

ITRF2005 densification and product validation

SUMMARY OF THE DETAILED REPORT
no "bla-bla"

prepared by
Ambrus Kenyeres
former EPN Time Series Project

OUTLINE

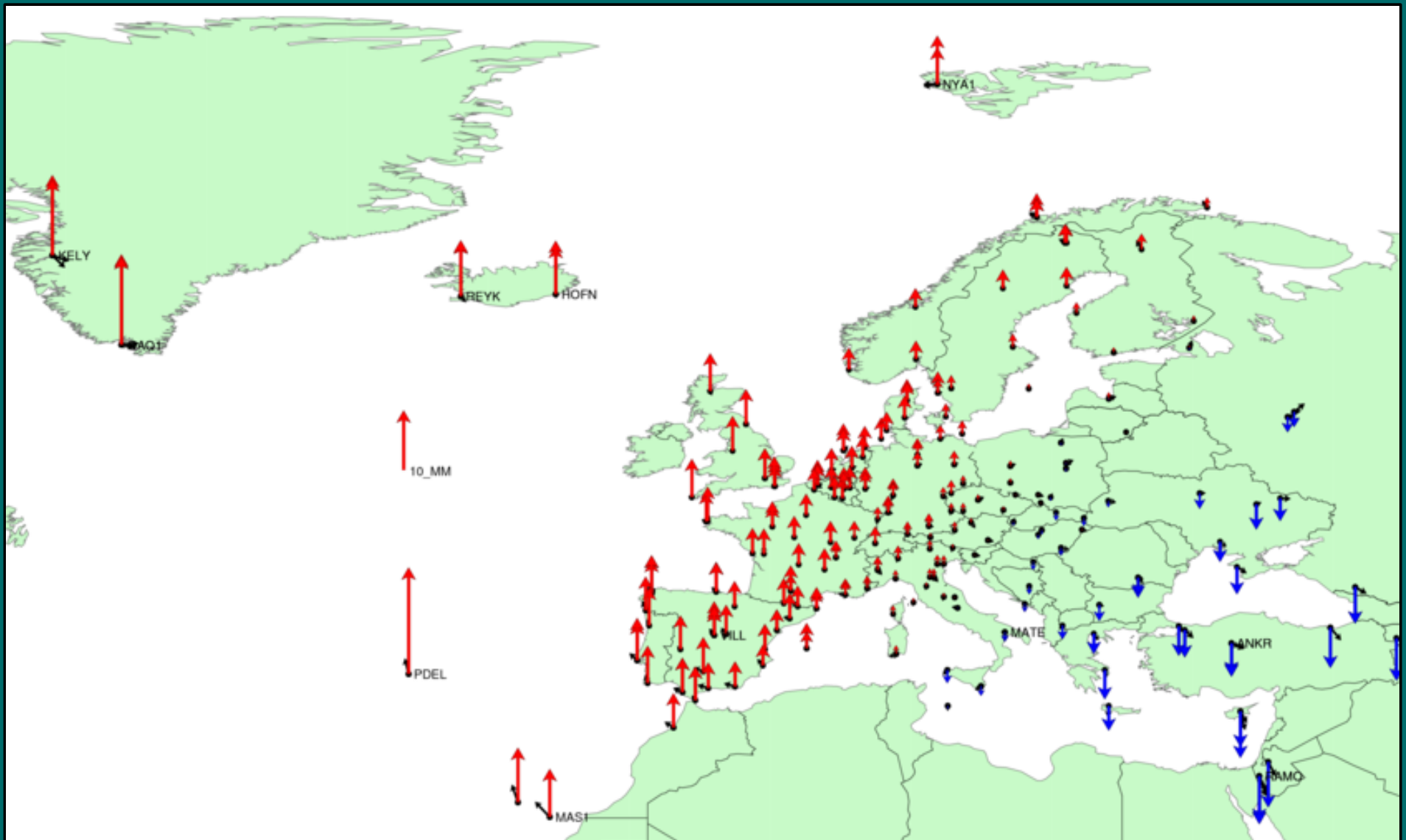
- DATUM DEFINITION
- VALIDATION OF THE CUMULATIVE SOLUTION (GPSWEEK 860 - 1355)
- INTERCOMPARISONS WITH THE AC SOLUTION

DATUM DEFINITION

- **Minimum Constraint**
 - no direct constraints allowed, because of the site specific differences in ITRF/IGS and EPN
 - MC over 3 (**T**) or 7 (**TRS**) parameters
- **ITRF2005 versus IGS05**
ITRF/IGS - EPN discontinuity table
- **Reference network selection**
Criteria: **optimal** agreement with ITRF2005
 - Geometry - extend EPN as broad as possible
 - Quality - **catch 22**
 - Number of sites (22 with 43 solution numbers)

