Development of an early warning system in support of offshore industry

Towards environmental impact assessment and sustainable development of marine resources in Africa

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GOOS-AFRICA/NORWAY COOPERATION, Cape Town
Thursday 9th November 2006
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Geophysical Institute, Bergen

Forecasting Division Western Norway (50)
- 8 forecasters
- 2 scientists
- IT (2 of 11)
- Sales / marketing

Marine Forecasting Centre (14)
- 8 forecasters
- 2 scientists
- IT (2 of 11)
- Sales / marketing

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Overview

- Example of an early warning system developed in close cooperation with the end user
  - Short history of development
  - Storm 31.10 – 01.11.2006: An extreme wave case
  - Real time data analysis → data quality assurance → profit for wide model community

- Potential cooperations
  - National fundings in support of GOOS AFRICA
  - Test user needed for the ESA project CAMMEO
  - … ?
Hs – field at maksimum

12.12.1990

01.01.1995
12UTC

Figur 3: Også et bølgefelt kan illustreres ved hjelp av linjer gjennom like bølgehøyder. Vi ser hvordan bølgehøyderen øker sørover fra Nordsjøen og linjen for 10 meter signifikant bølgehøyde strekker seg med i sørøstre Nordsjøen. Maksimal...
01.01.1995 Hs (-- & mslp)

01.01.1995 (storm track)
The "Draupner wave"

The "New Year wave"

Hs = 11.9m
Crx = 18.5m
Hmax = 26m
Crx/Hs = 1.55
Hmax/Hs = 2.1
Crx/Hmax = 0.71

Courtesy of Statoil ASA, Norway
The sea bottom at the Ekofisk field in central North Sea is subsiding due to the oil extraction, and constructions are therefore more and more exposed to wave forces.

Special procedures (EXWW) have been developed between ConocPhillips and the Norwegian Meteorological Institute (met.no) to ensure safe production. In this, monitoring of environmental parameters in real time is of primary importance.
Environmental parameters:
Atmospheric pressure, air and sea temperature, data from 4 wave recorders and 2 wind sensors.
Development of EXWW procedures

- **EXWW**: Ekofisk eXtreme Wave Warning (*english, later norwegian*)
- First introductory meeting in January 1991 (*end user approach at first*)
- Work-meeting including personell from Offshore helitower, IT, HSE
- → definition of product and procedures
  - STORM EXERCISE AT START OF EACH SEASON
  - CONTINUOUS UPDATING OF PROCEDURES BY MID-WINTER MEETINGS EVERY YEAR.
  - CONTINUOUS UPDATING OF FORECASTING COMPETANCE (participation in international research on extreme waves a.o., in-house training, validation of forecasts…).
Procedures in short

- 4 expert forecasters - scientists/forecasters with wave expertise - on a special contingency watch during winter season, implying 2 persons always available.

- Procedures for
  - Met.no
  - Company Offshore
  - Company Onshore

- Procedures for actions to take
  - before a storm
  - During the storm
  - After the storm
EXWW – from fax to a web based product

1991-2002

Advantages of web solution:
- help functions
- definitions available
- platform specific
- forecast + criteria
- Production tool prevents human errors
- Available on any web browser, passw protected outside firewall

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Wednesday 1. November 2006 at 00UTC: Hs = 12m
Medium range forecasts from ECMWF (20km globally) predicted the storm development many days ahead.

- Sunday evening: first phone contact to Valhall (BP) ← special procedures (including email). Hs > 9m.
- Monday morning: first phone contact to Ekofisk (CoPno): Hs ≈ 10-11 m
  - Thereafter contact every 6 hours with updated info on email
  - Procedure update: end user want phone contact at each new email

Forecasts from ECMWF / met.no / Deutsche Wetter Dienst agree

- Forecasting Wave height (Hec. Height Ekofisk Crest) would be less than 11.5m
- Hec is combination of Hs and water level above Lowest Astronomical Tide due to storm surge and tides (comparable to crest height above LAT, but not quite, but: comparable to criterie set for specific platforms).
Wind direction change between 10 and 11 UTC (SW veering NNW later N)

Wind speed gradually increases to 50 knots (22 – 01 UTC)

Wave height from Waverider (blue line) is a problem. Wave height from Laser (red line) has high variations. Hs=13m not relied on in real time. Wave height at Flare South (black line) is low because of lee of the Tank.

