

# Testing sea bed variability using GOCE03s gravity gradients in the Intra-Americas Seas: a preliminary approximation

ESA Living Planet Symposium 2016 - Prague

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## Introduction

Satellite derived gravity anomalies and gradients in marine environments have been commonly used for a spatial description of tectonic features<sup>[1],[2]</sup>: trenches, ridges, seamounts, oceanic-continental lithospheric boundaries, and elastic properties of crustal and lithospheric configuration. But, only a few works considered the temporal variability of these anomalies and gradients in the sea floor, except for a few studies about the gravity signature of mega-earthquakes<sup>[3],[4]</sup>.

Using the monthly solutions of GOCE03s model, from November 2009 to September 2013, we are in the process of identifying a link between gravity gradients and sea bed density (mass) anomalies associated with landslides and thermal processes (volcanism and diapirism) in the Intra-Americas seas, given the great variety of sea bed morphodynamic environments in this region.

## Methodology

The methodology (Figure 1) includes the identification of target zones associated with mass variations due to **submarine landslides** (Figure 2) and **thermal processes** worldwide. The latter comprises the eruption and the inflation of seamounts associated with magma migration (Figure 3).

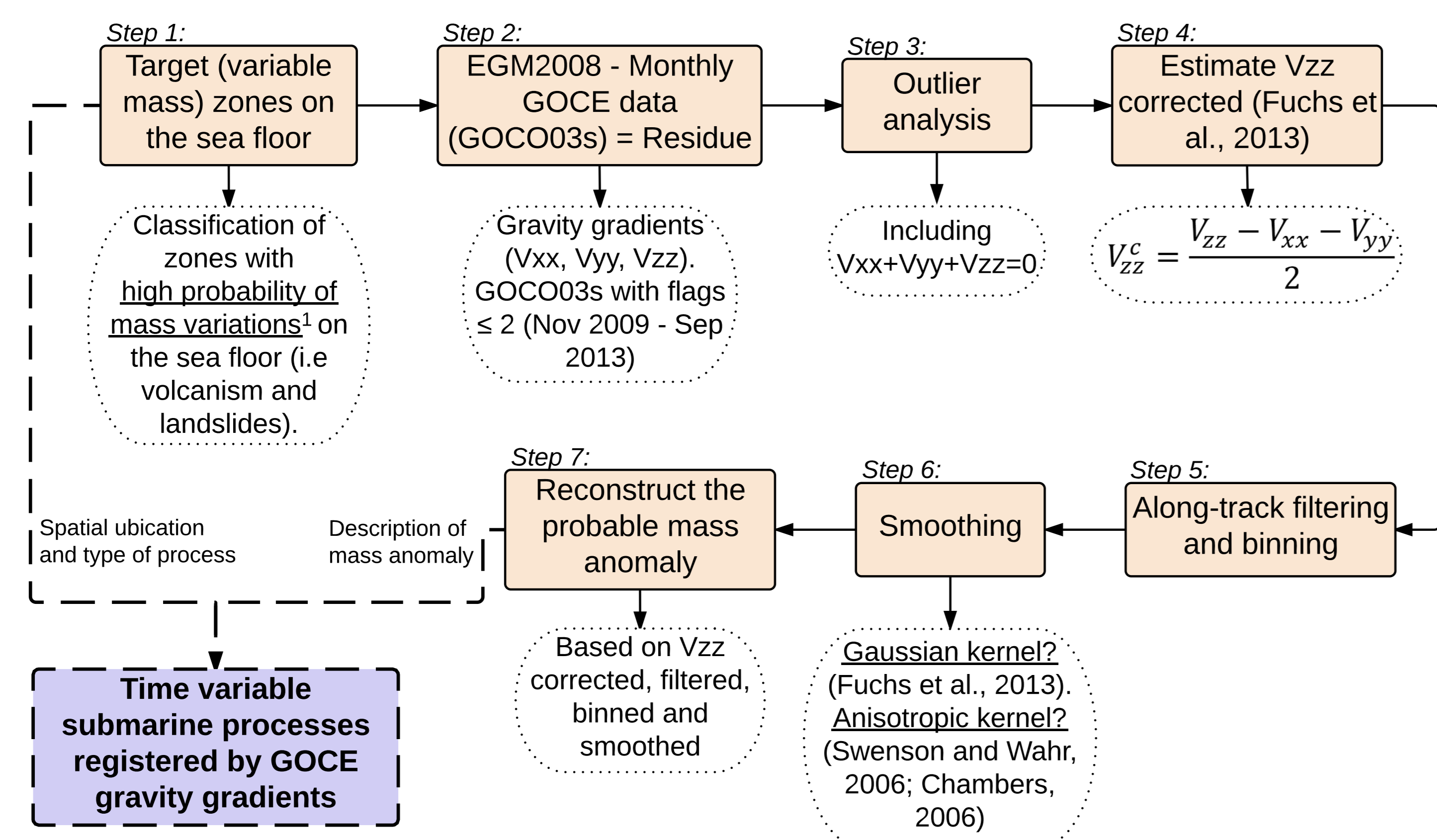


Figure 1: Preliminary methodology scheme proposed for the research based on [4]. <sup>1</sup> Processes in monthly and annual scales.

## Submarine processes with mass variations

### Landslides

Submarine landslides can be far larger than their terrestrial counterparts, and can involve the movement of even several thousands of cubic kilometers of material, making them perfect triggers of geohazards like tsunamis, or to damage expensive sea floor infrastructure<sup>[5]</sup>. Passive continental margins, specially glaciated and river deltas dominated are the most affected regions by landslides<sup>[6]</sup>.

