OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

POSTER ABSTRACTS

Theme 4:
Data Assimilation

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P47 - **Abstract ID: 3528655**

DIFFERENT STRATIGIES FOR ASSIMILATING ARGO INTO A HYBRID COORDINATE OCEAN MODEL

Costa, Filipe[1], Tanajura, Clemente[1] [1]REMO, Salvador, Brazil fbcosta.oceano@gmail.com

Operational ocean forecast provided by GODAE OceanView (GOV) systems assimilates Argo Temperature (T) and Salinity (S) profiles, Sea Surface Temperature (SST), Sea-Level Anomalies (SLA) and other data. Due to the relationship between subsurface thermohaline structures and the Absolute Dynamic Topography (ADT) and also the multivariate nature of assimilation techniques, the assimilation of ARGO can impact the model ADT. Although this has already been documented by few works, these did not conclude if the changes on ADT were positive or negative and its influence on currents. Here we propose to investigate these impacts by assimilating ARGO into the HYbrid Coordinate Ocean Model (HYCOM).

Since the vertical nature of the model been mostly isopycnal, there are basically two ways of assimilating ARGO into HYCOM. One is interpolating model layer to Z coordinates and the other is taking ARGO to model isopycnal coordinates which will be denominated here as ARGOz and ARGOdp respectively. This work explores both techniques through a multivariate Ensemble Optimal Interpolation (EnOI) scheme. The model was configured with a vertical resolution of 21 layers and horizontal resolution of 1/12 over the Western South Atlantic. Four experiments were integrated from 1 January 2008 to 31 December 2013 having initial conditions from a free run spin up: (1) Control with no assimilation, (2) ARGOdp assimilates T, S and layer thickness interpolating these from Z to isopycnal coordinates, (3) ARGOz assimilates T and S interpolating model layer to Z coordinates, (4) ARGOzT assimilates only T interpolating model layer to Z coordinates.

ARGOdp, ARGOz and ARGOzT reduced the root mean square deviation (RMSD) of the Control temperature by 13%, 16% and 19% and for salinity by 15%, 20% and 4% respectively. Significant reduction of mean ADT was observed only on the ARGOdp which led to a smoothing of the ADT gradient on the Brazil Current (BC) region which is not observed on AVISOs ADT nor on the other three experiments. Consequently, the ARGOdp simulated the least intense BC among the experiments and in some regions it was detected the presence of the Intermediate Counter Current instead of the BC. Therefore, the ARGOdp had a negative impact on the model ADT and on the BC while ARGOz and ARGOzT showed some positive impacts. Also, ARGOzT presented a significant impact on temperature RMSD and a little correction on salinity showing that it is possible to assimilate data that has only temperature, like XBT.

Keywords: DA - Ensemble data assimilation, DA - Data assimilation applications, DA - Data assimilation diagnostics, ,

Presenter:
Filipe Costa
REMO
Salvador, Brazil
fbcosta.oceano@gmail.com

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P48 - **Abstract ID: 3545819**

Impacts of the observation system in the eastern Yellow Sea on the ocean analysis fields

Kwon, Kyungman[1], Choi, Byoung-Ju[2], Park, Su-Jung[2], Jung, Young-Joo[2], Kim, Young-Ho[3], Lee, Joon-Soo[4], Byun, Do-Seong[5] [1]Chonnam National University, Gwangju, Rebublic of Korea [2]Chonnam National University, Gwangju, Republic of Korea [3]Korea Institute of Ocean Science & Technology, Busan, Republic of Korea [4]National Institute of Fisheries Science, Busan, Republic of Korea [5]Korea Hydrographic & Oceanography Agency, Busan, Republic of Korea hydra82@hanmail.net

The observation data for the ocean analysis very lack in the Yellow Sea. The observation data have been provided for the ocean analysis in the eastern YS were the daily satellite-borne SST data, the CTD data from the National Institute of Fisheries Science (NIFS), the Korea Hydrographic and Oceanographic Agency (KHOA), and the Korea Marine Environment Management Corporation (KOEM). In this study, the effect of these data on the accuracy of the ocean analysis fields was investigated through Observation System Experiments (OSEs). The ocean circulation model used in this study was the Regional Ocean Modeling System (ROMS) and the data assimilation method was the Ensemble Kalman Filter (EnKF). Horizontal grid spacing was 3 km horizontally and the number of vertical levels was 41. The model domain included the Yellow and East China Sea (YES). The OSEs were conducted using all observation data (ALL), expect for the NIFS data (noNIFS), expect for the KHOA data (noKHOA), and expect for the CTD data (SSTonly). A free running model experiment (FR) without data assimilation was also conducted. Impacts of each observation dataset on the accuracy of the analysis fields are assessed using Root-mean-square deviation (RMSD) between the model results and observation data.

