

# GPS Pratique



```
Text Console
11:05:43 $GPTXT,01,01,00,txbuf alloc*7F
11:05:45 $GPRMC,110545.00,A,4630.94973,N,00641.11672,E,0.0,0.0,0.0,0.0,0.0,0.0
11:05:46 $GPRMC,110546.00,A,4630.95015,N,00641.11685,E,0.0,0.0,0.0,0.0,0.0,0.0
11:05:46 $GPVTG,,T,M,0.317,N,0.586,K,A*2D
11:05:48 $GPTXT,01,01,00,txbuf alloc*7F
11:05:53 $GPTXT,01,01,00,txbuf alloc*7F
11:05:56 $GPRMC,110556.00,A,4630.95461,N,00641.11773,E,0.0,0.0,0.0,0.0,0.0,0.0
11:05:57 $GPRMC,110557.00,A,4630.95461,N,00641.11775,E,0.0,0.0,0.0,0.0,0.0,0.0
11:05:58 $GPTXT,01,01,00,txbuf alloc*7F
11:06:02 $GPRMC,110602.00,A,4630.95539,N,00641.11815,E,0.0,0.0,0.0,0.0,0.0,0.0
11:06:03 $GPVTG,,T,M,0.866,N,1.604,K,A*28
11:06:04 $GPTXT,01,01,00,txbuf alloc*7F
11:06:05 $GPRMC,110605.00,A,4630.95470,N,00641.11810,E,0.0,0.0,0.0,0.0,0.0,0.0
11:06:08 $GPTXT,01,01,00,txbuf alloc*7F
11:06:13 $GPRMC,110613.00,A,4630.95292,N,00641.11785,E,0.0,0.0,0.0,0.0,0.0,0.0
11:06:13 $GPTXT,01,01,00,txbuf alloc*7F
11:06:18 $GPTXT,01,01,00,txbuf alloc*7F
11:06:23 $GPTXT,01,01,00,txbuf alloc*7F
11:06:28 $GPTXT,01,01,00,txbuf alloc*7F
11:06:29 $GPRMC,110629.00,A,4630.95132,N,00641.12001,E,0.0,0.0,0.0,0.0,0.0,0.0
11:06:33 $GPTXT,01,01,00,txbuf alloc*7F
11:06:34 $GPRMC,110634.00,A,4630.95184,N,00641.12091,E,0.0,0.0,0.0,0.0,0.0,0.0
11:06:34 $GPVTG,,T,M,0.320,N,0.592,K,A*2C
11:06:37 $GPRMC,110637.00,A,4630.95160,N,00641.12142,E,0.0,0.0,0.0,0.0,0.0,0.0
11:06:39 $GPTXT,01,01,00,txbuf alloc*7F
```



