Supplementary Information

Climate change effects on seawater reverse osmosis desalination: an Australian case study

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Table S1 Coefficients for the first and second carbonic acid dissociation constants[1]

	pK_1^*	pK_2^*
a_0	+13.4051	+21.5724
a_1	+0.03185	+0.1212
a_2	-5.218e-05	-3.714e-04
a_3	-531.095	-798.292
a_4	-5.7789	-18.951
a_5	-2.0663	-3.103
b_0	-126.34048	-90.18333
b_1	+6320.813	+5143.692
b_2	+19.568224	+14.613358

**Table S2** Coefficients for the solubility coefficient of $CO_{2(aq)}$ by volume[1].

|	pK_2^*
A_1	-58.0931
A_2	+90.5069
A_3	+22.2940
B_1	+0.027766
B_2	-0.025888
B_2	+0.0050578
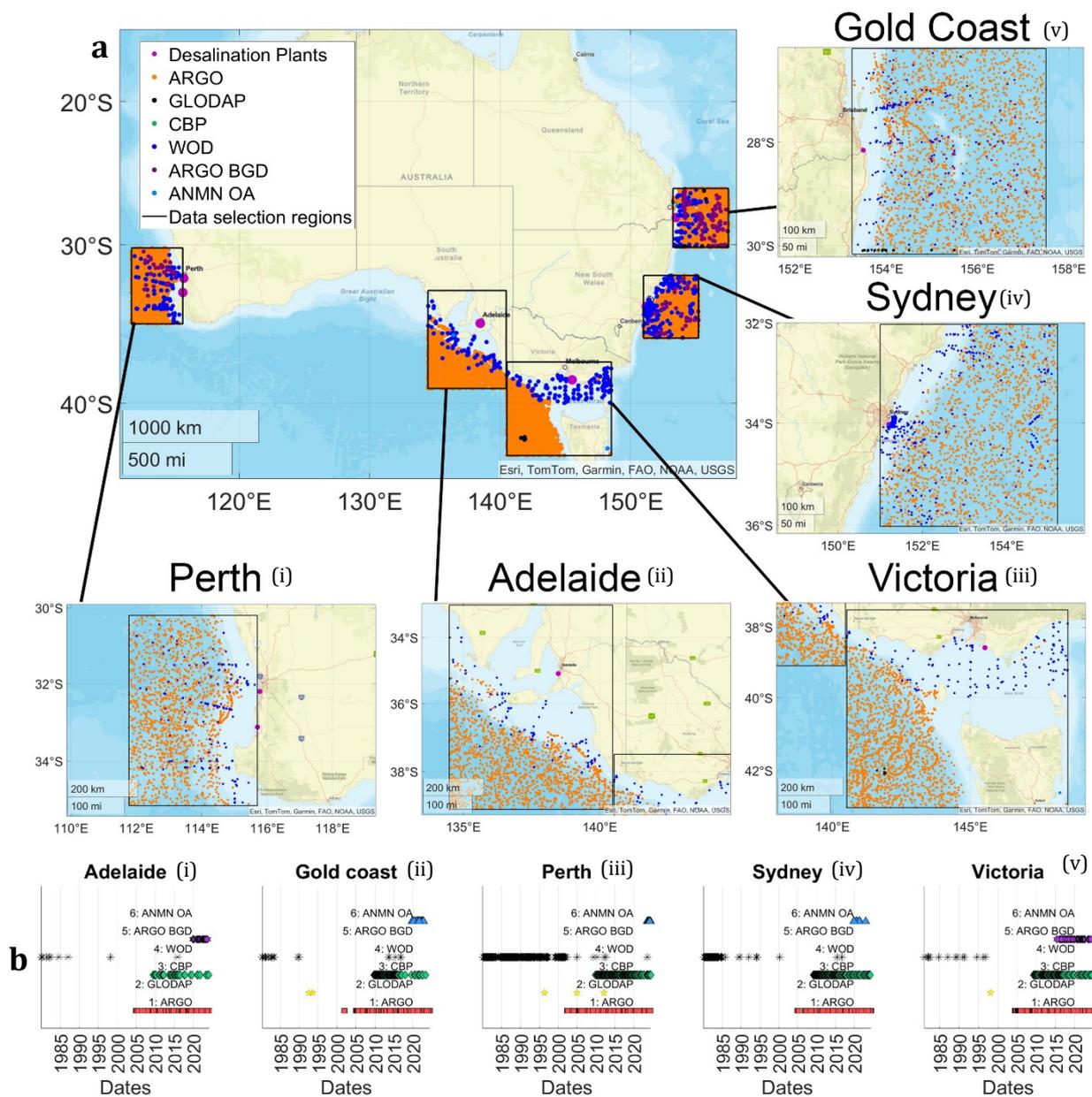
Fig. S1. Geographical and chronological distributions of the historical datasets analysed. a - geographical distributions for Perth (i), Adelaide (ii), Victoria (iii), Sydney (iv), and the Gold Coast (v), along with the desalination plant locations (magenta markers). b - chronological distributions for Adelaide (i), the Gold Coast (ii), Perth (iii), Sydney (iv), and Victoria (v).
