Multivariate bias corrections of climate simulations: Which benefits for which losses?

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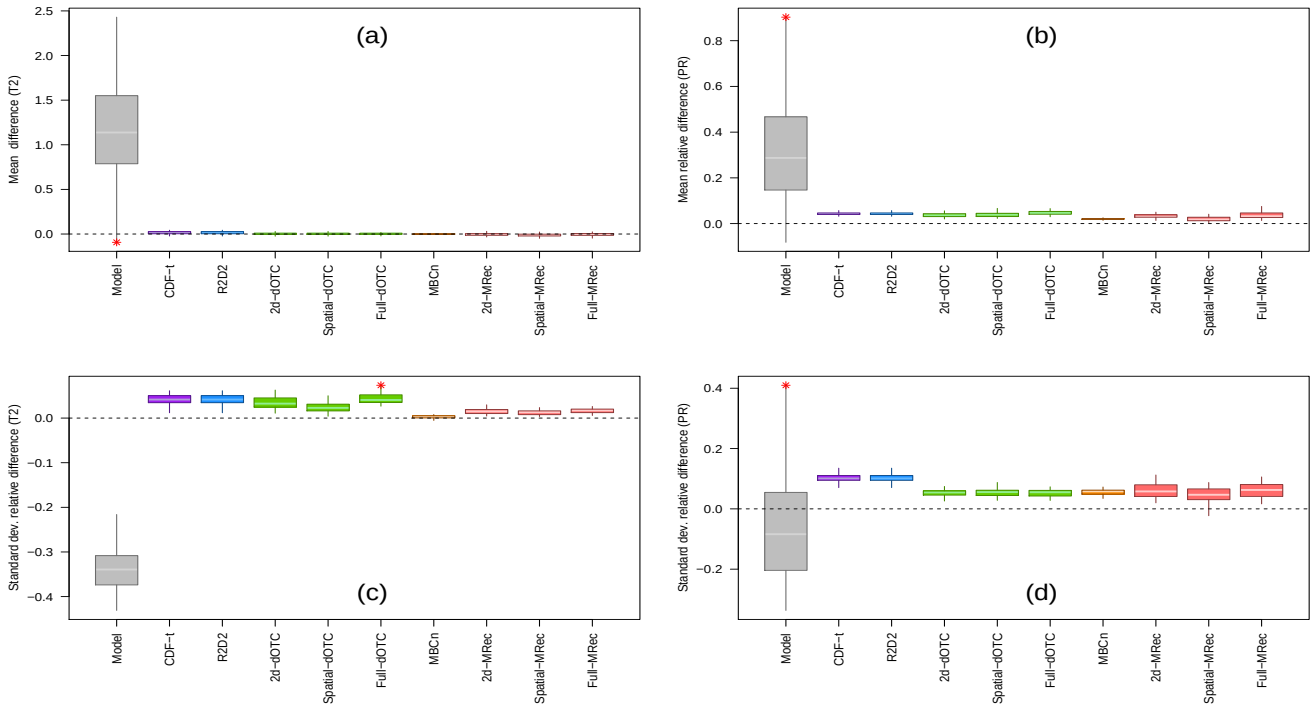

Figure S1. Boxplots of mean **(a and b)** and standard deviation **(c and d)** differences for Temperature (T2, a and c) and Precipitation (PR, b and d) during winter over the 1979-2016 period for the Brittany region (SAFRAN reference). Results are shown for: plain IPSL; CDF-t; R^2D^2; dOTC (2d-, Spatial- and Full-versions); MBC-n and MRec (2d-, Spatial- and Full-versions) outputs. Red asterisks indicate values lying outside the plotted range.

