A small scale InSAR view of the M_w8.3, 2105 Illapel Earthquake

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The University of Memphis

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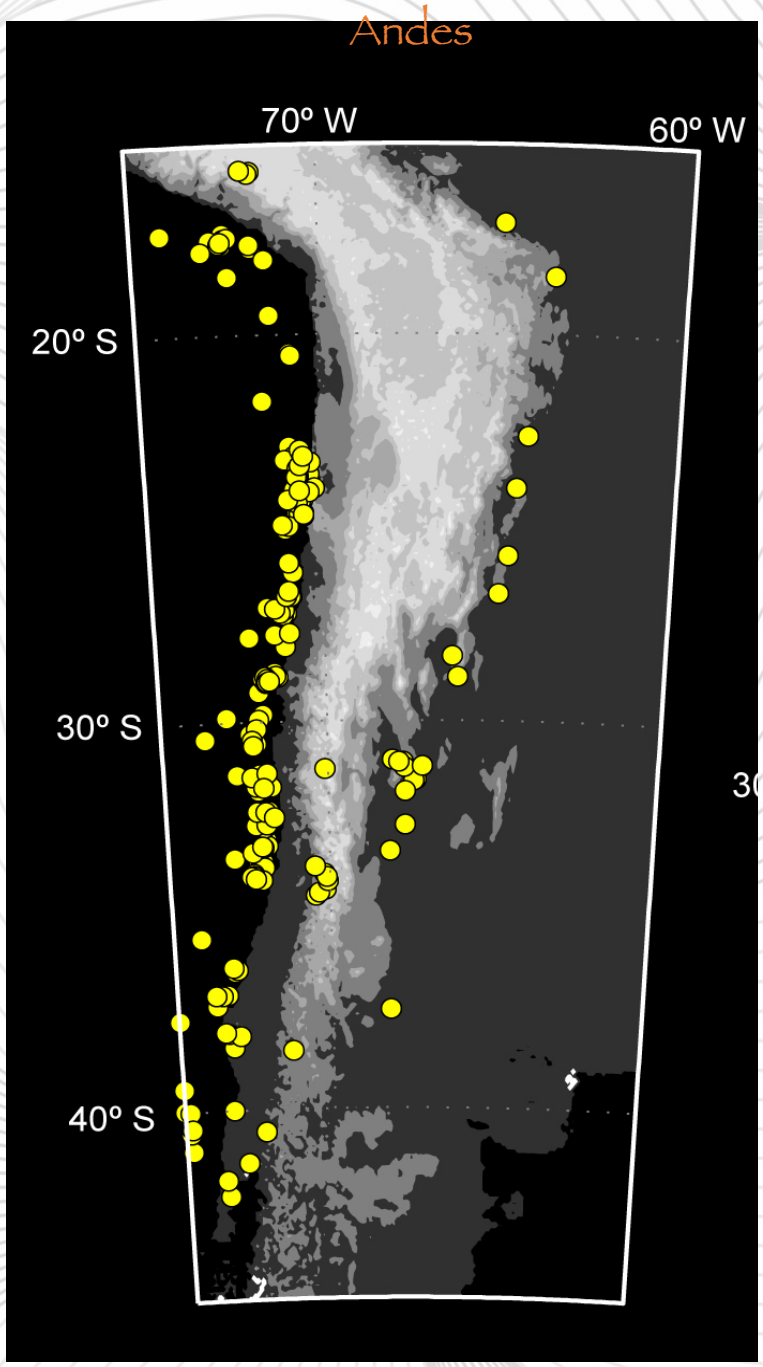
November 07 to 09, Santiago, Chile

Seismicity of the Andes.

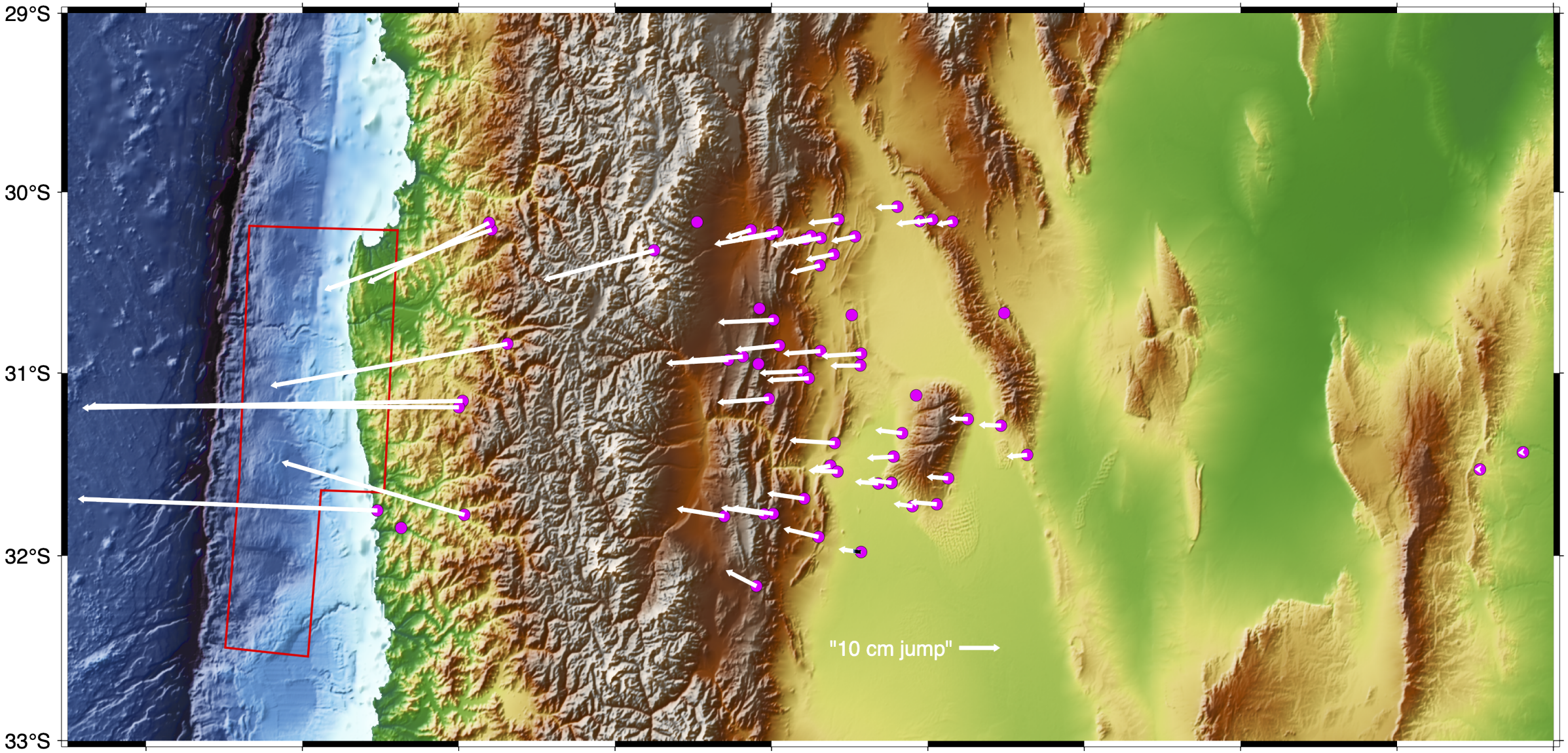
Earthquakes at “edges”

Plate boundary on west.

Earthquakes indicate Andes growing to east.

