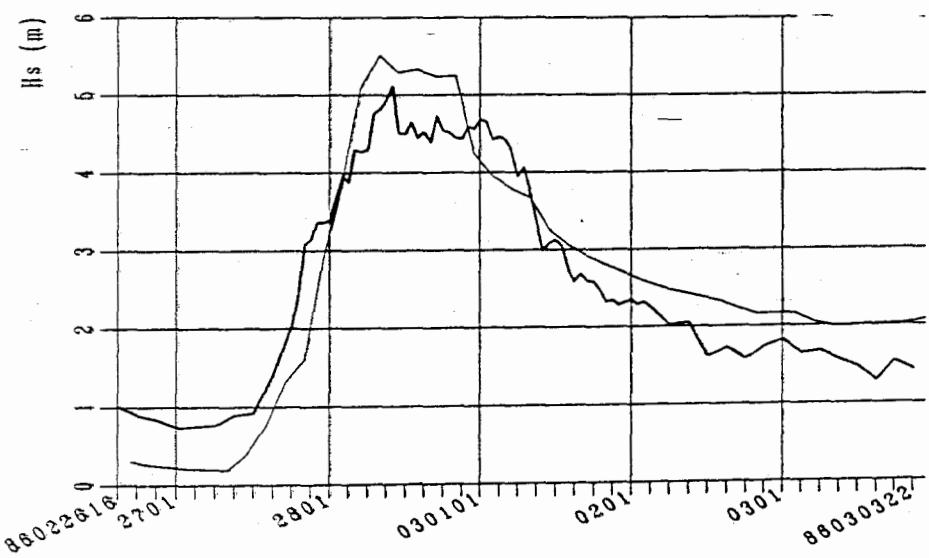
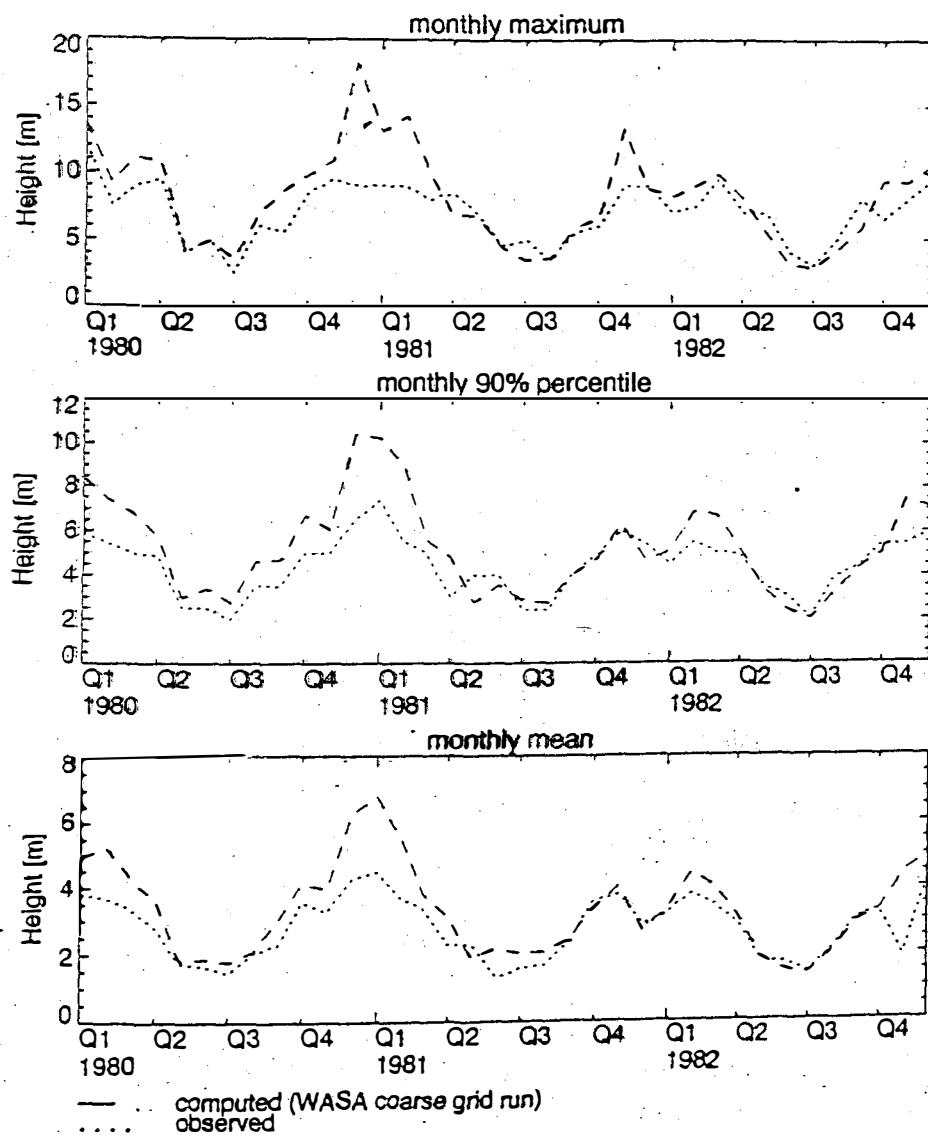


Figure 12: Monthly percentiles of significant wave height at the location of Statfjord/Gullfaks for the years 1980 to 1982. The dotted line represents the observed wave heights, and the dashed line the hindcasted wave heights.

