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DEFINITION OF A UNIQUE TRANSFORMATION PARAMETERS FOR BURSA METROPOLITAN MUNICIPALITY AREA OF RESPONSIBILITY

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- CONCLUSION

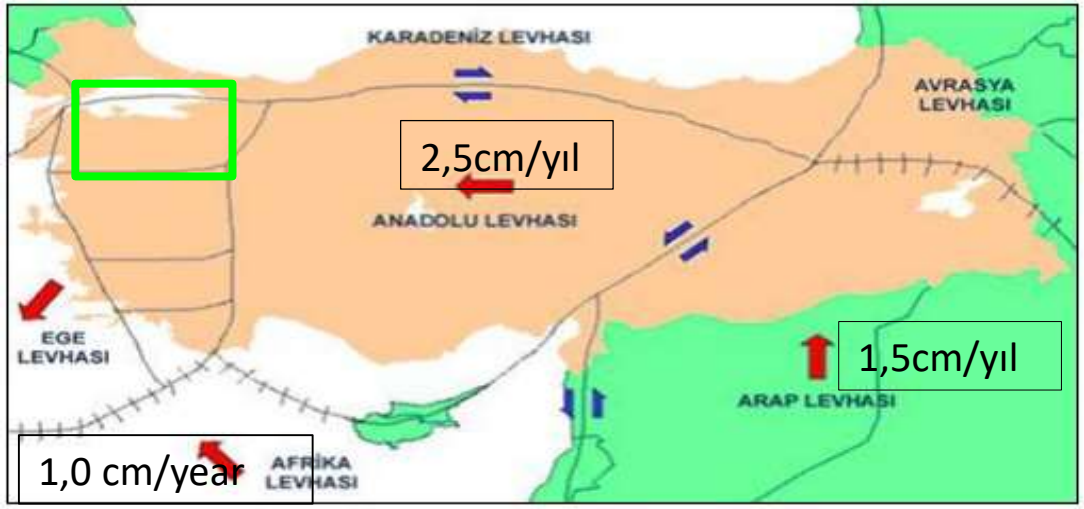
MOTIVATION

Bursa Metropolitan Municipality(BMM) M5 Mapping Project namely ;

- «1/1K & 1/5K Scale Digital Photogrammetric Line and Orthophoto Map Production » is awarded in 2014 .
- One of the demand was define a unique transformation parameter set for the area of responsibility(AOR) of 12000 km^2.

BACKGROUND

- Turkish National Horizontal (Triangulation) Control Network (TNHCN) adjusted in 1954 (Hayford 1925 ellipsoid 'European Datum 1950:'ED50'),
- Turkish National GPS Network(TNGN05) adjusted in 2005 (GRS80 ellipsoid, ITRF96 and 2005.0 Epoch),
- Project Area is located one of the most active seismic zone of Anatolian Peninsula



Tectonic of Anatolian Peninsula

Seismic Activities in between 1900-2011 Mag≥5.0

PROJECT AREA

BACKGROUND

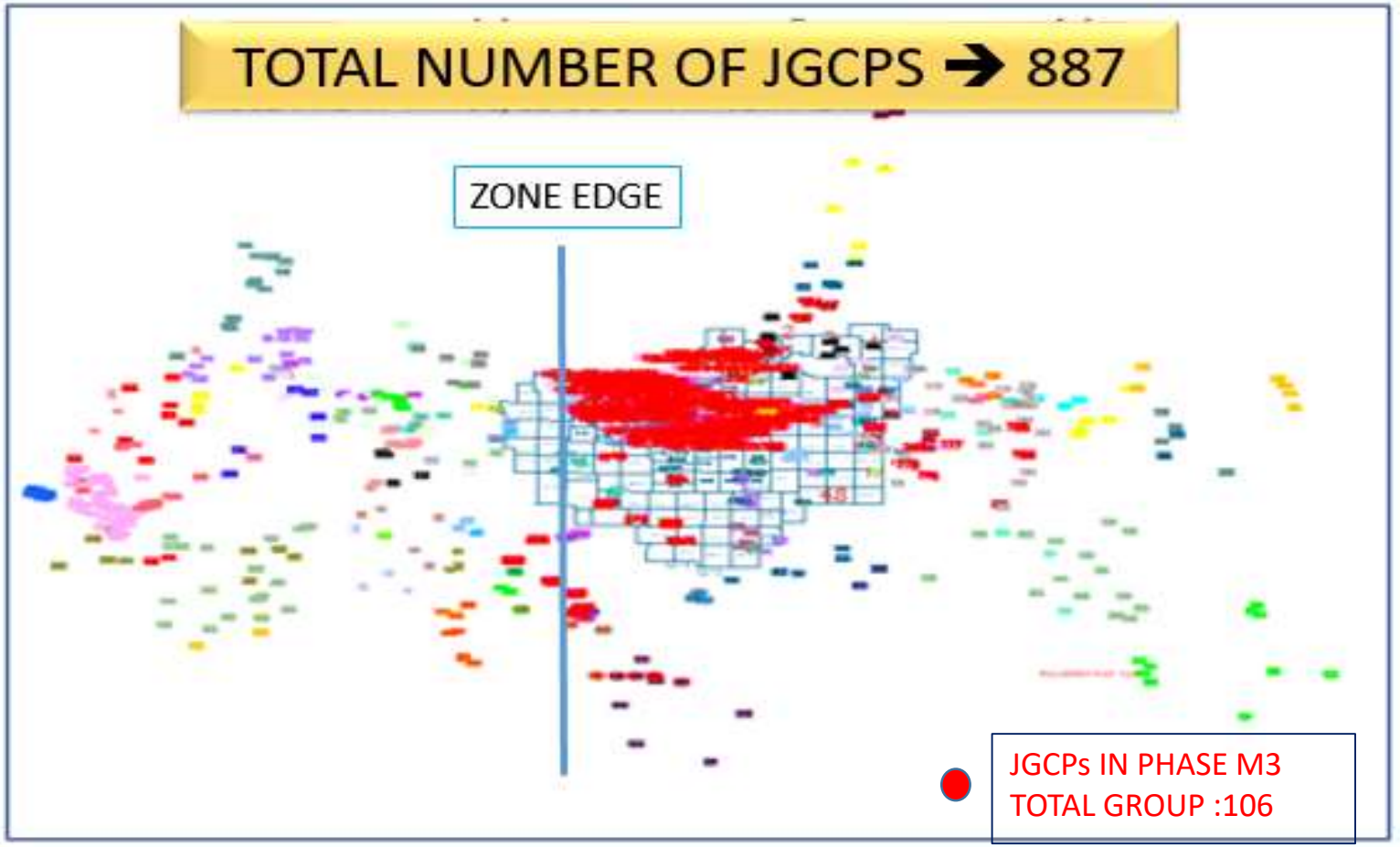
- BMM Mapping Projects

					TRANSFORMATION		
PRJ ID	START	END	AREA(km²)	DATUM	HST	JGCP	DEG(ED50)
M1	1996	1998	1600	ED50			
M2	2002	2004	2200	ED50			
M3	2009	2011	3500	ITRF96	2009	34	III/IV
M4	2011	2013	3500	ITRF96	2009	34	III/IV
M5	2014	2017	12000	ITRF96	2017	146	I/II/III

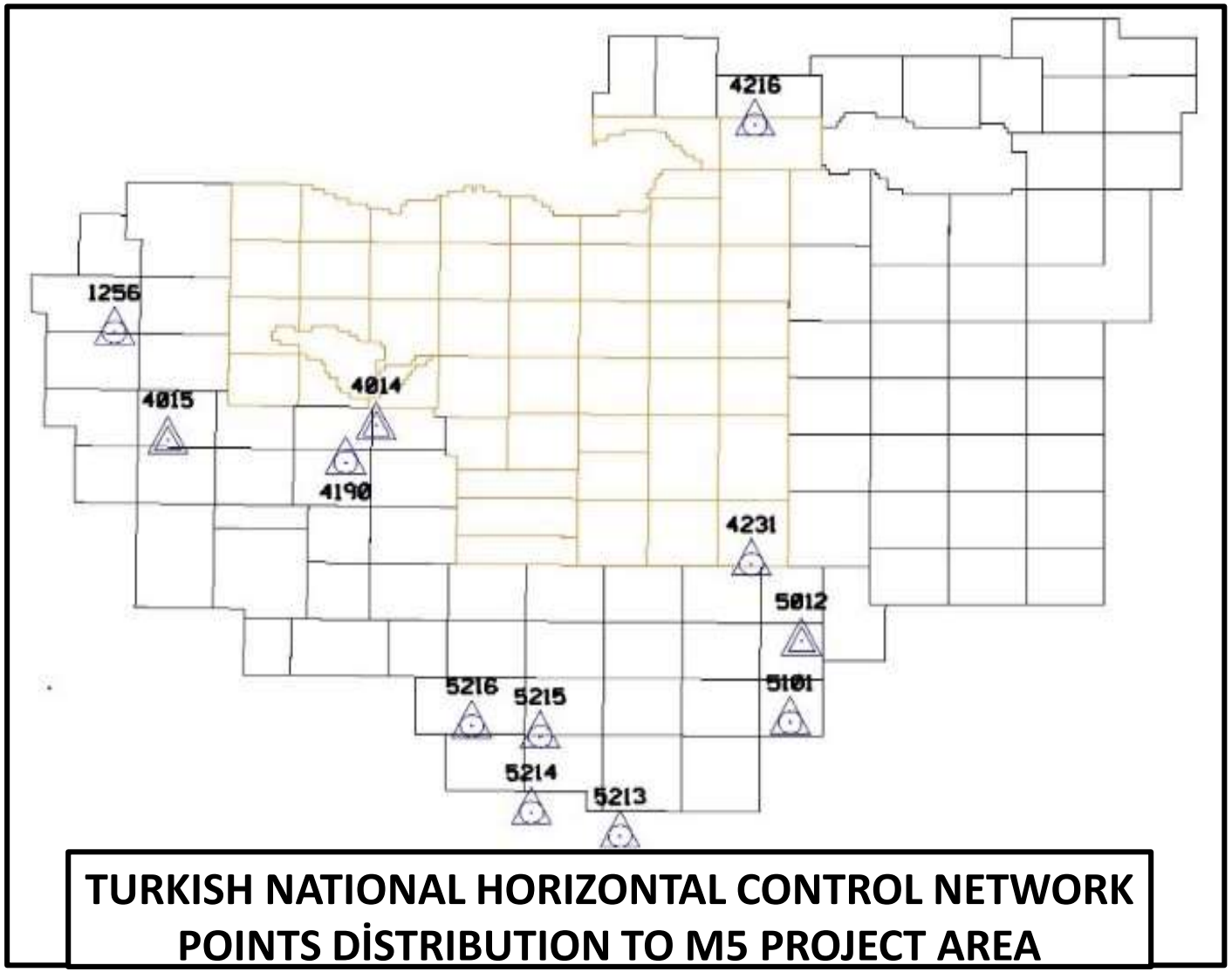
- **When the Project area is examined,**
  - Since 2005,106 different transformation groups in and around the Project area determined ,
  - A total of 887 Points defined as Joint Transformation Set

PREPARATORY WORKS

- 887 Points located in 106 Groups Distribution to Project Area



TURKISH NATIONAL HORIZONTAL CONTROL NETWORK
FIRST AND SECOND ORDER POINTS IN M5 PROJECT AREA



TURKISH NATIONAL HORIZONTAL CONTROL NETWORK POINTS DİSTRIBUTION TO M5 PROJECT AREA

FIRST(I) ORDER 3 GCP
SECOND(II) ORDER 9 GCP

TOTAL : 12 GCPs PHYSICALLY ALIVE (GENERAL COMMAND OF MAPPING: GCM POINTS)

CONSTRAINTS

- Constraints imposed by TOR ; New Transformation parameters :
  - **TOR CONS. : should not create matching problems with**
    - **M3/M4**
    - **OTHER GROUPS of TRANSFORMATIONS**
- Constraints imposed by Technical Regulation

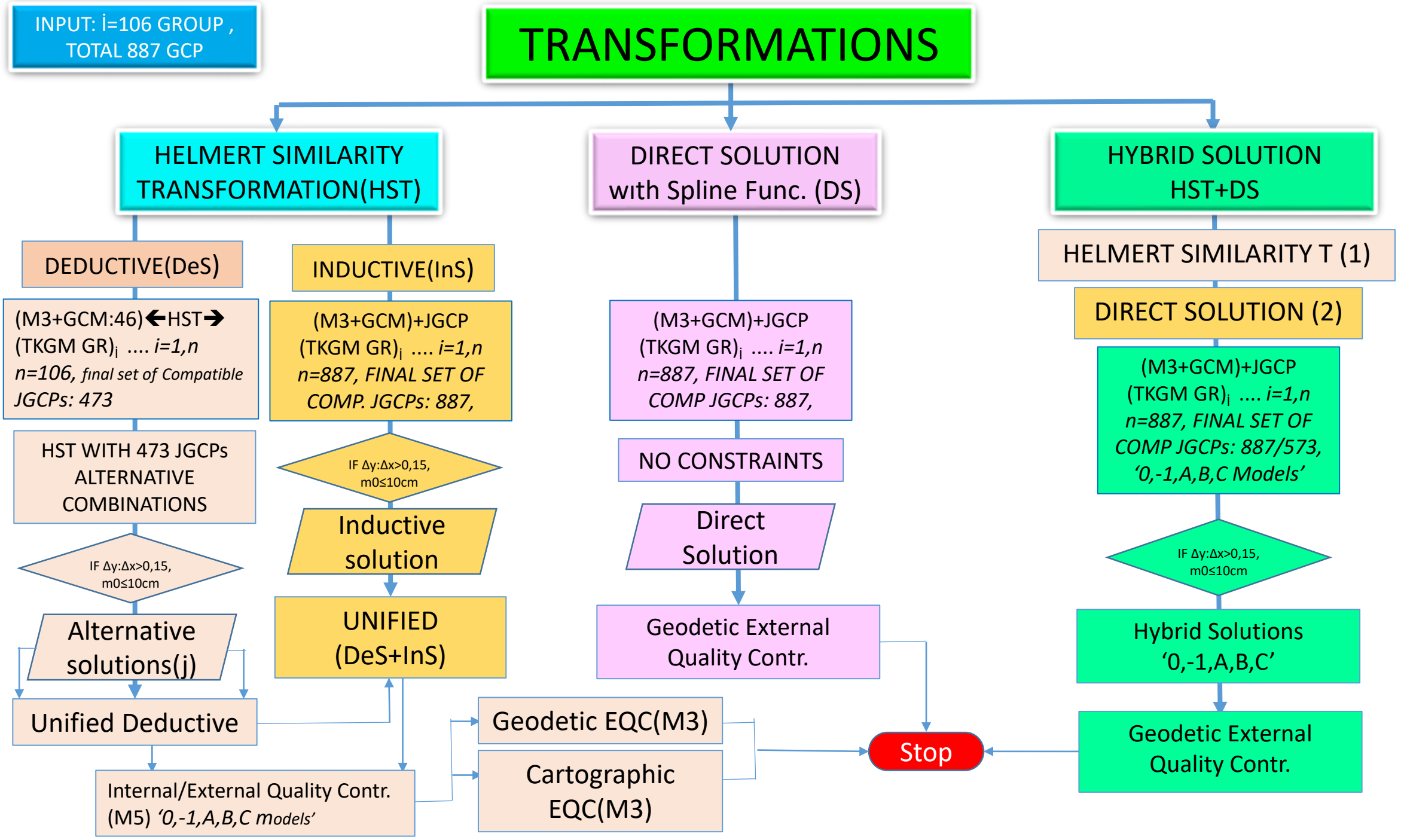
REG CONS:

- Transformation **adjustment corrections** (IQC) and
- External Quality Control (EQC) **differences** should be less than 0.15m.

$$\Delta y \leq 0.15m; \Delta x \leq 0.15m$$

- Adjustment **Mean Square Error** should be less than

$$m_0 \leq \pm 0.10m$$


INPUT: İ=106 GROUP , TOTAL 887 GCP
TRANSFORMATIONS
HELMERT SIMILARITY TRANSFORMATION(HST)
DIRECT SOLUTION with Spline Func. (DS)
HYBRID SOLUTION HST+DS
DEDUCTIVE(DeS)
INDUCTIVE(InS)
(M3+GCM:46)←HST→ (TKGM GR)ᵢ .... i=1,n n=106, final set of Compatible JGCPs: 473
(M3+GCM)+JGCP (TKGM GR)ᵢ .... i=1,n n=887, FINAL SET OF COMP. JGCPs: 887,
(M3+GCM)+JGCP (TKGM GR)ᵢ .... i=1,n n=887, FINAL SET OF COMP JGCPs: 887,
HELMERT SIMILARITY T (1)
DIRECT SOLUTION (2)
(M3+GCM)+JGCP (TKGM GR)ᵢ .... i=1,n n=887, FINAL SET OF COMP JGCPs: 887/573, '0,-1,A,B,C Models'
HST WITH 473 JGCPs ALTERNATIVE COMBINATIONS
IF Δy:Δx>0,15, m0≤10cm
NO CONSTRAINTS
IF Δy:Δx>0,15, m0≤10cm
IF Δy:Δx>0,15, m0≤10cm
Inductive solution
Direct Solution
Alternative solutions(j)
UNIFIED (DeS+InS)
Geodetic External Quality Contr.
Hybrid Solutions '0,-1,A,B,C'
Unified Deductive
Geodetic EQC(M3)
Stop
Geodetic External Quality Contr.
Internal/External Quality Contr. (M5) '0,-1,A,B,C models'
Cartographic EQC(M3)

DEDUCTIVE HST APPROACH

HSTs AND HIERARCHICAL POINT BASED ELIMINATION OF 473 JGCPs SET ,FOUND AS COMPATIBLE WITH (M3+HGK) DATA AS PER THE RESULT OF DUAL HELMERT SIMILARITY TRANSFORMATION

(M3+HGK)←HST→
$(TKGM\ GR)_i$ .... *i=1,n*
TOTAL JGCPs: 473

HST WITH 473 JGCPs

m_0 > 1,00 m

0,10m<m_0 ≤ 1,00 m

m_0≤ 0,10 m

Till Δy:Δx<0,15m

M3+HGK VE TKGM GRUPLARI İKİLİ ÇÖZÜMLERİ SONUCU UYUŞUMLU BULUNAN NOKTALAR İLE OLUŞTURULAN DÖNÜŞÜM ORTAK NOKTA KÜMELERİ VE DÖNÜŞÜMLERİN ÖZETLERİ

			Nokta Sayısı			Dönüşüm Parametreleri				Dengeleme İstatistikleri		MAKSIMUM		MINIMUM	
Açıklamalar	Çözüm No	Eleme	Ortak	Uyuşum suz	Kul.lan	Ölçek	(α)Dönük (grad)	Cy (Δy) (m)	Cx (Δx) (m)	m_0 (m)	m_p (m)	(Δy) (m)	(Δx) (m)	(Δy) (m)	(Δx) (m)
M3	M3	Δy:Δx=> 0,5	34	0	34	6,506	0,00010	39,531	156,137	0,057	0,080	0,45	0,16	-0,23	-0,22
İkili Çözümler	M3+HGK+TKGM M5	EŞLENİK	487	14	473	15,826	-0,00026	47,756	114,365	1,481	2,095	2,71	1,66	-5,50	-2,91
Grup Bazlı Eleme	Ön Eleme 1	Δy:Δx=> 2m	473	89	384	15,826	-0,00026	47,756	114,365	1,481	2,095	2,71	1,66	-5,50	-2,91
	Ön Eleme 2	Δy:Δx=> 2m	384	19	365	4,134	0,00000	33,982	167,447	0,201	0,284	1,15	1,28	-1,93	-1,47
Nokta Bazlı Eleme	Ön Eleme 3	Δy:Δx=>0,3m	365	52	313	4,068	-0,00001	34,092	167,737	0,181	0,256	0,67	0,57	-0,46	-0,61
	Ön Eleme 4	Δy:Δx=>0,25m	313	8	305	3,886	0,00000	34,066	168,547	0,174	0,246	0,50	0,57	-0,44	-0,61
	Ön Eleme 5	Δy:Δx=>0,25m	305	4	301	3,85	-0,00001	34,268	168,688	0,174	0,241	0,27	0,56	-0,43	-0,62
	Ön Eleme 6	Δy:Δx=>0,15m	301	29	272	3,798	-0,00002	35,283	168,839	0,164	0,232	0,24	0,55	-0,41	-0,63
	Ön Eleme 7	Δy:Δx=>0,3m	272	31	241	4,072	-0,00004	36,654	167,481	0,129	0,183	0,25	0,29	-0,34	-0,34
	Ön Eleme 8	Δy:Δx=>0,15m	241	95	146	3,891	-0,00003	36,229	168,297	0,090	0,128	0,22	0,23	-0,32	-0,19
	Ön Eleme 9	Δy:Δx=>0,15m	146	14	132	3,872	-0,00002	35,139	168,465	0,081	0,115	0,21	0,22	-0,23	-0,19
	Ön Eleme 10	Δy:Δx=>0,15m	132	12	124	3,934	-0,00002	35,267	168,172	0,076	0,107	0,13	0,17	-0,15	-0,15
	Ön Eleme 11	Δy:Δx=>0,15m	124	3	121	3,961	-0,00002	35,246	168,060	0,074	0,105	0,13	0,15	-0,15	-0,14
	Ön Eleme 12	Δy:Δx=>0,15m	121	19	102	4,103	-0,00002	34,855	167,462	0,065	0,092	0,13	0,13	-0,10	-0,11
	ORTALAMA(eşlenik+Ön eleme1)		480	52	429	15,826	-0,00026	47,756	114,365	1,481	2,095	2,71	1,66	-5,50	-2,91
	ORTALAMA(Ön Eleme 2-7)		323	24	300	3,968	-1,3E-05	34,724	168,1231	0,171	0,240	0,51	0,64	-0,67	-0,71
	ORTALAMA(Ön Eleme 8-12)		153	29	125	3,952	-2,1E-05	35,347	168,091	0,077	0,109	0,16	0,18	-0,19	-0,16
	ORTALAMA (Tümü)		264	28	237	5,838	-4,3E-05	37,152	159,5757	0,316	0,447	0,70	0,59	-1,16	-0,79

INDUCTIVE APPROACH

GROUPS , JGCPs AND TM ZONES

			CM					CM					CM				CM	
Ord	GRNU	JGP	27	30	Ord	GRNU	JGP	27	30	Ord	GRNU	JGP	27	30	Ord	GRNU	JGP	27	30
1	1	6		1	19	20	9		18	37	45	6	5		55	83	6		45
2	2	5		2	20	21	5		19	38	47	6		33	56	86	13		46
3	3	23	1		21	22	5		20	39	48	11		34	57	87	11		47
4	4	5		3	22	23	8		21	40	49	17		35	58	88	4	11	
5	5	7		4	23	25	9	2		41	50	10		36	59	89	5	12	
6	6	6		5	24	26	4		22	42	53	4	6		60	90	8		48
7	7	5		6	25	27	13		23	43	57	26		37	61	93	8		49
8	8	12		7	26	30	5		24	44	58	8		38	62	95	6		50
9	9	7		8	27	31	7		25	45	61	6		39	63	101	7	13	
10	10	6		9	28	33	25		26	46	62	4		40	64	103	5		51
11	11	4		10	29	34	7		27	47	65	10		41	65	104	8	14	
12	12	5		11	30	38	6		28	48	67	13		42	66	107	6	15	
13	13	5		12	31	39	7		29	49	70	5	7		67	108	5	16	
14	14	20		13	32	40	9		30	50	71	5	8		68	111	10	17	
15	15	6		14	33	41	5		31	51	72	6	9		69	114	5	18	
16	16	7		15	34	42	10		32	52	73	11	10		70	118	9		52
17	18	4		16	35	43	7	3		53	77	4		43	71	119	6		53
18	19	9		17	36	44	5	4		54	82	11		44					
Sum	18	142	1	17	TOP	18	146	3	15	TOP	18	163	6	12	TOP	17	122	8	9
												GR TOTAL				71	573	18	53

TOTAL

GROUP: 71 (CM:27➔18 Grp., CM:30➔53 Grp.)

