THE ED ZIPSER SESSION

Celebrating 50+ Years in the Field

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Early Life, New York

Ed Zipser was born in New York City on December 2, 1937, and grew up in the Bronx, with parents Sam and Sylvia. All 4 grandparents emigrated to the U.S. from a region of then-Austria-Hungary known as the "Zips", hence the surname. His father ran a small advertising agency based in Manhattan. He has one younger sister, born in March 1945. The family was rather close-knit, with his maternal grandmother and several of his mother's sisters living close by. By age 5, Ed showed keen interest in the weather, and one of his aunts then taught him how to read the daily weather maps in the New York Times. At age 6, the Great Atlantic Hurricane of 1944 had a strong impact on him, downing many trees in Poe Park across the street where he rode his tricycle. He avidly read books on astronomy and meteorology in his local public library.

The major event of his childhood was contracting polio in 1947, scaring his parents half to death and putting him in the hospital and rehabilitation centers for the next 14 months, followed by 5 additional months in 1951 for 2 surgeries and more rehabilitation. In retrospect, Ed believes that this experience had a major positive impact on the rest of his life. First, it exposed him to a broad cross-section of humanity, ethnic backgrounds, and to people who were far worse off, for example kids in iron lungs and many who would never walk again. Just as importantly, he became determined to hike, climb mountains, and travel, and get his nose out of his library books. His father was not a hiker, but Ed had a great-uncle who was really happy to take him for long walks under the New Jersey Palisades.

Ed attended DeWitt Clinton High School in the Bronx, with his good friend Lester Seigman from across the street, and the two of them loved music, Ed playing piano and Les the violin. They often took the subway to the Metropolitan Opera, taking standing room spaces for 50 cents, and later playing or recording music on home tape recorders. Despite losing a semester during his recovery, he had skipped enough grades that he was ready for college while still 16.

Princeton University, 1954-1958

His mother drove him to Princeton in heavy rain and wind from the outskirts of Hurricane Carol 1954. His fascination with hurricanes was reinforced by Edna (1954) and Hazel (1954). Not realizing that Hazel had accelerated north from the Carolinas, he stood for 6 hours in hurricane force winds waiting for a train to go home for the weekend. Little did he know then that Bob Simpson used those 3 hurricanes to create the National Hurricane Research Project, and pave the way for an area of research that he would enter only 4 years later.

At Princeton, there was no meteorology program, so Ed was advised to "become an engineer", and majored in aeronautical engineering. But he found out that David Ludlum, the editor of Weatherwise magazine, had his office in Princeton, and that he could earn $1/hour by spending hours in the bowels of the Firestone Library researching early American weather disasters. It was also Dave who told Ed that it was indeed possible to have a career in meteorology by first going to graduate school. After a very boring summer working for McDonnell Aircraft in St. Louis, Ed was ready to switch fields. But the most important turning point in Ed's life came during his 2nd year at Princeton, an example of a stroke of good luck that he has been thankful for ever since.

The day after his 18th birthday, Ed said to himself, "I ought to have a girlfriend". What to do? His Princeton classmates, mostly from well-to-do families and who went to expensive private schools, often had girlfriends from schools like Smith, Wellesley, Vassar, etc. But Douglass College, the women's school affiliated with Rutgers University, was only a short bus ride away, so Ed hopped on a bus and walked through the Student Union. For reasons he could not tell you today, he struck up a conversation with a student multi-tasking by knitting while studying for a Psychology test. She was Marelynn Weiss, daughter of a high school teacher father and nurse mother from North Bergen, New Jersey, majoring in Food Science and Nutrition. Something clicked, so they saw each other again and again. During Senior Year, they decided to marry and go to graduate school together. Which one? They made a list of graduate schools that would be good for both, and the top 3 that worked were Florida State, Penn State, and MIT. They decided that the first school to offer them both assistantships would be the one. FSU it was.

Florida State University, 1958-1966

Once that decision was made, Ed and Marelynn never looked back. They arrived in Tallahassee as newlyweds, moving into a small apartment with a bed that lowered from the wall, for $50/month rent. Ed's office was on the second floor of an old former dormitory, and of course neither the office nor apartment had the slightest thought of air conditioning. But upon entering his grad assistant office for the first time, he quickly learned that his office mate was Mike Garstang, a stroke of good fortune second only to finding Marelynn, as he would come to realize over the years. Mike was by comparison a "man of the world" who had lived in South Africa, been a lead forecaster in the British Caribbean Met Service, been on a research cruise on a Woods Hole ship under the sponsorship of then-Joanne Malkus, followed by a year at Woods Hole. Mike could build things with his own hands and make things work; Ed hardly knew one end of a hammer from the other. When it came time for Ed to go into the field to gather and study data, he knew that success depended on scientists like Mike.

Another stroke of good fortune was in our professor, Noel LaSeur, whose wise guidance gave us the education we would make good use of every day of our careers. Noel taught us respect for the data, first and foremost, and while he also taught us theories and concepts, we will never forget the way he would talk about some model result, intoning "in the model" at some point to hammer home the difference between a model result and the true event. Noel's physical understanding of the atmosphere, and his gift for conveying that understanding to students, was unparalleled. His wise counsel carried over into the design of field campaigns and was a key element in any success that we had well after we left FSU.

Noel LaSeur also paved the way for Ed to start his experiences outside of FSU. He arranged for Ed to spend the summers of 1960-61-62 at NHRP in Miami, where he worked for Jose Colon, Harry Hawkins, and Cecil Gentry, and met people like Krish, Bill Gray, Michio Yanai, Herbert Riehl, among others. In 1960 he got his first research flight on the NOAA DC-6 into Hurricane Donna, paying no attention to the seat belt sign during the first penetration of the strong side of the eyewall, fortunately learning his lesson without major injury. When Ed was uncertain about a dissertation topic, Noel offered the opportunity to fly with the Navy for the summer of 1963, taking high quality cloud movies and photographs from the hurricane hunter aircraft to be compared with the rather new TIROS satellite images, making use of his friendship with Captain

Max Eaton to get Ed permission be based in Roosevelt Roads, Puerto Rico and fly on the WC-121'a on any and all recon missions. His last week was spent flying into Edith 10 times in 5 days, with 110 hours in the air. He didn't sleep much, but fortunately he was not responsible for flying the aircraft.

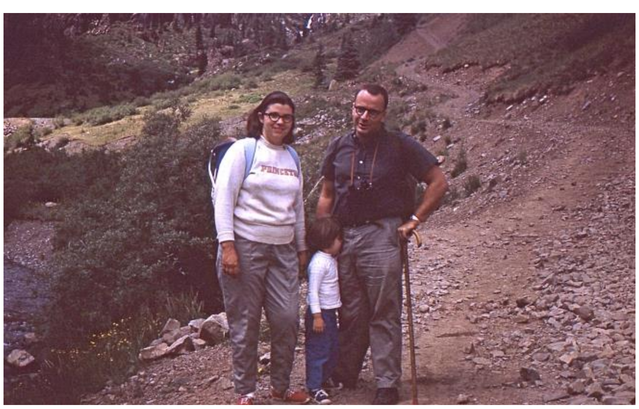
During the 7 years it took Ed to get his Ph.D., Marelynn got her Ph.D., put in two years of Post-Doctoral research with her Professor Dr. Betty Watts, published several papers, and gave birth to 1 8/9 children. They waited until the second girl was 3 months old before leaving FSU for the

Marelynn as a Post-Doc with Gerry, 3 years old, and 5-day-old Jacqui, Tallahassee, Florida. January, 1966

drive to Boulder, Colorado. In addition to the love and support Ed received from Marelynn for all the years after that, he has been very much aware of the sacrifices to her own career that she made during all the years that the 2 girls, now known ad Gerry and Jacqui, were growing up. While Ed was away for months at a time on so may field campaigns, Marelynn took care of the house, the girls, and somehow maintained part time jobs in Ft. Collins, Denver, and Boulder.

