Wistell group summary

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Wistell Meeting, Jul 6, 2018

Update on turbulence optimization

- Update on agreement between internal calculation and GIST
- Problems with current optimization technique

Reminder: What the metric is

- We are trying to maximize the transfer of energy between the unstable and stable modes
- We are mostly interested in non-zonal transfer, since that is the dominant pathway for QHS
- The current metric (PTSM3D) adds all the transfer coefficients, τ_{ijk}, weighted by k_x and k_y to provide a global transfer quantity, evaluated at a given flux surface
- Calculation requires some geometric quantities evaluated on a field line for many ($\sim$100-200) poloidal turns

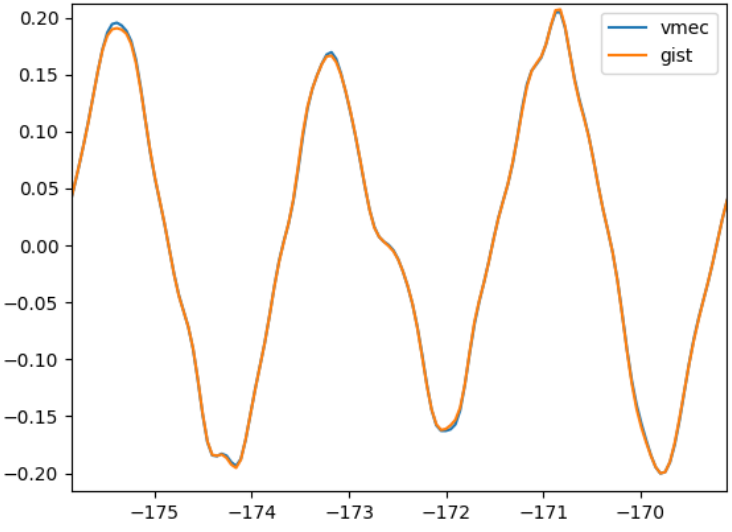
Three ways to calculate the parameters

VMEC equilibrium	VMEC equilibrium	VMEC equilibrium
Geometric pars.	Geometric pars.	**EXIT STELLOPT**
PTSM3D	**EXIT STELLOPT**	Geometric pars.
EXIT STELLOPT	PTSM3D	PTSM3D

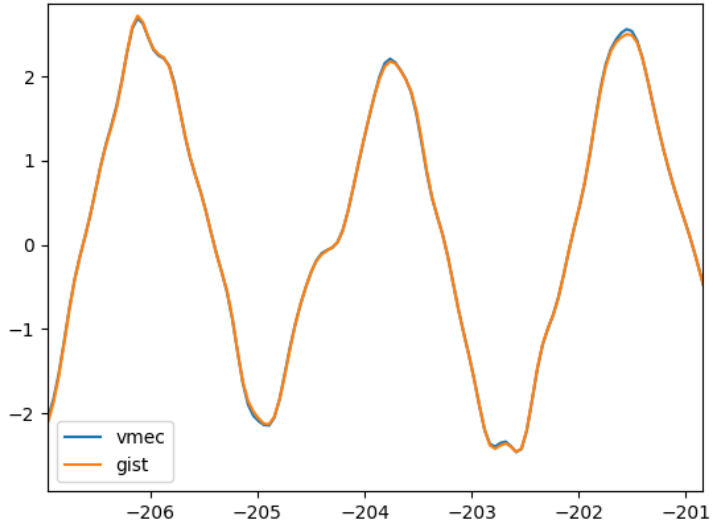
Methods 1 and 2 agree exactly at this stage. Method 3, where we calculate the Geometric parameters from the VMEC eq file using GIST differs slightly.

