GNSS Processing Status @ ASI/CGS
E-GVAP Annual Meeting 2019

R. Pacione, e-GEOS, ASI/CGS Matera, Italy

S. Di Tomaso, e-GEOS, ASI/CGS Matera, Italy

G. Bianco, ASI/CGS Matera, Italy

Outline

- E-GVAP Tropospheric solutions:
  - European NWP DA **_ASI__**
  - NWP DA , QC **_ASIC_**
  - rapid-cycle NWP DA **_ASIS_**
  - hourly PPP test solution **_ASIR_**
- EPN Tropospheric solutions:
  - Routine **_ASI, EUR_**
- SINEX_TRO v2.0
- Evaluation of Horizontal Gradients

E-GVAP Tropospheric solutions

4 solutions delivered to E-GVAP

ASI_

Available from **June 2001**
Input: hourly RNX files/IGU

Update cycle: hourly
Purpose: NWP data assimilation

Operational
5 scores per hour @ hh:00, hh:15, hh:30, hh:45, hh:59
COSTV2.2a/ZTD + gradients
~ 350 European stations

ASIC

Available from **November 2008**
Input: hourly ope. cost solutions from 19 AC:
ASI_, BKG_, GF1G, GOPG,
GOP_, IGE_, LPT_, METG, METO_,
NGAA, ROBG_, ROB_, SGN1, SGN3,
SGNC, SGN_, SGNR, WLIT, WUEL
Purpose: NWP data assimilation + QC

Operational
5 scores per hour @ hh:00, hh:15, hh:30, hh:45, hh:59
COSTV2.2a/ZTD
~ 670 global stations

ASIS

Available from **January 2014**
Input: RT GNSS observation/IGS RT
Update cycle: 15min
Purpose: test RT obs+prod in sub- y PPP

Stop uploading
under revision

Test
4 scores per hour every 15min
COSTV2.2a/ZTD + gradients
~ 17 stations

ASIR

Available from **March 2014**
Input: Hourly RNX files/IGS RT
Update cycle: hourly
Purpose: test IGS RT prod in hourl for NWP

Stop uploading
under revision

Test
4 scores per hour every 15min
COSTV2.2a/ZTD + gradients
~ 41 stations

EPN Tropospheric solutions

2 solutions delivered on routine basis

ASI

Available from **2001**
Input: daily RNX files of ASI EPN sub-network/IGS final
Update cycle: daily
Purpose long term monitoring

24 scores per day
SINEX_TRO/ZTD+ grad.
70 EPN stations

EUR

From **July 2014**
Input: daily operational EPN LAC solutions
Update cycle: daily
Purpose long term monitoring + QC

24 scores per day
SINEX_TRO/ZTD
full EPN Network

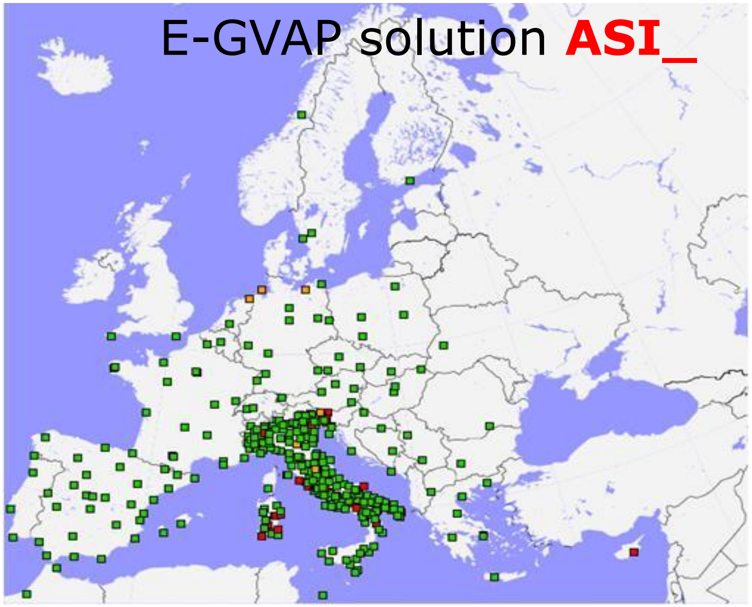
1 solution for internal use only

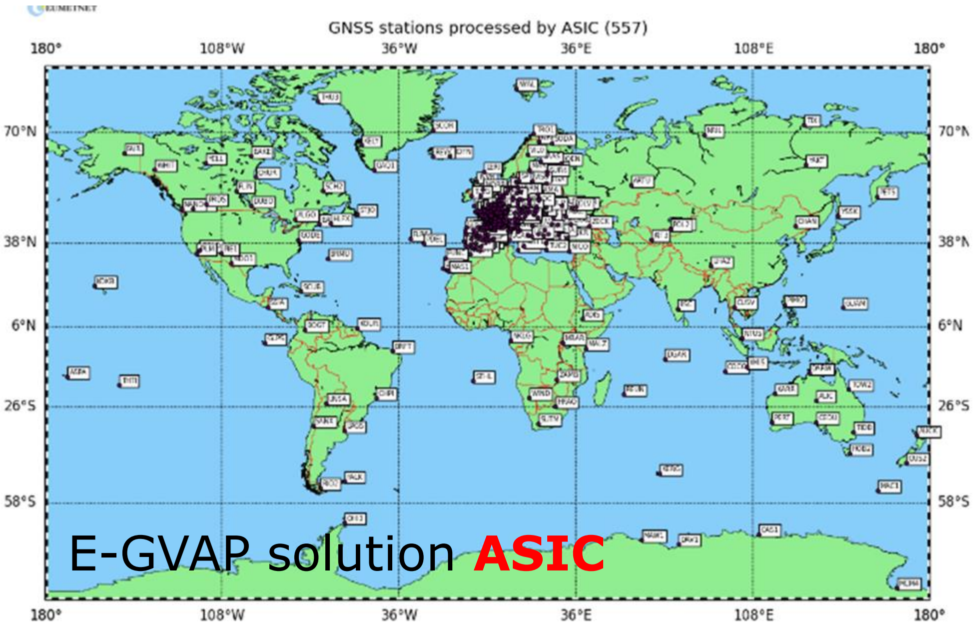
ASIP

Available from **2000**
Input:daily RNX files of Italian network/JPL final
Update cycle: daily
Purpose coordinates monitoring

