

Supplementary Materials:

Chaelim Lee, Jiyu Seo, Jeongeun Won and Sangdan Kim *

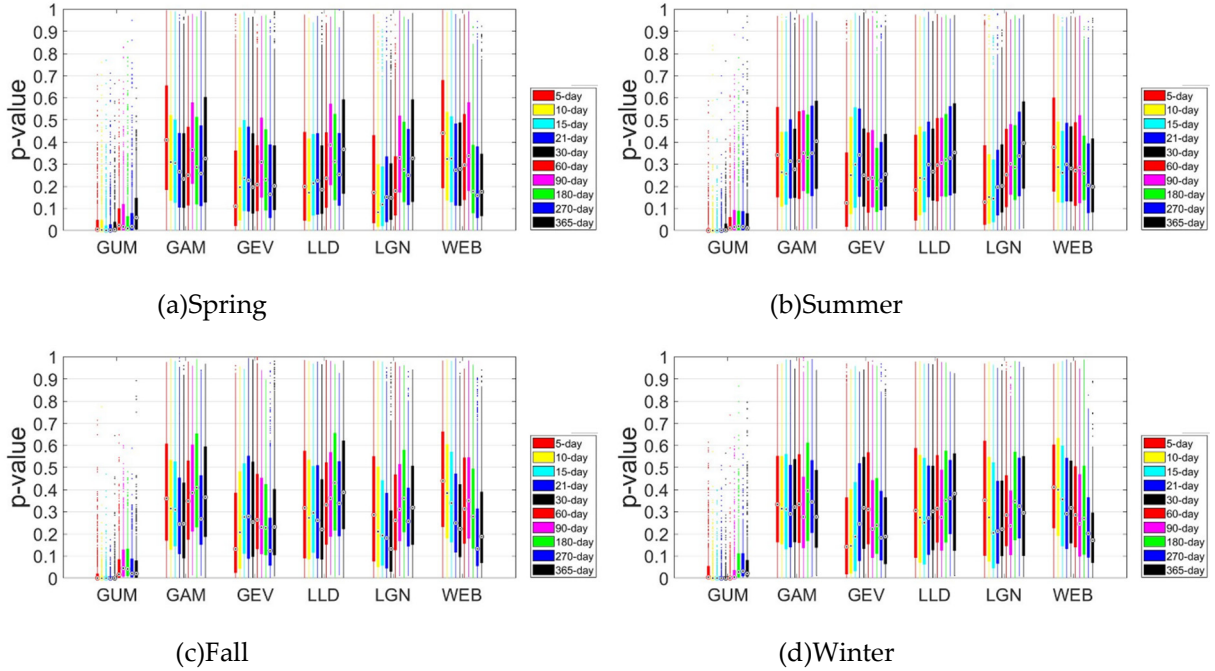


Figure S1. Box-plot of the p -values of the chi-square test for 6 candidate PDFs in 4 seasons in the Gangwon region. (a) Spring, (b) Summer, (c) Fall, (d) Winter

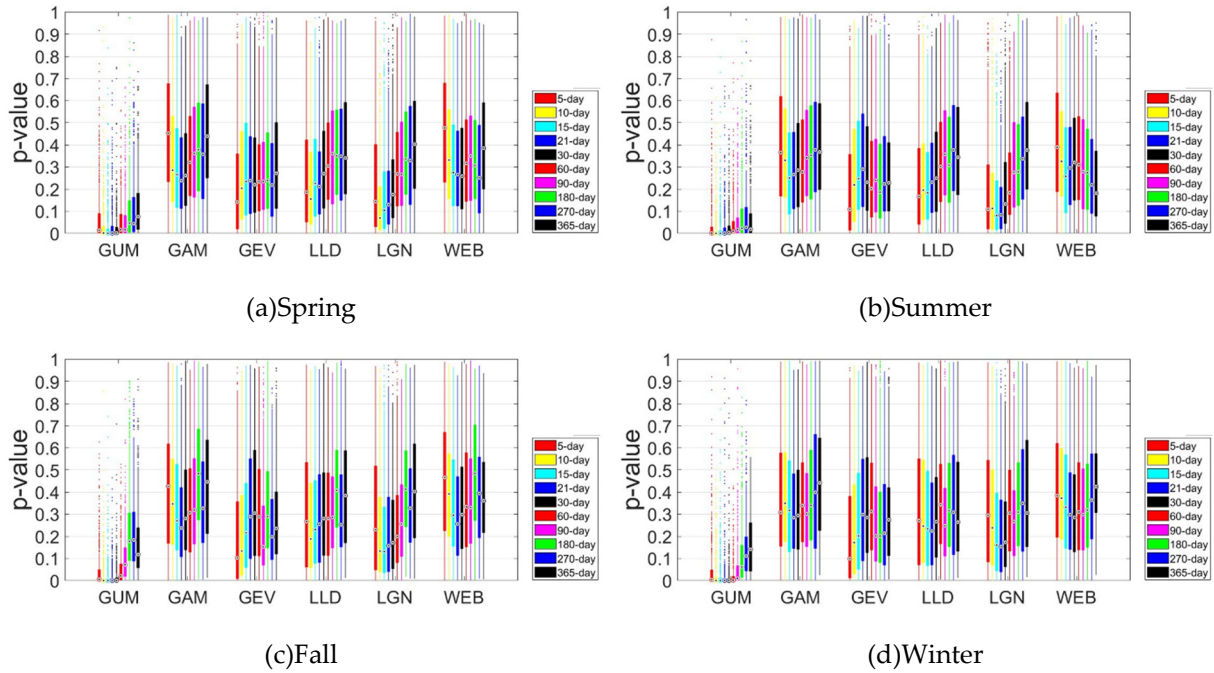


Figure S2. Box-plot of the p -values of the chi-square test for 6 candidate PDFs in 4 seasons in the Capital region. (a) Spring, (b) Summer, (c) Fall, (d) Winter

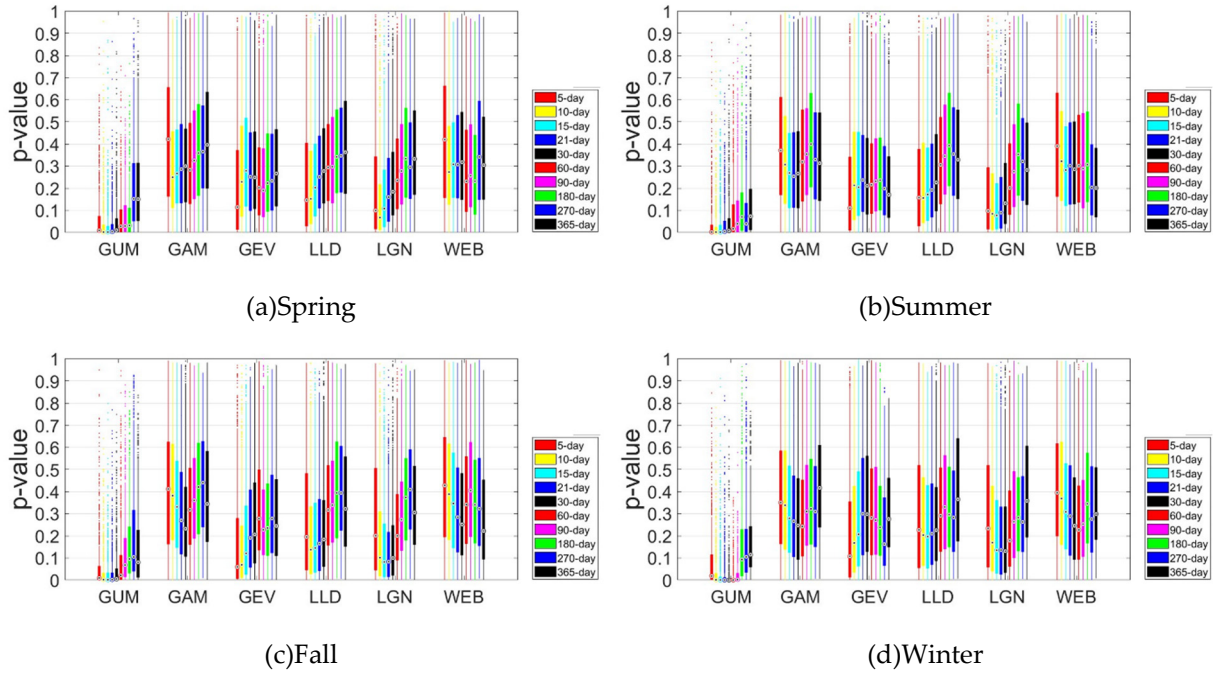


Figure S3. Box-plot of the p -values of the chi-square test for 6 candidate PDFs in 4 seasons in the Buulgyeong region. (a) Spring, (b) Summer, (c) Fall, (d) Winter

