The forest or the supertree:

does the world tree make the same predictions about linguistic change as family-specific phylogenies?

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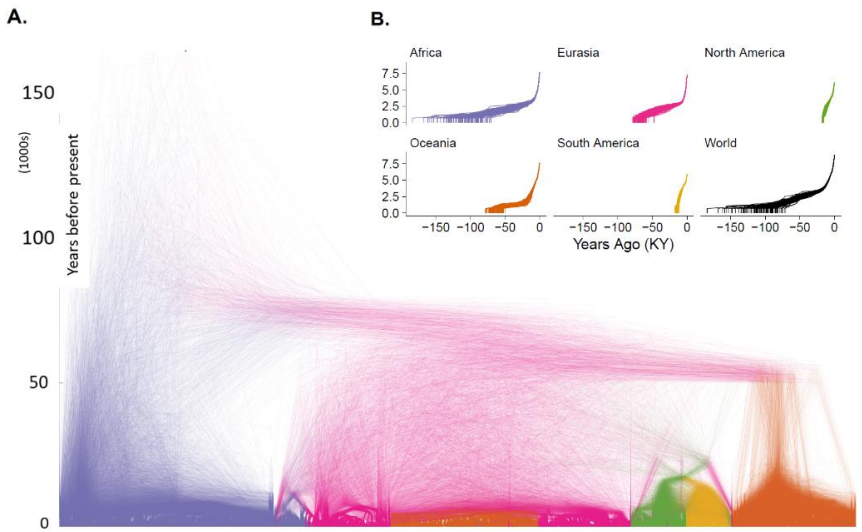
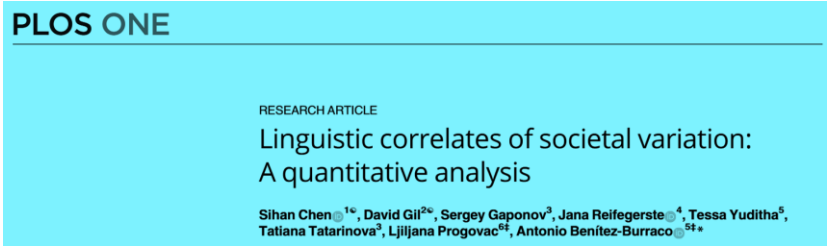


The world tree

- Bouckaert et al. (2022)
- Global phylogeny of over 6000 languages
- Family-level relationships more defined, with very long branches connecting these
- Benefit: inferences can be made on a global scale, including small families and isolates

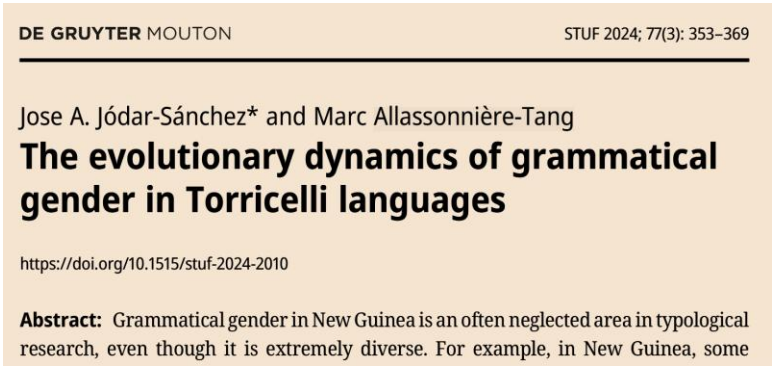
Bouckaert et al. (2022). Global language diversification is linked to socio-ecology and threat status.


PLOS ONE

RESEARCH ARTICLE

Linguistic correlates of societal variation: A quantitative analysis

Sihan Chen[1☯], David Gil[2☯], Sergey Gaponov[3], Jana Reifegerste[4], Tessa Yuditha[5], Tatiana Tatarinova[3], Ljiljana Progovac[6‡], Antonio Benítez-Burraco[5‡*]


DE GRUYTER MOUTON STUF 2024; 77(3): 353–369

Jose A. Jódar-Sánchez* and Marc Allassonnière-Tang

The evolutionary dynamics of grammatical gender in Torricelli languages

https://doi.org/10.1515/stuf-2024-2010

Abstract: Grammatical gender in New Guinea is an often neglected area in typological research, even though it is extremely diverse. For example, in New Guinea, some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ARTICLE

https://doi.org/10.1057/s41599-023-02506-z OPEN

Check for updates

Early humans out of Africa had only base-initial numerals

One-Soon Her[1,2], Yung-Ping Liang[2], Eugene Chan[3], Hung-Hsin Hsu[2,4], Anthony Chi-Pin Hsu[1] & Marc Allassonnière-Tang[5✉]

The world tree

- This tree has already been used to make big claims
  - Connections of language + societal structure (Chen et al. 2024)
  - Change in a small family (Jódar-Sánchez & Allassonnière-Tang 2024)
  - Inferring ancestral features of early human language (Her et al. 2024)

The world tree

Unanswered questions:

1. Does a global phylogeny make the same predictions as those made using many single-lineage trees?

2. Are there any systematic differences in rate inference due to the long branch lengths the world tree requires?

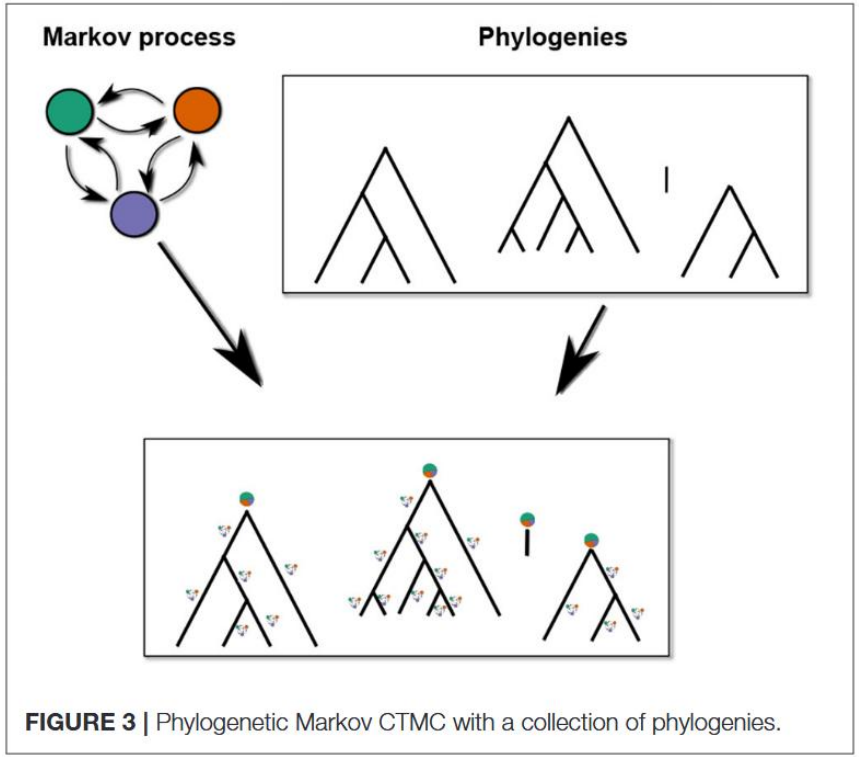


FIGURE 3 | Phylogenetic Markov CTMC with a collection of phylogenies.

