Mantle Anisotropy and Asthenospheric Flow Around Cratons in SE South America

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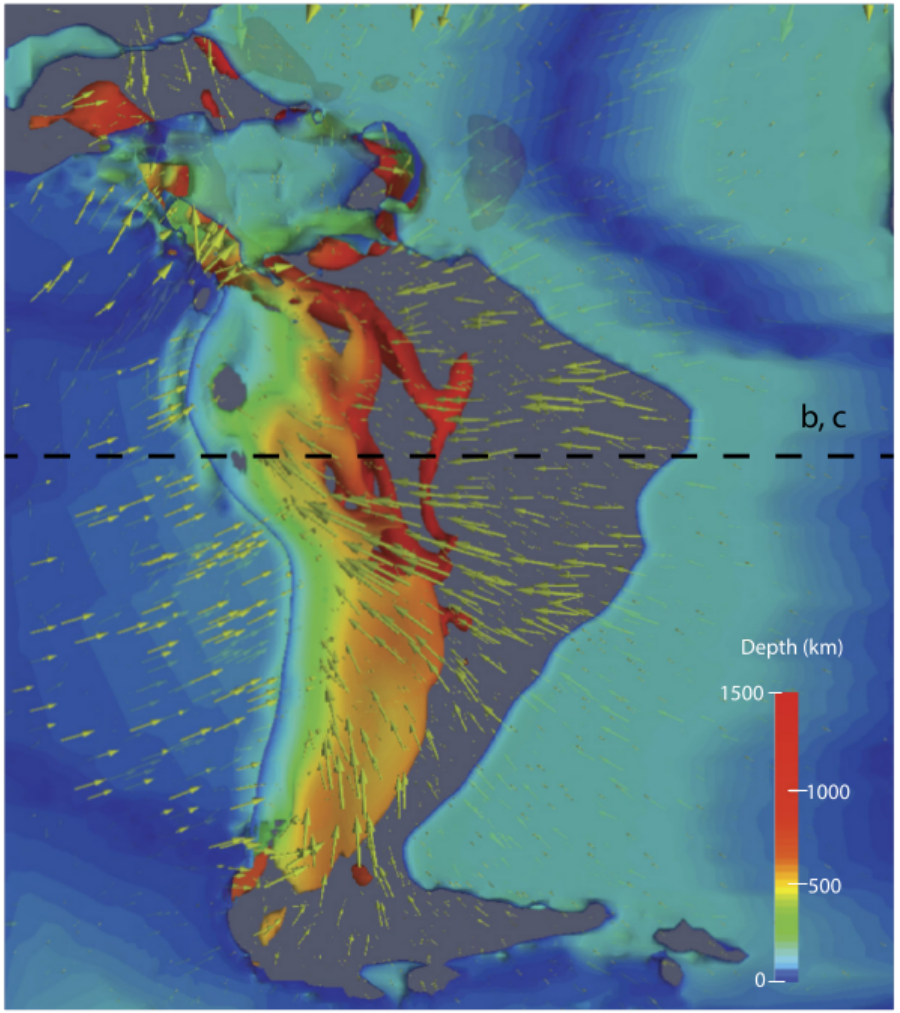
Motivation

SEISMIC ANISOTROPY

PATTERNS OF MANTLE DEFORMATION

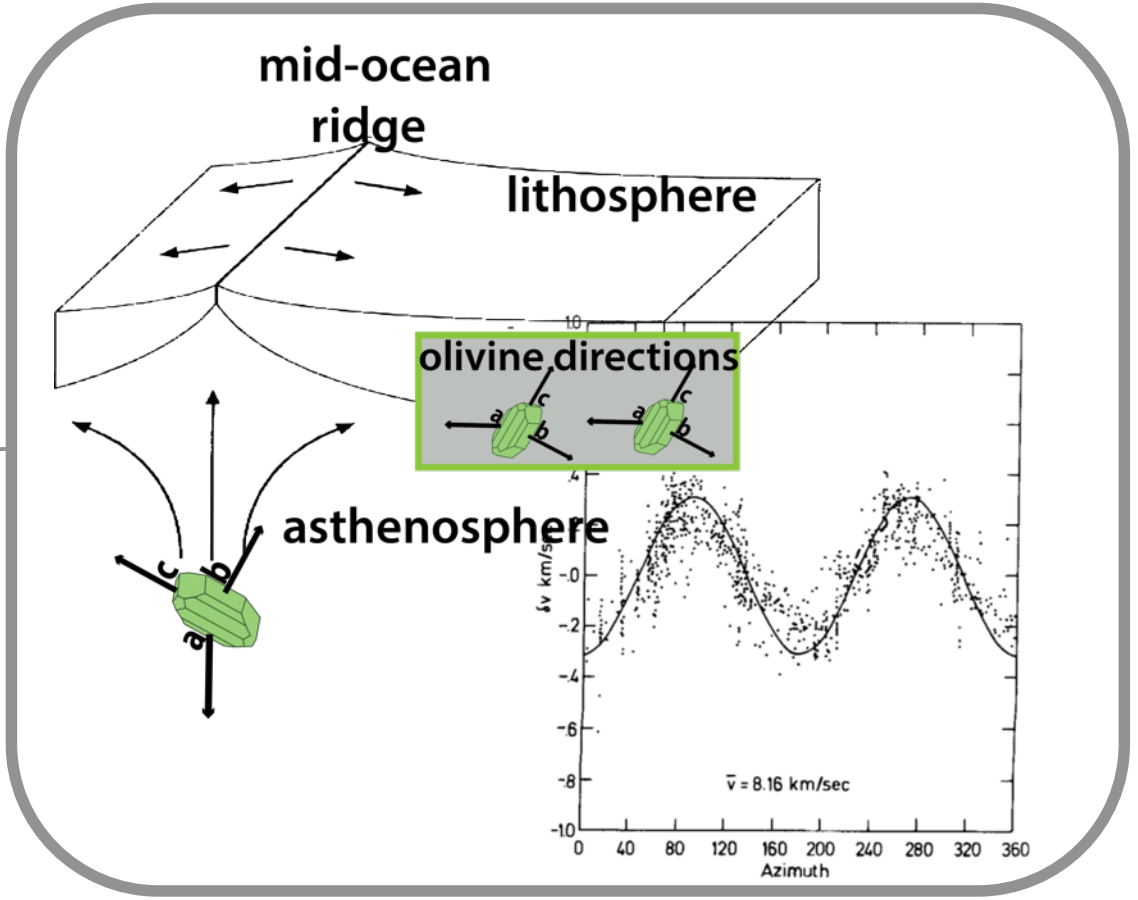
PAST & PRESENT TECTONIC PROCESSES

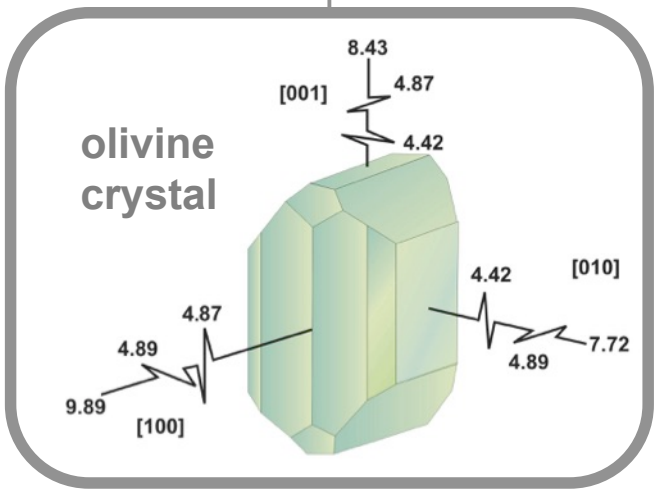


3D geodynamic model at present day. The 3D isosurface with a constant temperature shown with color representing depth. Green arrows are velocity vectors in the mantle at 200 km depth. Hu et al., (2017).

Seismic Anisotropy

- **Seismic anisotropy is the dependence of wave speed on the direction of seismic polarization and wave propagation;**

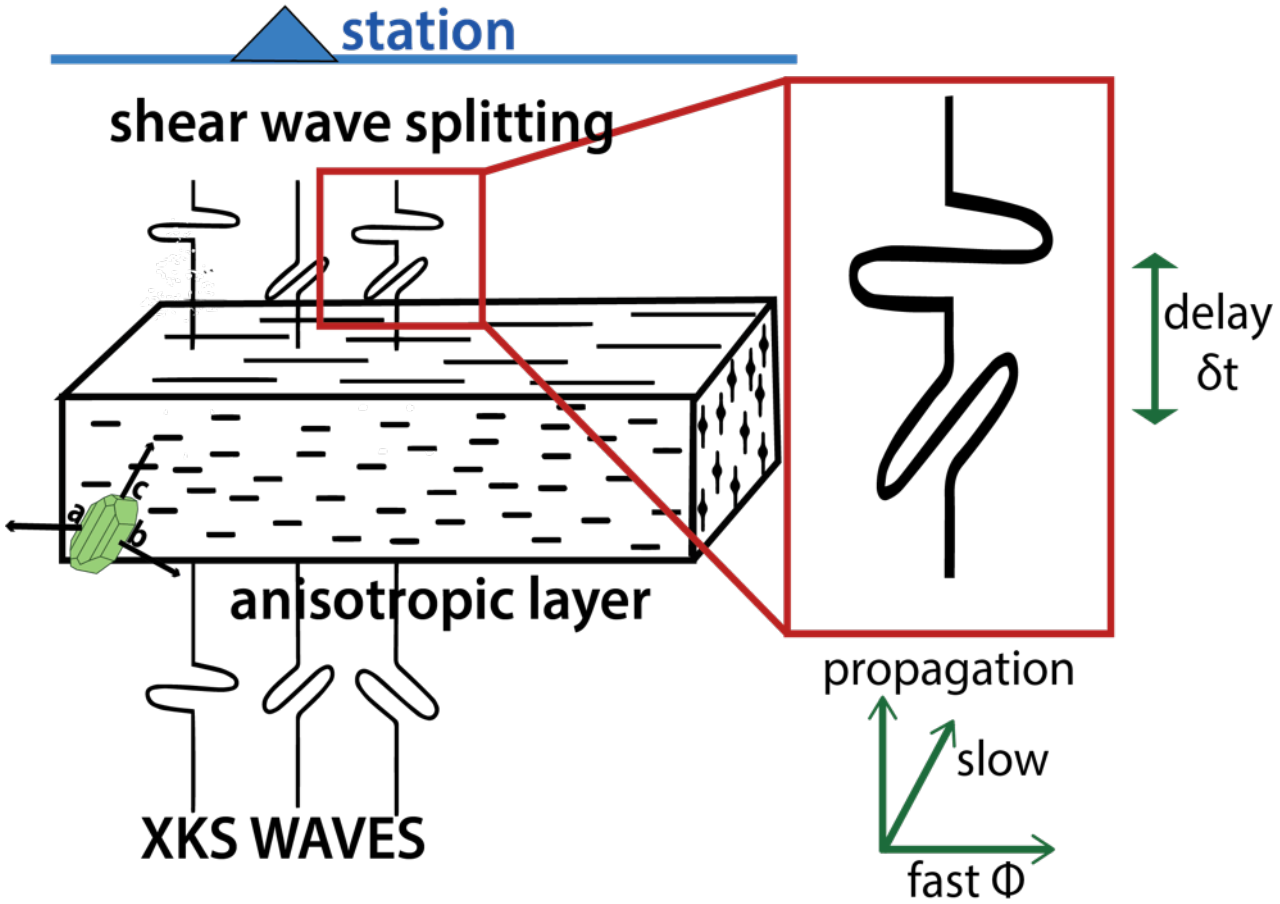




- **shear deformation in the mantle causes lattice preferred orientation (LPO) of olivine.**

