Return Value Estimates of Significant Wave Height based on a new Norwegian Hindcast (NORA10) (Preliminary results)

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Motivation

Main objective:

- Obtain 100-year return value estimates of Hs covering the Northeast Atlantic using a new Norwegian hindcast (NORA10)
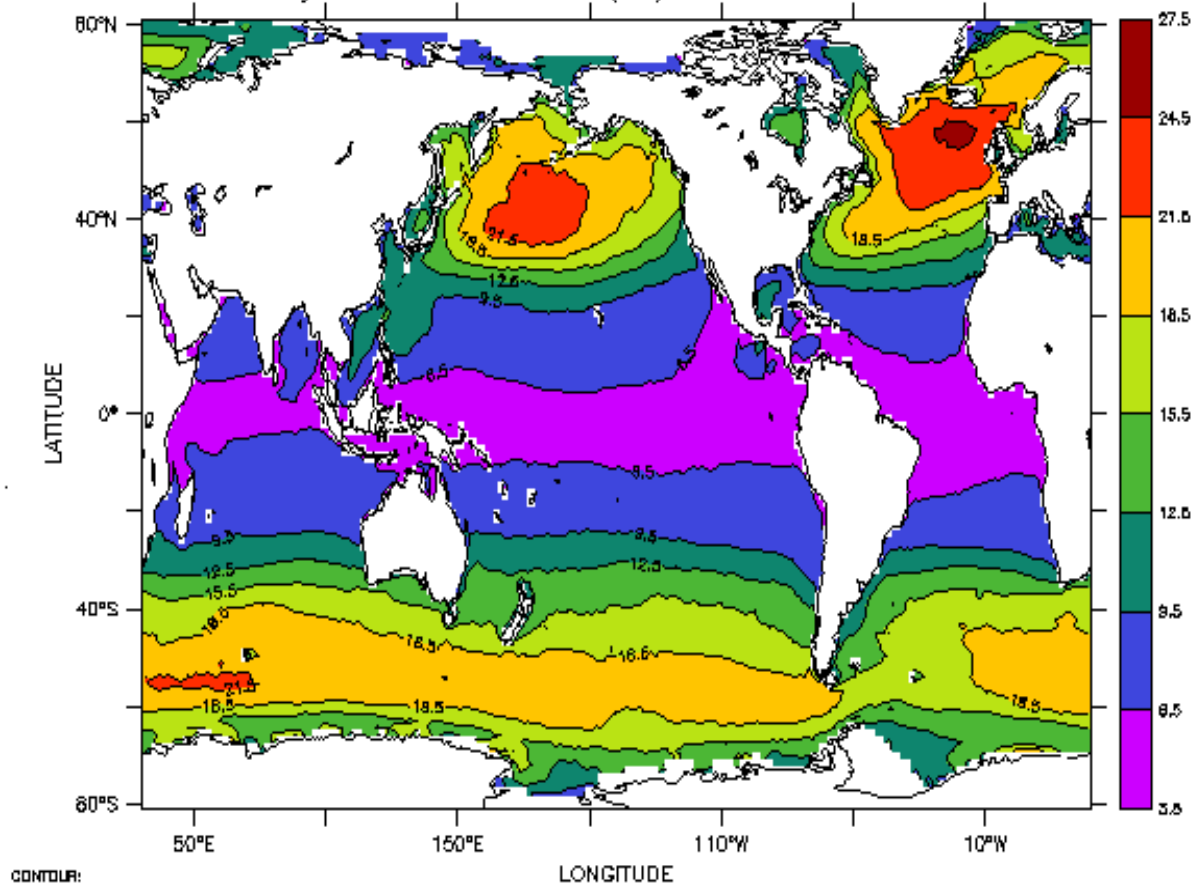- Calibrate result to observations

Sub-goal:

- Model validation of Hs: NORA10 vs. ERA40

Motivation

Hs 100-yr return values (m) 1958-2000

Caires and Sterl, 2005

- www.knmi.nl/waveatlas/

Methodology

$$F(h) = \exp\left\{-\exp\left[\frac{-(h-A)}{B}\right]\right\} \iff h = A + B\left[-\ln(-\ln F_R)\right]$$

- CDF:
  - Gumbel-distribution (GEV)
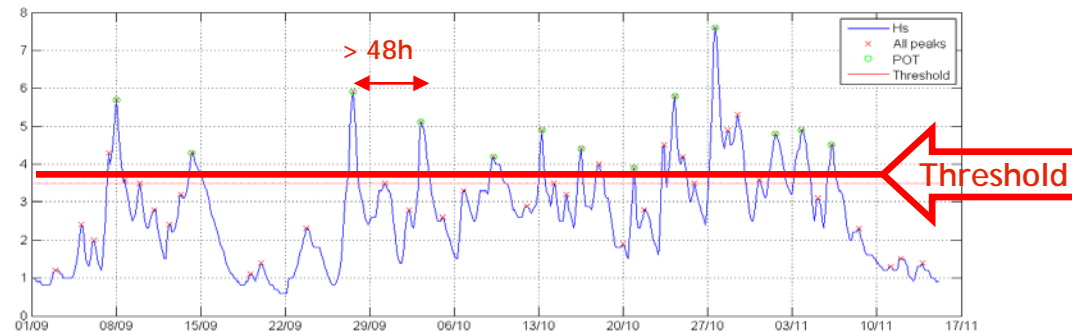 - Fitted by "method of moments"

$$A = \bar{x} - \gamma B$$
$$B \approx \sqrt{6}\,\frac{s}{\pi}$$
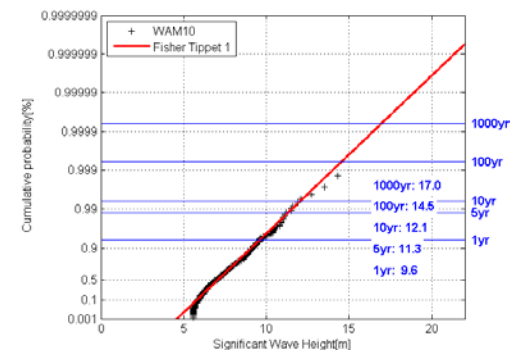$$\gamma = 0.5571$$

$$F_R = 1 - \frac{1}{R \times N_R}$$

- Data sampling:
  - IDM (Initial distribution method)
  - POT (Peaks-over-threshold)
    - Peaks: minimum 48h apart
    - Threshold: 85/90/95-percentile

- Goodness-of-fit:
 - Crudely decided by eyeballing return value plots

Conclusions

- Preliminary estimates of Hs100 (4h means) for the NE-Atlantic are feasible, but probably on the low side in certain regions.
    - Global maximum: ~18m

- When utilizing POT, the threshold should be let to vary over the model domain to obtain an optimal fit between the data and the CDF.

