Kuo-Nan Liou Receives 2013 Roger Revelle Medal

Kuo-Nan Liou

Kuo-Nan Liou was awarded the 2013 Roger Revelle Medal at the AGU Fall Meeting Honors Ceremony, held on 11 December 2013 in San Francisco, Calif. The medal is for "outstanding contributions in atmospheric sciences, atmosphere-ocean coupling, atmosphere-land coupling, biogeochemical cycles, climate, or related aspects of the Earth system."

PAGE 8

Citation

The Revelle Medal is awarded for "outstanding contributions in atmospheric sciences, atmosphere-ocean coupling, atmosphere-land coupling, biogeochemical cycles, climate, or related aspects of the Earth system." It also celebrates the man Roger Revelle, who through his broad interests, his awareness of global change, and his national and international service, was a true statesman of science. Dr. Kuo-Nan Liou's accomplishments in research and leadership service are the perfect embodiment of this ideal. He made trailblazing contributions in radiation, the prime driver in the Earth's energy budget, and in cloud physics; both are fundamental to our understanding of climate dynamics and atmosphere-surface interactions. Moreover, his leadership successively as chair of two departments and as director of two separate Institutes and his outreach initiatives in spearheading hydrologic-atmospheric experimentation and in founding the Joint Institute for Regional Earth System Science and Engineering at UCLA reveal him to be a true leader in the image of Roger Revelle.

It was unavoidable that in my own research into the radiative aspects of evaporation, I would sooner or later come across Dr. Liou's numerous publications. Indeed, they are a testimony to his major contributions and improvements to the theory and application of radiative transport in the atmosphere and its interaction with clouds and aerosols. One specific area where Dr. Liou has been the foremost pioneer is light scattering by ice crystals in cirrus clouds; his unified theory, encompassing light scattering and absorption by ice crystals of all sizes and shapes, similar to the Mie theory for spherical droplets, has transformed the field of remote sensing of cloud composition and structure for years to come. In a second class of contributions in the context of satellite remote sensing, he has developed methods for distinguishing between ice and water clouds, a novel technique for detecting the thickness and composition of cirrus clouds, the theory and a numerical scheme to retrieve atmospheric heating rates, and the estimation of surface radiative fluxes from observations at the top of the atmosphere. In a third major area, he has focused on the role of clouds as radiation regulators of climate. For instance, he showed that high cirrus clouds are critical and can amplify surface temperature increases resulting from greenhouse radiative forcing. Following this, he developed a cloud-precipitation-climate model to investigate links between cloud particle size distributions, perturbed by greenhouse warming, and air pollution; this is now universally referred to as the second indirect forcing in aerosol-cloud feedbacks.

Beside his fundamental contributions in these three research areas, his two highly successful books have had a major impact and have established him as the undisputed leader in atmospheric radiation. The first, *An Introduction to Atmospheric Radiation* (2002), already in a second edition, unified the fundamentals, including the subject of remote sensing; in the second, *Radiation and Cloud Processes in the Atmosphere* (1992), Dr. Liou bridged the fields of radiative transfer, cloud physics, and atmospheric dynamics. For all these scientific contributions, Dr. Liou is widely recognized, and he has received numerous prestigious awards.

In summary, it is difficult to think of anyone with more appropriate credentials for the Revelle Medal than Kuo-Nan Liou.

—WILFRIED H. BRUTSAERT, Cornell University, Ithaca, N. Y.

Response

I was surprised and thrilled to receive AGU's 2013 Roger Revelle Medal. Indeed, it is a great pleasure and distinct honor to be on the roster of previous outstanding awardees. I would like to thank Wilfried Brutsaert for his generous remarks and unwavering support and encouragement in my pursuit of academic and research excellence and to extend my appreciation to the Revelle Medal Selection Committee for recognizing my contributions to radiative transfer and related climate and remote sensing fields.

Radiative transfer is an interdisciplinary subject and was initially studied by astrophysicists and later by planetary scientists and meteorologists for atmospheric applications. It is also an important field in optics and various engineering disciplines. The concept of radiative forcing, first proposed by Bob Dickinson, requires radiative transfer analysis to determine the impacts of anthropogenic greenhouse gases and aerosols and cloud feedback on global warming and climate change. Development of remote sensing techniques to infer atmospheric compositions and surface properties must follow the principle of radiative transfer.

Early in my career, I had the opportunity to study Chandrasekhar's book *Radiative Transfer,* written in 1950, which led me to develop simplified solutions for the transfer of solar and thermal infrared radiation in atmospheres containing clouds and aerosols and, later, for three-dimensional inhomogeneous mountain and snow topography. My exposure to Born and Wolf's book *Principles of Optics,* first published in 1959, guided me to initiate the geometric optics approach to understand the scattering, absorption, and polarization processes of irregular ice crystals and aggregated soot aerosols. I realized that exact solutions for light scattering by these intricate and complicated particles, widely variable in size and morphology, could not be derived on the basis of conventional wave equations and boundary conditions.

Seminal books by Richard Goody in 1966 and Henk van de Hulst in 1957 inspired me to seek approximations based on the first principles. A number of graduate students and I have been able to develop improved geometric optics approximations based on a number of fundamental electromagnetic theories to cover different size ranges and morphologies. Since joining the University of California, Los Angeles (UCLA) in 1997, I have had some success incorporating simplified radiative transfer solutions and light scattering and absorption approximations in forms of spectral radiation parameterization into general circulation models for climate studies, specifically involving high-level clouds and aerosols.

My expertise in radiative transfer also led me to work with a group of graduate students on remote sensing challenges, including differentiation of ice crystals and water droplets based on the backscattering depolarization approach, determination of cirrus cloud composition, understanding of aerosol-cloud interactions, and retrieval of heating rates and surface fluxes from space.

Indeed, over the last 30 years, I have had the privilege of working with a number of bright and talented graduate students at the University of Utah and UCLA who complemented my strengths in research. They deserve to share, in equal measure, any recognition I have received, including this great honor from AGU. It is in this spirit that I accept the Roger Revelle Medal.

—Kuo-Nan Liou, University of California, Los Angeles