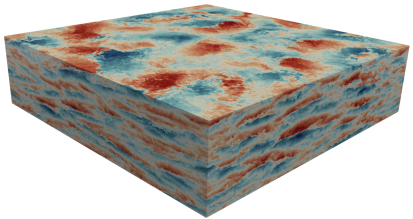
Numerical simulations of internal gravity wave turbulence

V.Labarre & G.Krstulovic & S.Nazarenko



Stratified flows:

$$\boldsymbol{\nabla}\cdot\boldsymbol{v}=0,$$
$$\partial_t\boldsymbol{v}+\boldsymbol{v}\cdot\boldsymbol{\nabla}\boldsymbol{v}=-\boldsymbol{\nabla}p+b\boldsymbol{e}_z+\nu\Delta\boldsymbol{v}+\boldsymbol{f},$$
$$\partial_t b+\boldsymbol{v}\cdot\boldsymbol{\nabla}b=-N^2v_z-\kappa\Delta b,$$

(Labarre et al., arXiv, 2023)

Kinetic equation for waves:

$$\dot{n}_{\boldsymbol{k}}=\int\left[\mathcal{R}^{\boldsymbol{k}}_{12}-\mathcal{R}^{1}_{\boldsymbol{k}2}-\mathcal{R}^{2}_{\boldsymbol{k}1}\right]\mathrm{d}^3\boldsymbol{k}_1\,\mathrm{d}^3\boldsymbol{k}_2+f_{\boldsymbol{k}}-d_{\boldsymbol{k}},$$
$$\mathcal{R}^{\boldsymbol{k}}_{12}=4\pi\,\delta(\boldsymbol{k}-\boldsymbol{k}_1-\boldsymbol{k}_2)\,\delta(\omega_{\boldsymbol{k}}-\omega_1-\omega_2)\,|V^{\boldsymbol{k}}_{12}|^2\,\left(n_1n_2-n_{\boldsymbol{k}}n_1-n_{\boldsymbol{k}}n_2\right),$$

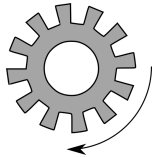
$n_{\boldsymbol{k}}$: wave action spectrum, $f_{\boldsymbol{k}}$: forcing, $d_{\boldsymbol{k}}$: dissipation,
$\omega_{\boldsymbol{k}}$: wave frequency, $V^{\boldsymbol{k}}_{12}$: interaction coefficients

Weak Wave Turbulence:

(Zakharov et al., Springer, 1992)

only waves, infinite size,

$$Fr=\frac{U}{NL}\to 0,$$
$$Re=\frac{UL}{\nu}\to\infty$$



Numerical simulations of internal gravity wave turbulence

V.Labarre & G.Krstulovic & S.Nazarenko

Kinetic equation simulations:

- Logarithmic grid $k_n = k_0 \lambda^n$, $1 \lesssim \lambda$
- Interpolation and integration tools
- Runge-Kutta
- Parallelized

Localized forcing:

No pure power law, nonlocal transfers are important for the development of the spectrum

(McComas & Bretherton, J. Geophys. Res., 1977)