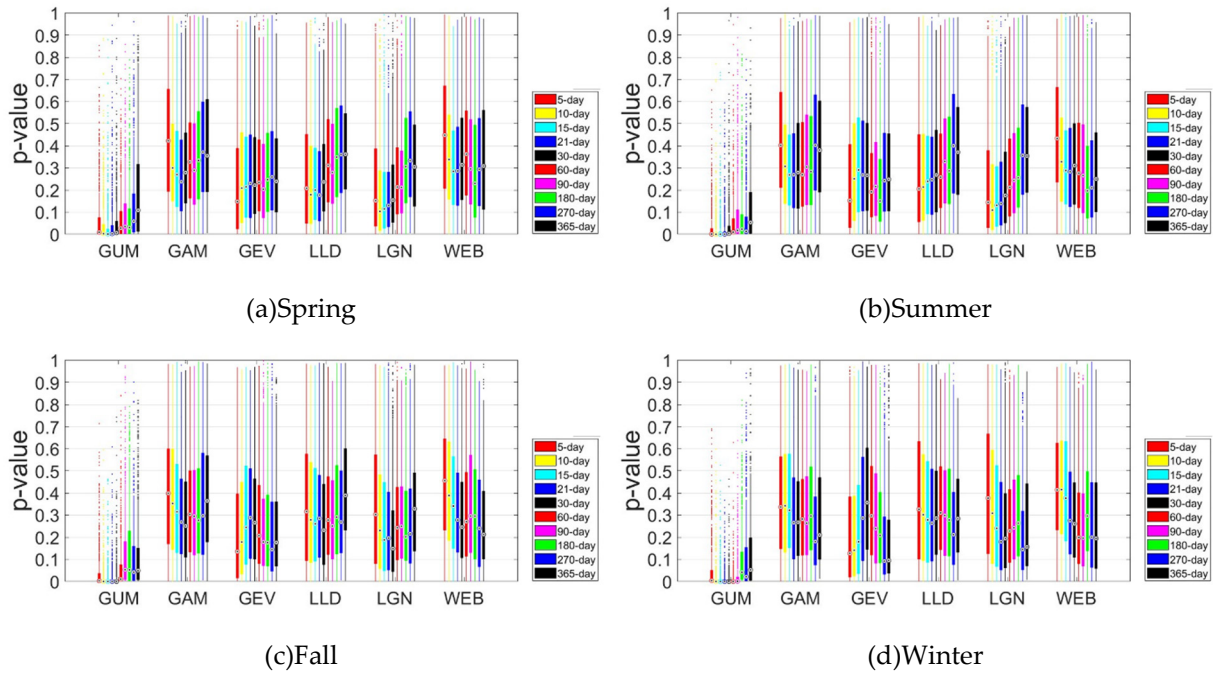


Figure S4. Box-plot of the p -values of the chi-square test for 6 candidate PDFs in 4 seasons in the Daegyong region. (a) Spring, (b) Summer, (c) Fall, (d) Winter

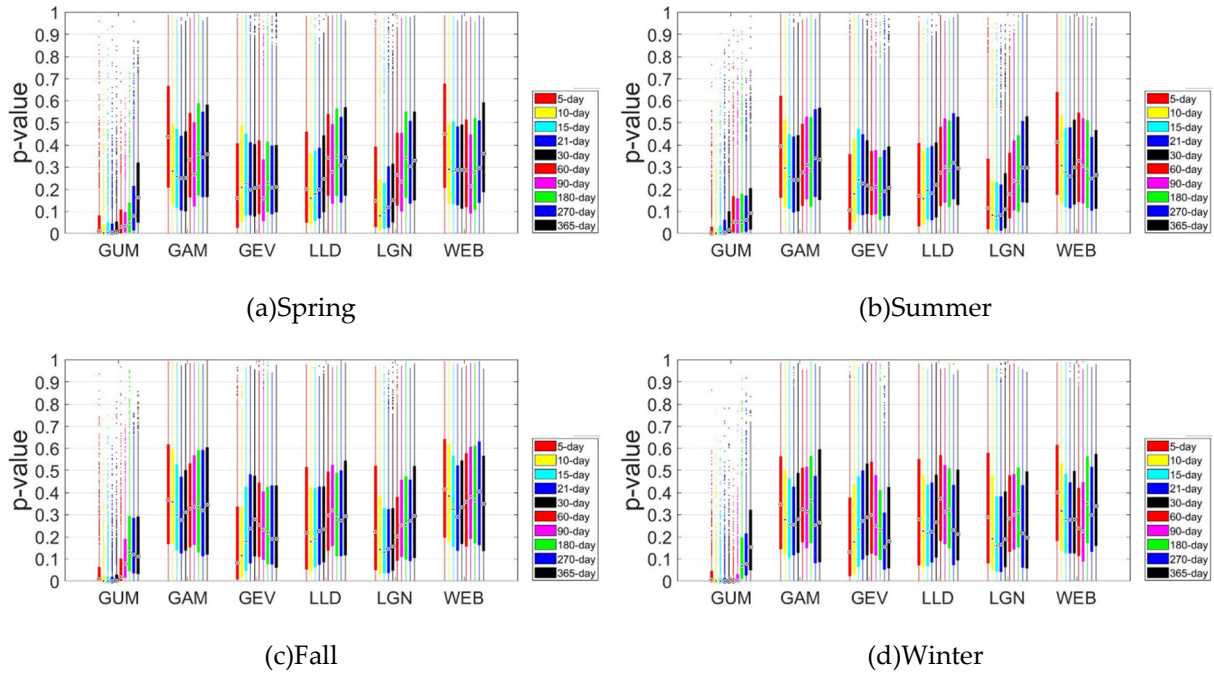


Figure S5. Box-plot of the p -values of the chi-square test for 6 candidate PDFs in 4 seasons in the Honam region. (a) Spring, (b) Summer, (c) Fall, (d) Winter

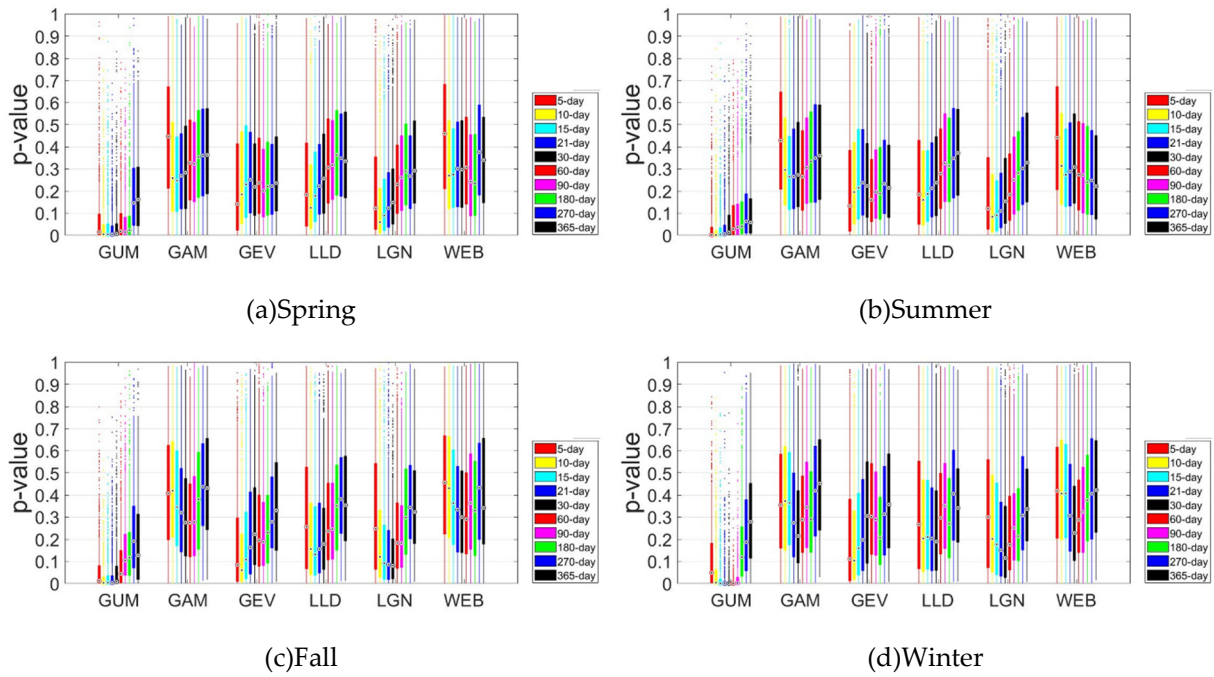


Figure S6. Box-plot of the p -values of the chi-square test for 6 candidate PDFs in 4 seasons in the Chungcheong region. (a) Spring, (b) Summer, (c) Fall, (d) Winter

