Sparse wavelet-based solutions for the M/EEG inverse problem : additional material

1. Simulated data

1.1. Small support cortical activity

Some results with respect to the Wasserstein distance

• Patch n°87 : minimizes the distance for MNE and sgw-SBL. sVB-SCCD yields a distance which is close to its minimum value.

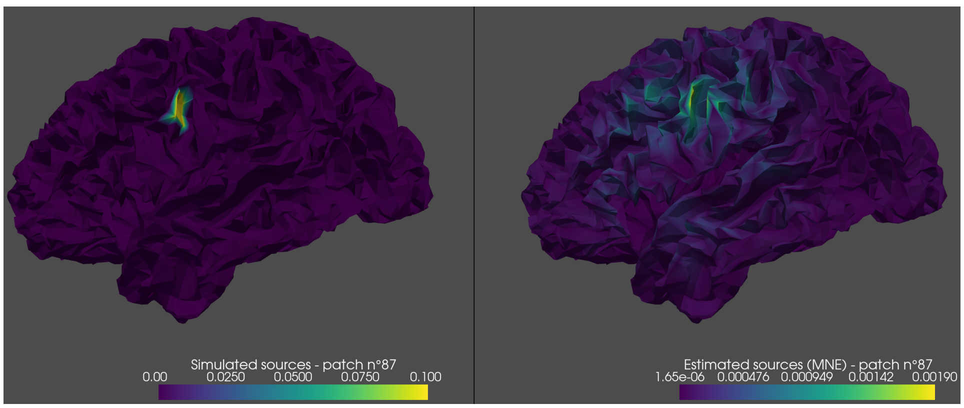

Figure 1: Patch n°87 - simulated sources (left) and MNE (right)

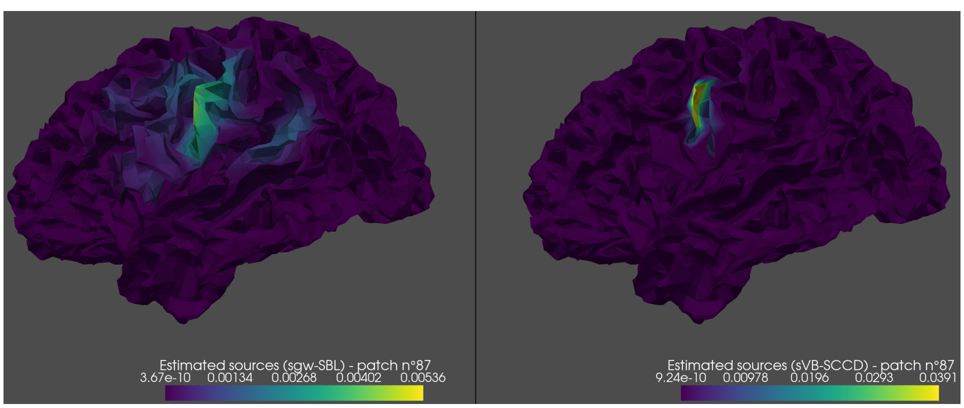

Figure 2: Patch n°87 - sgw-SBL (Champagne, left) and sVB-SCCD (right)

On this first example, Figures 1-2 show that sVB-SCCD is the closest to the actual active area, and is also able to follow the activity deep in the local "canyon". Its spatial extent is allow very satisfactory. As for sgw-SBL, it improves the MNE results in terms of order of magnitude, but exhibits unsatisfactory spatial localization. Nevertheless, it is also able to follow the activity deep in the "canyon", but highlights the lower side of the "canyon".

• Patch n°85 : minimizes the distance for MCE.

