WFU_MMNET v1.1 User Manual for Regional and Dynamic networks Analysis
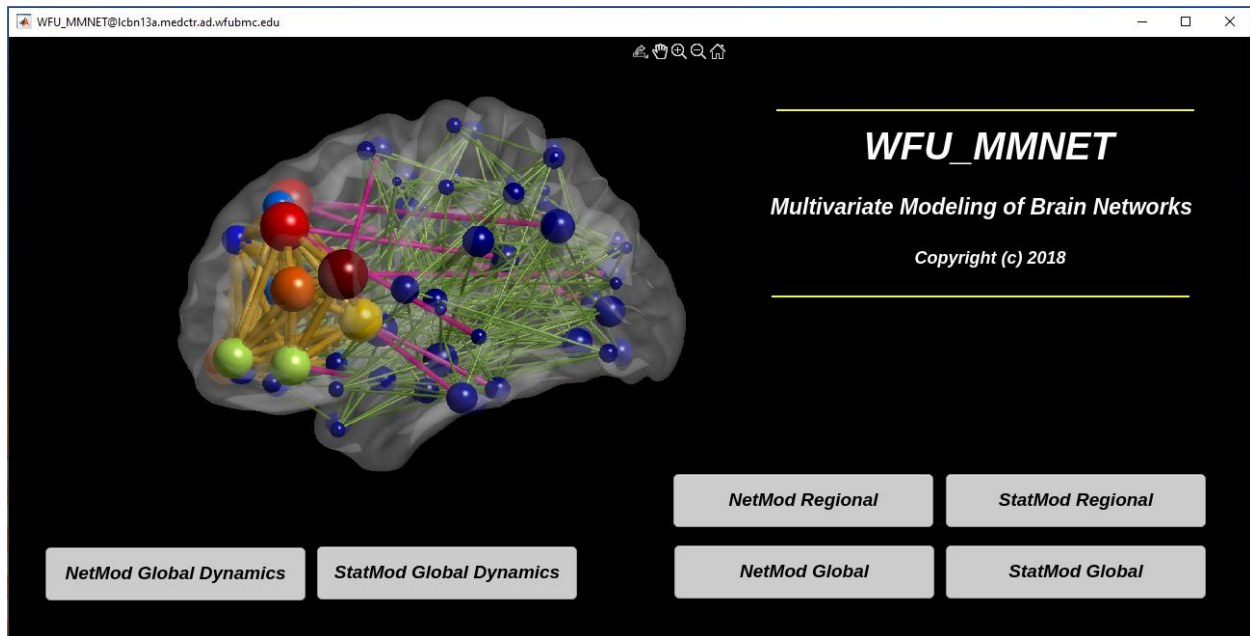
Regional and dynamic network analysis are now possible in the new version of WFU_MMNET. Utilities for analyzing subnetworks of the brain (regional network analysis) and whole-brain dynamic networks (global network analysis) have been added to WFU_MMNET in the new version, v1.1. The new version also has a different appearance and has been developed in Matlab App Designer. However, analysis of whole-brain (global) static networks can still be done as detailed in the Manual for v1.0. Below, we briefly explain how to use the new version for analyzing regional networks and (global) dynamic networks. The fully updated user manual will be provided very soon. Mixed-effects modeling frameworks developed for regional and dynamic network analyses can be found in (Bahrami et al. 2019) and (Bahrami et al. 2021), respectively.