Shear Wave Splitting

- **A shear wave propagating through an anisotropic medium is split into two orthogonal quasi shear waves;**

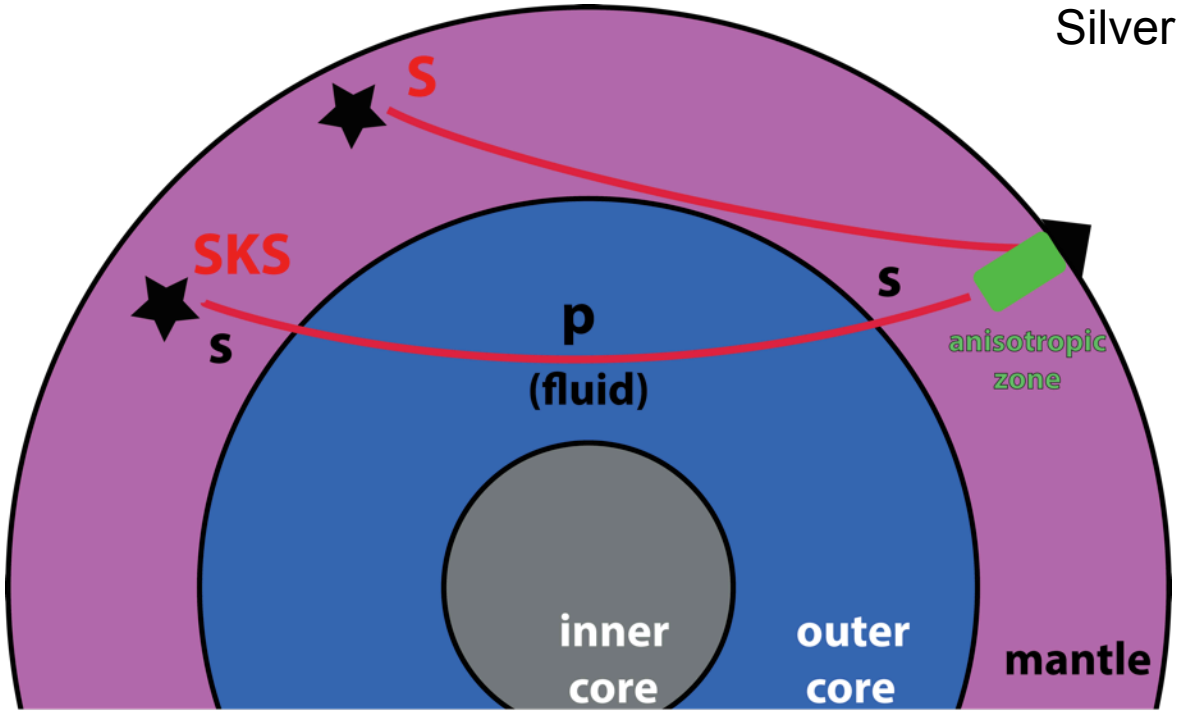


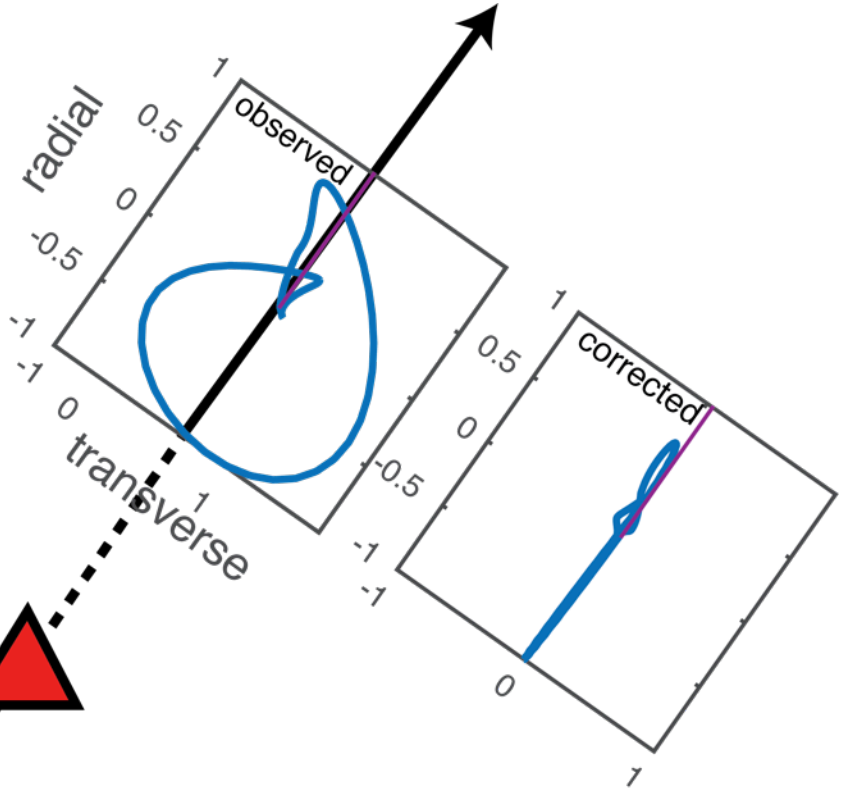
- **the delay time between the two components (dt) depends on the thickness/strength of the anisotropic layer;**

- **the orientation of the fast component (phi) indicates the anisotropy orientation, related to the a-axis of olivine crystals.**

Transverse Minimization Method

Silver and Chan, 1991

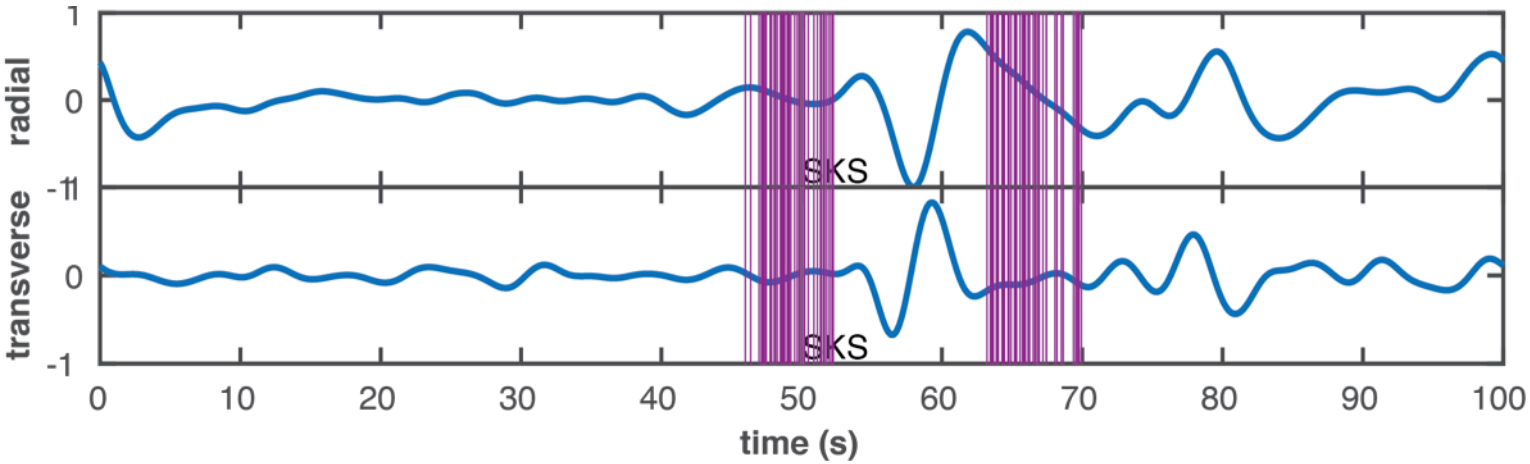


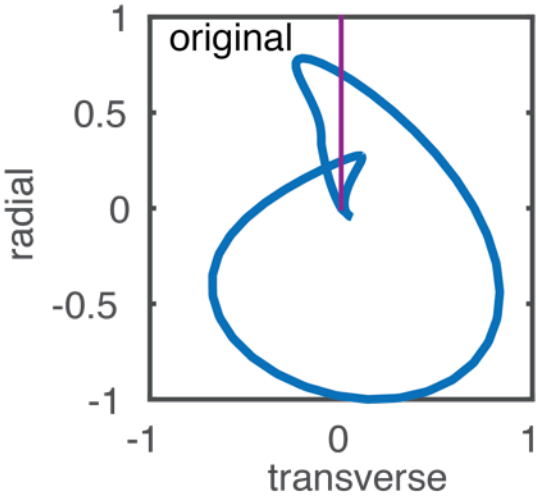


- **XKS waves will refract from the outer core only with energy on the radial seismogram component;**

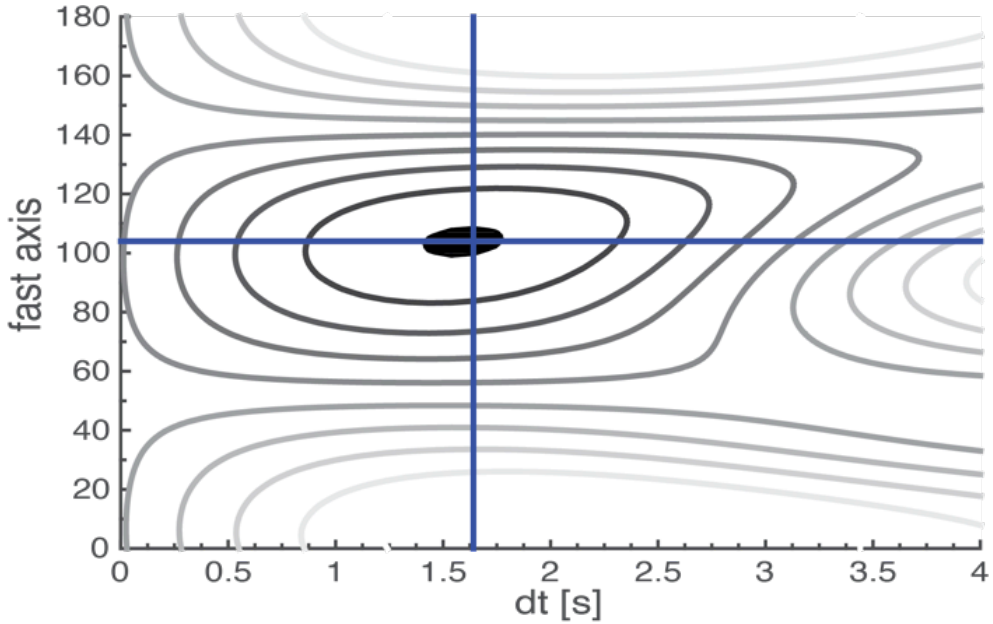
- **if energy on the radial component is observed, it is due to polarization by the effect of an anisotropic layer.**

