3D distribution of elastic properties and subduction inter-plate relief in NW Ecuador from joint refraction and inter-plate reflection travel-time tomography

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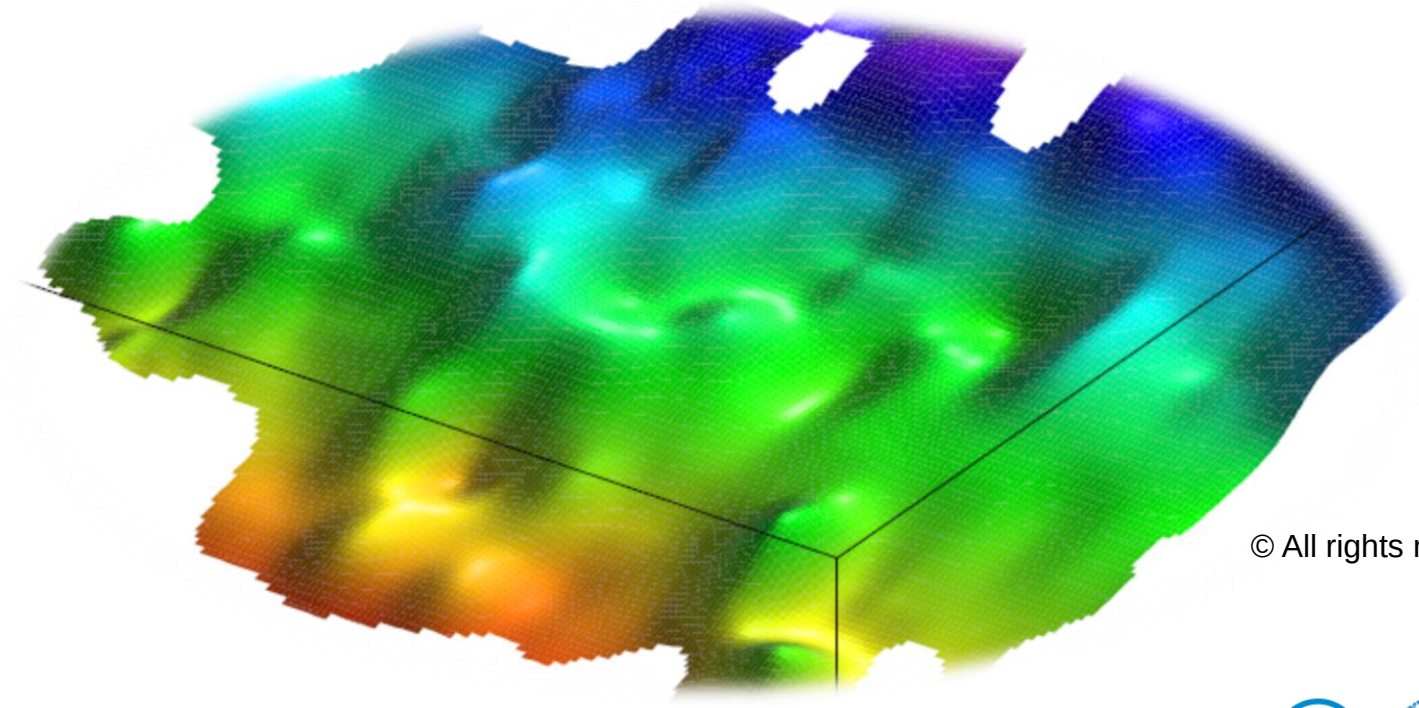


Barcelona CSI Center for Subsurface Imaging

ICM Institut de Ciències del Mar

CSIC Consejo Superior de Investigaciones Científicas

Géo Azur

IRD Institut de Recherche pour le Développement FRANCE

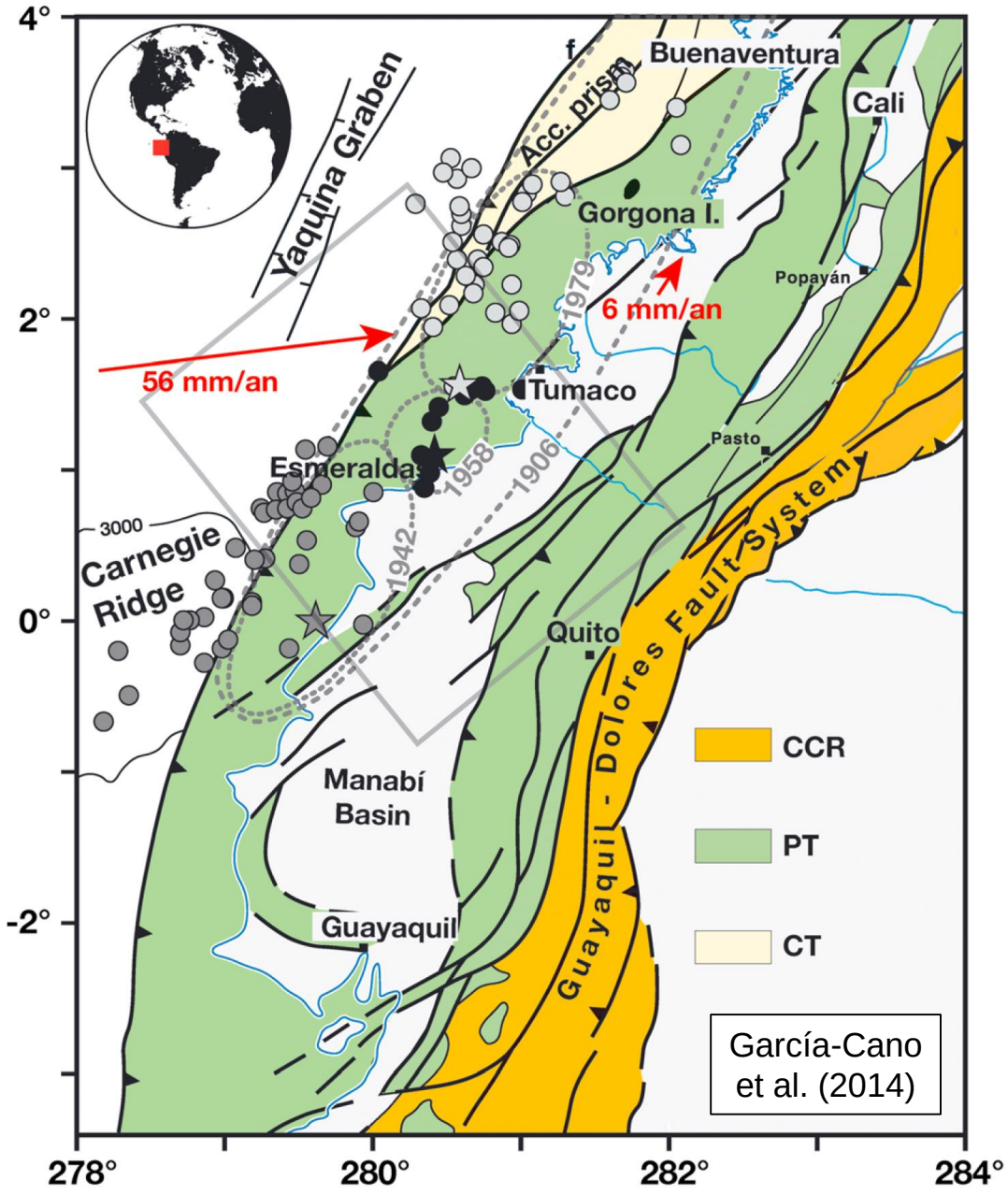
Setting

Complex margin off NW Ecuador S Colombia, made of numerous **accreted terranes**:

- Pacific terranes (green) including NE migrating Andean block
- Central Continental Realm (orange)
- Choco terranes (pale yellow) made of small acretionary prisms