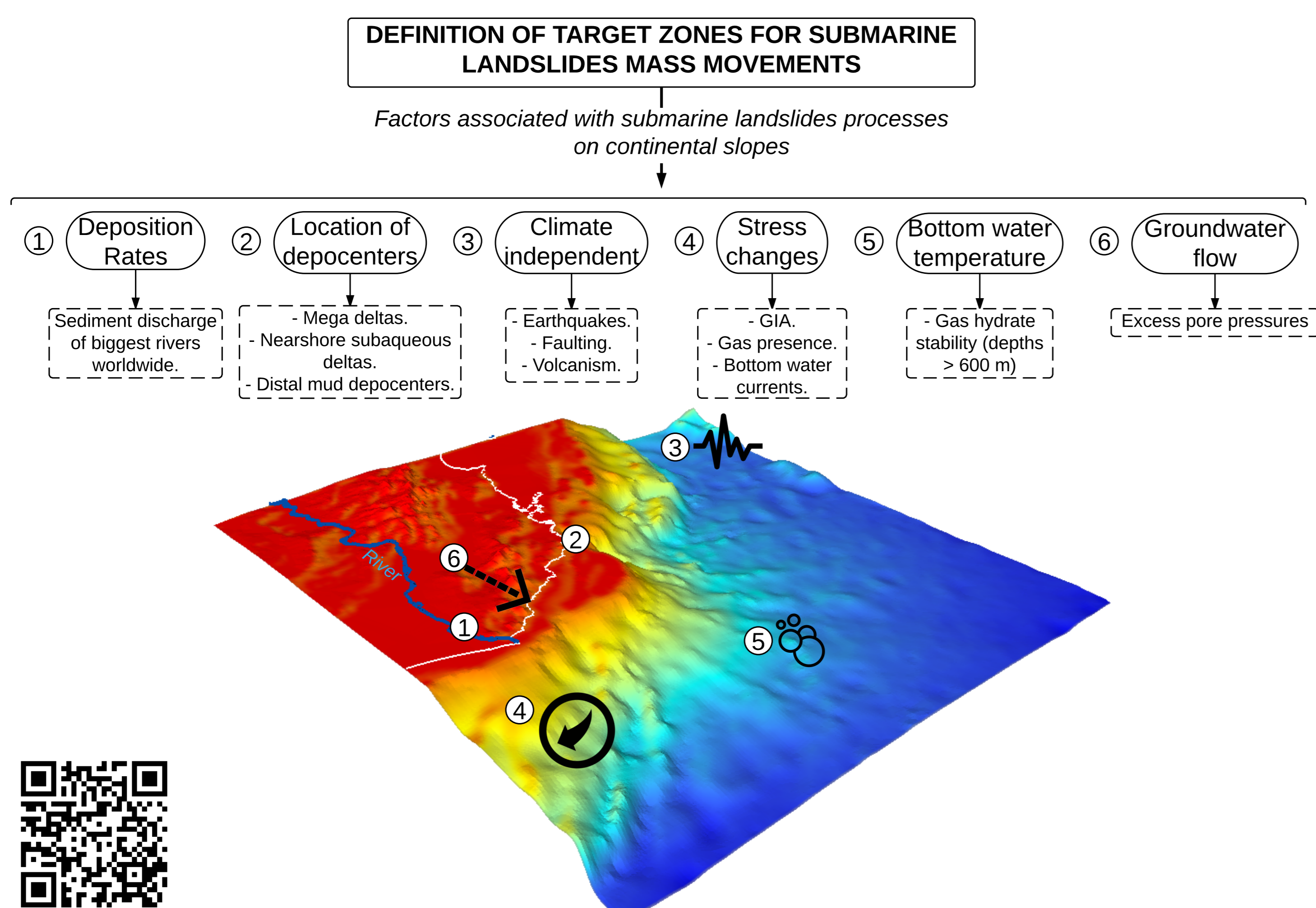


Figure 2: Factors triggers of submarine landslides processes. Modified from [6].

### Volcanism

Limited shipboard bathymetry and global satellite altimetry suggest about 32.000 seamounts worldwide, principally related to volcanic origin<sup>[2]</sup>. Currently there are only a few reports about the evolution of submarine volcanoes, which makes them one of the less explored morphological features on Earth<sup>[7]</sup>.

The methodology for localization of possible zones with thermal activity such as volcanism includes the bibliographic research of seamounts provinces which have associated thermal anomalies and seismic activity.