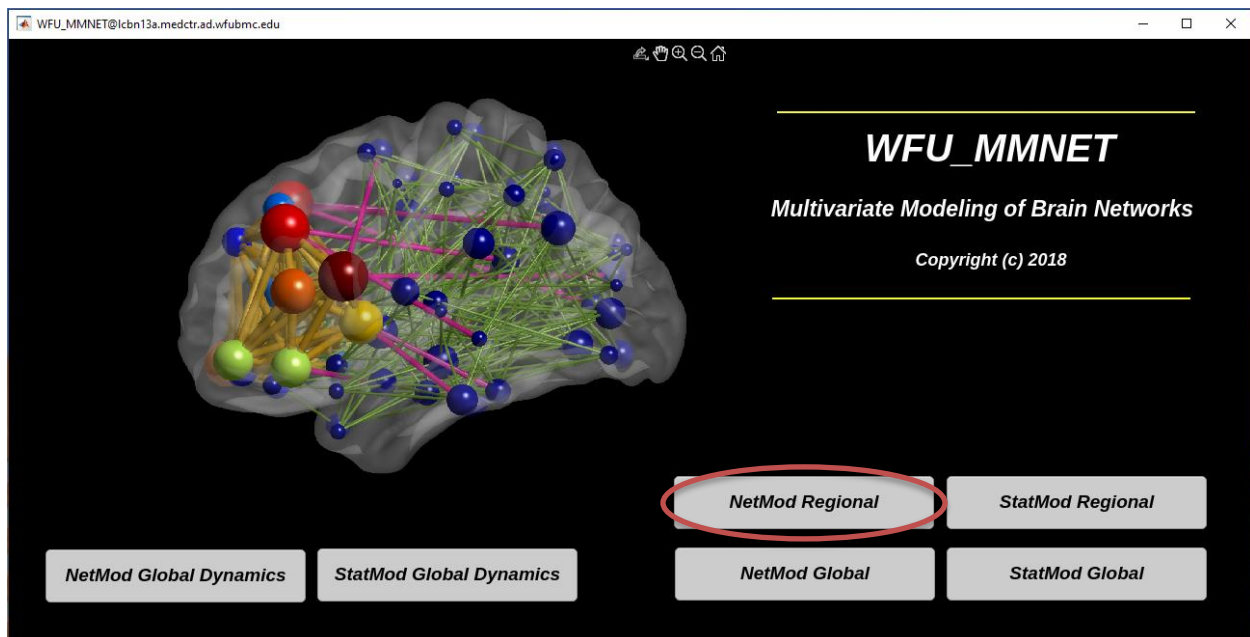**Installation.** For installation see User manual for v1.0.

Modeling Software. For the whole-brain static networks, SAS, R, or Python can be used as detailed in the manual for v1.0 (we recommend using SAS or R), but, **for analyzing regional and dynamic brain networks, only SAS can be used at present.** The executable file path should be added as instructed in user the manual for v1.0. As for the v1.0, the new release must be used in Linux as well.

