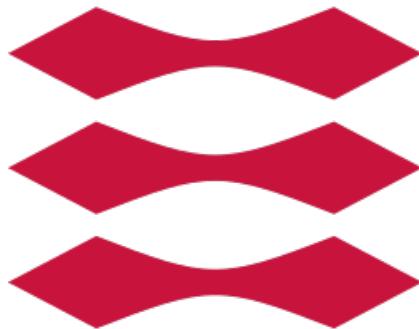




Kartverket

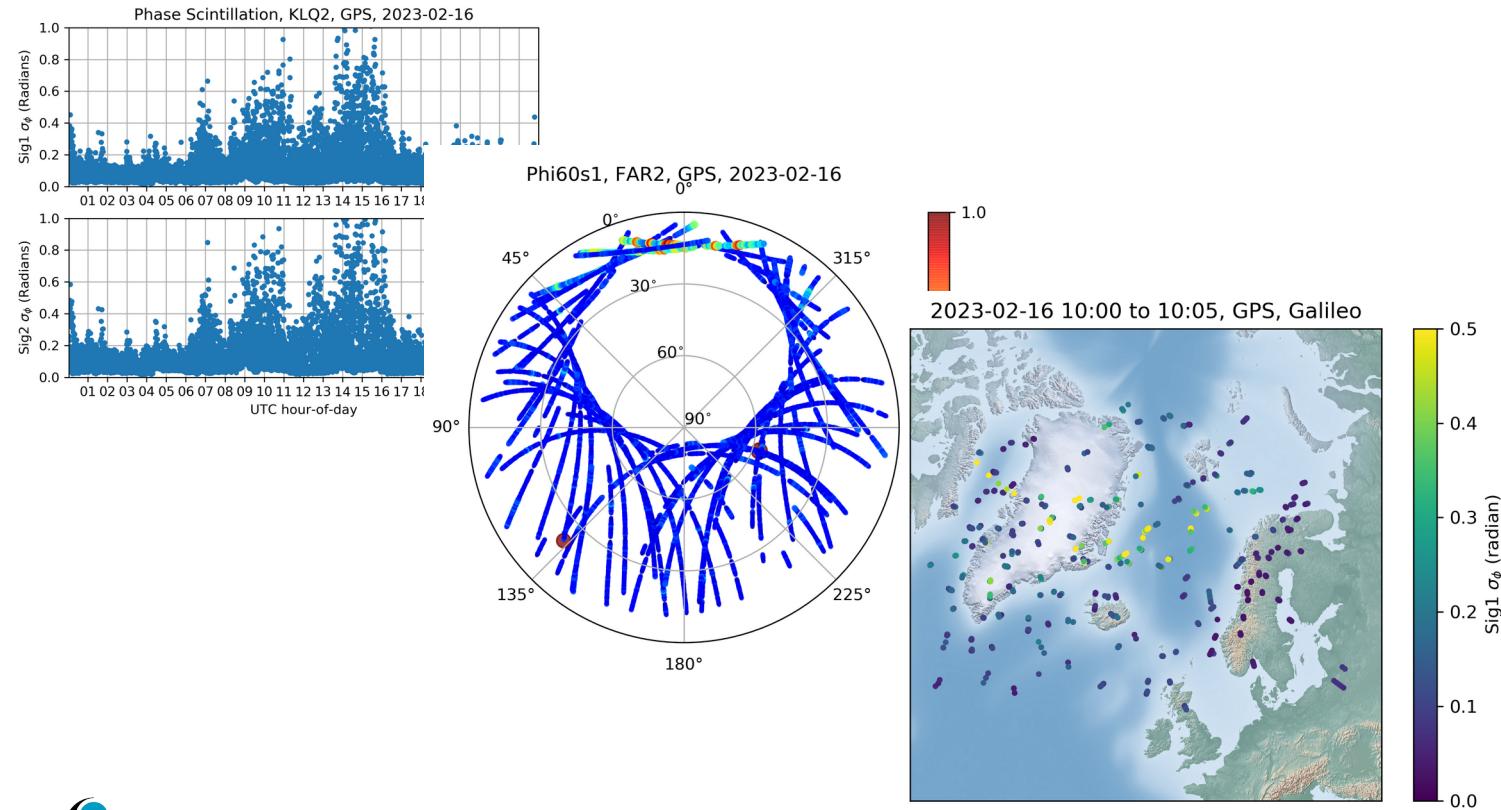
DTU



BiScEF - A new format for archiving and sharing scintillation data

Knut Stanley Jacobsen (NMA), Sarah Schultz Beeck (DTU)

Bi – Binary **Sc** – Scintillation **EF** – Exchange Format



BiScEF format

The format is intended to be used for archiving and exchange of scintillation data.

It is a flexible and extensible format. Although it defines many parameters and datasets, only a minimum set of information is mandatory.

It is based on NetCDF4 / HDF5 (A BiScEF file is both a valid NetCDF4 file and a valid HDF5 file)

Many metadata fields are defined. Some of these are mandatory. They are Attributes in the Root Group in the file.

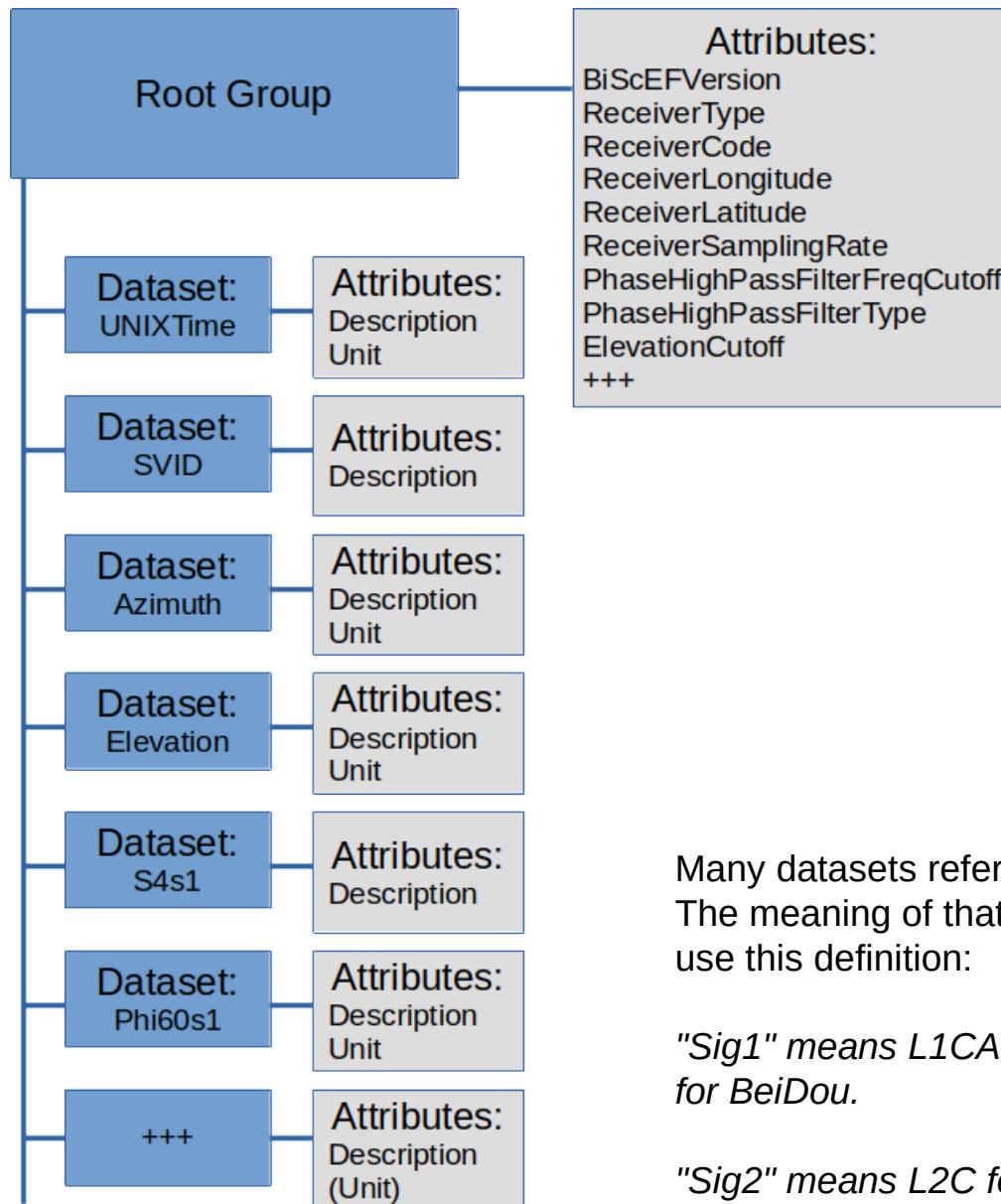
Data are organized as separate datasets containing 1D arrays in time.