An alternative method

Jäger & Wahle (2021): “independent but identical” CTMC processes run on each branch of each phylogeny

- Also accounts for small families and isolates by using a joint likelihood across phylogenies
- Does not have the ‘long branch problem’
- Is overall more computationally efficient

Jäger, G., & Wahle, J. (2021). Phylogenetic Typology. *Frontiers in Psychology*.

The current study

- Testing rate inference on Bouckaert et al. (2022)'s global phylogeny against single-lineage subtrees of this phylogeny using Jäger & Wahle (2021)'s method
- Inferring *rates of change* of GramBank features across these two regimes
- Comparing *correlated evolution* for some likely-correlated and likely-uncorrelated feature pairs

Methods

- GramBank: 195 features, most are binary-coded
  - Around 2,500 language varieties
- Two models of evolution:
  - ‘Non-covarion’ CTMC
  - Covarion: ‘hot’ and ‘cold’ regimes within each CTMC
- Two types of phylogeny:
  - **Global:** Bouckaert et al. (2022)’s world tree
  - **Local:** Separate lineages, extracted from the global phylogeny

Methods

- Method from Jäger & Wahle (2021):
  - “independent but identical” CTMC processes run on each branch of each phylogeny
  - Joint likelihood across phylogenies determined using Felsenstein’s (1981) pruning algorithm
- Models were run in Stan
- For the global phylogeny, basic setup is similar but there is only one tree

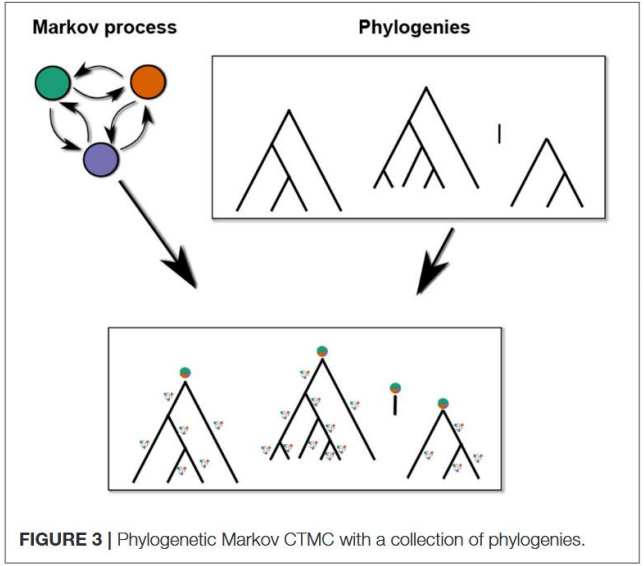


FIGURE 3 | Phylogenetic Markov CTMC with a collection of phylogenies.

Jäger, G., & Wahle, J. (2021). Phylogenetic Typology. *Frontiers in Psychology.*
Felsenstein, J. (1981). Evolutionary trees from gene frequencies and quantitative characters. *Evolution.*

Correlated evolution

- **Do these phylogeny types make the same predictions about correlated evolution?**
- 10 pairs of likely-correlated features, and 10 pairs likely-uncorrelated features
  - Determined in part by mutual information scores
- Determine Q matrices using Pagel's (1994) method
- Calculate *phi coefficient* of correlation
  - On a scale from -1 to 1
  - Also from Jäger & Wahle (2021)

$$\frac{\mathrm{cov}(f_1, f_2)}{\sqrt{\mathrm{var}(f_1)\mathrm{var}(f_2)}} = \frac{p_{00}p_{11} - p_{10}p_{01}}{\sqrt{(p_{00}+p_{01})(p_{10}+p_{11})(p_{00}+p_{10})(p_{10}+p_{11})}}$$

Pagel, M. (1994). Detecting correlated evolution on phylogenies. *Proceedings of the Royal Society of London*.

Correlated Features

Feature 1	Feature 2
37 Is there a postposed complementizer in complements of verbs of thinking and/or knowing?	64 Is there a preposed complementizer in complements of verbs of thinking and/or knowing?
92 Is there grammatical marking of direct evidence (perceived with the senses)?	93 Is there grammatical marking of indirect evidence (hearsay, inference, etc.)?
139 Is there a comparative construction that employs a marker of the standard which elsewhere has a locational meaning?	169 Is there a comparative construction with a standard marker that elsewhere has neither a locational meaning nor a 'surpass/exceed' meaning?
31 Can predicative possession be expressed with an S-like possessum and a locative-coded possessor?	173 Can predicative possession be expressed with an S-like possessum and a dative-coded possessor?
61 Is there a non-bound comparative degree marker modifying the property word in a comparative construction?	166 Is there a bound comparative degree marker on the property word in a comparative construction?
169 Is there a comparative construction with a standard marker that elsewhere has neither a locational meaning nor a 'surpass/exceed' meaning?	178 Is there a comparative construction that includes a form that elsewhere means 'surpass, exceed'?
139 Is there a comparative construction that employs a marker of the standard which elsewhere has a locational meaning?	178 Is there a comparative construction that includes a form that elsewhere means 'surpass, exceed'?
65 Can the A argument be indexed by a prefix/proclitic on the verb in the simple main clause?	167 Can the S argument be indexed by a prefix/proclitic on the verb in the simple main clause?
3 Can predicative possession be expressed with an S-like possessor and a possessum that is coded like a comitative argument?	173 Can predicative possession be expressed with an S-like possessum and a dative-coded possessor?
3 Can predicative possession be expressed with an S-like possessor and a possessum that is coded like a comitative argument?	31 Can predicative possession be expressed with an S-like possessum and a locative-coded possessor?

