National Report

a. ECMWF

During the last two years no major changes were made to the ocean modelling system in terms of ocean model upgrades. Work on migrating the currently operational system from the Cray supercomputers located at the ECMWF headquarters in Reading to Atos machines at the new supercomputer facility in Bologna is ongoing. A major upgrade of the ocean modelling system from NEMO V3.4 to NEMO V4.0.X is progressing, and we expect to implement this upgrade operationally in 2022.

ORAS5: This system is used for initial conditions for the ocean and sea-ice for all forecasting systems from medium-range to seasonal. The output sea-ice concentration is used as input to the atmospheric data assimilation system and with the introduction of CY46R1 in June 2019 the SST in the tropics is used as well. The use of ORAS5 SST in the atmospheric analysis system is done consistently with the partial coupling setup for the HRES and ENS forecasting systems. The use of ORAS5 sea-ice concentration and SST in the atmospheric data assimilation forms a weak coupling between the ocean and atmosphere data assimilation systems.

HRES: Coupled 10-days atmosphere-ocean-seaice-waves-land forecasts produced twice daily. Atmosphere is the ECMWF IFS at TCo1279 (~9 km). Based on IFS CY47R1. It uses partially coupling in the extra-tropics only with a linear ramp from 20 degrees N/S to 25 degrees N/S.

ENS: Coupled 15-days atmosphere-ocean-seaice-waves-land forecasts, produced twice daily, 51 ensemble members. Atmosphere is the ECMWF IFS, at TCo639 (~18 Km). Use the same IFS cycle as HRES. The partial coupling is done in the same way as for HRES.

Extended-ENS: Coupled 46-days atmosphere-ocean-seaice-waves-land forecasts, produced twice weekly, 51 ensemble members. Extension of ENS. The extension (from days 16-46) is run with a lower atmospheric resolution (TCo319, ~36Km). Same IFS version as HRES

S5 (seasonal 7-month forecasts, 51 ensemble members, coupled, produced once a month). Same resolution as Extended-ENS. This is based on IFS CY43R1.

System information overview

System name	
Ocean Models	
OGCM	NEMO V3.4
Domain	Global
Horizontal resolution	¼ degree
Vertical sampling	75 levels, 1m-1.5m thickness upper levels
Atmospheric Forcing	Bulk formulation including wave forcing: ERA-Interim from 19790101 un 20151231 ECMWF NWP from 20160101 to present ECMWF operational NWP since 2010

Assimilation characteristics	
Assimilation Scheme	NEMOVAR
SST	HadISST2 v2 pentad ¼ degree until 2008, and OSTIA thereafter
SIC	OSTIA reanalysis until 2008, OSTIA operational thereafter
SSH	AVISO along track sea level anomalies and global maps
Other	XTB,CTD,Argo,Moorings from the EN4 (XBT corrected) data set until 2016 and from the GTS thereafter
System Set-ups	
Forecast range	The ocean model runs as part of the coupled ocean-atmosphere model at different ranges: 15-days fc (twice daily), 46-days fc (twice weekly), and 7-months fc (monthly after November 2017). All the forecasts are an ensemble of 51 members. The ocean forecast products are not disseminated. The twice daily 10 day HRES deterministic forecast has been coupled from June 2018.
Update frequency	Daily for the real time Every 5-days for the delayed product
Hindcast length	19790101 to present
System website links	
General information	http://www.ecmwf.int/en/forecasts/documentation-and-support https://www.ecmwf.int/en/research/climate-reanalysis/ocean-reanalysis
Technical description	H. Zuo; M. Alonso-Balmaseda; K. Mogensen; S. Tietsche: OCEAN5: The ECMWF Ocean Reanalysis System and its Real-Time analysis component, ECMWF Tech 823, 08/2018. Available from: https://www.ecmwf.int/en/elibrary/18519-ocean5-ecmwf-ocean-reanalysis-system-and-its-real-time-analysis-component T. Stockdale; M. Alonso-Balmaseda; S. Johnson; L. Ferranti; F. Molteni; L. Magnusson; S. Tietsche; F. Vitart; D. Decremer; A. Weisheimer; C.D. Roberts; G. Balsamo; S. Keeley; K. Mogensen; H. Zuo; M. Mayer; B.M. Monge-Sanz: SEAS5 and the future evolution of the long-range forecast system, ECMWF Tech 835,11/2018. Available from: https://www.ecmwf.int/en/elibrary/18750-seas5-and-future-evolution-long-range-forecast-system P.A. Browne; P. de Rosnay; H. Zuo; A. Bennett; A. Dawson. Weakly Coupled Ocean–Atmosphere Data Assimilation in the ECMWF NWP System. Remote Sensing. 2019; 11(3):234. Available from: https://www.mdpi.com/400520
Viewing service	The output of the ocean5 reanalysis are available on: https://www.ecmwf.int/en/forecasts/charts/oras5/