

**The Influence of Continental Water Storage  
on Gravity Rates Estimates:  
case study using absolute gravity measurements  
from Lower Silesia area**

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POLITECHNIKA



# Environmental impact on gravity measurements

## Treatment in absolute gravity measurements

### Ballistic gravimetry

#### Environmental effects

#### Continental water storage loading

##### Effects on gravity

##### Modelling

#### Data

##### Gravity

##### Mass variation

#### Results

##### Comparison

##### Shortcomings

#### Gravity Rates

#### Conclusions

- Instrumental features and details of processing are given somewhere else
- solid earth tides removed using nominal gravimetric factor along with tidal potential of Tamura,
- nominal atmosphere admittance factor of  $-3 \frac{\text{nm}}{\text{s}^2 \cdot \text{hPa}}$  ,
- ocean tidal loading removed with FES2004 ocean tides model,
- polar motion tide and ocean pole tide removed,
- non-tidal ocean loading not modelled,
- local hydrology impact not evaluated ,
- continental water storage loading not modelled .



# Environmental impact on gravity measurements

Main limitation for gravity rates assesment (concerning studied area)

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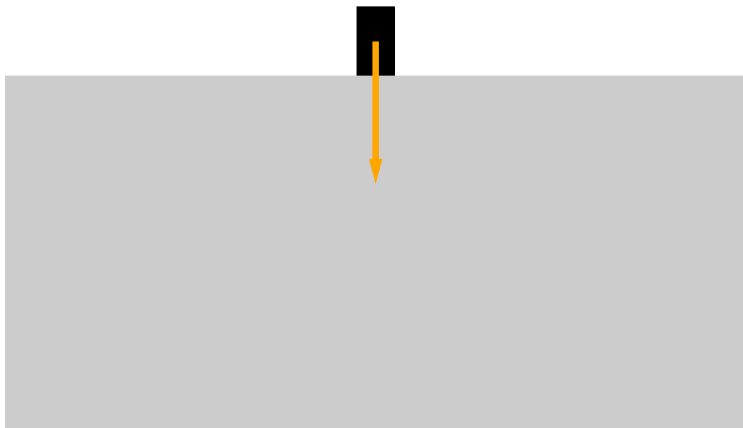
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# Surface mass loading impact on gravity

