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Resolving the phasing and forcing dynamics between North Atlantic climate and deep ocean circulation changes

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Multidecadal changes in North Atlantic climate (e.g., AMO/AMV) have been attributed to changes in the Atlantic Meridional Overturning Circulation (AMOC) and suggested as a driver of overturning changes. While simulations find an in-phase relationship when AMOC modulates basin-wide climate, AMOC lags when basin scale climate is forced externally (e.g., volcanoes and solar). Unfortunately the observational records are too short to assess these multi-decadal scale dynamics. The surface climate reconstructions, based on annually resolved archives, have excellent time control raising the possibility for precise determination of phasing with other well dated records. Yet, all currently available reconstructions of deep ocean circulation have radiometric based age models; with inherent errors ($\pm$30-50 years minimum) preventing the determination of the absolute phasing between deep ocean circulation changes and AMO/AMV. In order to reduce these uncertainties we use stratigraphical appearance, abundance and geochemical composition of tephra grains from a high sedimentation rate site off the Gardar Drift, south of Iceland (GS06-144-09MC-D; 60˚19'N, 23˚58'W, 2081 m water depth). Identifying tephra layers (and their association) in the core and fingerprinting with known volcanic eruptions on Iceland provides absolute age markers. Combining these age markers with ^{210}Pb and ^{14}C AMS dates within the same core, we have built a new chronology for the core GS06-144-09MC-D. Changes in surface ocean hydrography and climate are further portrayed using planktonic foraminiferal δ^{18}O, assemblage counts, modern analog technique derived sea surface temperatures and Mg/Ca paleothermometry. Records of Iceland Scotland Overflow Water (ISOW) vigor (Sortable Silt mean grain size; *Mjell et al., 2016*) and benthic carbon isotopes from the same core allow us to determine the absolute phasing between changes in basin-wide climate, deep ocean circulation, and deep water carbon chemistry spanning the past 800 years; constraining the mechanisms coupling circulation, ventilation, and climate on multidecadal timescales.

Comparison of our records of ISOW variability and AMO confirms that deep ocean flow varies on similar timescales as the basin-wide climate. However, although tephra markers provide absolute ages, going back to $\sim$1240 AD, the precise phasing is still difficult to determine when all uncertainties are taken into account (including differences in AMO reconstructions). Our results suggest that the last century is the most promising interval for determining the absolute phasing between climate and overflow changes and the recovery and analysis of additional sediment sequences spanning this interval should be prioritized.