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Reply on RC2

Anam M. Khan et al.

Author comment on "Reviews and syntheses: Ongoing and emerging opportunities to improve environmental science using observations from the Advanced Baseline Imager on the Geostationary Operational Environmental Satellites" by Anam M. Khan et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-454-AC2, 2021

General comments:

This is a well written and valuable synthesis of the emerging and potential uses of new geostationary sensors. I think it will be a useful reference for a broad audience of ecologists and environmental scientists, especially those who perhaps already use remote sensing but haven't yet added geostationary sensors to their toolbox. It certainly spurred new ideas for me.

I really only have one general comment (though see below for some more specific and technical comments): is this a review specifically of ABI, or of the new generation of geostationary sensors more broadly? The title states ABI, but there are many places throughout the article that seem much more general than the title implies, even places (especially in sections 3 and 4) that don't seem tied to geostationary sensors at all but are more general overviews of broadly applicable issues in remote sensing (e.g., descriptions of atmospheric correction, vegetation indices, and derivation of incident PAR that could use more specifics on how these would be applied to and/or benefit from geostationary observations and what the challenges would be in their derivation/use). My main suggestion would just be to tighten up this focus a bit throughout. (I have a couple of additional specific suggestions below on a few specific places where this would be helpful.)

Author response: We would like to thank Referee 2 for their comments and review of our manuscript. We are glad that our manuscript could serve as a useful reference for ecologists and environmental scientists and excited that our manuscript can add inspiration for users of remote sensing. Our review is meant to focus on the ABI as we felt that it is a largely untapped resource for environmental science in the Western Hemisphere while other geostationary imagers such as SEVIRI already offer various products for environmental science. When we refer to other geostationary imagers, our intention was to reference the existing work with geostationary imagers that could be extended and/or further developed with ABI while not excluding other imagers that can be combined to create near-global coverage. The purpose of reviewing the more general issues of atmospheric corrections and vegetation indices was to explain some fundamentals of remote sensing to offer a starting point in expanding the use of ABI. We believe each section has specific references to ABI (the current efforts in each section being carried out for ABI and/or the issues that might arise with ABI) or other geostationary sensors when an example for ABI was not found, but we will expand on some more ABI specific details.

Specific comments:

-Line 112: I might choose a different heading here. This section seems less about working with ABI data (which I had initially interpreted as being from the perspective of a typical environmental science user) than about some of the issues and uncertainties in ABI data that need to be corrected before you can even start working with it.

Author response: Thank you for this suggestion. We will change the title of the section to “Preprocessing ABI data” or similar following discussions with coauthors.

-Section 3.3.2: This section is kind of general and could be more specifically focused on LST from ABI (or others of the newer generation of geostationary sensors).

Thank you, we wrote about LST and specifically the GOES LST algorithm in section 4.4. We will move the entire discussion of retrieving land surface temperature with land emissivity estimates to section 4.4. We can keep section 3.3.2 focused on the removal of atmospheric effects on thermal band data.

-Lines 231-232: It might also be worth noting that EVI has a soil background correction factor built in that may also make it more suitable for open canopy systems (Huete et al., 2002).

Author response: Thank you for pointing this out. We will include this advantage of EVI.

-Lines 356-358: There’s a really good article from Zhang et al. (2009) on the impact of temporal resolution on vegetation phenology retrieval (as well as the impacts of missing data around vegetation transitions) that might be useful here. It might be worth expanding a bit on where and how much geostationary data could improve on the composite data (typically 8- to 16-day) that are often currently used for vegetation phenology retrieval. The authors specifically mention how it could be useful where cloudy conditions occur around seasonal transitions, but another thing to highlight might be the utility of geostationary observations in some dryland systems, where phenological transitions can occur very rapidly and unpredictably in response to rainfall pulses (Smith et al., 2019), which might be either missed by polar orbiting sensors or washed out in the composite. Monitoring phenology in these regions has definitely been a long-standing problem (e.g., the White et al. 2009 and Ganguly et al. 2010 articles that are already cited by the authors). Of course, there are other challenges aside from temporal resolution that make dryland phenology difficult to model/detect (Smith et al., 2019), but any potential improvement from geostationary observations in these regions could be worth noting.

Author response: Thank you for these suggestions, we were unaware of the Zhang and Smith references and will incorporate these ideas into the revised manuscript.

-Line 416: I think this should say “linear relationship between absorbed PAR (APAR) and _gross_ primary production,” right? The MODIS algorithm first models GPP at an 8-day frequency then estimates annual NPP as the annual integral of GPP minus the annual integral of autotrophic respiration (modeled from allometric relationships and air temperature).

