

We would like to thank both Reviewers for the time and effort provided to review our manuscript and for their constructive comments. We have addressed their suggestions for corrections/modifications in the revised version of the manuscript. Overall, we believe that the manuscript has been significantly improved, in respect to their valuable contribution. Please follow our detailed responses to Reviewer's II comments below:

## Reviewer #2

1: Abstract. "Assessing seasonal and interannual variability" of particulate export does not represent a scientific hypothesis. The authors should more clearly state that their objective was linking temporal patterns of particulate export with processes including primary productivity, upwelling of intermediate waters and influence of episodic events of dust deposition.

Reply: The last paragraph of the Abstract was revised according to the Reviewer's suggestions:

*'Besides the late winter/early spring convective mixing period, leading to enhanced productivity and thus increased mass flux to depth, we observe high mass fluxes during late spring/ summer. These seasonal maxima could be attributed to the combined action of: (a) episodes of increased productivity, as witnessed by the organic carbon, carbonate, and opal fluxes in the mesopelagic and bathypelagic layers; they are related to the upwelling of intermediate waters of Levantine/Cretan waters in late spring-early summer, which causes nutrient inputs in the surface layer of the Ionian Sea and (b) enhanced fluxes of lithogenic matter, associated with episodic dust input events, giving also rise to surface productivity events.'*

2: Introduction. This section is well written and fluently readable and does not need any major change. The only suggestion is to clearly state the objective of the study (as suggested for the abstract) at the end of the paragraph.

Reply: The last paragraph of the Introduction was revised as follows:

*'The present work focuses on the study of downward fluxes of total mass, organic carbon, carbonate, opal, and lithogenic matter, obtained during a four-year sediment trap experiment (February 2006 to March 2010), in the deepest Mediterranean basin, NESTOR site, SE Ionian Sea, Eastern Mediterranean. We examine: (i) the interannual; and (ii) the seasonal variation of mass flux, in relation to biogeochemical and physical exchange processes, and investigate particle-transfer mechanisms to depth in the SE Ionian Sea'.*

3: Results. p. 596 para 2.1. The description of the morphological setting could largely benefit of a figure or a panel of figures illustrating sub-bottom seismic profiling data.

Reply: A reference was added (Trimonis and Rudenko, 1992). However, there are no published figures with seismic profiles available.

4: Results. p. 600, para 4.2. Any comparison with previous data should be moved in the discussion.

Reply: Moved to section 5.1.

5: Discussion. As a matter of fact, all the relationships between fluxes and regulating factors are inferred observationally, but are not tested statistically. This denotes that these inferences should be somehow passed through some statistical tests. I specifically suggest the authors to use their complex data set to identify major shifts in the composition of fluxes among different seasons, years, and/or in coincidence with peaks in primary productivity or dust deposition events. This can be performed using multivariate analyses (MANOVA or similar) and their relative representation in bi-dimensional plots (like PCA or similar). I'm not really sure whether the region under scrutiny is monitored for remotely-sensed primary productivity data, but, if so, I would suggest the authors to relate their flux data with the data on primary productivity in the surface waters.

Reply: Indeed, most identified relationships between fluxes are inferred observationally. However, some correlation coefficients were given for ballast mineral fluxes vs. OC fluxes. We have examined in great detail the possibility to applying MANOVA, PCA or similar statistical methods to our data set taking into consideration the following:

- (i) Published literature on sediment trap time series data and interpretations is available at least since Honjo et al. (1978). However, we were unable to find consistent statistical methods addressing various fluxes and their interrelations; the majority of published work does not use at all statistics or presents simple correlation routines
- (ii) We applied PCA on the flux data set, and as expected >99% of variance was explained by a single factor. This is due to strong interrelation between the material fluxes variables
- (iii) A useful test would be to compare material fluxes against satellite-derived chlorophyll  $\alpha$  (chl  $\alpha$ ). Comparing in situ productivity fluxes versus satellite products carries an inherent problem: satellite sensors penetrate some meters into the water column (cannot be defined) and usually miss deep chl  $\alpha$  maximum (deeper than 70 m in the study area; e.g. Karageorgis et al. (2012))
- (iv) Another inherent problem of the data sets is that some variables are associated with measurable effects, but with a considerable time delay. For example, AOD variability would relate to lithogenic flux measured in the shallower trap (700 m-depth) (e.g. Ternon et al., 2010). Apparently, it would take several days for an AOD increase event (e.g. dust) to be recorded at the 700 m-depth sediment trap, and subsequently to cause

an increase of the lithogenic flux. Thus, simple correlation methods cannot be applied. We have tested, however, the more suitable lagged-correlation method, but clear trends could not be identified.

