# Supplementary Materials for the paper

# *A Clustering Approach to Improve IntraVoxel Incoherent Motion Maps from DW-MRI using Conditional Auto-Regressive Bayesian Model*


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**Abstract**

1. Details on the Bayesian CAR approach

    (a) Llikelihood function for the first step

    (b) Llikelihood function for the first step

    (c) Hyperparameters of the mixture prior densities

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## 1. Details on the Bayesian CAR approach

### 1.1. Llikelihood function for the first step

The coefficients to be estimated are included in set $\boldsymbol{\Theta}_I = \boldsymbol{D} \cup \tilde{\boldsymbol{f}}$, with $\boldsymbol{D} = \{D(i,j), (i,j) \in \mathcal{I}\}$ and $\tilde{\boldsymbol{f}} = \left\{\tilde{f}(i,j), (i,j) \in \mathcal{I}\right\}$.

Each coefficient in $\boldsymbol{\Theta}_I$ and the signal intensity at $b = 0$ are assumed to be random variables. Therefore, the decay equation becomes a random process, in which the probability density function of each $SI(i,j,b)$ is expressed as conditioned to $D(i,j)$, $f(i,j)$ and $SI(i,j,0)$:

$$SI(i,j,b) \sim \mathcal{L}_{simp}\left(SI(i,j,b)\,|D(i,j), \tilde{f}(i,j), SI(i,j,0)\right)$$
$$\forall\ (i,j) \in \mathcal{I}, b \in B : b \geq \hat{b} \tag{1}$$

where $\mathcal{L}_{simp}$ denotes the probability law based on the simplified IVIM model.

Values $SI(i,j,0)$ are assumed to follow a Gaussian distribution with mean value $SI^{obs}_{ij0}$ and standard deviation $\sigma_{lik}$ [12]:

$$SI(i,j,0) \sim \mathcal{N}\left(SI^{obs}_{ij0}, \sigma^2_{lik}\right) \quad \forall\ (i,j) \in \mathcal{I} \tag{2}$$

Observations $SI^{obs}_{ijb}$ with $b \geq \hat{b}$ are assumed to be subject to an error (e.g., a measurement error) and modeled as stochastic variables. Other Gaussian distributions $\mathcal{N}$ with mean value $SI(i,j,b)$ computed by (1) and standard deviation $\sigma_{lik}$ are considered:

$$SI^{obs}_{ijb} \sim \mathcal{N}\left(SI(i,j,b), \sigma^2_{lik}\right) \quad \forall\ (i,j) \in \mathcal{I}, b \geq \hat{b} \tag{3}$$

A Rician distribution should be theoretically employed at low $SNR$, while the Rician distribution is well approximated by the Gaussian one for high $SNR$. Nevertheless, Gaussian and Rician likelihood functions give similar results for a large range of $SNR$ [20].

Parameter $\sigma_{lik}$ is another parameter to be estimated together with $\boldsymbol{\Theta}_I$. The conditional law of each observation $SI^{obs}_{i,j,b}$ is given by the combination of (1) and (3), and their product over $(i,j) \in \mathcal{I}$ and $b \geq \hat{b}$ gives the likelihood function, which depends on $\boldsymbol{\Theta}_I$ and $\sigma_{lik}$.

### 1.2. Likelihood function for the second step

The coefficients to be estimated in the second step are included in set $\boldsymbol{\Theta}_{II} = \boldsymbol{D}^* \cup \boldsymbol{f}$, with $\boldsymbol{D}^* = \{D^*(i,j), (i,j) \in \mathcal{I}\}$ and $\boldsymbol{f} = \{f(i,j), (i,j) \in \mathcal{I}\}$.

All observations are considered, and the parameters $D(i,j)$ assume the expected value of the respective marginal posterior density from the first step. Again, each coefficient in $\mathbf{\Theta}_{II}$ and the signal intensity at $b = 0$ are assumed to be random variables. Therefore:

$$SI(i,j,b) \sim \mathcal{L}\left(SI(i,j,b) \,|D^*(i,j), f(i,j), SI(i,j,0)\right)$$
$$\forall\ (i,j) \in \mathcal{I}, b \in B \setminus \{0\} \tag{4}$$

where $\mathcal{L}$ with no subscript denotes the conditional probability law based on the original IVIM model.

The same Gaussian distributions with standard deviation equal to $\sigma_{lik}$ are assumed for $SI(i,j,0)$ and the observations $SI^{obs}_{ijb}$ with $b \in B \setminus \{0\}$, as in the first step.

