HRSC_footprints_report

February 6, 2022

1 HRSC footprints issue

In the process of acquiring images from multiple experiments, I noticed some problems in HRSC footprints. This document expose the issues with the goal to report them to USGS/PDS/ODE people in charge.

As an example, the footprints we are going to see are in the region of Mawrth Vallis, Mars (~ 22.5o,343.5o; C180+E).

[1]:
```
bbox = {
    'minlat': 22,
    'maxlat': 23,
    'westlon': 343,
    'eastlon': 344
}
```

1.1 Data query

The we are eventually going to download comes from USGS/PDS; to know where the data is available for download (ie, URL), we query USGS' ODE (https://ode.rsl.wustl.edu/) servers. All those quirks – query, retrieve, select, etc. – are implemented in the lib.

First thing we do is to query what are the datasets the (NPT) lib supports; And then we go query for them products.

[2]:
```
import requests

url = ('https://oderest.rsl.wustl.edu/live2/?
 ↪query=product&results=fmpc&output=JSON&loc=f'
       '&minlat={minlat}'
       '&maxlat={maxlat}'
       '&westlon={westlon}'
       '&eastlon={eastlon}'
       '&target=MARS'
       '&ihid=MEX'
       '&iid=HRSC'
       '&pt=REFDR3').format(**bbox)

res = requests.get(url)
```

```
print("URL queried: '{}'".format(res.request.url))
assert res.status_code == 200, "Request failed."
```

```
URL queried: 'https://oderest.rsl.wustl.edu/live2/?query=product&results=fmpc&ou
tput=JSON&loc=f&minlat=22&maxlat=23&westlon=343&eastlon=344&target=MARS&ihid=MEX
&iid=HRSC&pt=REFDR3'
```

[3]:
```
_answer = res.json()
assert _answer['ODEResults']['Status'].lower() == 'success' and␣
 ↪int(_answer['ODEResults']['Count']) > 1

products = _answer['ODEResults']['Products']['Product']
assert len(products) == int(_answer['ODEResults']['Count'])

print("{} data products found.".format(len(products)))
```

```
85 data products found.
```

For simplicity, I'll filter for *Nadir* images.

[4]:
```
products_nadir = [p for p in products if 'ND3' in p['pdsid']]

print("{} (Nadir) images being used.".format(len(products_nadir)))
```

```
9 (Nadir) images being used.
```

Finally, let's check those footprints. First, we will check the "C0" (-180:180) footprints; then, the "GL" footprints (0:360). They are the same, but we like double-check anyways...

[5]:
```
from geopandas import GeoDataFrame
import shapely

products_data_selected = []
for p in products_nadir:
    _data_selected = {k:p[k] for k in 'pdsid ihid iid pt ProductURL␣
 ↪Footprints_cross_meridian Footprint_C0_geometry Footprint_GL_geometry'.
 ↪split()}
    products_data_selected.append(_data_selected)

gdf = GeoDataFrame(products_data_selected)
gdf
```

[5]:

	pdsid	ihid	iid	pt	\
0	H2229_0001_ND3.JP2	MEX	HRSC	REFDR3	
1	H2938_0000_ND3.JP2	MEX	HRSC	REFDR3	
2	H3308_0000_ND3.JP2	MEX	HRSC	REFDR3	
3	H5145_0000_ND3.JP2	MEX	HRSC	REFDR3	

```
4  H5163_0009_ND3.JP2  MEX  HRSC  REFDR3
5  H5181_0000_ND3.JP2  MEX  HRSC  REFDR3
6  HD633_0000_ND3.JP2  MEX  HRSC  REFDR3
7  HH783_0009_ND3.JP2  MEX  HRSC  REFDR3
8  HH857_0000_ND3.JP2  MEX  HRSC  REFDR3

                                          ProductURL  \
0  https://ode.rsl.wustl.edu/mars/indexproductpag…
1  https://ode.rsl.wustl.edu/mars/indexproductpag…
2  https://ode.rsl.wustl.edu/mars/indexproductpag…
3  https://ode.rsl.wustl.edu/mars/indexproductpag…
4  https://ode.rsl.wustl.edu/mars/indexproductpag…
5  https://ode.rsl.wustl.edu/mars/indexproductpag…
6  https://ode.rsl.wustl.edu/mars/indexproductpag…
7  https://ode.rsl.wustl.edu/mars/indexproductpag…
8  https://ode.rsl.wustl.edu/mars/indexproductpag…

  Footprints_cross_meridian  \
0                     False
1                     False
2                     False
3                     False
4                     False
5                     False
6                     False
7                     False
8                     False

                               Footprint_C0_geometry  \
0  POLYGON ((-19.076 11.606, -19.085 11.771, -19…
1  POLYGON ((-12.48 37.056, -12.496 36.881, -12.5…
2  POLYGON ((-15.039 27.395, -15.037 27.271, -15…
3  MULTIPOLYGON (((-14.653 20.4432, -14.645 21.05…
4  GEOMETRYCOLLECTION (LINESTRING (-16.9439997673…
5  POLYGON ((-16.379 27.952, -16.383 27.552, -16…
6  MULTIPOLYGON (((-16.8285 19.6865, -16.83 19.81…
7  POLYGON ((-16.37 24.428, -16.37 24.321, -16.36…
8  POLYGON ((-15.145 24.187, -15.145 24.135, -15…

                               Footprint_GL_geometry
0  POLYGON ((340.924 11.606, 340.915 11.771, 340…
1  POLYGON ((347.52 37.056, 347.504 36.881, 347.4…
2  POLYGON ((344.961 27.395, 344.963 27.271, 344…
3  MULTIPOLYGON (((343.9890983468124 20.983601702…
4  MULTIPOLYGON (((343.05614681710136 22.87723559…
5  POLYGON ((343.621 27.952, 343.62 27.852, 343.6…
6  GEOMETRYCOLLECTION (POLYGON ((343.171499938967…
```

```
7  POLYGON ((343.63 24.428, 343.63 24.375, 343.63…
8  POLYGON ((344.855 24.187, 344.855 24.135, 344…
```

