



Collaborative Approaches for Swell Affected Operations on Australia's North West Shelf

Forum for Operational Oceanography
Fremantle, July 2017

Presented by Greg Williams, RPS MetOcean

- Part of the RPS Group, an international consultancy offering a wide range of services, including metocean measurement, management, and modelling
- Over 40 years of local metocean measurement, design and engineering criteria, operational limits, government and industry tropical cyclone databases, and realtime systems – for mining, oil & gas, defence, ports and harbours
- Ongoing involvement and collaboration with government agencies, CSIRO, WAMSI, APPEA, Curtin, UWA, IMOS, and others
- Instrument design and fabrication, innovation, calibration, good science
- Fundamental aims of quality assurance, quality control, data management

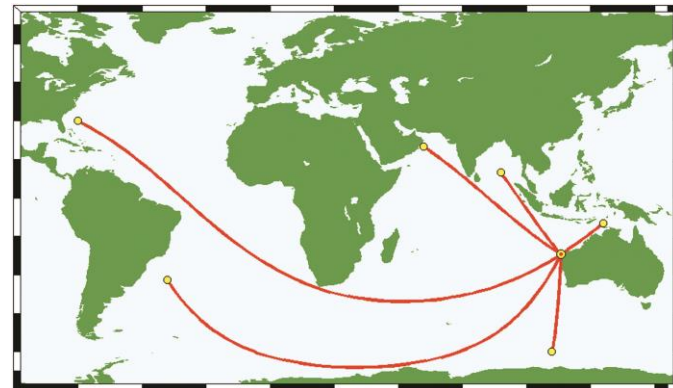
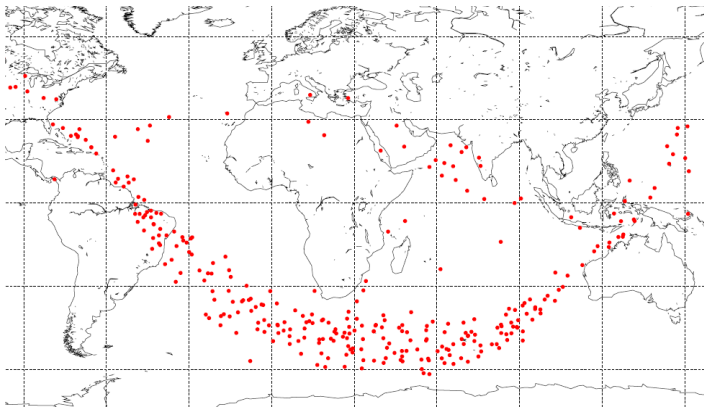


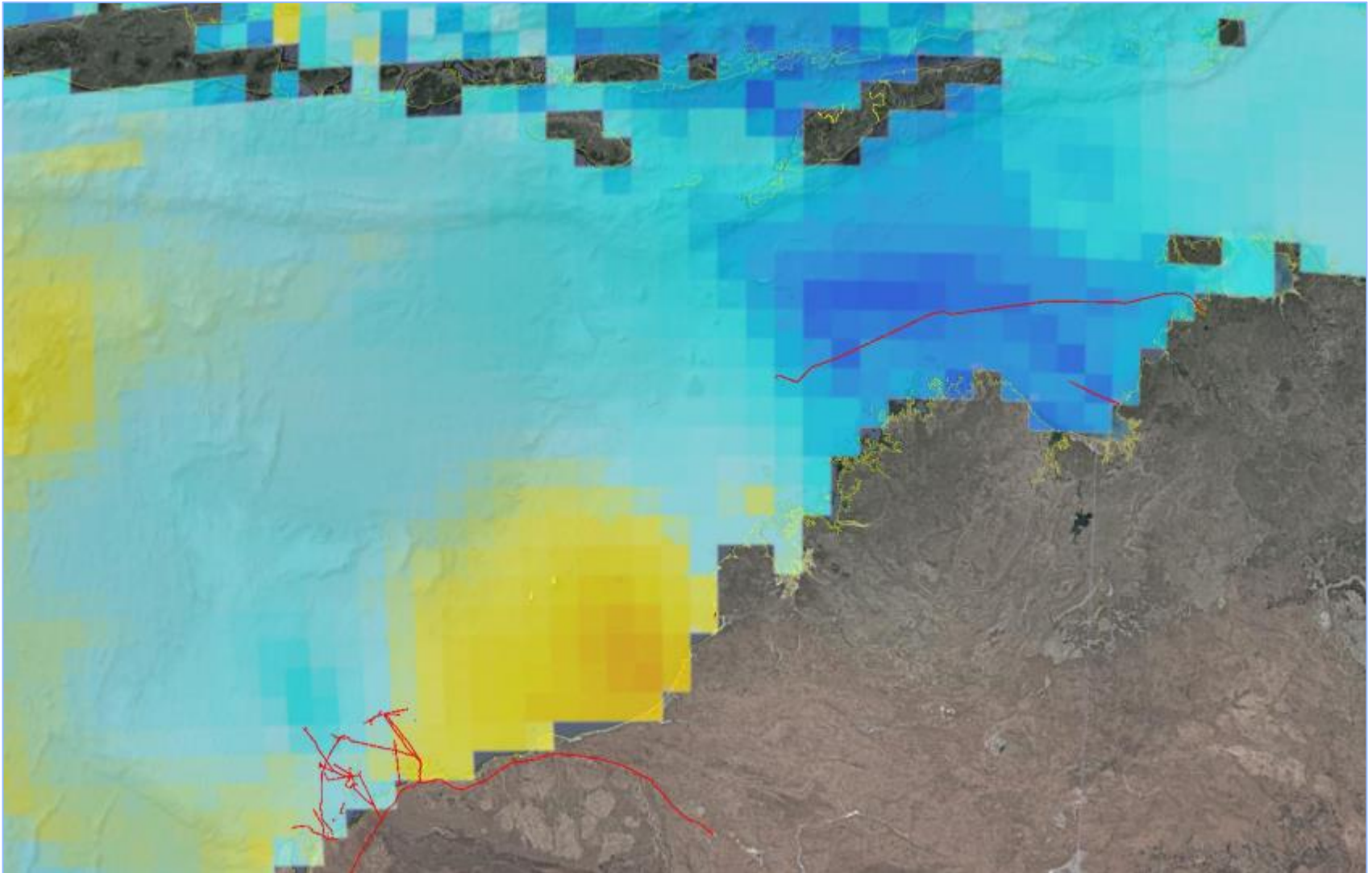
- Mining and oil & gas industries provide the bulk of WA revenue and a large proportion of Australia's wealth
- Largest producer and shipper of iron ore in the world
- LNG export capacity is 87 million tonnes per annum (largest of any country)
- A **trillion dollars** of coastal installations, LNG terminals, ports exporting iron ore, and oil & gas production facilities
- Offshore oil & gas fields, wells, subsea infrastructure, pipelines, platforms, and floating facilities in **the most exposed and extreme** environments in the world
- Formation zone for some of the **strongest tropical cyclones** in the world
- Severe storms originating in distant ocean basins generate **very long-period swells** into the North West Shelf

