Blocking: Variability and Prediction

- What modulates the blocking occurrence?
- How well do models represent and predict blocking?

Variability of Blocking: the North Pacific-Bering Strait Regions

ENSO

TABLE 1. Means and standard deviations of the listed quantities, stratified in accordance with the phase of the ENSO cycle, for the DJF winter season. "Alaskan index" denotes the index or strength of the Alaskan pattern (Fig. 1). Student's t values are all significant at the 95% level, for a two-tailed test. Frequencies in the right-hand column pertain to the Monte Carlo significance testing procedure.

Variable	Warm	Cool	t value	Monte Carlo frequency (%)
PNA index	0.34 ± 0.44	-0.14 ± 0.39	+3.5	<1
Alaskan index	-0.31 ± 0.28	0.12 ± 0.38	−3.6	<1
Block days	13 ± 8.2	22 ± 12	−2.5	2

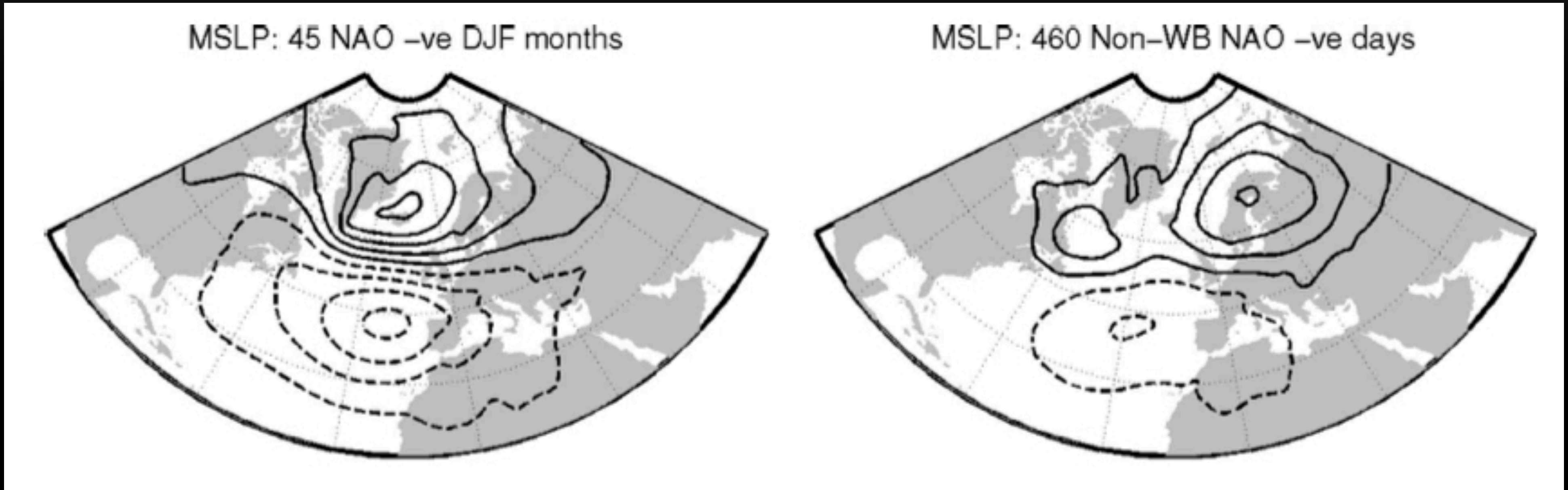
Pacific-North American Pattern (PNA)

TABLE 2. As in Table 1 but stratified in accordance with the sign of the PNA index averaged over the DJF season.

Variable	PNA pos	PNA neg	t value	Monte Carlo frequency (%)
Alaskan index	-0.16 ± 0.40	0.13 ± 0.36	−2.5	3
Block days	15 ± 9.2	24 ± 11	−2.8	1

It was found that blocking occurs more frequently in the cool phase of ENSO and the negative phase of PNA.

Blocking and NAO



(left) MSLP anomalies in NAO- and (right) the same anomalies when all days featuring a high-latitude blocking episode the North Atlantic have been removed from these months

- After removing the blocking episodes, the NAO pattern becomes much weaker. *What does this imply?*
- Woollings et al. (2008) suggested that the negative NAO and high-latitude blocking over the Atlantic are simply two different descriptions of the same phenomenon. That's why NAO- is characterized by more frequent occurrence of blocking.

