Gabor multipliers revisited

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Abstract

Time-frequency methods have proven to be valuable in seismic data processing. Gabor deconvolution by way of Gabor multipliers is an effective way of extending Weiner decon and spectral whitening to the nonstationary seismic domain. We propose the continuous wavelet transform as an improvement over Gabor, using the logarithmically-spaced frequency bins to improve resolution and control in lower frequency ranges.

Introduction: Time - Frequency transforms

Gabor and wavelet transforms analyse signals in a time-frequency representation, similar to a localized Fourier transform. Wavelet transforms use a variable-sized localizing window to improve resolution across decades of frequency.

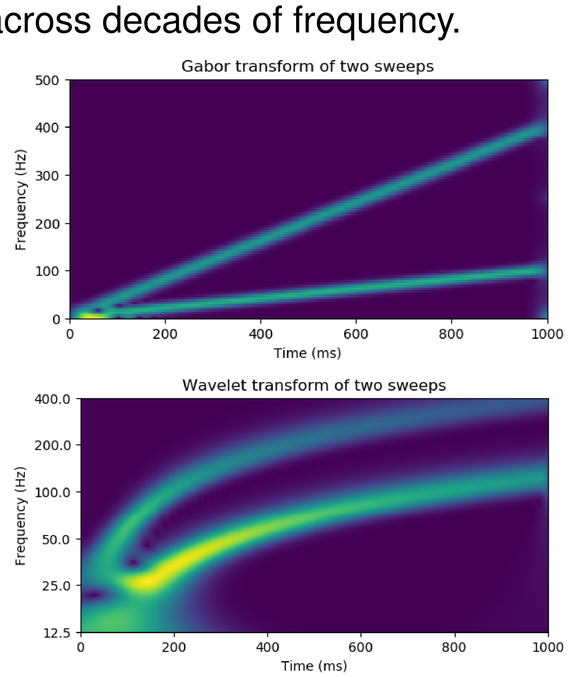


Figure: Comparison of Gabor, Wavelet transforms. Note resolution at low frequencies.

T-F methods implement Kjartansson's (1979) model for constant Q attenuation and minimum-phase via a ΨDO with symbol

$$\alpha(t,f) = \exp\left[\frac{-\pi t}{Q(t)}(|f| + iH(|f|))\right],$$

where H is the Hilbert transform.

Method

Once in the Gabor or wavelet domain, deconvolution is implemented by modifying the transformed signal $S_{trans}(t,f)$ using a multiplier of the form

$$m(t,f) = \frac{1}{\alpha(t,f)}.$$

We test this approach by applying the multiplier to a sequence Q-decayed spikes. Result is a series of sharpened spikes, shown here:

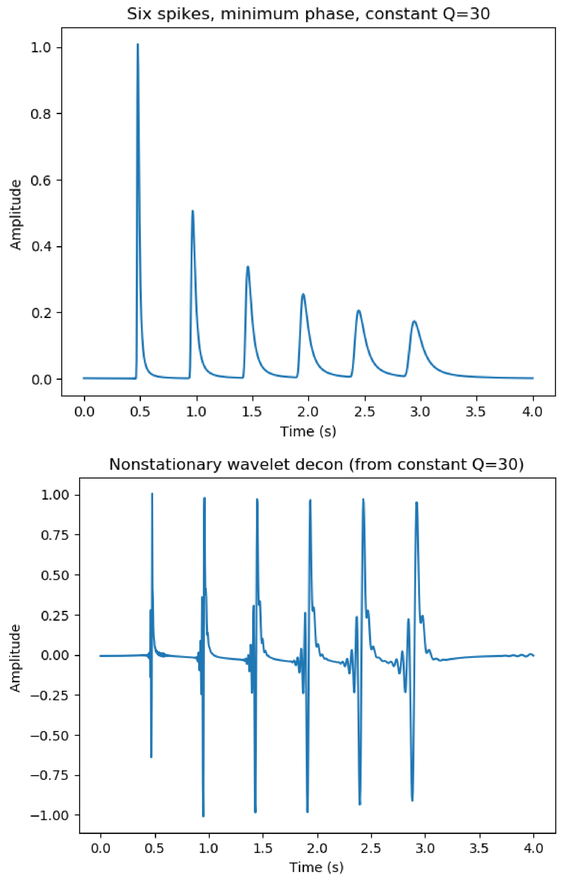
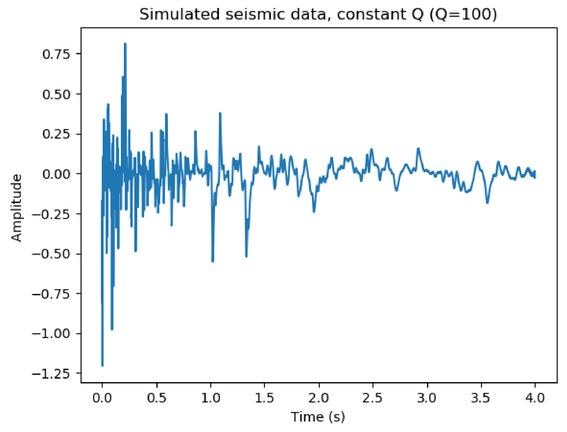


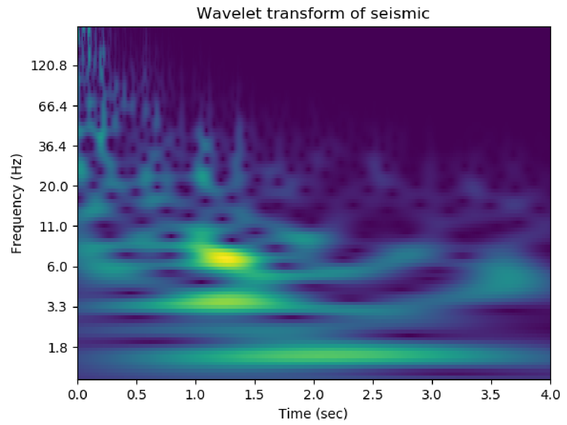
Figure: Six spikes in a constant Q medium and result of nonstationary wavelet decon.

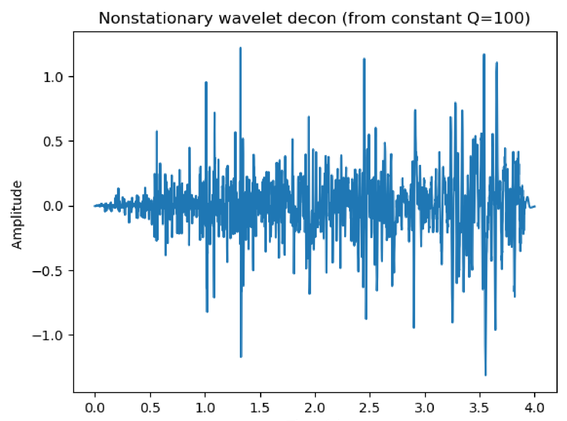
Application and results

We use the pseudodifferentional operator of Kjartasson's model to generate synthetic seismic data with Q-attenuation, apply the continuous wavelet transform, then implement the multiplier as the deconvolution method. The three images in the next section show the results.

Results - in images







Conclusions

- Wavelet multiplier for decon shows promise.
- Much work to be done.

References

- Kjartansson E (1979), *Constant Q-Wave Propagation and Attenuation,* Geoph. Res.
- Margrave G, Lamoureux M, Henley D (2011), *Gabor deconvolution,* Geophysics 76.

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