From oceanic waves to seismic wiggles, then and now

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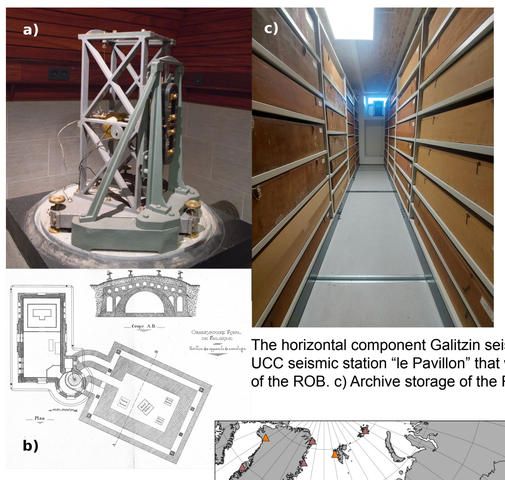
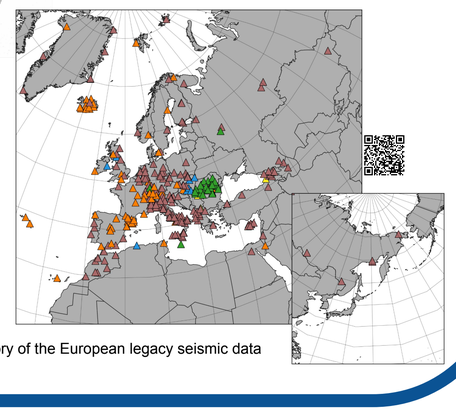
Background

- Ocean waves generate a seismic noise that has been continuously recorded by all seismometers in the last 140 years
- Legacy seismograms are digitized to be used with modern seismic methods
- The vectorized traces can be converted into ground-motion but needs additional validation
- The microseisms in the converted waveforms is compared to a modeled microseism that combines a numerical wave model and a transformation of wave spectra into microseisms

Legacy data

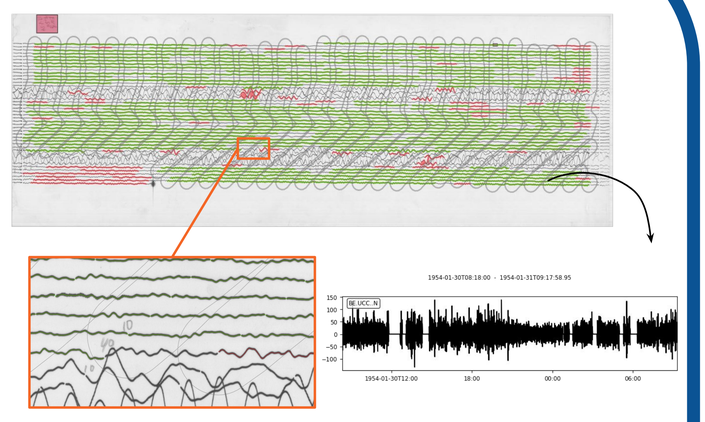


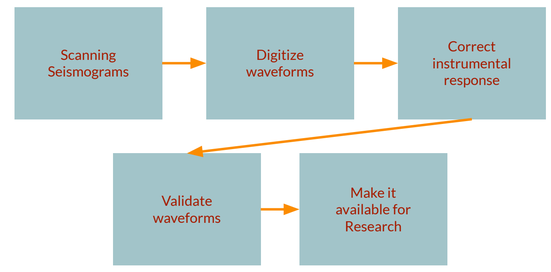
The horizontal component Galitzin seismometer. b) Plan of the UCC seismic station “le Pavillon” that was built in 1908 on the site of the ROB. c) Archive storage of the ROB.



Inventory of the European legacy seismic data

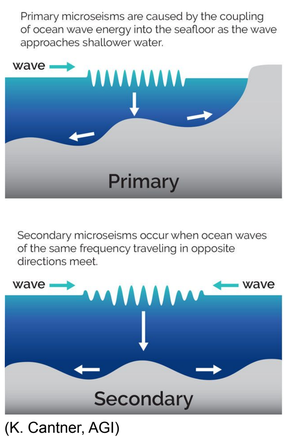
Digitizing seismograms





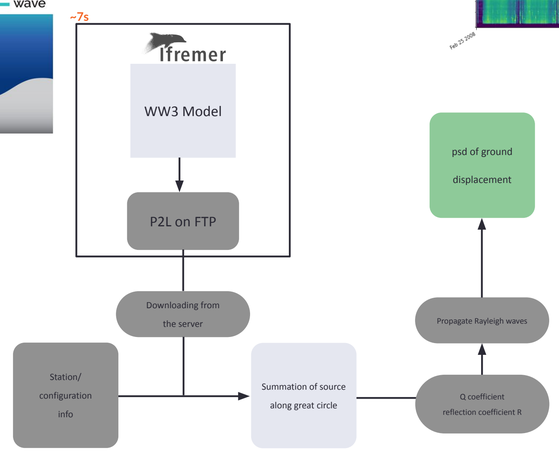
Full workflow to convert legacy seismograms to usable digital seismic data.

