GRIP-LIP Contributions to the Ongoing Study of the Sources and Currents in the Global Electric Circuit

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Diurnal variations of the fair weather electric field as a function of UTC were characterized by measurements from the Carnegie and Maud research ships. The source of these variations in the global electric circuit was theorized to be from the diurnal variations in thunderstorms and other electrified clouds. Much subsequent research on the global electric circuit has focused on linking the fair weather field variation – commonly called the Carnegie curve – to worldwide variations in electrified weather by using the proxy of lightning rates. For example, some found worldwide thunderstorm statistics produced a curve with similar phase, but incorrect amplitude variation to the Carnegie curve. Others obtained results with orbital lightning climatology data from the Optical Transient Detector (OTD) and Lightning Imaging Sensor (LIS) similar to the earlier thunderstorm statistics in that they agree with the Carnegie curve in phase, but not in amplitude.

One important objective of our high altitude aircraft observations of electrified clouds, which were initiated in the late 1980’s, was to measure the electric current output of these storms as a function of electric field and lightning. We have recently shown that a combination of the airborne data and the orbital based lightning climatology can correct the lightning based estimate of the global electric circuit diurnal variation. We have already published ground breaking results using our 650 aircraft storm overflight data sets prior to GRIP. We found that land storms had greater lightning rates than ocean storms but smaller mean conduction (Wilkison) currents. We also found that electrified, non-lightning producing storms – henceforth, referred to as electrified shower clouds (ESCs) – make a measurable contribution to the global electric circuit, particularly for ocean storms.

Although there were only 5 sorties with the Global Hawk aircraft in GRIP, the nominally 24 hour missions provided many more opportunities for storm overflights. The GRIP flights contributed an additional 213 storm overflights to our database, raising the total to 1063 (a 25% increase over the non-GRIP data). Although the GRIP data have not materially changed the mean measured currents (land/ocean/lightning/non-lightning), the extra data refined the statistics, supported our earlier assumptions, and allowed us to expand the analysis to seasonal data. A recently submitted manuscript on the seasonal variations in the global electric circuit indicates how data from a program such as GRIP (using an aircraft with a very long flight duration) can make a significant difference in the data analysis.

Diurnal Variations Associated With The Global Electric Circuit

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Conclusions. The impact of the electrification data from GRIP-LIP to our study illustrates how datasets collected with long flight duration aircraft, such as the Global Hawk, can make a significant contribution to the advancement of our understanding of atmospheric electricity. With these aircraft, much more time can be spent in the vicinity of storms. The long duration of the missions also mean that targets further away from the launch point can be studied for significant periods of time. Although our LIP system was not designed for 24 hour missions, we were able to adapt our data collection and data analysis software and hardware to accommodate the larger volume of useful data.