EGSIEM

European Gravity Service for Improved Emergency Management

WP3 Integration of complementary data

Working progress

- T3.1: Reference Frame reprocessing UBERN
  - M03-M10
- T3.2: SLR normal equations UBERN
  - M07-M09
- T3.3: NRT Reference Frame processing UBERN
  - M03-M06
- T3.4: Operational NRT Reference Frame processing UBERN
  - M28-M33
- T3.5: Validation of GRACE gravity products with GNSS UL
  - M19-M36: presented in January and in progress
- T3.6: Validation of GRACE gravity products with Ocean Bottom Pressure GFZ
  - M25-M36: presented in January
- T3.7: Preparation for Hydroweb data CNES
  - M01-M10
- T3.8 GIA for Hydrology LM
  - M11-M36: presented in January
- T3.9: Compilation of representative historical flood situations DLR
  - M01-M10: presented in January

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Validation with GNSS loading

Ulux progress on WP3 T3.5

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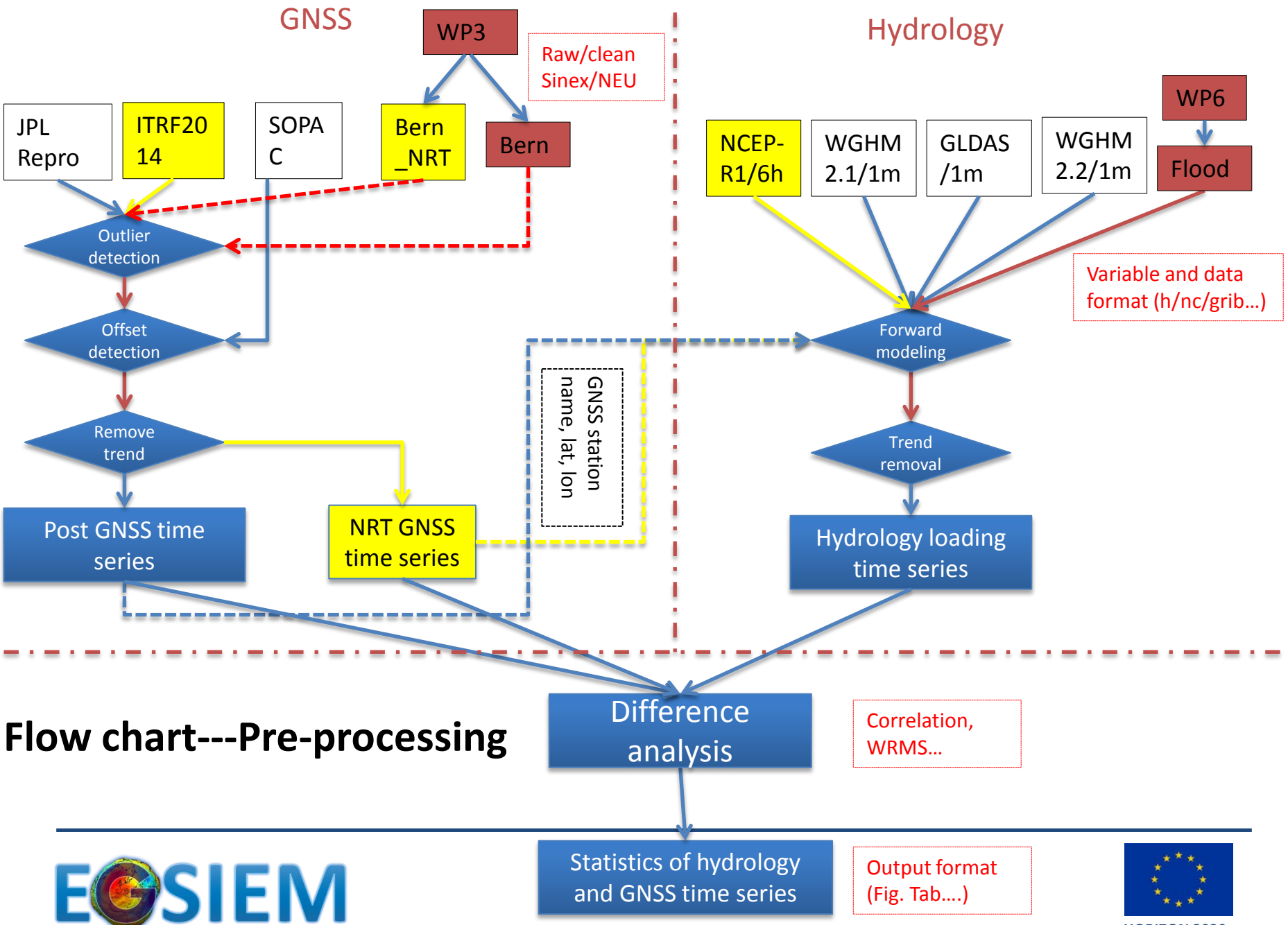
Validation with GNSS loading

