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MEDGEO92

PROGRESS IN THE GRAVIMETRIC GEOID COMPUTATIONS

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ABSTRACT

The research developed by the Madrid GEOMED Group in the field of the Gravimetric Mediterranean Geoid computation is outlined. The incorporation of new gravity data and the analysis of the merging zones allow to complete the gravimetric geoid in the whole area.

1. INTRODUCTION

Recently, new data has been added to the original dada bank which has been used to compute a geoid in the Mediterranean Sea following the same method as shown in Sevilla et al. (1992) and presented in the GEOMED Meeting held in Vienna in 1991. The new data has been provided by BGI corresponding to the area of limits $37<\phi<48$ and $10<\lambda<16$. There are 1104 free-air anomalies irregularly distributed.

After having checked the new data, a comparison has been done to see their goodness which resulted in the same precision about 6 mgal. These gravity anomalies have been changed to IGSN71 and GRS80 systems and divided into several zones to be validated.

Having validated the data a new geoid has been computed in the area mentioned before and several analysis have been carried out as shown in the sequel.

2. SOURCE DATA BANK AND VALIDATION

The updated available Mediterranean gravimetry data bank is formed as show Table 1 and Figure 1.

TABLE 1. *Source Data Bank*

FILE	DESCRIPTION	NUMBER OF DATA	DISTRIBUTION
G1MED	Eastern Mediterranean $31<\phi<37$, $26<\lambda<36$	3652	irregular
G2MED	Central Mediterranean $31<\phi<48$, $10<\lambda<26$	15062	gridded
G2BGI	BGI Data $37<\phi<48$, $10<\lambda<16$	1104	irregular
G3MED	Western Mediterranean $31<\phi<48$, $-6<\lambda<10$	8390	gridded

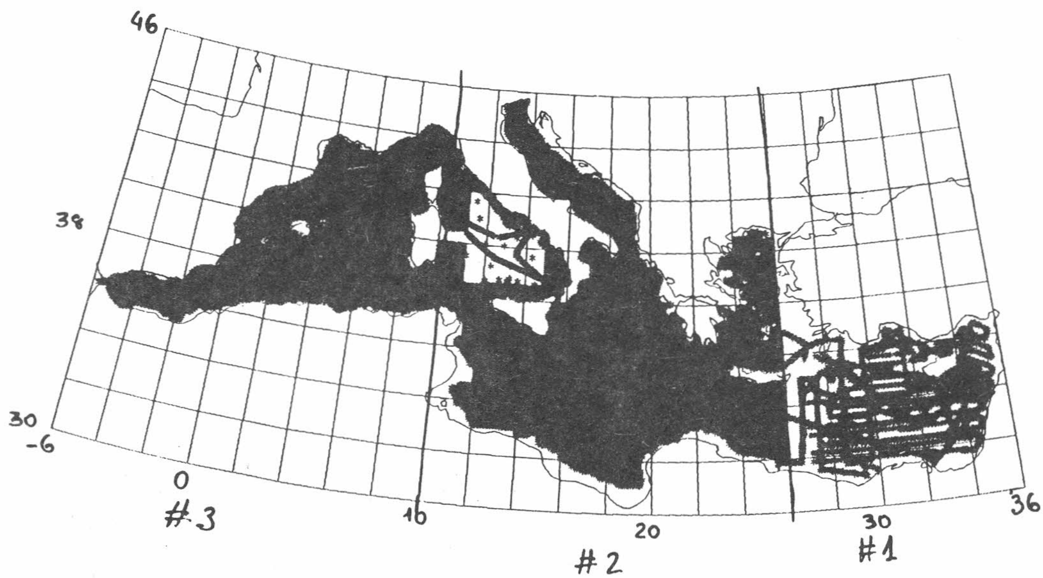

Figure 1. Distribution of the available gravity data in October 1992

In the new file G2BGI the measured gravity g is referred to IGSN71 system and the theoretical gravity γ to GRS67. The reference ellipsoid to which the coordinates of the points are referred, is unknown. The points are irregularly distributed. There were 87 duplicate points. These new free air anomalies have been validated using the IFE88E2 geopotential model. The complete results of validation are shown in the Table 2

