We thank Referee #1 for its important and helpful comments. The revised text has been improved using most of them. Here is our specific responses to these comments:

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**C1:** The author define a set of 16 stations across the basin to evaluate connectivity among pairs of them. However, the choice of the number of stations and their location seems arbitrary. How much the analysis is sensitive to such choice? Did the authors tested different stations configurations? Why they did not consider a full covering of the domain instead than a few sparse stations?

**R1:** We thank the reviewer for raising this point. We have expanded the discussion in the paper to justify our approach. There are two aspects to this question. One is the sensitivity of the results to the exact location of the station, in the vicinity of the station. Since there might have been some ambiguity in the meaning of “station” which could have been understood as a single precise location, we now use the word “site” instead of “station” throughout the paper. By sites, we mean small circular regions of 1° radius. This radius corresponds to the largest size of mesoscale eddies. By deploying 100 000 particles at each site, spread at different locations within the site (both on the horizontal and on the vertical), and also at different times, we are able to provide statistical estimates which are reliable at the scale of each site. The second question concerns how different parts of the model domain are connected with one another. To address that, we have considered 16 sites, located in key areas of the model domain, but indeed with some degree of arbitrariness in their exact position. There are 4 key areas in the domain, which are: the subpolar gyre, the subtropical gyre, the jets, and the quieter regions between the jets. To reduce the arbitrariness in the exact position of the sites, we have positioned several sites in each of the key regions. This is now better explained in the text.

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**C2:** A literature review would be useful since the authors did not discuss their work in the context of other similar approaches missing some key references (see specific comments for details).

**R2:** The literature review in the introduction section has been improved by adding more recent studies and references in the field of connectivity analysis. (Please refer to Introduction section).

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**C3:** Regarding the analysis of Lagrangian pdf the authors did not clearly explained when and where they use minimum connection times or connection probabilities and how the two quantities relates between them.

**R3:** The concept of connectivity analysis in this study is based on minimum connection times (please refer to section “2.2.3 Lagrangian indices” in the methodology part). The minimum time required for each particle to reach the destination from the source station was calculated, and further analysis was carried out based on this minimum connection time. Once the minimum connection time was calculated for each particle, further analysis was carried out. This analysis included the calculation of the mean and median values of the minimum time. These values provide insight into the typical travel time required for particles to reach their destination. Figures [6,7,9,11,12]

In addition, the probability density function (PDF) values were calculated based on the numbers of particles arrived at their destination. This allowed us to understand the distribution of travel times/ arrival depth across the network and identify any patterns or trends in travel times/ arrival depth. These methods have been applied to generate figures [5,8].

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**C4:** The authors seem to have misunderstood the concept of betweenness centrality confusing it with the concept of paths across a network (see specific comments).

**R4:** The section on betweenness centrality has been thoroughly revised and improved. The main objective of this paper is to assess the impact of the OGCM resolution and vertical turbulence on the analysis of connectivity in oceanic flows. In addition to this objective, the concept of betweenness was used as a way to investigate the connection between various stations or sites.

In short, we add that betweenness centrality is a way to quantify the importance of a node in a network by measuring how many shortest paths between any two nodes in the network pass through that node. By calculating the betweenness of each node, we can identify the most important locations for water transport in the ocean. Therefore, by comparing the betweenness centrality obtained from different OGCM resolutions, we can simply assess how well the models represent the true connectivity patterns in the ocean, and identify areas for model improvement. (Please refer to Sections 2.2.5 and 3.3 Betweenness Centrality for more information)

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***Line-by-line comments on the manuscript:***

**CL1:** The author should also introduce other works where these concepts have been developed, for instance:

- Richter, DJ, et al. "Genomic evidence for global ocean plankton biogeography shaped by large-scale current systems." Elife 11 (2022)
- Ward, BA, et al. "Selective constraints on global plankton dispersal." Proceedings of the National Academy of Sciences 118.10 (2021)
- Jacobi, Martin Nilsson, et al. "Identification of subpopulations from connectivity matrices." Ecography 35.11 (2012)

(l. 93-95) Connection time is just one possible option to characterise connectivity, see for instance different approaches based on fluid fractions (i.e. probabilities):

- Froyland, G, et al. "Almost-invariant sets and invariant manifolds—connecting probabilistic and geometric descriptions of coherent structures in flows." Physica D 238.16 (2009)

- Ser-Giacomi, E, et al. "Explicit and implicit network connectivity: Analytical formulation and application to transport processes." Physical Review E 103.4 (2021)

**RL1:** All of the suggested references have been added to the revised version of paper. (Lines. 36, 54, 67, 148).

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**CL2:** Connection time is just one possible option to characterise connectivity, see for instance different approaches based on fluid fractions (i.e. probabilities)

**RL2:** The aim of this study is to calculate transit time (minimum connection time) and to examine the effects of fine-scale structures on the connectivity properties of the flow. Most of our analysis was based on minimum transit times. However, in addition to this, we used the Lagrangian PDF as a way to analyze the connectivity between different sites during different periods. We added figures based on the PDF fields (please refer to section 2.2.4 and Fig. 4 and supplementary Figs. S1-5). Therefore, two different methodologies were used for connectivity analysis: transit (connection) time and Lagrangian PDF.

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**CL3:** (eq. 1) The formula is not explained sufficiently:
- please define the variable "a"
- how a pair of station for which the connectivity is calculated is specified in the equation?

