

Fuel Cells in Ships

Degradation of PEM Fuel Cell in Maritime Environments

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Fuel Cells in Ships

Degradation of PEM Fuel Cell in Maritime Environments



Review still to be published elsewhere

Method

Review with **key words**: PEMFC, maritime, degradation, modeling, NaCl and inclination
>> 49 papers <<

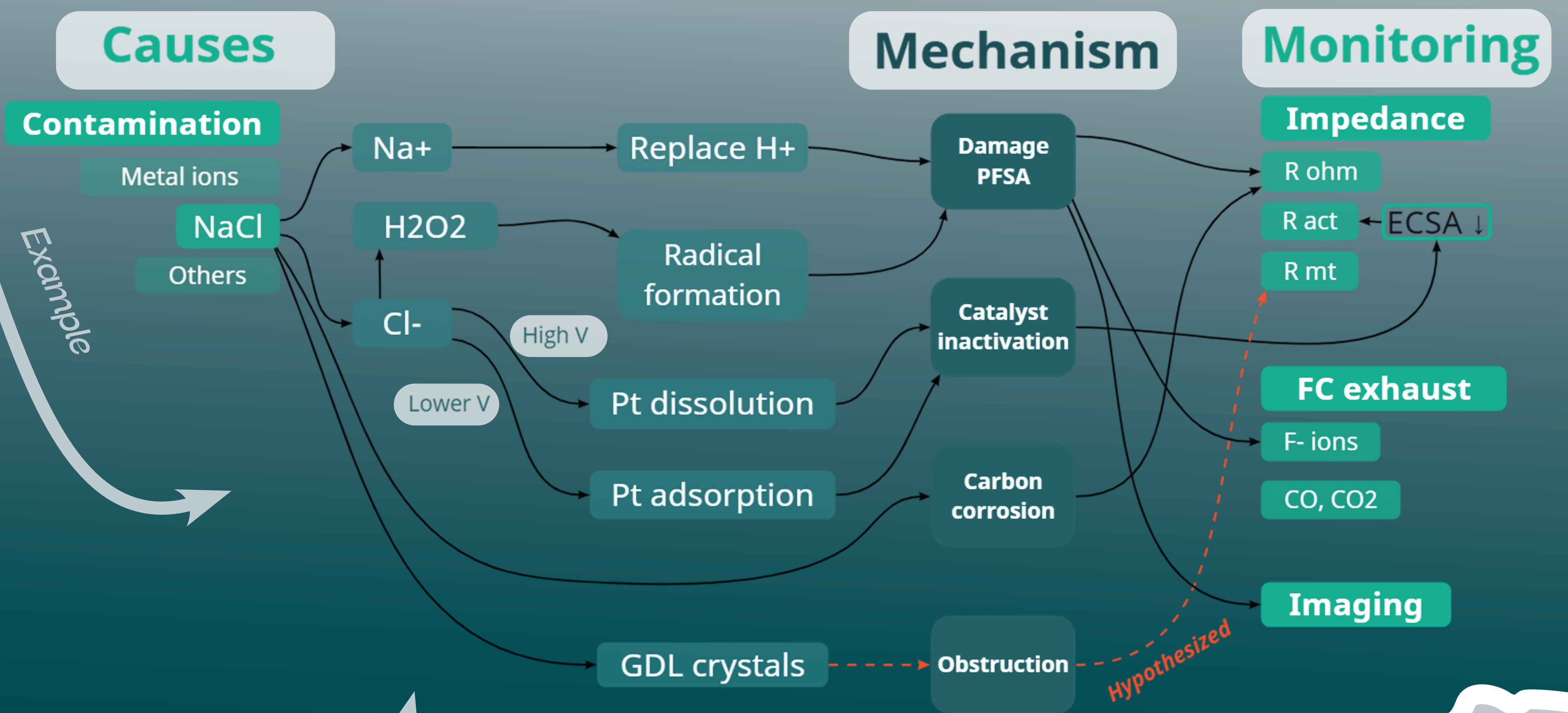
Motivation

Marine industry: 3% of global **GHG emissions**
11% of **SO_x** and 19% **NO_x** emissions in Europe
>> **H₂ powered PEMFC can reduce emissions** <<

