Bayesian earthquake source modeling

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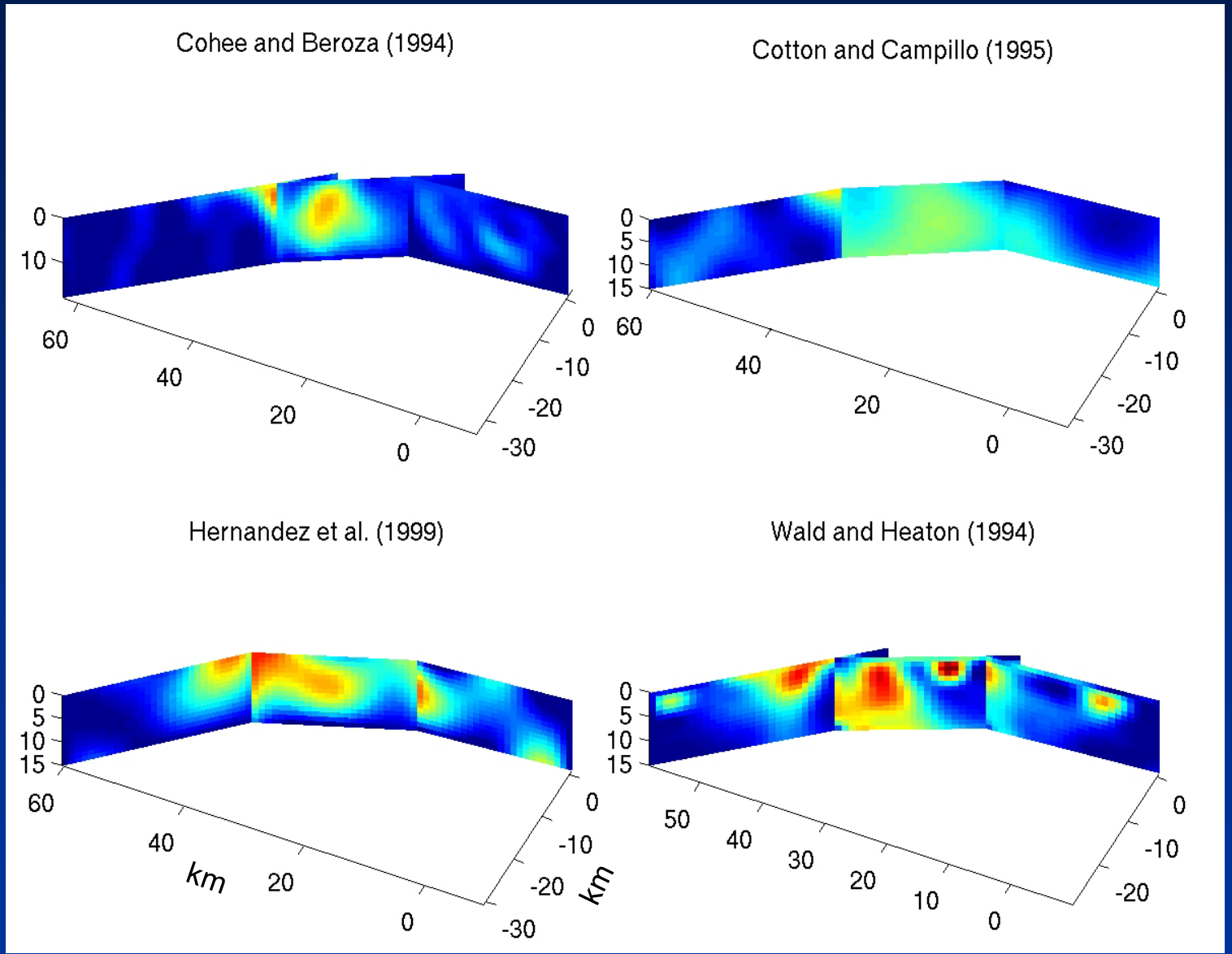
Motivation

- Many kinds of optimization techniques
  - Optimization only yields one solution
  - Different researchers can obtain very different solutions for the same earthquake
- With Bayesian techniques, we can determine the family of all acceptable models which fit the data
  - The utility of Monte Carlo techniques is limited by the “Curse of Dimensionality”