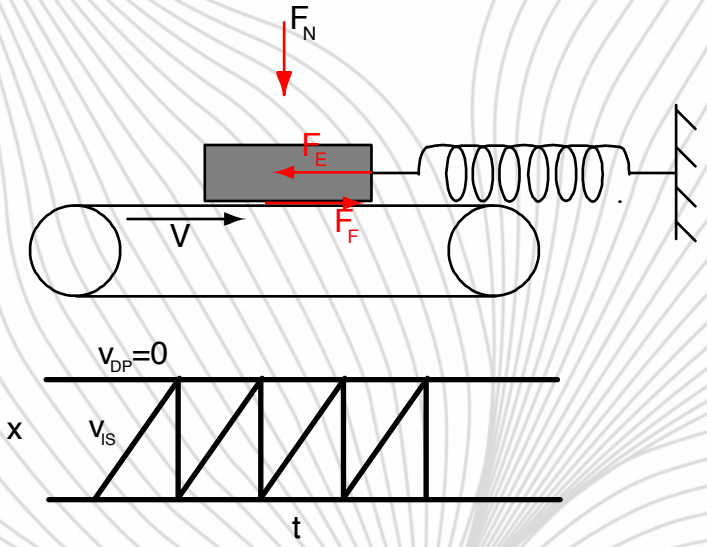


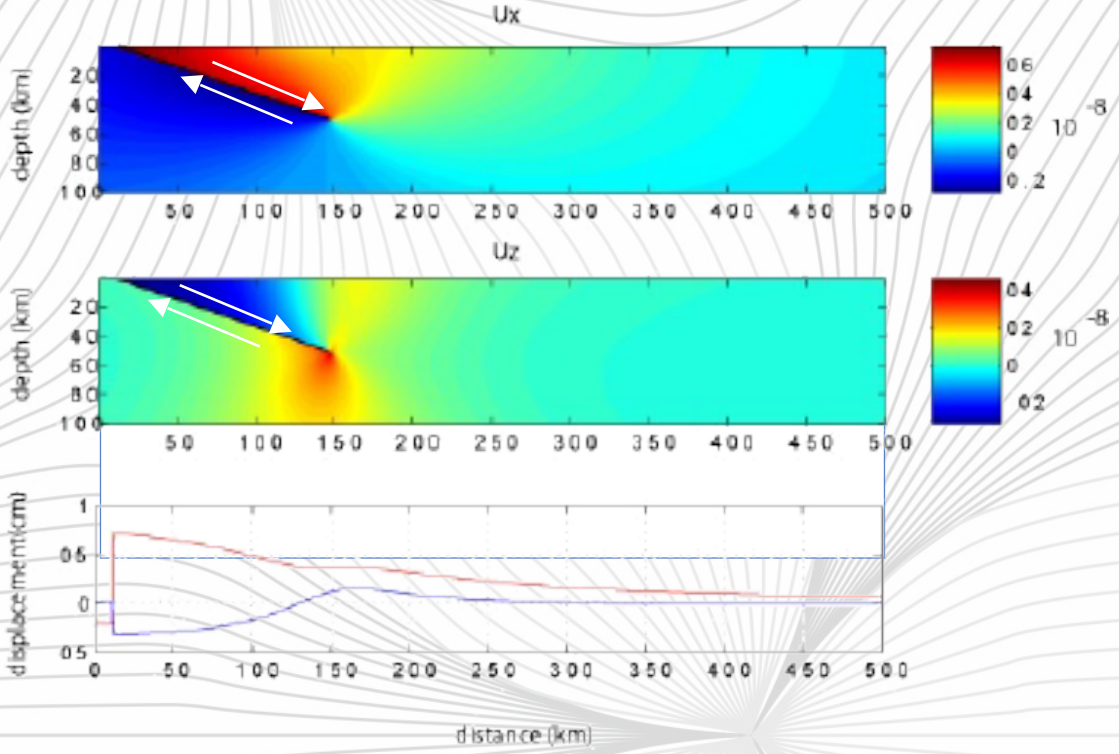
2015, M_w8.2, Illapel earthquake as imaged by GPS.



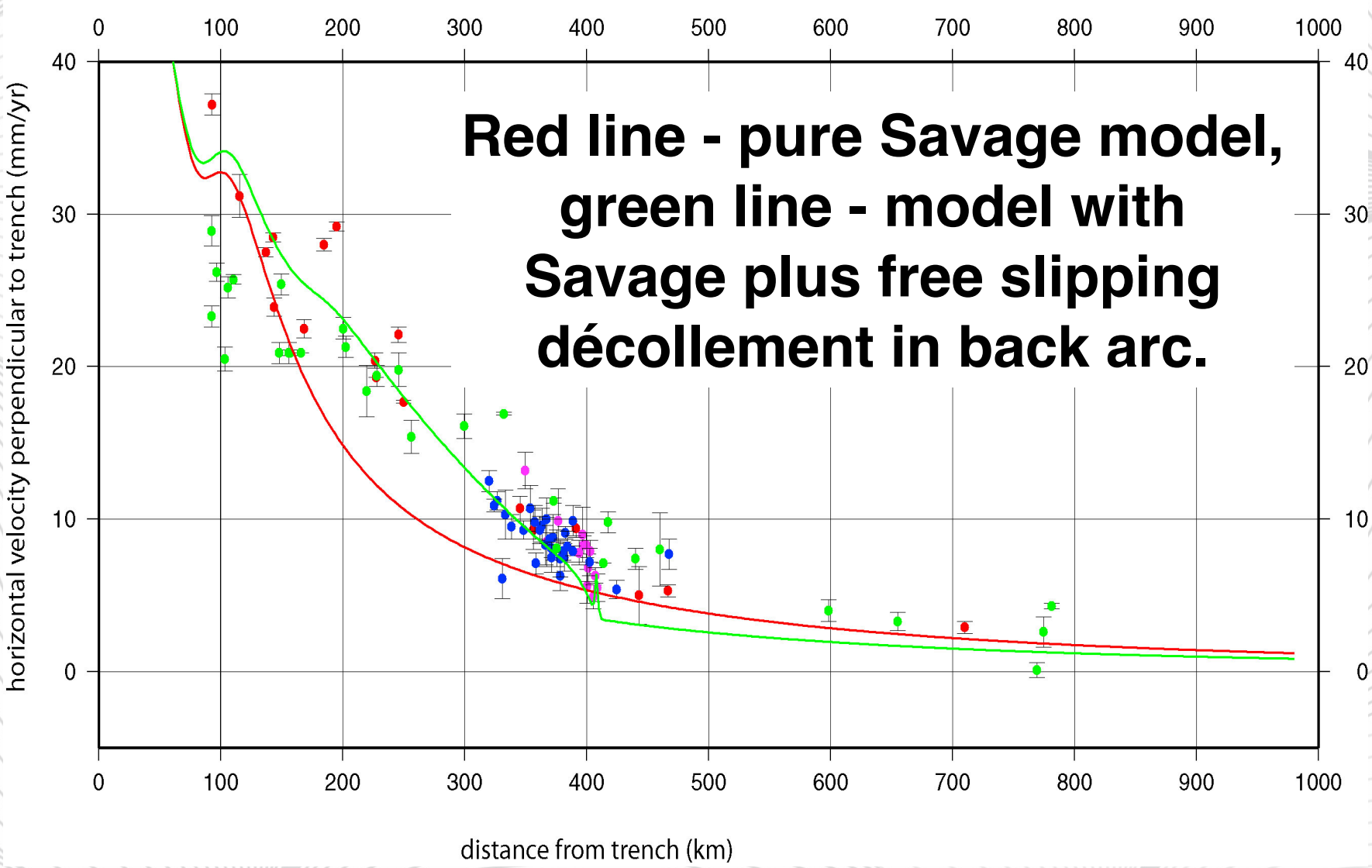
Elastic modeling of subduction process

inter-seismic deformation





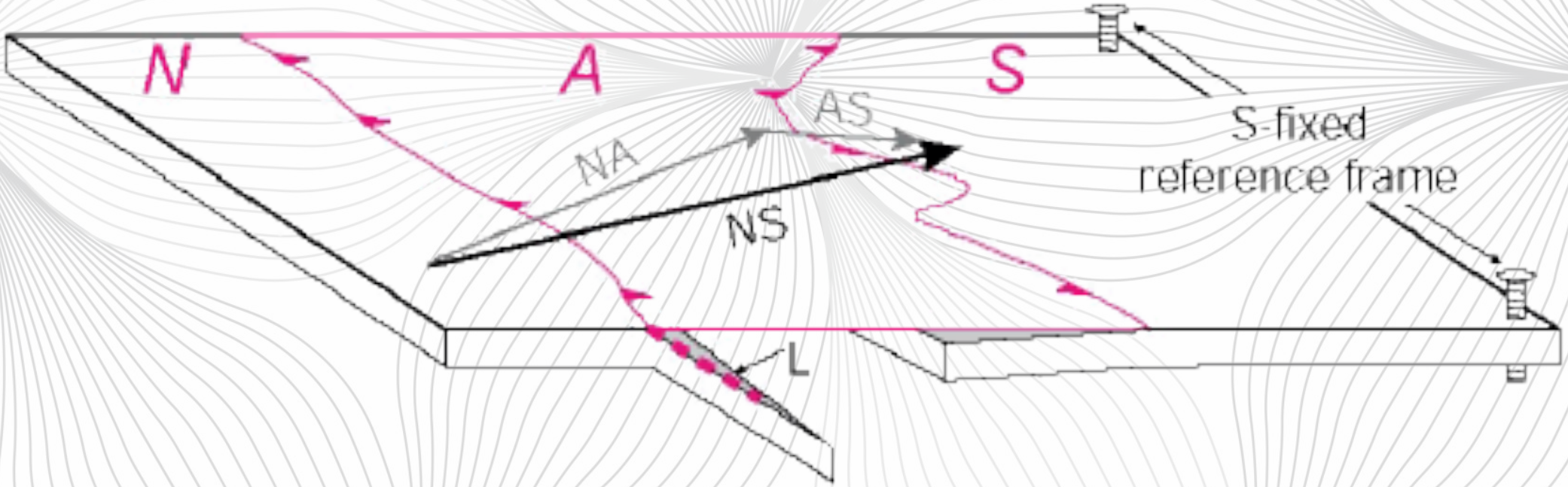
No permanent deformation (no mountains)