JGCPs : 573 ; (+46=M3+HGK)➔ 619

INDUCTIVE APPROACH: HSTs WITHOUT ANY CONSTRAINT

SLTN IV	ELMN	JC Pt	In Ct	Cx(Δx)	Cy(Δy)	Rot α (grad)	Δ(Ölçek) (ppm)	m_o (m)	m_p (m)
Sltn 1	Δy:Δx≥2,0m	619	3+216	96,83	42,64	0,000204	19,867	1,83	2,58
Sltn 2	Δy:Δx≥0,3m	400	3+158	157,96	29,81	0,000044	6,35	0,43	0,61
Sltn 3	Δy:Δx≥0,15m	239	107	166,83	32,30	0,000020	4,302	0,08	0,11
Sltn 4	Δy:Δx≥0,15m	132	8	167,86	32,11	0,000024	4,074	0,08	0,12
Sltn 5	Δy:Δx≥0,15m	124	2	168,10	32,27	0,000022	4,014	0,07	0,10

	Solution No TV VI-1		Solution No TV VI-2		Solution No TV VI-3		Solution No TV VI-4		Solution No TV VI-5	
	Nop	Inc	Nop	Inc	Nop	Inc	Nop	Inc	Nop	Inc
ONS	619	219	400	161	239	107	132	8	124	4
M3	34	0	34	7	27	10	17	0	17	0
HGK	12	6	6	1	5	3	2	0	2	0

UNIFIED DEDUCTIVE SOLUTIONS

- UNIFIED DEDUCTIVE SOLUTION OF 102 ÖNEL II-12 AND 107 ÖNEL III-7 : 102U107 : RESULT IS A 143 JGCPs SET.
- 143 JGCPs DISTRIBUTION (TGBÇ 143 VII-1)
- FOR 11 POINTS Δy:Δx>0,15m

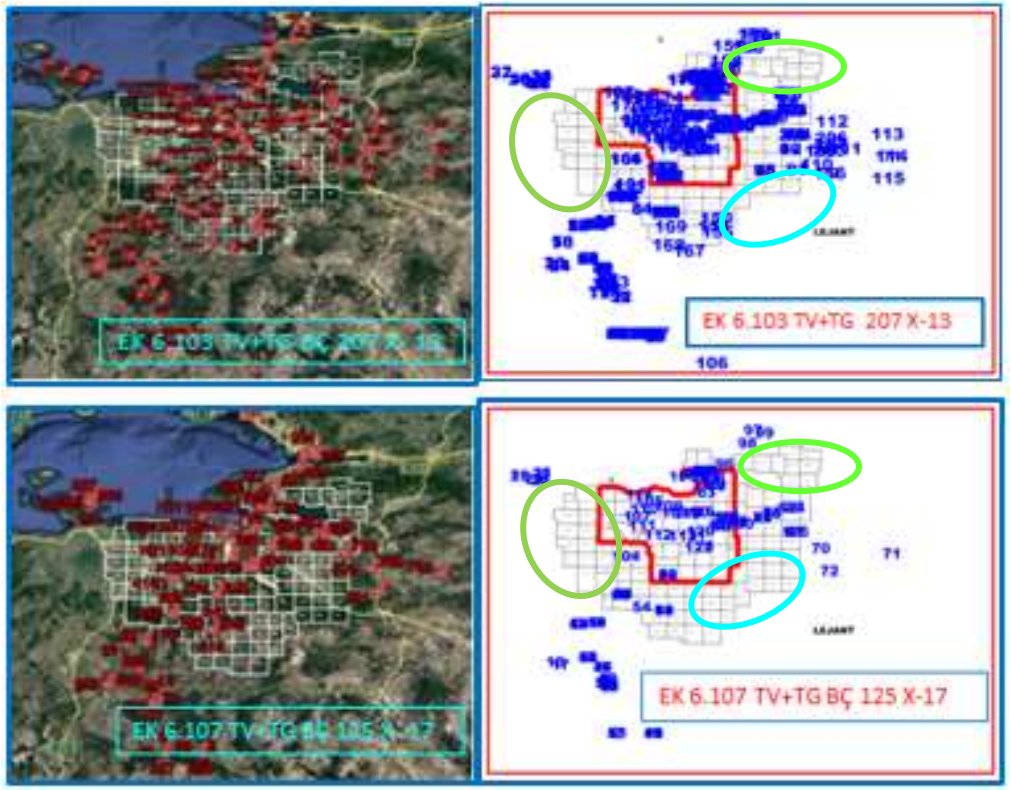
- 132 JGCPs DISTRIBUTION(TGBÇ 132 VII-2)
- FOR ALL POINTS Δy:Δx<0,15m

- STATISTICS FOR 143 AND 132 JGCPs HSTs.

		Nokta Sayısı		Dönüşüm parametreleri				Deng. İstatistik.		FARKLAR			
										MAKSİMUM		MİNİNİMUM	
Çözüm No	Eleme	Ortak	Uyu. suz	Δ ppm (Ölçek)	Dönüklük (α) (grad)	cy (Δy) (m)	cx (Δx) (m)	mo (m)	mp (m)	*Δy(m)*	*Δx(m)*	*Δy(m)*	*Δx(m)*
TG BÇ 143 VII-1	-	143	11	4,029	-0,000042	36,738	167,60	0,081	0,115	0,24	0,21	-0,23	-0,19
TG BÇ 132 VII-2	Δy:Δx>0,15 m	132	0	4,073	-0,000041	36,631	167,41	0,073	0,104	0,14	0,13	-0,12	-0,13

UNIFIED DEDUCTIVE(TG) & INDUCTIVE(TV) SOLUTIONS(BÇ)

TG 331 ÖNEL III-1 U TV 400 ÖNEL VI-2 = (TG U TV) BÇ 469



İŞLEM	TV 400 ÇÖZÜM VI-2 ve TG 331 ÖNEL III-1 KÜMELERİ BİRLEŞİMİ DATUM DÖNÜŞÜMLERİ ÖZET													
		Nokta Sayısı			Dönüşüm parametreleri				Dengeleme İstatistikleri		FARKLAR MAKSİMUM		FARKLAR MİNİMUM	
Çözüm No	Eleme	Ortak	Uyu. suz	Kul.	1 + Δ ppm (Ölçek	Dönüklük (α) (grad)	cy (Δy) (m)	cx (Δx) (m)	mo(m)	mp(m)	Δy(m)	Δx(m)	Δy(m)	Δx(m)
400+331fark_gncl_1	Uyuşumsuz	469	3	466	5,963	0,0000250	31,238	159,575	0,407	0,575	0,70	1,38	-6,44	-1,55
400+331fark_gncl_2	Uyuşumsuz	466	5	461	4,905	0,0000500	29,896	164,414	0,270	0,382	0,83	0,69	-0,99	-1,37
400+331fark_gncl_3	Uyuşumsuz	461	3	458	4,767	0,0000370	30,876	164,930	0,254	0,360	0,84	0,66	-0,98	-0,98
400+331fark_gncl_4	Uyuşumsuz	458	2	456	4,646	0,0000310	31,368	165,421	0,247	0,349	0,85	0,64	-0,97	-0,95
400+331fark_gncl_5	Uyuşumsuz	456	4	452	4,632	0,0000260	31,681	165,451	0,242	0,343	0,85	0,63	-0,97	-0,96
400+331fark_gncl_6	Uyuşumsuz	452	2	450	4,489	0,0000220	32,025	166,053	0,233	0,330	0,76	0,62	-0,85	-0,97
400+331fark_gncl_7	Uyuşumsuz	450	1	449	4,454	0,0000180	32,341	166,180	0,229	0,324	0,74	0,61	-0,85	-0,89
400+331fark_gncl_8	Uyuşumsuz	449	4	445	4,413	0,0000150	32,517	166,344	0,227	0,320	0,75	0,61	-0,84	-0,90
400+331fark_gncl_9	Uyuşumsuz	445	2	443	4,269	0,0000050	33,308	166,905	0,218	0,308	0,76	0,59	-0,82	-0,92
400+331fark_gncl_10	Δy : Δx ≥ 40 cm,Grup	443	56	387	4,231	0,0000010	33,619	167,043	0,213	0,302	0,77	0,58	-0,82	-0,73
400+331fark_gncl_11	Δy : Δx ≥ 40 cm,Grup	387	65	322	4,322	-0,0000360	36,121	166,373	0,176	0,249	0,59	0,50	-0,46	-0,57
400+331fark_gncl_12	Δy : Δx ≥ 20 cm	322	115	207	4,293	-0,0000380	36,280	166,495	0,139	0,197	0,31	0,30	-0,26	-0,29
400+331fark_gncl_13	Δy : Δx ≥ 20 cm	207	67	140	4,086	-0,0000330	36,075	167,436	0,099	0,140	0,21	0,18	-0,17	-0,20
400+331fark_gncl_14	Δy : Δx ≥ 15 cm	140	2	138	4,064	-0,0000230	35,409	167,589	0,074	0,104	0,17	0,13	-0,13	-0,17
400+331fark_gncl_15	Δy : Δx ≥ 15 cm	138	9	129	4,048	-0,0000220	35,309	167,668	0,073	0,103	0,16	0,13	-0,13	-0,14
400+331fark_gncl_16	Δy : Δx ≥ 15 cm	129	4	125	4,122	-0,0000230	35,386	167,323	0,069	0,097	0,16	0,13	-0,10	-0,13
400+331fark_gncl_17	Δy : Δx ≥ 15 cm	125	0	125	4,144	-0,0000220	35,287	167,237	0,067	0,094	0,14	0,13	-0,10	-0,13

SELECTED HELMERT SIMILARITY TRANSFORMATIONs SATISFYING THE REGULATION IMPOSED CONSTRAINTS

IQC

2D HSTs	TRANSFORMATION PARAMETERS						ADJ. STATISTCS	
	a	b	cy (Δy) (m)	cx (Δx) (m)	Δ ppm SCALE	ROTATION (α) (grad)	mo (m)	mp (m)
EK6.25 102 ONEL II-12>0,15	1,000004103072	--2.39817431856064E-07	34,855	167,462	4.103 ppm (1:243719)	-0,000015	0,065	0,092
EK6.34 114 ONEL III-6>0,15	1,000004073625	--1.19048737803999E-06	39,065	167,184	4.074 ppm (1:245481)	-0,000076	0,100	0,141
EK6.35 107 ONEL III-7>0,15	1,000004032359	--1.13143261648139E-06	38,830	167,384	4.032 ppm (1:247993)	-0,000072	0,079	0,111
EK6.42 136 ONEL IV-6>15CM	1,000004024194	--5.16007741719758E-07	36,112	167,690	4.024 ppm (1:248496)	-0,000033	0,077	0,109
EK6.64 TV132 VI-4>0.15m	1,000004074489	-0,000000379536415569	32,111	167,852	4.074 ppm (1:245429)	0,000024	0,075	0,106
EK6.65 TV124 VI-5>0.15m	1,000004014207	-0,000000349515641749	32,275	168,100	4.014 ppm (1:249115)	0,000022	0,069	0,097
EK6.66TGBÇ VII-1 143	1,000004028843	--6.57464520521047E-07	36,738	167,598	4.029 ppm (1:248210)	-0,000042	0,081	0,115
EK6.67TGBÇ VII-2 132	1,000004073175	--6.37117179743849E-07	36,631	167,412	4.073 ppm (1:245508)	-0,000041	0,073	0,104
EK6.69 TGBÇ 140 VIII-1	1,000004012005	--5.09409810501002E-07	36,083	167,744	4.012 ppm (1:249251)	-0,000032	0,082	0,117
EK-6.71 TGBÇ 127 VIII-3	1,000004004254	--5.23520330090384E-07	36,150	167,771	4.004 ppm (1:249734)	-0,000033	0,077	0,109
EK6.75 TGBÇ 93 VIII-7	1,000004116881	--3.01798707420228E-07	35,138	167,375	4.117 ppm (1:242902)	-0,000019	0,059	0,083
EK-6.77 TGBÇ 2005.0 140 IX-1	1,000004158667	--6.68304777802978E-07	36,466	166,925	4.159 ppm (1:240461)	-0,000043	0,104	0,147
EK-6.89 TGBÇ 2005.0 93 IX-13	1,000004258497	--2.5924527133404E-07	34,629	166,659	4.258 ppm (1:234824)	-0,000017	0,057	0,080
EK-6.104 TV+TG BÇ140 X-14	1,000004063769	--3.62475890535616E-07	35,409	167,589	4.064 ppm (1:246076)	-0,000023	0,074	0,104
EK-6.107 TV+TGBÇ125 X-17	1,000004143982	--3.40858863204587E-07	35,287	167,237	4.144 ppm (1:241313)	-0,000022	0,067	0,094
EK-6.114 TV+TG 140 XI-6	1,000004077059	--4.19891266647572E-07	35,662	167,493	4.077 ppm (1:245274)	-0,000027	0,076	0,107
EK-6.118 TV+TG 142 XII-3	1,000004004438	--4.47044115224035E-07	35,810	167,801	4.004 ppm (1:249722)	-0,000028	0,077	0,109
EK-6.120 TV+TG BÇ 147 XIII-1	1,000003978227	--5.81480170896947E-07	36,418	167,855	3.978 ppm (1:251368)	-0,000037	0,083	0,117
EK-6.122 TV+TG 139 XIII-3	1,000003999268	--5.59127692436633E-07	36,311	167,770	3.999 ppm (1:250045)	-0,000036	0,076	0,108
EK-6.124 TV+TG 146 XIII	1,000003969571	--7.3609270510578E-07	37,106	167,840	3.970 ppm (1:251916)	-0,000047	0,106	0,150

EXPERIMENTAL RE-DESIGN OF JGCPs SET TO PROVIDE THE BEST POSSIBLE COVERAGE FOR THE PROJECT AREA

WITH 146 JGCPs

- **MINIMUM GAPs**
- **$-0,38m \leq \Delta y \leq 0,30m$; $-0,31m \leq \Delta x \leq 0,34m$**
- **$m_0 = \pm 0,106m$**

FINAL UNIQUE TRANSFORMATION

		PT NU.		TRANS. PARAMETERS				STATISTICS.		Differences			
										Maximum		Minimum	
SOLUTION No:	ELIMINTN	JGCP	REJT	Δ ppm SCL	ROTATAT (α) (grad)	cy (Δy) (m)	cx (Δx) (m)	mo (m)	mp (m)	*Δy(m)*	*Δx(m)*	*Δy(m)*	*Δx(m)*
TV+TG BÇ 146 XIII-1	Δy:Δx> ? m	146	8	3,97	-0,000047	37,106	167,84	0,106	0,15	0,30	0,34	-0,38	-0,31

EXTERNAL QUALITY CONTROLS FOR HSTs

HSTs USED FOR EXTERNAL QUALITY CONTROL HSTs USED FOR EXTERNAL QUALITY CONTROL

IQC

2D HSTs	TRANSFORMATION PARAMETERS						ADJ. STATISTCS	
	a	b	cy (Δy) (m)	cx (Δx) (m)	Δ ppm SCALE	ROTATION (α) (grad)	mo (m)	mp (m)
EK6.25 102 ONEL II-12>0,15	1,000004103072	--2.39817431856064E-07	34,855	167,462	4.103 ppm (1:243719)	-0,000015	0,065	0,092
EK6.34 114 ONEL III-6>0,15	1,000004073625	--1.19048737803999E-06	39,065	167,184	4.074 ppm (1:245481)	-0,000076	0,100	0,141
EK6.35 107 ONEL III-7>0,15	1,000004032359	--1.13143261648139E-06	38,830	167,384	4.032 ppm (1:247993)	-0,000072	0,079	0,111
EK6.42 136 ONEL IV-6>15CM	1,000004024194	--5.16007741719758E-07	36,112	167,690	4.024 ppm (1:248496)	-0,000033	0,077	0,109
EK6.64 TV132 VI-4>0.15m	1,000004074489	-0,000000379536415569	32,111	167,852	4.074 ppm (1:245429)	0,000024	0,075	0,106
EK6.65 TV124 VI-5>0.15m	1,000004014207	-0,000000349515641749	32,275	168,100	4.014 ppm (1:249115)	0,000022	0,069	0,097
EK6.66TGBÇ VII-1 143	1,000004028843	--6.57464520521047E-07	36,738	167,598	4.029 ppm (1:248210)	-0,000042	0,081	0,115
EK6.67TGBÇ VII-2 132	1,000004073175	--6.37117179743849E-07	36,631	167,412	4.073 ppm (1:245508)	-0,000041	0,073	0,104
EK6.69 TGBÇ 140 VIII-1	1,000004012005	--5.09409810501002E-07	36,083	167,744	4.012 ppm (1:249251)	-0,000032	0,082	0,117
EK-6.71 TGBÇ 127 VIII-3	1,000004004254	--5.23520330090384E-07	36,150	167,771	4.004 ppm (1:249734)	-0,000033	0,077	0,109
EK6.75 TGBÇ 93 VIII-7	1,000004116881	--3.01798707420228E-07	35,138	167,375	4.117 ppm (1:242902)	-0,000019	0,059	0,083
EK-6.77 TGBÇ 2005.0 140 IX-1	1,000004158667	--6.68304777802978E-07	36,466	166,925	4.159 ppm (1:240461)	-0,000043	0,104	0,147
EK-6.89 TGBÇ 2005.0 93 IX-13	1,000004258497	--2.5924527133404E-07	34,629	166,659	4.258 ppm (1:234824)	-0,000017	0,057	0,080
EK-6.104 TV+TG BÇ140 X-14	1,000004063769	--3.62475890535616E-07	35,409	167,589	4.064 ppm (1:246076)	-0,000023	0,074	0,104
EK-6.107 TV+TGBÇ125 X-17	1,000004143982	--3.40858863204587E-07	35,287	167,237	4.144 ppm (1:241313)	-0,000022	0,067	0,094
EK-6.114 TV+TG 140 XI-6	1,000004077059	--4.19891266647572E-07	35,662	167,493	4.077 ppm (1:245274)	-0,000027	0,076	0,107
EK-6.118 TV+TG 142 XII-3	1,000004004438	--4.47044115224035E-07	35,810	167,801	4.004 ppm (1:249722)	-0,000028	0,077	0,109
EK-6.120 TV+TG BÇ 147 XIII-1	1,000003978227	--5.81480170896947E-07	36,418	167,855	3.978 ppm (1:251368)	-0,000037	0,083	0,117
EK-6.122 TV+TG 139 XIII-3	1,000003999268	--5.59127692436633E-07	36,311	167,770	3.999 ppm (1:250045)	-0,000036	0,076	0,108
EK-6.124 TV+TG 146 XIII	1,000003969571	--7.3609270510578E-07	37,106	167,840	3.970 ppm (1:251916)	-0,000047	0,106	0,150

PHASE 2 EQC : EQC JGCPs SET CLASSIFICATION

‘0’ CODED EQC : ALL EQC JGCPs SET, FORMED WITH UN-USED POINTS IN THE RELATED TRANSFORMATION,

‘-1’ CODED EQC: SET FORMED THE POINTS CREATING DIFFERENCES>1.0m IN ‘0’ CODED EQC PROCESS,

‘A’ CODED EQC : SET FORMED AFTER EXCLUSION OF ‘-1’ CODED POINTS FROM ‘0’ CODED SET,

‘B’ CODED EQC : SET FORMED BY ALL POINTS FALLING IN THE PROJECT AREA.