National Center for Atmospheric Research, 1966-1989

Ed was excited to come to NCAR in Boulder in 1966 for so many reasons. After 7 years in the heat and humidity of Florida, he could not wait to explore the mountains. But it turned out that



Ed, Marelynn, and the 2 girls in the San Juan Mountains, July 1966 the time was right for the nation to plan for the Global Atmospheric Research Program (GARP) in the aftermath of President Kennedy's speech to the United Nations inviting international cooperation for a concerted effort to advance the science. In 1962, the Charney Report had outlined what would be needed to advance toward the 2-week forecast, and a World Weather Watch. Together with Vern Suomi, the father of meteorological satellites, and Joe Smagorinsky, outlining the requirements for global prediction, the greatest obstacle was seen to be the need for parameterization of deep convection in the tropics in general circulation models. So in 1966, NCAR convened a major summer colloquium, with 3 components. One, to design a "pilot experiment" in the tropics, based in the Line Islands, under the first geosynchronous satellite over the equator in the central Pacific, two, to outline a more comprehensive tropical experiment (TROMEX, later evolved into GATE), and third, to point the way toward improvement of global numerical models. It came as quite a shock to Ed to be appointed as scientific coordinator of the Line Islands Experiment (LIE) 4 months after arriving at NCAR.

Ed was in no way capable of making the arrangements to put 100+ people in the field, or provide food, shelter, communications, or observing equipment for the experiment. Fortunately, NCAR and many agencies rose to the challenge, leaving Ed with the task of formulating observational plans and providing some measure of leadership in the field. Lessons learned from his FSU days were vital in the success of the program. One of the important ones directly from Noel and Mike was "make measurements when and where needed". Knowing the importance of the boundary layer over tropical oceans, Ed insisted that many of the aircraft flights be made at 500 ft. altitude. Knowing the importance of frequent soundings, they were made at 3- and 6-hour intervals. That combination was the basis for diagnosing the nature of the unsaturated mesoscale downdrafts that we had the good fortune to measure on April Fools day, by coincidence the same day that some of the group walked to the south side of the island and found Japanese fishing floats.

With Bob James, Jim Maynard, and Steve Cox, Palmyra, April 1, 1967

The extraordinary community support for the Line Islands Experiment continued after the field phase. The University of Hawaii made space for a data reduction effort, where Marelynn was able to rejoin Ed for 2 months. Colin Ramage, Jim Sadler, and Ron Taylor helped make that visit a true learning experience. Ed and Ron published the data catalogue as an NCAR tech note, followed by the valuable sounding data some years later. NCAR brought in scientists to assist in the research as part of Chester Newton's group, notably including Rol Madden, who, together with Paul Julian, went beyond the spectral analysis of 2 months data to analyze 10 years' data from Canton Island, discovering the MJO in the process.

Mike Garstang and Noel LaSeur had long planned a field program in Barbados, to study tropical Atlantic processes together with the effects of the island. Ed had good intentions of joining that effort, but was diverted by the LIE. Therefore he was glad that NCAR permitted him to bring the NCAR Queen Air to Barbados during the summer of 1968, for the FSU Barbados experiment, although the rest of the world called it "pre-BOMEX". While not as extensive as BOMEX 1969, Mike and Noel led a comprehensive study of the island effects, with the NOAA ship Discoverer 60 miles to the east, the TRITON buoy just upwind, extensive surface and tethered

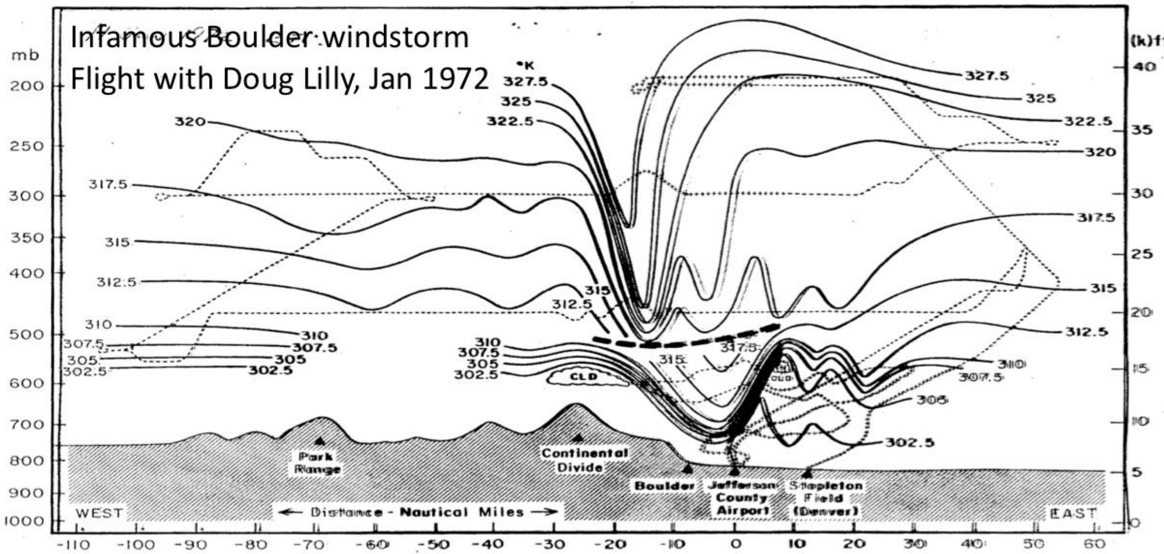
Mike Garstang and Noel LaSeur (white cap) at the tethered balloon site, East Point, Barbados, 1968

balloon data in the island boundary layer, and Ed working with the aircraft circumnavigating the island as often as possible. By serendipity, Ed was able to obtain low-level data in more disturbances, leading to papers that led eventually to both Ed's and Bob Houze's papers on squall lines, convective vs. stratiform precipitation, and more.   The success of those flights can be credited to flexibility; when squall lines crossed Barbados, the aircraft took off less than 2 hours later; when we recognized a classic stratiform precipitation region, the pilot found a way to change the flight plan and make an aircraft sounding then and there.

Hangar for NCAR Queen Air, and scenes from FSU 1968 field campaign, East Point, Barbados

The years from 1969-1974 seem in retrospect like a blur of activity in Ed's memory. First came a major field program led by Josh Holland of NOAA called the Barbados Oceanographic and Meteorological Experiment (BOMEX 1969), involving many ships and aircraft, focused on the most accurate measurement possible of the sea-to atmosphere fluxes, and structure of the atmospheric and oceanic boundary layers. Herbert Riehl and Jule Charney asked for an additional component that would obtain more flexible data on tropical disturbances than the BOMEX box pattern that dominated the core BOMEX period, and for the 3rd straight year, Ed accompanied the NCAR Queen Air to assist in that effort. The lessons learned in 1967, 1968, and 1969 contributed greatly to the knowledge base, and to the design of what was to become the "mother of all field programs", the GARP Atlantic Tropical Experiment (GATE). This is not the place to describe the international scientific and political struggle that led "TROMEX" to evolve from the Marshall Islands to the East Pacific to the West Atlantic to the highly successful program centered in the East Atlantic, southwest of Dakar, Senegal. During the early 1970s, Ed was asked to formulate the aircraft plan for GATE, a collaborative effort that came to dominate his professional life for years.

