Trouble-shooting BEAST 2 Analyses

Tim Vaughan

Taming the BEAST Online 2021, Day 2

What could possibly go wrong?

Trouble shooting
Initialization Failure
One parameter does not mix
Many parameters do not mix
Problem solving in general

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- The chain runs, but one or more parameters mix slowly compared to the rest.

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Many things! But we will focus on the following three possibilities:

- MCMC chain fails to initialize.
- The chain runs, but one or more parameters mix slowly compared to the rest.
- The chain runs, but many parameters fail to mix adequately.

Problem 1: MCMC chain fails to initialize


```
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Start likelihood: -Infinity after 10 initialisation attempts
P(posterior) = -Infinity (was -Infinity)
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                P(treeLikelihood.seqs) = NaN (was NaN)  **
Fatal exception: Could not find a proper state to initialise. Perhaps try another seed.
See http://www.beast2.org/2018/07/04/fatal-errors.html for other possible solutions.
java.lang.RuntimeException: Could not find a proper state to initialise. Perhaps try another seed.
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        at beast.core.MCMC.run(Unknown Source)
        at beast.app.BeastMCMC.run(Unknown Source)
        at beast.app.beastapp.BeastMain.<init>(Unknown Source)
        at beast.app.beastapp.BeastMain.main(Unknown Source)
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See http://www.beast2.org/2018/07/04/fatal-errors.html for other possible solutions.
java.lang.RuntimeException: An error was encounted. Terminating BEAST
        at beast.app.util.ErrorLogHandler.publish(Unknown Source)
        at java.logging/java.util.logging.Logger.log(Logger.java:979)
        at java.logging/java.util.logging.Logger.doLog(Logger.java:1006)
        at java.logging/java.util.logging.Logger.log(Logger.java:1029)
        at java.logging/java.util.logging.Logger.severe(Logger.java:1776)
        at beast.app.beastapp.BeastMain.<init>(Unknown Source)
