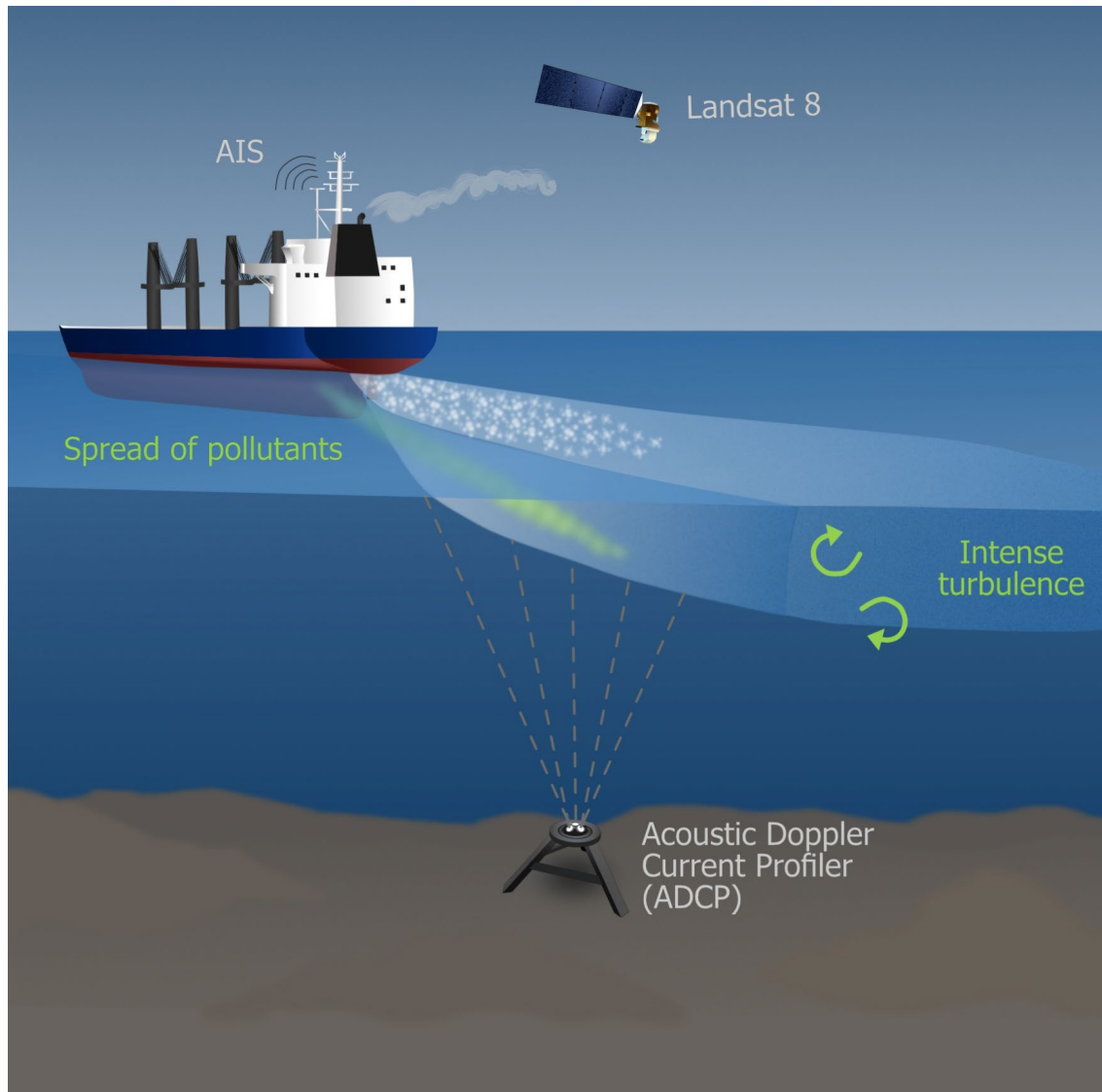


The importance of the turbulent ship wake regime for pollutant fate and transport