NCAR was an exciting place to be for Ed in those days. The National Hail Research Experiment was in full swing, with scientists like Charlie Knight, Brant Foote, and Jim Fankhauser, and Ed took advantage of several chances to fly around hailstorms in northern Colorado. Doug Lilly and Don Lenschow were leading the experiment to observe mountain waves and their momentum flux. During the same period, Boulder was struck by several severe windstorms, and we often asked what the difference was between an ordinary day with lee waves, and a day with severe downslope windstorms. Doug agreed that this was a question worth exploring, so one day when

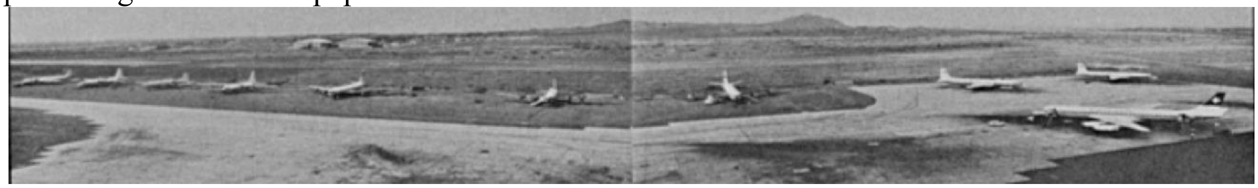


winds started gusting over 100 mph at NCAR, Doug and Ed found out that it was still safe to fly from the Jeffco Airport where the NCAR research planes were based, so they quickly drove to the airport and made what turned out to be the roughest flights either of them had ever made, documenting the large amplitude mountain wave responsible for the damaging winds. These data were used in subsequent papers, led by Doug Lilly, providing a satisfactory theory.

It is doubtful that there will ever be another field experiment of the scope of GATE, with 40 ships and 13 aircraft. The degree of interagency and international cooperation, even in the heart of the cold war, was amazing and will never be forgotten by the participants. Formulating and writing the aircraft plan dominated Ed's time for years, culminating in international meetings led by Joach Kuettner, the GATE Director, in Bracknell, England. It turned out that there was a labor dispute that required "lights out" in office buildings in England (in December!), so Ed was forced to return to his room in the pub (where some lights were of course permitted) and work on the plan from 3 pm to well into the night each night. Let there be no mistake: The success of

Joanne Simpson and Bob Grossman *GATE Operations Center* *Bob Grossman and Ed Zipser*

GATE is due to the unselfish cooperation and hard work and sacrifice of all those who participated in the planning, the 3+ months in the field, and the 6+ years validating the data and producing the scientific papers.



Some of the 13 GATE aircraft parked at Dakar, Senegal

During Ed's 3 months in the field in Dakar, as she had done so often, Marelynn took care of the house and the 2 girls, now 11 and 8. After GATE, Ed had an invitation to spend an academic year at Imperial College in London from Frank Ludlam. Ed and Marelynn had decided that this would be a good experience for the whole family, so instead of returning to the U.S., Ed met the family in Luxemburg, the European hub for the low-fare Icelandic Airlines. They toured Germany in their new Volvo, crossing the Channel in early October to get the girls into School in England. Ed then started his visit to Imperial College, where he spent time with Ludlam, Brian Ryan (also on a year's visit from Australia), and with recent Ph.D.'s Martin Miller and Mitch Moncrieff. The latter two had been sent to GATE by Frank Ludlam to fly on research airplanes and "learn what the real world is like" before their illustrious careers in theory and modeling. Ed and Mitch, in particular, struggled to interpret the data on tropical squall lines, eventually leading to famous papers by Betts and Miller, Moncrieff's overturning squall line model, and Ed's later squall line papers. Before leaving England, the Zipser and Ryan families enjoyed a week together on a canal boat in the hills of western England and Wales.

Peggy Lemone, Ed's collaborator on many of the papers resulting from GATE, wrote a BAMS article documenting that the peak year of production of GATE papers was in fact 6 years after the field program, a time lag that has been shown to be typical for most large programs. It is no coincidence that Ed spent the 10 years after GATE together with his colleagues, Peggy, Gary Barnes, Ed Szoke[1] and others mostly writing papers, and it was 7 years after GATE before he spent much time on another major field campaign.

That field campaign was the Cooperative COnvective Precipitation Experiment (CCOPE), based in Miles City, Montana, aimed at a comprehensive understanding of the processes leading to hailstorms, and as a sequel to the National Hail Research Experiment (NHRE). The change in focus from the tropics was partly due to a major reorganization of NCAR, eliminating both

NHRE and the GATE Group, consolidating both in the new Convective Storms Division (CSD). The interagency collaboration continued in CCOPE, with data from aircraft, radars, soundings, and surface mesoscale networks. The NCAR Queen Airs soared under cloud base in hailstorm updrafts (Gary Barnes found one with large hail falling out of the updraft …"oops"), Ed flew through anvil outflows in the NCAR Sabreliner (below), obtaining valuable ice microphysics data that Andy Heymsfield used to great advantage. The NASA DC-8 joined in many multi-

[1]These 4 individuals were well known at NCAR for loud arguments as they wrote their papers, and they believed that the conflicts improved the papers. The group was called Garpee Barleszi to signify GARy BARnes, Peggy LEmone, Ed Szoke, Ed ZIpser. Garpee continues to be cited as a tough peer reviewer.

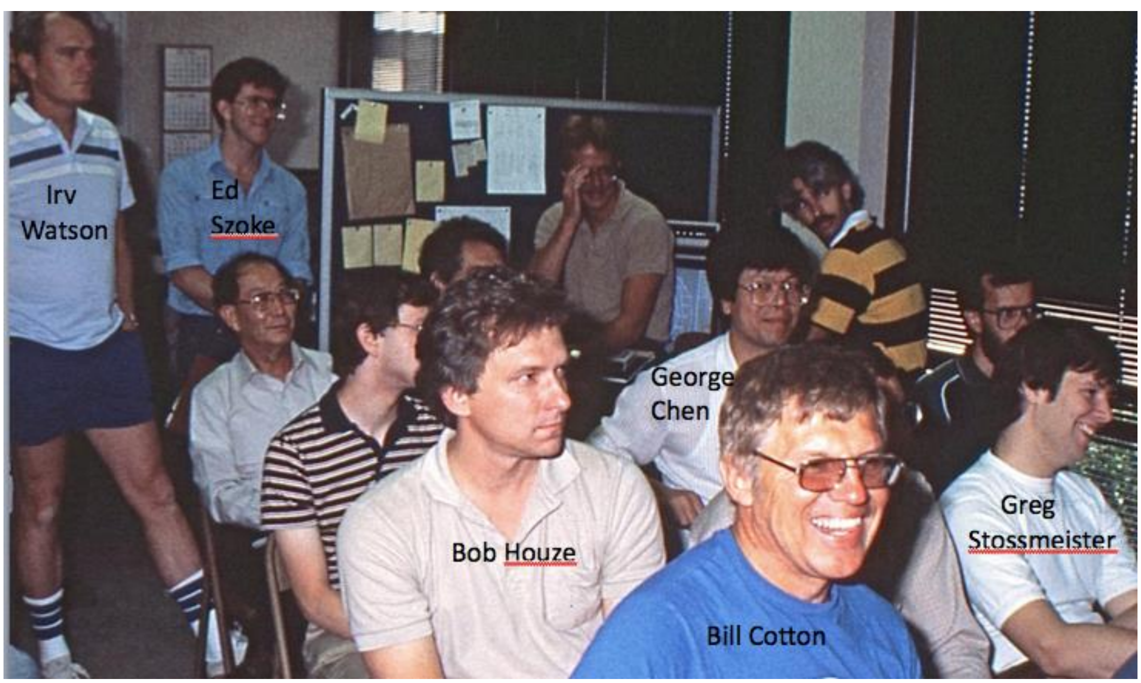
NCAR Sabreliner in CCOPE, 1981

aircraft missions, and the South Dakota School of Mines T-28 penetration aircraft supported by the NSF obtained data through the heart of severe storms. The NCAR sailplane ascended in updrafts, with cloud cameras, that Jim Dye and colleagues used to demonstrate that graupel of 5 mm size preceded the development of lightning in young convective clouds. The program was led by Charlie Knight and Brant Foote, veterans of NHRE, with Pat Squires the CSD Director.