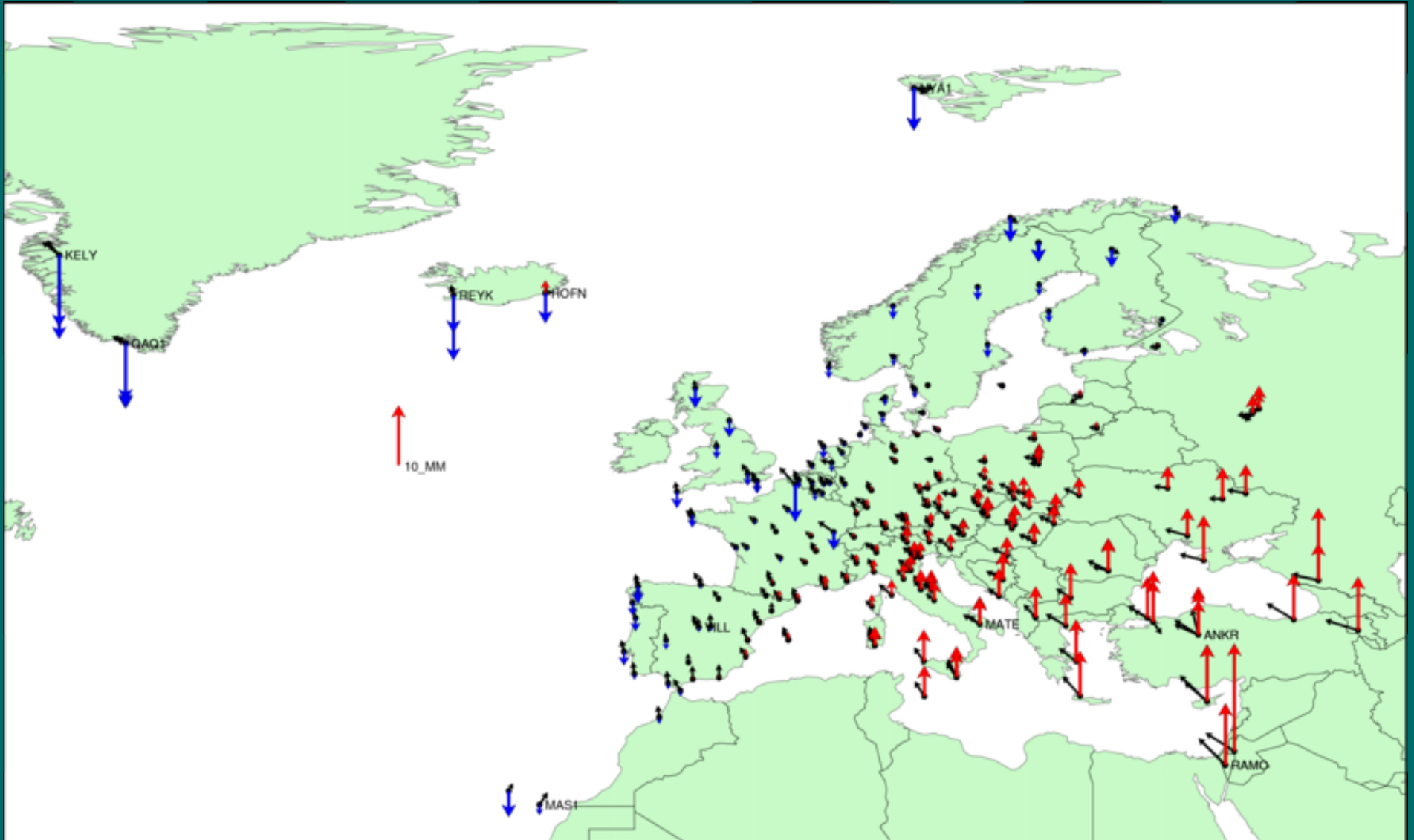
NETWORK EFFECT IN MC

COORDINATE DIFFERENCES



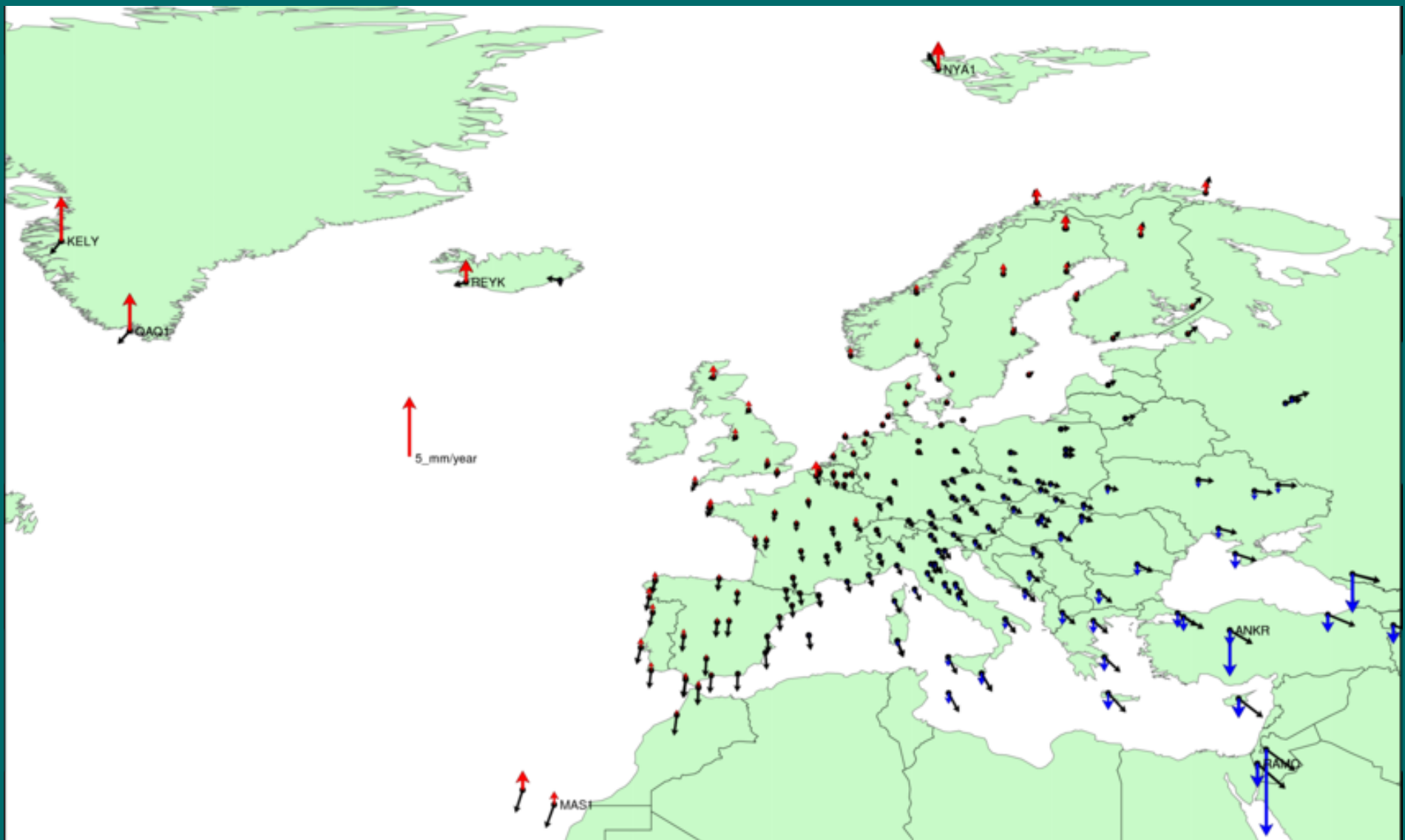
MC over T and TRS

COORDINATE DIFFERENCES



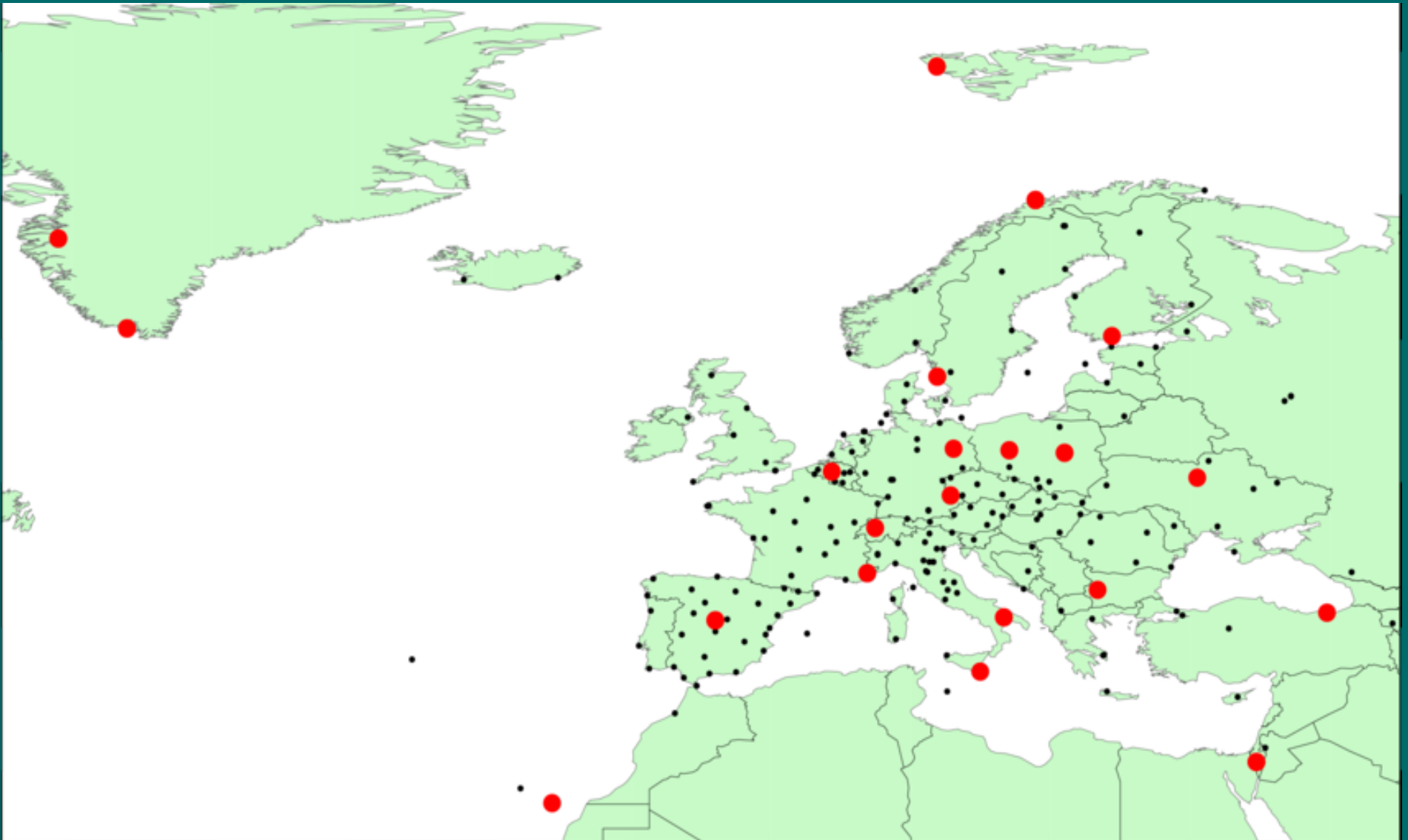
MC over T and TRS

VELOCITY DIFFERENCES

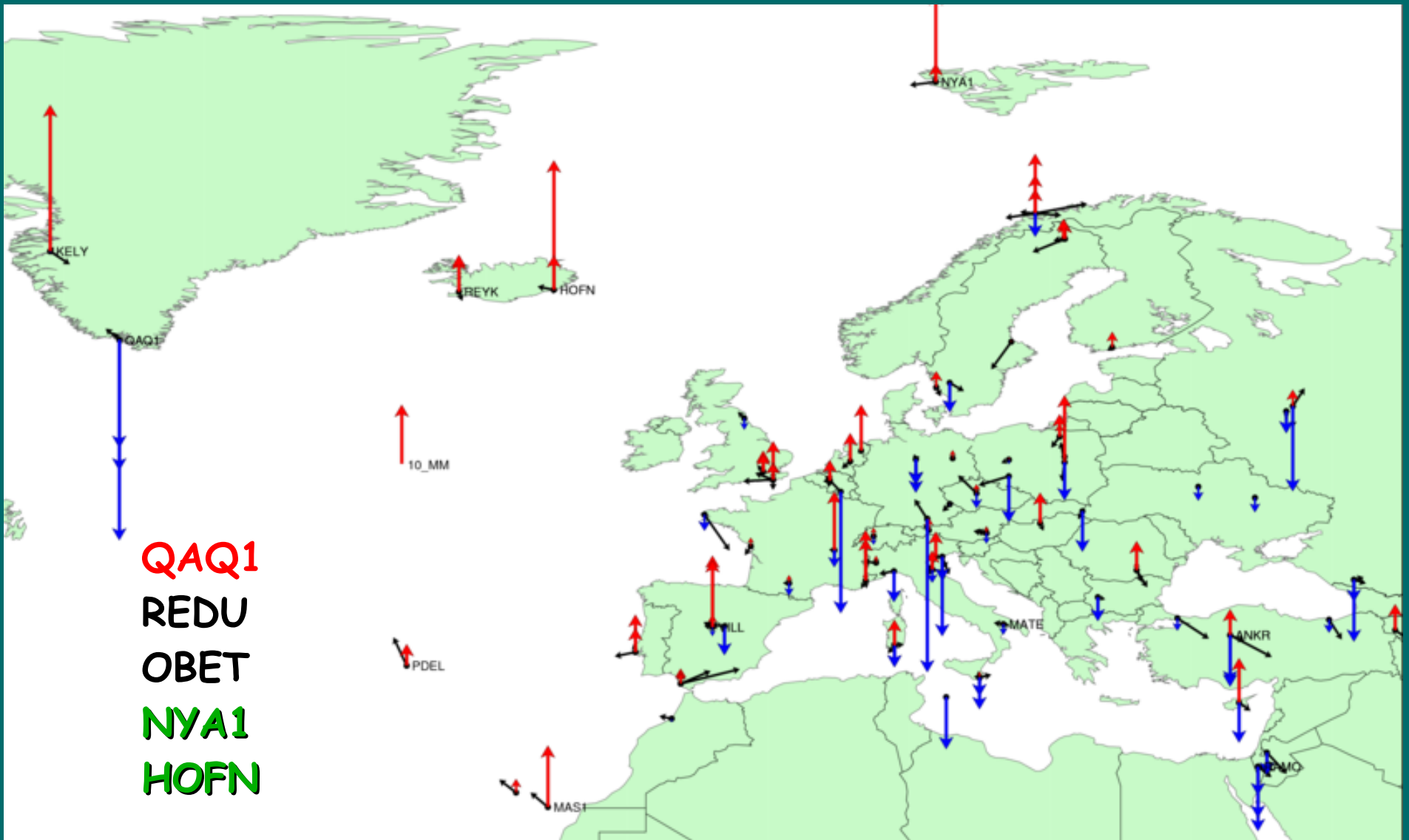


SELECTED REFERENCE NETWORK

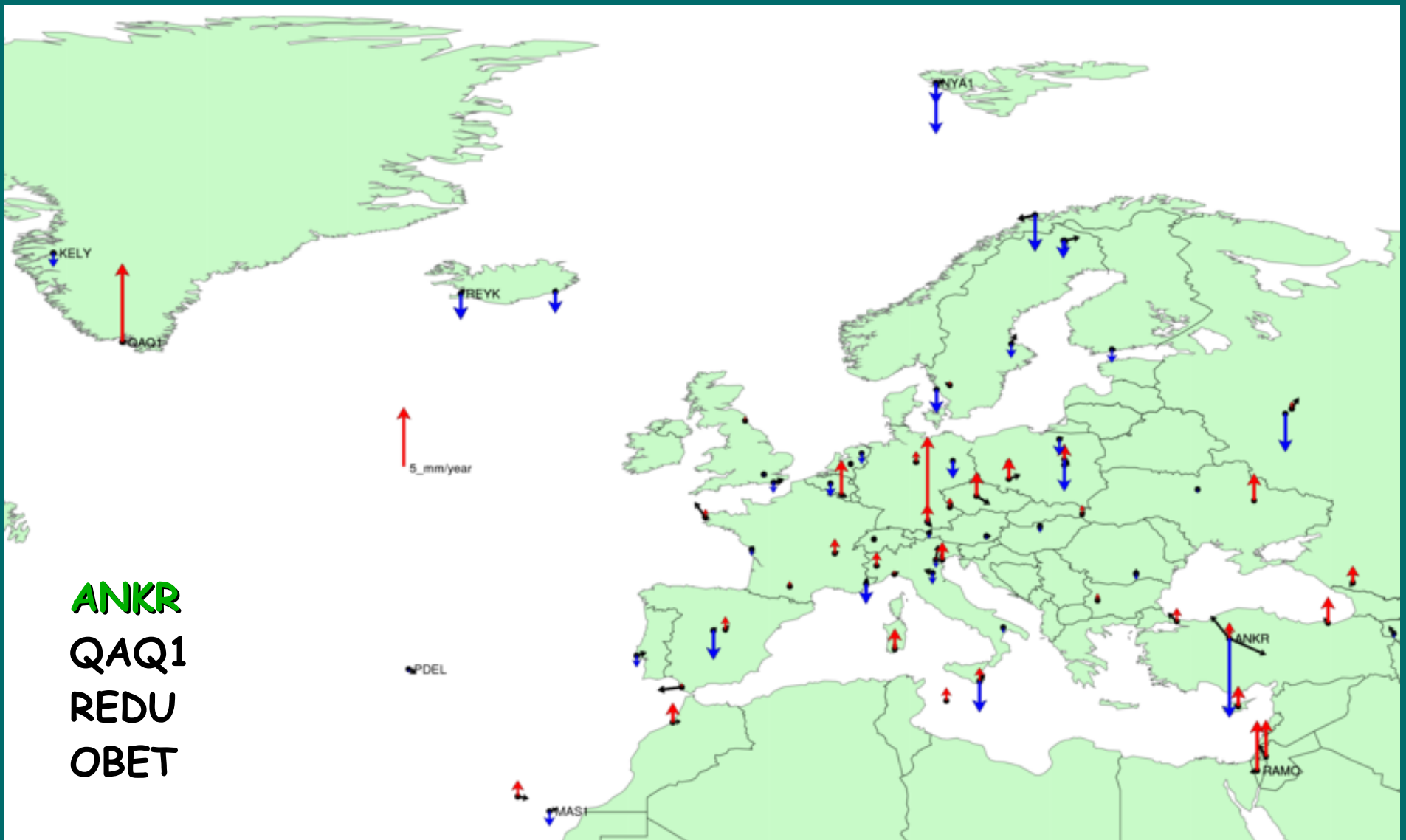
22 SITES, 43 SOLUTION NUMBERS



VALIDATION WITH ITRF2005 COORDINATES



VALIDATION WITH ITRF2005 VELOCITIES



INTERCOMPARISONS WITH THE AC SOLUTION

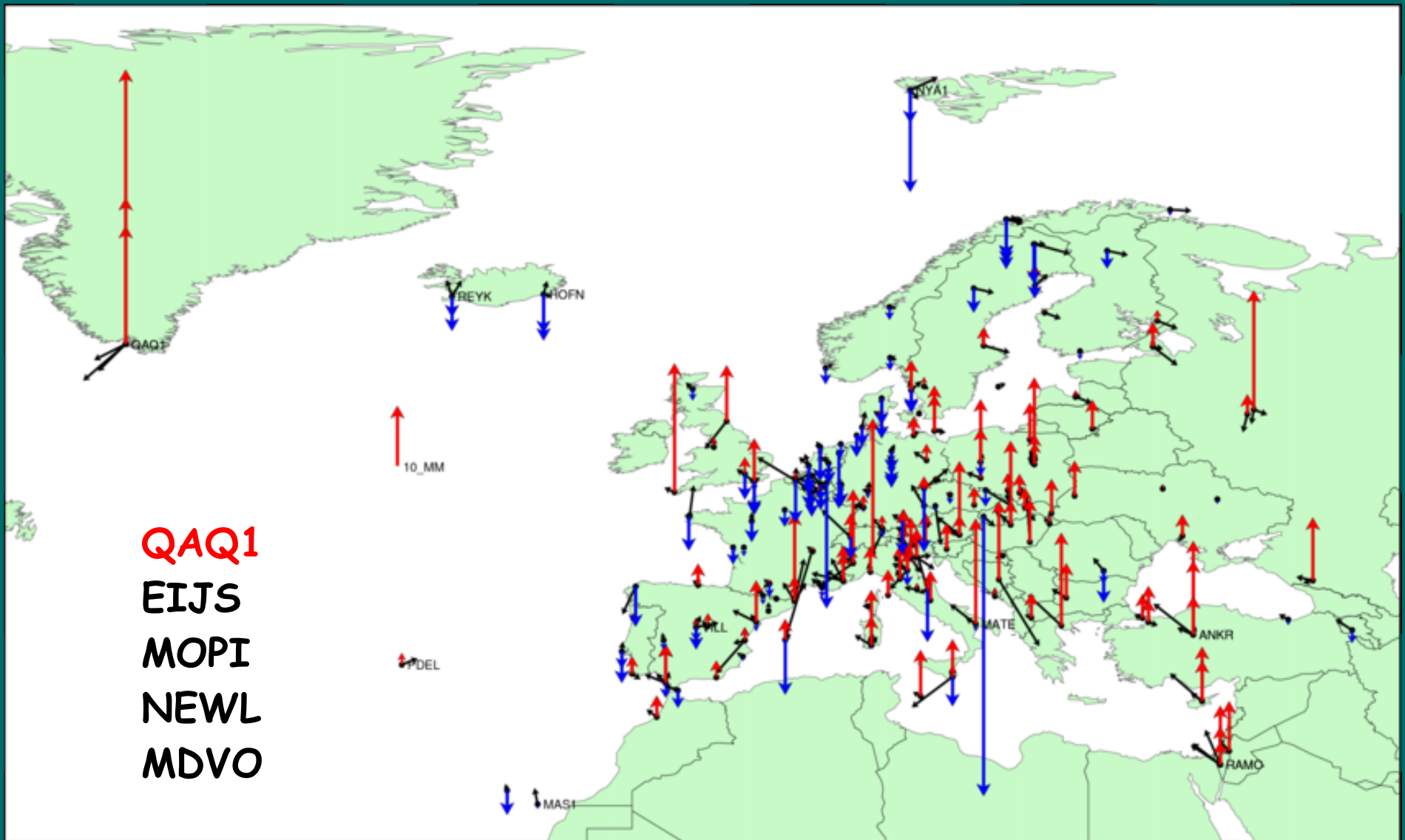
DATUM DEFINITION DIFFERENCES

- 22/43 versus 40/51 sites/solution numbers

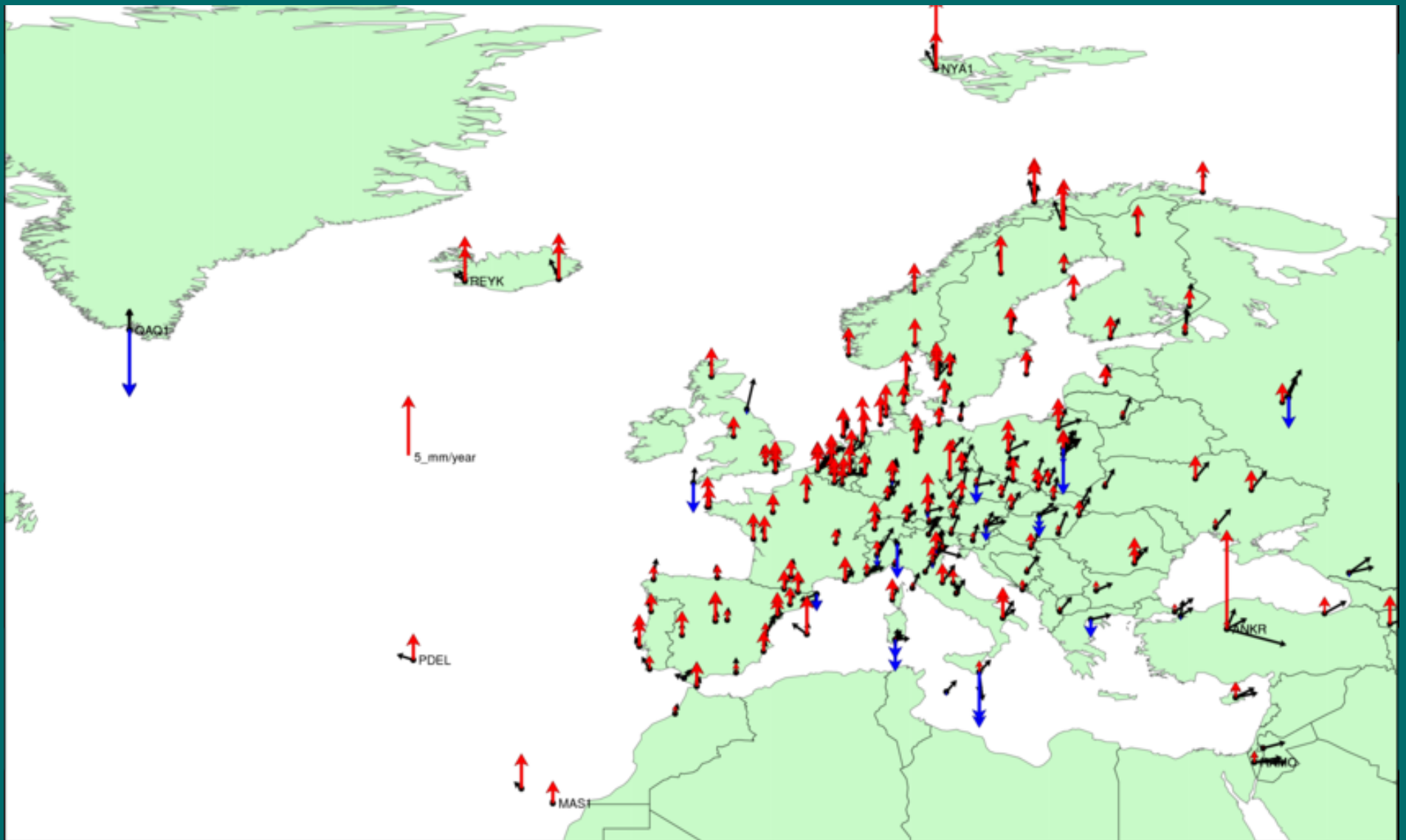
Not all solutions used available in ITRF2005

- **Heavily constrained** versus MC solution
limits the validity/reality of the comparison

COMPARISON of the AC and TSP COORDINATE SOLUTIONS



COMPARISON of the AC and TSP VELOCITY SOLUTIONS



SUMMARY, CONCLUSIONS

- DETAILED ANALYSIS ON DATUM REALIZATION

'STATISTICALLY OPTIMAL' SET OF REFERENCE SITES

- EPN CUMULATIVE SOLUTION VALIDATION

RMS AGREEMENT WITH ITRF2005: CRD-(1.7; 2.3; 7.7 mm)

VEL-(0.4; 0.7; 2.1 mm/y)

- COMPARISON WITH AC SOLUTION

LIMITATION: CONSTRAINED vs MC

- ACCEPTABLE AGREEMENT OF THE COORDINATES
- BIASED AC VELOCITY SOLUTION

MAINTENANCE OF THE EPN
ETRS89 COORDINATES

/

MAINTENANCE OF THE ETRS89
USING EPN

AMBRUS KENYERES

EUREF TWG 2008 FALL MEETING,
MUNICH 3-4 NOVEMBER 2008

INITIAL POINT: EPN CUMULATIVE SOLUTION

- Created with CATREF and MC approach using the weekly combined EPN solutions,
- Solution details and ITRF2005 validation presented before,
- Regularly (3-4 / year) updated **since 2002**

EPN CUMULATIVE SOLUTION

- Up-to-date CRD&VEL (SSC) estimates in ITRFyy and ETRFyy
- EPN discontinuity table (SINEX), harmonized with IGS (conversion tools)
- EPN cumulative SINEX solution
- Availability on the EPBCB website

UPDATED WEB PAGES

EUREF Permanent GNSS Network > Data & Products > Products > Time Series Analysis - Mozilla Firefox