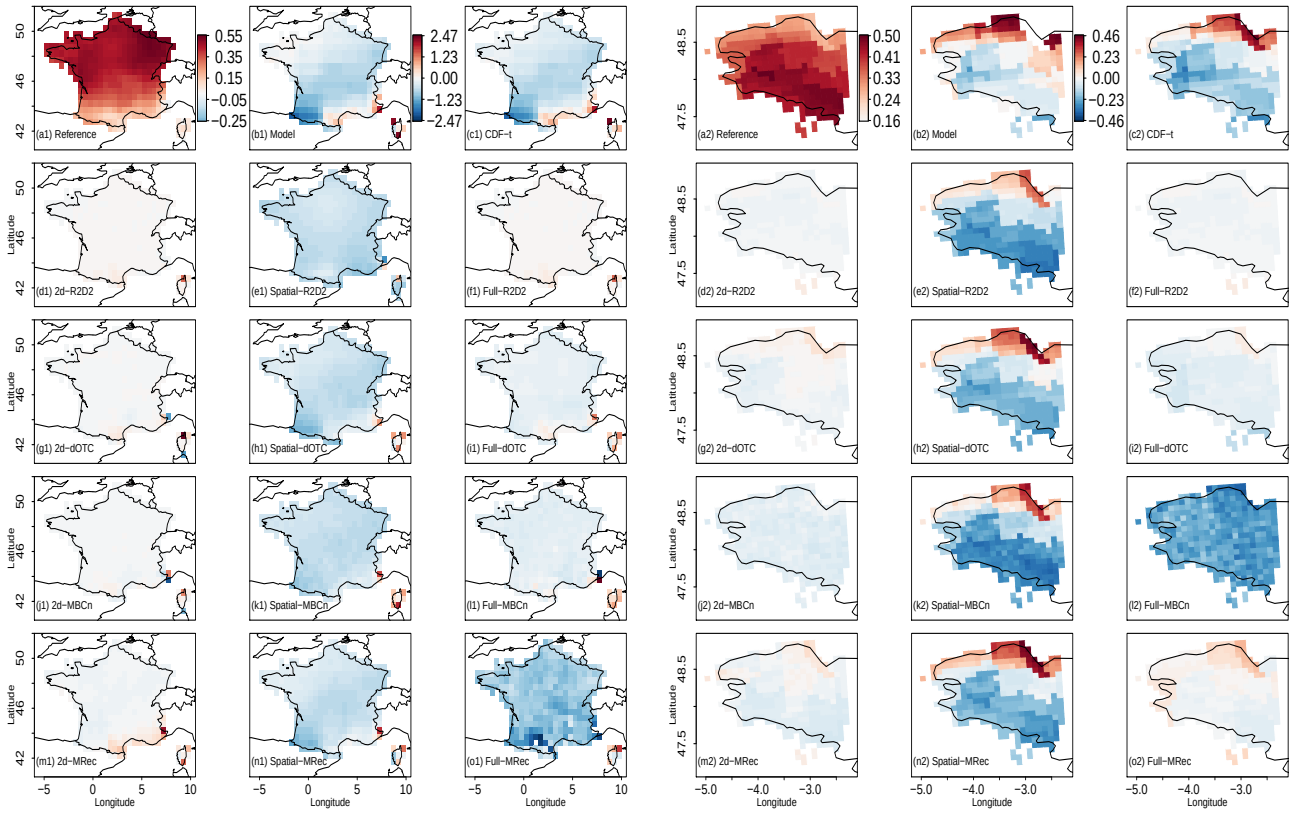

Figure S2. Differences of temperature vs. precipitation Spearman correlation maps computed at each grid cell using WFDEI reference **(a1-o1)** and SAFRAN reference **(a2-o2)** during winter over the 1979-2016 period. . Results are shown for: Reference; plain IPSL; CDF-t; R^2D^2; dOTC; MBC-n and MRec outputs for respectively 2d-, Spatial- and Full- versions. Note that the color scales between **(a1-o1)** and **(a2-o2)** are not the same to better emphasize intensities of values of the two regions.