All arrays are of the same length, such that all data at the same index are associated.

All datasets in the file share the same dimension "UNIXTime".

This has been chosen to provide all data on a common time axis which is not dependent on the GNSS constellation, and is supported by all computer systems.

BiScEF format



The Attributes list connected to the Root Group shows the mandatory attributes.

The Dataset boxes shows some common datasets.
UNIXTime, SVID, Azimuth and Elevation are mandatory.

S4s1 (S4 for signal 1) and Phi60s1 (sigma phi for signal 1) are not mandatory, but expected to often be present.

There are many more datasets defined in the format description.

Many datasets refer to s1, s2, s3 («signal 1», «signal 2», «signal 3»). The meaning of that is defined in one of the metadata fields. We currently use this definition:

"Sig1" means L1CA for GPS/GLONASS/SBAS/QZSS, L1BC for Galileo, B1 for BeiDou.

"Sig2" means L2C for GPS/GLONASS/QZSS, E5a for Galileo, L5 for SBAS, B2 for BeiDou.

"Sig3" means L5 for GPS/QZSS or E5b for Galileo.

BiScEF format – On the web

The format description is available on the web, in a git repository:

<https://github.com/kartverket/BiScEF/>

The repo also contains:

- Data files from the NMA and DTU stations, for 3 scintillation events in 2023.
- Some example plots from those data
- Python scripts that can be used to generate plots from BiScEF format files.

The screenshot shows the GitHub repository page for 'BiScEF' owned by 'kartverket'. The repository is public and has 1 branch and 0 tags. The main page displays a list of commits from 'knutstanley' and other contributors. The 'About' section provides a brief description of the Binary Scintillation Exchange Format, mentioning gnss, ionosphere, space-weather, s4, scintillation, and sigma-phi. It also includes links for Readme, MIT license, Activity, stars, watching, forks, and reporting issues. The 'README.md' file is shown with its content, which describes the format as a binary scintillation exchange format and provides details about the Python scripts, ExampleEvents, and ExamplePlots. The 'Contributors' section lists three individuals: saschu-space, stenseng Lars Stenseng, and knutstanley Knut.

knutstanley Update README.md

1184ff4 on Sep 26 40 commits

ExampleEvents Event data from Kulusuk 2 months ago

ExamplePlots Updated format description. 3 months ago

Python Files are moved to event folder 2 months ago

BiScEF_FormatDescription_v1.0.odt Updated format description. 3 months ago

BiScEF_FormatDescription_v1.0.pdf Updated format description. 3 months ago

BiScEF_Structure.odg Updated format description 8 months ago

BiScEF_Structure.png Updated format description 8 months ago

LICENSE Update LICENSE 2 months ago

README.md Update README.md 2 months ago

BiScEF

Binary Scintillation Exchange Format

The format description document is the main content of this repository.

The "Python" folder contains python scripts that can be used to interact with files in the format.

The "ExampleEvents" folder contains sets of data files from a few events, as an example of the data files.

The "ExamplePlots" contain some examples of plots of data from the files. (Note: They do not show all possible content of the data files.)

Contributors 3

- saschu-space
- stenseng Lars Stenseng
- knutstanley Knut

BiScEF format – Example data

Example data files in the BiScEF format are provided in the git repository for three events in 2023. While these are not the most spectacular events they do contain measurements of scintillation activity. Feel free to use them for scientific studies, with appropriate acknowledgements.

Event #1

2023-01-13, 2023-01-14, 2023-01-15

Event #2

2023-02-14, 2023-02-15, 2023-02-16

Event #3

2023-03-02, 2023-03-03

The screenshot shows a GitHub repository interface for the 'BiScEF' project. The repository name is 'kartverket / BiScEF'. The 'Files' tab is selected, showing a list of files under the 'ExampleEvents' folder. The folder contains sub-folders for different event periods: '20230113to20230115', '20230214to20230216', and '20230302to20230303'. Each sub-folder contains several .nc files representing event data. The right side of the screen displays a table of commits from the 'saschu-space' user, all dated 2 months ago, with messages like 'Event data from Kulusuk' and 'More example files'.

Name	Last commit message	Last commit date
...		2 months ago
20230113to20230115	Event data from Kulusuk	2 months ago
20230214to20230216	Event data from Kulusuk	2 months ago
20230302to20230303	More example files	2 months ago

BiScEF format – Plotting scripts

This format description is distributed with python scripts that can be used to generate a selection of plots from this kind of file. They are located in the folder «Python/Plotting/» in the repository.

There is one script to produce time series and skyplots from a single file, and one script to produce map plots based on data from multiple files.

The plots that are shown later in this presentation have been made using those scripts.

If run with the option "-h", they print instructions for usage:

```
$ python3 MakeDataPlots.py -h
usage: MakeDataPlots.py [-h] [-G] [-R] [-E] [-C] [-S] [--plot_ts_simple]
                       [--plot_ts_box] [--plot_sky] [--plot_heat_sigPhi]
                       [--elevationCutoff ELEVATIONCUTOFF]
                       filename

BiScEF data plotter

positional arguments:
  filename            Filename of input data file

optional arguments:
  -h, --help          show this help message and exit
  -G, --GPS           Make plots for GPS (default: False)
  -R, --GLONASS        Make plots for GLONASS (default: False)
  -E, --Galileo        Make plots for Galileo (default: False)
  -C, --BeiDou         Make plots for BeiDou (default: False)
  -S, --SBAS           Make plots for SBAS (default: False)
  --plot_ts_simple    Plot simple time series (default: False)
  --plot_ts_box        Plot box-and-whiskers time series (default: False)
  --plot_sky           Plot skyplots (default: False)
  --plot_heat_sigPhi   Plot 2d histogram of sigma phi over time with mean
                      sigma phi (default: False)
  --elevationCutoff ELEVATIONCUTOFF
                      Set elevation angle cutoff (default: 5)
```

