

## **IS-ENES3 Milestone M4.1**

### **Development strategy workshop for European Platform for Sea Ice modelling**

*Reporting period: 01/01/2019 – 30/06/2020*

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#### **ABSTRACT**

The milestone M4.1 provides a short description of the objectives and the content of the Development strategy workshop for European Platform for Sea Ice modelling that was held in Laugarvatn, Iceland on the 23<sup>rd</sup>-26<sup>th</sup> September 2019.



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### **1. Objectives**

The goal of this activity was to organize a workshop devoted to the future direction of sea ice modelling to help inform the development strategy of the new European Platform for Sea Ice modelling – NEMO’s Sea Ice modelling Integrated Initiative (SI<sup>3</sup>). The planned approach was to bring together NEMO Sea Ice Working Group (SIWG) members, with several external experts from the international sea ice modelling community, to discuss priorities, opportunities and potential threats relevant to large-scale sea ice modelling. The activity will contribute towards D4.2 to write a development strategy for the NEMO SI3 sea ice model.

### **2. Description of work**

The workshop was held in Laugarvatn, Iceland on the 23<sup>rd</sup>-26<sup>th</sup> September 2019. The workshop was co-hosted/organised by Ed Blockley (Met Office) and Martin Vancoppenolle (CNRS) from the IS-ENES3 project and NEMO SIWG, along with Elizabeth Hunke from the US DOE (Los Alamos National Laboratory) and lead scientist for the CICE Consortium.

Workshop attendance comprised 32 sea ice modelling scientists, including 10 invited experts from North America and 22 from Europe – including 13 NEMO developers and Sea Ice Working Group members. As well as including 10 IS-ENES3 project partners, several of the workshop attendees had strong links to relevant European activities including CMEMS and C3S, as well as large EU polar and modelling projects such as APPLICATE, ICE-ARC, KEPLER, PRIMAVERA, SPICES, and IMMERSE. The full attendance list can be found in the workshop agenda document attached to this report.

The workshop was structured around a set of important motivating questions. These questions were defined over the summer, in conjunction with Elizabeth Hunke and NEMO SIWG members, and were circulated to guests in advance of the workshop.

The workshop was split into 2 key themes:

- Theme 1: scientific and technical validity/limitations of the current models
- Theme 2: Physical processes and complexity: bridging the gap between weather and climate requirements

A set of 5 keynote speakers, of international repute, were invited to speak to each theme and to answer selected points from the motivating questions. The keynote speakers were deliberately chosen to provide insightful and/or controversial opinions to stimulate debate. Details of the keynote speakers and the motivating questions can be found in the attached agenda document.

### **3. Next steps**

We are planning to write up the workshop proceedings for publication in a top peer-reviewed scientific journal in spring 2020. The workshop organisers have also been invited to lead a scientific journal article on the future direction of sea ice model development within a series entitled “Advances and Future Directions in Earth System Modelling”. Finally, the workshop discussions and conclusions will be used within D4.2 to write a development strategy for the NEMO SI3 sea ice model (due M26).

## **Agenda – Iceland Sea ice modelling workshop**

Venue address: University of Iceland Building, Lindarbraut 4, 480 Laugarvatn, Iceland

### **Monday 23rd September 2019**

17:00: bus transit leaves Keflavik airport to Laugarvatn (~1hr 45min)

19:00: arrival and get settled into accommodation

19:45: Informal introduction to the workshop

20:00: Dinner and reception

### **Tuesday 24th September 2019**

07:30 - 08:15: Breakfast

08:30 - 08:50: Welcome, housekeeping, and introduction to day 1

08:50 - 12:30: Speaker presentations (15-20 min + 10 min) [Chair: Ed Blockley]

08:50 – Danny Feltham

09:20 – Martin Losch

09:50 – Pierre Rampal

10:30 - 11:00: Coffee

11:00 – Eric Maissonave

11:30 – Adrian Turner

12:00 - 13:00: Synthesis and initial discussion

13:00 - 14:00: Lunch

14:00 - 15:30: Free time [suggestion: walk in nearby mountains]

