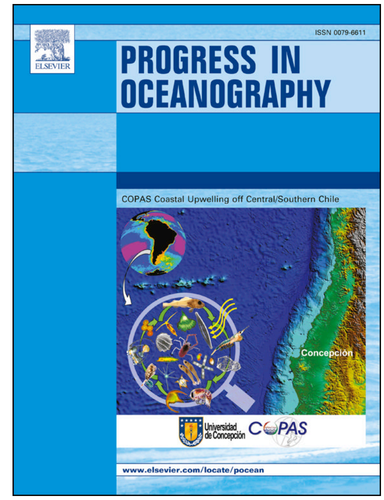
Accepted Manuscript



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PII: S0079-6611(17)30100-3
DOI: https://doi.org/10.1016/j.pocean.2017.10.004
Reference: PROOCE 1860

To appear in: *Progress in Oceanography*

Received Date: 13 March 2017
Accepted Date: 11 October 2017

Please cite this article as: Hosegood, P.J., Nightingale, P.D., Rees, A.P., Widdicombe, C.E., Woodward, E.M.S., Clark, D.R., Torres, R.J., Nutrient Pumping by Submesoscale Circulations in the Mauritanian Upwelling System, *Progress in Oceanography* (2017), doi: https://doi.org/10.1016/j.pocean.2017.10.004

Nutrient Pumping by Submesoscale Circulations in the Mauritanian Upwelling System

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Abstract

Observations made within a cold filament in the Mauritanian upwelling system demonstrate that intense submesoscale circulations at the peripheral edges of the filament are likely responsible for anomalously high levels of observed primary productivity by resupplying nutrients to the euphotic zone. Measurements made on the shelf within the recently upwelled water reveal that primary production (PP) of 8.2 gC/m^{-2} day^{-1} was supported by nitrate concentrations (NC) of 8 mmol m^{-3}. Towards the front that defined the edge of the filament containing the upwelled water as it was transported offshore, PP dropped to 1.6 gC m^{-2} day^{-1} whilst NC dropped to 5.5 mmol m^{-3}. Thus, whilst the observed nutrients on the shelf accounted for 90% of new production, this value dropped to ∼60% near the filament's front after accounting for vertical turbulent fluxes and Ekman pumping. We demonstrate that the N^{15} was likely to have been supplied at the front by submesoscale circulations that were directly measured as intense vertical velocities ≥100 m day^{-1} by a drifting acoustic Doppler current profiler that crossed a submesoscale surface temperature front. At the same time, a recently released tracer was subducted out of the mixed layer within 24 hours of release, providing direct evidence that the frontal circulations were capable of accessing the resevoir of nutrients beneath the pycnocline. The susceptibility of the filament edge to submesoscale instabilities was demonstrated by $O(1)$ Rossby numbers at horizontal scales of 1-10 km. The frontal circulations are consistent with instabilities arising from a wind-driven nonlinear Ekman buoyancy flux generated by the persistent northerly wind stress that has a down-front

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