Non-correlated Features

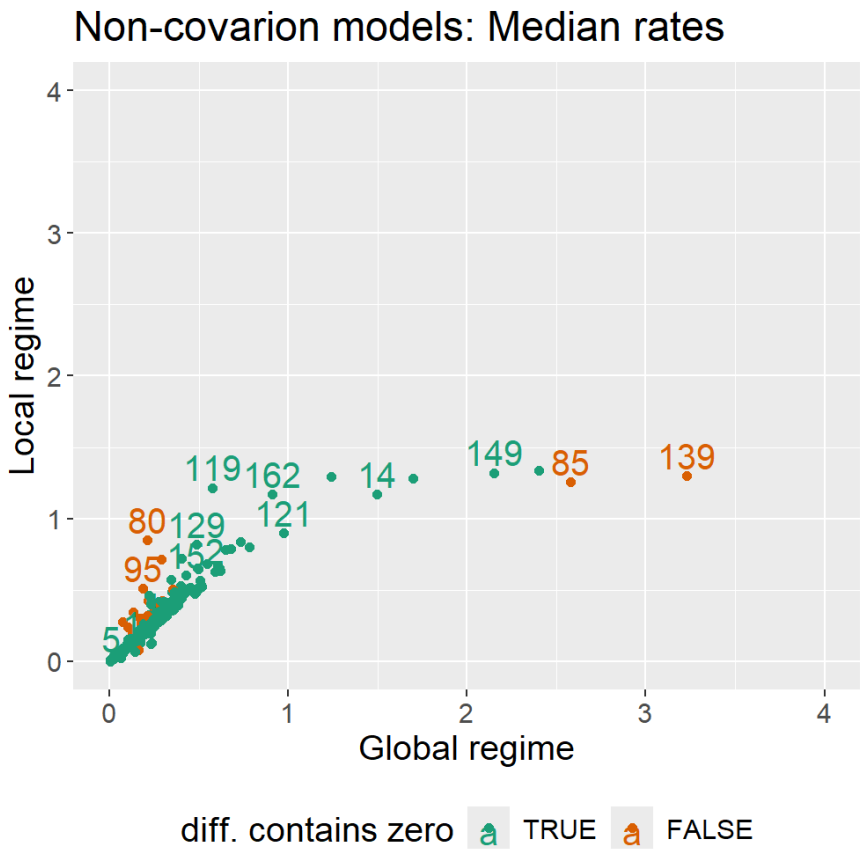
Feature 1	Feature 2
7 Do indefinite nominals commonly have indefinite articles?	74 Can the S or A argument be omitted from a pragmatically unmarked clause when the referent is inferable from context ("pro-drop" or "null anaphora")?
7 Do indefinite nominals commonly have indefinite articles?	179 Can adnominal possession be marked by a suffix on the possessor?
7 Do indefinite nominals commonly have indefinite articles?	97 Can adnominal possession be marked by a prefix on the possessed noun?
7 Do indefinite nominals commonly have indefinite articles?	56 Can adnominal possession be marked by a suffix on the possessed noun?
56 Can adnominal possession be marked by a suffix on the possessed noun?	183 Is there a morphologically marked inverse on verbs?
7 Do indefinite nominals commonly have indefinite articles?	177 Is there any ergative alignment of flagging?
4 Can adnominal possession be marked by a prefix on the possessor?	183 Is there a morphologically marked inverse on verbs?
7 Do indefinite nominals commonly have indefinite articles?	102 Is there any accusative alignment of flagging?
4 Can adnominal possession be marked by a prefix on the possessor?	7 Do indefinite nominals commonly have indefinite articles?
7 Do indefinite nominals commonly have indefinite articles?	21 Is there any neutral alignment of flagging?

Results

RATE INFERENCE

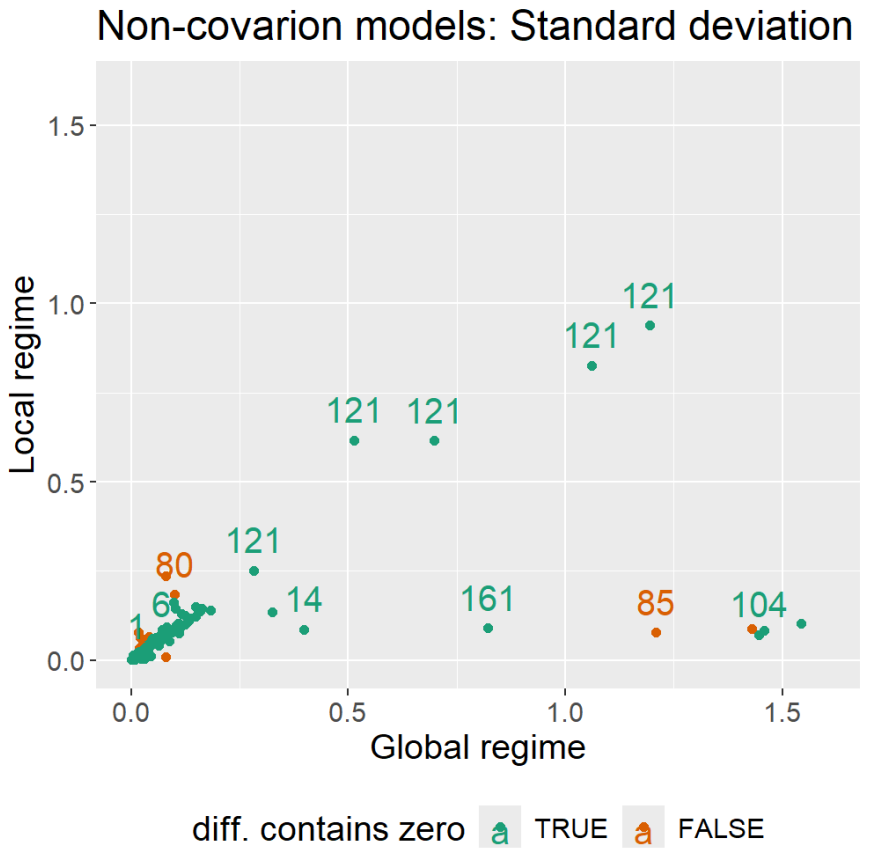
Non-covarion models

- Median rates are indistinguishable from one another most of the time
- Some outliers, most of which have a higher global median compared to local
  - (but there are outliers in the other direction too)