Laurent Francey, Rolf Ziegler, 2.11.2018

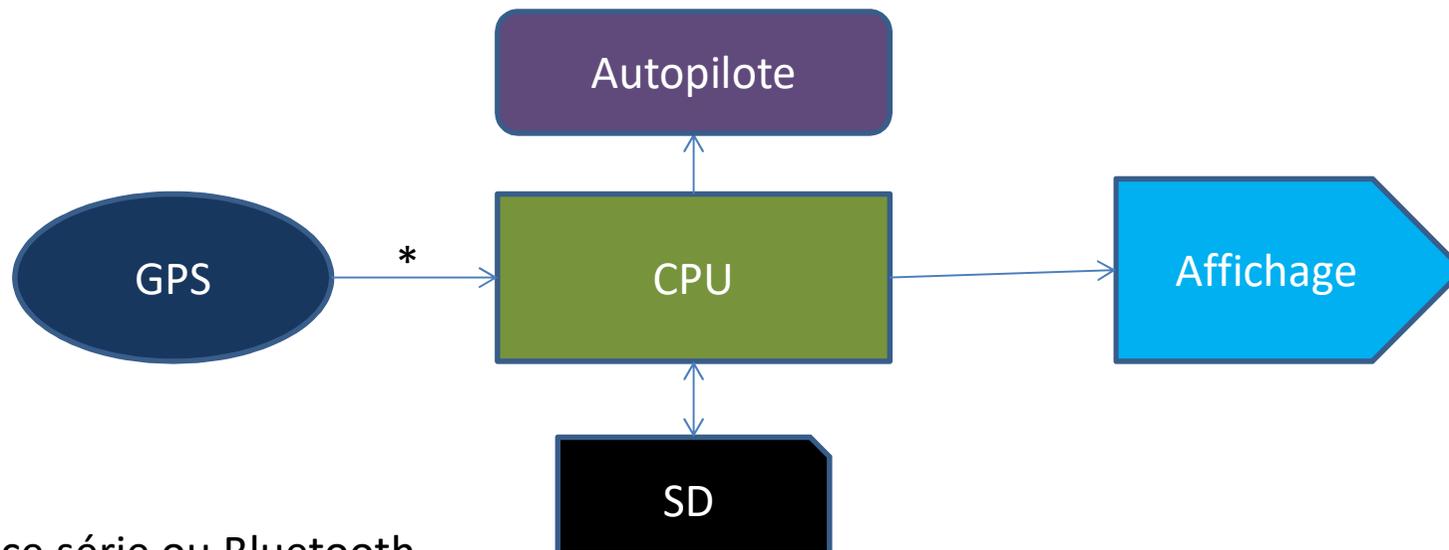
# GPS Pratique

## Agenda

- Utilisation
- Matériel, Interface
- Langage NMEA (\$ strings)
- Configuration du GPS (Ublox)
- Utilisation dans un montage
- Programmation, Librairies
- Exemples

# GPS Pratique Utilisation

- Voiture, Navigation
- Aviation
- Téléphonie (Smartphone), Balades, fitness,...
- Drones, positionnement, navigation



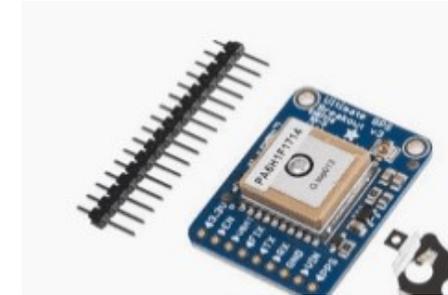
\* interface série ou Bluetooth

# GPS Pratique

## Matériel



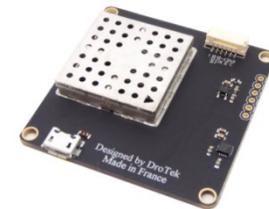
Module simple  
GPS+REG+Bat (UART)



Fix = position trouvée



Module avec Mag.  
GPS+Reg+Bat+Mem+Magneto  
(UART +I2C)



! Attention au copies !

# GPS Pratique

## Langage NMEA

- Standardisé, chaîne de caractères ou binaire (Ublox)
- Vitesse de transmission, messages, alimentation,...
- Messages utiles:
  - GGA lat,long,alt, fix information
  - GLL longitude, latitude
  - RMB données de navigation recommandées

- [AAM](#) - Waypoint Arrival Alarm
- [ALM](#) - Almanac data
- [APA](#) - Auto Pilot A sentence
- [APB](#) - Auto Pilot B sentence
- [BOD](#) - Bearing Origin to Destination
- [BWC](#) - Bearing using Great Circle route
- [DTM](#) - Datum being used.
- [GGA](#) - Fix information
- [GLL](#) - Lat/Lon data
- [GRS](#) - GPS Range Residuals
- [GSA](#) - Overall Satellite data
- [GST](#) - GPS Pseudorange Noise Statistics
- [GSV](#) - Detailed Satellite data
- [MSK](#) - send control for a beacon receiver
- [MSS](#) - Beacon receiver status information.
- [RMA](#) - recommended Loran data
- [RMB](#) - recommended navigation data for gps
- [RMC](#) - recommended minimum data for gps
- [RTE](#) - route message
- [TRF](#) - Transit Fix Data
- [STN](#) - Multiple Data ID
- [VBW](#) - dual Ground / Water Speed
- [VTG](#) - Vector track and Speed over the Ground
- [WCV](#) - Waypoint closure velocity (Velocity Made Good)

# GGA – données fixes essentielles offrant une localisation précises

```
$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M
```

Where:

GGA Global Positioning System Fix Data

123519 Fix taken at 12:35:19 UTC

4807.038,N Latitude 48 deg 07.038' N

01131.000,E Longitude 11 deg 31.000' E

1 Fix quality: 0 = invalid

1 = GPS fix (SPS)

2 = DGPS fix

3 = PPS fix

4 = Real Time Kinematic

5 = Float RTK

6 = estimated (dead reckoning)

7 = Manual input mode

8 = Simulation mode

08 Number of satellites being tracked

0.9 Horizontal dilution of position

545.4,M Altitude, Meters, above mean sea level

46.9,M Height of geoid (mean sea level) above WGS84

# GSA – Degré de précision et liste des satellites actifs.

```
$GPGSA,A,3,04,05,,09,12,,,24,,,,,2.5,1.3,2.1*39
```

Where:

GSA	Satellite status
A	Auto selection of 2D or 3D fix (M =
3	3D fix - values include: 1 = no fix
	2 = 2D fix
	3 = 3D fix
04,05...	PRNs of satellites used for fix (spa
2.5	PDOP (dilution of precision)
1.3	Horizontal dilution of precision (HD

