User guide

Using centimeter accurate GNSS devices with FlorApp

Real time centimeter accuracy has become very affordable. This is good news for monitoring plant populations with the PopCount method developed by Info Flora. This report presents the advantages and disadvantages of different GNSS devices tested by Info Flora and provides a quick guide to enjoy centimeter accuracy in FlorApp.

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First experiences of Info Flora with GNSS devices

In 2012, Info Flora adopted a method for the monitoring of threatened plant populations where the use of GNSS devices providing very accurate positioning was central (Bornand 2012). This method, called "PopCount" since 2013 (the first name was "module 2" of the Red List Project) presented the advantages that permanent marking in field and definition of counting units were not necessary anymore. The major issue with this method was to find accurate, portable, and affordable GNSS devices. At that time, accurate GNSS devices were expensive, heavy, the signal unstable, the battery autonomy poor and the accuracy indicated by the resellers was usually far too optimistic. The use in mountainous area or in forest was almost impossible. Even with open and clear sky, the expected meter accuracy was often not achieved.

The Arrow Serie

In 2019, Info Flora tested the GNSS devices of the Arrow Series by the Canadian company Eos. Most of the problems were solved with the Arrow100 (~ 3'200 CHF) a light, compact device with good autonomy. Our tests showed that the estimation of the location accuracy obtained with the Arrow100 through the Eos Tools App was reliable, which is an important positive parameter since most other devices provide far too optimistic accuracy (an observation confirmed by several independent tests, e.g. Anatum Field Solutions 2016). But the Arrow100 is a single frequency GNSS (L1) which impacts its performance in RTK mode. In comparison to GNSS devices using dual- or triple-frequency, we observed during our comparative tests that the Arrow100 needed much more time to achieve a RTK fix and that the fix was less stable (e.g. lost when passing under the canopy of a tree). In the Arrow Series, the ArrowGold provide triple-frequency (L1/L2/L5) but is much more expansive (~ 8'000 CHF). The Arrow Serie devices are very well designed for field work (e.g. ease to change the battery), the estimated accuracy is reliable, and they are the only user friendly solution compatible with iOS devices (among the devices presented in this report).

GNSS based on ublox ZED-F9P

In 2020, Info Flora tested a series of GNSS devices based on the ZED-F9P chip developed by the Swiss company u-blox. In a static mode, the u-blox technology achieved after post processing similar accuracy than Leica GS16 (> 10'000 CHF) and the real-time measurements with u-blox also provided the expected accuracy of 1-3cm (Bredesen & Helder 2019). This ZED-F9P chip was released in 2018 and is now included in several devices. We tested the following:

- **Ardusimple** simpleRTK2Blite+BT Case Kit (the cheapest option within the different professional sets of Ardusimple)
- **OptimalSystem kit** designed for the need of the monitoring program ALL-EMA by Agroscope, lent for few months by Susanne Riedel

- **PPM 10xx** – lent by the swiss reseller TOPTEC Lutz
- **ublox C099-F9P Application board** (rev. E), ODIN-W2 Mbed™ firmware

All products listed above use the same technology (ublox chip ZED-F9P) and the results of our tests confirmed that they behave similarly. The only exception was the **OptimalSystem Kit** that provided accurate location in RTK mode but often unreliable locations without access to a correction signal. For this reason, we will not discuss this product later in this report.

The **ublox C099-F9P Application board** is the cheapest option but is not a user friendly and ready-to-use product. One needs some effort to parametrize the board, integrate power supply and connect the antenna until one can start any monitoring in the field. For this reason, we will not discuss this product later in this report.