Regional Network Analysis. Before starting regional network analysis, the regional subnetwork covariate must be generated. This covariate is a 2d binary matrix with rows representing the brain ROIs and the columns representing the subnetworks of interest. The ones represent ROIs located within the subnetwork of interest and zeros represent remainder ROIs. All desired subnetworks can be made and included in this single 2d matrix, and later any combination of them can be analyzed (i.e., the subnetworks included in this matrix are not the final ones used for analyzing brain subnetworks). After generating this covariate and other required covariates (i.e., data files, atlas files, etc.), as detailed in the manual for v1.0, you can proceed to starting the regional network application.
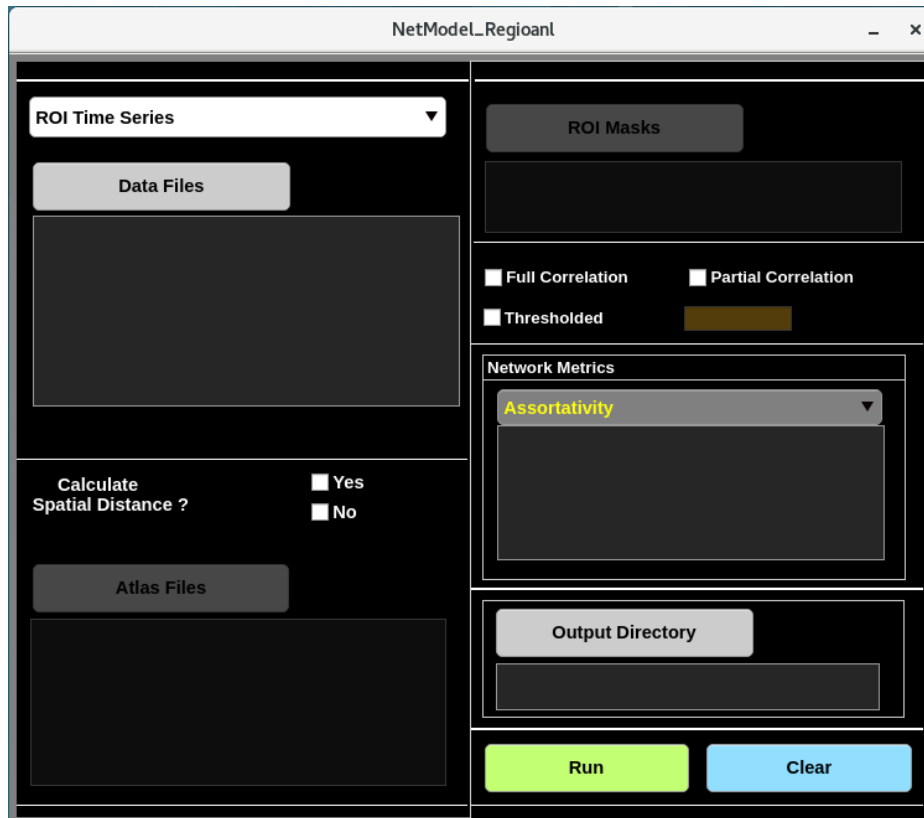
After installing the toolbox and preparing the required data files (for supported data formats see the manual for v1.0), to start regional network analysis type 'WFU_MMNET' in the command window of Matlab. You should see the following window:
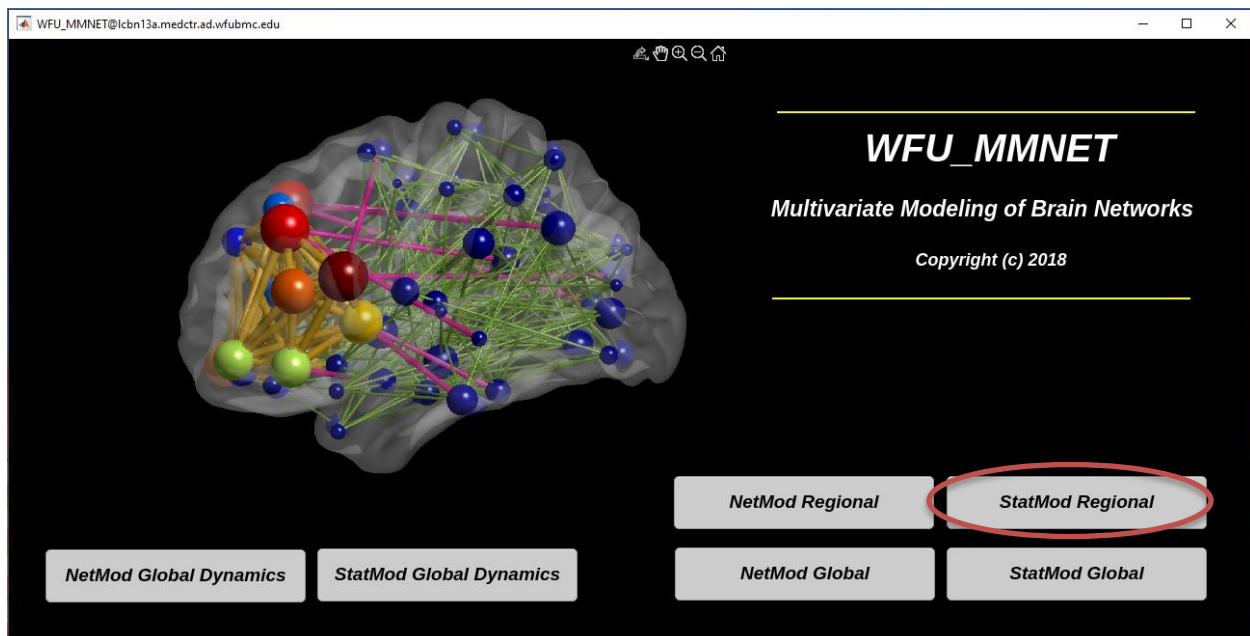
Click 'NetMod Regional' button to start Network Model for the regional network analysis.
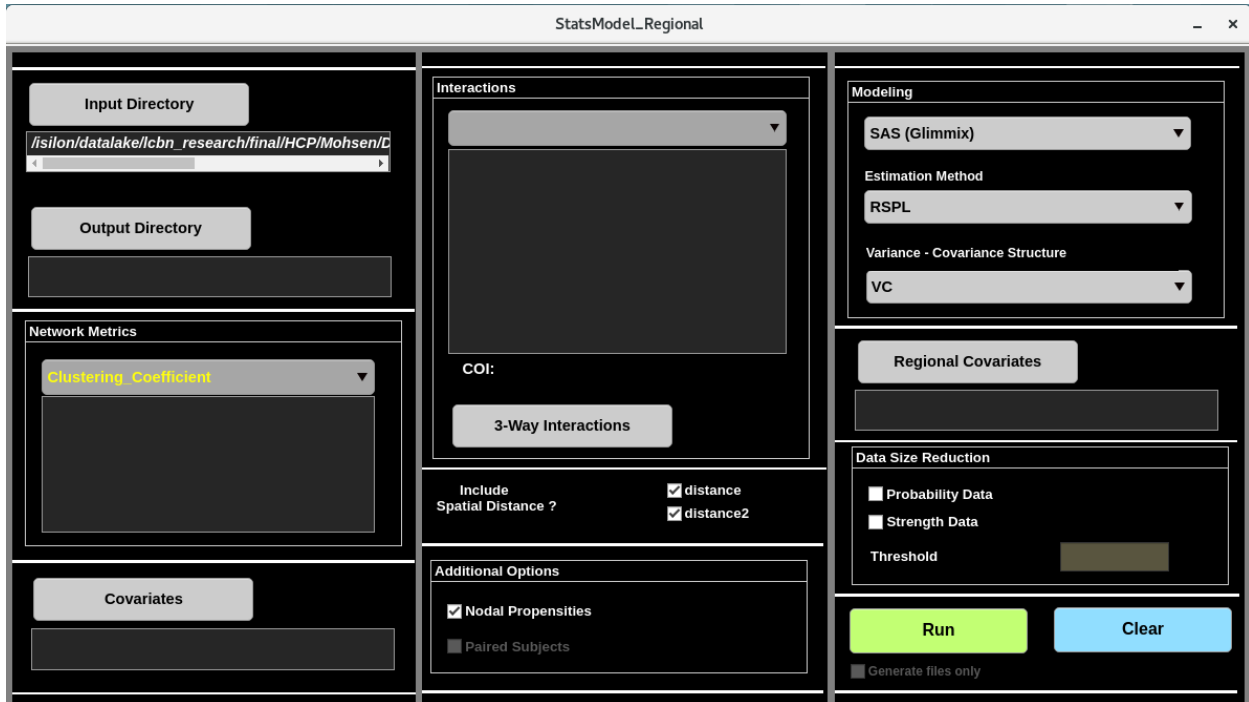

