GRAVIMOB : a new **gravi**metry and **gra**diometry **mob**ile system for the subsea domain.

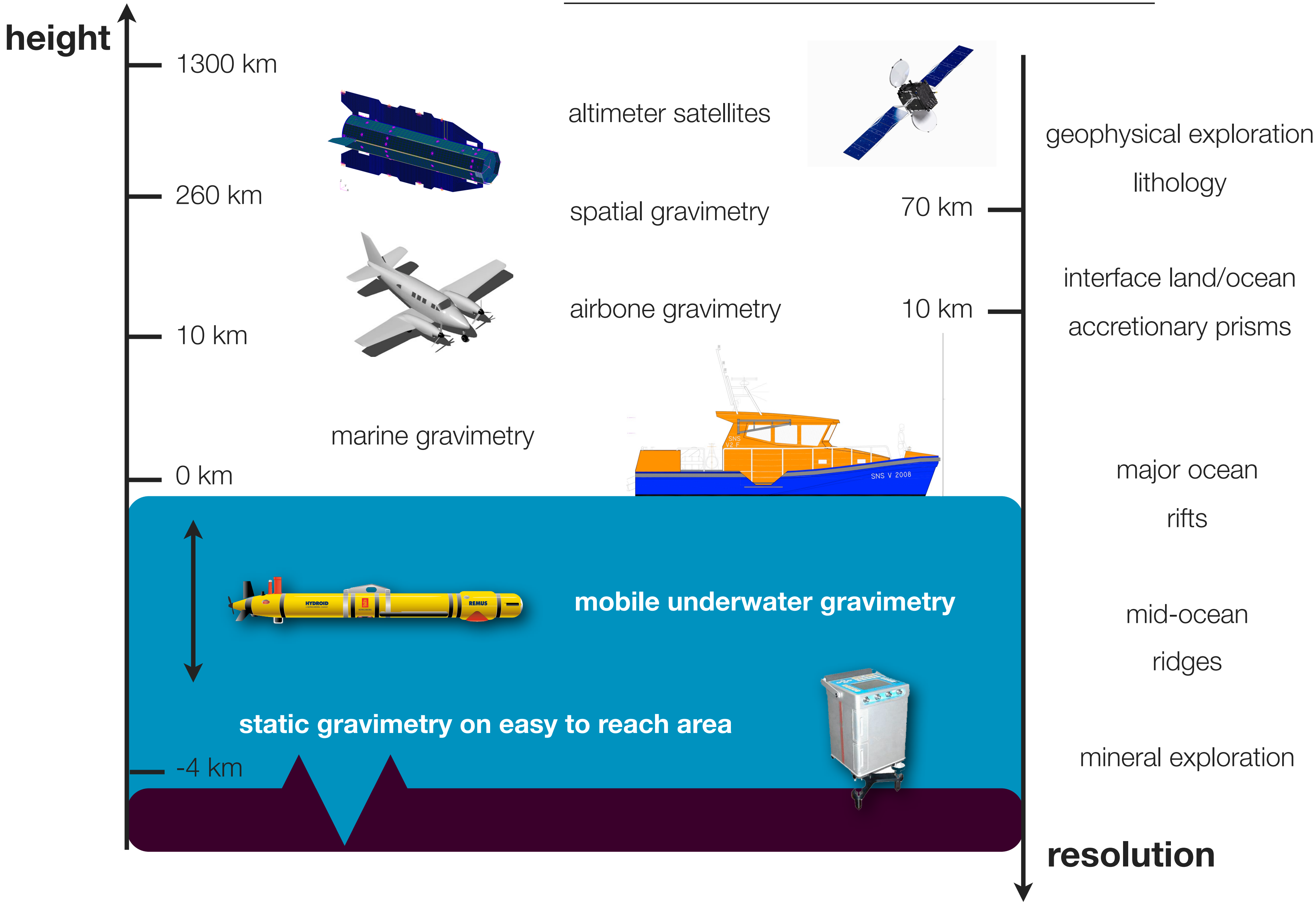
Colloque G2 2014 - Strasbourg

Clément Roussel - PhD Student

Jérôme Verdun - supervisor

Marcia Maïa - co-supervisor

Motivation



GRAVIMOB : a new gravimetry and gradiometry mobile system for the subsea domain.

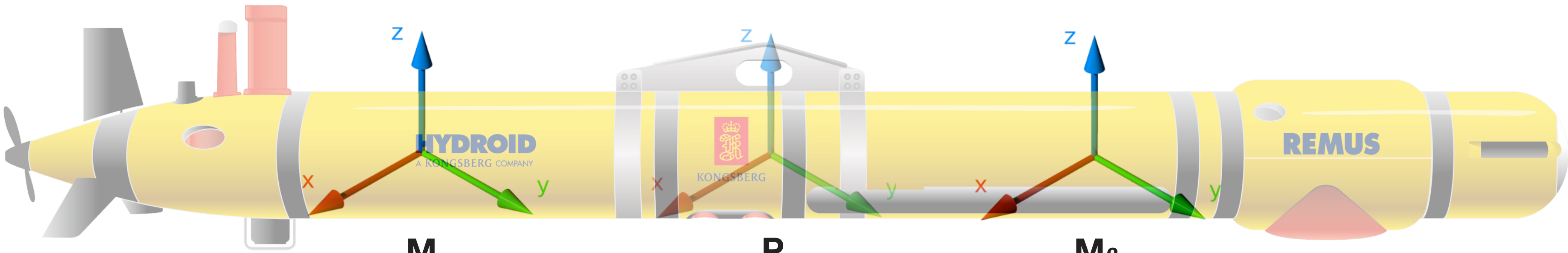
Stakes

source : flotte.ifremer.fr

AUV AsterX (**A**utonomous **U**nderwater **V**ehicule)

