

## data\_monthly\_v1\_0\_EDA

### Load Libraries

```
# Load libraries
library(tidyverse)
library(Hmisc)
library(gridExtra)
library(finalfit)
library(stargazer)
## To load All data sets in the book "Forecasting: principles and practice."
#by Rob J Hyndman and George Athanasopoulos
library(fpp3)
# To create and work with tidy temporal data
library(tsibble)
# To work with date-times and time-spans
library(lubridate)
# Provides a collection of commonly used univariate and multivariate time series models
library(fable )
## To interact directly with the Quandl API and download data
library(Quandl)
# For analyzing tidy time series data.
library(feasts)
# Provides methods and tools for displaying and analyzing univariate time series forecasts library(fore
# For estimation, lag selection, diagnostic testing, forecasting, and impulse response functions of VAR
#provides tools for statistical calculations
library(stats)
# To assist the quantitative trader in the development,
#testing and deployment of statistically based trading models.
library(quantmod)
# For statistical analysis
library(car)
## To retrieve and display the information returned online by Google Trends
library(gtrendsR)
# To do time series analysis and computational finance.
library(tseries)
```

### Import data from csv file

Rows: 19015 Columns: 62

```
# EDA/src/
raw_df <- read_csv("../../data/datasets/data_monthly_v1_0.csv")
glimpse(raw_df)
```

```

## Rows: 19,015
## Columns: 62
## $ SITE_ID      <chr> "AR-SLu", "AR-SLu", "AR-SLu", "AR-SLu", "AR-SLu", "A~
## $ year         <dbl> 2010, 2010, 2010, 2010, 2010, 2010, 2010, 2010, 2010~
## $ month        <dbl> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 1, 2, 3, 3, 4~
## $ TIMESTAMP    <dbl> 201001, 201002, 201003, 201004, 201005, 201006, 2010~
## $ dataset      <chr> "FLUXNET", "FLUXNET", "FLUXNET", "FLUXNET", "FLUXNET~
## $ SITE_IGBP    <chr> "MF", "MF", "MF", "MF", "MF", "MF", "MF", "MF", "MF"~
## $ LOCATION_LAT <dbl> -33.4648, -33.4648, -33.4648, -33.4648, -33.4648, -3~
## $ LOCATION_LONG <dbl> -66.4598, -66.4598, -66.4598, -66.4598, -66.4598, -6~
## $ TA_F         <dbl> 28.493, 26.673, 25.744, 18.450, 13.493, 11.273, 8.13~
## $ VPD_F        <dbl> 23.378, 14.369, 15.167, 9.185, 5.823, 5.219, 4.949, ~
## $ P_F         <dbl> 0.903, 1.986, 0.371, 0.100, 1.852, 0.030, 0.003, 0.1~
## $ NETRAD       <dbl> 188.59881, 144.21620, 125.64314, 71.50069, 41.24915,~
## $ NEE_VUT_REF  <dbl> -5.6327800, -4.4743300, -3.8928800, -3.1115900, -1.7~
## $ NEE_VUT_REF_QC <dbl> 0.944892, 0.969494, 0.938844, 0.962500, 0.895833, 0.~
## $ NEE_CUT_REF  <dbl> -5.627700, -4.453580, -3.884050, -3.107050, -1.55985~
## $ NEE_CUT_REF_QC <dbl> 0.948253, 0.970982, 0.938844, 0.962500, 0.913978, 0.~
## $ GPP_NT_VUT_REF <dbl> 10.20950, 8.16307, 7.06222, 5.72781, 3.47763, 2.7738~
## $ GPP_DT_VUT_REF <dbl> 11.91330, 9.97563, 9.00824, 6.54333, 4.15484, 3.7793~
## $ GPP_NT_CUT_REF <dbl> 10.08900, 8.09051, 7.07681, 5.65260, 3.56473, 2.9719~
## $ GPP_DT_CUT_REF <dbl> 11.92320, 10.16630, 9.00492, 6.60730, 4.16886, 3.691~
## $ RECO_NT_VUT_REF <dbl> 4.46072, 3.62522, 3.18909, 2.55268, 1.78421, 2.86141~
## $ RECO_DT_VUT_REF <dbl> 7.03163, 5.68557, 6.51721, 4.14082, 3.35165, 3.07628~
## $ RECO_NT_CUT_REF <dbl> 4.45634, 3.61530, 3.18613, 2.54582, 1.84822, 2.83905~
## $ RECO_DT_CUT_REF <dbl> 7.06081, 6.02964, 6.61985, 4.04346, 3.54627, 3.19315~
## $ time         <chr> "1/31/10", "2/28/10", "3/31/10", "4/30/10", "5/31/10~
## $ ET           <dbl> 9.014540, 7.677973, 5.890317, 2.345664, 2.208000, 1.~
## $ 'BESS-PAR'   <dbl> 154, 120, 107, 81, 56, 48, 58, 72, 92, 124, 147, 157~
## $ 'BESS-PARdiff' <dbl> 40, 46, 31, 27, 19, 15, 15, 23, 30, 35, 39, 38, 42, ~
## $ 'BESS-RSDN'   <dbl> 336, 258, 231, 175, 122, 105, 129, 158, 202, 271, 32~
## $ 'CSIF-SIFdaily' <dbl> 0.20432499, 0.14553030, 0.10980482, 0.07672890, 0.06~
## $ 'CSIF-SIFinst' <dbl> 0.5166268, 0.3872625, 0.3072417, 0.2238720, 0.200635~
## $ PET          <dbl> -0.013386652, -0.008937791, -0.008132122, -0.0067583~
## $ Ts           <dbl> 302.4697, 298.7886, 297.5482, 291.6960, 287.0565, 28~
## $ Tmean        <dbl> 300.1098, 297.2751, 296.4367, 290.6138, 286.8832, 28~
## $ prcp         <dbl> 0.002115019, 0.003131761, 0.002206154, 0.000209161, ~
## $ vpd          <dbl> 2.0661800, 1.0901145, 1.1686398, 0.9461956, 0.716290~
## $ 'prcp-lag3'   <dbl> 0.008738702, 0.009724296, 0.007452934, 0.005547076, ~
## $ 'ESACCI-sm'   <dbl> 0.1515208, 0.1665578, 0.1640767, 0.1240165, 0.142726~
## $ MODIS_LC     <dbl> 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 9, 9, 9~
## $ b1           <dbl> 0.08442580, 0.09180000, 0.08556129, 0.08740333, 0.07~
## $ b2           <dbl> 0.2687742, 0.2524464, 0.2304000, 0.2158133, 0.198193~
## $ b3           <dbl> 0.04531612, 0.04803214, 0.04453871, 0.04530000, 0.03~
## $ b4           <dbl> 0.08052903, 0.08092143, 0.07463870, 0.07454334, 0.06~
## $ b5           <dbl> 0.3005774, 0.2924500, 0.2694322, 0.2600900, 0.231483~
## $ b6           <dbl> 0.2505258, 0.2522143, 0.2411645, 0.2348300, 0.202816~
## $ b7           <dbl> 0.15535806, 0.15945713, 0.15363870, 0.14688666, 0.12~
## $ EVI          <dbl> 0.3212592, 0.2783001, 0.2568952, 0.2292145, 0.223529~
## $ GCI          <dbl> 2.349203, 2.121655, 2.087431, 1.895962, 2.061106, 1.~
## $ NDVI         <dbl> 0.5227052, 0.4668434, 0.4583453, 0.4235885, 0.445367~
## $ NDWI         <dbl> 0.035415366, 0.000400779, -0.022856813, -0.042024087~
## $ NIRv         <dbl> 0.14050612, 0.11781442, 0.10565167, 0.09139932, 0.08~
## $ kNDVI        <dbl> 0.26745087, 0.21459042, 0.20721813, 0.17754844, 0.19~