‘C’ CODED EQC : SET FORMED WITH THE POINTS FALLING IN THE AREA DEFINED BY THE MOST OUTER POINTS OF THE RELATED TRANSFORMATION JGCPs SET

POINT AND GROUP BASED DIFFERENCE CLASSIFICATION USED FOR EQC

POINT AND GROUP BASED DIFF. CLASSIFICATION FOR EQC WITH 887 JGCPs SET FOR THE 146 JGCPS HST

CLASS INTER	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	169	39	1,2,3,5,10,14,27,30,33,38,40,43,44,47,48,49,55,57,58,61,62,65,67,68,71,82,83,85,86,87,89,90,93,94,95,101,105,106,107
0,15<ΔY:ΔX<0,25	115	41	1,3,5,10,13,14,27,30,33,40,41,47,48,49,50,51,52,53,55,57,58,61,62,65,67,68,69,70,71,77,82,83,85,86,87,89,90,93,101,106,107
0,25<ΔY:ΔX<0,50	183	51	1,2,3,4,5,13,14,25,27,30,33,38,40,41,43,44,45,46,47,48,49,50,51,52,53,55,57,63,65,67,68,69,70,71,77,82,83,86,87,88,90,93,95,97,99,100,101,102,105,106,108
0,50<ΔY:ΔX<0,85	98	29	4,10,25,28,46,47,52,63,65,68,72,73,77,78,81,88,90,91,94,96,97,98,99,100,102,104,108,110,112
0,85<ΔY:ΔX<1,00	26	18	24,28,59,66,73,78,79,81,94,96,97,98,104,109,110,111,112,116
ΔY:ΔX>1,0	193	29	6,7,8,9,11,12,15,16,18,19,21,22,23,26,31,34,39,42,56,64,74,76,84,92,103,113,114,118,119
	103	18	24,25,28,46,59,66,72,78,79,81,91,94,97,109,110,111,112,116
TOTAL	887		

ΔY:ΔX>1,0	193	29	6,7,8,9,11,12,15,16,18,19,21,22,23,26,31,34,39,42,56,64,74,76,84,92,103,113,114,118,119
	92	17	24,25,28,46,59,66,72,79,81,91,94,97,109,110,111,112,116
TOTAL	887		

JGCPS:747	Differences		Abs. Differences		
	ΔY	ΔX	ΔY	ΔX	Δs
MAKSİMUM	7,258	2,732	7,258	2,732	7,397
MİNİMUM	-2,011	-1,574	0,016	0,025	1,074
MEAN	2,403	1,259	3,149	1,330	3,654
mo	3,389	0,475	2,720	0,408	2,466

GRPs:106	Differences		Abs. Differences		
	ΔY	ΔX	ABS(ΔY)	ABS(ΔX)	Δs
MAKSİMUM	7,116	2,609	7,116	2,609	7,177
MİNİMUM	-1,652	-1,247	0,063	0,077	1,074
MEAN	2,249	1,193	2,975	1,261	3,473
mo	3,304	0,452	2,686	0,381	2,437

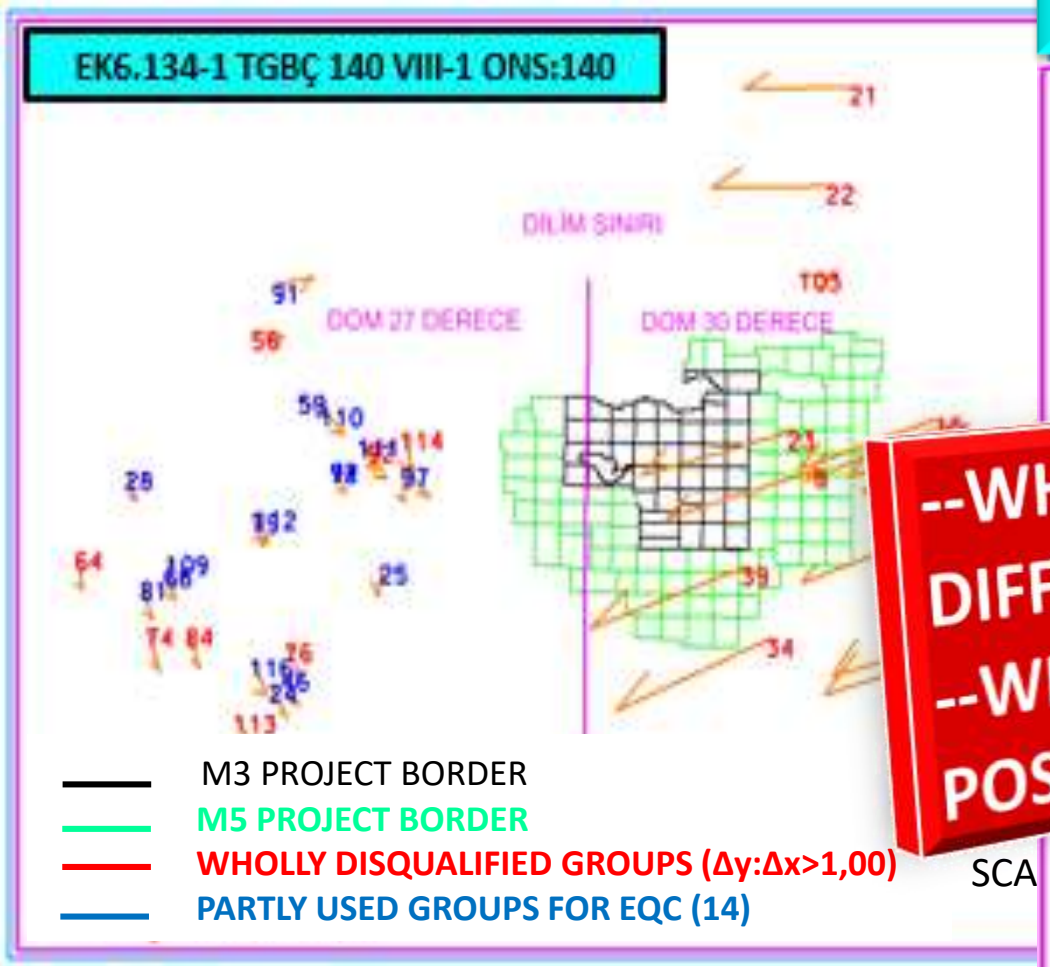
PHASE 2 '0' CODED: POINT AND GROUP BASED EQC STATISTICS FOR 140 JGCPs HST

PHASE 2 '0' CODED : POINT AND GROUP BASED EQC STATISTICS FOR 146 JGCPs HST

JGCPS:741	Differences		Abs. Differences		
	ΔY	ΔX	ΔY	ΔX	Δs
MAKSİMUM	7,251	2,739	7,251	2,739	7,406
MİNİMUM	-2,025	-1,538	0,028	0,016	1,045
MEAN	2,521	1,260	3,242	1,336	3,733
mo	3,407	0,493	2,733	0,419	2,489

GRPs:106	Differences		Abs. Differences		
	ΔY	ΔX	ABS(ΔY)	ABS(ΔX)	Δs
MAKSİMUM	7,107	2,621	7,107	2,621	7,174
MİNİMUM	-1,662	-1,220	0,061	0,082	1,105
MEAN	2,308	1,191	3,024	1,262	3,510
mo	3,319	0,460	2,696	0,393	2,457

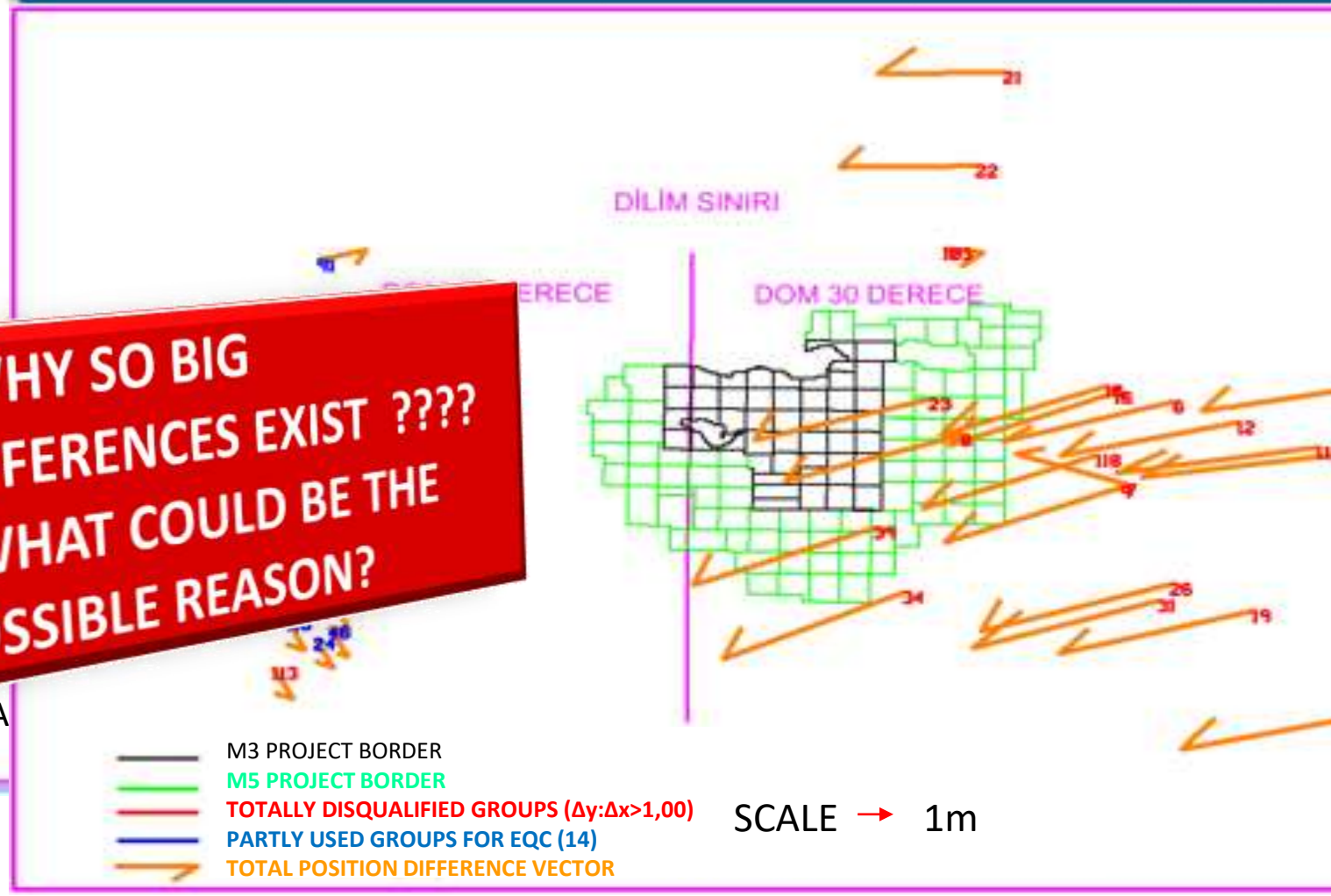
POSITION DIFFERENCE VECTORS FOR NEVER AND PARTLY USED GROUP'S WEIGTH CENTERS OF Δy:Δx: ΔS>1.0m ➔ RESPECTIVELY OF 140 & 146 &102 JGCP HSTs : PHASE 2 '-1 CODED' EQC



--WHY SO BIG DIFFERENCES EXIST ???? --WHAT COULD BE THE POSSIBLE REASON?

SCA

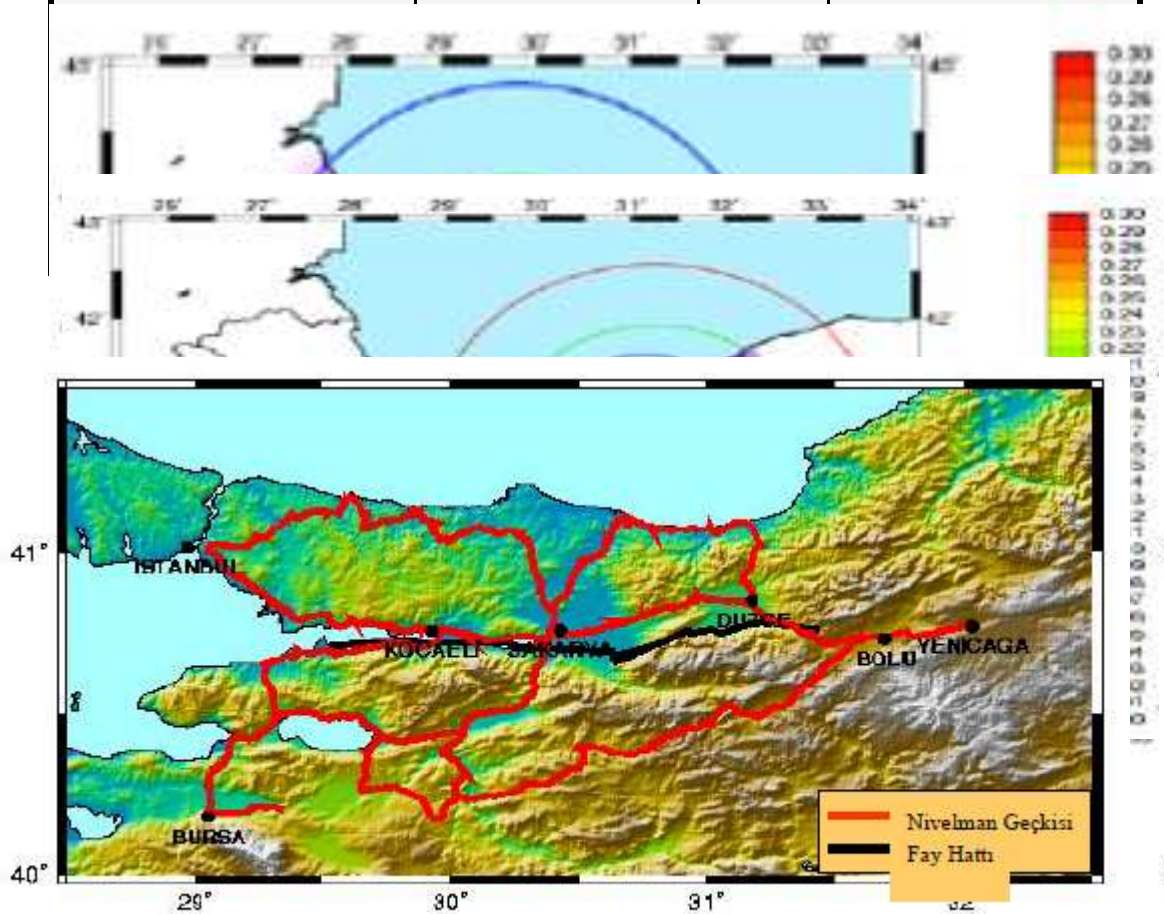
POSITION DIFFERENCE VECTORS FOR NEVER AND PARTLY USED GROUPS W CENTERS OF Δy:Δx>1.00m ➔ ΔS>1.0m 102 JGCP HST



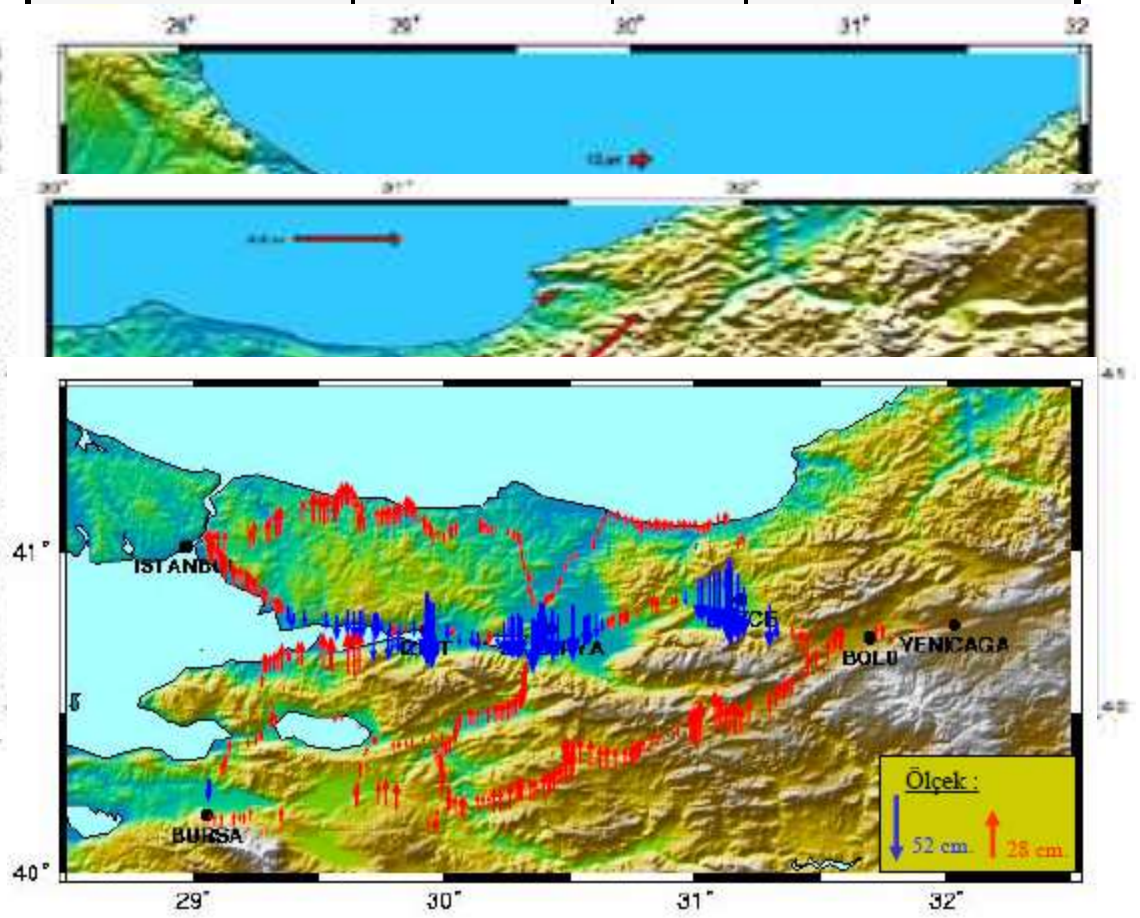
IMPORTANT EARTHQUAKE IN AND AROUND PROJECT AREA HAVING MAGNITUDE BIGGER THAN 6.0 AFTER 1950 (MTA,Ayhan etal, 2001)

EPICENTER	DATE	Mag.	DİSTANCE TO PRJ. ARE.(km)
YENİCE-GÖNEN	18.03.1953	7.4	120

EPICENTER	DATE	Mag.	DİSTANCE TO PRJ. ARE.(km)
AKYAZI	30.07.1967	6.0	144

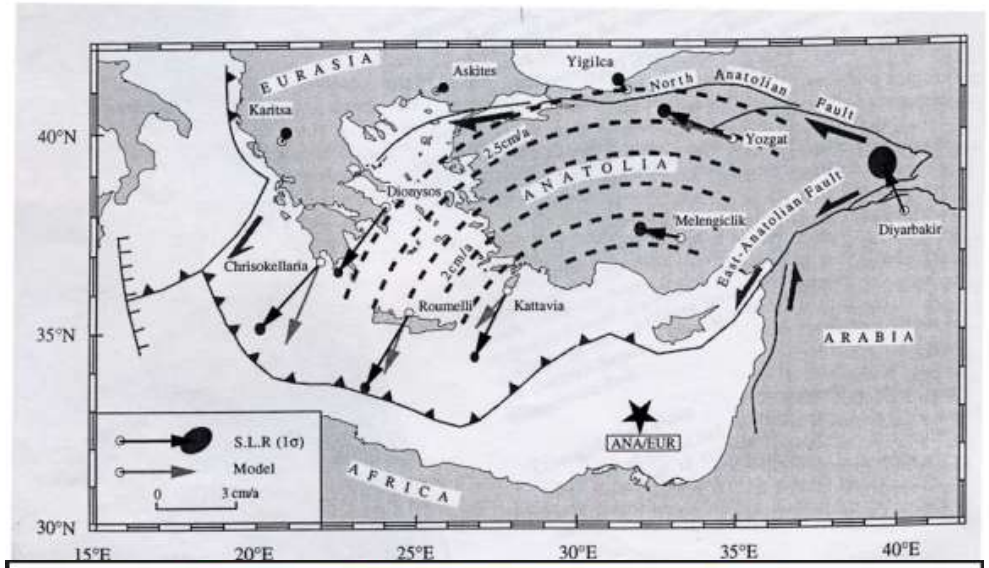


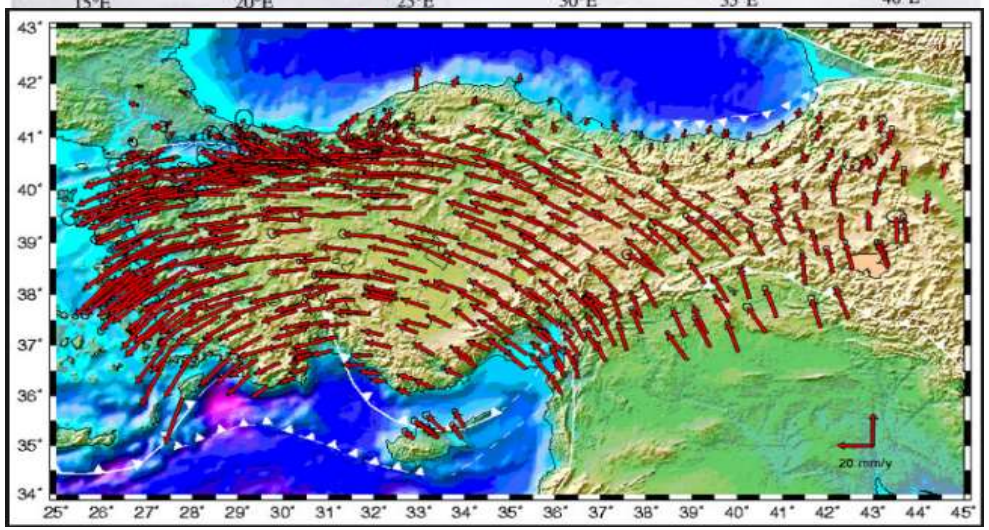
Şekil-5.4: 2000 yılında ölçülen TUDKA-99 geçkileri.



