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Yoshio Kurihara: His Contributions to Tropical Meteorological Research and forecasting through numerical modeling

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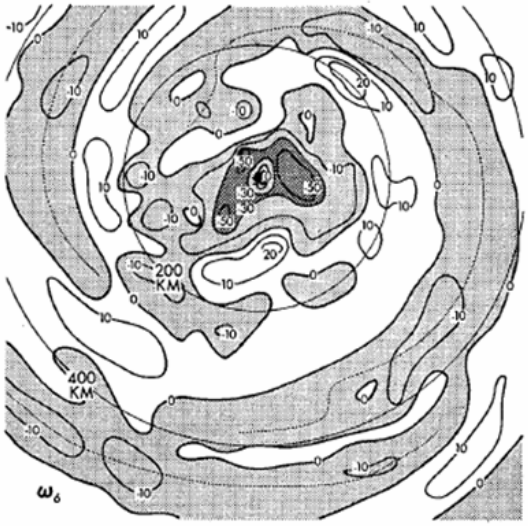
Yoshio Kurihara, founder and head of the Hurricane Dynamics Project at the Geophysical Fluid Dynamics Laboratory (GFDL) until his retirement in 1998, died in March, 2007. Dr. Kurihara, affectionately known as "Kuri" to his many friends and associates is perhaps best known for his leadership in the development of the GFDL moveable nested grid and hurricane prediction system, which has been the official operational hurricane model for the National Weather Service since 1995. However, his career in meteorology, which spanned 50 years, covered other diverse topics such as development of new numerical methods and time integration schemes, global modeling and various climate studies. Remarkably, the GFDL hurricane model is still in use today in the operational scene, used both by NOAA and the Navy, and remains the benchmark performer for hurricane prediction.

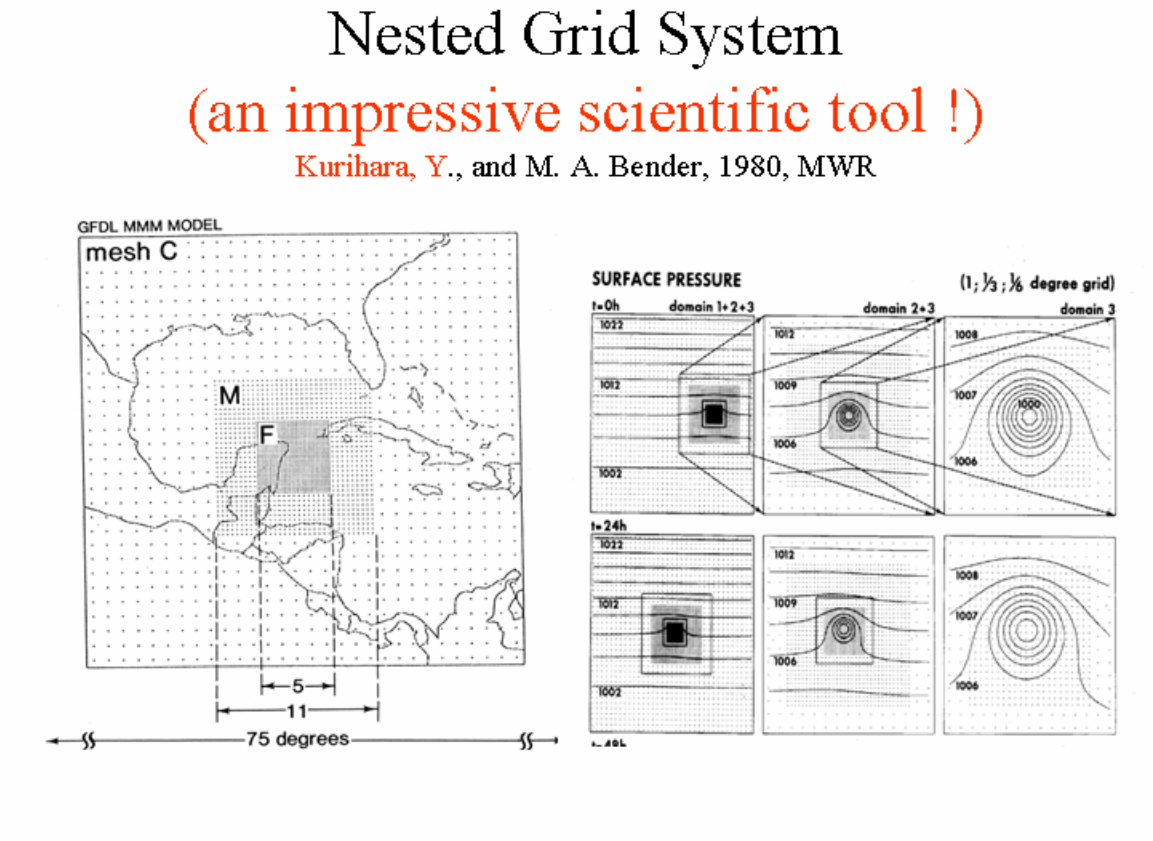
Kurihara's contributions will be highlighted in this presentation from an historic prospective. Kuri's early work was in the GFDL Climate group first as a visiting scientist and then as a full time research scientist in 1968. Kuri developed a statistical-dynamic general circulation model and designed the grid configuration masterpiece, the Kurihara grid and box method which preserved the same resolution throughout the global grid. His grid system was indispensable for the successful development of the global climate model at the Geophysical Fluid Dynamics Laboratory and is still used today in some tracer studies. He also developed a time differencing scheme which was essential to the later development of the GFDL hurricane model.

