Operational needs

Mike Bell, Met Office

UK-IMON work-shop, NOC Southampton, Sep 2013

Contents

- Types of operational marine prediction systems
- A brief summary of applications
- Roles of measurements
- Requirements for observations from each prediction system
  - Present status and priorities for improvement
- How prediction systems can guide observation needs
  - The relative impact of different observations in NWP
  - Sampling scales calculated as part of data assimilation
- Summary

- Will not cover climate monitoring needs

Types of operational marine prediction systems

Prediction type	North-west European shelf	Global
Storm surges	Yes	No
Surface waves	Yes	Yes
3D physical(T, S, u, v)	Yes	Yes
3D bio-geochemical (sediments, nutrients, phyto & zooplankton)	Yes	Pre-opnl (simple NPZD)

- Predictions made at least daily to 5-10 days ahead
- 10-40 year “re-analyses” also generated for most systems

Typical applications

- Coastal flooding (surge & waves)
- Safety of operations at sea (ships) (surface waves, currents)
- Search & rescue, pollutant dispersion (surface waves, currents – mainly near the coast)
- Naval tactical advantages (all systems)
- Oil & gas extraction (surface waves, current profiles)
- Weather forecasting (SST & all systems)

Roles of measurements

Calibration: development or tuning of parametrisations

Validation: prior to operational implementation

Monitoring: of accuracy and “busts” on daily basis

Verification: statistics on operational accuracy

Assimilation: to constrain / initialise daily analyses

- The sampling requirements for the various roles differ
- Validation and verification statistics are essential to support exploitation of the predictions

Requirements for observations

- WMO and Space Agencies have “methodologies” for capturing requirements in terms of accuracy and spatial-temporal sampling for each variable
- Max and min values are quoted for each requirement
- Maximum value is threshold to be of any value
- Minimum is value below which little further is gained
- It is essential for the basis of these numbers to be explained because the requirements depend on the prediction system and the role of the observations within it
- Values given here are illustrative not definitive

Surface waves

Current Status

- Moored buoys: very important for calibration, validation & verification
- Altimeter data for surface wind speed and H_s are asimilated by some centres; impact is relatively short-lived
- Required accuracies for H_s 10-50 cm (depending on H_s)
- Spatial scales: in open ocean > 300 km; in shallow water depend on bathymetry; isolated measurements useful for calibration & validation

Some future priorities for improvement

- Moored buoys are expensive: opportunity e.g. for wave gliders ?
- Sentinels & Jason are expensive, AltiKa constellations more affordable
- Assimilation of spectral data (e.g. from SAR) could improve swell prediction

Storm surges

Current Status

- Tide gauges: used many times each day to monitor predictions but not for assimilation
- Value of altimeter data on shelf being assessed
- Accuracies of order 2-10 cm; spatial scales 10-100 km

Future Opportunities/Priorities

- A constellation of cheap altimeters ? (or a swath altimeter ??)

Present requirements for assimilation into open ocean prediction systems

Variable	Present data	Accuracy	Spatial sampling	Temporal sampling
SST	In situ, satellites	0.1-0.5K	5-300 km	3 hr – 5 days
SSH	Altimeter	2 – 5 cm	5-25 km	2-10 days
Surface currents	Drifters, satellite	5-25 cm/s	5-100 km	3 hr – 10 days
T profiles	Argo, gliders, XBTs, seals	0.1 – 0.3K	5-300 km	3 hr – 10 days
S profiles & SSS	Argo & satellite	0.05 – 0.2 psu	5-300 km	3 hr – 10 days

- The ranges are very broad. The table does not capture subtleties
- Observations can make complementary contributions (e.g. for SST)
- Globally there are also requirements for sea-ice data (depth particularly)
- Time and space scales for shelf-seas predictions are different

