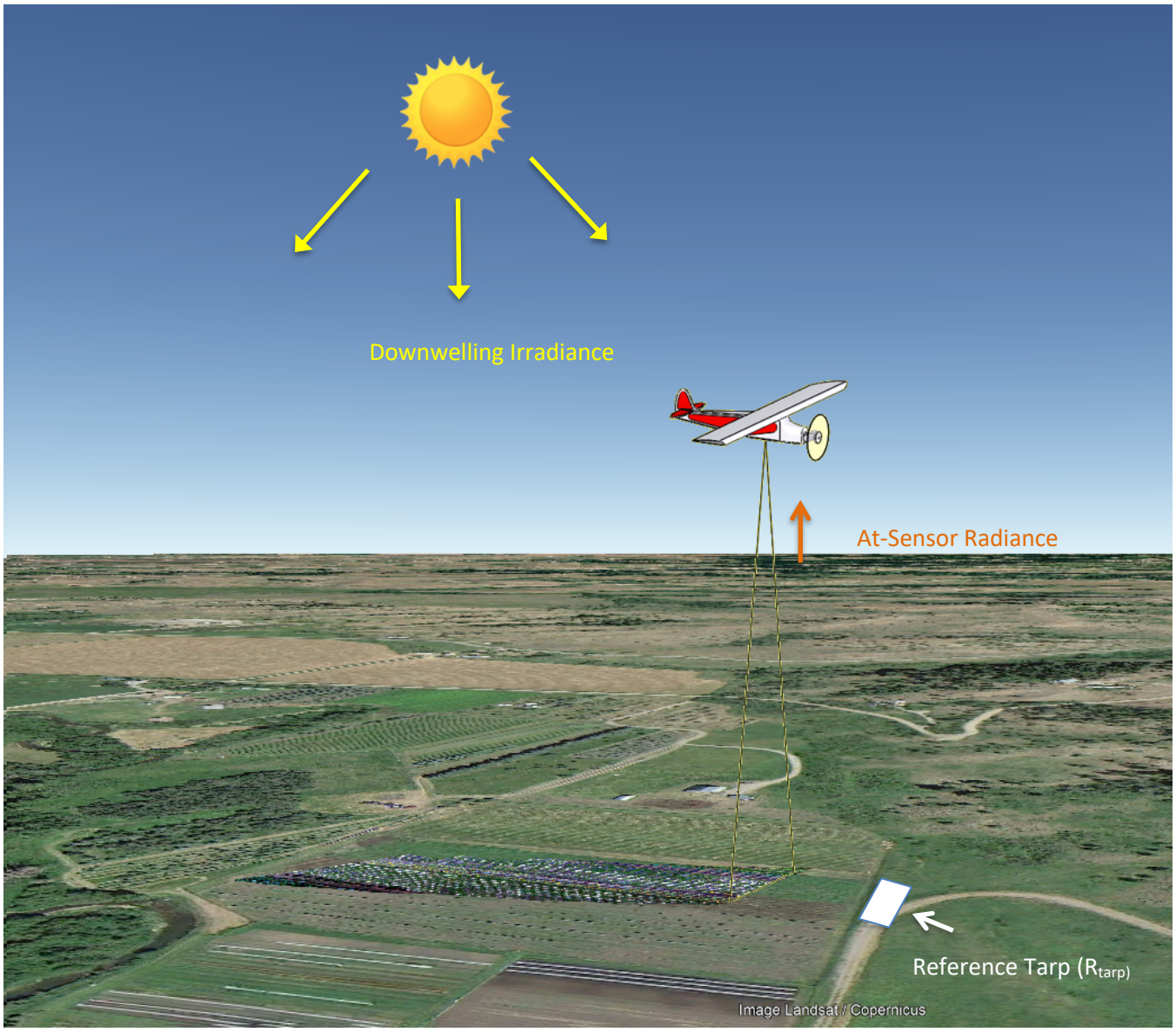
Remote Sensing Radiometry Basics



Downwelling Irradiance (more precisely *downwelling spectral irradiance*) is a measurement of the solar illumination incident on the ground, measured with a single-point spectrometer and cosine corrector, also known as a *downwelling irradiance sensor*. The raw data collected by this sensor needs to be converted to calibrated irradiance units by using the *Downwelling Calibration Pack* file (*.dcp). This is done automatically in the *Reflectance from Raw Data and Downwelling Irradiance Data* plugin. Resonon uses the units of $\mu W \cdot cm^{-2} \cdot \mu m^{-1}$ for spectral irradiance.

At-Sensor Radiance (often called *radiance* in the context of a hyperspectral imager) is the quantity most often measured in remote sensing applications. It is commonly thought of as the quantity of light the instrument collects. In the above image, it is noted as the *at-sensor radiance* for this reason. Radiance data is a function of both the illumination and the reflectivity of the imaged object, as well as atmospheric effects. Radiance most often has units of $(W \cdot sr^{-1} \cdot m^{-2} \mu m^{-1})$, but the Resonon convention (and many others as well) is to use microFlicks $(\mu W \cdot sr^{-1} \cdot cm^{-2} \cdot \mu m^{-1})$. Raw data from Resonon spectral imagers can be converted to calibrated radiance units with the *Radiance from Raw Data* plugin in Spectronon.

Reflectivity is the ratio of the amount of light leaving a target to the amount of light incident to the target. It is a unit-less quantity. Reflectance is a property of the material, independent of the illumination or instrumentation. If Downwelling Irradiance and At-Sensor Radiance are known, the reflectivity of an object (assuming the object is Lambertian) can be computed by: $R = \pi * L / E$, where L is the At-Sensor Radiance and E is the downwelling irradiance. This calculation is performed in Spectronon with the *Reflectance from Raw Data and Downwelling Irradiance Spectrum* (along with all of the necessary corrections for differences in shutter and gain).

Reflectivity can also be computed with a ground target of known spectral reflectance. After converting the airborne datacube to Radiance using the Radiance from Raw Data plugin, a mean spectrum of an ROI of the ground reference target can be made. This signal is the at-sensor radiance of the tarp, L_{Tarp}, and can be represented as a function of the reflectivity of the tarp and the downwelling irradiance: $L_{Tarp} = R_{Tarp} * E / \pi$. Thus, the radiance of the tarp along with the measured reflectance of the tarp can be used to solve for the downwelling irradiance. The Spectronon plugin *Reflectance from Radiance Data and Measured Reference Spectrum* can be used to convert a datacube to units of reflectivity in this manner.

In some applications, raw data, radiance and reflectance may be of comparable utility in obtaining results from hyperspectral data. However, since reflectance is a fundamental property of the object itself, it is often preferred.