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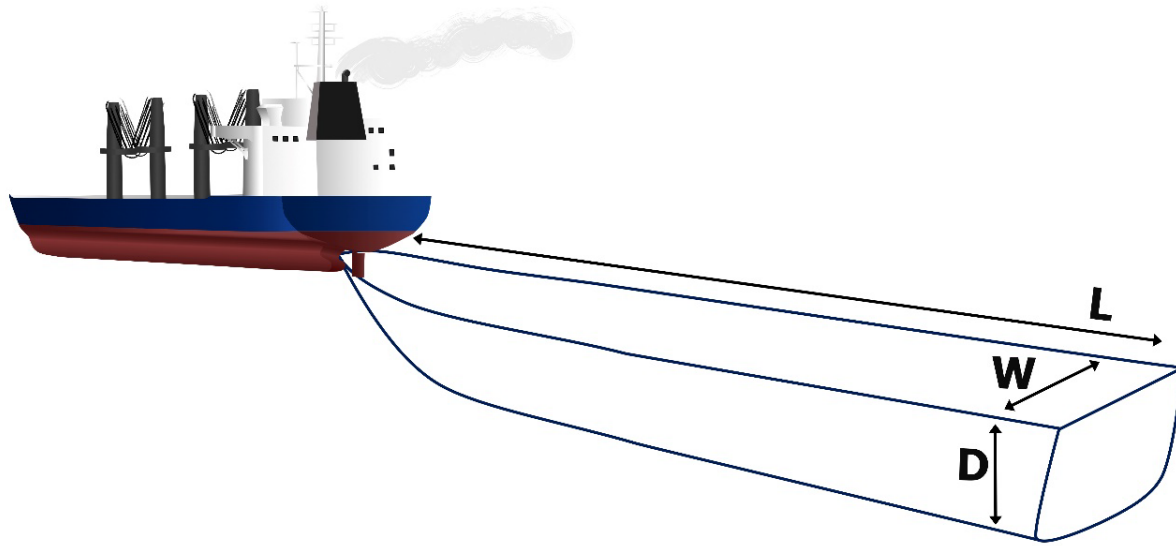
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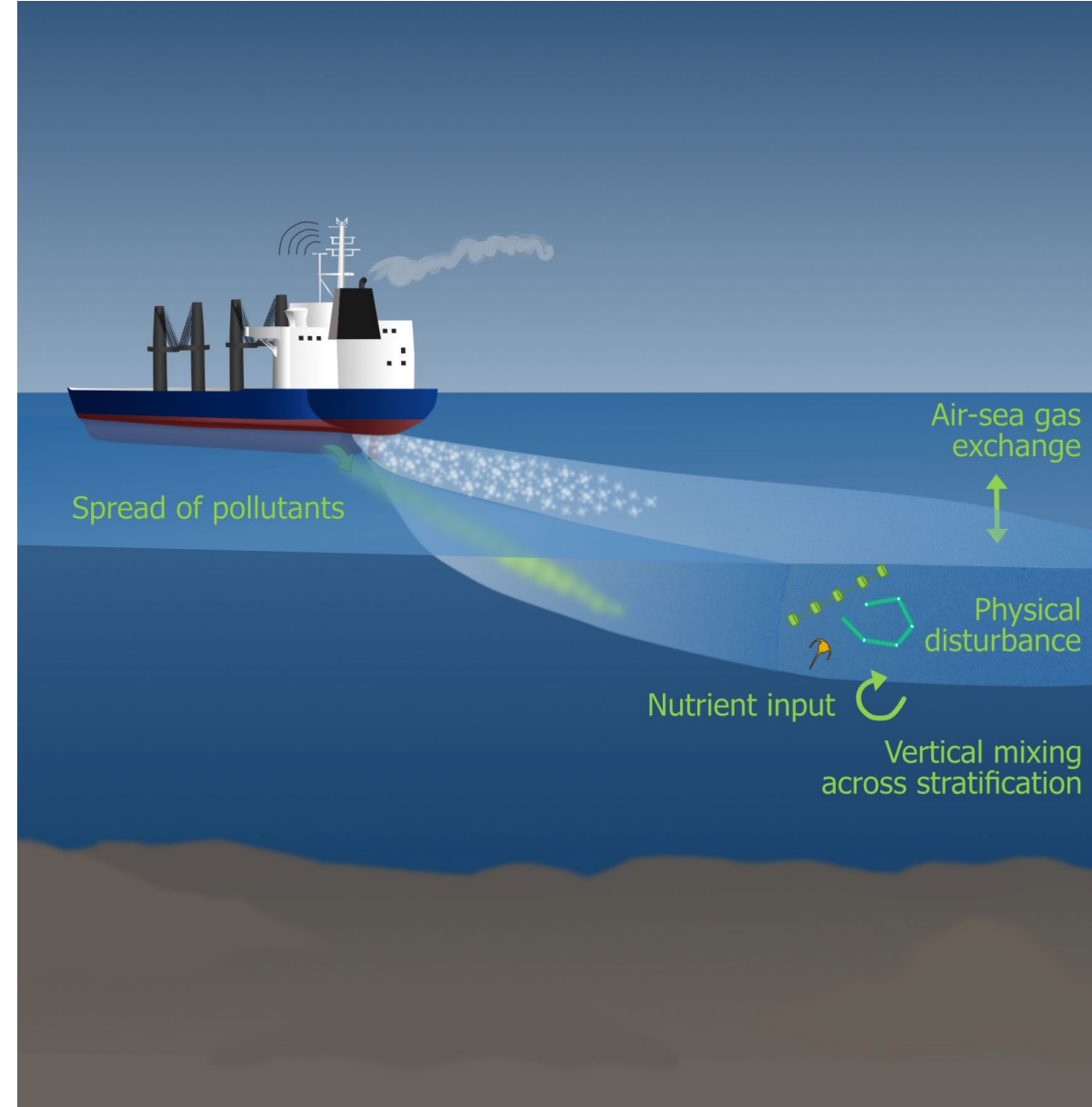
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Turbulent wake extent and impact

