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Preface

Climate is largely a story of how heat is transported from the tropics to the pole. The task of transporting heat from the tropics to the pole is accomplished by circulations in the atmosphere and currents in the ocean. The motions in the atmosphere and the currents in the ocean are not independent of, but strongly coupled to each other as the atmosphere and ocean exchanges heat, water, momentum, and biochemical species. The processes that enable the state of the atmosphere and the state of the ocean to mutually influence each other are referred to as ocean-atmosphere coupling. Ocean-atmosphere coupling is a major cause of climate variability, such as the El Nino Southern Oscillation (ENSO) (Philander, 1990).

Great strides have been made in understanding ocean-atmosphere coupling since Bjerknes's pioneering work in this area in the early decades of the last century (Neelin et al., 1998). Still, our understanding of ocean-atmosphere coupling is far from being adequate for understanding climate, as indicated by the inability of coupled climate models in simulating many climatic phenomena that are linked to ocean-atmosphere coupling. For example, models tend to have an excessive equatorial cold-tongue (Sun et al., 2006). Related to that, ENSO in the models is too equatorially confined and occurs too frequently (Deser et al., 2006). The models also continue to have difficulties in simulating correctly the equatorial annual cycle (de Szoeke and Xie, 2008).

To promote research in the area of ocean-atmosphere coupling, a special session under “Ocean-Atmosphere Coupling” was organized in IUGG XXIV, Perugia, Italy, July 2–13, 2007. This special edition is devoted to cover the presentations given in this session. It also includes a few articles solicited from active researchers in this area who were not able to come to the meeting because of schedule conflicts.

The research presented in these articles covers ocean-atmosphere coupling on different spatial and temporal scales. The detailed understanding of these multi-scale interactions is crucial to understand and correctly model climate variability. In fact, many of the still existing systematic biases in state-of-the-art climate models can be attributed to shortcomings in the representation of multi-scale interactions between the ocean and the atmosphere. As ENSO is one of the most important large scale coupled phenomena of the climate system, several contributors to the special issue study the physics, dynamics and predictability of ENSO and its impact on related tropical phenomena such as oceanic equatorial waves and tropical instability waves, as well as on the Asian monsoon systems (An and Choi, 2009; Duan et al., 2009; Mahajan et al., 2009; Shinoda et al., 2009; Zhao et al., 2009). Mahajan et al. (2009) also look into the role of surface-evaporation feedback in enhancing the equatorial annual cycle. On smaller space and faster time scales, four studies examine observed local air-sea interaction in marginal and inland seas (Pospelov et al., 2009; Repina et al., 2009; Subrahamanyam et al., 2009; Zeng et al., 2009), and one study investigate processes controlling the ocean circulations along California and Baja California coasts by employing an ocean GCM and outputs from an Atmospheric mesoscale model (Paklar, 2009). Two other contributions deal with the impact of rapidly varying atmospheric variability on air-sea fluxes and related large scale sea surface temperature variability (Kug et al., 2009; Sura and Sardeshmukh, 2009).

Two trends appear to come out this collection of articles. First, the study of ocean-atmosphere interaction on more regional scales. As new high-quality regional datasets become available researchers can focus on local conditions, potentially improving the bulk parameterizations of air-sea momentum, heat, and moisture fluxes. Better flux parameterizations will in turn very likely improve the ability of coupled models to simulate present and future climates.That brings us to the second point. We are beginning to understand multi-scale interactions better. For example, it becomes obvious that the state-dependent character of atmospheric weather variability, modeled as state-dependent noise, has a significant impact on sea surface temperature variability (Sura et al., 2006; Sura and Sardeshmukh, 2009). In a similar vein, ENSO may have significant time-mean effects on its background state. For example, Sun and Zhang (2006) and Sun (2007) shows that collectively, ENSO events may act as a basin-scale heat mixer that regulate the stability the coupled tropical ocean-atmosphere system on the decadal and longer time-scales.

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