

Cluster Analysis

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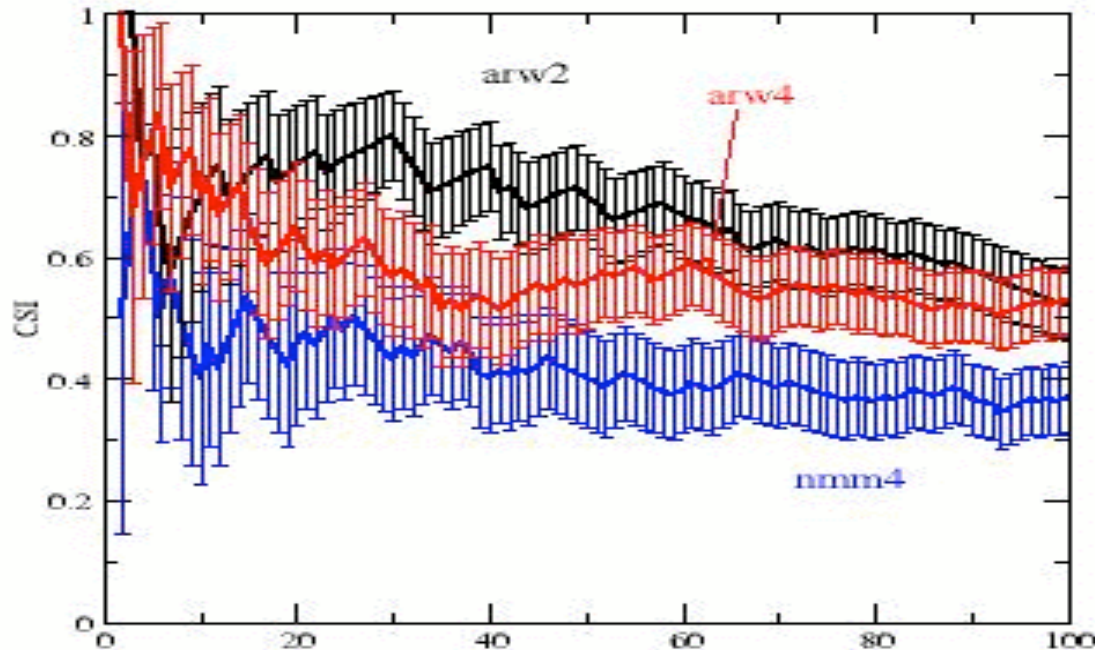
- **Marzban, C., S. Sandgathe 2006: Cluster analysis for verification of precipitation fields.** Wea. Forecasting, Vol. 21, No. 5, 824-838. 29.
- **Marzban, C., S. Sandgathe 2006: Cluster Analysis for Object-Oriented Verification of Fields: A Variation.** Submitted to Monthly Weather Review.
- Everitt, B. S. 1980. Cluster Analysis. Second Edition, Heinemann Educational Books. London.
- Uses gridded data. Developed for “object” verification, i.e., a discontinuous field such as precipitation or reflectivity. Can be used on other fields with thresholding. Allows verification of multiple parameters, i.e., n-dimensions (space, time, intensity etc.)
- Output is scale-dependent CSI curve.

CA-based Methodology

For a given forecast and observed field:

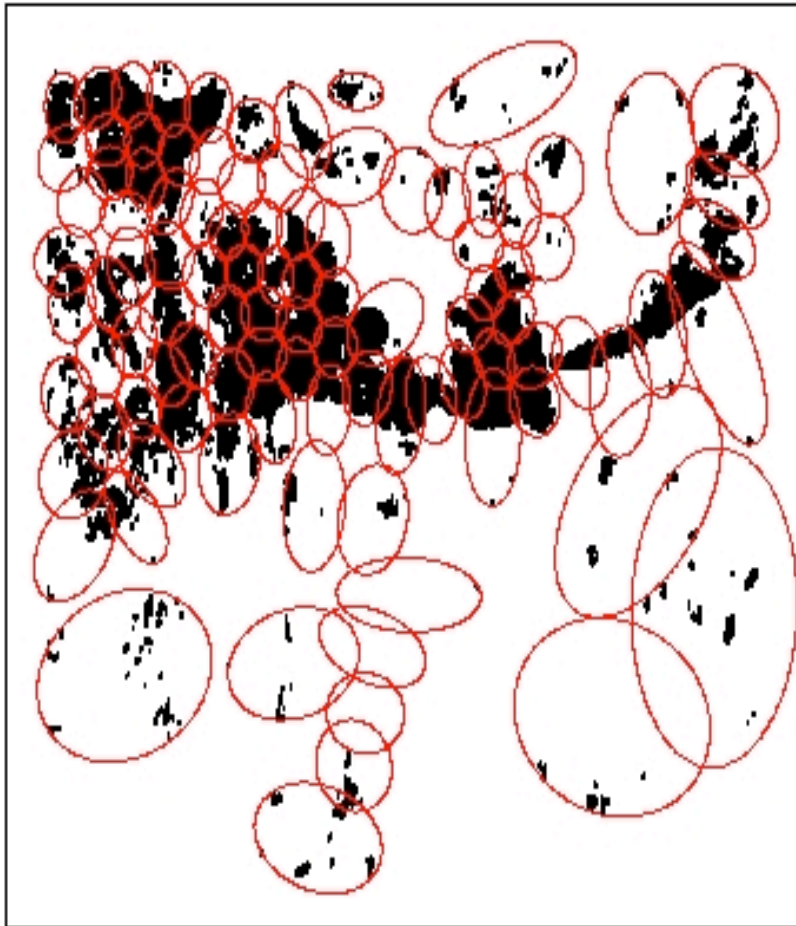
- The observation and the forecast field is combined into a single field.
- Initially, there are as many clusters in the field as the number of non-zero pixels.
- K-mean clustering (with $k=100$) is employed to identify 100 clusters.
- Agglomerative hierarchical clustering is employed to iteratively combine the clusters until only one cluster remains (containing the entire field).
- At each iteration, a given cluster is declared as “hit” if the proportion of observed pixels is between 20% and 80%. Otherwise, it's a miss ($>80\%$ obs) or a false alarm ($<20\%$ obs).
- At each iteration, the Critical Success Index (CSI) is computed.
- A simple methodology is used to compute the confidence intervals for the data.