TABLE 2. *Results of validation at october 1992*

	Number of points	Mean (mgal)	Standard deviation	Minimum	Maximum	Correlation
MEDIGRAV $30<\phi<46$, $-6<\lambda<36$. **(26949)**						
FREE AIR	26949	-10.09	45.79	-226.96	142.52	
OSU81	26949	-7.43	42.64	-173.34	122.45	
FREE AIR-OSU81	26949	-2.66	25.41	-125.84	136.40	
MEDGRA92 $30<\phi<46$, $-6<\lambda<36$. **(26575)** (validated, 374 outliers detected)						
FREE AIR	26575	-10.42	45.46	-226.96	124.00	
OSU81	26575	-7.58	42.48	-173.34	122.45	
FREE AIR-OSU81	26575	-2.84	24.96	-125.84	122.80	
PREDICTION	26575	-10.32	45.16	-228.57	127.37	
FREE AIR-PRED.	26575	-0.10	4.14	-23.85	30.59	
G1MED $31<\phi<37$, $16<\lambda<36$. **(4244)** (With margin points)						
FREE AIR	4244	-50.31	56.02	-220.48	113.79	
OSU81	4244	-40.18	57.08	-172.74	118.69	
FREE AIR-OSU81	4244	-10.14	32.51	-133.97	104.91	
G1MED $31<\phi<37$, $26<\lambda<36$. **(3652)**						
FREE AIR	3652	-47.83	53.35	-220.48	113.79	
OSU81	3652	-38.23	54.90	-172.74	117.25	
FREE AIR-OSU81	3652	-9.60	33.03	-133.97	104.91	
G1MED $31<\phi<37$, $26<\lambda<36$. **(2587)** (gridded)						
FREE AIR	2587	-45.95	53.24	-216.31	96.78	
OSU81	2587	-36.68	55.17	-172.49	116.35	
FREE AIR-OSU81	2587	-9.27	30.99	-125.84	102.02	
G1MED $31<\phi<37$, $26<\lambda<36$. **(2583)** (gridded-validated, 4 outliers detected)						
FREE AIR	2583	-45.94	53.25	-216.31	96.78	0.63
OSU81	2583	-36.59	55.12	-172.49	116.35	
FREE AIR-OSU81	2583	-9.35	30.93	-125.84	102.02	0.07
PREDICTION	2583	-45.68	53.45	-215.15	93.58	
FREE AIR-PRED.	2583	-0.26	4.71	-28.57	30.60	1.00
G1MED $31<\phi<37$, $26<\lambda<36$. **(2566)** (gridded-validated, 21 outliers detected)						
FREE AIR	2566	-45.81	53.16	-216.31	96.78	0.63
OSU81	2566	-36.36	55.05	-172.49	116.35	
FREE AIR-OSU81	2566	-9.44	30.61	-125.84	102.02	0.06
PREDICTION	2566	-45.57	53.40	-215.15	93.58	
FREE AIR-PRED.	2566	-0.24	4.32	-19.66	19.65	1.01
G2MED $31<\phi<46$, $10<\lambda<26$. **(15062)** (Original data)						
FREE AIR	15062	-10.68	50.42	-226.96	142.52	
OSU81	15062	-8.03	47.62	-173.34	122.45	
FREE AIR-OSU81	15062	-2.66	24.12	-114.45	136.40	

G2MED **31<φ<46, 10<λ<26. (14861)** (validated, 201 outliers detected)

FREE AIR	14861	-11.13	50.21	-226.96	124.00	0.52
OSU81	14861	-8.28	47.58	-173.34	122.45	
FREE AIR-OSU81	14861	-2.85	23.55	-114.45	114.63	0.15
PREDICTION	14861	-10.98	49.83	-228.57	121.39	
FREE AIR-PRED.	14861	-0.14	4.55	-33.82	31.65	0.99

G2MED **31<φ<46, 10<λ<26. (14806)** (validated, 256 outliers detected)

