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Infrasound from lightning measured in Ivory Coast

T. Farges (1), C. Millet (1), R. S. Matoza (1,2)

(1) CEA, DAM, DIF, F-91297 Arpajon Cedex, FRANCE (thomas.farges@cea.fr), (2) Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, La Jolla, CA 92093-0225, USA

It is well established that more than 2,000 thunderstorms occur continuously around the world and that about 45 lightning flashes are produced per second over the globe. More than two thirds (42) of the infrasound stations of the International Monitoring System (IMS) of the CTBTO (Comprehensive nuclear Test Ban Treaty Organisation) are now certified and routinely measure signals due to natural activity (e.g., airflow over mountains, aurora, microbaroms, surf, volcanoes, severe weather including lightning flashes, …). Some of the IMS stations are located where worldwide lightning detection networks (e.g. WWLLN) have a weak detection capability but lightning activity is high (e.g. Africa, South America). These infrasound stations are well localised to study lightning flash activity and its disparity, which is a good proxy for global warming.
Progress in infrasound array data processing over the past ten years makes such lightning studies possible. For example, Farges and Blanc (2010) show clearly that it is possible to measure lightning infrasound from thunderstorms within a range of distances from the infrasound station. Infrasound from lightning can be detected when the thunderstorm is within about 75 km from the station. The motion of the squall zone is very well measured inside this zone. Up to 25% of lightning flashes can be detected with this technique, giving better results locally than worldwide lightning detection networks.
An IMS infrasound station has been installed in Ivory Coast for 9 years. The lightning rate of this region is 10-20 flashes/km^2/year from space-based instrument OTD (Christian et al., 2003). Ivory Coast is therefore a good place to study infrasound data associated with lightning activity and its temporal variation. First statistical results will be presented in this paper based on 4 years of data (2005-2009). For short lightning distances (less than 20 km), up to 60 % of lightning detected by WWLLN has been one-to-one correlated. Moreover, numerous infrasound events which have the infrasound from lightning signature could not be correlated when thunderstorms were close to the station. Statistical analyses of all correlated infrasound events show an exponential decrease of the infrasound amplitude with the distance of one order of magnitude per 50 km. These analyses show also that the relative position of lightning is important: the detection limit is higher when lightning occur at the East of the station than when they occur at the West. The dominant wind (the Easterlies) could be responsible of this dissymmetry. It also exists a high variability of detection efficiency with the seasons (better efficiency in fall than in spring). Finally, these statistics show clearly a structure inside the shadow zone (from 70 to 200 km away from the station).
These results will be compared with intensive numerical simulations. The simulations are separated into two parts: the simulation of the near-field blast wave generated by a lightning and the simulation of the non-linear propagation of the shock front through a realistic atmosphere. By comparing our numerical results to recorded data over a full 1-year period, we aim to show that dominant features of statistics at the IMS station may be explained by the meteorological variability.