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| **ICESat2VegR: An R Package for NASA's Ice, Cloud, and Elevation Satellite (ICESat-2) Data Analysis for Land and Vegetation Applications.** |
| **Introduction/Aim:** The ICESat-2 mission, launched on September 15th, 2018, was primarily designed to precisely measure the Earth’s elevation of ice sheets, glaciers and sea ice. Since data became available in May 2019, the mission science team also made available geophysical data products, such as ATL08 highlighting its suitability for characterizing surface heights within vegetated land surfaces and calculating relevant vegetation metrics. The ICESat-2 instrument is sensitive enough to detect each photon, generating a photon cloud that demands the use of distinct processing tools and methods. Moreover, the data is distributed in HDF5 format using a specific hierarchical and relational schema, posing potential challenges in handling and analysis. In R programming language, there are currently no packages covering the most common land and vegetation analysis tasks for ICESat-2. Herein, we introduce a new R package to address this issue, providing functions for locating, downloading, visualizing, and processing land and vegetation data, while integrating both ATL03 and ATL08 ICESat-2 products**Methods:** The ICESat2VegR package is currently under development, aiming to provide an open-source tool for managing ICESat-2 data in land and vegetation applications. The package is accessible at <https://github.com/carlos-alberto-silva/ICESat2Veg>R. It is designed to maintain a consistent naming pattern for its functions, starting with the product it is intended to work on, followed by the unit of analysis level and the operation it performs. All data read from ICESat-2 will utilize S3 and S4 classes for dispatching generic methods to the internal classes. This design ensures that functions like "clip" can be used for both ATL03 and ATL08 products, adapting to clip the data to the provided extents or geometry. The provided functions are tailored to enable users to develop their workflow entirely in R. They facilitate tasks such as locating, downloading, visualizing data, clipping, processing, and transforming data into widely known formats such as regular R data frames, data.table, GDAL raster and vector formats, or LAS point cloud format.**Results:** We have developed more than 40 functions that allow users to download, read, process, and analyze ICESat-2 ATL03 and ATL08 data. ICESat2VegR is also integrated with Google Earth Engine (GEE), enabling users to upscale ICESat-2 vegetation attributes using other sources of remote sensing data (e.g., Landsat 8 OLI, Sentinel 2A). The data processing workflow using ICESat2VegR can be summarized as follows: i) Find the data pairs for ATL03 and ATL08; ii) Download the data or access cloud-hosted data; iii) ATL03: Extract the photon attributes to the data.table data format; iv) ATL08: Extract land segment attributes to the data.table data format; v) ATL03/ATL08: Join both products to extract classified photons to the data.table data format; vi) Compute vegetation metrics within user-defined segment lengths; vii) Connect extracted ICESat-2 metrics with GEE for vegetation structure upscaling and wall-to-wall mapping. **Conclusion:** In this paper, we introduce and demonstrate the application of ICESat2VegR, a package designed for manipulating ICESat-2 data with a focus on land and vegetation applications. Being an open-source project, we actively encourage community participation, emphasizing that the package will undergo continuous development and is anticipated to incorporate additional features. |