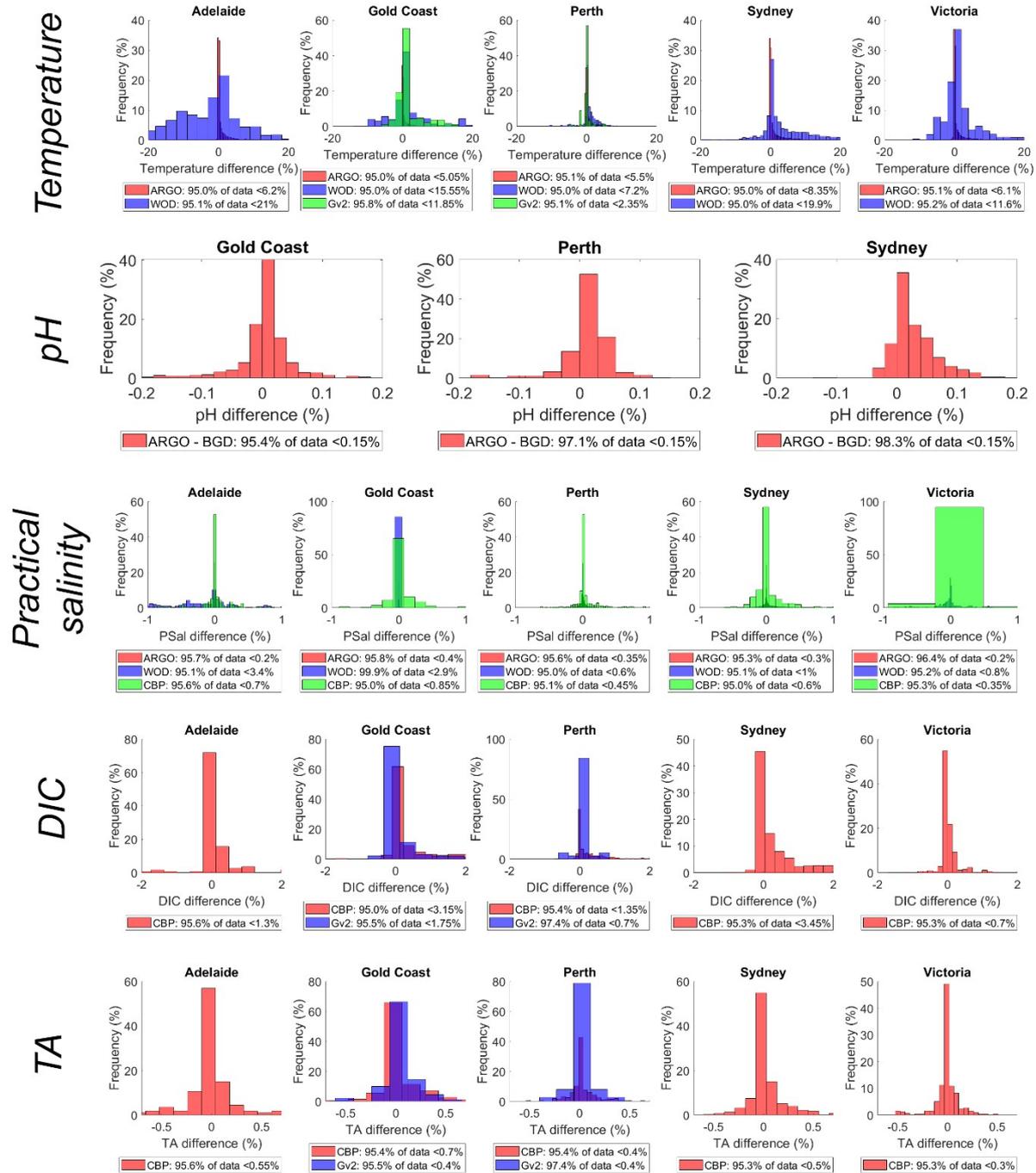
Fig. S2. Depth variation calculations up to 50 m deep (approximately 50 dbar) for the historical datasets regarding seawater temperature, pH, practical salinity, dissolved inorganic carbon (DIC), and total alkalinity (TA).
