

An update on work towards:
“A European Platform for Sea Ice modelling”

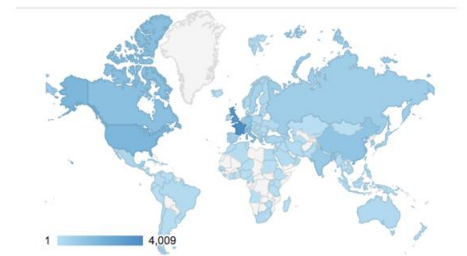
Ed Blockley (Met Office)
Martin Vancoppenolle (CNRS-IPSL)

Task 2 leads, WP4 & WP8

Building a new community around a European Platform for Sea Ice modelling in NEMO

- Previously NEMO sea ice community was fragmented:
 - LIM (2&3), CICE & GELATO models used routinely with NEMO
- New collaboration within Europe to pool resources and develop unified NEMO sea ice model:
 - **Sea Ice modelling Integrated Initiative (SI³)**
 - Led by NEMO Sea Ice Working Group - Ed Blockley (Met Office) & Martin Vancoppenolle (IPSL) co-chairs
 - Merging functionality from LIM, CICE & GELATO models used with NEMO
 - Bringing sea ice fully within the NEMO Consortium – including long-term development strategy

NEMO web/code access (2016)



Top 10 number of sessions by countries

| Country | Sessions |
|----------------|----------|
| France | 4,009 |
| United Kingdom | 3,378 |
| United States | 1,899 |
| Italy | 1,635 |
| Canada | 1,490 |
| China | 1,222 |
| Germany | 1,149 |
| India | 983 |
| Spain | 772 |
| Russia | 770 |



IS-ENES3 provides important funding support for NEMO-SI3

Two main strands:

1. Building a community around NEMO-SI3 [WP4/NA3]:

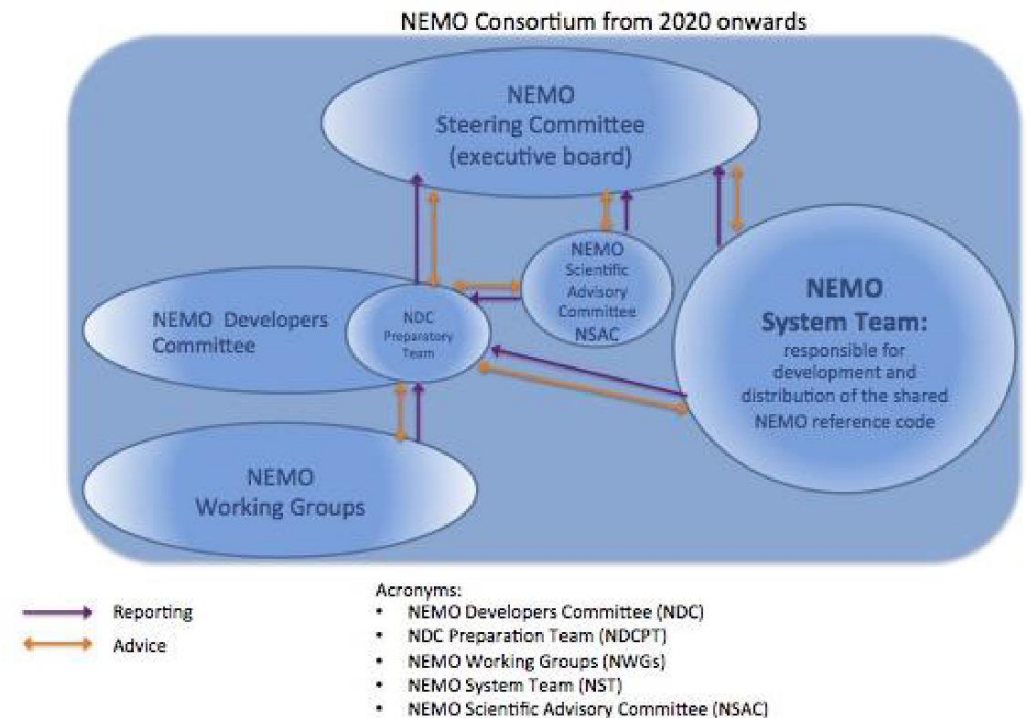
- Developing a sustainable development strategy for sea ice in NEMO – inc. governance, technical (coding standards, testing,...), scientific
- Updating sea ice science chapter of the NEMO development strategy
- **D4.2: Development strategy for sea ice modelling in NEMO** [July 2021]