# GPS Pratique

## RMC - NMEA données position, vitesse et temps

```
$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,23039
```

Where:

RMC	Recommended Minimum sentence C
123519	Fix taken at 12:35:19 UTC
A	Status A=active or V=Void.
4807.038,N	Latitude 48 deg 07.038' N
01131.000,E	Longitude 11 deg 31.000' E
022.4	Speed over the ground in knots
084.4	Track angle in degrees True
230394	Date - 23rd of March 1994

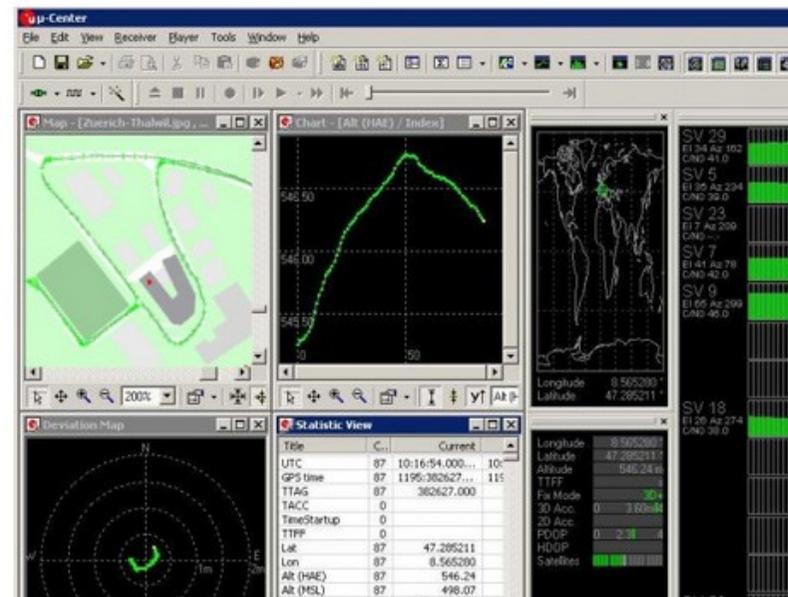
Déviation Magnétique: Erreur locale du nord par rapport au nord magnétique. Très Important pour la navigation en mer et aussi pour les balades dans le brouillard !

# GPS Pratique

## Configuration du GPS (UBLOX)

- Changer la vitesse de transmission
- Changer le contenu (nous ne voulons pas tout)
- Changer le langage (NMEA, UBLOX/binaire)
- Exemple UBLOX U-Center (Swiss R&D)

- [Démonstration](#)



# GPS Pratique

## U-Center de Ublox

COM30\_181031\_173207.ubx - u-center 18.05.02

File Edit View Player Receiver Tools Window Help

Text Console

```
17:36:11 $GPGSV,3,2,11,09,02,105,,13,51,294,15,15,14,291,,21,07,327,22*73
17:36:11 $GPGSV,3,3,11,27,02,020,,28,44,131,30,30,66,059,47*4A
17:36:11 $GPGLL,4630.96946,N,00641.11219,E,173611.00,A,A*66
17:36:12 $GPRMC,173612.00,V,,,,,,311018,,N*77
17:36:12 $GPVTG,,,,,,N*30
17:36:12 $GPGGA,173612.00,,,,,0,03,74.19,,,,,*6E
17:36:12 $GPGSA,A,1,05,30,07,,,,,,74.19,74.19,1.00*00
17:36:12 $GPGSV,3,1,11,02,02,219,11,05,64,238,19,07,33,057,48,08,06,049,*7D
17:36:12 $GPGSV,3,2,11,09,02,105,,13,51,294,07,15,14,291,,21,07,327,22*70
17:36:12 $GPGSV,3,3,11,27,02,020,,28,44,131,30,30,66,059,47*4A
17:36:12 $GPGLL,,173612.00,V,N*4A
17:36:13 $GPRMC,173613.00,A,4630.96830,N,00641.11353,E,0.414,,311018,,A*79
17:36:13 $GPVTG,,T,,M,0.414,N,0.767,K,A*24
17:36:13 $GPGGA,173613.00,4630.96830,N,00641.11353,E,1.04,3.35,615.3,M,47.2,M,,*5F
17:36:13 $GPGSA,A,3,05,30,07,13,,,,,,6.02,3.35,5.00*05
17:36:13 $GPGSV,3,1,11,02,02,219,11,05,64,238,21,07,33,057,48,08,06,049,*76
17:36:13 $GPGSV,3,2,11,09,02,105,,13,51,294,18,15,14,291,,21,07,327,23*7F
17:36:13 $GPGSV,3,3,11,27,02,020,,28,44,131,30,30,66,059,47*4A
17:36:13 $GPGLL,4630.96830,N,00641.11353,E,173613.00,A,A*6B
17:36:14 $GPRMC,173614.00,A,4630.96737,N,00641.11453,E,0.325,,311018,,A*74
17:36:14 $GPVTG,,T,,M,0.325,N,0.602,K,A*23
17:36:14 $GPGGA,173614.00,4630.96737,N,00641.11453,E,1.04,3.35,615.3,M,47.2,M,,*57
17:36:14 $GPGSA,A,3,05,30,07,13,,,,,,6.02,3.35,5.00*05
17:36:14 $GPGSV,3,1,11,02,02,219,14,05,64,238,21,07,33,057,49,08,06,049,*72
17:36:14 $GPGSV,3,2,11,09,02,105,,13,51,294,23,15,14,291,,21,07,327,23*77
17:36:14 $GPGSV,3,3,11,27,02,020,,28,44,131,30,30,66,059,47*4A
17:36:14 $GPGLL,4630.96737,N,00641.11453,E,173614.00,A,A*63
17:36:15 $GPRMC,173615.00,A,4630.96670,N,00641.11527,E,0.188,,311018,,A*70
17:36:15 $GPVTG,,T,,M,0.188,N,0.349,K,A*2C
17:36:15 $GPGGA,173615.00,4630.96670,N,00641.11527,E,1.04,3.35,615.3,M,47.2,M,,*56
17:36:15 $GPGSA,A,3,05,30,07,13,,,,,,6.02,3.35,5.00*05
17:36:15 $GPGSV,3,1,11,02,02,219,14,05,64,238,22,07,33,057,49,08,06,049,*71
17:36:15 $GPGSV,3,2,11,09,02,105,,13,51,294,24,15,14,291,,21,07,327,23*70
```

