New approach to the problem of tropospheric delay modeling in SLR

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New method of determination of tropospheric refractivity corrections in SLR using ground meteorological data is discussed. This method is based on integral ray optics approximation (IROA) which was intended specially for the determination of integral characteristics of electromagnetic waves propagation in three-dimensional inhomogeneous mediums. Within the framework of IROA the initial integrals for optical group delay and ray path lengthening in Earth's atmosphere are represented as Euler - Maclourins quadrature sums.

The IROA approach has been passed the preliminary testing in solving the problems of determination of both astronomical refraction (Prokopov and Remayev, 1996) and tropospheric correction in SLR (Mironov, Prokopov and Remayev, 1997; Prokopov and Remayev, 2000). The special computer programs for testing were developed (see Fig. 1).

In the case of SLR this testing has been carried out by the ray tracing technique for the annual sets of meteorological profiles in the five points of territory of Ukraine and in the one point of USA. The examples of testing results are presented in Fig. 2 and in the Table. The testing has shown that the accuracy of IROA algorithms of determination of tropospheric corrections can be higher than accuracy of known ones (for example Marini - Murray's one).

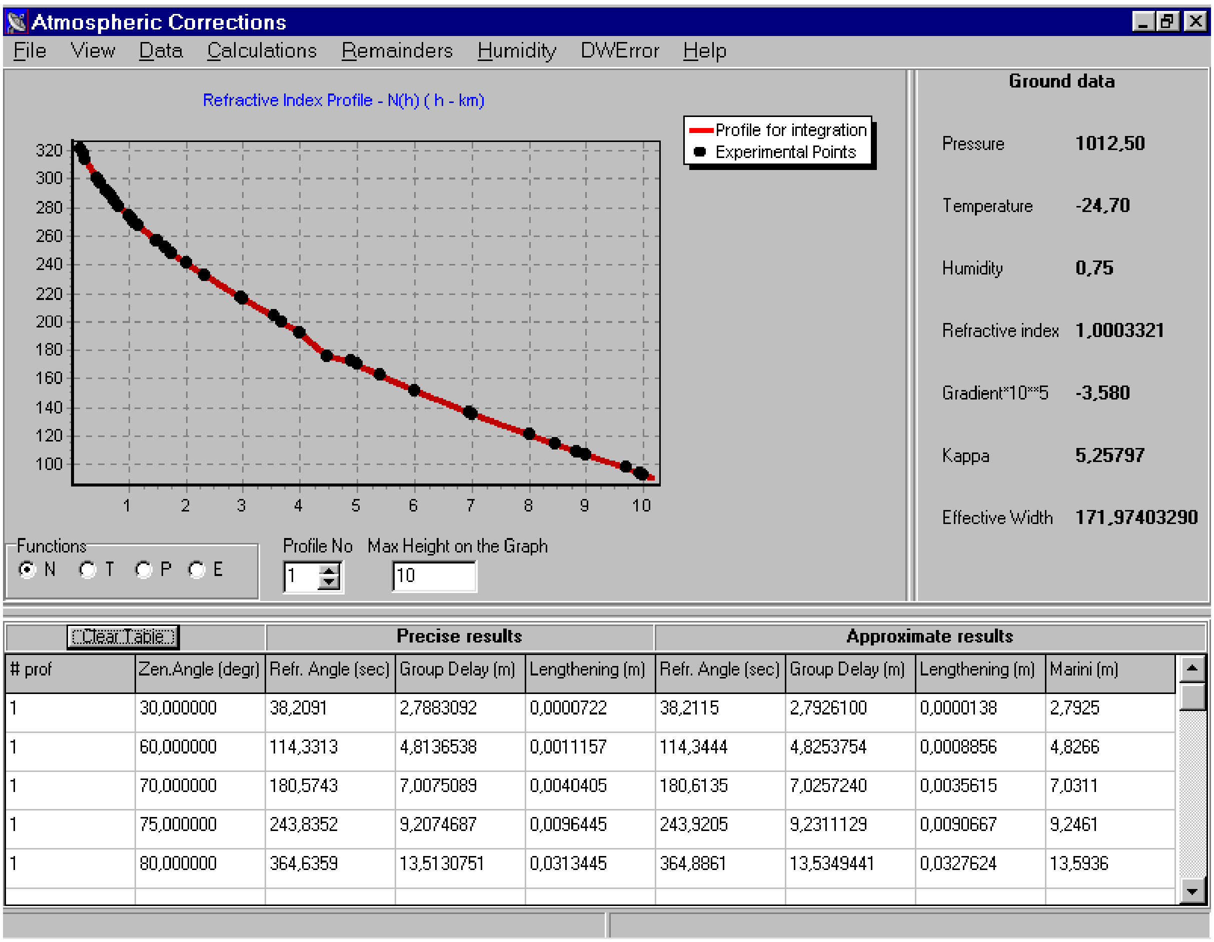

Fig 1. The main window of the program for calculations of atmospheric corrections

