Downloading/Accessing NCEP forecast grids from NCEP NOMADS sever

Downloading subset forecast model data from an NCEP server.

Go to https://nomads.ncep.noaa.gov/, choose the model data you want in Data Set column. For example, "GFS 1.00 Degree" for 1 degree resolution GFS data set.

There are three ways of downloading/accessing the data.

1. ***The 'https' direct download approach***

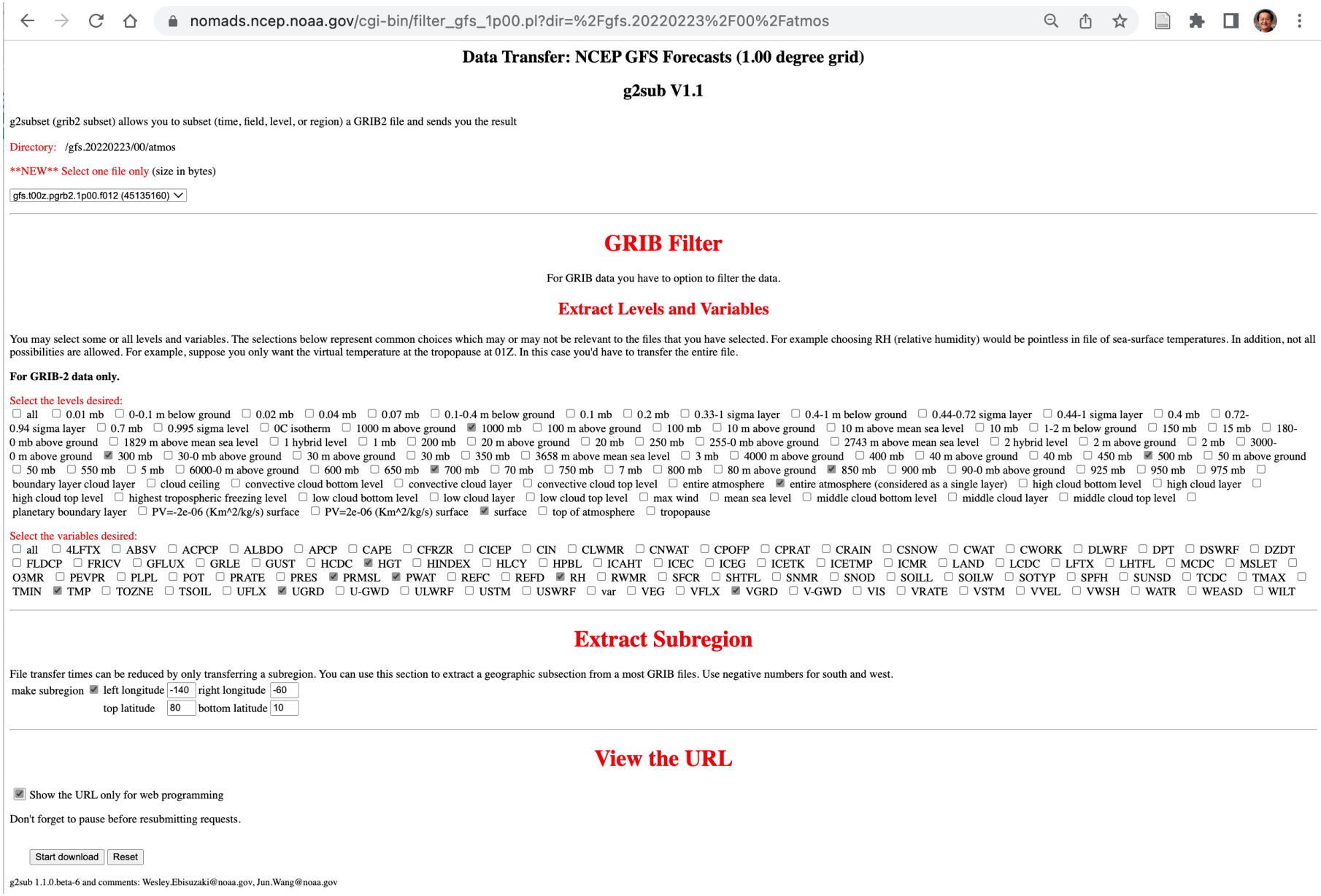
The 'https' approach takes you to the data directory and files where you can click and download individual files, either manually or using `wget` with the full URL pointing to the specific files. For example:

```
wget https://nomads.ncep.noaa.gov/pub/data/nccf/com/gfs/prod/gfs.20220223/00/atmos/gfs.t00z.pgrb2.1p00.f012
```

will download file gfs.t00z.pgrb2.1p00.f012.

