

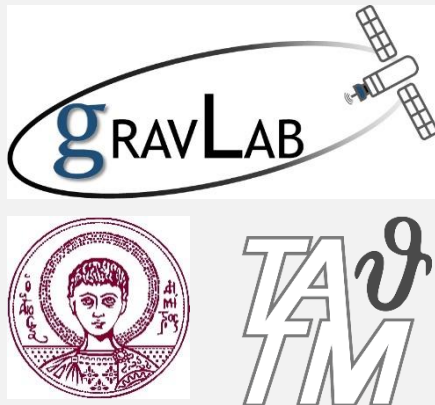
IOST in the downward continuation of GOCE SGG

Theoretical frame for the application of IOST in the downward continuation of GOCE SGG data

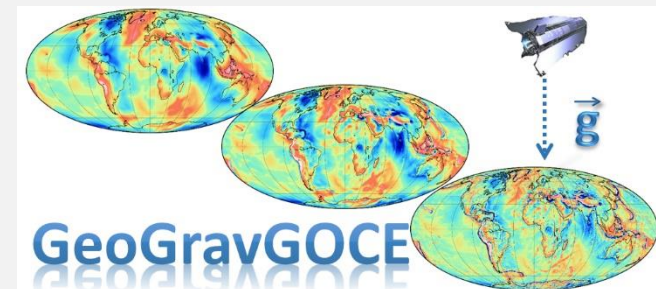
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Introduction

Main goal: the investigation of downward continuation schemes for GOCE SGG data.

A crucial point for gravity field and geoid determination refers to the combination of GOCE data with local gravity field information.

SHS → a GOCE-only and/or a combined Global Geopotential Model.

Aim: overcome the inherent smoothing of SHS and use directly the SGG data in order to investigate their contribution to regional gravity field and geoid determination.

Introduction

IOST → combination of heterogeneous data, in the spectral domain, on the Earth's surface and at the satellite altitude or at a mean sphere.

GOCE Level 2 gradients $\xrightarrow{\text{IOST}}$ processed, transformed and reduced to a MO

downward continuation $\xrightarrow{\text{MC}}$ to the Earth's surface

Methodology

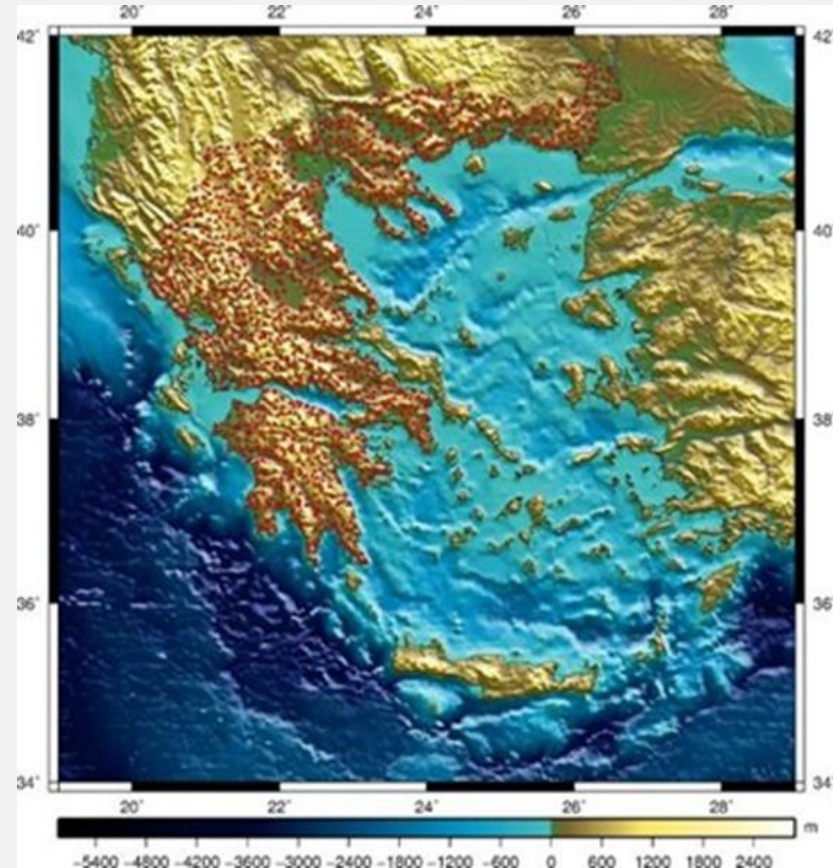
Original GOCE gravity gradients $\rightarrow$ GRF

In order to be more easily compared with in-situ gravity data $\rightarrow$ LNOF

GRF $\rightarrow$ IRF $\rightarrow$ EFRF $\rightarrow$ LNOF

$$T_{ij} = V_{ij} - \bar{V}_{ij}$$

$$V_{ij}^{res} = V_{ij} - V_{ij}^{GGM}$$



$$V_{ij}^{red} = V_{ij}^{GOCE} - V_{ij}^{TIM R6^{165}} - V_{ij}^{EGM2008^{2190}_{166}}$$

Filtering

Filtering the reduced GOCE gravity gradients

- i. FIR
- ii. IIR
- iii. WL-MRA

FIR filter with order $N=1500$ and the IIR with order $N=5 \rightarrow$ optimal results.