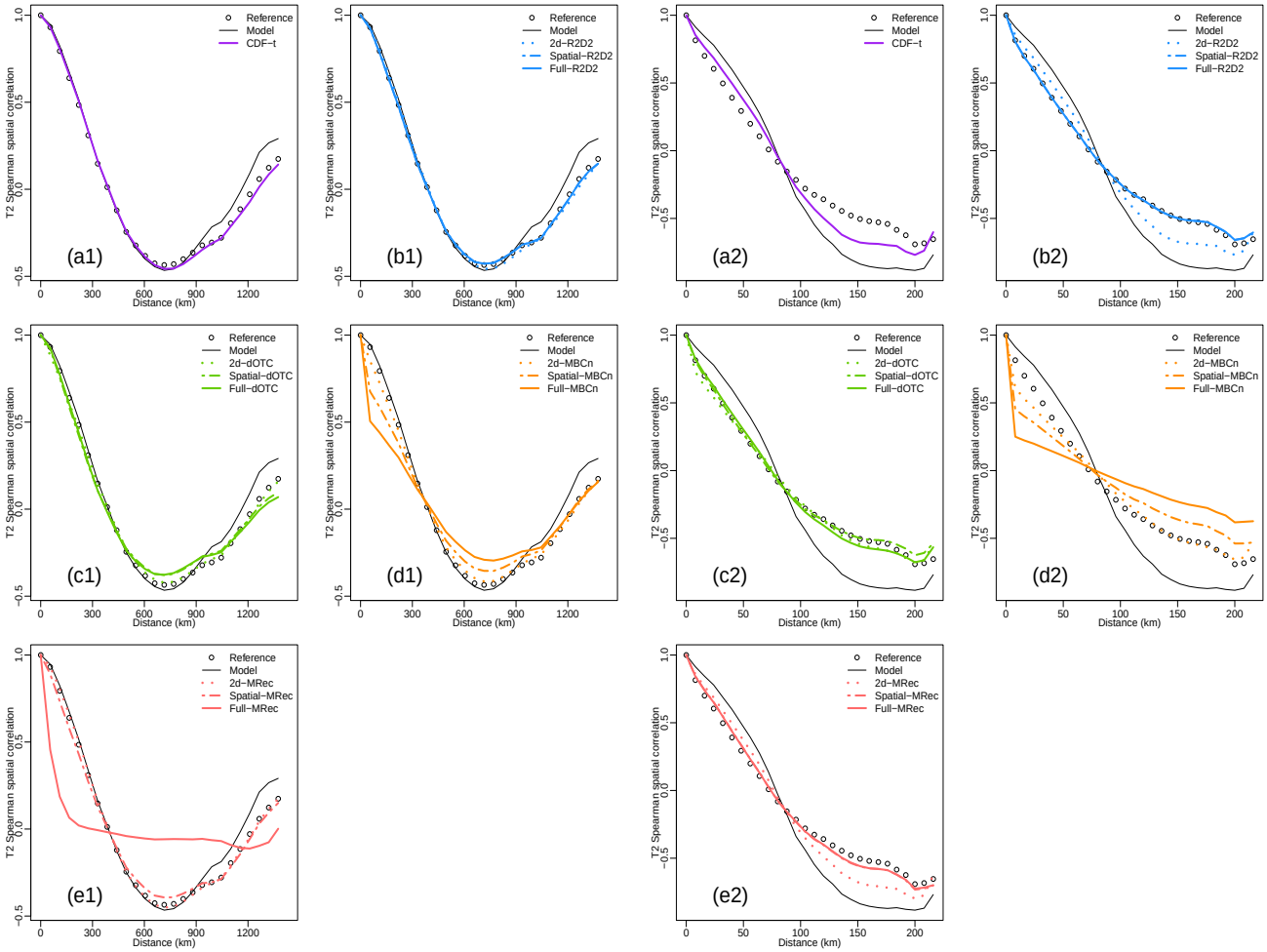

Figure S3. Correlograms for temperature using WFDEI reference **(a1-e1)** and SAFRAN reference **(a2-e2)** during winter over the 1979-2016 period. Results are shown for Reference (circles) and plain IPSL (black line). Results are displayed for: CDF-t; R^2D^2; dOTC; MBC-n and MRec outputs for respectively 2d- (dotted), Spatial- (dashed) and Full-versions (solid lines).