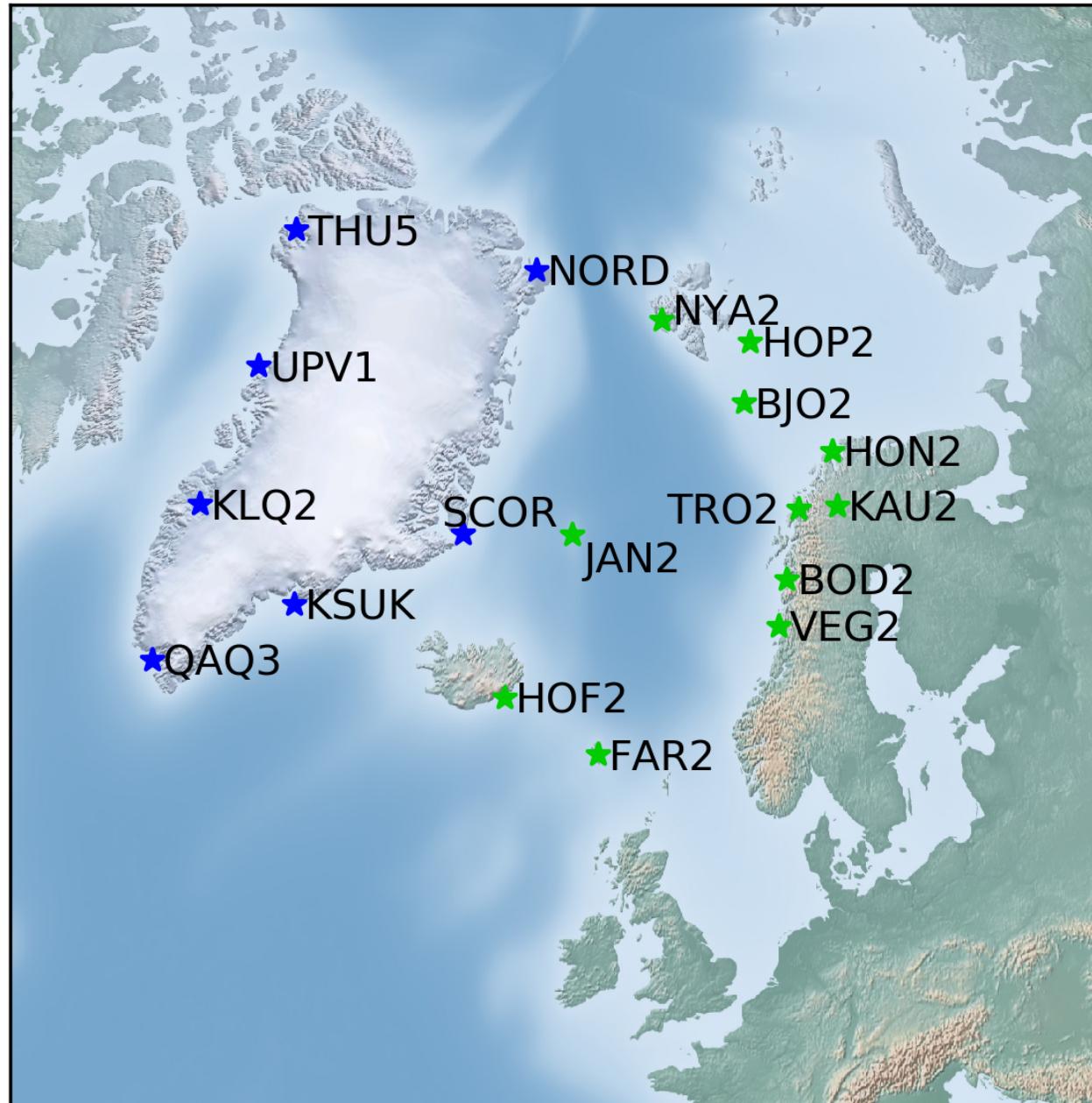
NB: This script assumes that the file contains data from one day (or less)



BiScEF data – DTU & NMA networks

DTU:

Data available from 2021.
Some stations were not installed until 2022.



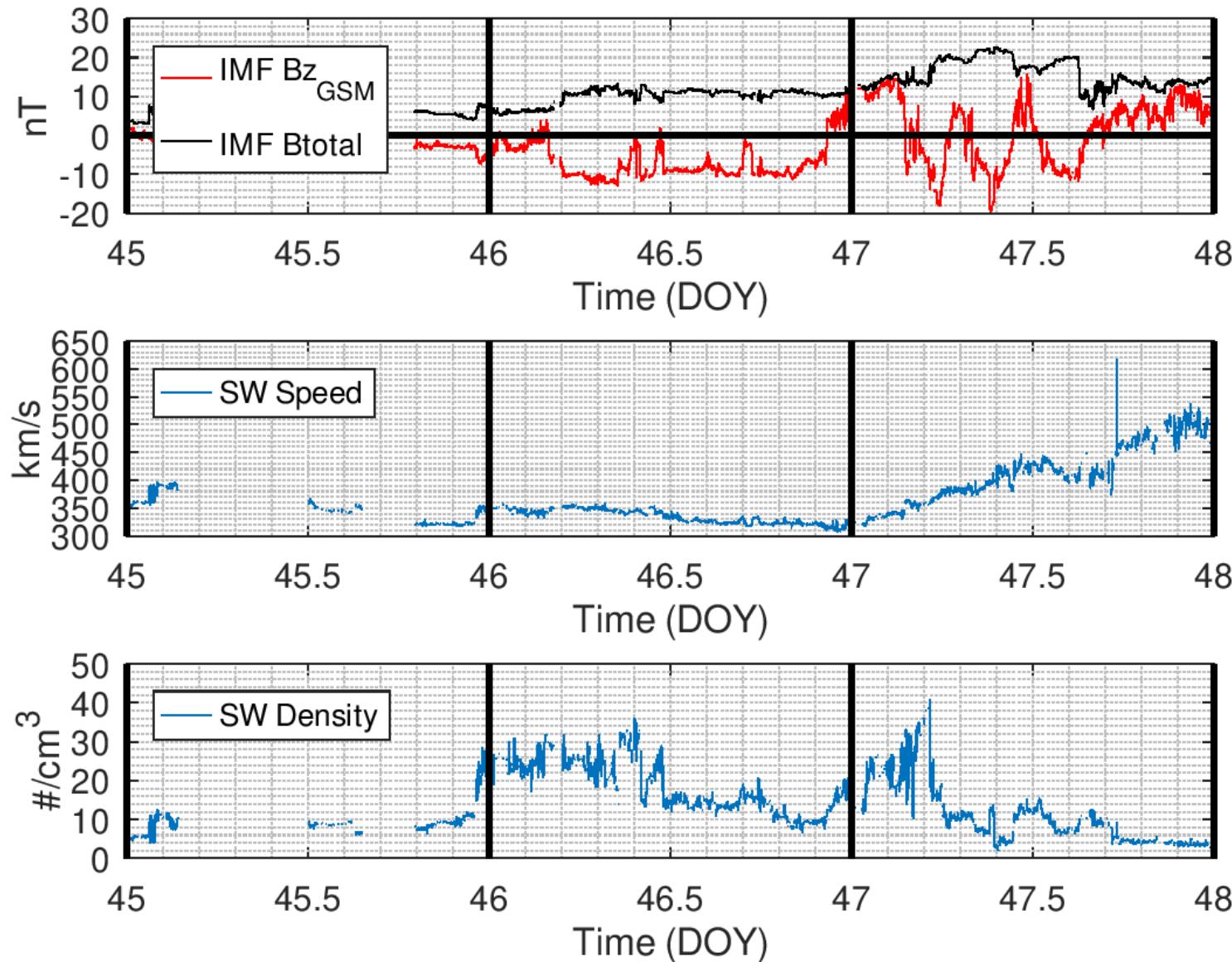
NMA:

Data available from 2012, but there are data gaps

Mostly complete datasets for recent years (2020+)

