The CARIB97 High Resolution Geoid Height Model for the Caribbean Sea

by

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CARIB97

BACKGROUND:

- NGS needed a high resolution geoid height model to support GPS surveys at Caribbean airports
- NGS gravity coverage was insufficient, and asked NIMA to collaborate on this project

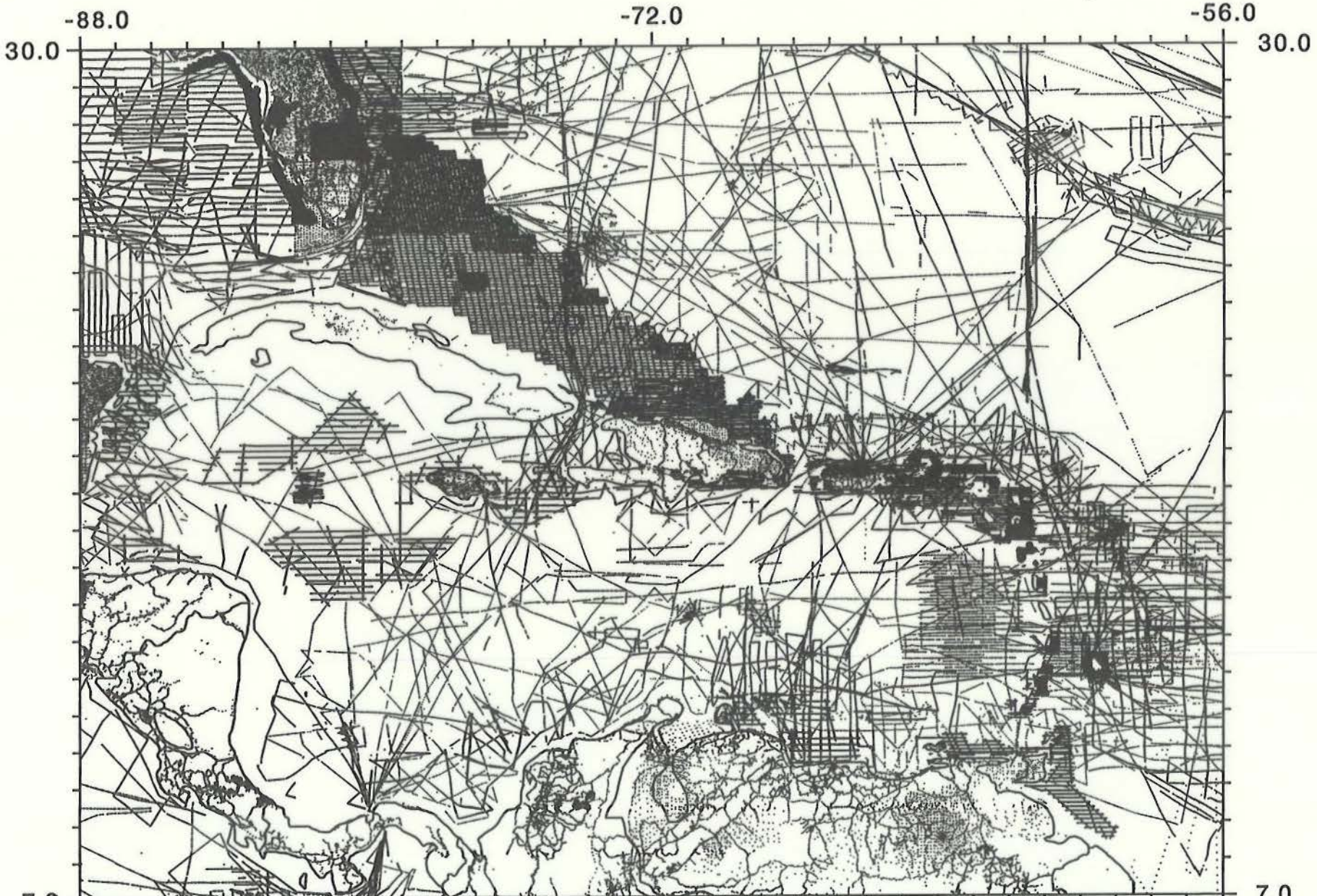
Tie into Local DATUM

DATA:

- 559,000 NIMA/NGS gravity points
- 154,000 KMS Altimetry derived gravity anomalies
- EGM96 for long wavelength structure
- GTOPO30 (USGS) 30" DEM

Good 1/2 Millware NIMA

CARIB97 Gravity Coverage (no altimetry)