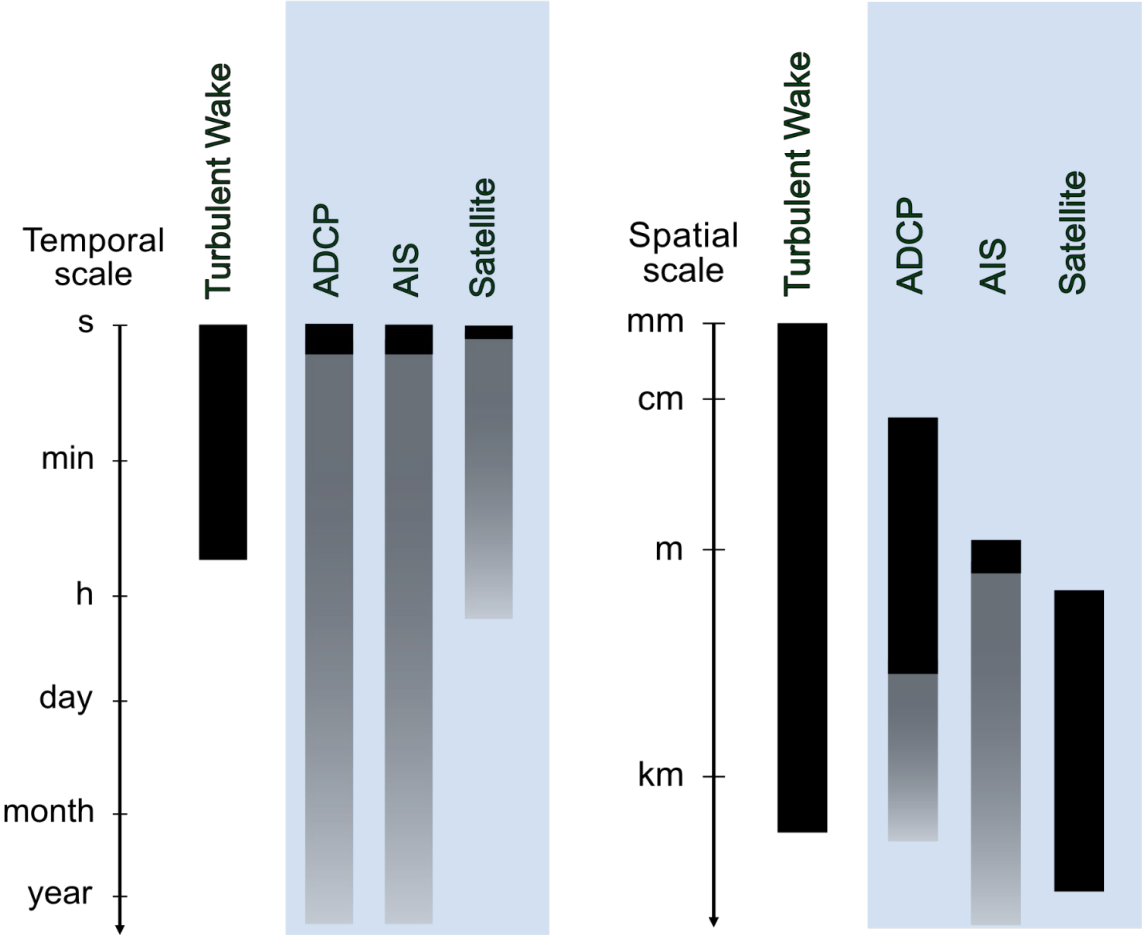
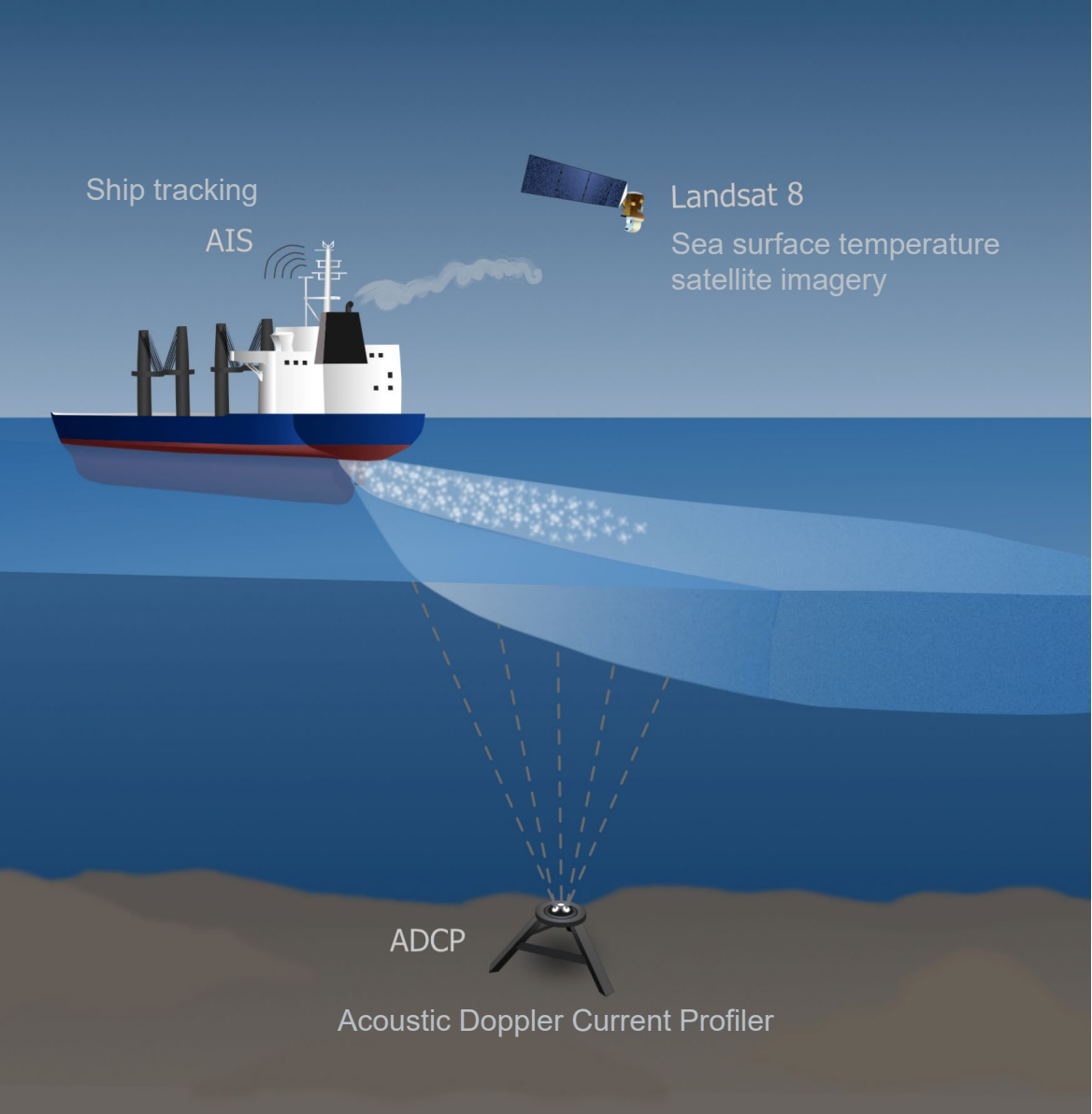


