

OPERATIONAL MARINE AND OCEAN SERVICES AT THE BUREAU



Dr. Ray Canterford PSM
Division Head: Hazards, Warnings and Forecasts

Forum for Operational Oceanography, Fremantle WA, July 2015



Australian Government
Bureau of Meteorology



Forum for Operational
Oceanography

THE BUREAU MARINE TEAM

HERE TODAY

Observations
Research

Sue Barrell, Boris Kelly-Gerreyn
Peter May, Eric Schulz, Gary
Brassington, Stefan Zieger,
Jeff Keppert

Services

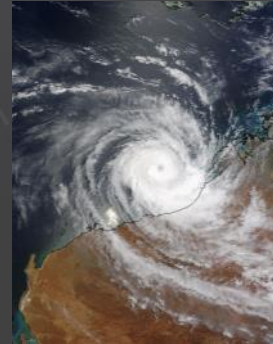
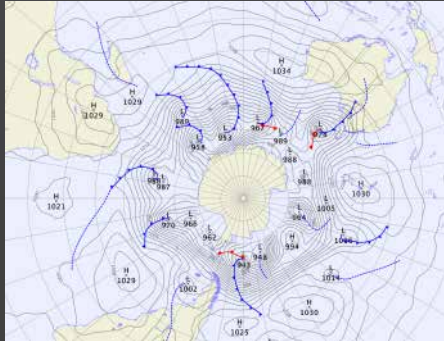
Rick Bailey, Mikhail Entel, Neal
Moodie, Ray Canterford, Mike
Bergin; Bill Mitchell

Marine Information

Louise Minty, Greg Stuart

OUR MISSION

- Observe, understand and forecast our weather, climate, oceans and water resources
- Assist our stakeholders via products, services and advice



Australian Government
Bureau of Meteorology

OUR PURPOSE

ENVIRONMENTAL INTELLIGENCE



WHAT IS OPERATIONAL OCEANOGRAPHY

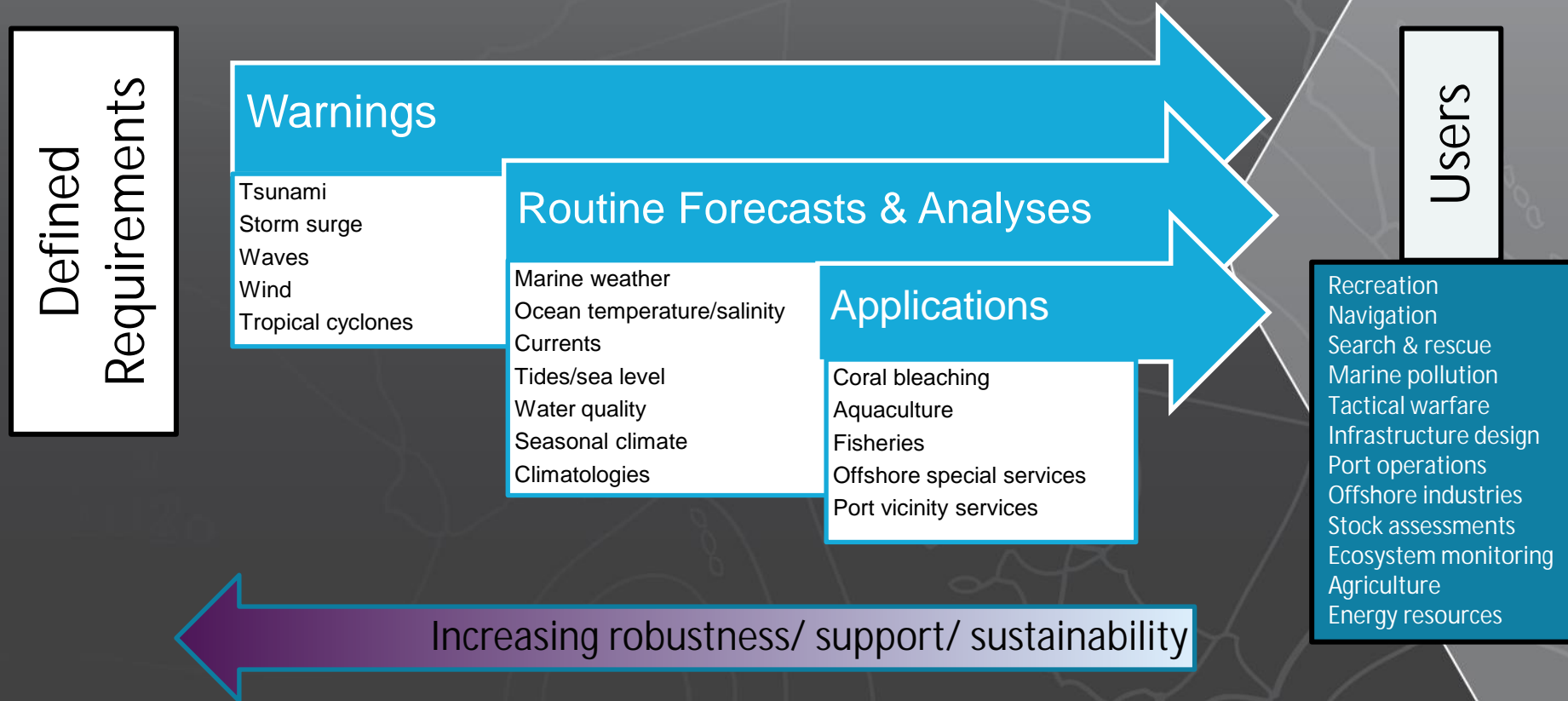
A Bureau Perspective

Ø Operational Oceanography is like operational **weather forecasting**
➡ **Observations, Research, Forecasts/warnings and Information Services**

Ø These OO services meet user and regulatory requirements:

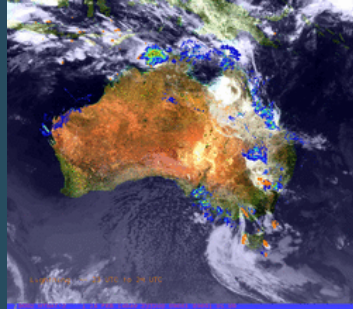
- Routine
- Sustained
- Robust
- Dedicated Support
- Specified
- Competent
- Quality Assured

RANGE OF BUREAU MARINE SERVICES

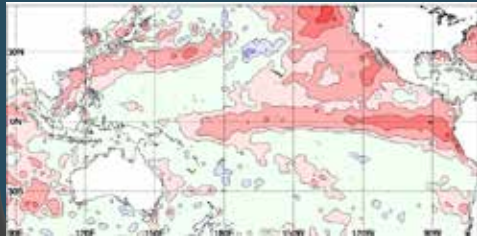


Observations

Situational awareness

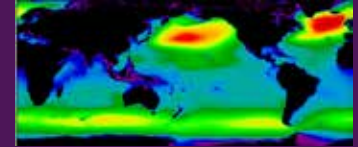


Analysis

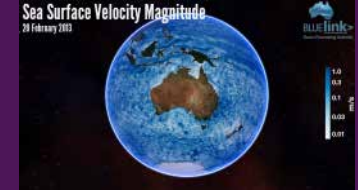


Modelling

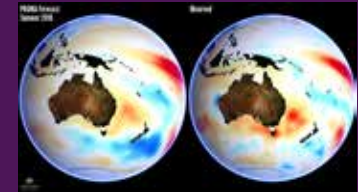
Re-analysis



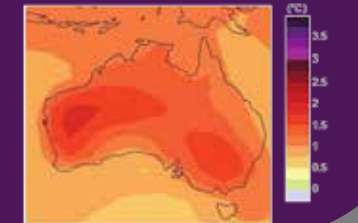
Forecasts (Deterministic)



Outlooks (Probabilistic)