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- The cause of the problem seems to be the 0 in the prior on the starting A→C transition rate.

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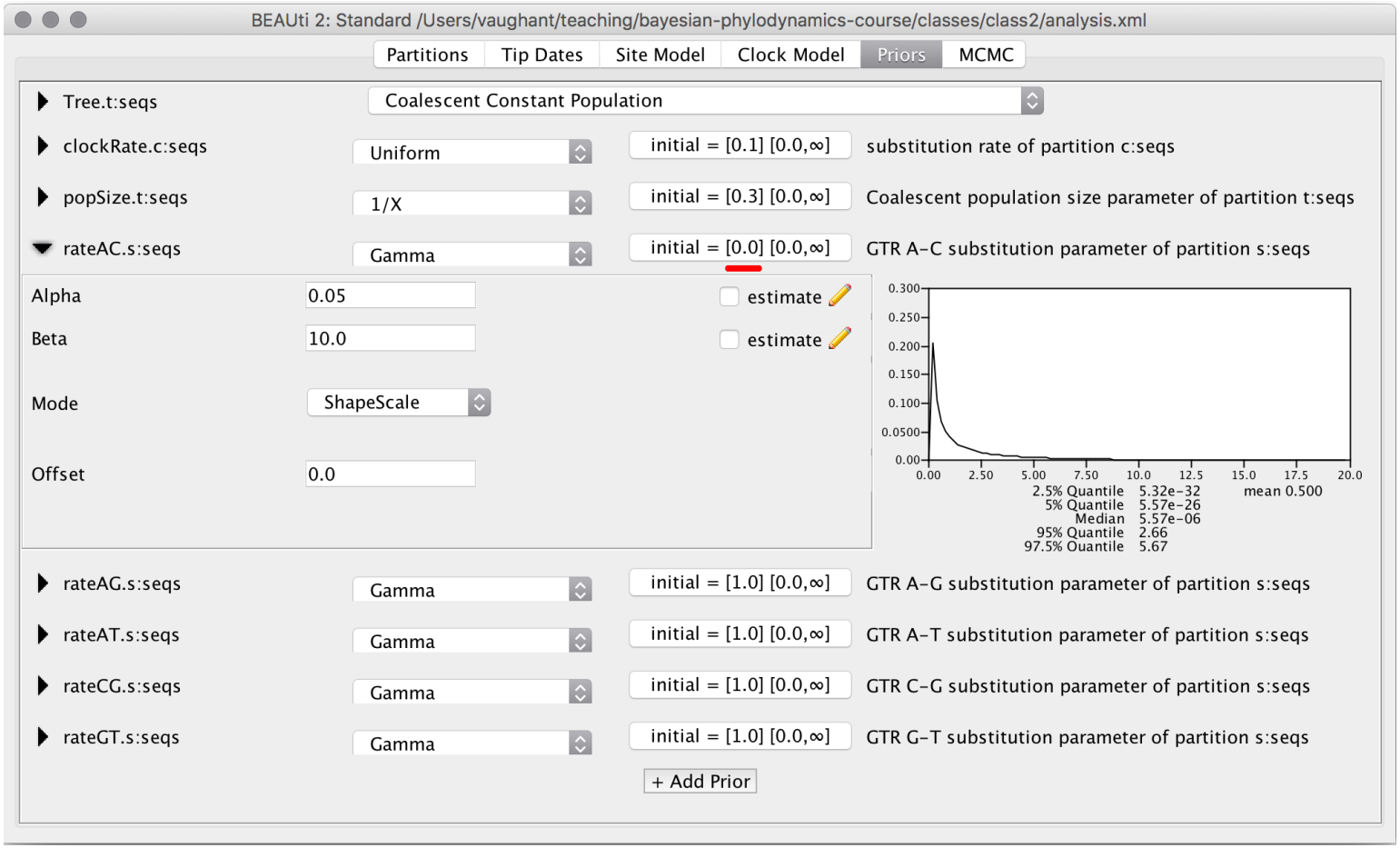

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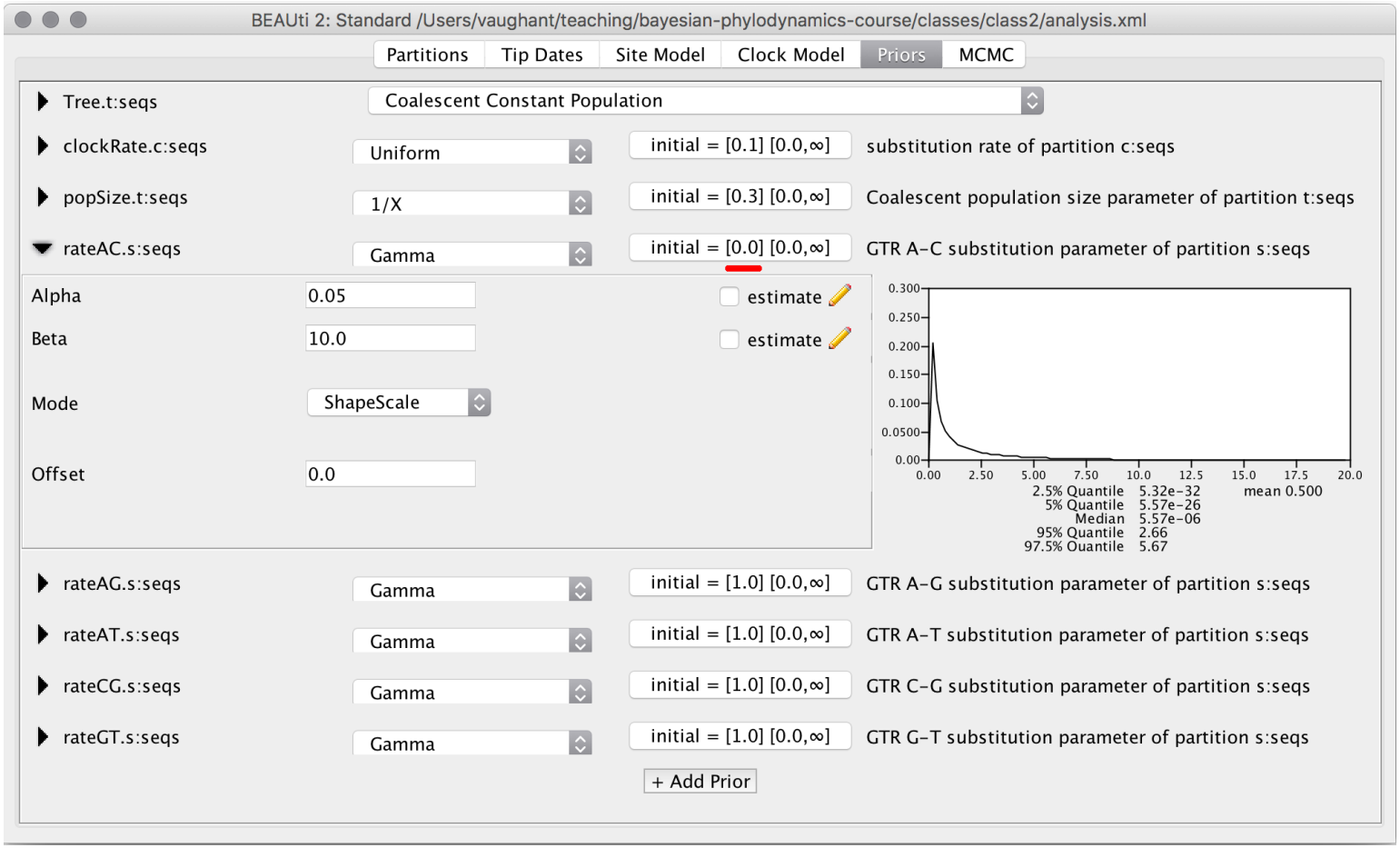

- Problem is that A→C rate is initially zero, while the prior on A→C excludes zero.

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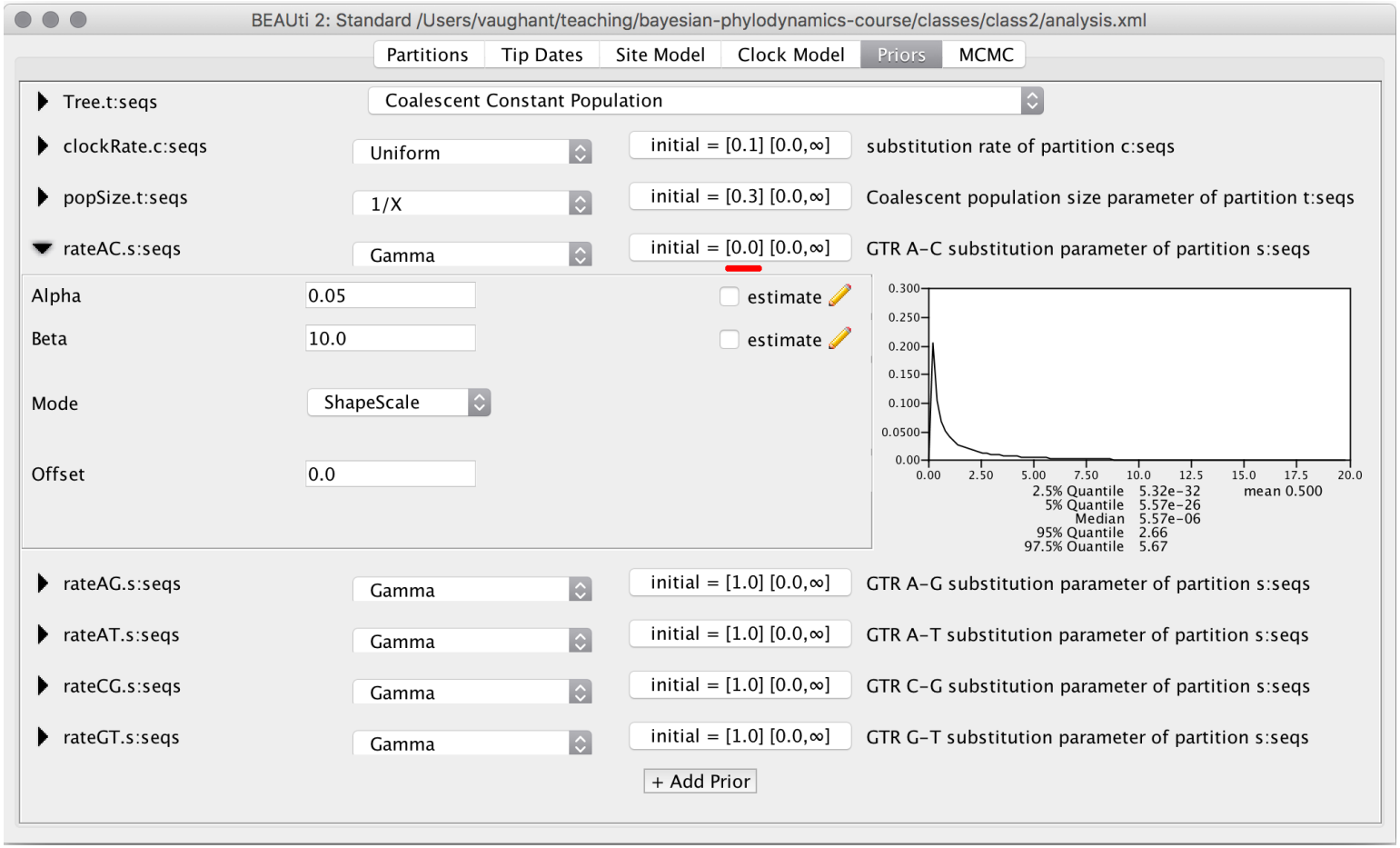

- Problem is that A→C rate is initially zero, while the prior on A→C excludes zero.
- Fix is to change the starting value (proper solution in this particular situation) or to modify the prior to allow the starting value.

Problem 2: One parameter mixes slowly

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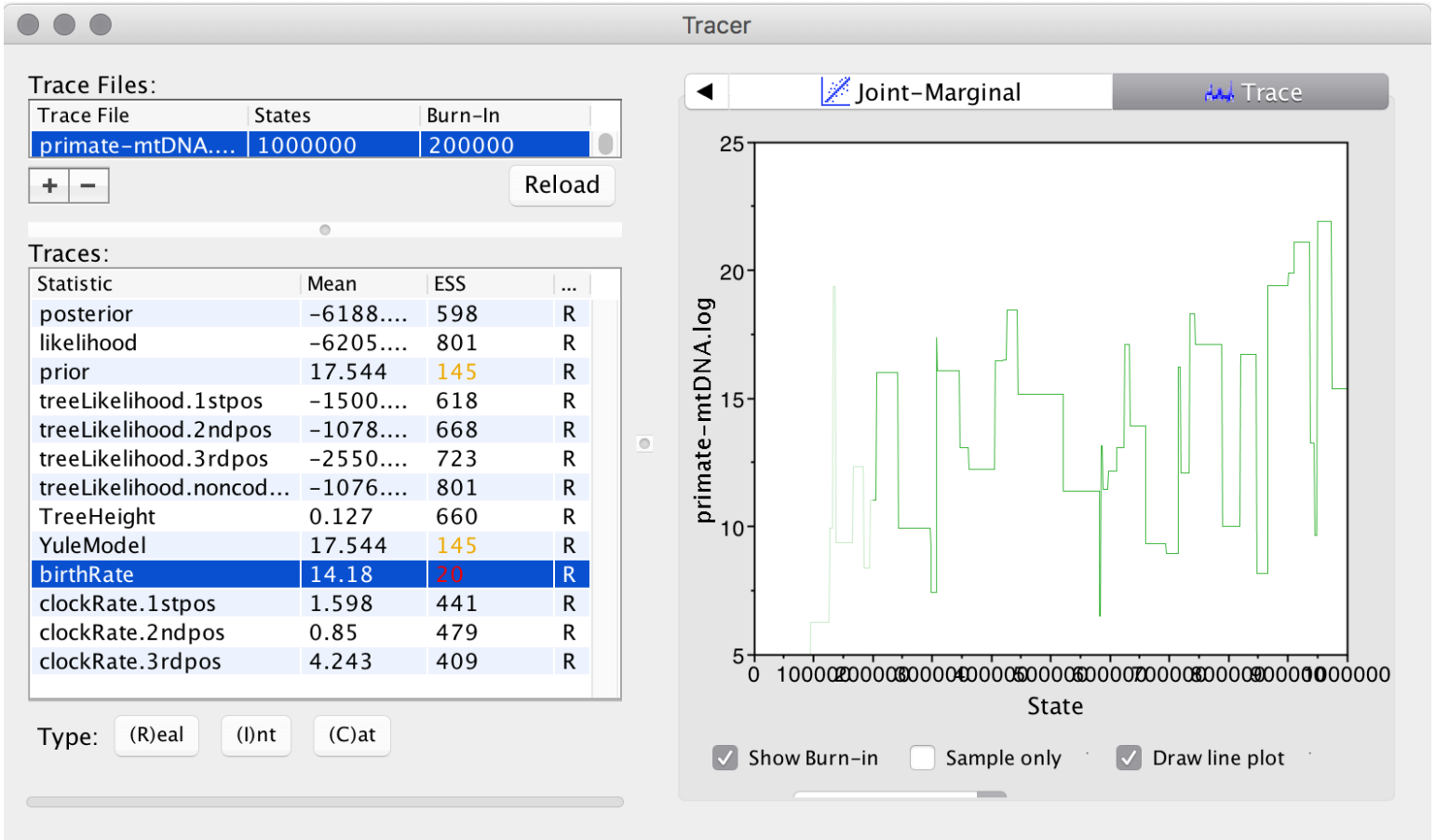

- Tracer output of run shows the birth rate parameter is mixing much slower than the others.

Why might MCMC mix poorly?

