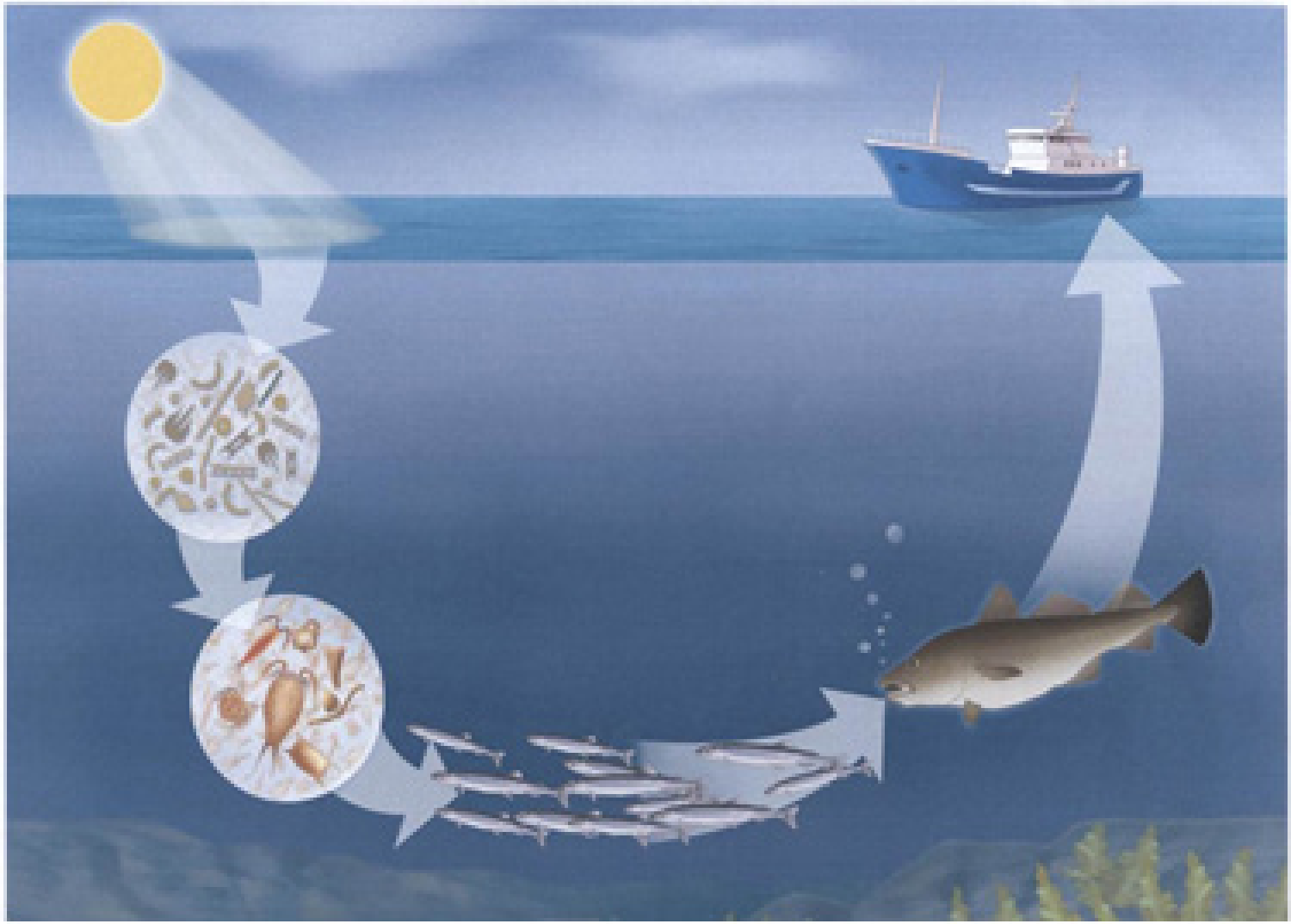
Johanne Arff

The Water Column - Measurements and Modeling

Public Meetings

Lüderitz June 2nd and 3rd

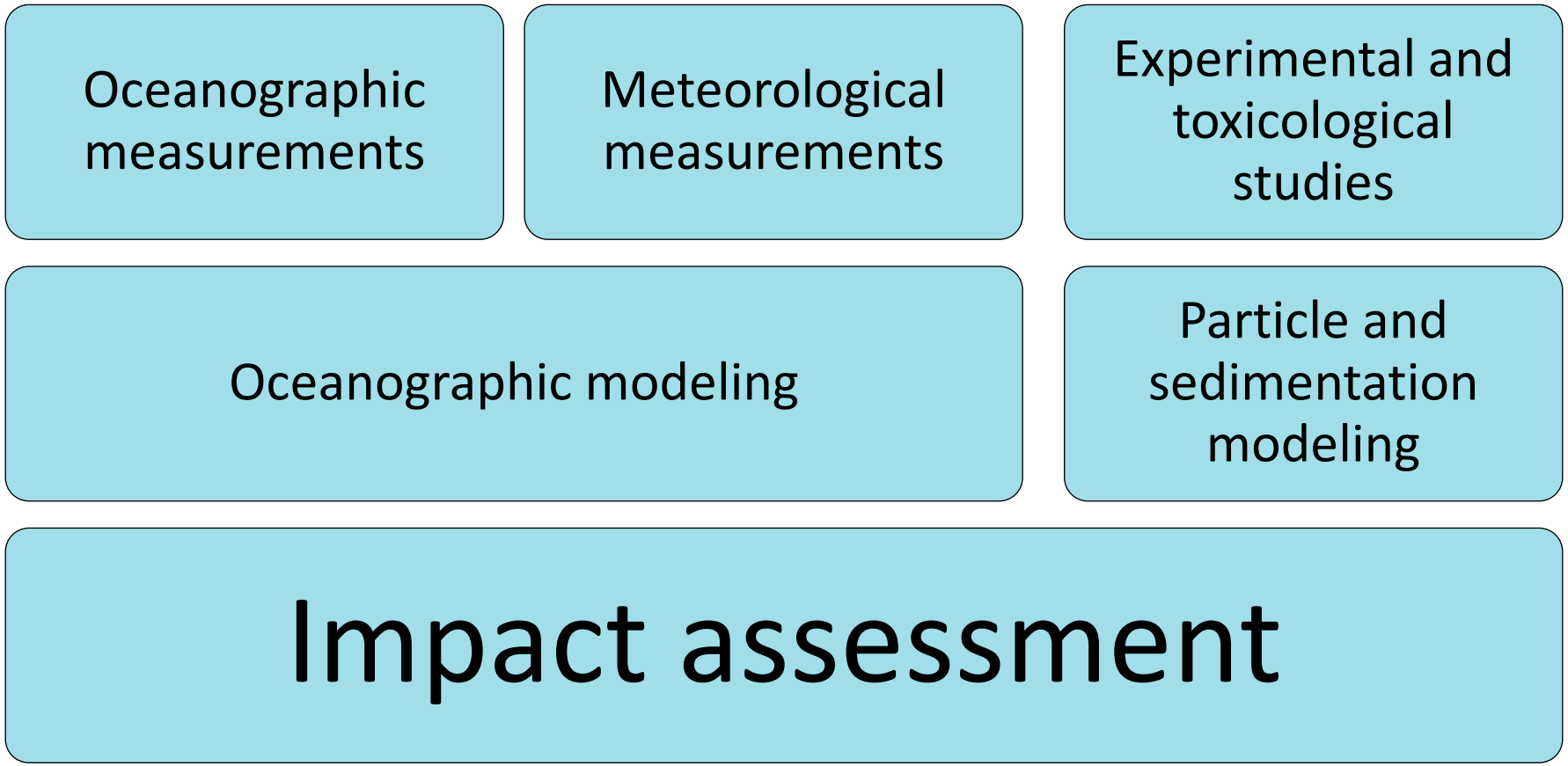
