Estimation de la variabilité spatiale et temporelle du signal hydro-gravimétrique en zone karstique

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Outline

- **I] Introduction**
- **II] Site presentation**
  - * The karstic basin
  - * The Observatory
  - * The iGrav
- **III] Hydrological modeling**
  - * Site effect
  - * Tank modeling
  - * Hydrus-1D modeling
- **IV] Conclusion**

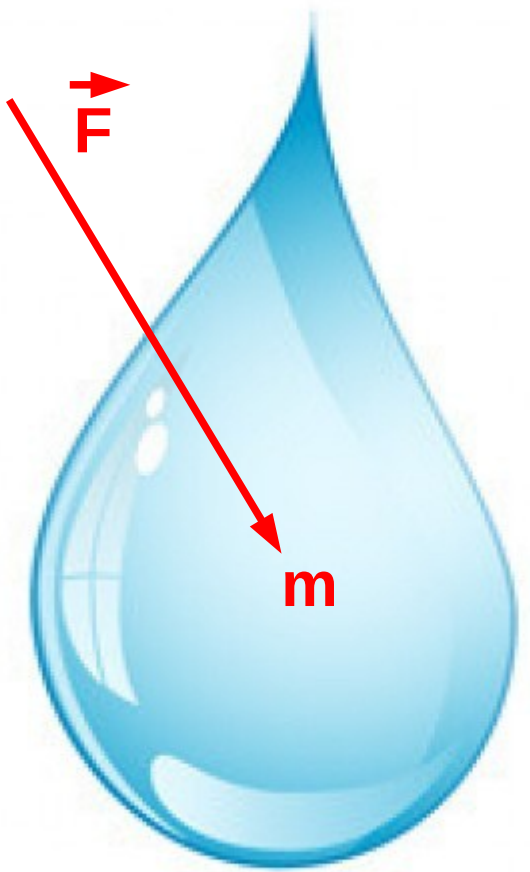
Photo : N. Le Moigne, 2011

Principle & basic assumption

- **Principle :**

  Water = masse = attraction

  Infinite slab : 4 nm/s²/cm of water



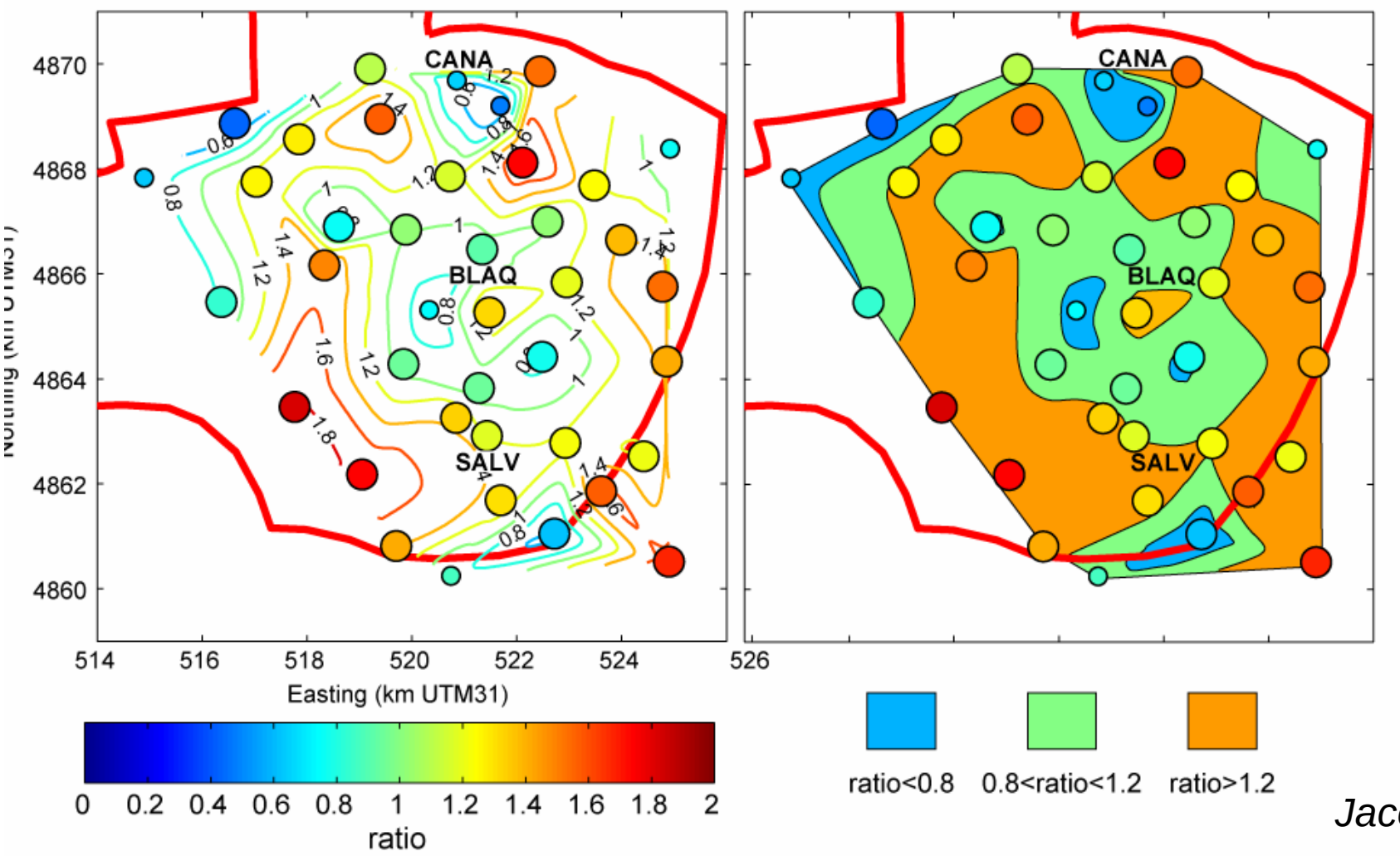
- **Assumption:**

  time serie : $\Delta_{gravity} = \Delta_{ground\ water\ storage}$

--> Gravity monitoring of the water storage in karst ?

8 years of hydro-gravimetry at GM

- Thomas Jacob (2006 - 2009)

