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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 1**. Cross correlation matrix of Tree Nob and 10 Synthetic chronologies comprising TN Sim1. | | | | | | | | | | | |
|  | Tree Nob | Syn 1 | Syn 2 | Syn 3 | Syn 4 | Syn 5 | Syn 6 | Syn 7 | Syn 8 | Syn 9 | Syn 10 |
| Tree Nob | 1.00 | 0.77 | 0.78 | 0.77 | 0.77 | 0.80 | 0.79 | 0.76 | 0.82 | 0.80 | 0.77 |
| Syn 1 | 0.77 | 1.00 | 0.72 | 0.72 | 0.72 | 0.70 | 0.74 | 0.68 | 0.74 | 0.72 | 0.71 |
| Syn 2 | 0.78 | 0.72 | 1.00 | 0.73 | 0.72 | 0.72 | 0.73 | 0.69 | 0.74 | 0.77 | 0.68 |
| Syn 3 | 0.77 | 0.72 | 0.73 | 1.00 | 0.71 | 0.70 | 0.76 | 0.70 | 0.75 | 0.70 | 0.70 |
| Syn 4 | 0.77 | 0.72 | 0.72 | 0.71 | 1.00 | 0.70 | 0.73 | 0.69 | 0.71 | 0.73 | 0.69 |
| Syn 5 | 0.80 | 0.70 | 0.72 | 0.70 | 0.70 | 1.00 | 0.74 | 0.70 | 0.72 | 0.71 | 0.69 |
| Syn 6 | 0.79 | 0.74 | 0.73 | 0.76 | 0.73 | 0.74 | 1.00 | 0.73 | 0.76 | 0.71 | 0.70 |
| Syn 7 | 0.76 | 0.68 | 0.69 | 0.70 | 0.69 | 0.70 | 0.73 | 1.00 | 0.69 | 0.69 | 0.69 |
| Syn 8 | 0.82 | 0.74 | 0.74 | 0.75 | 0.71 | 0.72 | 0.76 | 0.69 | 1.00 | 0.71 | 0.70 |
| Syn 9 | 0.80 | 0.72 | 0.77 | 0.70 | 0.73 | 0.71 | 0.71 | 0.69 | 0.71 | 1.00 | 0.70 |
| Syn 10 | 0.77 | 0.71 | 0.68 | 0.70 | 0.69 | 0.69 | 0.70 | 0.69 | 0.70 | 0.70 | 1.00 |

**Simulating a chronology**. The detrended indices of each chronology were simulated 40 times. The simulation function has several parameters that produce different characteristics in the resulting synthetic indices. In this example, the autocorrelation, correlation to the climate target, and rbar are held steady. Each synthetic chronology is calculated from the synthetic indices by robust biweight mean. The correlations among the original and 10 synthetic chronologies is shown.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 3**. Chronology Statistics | | |  |  |  |  |  |  |
|  | n.cores | n.trees | n.tot | rbar.eff | eps | snr | AR1 | TargCor |
| TreeNob | 77 | 77 | 618 | 0.63 | 0.99 | 129.88 | 0.59 | 0.59 |
| TN Sim1 | 77 | 77 | 618 | 0.56 | 0.99 | 97.57 | 0.58 | 0.61 |
| TN Sim2 | 77 | 77 | 618 | 0.55 | 0.99 | 92.62 | 0.57 | 0.52 |
| TN Sim3 | 77 | 77 | 618 | 0.29 | 0.97 | 31.78 | 0.56 | 0.60 |
| TN Sim4 | 77 | 77 | 618 | 0.55 | 0.99 | 91.84 | 0.48 | 0.61 |
|  |  |  |  |  |  |  |  |  |
|  | n.cores | n.trees | n.tot | rbar.eff | eps | snr | AR1 | TargCor |
| Ca646 | 89 | 66 | 2148 | 0.74 | 1.00 | 189.96 | 0.18 | 0.77 |
| Ca646 Sim1 | 89 | 66 | 2148 | 0.53 | 0.99 | 74.17 | 0.11 | 0.58 |
| Ca646 Sim2 | 89 | 66 | 2148 | 0.53 | 0.99 | 74.65 | 0.09 | 0.59 |
| Ca646 Sim3 | 89 | 66 | 2148 | 0.27 | 0.96 | 24.37 | 0.08 | 0.59 |
| Ca646 Sim4 | 89 | 66 | 2148 | 0.53 | 0.99 | 74.62 | 0.09 | 0.46 |
|  |  |  |  |  |  |  |  |  |
|  | n.cores | n.trees | n.tot | rbar.eff | eps | snr | AR1 | TargCor |
| Cana113 | 28 | 28 | 378 | 0.44 | 0.96 | 22.11 | 0.28 | 0.53 |
| Cana113 Sim1 | 28 | 28 | 378 | 0.53 | 0.97 | 31.70 | 0.26 | 0.39 |
| Cana113 Sim2 | 28 | 28 | 378 | 0.52 | 0.97 | 30.68 | 0.24 | 0.39 |
| Cana113 Sim3 | 28 | 28 | 378 | 0.27 | 0.91 | 10.15 | 0.18 | 0.37 |
| Cana113 Sim4 | 28 | 28 | 378 | 0.52 | 0.97 | 29.99 | 0.18 | 0.29 |
| Each simulation represents the average of 10 Synthetic chronologies | | | | | | |  |  |

Summary statistics show the range of chronologies tested. Each synthetic chronology is built with identical sample size characteristics to its parent chronology. Each set of chronology simulation parameters were replicated to times. Four different settings were used to simulate each original chronology.