MJO and Blocking (boreal winter)

- Blocking frequency in the North Atlantic decreases significantly following phase 3 of the MJO, which is characterized by enhanced convection over the tropical East Indian Ocean and suppressed convection in the west Pacific.
- The phase 7 of MJO is followed by a significant increase in Atlantic blocking.

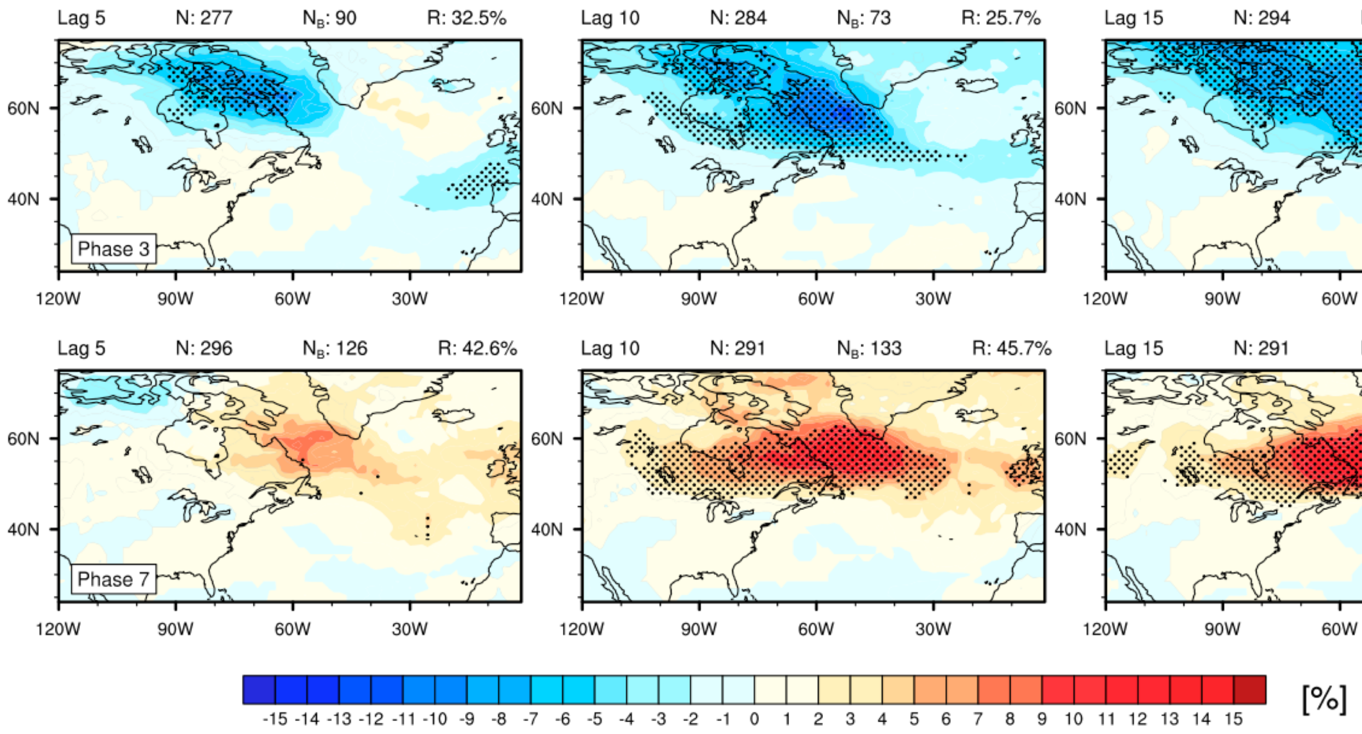


FIG. 7. Atlantic blocking frequency anomalies as determined by Eq. (1) for MJO phases (top) 3 and (bottom) 7. Shown are (left) lag 5, (middle) lag 10, and (right) lag 15, where a lag *n* represents the blocking frequency *n* days after the MJO phase. Blocking frequencies are shown as a deviation from the DJF mean. Black dotting demonstrates the anomalies found to be 95% significantly different from zero. For

Blocking Trends?