CARIB97 COMPUTATIONAL SCHEME

- Terrain corrections from 30" DEM

- Point by point computed refined Bouguer anomalies

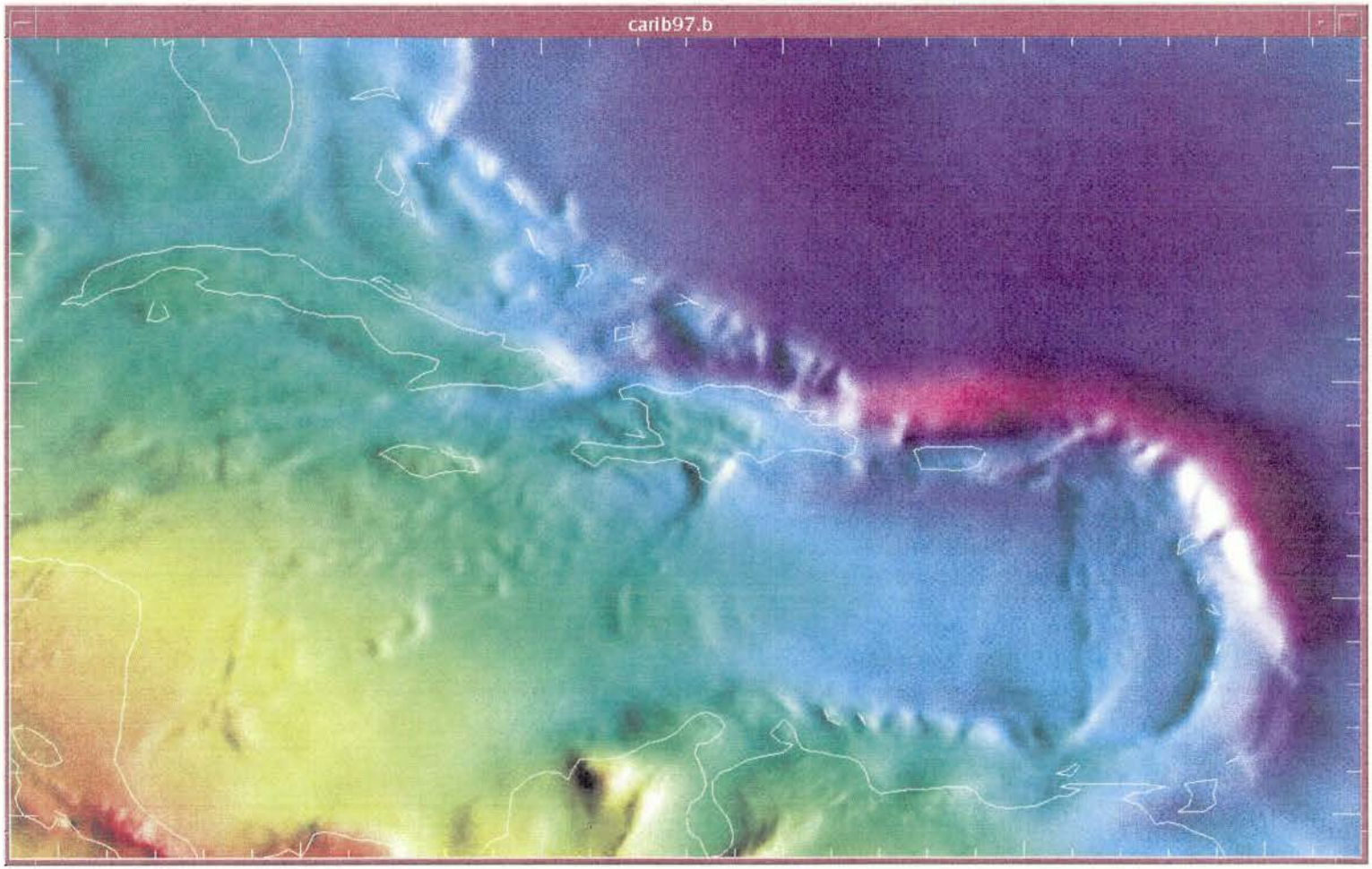
- Gridded refined Bouguer anomalies to a 2' x 2' grid

- Restored Bouguer Plate at grid node for Faye anomalies

- Faye anomalies approximating Helmert anomalies

- Remove/Compute/Restore 1-D FFT application of the Stokes integral using EGM96

CARIB97



Red=+17 meters

Magenta=-71 meters

Testing CARIB97 at Tidal Benchmarks

Remember: N = h - H

All things being equal

Compare N(CARIB97) to h(GPS) and H+ζ(Tide Gauge) at 31 tidal benchmarks.

