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EUREF Symposium 2021

RGF93v2b :
A New Realization of the French Coordinates Reference System

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1. What is RGF93

- **RGF93 = Legal Coordinates system in mainland France**

  => Defined as aligned to ETRS89

  => No velocities

  because no or very few tectonic activity (stable Europe)

- **1st realization : RGF93v1**

  => 1993: multi-days GPS observations on 23 benchmarks (only in France)
  aligned to ETRF93, epoch 1993.0 thanks to 3 mobile VLBI points
  (Grasse, Toulouse, Brest)

  => 1995: densification on 1000 benchmarks, with short GPS observations

1. What is RGF93

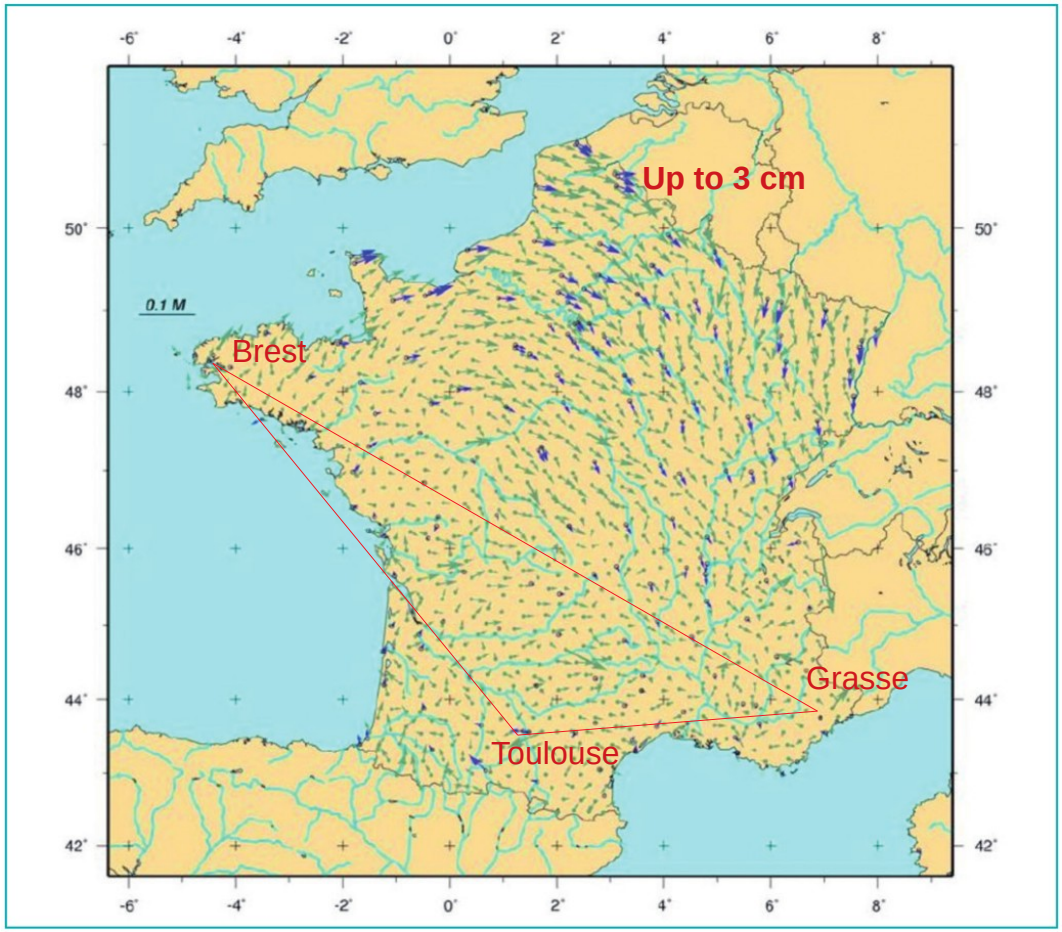
- **RGF93v2 : 2nd realization (2010)**

  => Our first reprocessing: 10 years of CORS data (RGP (France) and EPN)
  BERN5.0 (weekly solutions) and CATREF

  => processed in IGS05, IGS05.atx

  => Coordinates in IGS05@2009.0
  - by estimated velocities if
  more than 2.5 years
  - V_{e00} = 0 if less than 2.5 years

  => ETRF2000 (epoch 2009.0)
  thanks to ETRF2000 (R05)
  (EUREF technical Note, table 3)



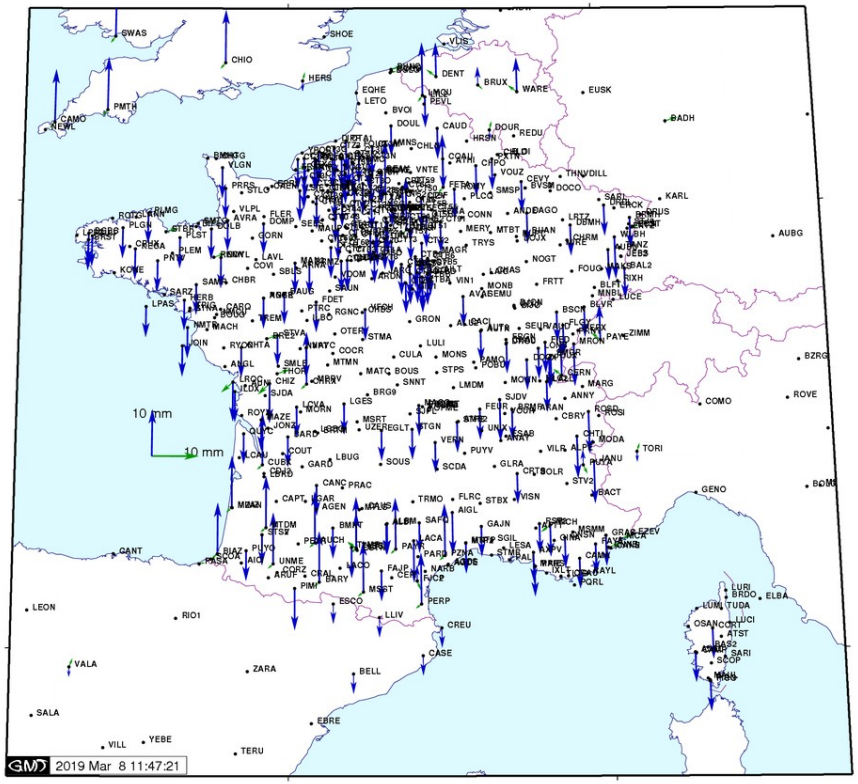
Horizontal differences between RGF93v2 and RGF93v1

