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Ocean mixing and the Meridional Overturning Circulation: a shifting paradigm

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Today, we tend to think of the Meridional Overturning Circulation (MOC) of the ocean as a layered circulation with multiple surface sources of dense water that flows along density surfaces until it approaches a boundary, where it is mixed vertically and transits to a different level of the overturning. In this context, oceanographers like to talk about the existence of an 'ocean mixing problem', in which two different schools of thought propose the dominance of either isopycnal mixing by mesoscale eddies or diapycnal mixing by breaking internal waves in closing the MOC by returning deep water to the upper ocean. These two paradigms result in similar- looking oceans (in terms of their temperature and salinity distributions) but exhibit very different energetics and sensitivities / feedbacks to changing climatic forcing. In this lecture, I will discuss a collection of observational and theoretical evidence from the Southern Ocean to argue for an alternative zeroth- order description of the MOC. This new model proposes that the two classical paradigms of ocean mixing are strongly intertwined and cannot be considered in isolation. This is so because regions where mesoscale eddies are dissipated (in particular, the Antarctic Circumpolar Current) emerge as 'hot spots' of rapid flow along and across density surfaces where water parcels can effectively short- circuit their circulation through the deep ocean.