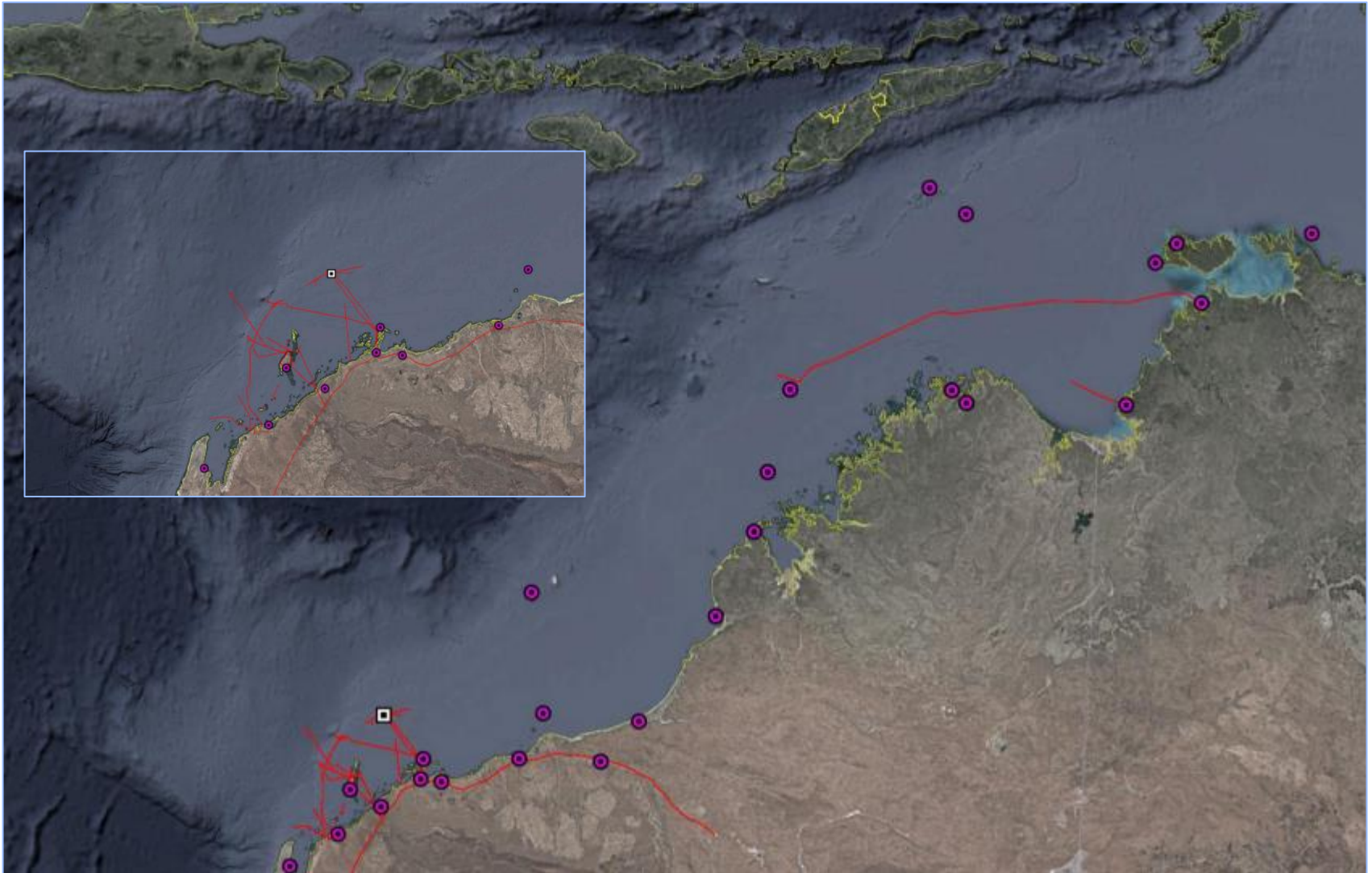
A frontier of high importance to government, mining, oil & gas, service industries, and offering research opportunities and commercial applications.

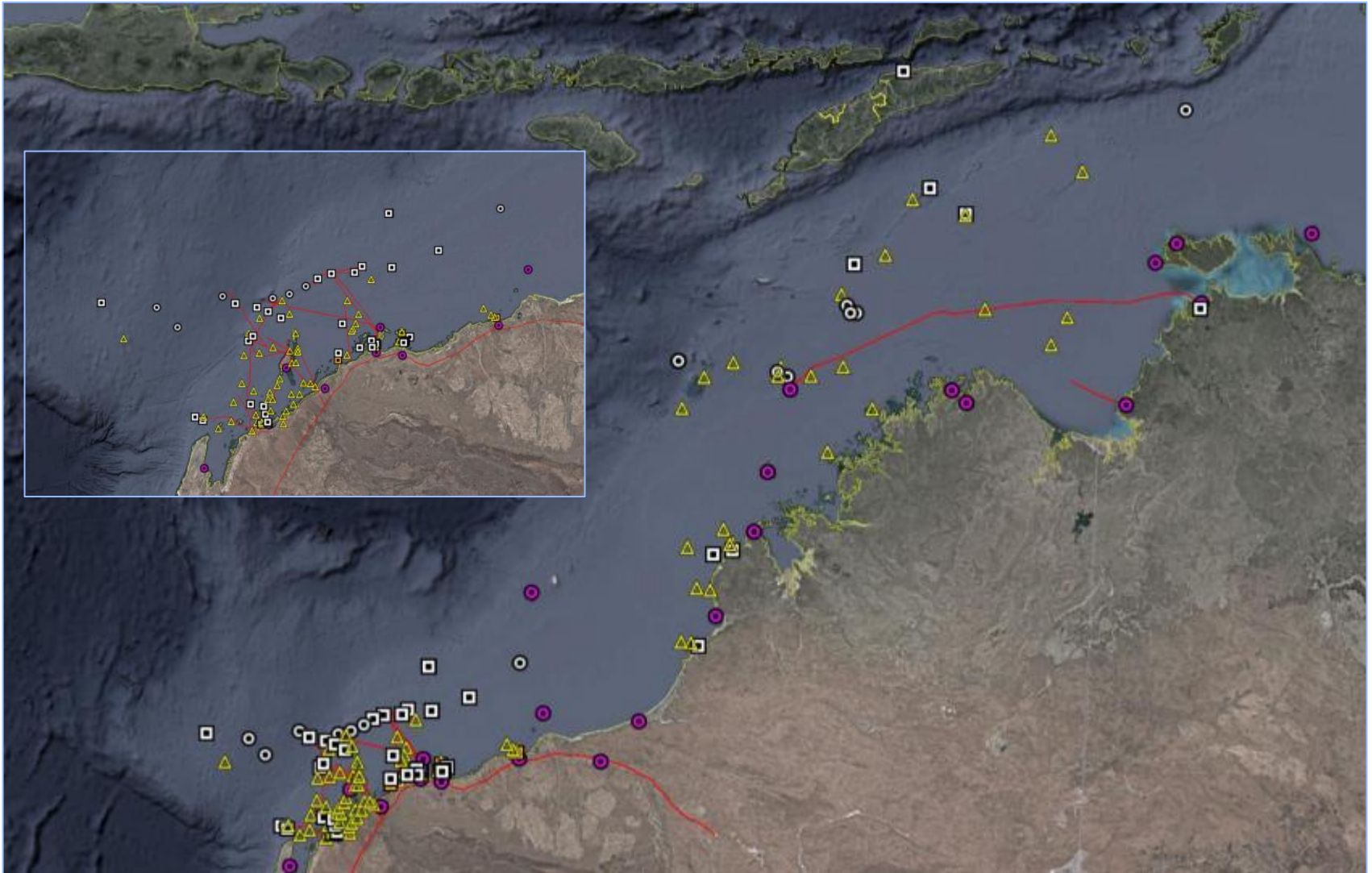
- **No single operator or government agency** has the budget or coverage to offer a full view of swell arrival or cyclone impacts in this region
- **Collaboration and data-sharing** offer the only reasonable and efficient solution to supporting operations in the NWS, protecting assets, and reducing risk