The OSEs confirmed that the CTD data generally had a positive impact. When RMSDs were compared for ALL and FR experiments, the analyzed temperature and salinity field were improved by 25% and 6%, respectively, and a relatively large improvement were made for the analysis fields in August. The ALL experiment had lower RMSD vertically in the 10-70 m than the CTD from June to August when the thermocline is strong. Therefore, the CTD profile is very important to improve the middle and lower layers. However, it was not enough to improve the salinity. The temperature field was relatively improved by satellite-borne SST data and temperature profile data, but there was no significant change in salinity. Further study is needed to improve the accuracy of the analyzed salinity field in the YS.

Keywords: DA - Ensemble data assimilation, DA - Data assimilation applications, DA - Observation impact assessment methods

Presenter:
Kyungman Kwon
Chonnam National University
Gwangju, Rebublic of Korea
hydra82@hanmail.net

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P50 - Abstract ID: 3552978

Assimilation of optical absorption by phytoplankton functional types into ecosystem model

Skakala, Jozef[1], Brewin, Robert[1], Bruggeman, Jorn[1], Ciavatta, Stefano[2], Ford, David[3] [1]Plymouth Marine Laboratory, Plymouth, United Kingdom [2]Plymouth Marine Laboratory, Plymouth, United Kindom [3]Met Office, Exeter, United Kingdom jos@pml.ac.uk

Novel (stand-alone) spectrally resolved bio-optical module was developed and combined with the Euroepan Shelf Seas Ecosystem Model (ERSEM) to improve representation of biogeochemistry in the North-West European Shelf (NWES). The ERSEM model using the bio-optical module was reparametrized and validated for NWSE using multiple observational data-sets. Novel observational products for the optical absorption by the four ERSEM phytoplankton functional types (diatoms, dinoflaggelates, nanophytoplankton, picophytoplankton) were assimilated into the model in a 1 year re-analysis. The re-analysis was subsequently validated using both satellite and in situ data.

Keywords: DA - Assimilation of new observation types, DA - Shelf-seas and coastal data assimilation, Models - Ecosystem/BGC modelling, ,

Presenter:
Jozef Skakala
Plymouth Marine Laboratory
Plymouth, United Kingdom
jos@pml.ac.uk

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P51 - **Abstract ID: 3553137**

The Assimilation of Phytoplankton Functional Types for Operational Forecasting in the Northwest European Shelf

Skakala, Jozef[1], Ford, David[2], Brewin, Robert[1], McEwan, Robert[2], Kay, Susan[1], Taylor, Benjamin[1], de Mora, Lee[1], Ciavatta, Stefano[1] [1]Plymouth Marine Laboratory, Plymouth, United Kingdom [2]Met Office, Exeter, United Kingdom jos@pml.ac.uk

We propose the use of assimilation of phytoplankton functional types (PFTs) surface chlorophyll for operational forecasting of biogeochemistry on the North-West European (NWE) Shelf. We explicitly compared the 5-day forecasting skill of three runs of a physical-biogeochemical model: (a) a free reference run, (b) a run with daily data assimilation (DA) of total surface chlorophyll (ChlTot), and (c) a run with daily PFTs DA. We showed that small total chlorophyll model bias hides comparatively large biases in PFTs chlorophyll, which ChlTot DA fails to correct. This is because the ChlTot DA splits the assimilated total chlorophyll into PFTs by preserving their simulated ratios, rather than taking account of the observed PFT concentrations. Unlike ChlTot DA, PFTs DA substantially improves model representation of PFTs chlorophyll. During forecasting the DA reanalysis skill in representing PFTs chlorophyll degrades toward the free run skill; however, PFTs DA outperforms free run within the whole 5-day forecasting period. We validated our results with in situ data, and we demonstrated that (in both DA cases) the DA substantially improves the model representation of CO2 fugacity (PFTs DA more than ChlTot DA). ChlTot DA has a positive impact on the representation of silicate, while the PFTs DA seems to have a negative impact. The impact of DA on nitrate and phosphate is not significant. The implications of using a univariate assimilation method, which preserves the phytoplankton stochiometry, and the impact of model biases on the nonassimilated variables are discussed.