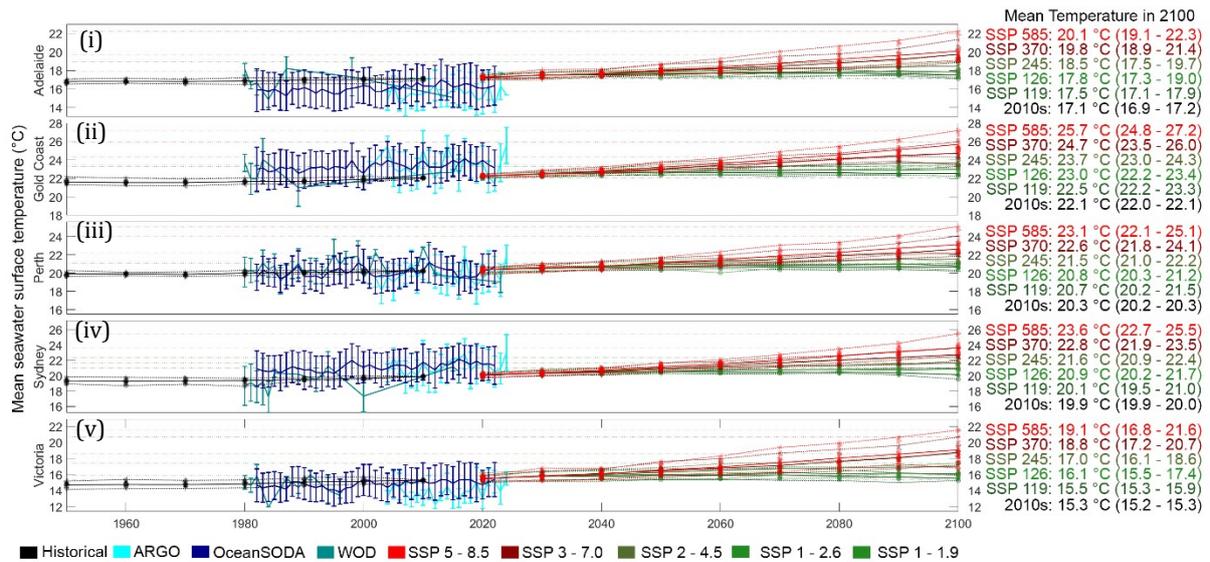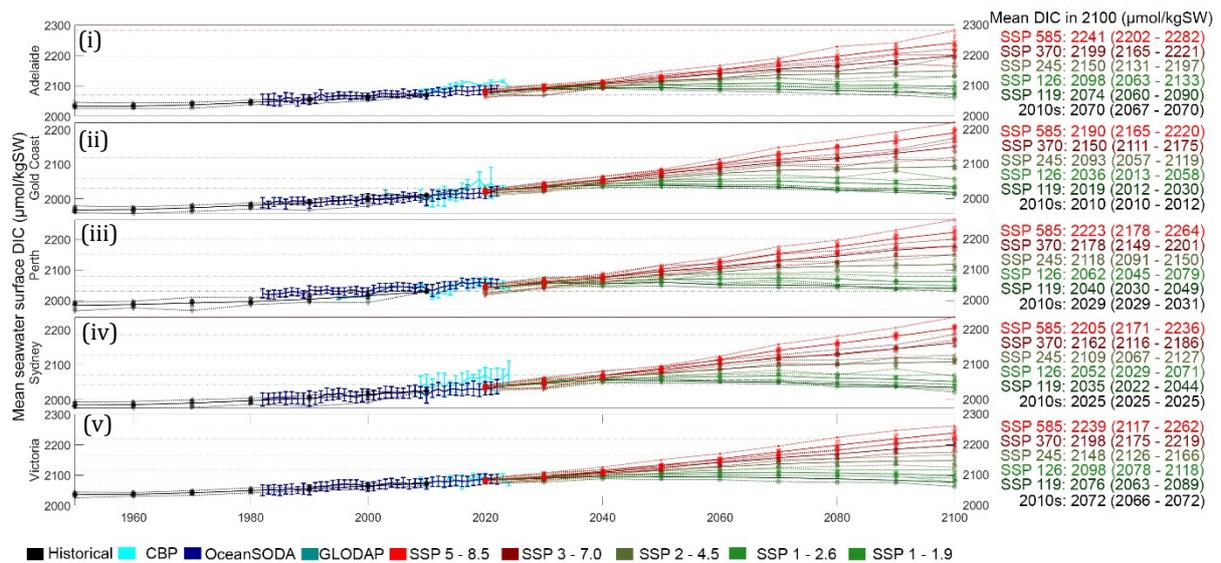
Fig. S3. Historical and SSP projections for seawater surface temperature across the studied regions of Adelaide (i), the Gold Coast (ii), Perth (iii), Sydney (iv), and Victoria (v). Yearly means and standard deviations have been calculated for the ARGO, WOD, ANMN – OA, and ARGO – BGD datasets, limiting their reach up to 50 m deep (≈ 50 dbar).
