API rNOMADS para recuperar dados de modelos climáticos NOAA

Previsão da precipitação acumulada (mm) para os próximos 15 dias

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rNOMADS

NOMADS (NOAA Operational Model Archive and Distribution System) é um sistema de distribuição e arquivamento de dados operacionais gerenciado pela NOAA (National Oceanic and Atmospheric Administration). Ele fornece acesso a uma ampla gama de dados meteorológicos, climáticos e oceanográficos gerados por modelos numéricos de previsão e reanálises. Fonte: https://nomads.ncep.noaa.gov/.

O rNOMADS é uma interface para o sistema NOMADS que pode recuperar dados binários em formato grib, bem como importar dados ascii diretamente para o R por meio da interface com o sistema GrADS-DODS. Fonte: https://r-forge.r-project.org/projects/rnomads/.

```
library(rNOMADS)
# update.packages(oldPkgs = "rNOMADS")
library(raster)
```

Modelos

```
#  ascii
model.list  <-  NOMADSRealTimeList ( "dods" )

modelos <- aggregate(url ~ name,
                     data = model.list,
                     FUN = paste, collapse = ", ")

knitr::kable(modelos, row.names = TRUE)
```

	name	url
1	CMC Ensemble	https://nomads.ncep.noaa.gov:443/dods/cmcens/
2	FNMOC Ensemble and Bias Corrected	https://nomads.ncep.noaa.gov:443/dods/fens/
3	GDAS	https://nomads.ncep.noaa.gov:443/dods/fnl/
4	GDAS 0.25	https://nomads.ncep.noaa.gov:443/dods/gdas_0p25/
5	GFS 0.25 Degree	https://nomads.ncep.noaa.gov:443/dods/gfs_0p25/
6	GFS 0.25 Degree Hourly	https://nomads.ncep.noaa.gov:443/dods/gfs_0p25_1hr/
7	GFS 0.50 Degree	https://nomads.ncep.noaa.gov:443/dods/gfs_0p50/
8	GFS 1.00 Degree	https://nomads.ncep.noaa.gov:443/dods/gfs_1p00/
9	GFS Ensemble 0.5 Degree	https://nomads.ncep.noaa.gov:443/dods/gefs/
10	GFS Ensemble 0.5 Degree (Secondary Params)	https://nomads.ncep.noaa.gov:443/dods/gefs/
11	GFS Ensemble 0.5 Degree Bias-Corrected	https://nomads.ncep.noaa.gov:443/dods/gens_bc/
12	GFS Ensemble NDGD resolution Bias-Corrected	https://nomads.ncep.noaa.gov:443/dods/gens_ndgd/
13	GFS Wave	https://nomads.ncep.noaa.gov:443/dods/gfswave/
14	Great Lakes Wave Unstructured (GLWU)	https://nomads.ncep.noaa.gov:443/dods/glwu/
15	HIRESW Alaska	https://nomads.ncep.noaa.gov:443/dods/hiresw/
16	HIRESW CONUS	https://nomads.ncep.noaa.gov:443/dods/hiresw/
17	HIRESW Guam	https://nomads.ncep.noaa.gov:443/dods/hiresw/
18	HIRESW Hawaii	https://nomads.ncep.noaa.gov:443/dods/hiresw/
19	HIRESW Puerto Rico	https://nomads.ncep.noaa.gov:443/dods/hiresw/
20	HRRR	https://nomads.ncep.noaa.gov:443/dods/hrrr/
21	HRRR AK	https://nomads.ncep.noaa.gov:443/dods/hrrr/
22	NAEFS NDGD resolution Bias-Corrected	https://nomads.ncep.noaa.gov:443/dods/naefs_ndgd/
23	NAEFS high resolution Bias-Corrected	https://nomads.ncep.noaa.gov:443/dods/naefs_bc/
24	NAM Alaska Pressure Level Vars (11.25km)	https://nomads.ncep.noaa.gov:443/dods/nam/
25	NAM CONUS (12km)	https://nomads.ncep.noaa.gov:443/dods/nam/
26	NAM Caribbean/Central America	https://nomads.ncep.noaa.gov:443/dods/nam/
27	NAM NEST Alaska	https://nomads.ncep.noaa.gov:443/dods/nam/
28	NAM NEST CONUS	https://nomads.ncep.noaa.gov:443/dods/nam/
29	NAM NEST HAWAII	https://nomads.ncep.noaa.gov:443/dods/nam/
30	NAM NEST Puerto Rico	https://nomads.ncep.noaa.gov:443/dods/nam/
31	NAM North America (32km)	https://nomads.ncep.noaa.gov:443/dods/nam/
32	NAM Pacific	https://nomads.ncep.noaa.gov:443/dods/nam/
33	NARRE	https://nomads.ncep.noaa.gov:443/dods/narre/
34	NCEP and FNMOC Combined Ensemble Wave	https://nomads.ncep.noaa.gov:443/dods/nfcens/
35	National Blend of Models	https://nomads.ncep.noaa.gov:443/dods/blend/
36	RAP	https://nomads.ncep.noaa.gov:443/dods/rap/
37	RAP 32km North America	https://nomads.ncep.noaa.gov:443/dods/rap/
38	RAP Eastern North Pacific	https://nomads.ncep.noaa.gov:443/dods/rap/
39	RTMA ALASKA	https://nomads.ncep.noaa.gov:443/dods/akrtma/
40	RTMA Guam	https://nomads.ncep.noaa.gov:443/dods/gurtma/
41	RTMA Hawaii	https://nomads.ncep.noaa.gov:443/dods/hirtma/
42	RTMA Puerto Rico	https://nomads.ncep.noaa.gov:443/dods/prrtma/
43	RTMA2.5 CONUS	https://nomads.ncep.noaa.gov:443/dods/rtma2p5/
44	RTOFS Global	https://nomads.ncep.noaa.gov:443/dods/rtofs/
45	SREF CONUS (40km)	https://nomads.ncep.noaa.gov:443/dods/sref/
46	SREF CONUS (40km) Bias-Corrected	https://nomads.ncep.noaa.gov:443/dods/sref_bc/
47	SREF North America (16km)	https://nomads.ncep.noaa.gov:443/dods/sref/