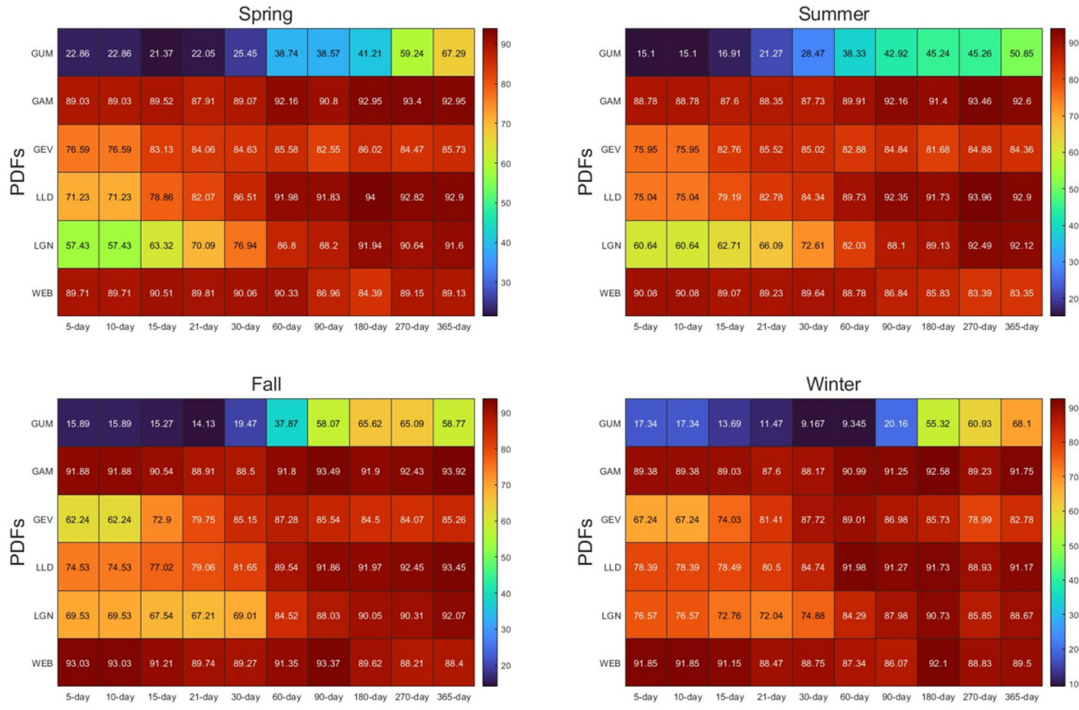


Figure S7. Heatmap of $h(\%)$ of chi-square test for 6 candidate PDFs in 4 seasons. We can see the noticeably darker red cells in the GAM and WEB at all time-scales. Furthermore, we can see that as the time-scale increases, the $h(\%)$ of all PDFs increases and the performance in terms of fit improves.

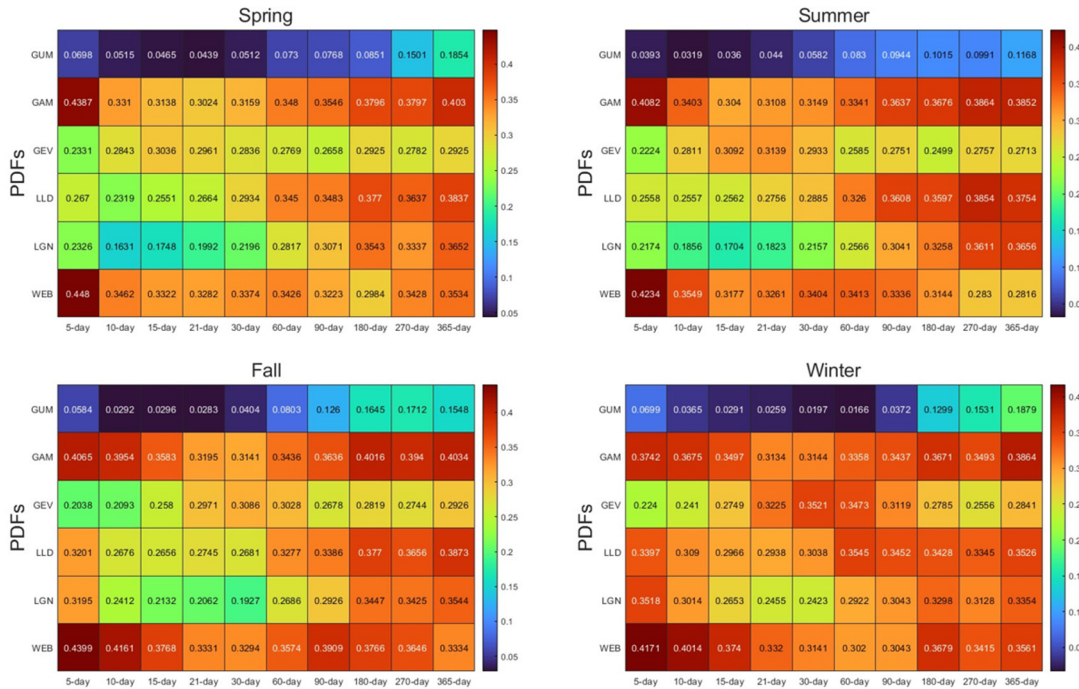


Figure S8. Heatmap of mean p of chi-square test for 6 candidate PDFs in 4 seasons. For mean p , we can also see that the overall p -value increases as the time-scale increases. However, in the case of WEB, the value of mean p is very high at short time-scales, and the value of mean p decreases as the time-scale increases.

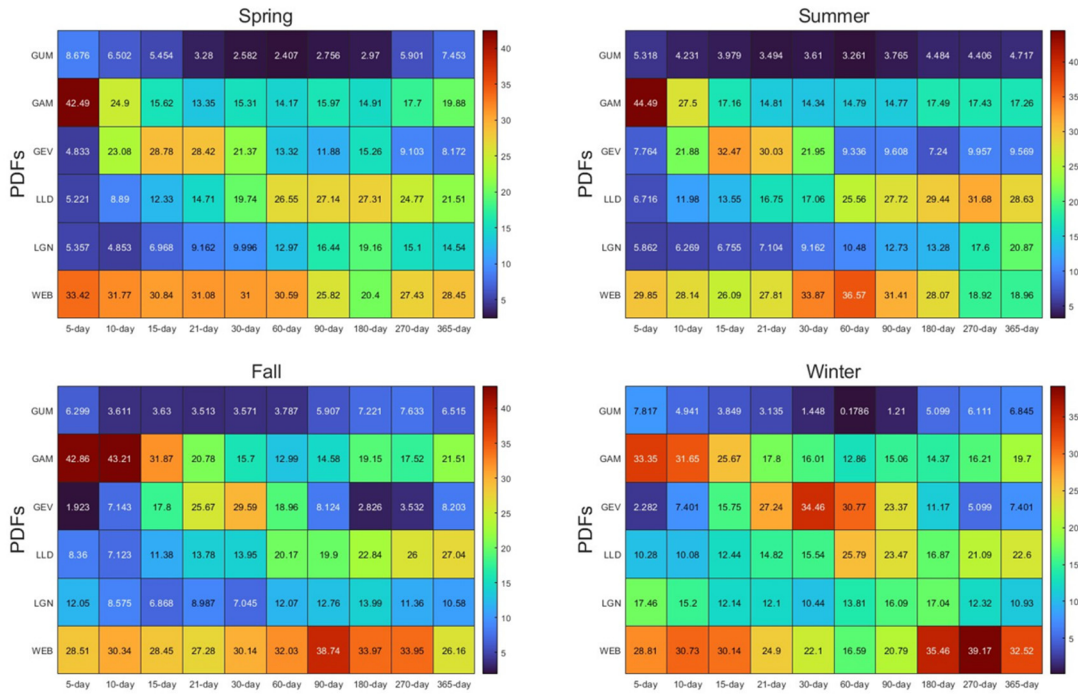


Figure S9. Heatmap of $w(\%)$ of chi-square test for 6 candidate PDFs in 4 seasons. $w(\%)$ shows that WEB is relatively superior at all timescales in all seasons. If you were to look at this figure alone, you would conclude that WEB is overwhelmingly superior, but $w(\%)$ is just the percentage with the highest p -value. It should be used as a guide in analyses alongside the results of other metrics.

