A Bayesian Approach to Regime Assignment

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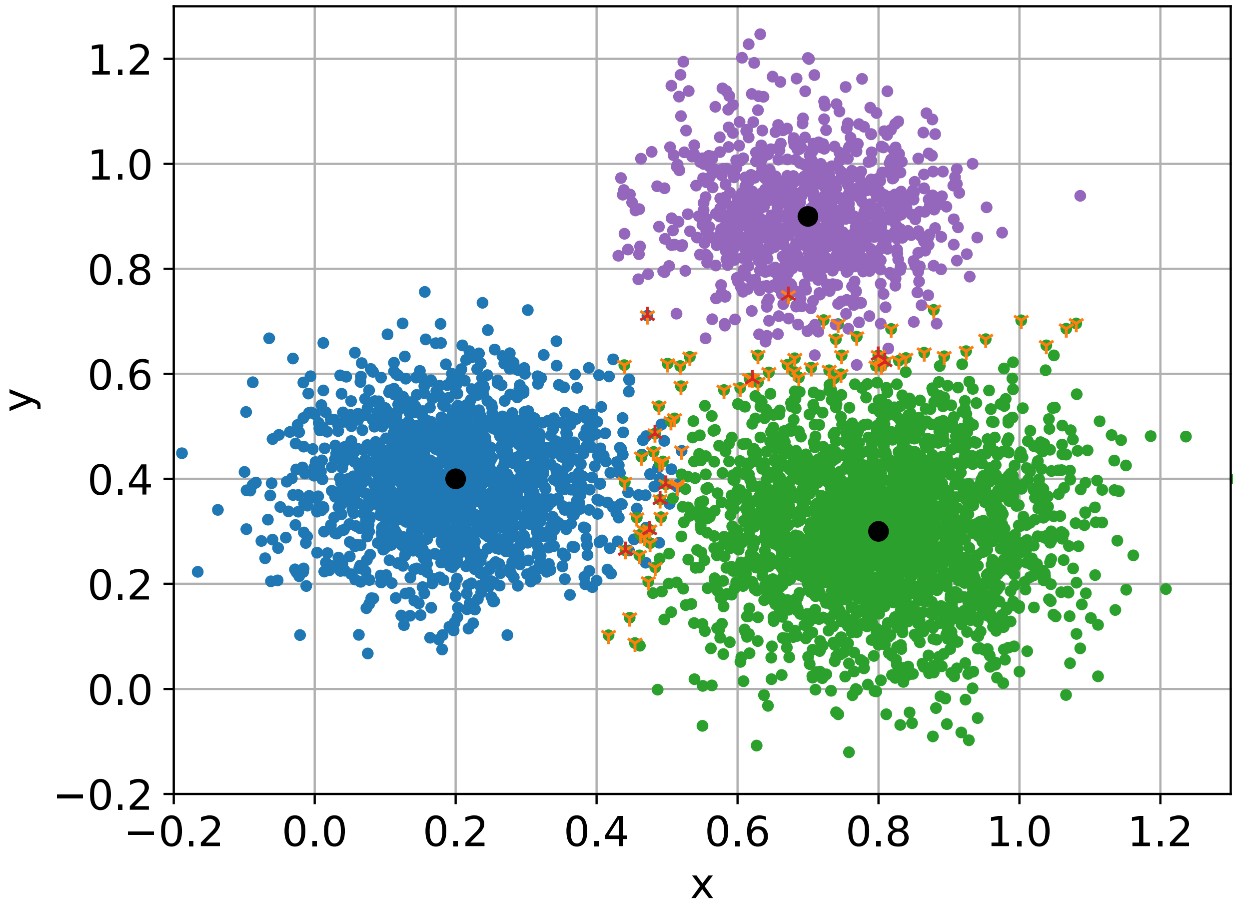
Regimes, or clusters, are subsets of data which are similar within a regime, but different between regimes.

