Vertical velocities in quasi-geostrophic floating vortices

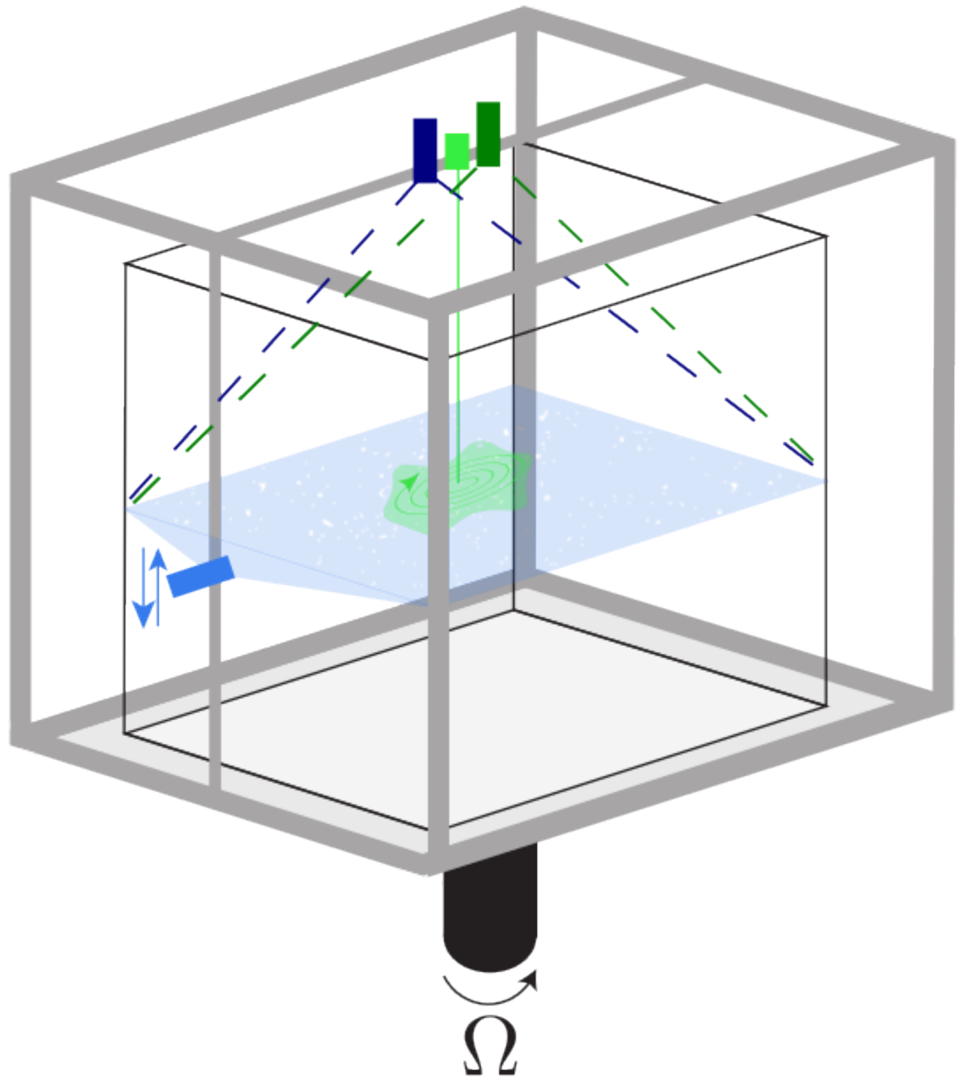
Marine Aulnette, Patrice Le Gal & Michael Le Bars

