We thank Reviewer #2 for the useful comments. The point by point response is provided below in blue font and the proposed text modifications in red.

Anonymous Referee #2

Reviewer comments on Assessment of the spectral downward irradiance at the surface of the Mediterranean Sea using the OASIM ocean-atmosphere radiative model by Paolo Lazzari 1 , Stefano Salon 1 , Elena Terzic 1 , Watson W. Gregg 2 , Fabrizio ´ D'Ortenzio 3 , Vincenzo Vellucci 4 , Emanuele Organelli 3,5 and David Antoine 6,3 The manuscript presents a model-observation validation study that compares the OASIM spectral radiation transfer model results at the surface of Mediterranean Sea to BOUSSOLE and BGC-Argo observations. The comparison has been done in the
framework of Copernicus Marine Environment Monitoring Service in order to prepare for development of a new multispectral bio-optical model with advanced data assimilation for marine research. The atmospheric input to OASIM is taken from the ECMWF ERA Interim reanalysis data, and the comparisons cover the years 2004-2017 (which is not clearly indicated). The general result is that at monthly level the model and observations correspond each other well, but daily variations are large, depending mostly on cloud dynamics.

Thanks, we propose to explicitly mention the time span of the analysis that is 2004-2017 both in the abstract and Introduction.

Large amounts of valuable observation data has been used and model simulations performed. The radiative transfer model and observations are described in a sufficient extent, the results extensively presented and analysed. For validation, suitable statistical methods seem to be used. Data and model availability is documented as required.
However, the reader is somewhat lost within this vast material as the presentation is not focused and clear enough.
Sometimes it is even difficult to understand what the authors want to say. The motivation and aims of this study should be stated clearly in the introduction and the conclusions tied to them.

We tried to better explain the motivations specifically introducing the applications in the abstract and in the introduction the application regarded to biogeochemistry we propose the following corrections

"This activity has been carried out within the framework of the CMEMS Service Evolution project BIOPTIMOD, which is aimed at the development of a new multispectral bio-optical model that will include the integration of MedBFM with data provided by both BGC-Argo floats and multispectral satellite sensors (e.g., the Ocean and Land Colour Instrument, OLCI, on-board Sentinel3-A and Sentinel3-B; Donlon et al, 2012)."

You might consider if all the figures are really necessary in order to support your conclusions.

Thanks for the comments, but we think that all the figures are interesting and useful to support our findings.

For example, in the abstract (L10-20) you write that "observations are combined with model outputs to analyse the spatial and temporal variabilities in the downward planar irradiance at the ocean-atmosphere interface". In fact you validate a radiation transfer model against ocean observations. In the introduction, you refer to development possibilities, including everything from advanced assimilation of satellite observations to improved coupled biogeochemical models applying bio-optical in-water light propagation algorithms. How exactly the comparison of a classical atmospheric radiative transfer model to the (new) in-situ observations, which is the topic of the present study, will contribute to those developments, is not detailed or prioritized.

The atmospheric multispectral input data are necessary to resolve the multispectral propagation of light along the water column. Evaluating the uncertainties of these input data is fundamental for all the future developments concerning multispectral bio-optical models. Since OASIM is used by our group and other groups we think that this assessment can be useful and interesting for the scientific community.

I have one major question for you to consider, as you use ERA reanalysis data and work within Copernicus monitoring services. ERA5 includes output of spec trally integrated surface downward UV (0.20-0.44 µm) and SW (0.20 - 12 µm) radiation fluxes (https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-singlelevels?tab=overview). ERA interim did not yet contain the separate UV flux. These fluxes result from application of the ECMWF radiation transfer model that is fully integrated in the atmospheric model at each time step. The previous version before the scheme described by Hogan and Bozzo, 2018 (your reference at L386-387) was applied for ERA interim and ERA5. I would suggest you to compare the ERA5 UV and SW to the BOUSSOLE and Argo DPAR and integrated UV measurements. This would give you a possibility to understand if these variables of operational or reanalysis NWP models were sufficient as input to MedBFM within CMEMS. It would give you a basis to request CAMS, ECMWF future output of some more spectral details of the downward global, direct and clearsky surface radiation fluxes, e.g. UV, visible, near-IR, or more, separately. If this would succeed, you would not need at all the coupling of OASIM within CMEMS but would benefit from the integrated advanced radiation scheme within the ECMWF model?

Concerning the comparison of the ERA5 model with the instruments presented in this manuscript we remark that neither the BOUSSOLE buoy nor the BGC-Argo floats optical sensors measure UV (0.20-0.44 µm) and SW (0.20 - 12 µm) radiation fluxes and a comparison with the ERA5 data is not straightforward.
In any case, as mentioned in the manuscript, we plan to further explore the optical output provided by CAMS and/or ECMWF in future studies and applications.

