Offsets between tide gauges in South America estimated from
the filtered satellite-only mean dynamic topography

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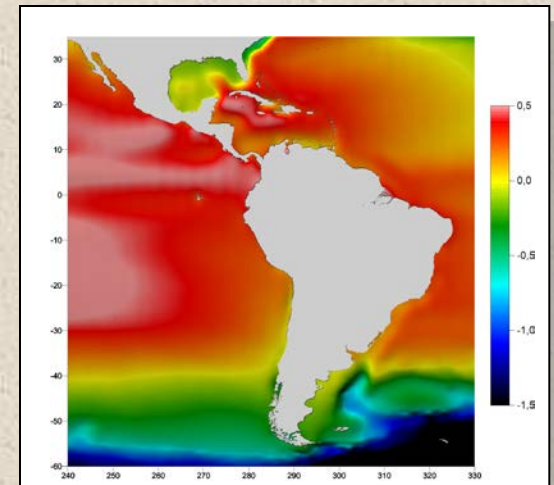
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Outline

- **<u>Motivation</u>**

  - geodetic approach to model the satellite-only MDT

- **<u>Nonlinear diffusion filtering on closed surfaces</u>**

  - regularized surface Perona-Malik model

- **<u>Nonlinear filtering of the satellite-only MDT</u>**

  - combination of *DTU13_MSS* and *GO_CONS_GCF_2_DIR_R5*
  - special treatment to prolong information towards continents

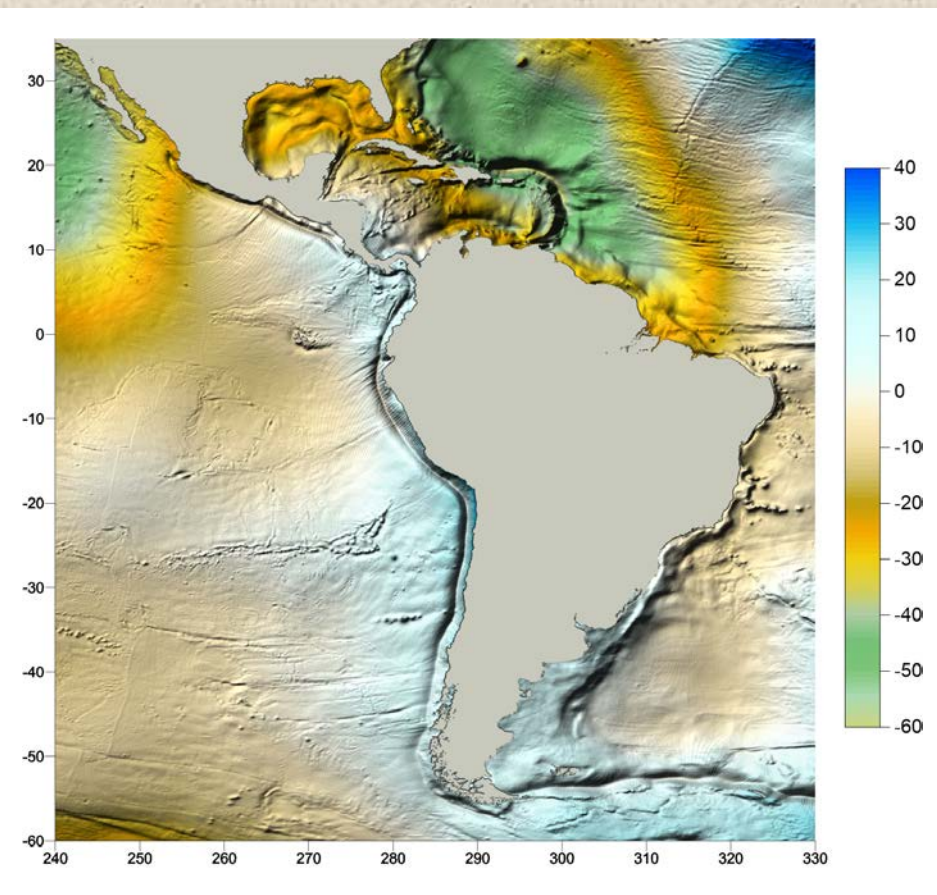- **<u>Interpolated values along coastlines or at tide gauges</u>**

  - in South America
  - detail in area of Caribbean Sea

- **<u>Conclusions</u>**

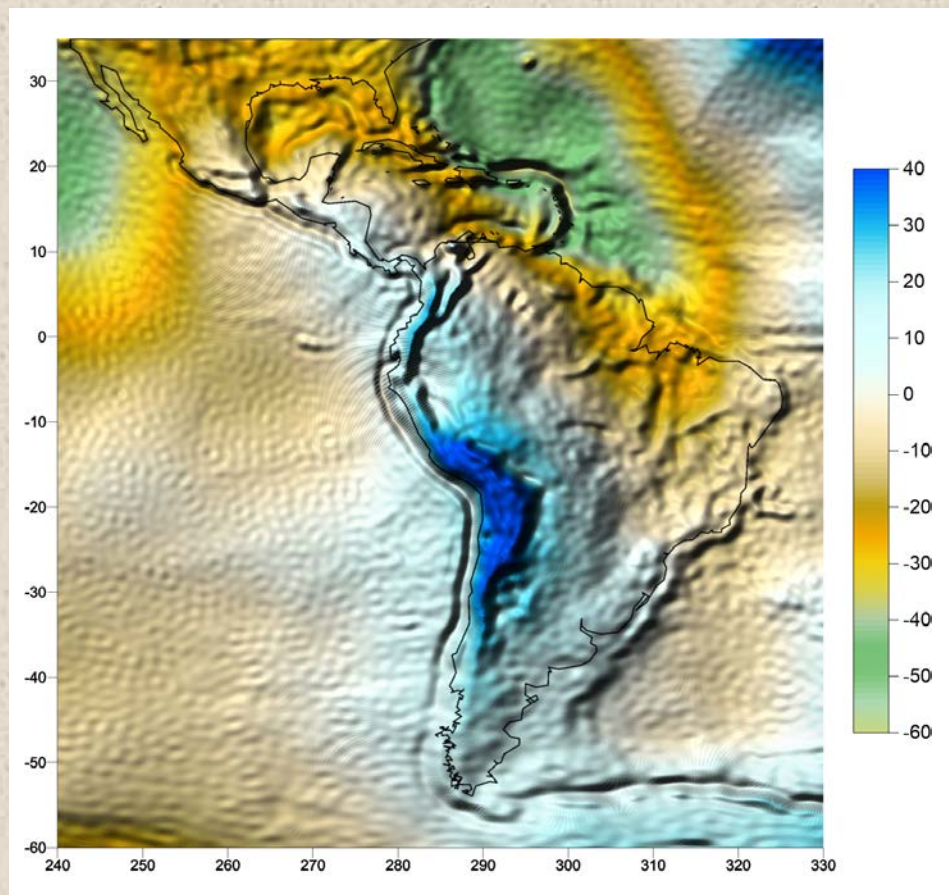# Combination of altimetry and gravity field

Satellite altimetry:

DTU13_MSS

Satellite-only geopotential models:
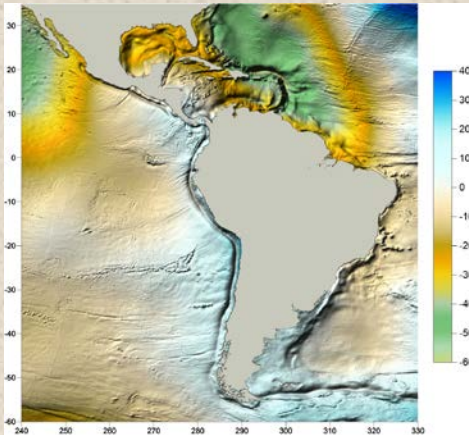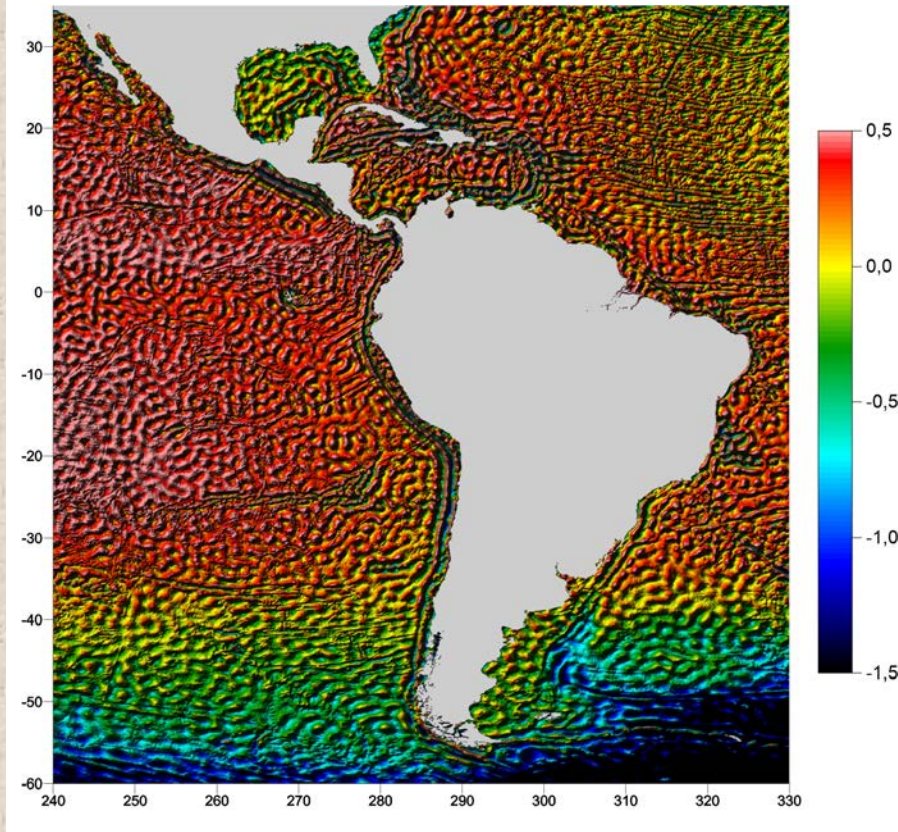
GO_CONS_GCF_2_DIR_R5 *(SH up to d/o 300)*
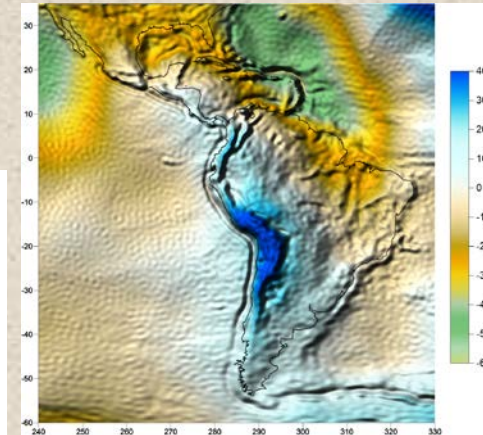
Satellite-only MDT in South America

Satellite-only MDT

$$h^{MDT} = h^{MSS} - N^{GGM}$$

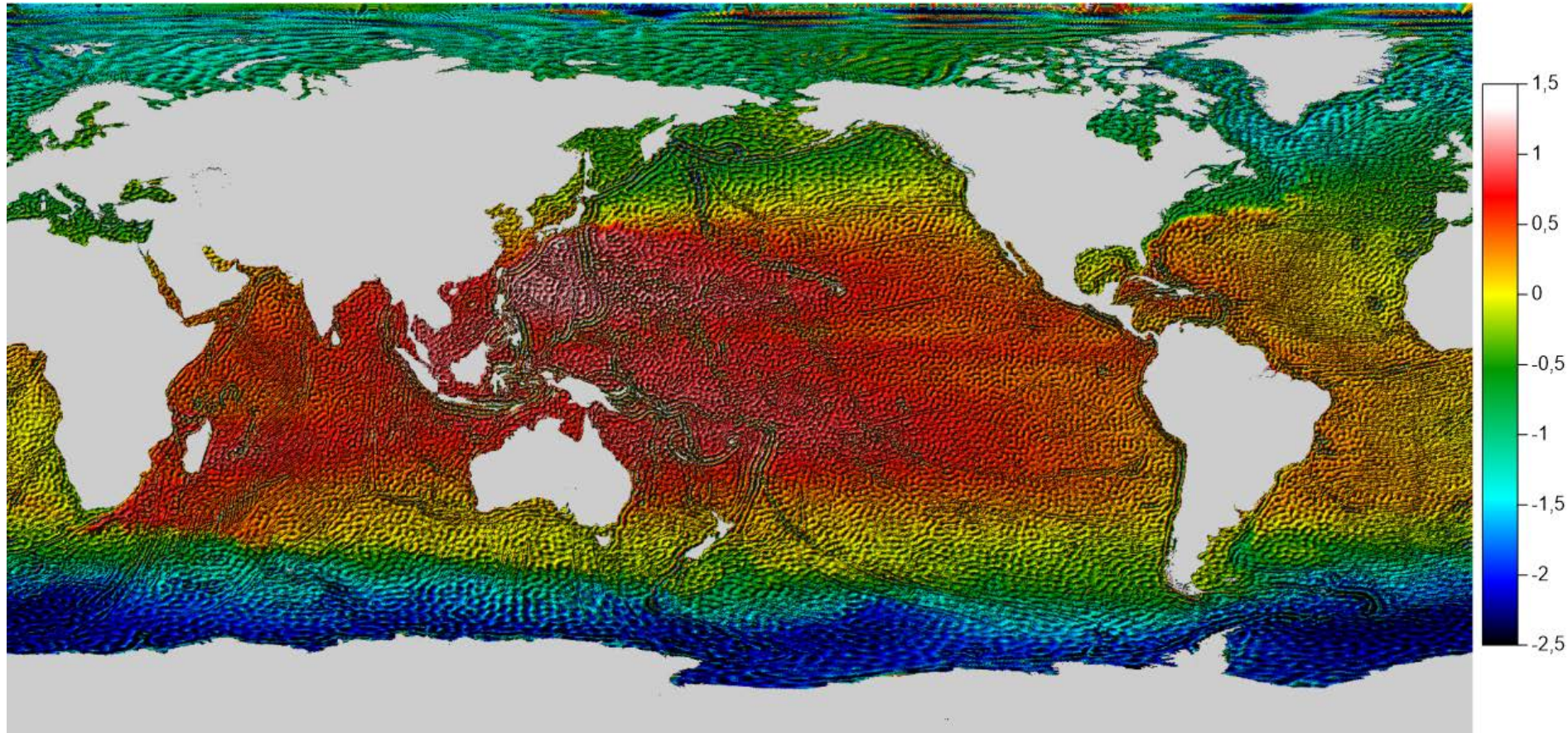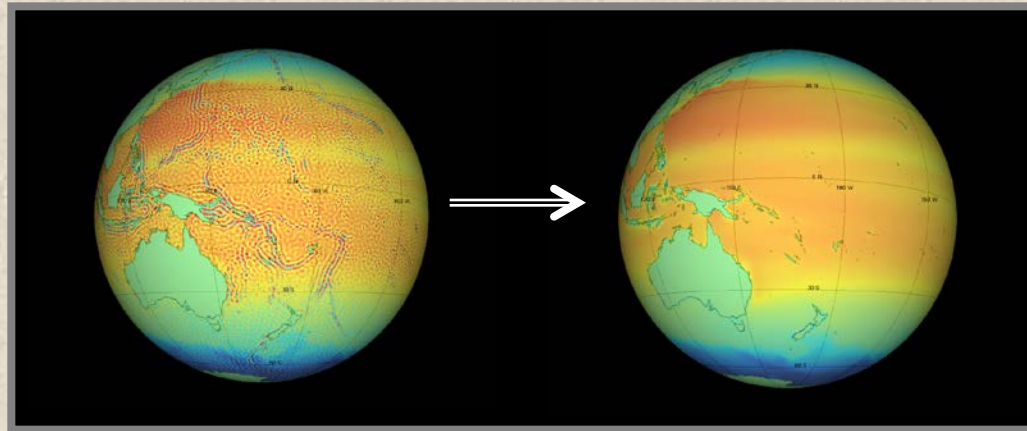# *Satellite-only MDT*

DTU13_MSS - GOCE_DIR5
(SH up to 300)