	name	url
48	SREF North America (32km)	https://nomads.ncep.noaa.gov:443/dods/sref/
49	STOFS 2D Global	https://nomads.ncep.noaa.gov:443/dods/stofs_2d_glo/
50	STOFS 3D Atlantic	https://nomads.ncep.noaa.gov:443/dods/stofs_3d_atl/
51	Sea Ice Analysis	https://nomads.ncep.noaa.gov:443/dods/ice/

Global Forecast System

O Global Forecast System (GFS) é um modelo de previsão do tempo produzido pelo National Centers for Environmental Prediction (NCEP). Dezenas de variáveis atmosféricas e de solo estão disponíveis através deste conjunto de dados, desde temperaturas, ventos e precipitação até umidade do solo e concentração de ozônio na atmosfera.

Mudanças são feitas regularmente no modelo GFS para melhorar seu desempenho e precisão de previsão. Este conjunto de dados é executado quatro vezes ao dia às 00z, 06z, 12z e 18z até 192 horas com uma resolução horizontal de 0,5 graus e uma resolução temporal de 3 horas.

gfs_0p50

O modelo "0p50" refere-se a uma grade global com intervalos de 0,50 graus (~55 km entre os pontos de grade na linha do Equador). Oferece um nível intermediário de detalhamento espacial em comparação a versões mais finas (0,25 graus) ou mais grossas (1,00 grau).

Fornece previsões de curto a médio prazo (até 384 horas, ou 16 dias). As saídas podem ser em intervalos de 3 ou 6 horas, dependendo da configuração.

```
model.urls <- GetDODSDates("gfs_0p50")
```

Região de interesse

```
lat <- -19.78753
lon <- -51.98899
```

Configurando a grade

```
# Subset
lons <- seq(0, 359.5, by = 0.5)
lats <- seq(-90, 90, by = 0.5)

lon.diff <- abs(lon + 360 - lons)
lat.diff <- abs(lat - lats)

model.lon.ind <- which(lon.diff == min(lon.diff)) - 1 # Indexado no 0
model.lat.ind <- which(lat.diff == min(lat.diff)) - 1


lon.inds <- c(model.lon.ind - 12, model.lon.ind + 12) # região
lat.inds <- c(model.lat.ind - 14, model.lat.ind + 14)
```