2. 2nd French reprocessing

- **An IGN cumulative solution after each ITRFxx release**

- **Why a cumulative solution :**
  - velocities estimation
  - Mandatory coordinates updates :
  1. ATX update

IGb08.atx => IGS14.atx



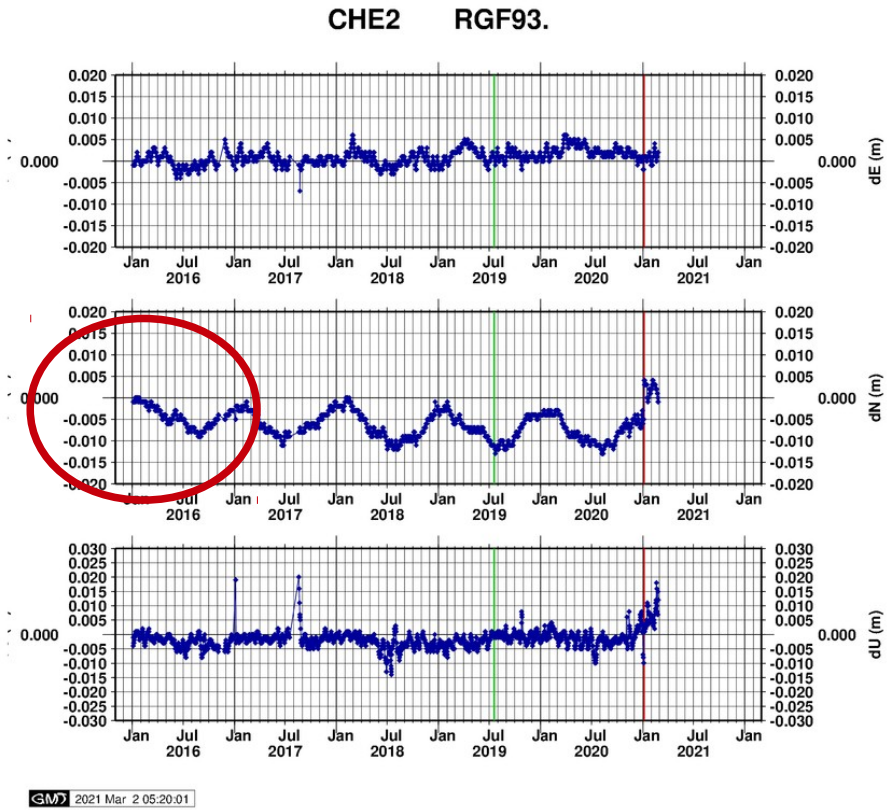
Theoretical coordinates shifts because of ATX update

2. 2nd French reprocessing

- **An IGN cumulative solution after each ITRFxx releasing**

- **Why a cumulative solution :**
  - **velocities estimation**
  - **Mandatory coordinates updates :**
  1. **ATX update**
  2. **Bad initial determination**

  - **Intial determination on 3 weeks**
  - **possible seasonal signals**



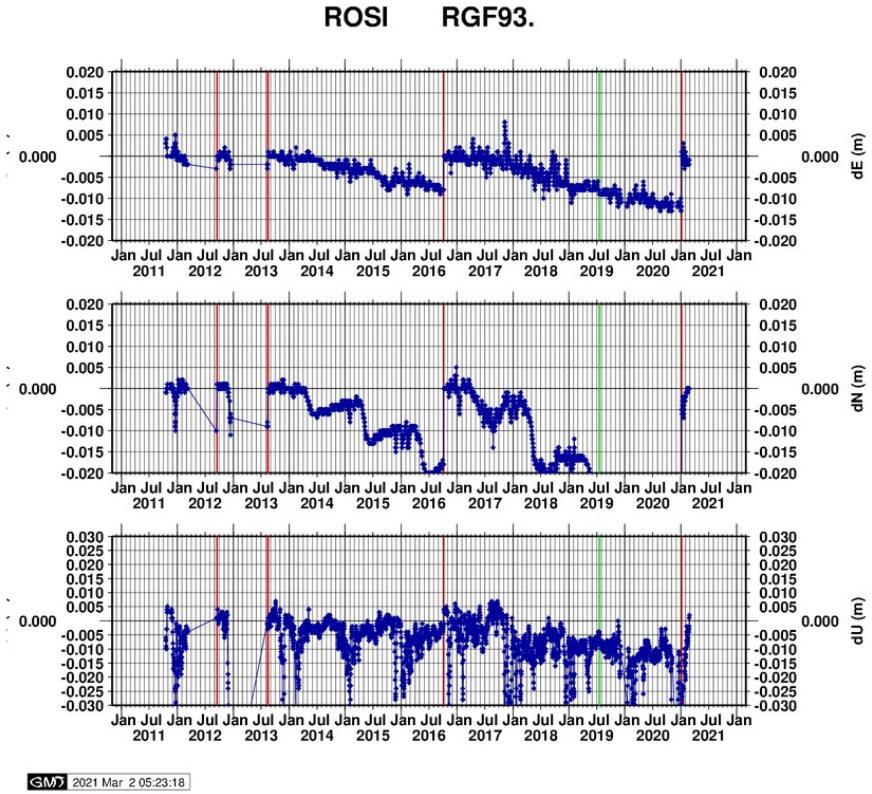
2. 2nd French reprocessing

- **An IGN cumulative solution after each ITRFxx releasing**

- **Why a cumulative solution :**
  - **velocities estimation**
  - **Mandatory coordinates updates :**
  1. **ATX update**
  2. **Bad initial determination**
  3. **Individual motion**