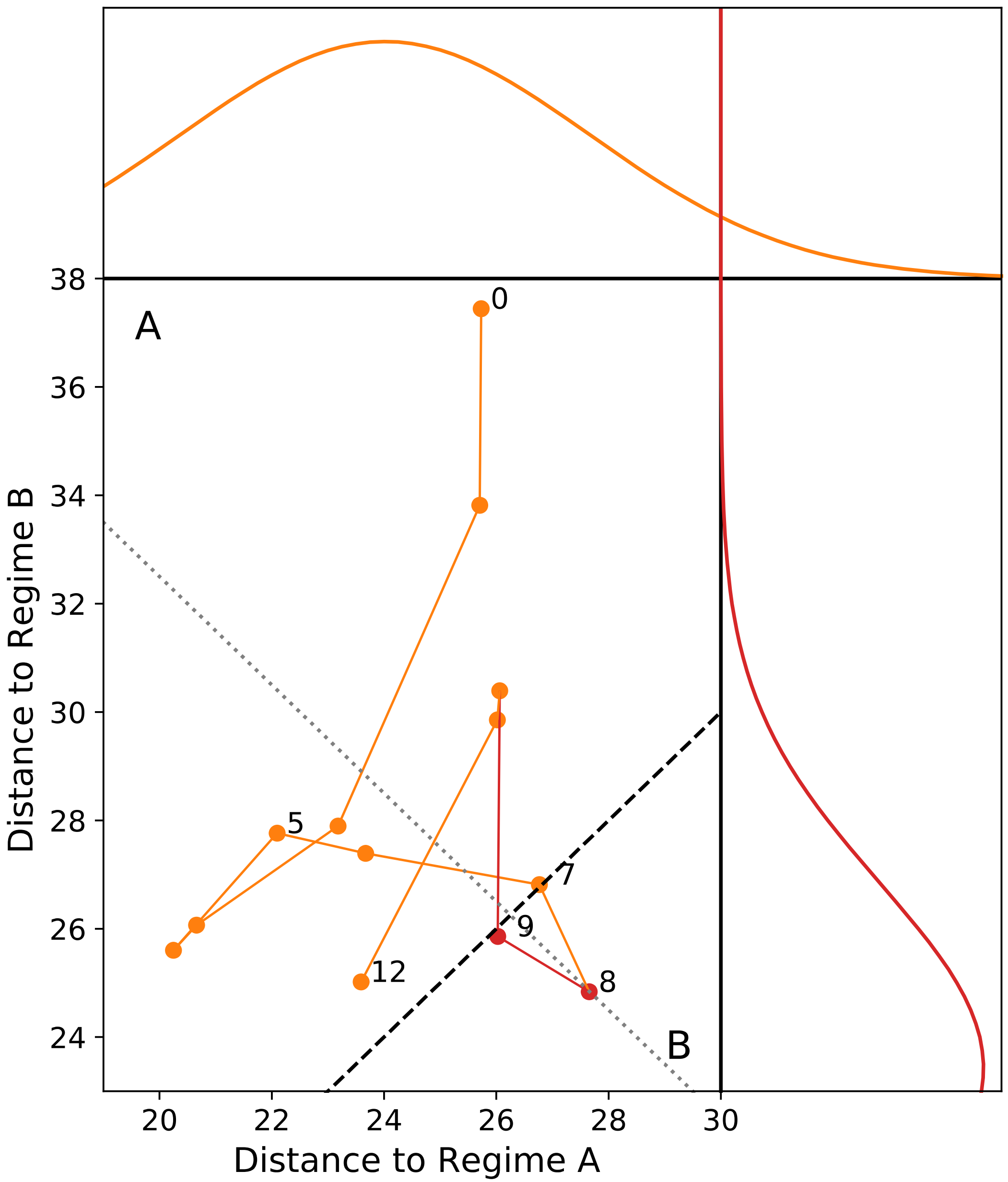
K-means clustering:
Split the data in k clusters or regimes

Drawbacks:

- Every data point has to be assigned to a regime
- Sensitive to small perturbations



