

Multi Year Products and Ocean Monitoring Indicators: overview for products consistency analysis and new data products generation

S. Simoncelli (INGV, Bologna)

SeaDataCloud WP11 Leader



OUTLINE

- Objectives
- Multi Year Products
- Ocean Reanalysis and challenges
- Ocean Monitoring Indicators
- Consistency analysis

References

CMEMS General Assembly 2019 presentations

https://atlas.mercator-ocean.fr/s/3GmczTwbj2ArCrE?path=%2FCMEMS_GA_presentations_plenary_session

OBJECTIVES

- to stimulate the development and generation of new data products
- to assess and document SDC/EMODnet products quality
- to improve the consistency analysis of SDC/EMODnet data products with available Multi Year Products (MYP)
- to develop new data products for long term monitoring of the marine environment (Ocean Monitoring Indicators, OMI) and the Climate Change effects
- to inform about the available Multi Year Products and available OMIS in CMEMS
- challenges

Marine Data and Data Products Initiatives



 \rightarrow CMEMS provides generic info (obs and forecast/rea) on the PHY state and dynamics of the ocean and marine ecosystems



 \rightarrow Pan-FU data infrastructure for ocean and marine data management, underpinning several EMODnet thematic lots. It assembles and distributes marine data, metadata and data products (T and S)



 \rightarrow assembles and distributes marine data, metadata and data products spanning on 7 thematic areas

adapted from Martin Miguez et al. (2019) - The European Marine Observation and Data Network (EMODnet): Visions and Roles of the Gateway to Marine Data in Europe. Front. Mar. Sci.

Environmental Monitoring and Reporting

Added value chain: high value for marine reporting at science quality



SDC could substantially contribute to the environmental monitoring and reporting:

- aggregated data sets and PIDocs
- glo® climatologies
- new data products, such as OMIs, HR coastal climatologies, integrated in situ and sat products

Multi Year Products and Ocean Monitoring Indicators

Contribution to marine reporting: Copernicus Marine

The Copernicus Marine Ocean State Report and Ocean Monitoring Indicator framework: Combining high-quality marine products and scientific expertise



REPROCESSED DATASET→ gridded products T and S, SST, SL, OC, CI

OCEAN REANALYSIS

How to reconstruct the past?

"Observations-only"
REP Multi Year Products
→ how SDC/EMODnet might contribute?



Gross exaggeration towards discontinuity

Reanalysis



"Model only" integration



Gross exaggeration towards continuity

from Paul Poli: ECMWF Meteorological Training Course Numerical Weather Prediction Data Assimilation and Use of Satellite Data

Ocean Reanalysis

- retrospective data assimilative experiment that uses the same forecast model and the same data assimilation scheme throughout the simulation period
- designed for climate applications and it differs from operational implementation because it does not aim at producing "the best analysis/forecast possible as of today" but "the most coherent and consistent state of the ocean within the reanalysis period"

 \rightarrow consistency issue: non-trivial to achieve, as observing networks (coverage, quality, technology) may change depending on the period

Storto A, et a I. (2019) Ocean Reanalyses: Recent Advances and Unsolved Challenges. Front.Mar. Sci. 6:418. doi: 10.3389/fmars.2019.00418



Reanalysis System

Product Validation



Assessing the product quality

How to measure product quality? Metrics to assess:

- accuracy (use model-obs)
- consistency → intercomparison of 2D fields (obs/model, model/model)
- representativeness
- robustness → assessment of integrated quantities (heat and salt content,...)
 How to communicate on product quality?
- reports → SDC PIDoc for monitoring/reviewing/reporting/improving
- websites
- validation studies
- user feedbacks



to be improved in SDC

Assessing the product quality

User Needs: Producers communicate on the quality Produce synthetic overview of Product trough: product quality for each product PIDocs on the catalogue ۲ More information on quality flags qualification & websites Produce user friendly scores validation Peer reviewed publications ۲ ... pre-release history of products consolidate routine qualification of and product's methodology products quality evolution • to facilitate QA • to keep track of • to guarantee reliability and transparency • to invest on activities and • to inform users about continuous R&D performances

products' usability and

limitations

http://www.marineinsitu.eu/ https://insitu.copernicus.eu/

In situ data Challenges



- Requirements
 - Data quality
 - Resolution in time and space
 - Timeliness
- Data gaps
- Accessibility
- Data policy
- Sustainability



from «Status of global and regional in-situ observing systems» H.S. Andersen (EEA), E. Buch (EuroGOOS)

https://insitu.copernicus.eu/

In situ data Challenges

Goals

- In situ data requirements for production and validation
- In situ data availability together with information on the data providers (SDC should better promote its potential on this)

→ comparing the requirements with data availability reveals the gaps **and omissions** in the present landscape **but also the fitness for purpose of the deriving targeted data products**

EMODnet Checkpoints develped a methodology to assess this!!!!



from «Status of global and regional in-situ observing systems» H.S. Andersen (EEA), E. Buch (EuroGOOS)