**Chart, scatter chart

Description automatically generated**

**Figure 1.** Three-period prediction interval testing. Black dots: climate target. Red line: Climate reconstruction. Yellow dashed line: prediction intervals based on measured distance between reconstruction and 90th percentile error. Cool-colored lines: prediction intervals by MEboot and no bootstrapping. Warm-colored lines: prediction intervals by traditional bootstrapping.

**Development and testing of Prediction Intervals**. Prediction intervals were developed for each chronology-target pair (1 original and 40 synthetic chronologies). The full chronology-target overlap was split into three independent intervals. The calibration interval was used to calculate regression coefficients, henceforth called the ‘short calibration’. The verification interval was used to calculate errors between the reconstruction and target, hereafter called the ‘verification error’. Prediction intervals were built in the ‘set-aside’ interval. All prediction intervals were based on a reconstruction calibrated in the full calibration-verification interval and some combination of 1) errors calculated in the verification interval using the short calibration, and 2) bootstrapped regression error as measured in the short calibration.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **No Bootstrapping** | | | | **MEboot** | | | | **Traditional Bootstrapping** | | | |
|  |  |  | **VEt** | | **VEe** | | **VEt** | | **VEe** | | **VEt** | | **VEe** | |
| Tree Nob Geoduck - Langara Island Sea Surface Temperature | 50% interval | TN Sim 1 | 0.52 | 1.99% | 0.52 | 1.99% | 0.53 | 3.34% | 0.53 | 3.34% | 0.57 | 6.52% | 0.57 | 6.52% |
| TN Sim 2 | 0.54 | 3.83% | 0.54 | 3.83% | 0.55 | 4.68% | 0.55 | 4.68% | 0.57 | 6.71% | 0.57 | 6.71% |
| TN Sim 3 | 0.52 | 2.13% | 0.52 | 2.13% | 0.54 | 3.87% | 0.54 | 3.87% | 0.59 | 9.40% | 0.59 | 9.40% |
| TN Sim 4 | 0.53 | 3.40% | 0.53 | 3.40% | 0.55 | 4.56% | 0.55 | 4.56% | 0.57 | 7.47% | 0.57 | 7.47% |
| Tree Nob | 0.49 | -1.37% | 0.49 | -1.37% | 0.49 | -0.81% | 0.49 | -0.81% | 0.55 | 4.68% | 0.55 | 4.68% |
|  | **2.00%** | | **2.00%** | | **3.13%** | | **3.13%** | | **6.95%** | | **6.95%** | |
| 90% interval | TN Sim 1 | 0.88 | -2.17% | 0.90 | 0.03% | 0.89 | -1.18% | 0.91 | 0.97% | 0.92 | 1.82% | 0.93 | 2.95% |
| TN Sim 2 | 0.87 | -2.53% | 0.90 | 0.23% | 0.89 | -1.45% | 0.91 | 0.92% | 0.91 | 0.66% | 0.92 | 2.27% |
| TN Sim 3 | 0.86 | -4.31% | 0.89 | -0.98% | 0.87 | -2.97% | 0.90 | 0.39% | 0.92 | 1.71% | 0.95 | 4.56% |
| TN Sim 4 | 0.86 | -4.11% | 0.89 | -0.79% | 0.87 | -3.11% | 0.91 | 0.61% | 0.90 | -0.08% | 0.94 | 3.58% |
| Tree Nob | 0.87 | -3.23% | 0.90 | 0.48% | 0.90 | 0.00% | 0.92 | 1.77% | 0.96 | 6.29% | 0.96 | 6.45% |
|  | **-3.27%** | | **-0.20%** | | **-1.74%** | | **0.93%** | | **2.08%** | | **3.96%** | |
| Rock Springs Ranch Blue Oak - Local Winter Precipitation | 50% interval | Ca646 Sim 1 | 0.55 | 4.65% | 0.55 | 4.65% | 0.55 | 5.02% | 0.55 | 5.02% | 0.56 | 6.03% | 0.56 | 6.03% |
| Ca646 Sim 2 | 0.53 | 3.38% | 0.53 | 3.38% | 0.54 | 3.73% | 0.54 | 3.73% | 0.54 | 4.40% | 0.54 | 4.40% |
| Ca646 Sim 3 | 0.55 | 4.81% | 0.55 | 4.81% | 0.55 | 5.16% | 0.55 | 5.16% | 0.57 | 6.73% | 0.57 | 6.73% |