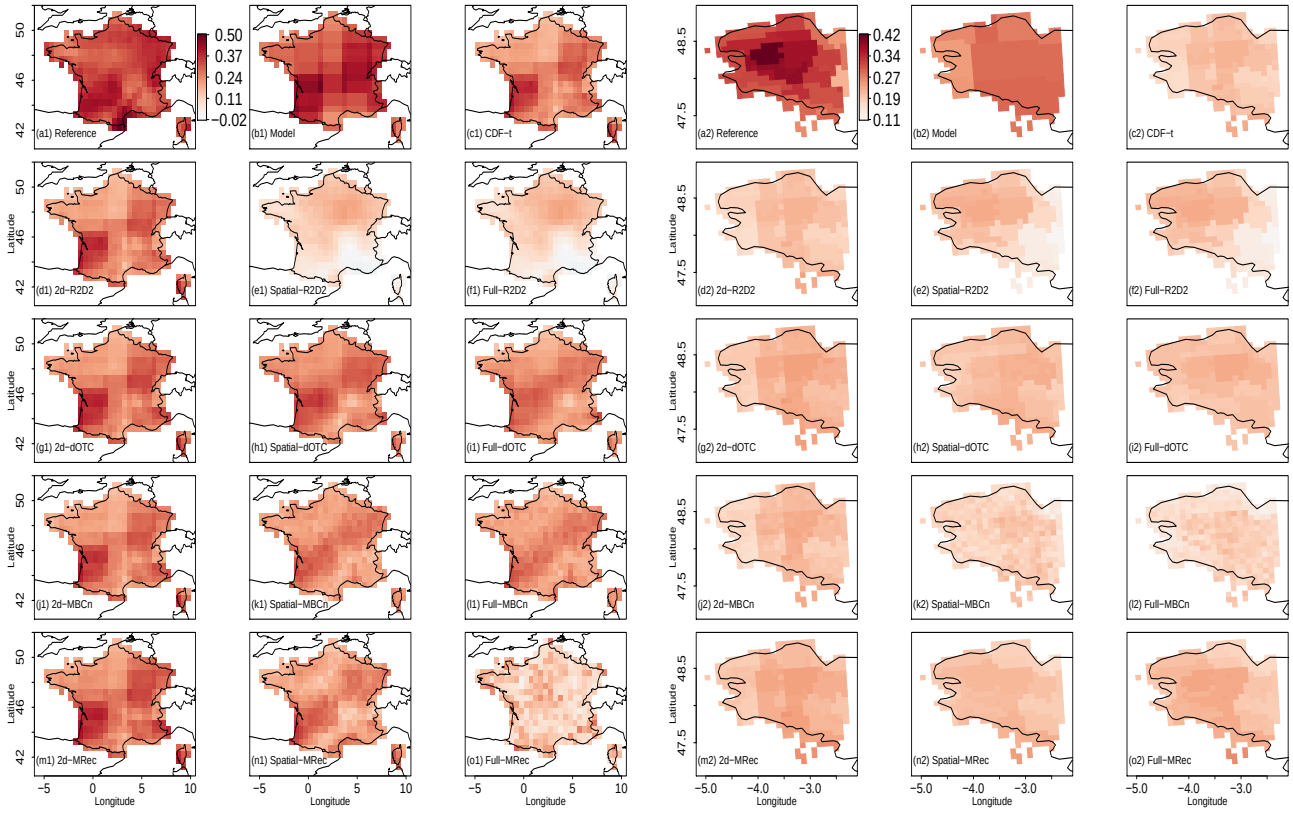

Figure S4. Order 1 autocorrelation for precipitation using WFDEI reference **(a1-e1)** and SAFRAN reference **(a2-e2)** during winter over the 1979-2016 period. Results are shown for: Reference; plain IPSL; CDF-t; R^2D^2; dOTC; MBC-n and MRec outputs for respectively 2d-, Spatial- and Full- versions. Note that the color scales between **(a1-o1)** and **(a2-o2)** are not the same to better emphasize intensities of values of the two regions.

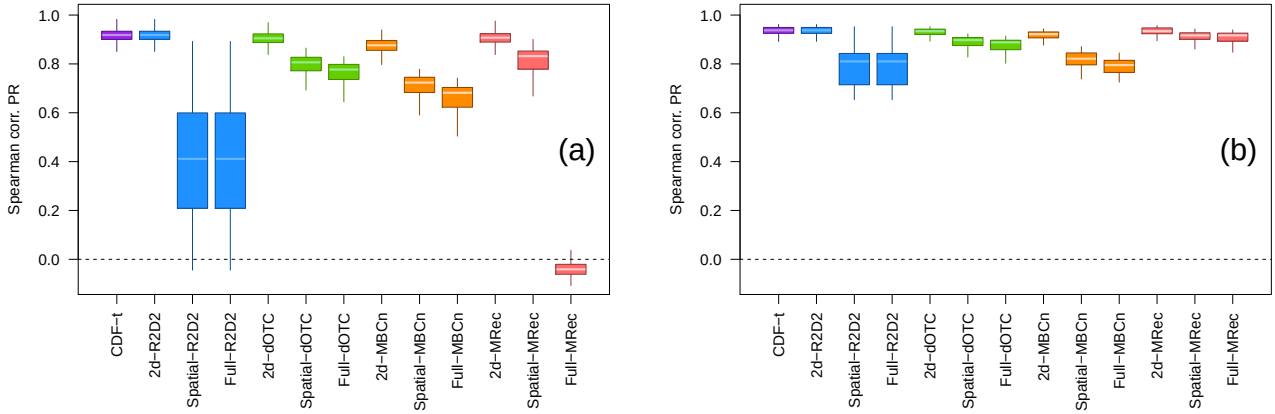

Figure S5. Boxplots of rank correlation computed at each grid cell between the bias corrected and the raw climate model time series for precipitation using WFDEI for France **(a)** and SAFRAN for Brittany **(b)** region during winter over the 1979-2016 period. For both boxplots, results are shown for: CDF-t; R^2D^2; dOTC; MBC-n and MRec outputs for 2d-, Spatial- and Full-versions.