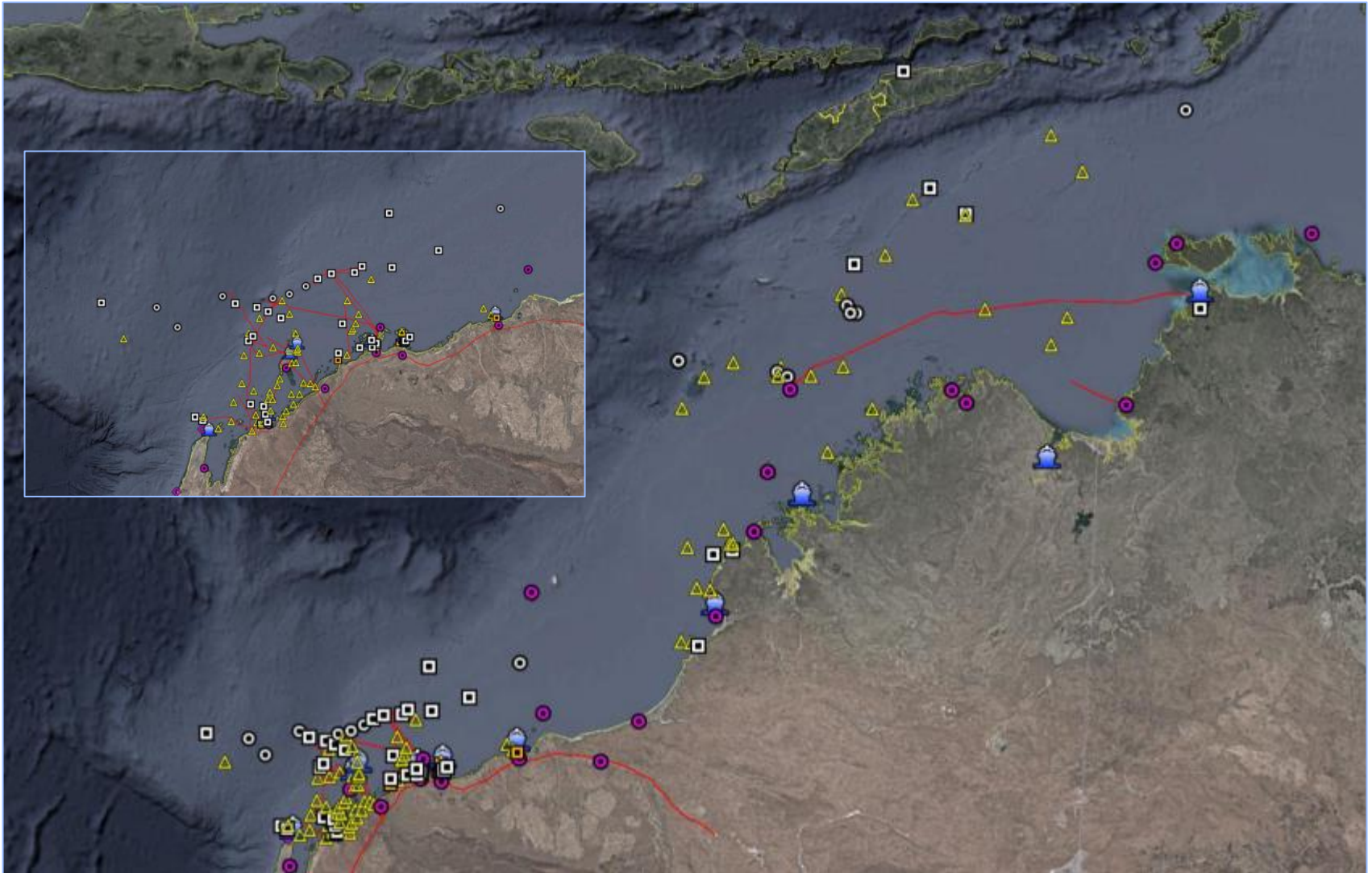
This is a case for a regional North West Shelf swell monitoring and prediction network, with all available information used and presented in a single system, to provide a clear understanding across all industry groups.

