test_cds_esacci_sm

January 11, 2019

```
In [2]: import sys
        sys.path.append("..")
        from c3s_511_trends import TrendLims1D
```

```
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/matplotlib/cbook/deprec
  warnings.warn(message, mplDeprecation, stacklevel=1)
```

1 Dataset description

ESA CCI Soilmoisture Combined. A soilmoisture product that blends different satellite products (both active and passive).

The selected gridpoint SAUD (22.1N;50.8E) corresponds to desert in Saudi Arabia. Su et al. 2006 [1] shows detected breakpoints in their Figure 2 using two different tests. For the selected gridpoint they find a breakpoint at the start of 1998 (t3,4) and another one halfway 2002 (t4,5) using alpha=0.01 for both tests. As can be seen below, the dataset contains several periods with missing data. We get rid of these missing data through resampling to monthly means as is done in Su et al. 2006.

The selected gridpoint AUST (19.1S;132.6E) is in the central northern territory in Australia. Also for this gridpoint, a breakpoint is found by Su et al. 2006.

[1] Su, C.-H., D. Ryu, W. Dorigo, S. Zwieback, A. Gruber, C. Albergel, R. H. Reichle, and W. Wagner (2016), Homogeneity of a global multisatellite soil moisture cli- mate data record, Geophys. Res. Lett., 43, 11,245–11,252, doi:10.1002/2016GL070458.

2 Breakpoint detection

```
In [4]: saud = TrendLims1D('CDS ESACCI SM - SAUD')
        saud.load_file('../test_data/cds_esacci_sm_SAUD.nc',var_name='sm')
        saud.subset(slice('1988','2017'))
        saud.plot('SAUD daily')
        saud.resample('M')
        saud.plot('SAUD monthly')
        saud.breakpoint_recipe_differences(resamplefreq='M')
        saud.breakpoint_recipe_values(resamplefreq='M')
```

```
Loaded datafile ../test_data/cds_esacci_sm_SAUD.nc
```
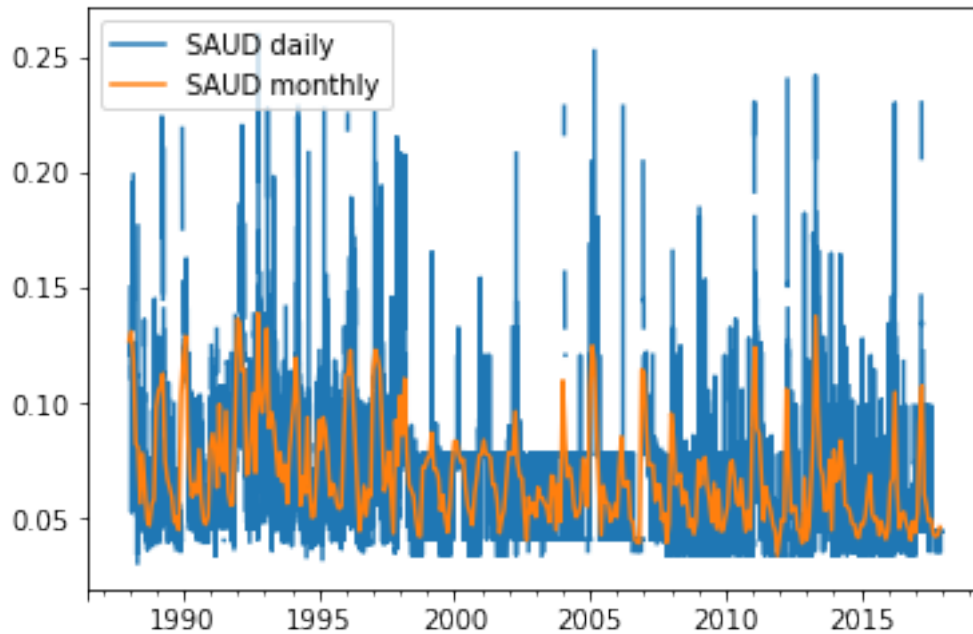
```
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/cf.py:
  warn_deprecated(msg)
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):


Warning: the data contains missing values
Subsetted to timeperiod 1988-2017
Warning: the data contains missing values
Creating a plot with label: SAUD daily
Resampled to M frequency
Creating a plot with label: SAUD monthly
This timeseries is marked as Suspect (variance based)
This timeseries is marked as Suspect (value based)
```