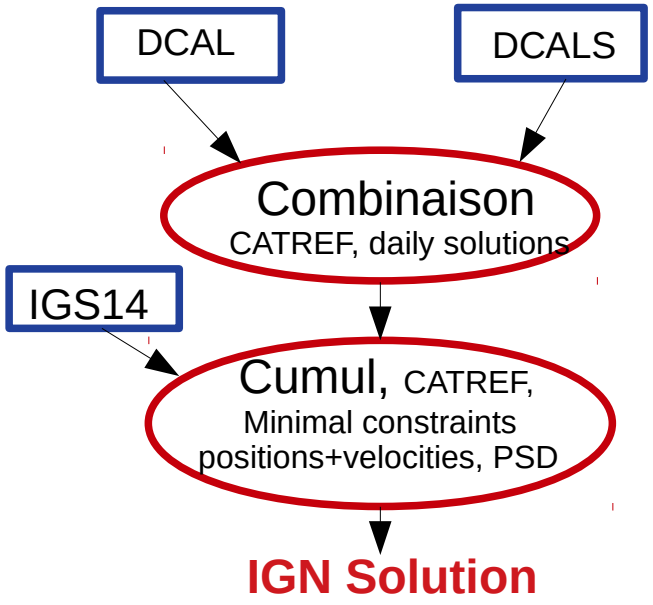
No velocities in RGF93

Regularly : New RGF93 soln for some stations (landslide, instability of the supporting building)



2. 2nd French reprocessing

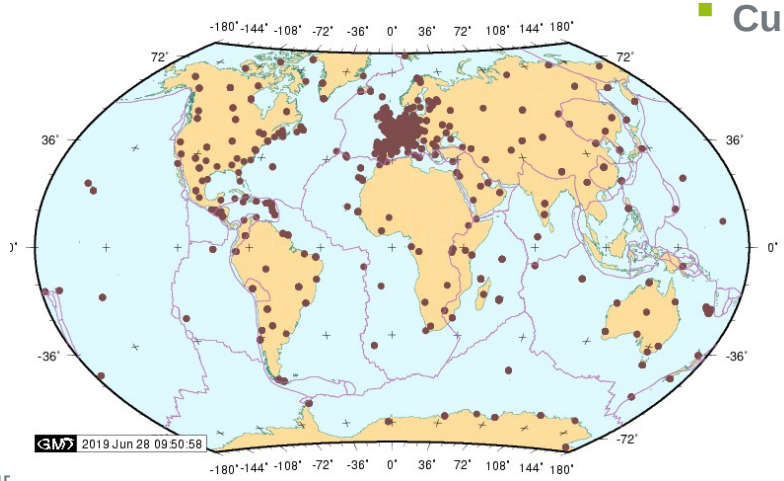
- **2019 IGN cumulative solution :**

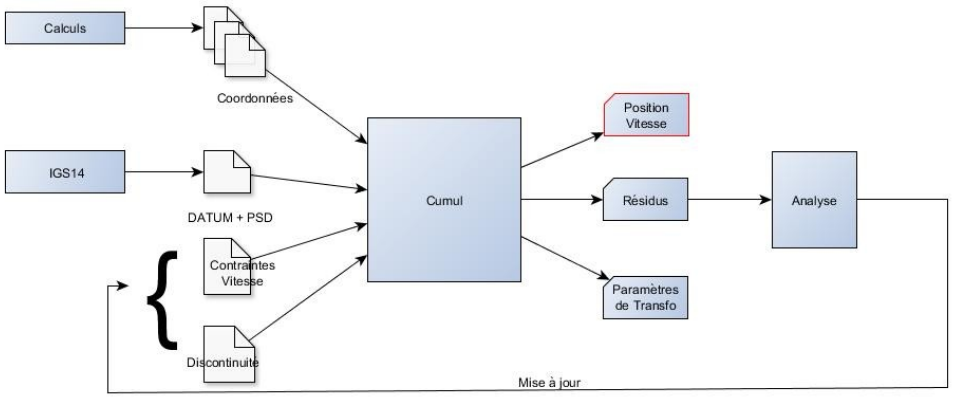


- **DCAL: « France process », rapid monitoring, initial determination**
  - **~500 stations : all French CORS, EPN stations**
  - **repro:**
    BERN5.2, GPS only, repro2 orbits (ig2)
    (lack of GPS+GLO(+GAL?) igs orbits)

- **DCALS: « World process »**
  - **~600 stations : ~350 RGP, IGS stations**
  - **repro:**
    BERN5.2, GPS only, repro2 orbits (ig2)