- Diagnostics of the observed blocking trends are limited by the short observational records, which make it challenging to separate a linear trend due to anthropogenic forcing and decadal/multi-decadal variability.
- *What do you learn from the figure on the right?*
- Barnes et al. (2014) showed that no clear hemispheric increase in blocking was found for the northern hemisphere over 1980-2012. Although trends were found for specific isolated regions and time periods, robustness of the trends was sensitive to blocking detection methods.
- Using CMIP5 models, Masato et al. (2013) showed that there is a decrease in European blocking and a poleward shift in Pacific blocking in winter and a general decrease in summer blocking, but the inter-model spread is large.

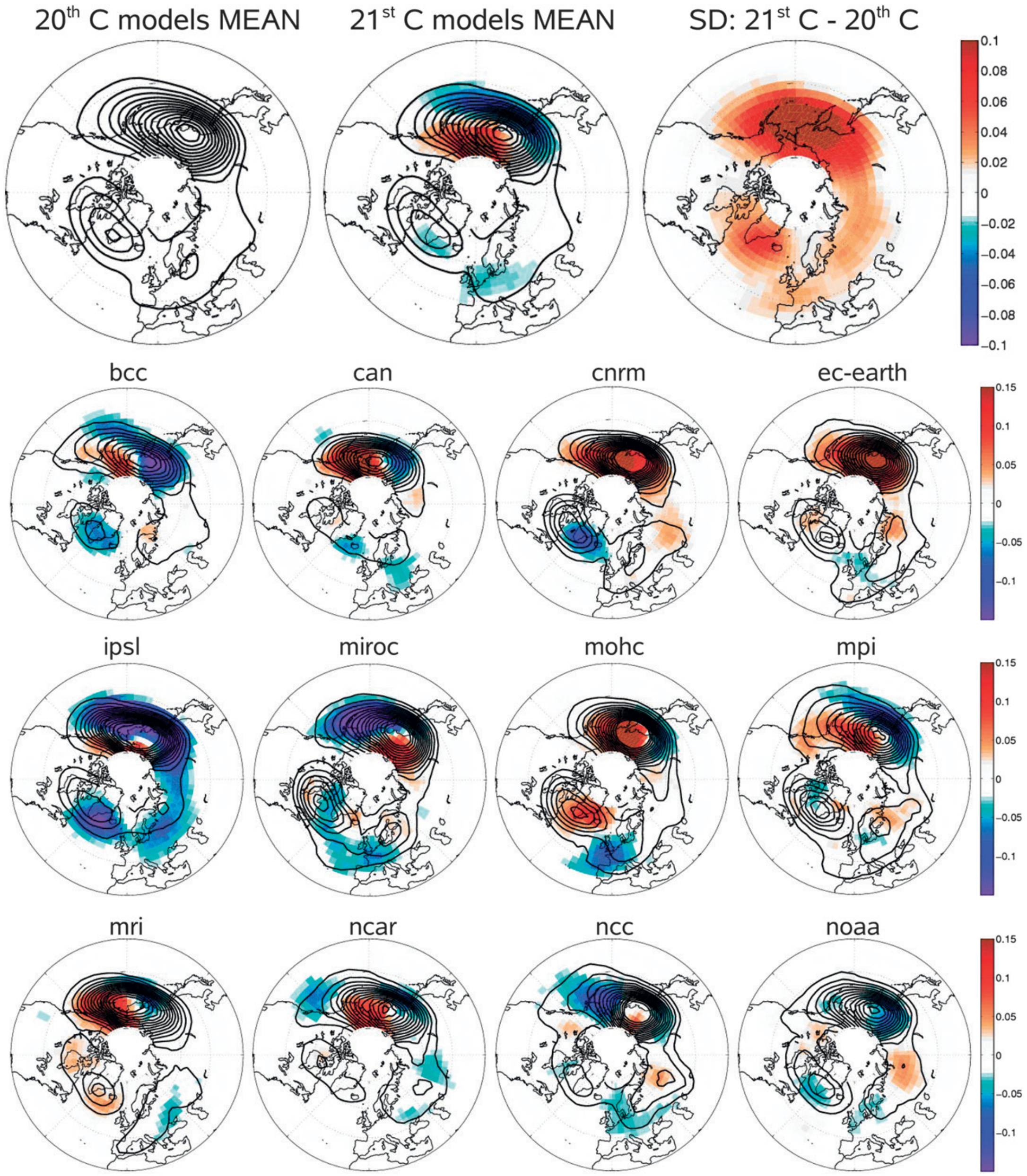
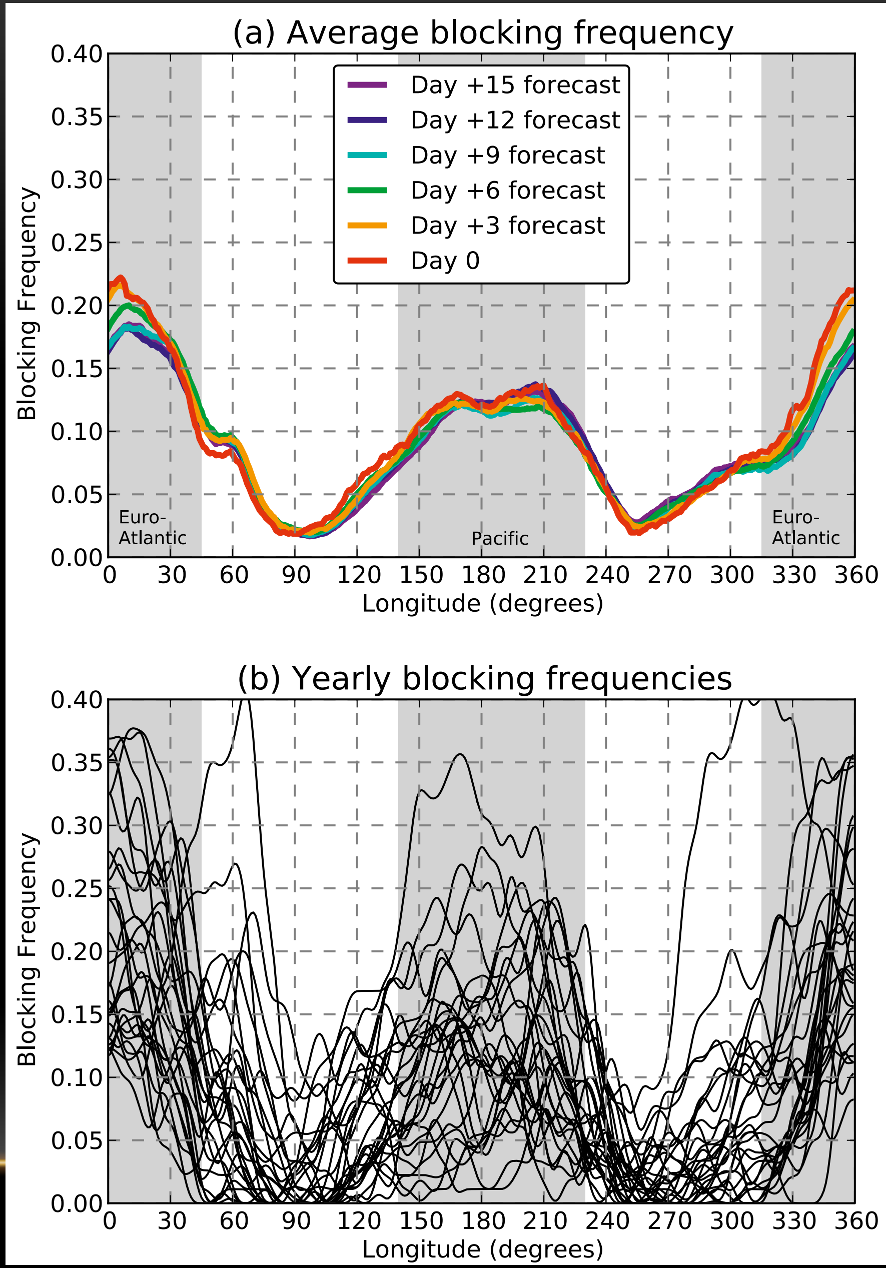


