НЦКИТ

The Abdus Salam International Centre for Theoretical Physics
50th Anniversary 1964-2014

United Nations/ICTP Workshop on the

Use of Global Navigation Satellite Systems (GNSS) for Scientific Applications

ICTP, 1 - 5 December 2014

GNSS applications in monitoring the movements of the Earth's crust to assess the seismicity of south-eastern Kazakhstan

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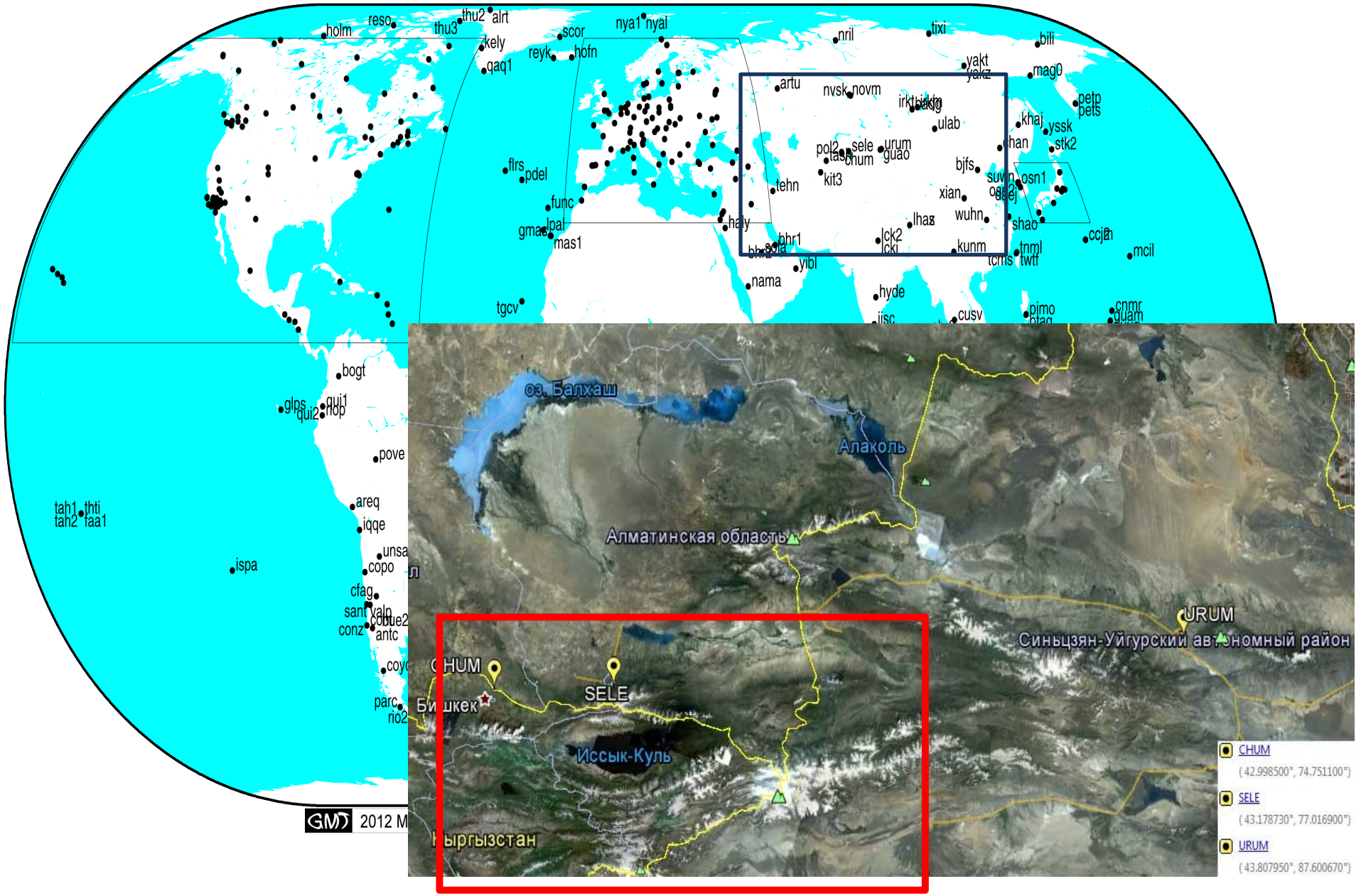
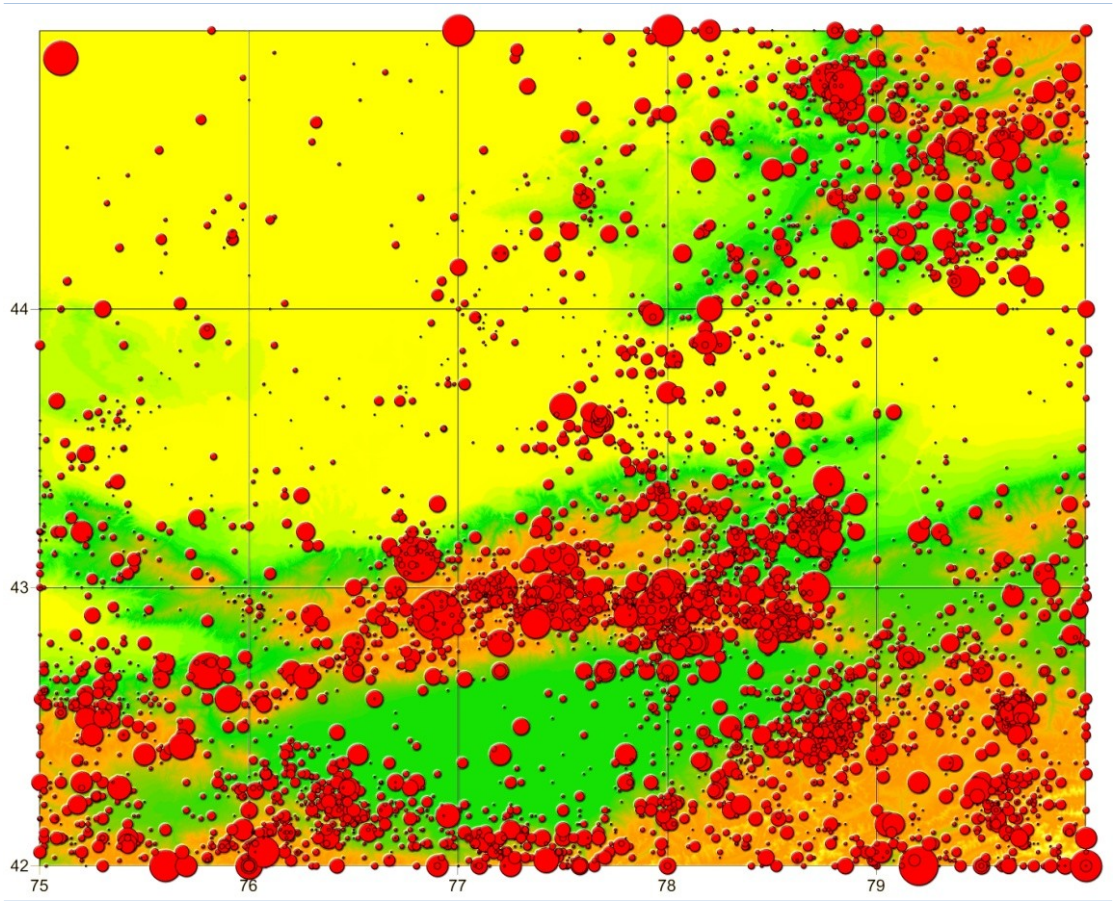
International GNSS Service
Tracking Network