You will see the following window after clicking 'NetMod Regional' button. Fill all fields and select all options as detailed in the manual for v1.0, and then click on 'Run' to generate the data frame and other required files for the next step.

After successfully generating the data frame (message will be shown in the command window of Matlab) you can close this window and start the Statistical Model by clicking 'StatMod Regional' button as shown below.
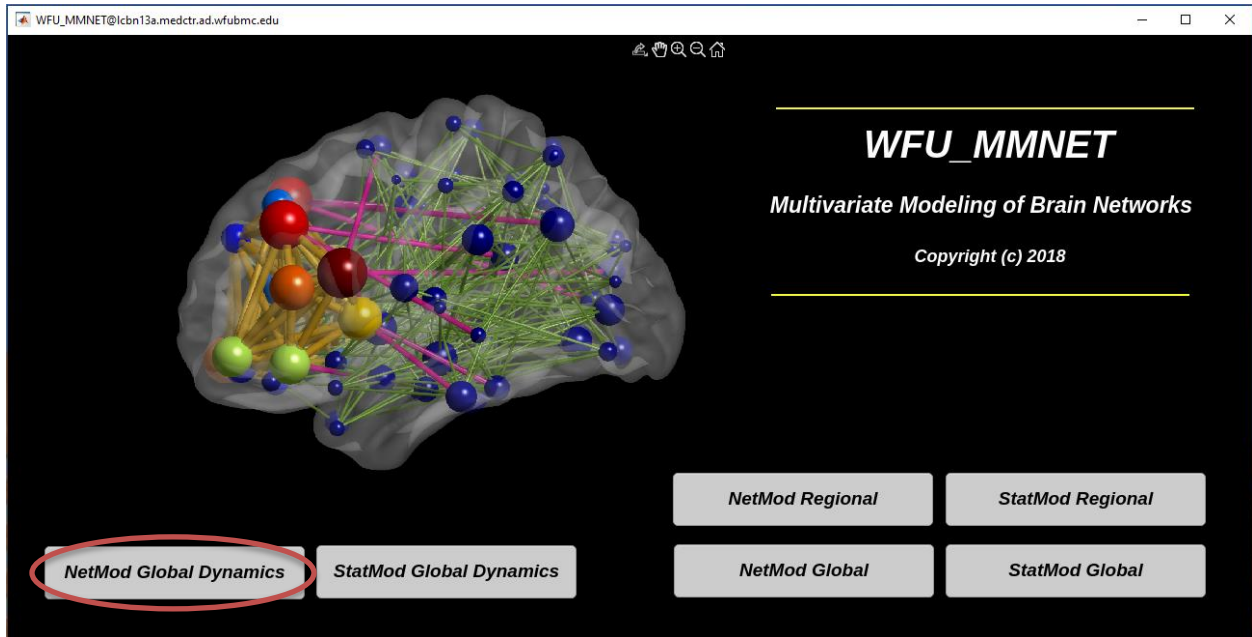
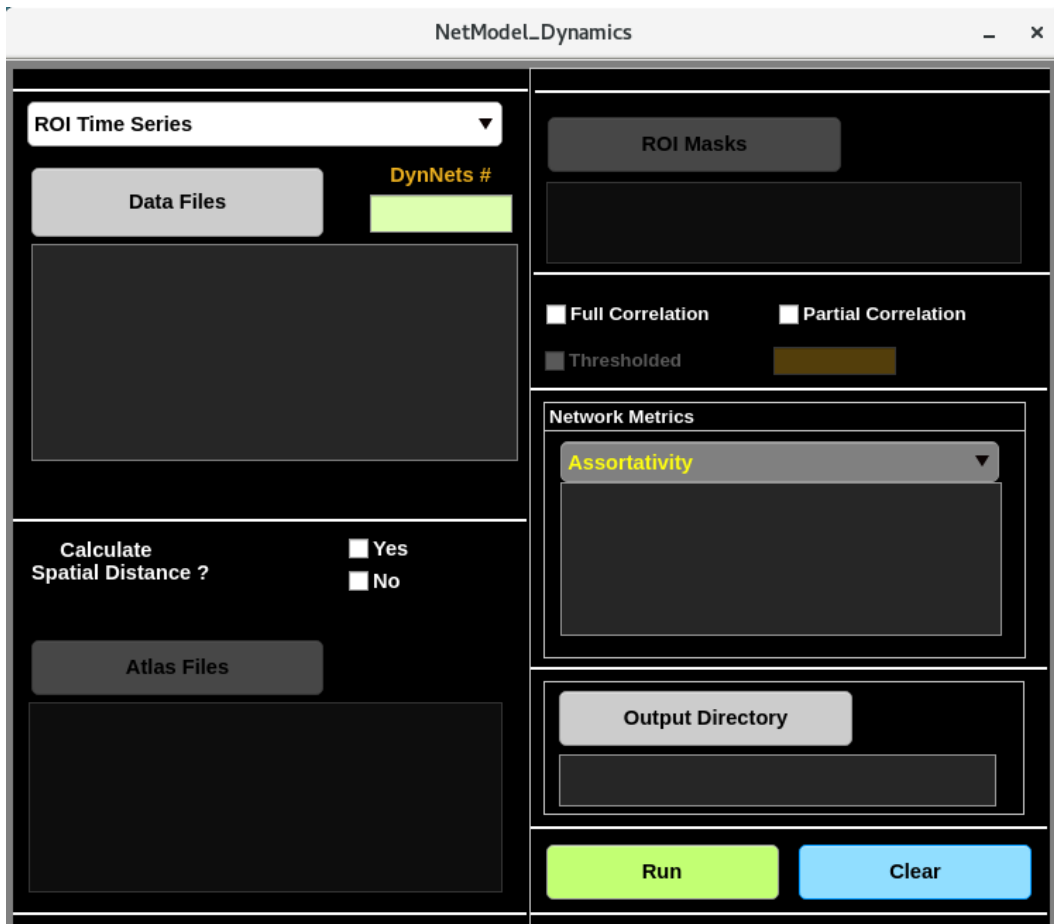You will see the following window after clicking 'StatMod Regional' button.