An example:

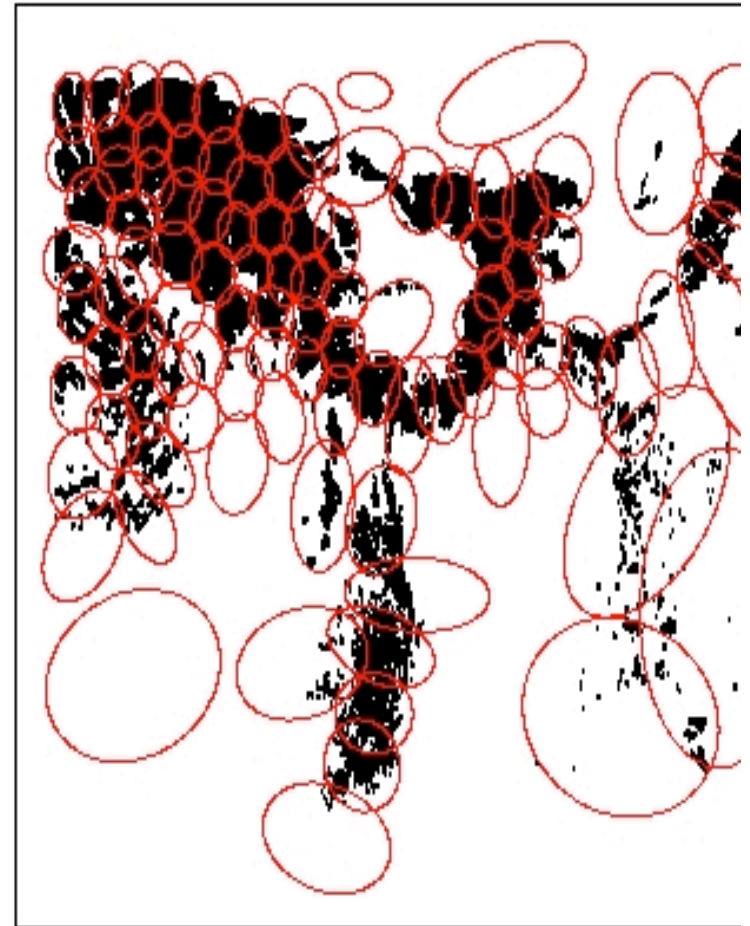


An Example of k-means clustering with $k=100$, performed on the combined set of forecasts and observations.

Obs 5/12, with kmeans ellipses



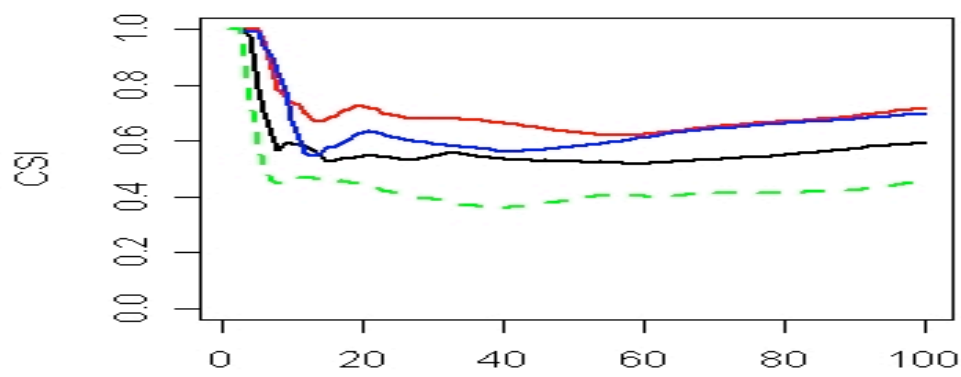
ARW2 5/11 with kmeans ellipses



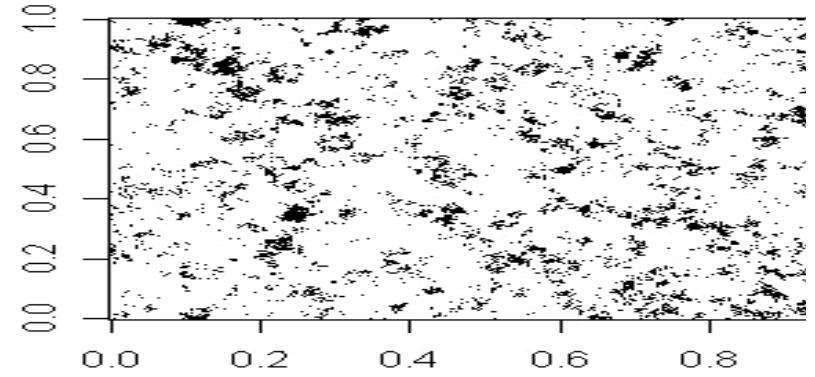
Cluster Analysis

- Strengths? (Too soon to be certain.)
 - Attempt to give comprehensive “single number” answer to goodness between models. Can consider location, timing, intensity for discontinuous field in a completely automated manner.
 - Contains scale-dependency information.
 - Appears to work based on few cases!
- Weaknesses?
 - Only run on 30 complex cases. Need to do idealized cases, more comprehensive analysis to develop confidence and understanding of results.
 - “Single number” answer to a complex question.