An overview map of the location of stationary GPS monitoring points

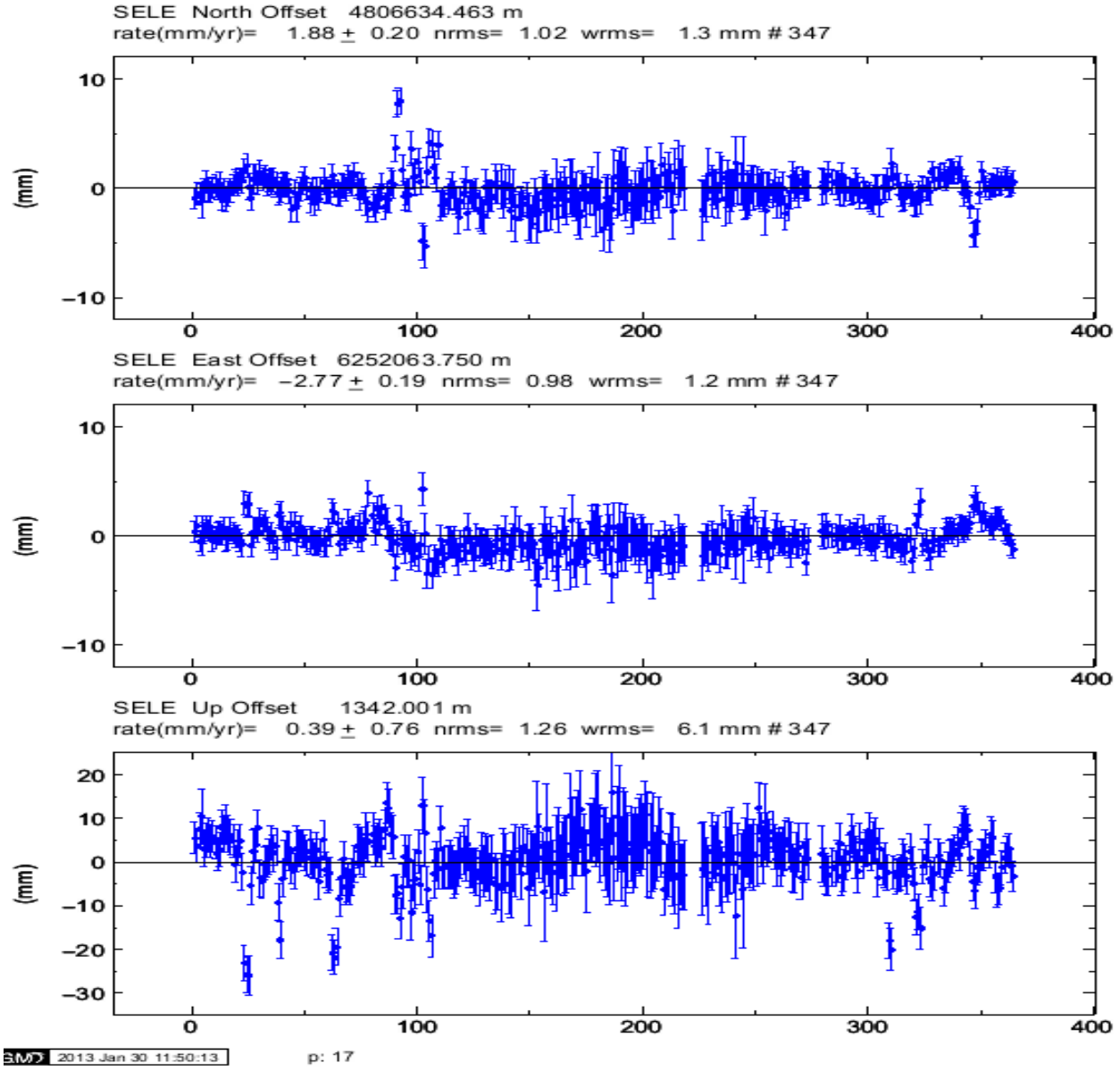
Map of the distribution of earthquake epicenters over energy class 8.0 for the period 1885 -2013 years. within the coordinates 42 ° N - 45 ° N and 75 ° E - 80 ° E

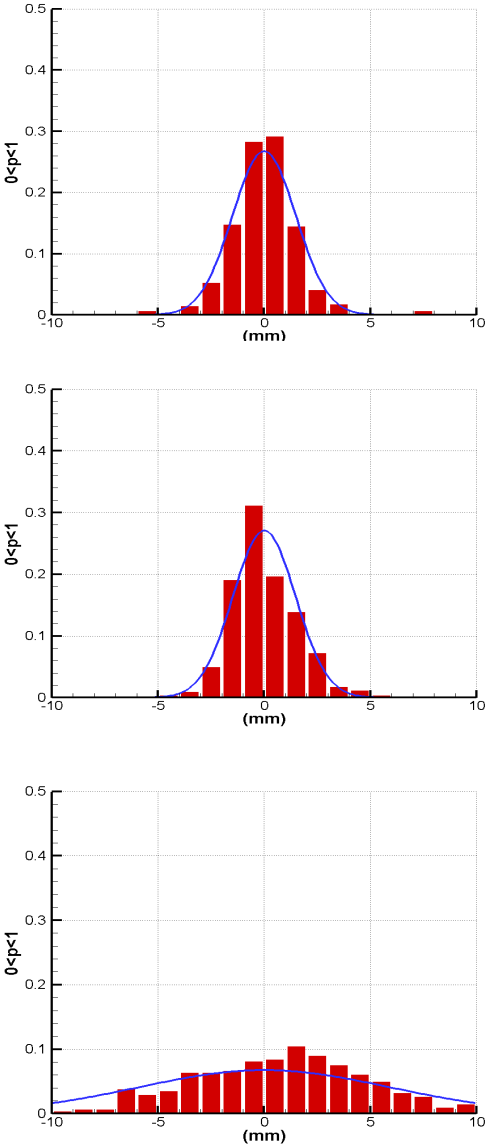


Level time-series changes in positions of points with daily increments, analysis of variance

Time series points Sele

Density function





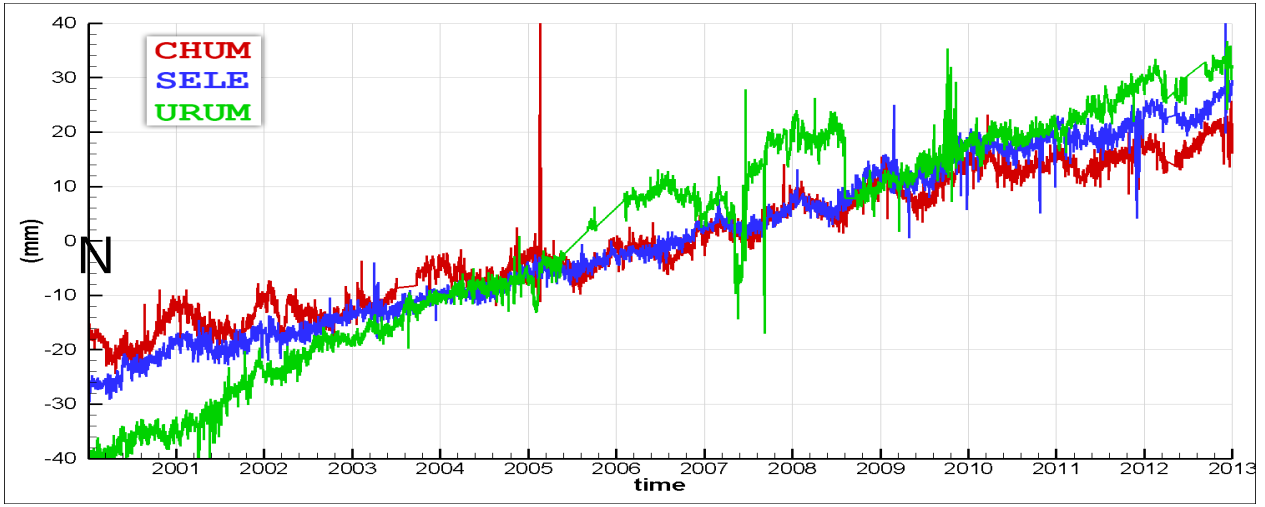
Error estimation

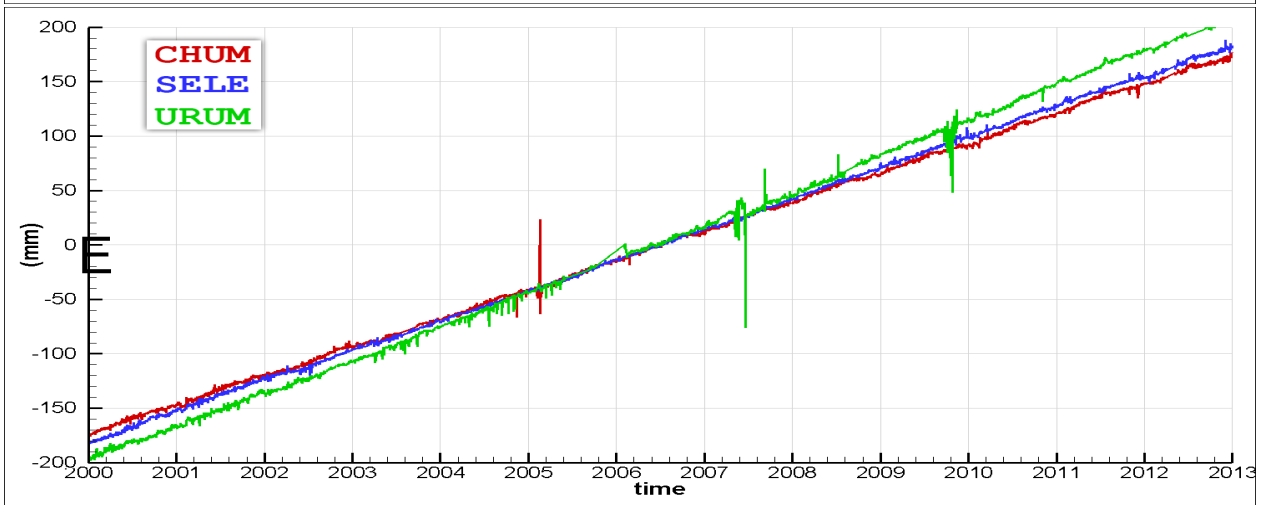
point	precision	classification
SELE_IGS	**0.80** mm/year	Best sites
ASTA	9.61 mm/year	Worst
ACT1_Local	13.5 mm/year	Noisy sites