FREE AIR	14806	-11.03	50.12	-226.96	124.00	0.52
OSU81	14806	-8.17	47.53	-173.34	122.45	
FREE AIR-OSU81	14806	-2.86	23.50	-114.45	114.63	0.15
PREDICTION	14806	-10.89	49.77	-228.57	121.39	
FREE AIR-PRED.	14806	-0.14	4.30	-23.85	25.66	0.99

G2MEDBGI **31<φ<46, 10<λ<26. (15972)** (Original data plus BGI data)

FREE AIR	15972	-8.63	50.06	-226.96	142.52
OSU81	15972	-6.51	47.19	-173.34	122.45
FREE AIR-OSU81	15972	-2.12	24.64	-114.45	136.40

G2MEDBGI **31<φ<46, 10<λ<26. (15753)** (validated, 219 outliers detected)

FREE AIR	15753	-9.16	49.79	-226.96	124.00	0.52
OSU81	15753	-6.82	47.11	-173.34	122.45	
FREE AIR-OSU81	15753	-2.34	24.07	-114.45	122.80	0.16
PREDICTION	15753	-9.02	49.41	-228.57	127.37	
FREE AIR-PRED.	15753	-0.14	4.59	-33.82	31.65	0.99

G2MEDBGI **31<φ<46, 10<λ<26. (15698)** (validated, 274 outliers detected)

FREE AIR	15698	-9.05	49.71	-226.96	124.00	0.52
OSU81	15698	-6.71	47.06	-173.34	122.45	
FREE AIR-OSU81	15698	-2.34	24.03	-114.45	122.80	0.16
PREDICTION	15698	-8.92	49.35	-228.57	127.37	
FREE AIR-PRED.	15698	-0.13	4.37	-23.85	30.59	0.99

G3MED **35<φ<45, -6<λ<10. (8390)**

FREE AIR	8390	-1.81	24.95	-131.92	84.19
OSU81	8390	-0.17	18.55	-55.57	50.16
FREE AIR-OSU81	8390	-1.64	24.63	-114.83	79.15

G3MED **35<φ<45, -6<λ<10. (8327)** (validated, 63 outliers detected)

FREE AIR	8327	-2.04	24.73	-131.92	79.79	0.41
OSU81	8327	-0.29	18.50	-55.57	50.16	
FREE AIR-OSU81	8327	-1.75	24.45	-114.83	77.84	0.04
PREDICTION	8327	-2.07	24.24	-121.50	74.74	
FREE AIR-PRED.	8327	0.03	3.77	-27.09	32.56	0.98

G3MED **35<φ<45, -6<λ<10. (8311)** (validated, 79 outliers detected)

FREE AIR	8311	-2.08	24.67	-131.92	79.79	0.41
OSU81	8311	-0.33	18.49	-55.57	50.16	
FREE AIR-OSU81	8311	-1.75	24.43	-114.83	77.84	0.04
PREDICTION	8311	-2.08	24.24	-121.50	74.74	
FREE AIR-PRED.	8311	0.00	3.59	-19.02	23.93	0.98

3. GEOPOTENTIAL MODELS IN THE MEDITERRANEAN SEA

The computations of free air gravity anomalies have been made by using three geopotential models namely IFE88E3, OSU89B and OSU91A, then these anomalies have been compared to the observed ones to see the goodness of the models. The results are presented in Tables 3, 4, and 5. The statistic is repeated for the gravity points in the Mediterranean Sea with and without removing the suspected data provided from validation

TABLE 3. *Row data*

Mediterranean Sea (26949 points)

	MEAN	SD	MINIMUM	MAXIMUM	RANGE	ZEROS
LATITUDES	37.33	3.16	31.08	45.58	14.50	0
LONGITUDES	14.85	9.00	-5.75	35.58	41.33	0
DEPTHS	-1639.16	1149.76	-4700.00	0.00	4700.00	617
FREE-AIR ANOMALIES	-10.09	45.79	-226.96	142.52	369.48	2
IFE88E2 ANOMALIES	-9.22	44.44	-220.43	137.13	357.56	5
OSU89B ANOMALIES	-9.40	41.49	-177.36	121.07	298.43	2
OSU91A ANOMALIES	-9.33	41.56	-179.57	118.53	298.10	3
FREE-AIR-IFE88E2	-0.87	16.33	-119.51	114.30	233.81	8
OSU91A-OSU89B	-0.07	1.82	-6.05	6.51	12.56	61