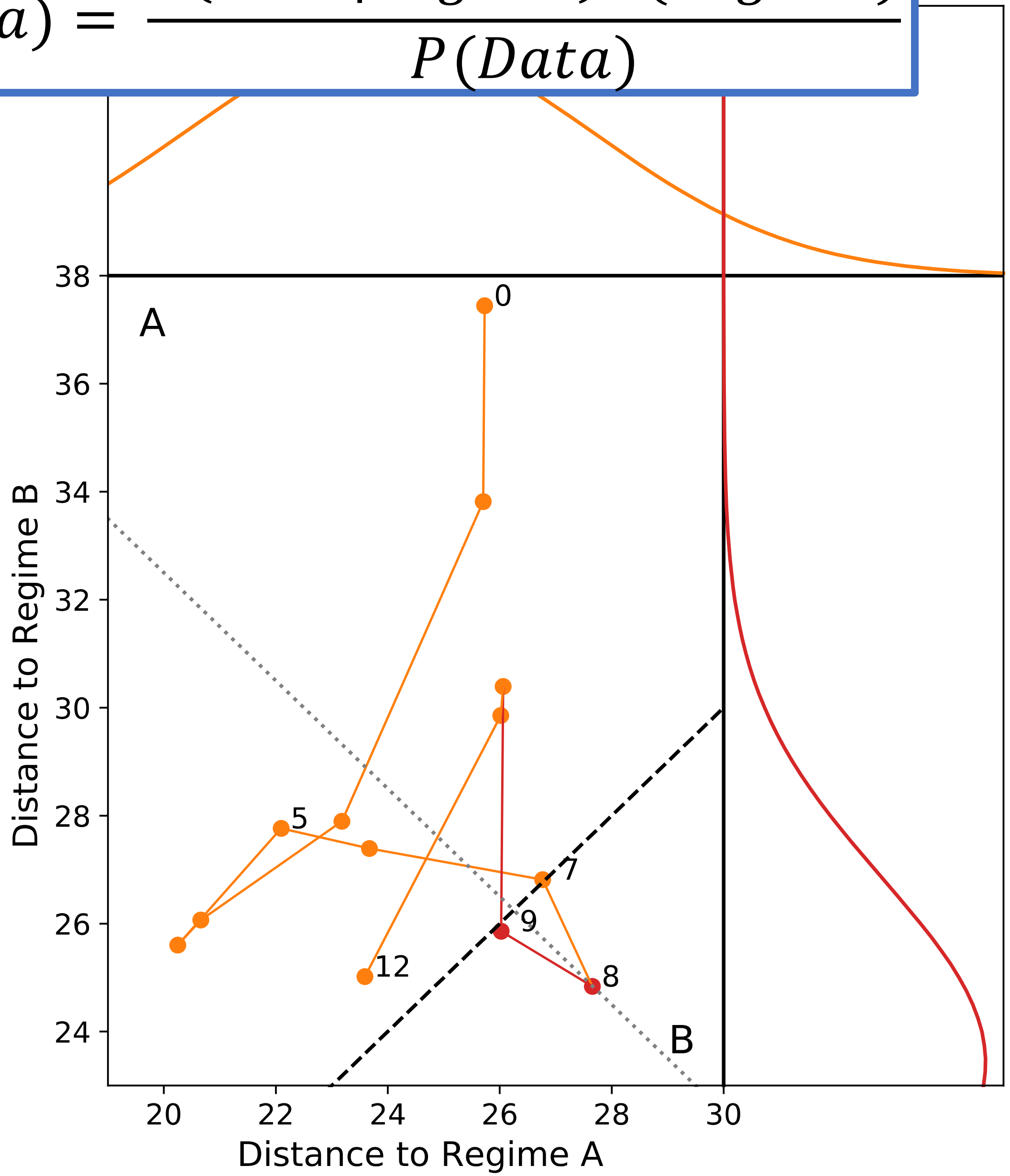
Noise can affect the distance to the regimes and this way alter the regime assignment.

