Operational Ocean Forecasting capacity in the ASEAN region: The INDESO system

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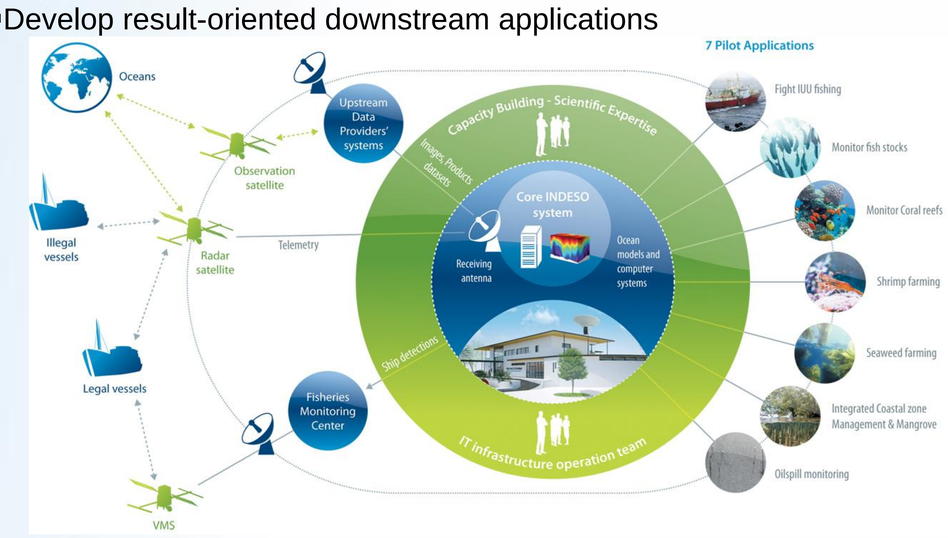
Context

➢**The INDESO solution**
- ▪Build and operate an operational center for monitoring and forecast (the Core System)
- ▪Implement an ambitious capacity building plan
- ▪Develop result-oriented downstream applications



➢**In this context, an Operational Ocean Forecasting center** is being currently developed to undertake activities on a weekly routine basis in order to:
- ▪Monitor the state of the Indonesian seas
- ▪Assess how Indonesian seas can be healthy, safe, clean and productive

Ocean Physics: Model vs data

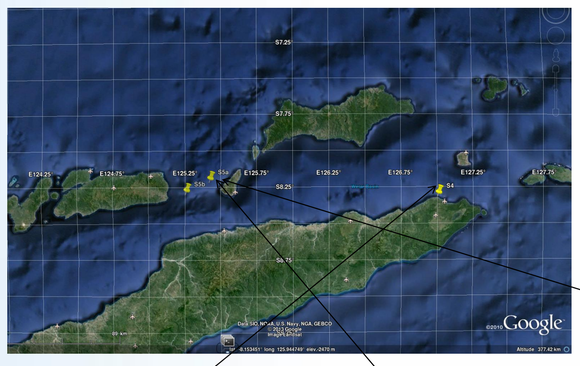


Fig.1: S4, S5a and S5b locations of CTD/LADCP profiles from INDOMIX campaign (Ombai Strait)

The INDOMIX campaign (July 2010) made some measurements in one of the most energetic section for internal tides through Halmahera sea and Ombai strait. Classical fine-scale CTD/LADCP measurements have been performed together with microstructure measurements at five locations, three in Halmahera sea, one in Banda sea and one in Ombai strait (Fig.1).

