SIMULATIVE IMPROVEMENT OF A HURRICANE BY IRREVERSIBLE THERMODYNAMIC OPERATORS

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I. INTRODUCTION

A proper description of the dissipation in a forcing-dissipative system, such as the atmosphere, is very important when the system is discretized. Atmospheric dissipation is generally treated as diffusion in numerical weather prediction (NWP) models. The commonly used fourth-order diffusion scheme (linear and nonlinear) generates spurious upgradient mass or heat transport, which violates the entropy constraint (Crandall and Majda, 1980; Liu and Liu, 2006). The methodology suggested in this paper improves the simulation of a hurricane, as an example, by a meso-scale model.

II. PRESENTATION OF RESEARCH

The diffusion scheme is re-constructed based on the second law of thermodynamics to ensure downgradient transport and the new physics-based scheme is applied to the Penn State/NCAR non-hydrostatic mesoscale model (Grell et al., 1995). Hurricane Andrew (1992) is taken as a case to simulate with the emphasis on the evolutions of its surface maximum velocity/minimum pressure.
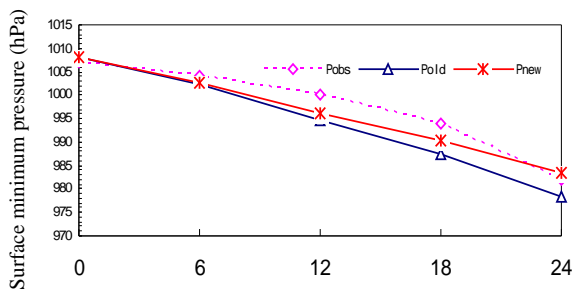

FIG. 1: Comparison of the observed change of the surface minimum pressure of the Andrew (1992) with the time from 1200 UTC August 21 to 1200 UTC August 22, 1992 with the simulated results by the original and improved MM5.
Pobs – observed pressure
Pold – simulated pressure by the original MM5
Pnew – simulated pressure by the improved MM5

III. Results and Conclusions

The comparative simulation results show that the new scheme improves noticeably the model accuracy in predicting the intensity of the hurricane. It is seen from figures 1 and 2 that the improved outputs are closer to the observations than ones from the original simulations.
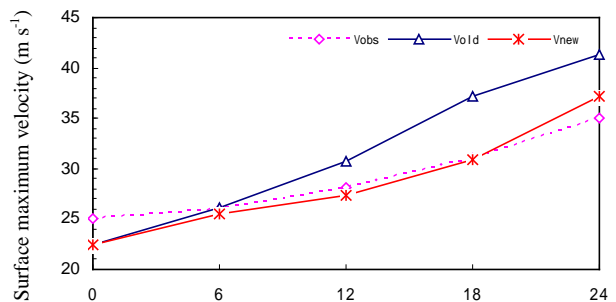
IV. ACKNOWLEDGMENTS

FIG. 2: The same as FIG.1 but for the surface maximum wind velocity.
Vobs – observed wind velocity
Vold – simulated wind velocity by the original MM5
Vnew – simulated wind velocity by the improved MM5

V. REFERENCES

Crandall M. G., Majda A., 1980: Monotone difference approximations for scalar conservation laws, *Mathermatics of Compatations*, 34 1-21

Grell, G. A., Dudhia J., and Stauffer D. R. 1995: A description of the fifth generation Penn State / NCAR mesoscale model (MM5), *NCAR Tech. Note*, *NCAR/TN-398+STR*, National Center for Atmospheric Research, Boulder, CO.

Liu C., Liu Y., 2006: A physics-based diffusion scheme for numerical models, *Geophys. Res. Lett.,* 33 L12805, doi: 10.1029/2006GL025781