Example event

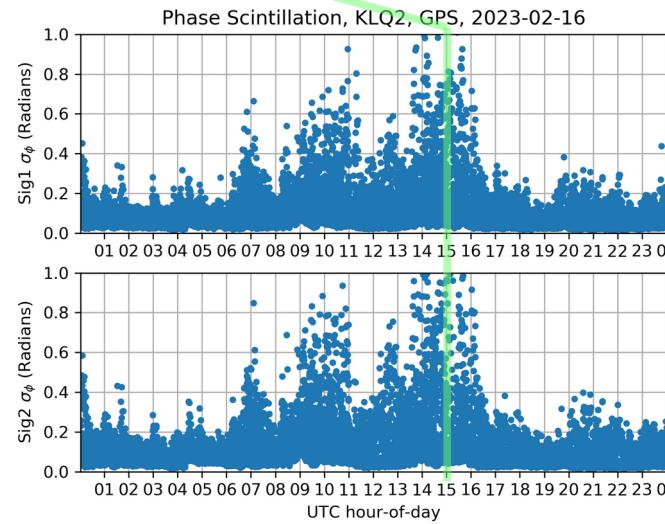
Solar wind data



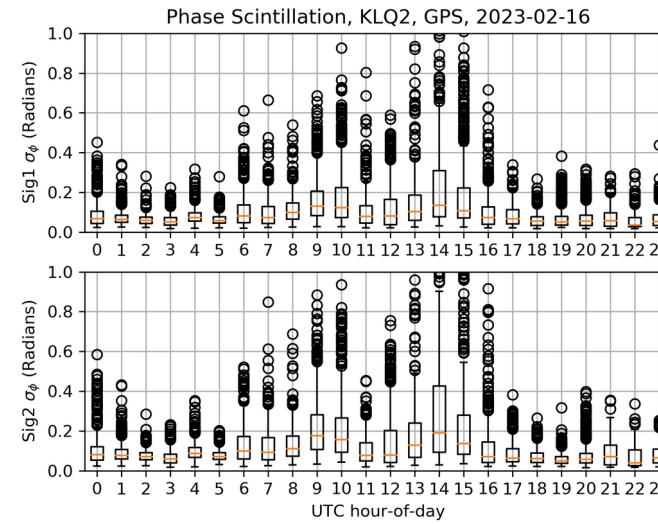
Example event

Examples of phase scintillation time series plots

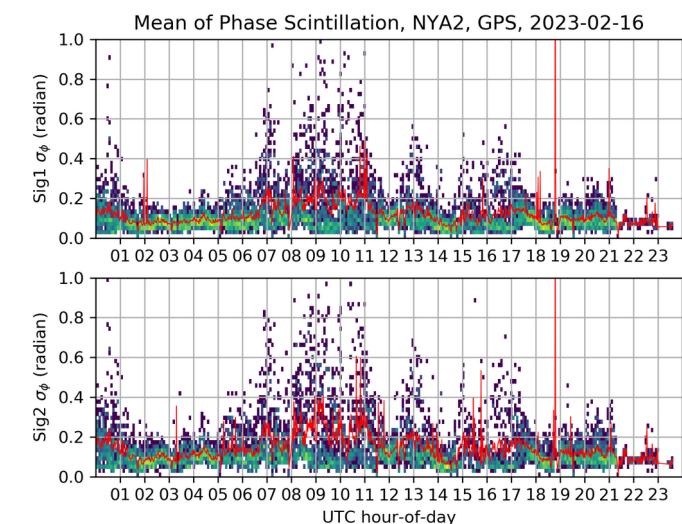
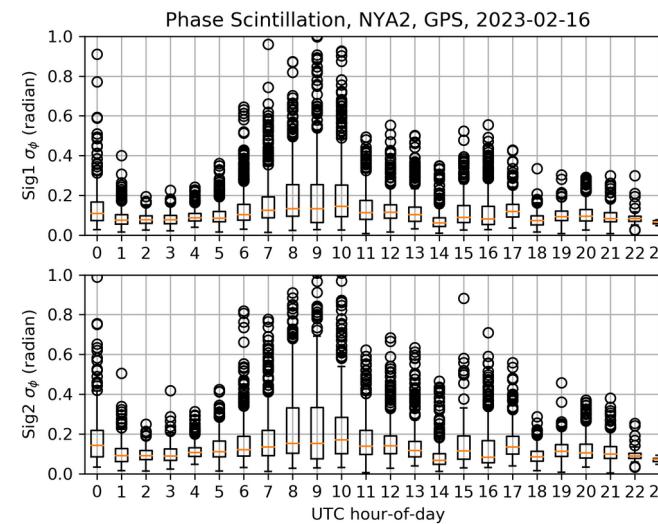
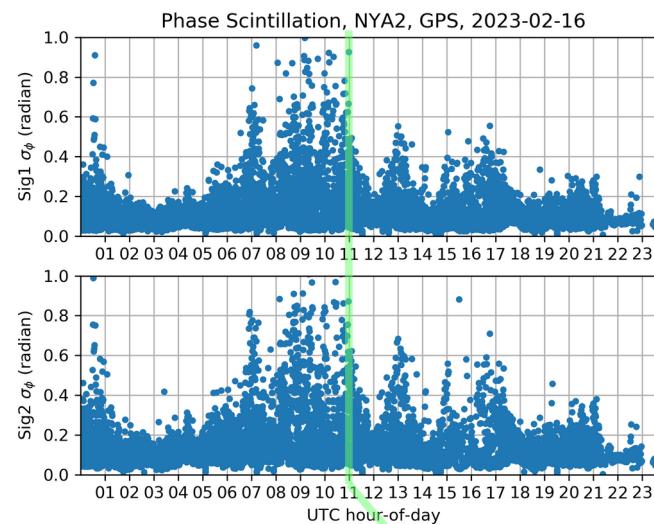
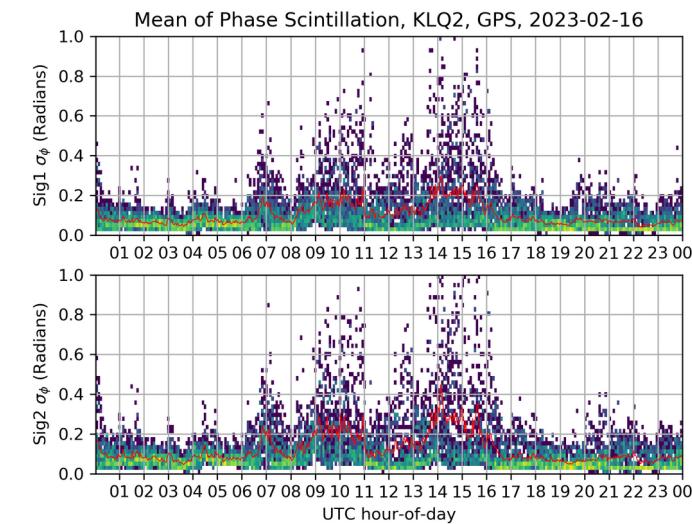
Local time mid-day
in Kangerlussuaq σ_ϕ points