Şekil-5.5: İzmit ve Düzce depremleriyle oluşan düşey deformasyon. Mavi renkli aşağı

SIMPLE EVALUATION OF DIFFERENCES(RESIDUALS)

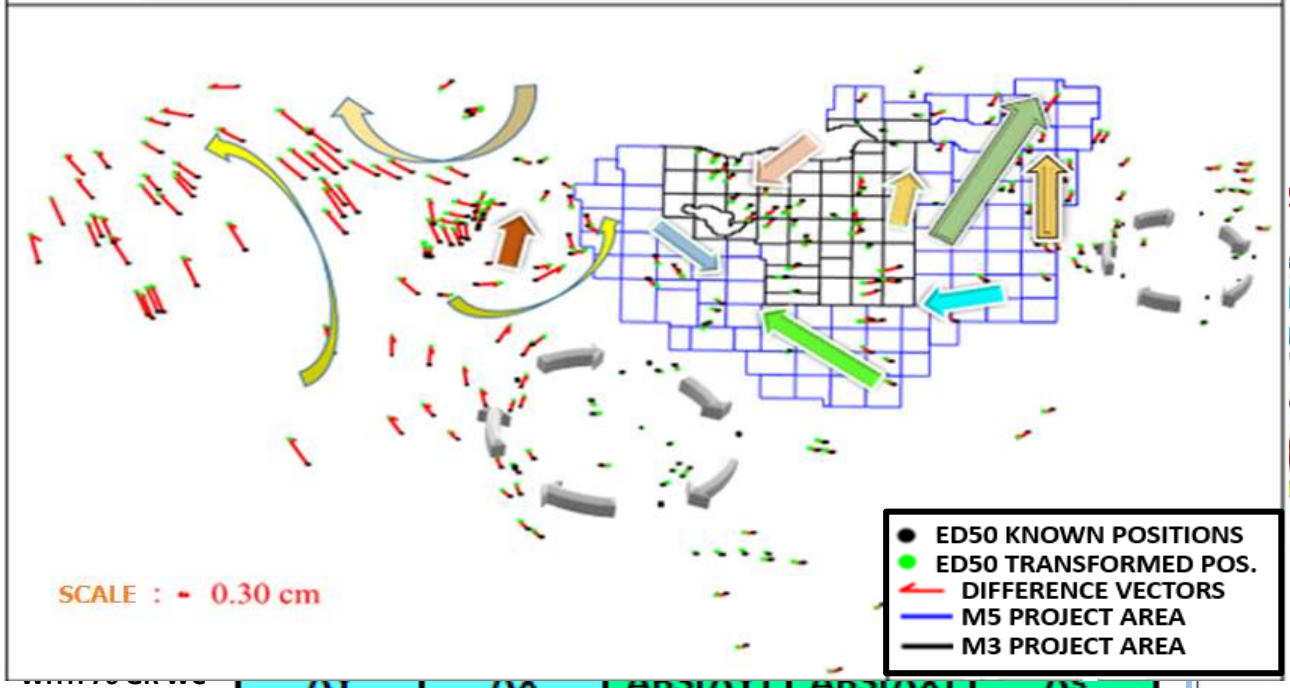




- Anatolian Plate westward average velocity 2.5 cm./year
- Time elapsed since Turkish Horizontal network adjustment (2015-1954= 61 Years)
- Average survey duration of Turkish National Horizontal Control Network (1953-1937=18 Year)
- Average Estimated duration elapsed since the mid of observation period (61+9=70)
- Assumption: no change in Anatolian Plate velocity field (70*2.5 cm= 175.0 cm Total Difference in 70 years)
- So a difference of 1.750m in any datum can be accepted an average displacement except co-siesmic effects and chances in the velocity field.

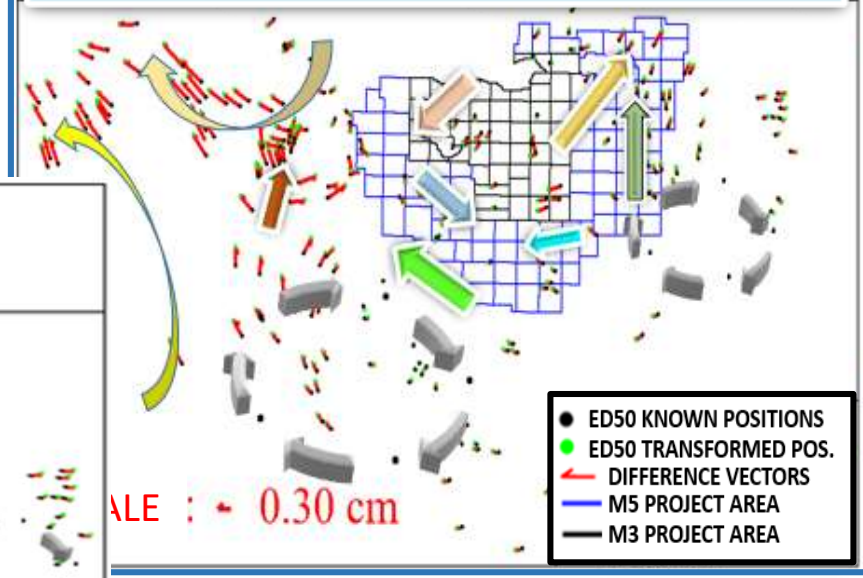
'A' CODED EQC WITH 468 JGCPs	DIFFERENCES		ABSOLUTE DIFFERENCES		
	ΔY	ΔX	ΔY	ΔX	Δs
MAKSİMUM	0,867	0,994	0,974	0,994	1,299
MİNİMUM	-0,974	-0,480	0,001	0,001	0,031
MEAN	-0,135	0,201	0,268	0,298	0,440

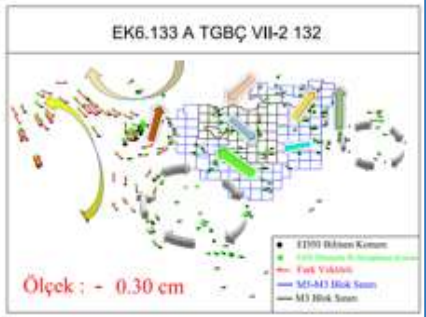
'A'CODED EQC WITH 511 GCPs FOR HST 102



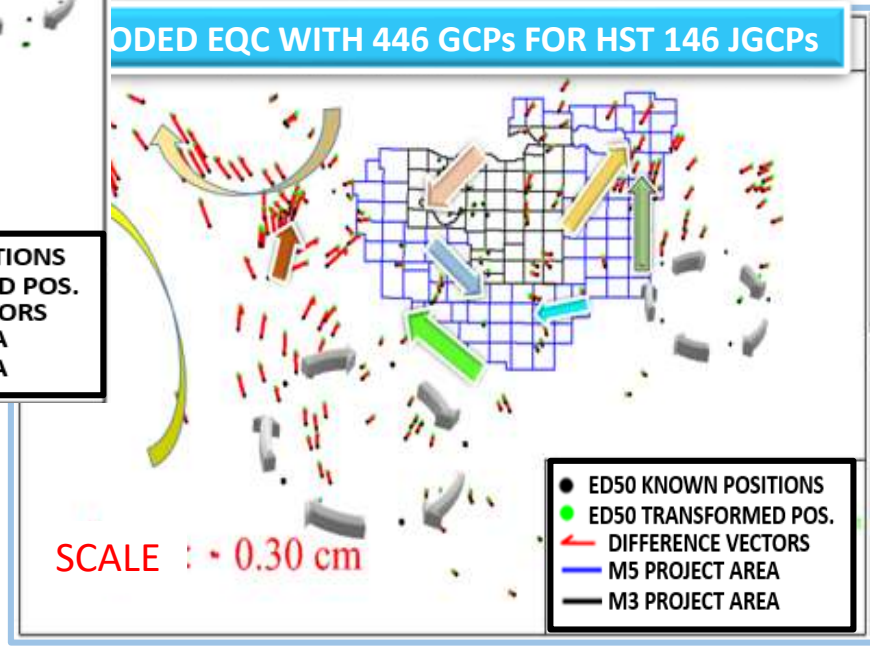
MAKSİMUM	0,362	0,978	0,950	0,978	1,322
MİNİMUM	-0,950	-0,336	0,033	0,047	0,085
MEAN	-0,164	0,260	0,297	0,342	0,476
mo	0,247	0,273	0,162	0,216	0,247

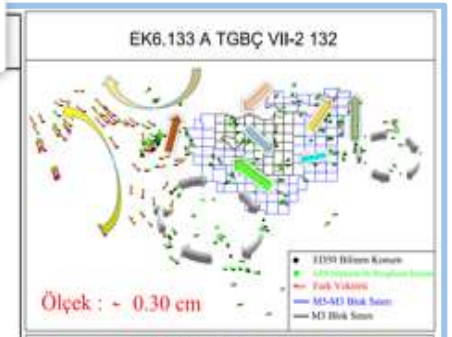
'A'CODED EQC WITH 468 GCPs FOR HST 140 JGCPs

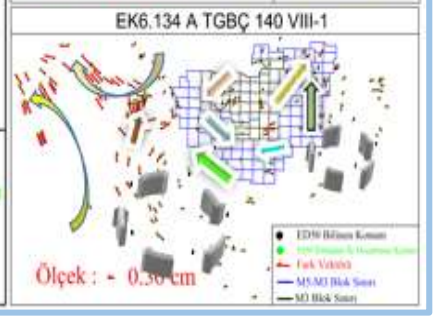




ODED EQC WITH 446 GCPs FOR HST 146 JGCPs







'B' CODED EQC WITH 124 JGCPs	DIFFERENCES		ABSOLUTE DIFFERENCES		
	ΔY	ΔX	ΔY	ΔX	Δs
MAKSİMUM	0,394	0,728	0,618	0,728	0,761
MİNİMUM	-0,618	-0,316	0,001	0,016	0,031
MEAN					
mo					

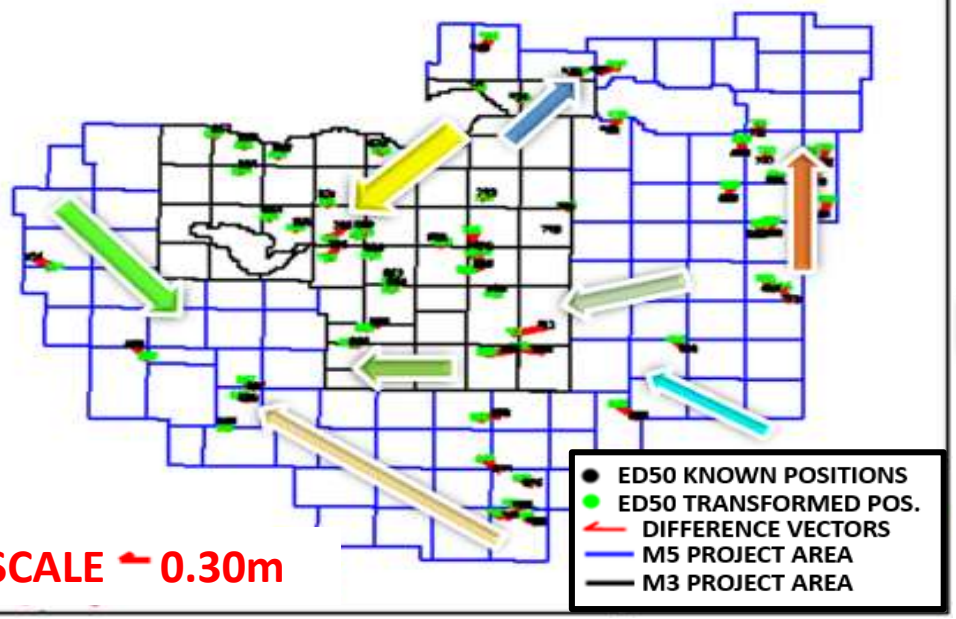
'B' CODED
WITH 23 G

MAKSİM	
MİNİM	
MEAN	
mo	

'B' CODED
WITH 111 J

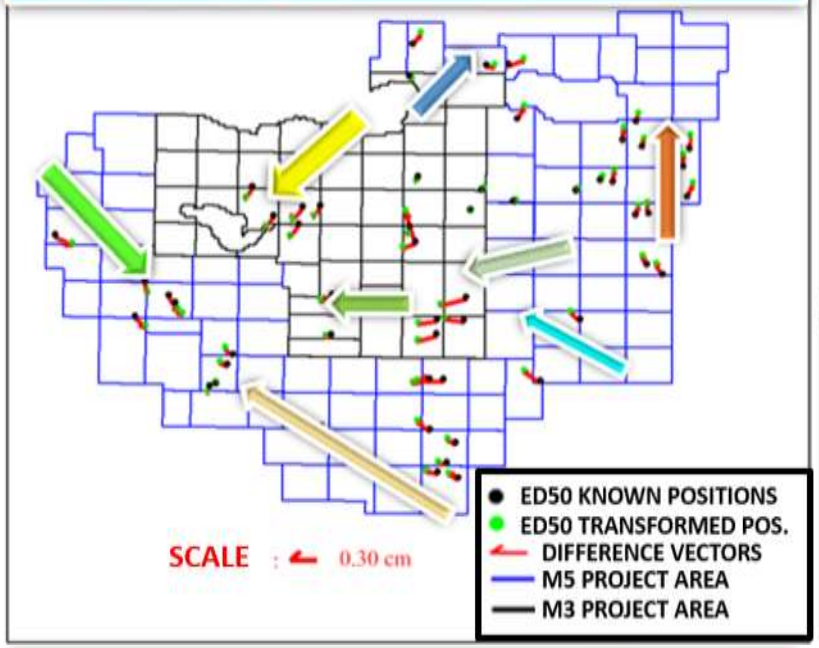
MAKSİ	
MİNİM	
MEA	
mo	

'B'CODED EQC WITH 94 GCPs FOR HST 102

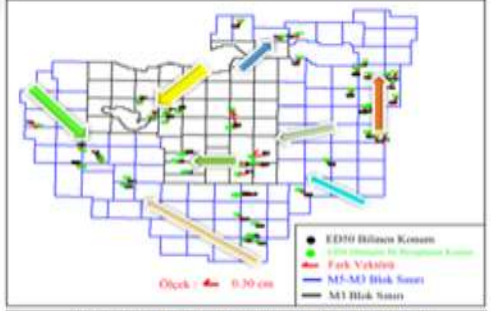


'B' CODED EQC WITH 21 GR WC	DIFFERENCES		ABSOLUTE DIFFERENCES		
	ΔY	ΔX	ABS(ΔY)	ABS(ΔX)	Δs
MAKSİMUM	0,328	0,321	0,452	0,342	0,474
MİNİMUM	-0,452	-0,230	0,008	0,010	0,085
MEAN	-0,062	0,060	0,174	0,184	0,280
mo	0,159	0,160	0,097	0,074	0,059