The conditional law of each observation $SI^{obs}_{i,j,b}$ is given by the combination of (4) and (3), and their product over $(i,j) \in \mathcal{I}$ and $b \in B \setminus \{0\}$ gives the likelihood function, which depends on $\mathbf{\Theta}_{II}$ and $\sigma_{lik}$.

### *1.3. Hyperparameters of the mixture prior densities*

The hyperparameters of the Gaussian component are set as follows: $\mu_{\tilde{f}} = \sigma_{0\tilde{f}} = 0.1$ and $\mu_D = \sigma_{0D} = 0.001 mm^2/s$ for the first step; $\mu_f = \sigma_{0f} = 0.1$ and $\mu_{D^*} = \sigma_{0D^*} = 0.01 mm^2/s$ for the second step. Mean values are chosen to center the priors on values with the same order of magnitude than those reported in the literature, while $\sigma_{0\lambda} = \mu_\lambda$ defines large densities. In addition, the priors of $D$ and $D^*$ are truncated in the interval $(0, +\infty)$, to ensure positivity [12], while that of $f$ in the interval $(0, 0.5)$, which largely covers its range of variability and avoid symmetries.

The hyperparameters of the CAR specification are set as follows: $\sigma_{\tilde{f}} \sim Gamma\,(0.25, 1)$ and $\sigma_D \sim Gamma\,(0.001 mm^2/s, 1)$ for the first step; $\sigma_f \sim Gamma\,(0.25, 1)$ and $\sigma_{D^*} \sim Gamma\,(0.01 mm^2/s, 1)$ for the second step. In the absence of information about the variability associated with the CAR specification, the imposed $\sigma_\lambda$ gives large densities.

They reflect the values adopted in Lanzarone *et al.* [15].

## 2. Supplementary tables

| Median error | | SNR10 | | | SNR25 | | | SNR50 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ |
| HN1 | Bayes | 0.086 | 0.022 | 0.142 | 0.023 | 0.020 | 0.056 | 0.003 | 0.024 | 0.025 |
| | CAR-orig | -0.036 | 0.345 | 0.229 | -0.034 | 0.238 | -0.125 | -0.019 | 0.071 | 0.031 |
| | CAR-cluster | -0.023 | 0.346 | -0.249 | -0.025 | 0.206 | -0.110 | -0.001 | 0.025 | 0.002 |
| HN2 | Bayes | 0.104 | 0.013 | 0.530 | 0.054 | -0.025 | 0.442 | 0.009 | 0.017 | 0.156 |
| | CAR-orig | -0.062 | 0.162 | -1.137 | -0.022 | 0.049 | -0.282 | 0.013 | -0.018 | 0.009 |
| | CAR-cluster | -0.059 | 0.120 | -1.252 | -0.011 | 0.006 | -0.217 | 0.005 | -0.011 | 0.059 |