Red arrows represent velocity of the Nazca Plate and the North Andean Block relative to South America [Nocquet et al., 2009]

Rupture zones of large megathrust earthquakes: **1906 (Mw8.8)**, 1942 (Mw7.8), 1958 (Mw7.7), and 1979 (Mw8.2)



Esmeraldas-2005 survey

French R/V l'Atalante

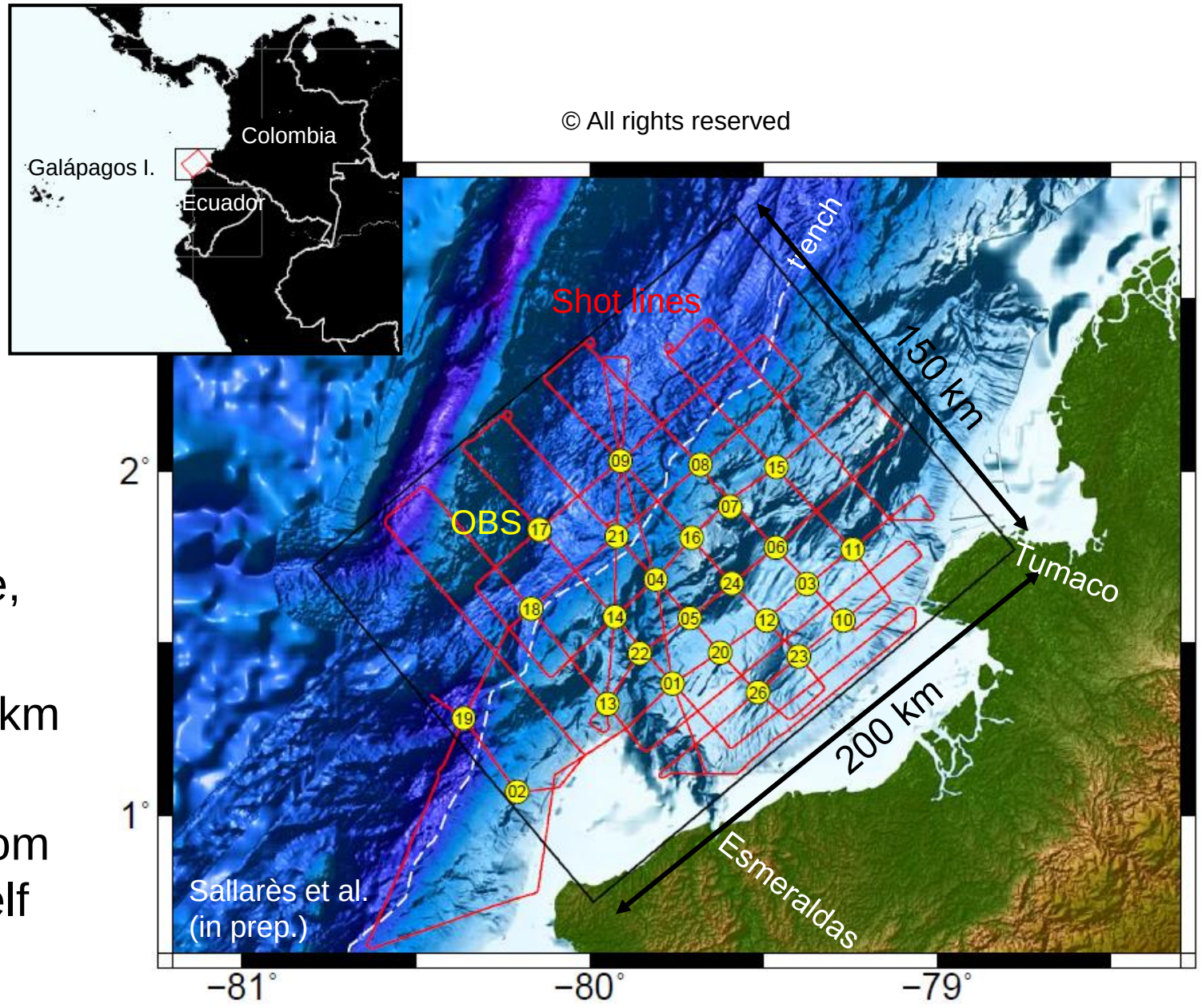
23 GeoAzur OBS (yellow circles)

10 trench-parallel and 10 trench-perpendicular profiles (red lines)

150-200 km-long lines on average, separation ~15 km

~18,500 shots fired along ~2,900 km of profiles (shot distance ~150 m)

