

Workshop Report on the Ocean Reanalyses Intercomparison Project (ORA-IP)

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Background

Several ocean reanalyses products are produced worldwide with different purposes and methodologies. The joint GODAE OceanView/CLIVAR-GSOP workshop in Santa Cruz (13-17 June 2011, Oke et al 2011) called for a community action on exploitation of the latest ocean reanalyses for real time climate monitoring and intercomparison. The first stage would be to complete an Ocean Reanalysis Intercomparison Project (ORA-IP), although the ultimate goal would be near realtime monitoring of the ocean through indices based on an ensemble of re-analysis.

A viable proposal was put forward in Santa Cruz, based on the criteria of minimum effort. The following procedure was proposed:

A) Production centers, including Operational and Reanalysis centers to provide relevant information (gridded fields of basic primary variables) in agreed formats and grids (where applicable), to enable the agreed intercomparison procedure.

B) Processing centers. For intercomparison purposes each processing centre would take on a particular variable in which that have a strong interest and expertise. They would then be responsible for the intercomparison and eventually monitoring of that variable. They would process ensemble statistics based on the input from the individual production centers, and create relevant indices or metrics or graphics which could be directly compared.

The ORA-IP workshop at ECMWF

The ORA-IP initiative proposed in SantaCruz 2011 got enough momentum: relevant ocean variables and responsible processing centres (de facto, individuals that volunteer to do the work, processing agents in what follows) were identified; the processing agents produced documents for specific data requests, grids and format; and different production centres provided the data in the requested format. It was time then to assess progress and discuss the way forward, and to this end a workshop was held at ECMWF 1st-3rd July 2013.

By the time of the workshop at ECMWF, the scope of the intercomparison exercise was the understanding the consistency and differences between the reanalysis products, the evaluation of fit-for-purpose, and the exploitation of this variety of reanalysis using the ensemble approach. The intercomparison targeted different areas:

- Routine monitoring of indices of societal relevance with uncertainty estimates using the ensemble.
- Production of robust data sets for understanding the ocean and for initializing and evaluating decadal prediction and IPCC models.
- Recommendations for future reanalyses production by identifying the weaknesses of existing approaches and the suitability of the ensemble approach.

The workshop format consisted on presentations by the different processing agents on the different variables, followed up by in-depth discussion of the results. Table 1 provides a list of the variables chosen for intercomparison, along with the responsible agent. The different ocean reanalyses included in the study appear in table 2.

Table 1: List of Ocean Variables Inter-compared

Variable	Responsible	Institution
Steric Height	Andrea Storto	CMCC
Sea Level	Fabrice Hernandez	Mercator Ocean
Ocean Heat Content	Matthew Palmer	UK MetOffice
Depth of 20 degree Isotherm	Fabrice Hernandez	Mercator Ocean
Mixed Layer Depth	Takahiro Toyoda	MRI-JMA
Salinity	Li Shi	BMRC
Surface fluxes and transports	Maria Valdivieso	University of Reading
Atlantic Meridional Overturning at 26N	Vladimir Stepanov/Keith Haines	University of Reading
Sea Ice	Gregory Smith	Environment Canada

The following outcomes were expected:

1. Specific recommendations on how to finalize the intercomparison of chosen ocean variables (ocean heat content, mixed layer depth, steric height, sea level, 20-degree Isotherm, salinity, surface heat fluxes, transports, sea-ice).
2. Recommendations on how to make the results and data accessible to the wide climate community.
3. Recommendations on how to improve the ocean observing system, assimilation methods, models and surface fluxes.

The different points were discussed in two separate working groups, which provided recommendations in a final plenary session.