To the filtered $\tilde{V}_{ij}^{res}$ the contribution of the removed GGM gradients will be restored, so that filtered GOCE gradients $\tilde{V}_{ij}$ will be formed.

Filtered disturbing potential gradients: $\tilde{T}_{ij} = \tilde{V}_{ij} - \bar{V}_{ij}$

Downward Continuation

$\tilde{T}_{ij}$ GOCE gradients reduced to a MO through MIMOST

$$\mathcal{F}(\tilde{T}_{ij}^{MO}) = \frac{PSD^{MO,SA}(T_{ij}^{GGM})}{[PSD^{SA,SA}(T_{ij}^{GGM}) + PSD^{SA,SA}(T_{ij,n})]} \mathcal{F}(\tilde{T}_{ij}^{SA})$$

Downward continuation $\rightarrow$ 2 scenarios.

- i. First, the available local gravity data will be used as a-priori information to downward continue GOCE SGG data from the MO.
- ii. XGM2019 will be the Gravity Anomaly Model generated on Earth's surface and for the evaluation of the gradients at the MO

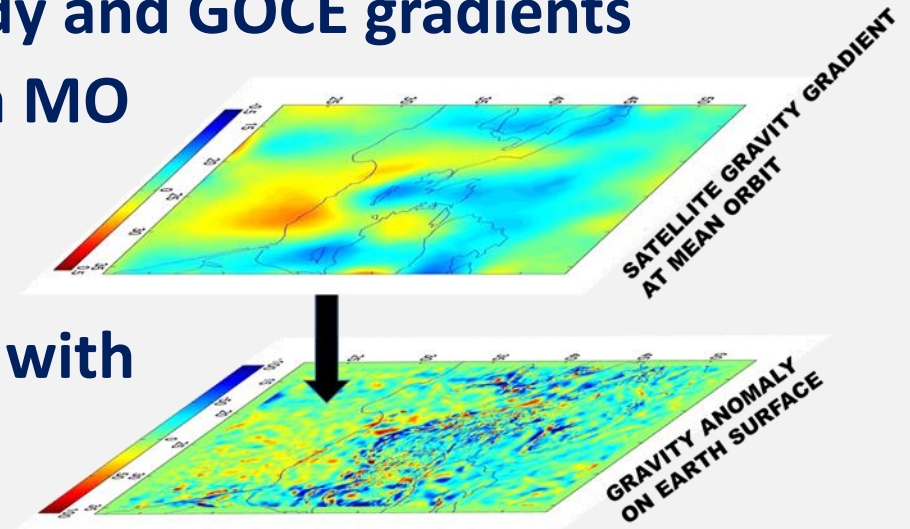
Geoid and gravity modeling with collocation

Studies rely either on the exploitation of GOCE SGG data in their original GRF at satellite altitude or through GGMs

GOCE SGG grids can be produced at some altitude (~ 250 km) $\rightarrow$ LSC

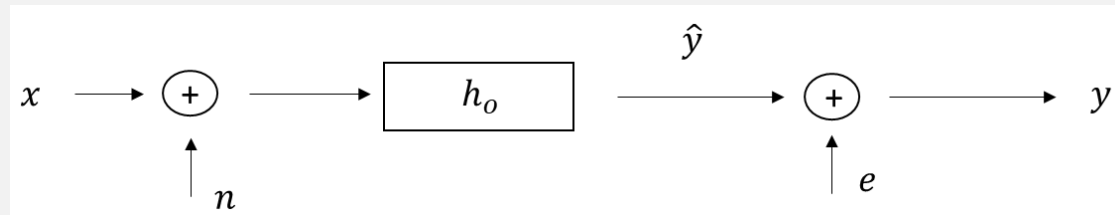
MIMOST: data will be $\{\Delta g(P_i)\}$, a set of free-air gravity anomalies in the area under study and GOCE gradients $\{\tilde{T}_{ij}\}$ that should be reduced to a MO

Consistent combination of all data and prediction of the geoid with LSC and its spectral counterpart MIMOST

