The DTU13 Global marine gravity field - first evaluation

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Steps towards DTU13
- Introducing Cryosat-2 and Jason-1 GM
- LW residual SSH signal in EGM08/MDT (remove/restore)
- Cross-over adjustment
- Decreasing filtering (resolving finer scale signals)

• The Arctic Ocean – Completing global Coverage with C2

• Accuracy, Compasison with marine gravity
DTU13 Free air global gravity is available
Two new “Geodetic” Missions

• **CryoSat-2**
  - High Inclination (88º) – Covers most of the Arctic
  - Completed 3 repeats of 369 days.
  - Offers LRM, SAR and SAR-in altimetry.
  - Track Spacing = 8 km
  - Used 1 Hz data from RADS for DTU13

• **JASON-1 EOL**
  - April 2012 – May 2013
  - Jason-1 End-of-Life Scenario
  - Low inclination (66º)
  - 406 Days GM
  - Track Spacing = 7 km
  - Use 1Hz RADS data
Gravity from Sea surface heights

With J1 (1.1Y) and C2 (3Y) we have 3 Times more GM data.

\[ h = (N_{\text{NW}} + \Delta N) + \text{MDT} + h(t) \]

\[ \Delta g = -\gamma \frac{\partial N}{\partial r} - 2\gamma \frac{N}{r} \]

Select Area-tile (process world in tiles)
Remove \( N_{\text{NW}} \) (EGM2008 d/o = 1960)
Remove MDT (MDT\textsubscript{DTU07/EGM2008} d/o=100)
Perform crossover adjust ("reduce" \( h(t) \))
Iterative (despiking /re-xover )
"Designed" collocation interpolate to a regular grid
Convert \( \Delta N \) to \( \Delta g \) using FFT
Restore EGM2008 gravity

NOTICE WE HAVE NOT USED GOCE MDT due to consistency issues
Deriving DTU13

Smaller tiles/regions (1° x 3° - process in 1.5° by 3.5°)
For x-over we assume "no ΔN" signal > 150 km

Introduced a remove/restore of "residual" wavelength (150-500 km)
Prior to x-over adjustment using ERM data.
Decrease spatial filtering from 9 km (DTU10) to 6.5 km (DTU13) half wl.

Resolves more signal related to geophysical Structures:

I.e. the Mid-Atlantic Spreading ridge.

Shows DTU10 – DTU13
Processed all C-2 Lead data retracked using a Gaussian peak retracker.
Employ updated EGM08E (north of 70ºN) due to striation in EGM08
## Comparison

LomGrav 2009 Airborne survey.

<table>
<thead>
<tr>
<th>All mGal</th>
<th>DTU10</th>
<th>EGM08</th>
<th>EGM08E</th>
<th>DTU13</th>
</tr>
</thead>
<tbody>
<tr>
<td>LomGrav 2009</td>
<td>8.78</td>
<td>9.82</td>
<td>4.74</td>
<td>4.45</td>
</tr>
</tbody>
</table>
Comparisons
NW Atlantic

Unclassified NGA marine gravity
($\Delta = 2 \text{mgal}$)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev.</th>
<th>Max Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>321.400 obs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KMS02</td>
<td>0.44</td>
<td>5.15</td>
<td>49.38</td>
</tr>
<tr>
<td>DNSC08</td>
<td>0.39</td>
<td>3.91</td>
<td>36.91</td>
</tr>
<tr>
<td>DTU10</td>
<td>0.39</td>
<td>3.88</td>
<td>36.89</td>
</tr>
<tr>
<td>DTU13</td>
<td>0.40</td>
<td>3.71</td>
<td>36.80</td>
</tr>
<tr>
<td>SS V16.1</td>
<td>0.59</td>
<td>4.88</td>
<td>45.29</td>
</tr>
<tr>
<td>SS V18.1</td>
<td>0.41</td>
<td>3.96</td>
<td>36.99</td>
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<tr>
<td>SS V19.1</td>
<td>0.43</td>
<td>3.93</td>
<td>36.81</td>
</tr>
<tr>
<td>SS V21.1</td>
<td>0.41</td>
<td>4.09</td>
<td>38.20</td>
</tr>
</tbody>
</table>

Know $\Delta g$ improvement is bigger. “the error is in the marine gravity data”
Marine Test Area

USGS marine survey Onboard US Bowditch.

Crosses the Marianer Trench And nearby Plateau 2-9 km depth.

Total. 66291 obs.

<table>
<thead>
<tr>
<th>Gravity variations +/- 200 mGal (a lot)</th>
<th>Std (diff) mGal</th>
</tr>
</thead>
<tbody>
<tr>
<td>KMS02</td>
<td>5.20</td>
</tr>
<tr>
<td>EGM08</td>
<td>4.41</td>
</tr>
<tr>
<td>DTU10</td>
<td>4.10</td>
</tr>
<tr>
<td>DTU13</td>
<td>3.14</td>
</tr>
<tr>
<td>SS 19.1</td>
<td>3.44</td>
</tr>
<tr>
<td>SS 21.1</td>
<td>3.01</td>
</tr>
</tbody>
</table>
Coastal -> deep regions

<table>
<thead>
<tr>
<th>All Regions has over 10,000 obs</th>
<th>Std KMS02</th>
<th>Std DTU10</th>
<th>Std DTU13</th>
<th>Std SS 18.1</th>
<th>Std SS 21.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple (0-20 m Depth)</td>
<td>6.54</td>
<td>3.46</td>
<td><strong>2.97</strong></td>
<td>3.26</td>
<td>3.81</td>
</tr>
<tr>
<td>Dark Blue (20-50 m)</td>
<td>4.16</td>
<td>3.14</td>
<td><strong>2.79</strong></td>
<td>2.88</td>
<td>3.34</td>
</tr>
<tr>
<td>Light Blue (50-100 m)</td>
<td>4.06</td>
<td>3.83</td>
<td><strong>3.16</strong></td>
<td>3.26</td>
<td>3.61</td>
</tr>
<tr>
<td>Green (100-500 m)</td>
<td>5.74</td>
<td>4.89</td>
<td><strong>3.61</strong></td>
<td>4.98</td>
<td>4.69</td>
</tr>
<tr>
<td>Yellow (500-1000 m)</td>
<td>5.36</td>
<td>4.38</td>
<td><strong>4.17</strong></td>
<td>4.05</td>
<td>4.05</td>
</tr>
<tr>
<td>Red+Pink (1-5 km)</td>
<td>5.60</td>
<td>4.89</td>
<td><strong>4.23</strong></td>
<td>4.40</td>
<td>4.16</td>
</tr>
</tbody>
</table>
DTU13
- Resolution: 1 minute by 1 minute (2 km by 2 km)
- True global gravity field (90°S to 90°N)

Tripled the amount of Geodetic Mission Data.
Improved x-over adjustment and shorter wavelength recovery.


- Internet point of download (coming very soon):
  FTP: ftp.space.dtu.dk/pub/DTU13
  WWW: www.space.dtu.dk

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