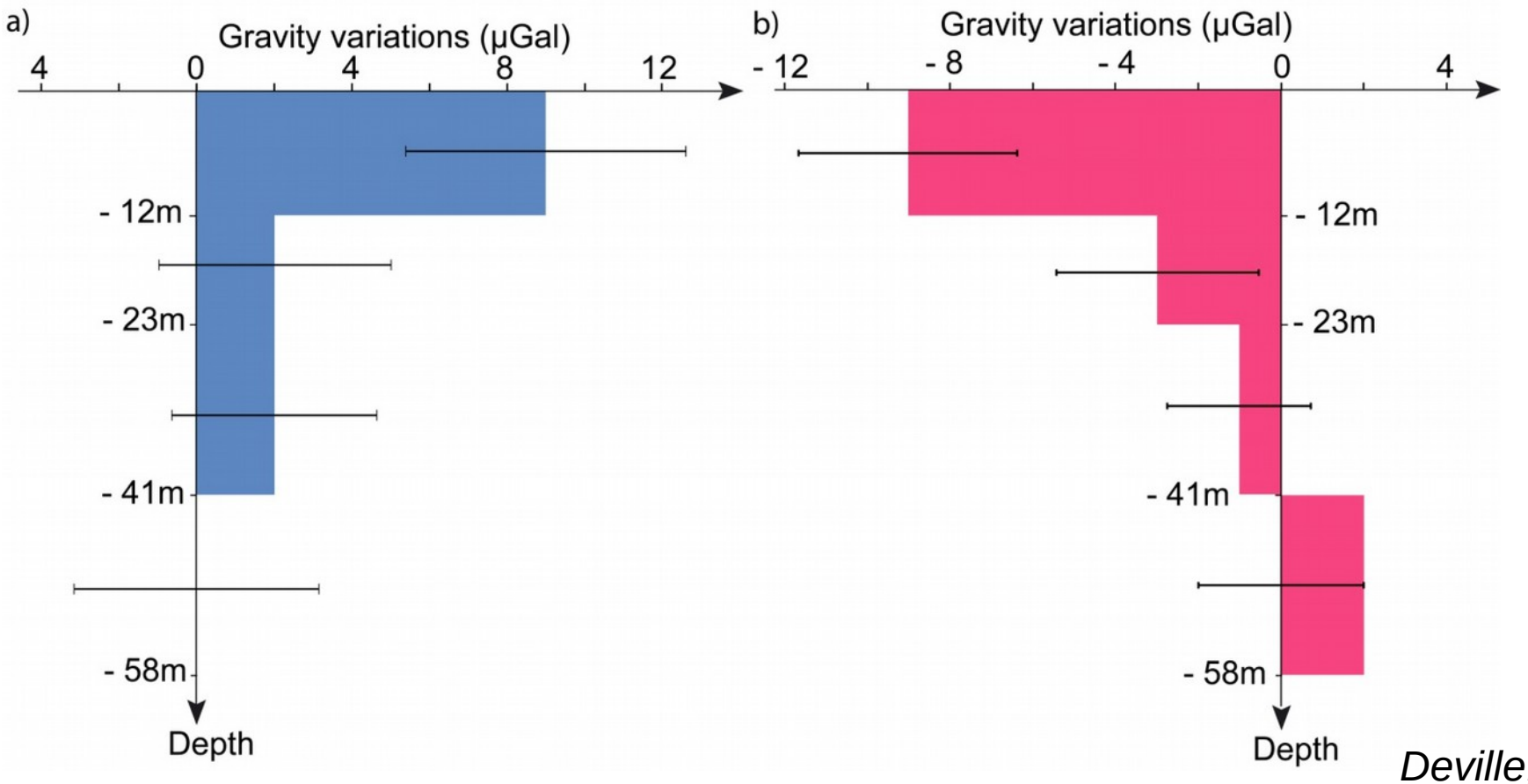


Jacob, 2009

- **Water storage variations in mediterranean karst (monthly FG5)**
- **Spatial heterogeneity (seasonal CG5 maps)**

8 years of hydro-gravimetry at GM

- Sabrina Deville (2009 - 2013)

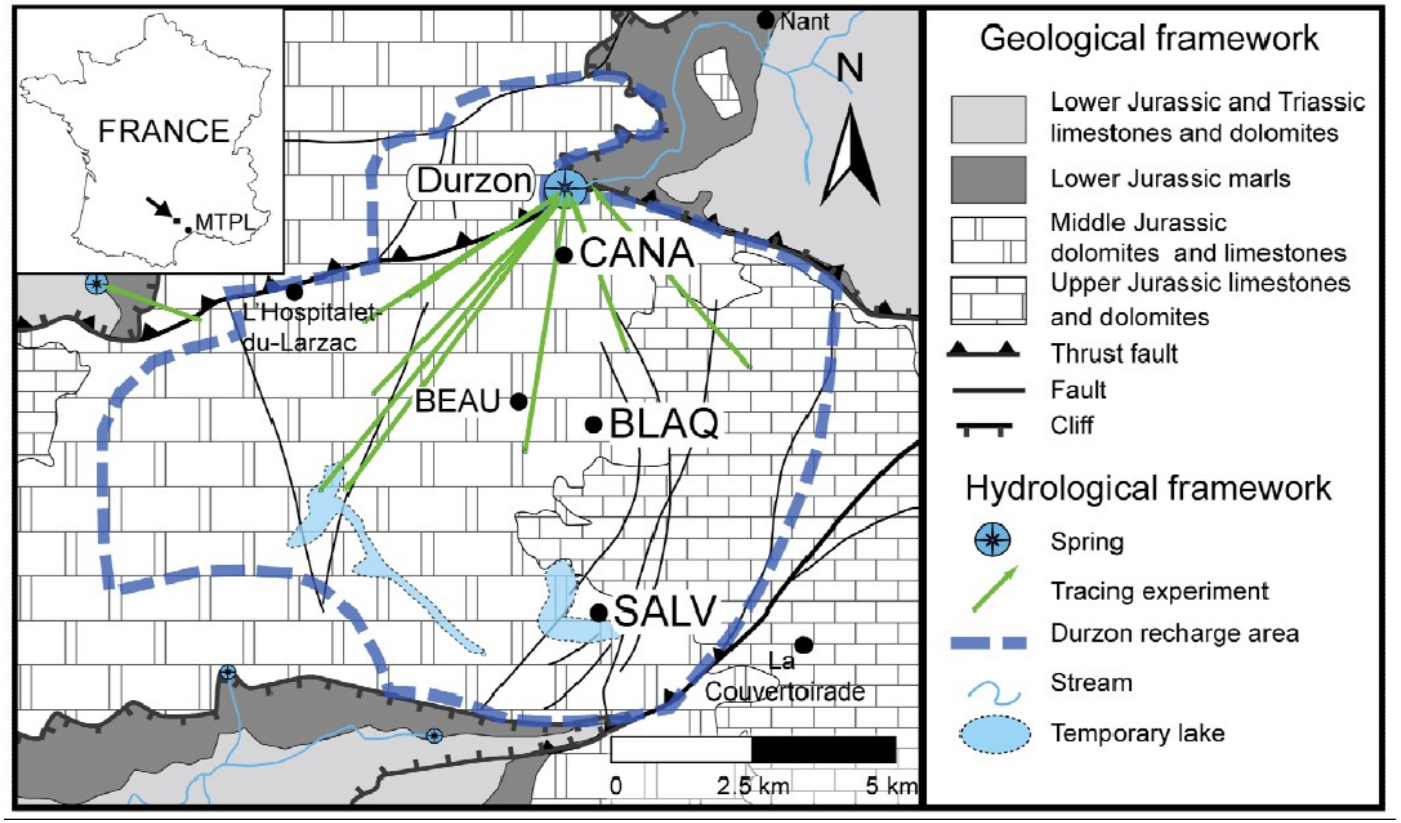


Deville, 2013

- **First tank modeling (monthly FG5)**
- **Variations and storage in the epikarst (surface to depth CG5)**

The Durzon basin

- **110 km²**
- **Unary karst**
- **Limestone/dolomite**
- **Only one spring**



Deville, 2011

- **Simple system**
- **Unsaturated zone > 150 m**

The observatory: the GEK

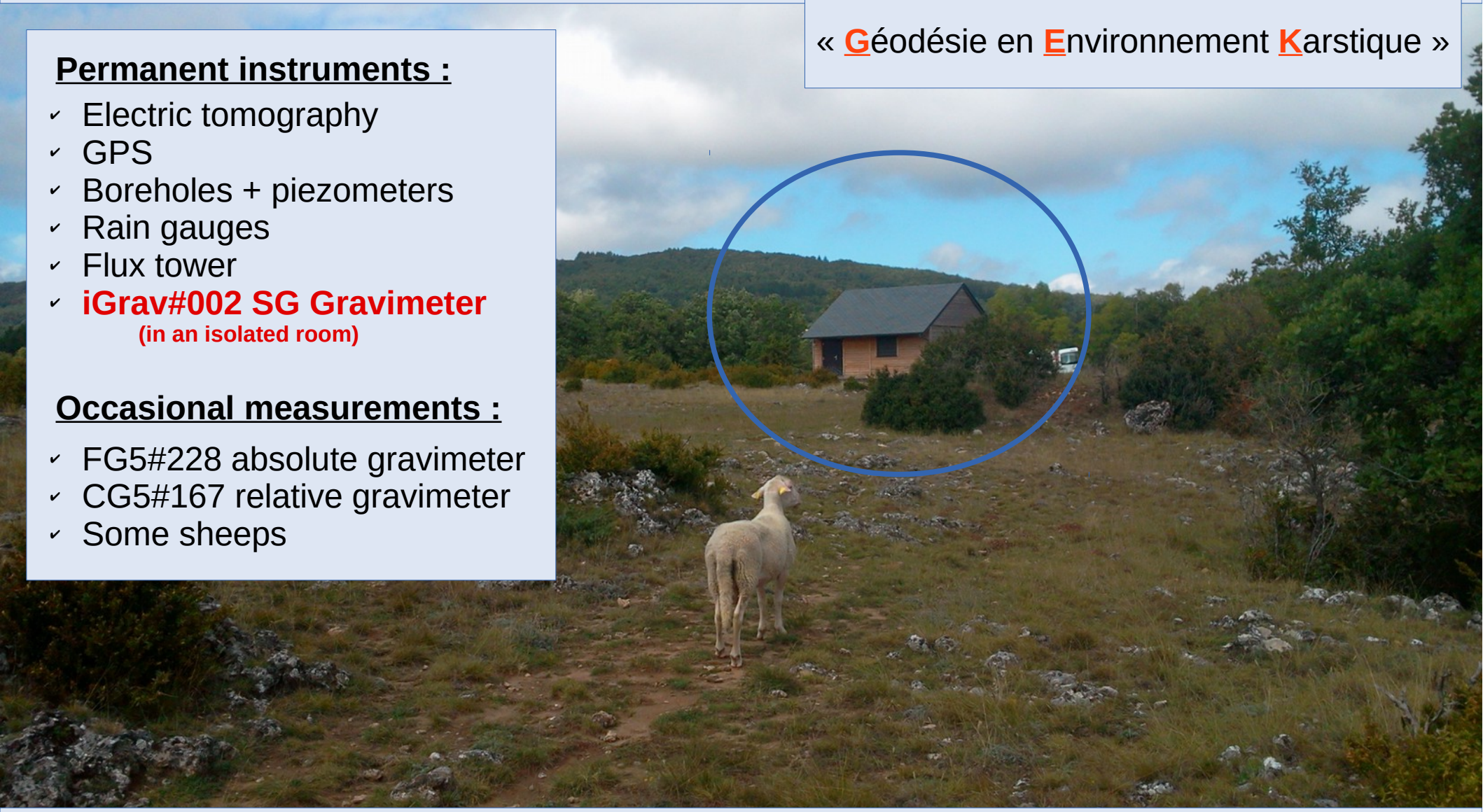
« Géodésie en Environnement Karstique »

