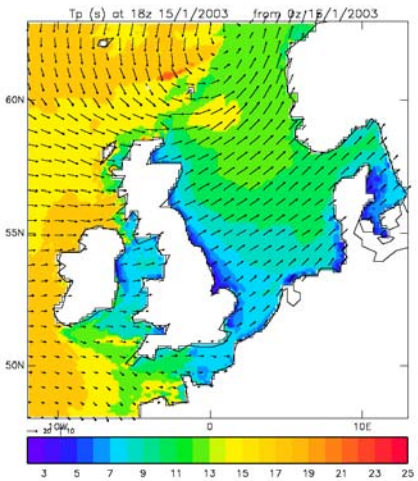
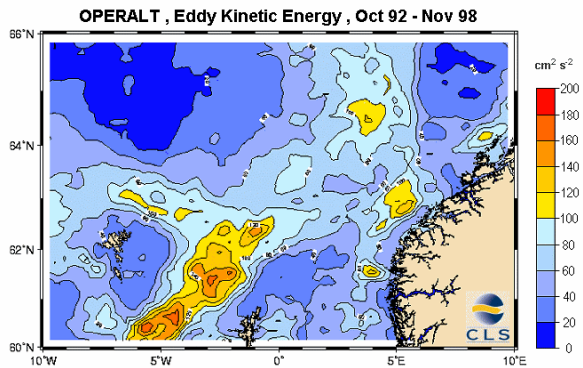
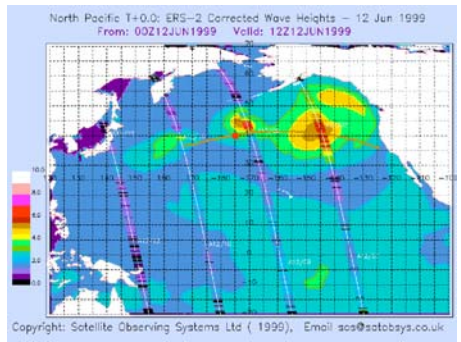
Operational requirements for sea state & surface current data from the offshore industry