- Hs100 obtained with different CDFs need to be compared and validated.

Model setup NORA10

- Nested model:
  - ➢ WAM50/ERA40
  - ➢ WAM10/HIRLAM10
- Digital filter between ERA40/HIRLAM10
  - Maintain large-scale features
  - Resolve polar lows
- Ice edge updated weekly
- Output:
  - 3-hourly data
  - 10 km resolution
 - Integrated wave parameters
  - Wave spectra

WAM10/HIRLAM10

WAM50/ERA40
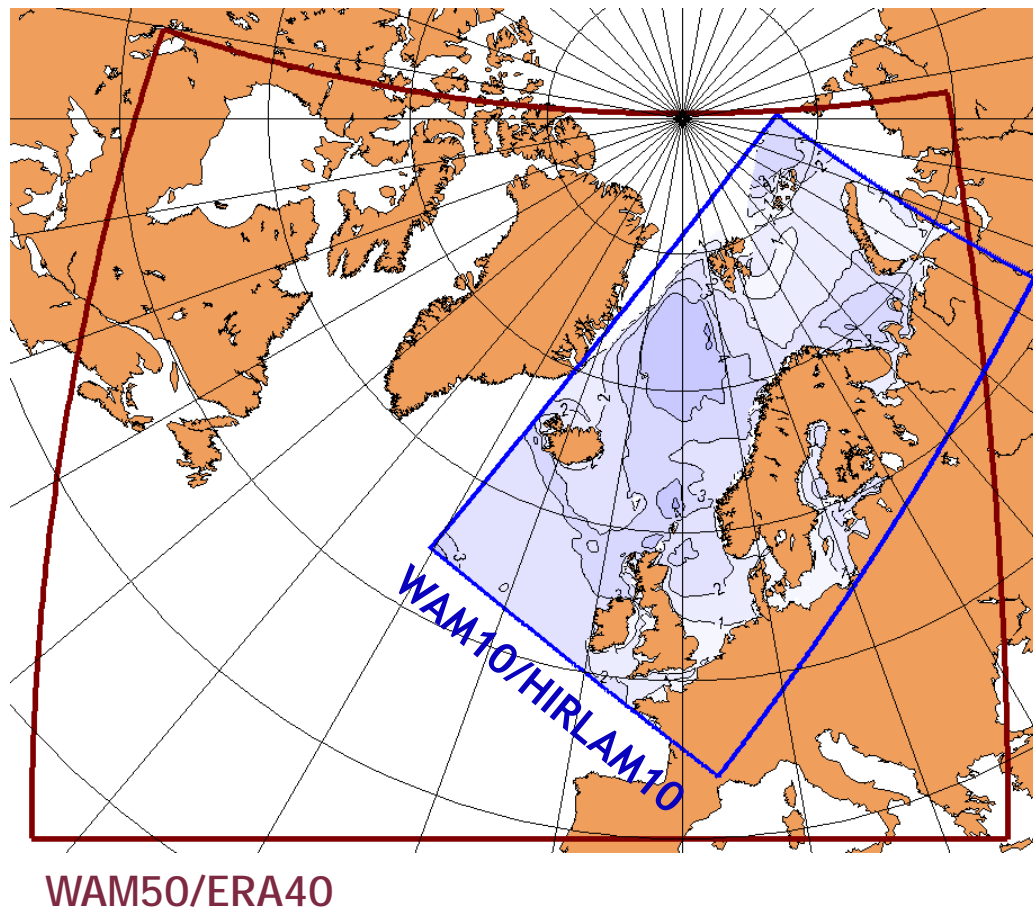
Observations (Jean Bidlot, ECMWF)

- 40(35) buoys/platforms

- 6 hourly data: Aug. 1991 - Aug. 2002

- 4 hour means (±2h windows)

- Variable length: 0-10 years

- Data contain gaps

- Non-uniform data coverage over a year

- Collocated with ERA40-data

- Retain data

  - ± 0.2° of the median lat

  - ± 0.4° of the median lon

NORA10:

• Closest grid point of median lat/lon of obs.
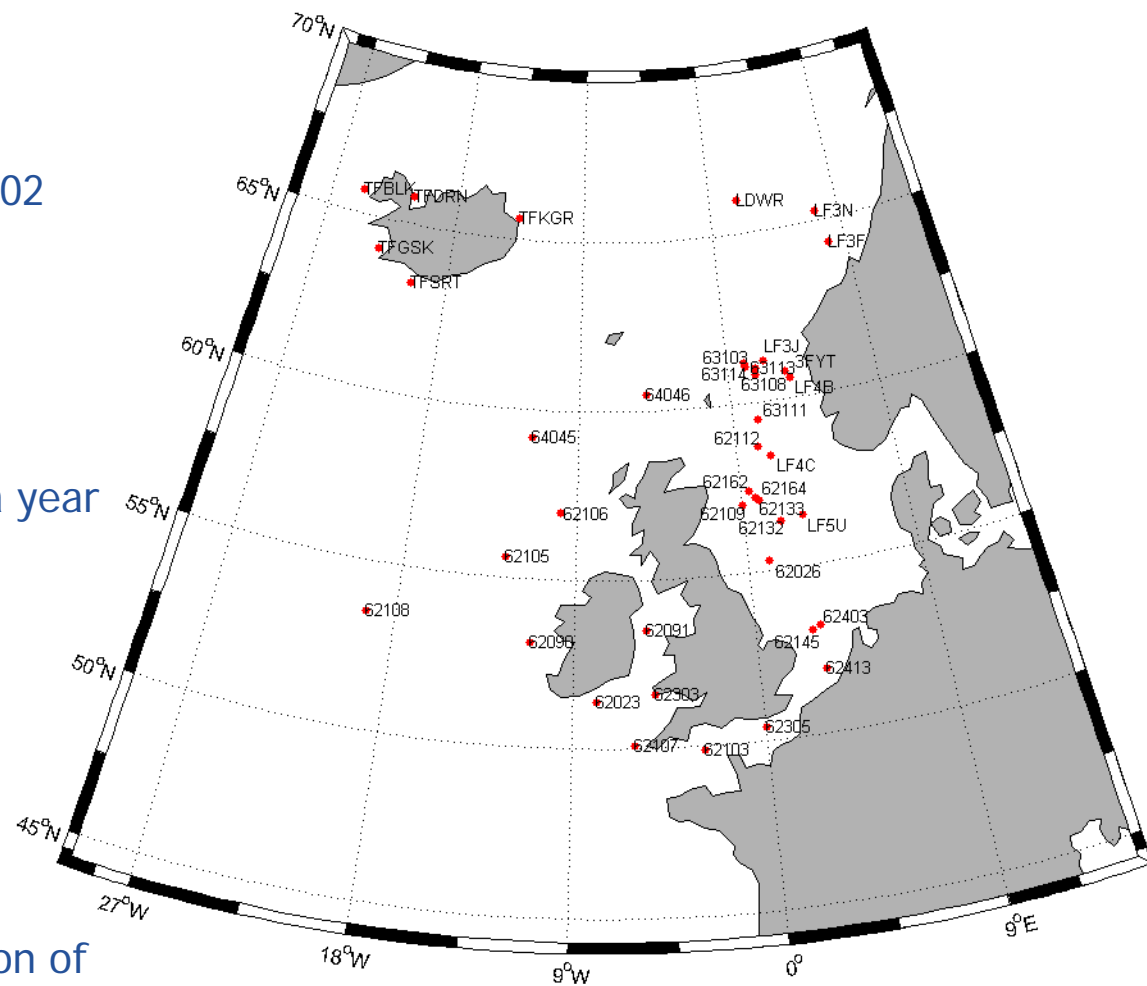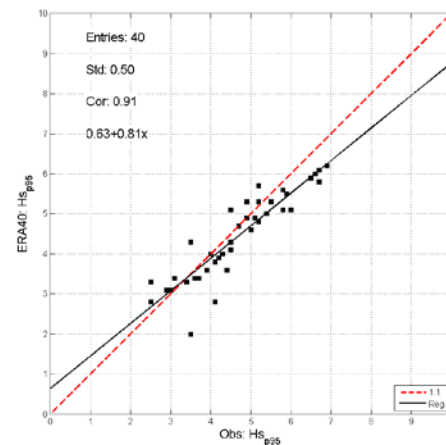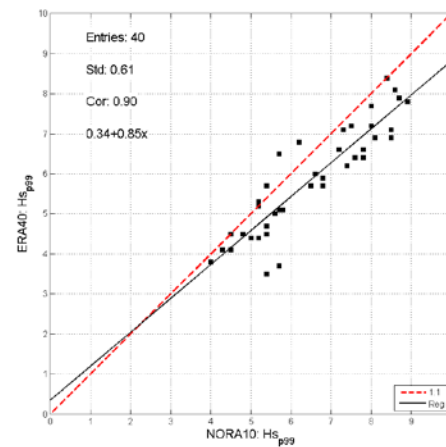
Validation Hs: NORA10 vs. ERA40
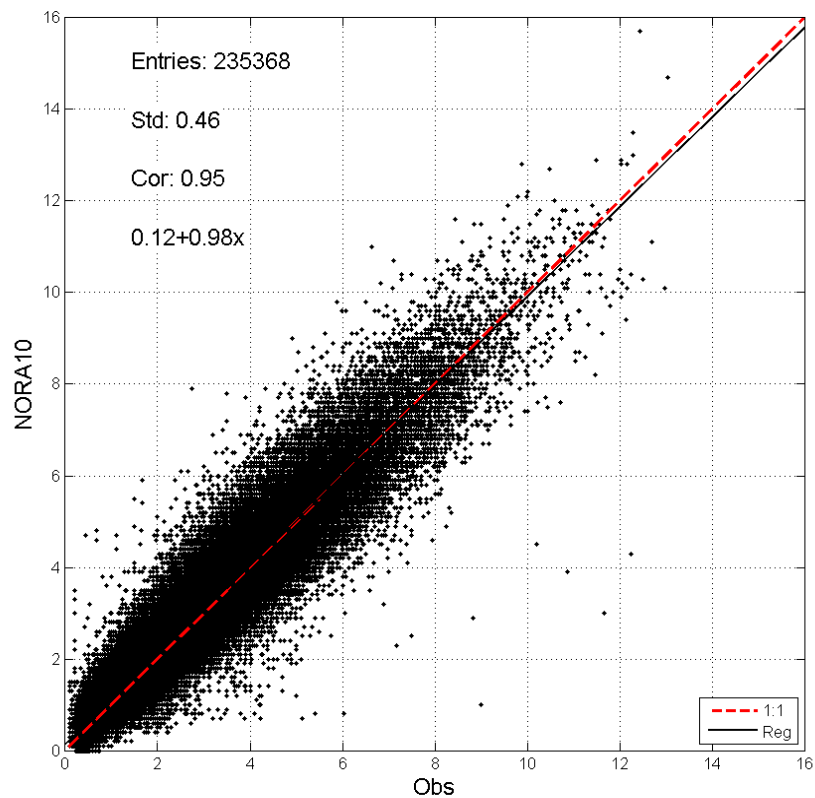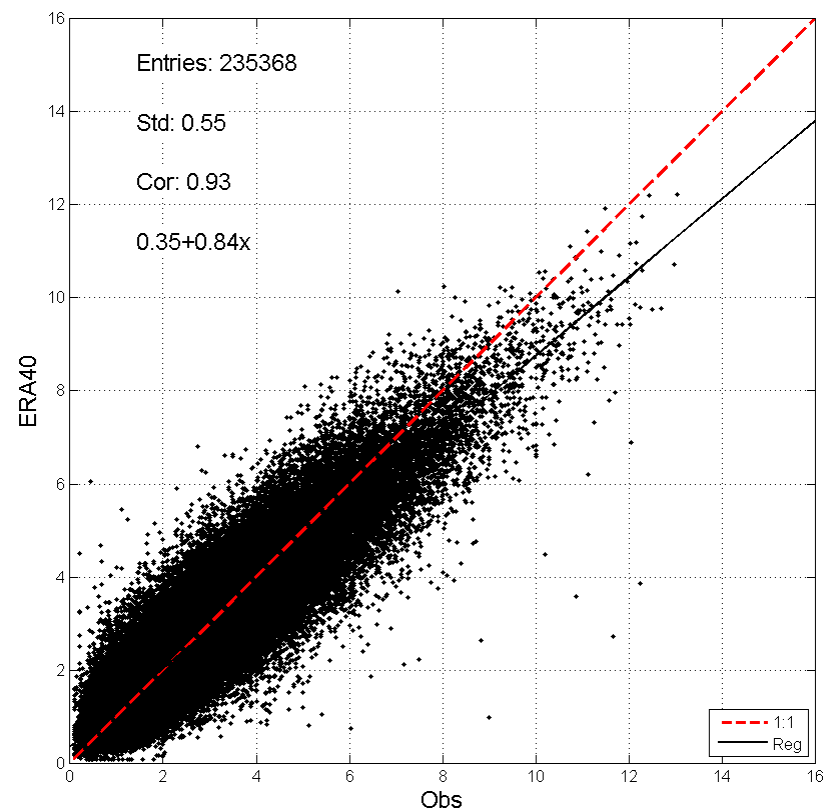
Validation 95/99-percentile of Hs

