Evaluation of GNSS reprocessing tropospheric products using GOP-TropDB

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Abstract

The IGS Troposphere Working Group (TWG) aims at improving the accuracy and usability of GNSS-derived troposphere estimates. For this reason, an evaluation database and web-based exploring system is under development for performing continuous monitoring and automated comparisons of troposphere estimates obtained from independent observation techniques such as GNSS, VLBI, DORIS, radiosondes, WVR and products such as Numerical Weather Models (NWM) or other specific tropospheric models, e.g. blind or augmentation.

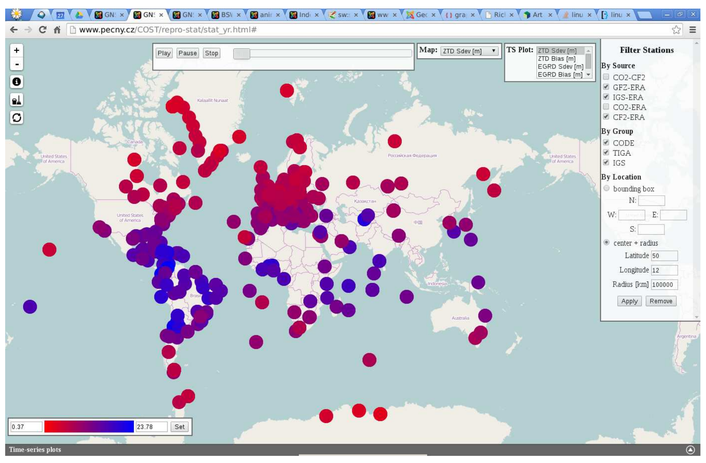
Recently, the second reprocessing of observations from space geodetic techniques were completed mainly in order to improve global terrestrial reference frame, but the solutions also provided homogeneous time-series of coordinates and tropospheric parameters. Although they are suitable for various scientific applications, they serve primarily as a feedback for assessing models and strategies applied in the reprocessing.

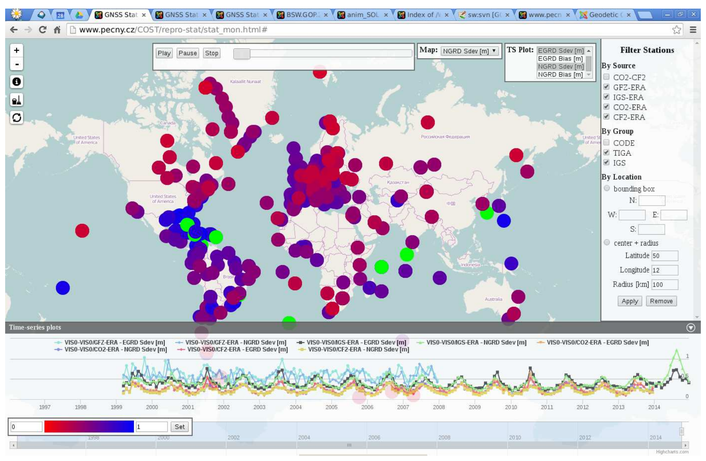
The poster shows recent developments of the TWG service foreground - the web-based monitoring and exploring system and it demonstrates the background of the TWG service - the GOP-TropDB database system - by evaluating several global GNSS reprocessing tropospheric products, namely estimated zenith total delays and linear horizontal gradients, with respect to a global NWM reanalysis products serving as a good reference in this case.

The Table summarizes solution strategies of three IGS Repro2 tropospheric solutions - CO2 and CF2 (CODE), GFZ and IGS Repro1 final tropospheric product. ZTDs and horizontal gradients for all IGS stations and period of 1996–2013 (2014) were compared to results obtained from ERA-Interim ray-tracing (Zus et al, 2014).