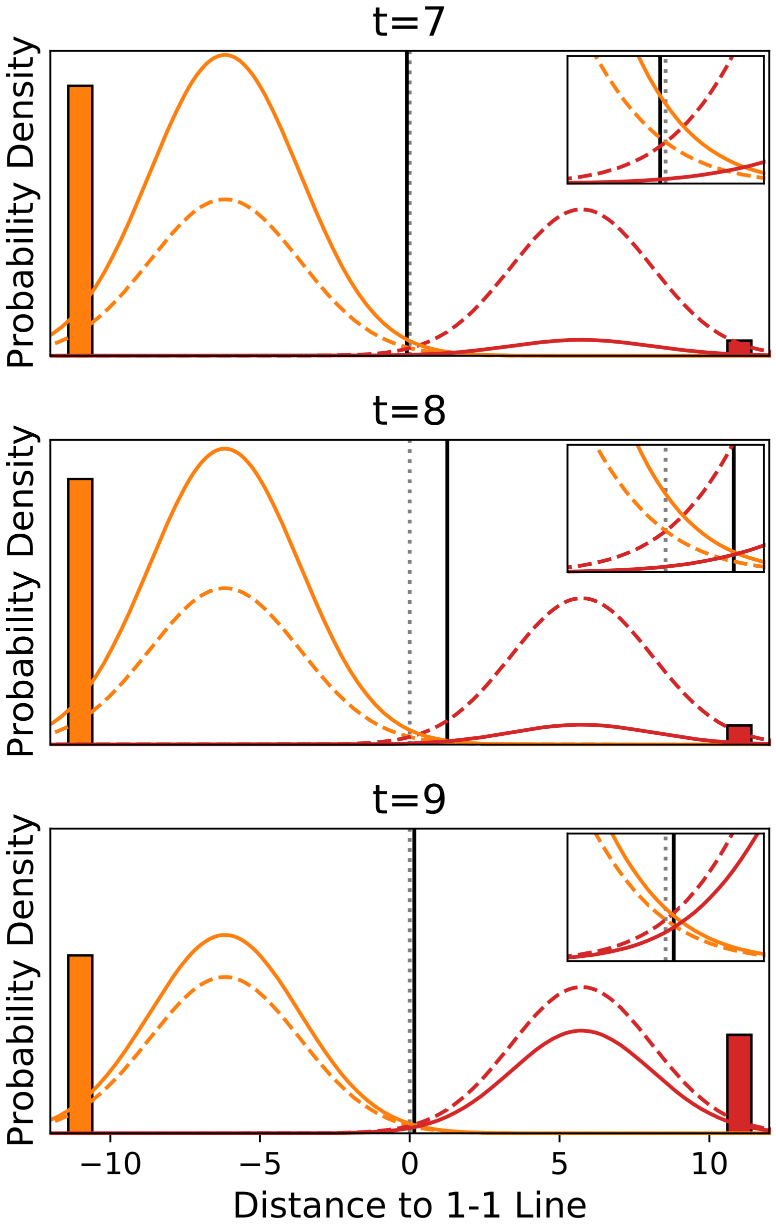


Probabilistic regime assignment

$$P(Regime|Data) = \frac{P(Data|Regime)P(Regime)}{P(Data)}$$

We use Bayes Theorem to obtain a probabilistic regime assignment.





Apply this approach to atmospheric circulation regimes.

