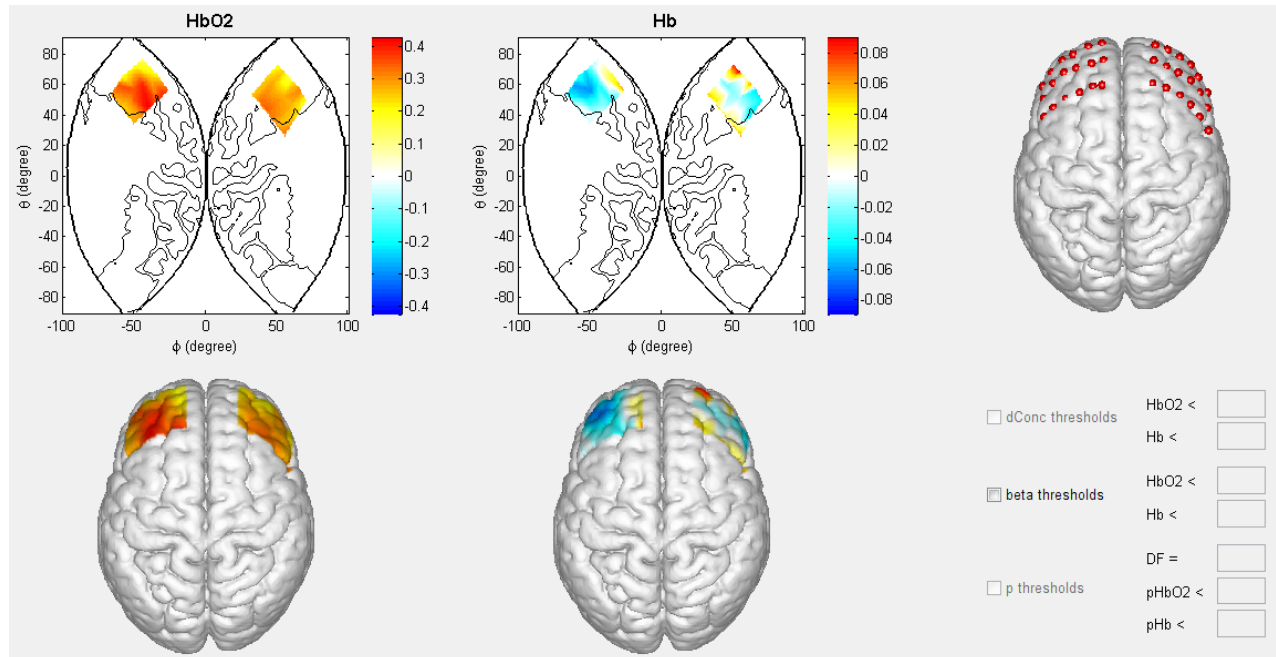# EasyTopo 2.0 User Manual

Brain Imaging Simplified

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Contents

About EasyTopo

EasyTopo is a toolbox for diffuse optical topography based on a standard brain template (ICBM 152 nonlinear asymmetric template). It implements 2D angular interpolation in a spherical coordinate system. It does not require solving the forward and inverse problems of light propagation and thereby is computationally efficient. It displays HbO_2, Hb and their t-statistic images in a 2D whole-brain map (the "map") and on a 3D brain surface (the "img"). For details, please refer to our publications:

- Tian F, Lin Z-J, Liu H. EasyTopo: A toolbox for rapid diffuse optical topography based on a standard template of brain atlas. *Proceedings of the SPIE*, 8578: 85782J (2013). doi: 10.1117/12.2003907
- Tian F, Kozel FA, Yennu A, Croarkin PE, McClintock SM, Mapes KS, Husain MM, Liu H. Test-retest assessment of cortical activation induced by repetitive transcranial magnetic stimulation with brain atlas-guided optical topography. *J. Biomed. Opt.* 17(11): 116020 (2012). doi: 10.1117/1.JBO.17.11.116020

Input Data

EasyTopo accepts five types of input data:

1. mni: the MNI coordinates of each fNIRS channel

How to generate mni data: Once the fNIRS probe is placed on a subject's head, the real-word stereotaxic positions of the optodes along with several cranial landmarks (e.g., the nasion, inion, left and right earholes, and vertex) can be measured with a 3D digitizer. Then a probabilistic registration can be implemented to convert the real-world coordinates of the optodes to the standard Montreal Neurological Institute (MNI) coordinates. The position of each channel can be determined as the midpoint between the source and detector.