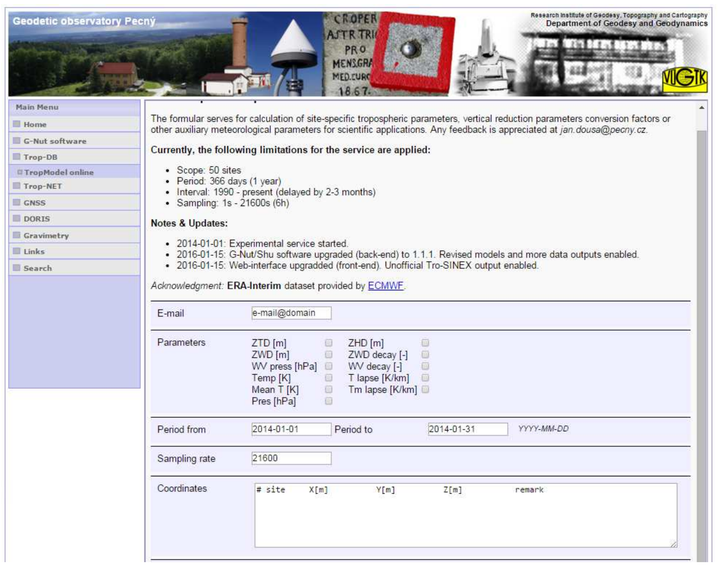
AC	Solution strategy	ZTD			N-GRD			E-GRD			mean
		bias [mm]	sdev [mm]	rms [mm]	bias [mm]	sdev [mm]	rms [mm]	bias [mm]	sdev [mm]	rms [mm]	pair count
CO2	3-day, DD, 3 deg, VMF, ZTD(2h), GRD(24h) pw-linear	-2.01	8.37	9.16	-0.03	0.31	0.32	0.00	0.32	0.34	17447
CF2	1-day, DD, 3 deg, VMF, ZTD(2h), GRD(24h) pw-linear	-2.04	8.37	9.23	-0.03	0.32	0.33	0.00	0.35	0.37	17450
GFZ	1-day, ZD, 7 deg, GMF, ZTD(1h), GRD(24h)	-1.44	10.17	10.73	0.06	0.58	0.61	0.35	0.64	0.78	9364
IGS	1-day, ZD, 7 deg, GMF, ZTD(5min), GRD (5min)	-2.28	9.19	9.94	-0.01	0.44	0.44	0.00	0.51	0.52	13238

Preliminary URL: **http://www.pecny.cz/COST/TROPO-STAT/IGS-Repro.html**. The Figures show the interactive web GUI developed for browsing results of evaluation troposphere parameters in GOP-TropDB. User may 1) select sources and stations by various filters, 2) select parameters of interests for visualization, 3) display statistics summary results in geographical maps, 4) animate temporal evolution in geographical maps, 5) display temporal evolution in interactive time-series.