Map - [MapView\_roadmap\_0.8118584\_0.1166797\_1]

GPS 02  
EI 0.03 Az -4  
CIN0 7.0  
GPS 05  
EI 112.00 -2  
CIN0 24.0  
GPS 07  
EI 0.58 Az 0  
CIN0 48.0  
GPS 019  
EI 0.89 Az -1  
CIN0 7.0  
GPS 021  
EI 0.12 Az -4  
CIN0 13.0  
GPS 026  
EI 0.77 Az 2  
CIN0 25.0

Satellite	Signal Strength (dB)
G13	~10
G2	~10
G21	~22
G28	~30
G30	~47
G5	~19

# GPS Pratique Protocol

- GGA Fix info
- GSV Sat Data
- GLL Long.Lat.
- RMC Min. Data
- VTG Vector+Speed

```
Text Console
18:08:23 $GPGSV,3,1,09,05,54,214,,07,20,061,43,08,07,036,,13,64,306
18:08:23 $GPGSV,3,2,09,15,26,297,,21,08,315,33,24,03,247,,28,54,113
18:08:23 $GPGSV,3,3,09,30,52,059,47*4B
18:08:23 $GPGLL,4630.94379,N,00641.11376,E,180823.00,A,A*69
18:08:24 $GPRMC,180824.00,A,4630.94369,N,00641.11372,E,0.018,,31101
18:08:24 $GPVTG,,T,,M,0.018,N,0.033,K,A*2A
18:08:24 $GPGGA,180824.00,4630.94369,N,00641.11372,E,1,06,2.64,580.
18:08:24 $GPGSA,A,3,05,30,28,07,13,21,,,,,3.50,2.64,2.30*0F
18:08:24 $GPGSV,3,1,09,05,54,214,23,07,20,061,43,08,07,036,,13,64,3
18:08:24 $GPGSV,3,2,09,15,26,297,,21,08,315,33,24,03,247,,28,54,113
18:08:24 $GPGSV,3,3,09,30,52,059,47*4B
18:08:24 $GPGLL,4630.94369,N,00641.11372,E,180824.00,A,A*6B
18:08:25 $GPRMC,180825.00,A,4630.94354,N,00641.11369,E,0.234,,31101
18:08:25 $GPVTG,,T,,M,0.234,N,0.434,K,A*25
18:08:25 $GPGGA,180825.00,4630.94354,N,00641.11369,E,1,06,2.64,580.
18:08:25 $GPGSA,A,3,05,30,28,07,13,21,,,,,3.50,2.64,2.30*0F
18:08:25 $GPGSV,3,1,09,05,54,214,23,07,20,061,43,08,07,036,,13,64,3
18:08:25 $GPGSV,3,2,09,15,26,297,,21,08,315,32,24,03,247,,28,54,113
18:08:25 $GPGSV,3,3,09,30,52,059,47*4B
18:08:25 $GPGLL,4630.94354,N,00641.11369,E,180825.00,A,A*6E
18:08:26 $GPRMC,180826.00,A,4630.94352,N,00641.11373,E,0.036,,31101
18:08:26 $GPVTG,,T,,M,0.036,N,0.068,K,A*28
18:08:26 $GPGGA,180826.00,4630.94352,N,00641.11373,E,1,06,1.58,580.
18:08:26 $GPGSA,A,3,05,30,28,07,13,21,,,,,2.56,1.58,2.01*06
18:08:26 $GPGSV,3,1,09,05,54,214,23,07,20,061,43,08,07,036,,13,64,3
18:08:26 $GPGSV,3,2,09,15,26,297,,21,08,315,32,24,03,247,,28,54,113
18:08:26 $GPGSV,3,3,09,30,52,059,47*4B
18:08:26 $GPGLL,4630.94352,N,00641.11373,E,180826.00,A,A*60
18:08:27 $GPRMC,180827.00,A,4630.94352,N,00641.11377,E,0.067,,31101
```

