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Processes control the shelf-to-basin transport of particulate and dissolved iron in the Pacific Ocean

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In the continental margins, iron (Fe), which is stored on shelf sediments, can be released to the water column in both dissolved (dFe) and particulate (pFe) forms under reducing oxygen conditions or a physical resuspension event. However, mechanisms governing the fate of shelf-derived Fe species remain poorly understood. Here, we use a regional physical-biogeochemical model to investigate processes governing the fate of pFe and dFe released from continental margins in the Pacific Ocean. Comparison between our model distributions of dFe and pFe with measurements from GEOTRACES cruises and a recent cruise along the Oregon coast showed that our model captures the magnitude and pattern of hotspots of pFe and dFe being released from benthic sediments, which are then being transported hundreds of kilometers away from the coast. Model analyses showed that while the shelf-to-basin transport of dFe is controlled by ligand protection and scavenging removal, the pFe transport is modulated by the sinking speed of pFe. This mechanism difference causes the dFe plumes to extend further offshores and the pFe plumes to reach deeper water levels. Both pFe and dFe transports from the eastern boundaries to the open ocean are facilitated by zonal jets, which are prevalent in the subsurface ocean (500 - 1500m). Our study thus demonstrated that the release of Fe along continental shelves is a major source of this limiting nutrient for phytoplankton in the open ocean, especially if pFe can release dFe along its transport pathway.