Nonlinear diffusion filtering on a closed surface

Linear heat equation on a (closed) surface:

$$\frac{\partial u(X,t)}{\partial t} = \Delta_S u(X,t)$$

$$\frac{\partial u}{\partial t} = \nabla_S.(\nabla_S u)$$

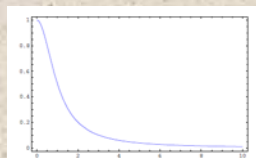Δ_S *- the Laplace-Beltrami operator*

Regularized surface PM model   *- nonlinear parabolic PDE*

$$\frac{\partial u}{\partial t} = \nabla_S \cdot (g(|\nabla_S u^{\sigma}|)\nabla_S u)$$

∇_S *- surface gradient*

Edge detector

$$g(\nu) = \frac{1}{1 + H\left|\nabla_S u^{\sigma}\right|^2}$$

More details: *Čunderlík R, Mikula K, Tunega M (2013) Nonlinear diffusion filtering of data on the Earth's surface. Journal of Geodesy, Vol. 87(2), pp. 143–160*
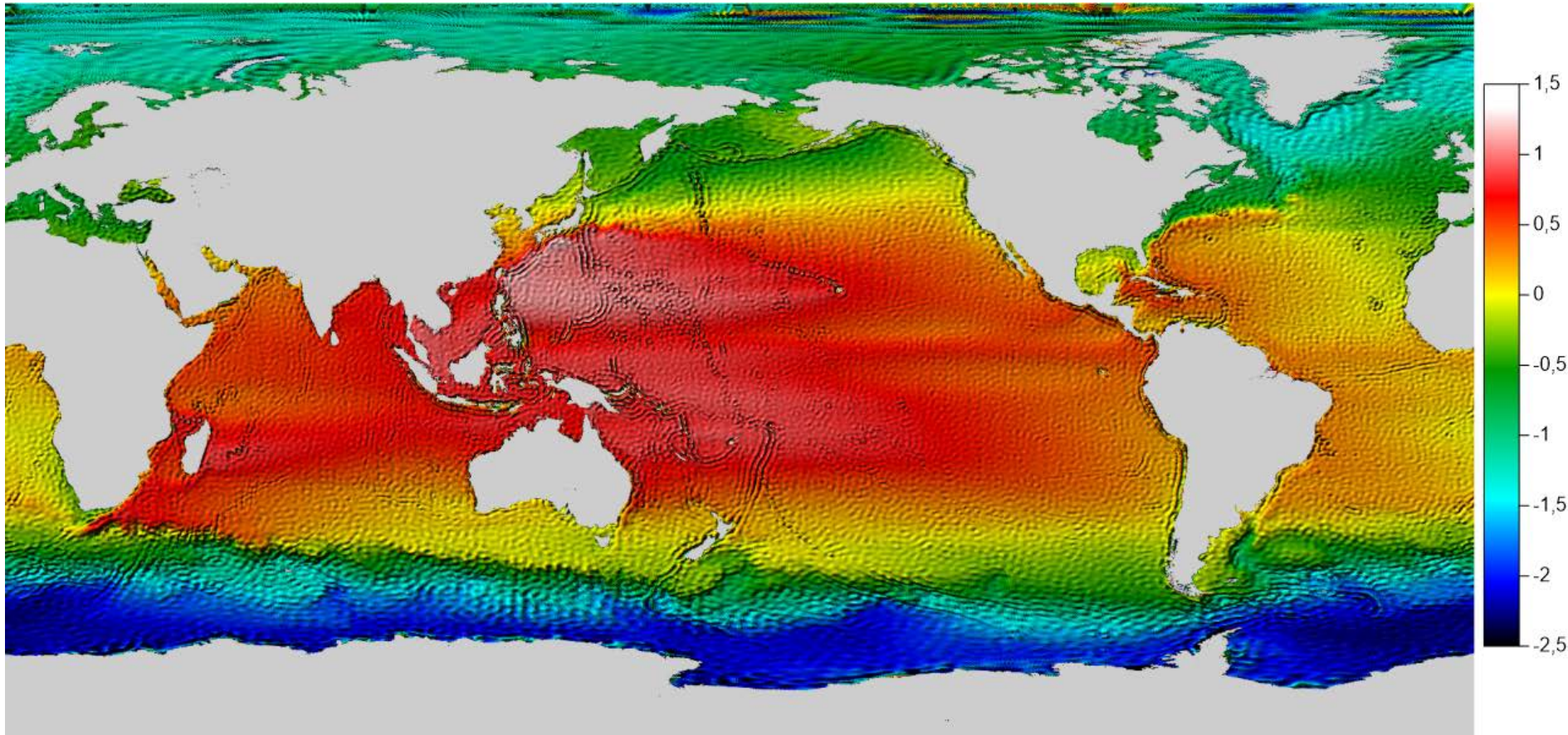
Satellite-only MDT

Initial data

Satellite-only MDT

2 iterations

Satellite-only MDT

4 iterations

18 – 20 November 2015, Santo Domingo, Dominican Rep.
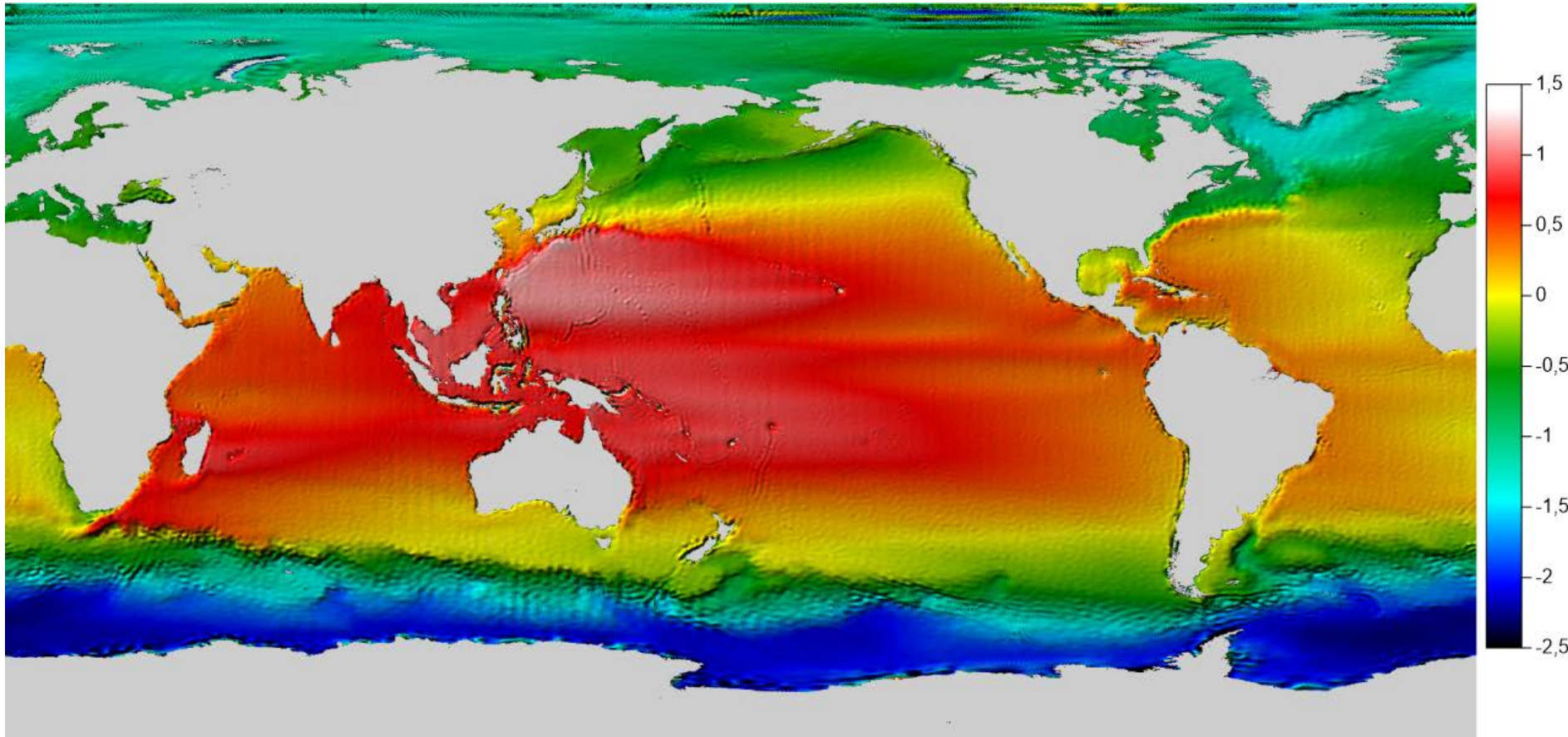
Satellite-only MDT

6 iterations
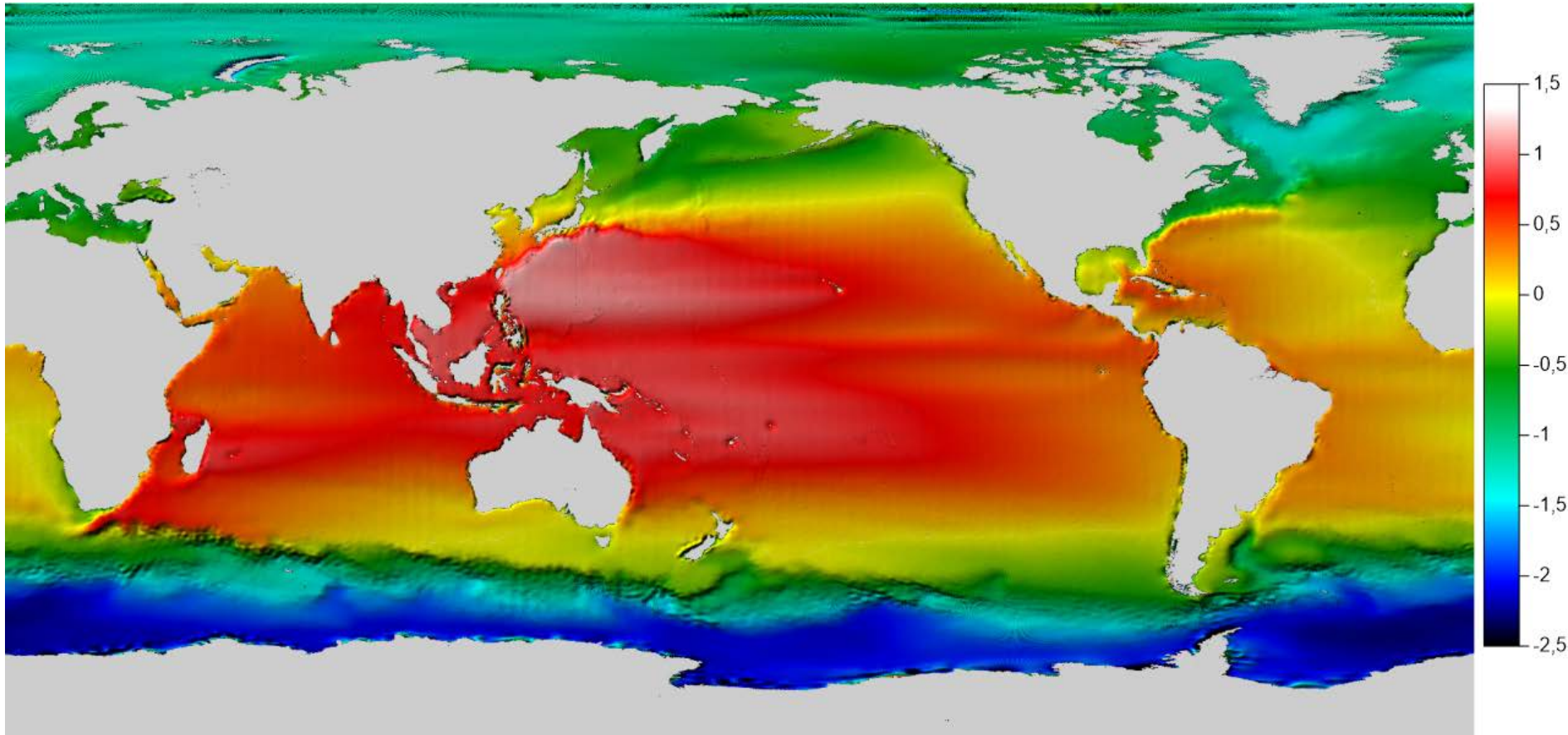
Satellite-only MDT
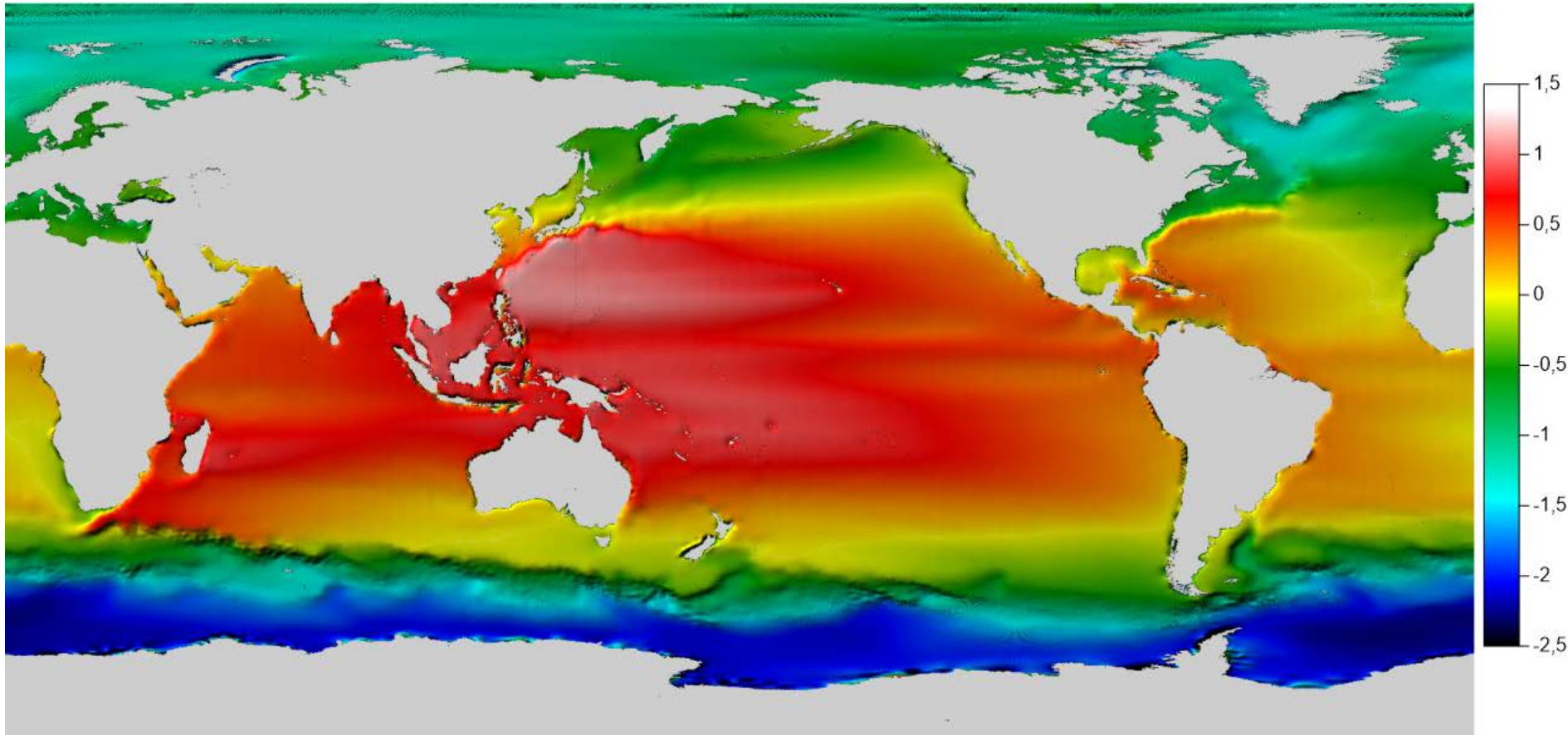
8 iterations

