**Supplementary tables**

| **params** | |  | | |  | | |  | | | **R2** | | **d** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Method** | **bias** | **N10** | **cov** | **bias** | **N10** | **cov** | **bias** | **N10** | **cov** | **R2r** | **R2g** | **d** |
| 1: Reference condition | DYNR | 2 [-12;2672] | 35.1 | 44.1 | 10 [-4;843] | 49.5 | 0.1 | 12 [-33;3796] | 13.9 | 40.9 | 0.37 | 0.37 |  |
| OPENMX | -7 [-15;0] | 66.4 | 84.1 | 0 [-5;8] | 93.6 | 0 | -16 [-38;5] | 28.5 | 79.5 | 0.45 | 0.45 |  |
| NLME | 2194 [383;3846] | 0.2 | 0.9 | 160 [-26;516] | 0.4 | 0 | 1749 [384;2747] | 0.4 | 1.4 | 0.50 | 0.10 |  |
| GLLA | 8 [-1;17] | 63.6 | 81.1 | 17 [9;25] | 14.0 | 0 | -7 [-31;17] | 37.1 | 91.8 | 0.79 | 0.45 | 15 |
| FDAFDA | -1 [-8;7] | 91.9 | 93.5 | 5 [-2;12] | 81.7 | 0 | -8 [-28;13] | 41.2 | 91.8 | 0.81 | 0.45 | 0.73 |
| 2: | DYNR | -8 [-16;720] | 20.6 | 16.1 | -4 [-13;437] | 40.9 | 27.9 | -5 [-29;996] | 17.6 | 30.6 | 0.61 | 0.61 |  |
| OPENMX | -12 [-18;-6] | 34.4 | 25.6 | -8 [-14;-2] | 65.6 | 0 | -17 [-33;2] | 27.2 | 47.8 | 0.66 | 0.66 |  |
| GLLA | -3 [-8;4] | 94.1 | 87.3 | 4 [-2;12] | 80.9 | 0 | -12 [-29;7] | 39.6 | 83.3 | 0.96 | 0.65 | 11 |
| FDAFDA | -10 [-16;-4] | 46.3 | 38 | -5 [-11;3] | 84.6 | 0 | -17 [-33;0] | 28.8 | 71.9 | 0.94 | 0.65 | 0.73 |
| 3: 1/10 | DYNR | -2 [-13;1728] | 36.9 | 38.1 | 4 [-6;736] | 53.0 | 0.8 | 1 [-29;2387] | 15.3 | 39.7 | 0.48 | 0.48 |  |
| OPENMX | -8 [-14;-1] | 63.7 | 64.4 | -2 [-8;5] | 92.2 | 0 | -16 [-33;6] | 26.5 | 66.6 | 0.53 | 0.53 |  |
| GLLA | -2 [-9;6] | 92.0 | 90.4 | 9 [1;16] | 59.6 | 0 | -14 [-36;6] | 31.5 | 77.7 | 0.93 | 0.54 | 11 |
| FDAFDA | -4 [-10;3] | 90.1 | 86.4 | 3 [-3;10] | 89.7 | 0 | -12 [-31;9] | 35.8 | 83.9 | 0.89 | 0.54 | 0.73 |
| 4: | DYNR | 3108 [-14;3649] | 25.0 | 40.4 | 484 [-2;911] | 40.9 | 0 | 4105 [-32;5200] | 10.3 | 39.9 | 0.01 | 0.01 |  |
| OPENMX | -8 [-16;1] | 60.8 | 92 | 2 [-5;9] | 91.6 | 0 | -19 [-40;6] | 24.0 | 86.8 | 0.38 | 0.38 |  |
| GLLA | 5 [-4;15] | 72.8 | 88.3 | 17 [9;25] | 12.9 | 0 | -13 [-38;14] | 29.9 | 86.7 | 0.46 | 0.38 | 15 |
| FDAFDA | 0 [-9;9] | 87.5 | 93.9 | 6 [-2;12] | 78.4 | 0 | -6 [-29;19] | 37.1 | 91.8 | 0.63 | 0.39 | 0.73 |
| 5: Excitation: one step | DYNR | 2580 [-31;2804] | 1.7 | 10.1 | 392 [-3;504] | 25.8 | 0.1 | 2965 [-44;3329] | 1.2 | 9.5 | 0.02 | 0.02 |  |