You have shown that the aerosols play a minor role compared to clouds (L324). In any case, use of detailed aerosol information in the radiation schemes of the NWP models would make the additional use of atmospheric MODIS aerosol data unnecessary for the coupled ocean bio-optical modules. You can find out about CAMS and ECMWF treatement of aerosol information in Bozzo et. al., https://doi.org/10.5194/gmd-13-1007-2020, 2020 and references therein. Some regional NWP models plan to use CAMS aerosol in near-real-time (e.g. Rontu et al, 2020, https://doi.org/10.3390/atmos11020205) for the weather forecast (but with spectrally simple radiation schemes, with output not sufficient for your purposes).

Thanks for the comment, we propose to add these references in the revised manuscript.

A few specific minor comments follow:

1. L31-34. Please clarify the complicated sentence, what does it mean?

   Thanks, we propose to rephrase with the following sentence:

   Such data may be exploited to improve the calibration and tuning of the bio-optical models embedded in three-dimensional global and regional physical-biogeochemical coupled models. Radiometric data availability will further increase with the development of new autonomous profiling floats dedicated to ocean colour measurements (Leymarie et al., 2018) and with the expanding data streams provided by the Ocean Colour Radiometry Virtual Constellation (OCR-VC) satellite.

2. L121 and elsewhere: photosynthetically available radiation -> photosynthetically *active* radiation

   Ok, we will substitute with photosynthetically active radiation.

3. L133-134. How to understand this: at a depth shallower than 1.5 metres, with at least 4 measurements in the first 10 metres ?

   We updated the text proposing the following information:

Before comparing model values to observations, the irradiance profiles obtained from floats were extrapolated to the surface with an exponential fitting procedure based on the *curve_fit* tool of the python package scipy. Further, we required profiles to have at least one measurement in the first 1.5 m depth from sea surface and to have at least 4 measurements in the first 10 m. In addition, any sub-basin (as defined in Fig.2) and month containing fewer than 5 profiles was discarded.

4. Section 3.1. What is the role of surface pressure and wind from the point of view of (solar) radiation flux comparison?

We copy the same response given to Reviewer#1 [item 4] since the comments are similar.

Sensitivity test to meteorological inputs were performed by Gregg and Carder (1990), showing that pressure and mean wind speed produced differences in surface spectral irradiance less than 1% in terms of RMS model error over the 350-700 nm range, much less than air-mass type, visibility and total ozone. More specifically, their Fig. 5 shows that the ratio Ed(0-)/Ed(0+) mainly remains larger than 0.90 for wind speed ranging 0-15 m/s and two visibility values (5 and 25 km). The ratio decreases to 0.85 only for visibility equal to 25 km, absence of wind and solar zenith angle around 80 degree.

Furthermore, according to Gregg and Carder (1990), direct and diffuse sea surface reflectance can be decomposed in specular and sea foam-dependent reflectance. Foam reflectance is affected by sea-surface roughness, which in turn has previously been related to wind stress and, secondarily, to wind speed (Koepke, 1984). We propose to add this information in the methods Section.

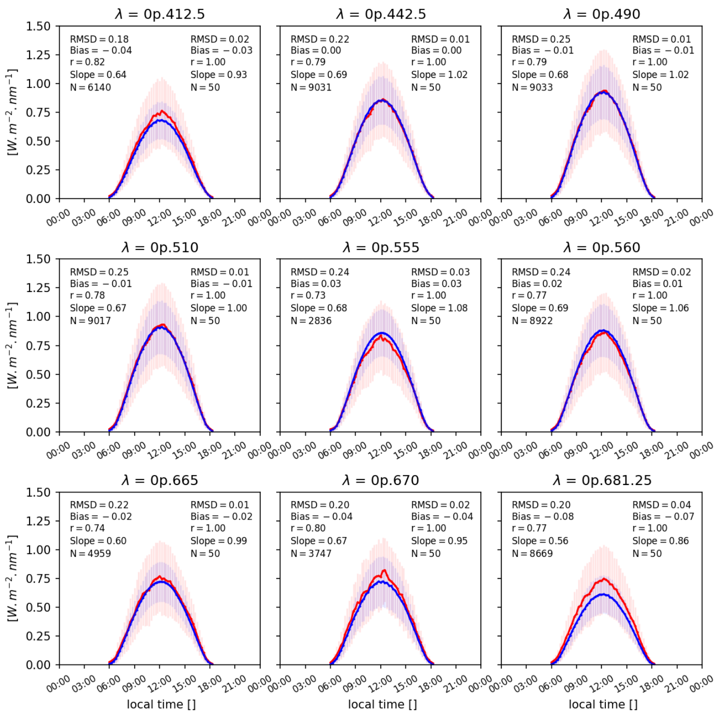

Figure R1. Multispectral downward planar irradiance **Ed(λ,0+)** simulated by OASIM (blue lines) and measured at BOUSSOLE (red lines). The wavelengths considered are those measured by the BOUSSOLE sensors for the average March data derived from the time series. For each panel, the reported statistics (RMSD, Bias, r, and regression slope) are related both to the high-frequency signal (with a temporal resolution of 15'; top left) and to the average day in the considered month (top right). The vertical bars indicate the variance in the monthly averaged values of the average day.