Total significant wave height

Station: Statfjord A/Gulfaks C
 Position: 61.2 N, 1.8E/2.3E



Summary

The results obtained so far are:

- The storm climate in the near-coastal areas of Northwest Europe has not systematically worsened in the past century.

There is considerable natural variability on the decadal time scale.

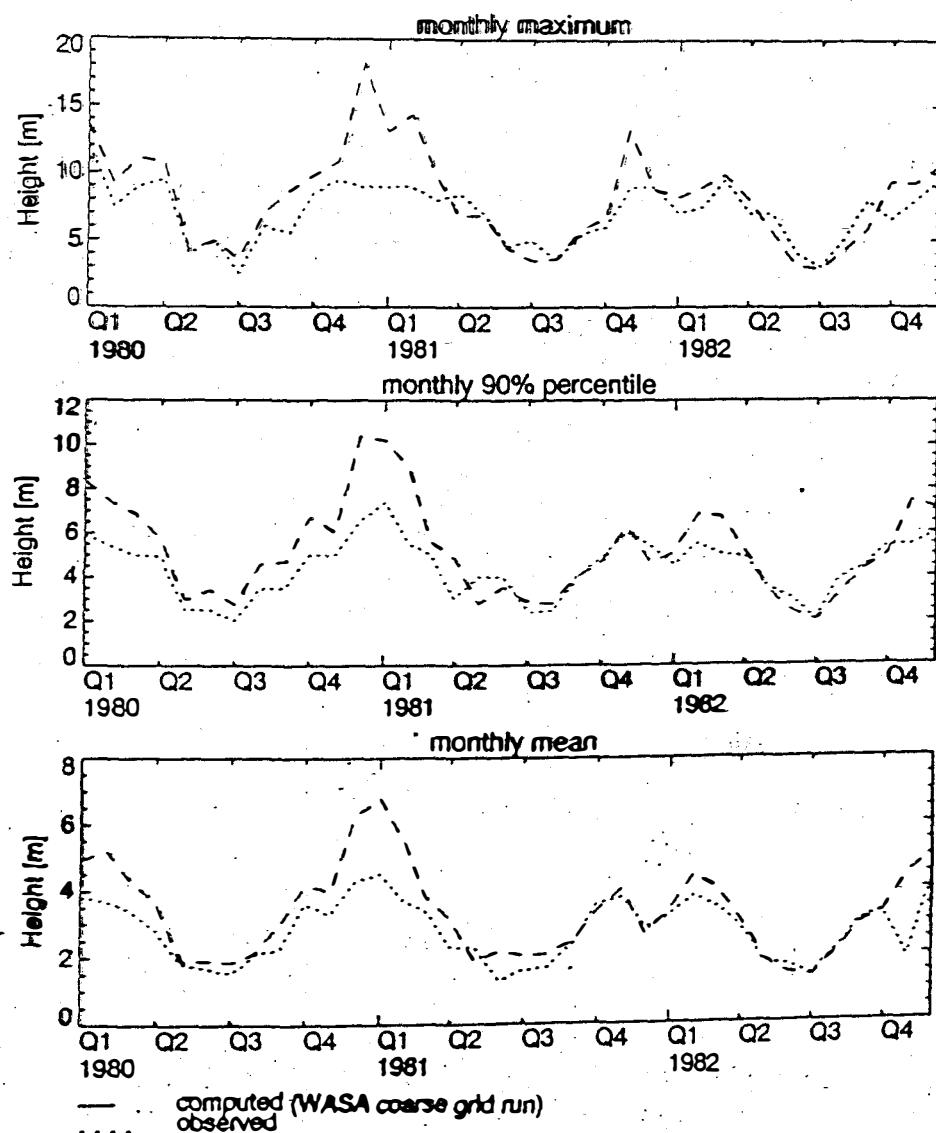
- The statistics of sig. wave height in the Northeast Atlantic has undergone a steady increase in the last 30 years.

**Upper bound estimates are: 2 - 3 cm/year for the 50% and
3 - 4 cm/year for the 10% annual percentile.**

Figure 12: Monthly percentiles of significant wave height at the location of Statfjord/Gullfaks for the years 1980 to 1982. The dotted line represents the observed wave heights, and the dashed line the hindcasted wave heights.

