A Project for archiving and managing physical geodesy data in Antarctica

A. Capra [(1)] and S. Gandolfi [(2)]

[(1)] *Engineering Faculty of Taranto – Polytechnic of Bari (ITALY)*
[(2)]*DISTART - University of Bologna (ITALY)*
e-mail- Alessandro.Capra@mail.ing.unibo.it
e-mail- Stefano.Gandolfi@mail.ing.unibo.it

Abstract

Within the activities of WGGGI (Working Group on Geodesy and Geographic Information) of SCAR (Scientific Committee on Antarctic Research), a "Physical Geodesy" project was planned for the period 1998-2000.
Till today a geoid map of Antarctica was produced by AUSLIG (Australia) showing the geoid-ellipsoid separation between GRS80 and OSU89A. Researchers from different countries tried to compute new local and regional high-resolution geoid. The goal of the Physical Geodesy project is the collection and the analysis of data useful for the development of a new high resolution geoid for the most part of Antarctica. A first phase of information and extensive data collection, related to geodesy, topography, bathymetry and gravity, was activated in collaboration with Institutions and Specialists Group (BEDMAP, ADGRAV, ADMAP and RAMP).
In order to have a correct data archiving and management, useful for successive geoid computation, a preliminary plan of DBMS (Data Base Management System) is presented.

1 - Introduction

A new high resolution geoid has to be obtained starting from a global model of geoid and corrected by the use of geodetic, gravimetric measurements and density model (Fig.1).

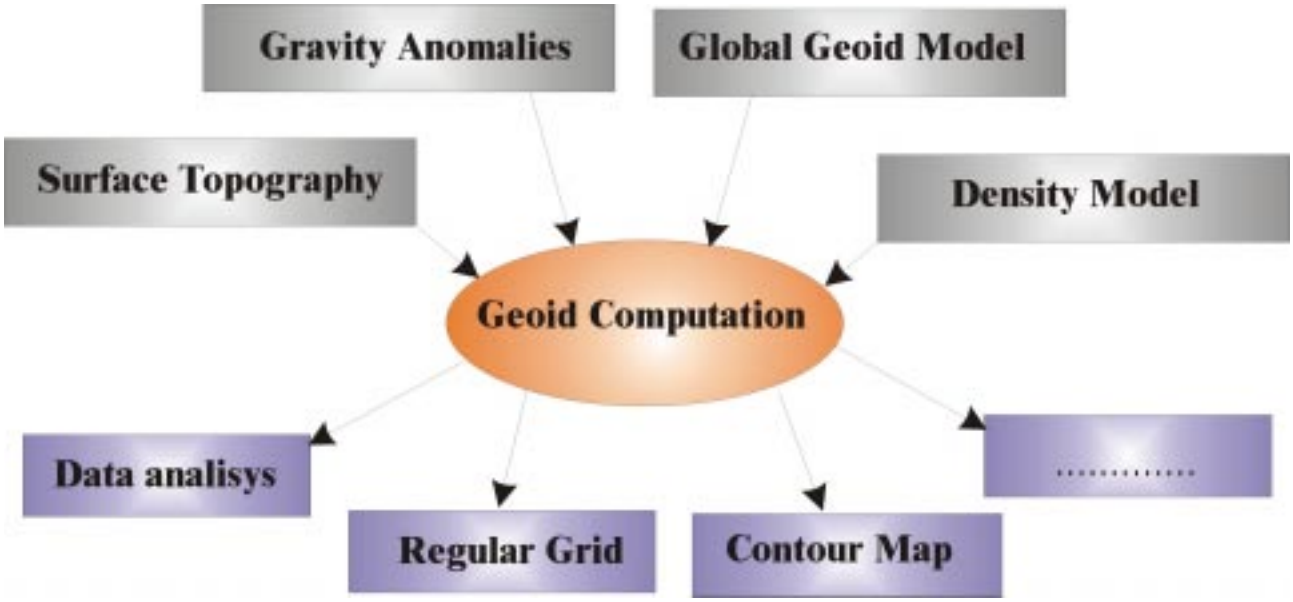

Fig. 1 – *Scheme of Physical Geodesy Program*

The scheme shown in figure 1 represents a classical approach for Gravimetric geoid computation (Barzaghi R., et al. 1993; Reigberg C. 1989; Rapp R.H. et al. 1994; Rapp R.H. 1989; Moritz H., Heiskanen W.A 1967). The particularity of Antarctic continent present some peculiarities by the