Permanent instruments :

- Electric tomography
- GPS
- Boreholes + piezometers
- Rain gauges
- Flux tower
- **iGrav#002 SG Gravimeter**
  (in an isolated room)

Occasional measurements :

- FG5#228 absolute gravimeter
- CG5#167 relative gravimeter
- Some sheeps



Operational since 2011
8x8m in a low-noise environment

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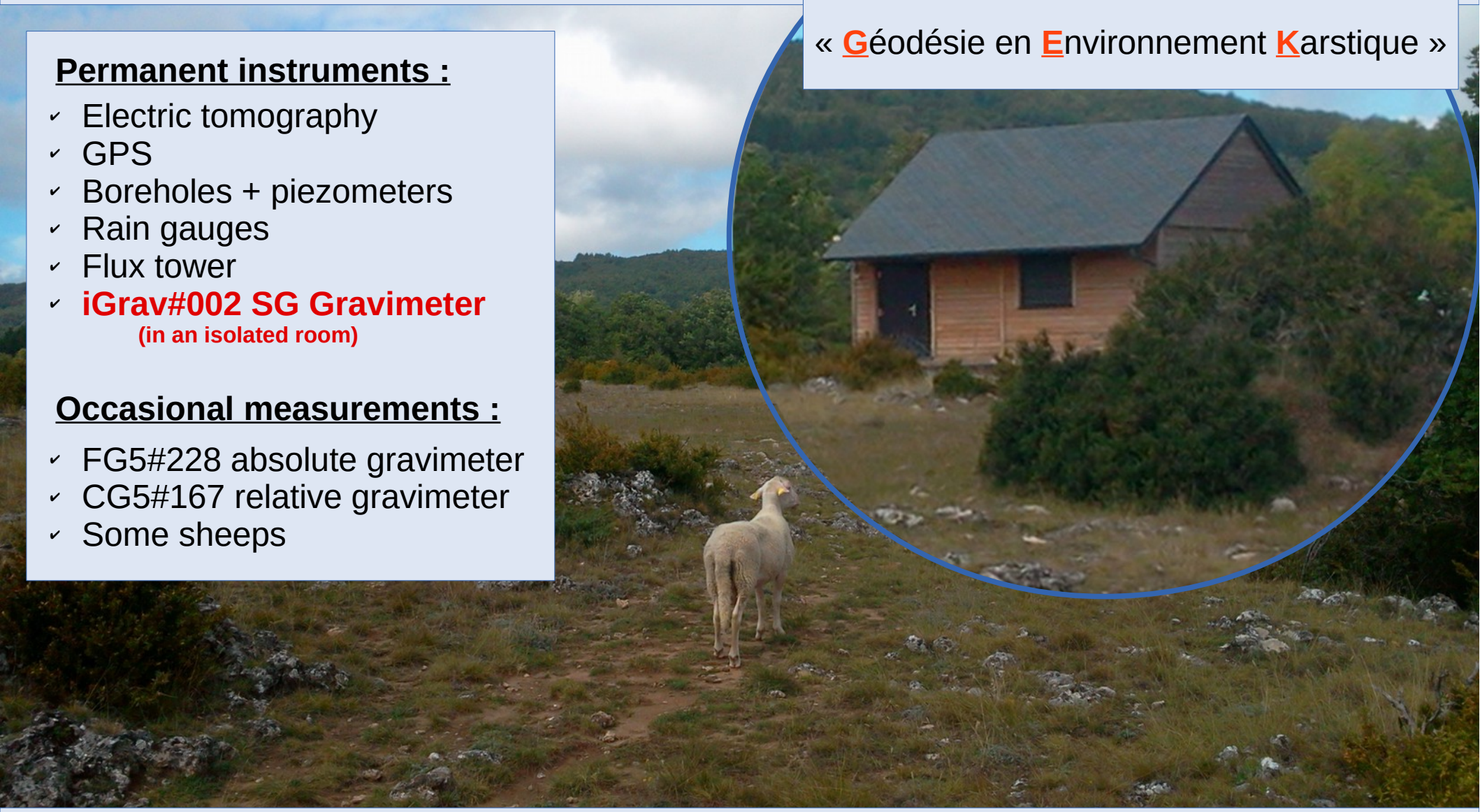


Operational since 2011
8x8m in a low-noise environment

iGrav #002

Supraconducting gravimeter, with a reduced size

Photo : N. Le Moigne, 2011

1 Hz continuous time serie since summer 2011

iGrav #002 : Calibration

iGrav #002

1Hz Raw voltage

Comparison

FG5 #228

5-days records

Day start Time	Duration (days)	Number of sets	Calibraction factor (nm/s²/V)	Standard deviation (nm/s²)
2011-07-04 10:50	6.0	144	**-894.17 ± 0.96**	6.41
2011-08-25 10:15	6.4	153	**-895.49 ± 0.79**	6.97
2011-12-06 15:30	6.3	150	**-895.54 ± 0.86**	9.31
2012-02-20 15:15	6.0	144	**-895.94 ± 1.03**	7.17
2013-03-25 14:35	2.1	50	**-894.65 ± 1.21**	5.24
2013-06-13 11:45	5.0	120	**-895.38 ± 0.97**	7.30