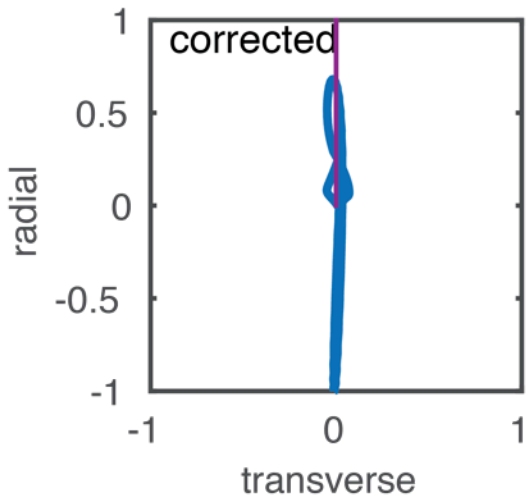
Transverse Minimization Method



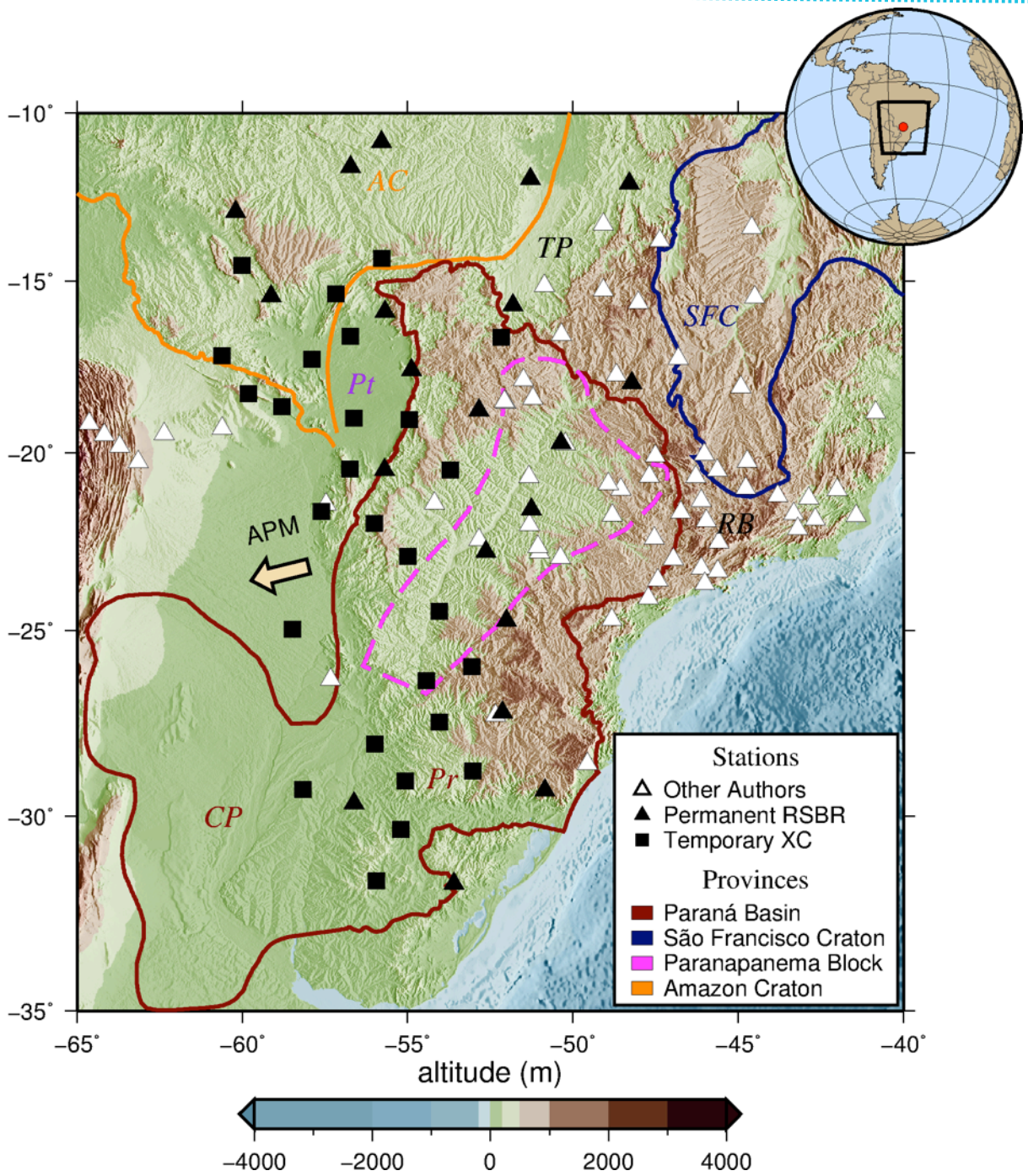


- **The anisotropy effect is removed by a grid search of the splitting parameters which minimize the energy on the transverse component.**



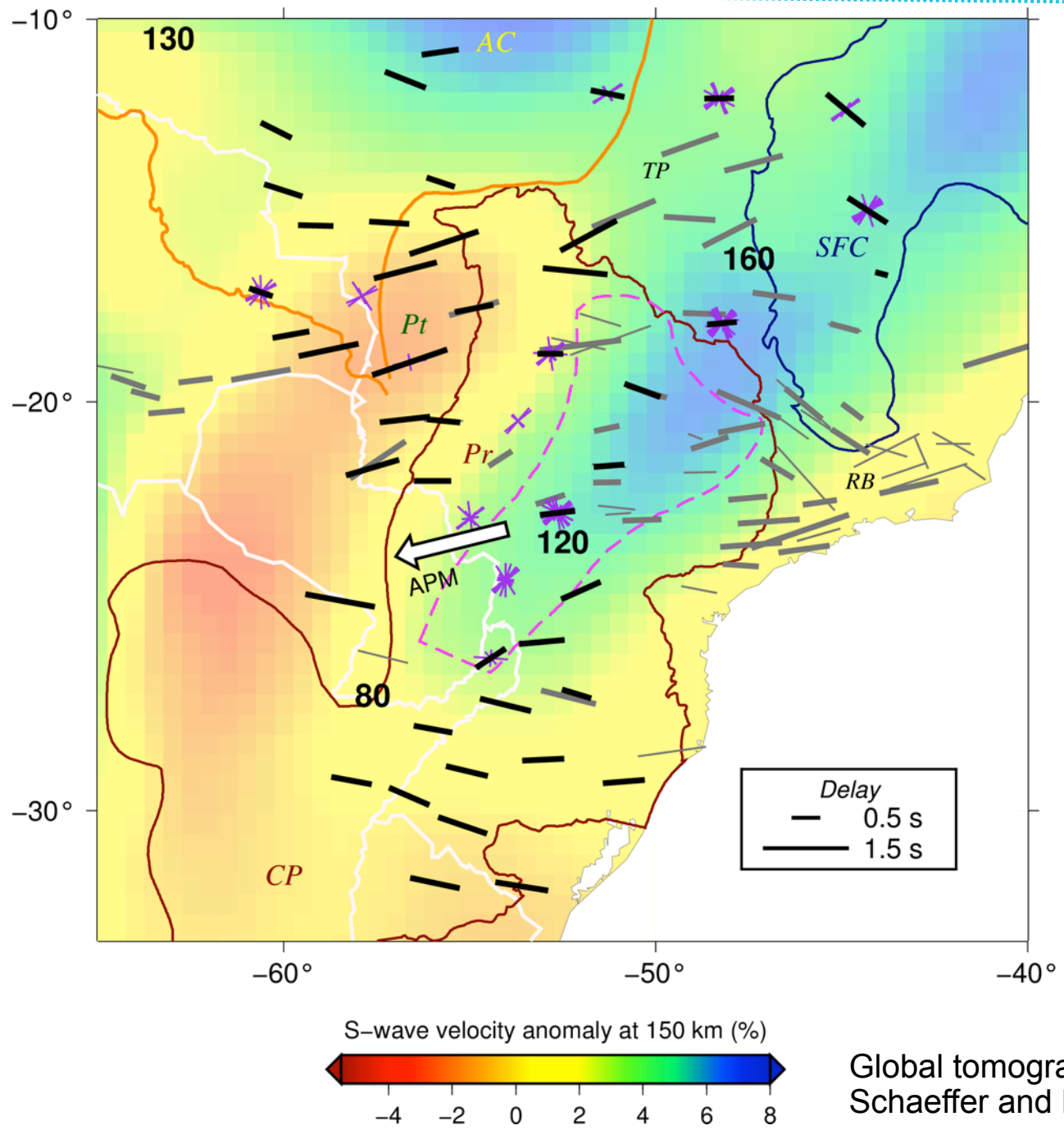


Data



- **47 new measurements from stations of the BL, BR and XC (FAPESP – 3 Basins) networks.**

