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DISSERTATION TITLE:	*Modelling and removal of time-varying sea-surface and overburden effects in multi-component data*

Hvordan takle dårlig vær ved olje- og gassfunn til havs

Et stadig økende antall olje- og gassundersøkelser gjennomføres under dårlige værforhold med sterk vind og store bølger (> 2,5 m). Hovedforutsetningen som gjøres når data fra et mulig marint oljefelt behandles er imidlertid å anta at havoverflaten er flat. Vi har utviklet et modelleringsverktøy som tar i betraktning de rådende meteorologiske forholdene og effektene disse har på det registrerte bildet av undergrunnen. Vi viser at ved å ignorere værforholdene får man en feil på inntil 8% i det oppnådde geologiske bildet, og dermed kompromitterer suksessen ved olje- og gassleting til havs.

In the oil and gas industry, drilling an unprofitable well onshore is only top up as a financial catastrophe by drilling an unprofitable well in several meters of water. Fortunately for the offshore industry, marine seismic surveys permit to save millions of dollars by giving precise information on the subsurface and the presence of oil and gas reservoir.
The success of these surveys is hidden beneath the sea surface. Hence, to obtain a geological image of the subsurface, mechanically generated sound waves (or seismic waves) are sent into the earth, reflect on the different geological layers and are finally recorded near the surface by measuring devices called receivers, in the same way doctors x-ray a human body to "see" what is inside. Once the information has been recorded, seismic data processing transforms the signal into an image of the subsurface.
If the presence of the sea is of great use when it comes to record data on thousands of kilometers square, it is less simple when it comes to processing the data. Indeed, the sea surface acts as a very good reflector for the sounds waves. This interaction with the sea surface creates unwanted information in the data (very similar to an echo in a phone call) that needs to be remove to obtain a clean image of the subsurface. To remove the sea-surface effects, it is so far consider that a flat-sea-surface model is sufficient. However, more than 20% of all marine seismic surveys are acquired with sea-surface wave heights above 2.5 m, and this number is increasing thanks to improvement in the seismic equipment now able to sustain greater waves. So what about considering realistic weather conditions when processing the seismic data?
This thesis develops a method to model the interaction with realistic sea surface model, and assess the obtained effects on the seismic data and on their processing. In particular, it is shown that under rough weather (wind above 50 km/h and wave height > 2.5 m), the flat sea surface assumption is no longer adequate, and we witness an error up to 8% when

removing the sea-surface effects from the data. Such an error, could lead to a wrong interpretation of the subsurface image and an empty drilled well. However, by taking into account a realistic sea-surface model (with waves and wind), an image of the subsurface is obtained without making any error on the sea-surface effects. This study will thus help to extend the usable ship time in adverse weather conditions without loss of data quality.