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http://www.epncb.oma.be/_dataproduts/products/timeseriesanalysis/index.php

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TIME SERIES ANALYSIS

The main target of the EPN coordinate time series analysis and monitoring is to strengthen the EPN as a geodetic reference network and to offer various products for geodesists and geophysicists.

Using the CATREF software (Altamimi et al, IGN, France), regularly updated EPN cumulative solutions are created based on the [weekly combined EPN SINEX solutions](#).

During the time series analysis all station specific events (coordinate outliers and discontinuities) are identified and taken into account. This regular monitoring and correction allows to keep the EPN time series products up-to-date.

Within the EPN, this analysis is done by [A. Kenyeres](#) (FÖMI, Hungary).

Products

The time series analysis provides regularly (4 times per year) an updated cleaned cumulative EPN SINEX solution together with the following products:

- The [EPN cumulative solution](#) in SINEX format (zipped, >50 Mbyte!), is available on request from [A. Kenyeres](#). It is tied to the [ITRF2005](#) reference frame using minimum constraints.
- [EPN station coordinates and velocities](#) are the most accurate and up-to-date solutions for the EPN sites. They are used for the maintenance of the regional densification of the ITRFyy between two releases and also for the maintenance of the ETRS89.
- An up-to-date list of station discontinuities ([EPNsoln.snz](#)) fully harmonized with the [IGS/ITRF discontinuity table](#).
- [Residual coordinate time series](#) as the Helmert difference between the coordinates in the cumulative solution and the ones in the weekly input SINEX solutions.
- [Harmonic analysis](#) of the time series to detect seasonal coordinate variations
- [Noise analysis](#) to estimate reliable velocity uncertainties and station-specific noise characteristics
- Miscellaneous plots:
 - [Helmert transformation parameters](#) between the cumulative and the weekly input SINEX solutions
 - [Weighted weekly rms](#) of the input SINEX solutions

http://www.epncb.oma.be/_newsmails/web_site_history.php

UPDATED WEB PAGES


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EPN STATION COORDINATES AND VELOCITIES

The EPN following station coordinates and velocities result from the regular time series analysis and are the most accurate and up-to-date solutions for the EPN sites. They are used for the maintenance of the regional densification of the ITRFyy between successive ITRFyy release and for the maintenance of the ETRS89:

- [EPN station coordinates and velocities in the latest realization of the ETRS89: ETRF00\(R05\)](#)
- [EPN station coordinates and velocities in the latest realization of the ITRS: ITRF2005](#)



http://www.epncb.oma.be/_newsmails/mails.php

EPN CUMULATIVE SOLUTION

- CRD&VEL data in SINEX and SSC format
- Pre-defined single epoch for ALL stations
all site coordinates are mapped from their mean epoch to the common epoch
- The younger a station, the bigger the epoch difference and the weaker the velocity value!
- Consequence: new stations show VERY high coordinate variation at the common epoch!

EPN station categorization

STATIONS WITH SUFFICIENT LENGTH OF OBSERVATIONS (say 3 years) AND HIGH QUALITY VELOCITIES SHOULD BE DISTINGUISHED FROM 'YOUNGER' SITES.

AS IN THE EUREF NETWORK:

CATEGORY A: 1 CM ACCURACY ETRS89
COORDINATES AT **ANY** EPOCH

CATEGORY B: 1 CM ACCURACY ETRS89 CRD
AT THE **MEAN** EPOCH

Categorization in the practice

EPN_CWWWW.SNX

EPN cumulative SINEX

snx2ssc

conversion tool

EPN_**A**WWWW**I**.SSC

ITRFyy CRD & VEL

EPN_**B**WWWW**I**.SSC

EPN_**A**WWWW**E**.SSC

ETRFyy CRD & VEL

EPN_**B**WWWW**E**.SSC

A - pre-defined single epoch (2000.0)

B - the actual mean epoch of each single station

SSC format (Set of Station Coordinates)

EPN ITRF2005 STATION POSITIONS (EPOCH 2000.0) AND VELOCITIES
 CUMULATIVE SOLUTION OF GPSWEEKS [0860 - 1355]
 CREATED BY THE EPN TIME SERIES SP USING CATREF

