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Subseasonal forecasts of heat waves in West African cities

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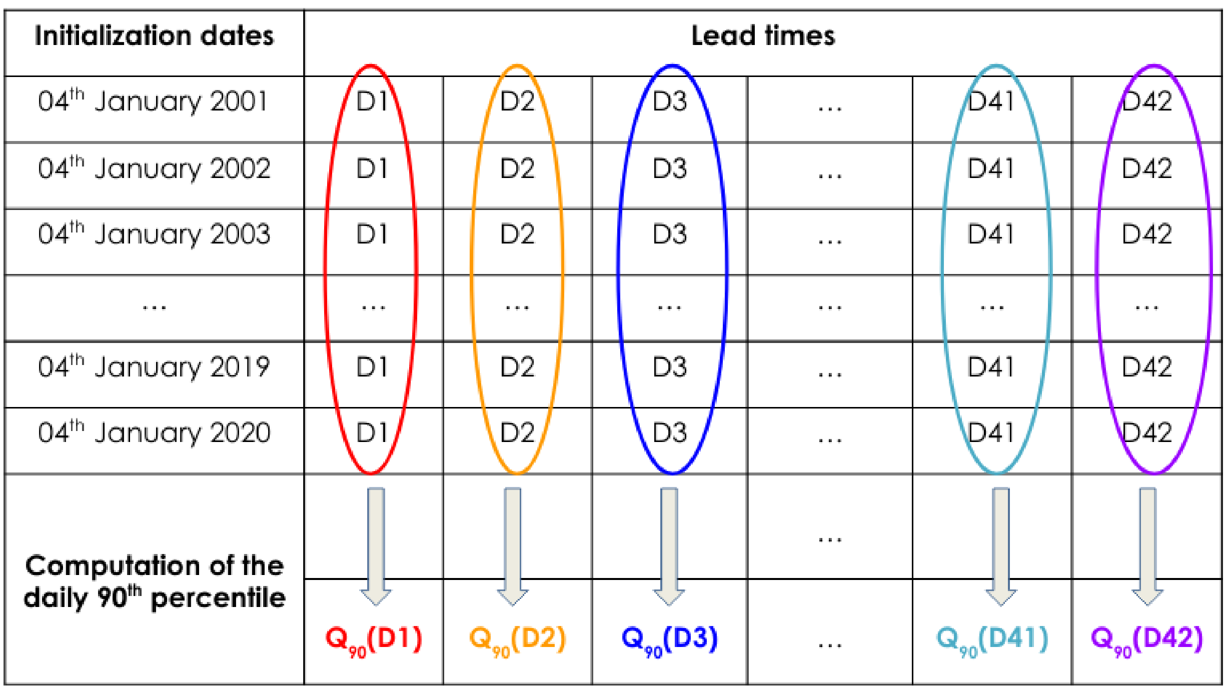


Figure S1. Illustration of the computation of the daily climatological 90^{th} percentile using ECMWF hindcasts initialized on January 04th over the study period (2001-2020) over all lead times.

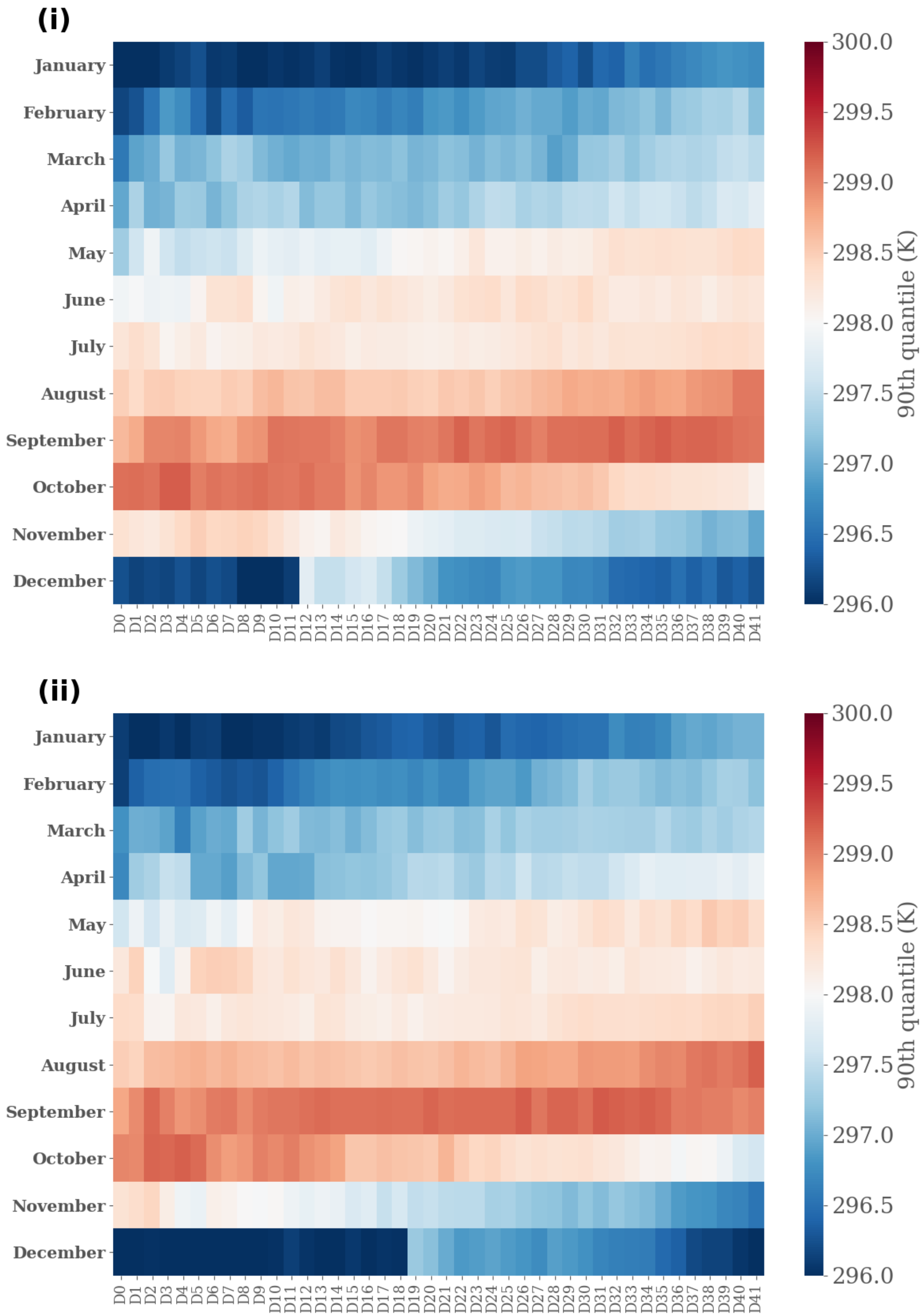


Figure S2. Seasonal evolution of the daily climatological 90^{th} percentile threshold over AT region using T2m_min ECMWF hindcasts run on: the first thursday of the month (e.g. Thursday 04^{th} for January) **(i)** and the second thursday of the month (e.g. Thursday 11^{th} for January)**(ii)**.

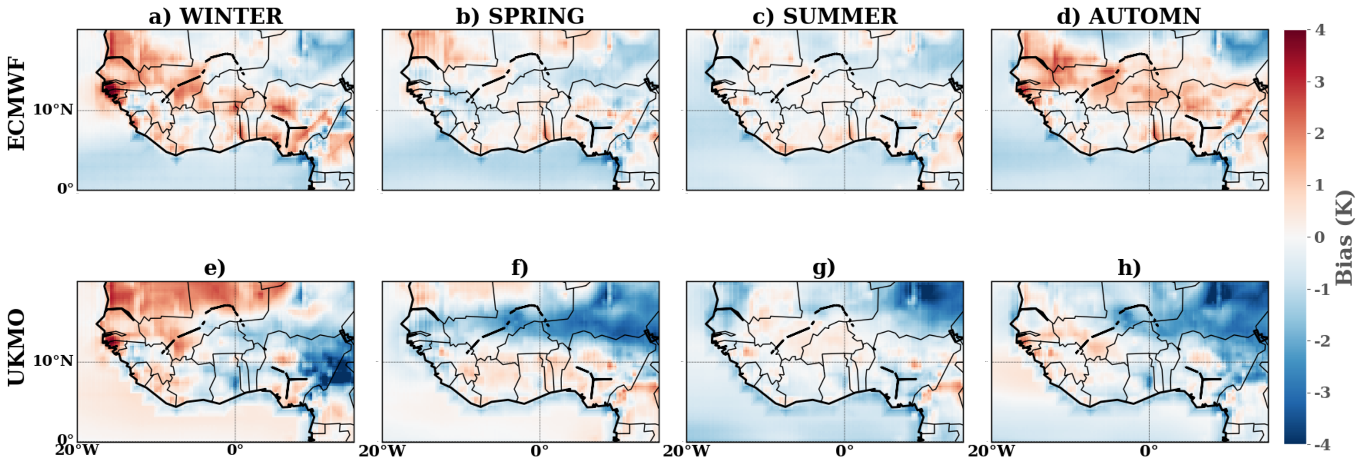


Figure S3. Spatial variability of the climatological bias between the forecast models ensemble mean and MERRA reanalysis over the period 2001-2020 for T2m_min during the seasons : (a,e) winter; (b,f) spring; (c,g) summer and (d,h) autumn. The bias is computed as the difference between the forecast models and ERA5 considering all the lead times. The color indicates the bias values in degrees Celsius. The X and Y axes represent the longitude and latitude respectively.