<u>Turbulent</u>	Median	Max
Longevity	8 min	29 min
Depth	13.5 m	31.5 m

<u>Thermal</u>	Median	Max
Longevity	13.7 km	62.5 km
Width	157 m	



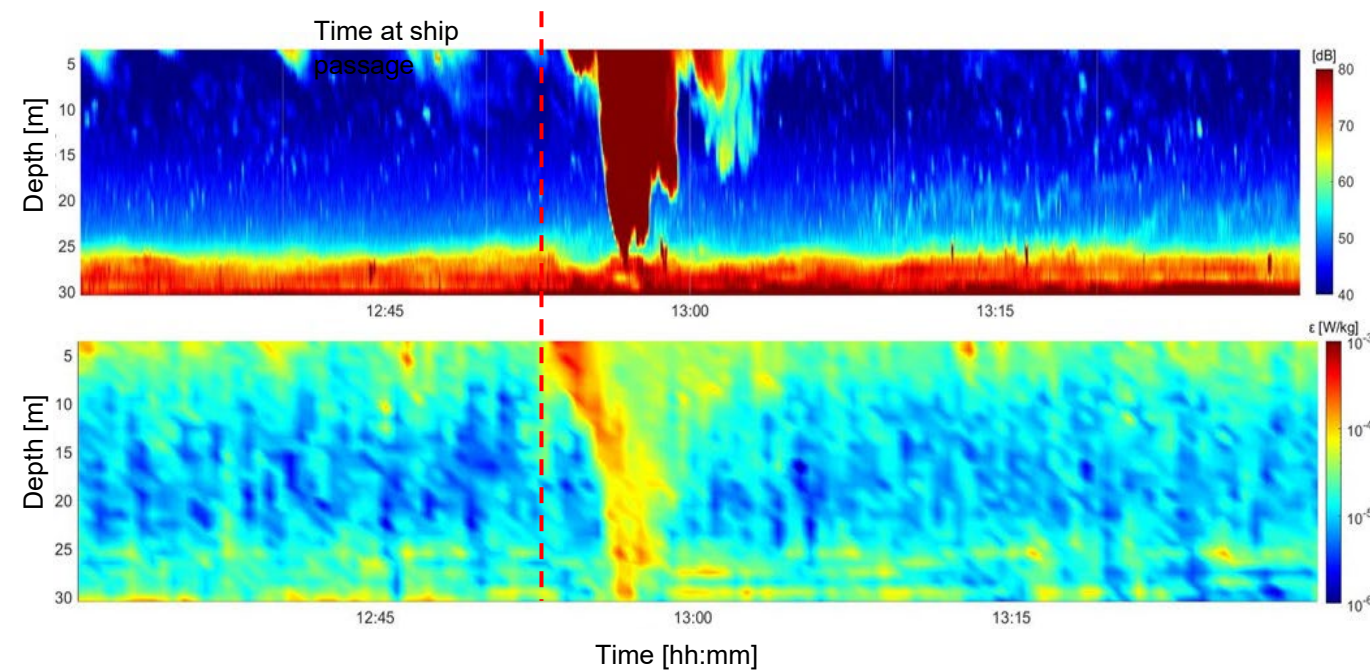
Methods of observation



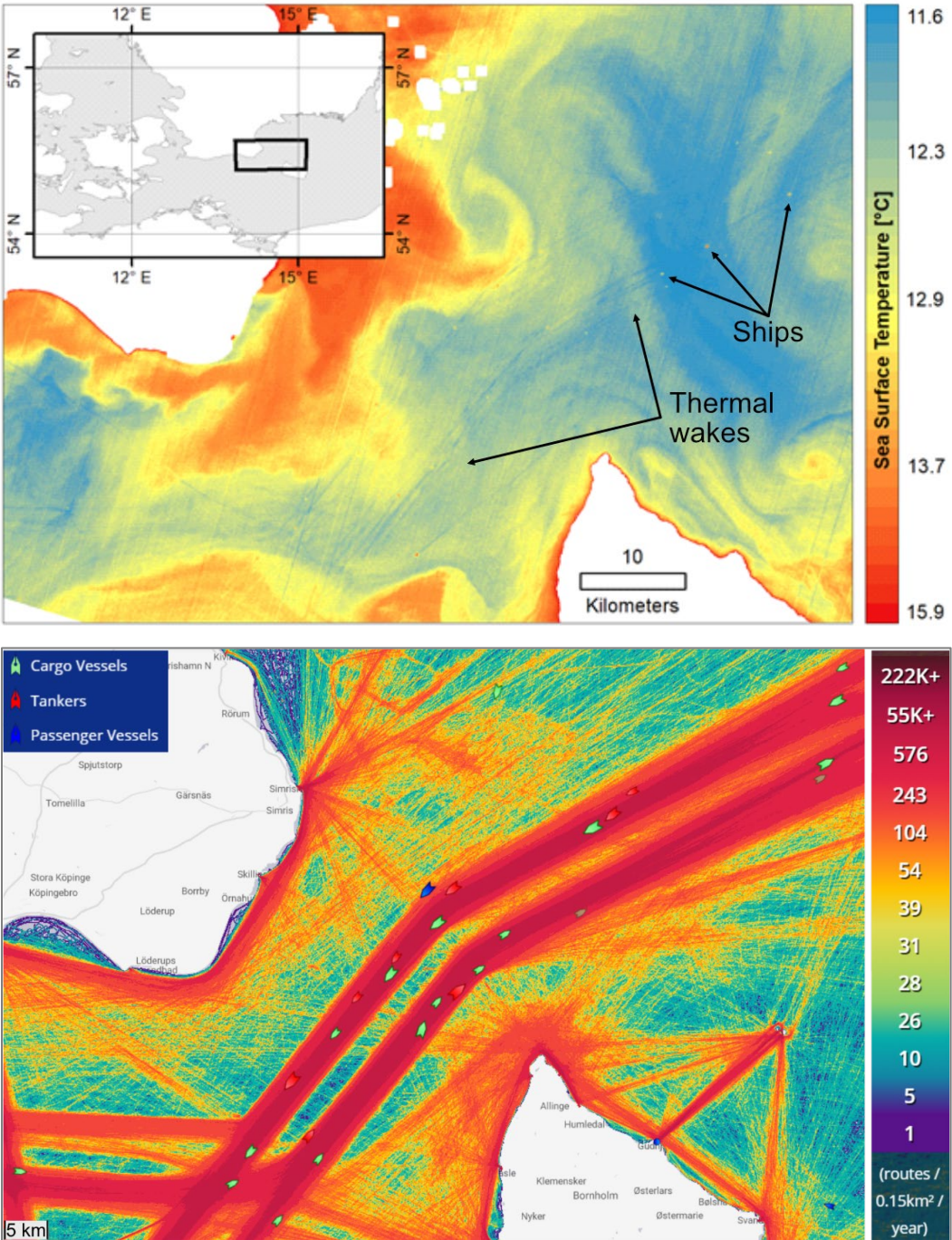
Observed spatiotemporal extent

Sea surface temperature (SST) satellite imagery of thermal wake extent →

Example of ADCP observations of the vertical extent of the turbulent wake. Echo amplitude (top) and dissipation rate of turbulent kinetic energy (bottom).