| Ca646 Sim 4 | 0.55 | 4.74% | 0.55 | 4.74% | 0.55 | 4.90% | 0.55 | 4.90% | 0.56 | 5.92% | 0.56 | 5.92% |
| Ca646 | 0.55 | 5.48% | 0.55 | 5.48% | 0.56 | 5.65% | 0.56 | 5.65% | 0.56 | 5.81% | 0.56 | 5.81% |
|  | **4.61%** | | **4.61%** | | **4.89%** | | **4.89%** | | **5.78%** | | **5.78%** | |
| 90% interval | Ca646 Sim 1 | 0.91 | 1.27% | 0.92 | 2.09% | 0.91 | 1.40% | 0.92 | 2.23% | 0.92 | 2.06% | 0.93 | 2.85% |
| Ca646 Sim 2 | 0.91 | 0.64% | 0.92 | 1.77% | 0.91 | 0.71% | 0.92 | 1.84% | 0.92 | 1.53% | 0.92 | 2.16% |
| Ca646 Sim 3 | 0.90 | 0.16% | 0.92 | 1.94% | 0.90 | 0.48% | 0.92 | 2.11% | 0.92 | 2.45% | 0.94 | 3.50% |
| Ca646 Sim 4 | 0.90 | -0.25% | 0.91 | 1.43% | 0.90 | 0.16% | 0.92 | 1.65% | 0.91 | 1.37% | 0.92 | 2.48% |
| Ca646 | 0.93 | 3.23% | 0.93 | 2.90% | 0.93 | 3.23% | 0.93 | 3.06% | 0.93 | 3.39% | 0.93 | 3.39% |
|  | **1.01%** | | **2.02%** | | **1.20%** | | **2.18%** | | **2.16%** | | **2.88%** | |
| Arrowsmith Mountain Mountain Hemlock MXD - Local Growing Season Air Temperature | 50% interval | Cana113 Sim 1 | 0.52 | 1.78% | 0.49 | -1.47% | 0.52 | 1.66% | 0.49 | -1.30% | 0.53 | 2.64% | 0.49 | -0.75% |
| Cana113 Sim 2 | 0.52 | 1.66% | 0.48 | -1.83% | 0.52 | 1.86% | 0.49 | -1.50% | 0.52 | 1.95% | 0.48 | -1.80% |
| Cana113 Sim 3 | 0.51 | 0.61% | 0.47 | -2.59% | 0.51 | 0.66% | 0.47 | -2.66% | 0.52 | 1.61% | 0.48 | -1.64% |
| Cana113 Sim 4 | 0.52 | 2.40% | 0.49 | -0.80% | 0.52 | 2.36% | 0.49 | -0.64% | 0.53 | 3.36% | 0.50 | -0.14% |
| Cana113 | 0.52 | 1.70% | 0.46 | -3.75% | 0.52 | 2.27% | 0.48 | -2.50% | 0.53 | 3.41% | 0.50 | -0.45% |
|  | **1.63%** | | **-2.09%** | | **1.76%** | | **-1.72%** | | **2.60%** | | **-0.95%** | |
| 90% interval | Cana113 Sim 1 | 0.87 | -3.25% | 0.86 | -3.52% | 0.87 | -3.11% | 0.86 | -3.55% | 0.87 | -3.11% | 0.87 | -3.05% |
| Cana113 Sim 2 | 0.86 | -3.68% | 0.86 | -3.74% | 0.86 | -3.66% | 0.86 | -3.64% | 0.87 | -3.27% | 0.87 | -3.50% |
| Cana113 Sim 3 | 0.86 | -3.82% | 0.86 | -4.13% | 0.86 | -3.70% | 0.86 | -4.00% | 0.87 | -2.95% | 0.87 | -3.25% |
| Cana113 Sim 4 | 0.86 | -3.89% | 0.86 | -4.01% | 0.86 | -3.86% | 0.86 | -3.98% | 0.87 | -3.50% | 0.87 | -3.43% |
| Cana113 | 0.86 | -3.64% | 0.86 | -3.98% | 0.86 | -3.86% | 0.86 | -4.09% | 0.88 | -1.59% | 0.87 | -2.73% |
|  | **-3.65%** | | **-3.88%** | | **-3.64%** | | **-3.85%** | | **-2.89%** | | **-3.19%** | |

Rate of capture by prediction intervals and the discrepancies relative to the intended capture.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **No Bootstrapping** | | **MEboot** | | **Traditional Bootstrapping** | |
|  | t-val | empricial | t-val | empricial | t-val | empricial |
| **50% interval** | 2.75% | 1.51% | 3.26% | 2.10% | 5.11% | 3.93% |
| **90% interval** | -1.97% | -0.68% | -1.40% | -0.25% | 0.45% | 1.22% |

Summary evaluation of prediction interval methods. Three bootstrapping methods and two error measurement techniques gives six methods alongside two prediction interval bands. For 90% prediction intervals, MEboot empirical errors produce the best prediction intervals.

Better proxies – those chronologies with higher correlations to their climate targets – produce prediction intervals wider than necessary for the %capture intended.