David Cotton
Satellite Observing Systems

Offshore Operators' Requirements - Sources of Information

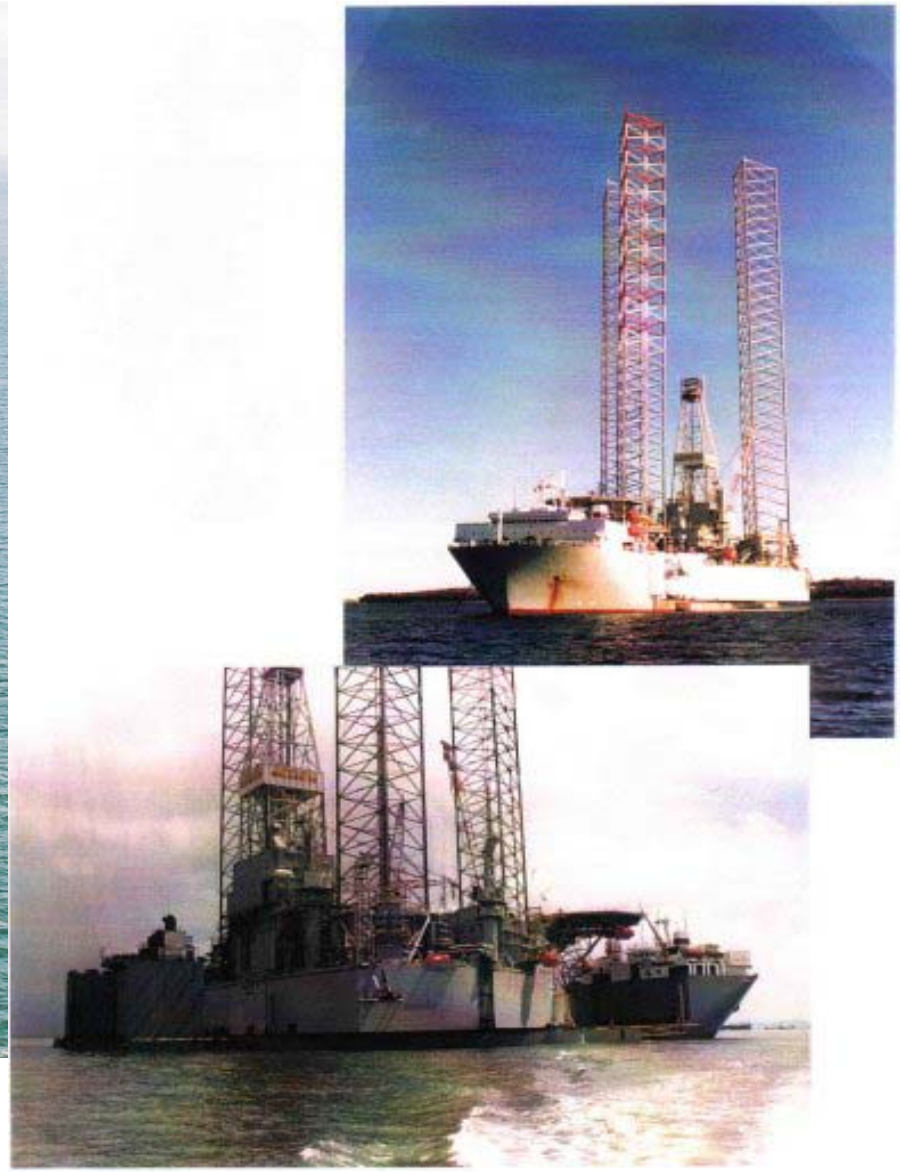
- Workshop with International Association of Oil and Gas Producers (OGP).
- Trans-ocean shipping companies (tankers, conventional loads, heavy/unusual loads, cable laying).
- High speed craft - coastal and trans-ocean.
- Certification Agencies.
- "Value-Adders" - Suppliers of Met-Ocean Information.
- EuroGOOS users survey

Changing Needs

- Offshore exploration and drilling in deep water
  - More hostile environment.
  - Floating rigs, dynamic positioning
  - Currents, directional wave information even more important.
  - Important issue of “heave” and vulnerability to long period swell.
- Heavy/unusual loads
  - Operations which have very specific operational thresholds - accurate met-ocean information vital.
- Cable Laying
  - See above + must be abandoned “gracefully” - otherwise very expensive (M€).
- High speed craft
  - Now trans-ocean as well as coastal.
  - Specific operational limits.
  - Real time data with high resolution in time and space required.

The Schiehallion FPSO is the world's largest new-build vessel of its type. It is capable of storing 950,000 barrels of oil.