Landers earthquake

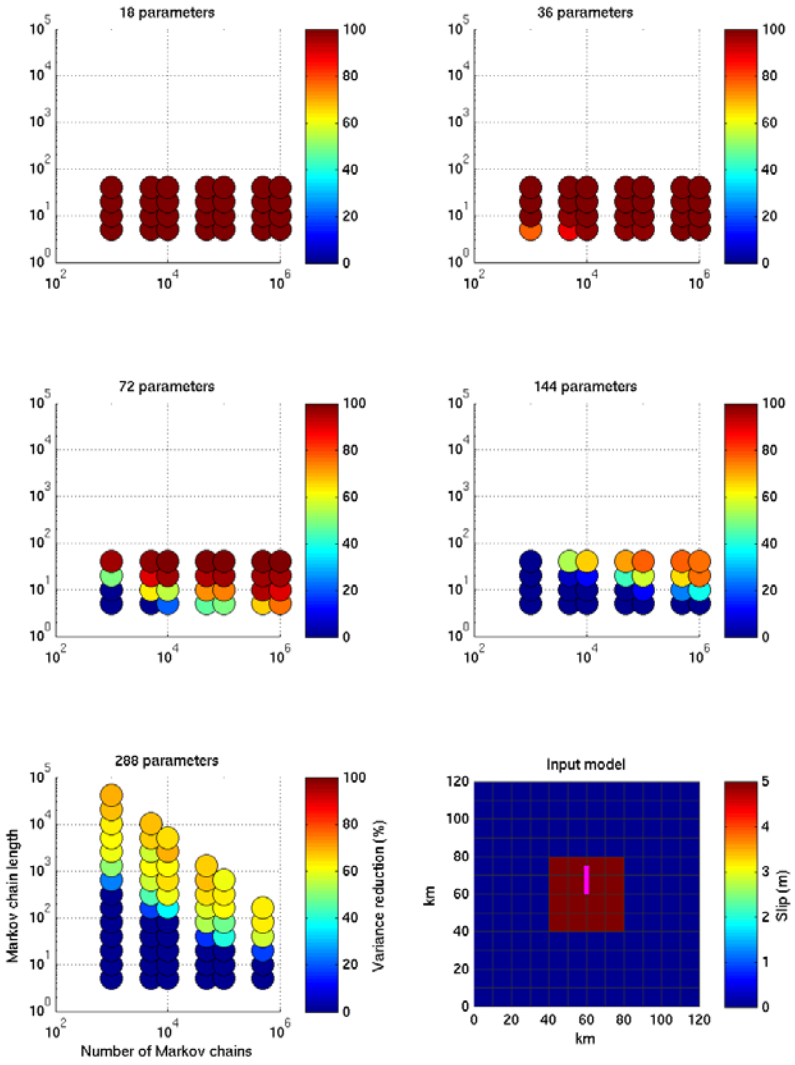


Modified Transitional Markov Chain Monte Carlo

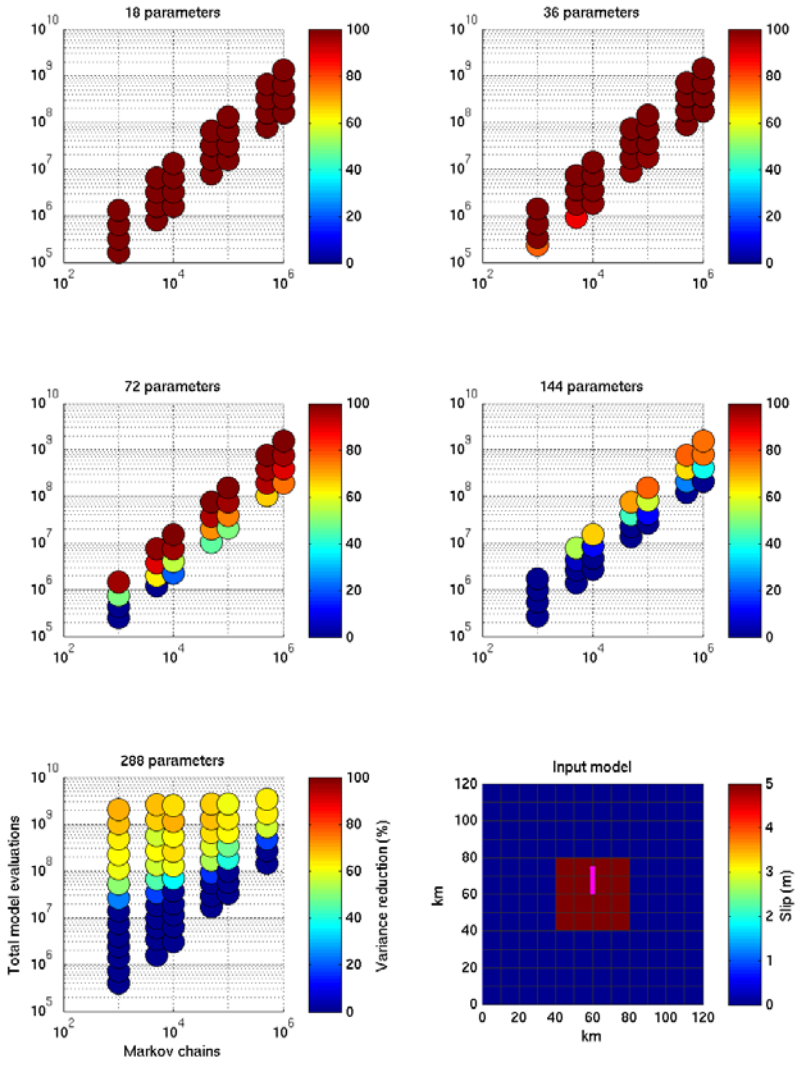
- a posteriori PDF is “tempered” so that we are always near equilibrium with our target PDF
  - $F_m(\theta) \propto p(D|\theta)^{\beta m}\, p(\theta)$
- Many parallel Metropolis samplers
  - Proposal PDF is Gaussian approximation of current a posteriori PDF
    - Insensitive to trade-offs between model parameters
- Seeds of Markov chains are chosen according to a posteriori probabilities

