



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Session 3B : Delivering services to society: forecasting

Plenary Paper : Short-term forecasts: delivery and observational requirements

Gary B. Brassington

CAWCR, Bureau of Meteorology

Chair of JCOMM Expert Team for Operational Ocean Forecast Systems



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Content

1. Quick overview of status
2. Application performance requirements
 1. Ocean mesoscale/sub-mesoscale, a frontier science
 1. Observing system requirements for operational ocean forecasting.
 1. Major and Grand challenges



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Imagine...

..yourself floating in the water awaiting rescue,
out of sight of land, in the dark
you have no food, and no paddle...

...of course you are relaxed, confident because you read in the
online paper about a brilliant new ocean forecast service...

What they forgot to mention to you were a couple of minor details
the next altimeter track will only be 50 km away...
however it should arrive in two days...
your next Argo is unknown but perhaps in the next 5 days..
and only 150km away...

...yes you will be confident and if unlucky you will at least die peacefully...



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Imagine...

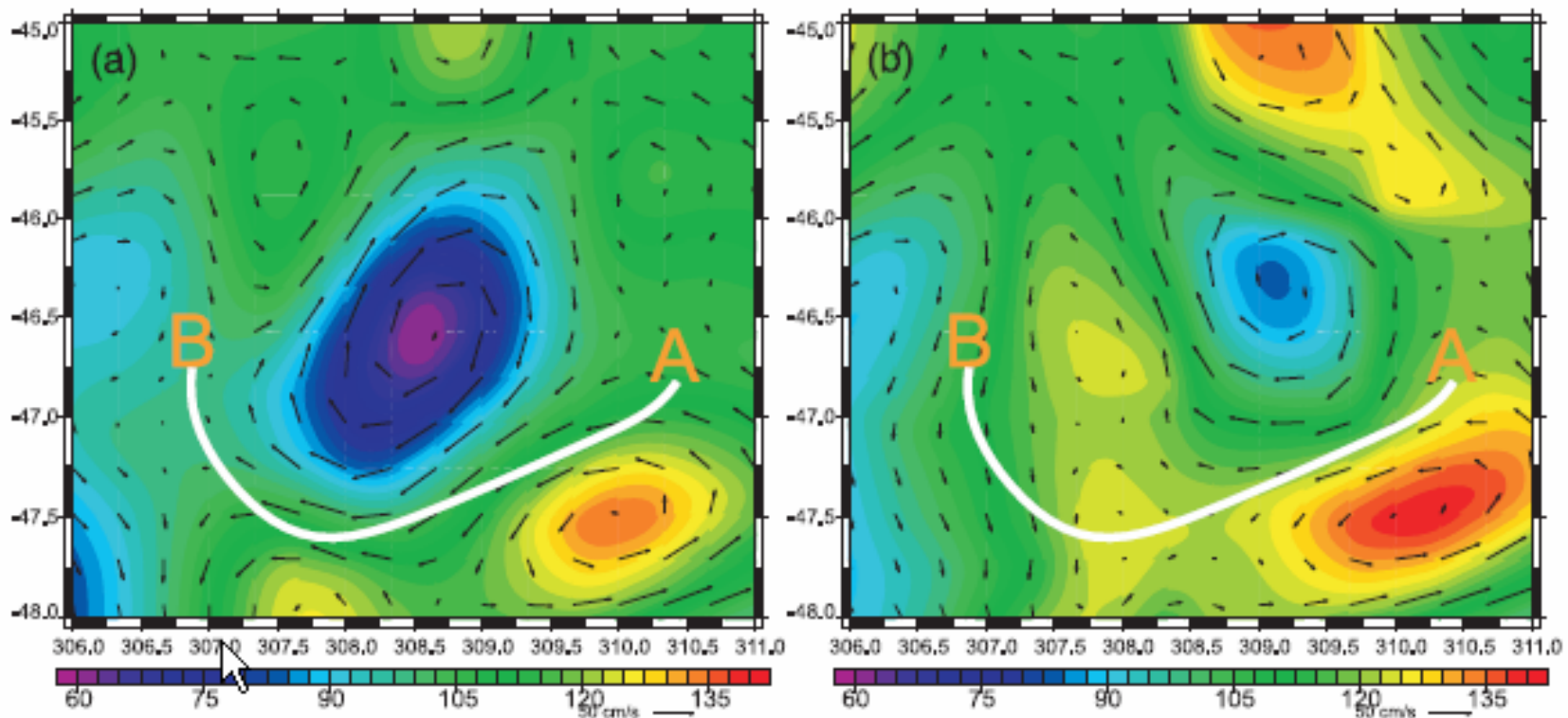
..yourself floating in the water awaiting rescue,
out of sight of land, in the dark
you have no food, and no paddle...

...of course you are relaxed, confident because you read in the
online paper about a brilliant new ocean forecast service...