Fill all required fields and load required data files as detailed in the manual for v1.0. After loading the regional subnetwork covariate, you can choose your desired network measures and subnetworks for regional analysis. You can then click 'Run' to run the model and fit the statistical models.

Dynamic Network Analysis. For dynamic network analysis, you first need to generate all dynamic networks (e.g., through a sliding window correlation analysis) at present. Utilities for computing dynamic networks from ROI time series with options for window length, shift size, and window types will be added very soon. After generating all dynamic networks, type 'WFU_MMNET' in the command window of Matlab and then click 'NetMod Global Dynamics' button to start the Network Model for dynamic network analysis.
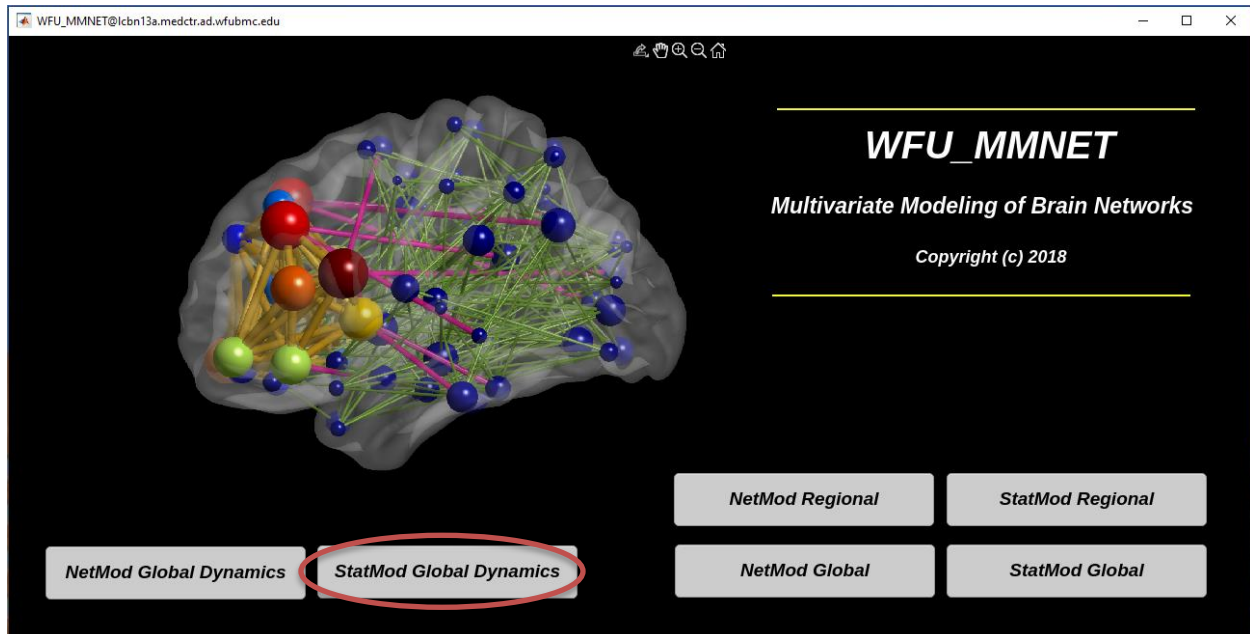
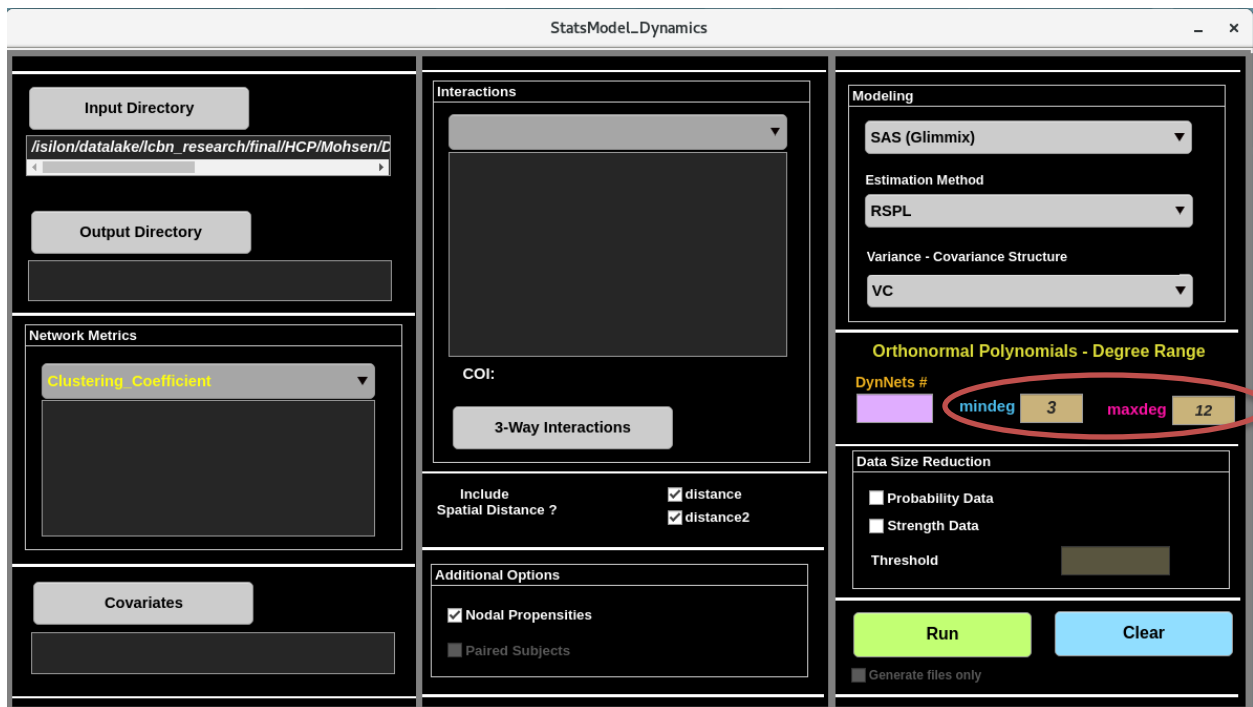After clicking 'NetMod Global Dynamics' you will see the following window.