Results

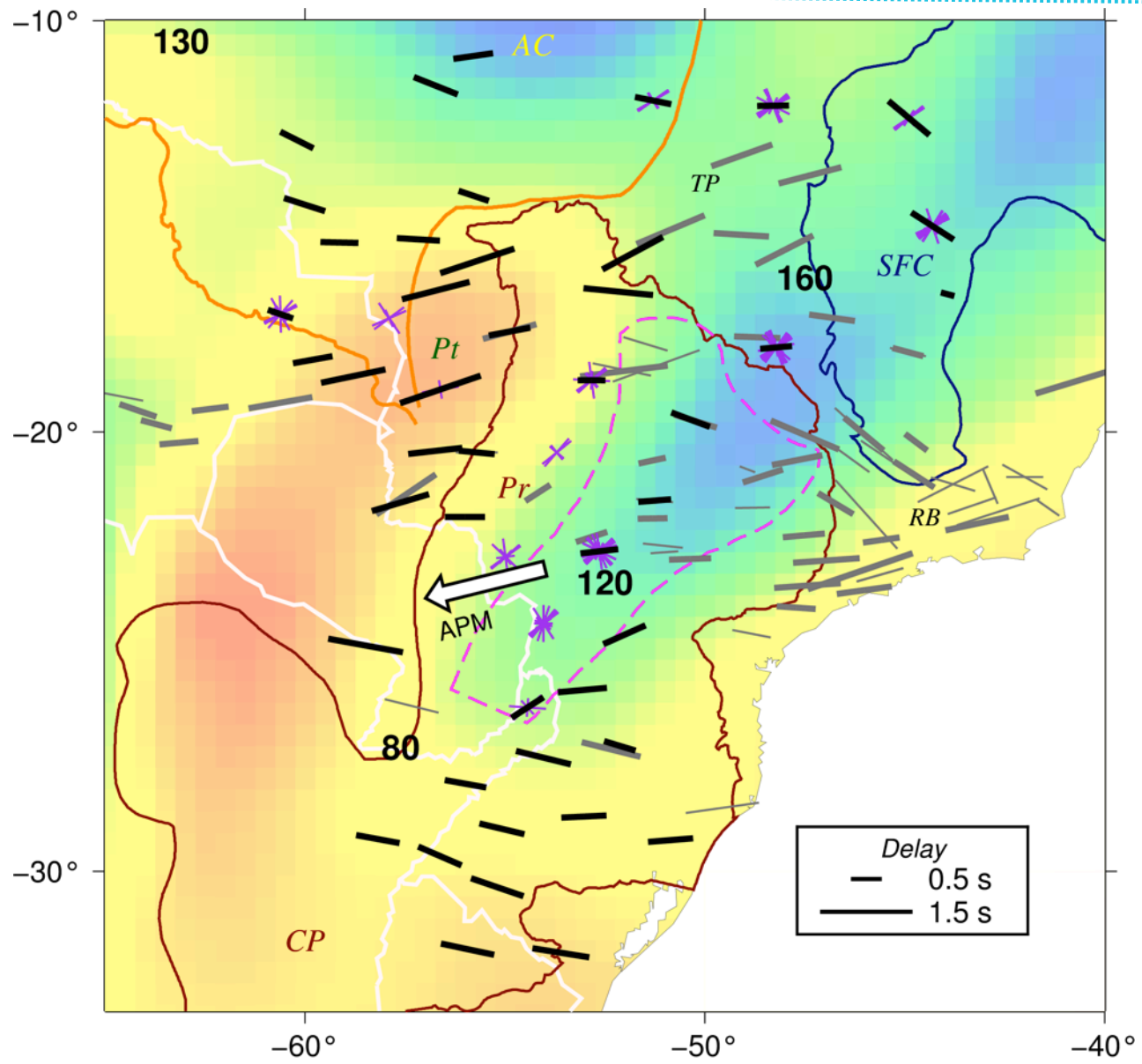


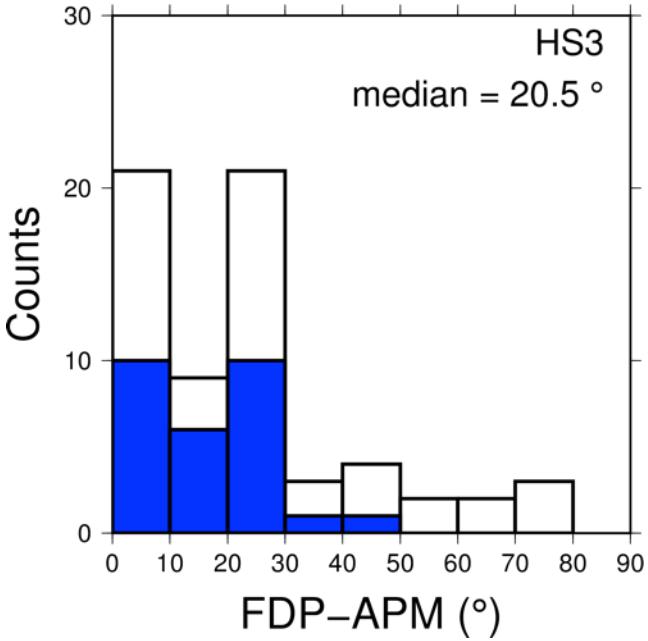
- **Paraná Basin: thick lithosphere;**
- **Amazon and São Francisco cratons: deep lithospheric keels;**
- **Pantanal basin: S-wave low velocity anomaly.**

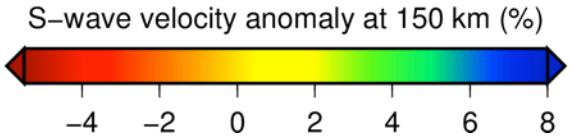
Global tomography from the model SL2013 of Schaeffer and Lebedev, (2013).

Results

- **Absolute Plate Motion (NUVEL1A-HS3): doesn't explain deviations in the overall WNW-ESE directions, oversimplification.**

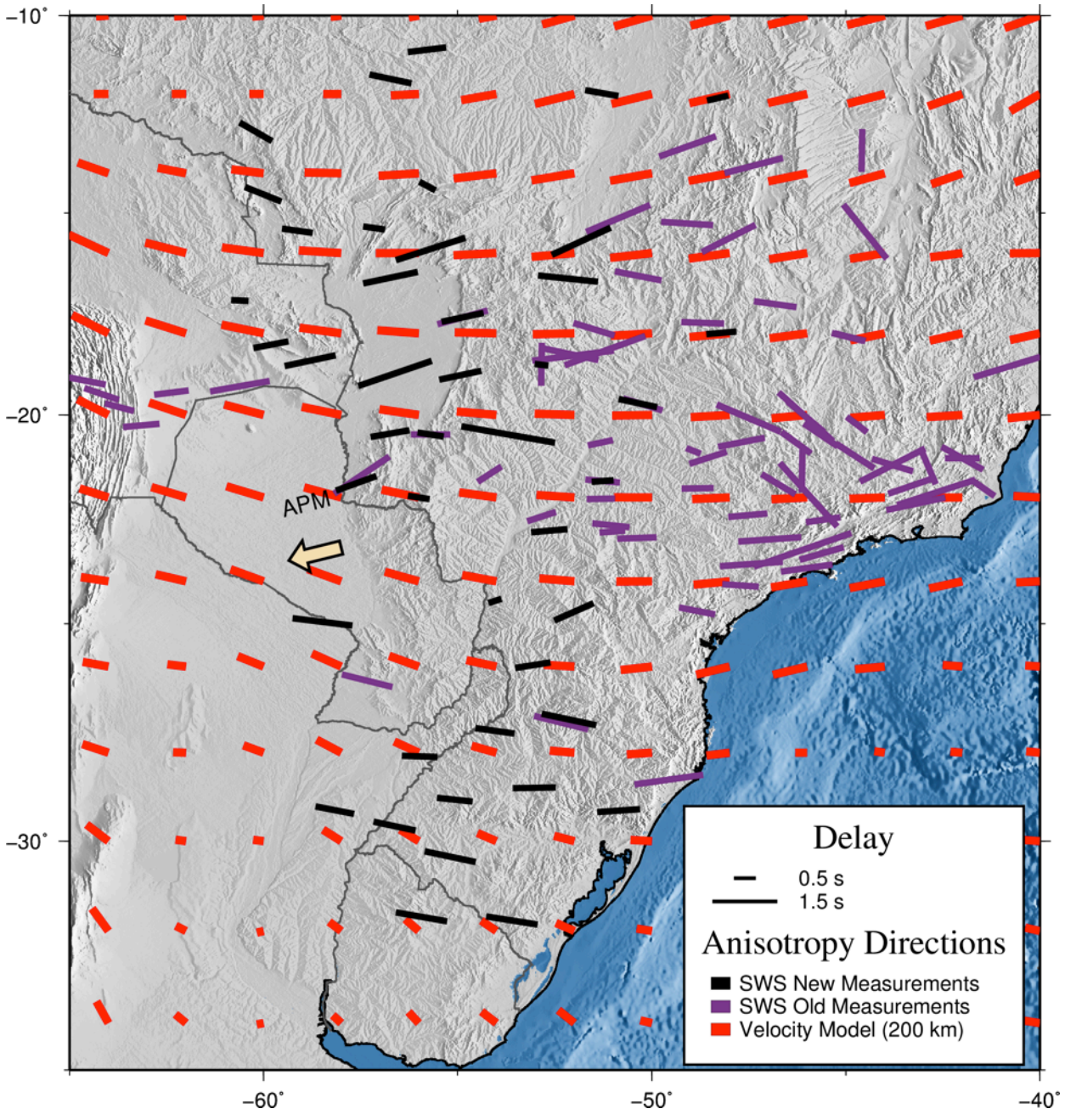




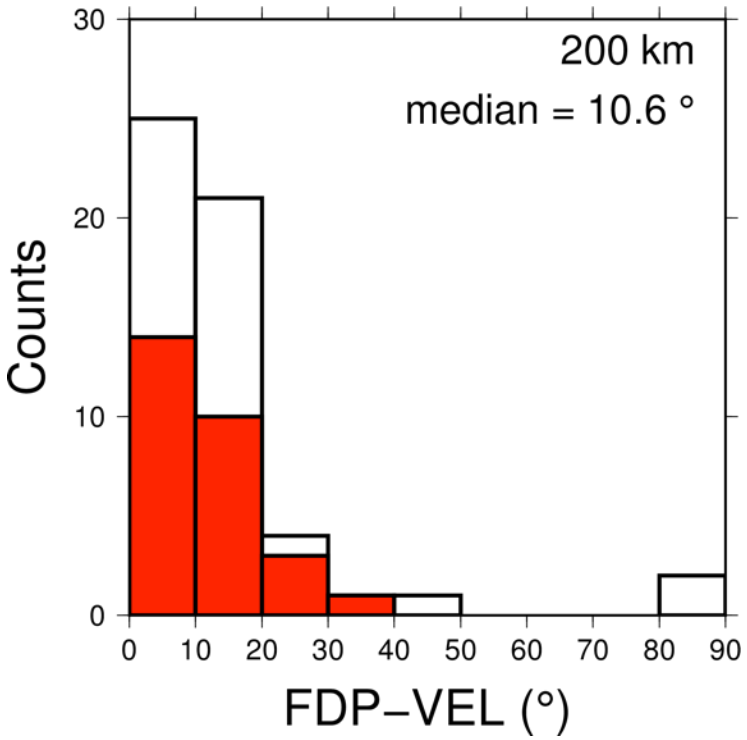


Global tomography from the model SL2013 of Schaeffer and Lebedev, (2013).

