

Figure 3: ECCO2 average fields of θ , S, and γ^n for the (a) surface layer - SL (100–150 m), (b) intermediate layer - IL (409–634 m), and (c) bottom layer - BL (3000 m to seabed). The bottom right panels show the difference between reanalysis and observational density fields.



Figure 3: (continued).



Figure 3: (continued).



Figure 6: Hydrographic properties of the repeat (a) section WOCE SR3, (b) section WOCE SR4, and (c) section WOCE SR2. Average fields of θ , S, and γ^n during section occupations for the ECCO2 (left) and observational (right) data. Panels labeled $\gamma^n_{rea} \cdot \gamma^n_{obs}$ refer to the difference between reanalysis and observational density fields. Dotted lines indicate isolines of $\theta = 0^{\circ}$ C, S = 34.64, and $\gamma^n = 28.27$ kg m⁻³ of the ECCO2 reanalysis (black) and observations (white). The bottom left panels show average θ -S diagrams for the section. The color bar indicates neutral density (kg m⁻³), with a brown (gray) gradient referring to the ECCO2 (observations) data. The bottom right panels show the position of the section on the map.



Figure 6: (continued).



Figure 6: (continued).



Figure 14: (a) Annual time series of θ , S, and γ^n for the Southern Ocean AABW layer based on the ECCO2 (filled squares) and observational (open circles) data. The vertical gray bars show the standard deviations of annual averages (reanalysis – dark gray; observations – light gray). (b) The ECCO2 annual time series of θ , S, and γ^n for the Southern Ocean AABW layer for each ocean sector (see Figure 1): Indian (Ind), B&A (BA), Ross Sea (RoS), Western Pacific (WP), and Weddell Sea (We). The latter follows the right axis of the discrepant values. Shaded regions indicate the period during which the reanalysis reproduced unrealistic hydrographic conditions in the Southern Ocean.



Figure 14: (continued)



Figure 15: (a) The upper panel shows a comparison of monthly (gray) and annual (black) time series of sea ice covered area (%) from the ECCO2 (continuous line) and remote sensing (dashed line) data. The bottom panel shows monthly (gray) and annual (black) time series of sea ice thickness from the ECCO2 data. (b) The ECCO2 sea ice covered area (%) annual anomalies relative to the long-term (1992–2011) average.

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b) 1992 1993 1994 60°W 1996 1995 60°W ₫ 120°E 120°E ₫ 120°E 0 120°€ 120°E 1997 1998 1999 o^ow 2000 2001 40 20 60°E 80 20°E 8 20°E 0 120°E ₫ 120°E 0 120°€ 0 2002 2003 2004 2005 2006 -20 20% -40 600 € 220°E 8 200 120°E 80000 120°E 200 120°E € 120°E -60 2007 2008 2009 2010 2011 ∂009 20°E 2 0 120°E 20°120°E ₩ 120°E \$ 120°E

Figure 15: (continued)