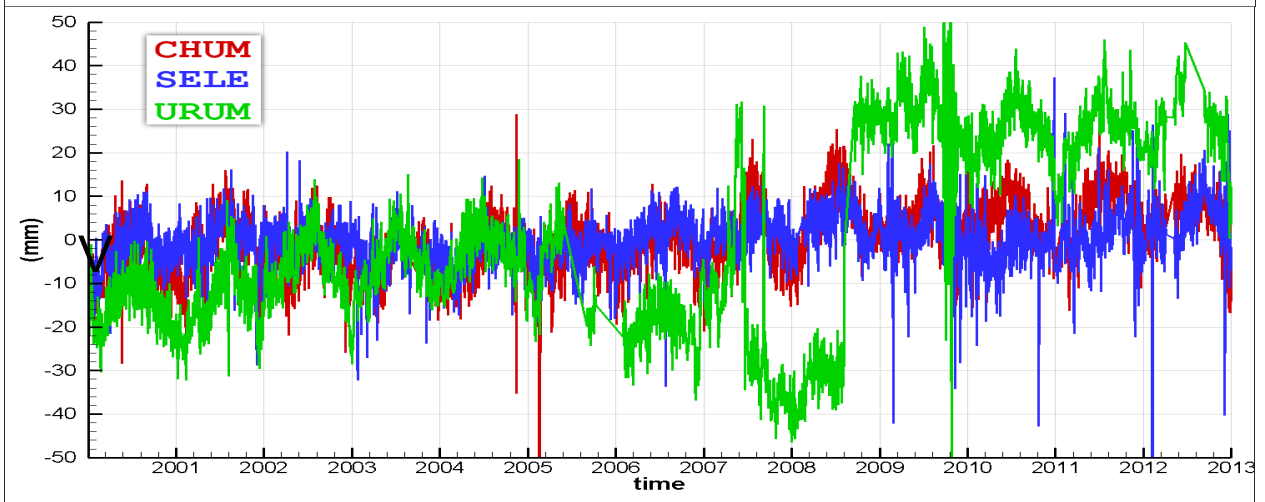
The best sites will have values of 3-5 mm, and the worst 7-9 mm.
Values between 10 and 15 mm indicate high but acceptable levels of noise.

*Introduction to GAMIT/GLOBK Release 10.4, 26 October 2010.
T. A. Herring, R. W. King, S. C. McClusky, Department of Earth, Atmospheric, and Planetary Sciences Massachusetts Institute of Technology.

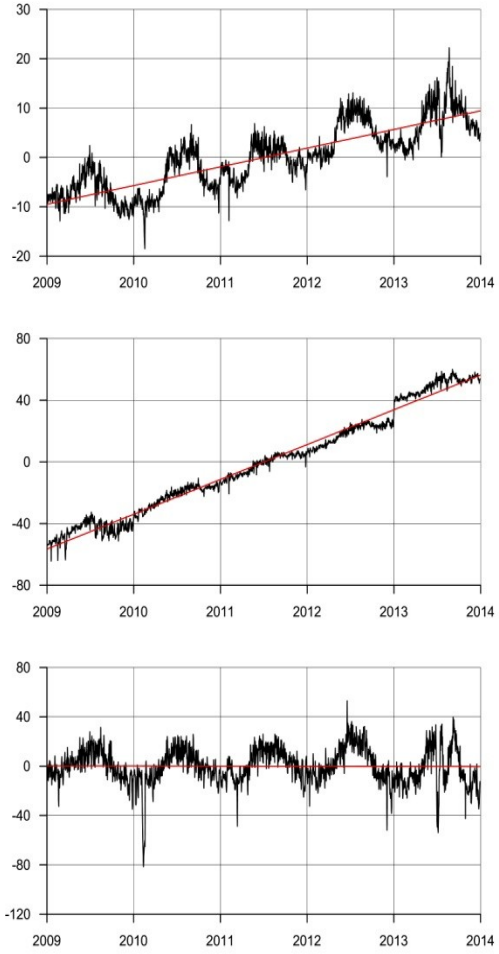
Time series analysis of displacement (mm) of points CHUM, SELE, URUM

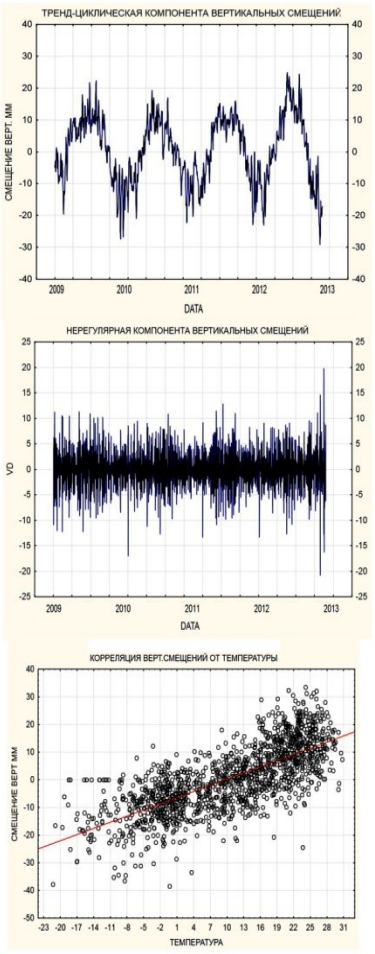


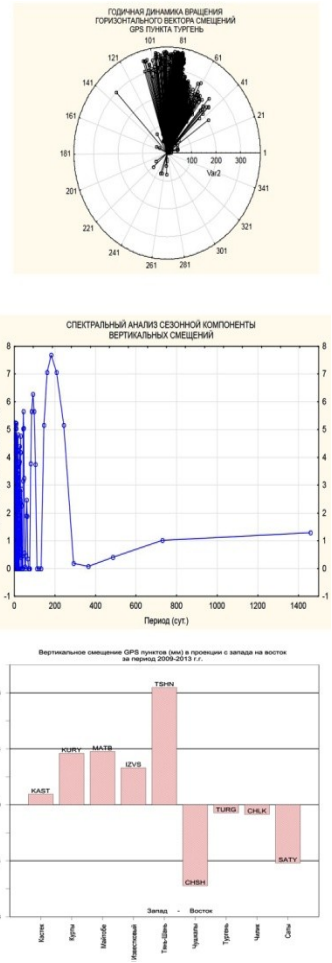




GPS Point - Turgen 2009-2013







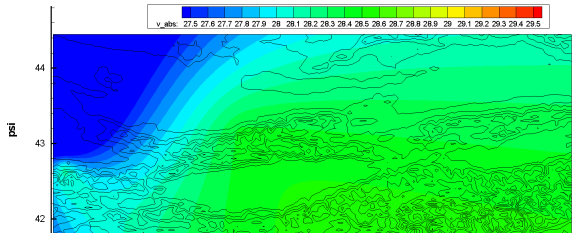
Catalogue of velocities and the displacement components

Таблица характеристик миграции глобальных пунктов GPS за период 2009-20013 относительно Евразии