- 3-step concept
  - Data pre-processing
  - Data processing
  - Output (Correlation coefficient and WRMS reduction ...)


GNSS
WP3
Raw/clean Sinex/NEU
Hydrology
JPL Repro
ITRF2014
SOPAC
Bern_NRT
Bern
WP6
Flood
NCEP-R1/6h
WGHM 2.1/1m
GLDAS /1m
WGHM 2.2/1m
Outlier detection
Offset detection
Remove trend
Variable and data format (h/nc/grib…)
Forward modeling
GNSS station name, lat, lon
Trend removal
Post GNSS time series
NRT GNSS time series
Hydrology loading time series
Difference analysis
Correlation, WRMS…
Statistics of hydrology and GNSS time series
Output format (Fig. Tab.…)
Flow chart---Pre-processing
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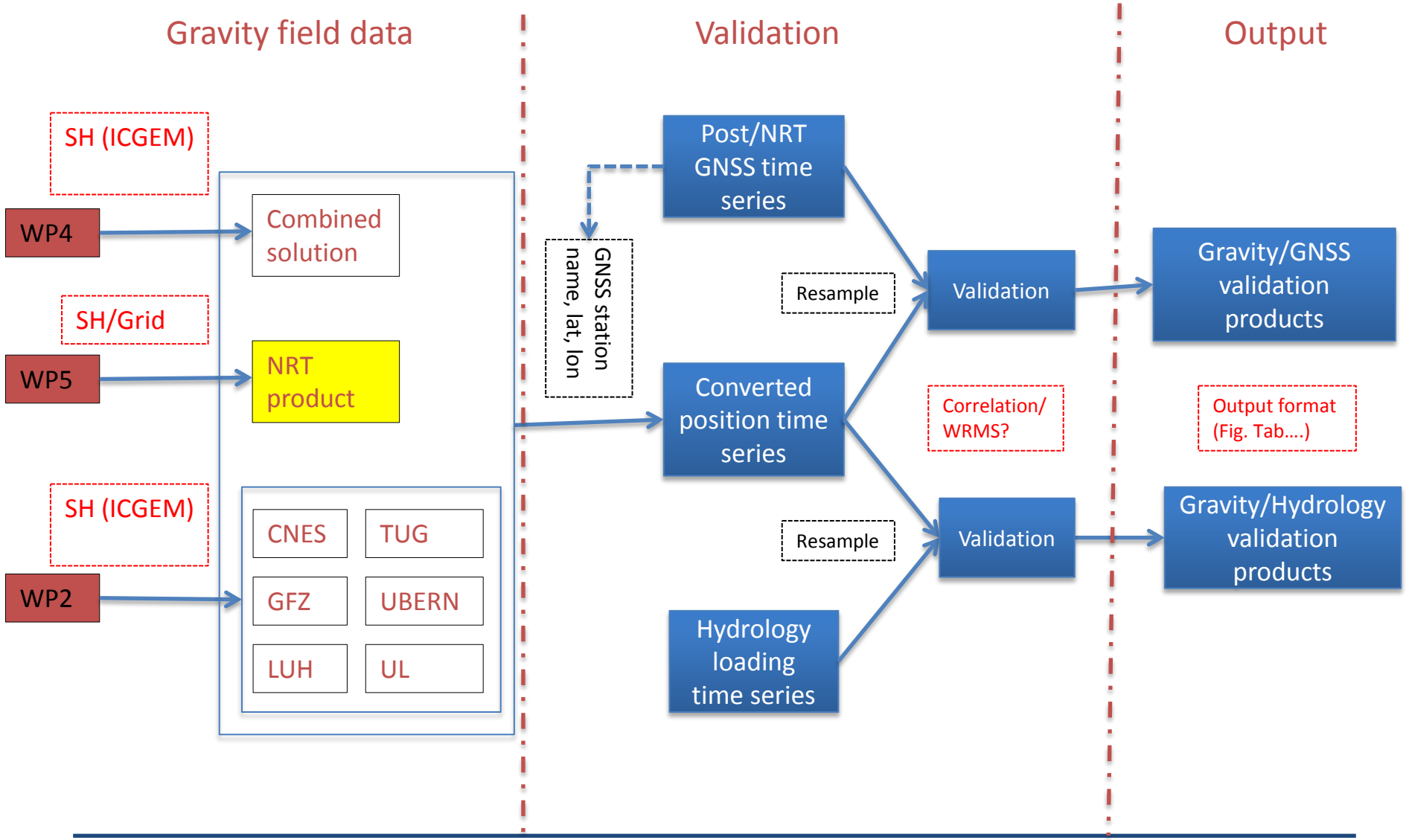
Flow chart---Data-processing and output



