Waves in sea-ice: experiments in the ice tank at Aalto University

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GEOPHYSICAL RESEARCH LETTERS, VOL. 38, L06605, doi:10.1029/2011GL046827, 2011

Extreme waves in random crossing seas: Laboratory experiments and numerical simulations

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Nat. Hazards Earth Syst. Sci., 14, 705–711, 2014
www.nat-hazards-earth-syst-sci.net/14/705/2014/
doi:10.5194/nhess-14-705-2014

Natural Hazards and Earth System Sciences
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Modulational instability and wave amplification in finite water depth

L. Fernandez[1], M. Onorato[2,3], J. Monbaliu[1], and A. Toffoli[4]

Nat. Hazards Earth Syst. Sci., 11, 895–903, 2011
www.nat-hazards-earth-syst-sci.net/11/895/2011/
doi:10.5194/nhess-11-895-2011

Natural Hazards and Earth System Sciences

Occurrence of extreme waves in three-dimensional mechanically generated wave fields propagating over an oblique current

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Aalto ice tank

40m x 40m basin

15 individually controlled plungers (unidir. and dir. waves)

Linear beach

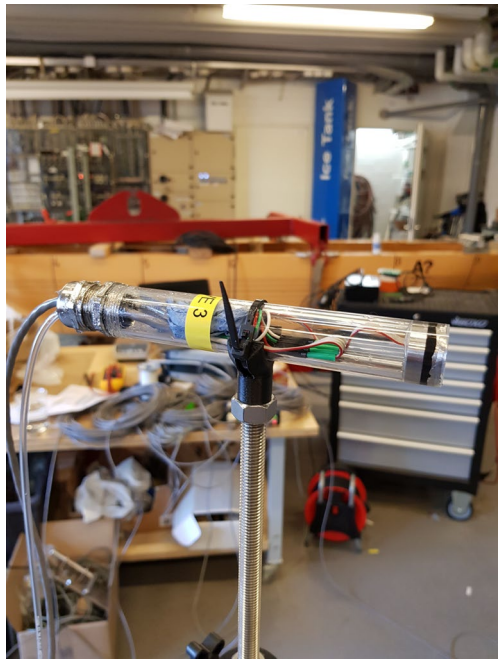
Aalto ice tank

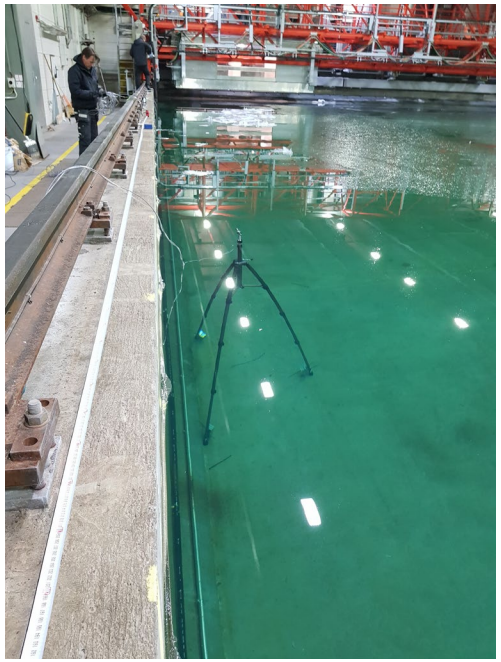
Instrumentation:

3 resistance wave gauges to measure incident wave field

5 pressure sensors (@0.2m from surface) to measure waves-in-ice

8-16 motion sensors to measure ice displacements





Model ice

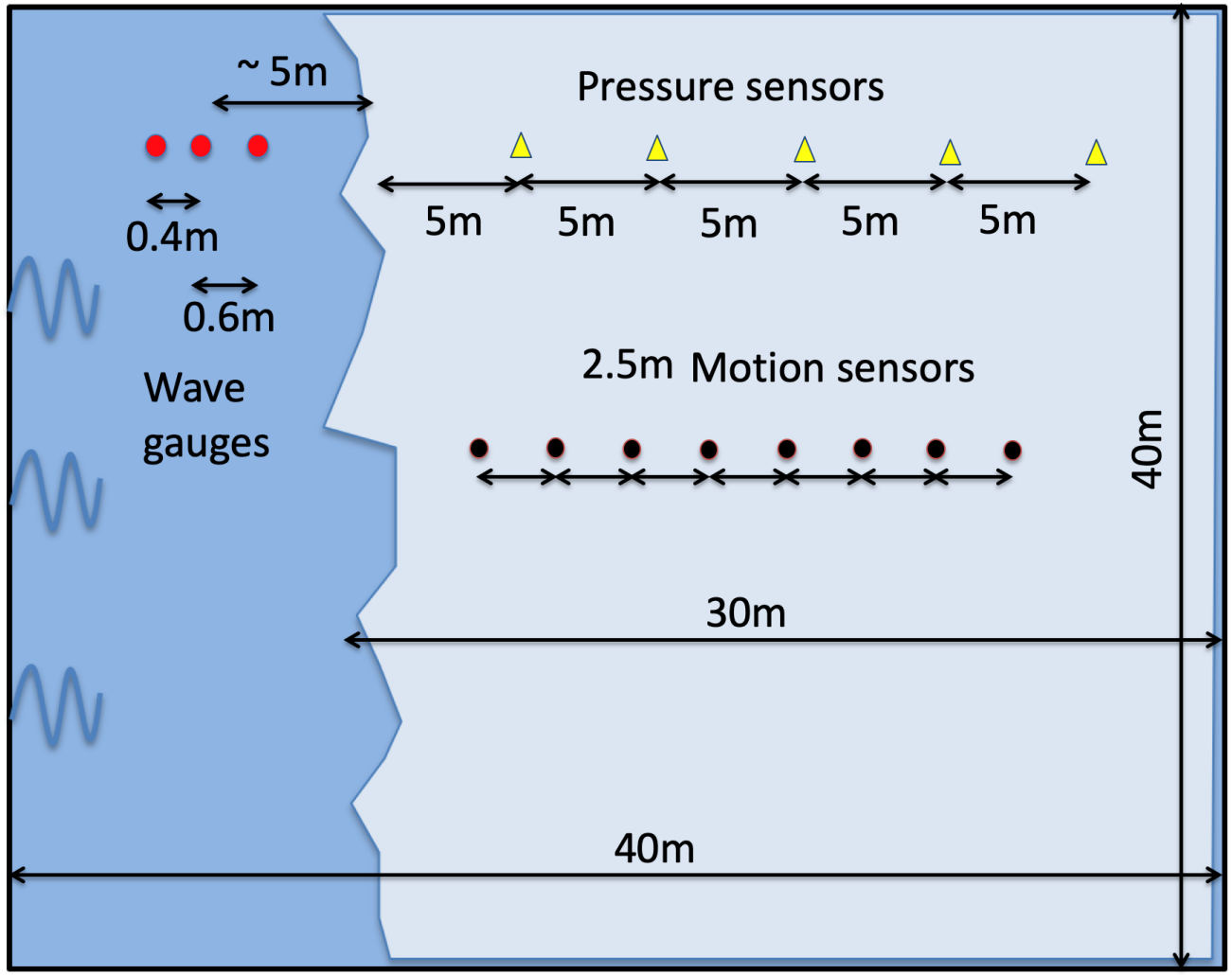
Model ice is produced by laminating the water surface with layers of ice crystals, which are generated by spraying fine water mist doped with 0.3% of ethanol (seeding) onto the cooled water surface