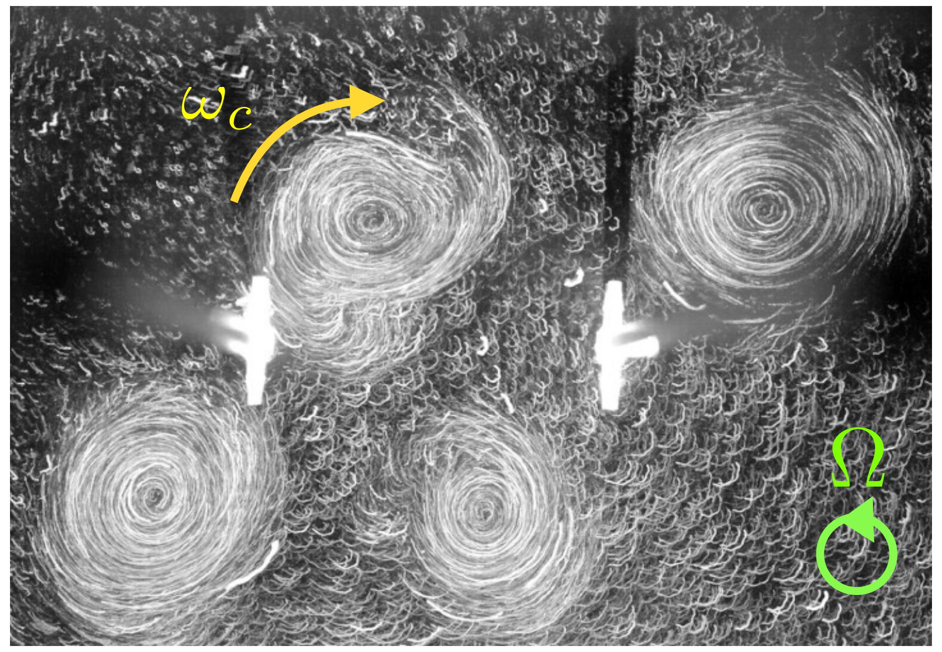
Motivation

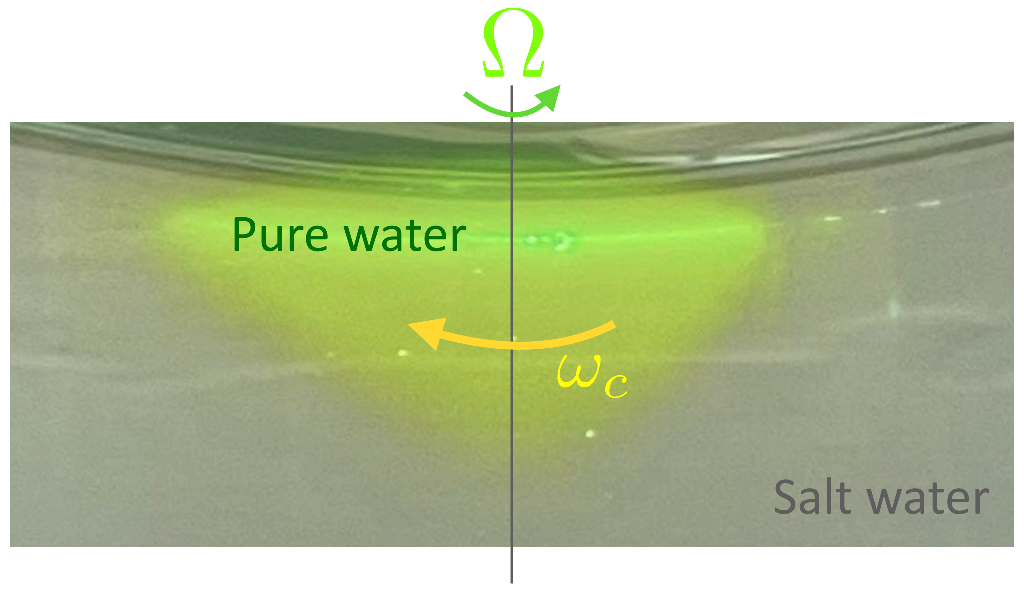
- Sub-mesoscale oceanic structures escape the 2D geostrophic description ⟶ **fine scale vertical motions**
- Vertical motions have an impact on transport of biochemical components
- Vertical motions may shed light on part of the **ocean energy budget**
- Very small velocity compared to horizontal motions ⟶ **Big challenge for in situ measurements**

How can we measure and understand these fine scale vertical motions in the lab?

