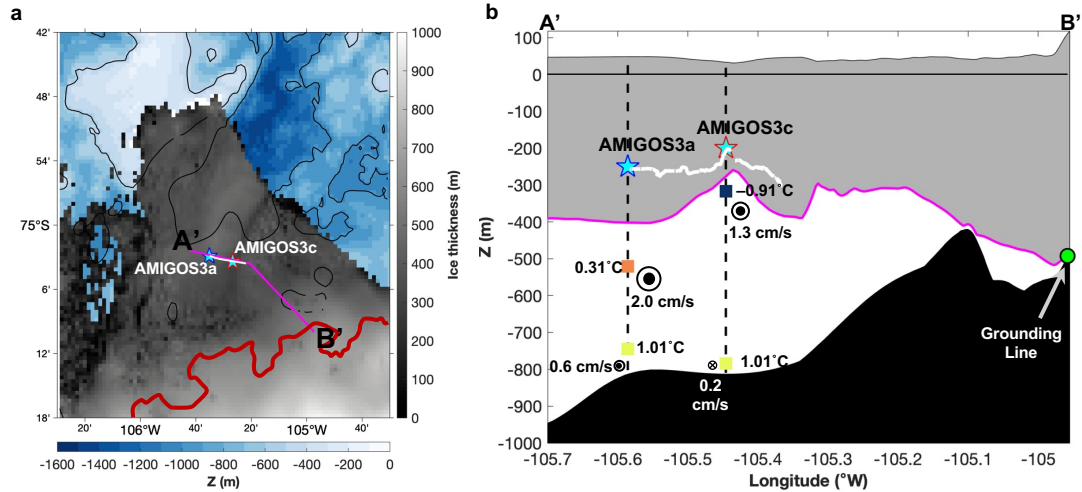
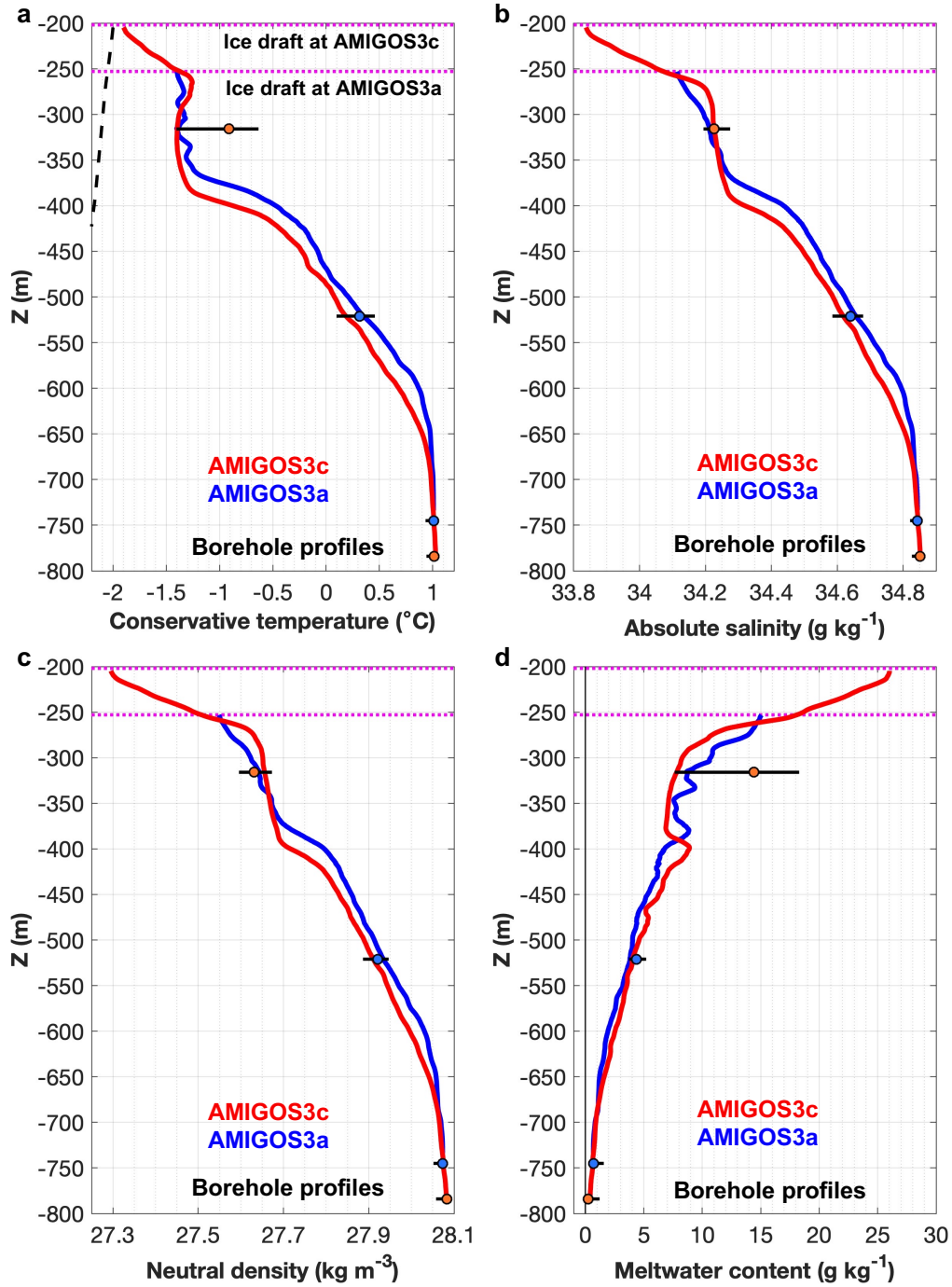
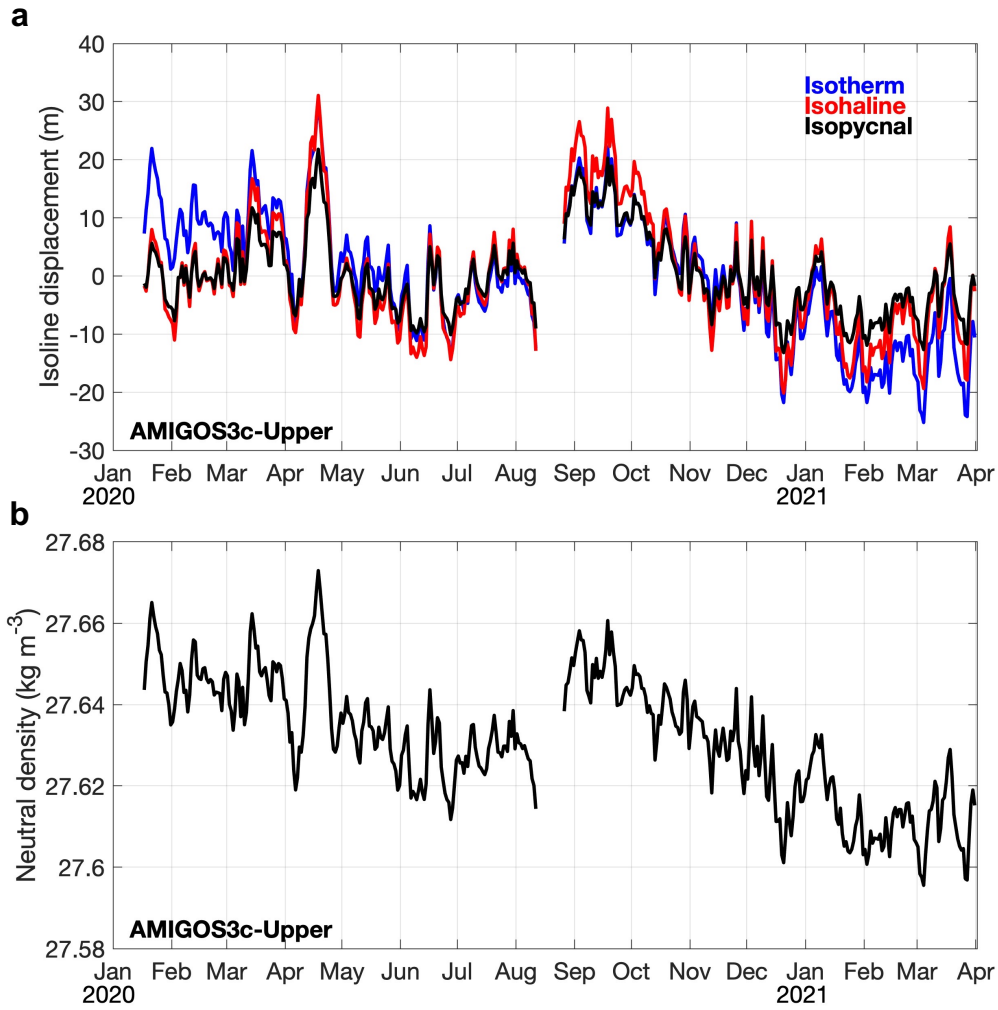




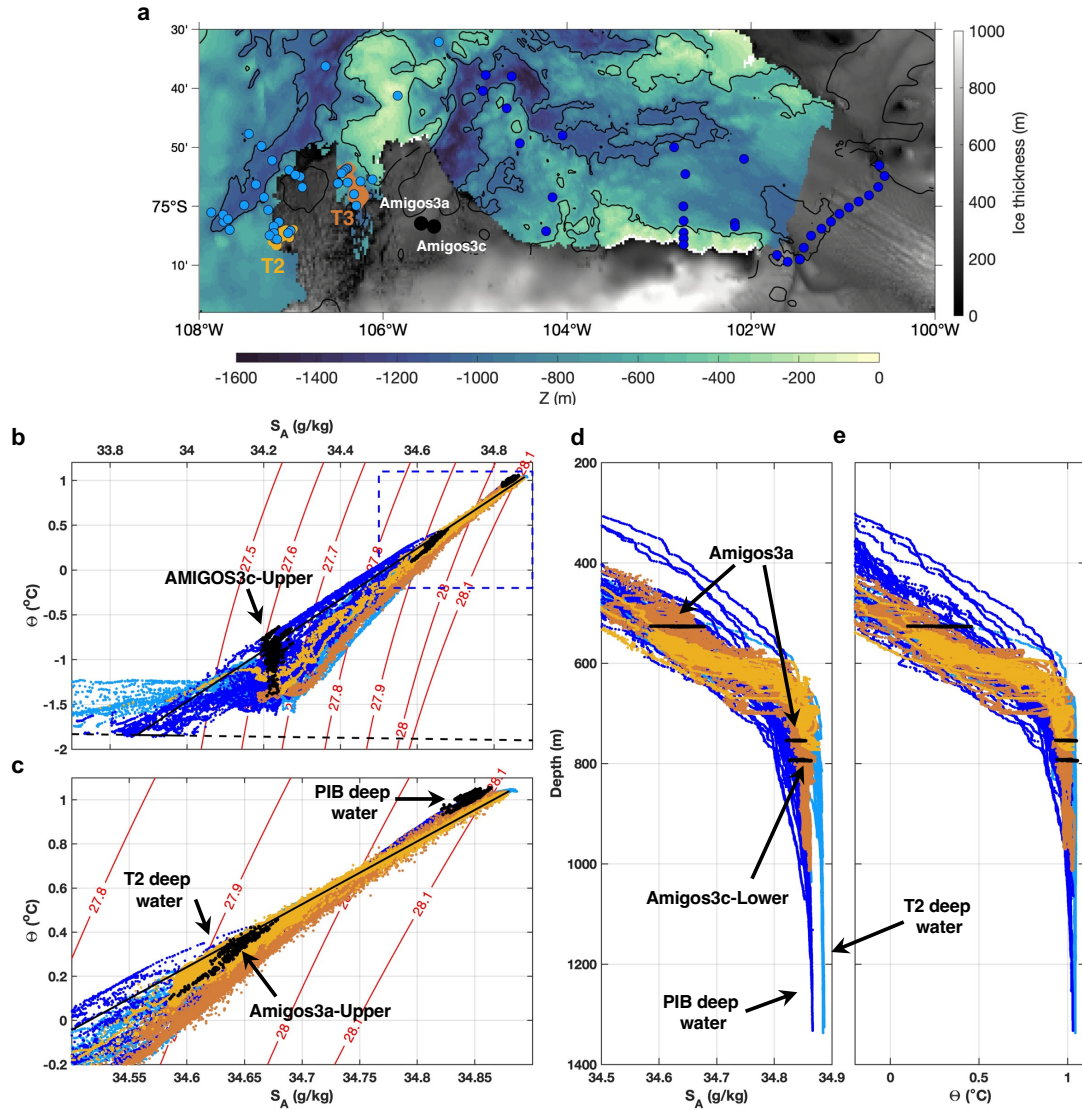
Supplementary Figure 1. Study area and section beneath TEIS. **a**, Bathymetry and thickness of TEIS from BedMachine Antarctica v2, ref.³⁷. Cyan stars show the location of AMIGOS3a (blue edge) and AMIGOS3c (red edge), respectively. Dark red line shows the grounding line from BedMachine. Magenta and white