DOMES NB.	SITE NAME	TECH.	ID.	X/Vx	Y/Vy	Z/Vz	Sigmas			SOLN	DATA_START	DATA_END
				-----m/m/Y-----								
13434M001	ACOR	GPS	ACOR	4594489.746	-678367.887	4357066.065	0.001	0.000	0.001	1	99:248:00000	00:009:00000
13434M001				-0.0100	0.0235	0.0107	0.0003	0.0001	0.0003			
13434M001	ACOR	GPS	ACOR	4594489.746	-678367.885	4357066.073	0.001	0.000	0.001	2	00:009:00000	02:209:00000
13434M001				-0.0100	0.0235	0.0107	0.0003	0.0001	0.0003			
13434M001	ACOR	GPS	ACOR	4594489.736	-678367.883	4357066.059	0.001	0.000	0.001	3	02:209:00000	03:313:00000
13434M001				-0.0100	0.0235	0.0107	0.0003	0.0001	0.0003			
13434M001	ACOR	GPS	ACOR	4594489.752	-678367.888	4357066.073	0.002	0.001	0.002	4	03:313:00000	06:309:00000
13434M001				-0.0100	0.0235	0.0107	0.0003	0.0001	0.0003			
10077M005	AJAC	GPS	AJAC	4696989.506	723994.380	4239678.481	0.001	0.000	0.001	1	00:051:00000	06:309:00000
10077M005				-0.0139	0.0189	0.0116	0.0001	0.0000	0.0001			
13433M001	ALAC	GPS	ALAC	5009051.241	-42072.294	3935057.669	0.001	0.000	0.000	1	99:248:00000	06:148:00000
13433M001				-0.0104	0.0196	0.0129	0.0001	0.0000	0.0001			
13437M001	ALME	GPS	ALME	5105220.136	-219278.615	3804387.059	0.001	0.000	0.001	1	01:021:00000	06:309:00000
13437M001				-0.0081	0.0186	0.0131	0.0002	0.0001	0.0001			
20805M002	ANKR	GPS	ANKR	4121948.562	2652187.938	4069023.702	0.001	0.000	0.001	1	96:210:00000	98:259:00000
20805M002				-0.0078	-0.0042	0.0081	0.0001	0.0001	0.0001			
20805M002	ANKR	GPS	ANKR	4121948.578	2652187.929	4069023.724	0.001	0.000	0.001	4	99:316:61020	06:309:00000
20805M002				-0.0078	-0.0042	0.0081	0.0001	0.0001	0.0001			
12757M001	AQUI	GPS	AQUI	4592507.656	1089876.271	4276392.929	0.001	0.000	0.001	1	01:287:00000	06:309:00000
12757M001				-0.0174	0.0185	0.0126	0.0002	0.0001	0.0002			
13431M001	BELL	GPS	BELL	4775849.450	116814.272	4213018.902	0.001	0.000	0.001	1	99:031:00000	06:309:00000
13431M001				-0.0105	0.0188	0.0127	0.0001	0.0000	0.0001			

ETRS89 MAINTENANCE TEST

- SERIES OF CUMULATIVE SOLUTIONS HAS BEEN COMPUTED

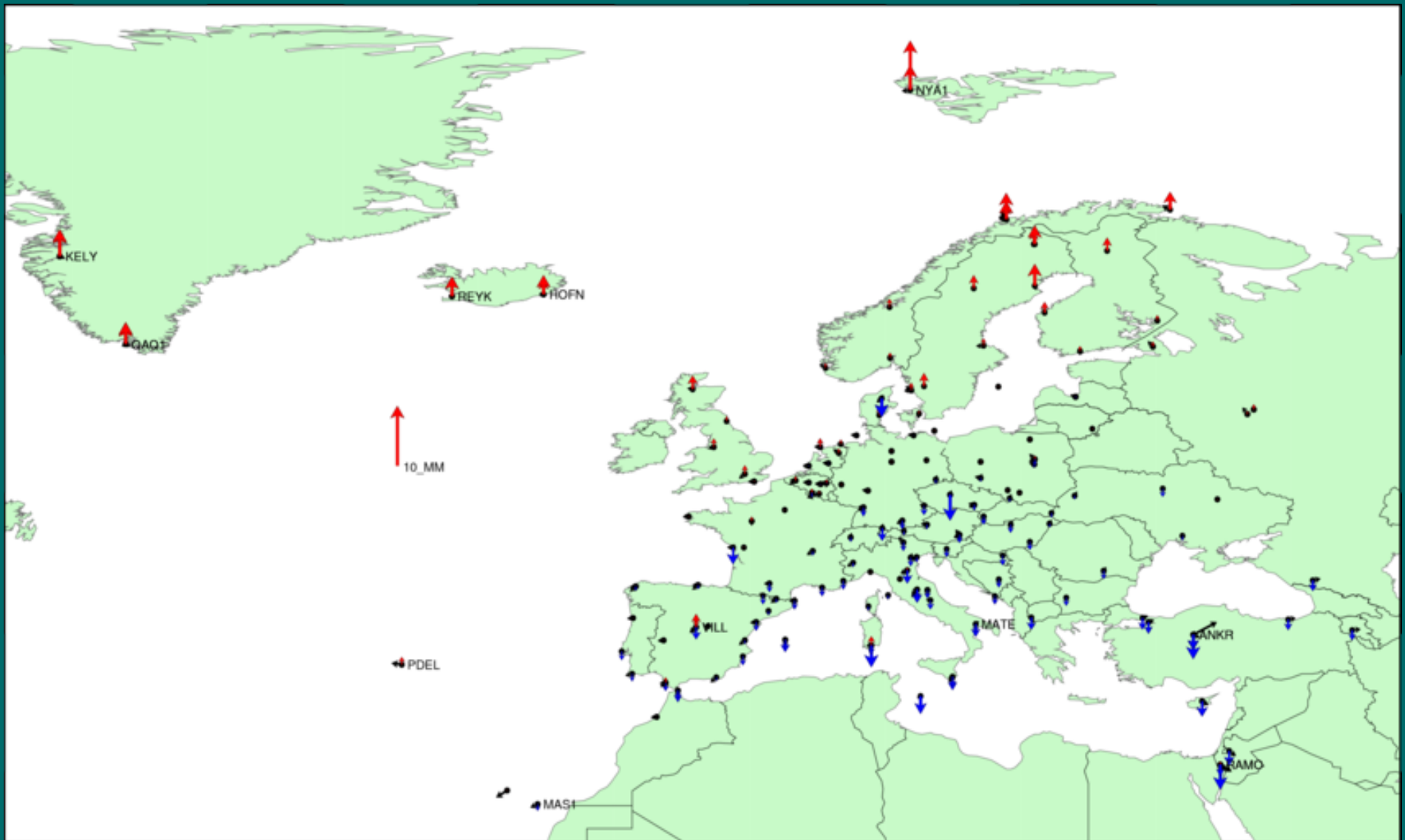
GPSWEEK 860-1355;1399;1420;1440; ... 1494

- SAME DATUM DEFINITION AS SHOWN BEFORE (22 site / 43 soln)

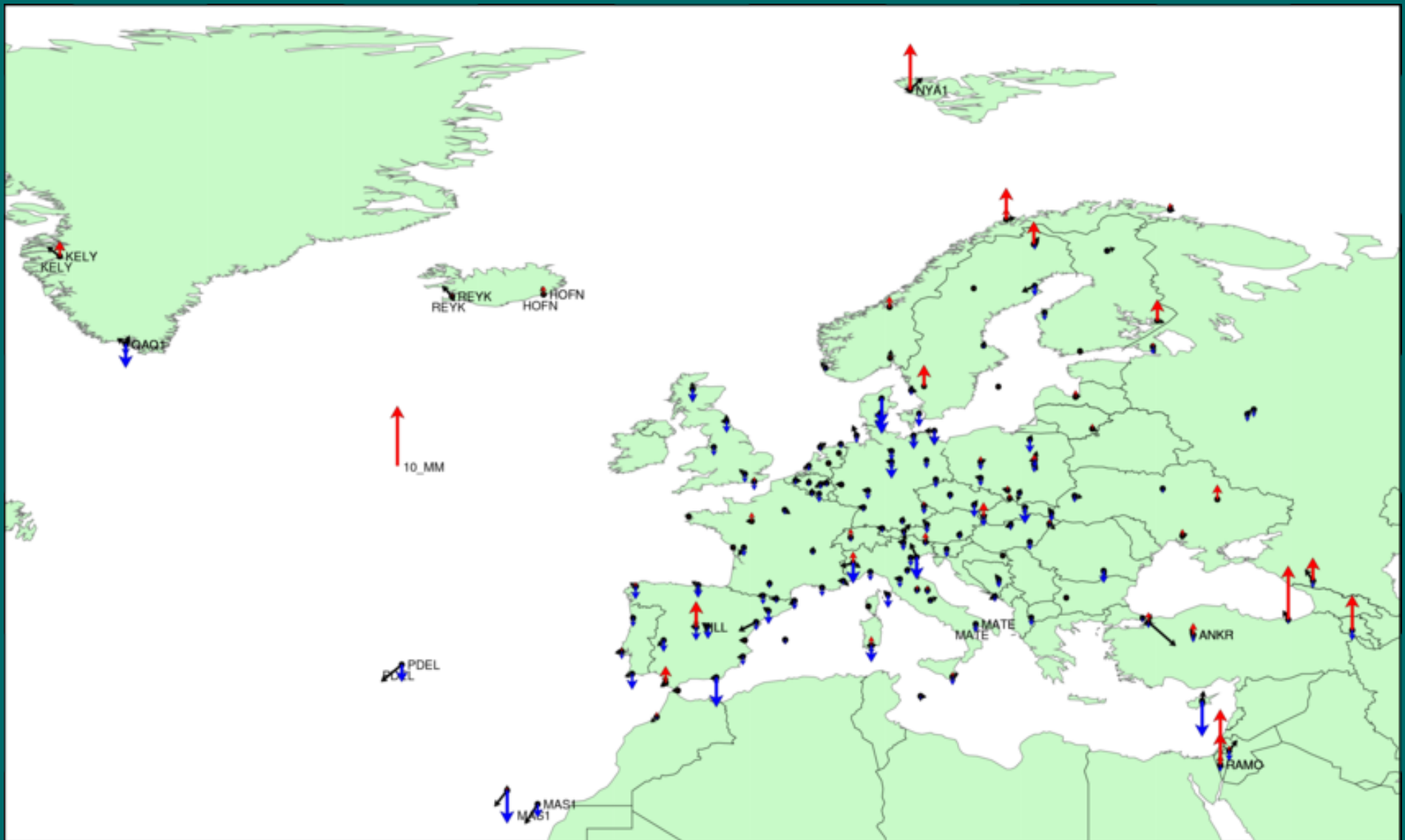
SITES WITH SMALL OFFSET AT GPSWEEK 1400 WERE SELECTED - LIMITED VALIDITY DATUM DEFINITION

