

# **GROUND SITE OVERPASS TOOL – FILE TRANSFER DOCUMENT**

## **1. INTRODUCTION**

This is the File Transfer Document for the GroundSitePass executable program that calculates the time when a given instrument swath passes over a ground site or set of ground sites.

### **1.1 Change History**

<b>Issue</b>	<b>Change Description</b>
1.0	First Issue
1.1	Internal release
1.2	Update <i>mission_configuration_files</i> folder to v1.4 GroundSitePass generates HTML output files

### **1.2 Distribution List**

<b>Project/Unit</b>	<b>Name</b>	<b>Project/Unit</b>	<b>Name</b>	<b>Project/Unit</b>	<b>Name</b>

### **1.3 Reference Documents**

[RD 01] Earth Observation Mission CFI Software. EO\_DATA\_HANDLING Software User Manual.  
Ref. EO-MA-DMS-GS-0007. Issue 4.14- 16/11/17

[RD 02] OGC® KML Standard  
Ref. OGC 12-007r2 - Version: 2.3.0 - Date: 2015-08-04

## **2. ARCHIVE CONTENT**

Separate archive files are available, to support execution in Linux, Mac OS X and Windows platforms.

### **2.1 Linux 64-bit**

The following archive file has been delivered (compressed with the zip utility):  
`GroundSitePass_LINUX64_v1_2_date_05_FEB_2018.zip`

The archive has the following MD5 checksum:  
`7f5ce21795ff23e5366a590075ffc82f`

The archive contains the following files:

```
GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF
GroundSitePass
input_config_file.txt
mission_configuration_files/...
overpass_table.css
Readme.txt
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.CSV
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.HTML
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.KML
```

### **2.2 Mac OS X 64-bit**

The following archive file has been delivered (compressed with the zip utility):  
`GroundSitePass_MACIN64_v1_2_date_05_FEB_2018.zip`

The archive has the following MD5 checksum:  
**bdcce70b01171eff570efaef33fcd4ac**

The archive contains the following files:

```
GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF
GroundSitePass
input_config_file.txt
mission_configuration_files/...
overpass_table.css
Readme.txt
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.CSV
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.HTML
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.KML
```

### 2.3 Windows 32-bit

The following archive file has been delivered (compressed with the zip utility):  
**GroundSitePass\_WINDOWS32\_v1\_2\_date\_05\_FEB\_2018.zip**

The archive has the following MD5 checksum:  
**9481cb590bf80c01a060d6592c5d4c8f**

The archive contains the following files:

```
GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF
GroundSitePass.exe
input_config_file.txt
mission_configuration_files/...
overpass_table.css
pthreadVC2.dll
Readme.txt
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.CSV
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.HTML
S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.KML
```

## 3. ARCHIVE CONTENT DESCRIPTION

The files contained in the archives are described in table below:

File	Description
GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF	Example Zone Database File
input_config_file.txt	Example configuration file of SENTINEL5P with TROPOMI swath, with example zone database file
mission_configuration_files/...	Default input orbit files and swath files for Aeolus, EarthCARE, Sentinel1A, Sentinel1B, Sentinel2A, Sentinel2B, Sentinel3A, Sentinel3B, Sentinel5P
Readme.txt	Readme file with example commands and input/output file description
overpass_table.css	CSS stylesheet file for HTML output
For LINUX 64-bit	GroundSitePass
For MAC OS X 64-bit	GroundSitePass
For WINDOWS 32-bit	GroundSitePass.exe
	pthreadVC2.dll
	Auxiliary pthread library for Windows

## 4. INSTALLATION

The archive can be expanded with Winzip / 7-zip (in MS Windows) or with the command unzip (in Linux/Mac OS).

## 5. USAGE

### 5.1 Executable program GroundSitePass

For a requested UTC time interval, the executable program *GroundSitePass* calculates the UTC times when a given orbit ground-track or instrument swath passes over a given ground site (or set of ground sites).

