IVS Memorandum 2008-004v01

19 June 2008

“Evaluation of the new Cn values for the turbulence model with CONT05 real data”

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The most realistic description of stochastic fluctuations of wet refractive index up to date is provided by turbulence theory (Treuhaft and Lanyi 1987, Wheelon 2001). The parameters driving the turbulence are refractive index structure constant *(Cn)*, effective height of wet troposphere *(H)*, and wind velocity *(v)*. These parameters can be derived from high resolution radio sonde data and numerical weather models, respectively, and are provided for the VLBI2010 Monte Carlo simulations by T. Nilsson from Onsala Space Observatory, Sweden. Before using the parameters for V2C simulations, a comparison with the Cont05 real data is performed. This investigation compares different values for the refractive index structure constant Cn and for the tropospheric height H, given in Table 1. The simulation of the turbulence for the "old" Cn and H values is done with the Onsala approach by T. Nilsson (Nilsson et al., 2007) and the Vienna approach, which is based on the Onsala approach but uses constant wind speed and wind direction for all numbers of Monte Carlo Simulations. Also the tropospheric height is slightly different for the Vienna and the Onsala turbulence model. For the new Cn and H values which T. Nilsson presented at the IVS-GM in St. Petersburg 2008 there are no simulated turbulences with the Onsala approach available.

Table 1: Old and new Cn values [10^{-7} $m^{(-1/3)}$], H [m] and the wind speed [m/s] in North and East direction.

Station	Cn old	H Onsala	H Vienna	Cn new	H new	Wind North	Wind East
AP	1.04	2000	2000	2.0573	2573.8	-2.32	9.91
GC	0.55	2079	1963	0.8323	3841.4	-2.72	-12.24
HA	2.03	2450	1851	1.8897	3053.7	7.6	-5.56
KK	2.30	1477	1779	4.0287	2104.7	7.95	8.71
NY	0.35	2173	1845	0.0596	4363.8	3.02	1.97
ON	0.72	2100	2100	1.5438	2929.5	2.57	12.49
SV	0.64	2000	1705	1.384	2631.5	11.12	-1.3
TC	1.41	1869	2176	0.9198	3540.9	8.93	-2.94
TS	1.45	1767	1912	3.7136	2054.9	10.6	-0.3
WS	1.17	2887	2269	3.4378	2288.8	6.01	-10.45
WZ	0.94	2040	1856	4.4662	2238.9	7.25	-7.47

The new parameters for Cn and H are derived from high resolution radio sonde data near the VLBI stations. The VLBI station locations and the locations of the corresponding radio sonde starts are given in Table 2.

Table 2: Location of the VLBI stations contributing to Cont05 and the location of the radio sonde starts (RS) with the radio sonde data.

VLBI Station		lat	lon	RS Station	lat	lon	Cn	H
Algopark	AP	45.96	-78.07	Buffalo	42.9	-78.7	2.0573	2573.8
Gilcreek	GC	64.98	-147.50	Fairbanks	64.8	-147.9	0.8323	3841.4
HartRAO	HH	-25.89	27.69	Miami (March 2005)	25.8	-80.4	1.8897	3053.7
Kokee	KK	22.13	-159.67	Lihue	22.0	-159.4	4.0287	2104.7

NyAlesund	NY	78.93	11.87	Point Barrow	71.3	-156.8	0.0596	4363.8
Onsala	ON	57.39	11.93	Lerwick	60.1	-1.2	1.5438	2929.5
Svetloe	SV	60.53	28.78	Anchorage	61.2	-150.0	1.384	2631.5
TigoConc	TC	-36.84	-73.02	Greensboro (March 2005)	36.1	-79.9	0.9198	3540.9
Tsukuba	TS	36.11	140.09	Nashville	36.2	-86.6	3.7136	2054.9
Westford	WF	42.62	-71.49	Chatham	41.7	-70.0	3.4378	2288.8
Wettzell	WZ	49.14	12.88	Herstmonceux	50.9	0.3	4.4662	2238.9

The Monte Carlo simulation is based on the equation which is explained in detail in Wresnik et al., 2007.

$$o - c = (zwd_2 \cdot mfw_2(e_2) + cl_2) - (zwd_1 \cdot mfw_1(e_1) + cl_1) + wn_{Bsl}$$

The simulations of zenith wet delays *(zwd)* and clocks *(cl)* are explained in Böhm et al., 2007.

