NATIONAL MARINE SCIENCE SYMPOSIUM

Maritime Sovereignty, Security and Natural Hazards

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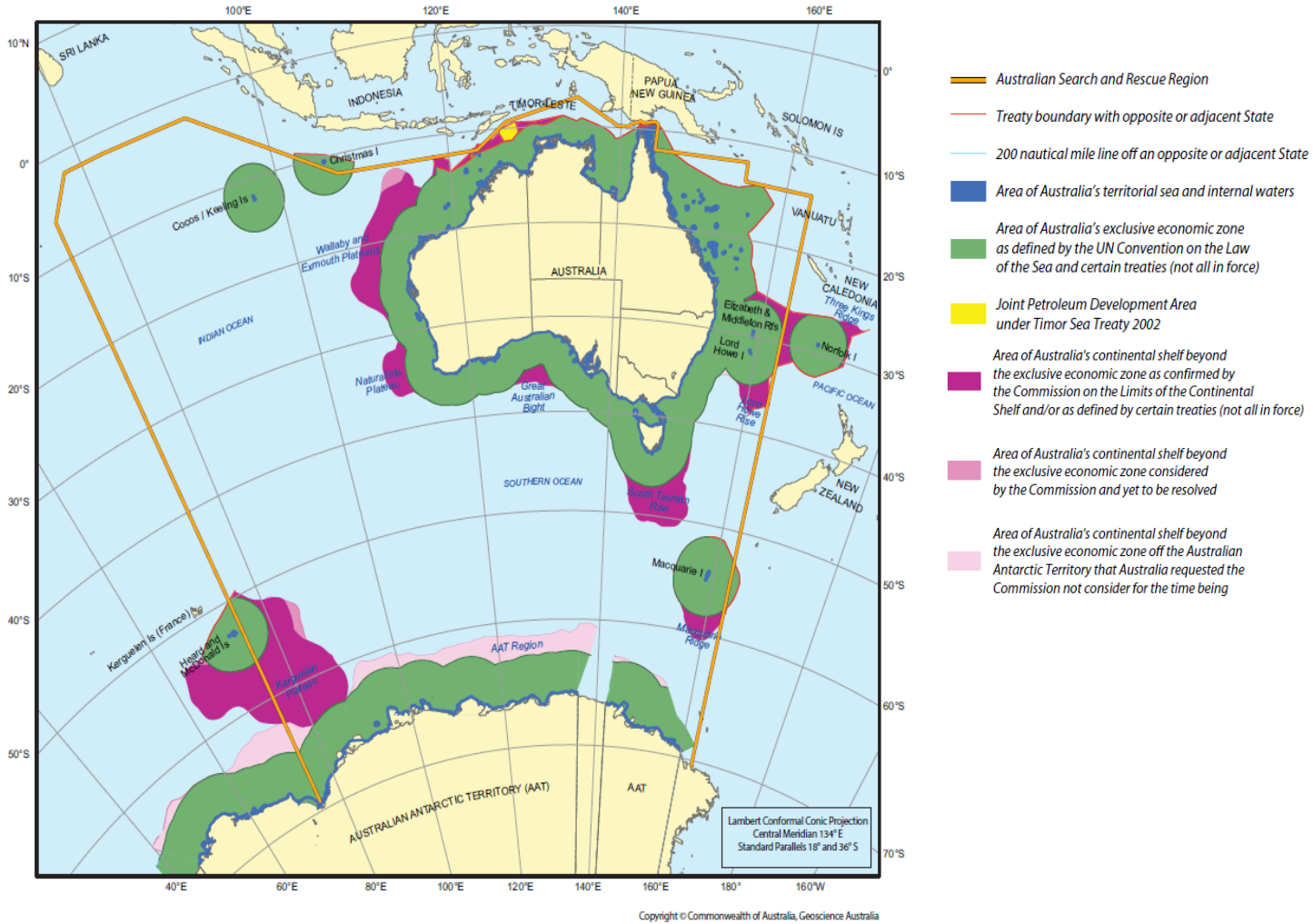
Australia's total area of maritime responsibility:

