Cooperating for optimizing seismic acquisition: a case study in the Horda Tampen area

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SUMMARY

Limiting the amount of time share to seismic interference as well as ensuring good data quality is a key factor for a successfulseismic survey. Experience from previous seasons has shown that vessel to vessel coordination between different contractorscan be challenging. In 2015, due to the time constraints, all acquisitions over the Horda Tampen area had to occur at the same time. A third party contractor was given the responsibility of coordinating the acquisition plans of the acquisitions ongoing on the Visund field as well as on the Horda and MøreTampen multiclient surveys. Having an unbiased third party taking care of the coordination across the area made it easier to cooperate. It significantly improved the acquisition efficiency and ensured that the allowed seismic interference could be attenuated during processing.

Introduction

Seismic Interference (SI) is a common problem that occurs when two or more seismic vessels shoot simultaneously close to each other. This is a common problem in congested areas. A traditional and well-known mitigation measure is timeshare, where the different parties agree to distribute the time slots to shoot the survey. This is both costly (as one vessel is on standby while the other is acquiring) and inefficient (as the total acquisition time is increased). Minimizing the timeshare is a key element to the success of an acquisition season, especially in areas such as the Norwegian Continental Shelf, with both a limited weather window and acquisition window due to the fisheries. Dhelie et al. (2013), Laurain et al (2013) and Elboth et al. (2014) showed that controlling the moveout of the SI and the randomness of its arrival time on the seismic records are key parameters to remove SI without significantly degrading the data.
The North Sea Tampen area in 2015 provided the opportunity to bring different participants of the seismic business together and to let one single point of contact perform the optimization of the shooting patterns, regardless of the nature of the seismic acquisition (Towed seismic or OBC; proprietary or multiclient). This strategy allowed all the participants to successfully acquire the entire programs in time and with good quality seismic, from which the SI could be successfully removed.

Method

Laurain et al. (2014) presented a method based on the analysis of the acquired sequence in the slowness domain (p-domain). After the acquisition of an SI contaminated sequence, a simple processing flow is applied and QC products are made available to the geophysicists to QC. Based on experience and testing of the SI removal algorithms, a series of thresholds in the p-domain have been established. More details related to the criteria used for SI acceptance can be found in Laurain et al (2013). The method has been applied with success on two acquisition seasons in the North Sea.
The criteria in slowness have been mapped into the space domain allowing for a quick analysis. The threshold values in slowness can be expressed in terms of angles from the sailing direction, resulting in a cone around the acquiring vessel. The area in which the SI is a problem is then converted into a cone centred on the emitting vessel and oriented perpendicular to the sailing direction (Figure 1). The lateral extension of the cones is based on the assumption that the SI is not a problem anymore if its emission point is 80km or more away. This can be updated depending on the bathymetry and the sea bottom quality.
In addition, Elboth et al (2015) showed that even small differences in the shot-point interval (speed) of interfering vessels significantly increase the randomness in the SI arrival time. Shot-to-shot randomness/incoherency of SI is a significant advantage for most SI attenuation algorithms (Lynn et al., 1987).

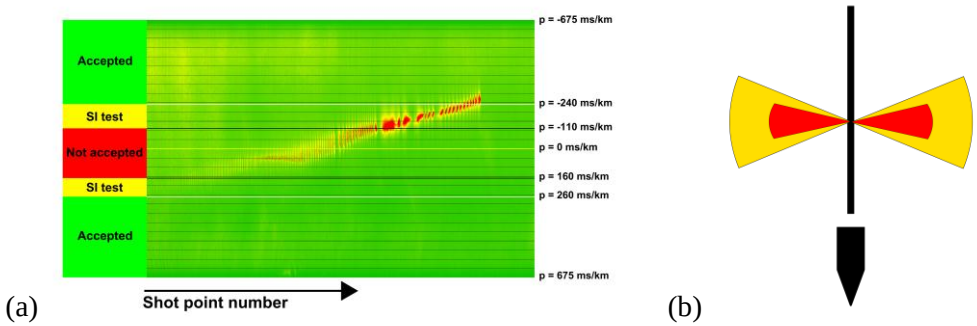

Figure 1 *(a) example of p-display and intervals used for evaluation. Shot averaged Tau-P transform with SI noise tolerance specifications. Horizontal axis is shot point along the line and vertical axis is slowness in ms/km. (b) corresponding cone display.*

Seismic acquisition in the Tampen area in 2015

The acquisition season in the Tampen area in 2015 was very busy with three proprietary acquisitions from Statoil over Snorre, Visund, and Oseberg (Figure 2). In addition, two multiclient surveys were acquired by CGG (with two vessels) and Dolphin Geophysical (with one vessel). Due to the acquisition time constraints, all acquisitions had to occur at the same time.