2.0.1 The timeseries is indeed marked as suspect for the breakpoint test applied to values and to differences. This is consistent with Su et al. 2006.

```
In [5]: oman = TrendLims1D('CDS ESACCI SM - OMAN')
        oman.load_file('../test_data/cds_esacci_sm_OMAN.nc',var_name='sm')
        oman.subset(slice('1988','1997'))
        oman.plot('OMAN daily')
        oman.resample('M')
        oman.plot('OMAN monthly')
        saud.breakpoint_recipe_differences(resamplefreq='M')
        saud.breakpoint_recipe_values(resamplefreq='M')

Loaded datafile ../test_data/cds_esacci_sm_OMAN.nc


/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/cf.py:
  warn_deprecated(msg)
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
```

```
    if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
    if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
    if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
    if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
    if np.issubdtype(cf_var.dtype, np.str):
```

```
Warning: the data contains missing values
Subsetted to timeperiod 1988-1997
Warning: the data contains missing values
Creating a plot with label: OMAN daily
Resampled to M frequency
Creating a plot with label: OMAN monthly
This timeseries is marked as Suspect (variance based)
This timeseries is marked as Suspect (value based)
```
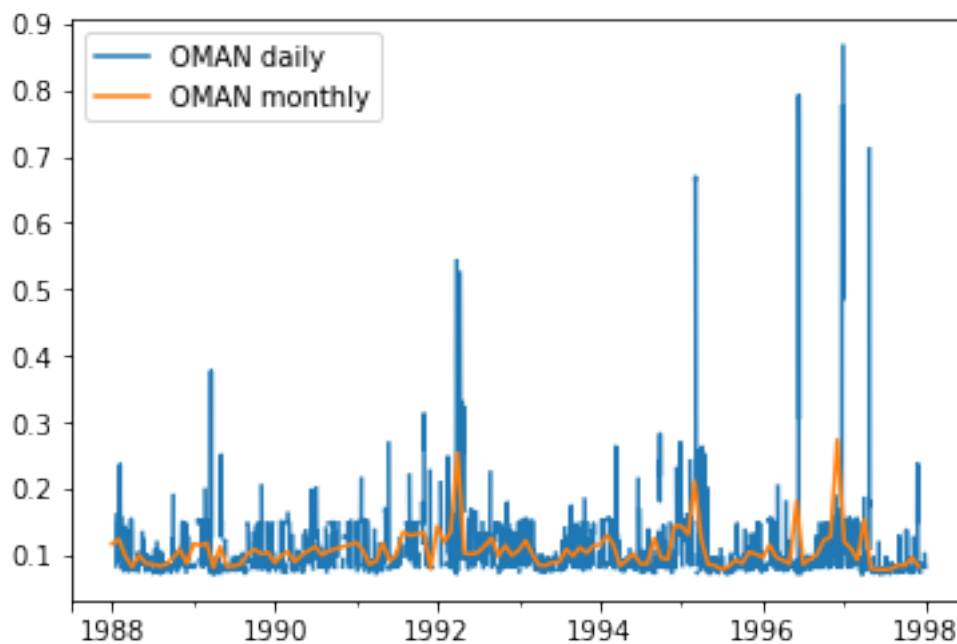

