Response to the Anonymous Referee #1

The referee is gratefully acknowledged for providing valuable comments about the manuscript leading to improvement of the paper. Below the authors refer to the individual comments and specify changes that were made to the text.

"Although the title says 'Ocean colour products from geostationary platforms' and the introduction claims 'This paper describes the ongoing effort to develop operational ocean colour products' not a single novel ocean color product is presented, only a small scale figure adopted from another publication. "

To provide a preliminary insight into the ongoing SEVIRI product development, an image of East Anglian plume is included as Figure 1. The statement about novel ocean colour products is however unclear. The paper emphasizes that SEVIRI is not an ocean colour instrument so it cannot be expected to support novel products. The paper points at limitations of SEVIRI for ocean colour. However it also documents that SEVIRI's multi-temporal capabilities can benefit some users requiring improved local-area coverage or frequent diurnal observations for a subset of standard ocean colour products. Perhaps the understanding of 'products' as providing hourly diurnal coverage and a long-term time series of these diurnal observations is what the referee suggests as a novel contribution.

"In my opinion a fare title would be 'Review of the user requirements and actual possibilities of ocean color products from Meteosat Second and Third Generation satellites'"

Change to the paper title is proposed as: 'Ocean colour opportunities from Meteosat Second and Third Generation geostationary platforms'.

"The user requirements are listed at a very high level and don't match the list of limitations given at a low technical / scientific level. Which requirements can actually be met if any? It is possible to give answer to this question based on the available knowledge and such an answer is the main thing worth publishing. However it remains unclear. A proper qualitative analysis of limitations with respect to all requirements is absolutely needed and can be summarized as an additional column in table 3: 'Feasibility'. For example, fig. 3. indicate that lowest error in water leaving reflectance in the North Sea in the best conditions cannot be below 50%. Does it automatically indicate that almost all products from table 3 become non feasible since they require accuracy in the order of 5% (OCCCG reports) ?"

We understand the drive for specific feasibility and uncertainty definitions. However, we did not obtain from users qualitative requirements on the uncertainties for the subset of products obtainable from SEVIRI. Community requirements for these products are also not available. The 5% water reflectance uncertainty in IOCCG documents relates to case 1 waters (clear, non-turbid waters) and typically to blue-green wavelengths and it reflects the follow-on requirements for chlorophyll-a concentration retrievals. Our approach therefore has been to develop the best algorithms and products we can, bearing SEVIRI limitations, and estimate product uncertainties through the process of comprehensive validations (although we are further limited by a small number of in situ turbidity measurements coinciding with water-reflectance measurements in the red-NIR). To improve on SEVIRI's signal-to-noise ratio, we are accumulating products sensed every 15 min to the hourly coverage. The validations will provide the uncertainties for users to decide on the use of the data in their specific applications. In our view it is better to make these products available as evaluation products and to galvanize community interest in potential future geostationary ocean colour missions than not to produce them at all. Explanations as to this point are now included in the text, particularly in section 2 and section 3.1.

“It is very hard to judge which group of users is represented in the given requirements. Details of surveys are not given. Number of interviewees, their scientific and technical level, background and field of work is not specified. “

Section 2 introduction was appropriately updated to address this point.

“In this context the list of the required products seems to be rather arbitrary. It is recommended to extend this list to include all common products currently derivable from polar orbiting satellites and, us suggested above, tentatively indicate ’realistic accuracy’ or ’feasibility’ for each of them to clearly illustrate potential of ocean color from geostationary satellites. “

Many ocean colour products are at all feasible from SEVIRI. It is not useful to list all products currently derivable from polar orbiting satellites because only a small subgroup of these products is possible from SEVIRI. Dedicated ocean colour sensors in polar orbits incorporate narrow-band wavelengths in the blue, green, red, NIR which are not available on SEVIRI. Table 4 is now modified to include additional products that are not feasible from SEVIRI but may be feasible from the FCI instrument.

“I find these two phrases "EUMETSAT’s Meteosat Third Generation (MTG) Imaging satellites, with the first of the series planned for launch in 2020" and "The main goal of the MSFD is to achieve Good Environmental Status of EU marine waters by 2020." compromising the entire idea of the manuscript. “

We are not fully clear what is meant but try to respond: achievement of the Good Environmental Status is not marked by a single date and assumed to be compliant indefinitely. Monitoring whether GES requirements are met will have to be continuous into the future. SEVIRI/FCI data can provide systematic and synoptic measurements supporting continues evidence and detection of nonconformance.