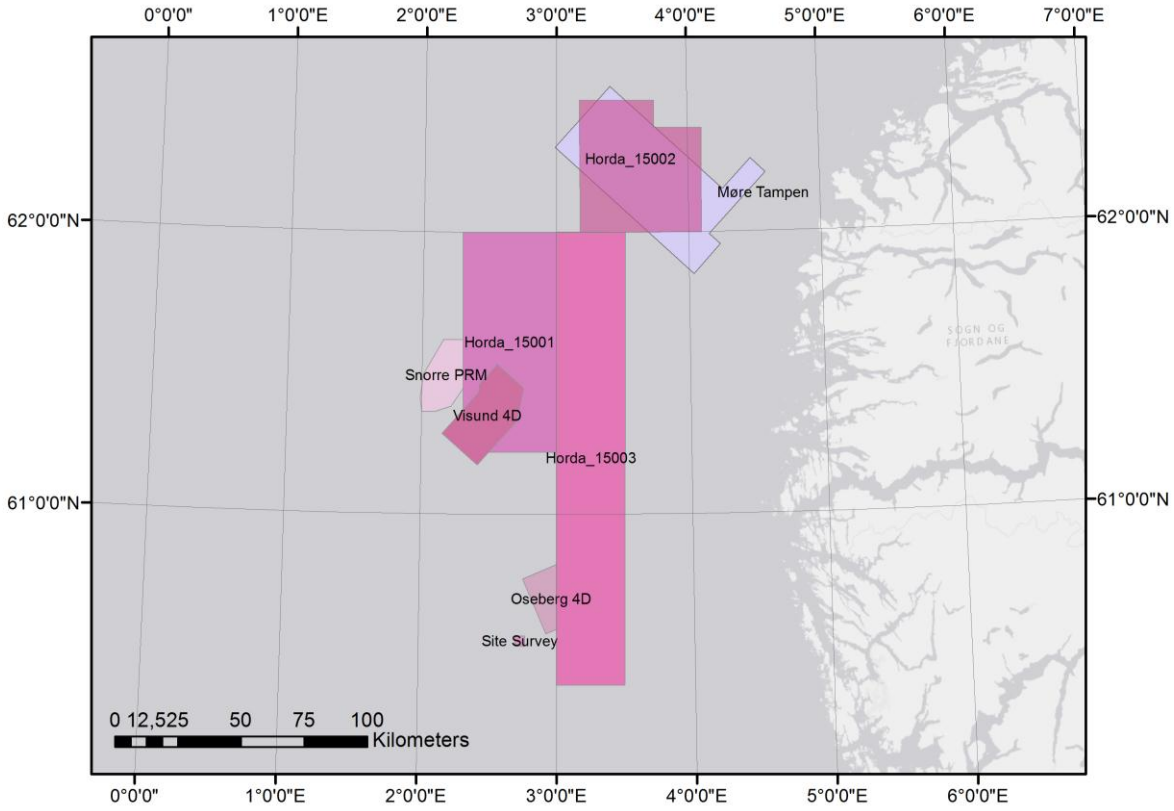

Figure 2 *map of the seismic acquisitions over the Tampen area during the period 06/04-2015 to 20/10-2015.*

Operational areas such as Snorre PRM and Visund 4D were overlapping with the neighbouring streamer multiclient survey (CGG Horda and Dolphin Geophysical Møre-Tampen). All vessels involved with towed seismic vessels had similar recording equipment and source volumes.

Due to spawning restrictions it was impossible to start acquisition in the Tampen area before early April. Mackerel fishing was expected from the middle of August to the middle of October. In order to perform the required acquisitions in the area, all participants had to cooperate and find an efficient way to coexist.

Cooperation for reducing timeshare and ensure optimum data quality

In this context, the different participants involved in acquiring data over the Tampen area decided to appoint one single point of contact for estimating the optimum shooting patterns for all the ongoing acquisitions. This is common practice for 4D acquisitions in the North Sea but dealing with one survey at a time. In this case, the coordination was performed for the whole Tampen area. Prior experience has shown that vessel to vessel coordination between different contractors can be challenging. Having an unbiased third party taking care of the coordination across the area made it

easier to cooperate. The overall aim was to either avoid seismic interference completely or make the angle of the interference on the shot gather such that it is easy to remove during processing. The shooting patterns have been optimized in order to minimize the time sharing required and ensure good data quality.