Satellite-only MDT
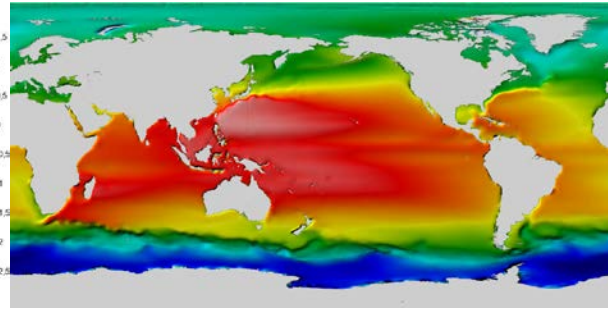
10 iterations
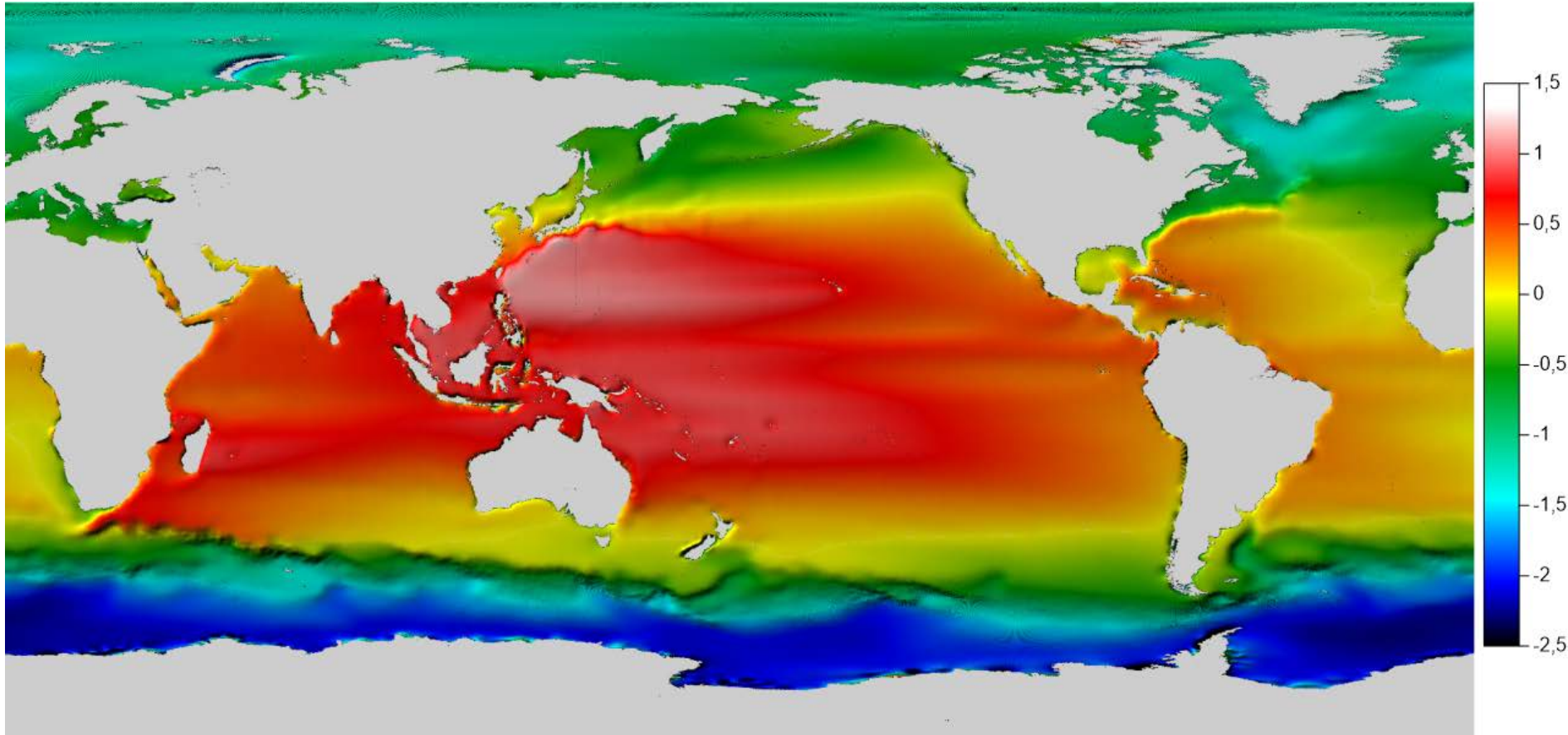
Satellite-only MDT

12 iterations
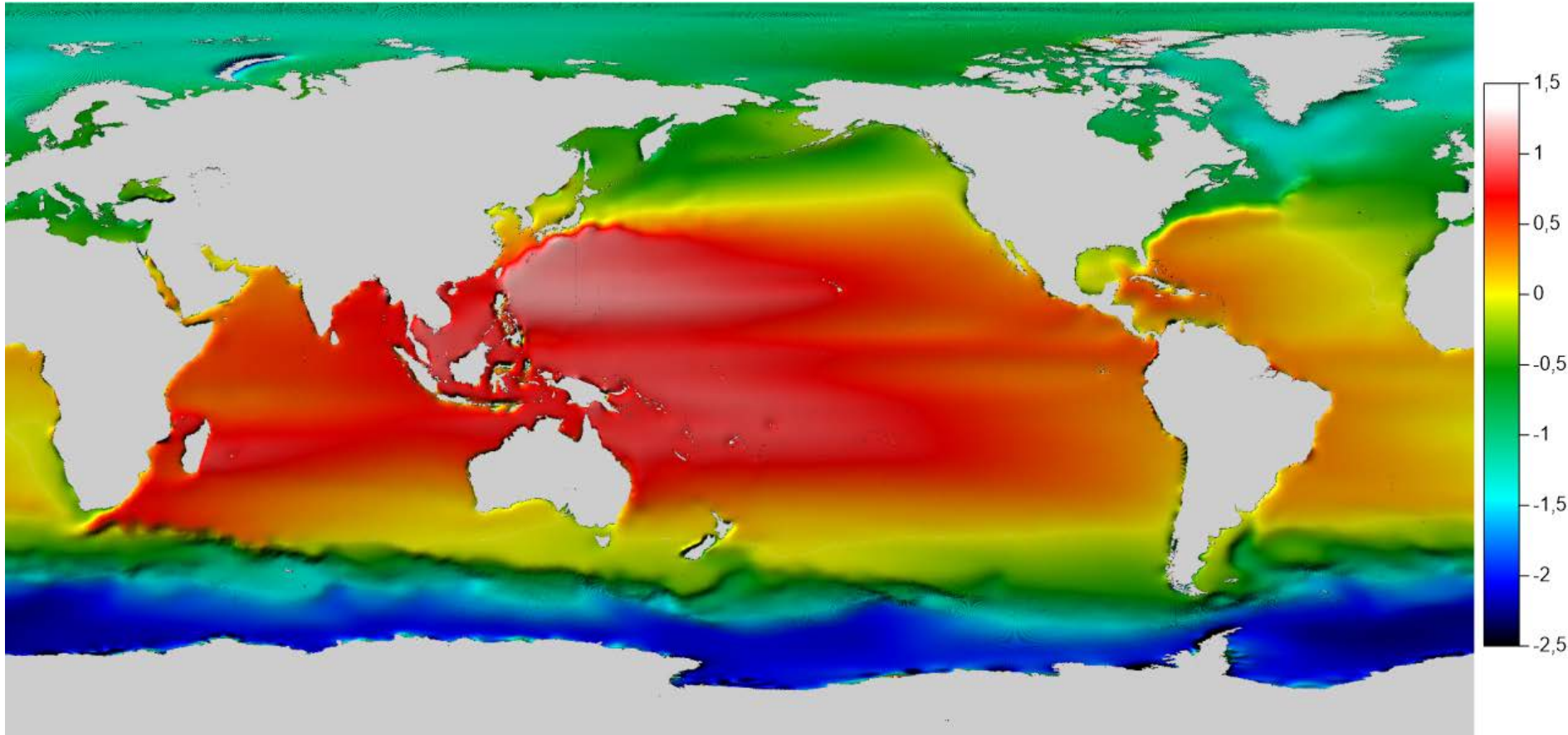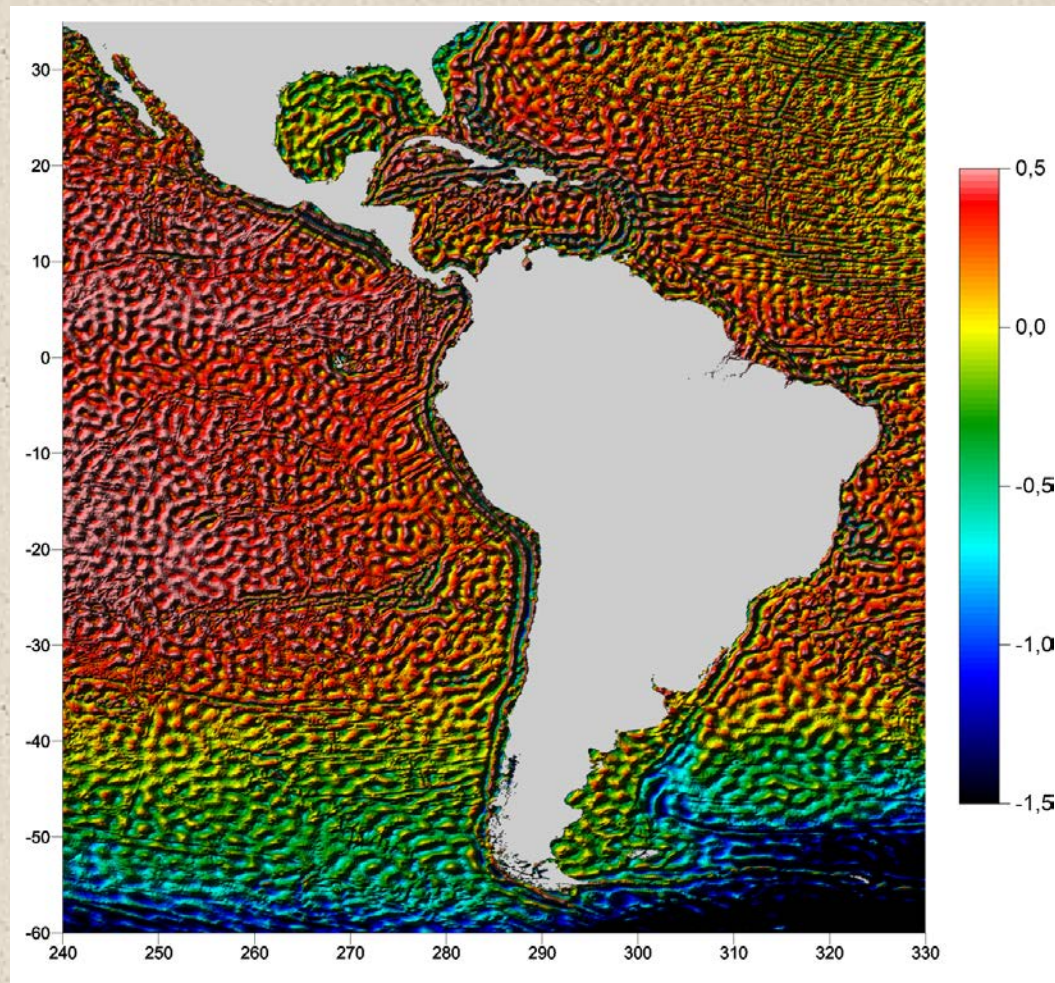
Stripping noise due to omission errors
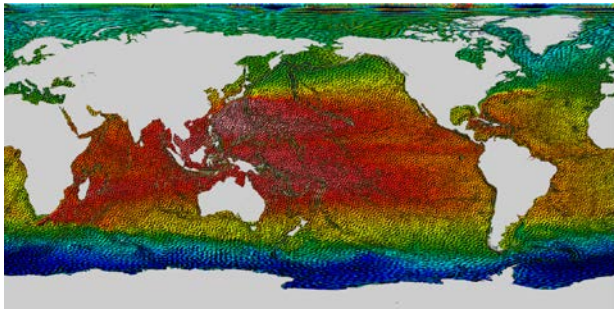
Statistics	TOTAL	Pacific
Mean [m²s⁻²]	0.019	-0.004
STD [m²s⁻²]	2.687	1.201

18 – 20 November 2015, Santo Domingo, Dominican Rep.
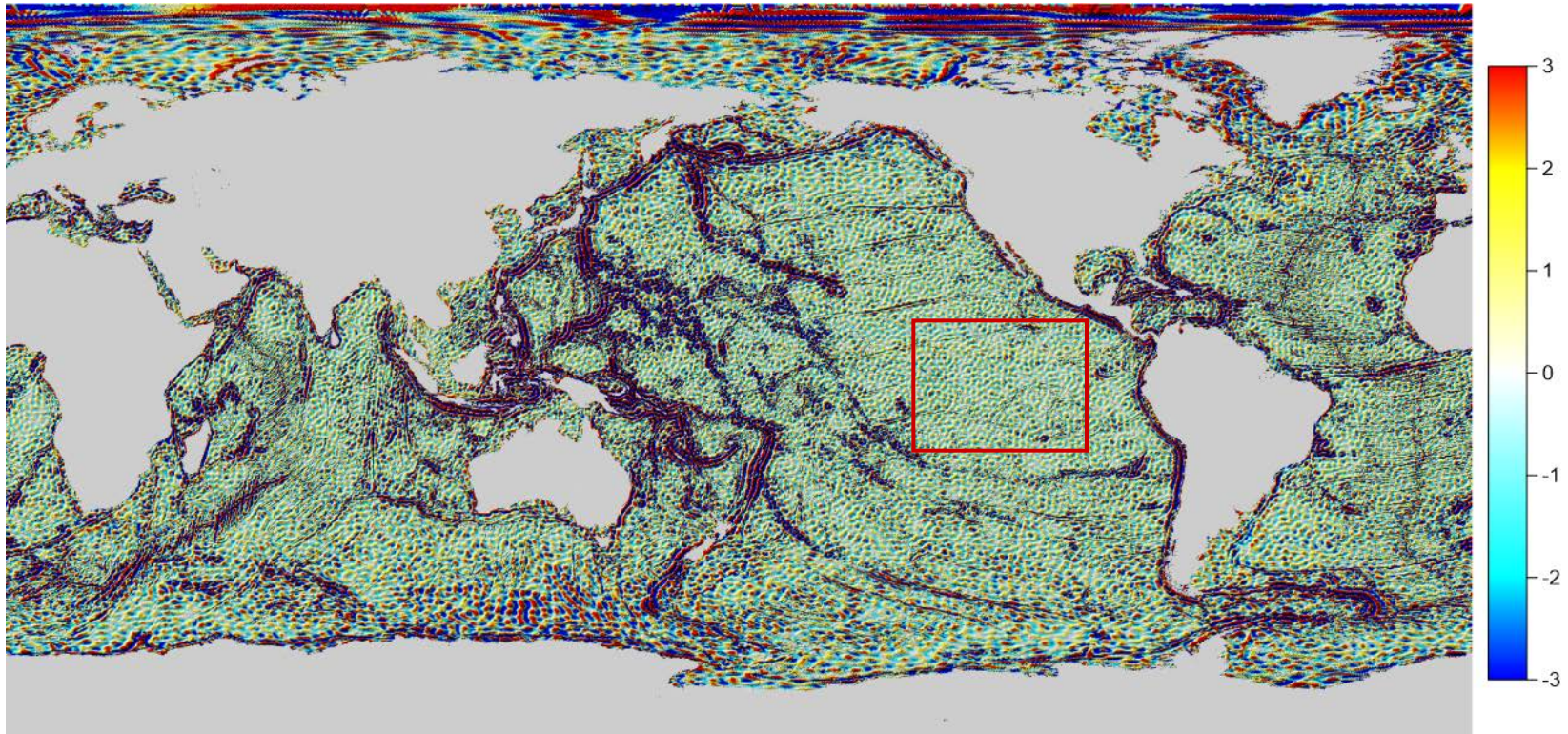
How to prolong MDT towards to lands?

Satellite-only MDT

How to prolong MDT towards to lands?