2. Development of key infrastructure for SI3 [WP8/JRA1]:

- Technical code development: modularity, robustness, coupling interfaces, ...
- **D8.1: Provision of SI3 code through the NEMO repository** [Sept 2021]

SI3 – governance, leadership, ownership

- The SI3 sea ice model will be part of the NEMO ocean modelling framework, wholly owned by the NEMO consortium
- The NEMO SIWG will be responsible for the day-to-day leadership of SI3
- The NEMO SIWG will propose the scientific direction of SI3, which will be agreed within the wider NEMO governance structure



SI3 – technical development strategy

- The SI3 model code will be available in the NEMO repository alongside the ocean model code
- SI3 will be developed adhering to NEMO procedures for code development described on the NEMO Trac system at <https://forge.ipsl.jussieu.fr/nemo/wiki/Developers>, adopting NEMO practices on:
 - code design and coding standards
 - work-flow processes (e.g. annual work plan, branches, tickets, (pre)review, etc.)
 - testing and evaluation strategy
- Reporting of bugs/issues and/or ideas for future SI3 code development through NEMO Trac system

SI3 – scientific development strategy

- In the short- to medium-term, SI3 will continue to merge in features from other sea ice models required by NEMO users (namely CICE & GELATO)
- In the longer-term, the scientific strategy of the SI3 model will be tied to the wider NEMO Development Strategy (NDS)
- Refresh of NDS sea ice chapter performed as part of D4.2. Key points:
 - We favour **smooth evolution** of the existing code, but also **encourage research on the feasibility of major structural changes** (e.g. discrete element and hybrid approaches).
 - Recognise that the most pressing needs for SI3 are not only related to evolving the sea ice physics, but also **improving access** to (or take-up of) the model. Specifically, we recommend **improving code modularity, coupling interfaces and documentation**.

SI3 code at NEMO 4+

- SI3 available in the NEMO trunk from v4.0

The screenshot shows the NEMO repository source browser. The main heading is "source: NEMO / trunk / src @ 15005". Below this is a table of directories:

| Name | Size |
|------------|------|
| ../ | |
| ABL | |
| ICE | |
| NST | |
| OCE | |
| OFF | |
| SAO | |
| SAS | |
| SWE | |
| TOP | |

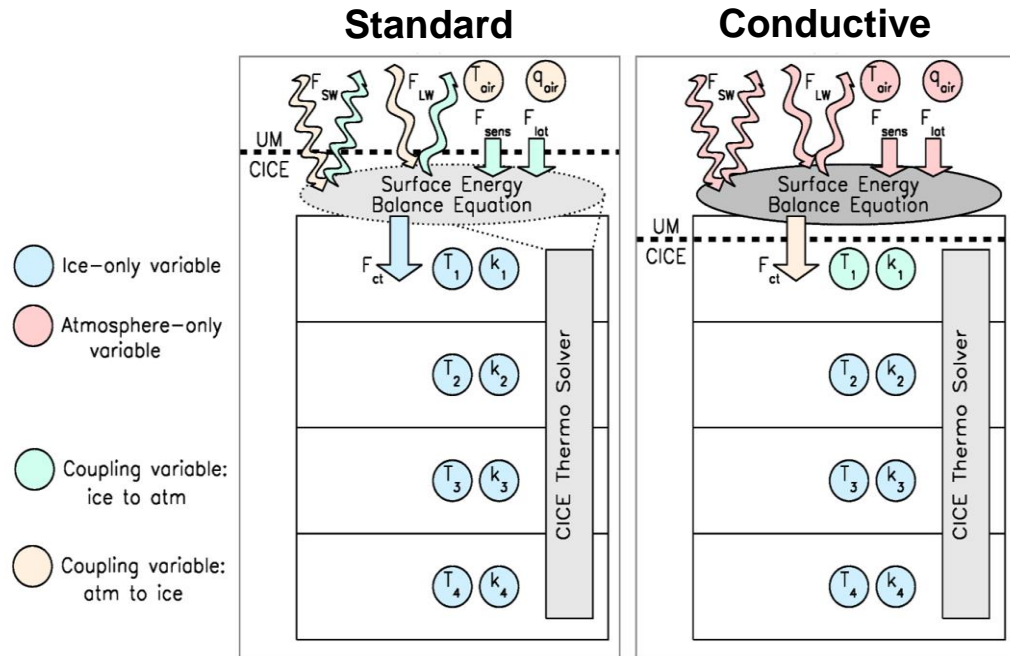
```

Line
1  MODULE  icestp
2  !!-----
3  !!          *** MODULE  icestp ***
4  !! sea ice : Master routine for all the sea ice model
5  !!-----
6  !!
7  !! The sea ice model SI3 (Sea Ice modelling Integrated Initiative),
8  !!          aka Sea ice cube for its nickname
9  !!
10 !! is originally based on LIM3, developed in Louvain-La-Neuve by:
11 !!   * Martin Vancoppenolle (UCL-ASTR, Belgium)
12 !!   * Sylvain Bouillon (UCL-ASTR, Belgium)
13 !!   * Miguel Angel Morales Maqueda (NOC-L, UK)
14 !! thanks to valuable earlier work by
15 !!   * Thierry Fichefet
16 !!   * Hugues Goosse
17 !! thanks also to the following persons who contributed
18 !!   * Gervan Madec, Claude Talandier, Christian Ethe (LOCEAN, France)
19 !!   * Xavier Fettweis (UCL-ASTR), Ralph Timmermann (AWI, Germany)
20 !!   * Bill Lipscomb (LANL), Cecilia Bitz (UWa) and Elisabeth Hunke (LANL), USA.
21 !!
22 !! SI3 has been made possible by a handful of persons who met as working group
23 !!   (from France, Belgium, UK and Italy)
24 !!   * Clement Rousset, Martin Vancoppenolle & Gervan Madec (LOCEAN, France)
25 !!   * Matthieu Chevalier & David Salas (Meteo France, France)
26 !!   * Gilles Garric (Mercator Ocean, France)
27 !!   * Thierry Fichefet & Francois Massonnet (UCL, Belgium)
28 !!   * Ed Blockley & Jeff Ridley (Met Office, UK)
29 !!   * Danny Feltham & David Schroeder (CPOM, UK)
30 !!   * Yevgeny Aksenov (NOC, UK)
31 !!   * Paul Holland (BAS, UK)
32 !!   * Dorotea Iovino (CMCC, Italy)
33 !!-----
34 !! History : 4.0 ! 2018      (C. Rousset)      Original code SI3
35 !!-----
36 #if defined key_si3
37 !!-----
38 !!   'key_si3'                      SI3 sea-ice model
39 !!-----