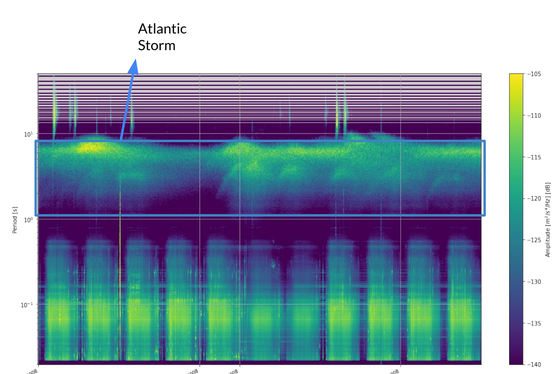
Microseisms and ocean models

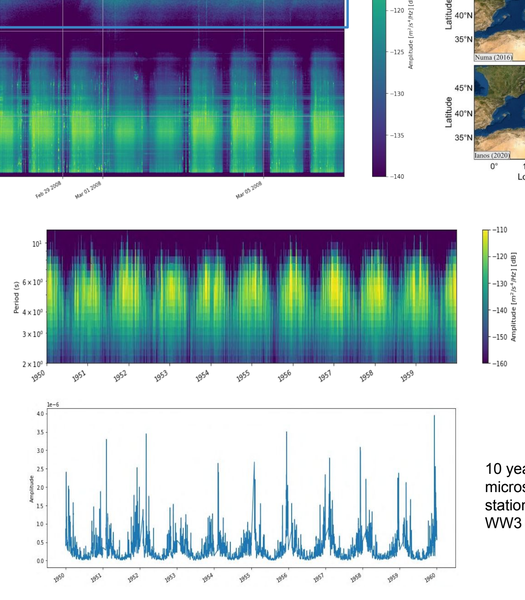


(K. Cantner, AGI)

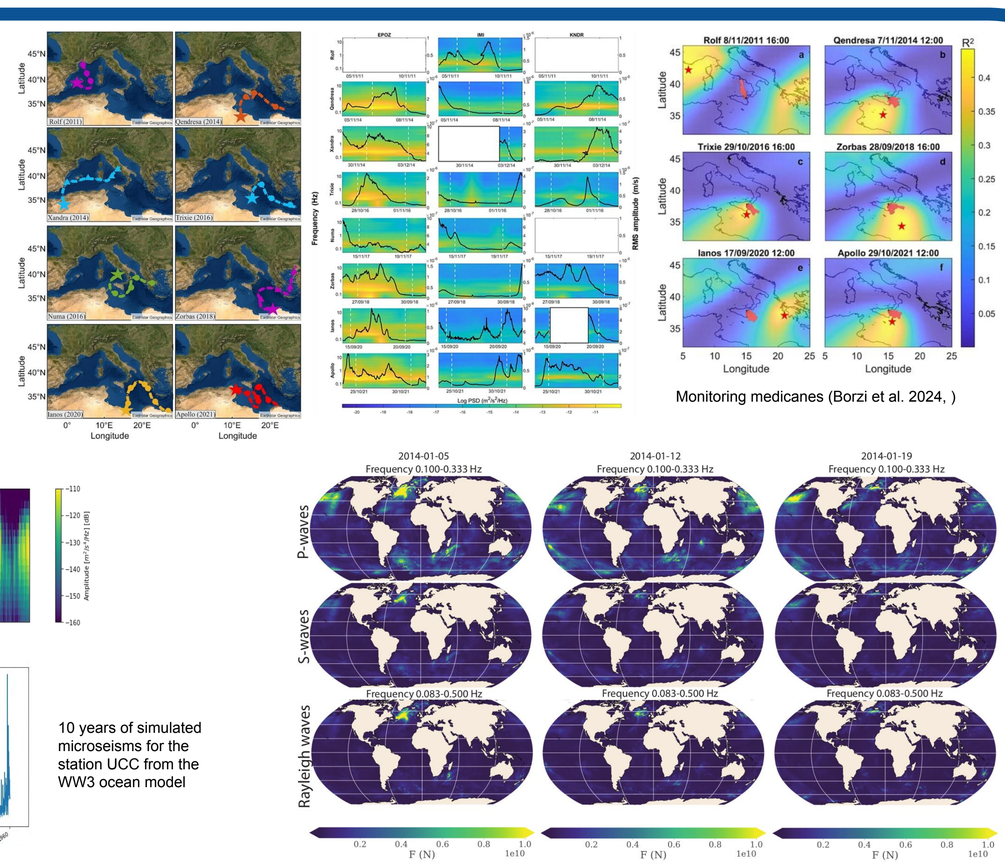
The microseisms are continuous ground motion recorded everywhere on Earth arising from the interaction between the atmosphere, the oceans, and the solid Earth through energy transfer via the water column.







