HOW THE ANDEAN TECTONICS AND DYNAMIC TOPOGRAPHY SHAPED THE LANDSCAPE EVOLUTION IN AMAZONIA: A NUMERICAL APPROACH

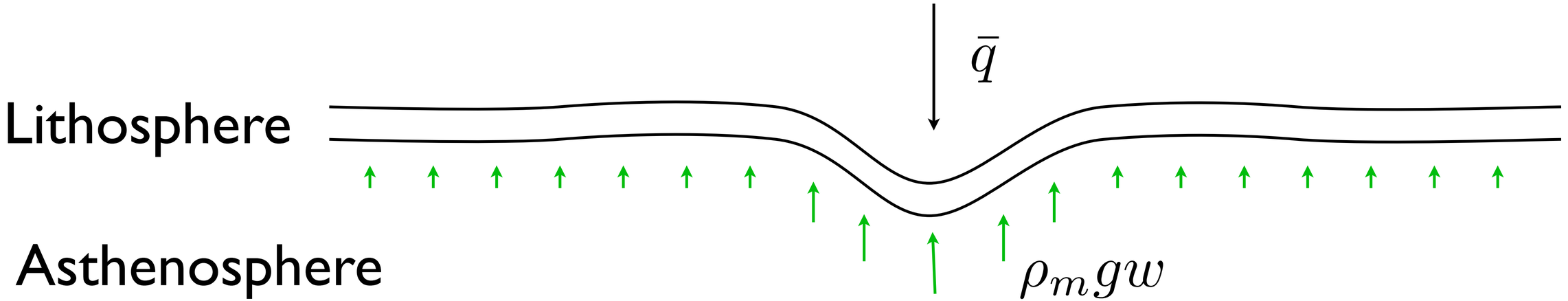
Victor Sacek[1]*, Tacio Cordeiro Bicudo[1], Renato Paes de Almeida[2]
*sacek@usp.br

1 Instituto de Astronomia, Geofísica e Ciências Atmosféricas

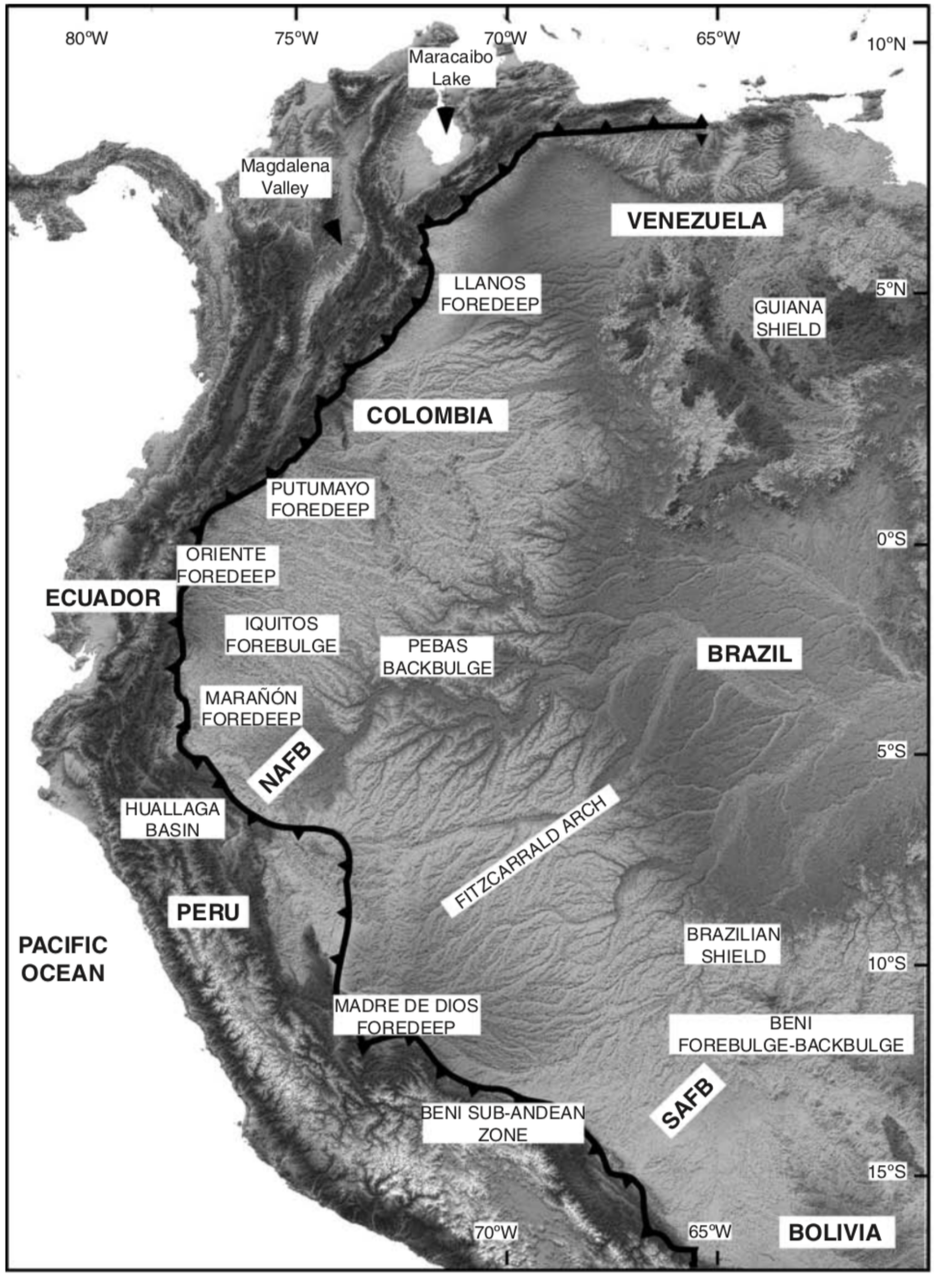
2 Instituto de Geociências

HOW CAN WE EXPLAIN VERTICAL MOVEMENTS OF THE SURFACE FAR FROM ACTIVE MARGINS?

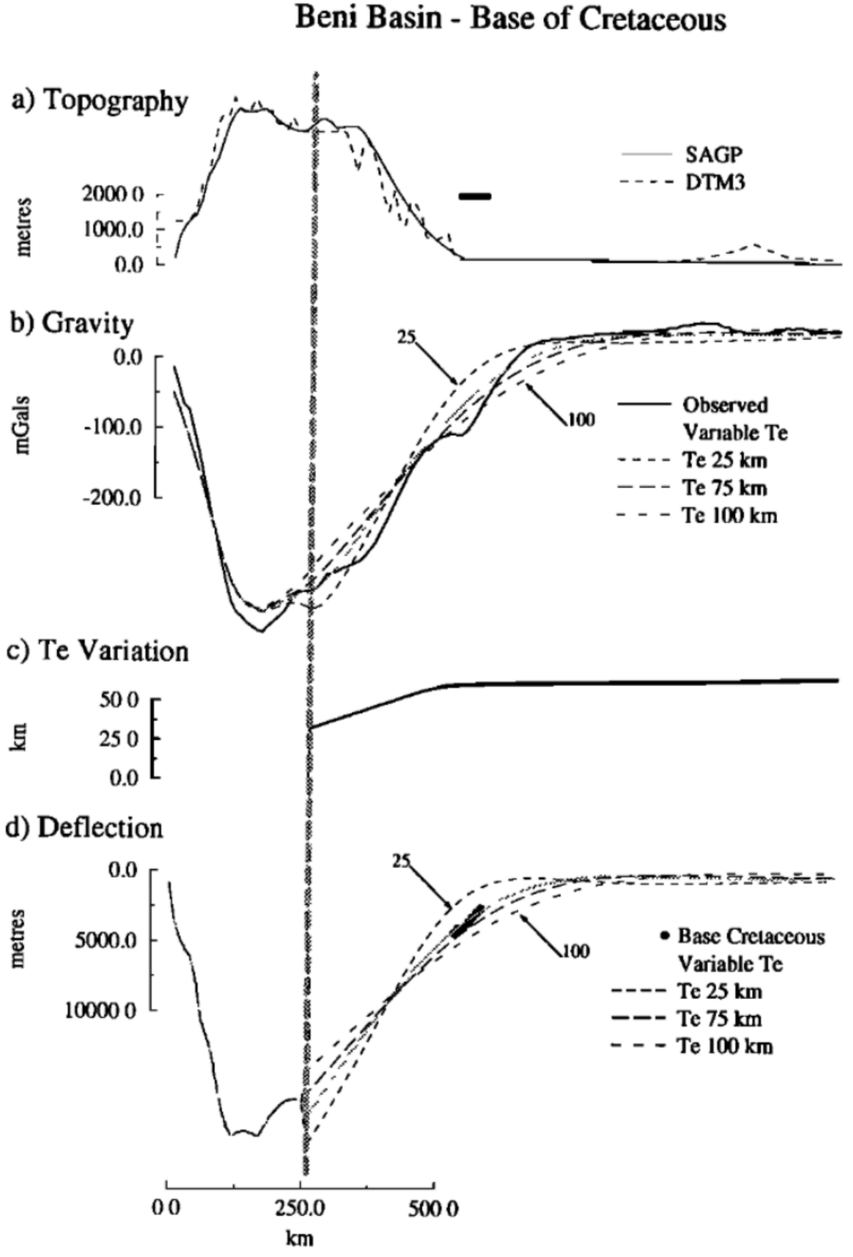
Flexure and Isostasy



$$D = \frac{ET_e^3}{12(1-\nu^2)}$$



Roddaz et al. (2010)

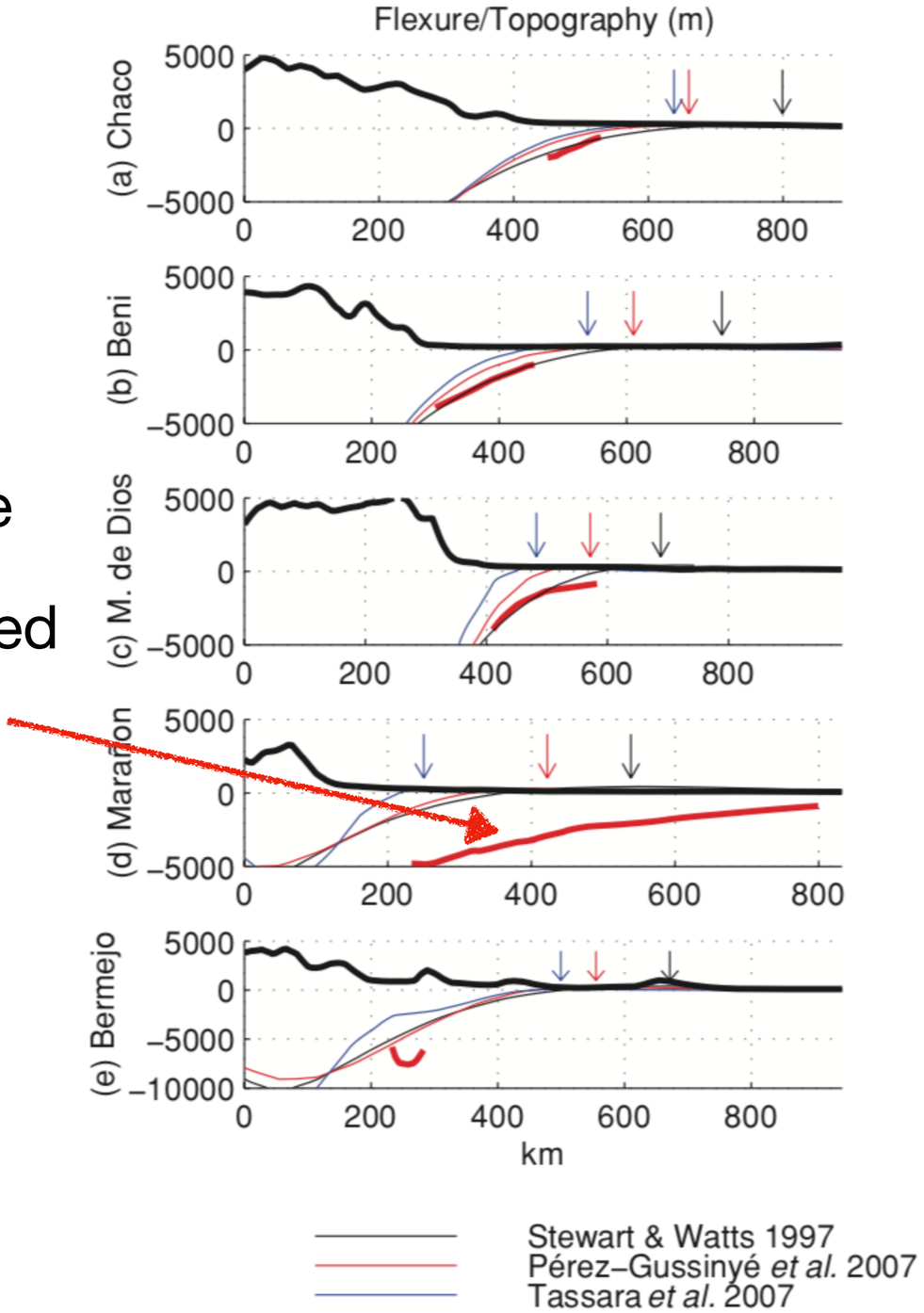


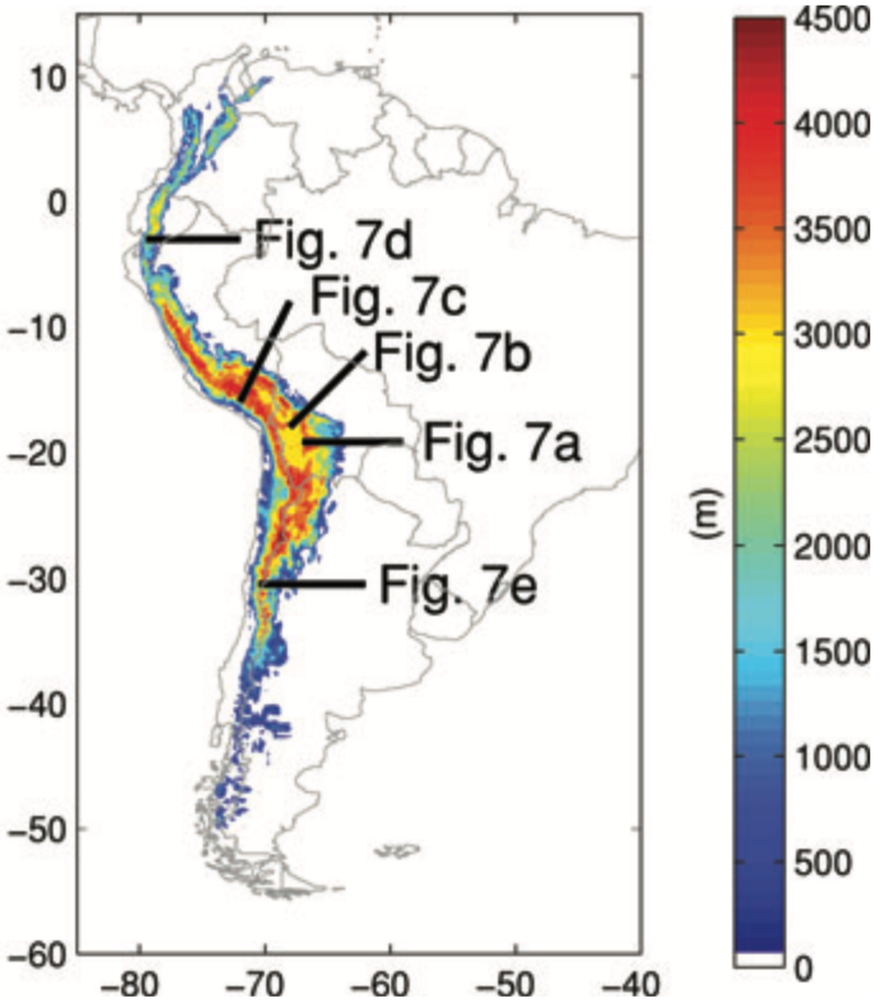
Stewart & Watts (1997)

Subsidence

not explained

by flexure





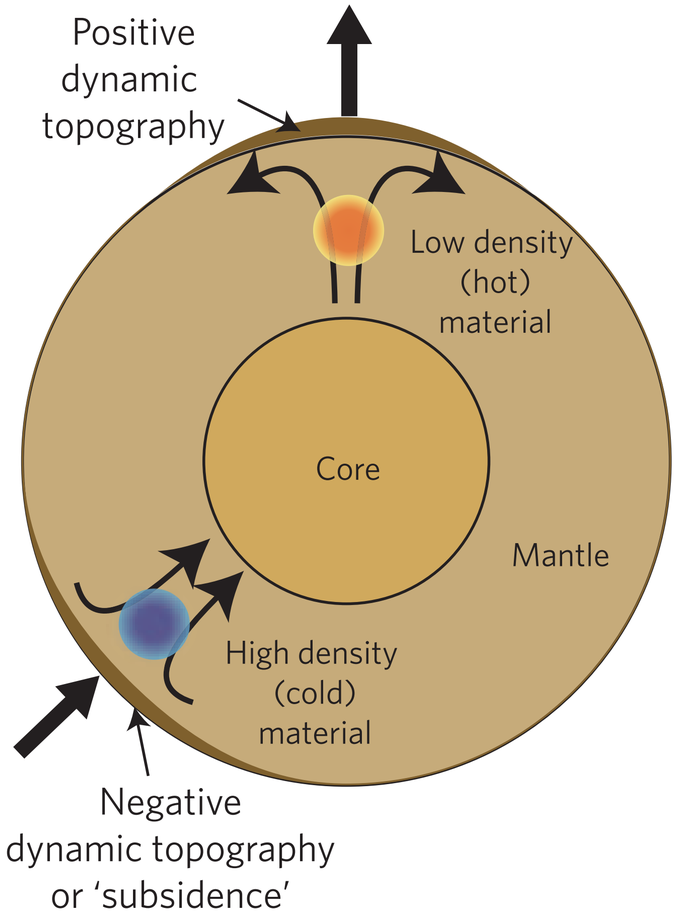
Sacek & Ussami (2009)

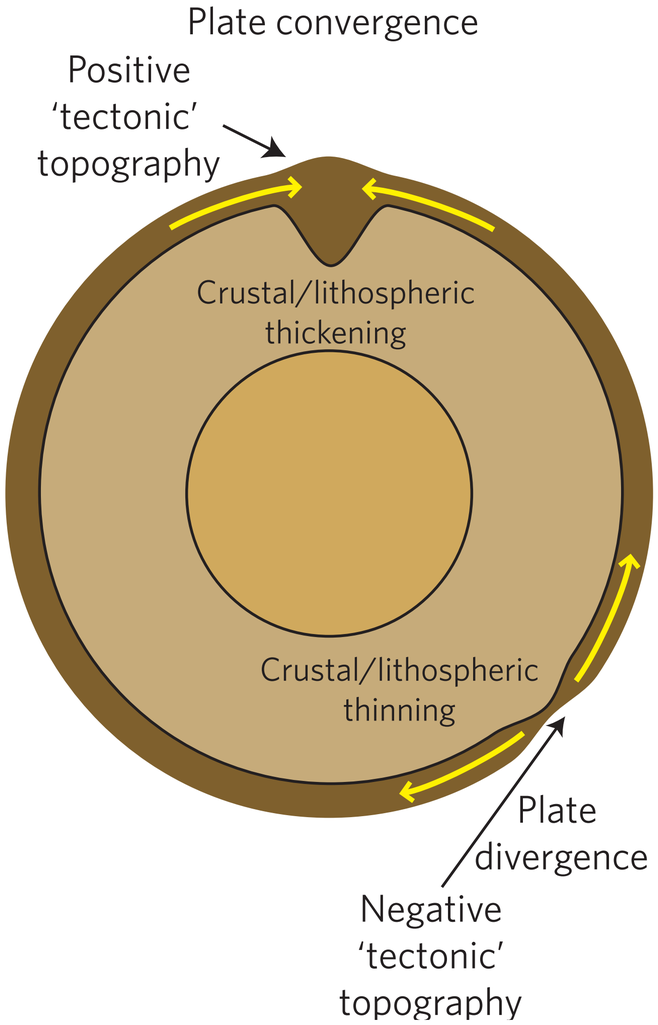
nature geoscience
REVIEW ARTICLE
PUBLISHED ONLINE: 28 NOVEMBER 2010 | DOI: 10.1038/NGEO1020

Dynamic topography

The many surface expressions of mantle dynamics

Jean Braun

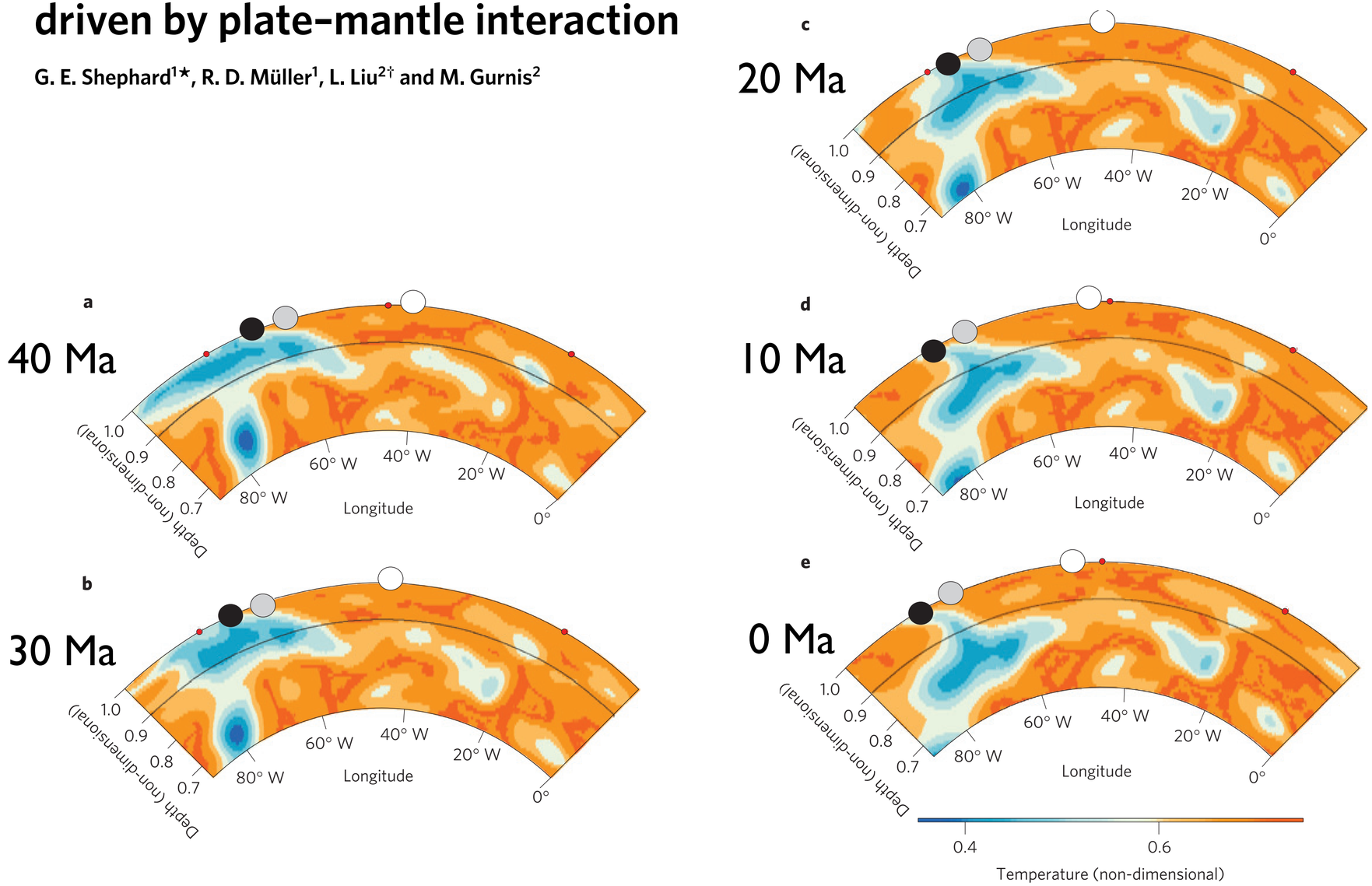




LETTERS
PUBLISHED ONLINE: 21 NOVEMBER 2010 | DOI: 10.1038/NGEO1017
nature geoscience

Miocene drainage reversal of the Amazon River driven by plate–mantle interaction

G. E. Shephard[1]*, R. D. Müller[1], L. Liu[2†] and M. Gurnis[2]

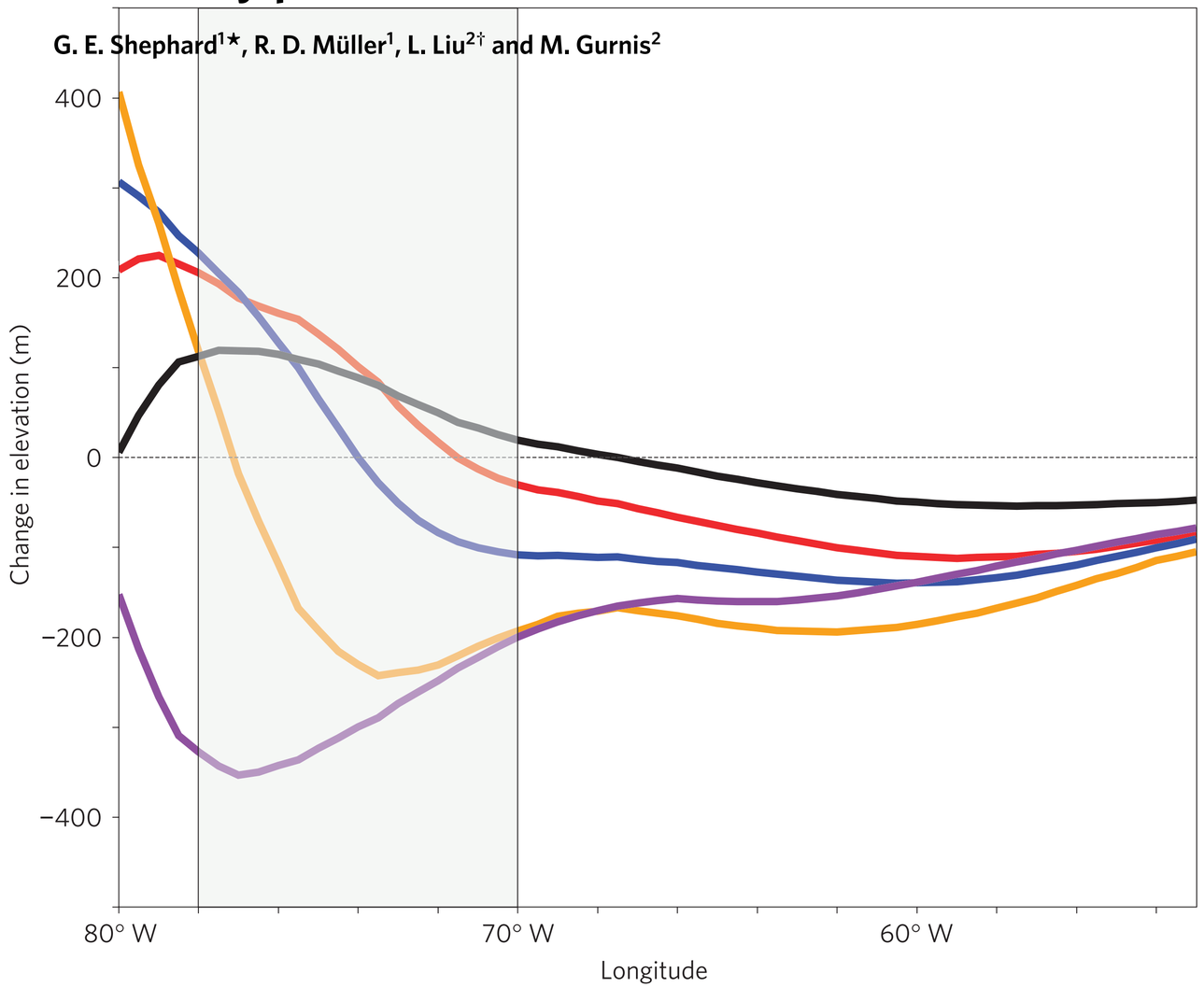


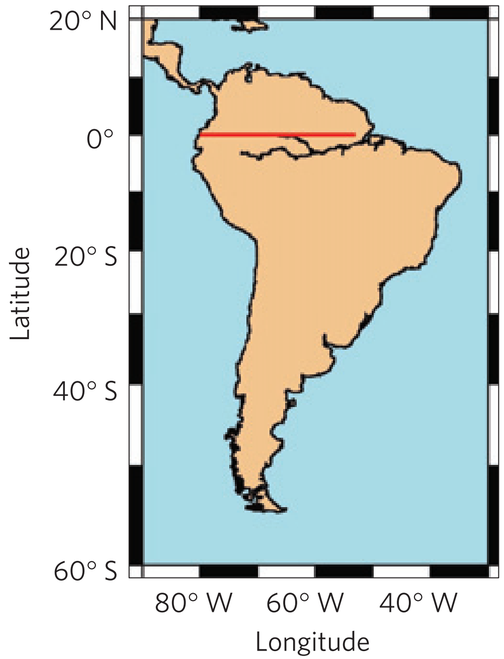
LETTERS
PUBLISHED ONLINE: 21 NOVEMBER 2010 | DOI: 10.1038/NGEO1017
nature geoscience

