HPCI システム利用研究課題　利用報告書
HPCI User Report

課題番号 Project Number	hp200264	
課題名	北極圏における海氷と海の相互作用高精度シミュレーション「SEDNA」の富岳におけるスケーリングスタディ	
Project Name	A scaling study of SEDNA, Hight resolution simulation of Arctic Ocean Sea Ice interplays, on Fugaku	
課題代表者 Project Representative	氏名	小鷹 ティナ
	Name	Tina ODAKA
	所属機関	LOPS—IFREMER
	Affiliation	UMR 6523 - Laboratoire d'Oceanographie Physique et Spatiale (LOPS), IFREMER
	所属機関の国名	フランス
	Country	France
キーワード [5-10 語程度]	NEMO、XIOS、北極海、海氷、DASK	
Keywords	NEMO, XIOS, Arctic Ocean, Sea Ice, DASK	
利用ソフトウェア Software	NEMO(OPA_SI^3_XIOS) DASK-XARRAY	
利用枠 Project Category	「富岳」試行的利用課題（利用準備課題）：随時募集 Fugaku Preliminary Use Project (Startup Preparation): Year-Round Opening Call	
実施期間 Periods of Use	2020/12/8 - 2021/3/31 Dec. 8, 2020 - Mar. 31, 2021	

利用計算資源情報
Resource Information

機関名 Institutions	資源名 Computer Resources	資源量（通期） Resources		
		単位 Units	割当量 Allocated	使用量 Amount Used
理化学研究所 RIKEN	スーパーコンピュータ「富岳」 Supercomputer "Fugaku"	ノード時間 node hour	100,000	14,384
東京大学(東)理研(西) Univ. of Tokyo(East), RIKEN(West)	HPCI 共用ストレージ HPCI Shared Storage	GB	20,000	-

Project Number: hp 200264

A scaling study of SEDNA, High resolution simulations of Arctic Ocean Sea Ice interplays, on Fugaku

Tina Odaka

UMR 6523 - Laboratoire d'Oceanographie Physique et Spatiale (LOPS), IFREMER

1. Objectives of the Project

In order to study how the dynamics of mesoscale turbulent eddies in the Arctic Ocean in the presence of sea ice affect the rate of sea ice loss, a highly accurate simulation model of sea ice and the ocean in the Arctic, SEDNA (Sea ice - EDdy resolving ocean paN-Arctic configuration), has been developed on a European supercomputer, Joliot-Curie AMD Irene ROME (ROME). The size of ROME does not allow us to perform long simulations of more than ten years. The goal of this project is to determine the feasibility of running long SEDNA simulations (over a few decades) on the supercomputer Fugaku.

2. Outline of Results

We have planned the following four steps to evaluate feasibility of running long SEDNA simulations on Fugaku:

- Porting SEDNA to Fugaku,
- Test, Scaling study and Tuning,
- Data transfer test between Japan and France,
- Test of the post-processing tool, Dask-Xarray.

We have completed the first step of this project, namely the installation of the SEDNA configuration on Fugaku. SEDNA uses NEMO-SI^3 [1] code together with Xml – IO – Server (XIOS) [2]. We have successfully compiled NEMO-ICE and XIOS using aarch64_fj, Fujitsu compiler available on Fugaku. For XIOS, we have used recent update done on Spack for aarch64_fj by HPCI-RIST support team [3].

We have carried out our first test on Fugaku. We used exactly the same SEDNA configuration as it was used on ROME for its MPI decomposition. SEDNA has three computational parts: 1. Initialization of NEMO-SI^3 which reads large input data, 2. iterative computational process along time axis using NEMO-SI^3, and 3. output writing using XIOS libraries. Our first test calculation performs the first and second part of shortened SEDNA configuration and we have measured the number of iterations computed per minute. As shown in *Figure 1*, although we did not perform any MPI domain decomposition optimization for Fugaku's node architecture nor it's TOFU network, we have observed an increased number of iterations computed per minute compared to ROME.