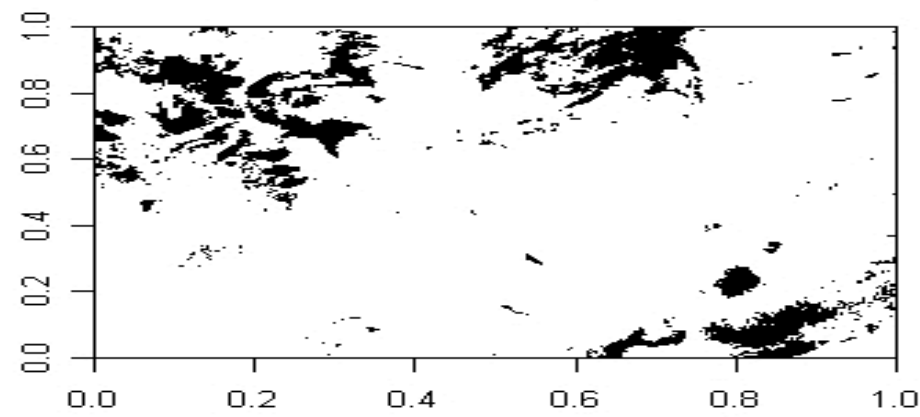
Obs 2005042000 -- Mean CSI



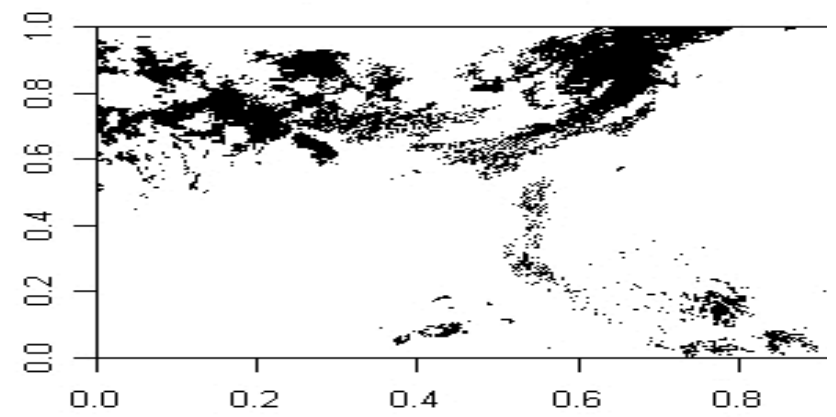
Random Field 2005042000



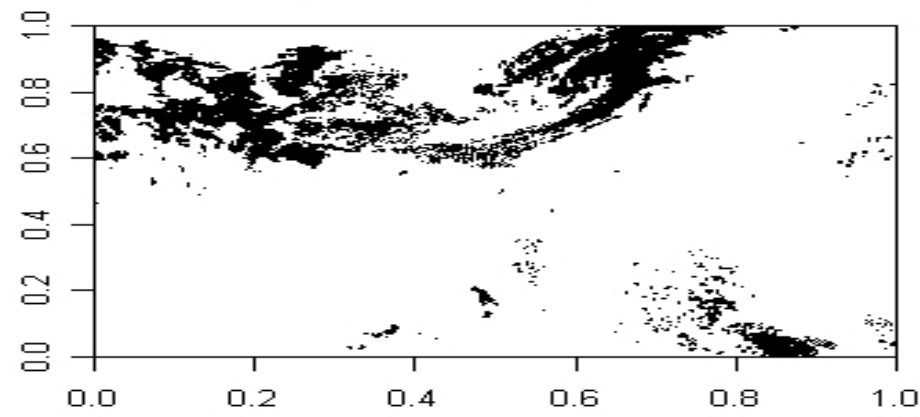
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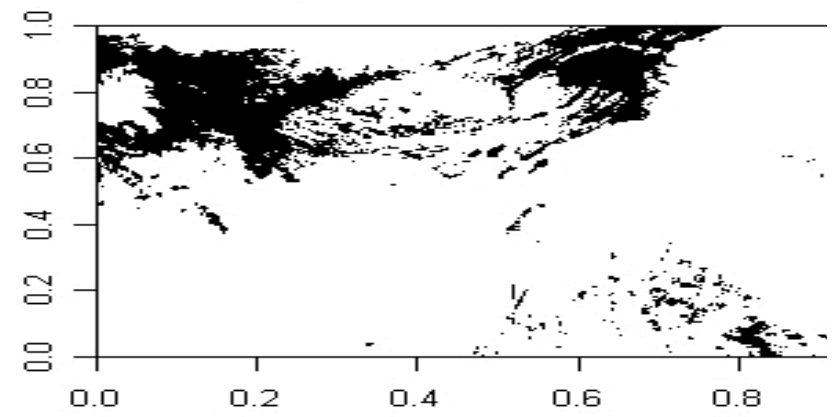
