Accuracy of GNSS campaign site velocities with respect to ITRF14 solution

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Introduction

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In this study, we assess the accuracy of deformation rates produced from GNSS campaign measurements sampled in different frequencies. The ideal frequency of the sampling seems to be 1 measurement per month however it is usually found to be cumbersome. Alternatively the sampling was performed 3 measurements per year and time series analyses were carried out. We used the continuous GPS time series of JPL, NASA from a global network of the IGS to decimate the data down to 4 monthly synthetic GNSS campaign time series. Minimum data period was taken to be 4 years following the suggestions from the literature. Furthermore, the effect of antenna set-up errors in campaign measurements on the estimated trend was taken into account. The accuracy of deformation rates were then determined taking the site velocities from ITRF14 solution as the truth. The RMS of monthly velocities agreed pretty well with the white noise error from global studies given previously in the literature. The RMS of four monthly deformation rates for horizontal positioning were obtained to be 0.45 and 0.50 mm/yr for north and east components respectively whereas the accuracy of vertical deformation rates was found to be 1.73 mm/yr. This is slightly greater than the average level of the white noise error from a global solution previously produced, in which antenna set up errors were out of consideration. Antenna set up errors in campaign measurements modified the above error level to 0.75 and 0.70 mm/yr for the horizontal components north and east respectively whereas the accuracy of the vertical component was slightly shifted to 1.79 mm/yr.

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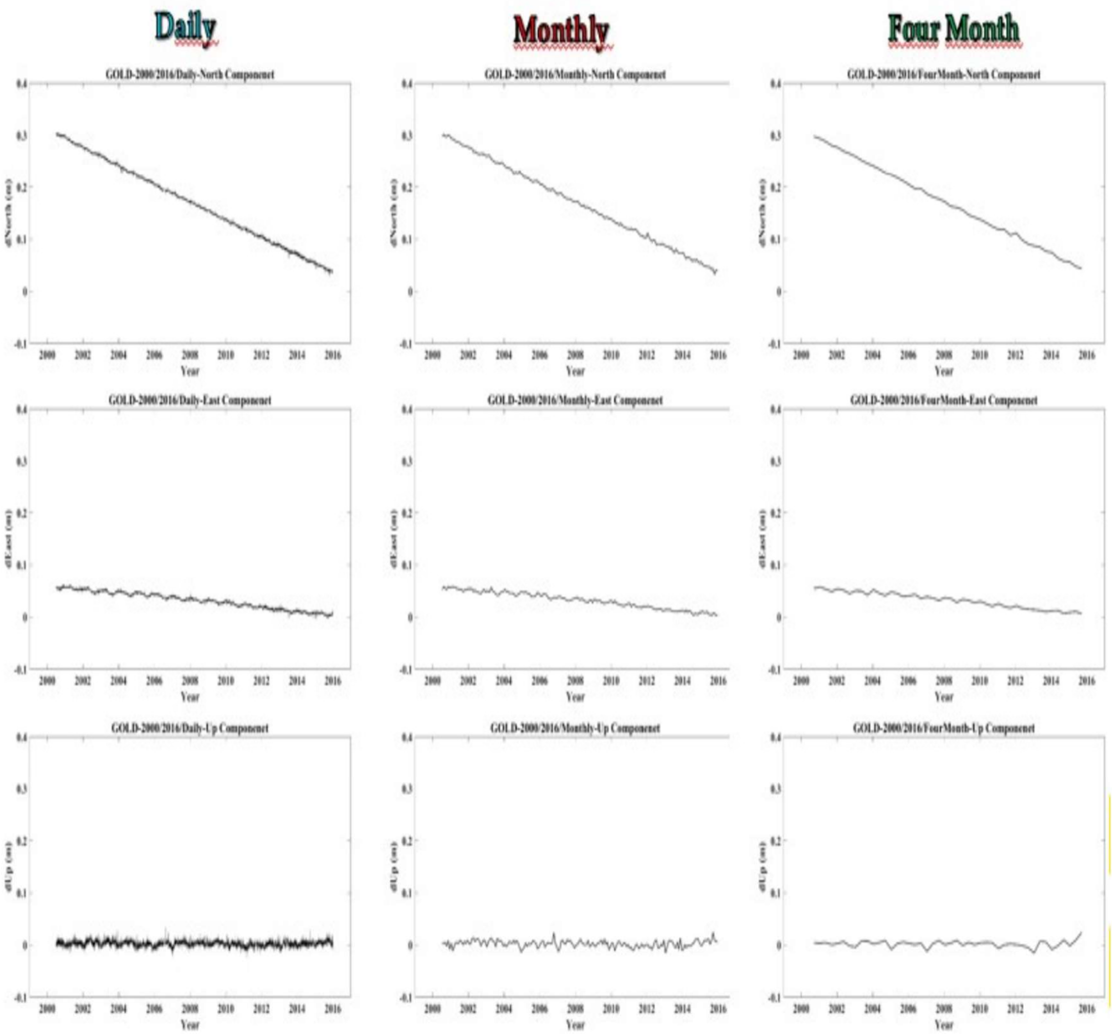
Time Series