Water level is at maximum at 22 UTC.
00 - 03 - 09 - 12 - 15 - 18 - 21
31.okt.2006

00 - 03 - 06
01.nov.2006

OSEBERG (mid day)

EKOFISK (midnight)
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31.okt.2006 - 01.nov.2006

00 - 03 - 06 - 09 - 12 - 15 - 18 - 21 - 00 - 03 - 06
Hs 13m!
Hs < 12.5m
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Wind (kts) - 31.10.2006 00 UTC
Wind (kts) - 31.10.2006 12 UTC
TOPICS TO ADDRESS

- QUALITY ASSURANCE OF DATA
  - Wind reduction from 100 m level to 10m
  - Time series of wave profile
  - Lack of standard method of calculating wave spectra

- QUALITY ASSURANCE ON MODELS
  - Atmospheric
  - Waves ➔ LEARNING FROM VALIDATION And FORECASTING !!!!
  - Currents
  - Ecosystem modelling

EXAMPLE OF WORK FOR VISITING STUDENT/SCIENTIST FROM AFRICA
WIND OBSERVATIONS FROM PLATFORMS ARE REDUCED FROM HIGH LEVELS (50-100M) TO 10M FOLLOWING NEUTRAL ASSUMPTION ON BOUNDARY LAYER (WMO CONVENTION AGREED UPON IN 1970’S)

Models (blue and green): 15 kts

Observation (black): 15 kts

Qscat (red): 20 kts
Examining the (eventual) development of a minor Polar Low
The NOAA Marine Environmental Buoy Database (NODC File 291) is one of the largest and most frequently used data archives maintained by the NODC. This database holds wind, wave, and other marine data collected by the NOAA National Data Buoy Center (NDBC). The data are collected from NDBC moored buoys and from C-MAN (Coastal-Marine Automated Network) stations located on piers, offshore towers, lighthouses, and beaches. Parameters reported by both buoys and C-MAN stations include air temperature and pressure, wind speed and direction, wind gust, and sea surface temperature. The buoys (and a few C-MAN stations located on offshore towers) also report wave data, usually including wave height, wave period, and wave spectra. Since the late 1980s some buoys have reported directional wave spectra. NODC receives the data from NDBC on a monthly basis.
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Wave – current interaction and occurrence of freak waves

- On going work in MERSEA
  - WP12.2 Wave-current interaction
    - Wave Hindcast one year with/without currents
    - Impact on response calculations on a floating platform.

CURRENT MODEL NESTING:
- TOPAZ (Atlantic)
- ECOM3D (20km) – red area
- MIPOM (4km) – black area

WAVE MODEL NESTING:
- WAM_50KM with winds from HIRLAM_20KM
- WAM_4KM (red) with winds from HIRLAM_10KM
The kurtosis in the high wave area is also reduced in the strong with-current.
COLLABORATION NORWAY-AFRICA

- Actions are taken to raise funds from Norwegian National Research foundation.
  - Johannes Guddal, former president of JCOMM
  - Peter Haugan, Norwegian delegate to IOC/UNESCO, professor at Univ of Bergen, dept. Physical Oceanography
  - Tor Gammelsrød, Professor at Univ of Bergen, dept Physical Oceanography
  - Johnny Johannessen, Professor NERSC
  - Anne Karin Magnusson, Scientist, met.no
  - Einar Svendsen, scientist, IMR

- Focus on coastal oceanography at first, but this is to be more concretised in a pre-project aiming to define work for a 3-5 year R&D project

Will be presented in more details next week by Johannes Guddal next week
USER – TRIAL IN CAMMEO

- CAMMEO (ESA EOMD, Longer Term Activities, Contract: 17737/03/I-IW)
  Co-ordinated Approach to Markets for Marine Earth Observations
- Partners: SOS, DNV, met.no, ARGOS, IFREMER

  - Real Time data (met.no / SOS)
  - S&R / Ship Drift (met.no / DNV)
  - Wave Forecasting (IFREMER/ARGOS)
  - Statistics (DNV / ARGOS)
- Involvment met.no
  - data formats – real time availability
  - 'GIS'-presentation on web
  - user trials
- Extension one year 2006-2007
  - Continuing with User Trials,
  - update data-presentation (user feedback)
  - continue user trials

Qscat winds
Alt. Hs
Scat winds
Jason
Envisat
ERS2
Qscat
2 WMS (Web Map Server) systems:
  • metoc (developed by CMR)
  • WMS-DIANA (met.no)
Advantage of using WMS-DIANA: a weather focused system (but: projection possibilities must be improved)
Choose bottom topography in different ways, here with isolines.

• OTHER GIS-INFORMATION DATA MAY BE ADDED.
  Example with oil-field information freely available from NPD. Could be
  - land maps
  - energy network
  - ....

• PREDEFINED AREAS
Link to time series / Forecasts / observations
Some ECMWF data are available at 1 degree resolution

Work in CAMMEO:
- improve visualisation of EO data from SOS
- Make knobs for predefined areas for low-bandwidth-users
- Eventually make new website for special user trials
- Get feedbacks from users.

VOLUNTEERS?
SUMMARY

- Example of end user product: EXTREME / STORM WAVE FORECAST
  Implies:
  - Real data monitoring
    - quality assurance
    - Competence in measuring systems
    - Validation of models
    - Validation of forecasts
  - Correction of forecasting procedures
  - Correction to measuring systems

- Some ideas for collaboration Norway-Africa:
  - Visitors to work on Model validation / data analysis
  - Trial user in on going ESA project CAMMEO
Thank you for your attention!