The program expects as input a configuration file setting the various input parameters, among them the mission name, orbit file, swath file, zone database file and instrument swath name.

A ground site is defined as an EOCFI point with a single point (geocentric longitude, geodetic latitude) and a given circle diameter. For point-like zones, the circle diameter is set to 0 m, otherwise it is a circular zone. In this case, the time of overpass will be half way between entry and exit time of the circular zone. Being able to define a circle centered on the site is useful to determine ground-track overpass.

The default orbit and swath characteristics are defined in the mission configuration files folder. It is possible to provide as orbit file other types of EOCFI-compatible OSV-based orbit files (see [RD 01]), e.g. Predicted Orbit File (ORBPRES file type) or Restituted Orbit Files (ORBRES file type).

The maximum distance to ground-track and the minimum Sun Elevation angles (parameters in the input configuration file) are used to discard passes not verifying the constraints.

For editing the Zone Database File, it is recommended to use an XML editor or source code editor (e.g Atom, Notepad ++, Xcode). Rich format editors (e.g. Word, TextEdit) may introduce characters that are not supported.

The program generates a set of output files with the overpass tables per zone (in .CSV, .KML format and .HTML format).

#### 5.1.1 Command line input parameters description

The command line parameters of the executable routine are the following (provided in the order in which they have to be supplied):

INPUT PARAMETERS	Definition	Value
Input Configuration File	Filename (it may include the path to the file)	Given by the user
UTC Start Time	UTC start time of the time interval CCSDS-A ASCII format with seconds (YYYY-MM-DDTHH:mm:ss)	Given by the user
UTC Stop Time	UTC stop time of the time interval CCSDS-A ASCII format with seconds (YYYY-MM-DDTHH:mm:ss)	Given by the user

### 5.1.2 Input configuration file format description

The contents of the input configuration file are detailed below:

INPUT PARAMETERS	Definition	Value	
Satellite	Satellite identifier	AEOLUS EARTHCARE SENTINEL1A SENTINEL1B SENTINEL2A SENTINEL2B SENTINEL3A SENTINEL3B SENTINEL5P	
Orbit Filename	Default orbit scenario file in <u>mission_configuration_files</u>	Given by the user	
Swath Filename	Default swath files in <u>mission_configuration_files</u>	Given by the user	
Zone Database Filename	File with list of zones, in EO CFI / Esov NG Zone Database format (see [RD 01])	Given by the user	
Instrument Swath	Instrument swath name	AEOLUS	ORBIT ALADIN
		EARTHCARE	ORBIT ATLID BBR_B BBR_F BBR_N CPR MSI
		SENTINEL1A SENTINEL1B	ORBIT SM1 to SM6 EW1 to EW5 IW1 to IW3 WV1 to WV2 WEW WIW
		SENTINEL2A	ORBIT MSI
		SENTINEL2B	ORBIT MSI
		SENTINEL3A	ORBIT OLCI SRAL SLSTR_N SLSTR_B MWR
		SENTINEL5P	ORBIT TROPOMI

	File with list of zones, in EO CFI / Esov NG Zone Database format (see [RD 01])	Given by the user	
Maximum Ground-track Distance	Maximum Distance between the ground site and the ground-track (in kilometers)	Set by default to 3000.0 km (bigger than half swath width i.e. no constraint applied, full swath used)	
Minimum Sun Elevation	Minimum Sun Elevation Angle at the ground point (in degrees)	Set by default to 0.0 (i.e. Sun visibility)	

### 5.1.3 Output file format description

The executable program *GroundSitePass* produces two output files per zone in Zone Database file:

- Comma Separated Value (.CSV)
- Google Earth KML file (.KML)
- Web browser HTML file (.HTML)

The output file names are automatically generated using the satellite identifier, the zone name, the swath name and the start and stop UTC times.

