Figure F1. Antarctic Circumpolar Current (from Marshall and Speer, 2012) and Expedition 383 sites. Sites U1539 and U1541–1544 are primary sites; Site U1540 is an alternate site. Orange line = Subantarctic Front (SAF) and Antarctic Polar Front (APF); line thickness represents variability in latitudinal position of the corresponding front. Green arrows = observed speed and direction of surface ocean currents measured by drifters floating at 15 m water depth.

Figure F2. Examples of surface buoy trajectories (circles = position every 30 days) indicating northeast flow of northern Antarctic Circumpolar Current (ACC) water after crossing the East Pacific Rise. Also shown is the bifurcation of surface water close to the Chile coast (at ~45°S) with northward flowing water in the Humboldt Current System (HCS) and strongly accelerated southward flow in the Cape Horn Current (CHC) toward the Drake Passage. West–east drifting buoys follow the South Pacific Current (SPC). Modified from Chaigneau and Pizarro (2005) and Lamy et al. (2015).

Figure F3. Basement ages of South Pacific oceanic crust (from Eagles, 2006; contours indicate age in Ma).

Figure F4. Tectonic setting of the Expedition 383 Chilean margin sites and Seismic Line IT95-171 across the southern Chile continental margin. Site U1544 is located in the fore-arc basin at the upper margin. Figures modified from Polonia et al. (2007). s.p. = shotpoint, cdp = common depth point.

Figure F5. Central and eastern South Pacific paleoceanography and Drake Passage (DP) throughflow (modified from Lamy et al., 2015). The pronounced glacial cooling in the eastern Subantarctic is consistent with a northward extension of Antarctic cold-water influence. Reduced Cape Horn Current (CHC) and more sluggish glacial northern DP transport results in reduced the export of Pacific Antarctic Circumpolar Current (ACC) water into the South Atlantic (cold-water route). Reduced Southern Westerly Winds (SWW) strength and extended sea ice diminish the wind forcing on the ACC and thus the DP transport. Stronger winds in the northern SWW enhance the South Pacific Gyre and the export of northern ACC water into the HCS. SAF = Subantarctic Front, APF = Antarctic Polar Front, SACCF-N = Southern ACC Front, HCS = Humboldt Current System, SPC = South Pacific Current, AAIW = Antarctic Intermediate Water, WSI = winter sea ice. A. Reconstructed DP throughflow during the Last Glacial Maximum (LGM) compared to modern setting. SS = sortable silt. B. Schematic view of the DP region with major surface and intermediate water circulation. C. LGM sea-surface temperature anomalies at core locations (red dots).

Figure F6. Expedition 383 sites in the Pacific Antarctic Circumpolar Current (ACC) (red dots) and cores previously collected during various expeditions in the Southeast Pacific (white dots; Ocean Drilling Program [ODP] Leg 202 Sites 1232–1240 and Leg 178 Sites 1095–1102) in context of modern oceanography. HCS = Humboldt Current System, SPC = South Pacific Current, EPR = East Pacific Rise, CHC = Cape Horn Current, SAF = Subantarctic Front (modern locations after Orsi et al., 1995, and Reynolds et al., 2002, 2007), WSI = winter sea ice. Inset figures show vertical water mass structure along two transects in the central and eastern South Pacific (oxygen content: AAIW = Antarctic Intermediate Water, PDW = Pacific Deep Water, CDW = Circumpolar Deep Water, AABW = Antarctic Bottom Water). The geographic locations and water depths of the sites allow us to (1) compare the dynamics of the ACC laterally between the central South Pacific in the vicinity of the EPR (bathymetric constraints) and the eastern South Pacific before entering the Drake Passage and (2) investigate the vertical structure of the ACC. The sites sample the major water masses of the ACC in the Pacific sector of the Southern Ocean from AAIW (Site U1542), across the CDW/PDW (Sites U1539–U1541), and potentially down to AABW (U1543) (Ferrari et al., 2014).