Dock Express 20 - Cable Laying Vessel



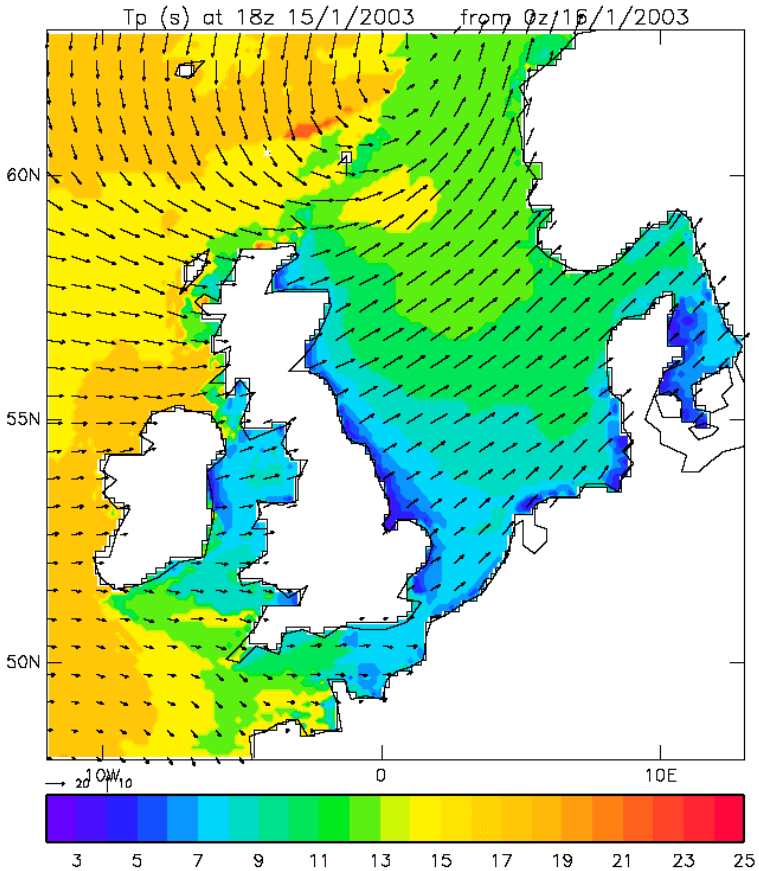
"Mighty Servant 1" & 37,000 tonne semi submersible rig Petrobras 36

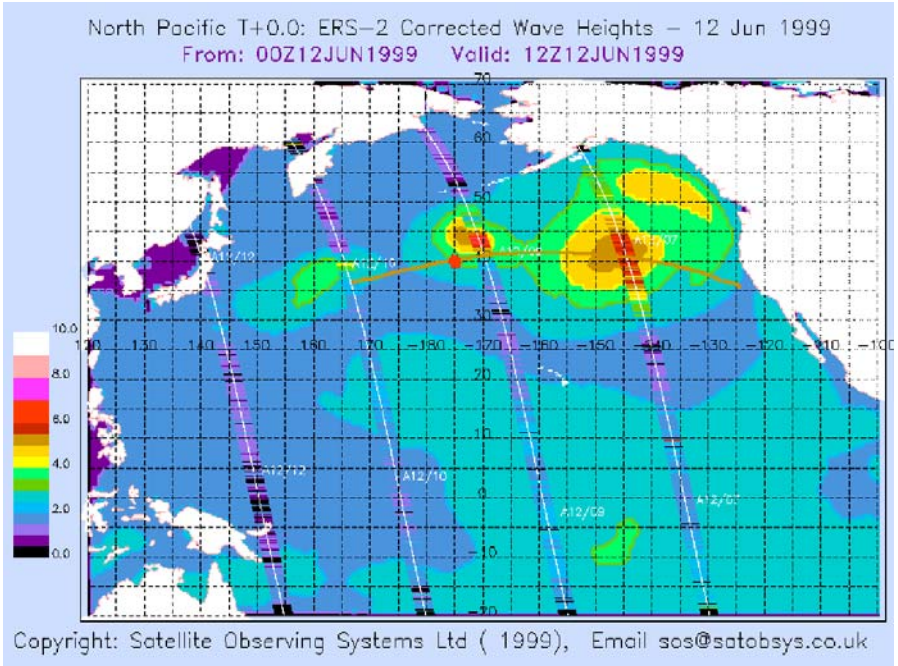
"Galaxy" - 200m high jack up drilling rig.

Ranges of Uses / Data types

- Design / Certification
  - Multi-year climatologies to derive estimates of extremes and exceedances.
- Lifetime performance monitoring
  - Time ordered climatologies / hindcasts to allows studies of accumulated forces
- Operational Planning
  - Time ordered climatologies / hindcasts and Monte-Carlo simulations to find operational “windows”.
- Short term forecasts, real time monitoring
  - Measurements and forecasts of winds, waves, currents to ensure situation within established safety limits, and to support operational decision making.