Nearest neighbor (NN)   *(using GS Surfer ®)*

How to prolong MDT towards to lands?
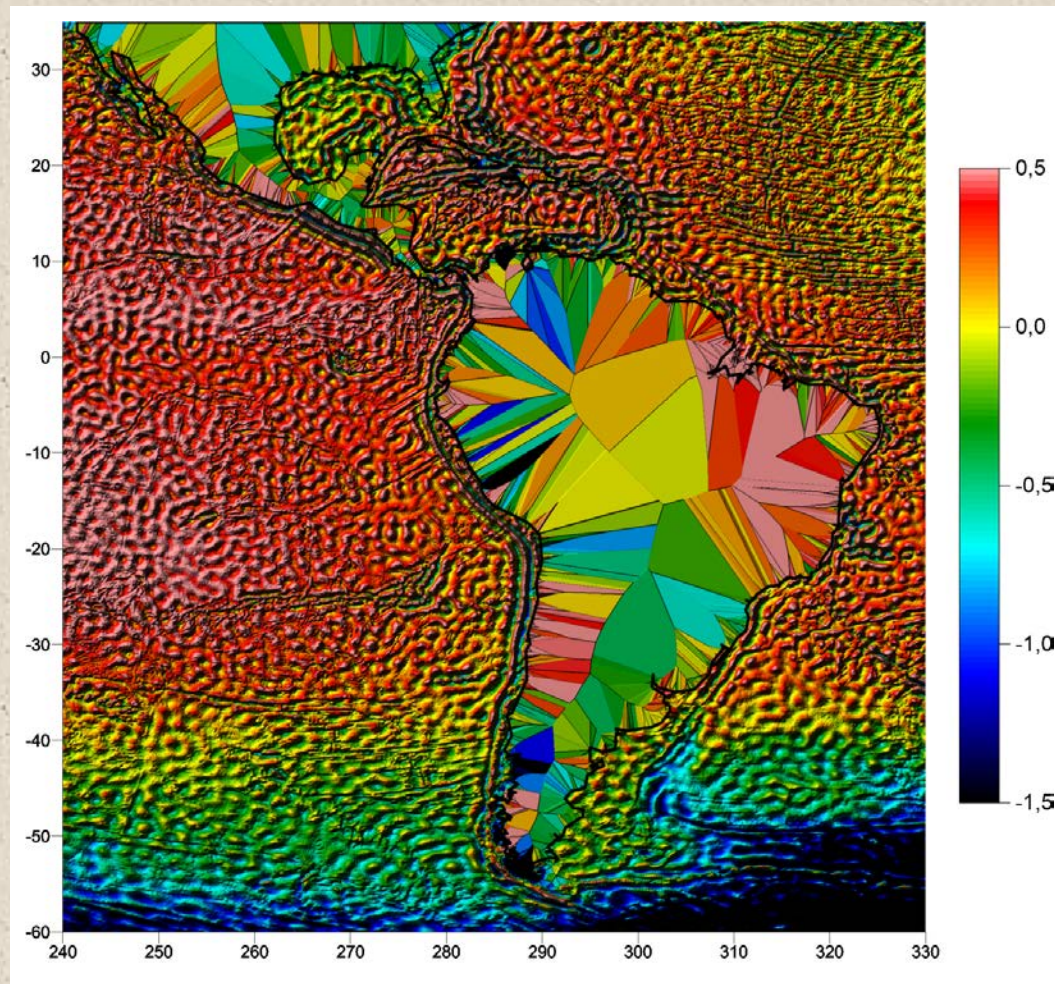
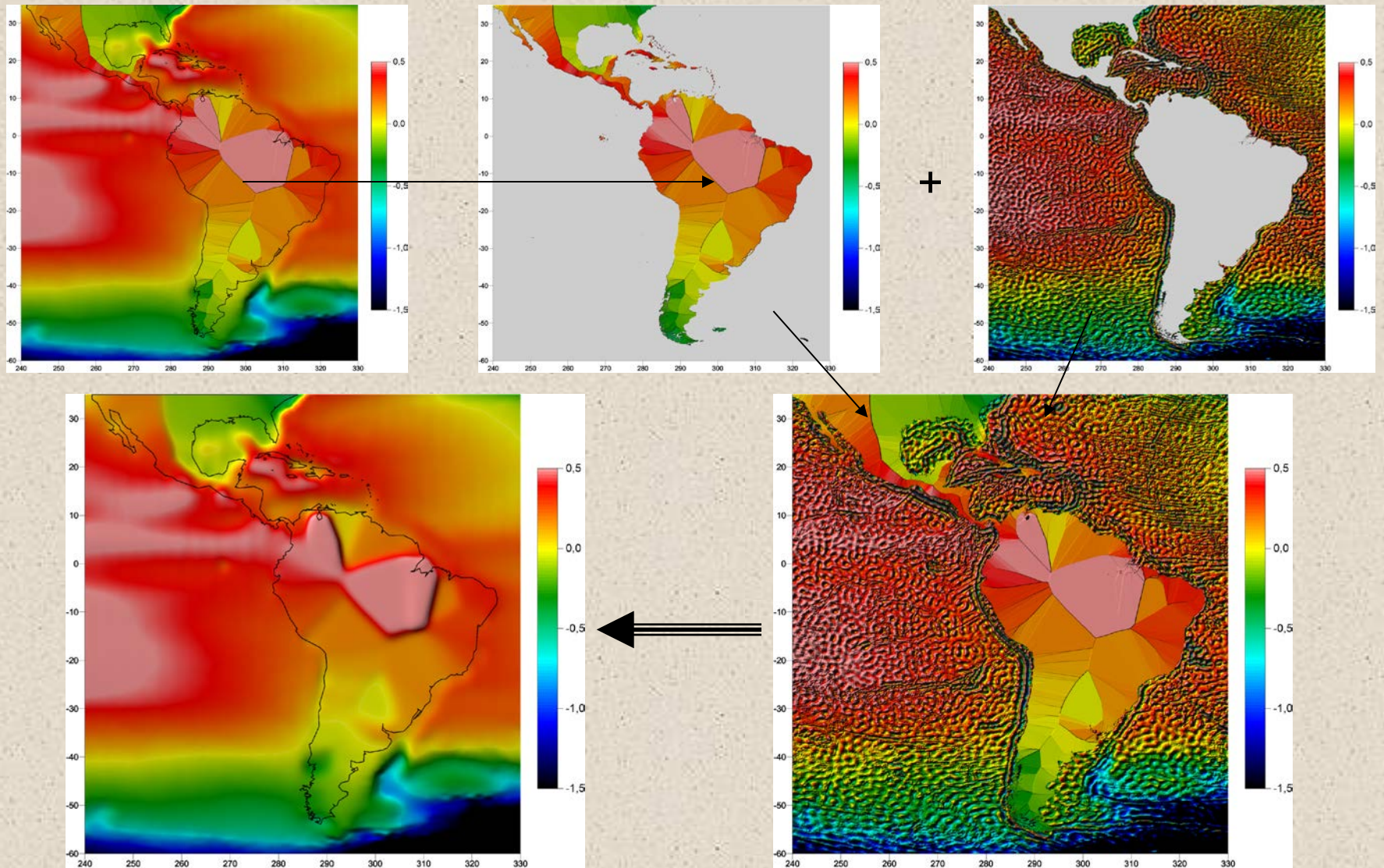# How to prolong MDT towards to lands?

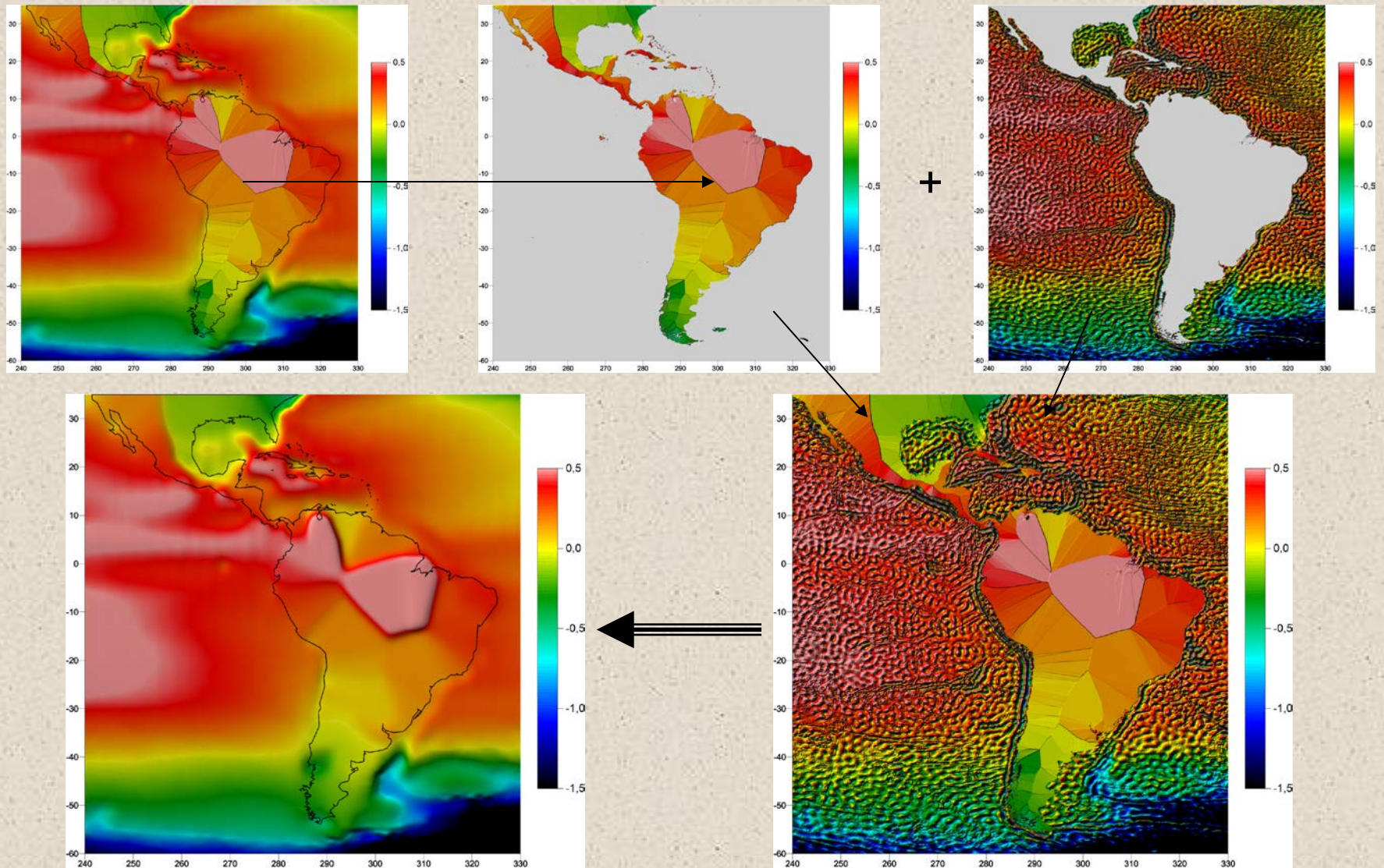**Local mean values + NN** *(using GS Surfer ®)*
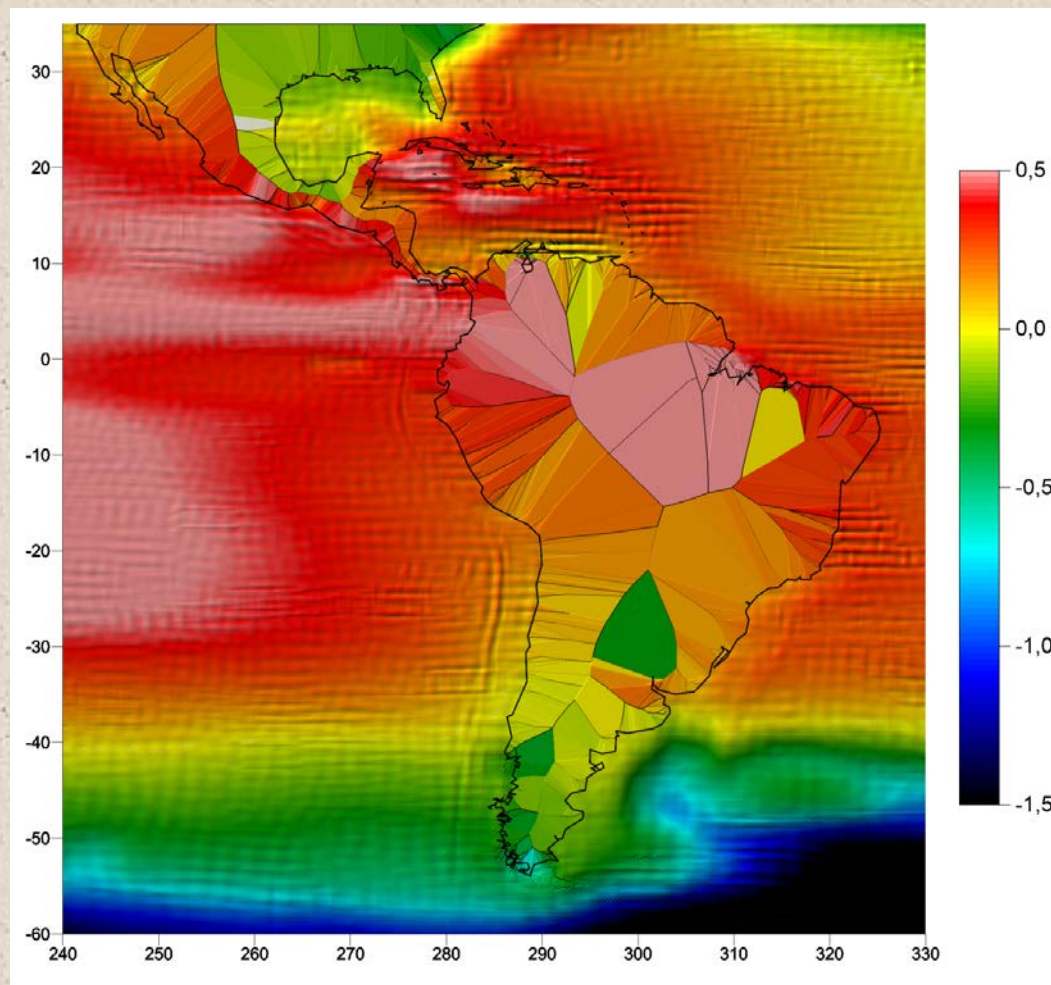
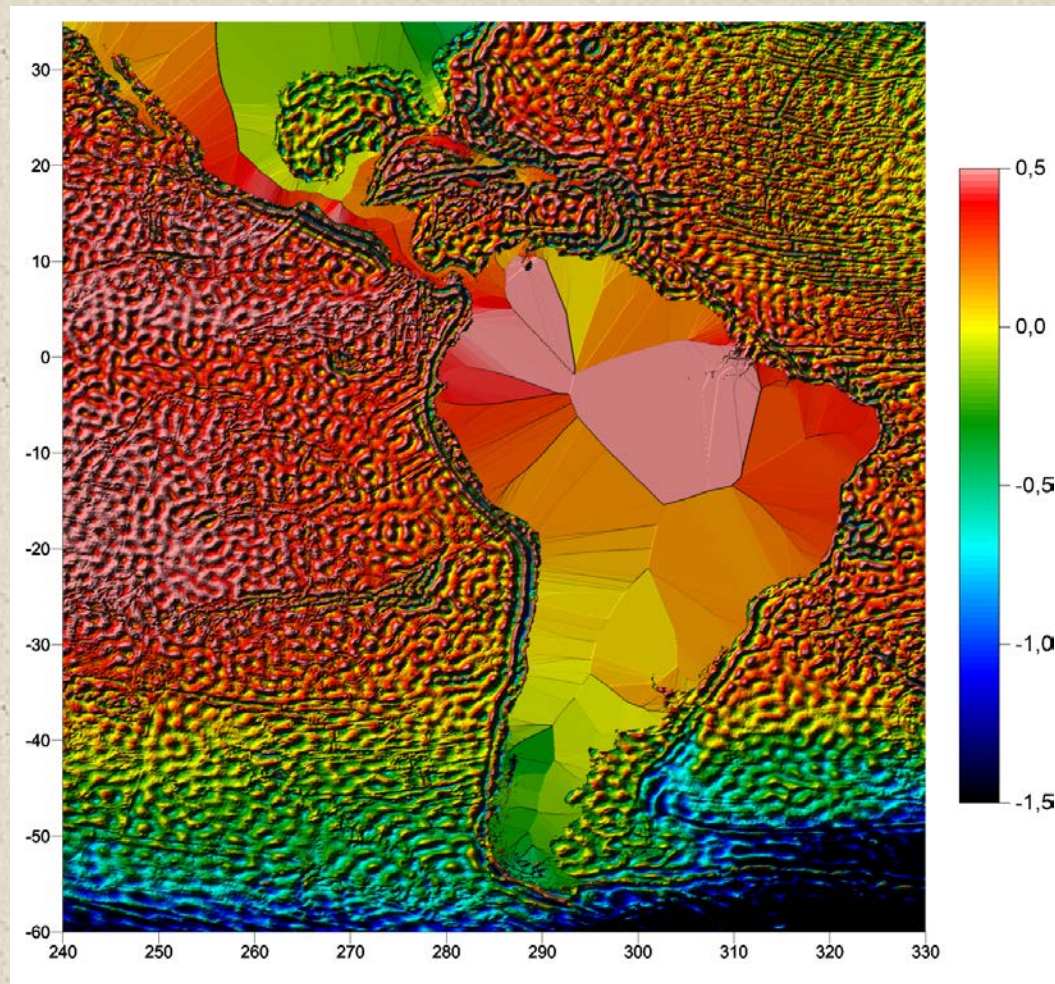# 1st pre-filtering
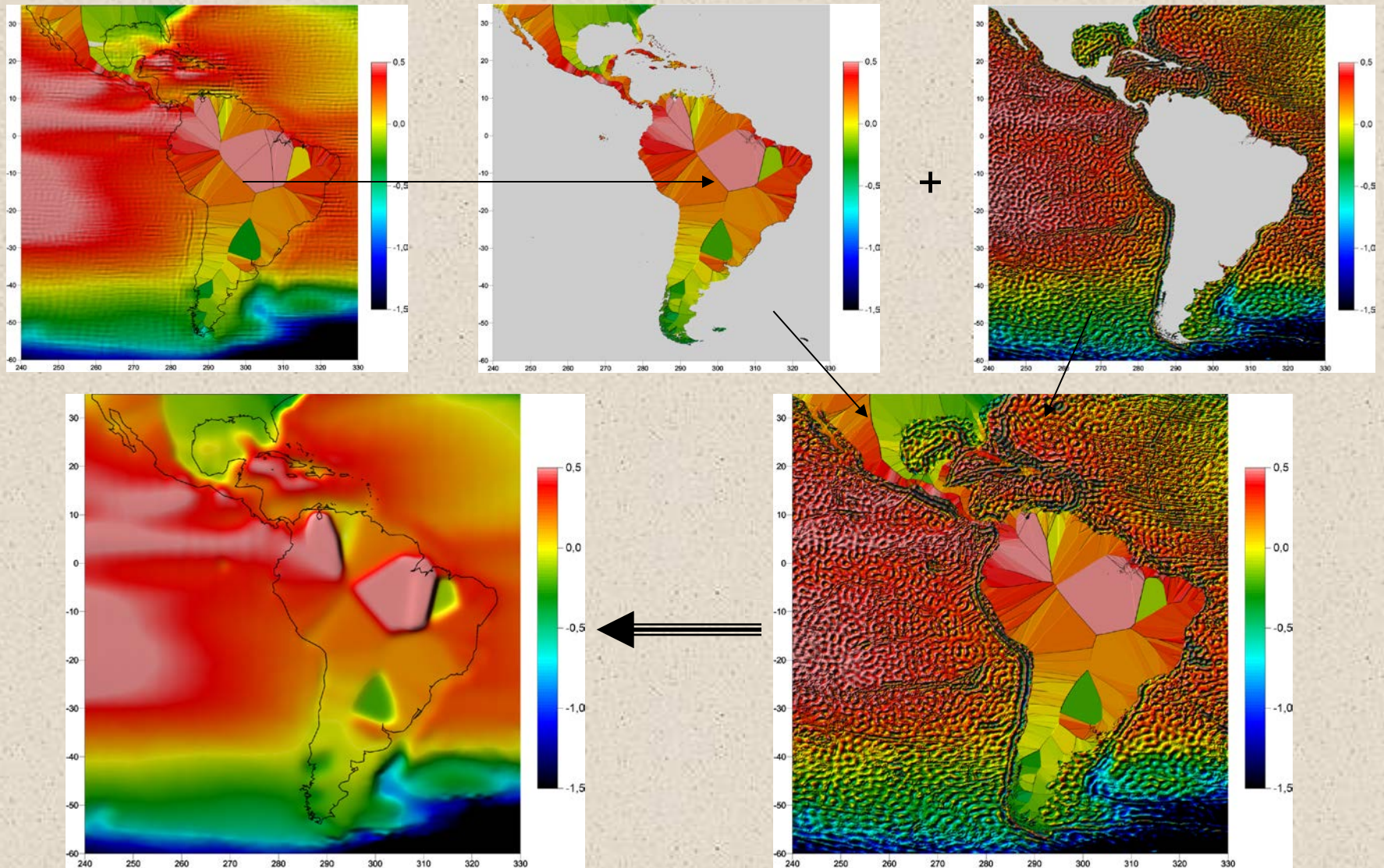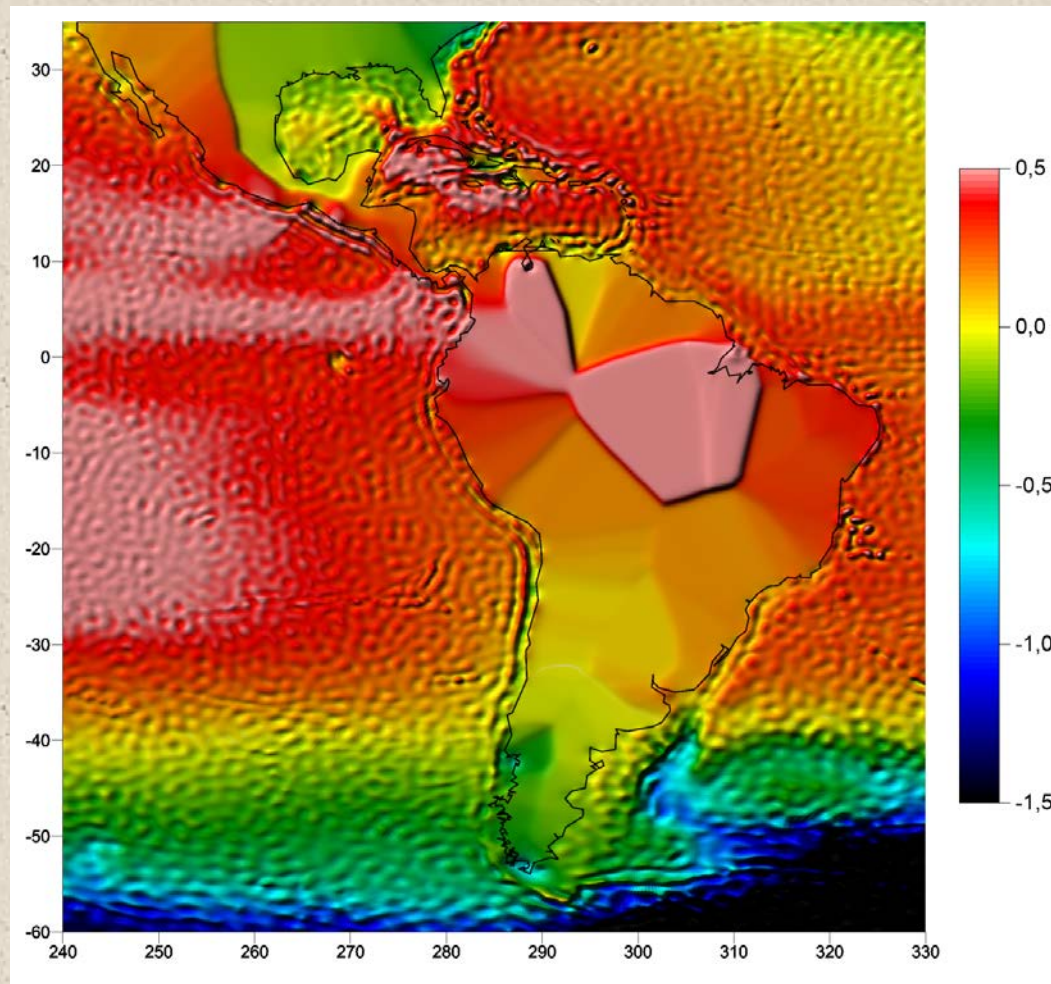
2nd pre-filtering