Errors between GIST and VMEC largest for L_1 and L_2 parameters

L_1

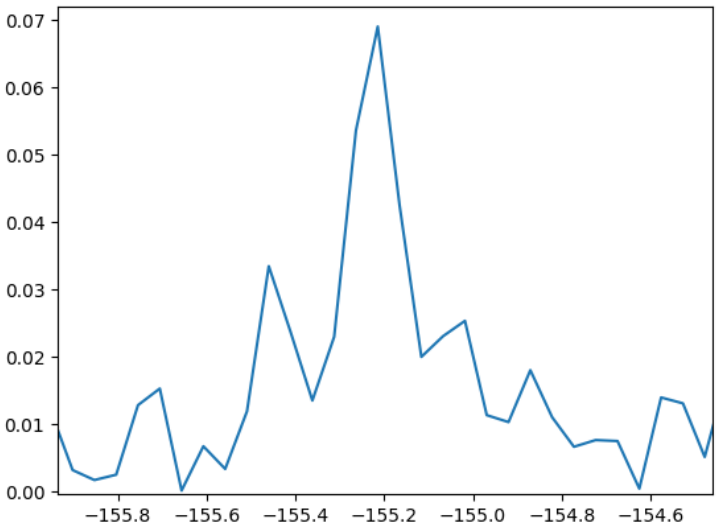


L_2

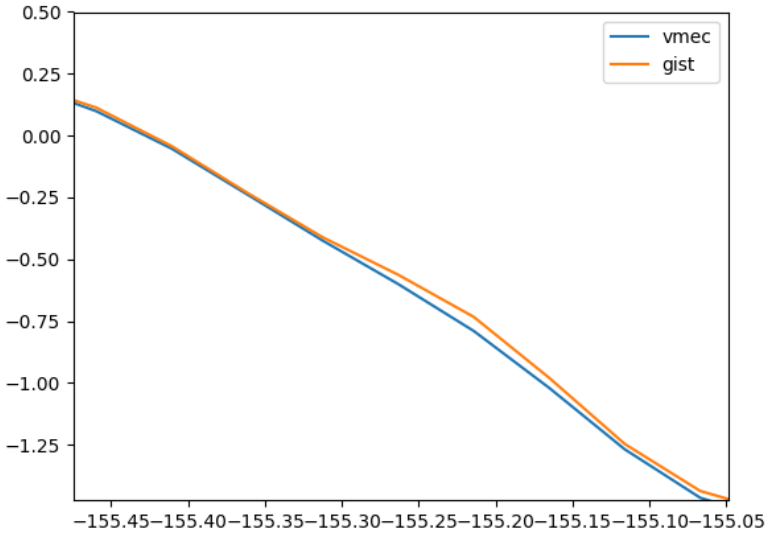


Zoom of error in the L_2 term

Error in L_2 term



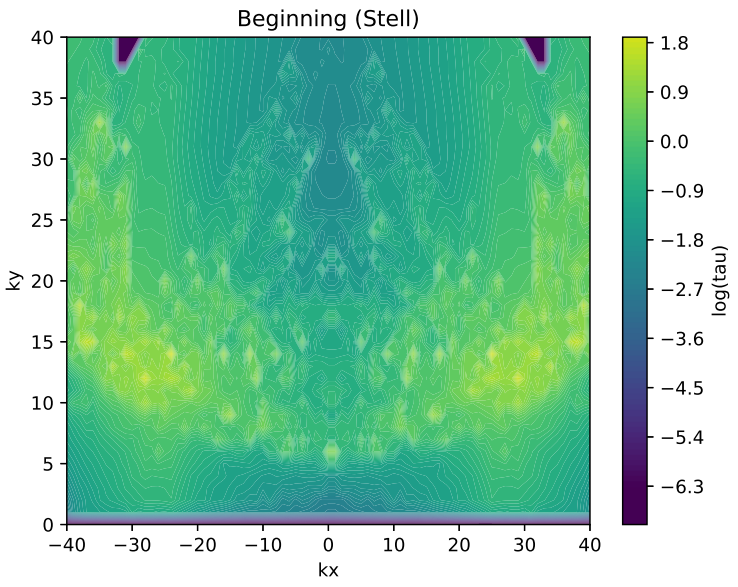
L_2 zoomed further



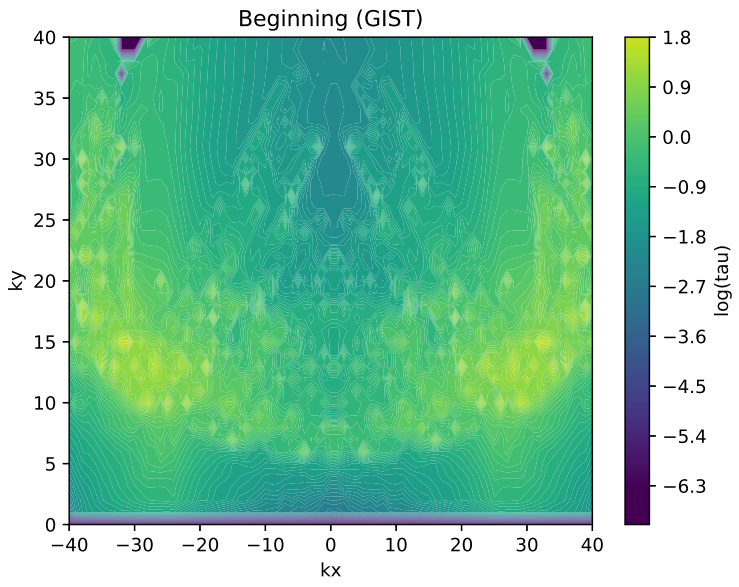
Other terms differ by significantly less

Calculation of coupling coeffs τ

Method 2 (initial state)