FIG. 3. (top) The 2D daily frequency of blocking (expressed in percentages; see section 2b for more details) during winter for the multimodel mean (twentieth and twenty-first century) and the intermodel standard deviation of their difference (twenty-first − twentieth century). The color shading represents the difference between the multimodel means (twenty-first − twentieth century). (bottom) The 2D daily blocking frequency by the end of the twenty-first century for all the models considered (see Table 1 for details). Contours are every 0.05. The color shading represents the difference between the twenty-first- and the twentieth-century frequencies for each of the models.

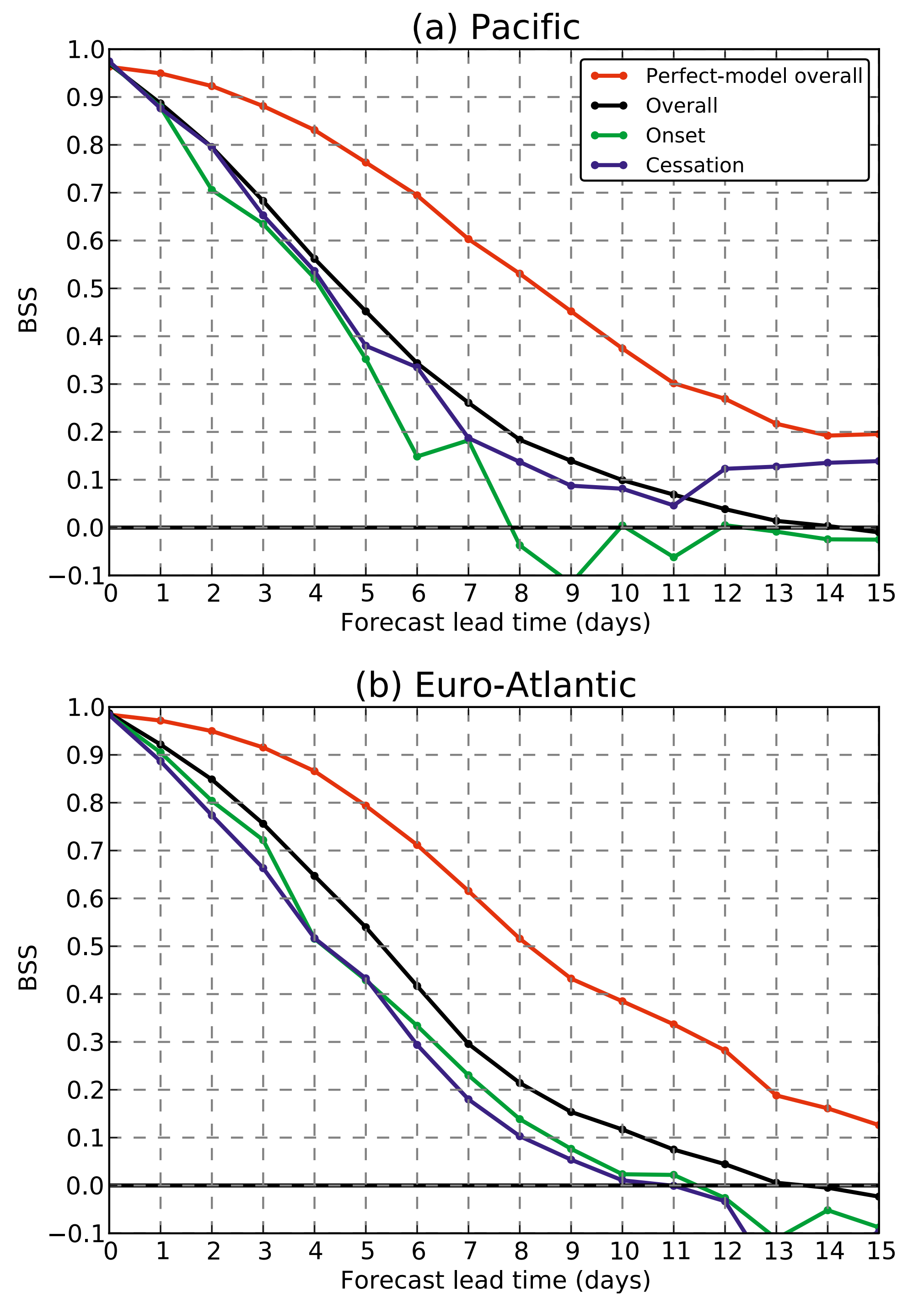
Blocking in GEFS

- With increasing forecast leadtime, the peak blocking frequencies over Euro-Atlantic is underpredicted.
- Blocking frequencies can vary by an order of magnitude or more from one year to the next for a given longitude.