Cover **surface of ~30,000 km²** from th outer rise to the continental shelf

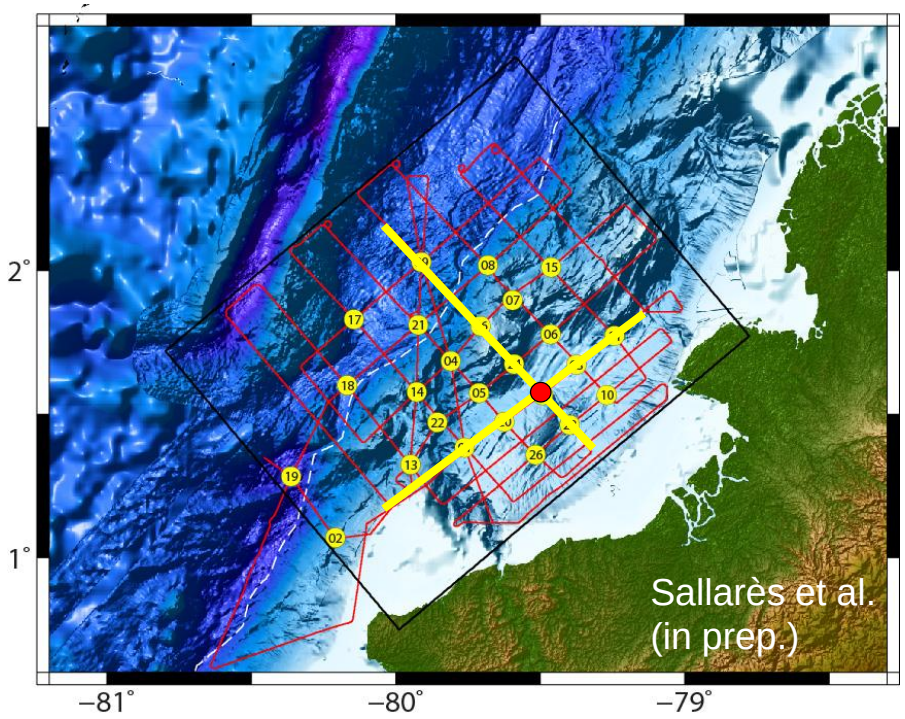


Methodological approach

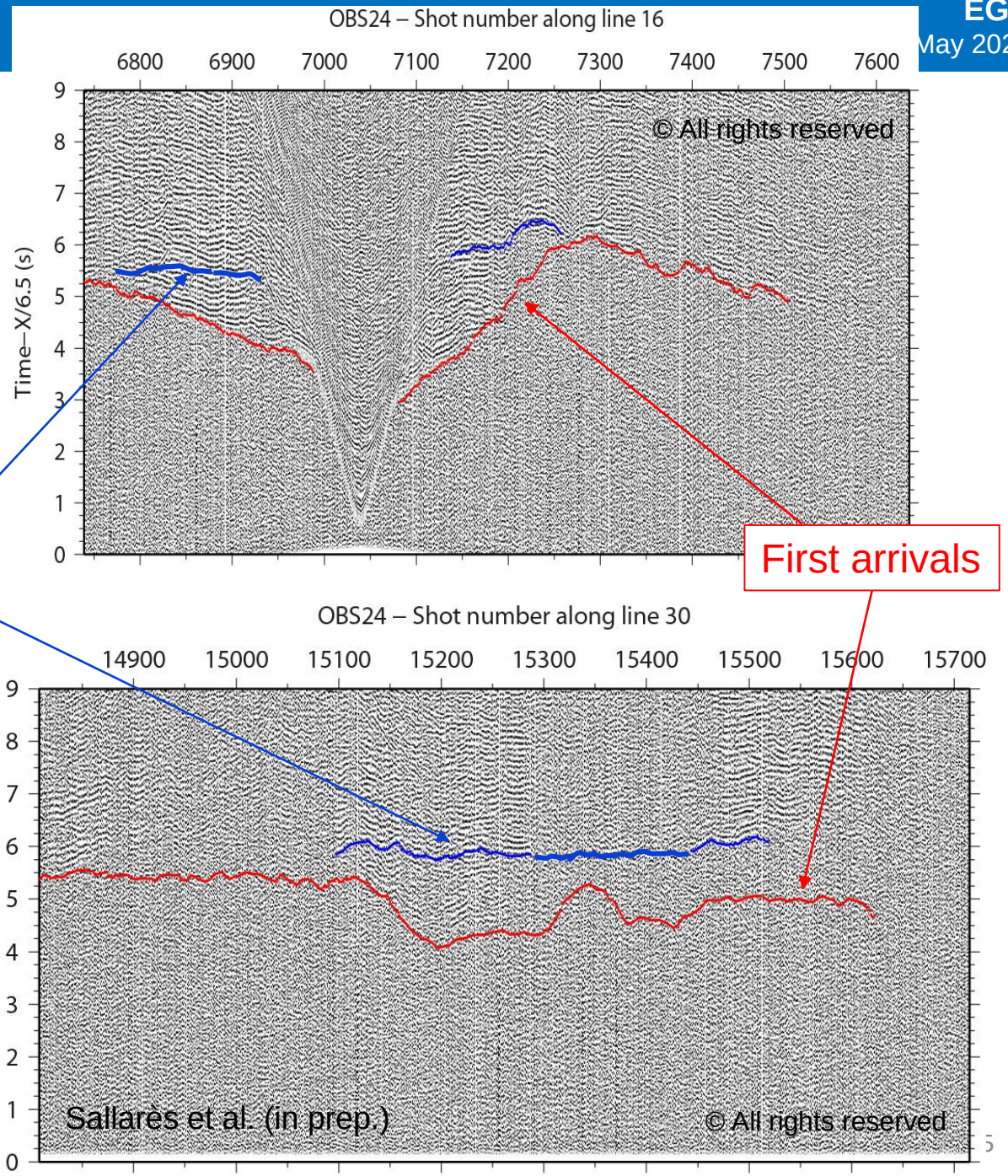
- Combine **first arrival AND inter-plate reflection travel-times** (*tomo3d* code)
- Need to **consistently pick inter-plate reflection travel-times** at on-line and off-line profiles of each OBS in KS (~450 record sections to be checked in total)
- **Check influence** of travel-time **picking errors** on results + check influence of **initial velocity model** + check influence of **initial reflector's geometry** → **statistical approach** using different data sets & initial models

  → Estimate "parameter uncertainty" (~standard dev. of model parameters)
- **Check data sensitivity to inverted inter-plate relief** → create data set with real acquisition geometry and obtained final model (Vp + reflector geometry) and replicate inversion procedure

Data set

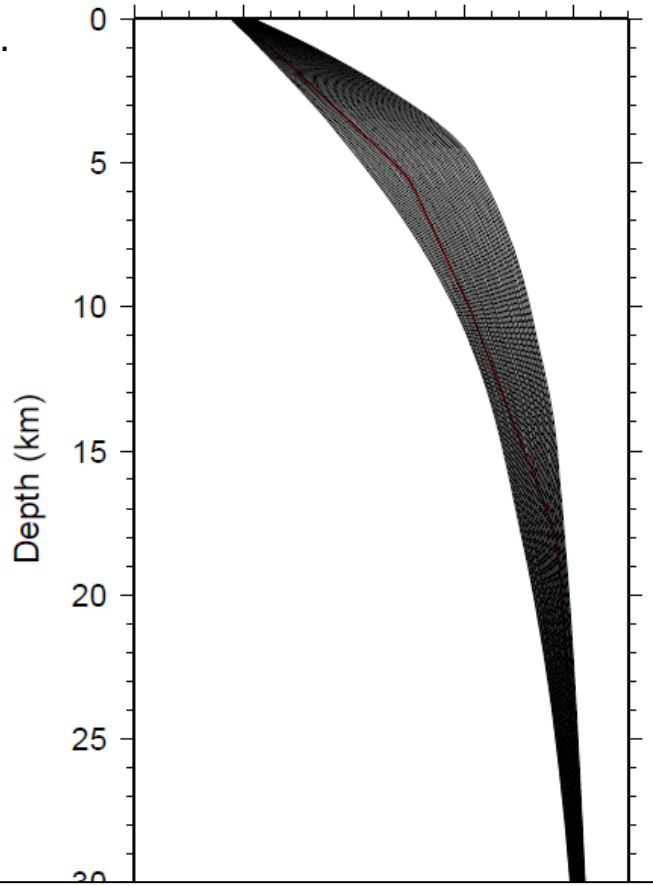


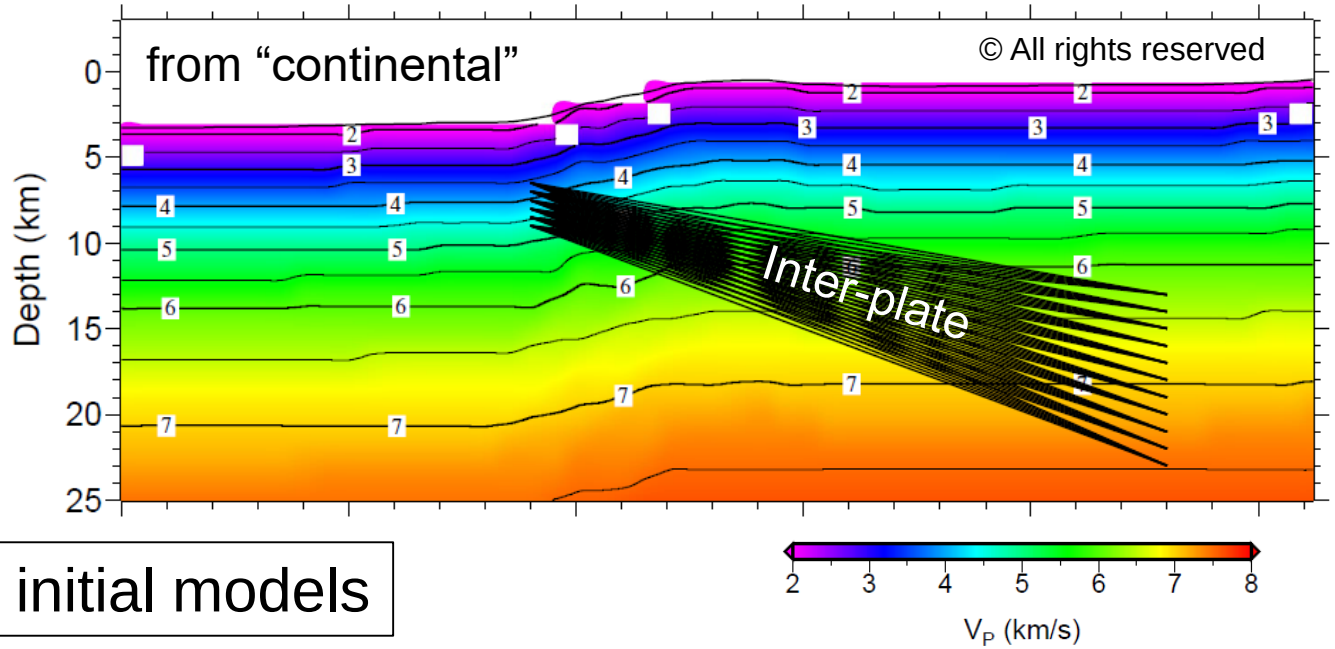
23 OBS
~220k first arrival picks (50% used)
~20k inter-plate reflections