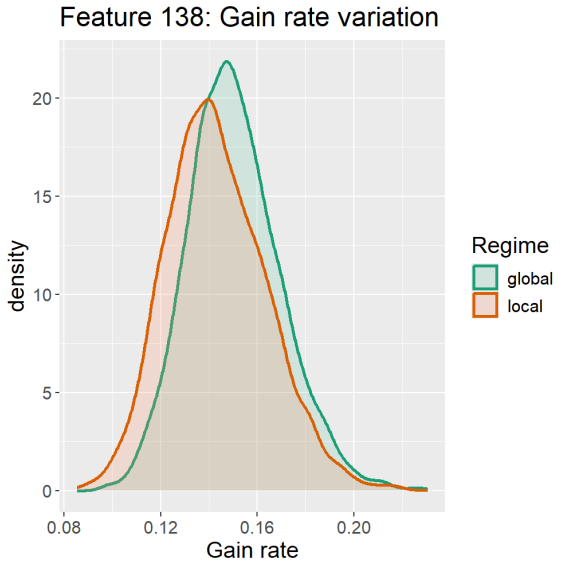
Non-covarion models

- Standard deviations are also very similar in most cases
- But some outliers exist, usually with higher SD in the global regime



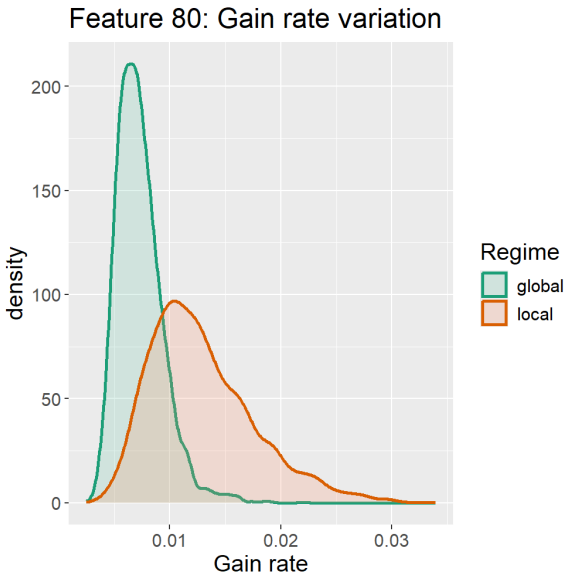
Rate variation: Similar distributions

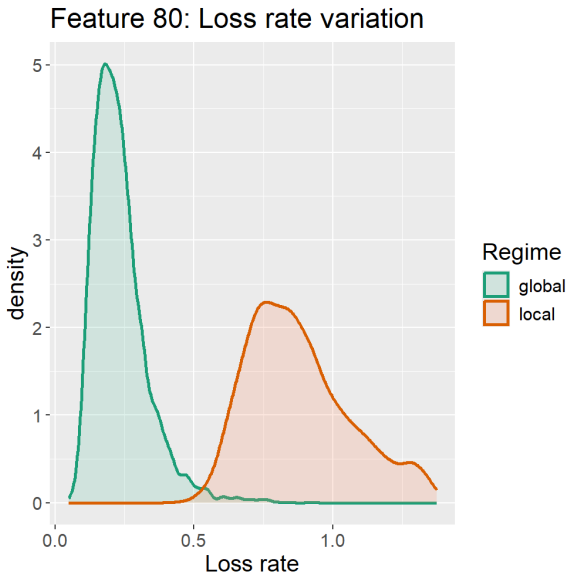
- Usual case: rate distributions are very similar in both median and SD



Rate variation: Local median > global median

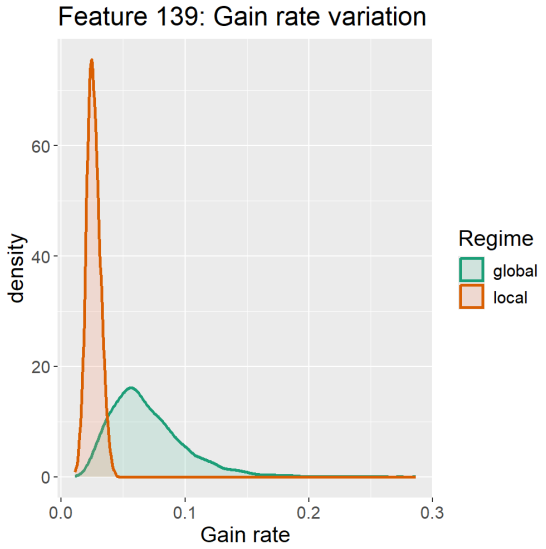
- Some outliers show higher local median with a more diffuse distribution

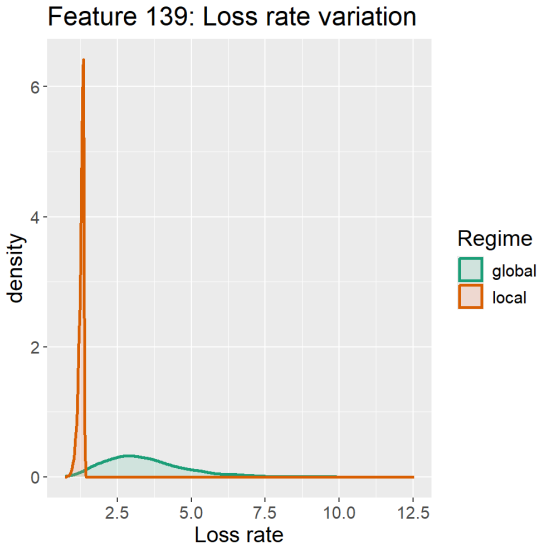




Rate variation: Global median > local median

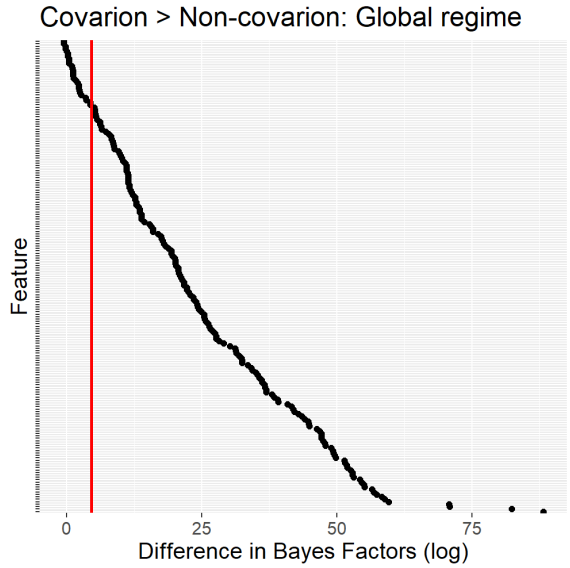
- Other outliers have higher global median with a more diffuse distribution

