Near-inertial waves *extract energy* from barotropic quasi-geostrophic flow

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Big picture and goal

The Xie & Vanneste (2015) minimal model

With barotropic quasi-geostrophic flow, $\psi = \psi(x, y, t)$, uniform background buoyancy frequency, N_0, and single-mode near-inertial vertical structure, $u_w + iv_w = \mathrm{e}^{\mathrm{i}(mz - f_0 t)}\phi(x, y, t)$, the Xie & Vanneste [1] coupled model reduces to

$$q_t + J(\psi, q) = D_q\,, \tag{1}$$

with the *wave-averaged* quasi-geostrophic potential vorticity (cf. [2])

$$q = \triangle\psi + \tfrac{1}{f_0}\Big[\tfrac{1}{4}\triangle|\phi|^2 + \tfrac{\mathrm{i}}{2}J(\phi^\star, \phi)\Big]\,, \tag{2}$$

and wave equation

$$\phi_t + J(\psi, \phi) + \tfrac{\mathrm{i}}{2}\phi\triangle\psi - \tfrac{\mathrm{i}}{2}f_0\lambda^2\triangle\phi = D_\phi\,, \tag{3}$$

Above, the streamfunction is defined so that the geostrophic velocity is $(u_e, v_e) = (-\psi_y, \psi_x)$, $\triangle \stackrel{\text{def}}{=} \partial_x^2 + \partial_y^2$ is the horizontal Laplacian, $J(f, g) = f_x g_y - f_y g_x$ is the lateral Jacobian, the superscript star * denotes complex conjugation, $\lambda = \frac{N_0}{f_0 m}$ is an intrinsic horizontal scale, and the D-terms represents an *ad hoc* dissipation.

$$\partial_t \tfrac{1}{2}|\phi|^2 + J(\psi, \tfrac{1}{2}|\phi|^2) + \nabla\cdot\mathbf{F}_w = \text{dissipation}\,. \tag{4}$$

Above, $\mathbf{F}_w$ is the wave flux of kinetic energy density:

$$\mathbf{F}_w \stackrel{\text{def}}{=} \tfrac{\mathrm{i}}{4}f_0\lambda^2\left(\phi\nabla\phi^\star - \phi^\star\nabla\phi\right) = f_0\lambda^2\nabla\Theta \times \tfrac{1}{2}|\phi|^2\,, \tag{5}$$

where the equality above follows from use of a polar representation $\phi = |\phi|\mathrm{e}^{\mathrm{i}\Theta}$.

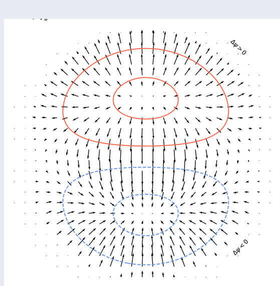
The physics of stimulated imbalance

From (3), we deduce an equation for the wave potential energy, $P_w \stackrel{\text{def}}{=} \frac{1}{4}\lambda^2\langle|\nabla\phi|^2\rangle$:

$$\dot{P}_w = \underbrace{\tfrac{1}{f_0}\Big\langle\tfrac{1}{2}\triangle\psi\nabla\cdot\mathbf{F}_w\Big\rangle}_{\stackrel{\text{def}}{=}\Gamma_r} + \underbrace{\tfrac{\lambda^2}{2}\Big\langle\tfrac{1}{2}\psi\left[J(\phi, \triangle\phi^\star) + J(\phi^\star, \triangle\phi)\right]\Big\rangle}_{\stackrel{\text{def}}{=}\Gamma_a} + \text{dissipation}\,, \tag{6}$$

where $\Gamma_r + \Gamma_a$ is the wave-potential energy generation, which occurs at the expenses of geostrophic kinetic energy, $K_e \stackrel{\text{def}}{=} \frac{1}{2}\langle|\nabla\psi|^2\rangle$, i.e.,

$$\dot{K}_e = -(\Gamma_r + \Gamma_a) + \text{dissipative terms}\,. \tag{7}$$



Altering Column Spans

You can make columns that span multiple other columns relatively easily. Lengths are defined in the template that make columns look normal-ish if you want to use a four-column layout like this poster. If you want to use a different number of columns, you will have to modify those lengths accordingly at the top of the poster.tex file.

In particular, near the top of the TeX file you will see lines that look like:

```
\setlength{\sepwid}{0.024\paperwidth}
\setlength{\onecolwid}{0.22\paperwidth}
\setlength{\twocolwid}{0.464\paperwidth}
\setlength{\threecolwid}{0.708\paperwidth}
```

Set "sepwid" to be some small length somewhere near 0.025 (this is the space between columns). Then if n is the number of columns you want, you should set

$$\begin{aligned}\text{onecolwid} &= \frac{1}{n}(1 - (n+1) \times \text{sepwid}),\\ \text{twocolwid} &= 2 \times \text{onecolwid} + \text{sepwid},\\ \text{threecolwid} &= 3 \times \text{onecolwid} + 2 \times \text{sepwid}.\end{aligned}$$

Block Colours

For the standard blocks there are two colours; one for the title and one for the block body:

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\setbeamercolor{block title}
{fg=red,bg=white}
\setbeamercolor{block body}
{fg=black,bg=white}
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References

Some references and a graphic to show you how

[1] J-H Xie and J. Vanneste (2015).

[2] G. L. Wagner and W. R. Young (2015).