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Attenuation surface noise with autoencoders

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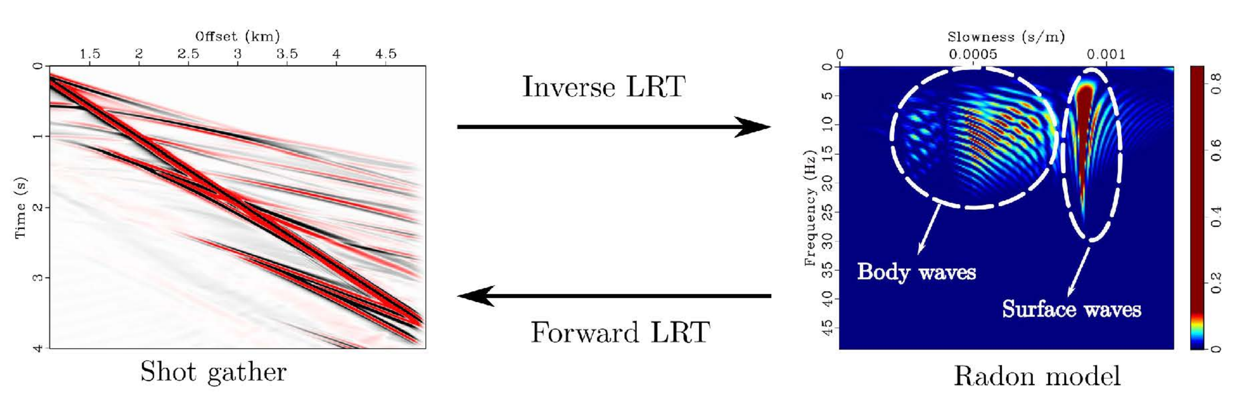
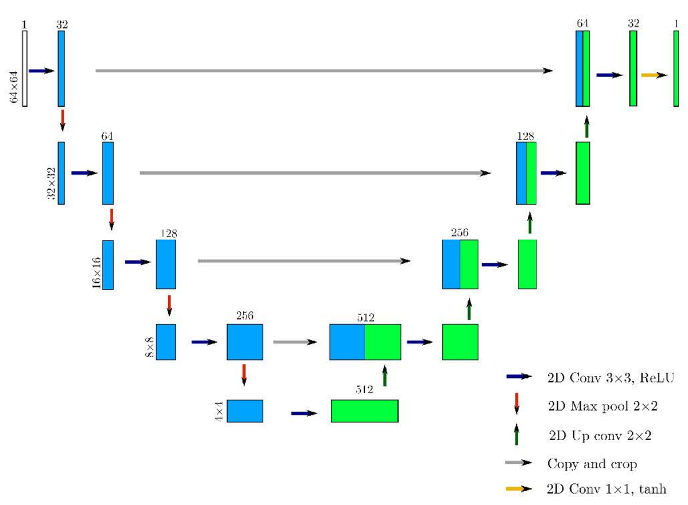
Introduction.

- Surface wave attenuation is one of the essential stages in data processing for land seismic exploration.
- The FK filter is the most widely used method to remove surface waves (ground roll). However, this filter has some limitations:
  - ➢ Requires data regularly sampled in both, time and offset.
  - ➢ Manually tuned.
  - ➢ Body wave events that overlap with the surface noise in the FK domain
- We propose a Machine Learning workflow that combines the frequency domain Linear Radon Transform LRT and the Unet autoencoder to remove the surface noise.

Theory.