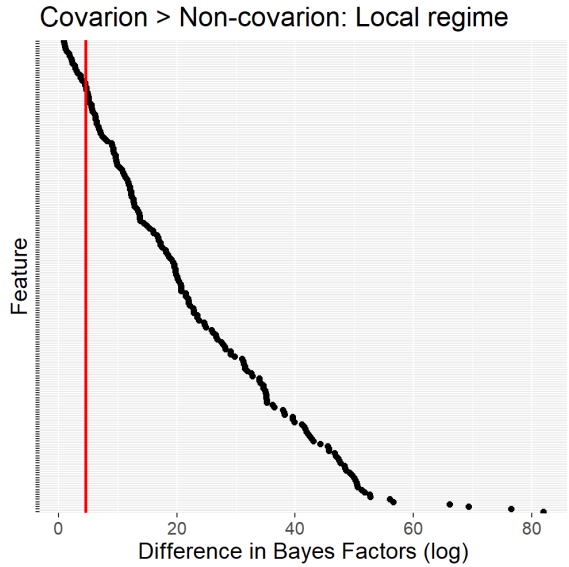




Covarion > Non-covarion

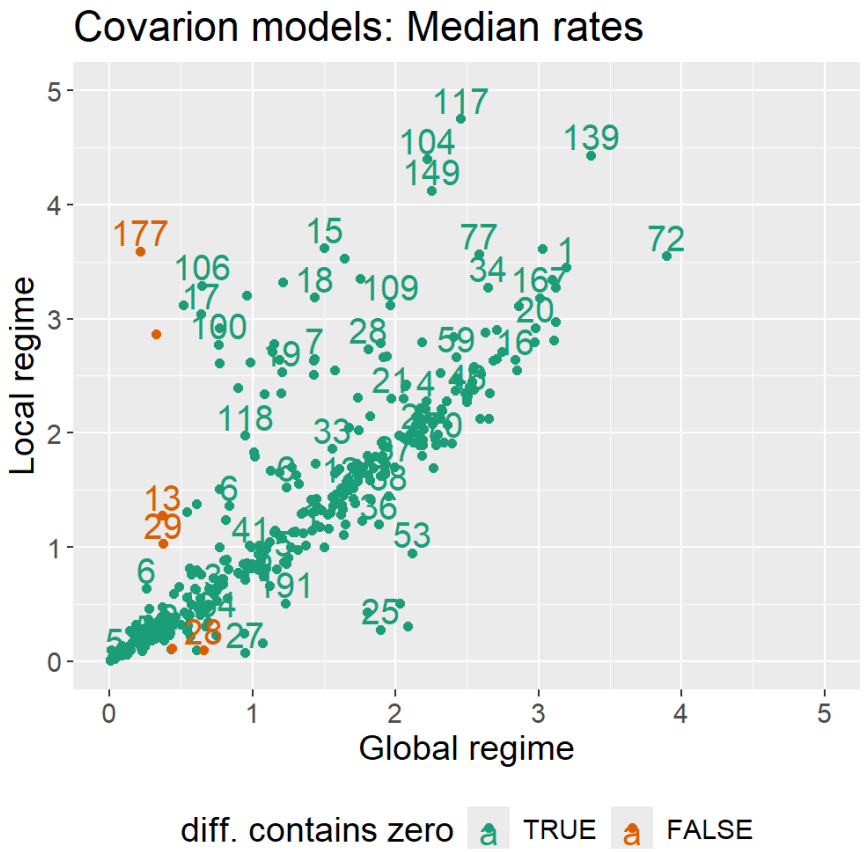
- Covarion models had consistently better fit to the data than non-covarion models





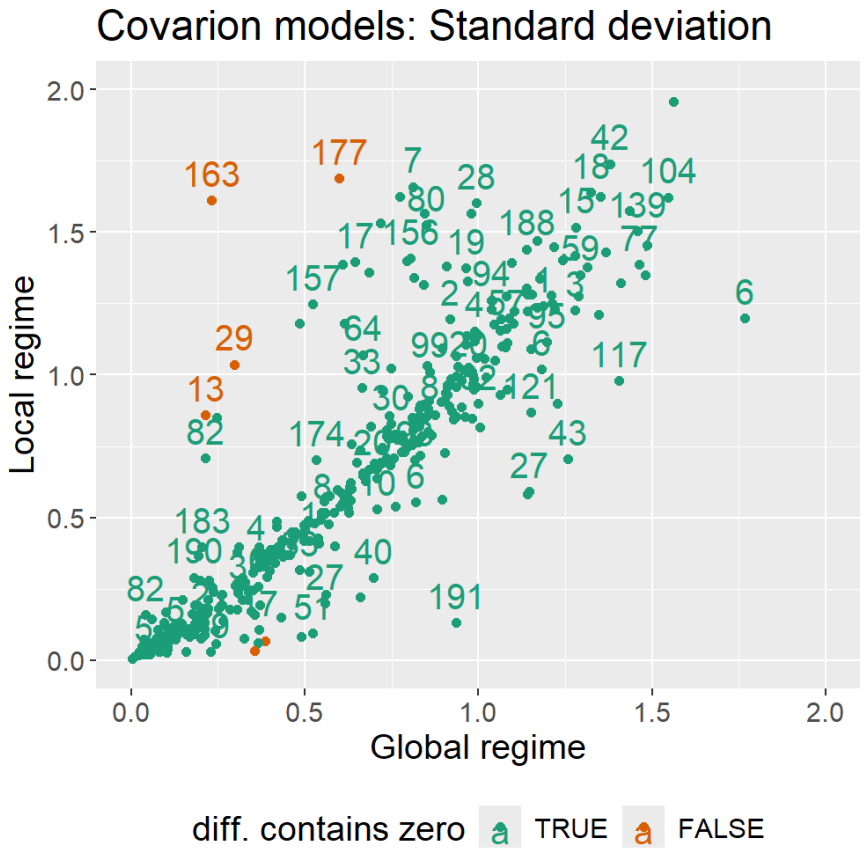
Covarion models

- Overall distribution of rate medians differs from non-covarion medians
- When rate medians differ, usually the global median is lower than the local