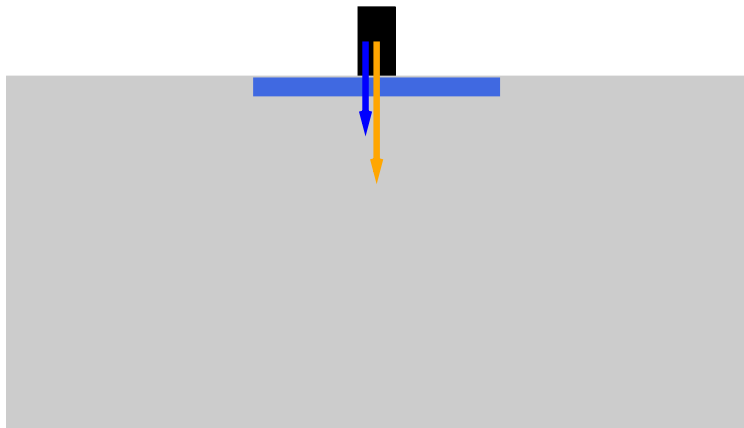
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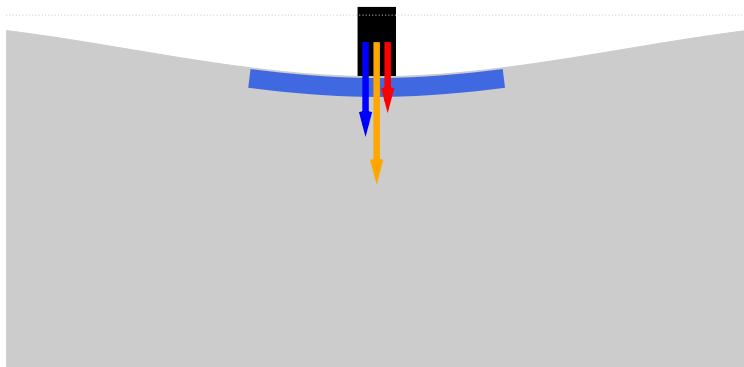
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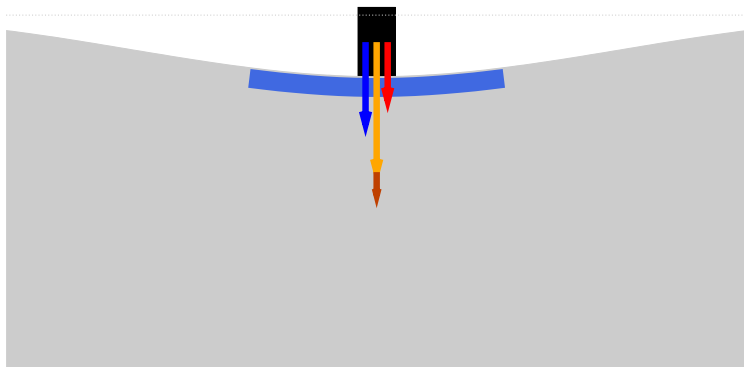
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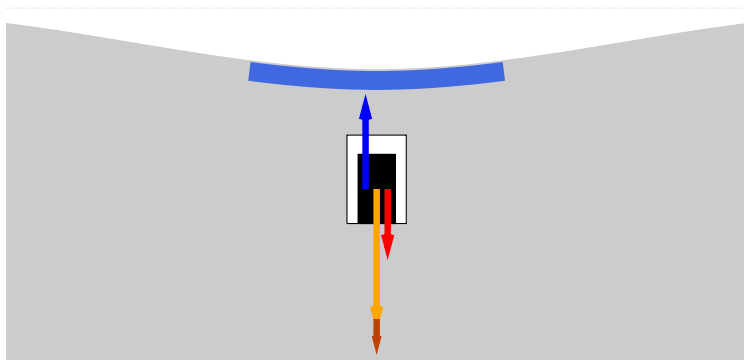
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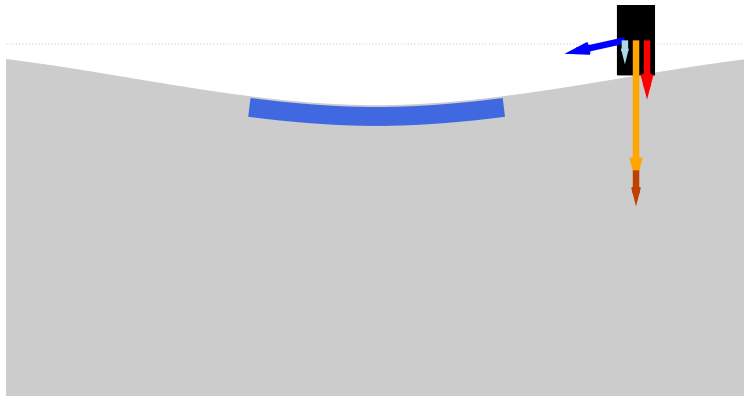






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# Basic equation

$$\mathbf{L}(\mathbf{r}) = \rho \cdot \iint_{Earth} G(|\mathbf{r} - \mathbf{r}'|) \cdot \mathbf{H}(\mathbf{r}') \cdot dA$$

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$$G(\psi) = \frac{g}{M} \sum_{n=0}^{\infty} (n + 2h'_n - (n + 1)k'_n) \cdot P_n(\cos \psi)$$



# Basic equation

$$\mathbf{L}(\mathbf{r}) = \rho \cdot \iint_{Earth} G(|\mathbf{r} - \mathbf{r}'|) \cdot \mathbf{H}(\mathbf{r}') \cdot dA$$