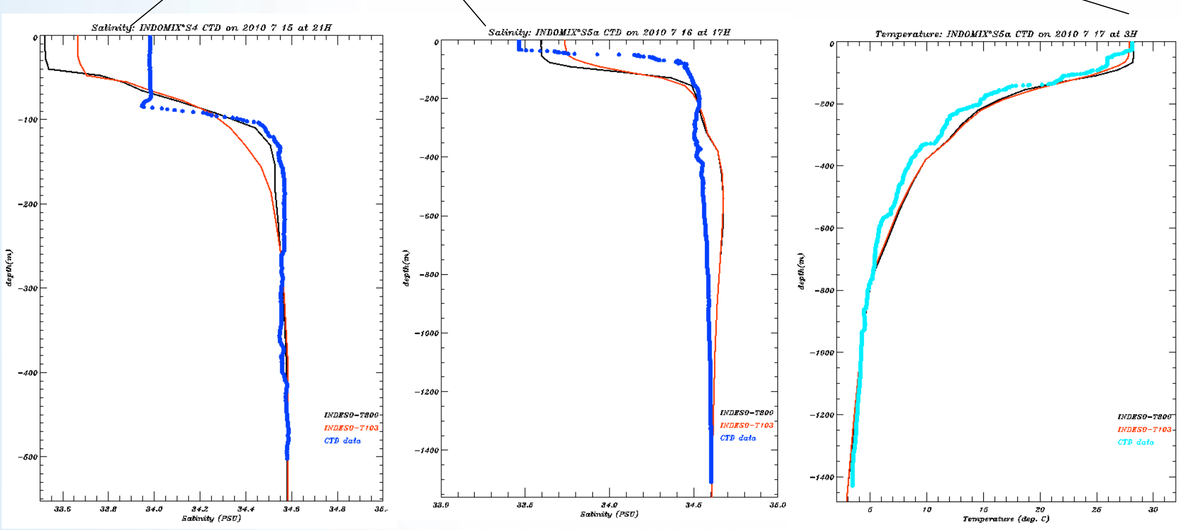


Fig.2: Salinity and temperature profiles at S4 and S5a locations from model simulations compared to data collected during the INDOMIX campaign (Ombai Strait)

Vertical mixing is very important in the Ombai strait. In the Figure 2, we see that water masses from 2 different simulations (tidal mixing changes) can be different. SSS from models are too high in S5a location and too low in S4 location. For these two different simulations, we also see that temperature profiles fit very well the observations.

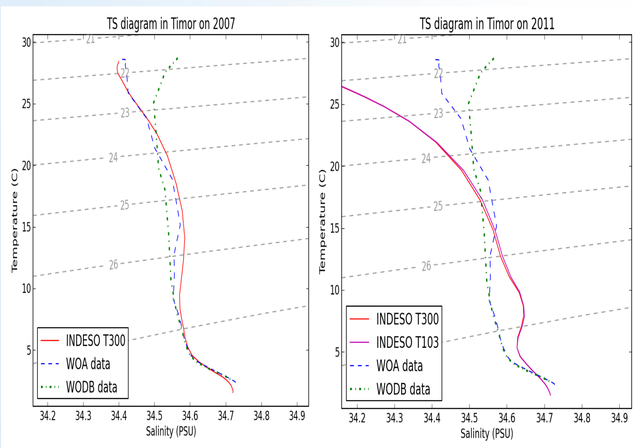


Fig.3: T/S diagrams calculated from yearly means (2007 & 2011) in the Timor region and compared to climatologies WOA 2009 and WODB 2001

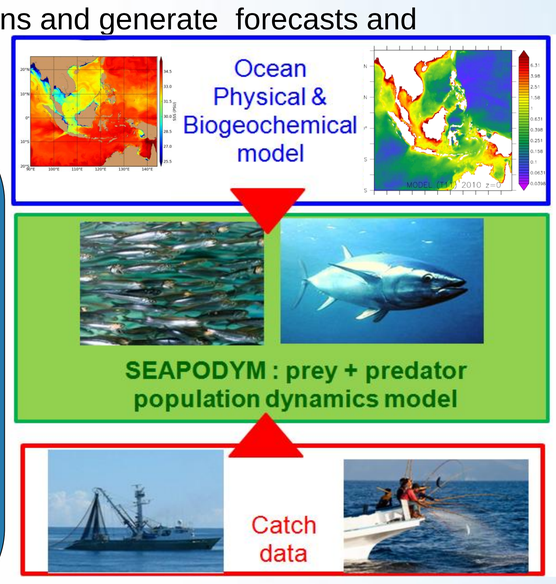
During their residence in the Indonesian archipelago, the incoming Pacific waters are transformed to produce a unique water mass associated with a unique tropical stratification having a strong, though relatively homohaline (34.58 psu, below 20°C), thermocline, see Koch-Larrouy et al 2008.
In our simulations and compared to climatologies (Fig, 3), this characteristic (see T/S diagram) is well reproduced. Some disparities exist depending on the year and a strong freshening occur in 2011 during the strong El-nina event (2010-2011). It could be due to the Surface fresh water coming from the Java sea water that represents the major freshwater input (70%).

Suite of numerical models

➢ **The Numerical models suite** consists of :
- ➢ocean physics,
- ➢Biochemistry
- ➢fish population dynamics

They are fed by satellite and in-situ observations and generate forecasts and analysis
useful for fish stock management

➢**The Ocean model** :
- ➢Based on **NEMO2.3** developed at Mercator Ocean for regional seas.
  - •ORCA grid at 1/12° (9 km) centered on Indonesian sea (20°S-25°N/90°E-144°E) with 50 vertical levels.
  - •Bathymetry : ETOPO2V2g (2') + GEBCO (1') +changes in main straits (Lombok, Ombai and Timor)
  - •Explicit tides
  - •Free surface: Explicite time-splitting
  - •Vertical mixing : k-ε + mixing parametrization induced by waves
  - •Tidal mixing: Koch-Larrouy parametrization (2007)



