

Responses to Thomas Holmes (manuscript #bg-2021-87)

General comments

The manuscript entitled “Subsurface iron accumulation and rapid aluminium removal in the Mediterranean following African dust deposition” by Bressac et al. is an interesting and well-written paper teasing apart the cycling of Fe and Al in the Mediterranean Sea and challenging the use of Al as a tracer of dust inputs to this region. Using a quick response dissolved and particulate water sampling regime, the authors were able to take high resolution time-series (hours to days) observations of two wet-deposition events while at sea and thus capture previously unobserved mechanisms controlling the cycling and removal of Fe and Al. This high-resolution sampling revealed that dissolved Fe increased in the surface layer during and at around 6h after deposition but was quickly scavenged to background concentrations, which is attributable to the saturation of Fe binding ligands in the region. Using Fe/Al concentration ratios in suspended and sinking particles, the authors were further able to show that phytoplankton, especially diatoms, actively accumulate Al. However, comparing Al/Si ratio of particles with published values for diatoms, the authors demonstrate that adsorption of Al onto biogenic particles, rather than active uptake by diatoms is the main sink for dissolved Al in the region. As a climate change hotspot, understanding current biogeochemical cycling mechanisms in the Mediterranean is important for ensuring the accuracy of modelled climate change impacts in this region. The mechanisms discussed in this study will be important for both optimisation of regional climate models and for future biogeochemical studies focusing on nutrient cycling in the Mediterranean. In my opinion, the scientific method utilised in this study is robust and the paper seems quite polished. I have few suggestions on the scientific discussion itself and have mainly suggested minor technical corrections. As such, this manuscript will be well suited for publication in Biogeosciences after minor revisions.

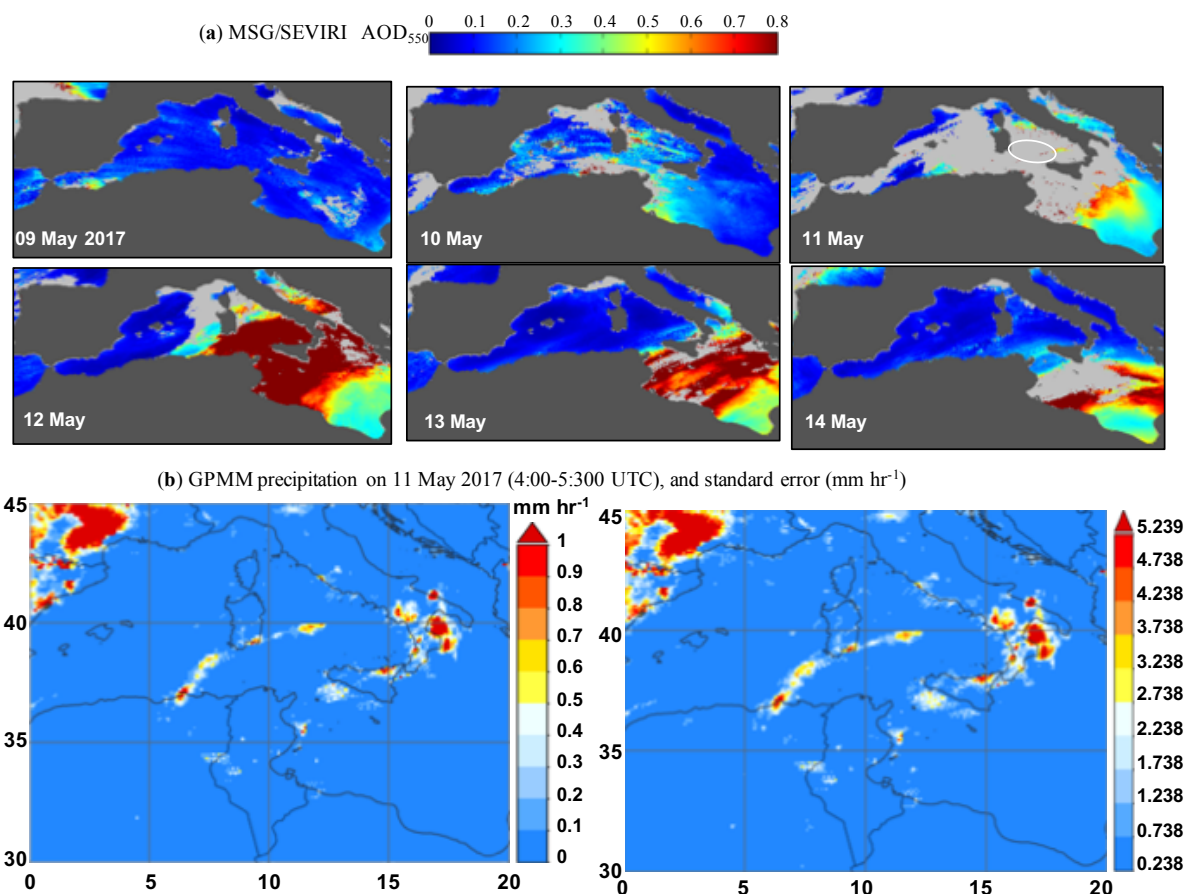
We thank Thomas Holmes for his constructive comments. Please find a point-by-point response to these comments.