- **Cumul :**





2. 2nd French reprocessing

- **2019 IGN cumulative solution :**

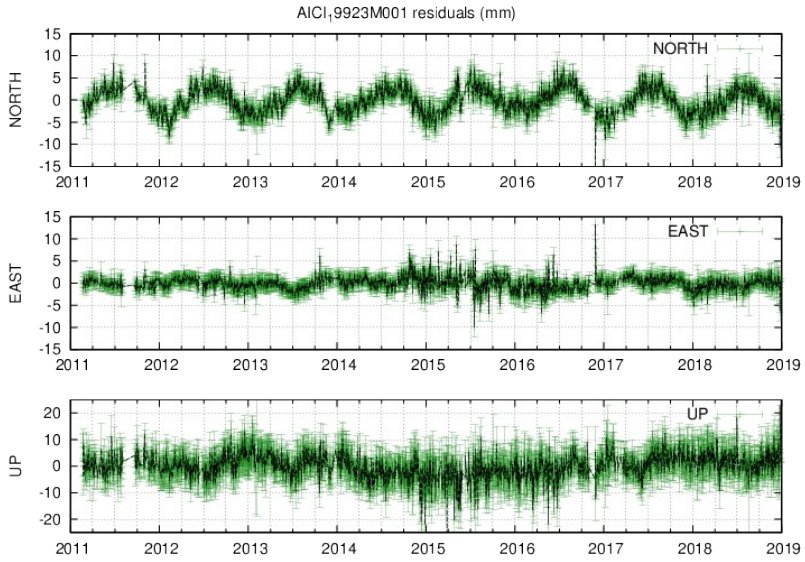
  Non scientific quality, operational quality

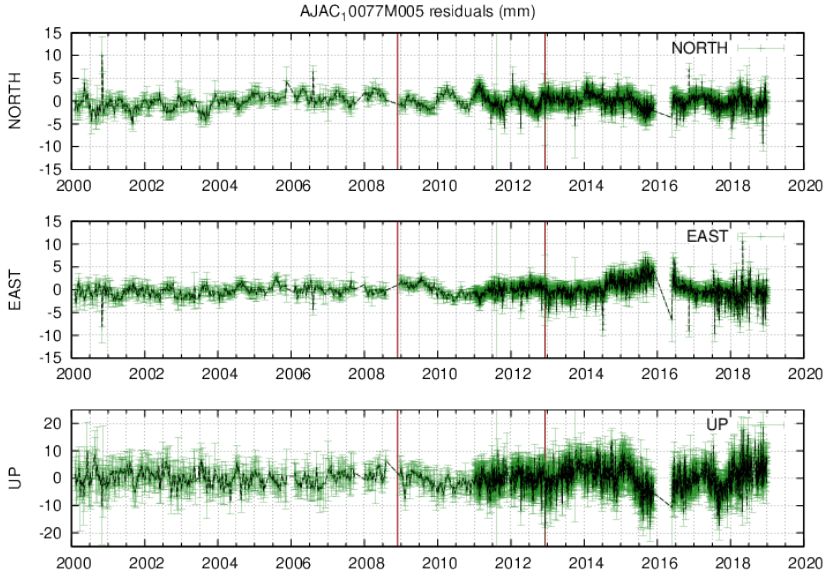
  => In particular, we seek to know the reality of each station (noise analysis)

  - No estimation of annual and semi-annual terms (inconvenience to positioning for end-user)

  - cleaning of outliers only at 5 cm and 5 normalized

  => Partially weekly solutions (server memory issues)

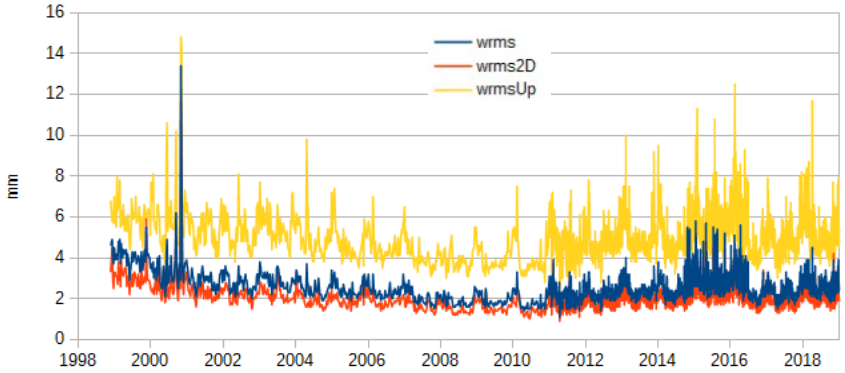


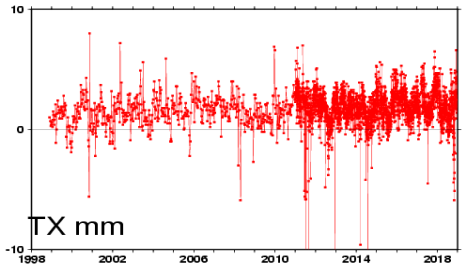


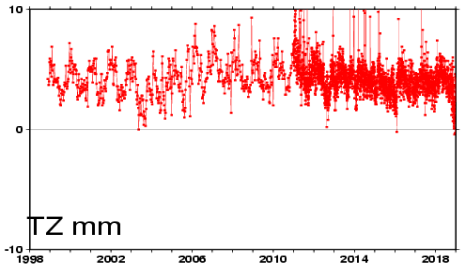
2. 2nd French reprocessing

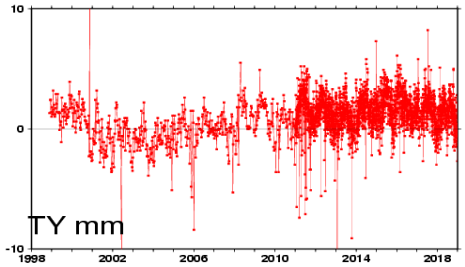
- **2019 IGN cumulative solution :**

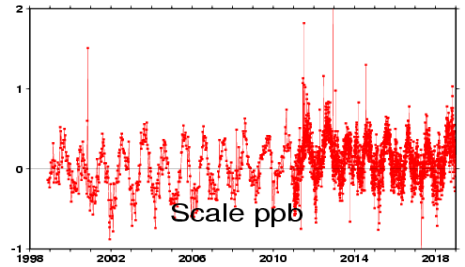
WRMS of each solution











Alignment to datum

Solution	T1 mm	T2 mm	T3 mm	D 10-9	R1 mas	R2 mas	R3 mas	Epoch y
../datum	0.0	0.0	0.0	0.00	0.000	0.000	0.000	13: 23
	0.3	0.3	0.3	0.04	0.010	0.010	0.010	
SOL-IGN	0.0	0.0	0.0	0.00	0.000	0.000	0.000	13: 23
	0.0	0.0	0.0	0.00	0.000	0.000	0.000	