```

```
## $ Percent_Snow      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ Fpar              <dbl> 0.49, 0.43, 0.41, 0.36, 0.37, 0.33, 0.32, 0.26, 0.25~
## $ Lai              <dbl> 1.2, 0.9, 0.8, 0.5, 0.5, 0.4, 0.4, 0.3, 0.4, 0.6, 0.~
## $ LST_Day          <dbl> 313.84, 309.86, 309.18, 303.24, 296.20, 293.18, 292.~
## $ LST_Night        <dbl> 293.58, 292.96, 290.52, 286.34, 277.82, 276.80, 271.~
## $ MODIS_IGBP       <chr> "OSH", "OSH", "OSH", "OSH", "OSH", "OSH", "OSH", "OS~
## $ MODIS_PFT        <chr> "SH", "SH", "SH", "SH", "SH", "SH", "SH", "SH", "SH"~
## $ koppen_sub       <chr> "BSk", "BSk", "BSk", "BSk", "BSk", "BSk", "BSk", "BS~
## $ koppen           <chr> "Arid", "Arid", "Arid", "Arid", "Arid", "Arid", "Ari~
## $ CO2_concentration <dbl> 387.110, 387.675, 388.195, 388.905, 389.320, 389.160~
```

## Original dataset

```
raw_df %>%
  group_by(dataset) %>%
  summarise(count=n())
```

```
## # A tibble: 4 x 2
##   dataset    count
##   <chr>      <int>
## 1 AmeriFlux  3703
## 2 FLUXNET    6614
## 3 ICOS2018   336
## 4 ICOS2020   8362
```

Sites are linked to dataset

```
raw_df %>%
  group_by(SITE_ID, dataset) %>%
  summarise(count=n())
```

```
## 'summarise()' has grouped output by 'SITE_ID'. You can override using the
## '.groups' argument.
```

```
## # A tibble: 243 x 3
## # Groups:   SITE_ID [243]
##   SITE_ID dataset count
##   <chr>   <chr>  <int>
## 1 AR-SLu  FLUXNET    15
## 2 AR-Vir  FLUXNET    16
## 3 AT-Neu  FLUXNET   121
## 4 AU-Ade  FLUXNET    17
## 5 AU-ASM  FLUXNET    51
## 6 AU-Cpr  FLUXNET    48
## 7 AU-Cum  FLUXNET    25
## 8 AU-DaP  FLUXNET    55
## 9 AU-DaS  FLUXNET    74
## 10 AU-Dry FLUXNET    45
## # ... with 233 more rows
```