The format of mni data is shown below:

	x	y	z	Region #
channel_1				
channel_2				
…				

Note: x, y, z represent the stereotaxic coordinates in the MNI space. Region # indicates the subregions of the brain in which topographic images will be generated. <u>Inter-hemispheric subregion is not allowed.</u>

An example of mni data:

mni <36x4 double>

	1	2	3	4	
1	57	38	11	1	
2	51	48	12	1	
3	46	56	13	1	
4	39	61	16	1	
5	31	66	17	1	
6	23	69	19	1	
7	57	28	26	1	
8	52	38	27	1	Channels on the
9	58	13	40	1	right hemisphere
10	52	22	43	1	
11	46	46	30	1	
12	38	51	33	1	
13	46	30	46	1	
14	39	36	47	1	
15	30	55	35	1	
16	22	59	36	1	
17	30	41	49	1	
18	21	44	52	1	
19	-51	42	12	2	
20	-45	51	14	2	
21	-38	59	14	2	
22	-31	63	17	2	
23	-21	68	19	2	
24	-12	70	21	2	
25	-50	34	27	2	
26	-44	44	29	2	Channels on the
27	-50	22	40	2	left hemisphere
28	-44	28	45	2	
29	-37	51	31	2	
30	-29	54	34	2	
31	-36	34	47	2	
32	-27	38	50	2	
33	-19	57	37	2	
34	-11	59	40	2	
35	-18	42	53	2	
36	-12	43	54	2	

2. **df: degree of freedom**

It usually represents the sample size (df = N-1).

3. **HbO$_2$ & Hb: dConc values**

Channel-wise relative concentrations of HbO$_2$ and Hb (default unit: μM).

4. **betaHbO$_2$ & betaHb: beta values**

Channel-wise beta values of HbO$_2$ and Hb concentrations (default unit: μM) that can be obtained from general linear model (GLM).

5. **tHbO$_2$ & tHb: *t*-statistic values**

Channel-wise *t*-statistics values of HbO_2 and Hb that can be obtained from a fixed effects model or random effects model.

      Note: The input data above should be stored in a ".mat" file. EasyTopo can accept partial data, e.g., HbO_2 and Hb data without t-statistic values.

Uploading Data

Steps to upload data:

1. Run EasyTopo through MABLAB;
2. Click on the "File" tab from the main menu on the top left of the window;
3. Select "Open";
4. In the pop-out dialogue window, choose the ".mat" file that you wish to upload.
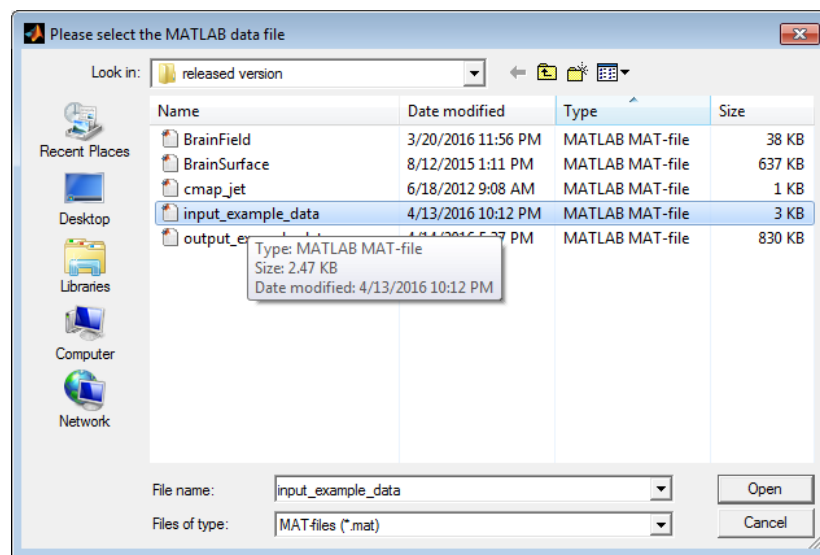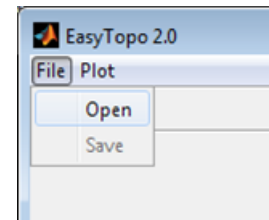
5. Click the "Open" button on the Folder View.
6. Check for any possible error messages on the MATLAB console. If no error messages appear, your data is now uploaded into the workspace, and ready for plotting.