Modelo mais recente

```
latest.model <- tail(model.urls$url, 1)
model.runs <- GetDODSModelRuns(latest.model)
model.runs
```

```
## $model.run
## [1] "gfs_0p50_00z" "gfs_0p50_06z" "gfs_0p50_12z"
##
## $model.run.info
## [1] "gfs_0p50_00z: GFS 0.5 deg starting from 00Z17nov2024, downloaded Nov 17 05:15 UTC"
## [2] "gfs_0p50_06z: GFS 0.5 deg starting from 06Z17nov2024, downloaded Nov 17 11:11 UTC"
## [3] "gfs_0p50_12z: GFS 0.5 deg starting from 12Z17nov2024, downloaded Nov 17 17:13 UTC"
```

```
latest.model.run <- tail(model.runs$model.run, 1)
latest.model.run
```

```
## [1] "gfs_0p50_12z"
```

Variáveis disponíveis

```
model.info <- GetDODSModelRunInfo(latest.model, tail(model.runs$model.run, 1))
model.info.var <- model.info[c(10,11,28,43,141:148,170,180,201:204,216,220,239)]

knitr::kable(as.data.frame(model.info.var), row.names = TRUE)
```

	model.info.var
1	acpcpsfc ** surface convective precipitation [kg/m^2]
2	albdosfc ** surface albedo [%]
3	cnwatsfc ** surface plant canopy surface water [kg/m^2]
4	fldcpsfc ** surface field capacity [fraction]
5	soill0_10cm ** 0-0.1 m below ground liquid volumetric soil moisture (non frozen) [proportion]
6	soill10_40cm ** 0.1-0.4 m below ground liquid volumetric soil moisture (non frozen) [proportion]
7	soill40_100cm ** 0.4-1 m below ground liquid volumetric soil moisture (non frozen) [proportion]
8	soill100_200cm ** 1-2 m below ground liquid volumetric soil moisture (non frozen) [proportion]
9	soilw0_10cm ** 0-0.1 m below ground volumetric soil moisture content [fraction]
10	soilw10_40cm ** 0.1-0.4 m below ground volumetric soil moisture content [fraction]
11	soilw40_100cm ** 0.4-1 m below ground volumetric soil moisture content [fraction]
12	soilw100_200cm ** 1-2 m below ground volumetric soil moisture content [fraction]
13	tmpsfc ** surface temperature [k]
14	tmp2m ** 2 m above ground temperature [k]
15	tsoil0_10cm ** 0-0.1 m below ground soil temperature validation to deprecate [k]
16	tsoil10_40cm ** 0.1-0.4 m below ground soil temperature validation to deprecate [k]
17	tsoil40_100cm ** 0.4-1 m below ground soil temperature validation to deprecate [k]
18	tsoil100_200cm ** 1-2 m below ground soil temperature validation to deprecate [k]
19	ugrd10m ** 10 m above ground u-component of wind [m/s]
20	ugrd50m ** 50 m above ground u-component of wind [m/s]
21	ugrdmwl ** max wind u-component of wind [m/s]

Precipitação

```
variables <- "acpcpsfc" # Accumulated precipitation surface (mm)
```

Previsão

A variável time no DODSGrab() é um vetor de dois componentes, como c(start, end), que define os índices do intervalo de tempo. O modelo GFS fornece previsões a cada 3 horas:

- time = c(0, 0) Previsão para o tempo mais atual.
- time = c(8, 8) 24 horas à frente (8 × 3 horas = 24 horas).
- time = c(116, 116) 116 × 3 horas = 348 horas, ou cerca de 14,5 dias.

```
time <- c(116,116) # Status de inicialização

model.data <- DODSGrab(latest.model, latest.model.run, variables,
                       time, lon.inds , lat.inds)
```

```
## [1] "https://nomads.ncep.noaa.gov:443/dods/gfs_0p50/gfs20241117/gfs_0p50_12z.ascii?acpcpsfc[116:116]
```

```
hoje <- Sys.time()
hoje
```

```
## [1] "2024-11-17 15:34:44 -03"
```

```
forecast <- ModelGrid(model.data, c(0.5, 0.5))
forecast$fcst.date
```

```
## [1] "2024-12-02 GMT"
```