Total significant wave height

Station: Statfjord A/Gulfaks C
 Position: 61.2 N, 1.8 E/2.3 E



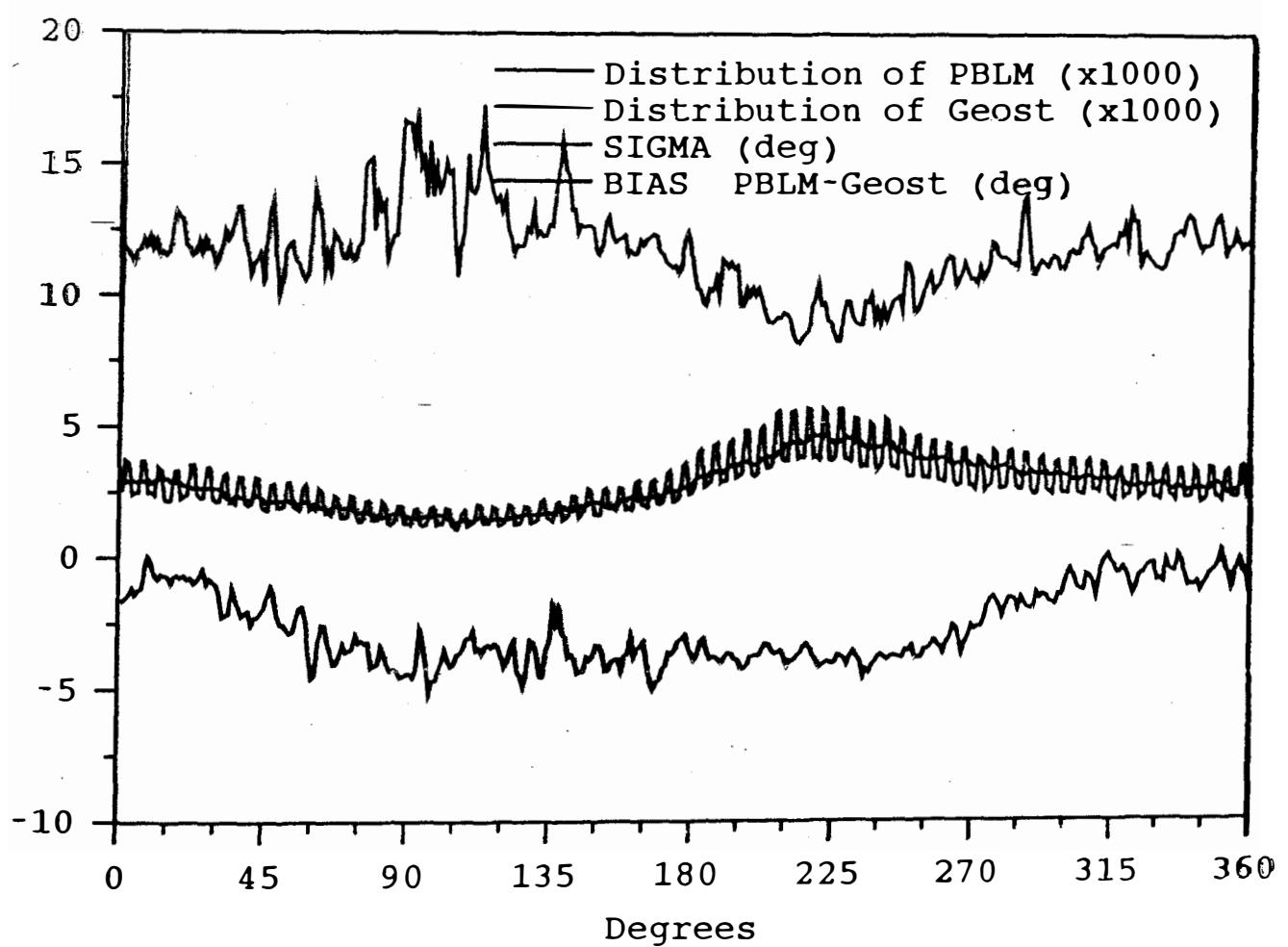


Fig. 2: Wind direction comparison. FNOC (PBLM Data) vs FNOC (Geost Data). Period: 110477-311277. Area: 54W-9W, 30N-62N.