| OPENMX | -14 [-22;-5] | 28.3 | 88.4 | -0 [-5;6] | 97.0 | 0 | -20 [-32;-6] | 17.4 | 85.3 | 0.30 | 0.30 |  |
| GLLA | -4 [-14;7] | 70.6 | 87.5 | 14 [8;23] | 20.8 | 0 | -12 [-27;5] | 39.3 | 78.7 | 0.79 | 0.29 | 11 |
| FDA | -11 [-20;-1] | 40.7 | 58.1 | 2 [-4;10] | 90.3 | 0 | -16 [-30;-1] | 28.3 | 65.7 | 0.50 | 0.30 | 0.64 |
| DYNRFDA | 2650 [-176;2855] | 3.8 | 1.6 | 37 [-29;84] | 9.3 | 0 | 2683 [-193;3095] | 3.9 | 1.6 | 0.00 | 0.00 |  |
| 6: Excitation: 3 points | OPENMX | -9 [-17;-0] | 58.4 | 99.8 | -14 [-20;-8] | 20.6 | 0 | -8 [-18;3] | 58.2 | 99.8 | 0.02 | 0.02 |  |
| GLLA | -11 [-25;1] | 43.5 | 70.8 | -73 [-78;-70] | 0.0 | 0 | -2 [-19;14] | 55.8 | 86.8 | 0.80 | 0.00 | 25 |
| FDA | -26 [-36;-16] | 2.4 | 7.2 | -3 [-12;5] | 79.9 | 0 | -26 [-38;-15] | 4.8 | 18.1 | 0.81 | 0.02 | 0.73 |
| DYNRFDA | 2558 [-128;2694] | 4.4 | 4.1 | -47 [-68;45] | 5.4 | 0 | 2764 [-142;3124] | 3.1 | 4.1 | 0.00 | 0.00 |  |
| 7: Excitation: 5 points | OPENMX | 4 [-7;15] | 72.3 | 100 | -24 [-31;-17] | 0.6 | 0 | 9 [-5;24] | 48.9 | 99.9 | 0.02 | 0.02 |  |
| GLLA | -17 [-51;-3] | 26.0 | 53.1 | -96 [-99;-93] | 0.0 | 0 | -1 [-43;18] | 47.3 | 82.8 | 0.28 | 0.00 | 25 |
| FDA | -37 [-97;-18] | 3.4 | 15.3 | -13 [-20;-4] | 33.7 | 0 | -40 [-107;-15] | 5.1 | 25 | 0.00 | 0.01 | 0.55 |
| DYNRFDA | 2519 [-236;2646] | 1.1 | 2.3 | -75 [-100;18] | 7.1 | 0 | 3062 [-306;3380] | 1.4 | 2.2 | 0.00 | 0.00 |  |
| 8: Excitation: 10 points | OPENMX | 11 [-1;23] | 46.0 | 99.7 | -44 [-53;-35] | 0.0 | 0 | 30 [13;47] | 6.9 | 99.5 | 0.03 | 0.03 |  |
| GLLA | -28 [-40;-15] | 4.5 | 10.7 | -73 [-77;-70] | 0.0 | 0 | -9 [-25;9] | 46.1 | 79.2 | 0.91 | 0.00 | 15 |
| FDA | -8 [-21;4] | 53.8 | 79.5 | -99 [-112;-86] | 0.0 | 0 | 26 [8;47] | 11.5 | 53.2 | 0.00 | 0.00 | 0.64 |
| DYNRFDA | 2260 [-112;2338] | 6.1 | 33.9 | 851 [-47;960] | 12.7 | 0 | 1693 [-96;2313] | 6.3 | 33.7 | 0.42 | 0.42 |  |
| 9: 30 Observations | OPENMX | -1 [-45;49] | 21.7 | 98.2 | -0 [-19;23] | 44.6 | 0 | -7 [-45;39] | 24.1 | 97.8 | 0.45 | 0.45 |  |
| GLLA | -106 [-116;-95] | 0.0 | 0 | -34 [-43;-25] | 0.0 | 0 | -101 [-116;-85] | 0.0 | 0 | 0.00 | 0.00 | 23 |
| FDA | -99 [-118;-80] | 0.0 | 0.2 | -43 [-57;-28] | 0.3 | 0 | -87 [-118;-55] | 0.0 | 70.3 | 0.00 | 0.00 | 0.18 |
| DYNRFDA | 7 [-16;2752] | 28.4 | 49 | 14 [-6;921] | 41.7 | 3.3 | 23 [-38;4002] | 12.9 | 46.9 | 0.34 | 0.34 |  |