- $\mathbf{L}(\mathbf{r})$  – loading effect (attraction + deformation term)
- $G(|\mathbf{r} - \mathbf{r}'|)$  – gravity Green's function
- $\rho \cdot \mathbf{H}(\mathbf{r}') \cdot dA$  – point mass load

$$G(\psi) = \frac{g}{M} \sum_{n=0}^{\infty} (n + 2h'_n - (n + 1)k'_n) \cdot P_n(\cos \psi)$$

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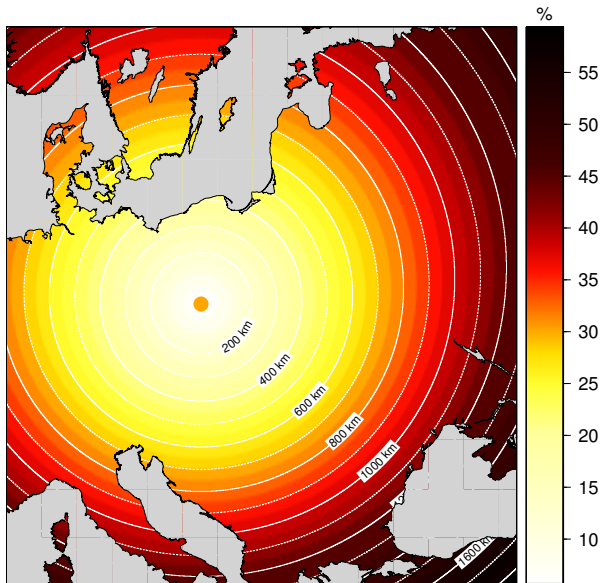
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# Computation area importance

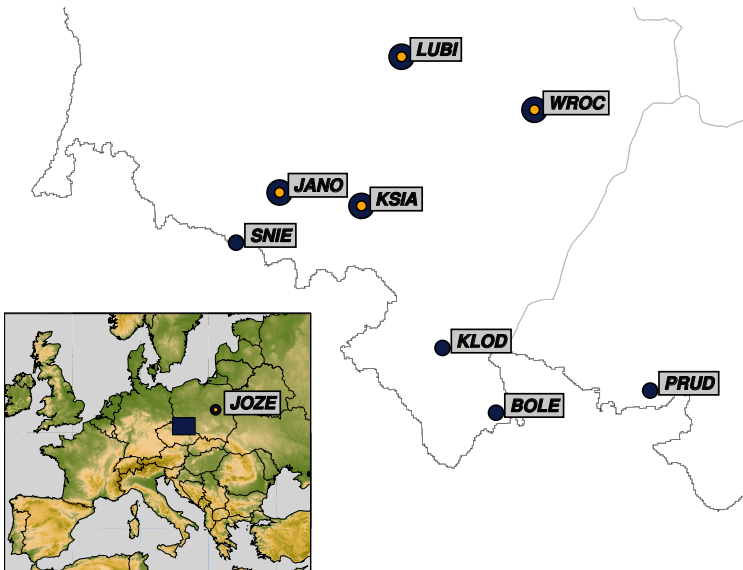
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# AG measurements with FG5 no. 230

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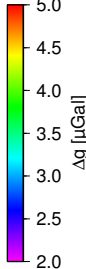
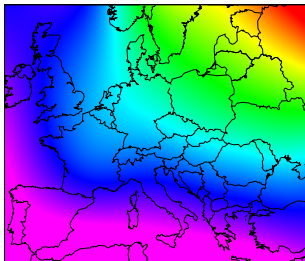
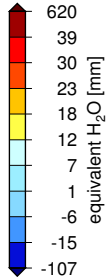
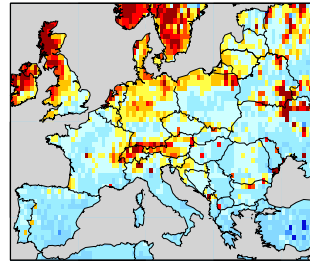
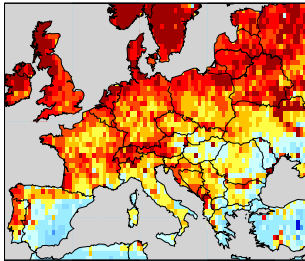