σ_ϕ box-and-whiskers



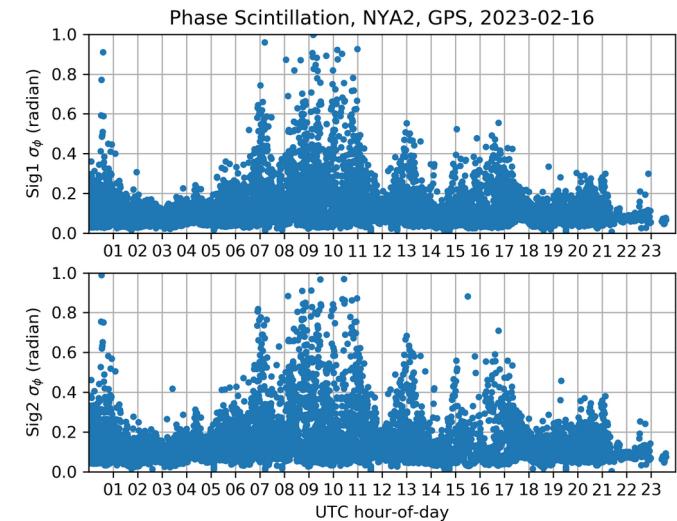
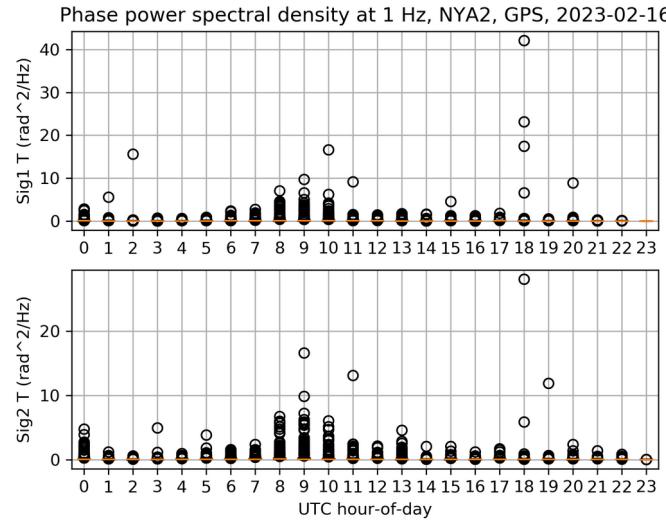
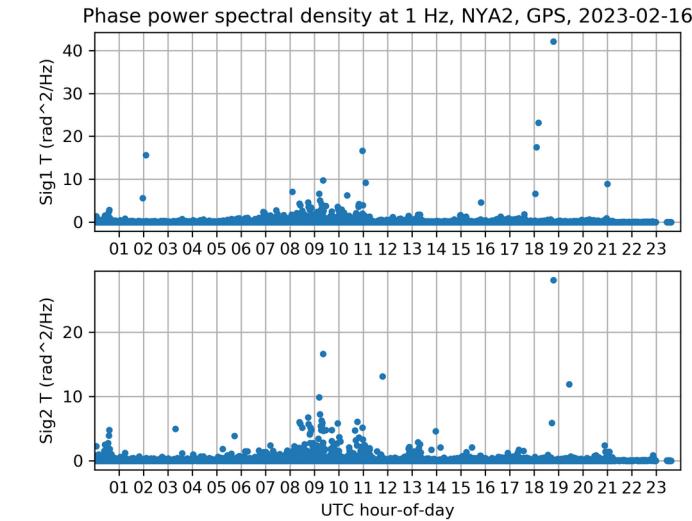
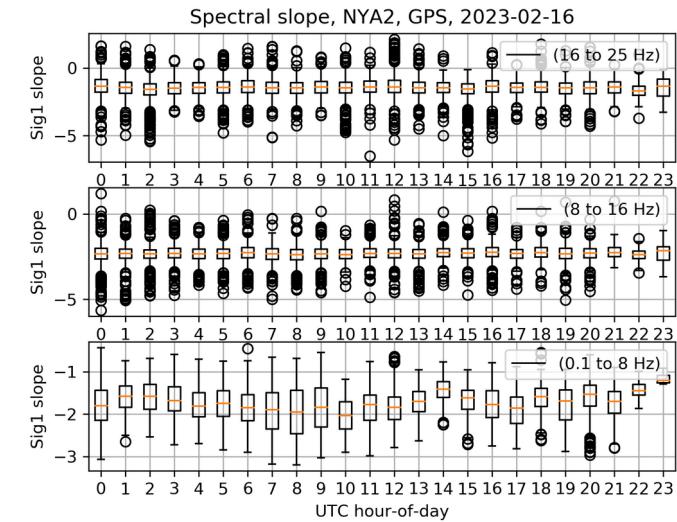
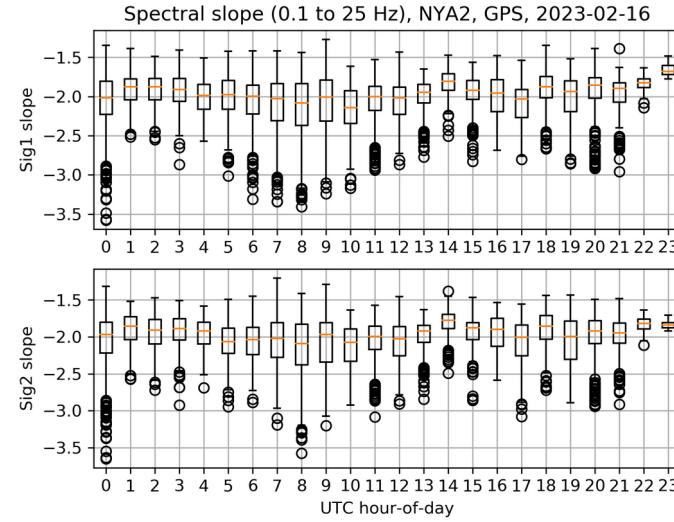
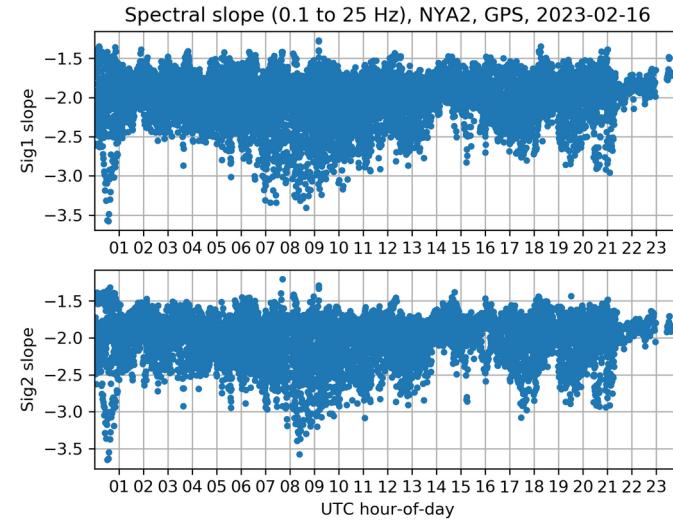
σ_ϕ heatmap & mean



Local time mid-day
in Ny-Ålesund

Example event

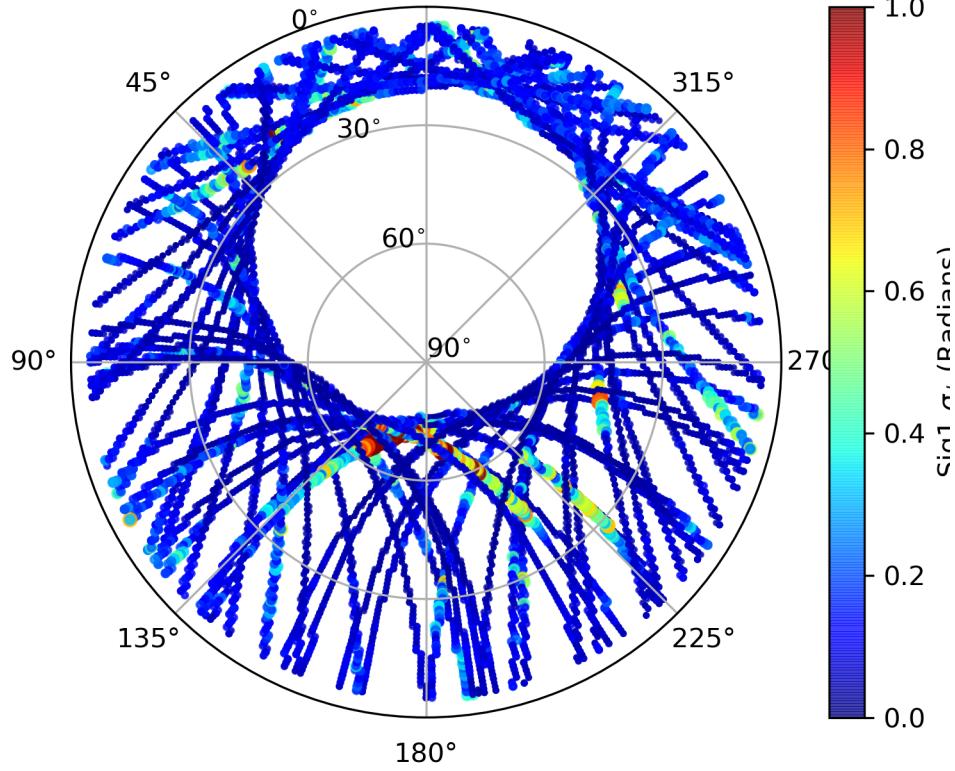
Examples of time series plots of spectral parameters



