Jellyfish : how vertical swimming behaviour affects their journey

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Introduction

Most jellyfish have both a benthic (polyp) and a pelagic phase. In order to predict when and where massive jellyfish swarms [1] could develop, a better understanding about their polyp stage is required. Currently, the natural habitat of most polyps is unknown [2]. A drift model could be a tool to find polyp locations in the Southern North Sea. The drift of jellyfish is strongly impacted by their vertical position in the water column .

➢ **We must first know what the <u>effect of vertical swimming behaviour</u> is on the jellyfish drift trajectories.**

Objectives

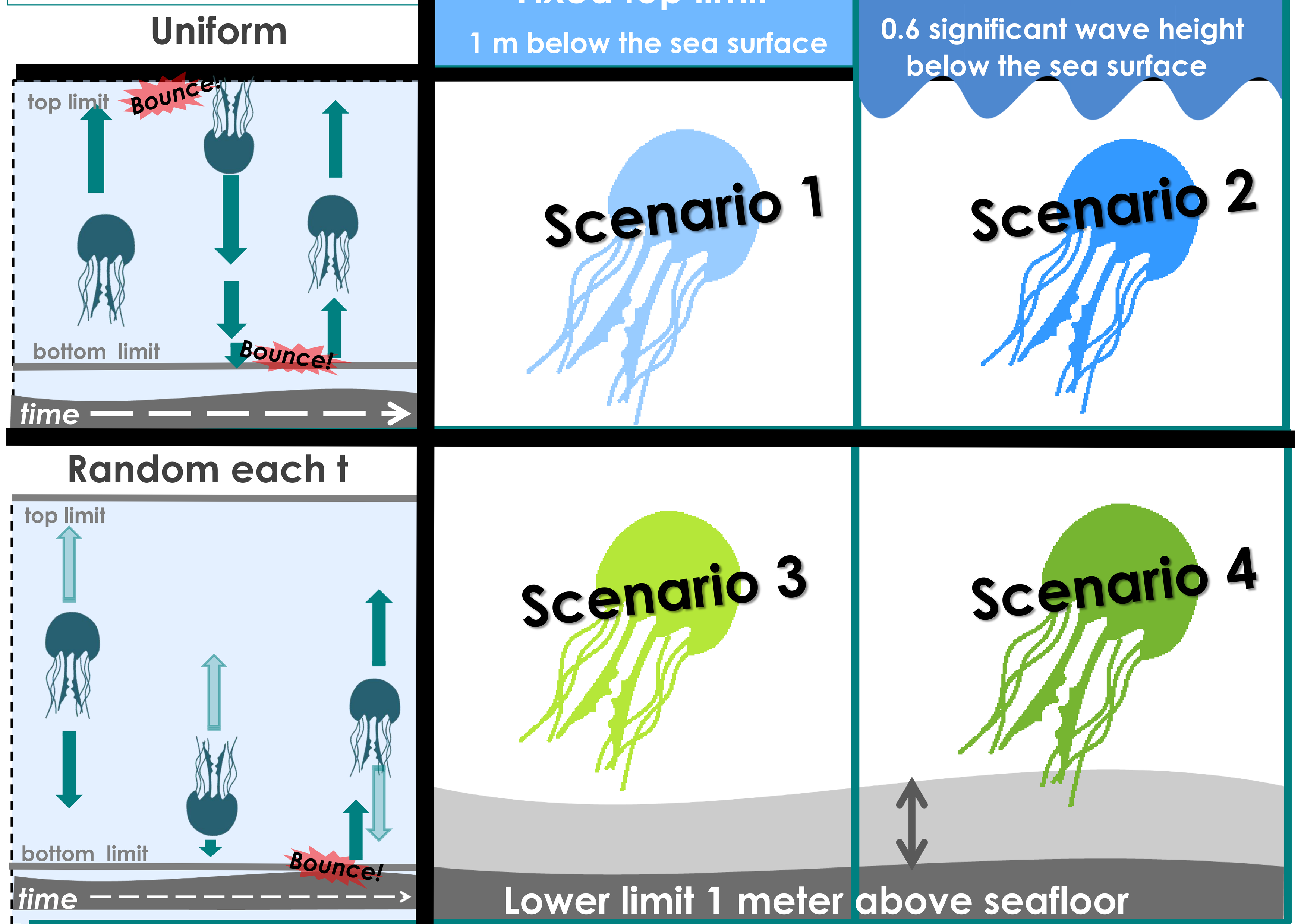
- **Parametrize jellyfish swimming behaviour, based on literature.**
- **Test the sensitivity of the modeled jellyfish trajectories to the designed swimming behaviours.**

4 swimming behaviour scenarios

- Jellyfish might perform complex swimming behaviours to increase their survival, to search for prey, to prevent stranding and enhance bloom maintenance [3].
- Jellyfish are often observed to perform vertical excursions in the water column and sometimes tend to avoid highly turbulent regions in the surface water.