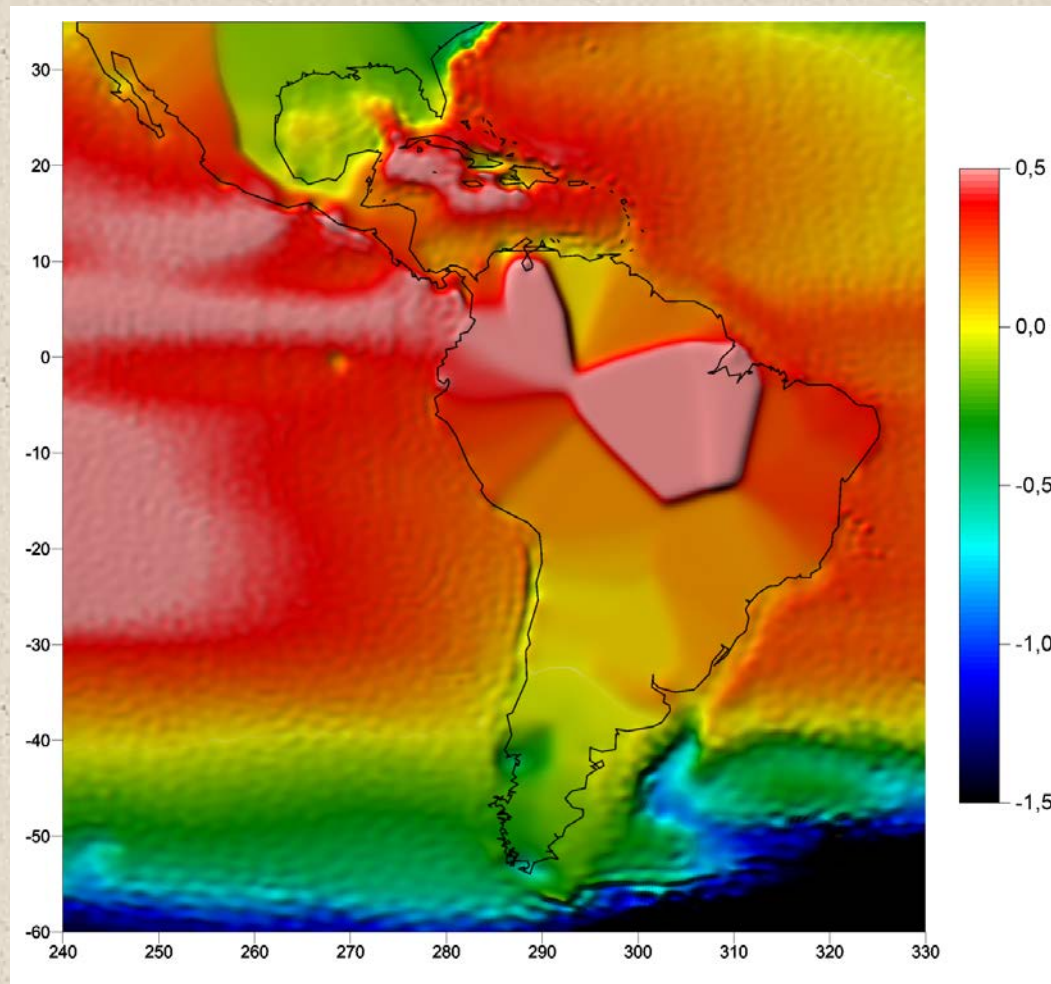# 3rd (final) filtering

Final filtering
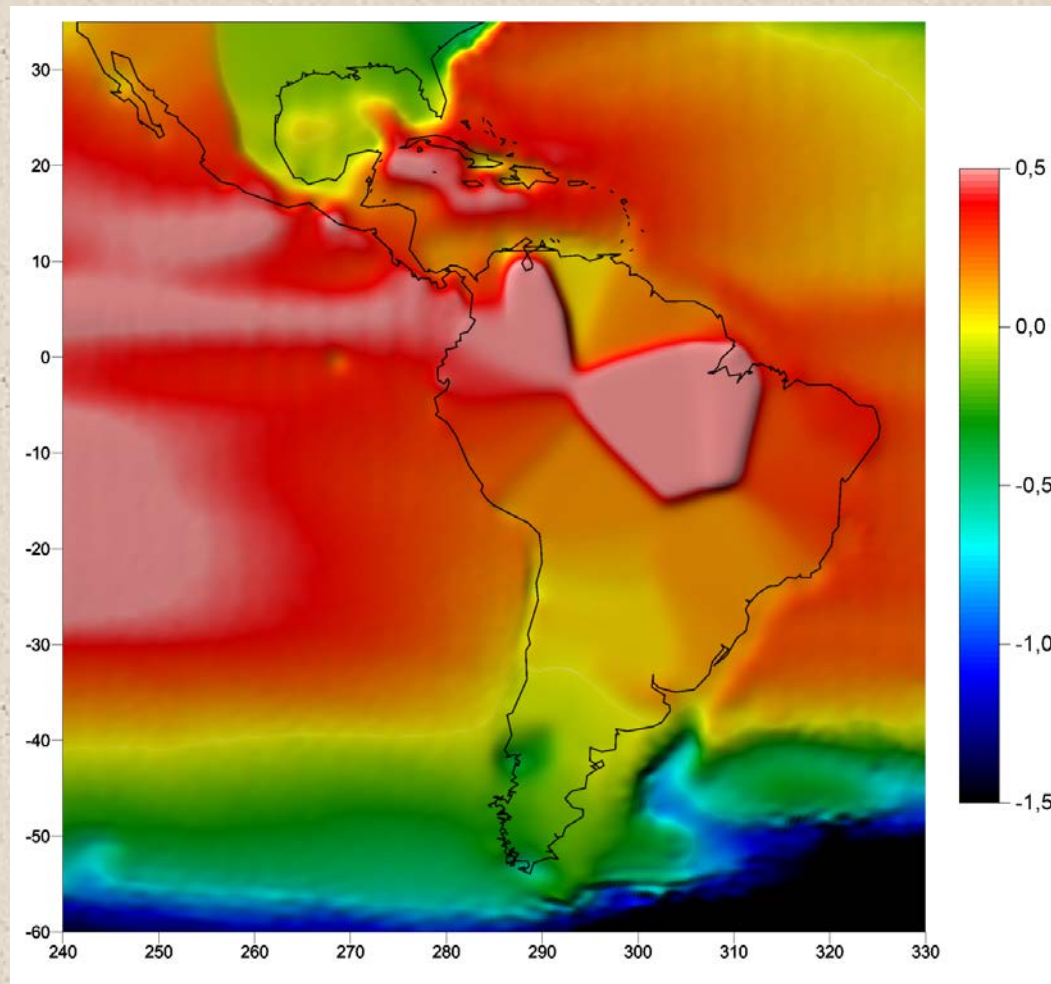
Initial data

Final filtering

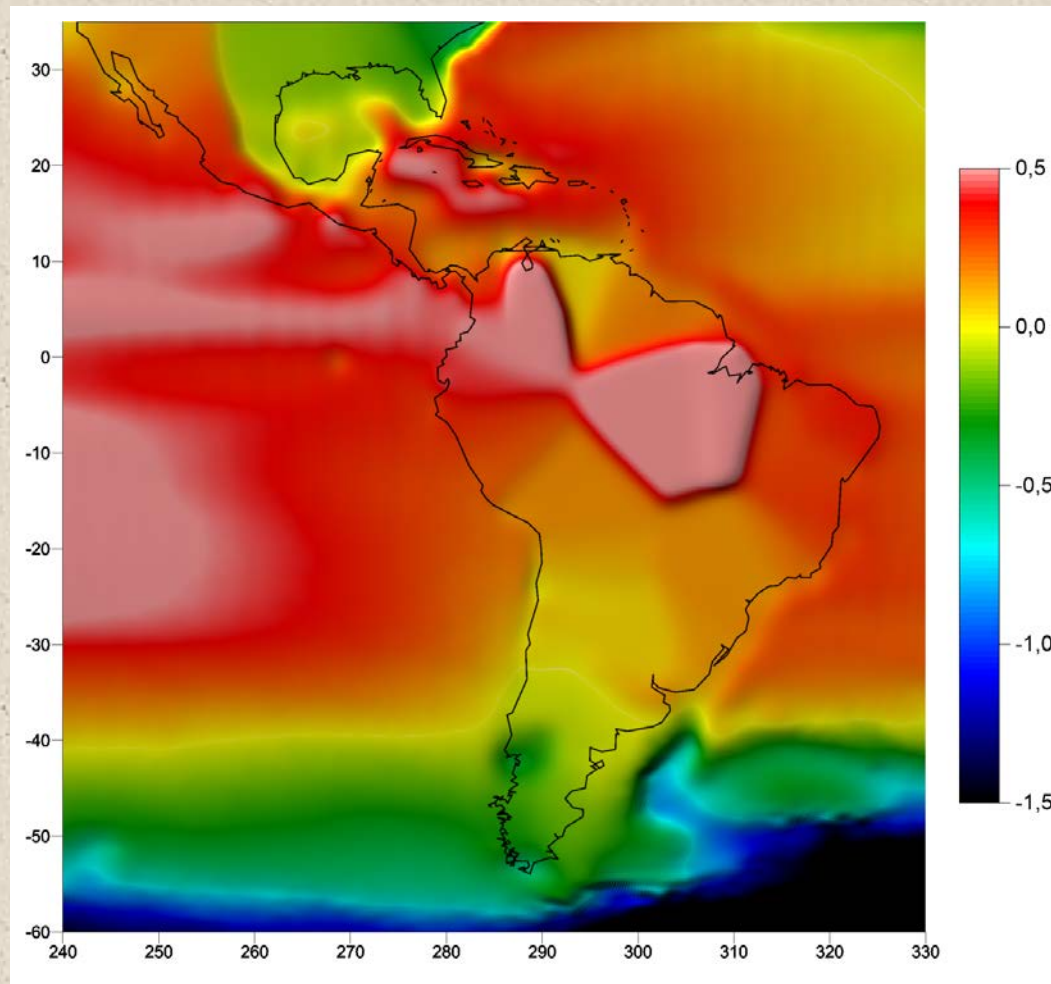## 2 iterations

Final filtering

4 iterations

18 – 20 November 2015, Santo Domingo, Dominican Rep.

