Reviewer Comment 1, F. d'Ovidio, and *author response*:

Major comments

The paper provides an analysis of the role of mesoscale eddies in the Southern Ocean on primary production, in terms of chlorophyll anomalies detected by remote sensing associated to them. Methodologically, the paper follows very closely some previous works, in particular Gaube et al. 2014, which were more focused on the global ocean. In respect to previous works, this manuscript has fine tuned the methodology, and discussed the results in the specific context of the Southern Ocean. The main original result in this manuscript is the finding of a strong seasonal signal in the mesoscale imprint on chlorophyll anomalies. This result and other more incremental findings are not surprising, but are very well discussed in terms of the previous literature and in terms of the biogeochemical activity of the Southern ocean (with possibly one direction of improvement which is described below). As a consequence, I find this manuscript as a useful contribution to the understanding of the role of mesoscale eddies on primary production in the Southern Ocean, even in its current form.

Thank you for the supportive review.

Comment a

1. There is however one issue that may improve further the manuscript. One of the main concept treated by the paper, is stirring, and in particular the imprint of stirring induced by the mesoscale eddies on the mesoscale anomalies of the chlorophyll field. The manuscript explains that the stirring created by a mesoscale eddy can create a local deformation of a preexisting chlorophyll gradient and I agree with this statement. However, this is not all about stirring. In fact, if I think to the imprint of stirring and chlorophyll in the Southern ocean, the main effect that comes to my mind is not the generation of local chlorophyll anomalies, but the huge plumes of chlorophyll induced when stirring by mesoscale eddies modulates iron delivery in a non-local way, preconditioning the blooms of this region. An analysis of this effect is not in the scope of this paper, and it has been done elsewhere (for instance, d'Ovidio et al. Biogeosciences 12, 2015; Ardyna et al. GRL 44, 2017). Nevertheless, I feel that the submitted manuscript should stress more that what the authors intend here for eddy stirring, is only the local effect of stirring, while other non-local effects of stirring by mesoscale activity also exist, and actually they are a prominent driver of the bloom extension and intensity in the Southern Ocean. In fact, it would be interested to know whether there is a signature of this non-local stirring effect in the analysis presented, for instance by finding stronger anomalies downstream of likely iron sources like the continental shelves present in the region. Or as a possible alternative explanation of the asymmetries in the chlorophyll anomalies. I am certainly biased in this comment by my

own work on the subject, therefore the authors are free to find some other papers instead of the two indicated above to add to their discussion. But in any case, I feel that the discussion on stirring merits to be extended.

2. *Thanks for pointing out this additional non-local effect of eddies on chlorophyll and the associated references. To accommodate your comment and the main comment of the second reviewer, Volker Strass, we have included in the Discussion section a paragraph on the potential effects of eddies on chlorophyll/biogeochemical rates which we do not consider in our analysis (see below); further, we have added the attribute "local" to "stirring" in several places throughout the manuscript; and, yes, indeed, we tend to find positive anomalies, both for cyclones and anticyclones downstream of shelves (see also below, p19L7ff).*

3. *We added in the Discussion section*
p19L7ff: "A possible explanation next to advection of Chl is the offshore advection of iron trapped in the nearshore region by eddies that fuels extra growth in the offshore waters, as suggested e.g., for Haida eddies in the North Pacific [Xiu et al., 2011], or for eddies passing the Kerguelen Plateau [D'Ovidio et al., 2015]. A substantial effect of trapping to cause δChl of eddies originating from boundary currents corroborates previous results [Gaube et al., 2014].", and
p20L22: "Further, we may underestimate the overall effect of eddies on Chl also because of additional effects of eddies that are not considered in our analysis. Such effects include the impact of smaller mesoscale features, and of submesoscale processes near the edges of eddies [Woods, 1988, Strass, 1992, Martin et al., 2002, Lévy, 2003, Klein and Lapeyre, 2009, Siegel et al., 2011], e.g., due to eddy-jet interactions and associated horizontal shear-induced patches of up- and downwelling. Such features are included in our analysis only insofar they have rectified effects on the larger mesoscale Chl patterns resolved by the data we use. Another effect we do not consider is non-local stirring [D'Ovidio et al., 2015], the contribution of eddies to lateral dispersion outside the eddies' cores in interaction with the ambient flow. This effect, for instance, shapes iron plumes downstream of shelves along the ACC, thus preconditioning Chl blooms [Ardyna et al., 2017]. Therefore, we note that the overall effect of eddies on biogeochemical rates may be larger than suggested by our analysis of the mesoscale, local imprint of eddies on Chl.";
further we added the reference of Ardyna et al in the context of the non-zonality of the Chl p9L7ff: "A few exceptions break this mostly zonal picture for Chl [Ardyna et al., 2017], and also for δChl.", and of the seasonality of the imprint of eddies, p10L6.

Minor comments

Comment b

1. timescale of chlorophyll: chlorophyll is just a pigment. Referring to the timescale of a bloom, or of phytoplankton demography, should be more appropriate.

2. *Thanks for the comment, we have adjusted the text accordingly (see below).*

3. *We have changed time scale of Chl to time scale of phytoplankton demography in the section* Causes of δChl by advective processes *(p3L6ff).*

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