$-895.4\ nm.s^{-2}.V^{-1}$

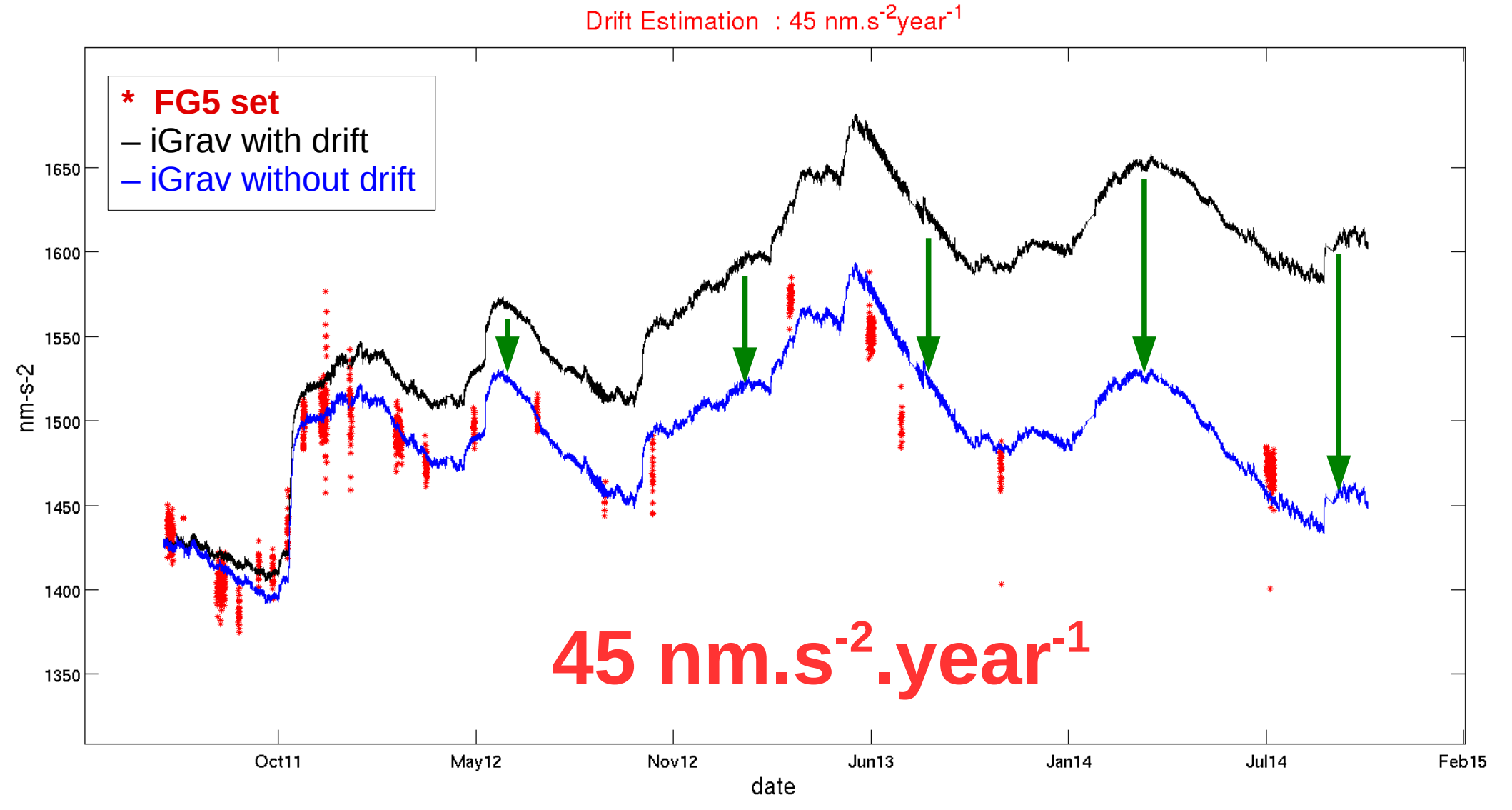
Stable

iGrav #002 : Drift

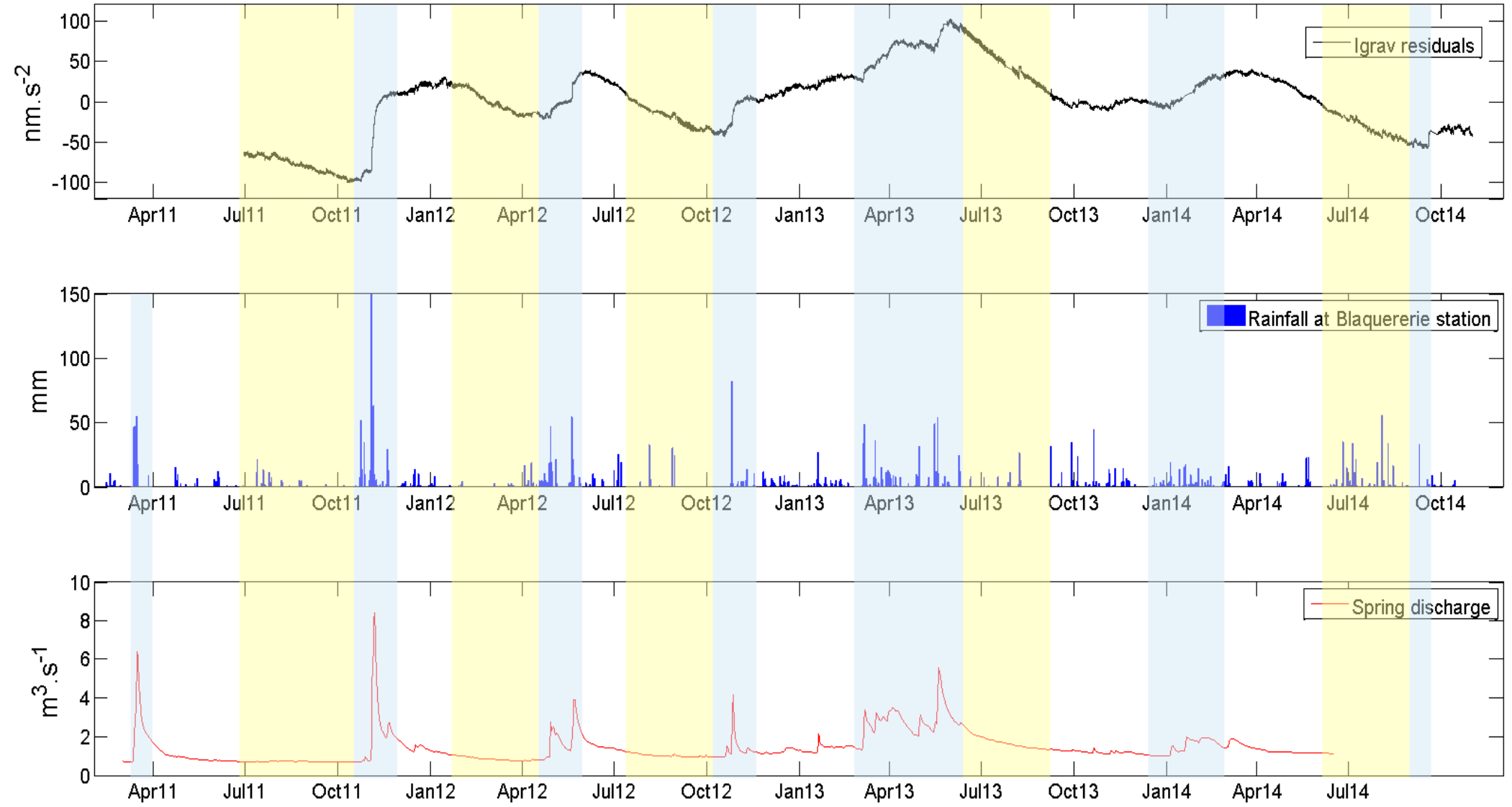
iGrav #002
Processed data

Comparison

FG5 #228
Processed data

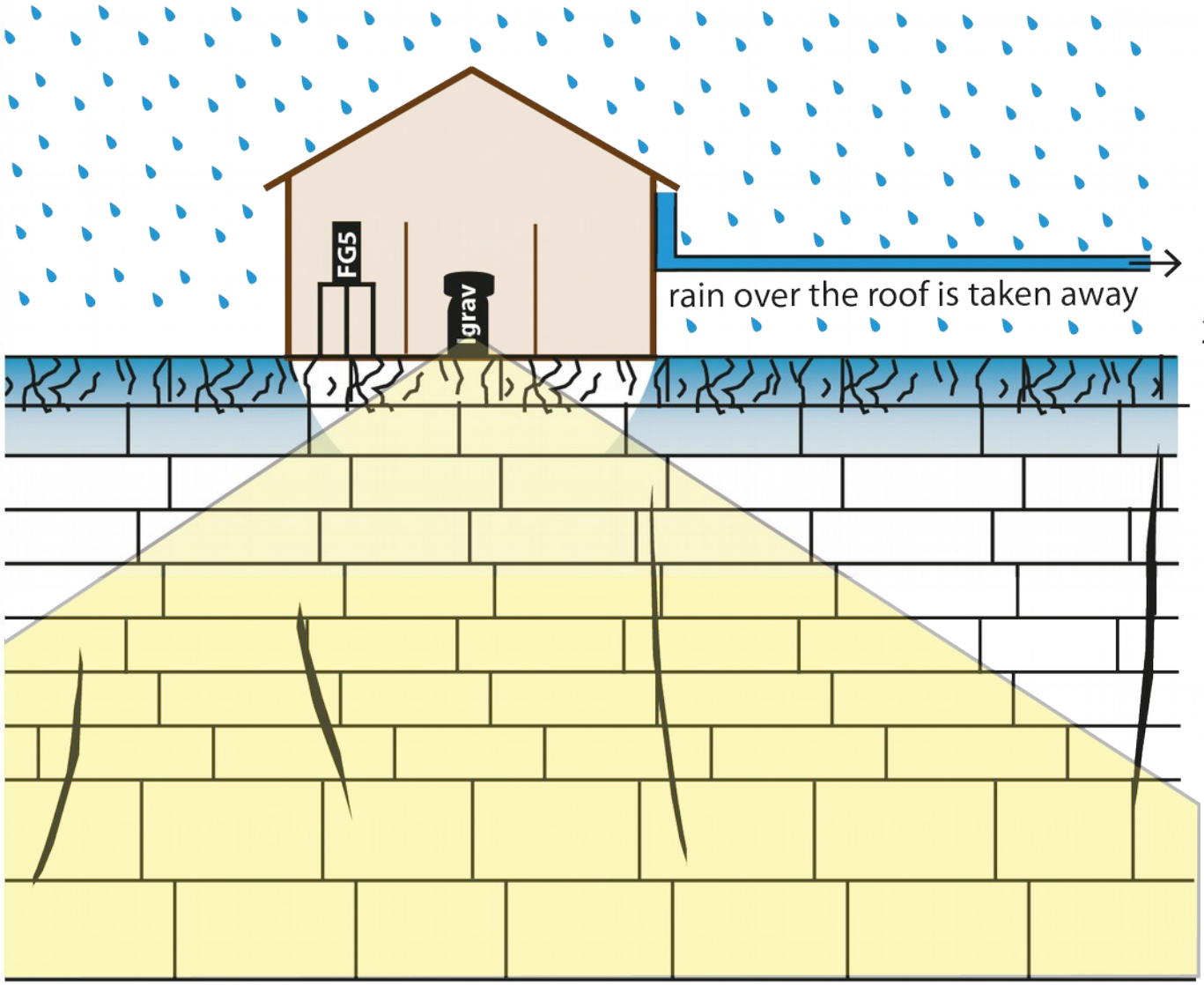


Residuals & Hydrology

