NOOS PROJECT SUMMARY: **Multi Model Ensemble Prediction System**

Date of revision: 12 October 2018

KEYWORDS: data exchange, multi model ensemble, ensemble prediction system, SST, SSS, water transports, currents

Project title: **NOOS Multi Model Ensemble Prediction System**	
Project Aims	Several NOOS partners provide operational ocean forecasting models for the North Sea area on a daily basis. A range of information and emergency response systems is based on the available forecasts. All these systems can benefit from a systematic combination of the variety of forecasts in a Multi Model Ensemble (MME). The project aims at providing a MME system, which • shall provide the basis for the development of uncertainty estimates for all forecast products on temporal and spatial scale • shall provide a supplement to validation by comparison of the contributing forecasts in order to reveal the degree of agreement and deviation for different parameters (benefit model developers) • shall provide some added value to the users of every single ensemble member Exactly the same approach is applied in the Baltic Sea area based on model forecasts provided by several BOOS members. A close cooperation between this NOOS project and the BOOS counterpart is aimed at.
Lead agency Lead scientist	Bundesamt für Seeschifffahrt und Hydrographie (BSH) Federal Maritime and Hydrographic Agency Inga Golbeck, inga.golbeck@bsh.de
Participants	• BSH: Inga Golbeck, Xin Li, Stephan Dick • DMI: Jacob Woge Nielsen, Vibeke Huess • FCOO: Johan Söderkvist • Met Office: Niall McConnell, Peter Sykes • Met.no: Harald Engedahl, Nils Melsom Kristensen, Øyvind Sætra • RBINS: Sebastien Legrand • SMHI: Patrik Ljungemyr, Lars Axell *BOOS - Participants* • *FMI: Simo-Matti Siiriä* • *MSI: Priidik Lagemaa* • *IOPAN: Jaromir Jakacki*
Present status: *Ongoing*	Project partners (BSH, DMI, FCOO, Met Office, Met.no, RBINS and SMHI) provide daily 48 h-forecasts of computed sea surface temperature (SST), – salinity (SSS), – currents (SSC), sea bottom temperature (SBT) and – salinity (SBS), as well as daily water and salt transport, based on different circulation models. The format of the input data to the MME is not fully standardised yet and a substantial amount of work is needed in reformatting the data to be used in the MME. The data are interpolated onto a common grid and ensemble products and uncertainty measures

	are produced. Figures showing the MME, uncertainty estimates of each parameter and the bias between each forecast product and the MME median are updated daily on the NOOS website. In addition, up to 4-monthly movies reflect the temporal and spatial variation of standard deviation fields for SST, SSS and SSC. Comparisons of computed SST with L3 satellite SST (provided by Copernicus), and validation of temperature and salinity at the sea surface and the bottom at 5 offshore stations are updated on a monthly basis. Spatio-temporal statistics of the collected MME data, are described in "Golbeck et al (2015) Uncertainty estimation for operational ocean forecast products - A Multi-Model Ensemble for the North Sea and the Baltic Sea". A so-called "warning system" has been added to the daily statistics with the aim to detect forecast products which start to drift away from the MME. The "warnings" of the last 30 days are displayed on additional figures for each forecast product.
Project timescale	• Sept. 2012: Start of planning phase / Pre-operational phase • Apr. 2013: Initialisation of MME • Aug. 2013 – Nov. 2014: Presentation of results at Baltic Sea Science Conference (Klaipeda), NOOS AM (Brussels), FutOOre (Hamburg), MyOcean-2 AM (Athens), EGU (Vienna), 7th EuroGOOS conference (Lisbon) • 22. Jan. 2014: MME Figures available on NOOS / BOOS websites • Aug. 2014: Definition of NOOS project • Oct. 2014: Development of MME for SBT and SBS • Feb. 2015: Submission of paper "Golbeck et al (2015) Uncertainty estimation for operational ocean forecast products - A Multi-Model Ensemble for the North Sea and the Baltic Sea" • Aug. 2015: Up to 4-monthly movies showing standard deviation of SST, SSS, SSC, SBT and SBS provided on NOOS / BOOS websites • Sept. 2015: Monthly comparison of computed SST to L3 satellite SST showing bias and RMSE provided on NOOS / BOOS websites • Oct./Nov. 2015: Golbeck et al 2015 has been published in Ocean Dynamics • Nov. 2015: Figures showing bias between forecasts and MME median published on NOOS / BOOS websites • Oct. 2016: Monthly validation of salinity and temperature at offshore stations published on NOOS / BOOS websites • Sept. 2017: "Warning-system" published on NOOS / BOOS websites • Oct. 2017: First version of weighted multi-model ensemble of 5 reanalyses for temperature and salinity published on NOOS website • Jul. 2018: Overview of warnings of the last 30 days published on NOOS website
Planned Developments and Activities (2018 - ...)	• Higher standardization of input data provided by NOOS partners. (This is urgently needed to make the MME sustainable when project funding is no longer available.) • Implementation of weighted-average methods (i.e. Bayesian model averaging) • Comparison with in-situ and satellite data • Include other physical and biogeochemical parameters • Re-calculate weighted multi-model ensemble of reanalyses for temperature and salinity; improve weighting method

Link to project documents (	• http://noos.eurogoos.eu/community-products/multi-model-ensemble-of-forecast-products/ • http://noos.eurogoos.eu/community-products/multi-model-ensemble-of-multi-year-products/ • ftp://ftp.bsh.de/outgoing/opmodel/my_ocean/MME/