Mapa para o modelo

```
prec <- list()
prec$x <- forecast$x
prec$y <- forecast$y
prec$z <- forecast$z[1,1,,]
r <- raster::raster(prec)
r2 <- raster::rotate(r)
crs_target <- CRS("+proj=longlat +datum=WGS84 +no_defs")
r3 <- projectRaster(r2, crs = crs_target)
# Converter raster para data.frame para ggplot
r_df <- as.data.frame(r3, xy = TRUE, na.rm = TRUE)
colnames(r_df) <- c("lon", "lat", "precip")
```

Base Cartográfica IBGE

```
library(dplyr)
library(sf)

# xmin       ymin       xmax       ymax # wkt filter - limite da consulta .gpkg
# -61.633383 -33.751178 -39.856829  -7.349028

pts <- st_sf(pt = 1:2,
             geom = st_sfc(st_point(c(
               -61.633383, -33.751178
             )), st_point(c(
               -39.856829, -7.349028
             ))),
             crs = 4326)
pol <- pts %>% st_bbox() %>% st_as_sfc(., crs = 4326)
```

```r
subset_reg <- st_as_text(st_geometry(pol))

bc_ibge <- "/IBGE/BC_250/bc250_ibge.gpkg"
st_layers(bc_ibge)

# Sys.setlocale("LC_ALL", "pt_BR.UTF-8")
cidade <- st_read(bc_ibge, layer = "lml_cidade_p",
                  wkt_filter = subset_reg) %>% # Evita carregar todos o municipios
  dplyr::filter(nome %in% c("Bataguassu",#MS
                            "Inocência", #MS
                            "Dourados", # MS
                            "Ortigueira", #PR
                            "Cascavel", # PR
                            "Uberlândia", # MG
                            "Bauru", # SP
                            "Ribeirão Preto", # SP
                            "Rio Verde", # GO
                            "Alto Araguaia", # GO
                            "Passo Fundo")) # RS

capital <- st_read(bc_ibge, layer = "lml_capital_p") %>% dplyr::select( - tipocapital)
mun_label <- rbind(cidade, capital)

uf <- st_read(bc_ibge, layer = "lml_unidade_federacao_a")

mun_label_coords <- cbind(mun_label, st_coordinates(mun_label))
```

Plot

```r
library(ggplot2)

ext.mapa <- c(xmin = -58.0, xmax = -46.25, ymin = -28, ymax = -13)

# Definir a codificação de caracteres para UTF-8
# Sys.setlocale("LC_ALL", "pt_BR.UTF-8")

 p <- ggplot() +
   geom_raster(data = r_df, aes(x = lon, y = lat, fill = precip)) +
   scale_fill_gradientn(
     colors = c("#FFFFCC", "#41B6C4", "#0C2C84"),
     name = "",
     na.value = "transparent"
   ) +
   geom_sf(
     data = uf,
     fill = "lightblue",
     color = "black",
     alpha = .10
   ) +
   geom_sf(data = mun_label,
           color = "red",
           size = .15) +
   geom_text(
```