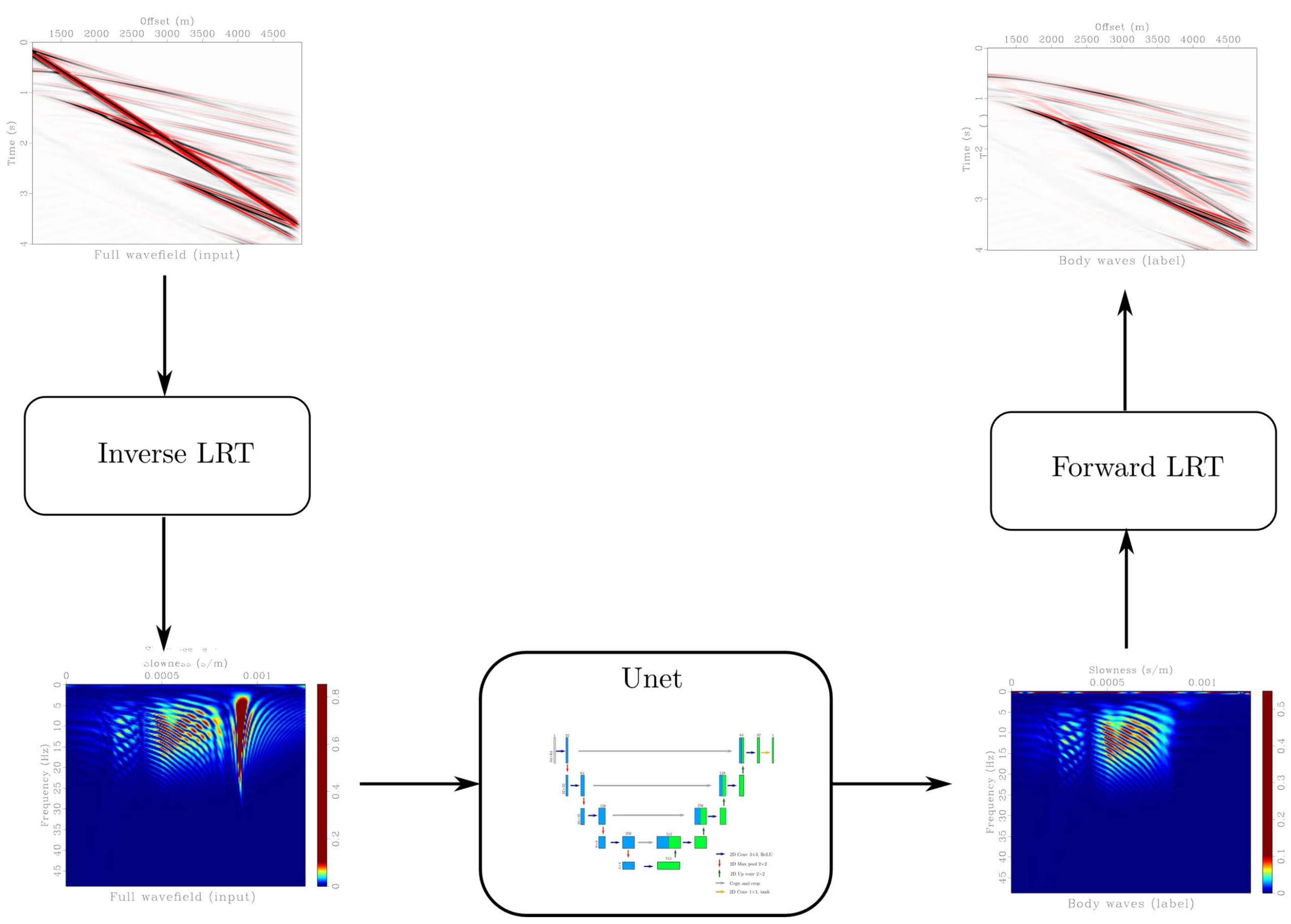
Linear Radon Transform: a The inverse LRT is used to estimate the Radon model (right) from the shot gather (left). The Radon model allows to identify the zones of body and surface waves in the frequency-slowness domain. The seismic shot gather is reconstructed by applying the forward LRT.



Unet: We use the Unet to predict the Radon model of seismic shot gathers without surface wave noise.