Figure F7. Last Glacial Maximum (LGM) winter sea-surface temperatures (SSTs) and sea ice extent in the Pacific Southern Ocean (from Benz et al., 2016). Colors of core symbols represents the same color code as the World Ocean Atlas 2009 winter SSTs (WOA09 WSST). White dots = no temperature data available. Eastern Last Glacial Maximum winter sea ice (E-LGM WSI) estimates include the maximum winter sea ice extent (>15% September concentration) and the average sea ice concentration (40% concentration). Modern winter sea ice (M-WSI) edges after Reynolds et al. (2007). GSSTF = Glacial Southern Subtropical Front.

Figure F8. A–G. Pliocene to recent sea-surface temperature (SST) and $\%C_{37:4}$ changes in (C, E) the subpolar North Pacific (Ocean Drilling Program [ODP] Leg 145 Site 882) and (B, E) Atlantic Southern Ocean (ODP Leg 177 Site 1090) compared to (F) SST difference records contrasting the western (ODP Leg 130 Site 806) and eastern (ODP Leg 138 Site 847) equatorial Pacific. Strong enhancement of meridional SST gradients and shift in orbital frequencies at Site 1090 coincide with the strengthening of the "cold tongue" between 1.2 and 1.8 Ma (from Martínez-García et al., 2010). EEP = eastern equatorial Pacific, SAP = Subantarctic Pacific, SAA = Subantarctic Atlantic, WEP = western equatorial Pacific.

Figure F9. Schematic representation of the Antarctic Circumpolar Current (ACC) overturning circulation in the Pacific sector of the Southern Ocean (modified from Ronge et al., 2016). Glacial pattern (left): northernmost extent of sea ice and Southern Westerly Winds (SWW). Increased Antarctic Bottom Water (AABW) salinity by brine rejection and reduced Southern Ocean upwelling favors stratification. Increased dust input promotes primary production and drawdown of CO_2. Modern and deglacial pattern (right): upwelling induced by southward shift of Antarctic sea ice and SWW. The erosion of the deepwater carbon pool releases ^{14}C-depleted CO_2 toward the atmosphere. Following air–sea gas exchange, the outgassing signal is incorporated into newly formed Antarctic Intermediate Water (AAIW; light blue shading). Blue shading = poorly ventilated old and CO_2-rich waters, darkest shading 2500–3600 m = water level influenced by hydrothermal CO_2. Green arrows = intermediate water, orange arrows = deep water, light blue areas = sea ice, curved arrows = diffusional and diapycnal mixing. CDW = Circumpolar Deep Water.

Figure F10. Left: contrasting paleoproductivity pattern in the Antarctic Zone (AZ; ODP Leg 177 Site 1094) versus the Subantarctic Zone (SAZ; ODP Leg 177 Site 1090) over the past 1 My (from Jaccard et al., 2013). Red and blue shading = intervals where AZ and SAZ processes, respectively, are dominantly controlling the partitioning of CO_2 between the ocean interior and the atmosphere. During glacial inceptions, the first half of the pCO_2 reduction is essentially accomplished by decreasing vertical mixing and upwelling in the AZ (red shading). The second portion of the pCO_2 reduction (blue shading), initiated around 225 ppmv, is achieved by enhancing carbon sequestration resulting from increased iron fertilization in the SAZ, thereby leading the climate system to reach full glacial conditions. Right: records of Subantarctic dust-borne iron flux, phytoplankton productivity, surface nitrate consumption, and atmospheric CO_2 over the last glacial cycle (from Martínez-García et al., 2014). Gray vertical bars = maxima in dust flux that correspond to minima in atmospheric CO_2. PDB = Peedee belemnite, EDC = EPICA Dome C ice core, MAR = mass accumulation rate.

Figure F11. Changes in lithogenic mass accumulation rates (MAR_{Litho}) in the Pacific Southern Ocean (from Lamy et al., 2014). Open diamonds = ^{230}Th-normalized MAR_{Litho}. A. Dust MAR in the EPICA Dome C ice core. B. MAR_{Litho} Core PS75/76-2. C. MAR_{Litho} Core PS75/59-2. D. MAR_{Litho} ODP Leg 177 Site 1090. E. ^{230}Th-normalized MAR_{Litho} values from Cores PS75/59-2, PS75/76-2, E11-2, and E33-2. F. ^{230}Th-normalized C_{29} and C_{31} *n*-alkane MAR from Core PS75/59-2. G. ^{230}Th -normalized MAR_{Litho} Core PS2489-2.