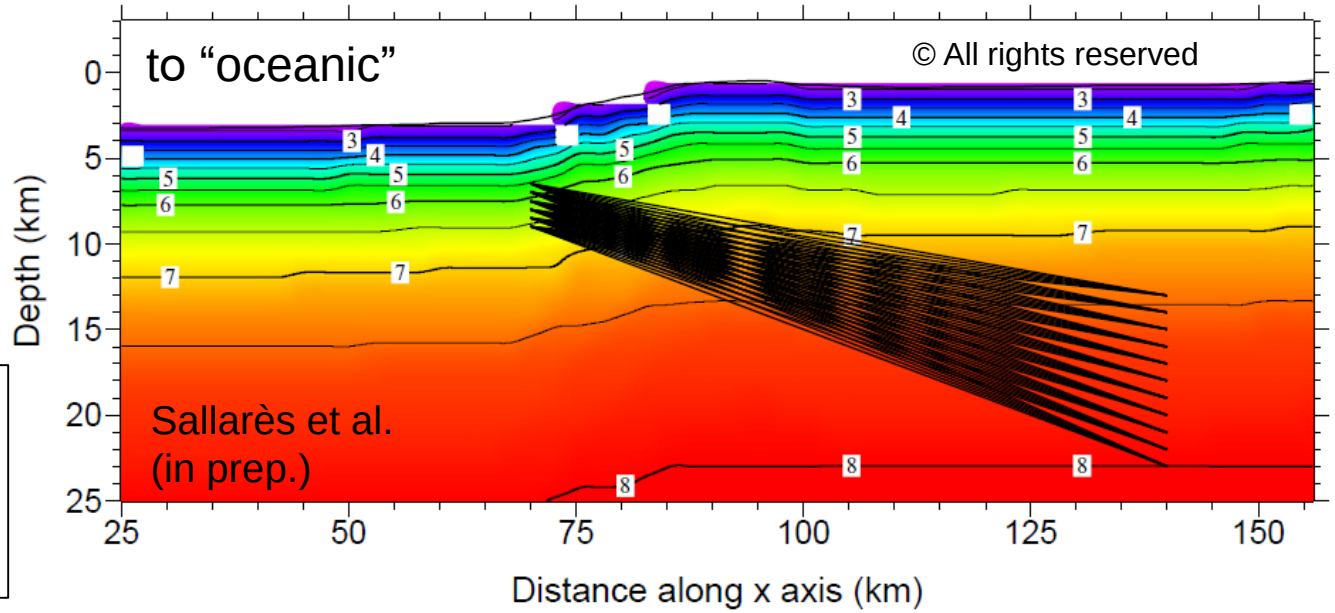
Statistical approach

Sallarès et al. (in prep.)