- THE SUBSEQUENT SSC SOLUTIONS [ETRF2000(R05)] WERE COMPARED

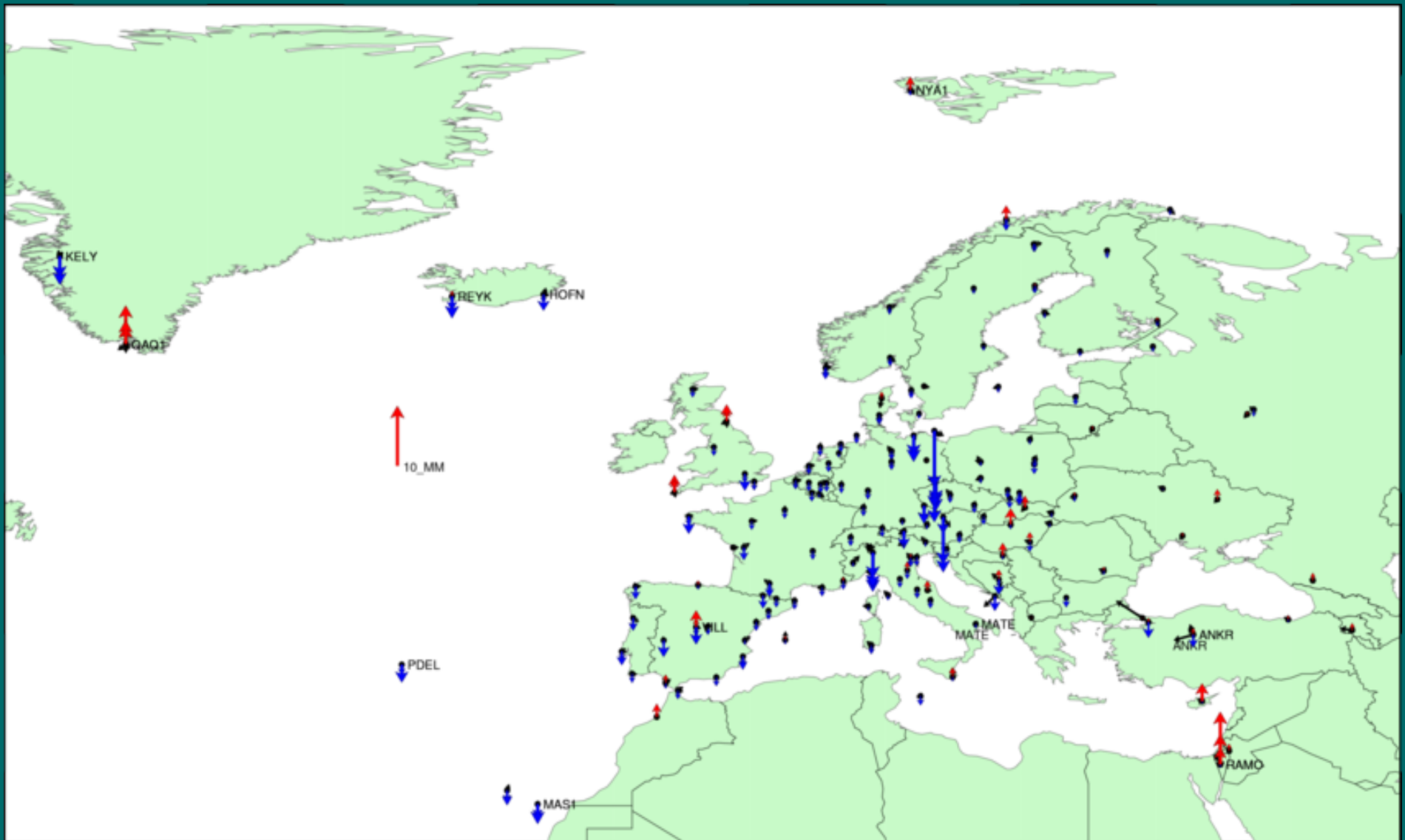
CAT_A: WK1399-1420 (CRD)



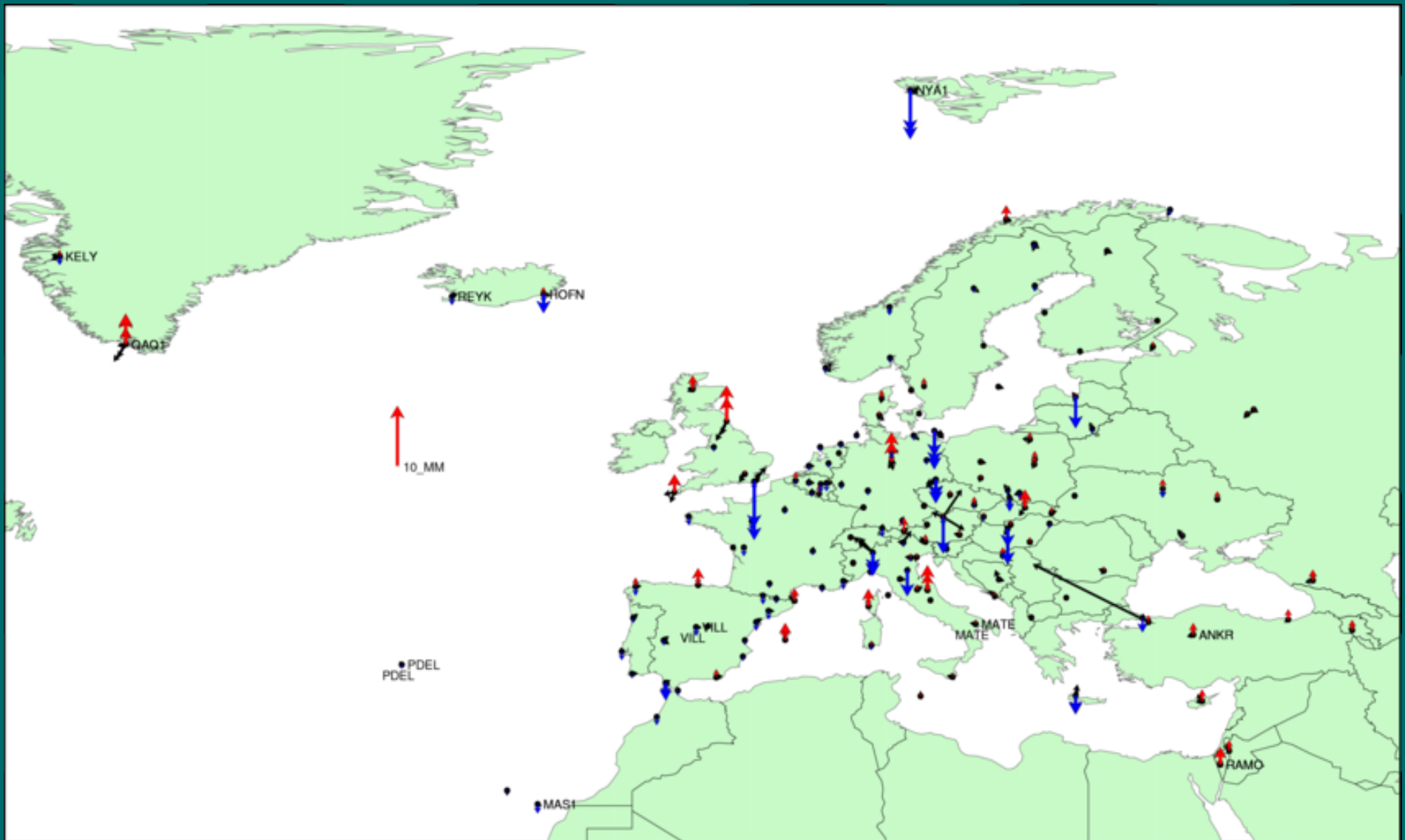
CAT_A: WK1420-1440 (CRD)