| HN3 | Bayes | 0.111 | -0.150 | 0.475 | 0.060 | -0.079 | 0.303 | 0.009 | 0.008 | 0.059 |
| | CAR-orig | -0.110 | 0.033 | -0.010 | -0.065 | 0.079 | -0.098 | -0.007 | 0.018 | 0.078 |
| | CAR-cluster | -0.105 | 0.069 | -0.479 | -0.051 | 0.054 | 0.026 | -0.006 | 0.012 | 0.078 |
| HN4 | Bayes | 0.025 | -0.002 | 0.298 | 0.037 | 0.010 | 0.128 | 0.007 | 0.027 | 0.039 |
| | CAR-orig | -0.371 | 0.252 | -0.140 | -0.205 | 0.099 | 0.215 | -0.075 | 0.048 | 0.183 |
| | CAR-cluster | -0.285 | 0.216 | 0.066 | -0.157 | 0.013 | 0.238 | -0.057 | 0.042 | 0.157 |
| HN5 | Bayes | 0.138 | -0.243 | 0.405 | 0.062 | -0.116 | 0.262 | 0.012 | 0.020 | 0.050 |
| | CAR-orig | 0.026 | -0.366 | 0.214 | 0.087 | -0.233 | 0.502 | 0.000 | -0.018 | 0.143 |
| | CAR-cluster | 0.063 | -0.355 | 0.273 | 0.081 | -0.199 | 0.503 | 0.003 | 0.006 | 0.069 |
| P1 | Bayes | 0.016 | 0.018 | 0.163 | 0.053 | -0.033 | 0.294 | 0.015 | 0.018 | 0.183 |
| | CAR-orig | 0.021 | -0.059 | 0.012 | 0.041 | -0.139 | -0.135 | 0.021 | -0.059 | 0.012 |
| | CAR-cluster | 0.016 | -0.035 | 0.080 | 0.034 | -0.094 | -0.052 | 0.016 | -0.036 | 0.083 |
| P2 | Bayes | 0.022 | 0.015 | -0.060 | 0.049 | -0.014 | -0.167 | 0.023 | 0.008 | -0.100 |
| | CAR-orig | -0.027 | 0.094 | -0.295 | 0.000 | 0.171 | -0.898 | -0.027 | 0.094 | -0.295 |
| | CAR-cluster | -0.031 | 0.062 | -0.178 | 0.026 | 0.143 | -0.533 | -0.035 | 0.055 | -0.151 |
| P3 | Bayes | 0.027 | 0.004 | 0.170 | 0.071 | 0.011 | 0.302 | 0.031 | 0.000 | 0.169 |
| | CAR-orig | 0.013 | 0.029 | -0.020 | 0.008 | 0.058 | -0.097 | 0.013 | 0.029 | -0.020 |
| | CAR-cluster | 0.010 | 0.014 | -0.058 | 0.017 | 0.035 | -0.094 | -0.003 | 0.013 | -0.055 |
| P4 | Bayes | 0.019 | 0.025 | 0.008 | 0.014 | 0.045 | -0.005 | 0.019 | 0.024 | 0.010 |
| | CAR-orig | 0.012 | 0.021 | -0.087 | -0.018 | 0.016 | -0.143 | 0.012 | 0.021 | -0.087 |
| | CAR-cluster | 0.007 | 0.014 | -0.049 | -0.007 | 0.001 | -0.086 | 0.009 | 0.015 | -0.051 |
| P5 | Bayes | 0.032 | -0.026 | 0.171 | 0.033 | 0.030 | 0.280 | 0.033 | -0.027 | 0.165 |
| | CAR-orig | -0.015 | -0.026 | -0.117 | -0.080 | 0.020 | -0.780 | -0.015 | -0.026 | -0.117 |
| | CAR-cluster | -0.004 | -0.007 | -0.094 | -0.025 | -0.004 | -0.493 | -0.002 | -0.005 | -0.114 |

