PREFACE

The variability of precipitation is an immensely important subject because of its direct control on and response to the atmospheric and surface water and energy cycles that strongly govern weather and climate. Precipitation variability takes place across the complete range of scales up to the very high local–diurnal scales down to the very low global–decadal and longer scales. The topic of this special issue is the diurnal variability of precipitation, cast in the framework of *Understanding Diurnal Variability of Precipitation through Observations and Models*. Since the advent of high-quality multiyear and globally distributed observations of precipitation from spaceborne sensors, there has yet to be a focused study concerning the topic of the diurnal variability of precipitation. This special issue of the *Journal of Climate* contains 11 papers that seek to bring about this focus.

For over a century observational and modeling studies have demonstrated that diurnal processes forced by the smooth daily cycle of incoming solar radiation at the top of the atmosphere occur in many atmospheric quantities including winds, surface pressure, vertical motion, cloudiness, and surface radiation fluxes as a selection of important variables—but most importantly precipitation. Studies on diurnal precipitation variability have been going on regularly since a seminal study that took place in 1901. However, until recently, observationally based precipitation studies had long been plagued by incomplete and inconsistent rain gauge and radar datasets that upheld a global view of the process and had never allowed regional and global model renditions of diurnal precipitation variability to be reliably checked, much less verified. This situation changed in July 1987, which marked the date of the advent of regularly flown passive microwave (PMW) radiometers on earth-orbiting satellites, namely, the launch of the first (F8) Special Sensor Microwave Imager (SSM/I) on a Defense Meteorological Satellite Program (DMSP) platform. The more recent launches of precipitation and cloud radars on the Tropical Rainfall Measuring Mission (TRMM) and *CloudSat* satellites in November 1997 and April 2006, respectively, have dramatically improved our ability to measure precipitation on a global scale. In the case of the TRMM satellite, because of its non-sun-synchronous inclined-prograde orbit, we can now regularly monitor the complete diurnal cycle with both TRMM's precipitation radar (PR) and its PMW radiometer called the TRMM Microwave Imager (TMI). As a result, it is now possible to overcome past shortcomings in precipitation datasets and make possible synergistic observational and modeling studies of how precipitation is regionally modulated across the entire globe.

Recent research (some of which has been published in American Meteorological Society journals), made possible by TRMM datasets of precipitation estimates dating back to November 1997, indicates that the diurnal variability of precipitation is a multifaceted global phenomenon with embedded regional phenomena far more complex than can be readily explained with generalized causal factors. For example, the generally dominant late-night to early-morning oceanic rainfall peak is often accompanied by a secondary afternoon peak, while the generally dominant mid- to late-afternoon continental rainfall peak can be accompanied or even replaced by a secondary early-morning peak. Over the earth's many regions, there are a host of mechanisms at work in producing diurnal rainfall processes, no single one of which can be used to explain the entire process. Instead it appears that, for a given region, a mixture of mechanisms are often in play whose individual components control smaller-scale diurnal modes, ultimately working together to describe the mean global process, which, when viewed as a mean process, generally disguises its component elements. Notably most modeling studies focused on diurnal variability, particularly atmosphere general circulation model (GCM) studies, have been focused on single mechanisms. Thus, based on the TRMM experience, it appears that modelers will need to refine the diurnal precipitation process capabilities of their models to be sure they are reliably simulating atmospheric circulations that emanate from the diurnal effects of precipitation, particularly the effects of latent heating arising from precipitation production.

To enhance the scientific exchange between observational analysts and modelers, a well-received 2-day special symposium concerning the diurnal variability of precipitation during 24–28 April 2006 at the 27th American Meteorological Society Conference on Hurricanes and Tropical Meteorology in Monterey, California, focused on the multimechanism–multispatiotemporal characteristics of diurnal precipitation variability. The major objectives of this scientific forum were 1) to obtain reports on the most recent results from observational and modeling investigations concerning the diurnal variability of precipitation and/or related phenomena, 2) to obtain reports on the multimechanism properties of the diurnal cycle to better understand its multispatiotemporal organization, 3) to establish communications between modelers and observational analysts so that future modeling studies could be better designed to further advance our understanding of the nature of diurnal precipitation variability, and 4) to encourage new collaborations between scientists from different fields of earth science to improve the depth and quality of future studies concerning the atmosphere's diurnal cycle of precipitation and related diurnal cycles of other key variables.

This special issue was initiated during the special symposium to communicate some of the most recent results concerning the diurnal variability of cloudiness and precipitation. A total of 11 articles appear in this special issue, in which 6 papers entail observational analyses based on satellite or ground rainfall measurements, 4 involve GCM modeling studies, and 1 focuses on the diurnal cycle of cloudiness based on satellite observations. Results from these studies demonstrate the complex nature of the diurnal variability of cloudiness and precipitation at different spatial and temporal scales. We expect this special issue to stimulate further interactions between modelers and the observational analysts concerning diurnal cycle–related scientific investigations, for which the return could lead to improvements in GCM designs and an overall better understanding of the mechanisms controlling rainfall's diurnal variability. The ultimate goals of this special issue are to help bring about improvements in quantitative precipitation forecasting (QPF), in understanding the role of diurnal precipitation variability in the earth's water and energy cycles, and in predicting future states of weather and climate.

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