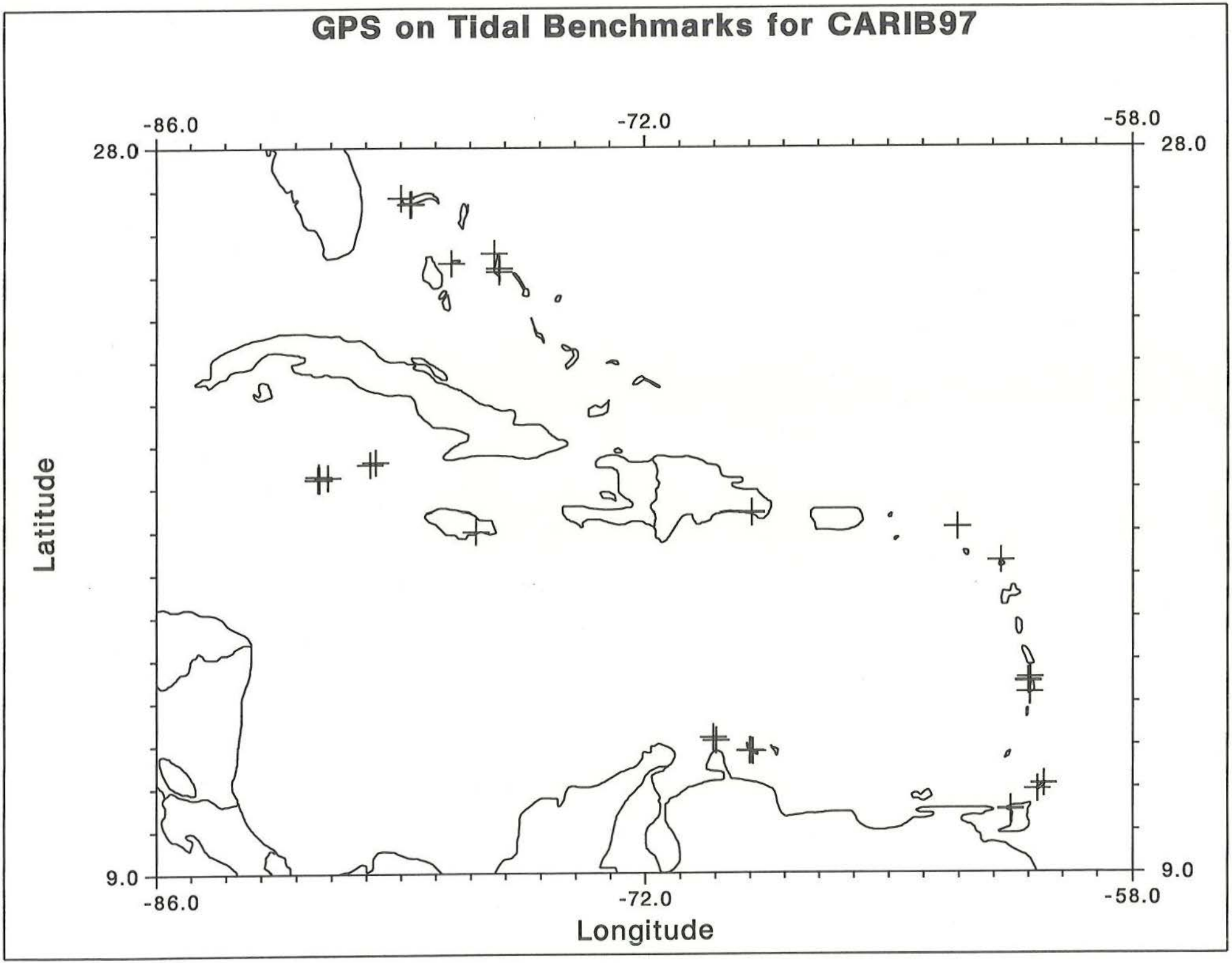
↑ zeta → Dyn Oc. Topo. or SST

Heights at Tidal Benchmarks are biased by a local ζ

- **Thus, residuals are: e = N - (h - {H + ζ})**
- **e should not necessarily average to zero**

↑ either in time or space.