Keywords: DA - Assimilation of new observation types, DA - Biogeochemical data assimilation, DA - Data assimilation applications, DA - Shelf-seas and coastal data assimilation,

Presenter:
Jozef Skakala
Plymouth Marine Laboratory
Plymouth, United Kingdom
jos@pml.ac.uk

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P52 - **Abstract ID: 3561216**

Combining machine-learning data-driven strategies and large-ensemble ocean simulations to improve satellite-derived gridded products

Tandeo, Pierre [1], leroux, stephanie[2], Alliot, Pierre[3], chapron, bertrand[4], Fablet, Ronan[1], Herzet, Cedric[5], Le Sommer, Julien[6], maze, guillaume[4], metref, sammy[6], penduff, thierry[6], verron, jacques[2], zhen, yicun[1] [1]IMTA, Brest, France [2]Ocean Next, Grenoble, France [3]Laboratoire de Mathématiques, Université de brest, brest, france [4]IFREMER, Brest, france [5]INRIA, brest, france [6]MEOM/IGE, Grenoble, france pierre.tandeo@imt-atlantique.fr

Over the last decades, altimeter and other satellite observations have provided crucial information to increase our knowledge of the global oceanic state, its variability, and long-term changes. With the increasing resolution of the next generations of satellites, and the still crucial need for near-real-time products for operational purposes, it becomes more and more important to be able to process and operate efficiently with larger and larger amounts of data. Methods and tools developed in the field of Data Science might bring interesting and promising alternative approaches for some applications in spatial oceanography.
In this poster, we will present a CMEMS-funded project which aims to investigate the relevance and potential benefit of the analog forecasting method AnDA method, combined to the use of a large-ensemble ocean simulation, to improve the interpolation of satellite-derived gridded products.

AnDA (Analog Data Assimilation, Lguensat et al 2017) is a fully data-driven method based on a representative catalog of historical data. It combines machine learning with the analog method (or nearest neighbor search) and stochastic assimilation techniques, to learn the local relationships between state variables and provide realistic forecasts from the analog method, without the need for an online evaluation with a physical model. The method can be seen as an optimal interpolation with a physically-constrained covariance structure.

The AnDA approach is first applied on the Lorenz-63 model when only the first component of the system is observed. We show that analog strategies can adaptively capture the covariance structure and outperforms the optimal interpolation approach.

Then, the methodology is applied to a historical database made of the Sea Surface Height (SSH) from a 50-member ensemble of global 1/4 ocean simulations (the NEMO-based OCCIPUT ensemble simulation, Bessieres et al 2017) in order to interpolate satellite observations of altimeter data.

Keywords: DA - Ensemble data assimilation, Applications - Ocean products for scientific, economic and societal use, DA - Fundamentals and methodologies of data assimilation, ,

Presenter:
Stephanie Leroux
Ocean Next
Grenoble, France
stephanie.leroux@ocean-next.fr

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P53 - **Abstract ID: 3573930**

Assimilation of ocean-colour phytoplankton functional types to improve the reanalysis and prediction of ocean ecosystem models

Ciavatta, Stefano[1], Brewin, Robert[1], Skakala, Jozef[1], Ford, David[2], Kay, Susan[3], Di Cicco, Annalisa[4], Sammartino, Michela[4], Santoleri, Rosalia[4] [1]Plymouth Marine Laboratory/National Centre for Earth Observation, Plymouth, United Kingdom [2]Met Office, Exeter, United Kingdom [3]Plymouth Marine Laboratory, Plymouth, United Kingdom [4]CNR – Istituto di Scienze Marine, Rome, Italy s.ciavatta@pml.ac.uk