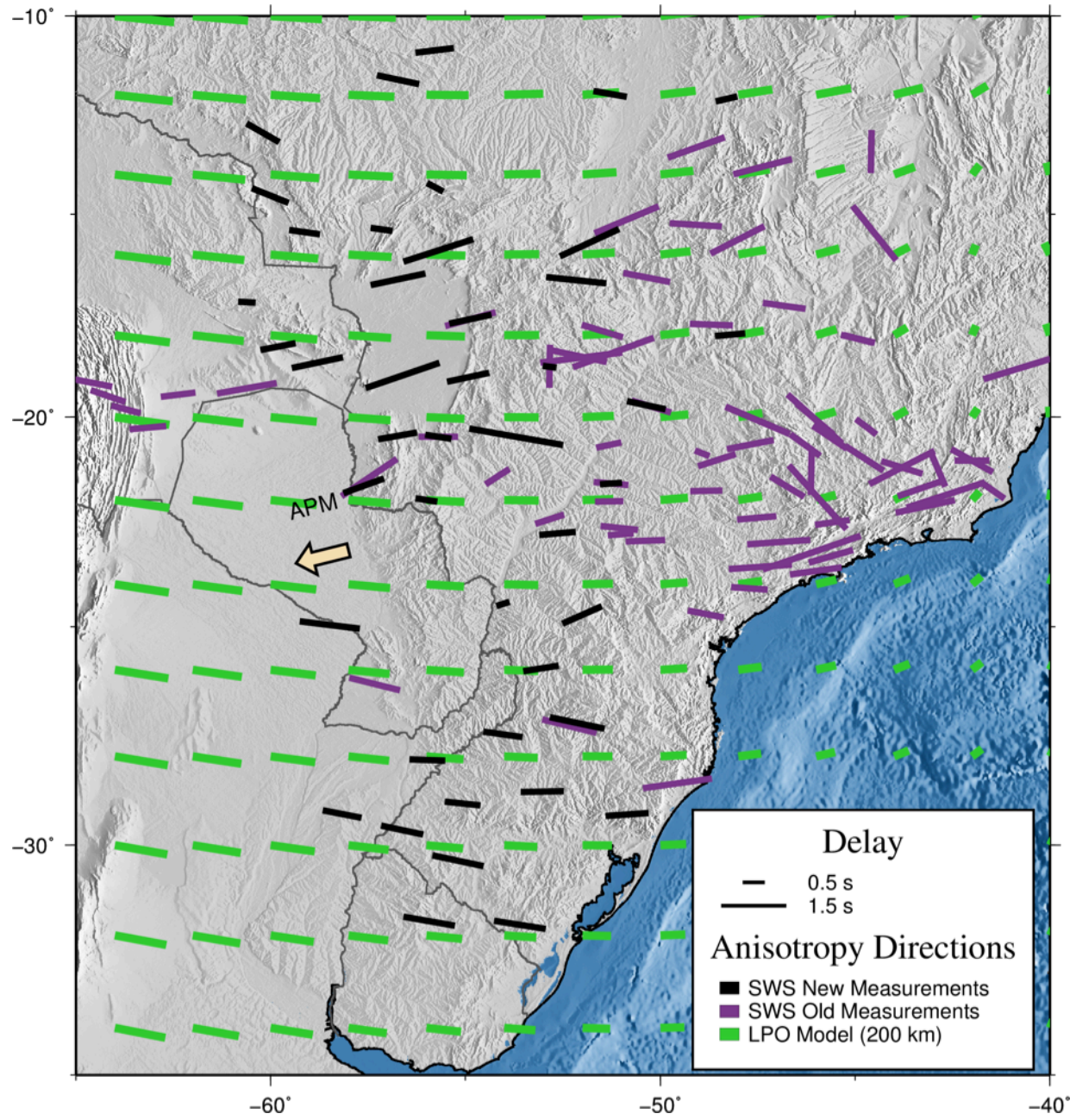
Results



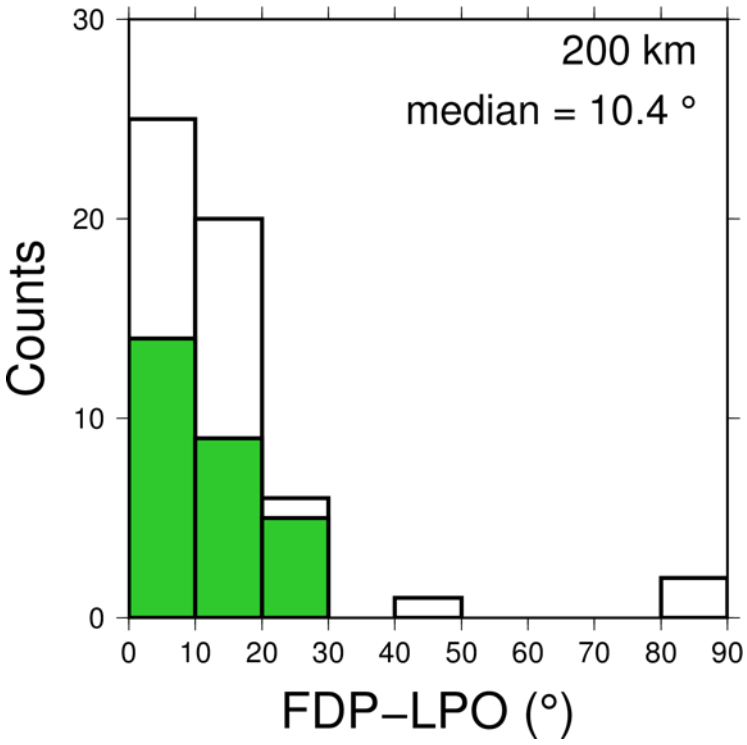
- **Convection velocity at the present day at 200 km depth (Hu et al., 2017).**



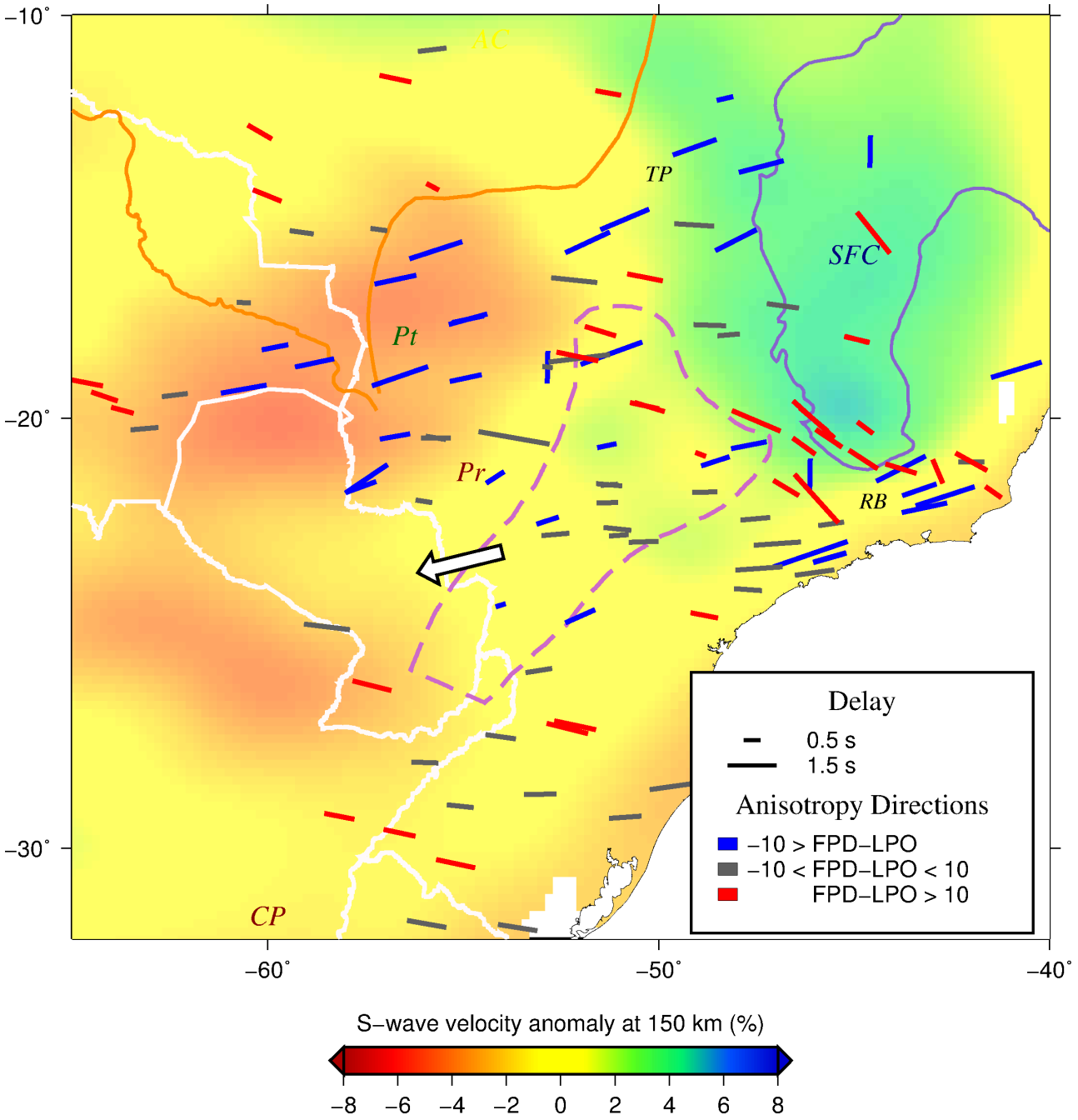
Results

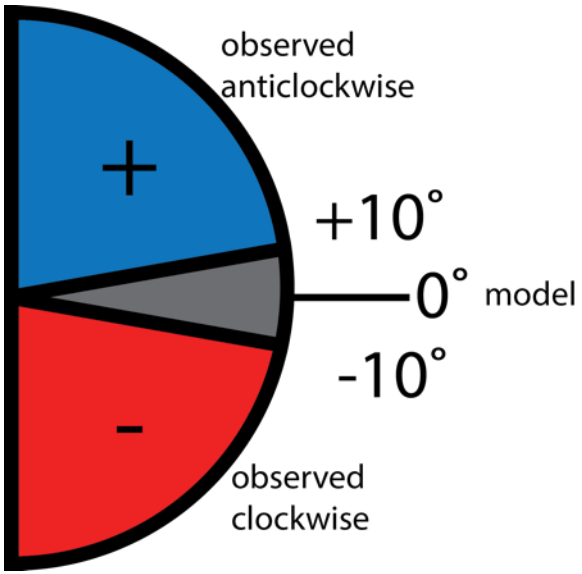


- **LPO time dependent directions from mantle flow driven by the Nazca plate subduction since the Mid-Cretaceous (Hu et al, 2017).**



