Spurious forces can dominate the vorticity budget of ocean gyres on the C-grid

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Background:

Gyres are large horizontal circulations in the ocean.

Gyres are **wind-driven** but it is not clear what forces balance the wind-stress in the real ocean or ocean models.

Methods:

If you integrate each term in the vorticity budget over the areas enclosed by **gyre streamlines** you can identify forces that spin the gyre up and forces that spin the gyre down.

Results:

The central figure shows the vorticity budget of the **Weddell Gyre** in NEMO (ORCA025).

Wind stress is the largest positive term. This tells us that the gyre is wind-driven.

The planetary vorticity term is the largest negative term. This term originates from the **Coriolis force** and **spins the gyre down.**

Theoretically, the planetary vorticity term should vanish when area integrated within streamlines.

In the model, the planetary vorticity term does not vanish because it contains identified spurious terms.

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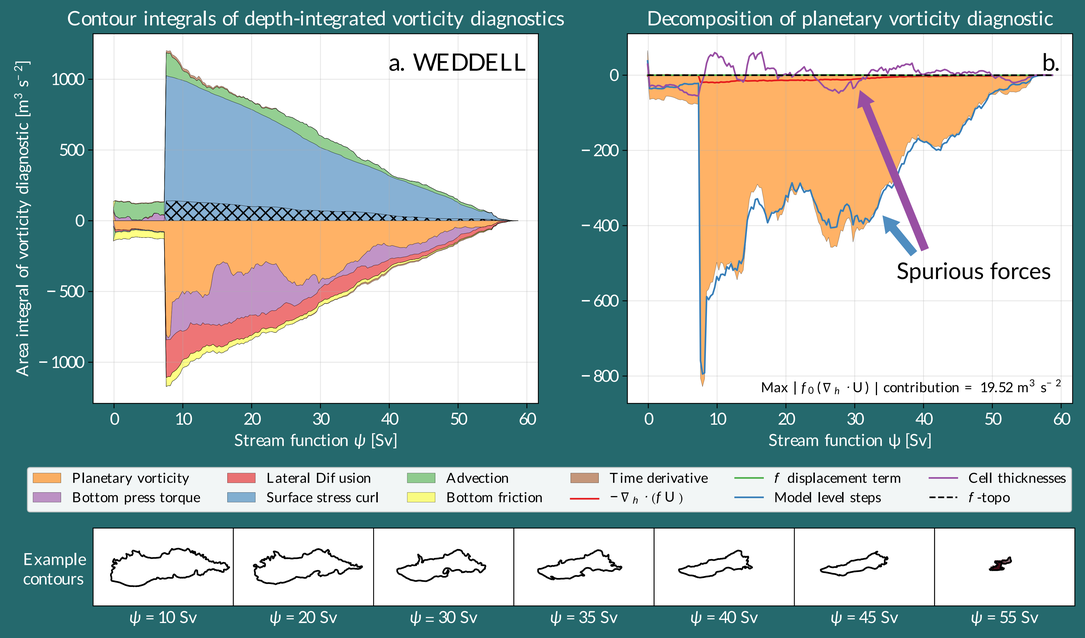
Read the full paper here



What is a vorticity budget?

A vorticity budget described how forces generate **local rotation.**

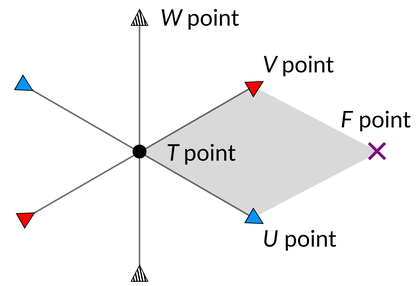
There are in fact many ways to construct a vorticity budget, that are all equally valid.

We calculate a term in the vorticity budget by **depth-integrating** an acceleration and then taking the **curl.**

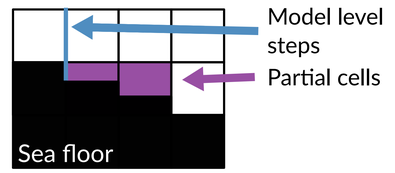
Where do the spurious terms come from?

The spurious terms come from the **grid** used by NEMO and many ocean models.

Variables are distributed on a staggered grid called the **C-grid.**



The sea floor is represented in **z-coordinates** with **partial cells**



Using a **C-grid model** with **z-coordinates** permits spurious topographic forces that emerge from **partial cells** and **model level steps**.

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