We show that the assimilation of phytoplankton functional types (PFTs) derived from ocean colour can improve the reanalysis and prediction of biogeochemical indicators and emerging properties in marine ecosystems. Error-characterized chlorophyll concentrations of four PFTs (diatoms, dinoflagellates, nanophytoplankton and picophytoplankton), as well as total chlorophyll for comparison, were assimilated into a coupled physical-biogeochemical model of the European North West Shelf (NWS) by applying a localized Ensemble Kalman filter. The ocean-colour PFT data were derived in the framework of the Service Evolution project TOSCA of the European Copernicus Marine Environment Monitoring Service. The reanalysis simulations spanned the years 1998 to 2003. The skill of the reference and reanalysis simulations in estimating ocean colour and in situ biogeochemical data were compared by using robust statistics. The reanalysis outperformed both the reference and the assimilation of total chlorophyll in estimating the ocean-colour PFTs (except nanophytoplankton), as well as the not-assimilated total chlorophyll, leading the model to simulate better the plankton community structure. Crucially, the reanalysis improved the estimates of not-assimilated in situ data of PFTs, as well as of phosphate and pCO2, impacting the simulation of the air-sea carbon flux.
The method proposed here can be applied to enhance the forecasts of operational systems. This is exemplified here by results of assimilating PFTs into the CMEMS North West Shelf model (NEMO-ERSEM), by using a 3DVar assimilation algorithm (NEMOVAR).

Finally, we stress that the method can be exported to other regions of the global ocean where adequate ocean-colour PFT data and PFT models are available. This is exemplified here by assimilating regional PFT data into a model of the Mediterranean Sea (POLCOMS-ERSEM with EnKF) to investigate the phytoplankton community structure and aquaculture sustainability in this complex ecosystem.

Keywords: DA - Biogeochemical data assimilation, DA - Assimilation of new observation types, Applications - Aquaculture, Applications - Environmental assessment, Models - Model assessments and verification

Presenter:
Stefano Ciavatta
Plymouth Marine Laboratory/National Centre for Earth Observation
Plymouth, United Kingdom
s.ciavatta@pml.ac.uk

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P54 - Abstract ID: 3600032

Weak and strong constraints variational data assimilation with the NCOM-4DVAR in the Agulhas region using the representer method

Ngodock, Hans[1], Carrier, Matthew[1], Smith, Scott[1], Souopgui, Innocent[2] [1]US Naval Research Laboratory, Stennis Space Center, USA [2]University of New Orleans, New Orleans, USA hans.ngodock@nrlssc.navy.mil

The difference between the strong and weak constraints four-dimensional variational (4dvar) analyses is examined using the representer method formulation, which expresses the analysis as the sum of a first guess and a finite linear combination of representer functions. The latter are computed analytically for a single observation under both strong and weak constraints assumptions. Even though the strong constraints representer coefficients are different from their weak constraints counterparts, that difference is unable to help the strong constraints compensate the loss of information that the weak constraints includes. Numerical experiments carried out in the Agulhas retroflection for a single and multi-observations assimilations clearly show that the weak constraint 4dvar produces analyses that fit the observations with significantly higher accuracy than the strong constraints.

Keywords: DA - Data assimilation applications, DA - Variational data assimilation, , ,

Presenter:
Hans Ngodock
US Naval Research Laboratory
Stennis Space Center, USA
hans.ngodock@nrlssc.navy.mil

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

P56 - Abstract ID: 3615185

An approach to calibration and validation by linear regression

Danielson, Rick[1], Perrie, William[1], Toulany, Bechara[1], Zhang, Minghong[1], Long, Zhenxia[1] [1]Bedford Institute of Oceanography, Dartmouth, Canada Rick.Danielson@dfo-mpo.gc.ca

The calibration and validation of geophysical data often employs, for practical purposes, a reference dataset that is familiar, with ordinary linear regression being helpful to evaluate the performance of newer datasets. Stoffelen (1998) proposed the use of a third dataset as a way to solve the regression equation when both the reference and newer datasets are erroneous. Triple collocation has since provided a benchmark approach to geophysical calibration and validation. We introduce a statistical model called INFERS that has evolved out of recent studies of the triple collocation model. INFERS may be one of the first regression models to diagnose error correlations, but once such contributions are accommodated, it is the true variance that is common to two datasets (i.e., truth rather than error) that appears to be the most interesting parameter. Building on prior studies of ocean surface current and heat flux data, we illustrate a general (numerical) model solution.

Keywords: DA - Fundamentals and methodologies of data assimilation, DA - Model and observation systematic errors, Observations - Estimates of measurement errors, ,

Presenter:
Rick Danielson
Bedford Institute of Oceanography
Dartmouth, Canada
Rick.Danielson@dfo-mpo.gc.ca