Table S1. Median error $\varepsilon$ for each simulated image at SNR10, SNR25 and SNR50 using the three different methods. HN: Head-and-Neck simulations; P: pelvis simulations.

| Median error | | SNR100 | | | SNR150 | | | SNR200 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ |
| HN1 | Bayes | 0.006 | 0.024 | 0.025 | 0.005 | 0.006 | 0.026 | 0.005 | 0.004 | 0.030 |
| | CAR-orig | -0.019 | 0.071 | 0.031 | 0.003 | 0.016 | 0.029 | 0.003 | 0.002 | 0.022 |
| | CAR-cluster | -0.001 | 0.023 | 0.003 | 0.003 | 0.010 | 0.011 | 0.001 | -0.005 | 0.007 |
| HN2 | Bayes | 0.009 | 0.020 | 0.160 | 0.006 | 0.019 | 0.067 | 0.003 | 0.013 | 0.043 |
| | CAR-orig | 0.013 | -0.018 | 0.009 | 0.005 | -0.018 | -0.006 | 0.002 | -0.025 | -0.012 |
| | CAR-cluster | 0.006 | -0.011 | 0.072 | 0.001 | 0.000 | 0.006 | 0.002 | 0.000 | -0.006 |
| HN3 | Bayes | 0.009 | 0.011 | 0.064 | 0.007 | 0.009 | 0.028 | 0.008 | 0.005 | 0.024 |
| | CAR-orig | -0.007 | 0.018 | 0.078 | -0.014 | 0.014 | 0.062 | -0.004 | 0.011 | 0.048 |
| | CAR-cluster | -0.008 | 0.015 | 0.076 | -0.017 | 0.007 | 0.053 | -0.001 | 0.004 | 0.029 |
| HN4 | Bayes | 0.008 | 0.028 | 0.043 | 0.006 | 0.006 | 0.011 | 0.008 | 0.007 | 0.022 |
| | CAR-orig | -0.075 | 0.048 | 0.183 | -0.027 | 0.002 | 0.114 | -0.006 | 0.004 | 0.103 |
| | CAR-cluster | -0.051 | 0.041 | 0.161 | -0.011 | 0.001 | 0.116 | -0.002 | 0.002 | 0.110 |
| HN5 | Bayes | 0.012 | 0.019 | 0.040 | 0.005 | 0.011 | 0.059 | 0.006 | 0.011 | 0.101 |
| | CAR-orig | 0.000 | -0.018 | 0.143 | -0.005 | 0.012 | 0.045 | -0.004 | -0.003 | 0.023 |
| | CAR-cluster | 0.002 | 0.006 | 0.054 | -0.001 | 0.006 | -0.007 | -0.003 | 0.010 | -0.014 |
| P1 | Bayes | 0.010 | 0.005 | 0.050 | 0.005 | 0.007 | 0.030 | 0.002 | 0.005 | 0.046 |
| | CAR-orig | 0.000 | -0.011 | 0.025 | 0.004 | -0.005 | 0.017 | -0.002 | 0.001 | 0.007 |
| | CAR-cluster | 0.003 | -0.015 | 0.035 | 0.008 | -0.007 | 0.018 | 0.000 | -0.001 | 0.009 |
| P2 | Bayes | 0.010 | 0.011 | 0.021 | 0.002 | 0.012 | 0.016 | 0.005 | 0.008 | 0.027 |
| | CAR-orig | -0.030 | 0.048 | -0.158 | -0.028 | 0.044 | -0.109 | -0.026 | 0.047 | -0.095 |
| | CAR-cluster | -0.017 | 0.036 | -0.102 | -0.018 | 0.033 | -0.075 | -0.006 | 0.008 | -0.030 |
| P3 | Bayes | 0.008 | 0.015 | 0.031 | 0.000 | 0.015 | 0.021 | 0.003 | 0.008 | 0.021 |
| | CAR-orig | -0.010 | 0.016 | -0.038 | -0.007 | 0.006 | 0.009 | -0.003 | 0.001 | 0.008 |
| | CAR-cluster | -0.002 | 0.007 | -0.017 | 0.000 | 0.001 | 0.021 | 0.002 | -0.003 | 0.017 |
| P4 | Bayes | 0.008 | 0.001 | 0.020 | 0.001 | 0.008 | 0.012 | 0.002 | 0.005 | 0.014 |
| | CAR-orig | -0.004 | 0.012 | -0.016 | -0.005 | 0.007 | 0.006 | -0.001 | 0.001 | 0.002 |
| | CAR-cluster | -0.001 | 0.004 | -0.005 | -0.002 | 0.002 | 0.003 | 0.000 | -0.001 | 0.000 |
| P5 | Bayes | 0.010 | 0.015 | 0.030 | 0.004 | 0.015 | 0.014 | 0.003 | 0.012 | 0.027 |
| | CAR-orig | -0.004 | -0.015 | -0.043 | -0.001 | -0.011 | -0.031 | -0.003 | -0.004 | -0.013 |
| | CAR-cluster | 0.000 | 0.002 | -0.058 | 0.003 | -0.004 | -0.031 | 0.000 | -0.001 | -0.016 |

Table S2. Median error $\varepsilon$ for each simulated image at SNR100, SNR150 and SNR200 using the three different methods. HN: Head-and-Neck simulations; P: pelvis simulations.