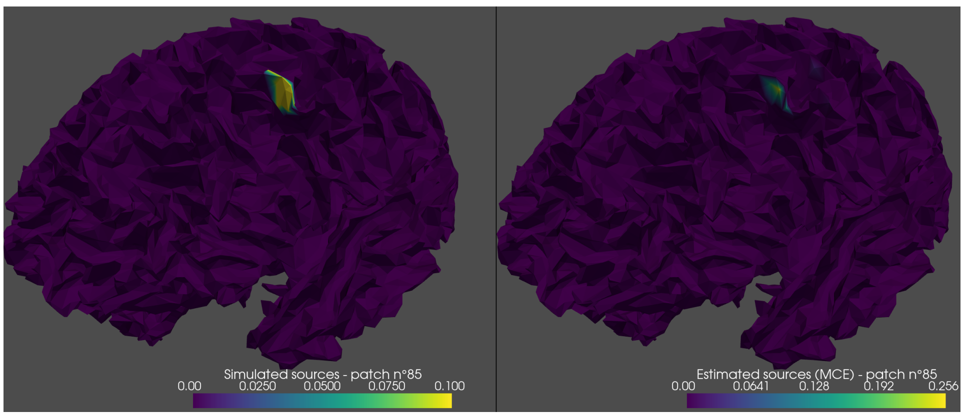

Figure 3: Patch n°85 - simulated sources (left) and MCE (right)

As expected from the statistics displayed in the article (table II), MCE exhibits the best minimum value for the Wasserstein distance for small support cortical activity. MCE even produces here a sparser activity.

• <u>Patch n°5</u> : maximizes the distance for all methods : MNE, sgw-SBL, MCE and sVB-SCCD. The activity is located near the junction between the two hemispheres. Here, only sgw-SBL appears to be able to approximately fit (with some blurring) the actual localization, deep in the brain.