In order to estimate the impact of surface pressure and wind in the model-observation comparison, we show in Fig. R1 the multispectral downward planar irradiance

(**Ed**(**λ**,**0**+)) simulated by OASIM (blue lines) and measured at BOUSSOLE (red lines) for the month of March. Comparing Fig. R1 with Fig. 6 proposed in the submitted version for **Ed**(**λ**,**0**-), we show that differences, related to the atmospheric parameters have in general a low impact on the results, otherwise we would observe a much higher deterioration in model performance when computing **Ed**(**λ**,**0**-) from **Ed**(**λ**,**0**+).
In order to provide a general overview of the impact of the parameters indicated by the Reviewer, we extracted Ed(**λ**,**0**+) from model and from BOUSSOLE and reported the skill in Tab. R1 in analogy to Tab. 1 proposed in the manuscript. The differences in the skill (e.g. percentual RMSD and BIAS) between computation of **Ed**(**λ**,**0**-) from **Ed**(**λ**,**0**+) indicates that the model is in general slightly better in computing **Ed**(**λ**,**0**+) than **Ed**(**λ**,**0**-) but the differences are, in any case of second order, so is the impact of surface pressure and wind. RMSD is only marginally affected with <1% differences. The BIAS for **Ed**(**λ**,**0**+) shows <5% differences.

Table R1. Summary of the model skill compared to the available data from the BOUSSOLE buoy (from 2004 to 2012) and BGC-Argo floats (from 2012 to 2017) for the irradiance (**Ed**(**λ**,**0**+)) at the different wavelengths (WL) and for DPAR. RMSD, bias, and Y-int are expressed in W m-2 nm-1, while all the other indicators (regression R and slope) are dimensionless, where N is the number of match-ups between the model and observations. For the BOUSSOLE comparison, the green numbers are derived by filtering out the day-to-day variability (i.e., the intra-monthly variability). Given the large number of samples, all statistics are significant (p-value < 0.05). For the RMSD and BIAS, the percentage values normalized by average data are reported in parentheses.

BOUSSOLE vs OASIM-ECMWF [2004-2012]						
WL	**RMSD**	**BIAS**	**R**	**SLOPE**	**Y-int**	**N**
412.5	0.15 (34.1%)	-0.04 (-9.5%)	0.83	0.66	0.08	55239
	0.04 (10.0%)	-0.04 (-9.6%)	0.99	0.88	0.00	
442.5	0.18 (33.6%)	0.00 (0.6%)	0.84	0.77	0.09	111010
	0.04 (7.2%)	0.00 (0.5%)	0.99	1.00	-0.01	
490	0.20 (34.4%)	0.00 (-0.1%)	0.84	0.76	0.10	112186
	0.04 (7.4%)	0.00 (-0.2%)	0.99	1.00	-0.02	
510	0.20 (34.6%)	-0.01 (-2.0%)	0.83	0.74	0.10	112071
	0.04 (7.2%)	-0.01 (-2.1%)	0.99	0.98	-0.02	
555	0.20 (33.4%)	0.03 (5.1%)	0.85	0.83	0.10	55309
	0.05 (8.6%)	0.03 (5.0%)	0.99	1.05	-0.03	
560	0.20 (35.5%)	0.01 (2.3%)	0.83	0.76	0.11	106660
	0.04 (7.9%)	0.01 (2.3%)	0.99	1.02	-0.02	
665	0.18 (34.1%)	-0.02 (-3.0%)	0.84	0.75	0.09	76247
	0.04 (7.1%)	-0.02 (-3.1%)	0.99	0.99	-0.03	
670	0.17 (39.6%)	-0.04 (-9.3%)	0.79	0.63	0.08	32733
	0.04 (10.1%)	-0.04 (-9.5%)	0.98	0.92	-0.02	
681.25	0.17 (36.4%)	-0.08 (-16.4%)	0.81	0.62	0.07	110418
	0.05 (10.3%)	-0.07 (-16.6%)	0.99	0.85	-0.02	

5. L.296 and elsewhere. How to compare fluxes in different units, 600 µmol quanta m -2 s -1 v.s. W m -2 nm -1 ?

   Thanks, the comment refers to figure 11 that is expressed in µmol quanta m -2 s -1 we propose to correct the text as follows:
   Consistent with the results shown in Fig. 11, major discrepancies arose when comparing DPAR, where the model values resulted in much higher values than those obtained from the floats, increasing especially during summer (up to 600 µmol quanta m-2 s-1 in August, as shown in Fig. 13).

6. L331-336. You are effectively saying that for the radiation flux results it is more important that clouds are in correct place in correct time than how the details of liquid cloud optics are treated in the simulated clouds. Which is true, of course.

   Thanks for the comment, we propose to add this remark to the text in line 337:
   In other terms, this implies that a correct localization of clouds in space and time is more important than specific details of the liquid cloud optics parameterizations.

7. L383-387. See the general comments.

According to the reviewer suggestion we propose to update the conclusions adding the following text:

The atmospheric multispectral input data are necessary to resolve the multispectral propagation of light along the water column. Evaluating the uncertainties and the quality of the these input data is fundamental for all the future applications involving bio-optical modelling and an important starting point to develop assimilation schemes based on bio-optical modelling.