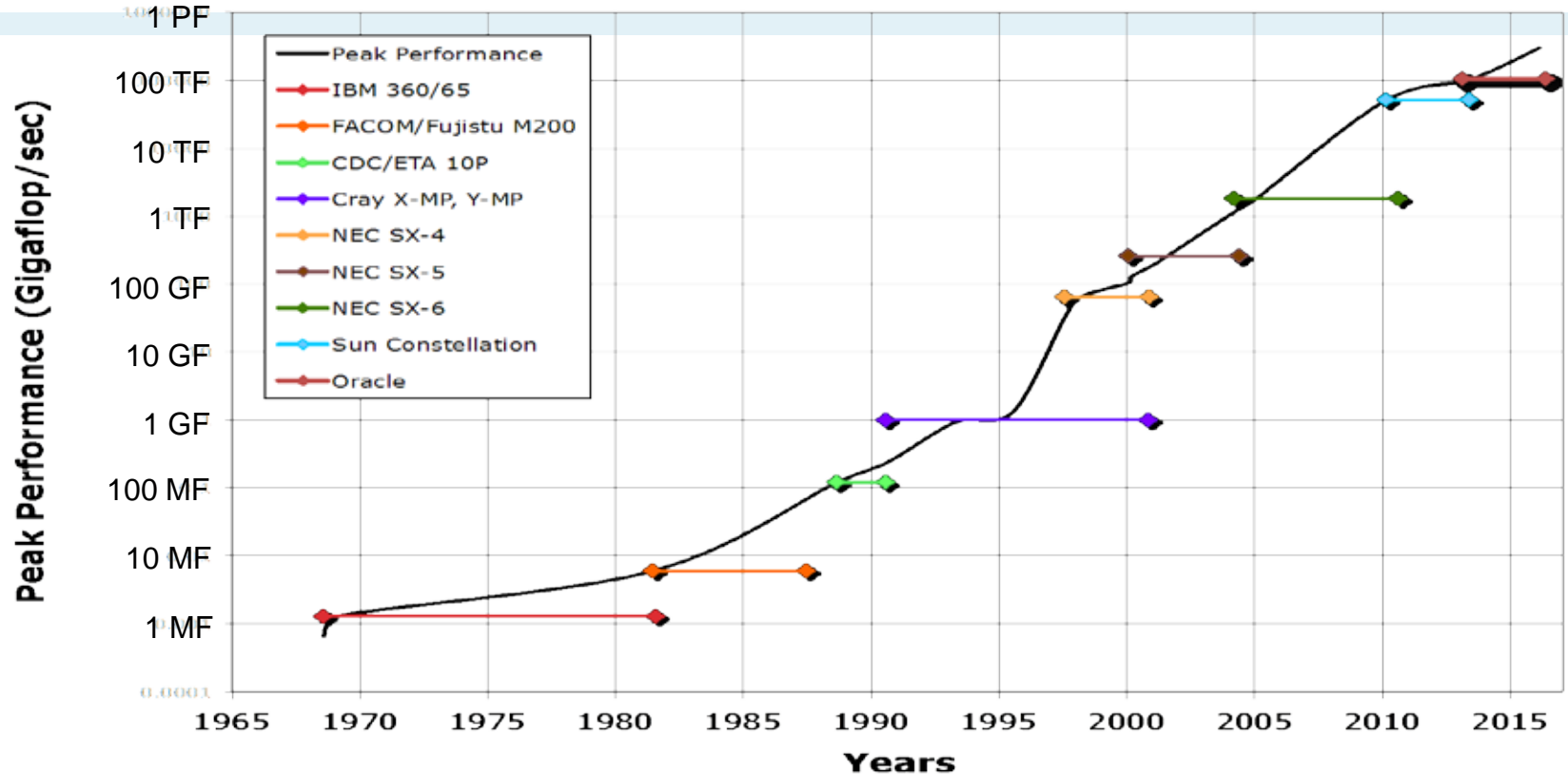


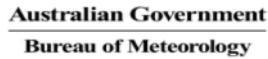
Projections (Scenarios)