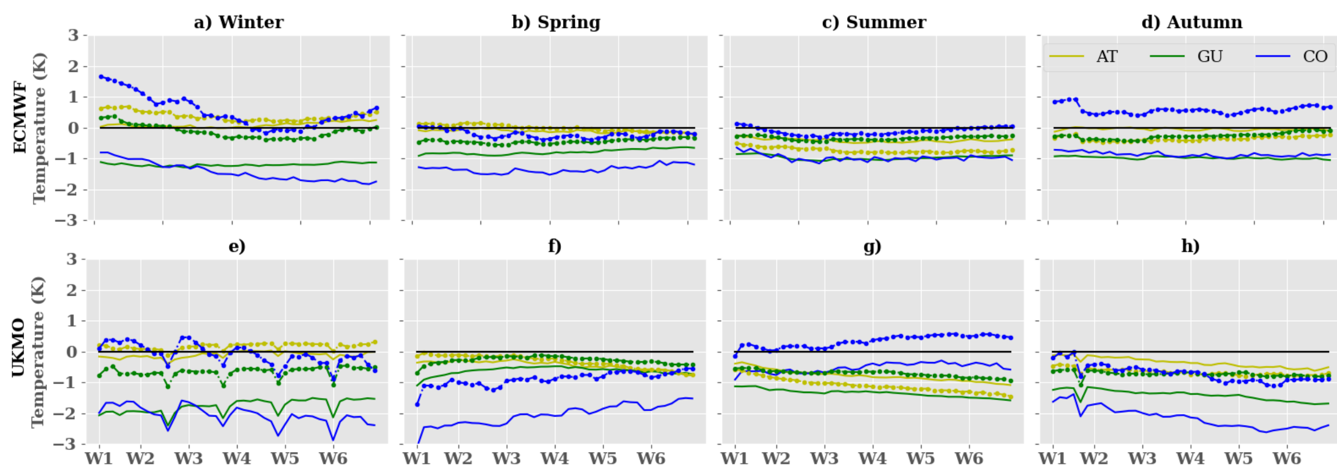


Figure S4. Evolution of the mean climatological biases between the forecast models and reanalyses using T2m_min over the period 2001-2020 during the seasons : (a,e) winter; (b,f) spring; (c,g) summer and (d,h) autumn. The solid black line indicates the zero value (no bias). Yellow, green, blue solid- and dotted- lines represent the bias computed using ERA5 and MERRA as references over the AT, GU and CO regions respectively. The Y and X axes represent the bias values in degree Kelvin and the time in days respectively.

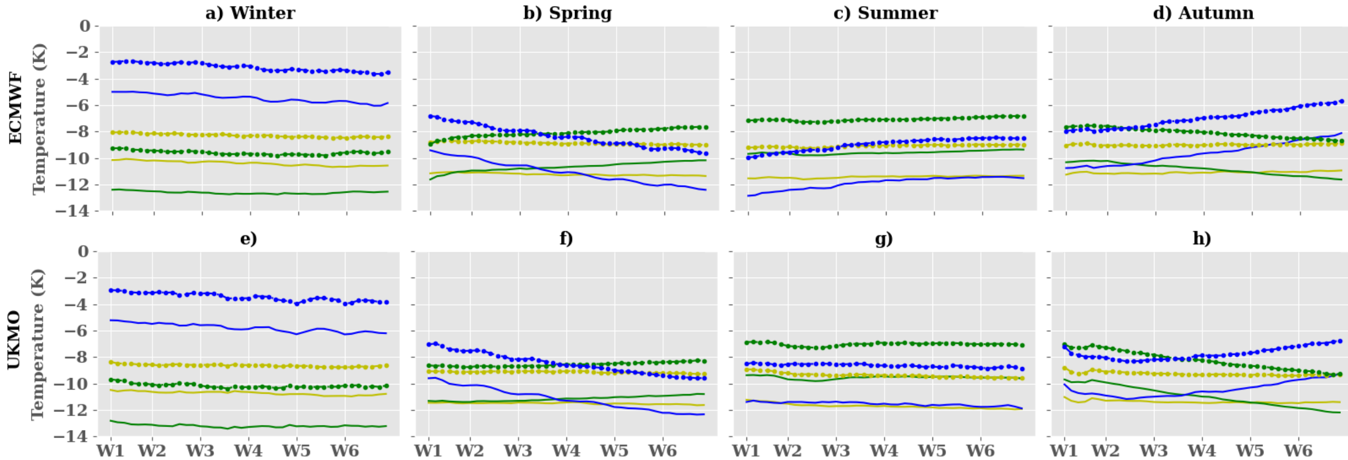


Figure S5. Evolution of the mean climatological biases between the forecast models and reanalyses using Tw over the period 2001-2020 during the seasons : (a,e) winter; (b,f) spring; (c,g) summer and (d,h) autumn. Yellow, green, blue solid- and dotted- lines represent the bias computed using ERA5 and MERRA as references over the AT, GU and CO regions respectively. The Y and X axes represent the bias values in degree Kelvin and the time in days respectively.

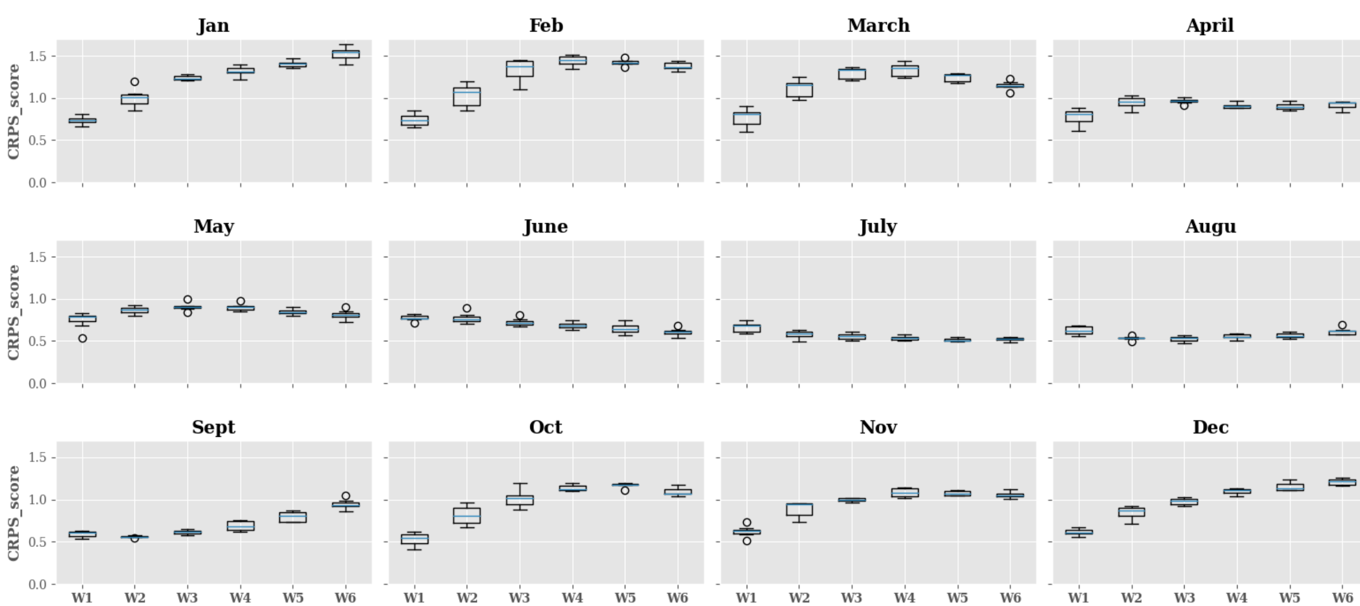


Figure S6. Evaluation of ECMWF model with respect to ERA5 reanalysis in the CONT region using T2m_min. The Y and X axes show the CRPS values and the lead times (from W1: week1 to W6: week6) respectively.