Probe Geometry

Once the data is uploaded successfully, a figure of probe geometry will show on the top left area of the window. In this
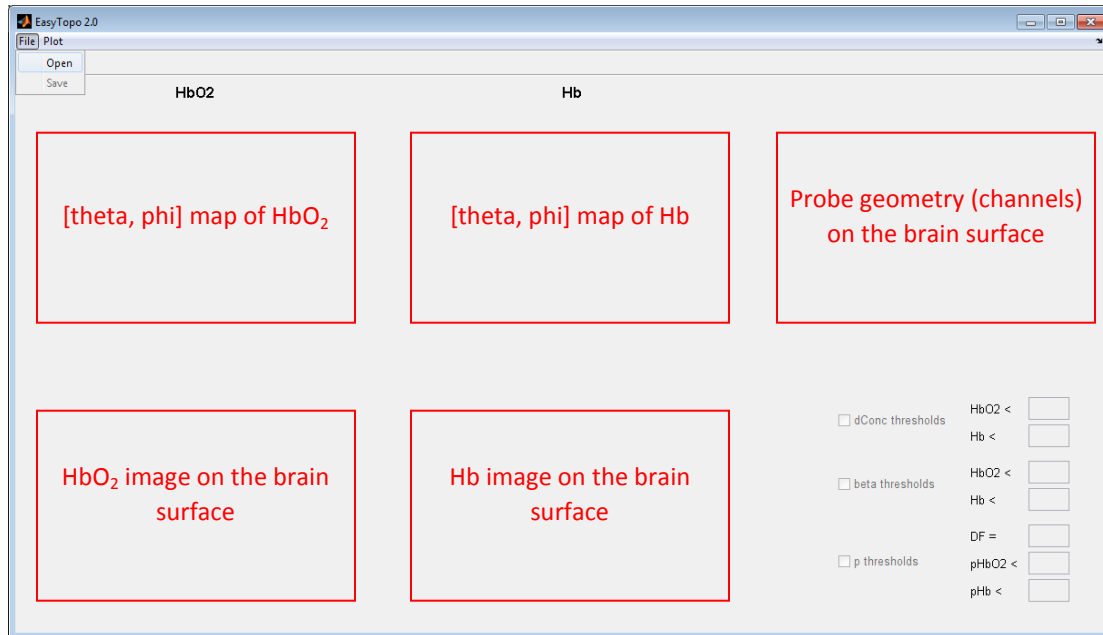

3
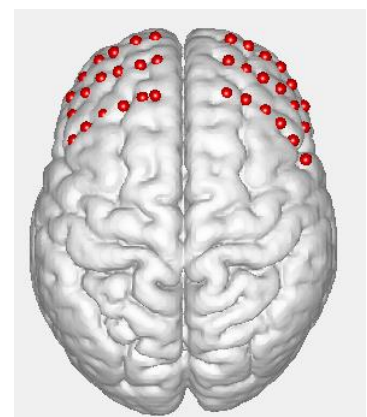
figure, the red spots represent the position of each fNIRS channel.

Plotting Data

Description of Main Window

1. The main window of EasyTopo contains five boxes for image displaying, as indicated below:

2. The colorbar beside each box shows the range of quantitative values of the image.
3. Only the subregions covered by channels (defined by Region # in the mni data) show colored map/image; other regions are gray.

Plot dConc Values

1. To begin plotting, click on the "Plot" tab on the main menu.
2. Select the "Plot dConc Values" option.

Plot Beta Values

Click on the "Plot" tab on the main menu, and then select the "Plot Beta Values" option.

Plot t-Statistic Values

Click on the "Plot" tab on the main menu, and then select the "Plot T Values" option.