```


- Updated SI3 available as part of **NEMO 4.2 “release candidate”** (beta)
 - Modularity and robustness:
 - Code simplification (structure, ice-atmosphere interface)
 - Improved conservation of mass and heat & associated diagnostics
 - Physics options development:
 - Adaptive EVP sea ice rheology (aEVP)
 - EAP rheology ported from CICE [funded under EU-IMMERSE]
 - Improved description of melt-ponds:
 - Adding lids to the “level-ice” melt-pond scheme
 - Porting the “topographic” melt-pond scheme from CICE (and offline LIM3 code)
 - Conductivity coupling functionality (required for Met Office/UK coupling)
 - Radiation scheme improvements

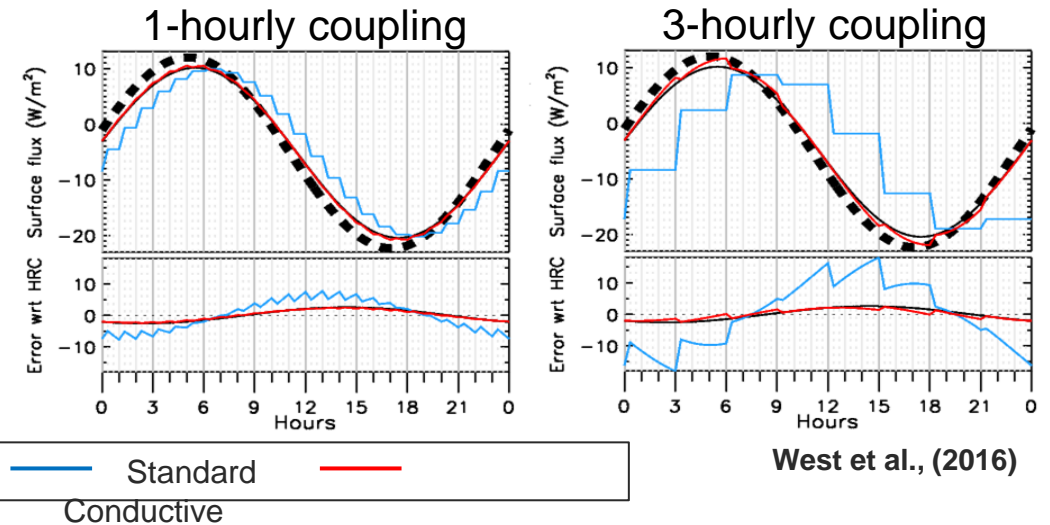
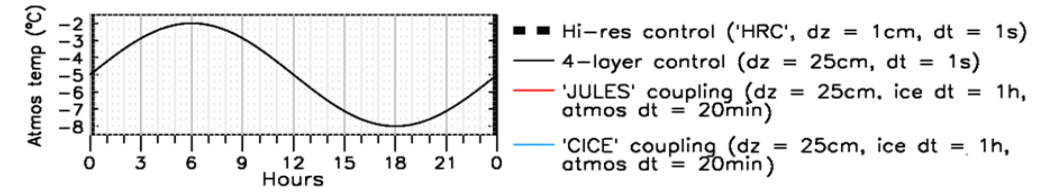
'Conductivity' coupling