Free-air regression line: 21.52012 + 0.01928*h
Standard deviations: 40.07 (of the coefficients: 0.43, 0.00)
Free-air correlation coefficient: 0.484
Free-air minus ife88e2 regression line: 0.62496 + 0.00091*h
Standard deviations: 16.29 (of the coefficients: 0.17, 0.00)
Free-air minus ife88e3 correlation coefficient: 0.064
Gross errors detected: 0

TABLE 4. *Validated data (flag 1)*

Mediterranean Sea (26663 points)

	MEAN	SD	MINIMUM	MAXIMUM	RANGE	ZEROS
LATITUDES	37.31	3.17	31.08	45.58	14.50	0
LONGITUDES	14.84	9.02	-5.75	35.58	41.33	0
DEPTHS	-1646.26	1150.73	-4700.00	0.00	4700.00	608
FREE-AIR ANOMALIES	-10.50	45.56	-226.96	124.00	350.96	2
IFE88E2 ANOMALIES	-9.47	44.38	-220.43	137.13	357.56	5
OSU89B ANOMALIES	-9.64	41.39	-177.36	121.07	298.43	2
OSU91A ANOMALIES	-9.57	41.46	-179.57	118.53	298.10	3
FREE-AIR-IFE88E2	-1.02	15.83	-119.51	101.15	220.66	8
OSU91A-OSU89B	-0.07	1.82	-6.05	6.51	12.56	60

Free-air regression line: 21.01652 + 0.01914*h
Standard deviations: 39.88 (of the coefficients: 0.43, 0.00)
Free-air correlation coefficient: 0.483
Free-air minus ife88e2 regression line: 0.41842 + 0.00087*h
Standard deviations: 15.80 (of the coefficients: 0.17, 0.00)
Free-air minus ife88e3 correlation coefficient: 0.064
Gross errors detected: 286

TABLE 5. *Validated data (flag 2)*

Mediterranean Sea (26575 points)

	MEAN	SD	MINIMUM	MAXIMUM	RANGE	ZEROS
LATITUDES	37.32	3.17	31.08	45.58	14.50	0
LONGITUDES	14.83	9.01	-5.75	35.58	41.33	0
DEPTHS	-1646.42	1151.31	-4700.00	0.00	4700.00	604
FREE-AIR ANOMALIES	-10.42	45.46	-226.96	124.00	350.96	2
IFE88E2 ANOMALIES	-9.39	44.30	-220.43	137.13	357.56	5
OSU89B ANOMALIES	-9.56	41.31	-177.36	121.07	298.43	2
OSU91A ANOMALIES	-9.49	41.38	-179.57	118.53	298.10	3
FREE-AIR-IFE88E2	-1.02	15.74	-119.51	101.15	220.66	8
OSU91A-OSU89B	-0.07	1.82	-6.05	6.51	12.56	60

Free-air regression line: 21.03456 + 0.01910*h
Standard deviations: 39.78 (of the coefficients: 0.43, 0.00)
Free-air correlation coefficient: 0.484
Free-air minus ife88e2 regression line: 0.39730 + 0.00086*h
Standard deviations: 15.71 (of the coefficients: 0.17, 0.00)
Free-air minus ife88e3 correlation coefficient: 0.063
Gross errors detected: 374

These tables confirm that the election of the IFE88E2 model to make the geoid calculation in this area is correct.

4. COVARIANCES OF THE NEW ZONES

To complete the report given in Sevilla et al., (1992) we present in the Tables 6 and 7 the covariance functions obtained from the new data. These update the covariance calculations. These tables include the covariance functions of the two blocks that we have named Alternative 1 and Alternative 2 and which use will be explained in the sequel.

