HIGRAD SPECTRA

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Simulation Setup

- Domain 600 km on a side, constant dx/dy=2 km, 30 vertical levels stretched, time step 20s, 6 h runs.
- Free slip of momentum and scalars on lower boundary, 3 km thick gravity wave absorber in upper levels.
- ICs…vortex in thermal wind balance, dry, mean tropical sounding as background, no forcing.
- 20 km wide relaxation zones on boundaries.
- Turbulence…constant eddy viscosities/diffusivities (K), tried stress tensor and LaPlacian for operator on all variables (they are identical for this problem).

Computation of Spectra

(1)Cut out x/y boundaries and gravity wave layer from data. Used data at 6 h.

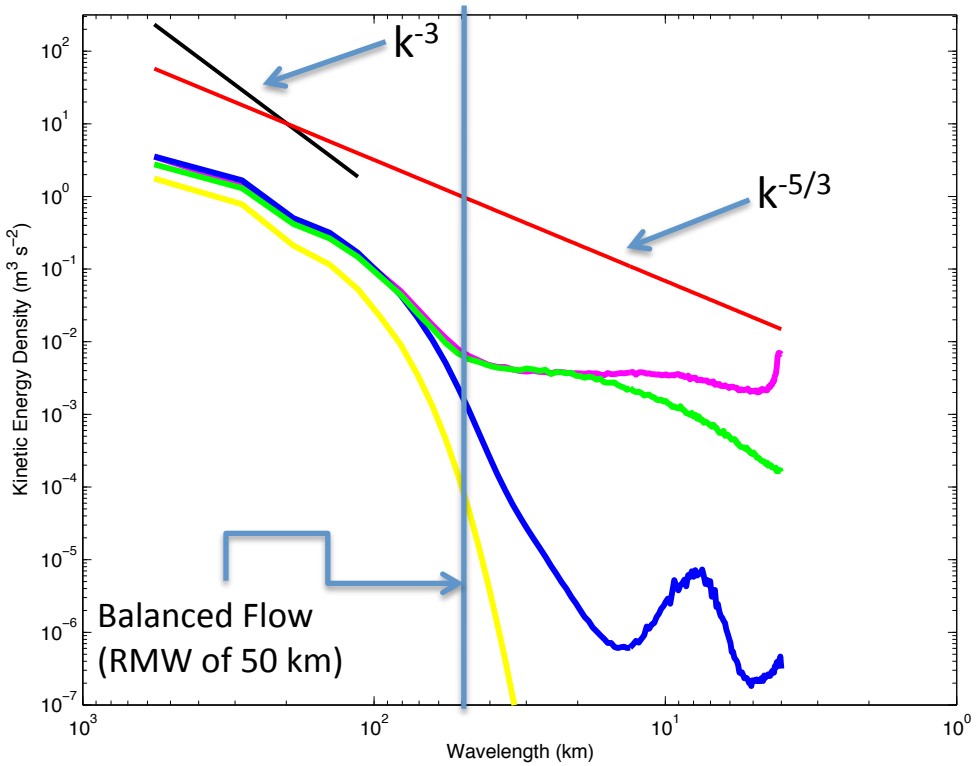
(2)removed linear trend to render data periodic

(3)compute 1D FFTs along x dimension for all y and z

(4)compute kinetic energy per unit wavenumber

(5)average kinetic energy spectra over all y and z

Kinetic Energy Spectra



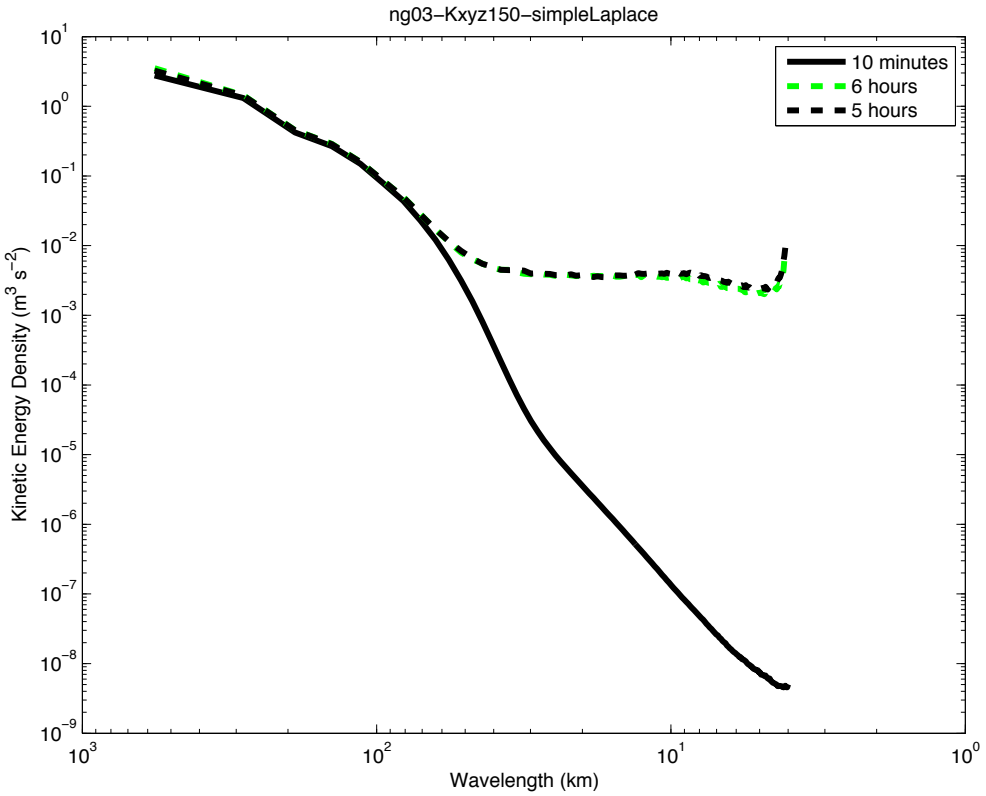
Pink: Kxyz = 150 m^2/s with LaPlacian

Green: Kxy = 300 m^2/s Kz = 50 m^2/s with LaPlacian

Blue: Kxyz = 500 m^2/s with LaPlacian

Yellow: Kxyz = 4000 m^2/s with Stress Tensor

Kinetic Energy Spectra: Examining Time Evolution



Initially, mesoscale portion of spectra contains steep slope, then gradually develops over a few hours. No differences beyond that time. In this case (see plot title), energy is piling up at small scales which is unphysical.

Conclusions

- For this problem, HIGRAD simulates large-scale (> 100 km wavelength) energetics well
- For this problem, HIGRAD simulates mesoscale (~ < 100 km wavelength) energetics poorly
- Unphysical build-up of energy at small scales for Kxyz = 150 and 500
- Balanced part of flow (vortex with radius of max velocity at 50 km) diffused heavily for most dissipation mechanisms
- Need to think about better way to handle mesoscale in HIGRAD
  - I am examining utility of 4^{th} order diffusion operator so balanced flow is left alone.