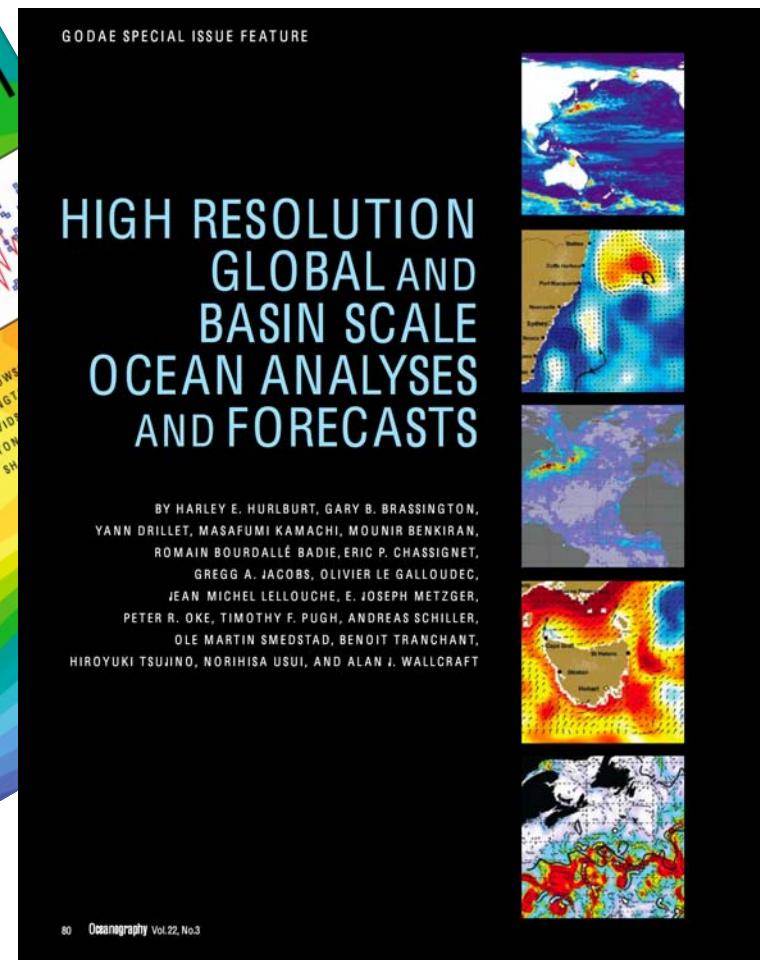
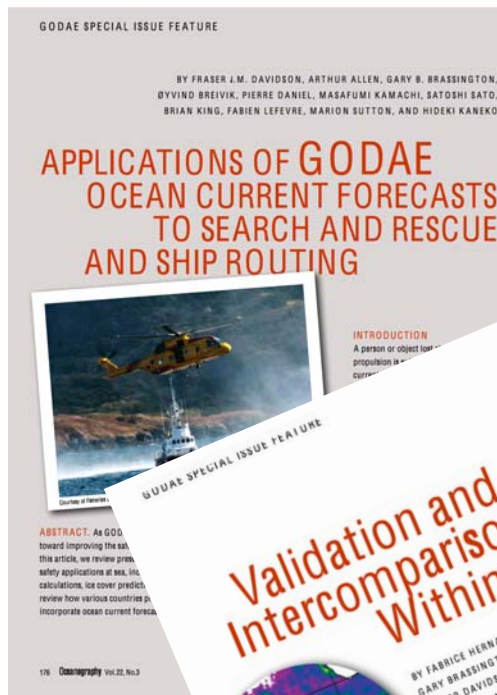
What they forgot to mention to you were a couple of minor details
the next altimeter track will only be 50 km away...
however it should arrive in two days...
your next Argo is unknown but perhaps in the next 5 days..
and only 150km away...

...yes you will be confident and if unlucky you will at least die peacefully...
that is unless you happen to be an observational oceanographer!!!

Two altimeters in delayed mode (left) and in real time (right)



4 altimeters in real time (nowcasting) are needed to achieve a similar accuracy as 2 altimeters in delayed mode (hindcasting) (Pascual et al., 2009). Benkiran et al (2009) : 7-day forecasting with two altimeters = nowcasting with one altimeter.



Oceanography special issue
+ Whitepapers

Table 1. GODAE systems: Main characteristics of ocean models

| System | OGCM | Domain | Horizontal Resolution | Vertical Sampling | Atmospheric Forcing |
|--------------|---------|---|---|--|--|
| BLUElink> | MOM4 | Global | 1° global 1/10° around Australia | 47 z-levels | GASP 3-hourly |
| C-NOOFS | NEMO | Canadian Atlantic | 1/4° | 50 z-levels | EC/GEM hourly |
| ECCO-GODAE | MIT | Global | 1° global (JPL+MIT) 1° x 0.3° tropics (JPL only) | 46 z-levels (JPL) 23 z-levels (MIT) | NCEP (JPL + MIT) + COADS (JPL only) |
| FOAM | NEMO | Global | 1/4° | 50 z-levels | UKMO 6-hourly |
| | | North Atl. + Med. + Indian | 1/12° | | |
| HYCOM/NCODA | HYCOM | Global | 1/12° | 32 hybrid layers | NOGAPS 3-hourly |
| Mercator | NEMO | Global | 1/4° | 50 z-levels | ECMWF daily |
| | | North Atl. + Med. | 1/12° | | |
| MFS | NEMO | Mediterranean | 1/16° | 71 z-levels | ECMWF 6-hourly |
| MOVE/MRI.COM | MRI.COM | Global | 1° | 54 sigma-z hybrid levels | JMA 6-hourly |
| | | North Pacific | 1/2° | | |
| | | Western North Pacific | 1/10° | | |
| NLOM/NCOM | NLOM | Global | 1/32° | 7 layers | NOGAPS |
| | NCOM | Global | 1/8° | 40 sigma or z levels | |
| NMEFC | IAP/CAS | Tropical Pacific (30°S–30°N) | 2° x 1° | 14 z-levels | NCEP + clim |
| RTOFS | HYCOM | North and Tropical Atlantic (> 25°S) | 4–18 km | 26 hybrid layers | NCEP 3-hourly |
| TOPAZ | HYCOM | Atlantic and Arctic | 11–16 km | 22 hybrid layers | ECMWF 6-hourly |

OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

OMAPS(fc) = Bluelink operational 3-4-d forecasts

OMAPS(ban) = Bluelink operational hindcast (6-9-d behind RT)

HYCOM = US Navy hindcast (5-d behind RT)

Mercator = French hindcast (7-14-d behind RT)