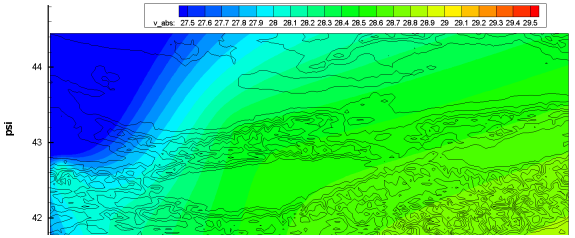
ID	ϕ	ψ	V1	V2	V3	Vгор	Азимут	DL гор (мм)	DL верт (мм)	Примечание
			2000-2013 (мм/год)			(мм/год)	(град)	2000-2013 (мм)	2000-2013 (мм)	
ID	PHI	PSI	V1	V2	V3	VG	AZ	DG	DV	
ARTU	58.56046	56.42982	-3.01336	-0.94819	5.03728	3.15902	197.46671	15.79510	25.18642	
CHLK	78.37319	43.52911	2.82784	1.21709	-0.23229	3.07863	23.28679	15.39315	-1.16143	2009-2013
CHSH	76.99760	43.85394	0.19586	0.91826	-1.62386	0.93892	77.95955	4.69458	-8.11928	2009-2013
CHUM	74.75110	42.99850	0.89376	-1.40493	2.36308	1.66512	302.46289	8.32562	11.81542	
CRAO	33.99098	44.41326	-3.02966	4.25641	13.52450	5.22455	125.44281	26.12274	67.62252	
GUAO	87.17731	43.47111	7.72745	4.07880	-0.73527	8.73786	27.82656	43.68929	-3.67636	2002-2013
HYDE	78.55087	17.41726	33.03248	13.78057	-0.33576	35.79174	22.64503	178.95872	-1.67880	2002-2013
IISC	77.57038	13.02117	34.40186	16.66443	0.07467	38.22554	25.84578	191.12768	0.37333	
IRKJ	104.31618	52.21902	2.50784	-0.37038	-5.66377	2.53504	351.59887	12.67521	-28.31887	2002-2013
IRKT	104.31624	52.21902	2.37190	-0.10078	-5.08362	2.37404	357.56697	11.87020	-25.41808	
IZVS	76.61011	43.03757	2.82265	-0.14270	0.76652	2.82626	357.10592	14.13129	3.83261	2009-2013
KAST	75.96739	43.04487	1.57199	0.68877	0.43425	1.71626	23.66057	8.58130	2.17125	2009-2013
KAZA	73.94351	41.38494	5.07611	0.30150	1.93587	5.08505	3.39910	25.42525	9.67937	2003-2013
KHAR	36.23901	50.00510	-4.22210	4.04865	11.56953	5.84959	136.20138	29.24795	57.84767	
KIT3	66.88545	39.13477	0.74161	0.62791	1.58775	0.97173	40.25414	4.85866	7.93873	2000-2012
KURY	76.33846	43.89349	0.96447	-0.05480	1.37018	0.96602	356.74825	4.83012	6.85090	2009-2013
LHAZ	91.10403	29.65733	18.13651	20.27608	-1.91894	27.20390	48.18806	136.01952	-9.59470	2002-2013
MATB	76.42687	43.12999	1.95690	-0.23705	1.22573	1.97121	353.09307	9.85603	6.12865	2009-2013
NOVM	82.90949	55.03050	0.32880	-2.06096		2.08702	279.06434	10.43511	0.00000	V3 брак
NRIL	88.35978	69.36183	1.66480	-5.21925	0.60794	5.47833	287.69127	27.39166	3.03970	2002-2013
NVSK	83.23545	54.84061	0.01010	-1.27818	-0.39152	1.27822	270.45287	6.39109	-1.95762	
POL2	74.69427	42.67977	2.58985	-1.67594	1.16489	3.08482	327.09228	15.42408	5.82446	
POLV	34.54293	49.60261	-3.48771	2.45181	11.33864	4.26327	144.89327	21.31635	56.69320	2002-2012
POTS	13.06609	52.37930	-4.44109	7.92663	12.47089	9.08597	119.26082	45.42983	62.35447	
SATY	78.40838	43.05680	5.24410	1.94110	-1.29791	5.59182	20.31200	27.95909	-6.48953	2009-2013
SELE	77.01690	43.17873	2.73896	0.12598	0.74911	2.74186	2.63353	13.70930	3.74554	
SUMK	73.99711	44.20813	0.38687	-0.59874	-0.89535	0.71285	302.86812	3.56424	-4.47673	
TALA	72.21045	42.44547	1.07356	-0.18769	3.84305	1.08984	350.08308	5.44922	19.21523	аппарат.брак
TASH	69.29557	41.32805	0.98385	-0.93710	4.43545	1.35872	316.39407	6.79359	22.17725	2002-2013
TCMS	120.98739	24.79799	-0.32008	8.53453	-12.03209	8.54053	92.14779	42.70266	-60.16044	2006-2013
TEHN	51.33410	35.69728	11.25391	1.77218	10.45128	11.39259	8.94902	56.96297	52.25642	2005-2013
TSHN	76.94381	43.04197	3.21635	-0.13122	2.65668	3.21903	357.66374	16.09515	13.28341	2009-2013
TURG	77.63341	43.30894	3.51202	1.04328	0.96077	3.66370	16.54461	18.31850	4.80385	2009-2013
ULAB	107.05233	47.86507	0.74682	3.09806	-5.71356	3.18680	76.44680	15.93401	-28.56780	2002-2012
URUM	87.60066	43.80795	6.55286	3.82328	3.36711	7.58667	30.26152	37.93333	16.83557	
ZECK	41.56507	43.78839	-0.87252	3.69266	11.90079	3.79434	103.29428	18.97171	59.50396	

Defining trend movements of the earth surface of investigated region using data from global and local networks of GNSS stations for the 2000-2012