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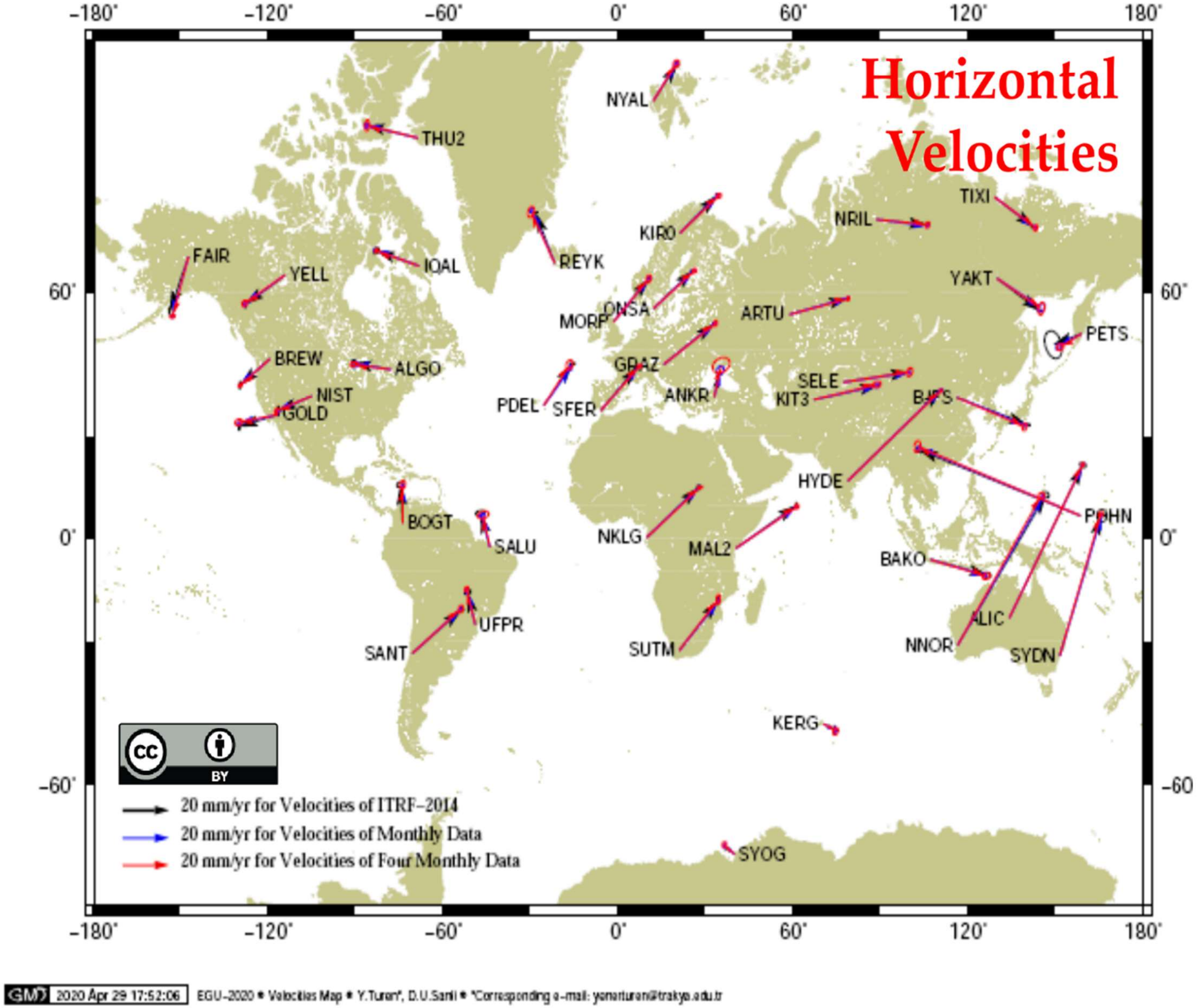

