

Supplementary Materials: Compensation of Oxygen Transmittance Effects for Proximal Sensing Retrieval of Canopy–Leaving Sun–Induced Chlorophyll Fluorescence

Neus Sabater ^{1*} , Jorge Vicent ¹ , Luis Alonso ¹, Jochem Verrelst ¹, Elizabeth M. Middleton ², Albert Porcar–Castell ³, and José Moreno ¹

- 1 1. Impact of oxygen transmittance compensation on high Spectral Resolution (SR) data evaluated
- 2 at the O₂-B region
- 3 Figure S1 shows the impact on estimated Solar–Induced chlorophyll Fluorescence (SIF) when
- 4 compensating for oxygen transmittance effects considering the set–up configurations (1–4) detailed in
- 5 Figure 5 (main manuscript) and evaluated at the O₂-B absorption region.

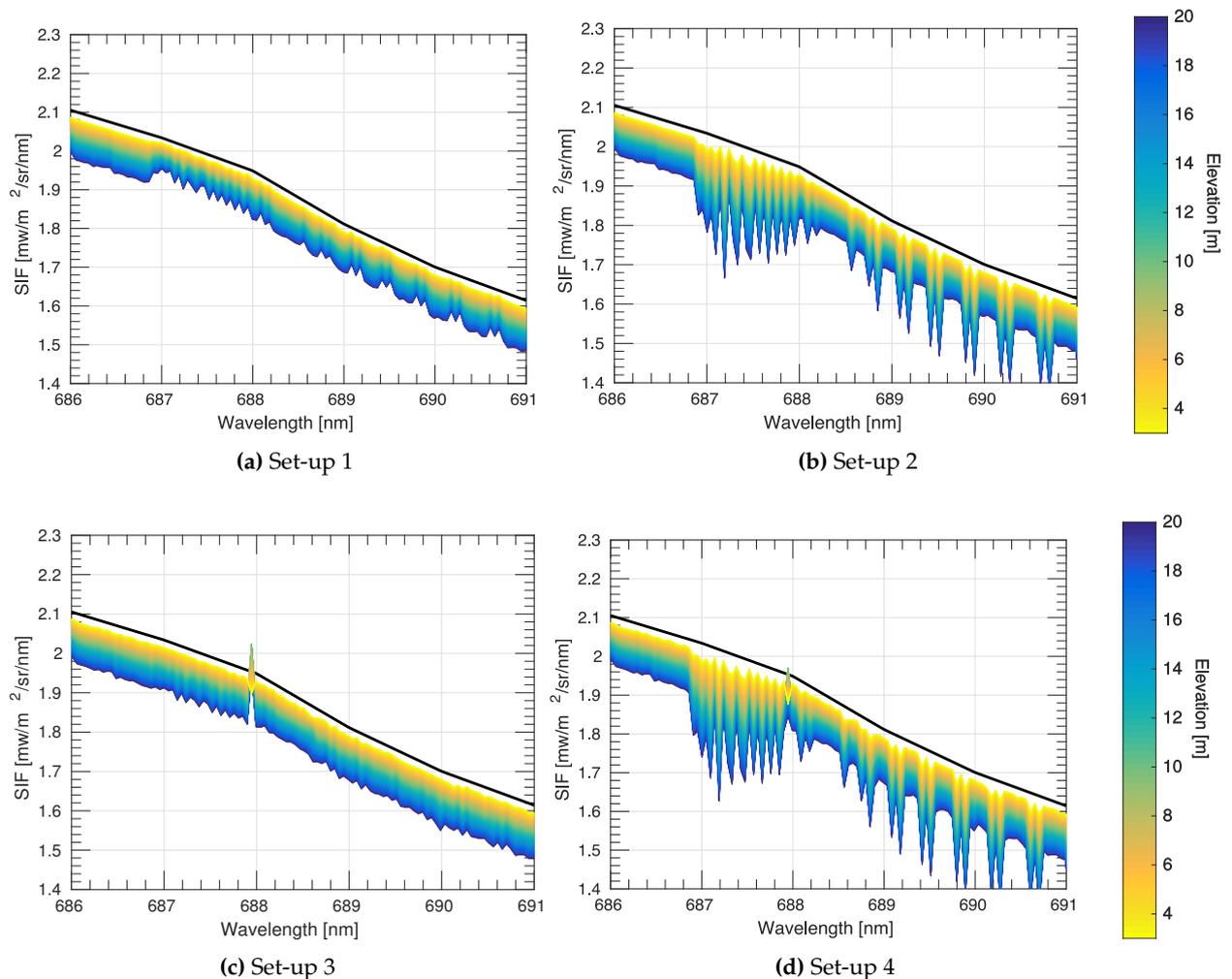


Figure S1. Retrieved SIF under conditions detailed in set–up configurations (1–4) for the O₂-B spectral range. Figure (a) Upward oxygen transmittance corrected ($t_{O_2}^\uparrow$) and solar irradiance measured at surface level (\bar{E}). (b) No upward O₂ transmittance corrected and solar irradiance measured at surface level (\bar{E}). (c) Upward oxygen transmittance corrected ($t_{O_2}^\uparrow$) and solar irradiance measured at sensor level (E). (d) No upward O₂ transmittance corrected and solar irradiance measured at sensor level (E).