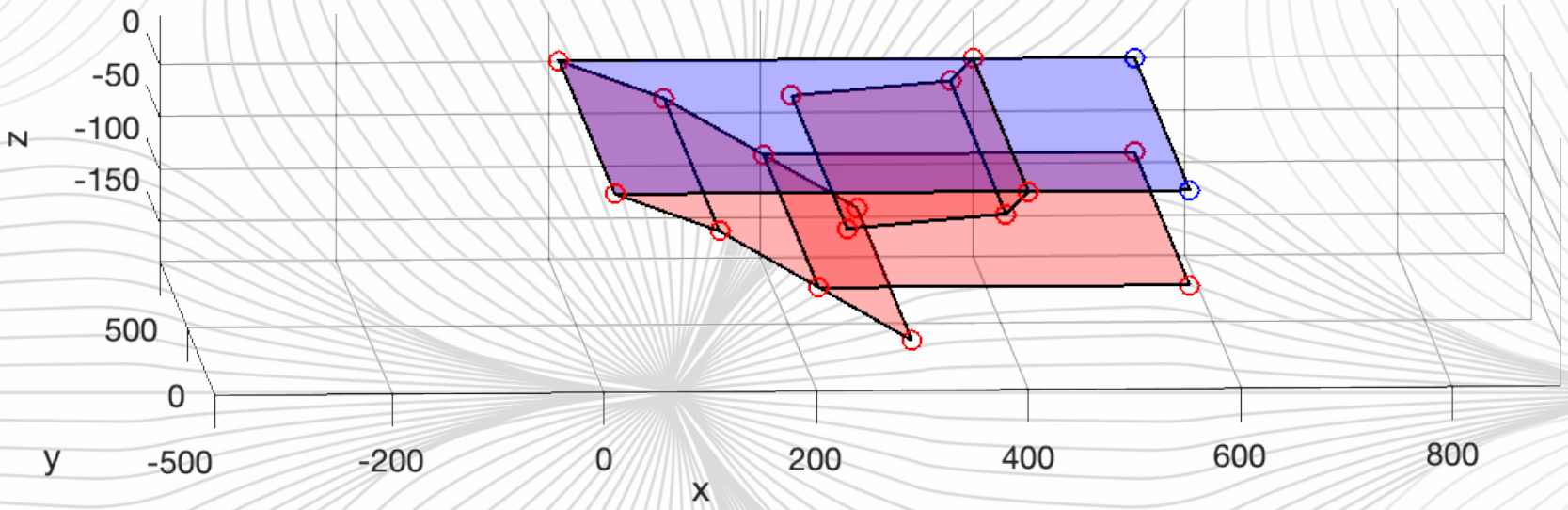


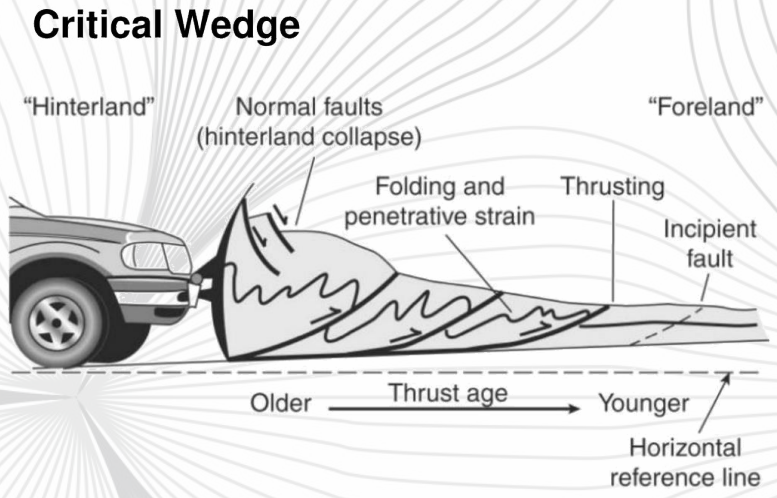
Cross section of horizontal velocity across south central Andes (concentrated between 29 and 34°S).
Strike of cross-section is perpendicular to the plate boundary.