2. ***The 'grid filter' approach***

This method allows you to pick and choose variables, model levels and spatial range of the grids, then either directly download or obtain an URL to allow you to download through common line or in a script using `curl`. The filter interface is shown in the following screen capture, where "Show the URL only for web programming" is selected.


nomads.ncep.noaa.gov/cgi-bin/filter_gfs_1p00.pl?dir=%2Fgfs.20220223%2F00%2Fatmos
Data Transfer: NCEP GFS Forecasts (1.00 degree grid)
g2sub V1.1
g2subset (grib2 subset) allows you to subset (time, field, level, or region) a GRIB2 file and sends you the result
Directory: /gfs.20220223/00/atmos
NEW Select one file only (size in bytes)
gfs.t00z.pgrb2.1p00.f012 (45135160)
GRIB Filter
For GRIB data you have to option to filter the data.
Extract Levels and Variables
You may select some or all levels and variables. The selections below represent common choices which may or may not be relevant to the files that you have selected. For example choosing RH (relative humidity) would be pointless in file of sea-surface temperatures. In addition, not all possibilities are allowed. For example, suppose you only want the virtual temperature at the tropopause at 01Z. In this case you'd have to transfer the entire file.
For GRIB-2 data only.
Select the levels desired:
all 0.01 mb 0-0.1 m below ground 0.02 mb 0.04 mb 0.07 mb 0.1-0.4 m below ground 0.1 mb 0.2 mb 0.33-1 sigma layer 0.4-1 m below ground 0.44-0.72 sigma layer 0.44-1 sigma layer 0.4 mb 0.72-0.94 sigma layer 0.7 mb 0.995 sigma level 0C isotherm 1000 m above ground 1000 mb 100 m above ground 100 mb 10 m above ground 10 m above mean sea level 10 mb 1-2 m below ground 150 mb 15 mb 180-0 mb above ground 1829 m above mean sea level 1 hybrid level 1 mb 200 mb 20 m above ground 20 mb 250 mb 255-0 mb above ground 2743 m above mean sea level 2 hybrid level 2 m above ground 2 mb 3000-0 m above ground 300 mb 30-0 mb above ground 30 m above ground 30 mb 350 mb 3658 m above mean sea level 3 mb 4000 m above ground 400 mb 40 m above ground 40 mb 450 mb 500 mb 50 m above ground 50 mb 550 mb 5 mb 6000-0 m above ground 600 mb 650 mb 700 mb 70 mb 750 mb 7 mb 800 mb 80 m above ground 850 mb 900 mb 90-0 mb above ground 925 mb 950 mb 975 mb boundary layer cloud layer cloud ceiling convective cloud bottom level convective cloud layer convective cloud top level entire atmosphere entire atmosphere (considered as a single layer) high cloud bottom level high cloud layer high cloud top level highest tropospheric freezing level low cloud bottom level low cloud layer low cloud top level max wind mean sea level middle cloud bottom level middle cloud layer middle cloud top level planetary boundary layer PV=-2e-06 (Km^2/kg/s) surface PV=2e-06 (Km^2/kg/s) surface surface top of atmosphere tropopause
Select the variables desired:
all 4LFTX ABSV ACPCP ALBDO APCP CAPE CFRZR CICEP CIN CLWMR CNWAT CPOFP CPRAT CRAIN CSNOW CWAT CWORK DLWRF DPT DSWRF DZDT FLDCP FRICV GFLUX GRLE GUST HCDC HGT HINDEX HLCY HPBL ICAHT ICEC ICEG ICETK ICETMP ICMR LAND LCDC LFTX LHTFL MCDC MSLET O3MR PEVPR PLPL POT PRATE PRES PRMSL PWAT REFC REFD RH RWMR SFCR SHTFL SNMR SNOD SOILL SOILW SOTYP SPFH SUNSD TCDC TMAX TMIN TMP TOZNE TSOIL UFLX UGRD U-GWD ULWRF USTM USWRF var VEG VFLX VGRD V-GWD VIS VRATE VSTM VVEL VWSH WATR WEASD WILT
Extract Subregion
File transfer times can be reduced by only transferring a subregion. You can use this section to extract a geographic subsection from a most GRIB files. Use negative numbers for south and west.
make subregion left longitude -140 right longitude -60
top latitude 80 bottom latitude 10
View the URL
Show the URL only for web programming
Don't forget to pause before resubmitting requests.
Start download Reset
g2sub 1.1.0.beta-6 and comments: Wesley.Ebisuzaki@noaa.gov, Jun.Wang@noaa.gov