## Convert dataset to TS

### TS month

```
IGBP_month_df <- raw_df %>%
  group_by(SITE_IGBP, month) %>%
  summarise(TA_F_avg = mean(TA_F, na.rm = T), VPD_F_avg = mean(VPD_F, na.rm = T),
    P_F_avg = mean(P_F, na.rm = T), NETRAD_avg = mean(NETRAD, na.rm = T),
    NEE_VUT_REF_avg = mean(NEE_VUT_REF, na.rm = T),
    NEE_VUT_REF_QC_avg = mean(NEE_VUT_REF_QC, na.rm = T),
    NEE_CUT_REF_avg = mean(NEE_CUT_REF, na.rm = T),
    NEE_CUT_REF_QC_avg = mean(NEE_CUT_REF_QC, na.rm = T),
    GPP_NT_VUT_REF_avg = mean(GPP_NT_VUT_REF, na.rm = T),
    GPP_DT_VUT_REF_avg = mean(GPP_DT_VUT_REF, na.rm = T),
    GPP_NT_CUT_REF_avg = mean(GPP_NT_CUT_REF, na.rm = T),
    GPP_DT_CUT_REF_avg = mean(GPP_DT_CUT_REF, na.rm = T),
    RECO_NT_VUT_REF_avg = mean(RECO_NT_VUT_REF, na.rm = T),
    RECO_DT_VUT_REF_avg = mean(RECO_DT_VUT_REF, na.rm = T),
    RECO_NT_CUT_REF_avg = mean(RECO_NT_CUT_REF, na.rm = T),
    RECO_DT_CUT_REF_avg = mean(RECO_DT_CUT_REF, na.rm = T),
    ET_avg = mean(ET, na.rm = T),
    `BESS-PAR_avg` = mean(`BESS-PAR`, na.rm = T),
    `BESS-PARdiff_avg` = mean(`BESS-PARdiff`, na.rm = T),
    `BESS-RSDN_avg` = mean(`BESS-RSDN`, na.rm = T),
    `CSIF-SIFdaily_avg` = mean(`CSIF-SIFdaily`, na.rm = T),
    `CSIF-SIFinst_avg` = mean(`CSIF-SIFinst`, na.rm = T),
    PET_avg = mean(PET, na.rm = T), Ts_avg = mean(Ts, na.rm = T),
    Tmean_avg = mean(Tmean, na.rm = T),
    prcp_avg = mean(prcp, na.rm = T),
    vpd_avg = mean(vpd, na.rm = T),
    `prcp-lag3_avg` = mean(`prcp-lag3`, na.rm = T),
    `ESACCI-sm_avg` = mean(`ESACCI-sm`, na.rm = T),
    b1_avg = mean(b1, na.rm = T), b2_avg = mean(b2, na.rm = T),
    b3_avg = mean(b3, na.rm = T), b4_avg = mean(b4, na.rm = T),
    b5_avg = mean(b5, na.rm = T), b6_avg = mean(b6, na.rm = T),
    b7_avg = mean(b7, na.rm = T), EVI_avg = mean(EVI, na.rm = T),
    GCI_avg = mean(GCI, na.rm = T), NDVI_avg = mean(NDVI, na.rm = T),
    NDWI_avg = mean(NDWI, na.rm = T), NIRv_avg = mean(NIRv, na.rm = T),
    kNDVI_avg = mean(kNDVI, na.rm = T),
    Percent_Snow_avg = mean(Percent_Snow, na.rm = T),
    Fpar_avg = mean(Fpar, na.rm = T), Lai_avg = mean(Lai, na.rm = T),
    LST_Day_avg = mean(LST_Day, na.rm = T),
    LST_Night_avg = mean(LST_Night, na.rm = T),
    CO2_concentration_avg = mean(CO2_concentration, na.rm = T)
  )
```

## 'summarise()' has grouped output by 'SITE\_IGBP'. You can override using the  
## '.groups' argument.

```
# raw_df_ts_month <- raw_df %>% as_tsibble(index=month)
IGBP_month_df
```

```
## # A tibble: 132 x 50
## # Groups:   SITE_IGBP [11]
##   SITE_IGBP month TA_F_avg VPD_F_avg P_F_avg NETRAD_avg NEE_VUT_REF_avg
##   <chr>      <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1 CRO        1     1.04     1.27     1.59     2.64     0.273
## 2 CRO        2     1.85     1.68     1.43     20.3     0.0456
## 3 CRO        3     6.19     2.86     1.70     57.8    -0.282
## 4 CRO        4    10.8     4.78     1.82     97.3    -1.40
## 5 CRO        5    15.0     6.03     2.52    123.    -1.96
## 6 CRO        6    19.3     7.65     2.48    145.    -2.57
## 7 CRO        7    21.4     9.00     2.59    146.    -2.83
## 8 CRO        8    20.7     8.16     2.53    122.    -1.34
## 9 CRO        9    17.0     6.19     2.02     80.6     0.750
## 10 CRO       10    11.9     3.75     1.80     38.3     1.17
## # ... with 122 more rows, and 43 more variables: NEE_VUT_REF_QC_avg <dbl>,
## #   NEE_CUT_REF_avg <dbl>, NEE_CUT_REF_QC_avg <dbl>, GPP_NT_VUT_REF_avg <dbl>,
## #   GPP_DT_VUT_REF_avg <dbl>, GPP_NT_CUT_REF_avg <dbl>,
## #   GPP_DT_CUT_REF_avg <dbl>, RECO_NT_VUT_REF_avg <dbl>,
## #   RECO_DT_VUT_REF_avg <dbl>, RECO_NT_CUT_REF_avg <dbl>,
## #   RECO_DT_CUT_REF_avg <dbl>, ET_avg <dbl>, 'BESS-PAR_avg' <dbl>,
## #   'BESS-PARDiff_avg' <dbl>, 'BESS-RSDN_avg' <dbl>, ...
```