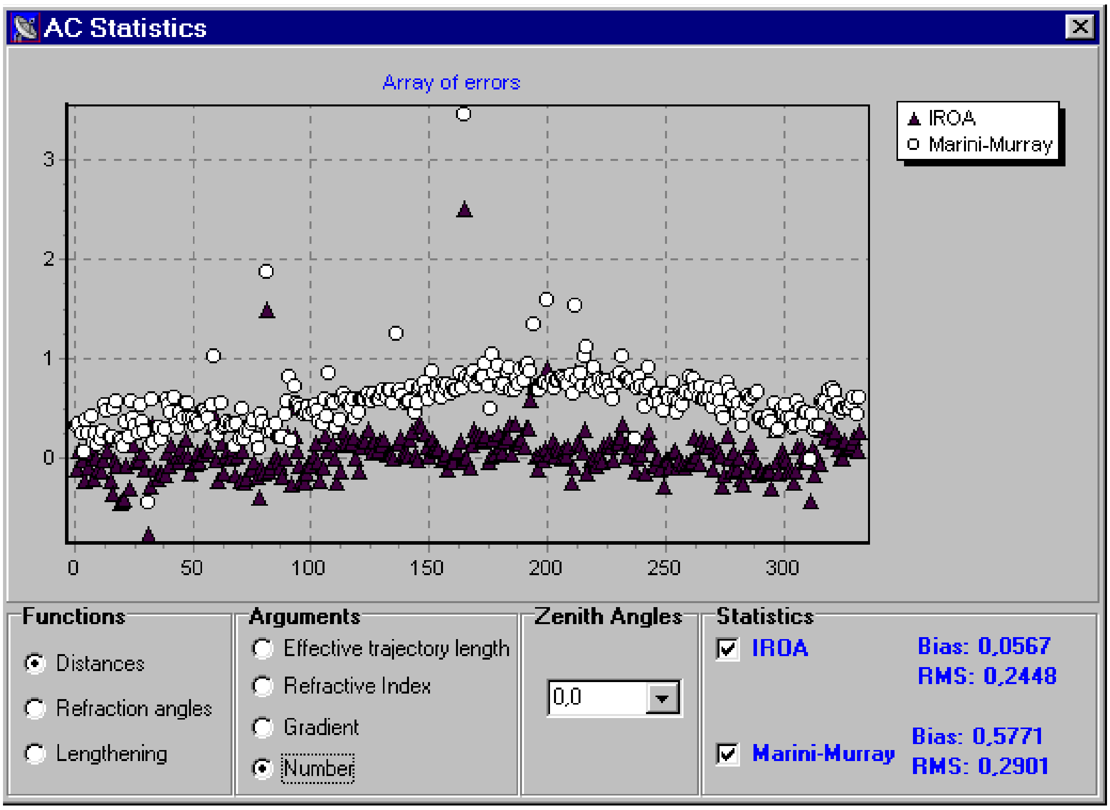

Fig. 2. The example of distribution of errors of group delay determination (in cm) for Oakland's (USA) station (1999 year profiles, optical range, λ=0,59 μ)

Table. The errors of tropospheric delay determinations (in cm) for IROA and Marini-Murray methods in the optical range

Zenit angle				0		30		70		80	
Station, year	Lati-tude, de-gree	Hight on sea level, m	Method	Syste matic error	Ran-dom error	Syste matic error	Ran-dom error	Syste matic error	Ran-dom error	Syste matic error	Ran-dom error
Kharkov, Ukraine, 1979	49,95	160	IROA	0,01	0,23	0,01	0,26	0,15	0,67	0,30	1,62
			Marini-Murray	0,39	0,32	0,46	0,37	1,40	0,92	2,64	1,69
Kyiv Ukraine, 1979	50,45	170	IROA	-0,16	0,24	-0,19	0,27	-0,36	0,68	-0,66	1,38
			Marini-Murray	0,23	0,27	0,27	0,31	0,89	0,77	1,53	1,43
Lvov Ukraine, 1979	49,83	330	IROA	-0,01	0,25	-0,01	0,29	0,15	0,72	0,62	1,45
			Marini-Murray	0,38	0,31	0,44	0,35	1,37	0,88	2,60	1,59
Shepetov-ka Ukraine, 1979	50,20	280	IROA	-0,18	0,17	-0,20	0,19	-0,33	0,47	-0,34	0,93
			Marini-Murray	0,25	0,19	0,30	0,22	0,99	0,54	1,87	0,98
Uzhgo-rod Ukraine, 1979	48,60	120	IROA	-0,18	0,26	-0,21	0,30	-0,40	0,73	-0,78	1,33
			Marini-Murray	0,24	0,26	0,28	0,30	0,94	0,76	1,66	1,48
USA, 1999, Oakland	37,73	6	IROA	0,06	0,25	0,07	0,28	0,49	0,72	2,07	1,48
			Marini-Murray	0,58	0,29	0,68	0,34	2,03	0,86	3,90	1,75

The high accuracy of algorithms developed is explained by absence of several error sources inherent in known methods. In particular, these algorithms do not use the theorem of static of atmosphere, do not contain empirical factors (determined by ray tracing) in principal terms of expansions using as the mathematical formulae for corrections. Such factors remain only in small residual terms of expansions used. For this reasons the IROA method is characterized by more high accuracy in comparison with Marini - Murray's one, which requires ray tracing to get the full formula for determination of the correction.

References

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