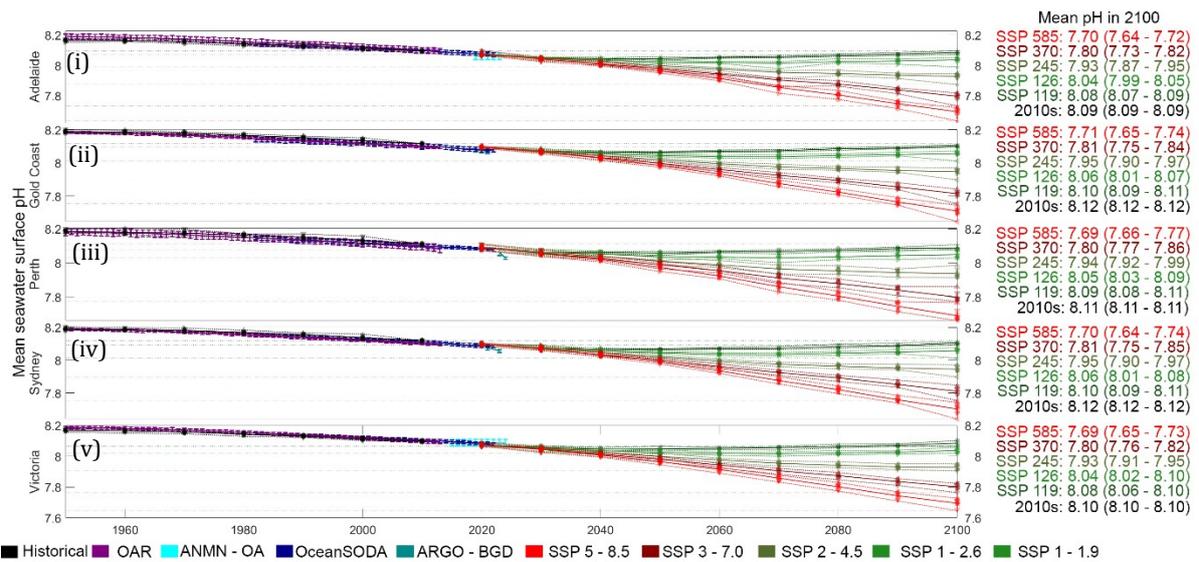

Fig. S4. Historical and SSP projections for seawater surface pH across the studied regions of Adelaide (i), the Gold Coast (ii), Perth (iii), Sydney (iv), and Victoria (v). Yearly means and standard deviations have been calculated for the ARGO, WOD, ANMN – OA, and ARGO – BGD datasets, limiting their reach up to 50 m deep (≈ 50 dbar).
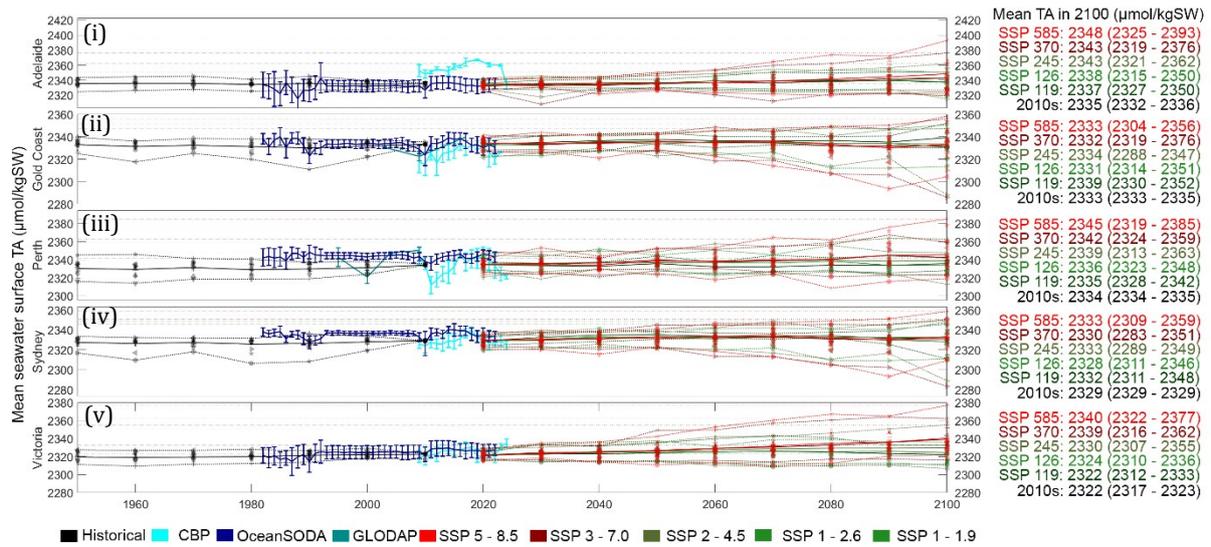
Fig. S5. Historical and SSP projections for seawater surface total alkalinity across the studied regions of Adelaide (i), the Gold Coast (ii), Perth (iii), Sydney (iv), and Victoria (v). Yearly means and standard deviations have been calculated for the CBP and GLODAPv2 datasets, limiting their reach up to 50 m deep (≈ 50 dbar).


Fig. S6. Historical and SSP projections for seawater surface dissolved inorganic carbon across the studied regions of Adelaide (i), the Gold Coast (ii), Perth (iii), Sydney (iv), and Victoria (v). Yearly means and standard deviations have been calculated for the CBP and GLODAPv2 datasets, limiting their reach up to 50 m deep (≈ 50 dbar).