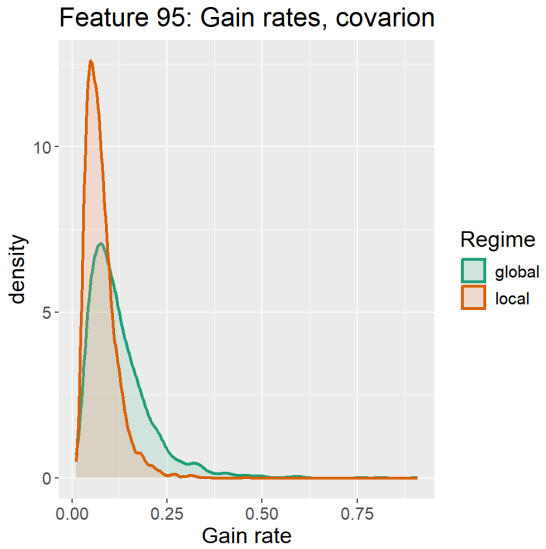
Covarion models

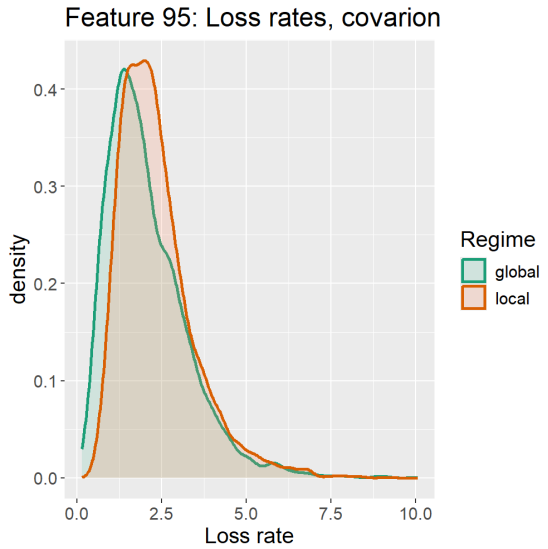
The global regime is also more likely to have a smaller SD than the local regime



Rate variation: similar distributions

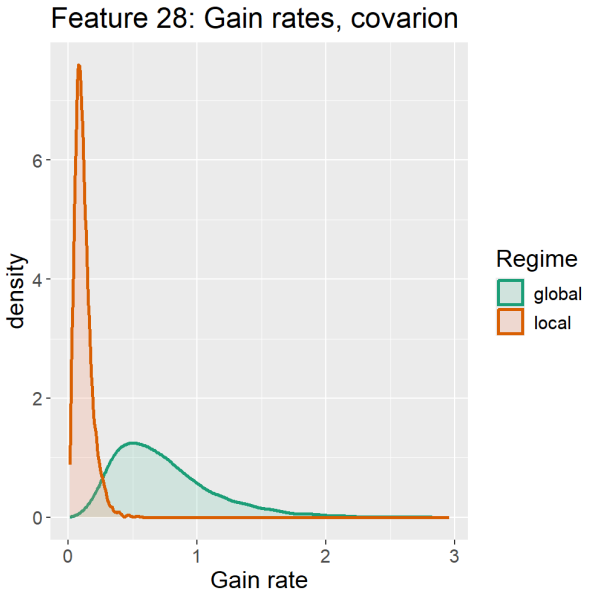
- Usual case: both gain and loss rates are similar across regimes

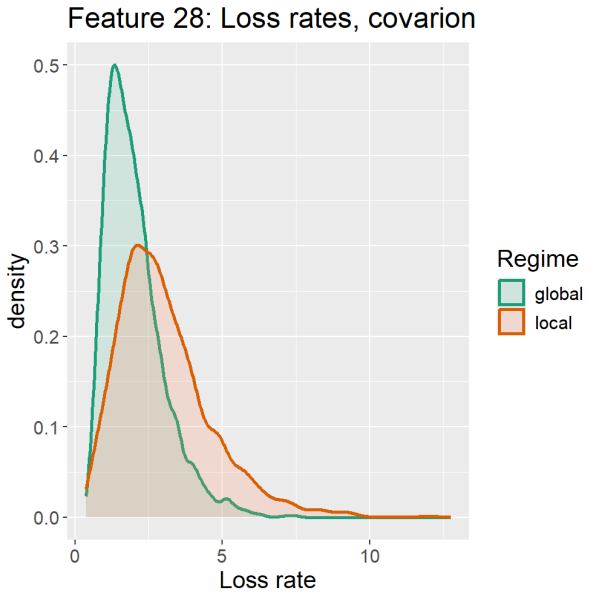




Rate variation: global > local

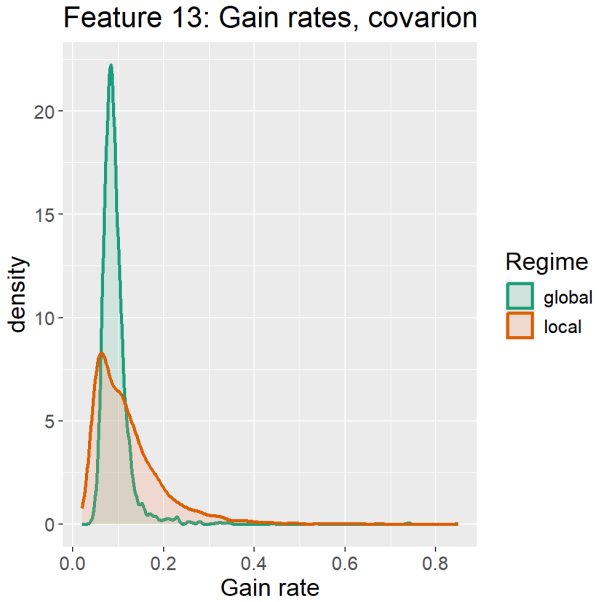
- Global rates are higher in **gain rates**