During our tests, the **PPM 10xx** (~ 2'000 CHF) and the **Ardusimple Kit** (~ 300 CHF) provided estimations of the location and accuracy of similar quality, both with and without connection to a correction signal (RTK). Without RTK, both GNSS devices provided an estimation of the accuracy that was far too optimistic. Since this estimation of the accuracy does not change a lot when the operator stays static, this may be totally misleading: one will think that he achieved 0.9 m accuracy, even if the correct accuracy is > 2 m. In comparison, the location accuracy estimated by the Arrow100 is very often updated and usually less optimistic but correct. Note that as an estimation of the location accuracy, we use the value:

- "Accuracy XY" provided by the App "PPM Commander" for PPM 10xx
- "2DRMS" provided by the App "Lefebure NTRIP Client" for the Ardusimple kit
- "H RMS" provided by the App "EOS Tools Pro" for the Arrow100

In RTK mode, as soon as a RTK fix has been reached, all smartphone apps provide estimations of position accuracy close to 1 cm, values that may be quite optimistic but still close to the truth. Indeed, the analyses provided by Bredesen & Helder (2019) confirm that the real-time measurements with the u-blox chip ZED-F9P provided an accuracy of 1-3cm.

Future direction

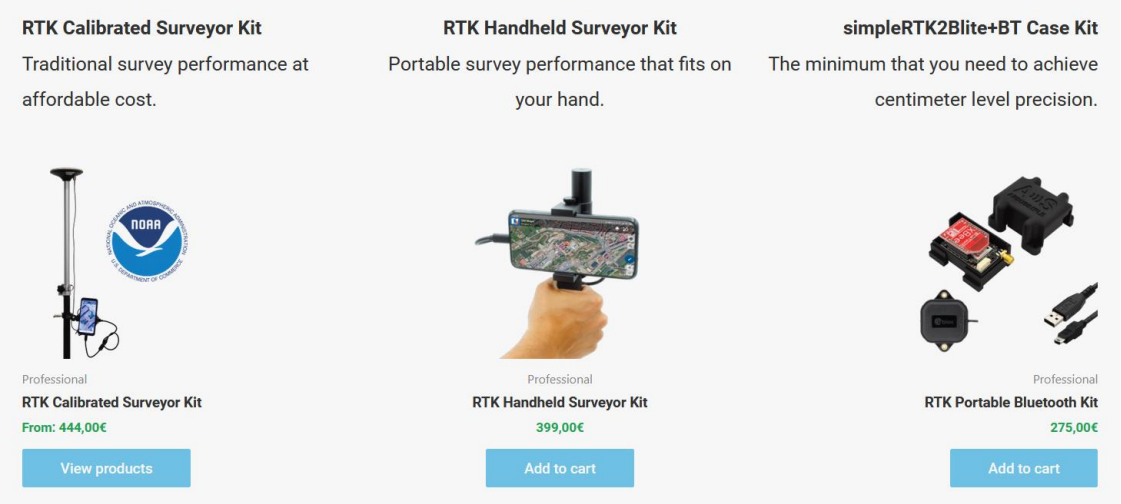
The only places where centimeter accuracy is a challenge are remote area without access to communication network (4G) and in canyons, forests, and other areas where the sky is obstructed. A future direction in 2021 would be to test the potential of "Base + Rover" setups in those harsh conditions.

Which GNSS device to choose?

Currently, the "professional sets" of **Ardusimple** are the most affordable and versatile solutions that Info Flora found on the market. There are currently 3 professional sets by Ardusimple. In all cases, the autonomy depends on the size of the external battery that you use. Here a few comments about advantages and possible disadvantages of different sets when used for monitoring plant populations.

- If you choose the cheapest option **simpleRTK2Blite+BT Case Kit** (275 €), note that 1) you will have to buy or build your own system to fix the antenna on a pole or behind your smartphone and 2) that a small piece of metal placed under the provided antenna improve the quality of the fix.
- If you choose the option **RTK Handheld Surveyor Kit** (349 €), note that the smartphone must be hold horizontally, which is not always convenient, e.g. with FlorApp. But you can buy this option an use the communication via Bluetooth to build your own "packback set" or to put the helicoidal antenna on a top of a pole. A plastic tube with the correct diameter should provide a perfectly working DIY solution.
- Finally, if you choose the option **RTK Calibrated Surveyor Kit** (399 €), you already have a survey calibrated antenna (IP67) that you can easily screw on a pole.