GPS on Tidal Benchmarks for CARIB97



Testing CARIB97 at Tidal Benchmarks, II

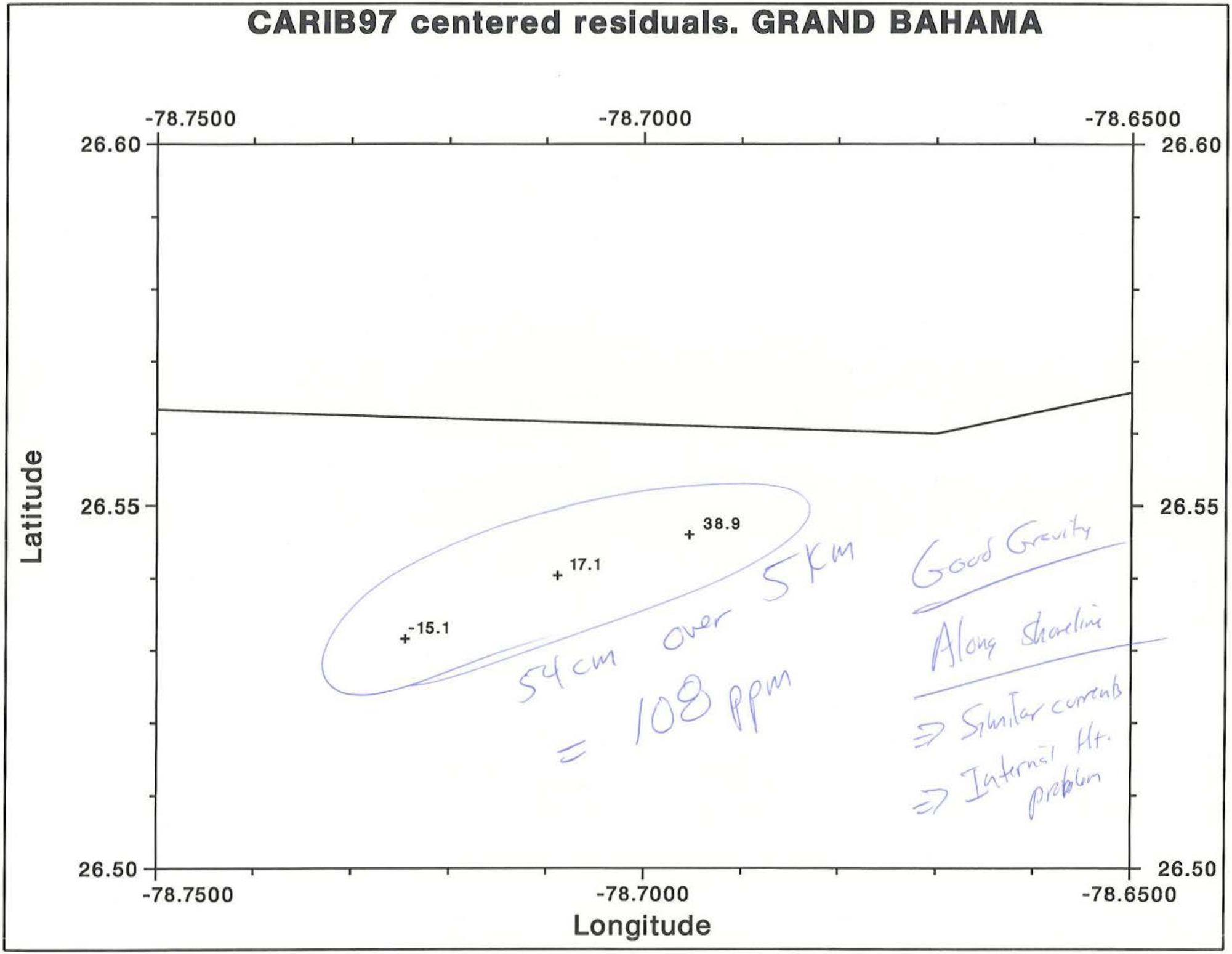
Test residuals (e) using EGM96 and CARIB97