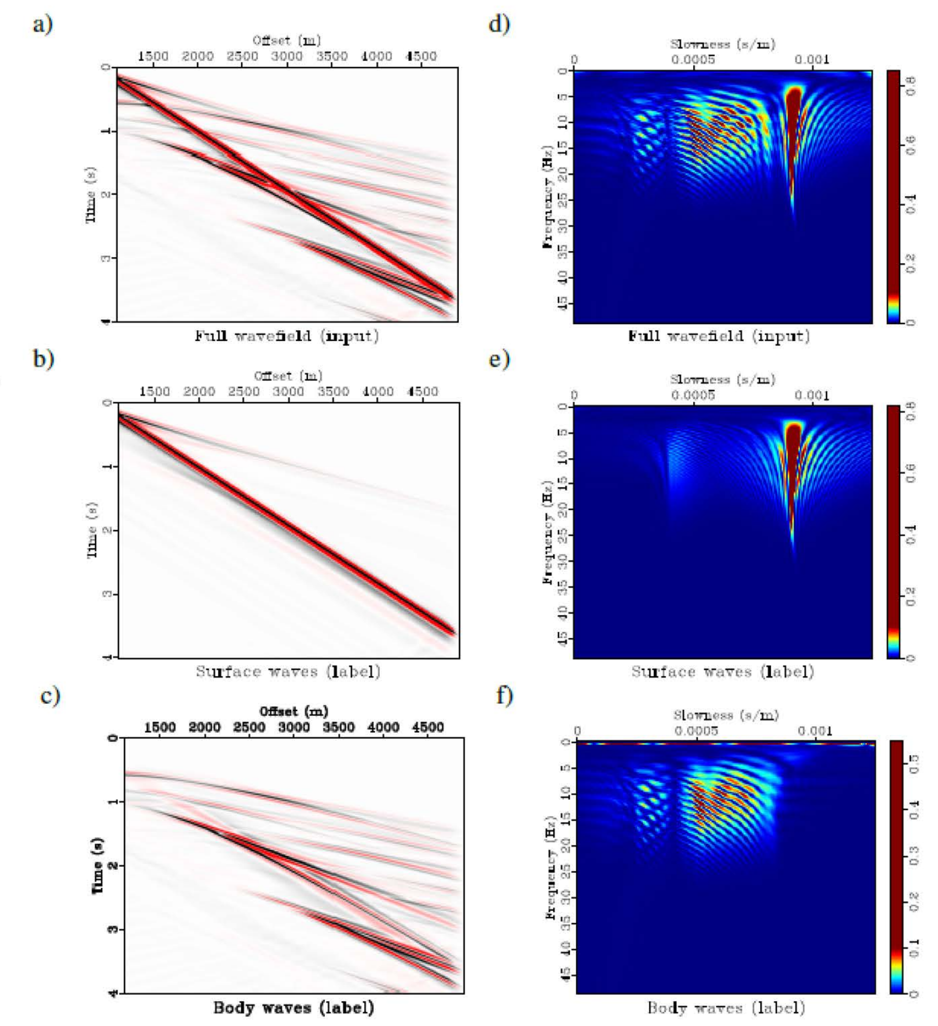
Machine Learning Workflow.

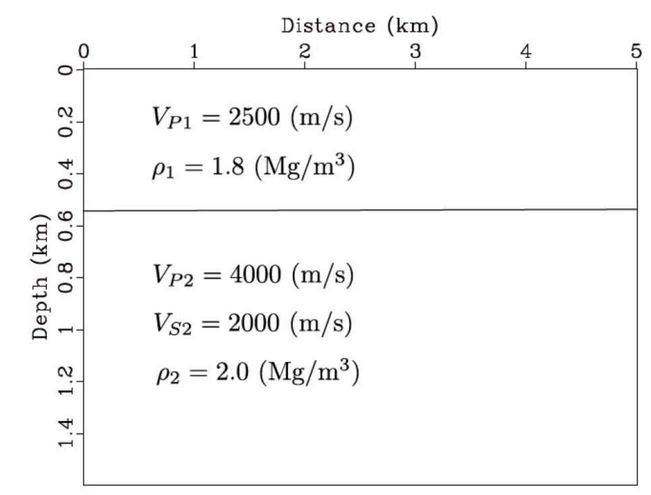
We train the Unet convolutional autoencoder to predict the Radon model of seismic data without surface waves. In the training process, the input and label are the Radon model of the seismic data with and without surface wave noise, respectively. The trained Unet is used in a workflow to attenuate the surface wave noise in seismic shot gathers



