A wavelet based approach to climate biome clustering

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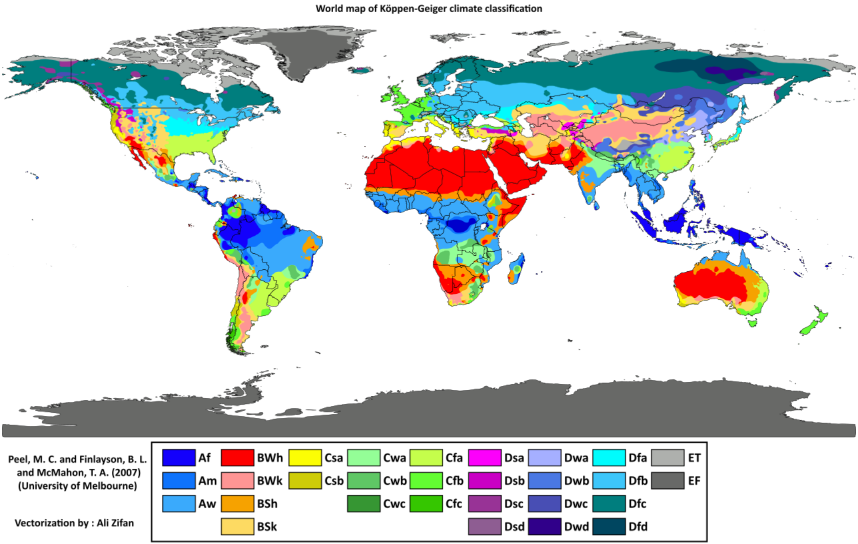
Type	Description	Criterion
A	**Equatorial climates**	$T_{min} \geq +18\ °C$
Af	Equatorial rainforest, fully humid	$P_{min} \geq 60$ mm
Am	Equatorial monsoon	$P_{ann} \geq 25\,(100 - P_{min})$
As	Equatorial savannah with dry summer	$P_{min} < 60$ mm in summer
Aw	Equatorial savannah with dry winter	$P_{min} < 60$ mm in winter
B	**Arid climates**	$P_{ann} < 10\,P_{th}$
BS	Steppe climate	$P_{ann} > 5\,P_{th}$
BW	Desert climate	$P_{ann} \leq 5\,P_{th}$
C	**Warm temperate climates**	$-3\ °C < T_{min} < +18\ °C$
Cs	Warm temperate climate with dry summer	$P_{smin} < P_{wmin}$, $P_{wmax} > 3\,P_{smin}$ and $P_{smin} < 40$ mm
Cw	Warm temperate climate with dry winter	$P_{wmin} < P_{smin}$ and $P_{smax} > 10\,P_{wmin}$
Cf	Warm temperate climate, fully humid	neither Cs nor Cw
D	**Snow climates**	$T_{min} \leq -3\ °C$
Ds	Snow climate with dry summer	$P_{smin} < P_{wmin}$, $P_{wmax} > 3\,P_{smin}$ and $P_{smin} < 40$ mm
Dw	Snow climate with dry winter	$P_{wmin} < P_{smin}$ and $P_{smax} > 10\,P_{wmin}$
Df	Snow climate, fully humid	neither Ds nor Dw
E	**Polar climates**	$T_{max} < +10\ °C$
ET	Tundra climate	$0\ °C \leq T_{max} < +10\ °C$
EF	Frost climate	$T_{max} < 0\ °C$


World map of Köppen-Geiger climate classification
Peel, M. C. and Finlayson, B. L. and McMahon, T. A. (2007) (University of Melbourne)
Vectorization by : Ali Zifan
Af
Am
Aw
BWh
BWk
BSh
BSk
Csa
Csb
Cwa
Cwb
Cwc
Cfa
Cfb
Cfc
Dsa
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- *Detect where biomes are shifting*
- *Want a data driven model*

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Given images of leaves, automatically sort images into bins based of features (not set or necessarily known).