| *CV* | | SNR10 | | | SNR25 | | | SNR50 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ |
| HN1 | Bayes | 0.229 | 0.335 | 0.352 | 0.133 | 0.245 | 0.353 | 0.055 | 0.079 | 0.160 |
| | CAR-orig | 0.085 | 0.096 | 0.087 | 0.057 | 0.065 | 0.148 | 0.040 | 0.057 | 0.118 |
| | CAR-cluster | 0.067 | 0.086 | 0.195 | 0.040 | 0.048 | 0.115 | 0.048 | 0.025 | 0.068 |
| HN2 | Bayes | 0.203 | 0.320 | 0.289 | 0.117 | 0.253 | 0.261 | 0.031 | 0.135 | 0.195 |
| | CAR-orig | 0.085 | 0.104 | 0.398 | 0.070 | 0.111 | 0.201 | 0.057 | 0.114 | 0.224 |
| | CAR-cluster | 0.076 | 0.090 | 0.303 | 0.046 | 0.064 | 0.149 | 0.029 | 0.061 | 0.130 |
| HN3 | Bayes | 0.193 | 0.310 | 0.276 | 0.132 | 0.272 | 0.293 | 0.041 | 0.216 | 0.228 |
| | CAR-orig | 0.068 | 0.112 | 0.321 | 0.049 | 0.128 | 0.256 | 0.032 | 0.134 | 0.174 |
| | CAR-cluster | 0.056 | 0.092 | 0.375 | 0.032 | 0.105 | 0.223 | 0.021 | 0.064 | 0.112 |
| HN4 | Bayes | 0.204 | 0.285 | 0.256 | 0.156 | 0.204 | 0.326 | 0.065 | 0.195 | 0.176 |
| | CAR-orig | 0.098 | 0.120 | 0.152 | 0.091 | 0.135 | 0.165 | 0.062 | 0.140 | 0.137 |
| | CAR-cluster | 0.078 | 0.076 | 0.169 | 0.054 | 0.108 | 0.141 | 0.027 | 0.060 | 0.101 |
| HN5 | Bayes | 0.213 | 0.318 | 0.248 | 0.126 | 0.273 | 0.256 | 0.047 | 0.232 | 0.271 |
| | CAR-orig | 0.123 | 0.125 | 0.204 | 0.096 | 0.156 | 0.160 | 0.057 | 0.115 | 0.150 |
| | CAR-cluster | 0.102 | 0.085 | 0.190 | 0.075 | 0.129 | 0.138 | 0.039 | 0.090 | 0.090 |
| P1 | Bayes | 0.074 | 0.140 | 0.215 | 0.142 | 0.195 | 0.285 | 0.072 | 0.114 | 0.208 |
| | CAR-orig | 0.101 | 0.097 | 0.195 | 0.133 | 0.119 | 0.281 | 0.101 | 0.097 | 0.195 |
| | CAR-cluster | 0.051 | 0.065 | 0.114 | 0.067 | 0.104 | 0.171 | 0.053 | 0.085 | 0.127 |
| P2 | Bayes | 0.104 | 0.243 | 0.323 | 0.163 | 0.287 | 0.342 | 0.105 | 0.246 | 0.315 |
| | CAR-orig | 0.075 | 0.096 | 0.206 | 0.108 | 0.115 | 0.216 | 0.075 | 0.096 | 0.206 |
| | CAR-cluster | 0.056 | 0.061 | 0.131 | 0.078 | 0.075 | 0.194 | 0.074 | 0.066 | 0.141 |
| P3 | Bayes | 0.075 | 0.162 | 0.240 | 0.127 | 0.217 | 0.315 | 0.074 | 0.160 | 0.238 |
| | CAR-orig | 0.082 | 0.101 | 0.204 | 0.124 | 0.105 | 0.271 | 0.082 | 0.101 | 0.204 |
| | CAR-cluster | 0.067 | 0.059 | 0.109 | 0.099 | 0.069 | 0.175 | 0.069 | 0.058 | 0.106 |
| P4 | Bayes | 0.080 | 0.125 | 0.251 | 0.143 | 0.189 | 0.297 | 0.082 | 0.121 | 0.240 |
| | CAR-orig | 0.077 | 0.064 | 0.127 | 0.103 | 0.081 | 0.151 | 0.077 | 0.064 | 0.127 |
| | CAR-cluster | 0.061 | 0.059 | 0.095 | 0.072 | 0.069 | 0.108 | 0.060 | 0.055 | 0.095 |
| P5 | Bayes | 0.075 | 0.107 | 0.277 | 0.116 | 0.206 | 0.258 | 0.075 | 0.109 | 0.276 |
| | CAR-orig | 0.073 | 0.081 | 0.195 | 0.094 | 0.089 | 0.201 | 0.073 | 0.081 | 0.195 |
| | CAR-cluster | 0.046 | 0.056 | 0.128 | 0.060 | 0.066 | 0.158 | 0.050 | 0.052 | 0.140 |

Table S3. *CV* for each simulated image at SNR10, SNR25 and SNR50 using the three different methods. HN: Head-and-Neck simulations; P: pelvis simulations.