Finally, we found the work of Heussner et al. (2006) as most appropriate guideline to apply on data statistical analysis. The following section was added to 'Materials and methods':

### *'3.3 Statistical analysis*

*Total mass flux data were transformed in continuous time series using 1-month step, according to Heussner et al. (2006). Missing data on the 15-day interval were computed by lineal interpolation, whilst long gaps (several months) were not corrected. The derived data set consists of mean monthly averaged total mass fluxes (mTMF), which is adequate to study the seasonal variability, although some episodic events (pulses) may have been smoothed.*

*The relationships of mTMF variations between different traps were studied by means of Pearson correlation coefficients; the significance level to test the correlations was 5%. Principal Component Analysis (PCA) was used to examine the relationships of mTMF and other factors influencing their variability: (a) satellite-derived aerosol optical depth (daily AOD at 550 nm from MODIS; NASA GES DISC); satellite-derived chlorophyll- $\alpha$  (8-day composite from MODIS; NASA GES DISC); and (iii) salinity measured at 20, 50, 75, 100, 250, 400, and 500 m from the nearby ( $36^{\circ} 50.15N$ ,  $21^{\circ} 36.68E$ ; Fig. 1) observational buoy of the Poseidon system ([www.poseidon.hcmr.gr](http://www.poseidon.hcmr.gr)). Missing data and averaging was performed similarly to total mass flux data.'*

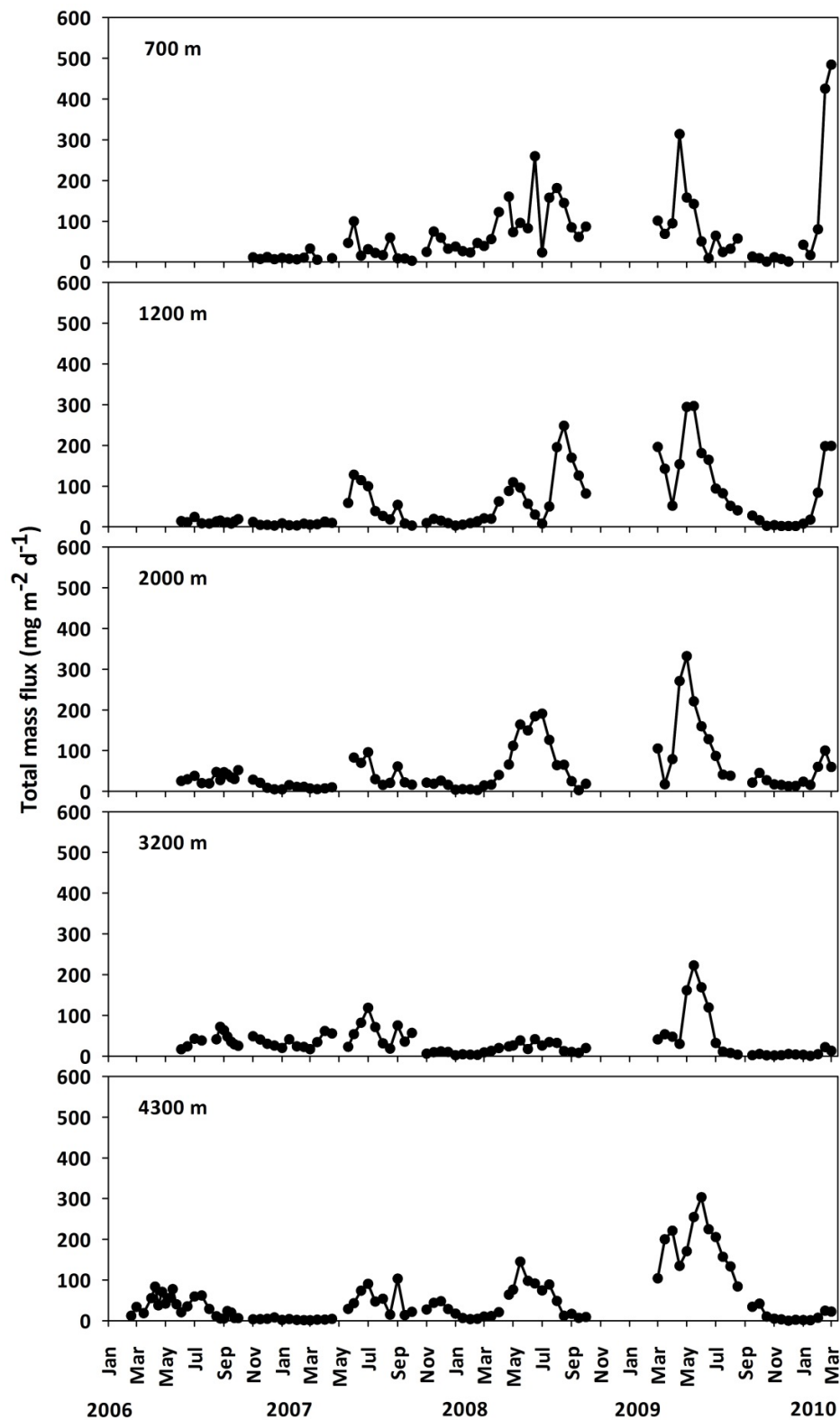
Section '4.2 Total mass flux' was rewritten and reads now as follows:

*'Time series of total mass fluxes are illustrated in Fig. 4. Mass fluxes range between two or three orders of magnitude at each depth. The lowest value of mass flux is recorded at 4300 m ( $0.12 \text{ mg m}^{-2} \text{ d}^{-1}$ , December 2010) and the highest at 700 m ( $484 \text{ mg m}^{-2} \text{ d}^{-1}$ , March 2010). Mean time weighted total mass fluxes measured during the experiment are generally low, confirming the oligotrophic character of the area and span over a narrow range, between  $66 \text{ mg m}^{-2} \text{ d}^{-1}$  at 700 m and  $34 \text{ mg m}^{-2} \text{ d}^{-1}$  at 3200 m (Table 1). Since the coefficients of variation ( $\text{CV}\% = \text{std. dev.}/\text{mean} * 100$ ) of mass fluxes are much higher compared to the coefficients of variation of percentages of major constituents at all depths (Table 1), the temporal evolution of fluxes of major constituents reflects the mass flux pattern. Among all traps, the upper trap shows the highest variability. However, all traps recorded the same seasonal signal with minor exceptions.*

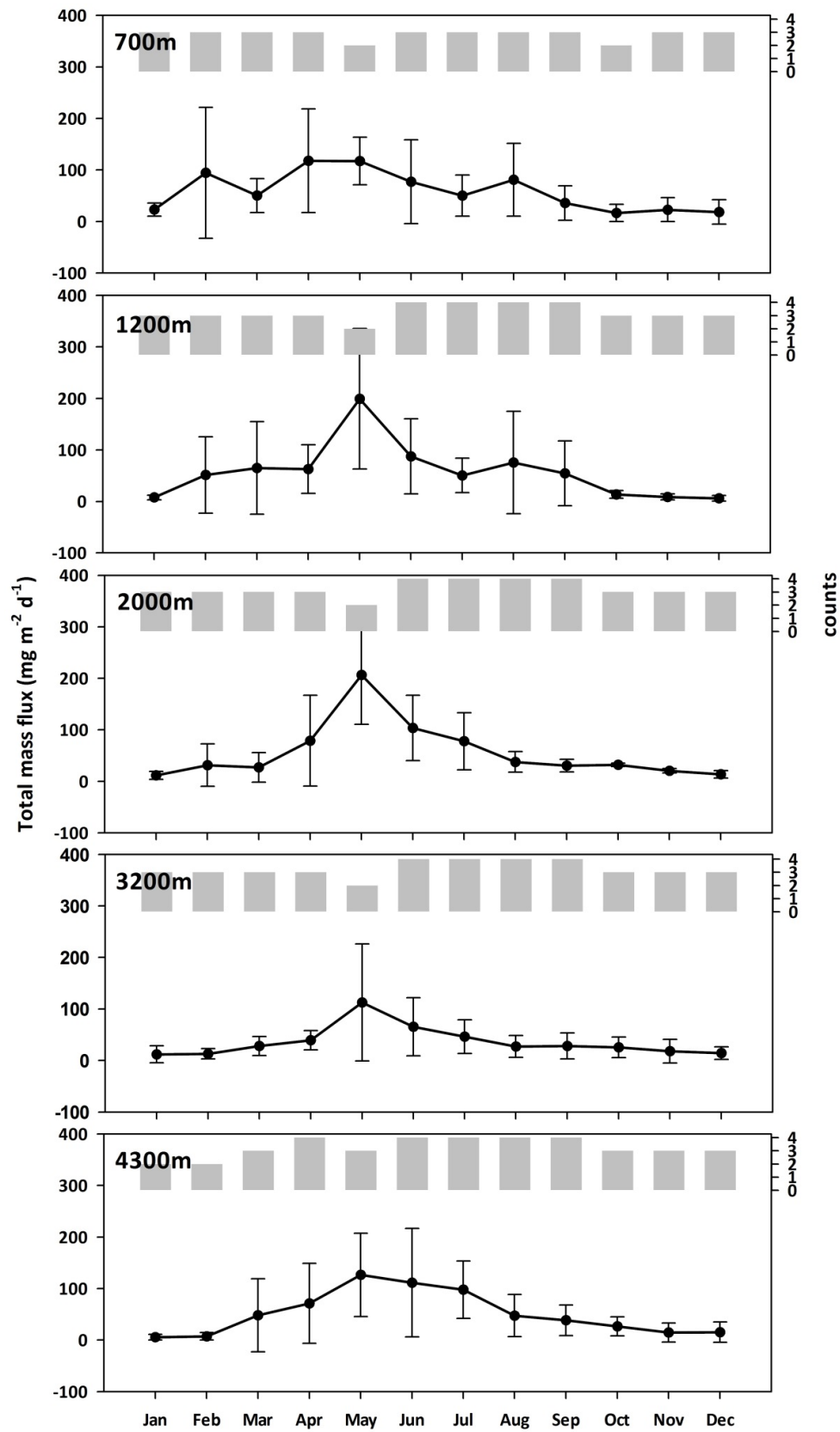
*The mean monthly total mass fluxes (mTMF) of all traps vary between 5.5 and  $207 \text{ mg m}^{-2} \text{ d}^{-1}$  (Fig. 5). The overall seasonal trend shows low total mass fluxes during winter, increasing in spring and peaking in May, whereas values decrease