#### 5.1.3.1 CSV Files

The CSV output file contains one row per each entry/exit visibility time segment, format of the CSV output file:

- Row 1-7: Header containing execution input information
- From Row 8:
  - Column 1: Ground Site Name
  - Column 2: UTC Time of overpass in calendar format (CCSDS format "yyyy-mm-ddThh:mm:ss")
  - Column 3: Absolute Orbit
  - Column 4: Relative Orbit
  - Column 5: Seconds since Ascending Node Crossing (ANX)
  - Column 6: Distance from site to ground-track [km]. Distance from site to ground-track is regarded as positive distance when the site is located on the left hand side of the ground-track. See Section 6.
  - Column 7: Topocentric Sun Azimuth Angle at site [deg]. Convention: az=0 is the North direction, az=90 deg = East direction
  - Column 8: Topocentric Sun Elevation Angle at site [deg]. Convention: el=90 is the Zenith direction, el < 0 means below Earth surface
  - Column 9: Ascending or Descending Pass (ASC/DESC)
- Last Row: End of file (EOF)

The CSV files can be opened with dedicated spreadsheet software (e.g. Excel, LibreOffice) or any text editor.

#### 5.1.3.2 KML Files

The KML output file contains the same information as the CSV but presented graphically. The format of the provided KML files is defined in KML Version 2.3 standard (see [RD 02]).

The KML files can be opened with Google Earth v7 or higher.

### 5.1.3.3 HTML Files

The HTML output file contains the same information as the CSV but presented in a tabular format, ready to be displayed in a web browser. A CSS stylesheet (*overpass\_table.css*) is provided as part of the package to apply a given style to the HTML elements. The HTML output file requires the CSS stylesheet to be located in the same folder.

The HTML files can be opened with any web browser (e.g. Firefox). Once opened in a web browser, it is possible to export the HTML report to PDF.

## 5.1.4 Example

### 5.1.4.1 Running the executable

The executable program can be called in the following way:

- From Mac OSX / Linux Terminal window

```
./GroundSitePass input_config_file.txt 2018-03-01T00:00:00 2018-03-03T00:00:00
```

- From Windows command prompt window

```
GroundSitePass.exe input_config_file.txt 2018-03-01T00:00:00 2018-03-03T00:00:00
```

The executable program shows the following messages:

```
Execution of program GroundSitePass v1.2
```

```
Input data set by the user:
```

```
Satellite: SENTINEL5P
```

```
Orbit File:
```

```
./mission_configuration_files/SENTINEL5P/OSF/S5P_OPER_MPL_ORBSCT_20171013T104928_99999999T999999_0005.EOF
```

```
Swath File: ./mission_configuration_files/SENTINEL5P/SDF/SDF_TROPOMI.S5P
```

```
Swath ID: TROPOMI
```

```
Zone File: GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF
```

```
Maximum Ground-Track Distance [km]: 3000.000000
```

```
Minimum Sun Elevation Angle [deg]: 0.000000
```

```
Start Time: 2018-03-01T00:00:00
```

```
Stop Time: 2018-03-03T00:00:00
```

```
Start Time: 6634.000000000000
```

```
Stop Time: 6636.000000000000
```

```
Start Orbit: 1967
```

```
Stop Orbit: 1995
```

```
Output Filename KML: S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.KML
```

```
Output Filename CSV: S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.CSV
```

```
Output Filename HTML: S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.HTML
```

```
Ground Point Anmyeondo (LON, LAT, ALT)=(126.331100, 36.538200, 0.000000)
```

```
Zone ID: Anmyeondo
```

```
Number of segments: 4
```

```
Segments: Start (Orbit, seconds, microseconds) -- Stop (Orbit, seconds, microseconds)
```

```
(1970, 608, 533137) -- (1970, 608, 533137)
```