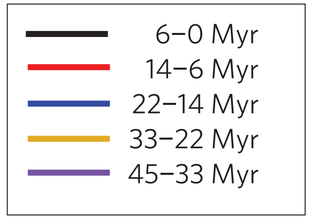
Miocene drainage reversal of the Amazon River driven by plate–mantle interaction

G. E. Shephard[1]*, R. D. Müller[1], L. Liu[2†] and M. Gurnis[2]

e



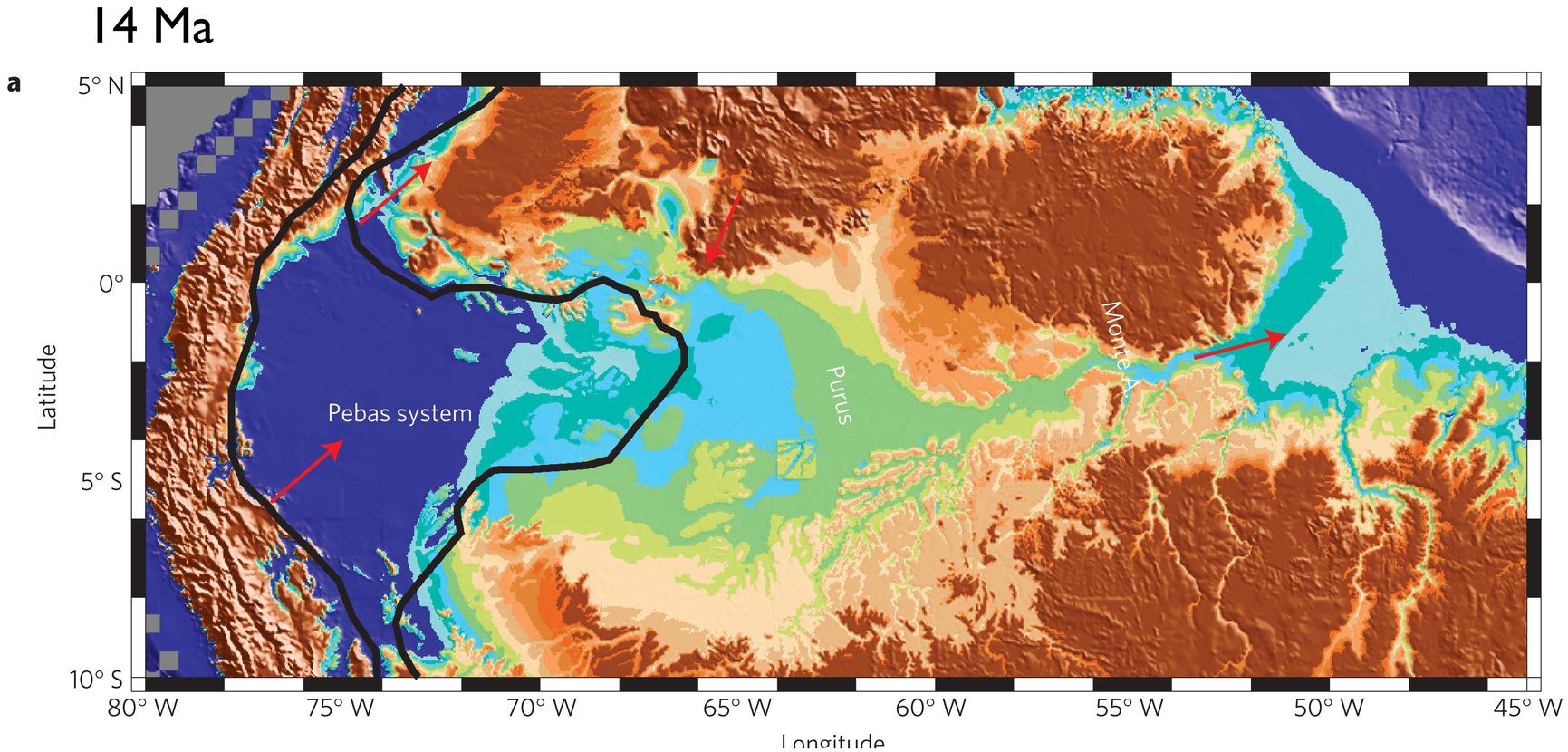




LETTERS
PUBLISHED ONLINE: 21 NOVEMBER 2010 | DOI: 10.1038/NGEO1017
nature geoscience

Miocene drainage reversal of the Amazon River driven by plate–mantle interaction

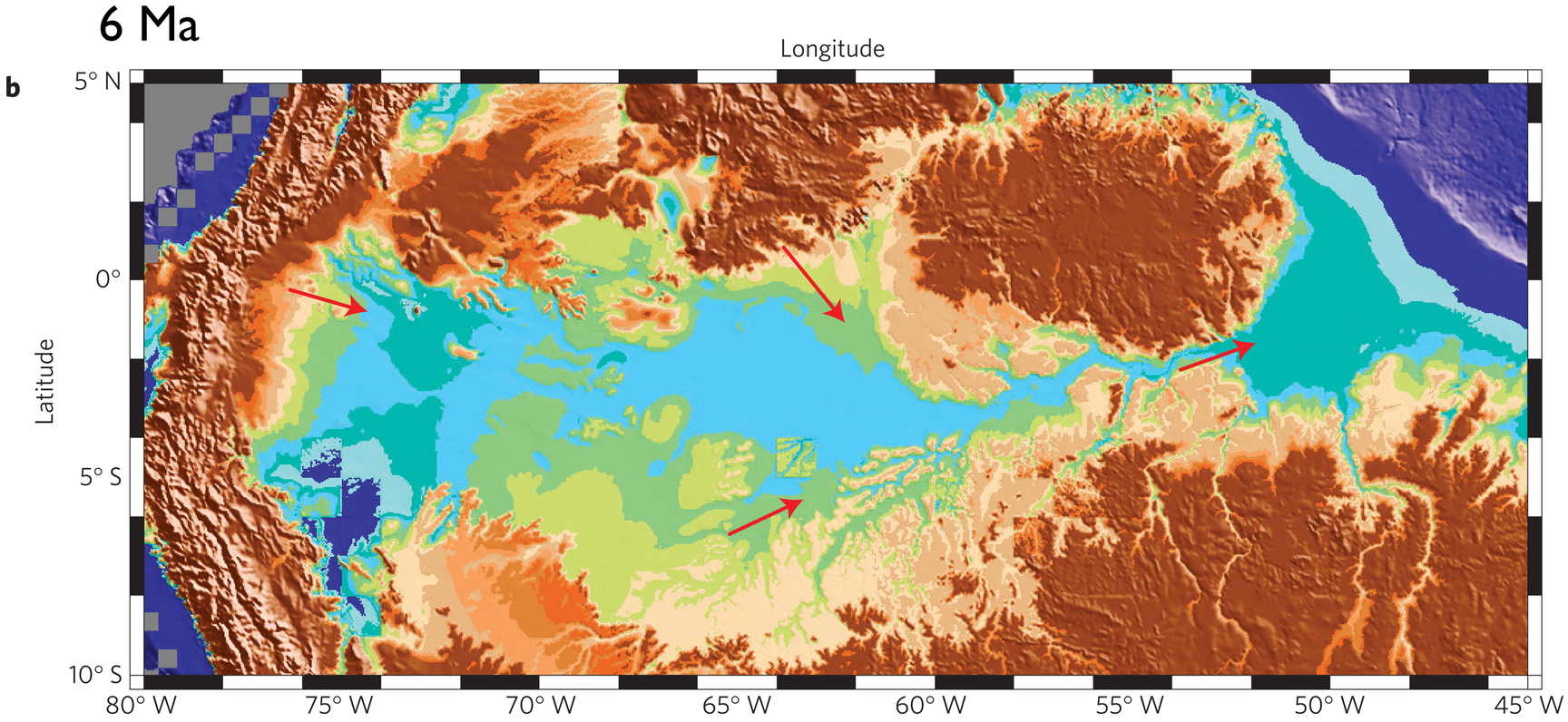
G. E. Shephard[1]*, R. D. Müller[1], L. Liu[2†] and M. Gurnis[2]



LETTERS
PUBLISHED ONLINE: 21 NOVEMBER 2010 | DOI: 10.1038/NGEO1017
nature geoscience

Miocene drainage reversal of the Amazon River driven by plate–mantle interaction

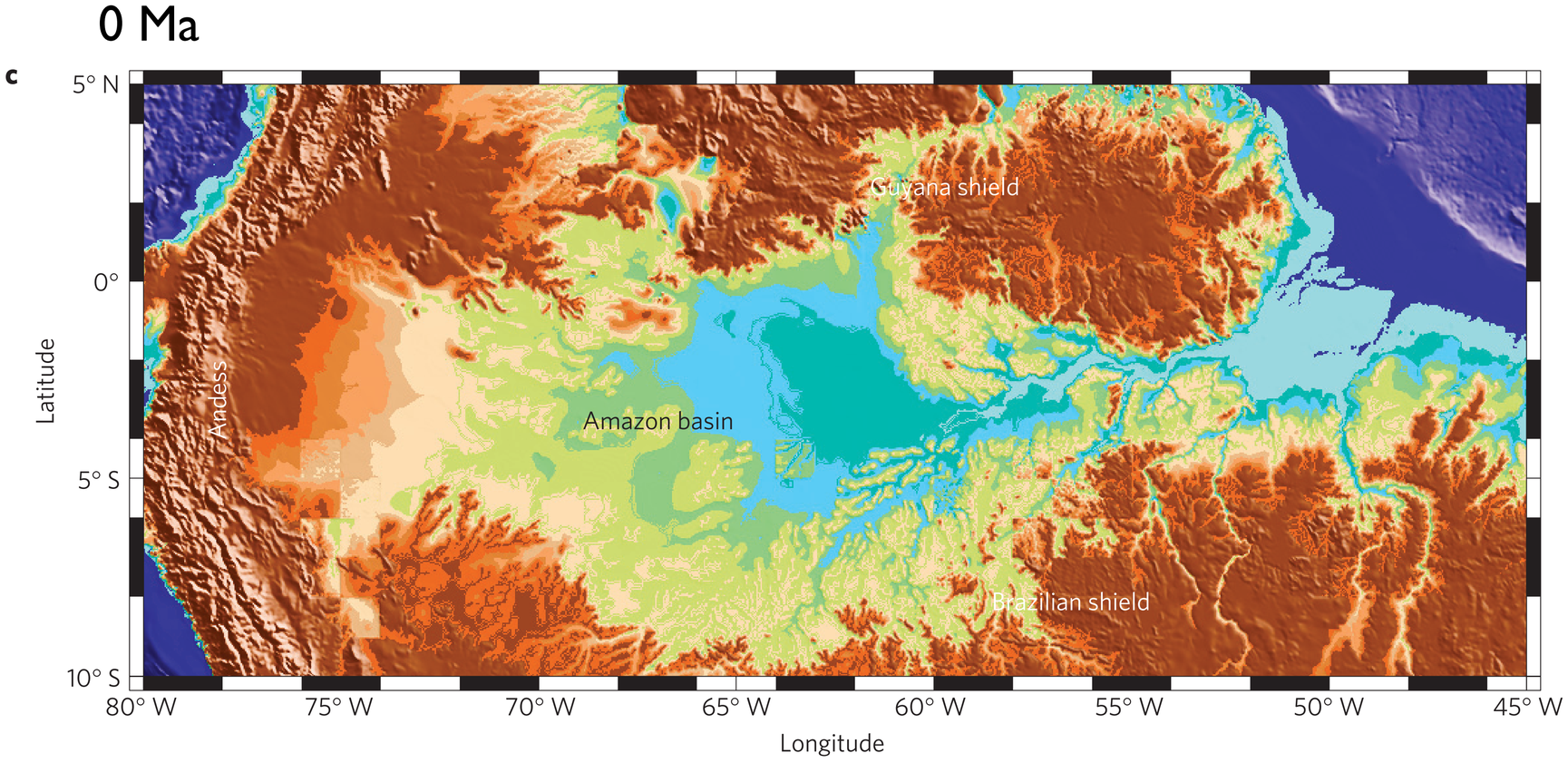
G. E. Shephard[1]*, R. D. Müller[1], L. Liu[2†] and M. Gurnis[2]



LETTERS
PUBLISHED ONLINE: 21 NOVEMBER 2010 | DOI: 10.1038/NGEO1017
nature geoscience

Miocene drainage reversal of the Amazon River driven by plate–mantle interaction

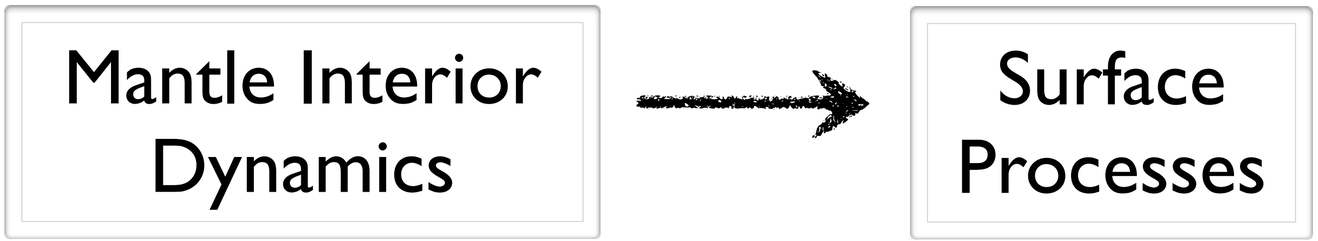
G. E. Shephard[1]*, R. D. Müller[1], L. Liu[2†] and M. Gurnis[2]



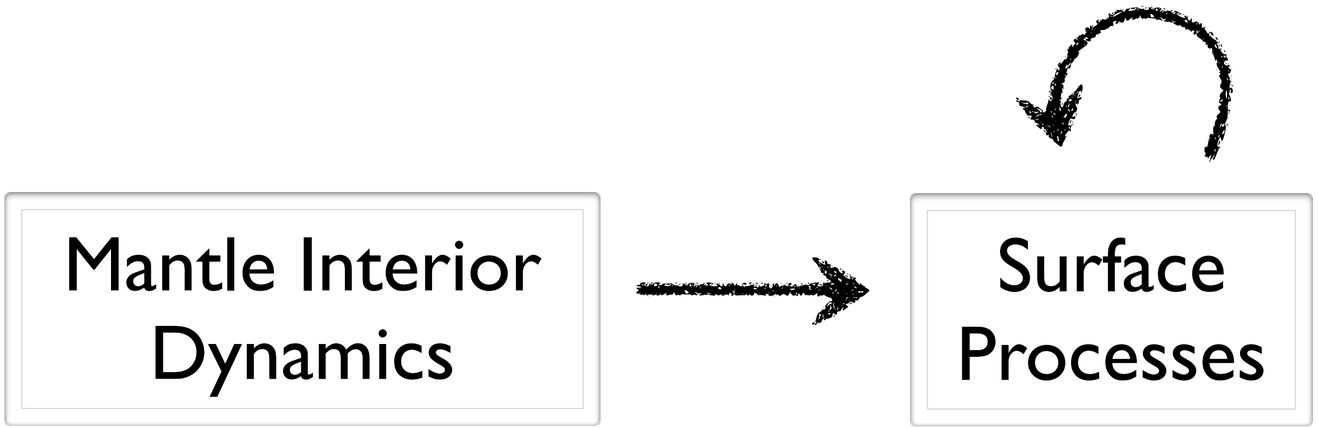
LETTERS
PUBLISHED ONLINE: 21 NOVEMBER 2010 | DOI: 10.1038/NGEO1017
nature geoscience

Miocene drainage reversal of the Amazon River driven by plate–mantle interaction

G. E. Shephard[1]*, R. D. Müller[1], L. Liu[2†] and M. Gurnis[2]



*Dynamic topography on a **static surface**, not affected by erosion/sedimentation.*


Mantle Interior Dynamics
Surface Processes

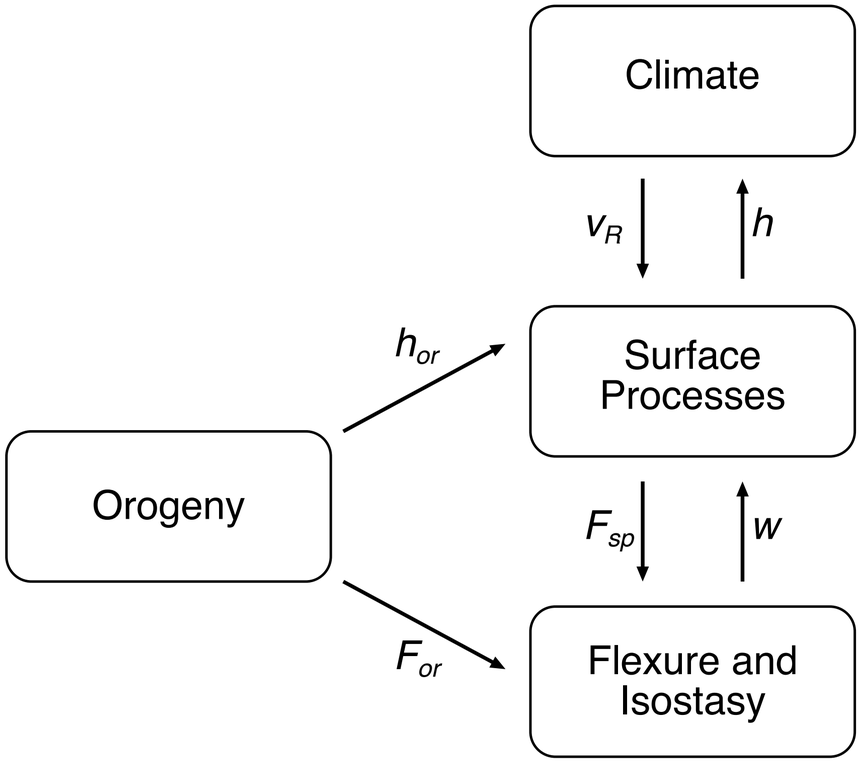
Contents lists available at ScienceDirect

Earth and Planetary Science Letters

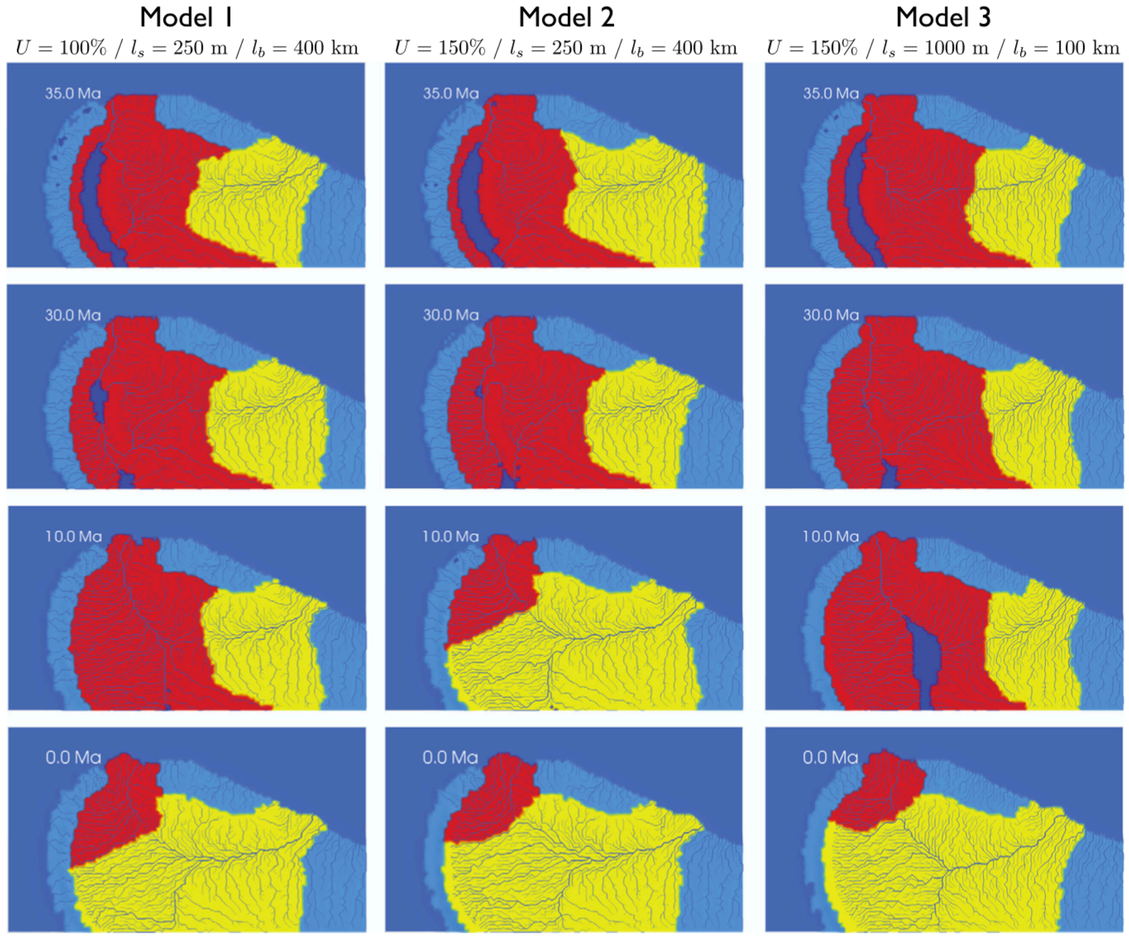
www.elsevier.com/locate/epsl

Drainage reversal of the Amazon River due to the coupling of surface and lithospheric processes

Victor Sacek



Tectono-sedimentary evolution of northern South America without dynamic topography.



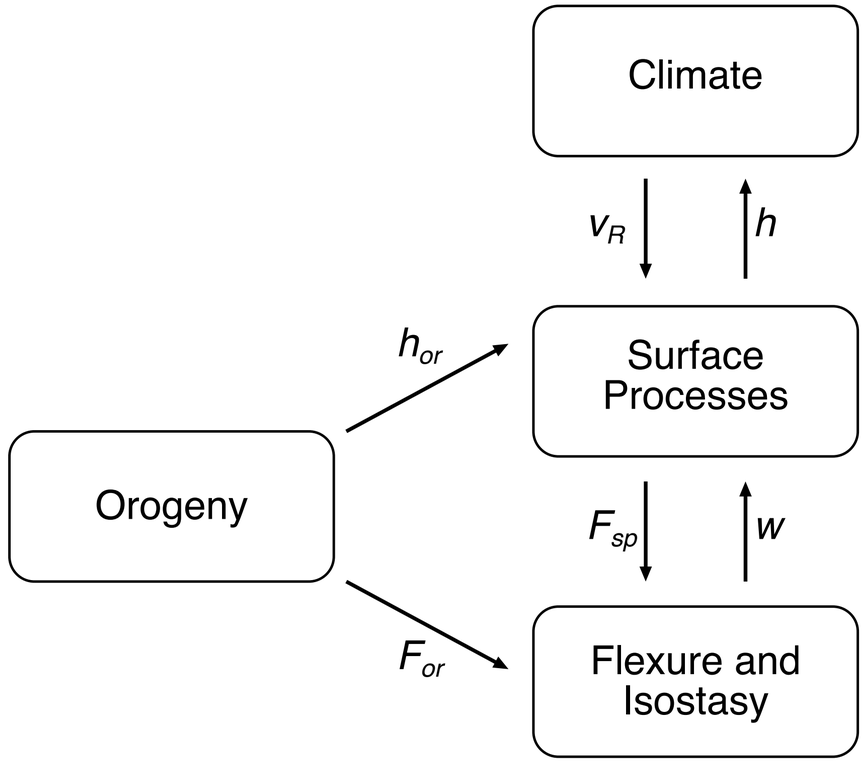
Contents lists available at ScienceDirect

Earth and Planetary Science Letters

www.elsevier.com/locate/epsl

Drainage reversal of the Amazon River due to the coupling of surface and lithospheric processes

Victor Sacek



Tectono-sedimentary evolution of northern South America without dynamic topography.

This numerical model shows that the Amazon drainage reversal during the Miocene was mainly guided by surface processes instead of dynamic topography due to mantle convection.