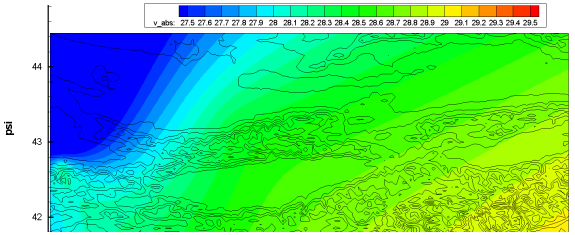
2003



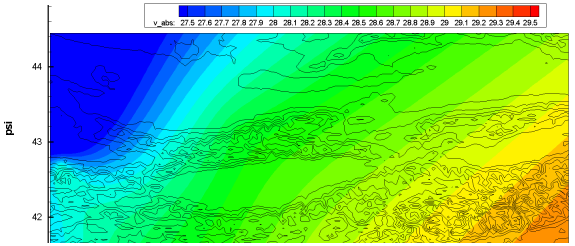
2004



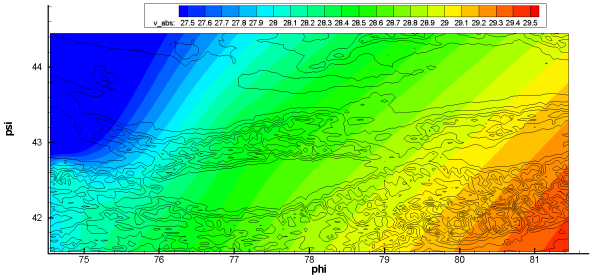
2005



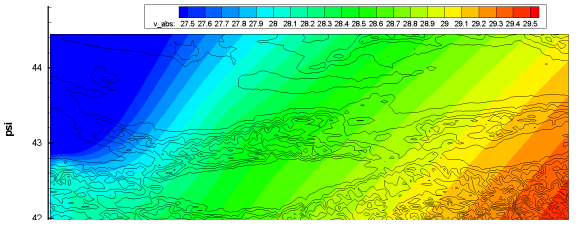
2006



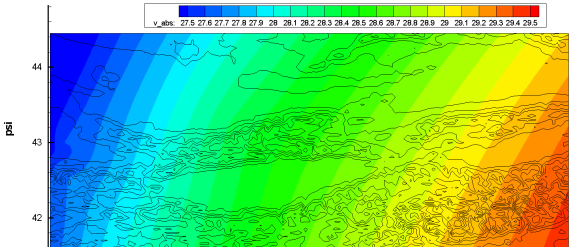
2007



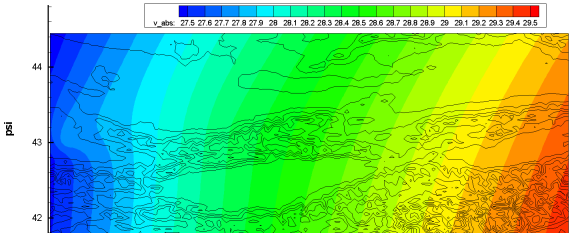
2008



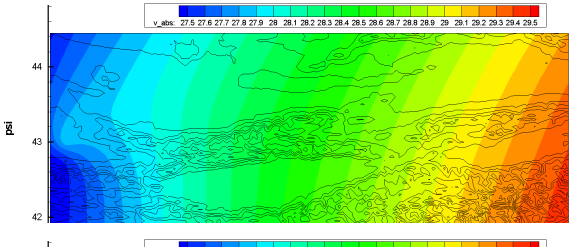
2009



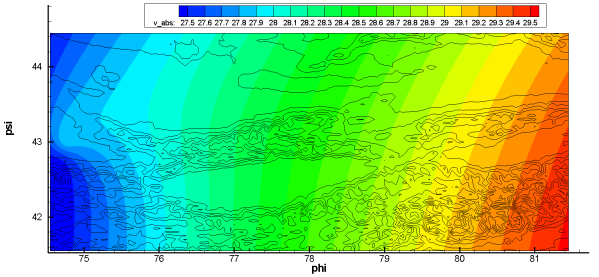
2010



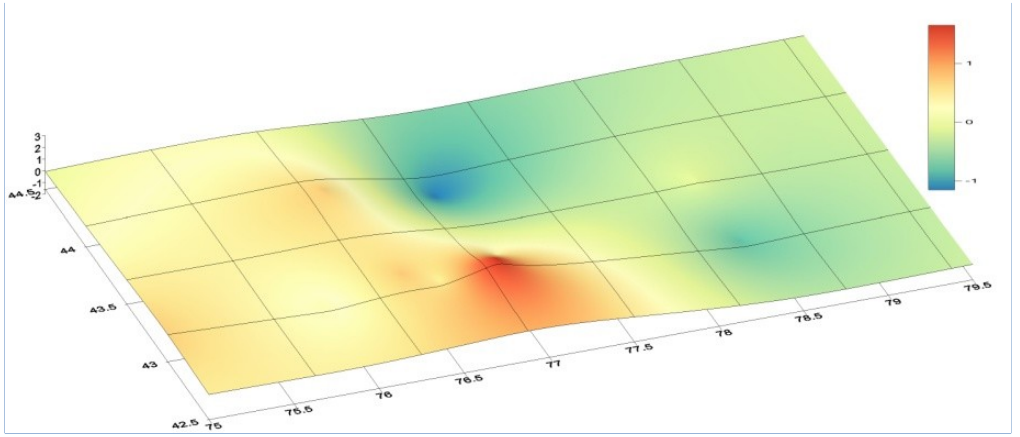
2011

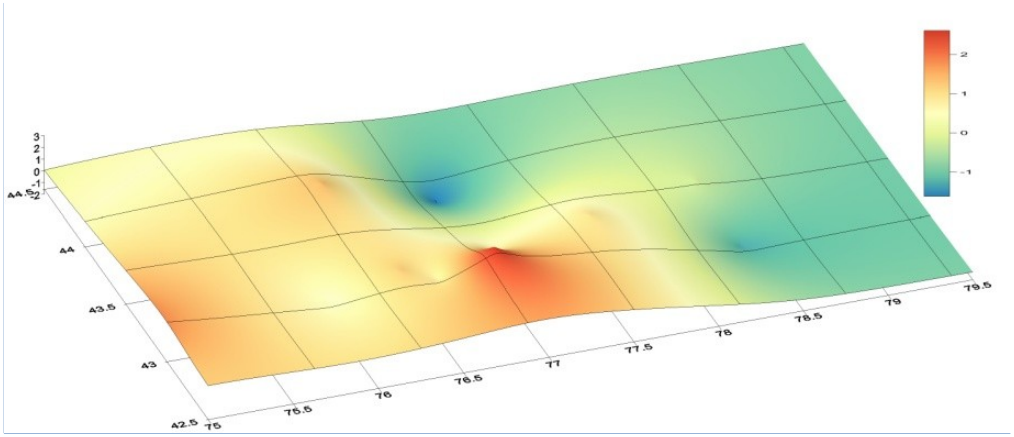


2012



Vertical velocities of movement



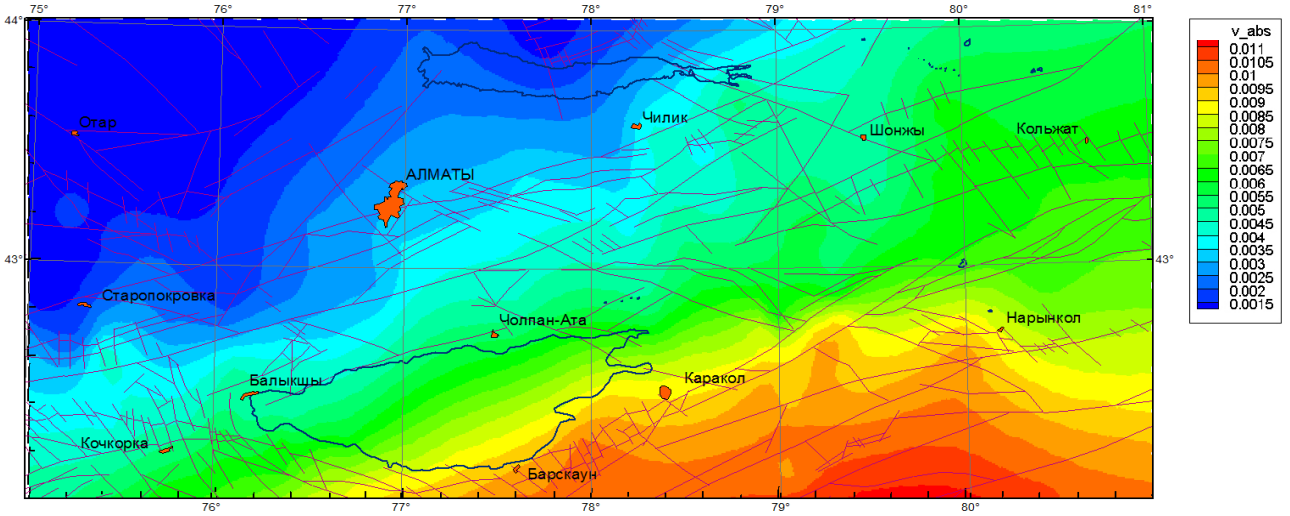


Map fragment of seismotectonics the Northern Tien Shan
by A.V.Timush, T.V.Taradaeva

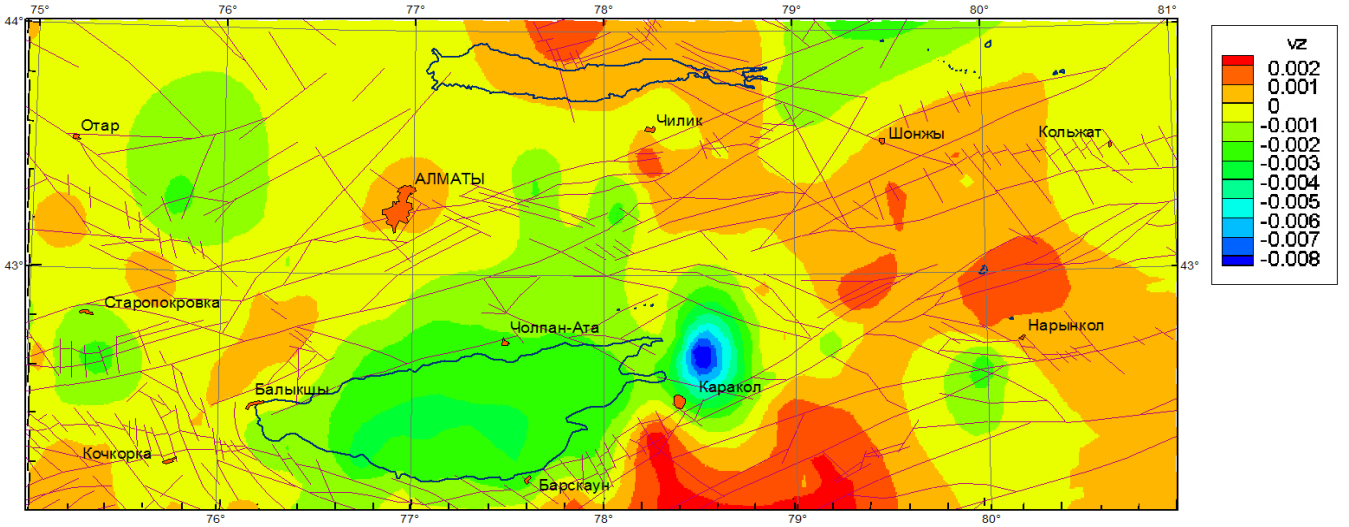
РАЙОНИРОВАНИЕ ЭПИПЛАТФОРМЕННЫХ ОРОГЕНОВ ПО РЕЖИМУ ДВИЖЕНИЙ

1	P_2^3-Q	Области поднятий различной длительности (возрастной интервал)
2	N_1-Q	
3	N_2-Q	
4	Q	
5	P_2^3-Q	Области опусканий (впадины предгорные, межгорные, внутригорные) различной длительности (возрастной интервал)
6	N_1-Q	
7	$\frac{P_2^3-N_1}{N_1}$	
8	$\frac{P_2^3-N_2}{Q}$	
9	$\frac{P_2^3-Q}{Q_1}$	Области дифференцированных движений (числитель - время опусканий, знаменатель - время начала поднятий)
10	$\frac{N_1-N_2}{Q_1}$	
11	$\frac{N_1-Q}{Q_1}$	
12	$\frac{N_2-Q}{Q_1}$	
13	$\frac{N_2-Q}{Q_1}$	