scores every 5min
COSTV2.2a/ZTD + gradients
~ 350 stations

GNSS Networks



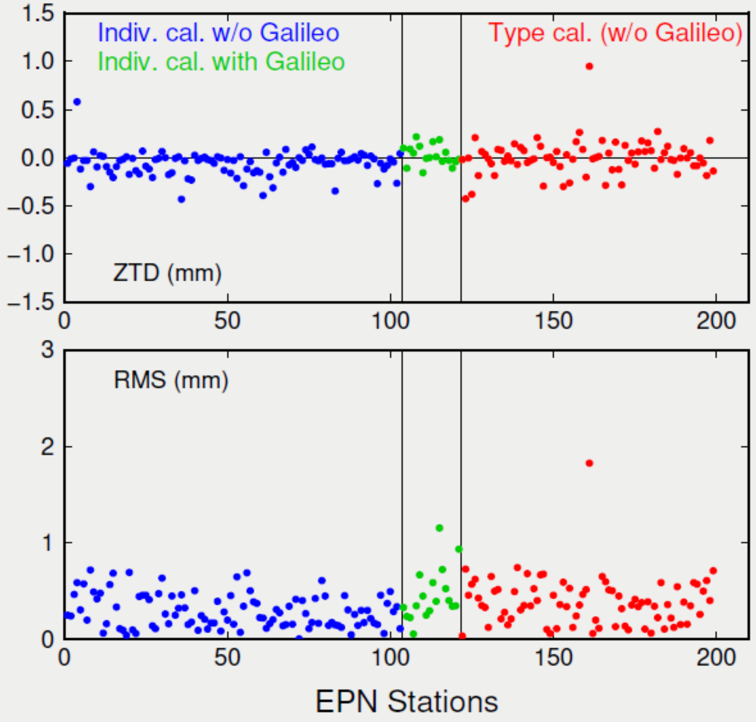


Effect of Galileo data on troposphere

EPN Products

- GPS wk 2044: switch to 3G (GPS + GLONASS + Galileo) solutions
- GPS wk xxxx: switch to RINEX3 data

<u>EUREF mail #09909</u> EPN stations submitting both RINEX 2 and RINEX 3 data will be allowed to stop submitting RINEX 2 data from January 2020 on



- Mean troposphere zenith total delay (ZTD) difference between operational (GPS+GLONASS) and 3 GNSS (GPS+GLONASS+Galileo) combined solutions, and its standard deviation (bottom figure)
- 42 weeks (GPS weeks 2002–2043) of ZTD solutions used
- Only stations observing Galileo are shown

T. Liwosz, R. Pacione, E. Brockmann: Usage of Galileo in EUREF Permanent Network Data and Products, 7th International Colloquium on Scientific and Fundamental Aspects of GNSS, 4-6 September 2019, Zurich.

EPN products in Regional Reanalysis

- SMHI is contracted to provide the **Regional Reanalysis for Europe by the EU Copernicus Climate Change Service**
- A high-resolution reanalysis from the early 1980's up to today
- GNSS Zenith Total Delay observations are planned to be used in the HARMONIE-ALADIN modelling system: **EPN-Repro2 + Operational**
- White list of stations to be considered reliable selected on data availability
- Variational bias correction
- A 4-week test assimilation has shown that **it works** and the data give a **reasonable and small positive impact.**
- **Continuity is vital for reanalysis**

SINEX_TRO v2.0 Format

- Following IGS Workshop 2018 Recommendation the **EPN combined solution** is disseminated in **SINEX_TRO v2.0 format** from GPS wk 2034 onward:
  - ✓ eur20347.tro/.tsu
  - ✓ EUR0OPEFIN_20183640000_07D_01H_TRO.TRO/.SUM

- IGS Repro3 tropospheric solutions will be disseminated in **SINEX_TRO v2.0 format**

- Format description reported in:
  - COST FR Appendix D
  - http://twg.igs.org/documents/sinex_tro_v2.00.pdf

