The DNOSC08MSS global Mean Sea Surface

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The DNSe08 Mean Sea Surface
Outline

• Notice: DNSC08MSS is identical to DNSC07MSS
• The DNSC08 Global Mean Sea Surface
• Adjusting different satellites together.
   – ERS-2 (8 years -> T/P+Jason 12 years)
   – ENVISAT onto ERS-2 (Arctic Ocean)
   – ICESAT onto ENVISAT onto ERS-2 (Arctic Ocean)
• Importance of an accurate MSS
• Inter-annual variability
• The DNSC08 Bathymetry

<table>
<thead>
<tr>
<th>Model (Name)</th>
<th>T/P data Years</th>
<th>Resolution(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KMS04</td>
<td>9 (93-01)</td>
<td>2</td>
</tr>
<tr>
<td>CLS01</td>
<td>7 (93-99)</td>
<td>2</td>
</tr>
<tr>
<td>GSFC00/00.1.</td>
<td>7 (93-99)</td>
<td>2</td>
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<tr>
<td>KMS01</td>
<td>7.5 (93-00)</td>
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</tr>
<tr>
<td>NCU01</td>
<td>6 (93-98)</td>
<td>2</td>
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<tr>
<td>GSFC98</td>
<td>3 (93-95)</td>
<td>2</td>
</tr>
<tr>
<td>CLS-SHOM 98,</td>
<td>3 (93-95)</td>
<td>2</td>
</tr>
<tr>
<td>KMS98</td>
<td>3 (93-95)</td>
<td>3.75</td>
</tr>
<tr>
<td>CSR95</td>
<td>2 (93-94)</td>
<td>3.75</td>
</tr>
<tr>
<td>OSU95</td>
<td>1 (93-93)</td>
<td>5</td>
</tr>
</tbody>
</table>
The DNSC08 Mean Sea Surface

Want complete coverage in space and time”
”Get the best out of ERM (Variability averaged out) and GM (high spatial resolution)”

- First purely Geometrical MSS (CLS01 + KMS04 used geoid remove/restore)
- T/P, T/P TDM, ERS1 ERM+GM, ERS2 ERM, ENVISAT, Geosat GM, and GFO
- Total 12 years of data using T/P + Jason-1 as reference
- Based on NASA Pathfinder Data (ERM),
- Double-Retracked ERS-1 GM (Berry) + Retracked GEOSAT GM (Sandwell)
- ICESAT added in Arctic ocean between 90E-90W
- ArcGP Geoid ”feathered” in at 86°N for global coverage (Extra/Inter-potating across pole)
- The MSS has been derived in the Mean Tide System

MSS = MDT + Geoid
ERS-2 pathfinder globally adjusted to T/P (3 year mean)
ERS-2 8 year mean on T/P+JASON-1 12 year mean (Spharm degree and order 4)
Adjustment problems 2 – ENVISAT onto ERS2

No icemask on pathfinder ERS-2 data.
Removing un-reliable data and adding in good Arctic Data from ENVISAT.

Diff with PGM04 (striping)
ICESAT (not trivial to use)

- 6 monthly datasets used (2B, 3B, 3D, 3E, 3F, 3G)
- 40 Hz data analysed
- 3 point lowest level filter applied (max 2 m)
- Captures many leads in the Ice.
- Ocean tide correction substituted with GOT00
- Inverse barometer correction applied
- +/- 2 meters editing rel to PGM04
- Waves in open ocean causes biasing low (70 meters footprint).
- Only used in icecovered part of Arctic ocean
  - between 90E and 90W and latitude > 72N
  - Latitude > 80N (all longitudes)
- Seasonal effects corrected / Monthly skewness correction.
Adjustment problems 3 – ICESAT onto ERS2

Diff with EGM04 geoid

2B

3B

3D

3E

Each month adj to ERS-2/ENVISAT -29, -13, -15, -36 cm
Having a good MSS and Geoid

[Map showing MSS and Geoid height differences]
Evaluation

320 GPS measured Tide Gauges Around Britain

TG – DNSC08MSS
Mean = 1.24 cm,
Std = 6.8 cm

Comparison by
Marek Ziebart, UCL London,
MSS and Inter-annual ocean variability

- The mean sea surface, a linear sea level change (over the 12 years) and the annual cycle in sea level is modelled like:

\[ h_{obs} = h_0 + h_1 t + h_2 \cos(\omega_{ann} t) + h_3 \sin(\omega_{ann} t) + e \]

where \( \omega_{ann} \) is the frequency of the annual cycle.

- All residual altimetric observations for each year is averaged to calculate mean annual variation
Inter-Annual variation relative to global trend

Annual mean offsets relative to mean and sea level trend over the 1993-2004 period

- 1993
- 1994
- 1995
- 1996
- 1999
- 2001

EGU meeting, Vienna, Austria | April 2008 | OA | page 13
Assuming the geoid is stationary

Adjustments to the MDTs / MSS’s for the inter-annual sea level variations is

\[
\text{Geoid} = \text{MSS} - \text{MDT}, \quad G (\text{period1}) = G (\text{period2})
\]

\[
\text{MDT(\text{period1})} = \text{MDT(\text{period2})} + \Delta \text{MSS(\text{period1})} - \Delta \text{MSS(\text{period2})}
\]

**EXAMPLE:**
The OCCAM MDT model represent the period 1993-1995.

OCCAM MDT representing the 1993-2001 period is then:

\[
\text{OCCAM(93-01)} = \text{OCCAM(93-95)} + \Delta \text{DNSC08(93-01)} - \Delta \text{DNSC08(93-95)}
\]

**DNSC08MSS** is provided with a program to perform this correction
DNSC08-OCCAM Synthetic Geoid Model

DNSC08 MSS

The OCCAM 93-95 MDT

The 93-95 -> 93-01 Interannual Sea Level Anomaly Correction.

DNSC08 MSS - OCCAM MDT synthetic geoid. Consistent inter-annual SLA modelling
Summary

- **DNSC08 Fields**
  - Resolution: 1 minute by 1 minute (2 km by 2 km)
  - True global fields (90°S to 90°N)

- **DNSC08MSS**: [ftp.spacecenter.dk/pub/MSS](ftp.spacecenter.dk/pub/MSS)
- **DNSC08ALL files**: [ftp.spacecenter.dk/pub/DNASC08](ftp.spacecenter.dk/pub/DNASC08) (all files)
- **DVD**: Contact [oa@space.dtu.dk](mailto:oa@space.dtu.dk)

**Consistent Products available:**

- Altimetric (geometrical) MSS **DNSC08-MSS**
- Altimetric derived Bathymetry **DNSC08-BAT**
- Altimetric Marine Gravity field **DNSC08-GRA**
- Mean Dynamic Topography **DNSC08-MDT**
- Products also available in Google Earth