What is presently available?
For Ocean Sea State

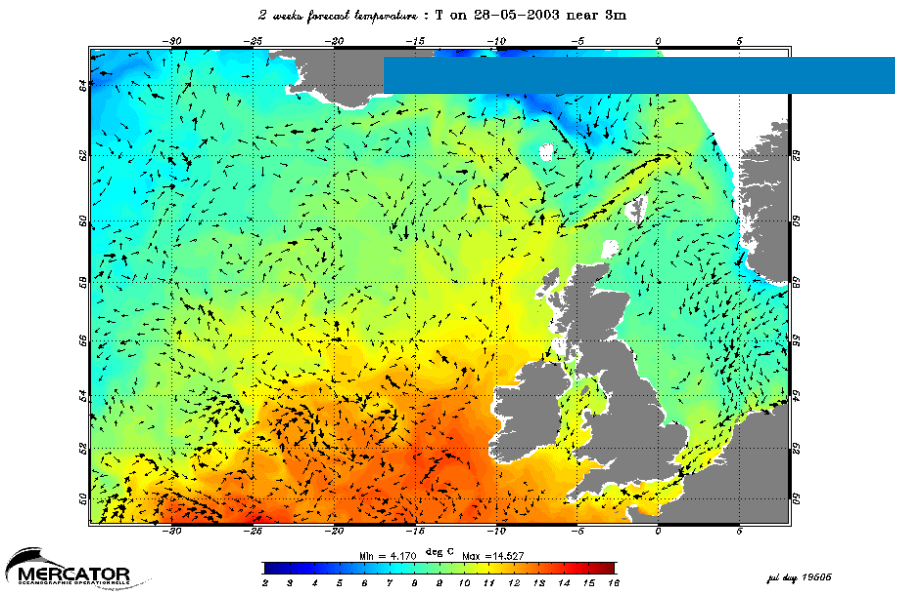


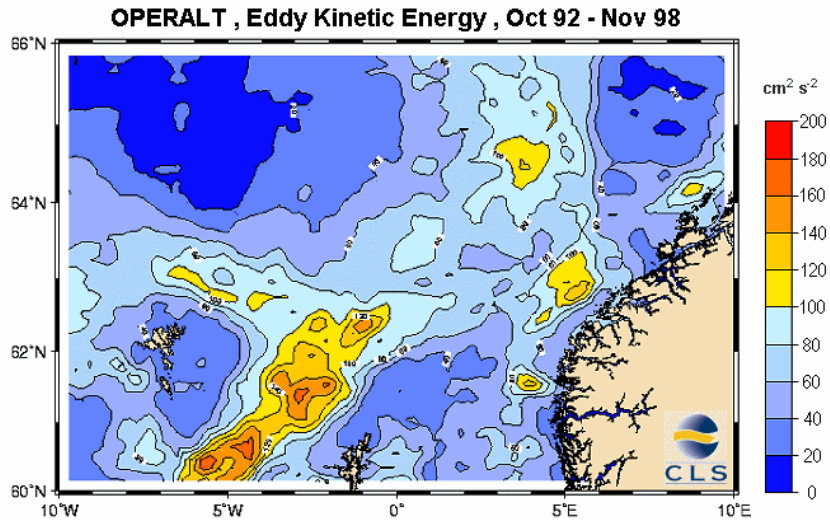


What is presently available? For Ocean Sea State

- Forecasts and analyses (hindcasts) are available from global and regional wave models which routinely assimilate satellite altimeter data. Resolutions range from 60km (global) to 12km(regional).
- Research is ongoing, aiming to provide improved representation of swell and identification of conditions favourable for “rogue waves”.
- Some trials of “value-added” information with combined presentation of model and measurements.
- > 10 year global altimeter based climatologies to aid design and certification - and to provide initial information on remote and /or unexploited regions

What is presently available?
Ocean Currents





What is presently available?
Ocean Currents

- Operational ocean models such as MERCATOR, FOAM, TOPAZ/DIADEM.
  - Forecasts and analyses of surface and subsurface currents with resolutions range from 1/3° (global) to 1/8° or better in regional models.