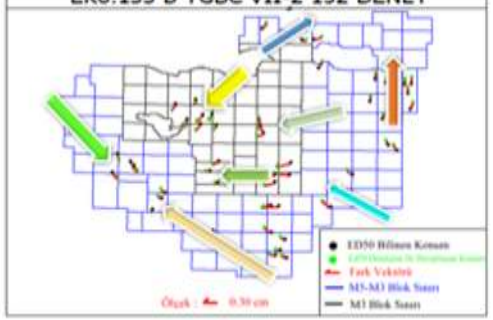
'B'CODED EQC WITH 124 GCPs FOR HST 140



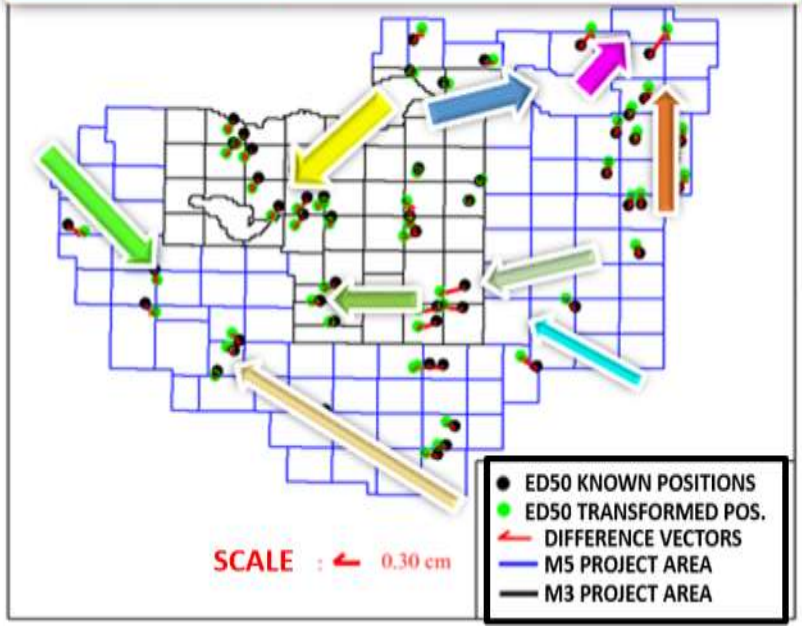
EK6.132 B TGBÇ VII-1 143 DENET



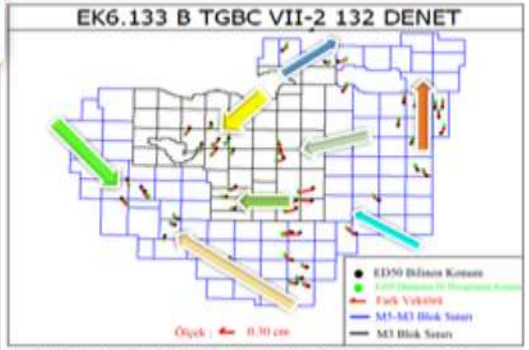
EK6.133 B TGBC VII-2 132 DENET



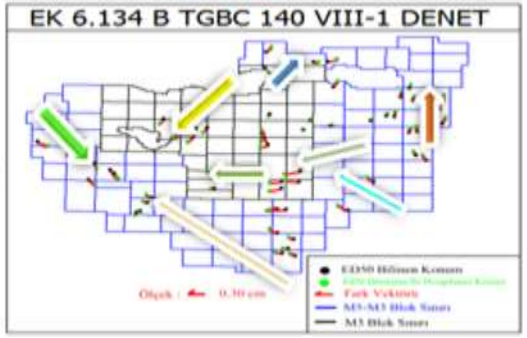
'B'CODED EQC WITH 111 GCPs FOR HST 146



EK6.133 B TGBC VII-2 132 DENET

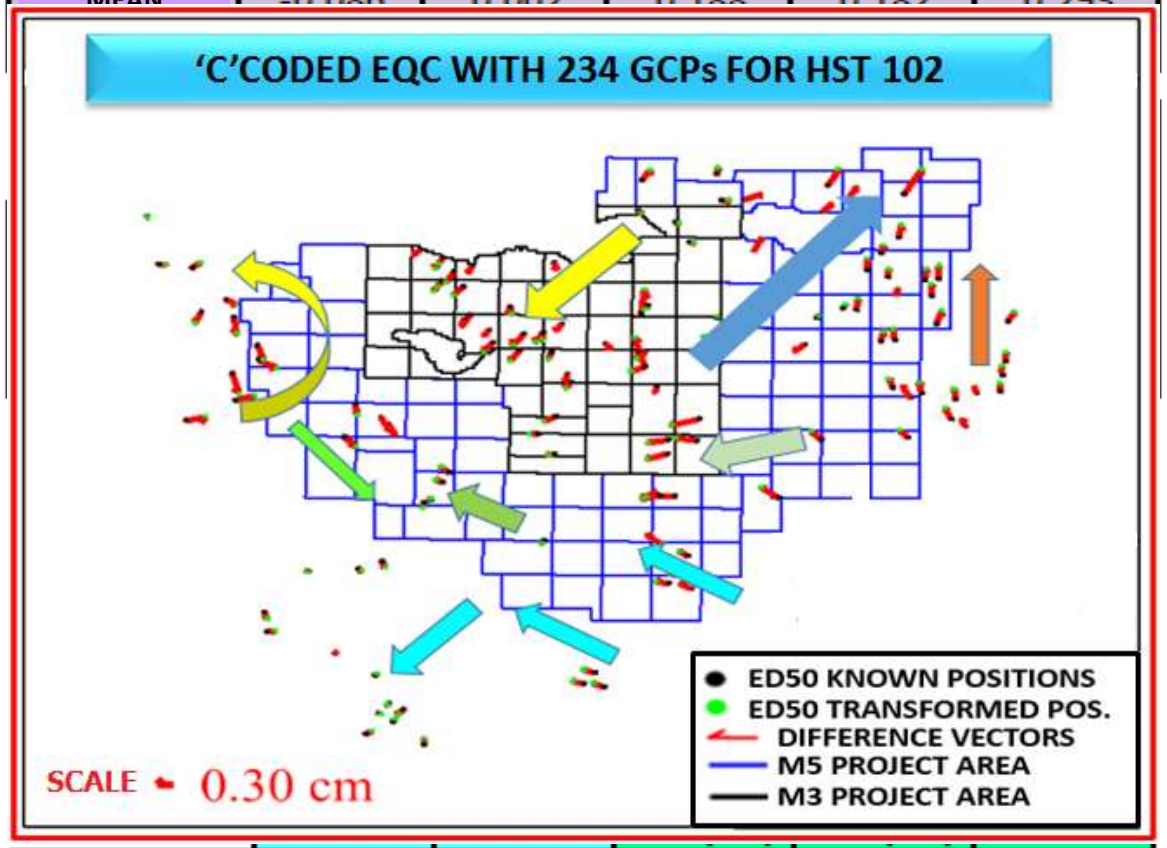


EK 6.134 B TGBC 140 VIII-1 DENET

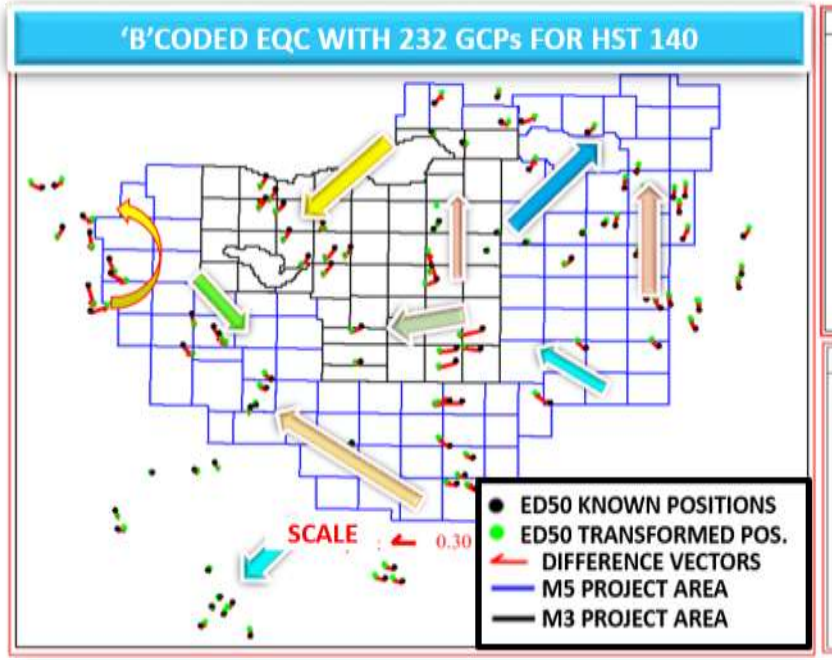


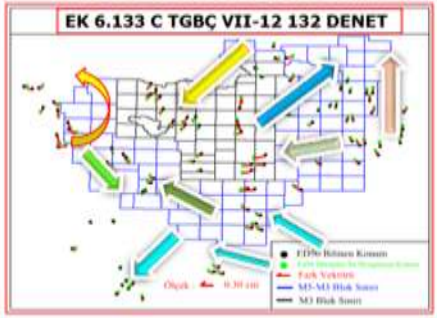
'C' CODED EQC WITH 238 JGCPs

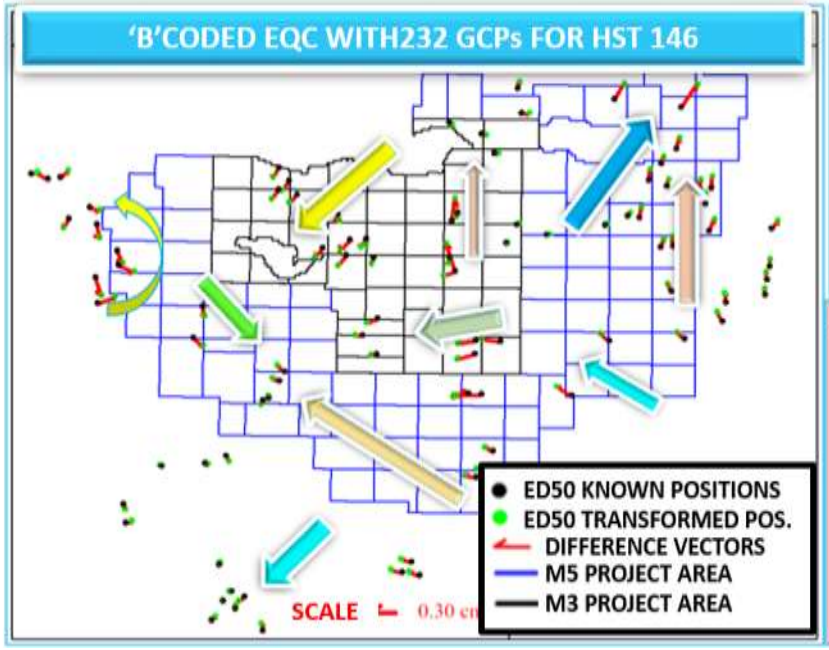
	DIFFERENCES		ABSOLUTE DIFFERENCES		
	ΔY	ΔX	ΔY	ΔX	Δs
MAKSİMUM	0,430	0,728	0,618	0,728	0,761
MİNİMUM	-0,618	-0,480	0,001	0,005	0,031
MEAN	-0,086	0,002	0,188	0,182	0,293

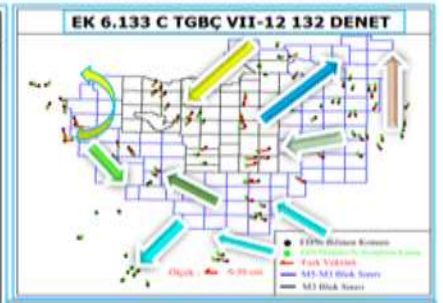


MAKSİMUM	0,427	0,499	0,452	0,499	0,601
MİNİMUM	-0,452	-0,336	0,033	0,039	0,059
MEAN	-0,023	0,031	0,185	0,173	0,273
mo	0,157	0,146	0,090	0,079	0,082









SOME RESULTS OF POINT BASED EQC FOR HST

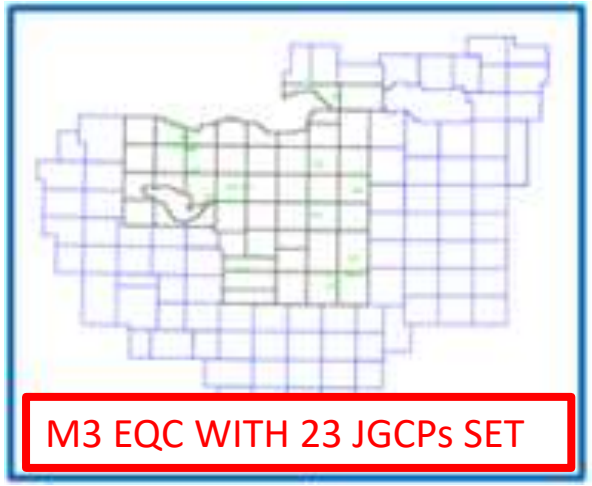
		0		(A)		(B)		(C)	
		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	ΔY	ΔX
EK-6.126 0,A,B,C ONEL II-12 102	MAKSİMUM	7,229	2,737	0,871	0,999	0,871	0,999	0,871	0,720
	MİNİMUM	-6,770	-1,504	-0,976	-0,512	-0,976	-0,294	-0,619	-0,512
	ORTALAMA	2,364	1,173	-0,135	0,183	-0,126	0,207	-0,084	0,026
	m0	3,698	0,592	0,237	0,276	0,226	0,257	0,184	0,173
EK-6.132 0,A,B,C TGBÇ VII-1 143	MAKSİMUM	7,229	2,737	0,863	0,996	0,392	0,737	0,426	0,737
	MİNİMUM	-6,770	-1,504	-0,971	-0,458	-0,626	-0,299	-0,598	-0,299
	ORTALAMA	2,364	1,173	-0,136	0,212	-0,135	0,064	-0,101	0,090
	m0	3,698	0,592	0,243	0,264	0,192	0,180	0,186	0,147
EK-6.132 0,A,B,C TGBÇ VII-2 132	MAKSİMUM	7,233	2,749	0,866	0,988	0,393	0,734	0,427	0,734
	MİNİMUM	-2,011	-1,544	-0,996	-0,463	-0,629	-0,302	-0,629	-0,463
	ORTALAMA	0,732	0,525	-0,138	0,206	-0,145	0,039	-0,099	0,011
	m0	1,627	0,595	0,242	0,265	0,183	0,174	0,180	0,175
EK 6.134 0,A,B,C TGBÇ VIII-1 140	MAKSİMUM	7,251	2,739	0,867	0,994	0,394	0,728	0,430	0,728
	MİNİMUM	-2,025	-1,538	-0,974	-0,480	-0,618	-0,316	-0,618	-0,480
	ORTALAMA	0,738	0,512	-0,135	0,201	-0,141	0,020	-0,086	0,002
	m0	1,630	0,590	0,246	0,273	0,196	0,172	0,182	0,182
EK6.145 0,A,B,C TV+TG XIII 146	MAKSİMUM	7,258	2,732	0,862	0,978	0,419	0,724	0,427	0,724
	MİNİMUM	-2,011	-1,574	-0,972	-0,464	-0,622	-0,275	-0,622	-0,464
	ORTALAMA	0,734	0,519	-0,134	0,197	-0,126	0,033	-0,090	0,004
	m0	1,632	0,595	0,244	0,266	0,182	0,179	0,179	0,169
SONUÇ İSTATİSTİKLERİ	MAKSİMUM	7,258	2,749	0,871	0,999	0,871	0,999	0,871	0,737
	MİNİMUM	-6,770	-1,574	-0,996	-0,512	-0,976	-0,316	-0,629	-0,512
	MAK. ORT	2,364	1,173	-0,134	0,212	-0,126	0,207	-0,084	0,090
	MAK. M0	3,698	0,595	0,246	0,276	0,226	0,257	0,186	0,182
	MİN ORT.	0,732	0,512	-0,138	0,183	-0,145	0,020	-0,101	0,002
	MİN M0	1,627	0,590	0,237	0,264	0,182	0,172	0,179	0,147

TO CONCLUDE :

1. **ALTHOUGH THERE ARE BIGGER RESIDUALS FOR ΔY:ΔX THAN 0.15 m; BEST RESULTS ARE ACHIEVED WITH THE HST OF 146 JGCPs , FROM THE POINTS OF ;**
   a) **NUMBER OF JGCPs,**
   b) **DISTRIBUTION TO PROJECT AREA,**
   c) **THE BEST m0 VALUE**
2. **ALTHOUGH MAX AND MIN VALUES FOR ΔY:ΔX ARE IN THE RANGE OF**
   $-0.622 < \Delta y < 0.427$
   $-0.464 < \Delta x < 0.724$

EQC PHASE 3 : GEODETIC EQC FOR M3 PROJECT AREA

- **23 GCPs COMMON IN EACH DATUM (ITRF96 AND ED50) DEFINED NOT USED IN M3 HST TRANSFORMATION .**
- **EQC PROCESS APPLIED TO THIS SET WITH HST M3(34) AND M5(146) transformation parameteres seperately**



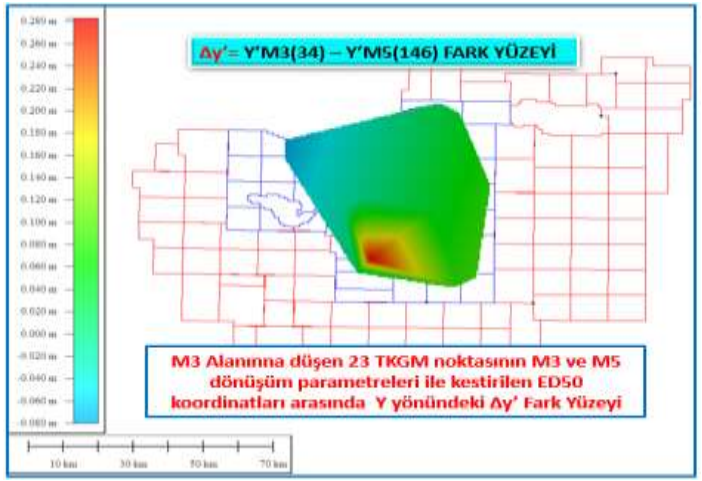
M3 EQC WITH 23 JGCPs SET

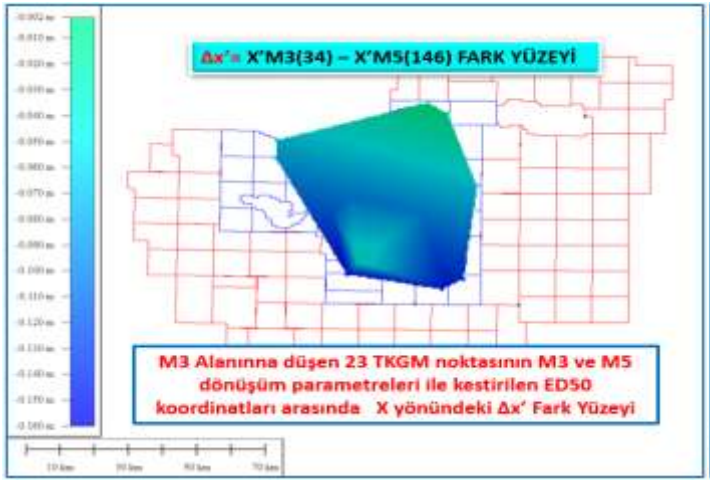
LEGEND
M3 PROJECT
M5 PROJECT
JGCPs :23

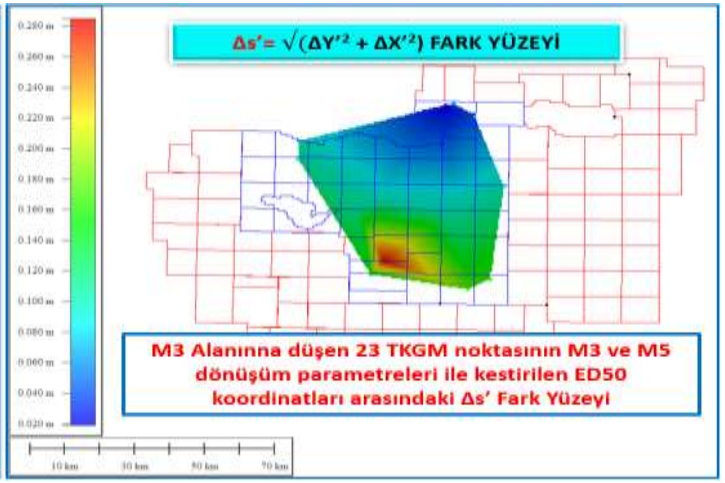
	WITH M3 TRANS. PRM. (GCP:34)				WITH M5 TRANS. PRM. (GCP:146)				DIFF (M3 - M5) TRANSFORMED		
	(Δy:Δx) DIFF ED50		ABS DIFF ED50		(Δy:Δx) DIFF ED50		ABS DIFF ED50		COMP(M3-M5)ED50		
	$Y-Y'_{M3(34)}$	$X-X'_{M3(34)}$	ΔY=Y-Y'	ΔX=X-X'	$Y-Y'_{M5(146)}$	$X-X'_{M5(146)}$	ΔY=Y-Y'	ΔX=X-X'	$Y'_{M3}-Y'_{M5}$	$X'_{M3}-X'_{M5}$	Δs
MAX.	0,076	0,196	0,686	0,196	0,118	0,059	0,592	0,275	0,283	-0,002	0,285
MIN.	-0,686	-0,187	0,028	0,013	-0,592	-0,275	0,000	0,000	-0,080	-0,160	0,019
MEAN.	-0,188	-0,040	0,205	0,097	-0,165	-0,125	0,190	0,134	0,023	-0,085	0,116
m_0	0,160	0,089	0,148	0,055	0,139	0,096	0,118	0,086	0,064	0,035	0,035

EQC PHASE 3 : GEODETIC EQC FOR M3 PROJECT AREA

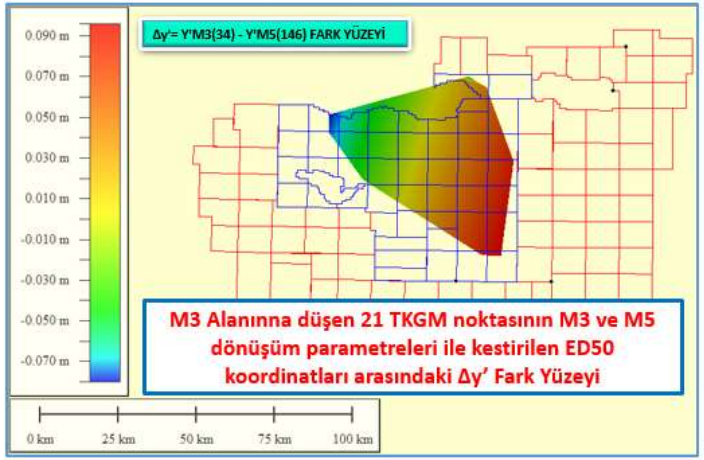
ΔY, ΔX, ΔS DIFFERENCES DISTRIBUTION TO PROJECT AREA FOR 23 GCPs