- 1) Le set de messages peut varier d'un module GPS à l'autre
- 2) On peut annuler certaines classes de message pour gagner du temps

# GPS Pratique

## Position des satellites

- 2 satellites en vue = pas de « Fix »

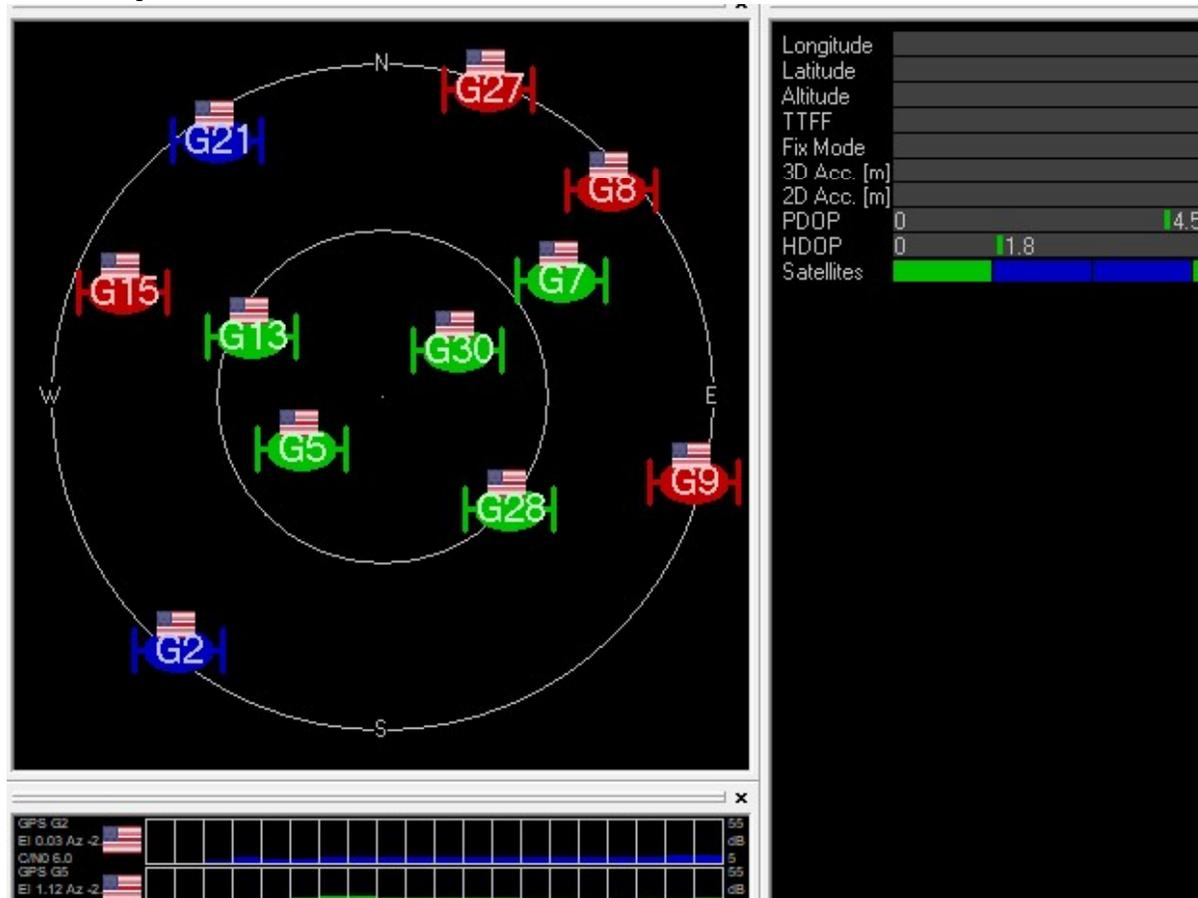


Le module GPS est à l'intérieur de mon bureau!

