Monthly NO2 Timeseries

2016-2022 Timeseries of Monthly NO2 Using `rioxarray`, `satsarch` and `stackstac`

```python
import rioxarray
import stackstac
from satsearch import Search
```

```python
stac_api_url = 'https://staging-stac.delta-backend.xyz/'
china_bbox = [
    73.675,
    18.198,
    135.026,
    53.459
]
datetime = "2000-01-01T00:00:00Z/2022-01-02T00:00:00Z"
collection = 'no2-monthly'

search = Search.search(
    url=stac_api_url,
    bbox=china_bbox,
    datetime=datetime,
    collections=[collection],
    limit=1000
)
items = search.items()
```

```
url is https://staging-stac.delta-backend.xyz/search
headers is None
kwargs is {'limit': 1000, 'bbox': [73.675, 18.198, 135.026, 53.459], 'datetime': '2000-01-01
```

```
len(items)
```

```
73
```

```
stack = stackstac.stack(items)
```

```
stack
```

```
<xarray.DataArray 'stackstac-a8afebb458dddd242ccfecc9f369d38d' (time: 73,
                                                                band: 1,
                                                                y: 1800, x: 3600)>
dask.array<fetch_raster_window, shape=(73, 1, 1800, 3600), dtype=float64, chunksize=(1, 1, 10
Coordinates:
  * time         (time) datetime64[ns] 2016-01-01 2016-02-01 ... 2022-01-01
    id           (time) <U46 'OMI_trno2_0.10x0.10_201601_Col3_V4-no2-month...
  * band         (band) <U11 'cog_default'
  * x            (x) float64 -180.0 -179.9 -179.8 ... 179.7 179.8 179.9
  * y            (y) float64 90.0 89.9 89.8 89.7 ... -89.6 -89.7 -89.8 -89.9
    proj:epsg    int64 4326
    proj:bbox    object {180.0, -180.0, 90.0, -90.0}
    proj:shape   object {1800, 3600}
    proj:geometry  object {'type': 'Polygon', 'coordinates': [[[-180.0, 90.0...
    proj:transform  object {0.1, 0.0, -0.1, 1.0, -180.0, 90.0}
    epsg         int64 4326
Attributes:
    spec:        RasterSpec(epsg=4326, bounds=(-180.0, -90.0, 180.0, 90.0), r...
    crs:         epsg:4326
    transform:   | 0.10, 0.00,-180.00|\n| 0.00,-0.10, 90.00|\n| 0.00, 0.00, 1...
    resolution:  0.1
```

```python
# Subset to Bounding Box for China
subset = stack.rio.clip_box(
    minx=china_bbox[0],
    miny=china_bbox[1],
    maxx=china_bbox[2],
    maxy=china_bbox[3]
)
subset
```

```
<xarray.DataArray 'stackstac-a8afebb458dddd242ccfecc9f369d38d' (time: 73,
```

```
                                                              band: 1,
                                                              y: 354, x: 614)>
dask.array<getitem, shape=(73, 1, 354, 614), dtype=float64, chunksize=(1, 1, 354, 535), chun
Coordinates:
  * time           (time) datetime64[ns] 2016-01-01 2016-02-01 ... 2022-01-01
    id             (time) <U46 'OMI_trno2_0.10x0.10_201601_Col3_V4-no2-month...
  * band           (band) <U11 'cog_default'
  * x              (x) float64 73.7 73.8 73.9 74.0 ... 134.7 134.8 134.9 135.0
  * y              (y) float64 53.5 53.4 53.3 53.2 53.1 ... 18.5 18.4 18.3 18.2
    proj:epsg      int64 4326
    proj:bbox      object {90.0, 180.0, -90.0, -180.0}
    proj:shape     object {1800, 3600}
    proj:geometry  object {'type': 'Polygon', 'coordinates': [[[-180.0, 90.0...
    proj:transform object {0.1, 0.0, 1.0, -0.1, -180.0, 90.0}
    epsg           int64 4326
    spatial_ref    int64 0
Attributes:
    spec:          RasterSpec(epsg=4326, bounds=(-180.0, -90.0, 180.0, 90.0), r...
    resolution:    0.1
```

```python
# select the band default
data_band = subset.sel(band='cog_default')
data_band
```

```
<xarray.DataArray 'stackstac-a8afebb458dddd242ccfecc9f369d38d' (time: 73,
                                                                y: 354, x: 614)>
dask.array<getitem, shape=(73, 354, 614), dtype=float64, chunksize=(1, 354, 535), chunktype=
Coordinates:
  * time           (time) datetime64[ns] 2016-01-01 2016-02-01 ... 2022-01-01
    id             (time) <U46 'OMI_trno2_0.10x0.10_201601_Col3_V4-no2-month...
    band           <U11 'cog_default'
  * x              (x) float64 73.7 73.8 73.9 74.0 ... 134.7 134.8 134.9 135.0
  * y              (y) float64 53.5 53.4 53.3 53.2 53.1 ... 18.5 18.4 18.3 18.2
    proj:epsg      int64 4326
    proj:bbox      object {90.0, 180.0, -90.0, -180.0}
    proj:shape     object {1800, 3600}
    proj:geometry  object {'type': 'Polygon', 'coordinates': [[[-180.0, 90.0...
    proj:transform object {0.1, 0.0, 1.0, -0.1, -180.0, 90.0}
    epsg           int64 4326
    spatial_ref    int64 0
Attributes:
    spec:          RasterSpec(epsg=4326, bounds=(-180.0, -90.0, 180.0, 90.0), r...
```

```
    resolution:   0.1
```

```
# Group data into months
no2_months = data_band.groupby('time')
```

```
# Average over entire spatial bounding box for each month
monthly_mean_no2 = no2_months.mean(dim=('x', 'y'))
```

```
%%time
monthly_mean_no2.plot()
```

```
CPU times: user 6.72 s, sys: 2.58 s, total: 9.29 s
Wall time: 35.8 s
```