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Interannual to interdecadal variability in the upper-layer tropical Atlantic

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The upper-layer circulation in the tropical Atlantic can be understood as a shallow meridional overturning between the subtropics and tropics (the STC) overlaid and influenced by the deep, interhemisheric meridional overturning circulation (MOC). We use a sequence of model experiments based on both an Atlantic (FLAME model with 1/3° resolution) and a global model configuration (ORCA 1/2°) to examine the mechanisms of low-frequency variability in the upper-layer flow fields, with a focus on the remote effect of changes in deep water formation in the subpolar North Atlantic reflected in the MOC. Hindcasting simulations forced by atmospheric reanalyses showed similar characteristics of STC variability in both models. Sensitivity experiments based on artificial pertubations in the surface forcing confirmed the leading role of the local (zonal) wind stresses in generating STC variability on interannual time scales; there is little coherence between the subtropical variability with the near-equatorial (within about 4°-5° latitudes) variability in this regime. However, both models also exhibit a much weaker interdecadal modulation of the upper-layer transports which are effectively masked by the wind-driven signal. Additional perturbation experiments linked these anomalies to the changes of Labrador Sea Water formation related to the large-scale atmospheric conditions (i.e., the NAO) over the subpolar North Atlantic, which induce a MOC variability signal of O (1-2 Sv) rapidly communicated to the tropical Atlantic. The (inter-)decadal MOC-related transport variability in the tropical Atlantic was found confined mainly to the deep and intermediate layers, with only a very weak expression in the near-surface current fields.