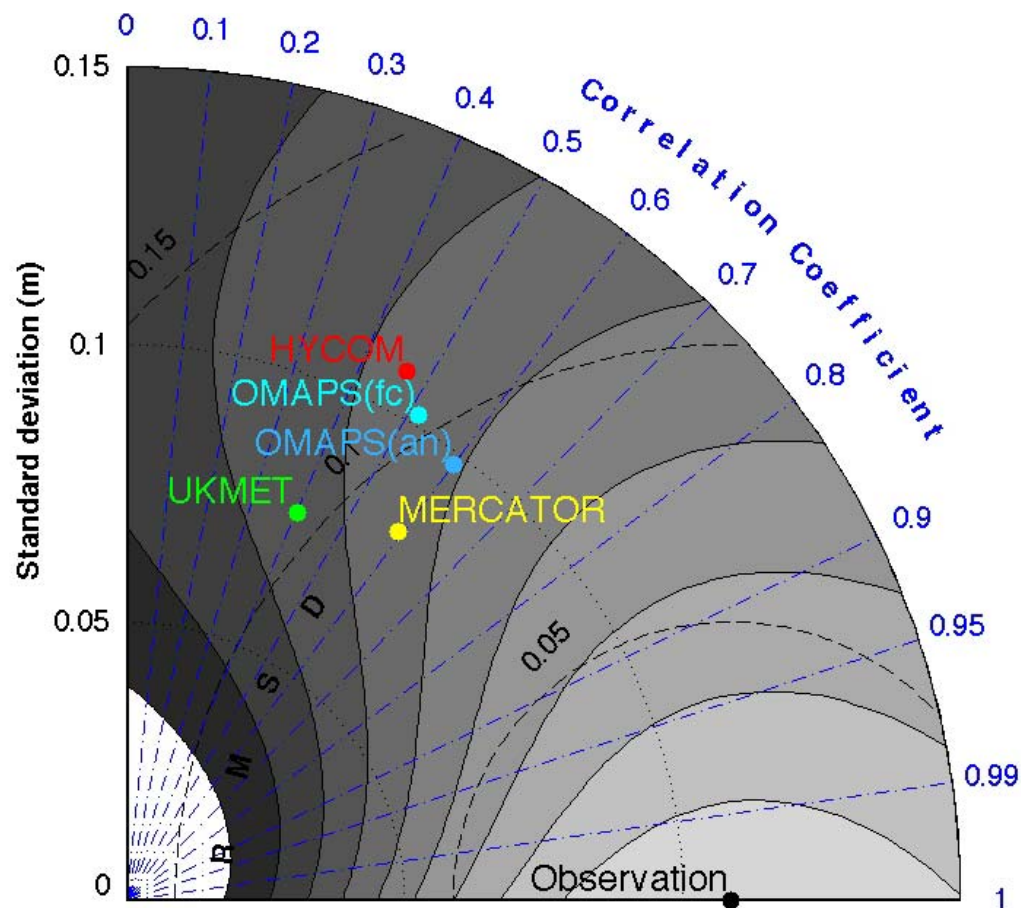
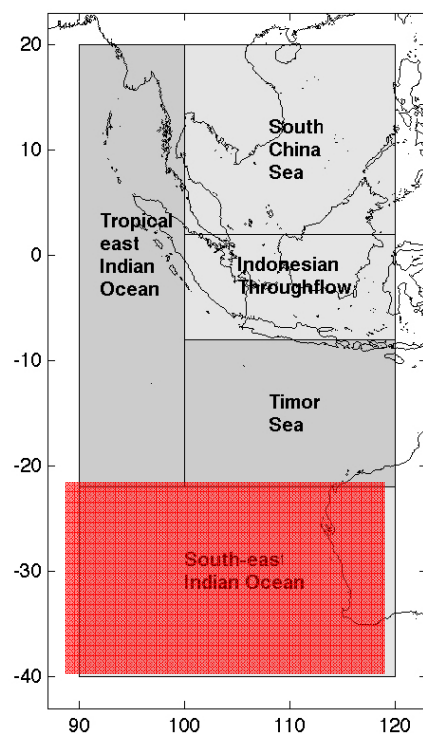
UKMet = UK hindcast (~3-m behind RT)

