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# GRAVITY ANOMALY AND GRADIENT RECOVERY FROM GOCE GRADIENT DATA USING LSC AND COMPARISONS WITH KNOWN GROUND DATA



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## GOCE EGM's and test Data Used

GLOBAL Earth Gravity Models, **SPW**, **TIM** (1,2), **DIR** (1,2)

Gradient data and error-estimates in North-Oriented Frame  
On Tabular Form (TRF) from 2009 and 2010. 8864812 rec.

Ground gravity and ground gravity gradients from test-areas  
used in earlier investigations.

Scandinavia (SC), Australia East and West (AE, AW),  
Canadian plains (CA), Mediterranean East, Mid and West  
(ME, MM, MW), Arctic (ARC, ARB, ARC), Antarctic  
(AZA, AZB, AZC, AZD), Taiwan (TA), Oklahoma (OK)

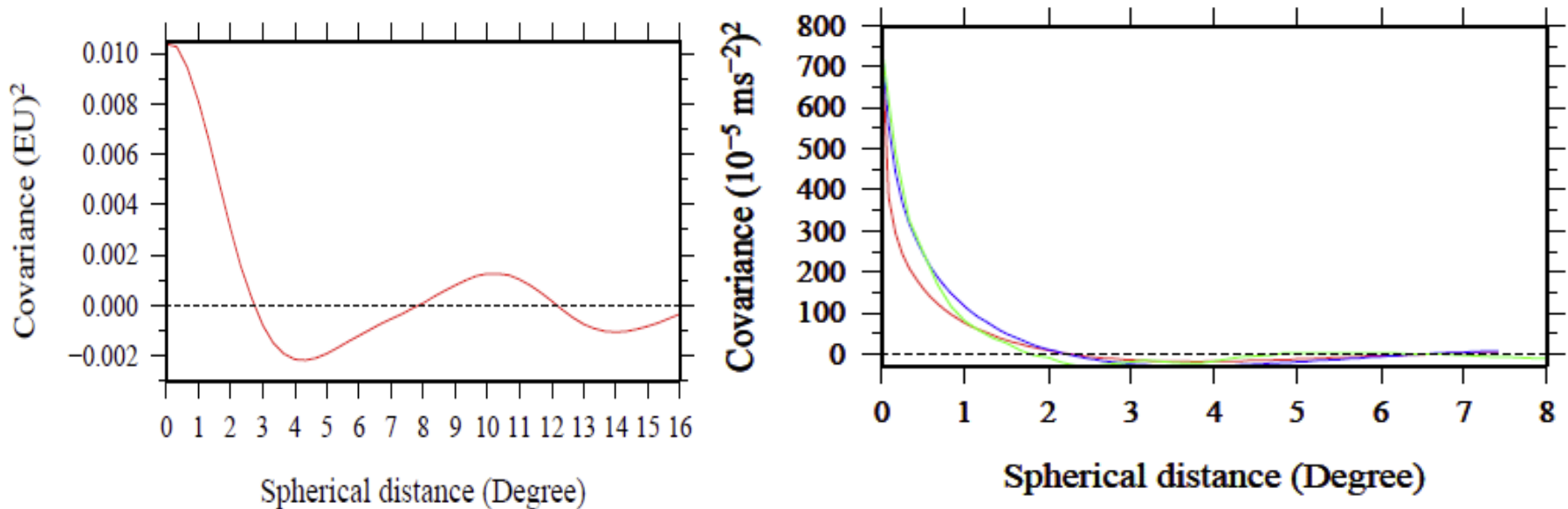
## Comparison GEM with ground data (mgal)

Area	Original Mean	Original Stdv.	MeanDiff . SPW	StdvDiff SPW	MeanDiff <b>TIM</b>	StdvDiff <b>TIM</b>	MeanDiff DIR	StdvDiff DIR
TA	15.2	70.1	-0.9	51.9	-0.9	51.8	0.4	48.0
MW	-1.9	24.9	-2.1	22.4	-1.6	21.4	-0.4	21.2
MC	-9.7	50.9	-2.4	22.8	-2.3	22.3	-1.5	20.6
ME	-50.2	52.0	-3.6	30.6	-2.8	28.6	-1.7	28.3
CA	-10.8	22.4	0.8	16.6	-0.8	16.7	0.2	15.4
SC	-10.8	19.7	-1.0	11.6	-1.1	12.0	-1.1	10.5
AW	-3.8	26.3	-0.6	15.4	-0.6	14.7	-0.6	13.2
<b>ARC</b>	<b>5.5</b>	<b>28.4</b>	<b>-1.8</b>	<b>21.2</b>	<b>-1.9</b>	<b>22.4</b>	<b>-1.9</b>	<b>19.5</b>