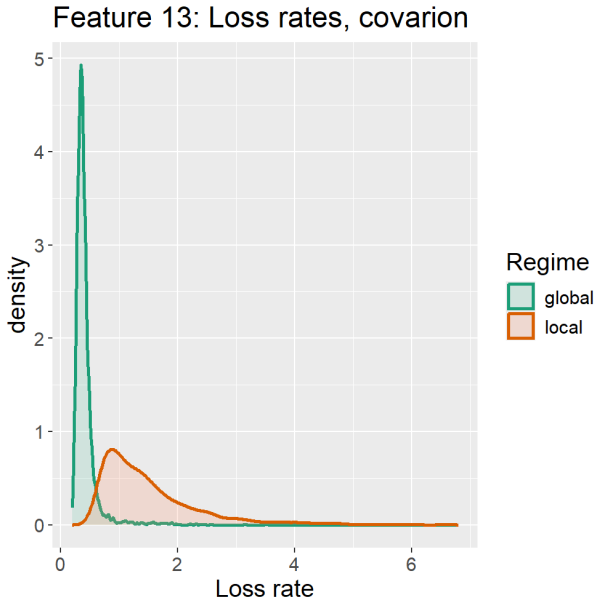




Rate variation: local > global

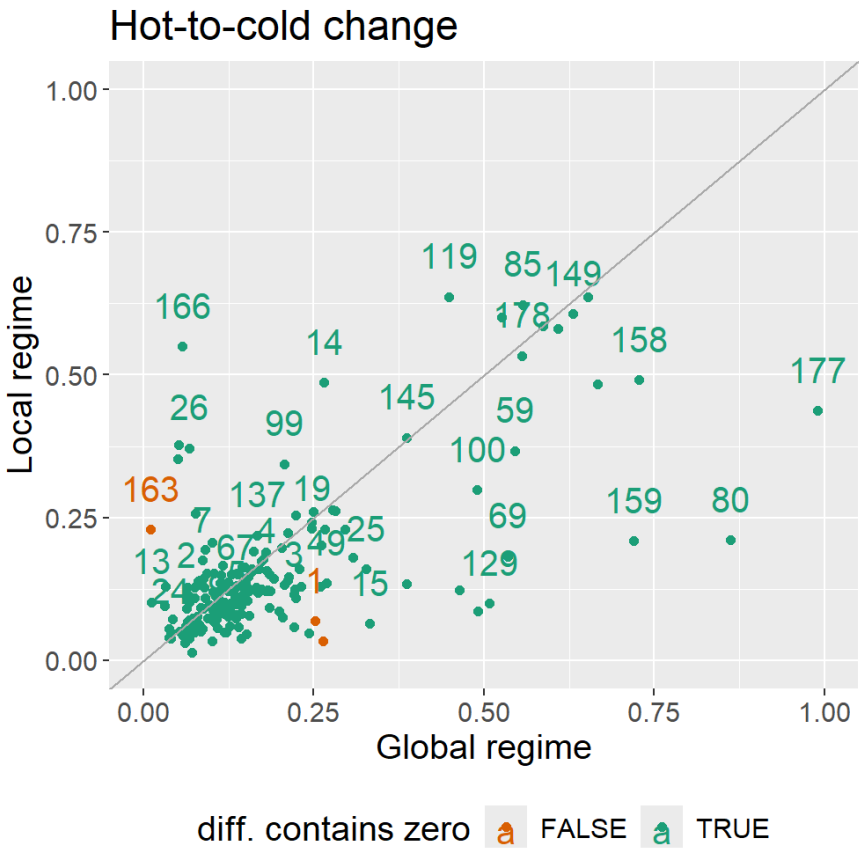
- Local rates are higher in **loss rates**





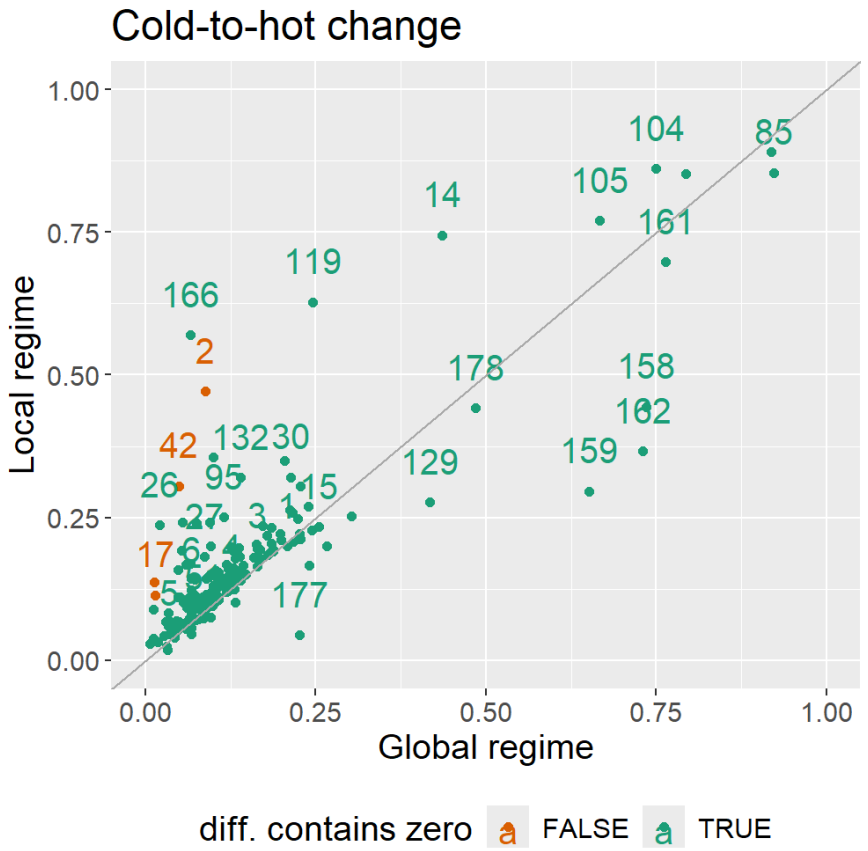
Covarion models

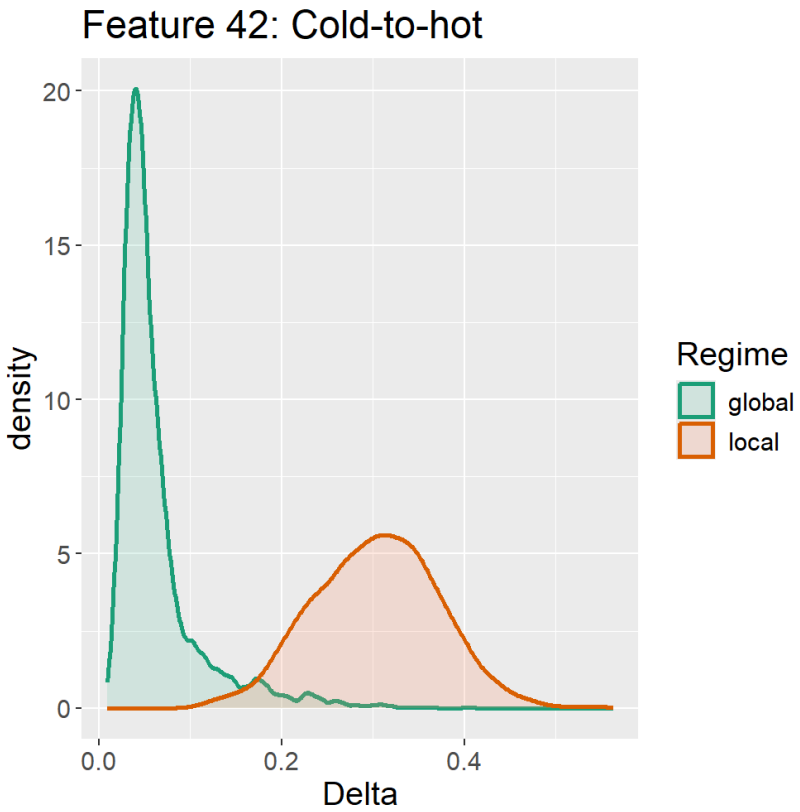
- Change rate from ‘hot’ to ‘cold’ regimes is variable, but not in any particular direction
  - Sometimes global rates are higher, sometimes local ones are



