Proposal of work for ESA Climate Change Initiative Phase 2 Climate Modelling User Group “optional extra” for seasonal predictions

Version 1.0

Dated 6 August 2015

In response to:

ESA Statement of Work: CCI-PRGRM-EOPS-SW-13-0043 (v3.2)

Centres providing input: Met Office, SMHI, BSC

Proposal of work CMUG Phase 2 “optional extra” for seasonal predictions

Contents

1. Status

Tenderer Status: The Met Office is the National Meteorological Service of the United Kingdom.

ESA Bidder Code 29281

Period of validity: The offer is valid until 05.10.2015

Statement of Compliancy: The offer is technically and managerially fully compliant with the CMUG SOW.

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2. Introduction and Overview

As part of the ESA Climate Change Initiative (CCI) the Climate Modelling Users Group (CMUG) has worked for five years on defining user requirements, assessing precursor and CCI climate datasets, and promoting the CCI datasets to the climate research and modelling community. To date, CMUG has achieved success over this period leading to an increasing awareness of the CCI and CMUG activities in the international satellite observations and climate modelling and research communities. As a result, the ESA Climate Science Advisory Body has strongly endorsed the continuation of the CMUG into Phase 2 of the CCI project to build on its success in Phase 1.

CMUG is a unique group that helps bring together the modelling and observational communities – something realized by the World Climate Research Programme (WCRP) as one of the impediments to progress in climate research. CMUG ensures that the CCI data products are developed and provided in a form most useful for climate analysis and modelling work and that they are widely promoted within the climate research community.

This proposal is in response to the ESA statement of work CCI-PRGRM-EOPS-SW-13-0043 of CMUG, it is one of several optional extra pieces of research that were submitted for consideration in Phase 2. It describes the research for using multiple ECV datasets that will develop seasonal forecast and decadal projections using the EC-Earth climate model.

3. Work Package Description

WP: O3.11		Start / end	18	36
Cross-assessment of SST, SI, ocean colour and sea-level data for seasonal and decadal predictions and CCI4MIP simulations				

CMUG participant	DLR	ECMWF	SMHI	IPSL	MeteoFrance	MetOffice	MPI-M	BSC
PM			5					18

Sum: 23

Key personnel	BSC: Virginie Guemas, François Massonet, Omar Bellprat, Francisco Doblas-Reyes SMHI: Torben Koenigk, Matthias Gröger, Ralf Döscher
Model(s)	• EC-Earth 3
Experiment type	• AMIP-type with the EC-Earth atmosphere stand alone model (SMHI) • Ocean stand alone with EC-Earth ocean model including the bio-geochemistry model, PISCES (SMHI) • Coupled EC-Earth simulations assimilating CCI sea ice concentration and sea surface temperature data to provide initial conditions for climate predictions (BSC) • Coupled EC-Earth hindcast prediction simulations (BSC)
Notes	• Minor code development is required to assimilate the CCI datasets: the assimilation of sea ice data has been implemented in the ocean component of EC-Earth in stand-alone mode but it needs to be tested in coupled mode.

ECVs	OC	SST	SSH	SI	SM	Fire	LC	GHG	..	..	..		
	x	x	x	x									

Period for experiment	• Complete observational period provided by CCI with both sea surface temperature (SST, 1991-2010) and sea ice concentration (SIC, 1979-2008): 1991-2008 for their assimilation in EC-Earth. The CCI sea ice thickness (SIT) will be used on its overlapping period with 1991-2008 which is 1993-2008 for the validation of these assimilation runs. • The CCI SST, SIC, SIT will be used over the 1991-2010, 1991-2008 and 1993-2012 respectively for verification of the prediction experiments, according to their availability and the period covered by the 5-year-long prediction experiments : 1991-2013. • The ocean stand alone experiments will be adapted to the period of availability of the CCI sea level, sea-ice and ocean colour data • The EC-Earth CCI AMIP simulations will be done for September 1991 - December 2008 (time-period based on the availability of the CCI

	datasets)

CCI data products	• Sea Surface Temperature (SST) • Sea Ice Concentration (SIC) • Sea Ice Thickness (SIT) • Ocean Colour (OC) • Sea Level (SSH)
Other data	• HadISST and NSIDC datasets for SIC • PIOMAS for SIT • ERSSTv3b and HadSST3 for SST • ORAS5, GLOSEA5 and GLORYS2v1 ocean reanalyses • WOA 2013 chlorophyll and bio-geochemical data sets

Objectives

The aim is to exploit the CCI sea ice concentration (SIC) and sea surface temperature (SST) data through their assimilation in coupled runs produced with EC-Earth3 which would, in turn, provide initial conditions for seasonal to decadal climate predictions. The observational uncertainty will be exploited to generate different members for these assimilation runs.

The sea ice thickness (SIT) data will be exploited to validate the sea ice cover in these assimilation runs, which has been seldom evaluated for this variable up to date. In addition, the bio-geochemistry component of EC-Earth NEMO stand-alone simulations will be evaluated using ocean colour data and the sea-ice and ocean components using CCI sea-ice and sea-level data, respectively. As a useful prerequisite for predictions and assimilation, the ocean colour data will be used to validate the seasonal cycle of the bio-geochemical tracers in the bio-geochemical components of the EC-Earth model.

A set of retrospective climate predictions will then be initialized from the assimilation runs, produced also with EC-Earth3, and its systematic error and forecast skill will be assessed against the CCI SIC, SST, SIT. We will also evaluate how the observational uncertainty used to generate different members for the assimilation runs translates into a dispersion between the different members of the predictions, and especially if it allows for more reliable predictions (with a dispersion of the same amplitude as the forecast error).

We will explore the importance of using high temporal and horizontal resolution surface boundary fields of SST and Sea-Ice for EC-Earth AMIP type simulations using daily CCI sea-ice and SST fields. The results will be compared to simulations using monthly mean CCI data and to standard monthly update EC-Earth AMIP runs driven by SST and SI from ERA-Interim

Use of CCI products

The CCI SIC and SST datasets will be assimilated in an ensemble of EC-Earth3 coupled simulation to provide initial conditions for ensemble climate predictions produced also with EC-Earth3. The CCI SIC, SIT, SST will be used to evaluate the systematic errors and for forecast quality assessment. The sea-level and ocean-colour data will be used for evaluation of the stand-alone NEMO runs. The CCI SIC and SST will be used to produce CCI4MIP boundary conditions and to assess the importance of high horizontal and temporal resolution.

Use of the Uncertainty information

The observational uncertainty provided with the CCI SST and SIC dataset will be exploited to generate different members of the assimilation runs produced with EC-Earth3. The dispersion between the members of the assimilation runs and how this dispersion translates into a dispersion between the prediction members and how this dispersion compares with the forecast error will be assessed.

Scientific questions to be addressed:

1. Does the use of CCI SIC and SST data to constrain initial conditions for climate predictions allow for reduced systematic errors and better forecast skill than traditionally used datasets?

2. How do the observational uncertainties provided with the CCI SIC and SST affect the dispersion between the members of the assimilation runs and between the members of the ensemble predictions and therefore their reliability?

3. What are the performance of EC-Earth3 in prediction mode relative to the CCI SIC, SST and SIT data?

4. How does the performance vary depending on the observational dataset used for validation?

5. How well does the ocean and bio-geochemistry component of EC-Earth compare to observations and to the CCI ocean colour, sea-ice and sea-level data?

6. What is the impact of daily varying forcing SST and Sea-Ice fields compared to their monthly
varying counterparts on atmosphere only AMIP type runs?

Tasks to be performed

1. Download and formate the CCI SIC and SST data for assimilation into EC-Earth 3 and test the assimilation procedure on these data [BSC 3PM]
2. Assimilate the CCI SIC and SST data into an ensemble of EC-Earth3 simulations covering the period of availability of the CCI data. [BSC, 4PM]
3. Validate this ensemble of assimilation runs against the CCI SIT and compare with previous assimilation runs using other observational datasets (ORAS4 or GLORYS2v1 ocean reanalyses) [BSC, 2PM]
4. Produce a set of ensemble retrospective climate predictions initialized from this ensemble of

assimilation runs [BSC 3PM]
5. Assess the systematic errors and the forecast quality of these predictions against the CCI SIC, SIT, SST data and compare these performance with those obtained when validating against other reference datasets (NSIDC, HadISST, PIOMAS, ERSST, HadSST3) [BSC 3PM]
6. Estimate how taking into account the observational uncertainty in the CCI datasets affects the dispersion of the assimilation runs and the dispersion of the ensemble predictions and therefore their reliability [BSC 2PM]
7. Evaluate the bio-geochemistry component of EC-Earth NEMO stand-alone simulations with CCI ocean colour, sea-ice and sea-level data. [SMHI 2.7PM]
8. Estimate the impact of using daily contra monthly SST and Sea-Ice on EC-Earth AMIP type simulations (CCI4MIP) and the impact of using CCI data compared to existing data sets. [SMHI 2PM]
9. Write annual reports summarising the main conclusions [BSC 1PM, SMHI 0.3PM]

Value, Impact metrics and expected outcome of the experiment

- These experiments will inform about the added-value of the CCI products as initial conditions for climate predictions
- They will also inform about the value of the observational uncertainty provided with the CCI products for producing reliable climate predictions, i.e. predictions with an ensemble dispersion representative of the forecast error
- The CCI4MIP simulations will inform on the added value of using CCI high temporal and spatial resolutions as surface boundary conditions.
- The SIT and ocean colour datasets will contribute to further validating EC-Earth3 on aspects that have been seldom evaluated up to now.
- The experiments produced will contribute to the research input to climate services

Complementarity with CCI experiments

- There are no other seasonal and decadal prediction runs using ESA-CCI data. These simulations will complement what is done in other CMUG, ocean and sea-ice ECV experiments

Output / Deliverables

- Results for phase 1 data reported in QAR D3.1 KO+24
- Final results for updated CCI data in QAR D3.1 KO+35
- Paper(s) in peer reviewed journal KO+36

4. Finance

BSC will be a sub-contractor to the Met Office. Payment schedule will be aligned with existing CMUG milestones and payment plan. Full details are given in the accompanying PSS forms.

The rates and overheads used to construct the costs described in this proposal are consistent with those in the core CMUG contract.

SMHI	
Work	59.0
Travel / meetings	1.0
BSC	
Work	87.1
Computer	3.5
Travel / meetings	1.5
Total:	**152.1 k €**

5. Management

This WP will describe its results in Deliverable 3.1 (v2 and v3 due in M24 and M36 respectively) along with other CMUG research results. The activity and outcomes from the WP will also be included in the project management quarterly and annual reports. BSC will engage with CMUG outreach activities as appropriate.

The Met Office will manage this work within the existing CMUG Phase 2 work, at no cost to ESA.