- **14% of the world's oceans**
- **3rd largest EEZ**

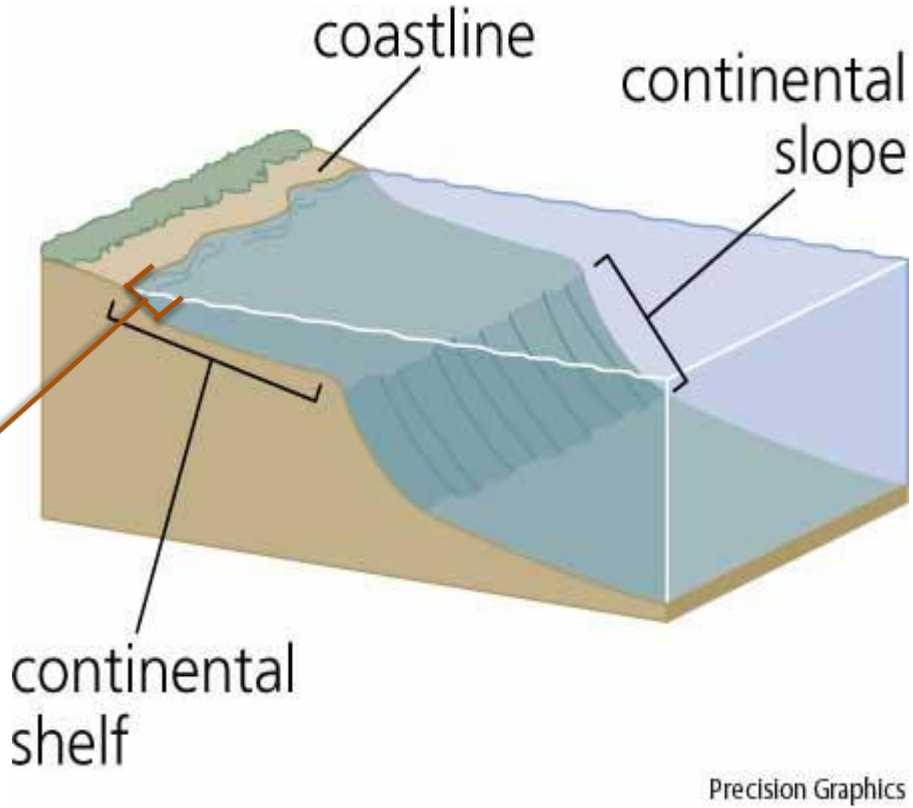


Sovereignty, Security and Safety

- **Sovereignty**… means a state or a governing body has the full right and power to govern itself without any interference from outside sources or bodies
- **Security** is the degree of resistance to, or protection from, harm
- **Safety** is… the condition of being protected against… types or consequences of… which could be considered non-desirable

by Wikipedia

Definitions



Scope

Maritime sovereignty, national security and safety:

- require accurate information about ocean, atmosphere and hazard domains
- support prediction, prevention, mitigation and compliance activities
- scales: global to littoral zone & weeks to hours

Users of Information

- **Offshore Industry**
- Short-term
  - needs reliable metocean hind- and forecasts
  - design criteria include 1/10000 years events, requires robust and accurate models
- Long-term
  - will advance to hundreds of kilometers offshore and to oceanic depths
  - understanding of subsurface dynamics