lines show the location of section profile shown in panel b. **b**, Section showing the time-mean conservative temperature and time-mean current speed (flow direction follow Fig. 1b) from the AMIGOS sensors relative to the ice and ocean depths. Ice shelf derived from BedMachine is shown in grey and bathymetry in black. White line is the ice shelf draft as observed by ground-penetrating radar in December 2019 (standard processing included stacking variable from 16-32, band pass filtering range approximately 30 to 150 MHz, gain based on mean attenuation of signal, no migration). Cyan stars show the field estimated ice shelf draft from drilling. Note the depth difference of the estimated ice shelf draft by BedMachine (magenta), radar measurement (white), and drilling (cyan stars). Green dot (right) shows the grounding line from BedMachine.



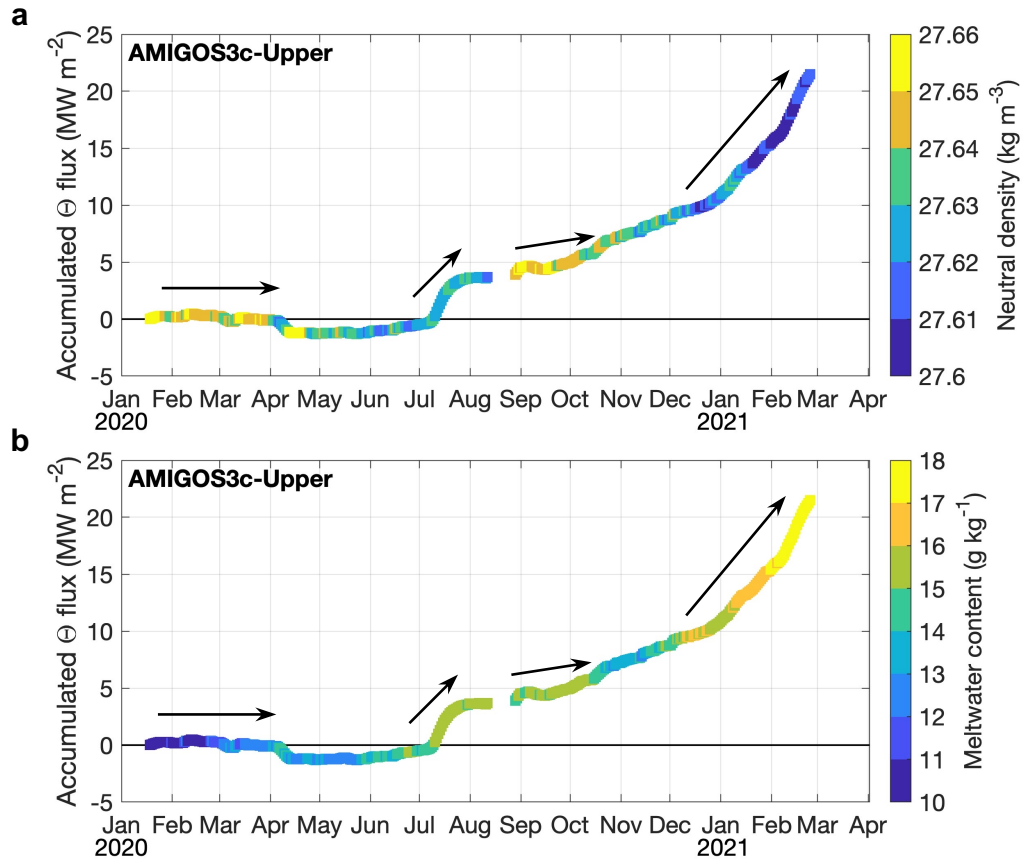
Supplementary Figure 2. Borehole CTD profiles. **a**, Conservative temperature profiles for AMIGOS3a (blue) and AMIGOS3c (red). Time-averaged temperatures for AMIGOS moorings are plotted at their measured depth and the horizontal black bars show the range of values recorded by each sensor. Field estimated ice shelf draft from drilling is shown by magenta dotted lines. **b**, Same as panel a, but for absolute salinity. **c**, Same as panel a, but for neutral density. **d**, Same as panel a, but for meltwater content.