TABLE 6. *Empirical Covariances*

Zone Number	Number of points	Mean (mgal)	Variance (mgal^2)	Correlation length(a m)	First zero length(a m)
100	54	2.61	472.70	3.70	7.07
101	77	-2.14	474.40	4.63	10.91
102	196	0.07	646.90	7.40	20.08
103	219	-3.22	839.80	7.60	17.17
104	245	-4.00	649.40	7.64	19.91
126	181	2.42	513.20	4.30	13.00
127	164	-0.76	609.00	5.31	11.78
128	252	-3.19	841.70	7.72	17.03
129	287	-11.25	981.20	11.06	22.41
130	364	-6.36	708.40	9.79	18.16
157	226	-10.93	710.70	7.80	51.29
158	326	-11.21	823.10	11.91	25.69
159	506	-1.49	474.90	10.45	19.90
187	390	-1.29	500.90	8.84	18.18
188	472	-1.29	535.70	8.64	15.77

ALT-1	392	-1.05	670.75	8.10	15.52
ALT-2	703	-6.06	790.47	11.90	17.52

TABLE 7. *Fitted covariances*

Zone Number	Variance signal	noise	Order	A ($mgal^2$)	$R - R_B$ (km)
100	463.46	0.49	719	1751.967	-3.497
101	467.21	1.03	496	1175.007	-3.996
102	636.90	6.00	269	758.687	-3.804
103	832.82	3.15	317	1144.077	-3.758
104	646.68	0.09	258	612.560	-2.862
126	506.36	3.99	414	546.593	-2.237
127	604.13	1.11	454	2855.670	-6.503
128	832.99	5.36	314	1232.294	-4.090
129	976.30	1.49	246	2084.206	-7.203
130	701.50	4.92	323	2984.357	-9.156
157	707.43	0.12	93	243.956	-0.833
158	820.17	0.37	210	1501.499	-7.296
159	469.11	4.87	284	1586.663	-8.926
187	496.18	3.43	312	1352.471	-6.981
188	533.39	1.22	377	2913.165	-9.130
ALT-1	670.11	0.29	346	1090.18	-4.06
ALT-2	788.77	1.69	309	2643.23	-7.79

A = scale factor of degree variance model
R_B = Bjerhammar radius

5. ZONES PATCHING CRITERIA

5.1. CHOICE OF BJERHAMMAR SPHERE RADIUS

The prediction of the geoid must be done by choosing a unique Bjerhammar sphere radius which defines the harmonicity domain of the function approximating the gravity field. There are large discrepancies in the values of this radius for each single zone as shown in Table 7. So, it is difficult to take a unique value.

To the election of the Bjerhammar radios we have applied several criteria based in the use of the mean value of the zones considered normal zones. This normal zones are the rest zones after having removed the zones included in the following cases.

1.- Coastal zones with fewer than 200 points.
2.- Zones with observed gravity minus implied model anomaly larger 5 mgal.
3.- Zones with standard deviation of reduced anomalies greater than observed ones.
4.- Zones whit standard deviation of implied model anomalies larger than observed ones.
5.- Zones with fewer than 250 points in any region.
6.- Zones with rough gravimetry, i.e. with standard deviation of free-air anomalies greater than 35 mgal.

7.- Zones with large correlations to depths.
8.- Very deep zones with values over 2000 meters.
9.- Zones with negative noise.
10.- Zones with data irregularly distributed.

The value for $R_B - R$ is the mean value of the normal zones.

$$R_B - R = -4.6105 \text{ km}$$

5.2. THE ZONES PATCHING. COMPARISON OF GEOID UNDULATIONS

As a general rule, the mean value is considered in the common boundary of two zones. This is applied when

a) The difference of gravity anomalies is under 4 mgal.
b) The difference of geoid undulations is under 15 centimeters.

When this is not satisfied, the following criteria are applied:
The general criterion in to take the closest result to the observation data, i.e. with the least residual anomalies. As the prediction points are not in correspondence with the observation ones the criteria is based in the comparison between the closest points or the comparison of the mean values in each prediction zone.