The easiest solution to fix the antenna on a pole is to buy a **survey grade antenna** (IP66 for 89 €, or IP67 for 149 €) and to fix it on a top of a **professional pole** (179 €). If you like to work with the antenna on a top of your backpack, you will have to find your preferred way to hold the antenna in the backpack. The screw thread of the IP66 and IP67 is 5/8" (a standard, e.g. same as the former NORTH device used by Info Flora, or the antenna of the Arrow100). Ardusimple provide a **thread adapter** (5/8" to 1/4", 10 €) for survey multiband GNSS antenna, to make it compatible with photography tripods.
The choice of a set depends mostly on your own preferences. Some people like the setup 1) with an helicoidal antenna on the back of the smartphone/tablet (handheld surveyor kit), other prefer to work 2) with a pole in the hand or 3) with the antenna on the top of their backpack. Connection of Ardusimple devices with Android smartphones/tablets is very simple (see following explanations). It may be possible also with iOS devices, although we have no experience with it (see tutorial by Ardusimple 2020).
Advantages of the **Arrow Serie devices** are their compatibility and simplicity of use with iOS devices and the reliable estimation of the accuracy, a quality especially interesting when not in RTK mode. If you choose the **Arrow100** (~ 3'200 CHF), note that it is a single frequency GNSS (L1) which impacts its performance in RTK mode. The above-mentioned devices of Ardusimple are quicker in RTK mode and the stability of the fix is better. The solution in the Arrow Serie is to choose the **ArrowGold**, providing triple-frequency (L1/L2/L5) but more expansive (~ 8'000 CHF).



Current products of Ardusimple in the category "professional sets" (2021-03-08) - https://www.ardusimple.com/professional-sets/

References

Anatum Field Solutions (2016). Bluetooth GPSGNSS for Mobile GIS Field Tested and Compared. Accessed on 2021-03-08 at https://www.agsgis.com/Bluetooth-GPSGNSS-For-Mobile-GIS-Field-Tested-and-Compared_b_38.html

Ardusimple 2020. How to use Ardusimple products with iOS smartphones/tablets. Accessed on 2021-03-08 at https://www.ardusimple.com/how-to-use-ardusimple-products-with-ios-smartphones-tablets/

Bornand Christophe (2012). Liste Rouge Flora – module 2 – suivi de population - Proposition de méthode : suivi de populations. Rapport interne Info Flora. 32 pages.

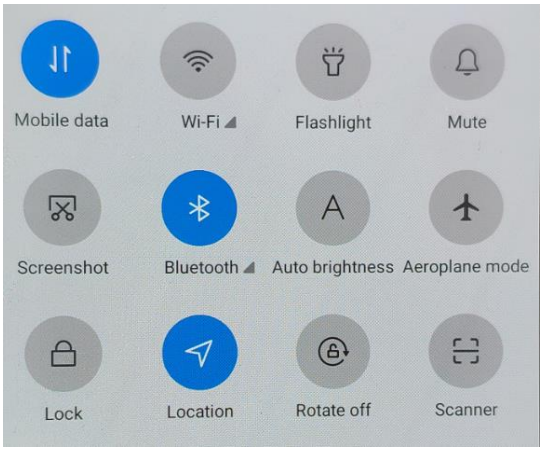
Bredesen Marius, Helder Edwin (2019). Analysis oft he positional accuracy of a low-cost dual frequency GNSS-mocule. The capabilities of the u-blox ZED-F9P. Norwegian University of Science and Technology, Faculty of Engineering. 114 p.

Quick guide: How to set up your Android smartphone in order to obtain centimeter accurate position in FlorApp?

Here a quick guide to connect an external GNSS device such as Ardusimple device with your smartphone and obtain through the Lefebure NTRIP Client app a real-time corrected position in FlorApp. Most steps must only be done once. Preparation time: 5-10 minutes. Setting in the field: 20 seconds.

