Validity domains and parametrizations for white-noise and multiscale models in turbulence and wave-turbulence interactions

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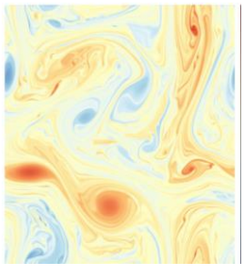
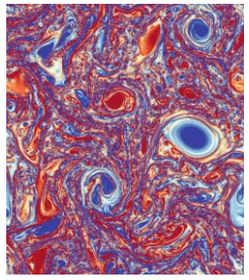
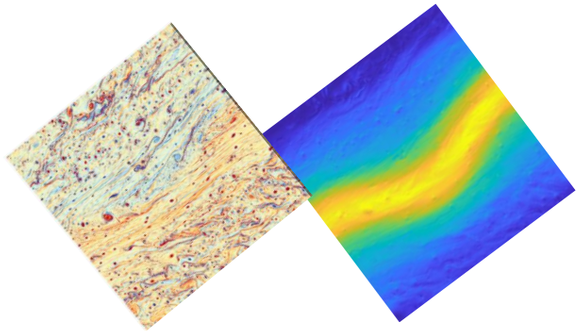
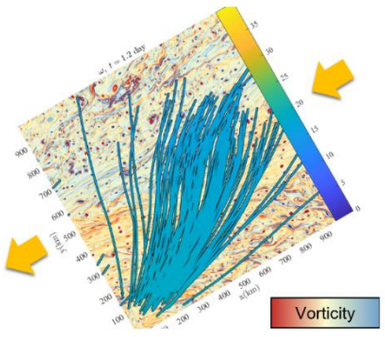
<u>Validity</u> of the time decorrelation assumption for v'
for turbulence / wave-turbulence:

$$\frac{\begin{pmatrix}\textbf{Along-flow/ray}\\ v'\text{ correlation time}\end{pmatrix}}{\begin{pmatrix}\text{characteristic time of}\\ \text{flow/wave group}\\ \text{properties }\textbf{evolution}\end{pmatrix}} = \frac{\left(\frac{l_{v'}}{\|v\|/\|C_g^0\|}\right)}{\left(\frac{1}{\|\nabla v\|}\right)} \ll 1$$

<u>Applied to</u>
steep-spectrum (SQG) and flat-spectrum (2D Euler) dynamics;
homogeneous and heterogeneous flows

Example of ray tracing



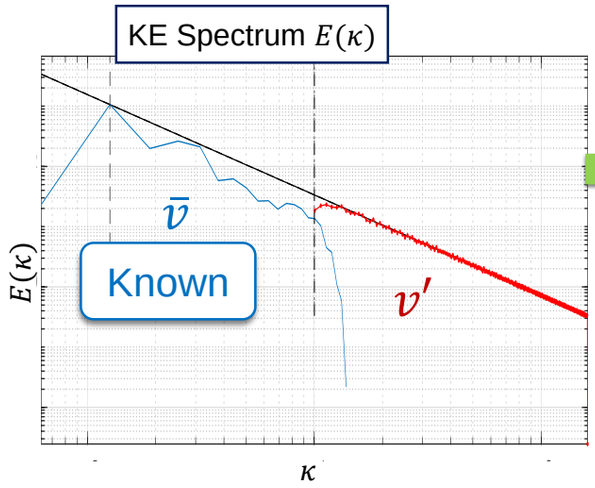
Wave-spectrum, Significant wave heights, and Currents predictions, Uncertainty quantification for data assimilation

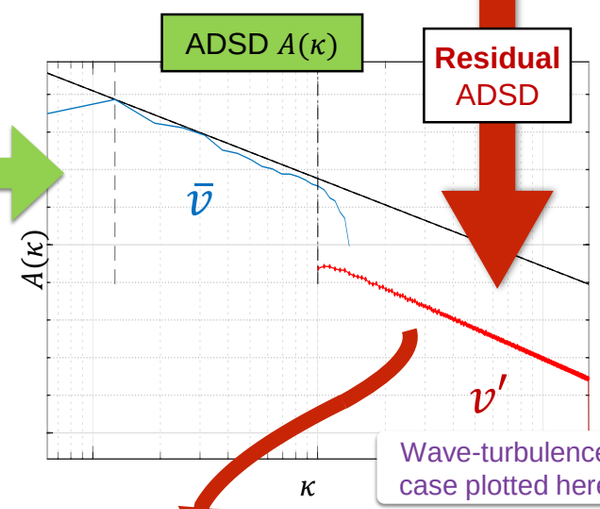
<u>Parametrization</u> of white v' for simulations

Absolute Diffusivity Spectral Density
$A(\kappa) = E(\kappa)\,\tau(\kappa)$

Current correlation time
$\tau(\kappa) = \frac{1/\kappa}{v_k} = \frac{1/\kappa}{\sqrt{\kappa\,E(\kappa)}}$

Correlation time along ray
$\tau(\kappa) = \tau_{ray}(\kappa) = \frac{1/\kappa}{\|C_g^0\|}$





Reference:
Resseguier, Pan & Fox-Kemper, NPG, 2020

$v' = (\text{filter}) * (\text{white noise})$

<u>Parametrization</u> of v' multiscale in space and time are also possible

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