FengYun-4B/GIIRS FYGeoAIR NH3 retrievals from July 2022 to June 2025

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1 Descriptions

This dataset contains tropospheric ammonia retrieval data observed by the Geostationary Interferometric Infrared Sounder (GIIRS) on board China's FengYun-4B satellite, which was launched in 2021. The datasets include NH3 column estimates, the uncertainty, and the column averaging kernel (AK) information. The spatial resolution is 2km and temporal resolution 2-hour covering both day and night. The data have been pre-filtered to ensure the high data quality. The nighttime data should be used with caution due to their low thermal contrast, which may lead to high retrieval uncertainty. Prior to using this dataset, please reach out to the project lead Zhao-Cheng Zeng for more detailed information. A Python code for reading and plotting the data is also available.

Data access [Zenodo]: https://doi.org/10.5281/zenodo.17193848

Algorithm reference: Zeng, Z.-C., Lee, L., Qi, C., Clarisse, L., and Van Damme, M.: Optimal estimation retrieval of tropospheric ammonia from the Geostationary Interferometric Infrared Sounder on board FengYun-4B, Atmos. Meas. Tech., 16, 3693–3713, https://doi.org/10.5194/amt-16-3693-2023, 2023.

Please visit project website for future updates: https://fengyunair.github.io/

2 Variables stored in the file

[**latitude**] : latitude for the observation
[**longitude**] : longitude for the observation
[**hour_utc**] : observation decimal hour UTC+0
[**sza**] : solar zenith angle
[**vza**] : satellite viewing zenith angle
[**ap_skint**] : a priori surface skin temperature [K] from ERA5 reanalysis
[**ret_surft**] : retrieved surface skin temperature [K]
[**ap_surfp**] : a priori surface pressure [hPa] from ERA5 reanalysis
[**midlayer_pres**] : mid-layer atmospheric pressure [hPa]
[**midlayer_temp**] : mid-layer atmospheric temperature [K]
[**ap_nh3_profile**] : a priori ammonia partial column for each layer [molecules/cm2]
[**ret_nh3_col**] : retrieved total column ammonia [molecules/cm2]
[**ret_nh3_col_uncertainty_percentage**] : retrieval uncertainty (%) for ammonia column
[**ret_columnaveragingkernel**] : column averaging kernel [molecule/molecule] for retrieval

3 Pre-filtering of the data

The retrievals have been pre-filtered using the following criteria: (1) RMSE of spectral fitting residual less than 0.2K; (2) Reduced χ^2 less than 5; (3) Retrieval error less than 300%; (4) The absolute difference of the a priori and retrieved surface skin temperature less than 10K; (5) Bottom layer column averaging kernel value larger than 0.

4 Changes in starting hour and location

The starting hours for the 12 measurement cycles in a day by FY-4B/GIIRS were 00:00, 02:00, 04:00,..., 22:00UTC, respectively, and were changed to 01:00, 03:00, 05:00,. . ., 23:00 UTC,

respectively, after 6 September 2022. The hour information in the file names changes accordingly. In addition, FY-4B/GIIRS migrated to 105°E in Feb of 2024 from 133°E. The GIIRS coverage become wider. During the satellite migration, no observations are available (in Feb 2024).