Mechanical properties are measured in-situ

Experimental set up

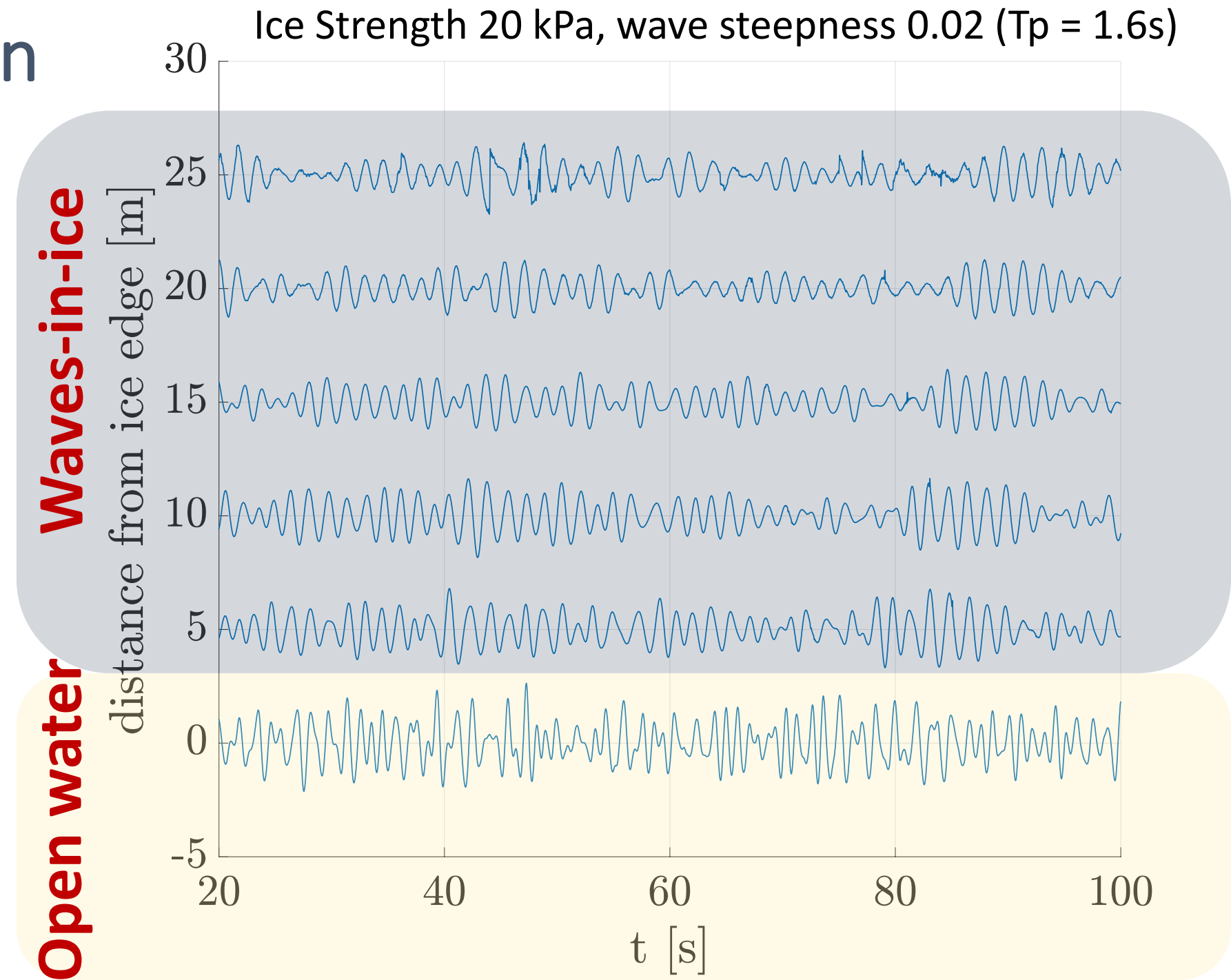
- An initial ice cover of thickness 30 mm was produced over the entire surface of the tank.
- Flexural strength was measured directly on the sheet (nearby the beach) with destructive cantilever beam tests
- A portion of the ice cover in front of the beach was removed; a strip of approximately 10 m in length.

- **Waves:** Unidirectional random fields forced by a JONSWAP spectrum with very low steepness (kp Hs / 2 = 0.02) to suppress wave nonlinearity
- **Ice:** Three different ice strengths were tested (20, 30 & 40 kPa)