“Why to mention FCI at all if its resolution is too low for WFD and it is launched after MSFD?”

At the end of section 2.1, the explanation is given that, for WFD, the spatial resolution of SEVIRI could only support monitoring of the few biggest lakes in Europe while FCI will have an increased spatial resolution with which it can support monitoring of additional lakes.

“There should also be other serious reasons (climate change is definitely being one of them) to employ FCI which are worth elaborating.”

Potential of FCI to provide the chlorophyll-a concentration product is emphasized in the text, which will then open further applications related to water resource monitoring and ecosystem modelling, as explained in section 2.3. Climate change is a possible application however before we have FCI data we are not ready to support such a bold statement because FCI specifications are currently insufficient to fulfil product uncertainty requirements dictated by GCOS.

Response to the Anonymous Referee #2

The referee is gratefully acknowledged for providing valuable comments about the user requirement process. Below the authors refer to the individual comments and specify changes that were made to the text.

"Such an analysis is welcome [capability of geostationary ocean colour], although the manuscript reads more like an opinion paper than a review. The analysis is placed firmly in the context of user needs and the requirements of the European water framework directive and marine strategy framework directive. Unfortunately, no (re-)analysis is presented of these user-defined requirements and the reader would have to be intimately familiar with the cited documents of individual projects, not generally subject to peer review but generally subject to significant production pressure, to assess how meaningful these user groups and responses have been. At minimum an overview of the nature (targeted audience, geographical spread) and size of the response should be provided."

An example of detailed but still preliminary user requirements collected as a process demonstration GMES-PURE is enclosed at http://gmes-pure.eu/deliverables/public-documents/ in the Marine User Requirements Database extract. Roughly one third of this database is related to ocean colour requirements. These user requirements are numerous and regard a large variety of parameters associated with marine biogeochemical properties, phytoplankton functional types, nutrients, and aquatic optics and turbidity. Many of these user requirements cannot be met by the SEVIRI and FCI instruments which design, spectral, radiometric and spatial characteristics, are not dedicated to ocean colour applications. Therefore this paper limits the description and analysis of user requirements to those requirements that are feasible for SEVIRI and FCI instruments. The requirement "(re-)analysis" in this paper is therefore the focus on requirements that are feasible from the SEVIRI instrument and, in the next instance, from FCI. Appropriate text with this explanation has been included at the beginning of section 2 and additional Table 3 summarizes the applications.

"The manuscript repeatedly claims to present "a review of user requirements for geo-stationary operational ocean colour products", but I would argue that it is a review of geostationary ocean colour capability and, as such, does not provide significant new insight. In the comments below are some suggested instances where this could be improved by additional discussion or analysis."

Section 2 now makes it clear that the user requirements described in the paper are specifically constrained to those that are feasible to be met by SEVIRI and FCI, which are the already existing or designed instruments. The paper cannot provide new insight into geostationary ocean colour user requirements. It is clear that SEVIRI and FCI will not push ocean colour state-of-the-art but may provide improved coverage and unique diurnal ocean colour observations above the Europe and Africa disk which could benefit many users and services.

"In summary, the paper could be more logically presented as either an opinion paper regarding the uptake of geostationary OC sensors, or (with additional analysis) as a review of user requirements, but one focus should preferably be selected and followed throughout. Either way, it would support the logical structure of the paper if capabilities and (current) algorithmic shortcomings of the geostationary approach were addressed before these were mapped to user requirements. This will require some restructuring of the paper. "

We think that the explanations above to the previous points regarding user requirements make the paper logic more clear. The scientific constraints section now more clearly refers to the

user requirements and describes the methods to mitigate instrument limitations to better match user needs.

Specific comments
‘‘There is some confusion in the first sentences of the abstract between sensors, missions, applications, and services. A case is made that applications are sufficiently matured to allow operational services. Examples are then given as satellite sensors/missions. ‘‘

Corrected

P3147 L20 "The spatial resolution of 1 km at nadir is an enhancement on SEVIRI's 3 km resolution and it is suitable for global ocean observations as well as provides meaningful improvement for coastal and lake studies." - 'global' is somewhat inappropriate here, as large swaths of mid- to high-latitude oceans will not be observable. This is only discussed later in the paper.

