Study for Seamless Prediction of Weather and Climate Using Atmosphere-Ocean Coupled Global Cloud-System Resolving Model

Project Representative

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The goal of this project is to create a seamless modeling platform for future Sub-seasonal-to-Seasonal (S2S) prediction research, with its main calculation framework consisting of global cloud-resolving model and high-resolution ocean model. Its notable characteristic is to serve as a new-type of process-resolving prediction in which dynamical and thermos-dynamical processes related to meso-scale cloud and precipitation in the atmosphere are explicitly calculated and evaluated responding to or interacting with the underlying ocean phenomena on wide-ranging scales. Toward this goal, most of the node resources in FY2014 were devoted to optimization and adjustment of component models that had been used for stand-alone or different combination of component models for calculating atmosphere-ocean system, including NICAM, NEMO, and OASIS3-MCT (coupler). The code editing and optimization were adopted to ES2-based calculation, and one-month calculation was completed at the final term of the fiscal year.

Keywords: sub-seasonal to seasonal (S2S) seamless prediction, global cloud-resolving atmosphere and ocean coupled model

1. Introduction

Recent drastic progress in the weather and climate research with high-resolution atmospheric models have matured to the extent that identification of extended predictability and more accurate magnitude and behavior of climate variability over meso- and synoptic-scale processes is necessary under atmosphere-ocean interactive framework. One facet of putting this issue into international collaborative project is WMO Sub-seasonal to Seasonal (S2S) project that is mainly driven by Operational communities for sharing and overcoming the

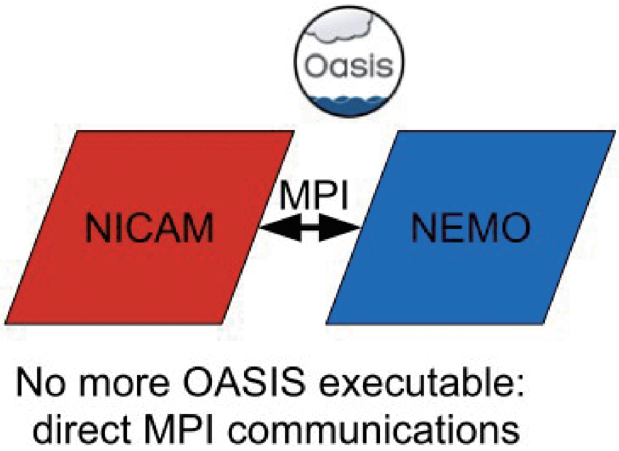

Fig. 1 Overview of works for the coupled model development; No OASIS executable I required; its function is provided as library (Maisonnave, 2014[3]).

common issues of interest.

In response to the movement and to exhibit originality of the specific strength of global cloud-resolving model (GCRM) that were demonstrated through many years of ES- and ES2-based project, we started a development of seamless prediction system that is based on a new coupled framework consisting of GCRM and global high-resolution ocean model. The aim of this project for FY2014 is to create the coupled model with the main efforts devoted to the adjustment of the codes for realizing a dynamically consistent coupling between atmospheric model (NICAM; Satoh et al. 2007 [1]) and an interface of ocean model (NEMO v3.4) - coupler (OASIS3-MCT) combination (Maisonnave et al. 2013[2]) on ES2 (Fig. 1).

2. Milestone works for model development

Many kinds of model adjustment and investigation of the relevant environment setting for ES2 were needed for the coupling development and test runs. Some important works include: modifications of subroutine in NICAM and NEMO for controlling coupling variables that are supposed to be sent and received between atmosphere and ocean models to keep budget consistency, and interface configuration adjustments in the subroutines for the coupler (OASIS3-MCT) function; creation of job script for ES2 run; investigation of compiler options and library environment for the specific coupler and ocean model operation.