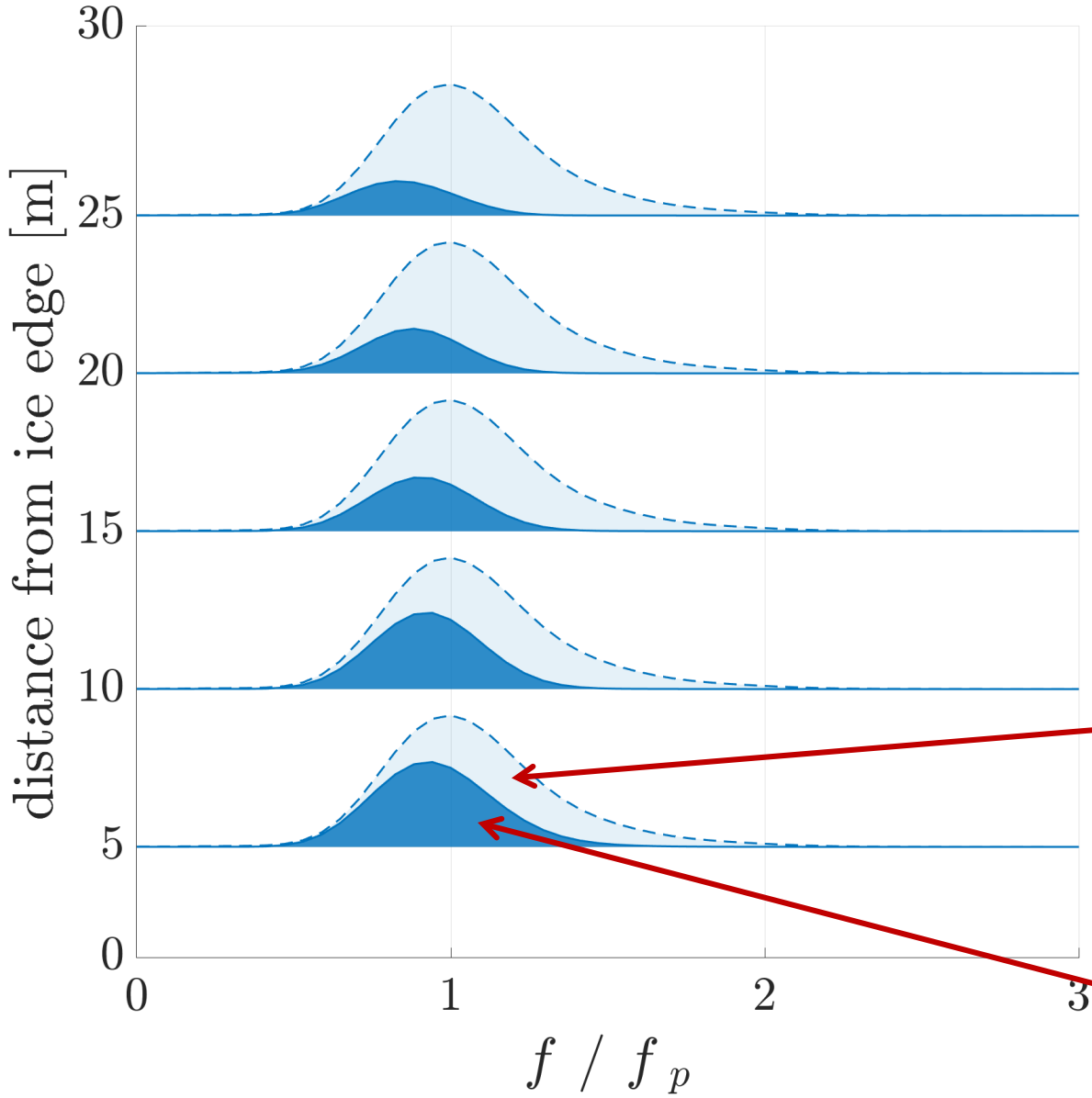


Surface elevation

Preliminary analysis with gentle sloping waves