# GPS

## Fix 2D

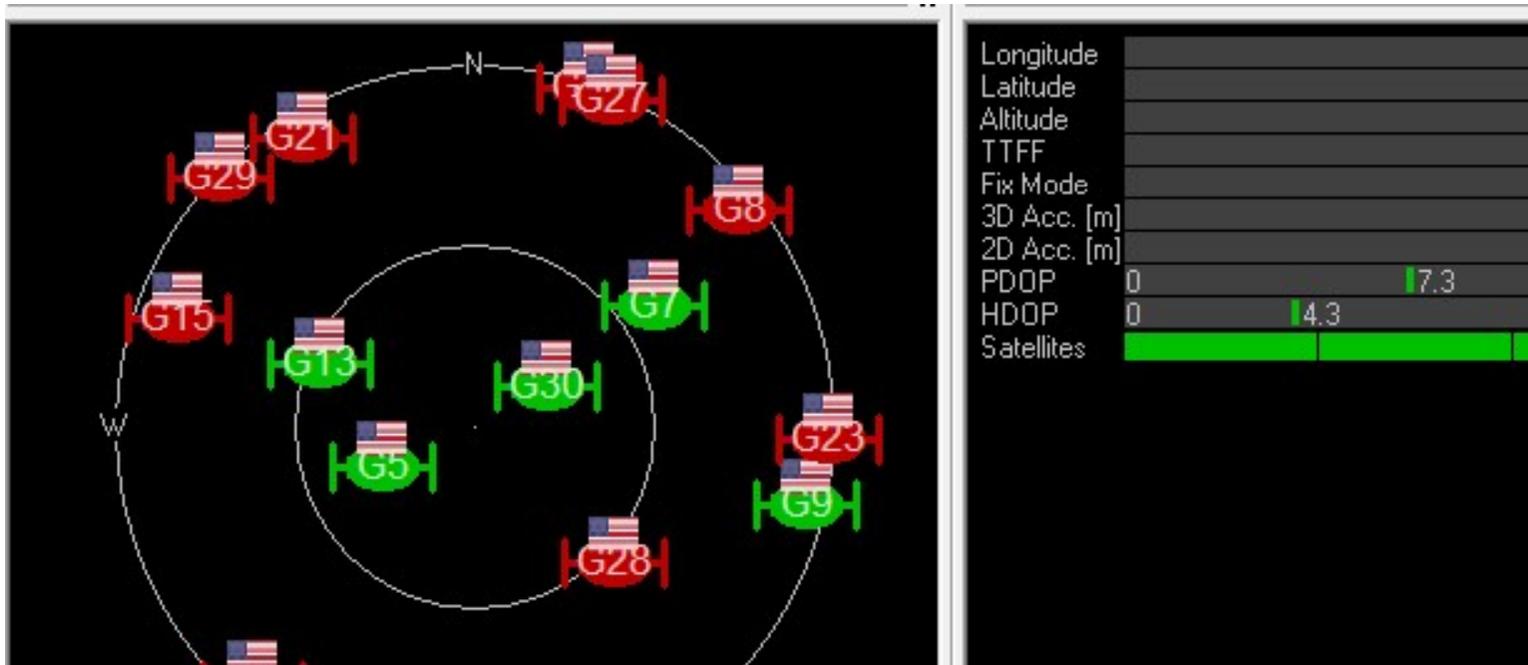
- 6 satellites mais mal positionnés ne donnent qu'une position en horizontal = 2D