Hurricanes continued to be of interest, and together with long-term colleagues Frank Marks and Dave Jorgensen, Ed and Gary Barnes were able to take part in some NOAA WP-3D flights. They were interested in flying similar flight patterns in hurricane rainbands that had been successful in teasing out the low-level structure in the LIE, Barbados, and GATE. Frank and Dave planned several of those low-level runs through rainbands, with Gary a lead author on the resulting paper.

Meanwhile, back in the mid-latitudes, a lengthy effort developed in the community to design a comprehensive field campaign, similar to GATE, but focused on obtaining the necessary knowledge to greatly improve forecasting of high impact weather. This program was named "STORM" (STormscale Operational and Research Meteorology). A long series of meetings generated enthusiasm, and a decision to mount a "pilot program" in Kansas and Oklahoma called (of course) OK PRE-STORM in 1985. In this case, the pilot program was highly successful, and in spite of its success, the interagency collaboration and funding never materialized for the planned national field program. One useful outcome of STORM planning has been a long-term success, and that is the recommendation for co-location of research and forecast activities, resulting in many National Weather Service offices relocating to be close to Universities or near other research centers.

Almost every scientist in the country interested in convective weather and its forecasting played a part in PRE-STORM. Bob Houze and his students led the use of the NCAR Doppler Radar pair in southern Kansas to produce valuable papers, while many others in the community were based at Oklahoma City with the NOAA research aircraft. Among those pictured below in the operations center is George Chen, National Taiwan University, later to lead the Taiwan Mesoscale Experiment (TAMEX). Ed was active in the PRE-STORM aircraft program, and as expected, it proved very difficult to fly aircraft when and where desired in the mid-continent. So experience like these stimulated the development of methods to probe strong storms with remote sensing as well as in situ flights. Ed didn't know it at the time, but he, Bob Houze, and many



colleagues would join the NASA science team during the following year (1986) developing ways to study storm structure from satellites, and from aircraft flying a safe distance above storms, in the stratosphere. The NASA program would become the TRMM Science Team, and in parallel, the NASA ER-2 was flying passive microwave radiometers above storms, and in due time, Gerry Heymsfield would develop radars that could fly aboard the ER-2.

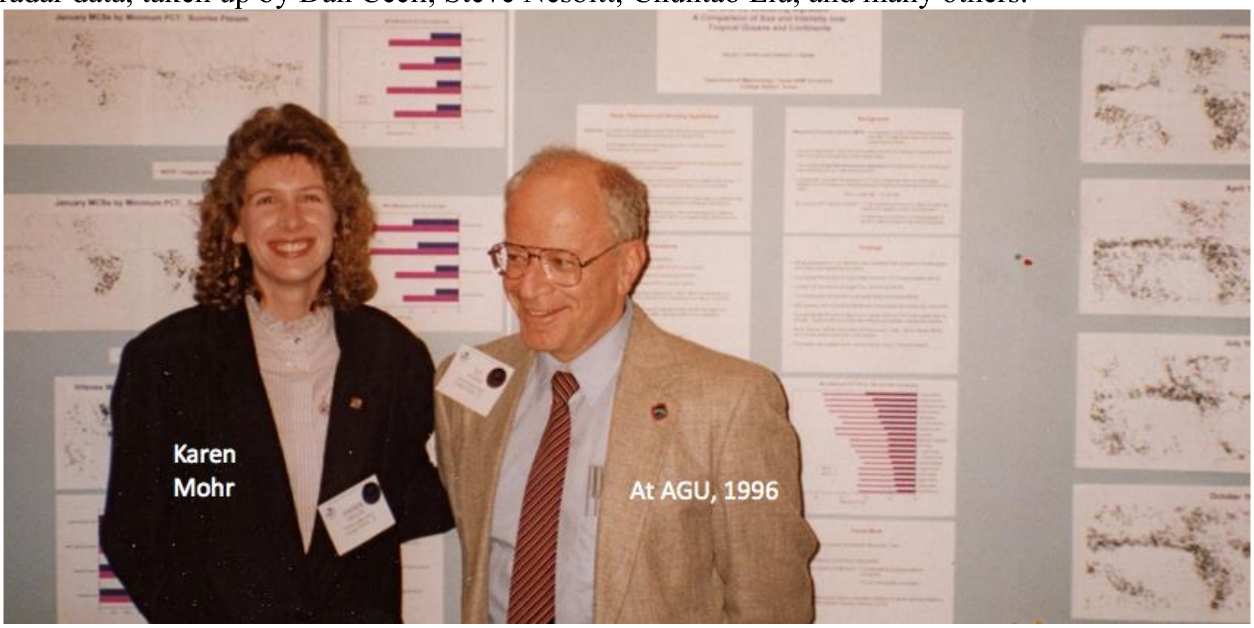
1984-1989 was a time of transition for Ed. He spent a few years as Director of NCAR's Convective Storms Division, learning some valuable lessons in how (and how not) to "manage" fellow scientists, lessons that would help him greatly in the future. In 1987, he participated in AMEX-EMEX in Darwin and Gove, Australia, probing cloud systems in a different part of the tropics, followed by TAMEX in Taiwan, and a convective initiation experiment in Colorado. That year, NCAR had another reorganization that eliminated CSD and formed MMM instead. In the next few years, without administrative tasks, Ed concentrated on research and spent Spring Quarter of 1989 visiting the University of Washington, interacting with Mike Biggerstaff and Brian Mapes while Bob Houze was visiting ETH in Zurich. During that period, Ed received an offer to become Department Head at Texas A&M University, and having decided (as others have found), "there is life after NCAR", took the plunge into Academia.

Texas A&M, 1989-1999

As a novice to university administration Ed was truly fortunate to join a Department that wanted him to continue to be active in research, so other faculty took care of most of the curriculum issues, and the Dean was supportive, and he was able to obtain grants from NSF, NOAA, and NASA that permitted him to remain active, and support graduate students. One of his first students, Chris Samsury, worked with NOAA data on hurricane rainbands. Mike Biggerstaff joined the faculty at about the same time, and used the radar on the roof as a teaching tool. Tom Wilheit also joined at that time, and together with Jerry North, facilitated Ed's interactions with NASA's TRMM Science Team. One of the first major opportunities came with TOGA COARE, a major field campaign in the equatorial west Pacific led by Peter Webster and Roger Lukas to study ocean-atmosphere interaction. While not as massive as GATE, both shipboard and aircraft instrumentation had improved. Bob Houze, Frank Marks, and Dave Jorgensen led the NOAA and NCAR turboprop aircraft based in Honiara (Solomon Islands) while Ed led the NASA ER-2 and DC-8 component based in Townsville Australia. There were a lot of strong-willed scientists in both locations (in addition to those named), so getting agreement was often more challenging than it had been in GATE. TOGA COARE data was used by many of Ed's grad students, including Kathy-Ann Caesar, later to join the faculty at the Caribbean Meteorological Institute.