to avoid break up



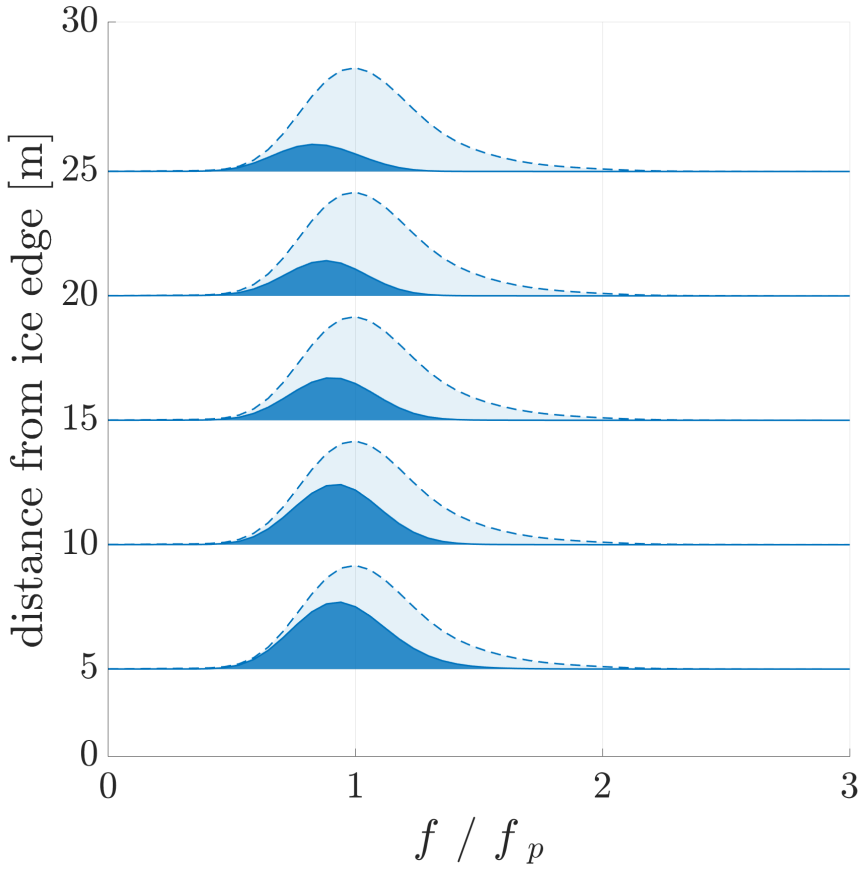
Spectral evolution: wave attenuation