Stakes

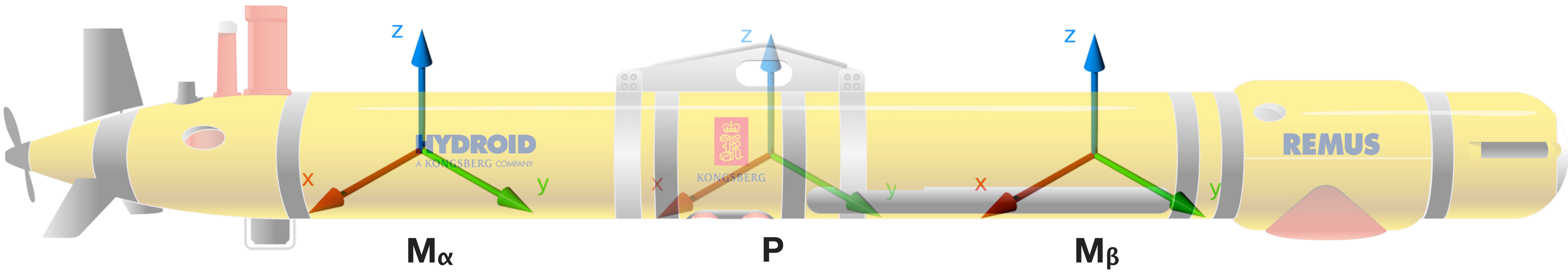
Measuring the components of the gravity field's vector and their spatial variations in the subsea environment !



$$g_\alpha^b = \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)X_P^b + 2\Omega_{ib}^b\dot{X}_P^b + \ddot{X}_P^b\right] + \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)L_\alpha^b\right] - a_\alpha^b$$

$$g_\beta^b = \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)X_P^b + 2\Omega_{ib}^b\dot{X}_P^b + \ddot{X}_P^b\right] + \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)L_\beta^b\right] - a_\beta^b$$

Equations



$$g_\alpha^b = \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)X_P^b + 2\Omega_{ib}^b\dot{X}_P^b + \ddot{X}_P^b\right] + \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)L_\alpha^b\right] - a_\alpha^b$$

$$g_\beta^b = \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)X_P^b + 2\Omega_{ib}^b\dot{X}_P^b + \ddot{X}_P^b\right] + \left[(\Omega_{ib}^b\Omega_{ib}^b + \dot{\Omega}_{ib}^b)L_\beta^b\right] - a_\beta^b$$

$$g_\alpha^b \approx g_P^b + \nabla g_P.PM_\alpha$$

$$g_\beta^b \approx g_P^b + \nabla g_P.PM_\beta$$

\+

$$g_\alpha^b + g_\beta^b \approx 2g_P^b$$

$$g_\alpha^b \approx g_P^b + \nabla g_P.PM_\alpha$$

\-

$$g_\beta^b \approx g_P^b + \nabla g_P.PM_\beta$$

$$g_\alpha^b - g_\beta^b \approx \nabla g_P.M_\beta M_\alpha$$

What are the resolutions and accuracies reachable with such a system ?

↓

Study of the gravity field's restitution by numerical simulation (Monte Carlo)

Numerical simulation

Principle

$$a_M^{ref} = \ddot{X}_M^{ref} - g_M^{ref}$$

Accélérations de rappel de référence **déduites**

Champ de gravité de référence **choisi**

Mouvement de référence du porteur **choisi**

$$g_M = \ddot{X}_M - a_M$$

Champ de gravité **déduit**

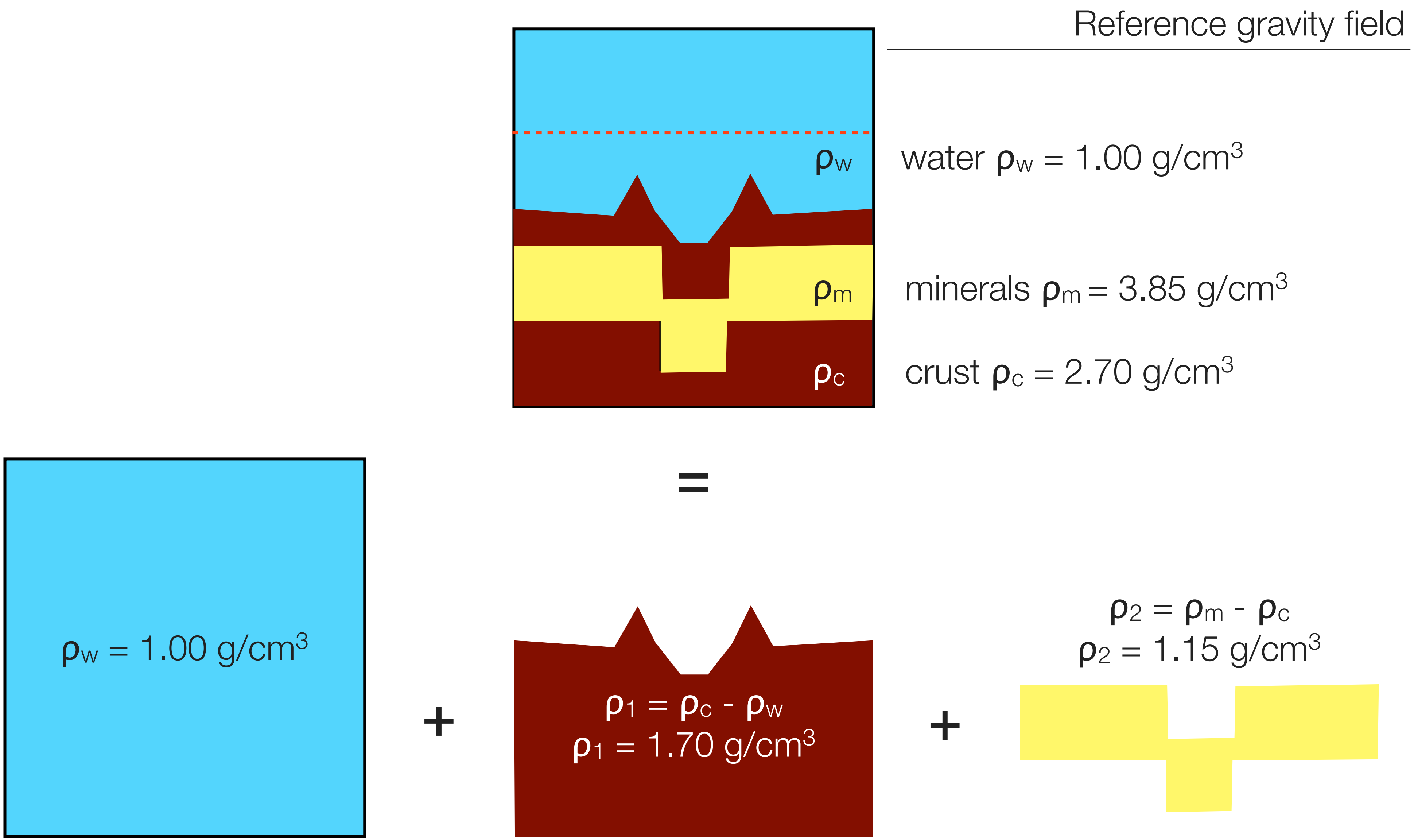
Accélérations de rappel de référence **+ bruit**