Final filtering
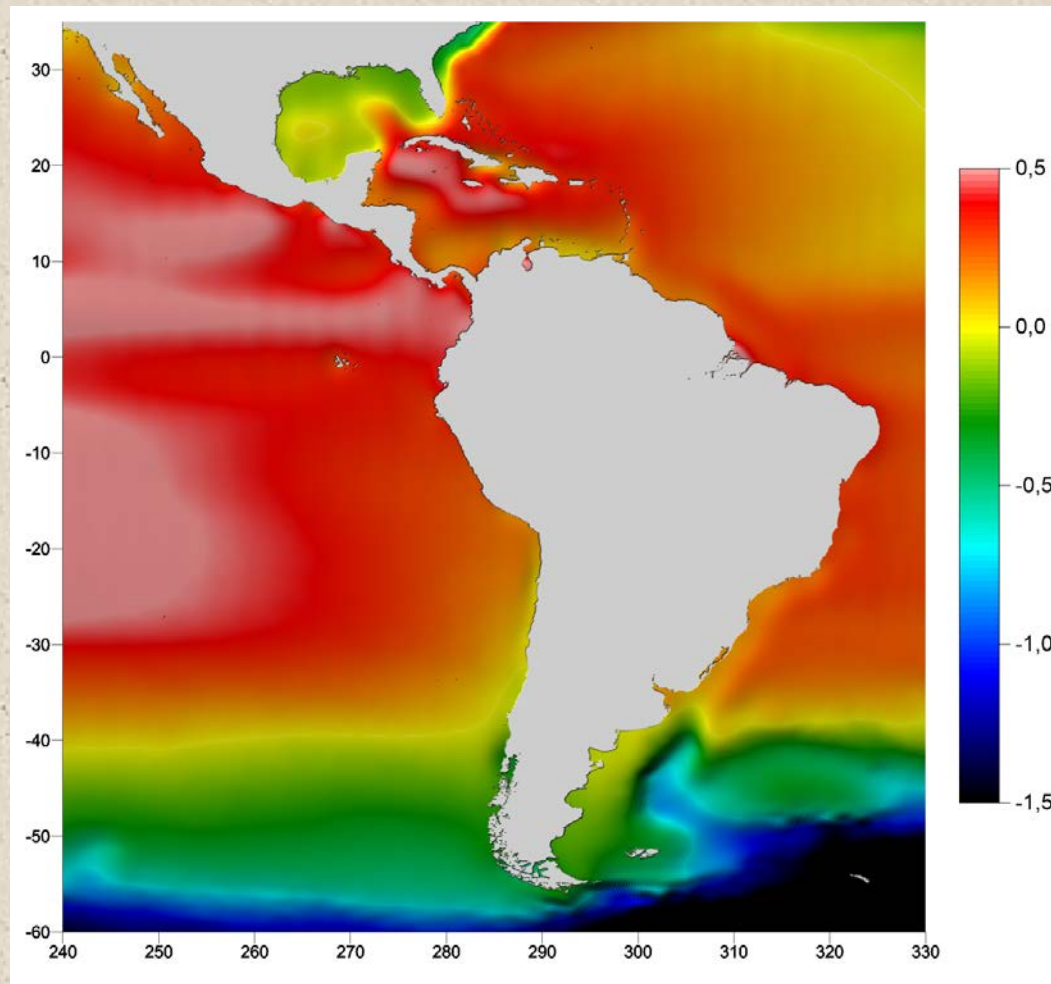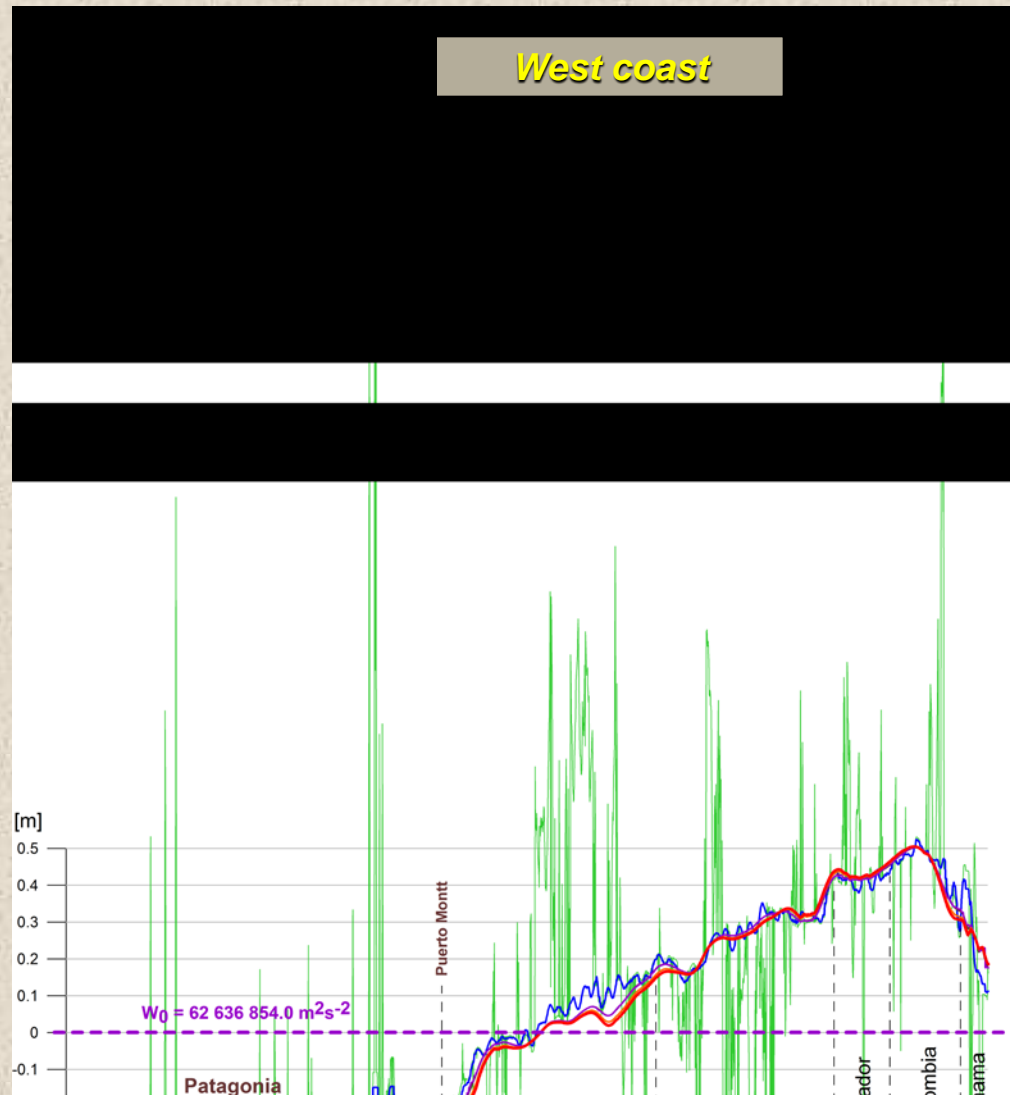
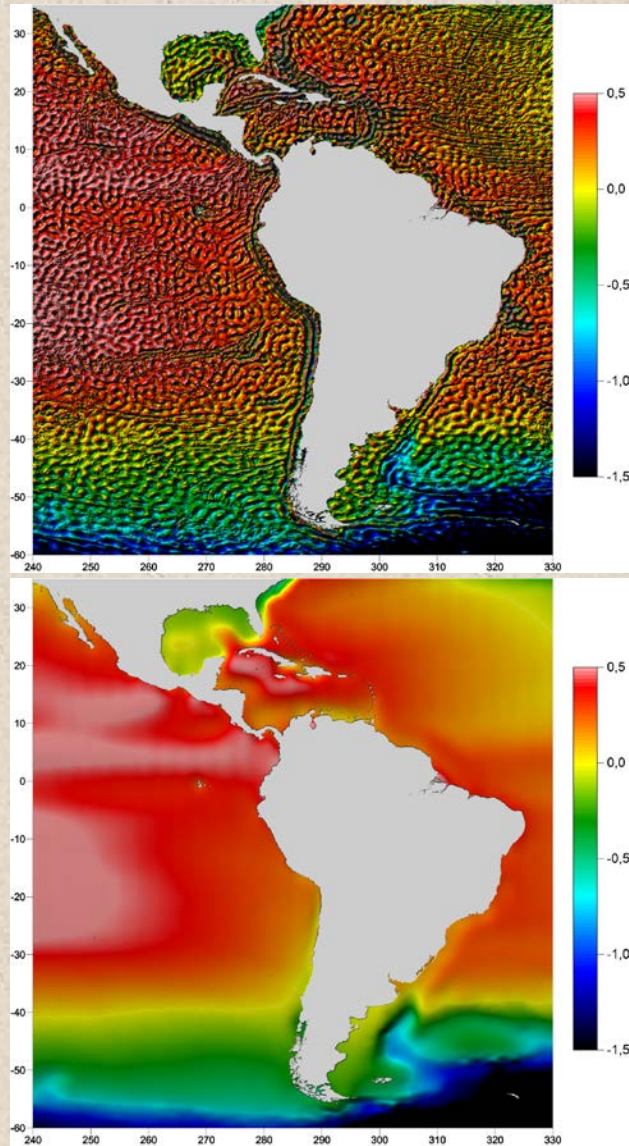**6 iterations**

Final filtering

Final filtering
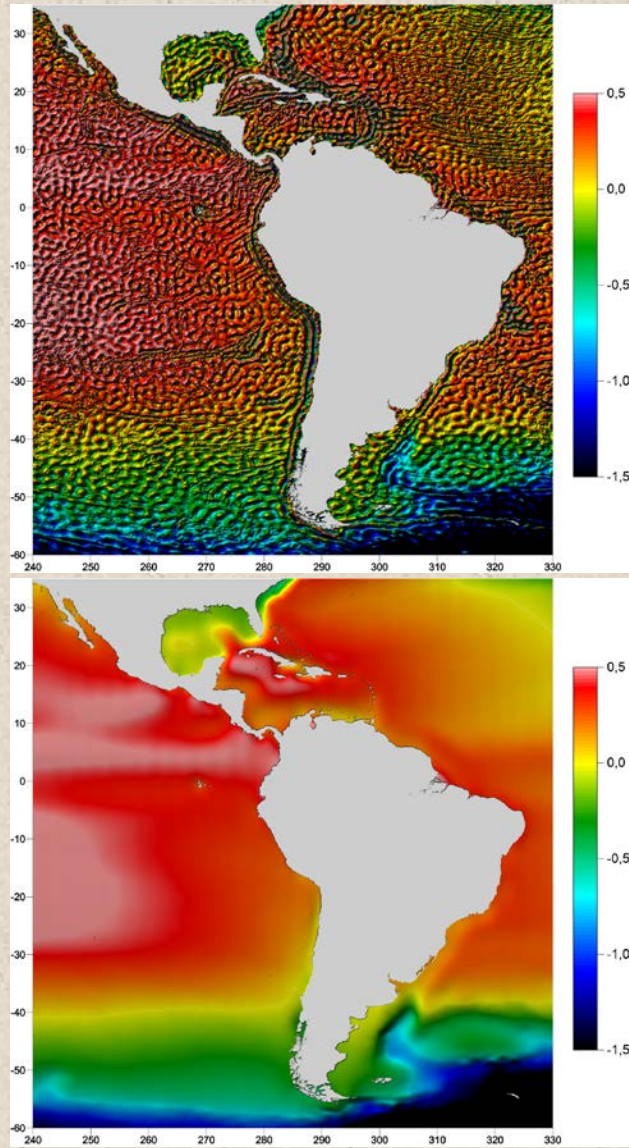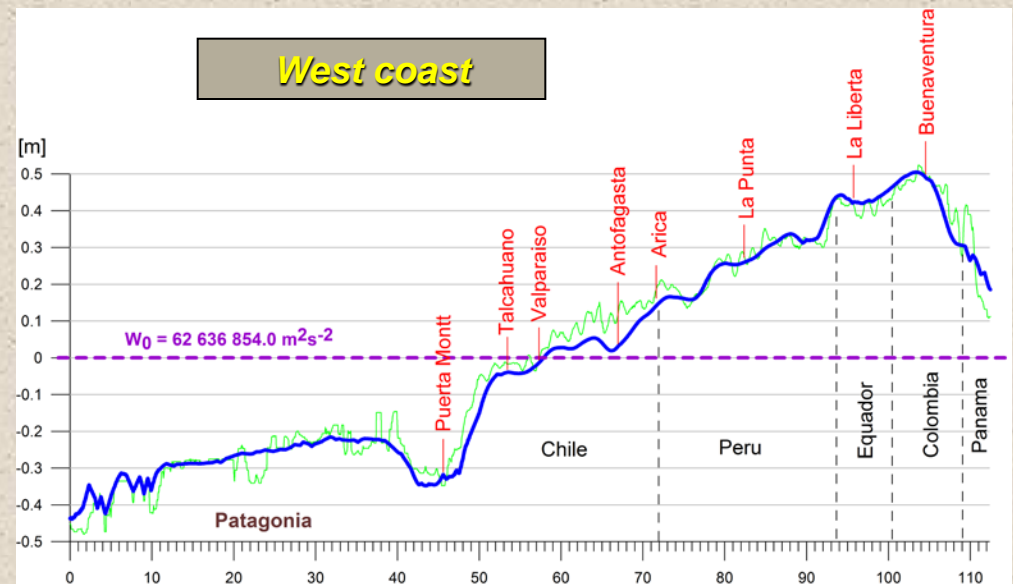
10 iterations
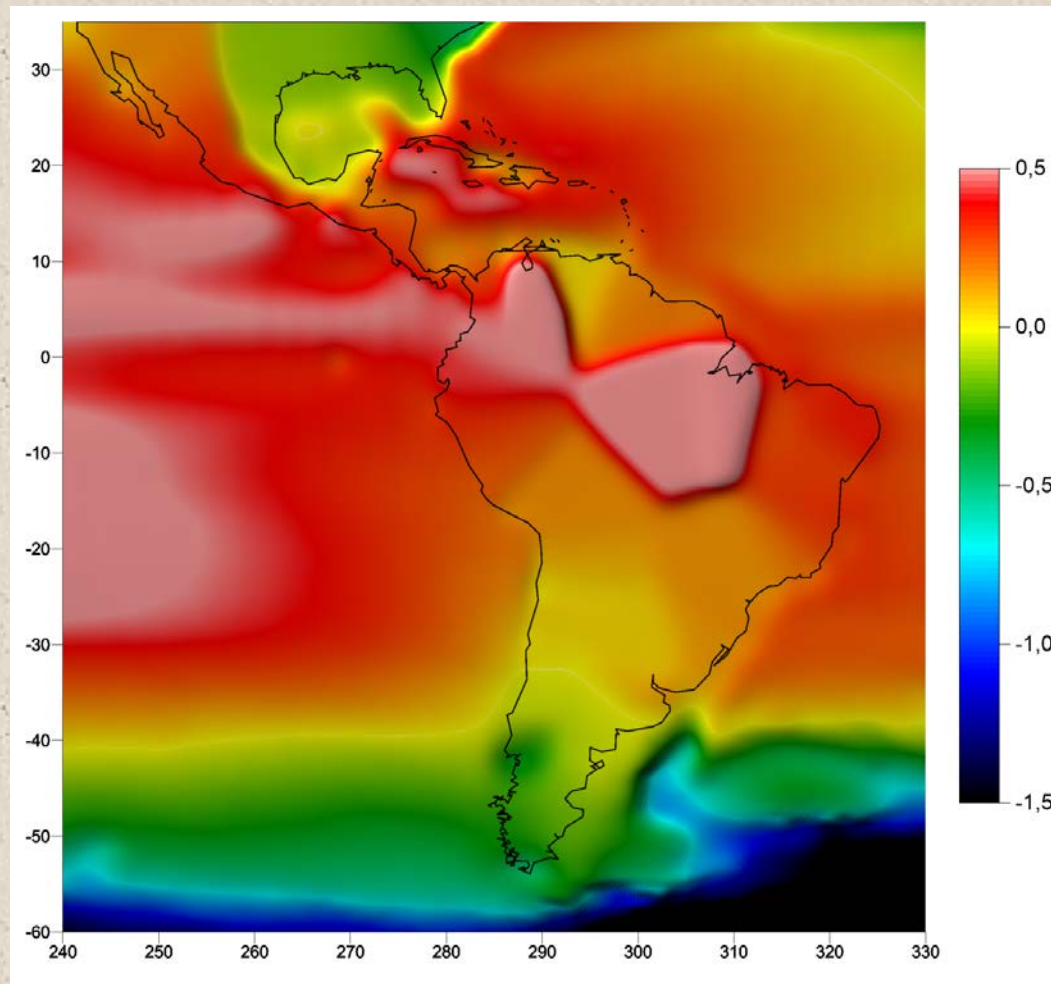
Filtered satellite-only MDT