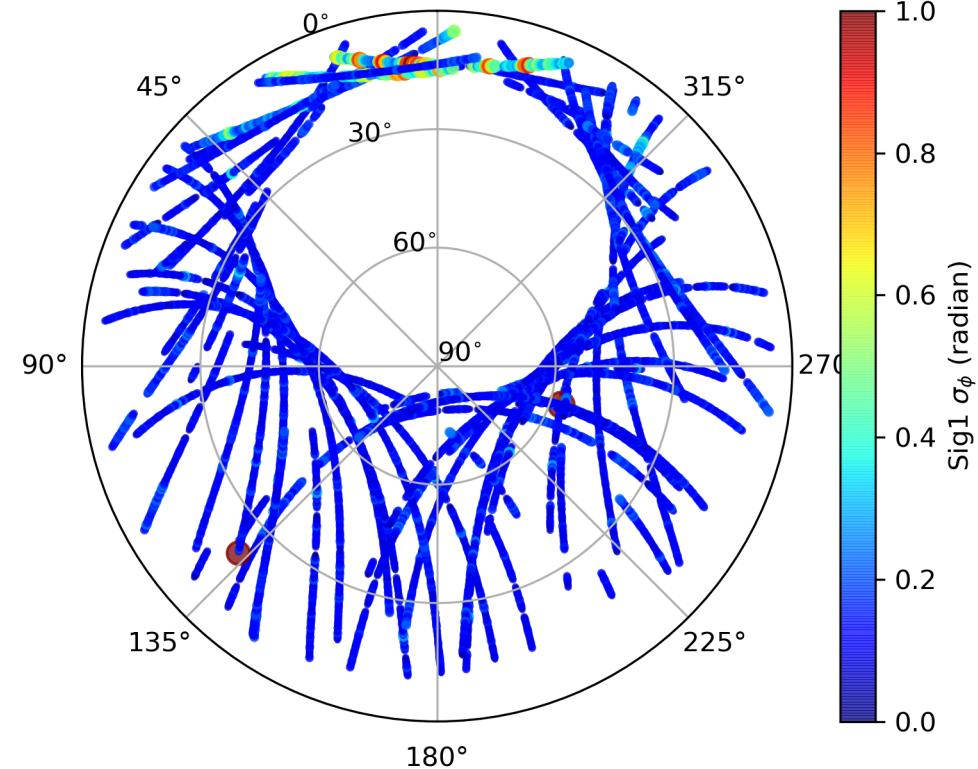
Example event

Examples of phase scintillation skyplots

Phi60s1, KLQ2, GPS, 2023-02-16



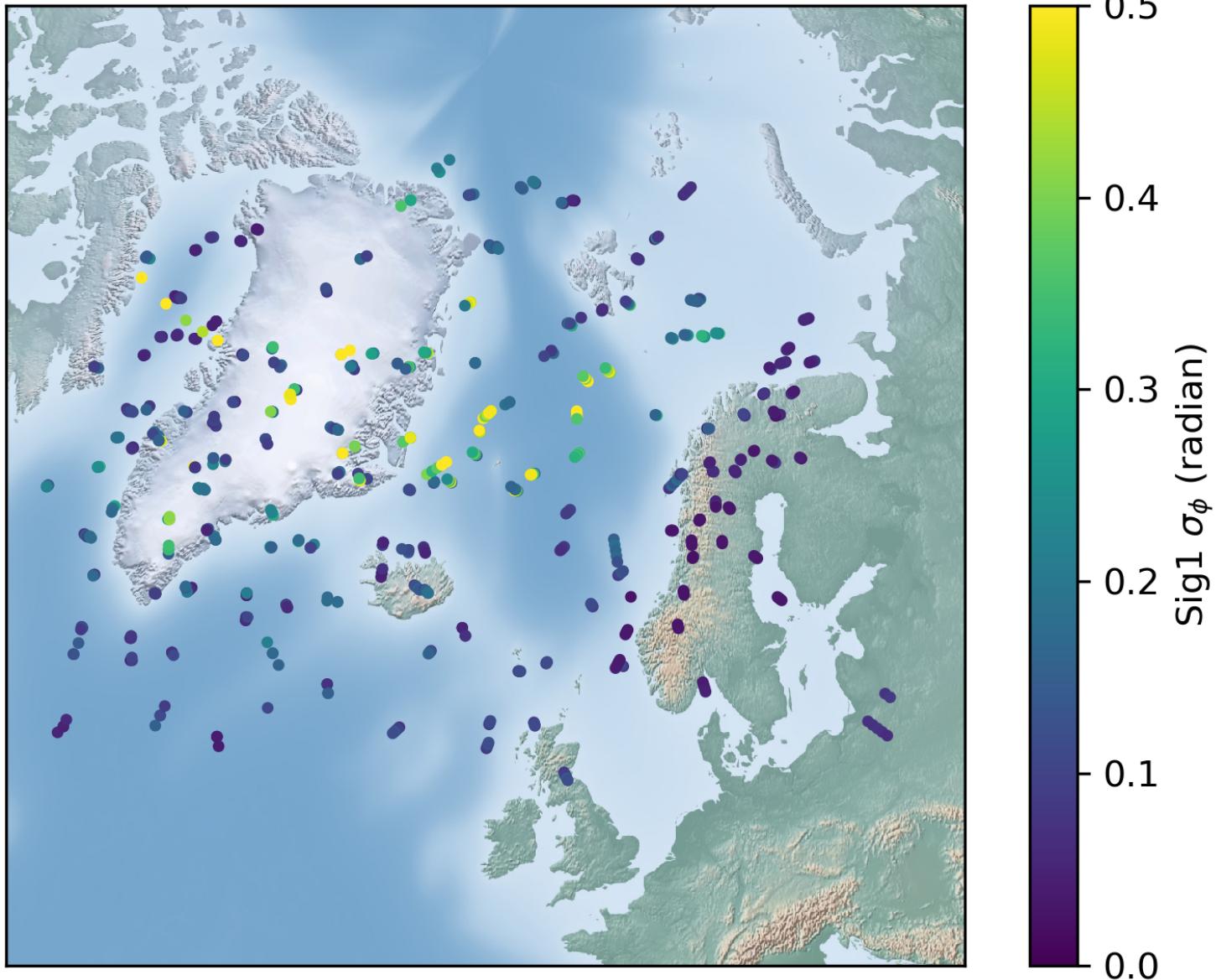