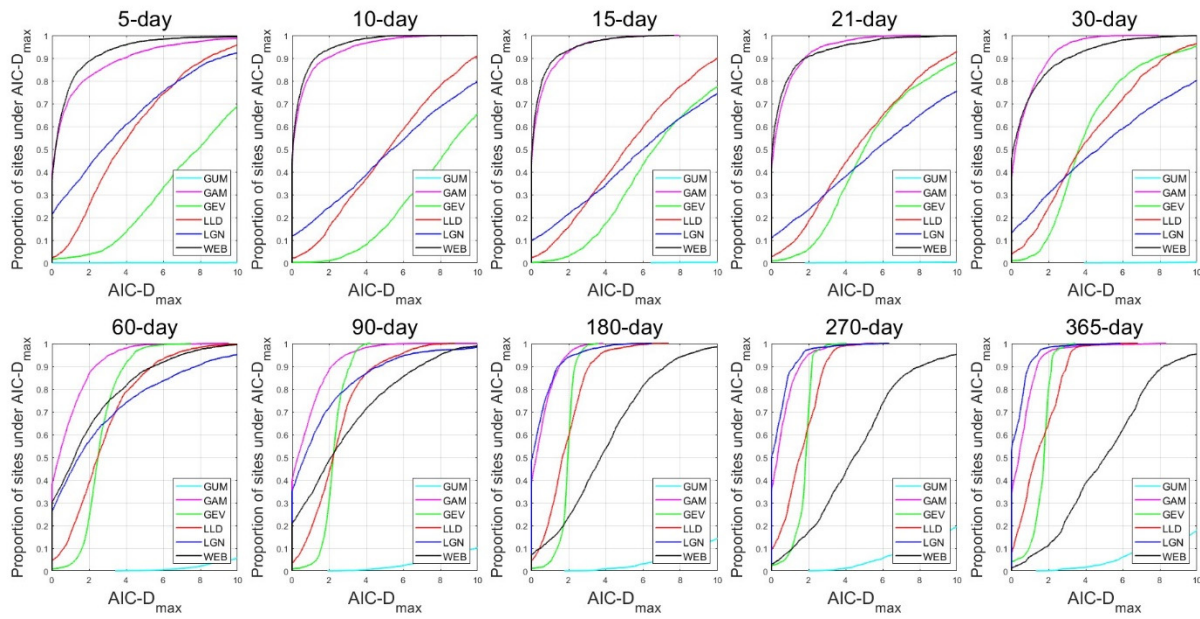


Figure S10. AIC frequencies for candidate PDFs in Gangwon region.

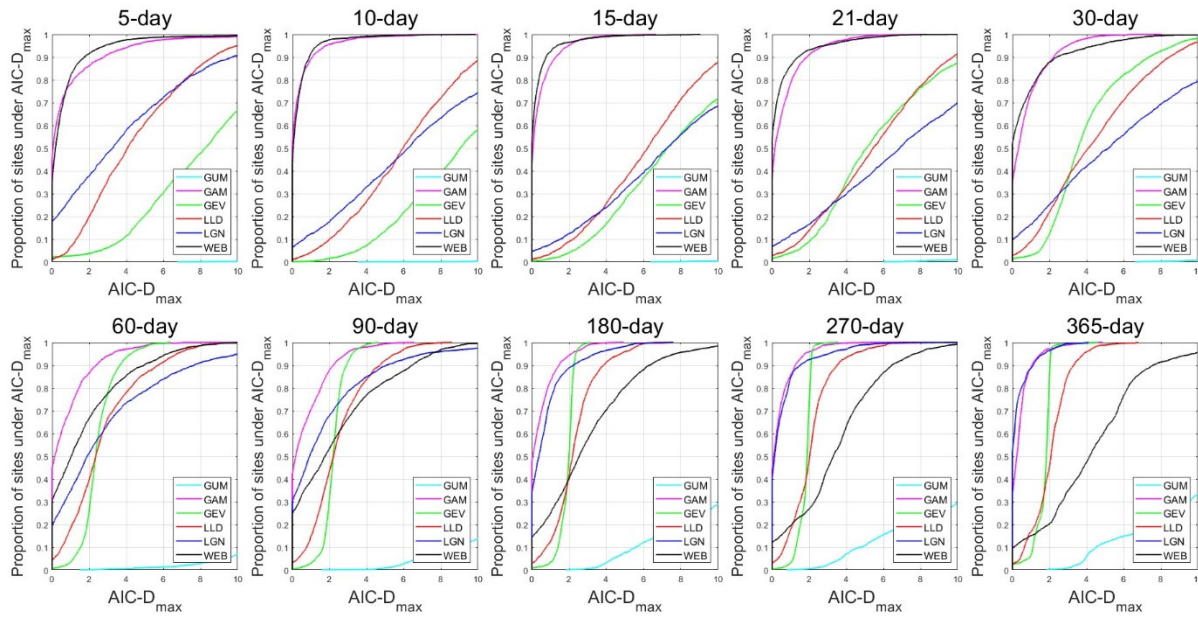


Figure S11. AIC frequencies for candidate PDFs in Capital region.

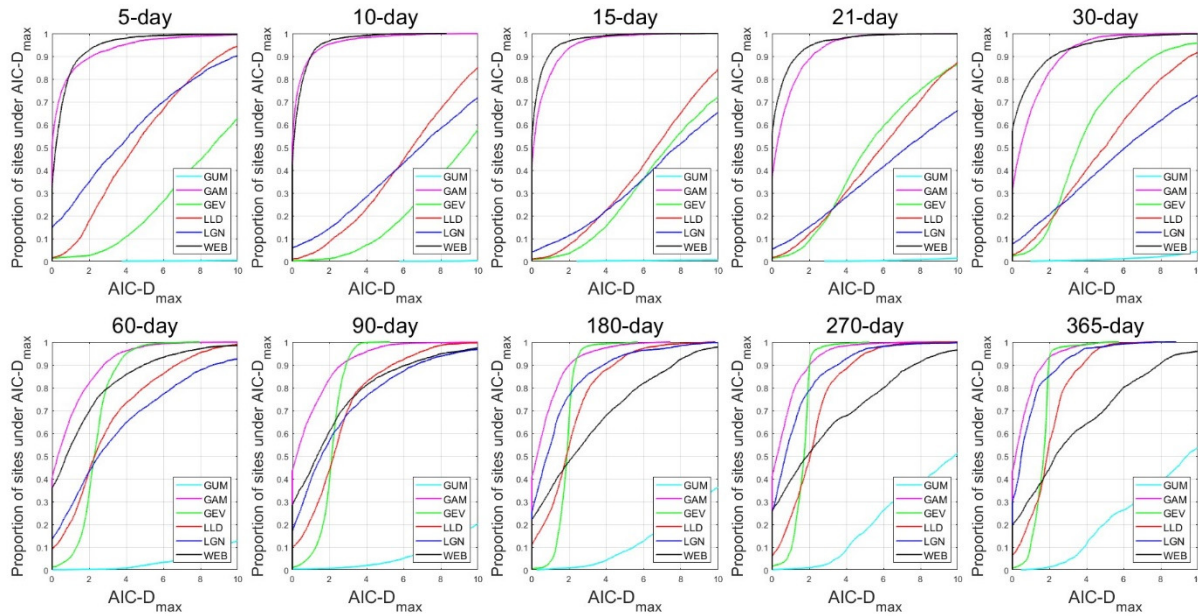


Figure S12. AIC frequencies for candidate PDFs in Buulgyeong region.

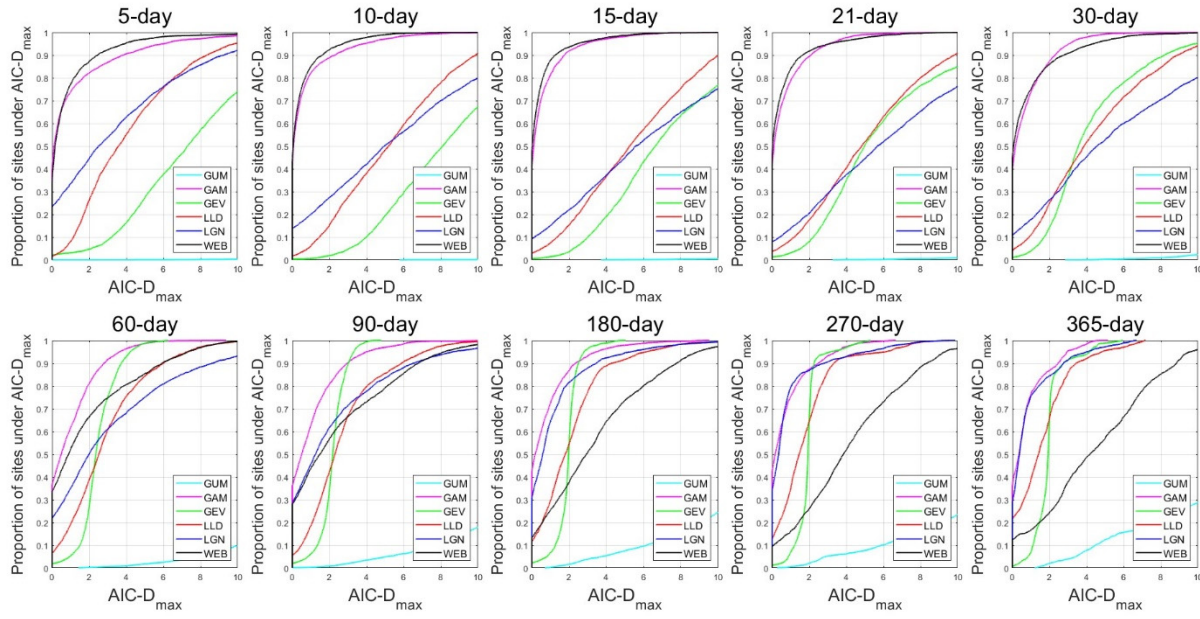


Figure S13. AIC frequencies for candidate PDFs in Daegyeong region.