PEMFC degradation is widely investigated but seldomly in the **maritime context**
>> **Our review provides an overview of mechanisms and research gaps** <<

9 schematic overviews

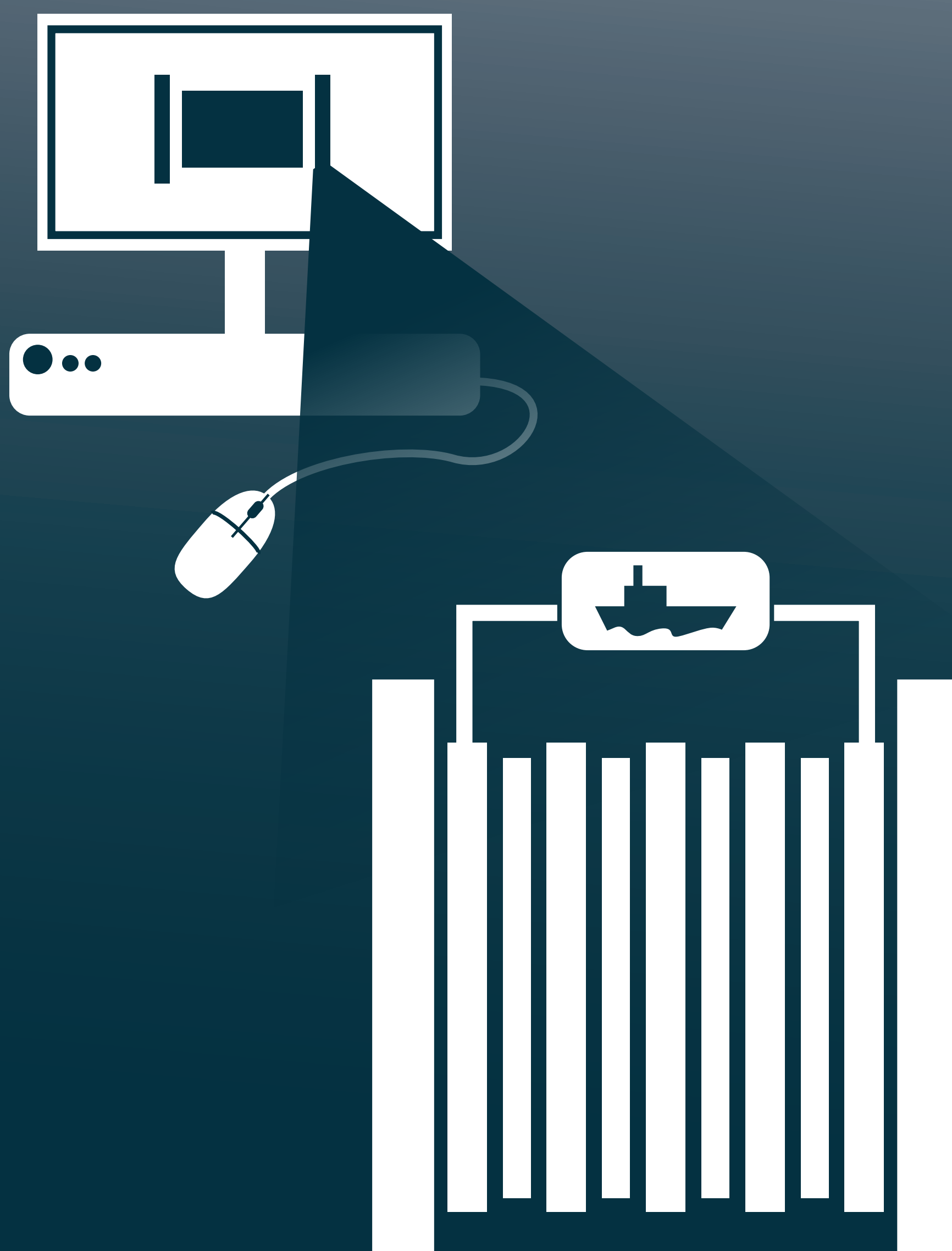
Causes (damage induced by load, contamination or movement) lined to **mechanisms** and their **monitoring** options.