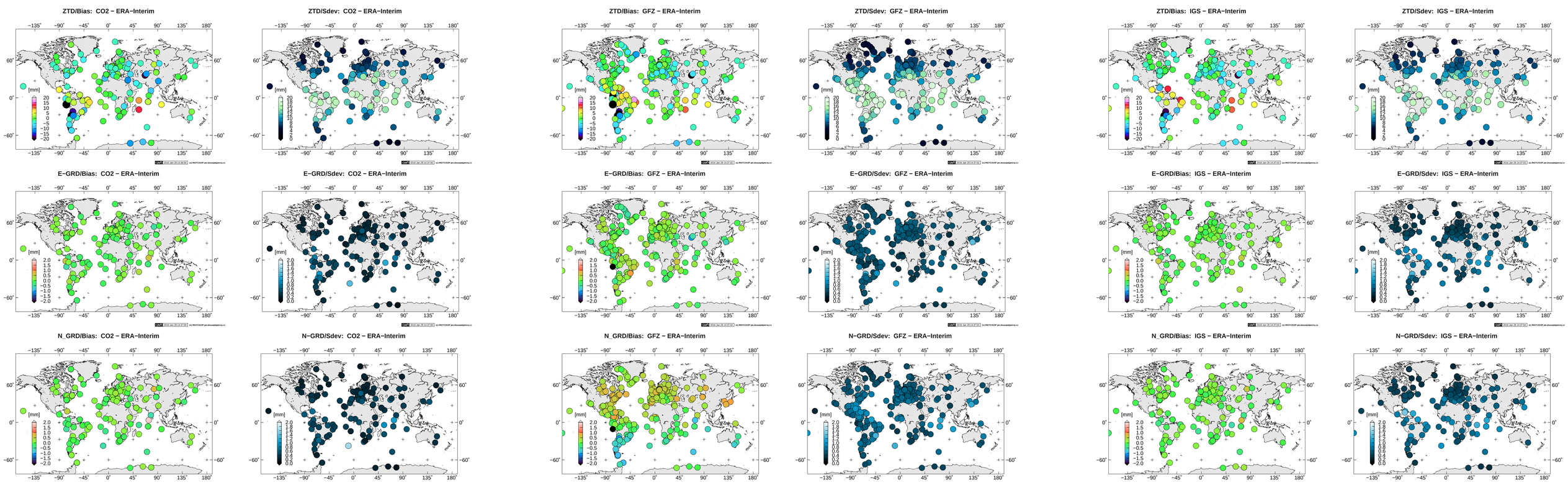


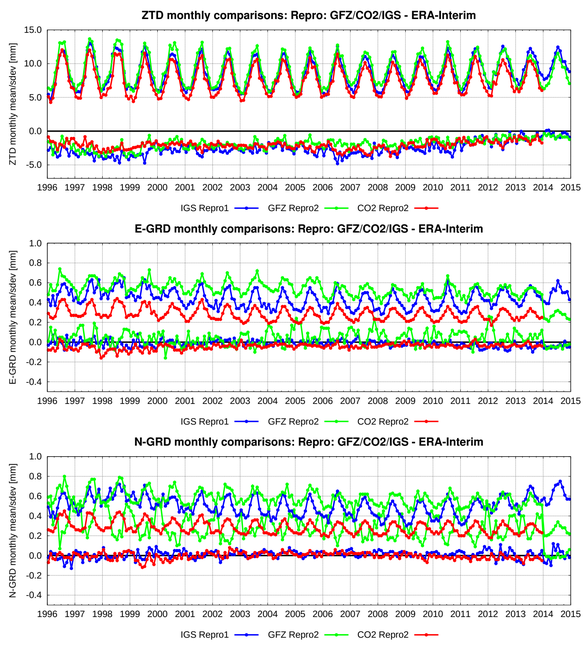


An example of other GOP's TropDB functionality is a new online Web service which enables on request extraction of selected meteorological or tropospheric parameters from the ERA-Interim data fields (1990-today, Dee et al, 2007).



The Figures below show a summary geographical maps for all solutions. From left to right: CO2, GFZ, IGS w.r.t ERA-Interim. From top to bottom: ZTD, E-/N-gradients.





IGS repro troposphere products were compared to ERA-Interim in GOP-TropDB. Results were initially studied and interactive web GUI was developed for a detailed study of individual results from all sources and sites.

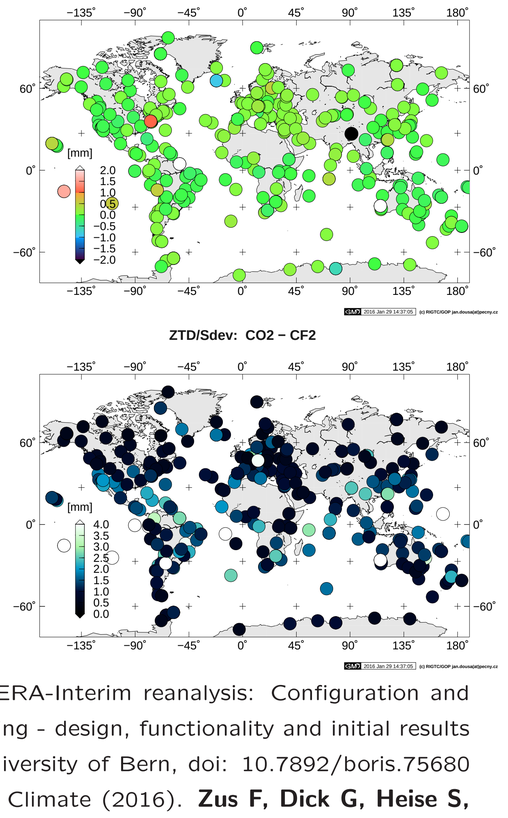
Statistical differences between CODE's 3-day and 1-day solutions showed a significant impact on tropospheric parameters at some global stations (right plots).

Particular check of midnight parameters as well as summary statistics (table), showed that the 3-day solution is in better agreement with ERA-Interim than the 1-day solution.

Gradient comparison revealed an opposed sign in GFZ's TroSINEX (later confirmed). Results for 2014 with reversed values showed good agreement with other solutions (left plots).

Higher values (and higher variability) for tropospheric gradients were observed (not shown) in IGS 5-min high-resolution product. CODE's solutions suggests a reasonable compromise for gradient modelling with a 24h piece-wise linear parameterization, while GFZ's gradients seems to be signigicantly smoothed when using 24h piece-wise constant model.

IGS final product shows a slow degradation for all parameters during the last years (left plots).



Byram S, Hackman C, Tracey J, Computation of a high-precision GPS-based troposphere product by the USNO, In: Proceedings of ION GNSS (2011). **Dee DP et al**, The ERA-Interim reanalysis: Configuration and performance of the data assimilation system, Q J R Meteorol Soc, Vol 137 (2011). **Gyori G, Dousa J** GOP-TropDB developments for tropospheric product evaluation and monitoring - design, functionality and initial results In: IAG Symposia Series, Vol 143 (2016). **Steigenberger P, Lutz S, Dach R, Schaer S, Jäggi A**, CODE repro2 product series for the IGS. Bern CHE: Astronomical Institute, University of Bern, doi: 10.7892/boris.75680 **Ning T, Wickert J, Deng Z, Heise S, Dick G, Vey S, Schone T,** Homogenized time series of the atmospheric water vapor content obtained from the GNSS reprocessed data, J Climate (2016). **Zus F, Dick G, Heise S, Dousa J, Wickert J**, The rapid and precise computation of GPS slant total delays and mapping factors utilizing a numerical weather model, Radio Science, Vol 49 (2014).

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