Choose 'Connectivity Matrices' for the data type , and then **enter the number of dynamic networks by filling 'DynNets #' box before loading dynamic networks.** After loading dynamic networks, load all other required files and select desired options as instructed in the manual for v1.0 and click 'Run' to generate the data frame.

After successfully generating the data frame (message will be shown in the command window of Matlab), proceed to the next step by clicking 'StatMod Global Dynamics' button.

You will see the following window. Note that the number of dynamic networks (i.e., 'DynNets #' box) will be automatically filled if you start from the same directory that you ran the Network Model. If not, you must first enter the number of dynamic networks. Then, load all other required files and select desired options as instructed in the manual for v1.0. For Orthonormal Polynomial degrees, if your dataset includes more than 12 dynamic networks per subject, we recommend leaving the default numbers (i.e., mindeg: 3 and maxdeg: 12). Otherwise, choose a degree range from 3 to one less than the number of your dynamic networks. You can then click 'Run' to generate the datasets and fit the statistical models. Note that the orthonormal polynomials for all degrees that you choose will be added only once and then different degrees will be modeled. For more detail, please see the referenced paper.

Please post your questions, reports, and comments on the NITRC forum. The fully updated manual will be uploaded very soon.

References

Bahrami M, Laurienti PJ, Simpson SL. 2019. Analysis of brain subnetworks within the context of their whole-brain networks. Hum Brain Mapp 40:5123-5141.
Bahrami M, Laurienti PJ, Shappell HM, Simpson SL. 2021. A mixed-modeling framework for whole-brain dynamic network analysis.2021.2002.2025.432947.