Phi60s1, FAR2, GPS, 2023-02-16



Example event

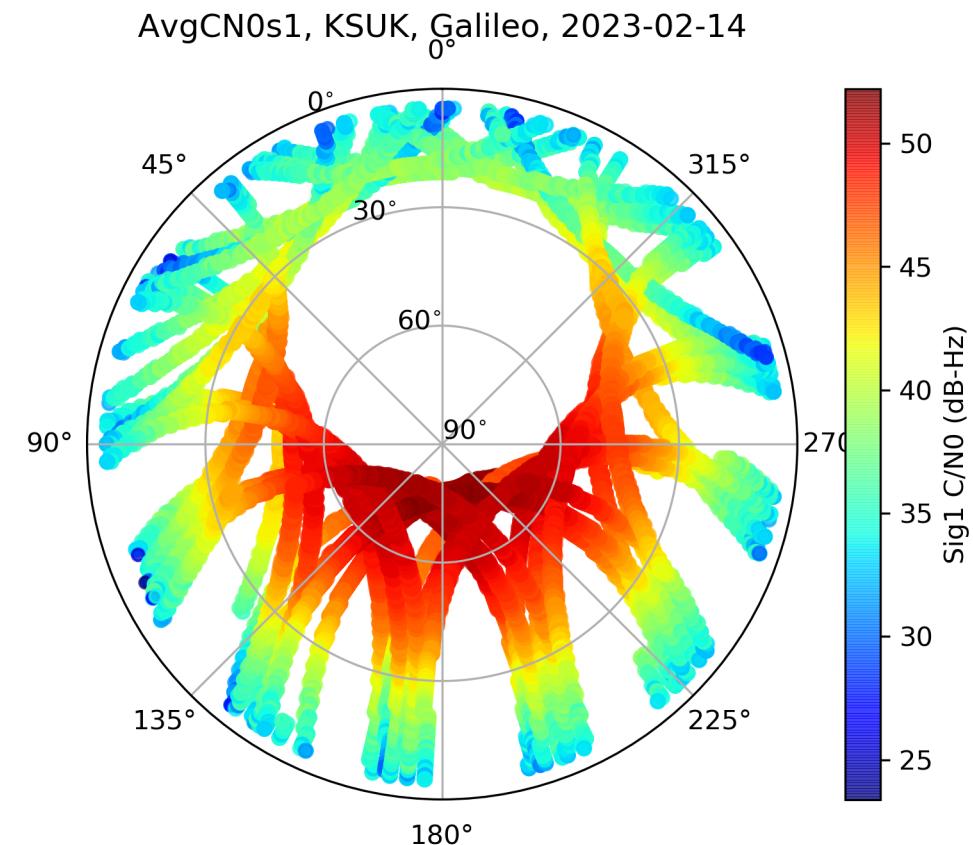
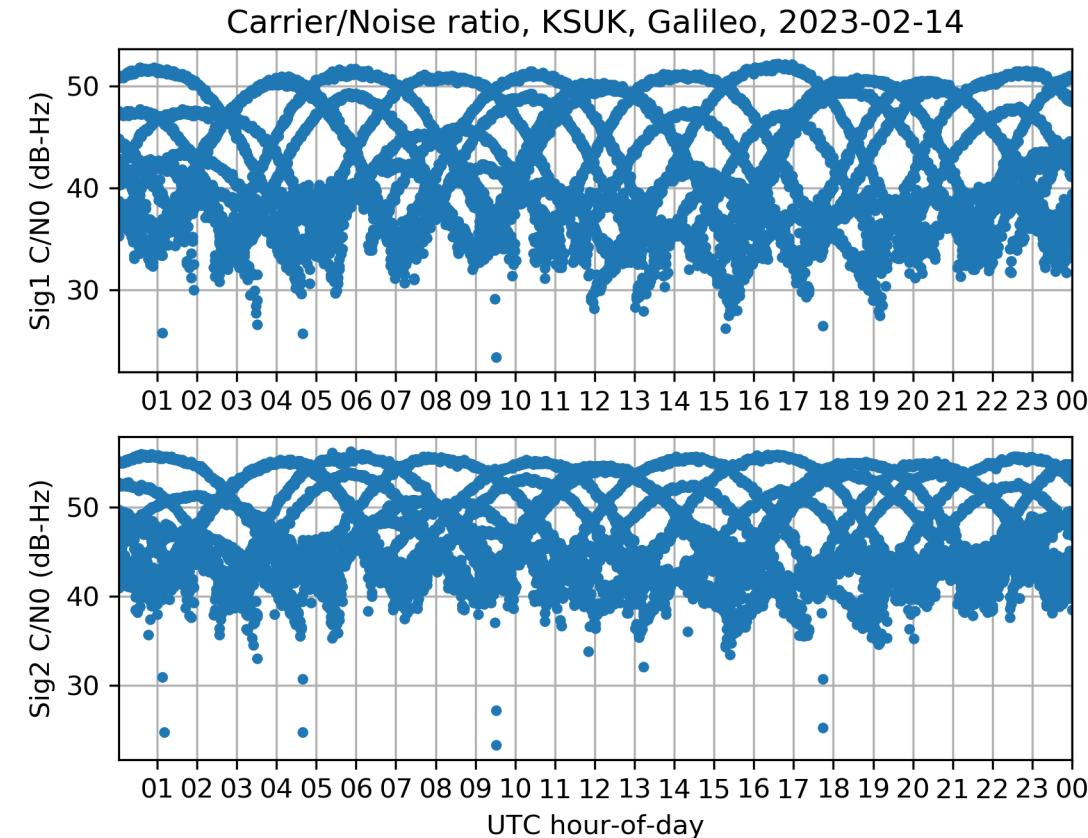
Example of phase scintillation map plots