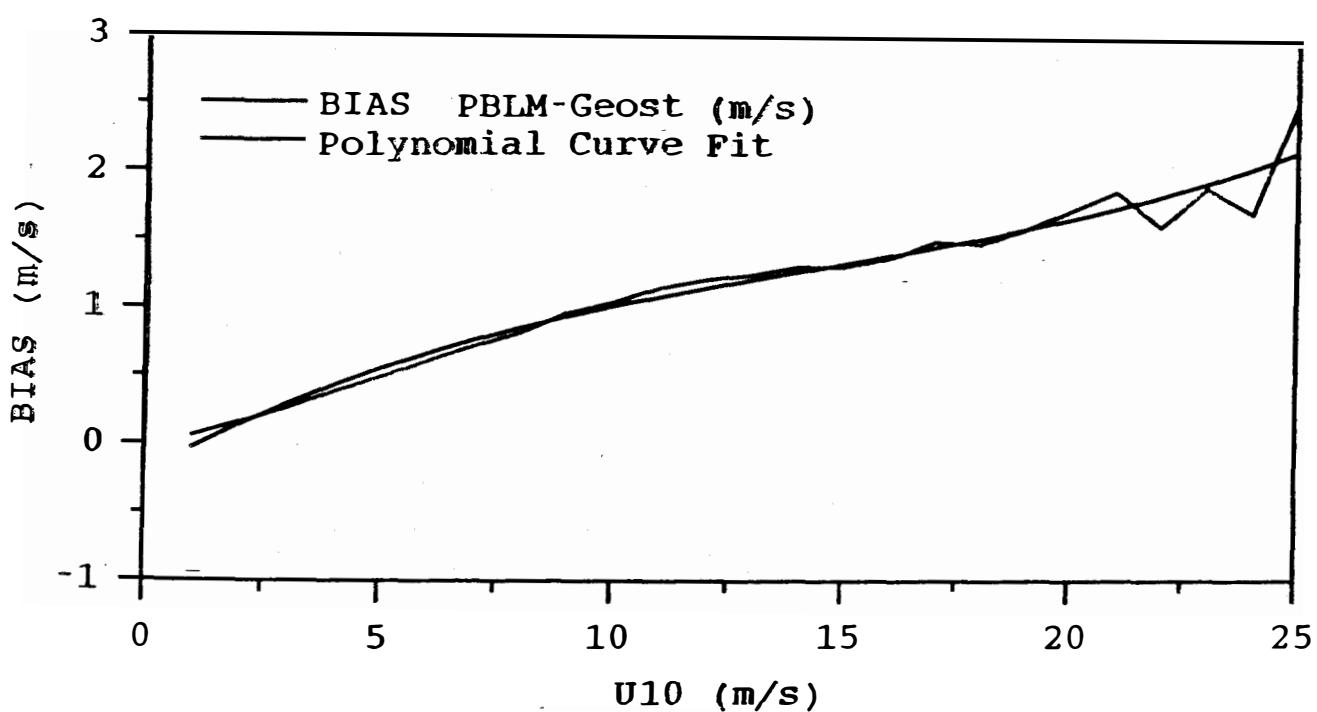


Fig. 4: Polynomial curve fit to the BIAS between wind modulus of FNOC (PBLM Data) and FNOC (Geost Data). Period: 110477-311277. Area: 54W-9W, 30N-62N.

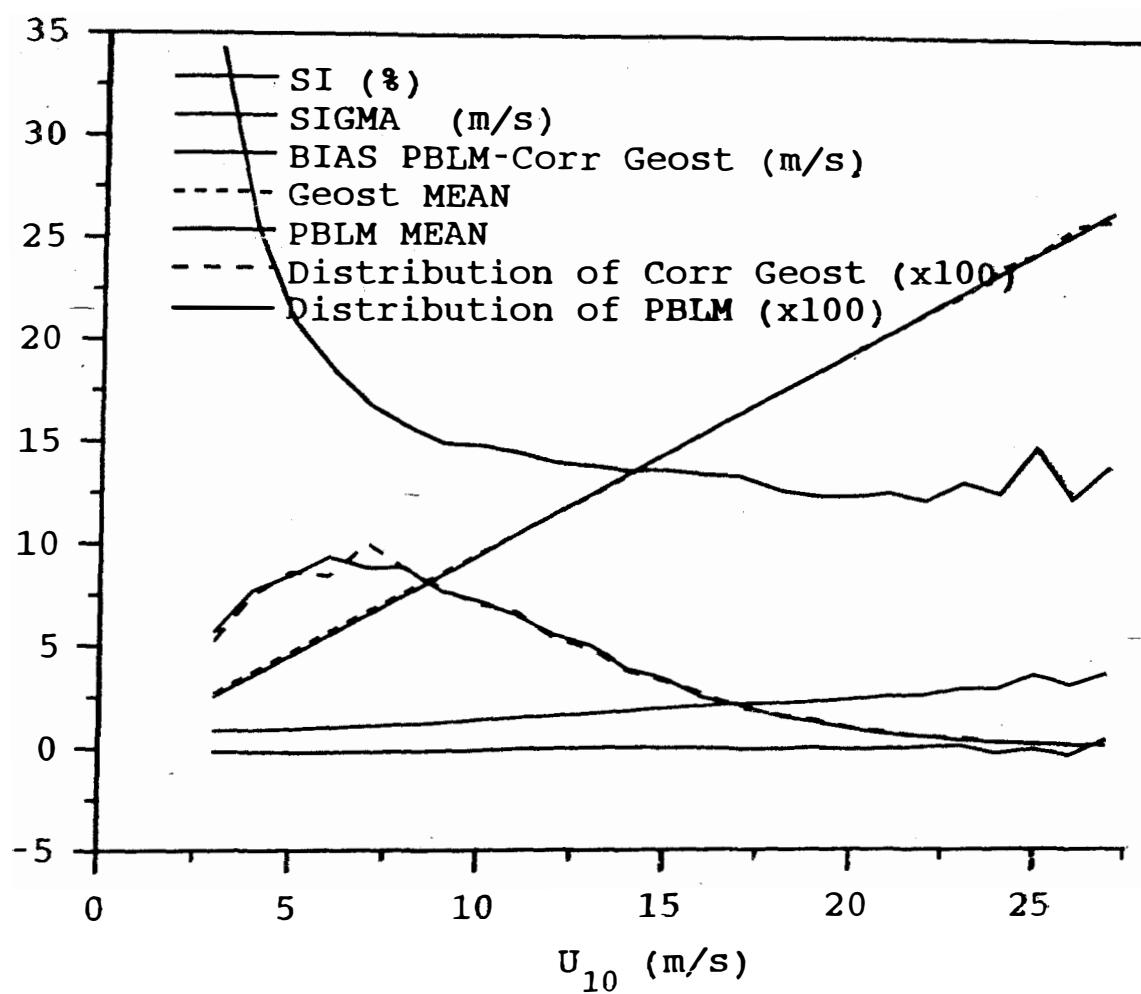


Fig.5: Wind modulus comparison. FNOC (PBLM Data FNOC (Geost Data corrected with a function der from a previous comparison)). Period: 110477-31 Area: 54W-9W, 30N-62N.