## Prediction using LSC of ground data from gravity gradients.

- LSC uses spherical approximation
- Data preprocessed by subtracting EGM96 to degree 36.
- Covariance functions estimated from ground data. If not available Tzz used. (GRAVSOFT program EMPCOV).
- Analytic model determined (COVFIT).
- LSC used for prediction and error-estimation (GEOCOL18)

# Covariance function from Tzz or ground gravity (-EGM96/36)



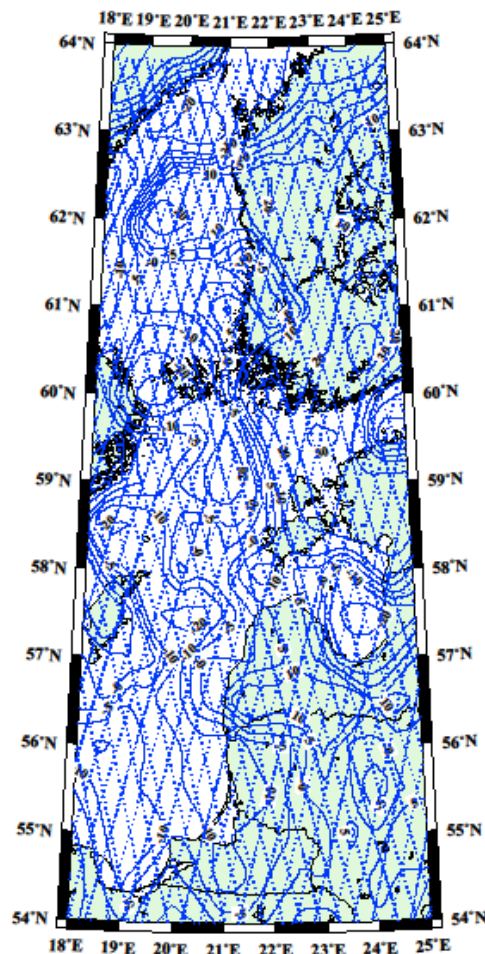
Left: Empirical Tzz: **red**,

Right: gravity anomalies: **green**, analytic model: **blue**, analytic from Tzz: **red**.

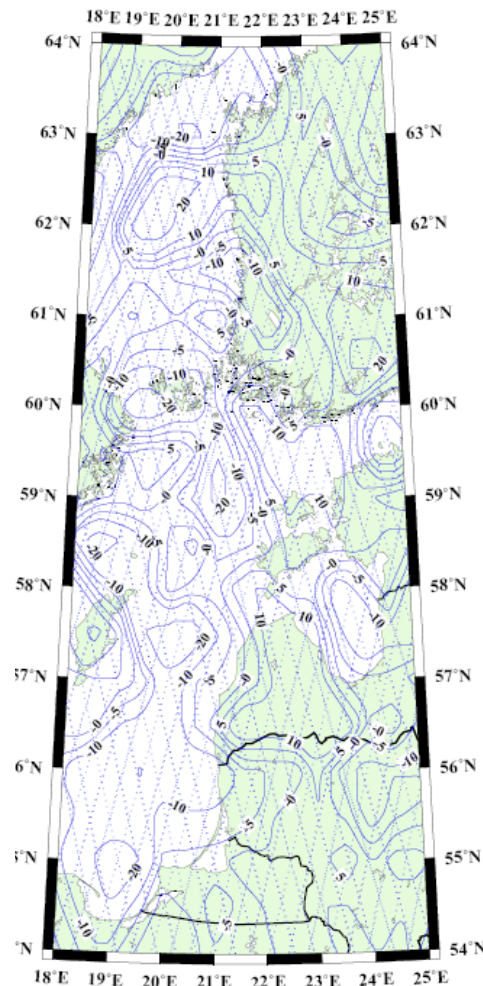
**Only isotropic quantities can be used for covariance estimation and modelling.**

# Differences predicted gravity and observed (mgal) using Tzz and Txx.

GOCE dgs diff. (mgal) from Tzz in central Fenno-Scandia.

