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Acoustic and infrasonic measurements of thunder during the HyMeX SOP1 campaign in 2012 and comparison with new modeling results

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Thunder is composed of complex acoustic waves with a rich infrasonic and audible frequency spectrum. This complexity depends both on the source and the propagation of the wave to the observer. However there is no mutual agreement on the link between the observed spectral content and the generation mechanisms.

The objective of this study is to provide new experimental results and their comparison to theoretical investigations. An acoustic station was deployed in Fall 2012 during the first Special Operation Period of the HyMeX project in South of France. This station was composed of 4 microphones arranged in a triangle of 50-m side with one of them at the center and 4 microbarometers arranged in a triangle of 500-m side with one of them co-localized with the central microphone (*Defer et al., 2015*). During more than 2 months, about ten thunderstorms occurred over the station producing many cloud-to-ground and intracloud flashes. Several thousands of acoustic signals and electromagnetic detections from research and operational lightning location networks were recorded. Our database contains a sufficient number of flashes close to the source ($< 1km$) to minimize propagation effects and to focus on the source effects.

The 3D reconstruction of the acoustical sources using the acoustic signals (from 1 to 40 Hz) shows that these signals are mainly localized inside the lightning channel joining the cloud to the ground and produced during the return stroke phase of the flashes (*Gallin et al., 2016*). These observations are compatible with a source mechanism due to the thermal expansion associated to the sudden heating of the air in the lightning channel. An original model inspired by Few's string pearl theory (*Few, 1969*) has been developed. It shows that the tortuous channel geometry explains at least partly the low frequency content of observed thunder spectrum.