Mouvement de référence du porteur **+ bruit**

$$\epsilon = g_M - g_M^{ref}$$

$$\begin{cases} E(\epsilon) = \frac{1}{n}\sum_{0}^{n} \epsilon \\ VAR(\epsilon) = E((\epsilon - E(\epsilon))^2) \end{cases}$$

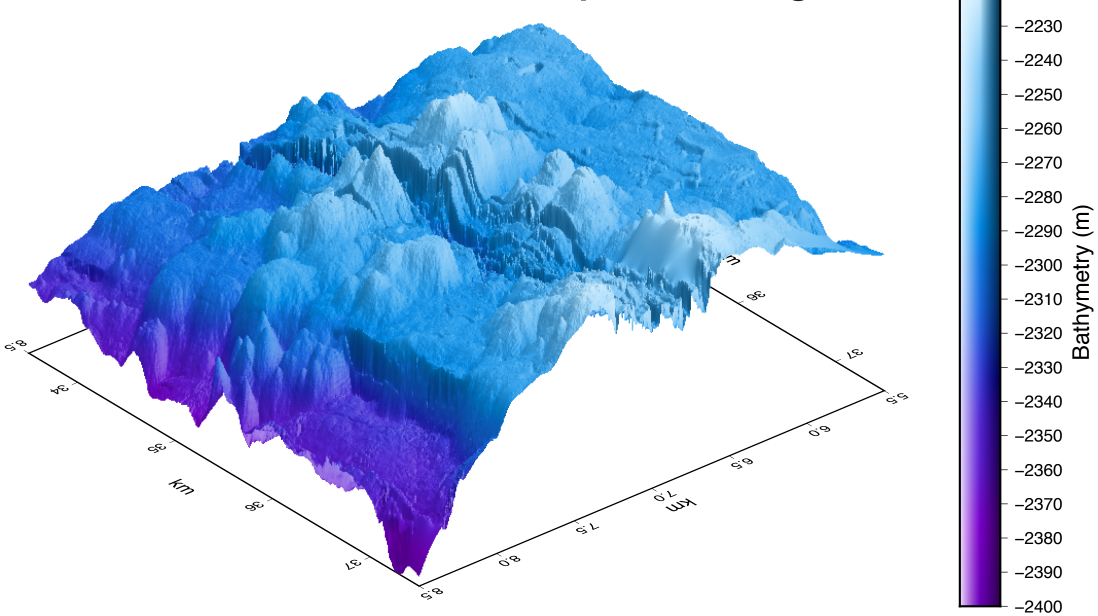
Numerical simulation



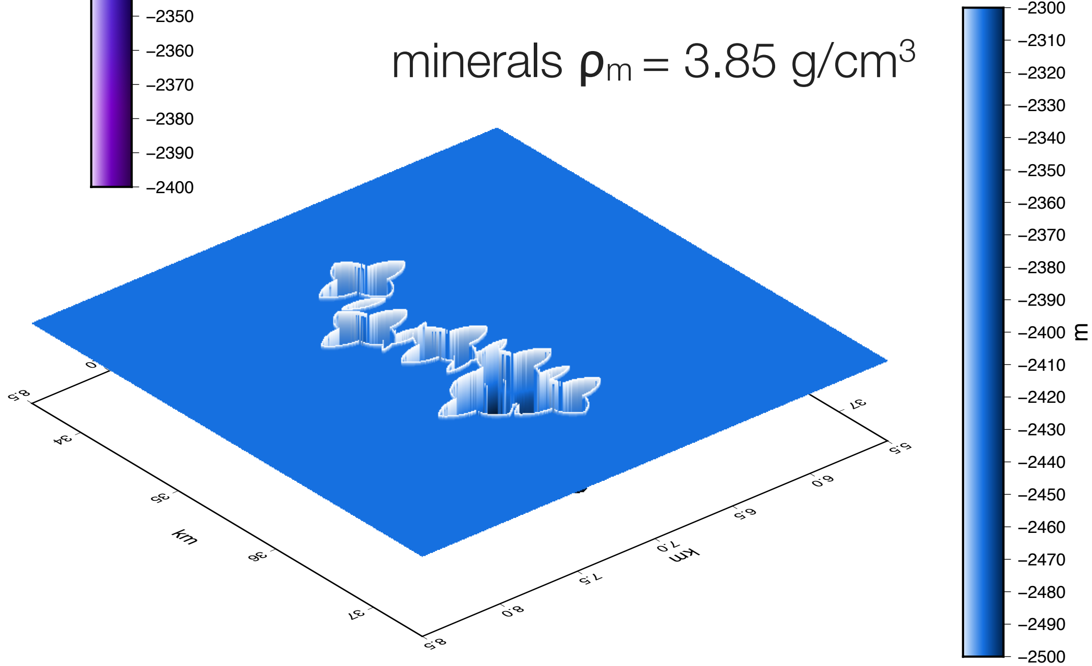
Numerical simulation

Reference gravity field

crust $\rho_c = 2.70\ g/cm^3$

