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Climate change and the surface salinity distribution in the ocean Hadley cell

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A conceptual model of the salinity distribution in the ocean Hadley cell is presented. The model pertains to the region of tropical easterly surface winds, where the surface salinity increases poleward from a local salinity minimum near the equator to a subtropical salinity maximum. A fundamental constraint is that the meridional freshwater transports in the atmosphere and the ocean have the same magnitude but opposite directions. A key assumption is that the strengths of the meridional overturning cells in the atmosphere and the ocean are proportional and set by the surface-layer Ekman transport. It is further assumed that the meridional salinity variation in the Hadley cell, to the lowest order of approximation, is controlled by zonally-symmetric physics, i.e. effects related to east–west variations of the flow are neglected. The model predicts that the salinity variation in the oceanic cell is directly proportional to the specific humidity of the near-surface air, but independent of the meridional mass transport (as long as the atmospheric and oceanic mass transports remain proportional). If the relative humidity of the near-surface air is constant, the salinity variation in the Hadley cell varies with the surface temperature according to the Calusius–Clapeyron expression for the saturation vapor pressure. The prediction of the conceptual model is compared to climate-model simulations of global warming and a LGM simulation and found to give a leading-order description of surface salinity changes in the tropics. Possible salinity-related feedbacks on the ENSO are discussed.