Figure F12. Oceanographic and bathymetric setting, Site U1539. A. Marine geological features and oceanic fronts (after Orsi et al., 1995). EPR = East Pacific Rise, FZ = Fracture Zone, SAF = Subantarctic Front, APF = Antarctic Polar Front. B. Detailed bathymetry with seismic lines and shotpoints.

Figure F13. (A) Multichannel seismic (MCS) and (B) Parasound profiles, Site U1539. CDP = common depth point, TWT = two-way traveltime.

Figure F14. Modern salinity and oxygen distribution in the central South Pacific used to visualize major water masses. SAF = Subantarctic Front, APF = Antarctic Polar Front, NPDW = North Pacific Deep Water, LCDW = Lower Circumpolar Deep Water, AABW = Antarctic Bottom Water.

Figure F15. Hole summaries, Site U1539. GRA = gamma ray attenuation, MSP = point magnetic susceptibility, RGB = red-green-blue, NGR = natural gamma radiation, cps = counts per second. (Continued on next three pages.)

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Figure F16. Summary of primary lithostratigraphic variations, Site U1539. The unit boundary at ~125 m CCSF-A separates the high diatom mat (Lithofacies 1b) abundance of the early part of the record from the more frequent and thicker nannofossil ooze facies (Lithofacies 3 and 4) in the latter part of the record. Relative ages of the units are based on preliminary shipboard age model. RGB = red-green-blue. A = absent, P = present.

Figure F17. Relationships between bulk sedimentary carbonate content and (A) red-green-blue (RGB) blue and (B) color reflectance L*, Holes U1539A (red) and U1539C (gray). Bracketed symbols = data points from the Holocene (Hole U1539A) that were excluded from the regression analysis.

Figure F18. Characteristic variations in major lithology and physical properties, Hole U1539A. Lithologies are determined by visual core description, smear slide analyses, and X-ray imaging. Gray bars = intervals of light-colored nannofossil ooze. NGR = natural gamma radiation, cps = counts per second, MS = magnetic susceptibility, GRA = gamma ray attenuation bulk density, RGB = red-green-blue.

Figure F19. Preliminary age model based on biostratigraphic markers, Site U1539.

Figure F20. Oceanographic and bathymetric setting, Site U1540. A. Marine geological features and oceanic fronts (after Orsi et al., 1995). EPR = East Pacific Rise, FZ = Fracture Zone, SAF = Subantarctic Front, APF = Antarctic Polar Front. B. Detailed bathymetry with seismic lines and shotpoints.

Figure F21. Parasound profile, Site U1540. TWT = two-way traveltime.

Figure F22. Hole summaries, Site U1540. Geomagnetic polarity timescale ages along the depth scale are placed at the midpoint of observed reversals. The placement of Pliocene and early Pleistocene stage boundaries in Holes U1540D and U1540E are estimated using the preliminary Site U1540 shipboard age model. GRA = gamma ray attenuation, MSP = point magnetic susceptibility, RGB = red-green-blue, NGR = natural gamma radiation, cps = counts per second. (Continued on next four pages.)

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Figure F23. Summary of primary lithostratigraphic variations, Site U1540. Lithostratigraphic units were defined based on the distribution, occurrence, and composition of major lithofacies. Relative age of the lithostratigraphic units are based on the preliminary shipboard age model. Lithology: green = diatom ooze (Lithofacies 2), blue = calcareous ooze, light brown = clay-bearing biogenic ooze, dark brown = biogenic-bearing clay. RGB = red-green-blue, A = absent, P = present.

Figure F24. Relationships between bulk sedimentary carbonate content and (A) red-green-blue (RGB) blue and (B) color reflectance L*, Holes U1540A (red), U1540B (gray), and U1540D (orange). Data points from the Holocene (Hole U1540B) were excluded from the regression analysis.