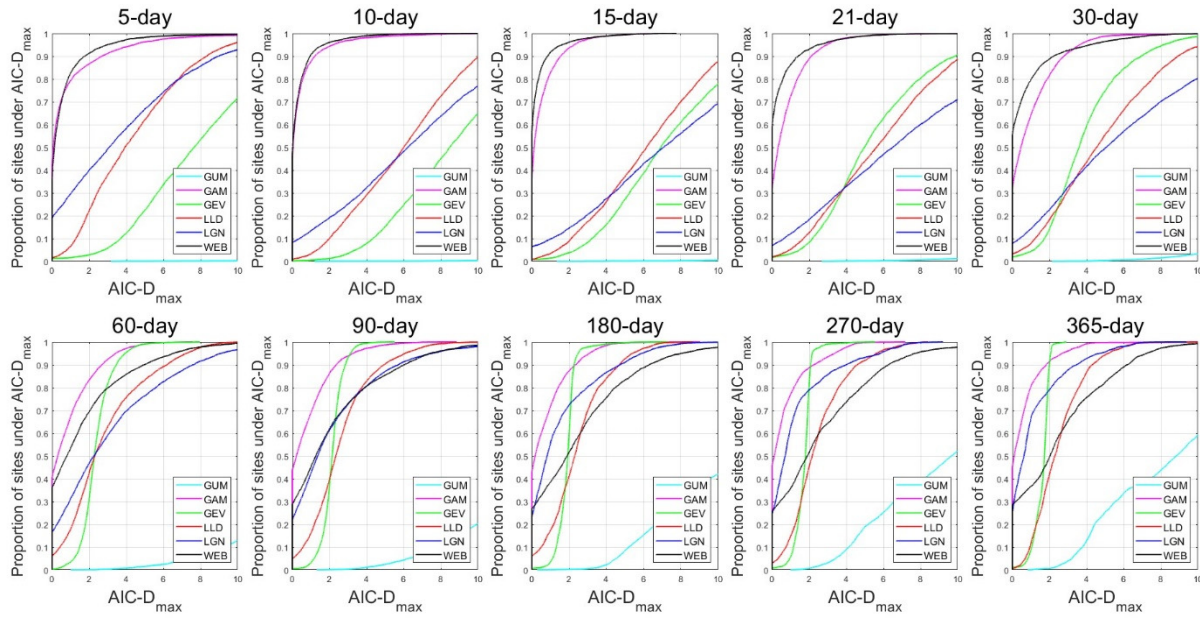


Figure S14. AIC frequencies for candidate PDFs in Honam region.

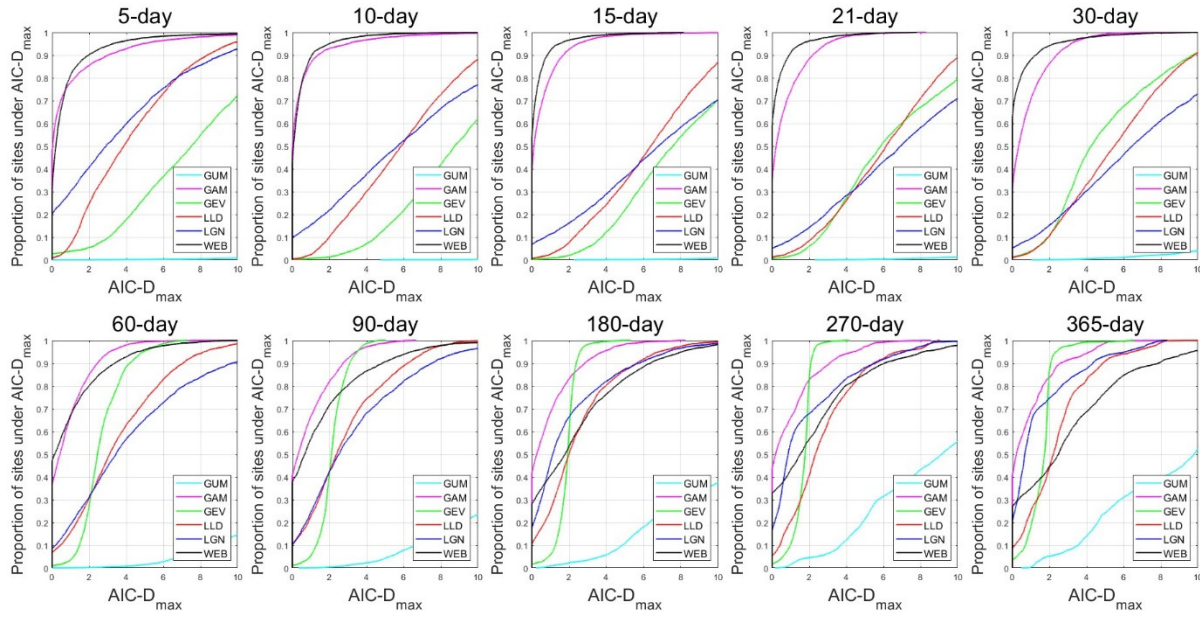


Figure S15. AIC frequencies for candidate PDFs in Chungcheong region.

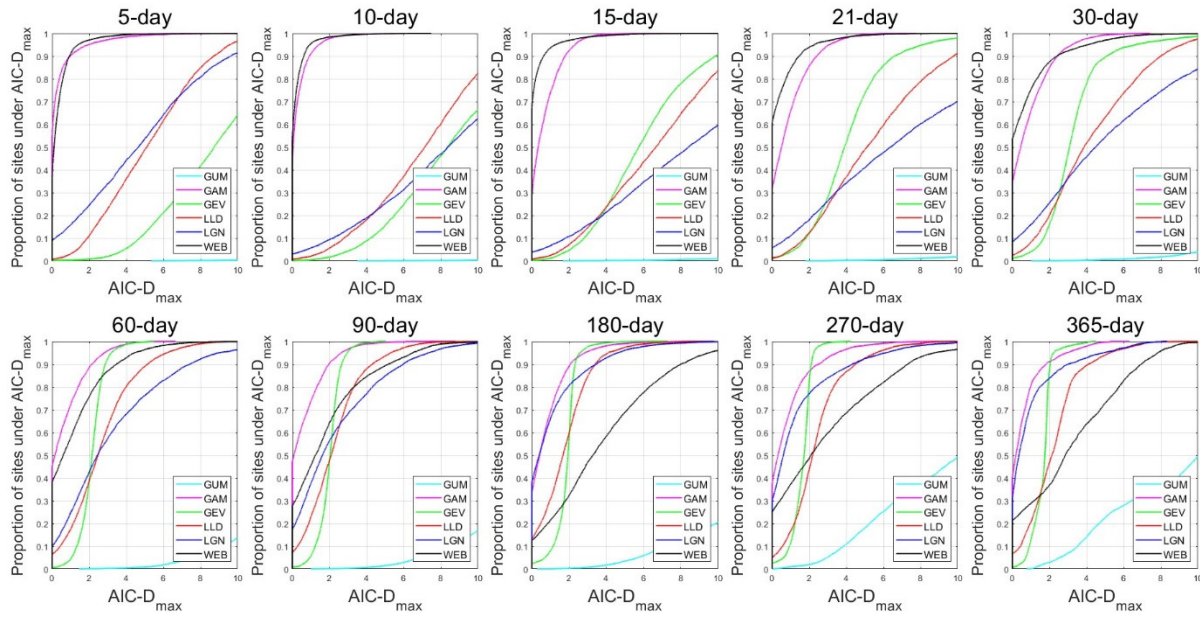


Figure S16. AIC frequencies for candidate PDFs in Spring season.