| 10: 20 individuals | OPENMX | -7 [-18;5] | 57.4 | 92.7 | 0 [-9;13] | 76.7 | 0.1 | -16 [-47;16] | 23.6 | 88 | 0.46 | 0.46 |  |
| GLLA | -4 [-17;10] | 62.4 | 88.1 | 10 [-2;22] | 49.4 | 0 | -21 [-56;16] | 19.8 | 80.4 | 0.89 | 0.45 | 11 |
| FDA | -2 [-12;11] | 69.7 | 92.3 | 5 [-6;16] | 69.8 | 0 | -8 [-43;28] | 27.3 | 89.6 | 0.84 | 0.46 | 0.73 |
| DYNRFDA | 2282 [-11;2658] | 32.9 | 32.7 | 473 [-2;828] | 47.2 | 0 | 3047 [-28;3766] | 9.5 | 30.5 | 0.07 | 0.07 |  |
| 11: 100 individuals | OPENMX | -7 [-13;-1] | 72.1 | 71.5 | 1 [-4;6] | 96.9 | 0 | -16 [-30;-1] | 24.0 | 70 | 0.45 | 0.45 |  |
| GLLA | 7 [1;14] | 68.8 | 64.5 | 17 [11;23] | 5.2 | 0 | -7 [-24;10] | 50.1 | 88.8 | 0.74 | 0.45 | 15 |
| FDAFDA | -1 [-6;5] | 97.4 | 92 | 5 [0;10] | 88.8 | 0 | -7 [-22;8] | 53.7 | 88.7 | 0.79 | 0.45 | 0.73 |
| 12: | DYNR | 2281 [-13;2676] | 27.0 | 35.9 | 472 [-3;851] | 44.1 | 0.1 | 0.00 [-0.00;0.00] | 99.5 | 36.1 | 0.07 | 0.07 |  |
| OPENMX | -2 [-10;7] | 82.5 | 93.7 | -2 [-9;5] | 89.0 | 0 | 0.00 [0.00;0.00] | 100.0 | 97.2 | 0.45 | 0.45 |  |
| GLLA | 2 [-6;11] | 83.2 | 92.6 | 14 [6;22] | 27.3 | 0 | -0.00 [-0.00;0.00] | 100.0 | 76.9 | 0.84 | 0.45 | 13 |
| FDAFDA | -1 [-8;7] | 91.2 | 93.8 | 5 [-2;12] | 81.1 | 0 | -0.00 [-0.00;0.00] | 100.0 | 89.7 | 0.81 | 0.45 | 0.73 |
| 13: STN = 10% | DYNR | 3653 [-11;3769] | 30.5 | 34.1 | 1533 [-3;1804] | 42.8 | 28.1 | 3728 [-27;4795] | 9.6 | 31 | 0.00 | 0.00 |  |
| OPENMX | -8 [-12;-3] | 72.2 | 77.5 | 0 [-5;6] | 96.0 | 0 | -17 [-31;-1] | 25.0 | 73.8 | 0.46 | 0.46 |  |
| GLLA | 1 [-4;7] | 97.4 | 92.5 | 6 [0;14] | 77.1 | 0 | -5 [-21;11] | 52.3 | 92 | 0.99 | 0.45 | 7 |
| FDAFDA | -0 [-5;5] | 98.9 | 92.3 | 3 [-3;10] | 89.2 | 0 | -4 [-20;13] | 53.8 | 92.5 | 0.98 | 0.45 | 0.55 |
| 14: STN = 50% | DYNR | 1 [-16;2283] | 33.7 | 51.4 | 7 [-5;511] | 51.6 | 0 | 7 [-37;3647] | 16.3 | 51.4 | 0.39 | 0.39 |  |
| OPENMX | -7 [-18;4] | 58.9 | 89.8 | 1 [-7;9] | 86.6 | 0 | -15 [-43;12] | 27.8 | 87.5 | 0.45 | 0.45 |  |
| GLLA | -0 [-12;14] | 65.9 | 92.1 | 18 [8;29] | 15.6 | 0 | -24 [-57;8] | 19.9 | 78.8 | 0.00 | 0.43 | 15 |
| FDAFDA | 8 [-4;19] | 58.4 | 85.3 | 7 [-3;17] | 66.3 | 0 | 10 [-15;38] | 34.7 | 92.8 | 0.00 | 0.45 | 0.82 |
| 15: Lm regression | DYNR | 43 [-250;57] | 0.1 | 0.1 | NA [NA;NA] | NA | 0 | 79 [50;97] | 0.0 | 0 | 0.00 | 0.00 |  |
| OPENMXFDA | 8 [2;13] | 71.0 | 98.5 | NA [NA;NA] | NA | 0 | 179 [160;202] | 0.0 | 0 | NA | NA |  |