Recurrent and persistent patterns

Low-frequency variability

Wintertime Euro-Atlantic sector

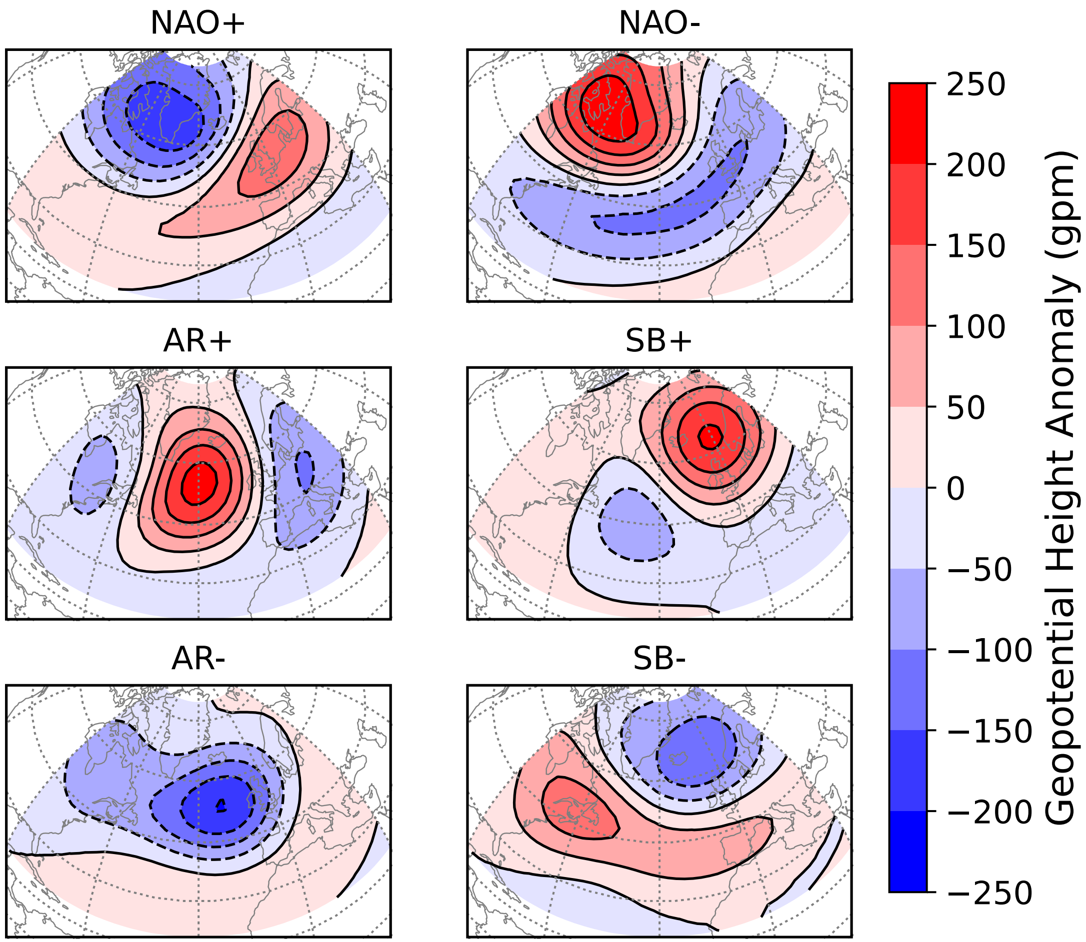
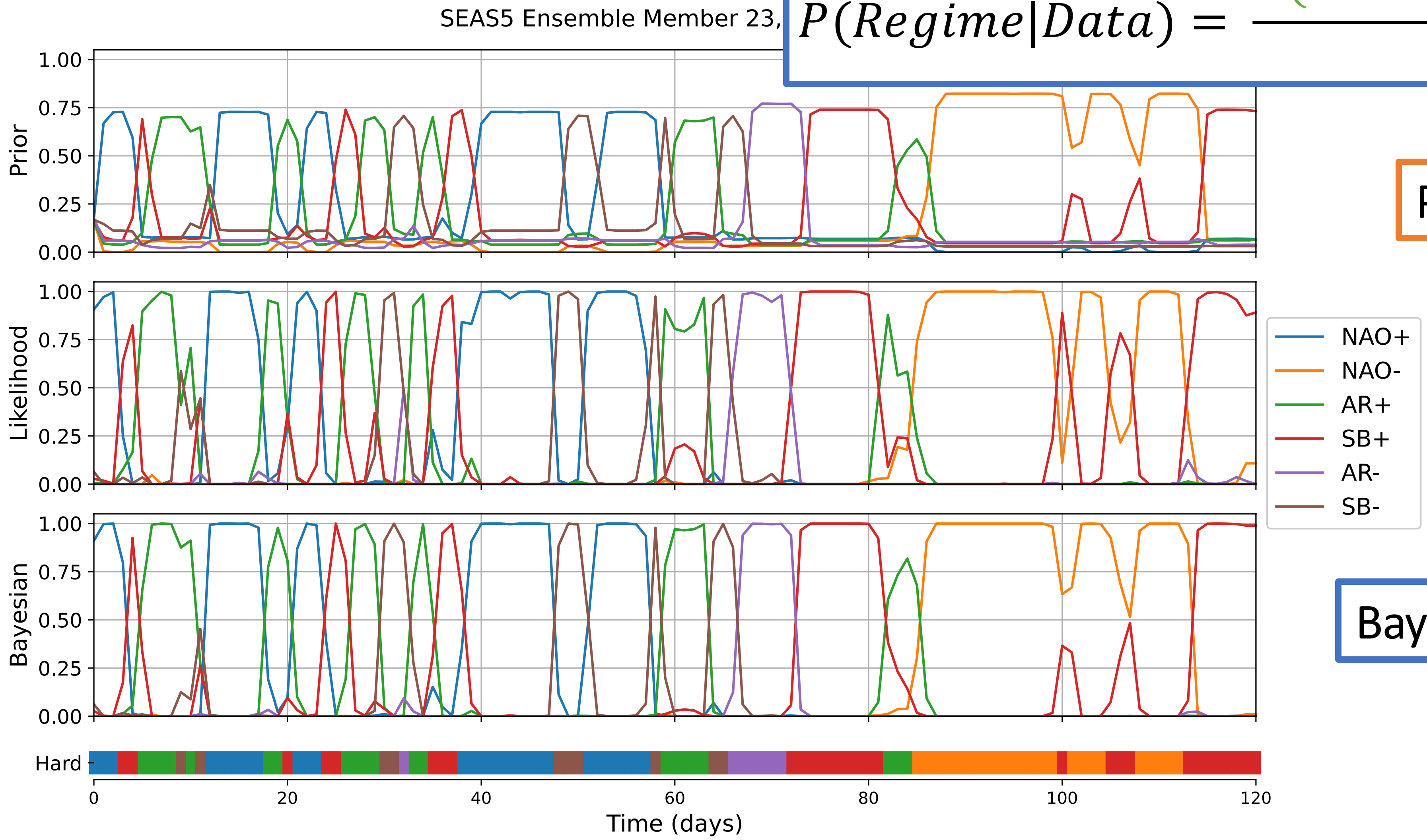