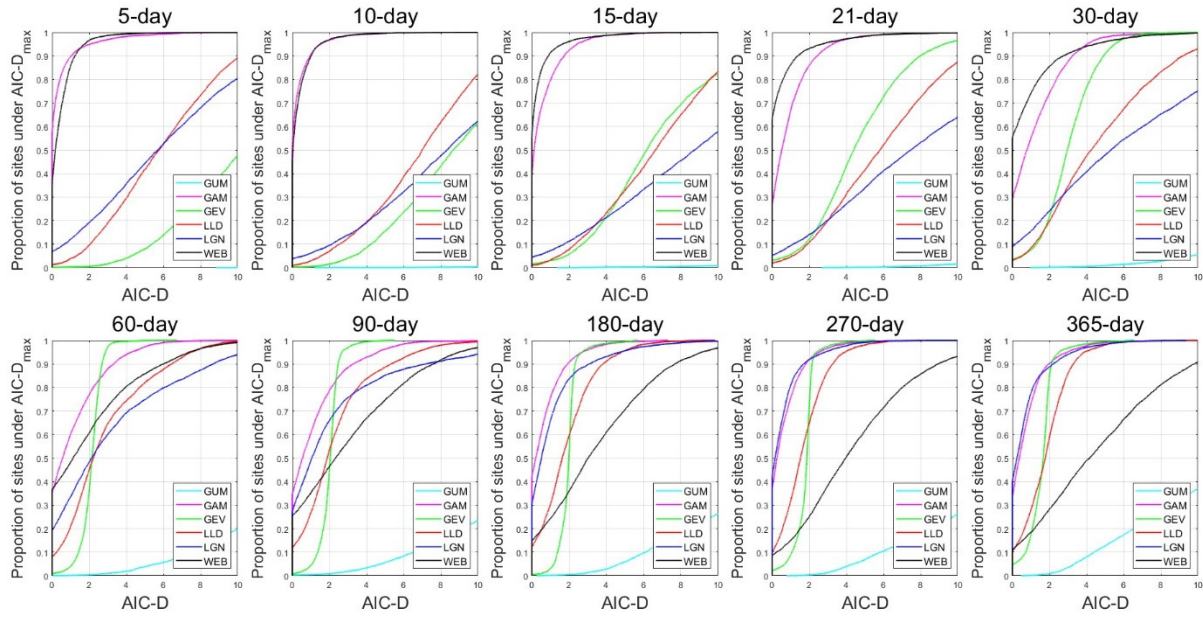


Figure S17. AIC frequencies for candidate PDFs in Summer season.

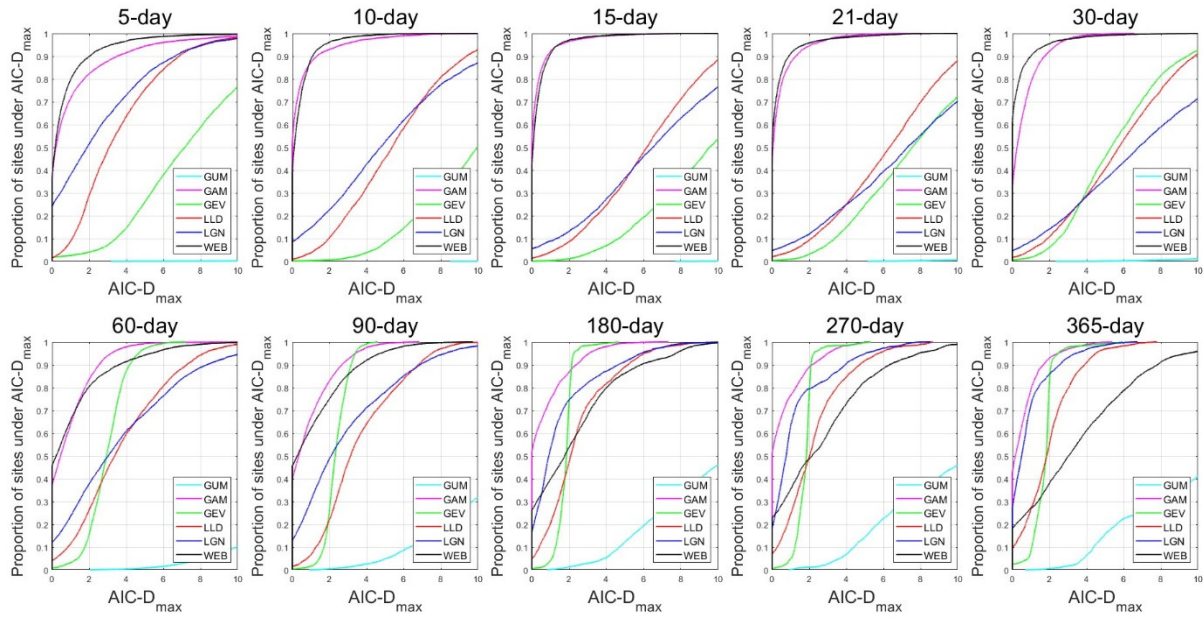


Figure S18. AIC frequencies for candidate PDFs in Fall season.

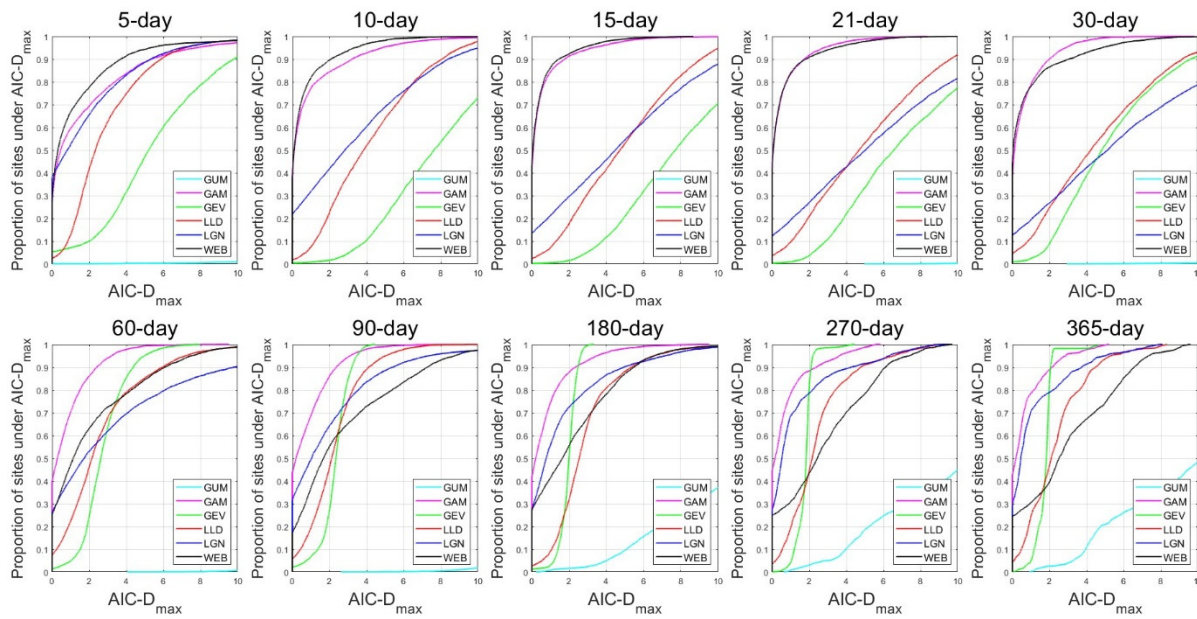
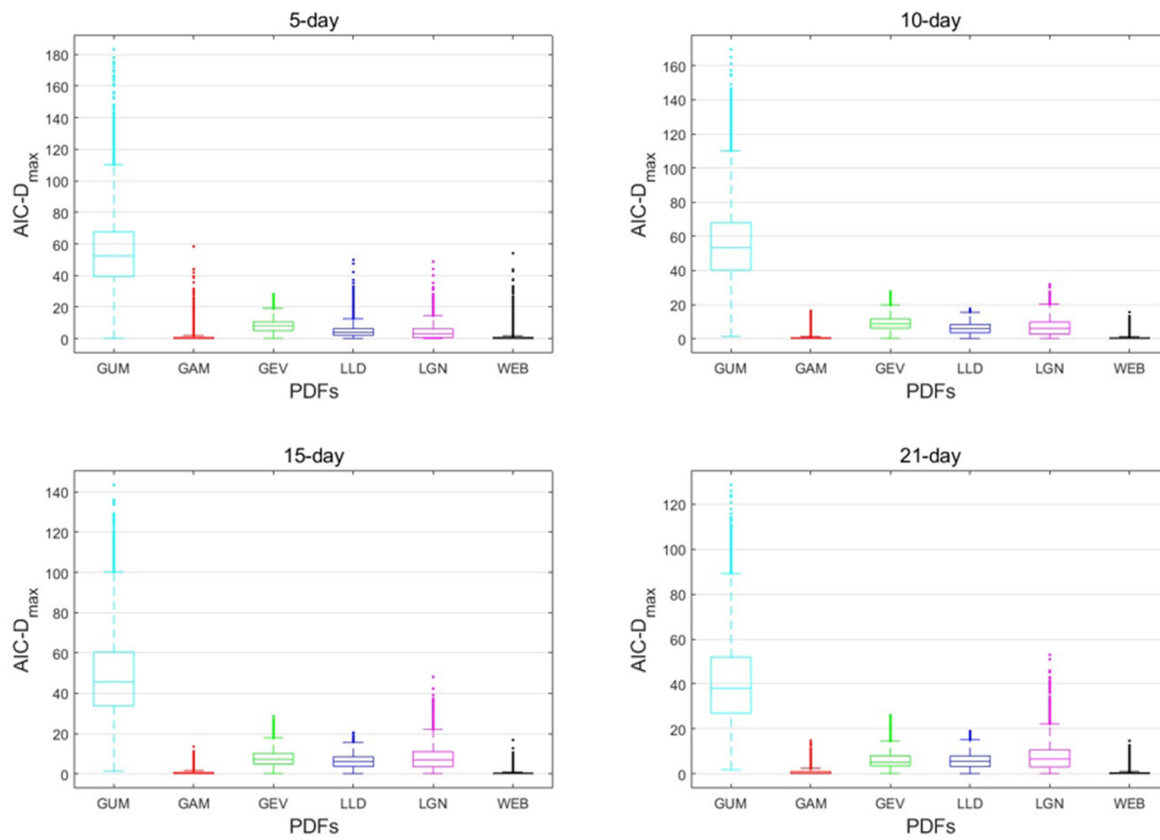