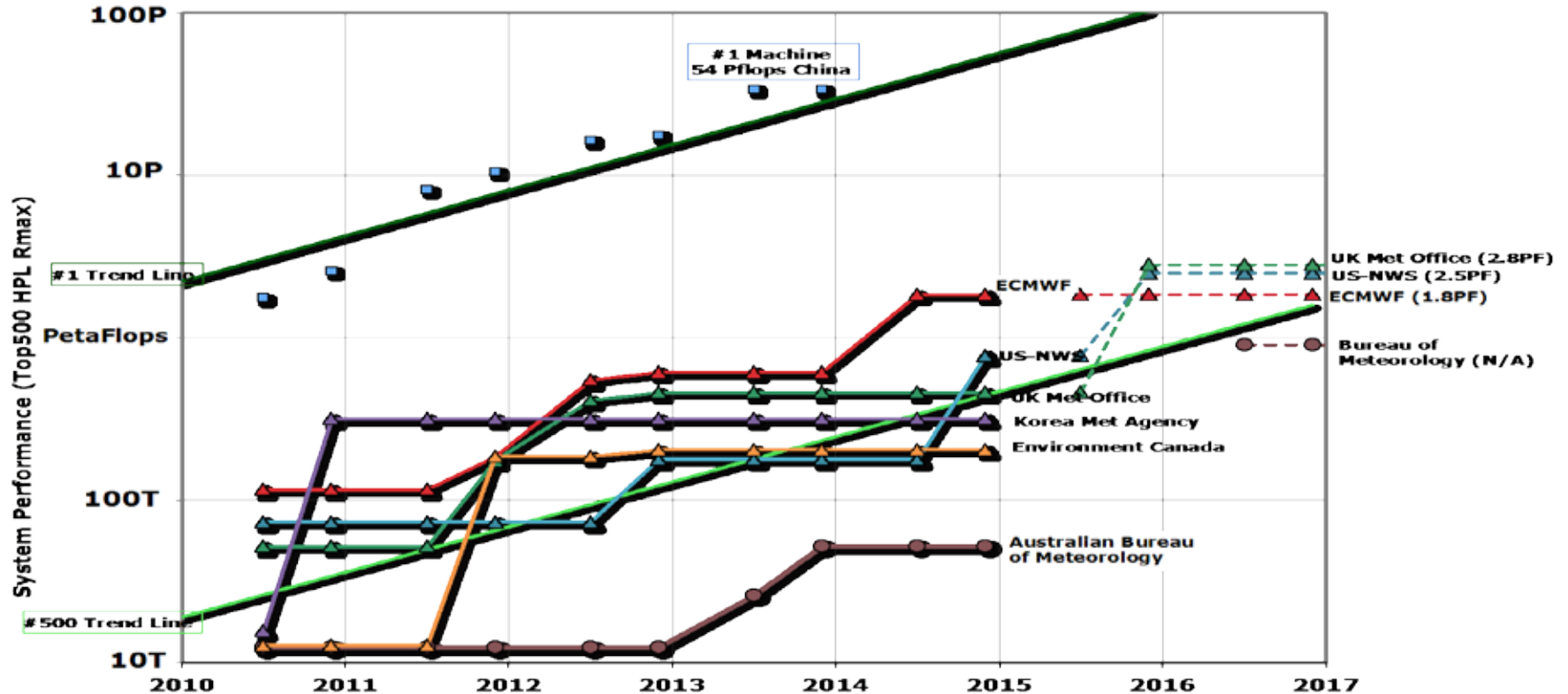


Bureau's History in Computing began in 1968

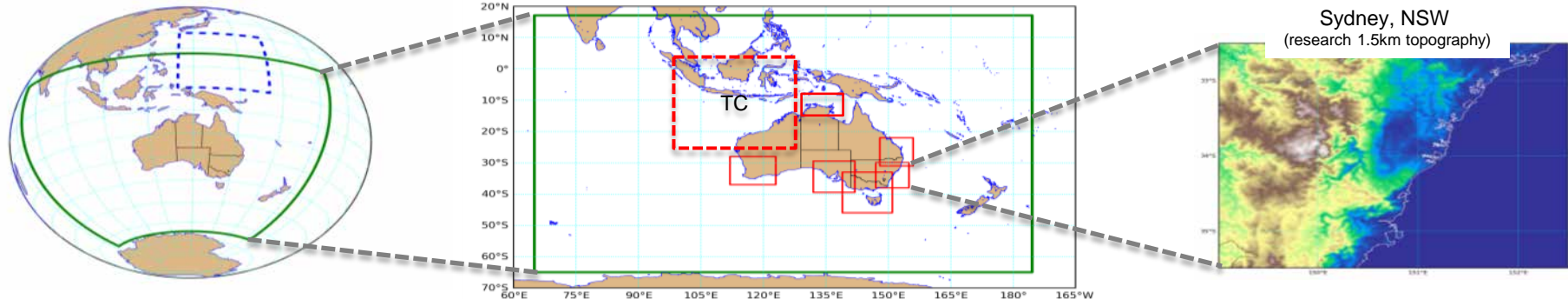




NWP Computing Capacity of National Meteorological Centres



Numerical Weather Prediction Roadmap

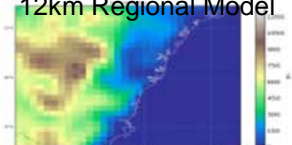


2 x daily 10-day & 3-day forecast
40km Global Model



Increasing model resolution
for improved local information

4 x daily 3-day forecast
12km Regional Model



Future model ensembles for
likelihood of significant
weather

4 x daily 36-hour forecast
4km City/State Model

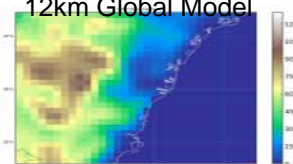


Model Topography of Sydney, NSW

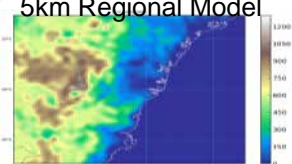
2013

2020

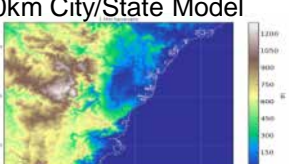
2 x daily 10-day & 3-day forecast
12km Global Model



8 x daily 3-day forecast
5km Regional Model



24 x daily 18h or 36h forecast
1.0km City/State Model



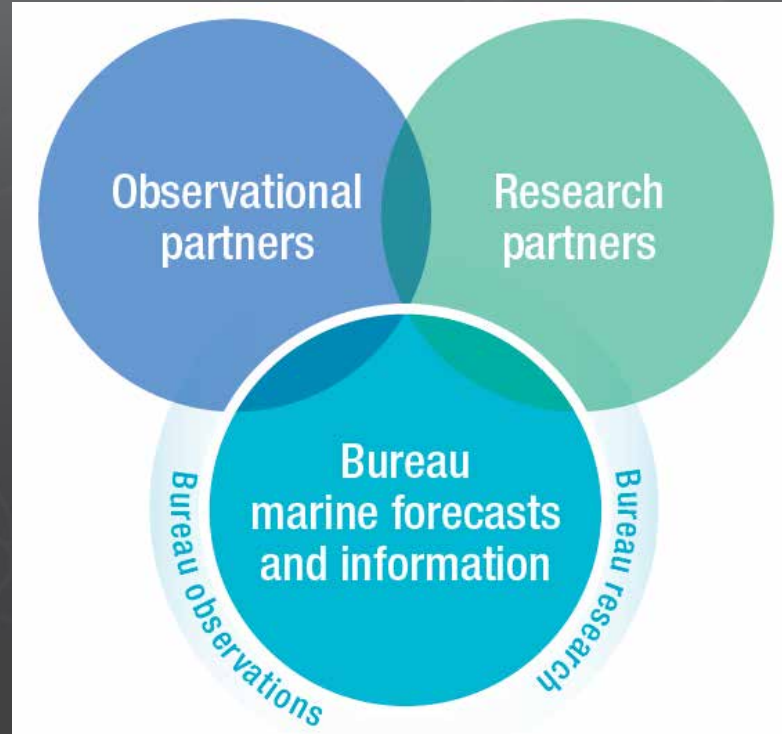
Projection of Nominal Modelling Resolutions for Future Computing Systems

Subject to sufficient investments in High Performance Computing

STRATEGIC DIRECTION



PARTNERSHIPS



MARINE FORECASTING IN CWS AND PARTNERSHIPS

Wind/Wave/Weather

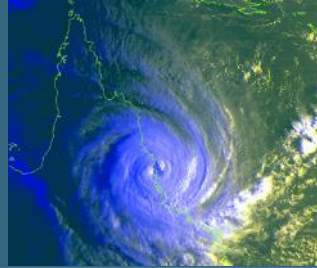


Real-time forecasting

Weather risk and climatology analysis

Severe weather including thunderstorms, squalls & lightning

Tropical cyclone



Formation outlooks

Real-time warnings

Expert briefings

Consultancy

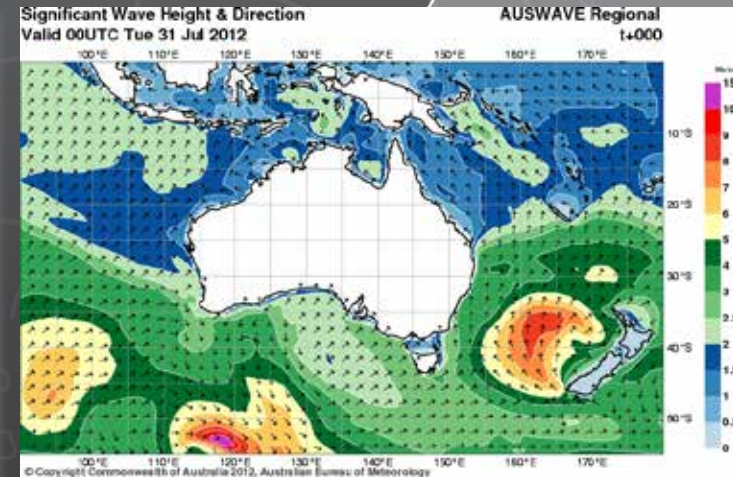


Specialised briefings and consultancy services for major weather sensitive operations