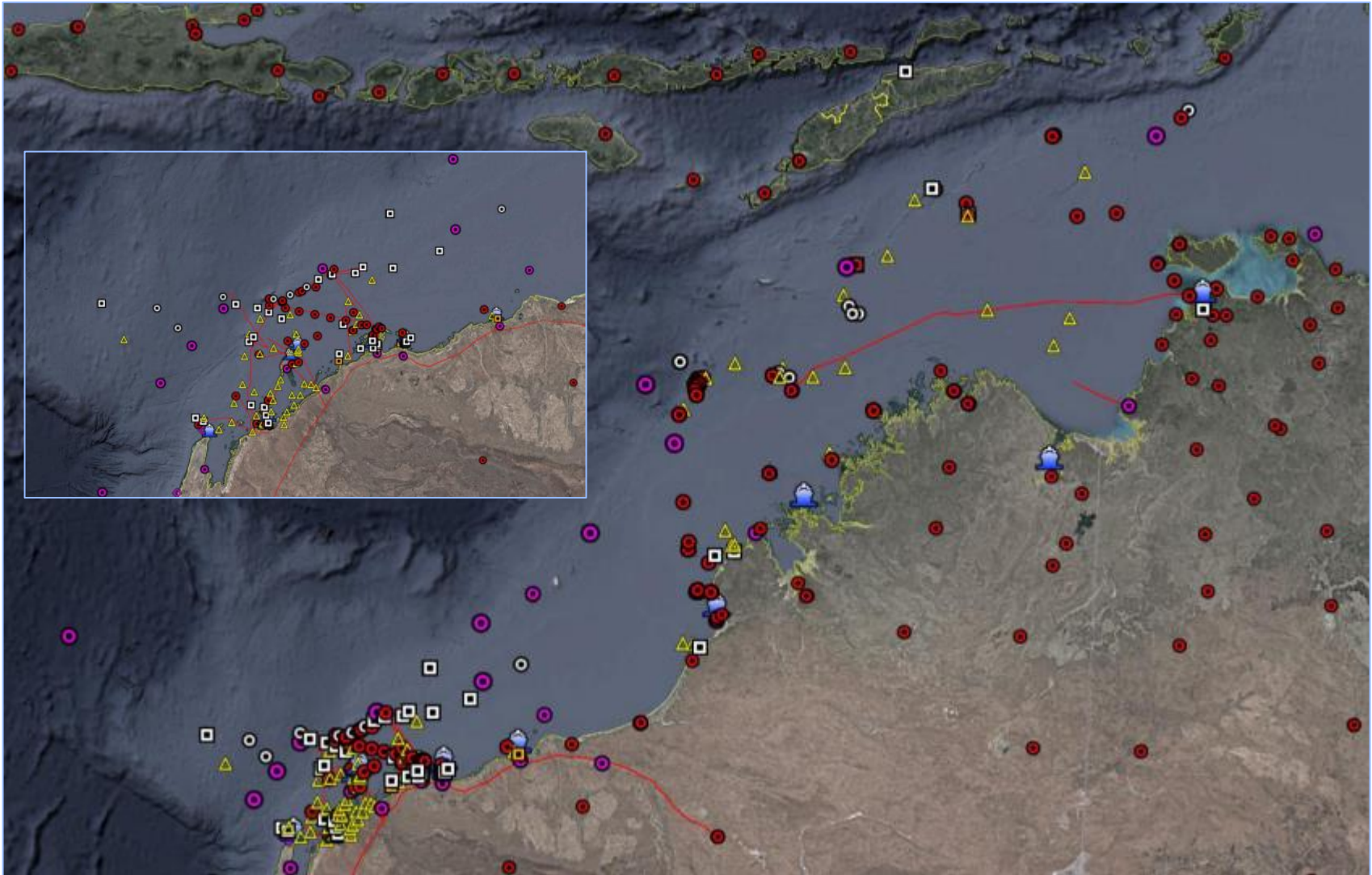


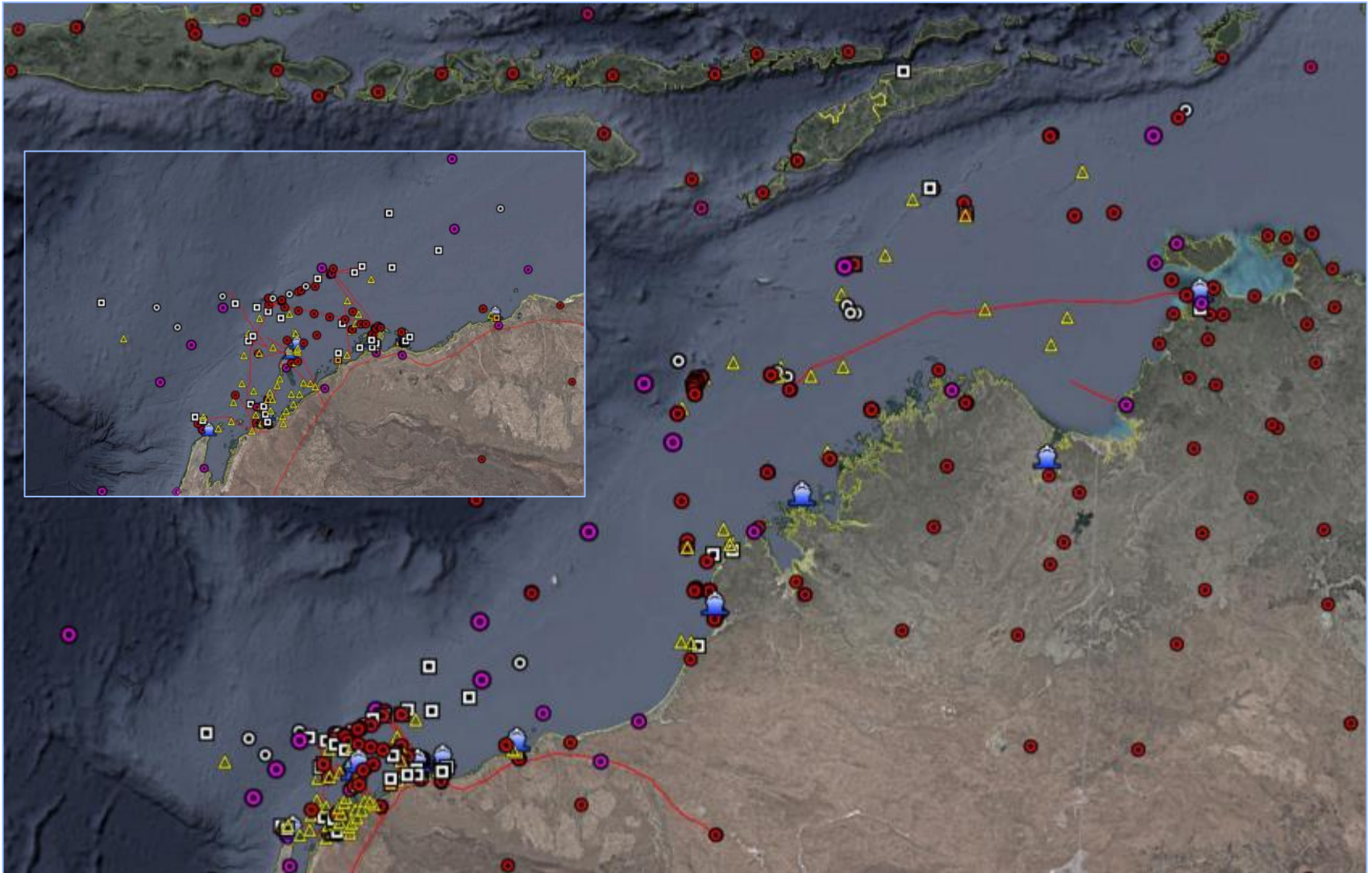


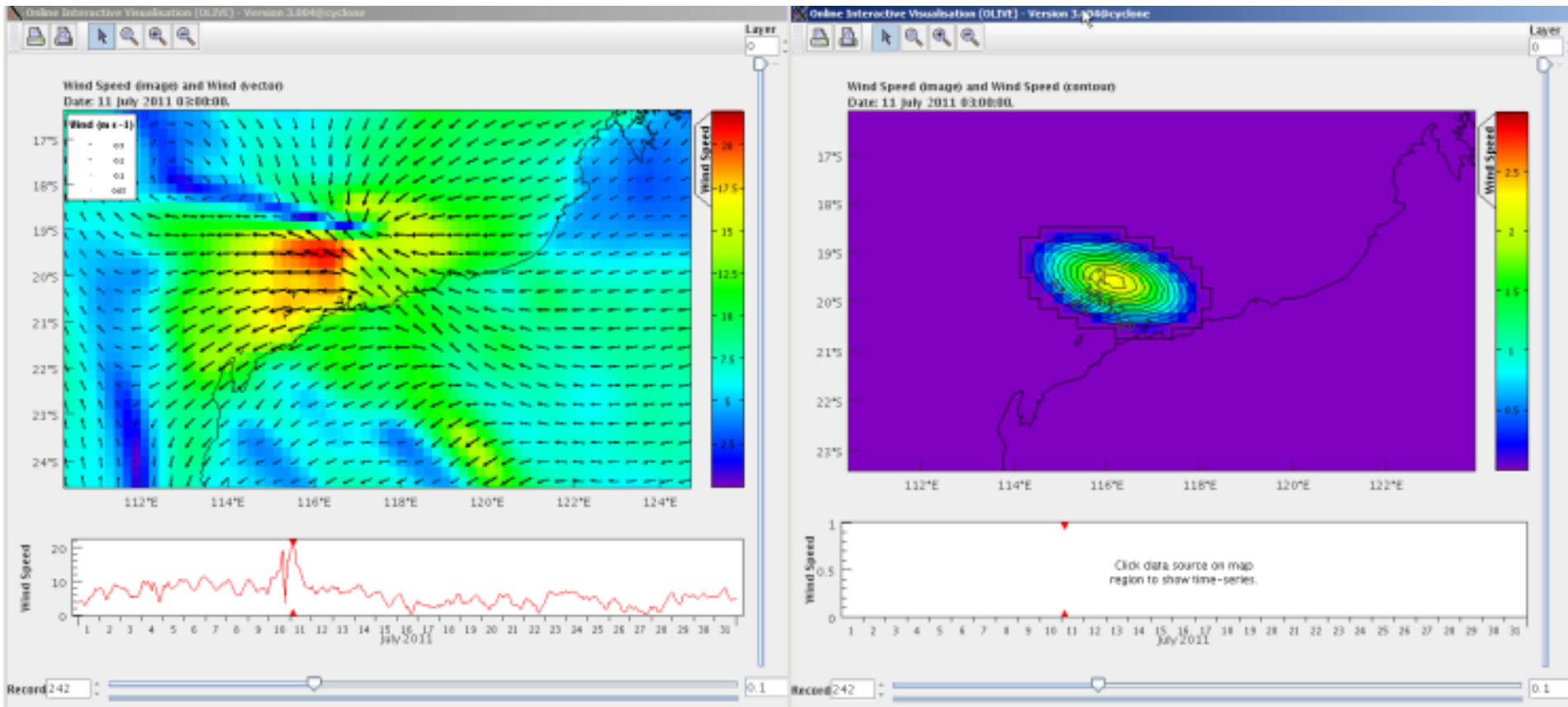




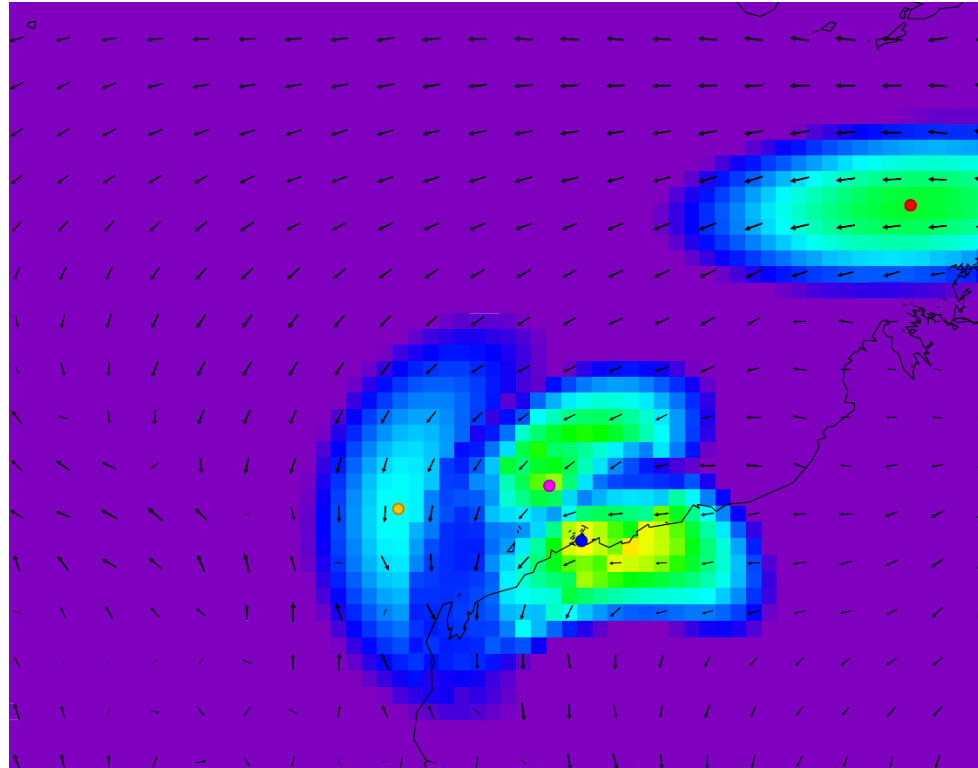




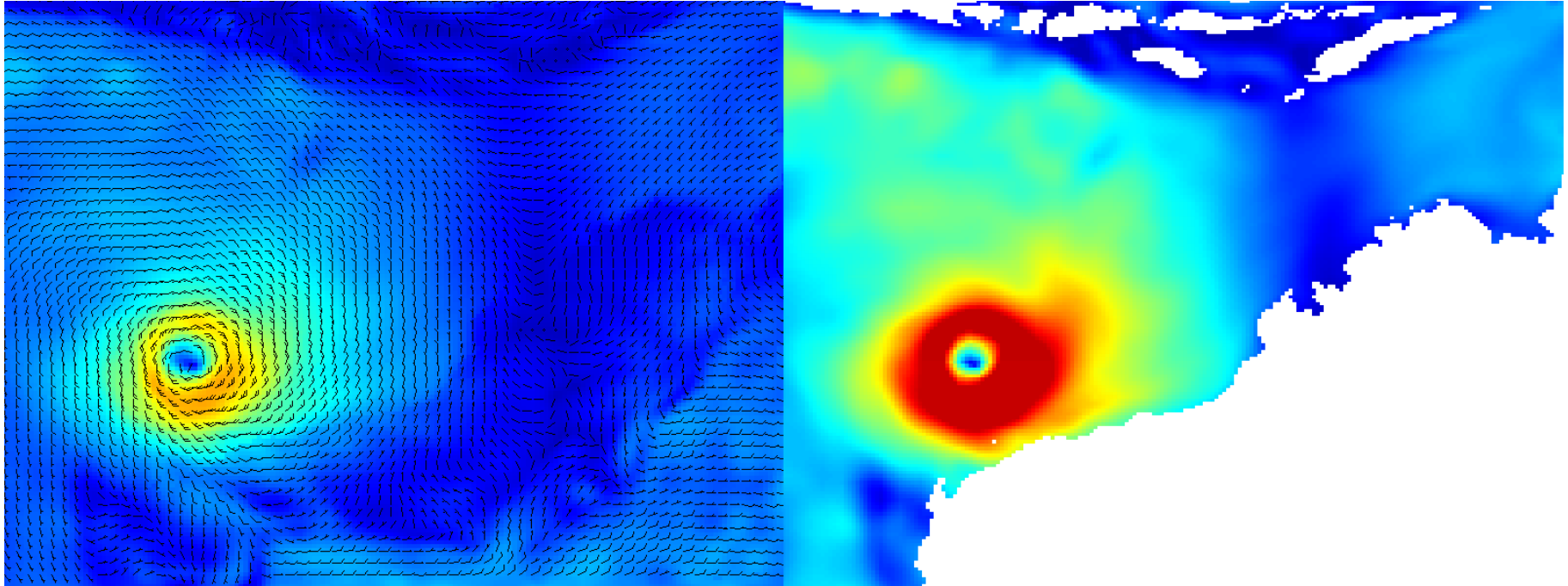




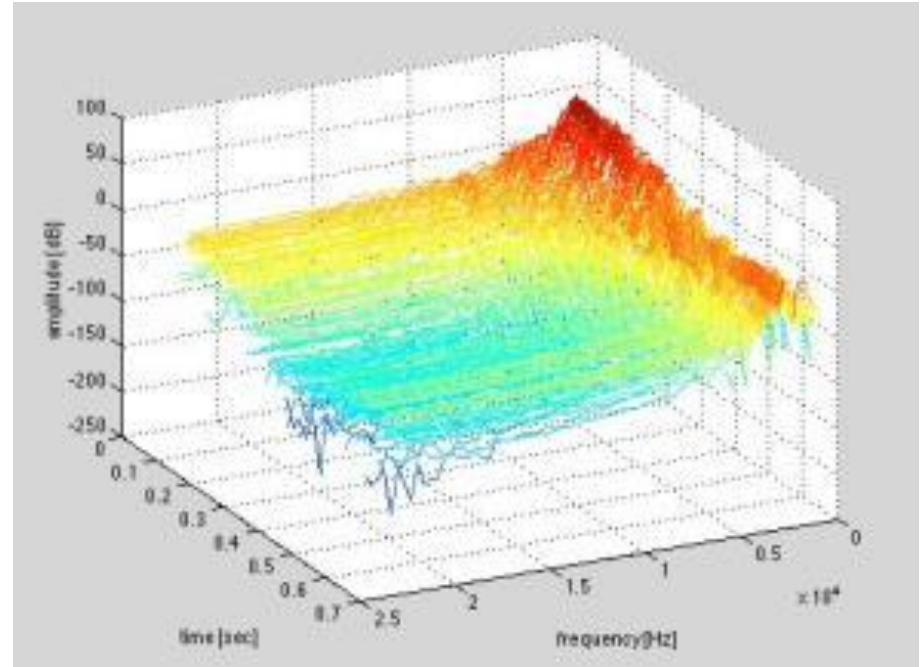
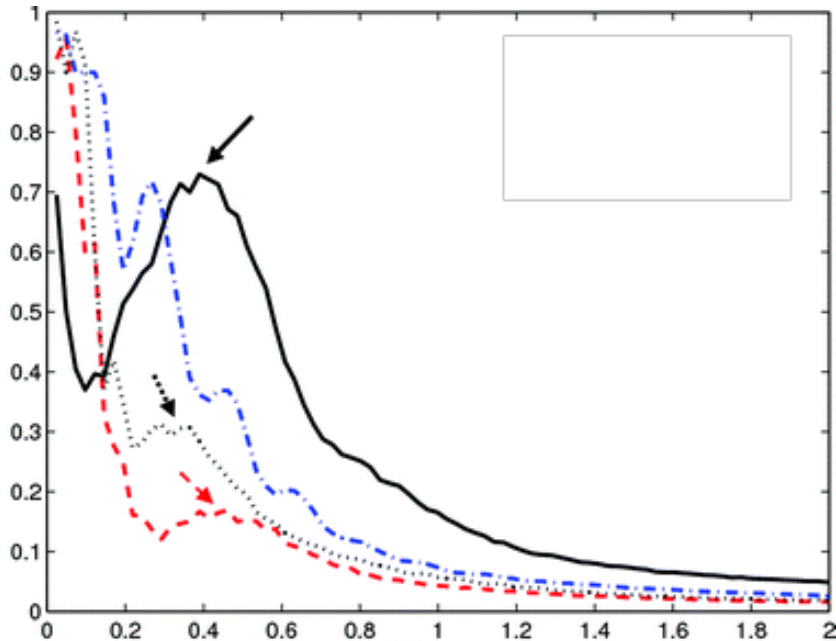