Click on ‘Start downloading’, you will be presented with the following URL, which specifies the data variables, their vertical levels and lat/lon ranges to be downloaded:

```
URL=
https://nomads.ncep.noaa.gov/cgi-
bin/filter_gfs_1p00.pl?file=gfs.t00z.pgrb2.1p00.f012&lev_1000_mb=on&lev_300_mb=
on&lev_500_mb=on&lev_750_mb=on&lev_800_mb=on&lev_entire_atmosphere_%5C%28consid
ered_as_a_single_layer%5C%29=on&lev_surface=on&var_HGT=on&var_PRMSL=on&var_PWAT
=on&var_RH=on&var_TMP=on&var_UGRD=on&var_VGRD=on&subregion=&leftlon=-
140&rightlon=-60&toplat=90&bottomlat=10&dir=%2Fgfs.20220223%2F00%2Fatmos
```

In the Unix/Linux terminal, such as the jupyter.lib.ou.edu terminal (I suggest you make a directory first and do the following within the directory), enter the following:

```
curl ‘https://nomads.ncep.noaa.gov/cgi-
bin/filter_gfs_1p00.pl?file=gfs.t00z.pgrb2.1p00.f012&lev_1000_mb=on&lev_300_mb=
on&lev_500_mb=on&lev_750_mb=on&lev_800_mb=on&lev_entire_atmosphere_%5C%28consid
ered_as_a_single_layer%5C%29=on&lev_surface=on&var_HGT=on&var_PRMSL=on&var_PWAT
=on&var_RH=on&var_TMP=on&var_UGRD=on&var_VGRD=on&subregion=&leftlon=-
140&rightlon=-60&toplat=90&bottomlat=10&dir=%2Fgfs.20220223%2F00%2Fatmos’ -o
GFS.grb
```

to download the subset GFS data.

You can convert the GRIB format GFS file to NetCDF format using wgrib2:

```
wgrib2 GFS.grb -nc4 -netcdf GFS.nc
```

If you don’t have wgrib2 command, try ‘conda install -c conda-forge wgrib2’ to install it.

