A Giga-Particle Atmospheric Trajectory Model

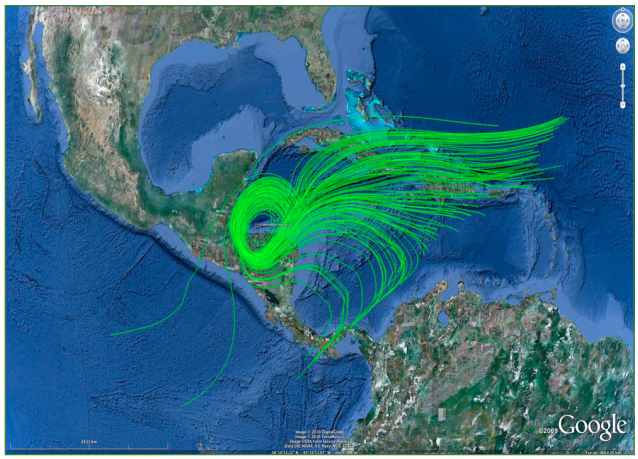
Science Mission Directorate

We present the Giga-Particle Atmospheric Trajectory Model (GTRAJ), a new parallel implementation of an atmospheric modeling trajectory framework that provides improved numerical accuracy, greater flexibility for specifying experiments, and sufficient raw performance to simultaneously simulate billions of parcel trajectories on suitable computing platforms. The ability to treat such large numbers of parcels is expected to enable a new generation of experiments to explore questions related to global stratosphere-troposphere exchange, age-of-air spectra, and transport of trace gases and aerosols.

The GTRAJ modeling framework is written in C++ for easy integration with other computing technologies. It is also parallelized using the Message Passing Interface (MPI) library, so that it can scale efficiently on a wide variety of modern computing platforms. GTRAJ was developed using Test-Driven Development (TDD), which provides confidence in the implementation and assists other developers who may wish to extend the framework.

The Discover supercomputer at the NASA Center for Climate Simulation (NCCS) has enabled us to carry out the massively parallel computations required for these trajectory simulations. Furthermore, NCCS supercomputing resources have allowed us to develop new approaches to solving problems that are not well addressed by non-parallel trajectory models.

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Hurricane Mitch kinematic trajectories at 9 kilometers, initialized for October 27, 2004 at 00UT using Modern Era Retrospective-analysis for Research and Applications (MERRA) reanalysis data. The trajectory model moves a tropical cyclone along based on the prevailing flow obtained from a separate dynamical model—the Goddard Earth Observing System Model, Version 5 (GEOS-5) in this case. *Shawn Freeman, Carlos Cruz, NASA/Goddard*