Solution	N	WRMS-Pos. E mm	N mm	U mm	Epoch y	WRMS-Vel. E mm/y	N mm/y	U mm/y	VF	MSF
../datumsnx	147	2.6	2.6	6.4	13: 23	0.4	0.3	0.8	0.00	1.00000
SOL-IGN.SNX	147	0.0	0.0	0.0	13: 23	0.0	0.0	0.0	0.00	0.01000

Sigma_0 = 0.00281

Transformation parameters of each daily/weekly solution

3. RGF93v2b

- **Checking ETRF2000@2019.0**

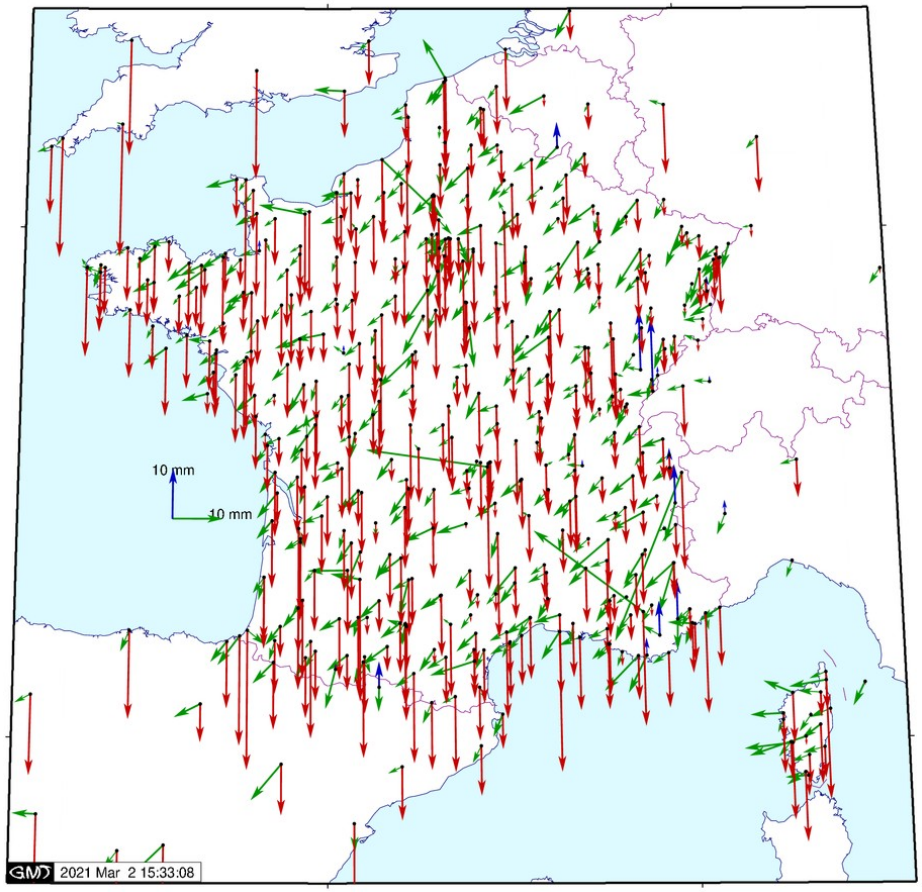
=> Coordinates in IGS14@2019.0
- by estimated velocities if more than 2.5 years
- V_{e00} = 0 if less than 2.5 years

=> ETRF2000 (epoch 2019.0) thanks to ETRF2000 (R14) (EUREF technical Note, table 3)

For all RGP stations :

Including
- ATX changes,
- bad initial determination,
- individual motion,
- some corrected errors