5 Sample Python codes for reading and mapping the data

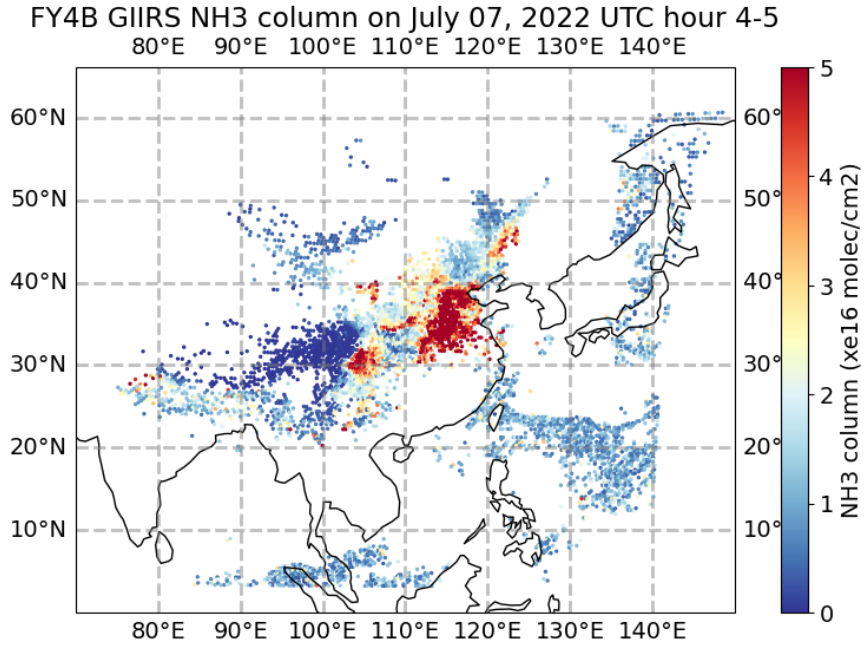
```
# import packages
import numpy as np
import numpy.matlib
import h5py as h5
import cartopy.crs as ccrs
import matplotlib.pyplot as plt

# reading file
YYYYMMDD = '20220707'
HH1Str = '04'
HH2Str = '05'

new_folder = 'RetrievalResults_202207_ForUsers/'
new_file  = new_folder + 'FY4B_GIIRS_FYGEOAIR_NH3_v1_' + YYYYMMDD + '_h' + HH1Str + '_h' +
HH2Str + '.h5'
f = h5.File(new_file,'r')
latitude = f['latitude'][:]
longitude = f['longitude'][:]
hour_utc = f['hour_utc'][:]
sza = f['sza'][:]
vza = f['vza'][:]
ap_skint  = f['ap_skint'][:]
ret_surft = f['ret_surft'][:]
ap_surfp = f['ap_surfp'][:]
midlayer_pres = f['midlayer_pres'][:]
midlayer_temp = f['midlayer_temp'][:]
ap_nh3_profile = f['ap_nh3_profile'][:]
ret_nh3_col = f['ret_nh3_col'][:]
ret_nh3_col_uncertainty_percentage = f['ret_nh3_col_uncertainty_percentage'][:]
ret_columnaveragingkernel = f['ret_columnaveragingkernel'][:]
f.close()

# Mapping ammonia columns
plt.figure(figsize=(10,6))
plt.rc('font',size=14)
proj = ccrs.PlateCarree()
ax = plt.axes(projection=proj)
ax.set_extent([70, 150, 0, 60])
ax.coastlines()
ax.gridlines(crs=ccrs.PlateCarree(), draw_labels=True,linewidth=2, color='gray', alpha=0.5, linestyle='--')
x = longitude
y = latitude
color = ret_nh3_col/1e16
plt.scatter(x,y,s=2,c=color,vmin=0,vmax=5,cmap='RdYlBu_r')
plt.colorbar(label='NH3 column (xe16 molec/cm2)')
plt.title('FY4B GIIRS NH3 column on July 07, 2022 UTC hour 4-5')
plt.show()
```

Mapping result



Plot column averaging kernel for the observation close to [35N,115E]

```
lat0 = 35.0
lon0 = 115.0
idx = np.argmin(np.abs(longitude-lon0)+np.abs(latitude-lat0))
plt.figure(figsize=(8,5))
plt.rc('font',size=14)
plt.plot(ret_columnaveragingkernel[idx,:],midlayer_pres[idx,:],markersize=10,marker='s')
plt.gca().invert_yaxis()
plt.xlabel('Column Averaging Kernel (molecule/molecule)')
plt.ylabel('Mid-layer Pressure [hPa]')
```

result