Results

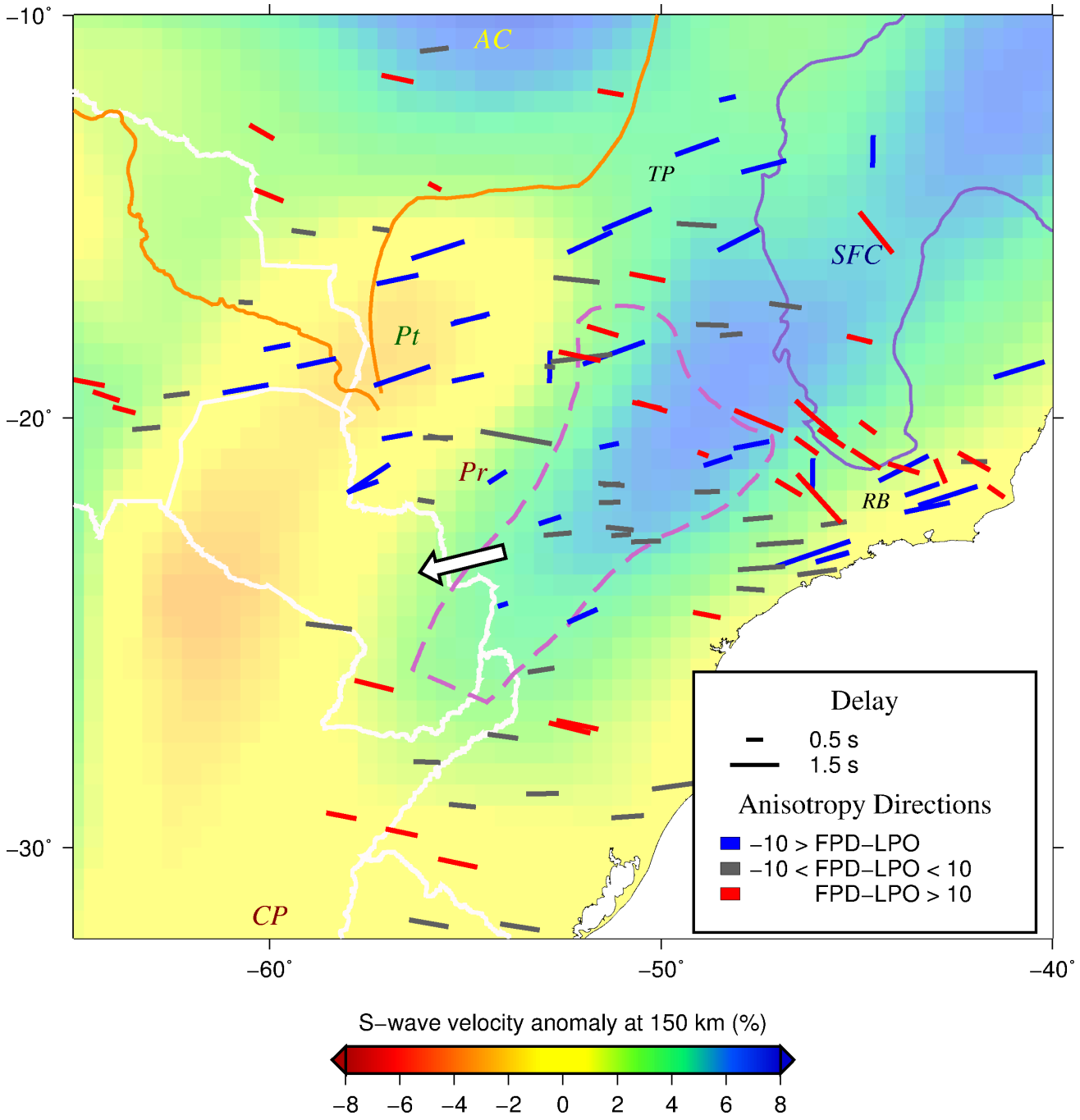




- **Orientations of fast polarizations indicate mantle flow around cratons and the Paranapanema block;**

Regional tomography from the work of Feng et al., (2007)

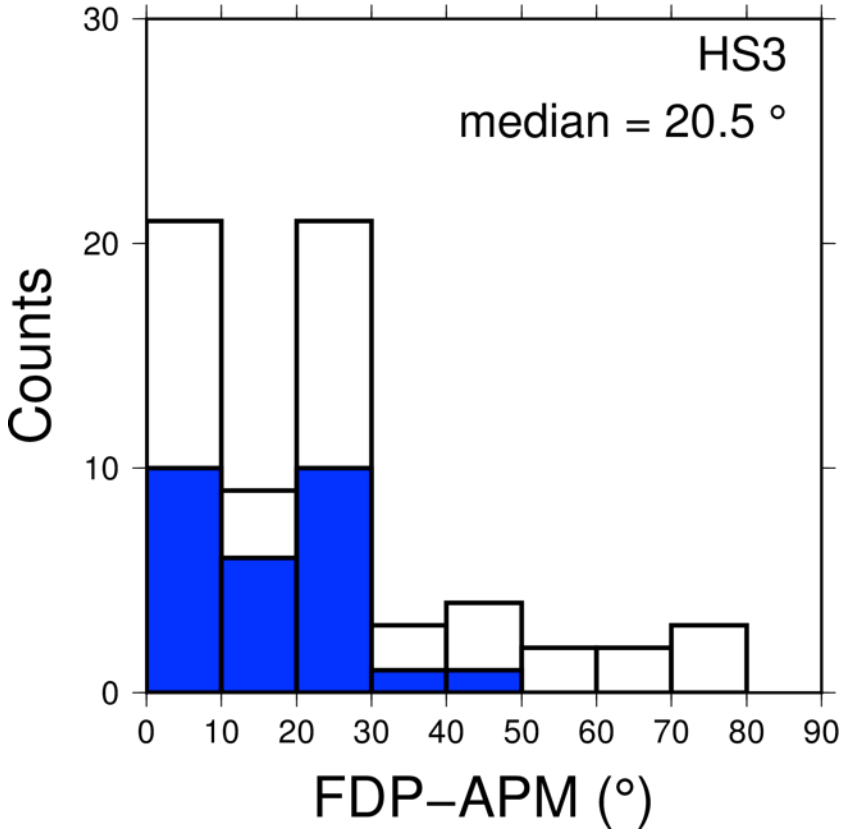
Results

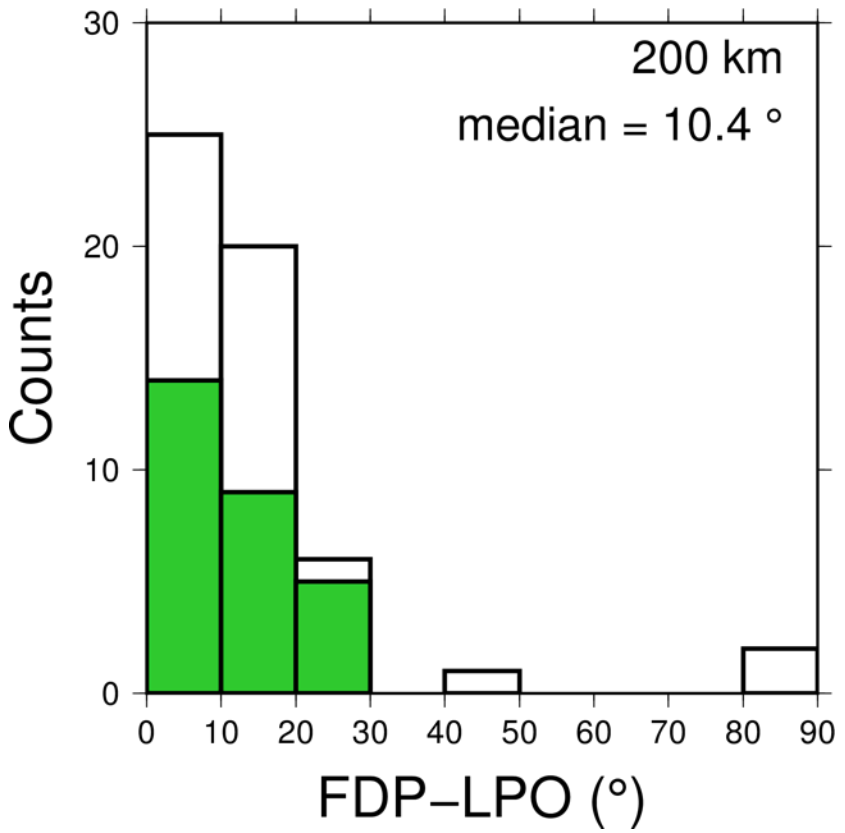


- **Large delays beneath the Pantanal Basin suggest a strong asthenospheric channel, more coherent flow, or thicker asthenosphere;**
- **Small delays beneath the northern Paraná basin may indicate thinner anisotropic asthenosphere.**

Global tomography from the model SL2013 of Schaeffer and Lebedev, (2013).