link to the handmade codebook

---

## Distribution of Land-cover Type by Site

SITE\_IGBP(Land-cover Type): 11 SITE\_ID(Sites): 243

```
raw_df %>%
  count(SITE_ID)
```

```
## # A tibble: 243 x 2
##   SITE_ID      n
##   <chr>   <int>
## 1 AR-SLu    15
## 2 AR-Vir    16
## 3 AT-Neu   121
## 4 AU-Ade    17
## 5 AU-ASM    51
## 6 AU-Cpr    48
## 7 AU-Cum    25
## 8 AU-DaP    55
## 9 AU-DaS    74
## 10 AU-Dry   45
## # ... with 233 more rows
```

```
site_igbp_distribution <-raw_df %>%
  select(SITE_ID,SITE_IGBP) %>%
  group_by(SITE_IGBP) %>%
```

```

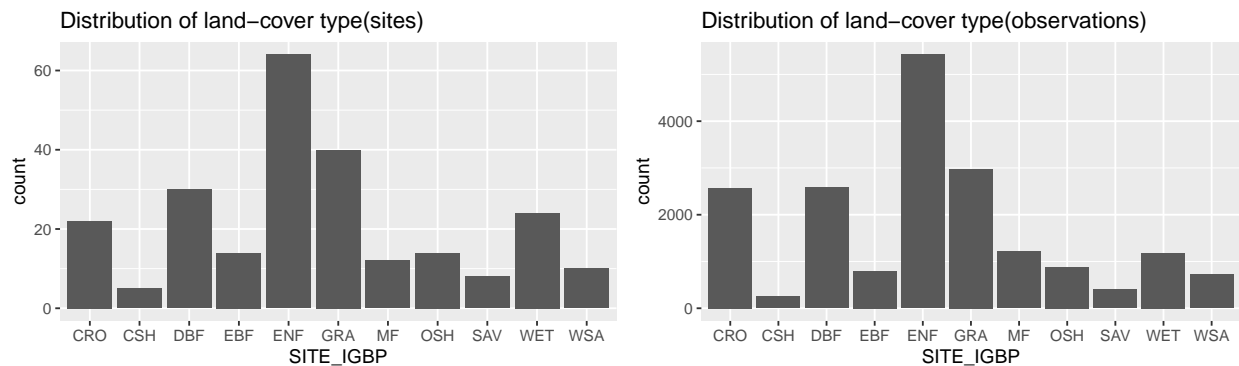
summarise(count= n())

fig1 <- raw_df %>%
  select(SITE_ID,SITE_IGBP) %>%
  unique() %>%
  group_by(SITE_IGBP) %>%
  summarise(count=n()) %>%
  ggplot(aes(x=SITE_IGBP, y=count)) +
  geom_bar(stat='identity') +
  labs(title = "Distribution of land-cover type(sites)")

fig2 <- site_igbp_distribution %>%
  ggplot(aes(x=SITE_IGBP, y=count)) +
  geom_bar(stat='identity') +
  labs(title = "Distribution of land-cover type(observations)")

grid.arrange(fig1, fig2, nrow = 1, ncol = 2)

```



```
site_igbp_distribution
```

```

## # A tibble: 11 x 2
##   SITE_IGBP count
##   <chr>      <int>
## 1 CRO        2574
## 2 CSH         252
## 3 DBF        2582
## 4 EBF         796
## 5 ENF        5422
## 6 GRA        2972
## 7 MF         1217
## 8 OSH         886
## 9 SAV         403
## 10 WET       1186
## 11 WSA         725

```

# Monthly transition of GPP and NEE by land-cover type

## Summary statistics of variables

Rows: 19015 Columns: 62

```
describe(raw_df)
```

```
## raw_df
##
## 62 Variables      19015 Observations
## -----
## SITE_ID
##      n missing distinct
## 19015      0      243
##
## lowest : AR-SLu AR-Vir AT-Neu AU-Ade AU-ASM, highest: US-Wi4 US-Wjs US-Wkg US-WPT ZM-Mon
## -----
## year
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 19015      0      20    0.997    2011    5.927    2002    2004
##      .25      .50      .75      .90      .95
## 2006    2011    2015    2018    2019
##
## lowest : 2001 2002 2003 2004 2005, highest: 2016 2017 2018 2019 2020
##
## Value      2001  2002  2003  2004  2005  2006  2007  2008  2009  2010  2011
## Frequency   444   619   730   927  1038  1017  1092  1179  1118  1147  1191
## Proportion 0.023 0.033 0.038 0.049 0.055 0.053 0.057 0.062 0.059 0.060 0.063
##
## Value      2012  2013  2014  2015  2016  2017  2018  2019  2020
## Frequency  1275  1212  1188   876   936   897   720   705   704
## Proportion 0.067 0.064 0.062 0.046 0.049 0.047 0.038 0.037 0.037
## -----
## month
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 19015      0      12    0.993    6.591    3.898      1      2
##      .25      .50      .75      .90      .95
##      4      7      10      11      12
##
## lowest : 1 2 3 4 5, highest: 8 9 10 11 12
##
## Value      1      2      3      4      5      6      7      8      9      10     11
## Frequency  1422  1479  1545  1560  1633  1629  1631  1682  1668  1673  1600
## Proportion 0.075 0.078 0.081 0.082 0.086 0.086 0.086 0.088 0.088 0.088 0.084
##
## Value      12
## Frequency  1493
## Proportion 0.079
## -----
## TIMESTAMP
##      n missing distinct      Info      Mean      Gmd      .05      .10
```

```

##      19015      0      240      1      201069      592.8      200210      200402
##      .25      .50      .75      .90      .95
##      200612      201103      201502      201804      201908
##
## lowest : 200101 200102 200103 200104 200105, highest: 202008 202009 202010 202011 202012
## -----
## dataset
##      n missing distinct
##      19015      0      4
##
## Value      AmeriFlux      FLUXNET      ICOS2018      ICOS2020
## Frequency      3703      6614      336      8362
## Proportion      0.195      0.348      0.018      0.440
## -----
## SITE_IGBP
##      n missing distinct
##      19015      0      11
##
## lowest : CRO CSH DBF EBF ENF, highest: MF OSH SAV WET WSA
##
## Value      CRO      CSH      DBF      EBF      ENF      GRA      MF      OSH      SAV      WET      WSA
## Frequency      2574      252      2582      796      5422      2972      1217      886      403      1186      725
## Proportion      0.135      0.013      0.136      0.042      0.285      0.156      0.064      0.047      0.021      0.062      0.038
## -----
## LOCATION_LAT
##      n missing distinct      Info      Mean      Gmd      .05      .10
##      19015      0      243      1      42.19      16.44      -12.49      31.79
##      .25      .50      .75      .90      .95
##      39.94      45.95      50.89      56.10      64.17
##
## lowest : -37.42590 -37.42220 -36.67320 -36.64990 -35.65660
## highest: 70.46960 70.82914 74.47328 74.48143 78.18600
## -----
## LOCATION_LONG
##      n missing distinct      Info      Mean      Gmd      .05      .10
##      19015      0      242      1      -21.17      73.53      -120.966      -109.942
##      .25      .50      .75      .90      .95
##      -90.080      5.744      13.513      29.610      131.152
##
## lowest : -157.4089 -155.7503 -147.8555 -147.4876 -125.3336
## highest: 147.4943 148.1517 148.4746 150.7236 161.3414
## -----
## TA_F
##      n missing distinct      Info      Mean      Gmd      .05      .10
##      19015      0      14594      1      10.34      10.72      -5.710      -1.971
##      .25      .50      .75      .90      .95
##      3.874      10.966      17.159      22.520      25.248
##
## lowest : -31.455 -28.628 -28.290 -28.173 -27.865
## highest: 32.618 32.707 32.847 32.992 33.400
## -----
## VPD_F
##      n missing distinct      Info      Mean      Gmd      .05      .10
##      19015      0      9775      1      5.432      5.098      0.495      0.832