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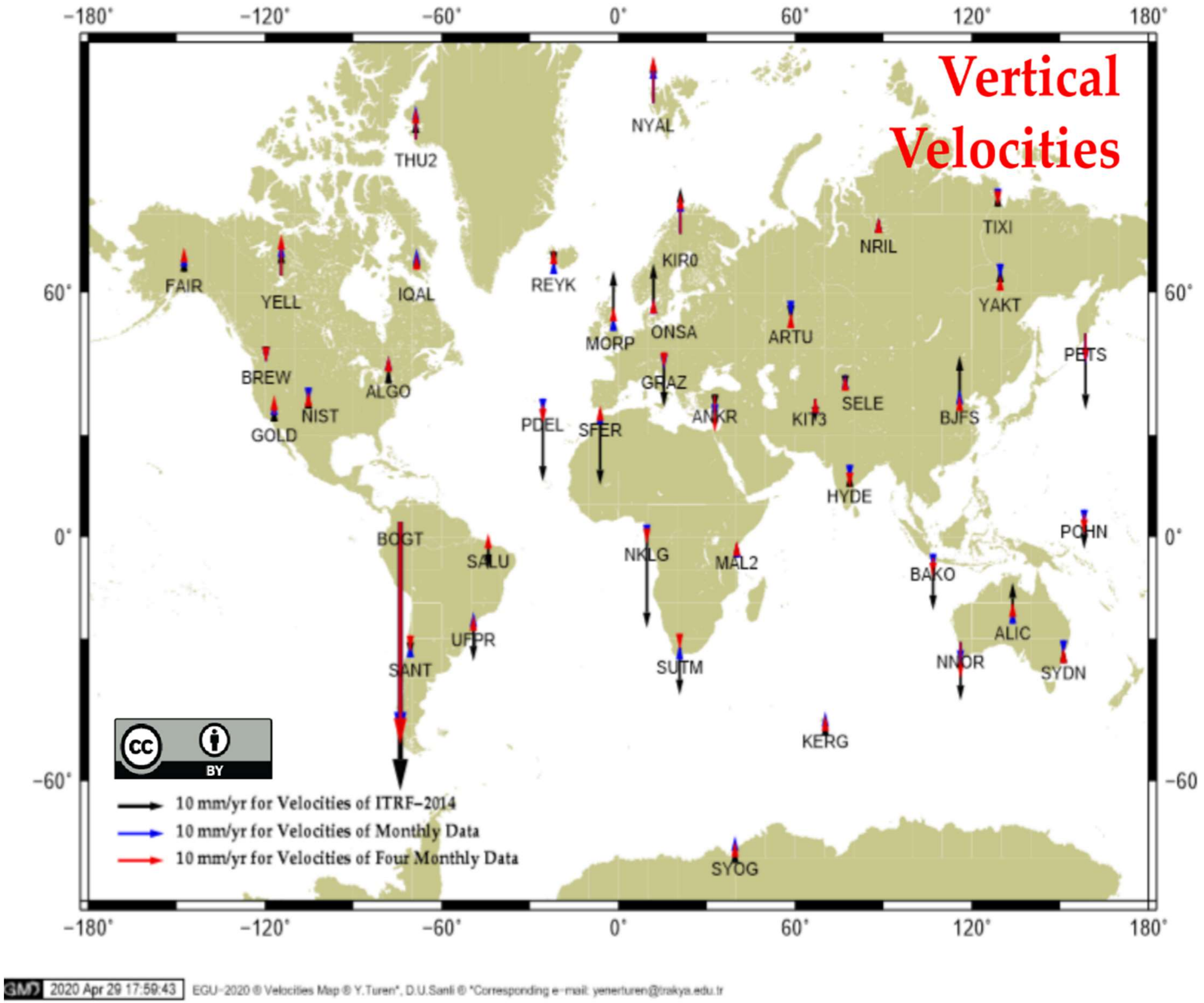