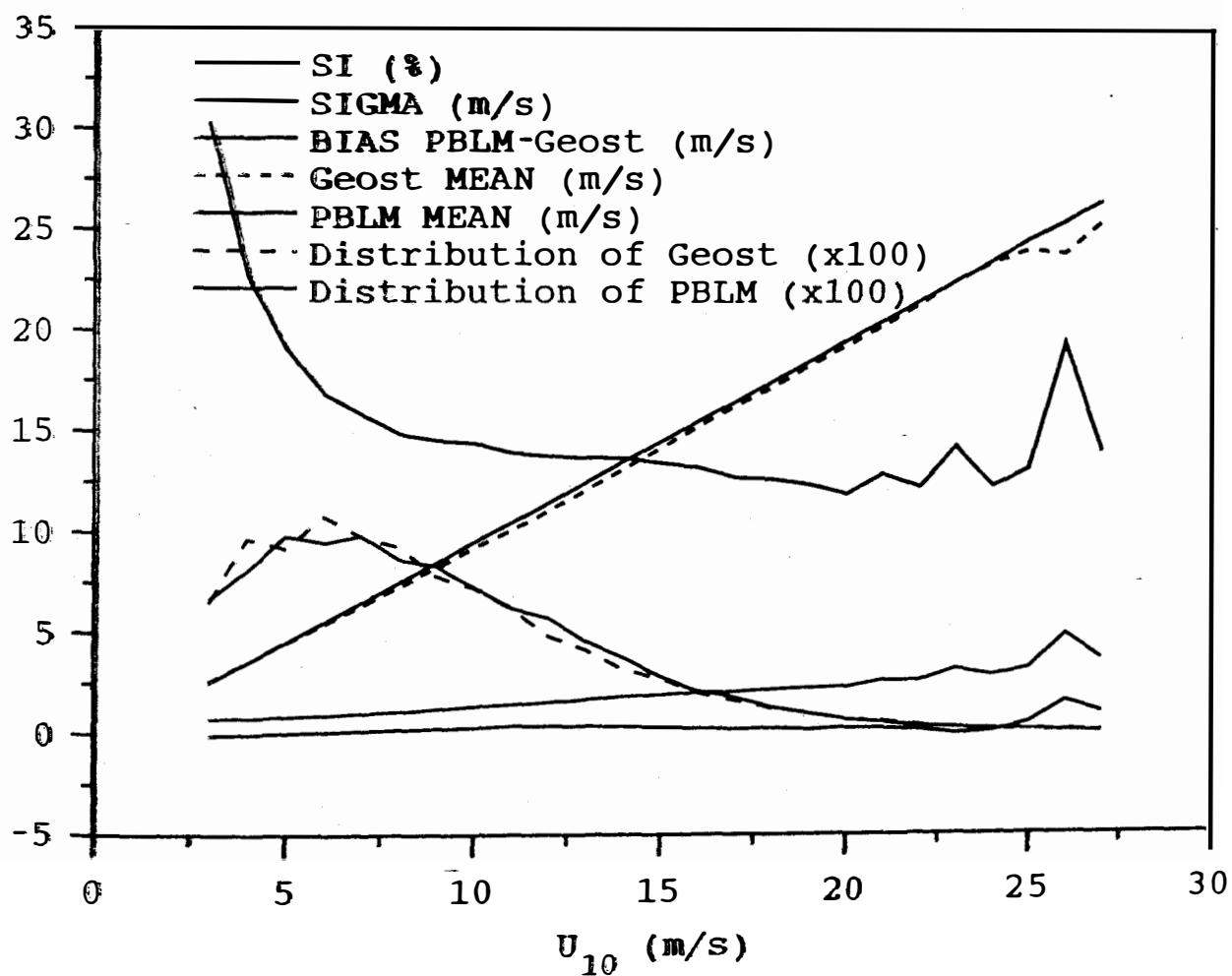


Fig. 6: Wind modulus comparison. FNOC (PBLM Data vs FNOC (Geost Data). Period: 110477-311277. Area: 54W-9W, 30N-62N. PBLM Data has been taken as U19.5, Geost Data as U10.

