

Interactive comment on “The 1 % and 1 cm perspective in deriving and validating AOP data products” by S. B. Hooker et al.

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General comments:

This paper presents state-of-the-art technologies employed to determine apparent optical properties (AOPs) in a wide range of optical conditions, from clear to turbid shallow waters. The southeastern Beaufort Sea, where the Malina's expedition took place, presents a wide dynamic range in terms of optical properties, making an ideal location to test the new technology. Indeed, Malina's field sampling strategy included two river transects in order to document optical and biogeochemical properties across a salinity gradient from the Mackenzie River to the blue and oligotrophic waters of the polar mixed layer. Obtaining high-quality AOPs data in waters as shallow as 2-m depth would not have been possible without the new technology presented in this study. For

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this reason, I consider this work an important contribution to the Malina project, as well as the ocean colour community concerned with AOPs measurements. That being said, the manuscript is not acceptable in its present form. It put way too much emphasis on the technology development and offers little insight about the AOPs variability found in the southeastern Beaufort Sea. The authors could likely address most issues and produced an acceptable version of the paper for the Malina special issue in Biogeosciences.

Major comments and suggestions:

1. Sections 2.2 and 3 are too long (almost 6 pages) and provide a lot of historical considerations and details about the instrument's specifications. Most of this information is not essential here. Moreover, many details can be found in a NASA Tech Memo :

Advances in Measuring the Apparent Optical Properties (AOPs) of Optically Complex Waters, NASA Tech. Memo. 2010–215856, edited by: Morrow, J. H., Hooker, S. B., Booth, C. R., Bernhard, G., Lind, R. N., and Brown, J. W., NASA Goddard Space Flight Center, Greenbelt, Maryland, 42–50, 2010b

I would, therefore, recommend removing section 3. You can keep section 2.2 Next-generation perspectives, but again remove the details. I also recommend to better explaining in the Introduction why the Malina's field sampling program was of interest to the testing of your technology (see above).

2. Methods: it would have been interesting to address (or, at least, discuss) methodological problems that are specific to High latitudes, or to low solar elevation.

For example, the authors use equations 2 and 3 to calculate E_{d0-} from E_{d0+} and L_w from L_{u0-} . The later uses a factor of 0.54, which comes from the expression $(1 - \rho_{\text{fresnel}})/n^2$, where ρ_{fresnel} is the so-called Fresnel reflectance and n the sea water refractive index (Ocean Optics Protocols, Mueller et al. 2003). For the upwelling radiance, I guess that ρ_{fresnel} does not vary significantly and 0.54 is an acceptable

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value.

For downwelling irradiance, a factor of 0.97 is used, which comes from the expression $(1 - \rho_{\text{fresnel}})$. Here, however, ρ_{fresnel} is a function of sun zenith angle (SZA). At 70°N in August, SZA is generally close to 60° at noon time. AOPs are often determined few hours before or after noon time. So SZA as high as 70 to 75° can be encountered as it was the case during Malina. According to Haltrin et al. (2000, IGARSS proceeding), ρ_{fresnel} is equal to 0.0624, 0.13 and 0.22 for SZA of 60°, 70° and 75° respectively. Note that this is for the direct component of the irradiance, so one should not take these ρ_{values} directly. But ρ_{fresnel} for the global irradiance can probably be as high as 0.1 in clear sky conditions. Anyways, because E_{d0} is used to get z_1 and z_2 (p. 9495), my question is: how much error can be introduced in the L_{u0} extrapolation if errors in E_{d0} are significantly > 1%? In the 1% perspective of AOP measurements, I would like to know if this issue is minor or not. You can probably make another sensitivity analysis for a clear sky condition with low sun elevation (if you have any of such conditions!)

3. I would request at least two additional figures for the benefit of the Malina project: A) A map of station depicting the station location, which would be shown using the same symbols as in Fig. 5. This figure can then be used to present the spatial variability of the optical classes encountered during the cruise. The patterns could then be presented in Section 5. attenuation classification. I would like to know where exactly were the different optical water masses. B) You should present a figure with the R_{rs} spectra measured during the cruise, on which you would highlight the chosen spectra used for Section 4. In fact, one would probably like to know how looks like a “blue water” spectrum in the Arctic Ocean! From my experience, I guess that the R_{rs} spectra will show a depression in the UV because of a relatively high CDOM background, even in the blue waters of the Beaufort Sea. This is not what you would expect in other “blue waters elsewhere”.

Minor comments and other suggestions: Please see the annotated PDF.

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