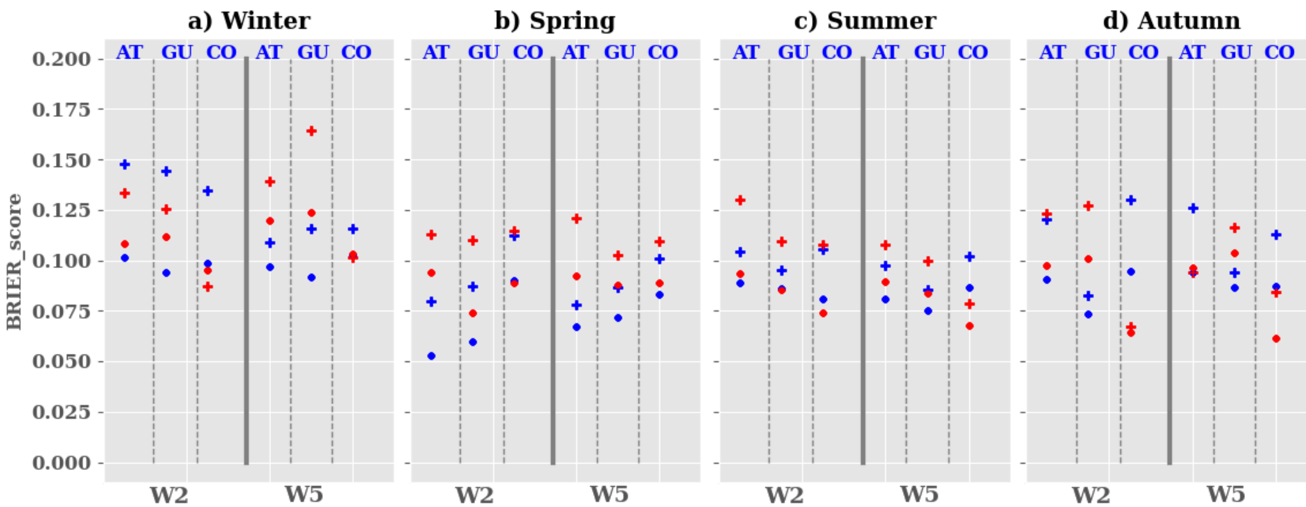


Figure S7. Evolution of the Brier score between the forecast models and MERRA reanalysis over the period 2001-2020 during the seasons : (a) winter, (b) spring, (c) summer and (d) autumn. The Brier is computed independently for each initialisation date within a month, and we computed the average Brier to obtain the Brier values for the given month. The blue and red colors represent the Brier score computed using T2m_min and T2m_max values respectively. The dot and cross symbols indicate the Brier score obtained with ECMWF and UKMO respectively. The Y and X axes show the CRPS values and the lead times (W2: week2 and W5: week5) respectively.

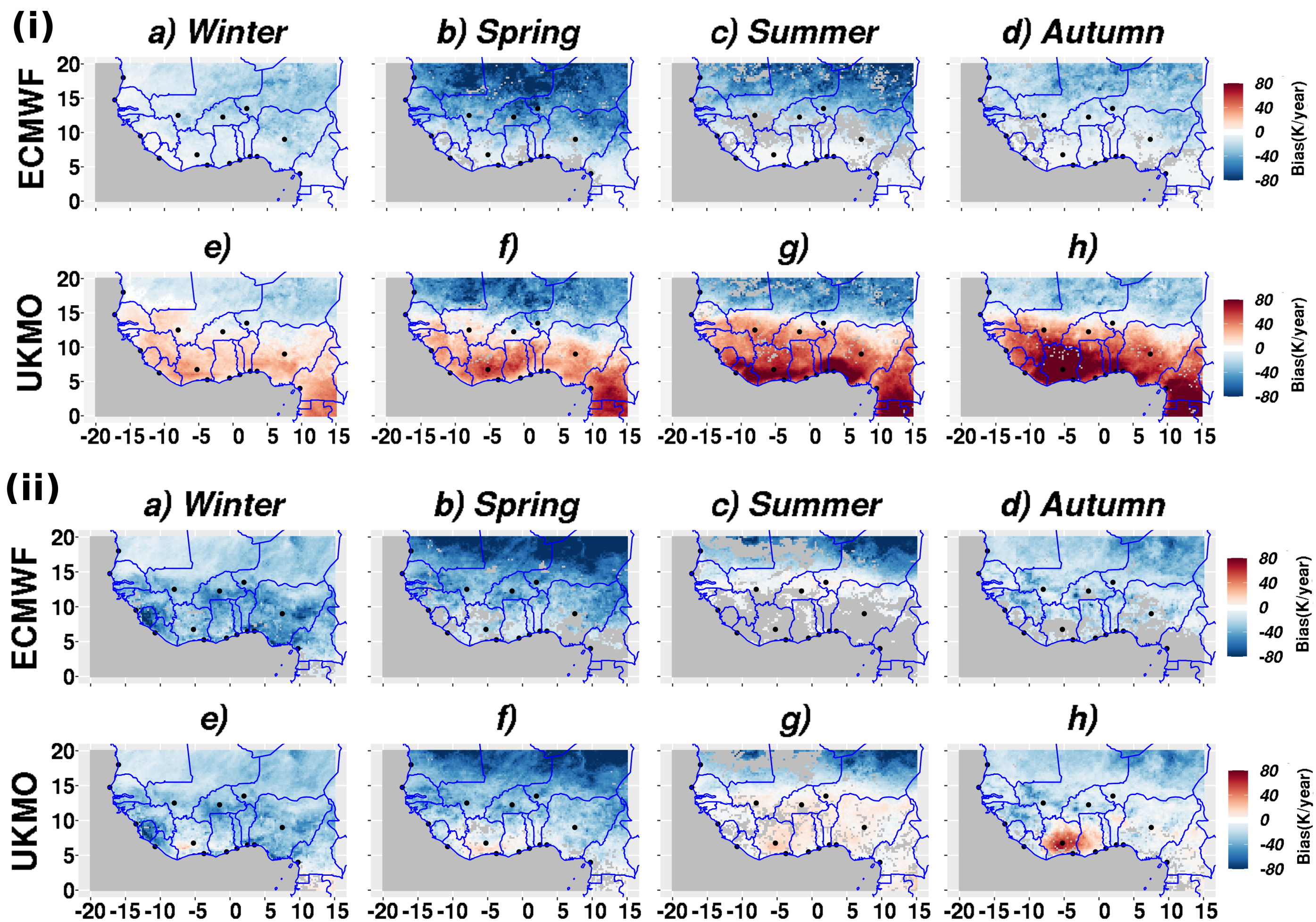


Figure S8. Spatial variability of heat wave intensity bias between the forecast models and ERA5 over West Africa from 2001 to 2020 for: **(i)** T2m_min values and **(ii)** T2m_max values, during: (a,e) winter; (b,f) spring; (c,g) summer and (d,h) autumn. The bias is computed as the difference in heat wave intensity between the models and ERA5. This analysis is performed using the unperturbed member of the models and the forecasts over all the lead times during years where heat waves were detected. The color bar indicates the bias values without units. The X and Y axes represent longitude and latitude respectively.

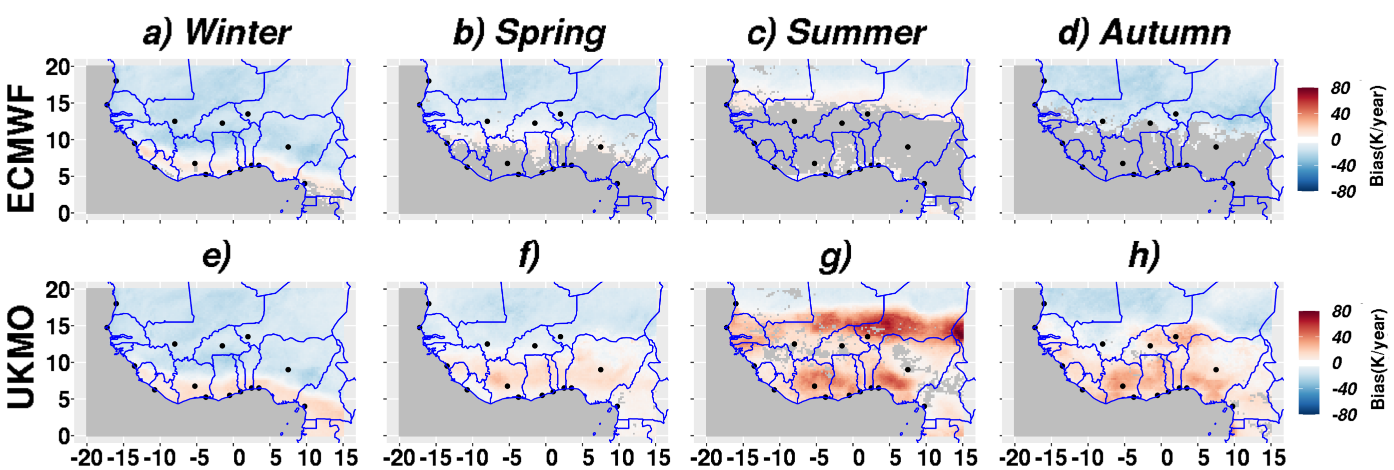


Figure S9. Spatial variability of heat wave intensity bias between the forecast models and ERA5 over West Africa from 2001 to 2020 for Tw during: (a,e) winter; (b,f) spring; (c,g) summer and (d,h) autumn. The bias is computed as the difference in heat wave intensity between the models and ERA5. This analysis is performed using the unperturbed member of the models and the forecasts over all the lead times during years where heat waves were detected. The color bar indicates the bias values without units. The X and Y axes represent longitude and latitude respectively.

