LIGHTNING SFERICS AND STROKE DELAYED PULSES MEASURED IN THE STRATOSPHERE: IMPLICATIONS FOR MESOSPHERIC CURRENTS

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During the Brazil Sprite Balloon Campaign 2002-03, the vector ELF to VLF (25 Hz - 8 kHz) electric and magnetic fields driven by cloud-to-ground (CG) lightning strokes at horizontal distances of 75-600 km were measured at altitudes of 30-35 km. Electric field changes were measured for each of the 2467 CG strokes detected by the Brazilian Integrated Lightning Network, and magnetic field changes above the background noise were measured for about 35 percent (858) of these strokes. ELF pulses that occur 4-12 ms after the retarded time of the lightning sferic, which have been previously attributed to sprites, were found for 1.4% of 934 strokes examined with a strong bias towards positive strokes (4.9% or 9/184) compared to negative strokes (0.5% or 4/750). These distant lightning events drove ELF to VLF electric and magnetic fields, with large vertical electric field and azimuthal magnetic field components, that are generally consistent with ground-based measurements [Cummer et al., GRL, 25, 1281, 1998] and models [Pasko et al., GRL, 25, 3493, 1998]. However, these results disagree with results from the Sprites99 Balloon Campaign [Bering et al., Adv. Space Res., 34, 1782, 2004], in which lightning-driven electric and magnetic field changes were rare and stroke delayed ELF pulses were frequent. Bering et al. 2004 concluded that mesospheric breakdown and currents are a fundamental response to nearly all lightning strokes. Thus, the Sprites99 data disagree with the quasi-electrostatic field (QSF) model that suggests that only very large charge moment lightning (greater than about 300-1000 C-km) are capable of producing mesospheric breakdown. Since the Brazil payloads rarely measured stroke delayed pulses, the Brazil data suggest that mesospheric breakdown and currents are not a fundamental response to most CG lightning strokes. This is consistent with previous ground-based measurements [Cummer et al., GRL, 25, 1281, 1998] and a fully electromagnetic model of lightning driven-fields [Pasko et al., GRL, 25, 3493, 1998]. Thus, the Brazil results are not inconsistent with the QSF model of mesospheric current production.

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