Research gaps

- PEMFC **degradation** due to:
- >> Hydrogen carrier (residues)
 - >> Air salinity
 - >> Vessel motions

Study these maritime causes in a multi-scale **degradation model** and laboratory experiments

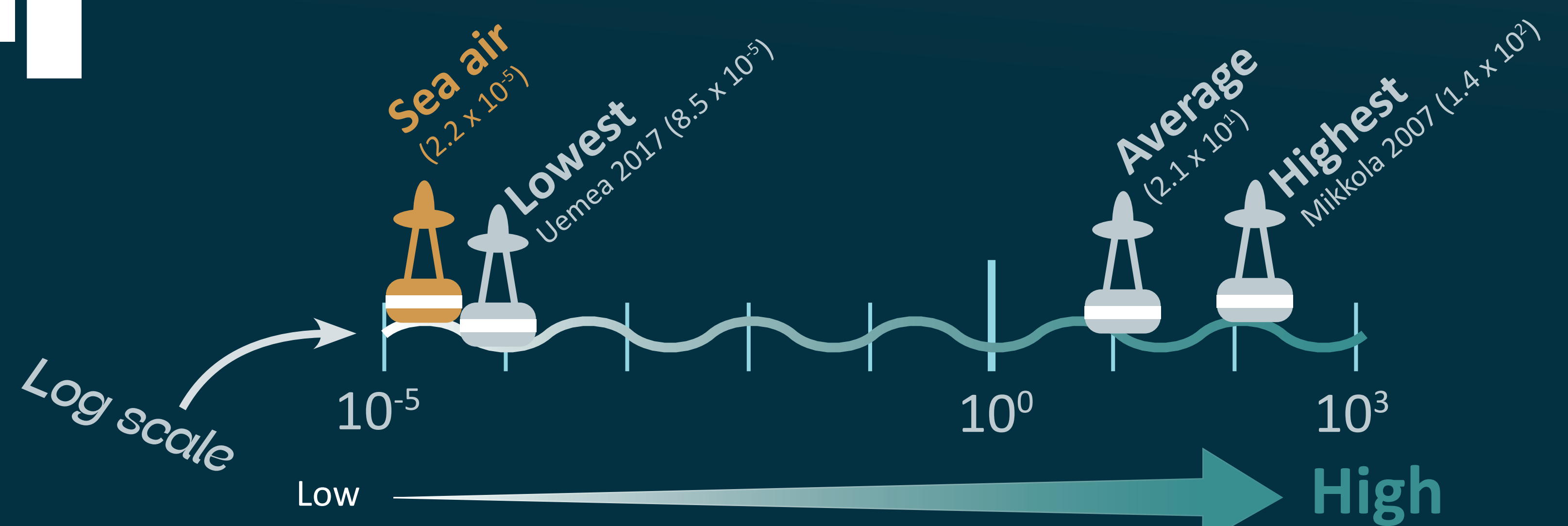


Vessel motions
Safety tests required
Durability effects seldomly studied

Air salinity
Several mechanisms known

Benchmark experiments use excessive salt flows (on average 9.5×10^5 times higher compared to sea air) >> **Low NaCl concentration tests needed**

Salt flows (mmol/min/cm²)
in literature compared to sea air



- LOHCs
- Ammonia
- (Boro)hydrides

Hydrogen carrier (residues)

No degradation studies on borohydrides or liquid organic hydrogen carriers (LOHCs)
A few ppm of NH₃ causes strong voltage drops