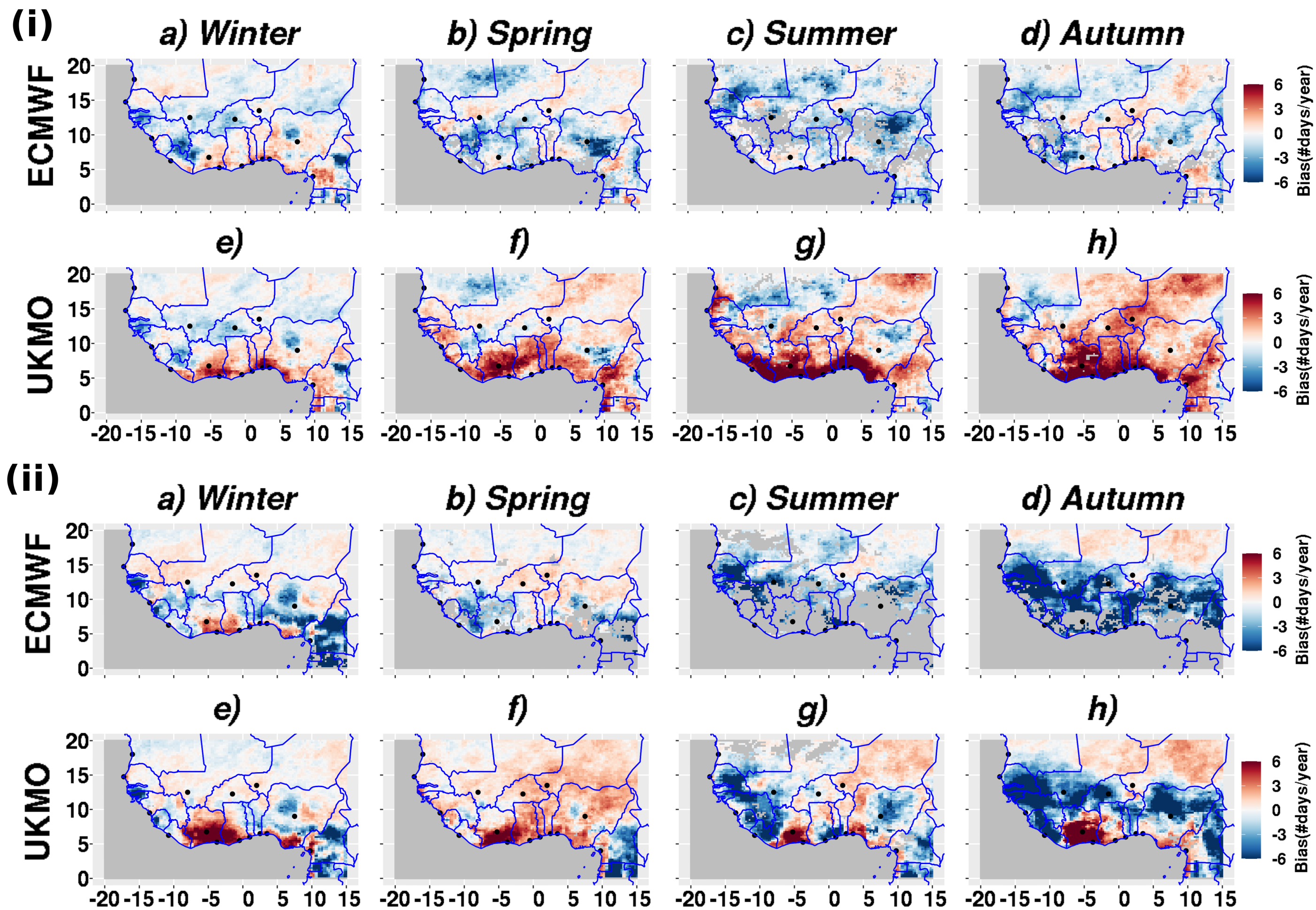


Figure S10. Spatial variability of heat wave duration bias between the forecast models and MERRA over West Africa from 2001 to 2020 for: **(i)** T2m_min values and **(ii)** T2m_max values, during: (a,e) winter; (b,f) spring; (c,g) summer and (d,h) autumn. The bias is computed as the difference in heat wave duration between the models and ERA5. This analysis is performed using the unperturbed member of the models and the forecasts over all the lead times during years where heat waves were detected. The color bar indicates the bias values without units. The X and Y axes represent longitude and latitude respectively.

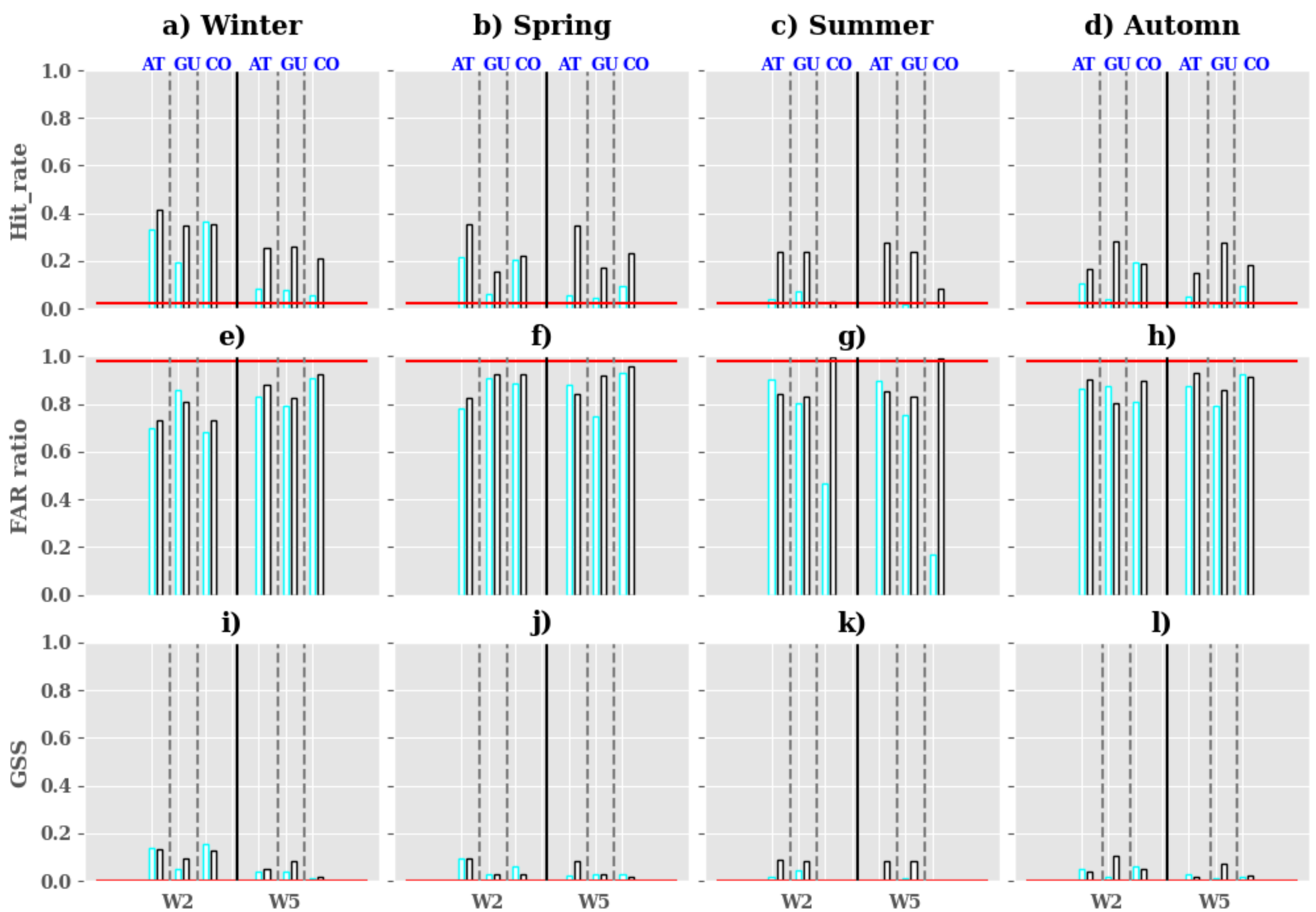


Figure S11. Evaluation of heat waves detection in the forecast models with respect to ERA5 at daily time scale over the period 2001-2020 using Tw for : (a-d) hit-rate, (e-h) FAR and (i-l) GSS. The metrics were computed using the optimized forecasts (see section Methods for the optimisation of the ensemble forecasts). The metrics are computed independently for each initialisation date within a month, and all initialisations are averaged to obtain the metric values for the given month. The dot and cross symbols indicate the Brier score obtained with ECMWF and UKMO respectively. The metrics were computed during the seasons : (a,e,i) winter; (b,f,j) spring; (c,g,k) summer and (d,h,l) autumn. The cyan and black borders of bar plots indicate the metrics obtained when using ECMWF and UKMO respectively. The Y and X axes show the metrics values and the lead times (W2: week2 and W5: week5) respectively. The horizontal red line represents the baseline climatology.