# Hydrology model output

2007-03

2007-09

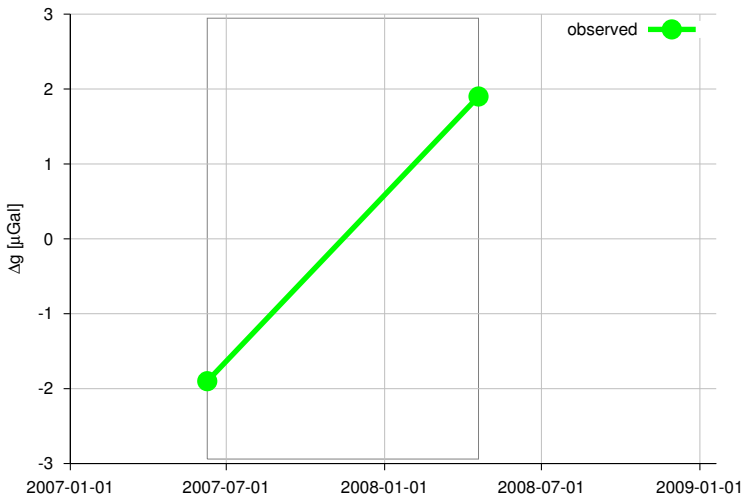


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# Observation vs Model

Wrocław



4.4 [ $\mu\text{Gal}/\text{year}$ ]

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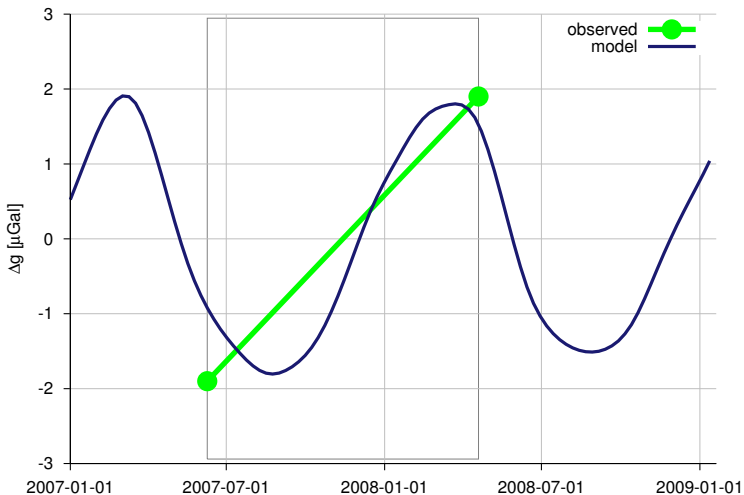
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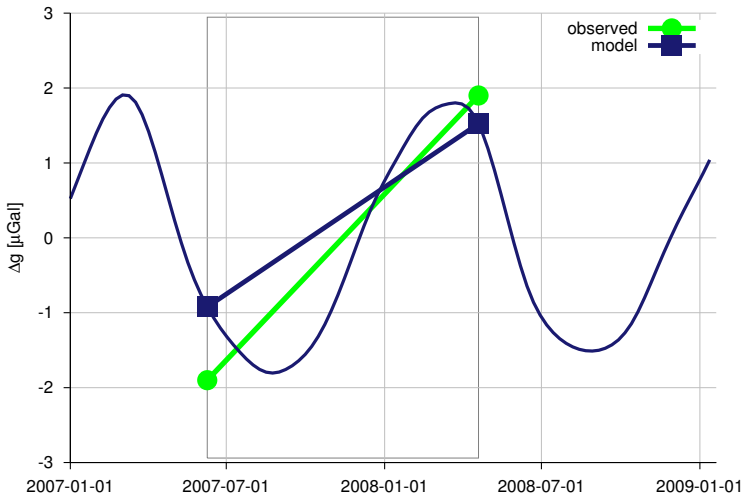
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# Observation vs Model

Wrocław



4.4 [ $\mu\text{Gal}/\text{year}$ ]    2.8 [ $\mu\text{Gal}/\text{year}$ ]