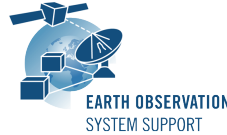
```
(1977, 2420, 179978) -- (1977, 2420, 179978)
```

```
(1984, 619, 171963) -- (1984, 619, 171963)
```

```
(1991, 2430, 790147) -- (1991, 2430, 790147)
```

```
Distance to Ground-Track Pass #0 = -576.556084 [km]
```

```
Sun Elevation angle Pass #0 = 42.252031 [deg]
```



Distance to Groud-Track Pass #1 = -113.462635 [km]  
 Sun Elevation angle Pass #1 = -53.256335 [deg]  
 Distance to Groud-Track Pass #2 = -159.128742 [km]  
 Sun Elevation angle Pass #2 = 44.102553 [deg]  
 Distance to Groud-Track Pass #3 = -530.435254 [km]  
 Sun Elevation angle Pass #3 = -55.348402 [deg]  
 [...]  
 Output files created successfully

### 5.1.4.2 Input File

Contents of the input configuration file used as example (input\_config\_file.txt):

```
SENTINEL5P
./mission_configuration_files/SENTINEL5P/OSF/S5P_OPER_MPL_ORBSCT_20171013T104928_99999999T999999_0005.
EOF
./mission_configuration_files/SENTINEL5P/SDF/SDF_TROPOMI.S5P
GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF
TROPOMI
3000.0
0.0
```

### 5.1.4.3 Output Files

#### 5.1.4.3.1 CSV Files

A CSV output file is created:

S5P\_TROPOMI\_VISIBILITY\_SEGMENTS\_20180301\_000000\_20180303\_000000\_0001.CSV

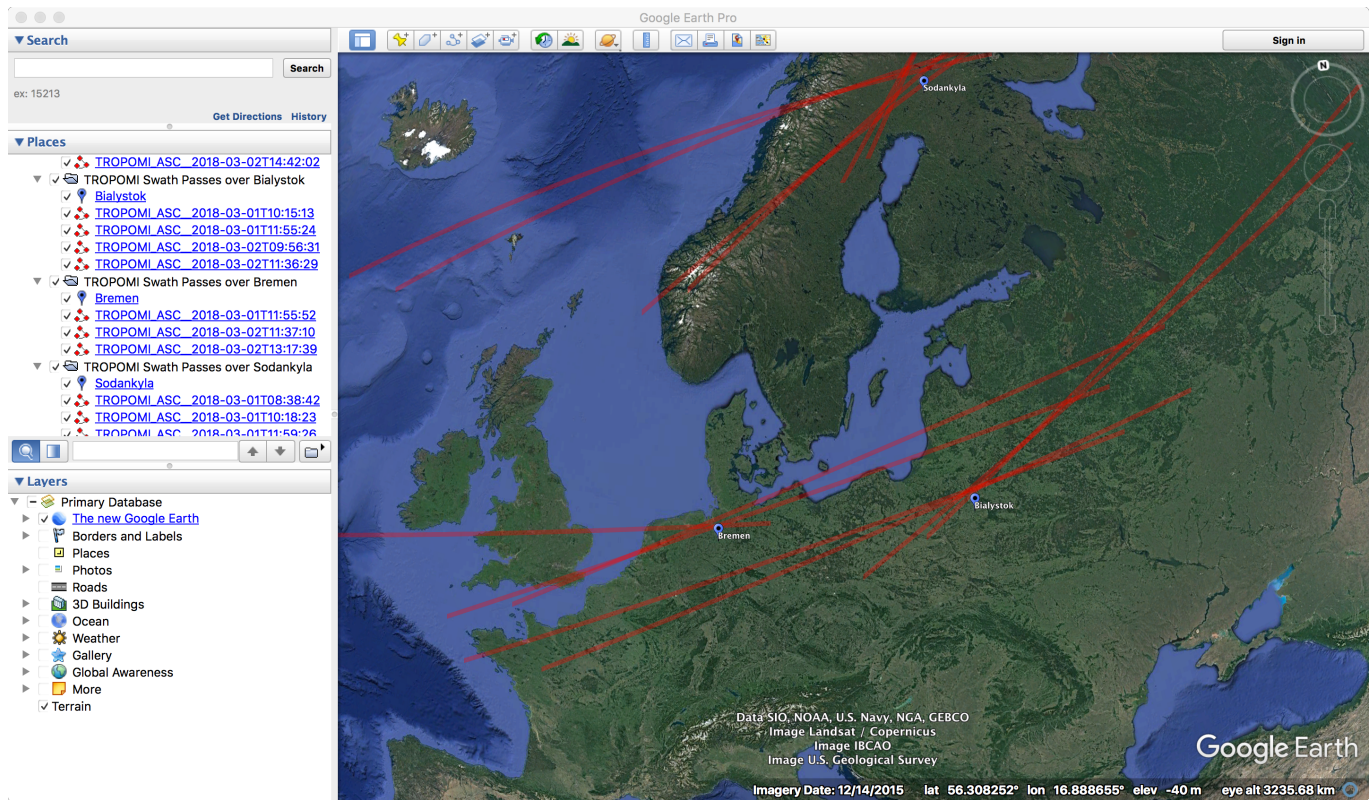
A	B	C	D	E	F	G	H	I	J	K	L
1	FILENAME	SSP_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.CSV									
2	CREATION_DATE	2018-02-05T18:14:26									
3	EXECUTABLE_NAME_VERSION	GroundSitePass_v1.2									
4	ORBIT_FILE	./mission_configuration_files/SENTINEL5P/OSF/S5P_OPER_MPL_ORBSCT_20171013T104928_99999999T999999_0005.EOF									
5	SWATH_FILE	./mission_configuration_files/SENTINEL5P/SDF/SDF_TROPOMI.S5P									
6	SWATH_ID	TROPOMI									
7	ZONE_DATABASE_FILE	GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF									
8	MAX_GROUNDRACK_DISTANCE [km]	3000									
9	MIN_SUN_ELEVATION [deg]	0									
10	VALIDITY_START	2018-03-01T00:00:00									
11	VALIDITY_STOP	2018-03-03T00:00:00									
12	GROUND_POINT	PASS	UTC_TIME	ABS_ORBIT	REL_ORBIT	SECONDS_SINCE_ANX[s]	DISTANCE TO GROUNDRACK [km]	SUN AZIMUTH [deg]	SUN ELEVATION [deg]	ASCENDING/DESCENDING PASS	
13	Anmyeondo	1	2018-03-01T05:04:39	1970	3330	608.533137	-576.556084	206.399054	42.252031	ASC	
14	Anmyeondo	2	2018-03-02T04:45:47	1984	3344	619.171963	-159.128742	200.557532	44.102553	ASC	
15	Arrival_Heights	1	2018-03-01T01:09:29	1967	3327	4767.93946	1375.675395	359.02729	19.833706	ASC	
16	Arrival_Heights	2	2018-03-01T02:50:35	1968	3328	4744.905185	783.729104	332.513847	18.506091	ASC	
17	Arrival_Heights	3	2018-03-01T04:31:43	1969	3329	4722.518122	232.95886	306.569513	15.046	ASC	
18	Arrival_Heights	4	2018-03-01T06:12:19	1970	3330	4669.270367	-178.644415	281.486234	10.212781	ASC	
19	Arrival_Heights	5	2018-03-01T07:52:29	1971	3331	4588.838488	-378.05779	257.004055	4.948166	ASC	
20	Arrival_Heights	6	2018-03-01T09:32:41	1972	3332	4511.132505	-329.272106	232.601055	0.178796	DESC	
21	Arrival_Heights	7	2018-03-02T02:31:37	1982	3342	4749.170627	894.861864	337.438036	18.550625	ASC	