Specific comments

Section 3: You refer to Supp. Fig. 3 quite regularly in the results section, and it is quite an interesting figure. It might be worth moving this figure into the text.

The figure below has been added to the revised manuscript. Maps of precipitation and wet dust deposition provided by the models are in the supp. info material.

Figure – (a) MSG/SEVIRI-derived daily (daytime) mean aerosol optical depth; the white ellipse on the 11th of May image includes the location of the 5 Tyrrhenian stations reported in Fig. 1; (b) Left: Time averaged map of the GPM mission multi-satellite precipitation final run estimate with gauge calibration (mm hr^{-1}) over 04:00-05:30 UTC on the 11th of May 2017 in the western Mediterranean region, from the GPM_3IMERGHH v06, half-hourly, 0.1° -resolution (Huffman et al., 2015). Right: Corresponding random error (mm hr^{-1}). After images produced by the Giovanni online data system (Acker and Lepkouth, 2007).



Can you comment at all on what impact future changing climate conditions might have on Mediterranean Fe/Al cycling in the context of your results? It seems that there is uncertainty as to whether dust deposition events are predicted to increase or decrease in the region based on observed trends over the last few decades (e.g. <https://doi.org/10.1016/j.atmosenv.2020.117736>), but though it may seem speculative I think it could still be valuable to mention the impacts that future changes may have on Fe/Al cycling based on your results.

A discussion about the impact of future climate conditions has been added to the revised manuscript. In particular, results obtained during minicosm experiments performed during the PEACETIME cruise, and investigating the impact of dust deposition on Mediterranean plankton communities under future conditions of pH and temperature (<https://doi.org/10.5194/bg-2020-202>; <https://doi.org/10.5194/bg-18-2663-2021>), are used to discuss the potential impacts that future changes could have on the Fe and Al cycles.

Technical corrections

Line 55: change to 'solubility as Fe'

Line 57: remove 'the' in 'the biological activity'

Line 64: change to either 'where dust is free' or 'where dust particles are free'

Line 65: change to 'they demonstrated'

Line 70: remove second comma and 'in fine'

Line 75: change 'under' to 'in'

Line 80: change 'contrasted' to 'contrasting'

Line 90: change 'investigate' to 'investigating'

Line 150: change 'weighted' to 'weighed'

Line 185: perhaps add a mean or range for the Chl a concentrations observed during the cruise.

Line 197: change 'could' to 'were'

Lines 203 – 208: this sentence is too long and needs to be broken up to make it easier to read. Suggest adding full stop after ‘10th of May’ on line 205, removing the next ‘with’ and then adding ‘was observed’ after ‘...Dulac et al., 1992)’ on line 207.

Line 210: change ‘was’ to ‘were’

Line 221: replace ‘that day’ with ‘11th of May’ and remove from end of sentence.

Line 222: does ‘...1.5 g m⁻² over 6 h, or more in the area of...’ mean that there was more than 1.5 g m⁻² forecasted at just stations 5, TYR and 6, or more than 1.5 g m⁻² forecasted over the whole area? If it’s the latter, I would replace ‘with up to’ with ‘with at least’, and remove ‘or more’.

Line 236: ‘occurred on the 3rd’. Also, can you define ‘neighbouring area’?

Line 238: ‘R/V on the 5th...’

Line 239: ‘clear dust signature’ isn’t technically wrong, and readers of this paper wouldn’t think you meant that the dust was clear, but it’s a little ambiguous, so I would recommend changing to ‘... by a dust signature clearly revealed by the chemical composition of the rain,...’

Line 246: ‘as do all’

Line 279: ‘This is an order-of-magnitude...’

Line 280: replace ‘with’ with ‘compared to’ and ‘indicates’ with ‘indicating’

Table 2: in footnote 6, change ‘a’ to ‘an’

Line 295: change ‘At the opposite’ to ‘In contrast’

Line 315: change ‘increased both’ to ‘both increased’

Line 316: change ‘was’ to ‘were’

Line 320: either change ‘concentration’ to ‘concentrations’, or add ‘a’ before ‘remarkably’, ‘was before ‘observed’ and ‘, which’ after the bracket.

Line 378: change ‘phytoplanktons’ to ‘phytoplankton’

Line 388: change ‘phytoplanktons’ to ‘phytoplankton’

Line 394: insert ‘the’ after (2)

Line 426: remove ‘a’

Line 440: change ‘week’ to ‘weeks’

Line 448: add ‘water’ after ‘surface’

Line 450: add ‘the’ before ‘low’

Line 460: change ‘with’ to ‘in’

Line 472: This sentence needs a little restructuring. I suggest: ‘...central Mediterranean, we observed two atmospheric wet deposition events while measuring Al and Fe water column distributions, providing...’

Line 474: This sentence could also do with a slight tweak. I suggest: ‘The water-column Al inventories were successfully utilised to assess deposition fluxes, complementing atmospheric...’

Line 481: change ‘and extended until’ to ‘extending to’ and ‘excess to dFe’ to ‘excess of dFe’

We think the referee for spotting all these spelling mistakes. All these proposed corrections have been taken into account in the revised manuscript.