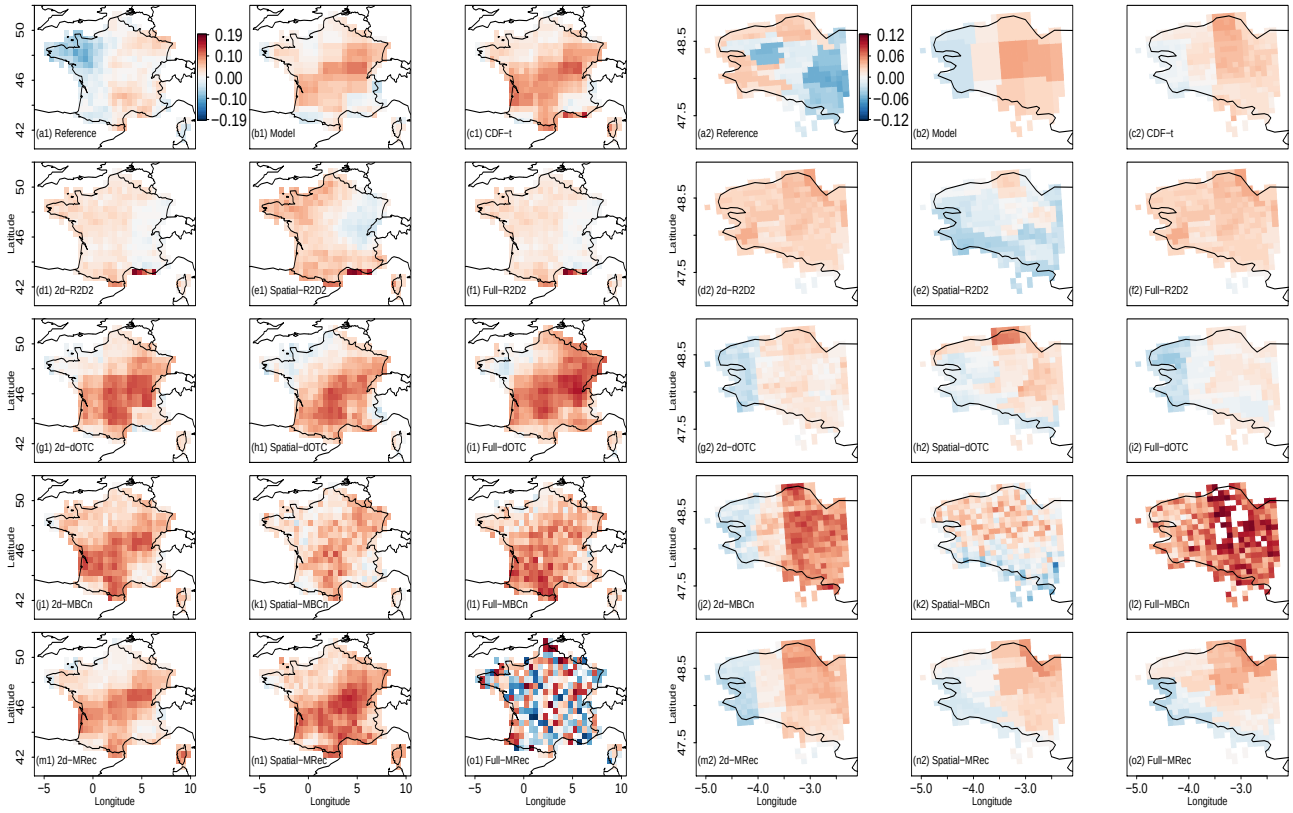

Figure S6. Differences of temperature vs. precipitation Spearman correlation computed at each grid cell between the 1979-1997 and 1998-2016 periods during summer. WFDEI **(a1-o1)** and SAFRAN **(a2-o2)** data are used for the bias correction. Note that the color scales between **(a1-o1)** and **(a2-o2)** are not the same to better emphasize intensities of values of the two regions.