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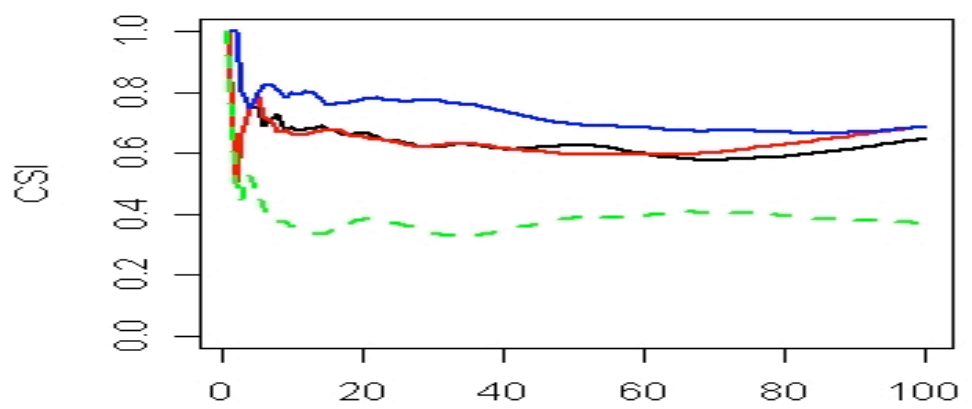
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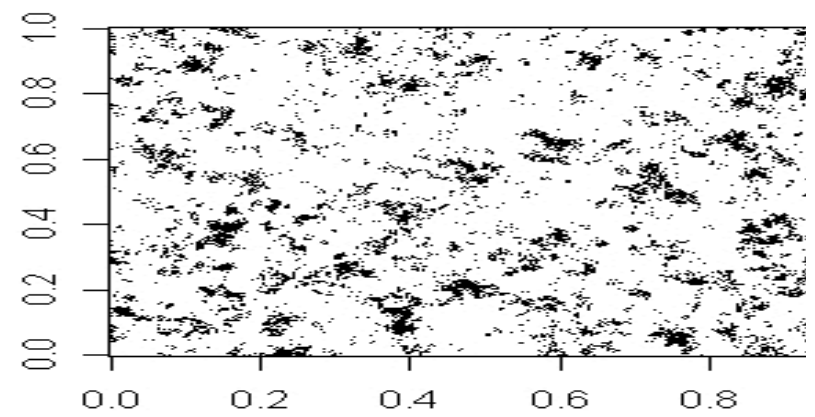
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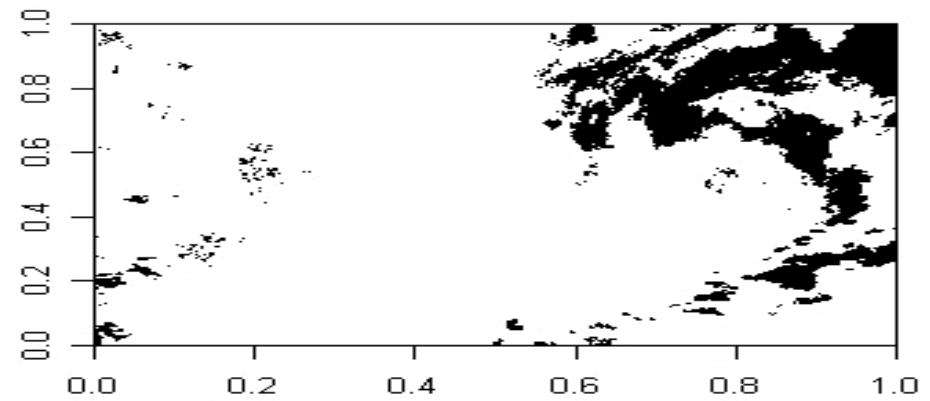
Obs 2005042300 -- Mean CSI