Examine the content of GFS.nc using ncdump:

```
ncdump -h GFS.nc
```

In the following are screen information when I ran the above commands:

```
jovyan@jupyter-mxue-40ou-2eedu:~/GetGFS/tmp$ curl 'https://nomads.ncep.noaa.gov/cgi-
bin/filter_gfs_1p00.pl?file=gfs.t00z.pgrb2.1p00.f012&lev_1000_mb=on&lev_300_mb=on&lev_500
_mb=on&lev_750_mb=on&lev_800_mb=on&lev_entire_atmosphere_%5C%28considered_as_a_single_lay
er%5C%29=on&lev_surface=on&var_HGT=on&var_PRMSL=on&var_PWAT=on&var_RH=on&var_TMP=on&var_U
GRD=on&var_VGRD=on&subregion=&leftlon=-140&rightlon=-
60&toplat=90&bottomlat=10&dir=%2Fgfs.20220223%2F00%2Fatmos' -o GFS.grb

  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100  293k    0  293k    0     0   792k      0 --:--:-- --:--:-- --:--:--  795k

jovyan@jupyter-mxue-40ou-2eedu:~/GetGFS/tmp$ wgrib2 GFS.grb -nc4 -netcdf GFS.nc

1:0:d=2022022300:HGT:300 mb:12 hour fcst:
2:13301:d=2022022300:TMP:300 mb:12 hour fcst:
3:23322:d=2022022300:RH:300 mb:12 hour fcst:
4:31703:d=2022022300:UGRD:300 mb:12 hour fcst:
5:40084:d=2022022300:VGRD:300 mb:12 hour fcst:
6:48465:d=2022022300:HGT:500 mb:12 hour fcst:
7:61766:d=2022022300:TMP:500 mb:12 hour fcst:
8:72607:d=2022022300:RH:500 mb:12 hour fcst:
9:80988:d=2022022300:UGRD:500 mb:12 hour fcst:
10:89369:d=2022022300:VGRD:500 mb:12 hour fcst:
11:97750:d=2022022300:HGT:750 mb:12 hour fcst:
12:111051:d=2022022300:TMP:750 mb:12 hour fcst:
13:121892:d=2022022300:RH:750 mb:12 hour fcst:
14:130273:d=2022022300:UGRD:750 mb:12 hour fcst:
```

```
15:141114:d=2022022300:VGRD:750 mb:12 hour fcst:
16:151955:d=2022022300:HGT:800 mb:12 hour fcst:
17:164436:d=2022022300:TMP:800 mb:12 hour fcst:
18:175277:d=2022022300:RH:800 mb:12 hour fcst:
19:183658:d=2022022300:UGRD:800 mb:12 hour fcst:
20:194499:d=2022022300:VGRD:800 mb:12 hour fcst:
21:205340:d=2022022300:TMP:1000 mb:12 hour fcst:
22:216181:d=2022022300:RH:1000 mb:12 hour fcst:
23:224562:d=2022022300:UGRD:1000 mb:12 hour fcst:
24:234583:d=2022022300:VGRD:1000 mb:12 hour fcst:
25:245424:d=2022022300:HGT:1000 mb:12 hour fcst:
26:257905:d=2022022300:HGT:surface:12 hour fcst:
27:270386:d=2022022300:TMP:surface:12 hour fcst:
28:278767:d=2022022300:PWAT:entire atmosphere (considered as a single layer):12 hour
fcst:
29:292068:d=2022022300:RH:entire atmosphere (considered as a single layer):12 hour fcst:

jovyan@jupyter-mxue-40ou-2eedu:~/GetGFS/tmp$ ncdump -h GFS.nc

netcdf GFS {
dimensions:
        latitude = 81 ;
        longitude = 81 ;
        time = UNLIMITED ; // (1 currently)
variables:
        double latitude(latitude) ;
                latitude:units = "degrees_north" ;
                latitude:long_name = "latitude" ;
        double longitude(longitude) ;
                longitude:units = "degrees_east" ;
                longitude:long_name = "longitude" ;
        double time(time) ;
                time:units = "seconds since 1970-01-01 00:00:00.0 0:00" ;
                time:long_name = "verification time generated by wgrib2 function
verftime()" ;
```

```
                time:reference_time = 1645574400. ;
                time:reference_time_type = 3 ;
                time:reference_date = "2022.02.23 00:00:00 UTC" ;
                time:reference_time_description = "forecast or accumulated, reference
date is fixed" ;
                time:time_step_setting = "auto" ;
                time:time_step = 0. ;
        float HGT_300mb(time, latitude, longitude) ;
                HGT_300mb:_FillValue = 9.999e+20f ;
                HGT_300mb:short_name = "HGT_300mb" ;
                HGT_300mb:long_name = "Geopotential Height" ;
                HGT_300mb:level = "300 mb" ;
                HGT_300mb:units = "m" ;
        float TMP_300mb(time, latitude, longitude) ;
                TMP_300mb:_FillValue = 9.999e+20f ;
                TMP_300mb:short_name = "TMP_300mb" ;
                TMP_300mb:long_name = "Temperature" ;
                TMP_300mb:level = "300 mb" ;
                TMP_300mb:units = "K" ;
        float RH_300mb(time, latitude, longitude) ;
                RH_300mb:_FillValue = 9.999e+20f ;
                RH_300mb:short_name = "RH_300mb" ;
                RH_300mb:long_name = "Relative Humidity" ;
                RH_300mb:level = "300 mb" ;
                RH_300mb:units = "percent" ;
…. omitted….
```

3. ***The OpenDAP approach – most attractive if the data server supports it***

See https://earthdata.nasa.gov/collaborate/open-data-services-and-software/api/opendap

From the above website: "Open-source Project for a Network Data Access Protocol (OPeNDAP) is the developer of client/server software, of the same name, that enables scientists to share data more easily over the internet. The OPeNDAP group is also the original developer of the Data Access Protocol (DAP) that the software uses. Many other groups have adopted DAP and provide compatible clients, servers, and SDKs. OPeNDAP's DAP is also a NASA community standard. For the rest of this document, "OPeNDAP" will refer to the software.

With OPeNDAP, you can access data using an OPeNDAP URL of any database server that supports OPeNDAP. You can do this via command-line, Internet browser, or a custom UI. You can also use other NetCDF compliant tools, such as Matlab, R, IDL, IDV, and Panoply."

At the https://nomads.ncep.noaa.gov/ site, click OpenDAP for the data set you want to access, such as 1 degree GFS. Select a date (e.g.,. gfs20220223), flick on info for the forecast cycle you want, then you are at a page with a URL like

https://nomads.ncep.noaa.gov/dods/gfs_1p00/gfs20220223/gfs_1p00_00z.info that shows the OpenDAP URL like the following:

OPeNDAP/DODS Data URL: http://nomads.ncep.noaa.gov:80/dods/gfs_1p00/gfs20220223/gfs_1p00_00z

http://nomads.ncep.noaa.gov:80/dods/gfs_1p00/gfs20220223/gfs_1p00_00z

is what you need to specify in the your python code, using

dataset = xr.open_dataset(“http://nomads.ncep.noaa.gov:80/dods/gfs_1p00/gfs20220223/gfs_1p00_00z”).

Here open_dataset is an xarray function for ‘open and decode a dataset from a file or file-like object.’

See https://xarray.pydata.org/en/stable/generated/xarray.open_dataset.html.