Algorithm efficiency

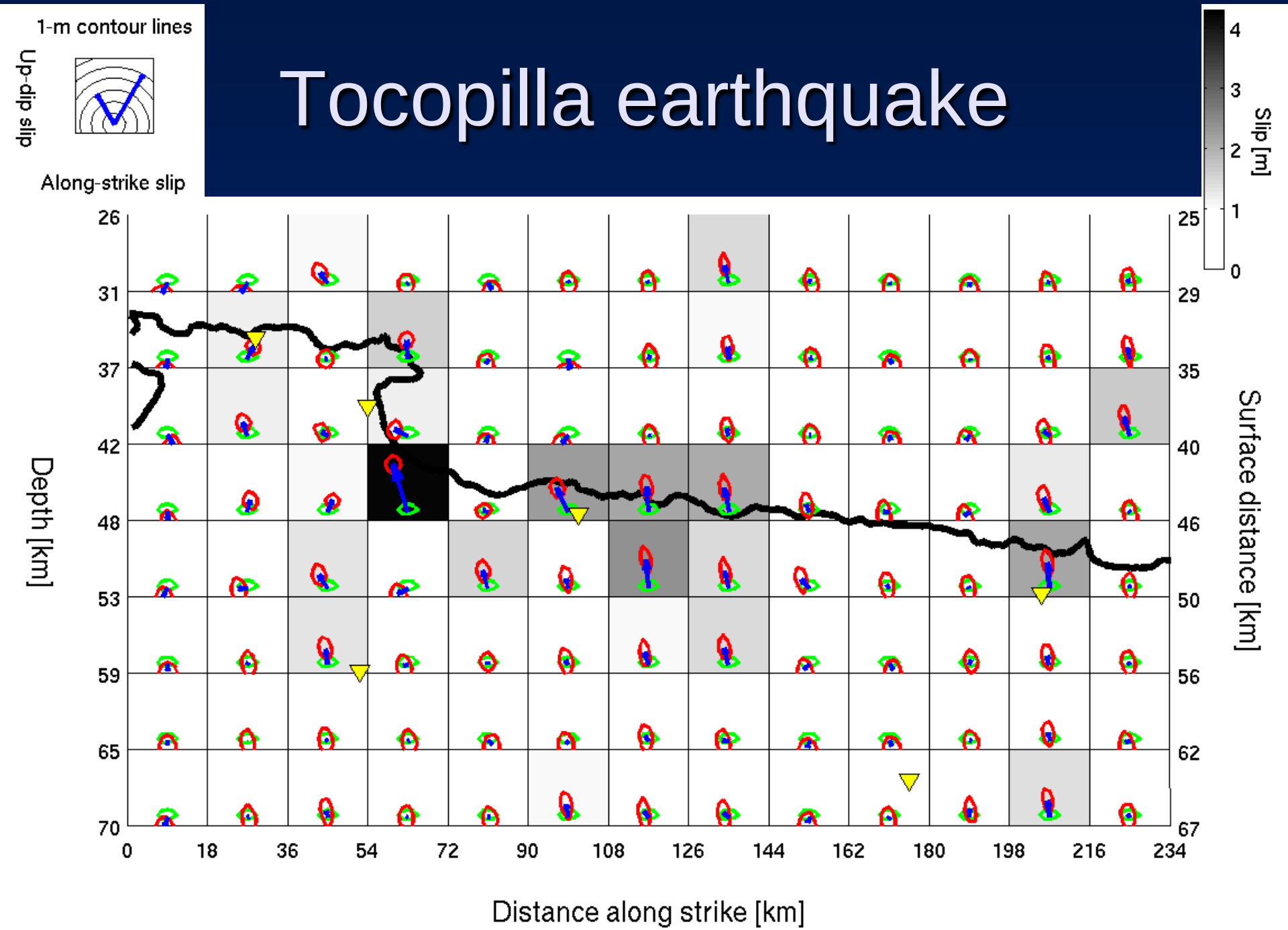
Markov chain length

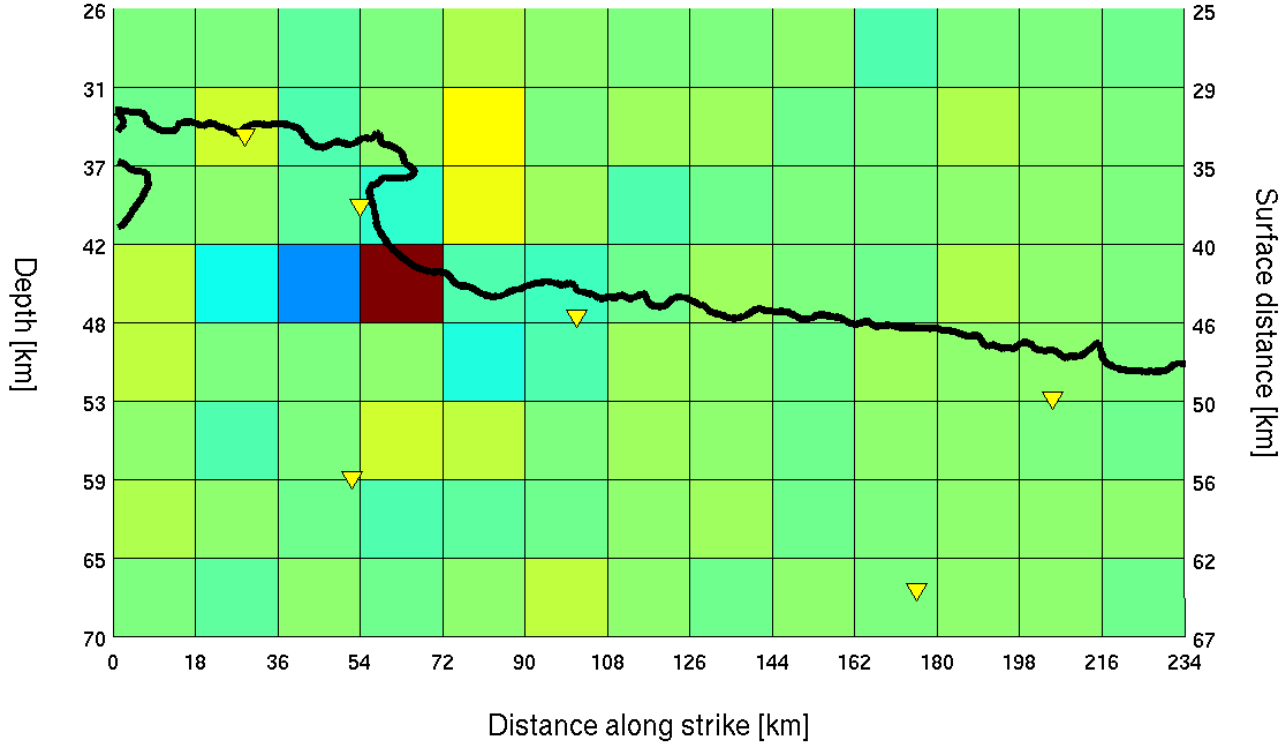


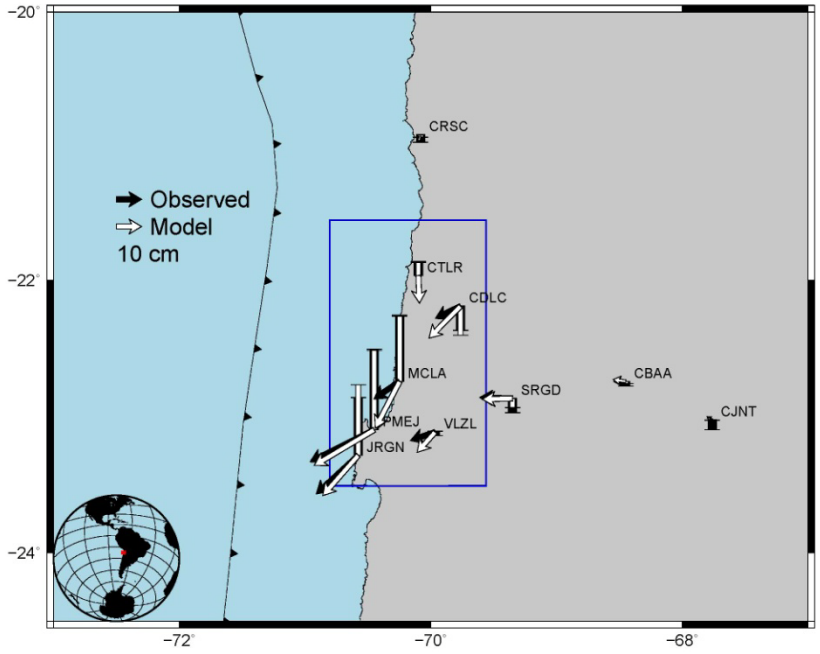
Total model evaluations