Swakopmund June 5th and 6th



Outline

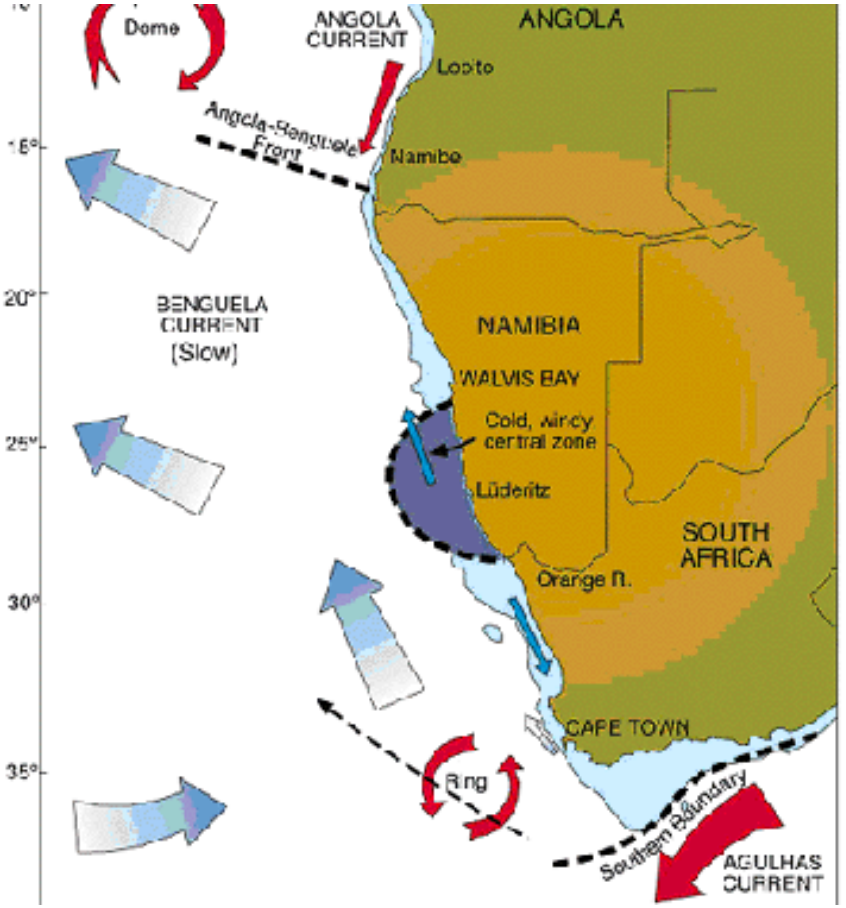
- Conceptual description
- Measurements
- Models
- Outcome

Conceptual description of the pre-mining study