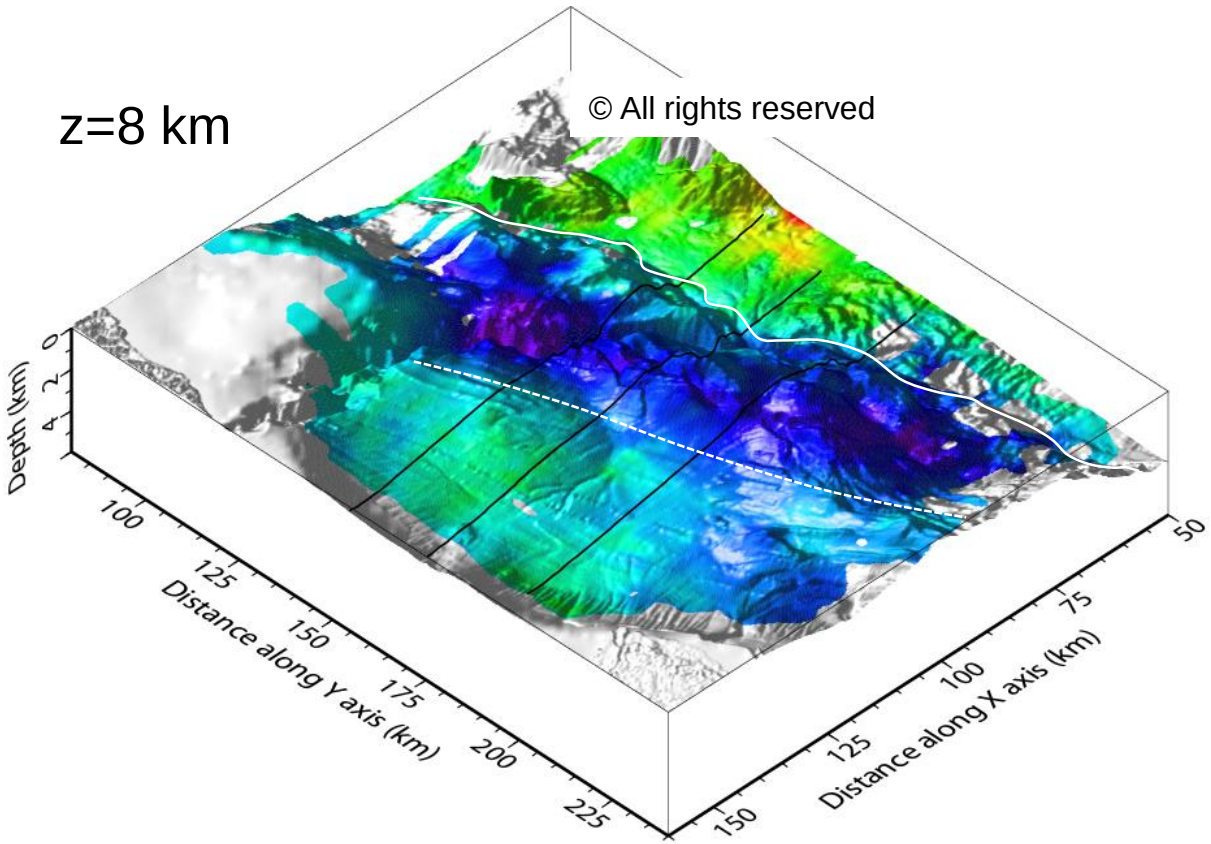


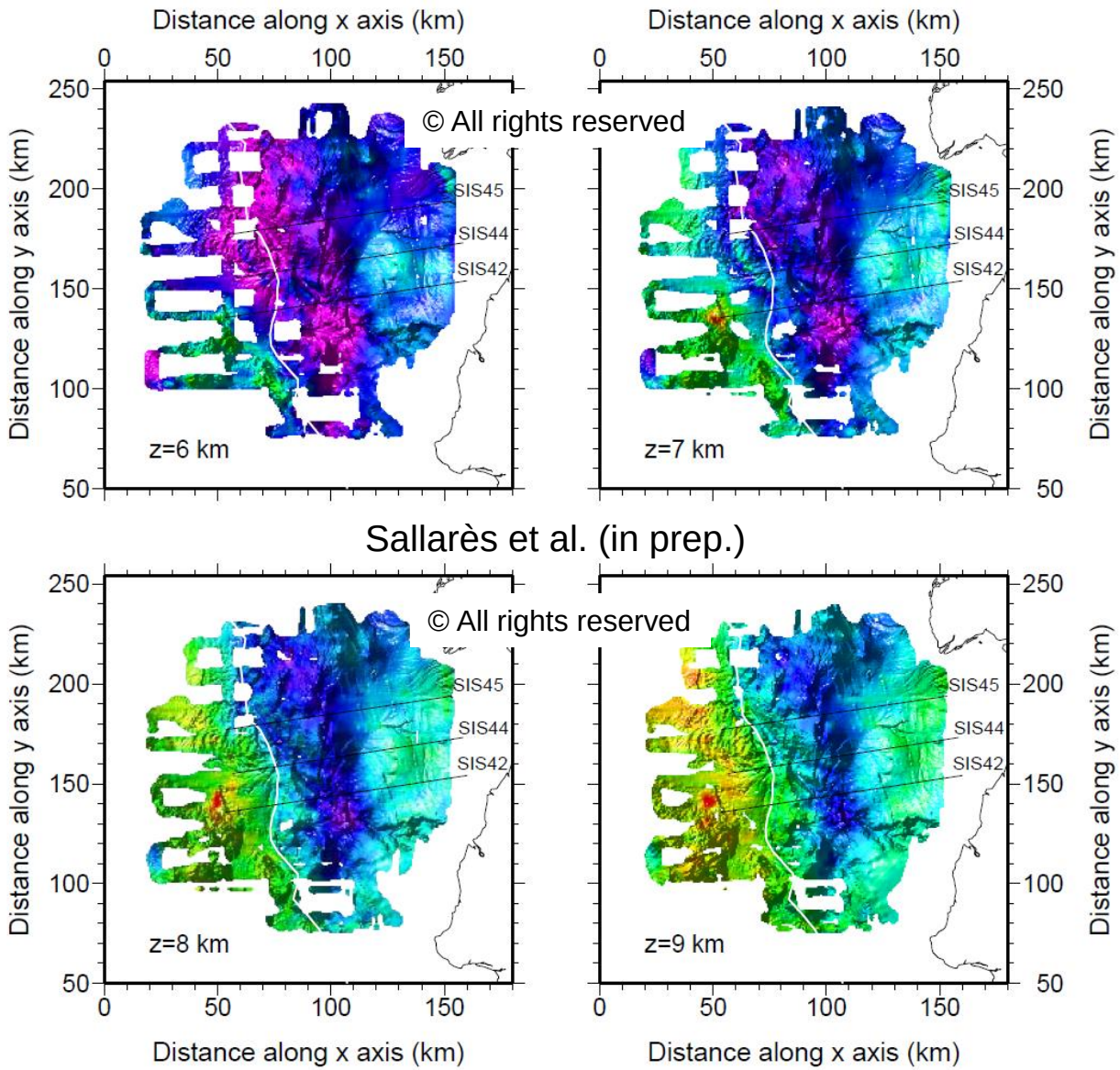
50 initial models



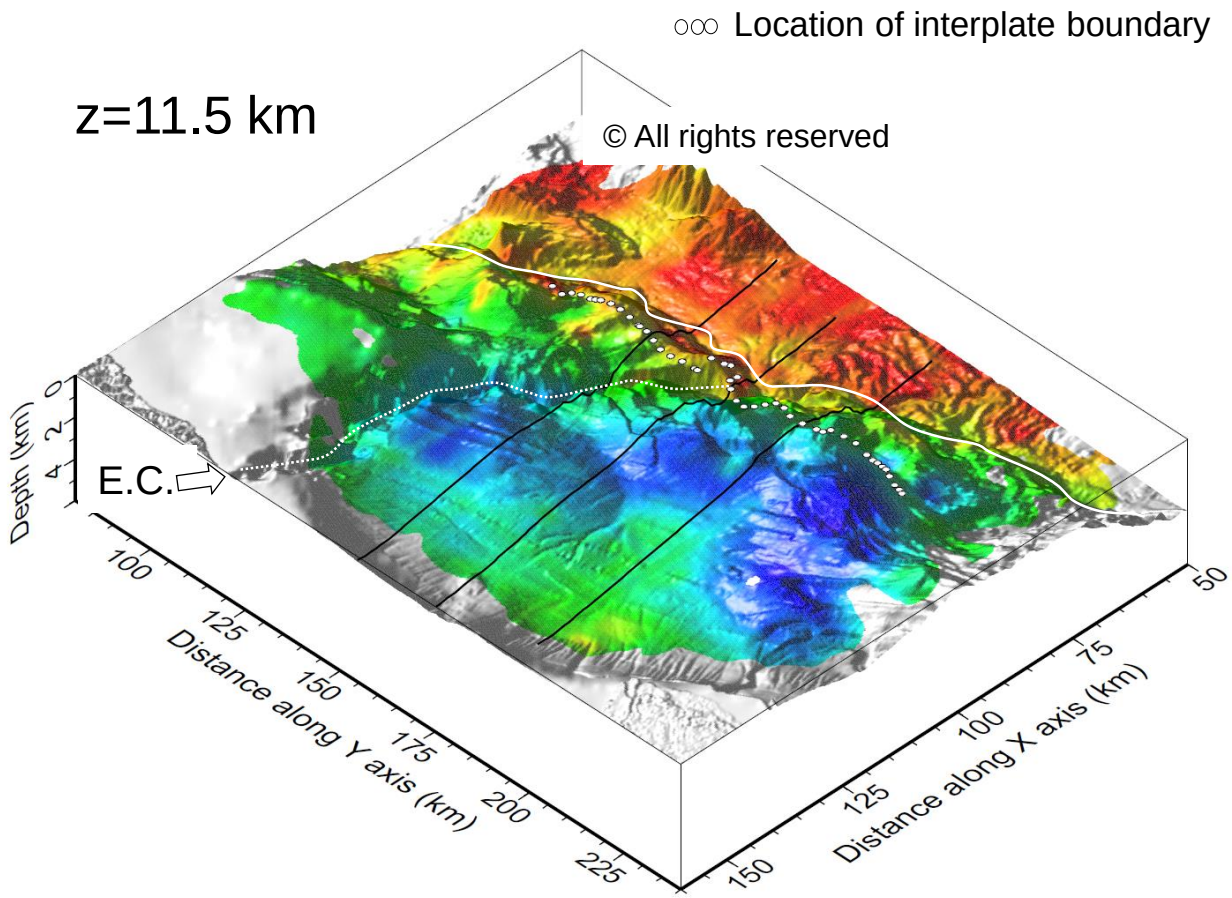
Different dataset for each initial model, created by adding random picking errors to FA and reflections