I may be wrong, but I don't think footprints should be a `MULTIPOLYGON` or `GEOMETRYCOLLECTION`. Actually, anything different from a simple `POLYGON` to represent an *image* seems wrong to me. Even more, the fact that some geometries are being represented by different objects – in a non-stable way – is quite worrisome. * See, for instance, geometries for products (`pdsid`) `H5163_0009_ND3.JP2` and `HD633_0000_ND3.JP2`.

For the time being, I'm fixing that by considering the *ENVELOPE* of those (wrong) geometries.

[6]:
```
# Let's do the metadata selection again, but now we take the geometrical␣
 ↪*envolope* of
# the footprints defined under *geometry-collection* and *multi-polygon*␣
 ↪geometries.

from geopandas import GeoDataFrame
import shapely

products_data_selected = []

for prod in products_nadir:
    _data_selected = {f:prod[f] for f in 'pdsid ihid iid pt ProductURL␣
 ↪Footprints_cross_meridian'.split()}

    for geom_field in ('Footprint_C0_geometry','Footprint_GL_geometry'):
        _geom = shapely.wkt.loads(prod[geom_field])

        if (type(_geom) == shapely.geometry.GeometryCollection or type(_geom)␣
 ↪== shapely.geometry.MultiPolygon):
            _geom = _geom.envelope

        _data_selected[geom_field] = _geom

    products_data_selected.append(_data_selected)

gdf = GeoDataFrame(products_data_selected)
gdf
```

