Supplementary Material

**Table S1.** The key mission parameters of ICESat-2/ATLAS and GEDI.

|  |  |  |
| --- | --- | --- |
| Parameters | ICESat-2 | GEDI |
| Launch date | 2018.09 | 2018.12 |
| Detector type | Photon counting | Full waveform |
| Wavelength | 532 nm (green) | 1064 nm (near IR) |
| Nominal altitude | 500 km | 405 km |
| Ground tracks | 6 | 8 |
| Geographic coverage | 88◦N ~ 88◦S | 51.6◦N ~ 51.6◦ S |
| Footprint size | 17 m | 25 m |
| Along-track | 0.7 m | 60 m |
| Across-track distance | 3.3 km | 0.6 km |
| Laser power  Track number | 120 μJ/30 μJ  6 tracks from 1 laser | 15 mJ/4.5 mJ  8 tracks from 3 lasers |

**TABLE S2.** ATL08 and ATL03 Data Product Extraction Parameter List

| Data Production | Parameter | Brief Description | Parameter Storage Location |
| --- | --- | --- | --- |
| ATL03 | lat\_ph | The latitude of each photon point | ATL03/gtx/heights/lat\_ph |
| ATL03 | lon\_ph | The longitude of each photon point | ATL03/gtx/heights/lon\_ph |
| ATL03 | h\_ph | The elevation of each photon point | ATL03/gtx/heights/h\_ph |
| ATL03 | delta\_time | The time at which each photon is recorded | ATL03/gtx/geolocation/ delta\_time |
| ATL03 | geoid | Elevation above the geoid (sea level) | ATL03/gtx/geophys\_corr/  geoid |
| ATL03 | segment\_id | The segment number corresponding to each photon | ATL03/gtx/geolocation/  segment\_id |
| ATL03 | segment\_length | The length along the track corresponding to each segment | ATL03/gtx/geolocation  /segment\_length |
| ATL03 | ph\_index\_beg | The photon number corresponding to the first photon in each 20 m segment | ATL03/gtx/geolocation/  ph\_index\_beg |
| ATL03 | dist\_ph\_along | The photon number corresponding to the first photon in each 20 m segment | ATL03/gtx/heights/  dist\_ph\_along |
| ATL08 | latitude | The central photon latitude is segmented every 100 m | ATL08/gtx/land\_segments/  latitude |
| ATL08 | longitude | The central photon longitude is segmented every 100 m | ATL08/gtx/land\_segments  /longitude |
| ATL08 | h\_te\_mean | Average terrain height per 100 m. | ATL08/gtx/land\_segments/  terrain/h\_te\_mean |
| ATL08 | h\_canopy | 98 % relative altitude | ATL08/gtx/land\_segments/  canopy/h\_canopy |
| ATL08 | ph\_segment\_id | The index between ATL08 classified photons and each segmented photon point of ATL03 | ATL08/gtx/signal\_photons  /ph\_segment\_id |
| ATL08 | classed\_pc\_flag | Photon classification identification. 0 denotes noise, 1 denotes ground, 2 denotes canopy photon point, 3 denotes canopy top photon point. | ATL08/gtx/signal\_photons/  classed\_pc\_flag |

**TABLE S3.** GEDI L2A data product extraction parameter list

| Parameter | Brief Description | Parameter Storage Location |
| --- | --- | --- |
| lat\_lowestmode | Spot center latitude | /BEAMXXXX//lat\_lowestmode |
| lon\_lowestmode | Spot center longitude | /BEAMXXXX/lon\_lowestmode |
| beam | beam | /BEAMXXXX/beam |
| quality\_flag | quality designation | /BEAMXXXX/quality\_flag |
| rx\_assess\_flag | Indicate various error conditions of waveform | /BEAMXXXX/rx\_assess/rx\_assess\_flag |
| degrade\_flag | State drop sign | /BEAMXXXX/degrade\_flag |
| sensitivity | signal noise ratio | /BEAMXXXX/sensitivity |
| shot\_number | Spot identification code | /BEAMXXXX/shot\_number |
| elev\_lowestmode | surface elevation | /BEAMXXXX/elev\_lowestmode |
| elev\_highestreturn | canopy height | /BEAMXXXX/elev\_highestreturn |
| rh（80,85,90,95,98,100） | Percentile height | /BEAMXXXX/rh |