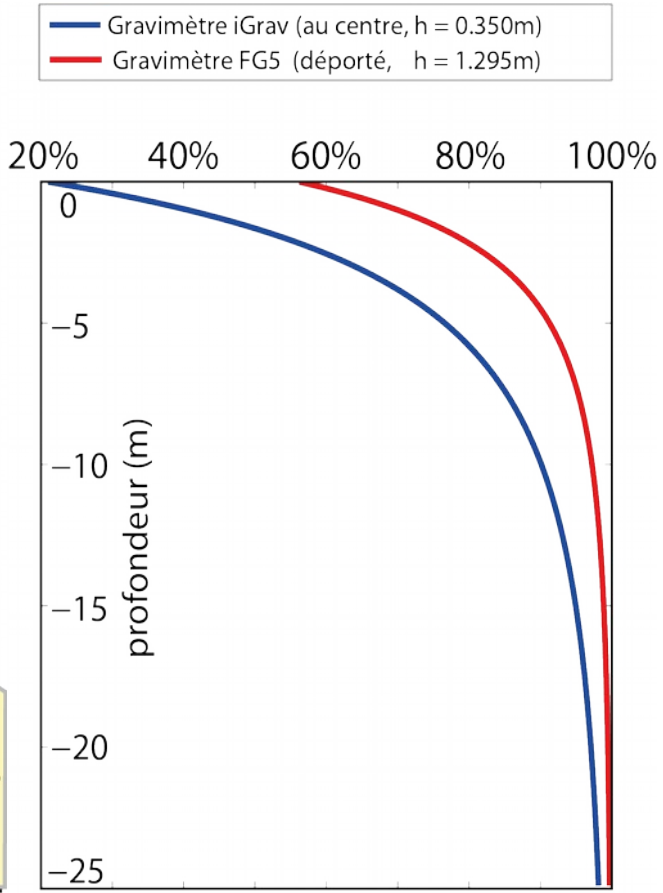


Good correlation between hydrology and gravity residuals

Building's mask effect

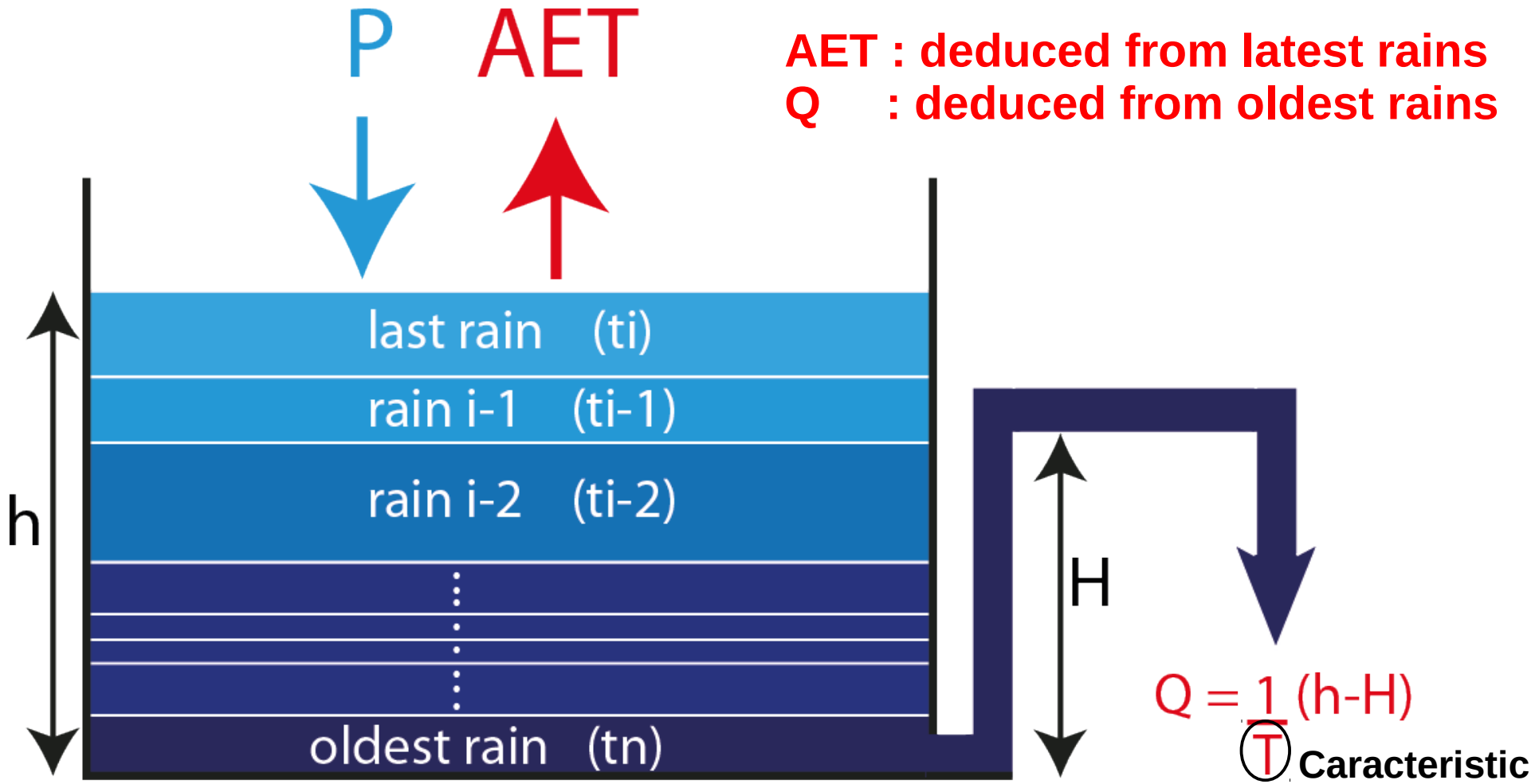


% of a theoretical plateau effect observed

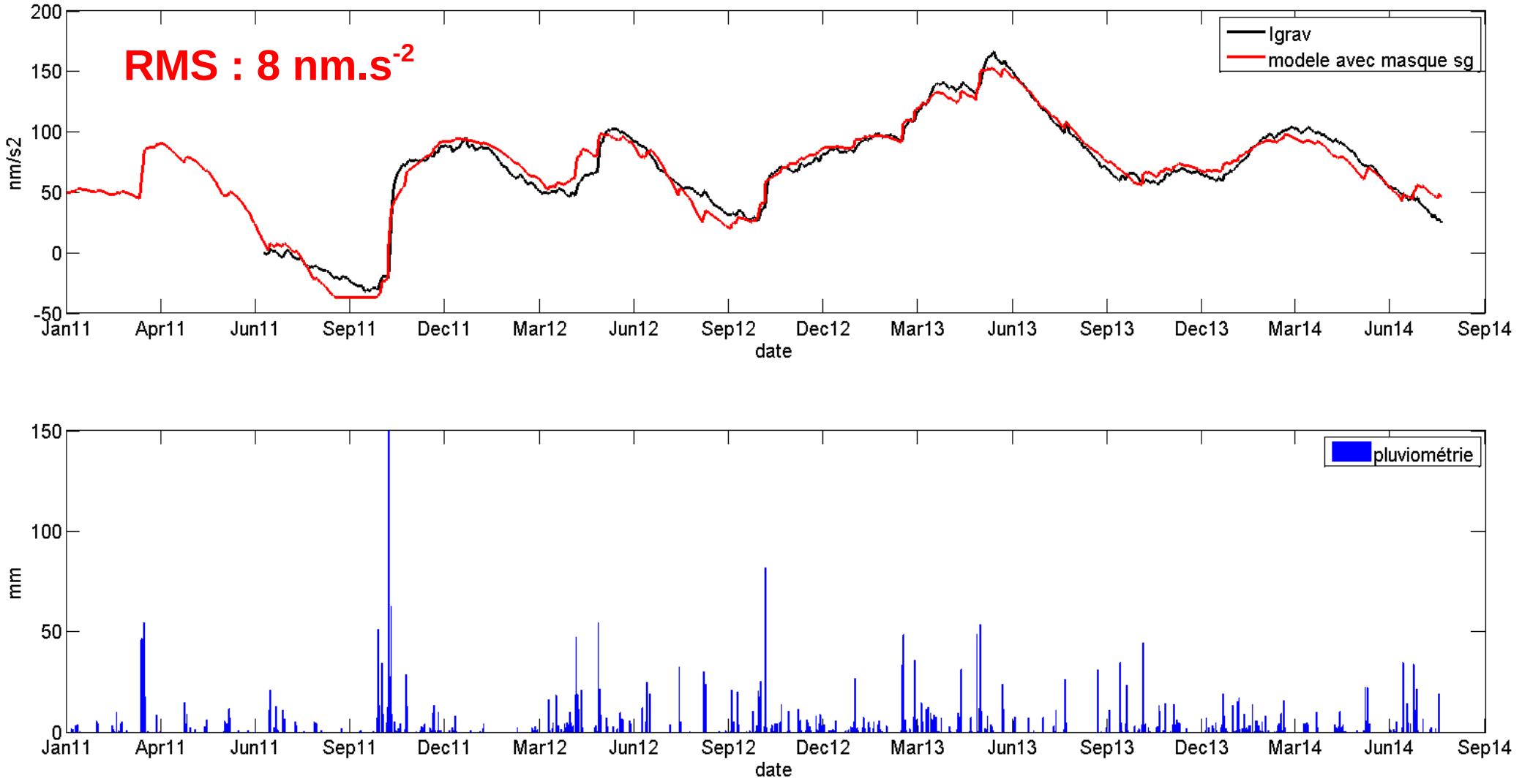


- **Delays the effect of rainfalls**
- **Important mask on evaporation**