- Gridded / interpolated parameters derived from altimeter Sea surface heights - DUACS/SSALTO, CATSAT
  - sea level anomalies, (variability in) geostrophic velocities, eddy kinetic energy.
  - available as 5-7 day averages, at resolutions of up to 1/3°.

Offshore Operators' Requirements - Sea State

- Wave heights continue to be the "most important" parameter for planning, design and operations.
- Wave period and direction are important.
- Problem at higher latitudes is the sudden development of polar lows, can generate severe wave conditions which models are unable to predict accurately.
- Monitoring of swell important.
- Extremes - need to map fields with high spatial gradients.
- "Rogue" waves - How to extract relevant information from altimeter signal?
- Linked time and space multi-parameter (height and period) wave data bases to calculate cumulative loads en route

Offshore Operators' Requirements - Surface Currents

- Although wave heights stated to be the "most important" parameter, biggest uncertainties lay in knowledge of ocean currents
- Daily/weekly surface current charts provide sufficient temporal resolution – spatial resolution seen as a bigger problem.
- Operators are aware of products on the web and are engaging in projects such as EMOFOR.
- Still felt to be a deficiency in the quality and amount of ocean current information available.
- Altimetry derived currents not representative of actual currents experienced - causes some confusion.
  - Clear representation of information, in form relevant to user is important.

Operators' Workshop - Other issues

- Renewable Energy
  - Sector of increasing importance - predicted 10-fold increase 2010-2020
  - Most installations are close to the coast -regions of high variability.
  - Best approach is through integrated systems, with models, in situ, onshore radar, satellite data
- Improved Presentation of Data
  - Improvements to forecasting models (higher resolution, shorter time steps, better accuracy) have not been mirrored by improvements in presentation of data
  - Should find ways of deriving levels of confidence in data?

Operators' Workshop Research Requirements

- New assimilation techniques - to use feature identification.
  - In ocean circulation models and wave models
- Integrated monitoring systems (satellite, in-situ, models,…)
- New statistical techniques to analyse infrequently / irregularly sampled data.
- Develop understanding of conditions favourable to occurrence of rogue waves.
  - Combined studies with SAR/alt/optical data
- Techniques to provide more accurate estimates of extremes
  - Analyse effect of inter-annual variability on multi-year extreme values
- Detection and tracking of swell.
- Better representation of variability in severe events.
- Validation and implementation of altimeter wave period algorithms.

Offshore Operations : Mission Requirements

- Currents - surface and sub-surface
  - High resolutions required (~10 km) - implies application of SSH data through assimilation in models.
  - Priority is early warning of energetic features. Hence much improved sampling more important than incremental improvement in accuracy.
  - Constellation of 6 alts gives ~ 40km / 10 day sampling.
  - Swath altimetry - potential of 20km / 5 day sampling .
- Waves
  - Swath altimeter not a useful option - effectively a nadir-only wave measurer.
  - Again improvement in sampling required. But frequent revisits to each ocean region a priority. Constellation of 6 would give 12 hourly, 400km sampling. Simulations required to estimate reduction in model and mapping errors.
  - SWIMSAT / SAR offer only opportunity for direction and spectra, and for separate wind sea /swell information.
  - Higher latitude orbits than TOPEX/JASON to capture polar lows.

Mission Requirements - Other issues

- Near Real Time data
  - Important for offshore operators- especially so for waves where situation can change rapidly. Ideally data needs to be with user < 1 hour.
  - Is it possible to build in “direct broadcast” type facility for altimeter products?
  - More ground stations with simple technology?
  - Can swath altimetry delivery NRT data?
- Sampling
  - Meso-scale SSH monitoring requires higher spatial resolution (~20 km) over longer (~10day) repeat period.
  - Sea state monitoring requires more frequent revisits to each ocean region (6-12 hour) but larger track separation acceptable (~500 km).
  - Are the two requirements necessarily incompatible?