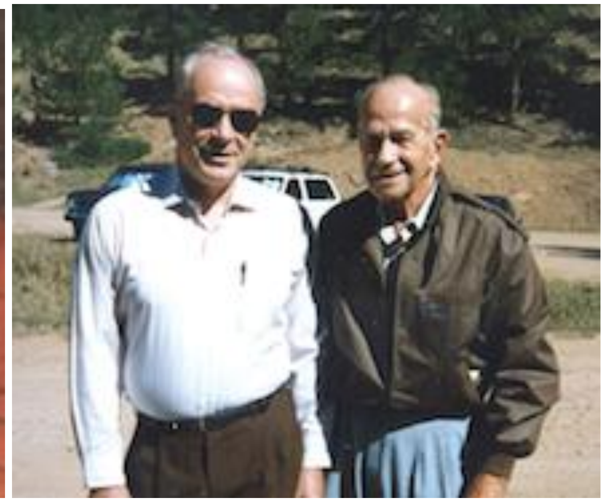
One important difference between TOGA COARE and GATE was that the convective weather in COARE was often located away from the few ships with radar, while in GATE the radar ships were centered in the ITCZ, that was reliably found within the ship network. Given the central role of sea-air interaction, this led to conflicts where to send the aircraft. Another set of conflicts was inter-agency; NASA leaders wanted the DC-8 and ER-2 to fly over deep convection, ships or no ships. One of Ed's contributions to a coordinated aircraft program was to convince NASA leaders that the NOAA P-3 scientists using the excellent P-3 radars were their best assets in finding the best deep convection. They protested to Ed "you mean that you want NASA to take direction from NOAA???". Fortunately, Ed was able to convince them that they would get the best data by accepting guidance from Frank and/or Dave.

Those successful flights were an eye-opener for Ed in many ways. The ER-2 had AMPR, the advanced microwave passive radiometer, with scientists Roy Spencer and Robbie Hood. Ed had never seen such data, and when reviewing some of the overflights, exclaimed to Robbie and Roy "holy &%#$, this is almost as good as having a radar in space!". With students at A&M looking for a research topic, these data became M.S. Theses for Gary McGaughey and Karen Mohr, and led directly to defining precipitation features, first from passive microwave data, and later from radar data, taken up by Dan Cecil, Steve Nesbitt, Chuntao Liu, and many others.



Another revelation from those ER-2 flights in TOGA COARE was in the area of electrification. The NASA science teams included a team led by Rich Blakeslee and Doug Mach who put field mills on both aircraft, expecting to find lightning in these equatorial storms. (Ed, of course, by that time knew that these oceanic storms were weaker than land storms.) After one flight, Ed found Rich sitting near his instruments bemoaning the lack of lightning, and Ed soothed Rich by telling him that that was the whole point! In later years, Chuntao and Ed would use the results of these overflights using the NASA field mills to write a paper with Earle Williams to show that there were many marginal storms over tropical oceans that did have significant electric fields, with "Wilson currents" above the storms, contributing to the global electric circuit, but with fields not quite strong enough for lightning.

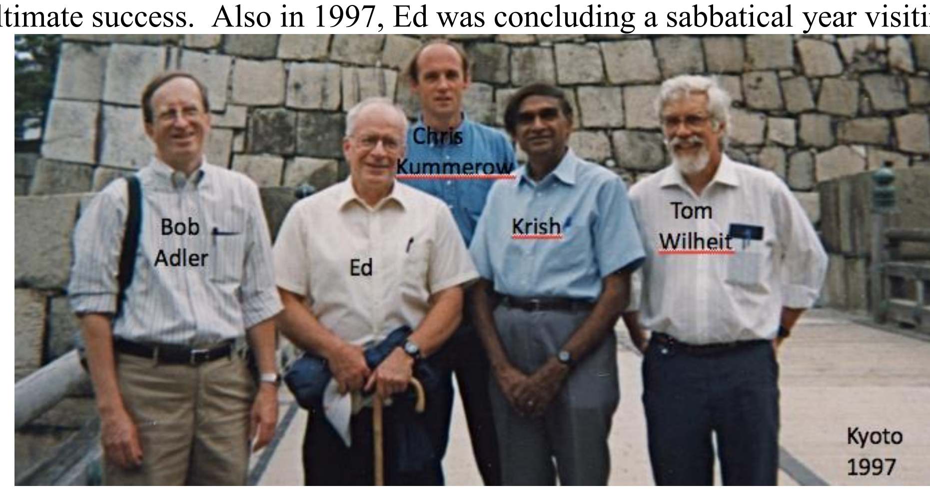
During the Texas A&M years, Ed was able to spend the summer months at NCAR to collaborate with NCAR colleagues. With his student Chris Lucas and Peggy Lemone, they wrote several papers adding to the growing knowledge of the properties of tropical oceanic updrafts by including the statistics from EMEX (near Darwin), and combining those with the scarcity of lightning shown in TOGA COARE to propose a threshold for updraft strength necessary for lightning. It was also a chance for Ed to hike again in the Colorado mountains with Herbert



Riehl. They had done this upon occasion for over 20 years, but during Herb's later years, his slower pace matched up better with Ed's, and it was a satisfying experience for both of them.

The late 1990s saw the final preparations for the launch of the TRMM satellite, a joint U.S. – Japan collaboration that was to provide unparalleled new knowledge of tropical convection and rainfall. Ed is forever grateful for the support and companionship of the NASA Science Teams, that did so much to sustain his research program and so many of his students over a 30-year period that still continues today. And the students made many of the advances that continue today. At Texas A&M, then-students Karen Mohr, Rick Toracinta, Dan Cecil, and Steve Nesbitt realized that the concept of analyzing precipitation features rather than individual pixels would be important in understanding the full range of convective clouds and mesoscale convective systems (MCSs) after TRMM was launched, much as Karen had pioneered with her M.S. work using passive microwave data. But the challenge was much greater, because we were preparing for the TRMM radar data with its all-important vertical profiles. Those students designed the programs and analysis methods that would be refined greatly in subsequent years, especially by Chuntao Liu at Utah.

In 1997, the U.S. and Japanese science teams got together in Kyoto (photo below) for a final planning meeting before TRMM launch. Missing from this photo is the TRMM Project Scientist for the U.S., Joanne Simpson, whose perseverance during the past 2 decades was so important in TRMM's ultimate success. Also in 1997, Ed was concluding a sabbatical year visiting NASA



GSFC, in which Ed had the good fortune to work together with Joanne, future TRMM project scientists Bob Adler and Chris Kummerow, and so many others, such as Gerry Heymsfield. During this period, Joanne asked Ed to be the lead scientist for the "ground validation" (GV) field campaigns that would provide both calibration data from both surface- and aircraft-based instruments, but data describing the evolution of convective systems before and after TRMM overpasses. Ed was very much aware that this would require a large community effort on the part of most of the science team. Major elements of these field campaigns were delegated to willing and able colleagues, notably Steve Rutledge for what became TRMM-LBA in Brazil, and Bob Houze for what became KWAJEX, or the Kwajalein experiment.

TRMM-LBA and KWAJEX were scheduled for 1999. Joanne did not want to take any chances of an early TRMM failure, so she insisted on having some GV activities in the field as soon as possible after TRMM launch. In a big hurry, these were carried out in April 1998 in Texas, with the ER-2 overflights based at Eglin AFB in Florida, and August-September 1998 in Florida, with the NASA ER-2 and DC-8 based at Patrick AFB near Melbourne FL, and the NCAR S-POL radar in the mosquito-filled swamps west of Melbourne, from which the aircraft were guided. This part of the TRMM GV program was merged with Program Manager Ramesh Kakar's first of several hurricane research programs, CAMEX-3, an efficient combination, because deep convection over Florida was almost always available when hurricanes were not.

CAMEX-3 had numerous flights into (DC-8) and over (ER-2, with Gerry Heymsfield's ER-2 Doppler radar) Hurricanes Bonnie and Georges. A full suite of instruments on both aircraft, combined with some timely TRMM overpasses, led to increased confidence in interpreting data from all the TRMM instruments. The rainfall estimates were compared with a dense rain gauge network operated near the Melbourne WSR-88D, one of the TRMM GV radars, in Florida thunderstorms when no tropical cyclones were within reach.