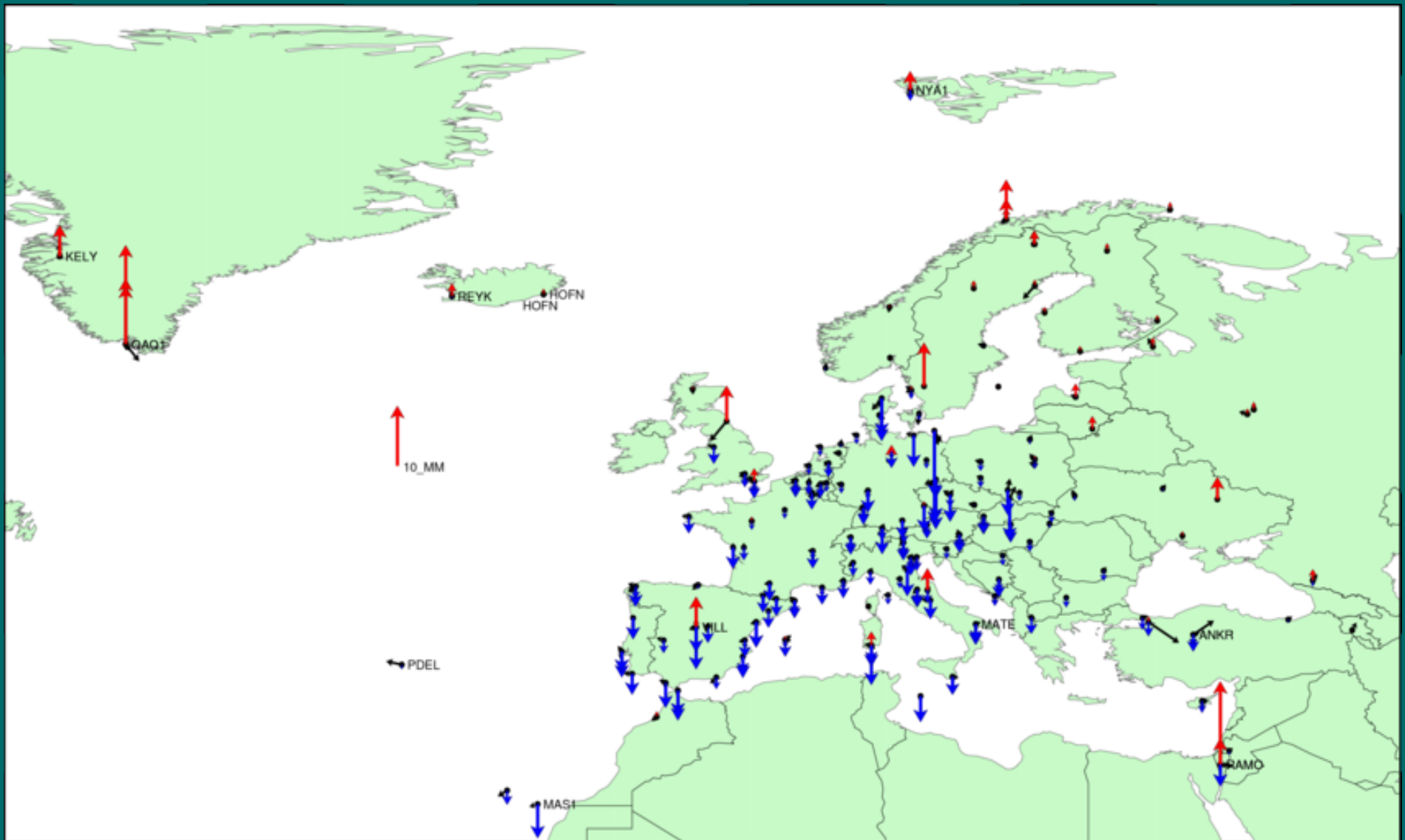
CAT_A: WK1440-1460 (CRD)



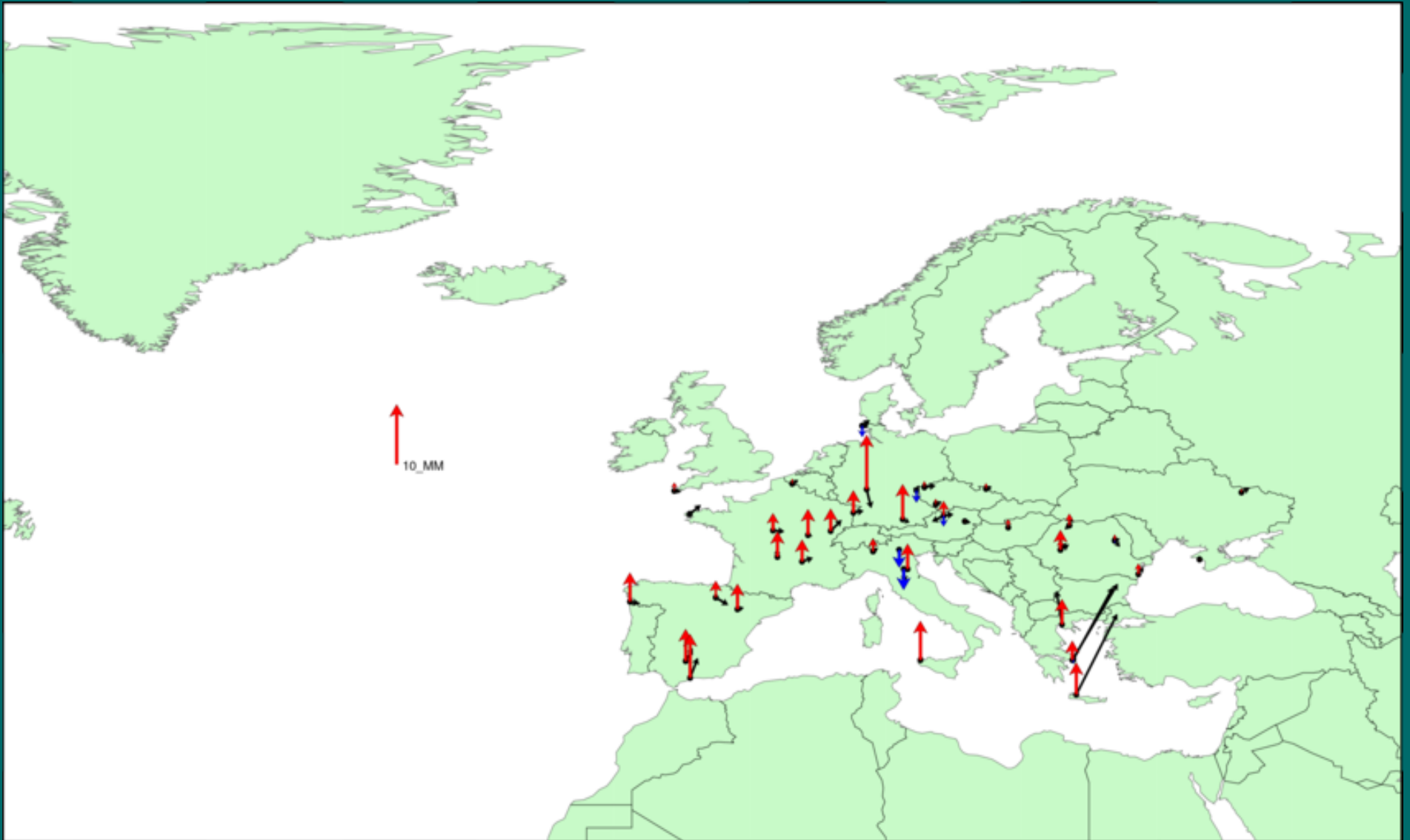
CAT_A: WK1460-1480 (CRD)



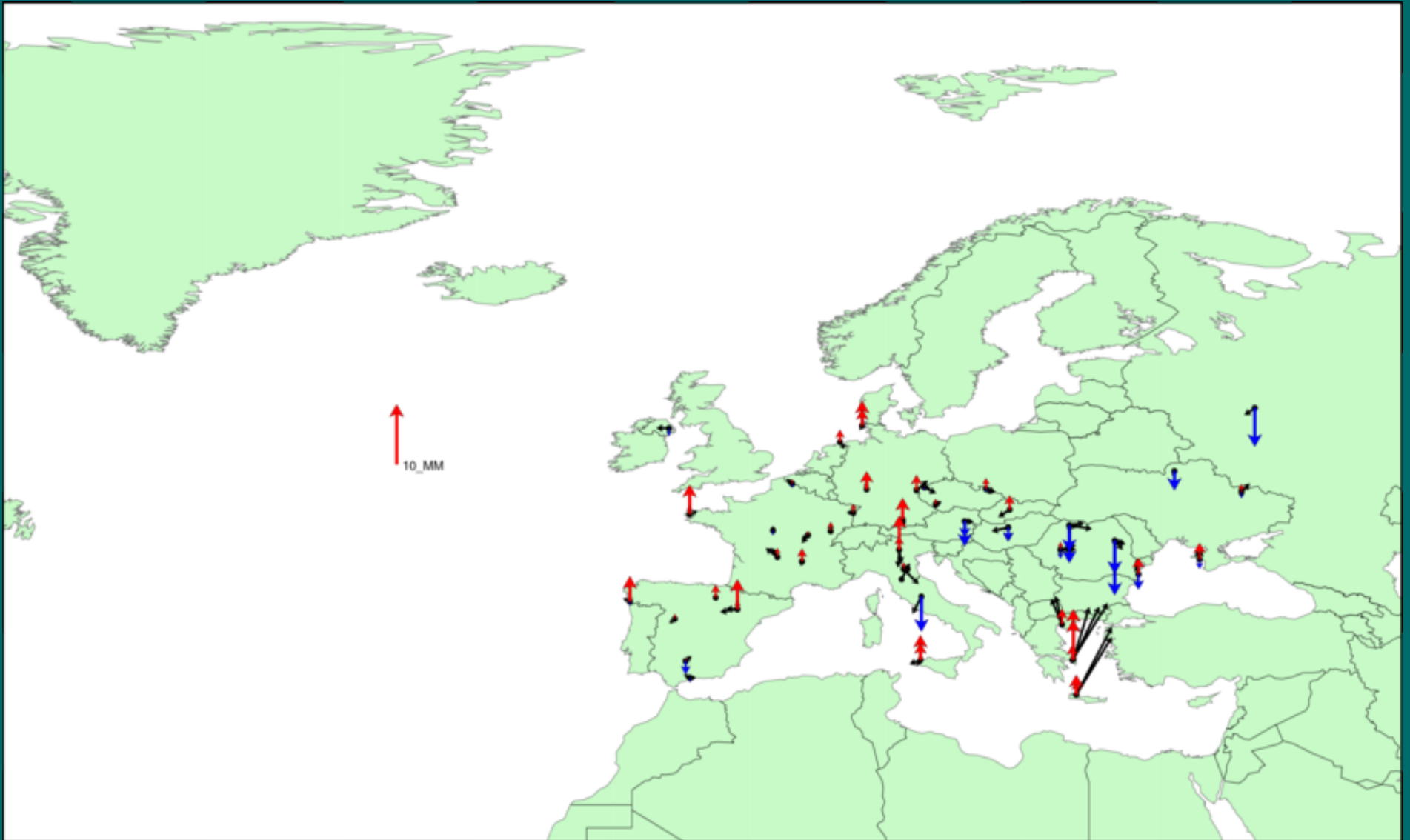
CAT_A: WK1399-1494 (CRD)