From Brooks et al, 2003

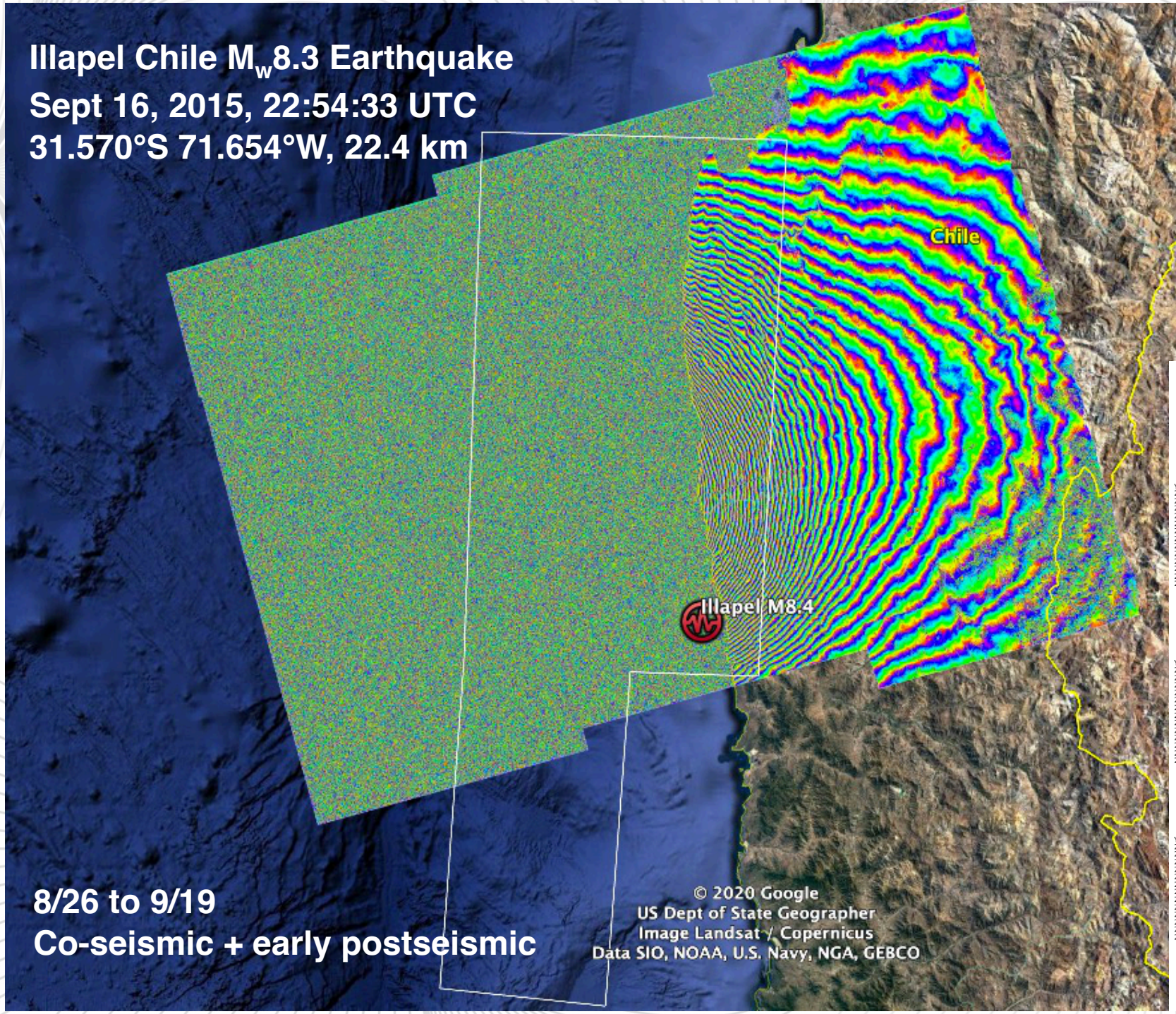
3-D, 3 "plate" model







From Brooks et al, 2003


Illapel Chile M_w8.3 Earthquake
Sept 16, 2015, 22:54:33 UTC
31.570°S 71.654°W, 22.4 km
Chile
Illapel M8.4
8/26 to 9/19
Co-seismic + early postseismic
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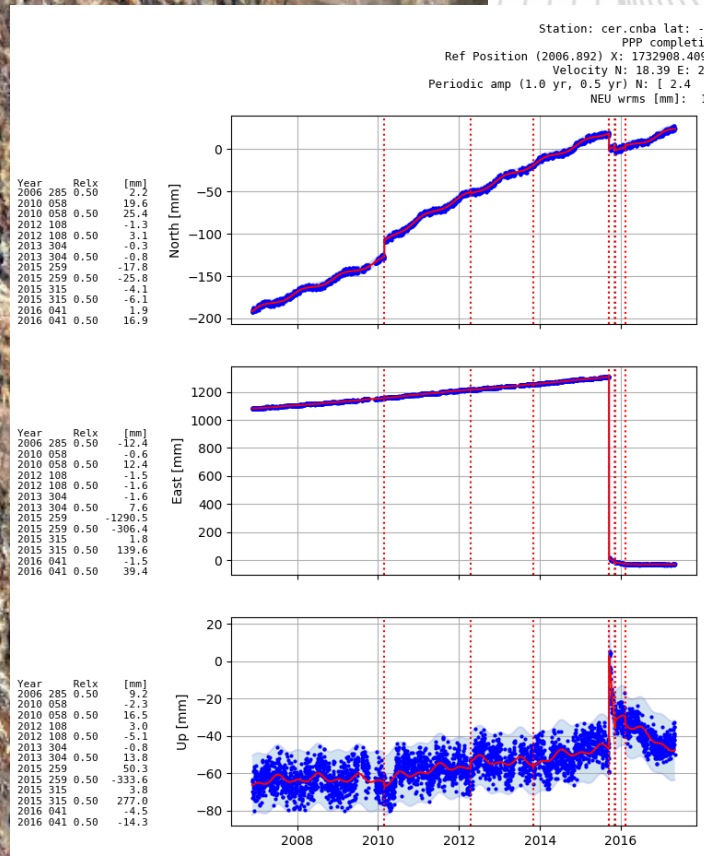
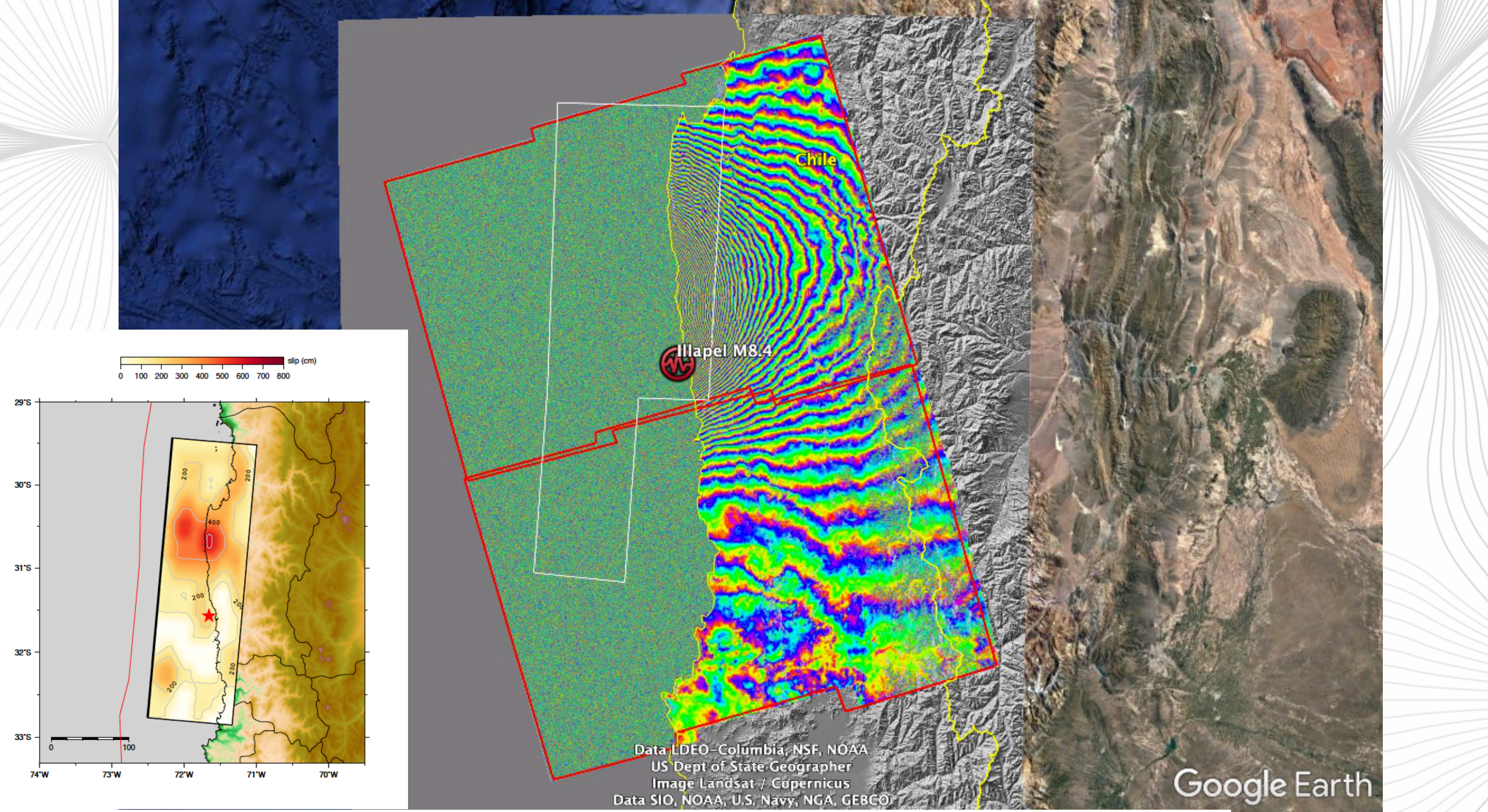
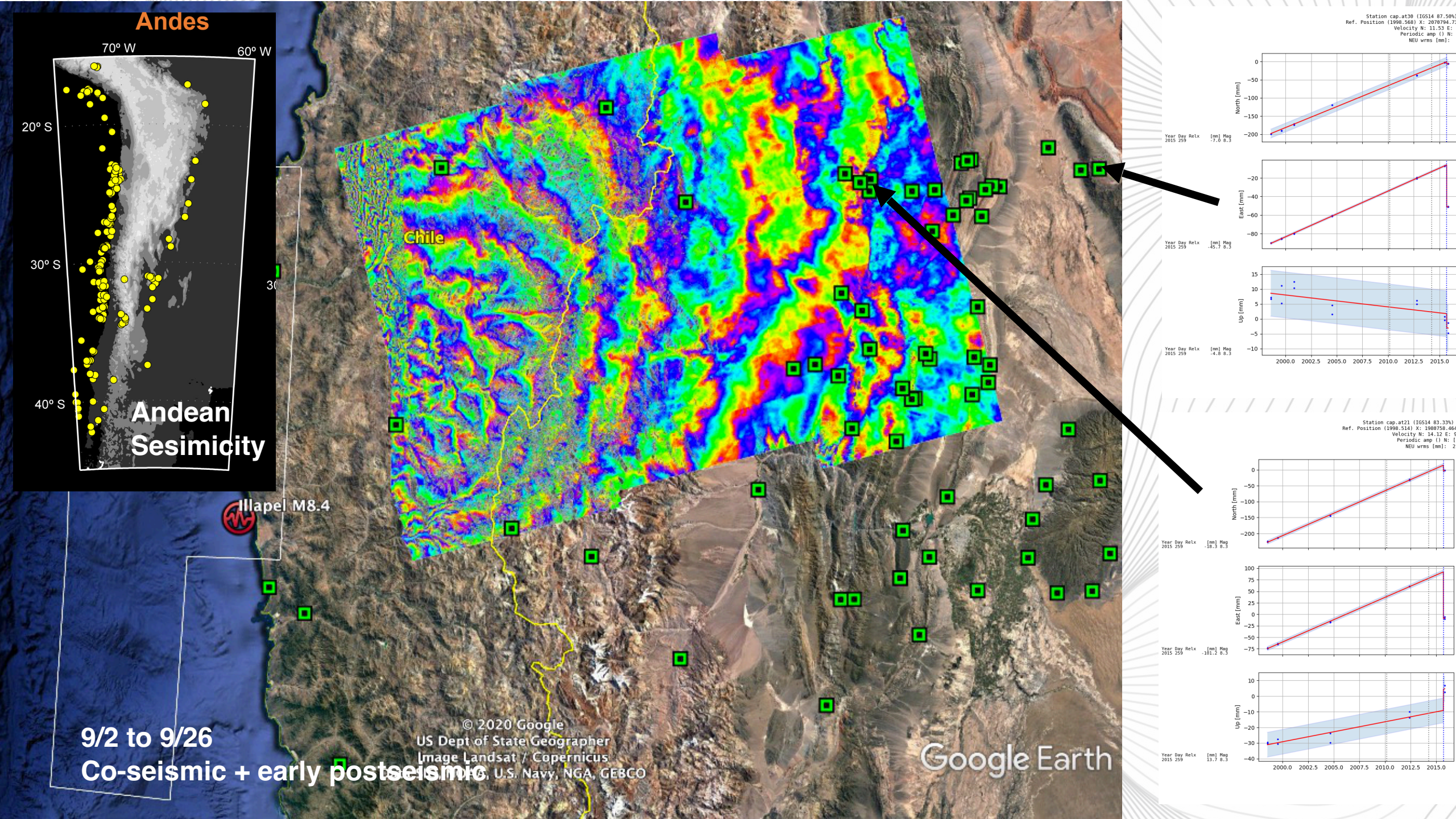
US Dept of State Geographer
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO


Station: cer.cnba lat: -
PPP completi
Ref Position (2006.892) X: 1732908.40
Velocity N: 18.39 E: 2
Periodic amp (1.0 yr, 0.5 yr) N: [2.4
NEU wrms [mm]:
Year Relx [mm]
2006 285 0.50 2.2
2010 058 19.6
2010 058 0.50 25.4