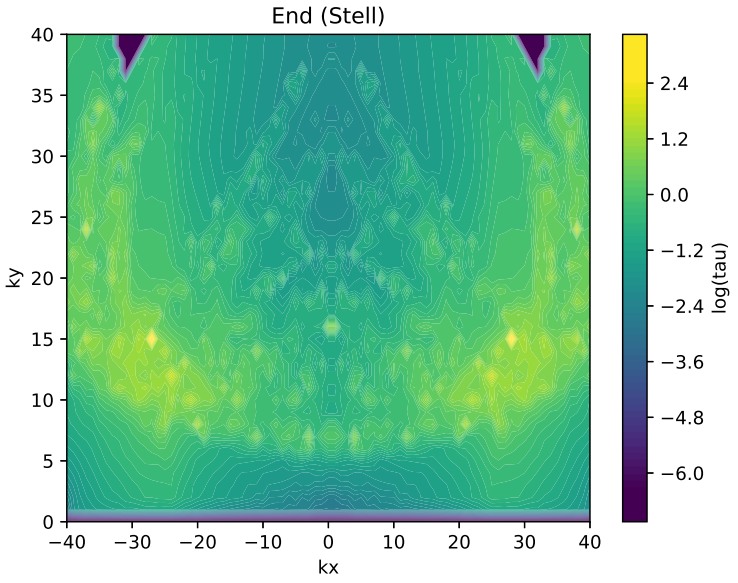
Method 3 (initial state)



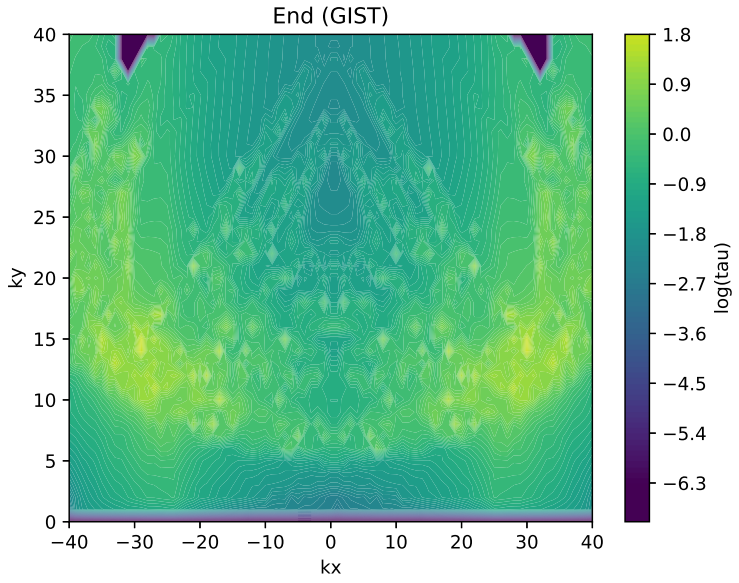
For both initial states, the PTSM3D metric outputs 1.3.

Calculation of coupling coeffs τ

Method 2 (final state)



Method 3 (final state)



Method 3 calculates 1.3, same as before. But methods 1,2, the optimized result in STELLOPT calculates 2.6, mainly due to the two resonant points.

We need to think harder about reformulating our metric

- Problem as I understand it
  - Fake resonances due to numerical imprecisions can appear
  - These resonances can be targeted and amplified
  - Amplifying these resonances is often the steepest descent path
- Ideas for improving the metric
  - Targeting resonant modes to transfer energy is probably desirable
  - Need a way to distinguish real resonant modes, from numerical artifacts
  - Option: Calculate PTSM3D multiple times with slightly different grids, and take minimum
  - Option: Use a smoothing function to knock down resonances (if theory says resonances should be broad)
  - Option: Use a different summation mechanic over modes to ignore resonances (if theory says resonances shouldn't be targeted)

Calculation of coupling coeffs τ

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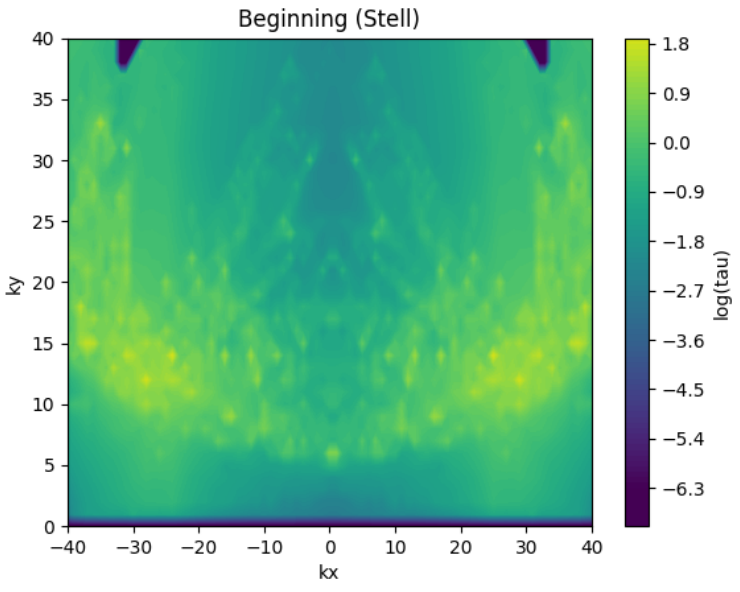