Using an objective analysis technique, the influence of a single site measurement (right) into a gridded wind field (left) used in model forcing improves local wind-sea and swell propagating to adjacent sites.



Multiple measurement sites improve the nearshore wind field over a larger area, support automated quality-control of realtime data, and limit the influence of coastal effects from onshore measurements.

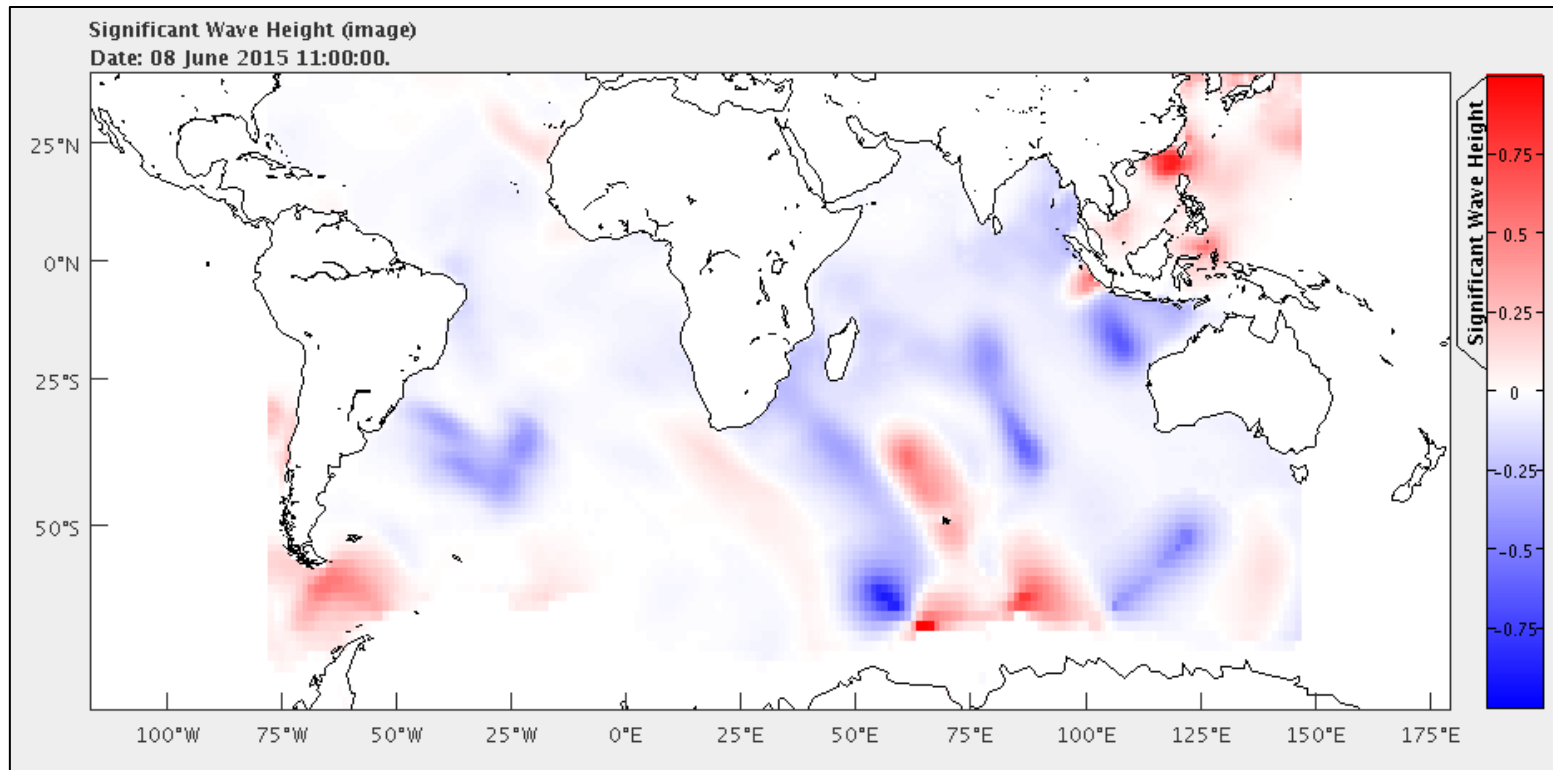


Blends official tropical cyclone position, intensity, movement, and profile into gridded wind fields to create vortex-corrected surface wind forcings. Blended vortex (left) results in correct energy transfer into the wave model sea state (right), and resulting short-period swell propagation.