8 iterations

MDT along coastlines in South America

West coast

$W_0 = 62\ 636\ 854.0\ m^2s^{-2}$

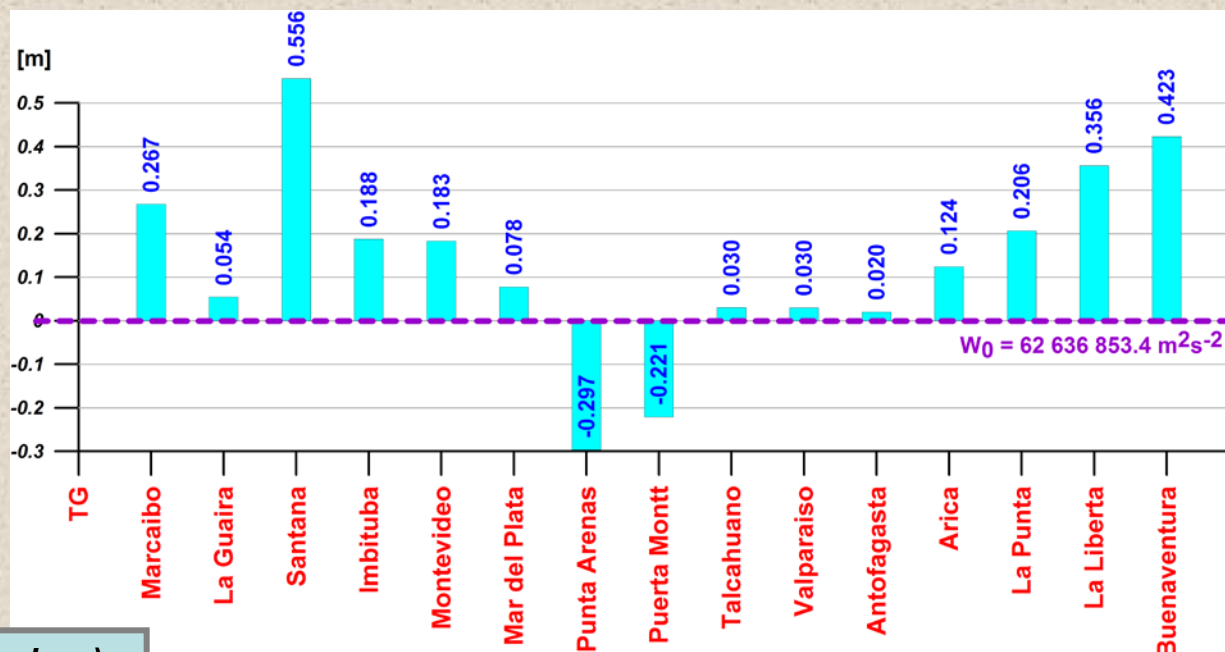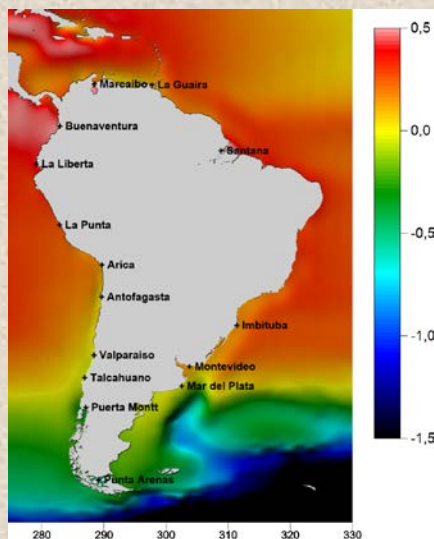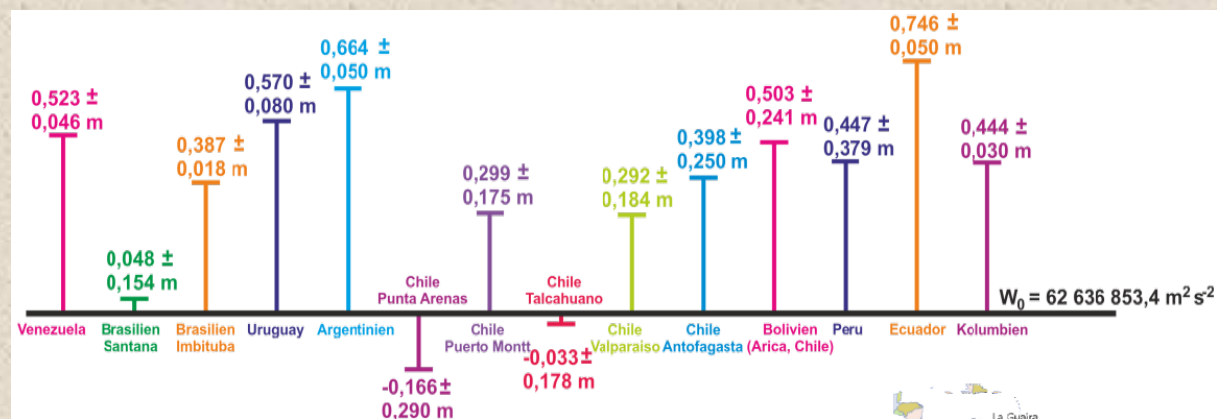# MDT along coastlines in South America
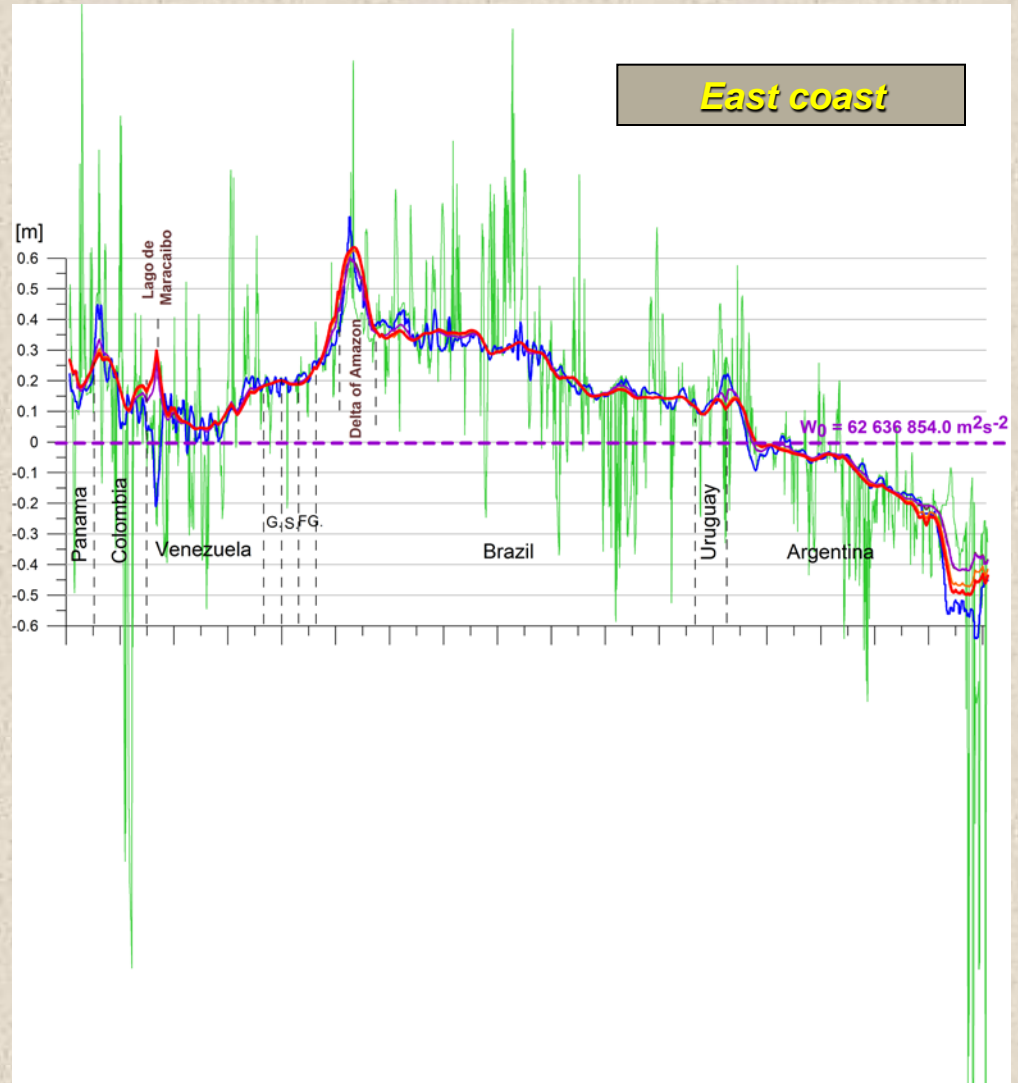
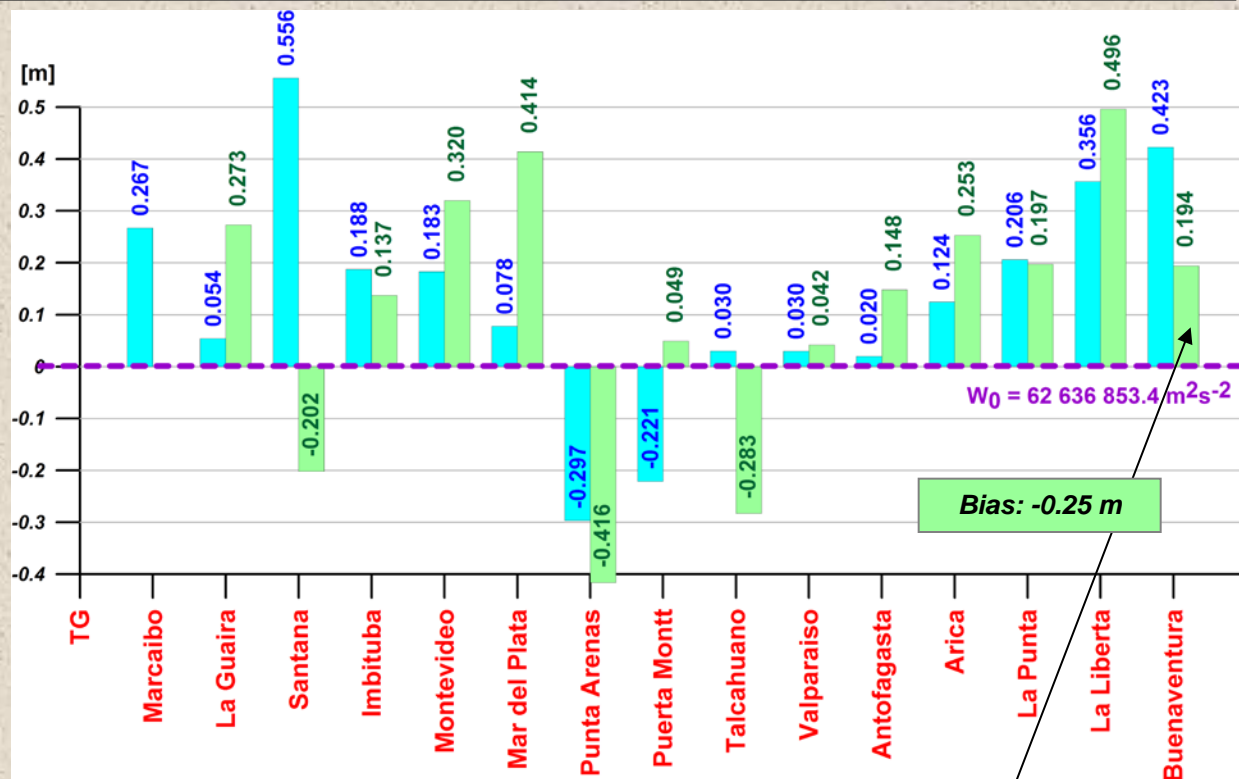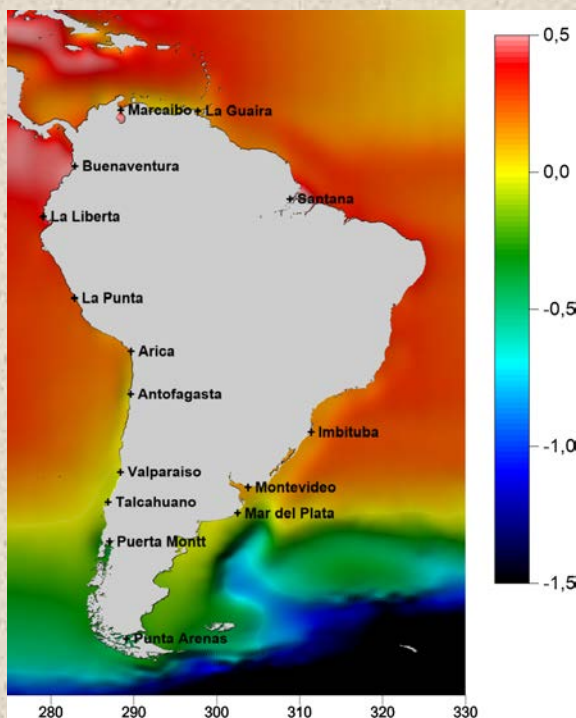# Interpolated values at tide gauges
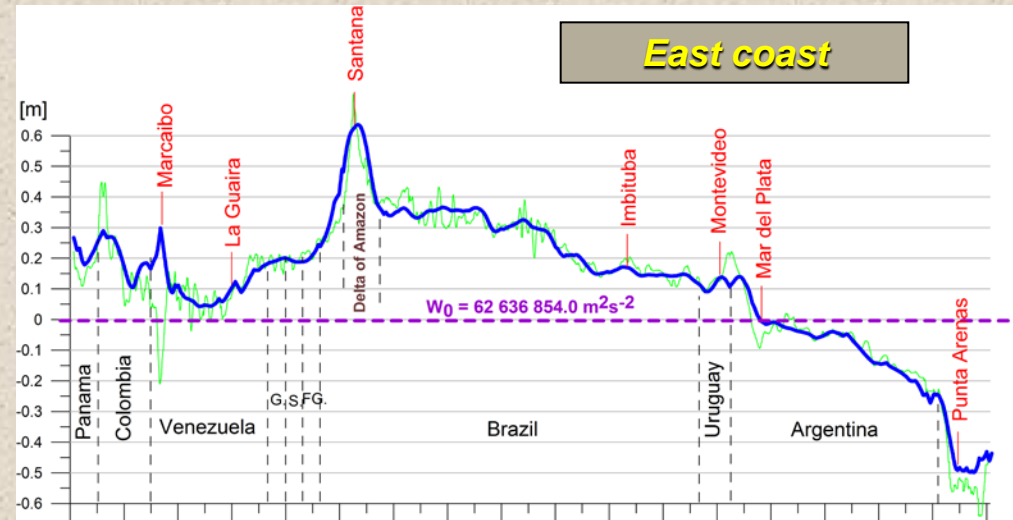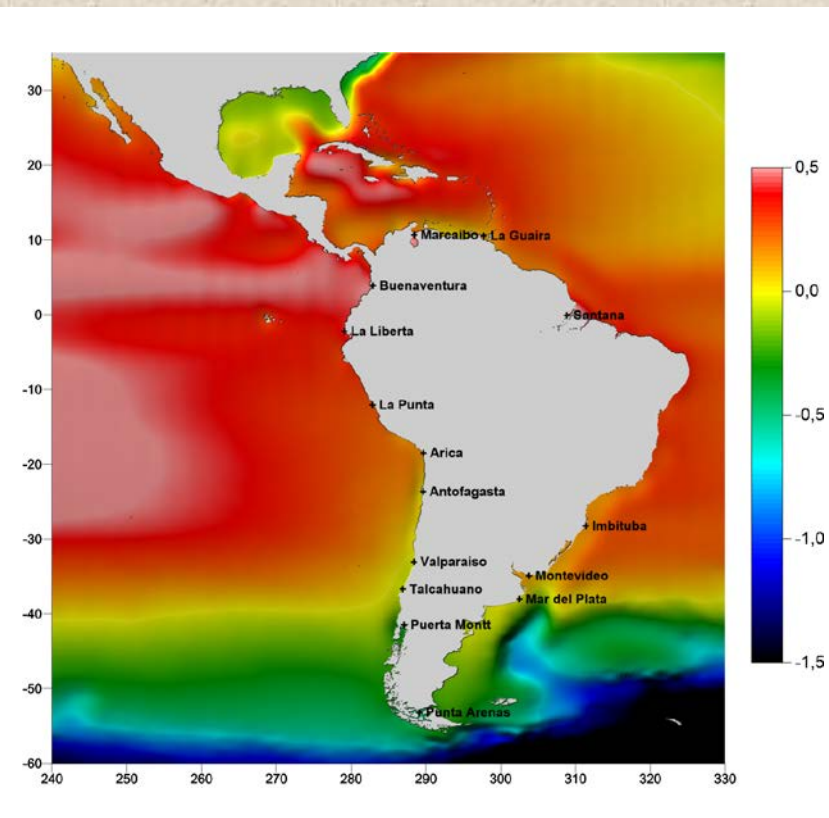
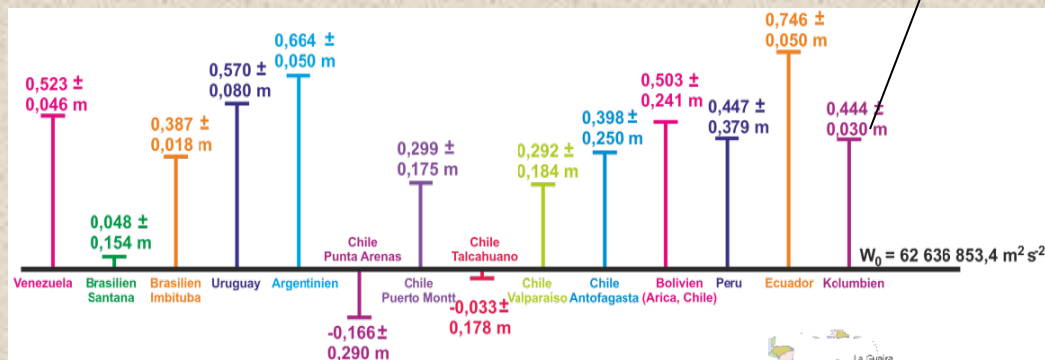# Estimated offsets between tide gauges