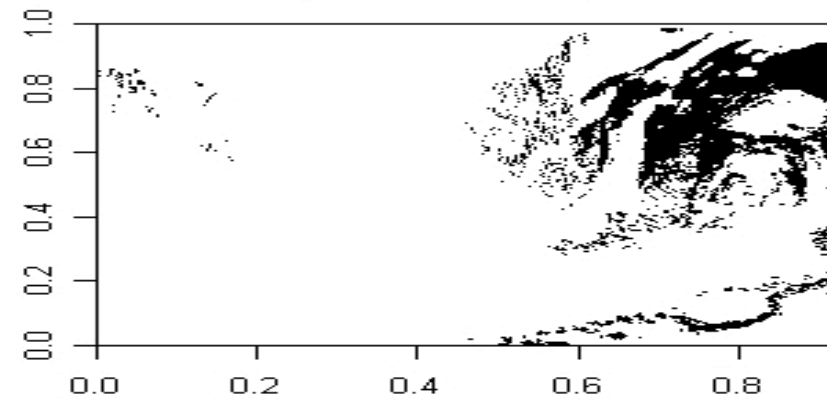
Random Field 2005042300



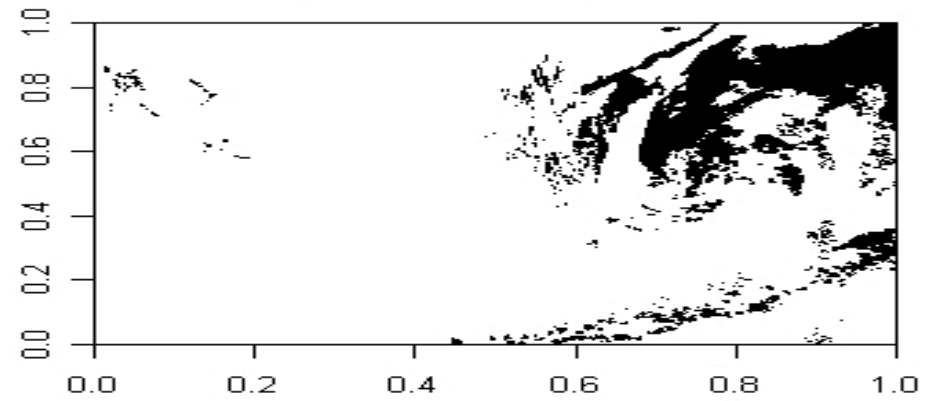
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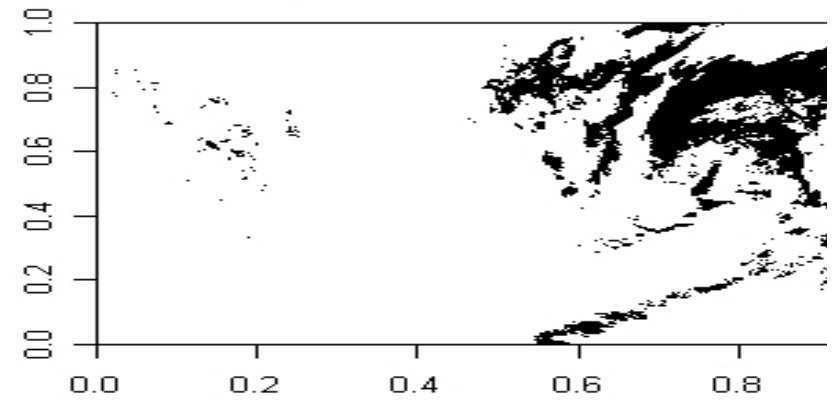
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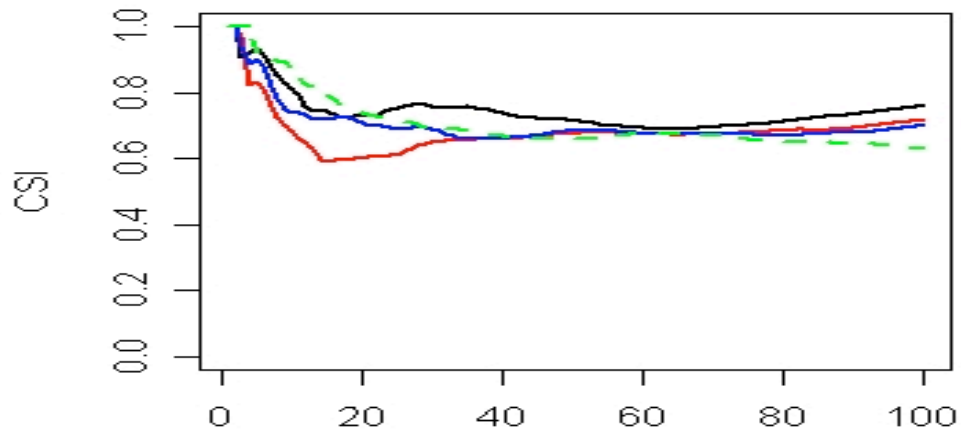
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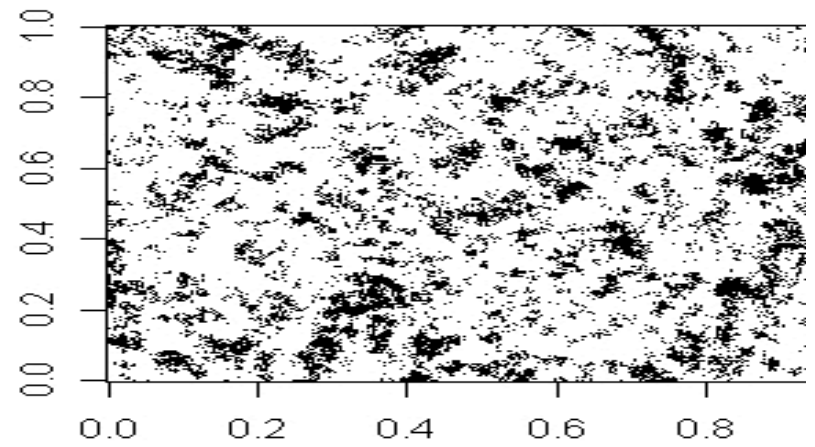
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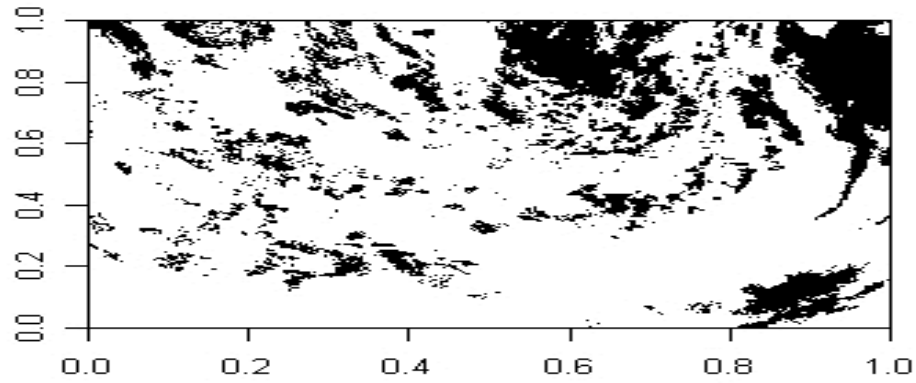
Obs 2005042700 -- Mean CSI