Smartphone Settings

1. Smartphone language: set to English
2. Install FlorApp (version 2.3 or above)
3. Install “Lefebure NTRIP Client” App
4. Activate Developer Options (the procedure is quite different depending on the smartphone device, please check on internet to find how to activate the Developer Options in your own smartphone device). Here the procedure on a Samsung Galaxy:
    - Go to "Settings", then tap "About device" or "About phone"
    - Scroll down, then tap "Build number" seven times (Depending on your device and operating system, you may need to tap "Software information", then tap "Build number" seven times)
    - Enter your pattern, PIN or password to enable the Developer options menu
    - The "Developer options" menu will now appear in your Settings menu (Depending on your device, it may appear under Settings > General > Developer options; on a Xiaomi device, it appears under Settings > Additional settings > Developer options)
5. In the Developer options
    - Allow “GPS Mock Locations”
    - Select mock location app → Lefebure NTRIP Client
        - If you use the GNSS device PPM 10xx, select the app “PPM Commander”
        - If you use the GNSS device Arrow100, select the app “Eos Tools Pro” and you may consider de-installing other apps providing mock location, since we encounter issue with Eos Tools Pro when other apps were installed (e.g. with Lefebure NTRIP Client installed on the same device)
6. Enable Bluetooth + Location + Mobile data (and/or Wi-Fi). Note that it will not work if “Aeroplane mode” is enabled or if “Location” is disabled.

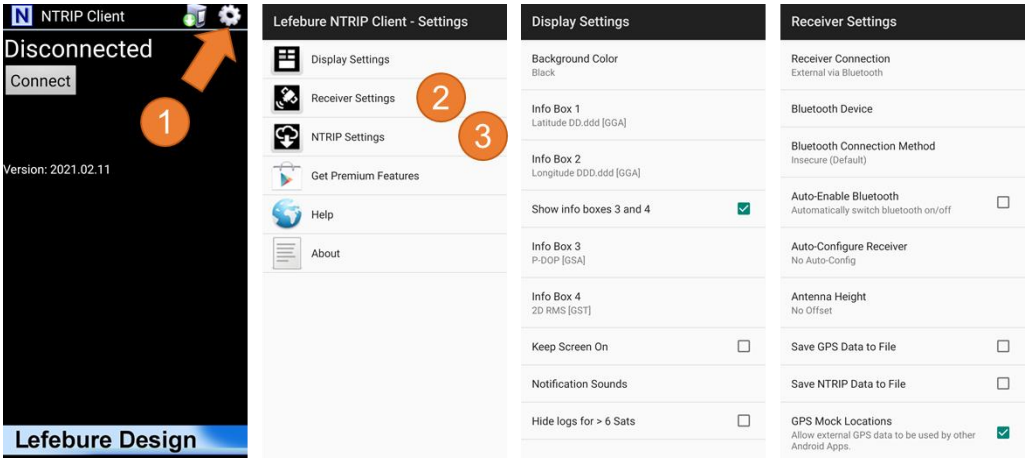


Pairing the smartphone with the GNSS device via Bluetooth

Enable Bluetooth on your smartphone/tablet, and pair it with your GNSS device.
When pairing your Ardusimple device, notice that it may appear as simpleRTK2B or as a generic MAC number (e.g.: F0:0A:95:9D:68:16). The password is always 1234. The pairing only needs to be done once.