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- *Generically speaking, supervised is "easier" than unsupervised*
- *Large scale unsupervised learning is notoriously difficult (AKA prohibitively expensive):*

$$K\text{-}means \sim \mathcal{O}(K * number\ data * dim)$$

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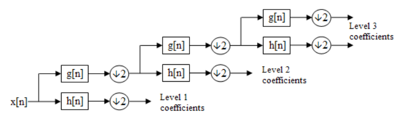
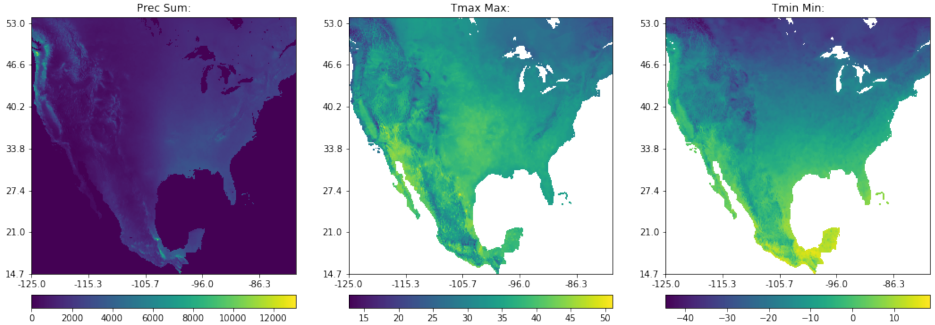


LOCA Data: 1950-1970



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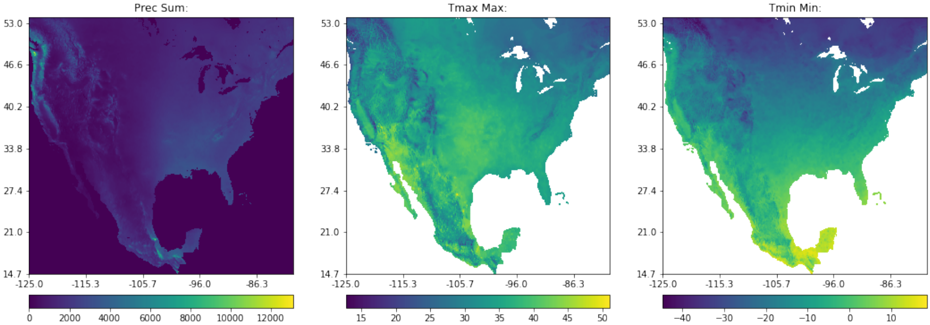
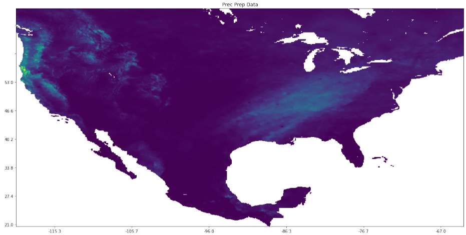


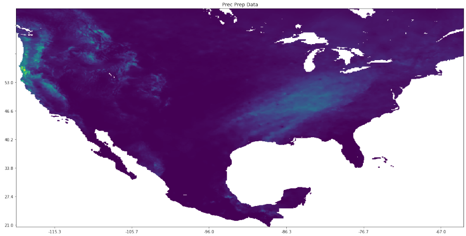
Choose wavelets:

- Space: Haar
- Time: db2

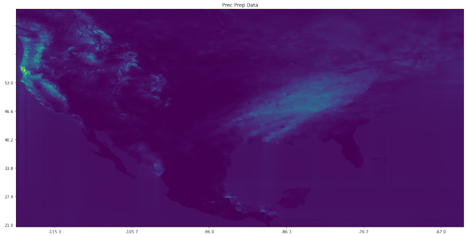
Prec Data: t=0


Prec Prep Data
53.0
46.6
40.2
33.8
27.4
21.0
-115.3
-105.7
-96.0
-86.3
-76.7
-67.0

Prec Data: t=0



Interpolate Nan:



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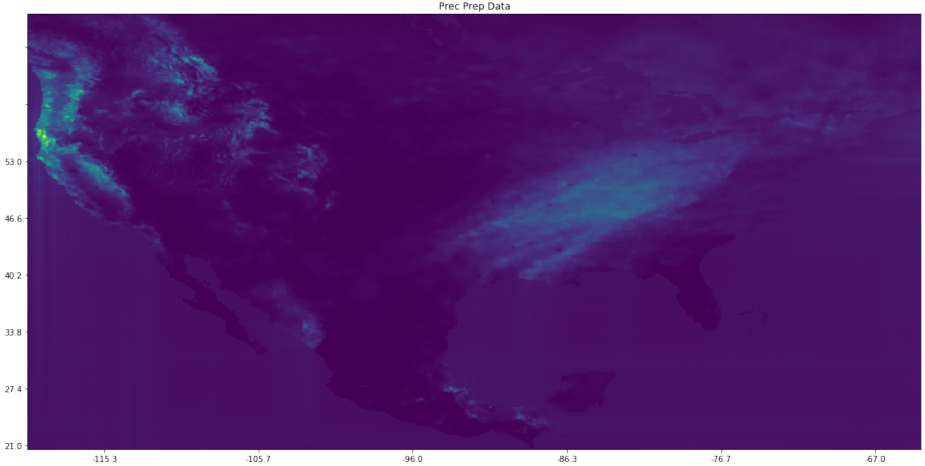
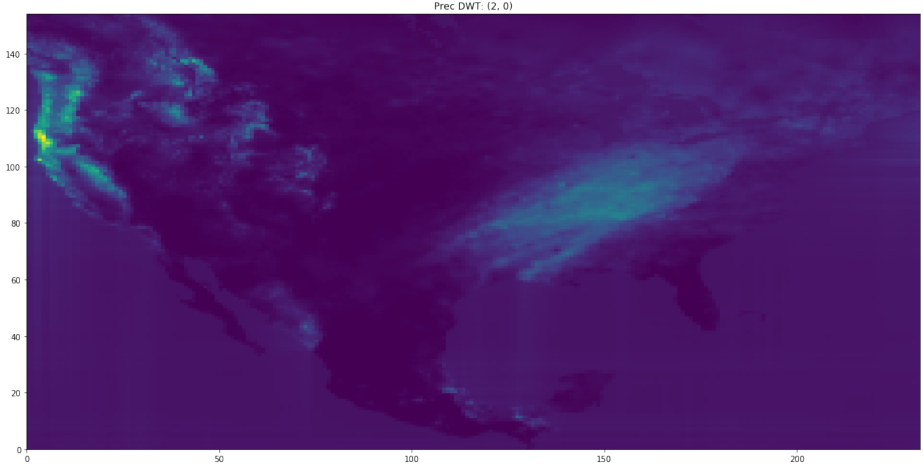


DWT: 2 space, 0 time



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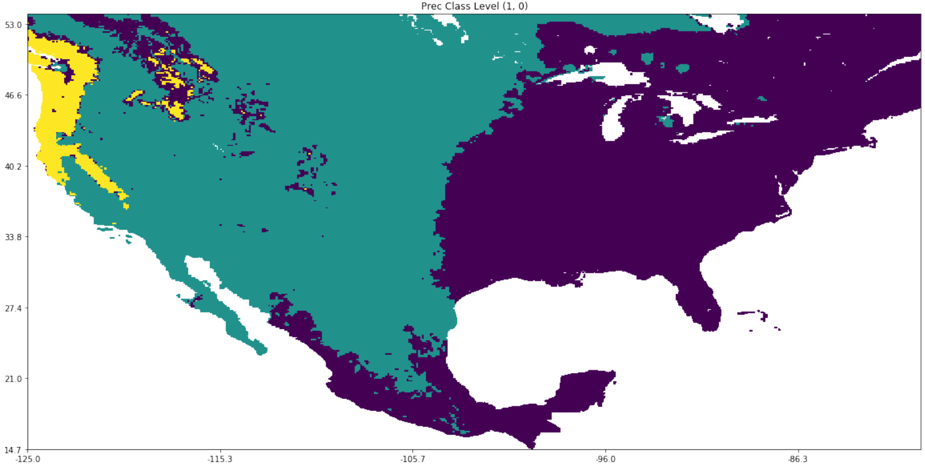
- Cluster the approximation coefficients for each variable
    - Settled on K-means
    - Determined number of clusters using silhouette and Calinski Harabaz scores
    - Used 3 clusters for Prec, 4 clusters for Tmin and Tmax