3. An example of calculation result

As a basic outcome for the model development, the performance of test run was checked by investigating if the dynamical coupling and coupling variables were processed and obtained as expected. As a first-step, the coupled model was found to work suitably. Figure 2 shows a snapshot of surface temperature one month after the start of a time integration with the coupled mode. The run was conducted at 3hourly coupling frequency with the horizontal resolutions of 224km-atmopshere (NICAM-GL05) and, 0.25 degree-ocean (NEMO with vertical 75 layers and 1 meter depth for the first surface layer). The ice evolution was given as an interpolation from a climatological data instead of predicted variable.

The aim of the test calculation remains a preliminary check of the dynamical coupling, and we need further analysis to confirm if the coupling yielded the suitable physical budget through, for example, appropriate flux transport between the ocean and the atmosphere. In addition, it is important to improve the treatment of model-coupler interfaces or coupler-associated workflow options to assure more smooth and suitable spatial interpolation for consistent transport of variables.

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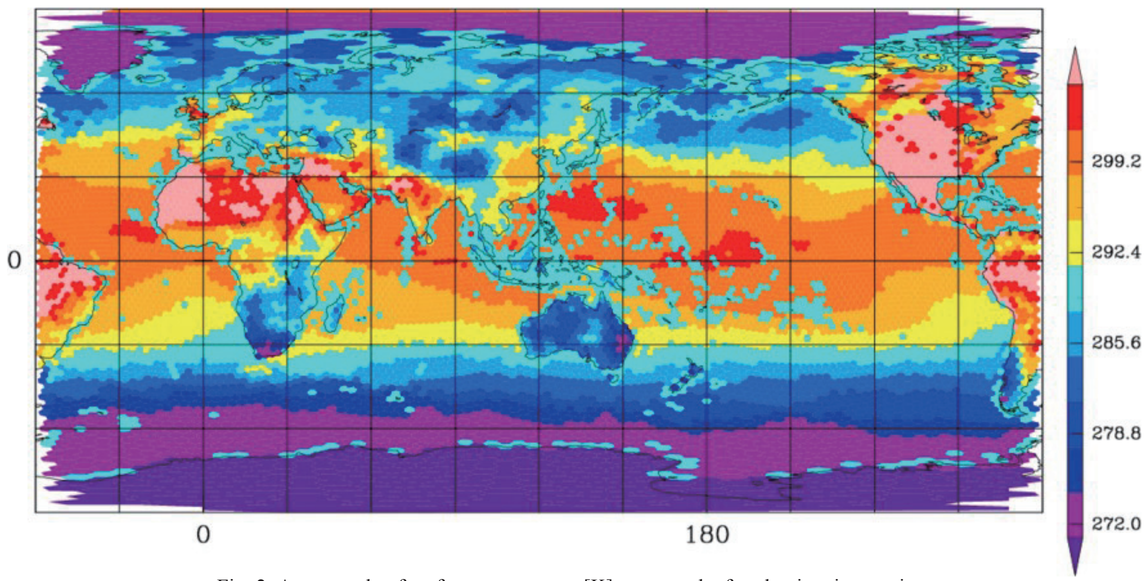

Fig. 2 An example of surface temperature [K] one month after the time integration.

on the calculation environments and technical aspects of model calculation on ES2.

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全球雲解像モデルを用いた大気海洋結合系シームレス予測のための基盤的研究

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本プロジェクトは、これまで雲を直接計算する発想のもとで雲・降水現象のスケール間相互作用の表現や大気のモデリング精度を格段に向上させた全球雲解像モデルを海洋モデルと結合させることで、世界初となる雲対流プロセス解像型の季節内 - 季節予測（シームレス予測）を実現するためのモデル基盤を構築することである。平成 26 年度の主な成果は、大気モデル NICAM と海洋モデル NEMO をカップラー（OASIS3-MCT）を介して結合させるための各要素モデルの編集・調整を行ったこと、地球シミュレータ上の計算のためのプログラムやスクリプト、ライブラリ環境等の調査・調整を経て、試験的な結合計算を地球シミュレータ上で実施したことである。

キーワード : 熱帯シームレス（季節内 - 季節規模）予測 , 全球雲解像海洋結合モデル