```



```

##      .25      .50      .75      .90      .95
##    1.884    4.008    6.998   11.903   16.286
##
## lowest : 0.007 0.022 0.034 0.046 0.060, highest: 37.228 37.798 38.316 39.361 45.384
## -----
## P_F
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    18662     353     5356         1     2.095     1.982     0.025     0.175
##      .25      .50      .75      .90      .95
##    0.727     1.619     2.871     4.424     5.762
##
## lowest : 0.000 0.001 0.002 0.003 0.004, highest: 20.696 22.810 23.365 24.635 25.172
## -----
## NETRAD
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    16322     2693     16321         1     81.5     69.64    -7.053     1.438
##      .25      .50      .75      .90      .95
##    25.833    83.546   131.353   160.143   175.072
##
## lowest : -67.89401 -62.49031 -59.65575 -57.19109 -52.67848
## highest: 287.13336 296.88608 301.63435 307.46765 307.99158
## -----
## NEE_VUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015         0     18934         1    -0.6366     2.187   -4.91723   -3.42104
##      .25      .50      .75      .90      .95
##   -1.49466  -0.03468  0.63834   1.31770   1.80338
##
## lowest : -14.02970 -13.83060 -13.71760 -13.37000 -13.29610
## highest:  7.01448  7.44355  8.05616  8.71916  8.81725
## -----
## NEE_VUT_REF_QC
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015         0     1002         1    0.9561    0.04623    0.8548    0.8905
##      .25      .50      .75      .90      .95
##    0.9395    0.9718    0.9886    0.9965    0.9987
##
## lowest : 0.431452 0.461022 0.501344 0.556452 0.614247
## highest: 0.999256 0.999282 0.999306 0.999328 1.000000
## -----
## NEE_CUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015         0     18907         1    -0.6406     2.185   -4.90614   -3.42255
##      .25      .50      .75      .90      .95
##   -1.48760  -0.03645  0.63756   1.31050   1.78472
##
## lowest : -14.08820 -13.90990 -13.83730 -13.43980 -13.34270
## highest:  7.05364  7.41292  7.49866  7.82519  8.75457
## -----
## NEE_CUT_REF_QC
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015         0      883         1    0.9576    0.04409    0.8594    0.8931
##      .25      .50      .75      .90      .95
##    0.9415    0.9724    0.9886    0.9965    0.9987

```

```

##
## lowest : 0.800287 0.800403 0.800694 0.801075 0.801339
## highest: 0.999256 0.999282 0.999306 0.999328 1.000000
## -----
## GPP_NT_VUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015      0     18855        1     3.634     4.11 -0.06870  0.01167
##      .25      .50      .75      .90      .95
##    0.40645  2.28575  6.06953  9.34163 11.16933
##
## lowest : -0.999454 -0.951902 -0.941732 -0.939231 -0.928428
## highest: 23.035600 23.229300 23.253600 23.286900 23.775600
## -----
## GPP_DT_VUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015      0     18583        1     3.516     3.896  0.01442  0.06147
##      .25      .50      .75      .90      .95
##    0.43092  2.24238  5.82667  9.00748 10.62423
##
## lowest : 0.00000000 0.00000467 0.00000486 0.00001580 0.00001890
## highest: 23.29540000 23.39650000 23.41760000 23.79160000 24.06010000
## -----
## GPP_NT_CUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015      0     18860        1     3.627     4.103 -0.06668  0.01335
##      .25      .50      .75      .90      .95
##    0.40735  2.27758  6.06802  9.31733 11.14000
##
## lowest : -1.223370 -1.059510 -1.044810 -1.032150 -0.955025
## highest: 22.793300 23.322800 23.347500 23.525300 23.888800
## -----
## GPP_DT_CUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015      0     18534        1     3.512     3.884  0.01458  0.06359
##      .25      .50      .75      .90      .95
##    0.43464  2.25236  5.81980  8.97261 10.60416
##
## lowest : 0.00000000 0.00000899 0.00000974 0.00001060 0.00001940
## highest: 23.02800000 23.37300000 23.73030000 24.07310000 24.78880000
## -----
## RECO_NT_VUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015      0     18770        1     2.986     2.749  0.1946  0.4017
##      .25      .50      .75      .90      .95
##    0.9853  2.2191  4.3961  6.5565  8.1156
##
## lowest : 0.00000e+00 3.49000e-09 4.47000e-09 3.42000e-08 4.04000e-08
## highest: 1.86266e+01 1.86878e+01 1.91984e+01 1.95403e+01 1.96794e+01
## -----
## RECO_DT_VUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19014      1     18816        1     2.931     2.611  0.2957  0.4771
##      .25      .50      .75      .90      .95
##    1.0106  2.2123  4.3329  6.3974  7.7122