6 **2. Total and oxygen transmittance effects on estimated SIF in the range of 650-800 nm**

7 In this Section, upward transmittance effects from canopy to sensor level are evaluated in a wider
 8 spectral range 650-800 nm. On the one hand, spectral difference between total and oxygen upward
 9 transmittance is shown in Figure S2(a) for a range of sensor heights, highlighting spectral regions
 10 affected by aerosol, water vapour and molecular oxygen. On the other hand, estimated SIF from
 11 set-up configuration 1 detailed in Figure 5 of the main manuscript is presented in Figure S2(b)
 12 covering the spectral range of 650-800 nm.

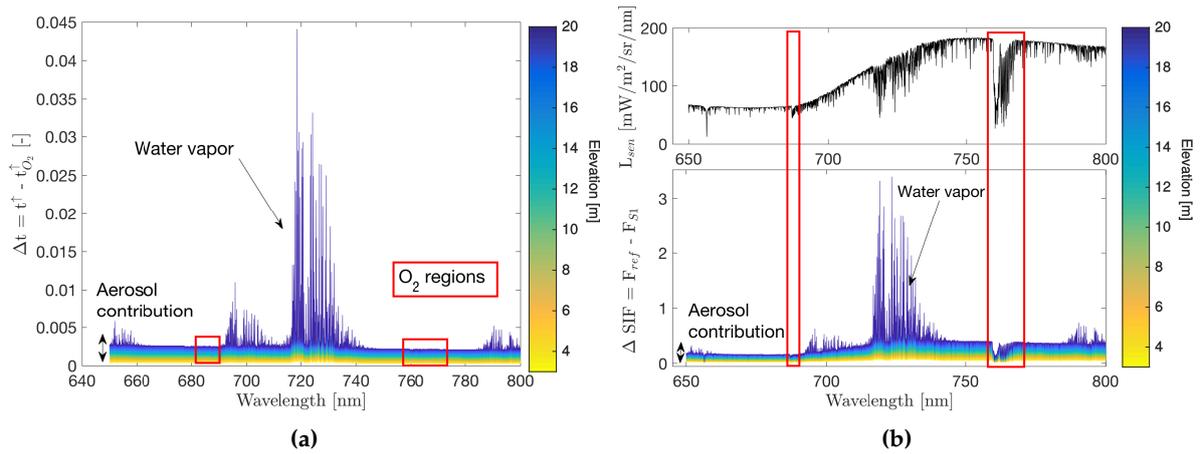


Figure S2. (a) Difference between total upward transmittance (t^{\uparrow}) and oxygen upward transmittance ($t^{\uparrow}_{O_2}$) computed for a range of target-sensor distances from 3 to 20 m. (b) Upper panel: radiance at sensor level L_{sen} (10 m from the canopy). Bottom panel: difference between reference SIF $_{ref}$ and estimated SIF for the set-up 1 configuration, SIF $_{S1}$ covering the O $_2$ -B and the O $_2$ -A regions.

13 **3. Coupling Oxygen Transmittance with the Spectral Fitting Method: Aerosol compensation**

14 This section shows, on the one hand, estimated SIF and surface reflectance when compensating for the
 15 **total atmospheric effects** in Figures S3 and S4 respectively. On the other hand, estimated surface
 16 reflectance when compensating for the oxygen absorption is shown in Figure S5.

