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## Deliverable 2.3

### SEAMLESS prototype “ready-to-transfer” to CMEMS MFCs

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**Document History:**

Release	Date	Reason for Change	Status	Distribution
1.0		Initial document, reviewed	Released	Public

**To cite this document**

This document describes the current software status for the 1D SEAMLESS prototype. Please cite the software SEAMLESS Ensemble and Assimilation Tool (EAT) publicly available in the repository <https://github.com/BoldingBruggeman/eat> along. If you use EAT for data assimilation and publish results, please also cite the data assimilation component PDAF (Parallel Data Assimilation Framework, <https://pdaf.awi.de>) as mentioned in the output of each assimilation run.

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## 1. Scope

Deliverable D2.3 (type “OTHER”) is a software product (the SEAMLESS prototype) release and made available to CMEMS MFCs in the GitHub repository <https://github.com/BoldingBruggeman/eat>.

This document accompanies the software release by documenting its ‘readiness’ for transfer to CMEMS MFCs. It is one of the final deliverables of work package 2 and linked to the preparation and publication of the SEAMLESS prototype system in Task 2.5. The final deliverable, D2.4, will be the public release and full documentation of the prototype. Overall, the tasks of work package 2 aimed at developing the SEAMLESS prototype, in particular the 1D system EAT (Ensemble and Analysis Tool). This deliverable basis on the different developments of work package 2 in generating the prototype, which includes the different MFCs’ biogeochemical models and data assimilation functionality.

Further developments will be made available via the repository and will include developments in response to SEAMLESS partners using the software in other work packages.

## 2. Introduction

The status of “ready-to-transfer” of the SEAMLESS prototype results from the completeness of the software developments. The status is as follows:

- The EAT system was built by combining the components GOTM (General Ocean Turbulence Model, <https://gotm.net>), the Framework for Aquatic Biogeochemical Models (FABM - <https://fabm.net>) and the Parallel Data Assimilation Framework (PDAF – <http://pdaf.awi.de>). The integration of these components in Task 2.2a resulted in a software product capable of performing ensemble simulations as well as data-assimilation simulations for any GOTM configuration where observations are available (see the SEAMLESS Deliverable D2.1).
- The different CMEMS BGC models are included. In particular, the models PISCES and BFM have been ported to the FABM in Task 2.1 so that they can be coupled to the system. Now, the included CMEMS BGC models are (see the SEAMLESS Deliverable D2.2).:
  - ECOSMO
  - ERGOM
  - ERSEM
  - PISCES
  - BFM
- The data assimilation component supports both ensemble Kalman filters and variational methods. The variational methods (both with parameterized and ensemble-based covariances) have been developed in Task 2.4a. These methods are also included in the public release of PDAF since its version 2.0.
- Ensemble generation methods are provided. Methods for direct perturbations from a state trajectory and by the perturbation of model parameters have been provided through task 2.4b.
- To allow for coupled data assimilation, support of simultaneous physical-BGC data assimilation is provided through developments in Task 2.2b. In addition, functionality for multiple observation types is provided.

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- Since process parameters in BGC models are uncertain, support for parameter estimation and corrections is supported through developments of Task 2.2c.

To provide a directly linkage to the CMEMS MFCs, the prototype has been configured at fixed stations in the different MFC regions (Arkona Basin, BATS, Stations M and L4) and for Lagrangian data (BGC-Argo floats). Both, the setup without data assimilation (Task 2.3a) and with support for data assimilation (Task 2.3b) have been prepared. In addition, the partners of the SEAMLESS consortium applied the prototype system for different tasks like the indicator and parameter sensitivity study (Task 3.2) documented in Deliverable D3.2 or weakly and strongly coupled data assimilation in Tasks 4.1 and 4.2 documented respectively in Deliverables D4.1 and D4.2.

Overall, these developments render the prototype system to be ready-to-transfer to the CMEMS MFCs since the software reached its expected functionality and mature state and different modelling and data assimilation applications are possible.

### 3. Procedures

Information on obtaining, configuring and building EAT is available via <https://github.com/BoldingBruggeman/eat>.

### 4. Conclusion and dissemination

The link to the Delivered D2.3 EAT software and this accompanying document will be transferred to CMEMS through the representatives of the CMEMS Entrusted Entity (Mercator Ocean) in the SEAMLESS Steering Committee (Dr Julien Lamouroux) and advisory board (Stefano Ciavatta), besides through the dissemination and communication pathways identified in the Plan for the Exploitation, Dissemination and Communication of the Results (PEDCR, D7.2).