22	Arrival_Heights	8	2018-03-02T04:12:44	1983	3343	4726.677521	328.343678	311.39187	15.446335	ASC	
23	Arrival_Heights	9	2018-03-02T05:53:33	1984	3344	4685.166875	-115.844087	286.148905	10.795752	ASC	
24	Arrival_Heights	10	2018-03-02T07:33:41	1985	3345	4603.457401	-359.070217	261.61168	5.543623	ASC	
25	Arrival_Heights	11	2018-03-02T09:13:53	1986	3346	4525.938669	-357.552794	237.207139	0.610255	DESC	
26	Ascension_Island	1	2018-03-01T15:00:46	1975	3335	5926.642623	-783.729507	269.061836	62.4711	ASC	
27	Ascension_Island	2	2018-03-02T14:42:02	1989	3349	5945.278887	-273.312085	270.548926	67.038609	ASC	
28	Bialystok	1	2018-03-01T10:15:13	1973	3333	973.099533	868.651903	172.89641	29.01182	ASC	
29	Bialystok	2	2018-03-01T11:55:24	1974	3334	894.683207	-734.035172	201.043413	27.213561	ASC	
30	Bialystok	3	2018-03-02T09:56:31	1987	3347	993.913456	1143.701249	167.637664	28.918036	ASC	
31	Bialystok	4	2018-03-02T11:36:29	1988	3348	902.07856	-421.114378	195.972176	28.472116	ASC	
32	Bremen	1	2018-03-01T11:55:52	1974	3334	922.496339	189.026669	185.377022	29.26747	ASC	
33	Bremen	2	2018-03-02T11:37:10	1988	3348	943.103519	486.377307	180.119759	29.776765	ASC	
34	Bremen	3	2018-03-02T13:17:39	1989	3349	882.159433	-1161.103933	208.103868	26.116078	ASC	
35	Sodankyla	1	2018-03-01T08:38:42	1972	3332	1271.951713	868.594023	152.745532	12.664948	ASC	
36	Sodankyla	2	2018-03-01T10:18:23	1973	3333	1163.857222	-9.448985	178.088485	15.095969	ASC	
37	Sodankyla	3	2018-03-01T11:59:26	1974	3334	1136.360306	-1065.228921	203.866189	13.279553	ASC	
38	Sodankyla	4	2018-03-02T08:20:01	1986	3346	1293.311772	1001.023221	148.065279	12.155692	ASC	
39	Sodankyla	5	2018-03-02T09:59:40	1987	3347	1183.10586	173.567297	173.196191	15.338416	ASC	
40	Sodankyla	6	2018-03-02T11:40:29	1988	3348	1141.679691	-861.189625	199.181475	14.313696	ASC	
41	EOF										
42											