Education and training to support risk management and response planning

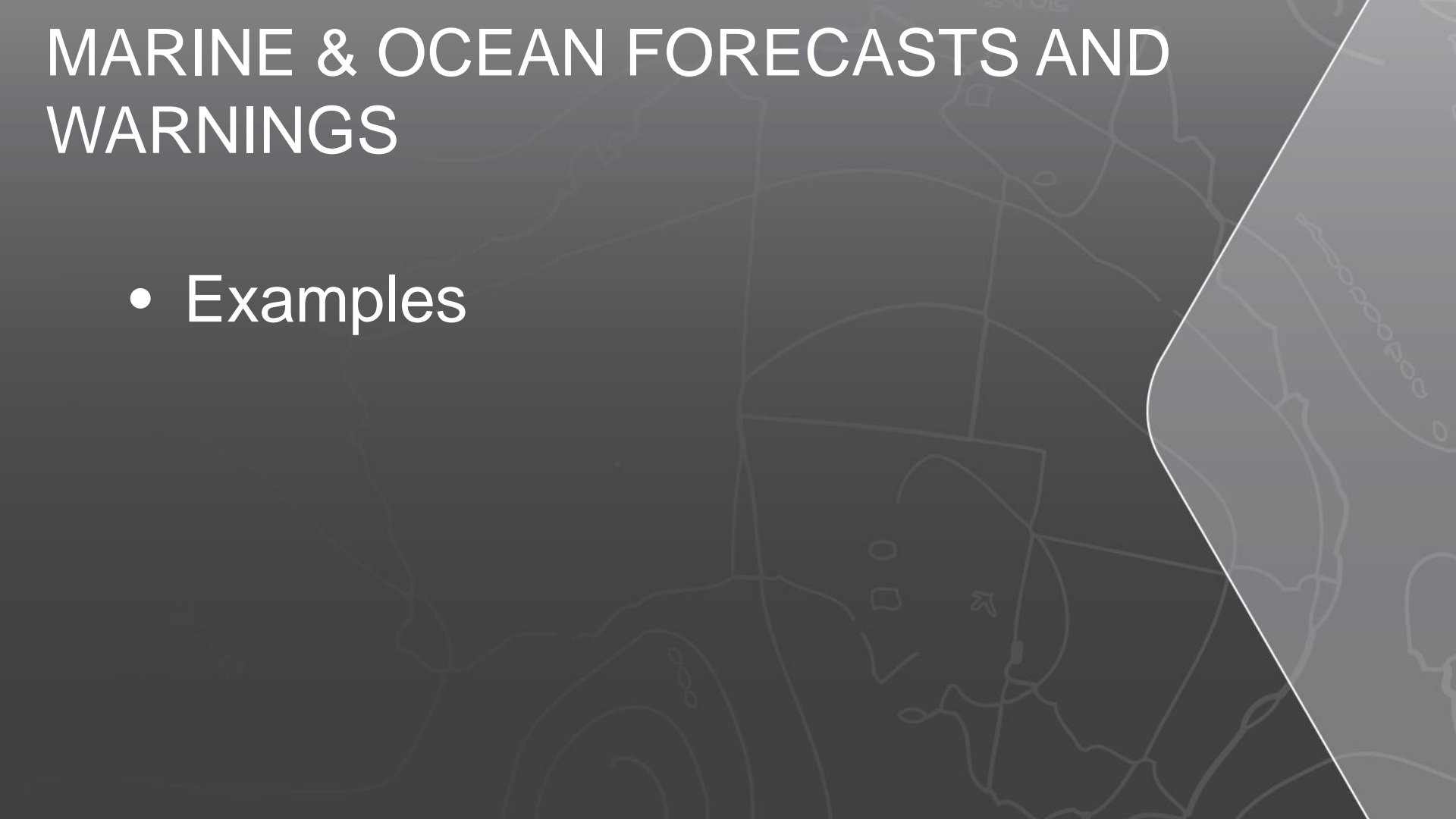
CURRENT MARINE AND OCEAN OPERATIONAL SERVICES

- Forecasts
- Warnings
- Information
- Observations
- Science



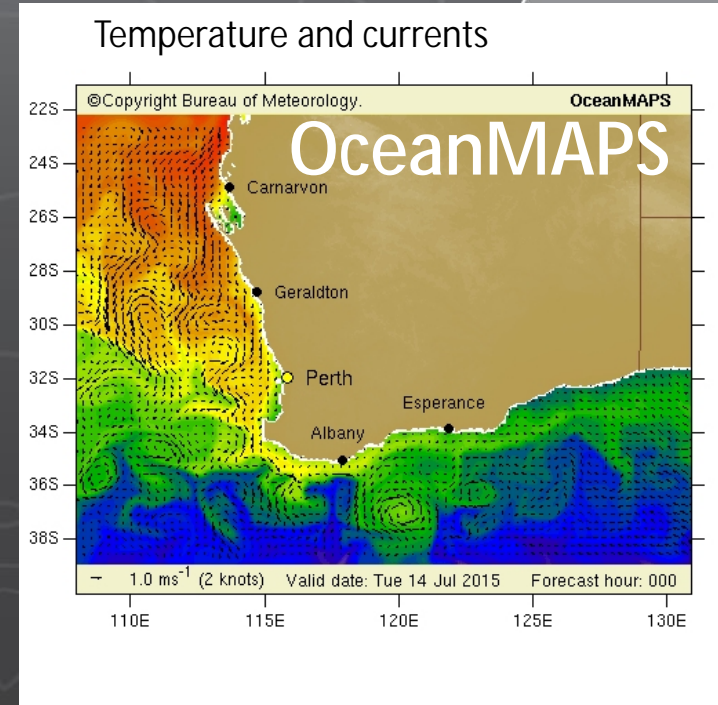
MARINE & OCEAN FORECASTS AND WARNINGS

- Examples



OCEAN FORECASTING SERVICES

- Search and rescue
- Oil spills
- Ocean temperature
- Salinity
- Currents
- Sea levels

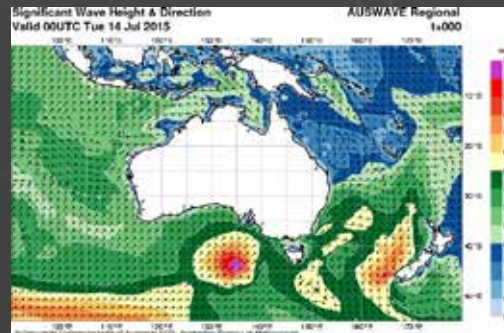
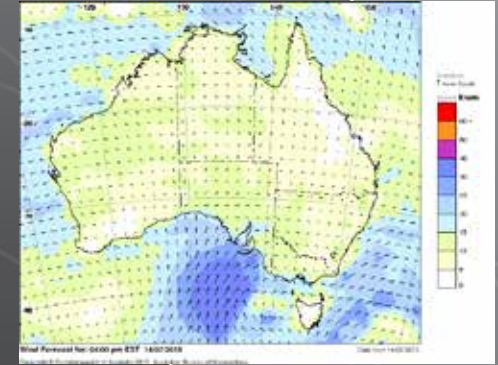


Partnership Bureau/CSIRO/Navy

MARINE WEATHER SERVICE

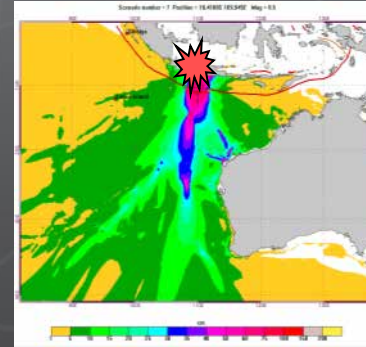
Regional Forecasting Centres (RFCs) and Bureau National Operations Centre (BNOC)

- Coastal and High Seas
- Wind
- Pressure
- Waves
 - Wind-waves
 - Swell



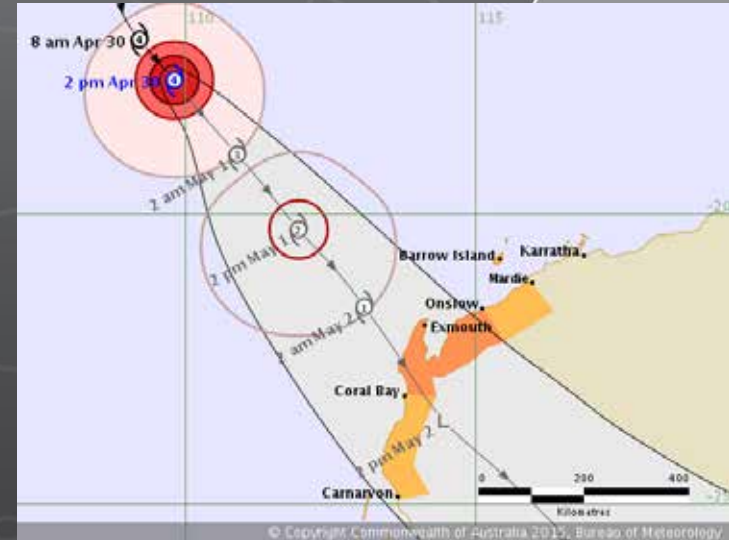
TSUNAMI WARNING SERVICE

- Tsunami Warning Service
 - Bureau/GA Joint Australian Tsunami Warning Centre (JATWC)
 - National authority for Australia
 - Provider of tsunami threat information to National Tsunami Warning Centres (NTWCs) of 28 countries around the Indian Ocean



TROPICAL CYCLONE WARNING SERVICE

- TC Warning Centres in Bureau's Perth, Darwin and Brisbane Regional Offices
- Storm surge advice to emergency services and local government authorities