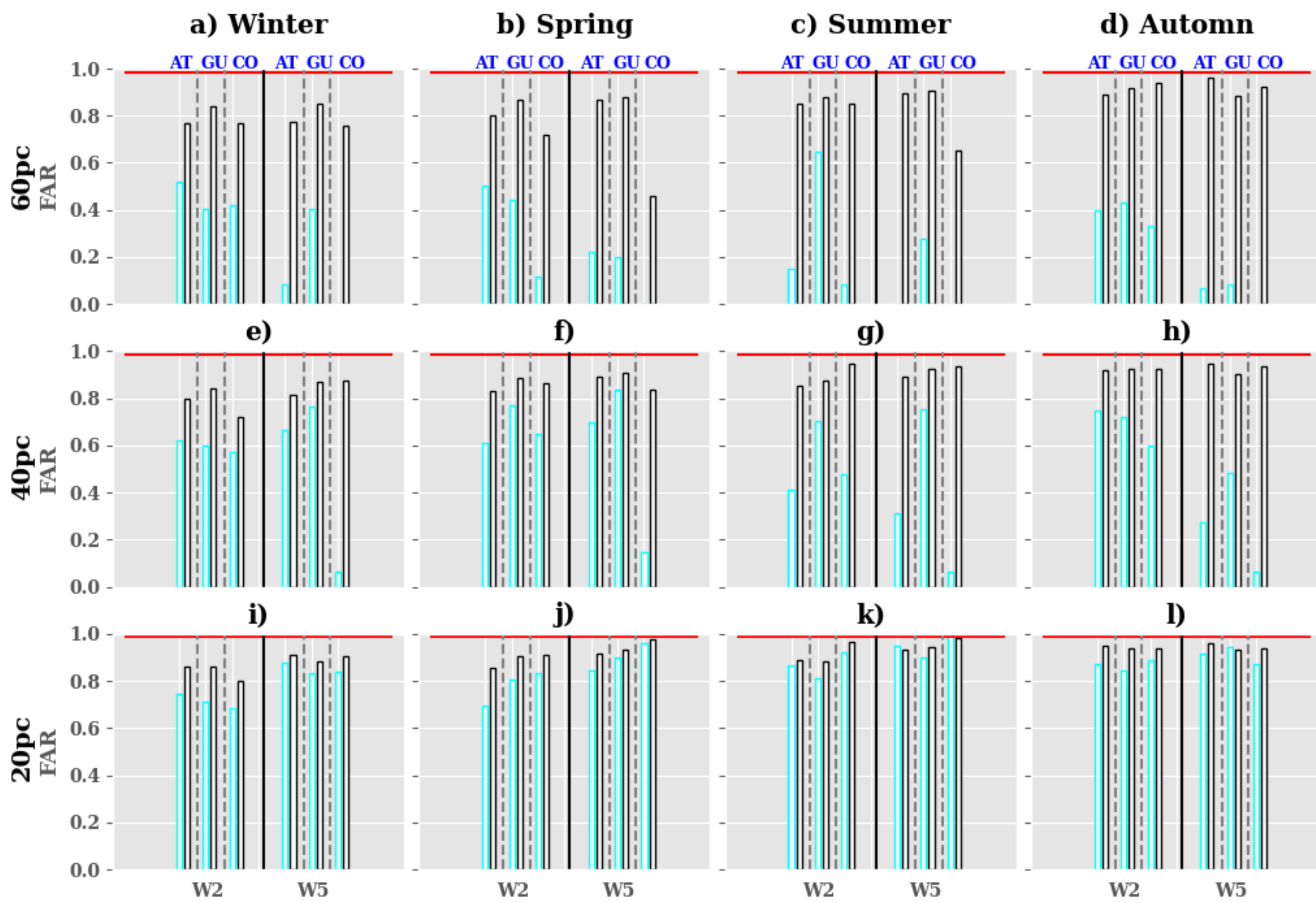


Figure S12. Sensitivity of the FAR to the thresholds used to optimize forecasts over the period 2001-2020 using T2m_min values at daily time scale for : (a-d) a 60 percentile threshold, (e-h) a 40 percentile threshold and (i-l) a 20 percentile threshold (see Section Methods on optimization forecasts for more details). The FAR is computed during the seasons : (a,e,i) winter; (b,f,j) spring; (c,g,k) summer and (d,h,l) autumn. The cyan and black borders of bar plots indicate the FAR obtained when using ECMWF and UKMO respectively. The Y and X axes show the FAR values and the lead times (W2: week2 and W5: week5) respectively. The horizontal red line represents the baseline climatology.

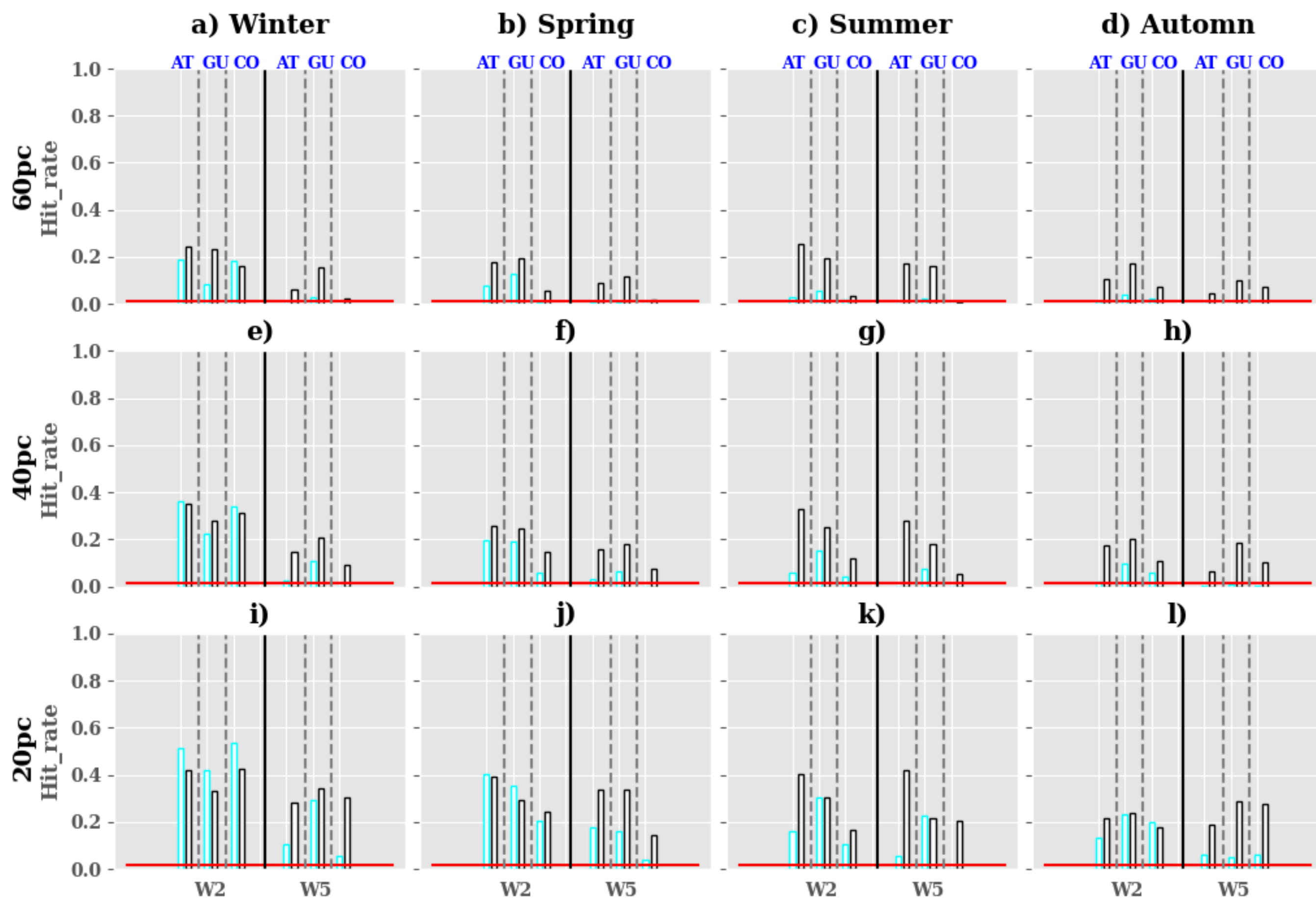


Figure S13. Sensitivity of the hit-rate to the thresholds used to optimize forecasts over the period 2001-2020 using T2m_min values at daily time scale for : (a-d) a 60 percentile threshold, (e-h) a 40 percentile threshold and (i-l) a 20 percentile threshold (see Section Methods on optimization forecasts for more details). The hit-rate is computed during the seasons : (a,e,i) winter; (b,f,j) spring; (c,g,k) summer and (d,h,l) autumn. The cyan and black borders of bar plots indicate the hit-rate obtained when using ECMWF and UKMO respectively. The Y and X axes show the hit-rate values and the lead times (W2: week2 and W5: week5) respectively. The horizontal red line represents the baseline climatology.