Beforehand, the acquisition contractors provided the shooting plans and the range of vessel speeds the different vessels could achieve. Based on real-time positioning of the acquisition vessels and the shooting plans, interference cones were simulated. In cases of conflict, the vessel speeds were updated and the simulation re-run. Once a good compromise was reached, the third party distributed the updated acquisition plans to the acquisition contractors. The speed of the involved vessels was actively adjusted in order to first prevent the vessels from entering any noise cone but also to ensure sufficient time difference in the SI arrival on the shot gathers.

In cases of problematic SI, the difference in vessel speed was increased by slowing down one vessel and speed up the other(s). This contributed to break the shot-to-shot coherence of the SI, which makes it easier to attenuate the noise in processing. Figure 3 illustrates a case involving Visund and Horda multiclient. The vessel tracks were optimized to avoid the SI cones to overlap with the neighbouring vessels at all times.

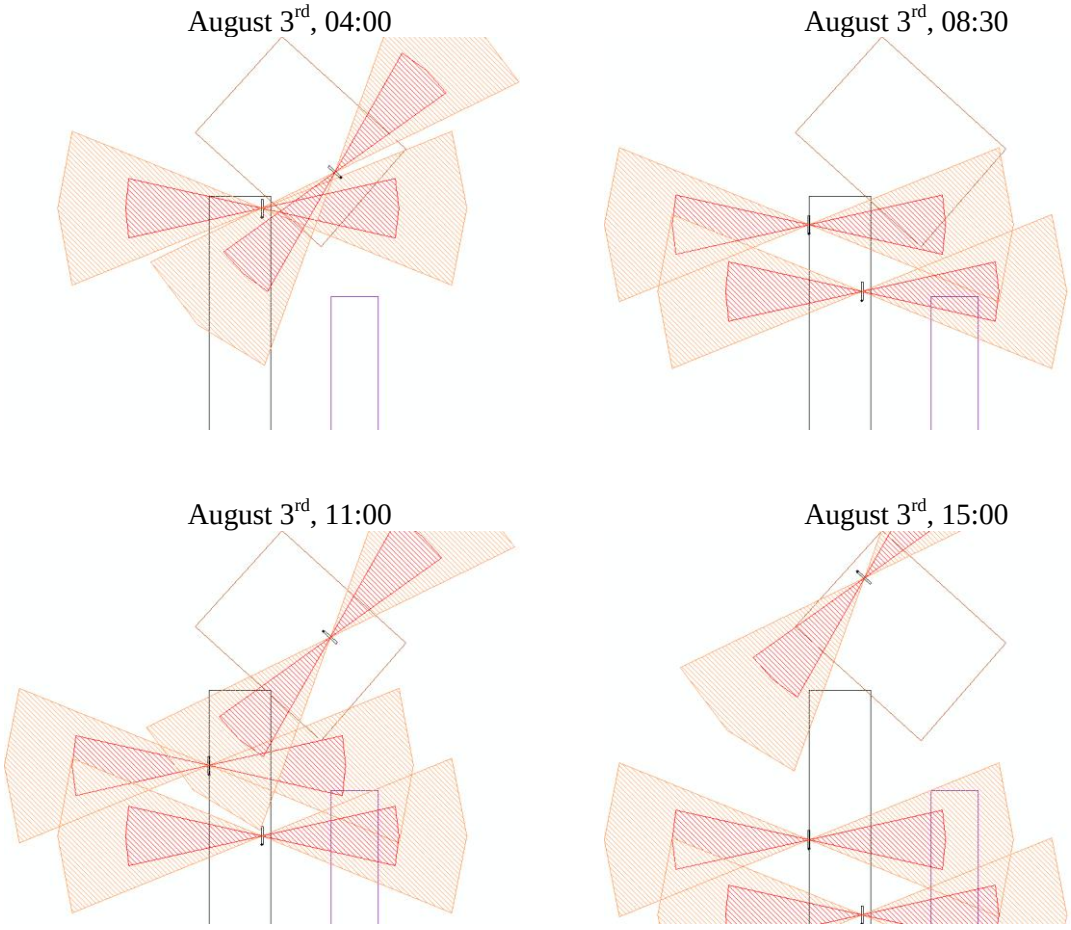

Figure 3 *map of the seismic interference cones over the Visund and Horda_15001 survey areas taken at three different times.*

Conclusions

Based on the arrival dip and by avoiding shot-to-shot coherent SI, a significant improvement in the acquisition efficiency has been achieved in the Tampen area during the 2015 acquisition season. This achievement is possible because all the participants agreed to rely on one single point of contact for performing the navigation planning. The seismic data was acquired either without SI or with SI that could be easily attenuated during processing. The total amount of time lost due to SI was less than 5%; mainly in the form of some extended line-changes, and having reduced vessel speed on some lines. Historically, the amount of lost time from SI in the North Sea summer season has been around 15-20%.

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