**RL3.** The simplified version of the formula, along with additional information, has been added in the revised version of the paper. (Line. 173, section 2.2.4 Lagrangian PDF)

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**CL4:** A general issue along the paper is that the authors did not clearly explained how the connectivity matrix used for network analysis is calculated. Is the matrix defined in terms of times or probabilities? Which algorithm they use to compute its elements?

**RL4:** The matrix used for the network analysis determining betweenness centrality was based on raw transfer probabilities. The calculation of betweenness was carried out using the methods defined by Costa et al. (2017). Instead of using different matrices for each site, the 1,600,000 trajectories deployed from all sites were used together to calculate betweenness values. For each site (node), betweenness values were determined based on the node/edge measure definition. Initially, the raw transfer probabilities $a_{ij}$ were used as edge weights, with the weight decreasing as the probability decreases. However, this method has a drawback, as noted by Costa et al. (2017), in that a high betweenness value could be associated with nodes through which a high number of unlikely paths pass. To address this issue, we applied a new metric ( $d_{ij}$ ), suggested by Costa et al. (2017), which transforms the transfer probabilities $a_{ij}$ into distances .

The connectivity indices presented in Figs. 11-12 are based on the minimum, mean, or median transit time between each pair of stations. To obtain these values, we identified the particles that arrived at the final site (station) from the source site (station) and recorded their arrival time.

In the revised version, we have added a new section “2.2.3 Lagrangian indices” in the methodology part and made the complete revision regarding the betweenness centrality calculation method (section 2.2.5).

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**CL5:** Please note that betweenness centrality and paths-related analysis in fluid flow have been extensively introduced in:
- Ser-Giacomi, E, et al. "Most probable paths in temporal weighted networks: An application to ocean transport." Physical review E 92.1 (2015)
- Lindner, M et al. "Spatio-temporal organization of dynamics in a two-dimensional periodically driven vortex flow: A Lagrangian flow network perspective." Chaos 27.3(2017)

**RL5:** We added these references to the betweenness section. (Line. 183)

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**CL6:** (eq. 2) As commented before, how the matrix elements a_ij are defined? Please note that depending on the definition of the connectivity matrix the distance associated to each step of a path should be evaluated accordingly

**RL6:** As previously replied to **CL4** (**RL4**), the $a_{ij}$ elements are based on the raw transfer probability, and the calculation of the shortest paths involves the sum of a variable number of transfer probability values. However, we have used a different metric, which transforms the transfer probabilities $a_{ij}$ into distances. First, we reversed the order of the probabilities to obtain higher values of the former metric $a_{ij}$ . Then, we calculated the log values of the new metric. (Please refer to Sections 2.2.5 and 3.3 Betweenness Centrality for more information)

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**CL7:** This seems an interesting feature? Why such separation is observed?

**RL7:** Particles are subjected to the same forces that drive the movement of water in the gyre. Over time, these particles can be transported by the gyre currents and accumulate in certain areas. This could be due to a number of factors, such as the speed and direction of the currents in these jets, and the interaction between the particles and the water masses in the gyre.

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**CL8:** Why the shape of the pdf is changing qualitatively depending on the velocity fields and/or the pair of stations? Such different features of the pdf should reflect some dynamical proprieties of the advection pattern. Could the authors comment on this?

**RL8.** The shape of the pdf can change qualitatively depending on the velocity fields and the pair of stations because it reflects the dynamical properties of the advection pattern in oceanic flows. The pdf represents the distribution of particles arriving at a destination station from a source station over time, and this distribution is influenced by the complex and variable flow patterns. For example, if the current is fast and unidirectional between two stations, the pdf will likely be narrow and peaked, indicating that particles tend to arrive at the destination station quickly and with little variation in arrival time. In contrast, if the current is slower and more variable, the pdf may be wider and flatter, indicating that particles arrive at the destination station over a broader time range and with more variation in arrival time. Other factors that can influence the shape of the pdf include the presence of eddies or other flow features that cause particles to meander or change direction, as well as variations in source or destination locations that affect the path and travel time of particles.

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**CL9:** This part should probably go to the Methods section and, again, it is not clear how the connectivity matrix is calculated

**RL9:** We have completely revised this part and moved it to the method section related to the calculation of betweenness centrality (Please see sections: 2.2.5 and 3.3 Betweenness centrality).

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**CL10:** Please note that the betweenness metric that the authors are trying to calculate is a node and NOT a link propriety! Maybe the authors are confusing the concept of betweenness with the one of a path between a pair of nodes?

**RL10:** We have revised the section on betweenness centrality and highlighted the improved parts on the new version of the paper; we are aware that betweenness is not a link propriety although it is a scalar measure of the number of shortest paths between pairs of nodes that pass through a given node. (Please see sections: 2.2.5 and 3.3 Betweenness centrality)

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**CL11:** No, Costa et al. did not improved the Dijkstra's algorithm.. They used a standard logarithmic transformation for the network links' weights, but they did not change anything of the algorithm.

**RL11:** This was a mistake and we have corrected this section (Please see sections: 2.2.5 and 3.3 Betweenness centrality).

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**CL12:** Again, maybe the authors are confusing the concept of betweenness with the one of path?

**RL12:** We have revised and corrected this section of the paper about the concept of betweenness centrality. (Please see sections: 2.2.5 and 3.3 Betweenness centrality)