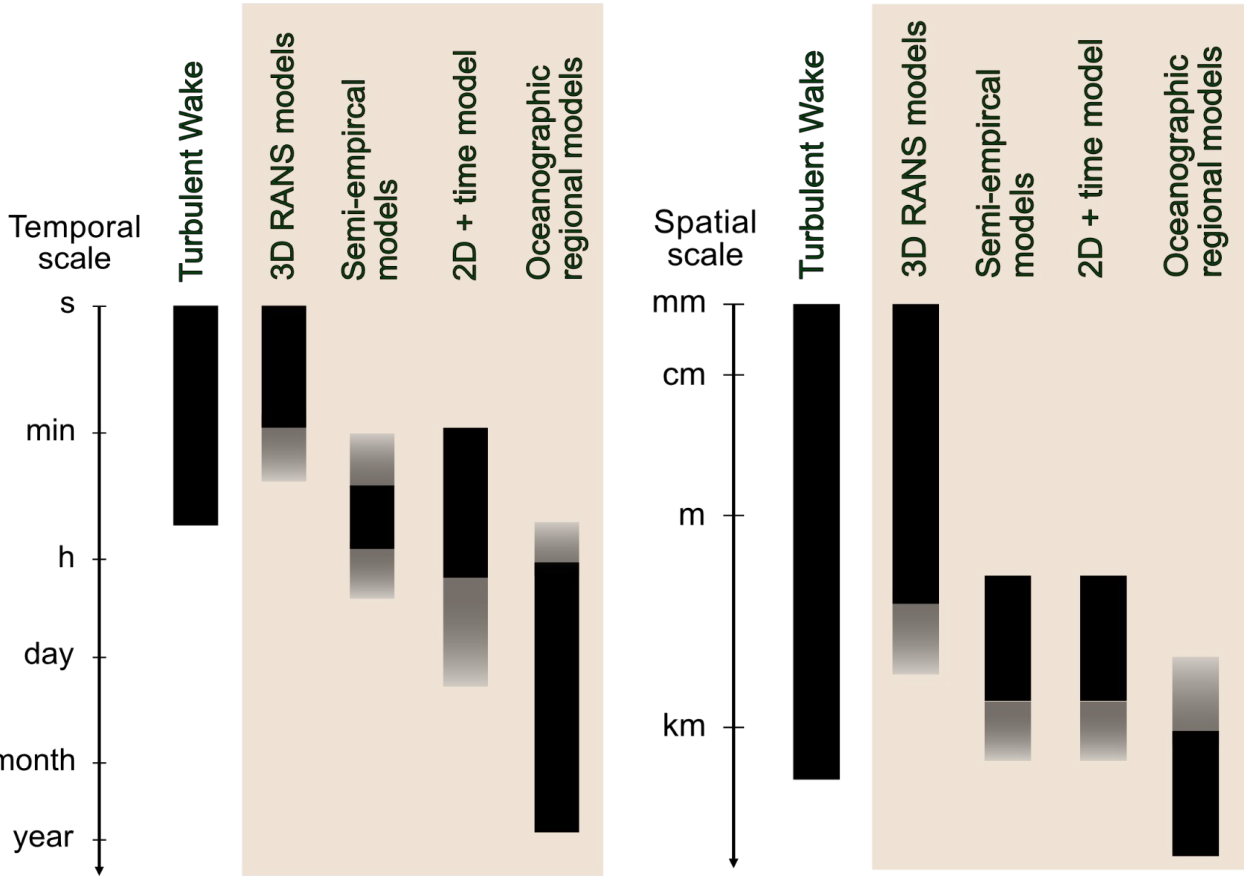


Ship traffic density map for the same area as the SST satellite image indicating the traffic separated ship lane in the area →