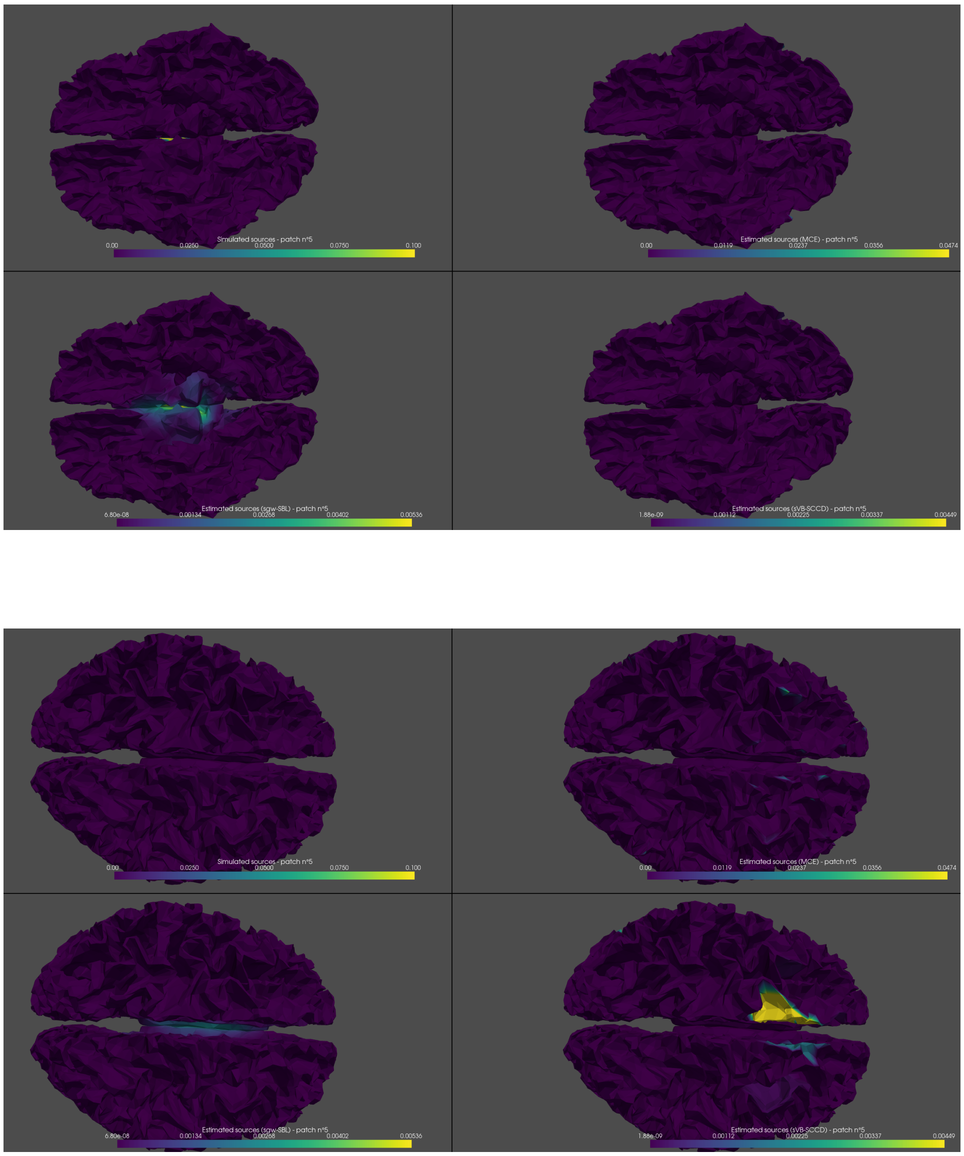

Figure 4: Patch n°5 - bottom (upper) and top (lower) view of the brain - from left to right, top to bottom : simulated sources, MCE, sgw-SBL (Champagne), sVB-SCCD

1.2. Large support cortical activity

Some results with respect to the Wasserstein distance

• <u>Patch n°57</u> : minimizes the distance for sgw-SBL and sVB-SCCD. MNE is also near its minimum value.

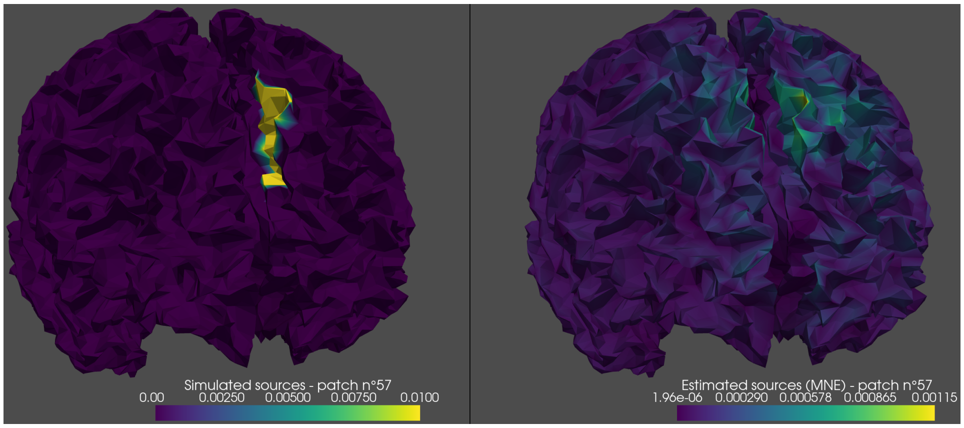

Figure 5: Patch n°57 - simulated sources (left) and MNE (right)

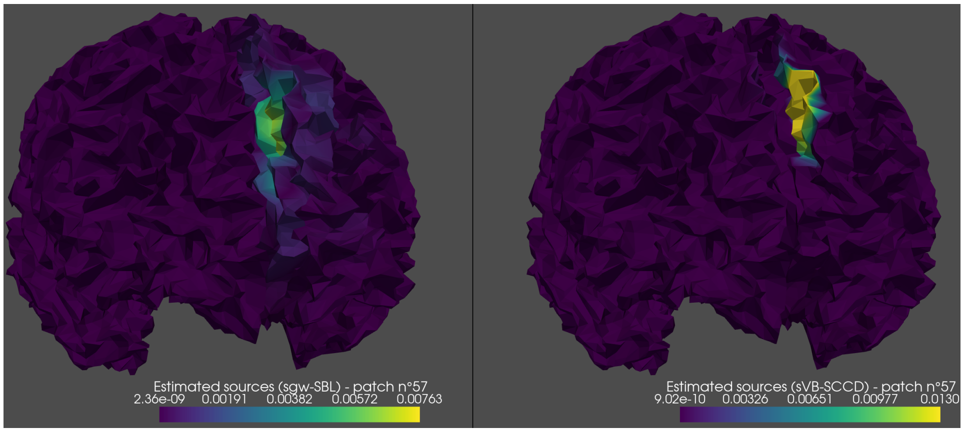

Figure 6: Patch n°57 - sgw-SBL (Champagne, left) and sVB-SCCD (right)

Figures 5-6 confirm the good performances (spatial localization, order of magnitude, depth) of sgw-SBL and sVB-SCCD with large support cortical activity. With a closer look, one can see that sVB-SCCD tends to detect activity a bit higher and closer to the brain surface than sgw-SBL, which is closer to the simulated sources.