Modeling: Tank model



Modeling: Tank model

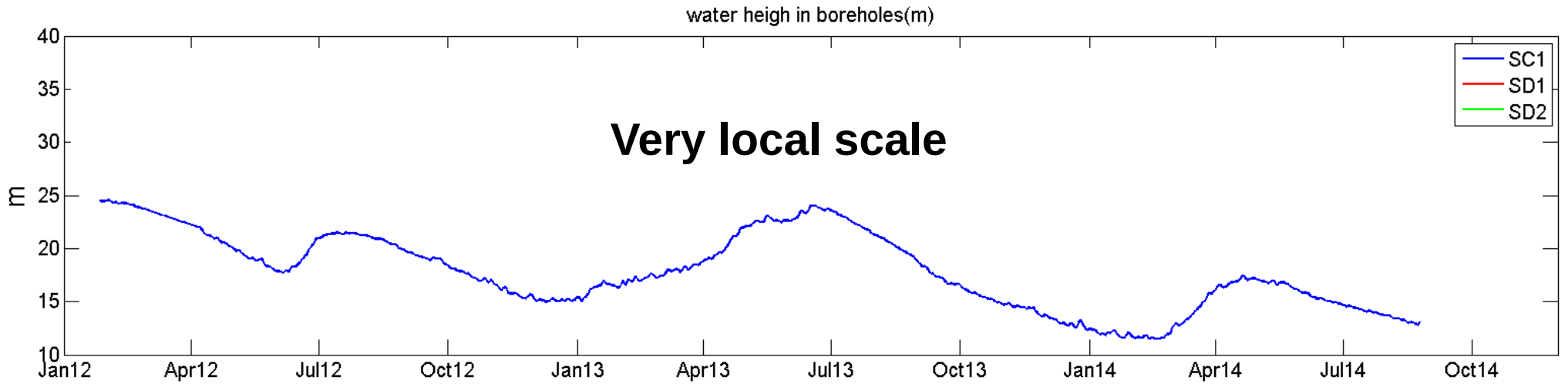


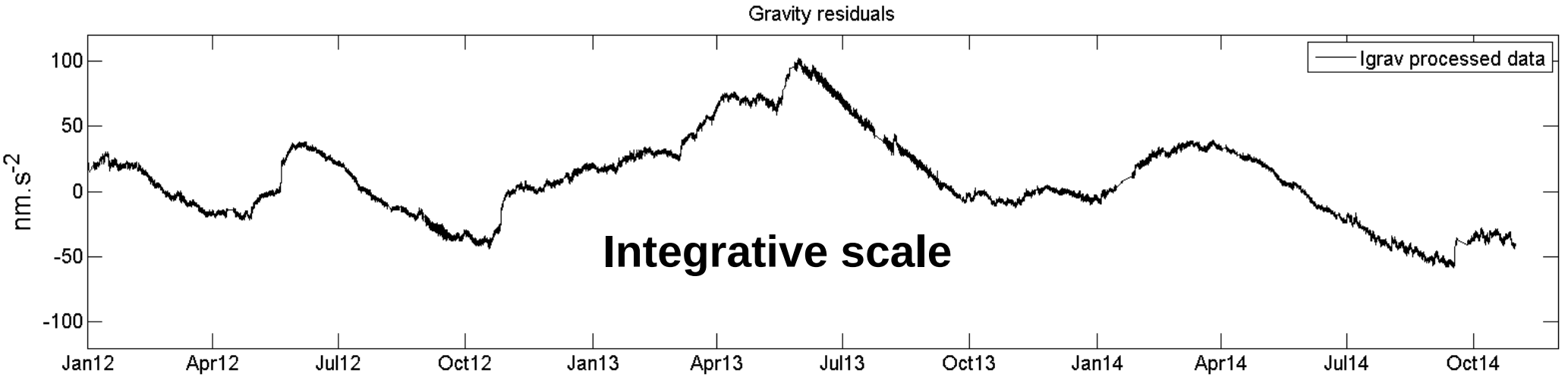
Best Parameters

Caracteristic time	:	300 days
Soil thickness	:	1.0 m
Infiltration rate	:	10 cm/day
Average discharge	:	0,8 mm/day (1m^3/s)