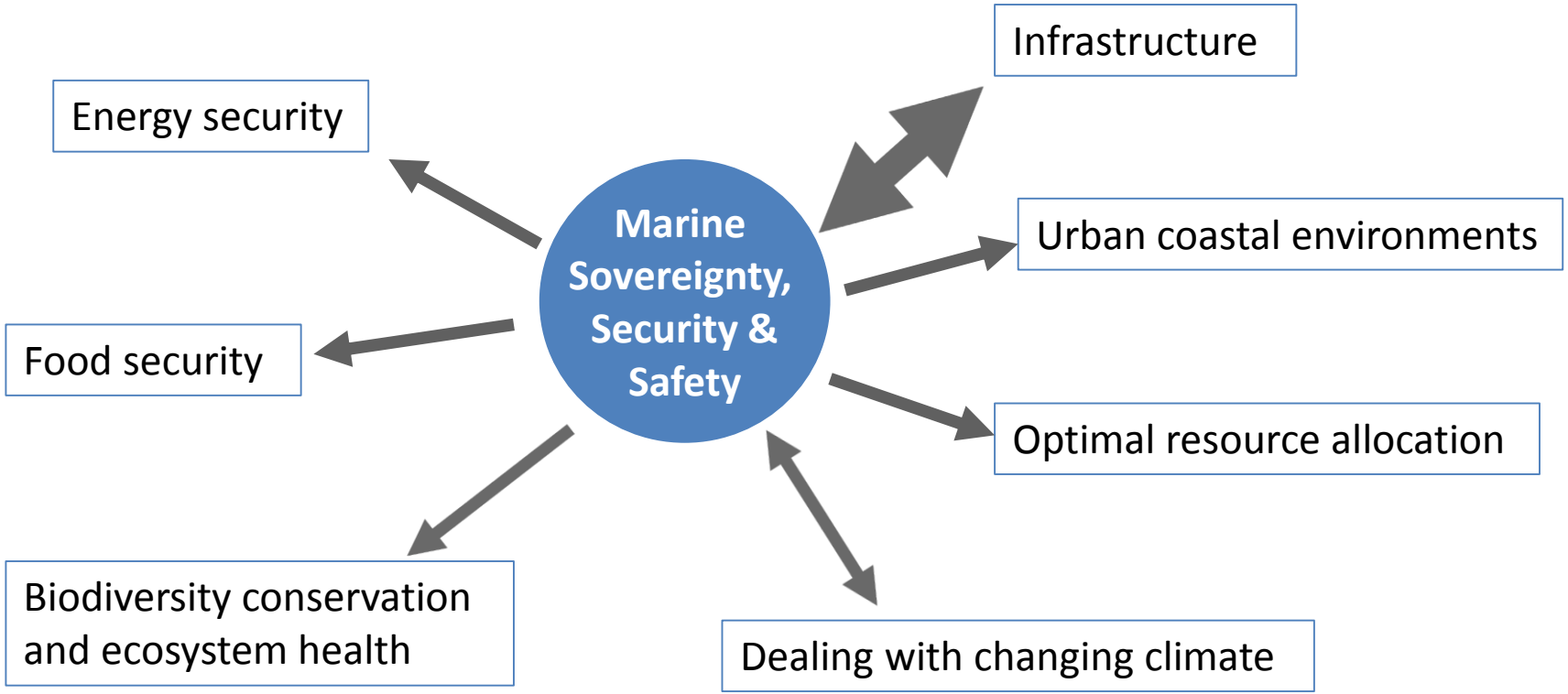
- **Coastal engineering, aquaculture and fisheries, shipping, tourism, recreational boating, …**

- **Governments: Emergency Services, Defence, EPAs, …**

Research Community

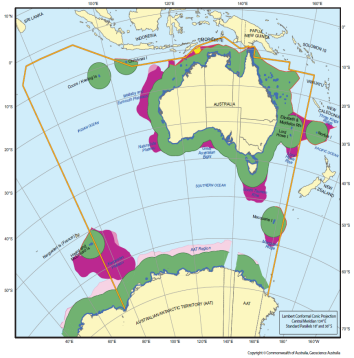
- **Universities, e.g. Swinburne, UNSW, UTas, UWA, …**
  - dedicated funding for research programs (ARC)
  - dedicated teaching programs in marine science
- **Leading federal and state government R&D providers: AIMS, BoM, CSIRO, DSTO, GA, SARDI, …**
  - mission-driven, multidisciplinary and operational (BoM)
  - creating opportunities for Australian research students and graduates

Linkages With Other NMSC Themes



Bathymetric Mapping

- Australia's **continental shelf** almost completely defined ("Legal Continental Shelf"). Exceptions:
  - Australian Antarctic Territory (AAT)
  - Joey Rise at north-western corner of Exmouth Plateau
  - Williams Ridge, part of Kerguelen Plateau



- **Coastline and Territorial Sea Baseline**: comprehensive mapping program underway (GA, State Govt's, AHS). Scale: 1:1000

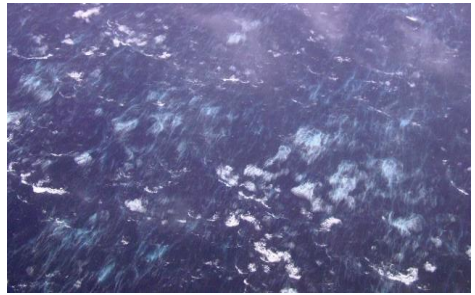
- **But significant gaps exist in high-resolution bathymetric data**:
  e.g. Great Barrier Reef is least well mapped area of Australian jurisdiction
  ➔ needed for many scientific & operational applications, e.g. inundation forecasting