Oceanographic surveys

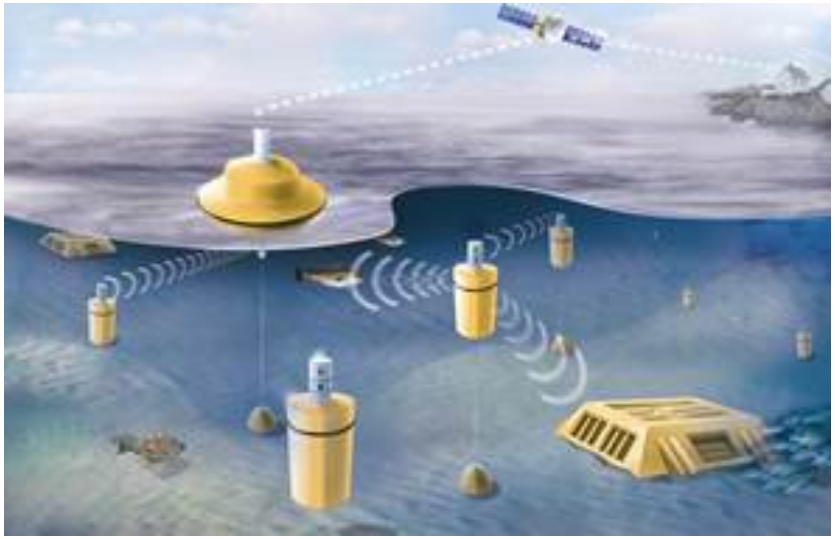
- Temperature
- Salinity
- Dissolved oxygen
- Turbidity
- Total organic carbon
- Nutrients
- Chlorophyll a
- Phytoplankton
- Zooplankton