# GPS

## Position des satellites

- 4 satellites en vue = fix 3d = position + altitude

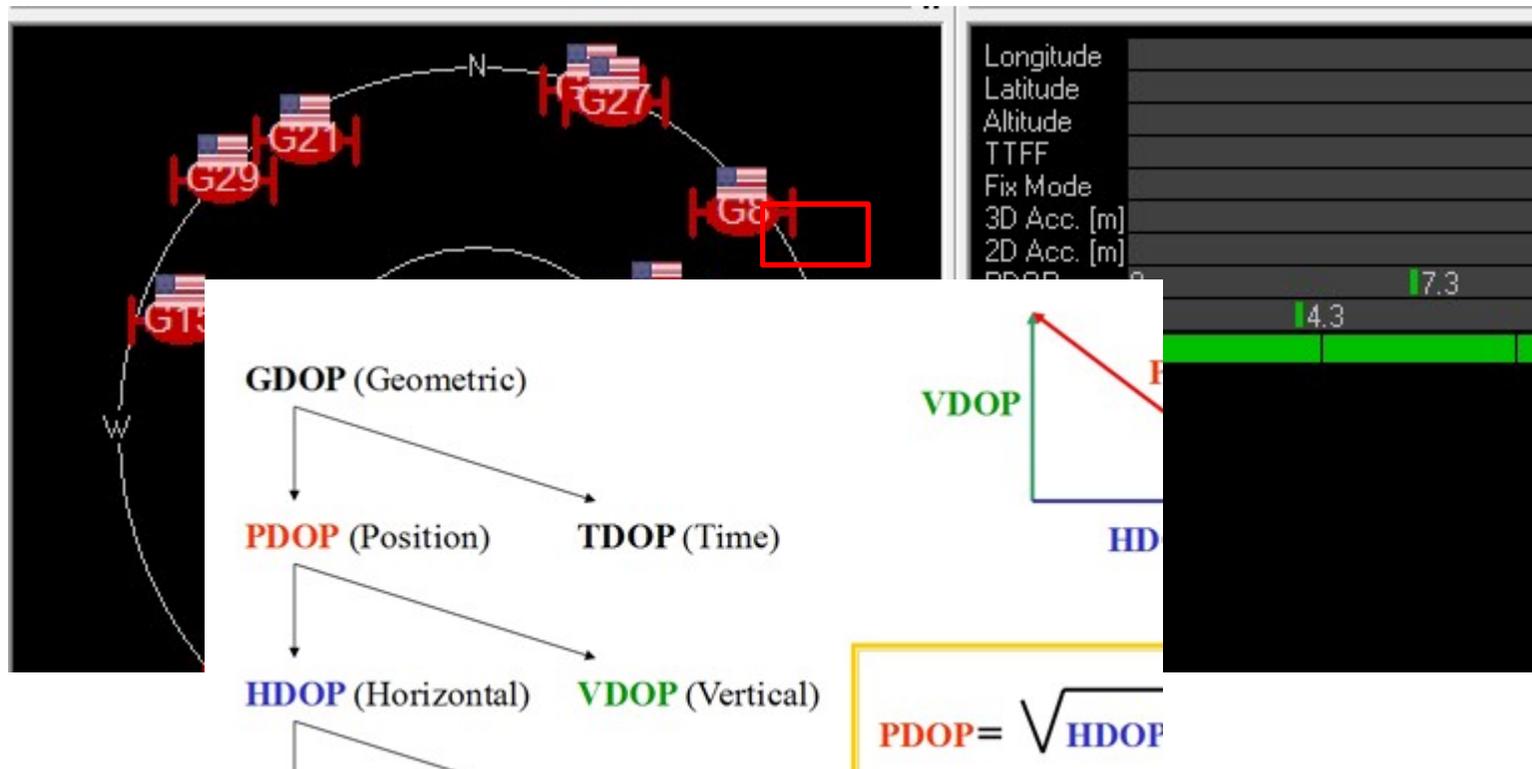


Le module GPS est sur le bord de la fenêtre côté nord!

# GPS Pratique

## Position des satellites

- 4 satellites en vue = fix 3d = position + altitude



Plus le nombre est petit, plus la mesure GPS est précise

# GPS Pratique

## Dispersion des positions mesurées !

- Avec une vue du ciel bouchée vers le sud, la dispersion est assez grand, 20-30m et l'erreur de la position, l'est également



