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Resolving submesoscale processes and cross-scale interactions in the Gulf of Oman

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The physical dynamics of the Sea of Oman are well resolved on meso- and basin-scales. The most prominent features are the slope current of the Persian Gulf Water (PGW), an energetic field of persistent eddies and circulation driven by seasonal monsoon wind regimes. Past work has shown that both oxygenation of the deep oxygen minimum zone and stimulation of local surface primary production are driven by submesoscale processes. In contrast to the pronounced summer-monsoon upwelling in the Arabian Sea, upwelling at the northern Omani shelf appears in the form of short irregular events. The main drivers for local upwelling and the exchange of water and its properties across the shelf break are not fully resolved. In particular, the relative importance of the two dominant causes of upwelling (ekman dynamics and eddy/topography interactions) and their interactions with the PGW slope-current are not known. Cross-shelf coupling is strongly determined by processes on the sub-mesoscale with weak surface signatures preventing analysis through remote sensing. The high system complexity and the lack of adequate observations explain past difficulties in resolving cross-shelf transport and local upwelling responsible for increased primary productivity and OMZ oxygenation.

Here we present new results identifying the submesoscale processes which control productivity and oxygenation in the region at a scale not previously described. These observations build on past work and illustrate how autonomous underwater vehicles can bring forward a full system understanding from basin-wide circulation and description of large ocean currents to submesoscale processes responsible for controlling biogeochemical cycling from a single campaign using standard ocean sensors and utilising the vehicles' inherent ability to measure upwelling and currents. We hope to illustrate the multidisciplinarity and flexibility of autonomous platforms in situations where vessels may not easily survey.