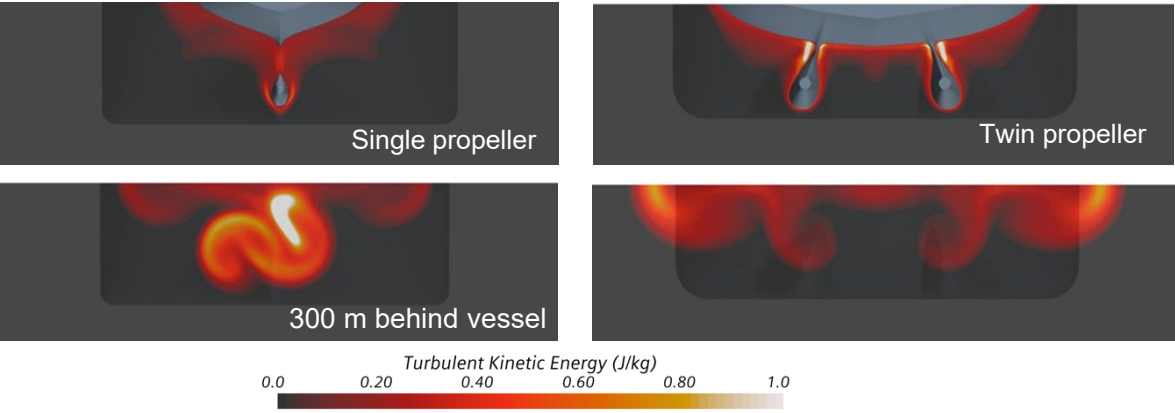


Density plot from Marine Traffic <https://www.marinetraffic.com>

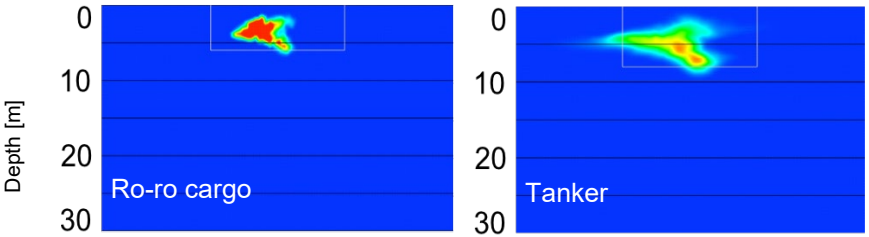
Models



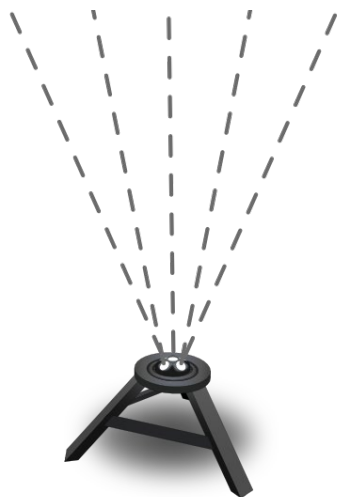
3D Reynolds-Averaged Navier-Stokes (RANS) model



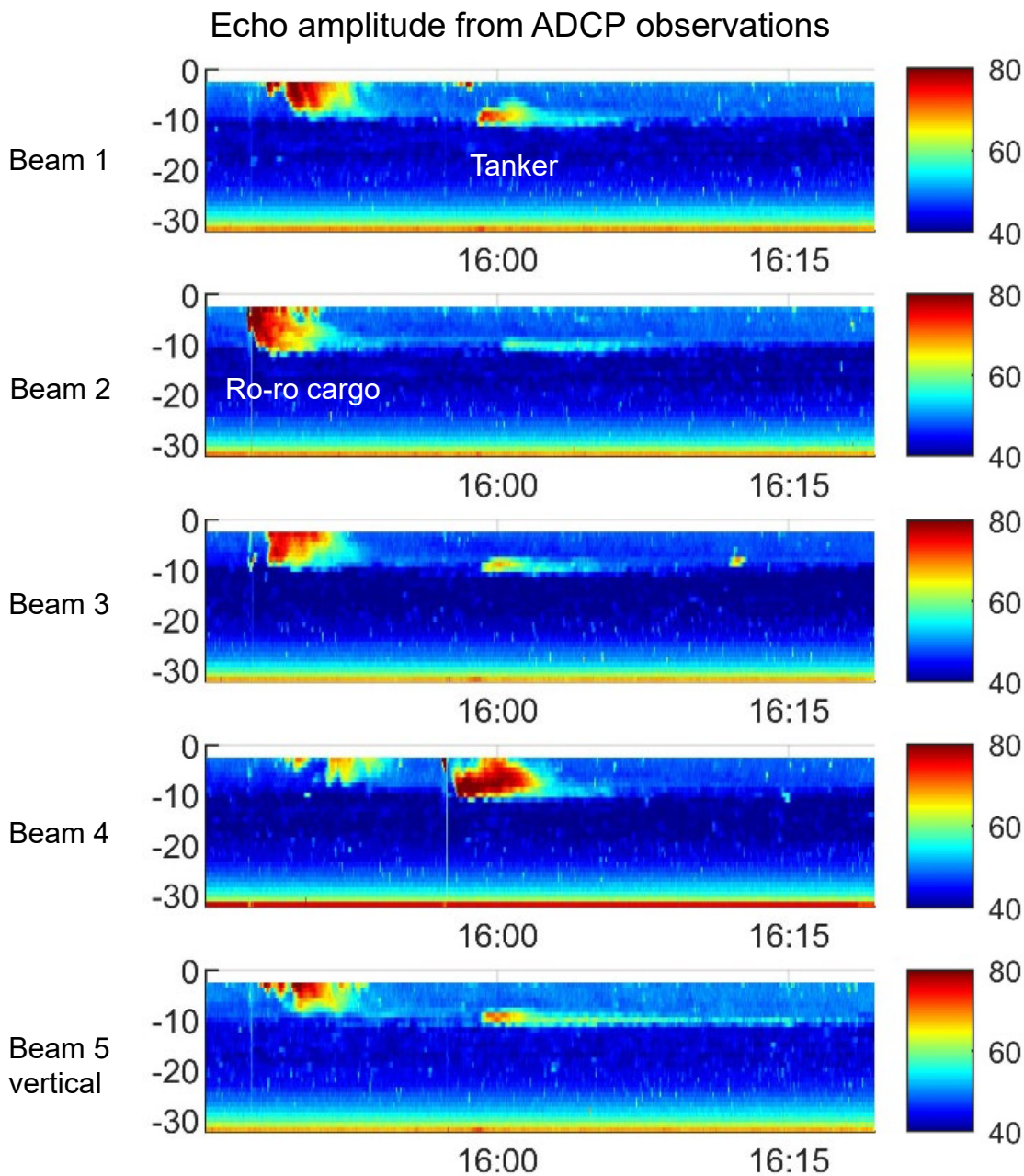
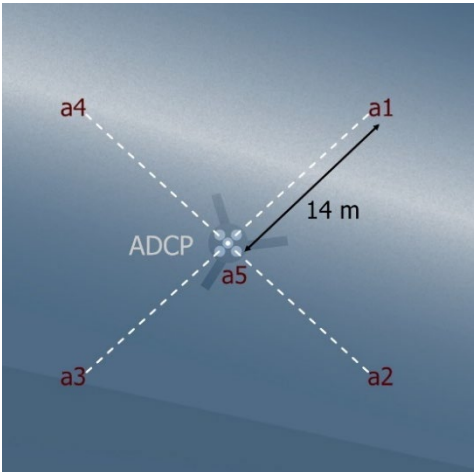
2D + time model results