Generation of multipoles of surface anticyclones







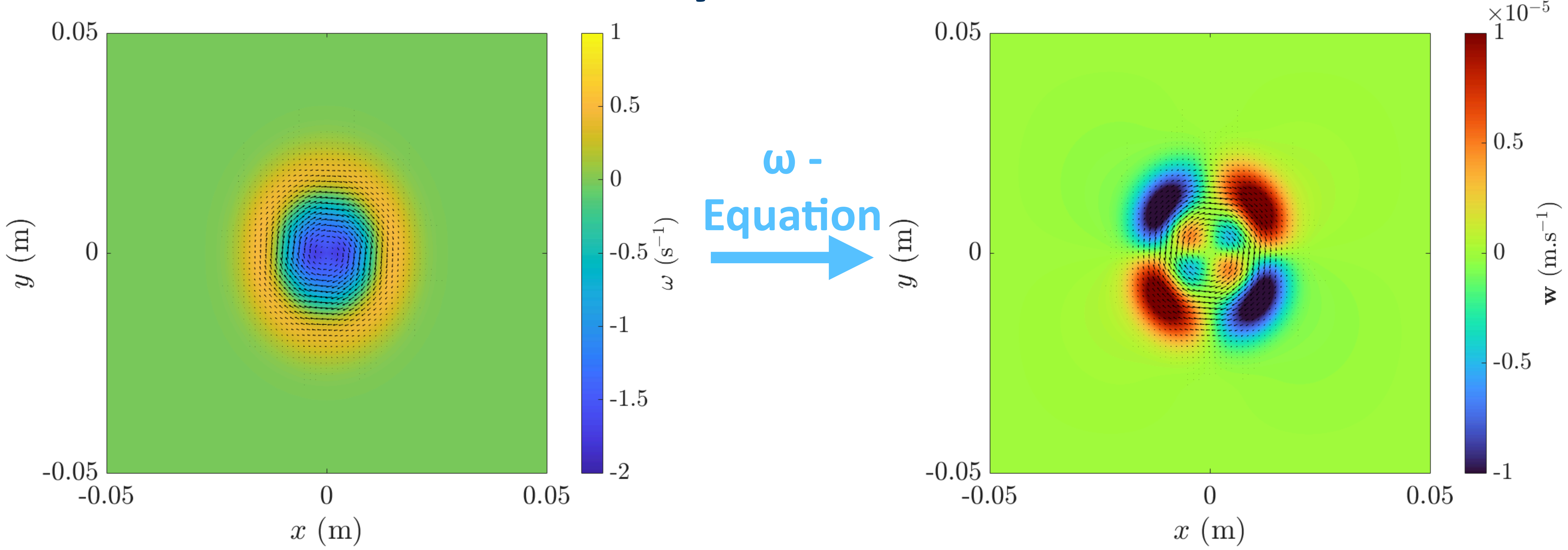
Oceanographic model : ω - Equation

$$\vec{u} = \underbrace{\vec{u_g}}_{(u_g, v_g, 0)} + \overbrace{\vec{u_a}}^{(u_a, v_a, \mathbf{w})}$$

Navier-Stokes equations

$$N^2 \nabla_h^2 \mathbf{w} + f^2 \frac{\partial^2 \mathbf{w}}{\partial z^2} = 2 \nabla_h \cdot (\nabla_h \vec{u_g} \cdot \nabla_h \rho)$$