➢ ***The 4 scenarios to represent jellyfish motion are defined by <u>combining 2 swim direction types and 2 top limit types</u> as in the table below :***

Table 1:Overview of the designed swimming behaviour scenarios



Jellyfish swim up and down with velocity w_{swim} between a top limit and a bottom limit

Compute $\overrightarrow{w_{swim}}$ magnitude and direction each time step

$$\overrightarrow{w_{swim}} = \overrightarrow{w_{mean}} \pm \overrightarrow{\{w_{std}\}_{random}}$$

W swim = 1.1 m/min + 0-0.5 m/min

Simulation set-up

- The numerical model [4], based on the Lagrangian particle approach, was adapted to compute the drift of jellyfish [5] as a function of water currents, tides and waves.
- In 4 different behaviour scenarios (table 1), 250 jellyfish are released from Katwijk to calculate the trajectories 18 days backward in time.
- 1 test case with no swimming behaviour, where a jellyfish is continuously thriving at the surface.

Initial conditions

- Time and location of stranded *Aurelia aurita were* used as <u>initial conditions</u>.
- This data was provided by Stichting Anemoon: an organization which systematically collected data on stranded flora and fauna on the Dutch coast since 1968.

Results

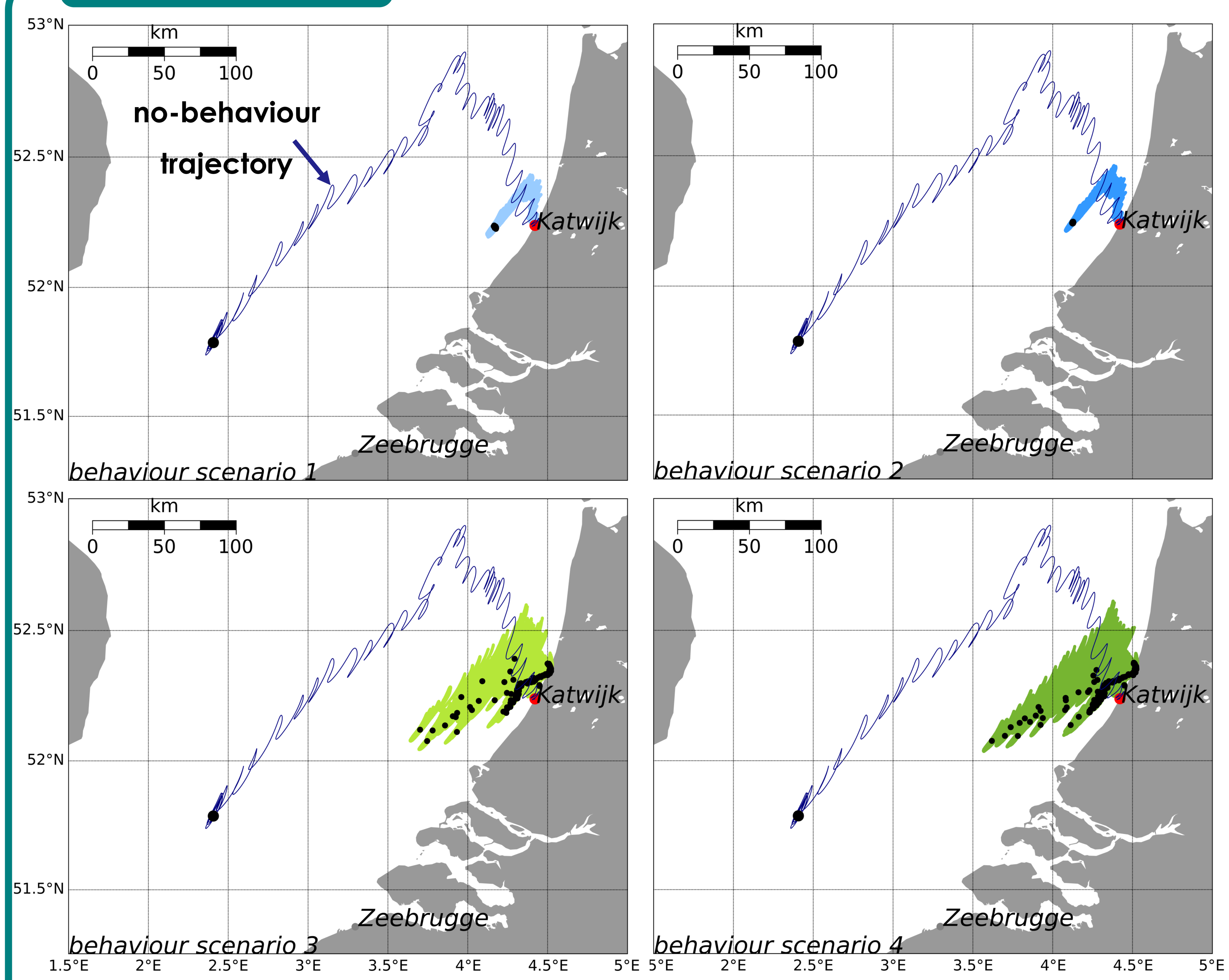