95-perc →
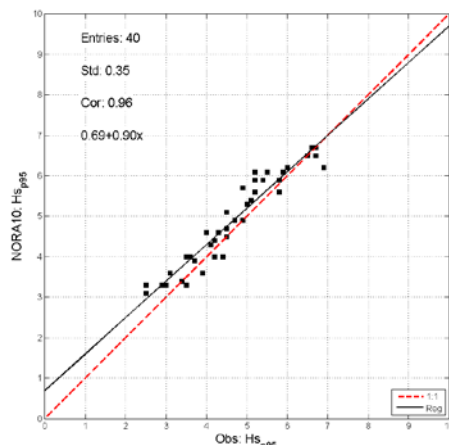
99-perc →
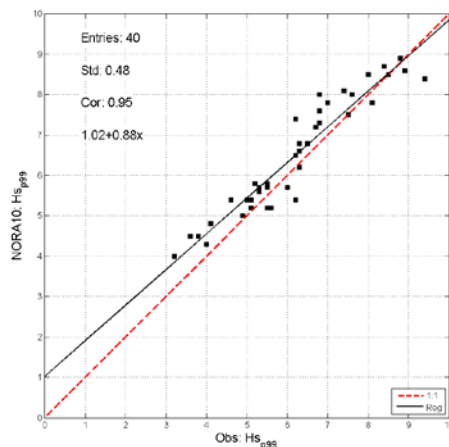
NORA10