```

```

##
## lowest : 1.94896e-04 4.33736e-03 4.45924e-03 4.84733e-03 5.38437e-03
## highest: 1.51963e+01 1.53055e+01 1.62103e+01 1.73310e+01 1.77965e+01
## -----
## RECO_NT_CUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##  19015      0    18794      1    2.965    2.735    0.1890    0.3946
##      .25      .50      .75      .90      .95
##    0.9733    2.2060    4.3738    6.5235    8.1121
##
## lowest : 0.00000e+00 3.49000e-09 4.47000e-09 3.49000e-08 4.04000e-08
## highest: 1.87690e+01 1.91544e+01 1.95403e+01 1.95475e+01 1.97785e+01
## -----
## RECO_DT_CUT_REF
##      n missing distinct      Info      Mean      Gmd      .05      .10
##  19014      1    18813      1    2.916     2.6    0.2936    0.4734
##      .25      .50      .75      .90      .95
##    1.0060    2.1998    4.3056    6.3702    7.6631
##
## lowest : 0.00433736 0.00445924 0.00511637 0.00725787 0.00790458
## highest: 15.33190000 15.48180000 16.39560000 17.53900000 17.79650000
## -----
## time
##      n missing distinct
##  19015      0      240
##
## lowest : 1/31/01 1/31/02 1/31/03 1/31/04 1/31/05
## highest: 9/30/16 9/30/17 9/30/18 9/30/19 9/30/20
## -----
## ET
##      n missing distinct      Info      Mean      Gmd      .05      .10
##  18983      32    18337      1    3.666    3.227    0.1080    0.2531
##      .25      .50      .75      .90      .95
##    1.2016    3.1427    5.6596    7.6979    8.9099
##
## lowest : 0.00000000 0.0000105 0.0000108 0.0000121 0.0000148
## highest: 14.3170140 14.5098940 14.6386310 14.7813740 14.8986400
## -----
## BESS-PAR
##      n missing distinct      Info      Mean      Gmd      .05      .10
##  19015      0      415      1    79.33    56.64     12     18
##      .25      .50      .75      .90      .95
##     39      77     106    129     145
##
## lowest : 0 1 2 3 4, highest: 588 597 599 600 611
## -----
## BESS-PARdiff
##      n missing distinct      Info      Mean      Gmd      .05      .10
##  19015      0      216      1    33.85    22.54      7     10
##      .25      .50      .75      .90      .95
##     18      32      45     52     56
##
## lowest : 0 1 2 3 4, highest: 226 232 235 240 241
## -----

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## BESS-RSDN
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    19015      0      374        1    157.8    100.8      25      37
##      .25      .50      .75      .90      .95
##      81      163      225      271      301
##
## lowest :   0   1   2   3   4, highest: 369 370 371 372 373
## -----
## CSIF-SIFdaily
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    18894     121    17919        1    0.1517    0.1517 -0.000505  0.010790
##      .25      .50      .75      .90      .95
##    0.041752  0.102851  0.235123  0.370362  0.440347
##
## lowest : -0.02919996 -0.02814803 -0.02656131 -0.02655265 -0.02044134
## highest:  0.68423855  0.68502396  0.68649540  0.69930070  0.70735025
## -----
## CSIF-SIFinst
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    18894     121    17772        1    0.4234    0.3902 -0.002229  0.036781
##      .25      .50      .75      .90      .95
##    0.148847  0.322552  0.641604  0.962354  1.140990
##
## lowest : -0.11166026 -0.10104087 -0.09271585 -0.08875447 -0.08076532
## highest:  1.72390760  1.73143880  1.75219540  1.75410040  1.79071280
## -----
## PET
##      n missing distinct      Info      Mean      Gmd      .05
##    18914     101    17748        1   -0.007306    0.006741 -0.0222709
##      .10      .25      .50      .75      .90      .95
##   -0.0164077 -0.0091421 -0.0055377 -0.0026242 -0.0011704 -0.0007637
##
## lowest : -0.05542774 -0.05510548 -0.05494109 -0.05482972 -0.05447997
## highest:  0.00003210  0.00003400  0.00003460  0.00003720  0.00004160
## -----
## Ts
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    18914     101    17589        1    283.6    12.11    265.3    269.6
##      .25      .50      .75      .90      .95
##    276.3    284.2    291.0    297.7    300.6
##
## lowest : 239.4686 239.6578 242.1032 242.7621 243.2340
## highest: 309.3234 309.5114 309.7074 310.0883 310.2855
## -----
## Tmean
##      n missing distinct      Info      Mean      Gmd      .05      .10
##    18914     101    17565        1    283.6    11.13    266.4    270.7
##      .25      .50      .75      .90      .95
##    277.0    284.3    290.7    296.2    298.9
##
## lowest : 241.8833 244.6789 245.3720 245.4935 245.5205
## highest: 305.7779 305.7994 305.8423 306.1157 306.8248
## -----
## prcp