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Data

- GNSS data
  - Latest global daily GNSS time series from JPL (1094 stations) and SOPAC (918 stations) (ftp://garner.ucsd.edu/pub/timeseries/measures/ats/Global)
    - Cleaned, detrended, outlier removed
    - Nearly real time
  - Latest ITRF2014 GNSS residuals (IGN), 1054 stations
    - Rigorously stacking the latest IGS repro2 solutions
  - Stations with less than 2-year data abandoned
- Continental Water Storage Models
  - GLDAS, monthly, 3-4m latency
  - WGHM_2.1f6, monthly, 2002-12/2013
  - WGHM_2.2_STANDARD, latest official version, 2002-10/2010, m and d
  - WGHM_2.2_STANDARD_CRU, a modification of 2.2standard, 2002-12/2012,but not calibrated for the climate input
- Gravity model
  - EGSIEM combined solution, 2003-2014
  - GRACE Release 5 from GFZ (RL05a), CSR and JPL (RL05.1)
  - GRACE data processing
    - Replacing C20 term (Cheng et al., SLR) and adding back degree-1 coefficients (Swenson et al., 2008)
    - The Gaussian filtering with a smoothing radius of 500 km
    - Adding back GAC products when comparing to GNSS

Recap from last meeting

- The GNSS observed and the EGSIEM derived displacements are in strong agreement. The ITRF2014 solutions provide the better performance than the JPL and SOPAC GNSS solutions.