ERA40
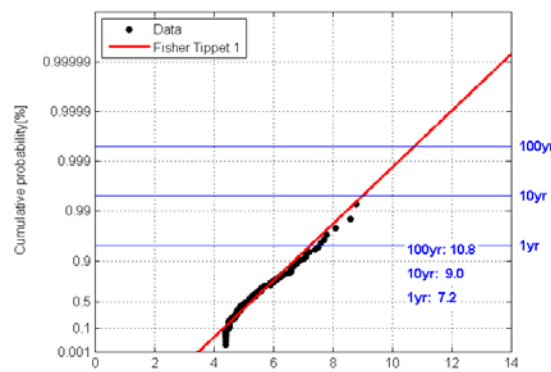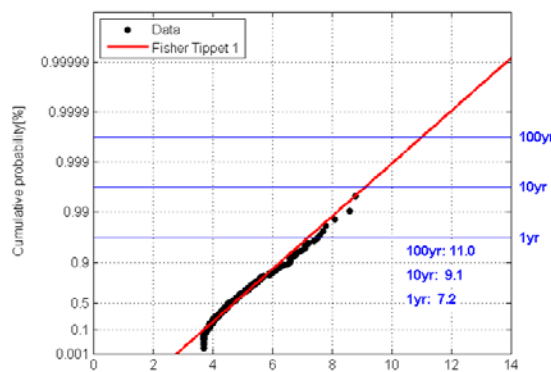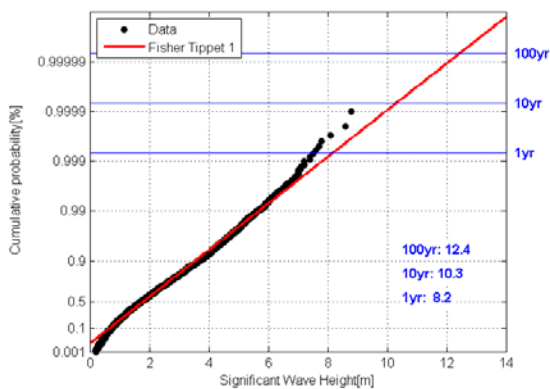
Goodness of fit: Location 62109
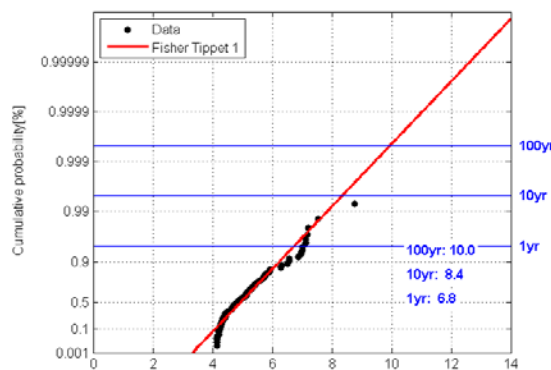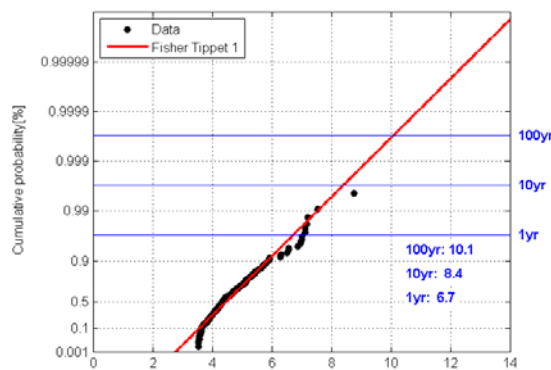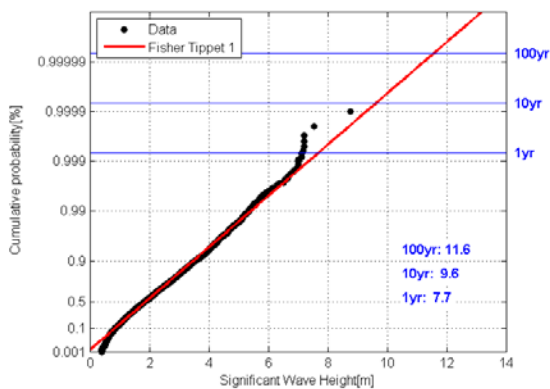
Goodness of fit: NE-Atlantic
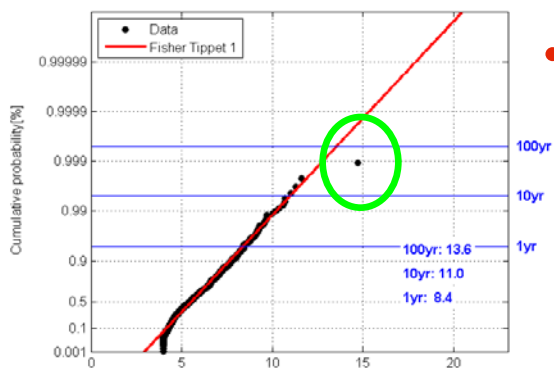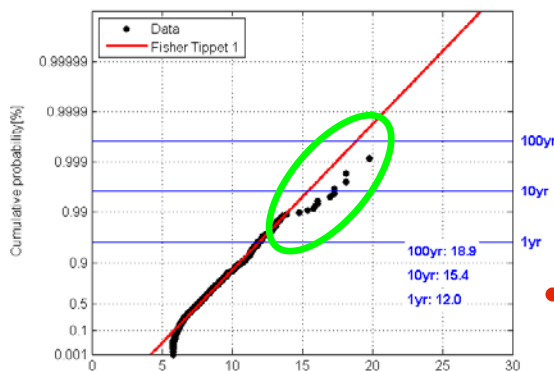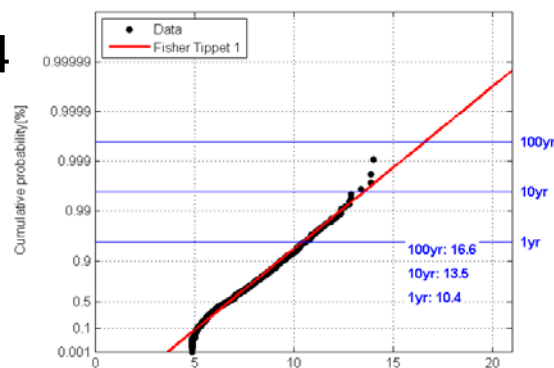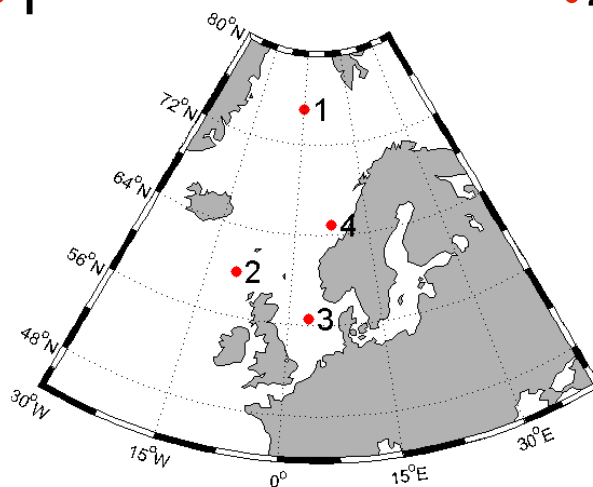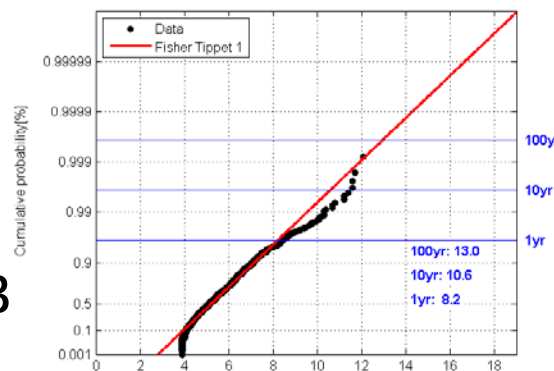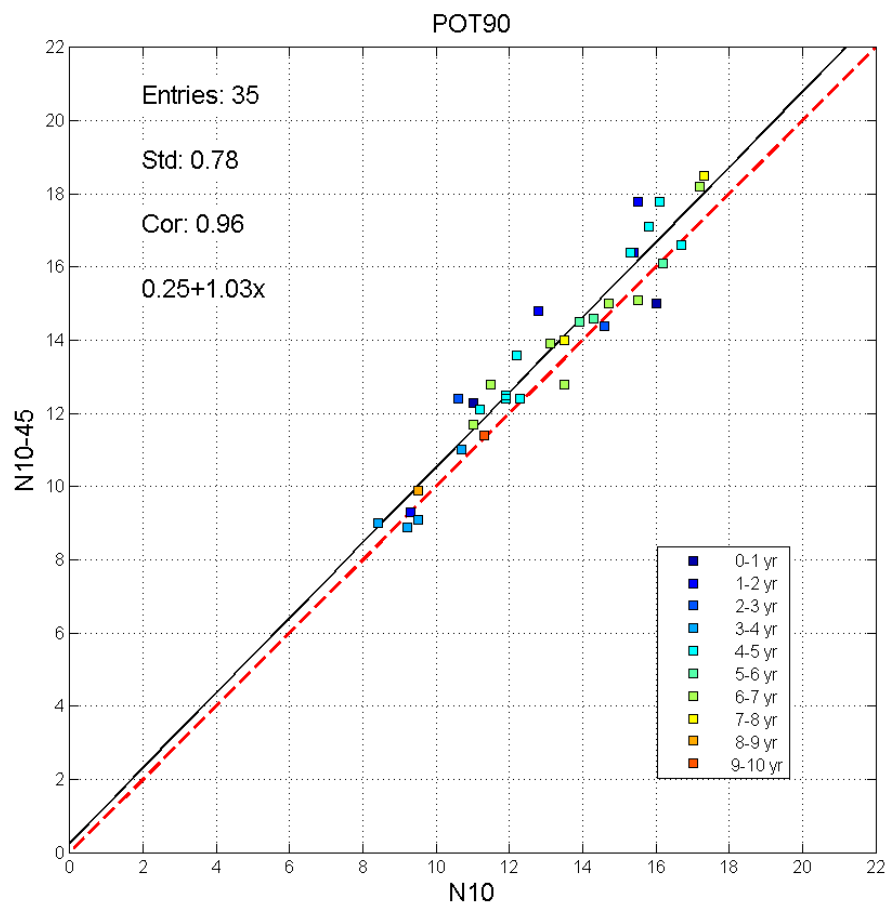
Hs100: 1957-2002 vs. obs-period

