

#### Meteorologisk institutt met.no

## What is True Sea State?

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## Content

- Motivation for study
- Variability in Wave Height measurements
  - → Several sensors at same site
  - Increased sampling rates more questions
  - Ekofisk is a "RollsRoyce" in terms of a wave laboratory, revealing a lot of 'problems' ...( no VW wanted anyway)
- Keywords: Sensor types wave exposure - quality controle - wave height statistics

2

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## **Motivation**

- A "true sea state" (close to?) is often difficult to assess even with many sensors around. NEEDED FOR VALIDATION of WAVE FORECASTING MODELS and WAVE FORECASTS
  - → Obvious discrepancies are seen on offshore platforms in Northern North Sea (Gullfaks/Statfjord/Troll) in general conditions
  - → Obvious discrepancies in measurements are seen at Ekofisk and Valhall during extreme storm monitoring and forecasting for ConocoPhillips and BP: what to choose as storm max Hs when you have many answers???
- Input to discussion on standardisation regarding wave observations







# Validation Northern North Sea

- Forecasting skills in relatively small wave heights is of great important for offshore exploration
  - → Hs ranges 1.5 to 3m
  - → weather waiting is expensive
  - → small margins (10-20 cm)
  - → Validations in Northern North Sea and off mid-Norway use observa (mostly?) MIROS Microwave which is used on many installations.









# MIROS MICROWAVE WAVE RADAR



- Measures doppler shift from surface waves in a 180° sector and evaluates wave spectrum in 6 x 30° or 12 x 15° → E(f,θ) → standard integrated parameters.
- It is known since mid-80's to underestimate sea state (Hs ...) when waves are receiding (go away from the sensor) and perhaps overestimate when waves are incoming.
- Correcting actions were performed, but the problem is still there.





#### From work in progress by Rasmus Myklebust (forecaster in Bergen)



Differances between Hs measured at Gullfaks and at Statfjord

in the time span

from 01 January 2007 to 28 September 2009



#### Validation of forecasts of highest Hs is storm (Ekofisk eXtreme Wave Warning: EXWW)



- What Hs-calculation to use :
  - → HM0 (nfft=2048)
  - → HM0 (nfft = 2400)
  - → H4std
  - → 1-hourly averages ?
  - → H1/3 (zd / zu)
- Different results with different sensors → Validity of extreme statistics ?





Wave instrumentation on Ekofisk, central North Sea (56.5 N 3





Laser Flare North

WAMOS

#### Laser array

Laser Flare South

# Historical info on data at Ekofisk



- 1980-1993: wave profiles were corrected and stored without spikes (and extreme waves)
- 1993: "Raw data stored".
- 1993 2003: 2 Optech lasers installed (north and south end of complex)
  WAMOS is installed in 1995.
- 2003: Flare North is decomissioned and laser at flare North is replaced by a laser array (LASAR) on bridge further North (bridge between 2/4 B and K).

Data communication:

- ftp transfer since 1995-1997(?) → real time monitoring → all data stored at met.no
  - D22 files with integrated parameters (10 min)
  - 2Hz wave profiles (20 min) from 3 sensors
  - 2D wave spectra from WAMOS at 2/4-K
  - 5Hz and 2D information from LASAR sensor.



# From the complete database April 1997- October 2009



# Selection of data difficult ...

# **S**

#### All EXWW storms 1997-2009





## Comparison of Hs in 20 storms jan2007-oct2009 qq-plot



Axes: 2-12m



### Average Hs in Wind dir sectors (dθ=10°)







#### Lee effects?



LASAR: 50% of data are 5% (or more) larger than Waverider Hs MRF: 50% of data are at 5% (or more) lower than Waverider Hs in the exposed (open) sector





Discrepancy is larger
 In the lee-sector

## Saab radar at Valhall



#### Also showing a discrepancy (vs Waverider at Ekofisk)



# What kind of error handling ??



- Waverider
  - → March 2006: recieved signal (analog) replaced by digital missing data = -999 →
  - → When Waverider is dragged under water:
    - Hs --> default values = -999

handled as meter values, resulting in explosiv Hs (obvious)

- MRF
  - → MIROS software: when too big akselerations, linear interpolation between points → SMOOTHING OF HIGH AND STEEP CRESTS

#### LASAR

- → Raw data available with a lot of spikes! No smoothing here!
- → Real time analysis is performed using median of best 3 sensors (Oceanor software)

# Waverider with missing data

350

Seconds from start

8

6

4

2

-2

-4

-6

-8

250

300

Ξ 0



Trx=-8.57 m

450

400

 $Hs = 4^{*}std = 12.1 m$ 

Hm0 (2399) = 12.4 m

Hm0 (2048) = 12.6 m





2006-10-31 23:40 nfft:2399 <Nfa>:1 \*BH2006-10-31 23:40 nfft:2399 <Nfa>:4 \*BH2006-10-31 23:40 nfft:2399 <Nfa>:9 \*BH\*



# H4std, Hm0, Tm02 and Tp





21

## SKEWNESS 20th march 2007





## SKEWNESS 20th march 2007





## SKEWNESS 20th march 2007





# Time averaging



- Variability is natural
- Should we evaluate integral parameters over one hour and give information on variability?
- Models validate well towards 1-hrly values (espacially as grid spacing has become smaller).

#### Storm 8.-9. november 2007 - 3 time series





















## Conclusions



- Different sensors give in average biases close to 5-10 % in Hs values 5-9m
- A need for standards in
  - → Quality control on wave profiles
  - → Quality control on spectra
  - → Wave parameters (low-high freq cut-offs?...which method?)

#### → Forecast Validation methods ??