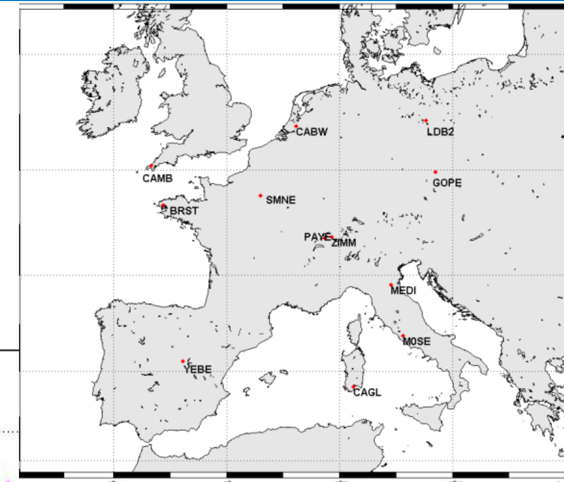
SINEX_TRO v2.0- Example from IGS-Repro3

```
*-------------------------------------------------------------------------------
+TROP/DESCRIPTION
*__________KEYWORD_____________ ___VALUES(S)___________________________________________
 TROPO PARAMETER NAMES        TRODRY TROWET TGNDRY TGNWET TGEDRY TGEWET
 TROPO PARAMETER UNITS        1e+03  1e+03  1e+03  1e+03  1e+03  1e+03
 TROPO PARAMETER WIDTH            6      6      6      6      6      6
 TROPO MODELING METHOD         Least Squares
 TROPO SAMPLING INTERVAL      300.000000
 A PRIORI TROPOSPHERE          VMF3 EraInterim 1x1Â° gridded including gradients (V3GR)
 TROPO MAPPING FUNCTION       Vienna Mapping Functions 3 (VMF3)
 GRADS MAPPING FUNCTION        Chen and Herring (1997), C_dry = 0.0031, C_wet = 0.0007
 DATA SAMPLING INTERVAL         180.000000
 ELEVATION CUTOFF ANGLE           5.000000
 GNSS SYSTEMS                     G R E
 TIME SYSTEM                        G
 OCEAN TIDE LOADING MODEL      FES2014b
 ATMOSPH TIDE LOADING MODEL  AOD1B RL06
 GEOID MODEL                          GOCO06s
-TROP/DESCRIPTION
*-------------------------------------------------------------------------------
+SITE/ID
*STATION__ PT __DOMES__ T _STATION_DESCRIPTION__ _LONGITUDE _LATITUDE_ _HGT_ELI_ _HGT_MSL_
 AREQ       A   42202M005 P Arequipa, Peru            288.507204   -16.465516   2488.935    40.335
 BADG       A   12338M002 P Badary, Russian Federa    102.234987    51.769705    811.425   -37.697
 BRAZ       A   41606M001 P Brasilia, Brazil          312.122130   -15.947474   1106.018   -12.914
 CAS1       A   66011M001 P Casey, Antarctica         110.519706   -66.283360     22.472   -17.609
 CHTI       A   50242M001 P Wharekauri, New Zealan    183.382882   -43.735472     75.678    10.173
```

- COST Format description: **EGM96**

E-GVAP Super Sites Monitoring (1)