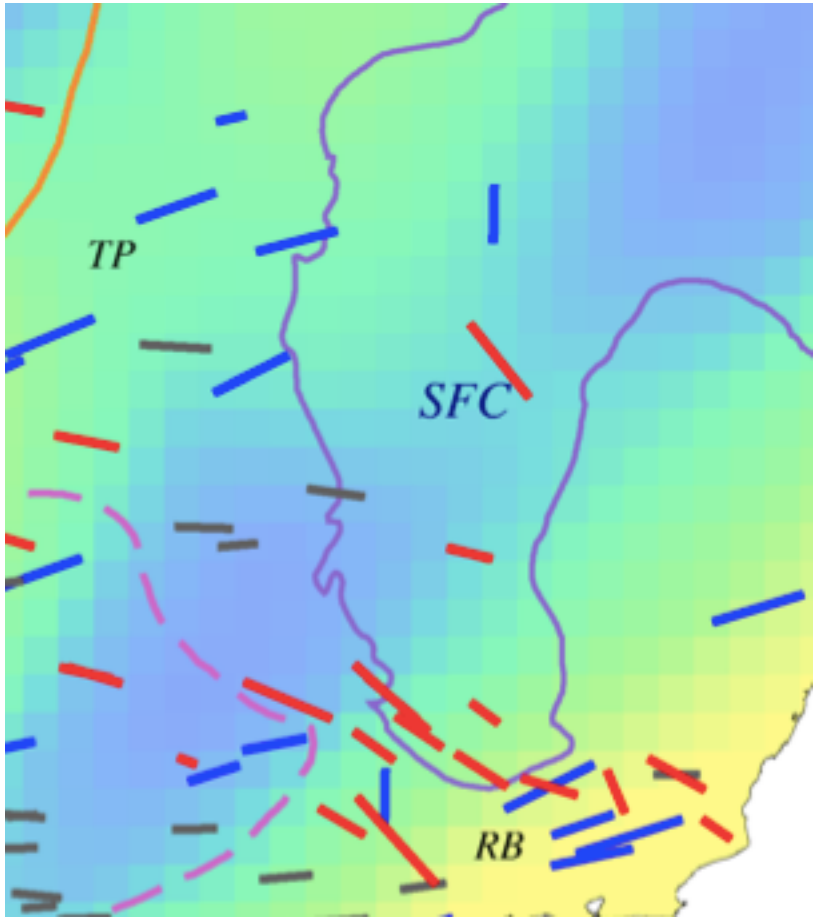
Conclusions





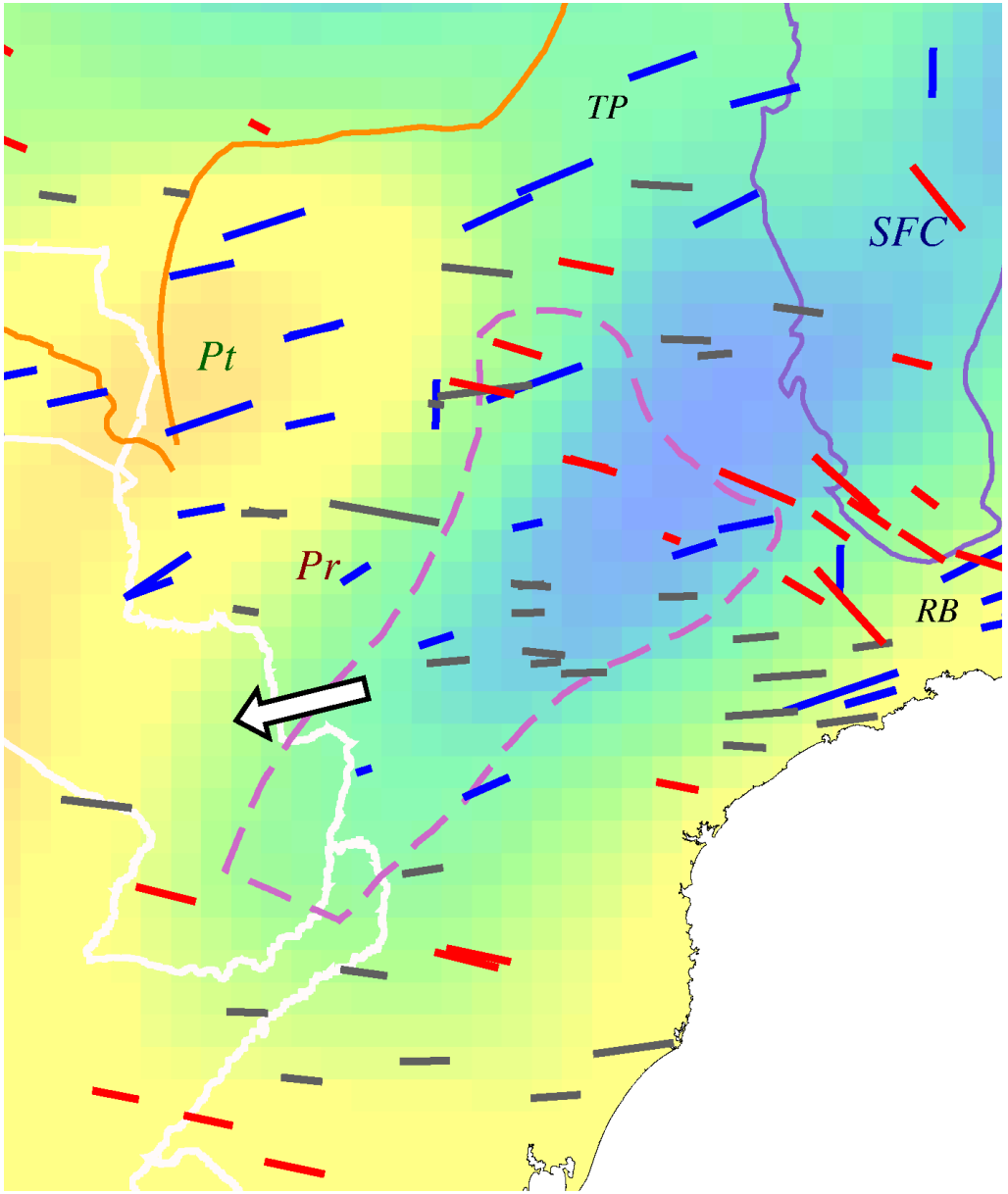
- **Subduction induced, time dependent flow model provides a better explanation for anisotropy compared to APM;**

Conclusions



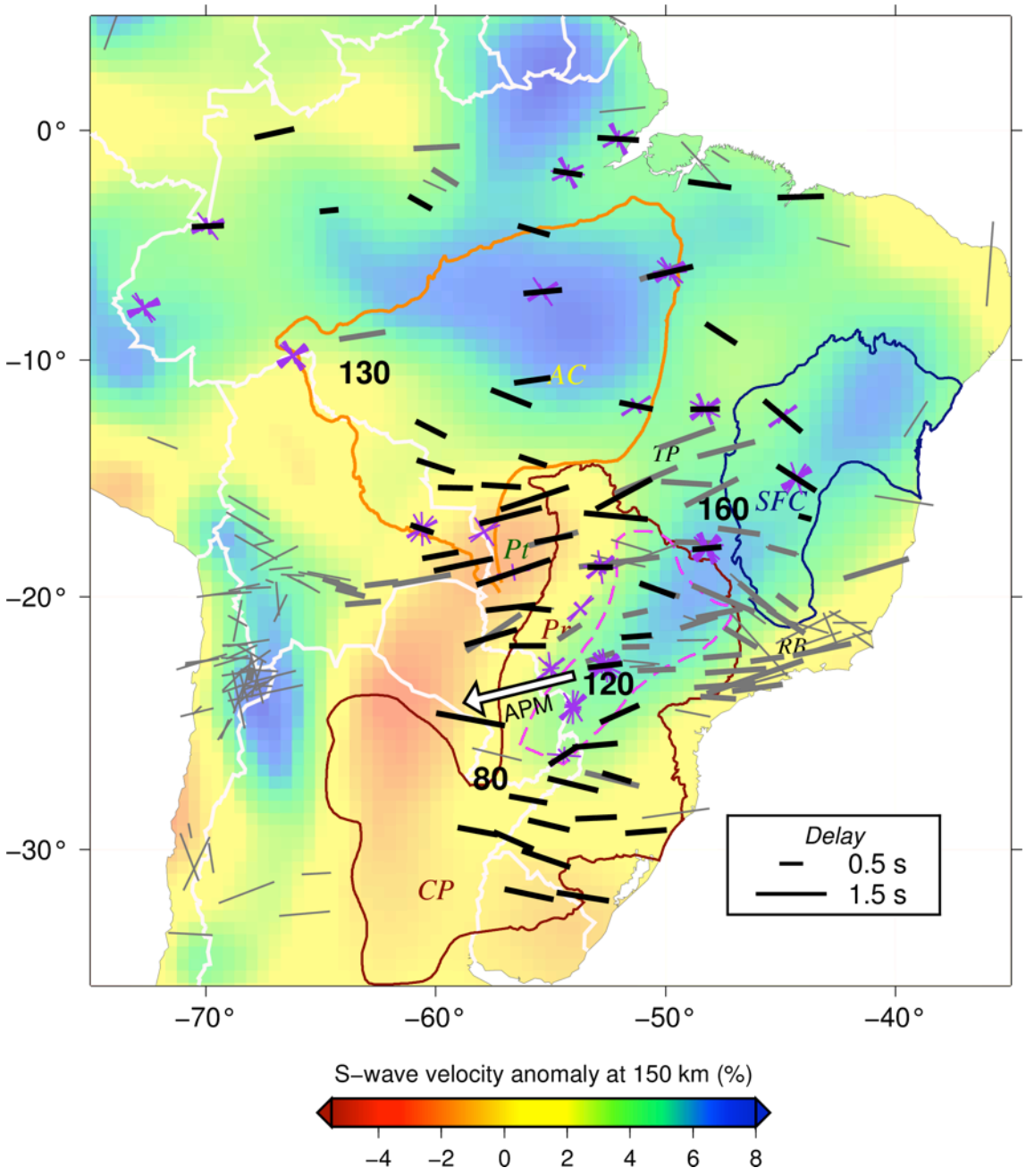
- **Orientations confirm flow around the SF craton;**

Conclusions



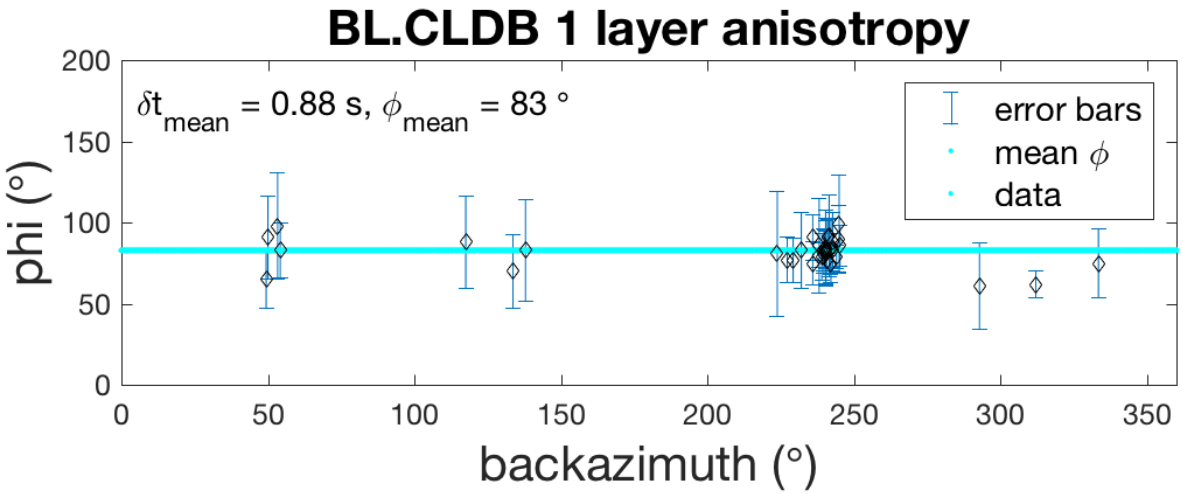
- **Existence of the Paranapanema block, which diverts mantle flow.**