South-east Indian Ocean 01-Feb-2008 - 30-Apr-2008

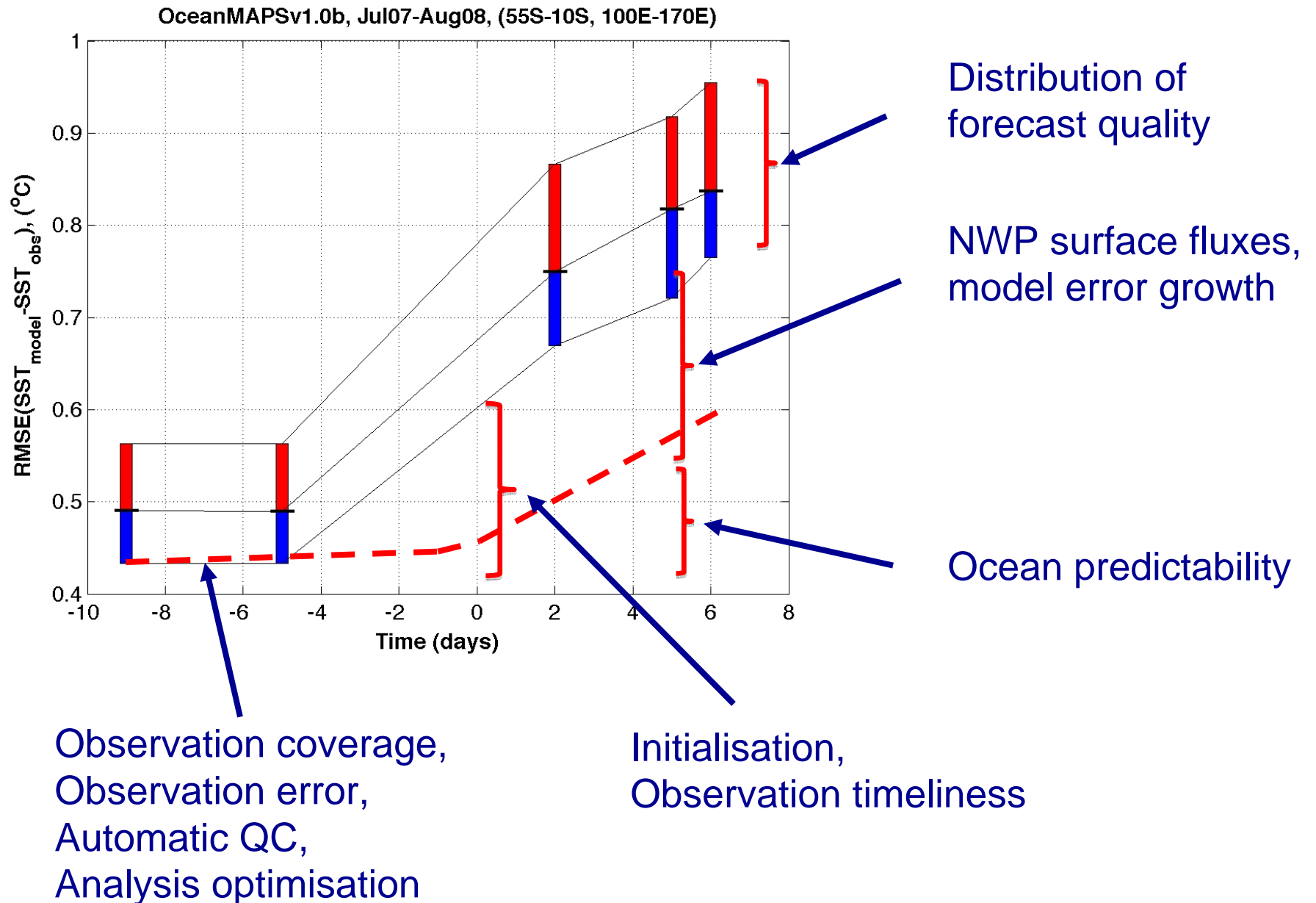
Sea Level Anomaly

Observations(#obs): JASON/ENVISAT (42356)

| System | HYC | MER | UKM | OM(an) | OM(fc) |
|----------|-------|-------|------|--------|--------|
| Bias (m) | -0.05 | -0.18 | 0.01 | 0.01 | 0.01 |



Operational performance – complex system



A status summary

YES GOOS is a remarkable achievement, a revolution in capability

YES GOOS can constrain the mesoscale variability

YES GODAE systems can achieve quality sufficient to impact some applications

BUT

GODAE systems are sub-optimal, we do not use all of the information of GOOS

Regardless a full spectrum of impacts cannot be achieved with GOOS as it is today

User requirements are not well defined

Regardless some important applications require higher precision to show impact

Applications by type – Planning and management

| | |
|-----------------------------------|--|
| Specific applications | Coral bleaching, Fisheries management, bi-catch, Ship routing, Offshore ship operations |
| Service type | Public good / industrial |
| Service providers | National operators / Third party providers |
| Service requirements | Fixed location, routine services Seamless prediction required short- medium-, seasonal- |
| Observational requirements | Homogeneous basin / marginal sea Sustained, long-term observations GOOS-2009 is impacting this application Likely to be satisfied by GOOS +10-20% |

Applications by type – Ad hoc time and space

| | |
|-----------------------------------|--|
| Specific applications | Search and Rescue (SAR), Marine Accident and Emergency Services (MAES), Criminal investigations, Insurance, TC's and storms, Coastal surge, Defence and national security operations |
| Service type | Public good / Defence |
| Service providers | National operators / Defence |
| Service requirements | Ad hoc location and time High precision nowcasts; skilful forecasts of surface state and circulation |
| Observational requirements | Rapid, intensive sampling Sustained for the period of the incident Not satisfied by GOOS-2009 Unlikely to be satisfied by GOOS +10-20% |



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Applications by type – Global and continuous

| | |
|-----------------------------------|---|
| Specific applications | Weather, Waves, Bio-geo-chem |
| Service type | Public good |
| Service providers | National operators |
| Service requirements | Global, routine services Seamless prediction required short- medium, seasonal- |
| Observational requirements | Homogeneous basin / marginal sea Sustained, long-term observations Progress can be made with GOOS-2009 May be satisfied by incremental investment over the decade |

OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Applications by type – Engineering / Industrial

| | |
|----------------------------|--|
| Specific applications | Offshore platforms, Renewable energy sites, Ship routes, Eco -tourism, Desalination discharge |
| Service type | Public good / industrial |
| Observational requirements | Not satisfied by GOOS-2009 Observation design to target value-adding to GOOS National capacity to deploy instrumentation |

Applications by type – Coastal / cross shelf

| | |
|----------------------------|---|
| Specific applications | Port management, bilge discharge, coastal weather, coastal surge and management |
| Service type | Public good / Industry |
| Observational requirements | Coastal observations integrated with GOOS Observation design to target value-adding to GOOS National capacity to deploy instrumentation |