- **E-GVAP Super-Sites -→ EPN stations**
- **ASIC versus EUR**



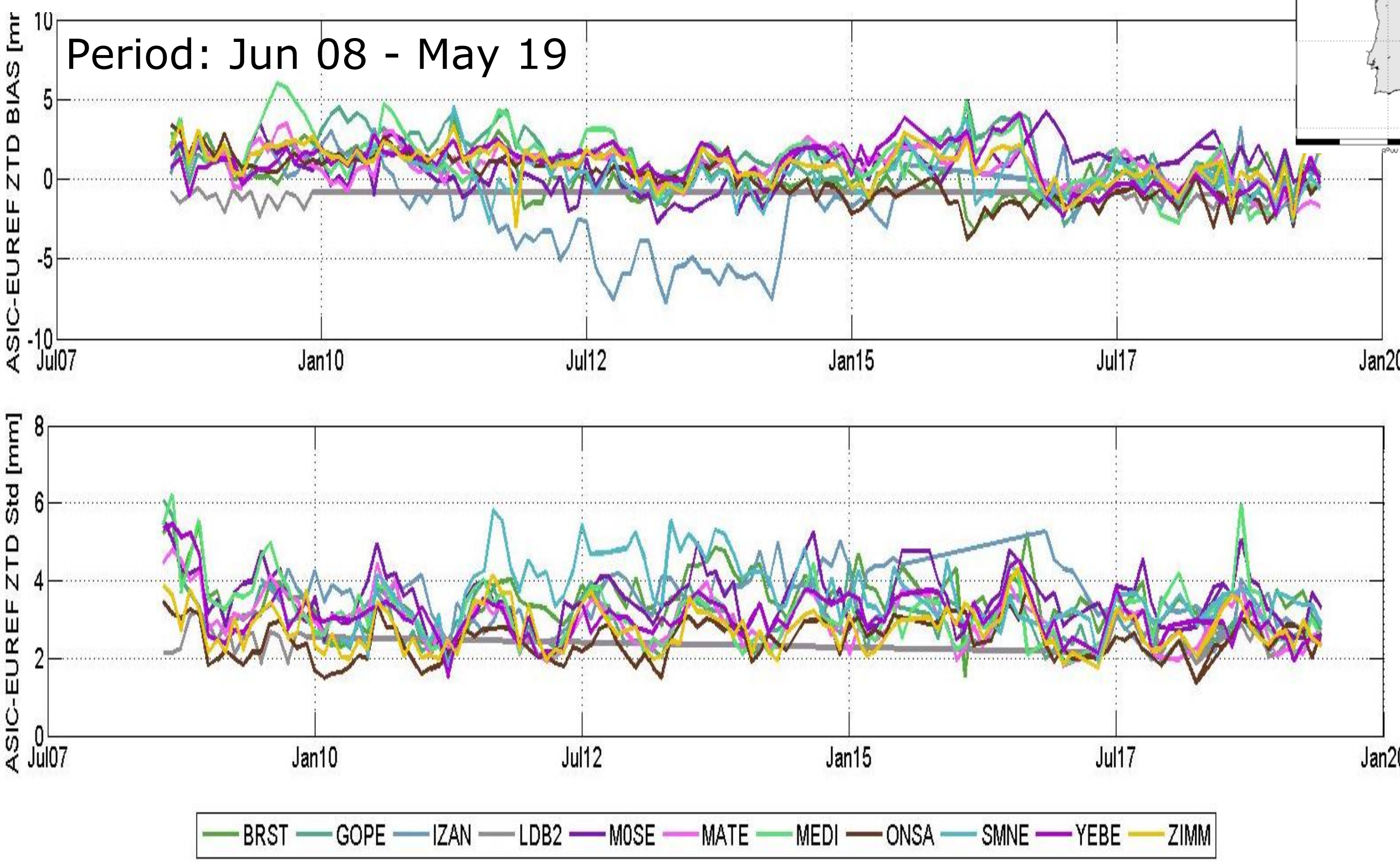
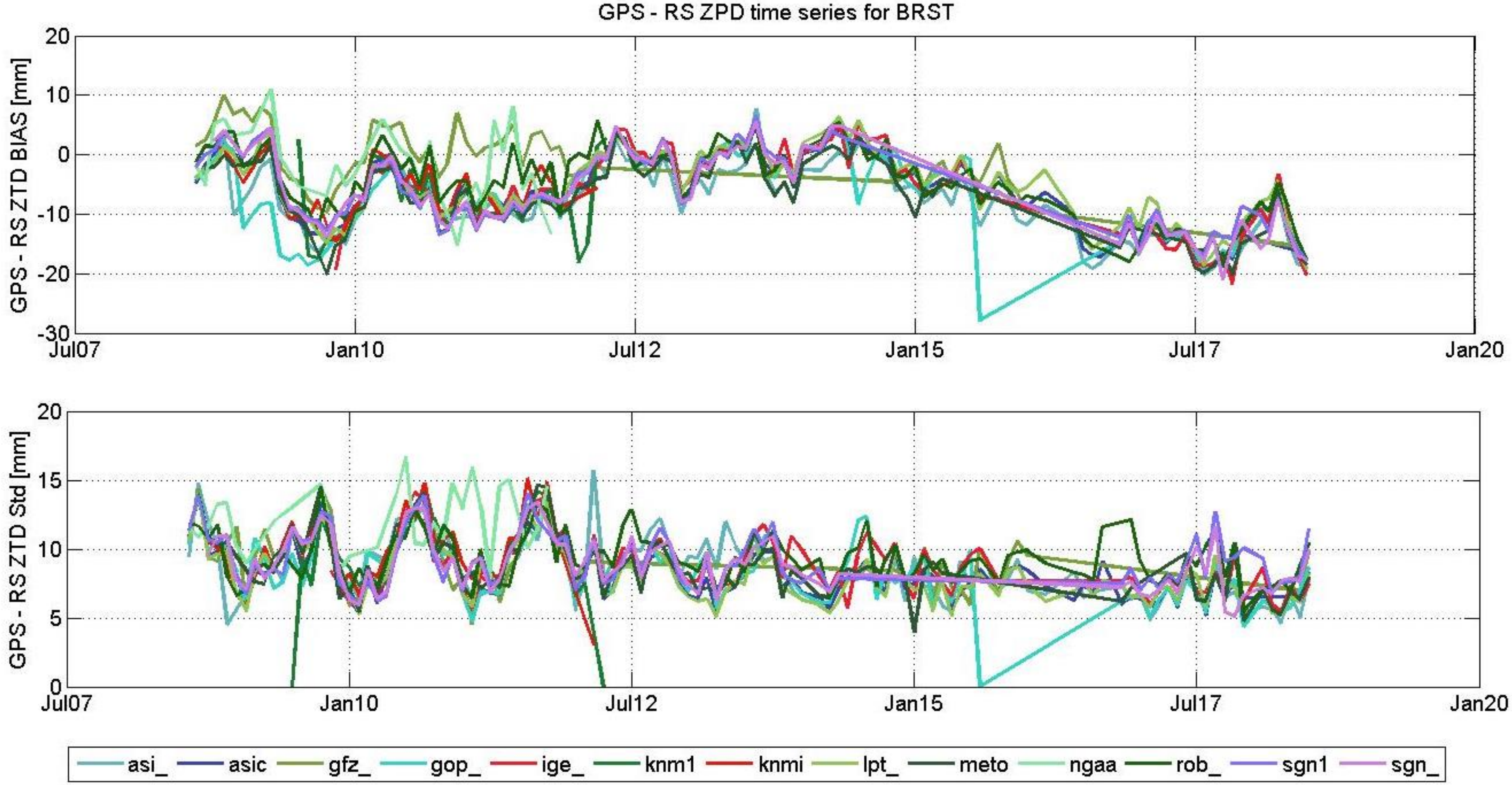


Figure 1 from R. Pacione et al., *Near Real Time GPS Zenith Total Delay validation at E-GVAP Super Sites, Bulletin of Geodesy and Geomatics , Vol. LXVIII pag. 65-77*