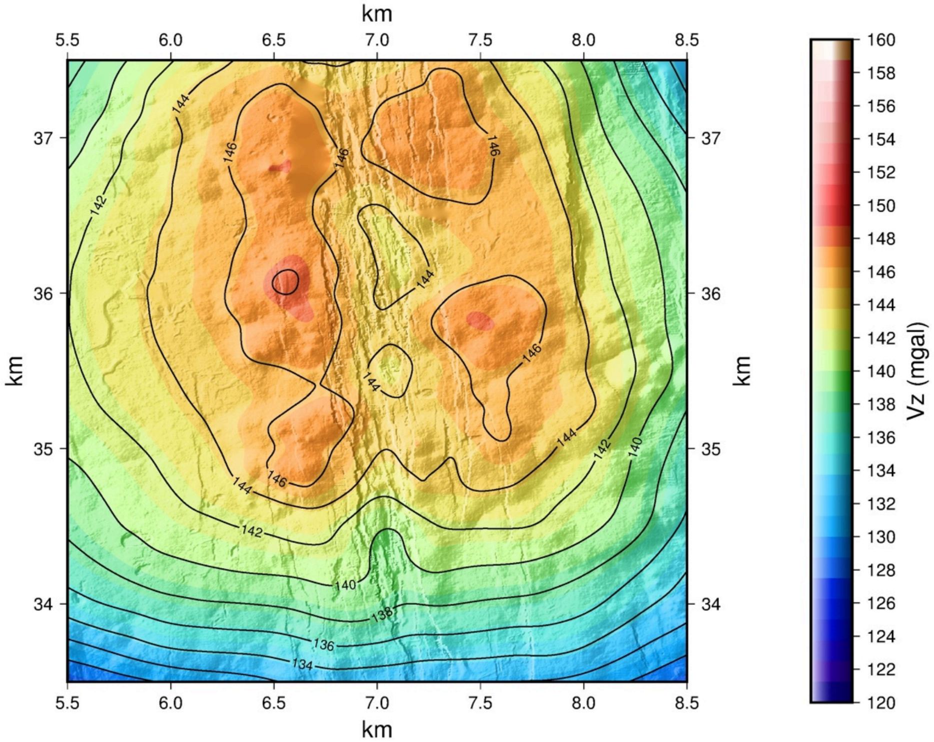


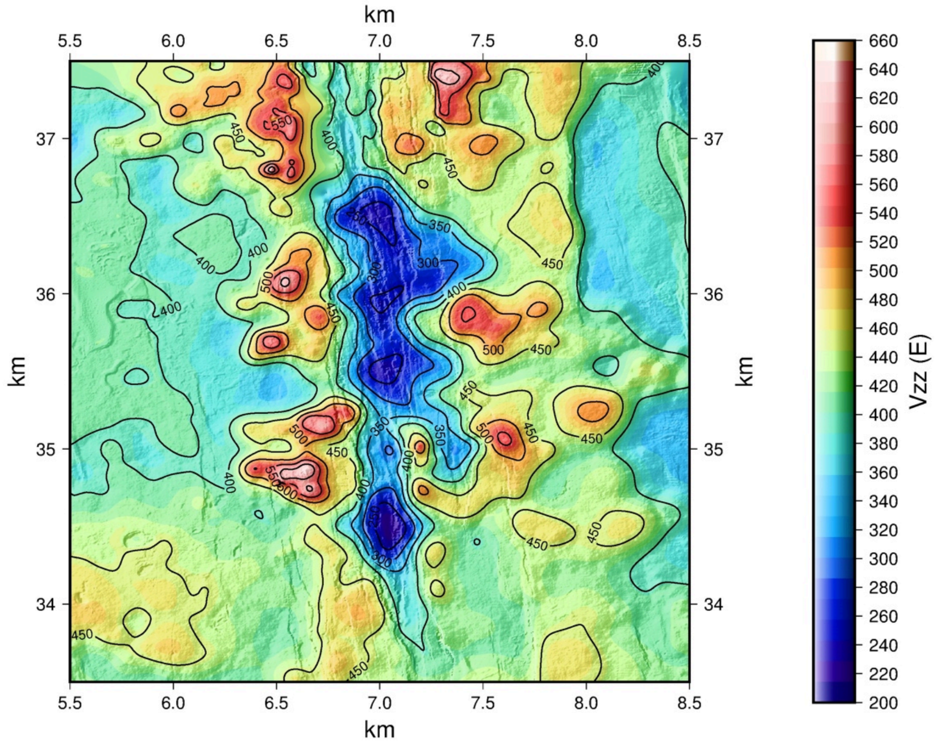
minerals $\rho_m = 3.85\ g/cm^3$



Numerical simulation

Reference gravity field



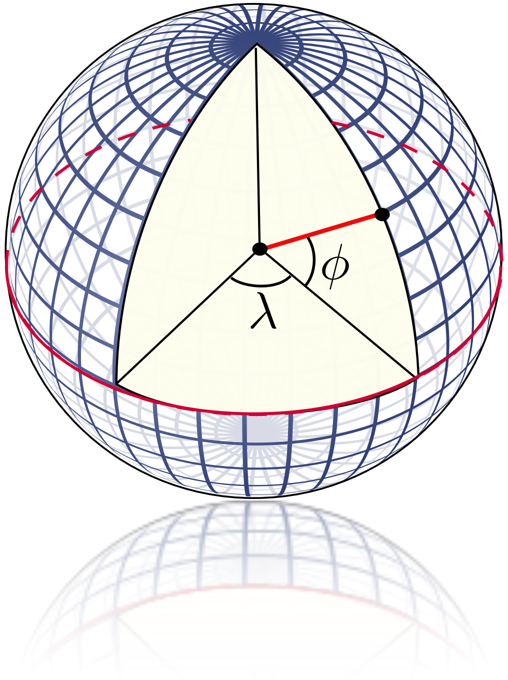


Logiciel **Tesseroid** - Leonardo Uieda

Leonardo Uieda, Everton P. Bomfim, C. B. E. M. (2011). Optimal forward calculation method of the marussi tensor due to a geologic structure at goce height