• Hs100 solely based on NORA10-data: 45 years vs. 1-10 year of data

• High correlation

• Mean bias: ~-4.1%

• Mean absolute bias: ~5.5%

• Higher spread for the shorter obs-periods

• Conclusion: Influence of non-uniform data coverage over a year/short time series are within reason
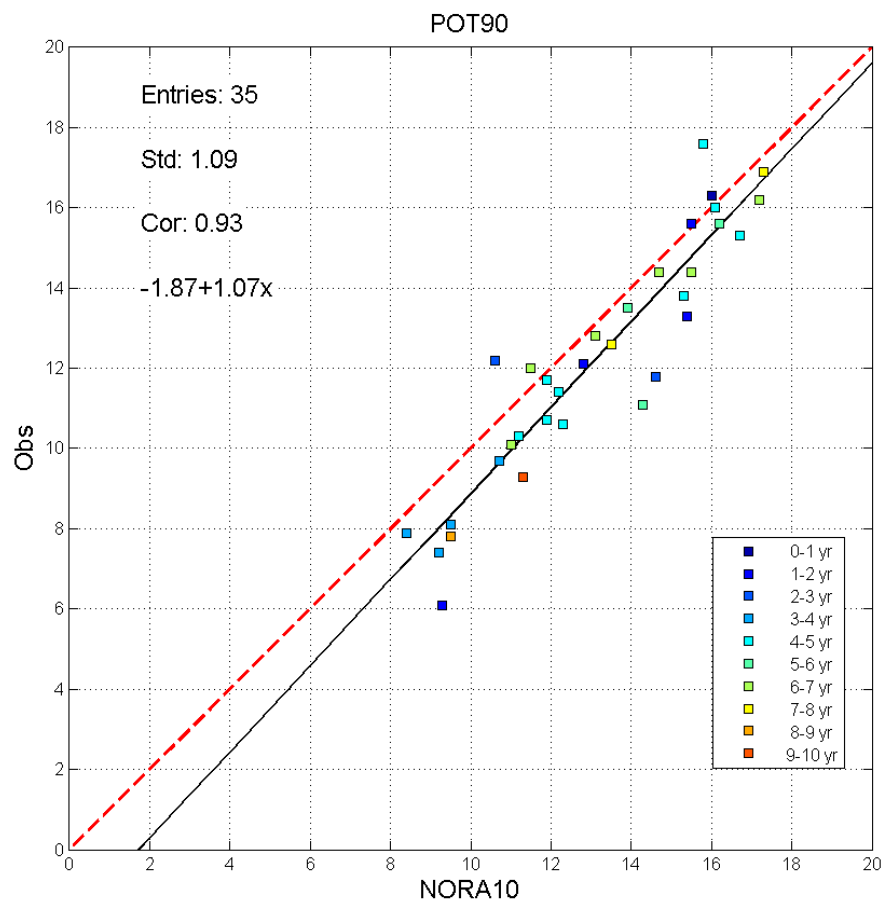
Hs100: Obs-period

- Hs100: NORA10 vs. observations for the periods of collocated data (1-10 years)

- Good correlation

- Mean bias: ~9%

- Mean absolute bias: ~11%

- Higher spread for the shorter obs-periods

- Linear relation to downscale Hs100 based on 45 years of NORA10:
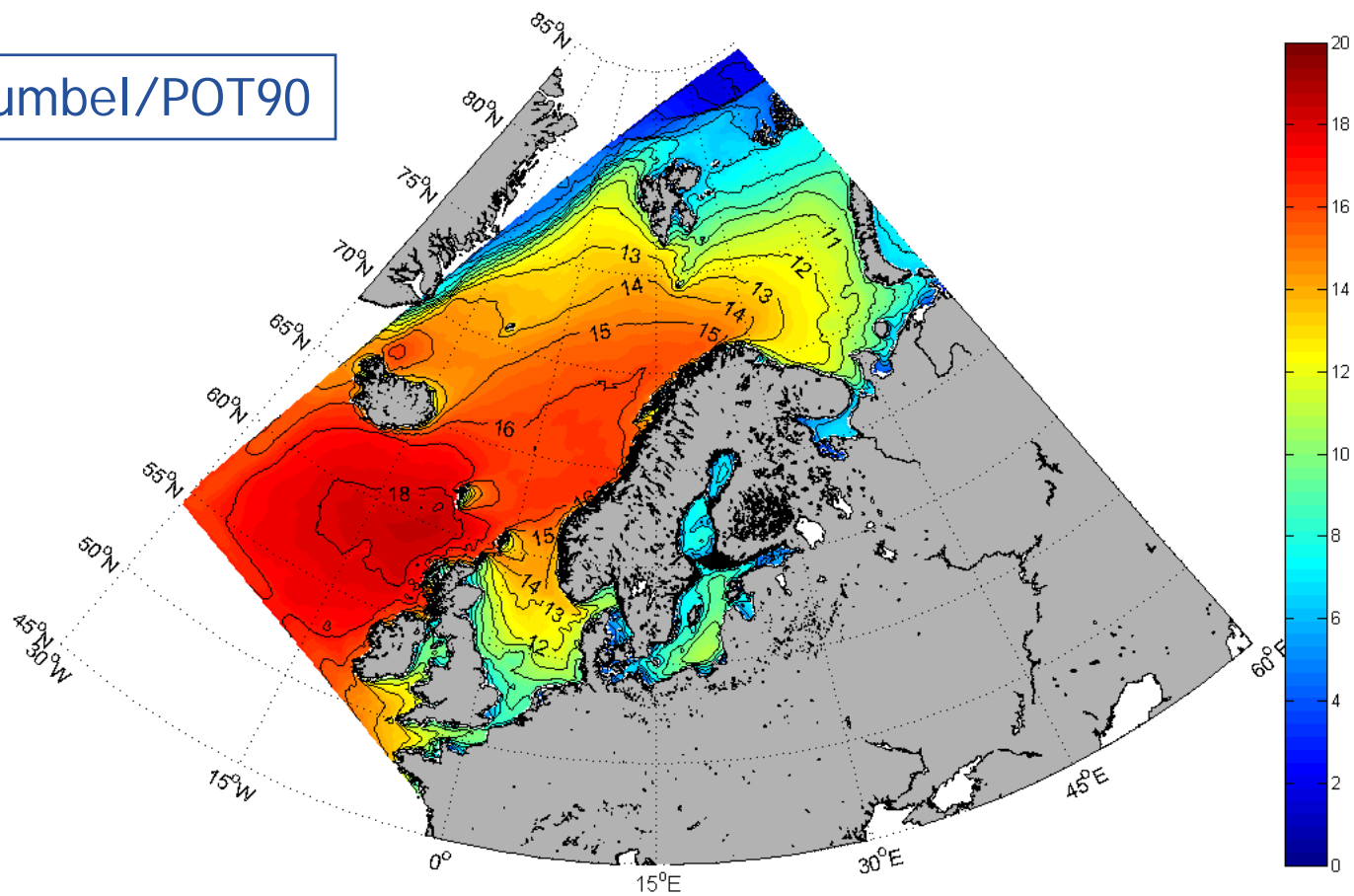
$$H_{S100}^{Obs} = -1.87 + 1.07 H_{S100}^{NORA10}$$