Mapping zoning on the complex data using GIS software for south-eastern Kazakhstan



Распределение скоростей движения земной поверхности Северного Тянь-Шаня (Горизонтальная составляющая)



Распределение скоростей движения земной поверхности Северного Тянь-Шаня (Вертикальная составляющая)

Interpolated data using global and local GNSS networks

A calculation the stress-strain state of North Tien Shan region within the parameters of contemporary movements of the earth's surface as a result of GPS-observations.

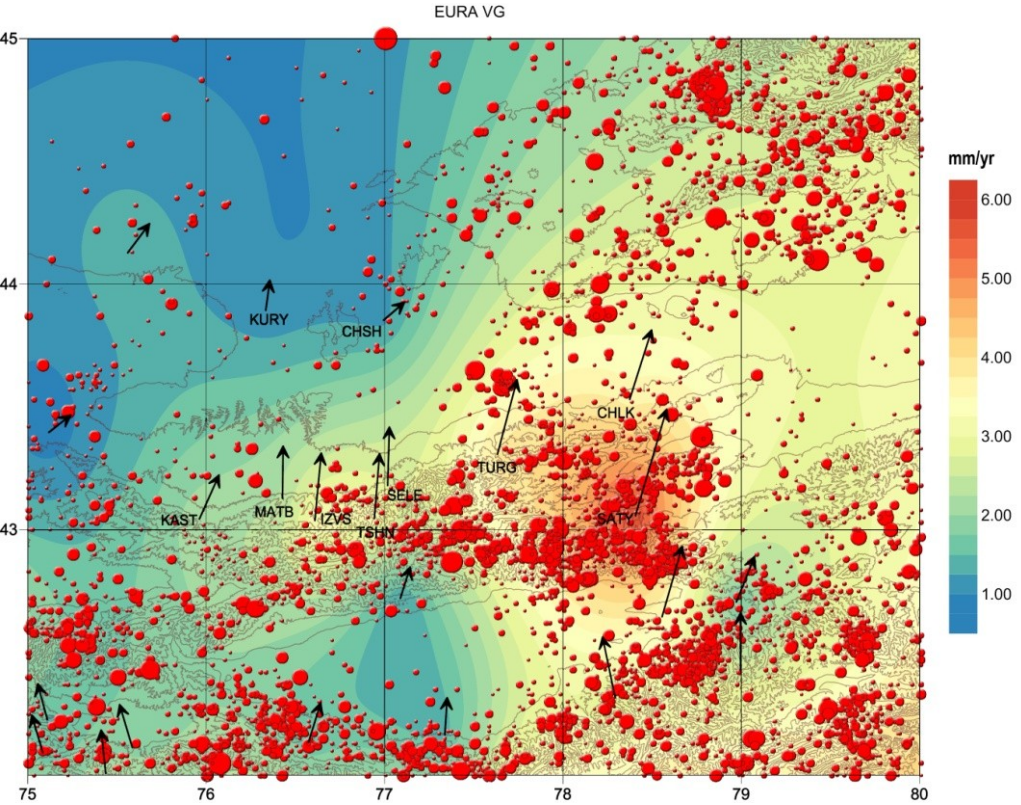


Diagram of horizontal velocity of GPS-points in the coordinate system relative to the Eurasian continent.

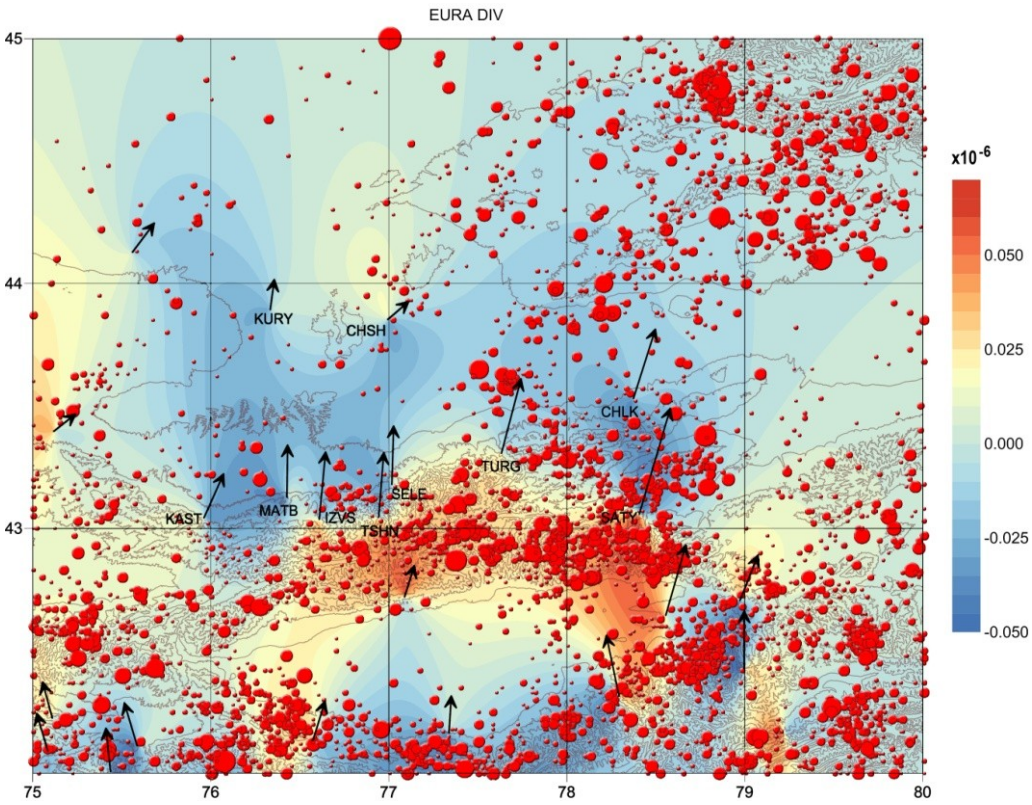
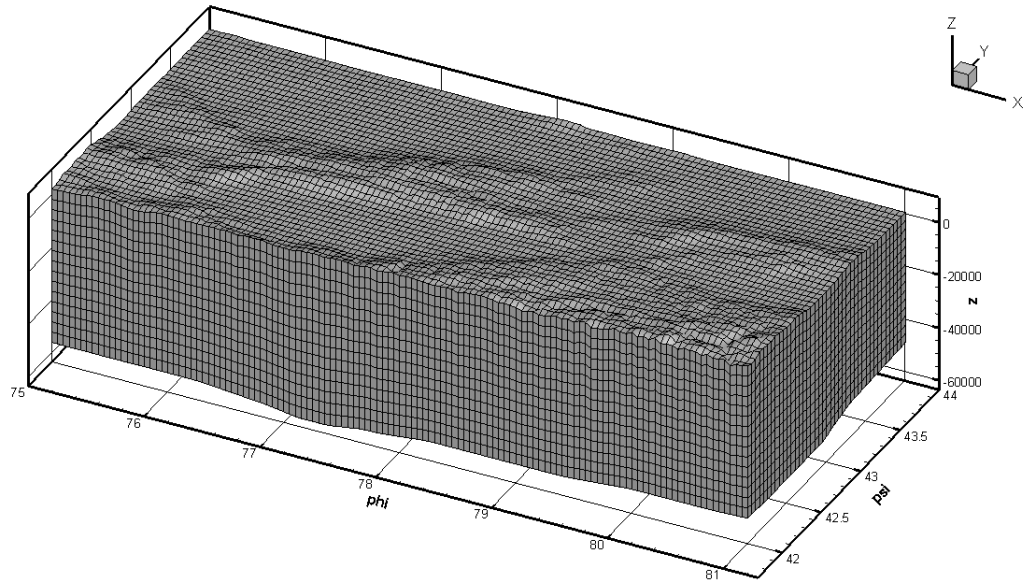