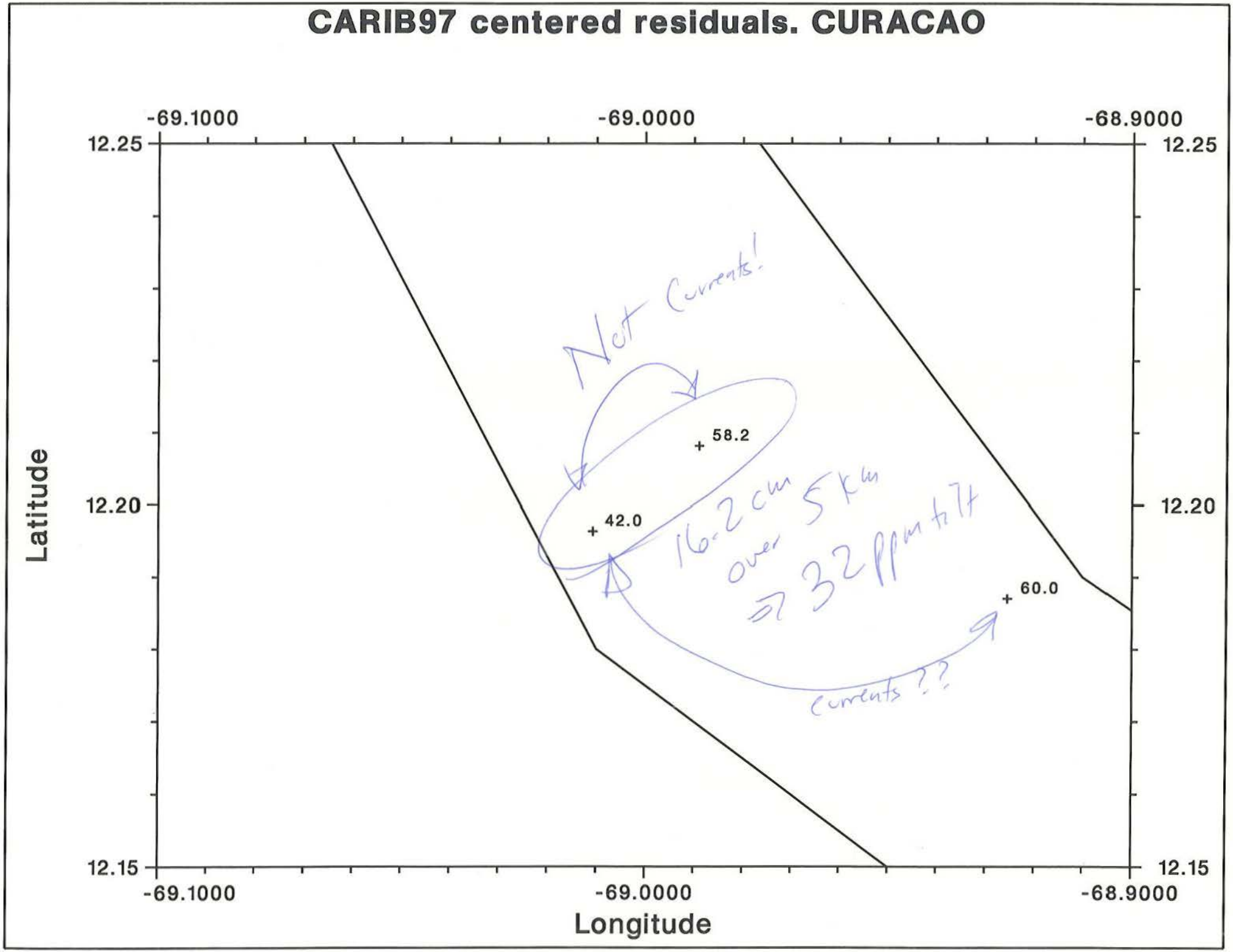
	Resolution	Average e	RMS
EGM96	50 km	-98 cm	77 cm
CARIB97	3 km	-51 cm	62 cm

Agrees with EGM96 QSST Model to 20 cm

Further improvements to comparisons require more information about local tidal heights, improved gravity coverage and a model of ocean circulation.

Individual island results yield local datum information.


CARIB97 centered residuals. GRAND BAHAMA
-78.7500
-78.7000
-78.6500
26.60
26.55
26.50
Latitude
Longitude
38.9
17.1
-15.1
54cm over 5km
= 108 ppm
Good Gravity
Along shoreline
⇒ Similar currents
⇒ Internal Ht. problem


CARIB97 centered residuals. CURACAO
-69.1000
-69.0000
-68.9000
12.25
12.20
12.15
Latitude
Longitude
58.2
42.0
60.0
Not Currents!
16.2 cm over 5 km
⇒ 32 ppm ± 7
Currents ??

CARIB98 (Experimental geoid)

- Similar to CARIB97 but added 2 helicopter borne gravity surveys over Florida and the Bahamas (61,000 points)

- General effect was to stablize the Bahamas geoid and introduce a long wavelength tilt which improved the overall statistics of all GPS/BM residuals in the region:

  Average e : -40 cm ← Closer to -25 for QSST dEGM96

  RMS : 59 cm Down from 62

- More detailed analysis shows that the absolute level of the airborne gravity seems ok, but high frequency information is masked in too much noise to be useful

CONCLUSIONS

- For the first time a unified high resolution geoid model of the Caribbean Sea has been computed

- Improvements over existing global model have been shown through GPS on tidal benchmarks

- Local tidal datums can be evaluated for internal errors using CARIB97

- Additional gravity coverage, and ocean circulation models needed to further improve the geoid