Biogeochemistry & sediments

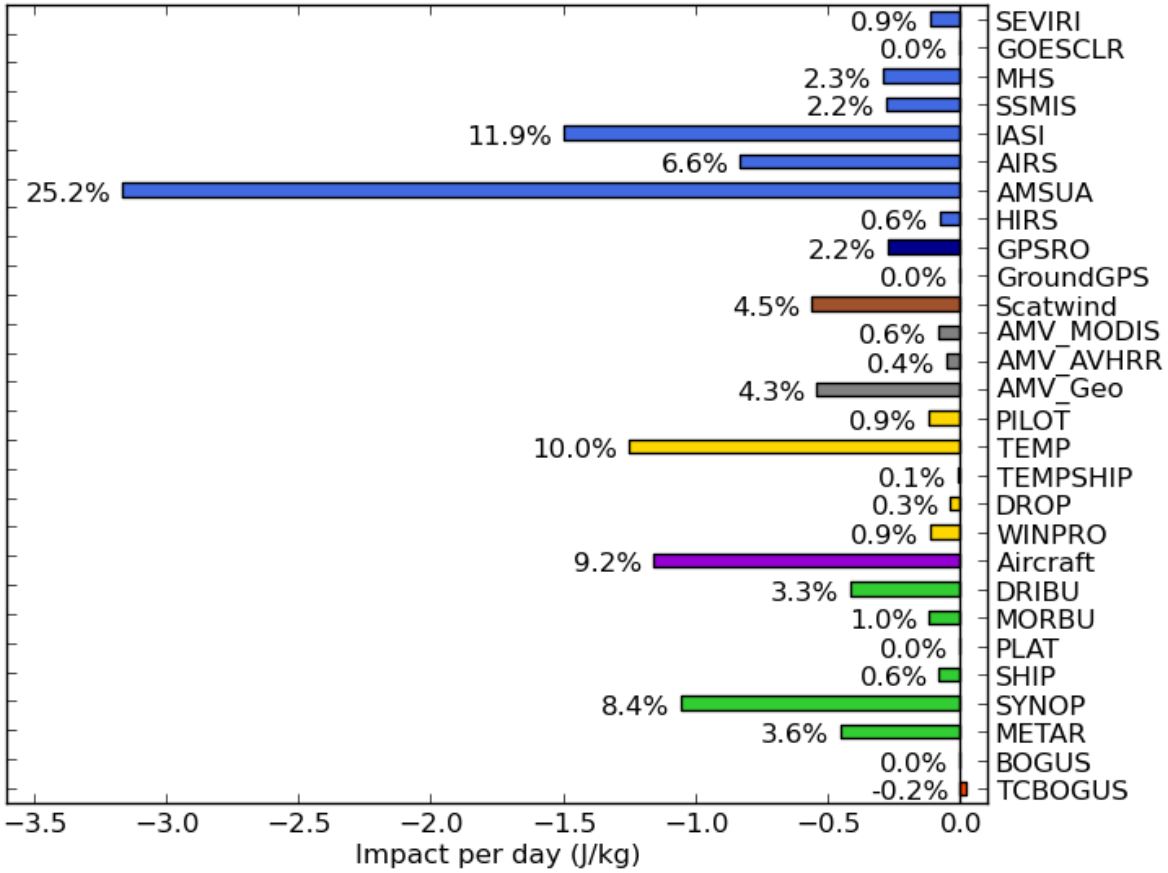
Current Status

- Sediments: satellite (ocean colour) & in situ data used for calibration
- BGC open ocean: AMT profiles used for validation; satellite (ocean colour) data assimilated; validation with CPR being considered
- BGC shelf seas: buoy & cruise data & satellite colour data used for validation
- Spatial sampling is a secondary issue for calibration and validation; model accuracies are not well established