point of view of measurement methodologies and instruments. Surface topography determination (DEM generation) has been done mainly trough satellite altimetry surveys due to the poor coverage of classical and other space geodesy techniques, overall for the inner part of Antarctica (generally satellite altimeter is used for sea surface determination in physical geodesy approach).
Moreover density model computation needs for ice thickness determination by the comparison of surface topography and bedrock surface (trough Radio Echo Sounding – RES profiles). The ice thickness variation change locally and in time so it is necessary to take into account also the repetition of surface determination.
The possibility to perform this project is strongly connected to the contribute of researchers from different countries who worked on geodesy, geophysics and geology in Antarctica. However data collection has to be clear and simple for scientist who should contributed to send data. In order to organize different kind of data, the realization of a Data Base Management System should be the better solution. However gravimetric and topographic measurements show different characteristics, so it is necessary to plan two different DBMS.
A preliminary DBMS was prepared using Microsoft Access for Windows 95, but others software are going to be studied that could allowed the management of bigger quantity of data with stronger facilities.

2 - DBMS for Geodetic data.

Many countries and many research groups performed a lot of topographic, gravimetric and tide gauge observations, so the first problem is how to collect and organize those data. The data acquired with different methodologies and generally in different reference systems must be transformed in the same DATUM in order to perform an homogeneous datasheet.
In Antarctica the ice-thickness is changing relatively quickly for many reason (ice movement and ice melting principally), so the ice topography should be computed periodically.
Regarding this point a closed data exchange should be made with BEDMAP (Bedrock Map Antarctica Project) and RAMP (Radarsat Antarctic Mapping Program).
The DBMS could allow an easier data archiving and a correct data analysis to establish the level of desired accuracy for high precision topography determination.
The DBMS for geodetic Measurements in Antarctica requires for some particularity with respect to other kind of DBMS for Geodesy:

1) the atmospheric, climatic and morphologic condition don’t permit the easier development of classical measurements, especially in the inner part of Antarctica Continent;
2) space geodesy will constitute the greater part of data;
3) despite of the above consideration, some classical observation will be considered in particular in region close to tide gauges.

Taking into account the previous consideration only some typology of data are available:

a) GPS data (Static - DGPS - Kinematic)
b) DORIS
c) SAR
d) Satellite Altimetry
d) Tide Gauge

and some typology of data are generally not available: Spirit Levelling, SLR and VLBI
In Fig.2 a scheme of the DBMS for geodesy is shown. As is shown in Fig.2, each measurement campaign datasheet must be coupled with a Form (Main Form + Sub Form) as Identity Card of the Survey.