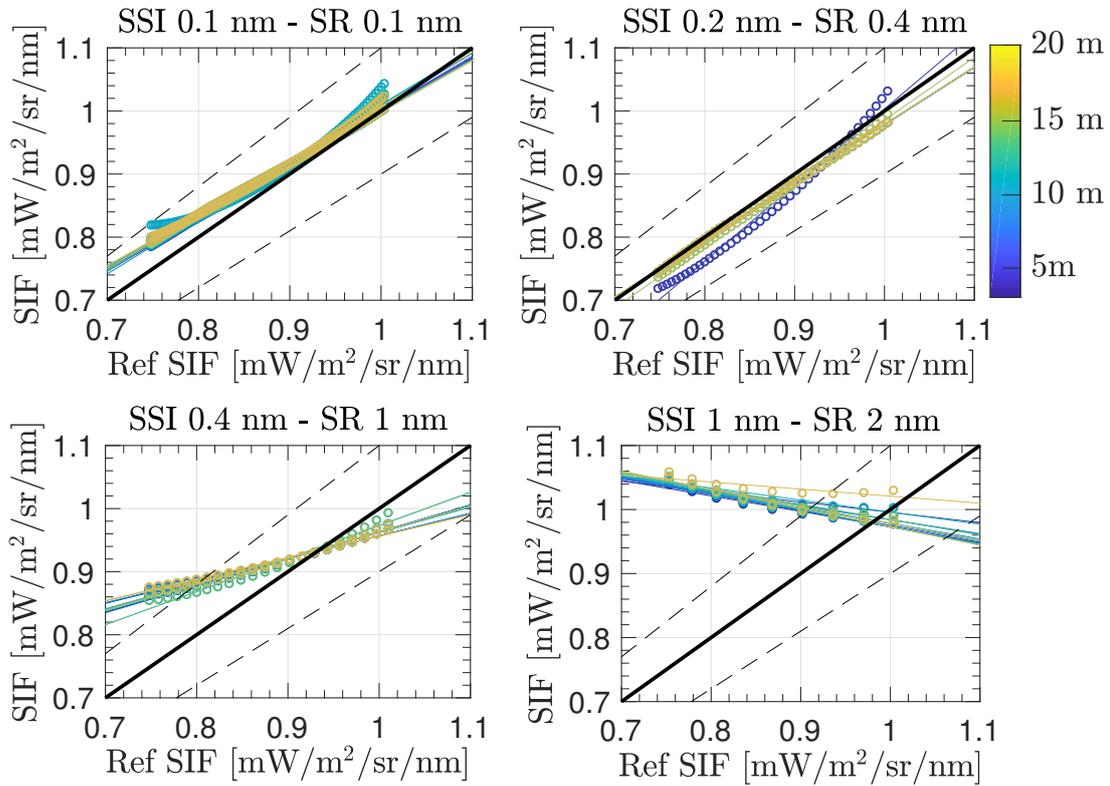


Figure S3. Scatter plots showing reference SIF versus estimated SIF in the interval between 759.0-767.5 nm, using the proposed SFM retrieval approach to compensate for **total atmospheric effects** while also accounting for the instrument spectral convolution effects for different instrument resolution and above TOC sensor heights from 3 m to 20 m (color scale). Coloured solid lines are regression lines for the range of sensor heights evaluated while actual estimations are marked as circles. Black solid and dashed lines represent the 1:1 line and the area with a SIF relative error lower than 10%.