[6]:
```
                pdsid ihid   iid      pt  \
0  H2229_0001_ND3.JP2  MEX  HRSC  REFDR3
1  H2938_0000_ND3.JP2  MEX  HRSC  REFDR3
2  H3308_0000_ND3.JP2  MEX  HRSC  REFDR3
3  H5145_0000_ND3.JP2  MEX  HRSC  REFDR3
4  H5163_0009_ND3.JP2  MEX  HRSC  REFDR3
5  H5181_0000_ND3.JP2  MEX  HRSC  REFDR3
```

```
6  HD633_0000_ND3.JP2  MEX  HRSC  REFDR3
7  HH783_0009_ND3.JP2  MEX  HRSC  REFDR3
8  HH857_0000_ND3.JP2  MEX  HRSC  REFDR3

                                          ProductURL  \
0  https://ode.rsl.wustl.edu/mars/indexproductpag…
1  https://ode.rsl.wustl.edu/mars/indexproductpag…
2  https://ode.rsl.wustl.edu/mars/indexproductpag…
3  https://ode.rsl.wustl.edu/mars/indexproductpag…
4  https://ode.rsl.wustl.edu/mars/indexproductpag…
5  https://ode.rsl.wustl.edu/mars/indexproductpag…
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7  https://ode.rsl.wustl.edu/mars/indexproductpag…
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3  POLYGON ((-16.093 17.364, -14.589 17.364, -14…
4  POLYGON ((-17.019999980926507 19.4799995422363…
5  POLYGON ((-16.379 27.952, -16.383 27.552, -16…
6  POLYGON ((-18.405 19.563, -16.827 19.563, -16…
7  POLYGON ((-16.37 24.428, -16.37 24.321, -16.36…
8  POLYGON ((-15.145 24.187, -15.145 24.135, -15…

                               Footprint_GL_geometry
0  POLYGON ((340.924 11.606, 340.915 11.771, 340…
1  POLYGON ((347.52 37.056, 347.504 36.881, 347.4…
2  POLYGON ((344.961 27.395, 344.963 27.271, 344…
3  POLYGON ((343.90700006484985 17.36400032043457…
4  POLYGON ((342.9800000190735 19.479999542236328…
5  POLYGON ((343.621 27.952, 343.62 27.852, 343.6…
6  POLYGON ((341.59499979019165 19.55699920654297…
7  POLYGON ((343.63 24.428, 343.63 24.375, 343.63…
8  POLYGON ((344.855 24.187, 344.855 24.135, 344…
```
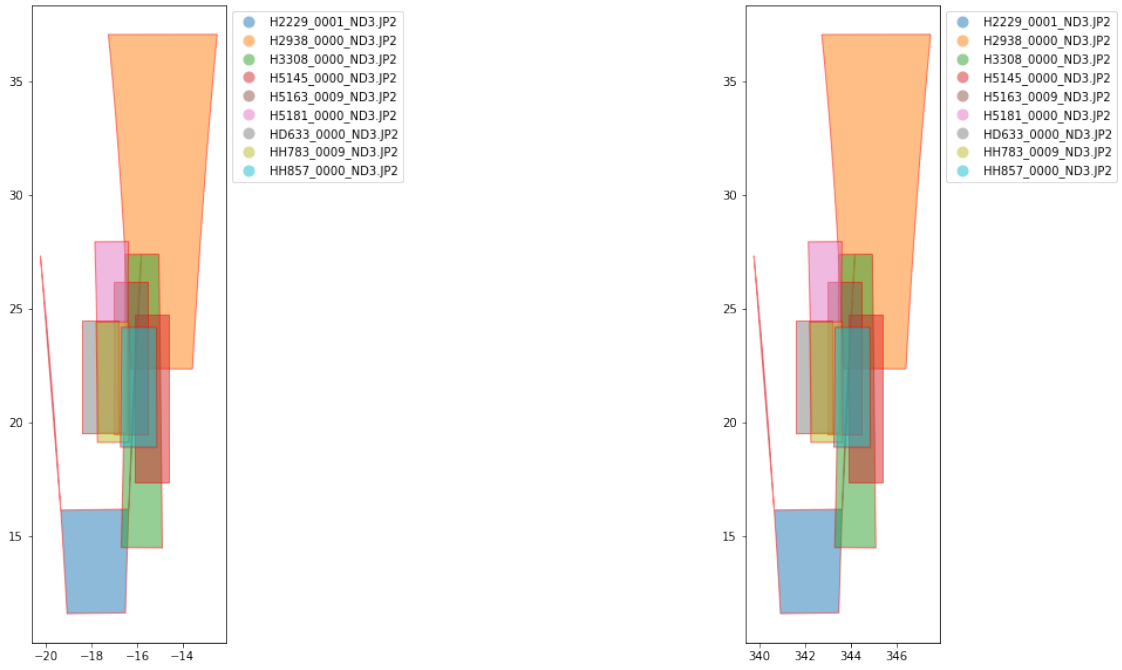

[7]:
```
%matplotlib inline

import matplotlib.pyplot as plt

plt.rcParams["figure.figsize"] = [20,10]

fig, (ax1, ax2) = plt.subplots(nrows=1, ncols=2)


(gdf.set_geometry('Footprint_C0_geometry')
    .plot(alpha=0.5, edgecolor='red', column='pdsid',
          legend=True, legend_kwds={'loc': 'upper left', 'bbox_to_anchor': (1,␣
 ↪1)},
          ax=ax1)
)

(gdf.set_geometry('Footprint_GL_geometry')
    .plot(alpha=0.5, edgecolor='red', column='pdsid',
          legend=True, legend_kwds={'loc': 'upper left', 'bbox_to_anchor': (1,␣
 ↪1)},
          ax=ax2)
)
```

[7]: <AxesSubplot:>



Footprint `H2229_0001_ND3` show a clear strange/erroneous shape.

1.2 Conclusion

We've shown some erroneous behaviour of footprints representing Mars Express' HRSC (*refdr3*) image data products as provided by ODE REST API (https://oderest.rsl.wustl.edu/).

Specifically, *two* are the issues here exposed (as seen on *three* data products):

- *Some* data product footprints are represented by different geometrical object/format – Multi-polygon or geometry-collection – depending on the coordinates reference. Data products `H5163_0009_ND3.JP2` and `HD633_0000_ND3.JP2` present such behaviour on (geometry) attributes `Footprint_GL_geometry` and `Footprint_C0_geometry`;
  - None of those images/footprints cross a meridian – is worth noticing.
- *Some* data product footprints – `H2229_0001_ND3.JP2`, for example – clearly do not properly represent an image as can be seeing from the plot(s) provided.

As *third* (and very worrisome) issue underlying the whole should be noticed: the *intermitent* factor; the two issues just discussed show some erratic behaviour.

[ ]: