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Complex propagation of explosion-generated infrasound revealed by the large-scale AlpArray seismic network

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On September 1st, 2018 a devastating explosion occurred on the facility of an oil refinery near Inoglstadt, Germany. We analyzed data of 400 permanent and temporary seismic stations within 400 km radius from the explosion site and find strong seismo-acoustic signals on more than 80 seismic stations. Thanks to the dense spatial coverage of the AlpArray seismic network, the infrasound signal generated by the explosion is detectable on seismic stations within 10 - 400 km from the source, with 40 km spatial resolution. We confirm the explosion site both by the seismic and seismo-acoustic arrivals. Apart from seismic P- and S-waves, we identified three separate acoustic phases with celerities of 332, 292, and 250 m/s, respectively, each of which has a particular spatial pattern of positive detections at the ground. Seismo-acoustic amplitudes are strongly affected by the type of seismic installation. Still, the uniform spatial coverage allows insight into regional infrasound attenuation. Our observations likely represent tropospheric, stratospheric, and thermospheric phases. We performed 3D acoustic raytracing of the infrasound propagation to validate our findings. Tropospheric and thermospheric arrivals are to some extent reproduced by the atmospheric model. However, raytracing does not predict the observed acoustic stratospheric ducts. Our findings suggest that small-scale variations had considerable impact on the propagation of infrasound generated by the explosion. Our observations underline the importance of dense infrasound observations on regional scale and indicate the capability of large-scale seismic networks for improving knowledge about the atmosphere on regional scale.