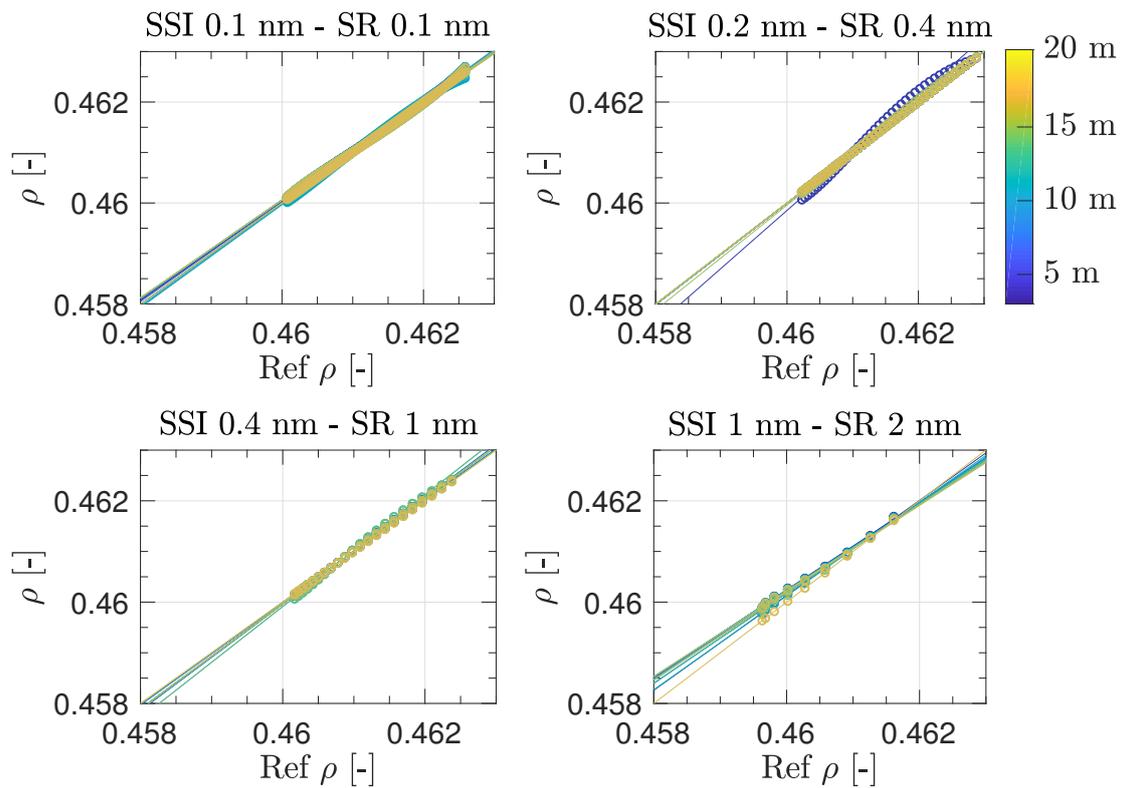


Figure S4. Scatter plots showing reference surface reflectance ($\text{Ref } \rho$) versus estimated surface reflectance (ρ) in the interval between 759.0-767.5 nm, using the proposed SFM to compensate for **total atmospheric effects** while also accounting for the instrument spectral convolution effects for different instrument resolution and above TOC sensor heights from 3 m. to 20 m. (color scale). Coloured solid lines are regression lines for the range of sensor heights evaluated while actual estimations are marked as circles.

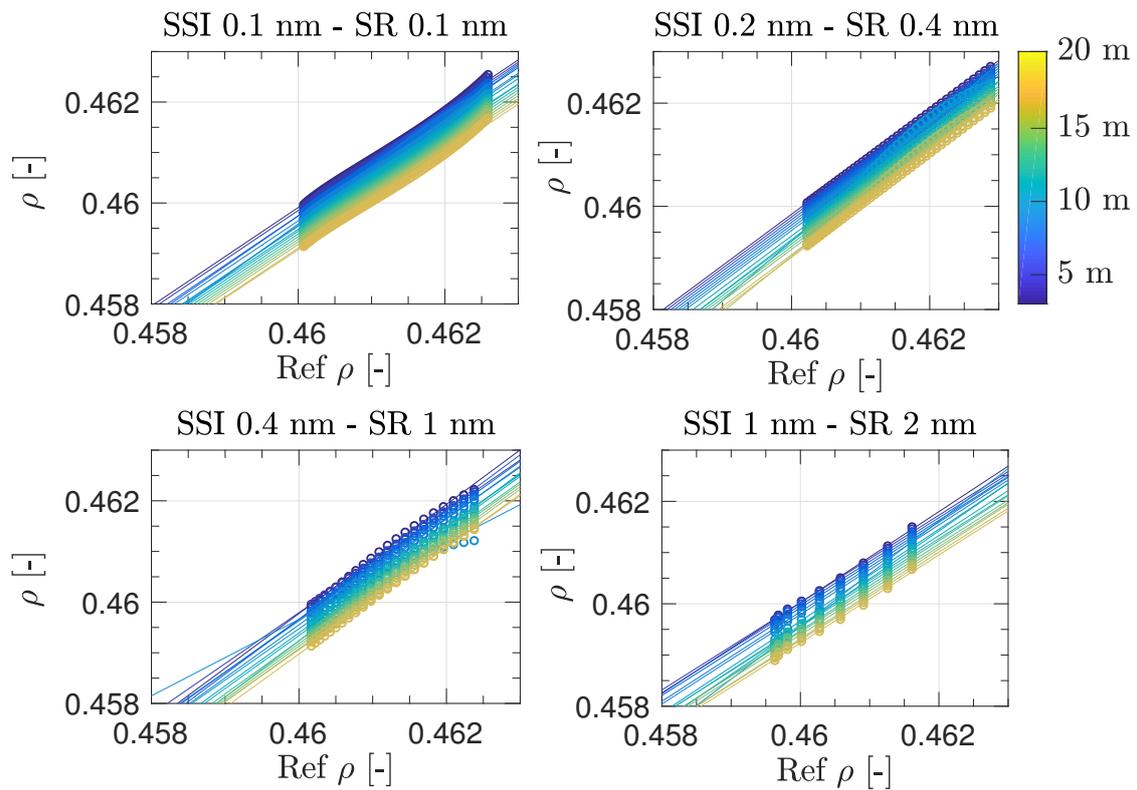


Figure S5. Scatter plots showing reference surface reflectance ($\text{Ref } \rho$) versus estimated surface reflectance (ρ) in the interval between 759.0-767.5 nm, using the proposed SFM to compensate for **oxygen absorption effects** while also accounting for the instrument spectral convolution effects for different instrument resolution and above TOC sensor heights from 3 m to 20 m (color scale). Coloured solid lines are regression lines for the range of sensor heights evaluated while actual estimations are marked as circles.