Others criteria are:

a) Take the prediction of the zone whose covariance function has a better behavior
b) Take the zone with more points inside or in the corresponding zone used for prediction
c) Take the zone with no coast.
d) Take the zone with least prediction error.
e) If the differences are larger It is not sufficient to treat only the common line, It is necessary to extend the prediction zones to get enough overlapping.
f) If the former do not solve the problem, news dimensions of the zones and news covariance functions must be taken.

5.3 RESULTS OF COMPARISON OF NEIGHBORING ZONES

Comparisons in the four boundaries of each zone have been done. The most of them give differences under 15 cm. Those differences greater than this value were analyzed individually, and in each case some action was taken to get a new value under the 15 cm. Nevertheless, in some areas this results are not completely satisfactory, showing the parts of the Mediterranean Sea which have some different characteristics.

The next Table shows: ZONES, number of the zones compared; DIFFERENCES, number of centimeters in the differences; POINTS, number of points with large differences and number of compared points; ACTION, shows the characteristics of the problematic zones in order to explain the differences obtained, and the action taken to correct o flaged as especial zones for particular geophysical analysis.

ZONES	DIFFER ENCES	POINTS	ACTION	RESULTS
14- 28	16 a 18	4 de 12	14 coast zone	Admitted
15- 16	18 y 32	2 de 7	Coastal points	Admitted
24- 38	16 y 20	2 de 12	24 coasts zone	Admitted
38- 39	18 y 20	2 de 13	39 coast zone	Admitted
50- 51	16	2 de 13	BGI zone	Admitted
51- 72	20 y 22	2 de 12	BGI zone	Admitted
63- 90	18	1 de 12	Point next to island	Admitted
64- 65	18	2 de 13	Point next to island	Admitted
70- 71	16	1 de 13	70 island zone	Admitted
71- 72	18 a 26	3 de 13	BGI zone	Admitted
71- 98	16 y 18	2 de 13	BGI zone	Admitted
74-101	16 a 18	3 de 13	BGI zone/Alternative 1	Admitted
75-102	32 a 78	8 de 8	Coastal zone BGI/Alternative 1	Admitted
78-106	22 a 26	4 de 11	Coastal points	Admitted
81- 82	21 a 26	4 de 9	Coastal zone	Admitted
83-111	16 a 38	5 de 11	83 island inside and few data	Admitted
90- 91	20 a 28	5 de 9	Island zone	Admitted
100-101	18	2 de 13	Sicily zone/Alternative 1	Admitted
100-126	18 a 28	8 de 12	Sicily zone/Alternative 1	Admitted
101-102	14 a 28	4 de 13	Sicily zone/Alternative 1	Admitted
103-129	18 a 24	2 de 9	Calabria zone/Alternative 1	Admitted
104-130	32 a 40	5 de 5	Coastal zone/Alternative 2	
	20 a 50	4 de 5	Conflictive zone	Admitted
105-131	20 a 25	2 de 13	Coastal zone	Admitted
124-125	16 a 18	2 de 13	Sicily zone	Admitted
125-126	16 a 26	4 de 13	Sicily zone/Alternative 1	
	16 a 25	8 de 13	Sicily zone/Alternative 1	Admitted
126-127	16 de 18	3 de 10	Sicily zone/Alternative 1	Admitted
126-155	21 a 28	2 de 5	Sicily zone/Alternative 1	Admitted
127-128	16 a 22	3 de 11	Sicily zone/Alternative 1	Admitted
128-129	26 a 60	5 de 12	Sicily zone/Alternative 1	Admitted
129-130	24 a 32	4 de 4	Calabria zone/Alternative 2	Admitted
129-158	29 a 105	5 de 6	Calabria zone/Alternatives 1 and 2	
	33 a 88	5 de 6	Conflictive zones	Admitted
135-136	20 a 24	3 de 3	Coastal zone	Admitted
137-138	18 a 26	7 de 13	Coastal zone	Admitted
137-166	18 a 20	3 de 12	Coastal zone	Admitted
156-186	18 a 20	2 de 13	Coastal zone	Admitted
157-158	44 a 154	13 de 13	Sicily zone/Alternative 2	Admitted
157-187	36 a 54	2 de 2	Sicily zone/Alternative 2	Admitted
158-159	18 a 72	4 de 13	Sicily zone/Alternative 2	Admitted
158-188	18 a 54	6 de 12	Sicily zone/Alternative 2	
	20 a 29	5 de 11		Admitted
166-196	14 a 22	1 de 12	Coastal zone	Admitted
168-169	16 a 26	4 de 12	Island zone. Boundary G1-G2MED	Admitted
168-198	22 a 36	6 de 12	Island zones	Admitted
169-170	25	1 de 1	Coastal zone	Admitted
173-174	26	1 de 7	Coastal points	Admitted
177-178	24	1 de 6	Coastal points	Admitted
187-188	18	1 de 13	Coastal points	Admitted
194-195	22	1 de 9	Coastal points	Admitted
198-199	18 a 26	8 de 13	Island zone. Boundary G1-G2MED	Admitted
200-232	18 a 22	4 de 8	Island zone	Admitted