Figure S19. AIC frequencies for candidate PDFs in Winter season.



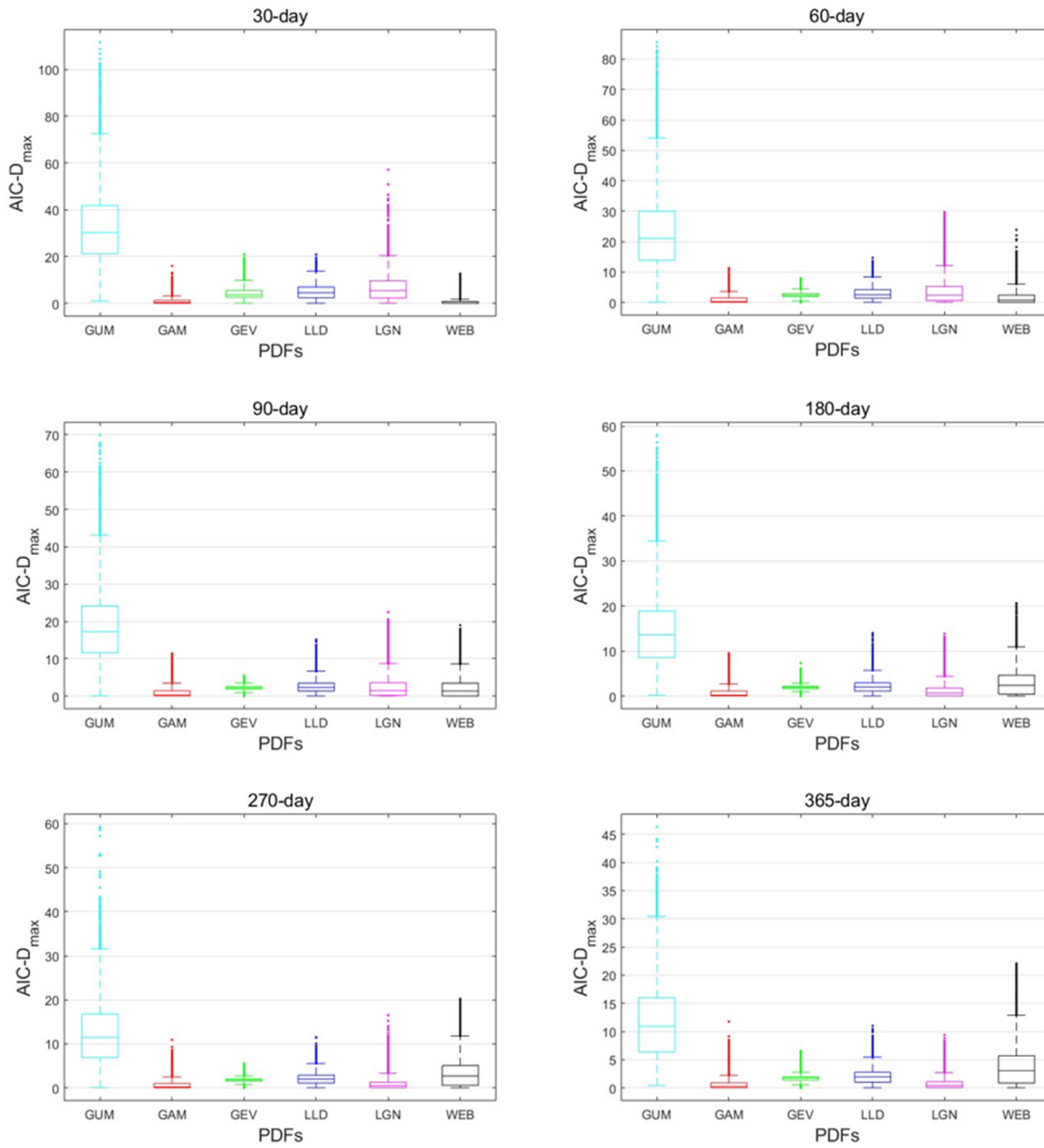
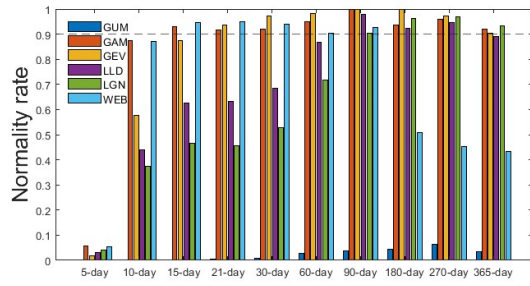
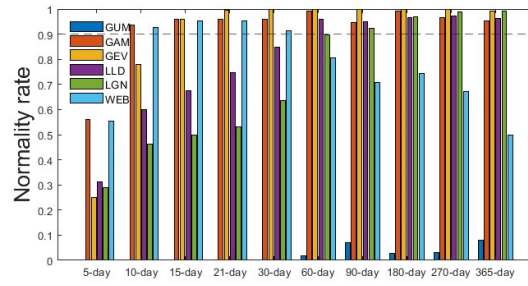


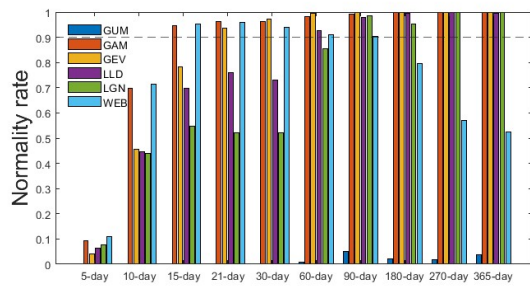
Figure S20. A box-plot showing $AIC - D$ values for each probability distribution by time-scale. It can be seen that GUM has a large $AIC - D$ value in all time-scales. GAM has a distribution of low $AIC - D$ values in all time-scales and can confirm excellent performance. In LLD and LGN, as the time-scale increases, the $AIC - D$ value generally decreases. In the case of WEB, excellent results are shown in a short time-scale, but as the time-scale increases, the distribution of $AIC - D$ values also increase.



