Everything you always wanted to know about debiasing quantitative spin density maps ... but were afraid to ask

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Mapping spin density, for example based on proton or sodium density, is of great interest for the quantitative analysis of food composition and processing by MRI. Boosting NMR sensitivity, e.g. by using array coils or high static fields, allows decreasing the uncertainty of spin density estimates. However, this improvement is counterbalanced by the bias due to the non-uniformity of emission and reception radiofrequency (RF) fields (respectively $f_{1,em}$ and $f_{1,rec}$). Since both responses are sample-dependent, a quantitative strategy for RF bias correction is to map $f_{1,em}$ in the presence of the sample and then to correct the biases due to both emission and reception, by assuming reciprocity ($f_{1,em} = f_{1,rec}$) [1].
We tested this strategy at 4.7 T on a homogeneous phantom using the same coil for emission and reception. We first mapped $f_{1,em}$ using DAM-SP [2], a flexible method for establishing a compromise between the level of noise propagated onto $f_{1,em}$ maps and the width of the range in which the field can be mapped. Secondly, we analyzed the efficiency of reciprocity-based RF bias correction on images. The results are discussed in terms of bias removal, magnification of propagated noise and loss of reciprocity, which occurs in some areas of the coil volume. While improvements were observed, our results underline further concerns for progressing towards full debiasing of quantitative MRI.

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[1] Hoult D.I., The principle of reciprocity in signal strength calculations: a mathematical guide. Concepts in Magnetic Resonance 2000; 12 (4): 173 – 187.
[2] Bouhrara M. and Bonny J.-M. B_1 mapping with selective pulses. Magn Reson Med. 2012; 68 (5): 1472 - 1480.