2.0.2 The timeseries for OMAN is also marked as suspect for the breakpoint test applied to values and to differences. This is consistent with Su et al. 2006.

```
In [6]: aust = TrendLims1D('CDS ESACCI SM - AUST')
        aust.load_file('../test_data/cds_esacci_sm_AUST.nc',var_name='sm')
```

```python
        aust.subset(slice('1991','2017'))
        aust.plot('AUST daily')
        aust.resample('M')
        aust.plot('AUST monthly')
        # Note that now the breakpoint detection is applied to yearly values (the default for th
        # this choice was made since there were data gaps
        aust.breakpoint_recipe_differences()
        aust.breakpoint_recipe_values()
```

```
Loaded datafile ../test_data/cds_esacci_sm_AUST.nc


/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/cf.py:
  warn_deprecated(msg)
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):
/net/exo/landclim/crezees/conda/envs/esmval2/lib/python3.6/site-packages/iris/fileformats/_pyke_
  if np.issubdtype(cf_var.dtype, np.str):


Warning: the data contains missing values
Subsetted to timeperiod 1991-2017
Warning: the data contains missing values
Creating a plot with label: AUST daily
Resampled to M frequency
Creating a plot with label: AUST monthly
This timeseries is marked as Useful (variance based)
This timeseries is marked as Useful (value based)
```
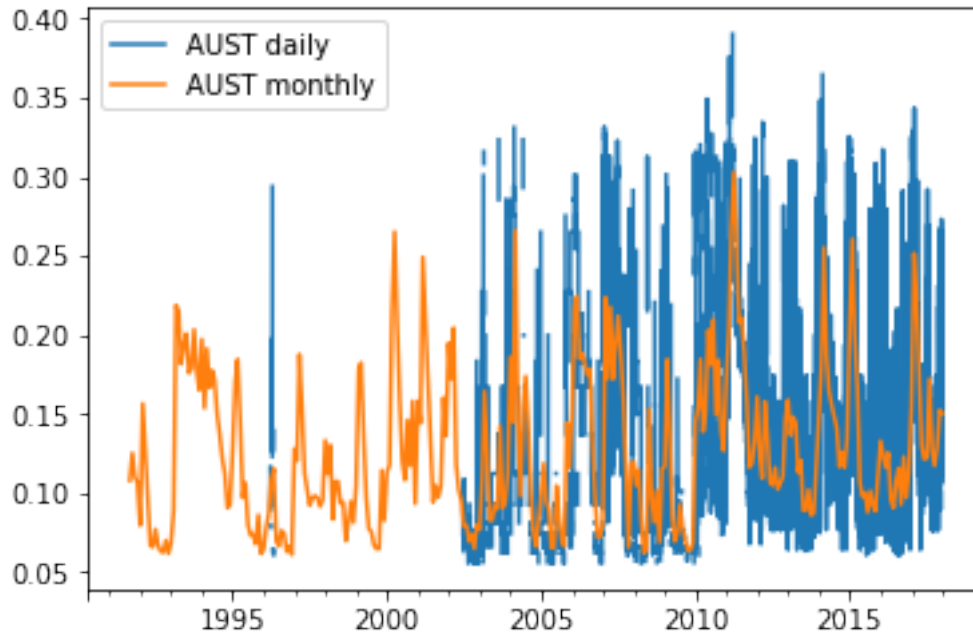
```
In [7]:  # Now try another subset, and use monthly values
         aust.reset()
         aust.subset(slice('2002','2017'))
         aust.plot('AUST daily')
         aust.resample('M')
         aust.plot('AUST monthly')
         # Note that now the breakpoint detection is applied to yearly values (the default for th
         # this choice was made since there were data gaps
         aust.breakpoint_recipe_differences(resamplefreq='M')
         aust.breakpoint_recipe_values(resamplefreq='M')
```

```
Subsetted to timeperiod 2002-2017
Warning: the data contains missing values
Creating a plot with label: AUST daily
Resampled to M frequency
Creating a plot with label: AUST monthly
This timeseries is marked as Useful (variance based)
This timeseries is marked as Suspect (value based)
```
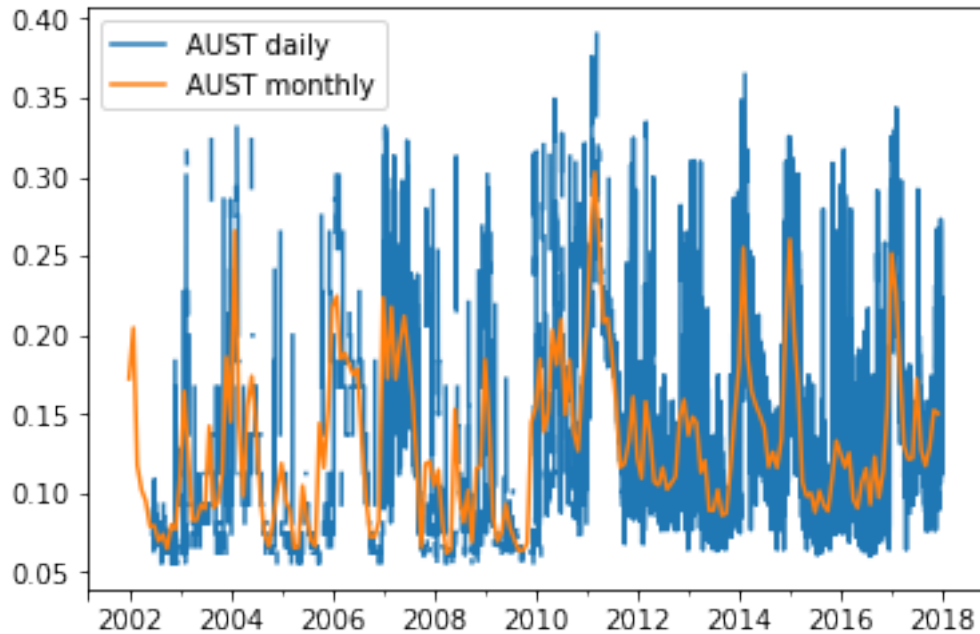
3 Timeseries length needed to assess GCOS stability for three different locations

```
In [8]: oman.weatherhead_framework(trend_magnitude=0.001)

Calculated Theil-Sen slope


Out[8]:     trend_magnitude [/decade]    std_res    acf_res      n_star    index
       0                        0.001   0.009774  -0.205078   40.942425       0

In [9]: saud.weatherhead_framework(trend_magnitude=0.001)

Calculated Theil-Sen slope


Out[9]:     trend_magnitude [/decade]    std_res    acf_res      n_star    index
       0                        0.001   0.006976   0.106689   40.343031       0

In [10]: aust.weatherhead_framework(trend_magnitude=0.001)

Calculated Theil-Sen slope


Out[10]:    trend_magnitude [/decade]    std_res    acf_res      n_star    index
       0                        0.001   0.027739  -0.020342   93.006878       0
```

7

3.0.1 The timeseries length needed to assess GCOS stability differs from ~40 years for SAUD/OMAN to ~97 years for Australia

4 Conclusions

- Testing three different grid points in a 'blended' satellite product covering about 30 years

- It was found that breakpoints are detected when they are expected to occur according to Su et al. It was not yet tested how the tests perform in regions where Su et al. do not detect any breakpoints

- The timeseries length needed to assess GCOS stability shows a strong variation between the different timeseries, from 40 to 97 years. These values seem reasonable.