Position

- λ : longitude
- Φ : latitude
- h : height



Attitude

- α : heading
- χ : pitch
- η : roll

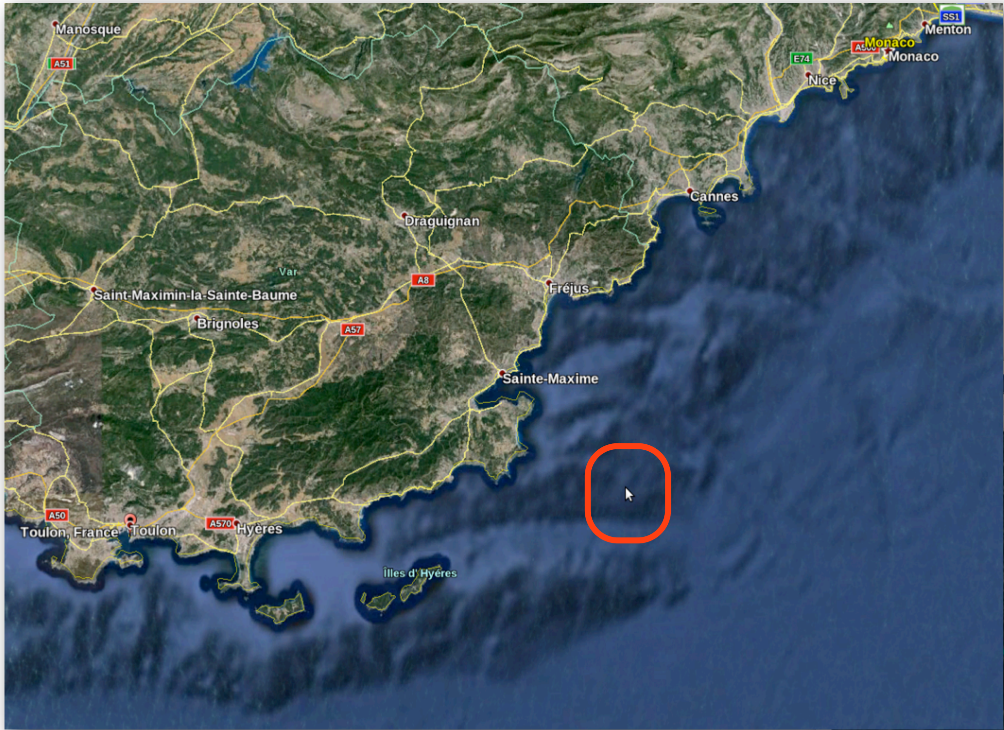
Numerical simulation

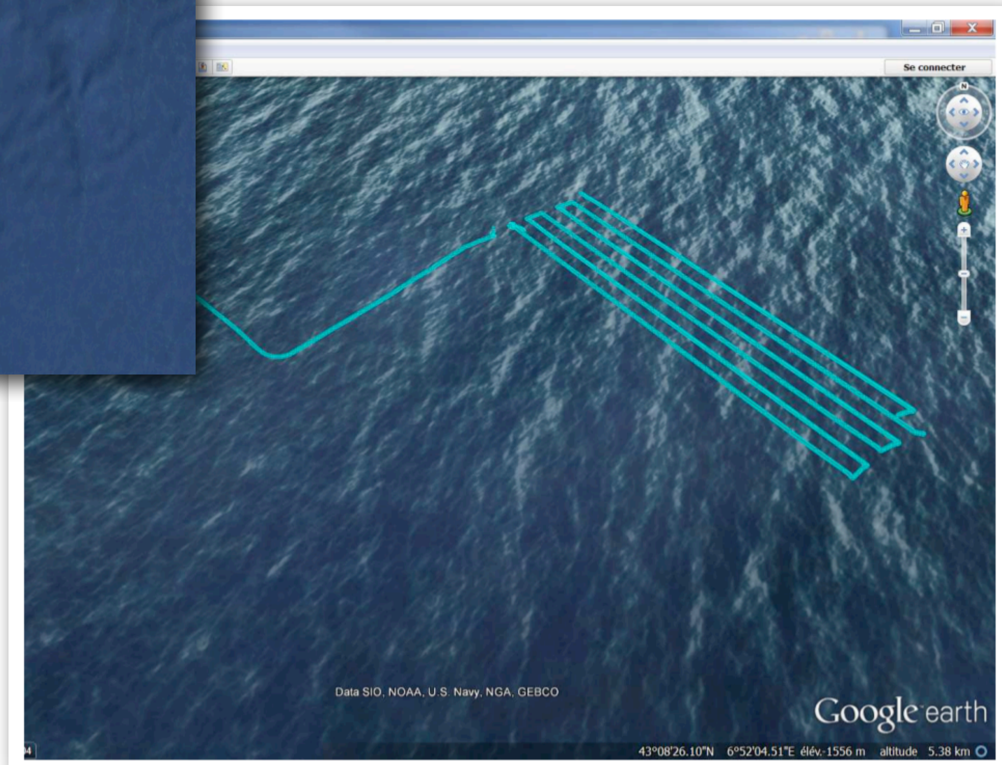
Reference motion of the carrier

Mission ESSAUV12

Plongée du

1 décembre 2012





