

**Scalability Improvement of the NASA Multiscale Modeling Framework
for Tropical Cyclone Climate Study**

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Abstract

One of the current challenges in tropical cyclone (TC)¹ research is how to improve our understanding of TC inter-annual variability and the impact of climate change on TCs. Recent advances in global modeling, visualization, and supercomputing technologies at NASA, show potential for such studies. In this study, we discuss the recent scalability improvement of the Multiscale Modeling Framework (MMF) that makes it feasible to perform long-term TC-resolving simulations. The MMF consists of the finite-volume General Circulation model (fvGCM), supplemented by a copy of the Goddard Cumulus Ensemble model (GCE) at each of the fvGCM grid points. The original fvGCM implementation does a 1D data decomposition. The revised MMF implementation retains the 1D decomposition for most of the code, but uses a 2D decomposition for the GCEs, and using a second level of parallelism to execute it. Since the vast majority of the computation time in the MMF is spent computing the GCEs, this approach can achieve excellent speedup without the cost of modifying the entire code. Intelligent process mapping allows differing numbers of processes to be assigned to each domain for load balancing. The revised parallel implementation shows very promising scalability, obtaining a speedup of nearly 80 by increasing the number of cores from 30 to 3,335. Future work will be discussed at the end.

¹ Depending on their location, TCs are referred to by other names, such as hurricane (in the Atlantic region), typhoon (in the West Pacific region), tropical storm, cyclonic storm, and tropical depression.