

## ***Interactive comment on “Mediterranean basin-wide correlations between Saharan dust deposition and ocean chlorophyll concentration” by R. Gallisai et al.***

**Anonymous Referee #1**

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The study reported in the manuscript was aimed at exploring whether atmospheric inputs of Saharan dust in the Mediterranean Sea produce an accumulation of phytoplankton biomass in the days following conspicuous deposition events. It is well established that atmospheric inputs are an important source of nitrogen, phosphorus and iron, among the others, for the Mediterranean basin. During the last ten-fifteen years, tens of papers have been published addressing the issue using different approaches. In the present study, the authors use a 3D numerical dust dispersion/deposition model to determine the areas of depositional events and the fluxes of dust into the surface layer. They correlate the chlorophyll concentration as derived by color remote sensing in the areas of deposition with different time lags from the day of deposition. They

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describe the different responses in different regions of the basin and in different times of the year, evidencing differences among the Western, Central and Eastern Mediterranean. Their conclusion is that, on the average, 11.5% of chlorophyll a variation is due to dust deposition.

Many of the existing contributions on the role of atmospheric deposition, and more specifically on Saharan dust inputs, are based on regular observations at fixed sites, or in meso- and macrocosms studies (some of them are listed in the references of the manuscript) while only few papers analyze the process at basin scale, without relying on extrapolations. This is a merit of the approach of the present study, which is the first, to the best of my knowledge, to use a full 3D atmospheric dispersion model to quantify the dust fluxes in the marine surface layer. Previous attempts were based on lagrangian interpolation techniques of flow fields to track dust paths or on satellite derived Atmospheric Optical Thickness data and a parametrization of deposition. The model used in the manuscript should provide a better estimate of fluxes than the other methods. However the paper has some weaknesses that cannot be easily overcome in a revision and that make me reluctant in supporting its publication in Biogeosciences.

The authors use 8 day averages of chlorophyll concentrations based on the NASA standard algorithm OC4v4. The 8 day averages introduce a significant uncertainty in what the authors are really correlating with the deposition data since they may reflect just one day randomly positioned in the 8 day interval or more than one, up to 8 days. So deposition is correlated with quantities always different and not necessarily representative of the time interval. The other problem is related to the use of NASA standard algorithm. It has been recurrently showed (see Volpe et al, 2007, Remote Sensing of Environment, 107: 625 and references therein) that NASA algorithm overestimates chlorophyll concentration in Mediterranean Sea, up to 100% at the very low concentrations that are typical of the Eastern and Central Mediterranean. In addition, the bias does not vary linearly with the concentration, which makes impossible to find a simple transformation to correct for the bias. For both reasons, the choice of using

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the SWF8D\_CHLO.CR data product makes the results of the analysis unreliable.

The other weak point, partially related to the previous one, is that Claustre et al. (Geophysical Research Letters, 29, 107, 2002) have convincingly argued that the backscattering due to the dust in the water column is among the causes of the bias in the blue-green ratio of the water leaving radiance in the Mediterranean sea. This paper is not even cited by the authors. This point is particularly relevant in this case, because it has to be expected that the amount of dust in the water column would be high in the days after a deposition event, which would amplify the error due to the algorithm. This aspect has been discussed in depth by Volpe et al. (2009) (cited by the authors), who concluded that in most cases the observed increase in chlorophyll was likely an artifact.

While data on stock and fluxes show clearly that the atmospheric contribution is crucial for balancing the nutrient budget of the basin and, therefore, is channeled through the food web, observations, experiments and model studies show a weak or negligible phytoplankton accumulation after fertilization by dust. This makes difficult to characterize the biotic response to dust fallout using remotely sensed chlorophyll.

Besides the weaknesses discussed above, the paper does not add to the existing knowledge on the impact of dust on the functioning of the basin and leaves open the key question of how the nutrients conveyed by the dust are channeled through the food web. Some insight comes from the Cyclops experiment (Thingstad et al, 2005, cited by the authors) who showed that phosphorus added to the system, as it may happen during a dust event, can quickly enter the food web without producing an increase of phytoplankton biomass. Additional reasons for a weak chlorophyll signal can also be the dilution (dust events are often coupled with strong winds), which may cause an undetectable, by remote sensing, increase in phytoplankton concentrations and a tight coupling between production and consumption, similarly to what occurred during Cyclops.

For all the above I propose to reject the manuscript

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#### Additional notes

L60-61 I would rephrase this sentence. Many papers cited by the authors show 'clear' evidence of the effect of dust inputs on unicellular autotrophic and heterotrophic plankton, even when the impact is negligible. As the authors highlight in the following, what is missing is quantification at basin scale derived from direct observations of plankton biomass (but see Volpe et al., 2009)

L. 142 As I understood correctly 'To be on the safe side' means that they have considered as reliable model dust inputs anything overpassing the threshold of  $10^{-8} \text{ Kg m}^{-2} \text{ d}^{-1}$ . This is certainly safe from the lowest value side, but might imply an overestimate by one order of magnitude of real inputs.

L76 Mediterranean L79 Necessarily L81 space before 'The' L100 (<http://..>) L 159, L392 and L216 (D'Ortenzio and Ribera d'Alcala', 2009)

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