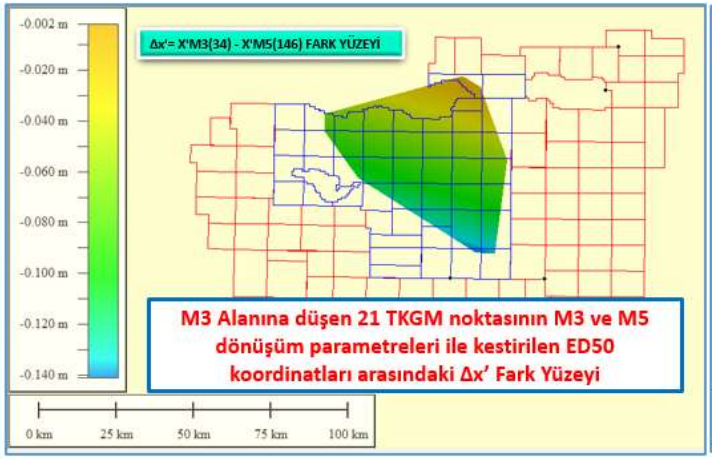


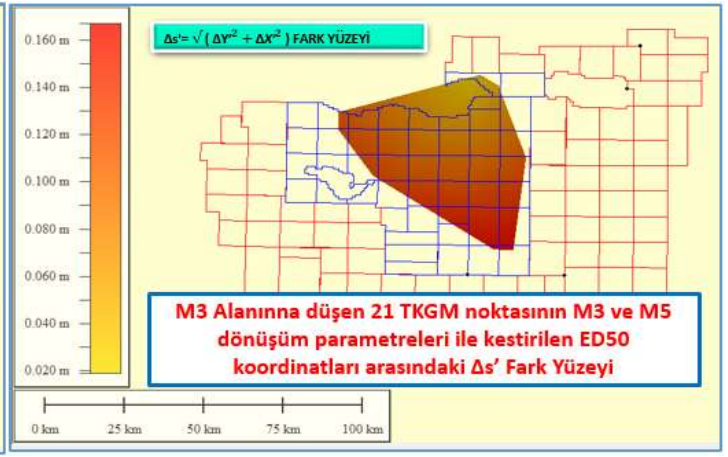




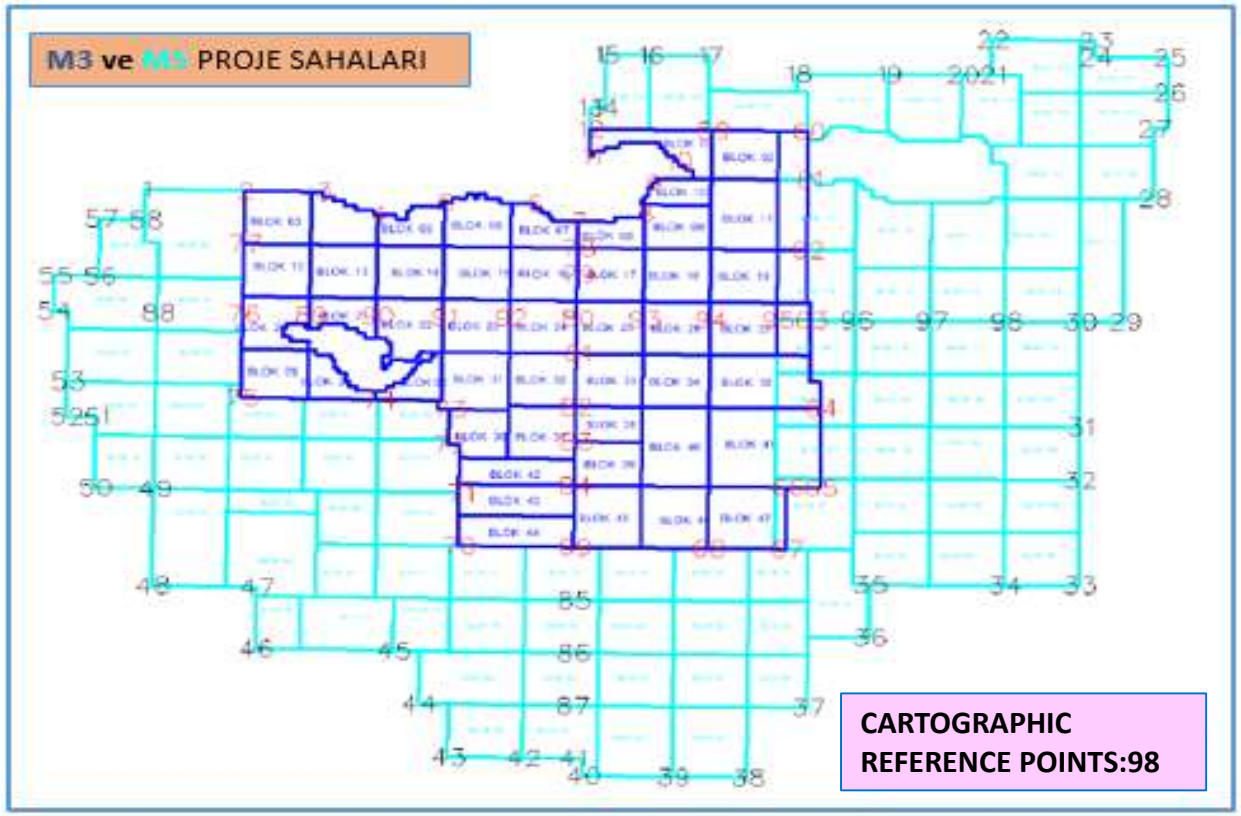
ΔY, ΔX, ΔS DIFFERENCES DISTRIBUTION TO PROJECT AREA FOR 21 GCPs







CARTOGRAPHIC CONTROLS



CARTOGRAPHIC CONTROL POINTS IN M3/M5 PROJECT AREA: 45/98
OVER M3/M5 EXTERNAL BORDERS : 45/58 POINTS
OVER M3/M5 WEST-EAST DIRECTION: 10/17 POINTS
OVER NORTH-SOUTH DIRECTION : 9/14 POINTS

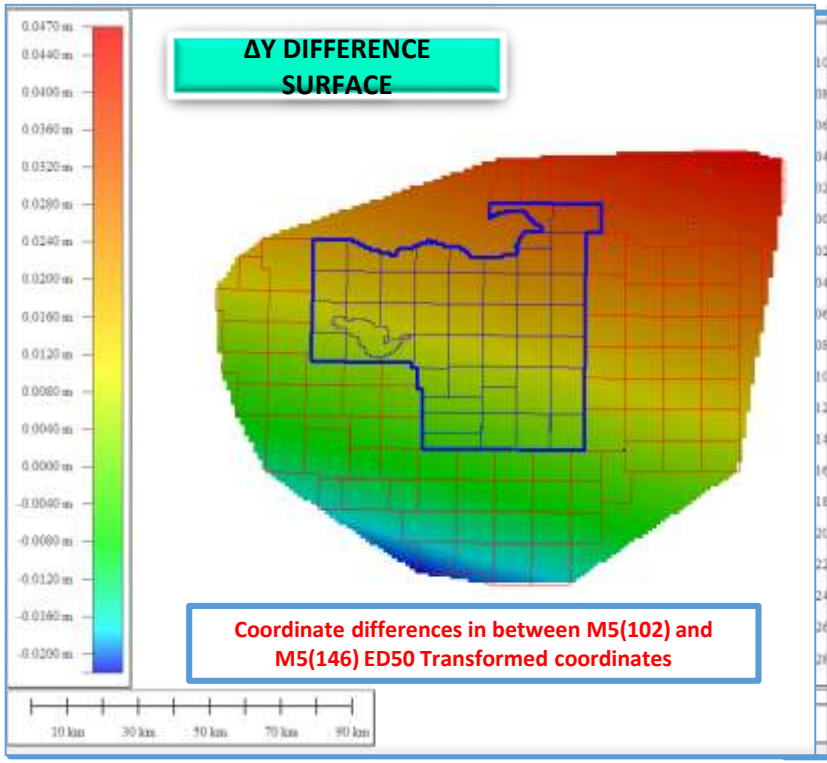
Classification of the $M3(34)_{ED50} - M5(146)_{ED50}$ transformed coordinate differences

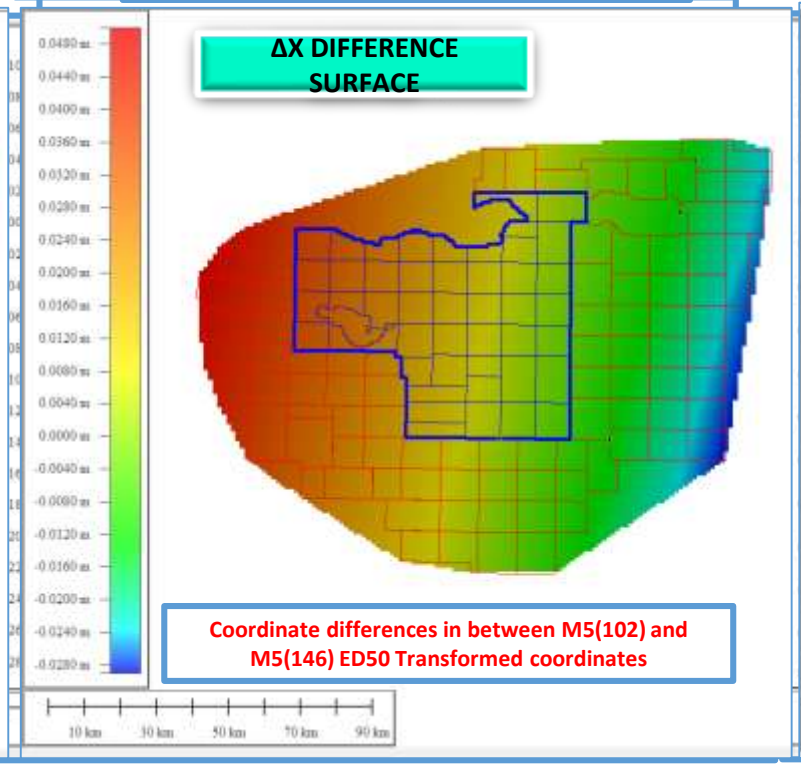
HELMERT SIMILARITY TRANS.	M3(34)ED50-M5(146)ED50		
	dΔY	dΔX	dΔs
Δy:Δx<0,15	90	62	39
0,15<Δy:Δx<0,25	8	25	39
0,25<Δy:Δx<0,50		11	20
TOPLAM	98	98	98

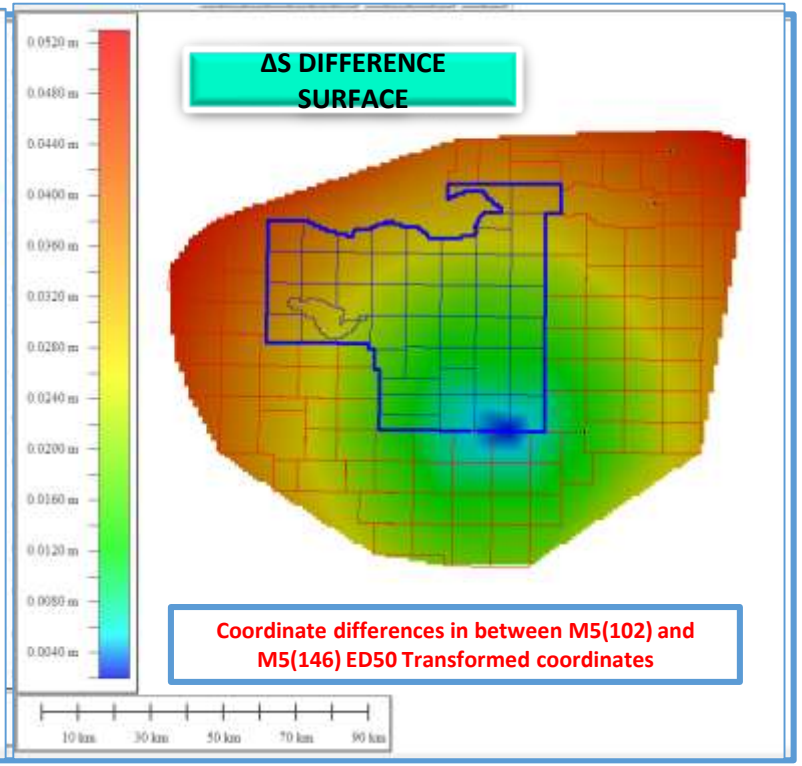
CCPS 98	HELMERT SIMILARITY TRANS. M3(34)ED50-M5(146)ED50			ED50 DIFFERENCES OF TRANS. M5(102)-M5(146)			HELMERT SIMILARITY TRANS. M3(34)ED50-M5(102)ED50		
	Δy	Δx	Δs	Δy	Δx	Δs	Δy	Δx	Δs
MAXIMUM	0,228	0,091	0,282	0,047	0,050	0,053	0,224	0,115	0,296
MINIMUM	-0,184	-0,276	0,007	-0,022	-0,029	0,002	-0,193	-0,288	0,002
MEAN	0,026	-0,097	0,159	0,013	0,009	0,030	0,013	-0,106	0,165
m0	0,088	0,080	0,066	0,015	0,017	0,011	0,088	0,089	0,069

Cartographic Control : DIFFERENCE SURFACE OF M3(102)-M5(146) IN ED50

TÜM M5(102)-M5(146) CCPS 98 3

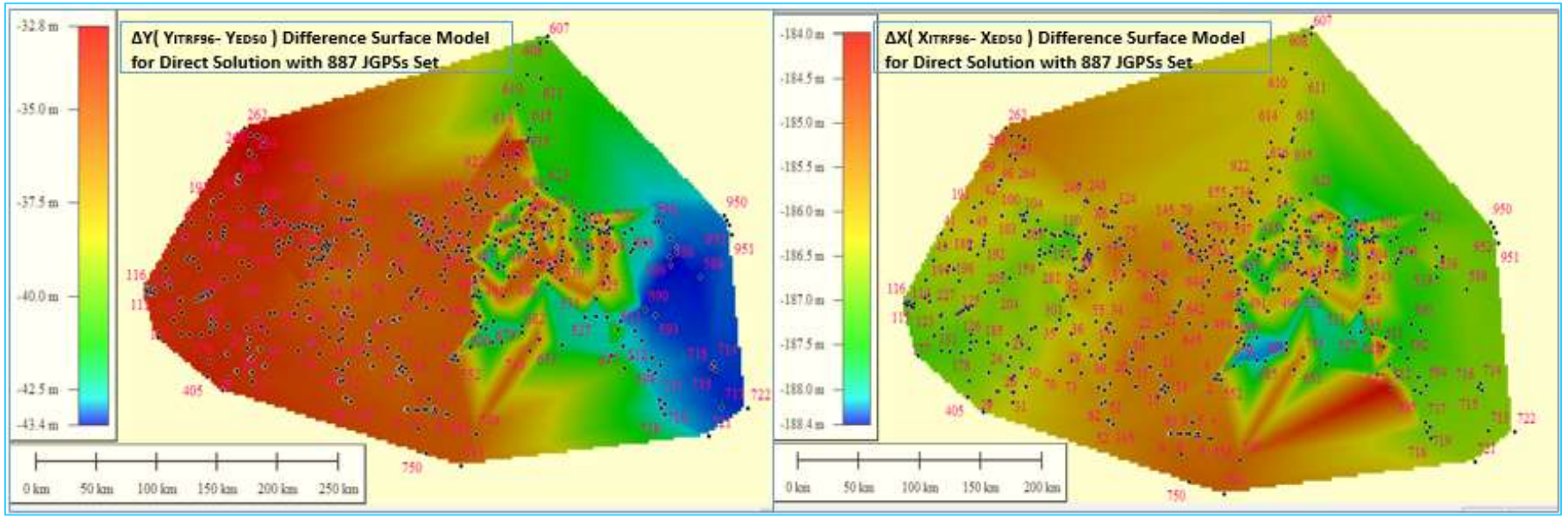






CCPS 98	HELMERT SIMILARITY TRANS. M3(34)ED50-M5(146)ED50			ED50 DIFFERENCES OF TRANS. M5(102)-M5(146)			HELMERT SIMILARITY TRANS. M3(34)ED50-M5(102)ED50		
	Δy	Δx	Δs	Δy	Δx	Δs	Δy	Δx	Δs
MAXIMUM	0,228	0,091	0,282	0,047	0,050	0,053	0,224	0,115	0,296
MINIMUM	-0,184	-0,276	0,007	-0,022	-0,029	0,002	-0,193	-0,288	0,002
MEAN	0,026	-0,097	0,159	0,013	0,009	0,030	0,013	-0,106	0,165
m0	0,088	0,080	0,066	0,015	0,017	0,011	0,088	0,089	0,069

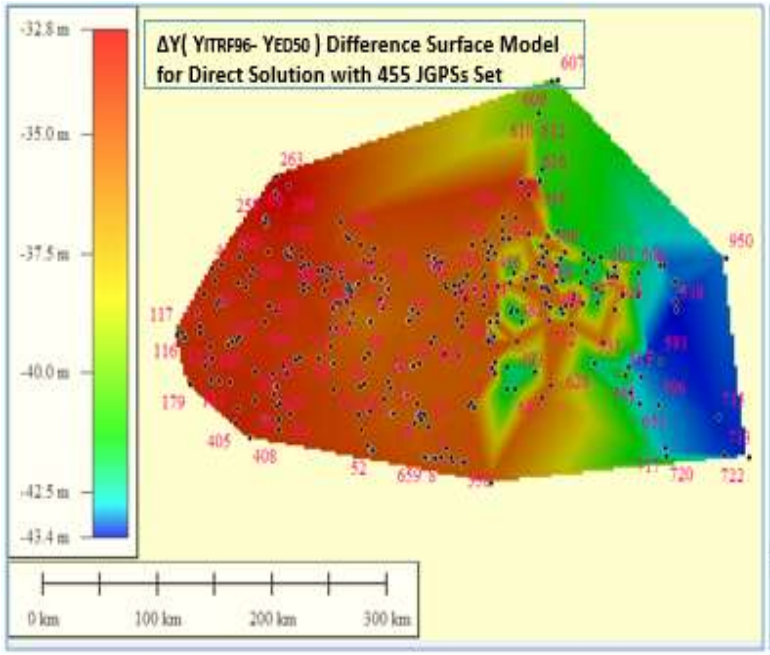
DIRECT SOLUTION WITH SPLINE FUNCTION (JGCPs:887)

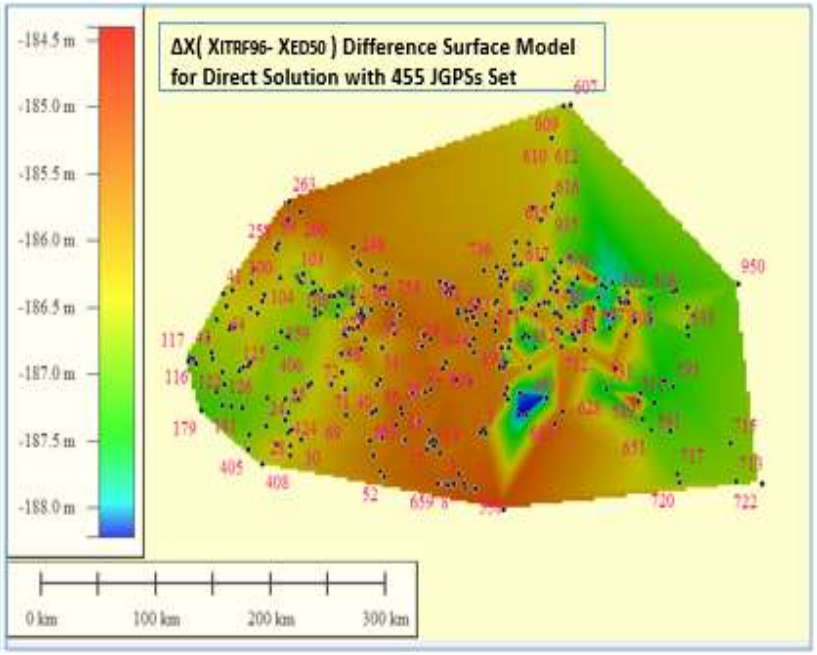


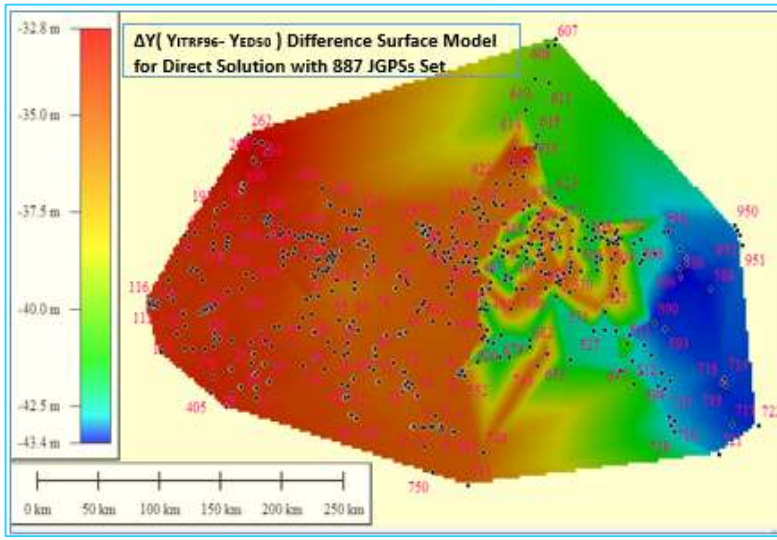
WHOLE SET :887	ΔY(YITRF-YED50)	ΔX=(XITRF-YED50)
MAKSİMUM	-32,768	-183,983
MİNİMUM	-43,445	-188,397
ORTALAMA	-36,058	-186,211

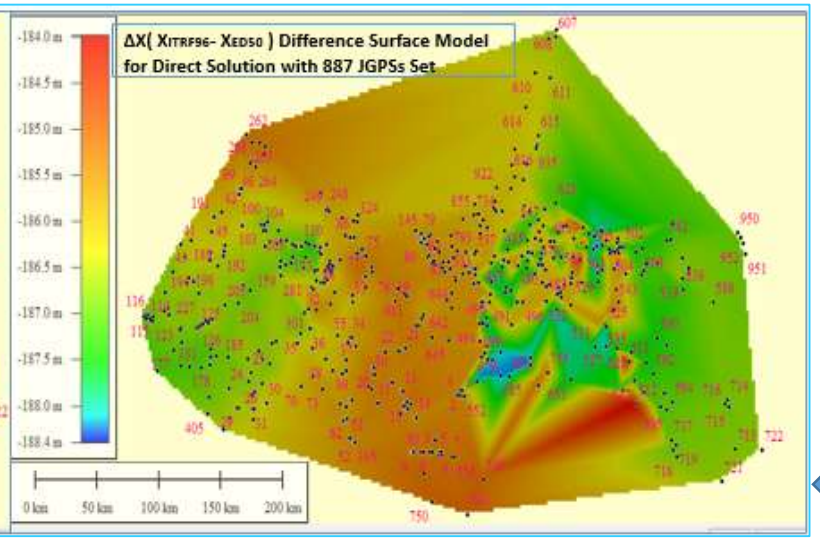
DIRECT SOLUTION WITH SPLINE FUNCTION NUMBER OF JGCPS:887 (WHOLE SET)