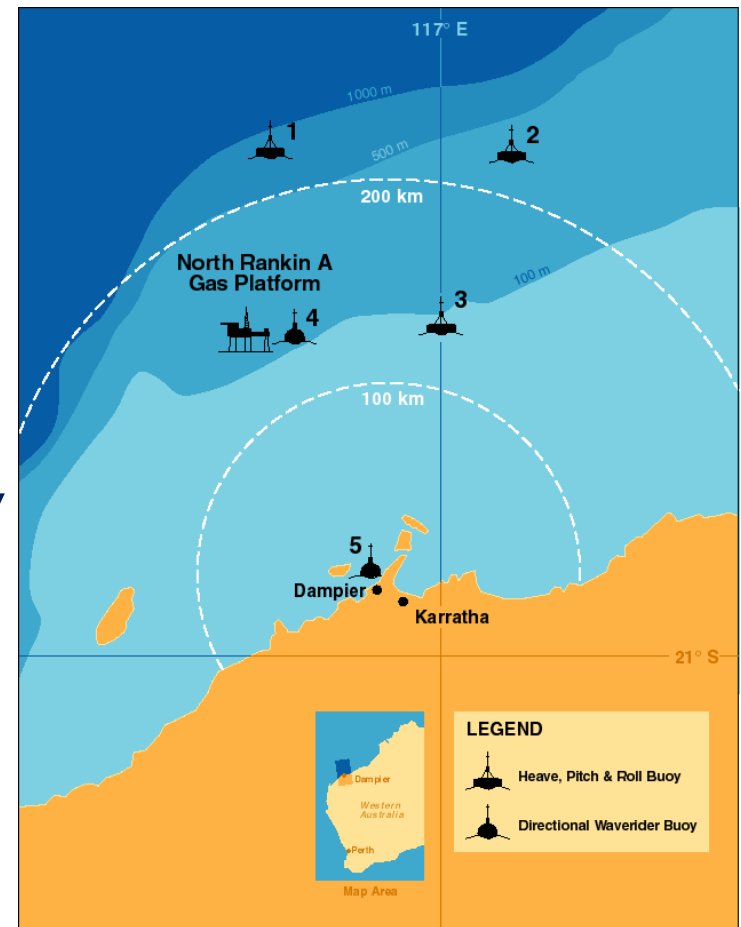
Wave measurements are used to calibrate spectral wave predictions (left) at coastal and offshore operational locations, resulting in correct energy distribution.

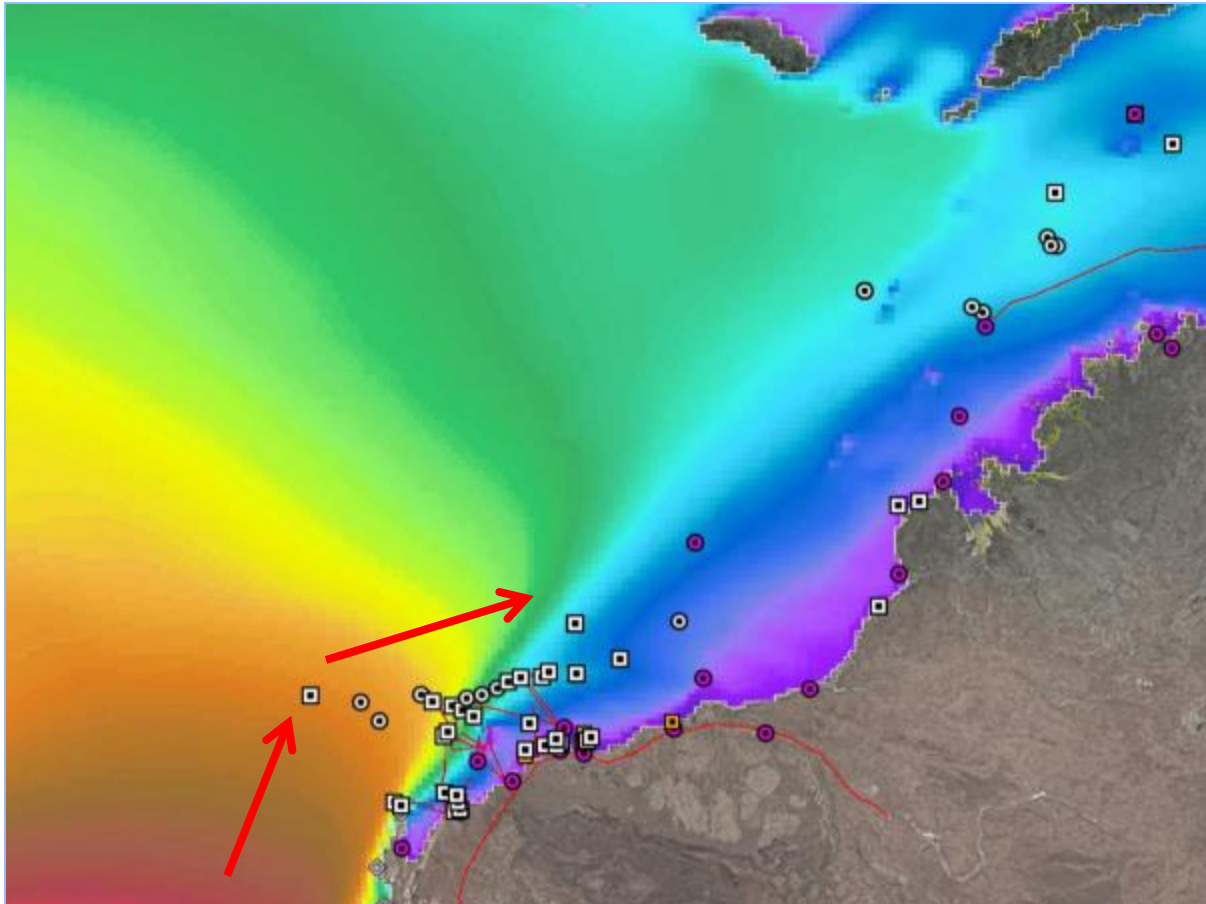
QC database provides profile coefficients from quality-controlled measurement datasets to improve predictions over time (right).



Remote wave heights derived from satellite altimeters are used to adjust swell fields during model data-assimilation, improving long-period swell arriving on the NWS of Australia.