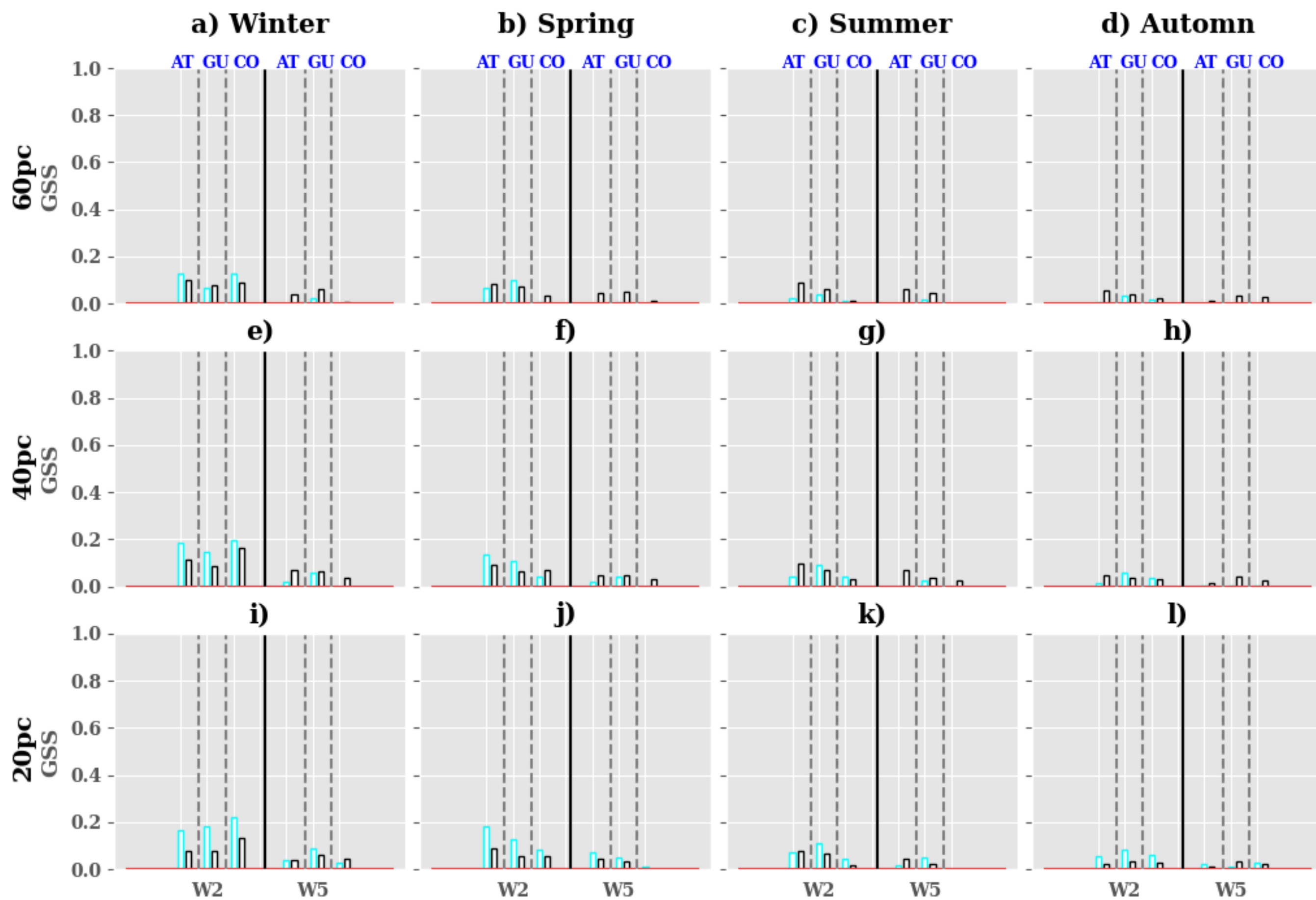


Figure S14. Sensitivity of the GSS to the thresholds used to optimize forecasts over the period 2001-2020 using T2m_min values at daily time scale for : (a-d) a 60 percentile threshold, (e-h) a 40 percentile threshold and (i-l) a 20 percentile threshold (see Section Methods on optimization forecasts for more details). The GSS is computed during the seasons : (a,e,i) winter; (b,f,j) spring; (c,g,k) summer and (d,h,l) autumn. The cyan and black borders of bar plots indicate the GSS obtained when using ECMWF and UKMO respectively. The Y and X axes show the GSS values and the lead times (W2: week2 and W5: week5) respectively. The horizontal red line represents the baseline climatology.