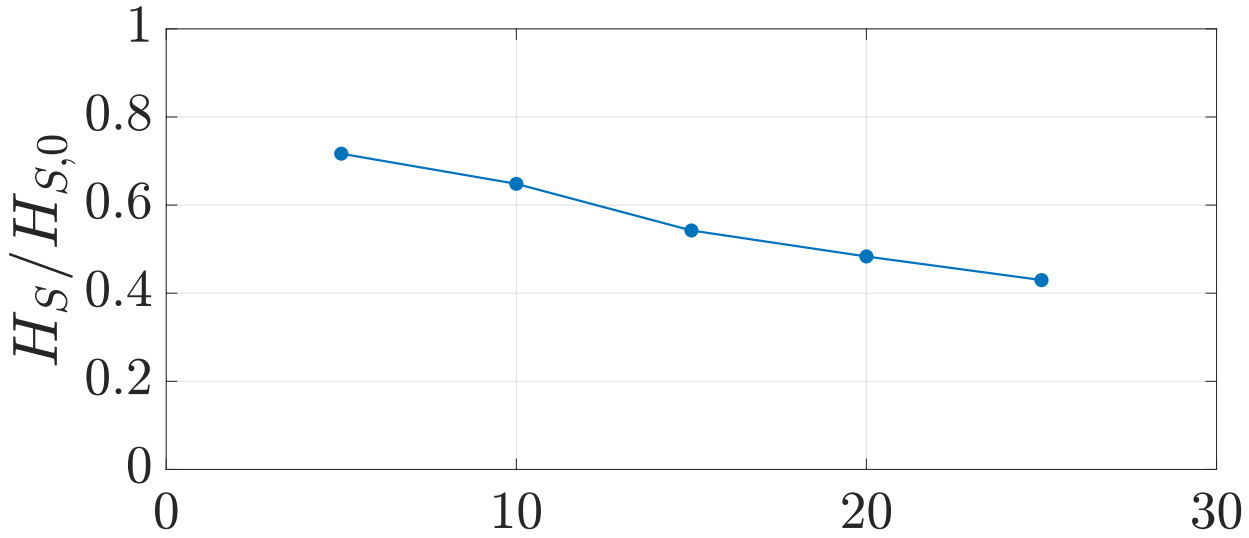


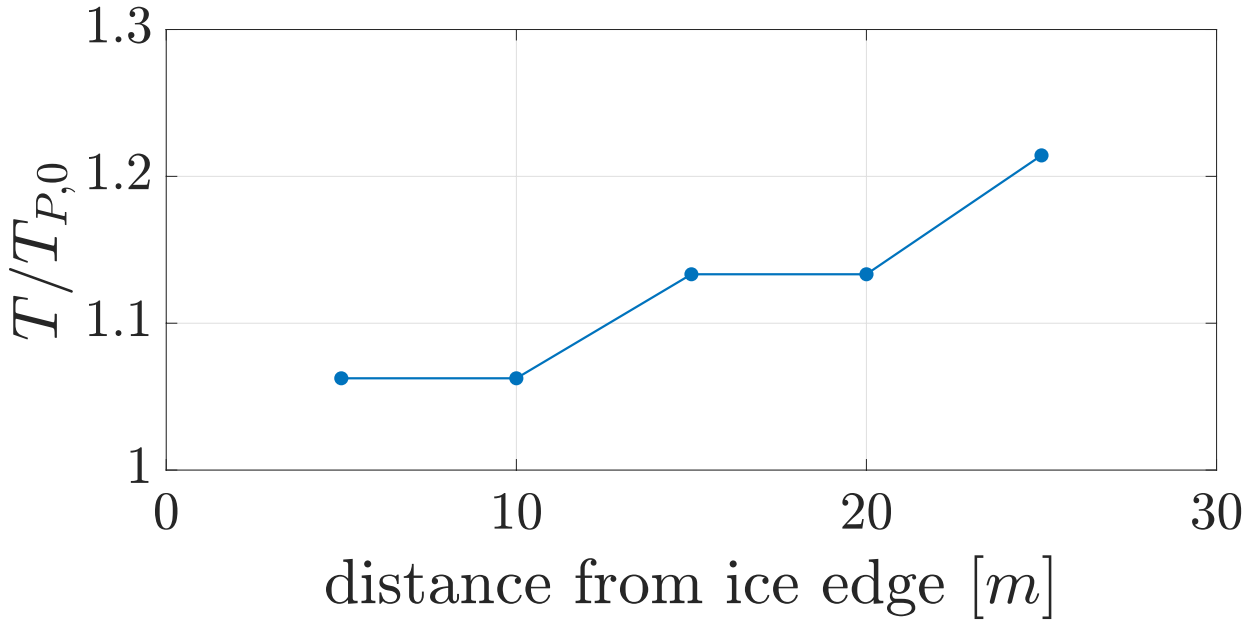
Incident spectrum (open water)