The TRMM-LBA GV program was a challenge to carry out, but with a great effort by all, it was very successful in early 1999 during the wet season in Rondonia, Brazil. The S-POL radar and NOAA TOGA radars were set up on either side of the town of Ji-Parana, and the operations center had the invaluable support of many Brazilians, led by Maria and Pedro Silvs Dias. The

With Maria and Pedro Silva Dias, Rondonia, Brazil, during TRMM-LBA, 1999

Larry Carey, Ed Zipser, Steve Rutledge, Bart Geerts,

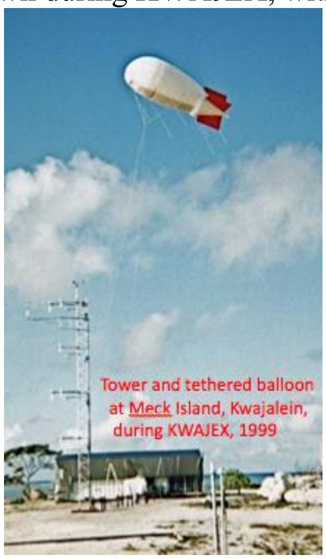
at S-POL radar, Rondonia, Brazil, guiding aircraft during TRMM-LBA, 1999.

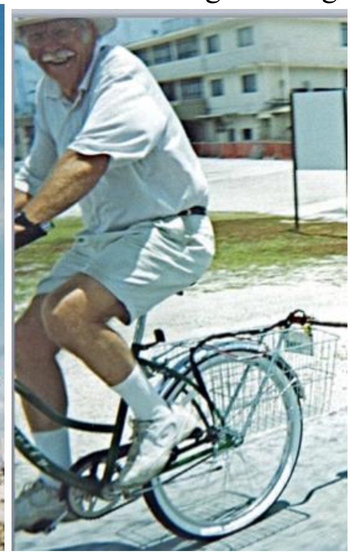
ER-2 was based in Brasilia and because of the regular afternoon deep convection was able to be positioned over the storms on most days, with an interesting variety of storm intensities, ranging from strong storms most common during easterly flow to “green ocean” near-oceanic weaker storms on days with westerly flow.

University of Utah, 1999 - date

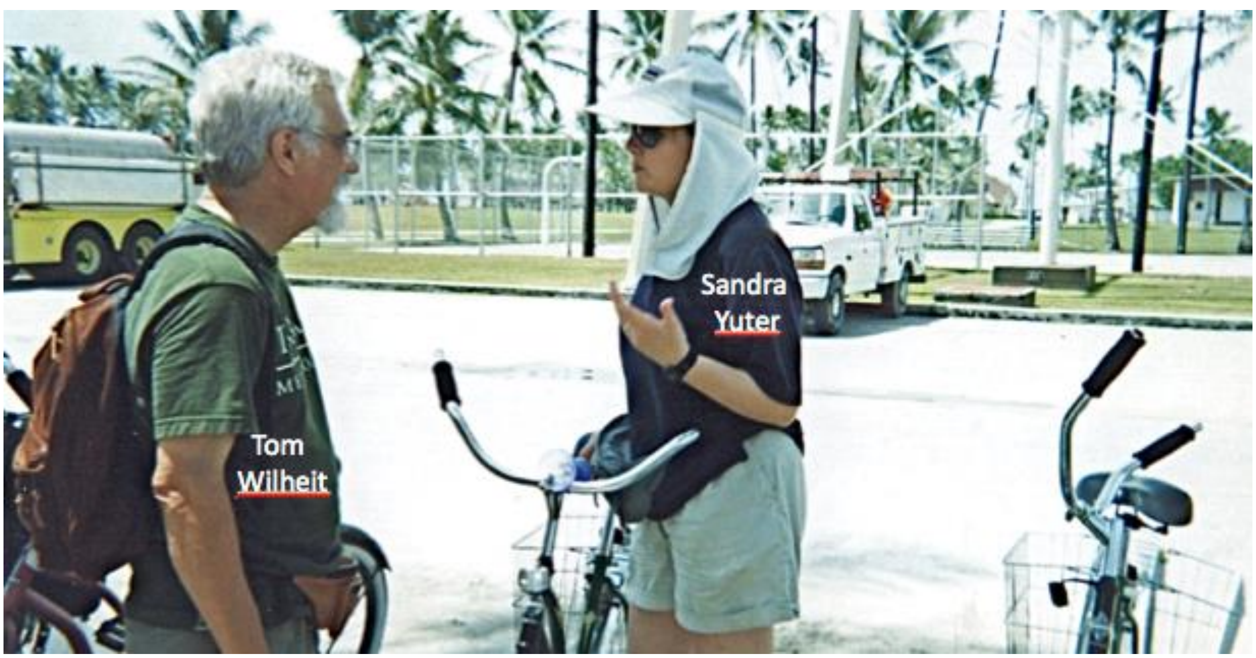
Between TRMM-LBA and KWAJEX, Ed moved from Texas A&M to the University of Utah, leaving students Dan Cecil and Rick Toracinta to finish their Ph.D.’s in Texas, with Ed continuing their advising at a distance, while Steve Nesbitt chose to move to Utah. Ed is forever grateful for the support he received from faculty and administration at both universities, and for Ed is forever the funding agencies’ support of his many students at both locations.

A highlight of both TRMM-LBA and KWAJEX for Ed was coaxing Mike Garstang out of semi-retirement to use his long experience to oversee the operation of the surface flux towers and the tethered balloon operations in both locations. The entire GV team understood the importance of accurate time series and profile data from the surface through boundary layer in both land and ocean environments, and together with the frequent radiosonde launches in both programs, this essential element of the GV programs added to their success. In the photos below, the tower and tethered balloon is shown during KWAJEX, with Mike Garstang showing how he gets around.





Just as Steve Rutledge had overseen TRMM-LBA, Bob Houze took responsibility for KWAJEX, with Sandra Yuter and Courtney Schumacher playing key roles in this long and successful effort.



Kwajalein, KWAJEX field campaign, 1999

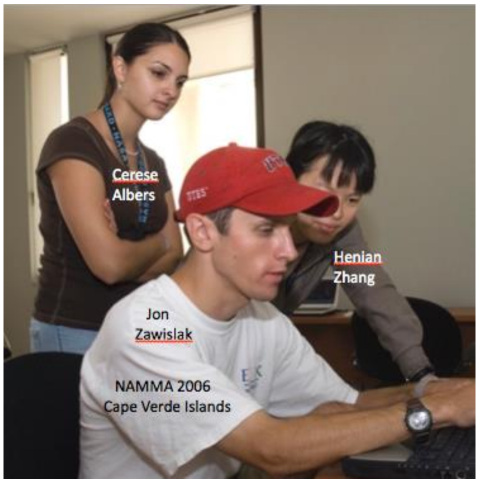
Remembering very well how his own career was jump-started by hands-on participation in field campaigns as a grad student and as a post-doc, Ed was motivated to extend such experiences to his own students, once in the academic world. The TRMM GV campaigns served as a great opportunity to do just that. Before leaving Texas A&M, Dan Cecil, Rick Toracinta, and Steve Nesbitt were heavily involved in the Texas-Florida 1998 program. Rick (below) worked with a

sounding team at a remote hacienda in Rondonia, Brazil during TRMM-LBA, while Steve spend several weeks on Kwajalein flying on the DC-8. Dan and Steve both flew into hurricanes in CAMEX-3 and CAMEX-4, great preparation for Dan's Ph.D. work using TRMM data in tropical cyclones. Sometimes the student tasks in field campaigns were less rewarding. Yaping Li wrote her dissertation on TRMM retrievals over tropical oceans, using radar and aircraft data from KWAJEX, one of the first results demonstrating that numerical simulations overpredicted ice water content; during CRYSTAL-FACE in the Florida Everglades she launched soundings at 5 am each day, feeding mosquitoes so well that she returned to Utah completely speckled.