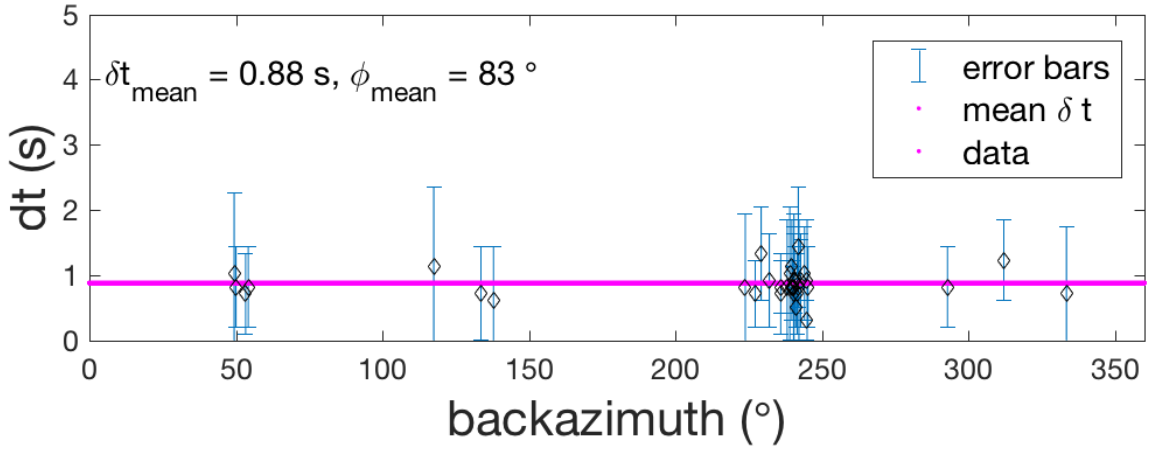
Next Steps

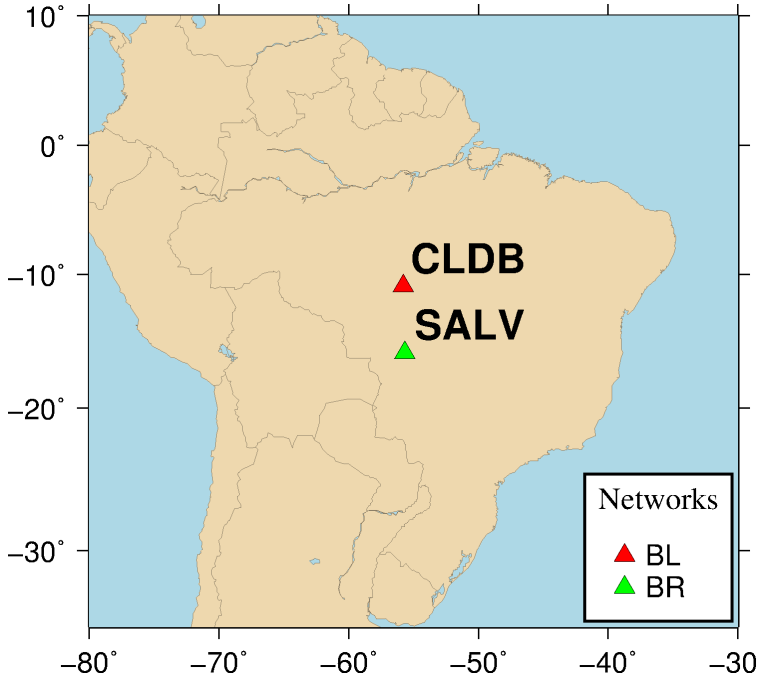


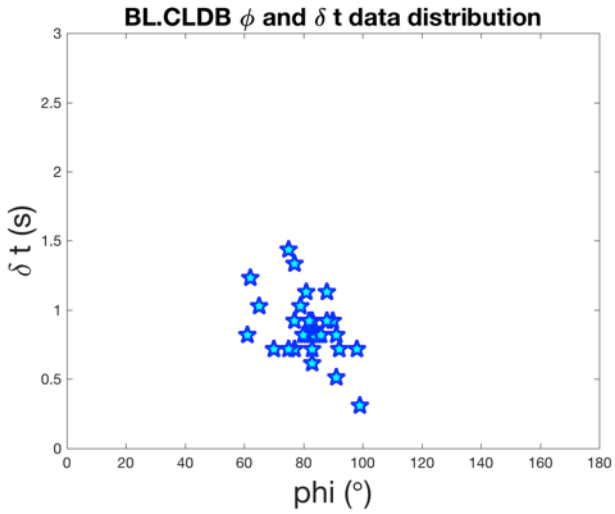
- **Correlate the new results with different anisotropy proxies;**
- **Analysis of complex anisotropy.**

Next Steps

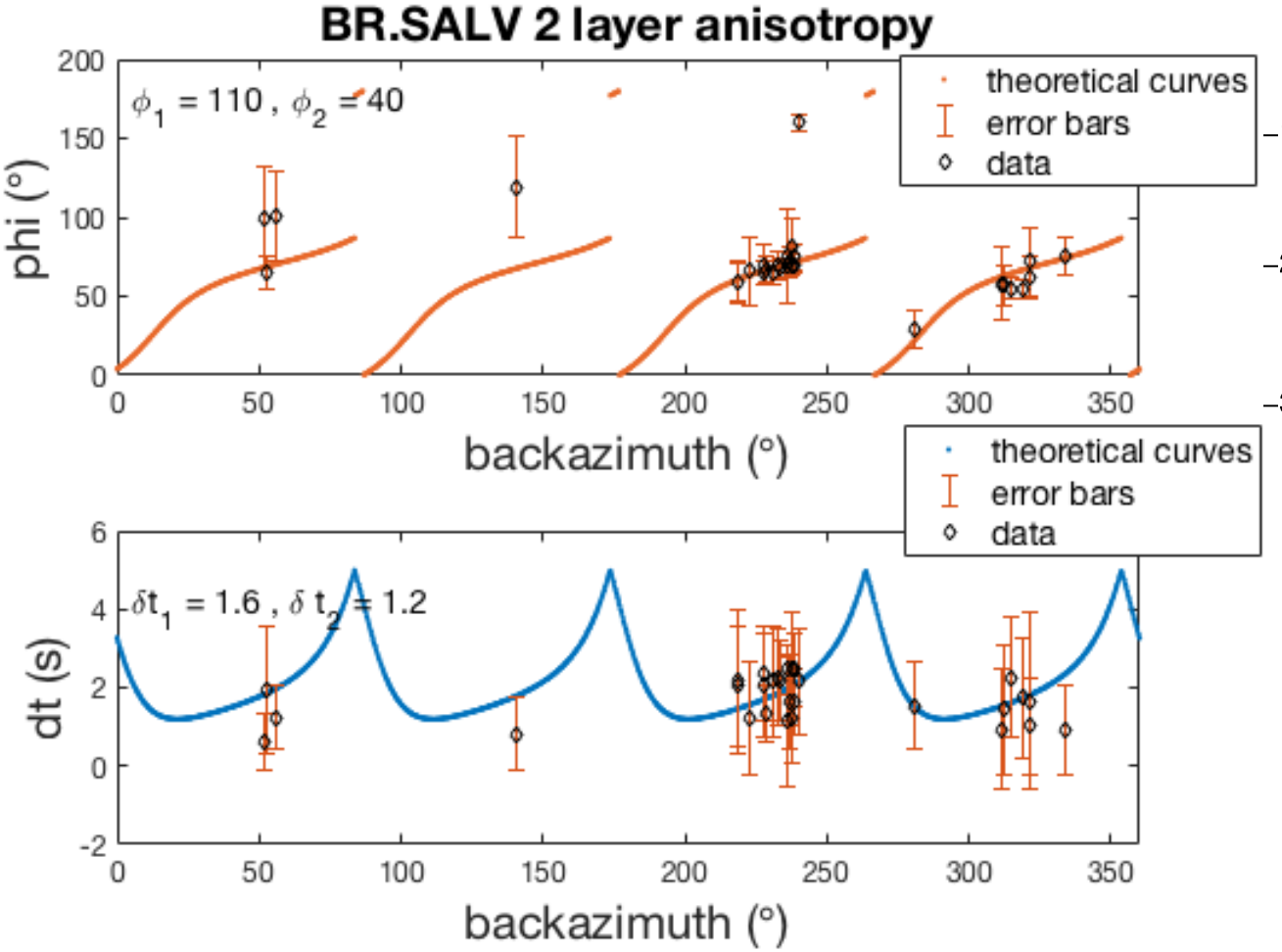

BL.CLDB 1 layer anisotropy
δt_{mean} = 0.88 s, ϕ_{mean} = 83 °
error bars
mean ϕ
data
phi (°)
backazimuth (°)

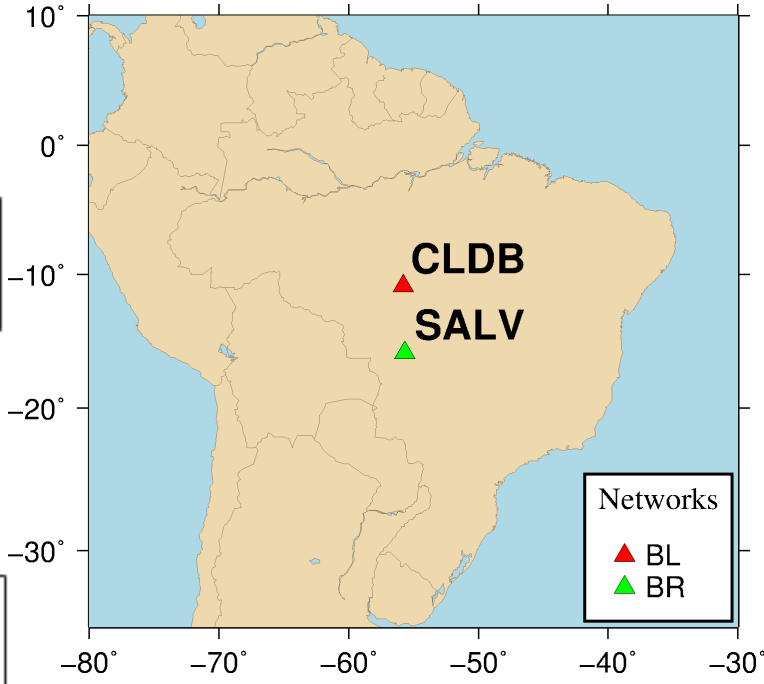

δt_{mean} = 0.88 s, ϕ_{mean} = 83 °
error bars
mean δ t
data
dt (s)
backazimuth (°)

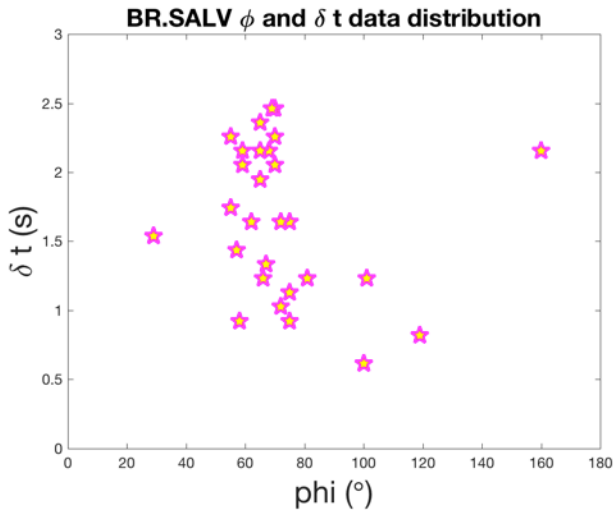

CLDB
SALV
Networks
BL
BR


BL.CLDB ϕ and δ t data distribution
δ t (s)
phi (°)

Next Steps


BR.SALV 2 layer anisotropy
ϕ_1 = 110 , ϕ_2 = 40
theoretical curves
error bars
data
phi (°)
backazimuth (°)
δt_1 = 1.6 , δt_2 = 1.2
theoretical curves
error bars
data
dt (s)
backazimuth (°)


CLDB
SALV
Networks
BL
BR


BR.SALV ϕ and δ t data distribution
δ t (s)
phi (°)

Thank you!

Obrigado!

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