Context – TOMAWAC code (http://www.opentelemac.org/):

Numerical resolution ➡ Sea state evolution ➡

At a given location:

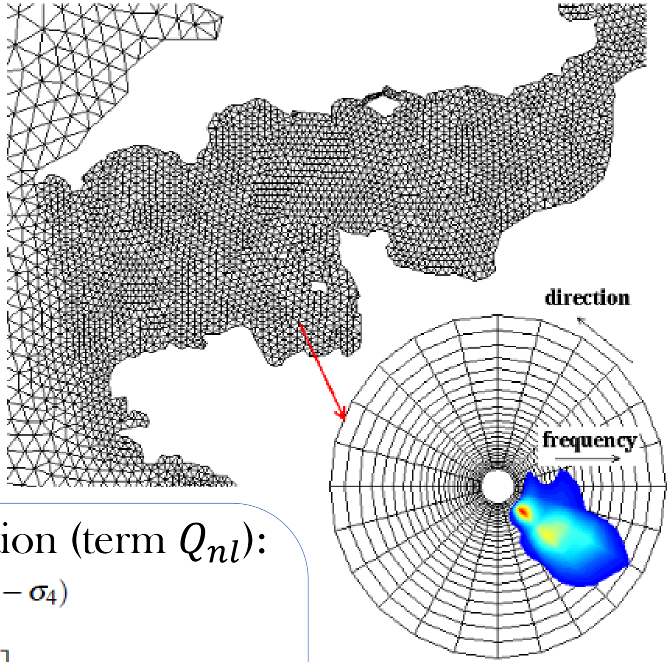
- Understanding climatology through statistical processing (*hindcast*)
- Short-term predictions

⬆

Modelling:

- Balance equation for wave action N
- Mathematical models for energy input, transfer and dissipation terms

$$\frac{\partial N}{\partial t}+\frac{\partial(\dot{x}N)}{\partial x}+\frac{\partial(\dot{y}N)}{\partial y}+\frac{\partial(\dot{k}_x N)}{\partial k_x}+\frac{\partial(\dot{k}_y N)}{\partial k_y}=Q(k_x,k_y,x,y,t)$$



Focus on the energy transfer due to 4-waves interaction (term Q_{nl}):

$$Q_{nl}^{exact}=\iiint \sigma_4.G.\delta\left(\mathbf{k}_1+\mathbf{k}_2-\mathbf{k}_3-\mathbf{k}_4\right)\delta\left(\sigma_1+\sigma_2-\sigma_3-\sigma_4\right)$$

$$\left[\frac{F(\mathbf{k}_1)}{\sigma_1}\frac{F(\mathbf{k}_2)}{\sigma_2}\left(\frac{F(\mathbf{k}_3)}{\sigma_3}+\frac{F(\mathbf{k}_4)}{\sigma_4}\right)-\frac{F(\mathbf{k}_3)}{\sigma_3}\frac{F(\mathbf{k}_4)}{\sigma_4}\left(\frac{F(\mathbf{k}_1)}{\sigma_1}+\frac{F(\mathbf{k}_2)}{\sigma_2}\right)\right]d\mathbf{k}_1 d\mathbf{k}_2 d\mathbf{k}_3$$

- Understanding its role in sea state physics
- Search of the most efficient numerical model to solve it between:
  - Approximate methods (DIA, mDIA)
  - Quasi-exact methods (GQM)

Dynamics of wave spectrum evolution due to 4-wave non-linear interactions evaluated with the quasi-exact Gaussian Quadrature Method (GQM)

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Study presentation

- **Objectives:**
  - Understand the role of quadruplet non-linear interactions in the wave spectrum dynamics
  - Comparison of results obtained with different numerical methods

- Beginning from <u>arbitrary initial condition</u>, we let the wave spectrum evolve under the only effect of Q_{nl} term (Hasselmann's kinetic equation) for a long physical time (roughly one year) in deep water conditions
- Q_{nl} is computed with GQM, mDIA and DIA
- The results are compared to the predictions from the weak turbulence theory

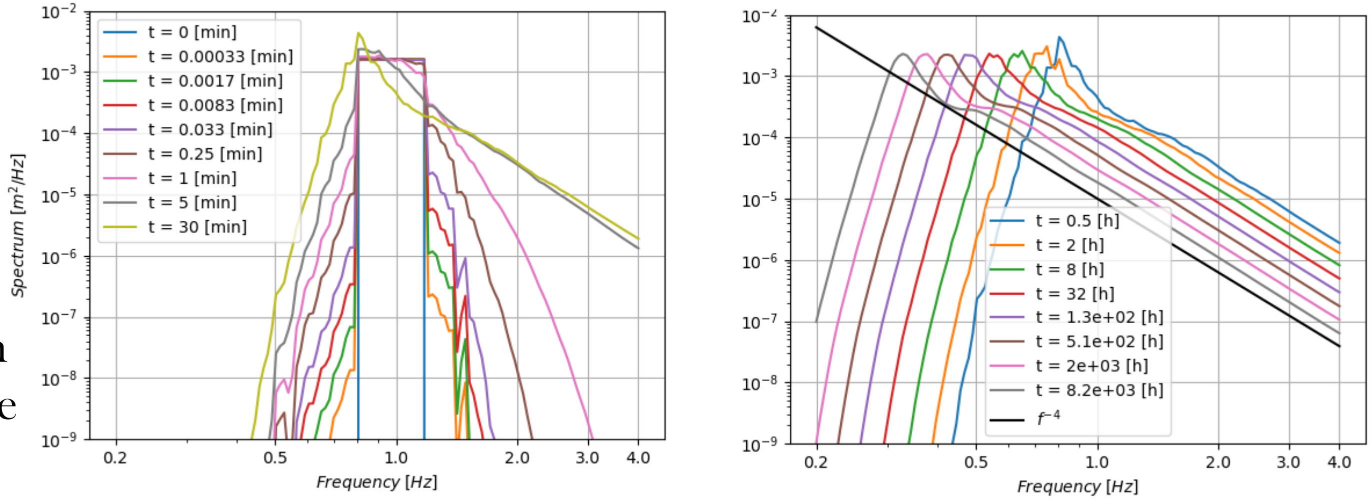

FIG - Evolution of frequency spectrum in the short-term (left) and long-term (right) for beginning step-shaped condition simulated with GQM

Take-overs

- Good agreement with theoretical results (weak turbulence theory)
- Once reached a near equilibrium state, self-similarity of the solution
- For GQM results, convergence to the same final spectrum regardless the initial condition (fixed initial steepness)