Future Opportunities/Priorities

- Robust sensors that could be carried by profiling gliders or drifters

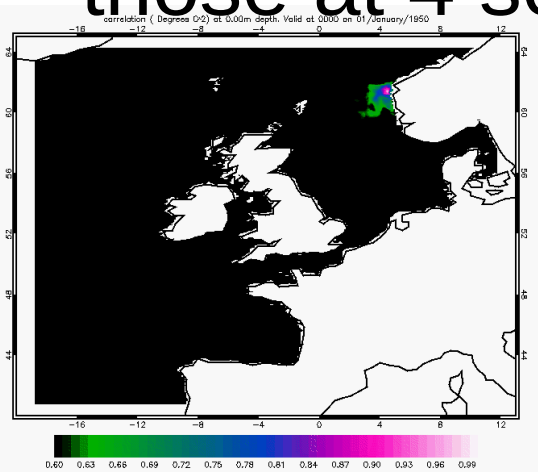
Impact of different obs types on NWP 24 hour forecast errors

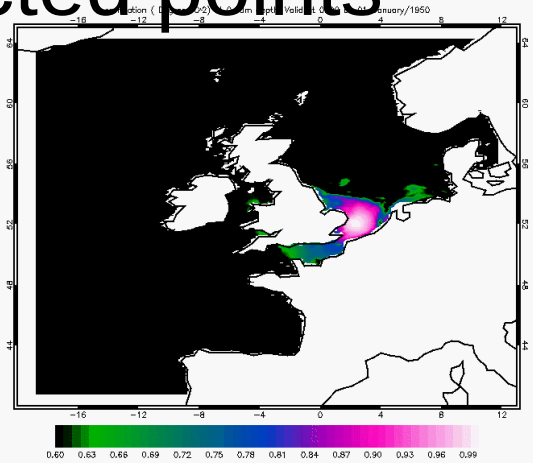


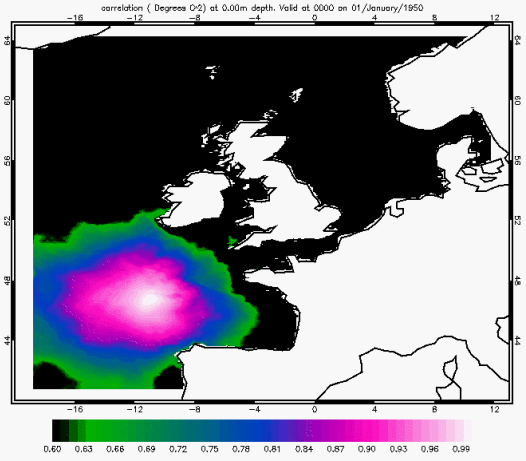
Bars depict the relative reduction in a single global measure of the error in energy, calculated using adjoint techniques

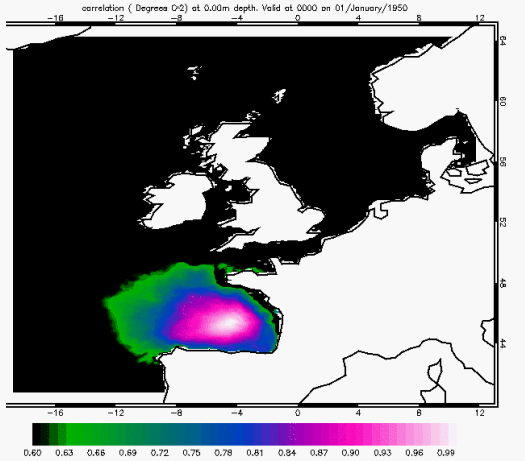
Estimates of correlation scales

Correlations of differences with those at 4 selected points









- Assimilation systems have to specify how errors in the background field are correlated
- Ensembles of model integrations are used to estimate this
- The correlation scales vary with location

Summary

- Requirement for observations depends on their role
  - Calibration, validation, monitoring, verification, assimilation
- Discussed requirements from each of our prediction systems
  - Surface waves, storm surge, 3D open ocean, BGC
  - What obs we currently use and their role
  - Some suggestions for future priorities:
    - More cost-effective platforms
    - Robust, autonomous BGC sensors
- More mature assimilation systems can guide investment in observations for monitoring