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- Mixing rate refers to how quickly (in terms of computation time) it takes the algorithm to explore the space of possible parameter values and trees.
- ESS (effective sample size) provides an *estimate* of how thoroughly the state space has been explored. (I.e. large ESS = good.)

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- Random walk strategy defined by a series of "operators" that modify the state (parameter values or trees). Operator "weights" determine how frequently a given operator is used.
- A single slow-mixing parameter may be the result of the operator responsible for adjusting that value having a weight which is too low.

Problem 2: One parameter mixes slowly

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BEAUti 2: Standard /Users/vaughant/Downloads/primates.xml

Partitions | Tip Dates | Site Model | Clock Model | Priors | Operators | MCMC

Scale: birthRate.t:tree Scales birth rate of Yule prior for partition.t:tree	0.01
Scale: Tree.t:tree Scales all internal nodes for tree.t:tree	3.0
Scale: Tree.t:tree Scales root node for tree.t:tree	3.0
Uniform: Tree.t:tree Draws new internal node heights uniformally for tree.t:tree	30.0
Subtree Slide: Tree.t:tree Performs subtree slide rearrangement of tree.t:tree	15.0
Exchange: Tree.t:tree Narrow exchange performs local rearrangement of tree.t:tree	15.0
Exchange: Tree.t:tree Wide exchange performs global rearrangement of tree.t:tree	3.0
Wilson Balding: Tree.t:tree Performs Wilson–Balding global rearrangement of tree.t:tree	3.0
Scale: clockRate.c:3rdpos Scale substitution rate of partition c:3rdpos	3.0
Scale: clockRate.c:1stpos Scale substitution rate of partition c:1stpos	3.0
Scale: clockRate.c:2ndpos Scale substitution rate of partition c:2ndpos	3.0
Up Down: clockRate.c:2ndpos Tree.t:tree Scale up substitution rate c:2ndpos and scale down tree t:($n)	3.0
Up Down: clockRate.c:1stpos Tree.t:tree Scale up substitution rate c:1stpos and scale down tree t:($n)	3.0
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- Operator corresponding to birth rate parameter has a very low weight.
- Increasing this weight solves the mixing problem.

