Supplement of

The emergence of the Gulf Stream and interior western boundary as key regions to constrain the future North Atlantic carbon uptake

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**Figure S1.** Emergent constraint between upper ocean northward volume transport accumulated between surface and 500 m depth for the years 2005-2014 (predictor) and the future North Atlantic C\textsubscript{ant+} uptake (predictand) for the years 2090-2099 for our model ensemble. Shown are scatter-plot (color coding of models as in Fig. 1 of the main article), best fit linear regression (gray line) including the interval of the 68% projection uncertainty (gray shading), cross-correlation between simulated predictor and predictand as well as mean observational constraint and its uncertainty (dashed brown lines and light-brown shading). Associated estimates for the unconstrained model ensemble (dashed gray bar) and the emergent constraint (gray bar) are shown on the right side of the panels. See Appendix A of the main article for a detailed description of the considered observational estimate.

**Figure S2.** Relationship between (i) upper-ocean northward volume transport accumulated between surface and 500 m depth for the years 2005-2014 and (ii) the northward propagation of the winter pCO\textsubscript{2,sea} anomaly for the years 1990-1999, here expressed as the difference between winter pCO\textsubscript{2,sea}-anomalies for latitudes 26°-28°N and latitudes 40°-42°N. Shown are scatter-plot (color coding of models as in Fig. 1 of the main article), best fit linear regression (dashed black line) and cross-correlation between both quantities.
Figure S3. Contemporary fraction of the North Atlantic $C_{ant}$ multi-model mean for our considered model ensemble. Panels (a-x) display results for different depth planes between surface and 2400m.
Figure S4. Contemporary fraction of the North Atlantic $C_{ant}$, multi-model mean for our considered model ensemble. Panels (a-x) display results for different depth planes between 2400m and 4800m.
**Multi-model standard deviation, $C_{ant^*}$-fraction, 1997-2007**

(a) 0-100m   (b) 100-200m   (c) 200-300m   (d) 300-400m

(e) 400-500m   (f) 500-600m   (g) 600-700m   (h) 700-800m

(i) 800-900m   (j) 900-1000m  (k) 1000-1100m (l) 1100-1200m

(m) 1200-1300m (n) 1300-1400m (o) 1400-1500m (p) 1500-1600m

(q) 1600-1700m (r) 1700-1800m (s) 1800-1900m (t) 1900-2000m

(u) 2000-2100m (v) 2100-2200m (w) 2200-2300m (x) 2300-2400m

**Figure S5.** Contemporary fraction of the North Atlantic $C_{ant^*}$ multi-model standard deviation for our considered model ensemble. Panels (a-x) displays results for different depth planes between surface and 2400m. Non-eligible points are colored in different shades of blue.
Figure S6. Contemporary fraction of the North Atlantic $C_{ant^*}$ multi-model standard deviation for our considered model ensemble. Panels (a-x) displays results for different depth planes between 2400m and 4800m. Non-eligible points are colored in different shades of blue.
Figure S7. Emergent constraint between interior-ocean southward volume transport accumulated between 700 m and 4700 m depth for the years 2005-2014 (predictor) and the future North Atlantic $C_{ant}$ uptake (predictand) for the years 2090-2099 for our model ensemble. Shown are scatter-plot (color coding of models as in Fig. 1 of the main article), best fit linear regression (gray line) including the interval of the 68% projection uncertainty (gray shading), cross-correlation between simulated predictor and predictand as well as mean observational constraint and its uncertainty (dashed brown lines and light-brown shading). Associated estimates for the unconstrained model ensemble (dashed gray bar) and the emergent constraint (gray bar) are shown on the right side of the panels. See Appendix A of the main article for a detailed description of the considered observational estimate.