| 16: Gee regression | GLLA | -78 [-82;-72] | 0.0 | 0 | NA [NA;NA] | NA | 0 | -11 [-24;5] | 43.6 | 70.9 | 0.00 | 0.00 | 13 |
| FDAFDA | -81 [-86;-76] | 0.0 | 0 | NA [NA;NA] | NA | 0 | -38 [-49;-24] | 0.6 | 2.5 | 0.00 | 0.00 | 0.82 |
| 17: Homogeneous equation | GLLA | -60 [-66;-53] | 0.0 | 0 | -8 [-14;-1] | 63.7 | 0 | -113 [-127;-97] | 0.0 | 0 | 0.00 | 0.00 | 5 |
| FDA | -61 [-68;-53] | 0.0 | 0 | -38 [-43;-33] | 0.0 | 0 | -62 [-76;-47] | 0.0 | 0 | 0.38 | 0.38 | 0.91 |
| GLLA | -2 [-10;6] | 86.9 | 89.3 | 12 [5;19] | 38.8 | 0 | -25 [-46;-2] | 18.5 | 66 | 0.44 | 0.44 | 15 |
| FDAFDA | 0 [-6;7] | 93.6 | 92.9 | -3 [-9;4] | 92.7 | 0 | 6 [-14;26] | 44.3 | 92.2 | 0.45 | 0.45 | 0.82 |

Table S1: summary of the simulation results. For each simulation condition (left column, see Table 1) and method, the median [2.5;97.5%] relative bias of the estimated parameter, the percentage of estimation with absolute relative bias below 10% and the coverage of the three parameters (decay rate , parameters associated with the gain and with the equilibrium value ) are given. The median R2 calculated with the estimated curve from the individual coefficients (R2r) and from the fixed effect coefficient (R2g) and the simulation signal without noise, as well as (d) the embedding dimension (for GLLA) or smoothing parameter (for FDA spline), are provided. Light grey cells are condition reaching at least 50% of the estimated parameter below 10% of relative bias. The stronger grey indicate situation were the estimation explain more than 80% of the initial simulated parameter (R2 random above 0.8).

|  |  |
| --- | --- |
| Subject number | 30 |
| Age (year) | 36.07 (8.19) |
| Height (cm) | 174.26 (6.82) |
| Weight (kg) | 72.52 (9.70) |
| BMI | 23.83 (2.39) |
| Sex = male (%) | 28 (93.3) |
| Fat % | 16.15 (2.65) |
| VO2 max (mL/min/kg) | 50.18 (6.16) |
| Maximum Speed | 17.71 (2.07) |
| Maximum HR | 182.33 (7.83) |
| VT1 speed (km/h) | 9.23 (1.52) |
| VT2 (km/h) | 13.20 (1.88) |
| HRR (beat/min) | 36.07 (8.91) |

Table S2: population characteristics of the 30 amateur athletes considered. Performance characteristics are the maximum dioxygen consumption (VO2 max), the maximum speed achieved during the effort test, the maximum heart rate, and the speed corresponding to the first ventilatory threshold (VT1) and the second one (VT2)