# NEMO 2020WP

Met Office Summary

# 2020

Below is a summary of the work carried out on 2020WP actions with Met Office staff listed as (one of the) PI(s).  Much of this work, in particular the tiling and RK3 work has of course been carried as part of wider collaborations with other institutions.  The Met Office PI is indicated in brackets.

**HPC (HPC01, HPC02)**

- *HPC01*: The adaptation to GPU with PSyclone continues and will not finish this year. A virtual Hackathon was held looking at the performance of MPI on GPU. Note that this is development work and is not likely to be merged to trunk (MAnrejczuk)
- *\*\* HPC02*: Significant work has been carried out on tiling.  This is an extensive project touching large parts of the code and overlapping with several other 2020WP actions.  So far, tiling has been implemented in the TRA modules and tested using a mono processor GYRE configuration. The performance impact is currently being assessed, but may be affected by code that cannot be tiled (e.g. due to lbc_lnk calls). The tiled code has not yet been tested with multiple processors or SETTE. The aim is to have the currently tiled code ready for this year's merge, with tiling of the ZDF or DYN modules as a stretch goal. Work will continue into 2021, focussing on the remainder of the code (prioritising routines with many 3D loops) and code from the 2020 development that could not be tiled. (DCalvert)

**Kernel (KERNEL01, KERNEL03, KERNEL04)**

- *\*\* KERNEL01*: (IMMERSE funded): Work on the hpg schemes for general vertical coordinates is ongoing.  Several new HPG schemes, as well as a corrected djc scheme have been tested in an idealised configuration but rigorous testing in realistic configurations, across a range of stretched vertical coordinates is still required.  The IMMERSE deadline for this has been extended to November 2021 (AYoung, MBell)
- *\* KERNEL03/04*: Initial RK3 implementation has been completed allowing for to start on KERNEL07, Gurvan's shallow water equation work (DStorkey)

**Enhancements (ENHANCE04, ENHANCE05)**

- *ENHANCE03*  Climatology output at obs locations has been implemented in r3.6 and now needs to be brought into the trunk (DLea)
- *ENHANCE04*: Generalising the observation operator to make it easier to add new variables (esp BGC) have been successfully implemented and tested in 3.6.  The implementation in the trunk should be completed by October or early November (DFord)
- *ENHANCE05*: Several options for multi-processor reading/writing have been tested but it was found that the most efficient method was 1 write/1 reader as NetCDF does not support parallel compression – no further work intended (MAndrejczuk/PMathiot)
- *ENHANCE06*: A temporary fix has been applied to resolve the iceberg melt stability issue but a permanent, scientifically justified solution is yet to be proposed.  This should certainly be pursued with high priority. (-)

**SI3 (SI302)**

- *SI302*: OBS and IAU code developments to allow for sea-ice-thickness observations to be assimilated have been successfully implemented in release 3.6. (DCaneiro)

**Validation (VALID06)**

- *VALID02*: Following EMaisonnave's NEMO/SI3 decoupling work on ORCA1 in 2019, this has subsequently been extended to ORCA025.  This work is still ongoing and will likely continue into 2021. (MAnrejczuk)
- *VALID06*: Extensive validation work has been carried out on the SI3 coupling interface ranging from short-term (1-day) process studies to analysis of long-term (50 year) climate characteristics.  Initial assessments highlighted some bugs which were subsequently fixed in NEMO 4.0.2/3.  With these fixes, the SI3 coupled interface has performed well, giving similar results to HadGEM3 + CICE with no long-term drifts or spin up issues.  This is on track to be completed by the end of 2020. (EBlockley)

**Publications (PUB03, PUB05)**

- *PUB03*: Work on the NDS SI chapter is ongoing with a deadline of Feb 2021 though this may be pushed back due to COVID.  Following a successful workshop in Sep 2019, "Defining a cutting-edge future for sea ice modelling", an article was published (*The Future of Sea Ice Modeling: Where Do We Go from Here?*) in BAMS.  The aim is to feed the outcomes of this workshop into the SI NDS chapter.  Note the workshop has also fed into two further publications, one accepted and one in review. (Eblockley co-PI with MVancoppenolle at IPSL).
- *PUB05*: SI3 Documentation work is on target for completion (MO PI but owned by MVancoppenonlle at IPSL) is on target