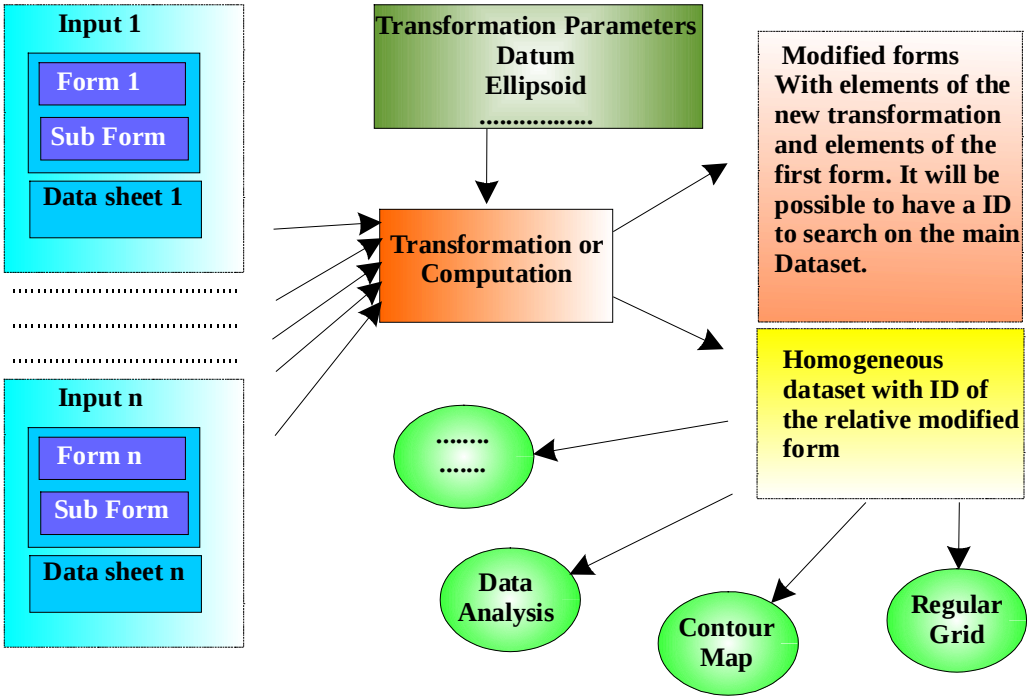

Fig. 2. - *Main Scheme of the DBMS for Geodesy*

In the Main Form some information on Company, Year, Reference, Name of Survey, Location or Region appear. For each kind of survey a particular "Sub Form" permits to better understand modality, instrumentation, software, reference frame and every kind of information relative to the datasheet. This is only a user facilities because the table of the general data contain all the field of every kind of survey and some of these will be filled. When some data-set are input, in his own reference frame, it will be possible to generate an homogeneous data set using transformation parameter and to create an associated table form containing the "history" of each data-set.