(mm)	MEAN	STD
E	-2,8	2,6
N	-2,9	2,8
EN	4,7	3,0
U	-8.5	5,8

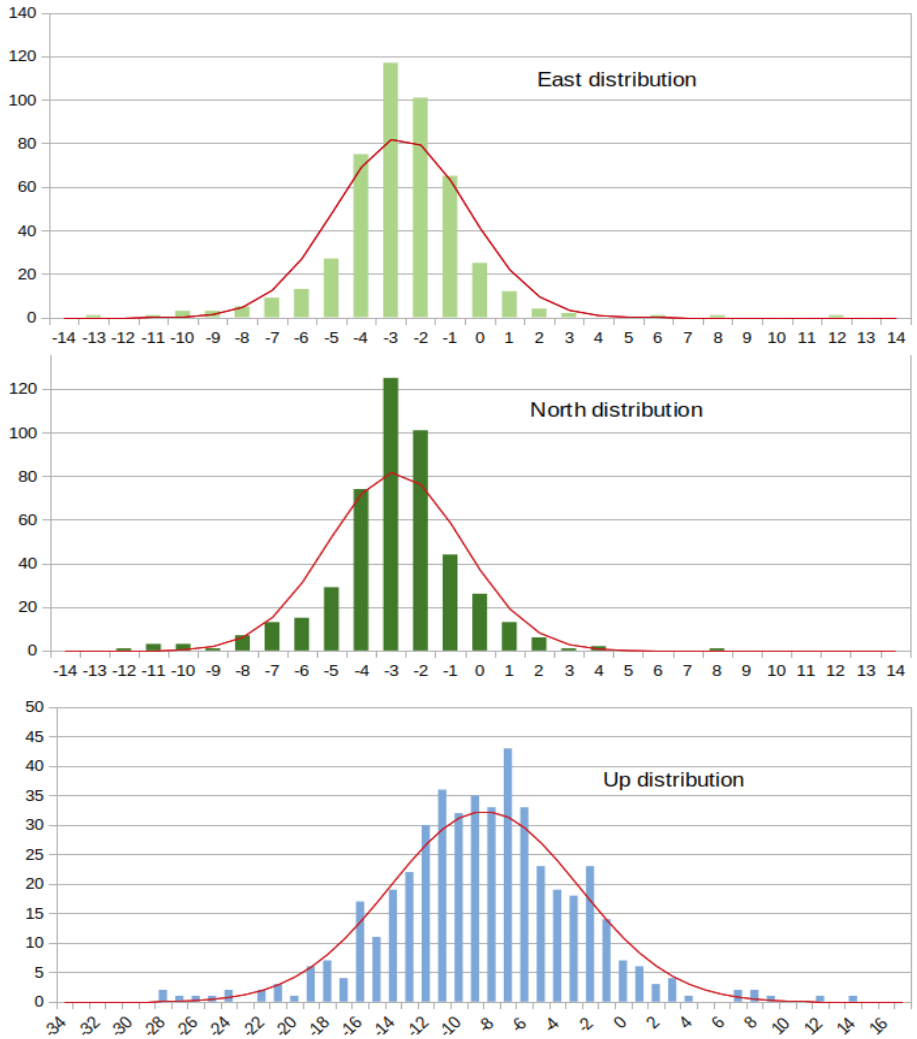


Differences between RGF93v2b and RGF93v2

3. RGF93v2b

- **Checking ETRF2000@2019.0**

- **main issues:**
  => Cross-border consistency
  => Access to RGF93 for PPP users



For all RGP stations :

Including
- ATX changes,
- bad initial determination,
- individual motion,
- some corrected errors

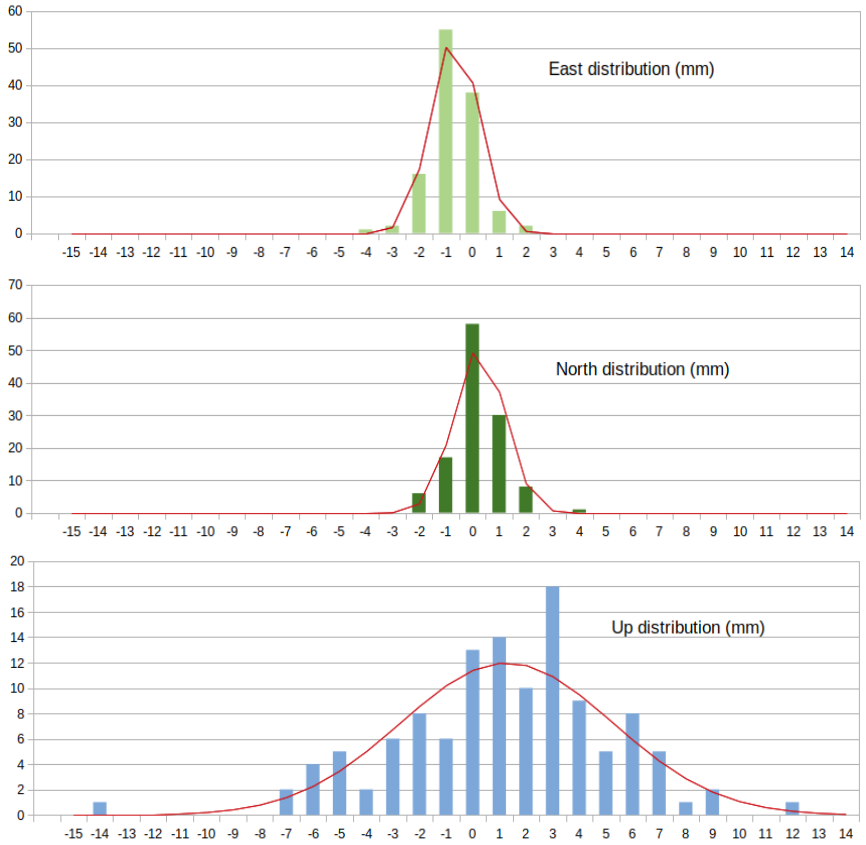
Excluding
3 extreme individual motions

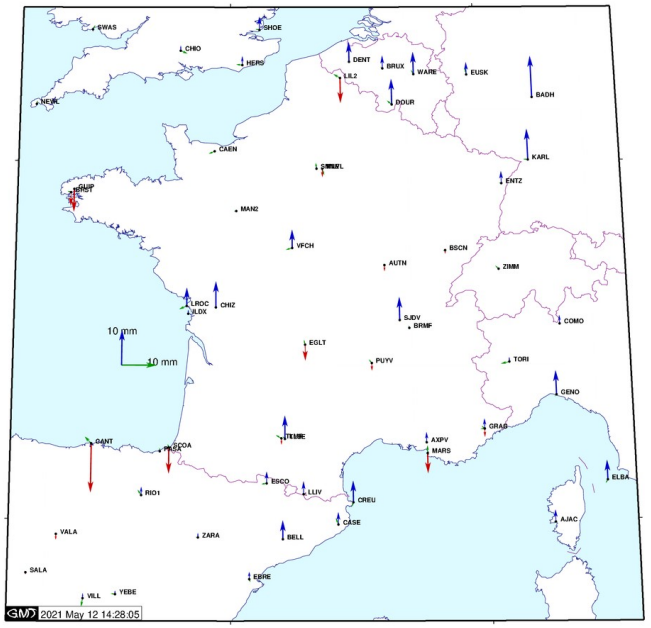
(mm)	MEAN	STD
E	-2,7	2,2
N	-2,8	2,3
EN	4,5	2,2
U	-8.5	5,7