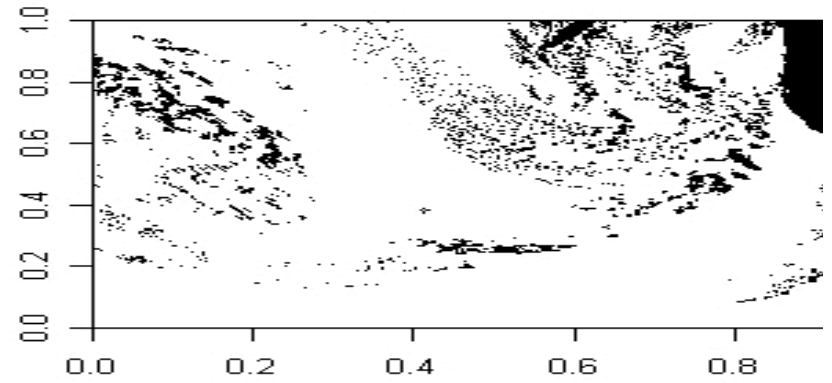
Random Field 2005042700



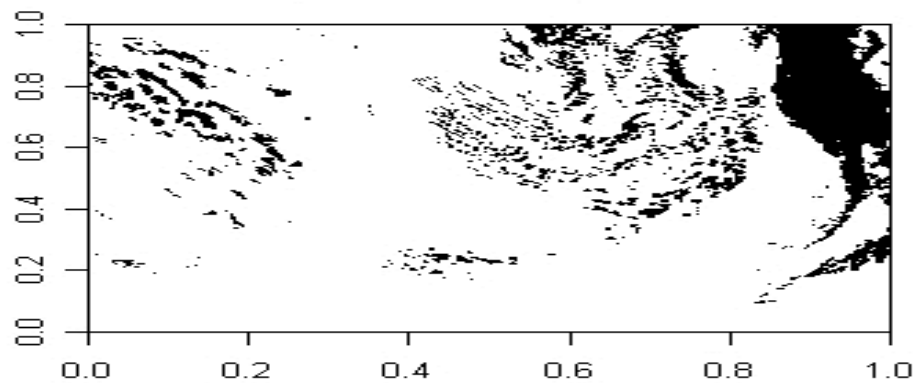
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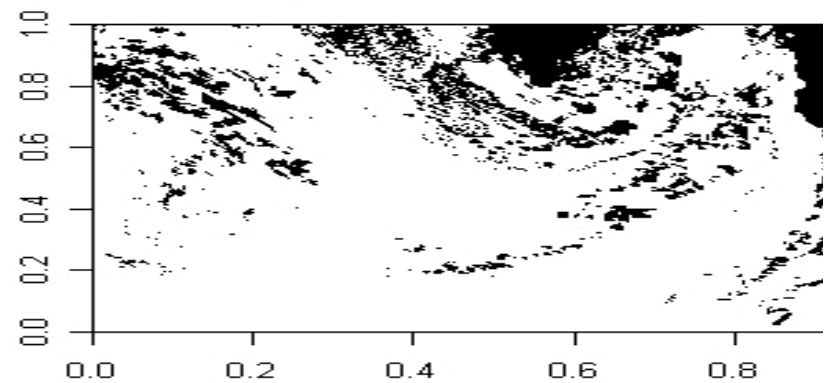
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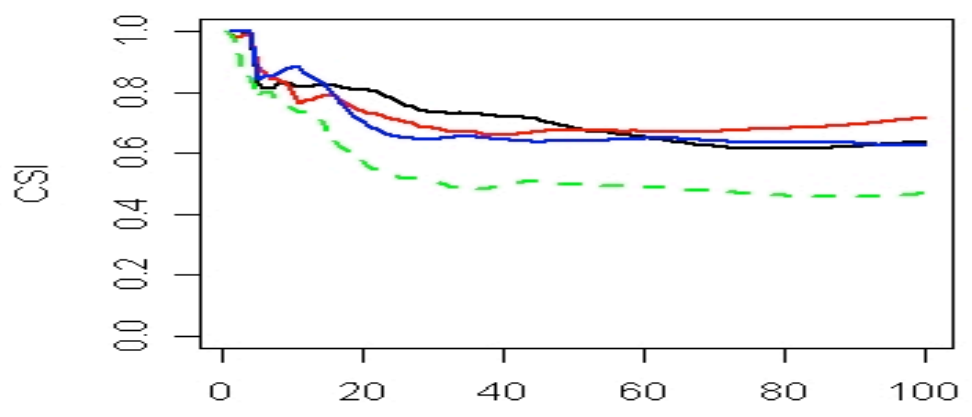
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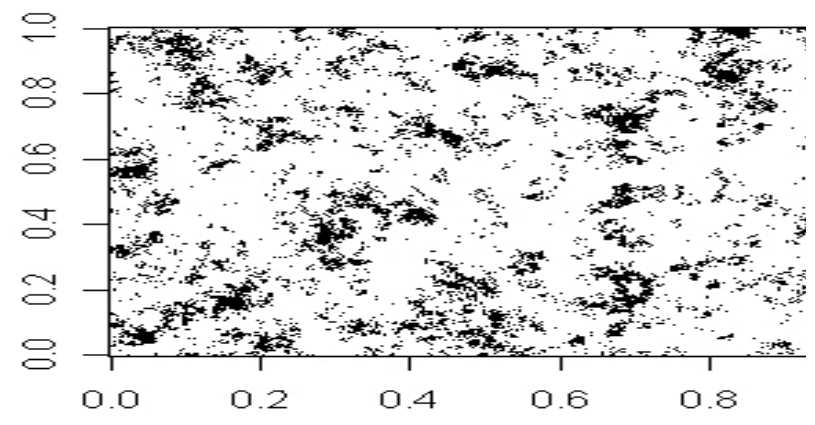
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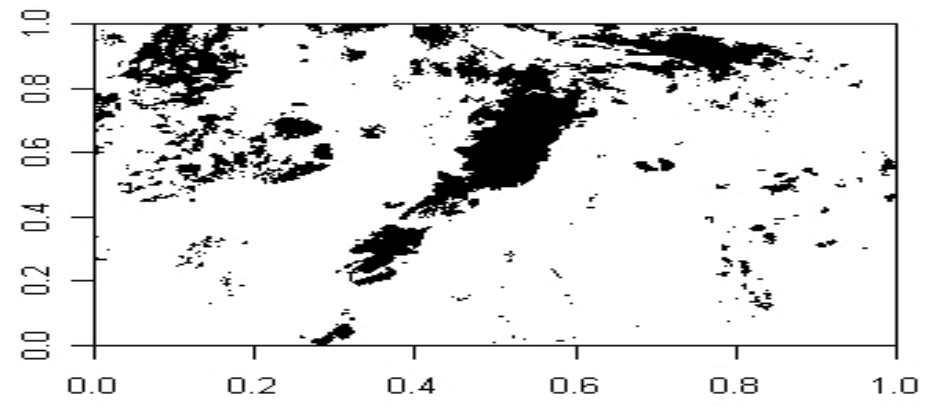
Obs 2005051300 -- Mean CSI