```

```

##          n  missing  distinct      Info      Mean      Gmd      .05      .10
##    18914      101      17622          1  0.002451  0.002055  0.0001412  0.0004147
##      .25      .50      .75      .90      .95
## 0.0010851 0.0020328 0.0032729 0.0047820 0.0060673
##
## lowest : 0.000000540 0.000000555 0.000000586 0.000000608 0.000000623
## highest: 0.022791667 0.022880048 0.023600347 0.023827540 0.023946350
## -----
## vpd
##          n  missing  distinct      Info      Mean      Gmd      .05      .10
##    18914      101      17821          1  0.5254    0.5012  0.06597  0.09283
##      .25      .50      .75      .90      .95
## 0.17472 0.37054 0.65985 1.18798 1.64899
##
## lowest : 0.01310228 0.01468146 0.01750002 0.01795330 0.01799651
## highest: 3.59606310 3.80632110 3.86339000 3.94436570 4.21067430
## -----
## prcp-lag3
##          n  missing  distinct      Info      Mean      Gmd      .05      .10
##    18914      101      17805          1 0.007331 0.005093 0.001072 0.002054
##      .25      .50      .75      .90      .95
## 0.004168 0.006535 0.009392 0.012903 0.015871
##
## lowest : 0.00000211 0.00000229 0.00000244 0.00000257 0.00000261
## highest: 0.05334827 0.05434239 0.05618351 0.06139616 0.06408255
## -----
## ESACCI-sm
##          n  missing  distinct      Info      Mean      Gmd      .05      .10
##    17405      1610      13985          1  0.2566  0.07281  0.1339  0.1658
##      .25      .50      .75      .90      .95
## 0.2168 0.2650 0.3011 0.3332 0.3529
##
## lowest : 0.00000838 0.04904429 0.05008446 0.05073670 0.05515835
## highest: 0.41661453 0.41684616 0.41879398 0.41975582 0.42007230
## -----
## MODIS_LC
##          n  missing  distinct      Info      Mean      Gmd      .05      .10
##    19015          0          14      0.98      7.97    4.218          1          1
##      .25      .50      .75      .90      .95
##          5          9          11          12          12
##
## lowest : 1 2 4 5 6, highest: 11 12 13 16 17
##
## Value          1          2          4          5          6          7          8          9          10          11          12
## Frequency    1973        306       1576       2032         99       894       2612       2475       2145        173       4197
## Proportion  0.104  0.016  0.083  0.107  0.005  0.047  0.137  0.130  0.113  0.009  0.221
##
## Value          13          16          17
## Frequency         73          8        452
## Proportion  0.004  0.000  0.024
## -----
## b1
##          n  missing  distinct      Info      Mean      Gmd      .05      .10
##    18609      406      16720          1  0.08678  0.06897  0.02623  0.03014

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##      .25      .50      .75      .90      .95
## 0.04208 0.06154 0.09900 0.17116 0.23396
##
## lowest : 0.01132731 0.01195806 0.01283010 0.01378667 0.01388188
## highest: 0.87467510 0.88530600 0.88612750 0.88924116 0.92057824
## -----
## b2
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18616      399      16698          1 0.2466 0.08636 0.1413 0.1625
##      .25      .50      .75      .90      .95
## 0.1933 0.2371 0.2930 0.3506 0.3789
##
## lowest : 0.00000000 0.04759337 0.06271509 0.06848542 0.07399469
## highest: 0.80770830 0.81104064 0.81478095 0.82439053 0.87086660
## -----
## b3
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18609      406      16481          1 0.05725 0.05532 0.01485 0.01771
##      .25      .50      .75      .90      .95
## 0.02400 0.03386 0.05265 0.09979 0.21867
##
## lowest : 0.005035000 0.005451613 0.005491508 0.005632258 0.005638444
## highest: 0.895115100 0.900761300 0.905036800 0.907366600 0.912842900
## -----
## b4
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18609      406      16622          1 0.08417 0.0584 0.03395 0.03839
##      .25      .50      .75      .90      .95
## 0.04768 0.06319 0.08669 0.14148 0.22247
##
## lowest : 0.01439973 0.01603387 0.01698667 0.01717167 0.01735941
## highest: 0.89055990 0.90379600 0.90579194 0.90936625 0.92817160
## -----
## b5
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18609      406      16848          1 0.2514 0.07687 0.1468 0.1652
##      .25      .50      .75      .90      .95
## 0.2011 0.2482 0.3031 0.3396 0.3598
##
## lowest : 0.08006774 0.08352830 0.08360645 0.08491613 0.08497245
## highest: 0.55240756 0.55939680 0.56861960 0.57122743 0.57889880
## -----
## b6
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18609      406      16863          1 0.1827 0.08793 0.07019 0.08663
##      .25      .50      .75      .90      .95
## 0.12622 0.17331 0.22305 0.29727 0.33825
##
## lowest : 0.03550000 0.03616667 0.03626785 0.03670000 0.03746371
## highest: 0.58307330 0.58979195 0.59474194 0.60415970 0.61979750
## -----
## b7
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18609      406      16810          1 0.1064 0.07094 0.03249 0.04020

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##      .25      .50      .75      .90      .95
## 0.05883 0.08849 0.13167 0.20513 0.25483
##
## lowest : 0.01204138 0.01282143 0.01320000 0.01405893 0.01506290
## highest: 0.50048065 0.50056000 0.51021450 0.52273680 0.55494900
## -----
## EVI
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 17395    1620    15854         1    0.3024    0.1415    0.1212    0.1479
##      .25      .50      .75      .90      .95
## 0.2117    0.2825    0.3834    0.4834    0.5426
##
## lowest : 0.007224556 0.008124289 0.009238364 0.014921306 0.014974085
## highest: 0.730268500 0.735327700 0.738576300 0.739212300 0.758484800
## -----
## GCI
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18546     469    16926         1    2.908    1.752    0.6390    0.9973
##      .25      .50      .75      .90      .95
## 1.7987    2.7476    3.8548    4.9870    5.7303
##
## lowest : 0.004437923 0.006397247 0.007219228 0.010492164 0.012310988
## highest: 9.911120000 9.975493000 10.064940000 10.871304500 11.263188000
## -----
## NDVI
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18563     452    16928         1    0.5351    0.2271    0.1612    0.2197
##      .25      .50      .75      .90      .95
## 0.4054    0.5700    0.6912    0.7745    0.8116
##
## lowest : 0.002544436 0.005292194 0.005326130 0.005357474 0.007510734
## highest: 0.914746340 0.914772150 0.915391200 0.915637900 0.915831740
## -----
## NDWI
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18609     406    16984         1    0.1658    0.2224 -0.14604 -0.10814
##      .25      .50      .75      .90      .95
## 0.02816    0.16970    0.28347    0.37611    0.57355
##
## lowest : -0.2761985 -0.2730416 -0.2723996 -0.2689405 -0.2687093
## highest: 0.8205857 0.8271840 0.8343591 0.8380104 0.8547556
## -----
## NIRv
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18563     452    16928         1    0.1316    0.08005    0.03988    0.05013
##      .25      .50      .75      .90      .95
## 0.07697    0.11663    0.17518    0.23585    0.27508
##
## lowest : 0.001237986 0.001943630 0.002343579 0.002388369 0.002575980
## highest: 0.411172300 0.418155250 0.419231680 0.424213470 0.426510000
## -----
## kNDVI
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18609     406    16979         1    0.3057    0.2001    0.02509    0.04672

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##      .25      .50      .75      .90      .95
## 0.16543 0.31532 0.44439 0.53669 0.57734
##
## lowest : 0.0000157 0.0000592 0.0000652 0.0000662 0.0000839
## highest: 0.6840645 0.6840799 0.6846792 0.6849552 0.6851109
## -----
## Percent_Snow
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18872      143      3426      0.618      11.62      19.92      0.000      0.000
##      .25      .50      .75      .90      .95
## 0.000      0.000      1.171      54.613      90.077
##
## lowest : 0.000000e+00 5.093379e-03 5.376344e-03 5.555556e-03 5.639098e-03
## highest: 9.988625e+01 9.989286e+01 9.990323e+01 9.993731e+01 1.000000e+02
## -----
## Fpar
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18080      935      86      1      0.4845      0.2297      0.14      0.19
##      .25      .50      .75      .90      .95
## 0.33      0.50      0.65      0.74      0.79
##
## lowest : 0.06 0.07 0.08 0.09 0.10, highest: 0.87 0.88 0.89 0.90 0.91
## -----
## Lai
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 18080      935      63      0.998      1.431      1.214      0.2      0.3
##      .25      .50      .75      .90      .95
## 0.5      1.1      2.1      3.1      3.7
##
## lowest : 0.1 0.2 0.3 0.4 0.5, highest: 5.9 6.0 6.1 6.2 6.3
## -----
## LST_Day
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 19015      0      3279      1      289.8      15.47      266.7      271.7
##      .25      .50      .75      .90      .95
## 280.4      290.9      298.5      307.0      312.9
##
## lowest : 238.54 241.24 242.12 242.84 243.24, highest: 327.64 327.90 327.92 328.08 328.28
## -----
## LST_Night
##      n missing distinct      Info      Mean      Gmd      .05      .10
## 19015      0      2375      1      277.2      10.87      260.0      264.5
##      .25      .50      .75      .90      .95
## 271.2      277.9      284.2      288.9      292.1
##
## lowest : 237.90 238.14 238.66 238.68 238.76, highest: 299.12 299.26 299.28 299.32 299.34
## -----
## MODIS_IGBP
##      n missing distinct
## 19015      0      14
##
## lowest : BSV CRO CSH DBF EBF, highest: SAV URB WAT WET WSA
##
## Value      BSV      CRO      CSH      DBF      EBF      ENF      GRA      MF      OSH      SAV      URB