Data Clusters (1,0): 1950-1970



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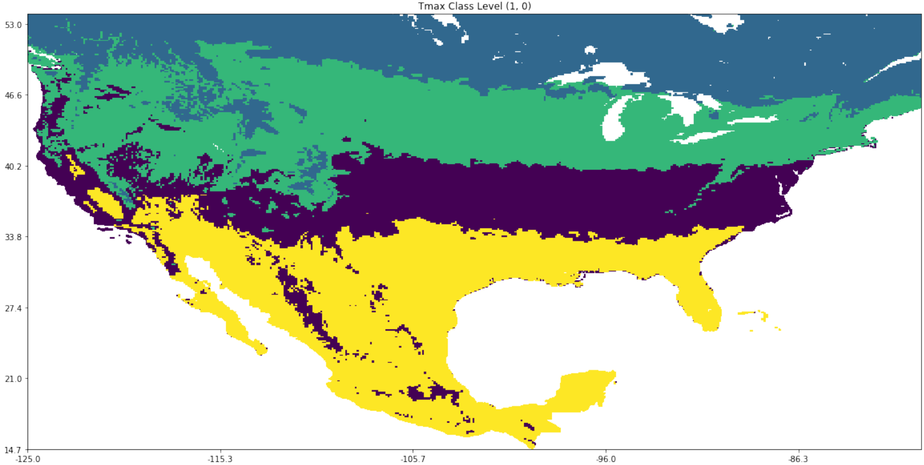

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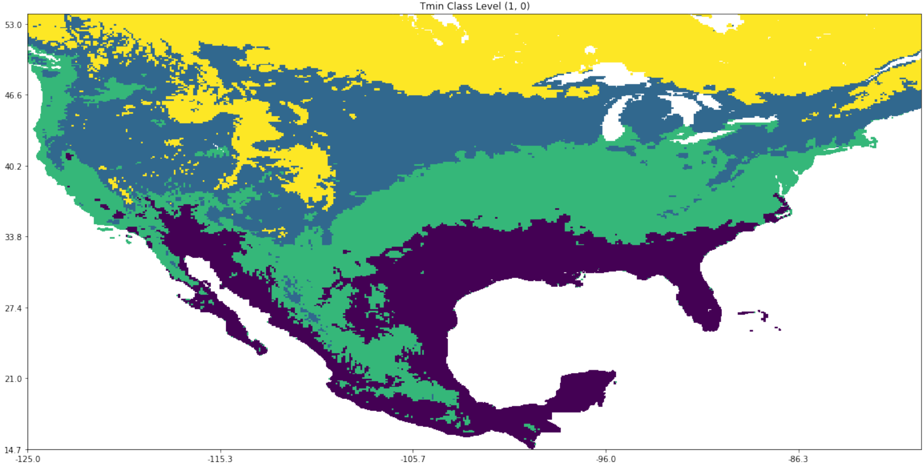

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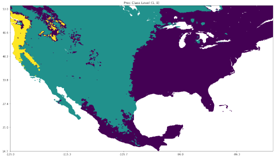
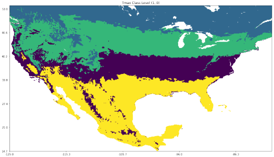
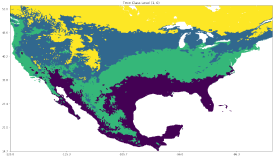
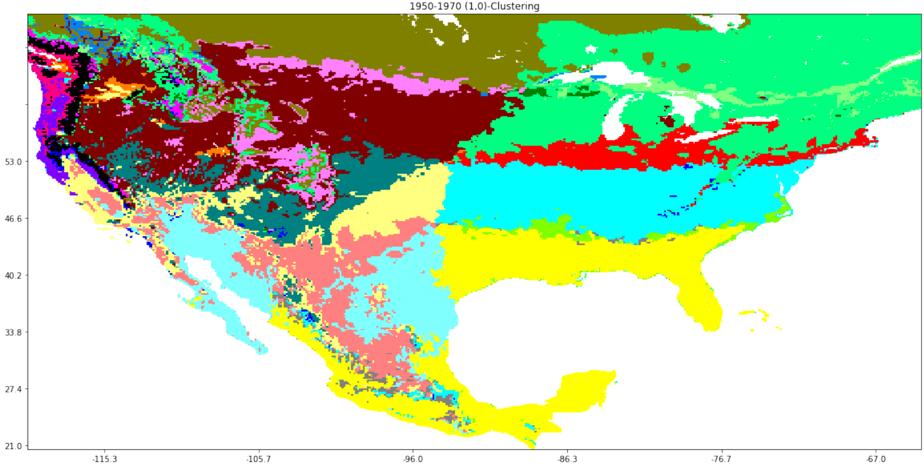