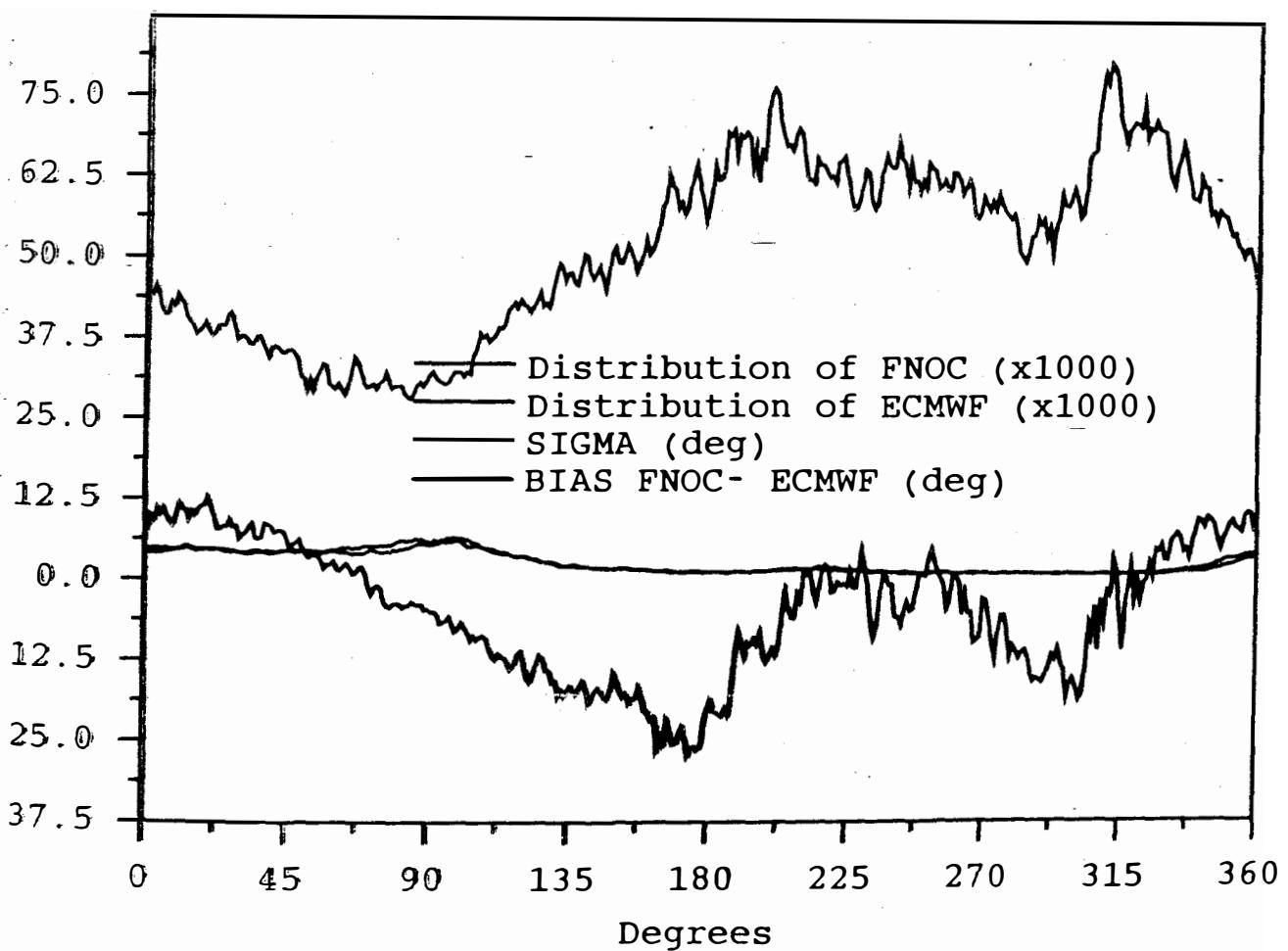


Fig.7: Wind direction comparison. FNOC (PBLM Data) vs ECMWF Wind Fields. Period: 050292-180292. Area 54W-9W, 30N-62N.