```



```

## Frequency      8 4197    99 1576    306 1973    2145 2032    894 2475    73
## Proportion 0.000 0.221 0.005 0.083 0.016 0.104 0.113 0.107 0.047 0.130 0.004
##
## Value          WAT   WET   WSA
## Frequency      452   173  2612
## Proportion 0.024 0.009 0.137
## -----
## MODIS_PFT
##      n missing distinct
##  19015      0      9
##
## lowest : CRO   DBF   EBF   ENF   GRA   , highest: GRA   MF   Other SA   SH
##
## Value          CRO   DBF   EBF   ENF   GRA   MF Other   SA   SH
## Frequency      4197  1576   306  1973  2145  2032   706  5087  993
## Proportion 0.221 0.083 0.016 0.104 0.113 0.107 0.037 0.268 0.052
## -----
## koppen_sub
##      n missing distinct
##  19015      0      21
##
## lowest : Af   Am   Aw   BSh BSk, highest: Dsc Dwa Dwb Dwc ET
## -----
## koppen
##      n missing distinct
##  19015      0      5
##
## lowest : Arid      Cold      Polar      Temperate Tropical
## highest: Arid      Cold      Polar      Temperate Tropical
##
## Value          Arid      Cold      Polar Temperate Tropical
## Frequency      1957    11013      299    5102      644
## Proportion      0.103    0.579    0.016    0.268    0.034
## -----
## CO2_concentration
##      n missing distinct      Info      Mean      Gmd      .05      .10
##  19015      0      238      1    390.3    12.92    373.0    375.7
##      .25      .50      .75      .90      .95
##  381.5    389.3    398.2    406.3    409.9
##
## lowest : 369.070 369.330 369.415 369.560 369.745
## highest: 412.435 412.715 412.780 413.135 413.325
## -----

```