Product	Institution	Product	Institution
CFSR	NCEP	ECCO-v4	NASA/JPL
GODAS	NCEP	GECCO2	Hamburg University
Glosea5	UK MetOffice	MOVE-C	MRI/JMA
ORAS4	ECMWF	MOVE-G2	MRI/JMA
PEODAS	BMRC	MOVE-CORE	MRI/JMA
GLORYS	Mercator	K7-ODA	JAMSTEC
C-GLORS	CMCC	K7-CDA	JAMSTEC
UR025.4	Reading University		
GEOS5	NASA/GMAO	ARMOR3D	CLS (T/S/SLA)
ECDA	GFDL	NODC	NOAA (T/S only)
SODA	University Meryland	EN3	MetOffice (T/S only)
ECCO-NRT	NASA/JPL	LEGOS	LEGOS (SLA only)

Table 2: List of Ocean Reanalysis products entering the intercomparison. The products in blue are observation-only products, i.e., they do not use any ocean model. The products in green are ocean-only simulations, i.e., they do not assimilate ocean observations.

Recommendations

The recommendations were structured in two big themes: I) how to finalize the current intercomparison in the short term and II) how to exploit further the ocean reanalyses (in the medium term). The importance of using reanalysis for real-time climate monitoring was acknowledged during the workshop, but not discussed explicitly. It was considered that the recommendations for themes I) and II) provided guidance and infrastructure on how to extend the intercomparison to eventual real-time monitoring.

Theme I: How to finalize the current intercomparison?

1. Finalize the current intercomparison including the minimum base period 1993-2009. There should also be a focus study on the 2004-2009 Argo period.
2. The intercomparison should include an evaluation of the ensemble mean, spread and signal-to-noise ratio for mean, seasonal cycle, interannual variability and trends.
3. The ORA-IP results should be ready for presentation in the GODAE Ocean View Symposium (November 2013)
4. The ORA-IP initiative and results should be announced in CLIVAR Exchanges
5. The ORA-OP results should be published in a special issue of a peer-reviewed scientific journal, in order to reach the wider oceanographic and climate community.

Theme II: How to exploit ensemble of ocean synthesis products further?

6. To promote interaction with the user community. Climate scientist, seasonal and decadal forecasts community are users of ocean reanalysis products. The reanalysis can be used for process studies, for validation of climate models, and for initialization and verification of long lead forecasts.
7. To encourage the archive of individual reanalysis products in a user-friendly format, such as that adopted for the CMIP-5 data repository (netcdf CF-complaint) or Obs4MIP.

8. The ORA-IP variables should be archived in a public data repository, including ensemble means and spreads, in the grid used for the intercomparison (1x1 lat/lon regular grid) and in an user friendly grid and format (netcdf CF-compliant format). An ORA-IP version number should be part of the metadata. The version number is important if we want to trace progress between subsequent ORA-IP, including improvements in the observing system and in the assimilation methods. Signal-to-noise ratios on different time scales are essential information to assess the adequacy of variables for process studies, forecast initialization, forecast verification and monitoring of climate indices. A public archive will benefit the interaction with the user communities.
9. In addition to the ORA-IP ensemble mean and spread upon the overlapping 1993-2009 period, it would also be desirable to archive also the individual reanalysis products in the same grid and format, although this may not be easy in a first instance due to data policy issues.
10. The information in current public web pages such as reanalysis.org and EasyInit should be as comprehensive as possible and kept up-to-date.
11. To encourage interaction with the Working Group for Ocean Model Development (WGCOMD) in the area of model evaluation and metrics.
12. To encourage interaction with the observation community to i) improve the observation quality control and ii) obtain guidance regarding observation uncertainty. The result of this interaction should be improved and consistent quality controlled data sets for assimilation and better formulation of the observation errors in the data assimilation.

References

Oke, P, M. Martin, M. A. Balmaseda, G. Brassington and K. Wilmer-Becker, 2011: [Report on the GODA Ocean View - CLIVAR GSOP Workshop on Observing System Evaluation and Intercomparison](https://www.godae-oceanview.org/outreach/meetings-workshops/task-team-meetings/godae-oceanview-gsop-clivar-workshop/). <https://www.godae-oceanview.org/outreach/meetings-workshops/task-team-meetings/godae-oceanview-gsop-clivar-workshop/>