Corrected

P3149 L5 "Chlorophyll a concentration could not be obtained from SEVIRI but may be supported by MTG FCI instruments." - How would this be supported? Give examples of algorithms for other RGB sensors with similar band configurations, and how have these been used? Will atmospheric correction be adequate?

Additional explanation has been added

P3149 L17 "Massive blooms of cyanobacteria" –> "Surface blooms and scums of cyanobacteria"

Corrected

P3149 L20 "The increased resolution of the FCI instrument will support coverage of additional lakes." - Please provide more detail, what pixel size could be expected and how relevant is this for lake water quality? Will atmospheric correction be adequate for inland applications?

Explained. There is a further explanation regarding the atmospheric correction in section 3.1

P3150 L9– "The lakes that can be monitored with SEVIRI include Lake Victoria/Nam Lolwe/Nalubaale [...]" - Please provide detail, how is 'monitoring capability' defined, what spatial resolution is considered relevant?

Explained.

P3152 L4 "Table 3 gives the range of ocean colour products feasible from the SEVIRI instruments which have been requested through user surveys." - The table caption suggests a list of "SEVIRI ocean colour products requested by users" rather than the authors' view of the feasibility of SEVIRI products to meet user requests. - It would provide useful context to also list user requests that cannot be addressed with SEVIRI, but can be met with other OC sensors, or not at all.

We think that listing the complete range of user requirements is beyond the scope of this paper. Just as the GMES-PURE user requirements show (please look at the link provided above), this list is extensive and most of the products are not feasible with SEVIRI. However,

on this list there is a set of requirements which ask for frequent diurnal observations of turbidity parameters and these are the specific requirements that this development addresses. To support this point, Table 4 has been expanded and Table 3 has been added listing the summary of relevant applications.

Response to the Anonymous Referee #3

The referee is gratefully acknowledged for providing valuable comments about the user requirement process. Below the authors refer to the individual comments and specify changes that were made to the text.

This paper provides an overview of the use of geostationary satellite ocean colour data for marine and inland water observation. The paper gives context of the marine policy/management issues where ocean colour data can provide relevant information, particularly for Europe and Africa. It compiles useful key information on sensor capabilities, which is often lacking in the literature. It also provides useful context for limitations of polar orbiting versus geostationary sensors. Tables and example figures summarising requirements and sensor capabilities are welcomed.

However, the paper would benefit from greater connection between the determined requirements from user consultation and the sensor/algorithmic capabilities determined. For example, it is stated that FCI will provide additional capability to measure phytoplankton concentrations through additional blue green bands. However, are these bands likely to be useful i.e. what algorithms could be applied and will signal to noise be sufficient? It's stated that "due to these [signal to noise] limitations, SEVIRI can only quantify strong marine optical signals, like high turbidity, and can observe only very high-biomass blooms". Will FCI improve on this? It would be useful to have additional context with regards to how errors from atmospheric correction/adjacency effects will compound these challenges. How do the likely errors in reflectance measurements compare to the underlying sensitivity imparted to the ocean colour signal from the constituents of interest? It would be good here to link to some reviews of algorithms for coastal/inland waters, to give a more complete overview of potential algorithm approaches that could be used.

Section 3.1 has been updated to include the discussion how the limitations of SEVIRI are addressed in the current development and mitigated where possible. Some background as to the FCI algorithms has also been added in section 3.2.

The paper discusses African uses for EO data but does not mention much with regards to African initiatives or government context (e.g. in abstract or in section 2.2). I would suggest additional context on growth in remote sensing in response to regional requirements (e.g. through projects such as ESA TIGER, EAMNET, DEVCOCAST) and references to inland and coastal remote sensing studies highlighting these requirements, which may see beneficial use of SEVERI/FCI data.

The specific references to these projects have been added in section 2.2.

Specific comments:
Title - I would suggest reframing the title as a review of the potential of ocean colour products from geostationary satellites.

Title has been updated: Ocean colour opportunities from Meteosat Second and Third Generation geostationary platforms

Line 22 - suggest changing 'global ocean' to 'open ocean'.

Done

Figure 1 - it is unclear what variable is being displayed here as it is not defined in the caption or with a colour scale.

It is the marine remote sensing reflectance in the red band. The explanation has been added to the Figure label.