Early 3-D model (hurricane in a box!)

Kurihara, Y., and R. E. Tuleya, 1974 . JAS



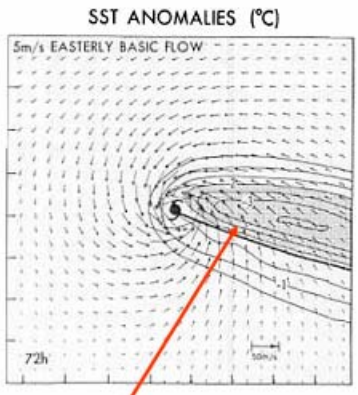
In 1970, Joe Smagorinsky commissioned Kuri to develop a tropical cyclone model at GFDL, and a hurricane dynamics group at GFDL was officially formed that year under his leadership for the purpose of performing hurricane research through numerical modeling. Kuri carefully approached the task, first developed a convective parameterization scheme and constructed an axi-symmetric hurricane model which was completed by the following year. In 1973 the first experiments with a three-dimensional model were made. Two years later a nested version of the model was developed with movement capability introduced in 1978. Throughout the next decade, numerous idealized numerical experiments demonstrated the capability of this model to reproduce a realistic hurricane structure.



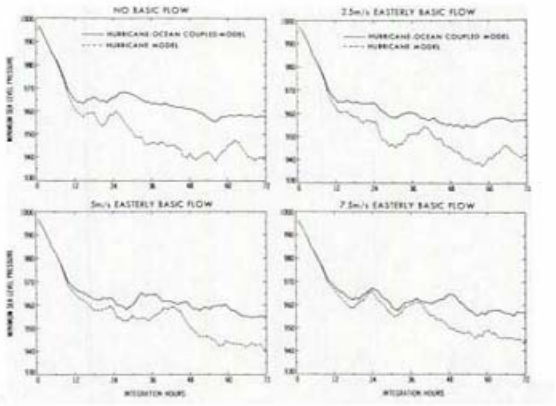
Many scientific studies were undertaken which lead to a better understanding of the behavior of tropical cyclones, including decay over land, eye structure, sensitivity of hurricane intensity to sea surface temperatures, effect of high mountains on storm motion and intensity, and environmental influences on storm genesis and decay. Kuri also initiated the collaboration that lead to the development of the atmospheric-ocean GFDL-URI coupled hurricane modeling system. These basic research studies, which were recognized through various awards and citations, also suggested the potential of improving hurricane prediction with a “state of the art” three-dimensional hurricane model.