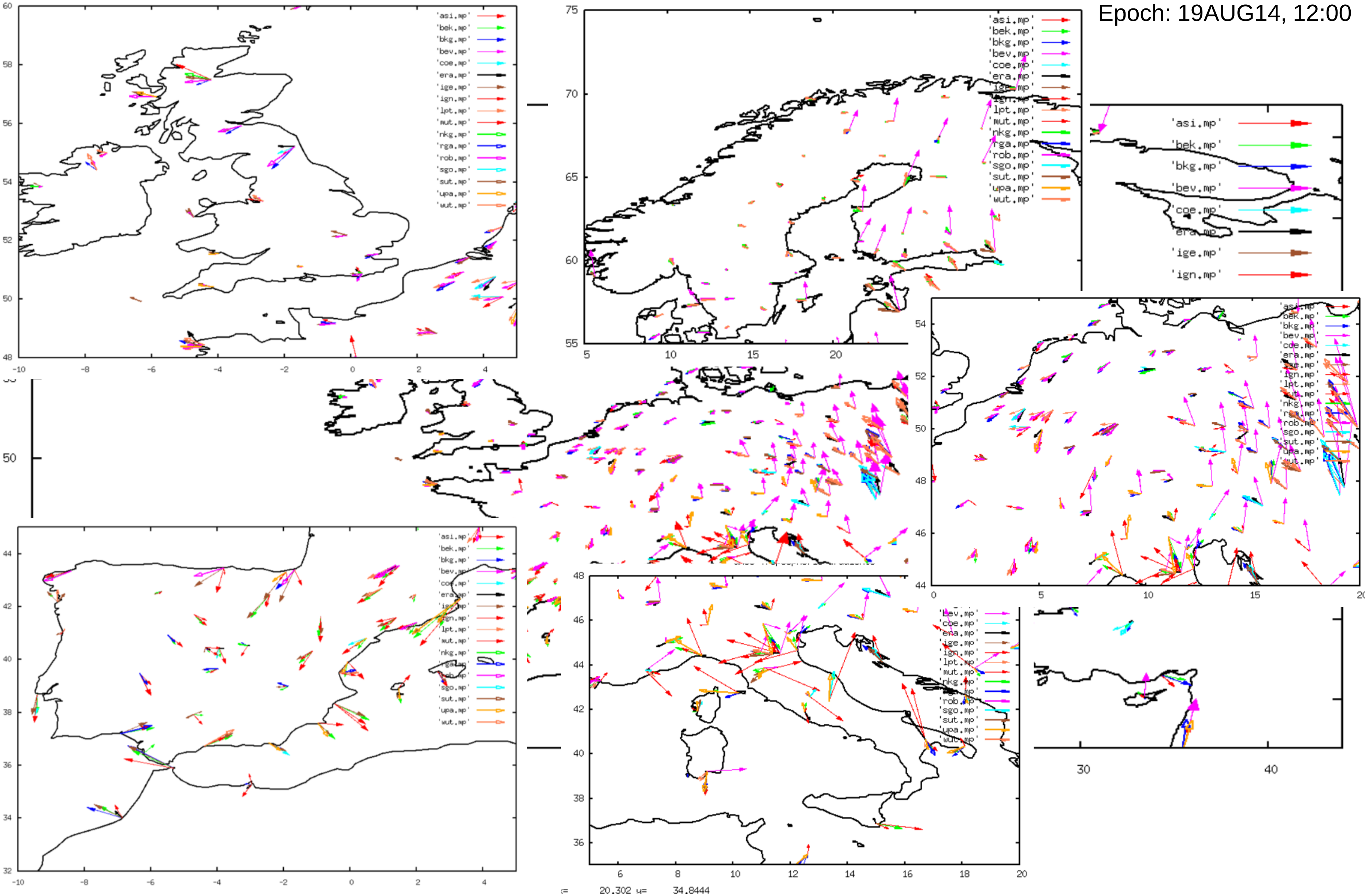
E-GVAP Super Sites Monitoring (2)

