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PBL and Microphysics Coupling to Charney-Phillips Vertical Grid in GRAPES Global Forecast System

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This study focuses on investigating physics-dynamics coupling on spatial aspects in GRAPES global forecast system. As the Charney-Philips (CP) grid is used, the horizontal velocity is staggered relative to potential temperature, which means that potential temperature and water substances are calculated on full levels, while horizontal velocity is calculated on half levels. In Lorenz physics scheme, all the variables are set on half levels and the correspondent tendencies are estimated on the half levels. The interpolation had to be used between full and half levels in physics-dynamics coupling before and after physics scheme package was called. An unexpected computational mode appeared in the temperature and moisture equation solving in PBL.
PBL_CP scheme has been developed based on microphysics implementation on CP grid so that the interpolation can be avoided for both PBL and Microphysics coupling to dynamics. In PBL_CP scheme the momentum diffusivity is required at full levels and the heat diffusivity is required at half levels. For local scheme in stable PBL and free convective atmosphere, potential temperature gradient is averaged so that Richardson number is calculated at the full levels. With PBL_CP scheme the spurious signals in temperature and moisture tendencies of PBL have been removed and the correspondent profiles appear to be smooth. Moreover the low level cloud is improved greatly compared to YOTC's data. Meanwhile water vapor distribution on high levels is more rational with microphysics scheme implementation on CP grid. An overall enhancement has been found in both summer and winter 4DVAR cycle experiments base on PBL and Microphysics implementation on CP grid in GRAPES_GFS model.