Example of data requirements in CIS2

Requirements for ocean data						
Name	Group	Uncertainty	Update Frequency	Timeliness	Horizontal resolution	Vertical resolution
Sea Surface Salinity	Ocean	Threshold: 0,1psu Breakthrough: 0,07psu Goal: 0,05psu	Threshold: 72d Breakthrough: 24d Goal: 6d	Threshold: 3d Breakthrough: 2d Goal: 1d	Threshold: 25km Breakthrough: 10km Goal: 5km	
Sea surface Temperature	Ocean	Threshold: 0,5K Breakthrough: 0,2K Goal: 0,1K	Threshold: 3d Breakthrough: 24h Goal: 6h	Threshold: 3h Breakthrough: 2h Goal: 1h	Threshold: 25km Breakthrough: 10km Goal: 5km	
Subsurface currents	Ocean	Threshold: 50cm/s Breakthrough: 20cm/s Goal: 10cm/s	Threshold: 3d Breakthrough: 1d Goal: 6h	Threshold: 3h Breakthrough: 2h Goal: 1h	Threshold: 100km Breakthrough: 50 km Goal: 10km	Threshold: 50m Breakthrough: 10m Goal: 1m
Subsurface salinity	Ocean	Threshold: 0,1psu Breakthrough: 0,07psu Goal: 0,05psu	Threshold: 12h Breakthrough: 3h Goal: 1h	Threshold: 1d Breakthrough: 6h Goal: 3h	Threshold: 30km Breakthrough: 5km Goal: 1km	Threshold: 100m Breakthrough: 10m Goal: 1m
subsurface temperature	Ocean	Threshold: 1k Breakthrough: 0,5k Goal: 0,1k	Threshold: 24d Breakthrough: 3d Goal: 1d	Threshold: 3d Breakthrough: 1d Goal: 12h	Threshold: 50km Breakthrough: 10km Goal: 2km	Threshold: 50m Breakthrough: 10m Goal: 1m
surface currents	Ocean	Threshold: 20cm/s Breakthrough: 10cm/s Goal: 5com/s	Threshold: 3d Breakthrough: 1d Goal: 12h	Threshold: 3d Breakthrough: 1d Goal: 6h	Threshold: 20km Breakthrough: 5km Goal: 1km	

Ocean Monitoring Indicators

http://marine.copernicus.eu/science-learning/ocean-monitoring-indicators/



- key reference information on the state
 of the ocean
- free downloadable trends and data sets covering the past quarter of a century based on historical satellite and in situ observations as well as numerical ocean models
- key variables used to track the vital health signs of the ocean and changes in line with climate change

omi_video

- Critical information for assessing and confronting oceanic and atmospheric changes associated with global warming
- Target users: scientists, decision-makers, environmental agencies, the general public, and in measuring our responses to environmental directives





Ocean Monitoring Indicators



OCEAN HEALTH OCEAN TEMP. & SAL. CLIMATE VARIABILITY NORTH ATLANTIC

MONINTORING

CURRENTS

SEA STATE

WATER & HEAT EXCHANGE

- •Ocean Health:
 - global seawater pH (2001-2016)
 - Will soon include new variables monitoring ocean health

Ocean Heat Content (OHC):

- Time extension update to 2017 for the global OHC (0-700 ٠ meters)
- OHC for the Mediterranean Sea (1993-2017) •

•Sea Level:

- global thermosteric sea level (0-700 meters) from 1993-2017 • •Sea Ice:
 - Time extension to 2017 for the Antarctic and Arctic sea ice ٠ extent

•Temperature and Salinity:

- Addition of new category "Temperature and Salinity" ٠
- Addition of Arctic freshwater content (1993-2017) •
- Addition of the **Baltic Sea subsurface salinity anomaly** (1993-٠ 2017)
- Addition of the **Baltic Sea subsurface temperature anomaly** ٠ (1993-2017)





OMIs



http://marine.copernicus.eu/science-learning/ocean-monitoring-indicators/catalogue/

Mediterranean OHC



OHC deviation from a reference period (1993-2014), closely proportional to the average temperature change from z1 = 0 m to z2 = 700 m depth, with a reference density of = 1030 kgm-3 and a specific heat capacity of cp = 3980 J kg-1 °C-1 (von Schuckmann et al., 2009).

Time series of annual mean values area averaged OHC for the Med (30°N, 46°N; 6°W, 36°E).

Quality evaluation of MEDSEA_OMI_OHC_area_averaged_anomalies is based on the "multi-product" (OSR, von Schuckmann et al., 2018)

6 global products and a regional (Med) product have been used to build an ensemble mean and its associated ensemble spread

- Mediterranean Sea Reanalysis (MEDSEA_REANALYSIS_PHYS_006_004, DOI: https://doi.org/10.25423/medsea_reanalysis_phys_006_004, Simoncelli et al., 2014)
- 4 global reanalyses (GLOBAL_REANALYSIS_PHY_001_025): GLORYS, C-GLORS, ORAS5, FOAM
- 2 observation based products: CORA (INSITU_GLO_TS_REP_OBSERVATIONS_013_001_b) and ARMOR3D (GLOBAL_REP_PHY_001_021)

SDC could contribute computing a new OHC product blending different data sources and using DIVAnd

see also Iona et al. (2018) https://doi.org/10.5194/essd-10-1829-2018

Ocean Monitoring Indicators

How SDC/EMODnet could contribute developing new data products?

- decadal climatologies
- OHC/OSC from sliding decades and trends
- PH, DO, trophic index sliding decades and trends
- SST products that blends in situ and satellite data?
- SSS products that blends in situ and satellite data?
- \rightarrow data integration SDC-CMEMS in situ-WOD in order to maximize data coverage
- \rightarrow ISSUE: consistency due to different QC and bias correction (i.e. XBTs)
- \rightarrow ISSUE: missing data and metadata (rescue of historical data and metadata)

References