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Finite frequency P-wave traveltime measurements on ocean bottom seismometers and hydrophones in the western Indian Ocean

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From 2011 to 2014, the RHUM-RUM project (Reunion Hotspot Upper Mantle – Reunions Unterer Mantel) instrumented a 2000x2000km2 area of Indian Ocean seafloor, islands and Madagascar with broadband seismometers and hydrophones. The central component was a 13-month deployment of 57 German and French Ocean Bottom Seismometers (OBS) in 2300-5600 m depth. This was supplemented by 2-3 year deployments of 37 island stations on Reunion, Mauritius, Rodrigues, the southern Seychelles, the Iles Eparses and southern Madagascar. Two partner projects contributed another 30+ stations on Madagascar.

Our ultimate objective is multifrequency waveform tomography of the entire mantle column beneath the Reunion hotspot. Ideally we would use all passbands that efficiently transmit body waves but this meets practical limits in the noise characteristics of ocean-bottom recordings in particular.

Here we present the preliminary data set of frequency-dependent P-wave traveltime measurements on seismometers and hydrophones, obtained by cross-correlation of observed with predicted waveforms. The latter are synthesized from fully numerical Green's functions and carefully estimated, broadband source time functions.

More than 200 teleseismic events during the 13-month long deployment yielded usable P-waveform measurements. We present our methods and discuss data yield and quality of ocean-bottom versus land seismometers, and of OBS versus broadband hydrophones. Above and below the microseismic noise band, data yields are higher than within it, especially for OBS. The 48 German OBS, equipped with Guralp 60 s sensors, were afflicted by relatively high self-noise compared to the 9 French instruments equipped with Nanometrics Trillium 240 s sensors. The HighTechInc (model HTI-01 and HTI-04-PCA/ULF) hydrophones (100 s corner period) functioned particularly reliably but their waveforms are relatively more challenging to model due to reverberations in the water column. We obtain $\sim$15000 combined cross-correlations measurements that should be usable in multifrequency P-wave tomography, in passbands between 30 s and 2.7 s dominant period.