#### 5.1.4.3.2 KML Files

A KML output file is created:

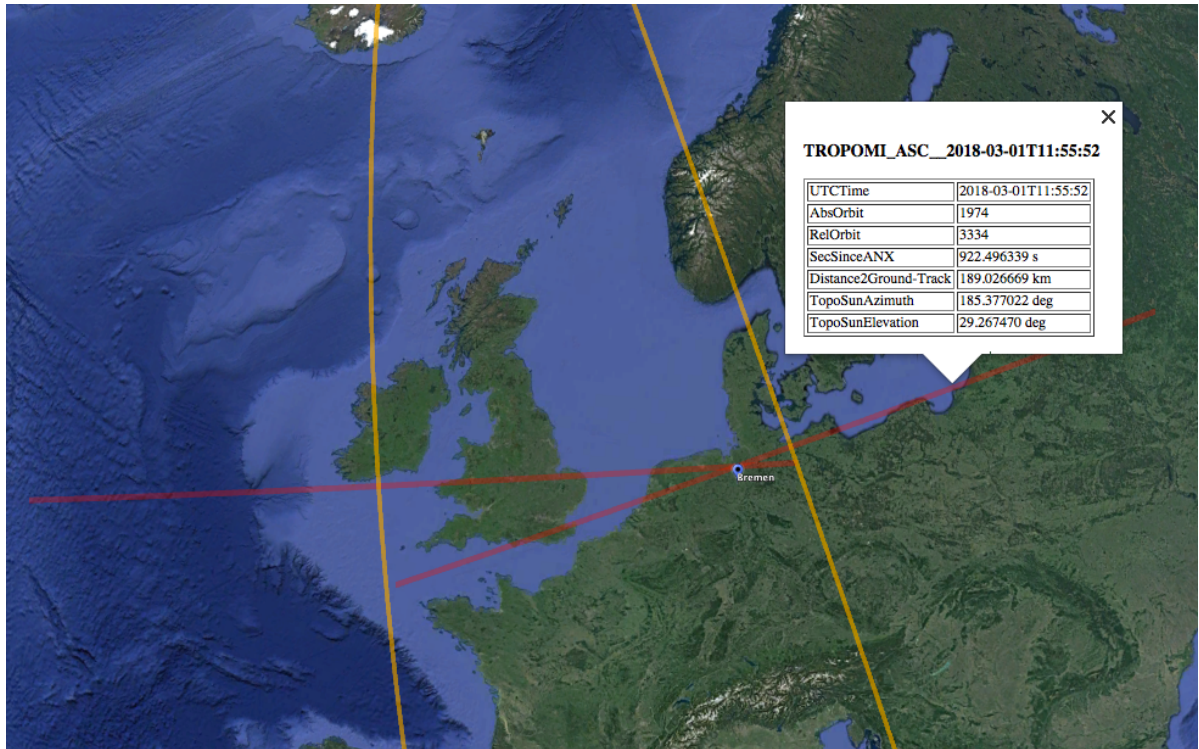
S5P\_TROPOMI\_VISIBILITY\_SEGMENTS\_20180301\_000000\_20180303\_000000\_0001.KML

After loading the files with Google Earth, the overpass data can be found in the "Places" window, under "Temporary Places".



When moving the mouse over the swaths, the lines are highlighted (increase in thickness and lighter in colour). Then by clicking on top of the track, a balloon showing additional information is displayed, namely the absolute and relative orbit number, seconds since ANX, distance between the site and the ground-track and the Sun azimuth and elevation at the site.





### 5.1.4.3.3 HTML Files

A HTML output file is created:

`S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.HTML`

By double-clicking on the HTML file, it opens with the default browser, applying the style from CSS stylesheet.

## GROUND SITE OVERPASS TABLE HTML REPORT

Creation Date: 2018-02-05T18:14:26

<b>Filename</b>	S5P_TROPOMI_VISIBILITY_SEGMENTS_20180301_000000_20180303_000000_0001.HTML
<b>Executable Name and Version</b>	GroundSitePass_v1.2
<b>Orbit File</b>	./mission_configuration_files/SENTINEL5P/OSF/S5P_OPER_MPL_ORBSCT_20171013T104928_99999999T999999_0005.EOF
<b>Swath File</b>	./mission_configuration_files/SENTINEL5P/SDF/SDF_TROPOMI.S5P
<b>Swath ID</b>	TROPOMI
<b>Zone Database File</b>	GROUND_SITES_EXAMPLE_ZONEDBFILE.EOF
<b>Maximum ground-track distance [km]</b>	3000.000000
<b>Minimum Sun elevation [deg]</b>	0.000000
<b>Validity Start</b>	2018-03-01T00:00:00
<b>Validity Stop</b>	2018-03-03T00:00:00