3. RGF93v2b

Checking ETRF2000@2019.0 : EPN_A_ETRF2000

120 common stations with more than 2.5 years





Differences between RGF93v2b and last EPN_A_ETRF2000, @2019.0 for valid soln

(mm)	MEAN	STD
E	-0,7	0,9
N	-0,2	0,9
EN	1,2	3,9
U	1.3	0,8

3. RGF93v2b

- **Checking ETRF2000@2019.0**

- **T(I14 to E00) = T(I14 to I08) + T(I08 to I05) + T(I05 to I00) + T(I00 to E00)**
  Estimated in ~2016
  Estimated in ~2010
  Estimated in ~2007
  Estimated in ~2002

- **Extrapolation of imperfections for the theoretical transformation parameters**
  for us, 10 relative years (2009 – 2019)
  19 absolute years (2000 - 2019)

4. RGF93v2b, other solutions

- **Do nothing:**
  - cross-border consistency: ❌
  - end-users (differential): 😀
  - end-users (PPP): ☹️
  - geodetists: ☹️

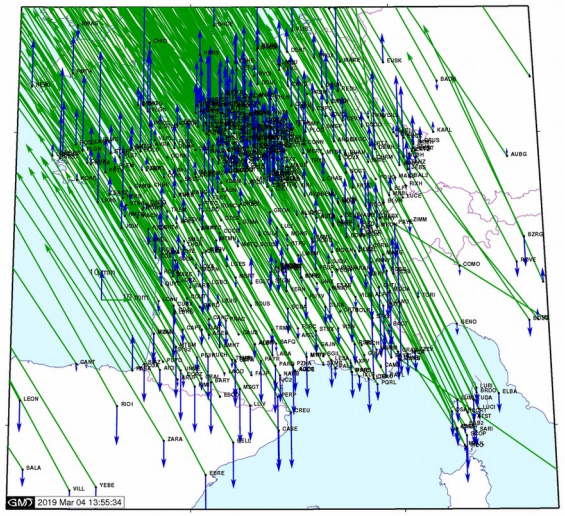
- **Using ETRF2000@2019.0:**
  - cross-border consistency: ✔
  - end-users (differential): 😐 (3/3/8 mm)
  - end-users (PPP): 😀
  - geodetists: -

- **Releasing an IGN transformation:**
  - cross-border consistency: ❌
  - end-users (differential): 😀
  - end-users (PPP): ☹️ (exept for a small number of very well informed users)
  - geodetists: -

- **Releasing a RGF2019, as ETRF2014@2019.0:**
  - cross-border consistency: ❌ ❌
  - end-users (differential): ☹️ ☹️
  - end-users (PPP): 😀 or ☹️ (backward compatibility)
  - geodetists: 😀 😀

=> 7 cm for horizontal components

=> huge issues with French laws



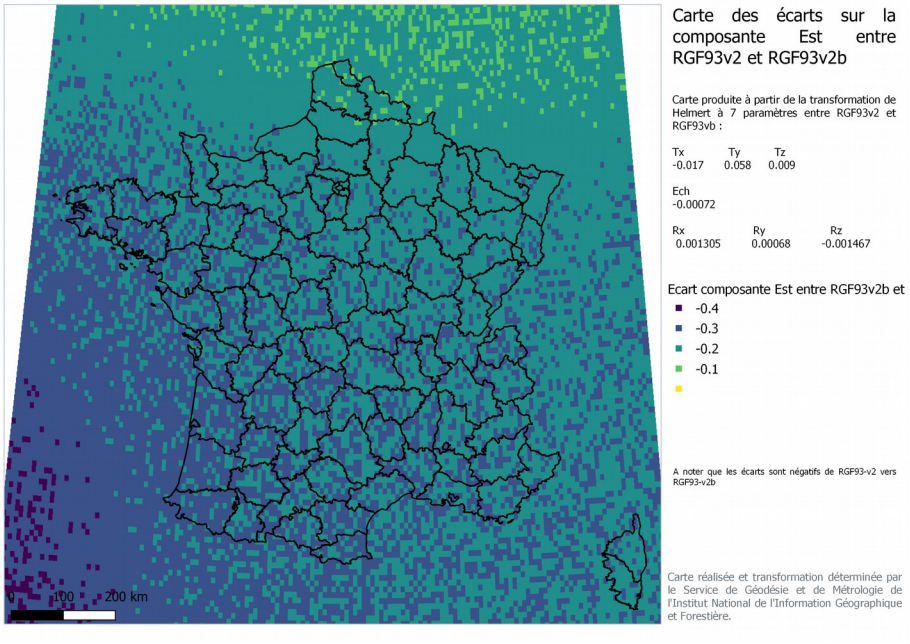
=> Parameters from EUREF Technical Note are widely recognized and used (online tools, manufacturers softwares, GNSS receivers)