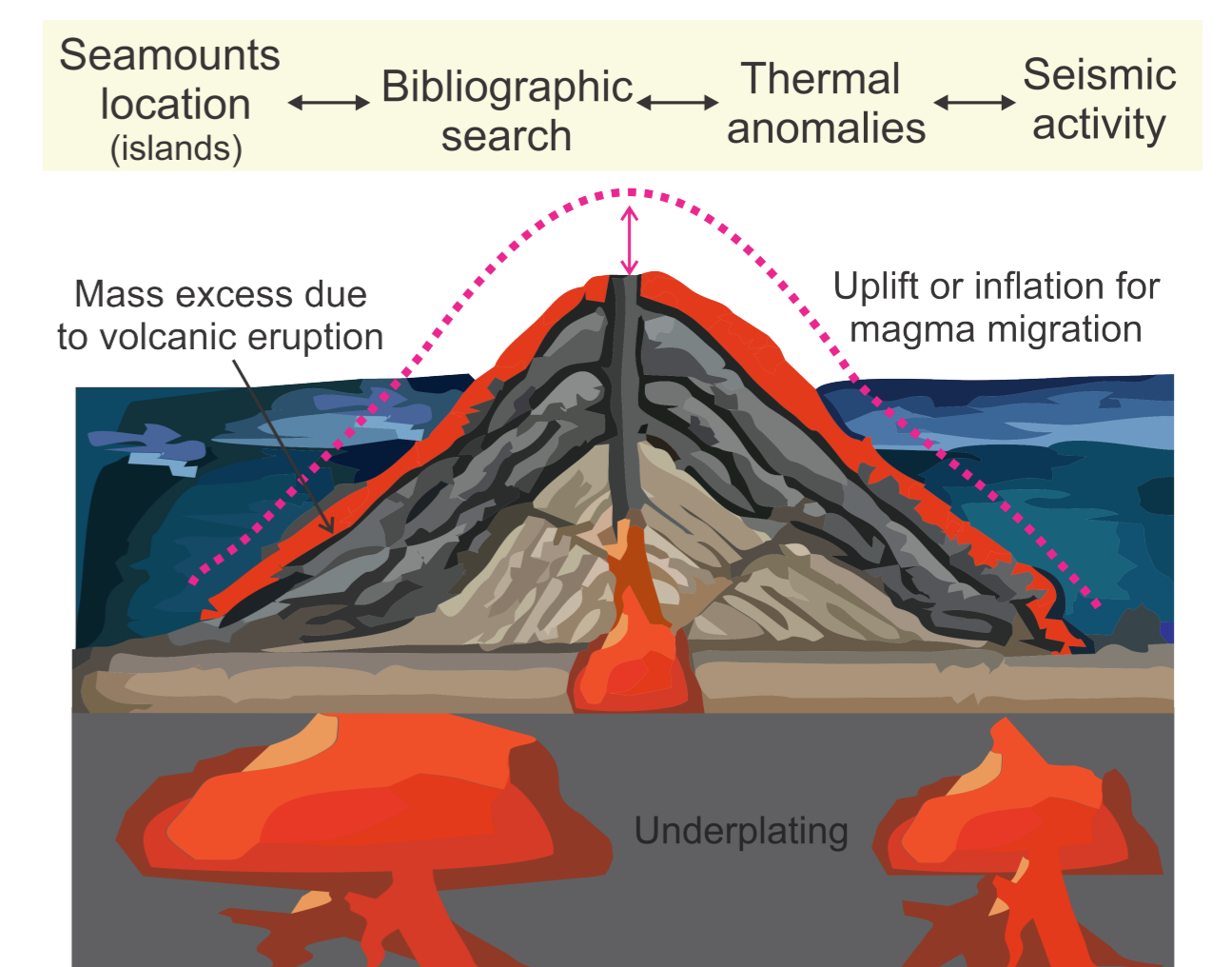


Figure 3: Volcanic process that could affect the temporal gravity signature.

### Preliminary advances in the Intra-Americas seas

#### Step 1: Target zones for Intra-Americas sea

Although our objective is to explore the methodology worldwide, we are in the process of test it in the Intra-Americas sea. Figure 4 shows a preliminary diagnostic of target zones in this complex region.

