

Thermodynamic Properties of Seawater, Ice and Humid Air: TEOS-10, Before and Beyond

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In the terrestrial climate system, water is a key player in the form of its different ambient phases of ice, liquid and vapour, admixed with sea salt in the ocean and with dry air in the atmosphere. For proper balances of climatic energy and entropy fluxes in models and observation, a highly accurate, consistent and comprehensive thermodynamic standard framework is requisite in geophysics and climate research. The new “Thermodynamic Equation of Seawater – 2010” (TEOS-10) constitutes such a standard for properties of water in its various manifestations in the hydrological cycle. TEOS-10 has been recommended internationally in 2009 by the Intergovernmental Oceanographic Commission (IOC) to replace the previous 1980 seawater standard, EOS-80, and in 2011 by the International Union of Geodesy and Geophysics (IUGG) “as the official description for the properties of seawater, of ice and of humid air”. This presentation briefly reviews the development of TEOS-10, its novel axiomatic properties, new oceanographic tools it offers, and important tasks that still await solutions by ongoing research. Among the latter are new definitions and measurement standards for seawater salinity and pH, in order to establish their metrological traceability to the International System of Units (SI), for the first time after a century of widespread practical use. Of similar climatological relevance is the development and recommendation of a uniform, unambiguous standard definition of atmospheric relative humidity, rigorously based on thermodynamic relations such as those provided and supported by TEOS-10.