Setting the App Lefebure NTRIP Client

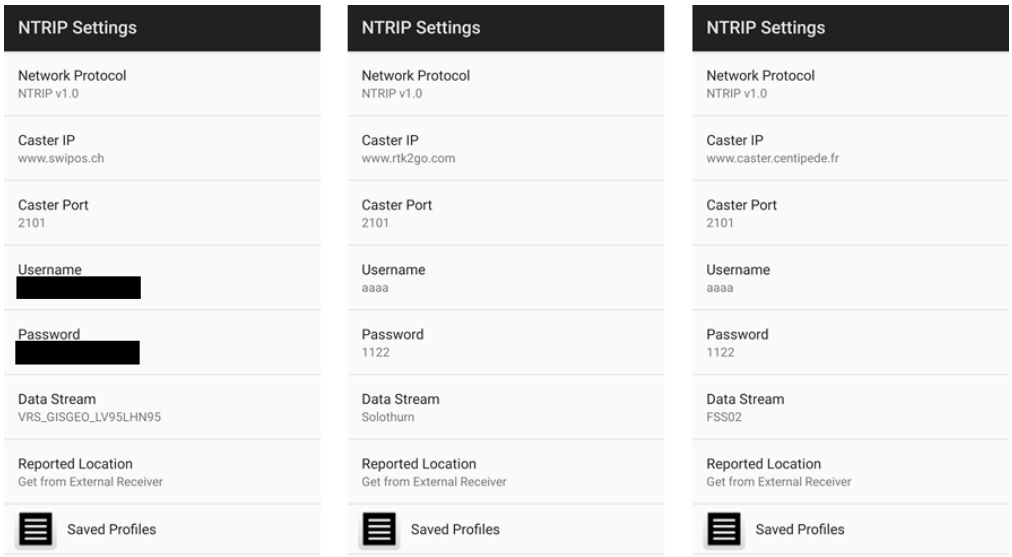
1. Open App Setting
2. Receiver Settings:
   - Receiver Connection: External via Bluetooth
   - Bluetooth Device: choose your device in the list
   - Auto-Enable Bluetooth: yes
   - GPS Mock Locations: yes



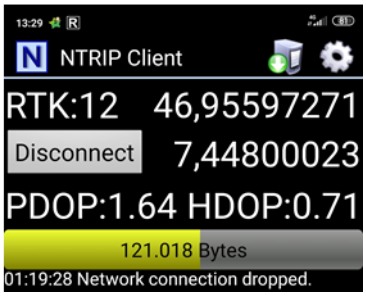
3. NTRIP Settings
   - Network Protocol: NTRIP v1.0
   - Other settings depending on the Caster, here a few examples with:
     - www.swipos.ch: username and password provided by swisstopo
     - www.rtk2go.com: username and password not important (write what you want), Data Stream depending on your location (choose the closest reference station)
     - www.caster.centipede.fr: username and password not important (write what you want), Data Stream depending on your location (choose the closest reference station)

   NB: the choice of a “reference station” is described in the next chapter “Choose an NTRIP Caster in your area”

Warning: the “Saved Profile” option is useful and worked well during our tests with most caster, excepted with swipos, where we had to reset the Data Stream (using the first option “Refresh Stream List”, and then choosing the “VRS_GISGEO_LV95LHN95” when connecting to the swipos-service).