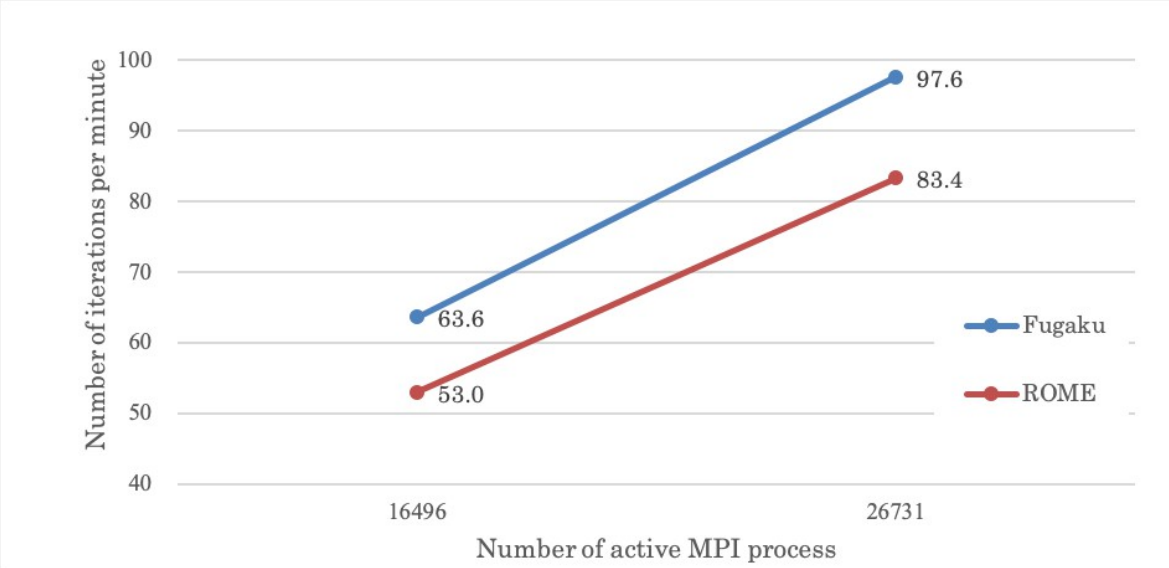

Figure 1**:** *Averaged computed number of iterations per minutes on ROME and Fugaku for SEDNA. The computation was carried out using 16496 and 26731 active MPI processes. On Fugaku, 48 MPI processes were placed for each computing node.*

However, the initialization step was anomaly slow (more than 14 seconds on Fugaku compared to less than one second on ROME). Further study on optimization of data placement on Fugaku IO architecture is required before the scaling study.

Data transfer rate measured between Fugaku and ROME was 4MB per second. This bandwidth information will be used when we will evaluate our post-processing workflow's feasibility.

Installation of Dask-Xarray, together with Pangeo HPC benchmark [4, 5] were conducted thanks to HPCI-RIST support team. Tips and configurations on Fugaku have been shared at an online conference DASK SUMMIT [6].

We conclude that Fugaku computed faster than ROME on our first test case. However further studies, such as optimum usage of disk, tuning of MPI decomposition and its scaling study, scaling study of Dask-Xarray, are required to conclude the feasibility of running a few decades long SEDNA simulations on Fugaku.

3. Please describe issues or suggestions through using the evaluation environment of the supercomputer Fugaku in the trial phase, as well as opinions or requests for improvement of the user environment.

N.A.

References

[1] **"Sea Ice modelling Integrated Initiative (SI^3) — The NEMO sea ice engine"**, NEMO Sea Ice Working Group, *Scientific Notes of Climate Modelling Center (31)* – ISSN 1288-1619, Institut Pierre-Simon Laplace (IPSL) http://doi.org/10.5281/zenodo.1471689

[2] XIOS, http://forge.ipsl.jussieu.fr/ioserver

[3] https://github.com/spack/spack/pull/20474

[4] Odaka T *et al.* (2019). *Tools and Techniques for High Performance Computing. Communications in Computer and Information Science*, vol 1190. pp.190-204. https://doi.org/10.1007/978-3-030-44728-1_12.

[5] https://github.com/pangeo-data/benchmarking

[6] DASK SUMMIT, "Real Time Monitoring of HPC Simulation Outputs using Dask and Xarray", Odaka T *et al.*, https://summit.dask.org/schedule/presentation/34/dask-in-hpc/ (May 2021)