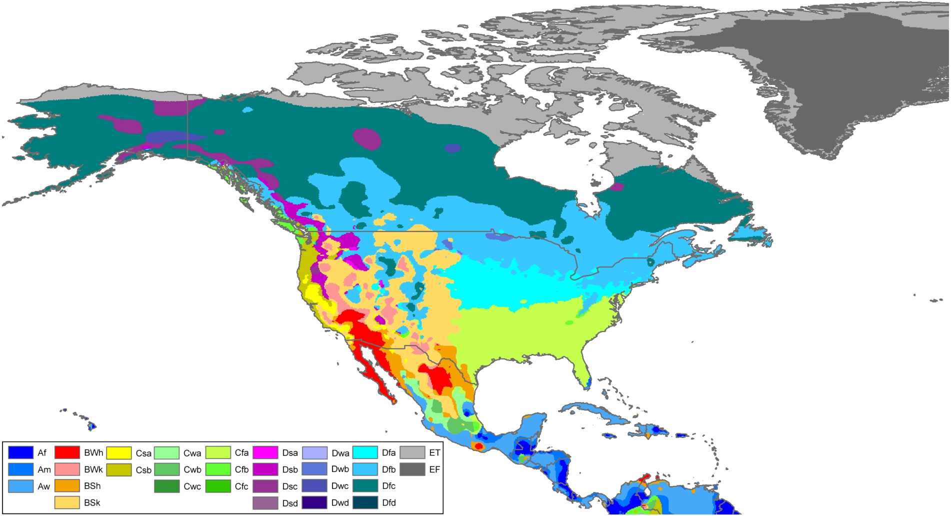




Combined Data Clusters (1,0): 1950-1970



North America Köppen-Gieger Model



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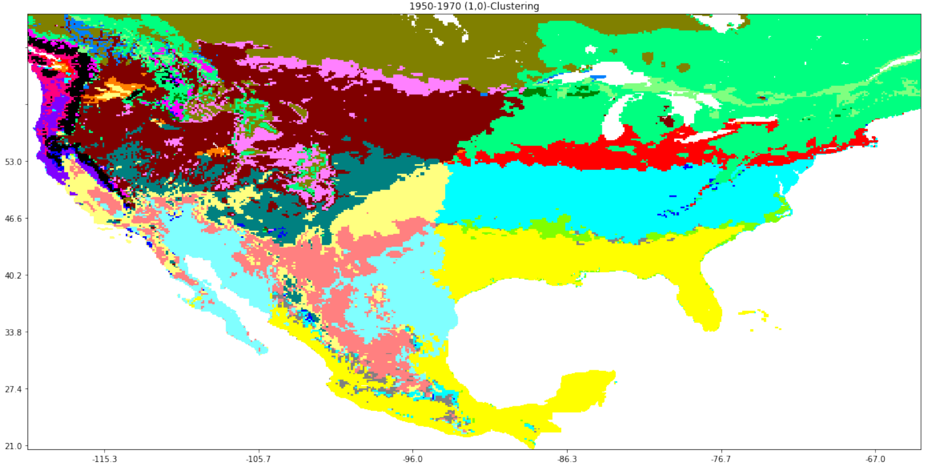
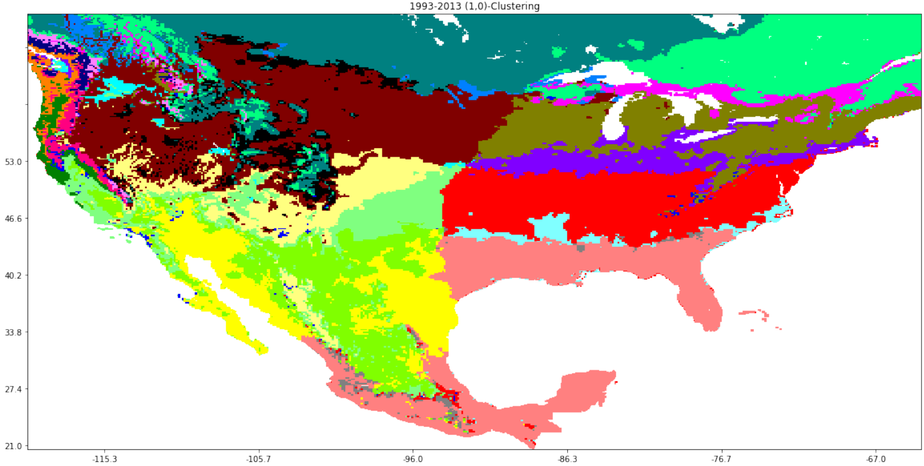
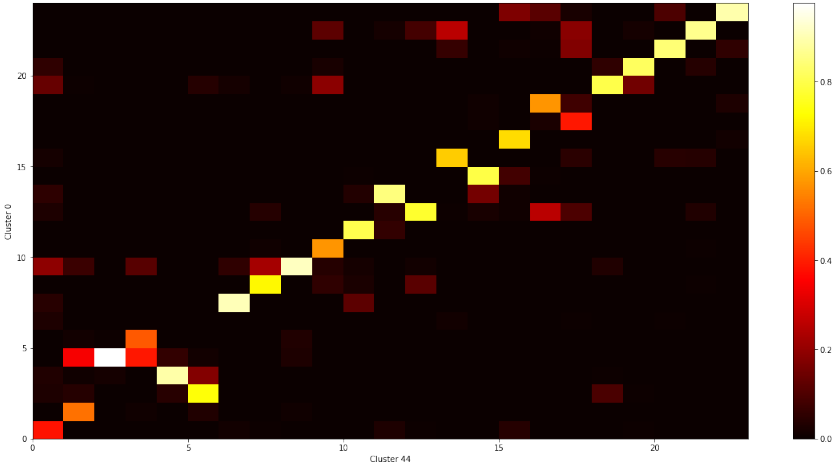