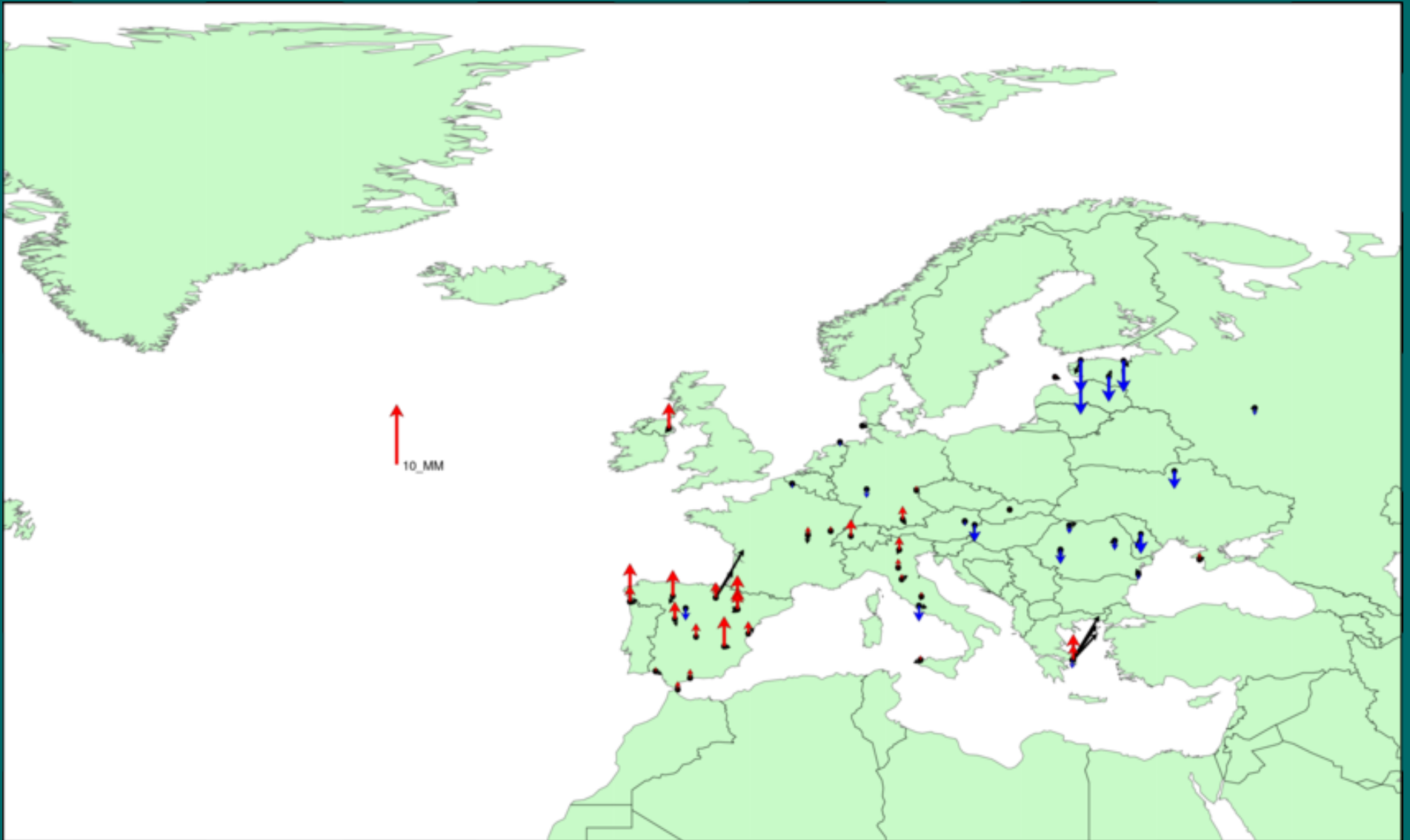
CAT_B: WK1399-1420 (CRD)



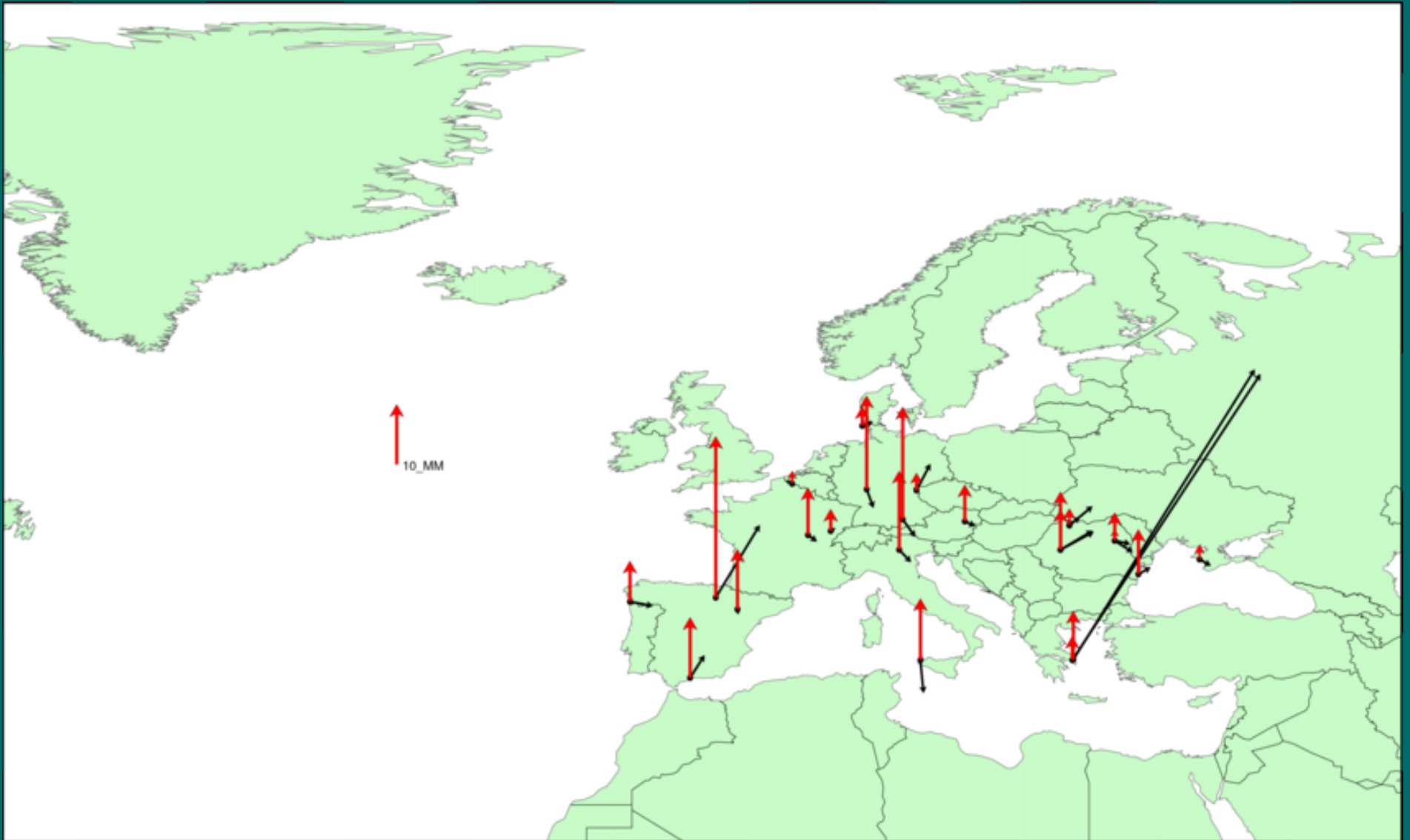
CAT_B: WK1420-1440 (CRD)



CAT_B: WK1480-1494 (CRD)



CAT_B: WK1399-1494 (CRD)



CONCLUSIONS

- THE EPN CUMULATIVE SOLUTION IS CAPABLE TO MAINTAIN 1 CM ACCURACY ETRS89 COORDINATES FOR THE EPN SITES!
- CONDITION: SITE CATEGORIZATION
 - CAT_A - 1 cm AT ANY EPOCH
 - CAT_B - 1 cm AT THE MEAN EPOCH
- FURTHER STUDIES, REFINEMENT
 - CATEGORY SEPARATION
 - FORMAT SPECIFICATIONS