Author response: In principle we agree but there are a couple of notable differences for how the algorithm works in practice. According to Monteith’s original logic, the linear relationship is specified between APAR and aboveground NPP (Medlyn, 1998). According to the MOD17 User's Guide, NPP is first simulated with the BIOME-BGC ecosystem model and epsilon which is the conversion efficiency under ideal environmental conditions is estimated between APAR and NPP (Running and Zhao, 2015).

-Lines 417-420: There are a couple (admittedly nitpicky) details of the MODIS algorithm that I think are incorrect here and should be double-checked. First, in the operational MODIS GPP/NPP product, NDVI is not the primary way that APAR is estimated (though in principle, it certainly could be). APAR is estimated from the MODIS FPAR product (MOD15), which is itself based primarily on an inversion of a radiative transfer model, with the NDVI~FPAR relationship only being used as a backup algorithm in case the full inversion fails (Knyazhikin et al. 1999; Myneni et al. 2002). Second, and this is merely a technicality, there are five (not three) biome-specific parameters in the model since Tscale and Wscale require two parameters each: a lower Tmin/VPD threshold and an upper Tmin/VPD threshold. (If you also include the allometry and Q10 parameters needed for the NPP estimates, then there are even more than five.)

Author response: Thank you for pointing out these important details. We will add that the calculation of Wscale, Tscale and respiration require additional biome-specific parameters. We will also add the updated MODIS FPAR (MOD15) input for APAR to clearly delineate the line of reasoning that leads to the MODIS carbon cycle products.

-Lines 429-432: Maybe here, or maybe elsewhere, it might be worth noting possible synergies with other satellite-based sensors. Here, for example, I'm thinking of possible synergies with soil moisture estimates from microwave sensors (e.g., SMAP or AMSR-E/AMSR-2) given the widespread importance of soil moisture for primary production and the known deficiencies in existing LUE models' ability to represent soil moisture stress (Stocker et al. 2018, 2019).

Author response: Thank you, we will add some details about using space-based soil moisture estimates in efforts to improve representation of soil moisture limitations in GPP estimates that use satellite data and refer to modeling techniques that have been able to capture the impacts of soil moisture on carbon assimilation (Anderson et al. 2000).

-Lines 434-435: This is very true, and worth noting that there is at least one relatively new LUE model that does indeed include effects of diffuse irradiance (Zhang et al., 2016).

Author response: Thank you for this reference. We will refer to it in our discussion on including the effects of diffuse radiation on GPP in models.

-Lines 439-441: Could the authors expand on this a bit?

-Section 6.2: Since recovery from disturbance is a relatively slow process (occurring mostly on the time scale of weeks to years, I imagine?), it's unclear to me what geostationary brings to the table that we're not already getting from polar-orbiting sensors like MODIS, especially given the challenges raised by the authors in lines 451-454. Could the authors expand more on why geostationary observations would be useful in this regard and how they would complement or expand on the capabilities already available from polar-orbiting sensors?

Author response: We will expand on the potentially increased availability of cloud-free imagery before and after disturbances to map immediate damage to ecosystems after a disturbance. We can also expand on the complementary use of high temporal resolution with polar-orbiting sensors to capture recovery trajectories with more detail and to capture the impact of short-term resource pulses on the trajectory of recovery from disturbance.

-Section 6.3: This is a really interesting section, and something that I hadn't really considered before. I think it could be more specifically tied to the article's focus on geostationary observations, though. Is this not something that can be done with existing polar-orbiting satellites (e.g., the morning/afternoon/nighttime overpasses of Terra/Aqua)? How specifically could you envision geostationary observations contributing to this?

Author response: Thank you for the kind words. We will expand on the ability of diurnal measurements of land surface temperature to gain insight into ecosystem thermodynamics, which often involves integrals of an observable over a given time interval (for example when calculating the thermal response number). You are correct in that Terra/Aqua can make important LST observations given their overpass times and we will expand this section to note that geostationary satellites are not unique in this regard; rather that their hypertemporal measurement capabilities open new avenues for satellite research. We would also like to point out that ABI is expected to be around for a longer time compared to Terra/Aqua and future geostationary missions like GEO-XO will be able to provide long term and consistent data.

Editorial suggestions/corrections:

-Line 113: I would suggest changing "certain" to "given" and deleting "on the Earth".

-Line 131: This should be section 3.2, not 3.1.

Author response references

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