4. Press the “Connect” button

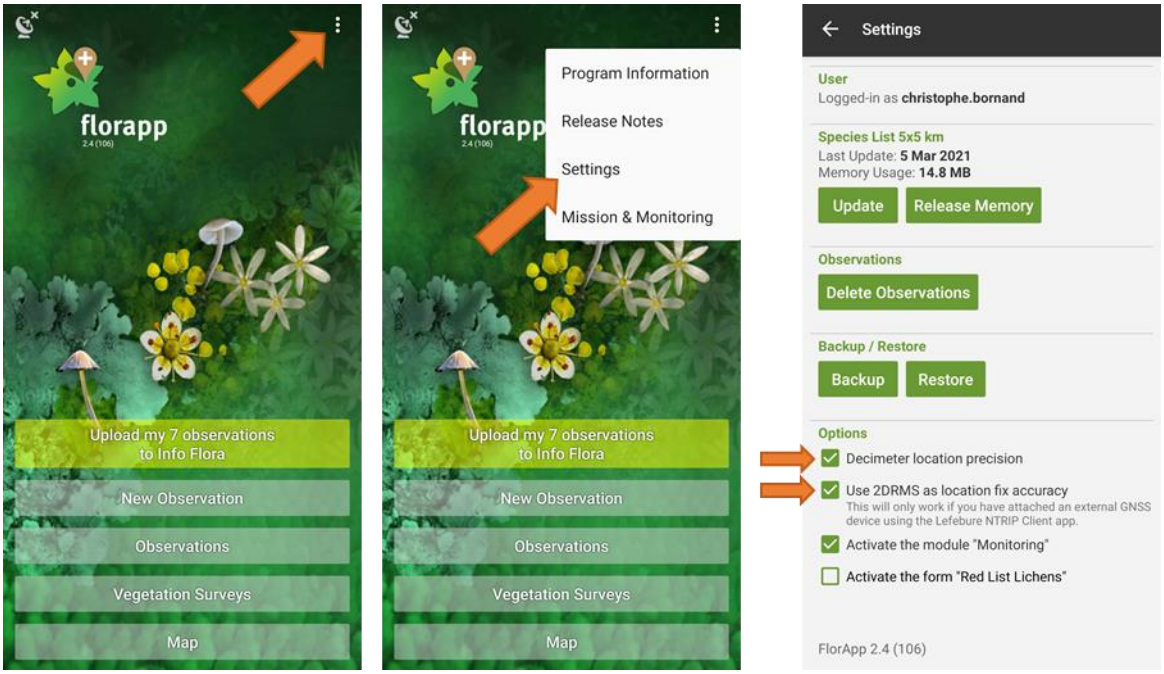


NB: when you quit the Lefebure NTRIP Client App, the quality of the signal is still visible on the top of your smartphone

- GPS >>> DPGS >>> FloatRTK >>>RTK

Setting FlorApp

In the Menu of FlorApp (top right), choose “Settings”
In the Options, enable “Decimeter location precision” and “Use 2DRMS as location fix accuracy”



Choose an NTRIP Caster in your area

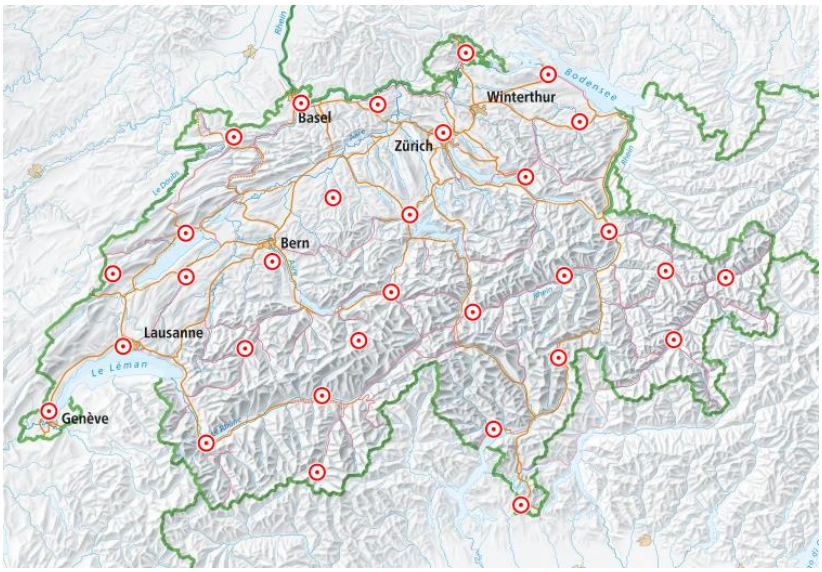
The official service by the Federal Office of Topography swisstopo is “swipos”. The swipos service covers whole Switzerland and is easy to use since you do not have to search for the closest reference station in your area. But in several regions of Switzerland, you can freely use other NTRIP Caster providing RTK corrections sources. Info Flora tested in 2020 several stations of the RTK2go and Centipede networks. The results were comparable to the one obtained with swipos and did not cost anything.

swipos

swipos – GIS/GEO is available under following fees: CHF 0.50/min or CHF 2’000/year.

swipos NAV is free of charge but based on a single reference station near Lucerne. The Federal Office of Topography states that one can achieve meter accuracy. The accuracy may be better in the close vicinity of Lucerne.

The swipos reference network is called AGNES (Automatisches GNSS Netz Schweiz). The map of the reference stations is available on https://map.geo.admin.ch



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Canton of Geneva – GNSS reference stations

Free of charge after registration.