Données fournies par l'**IFREMER**

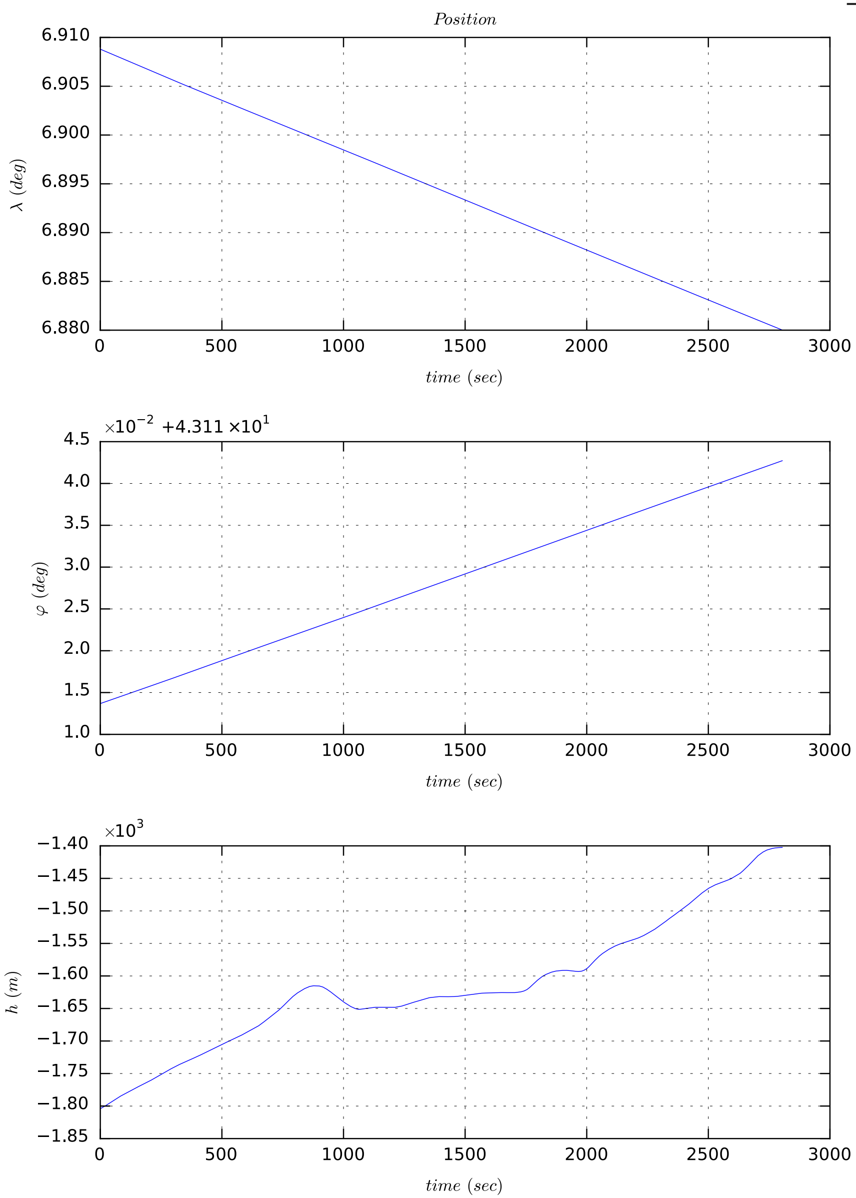
Marie-Edith BOUHIER

Données échantillonnées

Te = 1 s

Numerical simulation

Reference motion of the carrier



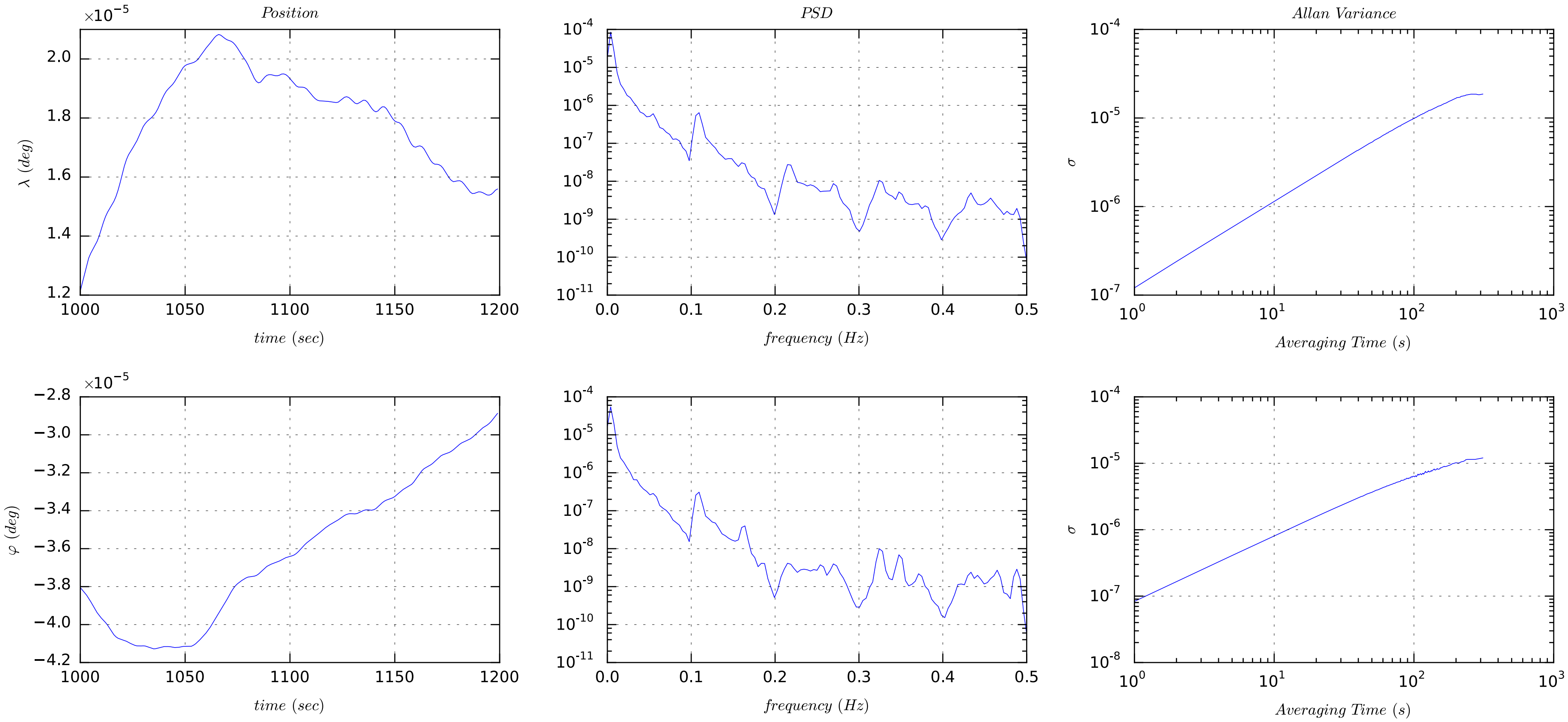
$$\lambda(t) = \lambda^{ref}(t) + b_{\lambda}(t)$$