However, the proposed model fails to fully reproduce the spacial and temporal evolution of the Pebas system.

www.nature.com/scientificreports

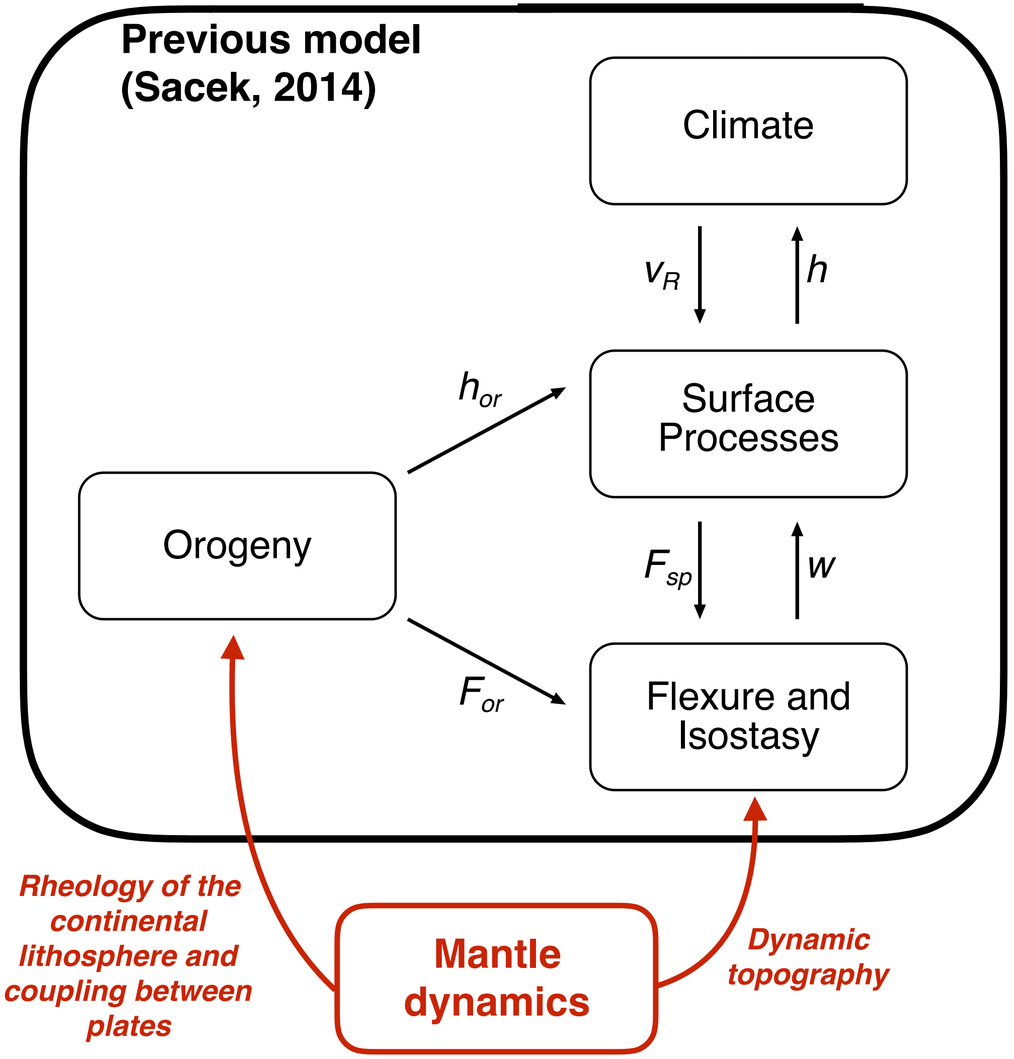
SCIENTIFIC REPORTS
nature research

OPEN

Andean Tectonics and Mantle Dynamics as a Pervasive Influence on Amazonian Ecosystem

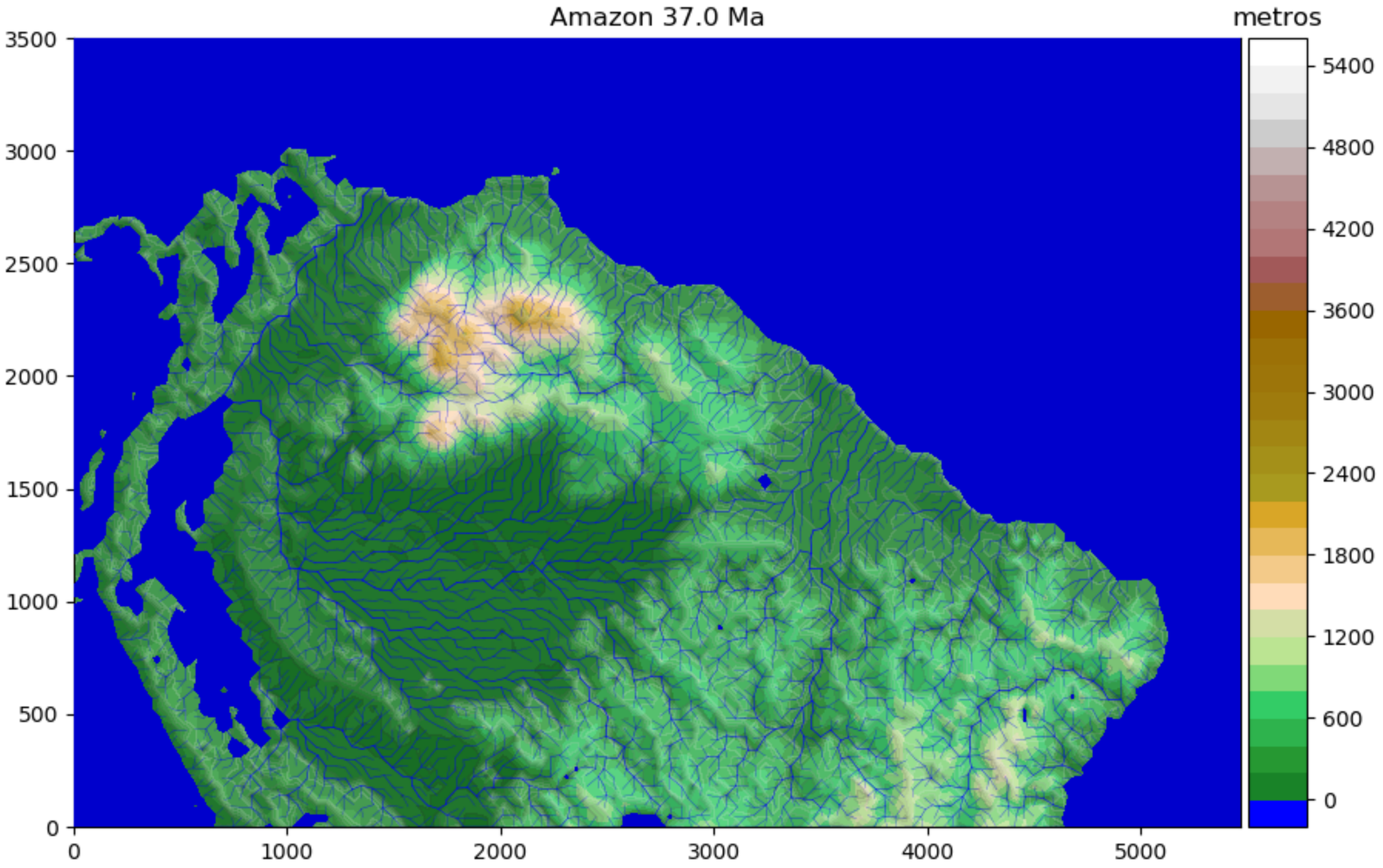
Tacio Cordeiro Bicudo[1*], Victor Sacek[1], Renato Paes de Almeida[2], John M. Bates[3] & Camila Cherem Ribas[4]

Numerical forward models considering the tectonic evolution of the Andean topography, surface processes, mantle dynamics and their subsequent effects on the spatial and temporal distribution of subsidence, uplift and sedimentation patterns in lowland Amazonia.



