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Joint inversion of fundamental mode and first overtone for deep imaging at the Valhall oil field using ambient noise

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Higher mode surface waves derived from ambient noise data are rarely observed, but they are very useful because they contain information on deep structure. We use 6.5 hours of ambient noise recorded by 2320 receivers from the Valhall Life of the Field Seismic and compute cross-correlogram stacks for every possible receiver pairs. We observe that on the radial component empirical Green functions, the first overtone is stronger than the fundamental mode. Forward modelling shows that a few hundred meters of sediments along with water layer plays an important role for generating strong first overtone on the radial component. We perform F-K filter to separate the fundamental mode and first overtone. Phase velocity maps are obtained using Eikonal tomography method. Phase velocity maps are then inverted using the neighbourhood algorithm to obtain the 3D distribution of isotropic S-wave velocity model down to 1 km depth. When we invert only the fundamental mode phase velocity, the S-wave velocity model have resolution down to 600 m. Combining the fundamental mode and first overtone enables to image deeper structure down to 1 km.