$$\varphi(t) = \varphi^{ref}(t) + b_{\varphi}(t)$$

$$h(t) = h^{ref}(t) + b_{h}(t)$$

Numerical simulation

Reference motion of the carrier



$$a_M^{ref} = \ddot{X}_M^{ref} - g_M^{ref}$$

Accélérations de rappel de référence **déduites**

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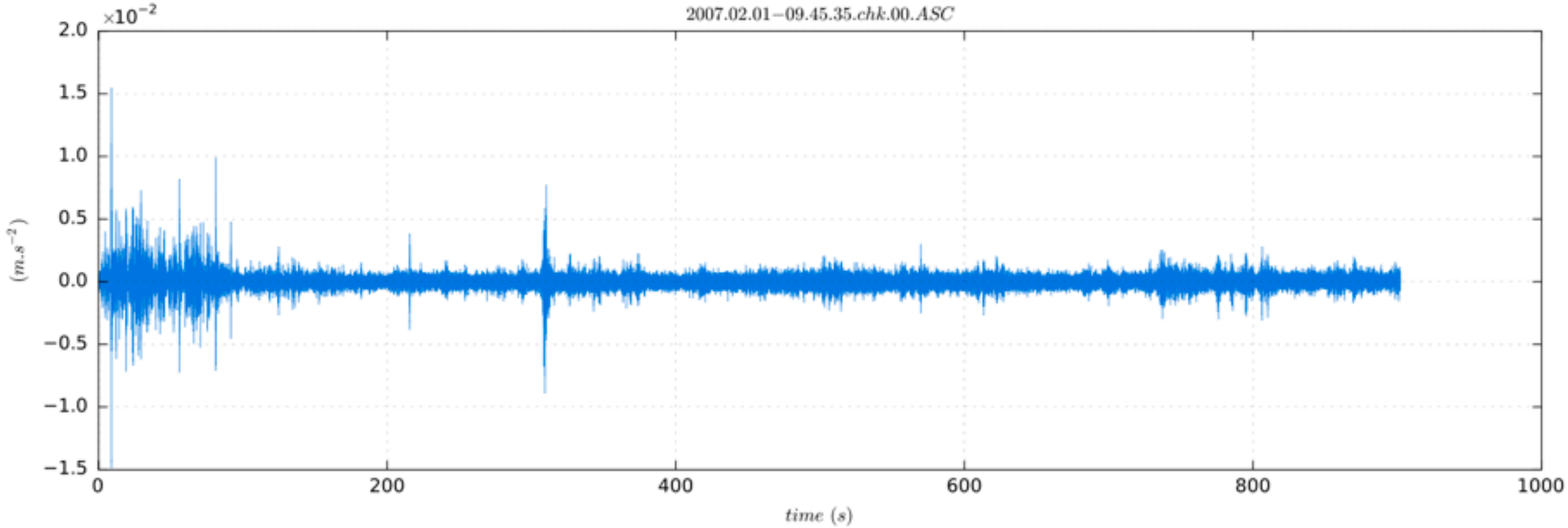
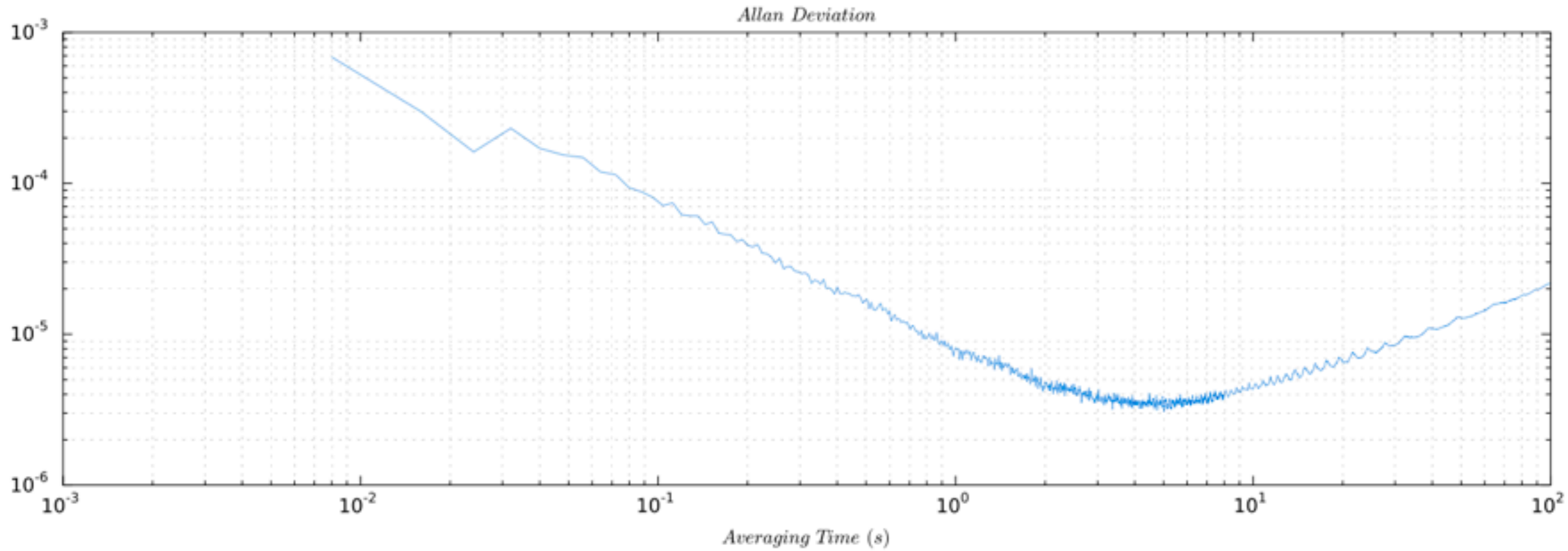
Numerical simulation

