Diurnal cycles of precipitation and lightning in the tropics observed by TRMM3G68, GSMaP, LIS, and WWLLN

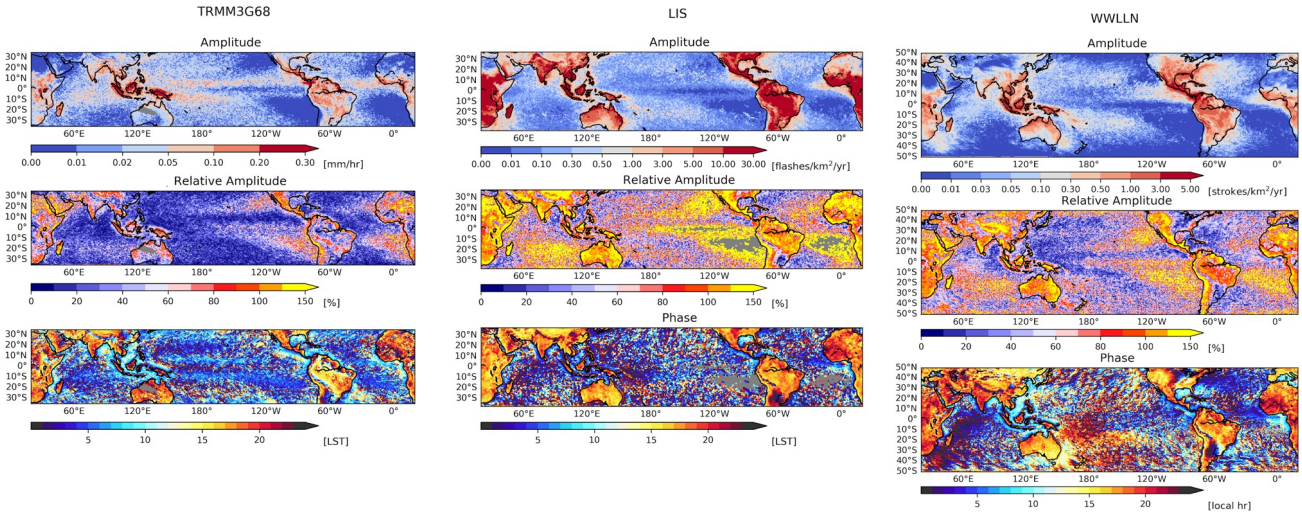
*Shoshiro Minobe[1], Jun Hyock Park[1], Katrina S. Virts[2]

1. Graduate School of Science, Hokkaido University, 2. The University of Alabama in Huntsville

The diurnal cycle is a major atmospheric variation in conditions including temperature, wind, precipitation, and lightning. Diurnal precipitation and lightning are closely related because they are both associated with convection, and thus previous studies compared diurnal cycles of these two variables. However, previous diurnal cycle comparisons between precipitation and lightning are conducted as regional studies, and no global comparisons were made. Moreover, previous comparisons used precipitation data derived mainly from infra-red satellite observations, although it is known that IR-based precipitation observations have biases of about three-hour delay. Therefore, the purpose of the present study is to understand the difference and similarity of diurnal cycles of precipitation and lightning over the global tropics.

Diurnal cycles of precipitation and lightning are investigated by analyzing rain rate of TRMM3G68 dataset, consisting of precipitation radar and microwave imager data only, rain rates of Global Satellite Mapping of Precipitation (GSMaP), for which IR data are also used, lightning flash rates observed by TRMM Lightning Imaging Sensor (LIS), and lightning stroke rates of World Wide Lightning Location Network (WWLLN) over the tropics. Diurnal amplitudes relative to averages are generally larger for lightning than for precipitation. Over ocean, relative amplitudes are stronger in the stratocumulus deck region in the southeast Pacific than those over typical ocean regions. The phase of GSMaP is substantially delayed to TRMM3G68 due to the phase-delay problem of IR based estimation. The diurnal peaks tend to occur between 14:00 and 18:00 LST over the continent after spatial averaging with a phase leading order of TRMM3G68, LIS, and WWLLN, and between 0:00 and 7:00 LST over oceanic regions where diurnal cycles are prominent in all datasets. Off-equatorward phase propagations are found in the precipitation in the Pacific and Indian oceans. Over selected coastal regions, all data exhibit consistent oceanward phase propagation with the longest, medium, and shortest phase propagation distances for TRMM3G68 precipitation, WWLLN lightning, and LIS lightning, respectively, with a phase leading order of LIS, WWLLN, and TRMM3G68. The summertime diurnal cycle over the Gulf Stream also exhibits oceanward phase propagation, but with strong amplitude enhancement over the Gulf Stream. Diurnal cycle amplitude is also enhanced over the Kuroshio in the East China Sea in the Baiu-Meiyu rainy season.

Keywords: stratocumulus cloud deck, phase propagation



Amplitude (top), relative amplitude (middle), which is the amplitude divided by average, and phase (bottom) of diurnal cycle of annual climatology for rain rate of TRMM3G68 (left), lightning flash rate observed LIS (middle) and lightning stroke rate observed by WWLLN.