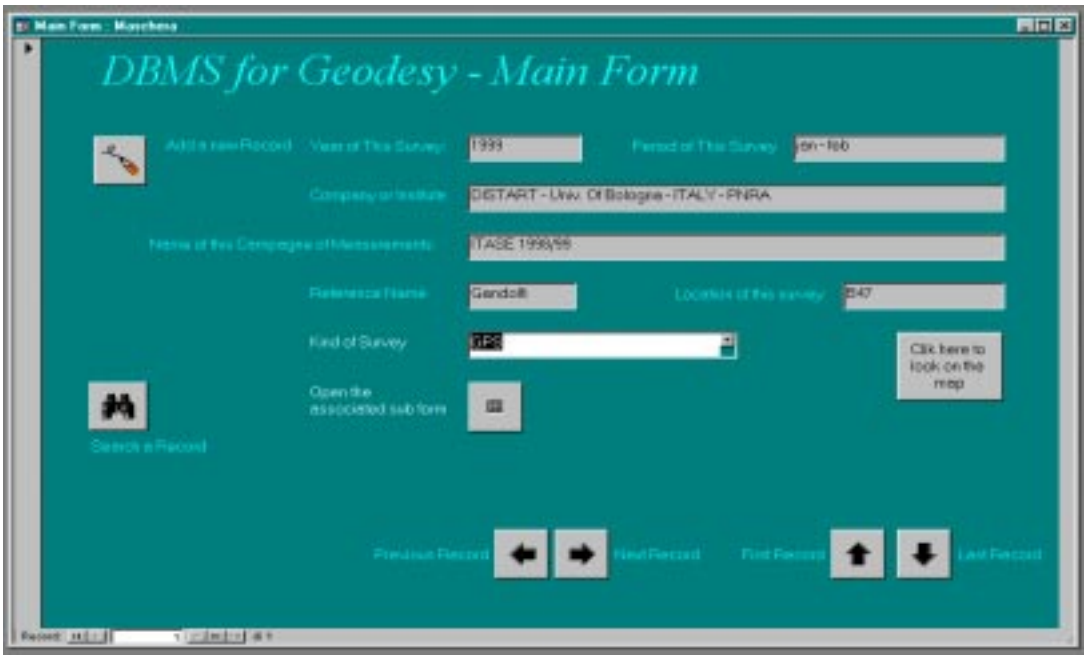

Fig. 3 – *Example of the Main Form.*

The new table has to contain the initial form, the new reference frame and the transformation parameters associated. When this step was concluded, it is possible to produce regular grid, contour map, data analysis etc..
In order to allows a faster selection for local data integration and processing, antarctica continent should be divided in sectors. So it will be possible to classify each survey with an associated label of the sector where the survey has been performed. This part should be inserted manually or produced automatically starting from coordinates of input points.
In order to divide Antarctica in sector a criteria should be, for coastal region, the use of INDEX map of the 24 planned 1:1.000.000 scale coastal change and glaciological USGS Antarctica Maps, while for the inner part should be used the limits in longitude of each map tracked to the geographic pole.
Another criteria should be obtained furnishing the division adopted by BAS (British Antarctic Survey) to produce the ADD (Antarctic Digital Database).
A third criteria should be the selection of sectors delimited in Longitude (10 degrees of amplitude) and in three strips: 60° - 70°, 70° - 80°, 80° - 90° of Latitude South.

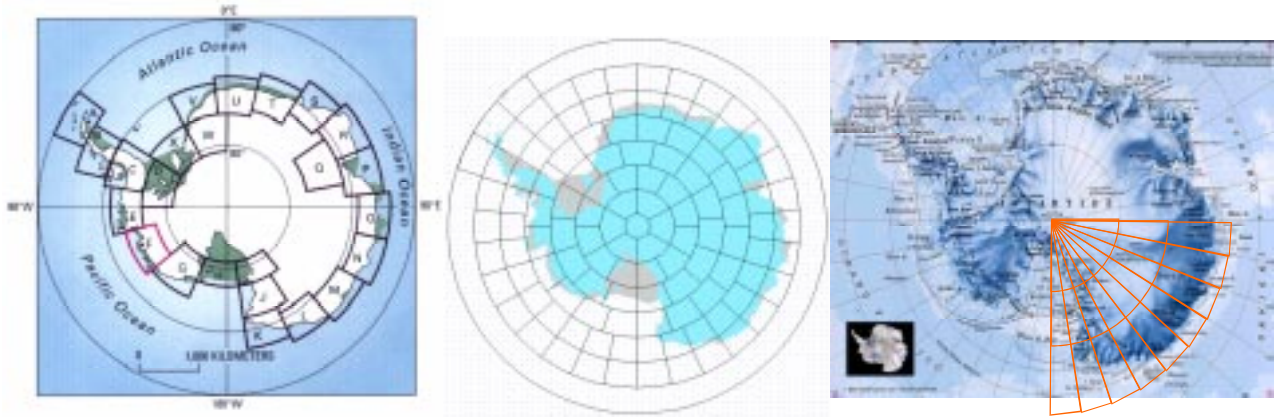

Fig. 4 – *Example of sector sub-division of Antarctica. The map on the left is the sub-division utilized by USGS, on center the sub-division adopted by BAS and on the right another suggested sub-division.*