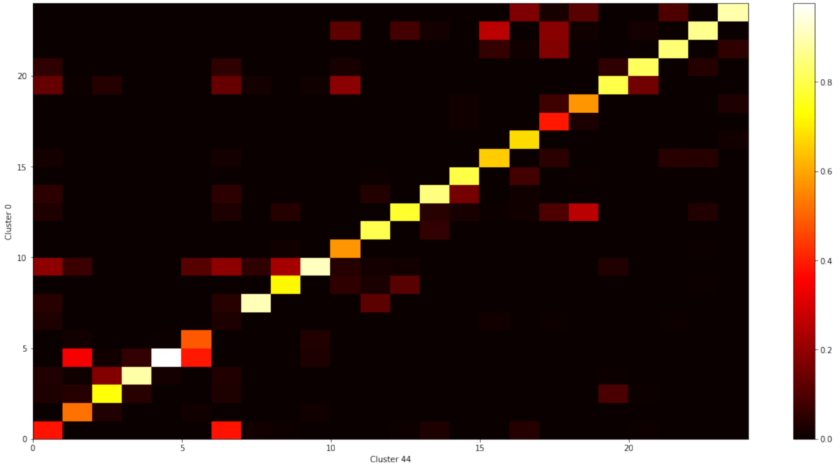
Combined Data Clusters (1,0): 1993-2013



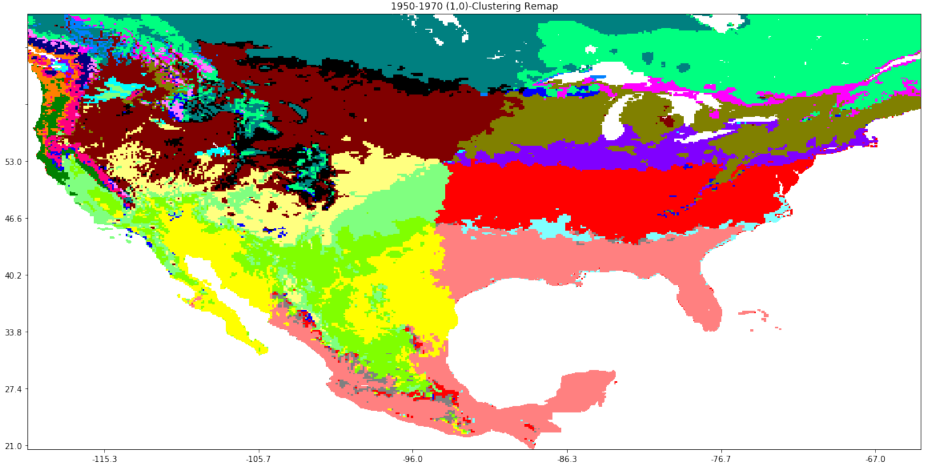
Correlation Between 1950-1970 Clusters and 1993-2013 Clusters



Sorted Correlation Between 1950-1970 Clusters and 1993-2013 Clusters



Reindex Combined Data Clusters (1,0): 1950-1970