Keppert et al
talk

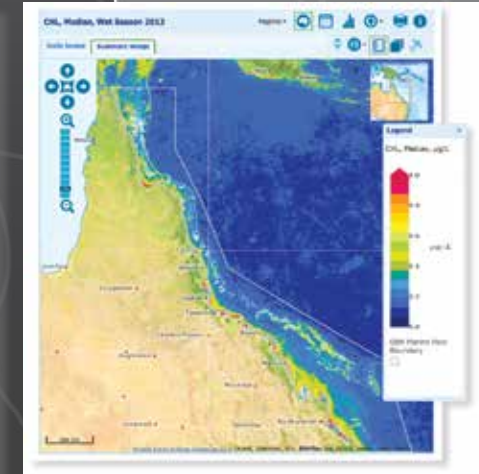
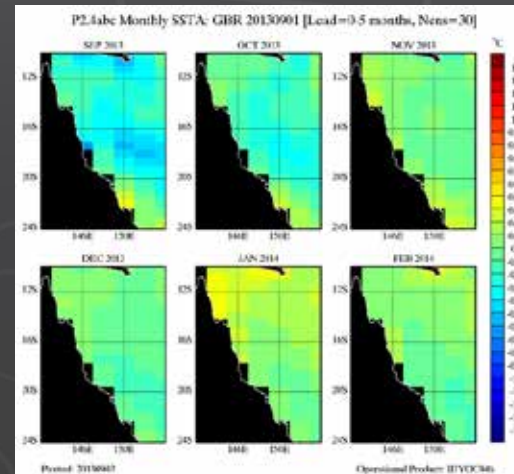
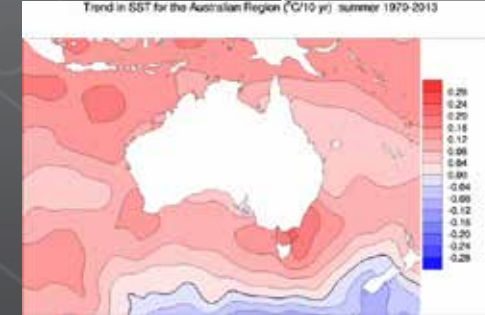
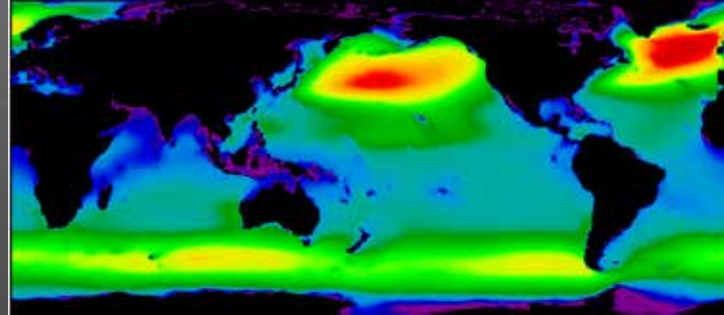
MARINE INFORMATION SERVICES



- Examples

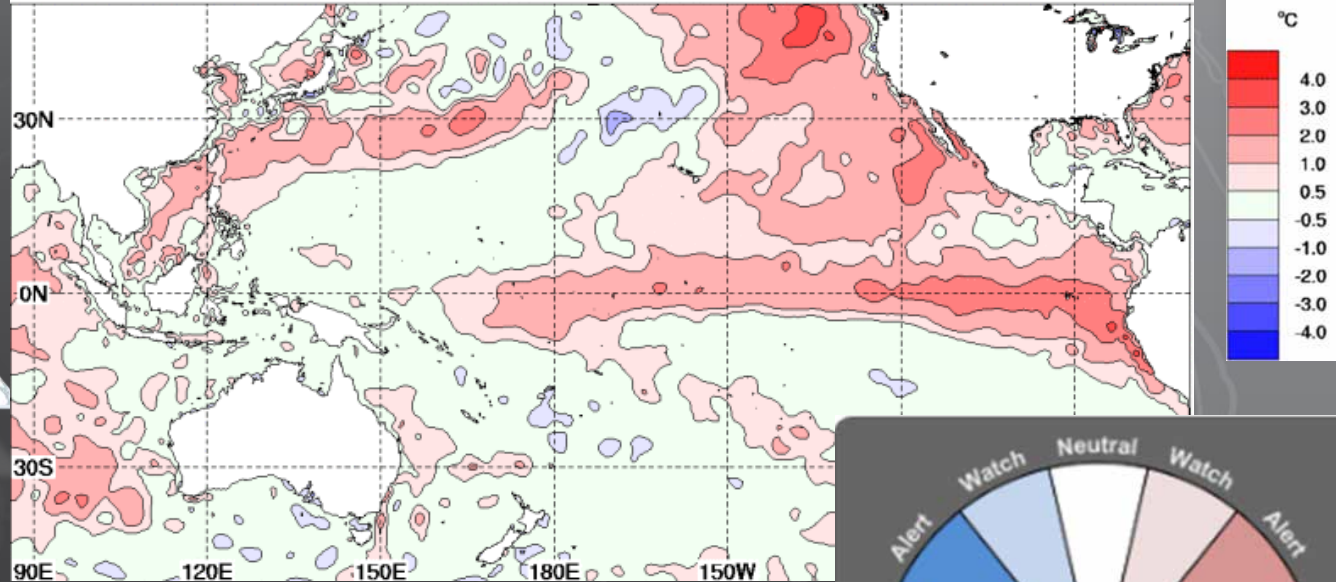
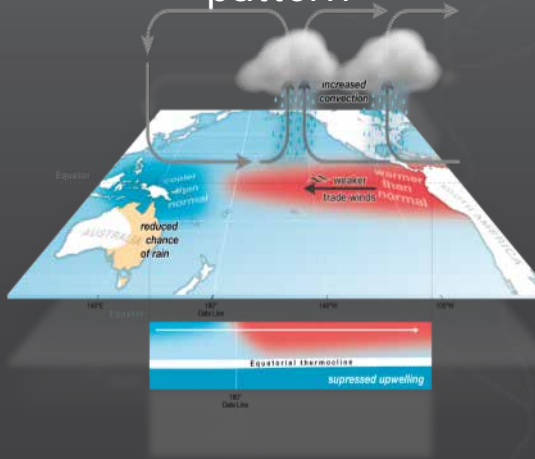
MARINE INFORMATION SERVICES

- Climatologies
 - Tropical Cyclones
 - Waves
 - Sea Surface Temperature
 - Sea Level
 - Seasonal outlooks (e.g. ENSO)
- Coral bleaching outlook
- Marine water quality



EL NIÑO ANALYSIS AND TRACKING

Typical El Niño pattern

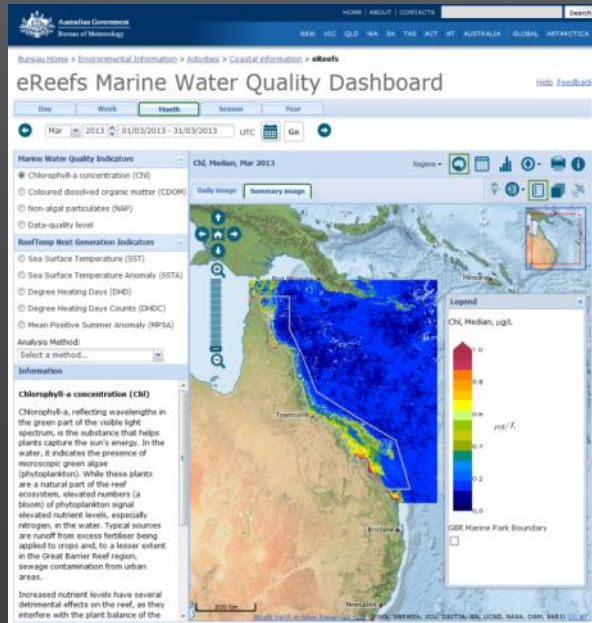


Monthly sea surface temperature anomalies
(June 2015)