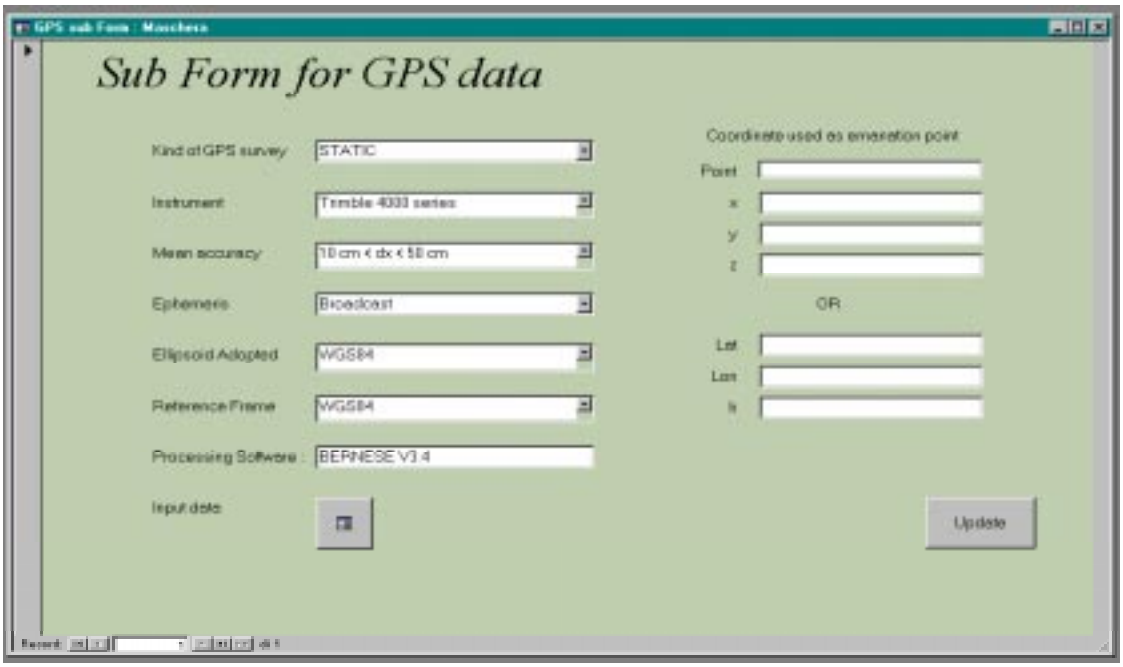

Fig. 5 – *Example of GPS data Sub Form.*

Fig. 6 – Example of data input panel.

Input data is available manually by user or automatically by file (eg. CSV, TXT, XLS, etc.). For Latitude and Longitude only a fixed format was adopted (eg. sexadecimal F13.10)

3 - DBMS for Gravimetry.

Some consideration and property of DBMS for Geodesy were applied also for DBMS for Gravimetry. Airborne gravimetry, ground gravimetry and satellite gravimetry are considered. At the moment only a first scheme was drafted and the work still in progress.

