Comments to "**A semi-analytical model for diffuse reflectance in marine and inland waters**" by Pravin et al., manuscript ID # **os-2015-43**

This paper proposed an approach to estimate spectral irradiance reflectance R, which is the continued work based on Dev (or Pravin?) and Shanmugam (2014b). The model requires inputs of inherent optical properties (IOPs) such as a and b_b, chlorophyll-a concentrations (Chl), and apparent optical properties such as Kd and Ku. The ultimate output is R. The major improvement lies on the formatting of the "proportionality factor" f. Under such improvement it was claimed that the newly proposed approach is further improved and is applicable to various types of water types, which is supported by the comparison between the modeled and in situ measured R at several key wavelengths.

However, the scientific value of this work is in doubt, and many aspects of this paper is not scientifically rigorous as well. Please see the detailed list (i) – (v).
(i) Scientific value: Accurate derivation of R from certain inputs are valuable for the purpose of validating and calibrating in situ instruments and satellite sensors and providing an alternative to fill the gap of missing data, etc. The key to such model is to use very limited inputs. However, the proposed approach uses a, b_b, Chl, Kd, and Ku. It means majority of field quantities are required. In particular, to compute Kd and Ku, the profiles of downwelling and upwelling irradiances, Ed and Eu, are needed. As a result, this model becomes redundant because you can easily derive R from Ed and Eu by taking ratios as R=Eu/Ed. The only possible value is to estimate R just beneath surface $R(0^-,\lambda)$ instead of the profiles of $R(\lambda,z)$ [see (ii)]. I would like the authors to answer: why is this model important and valuable?

(ii) Possible but questionable value: As discussed in (i), the remaining value of this model is to estimate $R(0^-,\lambda)$. To estimate $R(0^-,\lambda)$, the required in-water quantities are a, b_b, and Chl. At some cases it is true that you have these three quantities but not $R(0^-,\lambda)$. As a result, this may provide alternative means to derive $R(0^-,\lambda)$ for the purpose of validation of other devices. However, two problems remain. First of all, such model does not account for inelastic processes, which will cause dramatic errors in the red and near-infrared. In addition, it would be easier to make near-surface underwater Ed and Eu measurements and extrapolate to get $R(0^-,\lambda)$ than measuring all a, b_b, and Chl. Therefore, the value of this model exists but limited.

(iii) Scientific rigor: It is understandable and physically verified that the factor f is influenced by both solar zenith angle and underwater IOPs, so it can be proportioned to S_f and I_f. In fact, the scatter plots in Figure 2 evidently support this. However, how did the authors to know the values of S_f and I_f (and n) at the first place? There is no way that the values of S_f, I_f, and n can be known without priori knowledge. It may be not entire correct, but it is guessed that the authors presume a certain relationships (e.g. format of equations) between S_f and θ_s, between I_f and $a(400)$ (why choose $a(400)$ is also a question to answer), and between n and Chl. Then extensive regressions were made to determine the exact equations as shown in Eq. 4-6. If this is true, the relationships in Figure 2 and Eq. 4-6 do not represent the true representation of factor *f*, but only to the dataset the authors have. In addition, if the extensive regressions truly exist, is it still suitable to claim this model as semi-analytical model? Is it still suitable to conclude that this model works universally for different water bodies?

(iv) Mathematical and physical issue: In Eq. 7-8, the authors describe how to derive R(λ,z) from R(0^-,λ). They claimed that *f*(z) is a function of Kd and Ku. Eq. 7-8 are mathematically valid but not physically. The correct physics is:

$$R(\lambda,z)=\frac{Eu(\lambda,z)}{Ed(\lambda,z)}=\frac{Eu((0^-,\lambda)e^{-Ku(\lambda,z)}}{Ed((0^-,\lambda)e^{-Kd(\lambda,z)}}=R(0^-,\lambda)e^{-[Ku(\lambda,z)-Kd(\lambda,z)]}$$

with $R(0^-,\lambda)=f(0^-,\lambda)\left(\frac{b_b(0^-,\lambda)}{a(0^-,\lambda)+b_b(0^-,\lambda)}\right)$. As a result, the description within P1889 L18-P1990 L12 are mostly incorrect. In particular, the R (as well as Kd and Ku) are not necessarily constant even in homogeneous water column.

(v) Missing comparison with other models: It is not convincing that the newly proposed model is better than existing ones unless the model is compared to them, at least with model by Dev and Shanmugam (2014b).

Additional comments:

1. Title: What is the definition of diffuse reflectance? Many claims about R may not be correct depending on the exact definition. Is there any component in this paper related to inland waters?

2. Abstract: it mentioned that this newly proposed work eliminate Kchl and Kss, which were used in Dev and Shanmugam (2014b). It thereafter never appeared in the main text of the paper. However, I think this should be an important component in the introduction and discussion sections. Or else how can your motivation and scientific basis be clear?

3. Page 1895 L11-13: more context is needed to introduce the factor *f*.

4. In all equations: please specify the dependence on z and λ by a, b_b, Kd, and Ku.

5. Page 1900 L21-L24: Place in the captions of Figure 3.

6. Page 1901 L2 (and other places): In general, it does not say "higher" wavelengths. Instead "longer" or "greater" may be used.

7. Page 1903 L22-24: What is your basis to claim this model would work for homogeneous water? Does "inhomogeneous" include "stratified"? What are the real value of this model? [please see (i) and (ii)].

8. Table 1: For what stations? Could you please include information such as a, b_b, Chl, TSM as well?

9. Figure 4a: R is missing between surface and ~20 cm. What is the causes of the missing R? Are a, b_b, and Chl available between surface and 20 cm? If not, how did you derive $f(0^-,\lambda)$ and $R(0^-,\lambda)$? As explained in (iv), the $R(\lambda,z)$ solely depends on $R(0^-,\lambda)$ when Kd and Ku are in situ determined. It is critical to know how could you derive $R(\lambda,z)$ from $R(0^-,\lambda)$ when there are missing data below surface. I assume Ku and Kd within 0 – 20 cm layer is not available as well. What are the additional assumptions did you make to predict $R(\lambda,z)$ under such case? In fact, this is very critical because data are often missing within top 50 cm or so. If you make additional assumptions, please include them in the paper and discuss its potential influence on the model.

10. Figure 5: Are R from all depths included?