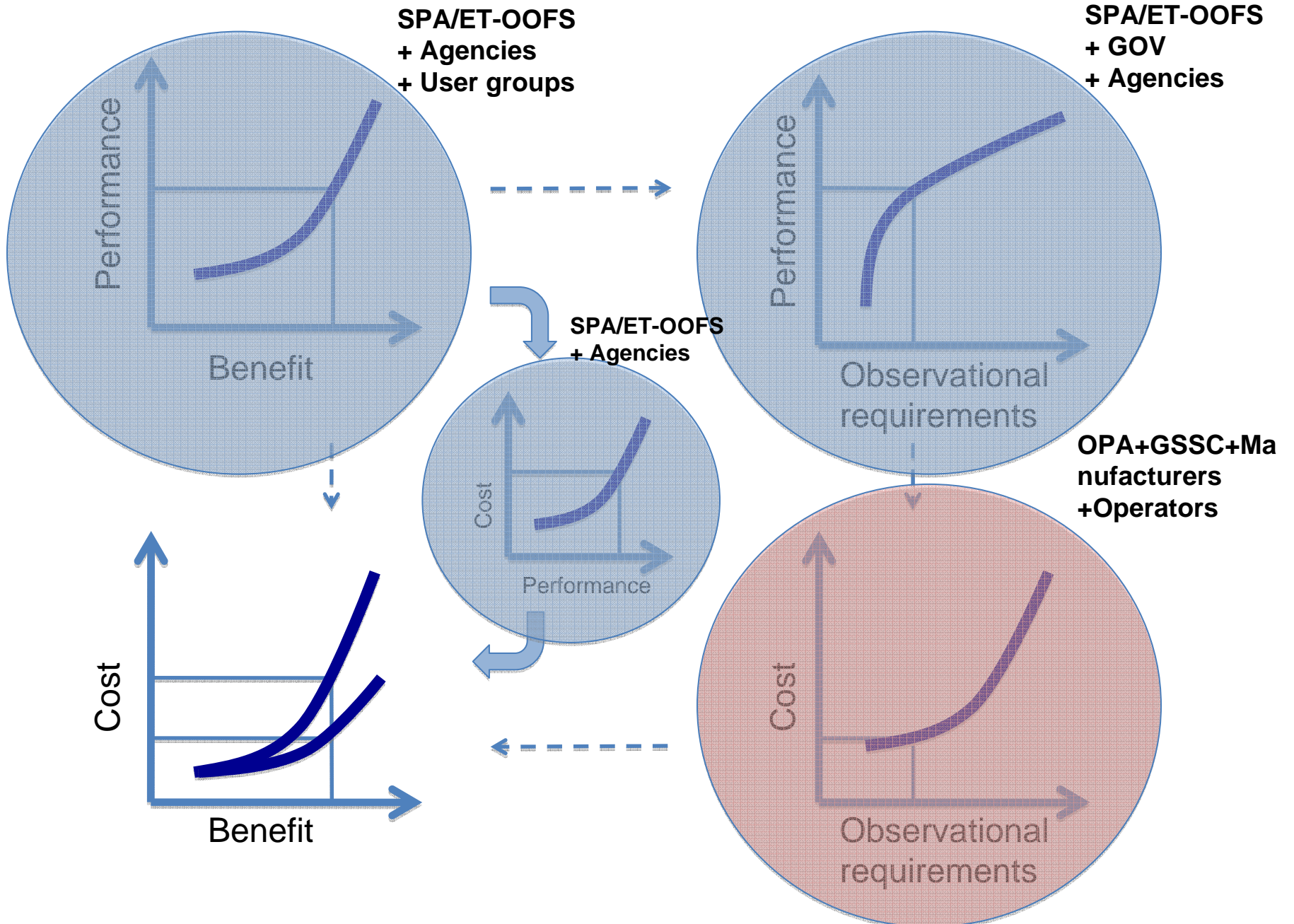
Applications by type – Public good / Public warnings

| | |
|----------------------------|---|
| Specific applications | Research, recreational fishing, diving, swimming, Yacht racing, adventurers |
| Service type | Public good |
| Observational requirements | GOOS-2009 is impacting this application Likely to be satisfied by +10-20% GOOS |

Major challenge: Making the case

- Substantive evidence of impacts has been slow going
- Performance of first generation systems is a limiting factor
- User champions are rare and need to be supported
 - Support for training, attending meetings
 - Operators have day jobs and limited time for charity work
- Need to meet users beyond halfway with current product suite
- Improved performance over the next 5 years will provide more obvious impacts
- When operators gain confidence in the information to make decisions advocacy will become easier to obtain and partnerships will strengthen

Making the case



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy



**Expert Team on
Operational Ocean Forecast Systems**

Work plan for JCOMM-3

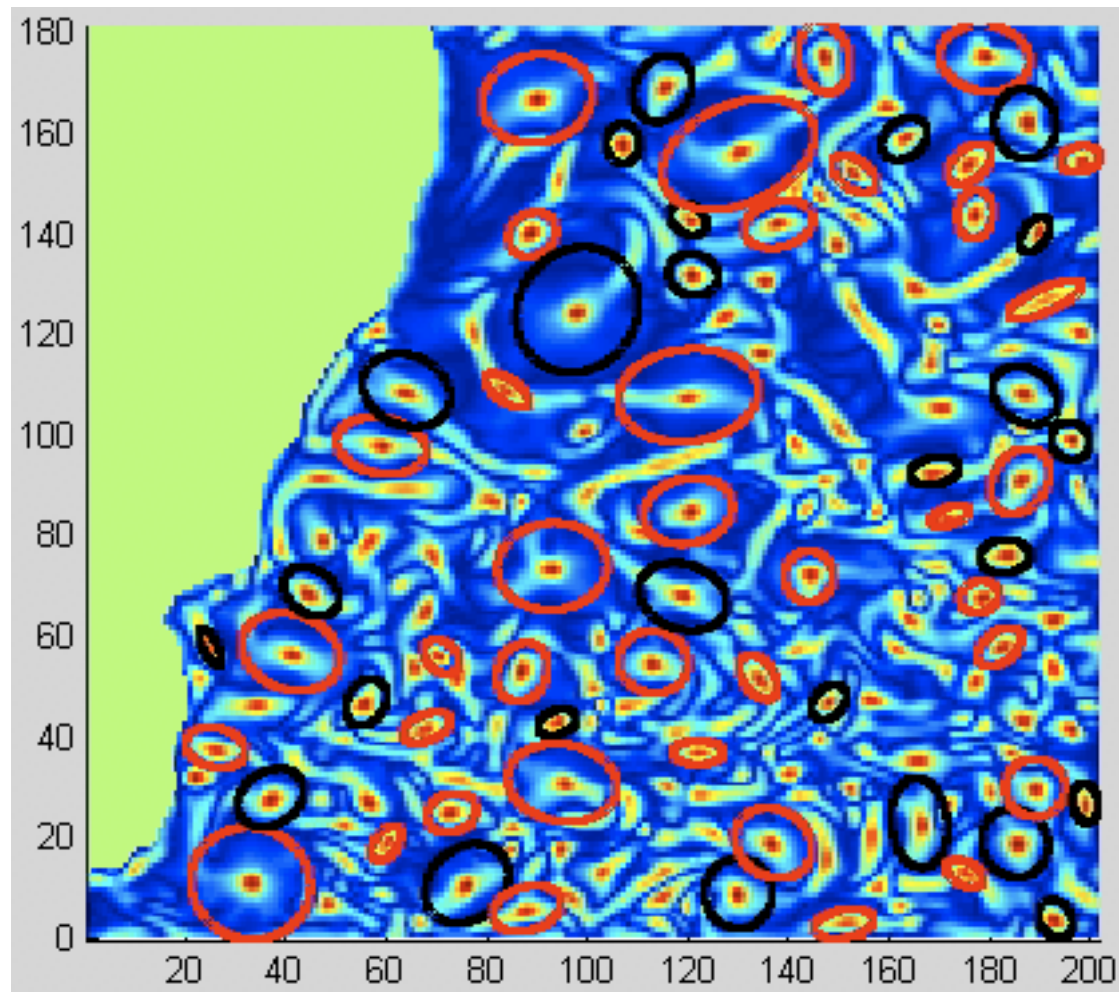
- Guide to operational ocean forecasting
- Operational performance monitoring
- Service requirements
- Observational requirements
- Impact evaluation
- Capacity building