Scenario without dynamic topography

Without dynamic topography

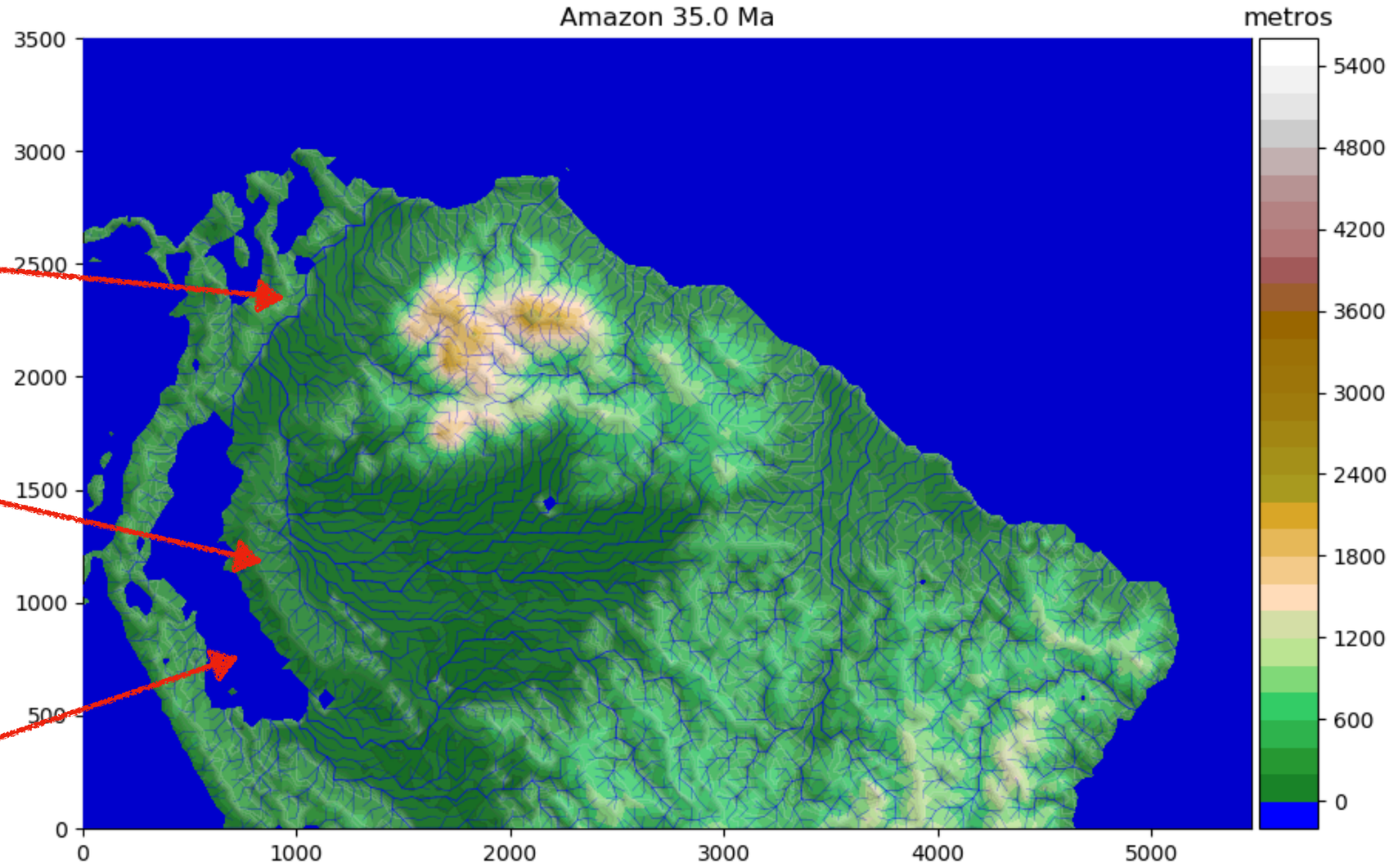


Without dynamic topography

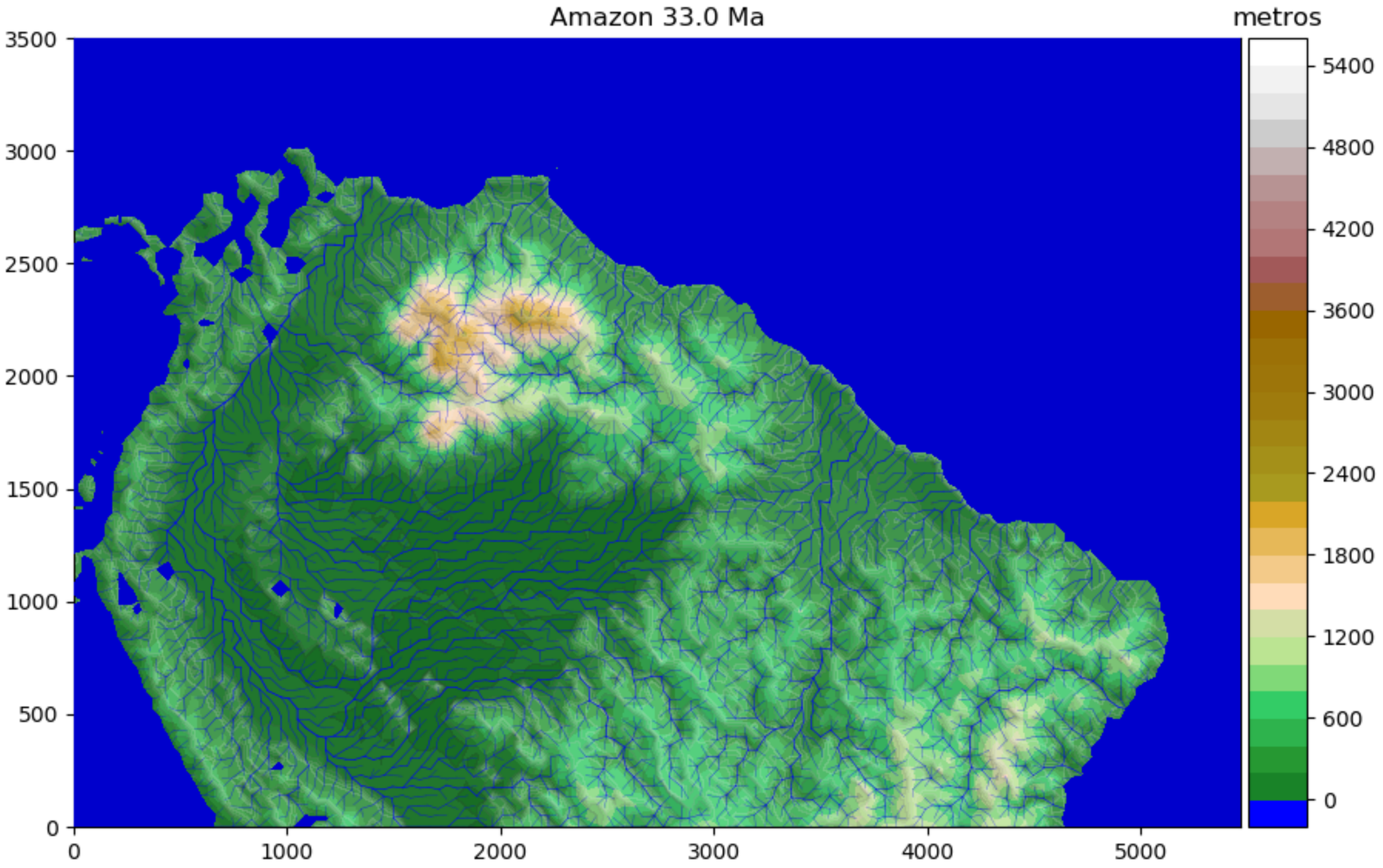
Drainage to the Caribbean

Flexural bulge

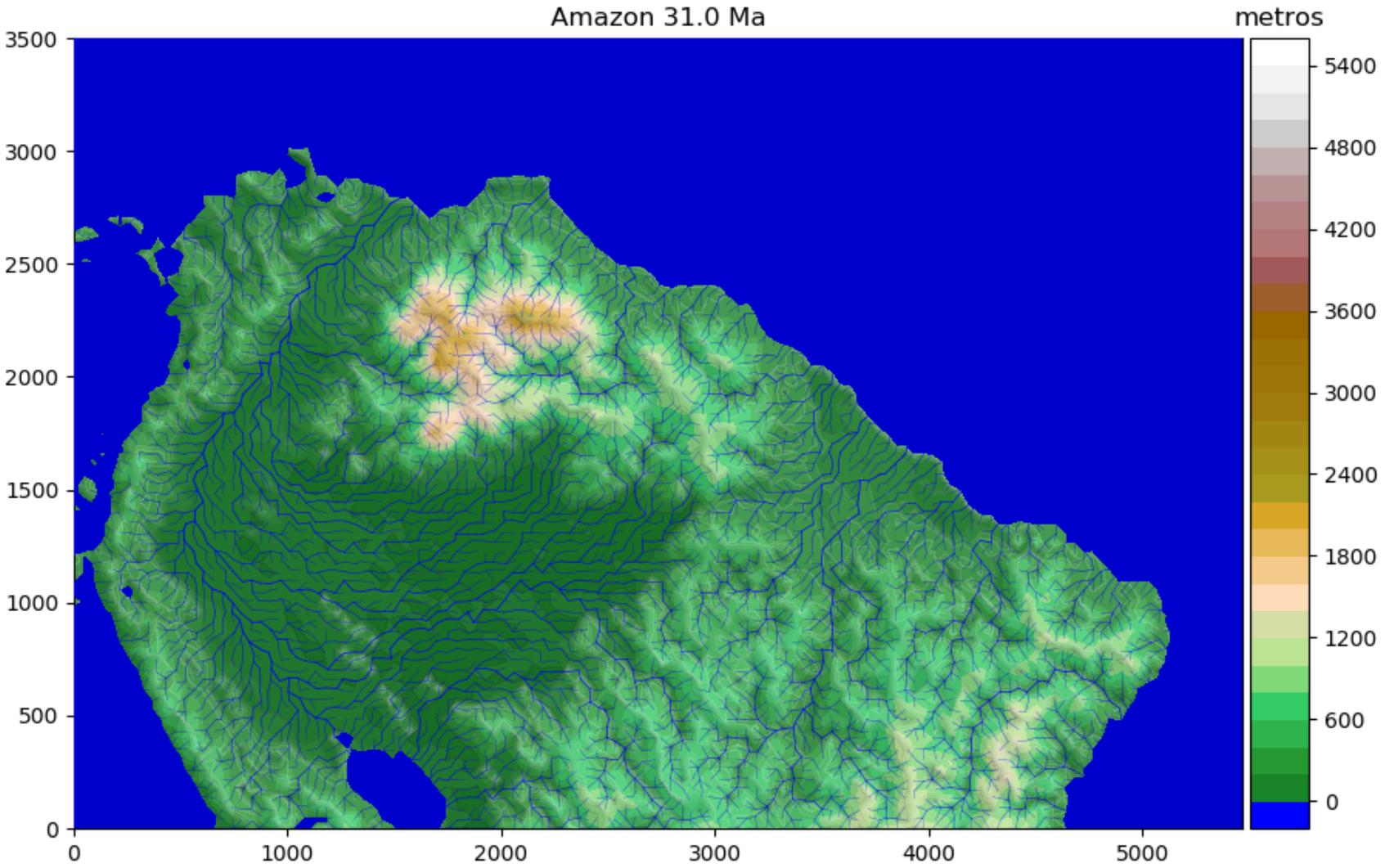
Lakes restricted to the foreland basins



Without dynamic topography

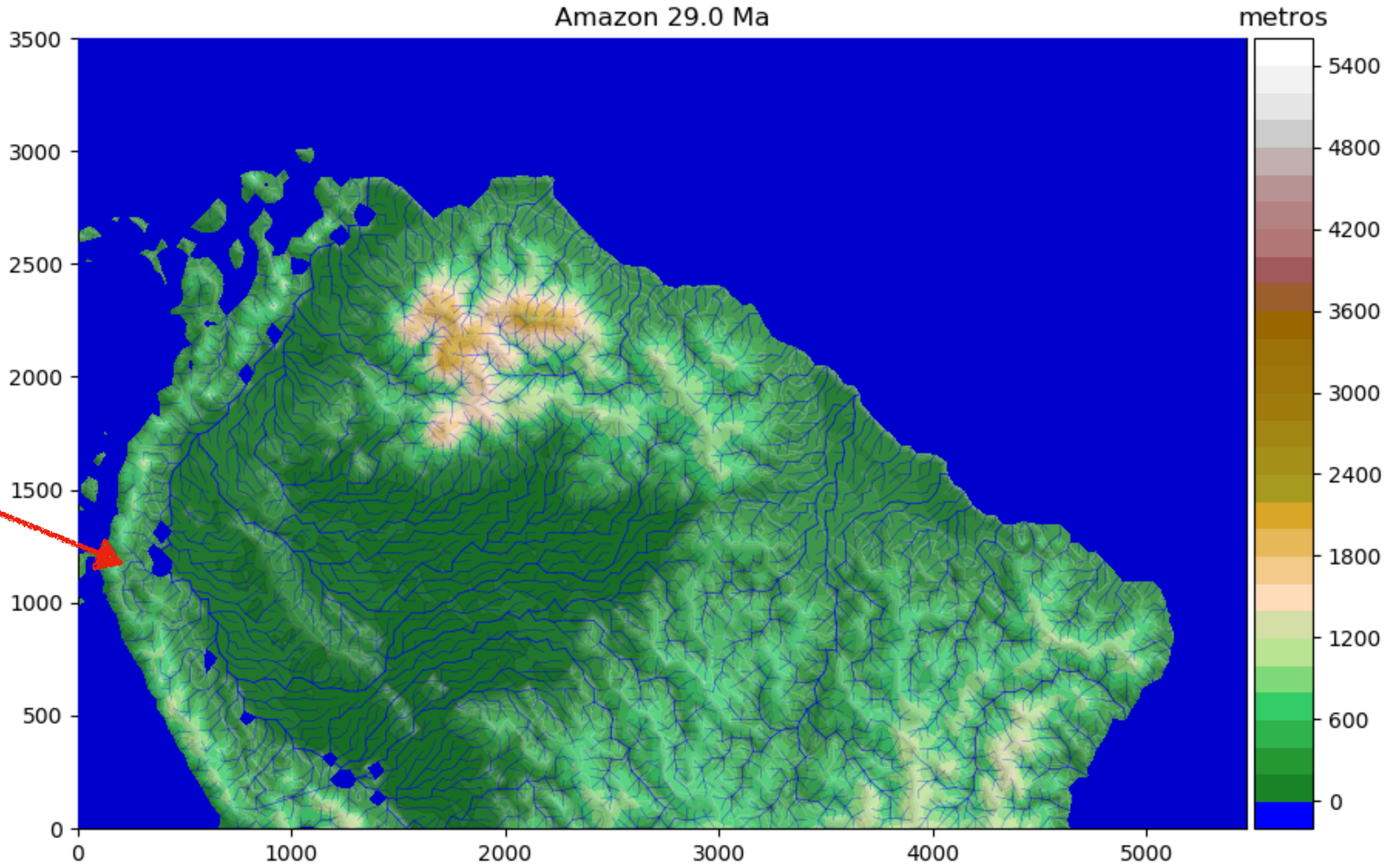


Without dynamic topography



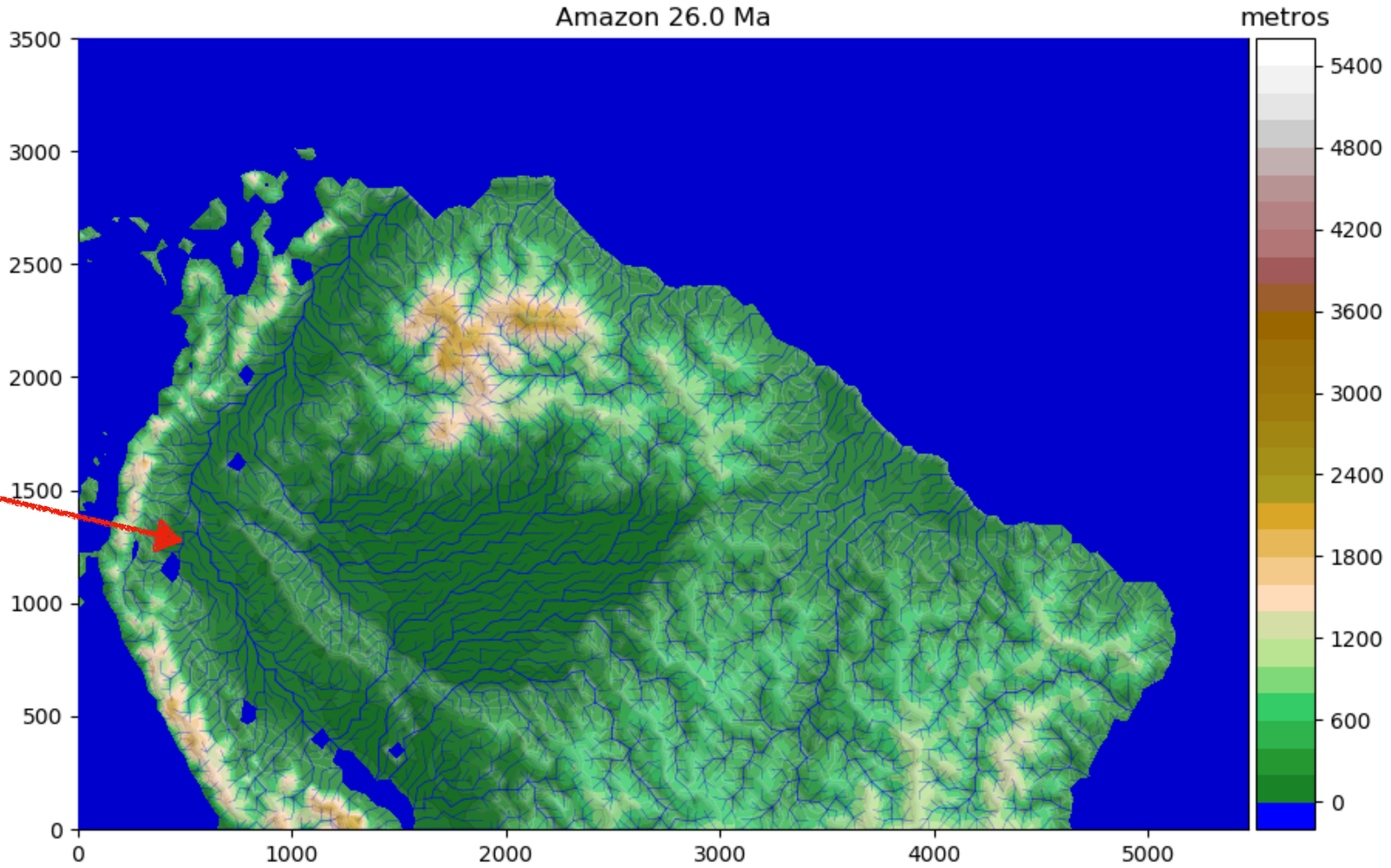
Without dynamic topography

Crustal thickening rate increased at 30 Ma in the Andes

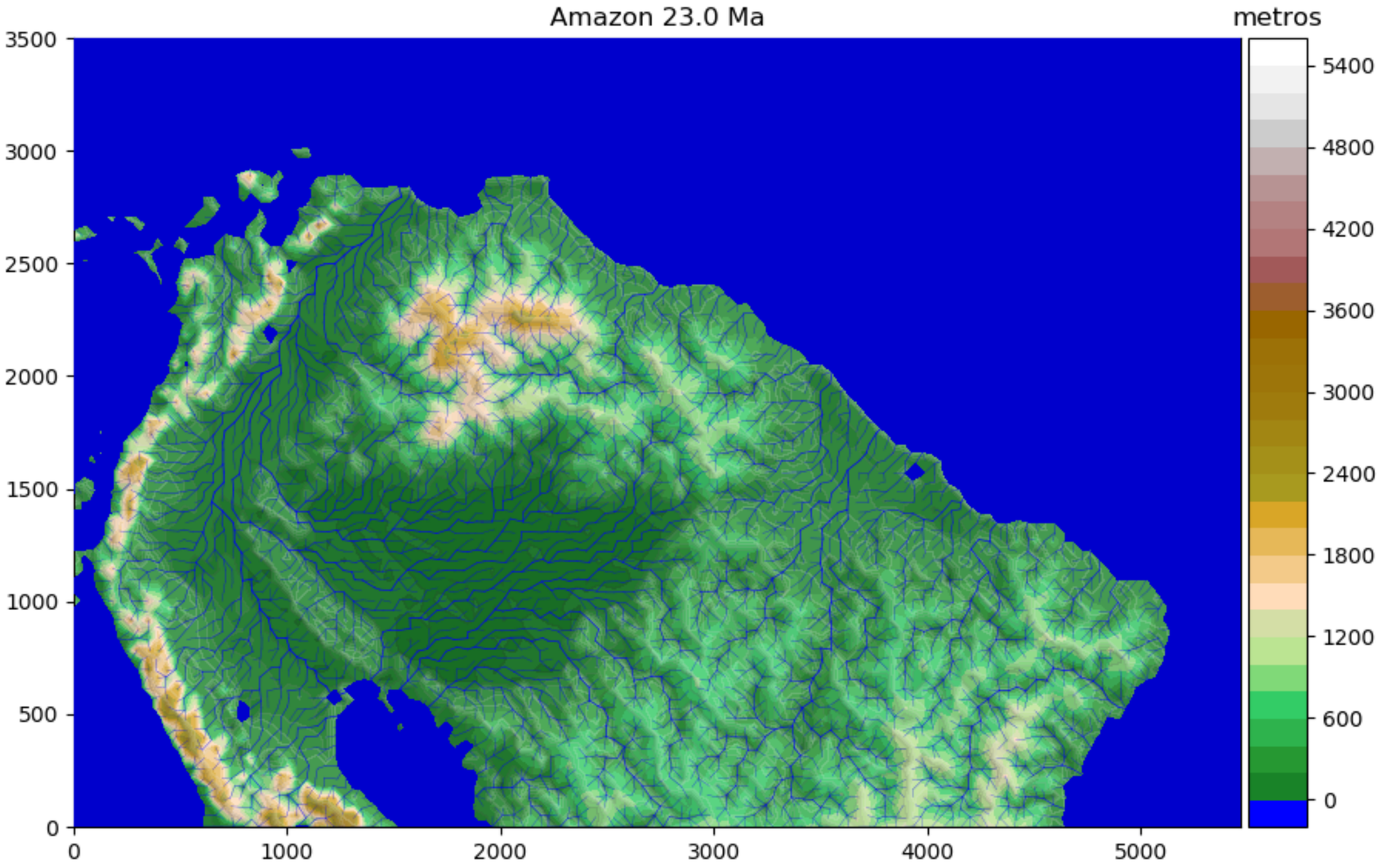


Without dynamic topography

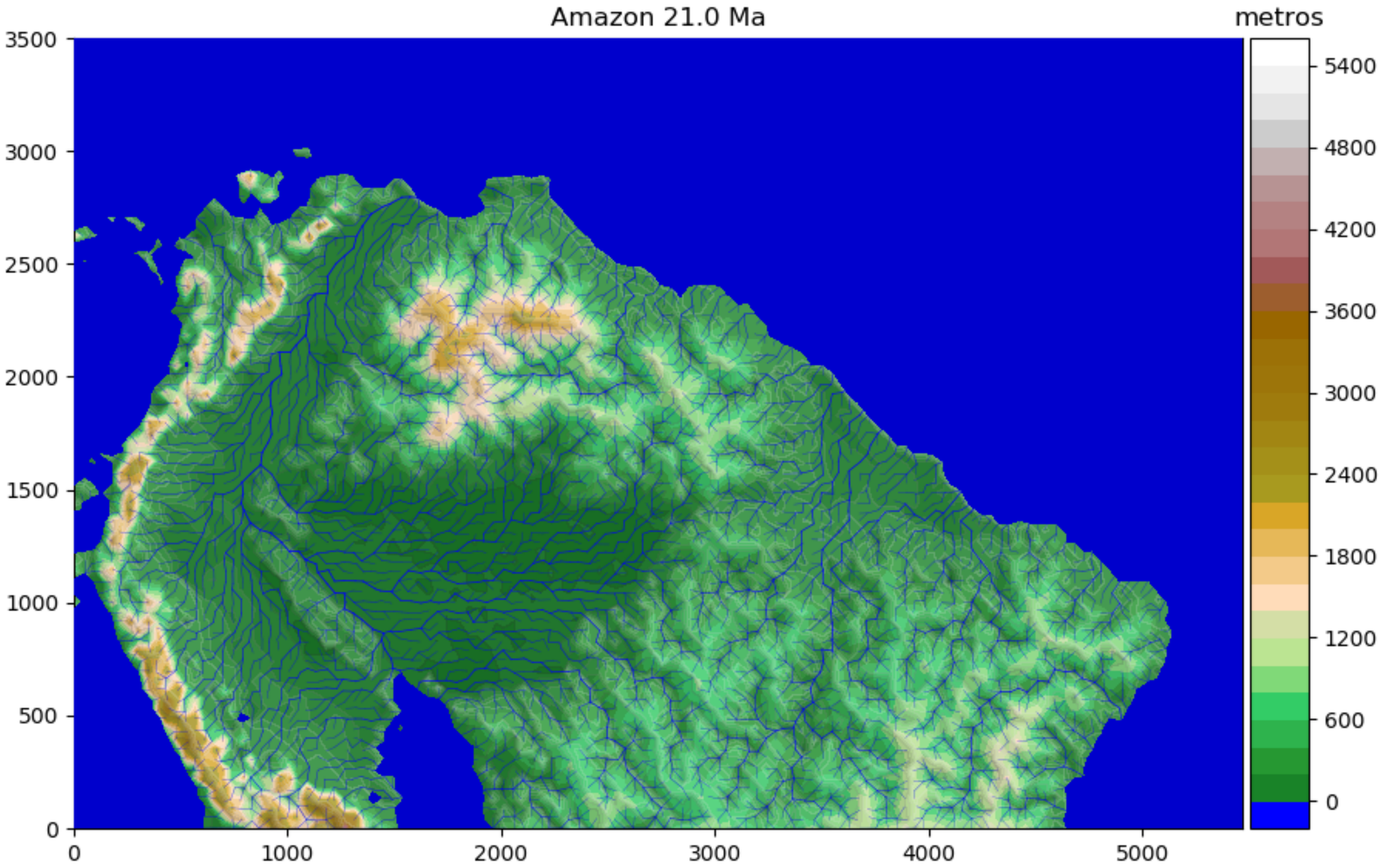
Axial river parallel to the cordillera



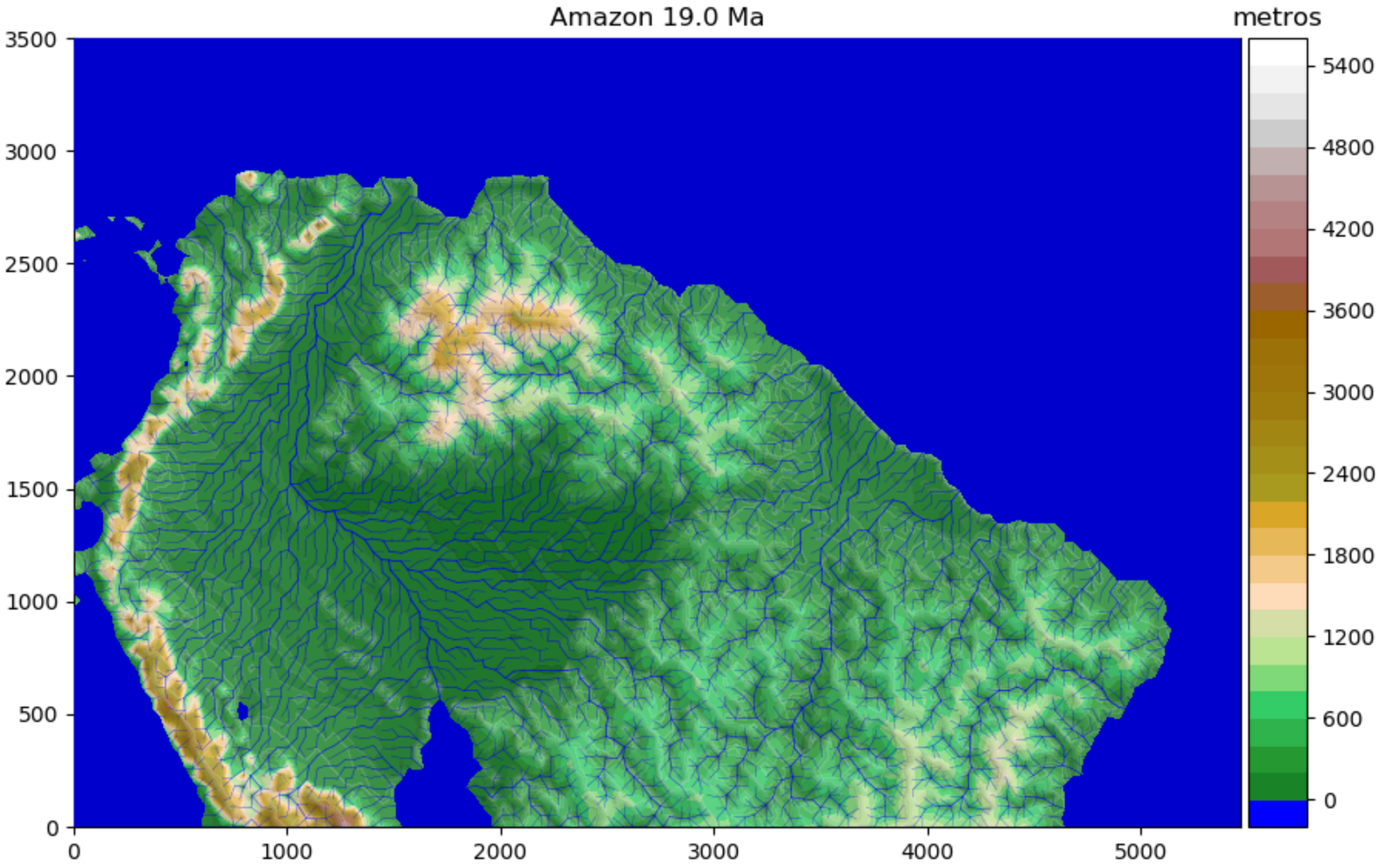
Without dynamic topography



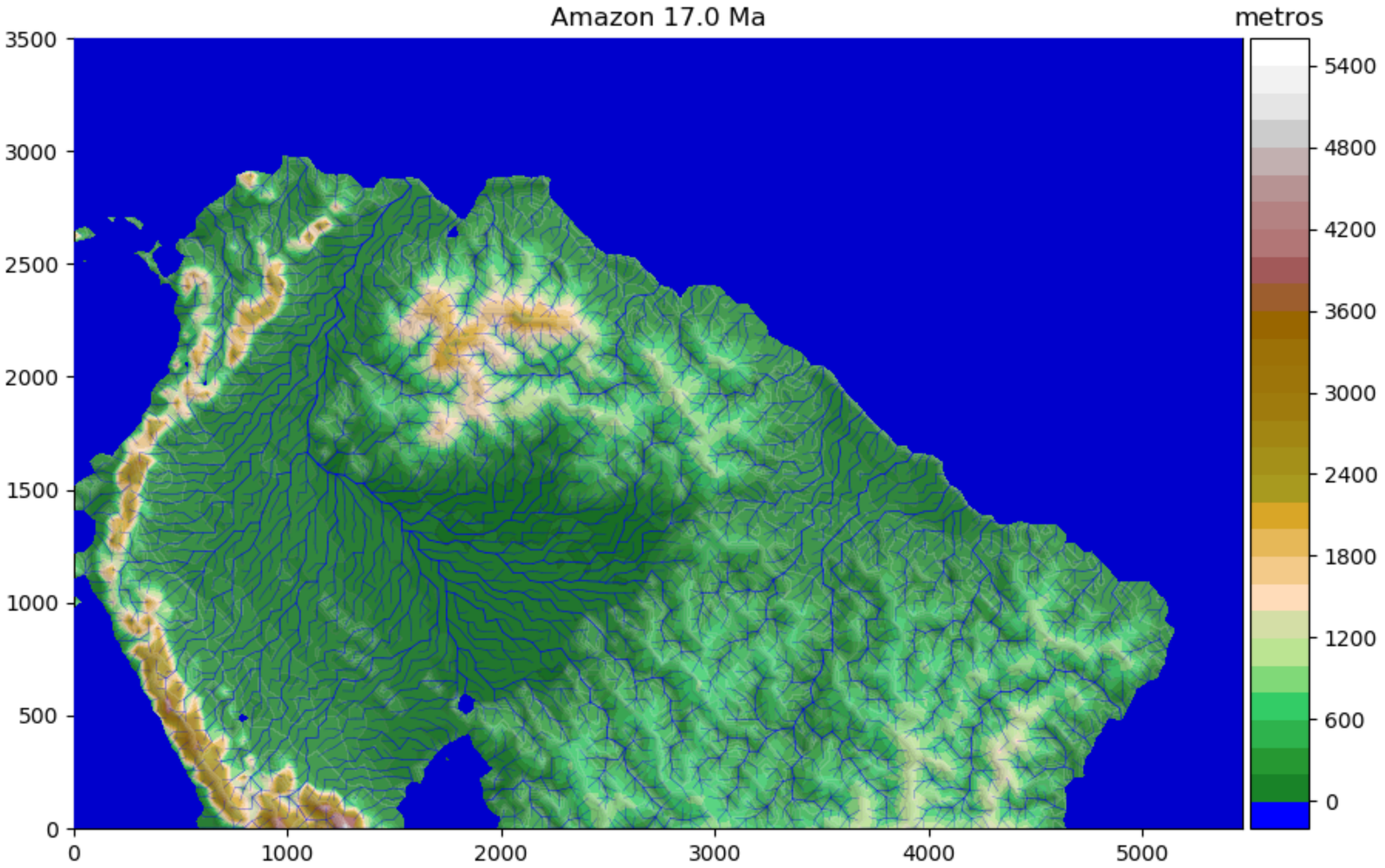
Without dynamic topography



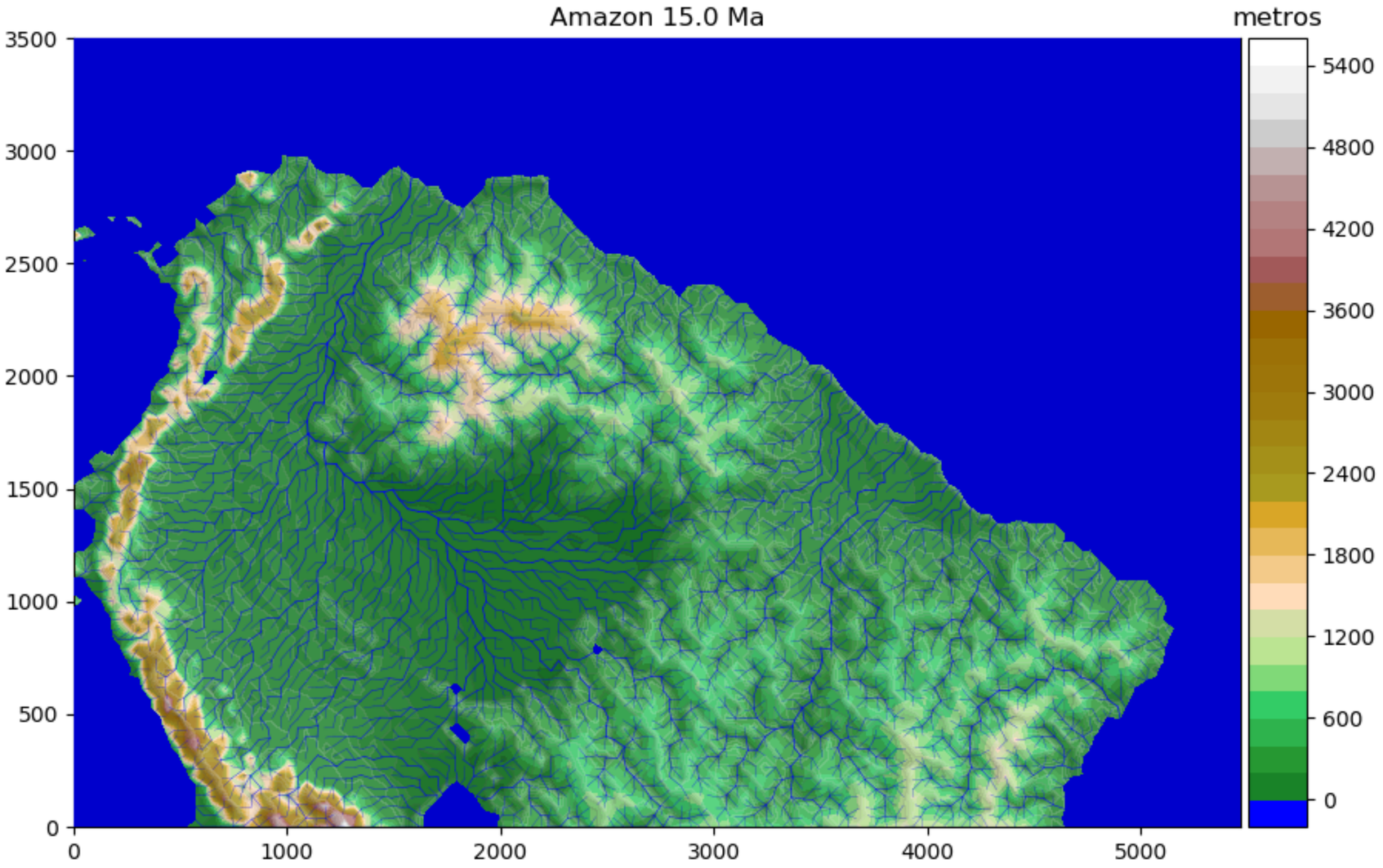
Without dynamic topography



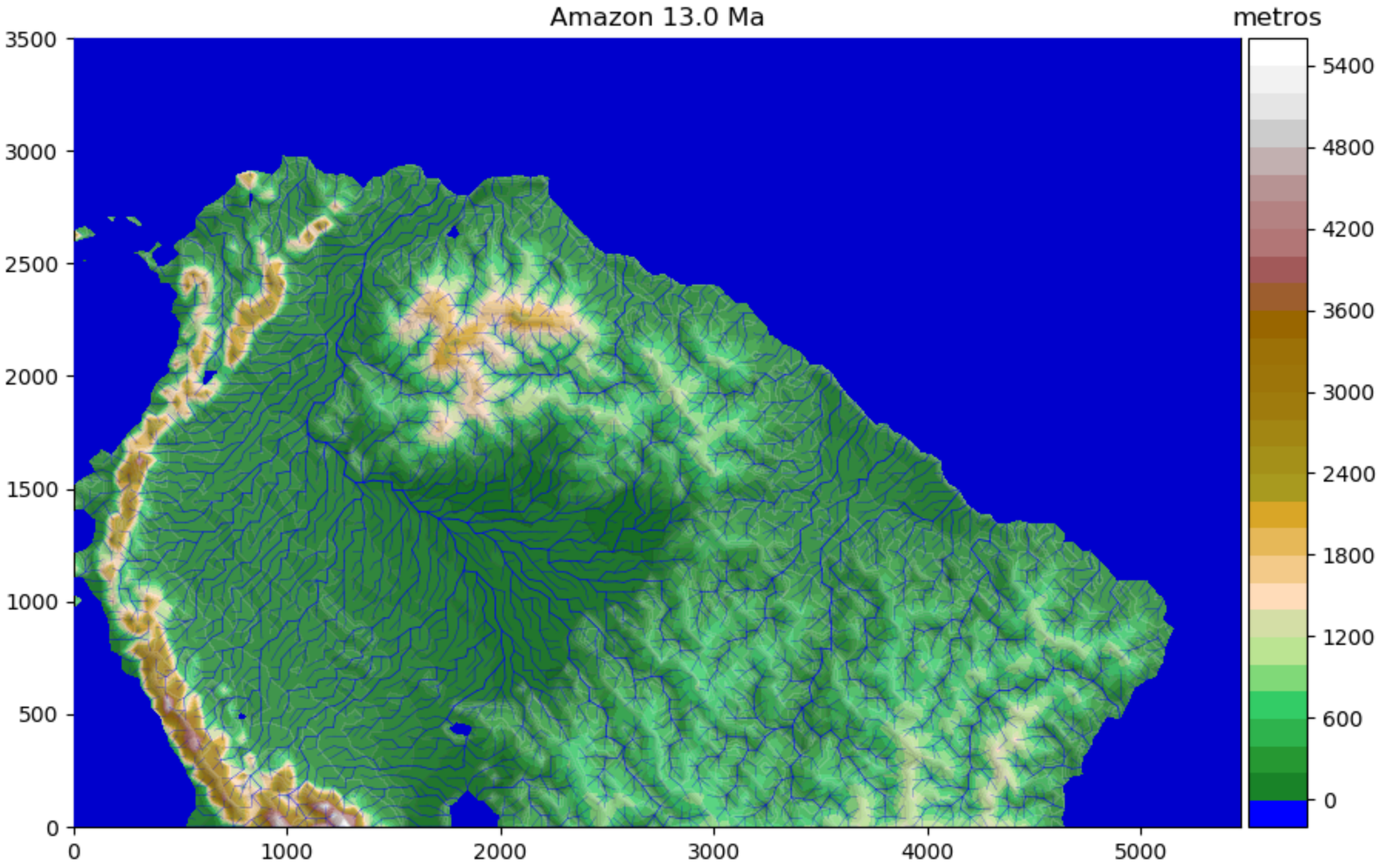