**The following actions have not been worked on**

- ENHANCE02 (MLD diagnostics), VALID01 (Sette improvements), VALID03 (AMM15), VALID04 (ORCA) , VALID05 (Debug), ENHANCE07 (Ice-sheet precipitation), HPC06 (text output control), ENHANCE08 (2D vorticity trends), AGRIF01 (Multiload balancing)

# IMMERSE Actions

**HPC**

- *HPC02*: Significant work has been carried out on tiling.  This is an extensive project touching large parts of the code and overlapping with several other 2020WP actions.  So far, tiling has been implemented in the TRA modules and tested using a mono processor GYRE configuration. The performance impact is currently being assessed, but may be affected by code that cannot be tiled (e.g. due to lbc_lnk calls). The tiled code has not yet been tested with multiple processors or SETTE but the aim is to have the currently tiled code ready for this year's merge, with tiling of the ZDF or DYN modules as a stretch goal. Work will continue into 2021, focussing on the remainder of the code (prioritising routines with many 3D loops) and code from the 2020 development that could not be tiled. (DCalvert)

**Kernel**

- *KERNEL01*: Work on the hpg schemes for general vertical coordinates is ongoing.  Several new HPG schemes, as well as a corrected djc scheme have been tested in an idealised configuration but rigorous testing in realistic configurations, across a range of stretched vertical coordinates is still required.  The IMMERSE deadline for this has been extended to November 2021 though we are looking into the possibility of delivering before this date.  (AYoung, MBell)
- ✓ *KERNEL03/04*: Initial RK3 implementation has been completed allowing for to start on KERNEL07, Gurvan's shallow water equation work (DStorkey)

# 2021

**Confirmed carry-overs**
- *HPC01*: Adaptation to GPU with Psyclone continues
- *HPC02:* Tiling Work
- *KERNEL01*: HPG Scheme development (target Nov 2021)
- *ENHANCE02*: MLD diagnostics
- *ENHANCE06*: Iceberg melt stability
- *VALID02*: SAS validation
- *VALID03*: AMM15 validation (may be completed by end of year)
- *PUB03*: NDS chapter (target Feb 2021)
- *PUB05*: SI3 documentation (IPSL)
- ENHANCE03 (Climatology output at obs locations), ENHANCE07 (Icesheet precipitation)
- *SI302*: The developments for the sea-ice-thickness observations will need to be implemented in SI3.

**No further work planned/reprioritisation needed**
- *ENHANCE05*: Parallel program for rebuilding NEMO exists but, as it is not used, there is no plan to merge it – would this be of interest to NEMO users?
- *HPC06*: Action to control the level of output is currently on hold.  Current development in NEMO regarding output to diagnostic files is "all or nothing" – is there an appetite for different levels of output?
- *VALID05*: Debug option to catch generic min/max and improved reproducibility check for generic variables implemented for isf in 2019 but no further work done

**Assumed carry-overs**
- VALID04 (ORCA), ENHANCE08 (2D vorticity trends)
- AGRIF01 (Multiload balancing this was being worked on by PMathiot though he has now left the MO)

**Natural continuations of 2020WP actions**
- *SI302*: Further work may also be done to incorporate snow-thickness measurements to improve sea-ice-thickness assimilation
- *ENHANCE04*: There is scope for further developments to the observation operator to make it more general, removing hardwiring

**New projects?**

# Summary

**Successes**

- External collaborations
  - Both the HPC Tiling (in conjunction with the extra halos and DO loop macros) and the time-stepping work are excellent examples of strong collaborations between the consortium members – what can we learn from this?

- Validation work
  - Extensive validation of the SI3 coupling interface is nearing completion with analysis ranging from short-term processes to long-term climate characteristics

**Challenges**

- 2020-specific
  - Personnel changes

- Legacy versions
  - Functionalities are often implemented in current systems in the first instance which may use legacy version. We need to work to ensure these improvements are pulled through to the trunk

- Validation time-frames
  - The Met Office has an excellent capacity for validation work – how can we best synchronise validation and release schedules to ensure bugs and functionality requirements are identified as early as possible?