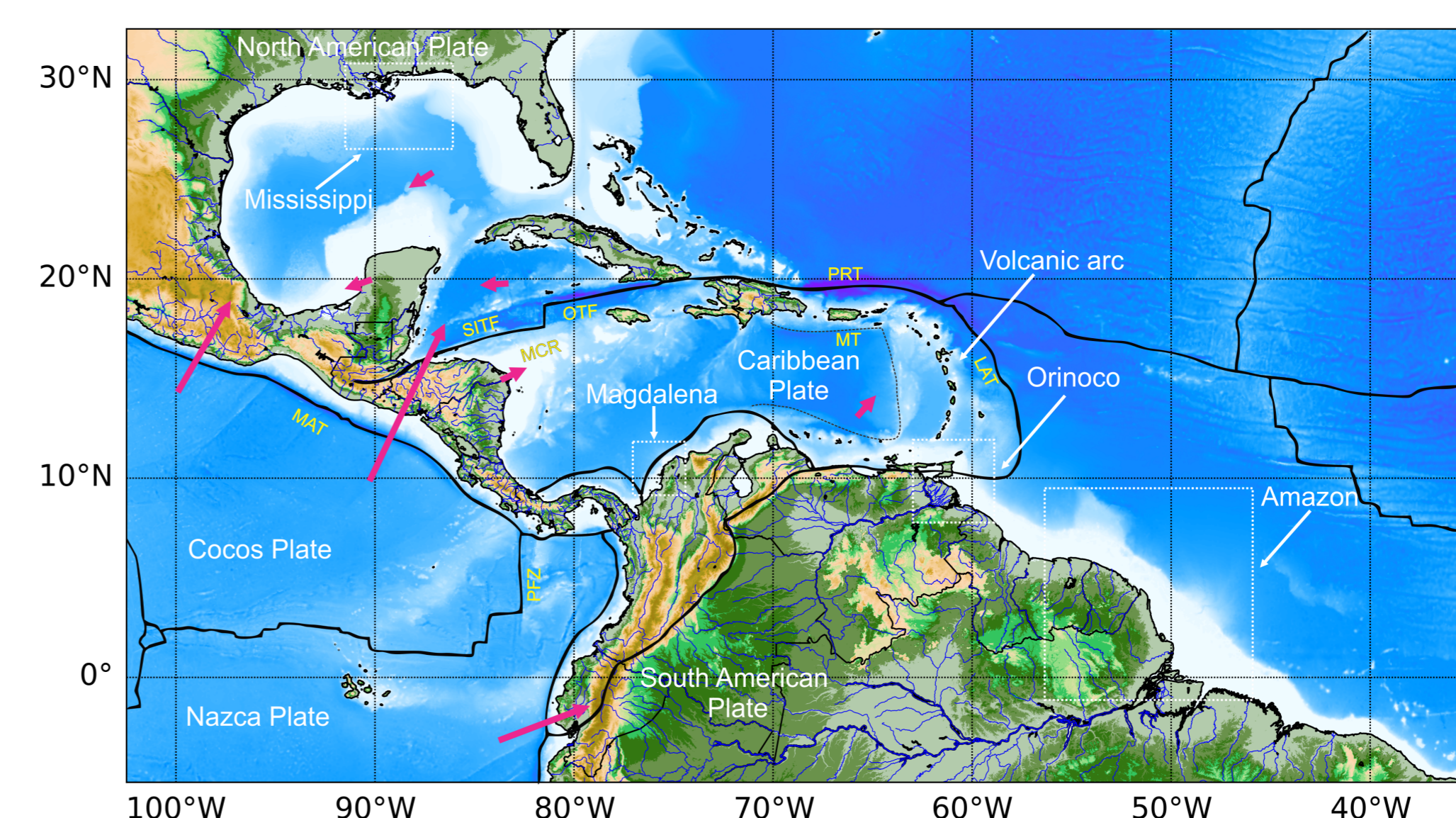


Figure 4: Preliminary characterization of variable mass zones in the Intra-Americas seas. Etopo1 Global Relief Model. LAT: Lesser Antilles Trench; MAT: Middle America Trench; MCR: Mid-Cayman Rise; MT: Muertos Trough; OTF: Oriente Transform Fault; PFZ: Panamá Fracture Zone; PRT: Puerto Rico Trench; SITF: Swan Island Transform Fault<sup>[1]</sup>.

#### Step 2: Exploring GOCE03s monthly data

Figure 5 shows one month of vertical gravity gradients of GOCE03s data filtered by flags ≤ 2.