• <u>Patch n°12</u> : maximizes the distance for MNE, sgw-SBL and sVB-SCCD.

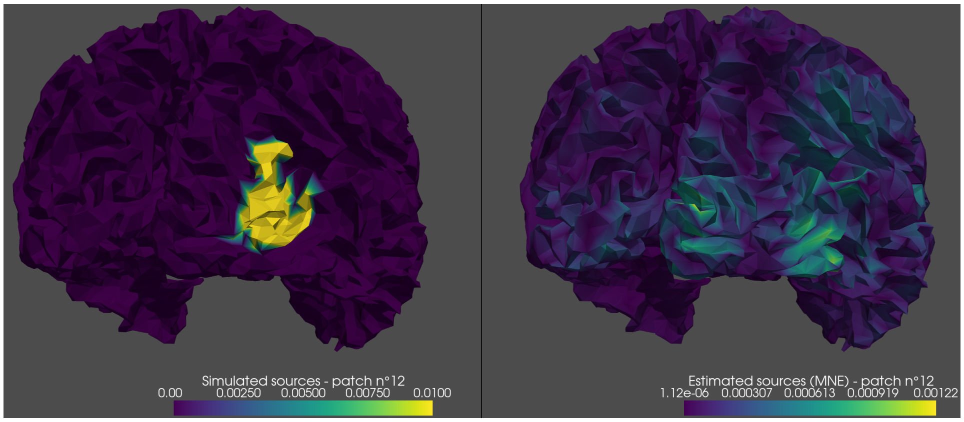

Figure 7: Patch n°12 - simulated sources (left) and MNE (right)

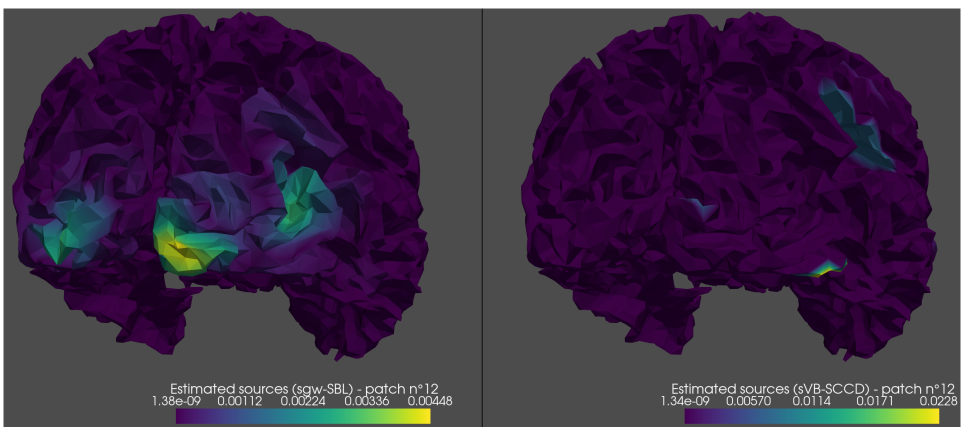

Figure 8: Patch n°12 - sgw-SBL (Champagne, left) and sVB-SCCD (right)

As expected from the statistics displayed in the article (table II), in the worst case scenario with respect to the Wasserstein distance (see Figures 7-8 above), sgw-SBL is the closest to the simulated sources. MNE suffers from excessive blurring, and sVB-SCCD rather detects one main and sparse activity below the right hemisphere, with some additional minor blurring on the side of the right hemisphere.

Some results with respect to the Spatial Dispersion metric

• Patch n°11 : mean Spatial Dispersion (0.72) for sgw-SBL.

