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Operational vibroseis system for long-distance traverses

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This poster presents results and performance of an operational vibroseis system used in Antarctica on the Ekströmisen and its catchment area. The about 500 km long overland traverse covered very different surface regimes in the elevation range from sea level up to 1000 m in the austral season 2013/14. The presentation is the successful culmination of a six-year effort to develop an operational vibroseis system for Antarctica and Greenland.

Over three weeks the campaign acquired:
• 407 km of seismic profiles in total, thereof
• 110 km in 6-fold resolution with 125 m shot spacing
• 25 km in 3-fold resolution with 250 m shot spacing.
The remaining distance was covered in single-fold with 750 m shot spacing.

The traverse used a well-established 60 channel 1.5 km streamer and a new setup with a vibroseis Buggy "EnviroVibe" with Mattracks on a polyethylen sled. The sled had a hole in the center to lower the vibrator pad directly onto the snow surface. With this setup data production varied between 20 km/day for 6-fold and 40 km/day for single fold for a decent 9h day of measurements. The combination of Mattracks with the PE-sled was especially advantageous on hard and rough surfaces because of the flexibility of each and the relatively lose mounting by cargo straps and wooden blocks. Production speeds were limited by the snow streamer, which had an increasing damage rate of geophone groups for velocities above 6 km/h. The source system itself could easily accommodate transfer velocities of 15 km/h. In combination with the streamer winch mounted in front of the source on a separate freight sled the channel spacing could be reduced to fractions of the 25 m spacing interval by combining several sweeps at the same location, thus increasing spatial resolution.

The vibrator source was operated with a 10-250 Hz sweep over 10 s with 80% of the peak force of 66 kN. On soft surfaces a setup-sweep was utilized. Preliminary data analysis shows that sea floor geomorphology, subglacial sedimentary layering and englacial layering can be clearly imaged in the respective resolution of the source's bandwidth. Interestingly, the ration of p-wave to s-wave energy varied considerably depending on the surface characteristics. In comparison to airborne and ground-based radar surveys, the system was able to image very steep sidewalls of subglacial trenches because of the large offset aperture where radar systems did not provide any reflections. Such system will help to considerably improve the future characterisation of sublglacial and englacial environments.