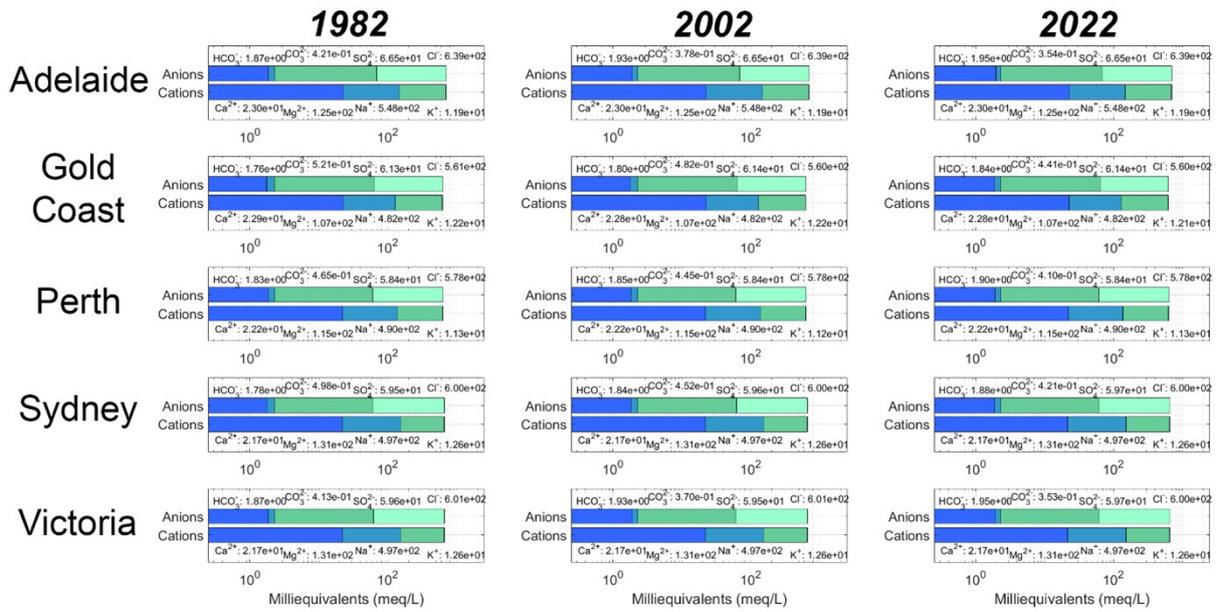
Fig. S7. 1982, 2002, and 2022 yearly mean OceanSODA ionic balances for the studied regions in the form of Collins Bar Graphs.
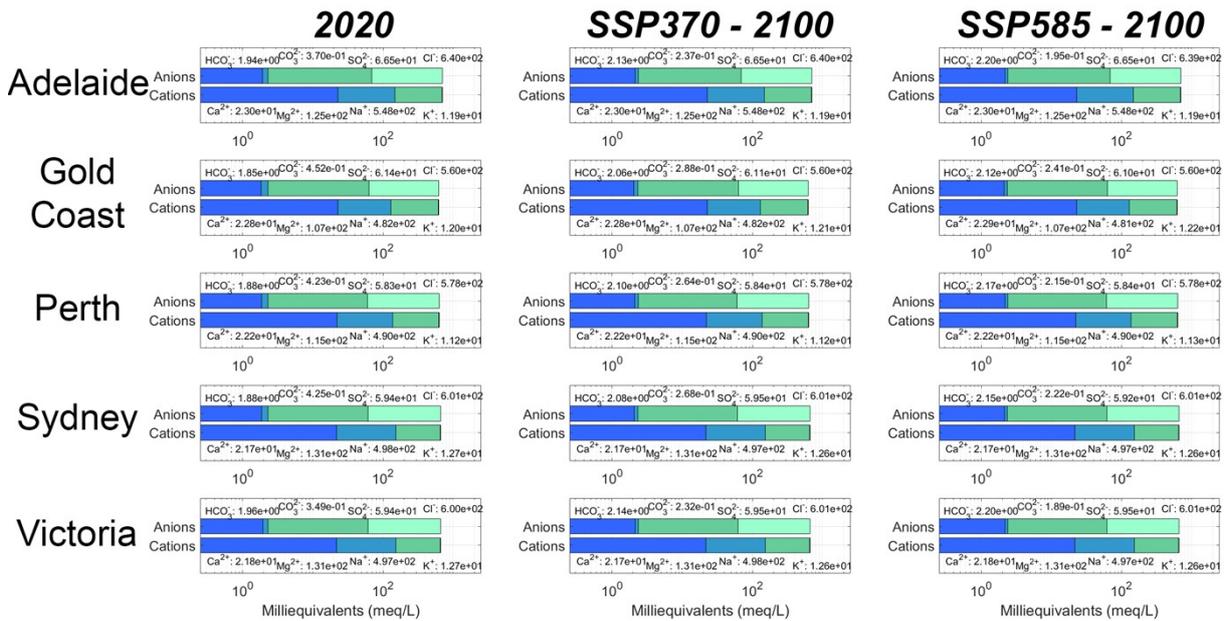

Fig. S8. Mean 2020, 2100 under SSP370, and 2100 under SSP585 ESM ionic balances for the studied regions in the form of Collins Bar Graphs.