Without dynamic topography



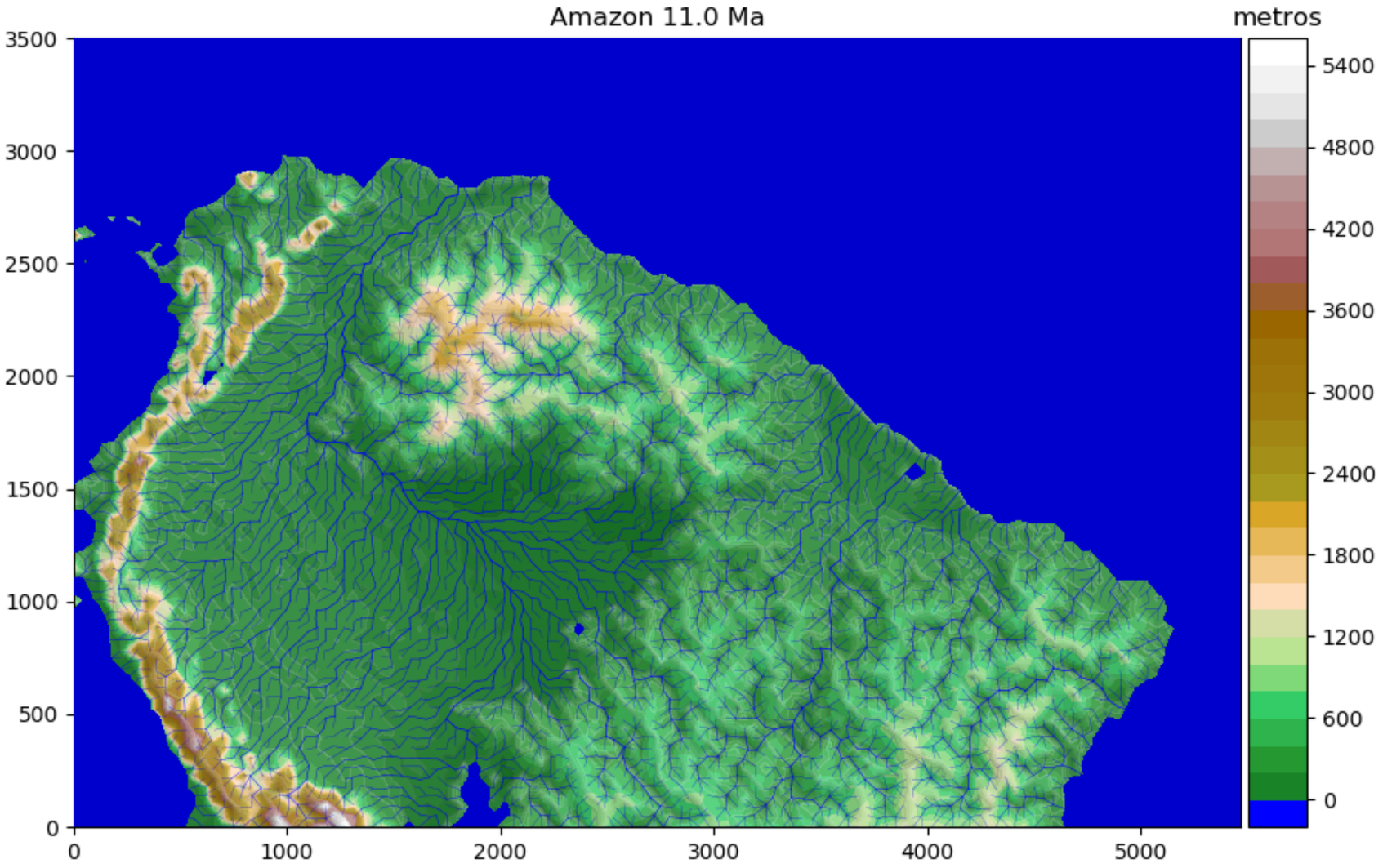
Without dynamic topography



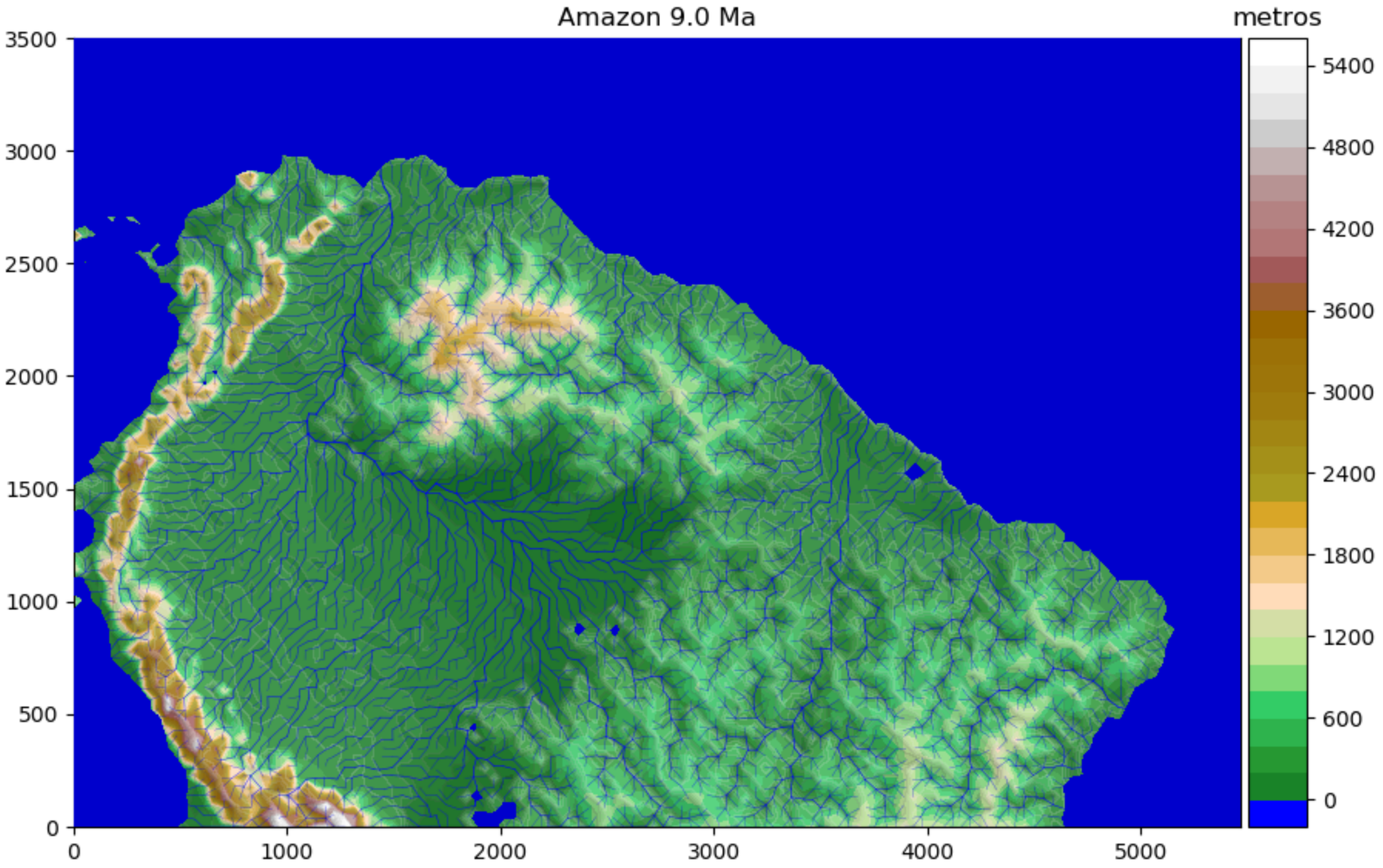
Without dynamic topography



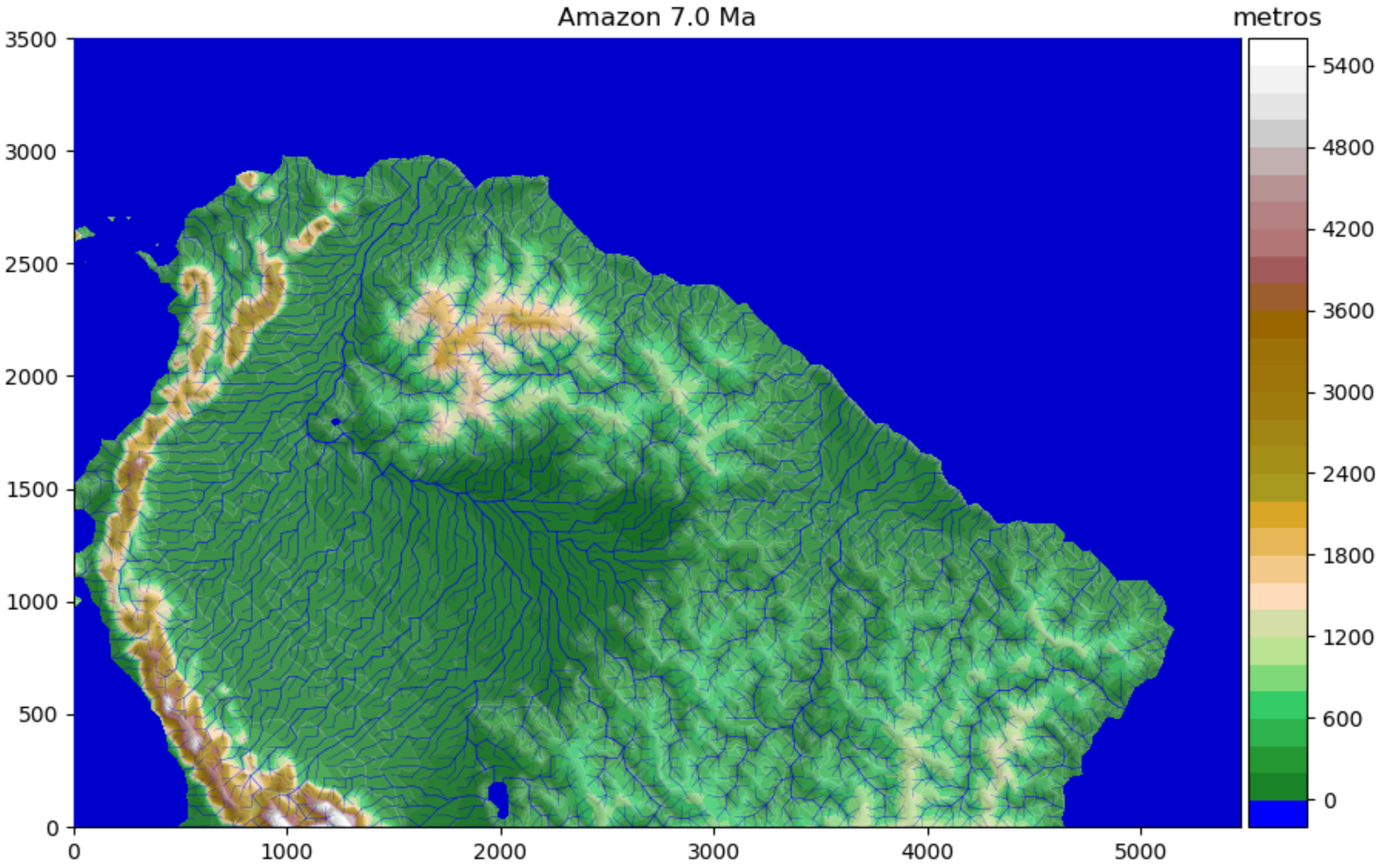
Without dynamic topography



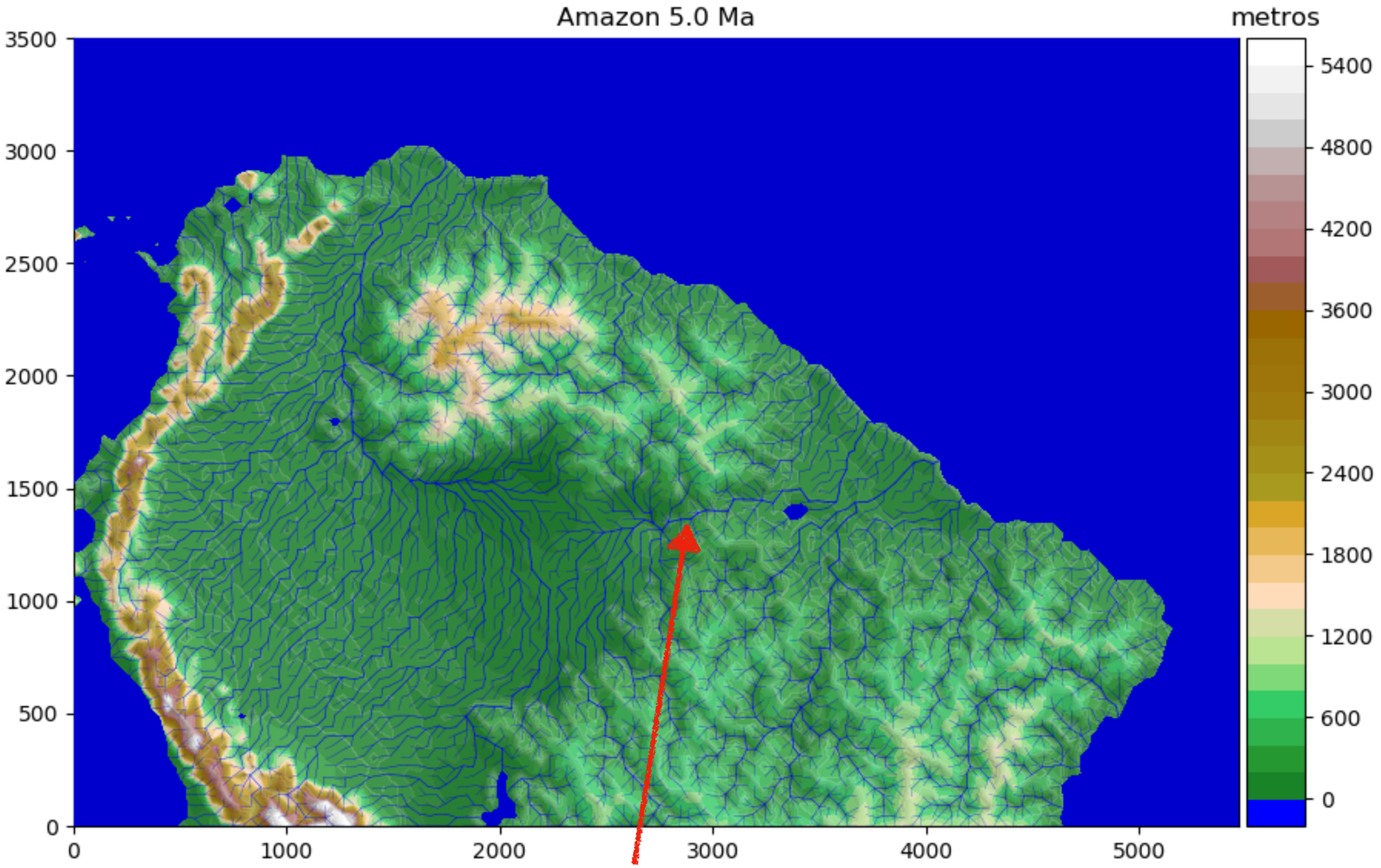
Without dynamic topography



Without dynamic topography

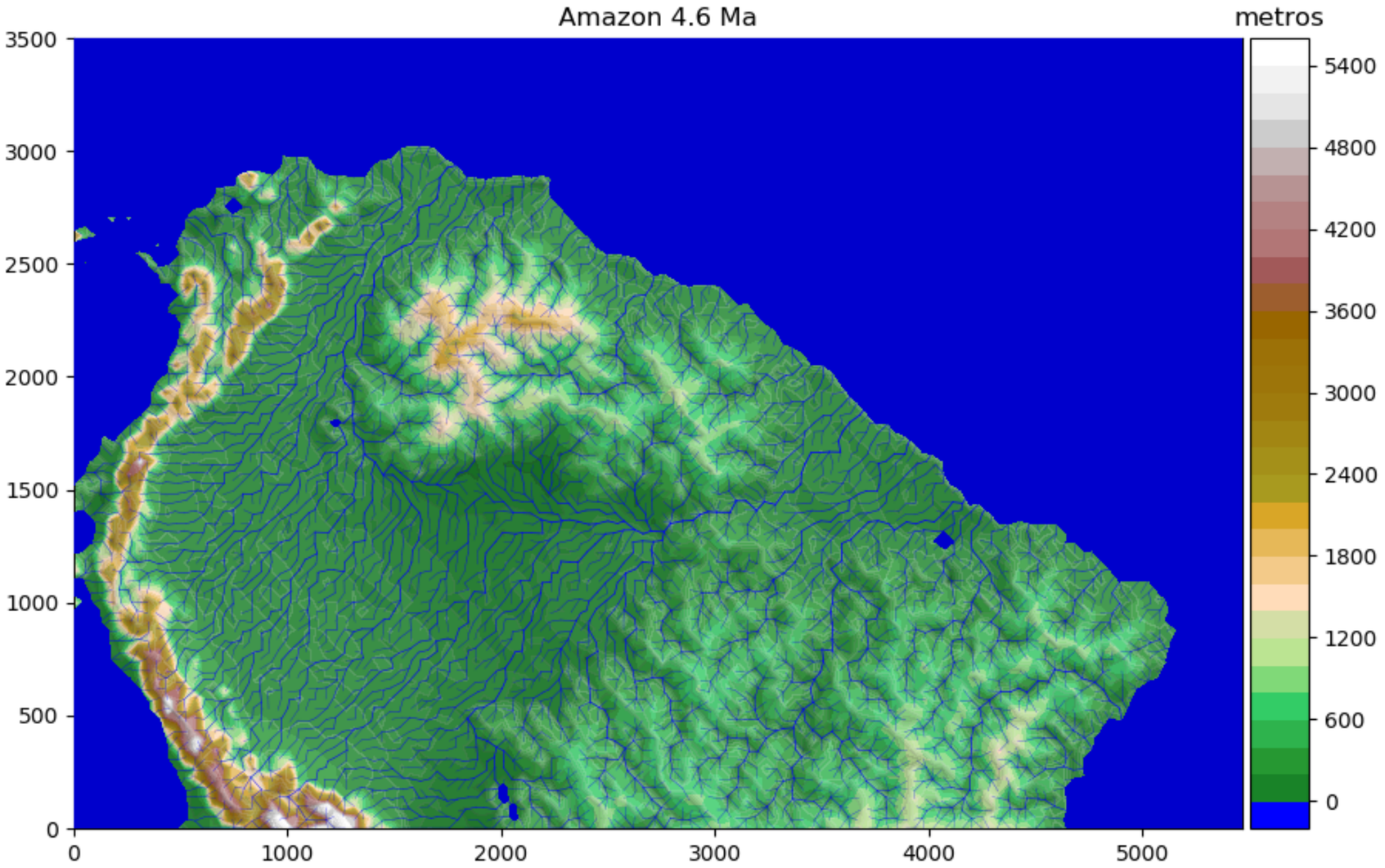


Without dynamic topography

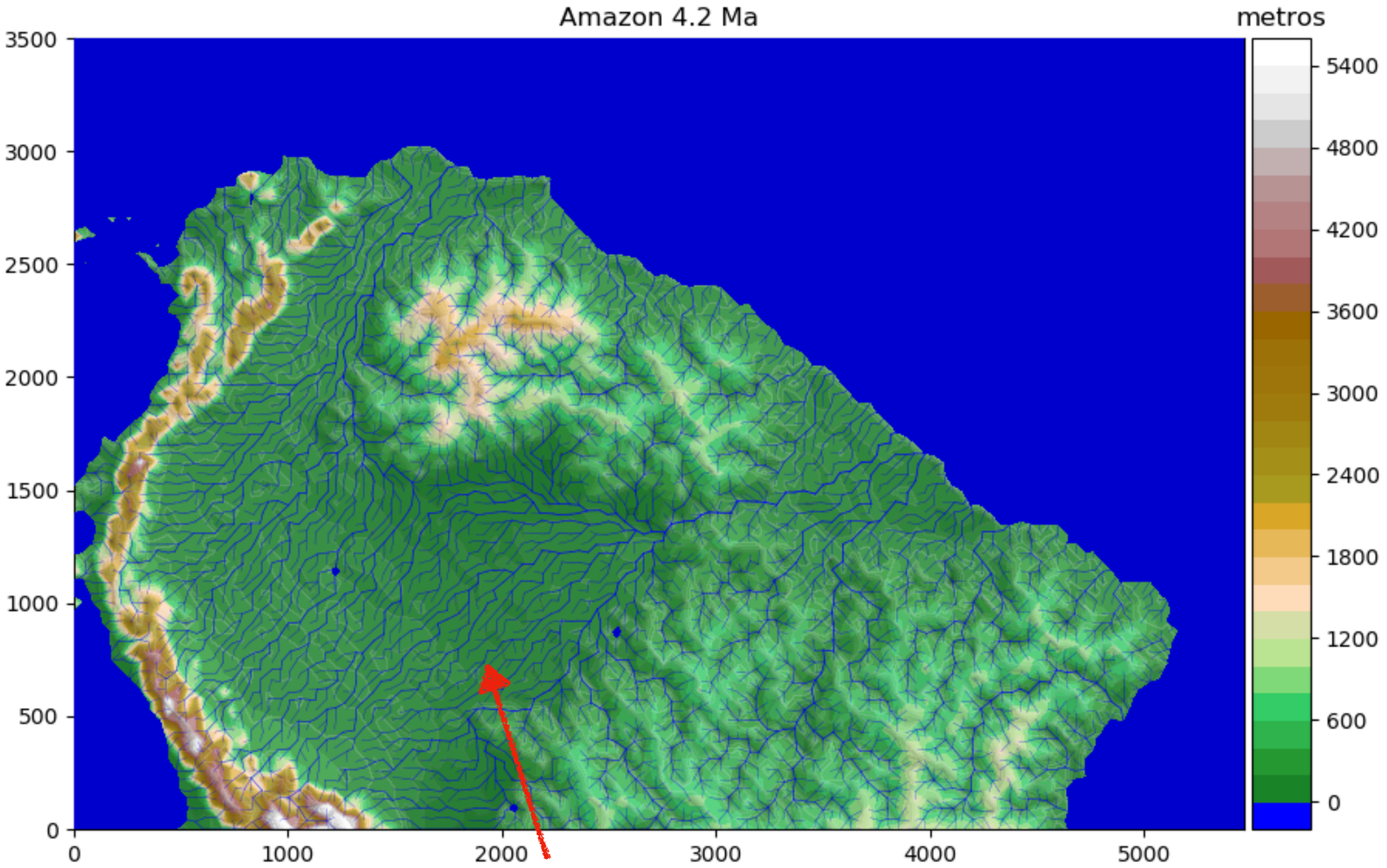


Initial connection of eastern and western Amazonia

Without dynamic topography

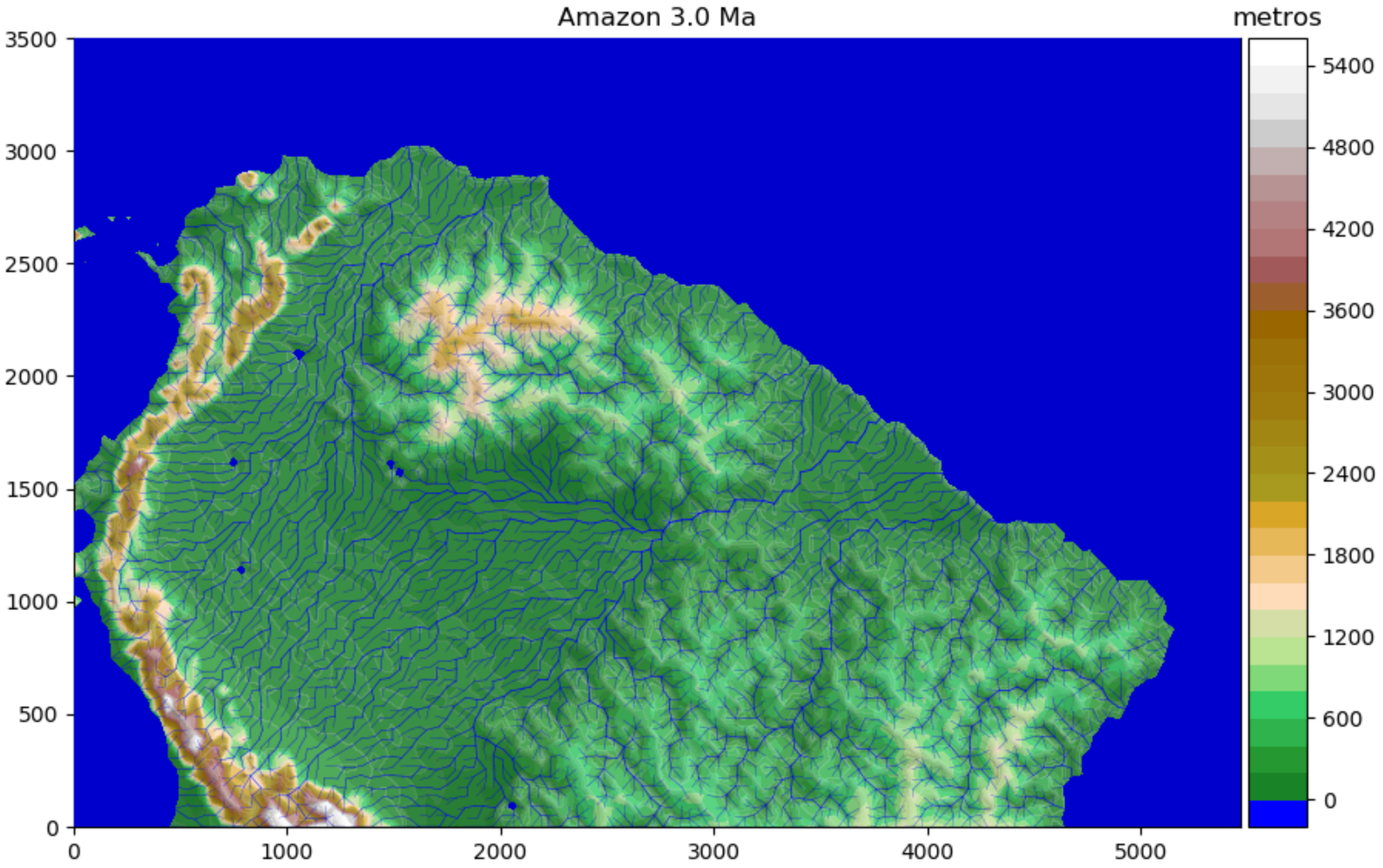


Without dynamic topography

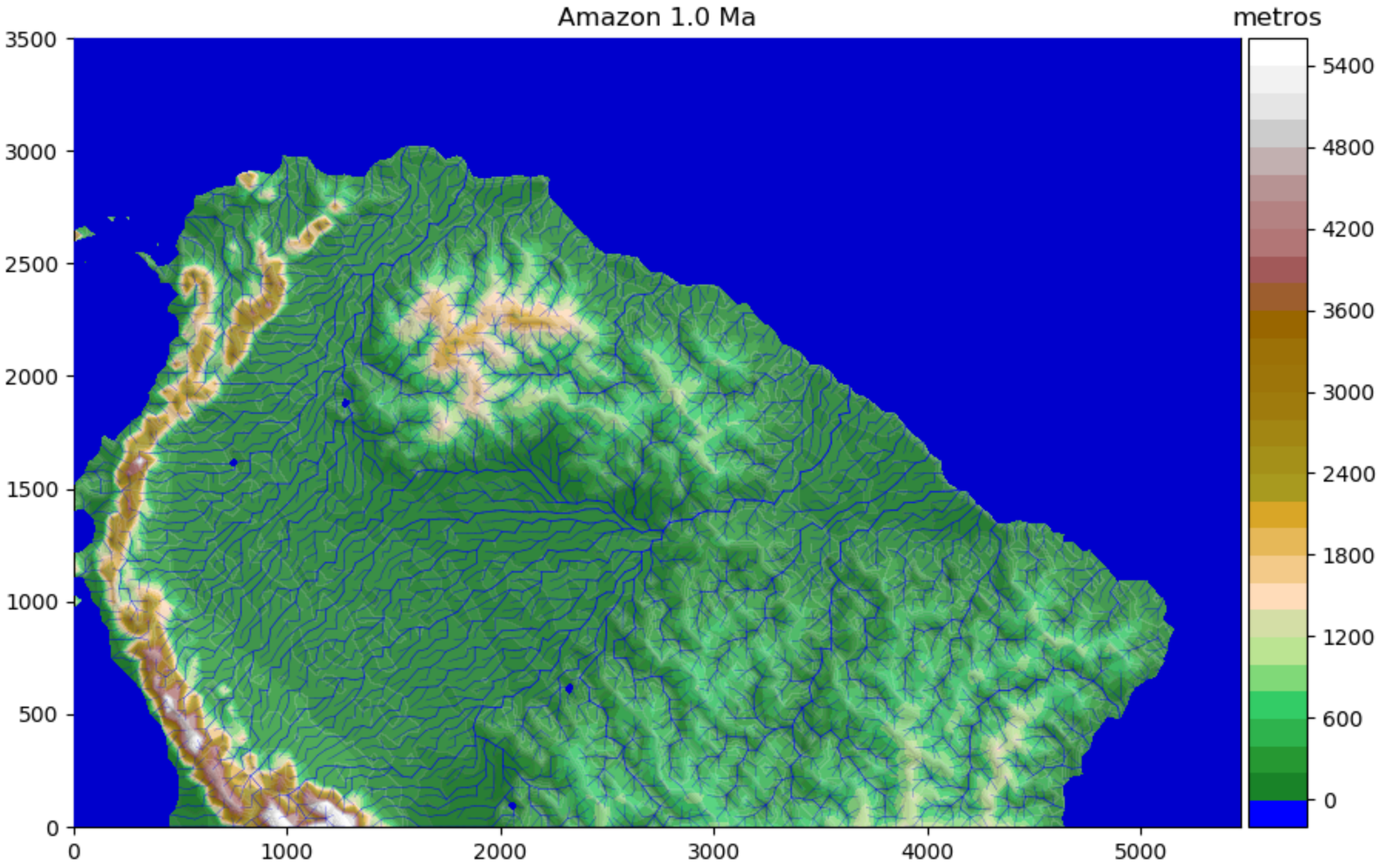


Expansion of the drainage basin

Without dynamic topography



Without dynamic topography

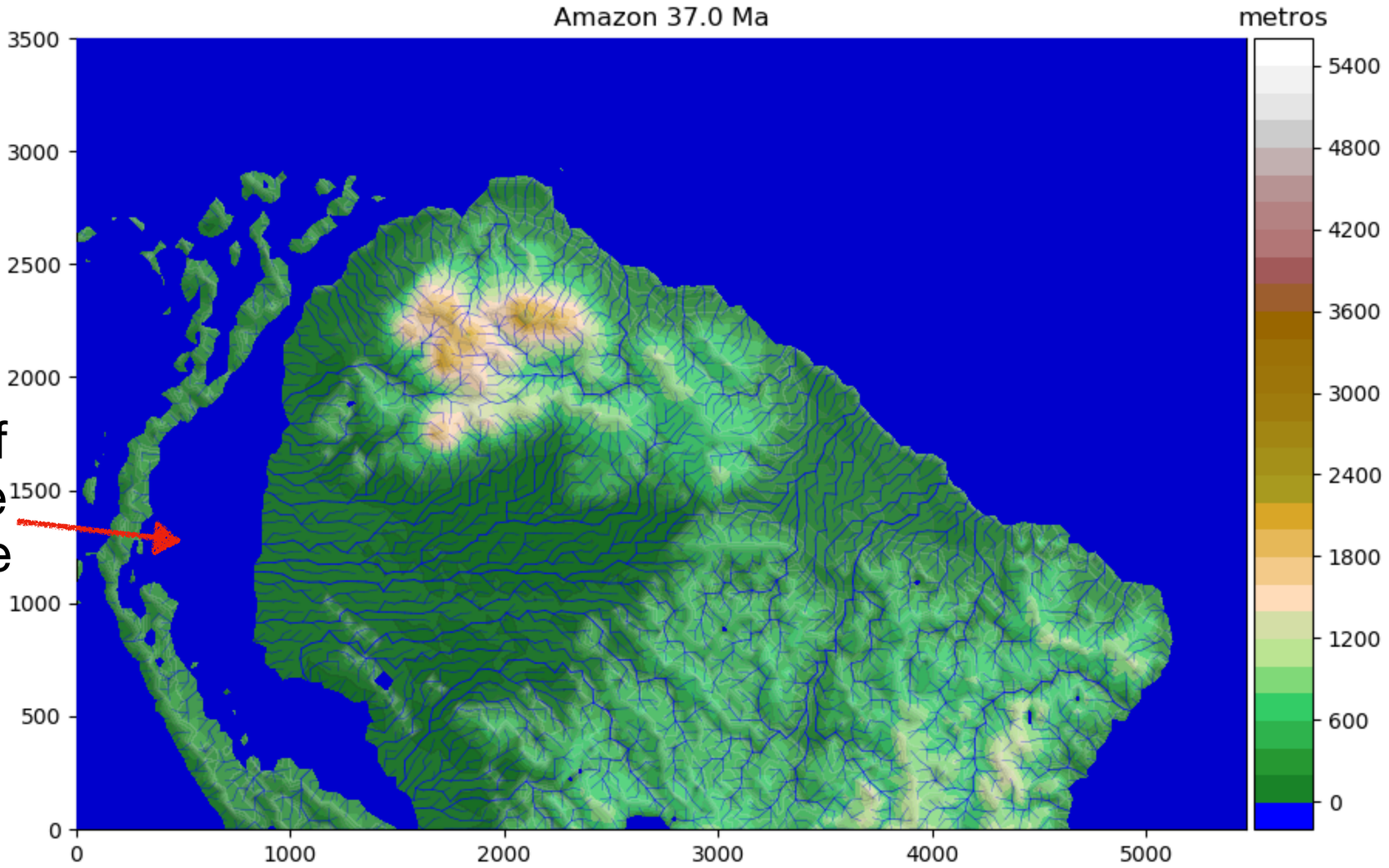


Scenario with dynamic topography

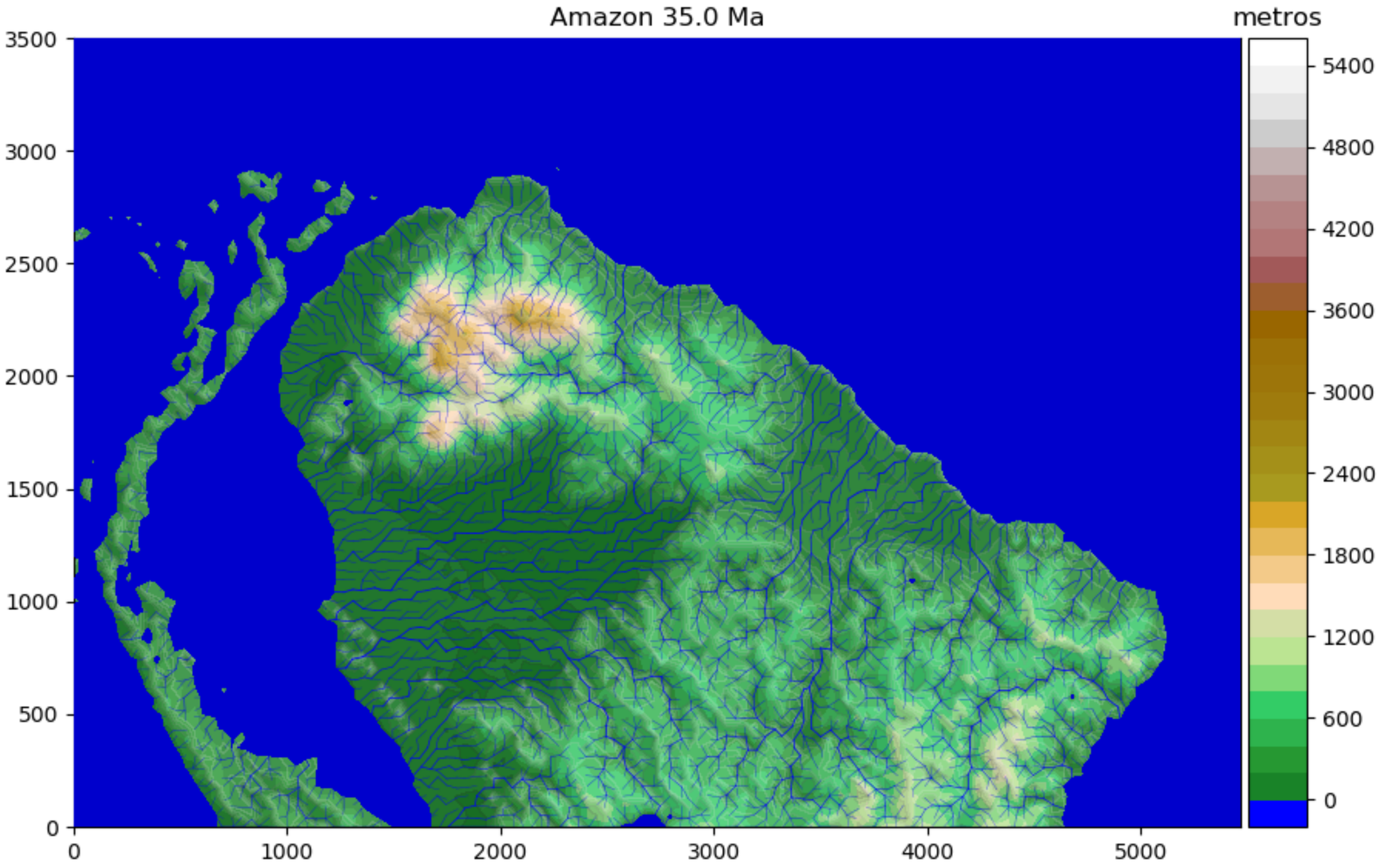
dynamic topography maps through time
calculated by Flament et al. (2015)