gradually during summer and autumn. The same general behavior is observed for all traps, suggesting that mean monthly total mass fluxes exhibit the same variability throughout the water column. The visual examination is supported by correlation*

*analysis; correlation coefficients were significant and varied between 0.597 and 0.984, for  $mTMF_{700}:mTMF_{4300}$  and  $mTMF_{2000}:mTMF_{3200}$ , respectively.*

*Mass flux close to the bottom is a good indicator of the sedimentation rate, thus, assuming, that the entire amount of particles caught by the trap at 4300 m reaches the seabed, the sedimentation rate in the study site is estimated at 1–1.45 cm kyr<sup>-1</sup>. This value is in good agreement with sedimentation rates reported earlier for the area, in the order of 0.7–1.8 cm kyr<sup>-1</sup> (Trimonis and Rudenko, 1992) or 0.86–1.89 cm kyr<sup>-1</sup> (Polimeris et al., 2009). Additionally, sediment cores collected close to the location of NESTOR site reveal sedimentation rates of 1.6-1.7 cm kyr<sup>-1</sup> (KM3NeT Collaboration, 2007), which is also in good agreement with those estimated from sediment trap measurements in our study.'*



**Fig. 4.** Time-series plots of total mass flux ( $\text{mg m}^{-2} \text{d}^{-1}$ ) of downward settling particles collected by sediment traps during the course of the long-term experiment in NESTOR site.