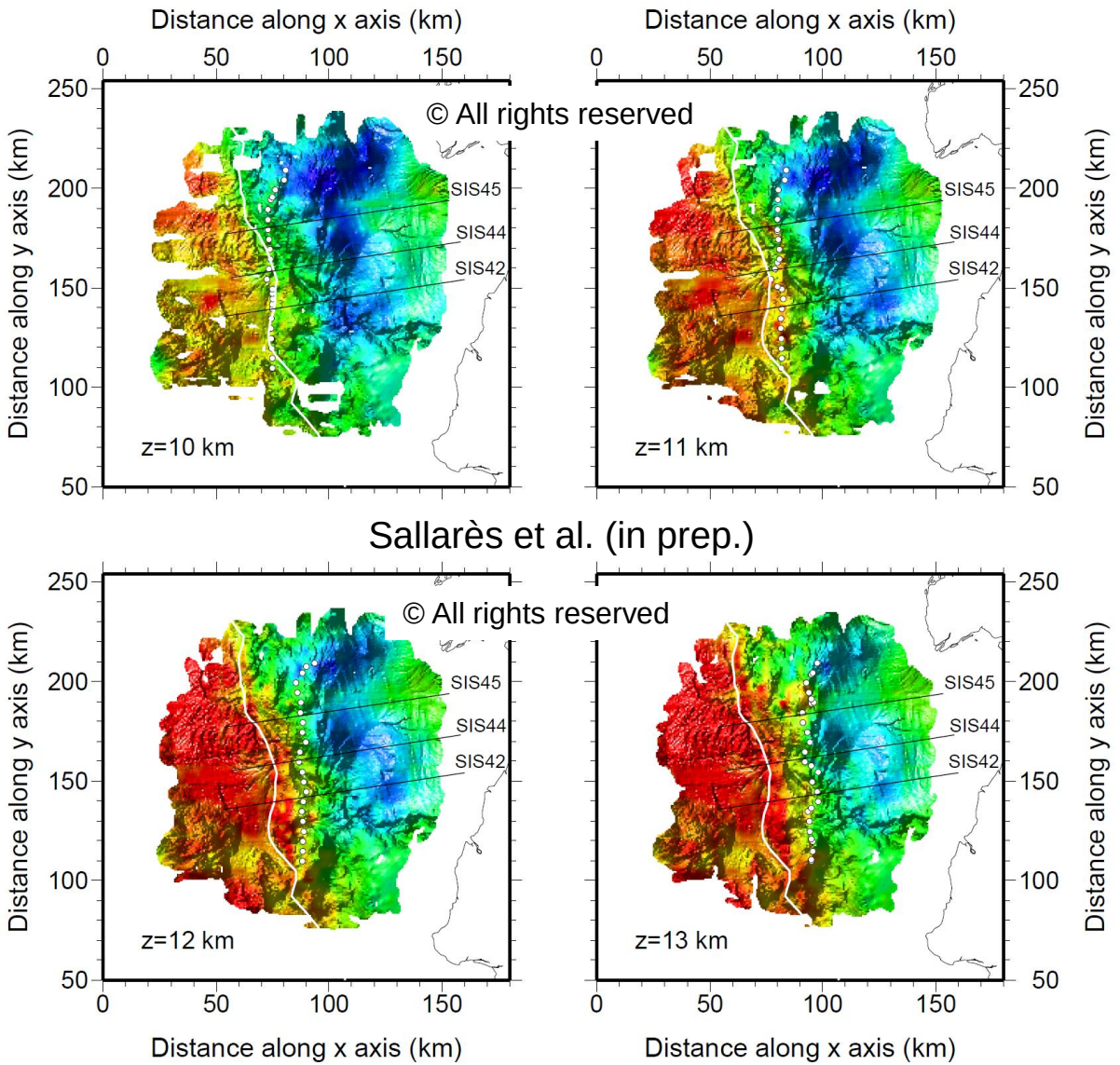
Preliminary results: V_P field





Preliminary results: V_P field





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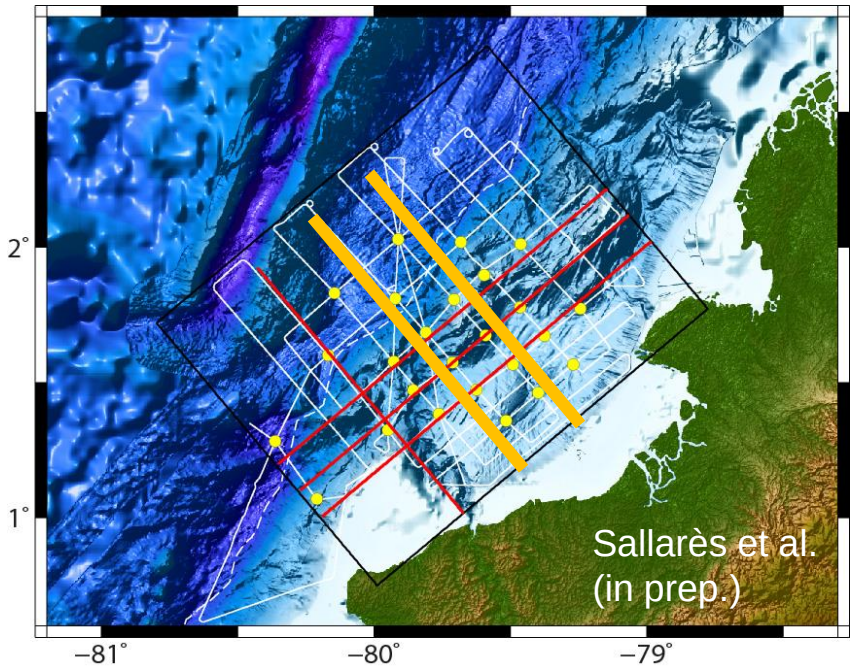
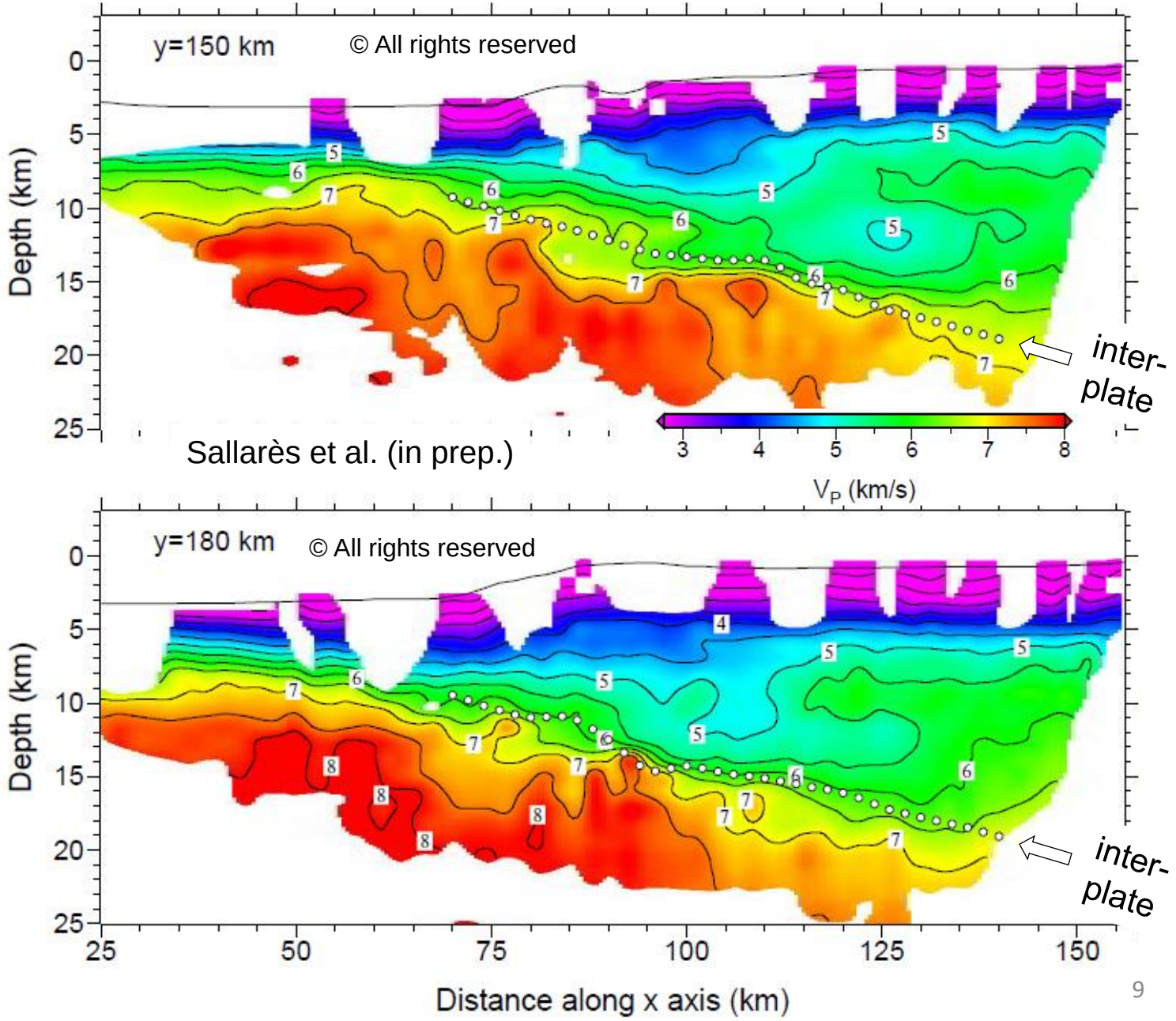