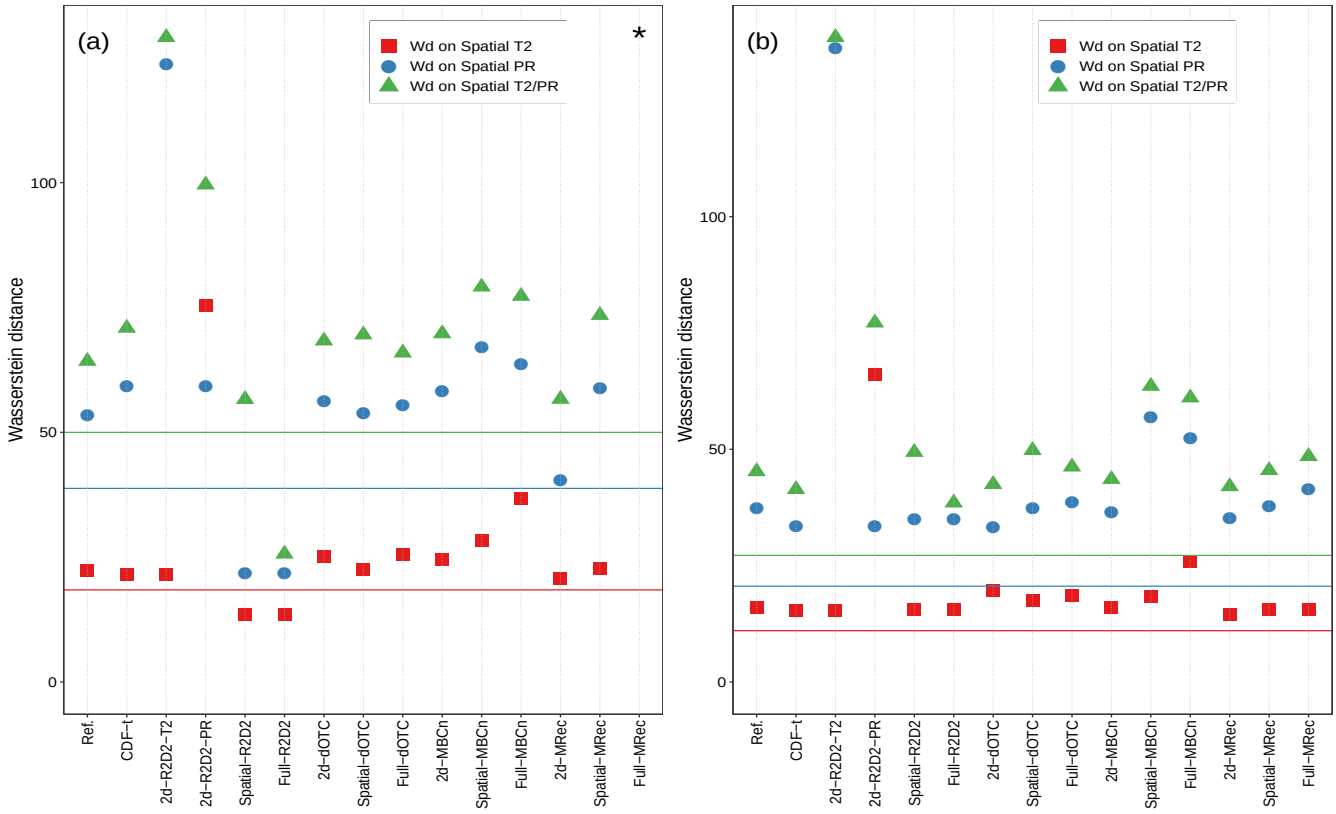

Figure S7. Values of the three Wasserstein distances between 1979-1997 and 1998-2016 periods during winter for temperature (square), precipitation (circle) and both temperature and precipitation (triangle) for the region of France **(a)** and Brittany **(b)**. Results are presented for: Reference; plain IPSL (lines); CDF-t and the different multivariate BC outputs. 2d-R^2D^2-T2 (resp. 2d-R^2D^2-PR) indicates results for 2d-R^2D^2 with temperature (resp. precipitation) used as reference dimension. Black asterisks indicate values lying outside the plotted range.