- **Reality of this model ?**

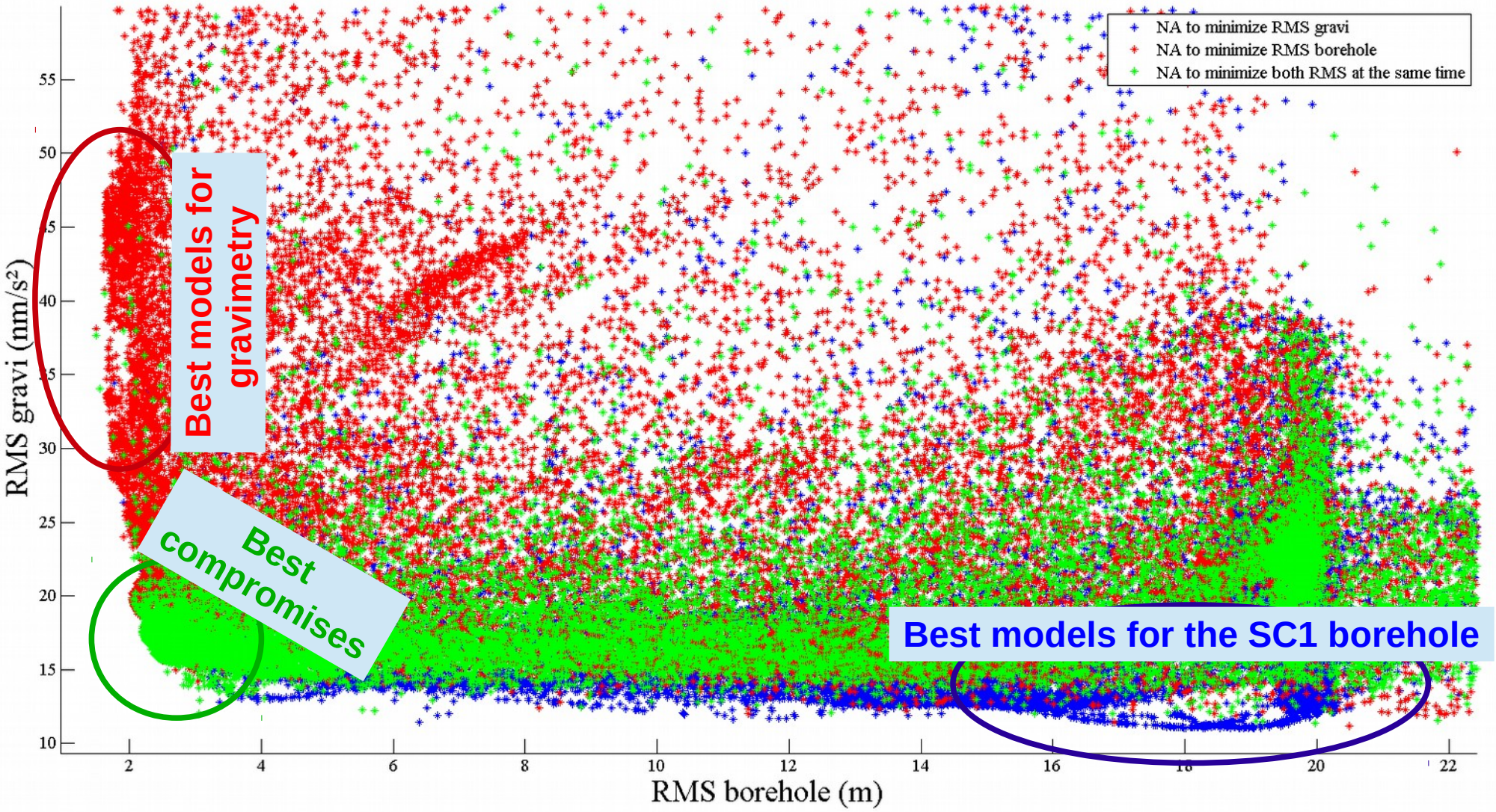
Hydrus-1D: Boreholes data ?





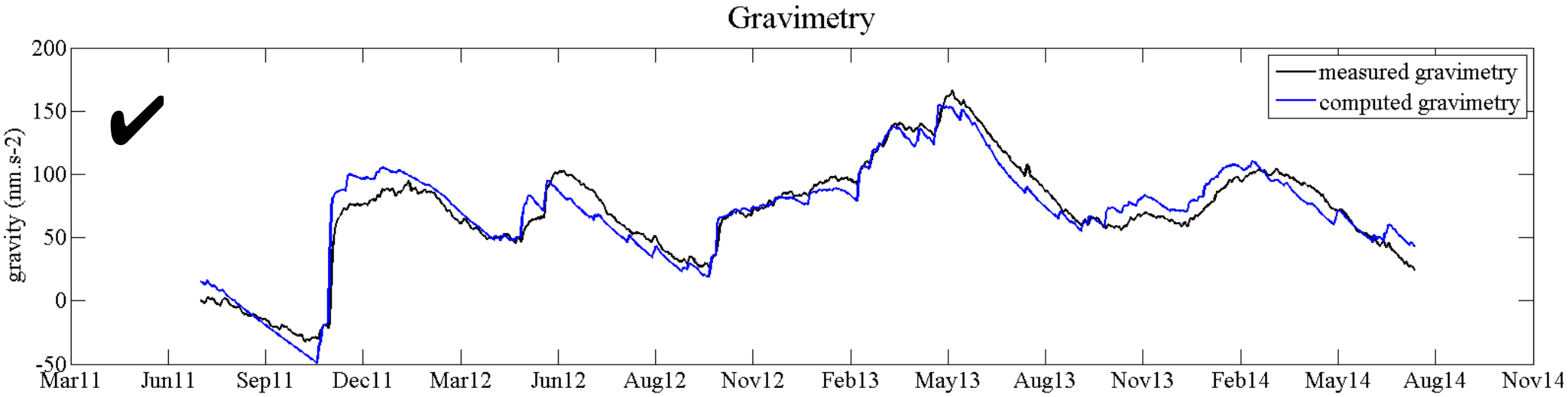
- **Two information at two different scales**
- **Combined utilisation in hydrological models ?**

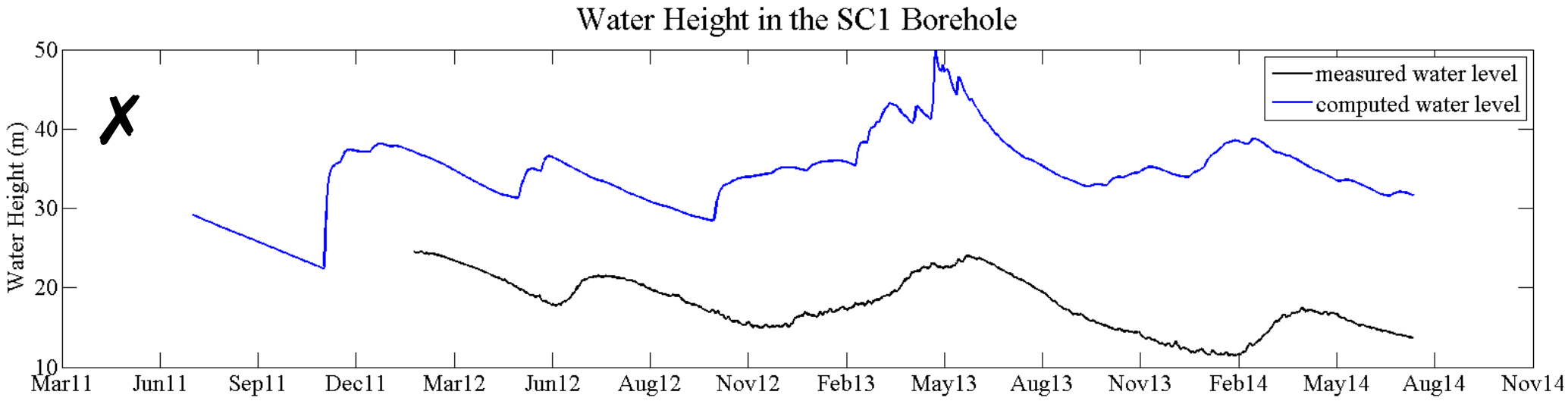
Modeling : Hydrus-1D



Simple 2 layers model (0 - 50 m / 50 - 100m)