### Zone Overpass Table

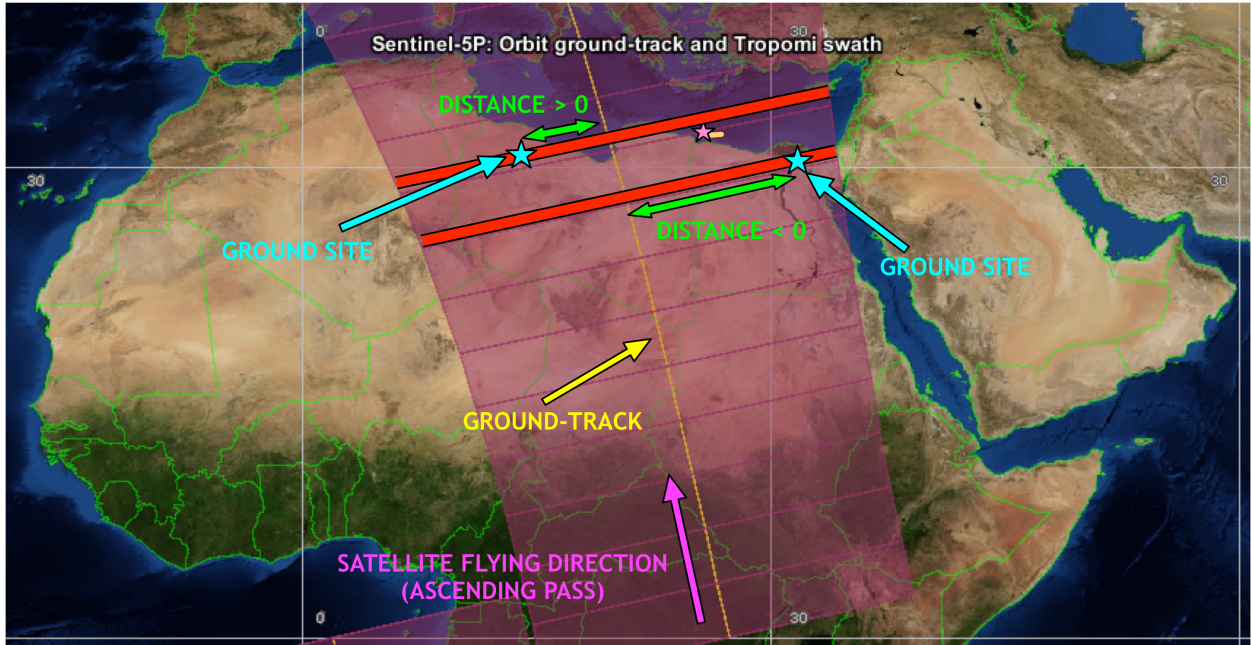
Ground Point	Pass	UTC Time	Abs Orbit	Rel Orbit	Seconds since ANX [s]	Distance to Ground-Track [ km]	Sun Azimuth [deg]	Sun Elevation [deg]	Ascending / Descending
Anmyeondo	1	2018-03-01T05:04:39	1970	3330	608.533137	-576.556084	206.399054	42.252031	ASC
Anmyeondo	2	2018-03-02T04:45:47	1984	3344	619.171963	-159.128742	200.557532	44.102553	ASC
Arrival_Heights	1	2018-03-01T01:09:29	1967	3327	4767.939460	1375.675395	359.027290	19.833706	ASC
Arrival_Heights	2	2018-03-01T02:50:35	1968	3328	4744.905185	783.729104	332.513847	18.506091	ASC
Arrival_Heights	3	2018-03-01T04:31:43	1969	3329	4722.518122	232.958860	306.569513	15.046000	ASC
Arrival_Heights	4	2018-03-01T06:12:19	1970	3330	4669.270367	-178.644415	281.486234	10.212781	ASC
Arrival_Heights	5	2018-03-01T07:52:29	1971	3331	4588.838488	-378.057790	257.004055	4.948166	ASC

## 6. TECHNICAL DETAILS AND ASSUMPTIONS

### 6.1 Earth Observation CFI Software Version

The dataset will be generated using EO CFI v4.14.

### 6.2 Distance between ground site and satellite ground-track



### 6.3 Sun Elevation

In this drawing, SENTINEL-5P is flying away from the viewer (velocity vector pointing into the diagram)