15:30 - 16:00: Coffee

16:00 - 18:30: Discussion session for day 1

Chair: Elizabeth Hunke

Rapporteurs: Andrew Roberts; Sophie Morellon

19:30: Dinner



**Wednesday 25th September 2019**

07:30 - 08:15: Breakfast

08:30 - 08:50: Housekeeping, and introduction to day 2

08:50 - 12:30: Speaker presentations (15-20 min + 10 min) [Chair: Ed Blockley]

08:50 – Dirk Notz  
09:20 – Elizabeth Hunke  
09:50 – Cecilia Bitz

10:30 - 11:00: Coffee

11:00 – Jean-Francois Lemieux  
11:30 – Steffen Tietsche

12:00 – 13:00: Synthesis and initial discussion

13:00 - 14:00: Lunch

14:00 - 15:30: Discussion session for day 2  
Chair: Martin Vancoppenolle  
Rapporteurs: François Massonnet; Sophie Morellon

15:30 - 1600: Coffee

16:00 - 17:00: Wrap up and exploring next steps

17:00 - 19:00: Free time [suggestion: Fontana Geothermal bath]

19:30: Farewell dinner

**Thursday 26th September 2019**

05:00: Bus transit to Keflavik airport from Laugarvatn

**Emergency contacts**

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## Iceland workshop: motivating questions (1)

### Top-level questions for the workshop:

- A1. What scientific questions or operational needs are driving current sea ice model development?**
- A2. Do we think the current continuum model formulation is still the best choice for sea ice modelling?**
  - a. If no: what would be the best alternative?
  - b. If yes: for how long will this be true? What will be the limitations?
- A3. Do we favour “evolution”, “revolution”, or “status quo” in relation to designing future sea ice models?**
- A4. What role can the sea ice model development community play to improve progress? Are there any current practices that are inhibiting scientific advancement?**

### ***Main questions for the discussion & workshop report***

- B1. Are we in a position to claim that any of the available sea ice modelling frameworks are better than any of the others? (e.g., Eulerian AIDJEX/Hibler, Lagrangian, Discrete Element, ...)
  - a. What are the key strengths and weaknesses of each approach?
  - b. How is scientific validity of sea ice models established, in particular dynamics? Is there a consensus? What are the advantages vs caveats of the different evaluation methods? Which data products are to be used or precluded?
  - c. Do we know what would be the “perfect” sea ice model physical framework (equivalent to Navier-Stokes for the ocean)?
- B2. What level of physical complexity is necessary for sea ice modelling?
  - a. Are there important missing processes in contemporary sea ice models?
  - b. Why are climate models with a more complex sea ice component not clearly superior to those with a very simple sea ice model?
  - c. Is there a place for very simple sea ice models for climate applications?
  - d. To what extent does it make sense to increase model physics given the large uncertainties in atmospheric and oceanic forcing?

## Iceland workshop: motivating questions (2)

### **Main questions for the discussion & workshop report (contd.)**

- B3. What is the contribution of forcing vs physics to model uncertainty, in light of internal variability?
- Do we know enough how sea ice affects its own atmospheric and oceanic forcing?
  - What are the trade-offs when considering coupling strategies to other Earth System Model components? How important are they?
- B4. Which other constraints should be considered, in the context of current and upcoming applications and computing platforms?
- What is the finest resolution that can currently be used with current models? Are these limitations of physical, numerical, or computational origin? Is there a discrepancy between these limitations and the resolution required for operational applications?
  - Should the same sea ice model be used for short-range forecasting and large-scale climate modelling?
  - Will contemporary sea ice models (i.e., continuum+rheology) scale well enough for the next generation of exascale HPC systems?
  - What are the most critical code design requirements for efficient use of new computational architectures?

### **Questions related to community practice & tools**

- C1. Are there current sea ice modelling practices slowing scientific progress?
- C2. Should the sea ice modelling community improve modularity among different model sub-components to develop modular, interchangeable components that can be plugged into a generic framework? If so, how fine should the granularity be?
- C3. Should the sea ice modelling community work toward one model or set of tools that everyone uses for many different purposes, or toward providing a diversity of model choices even for the same purpose?
- C4. Should analysis, evaluation and calibration tools (including data assimilation) be included within sea ice modelling repositories? Could we benefit from international coordination or even collaboration?