Effects of ocean coupling on TC

Bender, M. A., I. Ginis, and Y. Kurihara, 1993, JGR



Cold wake

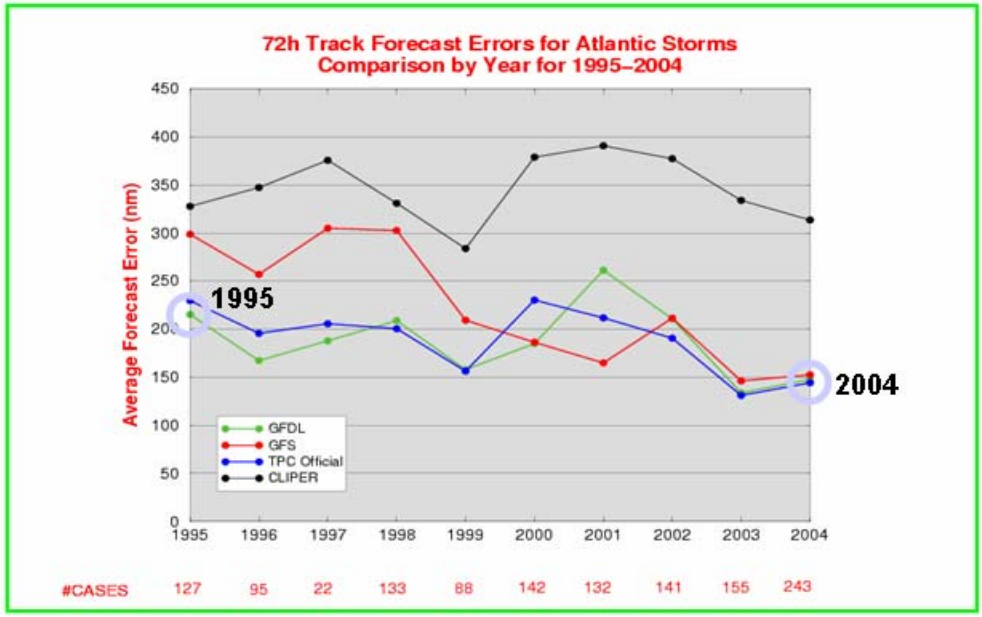


Effect on intensity depended on TC speed

Kuri not only reported his results of these studies at meetings and in numerous publications, but had the ability and desire to apply his results to the practical application of operational weather forecasting. Indeed, the model's success soon began to capture the attention of those involved in operational NWP. However, Kuri recognized that a multi-year effort by scientists in his hurricane group at GFDL would be necessary to transfer a model developed for basic research into a robust modeling system that could meet the rigorous demands of an operational environment. The GFDL hurricane group began to address the problems that needed to be solved before the model could be applied for operational forecasting. In the next several years, Kuri lead the development of an improved lateral boundary scheme, a new mass initialization technique and an original technique to insert a realistic and model-consistent vortex into the global analysis.

The new GFDL system was tested on a limited number of cases from the 1991 Atlantic hurricane season and was ready to run in parallel test mode at NMC for most forecasts during the entire 1994 Atlantic and east Pacific hurricane season. After the post-season analysis demonstrated a 20% reduction in track error at 72h compared to operational guidance, the GFDL Hurricane Prediction System was made fully operational by the National Weather Service in time for the 1995 hurricane season. Until his retirement in 1998, Kuri continued to oversee the improvements made to the GFDL hurricane system each year.

72h Forecast Errors for the GFS, GFDL and the Official Forecast Since 1995 in the Atlantic



Besides its use in NWP forecasting, the GFDL hurricane modeling system has also been used in the evaluation of the impact of global warming on hurricanes. These studies, initiated in collaboration with Kurihara, have served as a guiding tool in IPCC and WMO assessments. It is a tribute to Kurihara that the GFDL hurricane system has been so productive and useful in so many applications. In addition to serving as head of the GFDL hurricane project Dr. Kurihara was also a visiting lecturer with rank of Professor in the Geological and Geophysical Sciences and Geophysical Fluid Dynamics Department of Princeton University from 1971 until 1986. Dr. Kurihara was elected a Fellow of the American Meteorological Society in 1980. He was also the recipient of numerous awards.