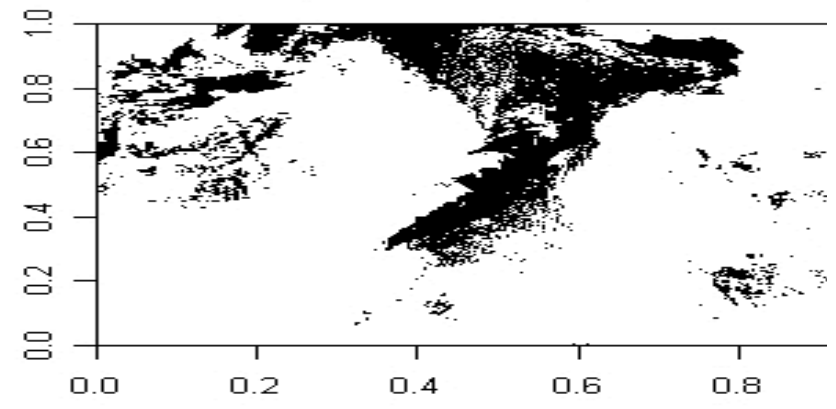
Random Field 2005051300



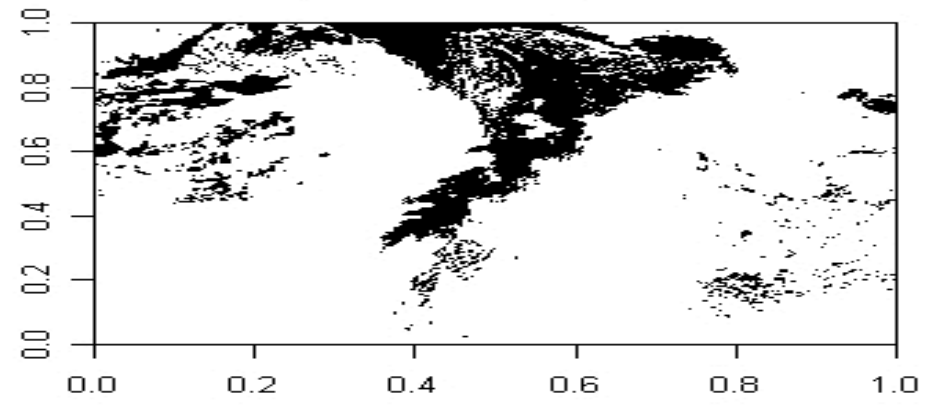
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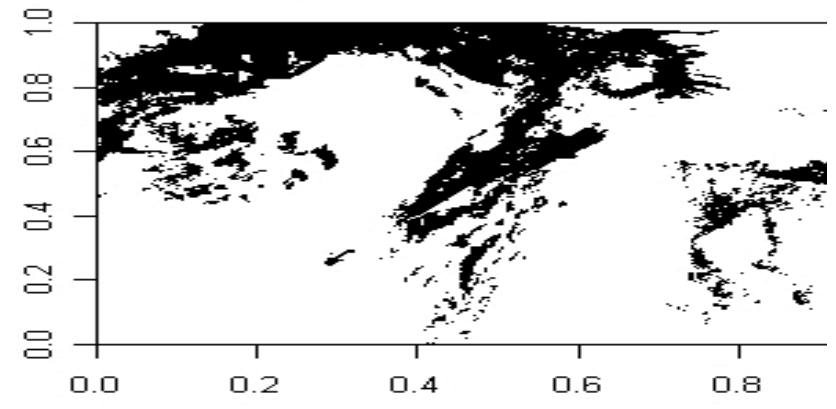
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arw4_2005051200.g240.f24.txt