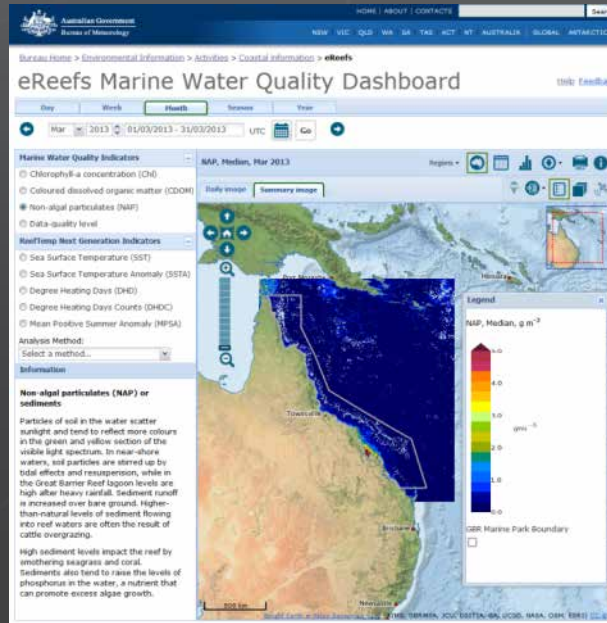


MARINE WATER QUALITY DASHBOARD

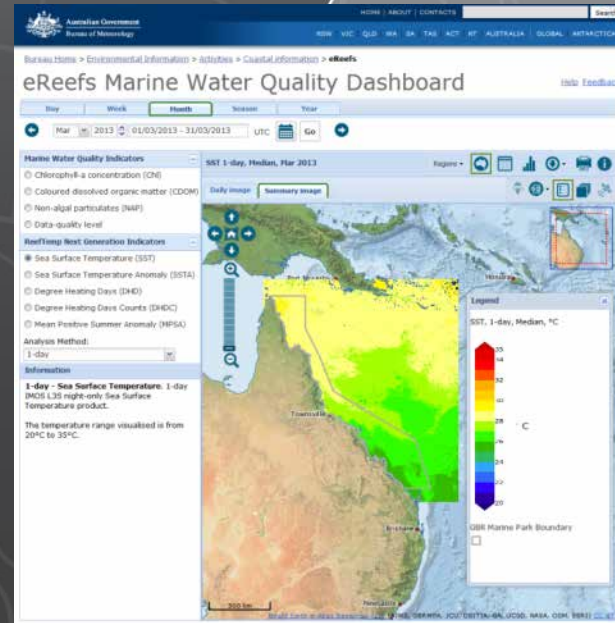
A whole of Great Barrier Reef perspective on...



Nutrients



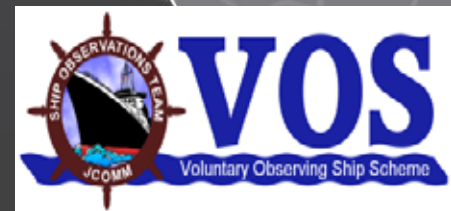
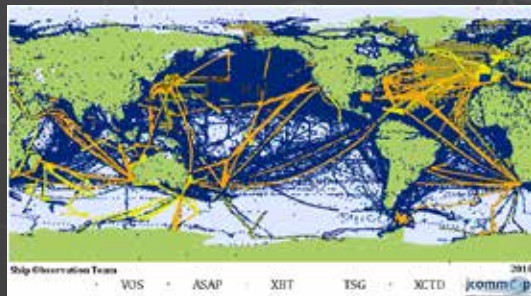
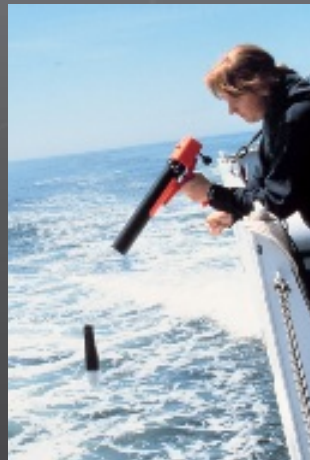
Sediments



Temperature

MARINE OBSERVATIONS

- Sea level gauges
- Bathythermographs
- Drifting buoys
- Wave buoys
- Profiling floats
- Tsunameters
- Volunteers



Bureau's In Situ Marine Observation Networks

>2 million in situ observations per year

Contributing to and benefiting from
large-scale national and
international observing efforts



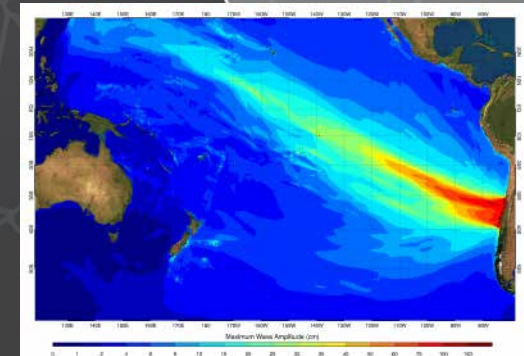
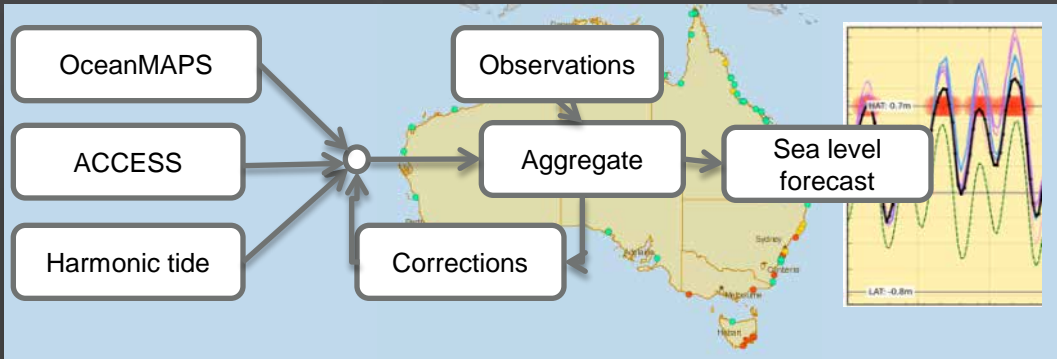
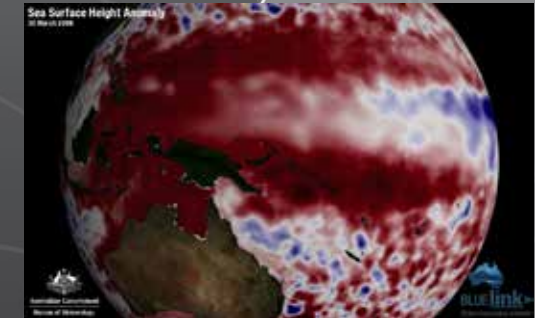
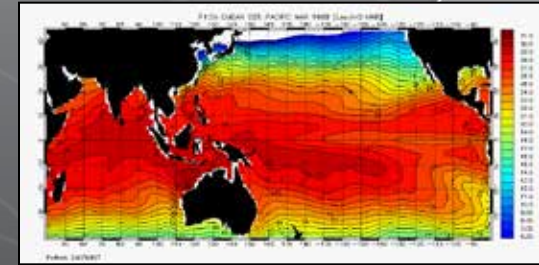

Australian Government
Bureau of Meteorology

12 sites
deployed in 2013-14
Monitoring Array - 13 sites
(SOOP) (4,000 obs in 2012-13 from an 8 ship network)
M contribute >400 floats (BoM 40) to 3,600 global array
n (incl 42 coastal and 9 deep water buoys in darker green)
y 2 are BoM)
et (AVOF) - 58,000 obs in 2012 (73 ships, incl 7 with AWS)

Observations and Infrastructure, Sept 2011
INTERNAL USE ONLY - Bureau of Meteorology

MARINE SCIENCE

- Dynamical modelling (BLUElink, POAMA)
- Ocean state modelling (BLUElink)
- Tsunami
- Total sea level



