9.1 A PERSONAL VIEW OF THE PROGRESS IN TROPICAL METEOROLOGY OVER THE LAST 50 YEARS

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1. BACKGROUND

I got started in meteorology as an Air Force student at the University of Chicago in 1953, taking Herbert Riehl's Tropical Meteorology class when he first used his Tropical Meteorology textbook (1954). This text was quite a 'tour-de-force' for a 38 year old who had none of the advantages of the satellite, computer, etc. Many of the ideas in this book are valid today. Some are not. A notable topic missing from Riehl's text is a discussion of the El Nino – Southern Oscillation and the work of Gilbert Walker. Walker's work was out of fashion in the 1930s through the 1950s. Yet no tropical meteorologist did more with the tools available to him than Walker.

This talk will give a brief history of the changing ideas that have occurred in our field over the last 50 years, some of the physical questions that remain, and some of the disappointments, as I see them.

2. NOTABLE FINDINGS DURING THE LAST 50 YEARS

It appears that most of the important new findings of the last five decades have come rather unexpectedly from people working with observations. No one could have foreseen 50 years ago the tremendous technical developments that would take place in the next five decades. No one in 1954 would have foreseen:

- The discovery of the stratospheric QBO and its currently accepted physical explanation.
- The Madden-Julian Oscillation (MJO) whose exact physics is still being researched.
- The fundamental nature of the large compensating up-and-down mass recycling of tropical weather systems. Total low-level up-and-down vertical motion is an order of magnitude larger than the mean (net) low-level vertical motion.
- The very large diurnal variation of Cb convection and heavy rainfall and clear region subsidence (mid-morning maximum – early evening minimum – variations ~2 to 1) over the tropical ocean regions with little or no significant diurnal lapse rate variation.
- That condensation warming from rainfall occurs indirectly from return flow subsidence often at remote locations. This seems simple now, but it was not obvious 40-50 years ago.
- The great improvements in recent years of numerical TC track predictions due to GCMs.
- The rediscovery of Gilbert Walker's largely forgotten seasonal forecasting techniques and the influences that the tropical circulation has on the evolution of mid-latitude weather and climate, and vice-versa.

3. SOME OF THE CONTROVERSIES OVER THE LAST 50 YEARS HAVE INVOLVED:

- Easterly waves – a great problem of semantics, oversold by Atlantic practitioners, undersold by the Pacific crowd.
- Cumulus cloud seeding – never came up to expectations.
- Hurricane Modification (Project Stormfurry) - did not prove feasible but brought about very valuable hurricane observations and knowledge gains that have greatly influenced our current thinking. Overall influence very positive.
- Numerical weather prediction skill in the tropics – short period precipitation forecasts much less feasible than in middle latitudes – convection cannot be realistically modeled – failure as far as 1-2 day rainfall predictions are concerned.
- Role of the satellite – without question the largest single advancement for tropical meteorology prediction and understanding. There were many early year doubts about its future importance.
- Importance of the baroclinic upper-trough and the TUTT for TC formation/intensification – oversold by many theoreticians but often fundamental in higher latitude and early-late season cases.
- Differences in Pacific and Atlantic forecast techniques – different synoptic settings and differing views on what is important.

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- Role of ocean in hurricane structure and intensity now well accepted but degree of importance 40-50 years ago was in question. Ocean role sometimes now oversold (i.e. Loop-current).

- Potential of multi-monthly tropical prediction – emerging recognition of its surprising potential.

- Physics of cold to warm-core transition of the lower level pre-TC disturbance – after 50 years physics still not settled, except in my mind!

- Global warming influence on TCs – grossly oversold, especially by those knowing little of TCs.

- Large oceanic diurnal variability in Cb convection – the most important and the least understood and appreciated phenomenon of current day research.

- CISK theory – great focus of discussion in the 1960s-1970s but, depending on definition, not so applicable to TC understanding or to cumulus-broader scale interaction physics.

- Differences in understanding of TC genesis and intensification – frequent lack of understanding of differing physical processes. Unlimited number of wrong ways to the right answers. Getting a realistic looking vortex does not imply understanding. Great overuse of the Jordan Mean Sounding.

- Tropical cyclone modeling. Early symmetric and 2-3 level models not very representative of fundamental a-symmetric nature of TC processes.

- Barotropic TC propagation modeling un-realistic. Propagation is a result of baroclinic processes. Beta much oversold.

4. LOST OPPORTUNITIES CAN BE ASSOCIATED WITH:

- Fractured administration (NOAA, NSF, military, universities, private) funding for tropical studies and the competition for funding.

- Too strong separation of operations from research and vice-versa.

- Too strong reliance on computer models to do our thinking for us.

- Little funding available to perform research on already collected data sets – many great opportunity losses. A classic case of a lost research opportunity in past years is seen in the general lack of research on the Guam based military aircraft reconnaissance flights into West Pacific TCs between 1946-1986. Only a very small fraction of this unique flight data has ever been studied.

- Too much money and too much focus on large and short-period field programs (BOMEX, GATE, TOGA, other) instigated largely by the GCM modeling community. In most cases money could have been more wisely spent in more diverse and longer period study of already collected data sets. Directed research, as with field programs, is not as conducive to new ideas and scientific breakthroughs. Field program data sets have not been fully analyzed before newer programs are started.

5. DISCUSSION AND SUMMARY

Most of the advances in tropical meteorology over the last 50 years have come from the great gains in technology.

A great new potential for advancement has been the construction of the new NOAA/NCEP and ECMWF global reanalysis data. These new reanalysis data sets are a gold mine for new tropical meteorology understanding. I predict they will have much impact on future knowledge gains. I wish I was 20 years younger and had more time to work with these new products.

These AMS tropical meetings have had a great growth in size from the early meetings of 50-60 individuals. This appears justified given the likely coming onslaught of US hurricane damage and the growing understanding of the importance of the tropics for both long and short range global predictions.

I predict that the future will see increased resources and opportunities for the ever growing number of talented and younger meteorologists entering the field. The fundamental role of the tropics will always require more research and better understanding.