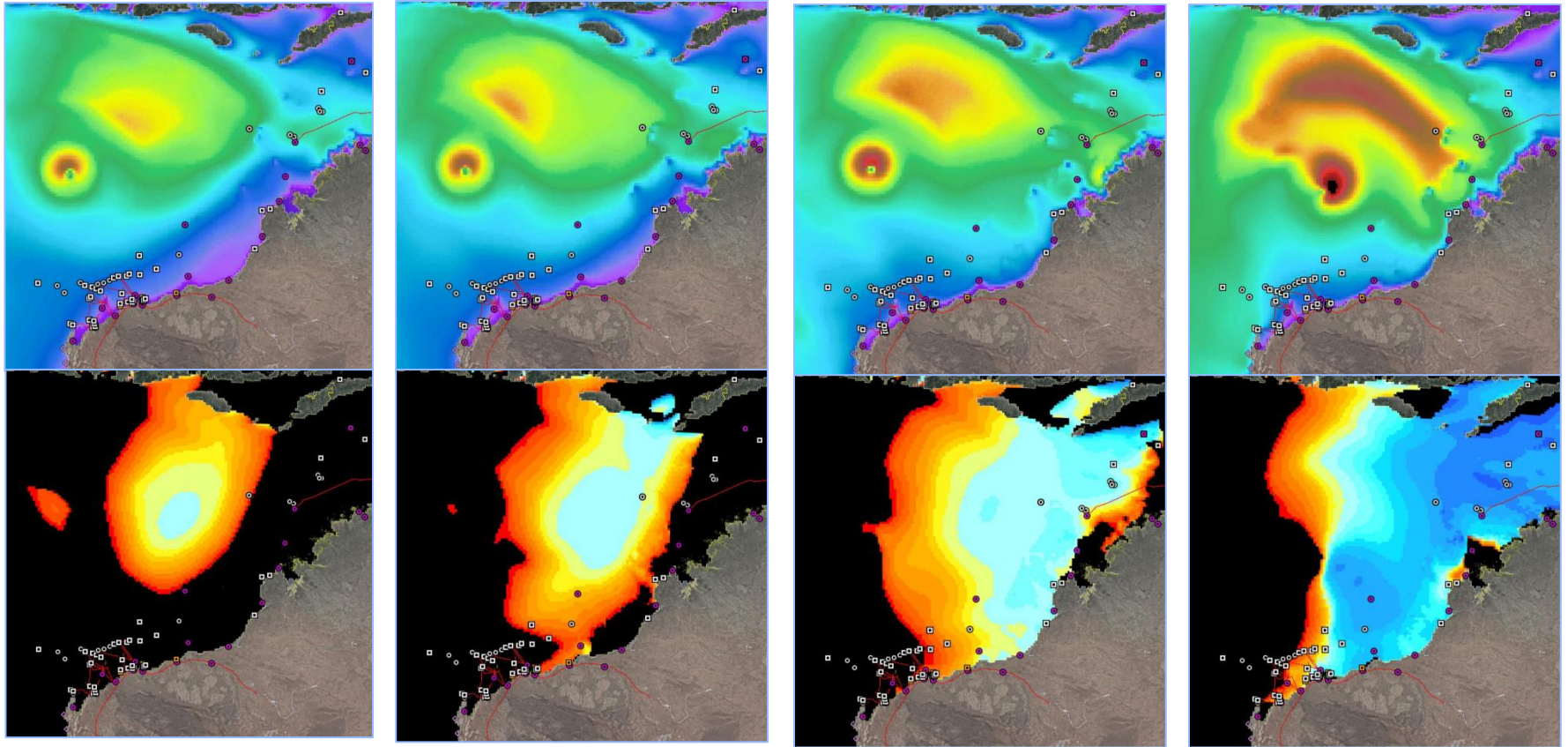
- Initiated in 1993 to provide tropical cyclone swell forecasts in Mermaid Sound for Woodside's LNG operations.
- Designed to give at least 4 hours forewarning of swell arrival.
- Based on real-time swell measurements from an array of offshore buoys
- Measurements fed into a reverse ray wave refraction model to propagate swell energy into Mermaid Sound and the LNG loading berth.
- Proprietary implementation, but spectral model and wave calibration produces similar results 12 hours ahead.
- Offshore to inshore swell propagation suitable for any NWS port.



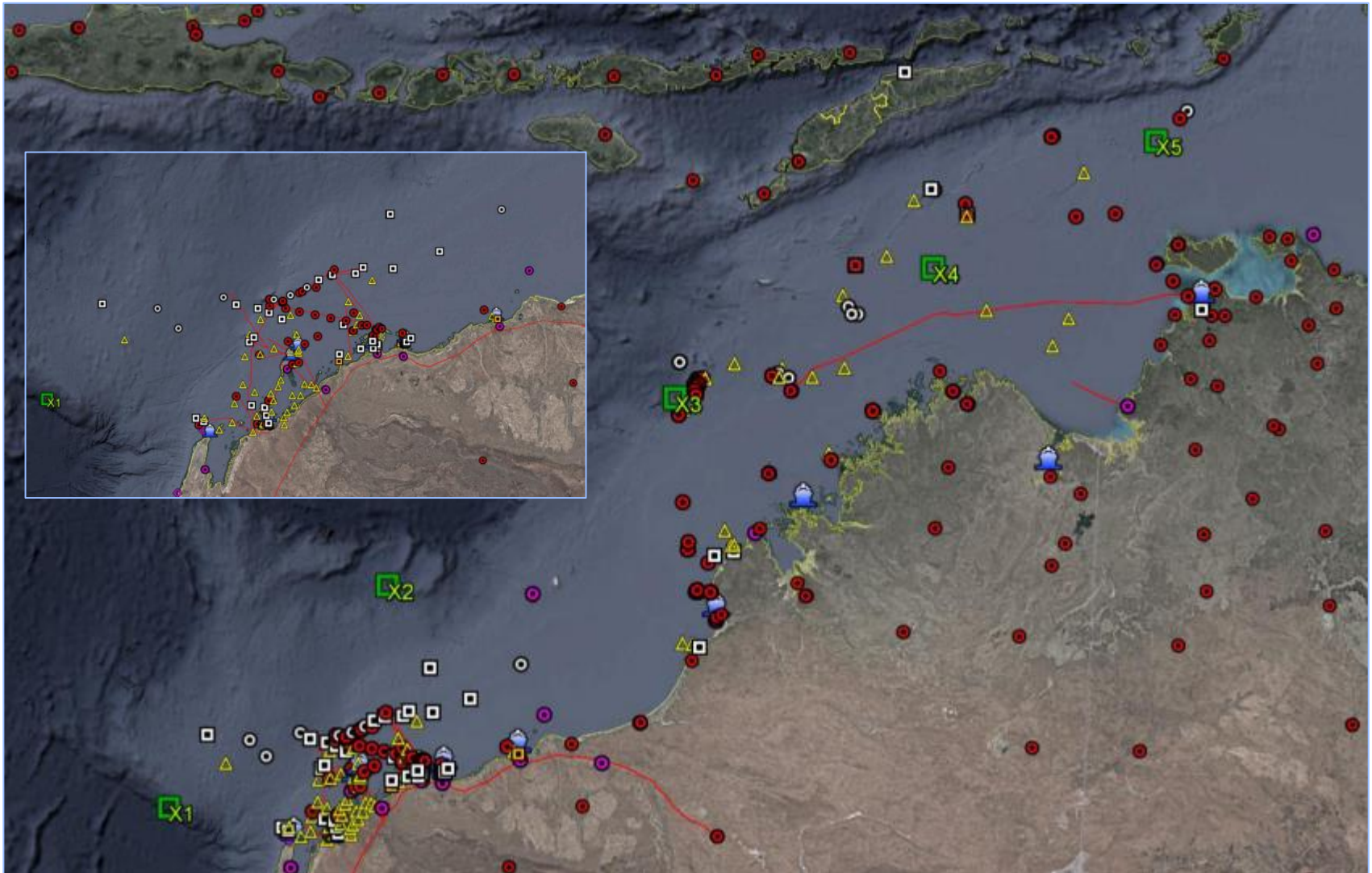


- Southern Ocean swell arrival from Indian Ocean
- NW Cape **shielding** effect
- Wave front **spreading**
- **Refraction** toward the NE, shoreward at shelf
- Some degree of **bathymetric steering** along the shelf-edge

Realtime wave measurements at outer NW Cape and Westerly sites establish swell energy propagating onward to NE/E sites. **Spectral wave calibration** and local **wind nudging** allow accurate predictions across sites within 300km.



TC Yvette (2016) held position for days, Top row (Hs plots) shows good structure and largest swells developing to NE sector. Bottom row (Tp plots) shows frequency band of 10-12 second period swell impacting ports and vessels along the NWS coast (blue = 10 sec, red = 12sec).





Questions?

For further information:
metocean@rpsgroup.com.au