2023-02-16 10:00 to 10:05, GPS, Galileo



Example event

Examples of time series plot and skyplot of C/N0

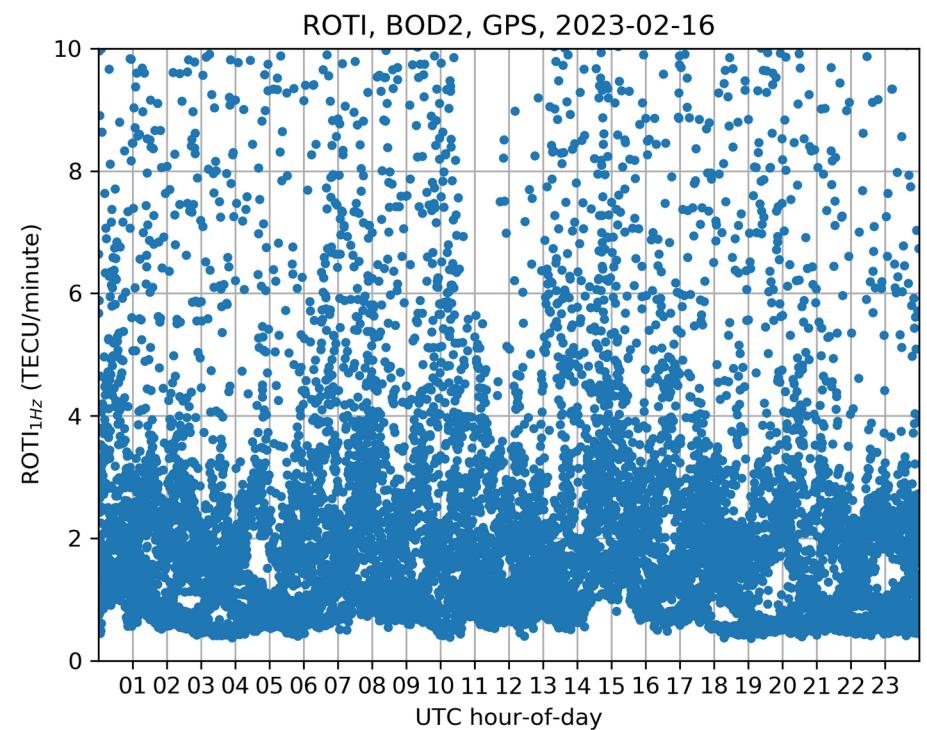
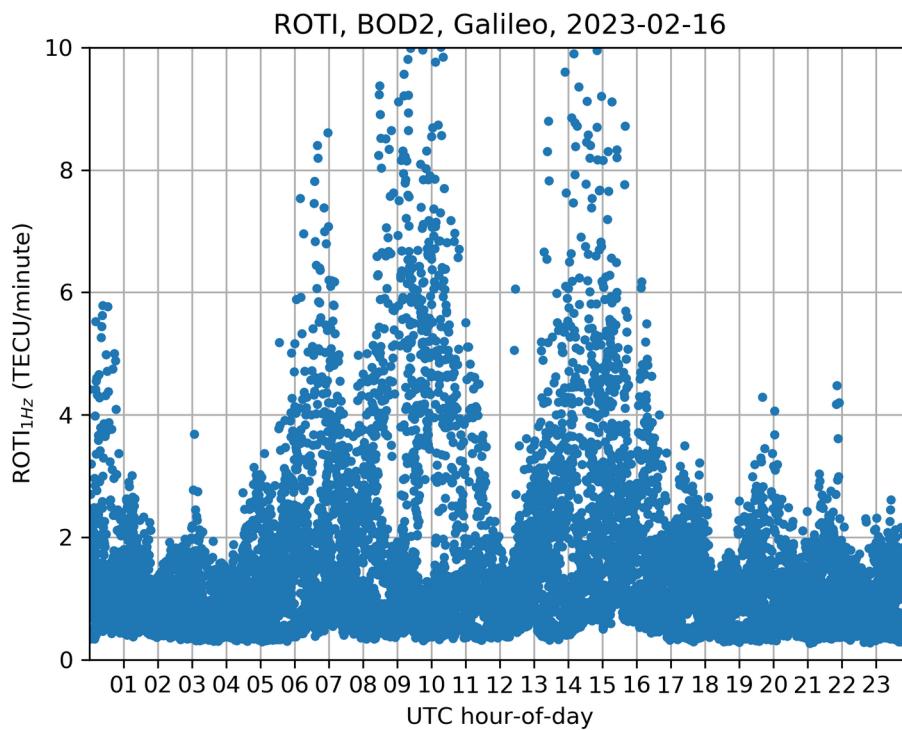


(no big surprises in the C/N0 data shown here, though)

Example event

Examples of ROTI time series plots

In the NMA data files, phase data from the scintillation receivers has been decimated to a 1 Hz rate and ROTI has been calculated. However, sometimes this fails for some reason...



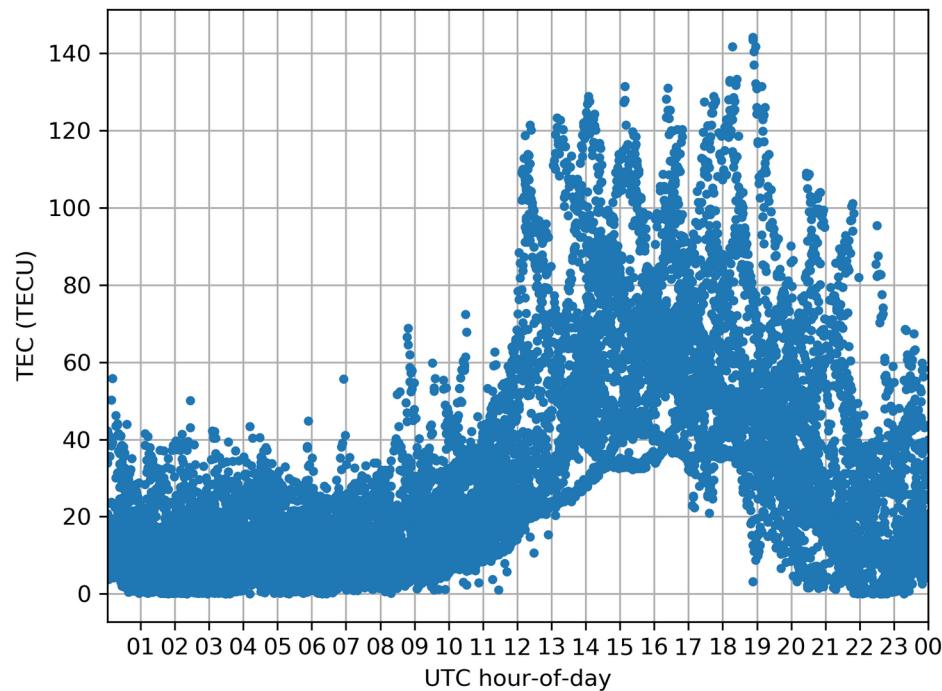
Example event

Examples of TEC time series plots

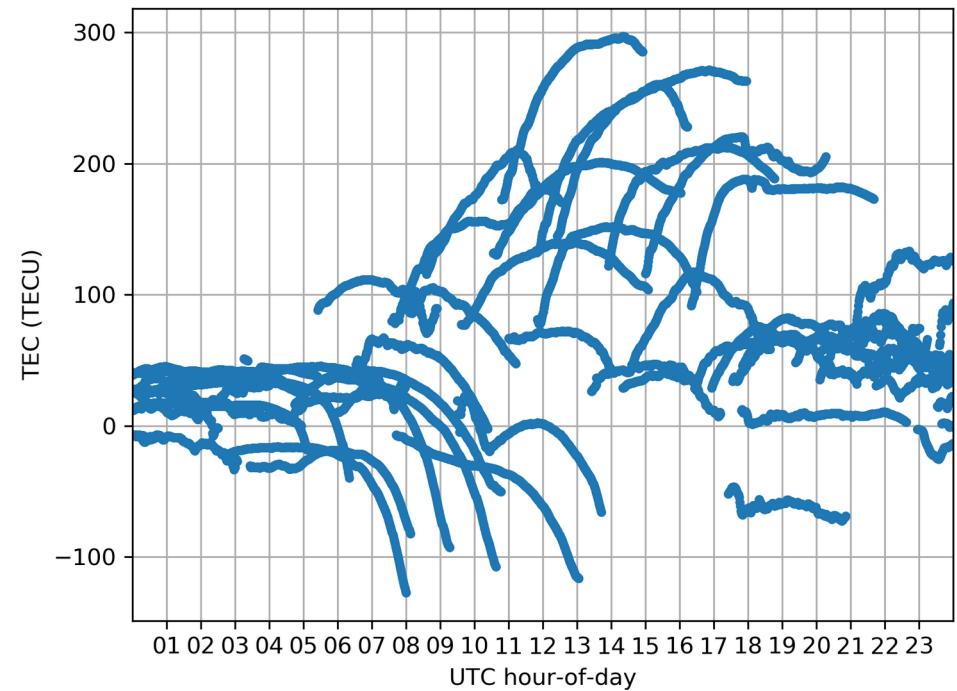
Slant TEC data are available in some data files.

They can be calibrated, or uncalibrated (i.e. Biases (DCBs) not applied)

TEC, QAQ3, GPS, 2023-02-14



TEC (uncalibrated), TRO2, GPS, 2023-02-14



Summary

The BiScEF format is based on NetCDF4 / HDF5, and is intended for archiving and sharing processed data from scintillation receivers.

The format description is available on the web, in a git repository:

<https://github.com/kartverket/BiScEF/>

It is made available under the very permissive MIT licence, permitting both non-commercial and commercial use.

Python scripts to make plots from the data files are available in the repository. They can be used as is, or as an example of how to read and handle the data.

Please make use of the format, give us feedback on the format, or request data from us.

Contacts:

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DTU: Sarah Schultz Beeck <saschu@space.dtu.dk>