DYNAMICAL MODELLING

Sea Surface Velocity Magnitude

1 January 2007

Sea Surface Height Anomaly

1 January 2007

1.0
0.3
0.1
0.03
0.01
m/s

0.8
0.4
0.0
-0.4
m

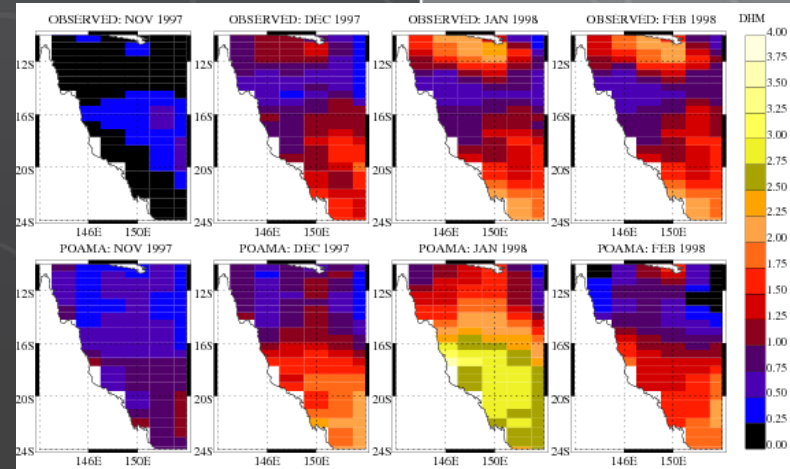


Oke &
Brassington
talk

CORAL BLEACHING RISK FORECASTS



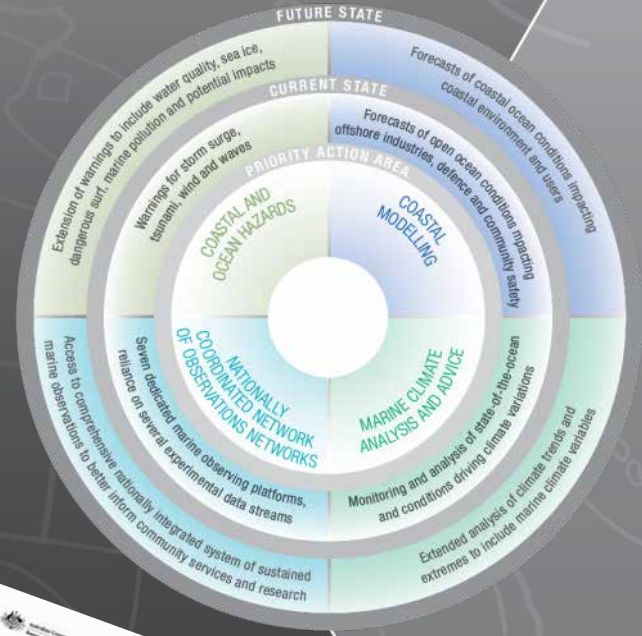
- First in the world
- Timely
- Improve community and stakeholder awareness
- Identify future threats for long term planning and policy development



1997/98 GBR bleaching event

GOING FORWARD FOUR PRIORITY AREAS

- Coastal and ocean hazards
- Coastal modelling
- Marine climate analysis and advice
- Sustained network of observations

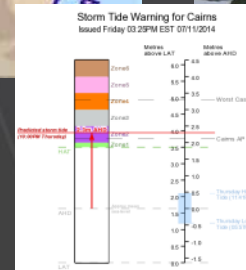


Boris Kelly-
Gerreyn et al
Poster
Session

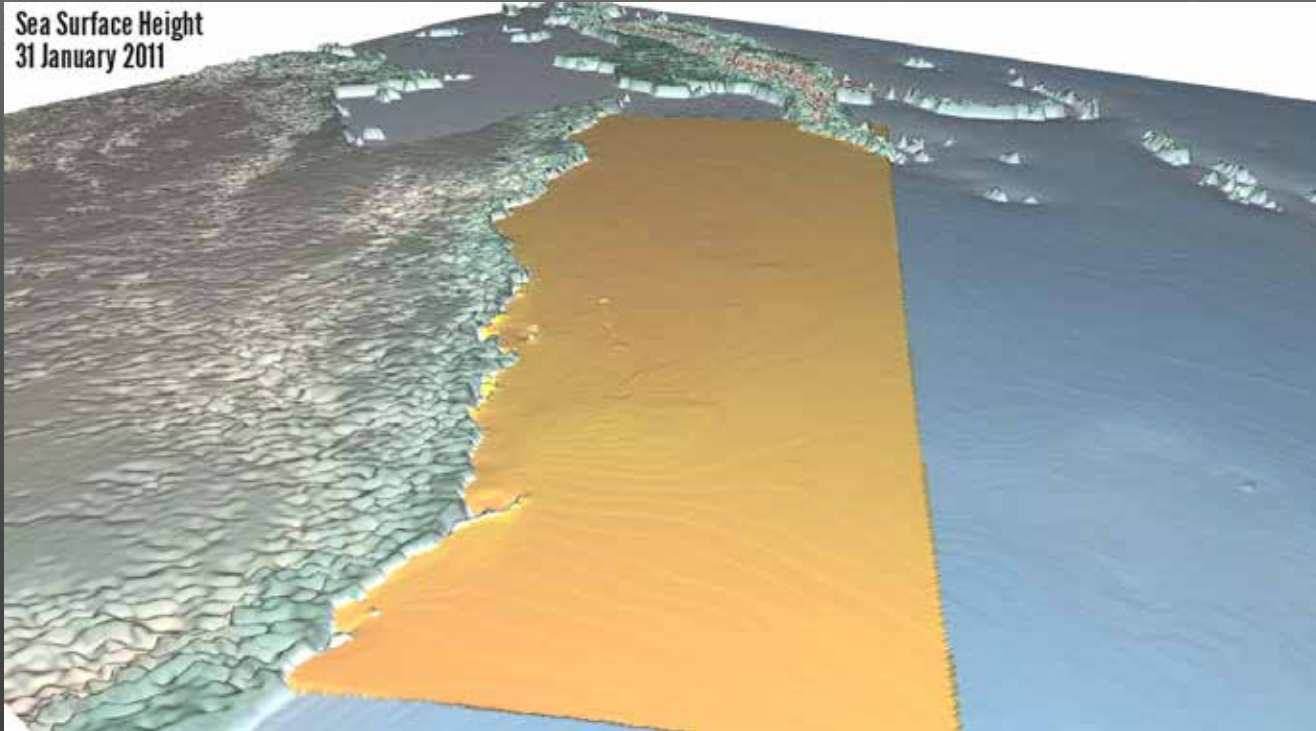
COASTAL AND OCEAN HAZARDS

STORM SURGE PROJECT (2013-17)

- Nationally consistent service
- Australia & offshore territories
- Dynamical forecasting capability
- Tropical cyclones (probabilistic)
- Extended lead time -> 48 hours
- Mid-latitude storms (deterministic)