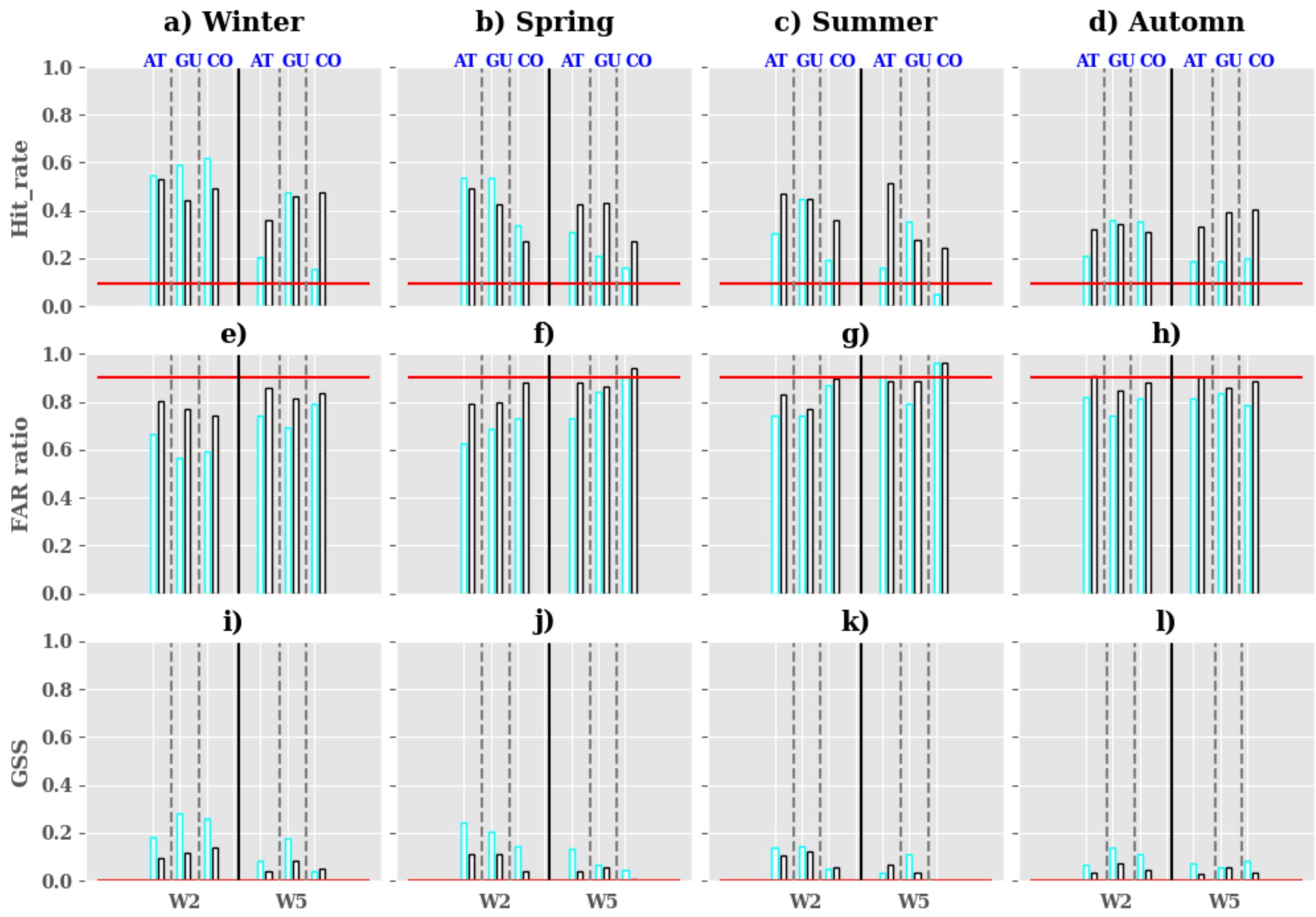


Figure S15. Evaluation of heat waves detection metrics in the models with respect to ERA5 at weekly time scale over the period 2001-2020 using T2m_min values for : (a-d) hit-rate, (e-h) FAR and (i-l) GSS. The metrics were computed using the optimized forecasts with the 20% threshold (see section Methods for the optimisation of the ensemble forecasts). The metrics are computed independently for each initialisation date within a month, and all initialisations are averaged to obtain the metric values for the given month. The metrics were computed during the seasons : (a,e,i) winter; (b,f,j) spring; (c,g,k) summer and (d,h,l) autumn. The cyan and black borders of bar plots indicate the metrics obtained when using ECMWF and UKMO respectively. The Y and X axes show the metrics values and the lead times (W2: week2 and W5: week5) respectively. The horizontal red line represents the baseline climatology.

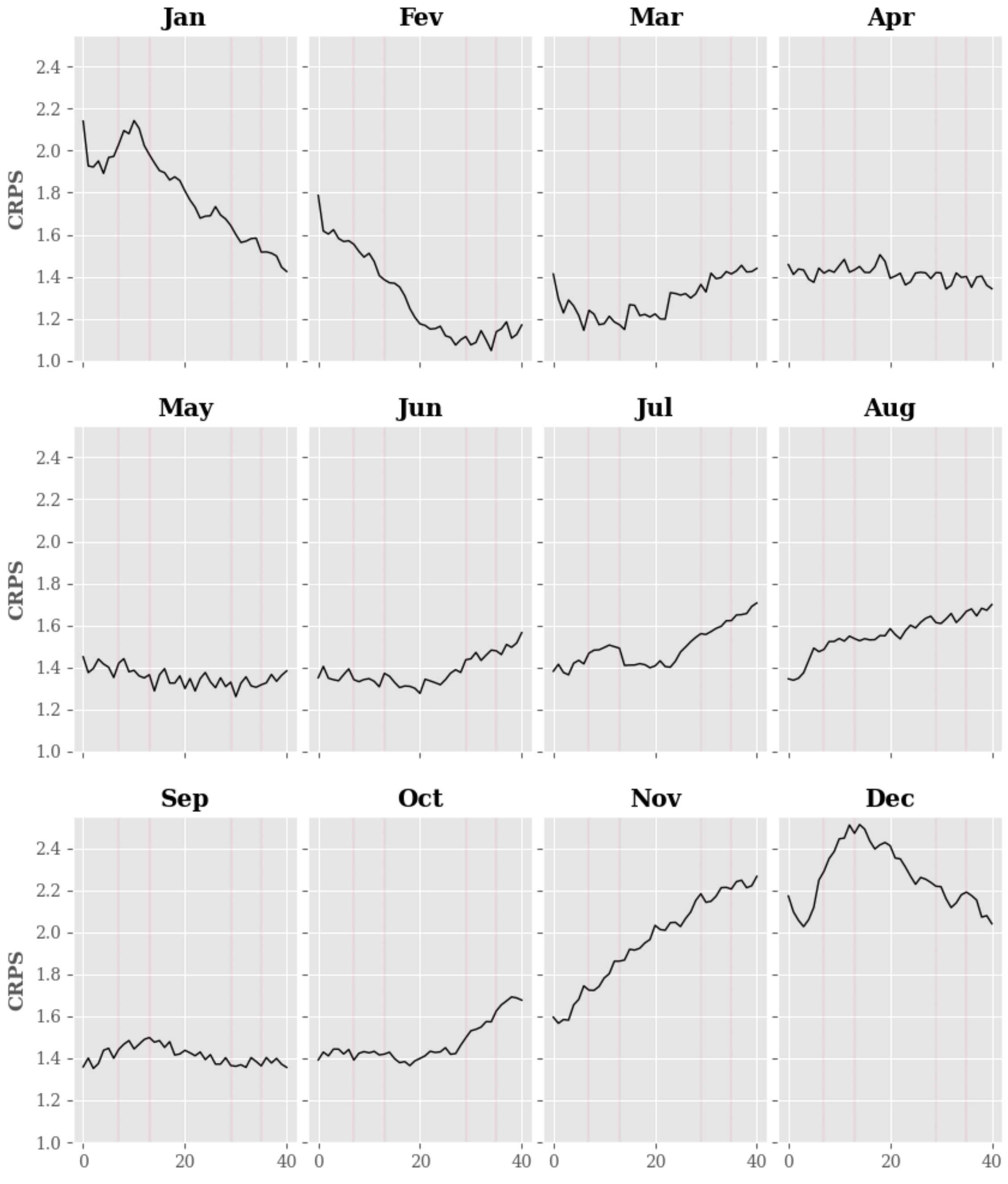


Figure S16. Evolution of the CRPS score between UKMO and ERA5 reanalysis using T2m_min over the period 2001-2020 in the Guinea region. We used for this specific analysis, the UKMO forecasts initialised on the 1^{st} of each month. The Y and X axes show the CRPS values and the lead times respectively.