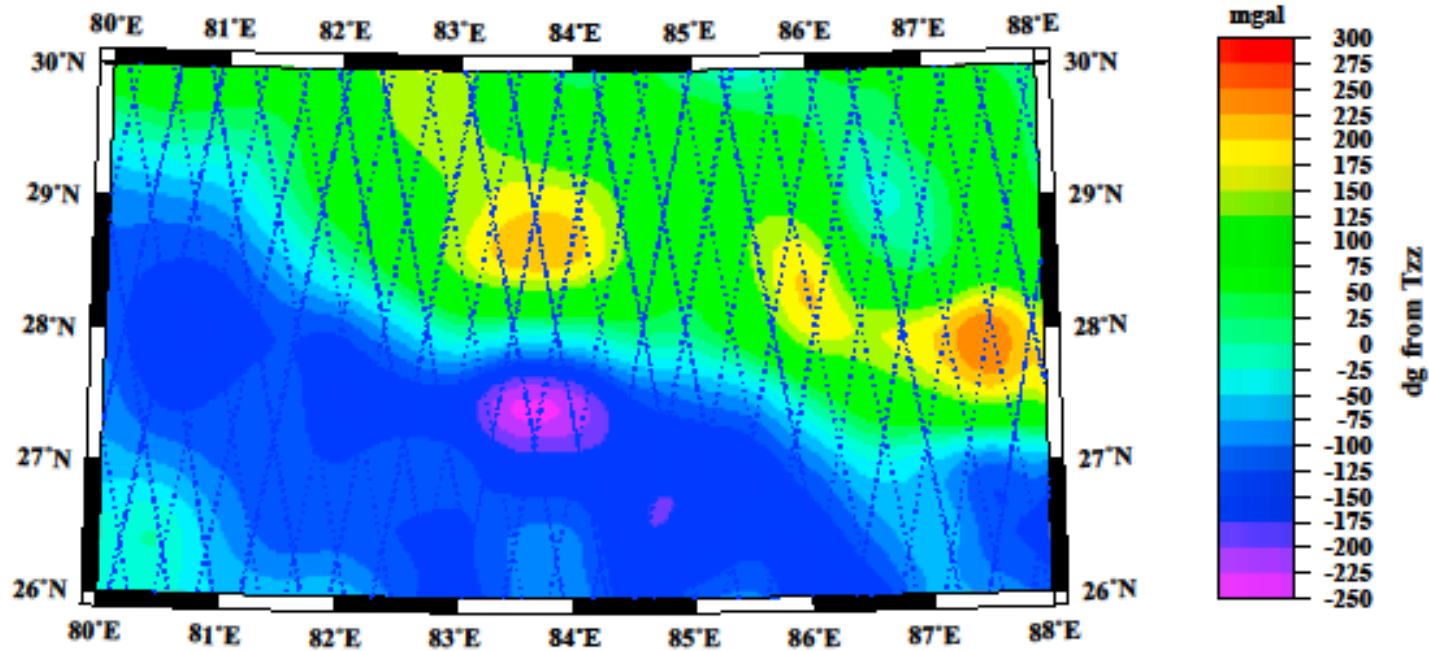


E dgs diff. (mgal) from Tyy in central Fenno-Scandia.



Orig: mean -2,  
std. 20  
From Tzz  
Mean diff: 0.7,  
std. 17, error  
estimate: 17  
From Txx:  
Mean diff : 0.9,  
std. 13, error  
estimate 14

# Prediction of gravity at 10 km in Himalaya (mgal)



## Differences Gravity predicted and observed in test areas (mgal)

Area	Mean	Stdv.	Tzz Mean	Tzz Stdv	Tzz+Txx Mean	Tzz+Txx Stdv
TA	15.2	70.1	-1.7	50.9	2.9	60.3
MW	-1.9	24.9	-2.8	21.5	-2.7	21.4
MC	-9.3	50.9	-1.2	24.5	-1.4	24.8
ME	-50.2	52.0	-2.4	34.6	-2.2	34.3
CA	-10.8	22.4	0.2	17.4		
SC	-10.7	19.7	-0.8	12.2	-0.8	12.0
AE	10.8	21.7	-1.0	14.2		
ARC	5.5	28.4	-1.7	21.7	-1.1	24.6



# GOCE Tzz (eotvoes) from Ground gravity and EGM (TA)

	Mean	Stdv.
Original data	0.051	0.161
Tzz – predicted from gravity	-0.006	0.047
Tzz – SPW	0.002	0.022
Tzz-TIM	0.002	0.022
Tzz-DIR	0.002	0.022

## Prediction of Tzz at ground (Oklahoma area)

Eotvoes	Mean	Stdv
Ground Tzz	-8.8	23.5
Tzz – Predicted from GOCE Tzz	-10.2	23.3
Tzz ground – TZZ-SPW	-10.2	23.2
Tzz ground – Tzz-TIM	-9.9	23.2
Tzz ground –Tzz-DIR	-9.7	23.1

## Test area results ver. Gravity variation (mgal)

Area	Stdv. Observed Gravity	Stdv differences Obs – predicted from Tzz
SC	20	15
AE	22	14
CA	22	14
ARC	31	16
MC	51	39
ME	52	37
TA	70	49

## Conclusion – Prediction from GOCE GG

**Tzz gives best results**

**Tzz+Txx only marginal improvements**

**Denser data-distribution – better results**

**Gravity prediction unbiased (Mean of differences small)**

**Results only slightly dependent of covariance function (not shown here)**

**Error estimates reliable in smooth areas (not shown)**

**Relative results better in areas with high gravity variation than in smooth areas**

## Conclusion Tzz and EGM's

GOCE EGM give results in test areas comparable or better than direct prediction from Tzz.

Tzz/Txx prediction may contain information not already in the GOCE EGM in high-mountain areas.