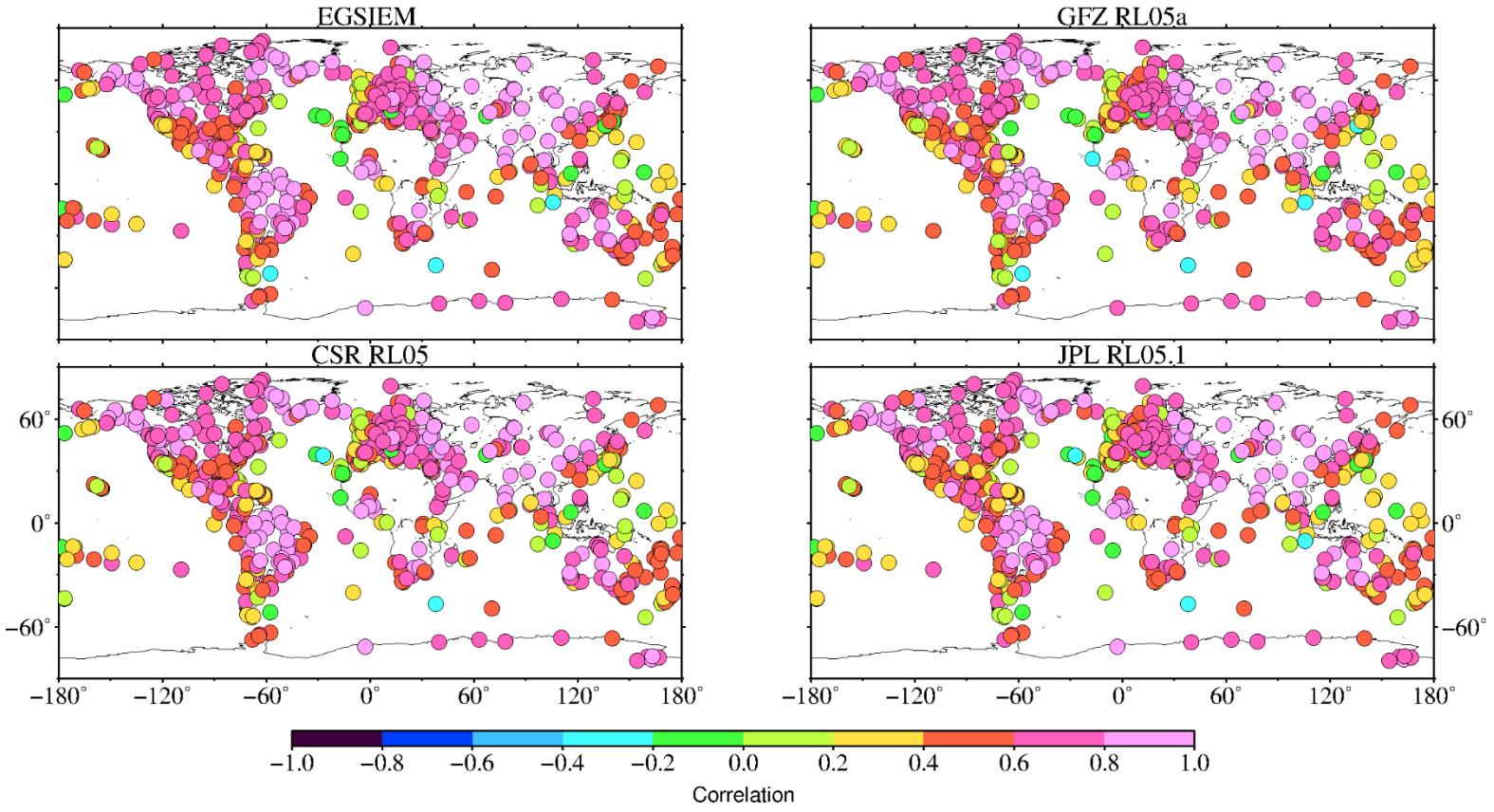
- Agreement between the four hydrological models and the three GNSS solutions is good as well and better agreement is found with the ITRF2014 time series than the JPL and SOPAC time series

- With respect to the three GNSS position time series, EGSIEM shows better statistics than the hydrological models.

see EGU Poster Li et al., (2016)