Period: Jan 2009 – May 2019

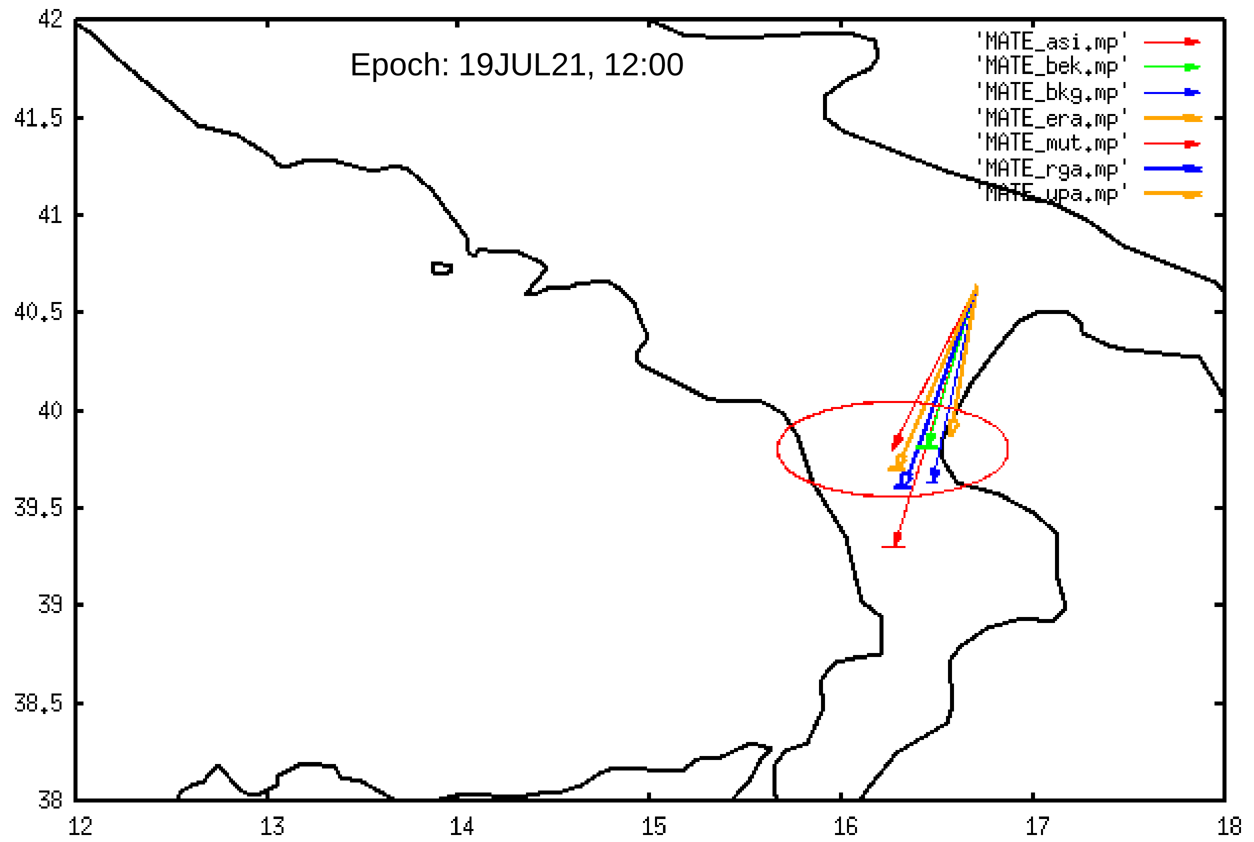


Bug concerning RS data of some stations to be fixed with new format from …….. on

Tropospheric Gradient Map – EPN Solutions



Tropospheric Gradient @ MATE – EPN solutions



AC	SW	MF	Magnitude [mm]		Angle [deg]	
			value	sigma	value	sigma
asi	Gipsy	BS	1,411	0,061	-162	0,003
bek	Bernese	CH	0,874	0,055	-162	0,005
bkg	Bernese	CH	1,042	0,035	-167	0,001
mut	Gamit	CH	0,952	0,604	-152	0,243
rga	Bernese	CH	1,111	0,048	-159	0,003
upa	Bernese	CH	1,034	0,035	-156	0,002

Tropospheric Gradient - E-GVAP solutions (1)

- Combined Solutions based on **19 AC solutions**:

  ASI_, BKG_, GF1G, GOPG, GOP_, IGE_, LPT_, METG, METO_, NGAA, ROBG_, ROB_, SGN1, SGN3, SGNC, SGN_, SGNR, WLIT, WUEL

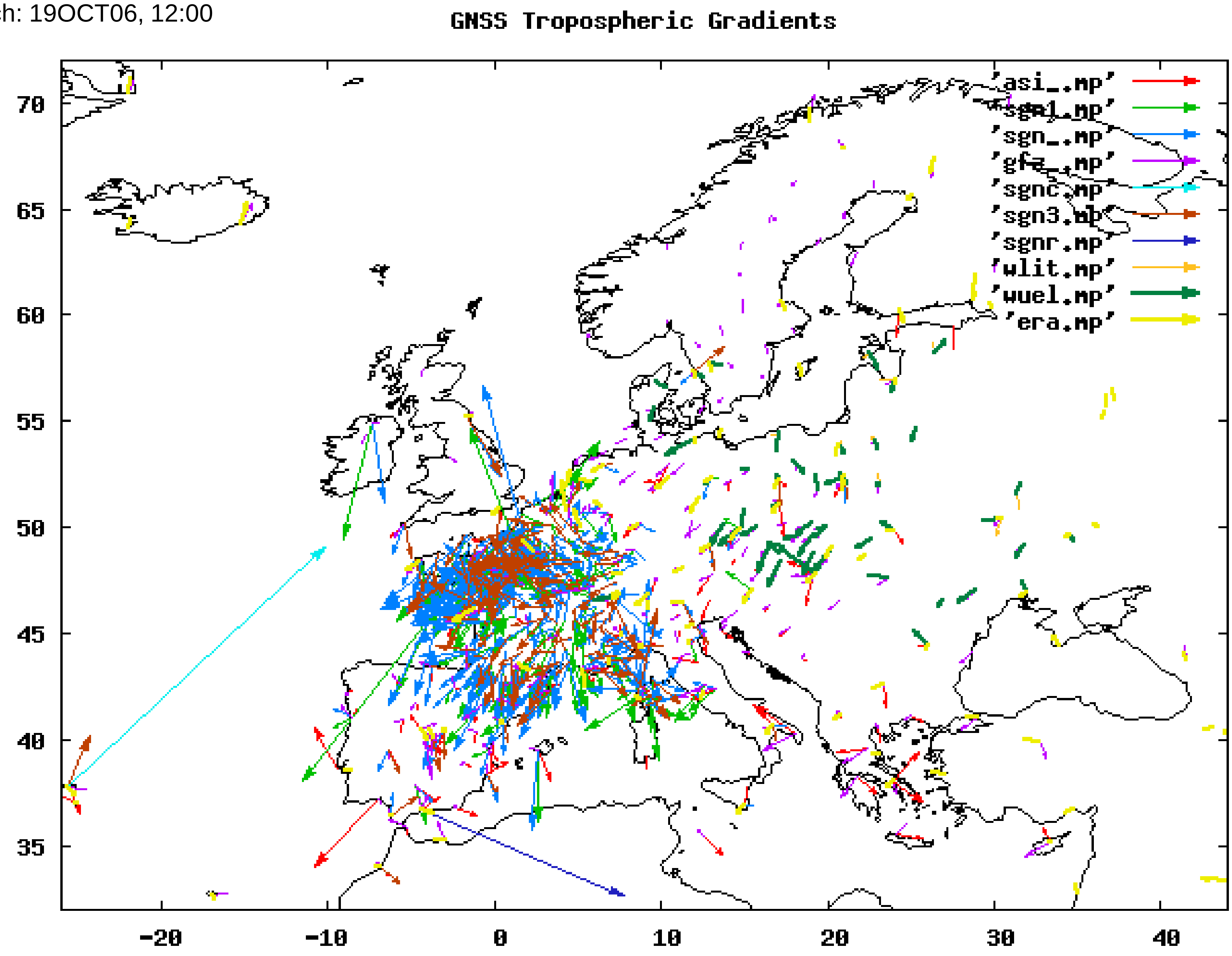
- Horizontal Gradients available in **7 AC solutions**:

  ASI_, GF1G, SGN1, SGNC, SGNR, WLIT, WUEL

- No errors in GF1G solution

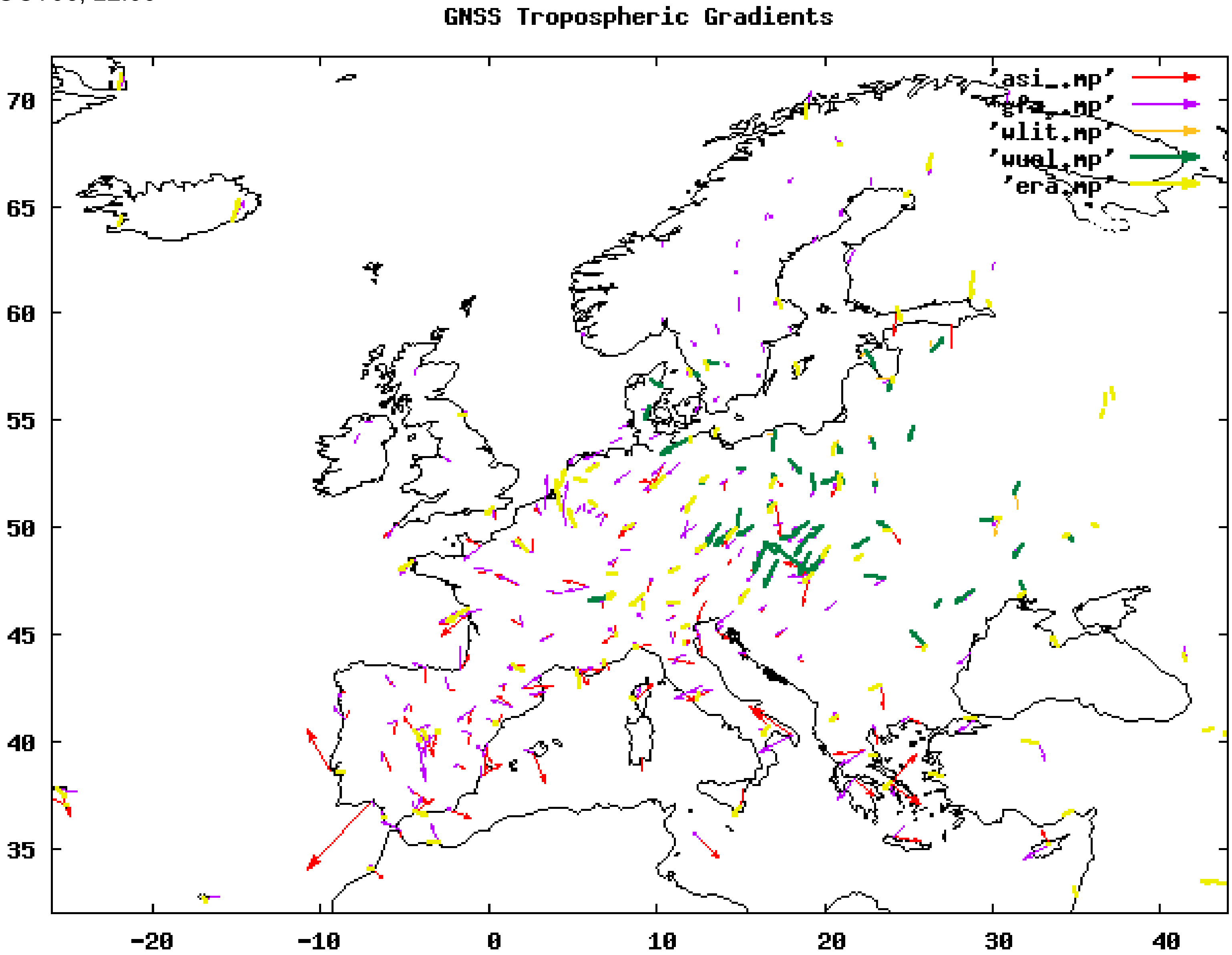
Tropospheric Gradient - E-GVAP solutions (2)