205-237	16 a 18	3 de 13	Island zone	Admitted
207-239	18	1 de 10	Island zone	Admitted
232-233	18 a 20	2 de 13	Island zone	Admitted
234-235	18	1 de 13	Island zone	Admitted
236-262	16 a 20	2 de 13	Island zone	Admitted
239-240	162 de 13		Coastal zone	Admitted
254-255	14 a 24	2 de 13	Crete zone	Admitted
256-257	16 a 22	5 de 13	Crete zone. Boundary G1-G2MED	Admitted
256-281	16 a 24	2 de 12	Boundary G1-G2MED	Admitted
257-258	20 a 70	9 de 13	Few data. Boundary G1-G2MED	Admitted
257-282	22	1 de 12	Few data	Admitted
258-259	18 a 26	3 de 13	Few data	Admitted
258-283	16	1 de 12	Few data	Admitted
262-263	18	1 de 13	Cyprus zone	Admitted
275-276	18 a 24	3 de 13	Coastal zone	Admitted
281-282	18 a 22	4 de 13	Few data. Boundary G1-G2MED	Admitted
291-292	18	3 de 12	Coastal zone	Admitted
306-322	18	1 de 12	Coastal zone	Admitted
322-323	16 a 18	2 de 4	Coastal zone	Admitted

5.4. ALTERNATIVES USED IN ZONES WITH PROBLEMS

There are two regions with a lot of problems as shown in the last Table. These zones were joint in two blocks in order to avoid these problems. This solves the numerical part but no the geodetic one. These two zones were called Alternative 1 and 2.

ALTERNATIVE 1

1. This block is formed by zones 100, 101, 102, 103, 126, 127, 128 and 129, it is between the limits $38<\phi<40$ y $12<\lambda<15.5$.
2. A covariance function is computed.
3. The geoid is predicted in this block.
4. A new check is done in the boundaries.

ALTERNATIVE 2

1. This block is formed by zones 104,128,129,130, 157, 158, 159, 187 and 188
2. A covariance function is computed.
3. The geoid is predicted in zones 129,130,158 and 159.
4. A new check is done in the boundaries.

The geoid in these two regions is shown in Figures 2: 2a geoid from single zones and 2b the geoid with the alternatives

5.5 GLOBAL RESULTS IN THE ZONE PATCHING

There are 151 points whit differences between 16 and 30 centimeters distributed in 57 boundaries of 571, and 10 points with differences between 30 and 88 cm in 2 boundaries. 154 boundaries give differences under 15 cm.