Après quelques minutes

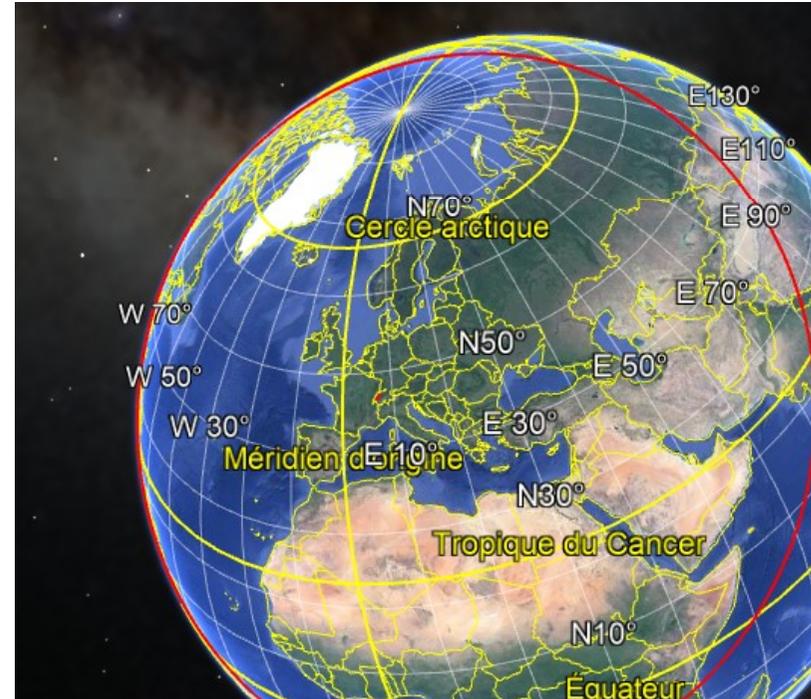
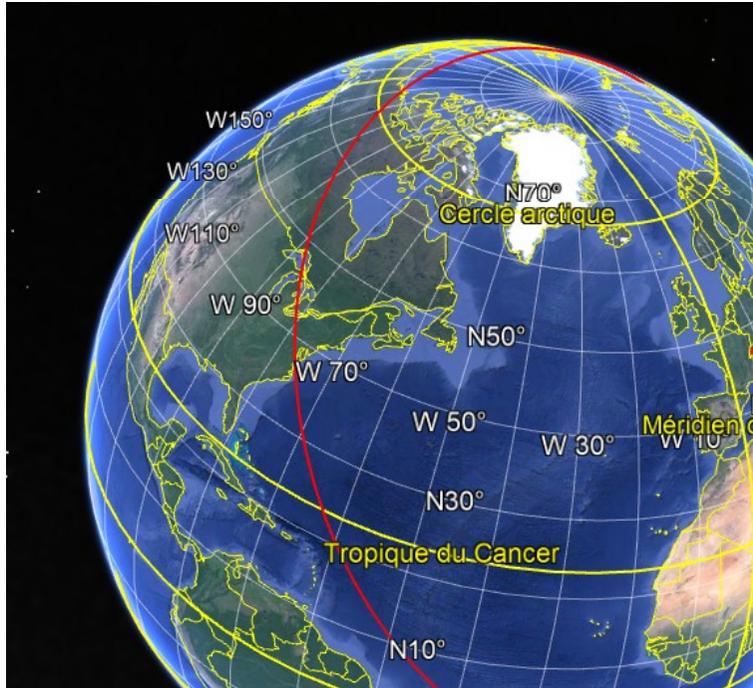


Après 1 heure

# GPS Pratique

## Couverture d'un Satellite

- Couverture du satellite à une altitude de 20km  
6'600km de rayon



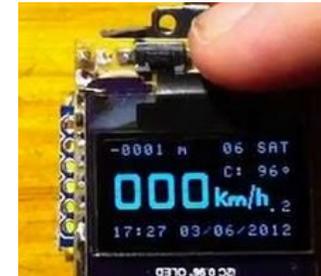
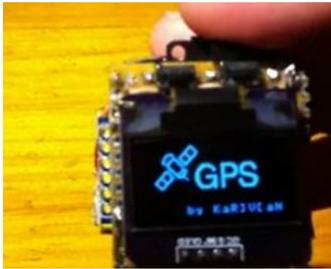
# GPS Pratique

## Résumé Ublox et pratique

- Un ciel ouvert améliore la précision
- Plus de satellites augmentent la précision
  - Pour un Drone, on décolle avec 7 satellites pour un vol programmé !
- Beaucoup de satellites en vue ne veut pas dire que leur position est favorable.
- Les paramètres PDOP et HDOP permettent d'identifier par logique si la position est ok. Donc le module GPS sait lui-même si la position est bonne ou pas.

# GPS Pratique

## Comment l'utiliser dans nos montages



- Librairie C toute cuite, donc pas besoins de réinventer la roue, et d'éviter des erreurs de logique et de programmation!
- TinyGPS++
- Adafruit\_GPS



# GPS Pratique

## Programmation (2)

- Dans Loop

- Impression des résultats

- *if (GPS.fix) {*

- Serial.print("Location: "); Serial.print(GPS.latitude, 4);*

- Serial.print(GPS.lat); Serial.print(", "); Serial.print(GPS.longitude, 4);*

- Serial.println(GPS.lon); Serial.print("Speed (knots): ");*

- Serial.println(GPS.speed); Serial.print("Angle: ");*

- Serial.println(GPS.angle); Serial.print("Altitude: ");*

- Serial.println(GPS.altitude); Serial.print("Satellites: ");*

- Serial.println((int)GPS.satellites);*

- }*

# GPS Pratique

## Exemple

- Exemple GPS sur M5 Stack (ESP32)
- Suivre les satellites sur internet:

lien: [satmap worldmap.php](http://satmap.worldmap.php)

Dico GPS, lien: [the gps dictionary.pdf](http://the_gps_dictionary.pdf)

Merci pour votre attention

Questions ?