Thermodynamic Properties of Deep-Ocean Water Mixtures from Experimental Sound-Speed Measurements

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The world's oceans play a key role in determining the Earth's climate, including through moderating temperatures and absorbing carbon dioxide (CO_2). Therefore, knowledge of the thermodynamic and transport properties of seawater with dissolved CO_2 is crucial for our understanding of climate change and accuracy of climate-model predictions. Our research expands on the limited range of thermodynamic property data for water mixtures representative of deep-oceanic conditions using the dual-path pulse-echo sound-speed measurement technique, which can be used to make very-high precision measurements at the high-pressure conditions typical of deep oceans. We will describe the design of a purpose-built apparatus suitable for sound speed measurements of corrosive solutions over a temperature range from (270 to 450) K and at pressures up to 100 MPa. The results of our experimental work measuring synthetic seawater solutions along with derived-property analysis, including density and heat capacity, will also be presented. We will also discuss progress towards measuring solutions with dissolved CO_2, with the aim of shedding new light into the effects of anthropogenic CO_2 emissions on the thermodynamic properties of seawater relevant for climate modelling.