Fig. Six circulation regimes for the Euro-Atlantic sector (North Atlantic Oscillation (NAO) + and -, Atlantic Ridge (AR) + and -, Scandinavian Blocking + and -

How does the sequential Bayesian regime assignment work?

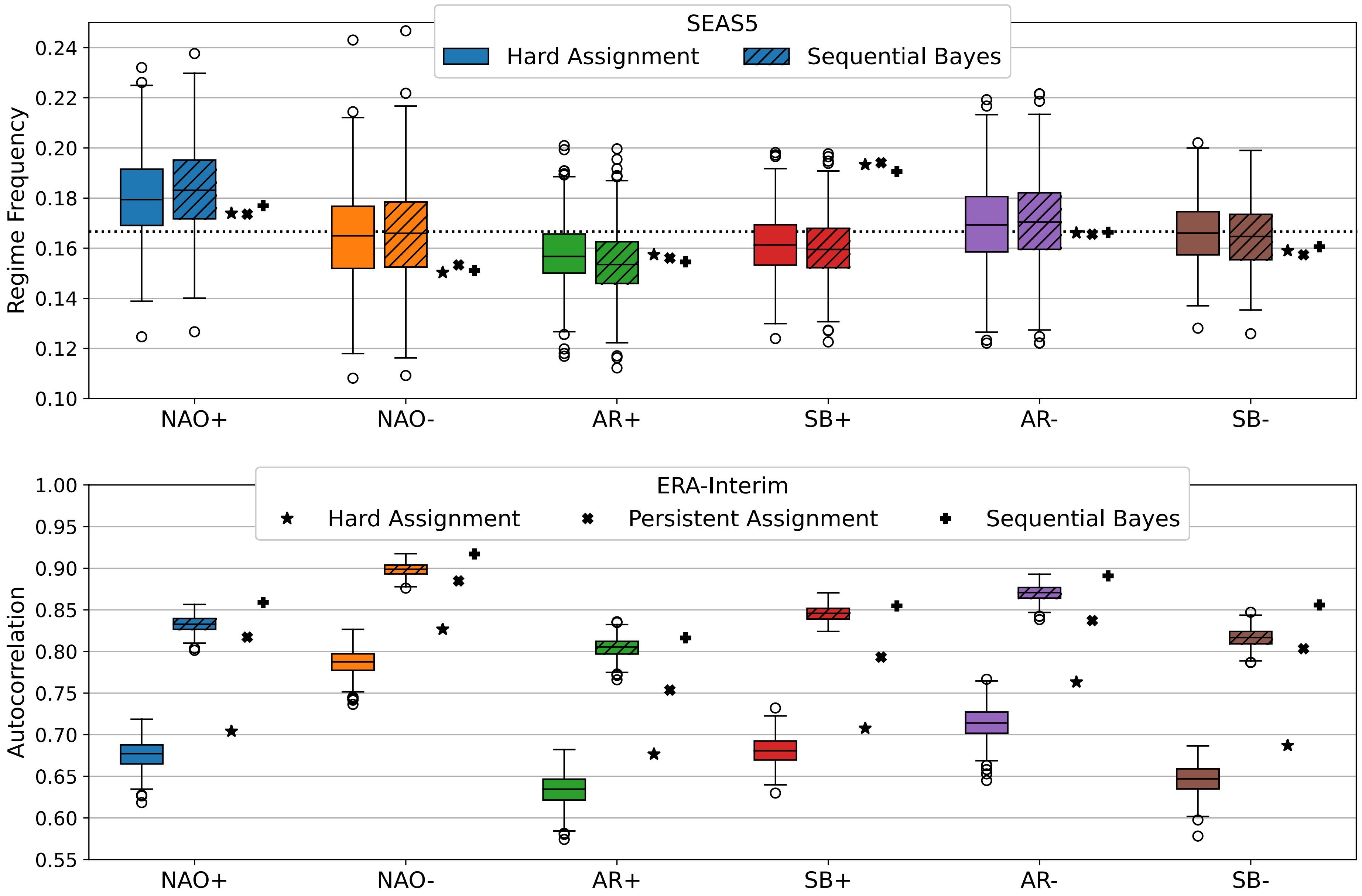
$$P(Regime|Data) = \frac{P(Data|Regime)P(Regime)}{P(Data)}$$