With dynamic topography

Broader aquatic environment due to the amplification of the subsidence due to negative dynamic topography

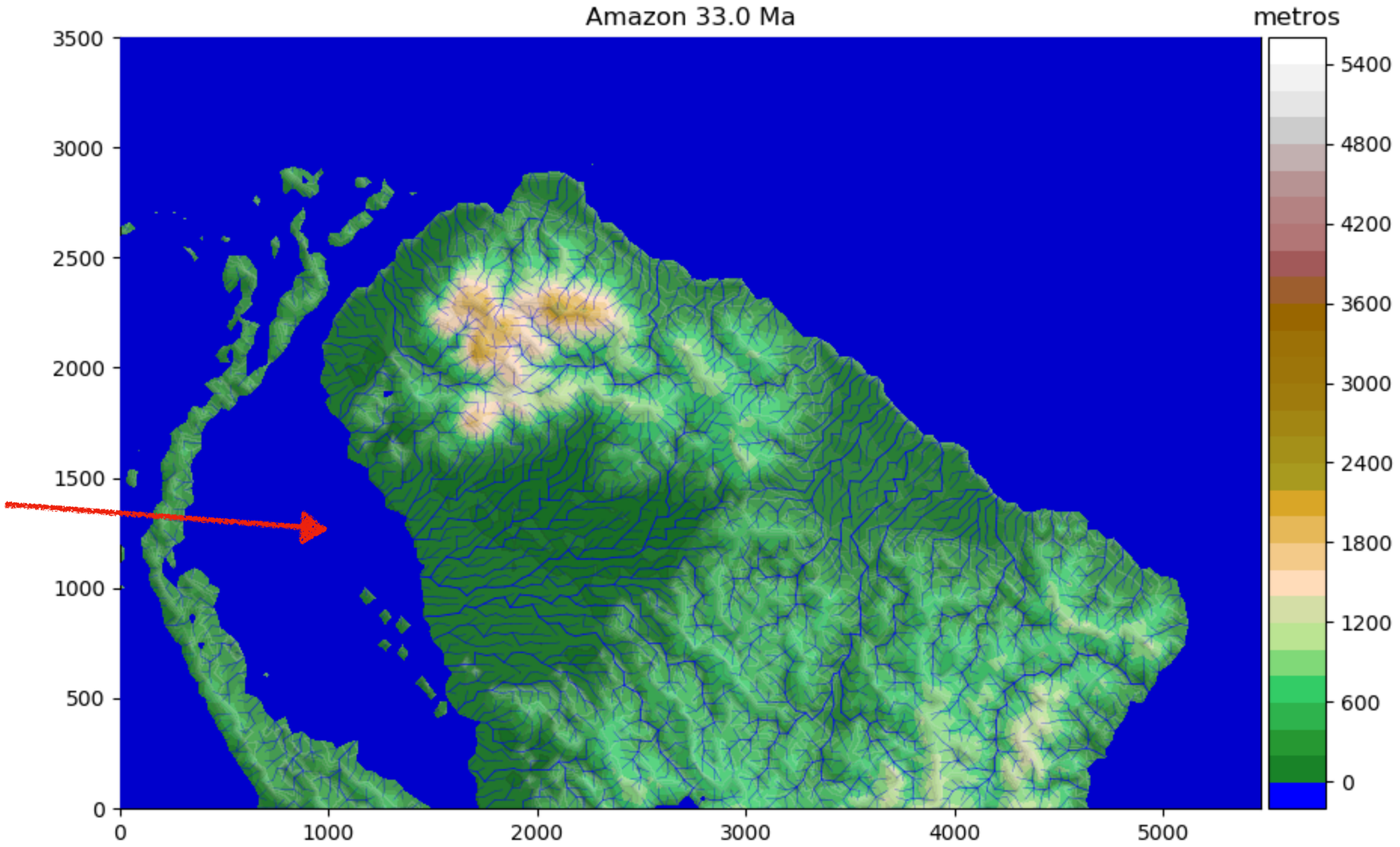


With dynamic topography

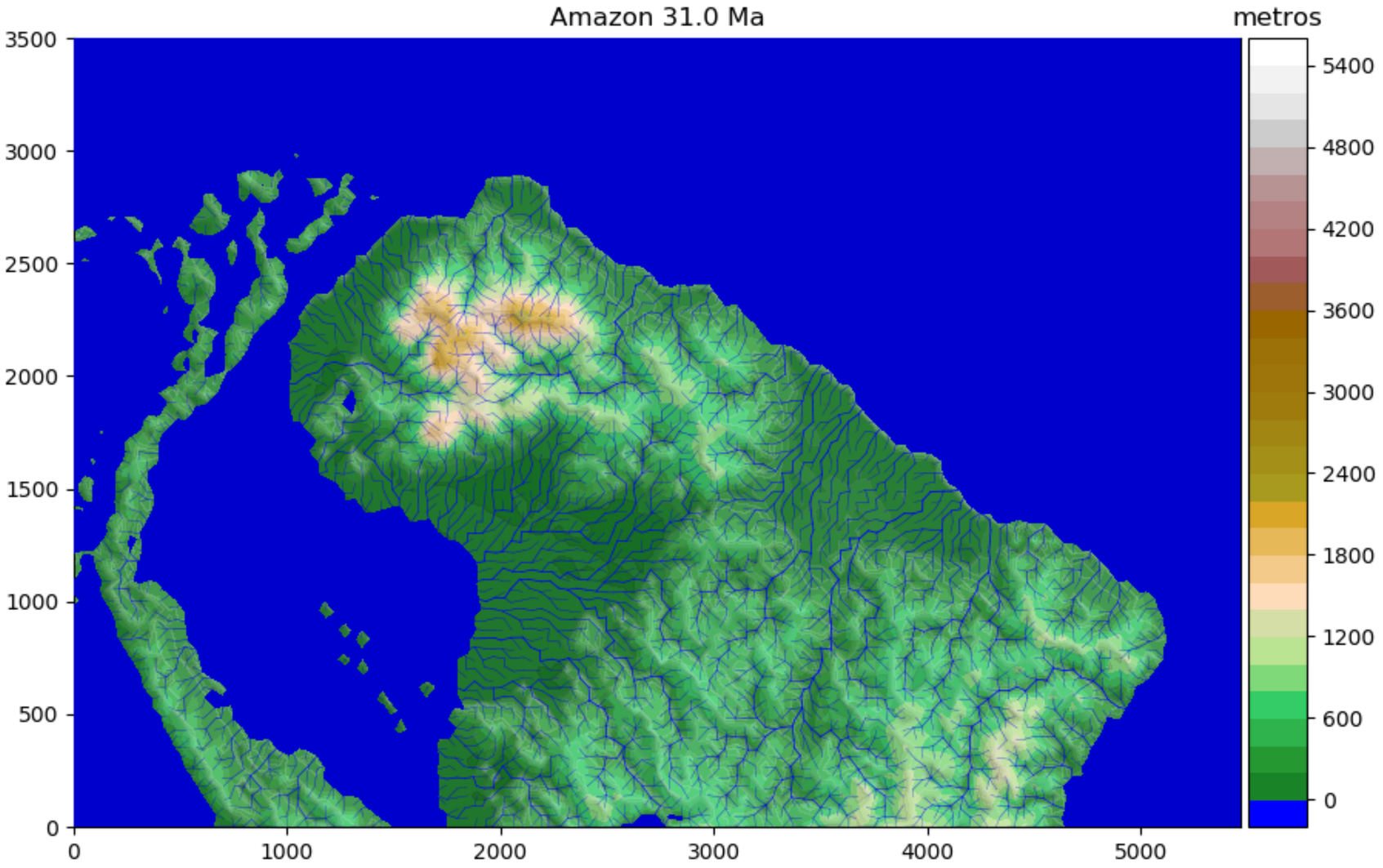


With dynamic topography

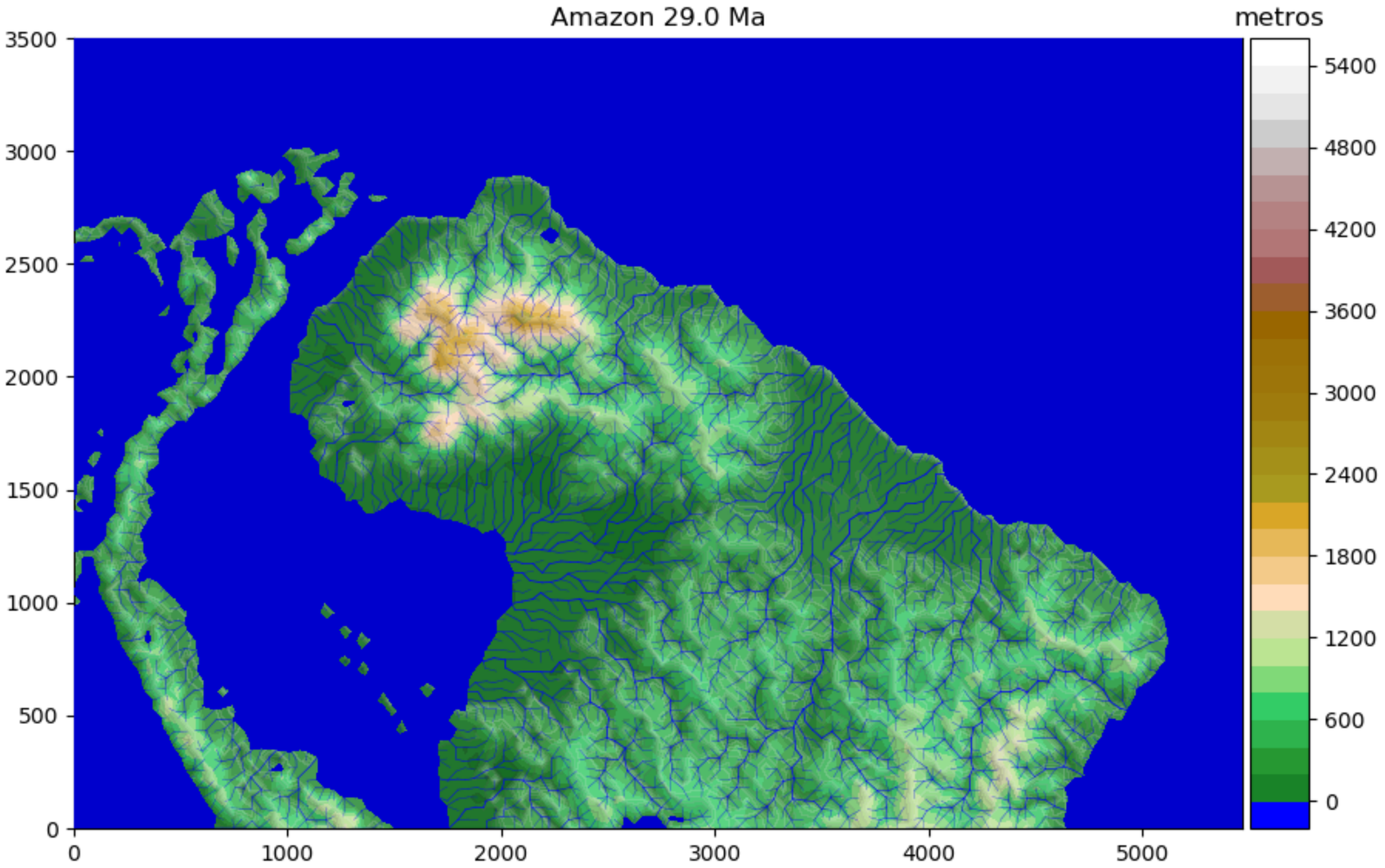
Eastward expansion of the aquatic environment (Pebas System?)