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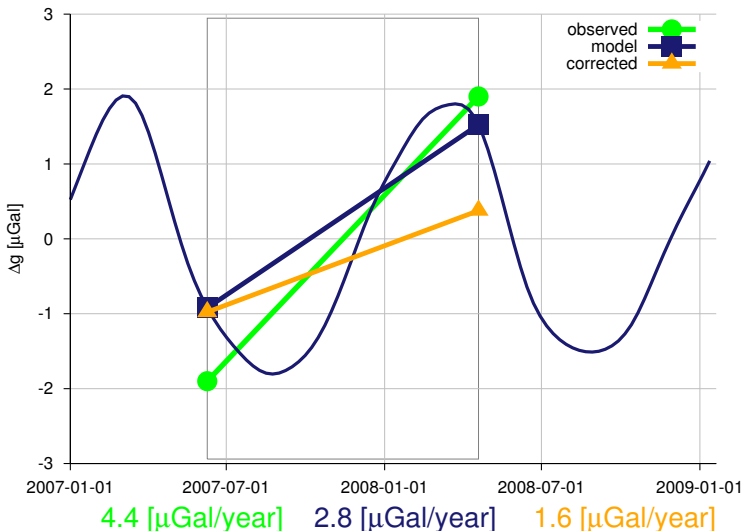
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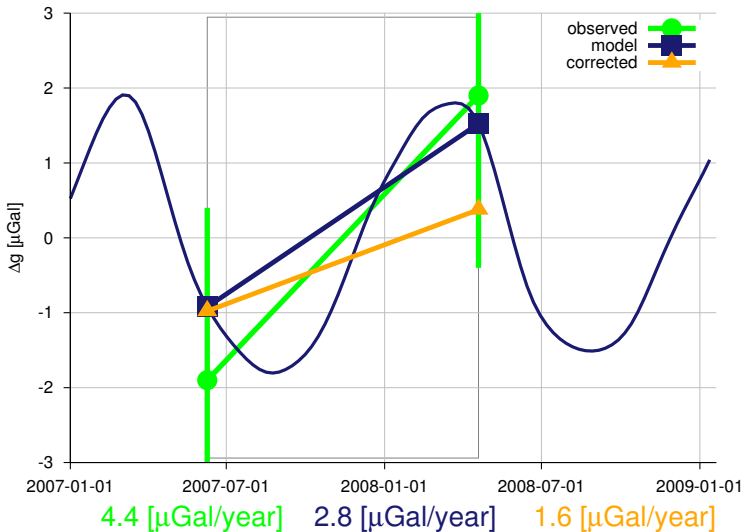
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# Observation vs Model

Janowice Wielkie

Ballistic gravimetry

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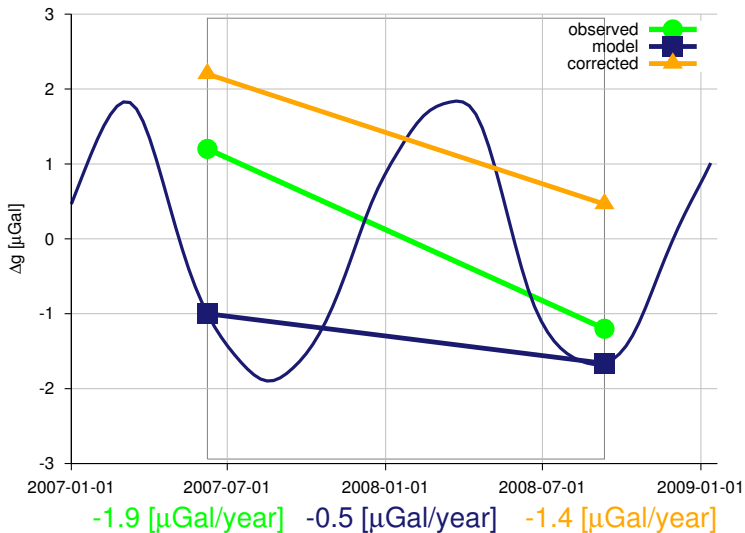
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# Observation vs Model