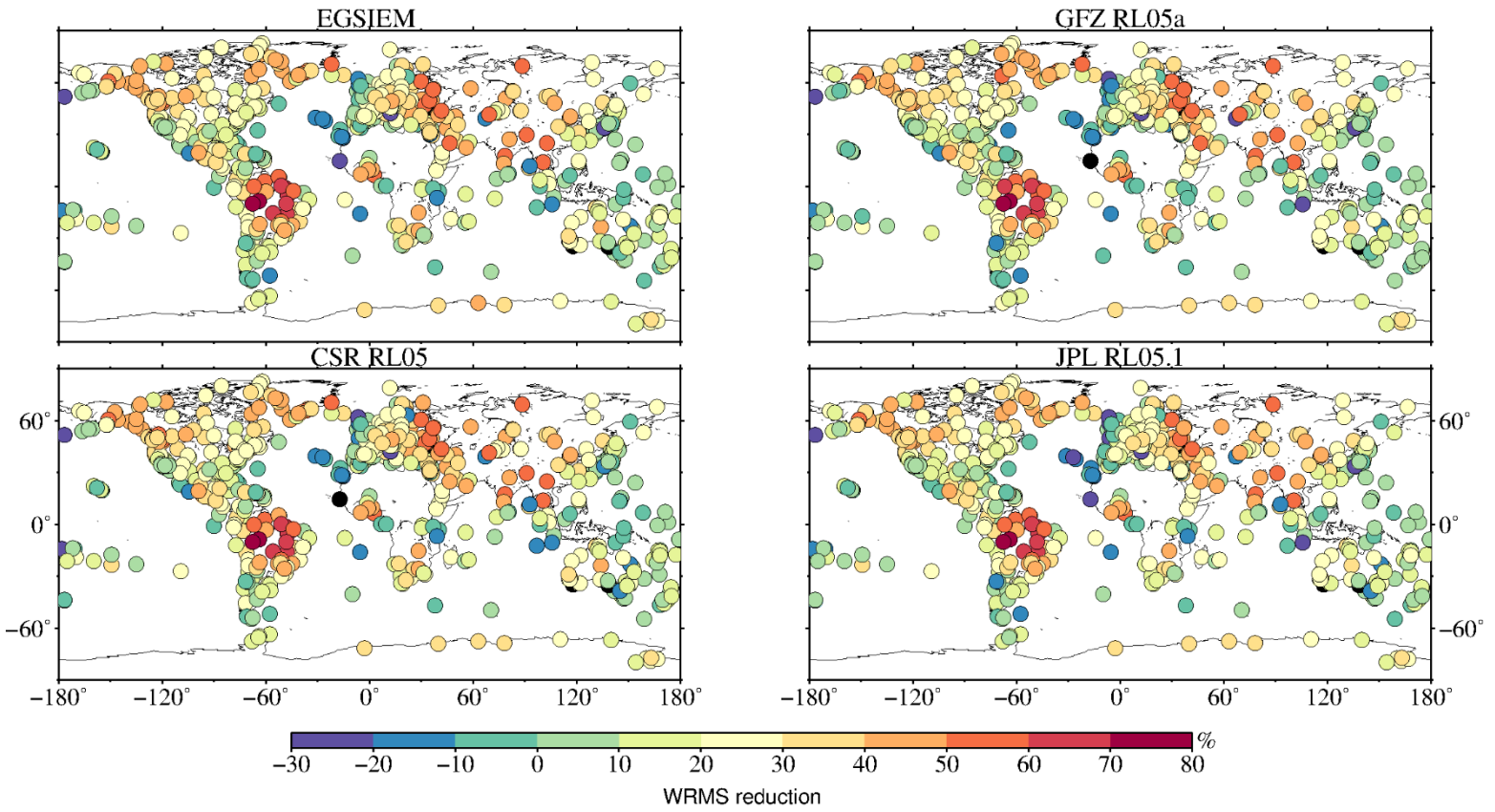
GRACE .VS. ITRF2014

- In a comparison to 949 ITRF2014 GNSS stations: correlation
- High correlations are observed between the GRACE-derived displacements and the ITRF2014 solutions



GRACE .VS. ITRF2014

- In a comparison to 949 ITRF2014 GNSS stations: WRMS reduction
- Up to around 75% of WRMS reduction at POVE station (Porto Velho, Brazil)