| *CV* | | SNR100 | | | SNR150 | | | SNR200 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ | $D$ | $f$ | $D^*$ |
| HN1 | Bayes | 0.055 | 0.079 | 0.155 | 0.037 | 0.059 | 0.101 | 0.028 | 0.048 | 0.084 |
| | CAR-orig | 0.040 | 0.057 | 0.118 | 0.039 | 0.055 | 0.104 | 0.031 | 0.056 | 0.126 |
| | CAR-cluster | 0.040 | 0.027 | 0.068 | 0.022 | 0.019 | 0.064 | 0.025 | 0.019 | 0.068 |
| HN2 | Bayes | 0.032 | 0.208 | 0.222 | 0.019 | 0.112 | 0.179 | 0.018 | 0.057 | 0.128 |
| | CAR-orig | 0.057 | 0.114 | 0.224 | 0.047 | 0.110 | 0.196 | 0.039 | 0.092 | 0.139 |
| | CAR-cluster | 0.028 | 0.064 | 0.113 | 0.024 | 0.055 | 0.077 | 0.019 | 0.059 | 0.089 |
| HN3 | Bayes | 0.042 | 0.219 | 0.228 | 0.028 | 0.117 | 0.175 | 0.021 | 0.092 | 0.142 |
| | CAR-orig | 0.032 | 0.134 | 0.174 | 0.030 | 0.098 | 0.179 | 0.032 | 0.086 | 0.165 |
| | CAR-cluster | 0.021 | 0.064 | 0.113 | 0.021 | 0.054 | 0.095 | 0.018 | 0.041 | 0.066 |
| HN4 | Bayes | 0.066 | 0.174 | 0.174 | 0.047 | 0.119 | 0.129 | 0.036 | 0.117 | 0.104 |
| | CAR-orig | 0.062 | 0.140 | 0.137 | 0.054 | 0.122 | 0.124 | 0.052 | 0.114 | 0.101 |
| | CAR-cluster | 0.027 | 0.061 | 0.107 | 0.023 | 0.051 | 0.112 | 0.024 | 0.046 | 0.100 |
| HN5 | Bayes | 0.062 | 0.360 | 0.261 | 0.027 | 0.152 | 0.196 | 0.025 | 0.163 | 0.122 |
| | CAR-orig | 0.057 | 0.115 | 0.150 | 0.045 | 0.111 | 0.130 | 0.047 | 0.089 | 0.145 |
| | CAR-cluster | 0.048 | 0.086 | 0.085 | 0.033 | 0.067 | 0.060 | 0.026 | 0.047 | 0.064 |
| P1 | Bayes | 0.039 | 0.069 | 0.141 | 0.028 | 0.053 | 0.105 | 0.019 | 0.043 | 0.080 |
| | CAR-orig | 0.072 | 0.059 | 0.171 | 0.061 | 0.050 | 0.114 | 0.042 | 0.045 | 0.080 |
| | CAR-cluster | 0.044 | 0.073 | 0.094 | 0.028 | 0.048 | 0.048 | 0.032 | 0.062 | 0.059 |
| P2 | Bayes | 0.052 | 0.121 | 0.216 | 0.045 | 0.115 | 0.166 | 0.035 | 0.080 | 0.133 |
| | CAR-orig | 0.054 | 0.081 | 0.168 | 0.045 | 0.073 | 0.141 | 0.047 | 0.089 | 0.145 |
| | CAR-cluster | 0.045 | 0.041 | 0.108 | 0.031 | 0.036 | 0.067 | 0.030 | 0.053 | 0.080 |
| P3 | Bayes | 0.034 | 0.088 | 0.156 | 0.025 | 0.059 | 0.134 | 0.020 | 0.044 | 0.123 |
| | CAR-orig | 0.055 | 0.087 | 0.147 | 0.052 | 0.080 | 0.130 | 0.031 | 0.071 | 0.113 |
| | CAR-cluster | 0.033 | 0.043 | 0.071 | 0.029 | 0.037 | 0.063 | 0.023 | 0.037 | 0.052 |
| P4 | Bayes | 0.046 | 0.084 | 0.150 | 0.031 | 0.054 | 0.125 | 0.021 | 0.042 | 0.089 |
| | CAR-orig | 0.055 | 0.057 | 0.111 | 0.038 | 0.047 | 0.095 | 0.032 | 0.045 | 0.072 |
| | CAR-cluster | 0.064 | 0.087 | 0.099 | 0.055 | 0.087 | 0.109 | 0.029 | 0.058 | 0.079 |
| P5 | Bayes | 0.037 | 0.069 | 0.156 | 0.020 | 0.031 | 0.113 | 0.018 | 0.026 | 0.081 |
| | CAR-orig | 0.049 | 0.064 | 0.127 | 0.050 | 0.055 | 0.110 | 0.046 | 0.061 | 0.145 |
| | CAR-cluster | 0.035 | 0.042 | 0.085 | 0.024 | 0.036 | 0.059 | 0.032 | 0.037 | 0.081 |

Table S4. *CV* for each simulated image at SNR100, SNR150 and SNR 200 using the three different methods. HN: Head-and-Neck simulations; P: pelvis simulations.