# Development of nonhydrostatic Double Fourier Series global spectral Model (DFSM) and Global 7km mesh Model Intercomparison Project for improving TYphoon forecast (TYMIP-G7)

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## Abstract

Based on the Japan Meteorological Agency Global Spectral Model (JMA GSM), we have developed a nonhydrostatic Double Fourier Series Model (DFSM) (Yoshimura 2012), where double Fourier series (DFS) are used as basis functions instead of spherical harmonics. The use of DFS reduces computational cost in high resolutions.

We had used the DFS basis functions of Cheong (2000) until recently. For improvement near the North and South poles, we have developed and introduced a new method using different basis functions. In the basis functions of Cheong (2000), scalar variables are expanded with $\sin n\varphi$ in the meridional direction for odd $m\ (\geq 3)$, where $\varphi$ is colatitude, $n$ is a meridional wavenumber, and $m$ is a zonal wavenumber. $U = u \sin\varphi$ and $V = v \sin\varphi$ are also expanded with $\sin n\varphi$, where $u$ and $v$ are westerly and southerly winds respectively. Therefore $u$ and $v$ are not zero at the poles ($\varphi = 0, \pi$) for odd $m \geq 3$, and $u$ and $v$ are not continuous at the poles. In the new method, scalar variables are expanded with $\sin^2\varphi \sin n\varphi$ in the meridional direction for odd $m \geq 3$. $u$ and $v$ are expanded with $\sin\varphi \sin n\varphi$. Therefore $u$ and $v$ are zero at the poles for odd $m \geq 3$, and the vector $(u, v)$ is continuous at the poles. This contributes to remove high zonal wavenumber noise near the poles. In the new method the least squares method is used for the calculation of DFS coefficients to make the error small.

In the Global 7km mesh Model Intercomparison Project for improving TYphoon forecast (TYMIP-G7), we conducted typhoon forecast experiments using the following three 7km mesh nonhydrostatic global atmospheric models: DFSM, the Nonhydrostatic

ICosahedral Atmospheric Model (NICAM), and the Multi-Scale Simulator for the Geoenvironment (MSSG) (Nakano et al. 2017). In DFSM, the development of typhoons tended to be excessive compared to NICAM and MSSG. One of the reasons seems to be that air-sea sensible heat flux around the storm center in DFSM was larger than in NICAM and MSSG. In the experiment with SST uniformly decreased by 2 degrees, the excessive development of the typhoon Lionrock in DFS was alleviated due to suppressed sensible and latent heat fluxes (Fig. 1). We will conduct experiments using high resolution atmospheric-ocean coupled models to consider SST cooling due to typhoons.

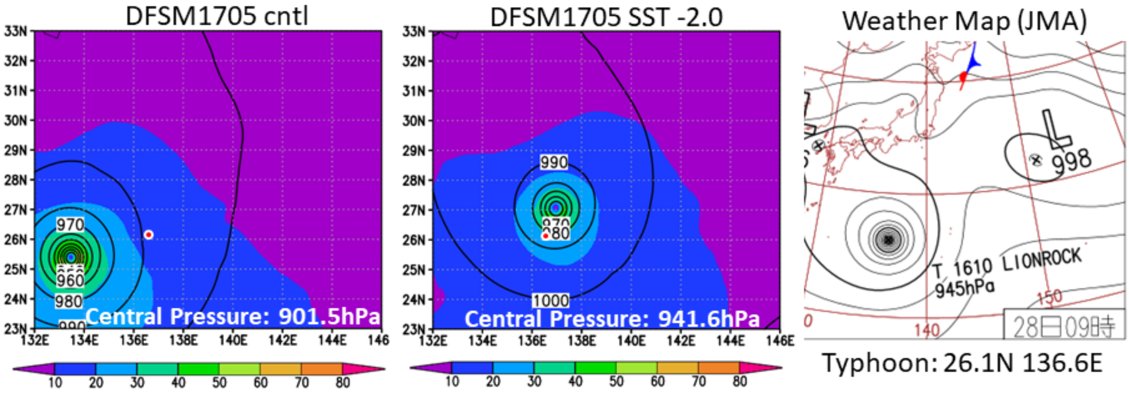


Figure 1. [Left and Middle] 120 hour forecasts of sea level pressure and surface wind velocity from initial condition of 00UTC 23 August 2016 in the control experiment (left) and the experiment with SST uniformly decreased by 2 degrees (middle). Red points show the observed position of Lionrock. [Right] Weather map at 00UTC 28 August 2016.

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