GEODETIC EQC FOR DIRECT SOLUTION









SET TYPE	NO OF POINTS
TRANSFORMATION	455
EQC	432
TOTAL	887

TRANS. SUB-SET	ΔY	ΔX
MAXIMUM	-32,791	-184,400
MINIMUM	-43,445	-188,221
MEAN	-36,088	-186,205
mo	1,837	0,573

EQC SUB-SET	ΔY	ΔX
MAXIMUM	-32,768	-183,983
MINIMUM	-43,429	-188,397
MEAN	-36,028	-186,217
mo	1,791	0,568

EQC STATISTICS	ITRF96-ED50		ED50	
	ΔY'(m)	ΔX'(m)	Y-Y (m)	X-X (m)
MAXIMUM	-33,004	-185,309	6,651	2,259
MINIMUM	-43,317	-187,947	-5,011	-2,956
MEAN	-35,919	-186,204	0,051	0,014

WITH 887 POINTS

GEODETIC EQC FOR DIRECT SOLUTION

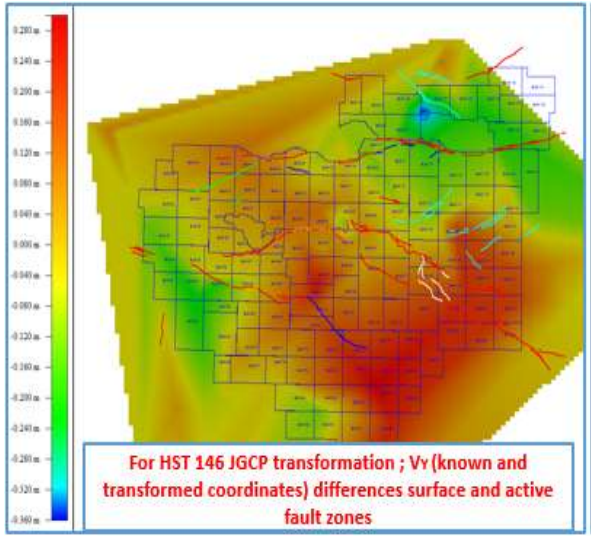
What was remarklable for the EQC process is

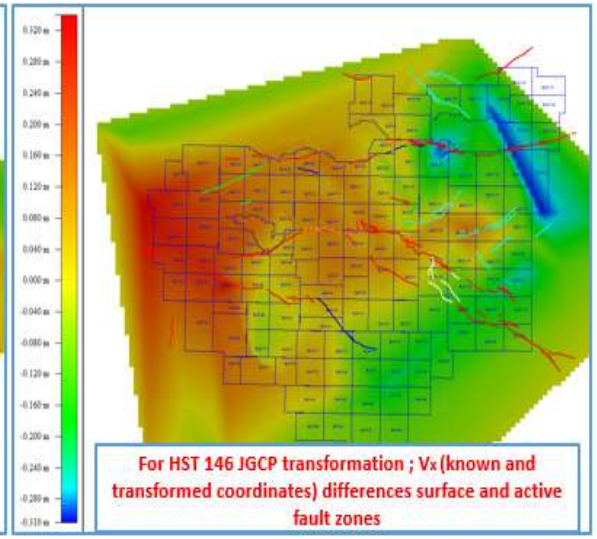
- For all EQC points ; the differences in between known and corrected coordinates were 0.00.
- So this a very impressive result

HYBRID SOLUTION

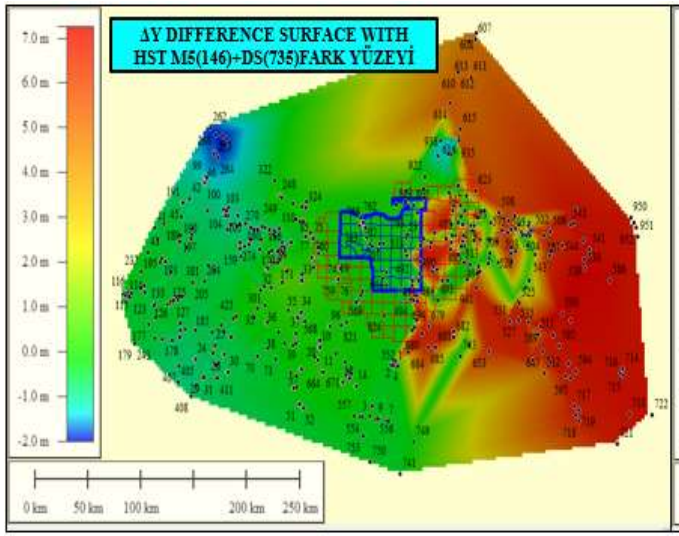
- The basic philosopy of this method is the stochastic process approach to the problem.
- Hybrid solution is planned as a two phase process.
- First phase is the Helmert Similarity transformation.
  - The purpose of this phase is to extract the deterministic part from the data set.
  - The residuals are assumed as the stochastic part of the process which signals could be detected via modelling «pre,co,post seismic Earthquake affects» or «other possible signals on data».
  - If this signals can be filtered the rest will be the random part.
- Second phase is the Direct Solution.
  - It is decided to proceed without a detailed investigation on data quality, which is beyond the purpose of this project.
  - So the residuals are modelled with spline functions, to minimize the final differences for M5 project area.

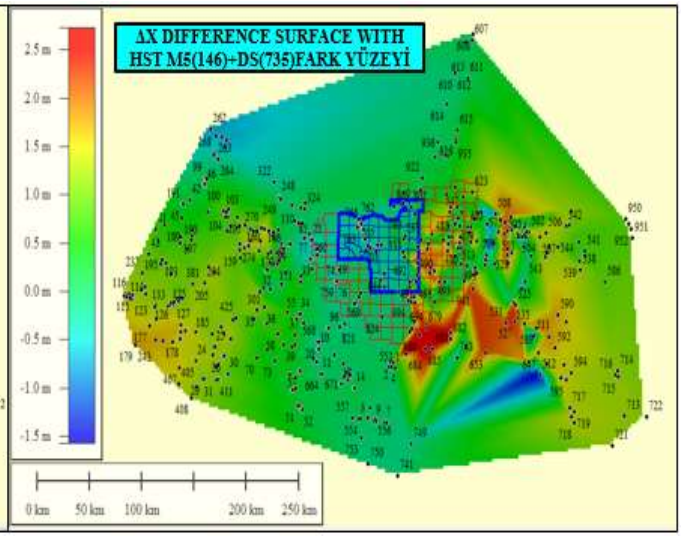
HYBRID SOLUTION (“0 Coded” Phase 1(146)&Phase 2(735))





Active faults in Project area and HST M5(146) Δy:Δx difference surfaces





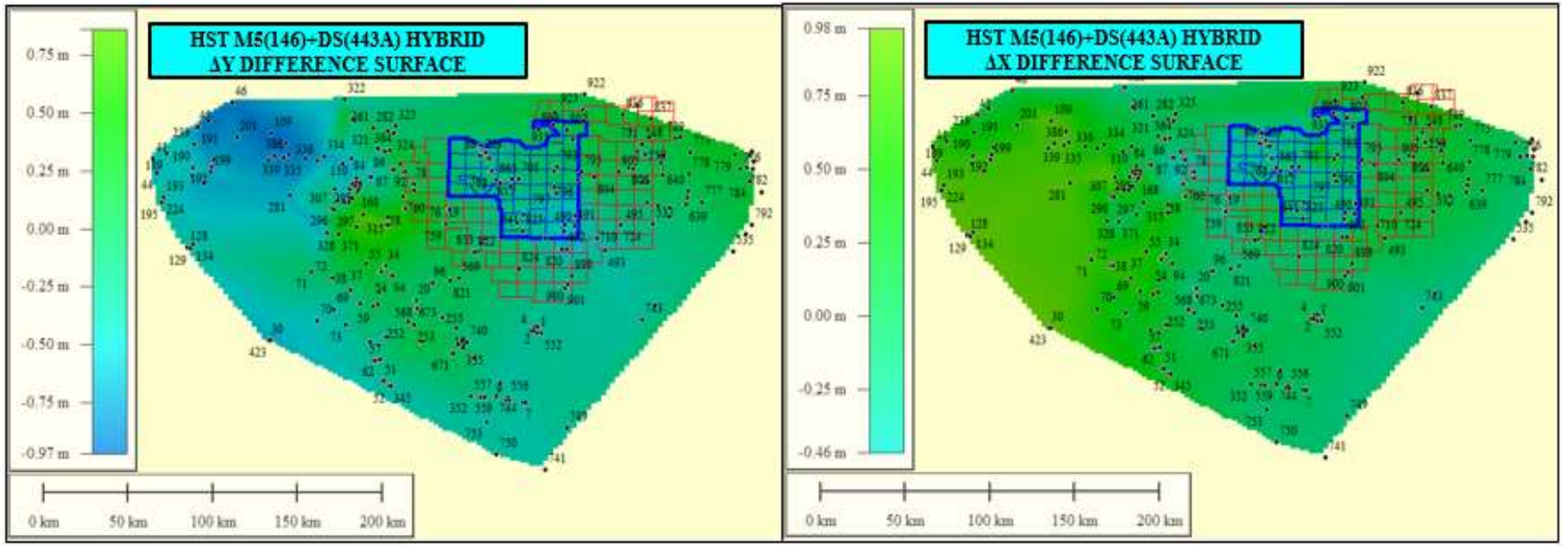
HYBRID SOLUTION HST M5(146) + DS(735) Δy:Δx difference surfaces

HYBRID SLTN. JGCPS:735	Farklar (ED50)		M.Farklar(ED50)	
	ΔY=Y-Y'	ΔX=X-X'	ΔY=Y-Y'	ΔX=X-X'
MAXIMUM	7,258	2,732	7,258	2,732
MINIMUM	-2,011	-1,574	0,007	0,001
MEAN	0,882	0,618	1,416	0,702
m0	1,900	0,618	1,718	0,556

HST M5(146)+ DÇ(735) HYBRID : POINT AND GROUP BASED CLASSIFICATION

SINIF ARALIĞI	NOKTA SAY.	GRP.SAY	BU SINIFTAKİ GRUP NUMARALARI
ΔY:ΔX=<0,15	45	22	3,10,14,33,49,55,57,58,61,67,68,71, 82,83, 85,89,94,95,101,105,106,107
0,15<ΔY:ΔX<0,25	103	37	1,3,5,10,13,14,27,33,40,41,47,48,49,50,51,52,53,55,57,58, 61,62,65,67,68,69,70,71,82,83,86,87,89,93,101,106,107
0,25<ΔY:ΔX<0,50	173	50	1,2,3,4,5,13,14,25,27,30,33,38,40,41,43,44,45,46,47,48,49,50,51,52,53,55,57, 63,65,67,68,69,70,71,77,82,83,86,87,88,90,95,97,99,100,101,102,105,106,108
0,50<ΔY:ΔX<0,85	97	29	4,10,25,28,46,47,52,63,65,68,72,73,77,78,81,88,90, 91,94,96,97,98,99,100,102,104,108,110,112
0,85<ΔY:ΔX<1,00	25	17	24,28,59,66,73,78,79,81,94,96,97,98,104,109,110,111,116
ΔY:ΔX>1,0	191	29	6,7,8,9,11,12,15,16,18,19,21,22,23,26,31,34, 39,42,56,64,74,76,84,92,103,113,114,118,119
	101	17	24,25,28,46,59,66,72,78,79,81,91,97,109,110,111,112,116
TOPLAM	735		

HYBRID SOLUTION (“A Coded - exclusion of Δy:Δx>1.0 Poınts- » : EQC Aplication” : 443 JGCPs)



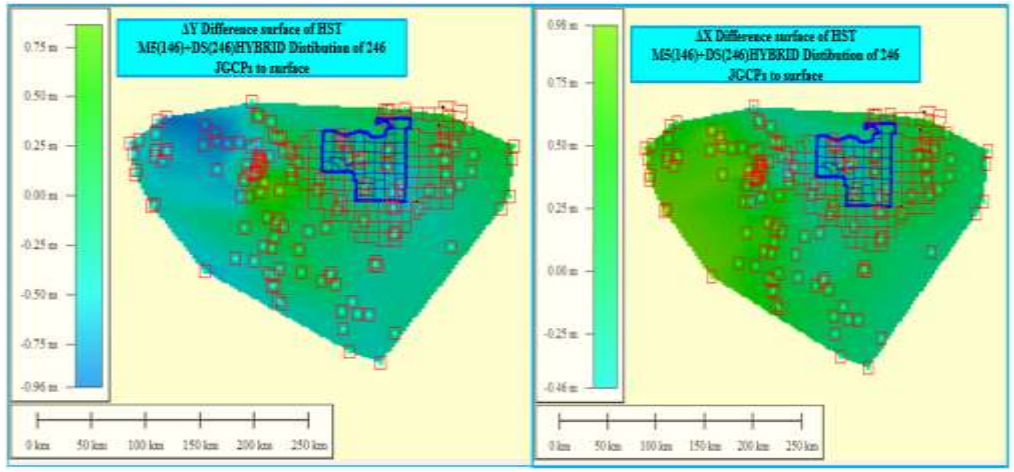
HYBRID SOLUTION HST M5(146) + DS(443) Δy:Δx difference surfaces

HYBRID SLTN. JGCPS:735	DIFFERENCES (ED50)		ABS DIFFERNCES(ED50)	
	ΔY=Y-Y'	ΔX=X-X'	ΔY=Y-Y'	ΔX=X-X'
MAXIMUM	0,862	0,978	0,972	0,978
MINIMUM	-0,972	-0,464	0,007	0,001
MEAN	-0,131	0,197	0,264	0,289
m0	0,244	0,265	0,158	0,199

HST M5(146)+DS(443) HYBRID:POINT AND GROUP BASED CLASSIFICATION			
CLASS INTERVAL	NOP	NOG	GRUP ID
ΔY:ΔX=<0,15	45	19	3,10,14,33,49,55,57,58,61,67,68,82,83,85,89,94,95,105,106,
0,15<ΔY:ΔX<0,25	103	37	1,3,5,10,13,14,27,33,40,41,47,48,49,50,51,52,53,55,57,58,61,62,65,67,68,69,70,71,82,83,86,87,89,93,101,106,107
0,25<ΔY:ΔX<0,50	173	50	1,2,3,4,5,13,14,25,27,30,33,38,40,41,43,44,45,46,47,48,49,50,51,52,53,55,57,63,65,67,68,69,70,71,77,82,83,86,87,88,90,95,97,99,100,101,102,105,106,108
0,50<ΔY:ΔX<0,85	97	29	4,10,25,28,46,47,52,63,65,68,72,73,77,78,81,88,90,91,94,96,97,98,99,100,102,104,108,110,112
0,85<ΔY:ΔX<1,00	25	17	24,28,59,66,73,78,79,81,94,96,97,98,104,109,110,111,116
TOPLAM	443		

HYBRID SOLUTION (”A Coded - exclusion of Δy:Δx>1.0 Poınts- » : EQC : 443 JGCPs”)

HST M5(146)+ DS (246 A)



HYBRID SLTN. JGCPS:246	DIFFERENCES (ED50)		ABS DIFFERNCES(ED50)	
	ΔY=Y-Y'	ΔX=X-X'	ΔY=Y-Y'	ΔX=X-X'
MAXIMUM	0,862	0,978	0,964	0,978
MINIMUM	-0,964	-0,464	0,008	0,001
MEAN	-0,152	0,222	0,291	0,311
m0	0,263	0,276	0,169	0,209

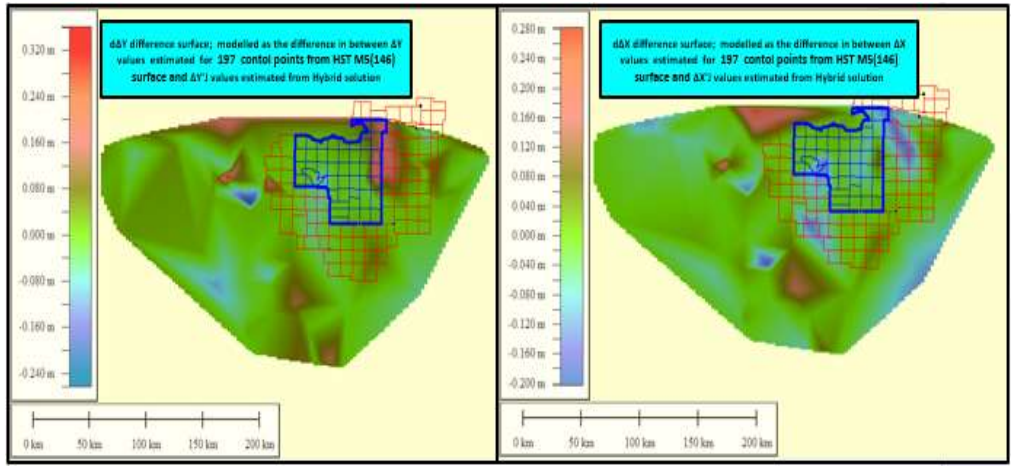
246 DS + 197 EQC = 443 HS

DENETİMDE KULLANILAN NOKTA VE GRUP BAZLI SINIFLANDIRMA			
SINIF ARALIĞI	NOKTA SAY.	GRP.SAY	BU SINIFTAKİ GRUP NUMARALARI
ΔY:ΔX=<0,15	17	17	3,10,14,33,49,55,57,58,67,68,82,83,85,94,95,105,106
0,15<ΔY:ΔX<0,25	46	37	1,3,5,10,13,14,27,33,40,41,47,48,49,50,51,52,53,55,57, 58,61,62,65,67,68,69,70,71,82,83,86,87,89,93,101,106,107,
0,25<ΔY:ΔX<0,50	102	47	1,3,4,5,14,25,27,30,33,38,40,41,43,44,45,46,47,48,49,50,51,52,53,55,57,63, 65,67,68,69,70,71,82,83,86,87,88,90,95,97,99,100,101,102,105,106,108
0,50<ΔY:ΔX<0,85	63	27	4,10,25,28,46,47,52,63,65,68,72,73,77,78,81, 88, 91,94,96,97,98,99,100,102,104,108,110
0,85<ΔY:ΔX<1,00	18	15	24,28,59,66,73,78,79,81,94,97,98,104,110,111,116
TOPLAM	246		

246 DS + 197 EQC = 443 HS

HST M5(146)+DS(246 A) Hybrid Solution Statistics and seperation of Δy:Δx values to class intervals.

EQC WITH 197 POINTS FOR HST M5(146)+ DS (246 A)

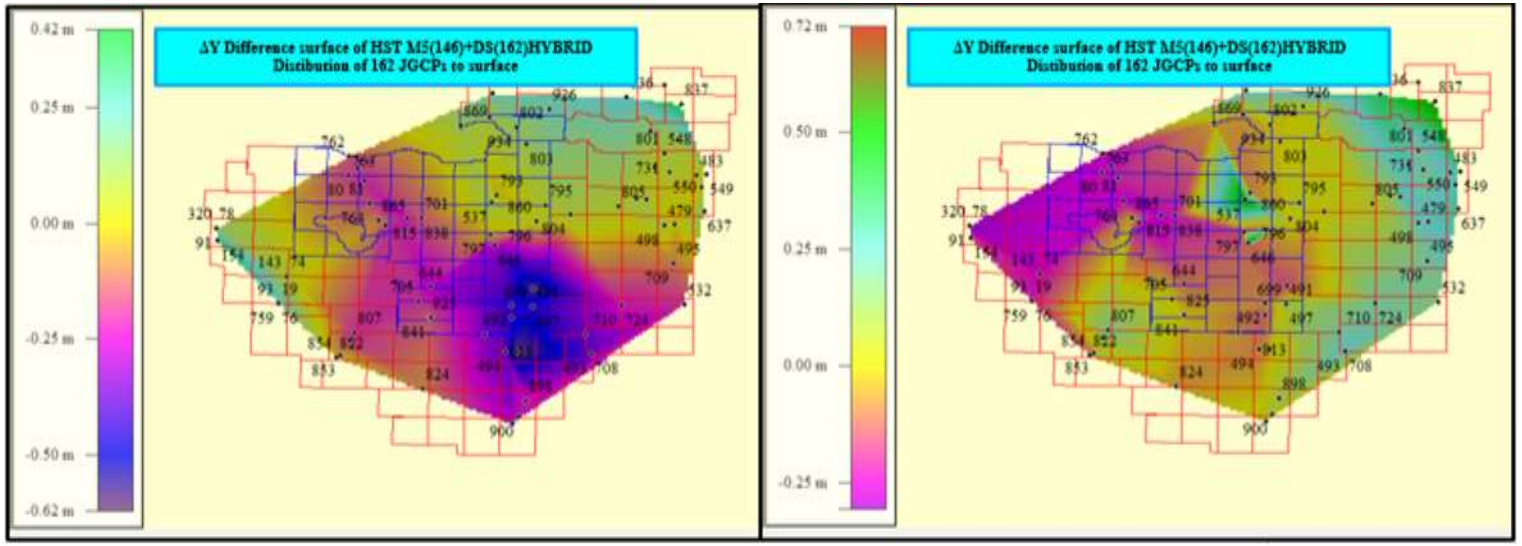


HYBRID SLTN. EQC JGCPS:188	Diff HST M5(146)		Diff DS(246) Surface		Diff From Positions	
	ΔY	ΔX	ΔY'	ΔX'	dΔY=Yi-Y'j	dΔX=Xi-X'j
MAXIMUM	0,833	0,967	0,815	0,964	0,361	0,282
MINIMUM	-0,972	-0,464	-0,955	-0,404	-0,263	-0,203
MEAN	-0,105	0,166	-0,135	0,169	0,024	0,000
m0	0,218	0,249	0,191	0,242	0,050	0,042

EQC POINT AND GROUP BASED CLASSIFICAATION			
CLASS INTERVAL	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	167	63	1,2,3,4,5,10,13,14,25,27,30,33,40,41,43,44,45,46,47,48,49,50,51,52,53,55, 57,58,61,62,65,66,67,68,69,70,72,73,78,81,82,83,85,86,87,89,90,95,96, 97,98, 99,100,102,104,105,106,107,108,109,110,111,112
0,15<ΔY:ΔX<0,25	15	13	3,14,33,58,61,67,83,85,93,71,88,96
0,25<ΔY:ΔX<0,50	6	5	73,96,99,101,107
Out of Surface	9		
TOPLAM	197		

EQC WITH 197 POINTS FOR HST M5(146)+DS(246 A) Hybrid Solution Statistics and seperation of Δy:Δx values to class intervals.

