Improvements in the WWLLN network: Growing Detection Efficiencies for "Big Lightning" Events

C. J. Rodger[1], J. B. Brundell[2], R. H. Holzworth[3], E. H. Lay[3], and R. L. Dowden[4]

[1] Department of Physics, University of Otago, P.O. Box 56, Dunedin, New Zealand
[2] UltraMSK.com, Dunedin, New Zealand
[3] Dept. Earth and Space Sciences, University of Washington, USA
[4] Low Frequency Electromagnetic Research, Ltd, New Zealand.

Powerful lightning flashes with large return stroke peak currents induce energetic and electrical coupling between the troposphere and the upper atmosphere via the quasi-electrostatic and/or the radiated electromagnetic pulse (EMP). In particular, a single lightning EMP can affect a large area (~105 km^2) at ionospheric D-region altitudes, and the decay rate for the ionization produced at these altitudes can be less than the rate at which a large thunderstorm generates lightning EMP bursts. Several researchers have suggested that the lightning EMP which drives ELVES may be a significant source of variation in the upper atmosphere at regional and global scales. In addition, "big" lightning is more loosely associated with other Transient Luminous Events (TLEs). The relatively recent discovery of "Terrestrial Gamma-ray Flashes" (TGFs) has been followed by work linking them to lightning discharges, both from Stanford University observations of lightning-generated sferics, and direct space and time agreement with observations from the World Wide Lightning Location Network (WWLLN).

Planned space-based TLE observing like ASIM and TARANIS will benefit from rapid access to global lightning locations, uniquely available through the experimental lightning detection network, the World Wide Lightning Location Network (WWLLN). The WWLLN-stations measure the very low frequency (VLF; 3-30 kHz) radiation from lightning discharges. Propagation at these very long electromagnetic wavelengths (up to 100 km) allows lightning strokes to be located in real time at up to 10,000 km from the receivers with a location accuracy that is estimated to be ~10-20 km, and sometimes better than this. True global mapping of lightning from widely spaced (a few Mm) ground-based receivers requires the use of frequencies <30 kHz. Lightning impulses in this frequency range suffer low propagation attenuation, and hence propagation in the Earth-ionosphere waveguide is possible over global distances.

From early 2008 there have been some significant changes in the operational structure of WWLLN. In this talk I will update the community on the current network status. The WWLLN-management team has been working on new algorithms to improve the Detection Efficiency of the existing network. In my presentation I will show evidence of Detection Efficiencies of ~30% for return stroke peak current CGs >50 kA, a significant step forward from the ~10% detection efficiencies provided by the previous algorithm working on the same received data. more progress is possible. one the experimental algorithms provided 50-60% detection efficiencies for >50 kA CGs, but with some associated issues that have been judged unacceptable for current operational use.

Nonetheless, this shows the possibilities for potential WWLLN-detection efficiencies in the near future, before the addition of extra stations.