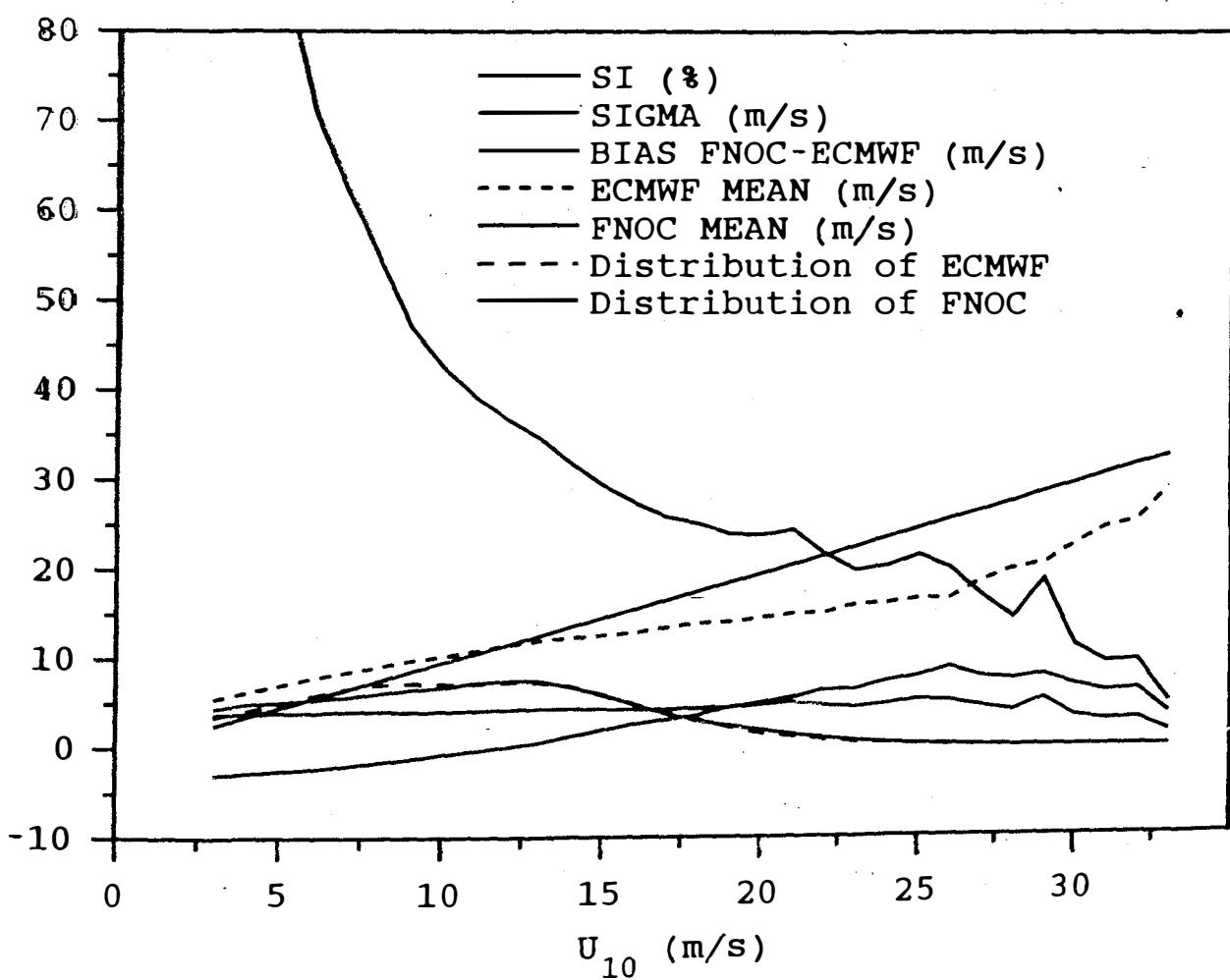


Fig. 8: Wind modulus comparison. FNOC (PBLM Data) vs ECMWF. Period : 050292-180292. Area: 54W-9W, 30N-62N.