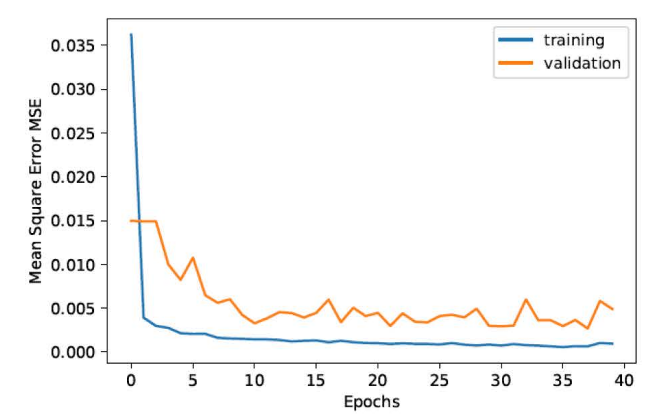
Numerical Example

- We generated synthetic shot gathers with and without surface waves by using a 2D elastic wave modeling solver.
- 100 different versions of the two-layers earth model were used.
- The S-wave velocity in the first layer ranges from 1000 to 1800 (m/s) in steps of 8 (m/s)

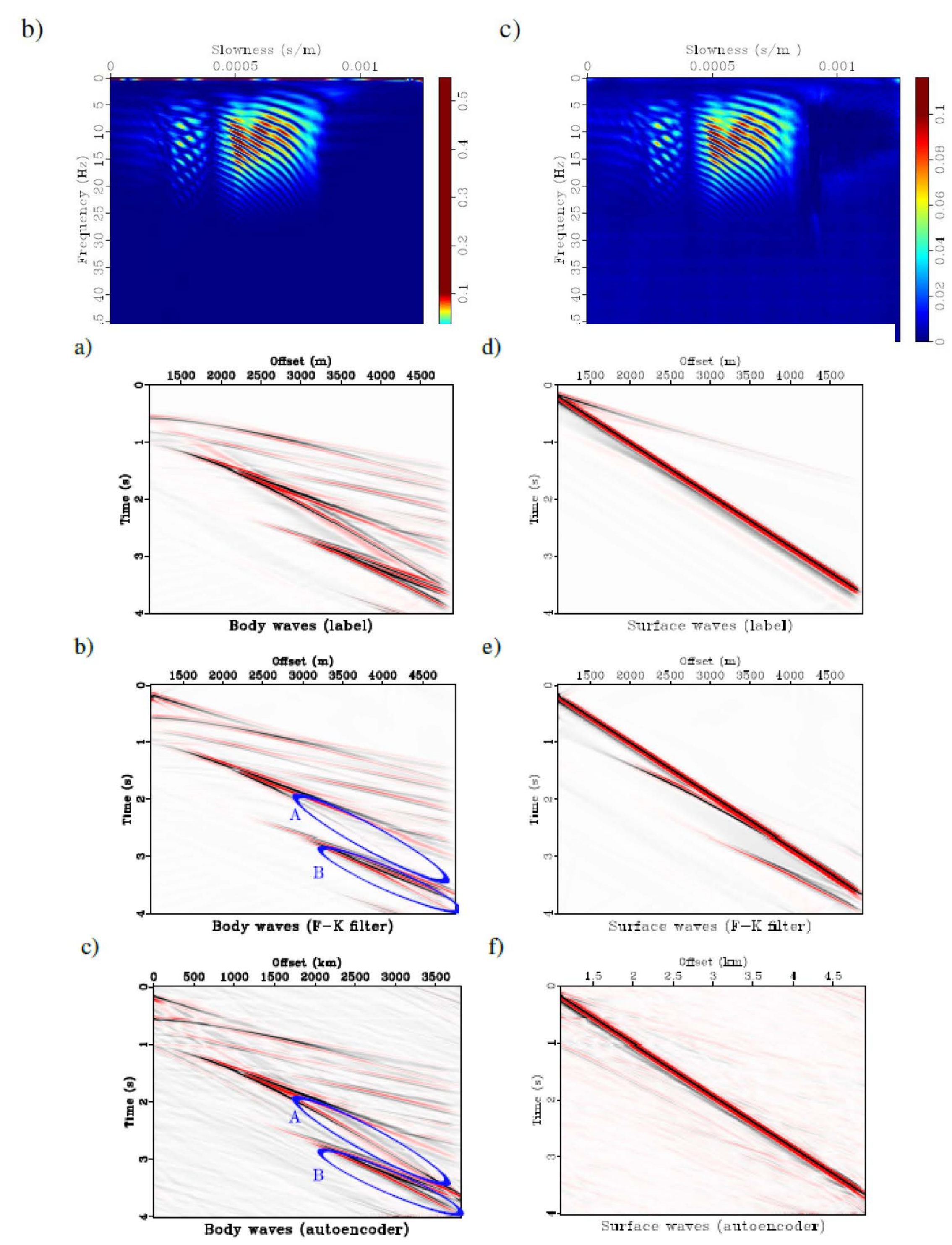




Numerical Results

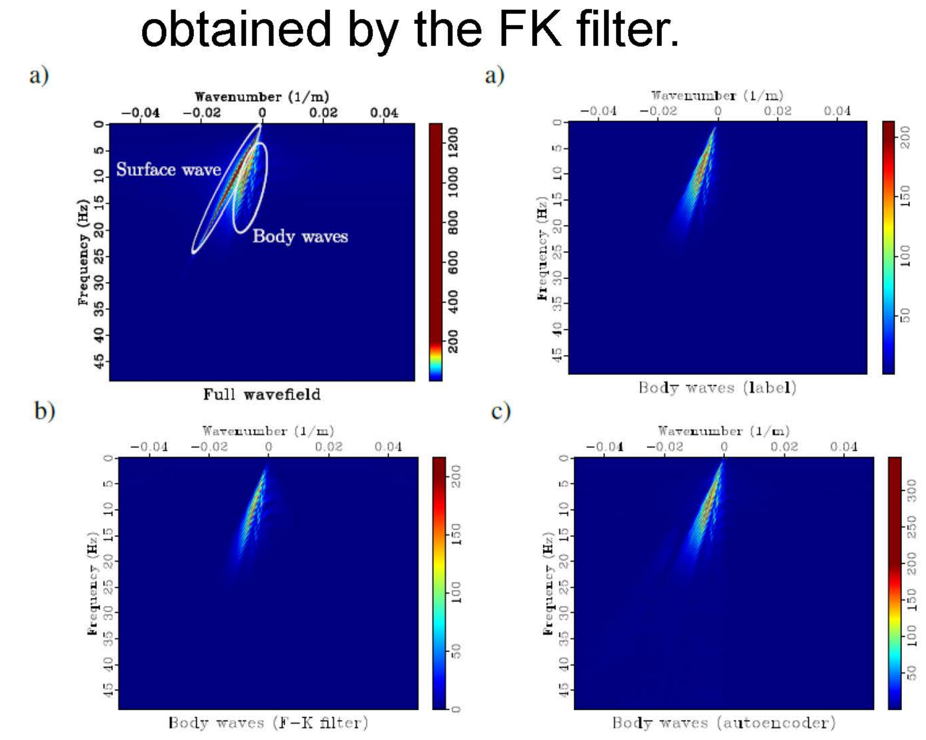


- We split the dataset. 80% for training and 20% for validation.
- We note that the training MSE decreases considerably in the first epochs and the knee effect is between 5 and 10 epochs.



- The Unet can accurately predict the Radon model without the surface noise. energy.
- The free-noise shot gather is reconstructed by using the forward LRT.

- FK filter produces more clear events but is more aggressive than the Unet autoencoder.
- FK filter attenuated two body wave events that the proposed workflow was able to preserve (events A and B)
- In the FK domain, data predicted by the
- Unet are more accurate than the data obtained by the FK filter.



Conclusions

We have presented a machine learning workflow to attenuate surface wave noise in seismic shot gathers. The workflow uses an Unet autoencoder to predict the Radon model of seismic data without surface noise. The Unet was trained with synthetic data generated by elastic wave modeling with several versions of the same 2D earth model the proposed workflow becomes a good alternative to attenuate surface wave noise with a performance similar to well-tuned FK filters.. .

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