While Steve Nesbitt was completing his Ph.D. in Utah, using the first 3 years of TRMM data to document the diurnal cycle of deep convection and MCSs over land and ocean, he was also the person keeping up our TRMM Precipitation Feature (PF) database, ingesting new data daily, all with one hand tied behind his back. With Steve's departure for a Post-Doc at CSU, Ed had a problem; and was advised to "hire an MS meteorologist to keep up with the data flow and programs". About 30 people applied for the job. One was a recent Ph.D. from the University of Wyoming whose satellite expertise was with limb scanning in the stratosphere, and field experience mainly in Antarctica. In one of the best decisions Ed ever made, he hired Chuntao Liu, and for the next 12 years, he vastly improved the TRMM PF database, but helped advise the grad students on its use, and together he and Ed became close partners, writing at least 25 papers.

Paola Salio's visit to Utah in 2003, following our participation in the South American Low Level Jet (SALLJEX) program, is thanks to Jan and Julia Paegle. Julia kept her ties to the University of Buenos Aires, and invited many UBA scientists to Utah. Ed's group used TRMM PF data to suggest that Argentina's storms are the strongest on the planet, and opened doors to many actual and planned studies to find out why.

NASA's field campaigns aimed at obtaining remote sensing from aircraft over tropical weather systems, including tropical cyclones, continued with the ER-2 in the Tropical Clouds and Precipitation Systems (TCSP) in Costa Rica in 2005, and the DC-8 in NAMMA, based at Sal in the Cape Verde Islands in 2006. Grad students played a major role in both programs.



Ed does not regret for a minute his participation with so many colleagues and students in either of these field campaigns. Yet, in spite of improved instrumentation in recent years, there is only so much that can be done from a remote site with a single aircraft. In 2005, we had hoped to fly many missions together with the NOAA P-3s, but 2005 was a record tropical cyclone year in the Atlantic, so the NOAA planes were frequently called back to Florida to fly storms threatening the U.S. In 2006, the NASA DC-8 was mostly alone in the east Atlantic with dropsondes and the JPL multi-frequency multi-parameter radar. Recognizing the need for multiple aircraft, in 2010, a multi-agency collaborative program was put in the field: GRIP (NASA), IFEX (NOAA) and PREDICT (NSF) that succeeded in obtaining multiple flights on multiple days into storms that


ranged from incipient disturbances to fully developed hurricanes. In the spirit of the larger-scale programs of past years, the 2010 effort demonstrated what could be done. One example: Karl (2010) was followed for the 4 days of its development in the Caribbean. During Karl's rapid intensification in the southern Gulf of Mexico 5 aircraft were in the storm at once, including the Global Hawk, which made 20 consecutive passes across the eye in 13 hours. The performance of the GH in GRIP led to NASA's HS3 program based at Wallops Island from 2012 – 2014.

The NASA-JAXA Global Precipitation Mission (GPM) core satellite was launched 27 February 2014 from Japan, overlapping with TRMM (operating normally) for several months, allowing for cross-calibrations. As for TRMM, a variety of field campaigns for Ground Validation (GV) and algorithm development and testing were carried out, this time both before and after launch, with airborne instruments acting as a satellite surrogate. Walt Petersen has taken on the role for these campaigns, much as Ed did for TRMM. Ed has participated in several of these between 2011-2015. One of the largest was collaborative with DOE at their Southern Great Plains (SGP) field site near Ponca City, OK, in May-June 2011. This time, almost all of Ed's research group took

part, even including our Argentine visitor (Lucho Vidal, Paola Salio's student). Christy Wall, Sarah Bang, and Weixin Xu (not shown above) also gained experience during MC3E on site.

Although Ed and his students participated in two additional GPM GV campaigns (IPHEx, North Carolina 2014 and OLYMPEX, Seattle 2015), those stories can wait to be told. So can the High Ice Water Content series of field campaigns in Darwin Australia and Cayenne, French Guiana, in which Ed and Adam Varble have been supported by NSF in a collaborative proposal with Greg McFarquhar of University of Illinois to find out more about the ice microphysics of convective clouds over tropical oceans that occasionally result in "engine events" of concern to commercial air carriers; this research is ongoing.

When Ed started supervising graduate students, Marelynn, always looking ahead, asked whether any of them would be in a position to carry on Ed's activities in hurricanes, tropical meteorology, and doing the things that Ed had been doing for so many years. Good question. In academia, it's all about the students. The last photograph in this story is a compressed collection of 19 grad students from Ed's group, starting with Dan Cecil and ending with current students. These students have brought the joy of learning into Ed's life over the past 17 years, and many of them are certainly in a position do more than "carry on" but to make major advances in the field.

PROJECT AND FIELD PROGRAM INVOLVEMENT BY ED ZIPSER

2015:	OLYMPEX; Seattle, WA. (NASA)
2015:	High Ice Water Content, Cayenne, French Guiana. (NSF and multi-agency)
2014:	Integrated Precipitation and Hydrology Experiment, Asheville NC (NASA)
2014:	High Ice Water Content; Darwin, Australia. (NSF and multi-agency)
2012-2014	NASA HS3 (Hurricane and Severe Storm Sentinel): Using unpiloted Global Hawk aircraft in hurricane research; Wallops Island, VA.

2011	NASA/DOE Mid-Latitude Continental Convective Clouds Experiment (MC3E)
2010	NASA Genesis and Rapid Intensification Processes (GRIP), Mission Scientist
2008	Taiwan Terrain-Influenced Monsoon Rainfall Experiment (TiMREX)
2006	NAMMA (NASA- African Monsoon Multidisciplinary Analysis) Experiment, Cape Verde Islands, lead scientist
2006	TWPICE (Tropical Warm Pool International Cloud Experiment, Darwin Australia, Member Management Team
2005	TCSP (Tropical Cloud Systems and Processes), Costa Rica, Mission Scientist
2003	SALLJEX (South American Low-Level Jet Exp; radar scientist on NOAA P-3
2002	CRYSTAL-FACE [Production of anvil cirrus by convection-Florida]
2001	Mission Science Management Team for CAMEX-4 (NASA ER-2 and DC-8 missions in hurricanes, based at Jacksonville NAS, Aug-Sept.)
1997-2000	NASA, Tropical Rain Measuring Mission (TRMM): Team Leader for field campaigns in Texas, Florida, Brazil (with LBA), and Kwajalein.
1992-1993	Tropical Ocean-Global Atmosphere, Coupled Ocean Atmosphere Response Experiment (TOGA COARE): Lead Scientist for Convection, NASA Aircraft.
1991	Tropical Experiment in Mexico: Participant.
1987	Equatorial Mesoscale Experiment; Management Team, co-PI on F-27 and Electra.
1987	Taiwan Mesoscale Experiment: Planning Team and Participant.
1987	Convection Initiation and Downburst Experiment: Member Management Team.
1985	Oklahoma-Kansas PRE-STORM experiment: Member, Management Team.
1984	Australian Cold Fronts Program: Lead Scientist on F-27.
1981	CCOPE (Cooperative Convection and Precipitation Experiment), Montana
1980-1981	Hurricane Research Flights in cooperation with HRD colleagues
1974	GATE: Coordinator, Aircraft Program; Airborne Mission Scientist, Mission Scientist, Mission Selection Team.
1971-1972	Mountain Waves and Severe Downslope Windstorms, Boulder CO area
1971-1972	National Hail Research Experiment, occasional participant
1969	BOMEX (Barbados Oceanographic and Meteorological Experiment)
1968	Pre-BOMEX: FSU Barbados Experiment; Led aircraft component
1967	Line Islands Experiment: Central Pacific Ocean. Scientific Coordinator
1963	Dissertation Research based in Roosevelt Roads, Puerto Rico
1960-1962	Occasional hurricane flights (working for NHRP as summer graduate student)

HONORS

- Carl-Gustav Rossby Research Medal, American Meteorological Society, 2016
- Walter Orr Roberts Lecturer, American Meteorological Society, 2010
- Special Award, American Meteorological Society, for "outstanding contributions to the editorial oversight of the Bulletin of the AMS", 2007.
- Invited Lecturer, NASA Goddard Space Flight Center, 2004.
- Editor's Award, American Meteorological Society, 1999.
- University Space Research Association Visiting Fellowship, NASA Goddard Space Flight Center, 1996-1997.
- Special Award, American Meteorological Society, for "Outstanding Contributions and Leadership in [GATE]", 1977.
- Research Fellow of (U.K.) NERC, Imperial College, London, 1974-75.
- NCAR Publications Prize, 1969.