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GRACE .VS. ITRF2014

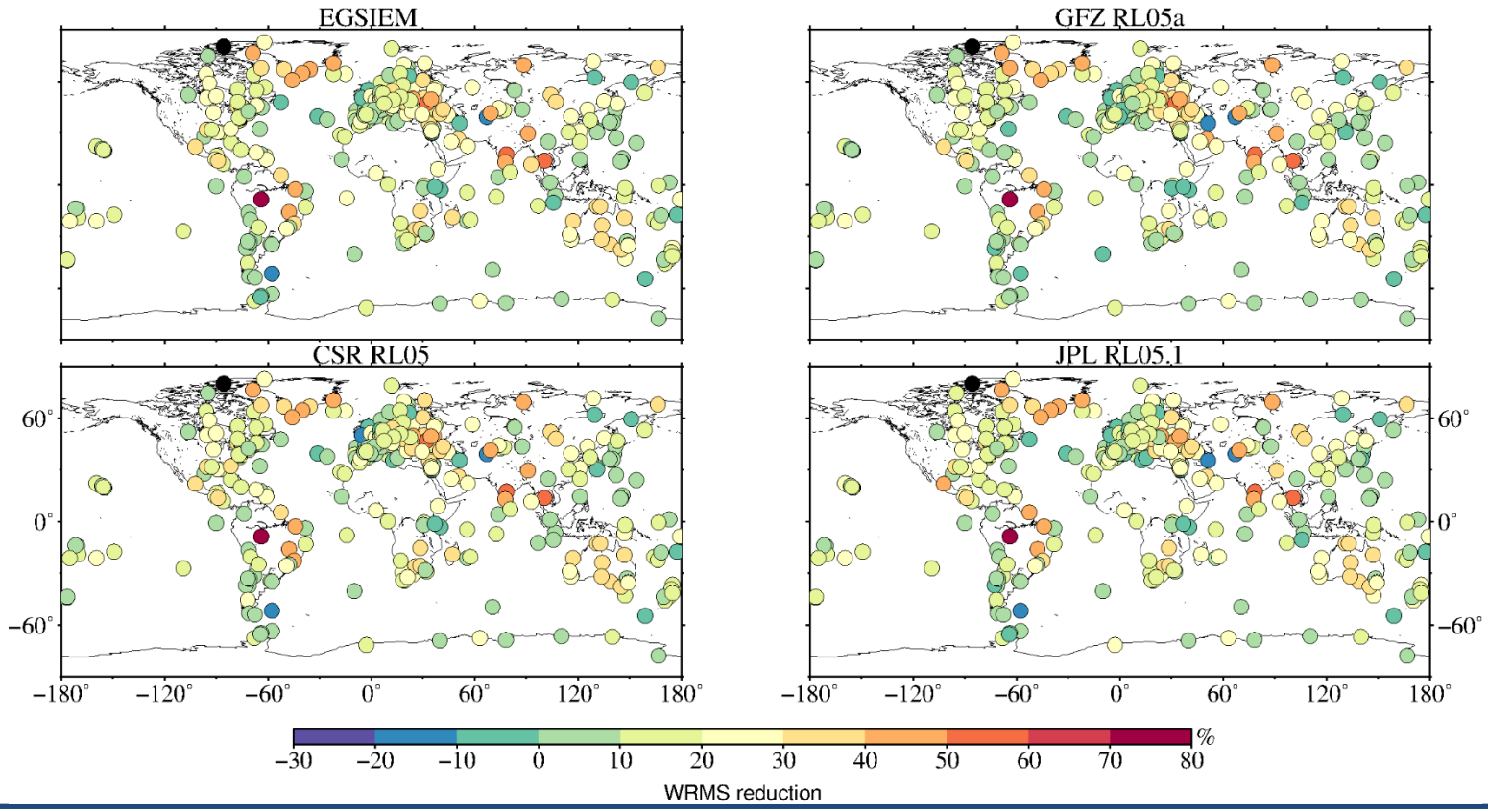
Table 1: *Statistics between GRACE and ITRF2014 solutions. High percentages of stations with positive WRMS reductions are observed using the four different GRACE products.*

	Correlation			Stations with correlation> 0.6 [%]	WRMS reduction [%]			Stations with positive WRMS reduction [%]
	min	max	mean		min	max	mean	
GFZ RL05a	-0.40	0.97	0.55	48.68	-55.67	74.46	17.69	84.93
CSR RL05	-0.40	0.97	0.57	52.90	-50.80	74.44	19.68	88.41
JPL RL05.1	-0.43	0.97	0.55	47.95	-58.50	73.95	17.99	87.04
EGSIEM	-0.39	0.97	0.57	53.74	-47.83	74.56	19.70	88.72

- All four GRACE products display good agreements with the ITRF 2014 solutions
- EGSIEM provides the best performance in terms of both correlation and WRMS reduction in a comparison to 949 ITRF2014 GNSS stations

