An introduction of Finite Volume WAve Model (FVWAM)

A Finite Volume WAve model (FVWAM) which adopted a novel Spherical Centroid Voronoi Tessellation (SCVT) computational grid and an advanced GPU acceleration / highly scalable parallel computing algorithm was developed by National Marine Environmental Forecasting Center, China. It is a third-generation wave spectrum model. This model has developed a new finite volume dynamic framework for SCVT grids, and the physical processes are based on the WAM4+ scheme proposed by Fabric Adhuin, optimized and improved with a large amount of observation data. The calculation of all components of FVWAM, including the power framework and physical processes, can be ported to GPU devices. It is the first fully GPU computed 3rd-gen model in the world. The computing speed of FVWAM on GPU is more than 100 times faster than on CPU. FVWAM can complete tasks that previously required 20 servers (equipped with double Intel E5-2680 CPU) to compute for 5 hours in just 1 hour on a server equipped with 8 Nvidia A100 modules. Under the same computing tasks as FVWAM, using GPU for computing only consumes 1/10 of the CPU's energy consumption. FVWAM also has highly scalable parallel computing capabilities, and X86 super-computing platform test results show that it can still accelerate linearly on more than 130,000 CPU cores (the super-computing platform can schedule 140,000 X86 CPU cores). The simulation accuracy of FVWAM is satisfactory. The hindcasting performance of this model was validated using CFOSAT (China France Oceanography SATellite)/SWIM (Surface Wave Investigation and Monitoring) wave data, in which significant wave height and wave period generated by FVWAM were compared with corresponding wave information retrieved from SWIM measurements onboard CFOSAT. Specifically, wave period was retrieved using an AI method extending the validation range with satellite data. These data were compared monthly and for a whole year. Results showed that model simulations and satellite measurements were in good agreements with average bias, RMSE and correlation coefficient of -0.11 m, 0.29 m and 0.96 for significant wave height and average bias, RMSE and correlation coefficient of -0.34 s, 0.86 s and 0.86 for mean wave period. The FVWAM global model was put into operational trial operation in 2022, and its nearshore version was also used for wave forecasting services in the 19th Asian Games sailing competition in 2023. The performance of forecasting system and services satisfy users. FVWAM will soon become a new member of the international open source community for wave numerical models.

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