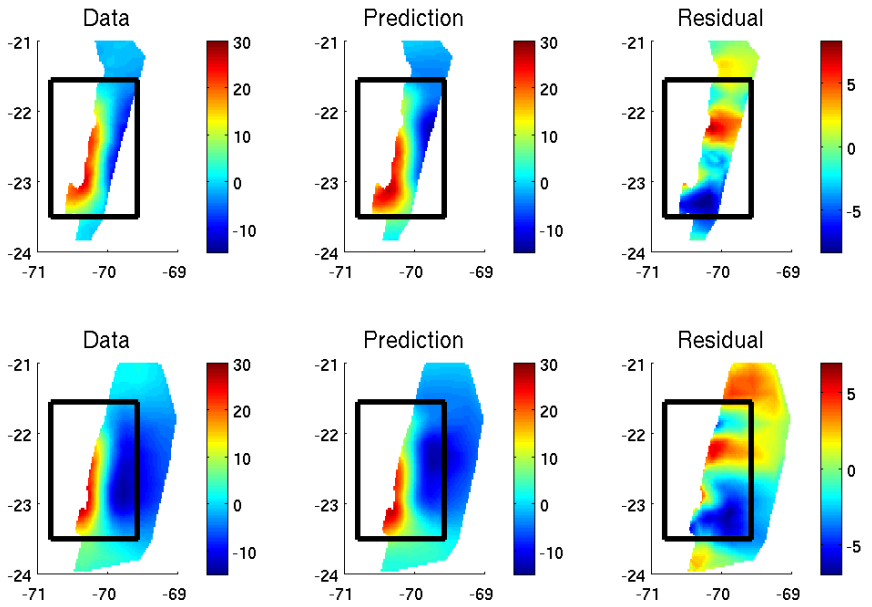


Tocopilla earthquake




Depth [km]
Surface distance [km]
Distance along strike [km]
Correlation
1
0.5
0
-0.5
-1
26
31
37
42
48
53
59
65
70
25
29
35
40
46
50
56
62
67
0
18
36
54
72
90
108
126
144
162
180
198
216
234


Observed
Model
10 cm
CRSC
CTLR
CDLC
MCLA
SRGD
CBAA
CJNT
PMEJ
VLZL
JRGN
-20°
-22°
-24°
-72°
-70°
-68°


Data
Prediction
Residual
Data
Prediction
Residual