Figure F25. A–D. Characteristic variations in major lithology and physical properties, Holes U1540A and U1540D. Lithologies were determined by visual core description, smear slide analyses, and X-ray imaging. Gray bars = nannofossil ooze, white bars = diatom ooze, orange bars = presence (C) or dominance (D) of clay. NGR = natural gamma radiation, cps = counts per second, MS = magnetic susceptibility, GRA = gamma ray attenuation bulk density, RGB = red-green-blue.

Figure F26. Preliminary age model based on biostratigraphic and paleomagnetic markers, Site U1540. FO-A = first occurrence in Hole U1540A, FO-D = first occurrence in Hole U1540D, LO-A = last occurrence in Hole U1540A, LO-D = last occurrence in Hole U1540D.

Figure F27. Oceanographic and bathymetric setting, Site U1541. A. Marine geological features and oceanic fronts (after Orsi et al., 1995). EPR = East Pacific Rise, FZ = Fracture Zone, SAF = Subantarctic Front, APF = Antarctic Polar Front. B. Detailed bathymetry with seismic lines and shotpoints.

Figure F28. (A) Multichannel seismic (MCS) and (B) Parasound profiles, Site U1541. TWT = two-way traveltime.

Figure F29. Hole summaries, Site U1541. Geomagnetic polarity timescale ages along the depth scale are placed at the midpoint of observed reversals in Holes U1541B and U1541C. The placement of Pliocene and early Pleistocene stage boundaries in Holes U1541B and U1541C are estimated using the preliminary Site U1541 shipboard age model. GRA = gamma ray attenuation, MSP = point magnetic susceptibility, RGB = red-green-blue, NGR = natural gamma radiation, cps = counts per second. (Continued on next two pages.)

Figure F29 (continued). (Continued on next page.)

Figure F29 (continued).

Figure F30. Summary of primary lithostratigraphic variations, Site U1541. Lithostratigraphic units were defined based on the distribution, occurrence, and composition of major lithofacies. Relative age of the units is based on the preliminary shipboard age model for Site U1541. Ages on depth scale indicate magnetic reversals. Lithologies: light green = diatom ooze, light blue = diatom-rich/bearing calcareous ooze, dark blue = nannofossil ooze, light brown = clay-bearing to clayey biogenic ooze. MSP = point magnetic susceptibility, RGB = red-green-blue. A = absent, P = present.

Figure F31. Age-depth relationship based on correlation to the geomagnetic polarity timescale (Cande and Kent, 1995), Holes U1541B and U1541C.

Figure F32. Relationships between bulk sedimentary carbonate content and (A) red-green-blue (RGB) blue and (B) color reflectance L*, Holes U1541A and U1541B.

Figure F33. A–E. Characteristic variations in major lithology and physical properties, Hole U1541B. Gray bars (A, B) = diatom ooze, light gray bars (C, D) = diatom bearing, orange bars = clay bearing. GRA = gamma ray attenuation bulk density, NGR = natural gamma radiation, cps = counts per second, MS = magnetic susceptibility, RGB = red-green-blue.

Figure F34. Preliminary age model based on biostratigraphic and paleomagnetic markers, Site U1541.

Figure F35. Oceanographic and bathymetric setting, Site U1542. A. Marine geological features. Yellow lines = seismic lines available in the region. B. Detailed bathymetry with seismic lines and shotpoints.

Figure F36. (A) Multichannel seismic (MCS) and (B) Parasound profiles, Site U1542. TWT = two-way traveltime, CDP = common depth point.

Figure F37. Schematic view of the southern Chilean margin and the Drake Passage region with approximate major surface and intermediate water circulation and Expedition 383 and ODP Leg 202 Site 1233 site locations. ACC = Antarctic Circumpolar Current, SPC = South Pacific Current, HCS = Humboldt Current System, CHC = Cape Horn Current, AAIW = Antarctic Intermediate Water, SAF = Subantarctic Front, WSI = winter sea ice.

Figure F38. Modern oxygen distribution in the eastern South Pacific used to visualize major water masses. AAIW = Antarctic Intermediate Water, PDW = Pacific Deep Water, CDW = Circumpolar Deep Water, AABW = Antarctic Bottom Water.

Figure F39. Hole summaries, Site U1542. GRA = gamma ray attenuation, MSP = point magnetic susceptibility, RGB = red-green-blue, NGR = natural gamma radiation, cps = counts per second. (Continued on next three pages.)