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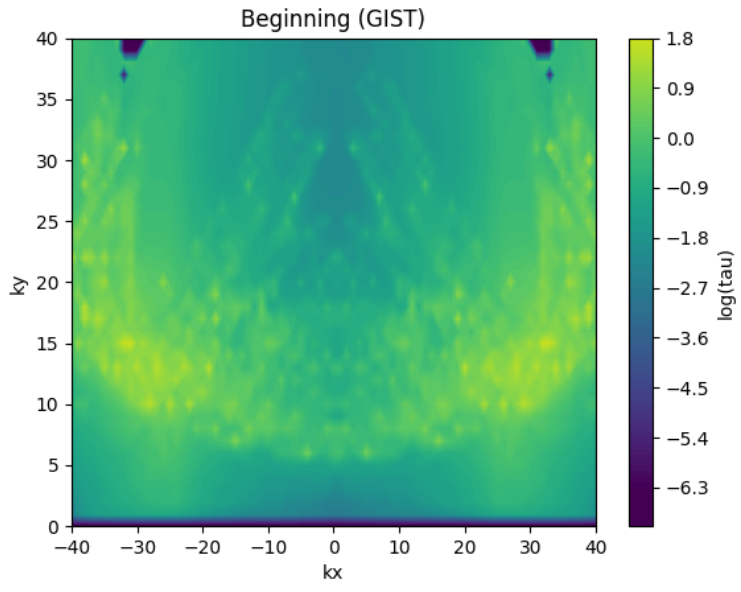

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Calculation of coupling coeffs τ

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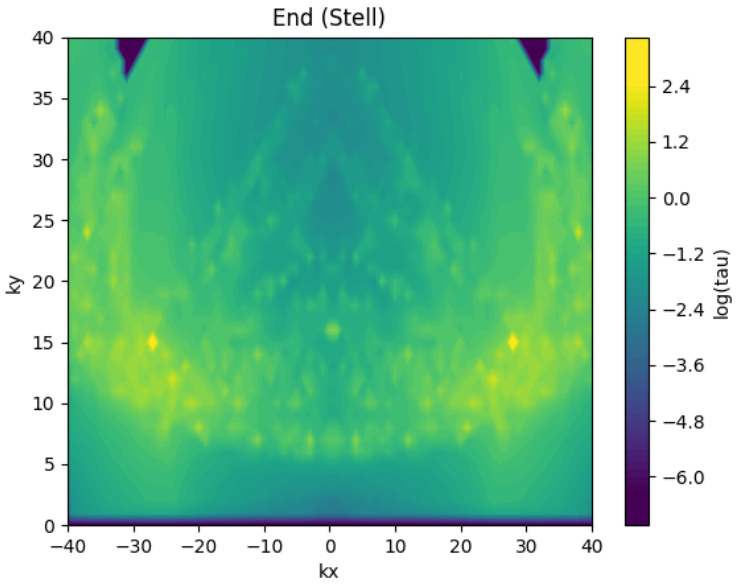

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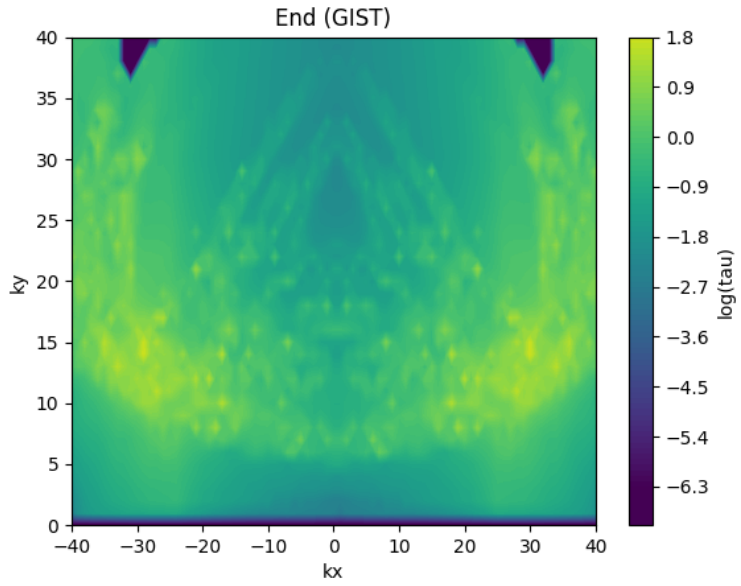

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