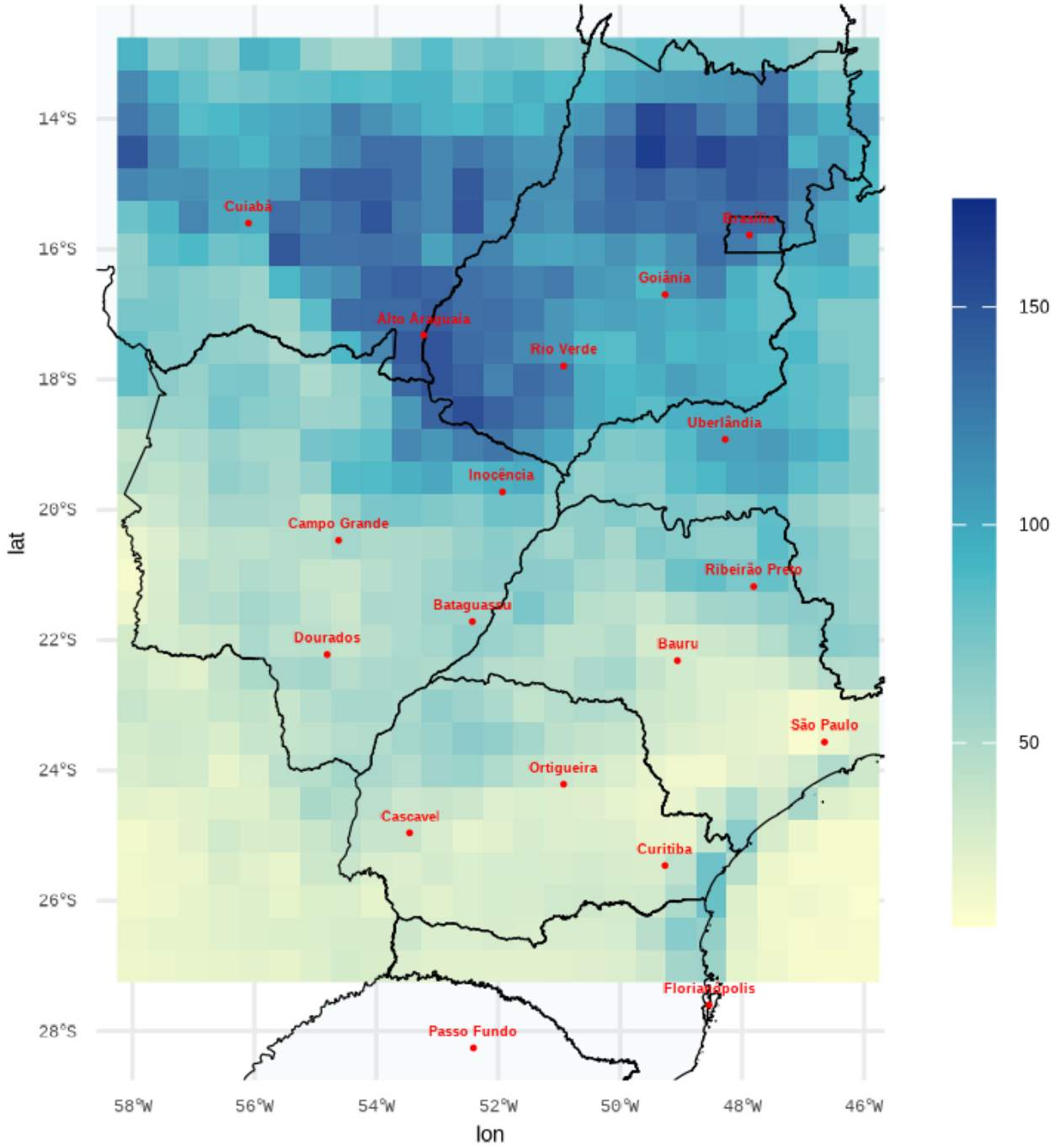
```
    data = mun_label_coords,
    aes(x = X, y = Y, label = nome),
    size = 2.25,
    nudge_y = .25,
    color = "red",
    fontface = "bold",
    check_overlap = TRUE
  ) +
  coord_sf(xlim = c(ext.mapa["xmin"], ext.mapa["xmax"]),
           ylim = c(ext.mapa["ymin"], ext.mapa["ymax"])) +
  theme_minimal()  +
  labs(
    title = "Modelo GFS 0.5 deg NCEP",
    subtitle = "Precipitação acumulada (mm) em 348 horas
             <2024-12-02 00:00:00 GMT>",
    caption = "gfs_0p50_12z: GFS 0.5 deg starting from 12Z17nov2024, 17:13 UTC"
  ) +
  theme(
    plot.title = element_text(
      size = 22,
      face = "bold",
      family = "serif"
    ),
    plot.subtitle = element_text(
      size = 12,
      face = "plain",
      family = "mono"
    ),
    plot.caption = element_text(
      size = 10,
      face = "plain",
      family = "mono"
    ),
    axis.text = element_text(family = "mono"),
    axis.text.x = element_text(family = "mono"),
    axis.text.y = element_text(family = "mono"),
    legend.key.height = unit(0.10, 'npc'),
    legend.key.width = unit(0.04, 'npc')
  )

ggsave(
  plot = p,
  filename = "./mapa_modelo_gfs.png",
  width = 9.5,
  height = 12.5,
  units = "cm",
  device = "png",
  dpi = 200,
  bg = "white"
)
```

Modelo GFS 0.5 deg NCEP

Precipitação acumulada (mm) em 348 horas

<2024-12-02 00:00:00 GMT>



gfs_0p50_12z: GFS 0.5 deg starting from 12Z17nov2024, 17:13 UTC