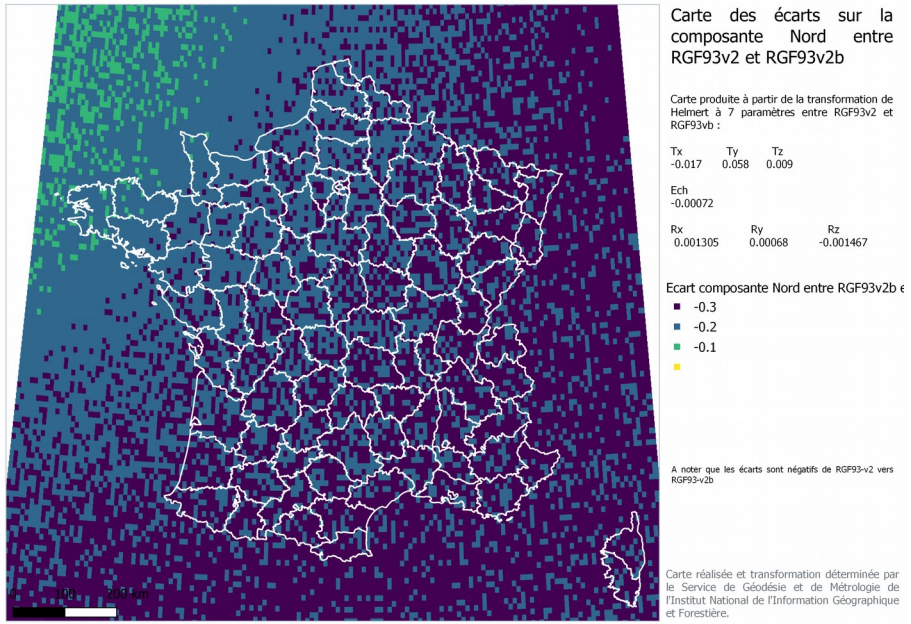
5. RGF93v2b, benchmarks

- **January 4, 2021:** **RGF93v2b is released as ETRF2000@2019.0**

- **Estimation of a transformation between RGF93v2 and RGF93v2b**
  - according to CORS : 47 rejected stations (ATX changes, individual motion, ...).
  - Transformation applied to 1000 benchmarks

- **Gridded differences for East and North components :**

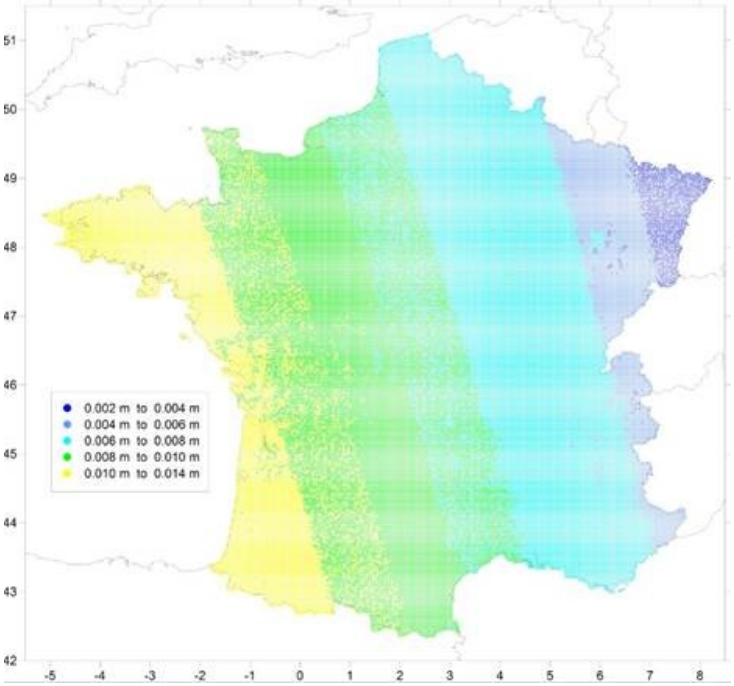


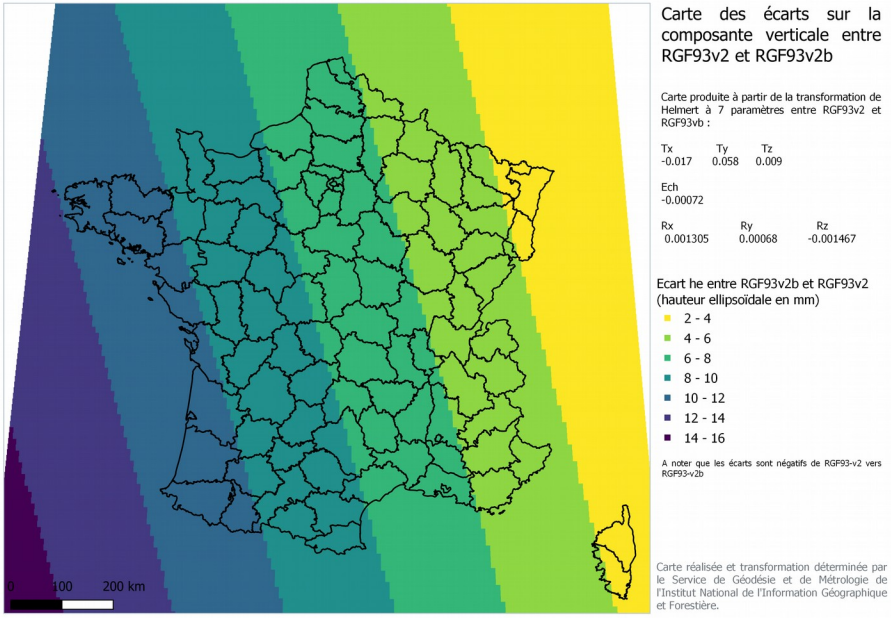


5. RGF93v2b, benchmarks

- **Gridded differences for vertical component :**
  significant East-West gradient

- **Creating ‘RAF18b’:**
  an update of our conversion grid between height and elevation





Thank you for your attention

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