Explaining the ADCP *in situ* observations



ADCP with 5 beams:
- 1 vertical
- 4 slanted at 25° angle

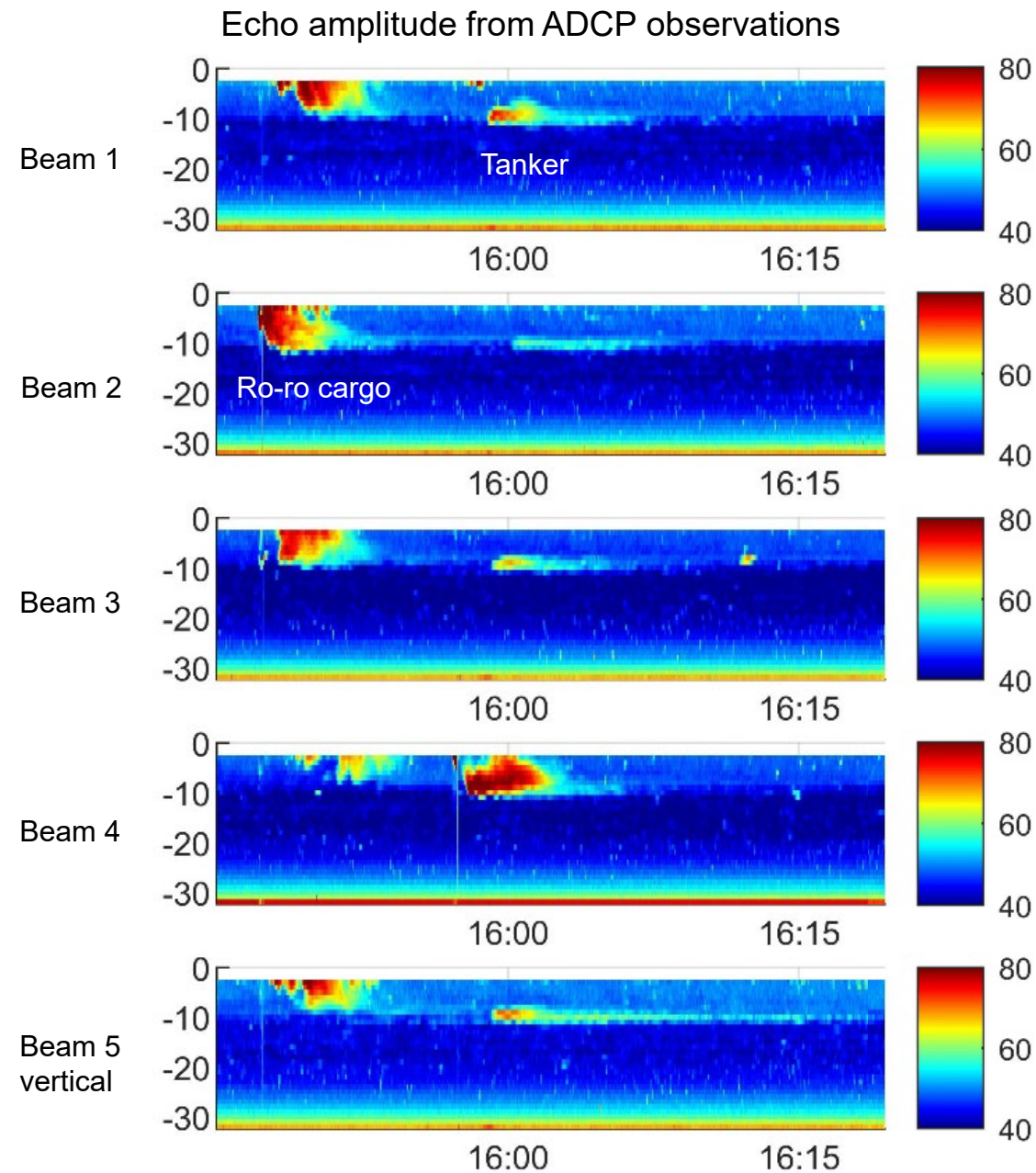


The red areas in the ADCP figure indicate a dense bubble cloud from the turbulent wake. The 5 beams observe different parts of the turbulent wake and can be used to estimate the horizontal expansion of the wake.

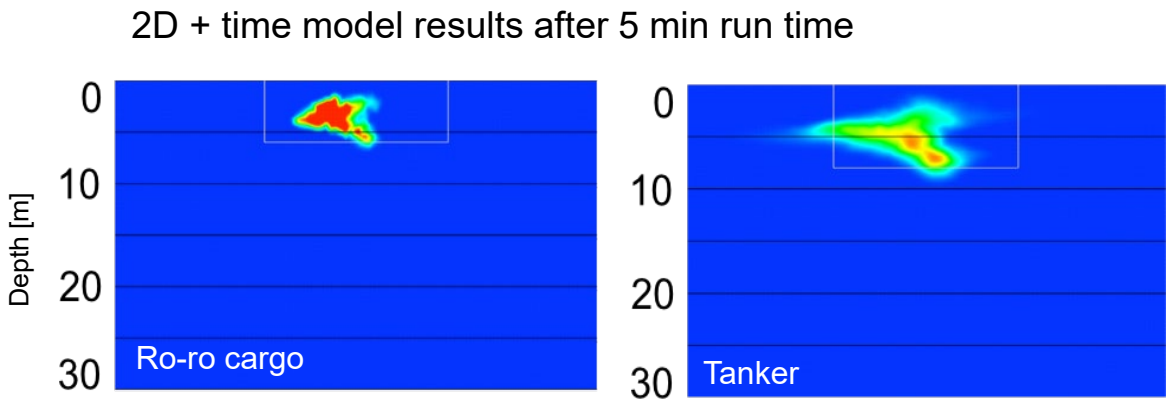
In bubble cloud of the ro-ro cargo vessel is similar in all the beams, with a bubble cloud reaching from the surface to approximately 10 m depth (stratification depth).