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Test Statistical

Namely we tested whether the velocities obtained from monthly and four monthly solutions differ significantly from the velocities derived from daily solutions.

$$y(t) = a + bt + c_1 \sin\left(\frac{2\pi t}{T_1}\right) + d_1 \cos\left(\frac{2\pi t}{T_1}\right) + c_2 \sin\left(\frac{2\pi t}{T_2}\right) + d_2 \cos\left(\frac{2\pi t}{T_2}\right) + v(t)$$

	Value of Test Statistic	Critical Region
b_d = *Daily velocity.* b_m = *Monthly (or Four-Monthly) velocity.* s = *Unit variance from LSE.* q_i = *Element of the cofactor matrix.*	$t = \frac{b_m - b_d}{s\sqrt{q_i q_i}}$	$t > 1.96$ *or* $t < -1.96$

Conclusions

	Velocities (mm/yr)								
	Continuous			Monthly			Four Monthly		
	North	East	Up	North	East	Up	North	East	Up
Averages	0.000049	0.000049	0.000158	0.000270	0.000271	0.000875	0.000502	0.000483	0.001719
	North			*East*			*Up*		
Differences	$N_C - N_M$ =	0.000220	mm/yr	$E_C - E_M$ =	-0.000222	mm/yr	$U_C - U_M$ =	-0.000717	mm/yr
	$N_C - N_{FM}$ =	0.000452	mm/yr	$E_C - E_{FM}$ =	-0.000434	mm/yr	$U_C - U_{FM}$ =	-0.001561	mm/yr
	$N_M - N_{FM}$ =	0.000232	mm/yr	$E_M - E_{FM}$ =	-0.000212	mm/yr	$U_M - U_{FM}$ =	-0.000844	mm/yr
Ratios	$N_C : N_M$ =	5.469574		$E_C : E_M$ =	5.523155		$U_C : U_M$ =	5.532258	
	$N_C : N_{FM}$ =	10.176471		$E_C : E_{FM}$ =	9.836132		$U_C : U_{FM}$ =	10.871758	
	$N_M : N_{FM}$ =	1.860560		$E_M : E_{FM}$ =	1.780890		$U_M : U_{FM}$ =	1.965157	

Root Mean Square (RMS) for 4-years data from 40 stations

	Annual		Annual (With user antenna error)		Mao et al. Results	
	Monthly Campaign mm/year	Four Monthly Campaign mm/year	Monthly Campaign mm/year	Four Monthly Campaign mm/year	Our same stations mm/year	All their stations mm/year
North	0.241	0.449	0.332	0.746	0.271	0.248
East	0.209	0.506	0.341	0.698	0.371	0.387
Up	0.885	1.727	0.863	1.788	0.686	0.700

Discussions

The accuracy of deformation rates has been determined taking the site velocities from ITRF14 solution as the truth. The RMS of monthly velocities agreed pretty well with the white noise error from global studies given previously in the literature. This is slightly greater than the average level of the white noise error from a global solution previously produced, in which antenna set up errors were out of consideration.

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