Prior: $P_{t+1} = TP_t$

Observed Likelihood

Bayesian probabilities



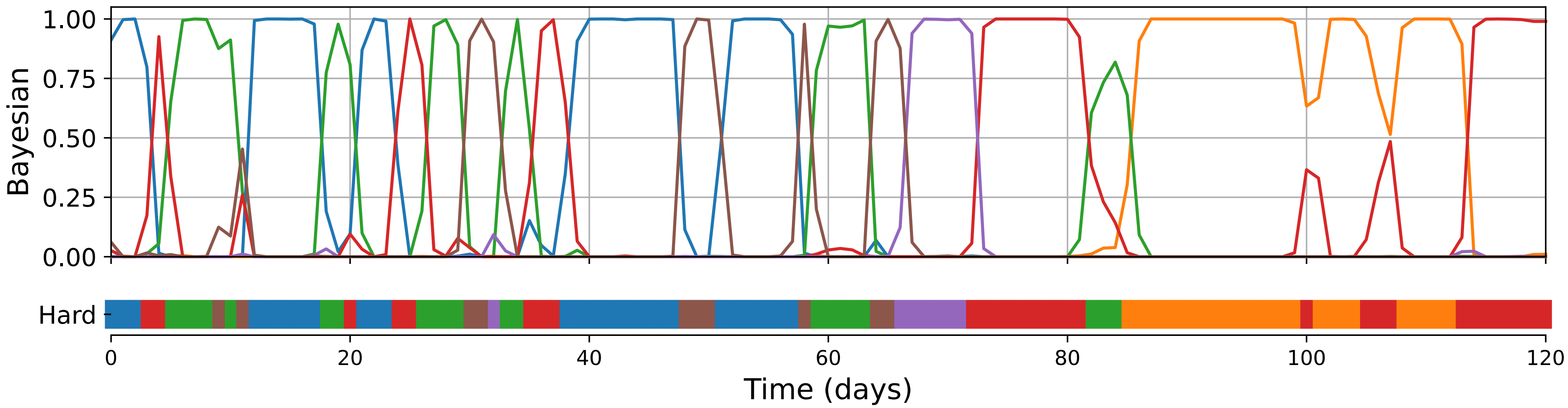
The sequential Bayesian approach yields more persistent regimes without affecting the regime frequencies.

The sequential Bayesian approach yields a more informative regime assignment compared to standard categorical methods.