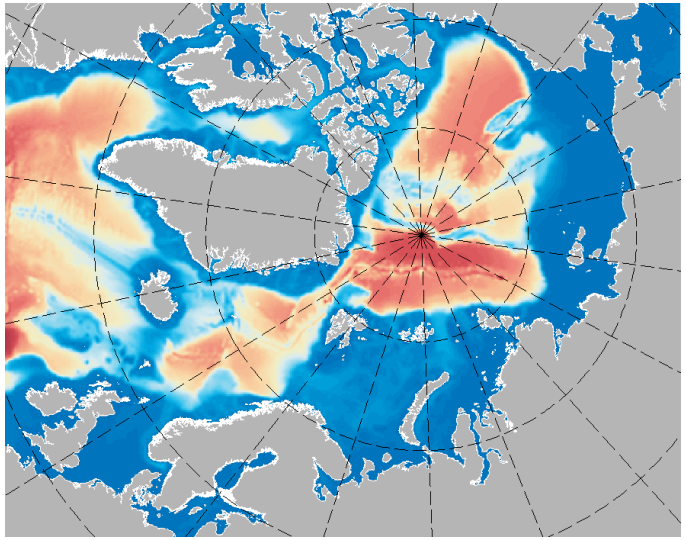
Map from: www.nacoma.org.na

Oceanographic measurement platforms

Oceanographic and meteorological buoy	Seabed platform
Wind	Currents
Wave	
Currents	
Temperature	
Salinity	
Turbidity	
Chlorophyll a	
Dissolved oxygen	



SINMOD ocean model

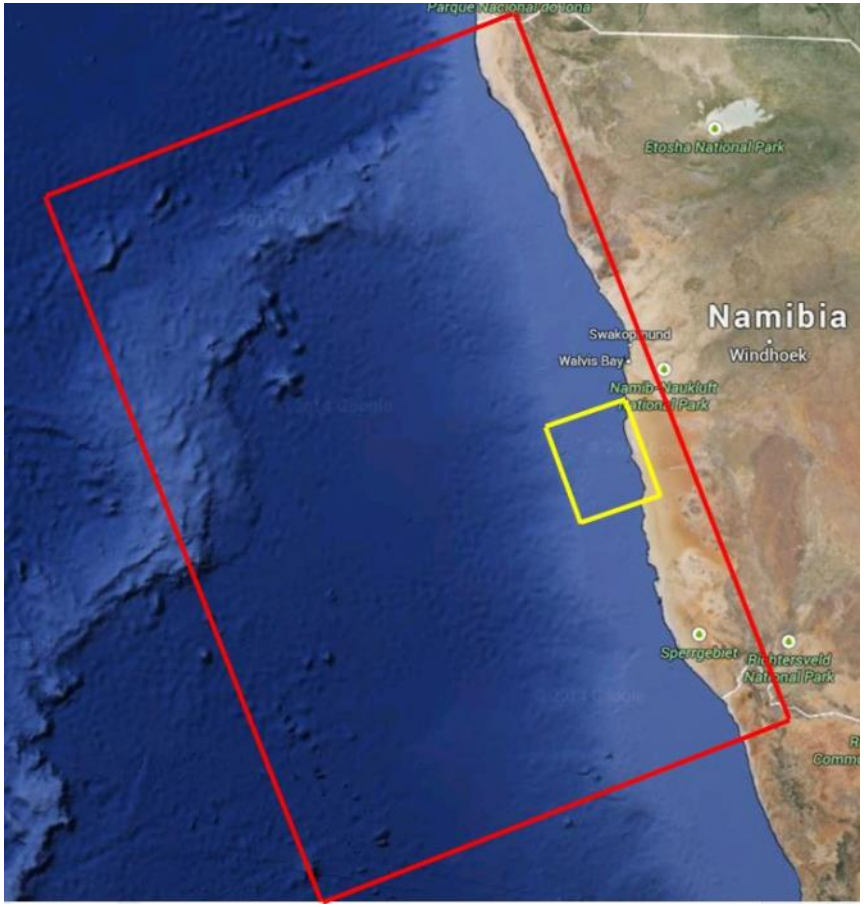


- Coupled physical and biological ocean model
- Developed at SINTEF since the 1980s
- Original purpose was to model stocks of zooplankton (*Calanus finmarchicus*)
- Today the model is used for aquaculture issues, oil drilling risk assessment, investigation of climate effects and more