Natural Hazards

- **Natural hazards** are severe and extreme weather and climate events that occur naturally in all parts of the world, although some regions are more vulnerable to certain hazards than others
- **Natural hazards** become **natural disasters** when people's lives and livelihoods are destroyed

by WMO

Marine Hazards in Deep Water

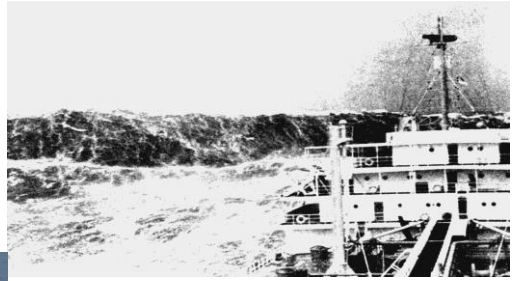


- **Destructive winds**

  for example, tropical cyclones

- **Large, steep and breaking waves**

  can reach more than 10 m in mean wave height



- **Rogue waves**

  at least twice as high as the mean waves, unexpected

- **Wave-current interactions**

  steepen the waves, cause rogue waves

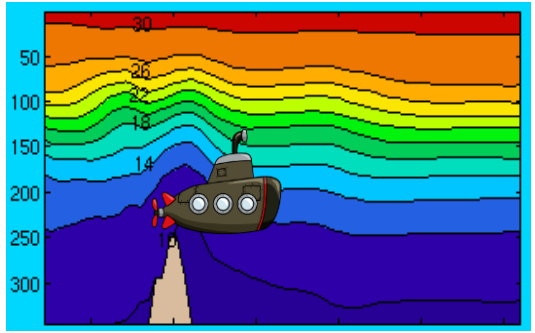
Marine Hazards in Coastal Domain

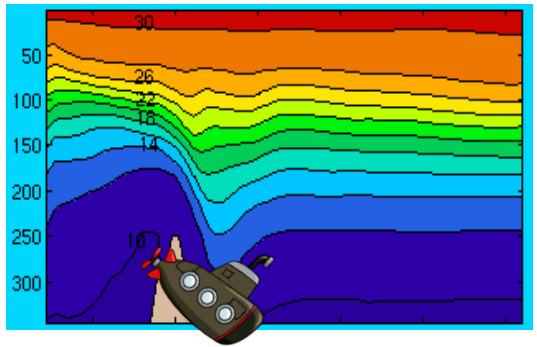
- Large waves
- Rogue waves
- Rip currents
- Coastal erosion
- Storm surges
- Sea level rise
- Tsunamis

Marine Subsurface Hazards

- Abnormal currents

  can be two orders of magnitude greater than the mean
- Internal waves
- Underwater landslides: tsunamis





Poorly understood, not predicted

Threats of failure or damage for offshore industry, underwater pipelines, submarine operations

Marine Biological Hazards

- Algal blooms
- Coral bleaching
- Invasive species

Can be accelerated, enhanced or initiated by changes to the geophysical environment, such as

- tropical cyclones over the Great Barrier Reef

- global warming

Marine Hazards: Science Issues

Common topics: interaction of wind, waves and currents, landslides/tsunamis and sea level rise (& biological hazards)

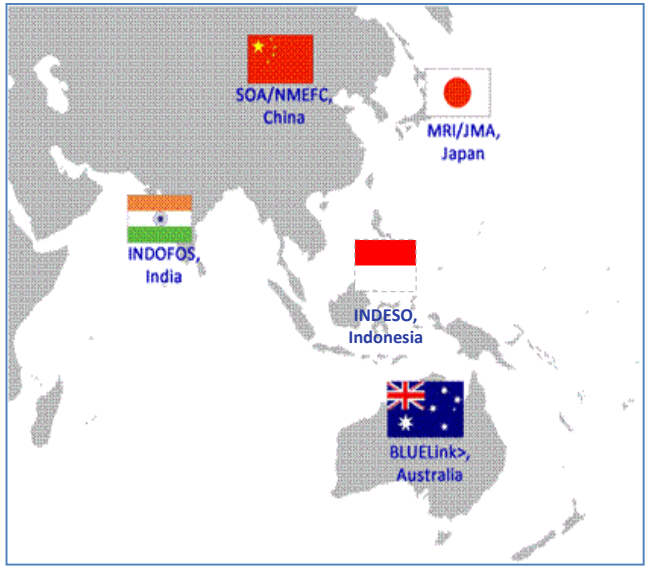
General science questions:

- **Climatological:** what is the general nature of wave and current patterns and how do these vary in time?
- **Operational:** what impact will present and predicted waves and currents have on specific activities?
- **Design:** what is the statistical character and probability of extreme winds, waves and currents and how might these impact coastal ocean infrastructure and adjacent settlements?

Marine Hazards: Science Approach

- Statistical approaches and extrapolations are not reliable for rare and extreme events
- **Fundamental research** into the nature of hazards and extremes
- **Physical modelling** of extreme events
- **Observations:**
  - In situ observations, consistent and long-term
  - Remote sensing, satellites, aircraft, radars
  - Dedicated observations within the natural extreme environments and events

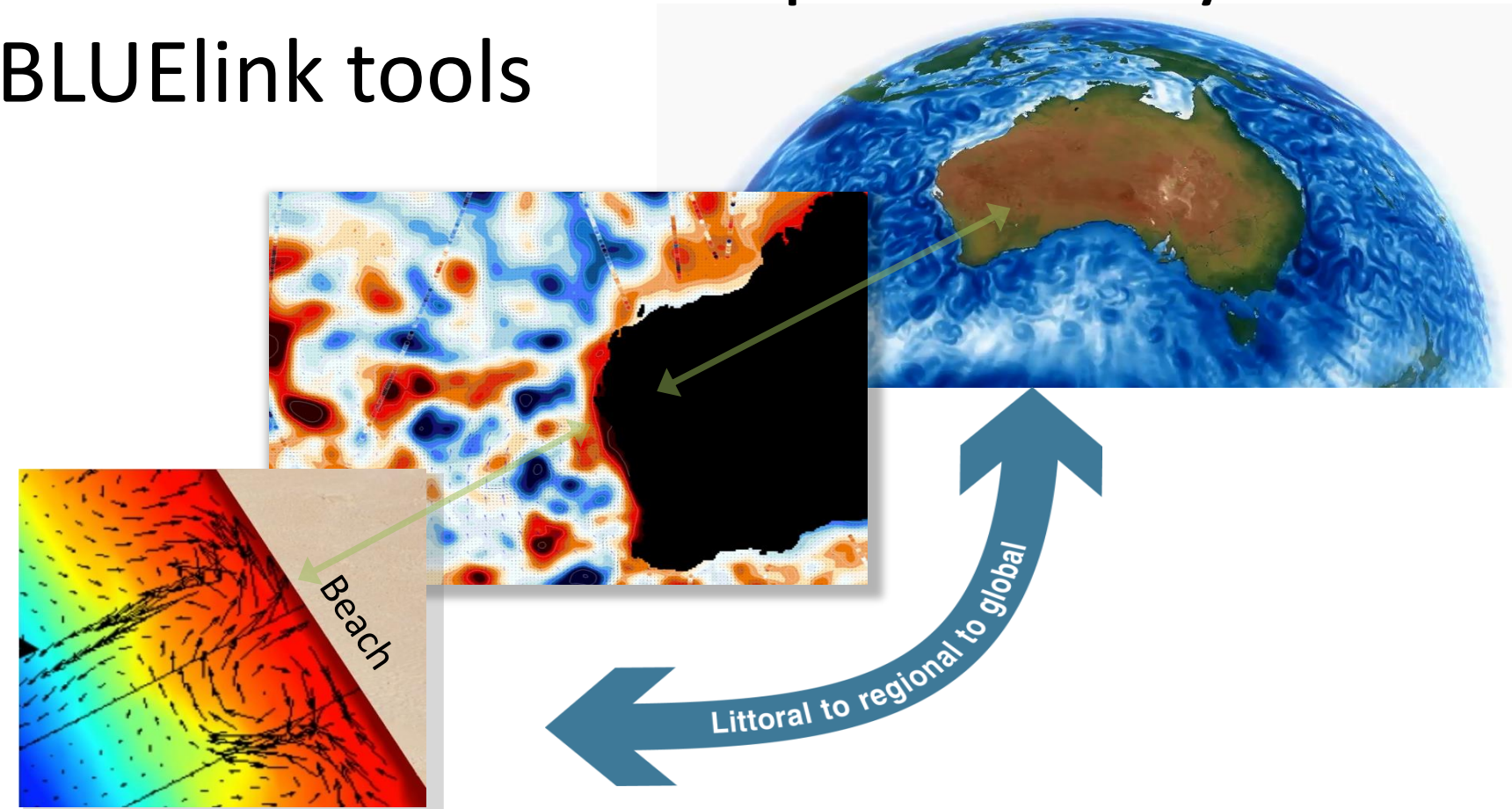
National Security



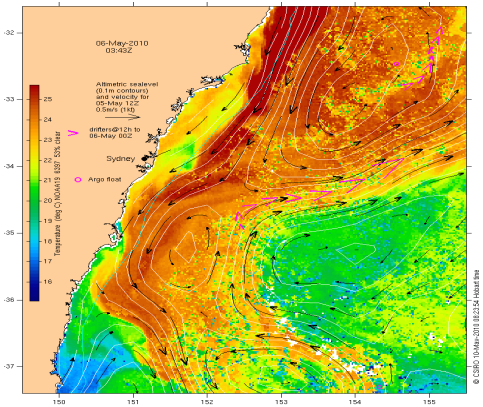
"The operational Navy requires accurate ocean and wave predictions to support Search and Rescue, anti-piracy initiatives, route planning, mine warfare, anti-submarine warfare, and amphibious operations."

Allard et al., 2014 (US Naval Research Laboratory)

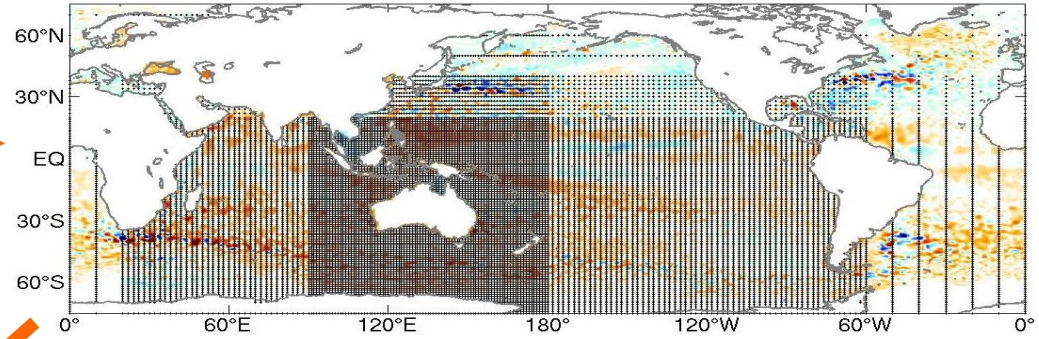
Scale of information provided by BLUElink tools