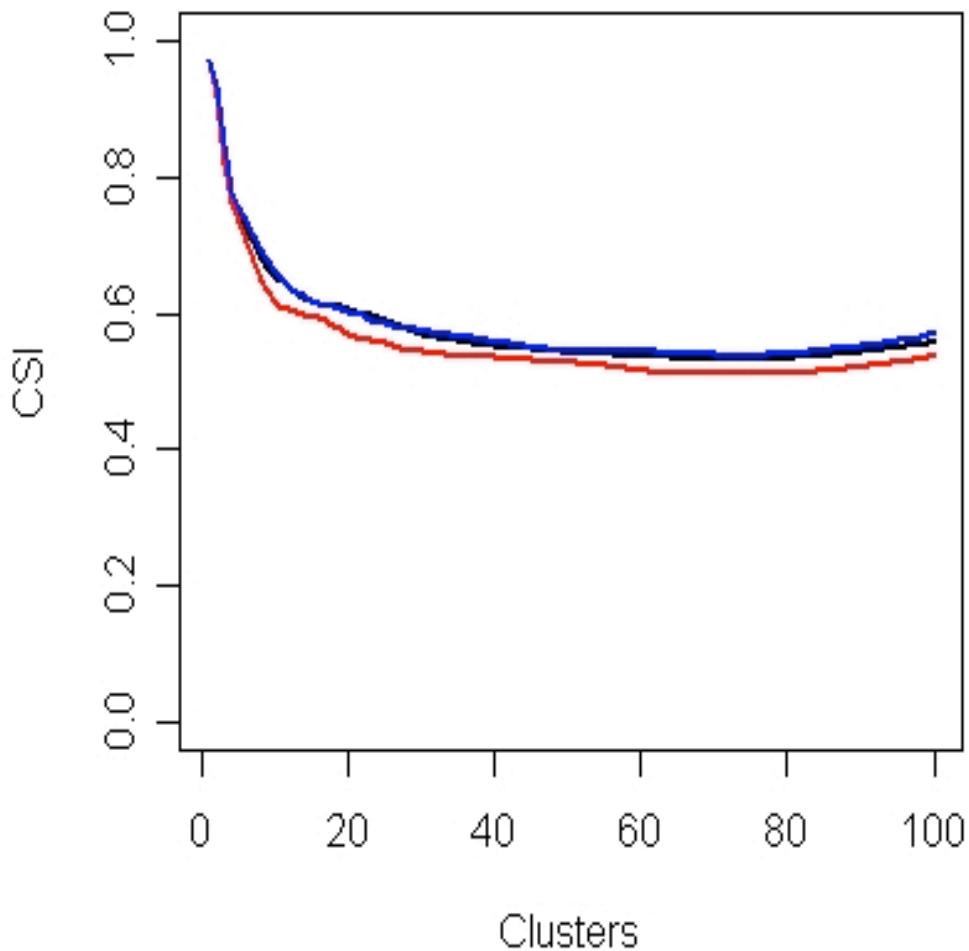


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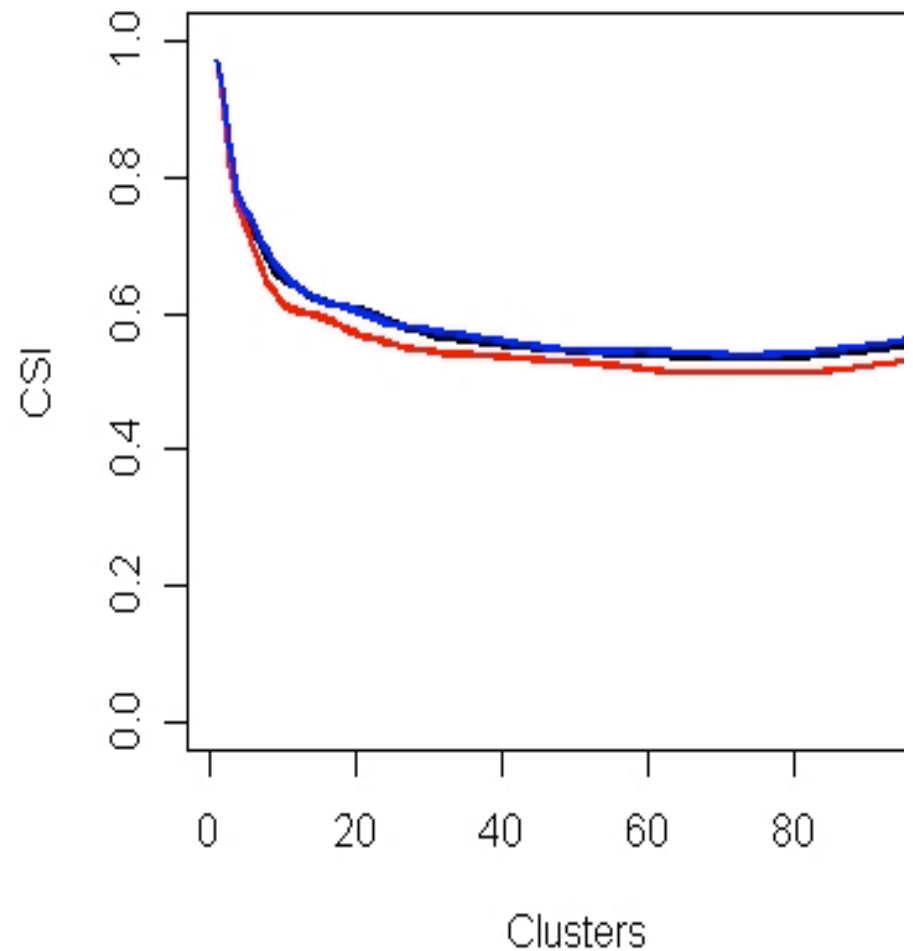


Mean CSI Scores

Mean CSI by forecast



CSI 95% CI by forecast



Human vs Machine Comparison

30 forecasts from Spring, 2005 mesoscale experiment verified

- Human manual verification: Good, So-So, Bad
- Automated Cluster Analysis CSI values are classified into categories: <0.55 , $0.55-0.75$, >0.75

	Good	So-So	Bad
CSI>0.5	3	2	0
0.5<CSI<0.75	2	10	5
CSI>0.75	0	1	7

(Also tested with 120 “cases” by splitting fields into quadrants.)