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The role of extreme variations in freshwater discharge on the Rhine River Plume

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Tidal river plumes dominate many shelf seas, transporting freshwater, sediment, nutrients, pollutants and larvae downstream. The Rhine River Plume is one of the largest in Europe, under typical discharge conditions it is dominated by tidal plume fronts in the near to mid-field plume and by tidal straining in the mid- to far field plume. Moreover, in agreement with other tidal river plumes discharging onto the shelf, internal waves generated ahead of tidal plume fronts are an important source of mixing in the river plume. We compare field data collected downstream of the mouth of the Rhine River in 2013 and 2014 under typical discharge conditions, with data collected in the near field plume during 2022 during a major drought. Together with numerical models we explore how extreme variations in freshwater discharge impact both tidal straining and the formation and strength of tidal plume fronts. Furthermore we explore how in turn, this influences the structure and mixing of the near to far-field Rhine River Plume. We use a 3D hydrostatic model of the Rhine River Plume and a potential energy anomaly analysis to explore changes in the mixing. We explore how the river plume adjusts to extremely low discharge conditions and discuss the possible impact on the transport of freshwater, tracers, larvae and fine sediment.

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