○○○ Location of interplate boundary



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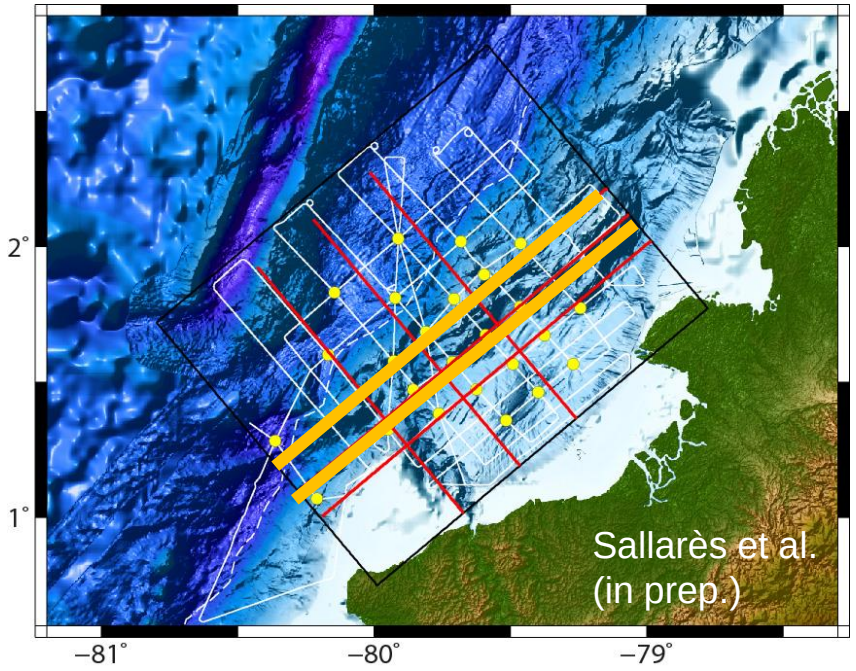