Książ

Ballistic gravimetry

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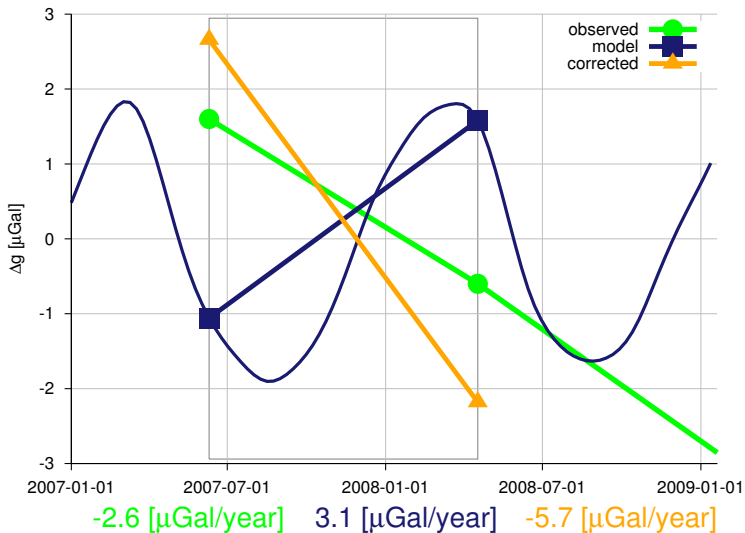
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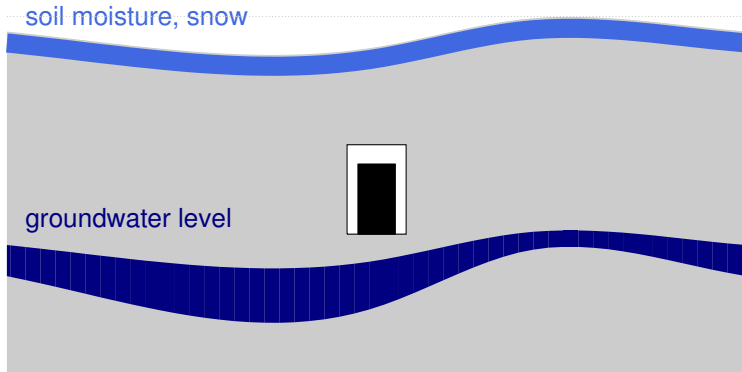
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# Józefosław case

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## Same season - different years