- SINMOD is a nested coupled physical and biological ocean model that is used on a variety of spatial scales
- High resolution model setups are nested from larger scale setups
- Nested runs allow us to model both large scale and small scale effects

SINMOD

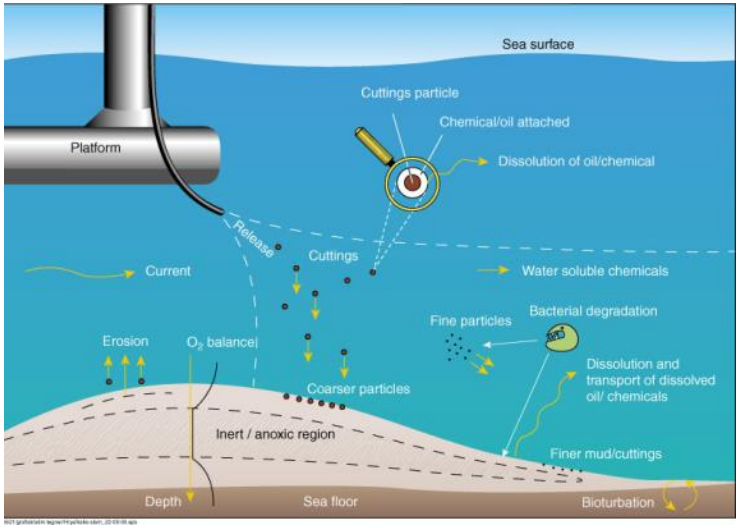
- Data assimilation from oceanographic surveys and measurement platforms
- Currents
- Temperature
- Salinity
- Primary and secondary production
- Turbidity and primary production
- Distribution of particles



SINMOD modeling areas with resolution:
800 * 800 m (red square) and
160 * 160 m (yellow square)

DREAM – Dose-related Risk and Effect Assessment Model

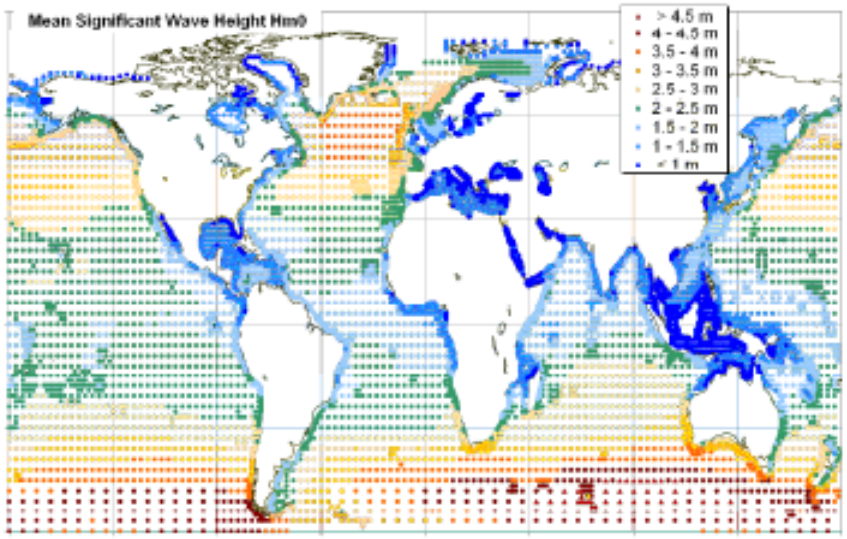
- Developed to reduce the environmental impacts from the Norwegian oil and gas production
- Developed over the past 20 years
- Now used for:
  - Produced water discharges
  - Drilling discharges
  - Chemical discharges
  - Mining deposits
- Three-dimensional Lagrangian transport model
  - 3D currents (input from SINMOD)
  - 3D concentration fields (output)
  - Sediment depositions (output)
  - Chemical and biological processes
- Calculate the environmental impact factor (EIF) from model results