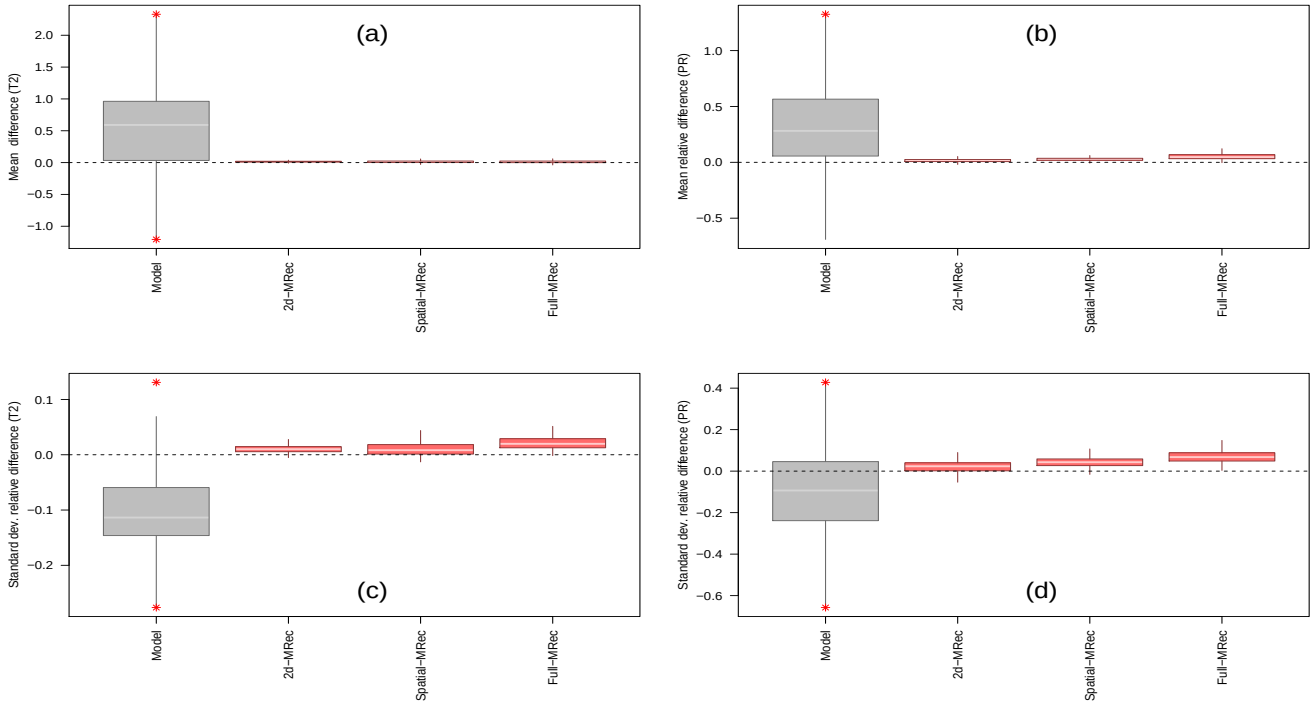

Figure S8. Boxplots of mean **(a and b)** and standard deviation **(c and d)** differences for Temperature (T2, a and c) and Precipitation (PR, b and d) during winter over the 1979-2016 period for the France region (WFDEI reference) with seasonal BC. Results are shown for: plain IPSL and MRec (2d-, Spatial- and Full-versions) outputs. Red asterisks indicate values lying outside the plotted range.

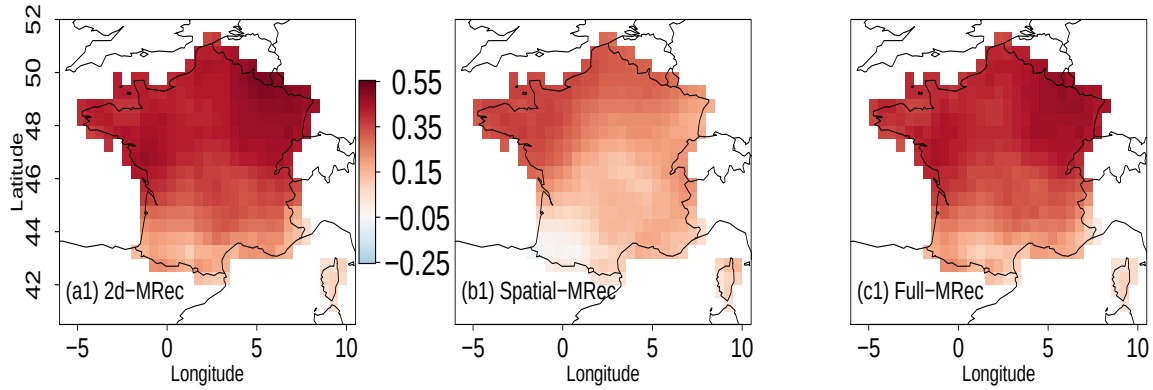

Figure S9. Temperature vs. precipitation Spearman correlation maps computed at each grid cell using WFDEI reference **(a1-c1)** during winter over the 1979-2016 period with seasonal BC. Results are shown for MRec **(a1-c1)** outputs for respectively 2d-, Spatial- and Full-versions.