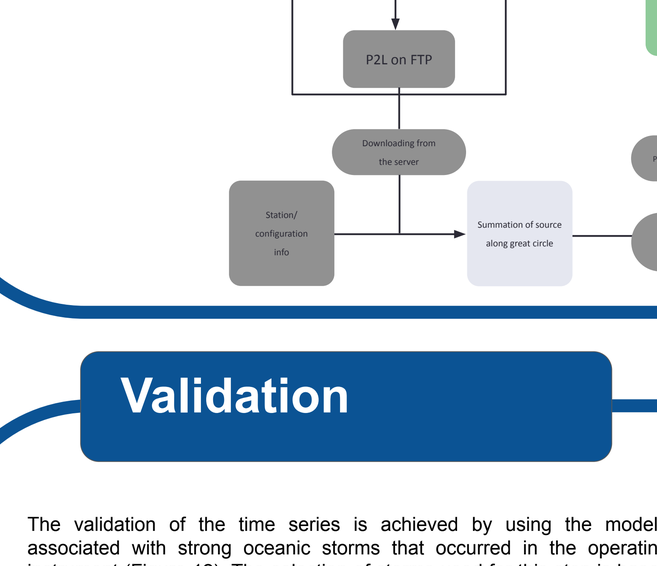
10 years of simulated microseisms for the station UCC from the WW3 ocean model



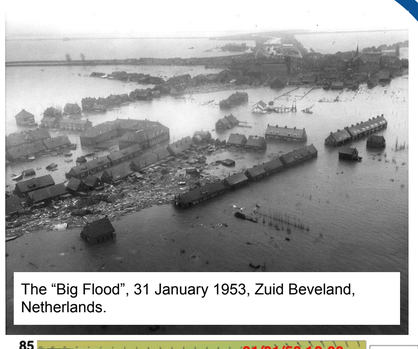
Monitoring medicanes (Borzi et al. 2024,)

Validation

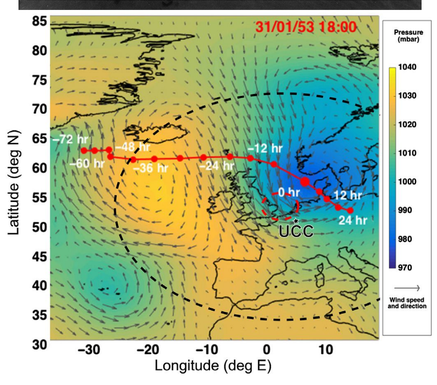
The validation of the time series is achieved by using the modeled microseisms associated with strong oceanic storms that occurred in the operating period of the instrument (Figure 12). The selection of storms used for this step is based on attenuation and ocean-solid earth coupling, which defines the largest sensitivity of the UCC station in the first 1000 km around it and is sensitive to strong sources up to 2000 km. The comparison of the spectra of the digitized waveforms is then done with the modeled ground motion.



Displacement power spectral density spectrograms of the microseismic activity between 15 January–15 February 1953 for the (a) vertical, (b) east-west, (c) north-south components, and (d) the corresponding modeled microseism at station UCC. The thick dashed white line indicates “Big Flood” (Figure 8). From Lecocq et al. (2020, SRL).



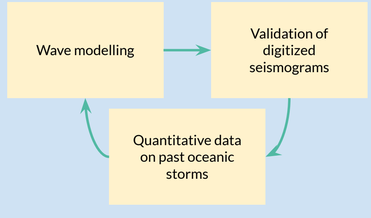
The “Big Flood”, 31 January 1953, Zuid Beveland, Netherlands.



Implications

Using **seismograms** to extract the **quantitative observation** of the last century of **oceanic storms**

- The **only** place where these **quantitative observations** remain stored for the last century
- Can be used to **improve** existing **ocean models**
- Incentivise bringing **legacy seismic** data to the **digital age** before they are lost
- Foster **modern** seismic research using **legacy seismograms**
- Valorize scientific investments



Challenges:

- Need to vectorize legacy seismic data at a global scale
- Need to improve the reflections of coastlines in ocean models
- Existing ocean model focus on Rayleigh waves generated by the Secondary microseism

Acknowledgements

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