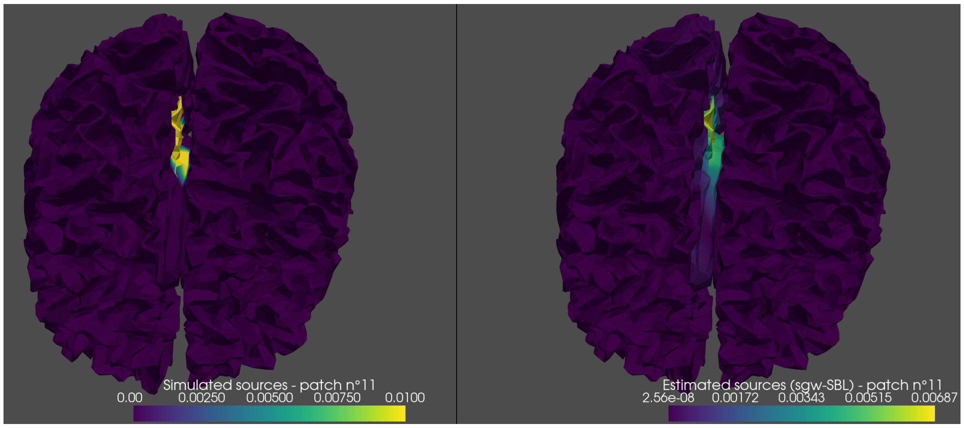

Figure 9: Patch n°11 - simulated sources (left) and sgw-SBL (Champagne, right)

• Patch n°9 : mean Spatial Dispersion (1.20) for sVB-SCCD.

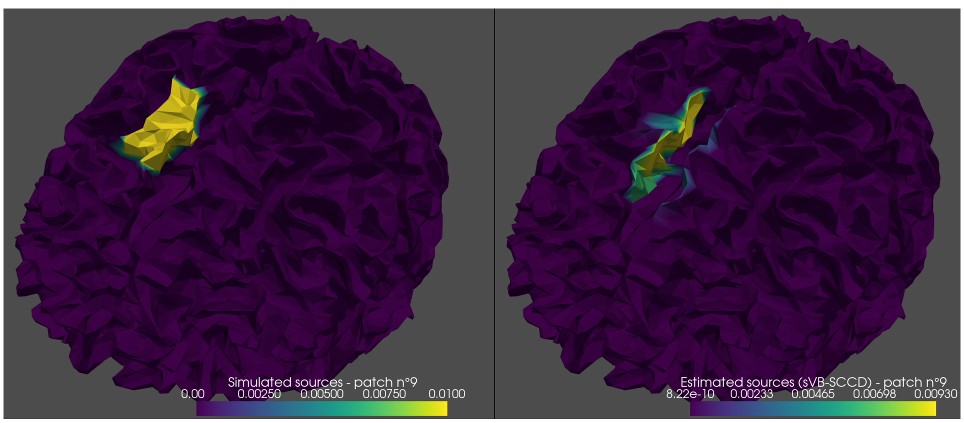

Figure 10: Patch n°9 - simulated sources (left) and sVB-SCCD (right)

Figures 9-10 display the results obtained when reaching the mean values for the (normalized) Spatial Dispersion of sgw-SBL and sVB-SCCD (respectively 0.72 and 1.20) : sgw-SBL is able to properly locate a deep cortical activity, while sVB-SCCD tends to locate the surface activity a bit too deep in the brain. This tends to confirm the better performances of sgw-SBL for large support cortical activity, as also highlighted by the Wasserstein metric statistics in the article (table II).

It is here worth noting that the Spatial Dispersion metric appears not to be sufficient on its own to ensure the proper localization of extended sources, as drastically proven by the MCE solver on Figure 11 below (a high amplitude focused on an excessively small support), despite the good value of its mean Spatial Dispersion.

• Patch n°54 : mean Spatial Dispersion (1.11) for MCE.

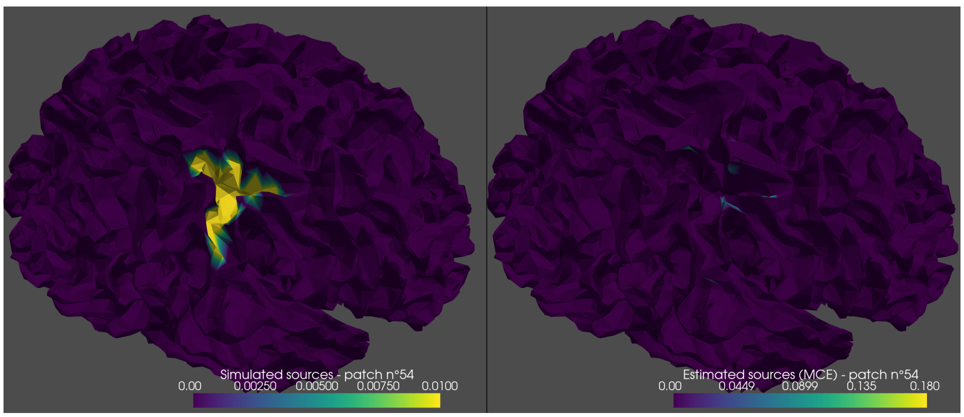

Figure 11: Patch n°54 - simulated sources (left) and MCE (right)