BSS of Blocking in GEFS

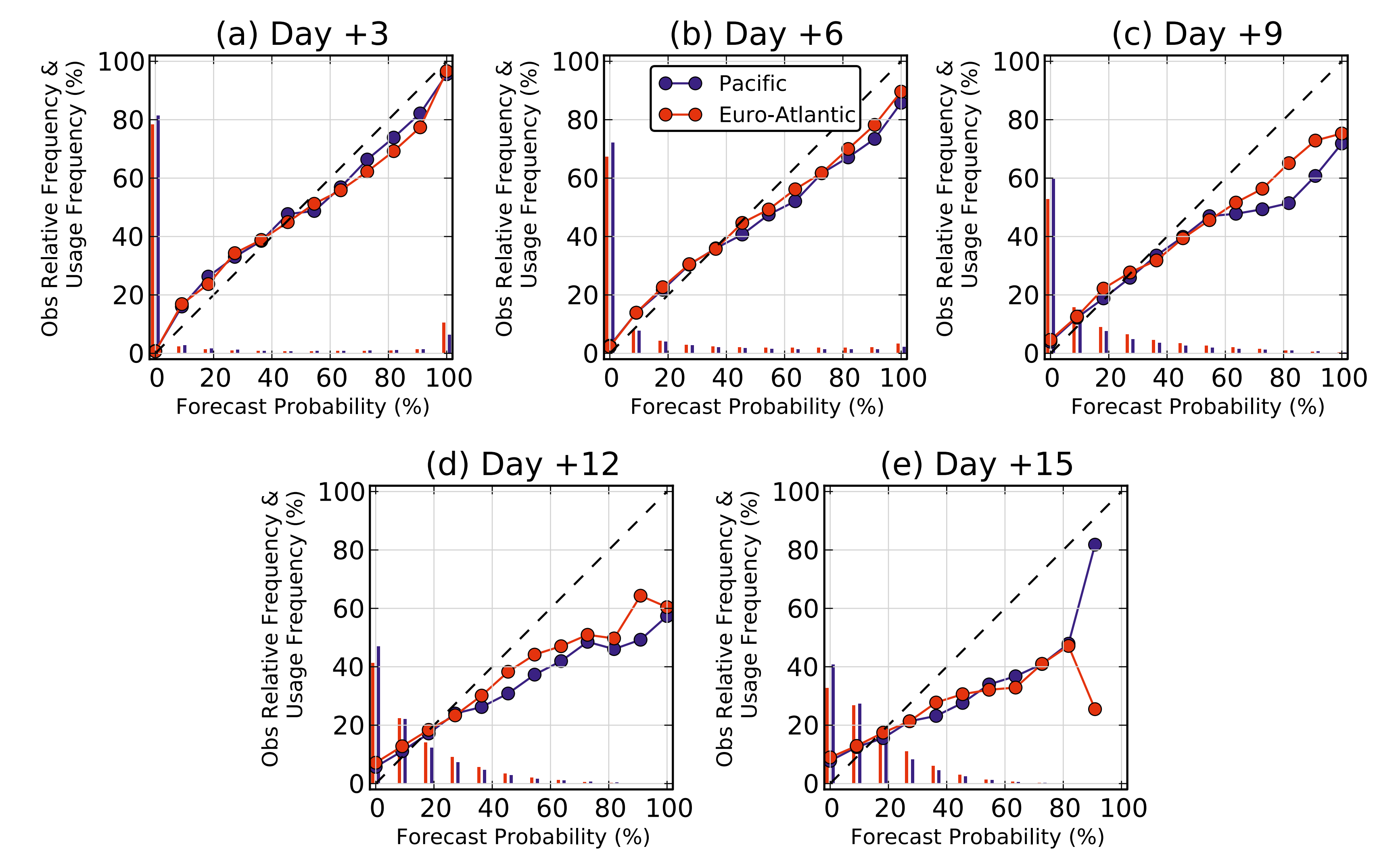
- Positive BSS is retained through day 13.
- The blocking onset and cessation forecasts are less skillful than the overall forecasts of blocking.
- “Perfect model” skill: one forecast member is used as the verification dataset (i.e., a surrogate of observations) and the remaining ensemble members are used to generate the probabilities.



Reliability diagrams for blocking probability

Could you summarize the model performance in terms of reliability and confidence or sharpness?

- At the earlier lead times the blocking forecasts are mostly reliable, but the reliability decreases.
- Blocking forecast sharpness decreases over time, as seen in the usage frequency histograms.



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