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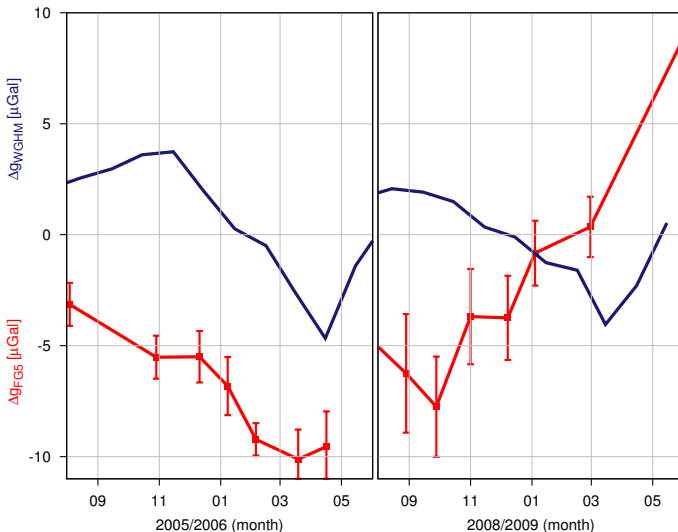
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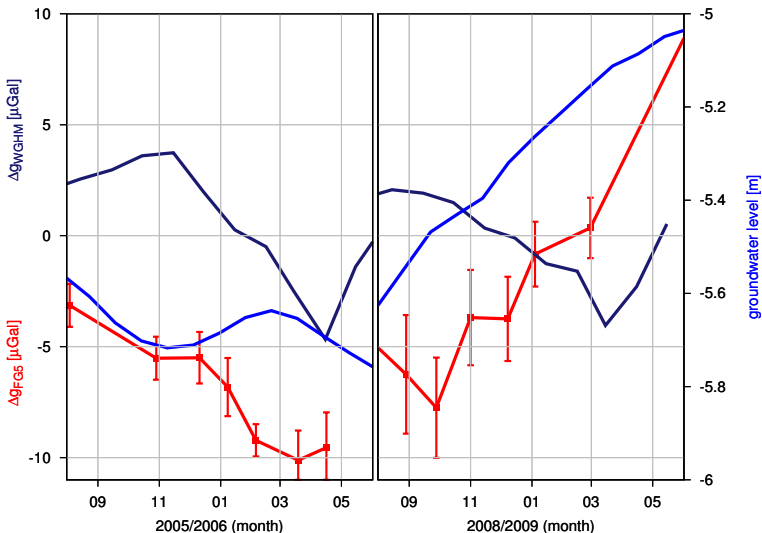
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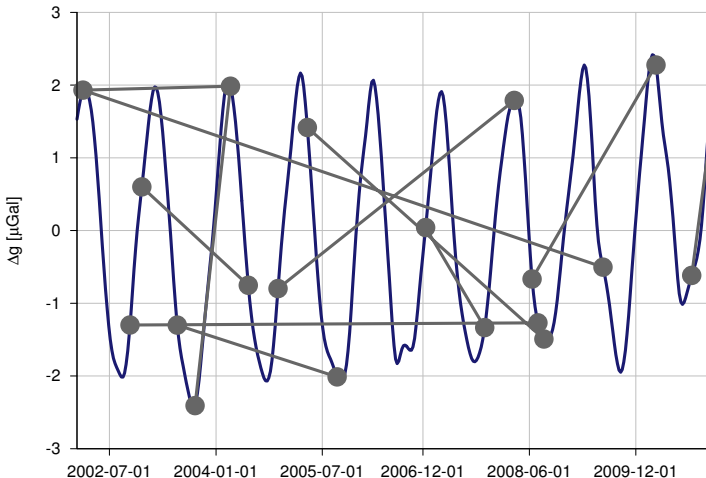






# How it affects gravity rates?

Wrocław



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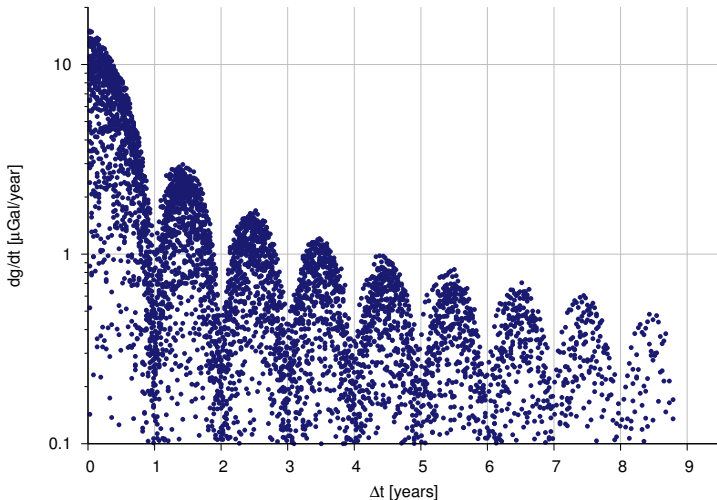
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## OBVIOUS RECOMENDATION

Taking measurements in the same season can mitigate the influence of continental water storage.

The long time span of measurements with the redundant records are desirable.

## PROBLEMS


Global hydrology signal are oftenly hidden through the local environmental effects.

Monitoring of local hydrology is extremely difficult and resource consuming.

Topogtaphy in site vicinity and graivimter position relative to syrface a subsurface water masses.

## CAUTION


Small gravity variation can lead to overinterpretation of results.



The Influence of Continental Water Storage  
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Thank you for your attention

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**The Influence of Continental Water Storage  
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*Additional slides*

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# Deformation - GNSS support

Presented in Wrocław, May 2011