Wave spectrum in ice

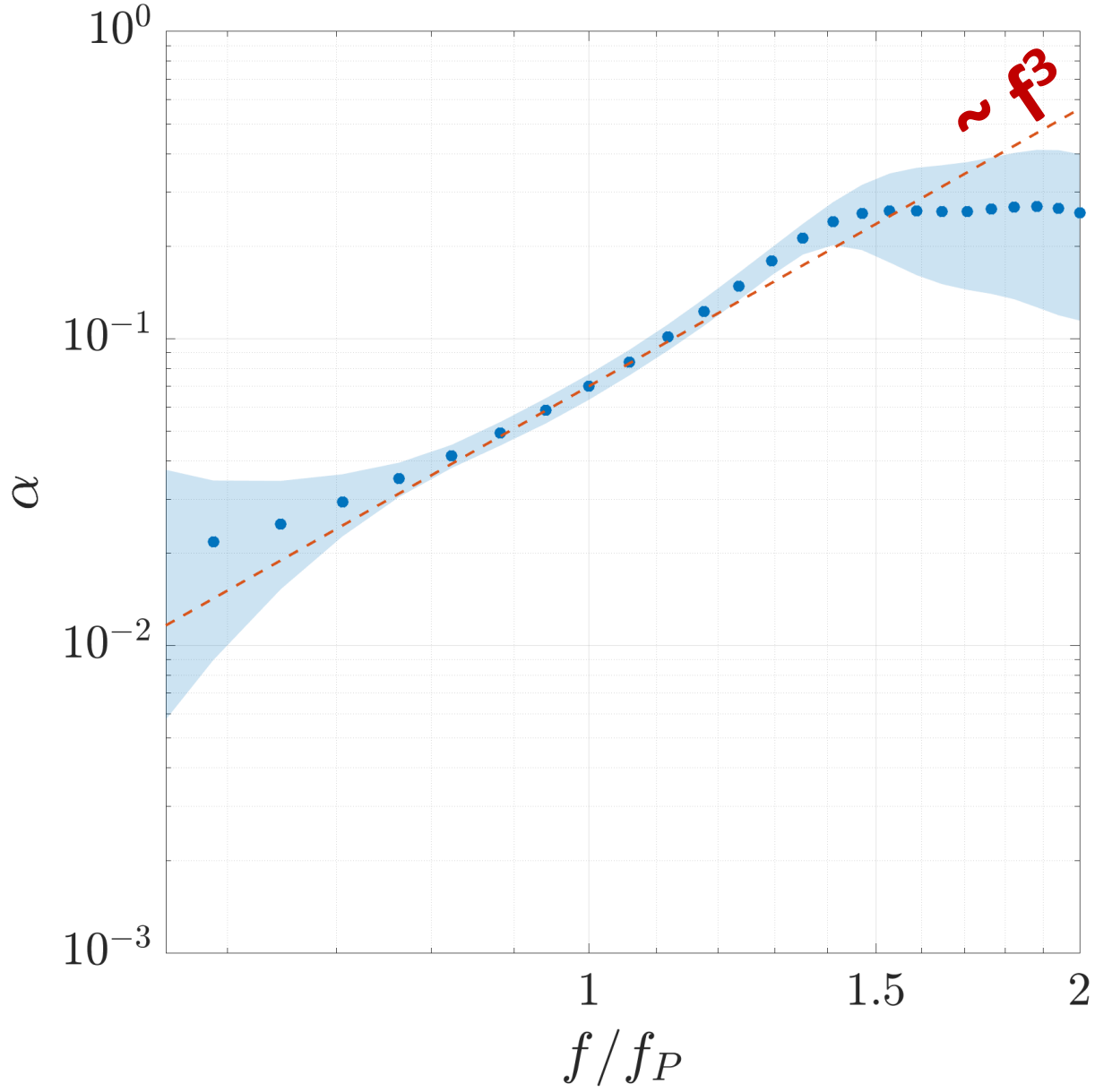
Spectral evolution: wave attenuation

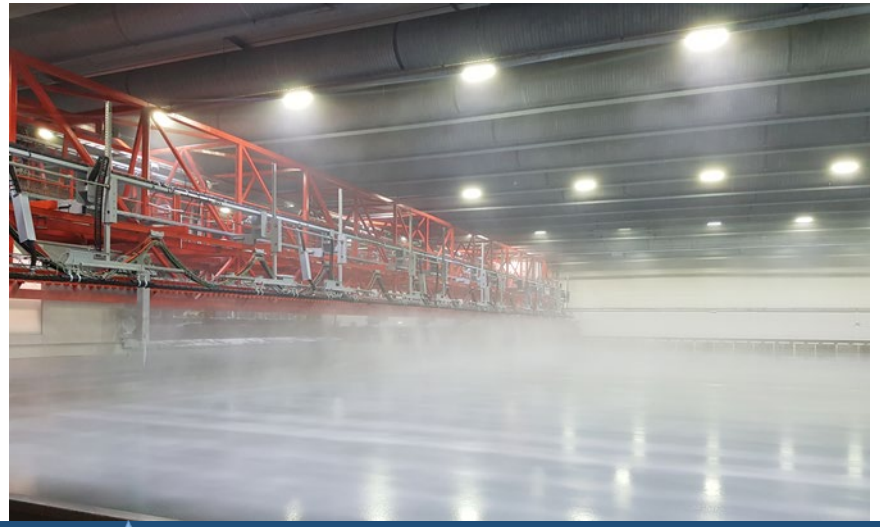






Wave attenuation (α) as a function of frequency





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Experiments of May 2019