Modelling of brain states using a coarse-grained Kuramoto model (KM) in TMS–EEG

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We use KM, a computationally simulated ensemble of coupled oscillators, for determining optimal sites and times of stimulation to enhance the effectiveness of closed-loop TMS–EEG. In our KM, certain oscillators represent specific brain areas, mimicking the dynamics of activated regions. The (differently) activated regions are determined in KM by relative differences between the phases of the individual oscillators. The matrix K, describing the coupling strengths between oscillators, changes in time so that the effective connectivity patterns of real TMS–EEG data are reproduced by KM.

The entire brain area was covered by 1000 oscillators, which was determined sufficient by comparing topographies from coarse-grained KM and the data. We determined K matrices that capture the time-spatial evolution of TMS–EEG data shortly after the stimulation of the left M1. By determining K for a number of relevant TMS-evoked brain states we lay the basis for simulating/modelling the dynamics of K, which can be used in the future for predicting brain states from the past and current K.

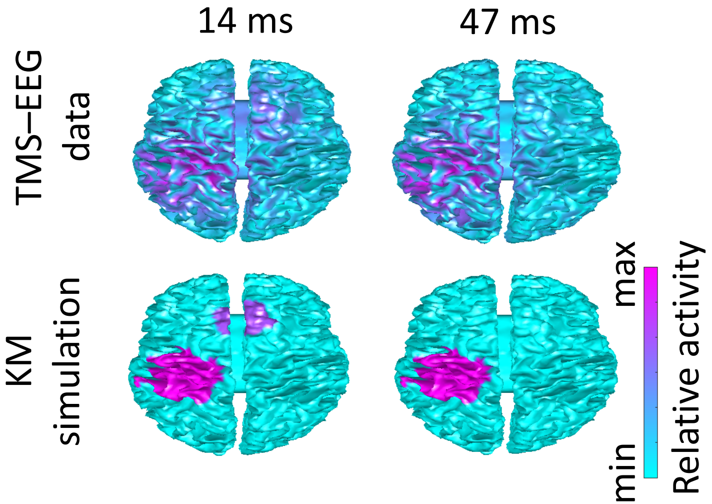

Figure. Minimum norm estimates of the TMS–EEG data at 14 and 47 ms after the TMS pulse (top) and the corresponding regions obtained by KM (bottom).