Epoch: 19OCT06, 12:00



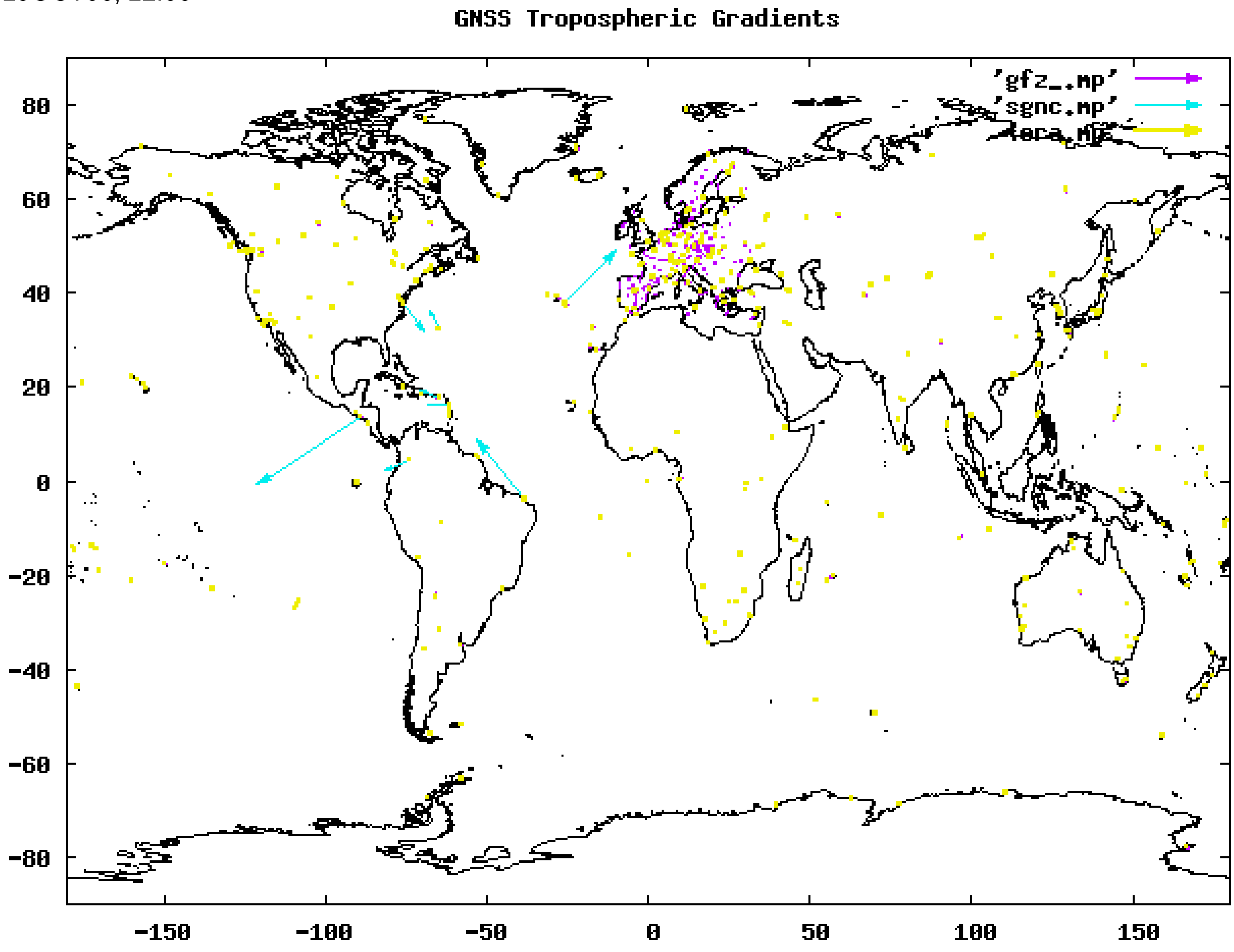
Tropospheric Gradient - E-GVAP solutions (3)

Epoch: 19OCT06, 12:00



Tropospheric Gradient - E-GVAP solutions (4)

Epoch: 19OCT06, 12:00



remote sensing

MDPI

Article

Intercomparison of Integrated Water Vapor Measurements at High Latitudes from Co-Located and Near-Located Instruments

Ermanno Fionda [1,*], Maria Cadeddu [2], Vinia Mattioli [3] and Rosa Pacione [4]

1 Fondazione Ugo Bordoni (FUB), 00161 Roma, Italy
2 Argonne National Laboratory (ANL), Lemont, IL, 60439, USA; mcadeddu@anl.gov
3 CETEMPS, 67100 L'Aquila, Italy; vinia.mattioli@ieee.org
4 e-GEOS Spa, 75100 Matera, Italy; rosa.pacione@e-geos.it
* Correspondence: efionda@fub.it

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check for updates

Abstract: Data from global positioning system (GPS) ground-based receivers, ground-based microwave radiometers (MWRs), and radiosondes (RS) at two high-latitude sites were compared. At one site, the North Slope of Alaska (NSA), Barrow, Alaska (USA), the instruments were co-located, while at the other site, the second ARM Mobile Facility (AMF2), Hyytiälä, Finland, the GPS receiver was located about 20 km away from the MWRs and RS. Differences between the GPS-derived integrated water vapor (IWV) and the other three instruments were analyzed in terms of mean differences and standard deviation. A comparison of co-located and near-located independently calibrated instruments allowed us to isolate issues that may be specific to a single system and, to some extent, to isolate the effects of the distance between the GPS receiver and the remaining instruments. The results showed that at these two high-latitude sites, when the IWV was less than 15 kg/m^2, the GPS agreed with other instruments within 0.5–0.7 kg/m^2. When the variability of water vapor was higher, mostly in the summer months, the GPS agreed with other instruments within 0.8–1 kg/m^2. The total random uncertainty between the GPS and the other systems was of the order of 0.6–1 kg/m^2 and was the dominant effect when the IWV was higher than 15 kg/m^2.

Keywords: water vapor; microwave radiometry; GPS; radio sounding; remote sensing

IAG Inter-Commission Committee "Geodesy for Climate Research"https://iccc.iag-aig.org/

- Established during the IUGG General Assembly in Montreal to enhance the use of geodetic observations for climate studies.
- The goal is to establish a systematic and comprehensive approach among the various geodetic communities, but also to establish and foster links to the climate science.
- WG 'Quality control methods for climate applications of geodetic tropospheric parameters' (Joint with Commission 4, IGS and IVS).