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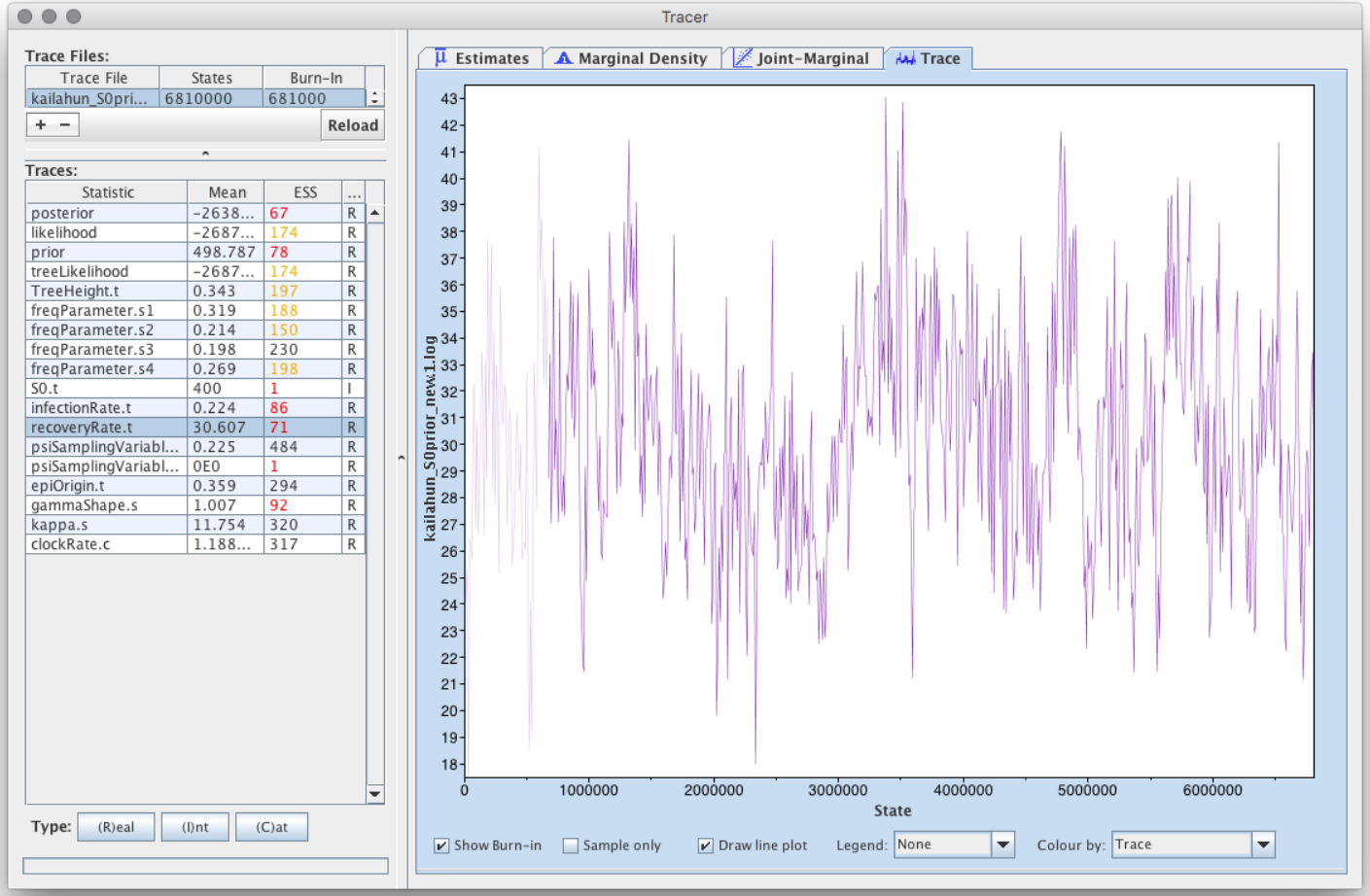

Problem 3: Many parameters mix slowly

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- Check burn-in percentage in tracer.

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- In general, if an analysis is not mixing well there is not much you can do besides run the analysis longer.

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- Check burn-in percentage in tracer.
- In general, if an analysis is not mixing well there is not much you can do besides run the analysis longer.
- A very good idea is to run multiple chains (i.e. multiple independent analyses).
  - This way, once you are happy that each chain is independently sampling the same posterior, you can combine the results to get sufficient ESS.
  - Results can be combined using the LogCombiner utility that comes with BEAST.
  - ONLY combine the results if each of the independent chains has "converged".

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  - Results can be combined using the LogCombiner utility that comes with BEAST.
  - ONLY combine the results if each of the independent chains has "converged".
- Note that you can resume completed chains to extend the analysis. (Select the "resume" option in the BEAST start dialog box.)

General problem-solving flow chart

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