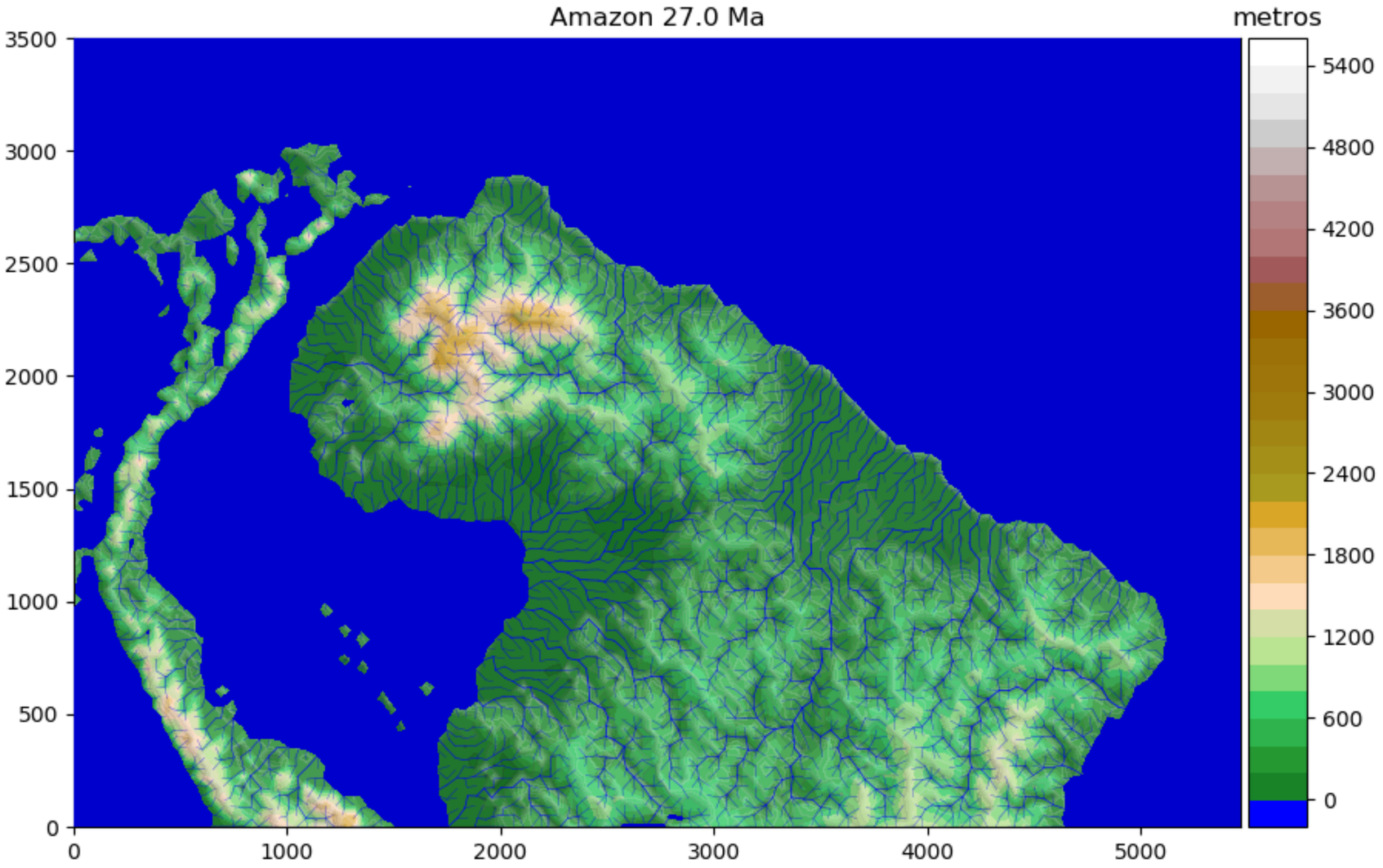
With dynamic topography



With dynamic topography

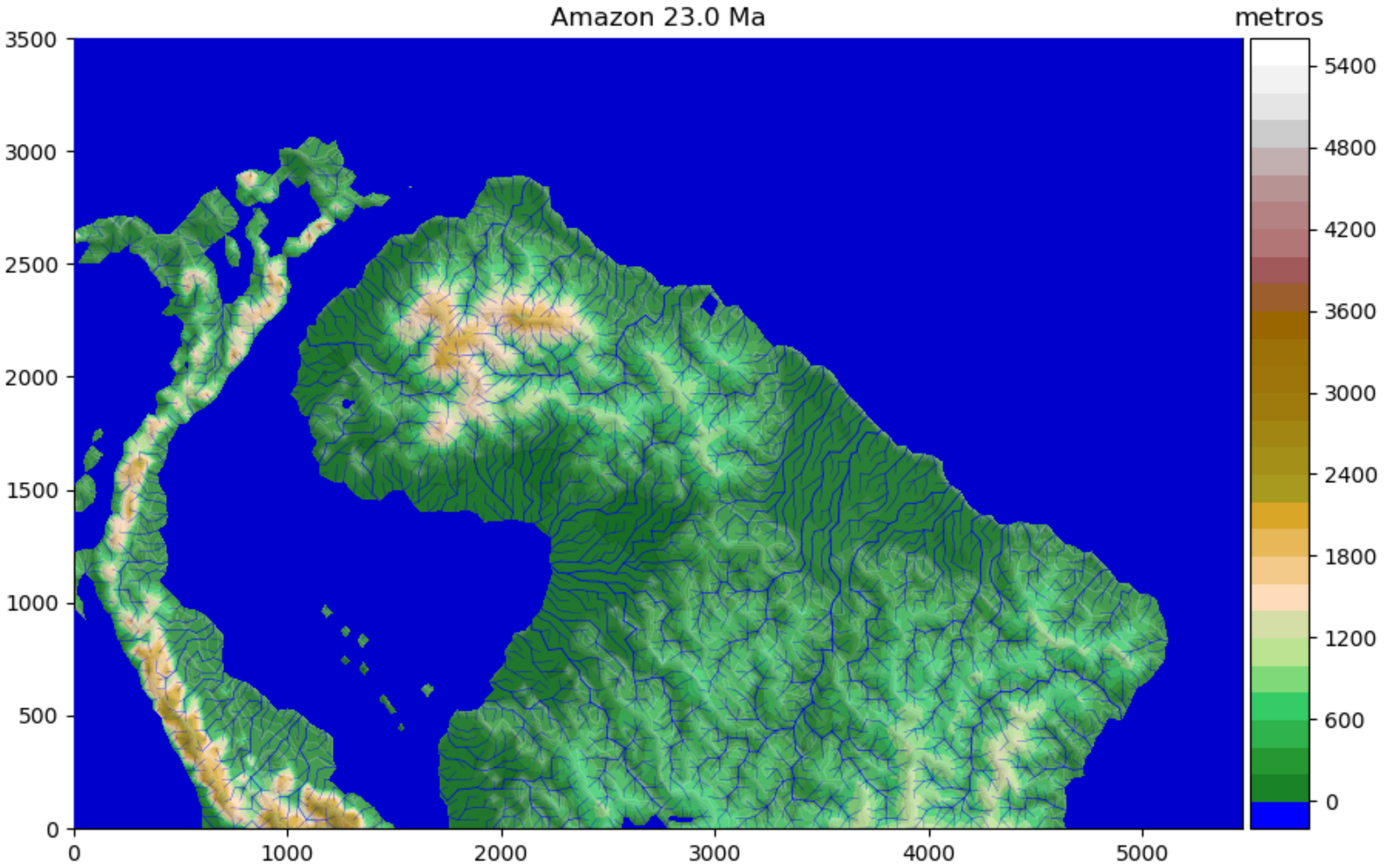


With dynamic topography



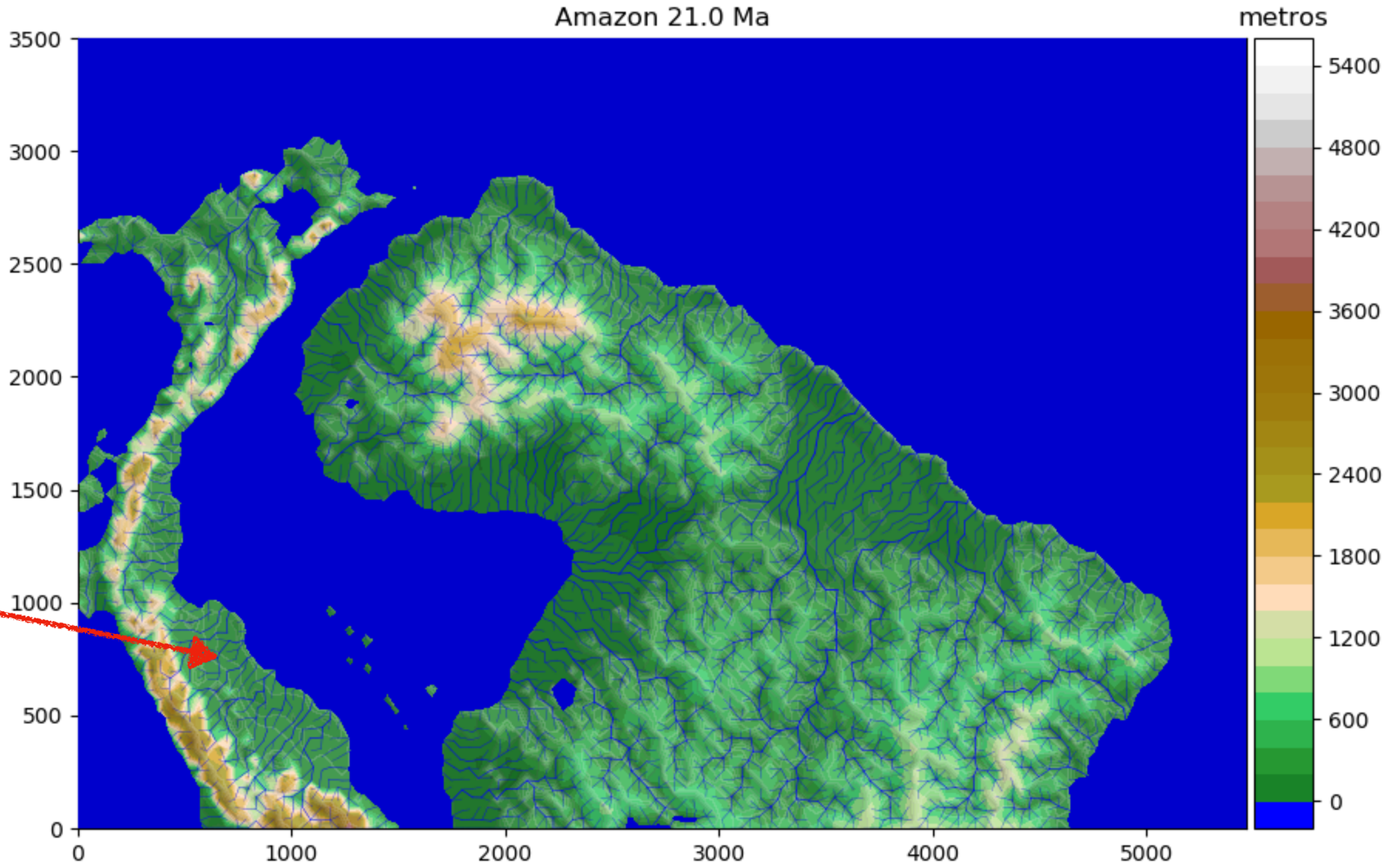
With dynamic topography

With dynamic topography

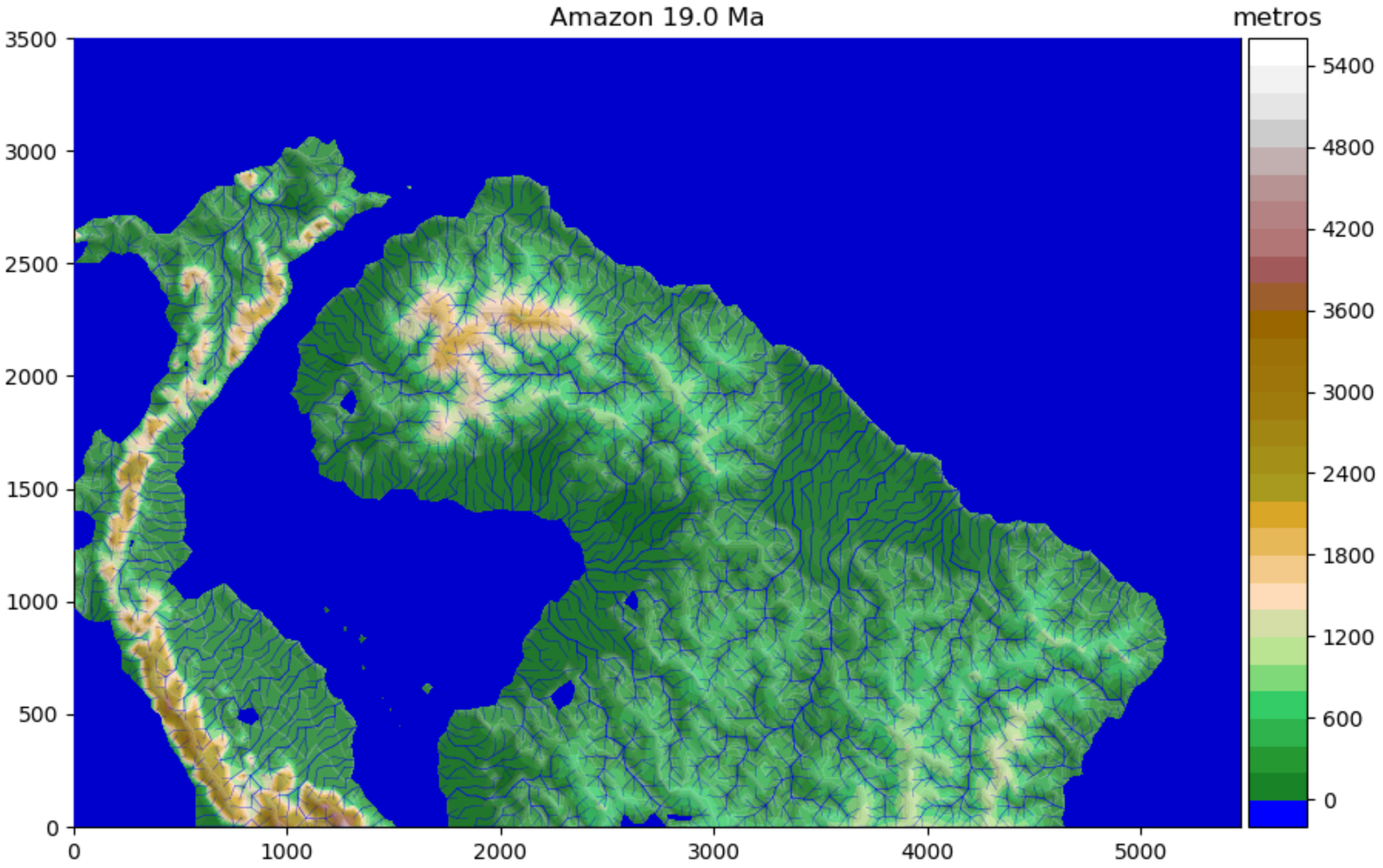


With dynamic topography

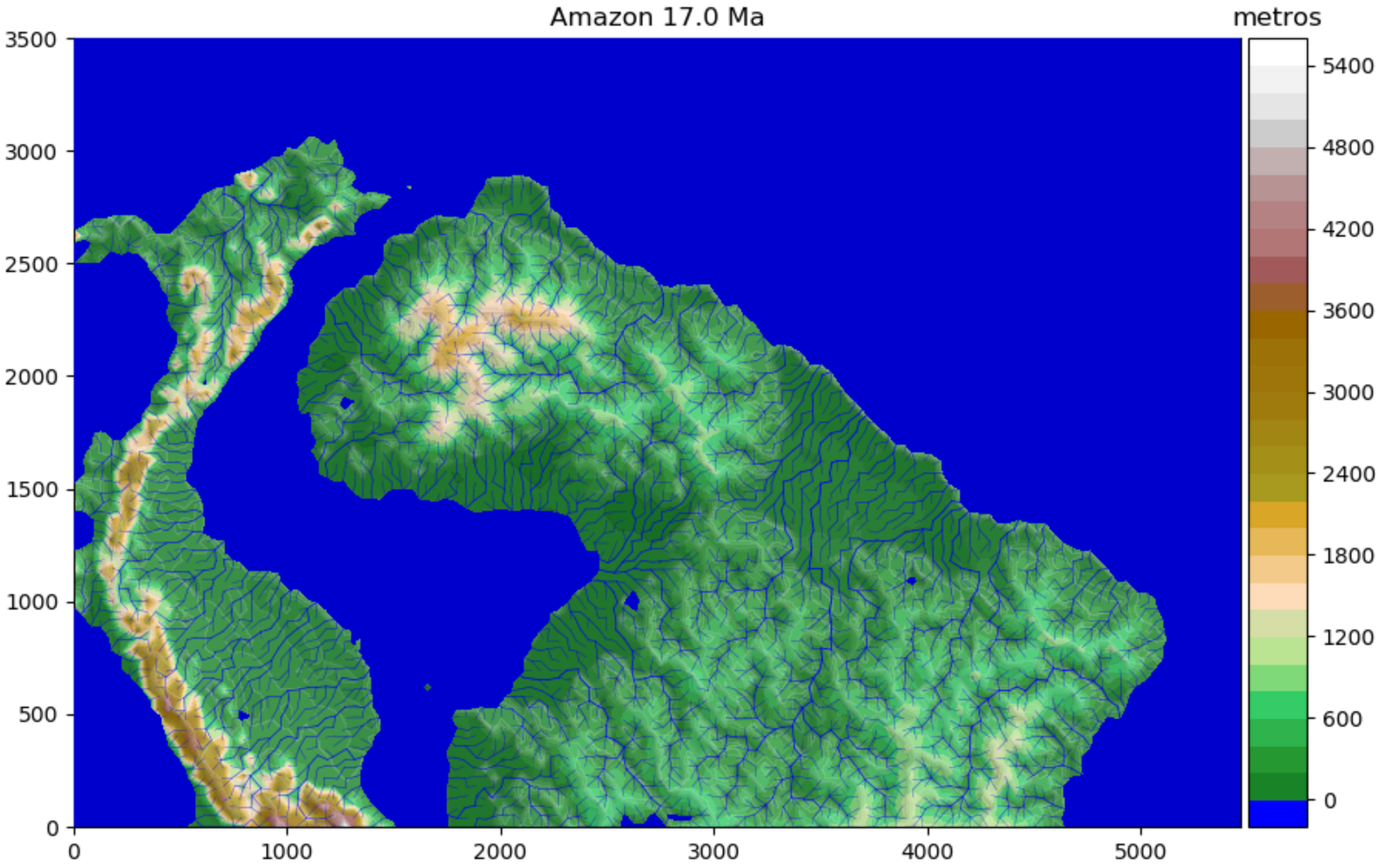
Andean-derived sediment wedge advancing eastward