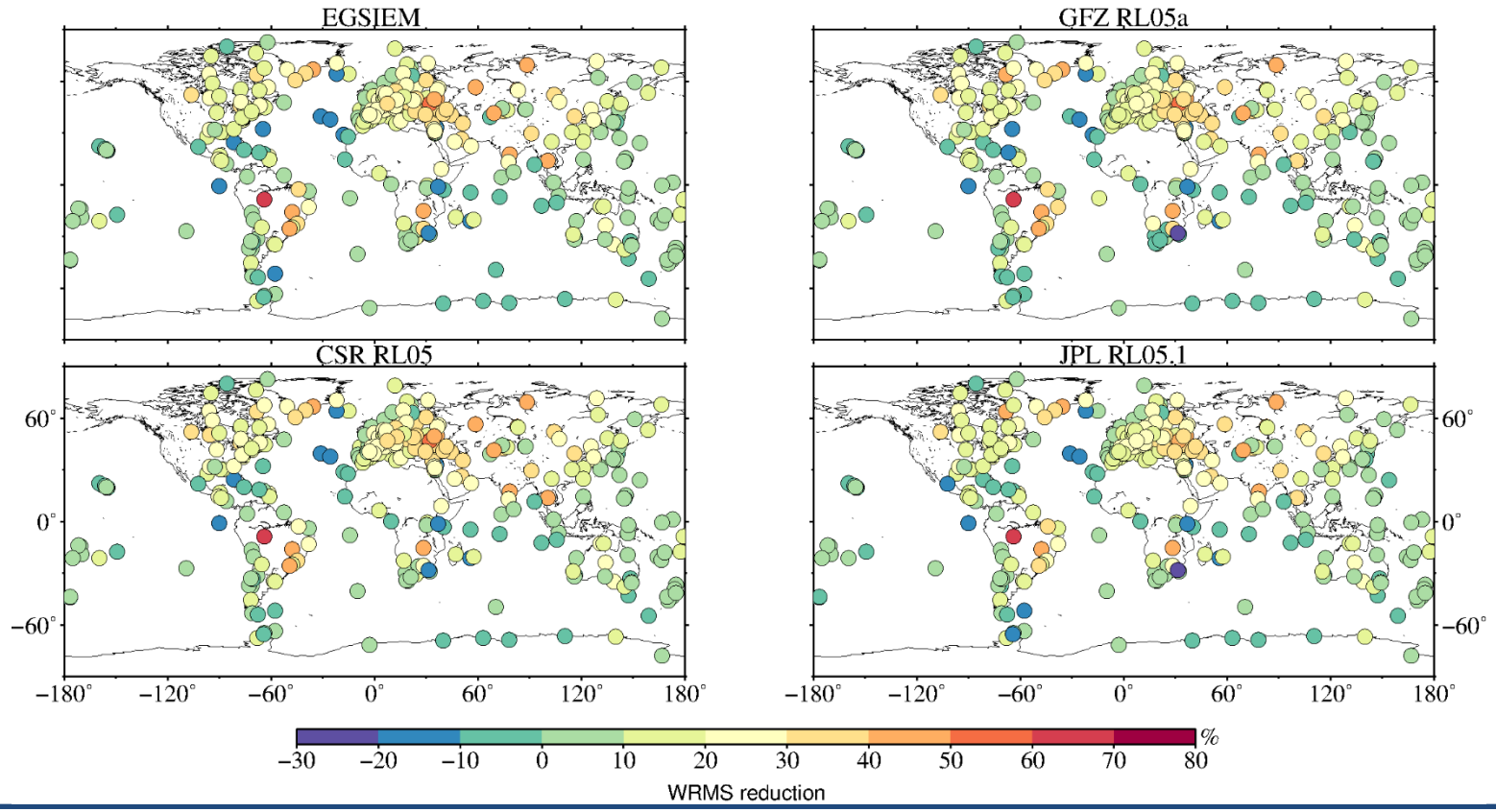
GRACE .VS. GNSS (JPL)

- In comparison to 394 common GNSS stations from JPL, SOPAC and ITRF2014 solutions



GRACE .VS. GNSS (SOPAC)

- In comparison to 394 common GNSS stations from JPL, SOPAC and ITRF2014 solutions



