Non-hydrostatic response in typhoon passing using 3-dimensional atmosphere-ocean regional coupled model, CReSS-NHOES

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1. Introduction

A three-dimensional atmosphere-ocean regional coupled model, CReSS-NHOES, has been developed to simulate non-hydrostatic meteorological and oceanic phenomena. In the coupled experiments of typhoons, remarkable differences resulting from air-sea interaction are represented in the comparison with the non-coupled experiments, with successfully simulating typical structures of typhoons. Intensity of the typhoons is suppressed resulting in the ocean circulation caused by the typhoons.

2. Numerical models

In the development of a new atmosphere-ocean coupled model in non-hydrostatic system, two well-developed three-dimensional regional models are employed: CReSS (Cloud Resolving Storm Simulator, Tsuboki and Sakakibara, 2002) is for the atmosphere part and NHOES (Non Hydrostatic Ocean model for the Earth Simulator, Aiki et al., 2006) is for the ocean part. MPI decomposition is employed for inter-node communications. One MPI sub-domain of a process is applied for one horizontal region of CReSS and NHOES. Intra-node parallelization is also employed with OpenMP for CReSS and microtask for NHOES. CReSS-NHOES utilized hybrid parallelization method achieves high performance in calculation on the Earth Simulator.

Three types of experiments are conducted. In CReSS-only experiments utilized JMA/MGDSST dataset, the sea surface temperature (SST) is calculated by a vertically one-dimensional slab-ocean model included in CReSS. The others are coupling experiments. In one-way coupling, CReSS performs the slab-ocean model utilizing JCOPE2 reanalysis SST dataset while NHOES receives time-varying atmospheric heat, momentum and water fluxes on the ocean surface from CReSS. In two-way coupling, CReSS-NHOES, CReSS receives the SST in time-varying while NHOES receives

atmospheric fluxes with utilizing JCOPE2 reanalysis dataset initially.

3. Typhoon simulations

Numerical simulations for the experiments of typhoons are performed on the Earth Simulator. The horizontal resolutions were 4 km in CReSS and 1 km in NHOES. The vertical resolution of the ocean was from 2 m near the surface.

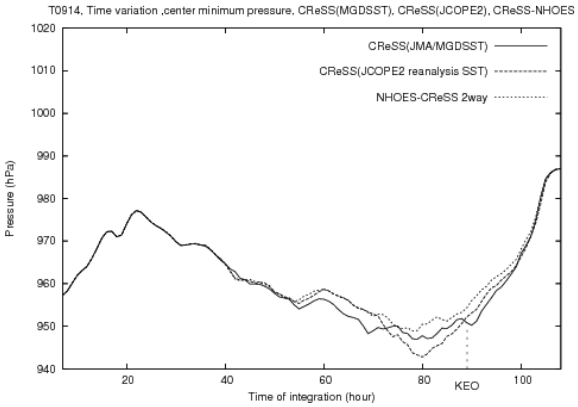

Fig.1. Time variation of central pressure in T0914, during 7- 108 hour of integration time. The lines denote CReSS-only (solid), CReSS with JCOPE2 (dashed) and CReSS-NHOES (dotted), respectively.

Experiments of coupling and non-coupling were performed for typhoons resulting in successfully representing typical structures, for T0505 (HAIGANG) that landed on China coast after passing the Taiwan Island during the active period as a typhoon and for T0914 (CHOI-WAN) that passed off the coast of Japan Honshu island in the western North Pacific with transforming toward an extra tropical cyclone.

In both simulations, the central minimum pressure of the typhoon is suppressed in the CReSS-NHOES coupled experiments, compared to those in the non-coupled experiments. In T0914 experiment, the central pressure is suppressed up to 7 hPa (Fig.1). It is found in the coupled experiment that cooler SST region appeared after passing typhoons, especially in T0505 experiment.

Acknowledgements

The Earth Simulator was utilized for main simulation in this study.

References

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