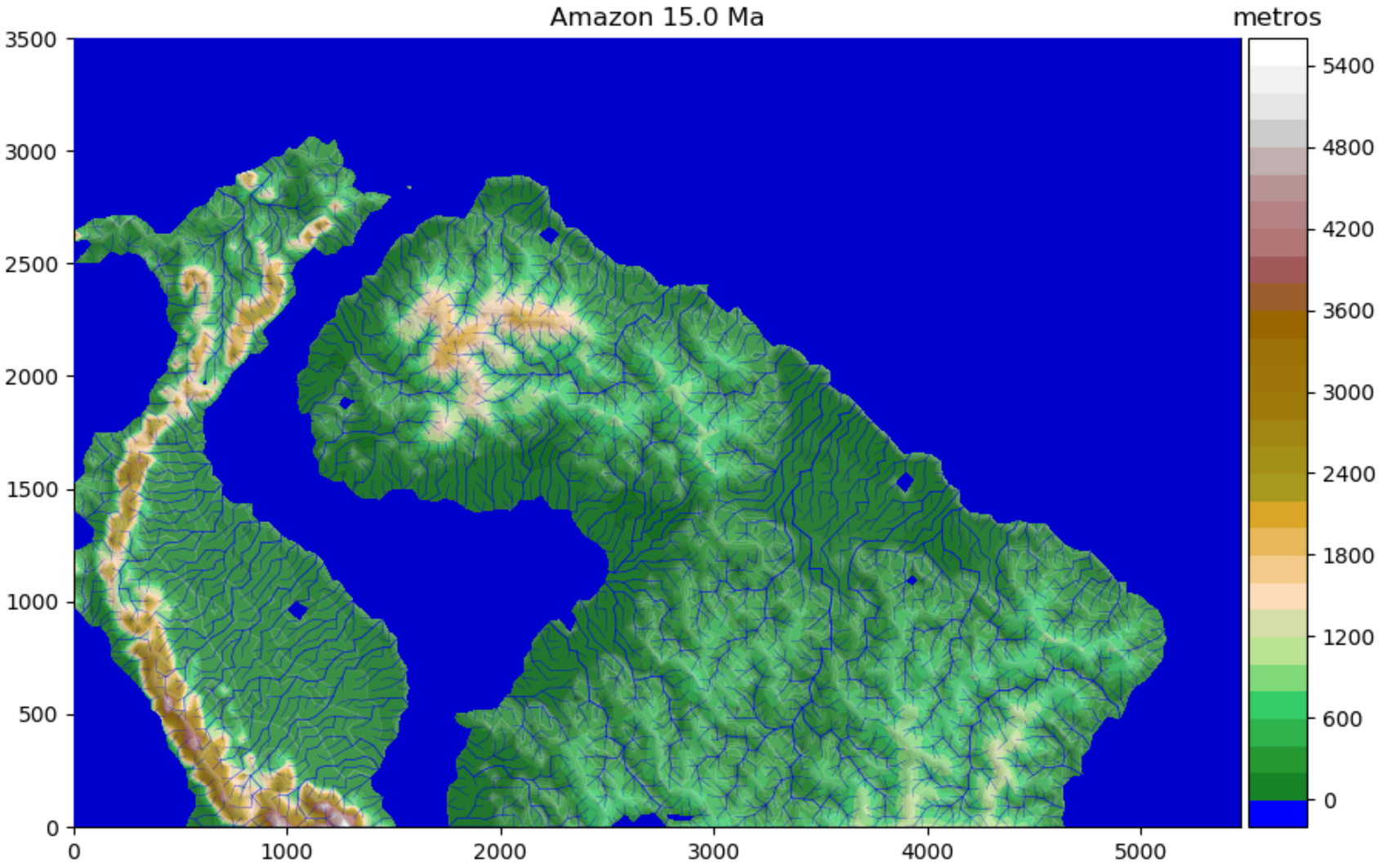
With dynamic topography



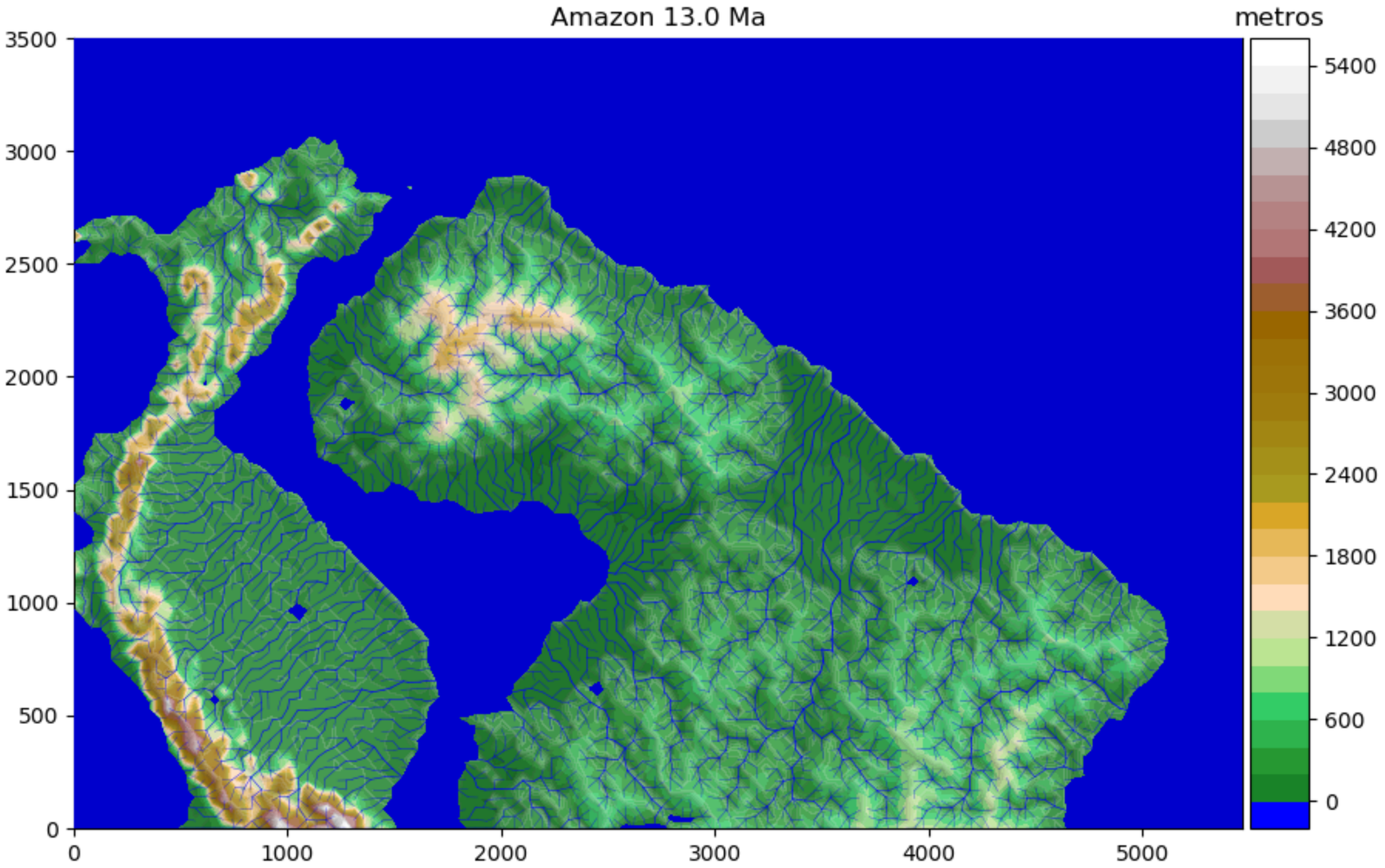
With dynamic topography



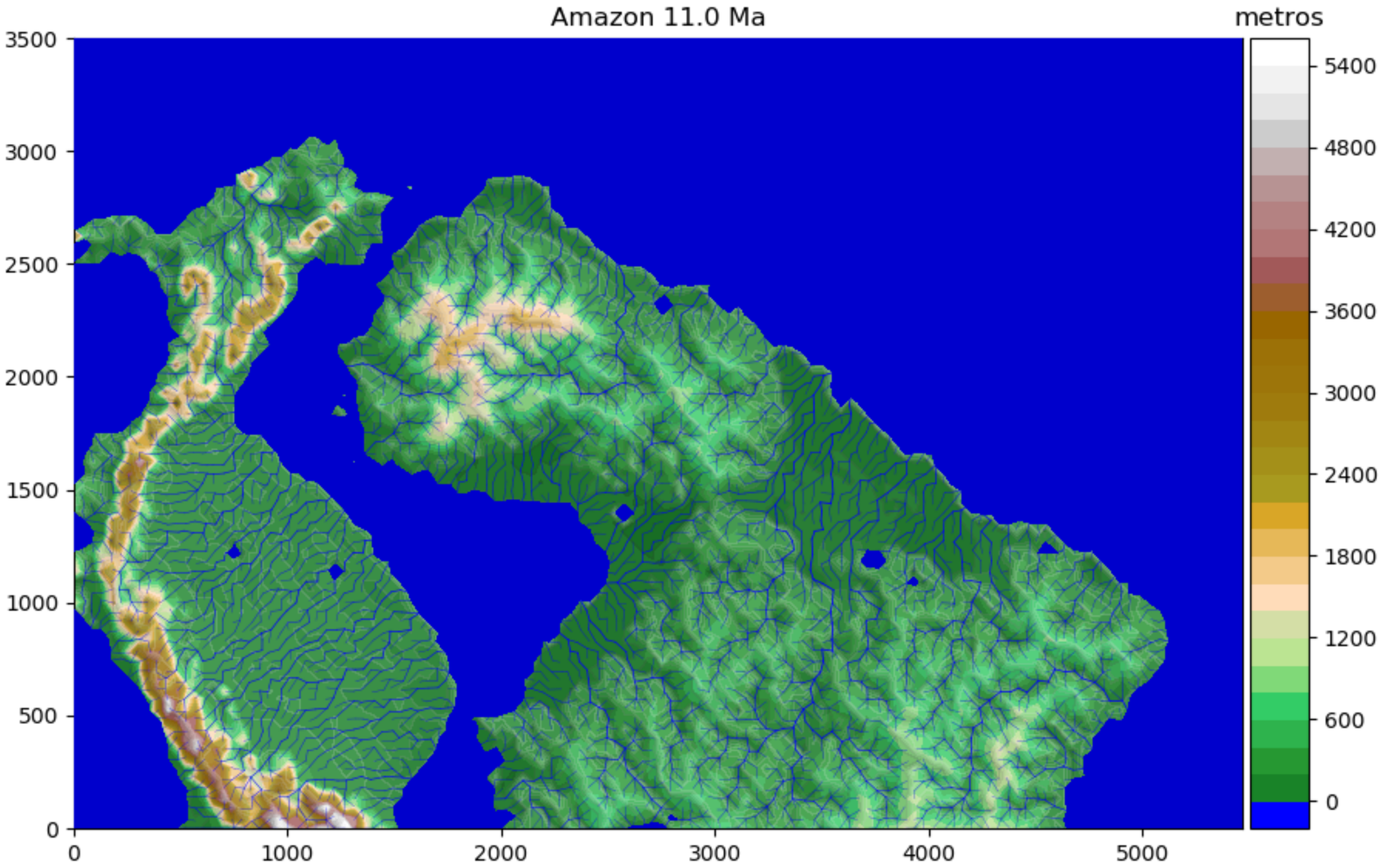
With dynamic topography



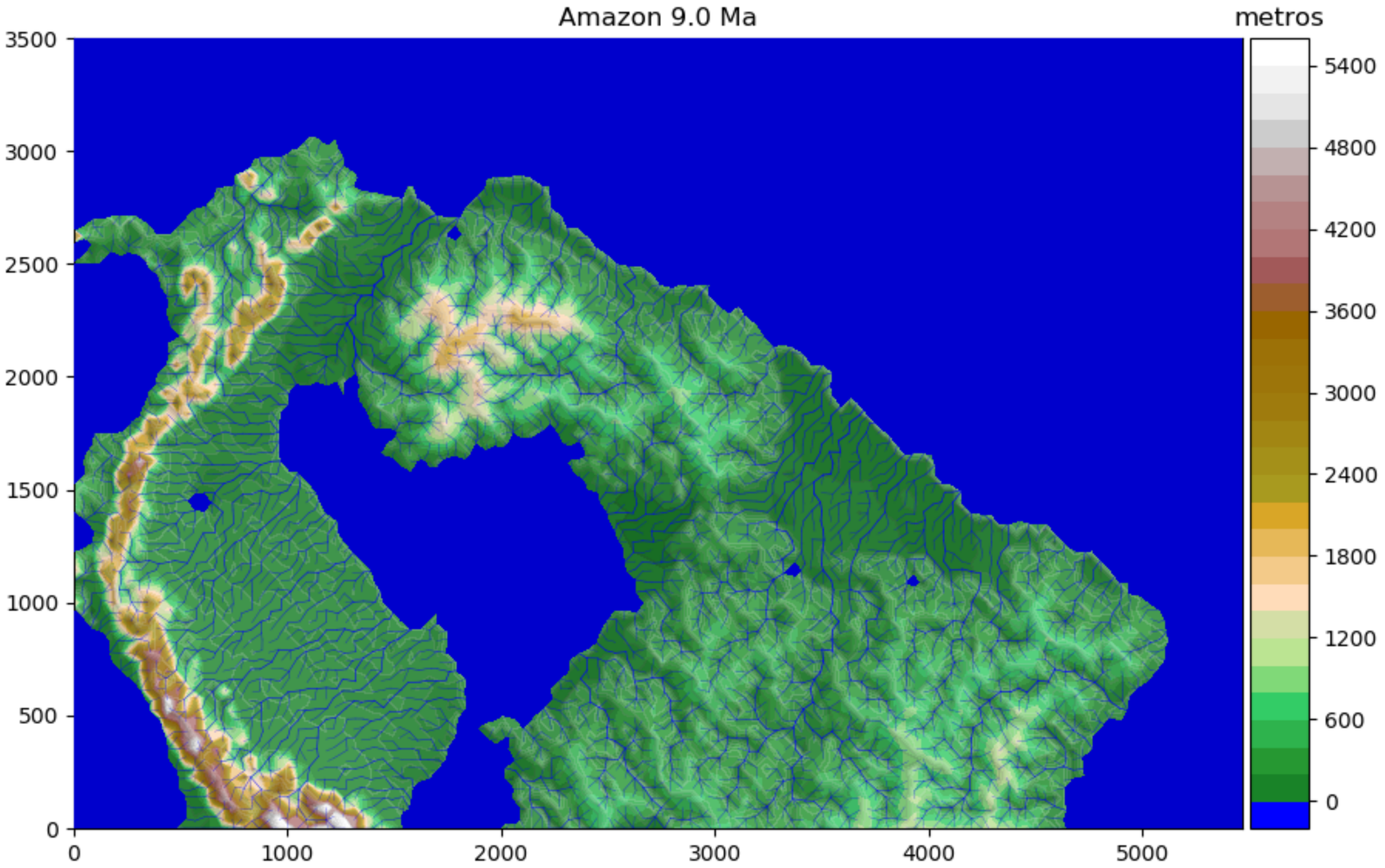
With dynamic topography



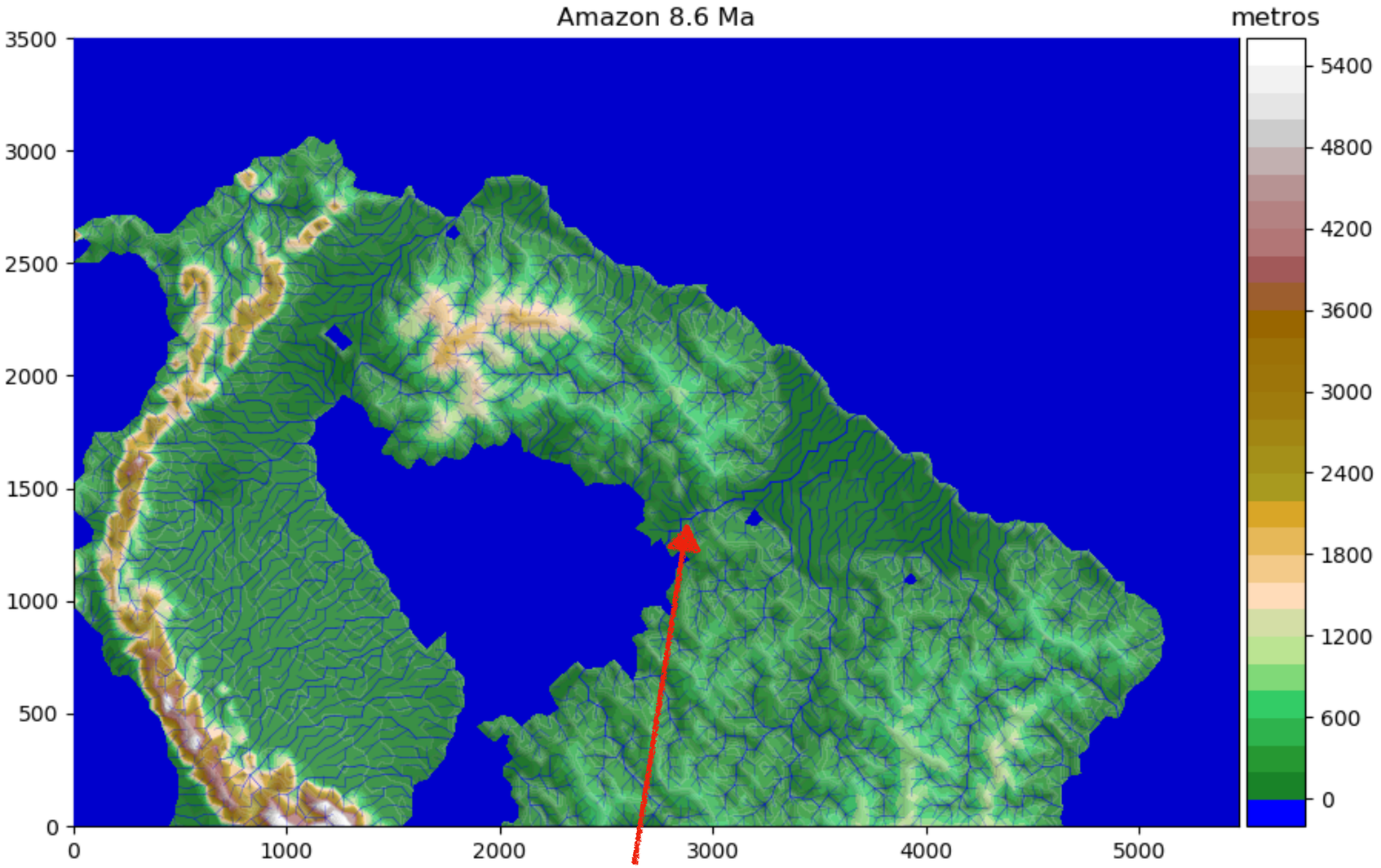
With dynamic topography



With dynamic topography

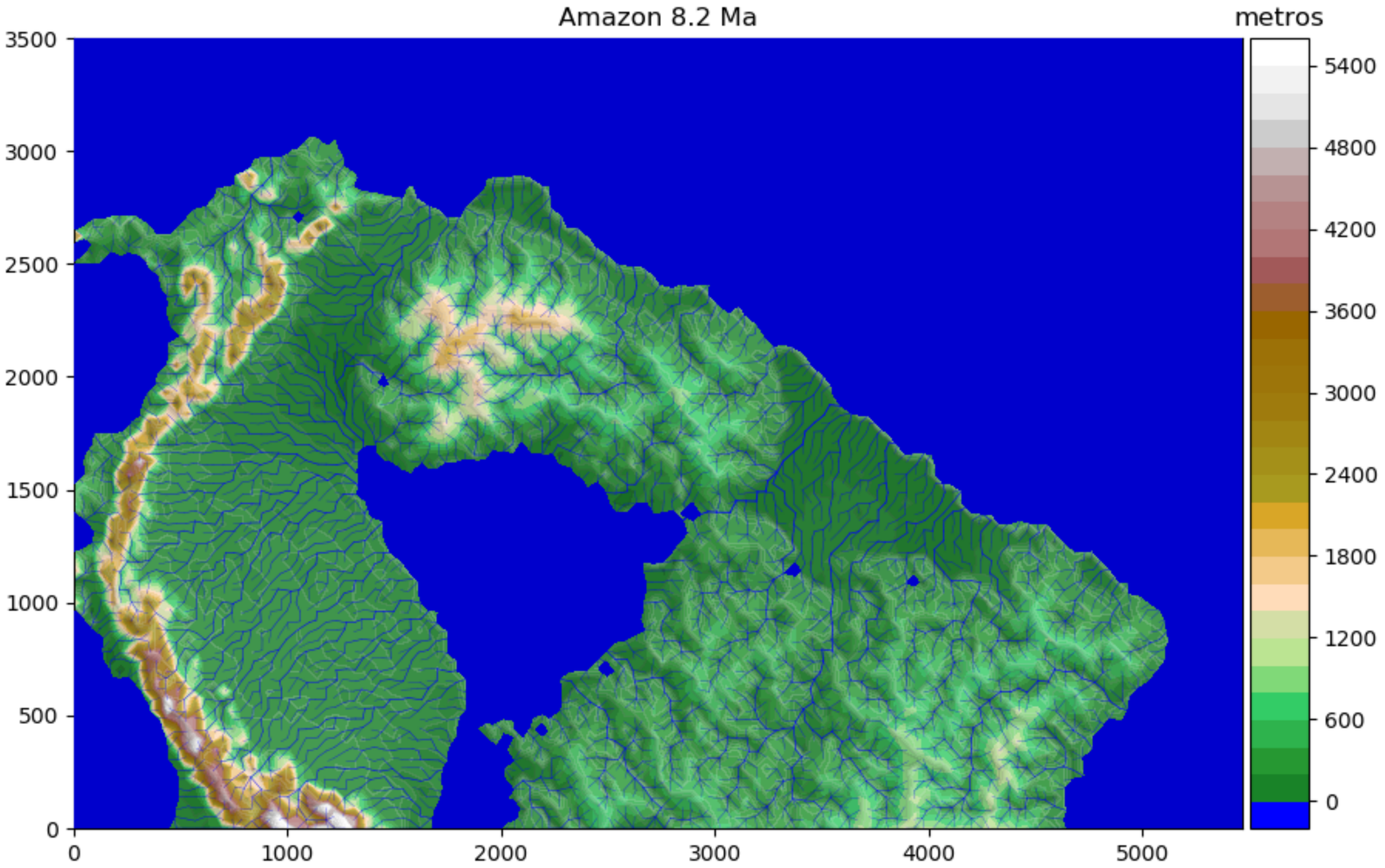


With dynamic topography

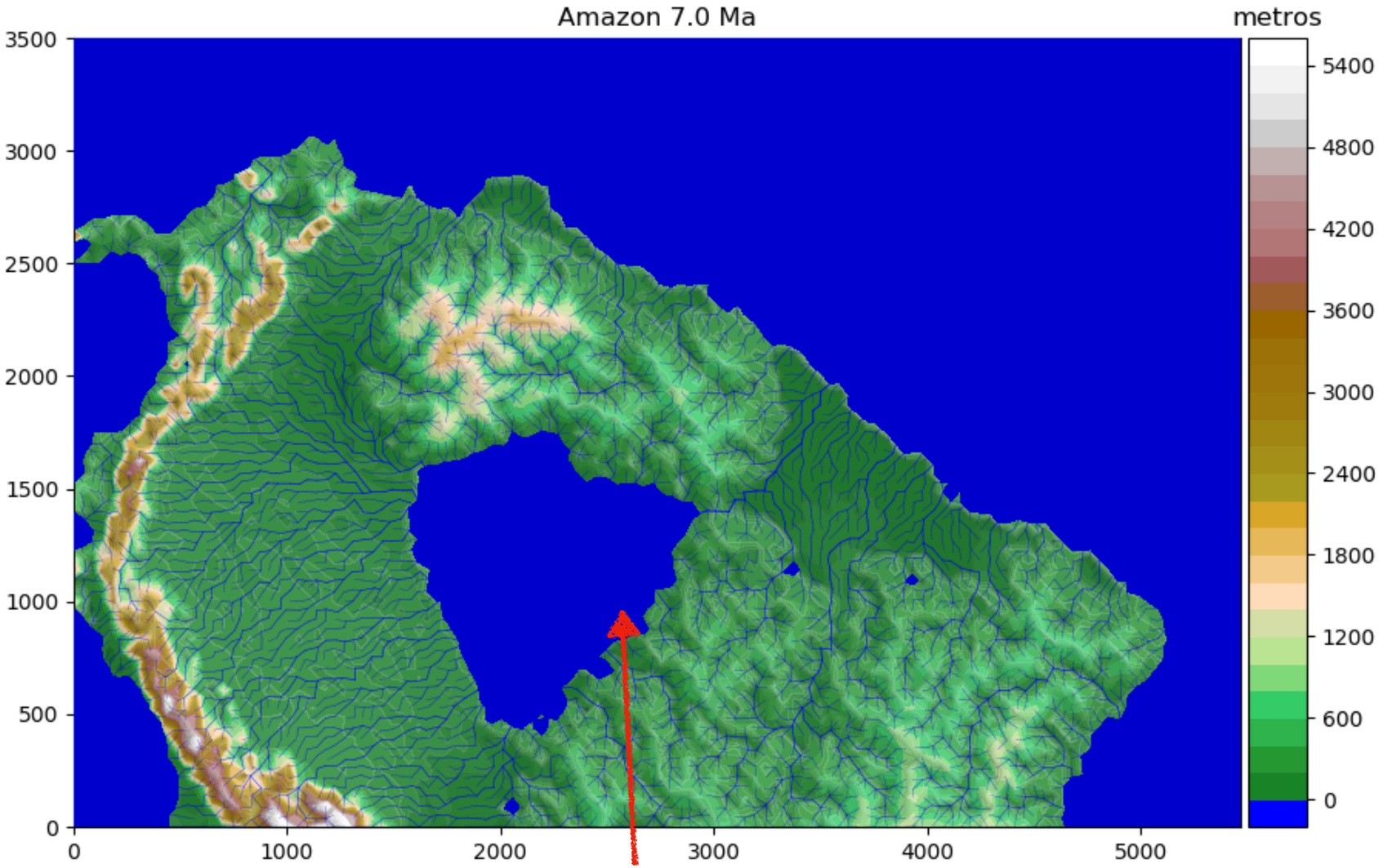


Initial connection of eastern and western Amazonia

With dynamic topography

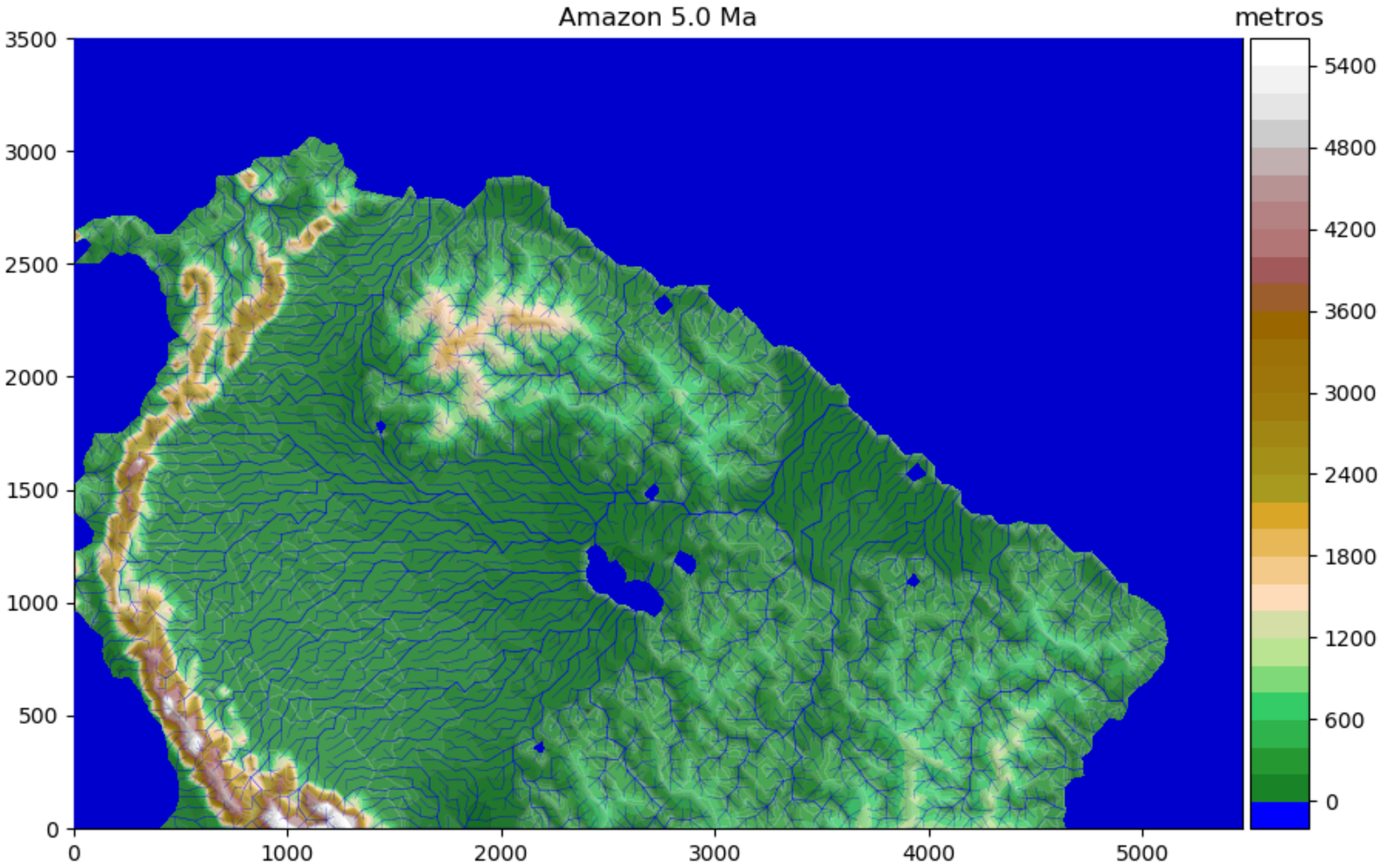


With dynamic topography

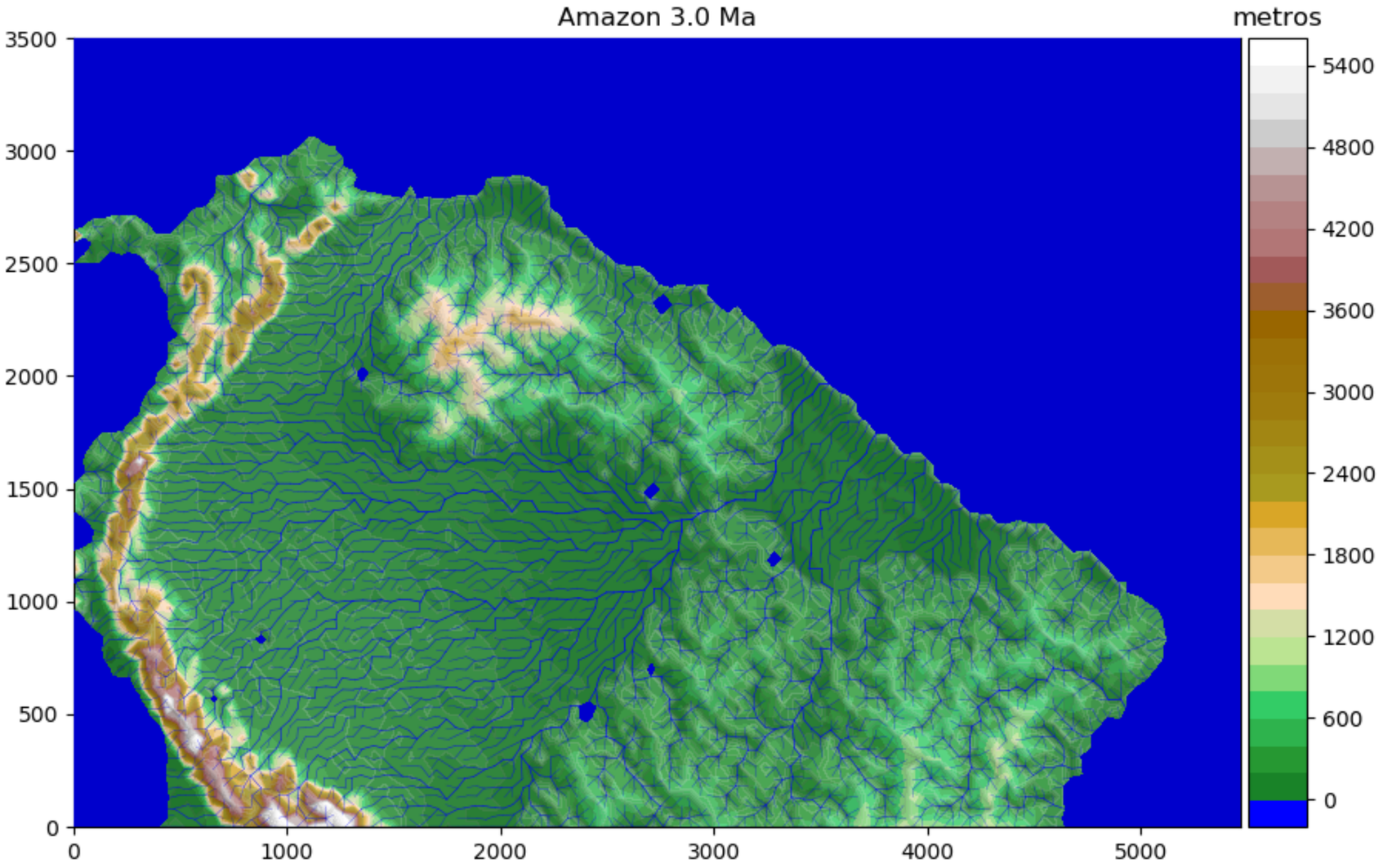


Large aquatic environment shrinks

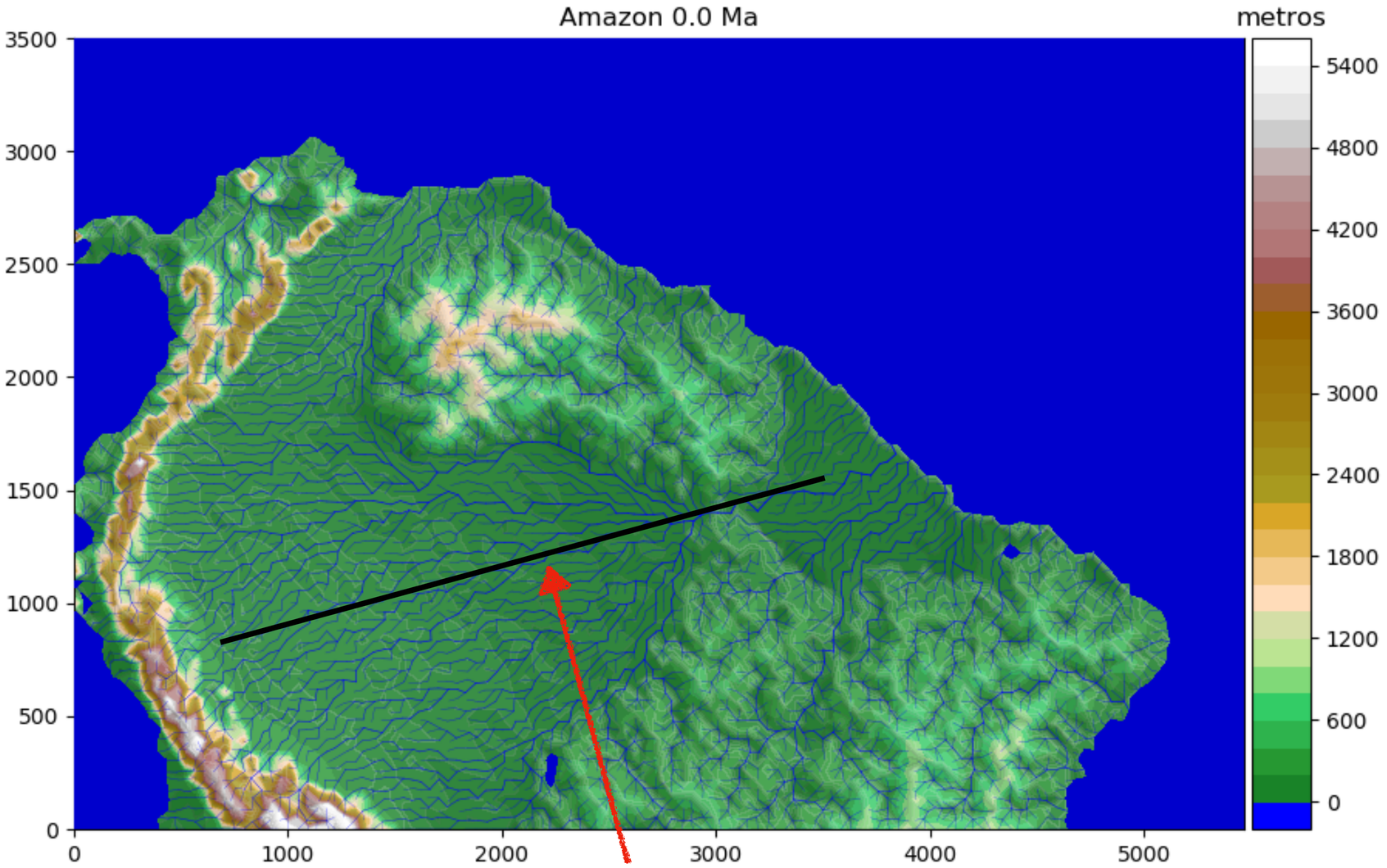
With dynamic topography



With dynamic topography

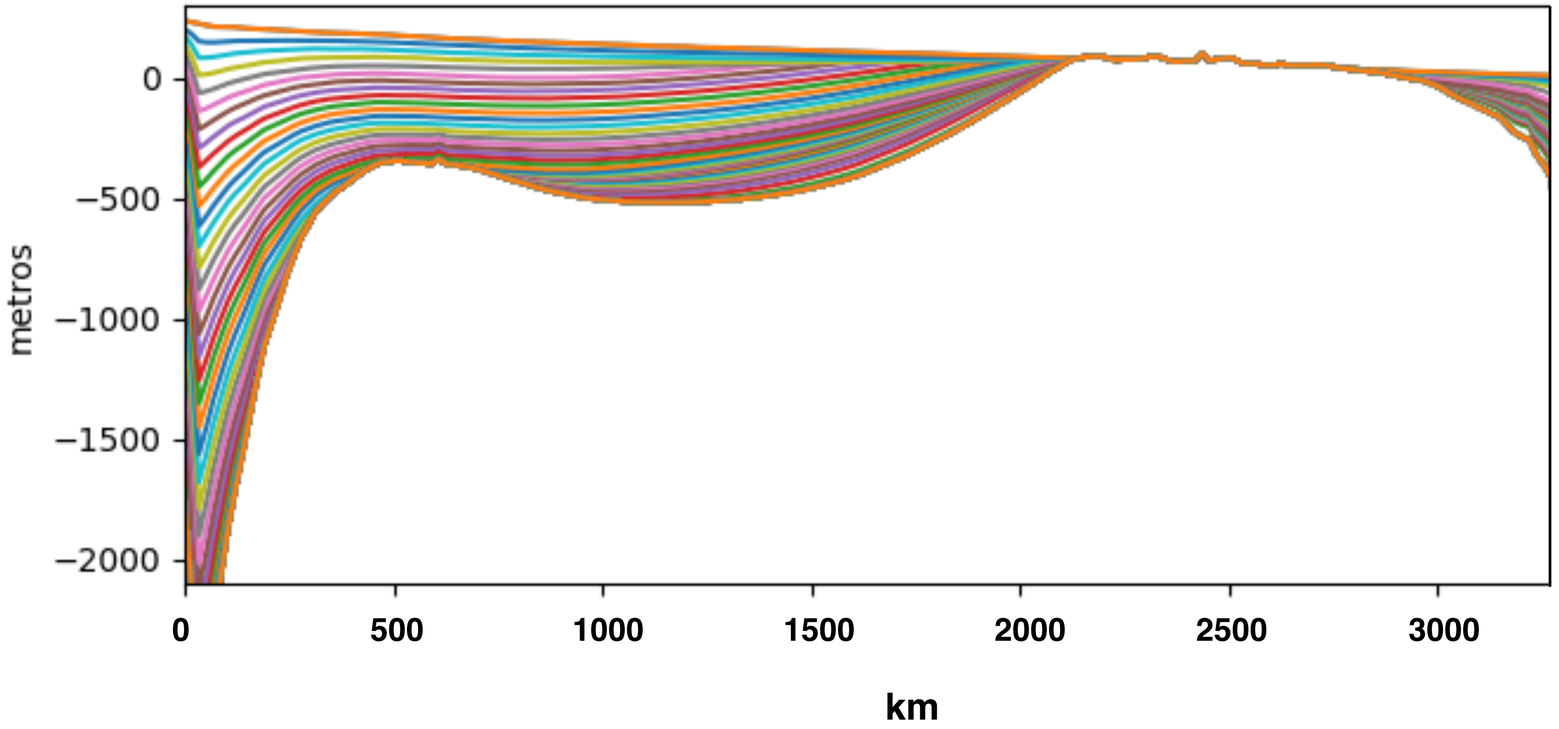


With dynamic topography



Stratigraphic section of the following slides

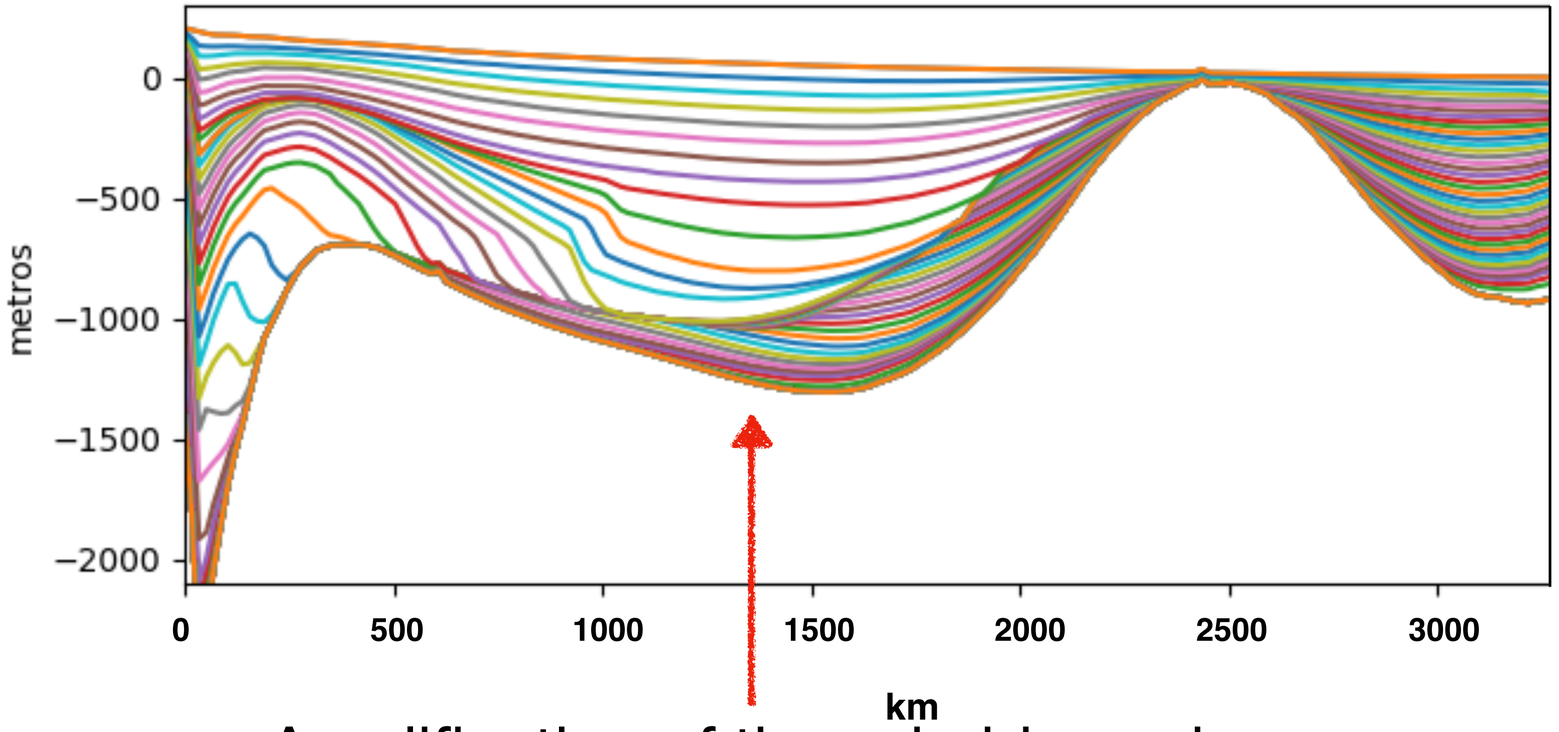
Without dynamic topography



Different colors mark the sediments deposited in intervals of one million years.

With dynamic topography

(based on the maps from Shephard et al. 2010)

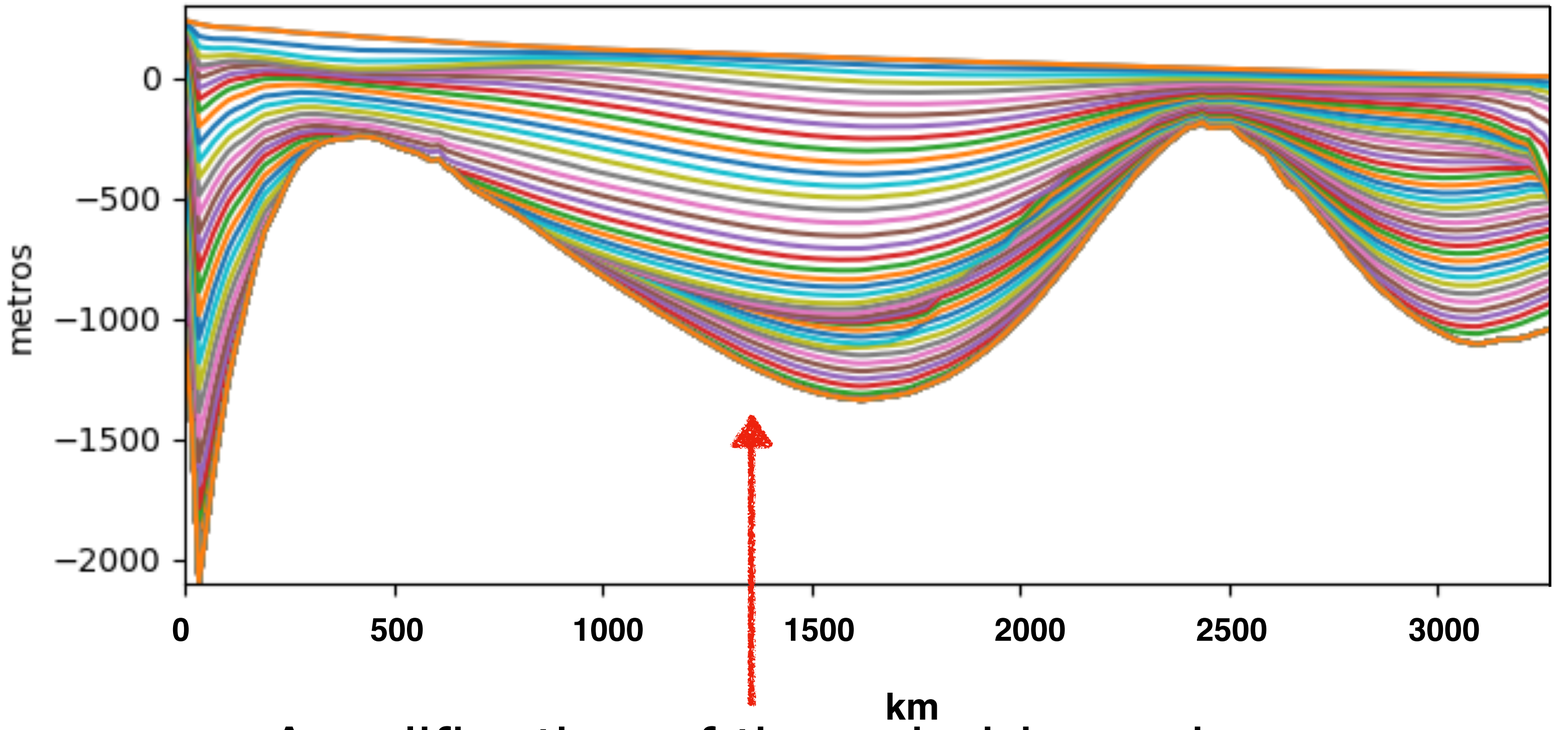


Amplification of the subsidence in central Amazonia (Solimões Basin)

Different colors mark the sediments deposited in intervals of one million years.

With dynamic topography

(based on the maps from Flament et al. 2015)



Amplification of the subsidence in central Amazonia (Solimões Basin)

Different colors mark the sediments deposited in intervals of one million years.

Conclusions

- New numerical models for the Cenozoic Amazonian landscape evolution are presented
- Formation of the transcontinental Amazon river mainly guided by Andean orogeny and surface processes
- Dynamic topography favoured the development of megawetland in central Amazonia
- Dynamic topography modified the stratigraphic evolution of intracratonic basins

Conclusions

- The correct understanding of the tectono-sedimentary evolution in Amazonia depends on the coupling of surface and geodynamic processes.

- The knowledge of the stratigraphic evolution in the interior sedimentary basins is an important constraint to understand the upper mantle dynamics under South America in the last ~40 Ma.