The specifications for the simulation are as follows

schedules:	c0501.skd modified from NGS card 050912XA.NGS
software:	OCCAM Kalman (standard solution, no gradients)
cl:	ASD 1e-14 @ 50 min, random walk + integrated random walk
zwd:	Onsala turbulence (old Cn values)
	Vienna turbulence (old and new Cn values)
wn:	observation error of real CONT05 data

The observation errors of the Cont05 real data had to be included in the white noise part of the simulation to see the influence of the simulated *zwd's* without any bias from the very small predicted *wn* corresponding to the VLBI2010 antenna system. To get the observation error of the real Cont05 observations into the simulation, the theoretically scheduled sessions of the sked file had to be reordered corresponding to the really observed sessions. There are discrepancies of the starting time as well as of the observation order and some sources couldn't be observed as they were scheduled.

Figure 1 shows the comparison between the different turbulence models, and between the different Cn and H values for the simulation with respect to baseline length repeatability. The agreement between the Cont05 real data (blue dots) and the simulated data using the old set of parameters and the Onsala (magenta squares) or the Vienna (red triangles) turbulence model is rather good for baselines < 8 000 km. The comparison of Cont05 real data with the new set of parameters (green triangles) shows an overestimating of baseline length repeatabilities with the simulated data for both short and long baselines. The differences between simulations and Cont05 real data for each baseline are plotted in Figure 2. Table 3 shows that the mean difference between Cont05 real data and the simulation with the new Cn and H values is > 5 mm.