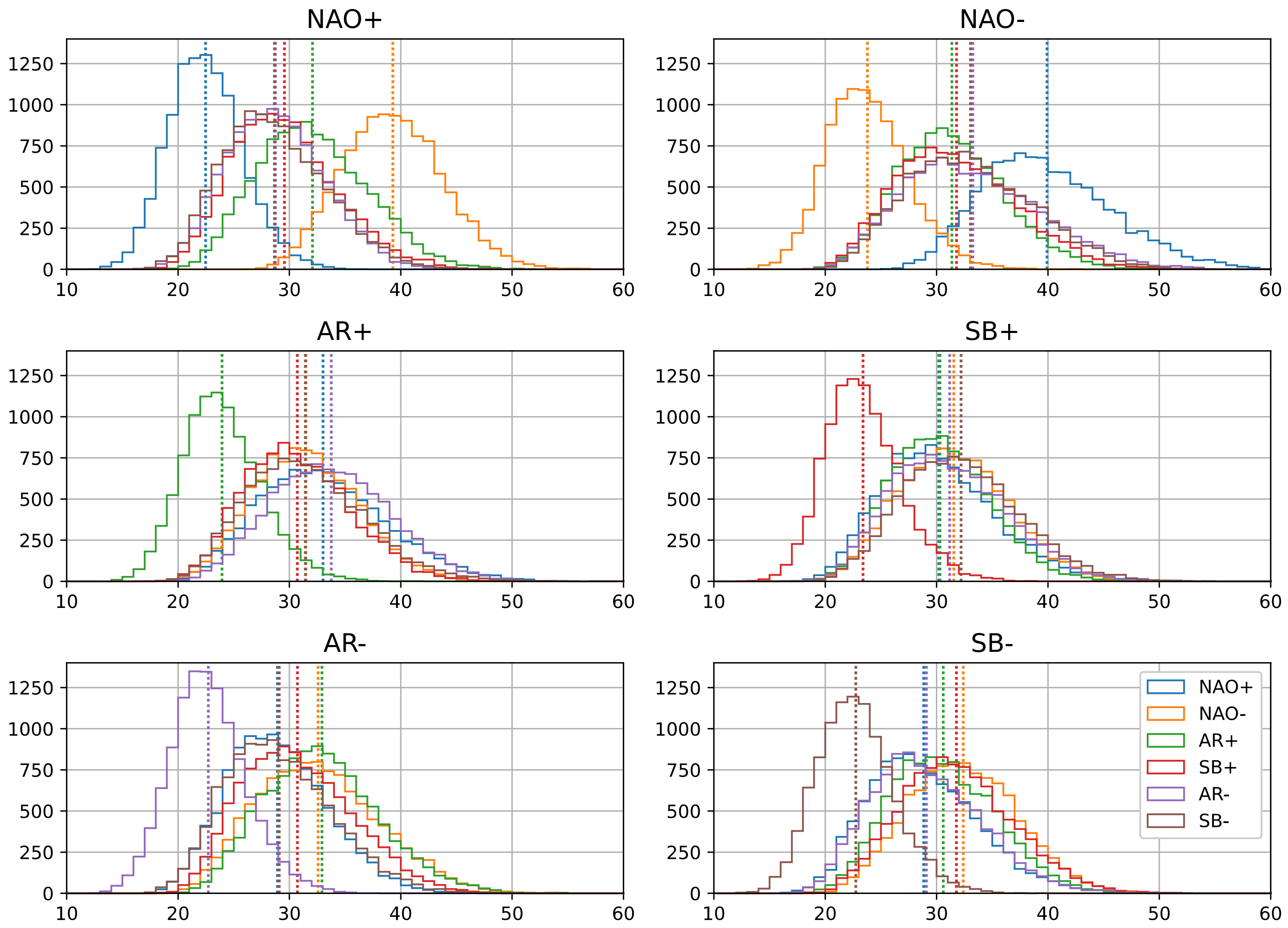
QUESTIONS?

Bayes Theorem:

$$P(Regime|Data) = \frac{P(Data|Regime)P(Regime)}{P(Data)}$$



A Bayesian approach treats the regime assignment in a probabilistic way



$\boxed{\text{Posterior}}$

Bayes Theorem:

$$\boxed{P(r|D)} = \frac{\boxed{P(D|r)}\boxed{P(r)}}{\boxed{P(D)}}$$

Prior: $P_t(r) = TP_{t-1}(r|D)$

Data: $P(D) = \sum_{r=1}^{k} P(D|r)P(r)$

Observations: $P(D|r) = \frac{-\frac{1}{2}(D-\mu_r)^T \Sigma_r^{-1}(D-\mu_r)}{\sqrt{(2\pi)^k |\Sigma_r|}}$