HYBRID SOLUTION (''B Coded : 162 JGCPs'')
- exclusion of the Points out of M5 Project Boundry-



HYBRID SOLUTION HST M5(146) + DS(162 B) Δy:Δx difference surfaces

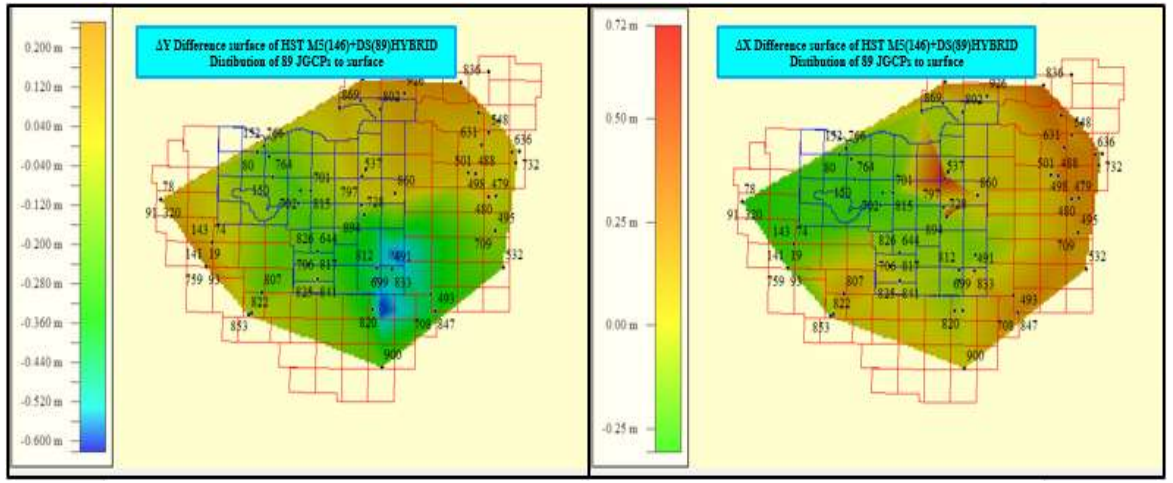
HYBRID SLTN. JGCPS:162	DIFFERENCES (ED50)		ABS DIFFERNCES(ED50)	
	ΔY=Y-Y'	ΔX=X-X'	ΔY=Y-Y'	ΔX=X-X'
MAXIMUM	0,419	0,724	0,622	0,724
MINIMUM	-0,622	-0,305	0,008	0,001
MEAN	-0,124	-0,003	0,203	0,177
m0	0,179	0,177	0,115	0,093

POINT AND GROUP BASED CLASSIFICATION			
CLASS INT	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	19	7	58,61,67,82,83,85,95
0,15<ΔY:ΔX<0,25	59	27	1,3,5,10,13,27,40,41,47,48,50,51,55,58, 61,62 ,65, 67,68,69,70,71,82,83,86,87,93
0,25<ΔY:ΔX<0,50	76	29	1,2,4,5,13,27,30,38,40,41,47,48,50,51,53, 57, 65,67,69,70,71,77,82,83,86,87,90,95,100
0,50<ΔY:ΔX<0,85	8	6	4,10,47,65,77,90
TOPLAM	162		

HST M5(146)+DS(162 B) Hybrid Solution Statistics and seperation of Δy:Δx values to class intervals.

HYBRID SOLUTION (“B Coded EQC”: 89 DS+58 EQC)
- exclusion of the Points out of M5 Project Boundry-

HST M5(146)+ DS (89 B)



HYBRID SLTN. JGCPS:89	DIFF.(ED50)		ABS DIFF.(ED50)	
	ΔY=Y-Y'	ΔX=X-X'	ΔY=Y-Y'	ΔX=X-X'
MAXIMUM	0,252	0,724	0,622	0,724
MINIMUM	-0,622	-0,305	0,008	0,001
MEAN	-0,106	0,015	0,194	0,185
m0	0,183	0,186	0,112	0,090

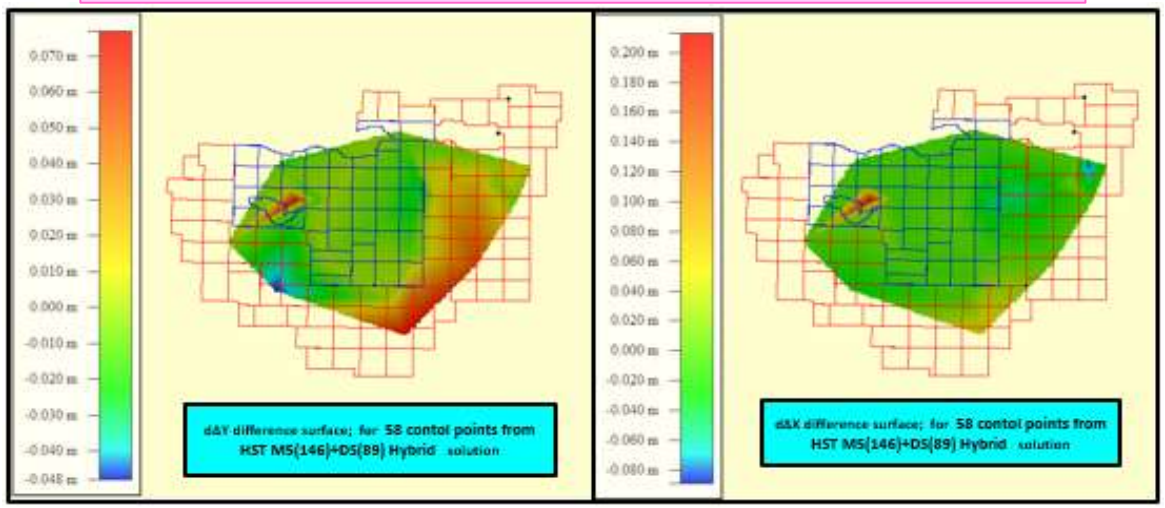
POINT AND GROUP BASED CLASSIFICATION

CLASS INTERVAL	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	10	7	58,61,67,82,83,85,95
0,15<ΔY:ΔX<0,25	37	26	1,3,5,10,13,27,40,41,47,48,50,51,55,58, 61,62,65,68,69,70,71,82,83,86,87,93
0,25<ΔY:ΔX<0,50	38	24	1,2,4,5,13,27,30,38,40,41,48,51,53, 57, 65,67,77,82,83,86,87,90,95,100
0,50<ΔY:ΔX<0,85	4	4	10,47,65,90
TOPLAM	89		

89 DS + 58 EQC = 147 HS

HST M5(146)+DS(89 B) Hybrid Solution Statistics and seperation of Δy:Δx values to class intervals.

EQC WITH 58 POINTS FOR HST M5(146)+ DS (89 B)



SLTN. EQC JGCPS:58	Diff HST M5(146)		Diff DS(246) Surface		Diff From Positions	
	ΔY	ΔX	ΔY'	ΔX'	dΔY=Yi-Y'j	dΔX=Xi-X'j
MAXIMUM	0,118	0,284	0,123	0,277	0,077	0,213
MINIMUM	-0,592	-0,275	-0,582	-0,267	-0,048	-0,089
MEAN	-0,191	-0,031	-0,193	-0,031	0,002	0,000
m0	0,151	0,139	0,153	0,145	0,011	0,015

EQC POINT AND GROUP BASED CLASSIFICATION

Class Interval	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	57	26	1,2,4,5,13,27,30,40,41,47,48,50,51,58,61, 62,65,67,69,70,82,83,86,87,90,95
0,15<ΔY:ΔX<0,25	1	1	85
TOTAL	58		

EQC WITH 58 POINTS FOR HST M5(146)+DS(89 B) Hybrid Solution Statistics and seperation of Δy:Δx values to class intervals.

HYBRID SOLUTION (“C Coded ” : HST(146)+HS(213))

HYBRID SLTN. JGCPS:213	DIFF.(ED50)		ABS DIFF.(ED50)	
	ΔY=Y-Y'	ΔX=X-X'	ΔY=Y-Y'	ΔX=X-X'
MAXIMUM	6,463	2,074	6,463	2,074
MINIMUM	-1,546	-0,464	0,005	0,001
MEAN	0,247	0,154	0,565	0,247
m0	0,685	0,248	0,675	0,196

POINT AND GROUP BASED CLASSIFICATION

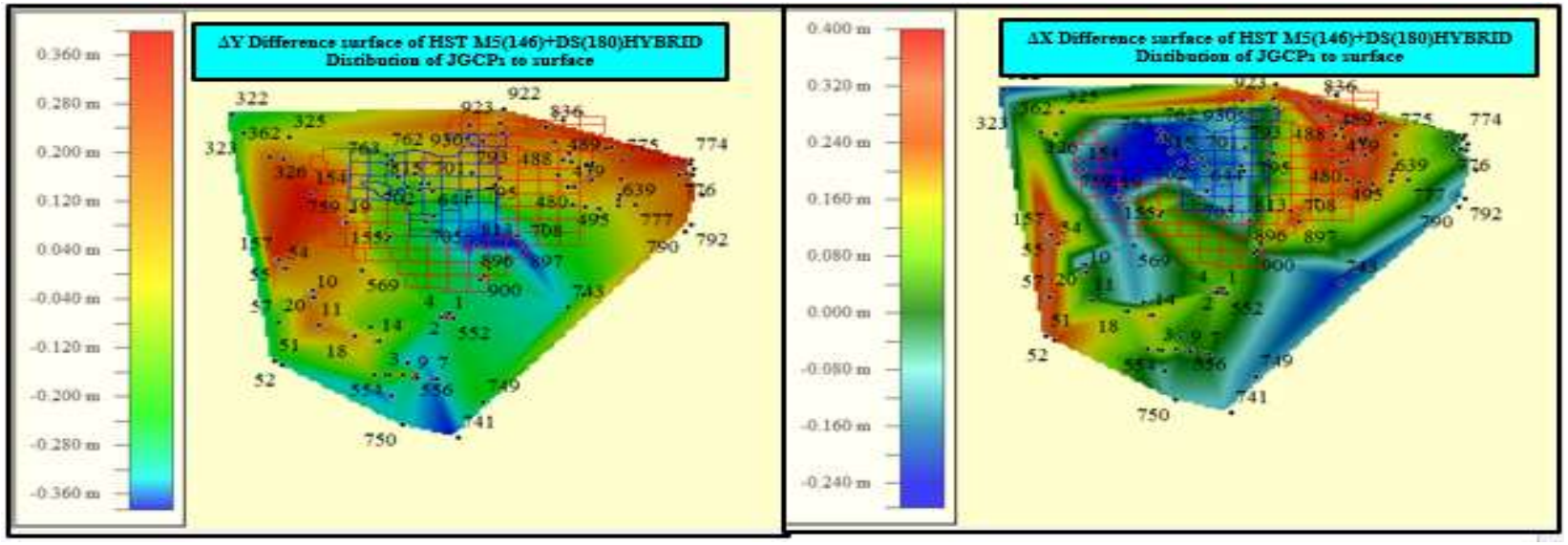
CLASS INTERVAL	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	19	8	3,14,33,49,57,58,89,95
0,15<ΔY:ΔX<0,25	76	25	1,3,5,13,14,27,33,40,41,47,48,49,50,57, 58,62,65,71,85,86,87,89,93,101,107
0,25<ΔY:ΔX<0,50	96	27	1,2,3,5,13,14,27,30,33,38,40,41,43,44,4 7,48,49,50,57,65,71,77,86,87,90,95,101
0,50<ΔY:ΔX<0,85	5	4	47,65,77,90
ΔY:ΔX>1,0	17	2	8, 103
TOPLAM	213		

Δy:Δx>0.40m : 33
Points are excluded from 213 JGCPs set

SLTN. JGCPS:180	DIFF.(ED50)		ABS DIFF.(ED50)	
	ΔY=Y-Y'	ΔX=X-X'	ΔY=Y-Y'	ΔX=X-X'
MAXIMUM	0,399	0,400	0,399	0,400
MINIMUM	-0,386	-0,275	0,005	0,001
MEAN	-0,058	0,057	0,177	0,153
m0	0,175	0,144	0,093	0,085

POINT AND GROUP BASED STATISTICS

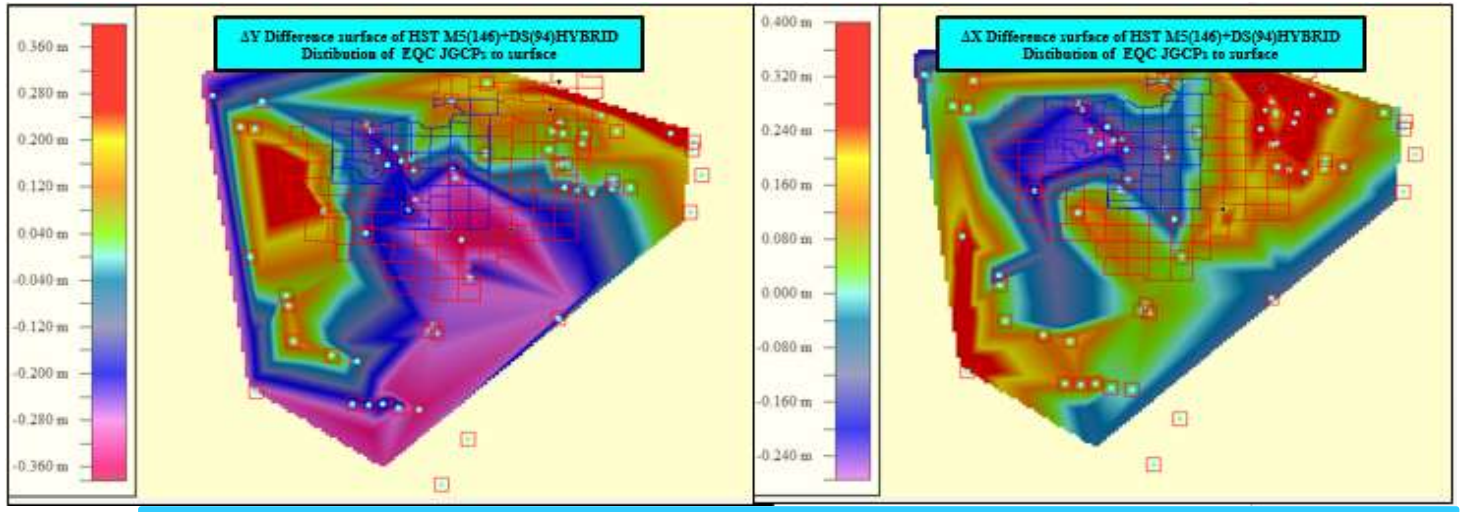
CLASS INTERVAL	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	19	8	3,14,33,49,57,58,89,95
0,15<ΔY:ΔX<0,25	76	25	1,3,5,13,14,27,33,40,41,47,48,49,50, 57,58,62,65,71,85,86,87,89,93,101,107
0,25<ΔY:ΔX<0,50	85	27	1,2,3,5,13,14,27,30,33,38,40,41,43,44,47, 48,49,50,57,65,71,77,86,87,90,95,101
TOPLAM	180		



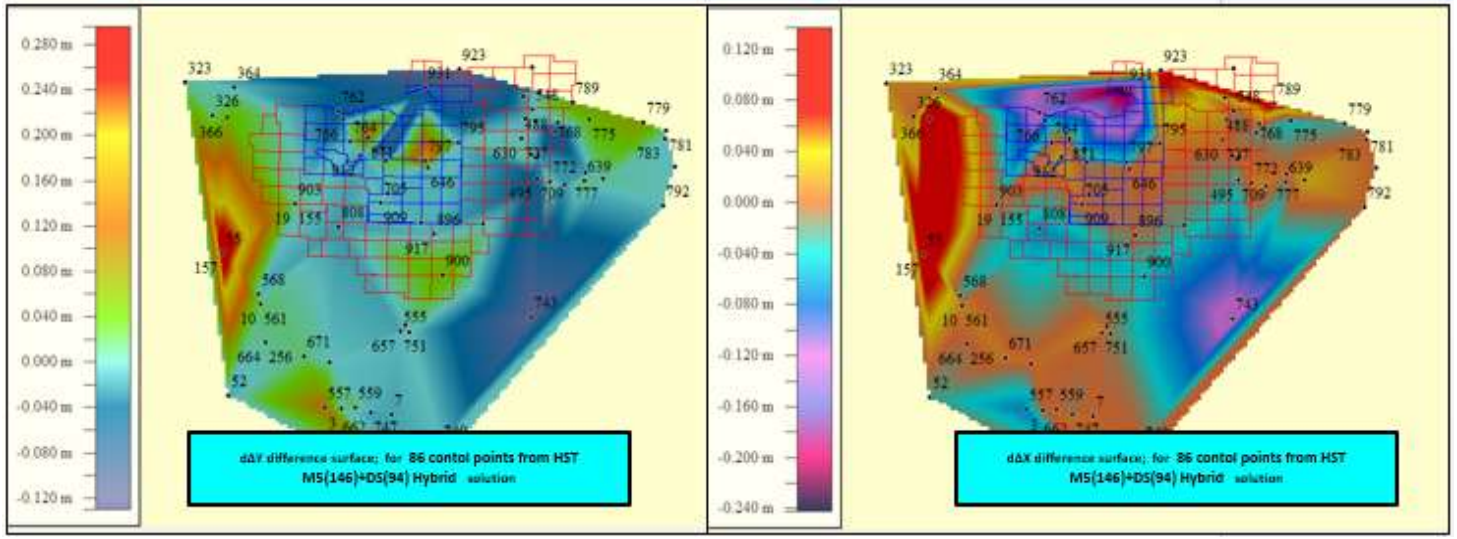
No points having
Δy:Δx>0.40m
No relevant points for EQC

HYBRID SOLUTION (“C Coded ” : HST(146)+HS(180))

HYBRID SOLUTION HST (146)+ HS(96)



EQC WITH 84 POINTS OF HYBRID SOLUTION HST (146)+ HS(96)



HYBRID SLTN. EQC JGCPS:84	Diff HST M5(146)		Diff DS(246) Surface		Diff From Positions	
	ΔY	ΔX	ΔY'	ΔX'	dΔY=Yi-Y'j	dΔX=Xi-X'j
MAXIMUM	0,378	0,391	0,303	0,301	0,296	0,137
MINIMUM	-0,386	-0,275	-0,380	-0,263	-0,130	-0,242
MEAN	-0,049	0,051	-0,064	0,067	0,006	-0,005
m0	0,168	0,145	0,149	0,134	0,035	0,027

POINT AND GROUP BASED CLASSIFICATION			
CLASS INTERVAL	NOP	NOG	GROUP ID
ΔY:ΔX=<0,15	76	30	1,2,3,5,13,14,27,30,33,38,40,41,43,47,48,49, 50,57,58,62,65,71,85,86,87,89,90,93,101,107
0,15<ΔY:ΔX<0,25	2	2	58,95
0,25<ΔY:ΔX<0,50	2	2	44, 71
Yüzey dışı	6		
TOPLAM	86		

CONCLUSIONS

- When TNHCN defined in ED50 datum; current concepts of
  - Plate Tectonics,
  - Velocity field,
  - Standart Epoch,
  - Observation Epoch,
  - Frame,
  - Displacement etc.

were not considered.

- So all coordinates are assumed static, since ED50 introduced.
- With the introduction of ITRF96 datum in 2005 , above concepts have found a vast use capability in geodetic community together with the other geosiences,

CONCLUSIONS

- So we have to remember ;
  - Used JGCPs sets for transformations -which are common and positions known in both datum- are not comparable to each other ; Cause all ITRF96 GCPs are corrected for the velocity field, while ED50 GCPs are kept un-changed since 1954.
  - So, during transformation and EQC process, GCPs or groups having differences ≥1m are observed and excluded from JGCPs set, but if only seismic velocity field considered, differences around 1.75m. will be quite normal.
  - Δy:Δx differences achieved at common points carries very important information about the past tectonic activities.
  - Points to be used for transformation and EQC should provide a well and homogenious distribution to project area and if possible extended beyond the project area boundry,

CONCLUSIONS

- At the end, which method is better is not discussed too much, because it depends on ;
  - Requirements of the projects ,
  - Dispersion and sufficiency of the old ED50 points if can be found in the region,
  - Possible positional accuracy of the known points and many other parameters .
- For these reason the decision is left to the practitioner.
- But at least we can say ;
  - Where Helmert Similarity Transformation is not good enough especially for the complex solutions,
  - Direct and Hybrid solutions were effective enough without any doubt.