2012 108 -1.3
2012 108 0.50 3.1
2013 304 -0.3
2013 304 0.50 -0.8
2015 259 -17.8
2015 259 0.50 -25.8
2015 315 -4.1
2015 315 0.50 -6.1
2016 041 1.9
2016 041 0.50 16.9
North [mm]
0
−50
−100
−150
−200
Year Relx [mm]
2006 285 0.50 -12.4
2010 058 -0.6
2010 058 0.50 12.4
2012 108 -1.5
2012 108 0.50 -1.6
2013 304 -1.6
2013 304 0.50 7.6
2015 259 -1290.5
2015 259 0.50 -306.4
2015 315 1.8
2015 315 0.50 139.6
2016 041 -1.5
2016 041 0.50 39.4
East [mm]
1200
1000
800
600
400
200
0
Year Relx [mm]
2006 285 0.50 9.2
2010 058 -2.3
2010 058 0.50 16.5
2012 108 3.0
2012 108 0.50 -5.1
2013 304 -0.8
2013 304 0.50 13.8
2015 259 50.3
2015 259 0.50 -333.6
2015 315 3.8
2015 315 0.50 277.0
2016 041 -4.5
2016 041 0.50 -14.3
Up [mm]
20
0
−20
−40
−60
−80
2008
2010
2012
2014
2016