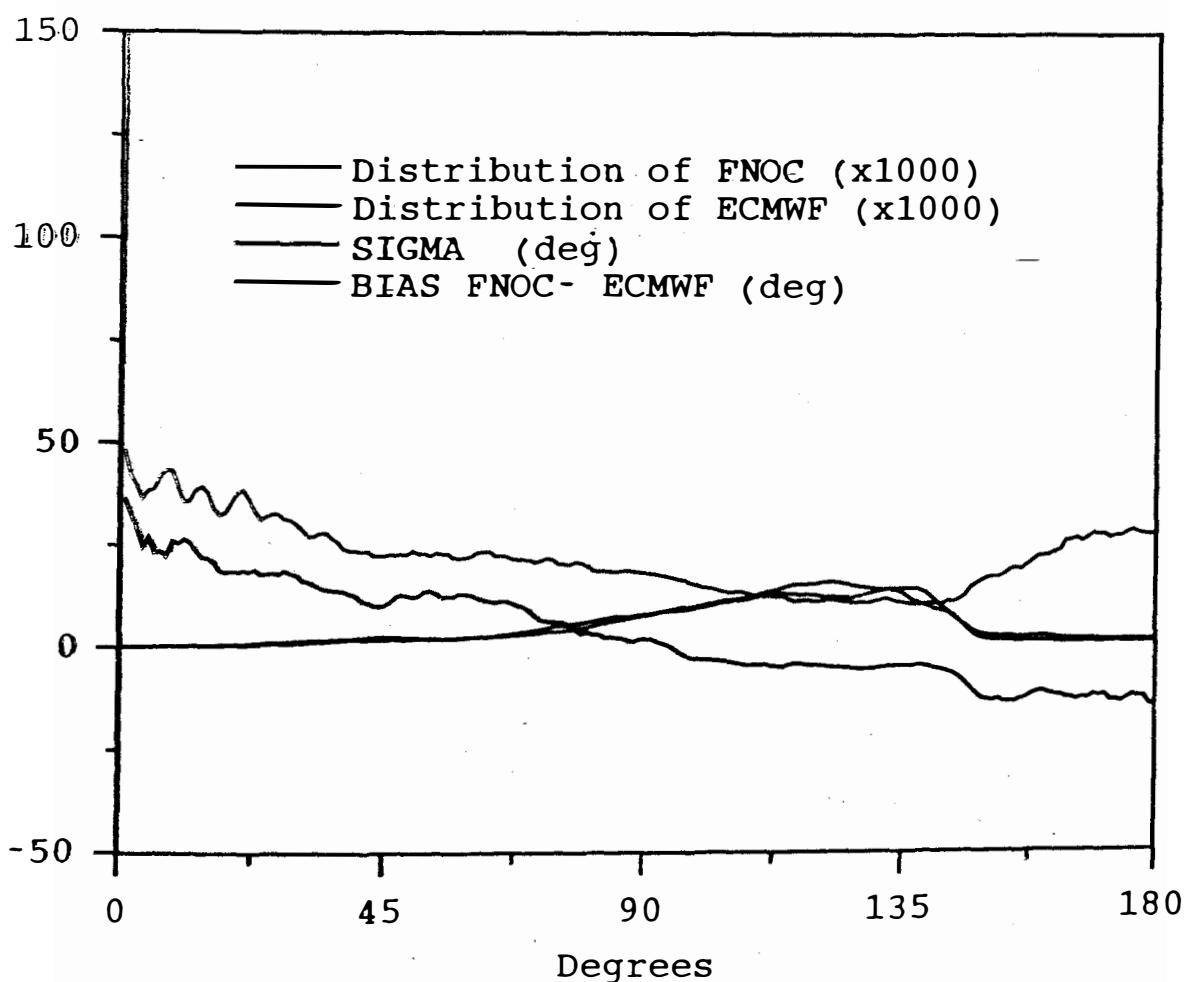


Fig. 9: Wave direction comparison. Waves (FNOC winds) vs Waves (ECMWF winds). Period: 070292-180292. Area 54W-9W, 30N-62N

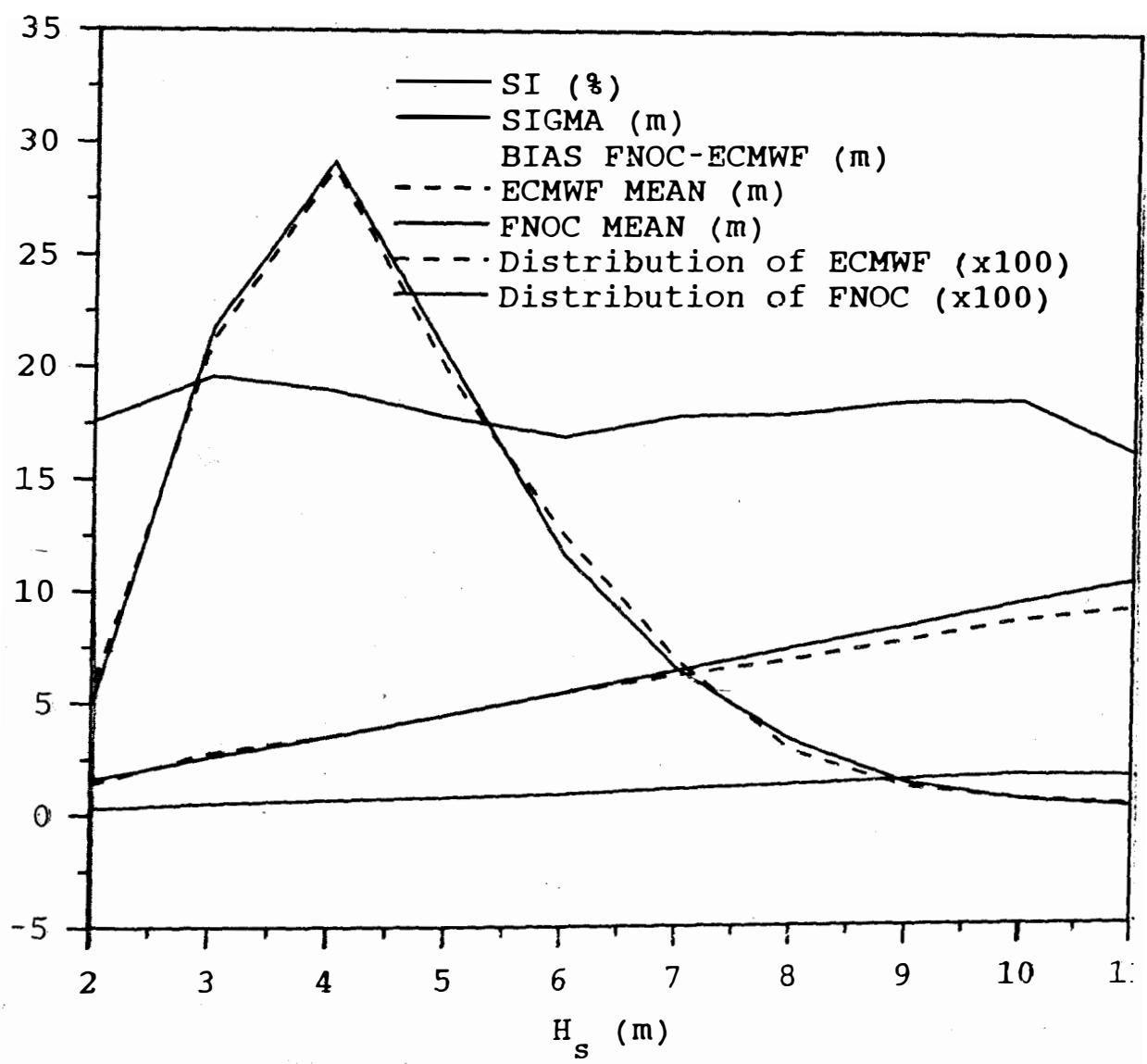


Fig.10: Significant wave height comparison. Waves (FNOC PBLM winds) vs Waves (ECMWF winds). Period: 070292-180292. Area: 54W-9W, 30N-62N.