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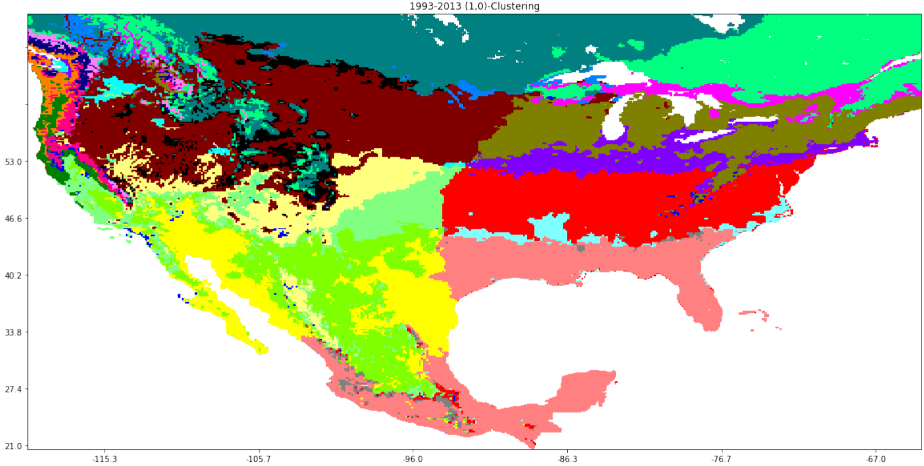
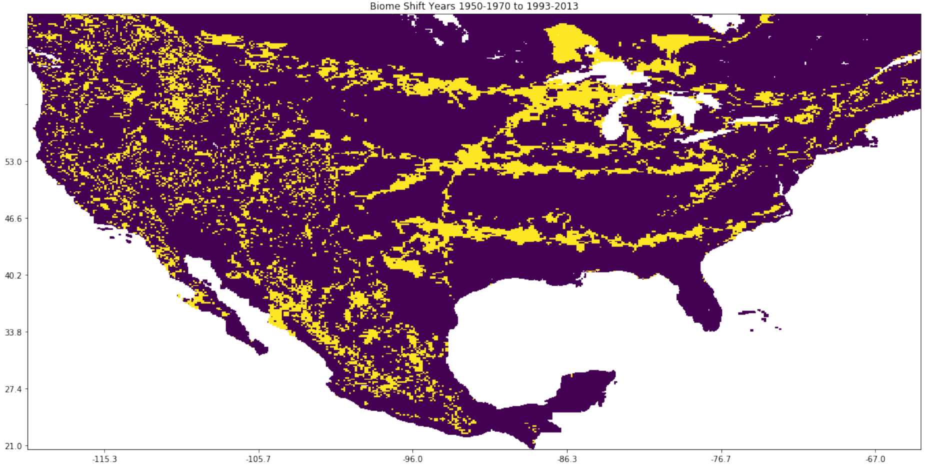


Difference Between 1950-1970 Clusters and 1993-2013 Clusters



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4. Apply this clustering method to the ocean data