➢**The Biogeochemical model PISCES** (Pelagic Interaction Scheme for Carbon and Ecosystem Studies) see Aumont and Bopp, 2006
- •**It is a biogeochemical model of intermediate complexity designed for global ocean applications**.
  - •It simulates the **marine biological productivity**.
  - •It describes the biogeochemical cycles of **carbon** and of the main nutrients **(**nitrate, ammonium, phosphate, silicate and iron**)**.
  - •It has been successfully used in a variety of biogeochemical studies (e.g. Bopp et al. 2005; Gehlen et al. 2006, 2007; Steinacher et al., 2010; Tagliabue et al. 2010).
- •**Primary production** is simulated in this model with explicit phyto- and zoo-plankton components.
- •**The dissolved oxygen content** and the **alkalinity** are also explicitly simulated.
- •In the INDESO project: online-coupling at 1/12°

➢**External forcings:**
- •**Atmospheric forcing** : 3h dynamic and radiative fluxes from ECMWF at 1/8°
- •**Oceanic forcing** : Daily boundary conditions from the global ocean forecasting system at ¼ of Mercator Ocean
- •**Tidal forcing** : Astronomical forcing (tidal potential term) from TPX0.7 (Egbert and Erofeeva, 2002).

Biogeochemistry results

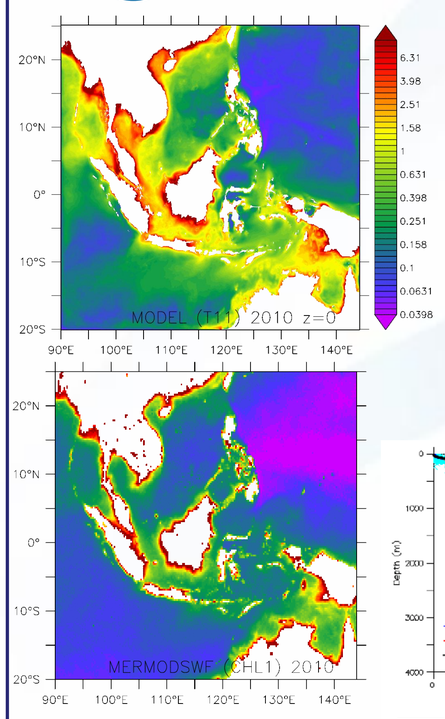


Fig.5: Annual mean chlorophyll-a concentrations (mgChl/m3) from Globcolour product (bottom; MERIS and MODIS merged product) and the simulation (top).

➢ Indonesia represents a significant part of tropical ocean productivity, biological diversity and fisheries.

➢Chlorophyll-a is strongly affected by the Asia-Australia monsoon system. Its variability is mainly drove by upwelling of nutrient-rich deep waters during the dry southeast monsoon (April to October) and by river discharges during the wet northwest monsoon (October to April).

➢ With few data available in the archipelago , the model highlights the key role of river runoff in the chlorophyll-a distribution (Fig. 5).

➢Transformations of the incoming waters masses conserve a correct vertical distribution of nutrients (here nitrate; Fig, 6).

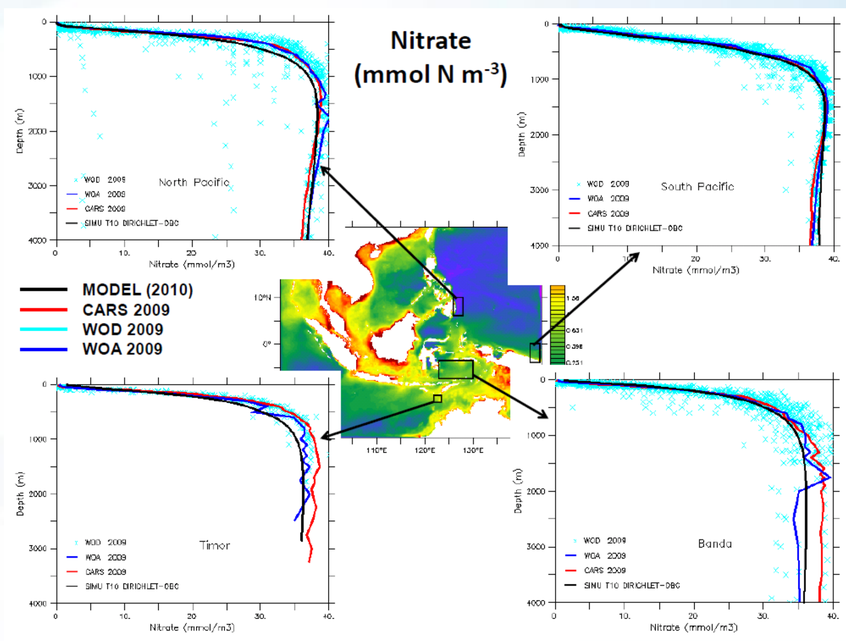


Fig.6: Vertical profiles of nitrate (mmolN/m3) from the simulation (annual mean – 2010), CARS 2009 and WOA 2009 annual climatologies, and the World Ocean Database (WOD 2009).

Mercator Ocean
Ocean Forecasters