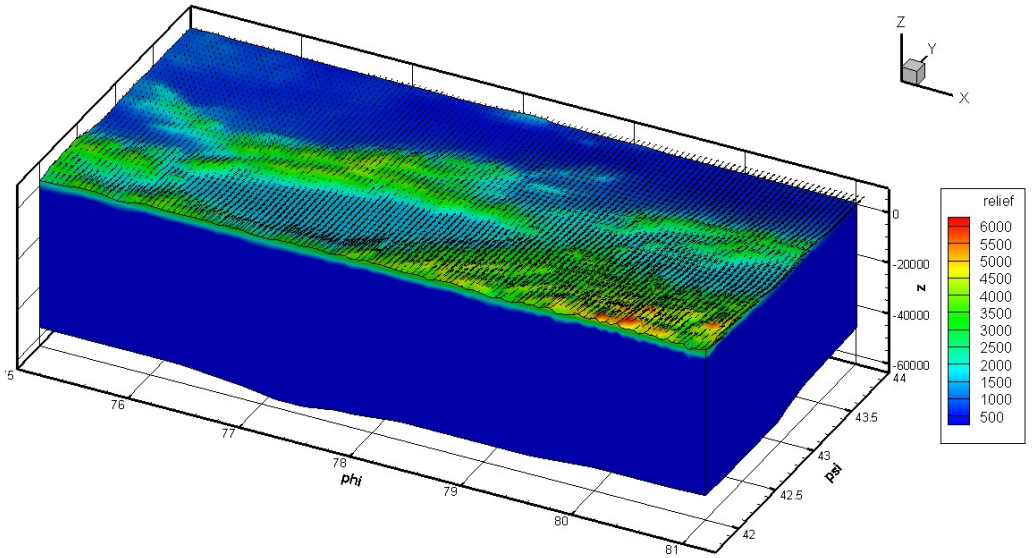
Diagram of divergence of horizontal velocity of GPS-points relative to the Eurasian continent.

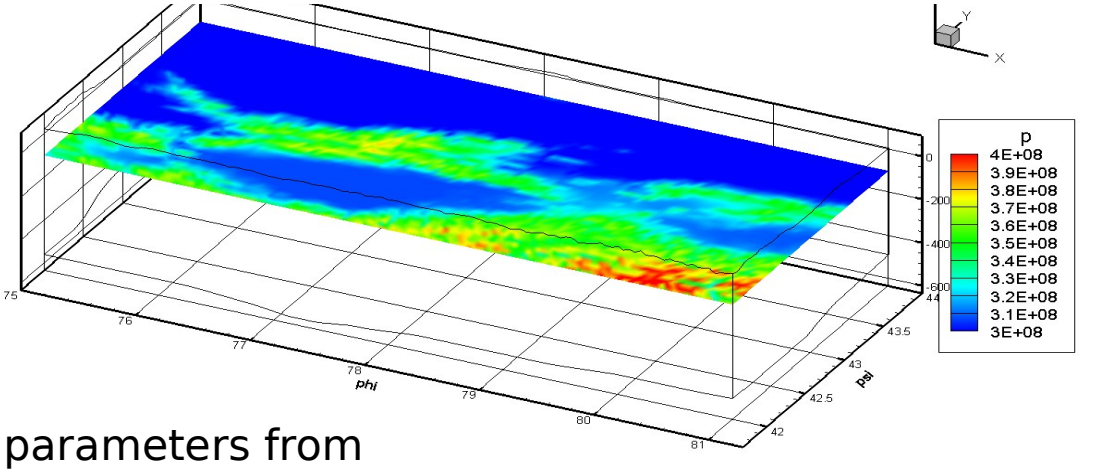
Geomechanical modeling



The three-dimensional mesh for the North Tien Shan region

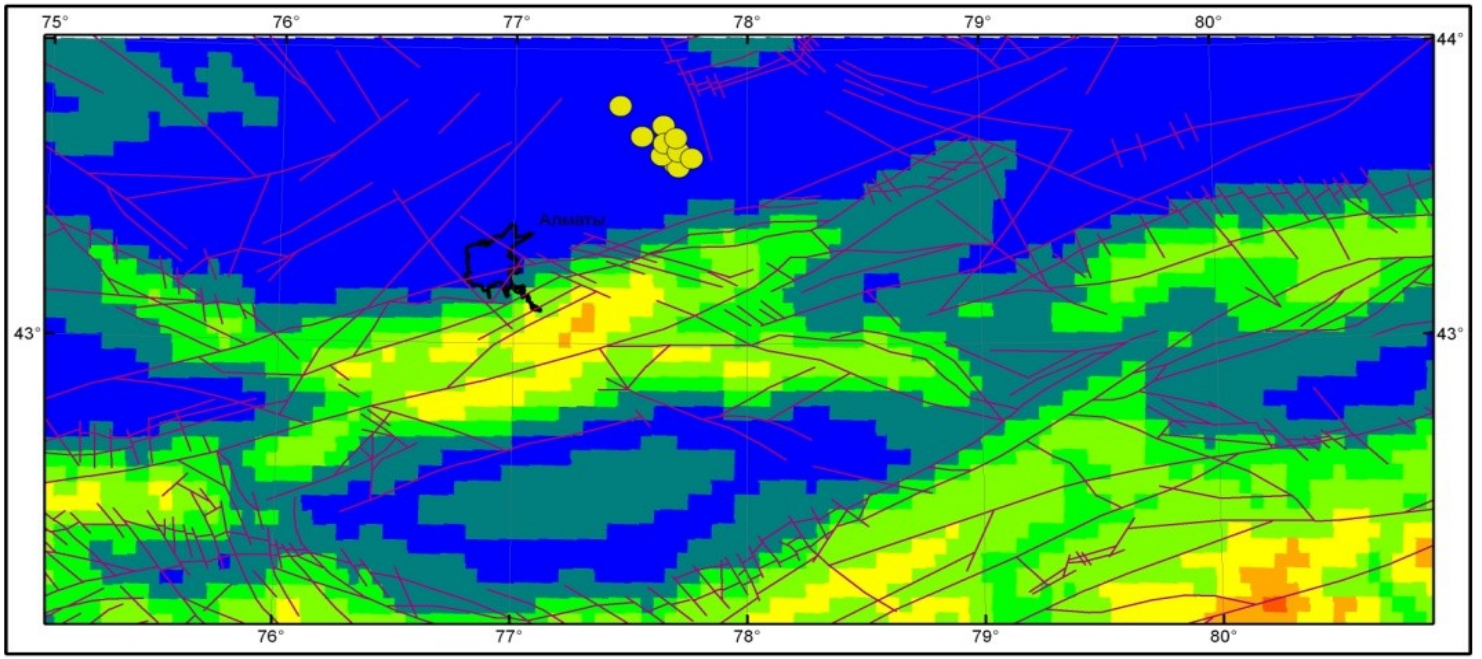
Surface topography (m) and the movement of the earth's surface