The tanker wake only expands from the surface to 10 m in beam 4. In the other beams, the wake signal is only visible at 10 m depth and not at all at surface level. This indicates a wake expansion sideways at the stratification depth.

Comparing model results with *in situ* observations

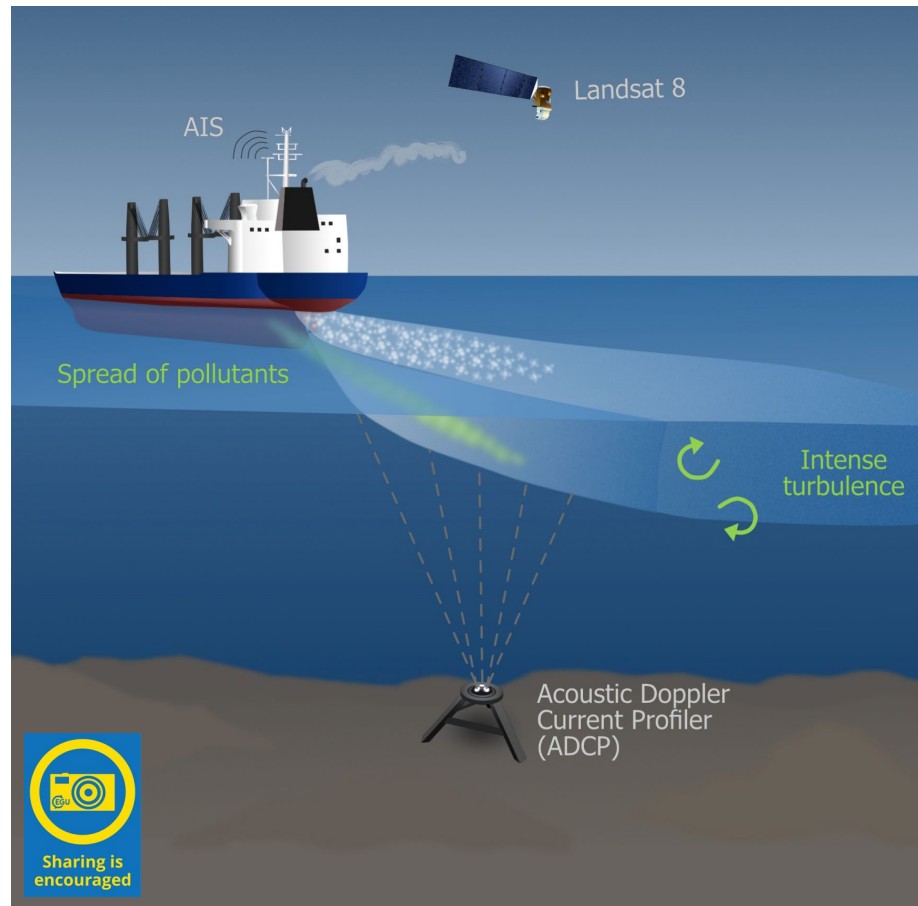


The 2D + time model was run using the same vessel specifications and stratification conditions as for the two ships in the ADCP observations to the left (tanker and Ro-Ro cargo, strong stratification at 10 m depth).

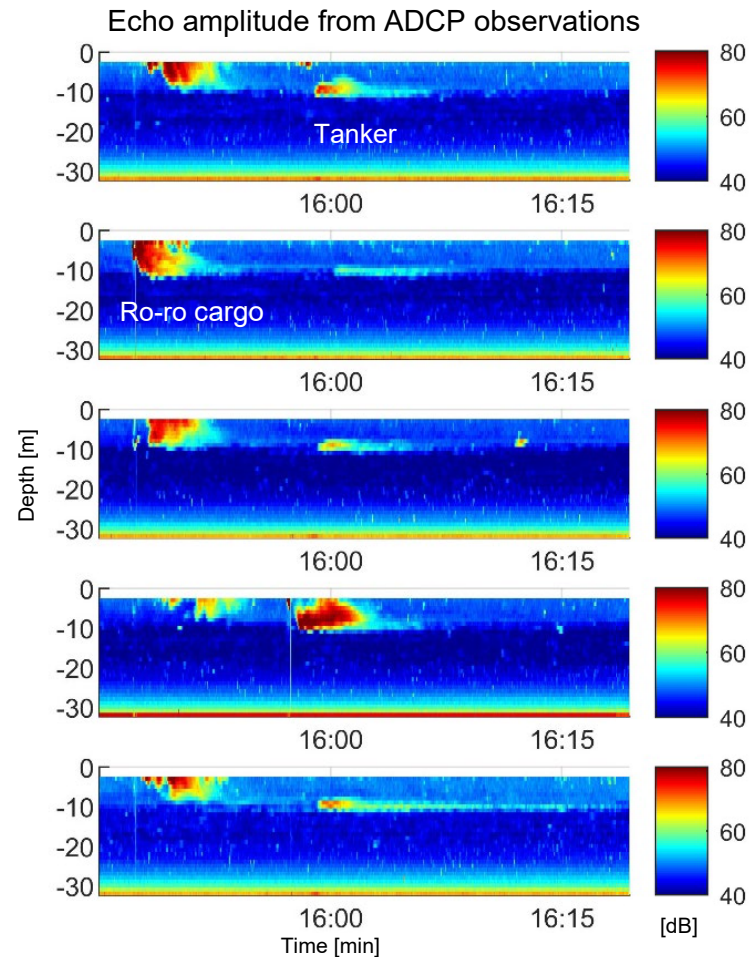


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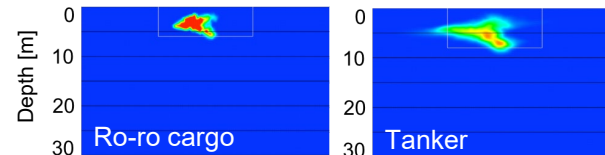
Issue



Results



2D + time model results



Methods