Ocean and Wave Hind- & Forecasting

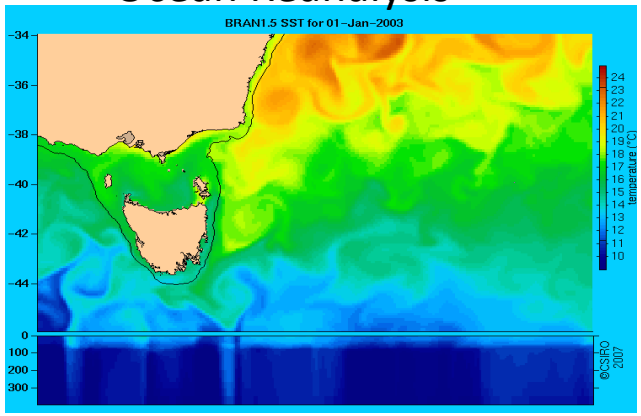


NRT Ocean Analysis



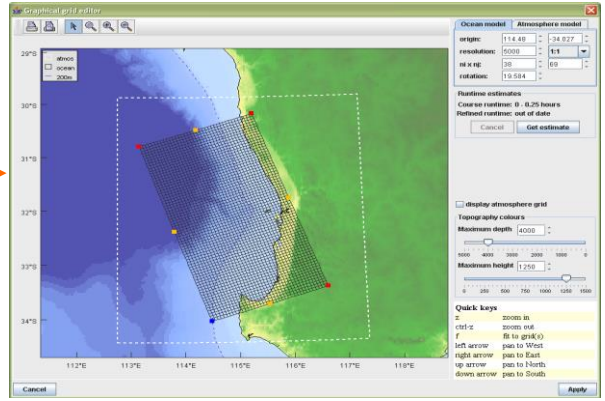
Global Ocean Modelling and Data Assimilation

Ocean Reanalysis



BoM: operational ocean forecasting and public service delivery

Regional Modelling and Data Assimilation (plus Littoral Ocean Modelling)



Modelling and Forecasting for Security: International Status

"Future versions of COAMPS [US Navy Coastal Ocean-Atmosphere Modelling and Prediction System] represent the first successful step toward a fully coupled modelling environment, where exchanges between the **ocean, atmosphere, ice, land, hydrosphere, biosphere, and space** occur in real time."

Bub et al., 2014 (US Naval Oceanographic Office)

US Navy schedule 2016: $(1/25)^{o}$ [~ 4 km at Equator] operational global ocean forecasting system

Modelling and Forecasting for Security: National Challenges

Australia:

- Need for nationally coordinated approach in coastal ocean predictions, including the ability to quantify contemporary and future coastline variability
- Bluelink: resource limitations – imminent risk of losing connection to leading-edge science; dependence on overseas systems (global-regional-littoral)
- **R&D required:**
  - coupled ocean-wave-ice-atmosphere-biogeochemical (incl. nutrients and carbon module)
  - global explicit tides
  - enhanced data assimilation (ensemble prediction), e.g. HF radar, sea-ice, biological/biogeochemical observations
  - routinely produced error estimates
  - up-to-date production of ocean reanalyses

Propositions (1)

- Comprehensive **national bio-physical-sediment observing system**, from deep water to coastal to littoral zone, in situ and remote sensing. National database, ongoing and consistent
  - e.g. dense (nation-wide) coastal HF-radar network to observe currents and waves for research, forecasting services and border security applications
- **Short-to-medium range (days to weeks) uncoupled and coupled atmosphere/ocean/ice /waves/land/biogeochemical models** in forecast and reanalysis mode, from deep water to coastal to littoral zone, initialised by observations
- Utilising and tailoring **overseas experiences and expertise** wherever possible and appropriate

Time Scales: Shelf-Scale Monitoring & Modelling

➢ **0-5 years:**

- Improve modelling and understanding of processes and interactions of physical & biogeochemical parameters on continental shelf scales
- Continue to leverage existing international efforts such as GODAE OceanView, CLIVAR and IMBER

➢ **5-10 years:**

- Sustained marine observing systems
- Develop and implement hazard impacts prediction services, building on knowledge
- Develop and implement fully coupled atmosphere/ocean/waves/bottom/coast modelling, high resolution, with assimilation of, e.g., in-situ data, coastal radar systems and satellite observations
- Development and implementation of coastal ocean interpretative tools to facilitate user uptake (linked to global and littoral zone tools)

➢ **20 years:**

- Operationally sustain marine observing and forecasting/reanalyses systems

Propositions (2)

- Increasingly, **service delivery to private and public sector** key to uptake
- Establish **Centre of Excellence on Marine Extreme Events** (related to White Paper about "*Establishment of a national coastline observatory facility*"); fill gap between TERN & IMOS (littoral zone)
- **National Committee for short-term fast track priority implementation**, between government, research community, industry, Navy etc.

Summary

- **Enhance capabilities** in national hydrographic, operational oceanographic and marine hazard forecasting, including coastal and littoral zone components
- Monitoring, analyses and forecasting of deep water, ocean waves, tsunamis, cyclones etc. require **long-term commitments** to meet growing public and private sector requirements (e.g. growing populations in coastal margins)
- Aspirations need to be supported by
  - **a wide range of observations and**
  - **national computational infrastructure**

  to feed into forecasting and compliance systems

Thank you!

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