# Correcting temporally upscaled SIF for better representations in complex terrain and regions with frequent cloud covers

Cheng et al. (2022) Impact of radiation variations on temporal upscaling of instantaneous solar-induced chlorophyll fluorescence. *Agricultural and Forest Meteorology*, 327, 109197. https://doi.org/10.1016/j.agrformet.2022.109197

## Science Question

- Satellites measure **Instantaneous** Solar-Induced Chlorophyll Fluorescence (SIF).
- For **daily averages**, when is the simple Solar Zenith Angle (SZA) approach a good approximation?
  - flat surface vs. complex terrain
  - weather
- At **longer time-scale**, how large is a sampling (clear sky) bias? When? Where?

## Analysis

- **PAR:** ERA5 reanalysis hourly surface radiation fields (direct and diffuse) with and without clouds
- **Solar angles:** PyEphem astronomy tool
- **Surface angles:** NASA SRTM v3 & RichDEM
- **SIF:** TROPOMI
- **Surface reflectance:** LandSat Collection 2 Level 2

$$\mathrm{PAR}_{\mathrm{direct}} \propto cos(\mathrm{SZA})$$

$$\mathrm{PAR}_{\mathrm{direct,DEM,t}} = \mathrm{PAR}_{\mathrm{direct,t}} \frac{\cos(\mathrm{SIA})}{\cos(\mathrm{SZA})} \mathcal{H}(\cos(\mathrm{SIA}_{t_m}))$$

## Results/Significance

- On flat surfaces, the SZA approach is a good approximation because biases from direct and diffuse light cancel out in total, with a residual around 10%.
- In complex terrain topographic correction is required, as errors can exceed 100%, especially for satellites with fine spatial resolutions.
- A clear sky bias due to cloud filtering can cause seasonal SIF biases of up to 25%.

## Acknowledgements

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San Gabriel Mountains, CA, USA
1:29 pm LST on July 3, 2020

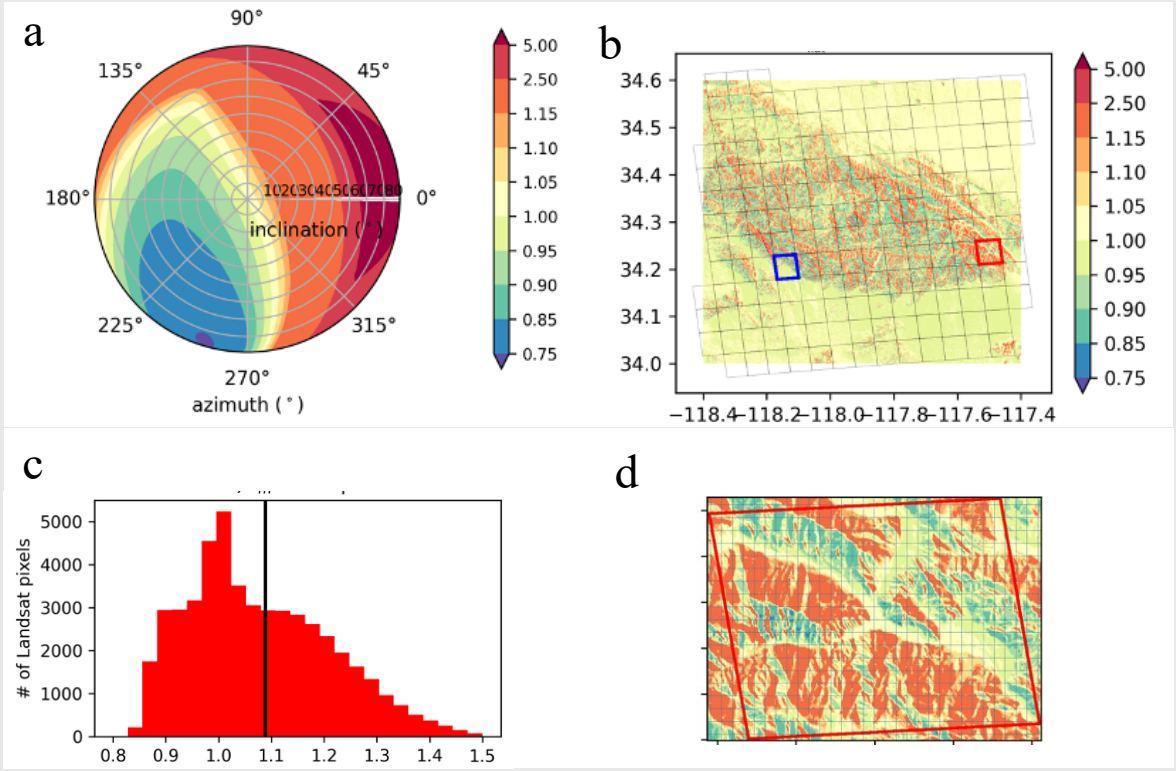


Figure. Change in daily average SIF (ratio) due to topography at aTROPOMI overpass time: a) in theory, b) in reality with TROPOMI footprints (5 km x 3.5 km at nadir), and d) in reality with FLEX footprints (300 m x 300 m). In one TROPOMI footprint (red rectangle in plots b and d), the change in daily average SIF (ratio) at 30-m resolution is shown in histogram (plot c), where the black bar indicates the mean change in this footprint.