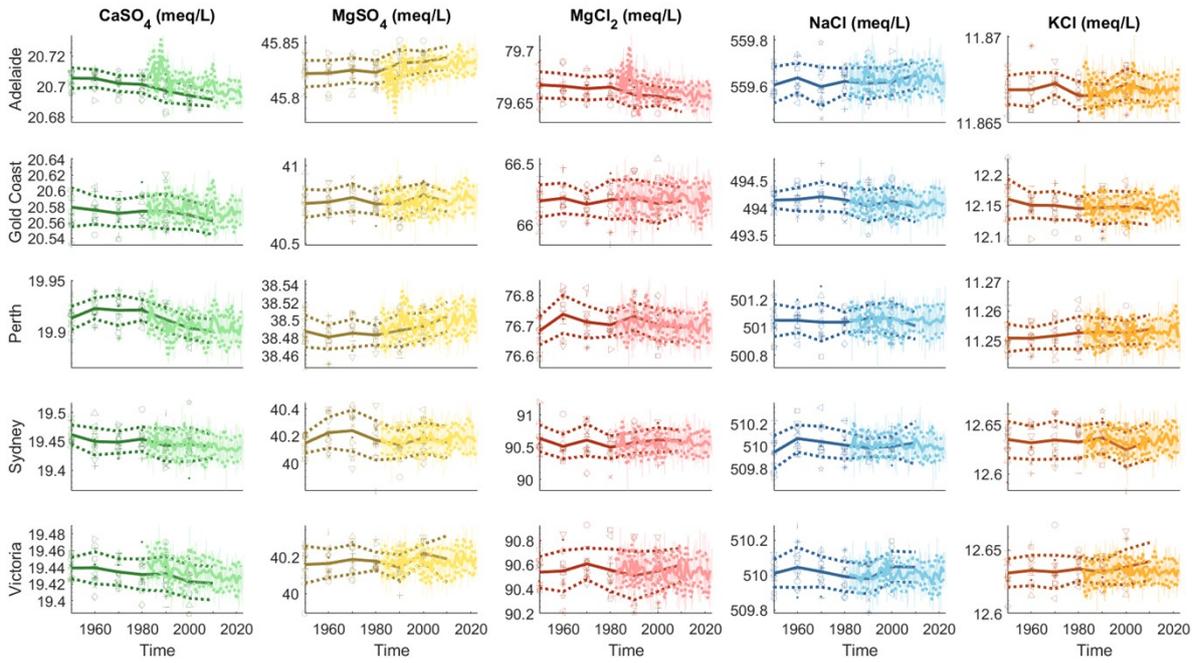
Fig. S9. Historical projections for CaSO₄, MgSO₄, MgCl₂, NaCl, and KCl concentrations for the studied regions. Historical salt concentrations. Full darker lines correspond to the average between all fourteen ESMs, while the darker dashed lines correspond to the standard deviation. Lighter full lines correspond to OceanSODA yearly means, and lighter dashed lines correspond to the OceanSODA standard deviation.
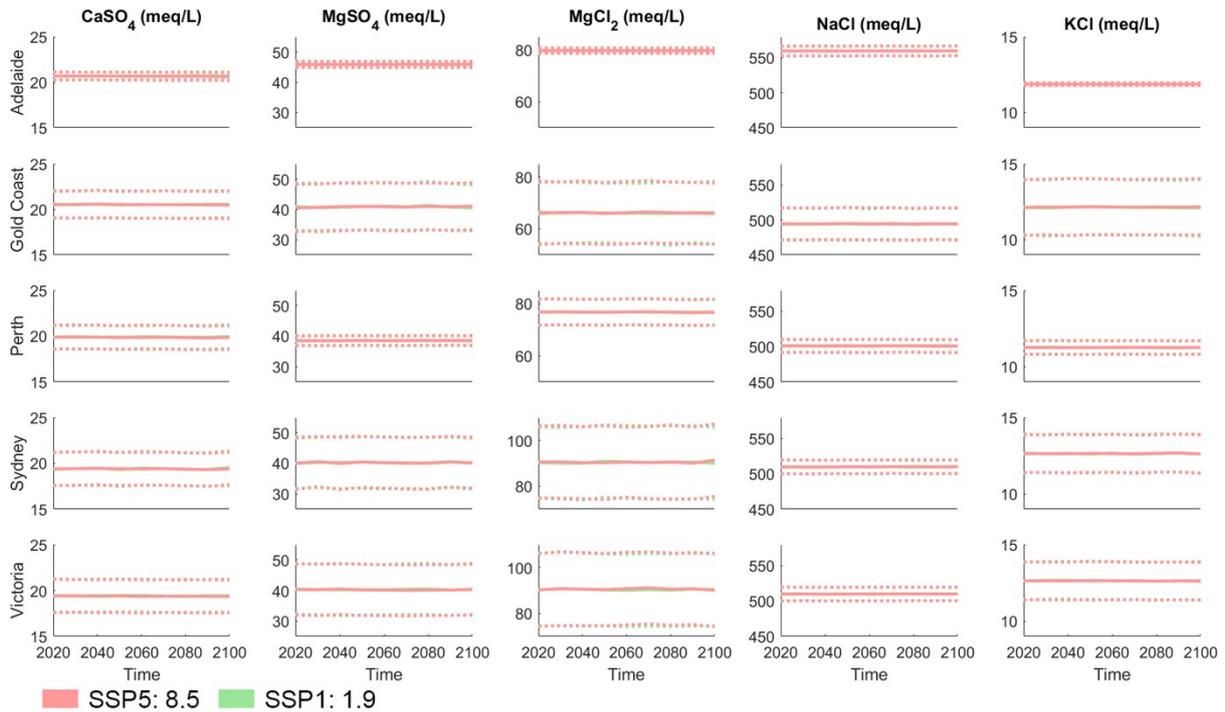
Fig. S10. SSP projections for CaSO₄, MgSO₄, MgCl₂, NaCl, and KCl concentrations for the studied regions. SSP projections for salt concentrations, with full lines corresponding to the average between all fourteen ESMs and dashed lines corresponding to the standard deviation. Only SSP119 and SSP585 are plotted to demonstrate that CaSO₄, MgSO₄, MgCl₂, NaCl, and KCl concentrations do not change with the scenarios under the current methodology.