Motivation:

- Consistent surface boundary-layer calculation
- Allows surface to respond more quickly to atmosphere (ATM vs CPL time-steps)

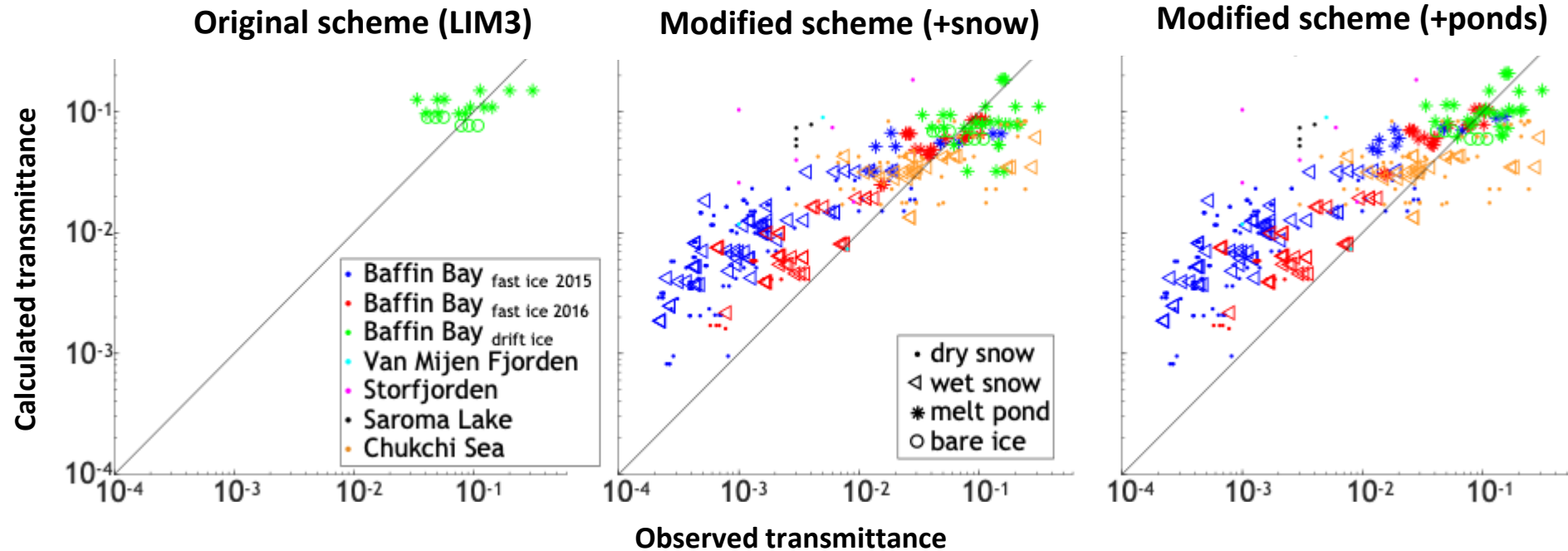
Impact from 1-D idealised study



Impact:

- Allows SI3 to be used with MetUM/JULES
- Use within HadGEM and UKESM models
- Plus international partners: Australia, New Zealand, South Korea, ...

Radiation scheme improvements



Motivation:

- Under-ice light (heat budget, photosynthesis)
- No effect of snow & ponds
- Weak observational basis

Impact:

- Allows transmitted light under snow
- Low-biased surface melting

SI3 code at NEMO 4+

- Additional functionality being worked on under IS-ENES3 for future SI3/NEMO releases:
 - Rothrock (1975) ridging formulation of ice strength
 - Mixed-layer ocean functionality for standalone SI3 runs
 - Porting form-drag from CICE
 - Further improvements to radiation budget under sea ice
 - Improved efficiency on GPUs (with HPC optimisation folk)
- SI3 documentation updates [M8.5]

THE CONSORTIUM

Coordinated by CNRS-IPSL, the IS-ENES3 project
gathers 22 partners in 11 countries



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Our website
<https://is.enes.org/>



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