Figure 1 : <u>Estimated jellyfish trajectories</u>: 18 days backtrack starting 25-05-2013 in Katwijk (red point). The black points represent the final position after 18 days. Dark blue: no –behaviour jellyfish, the other colours correspond to 250 trajectories following the swimming behaviour scenarios as in table 1.

- Including swimming behaviour reduced the no-behaviour traveldistance of 906 km by ± 25% [scenario 1 & 2] up to ± 50% [scenario 3 & 4].
- Scenarios including <u>random swimming</u> direction spread more and travelled less far (fig 2, 3) compared to a uniform direction scenario.
- The difference between the two top limit types was not clear for this considered period.

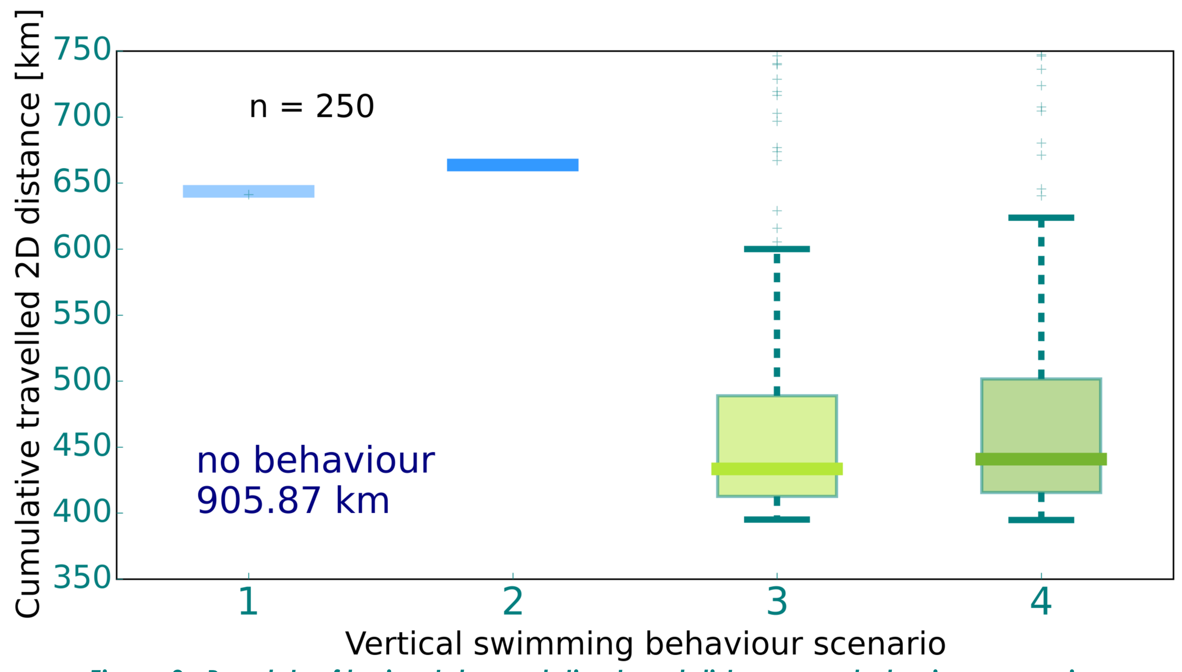


Figure 2 : Boxplots of horizontal cumulative travel distance per behaviour scenario.

Conclusions & Perspective

- The OSERIT model has been expanded with 4 swimming behaviour scenarios to simulate the drift of jellyfish.
- The estimation of the *Aurelia aurita* trajectories was very sensitive to including vertical swimming behaviour *or not*. The jellyfish travel up to 50% shorter distances when including behaviour.
- When a drift model is used to estimate polyp locations, vertical swimming behaviour must be taken into account and longer simulation periods are necessary.
- This tool could be used to calculate the connectivity of observed polyp habitats in the Southern North sea and stranding events on both the Belgian and Dutch coast.

References:

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