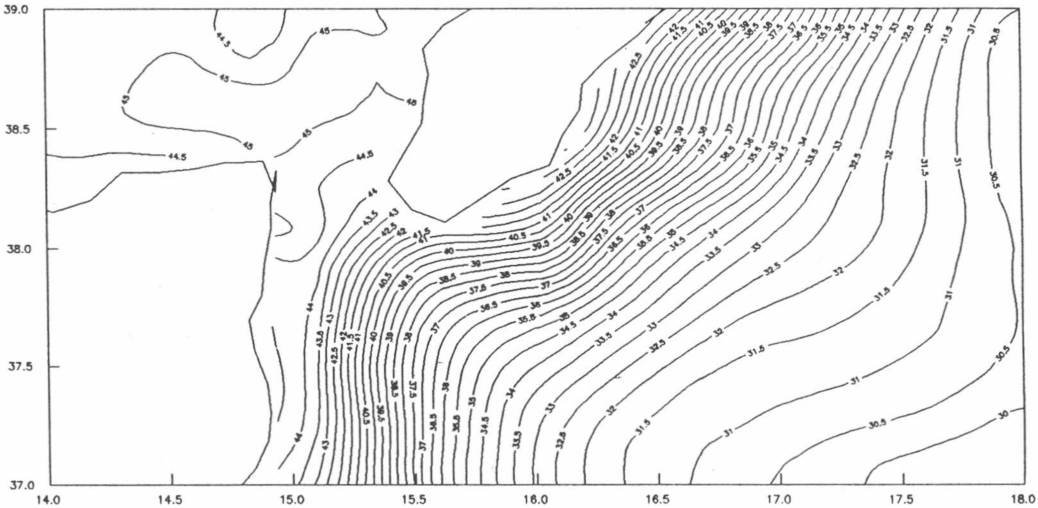

Figure 2a. Geoid from single zones

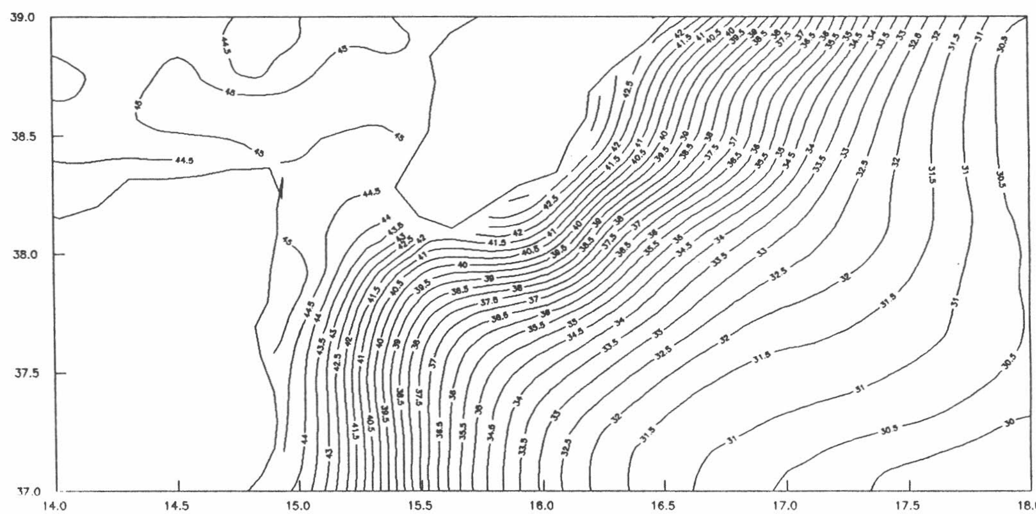

Figure 2b. Geoids from Alternative 2

6. NEW RESULTS

TABLE 6. *Statistical information MEDIGEO92*

LIMITS: $30.5<\phi<45.7$, $-6.0<\lambda<35.6$

NUMBER OF PREDICTED POINTS: 35226

	Mean (cm)	Standard deviation	Minimum	Maximum	Range
LATITUDES	37.18	3.32	30.58	45.67	15.08
LONGITUDES	16.60	9.43	-6.00	35.58	41.58
GEOID PREDICTION	33.38	13.76	0.19	50.97	50.78
IFE88E2 GEOID	33.38	13.76	0.15	50.93	50.78
(IFE-PRE) GEOID	-0.00	0.20	-1.38	1.30	2.68
PREDICTION ERROR	0.04	0.06	0.00	0.76	0.76

7. REFERENCES

SEVILLA, M.J., G.RODRIGUEZ-CADEROT and A.J.GIL (1992): A gravimetric geoid un the Mediterranean Sea. Mare Nostrum Num. 1, pp.37-83. Milan