**Table SI:**

**A list of open-source codes provided by this work** **for developing the Rangeland Carbon Tracking and Monitoring (RCTM) system. Each step is numbered to indicate the corresponding deposited codes.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function** **a** | **Step** | **Platform b** | **Description** | **Optional** |
| Extract land cover information for flux tower sites | 1 | GEE | Extract land cover information for all relevant Ameriflux and NEON sites in order to identify sites dominated by grasslands or rangelands | N |
| Download and convert flux tower data to a daily time step | 2a | R | An example for processing a typical Ameriflux site data and then visualize results | N |
| 2b | R | Examples for processing Ameriflux site data originally provided in Matlab or netCDF formats | Y |
| 3 | R | Batch downloading NEON datasets | N |
| 4 | R | Batch processing NEON datasets | N |
| 5 | R | Example for converting NEON data to daily time step and visualize results | N |
| Quality control of flux tower datasets | 6 | R | An example for conducting quality control for GPP measurements | N |
| 7 | R | An example for conducting quality control for NEE measurements | N |
| Extract environmental covariates for flux tower sites | 8a | GEE | Extract environmental covariates for GPP model | N |
| 8b | GEE | An example for extracting environmental covariates for GPP model using alternative climate inputs due to incomplete temporal data coverage | Y |
| 9a | GEE | Extract environmental covariates for the NEE model | N |
| 9b | GEE | An example for extracting environmental covariates for NEE model using alternative climate inputs due to incomplete temporal data coverage | Y |
| 10 | GEE | Extract environmental covariates model spin up | N |
| Combine datasets for vegetation type-based model calibration and validation | 11 | Colab | Combine quality-controlled flux tower measurements-derived GPP and covariates for all sites | N |
| 12 | Colab | Combine quality-controlled flux tower measurements of NEE and covariates for all sites | N |
| 13 | Colab | Combine covariate datasets for model spin up | N |
| 14 | R | Combine remote sensing inputs with environmental covariates and measured data | Y |
| Conduct GPP model calibration and validation | 15 | R | Fit GPP model with observations | N |
| 16 | R | Model calibration and validation for each individual site | **N** |
| 17 | R | Model calibration and validation using cross validation | **N** |
| 18 | R | Calculate error metrics associated with cumulative GPP | **N** |
| Conduct NEE model calibration and validation | 19 | R | Initialize carbon pools to reduce computation time | **Y** |
| 20 | R | Fit NEE model with observations | N |
| 21 | R | Model calibration and validation for each individual site | **N** |
| 22 | R | Model calibration and validation using cross validation | **N** |
| 23 | R | Calculate error metrics associated with cumulative NEE | **N** |
| SOC model validation | 24 | R | Validate model performance for estimating SOC stocks | **N** |

a STARFM: Spatial and Temporal Adaptive Reflectance Fusion Model; GPP: Gross primary Productivity; NEE: net ecosystem exchange of CO2; SOC: soil organic carbon.

b GEE: Google Earth Engine; Colab: Google Colaboratory.