Specific force





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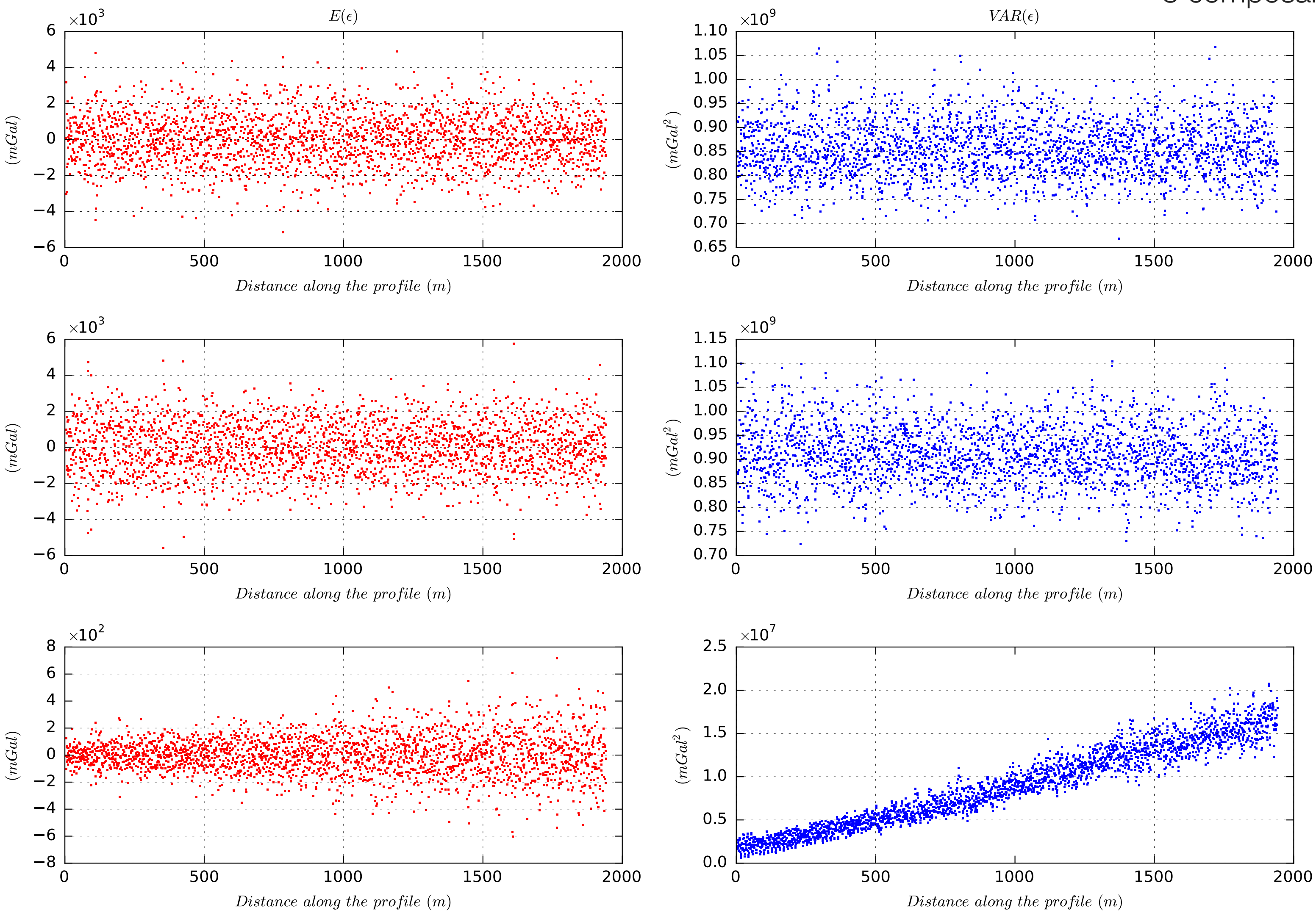
Numerical simulation

Espérance et Variance de l'erreur

3 composantes du champ



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