2. Real data (auditory evoked potentials)

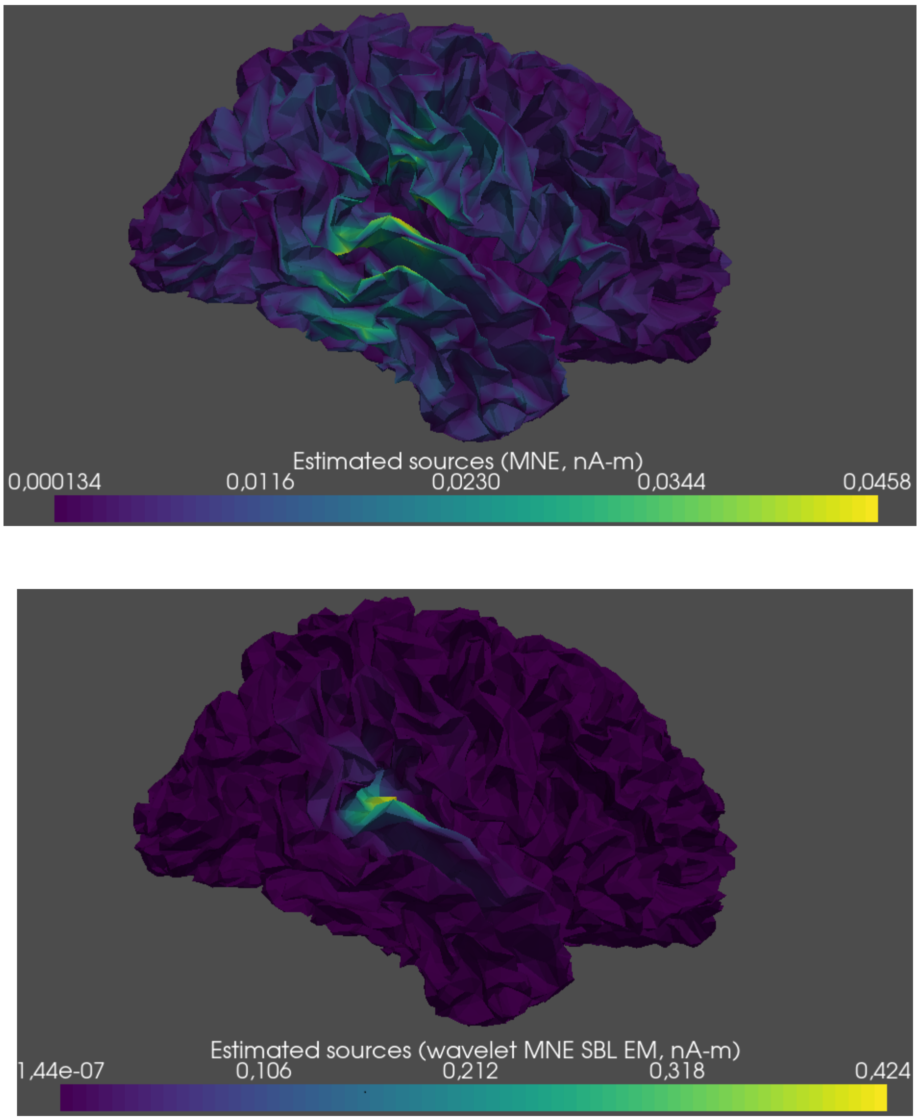

Figure 12: Estimated sources : MNE (upper) and sgw-SBL (EM, lower) - real data

Figure 12 confirms that sgw-SBL is able to prevent, on real data, the blurring effect of MNE, and to thus properly localize the activity in the auditory cortex, with moreover an order of magnitude ten times higher than MNE.