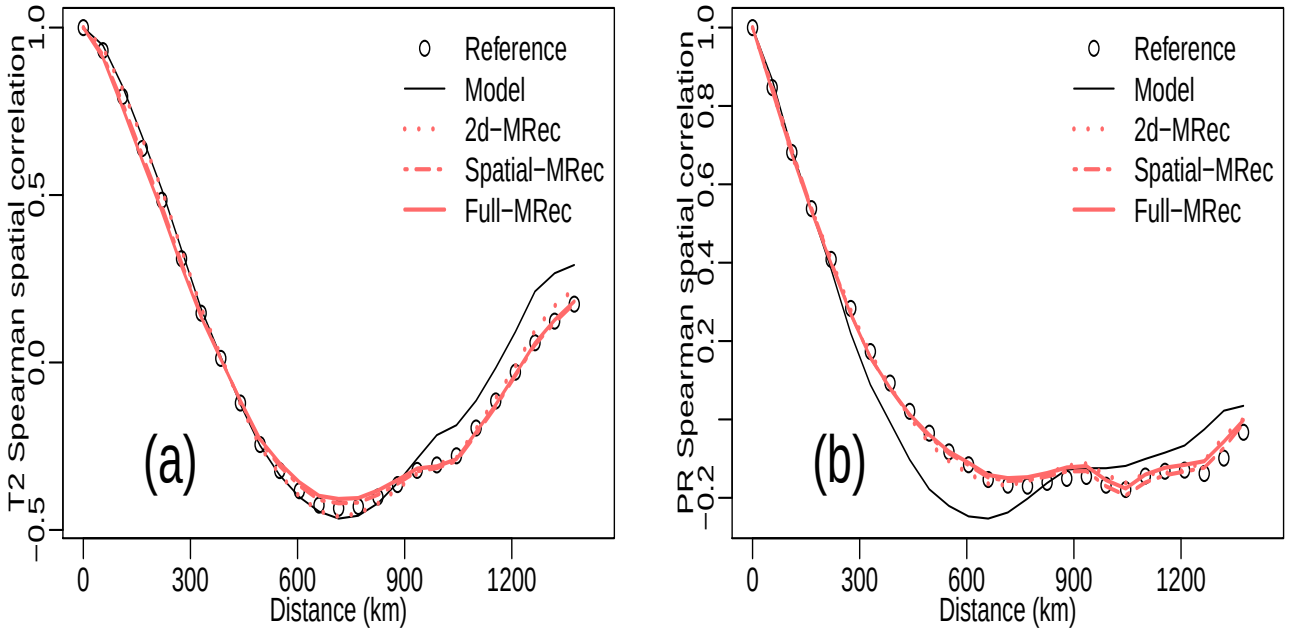

Figure S10. Correlograms for temperature **(a)** and precipitation **(b)** using WFDEI reference for France during winter over the 1979-2016 period with seasonal BC. Results are shown for: Reference (circles), plain IPSL (black line) and MRec outputs for respectively 2d- (dotted), Spatial- (dashed) and Full-versions (solid lines).

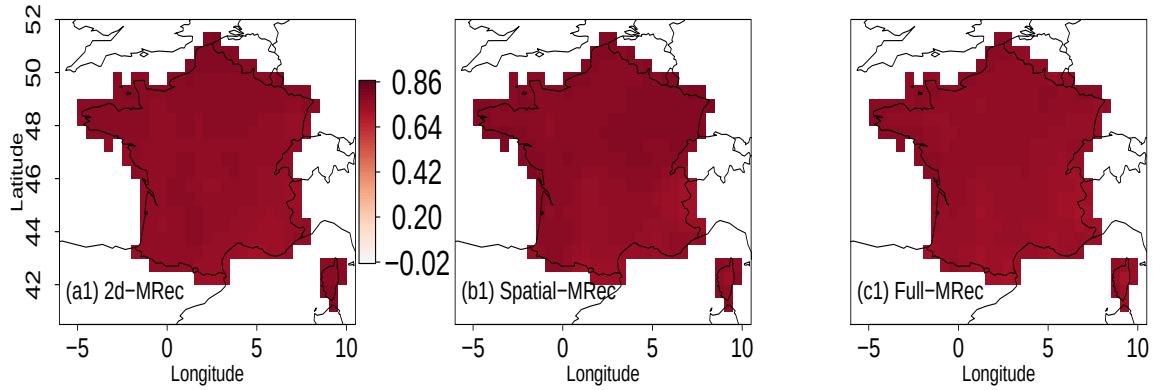

Figure S11. Order 1 Pearson autocorrelation for temperature using WFDEI reference during winter over the 1979-2016 period for the seasonal BC. Results are shown for MRec outputs for 2d-, Spatial- and Full-versions.

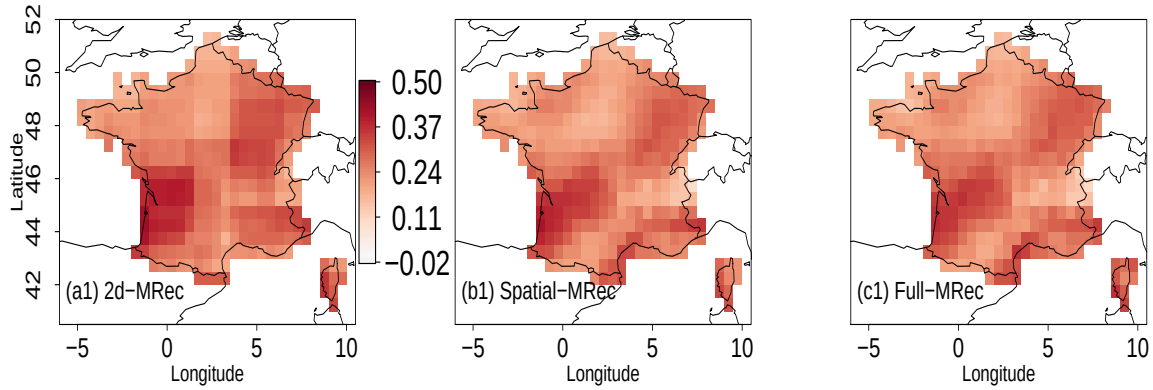

Figure S12. Order 1 Pearson autocorrelation for precipitation using WFDEI reference during winter over the 1979-2016 period for the seasonal BC. Results are shown for MRec outputs for 2d-, Spatial- and Full-versions.