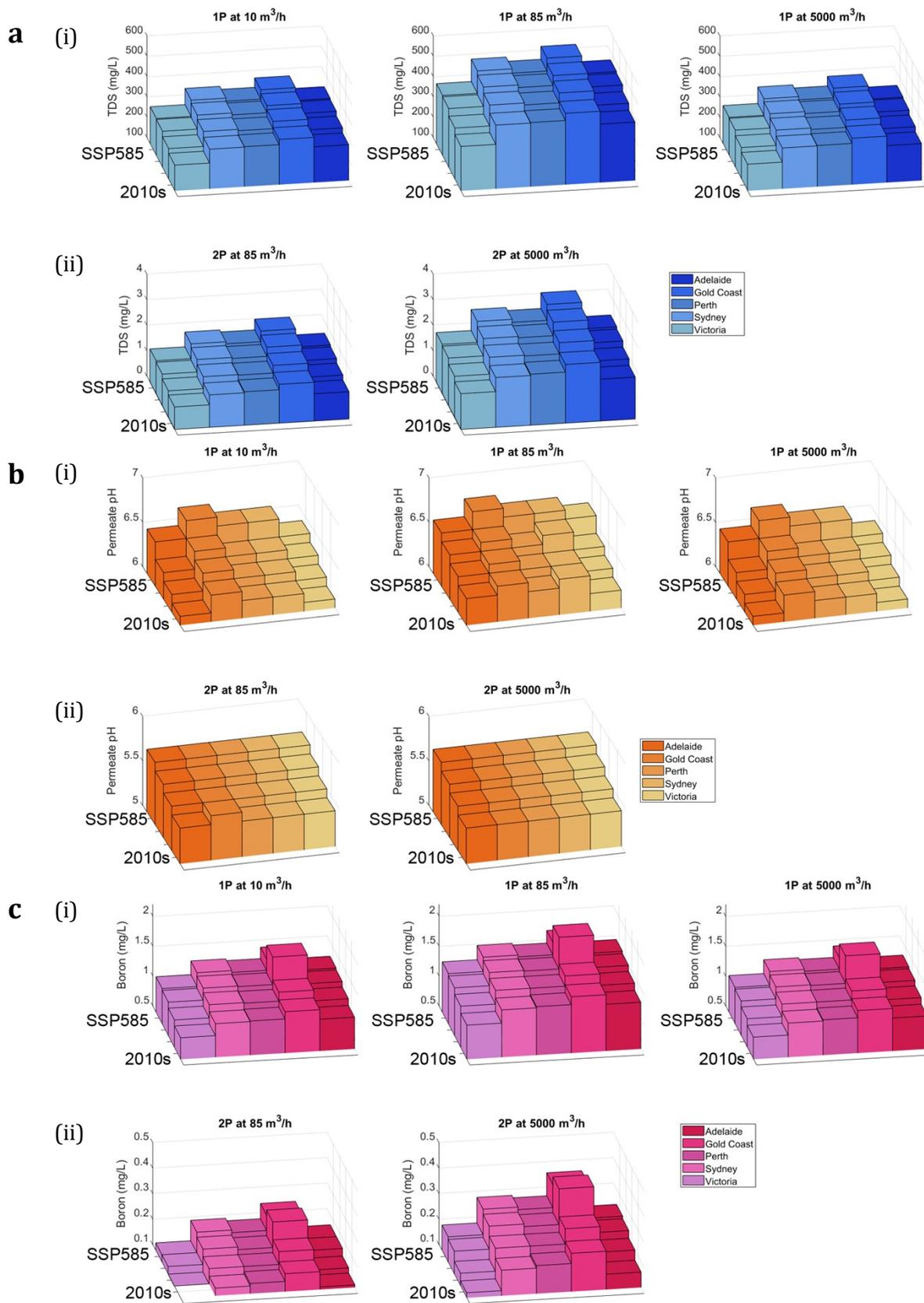
Fig. S11. Effects of climate change scenarios on UF-RO systems for different freshwater production rates. a - permeate total dissolved solids for the first (i) and second (ii) passes. b - permeate pH for the first (i) and second (ii) passes. c - permeate boron concentration for the first (i) and second (ii) passes.