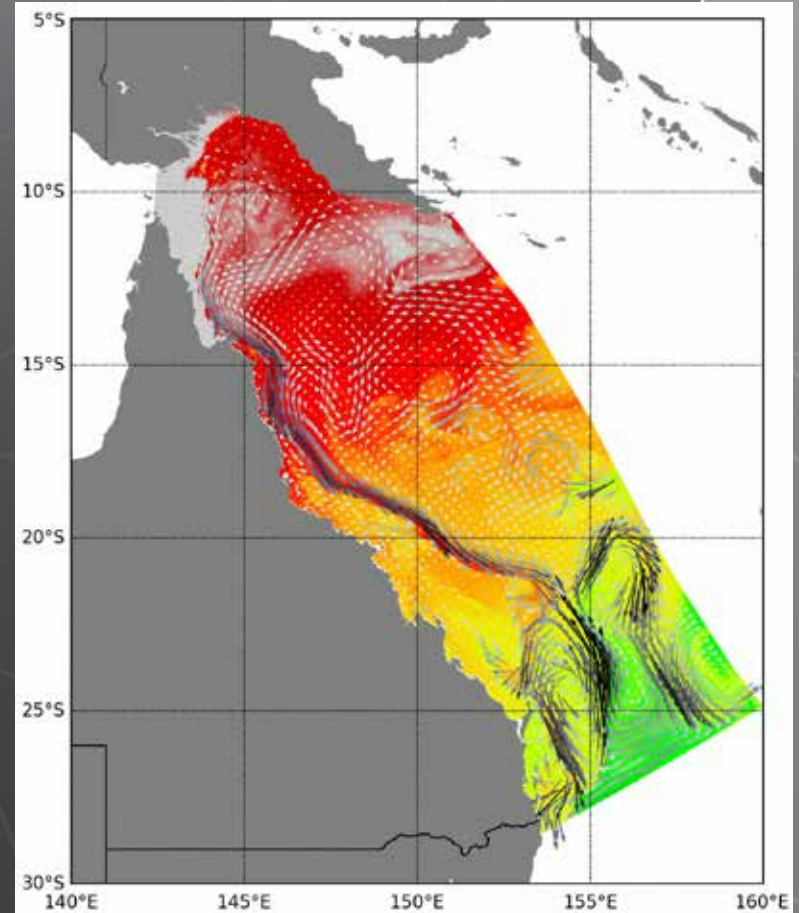
COASTAL AND OCEAN HAZARDS



Entel and
Schulz
talk

COASTAL MODELLING

- Nested within BLUElink>
- Finer resolution
- Forced by ACCESS-R
- Including coastal processes
- Regional specific applications

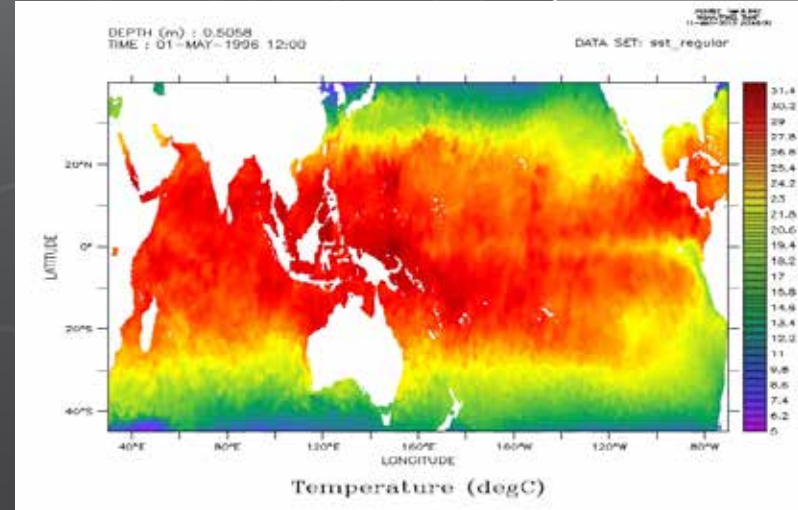


MARINE CLIMATE ANALYSIS AND ADVICE

Next generation seasonal forecasting



- Global at 0.25°
- Data assimilation
- Ensembles
- Coupled ocean-atmosphere
- Multi-week to seasonal timescales
- Improved Forecasts for early intervention (e.g. Fisheries, Reef Management)



NETWORK OF NETWORKS

- Greater automation
- Integration of more third party data
- Improved observing network design
- Streamlined research to operations
- Enhancing Partnerships (existing and new)



...And many more

THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)

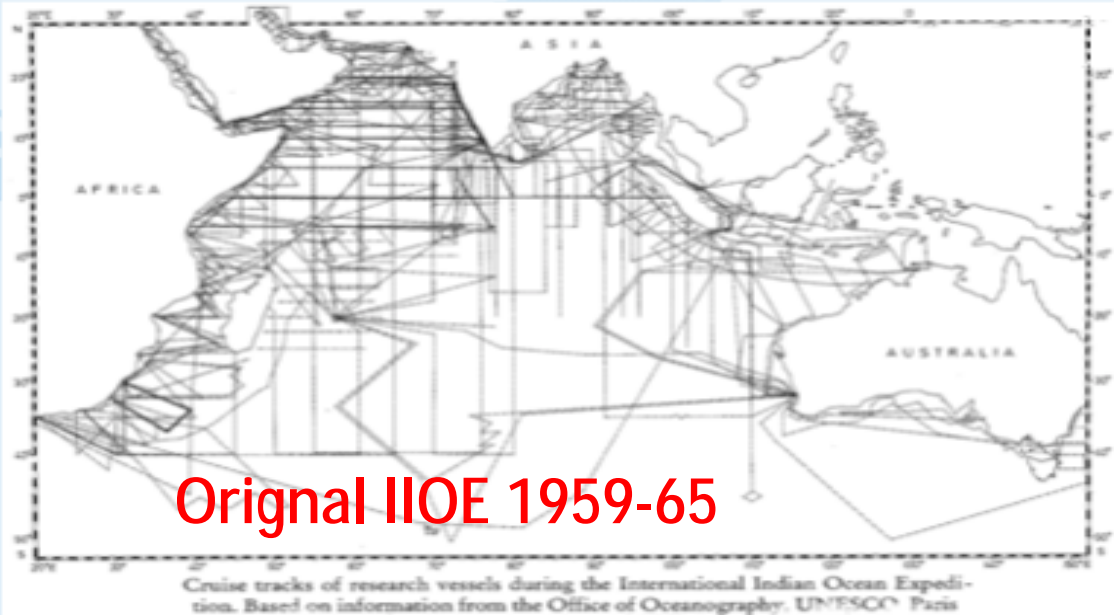


- 147 Member States
- Australian National Representative now from Bureau of Meteorology
- Biennial Assembly meetings
- Annual Executive Council meetings
- Concept for IIOE-2 discussed at IOC 27th Assembly in 2013 and requested a proposal to be put to 47th Session of the Executive Council (1-4 July 2014)

www.ioc-unesco.org

The planning for IIOE-2 has been undertaken under leadership of

- Indian Ocean Global Ocean Observing System (IOGOOS)
 - a GOOS 'Regional Alliance'
 - Marine/Environment/Climate institutional reps – deriving from most IO countries.
- Scientific Committee on Ocean Research (SCOR)
 - global = > 30 'national SCOR committees'
- UNESCO Intergovernmental Oceanographic Commission (IOC)
 - 147 Member States – Intergovernmental constituted



Hydrographic surveys (repeats) Chemical oceanography

Meteorology

Marine biology

Marine geology

Geophysics

Total **323 ship months**

- 1) Australia – 37 mths
- 2) France – 20
- 3) Germany – 7
- 4) India – 24
- 5) Indonesia – 3
- 6) Japan – 20
- 7) Pakistan – 8
- 8) Portugal – 3
- 9) South Africa – 13
- 10) Thailand – 2
- 11) USSR – 20
- 12) UK – 35
- 13) USA – 119

Courtesy: Satheesh Shenoi, INCOIS, India

KEY IIOE-2 OUTCOMES FROM 47TH SESSION IOC EC /28TH ASSEMBLY

- IIOE-2 adopted as a major IOC initiative, in partnership with SCOR and IOGOOS
- SCOR to lead development of science/research plan
- Est. Interim Planning Committee (Group of Experts) – IPC - to finalise planning
- IPC Report back to 28th IOC Assembly in June 2015
- All member states agreed to cooperate and contribute to success of IIOE-2 (inc. through nationally coordinated efforts, hosting of regional secretariat)



United Nations
Educational, Scientific and
Cultural Organization



Intergovernmental
Oceanographic
Commission



**THE SECOND INTERNATIONAL INDIAN OCEAN
EXPEDITION (IIOE-2)**

A Basin-Wide Research Program

Draft Science Plan
(February 10, 2015 release)



**Hood, R. R., H. W. Bange, L. Beal, L. E. Beckley, P. Burkill, G.
L. Cowie, N. D'Adamo, G. Ganssen, H. Hendon, J. Hermes, M.
Honda, M. McPhaden, M. Roberts, S. Singh, E. Urban, W. Yu,
(Eds.)**



THANKS.

QUESTIONS?



Forum for Operational
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Australian Government

Bureau of Meteorology