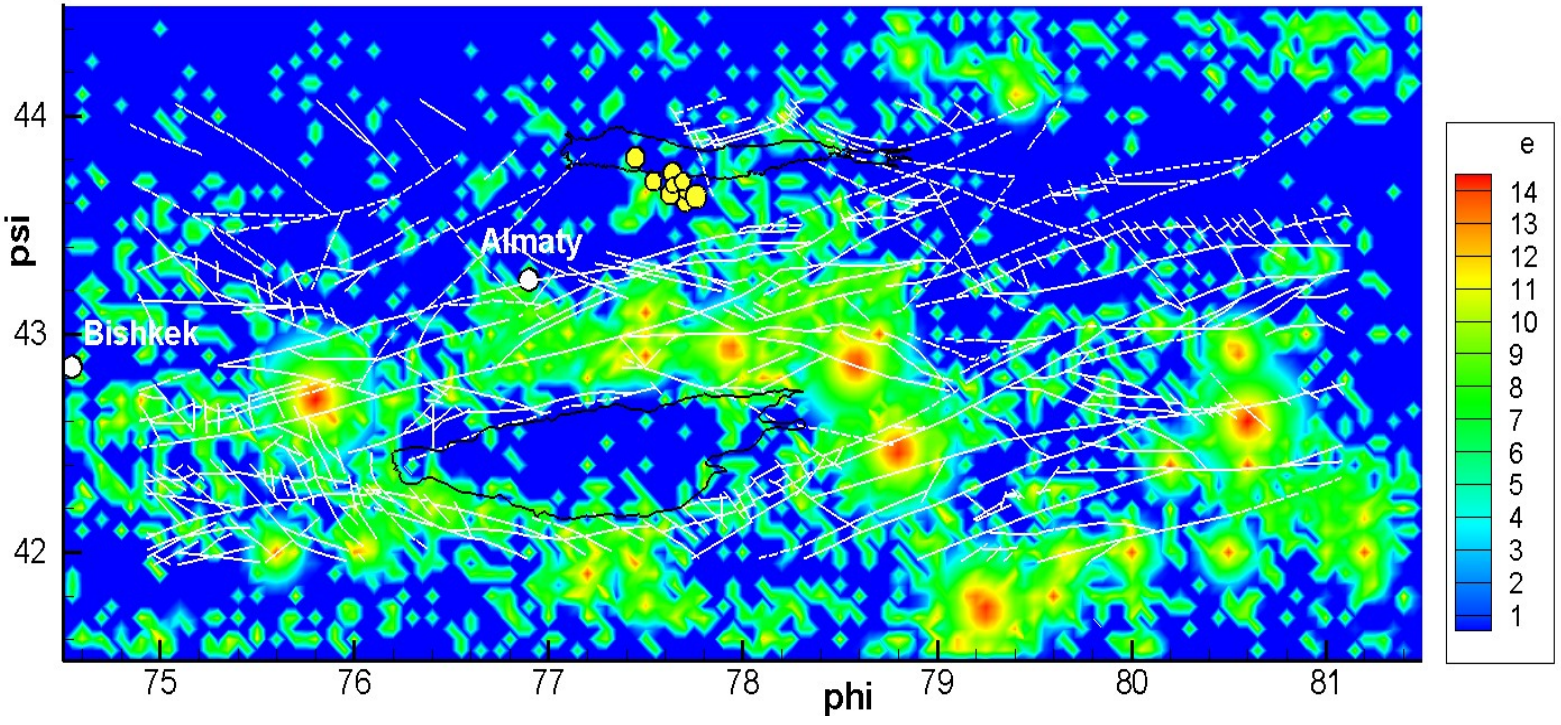


The distribution of the stress state parameters from the forces of its own weight (Pa) at a depth of 15 km from the sea level.

The intensity distribution of tangential stresses at the level of 10-15 km

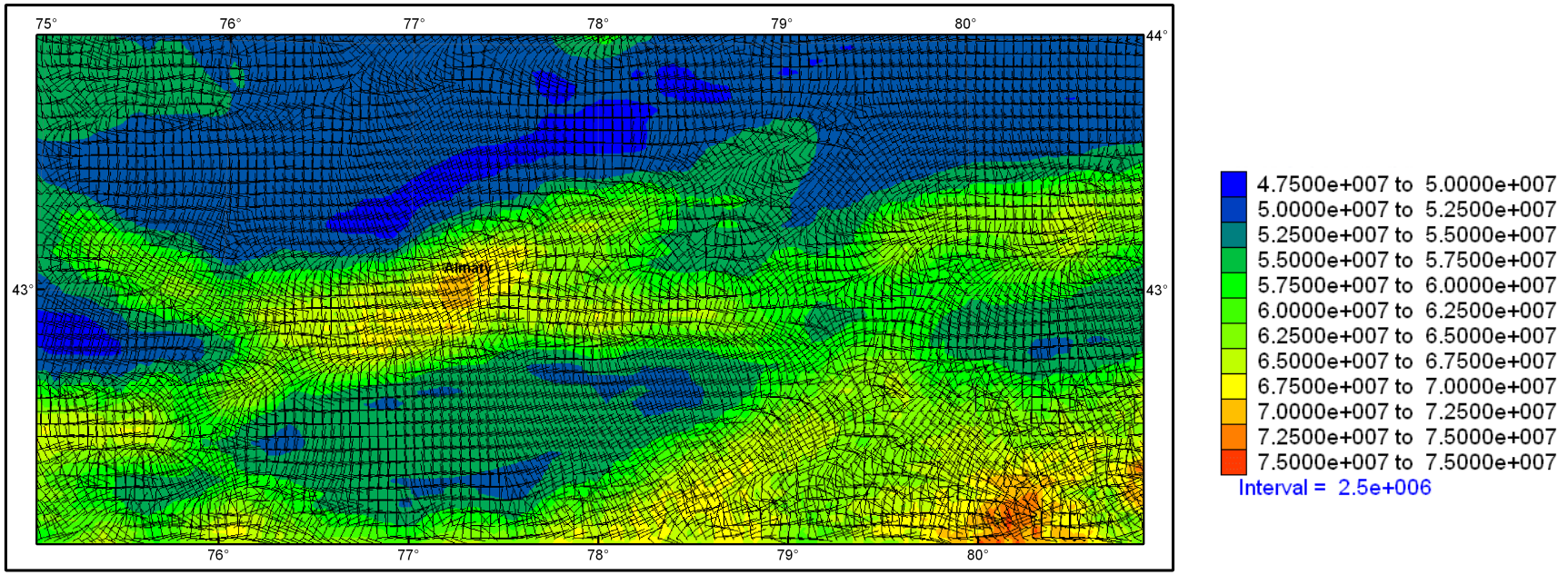


Earthquakes energy

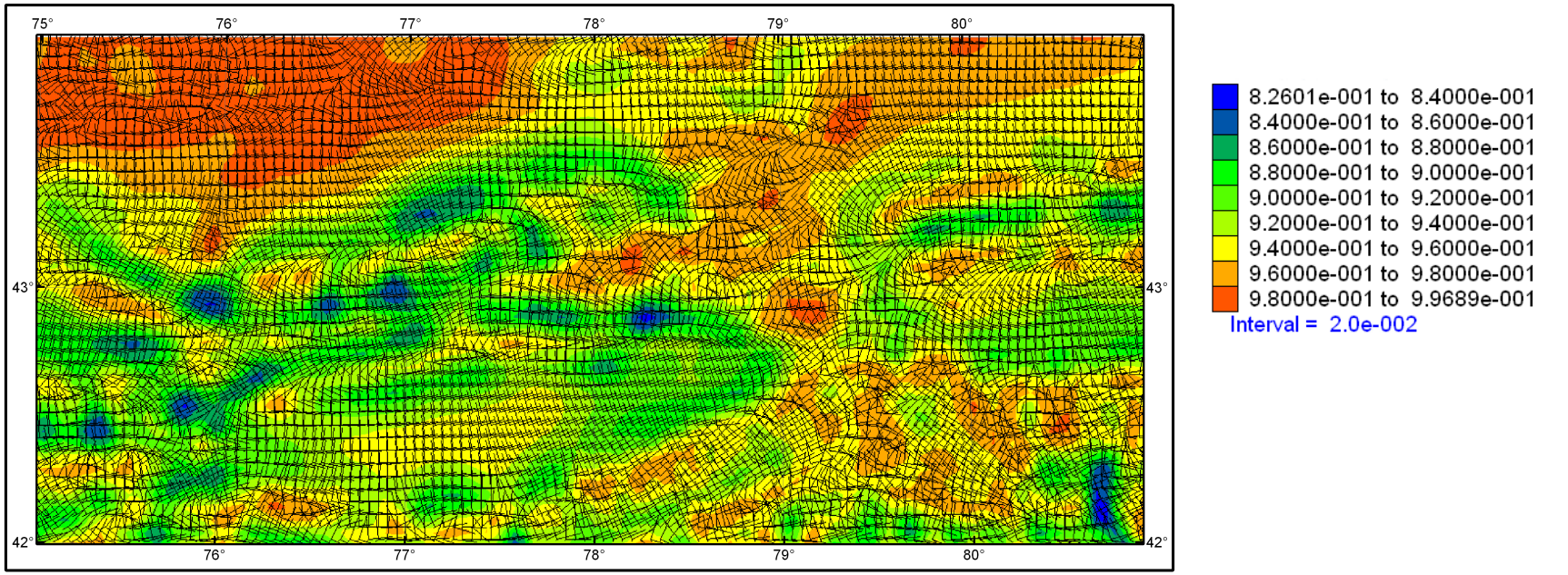


Distribution of shear stress intensity and Lode-Nadai parameter

Shear stress intensity (Pa), layer 10-15 km



Lode-Nadai parameter, layer 10-15 km



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The Abdus Salam International Centre for Theoretical Physics

50th Anniversary 1964-2014

Thanks for attention!