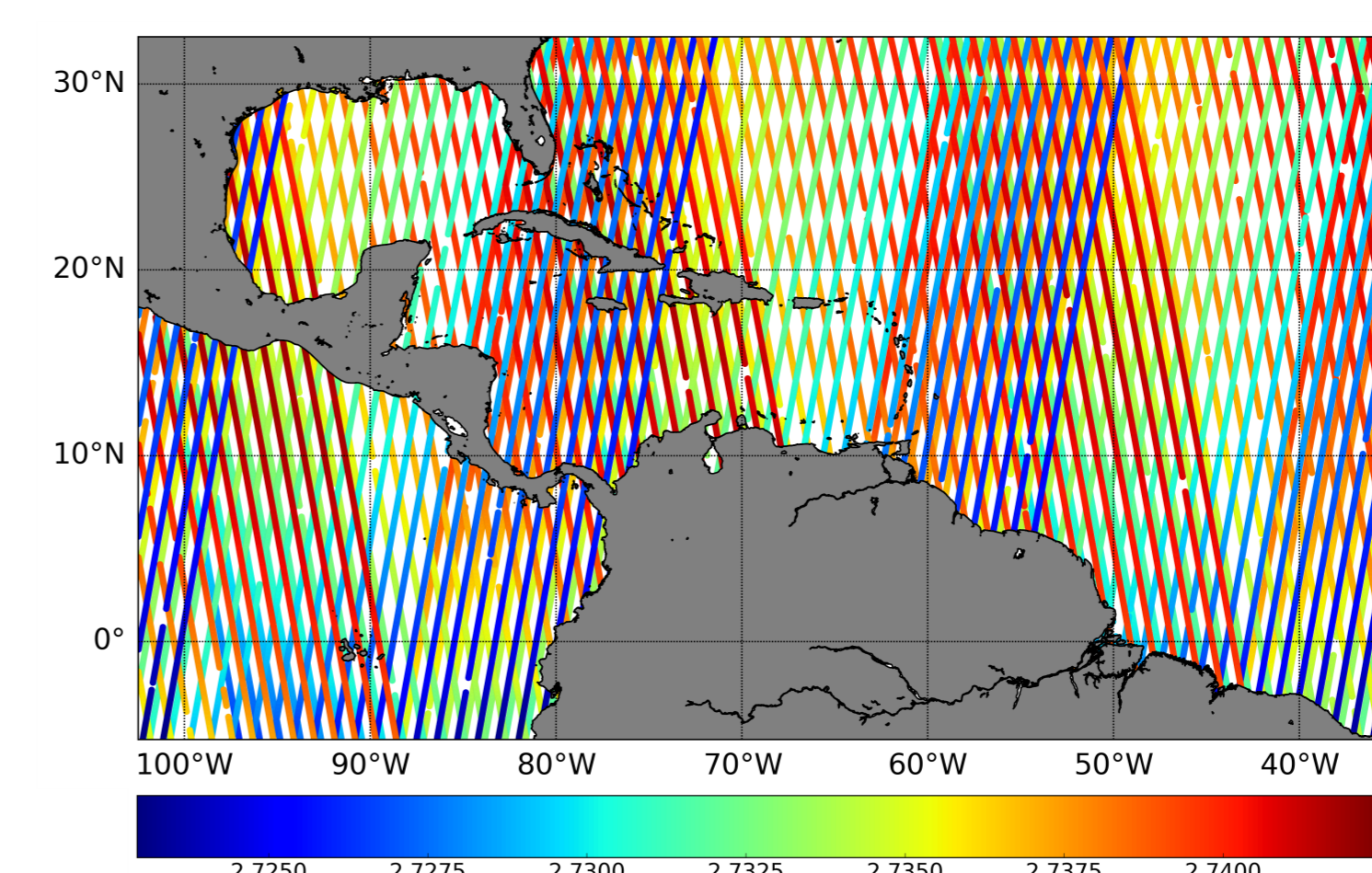


Figure 5: One month of GOCE03s vertical gravity gradients (T<sub>zz</sub>) in the study zone filtered by flags ≤ 2. It is evident the band pattern along-track.

### Forthcoming Research

The study of time variable gravity gradients in the ocean is a great opportunity to test the sensibility and the limitations of GOCE and future satellite missions. Despite our work is ongoing, we want to explore this methodology in other regions around the world.

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