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Figure F40. Summary of primary lithostratigraphic variations, Site U1542. Lithologies: brown = silty clay to clayey silt, yellow = sand, gray = carbonate and/or sand-bearing clayey silt, blue = nannofossil ooze, pale yellow = silt-bearing nannofossil ooze. MSP = point magnetic susceptibility, RGB = red-green-blue. A = absent, P = present.

Figure F41. Characteristic variations in major lithology and physical properties, Hole U1542C. GRA = gamma ray attenuation bulk density, MSP = point magnetic susceptibility, NGR = natural gamma radiation, cps = counts per second, RGB = red-green-blue.

Figure F42. Preliminary age model based on biostratigraphic and paleomagnetic markers, Site U1542.

Figure F43. Oceanographic and bathymetric setting, Site U1543. A. Marine geological features. Yellow lines = seismic lines available in the region. B. Detailed bathymetry with seismic lines and shotpoints.

Figure F44. (A) Multichannel seismic (MCS) and (B) Parasound profiles, Site U1543. TWT = two-way traveltime, CDP = common depth point.

Figure F45. Hole summaries, Site U1543. GRA = gamma ray attenuation bulk density, MSP = point magnetic susceptibility, RGB = red blue green, NGR = natural gamma radiation, cps = counts per second. (Continued on next page.)

Figure F45 (continued).

Figure F46. Summary of primary lithostratigraphic variations, Site U1543. Lithologies: tan = nannofossil ooze, blue = clay-, silt-, and/or diatom-bearing/rich calcareous ooze, orange = siliciclastic and/or carbonate-bearing/rich diatom ooze, white = diatom-bearing clay, gray = clayey silt to silty clay. MSP = point magnetic susceptibility, RGB = red-green-blue. A = absent, P = present.

Figure F47. Corrected inclination after 15 mT peak alternating field demagnetization, polarity interpretation, and correlation to the geomagnetic polarity timescale (GPTS; Hilgen et al., 2012), Hole U1543A. GTS = geologic timescale (Hilgen et al., 2012).

Figure F48. Relationships between bulk sedimentary carbonate content and (A) red-green-blue (RGB) blue and (B) color reflectance L*, Hole U1543A.

Figure F49. Characteristic variations in major lithology and physical properties, Hole U1543A. Pale orange bars = nannofossil/calcareous ooze (Lithofacies 4 and 10), green bars = diatom ooze (Lithofacies 6), white bars = siliciclastic sediments (Lithofacies 7 and 8). GRA = gamma ray attenuation bulk density, MS = magnetic susceptibility, NGR = natural gamma radiation, cps = counts per second, RGB = red-green-blue.

Figure F50. Preliminary age model based on biostratigraphic and paleomagnetic markers, Site U1543.

Figure F51. Oceanographic and bathymetric setting, Site U1544. A. Marine geological features. Yellow lines = seismic lines available in the region. B. Detailed bathymetry with seismic lines and shotpoints.

Figure F52. (A) Multichannel seismic (MCS) and (B) Parasound profiles, Site U1544.

Figure F53. Hole summary, Site U1544. GRA = gamma ray attenuation bulk density, MSP = point magnetic susceptibility, RGB = red-green-blue, NGR = natural gamma radiation, cps = counts per second.

Figure F54. Summary of primary lithostratigraphic variations, Site U1544. Lithologies: gray = silty clay, orange = sand, tan = clay-, silt-, and/or diatom-bearing/rich nannofossil ooze, white = biosilica-bearing silty clay. MSP = point magnetic susceptibility, RGB = red-green-blue. A = absent, P = present.

Figure F55. Characteristic variations in major lithology and physical properties, Hole U1544A. Orange bars = sand (Lithofacies 11), pale orange bars = nannofossil ooze (Lithofacies 4 and 10), white bars = diatom ooze (Lithofacies 6) and siliciclastic sediments (Lithofacies 7 and 8). GRA = gamma ray attenuation bulk density, MS = magnetic susceptibility, NGR = natural gamma radiation, cps = counts per second, RGB = red-green-blue.