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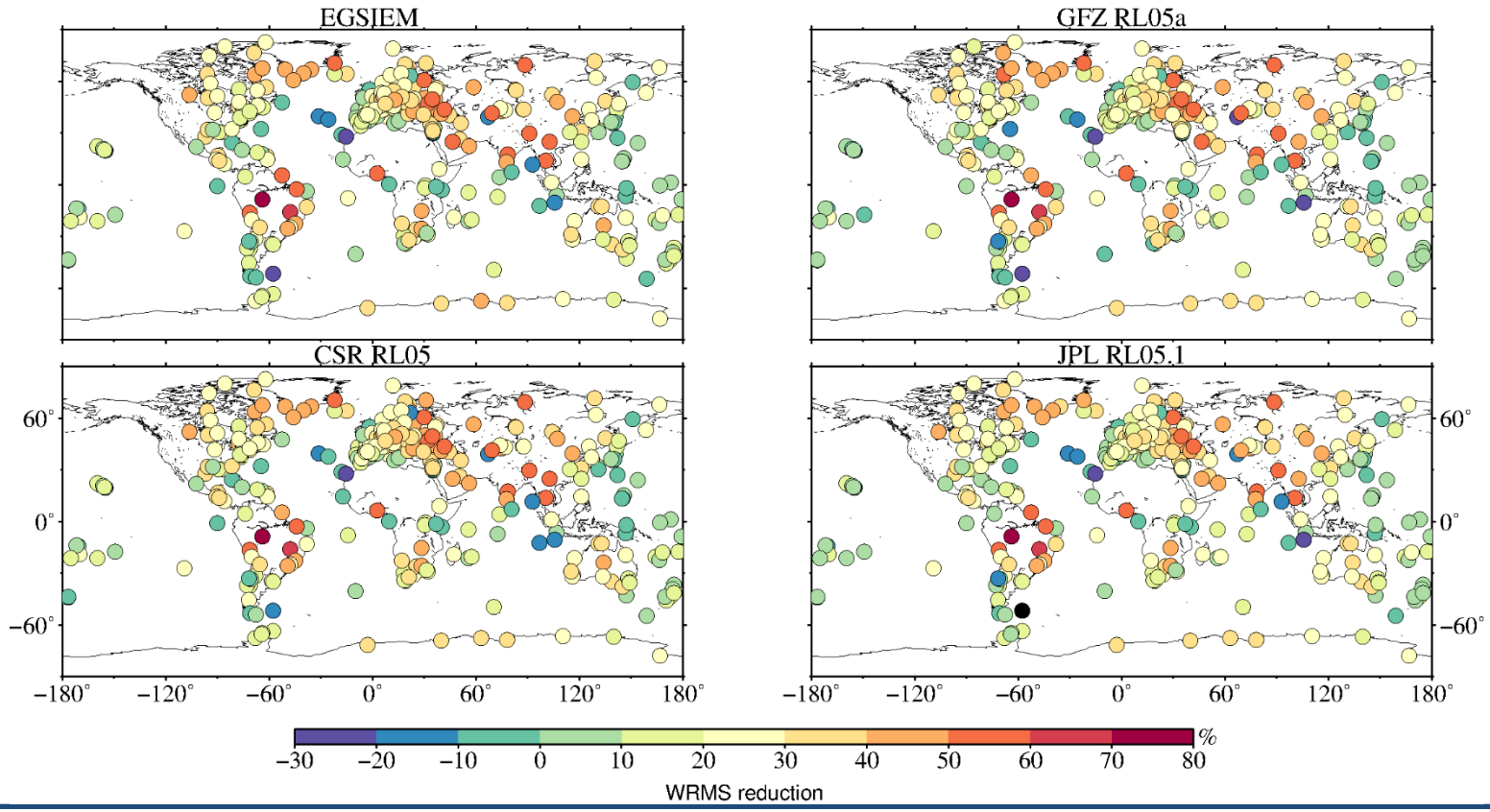
GRACE .VS. GNSS (ITRF2014)

- In comparison to 394 common GNSS stations from JPL, SOPAC and ITRF2014 solutions



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GRACE .VS. GNSS

Table 2: *The metric of WRMS reduction between four GRACE products and three GNSS solutions.*

	JPL		SOPAC		ITRF2014	
	mean WRMS reduction [%]	positive WRMS reduction [%]	mean WRMS reduction [%]	positive WRMS reduction [%]	mean WRMS reduction [%]	positive WRMS reduction [%]
GFZ RL05a	14.97	88.32	13.18	81.98	20.49	87.06
CSR RL05	16.42	91.62	14.38	85.03	22.35	88.58
JPL RL05.1	15.64	89.85	13.12	83.50	20.64	88.83
EGSIEM	16.64	92.13	14.07	84.77	22.14	88.32

- In comparison to 394 common GNSS stations from JPL, SOPAC and ITRF2014 solutions
- ITRF2014 performs better than other two GPS solutions
- EGSIEM and CSR RL05 provide close performance and they beat both GFZ RL05a and JPL RL05.1

Conclusions

- ITRF2014 solutions provide the best agreements with the four considered GRACE products.

- Generally, both four GRACE products are in good agreements with the three GNSS Solutions. More than 80% stations (out of 394 stations) have positive WRMS reduction.

- Comparing to the three GNSS solutions, close performances are observed between EGSIEM and CSR RL05. They show slightly better statistics than GFZ RL05a and JPL RL05.1.

Future work

- Adding other GRACE products into validation against the latest GNSS products
  - ITSG-GRACE 2016
  - AIUB Release 02
  - GRGS Release 03
- Validation on daily data level
  - Daily hydrological model data
  - Daily GNSS time series
- Near real time (NRT) validation
  - CWS: NCEP-R1, WGHM
  - GNSS: SOPAC, JPL
  - Gravity: waiting …

Thanks for your attention!