POT90

Entries: 35

Std: 1.09

Cor: 0.93

-1.87+1.07x

Obs

NORA10

0-1 yr
1-2 yr
2-3 yr
3-4 yr
4-5 yr
5-6 yr
6-7 yr
7-8 yr
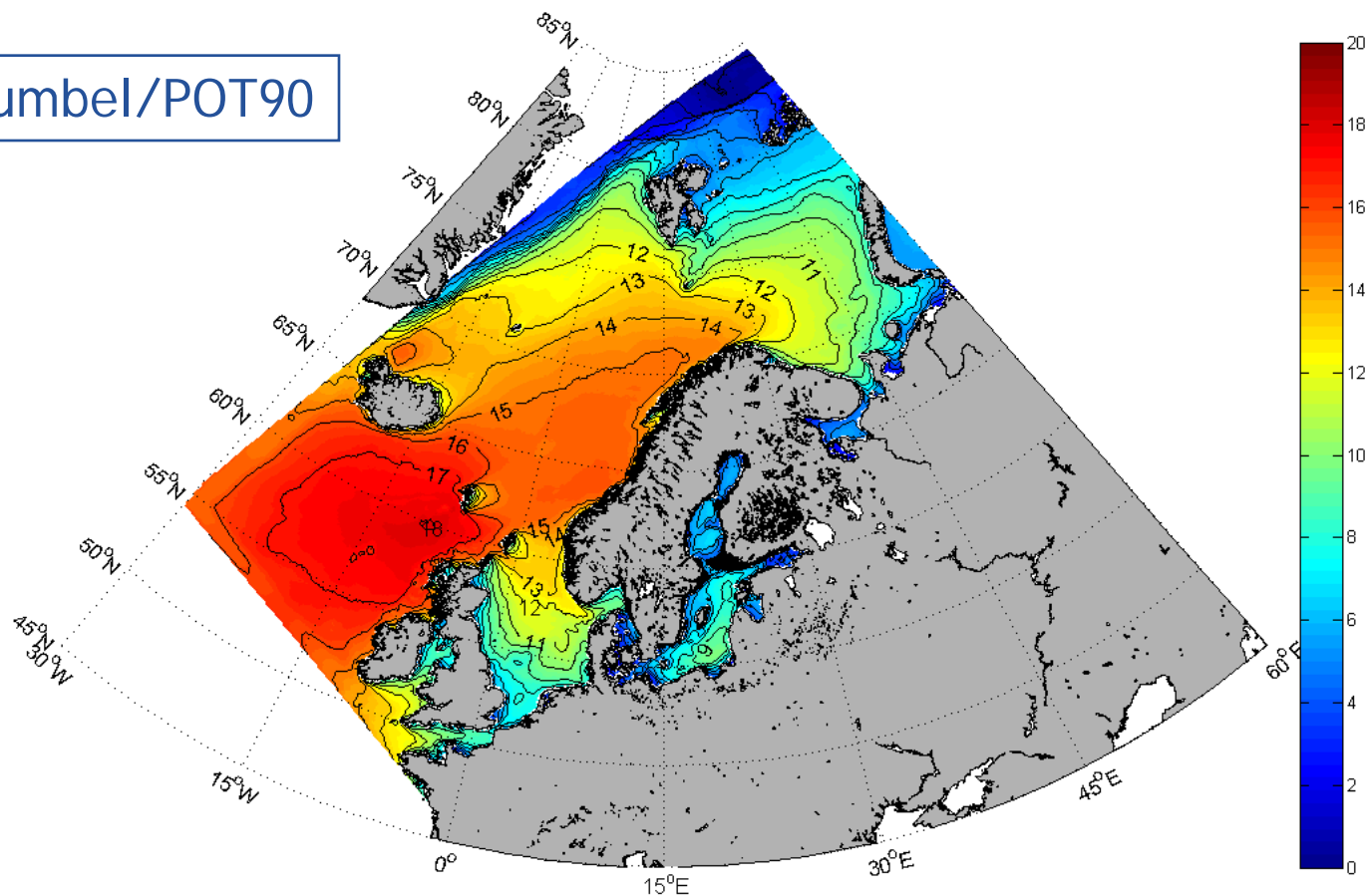8-9 yr
9-10 yr

Hs100 based on 45 years of NORA10

Gumbel/POT90

Hs100 based on 45 years of NORA10 - adjusted

Gumbel/POT90

$$H_{S100}^{Obs} = -1.87 + 1.07 H_{S100}^{NORA10}$$

Concluding remarks:

- Preliminary estimates of Hs100 (4h mean) for the NE-Atlantic are feasible, but probably on the low side in certain regions
- Question marks regarding analysis:
  - Visual assessment of the goodness of fit
  - The threshold (POT) should probably let to vary over the model domain
  - Obs-periods:
    - Non-uniformly distributed over the year
      - Variable length
      - Contain gaps
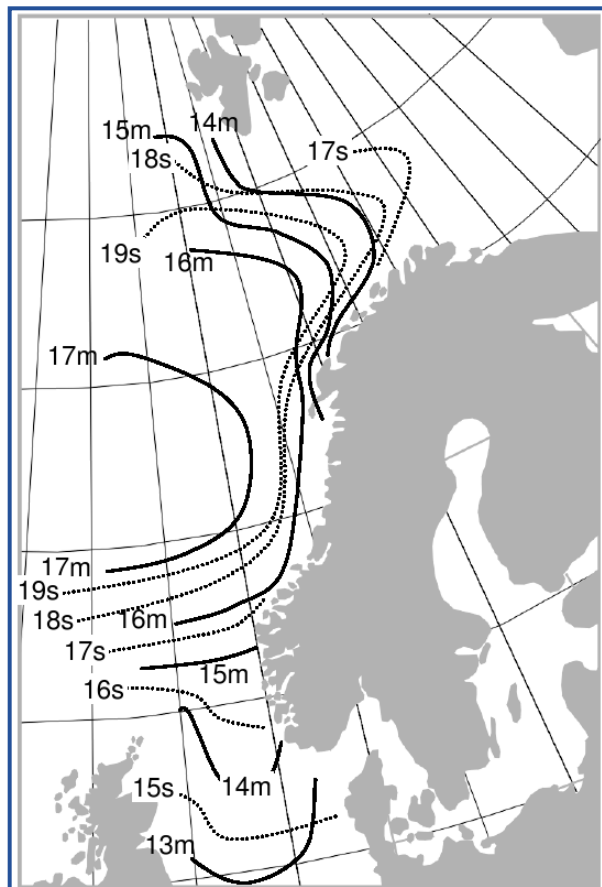   - Fairly short time span
  - One CDF fits all – probably not!

Max Hs based on 45 years of NORA10
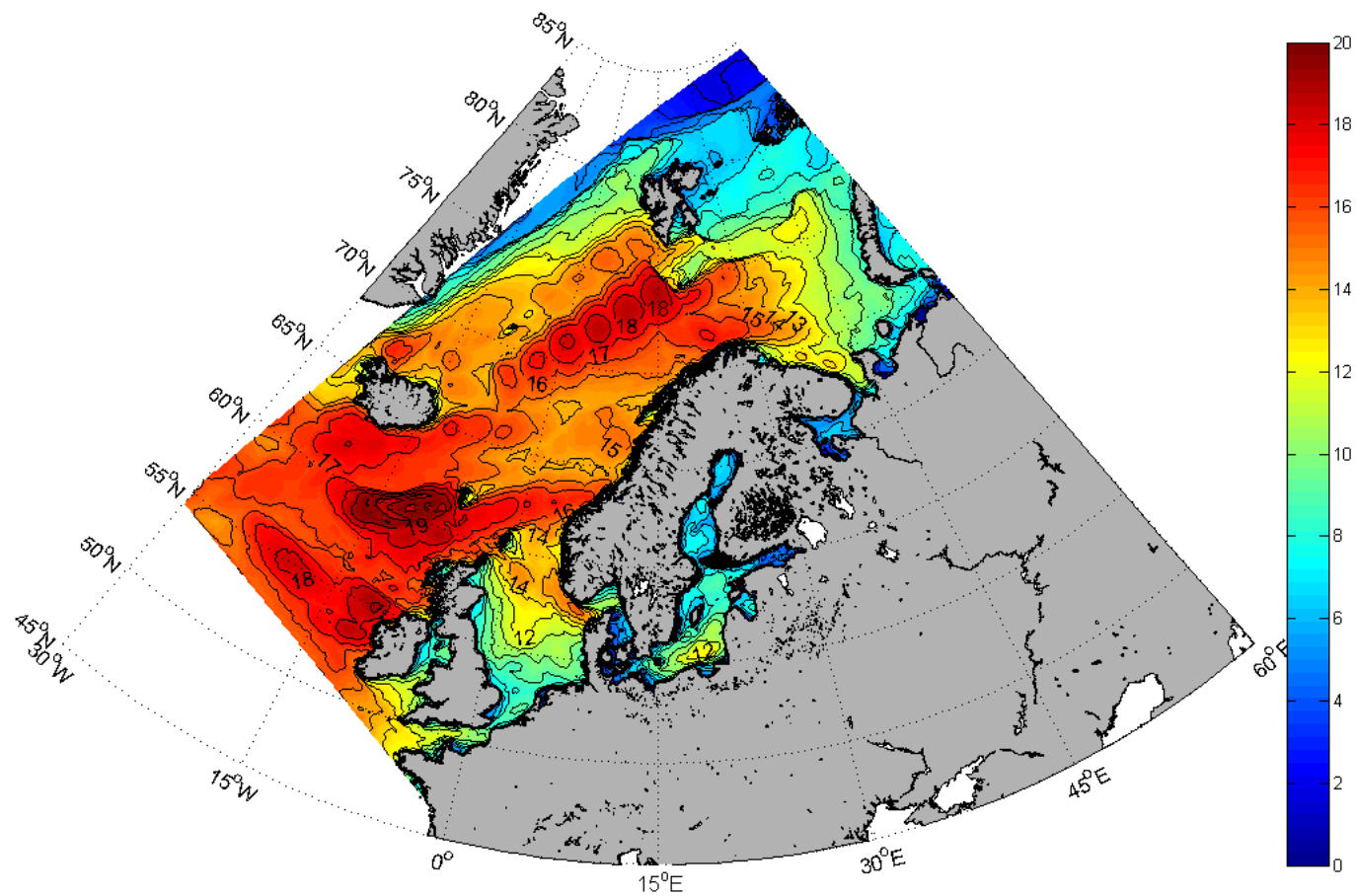
Related estimates

NORSOK Standard: 3h duration

IACS - International association of Classification Societies LTD:

→ Hs20 = 16.5m in the North Atlantic