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Ocean Science Discussions

Interactive comment on "Environmental controls on marine productivity near Cape St Francis, South Africa" *by* Mark R. Jury

Anonymous Referee #2

Received and published: 17 September 2019

General Comments

This exploratory study uses reanalysis products to investigate the ocean and its atmospheric drivers off the Eastern Cape province of South Africa. The influence of these environmental variables on productivity and fisheries are further investigated. The study is novel for the region, in that it uses freely available reanalysis products instead of the traditional in situ measurements or standard regional numerical models. Some in situ measurements made in the study area are assimilated into the reanalysis products, but not many. Apart from remote sensing products, the region is not widely covered in terms of in situ measurements. This makes the use of reanalysis products more useful and in future they will most likely become a necessary component of any large scale study in the region. This study shows the way for local researchers to use a

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new tool to investigate atmospheric-ocean interactions in an area short on large-scale in situ measurements.

The main suggestion of the study, as seen by the reviewer, is that the mid-Atlantic high pressure ridge underpins marine productivity in the area. It is this high pressure ridge moving anti-clockwise around southern Africa that is responsible for the easterly winds that drive coastal upwelling and hence productivity. Apart from wind, and rain, the high pressure is also responsible for the sea surface height gradient that contributes towards shelf and coastal ocean processes. The Agulhas Current also plays a big role through pressure gradients, nearshore currents and both cold and warm water intrusions. These all play a role in determining the marine productivity of the area.

The interpretation of the chlorophyll distribution between dry and wet conditions needs further clarification. Chlorophyll and currents change drastically over a period of days, while the change from dry to wet conditions happened over months. So, the author is comparing processes that occur over different time scales, and this could lead to an incorrect interpretation.

The movement of low salinity water south-westward from the Fish River needs to be checked. Can fresh water from the Fish River actually move that far across the shelf in that amount of time, and without dispersing? What about the counter coastal current, towards the north, that could hamper the south-westward movement of water? To the reviewer, the lower salinity structure shown in Fig 4 looks very similar to a structure that is observed after extensive, strong coastal upwelling when high chlorophyll is observed along the open-ocean side of joined upwelling plumes that originated at the capes.

A few improvements could be made to the paper. Figures are small, making them difficult to read, but the figures could be fine in the published paper so maybe it is not important. References are missing. There could be more references in the discussion, and even the results, if references in the results are acceptable.

I recommend that the paper be published.

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Specific Comments

38: Incorrect. Easterly wind increase during summer and decrease during winter while westerly winds are more or less constant throughout the year.

145:Fig 2a shows chlorophyll as lower around the capes as compared to the coastal band (band same distance offshore), not higher.

145: Fig 2b shows fluorescence as lower around the capes as compared the shelf.

148-9: The plume off Cape Recife is associated with wind-driven upwelling, not Agulhas Driven upwelling.

163-168: The time difference from dry conditions (Aug 2010) to wet condition (Mar 2011) had a span of approx. 7 months, as you state. Both coastal chlorophyll and currents (shelf and the Agulhas Current) change over periods of days or several days, or maybe even weeks in the case of the Current. To try correlate events fluctuating (or happening) at vastly different timescales, as shown by the 2 matching figures (Fig3e and 3f) as compared to rainfall, can lead to the wrong interpretation. The chlorophyll and currents could, and probably did, change many times over that 7 month period and it may just be that the day snapshots that you chose were biased towards your reasoning.

170: Should use “high/er salinity” and not “salty”.

170: You should place the Fish River on Fig 4. St Francis Bay, Algoa Bay and the coastal zone north to what appears to be the position of the Fish River had higher salinity than the shelf waters ($\sim$35.3 compared to $\sim$35.1). Don’t you find that strange?

169-177: Anyway, if the Fish River position were known, then, yes, it would appear from your plots that lower salinity water filled the mid-shelf region with its northern extremity around the Fish River. What concerns me is this: would lower salinity water move westward and fill the whole mid-shelf area (distance of $\sim$300km) over a period of 5-6 days (Fig4a to Fig 4b) without mixing and dispersing, and could it even do that from

theory? If it were possible, then, yes, your reasoning would be considered sound.

169-177: Yes, your Fig 4e does show a net easterly wind from 15-25 Oct 2014. From wind records, there were moderate to fresh breezes from 17-23 Oct, the rest of the days being westerly winds. So, 6 days of easterly winds (if we forget the westerly winds) to disperse a surface plume ∼300 km. Which gives a downwind velocity of ∼0.58 m/s. From local ADCP records, the downwind surface velocity of a particle moving with the water at that speed is not impossible. However, that low salinity structure looks very similar to a high surface chlorophyll structure that occurs after extensive, strong coastal upwelling. Which makes me wonder?

179: Your text says 17 Oct – 8 Nov whereas Fig 5 says 15 Oct - 5 Nov. Otherwise, I agree with what is presented in paragraph 178-188.

189-196: This paragraph reads more like a discussion. Upwelling along the inshore edge of the Agulhas Current, which moves along the bottom over the shelf in the direction of the coastline "primes" the capes for wind-driven upwelling. So, the upwelling response to easterly winds in almost immediate at the shoreline, whereas downwelling during westerly winds just "restores' the ocean back to normal.

197-202: I'm not sure about this. Maybe more explanation is needed to make it relevant.

210: Yes, I imagine that high offshore sea pressure could contribute to enhanced westward flow near at the coast and hence contribute positively towards upwelling. Actually, just that has been found from in situ data during Natal Pulses by Goschen et al (2015).

217: Agreed, large scale weather systems moving eastward over southern Africa produce easterly winds (among other phenomena), which are upwelling favourable.

Technical Errors

220 and 222: Should that not be "chlorophyll and fluorescence"? Are they not two different ocean variables?

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