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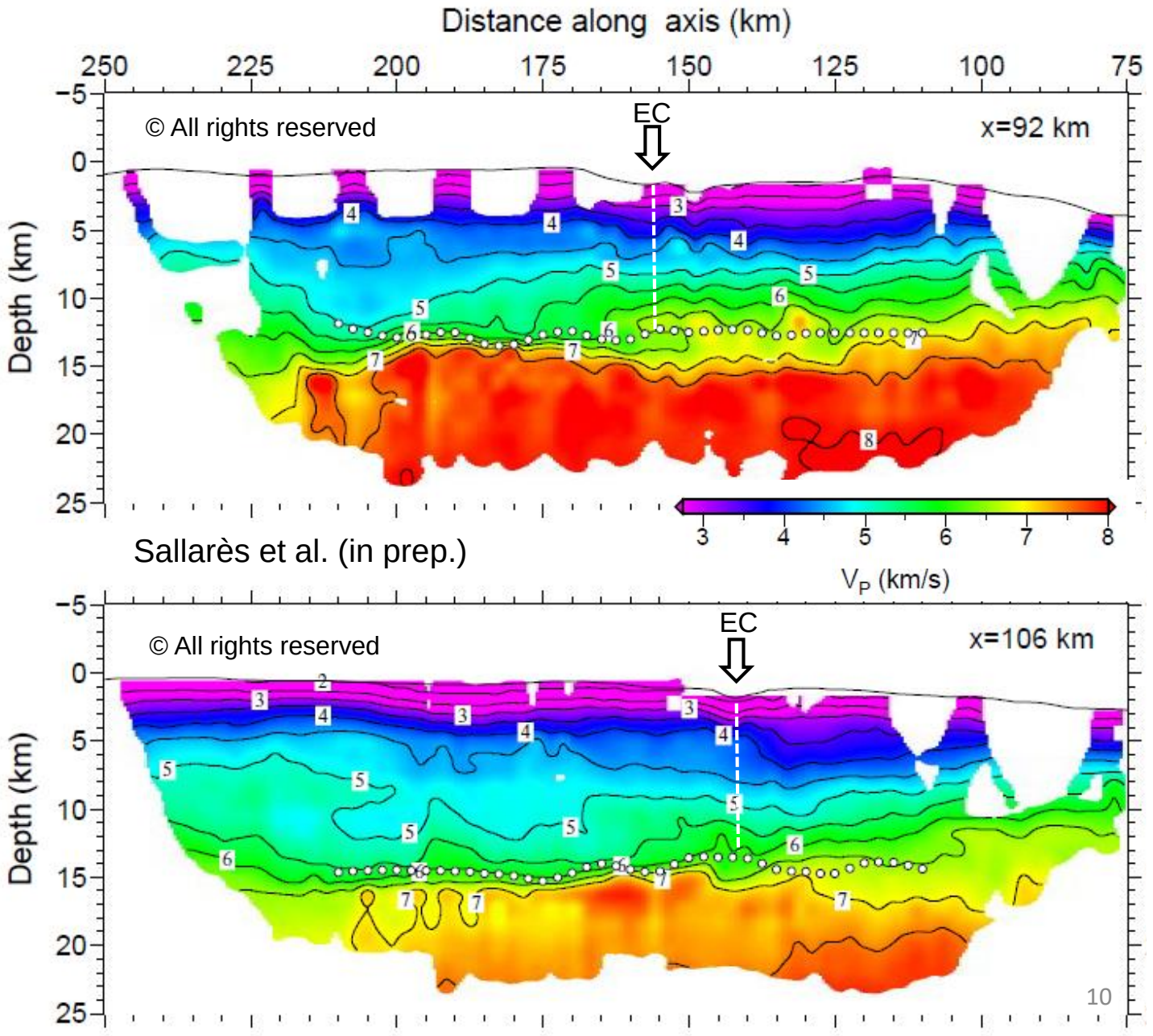
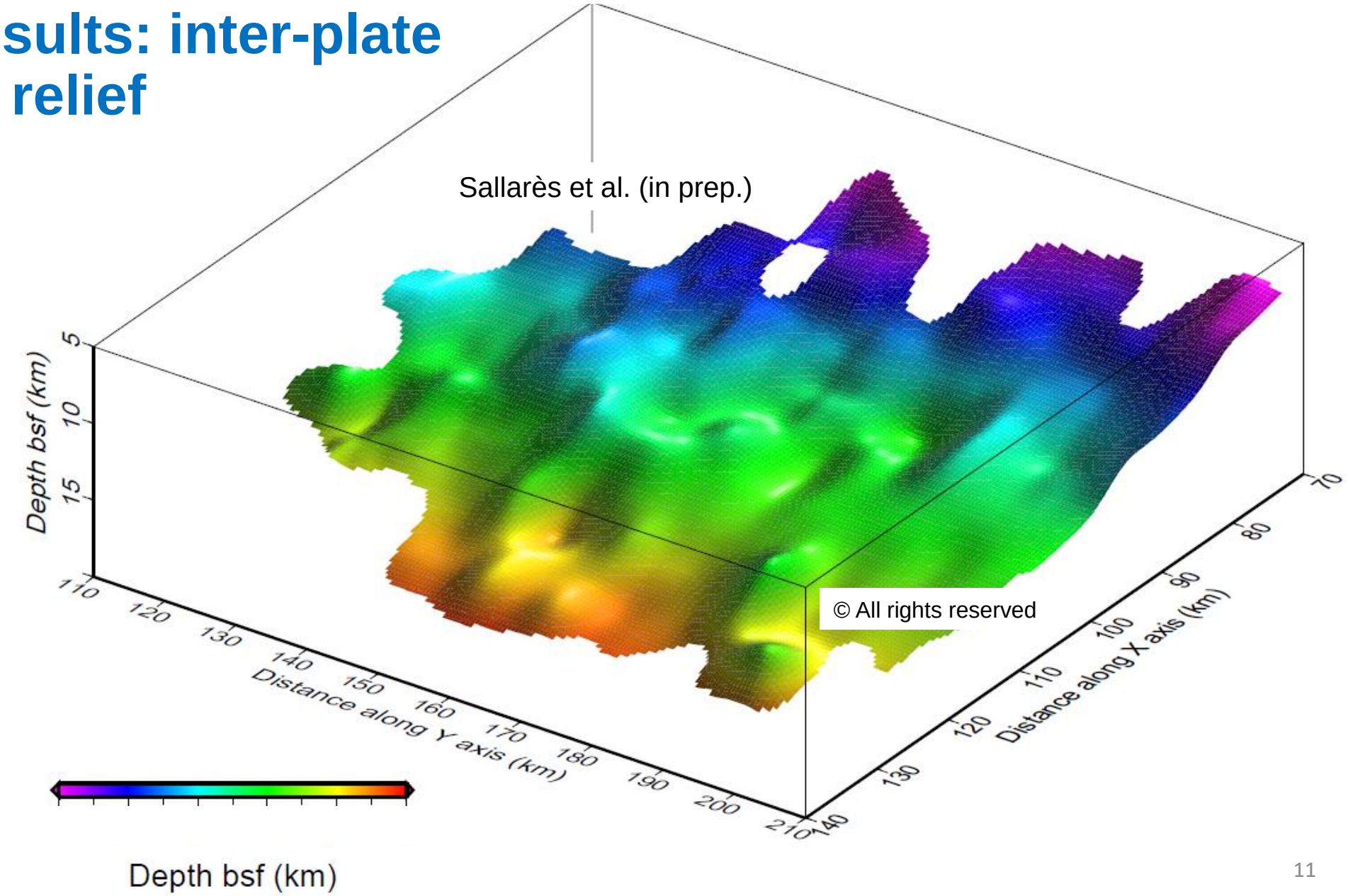
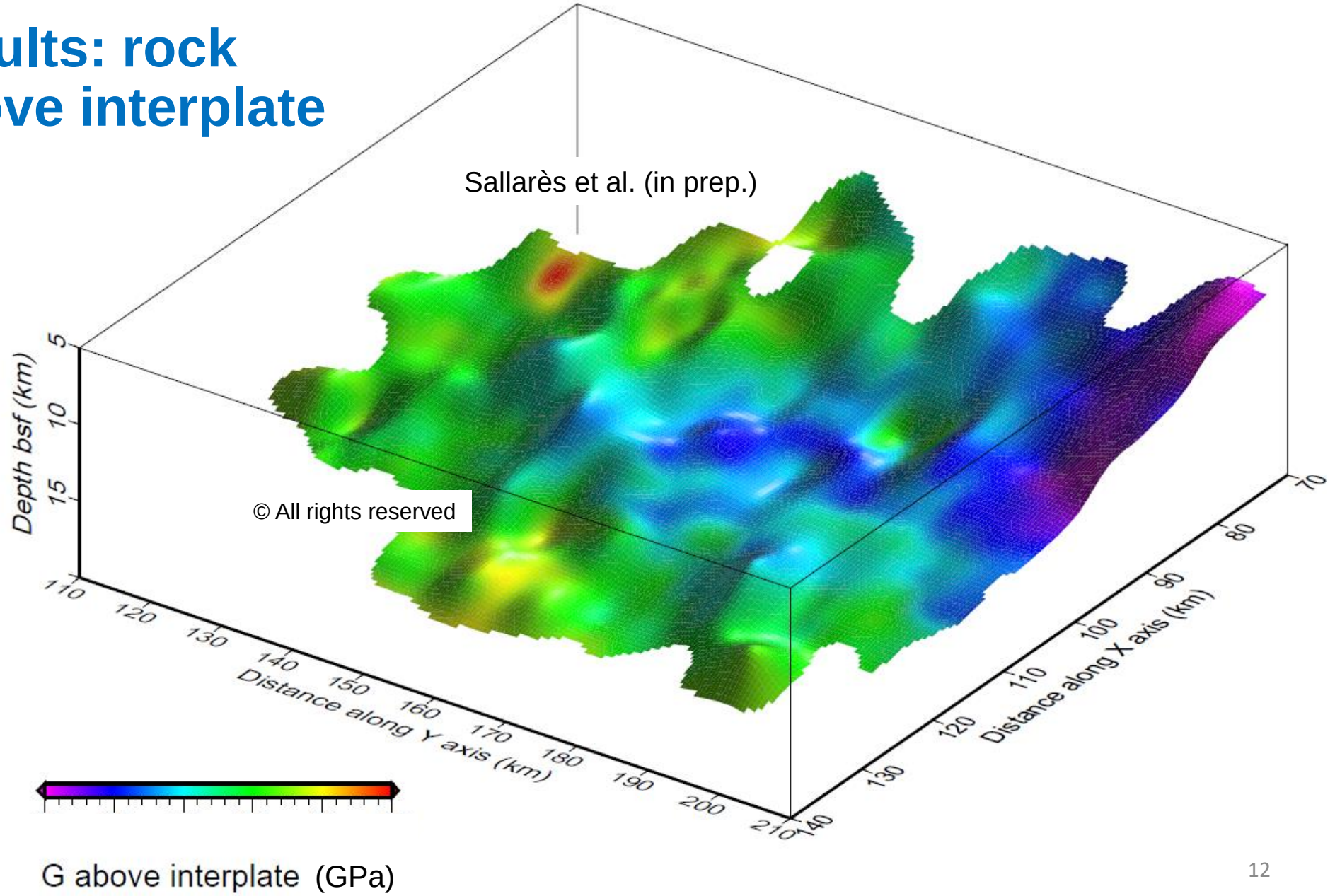


Preliminary results: inter-plate geometry and relief



Preliminary results: rock rigidity just above interplate

- Strong lateral rigidity contrasts
- Both along- and across-strike
- Changes in rigidity can be almost two-fold: 20 to 40 GPa
- To be taken into account when estimating slip from released moment



Summary

- Joint refraction and reflection travel-time inversion allows retrieving the Vp field as well as the geometry and relief of the inter-plate boundary
- Data sensitivity analysis confirms that Esmeraldas-2005 is adequate to get the 3D velocity field and the inter-plate boundary relief and shows that standard deviation is good proxy of model parameters uncertainty
- Inter-plate relief is rough, showing seamount-like features that are 2-3 km-high, 10-15 km-wide with a NE-SW trend
- Vp field is strongly heterogeneous, showing sharp contrasts (of >40% in rigidity)
- Contrasts appear to follow upper plate bathymetric features (faults?) that separate crustal blocks of different affinity → extension of inland units?
- “Realistic” inter-plate relief and rock properties at the megathrust should be taken into account to properly calculate source properties (estimate slip, simulate rupture, estimate coupling, etc)