Plot Probe Geometry

Click on the "Plot" tab on the main menu, and then select the "Plot Probe Geometry" option.
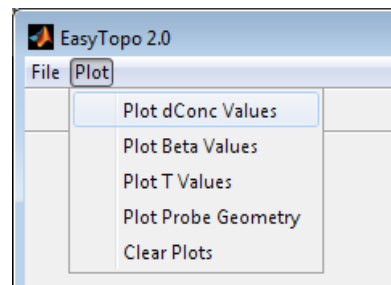
Changing the View Angle

To change the view angle of a 3D image (or probe geometry) on the brain surface, right-click the desired plot. A context menu will appear. Select the desired view angle from the presented options.

For example, to view the plot from the right-hand side, select the "View Right" option.
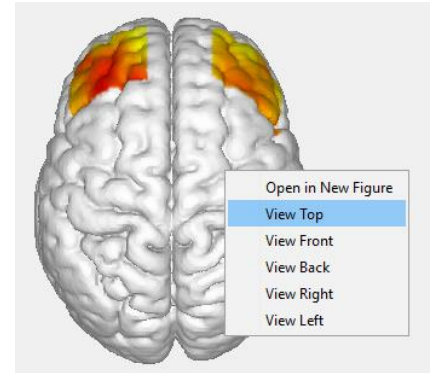

Open Plotted Figure in a New Window

1. To open a plotted map/image as a new MATLAB figure, right-click on the desired plot.
2. From the context menu that appears, select the "Open in New Figure" option.
3. This will open the selected plot as a new MATLAB figure, providing a way to edit or save a single display.
4. The new figure features the default functionality that MATLAB offers with any ordinary figure.
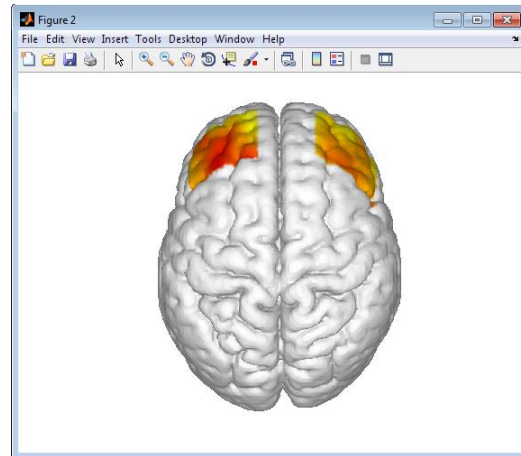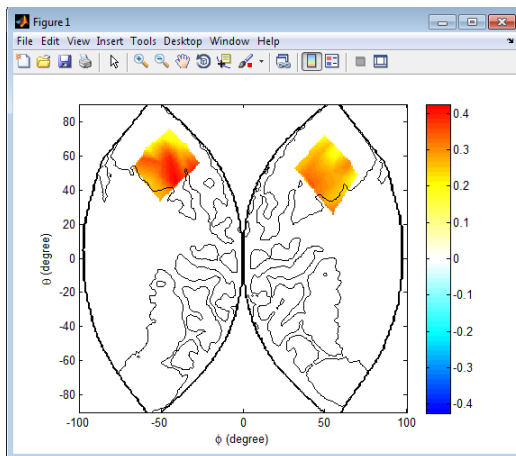
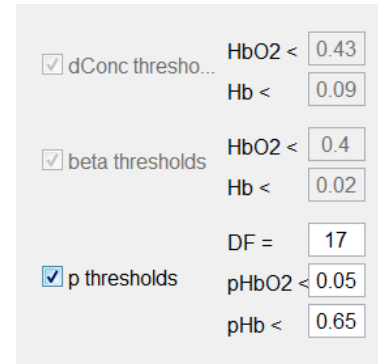**Clear All the Plots in Main Window**

To clear all the existing images in the main window, click on the "Plot" tab of the main menu, and then select the "Clear Plots" option.
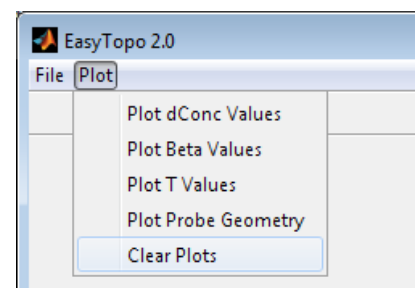
Thresholding the Images:

For each type of dConc, beta and t-statistic maps/images, EasyTopo provides thresholding options. You can use different thresholds to make the plots more recognizable. The thresholding options are shown on the bottom-right corner of the main window:

1. Click the matched checkbox.

2. Input box will be enabled and default value will be displayed.

3. Change the threshold values

4. Re-run matched plot function in the main menu and you will see the thresholded plots.

☑ dConc thresho...	HbO2 <	0.43
	Hb <	0.09
☑ beta thresholds	HbO2 <	0.4
	Hb <	0.02
	DF =	17
☑ p thresholds	pHbO2 <	0.05
	pHb <	0.65

Saving Data

How to save the data

1. To save the plotted data, click the "File" tab on the main menu.

2. Select the "Save" option.

3. In the pop-out dialogue window, select the desired directory and type the desired file name, and click "OK".
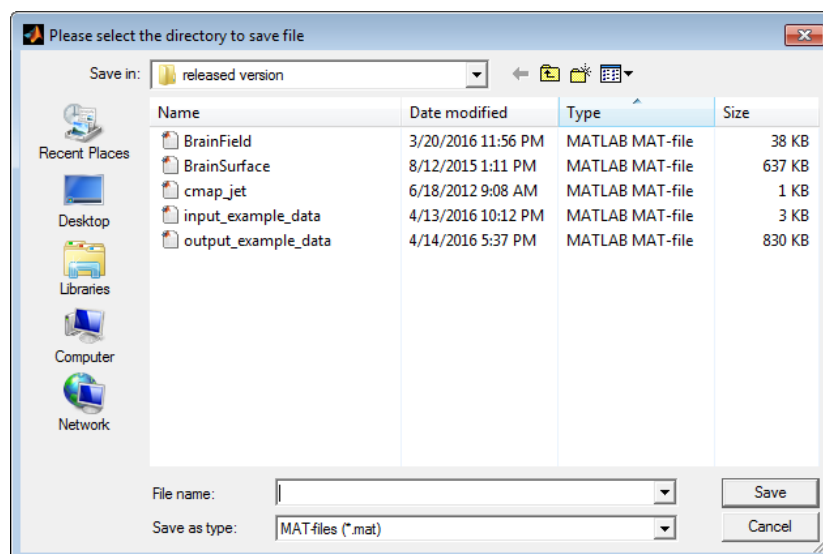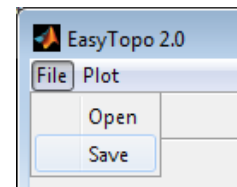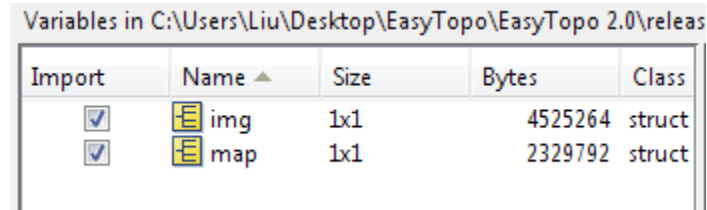
The file will be saved as a ".mat" file in the desired folder you have selected.

The types of data to be saved

EasyTopo save two types of data generated through the angular interpolation process:

1. Map: it contains the dConc, beta and *t*-statistic values interpolated in the [theta phi] space of the spherical coordinate system. Here $\theta \in$ [-90^0 90^0] and $\varphi \in$ [-100^0 100^0].

2. Img: it contains the 3D interpolated images on a brain surface mesh. The mesh is defined by "faces" and "vertices". The interpolated images denoted by vertical values.

Additional Information

*   EasyTopo was developed in MATLAB 7.7.0 (R2008b). Upgrades of source codes may be needed if you run the toolbox in a higher version of MATLAB;

*   A registration toolbox is available (GUI version will be published soon) to convert the real-world coordinates of the optodes to the standard MNI coordinates. Please contact Dr. Tian (fenghua.tian@gmail.com) if you need it.