**Fig. 5.** Mean total mass fluxes ( $\pm 1$  std. dev.) of the entire four-year data set, where years were used as replicates.

The following section was added to Section '5.2. Seasonal variability'

*'The seasonal variability of mass fluxes is influenced by aeolian inputs (dust), primary productivity at the euphotic zone, and upwelling of deep, saline, nutrient-rich waters, also affecting primary productivity. The Aerosol Optical Depth (AOD) is a measure of radiation extinction due to aerosol scattering and absorption (Giovanni online manual) and may be used as a satellite-derived proxy for potential dust events. Total chl- $\alpha$  is a data product generated by the NASA Ocean Biogeochemical Model (NOBM) based on data assimilation of remotely-sensed chl- $\alpha$  (SeaWiFS and MODIS satellite sensors), and is directly related to oceanic primary production (Giovanni online manual). Upwelling of deep waters, rich in inorganic nutrients, is a mechanism that fuels primary productivity; upwelling can be traced by salinity variations.'*

*Table 3. Factor loadings after Varimax rotation*

<i>Variable</i>	<i>F1 (55.9%)</i>	<i>F2 (27.8%)</i>
<i>mTMF 700 m</i>	<i>0.580</i>	<i>0.690</i>
<i>mTMF 1200 m</i>	<i>0.852</i>	<i>0.399</i>
<i>mTMF 2000 m</i>	<i>0.897</i>	<i>0.303</i>
<i>mTMF 3200 m</i>	<i>0.924</i>	<i>0.218</i>
<i>mTMF 4300 m</i>	<i>0.931</i>	<i>0.170</i>
<i>AOD</i>	<i>0.550</i>	<i>0.499</i>
<i>chl-<math>\alpha</math></i>	<i>-0.746</i>	<i>0.538</i>
<i>salinity</i>	<i>0.172</i>	<i>0.935</i>

*PCA was performed on mean monthly total mass fluxes at all traps, AOD, chl- $\alpha$ , and salinity measured at 50-m depth in order to identify possible interrelationships. A Varimax rotated matrix (Table 3) shows that a simple model of 2 factors explains 83.7% of the total data variability. Factor 1 accounts for 55.9% of the total variance and contains positive loadings for all mTMF and AOD, whereas chl- $\alpha$  is negatively loaded (Table 3). Factor 1 portrays the lithogenic constituent of the total mass flux, which is positively related to atmospheric inputs/dust events. Relatively low loading for mTMF at 700 m denotes that other processes contribute to the total mass flux at the shallowest observation depth. Factor 2 accounts for 27.8% of the total variance and relates salinity, mTMF at 700 m, chl- $\alpha$ , and AOD. We suggest that F2 represents the biogenic components of the total mass flux, controlled mainly by the upwelling of high-salinity and nutrient-rich deep waters, which enhance primary productivity at upper water layers. Relatively low loading of chl- $\alpha$  may be attributed to poor performance of regional algorithms used to compute chlorophyll concentrations from remote sensing reflectance. In the oligotrophic waters of the Eastern Mediterranean, the presence of absorbing aerosols (desert dust) results in inaccurate atmospheric corrections (Bosc et al., 2004 and references therein), and furthermore CDOM variability alters the optical properties of surface waters. Interestingly, AOD is positively loaded in the 'biogenic' factor, suggesting that atmospheric aerosols, apart from lithogenic components, may also transfer nutrients to the sea thus enhancing primary productivity (Guerzoni et al. 1999; Markaki et al., 2010). Overall, PCA*

*findings confirm visual observations and provide insight into studying relationships between various parameters'.*

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