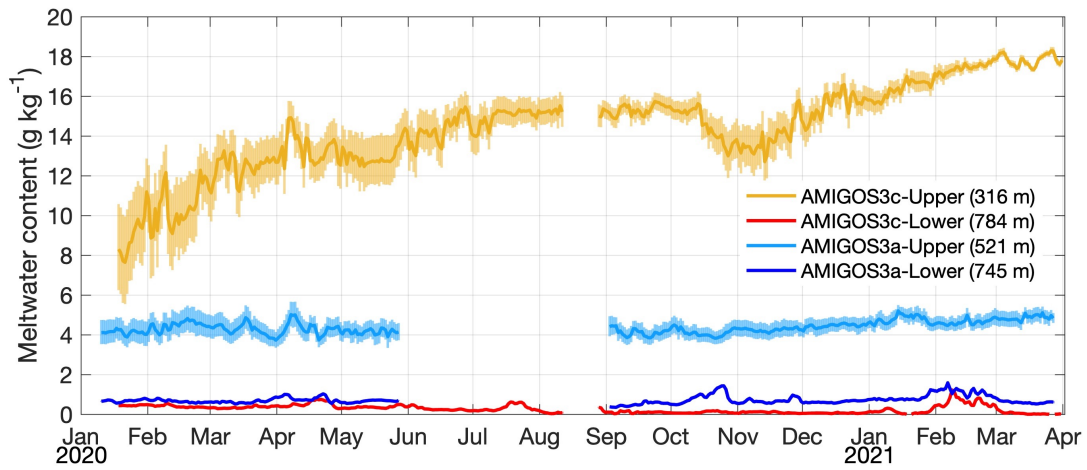
Supplementary Figure 3. a. Vertical isoline displacements deduced from temperature (blue), salinity (red) and density (black) at AMIGOS3c-Upper using vertical property gradients from the borehole CTD profiles shown in Supplementary Figure 2 (see Methods). **b,** Timeseries of neutral density (kg m^{-3}) from AMIGOS3c-Upper.



Supplementary Figure 4. Comparison of water masses recorded by the AMIGOS moorings (black), CTD stations in Pine Island Bay (dark blue), CTD stations in Thwaites Channel (light blue), and recorded by an autonomous underwater vehicle¹⁵ west (T2, light orange) and north (T3, dark orange) of Thwaites Ice Shelf. (a) Location of the profiles and the moorings. Ice thickness and bathymetry from BedMachine Antarctic v2, ref.³⁷. Note that the Pine Island Ice Shelf front is not calved in BedMachine. (b) Conservative Temperature (Θ)-Absolute Salinity (S_A) diagrams showing the water masses in Pine Island Bay, beneath, at the west and north of the Thwaites Eastern Ice Shelf. Red lines depict neutral density. Blue dashed rectangle shows the zoom in depicted in panel d. Black solid line is the Gade line used in Wåhlin et al.¹⁵ and the black dashed line is the in situ freezing temperature. (c) Zoom in showing the intermediate and deep waters. The deeper AMIGOS sensors record the fresher type of deep water found in Pine Island Bay, in agreement with previous findings of Wåhlin et al.¹⁵. (d) Profiles of S_A versus depth, and (e) profiles of Θ versus depth.



Supplementary Figure 5. Accumulated conservative temperature flux by neutral density and meltwater. **a**, Accumulated conservative temperature (Θ) flux from AMIGOS3c-Upper by neutral density (kg m^{-3}). **b**, Same as panel a, but coloured by meltwater content. The tilt of the black arrows highlights periods of acceleration (upwards) and deceleration (horizontal) of the flow.



Supplementary Figure 6. Estimated meltwater content error. Timeseries of meltwater content estimated from AMIGOS. The shading colour shows the error associated with changing the Winter Water end-member (Methods).