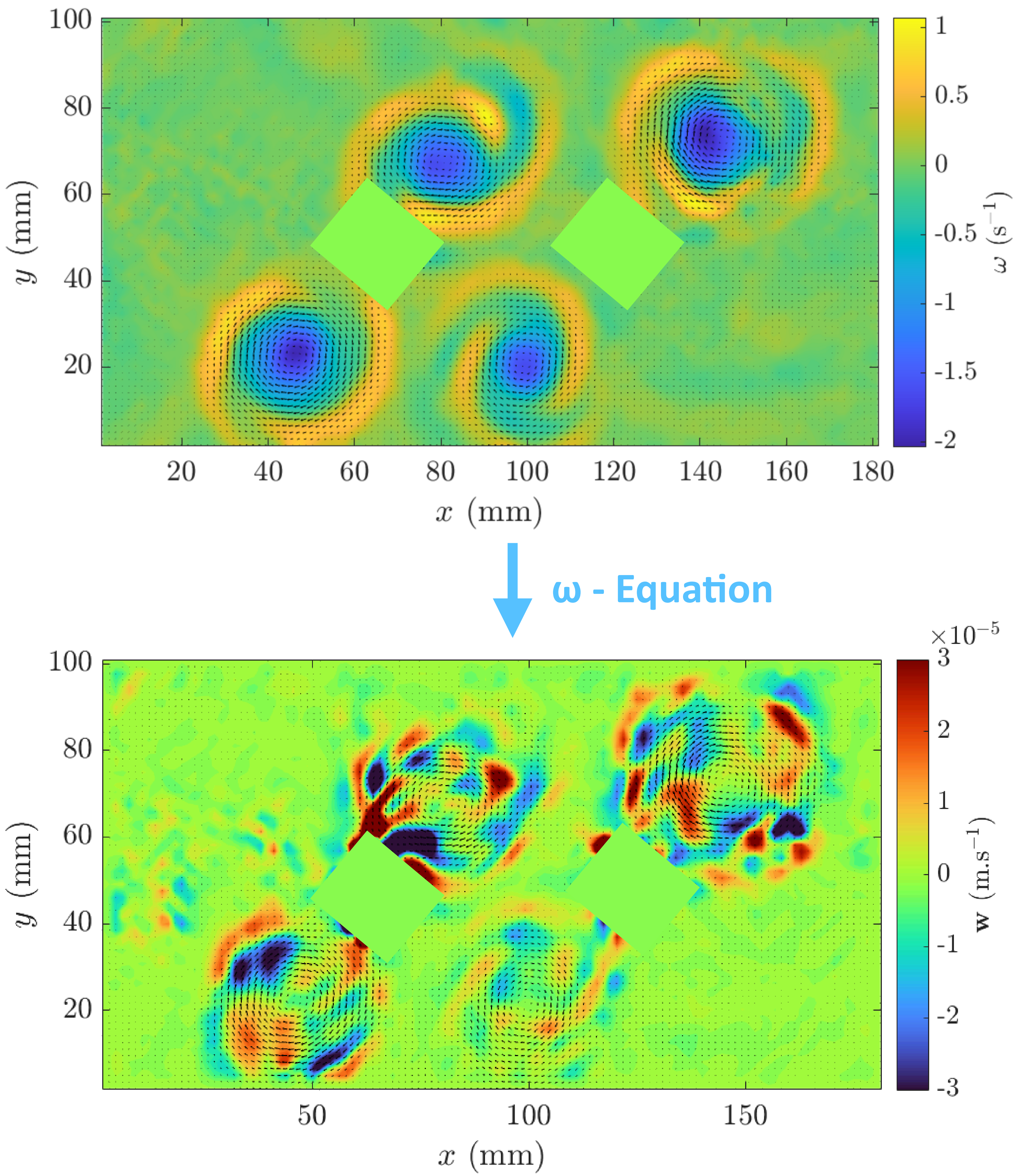
Analytical vortex



Elliptic shielded vortex : $v(r) = v_m \left(\frac{r}{r_m}\right) \exp\left(\frac{1}{b}\left[1 - \left(\frac{r}{r_m}\right)^b\right]\right)$

According to the ω - Equation : $\frac{\mathbf{w}}{|u_g|} \simeq 10^{-3}$

Experiments



Challenge : measure of w !