Slip map (https://www.earthobservatory.sg/news/september-16-2015-chile-earthquake)


Andes
70º W
60º W
20º S
30º S
40º S
Andean
Sesimicity
Chile
Illapel M8.4
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US Dept of State Geographer
Image Landsat / Copernicus
U.S. Navy, NGA, GEBCO
Google Earth
9/2 to 9/26
Co-seismic + early postseismic
Station cap.at30 (IGS14 87.50%)
Ref. Position (1998.568) X: 2070794.7
Velocity N: 11.53 E:
Periodic amp () N:
NEU wrms [mm]:
North [mm]
East [mm]
Up [mm]
Year Day Relx [mm] Mag
2015 259 -7.0 8.3
2015 259 -45.7 8.3
2015 259 -4.8 8.3
Station cap.at21 (IGS14 83.33%)
Ref. Position (1998.514) X: 1980758.464
Velocity N: 14.12 E:
Periodic amp () N:
NEU wrms [mm]:
2015 259 -18.3 8.3
2015 259 -101.2 8.3
2015 259 13.7 8.3
2000.0 2002.5 2005.0 2007.5 2010.0 2012.5 2015.0

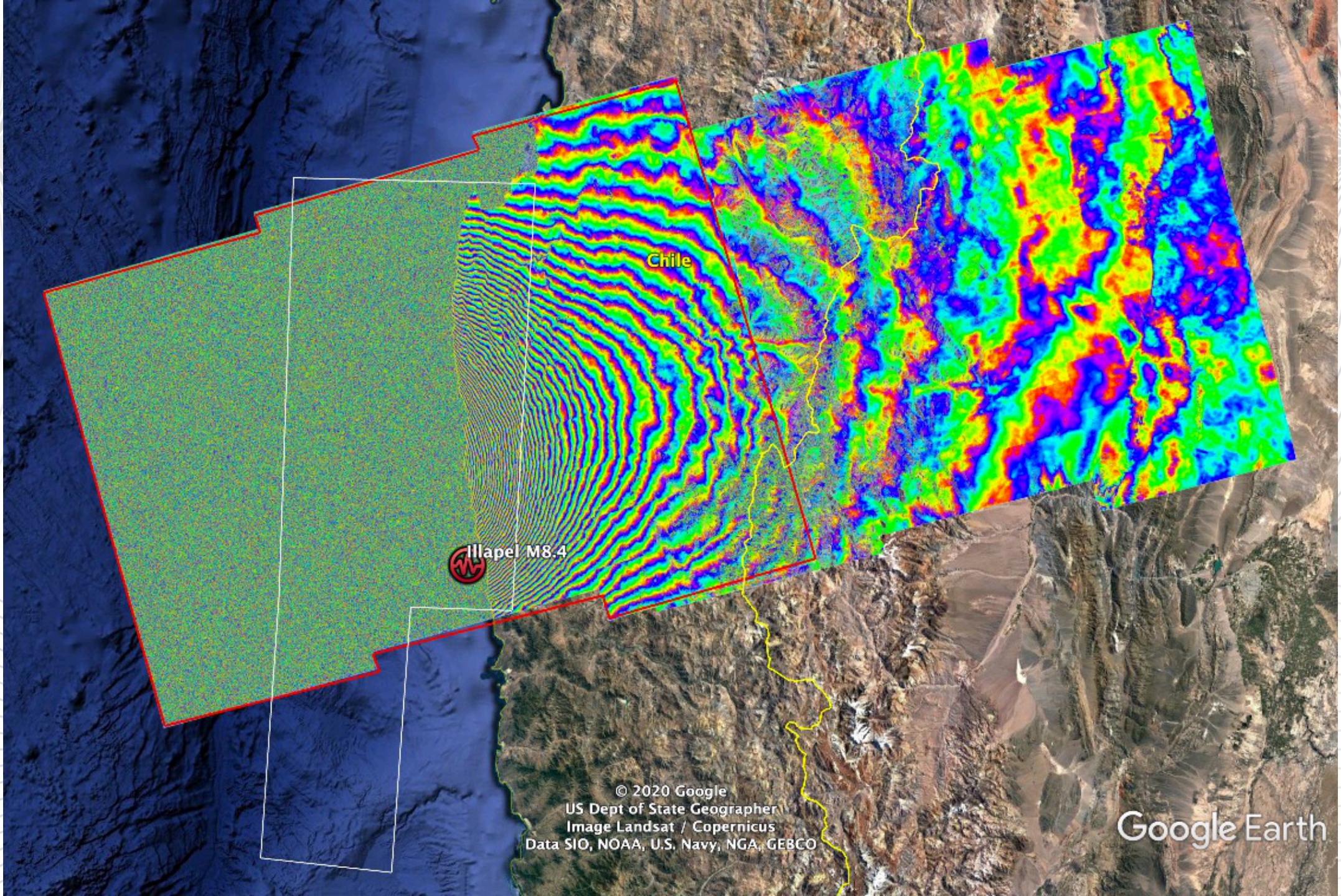
Chile
Illapel M8.4
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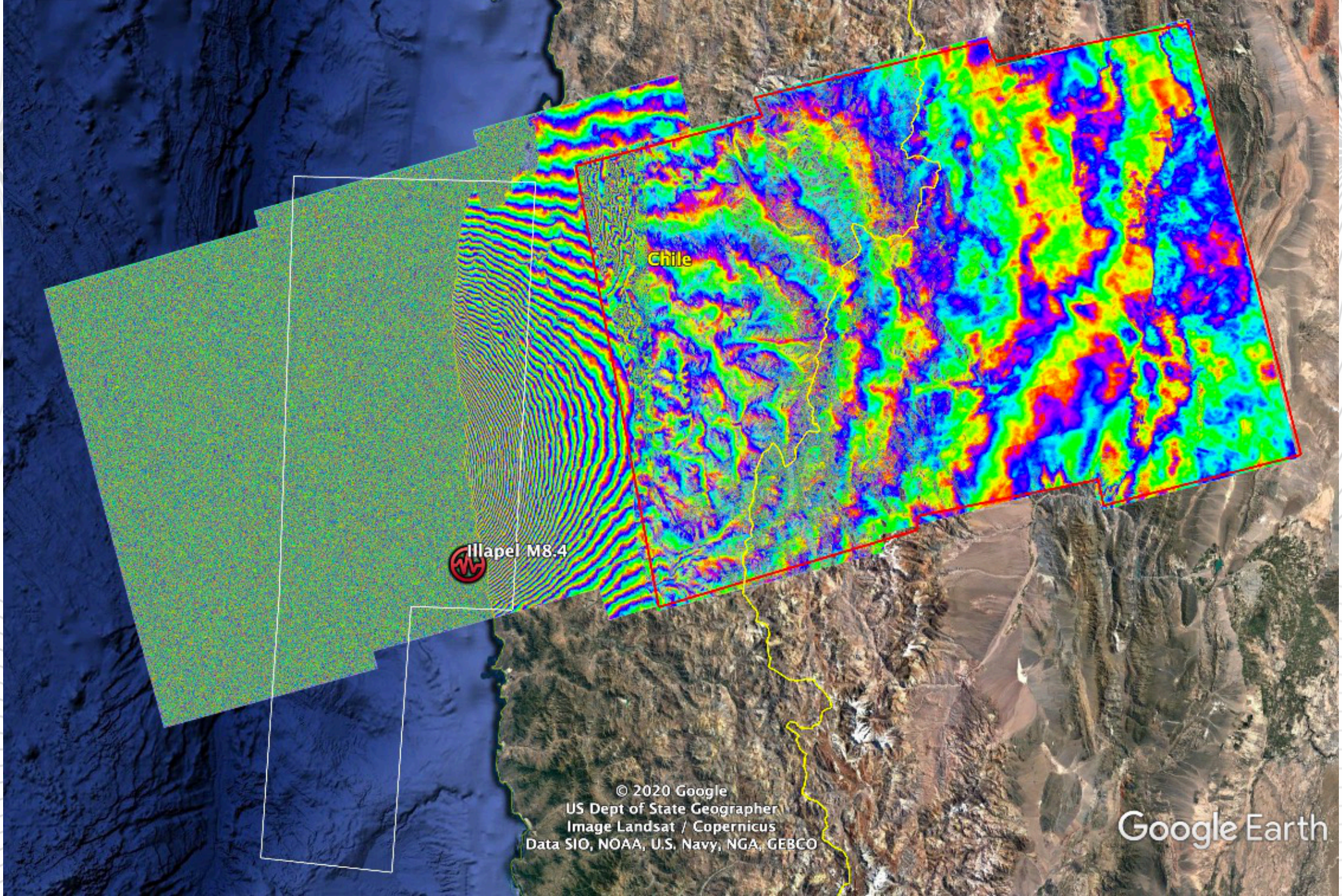
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth


Chile
Illapel M8.4
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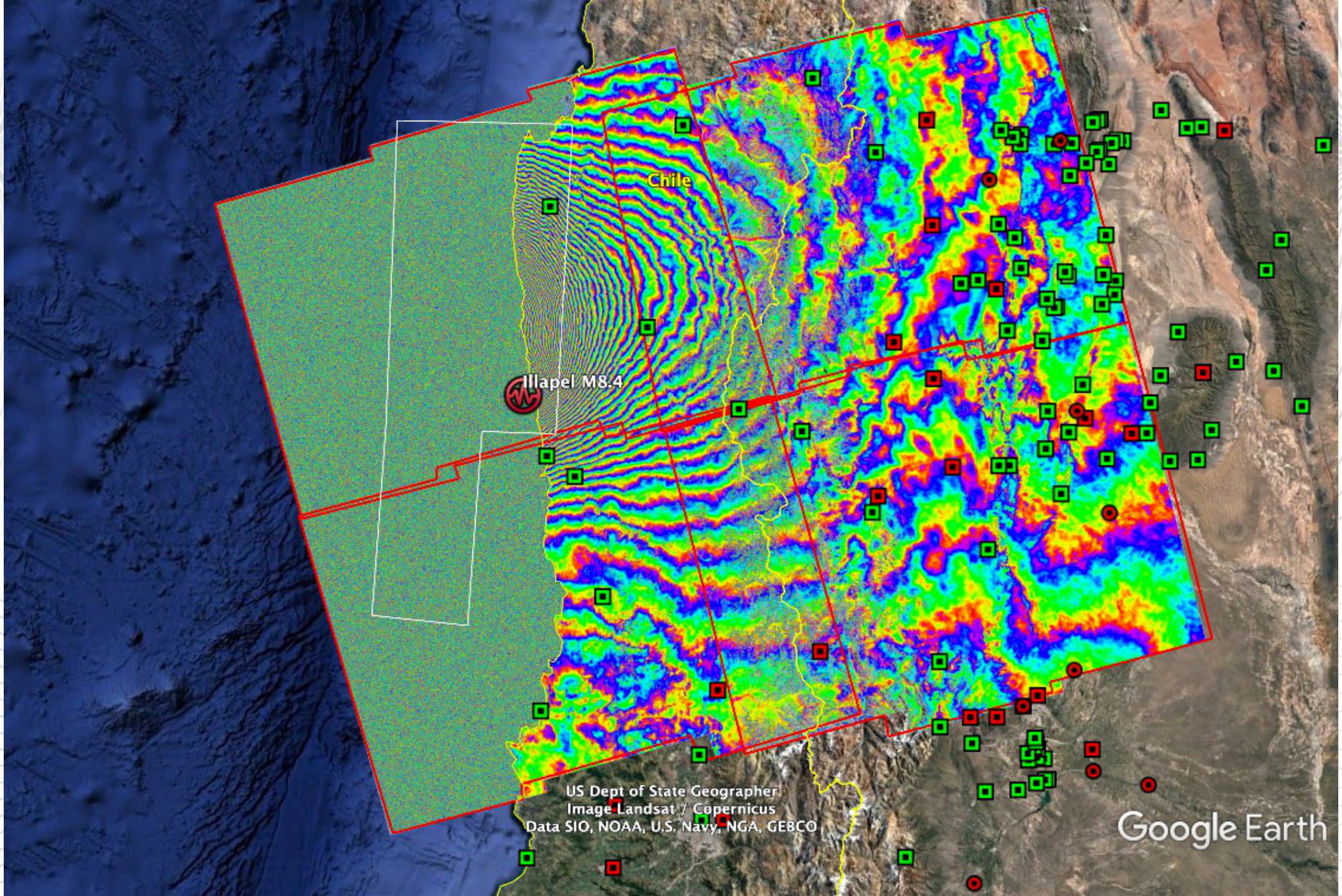
Chile
Illapel M8.4
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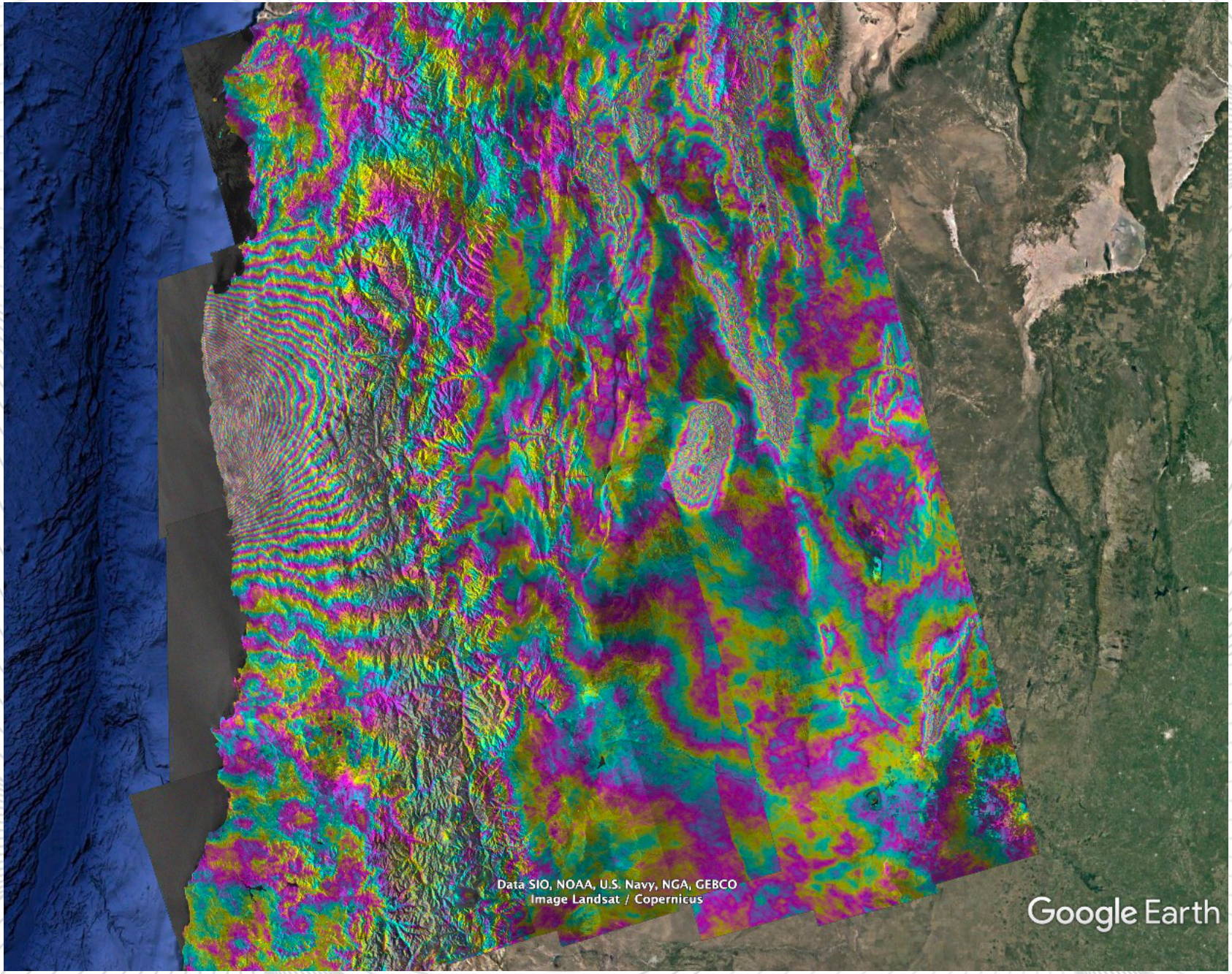
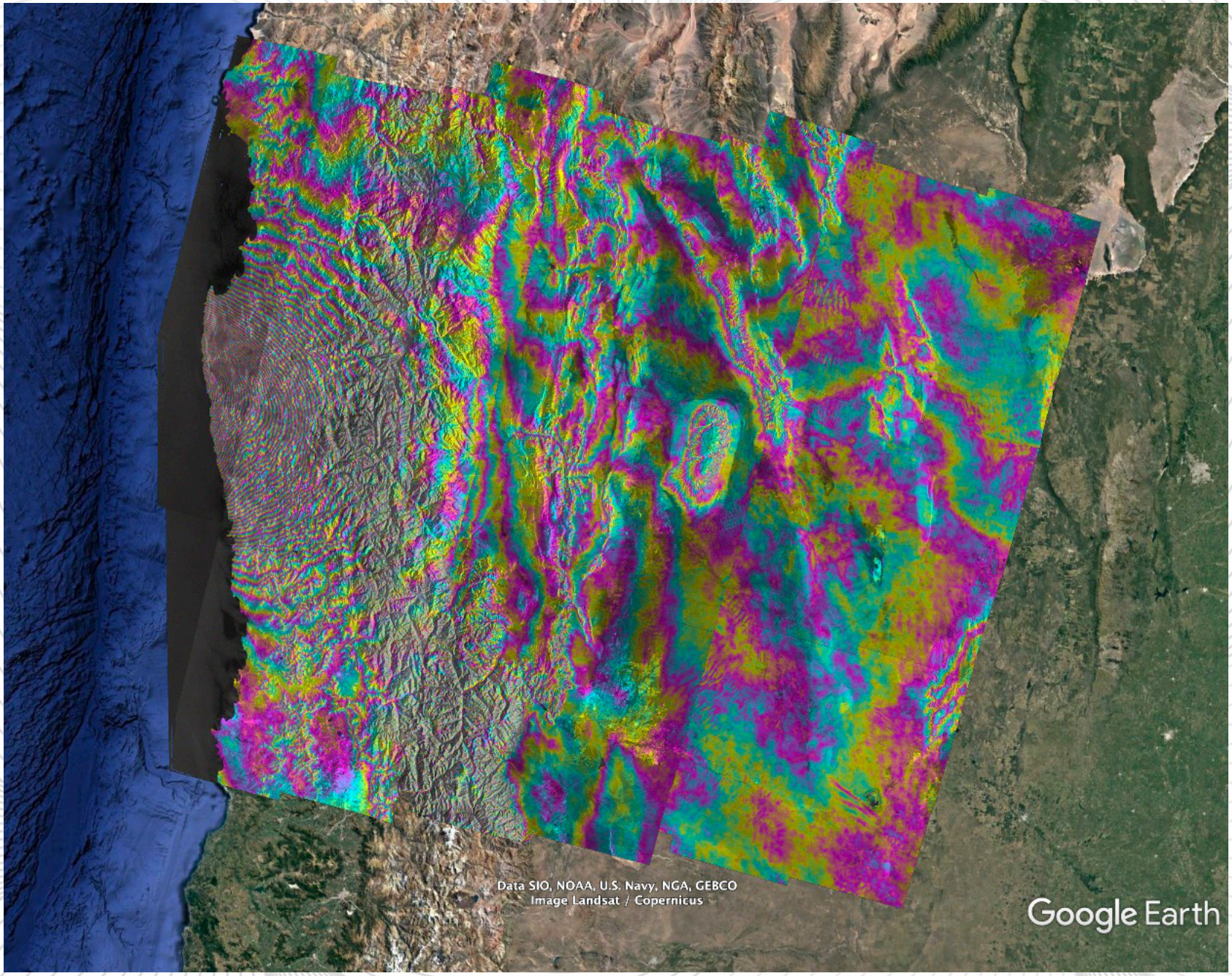
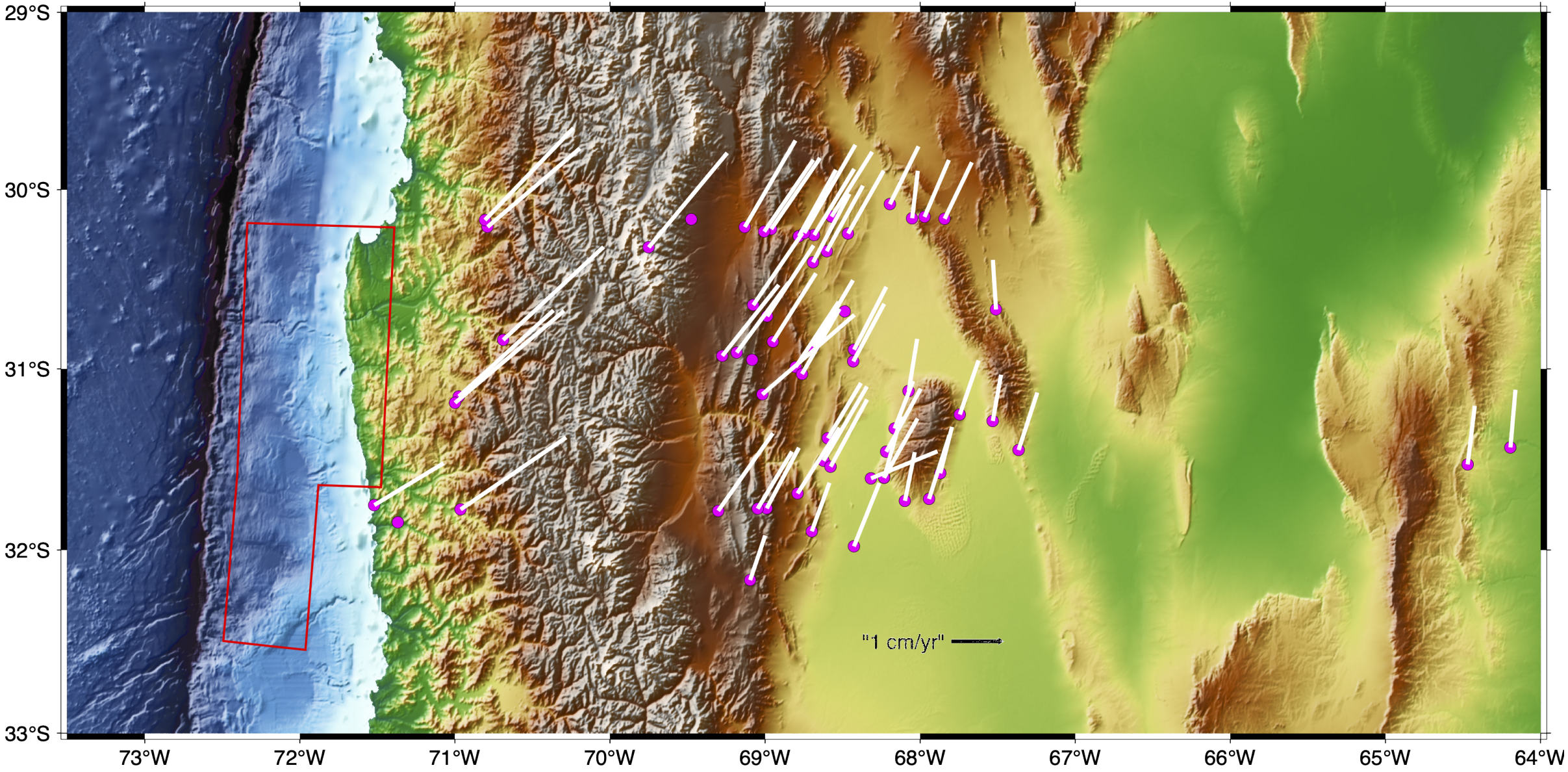
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth

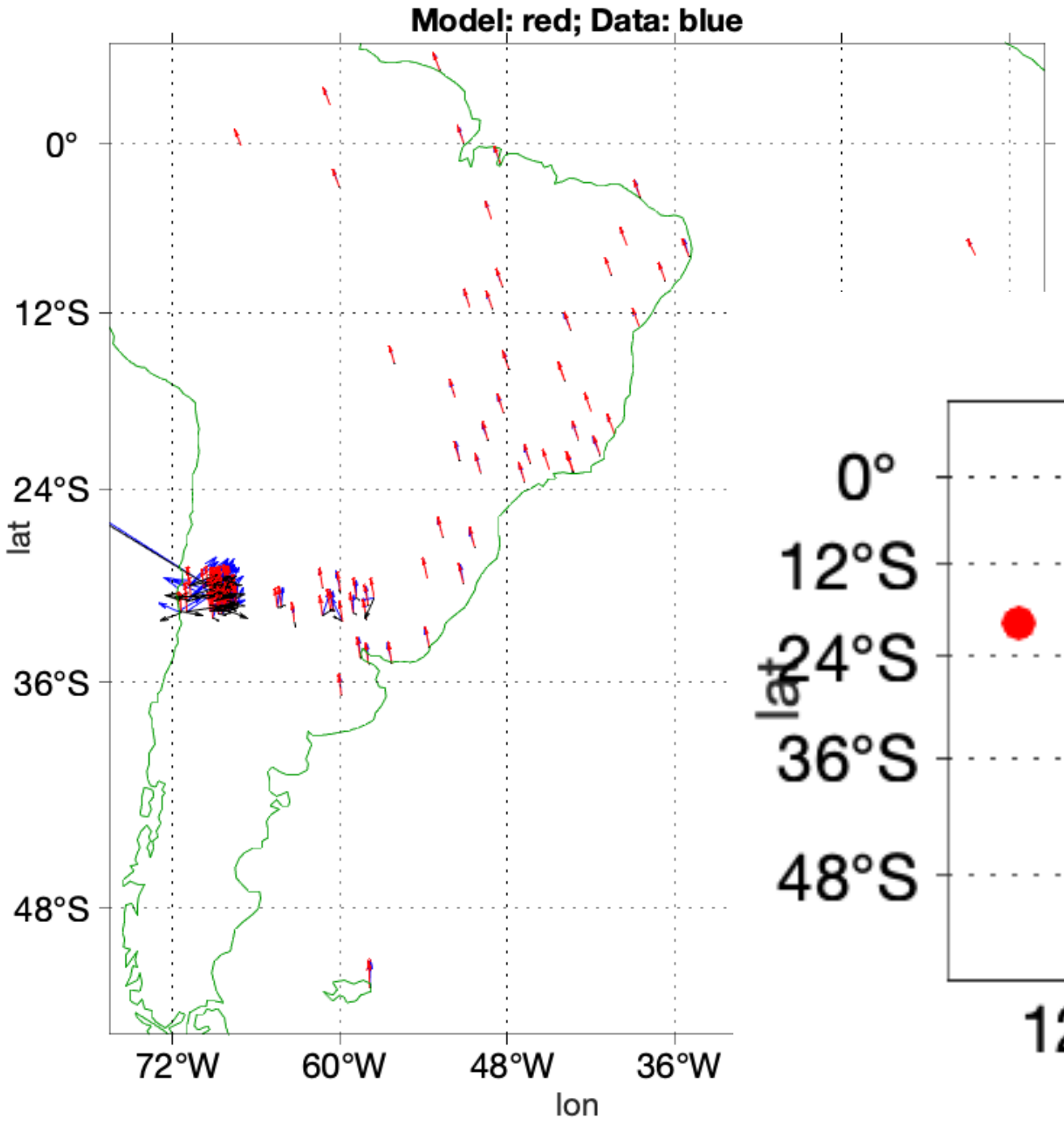

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth

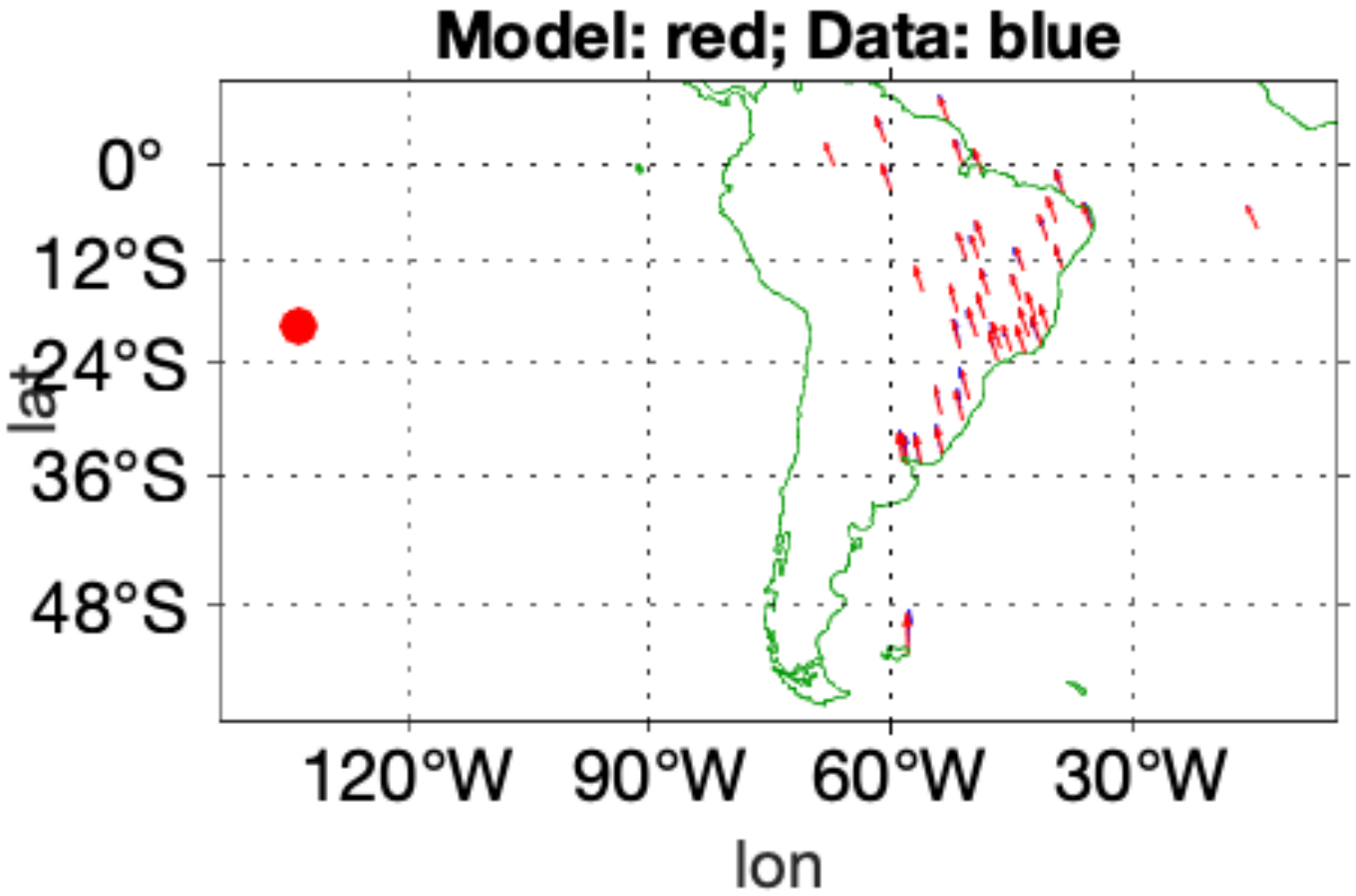

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth

Interseismic (from the start of GPS measurements till earthquake) velocities in ITRF reference frame (not too useful for tectonincs).

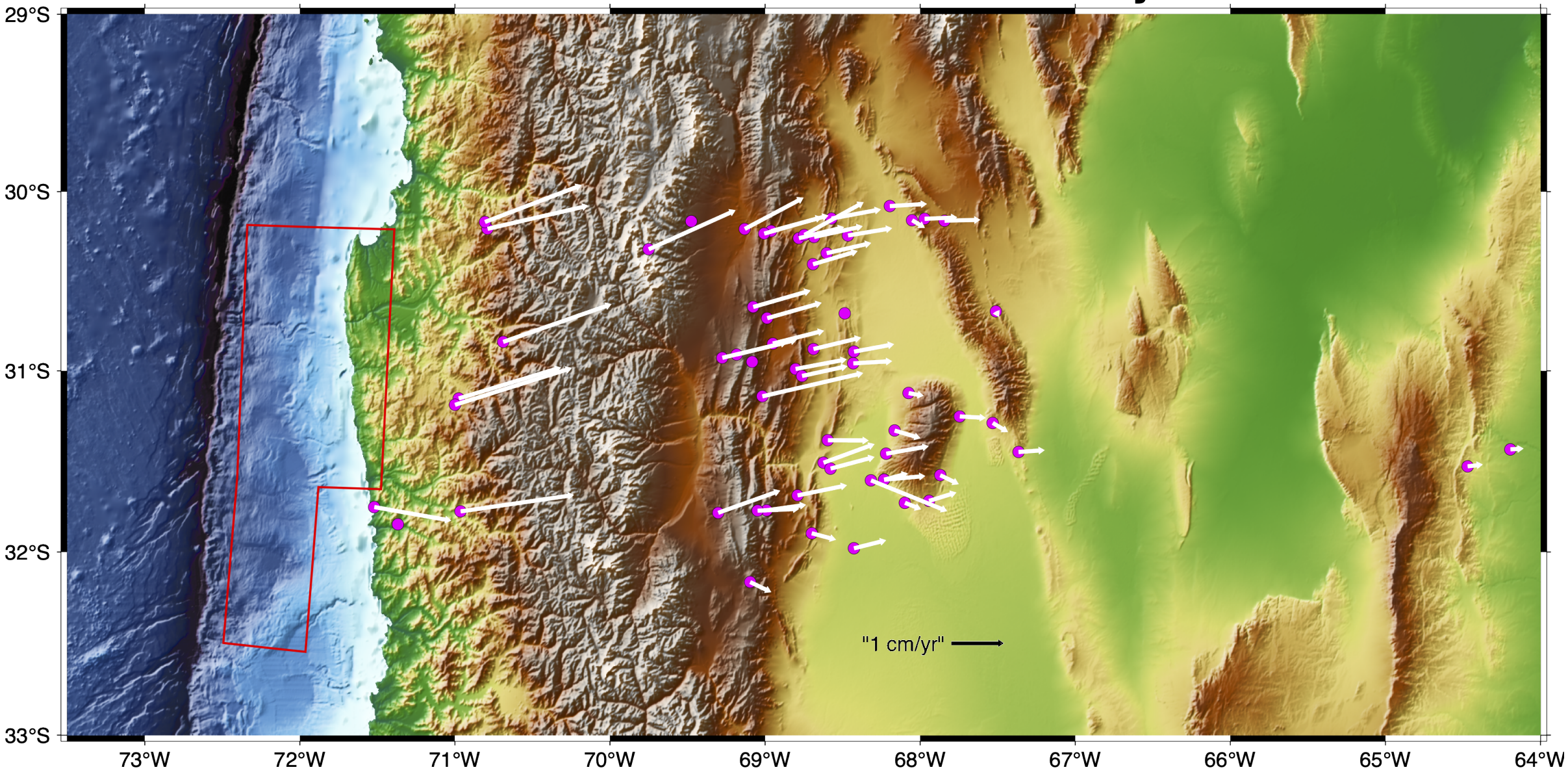


Euler poles/vectors and change of reference frames for tectonics.





Interseismic deformation velocities in a stable South America reference frame. This is what we need to study the tectonics.



Conclusions / recommendations.

InSAR can provide observations to be combined with the GPS data to fill in the holes (not interpolate) in the development of kinematic models of surface deformation.

Services, such as the Alaska Satellite Facility HYP3 program, provide, free, on demand, InSAR processing (such as shown here) with short (hour) turnaround and manageable sizes (<1Gb/scene).

Shortcoming – need a before and after scene. May have to wait 1-2 weeks for the “after” scene.

Combining GPS and InSAR can provide more accurate deformation fields for implementing kinematic reference frames.

Thank you to:

SIRGAS

IGM-Chile