Response to Reviewer #1
The review is pasted below; our responses are interspersed in blue font.

Summary

This manuscript discusses several indicators of the position of the Gulf Stream and finds that those based on following a specific isotherm at a specific depth (i.e., 15ºC at 200 m or 12ºC at 400) become biased northward relative to the maximum velocity core in models under warming scenarios. This result is perhaps a bit obvious, but it is worthwhile to make this point explicitly as well as quantify the size of the bias. The manuscript is clearly written and thoroughly documented. I am not convinced, however, that the location of the maximum velocity core is the best indicator for the "true" latitude of the Gulf Stream (see comment 1) and the statistical tests are not necessarily appropriate to the hypotheses being tested (see comment 2). The second comment should be straightforward to address and it is possible the first can be addressed by providing additional motivation in the introduction.

Response: We appreciate the reviewer's comments that our results are worthwhile. That the results seem obvious to the reviewer may indicate that we explained the issue related to the widely used 15 ºC -isotherm well. They further state, the manuscript is clearly written and thoroughly documented which we appreciate.

For responses to comments 1 and 2, see below. We agree that comment 2 is straightforward to address and believe we can compellingly address comment 1 as well (see below).

Specific Comments

1. The authors motivate interest in knowing the latitude of the Gulf Stream by invoking the Gulf Stream's connection to the AMOC and the Gulf Stream's impact on ecosystems. They then adopt the location of the maximum surface velocity (i.e., the SSH front at the surface) as the "true" location of the Gulf Stream, but it is not clear that the location of the SSH front is relevant to the AMOC or ecology. Biology, in particular, is much more sensitive to temperature than SSH or current speed, so the location of the Gulf Stream temperature front (at various depths) is likely more relevant to biology and regional climate than the location of the SSH front. Chi et al. (2019) showed that the two fronts have distinct spatiotemporal variability—especially downstream of the New England Seamounts—such that motion of one is not necessarily correlated with motion of the other. It is likely that the 12 & 15ºC isotherms also become biased north of the location of the temperature front under warming scenarios, but the size of the bias is likely to be different than the bias between these isotherms and the location of the SSH front. In light of these facts, I suggest that the authors provide stronger motivation for their interest in the location of the maximum velocity at the surface.

Response: The motivation for our study is that the rapid warming of the northwest North Atlantic shelf and adjacent slope regions, which are among the fastest warming ocean regions in the

world, is commonly attributed to a northward shift in the Gulf Stream (see references on line 25). This northward shift is commonly diagnosed using a temperature-based criterion which, as we show in the manuscript, is problematic. We believe we provide strong evidence that the warming of the shelf and slope region can occur without a northward shift of the Gulf Stream (see FOCI model projections) and that isotherm-based criteria are misleading in that they suggest a northward shift even when no such shift is occurring. We will articulate this motivation more clearly in the revised manuscript.

We mention the Gulf Stream's connection to the AMOC because it would feel like an omission not to do so but can remove this if it is perceived as misleading.

We don't state that the Gulf Stream location has an impact on ecosystems in the northwest North Atlantic shelf and slope regions, but that others commonly link these two causally. It is well documented that rapid warming in the shelf and slope region has severe impacts on ecosystems (we agree with the reviewer that temperate matters not SSH or current speed). Our point is that the warming is often causally linked to a northward shift of the Gulf Stream – an association that we believe is made in error because the temperature-based criterion can falsely indicate a northward shift.

We agree with the findings of the Chi et al. (2019) study which used data from 1993 to 2016 and documented a divergence between the isotherm criterion and the actual path of the Gulf Stream east of 71°W, in other words, a divergence in space. They attributed the divergence to the activity of mesoscale eddies, which is plausible. Our study addresses a different question, namely whether the two criteria diverge over time in a warming world. We would like to clarify this in our revised manuscript.

We agree with the reviewer's points about the isotherm criteria.

In summary, we believe there is a strong motivation for our study (see above) and we will be happy making this more explicit in a revised version.

2. While both the changes and slopes of the various indicators are all different from each other, it is not clear that these differences are statistically significant. Tables S1 and S2 give *p*-values for the slopes, but these only indicate that the slopes are significantly different from *zero*. Since the trends are being compared to each other, rather than zero, it would be more appropriate to give confidence intervals for the slopes so that the reader can assess whether or not the confidence intervals overlap.

Response: We agree and will be happy to follow this advice in a revised manuscript.