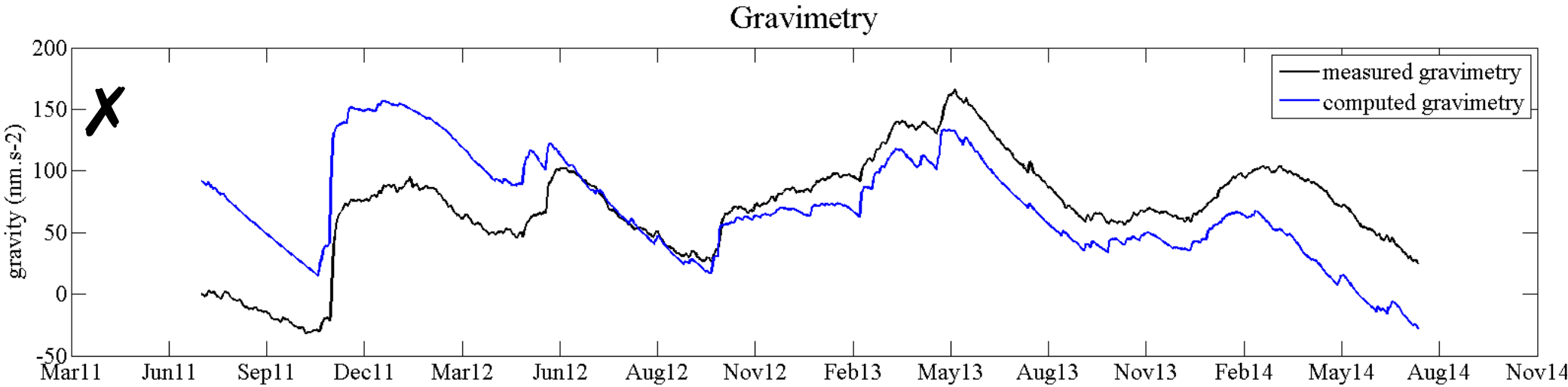
Hydrus-1D : gravity

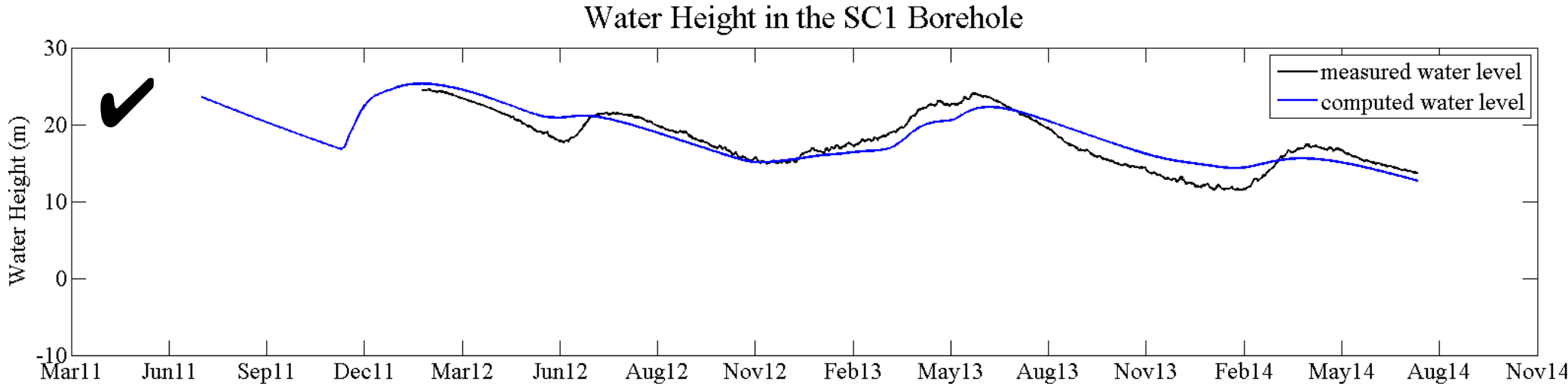




- **Gravimetry only : Good results**
- **Poorly constrained parameters**

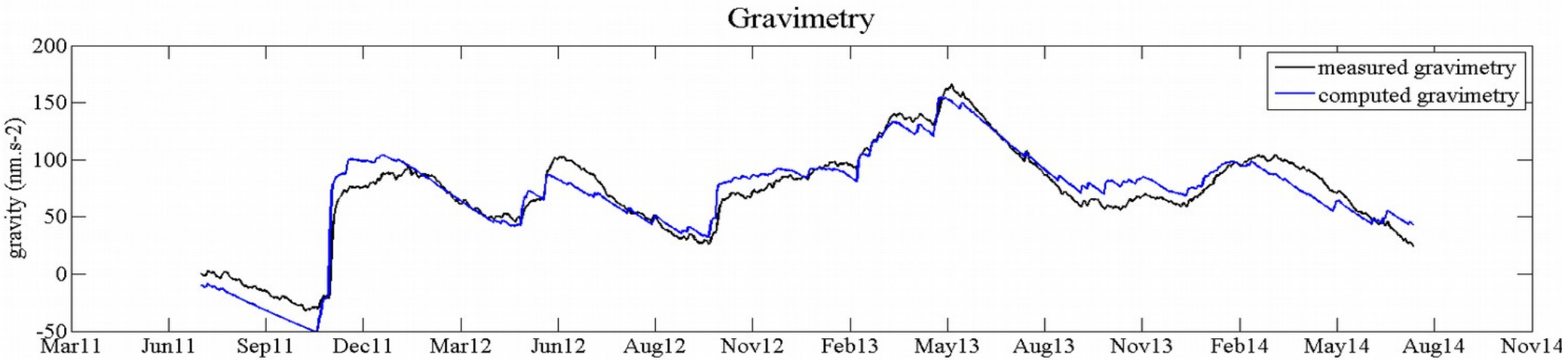
Hydrus-1D : Borehole

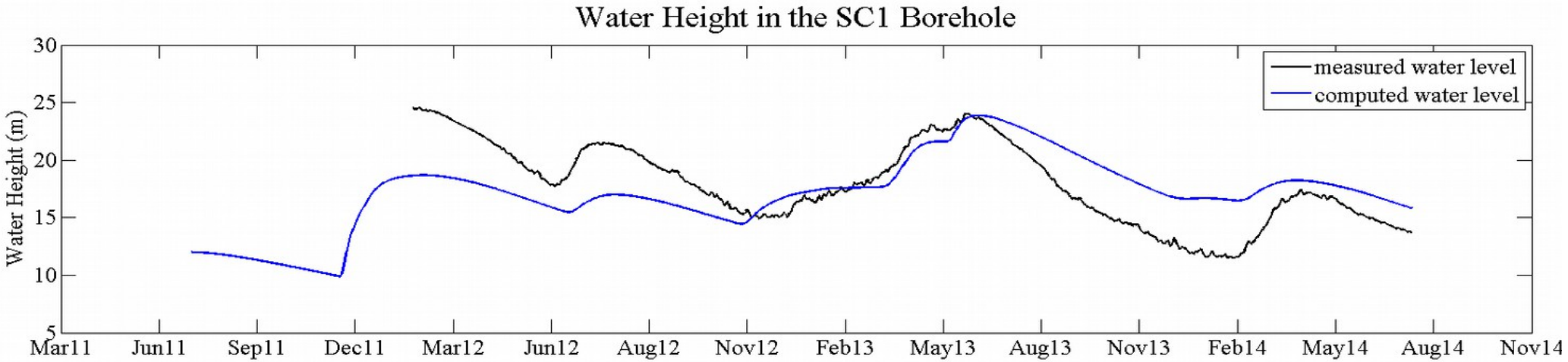




- **Borehole only : not so good**
- **Model's geometry? Boundary conditions ?**

Hydrus-1D : gravity + borehole





- **Parameters more constrained**
- **Average discharge: 0.5 mm/day (0.7 m^3/s)**
- **Model's geometry? Boundary conditions ?**

Conclusion

Conclusion :

- iGrav :
  - stable
  - moderate drift
  - hydrological signal

- Hydrological Modeling
  - important mask effect
  - first estimation of soil parameters
  - Use of boreholes ?

Photo : N. Le Moigne, 2011

On going

On going:

- Mask effect :
  - Tracing
  - Daily electric tomography
  - CG5 mesurements around the GEK
- Modeling with Hydrus :
  - Choice of the model
  - Boundary conditions
- Other site studied with CG5:
  - Abîme de Saint-Ferréol


THANKS FOR YOUR ATTENTION