DREAM model

- Input from:
  - SINMOD (currents)
  - Grain size
  - Experimental and toxicological studies
- Analysis of important scenarios:
  - Simulation of regular releases from dredging activities
  - Simulation of accidental releases during transport
  - Simulation of accidental releases from leakages in the installation
  - Simulation of shell grit (for environmental sustainability)
  - Simulation of waste deposit from land
- Identify those components contributing most to potential environmental risk
- Quantify environmental benefits of alternate mitigating measures
- Management tool… not an impact assessment tool

World Wave Atlas (WWA)



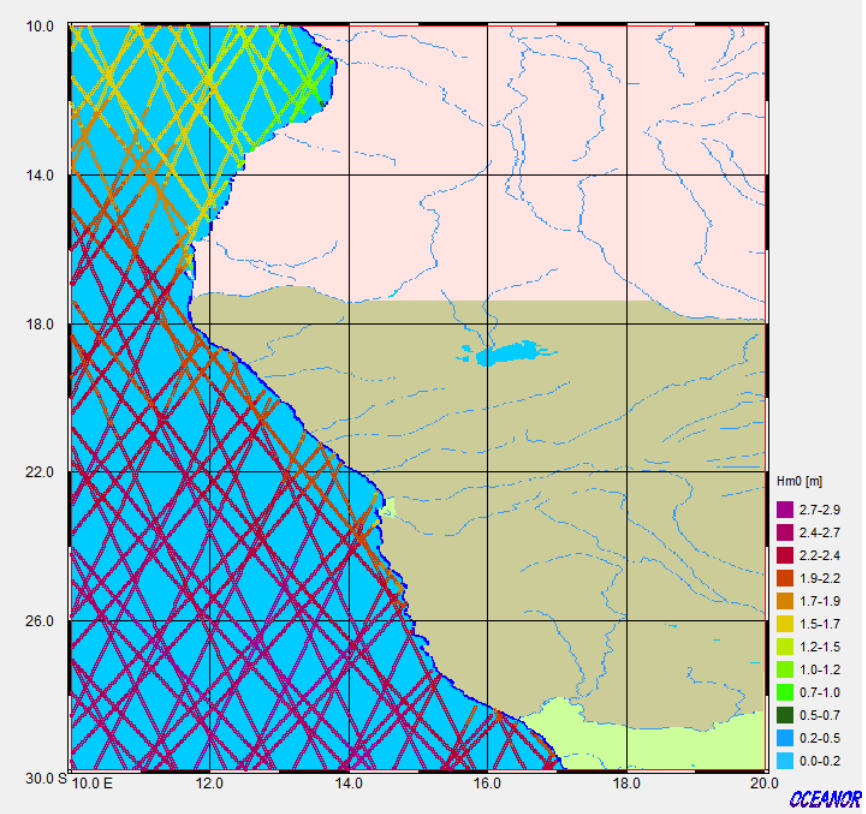
- Developed by Fugro OCEANOR
- WWA provides accurate wind and wave climate statistics for any country or region worldwide.
- Any area or time period can easily be selected for analysis.

Mean significant wave height at all WorldWaves grid points.

Map from Fugro OCEANOR.

World Wave Atlas (WWA)

- Examples of wave and wind statistics:
  - Frequency distribution
  - Extreme statistics for significant, maximum and crest wave height
  - Spatial and temporal variability
  - Seasonal and inter-annual variability
  - Direction roses



Mean multi-year seasonal wave heights in Namibian waters from satellite altimeter measurements.

Map from Fugro OCEANOR.

Outcome

- Documentation of the pre-mining situation in the water column based on the:
  - Oceanographic surveys
  - Oceanographic measurement platforms
  - SINMOD model
- Assessment of potential impacts from seabed phosphate mining on the marine ecosystem based on:
  - The pre-mining situation
  - DREAM model
- Develop and establish regulations for mining operations and discharges based on the:
  - Experimental and toxicological studies
  - DREAM model
  - WorldWaveAtlas

Thank you for your attention.