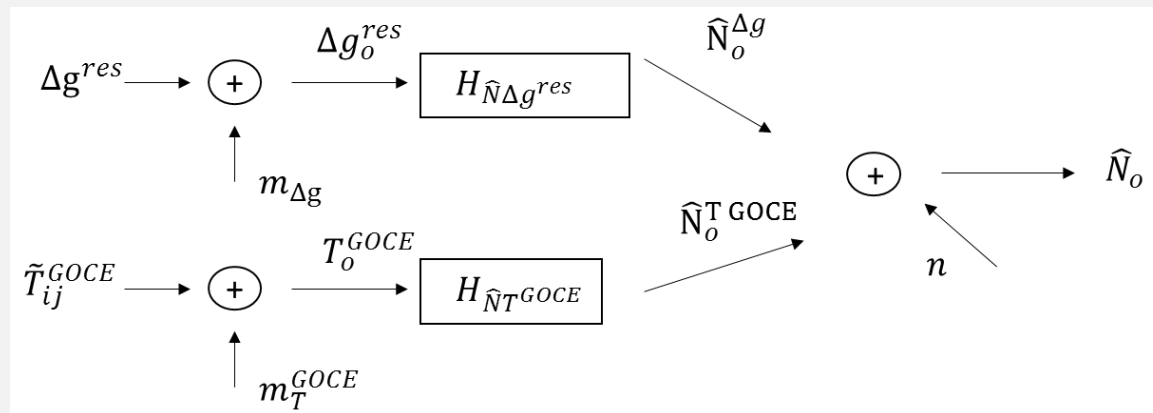


FT & FFT (-) requires gridded data,
 (-) offers a single output from a single input

LSC (-) solution of as many equations as the unknowns $\rightarrow$ time consuming



input/output systems: applications in different studies



$$\hat{N}_o = [\mathbf{H}_{\hat{N}\Delta g^{res}} \quad \mathbf{H}_{\hat{N}T^{GOCE}}] \cdot \left(\begin{bmatrix} \mathbf{P}_{\Delta g_o^{res} \Delta g_o^{res}} & \mathbf{P}_{\Delta g_o^{res} T_o^{GOCE}} \\ \mathbf{P}_{T_o^{GOCE} \Delta g_o^{res}} & \mathbf{P}_{T_o^{GOCE} T_o^{GOCE}} \end{bmatrix} - \begin{bmatrix} \mathbf{P}_{m\Delta g^{res} m\Delta g^{res}} & 0 \\ 0 & \mathbf{P}_{mT^{GOCE} mT^{GOCE}} \end{bmatrix} \right) \cdot \left(\begin{bmatrix} \mathbf{P}_{\Delta g_o^{res} \Delta g_o^{res}} & \mathbf{P}_{\Delta g_o^{res} T_o^{GOCE}} \\ \mathbf{P}_{T_o^{GOCE} \Delta g_o^{res}} & \mathbf{P}_{N_o^{GOCE} N_o^{GOCE}} \end{bmatrix} \right)^{-1} \begin{bmatrix} \Delta g_o^{res} \\ T_o^{GOCE} \end{bmatrix}$$

$$\begin{aligned}
 \mathbf{P}_{\hat{n}\hat{n}} = & \{ [\mathbf{H}_{\hat{N}\Delta g^{res}} \quad \mathbf{H}_{\hat{N}T^{GOCE}}] \cdot \\
 & \left(\begin{bmatrix} \mathbf{P}_{\Delta g_0^{res}\Delta g_0^{res}} & \mathbf{P}_{\Delta g_0^{res}T_0^{GOCE}} \\ \mathbf{P}_{T_0^{GOCE}\Delta g_0^{res}} & \mathbf{P}_{T_0^{GOCE}T_0^{GOCE}} \end{bmatrix} - \begin{bmatrix} \mathbf{P}_{m\Delta g^{res}m\Delta g^{res}} & 0 \\ 0 & \mathbf{P}_{mT^{GOCE}mT^{GOCE}} \end{bmatrix} \right) - \\
 & - [\hat{\mathbf{H}}_{\hat{N}\Delta g^{res}} \quad \hat{\mathbf{H}}_{\hat{N}T^{GOCE}}] \begin{bmatrix} \mathbf{P}_{\Delta g_0^{res}\Delta g_0^{res}} & \mathbf{P}_{\Delta g_0^{res}T_0^{GOCE}} \\ \mathbf{P}_{T_0^{GOCE}\Delta g_0^{res}} & \mathbf{P}_{T_0^{GOCE}T_0^{GOCE}} \end{bmatrix} \} \cdot \\
 & \left(\begin{bmatrix} \mathbf{H}^{\dagger}_{\hat{N}\Delta g^{res}} \\ \mathbf{H}^{\dagger}_{\hat{N}T^{GOCE}} \end{bmatrix} - \begin{bmatrix} \hat{\mathbf{H}}^{\dagger}_{\hat{N}\Delta g^{res}} \\ \hat{\mathbf{H}}^{\dagger}_{\hat{N}T^{GOCE}} \end{bmatrix} \right) + \\
 & + [\hat{\mathbf{H}}_{\hat{N}\Delta g^{res}} \quad \hat{\mathbf{H}}_{\hat{N}T^{GOCE}}] \begin{bmatrix} \mathbf{P}_{m\Delta g^{res}m\Delta g^{res}} & 0 \\ 0 & \mathbf{P}_{mT^{GOCE}mT^{GOCE}} \end{bmatrix} \begin{bmatrix} \hat{\mathbf{H}}^{\dagger}_{\hat{N}Ngr} \\ \hat{\mathbf{H}}^{\dagger}_{\hat{N}T^{GOCE}} \end{bmatrix}
 \end{aligned}$$

Acknowledgements

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