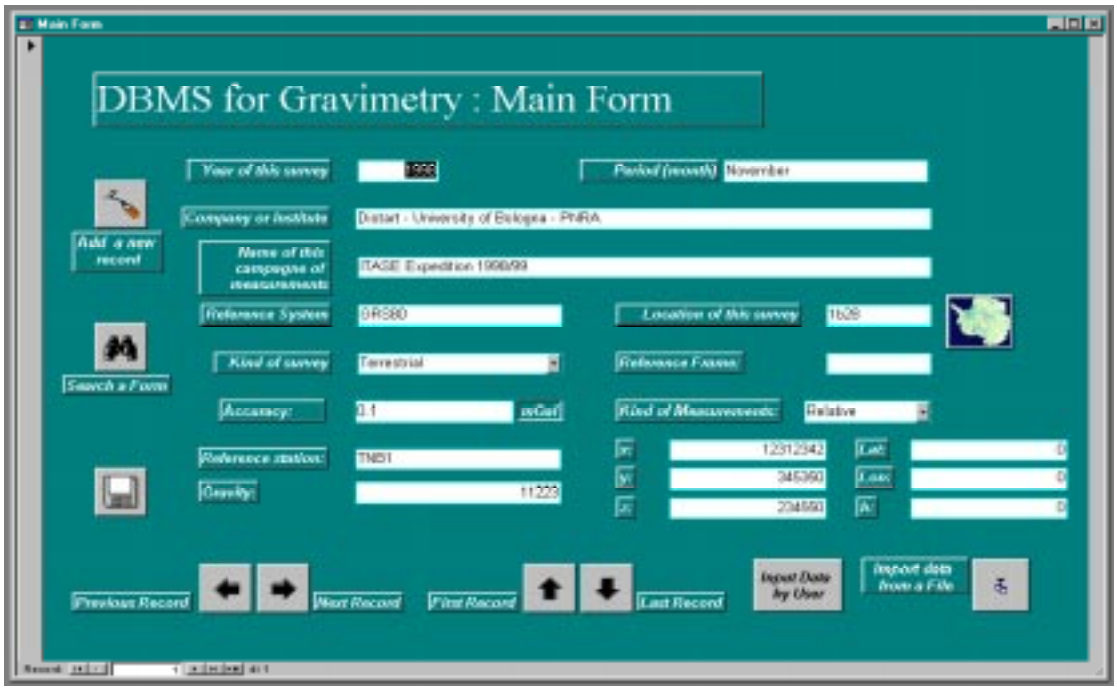

Fig. 7 - *Example of Gravimetry Main Form*

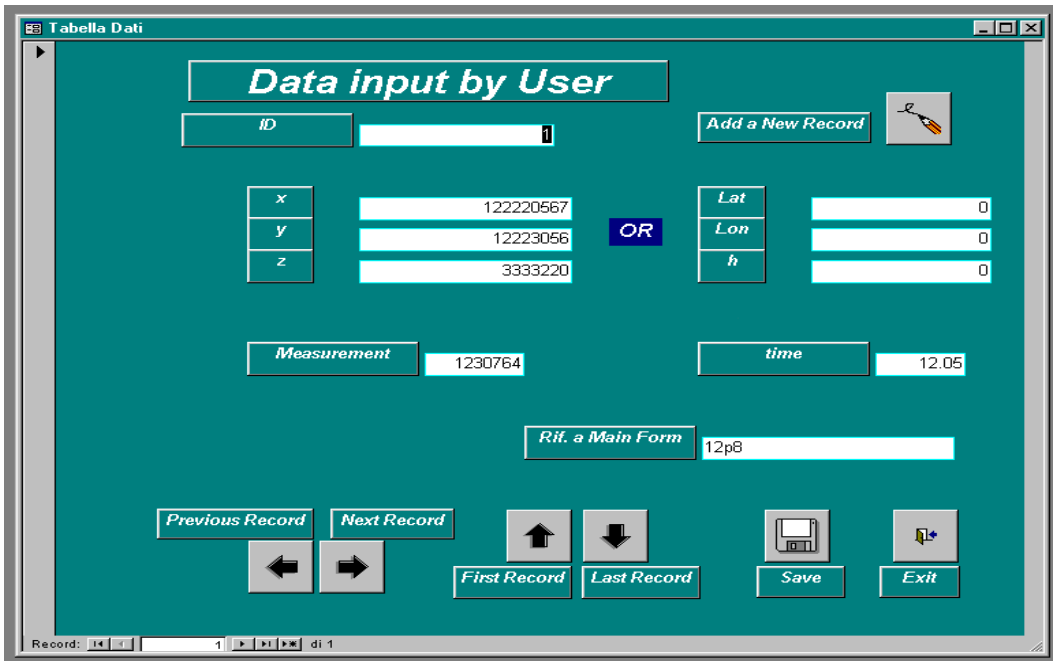

Fig. 8 – *Example of Gravimetric Data input by user.*

4 – Data collection

At the moment the most considerable gap in information regards gravimetric observation. Antarctic airborne gravimetry database is in progress (see ADGRAV Project). A collection of information on gravimetric absolute measurements has been made in GIANT Program (Geodetic Infrastructure of Antarctica) of SCAR WGGGI.
Geodetic and Tide Gauge observations are also collected by GIANT and most part are already available.
The information for the surface elevation are goals of data set projects like RAMP. While the ice bed elevation model is a goal BEDMAP Project. Within RAMP the Bird Polar Research Centre (BPRC) has created a DEM of whole Antarctica. Within BEDMAP, a new topographic model of the bed of Antarctic ice sheet will be developed, allowing ice thickness determination.
The information on the coast line and also of the inner part of continental topography are available on USGS Glaciology and Coastal-change Project and on Antarctic Digital Database (ADD) made by BAS.

5 - Conclusion

The goal of SCAR WGGGI Physical Geodesy Project is the high resolution geoid computation of Antarctica. The first step of data collection was the plan of a DBMS for different kind of data available for the Geoid computation: surface topography, bedrock surface, gravimetric observation and density models. A preliminary DBMS for geodesy and for gravimetry scheme was performed. The work is in progress and it is necessary to better define the DBMS and to start the verification of feasibility trough a real data input.
The second phase should be the data collection and it will be fundamental the data exchange with research programs like BEDMAP, ADGRAV, RAMP etc..
Moreover it is desirable a strict interaction with IAG Commission on “Gravity Field and Geoid” to perform an Antarctic gravity database, eventually trough a working group creation.

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WGGGI Working Group on Geodesy and Geographic Information
Web sit address: http://www.scar-ggi.org.au/

ADD - Antarctic Digital Database.
Web site address: http://www.nerc-bas.ac.uk/public/magic/add.html

RAMP – Radarsat Antarctic Mapping Program.
Web site address: http://polestar.mps.ohio-state.edu/ramp.html

BEDMAP – BEDrock MAPping.
Web sit address: http://www.nerc-bas.ac.uk/public/aedc/bedmap/