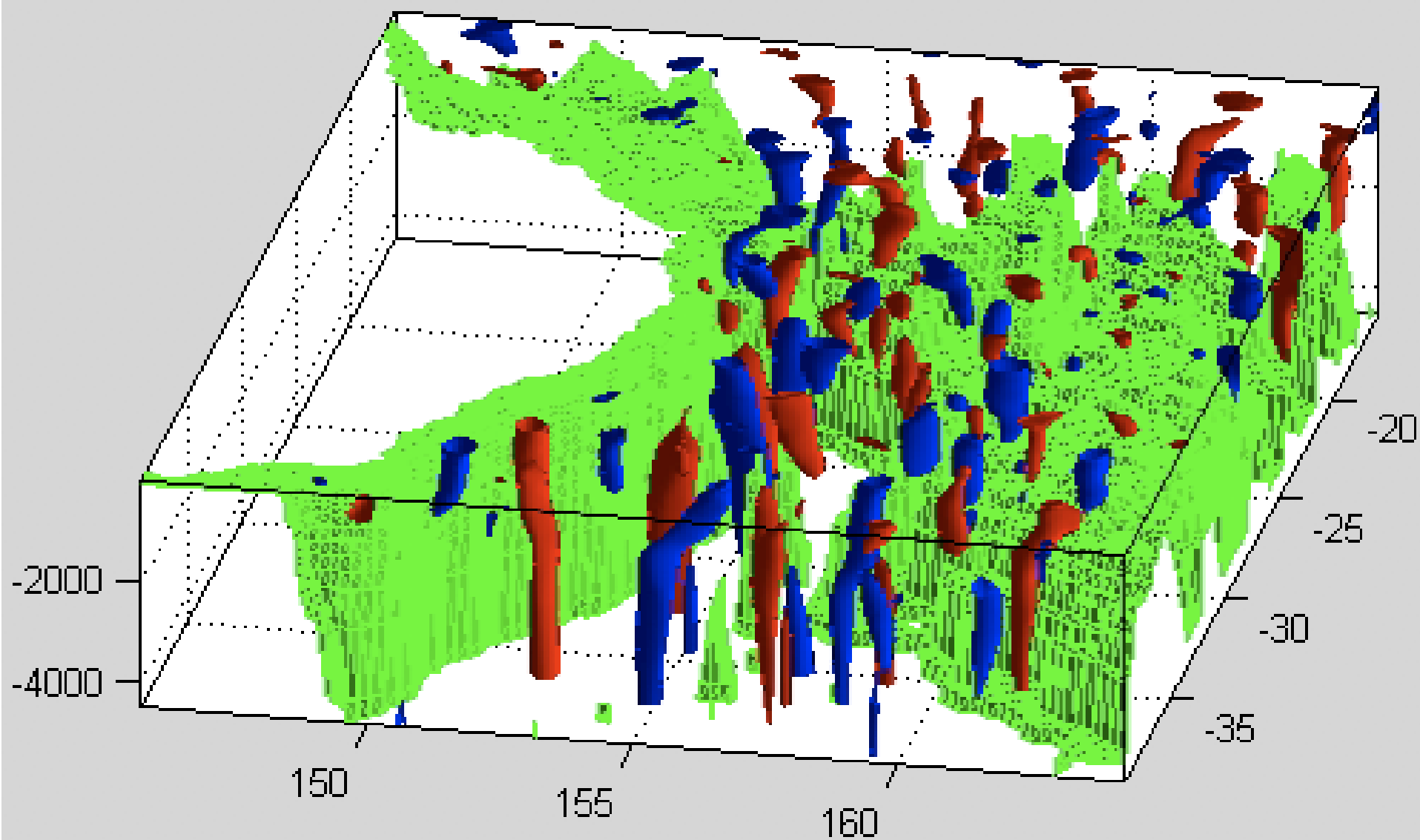
OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Mesoscale oceanography – a frontier science