See following information:
https://www.ge.ch/obtenir-donnees-gps
https://www.ge.ch/obtenir-donnees-gps/connexion-aux-antennes-reference
https://www.ge.ch/document/conditions-utilisation-station-gnss
A map is provided in the PDF available here:
https://www.ge.ch/document/conditions-utilisation-station-gnss
Note that the radius on the map provided p. 2 use a radius of 15 km. However, good results are obtained further away from a reference station. So, this service may be useful outside of the area of the canton of Geneva.

RTK2go

Free of charge.

To see a map of current reference stations, press the button “View All” at the bottom right side of the table on this site:
http://monitor.use-snip.com/?hostUrl=rtk2go.com&port=2101

Currently (2022-04-05), there are 4 stations useful in Switzerland:
- BUSSWIL between Lyss and Biel/Bienne
- Solothurn (very good results during our test in the city of Bern)
- Freiamt between Luzern and Zürich
- leedgps in the city of Zürich
- F9P-tomi between Winterthur and Schaffhausen
- Hombi north of Rapperswil
- GLABIPR near Varese (certainly the most useful for Ticino)

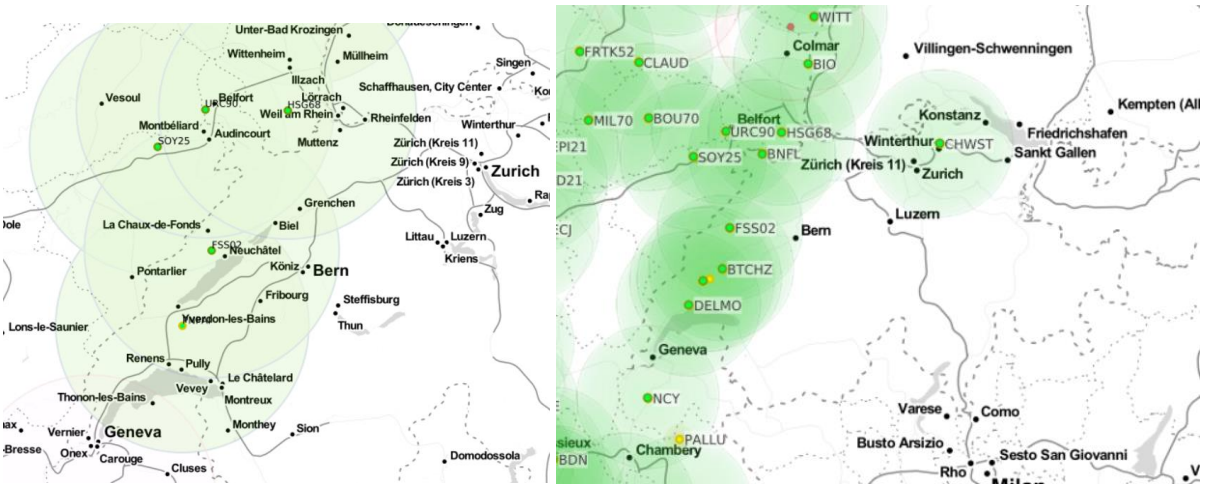
Centipede

Free of charge.
The map of the current reference stations is here:
https://centipede.fr/index.php/view/map/?repository=cent&project=centipede

In February 2021 the following stations were available and useful for Switzerland:

- PNPAI : north of Echallens (useful for most canton of VD and part of FR)
- FSS02 in Les Geneveys-sur-Coffrane (useful for NE and large parts of BE, FR, VD)
- SOY25 near Montbélliard
- URC90 near Belfort
- HSG68 near Altkirch in Alsace (useful for BL, BS, JU, part of SO and AG)

In 2022, the network was much more dense, with several new mount point in western Switzerland and one in the eastern part near Winterthur (**CHWST**).



Centipede network around Switzerland: state in February 2021 (left) and April 2022 (right)
Radius = 60 km. Map by Centipede. © OpenStreetMap contributors.