

THE AFRICAN GEOID PROJECT AND ITS RELEVANCE TO THE UNIFICATION OF AFRICAN VERTICAL REFERENCE FRAMES

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African Geoid Project & Unifying Vertical Reference Frames

❖ AFRICAN GEOID PROJECT:

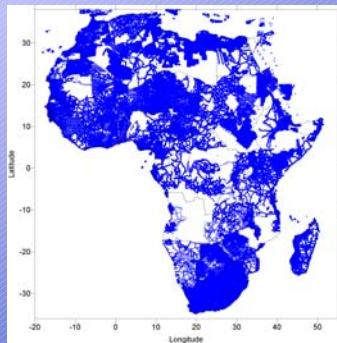
- African Geoid Project set up by IAG Committee for Developing Countries, now a project of Commission on Gravity
- Working Group of African geodesists (South Africa, Zambia, Tanzania, Egypt, Algeria)



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❖ DATA:

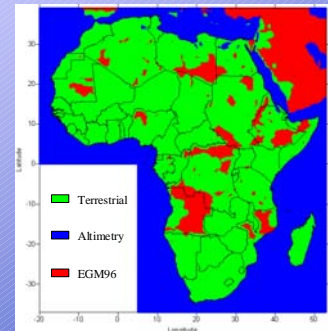
Terrestrial point gravity anomalies



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❖ DATA:

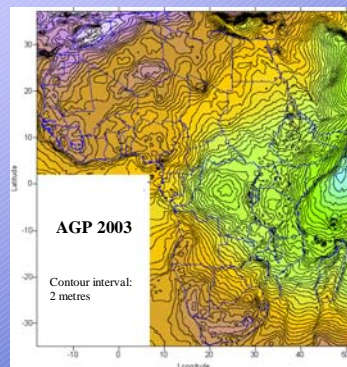
- Marine Δg_f : KMS satellite altimetry
- Data gaps: EGM96
- DEM: GLOBE 30"



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❖ RESULTS:

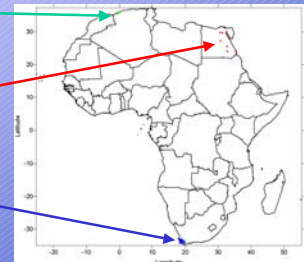
Preliminary African Geoid



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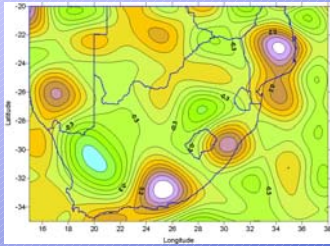
❖ COMPARISON WITH GPS/LEVELLING:

- Northern Algeria: bias: -17cm, σ : 48cm
- Eastern Egypt: bias: +124cm, σ : 80cm
- Southwest Cape Province: bias: -63cm, σ : 9cm



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❖ **LONG WAVELENGTH BIASES IN EGM96:**

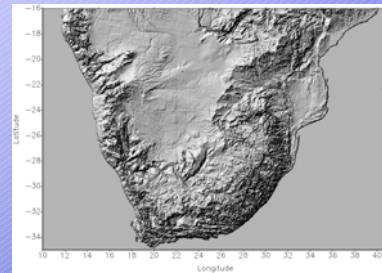


GGM01 minus EGM96 geoid (degree 90) for South Africa (contour interval: 10cm)



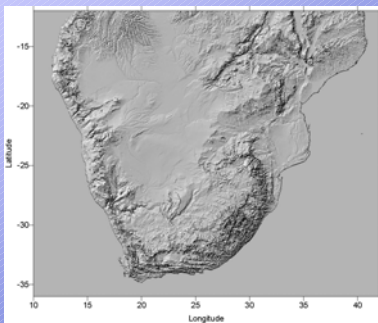
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❖ **GLOBE DEM (note tiling effect)**



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❖ **SRTM DEM:**



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❖ **IMPROVEMENTS:**

- ◆ **Fill gaps, possibly using airborne gravimetry**
- ◆ **Replace EGM96 with GGM01 or similar model**
- ◆ **Replace GLOBE DEM with NASA SRTM model**
- ◆ **Need for more GPS/levelling comparisons**



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❖ **VERTICAL DATUM:**

- ◆ **Geoid:** “equipotential surface of Earth’s gravity field that coincides on average with mean sea level (MSL)”
- ◆ Rise in MSL = Rise in Geoid?
- ◆ MSL is measured at a point (tide gauge) - how is global average determined?
- ◆ Problem of sea surface topography - departure of MSL from a single equipotential surface.



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❖ **NATIONAL VERTICAL DATUMS:**

- ◆ Each is based upon a different set of MSL measurements - there are departures of up to several metres.
- ◆ Regional development projects need consistent height data - there is a need to unify vertical datums in Africa
- ◆ AFREF project will help to unify horizontal datums - it can also be used to unify vertical datums



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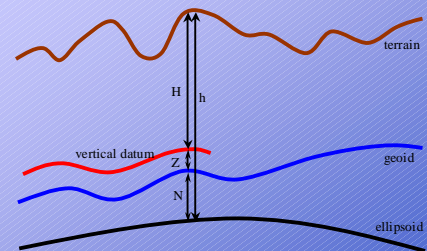
❖ UNIFICATION OF VERTICAL DATUMS :

- Common benchmarks at borders: relative offset only; needs several widely-spaced common BM's; can be affected by errors in levelling.
- SST model: absolute offset determined, but SST models are poor near coast; can only be used for adjacent coastal states, not for landlocked states.
- GPS plus geoid model: absolute or relative; needs precise reference frame (ITRF); systematic biases in geoid model can distort results.



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❖ UNIFICATION OF VERTICAL DATUMS :



$$Z = h - N - H$$



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❖ CONCLUSIONS :

- Need for unified vertical reference frame for Africa to support economic development.
- AFREF and AGP projects provide a means to unify vertical datums.
- AFREF: need to locate some GPS stations at datum zero points (TGBM's) and levelling network nodes.
- AGP: need to fill gaps and to reduce biases and long wavelength errors.



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