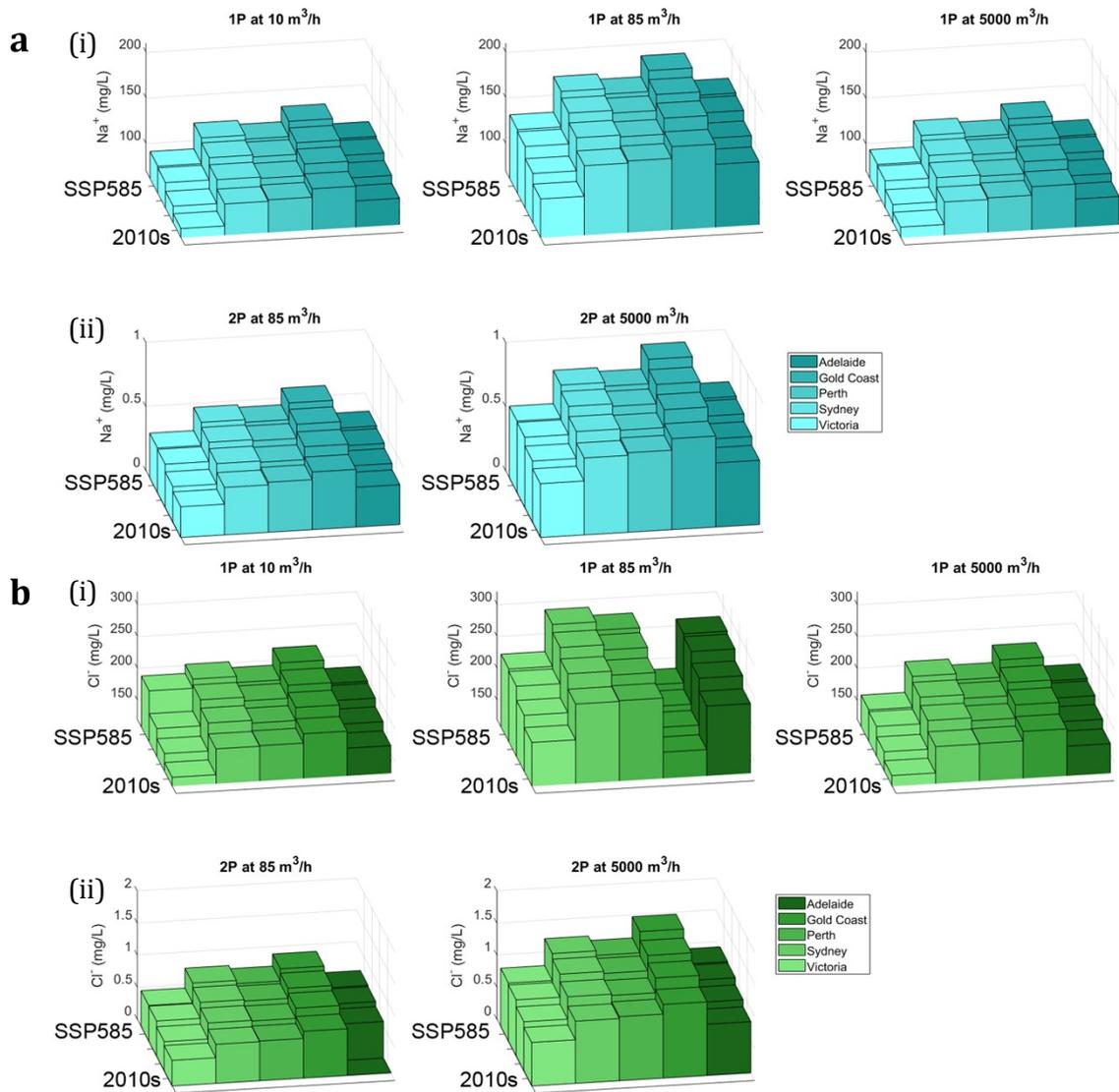
Fig. S12. Effects of climate change scenarios on UF-RO systems for different freshwater production rates. a - permeate sodium concentration after the first (i) and second (ii) passes. b - permeate chloride concentration after the first (i) and second (ii) passes.

References

1   H. Ludwig, *Reverse osmosis seawater desalination volume 1: Planning, process design and engineering - A manual for study and practice*, Springer Nature, Cham, Switzerland, 1st edn., 2022.