THESES AND DISSERTATIONS SUPERVISED

35. Alvey, George R. III (Trey), 2015: Tropical cyclone intensity change: Evaluating the effects of inner core precipitation properties and environmental influences. M.S. Thesis, Dept. of Atmospheric Sciences, University of Utah, May 2015, 109 pp.
34. Susca-Lopata, Gabriel A., 2014: Which environmental conditions and core precipitation characteristics led to the rapid intensification of Hurricane Earl (2010)? M.S. Thesis, Dept. of Atmospheric Sciences, University of Utah, August 2014, 93 pp.
33. Bang, Sarah D., 2013: On the mutual interactions between convective storms and their environments during the midlatitude continental convective clouds experiment (MC3E) field campaign in Oklahoma.. M.S. Thesis, Dept. of Atmospheric Sciences, University of Utah, Dec. 2013, 126 pp.
32. Varble, Adam C., 2013: Using TWP-ICE observations to evaluate and improve high resolution simulations of tropical convective precipitation systems. Ph.D. Dissertation, University of Utah, Salt Lake City, UT 84112-0110, May 2013, 188 pp.
31. Wall, Christina L., 2013: The impact of aerosols on convective clouds: A global perspective. . Ph.D. Dissertation, University of Utah, Salt Lake City, UT 84112-0110, May 2013, 145 pp.
30. Zawislak, Jonathan A., 2013: Necessary and sufficient conditions for tropical cyclogenesis. Ph.D. Dissertation, University of Utah, Salt Lake City, UT 84112-0110, May 2013, 117 pp.
29. Xu, Weixin, 2011: East Asian summer monsoon precipitation systems: Rainfall characteristics, storm morphologies and convective properties. Ph.D. Dissertation, University of Utah, Salt Lake City, UT 84112-0110, Aug. 2011, 283 pp.
28. Wall, Christina L., 2009: Characteristics of monsoonal thunderstorms in Arizona and New Mexico. M.S. Thesis, Dept. of Atmospheric Sciences, University of Utah, December 2009, 121 pp.
27. Zawislak, Jonathan A., 2008: Observations of seven African easterly waves in the east Atlantic during 2006. M.S. Thesis, Dept. of Meteorology, University of Utah, August 2008, 110 pp.
26. Kerns, Brandon, 2008: Four years of ERA-40 vorticity maxima tracks. Ph.D. Dissertation, University of Utah, Salt Lake City, UT 84112-0110, Aug. 2008, 155 pp.
25. Blacutt, Luis A., 2007: Precipitation features on the Altiplano and Tibet: A comparative study. M.S. Thesis, Dept. of Meteorology, University of Utah, May 2007, 75 pp.
24. Greene, K., 2006: Analysis of nondeveloping and developing easterly waves using ERA40-1.125° reanalysis data of relative vorticity. M.S. Thesis, Dept. of Meteorology, University of Utah, Salt Lake City UT 84112-0110, December 2006, 92 pp.
23 Li, Yaping, 2006: Cloud resolving simulations of tropical cloud systems: Using field program observations to evaluate ice phase microphysics parameterizations. Ph.D. Dissertation, University of Utah, Salt Lake City, UT 84112-0110, Aug. 2006, 185 pp.
22. Jiang, Haiyan, 2004: Quantitative precipitation and hydrometeor content estimation in tropical cyclones from remote sensing observations. Ph.D. Dissertation, University of Utah, Salt Lake City, UT 84112-0110, Aug. 2004, 207 pp.
21. Nesbitt, S.W., 2003: Precipitation estimates according to the Tropical Rainfall Measuring Mission. Ph.D. Dissertation, University of Utah, Salt Lake City UT 84112-0110, May 2003, 192 pp.
20. Mota, G.V., 2003: Characteristics of rainfall and precipitation features defined by the Tropical Rainfall Measuring Mission over South America. Ph.D. Dissertation, University of Utah, Salt Lake City UT 84112-0110, Dec. 2003, 215 pp.
19. Li, Yaping, 2003: Intensity of convective storms in Florida and their environmental properties. M.S. Thesis, Dept. of Meteorology, University of Utah, Salt Lake City UT 84112-0110, December 2003, 123 pp.
18. Mota, G.V., 2002: Rainfall estimates over South America. M.S. Thesis, University of Utah, Salt Lake City UT 84112-0110, May 2002, 65 pp.
17. Yorty, D.P., 2001: Extreme convection observed by the tropical rainfall measuring mission. M.S. Thesis, Dept. of Meteorology, University of Utah, Salt Lake City UT 84112-0110, December 2001, 114 pp.

16. Cecil, D.J., 2000: Reflectivity, ice scattering, and lightning characteristics of hurricane eyewalls and rainbands. . Ph.D. Dissertation, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Dec. 2000, 123 pp.
15. Toracinta, E.R., 2000: Radar, passive microwave, and lightning characteristics of precipitating features in the tropics. Ph.D. Dissertation, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Dec. 2000, 138 pp.
14. Nesbitt, S. W., 1999: A census of precipitation features in the tropics using TRMM: Radar, ice scattering, and lightning observations. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Aug. 1999, 97 pp.
13. Zolman, J., 1999: A comparison of tropical mesoscale convective systems in El Nino and La Nina. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, May 1999, 87 pp.
12. Lucas, C., 1998: Environmental variability during TOGA COARE and its effect on mesoscale convective systems: Observations and modeling. Ph.D. Dissertation, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, May 1998, 185 pp.
11. Cecil, D.J., 1997: Relationships between tropical cyclone intensity and satellite based indicators of inner core convection: 85 GHz ice scattering signature and lightning. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Aug. 1997, 126 pp.
10. Caesar, K.A., 1995: Cold domes over the warm pool: A study of the properties of cold domes produced by mesoscale convective systems during TOGA COARE. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, May 1995, 84 pp.
9. Devlin, [Mohr] K.I., 1995: Application of the 85 GHz ice scattering signature to a global study of mesoscale convective systems. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Aug. 1995, 100 pp. [Published under name Karen I. Mohr]
8. Restivo, M.E., 1995: The convective structures associated with cloud to ground lightning in TOGA COARE Mesoscale Convective Systems. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Aug. 1995, 98 pp.
7. Toracinta, E.R., 1995: Radar, satellite, and lightning characteristics of select mesoscale convective systems in Texas. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Dec. 1995, 70 pp.
6. McGaughey, G.R., 1994: High resolution passive microwave observations of convective systems over the tropical Pacific Ocean. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Dec. 1994, 84 pp.
5. Liu, C., 1994: Theoretical and numerical studies of organized convective lines. Ph.D. Dissertation, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, May 1994, 322 pp.
4. Lucas, C., 1993: Vertical velocity in oceanic convection off tropical Australia. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, May 1993, 119 pp.
3. Griffith, J.M., 1992: Properties of inflow and downdraft air of tropical mesoscale convective systems and the effect of downdrafts on the surface fluxes. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Dec. 1992, 110 pp.
2. Lutz, K.R., 1992: Vertical profiles of radar reflectivity of convective cells in tropical and mid-latitude mesoscale convective systems. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Dec. 1992, 113 pp.
1. Samsury, C.E., 1992: The kinematic structure of hurricanes and their rainbands - implications for hurricane intensity change. M.S. Thesis, Dept. of Meteorology, Texas A&M Univ., College Station TX 77843-3150, Dec. 1992, 123 pp.