Source: (SIRGAS-2014: Sánchez)

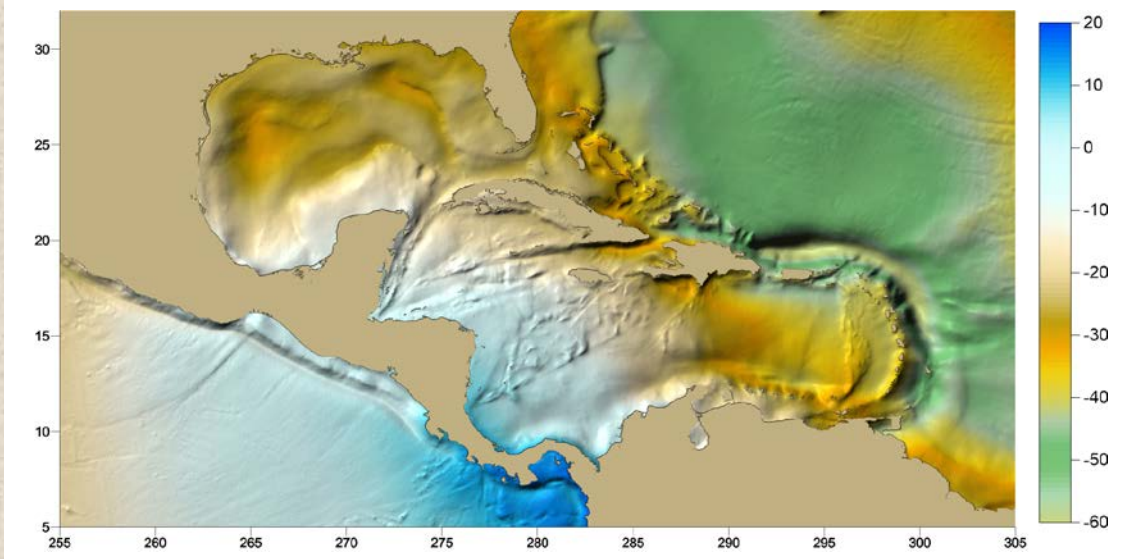# *Estimated offsets between tide gauges*

Source: (SIRGAS-2014: Sánchez)
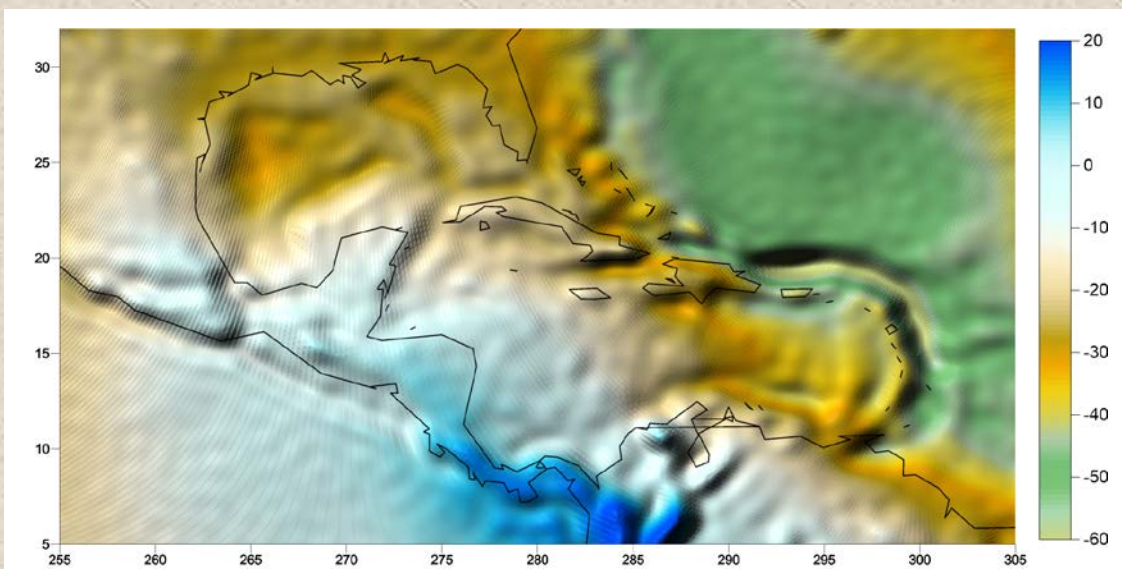
Detail in Caribbean Sea

Satellite altimetry:

DTU13_MSS

Satellite-only geopotential models:
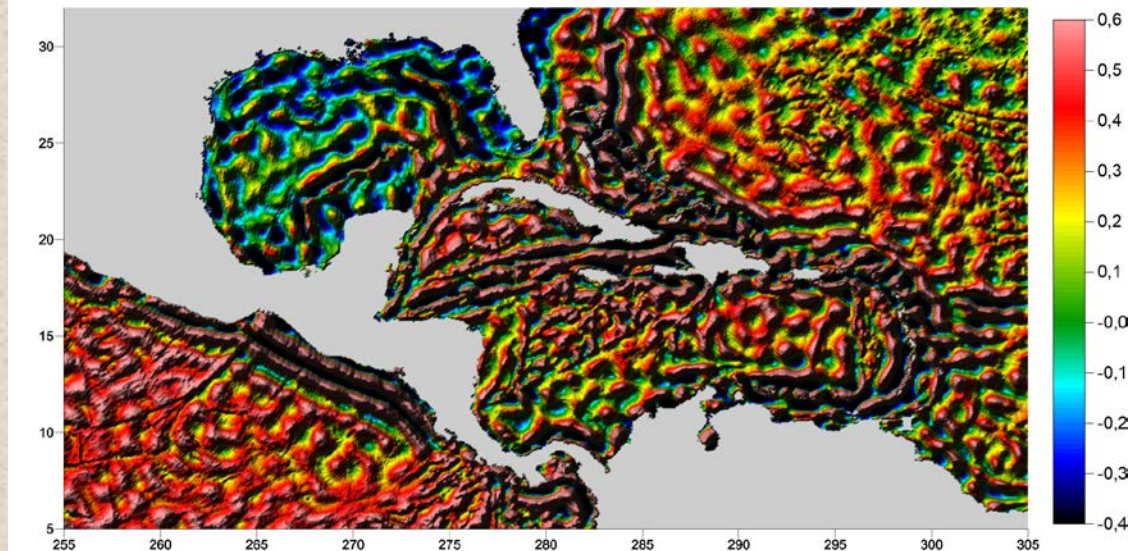
GO_CONS_GCF_2_DIR_R5

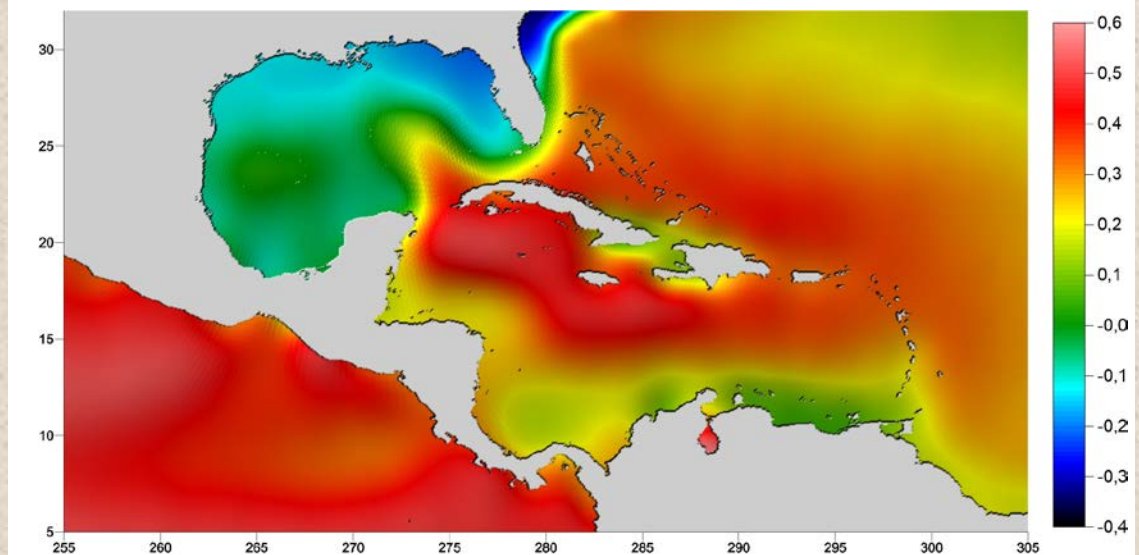*(SH up to d/o 300)*

Detail in Caribbean Sea

$$h^{MDT} = h^{MSS} - N^{GGM}$$

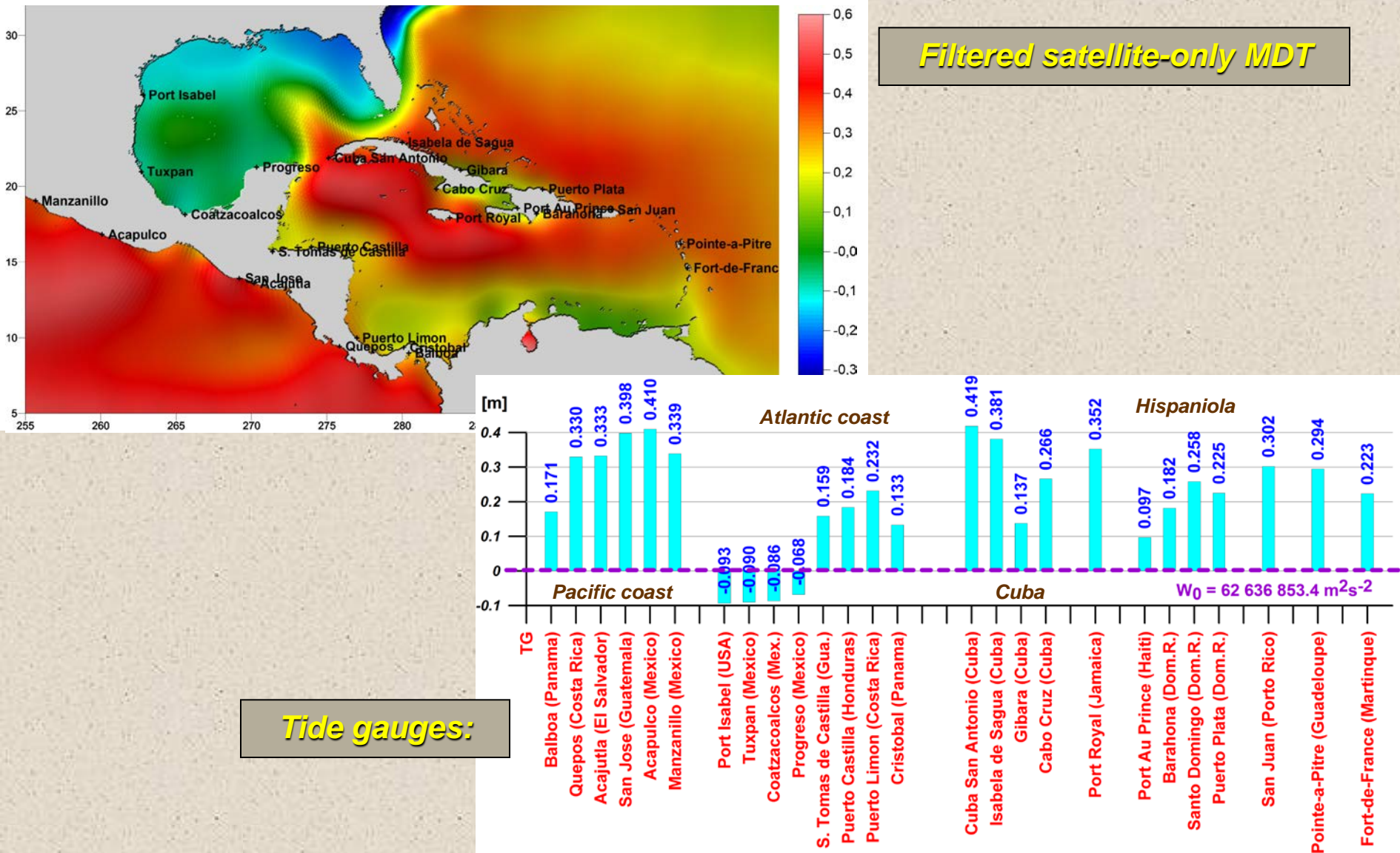**Filtered MDT**

(after nonlinear diffusion filtering)

Offsets estimates at tide gauges

Filtered satellite-only MDT

Tide gauges:

Conclusions

$\Rightarrow$ **nonlinear diffusion filtering of the satellite-only MDT can efficiently _reduce the stripping noise_**

$\Rightarrow$ **appropriate way how to prolong information from the satellite-only MDT from oceans towards lands is essential in the process of _detecting reliable values at tide gauges_ (or along coastlines)**

$\Rightarrow$ **the filtered satellite-only MDT can be useful for a _unifications of local vertical datums_ as well as for an _establishment of the World Height System_**

Muchas gracias por la atención