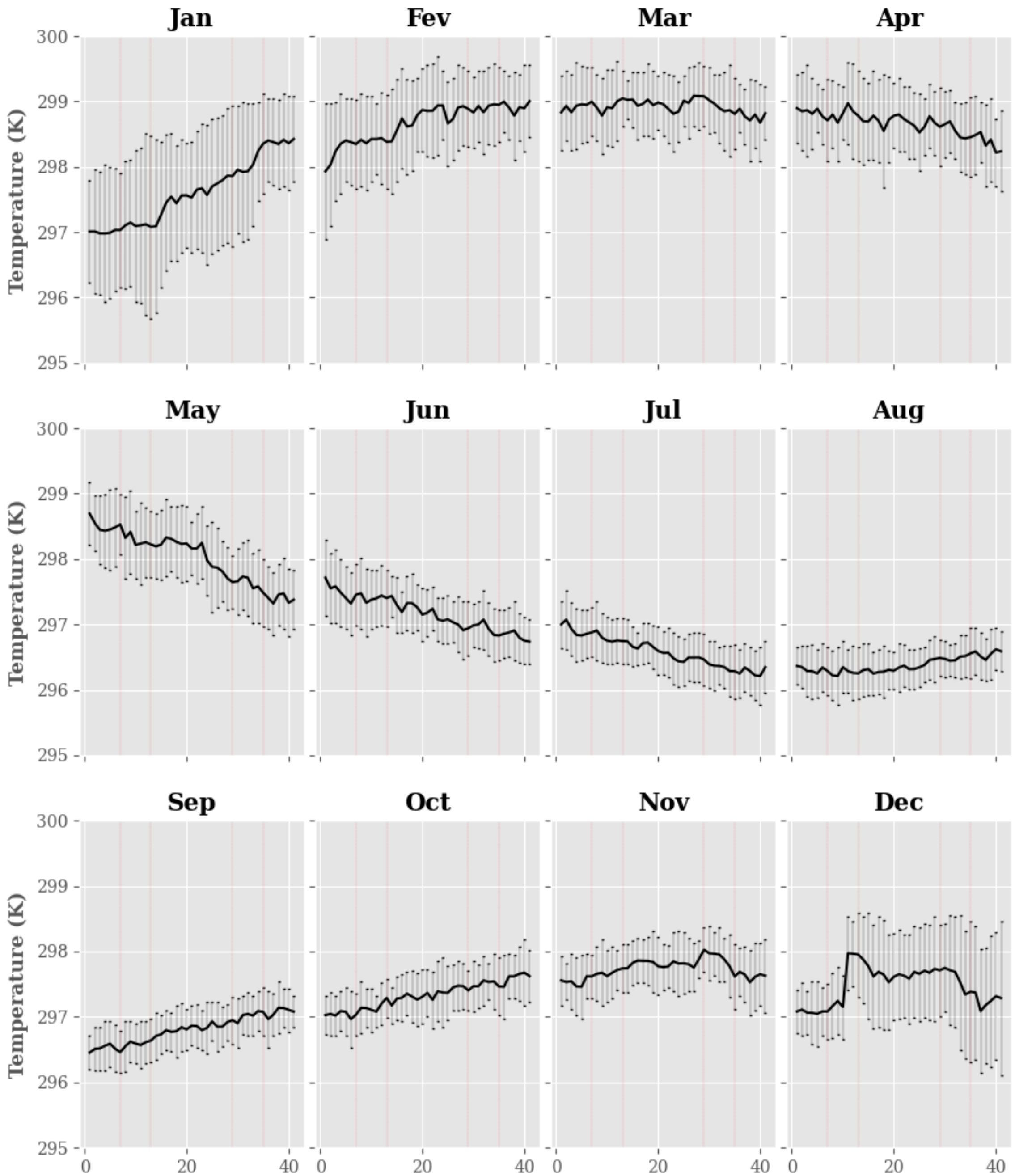
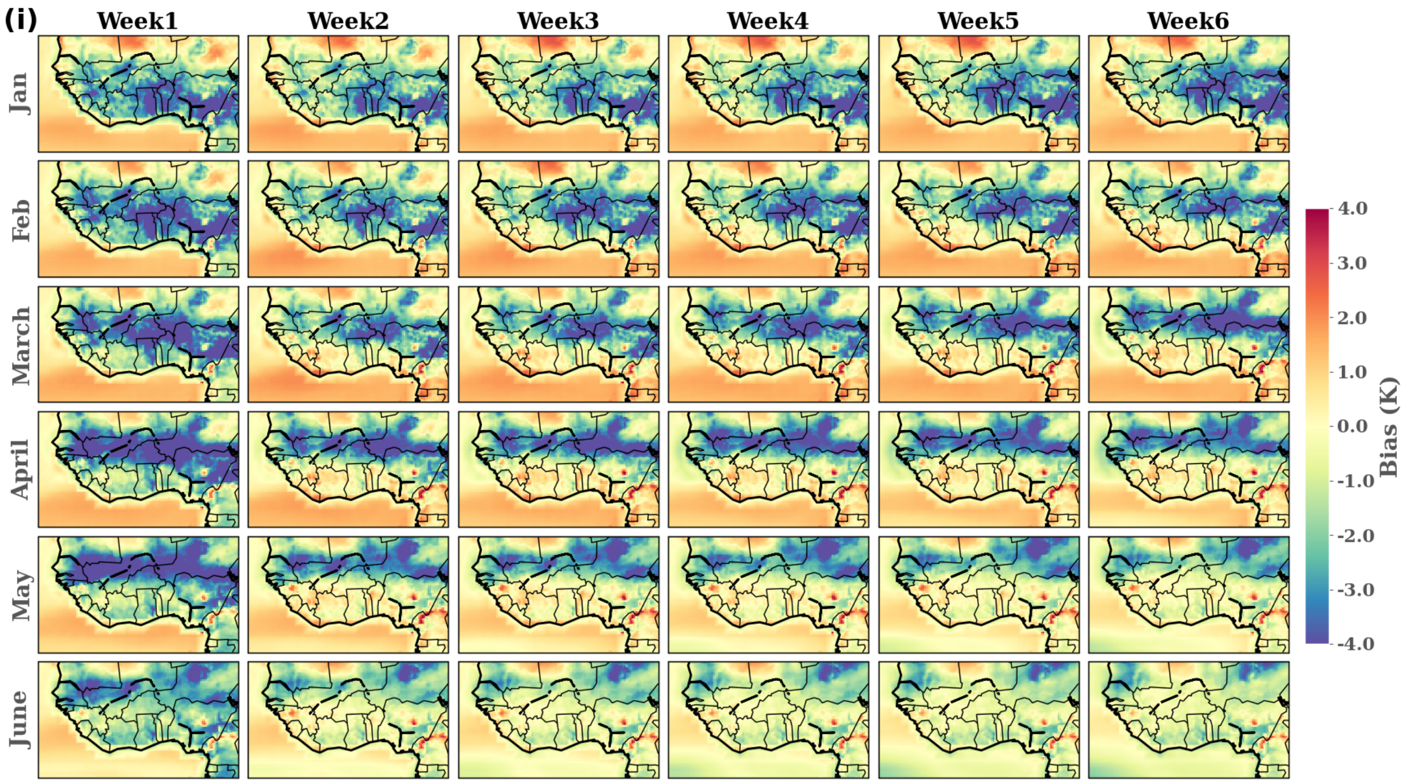


Figure S17. Evolution of the spread of temperatures in ERA5 reanalysis using T2m_min over the period 2001-2020 in the Guinea region. We used for this specific analysis, the UKMO forecasts initialised on the 1^{st} of each month. The Y and X axes show the temperature values and the lead times respectively.


(i)
Week1
Week2
Week3
Week4
Week5
Week6
Jan
Feb
March
April
May
June
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
Bias (K)

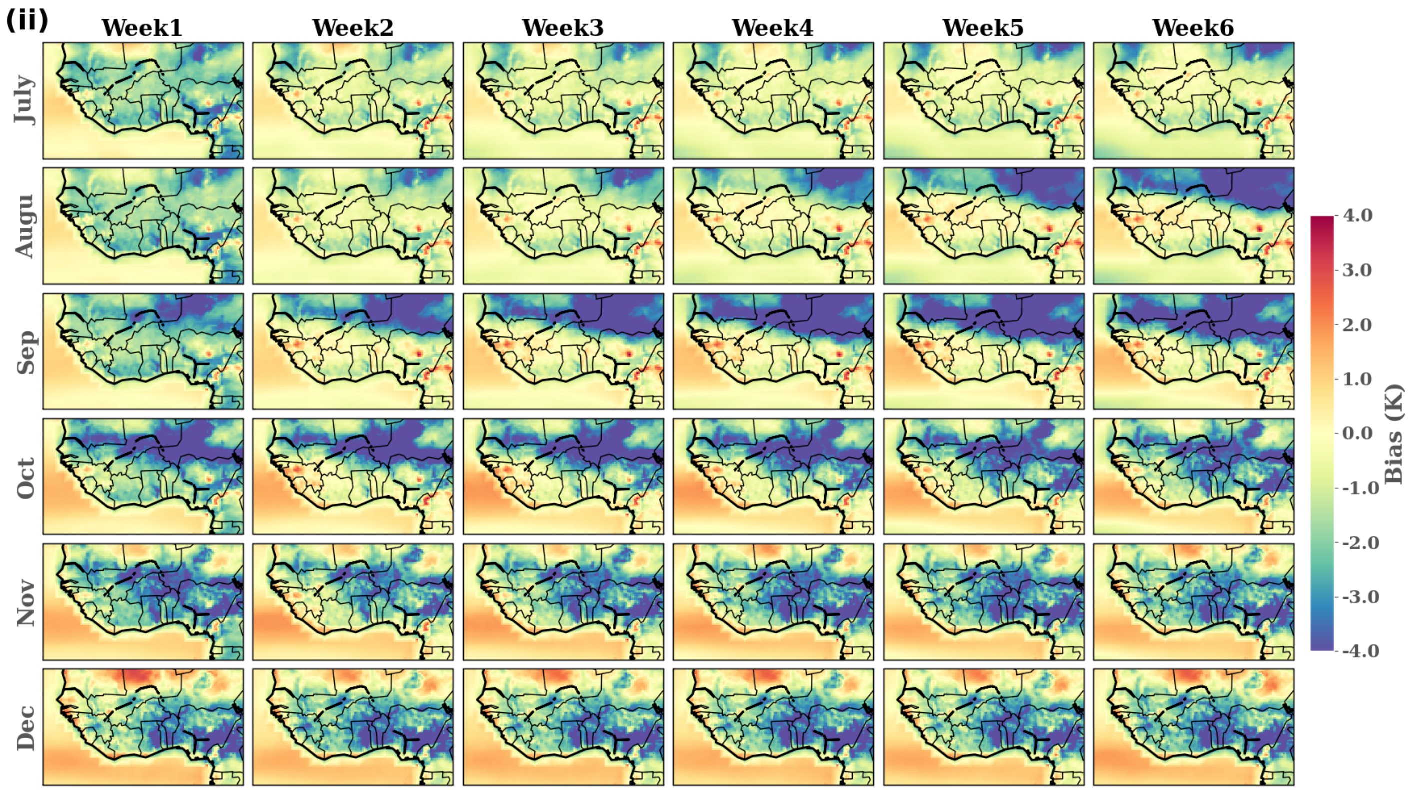


Figure S18. Evolution of the climatological bias between UKMO and ERA5 reanalysis over the lead times from week 1 to week 6 using T2m_min for : January to June **(i)** and July to August **(ii)**. The bias is computed using ERA5 reanalysis as reference. The model ensemble mean was used for this analysis. The color bar represents the bias values in degree Kelvin.