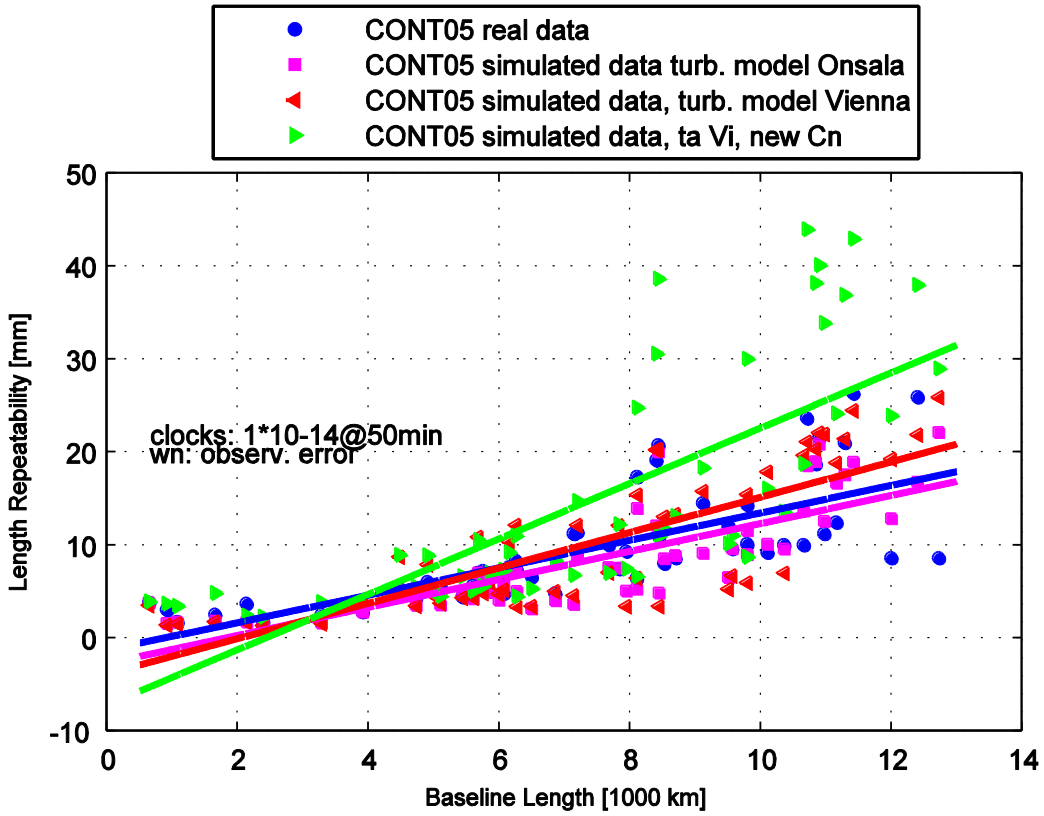

Figure 1: Baseline length repeatabilities for different approaches and different parameters for the simulation of zenith wet delays compared to Cont05 real data. The Cont05 real data is given as blue dots, the simulated data with the use of the Onsala turbulence model and the old Cn and H values is given a squares in magenta. The red triangles are corresponding to the Vienna turbulence model using the old Cn and H values and the green triangles are showing the simulated data modeled with the Vienna turbulence model and the new values for Cn and H.

Table 3: mean difference

turbulence model	mean diff. [mm]
Onsala: old Cn, H	1.2
Vienna: old Cn, H	-0.6
Vienna: new Cn, H	-5.1

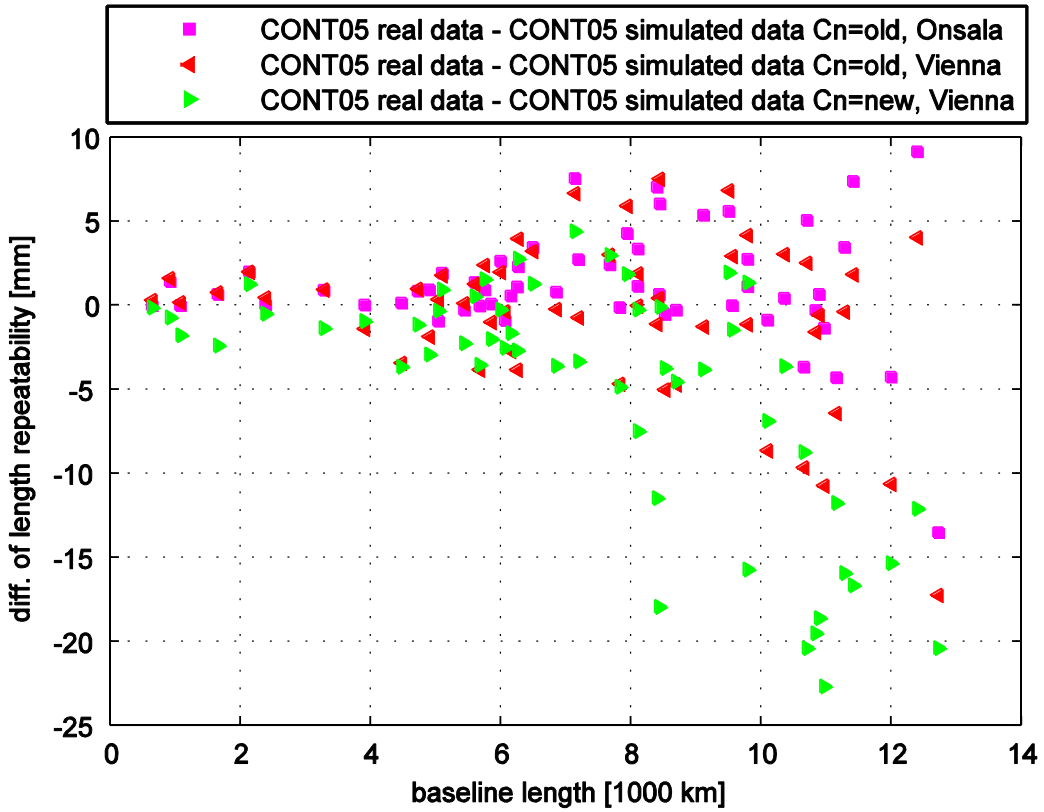

Figure 2: Differences of baseline length repeatabilities.

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