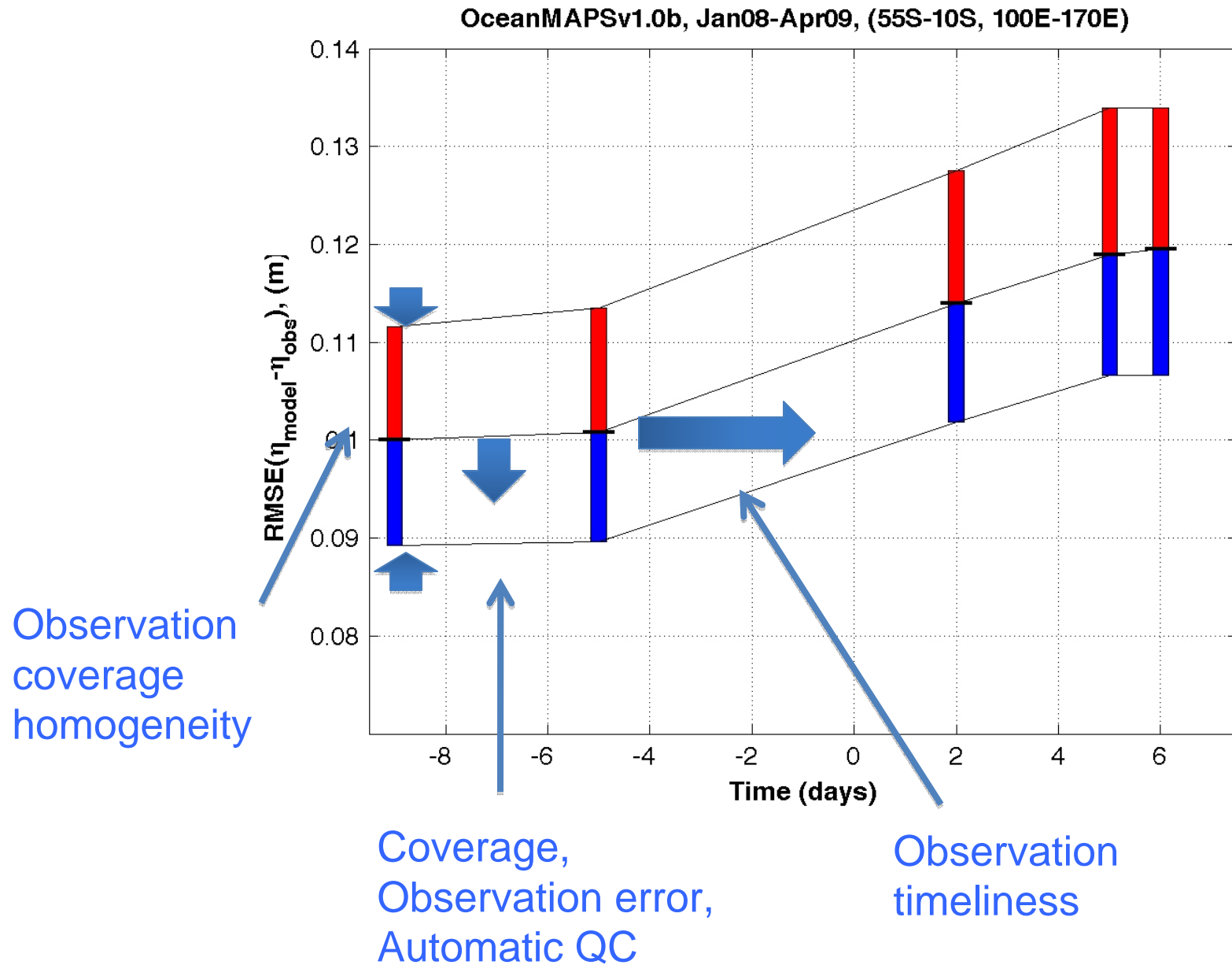




Prospects for forecast skill

- Majority of skill is persistence skill
- Secondary circulation critical to achieving genuine forecast skill
- Sub-optimal systems, adequacy of observing system unknown
- Anticipate substantial improvement in systems over the next 5 years
- GODAE OceanView OSE group working on optimal design
- Robust statements will also emerge on the 5 year timeframe

How and where can GOOS have an impact?



Observational requirements – essential elements

- No redundancy in GOOS-2009

One GOOS

- Critical to maximise impacts to services short- to climate scale
- It can be cheaper to sacrifice in one or other areas
- Recommend GOOS continue to discourage partial contributions

Essential forecast elements

- Timeliness
- Real-time Quality
- Homogeneity
- Robust / operational
- Standardisation
- Open data access policies
- Capacity building

Observational requirements

Surface observations

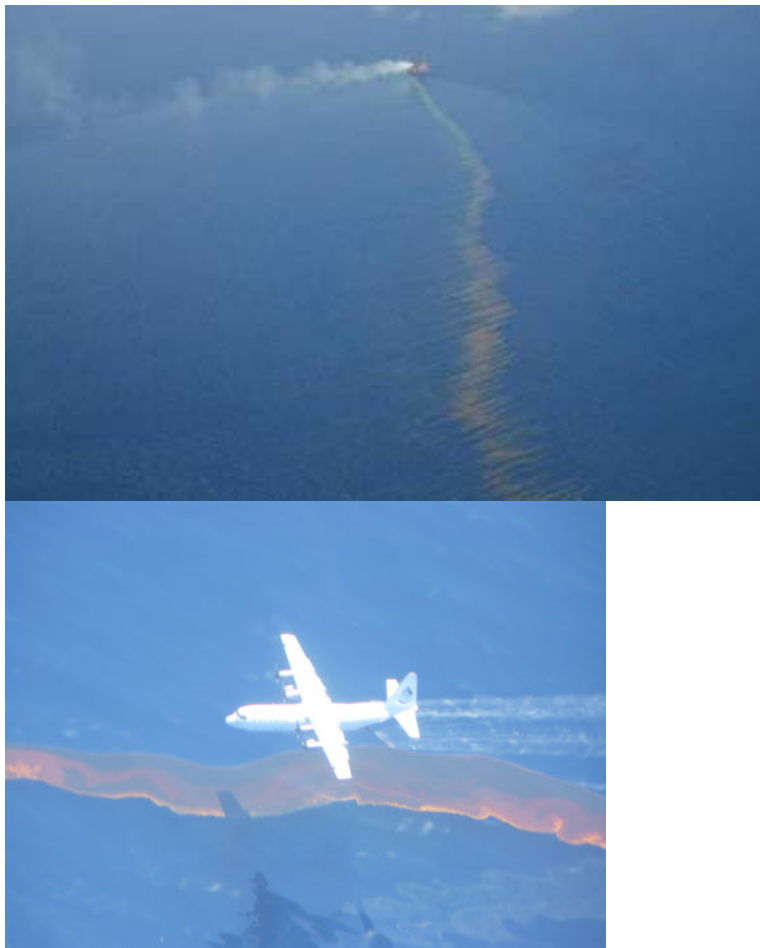
- Altimetry coverage remains a limitation for real-time nowcasting
- Interleaved Jason-1, Jason2 and Envisat clear performance gain
- **Strong support for Jason-3**
- Support both the **wide-swath and constellation proposals**
- Encourage improving **remote sensing of surface currents**
- Support the maintenance of the multi-sensor, multi-orbit SST network
- Support the continuance of microwave and geostationary SST
- SSS accuracy will limit impact, strong support for continued development
- Support sea-ice remote sensing
- Support for extension of scatterometry

Observational requirements

Sub-surface observations

- **In situ will likely always undersample** the mesoscale (no redundancy)
- 10 times Argo-2009 would still undersample the mesoscale
- Support **sustaining and incrementally increasing** Argo
- Support maintenance of XBT's
- **Support an increase in drifting buoy** deployments
- Strongly support the expanded use of gliders to sample deep ocean eddies, fronts, boundary currents, throughflows
- Support the tropical mooring arrays
- Other technologies measuring state variables and circulation