Covarion models

- Change rates from the ‘cold’ to ‘hot’ regime tend toward global being more conservative
  - i.e. the global regime tends to stay in the ‘cold’ regime longer





Cold-to-hot switch rate: local > global

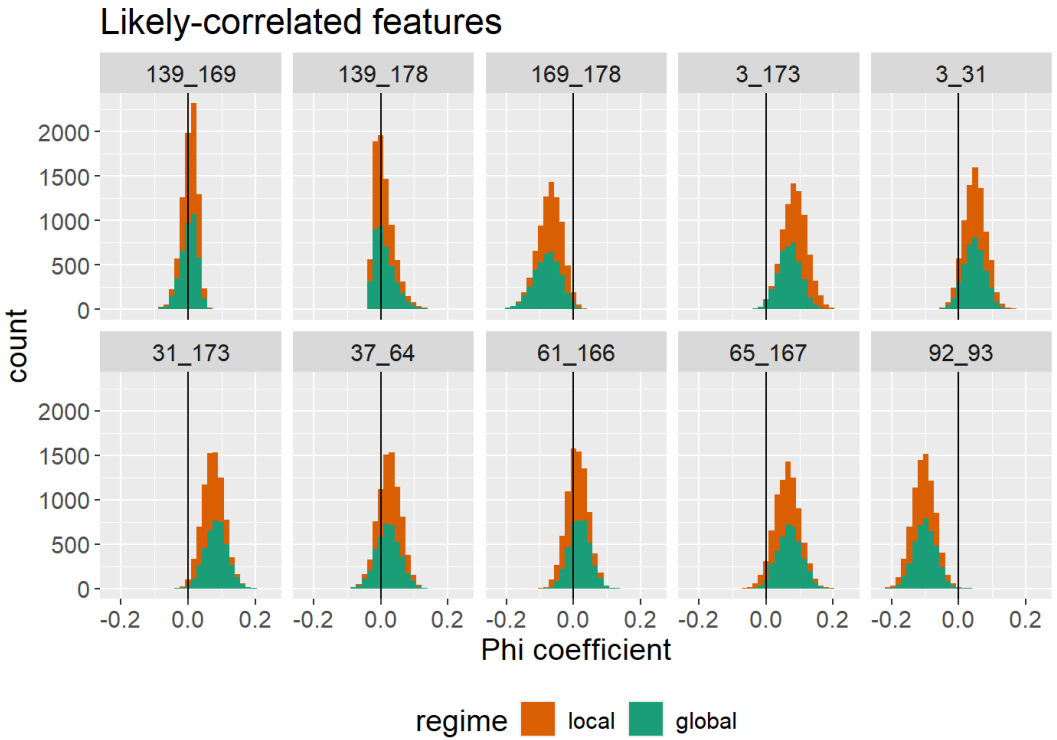
- The global regime tends to have lower switch rates from the ‘cold’ to the ‘hot’ regime
- This indicates an overall inference of slower change on the global phylogeny
- Rates in the global regime are less likely to leave the ‘cold’ regime

Results

CORRELATED EVOLUTION

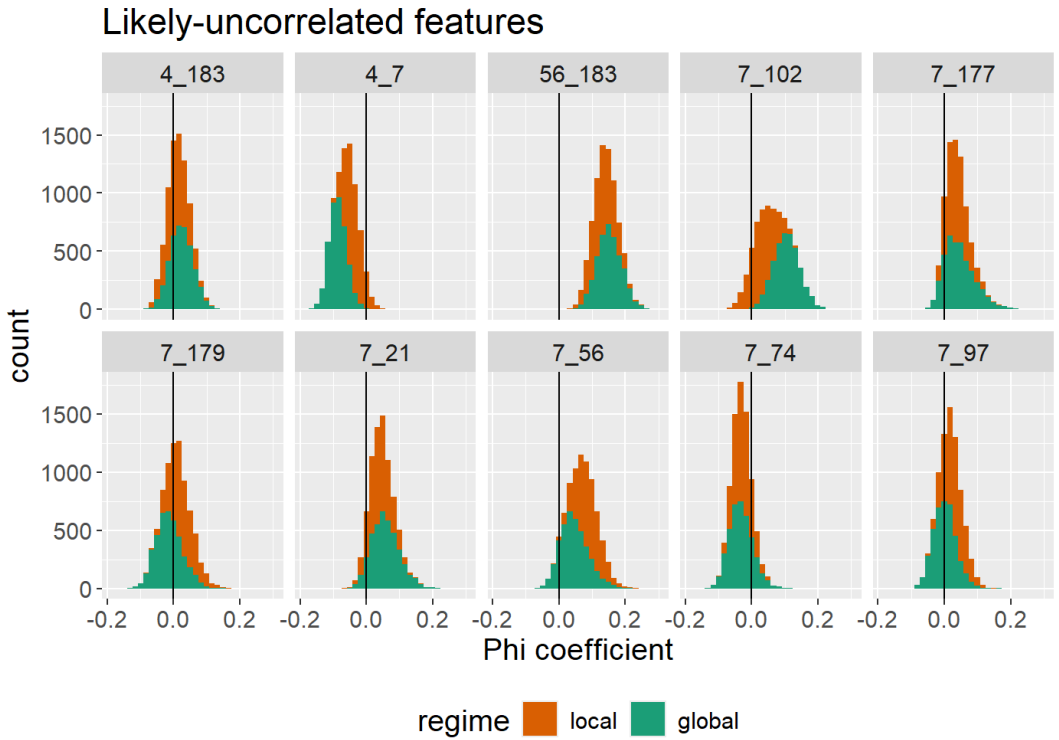
Likely-correlated features

- Correlations overall are not very strong
- Crucially: local and global regimes are not hugely different from one another



Likely-uncorrelated features

- Strange result: the strongest correlation across these 20 pairs is 56 & 183, which should not be correlated at all
- Again, not much difference between local and global regimes
- Will need additional support from Bayes Factors to determine if this correlation is meaningful



Summary

- Overall, rate inference may not be so different across global and local approaches to strongly prefer one over the other
- However, there may be a tendency for features to remain in the ‘cold’ regime in a covarion model for longer when using the global approach
  - Likely caused by long branches near the root
- Estimates of correlated evolution do not seem hugely different across regimes
- The local approach of Jäger & Wahle (2021) is more computationally efficient (and can be parallelized) so may be preferable
- Still to consider: Bayes Factors

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