Ocean heat transport (OHT) from the North Atlantic into the Arctic is thought to play a central role in driving Arctic climate change. Modeling studies differ in their predictions for future Arctic OHT changes under greenhouse gas (GHG) forcing with changes in the Atlantic Meridional Overturning Circulation (AMOC) playing a central role. Under decadal variability, a strong AMOC leads to increased northward OHT into the Arctic based on previous studies. Under forcing, AMOC weakens, yet northward OHT *increases* into the Arctic. Here we study the dynamics linking changes in AMOC, the subpolar gyre (SPG) circulation and northward OHT into the Arctic in GHG-forced and pre-industrial control simulations of a comprehensive climate model (NCAR's CCSM4). In particular, we decompose Atlantic OHT into overturning/gyre and active/passive components. Under decadal variability, a strong AMOC hands off extra heat to anomalously strong gyre circulations in the SPG and further north, which then deposit this heat in the Arctic. Under GHG forcing, AMOC and the SPG circulation weaken, yet anomalously warm surface waters are carried northward into the Arctic by a strong gyre circulation and the mean overturning. These findings suggest that distinct mechanisms link AMOC changes to anomalies in northward OHT under internal variability and GHG forcing.