Montara Well Oil Spill – A real-time disaster



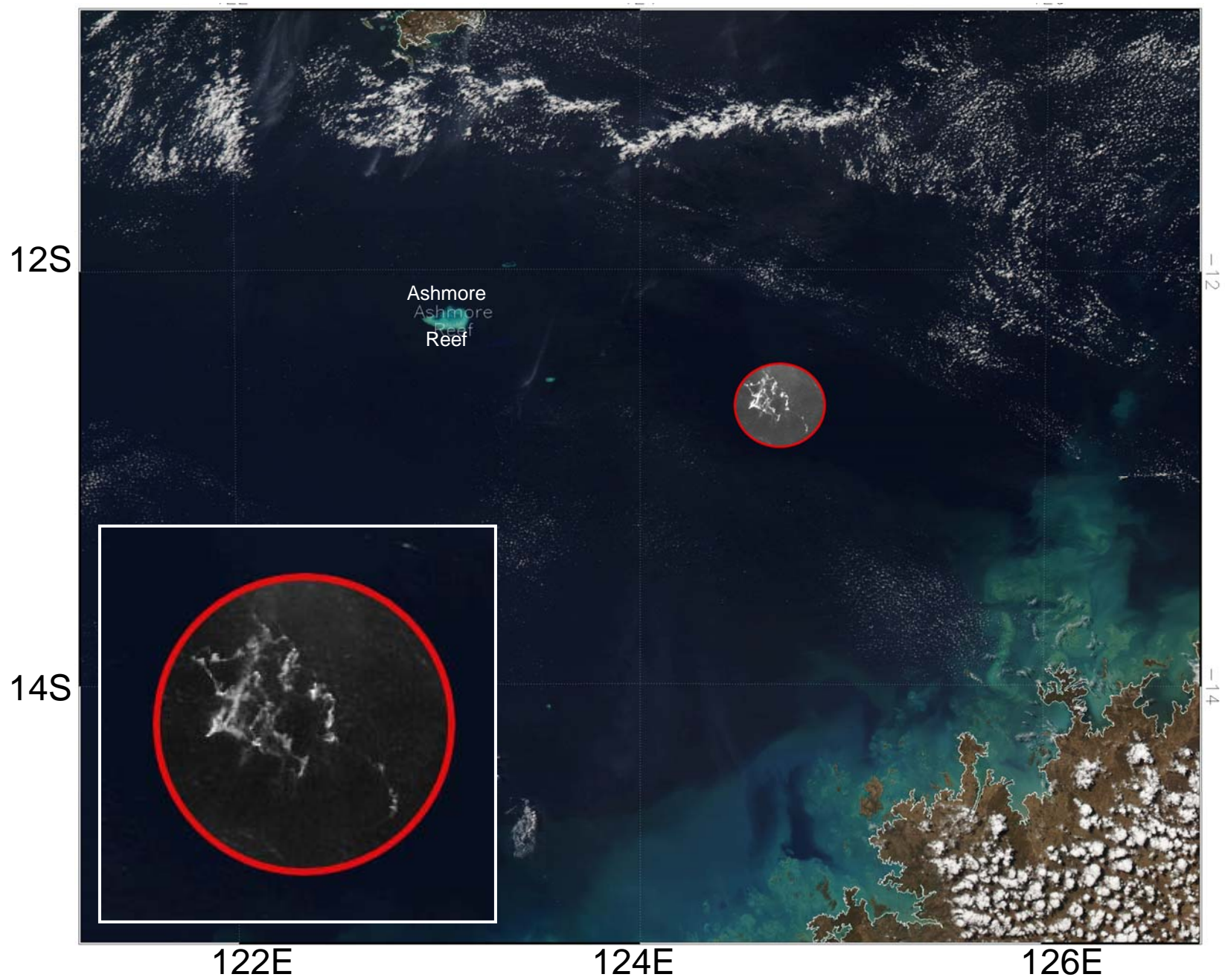
Summary

On the morning of Friday 21 August 2009, the West Atlas mobile drilling unit was engaged in well operations at the Montara Well in the Timor Sea. For reasons still unknown, the drilling rig had an uncontrolled release of oil and gas to the environment of the Timor Sea.

Fortunately there were no casualties, and the rig was successfully evacuated.

The oil spill response will be protracted and logistically demanding. It is expected that monitoring, plume trajectory predictions and dispersant operations will be required for around eight weeks. To date, the slick has remained offshore away from coastlines and coral reefs.

Brian King
APASA



23rd Aug 2009

Major challenge – responding to disasters/emergencies

Surface observations – options

- International charter for tasking member satellites
- Coordination with ocean forecasting services

Sub-surface observations – options

- Recommend GOOS also support an international charter
- Adaptive cycling of Argo cycles – via Iridium retasking
- Adaptive cycling of gliders
- Aerial deployment of rapid, shallow cycling Argo floats
- Aerial deployments of gliders
- National / International coordination of this capability



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy

Grand challenge: Seamless prediction

- Climate change effects are already here, more is coming
- Society requires a seamless transition of error bars to plan and manage risk
- Climate => Seasonal => Medium-range => Short-range
- GOOS will have a growing role to serve the needs across time and space scales

Grand challenge: coupled earth weather forecasting

- WMO exploring coupled modelling
- GODAE OceanView is exploring coupled modelling
- Seasonal community exploring intra-seasonal prediction
- 10 year vision
- GOOS will have a major role in supporting the pilot activities
- JCOMM/WMO/IOC should drive the case for operationalisation of mature parts of GOOS
- Challenges – too numerous to summarise
- Essential that multiple groups come together
- GODAE OceanView has proposed a pilot working group to evaluate the scope of the work, review the leading science, determine what groups are already in this space and make some recommendations
- GODAE OceanView will present this to CAS and WGNE



Thank you to the GOOS community

**We should be very proud of these new services
just not complacent**

**Acknowledge the whitepaper authors and colleagues within
the operational forecasting community**



OceanObs'09

*Ocean information for society:
sustaining the benefits,
realizing the potential*

21-25 September 2009, Venice, Italy