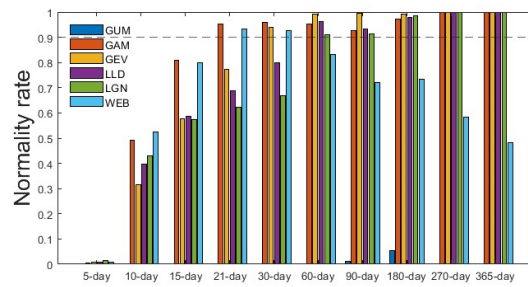
(a) Spring



(b) Summer

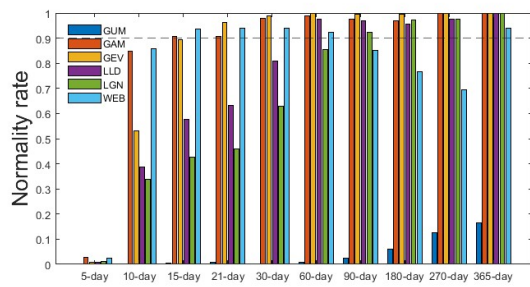


(c) Fall

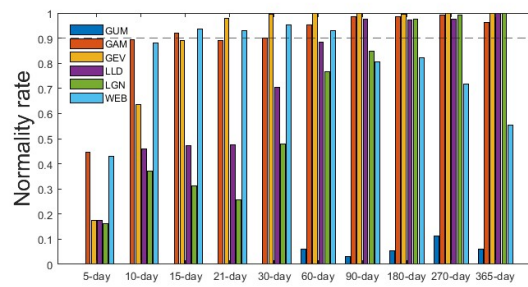


(d) Winter

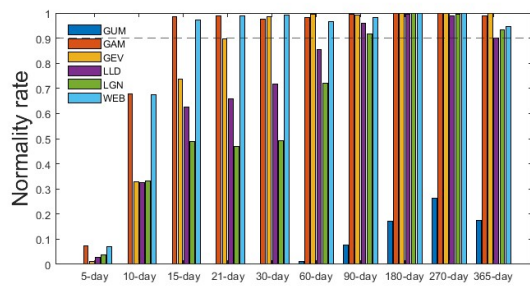
Figure S21. Normality ratio for 6 candidate PDFs in all seasons in the Gangwon region. (a) Spring, (b) Summer, (c) Fall, (d) Winter



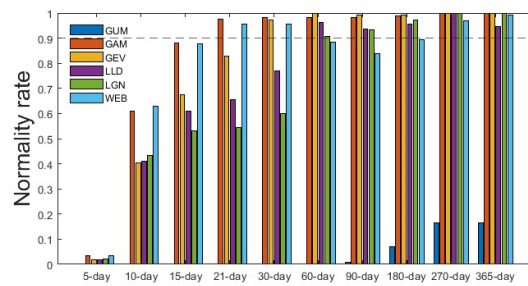
(a) Spring



(b) Summer

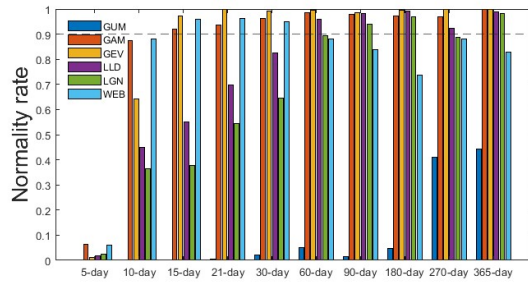


(c) Fall

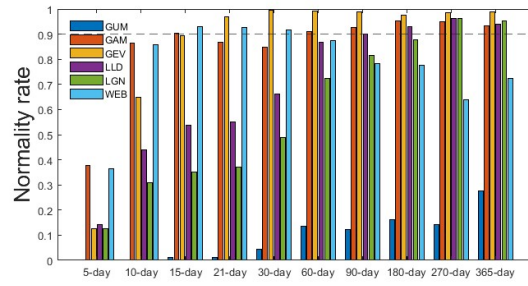


(d) Winter

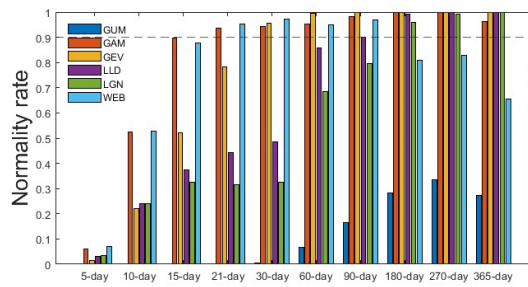
Figure S22. Normality ratio for 6 candidate PDFs in all seasons in the Capital region. (a) Spring, (b) Summer, (c) Fall, (d) Winter



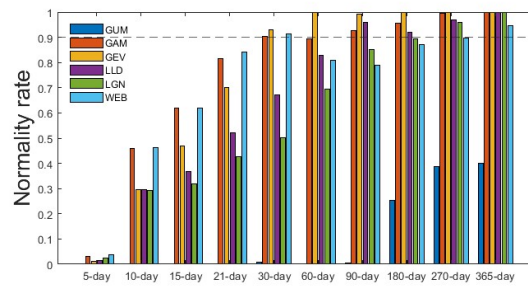
(a) Spring



(b) Summer

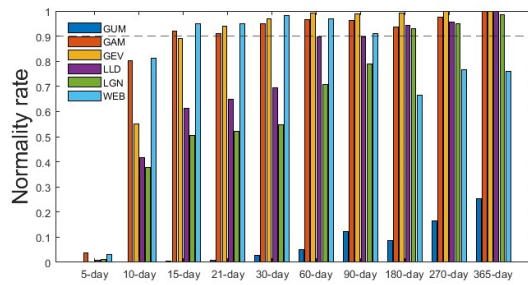


(c) Fall

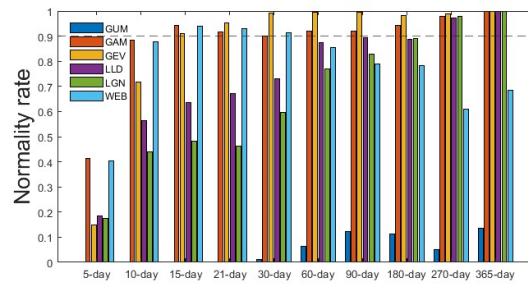


(d) Winter

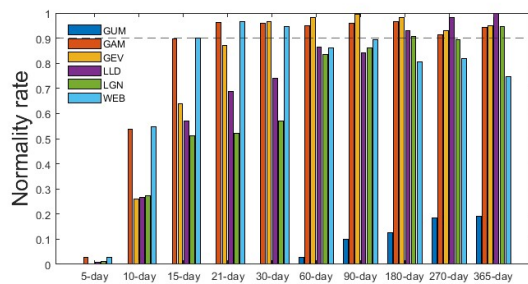
Figure S23. Normality ratio for 6 candidate PDFs in all seasons in the Buulgyeong region. (a) Spring, (b) Summer, (c) Fall, (d) Winter



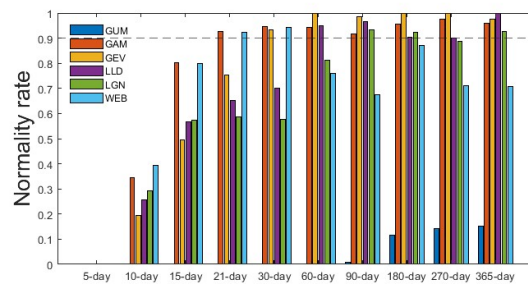
(a) Spring



(b) Summer

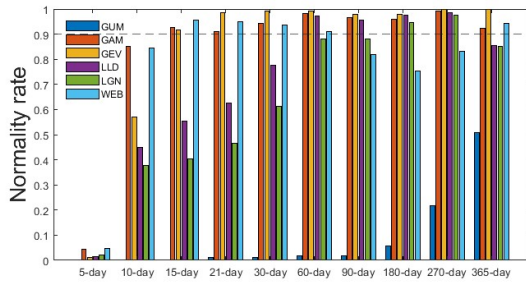


(c) Fall

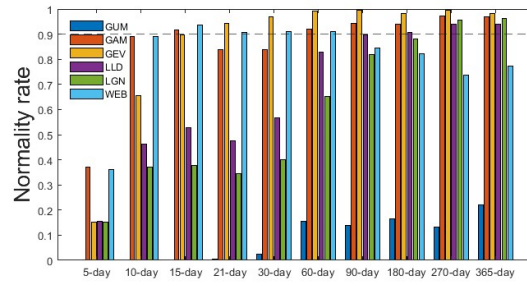


(d) Winter

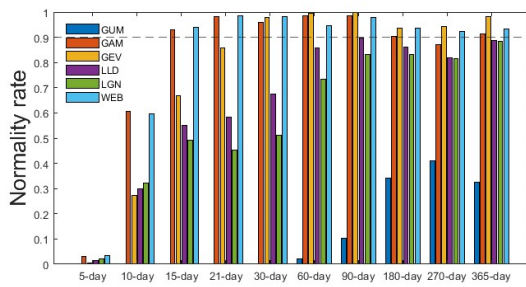
Figure S24. Normality ratio for 6 candidate PDFs in all seasons in the Daegyeong region. (a) Spring, (b) Summer, (c) Fall, (d) Winter



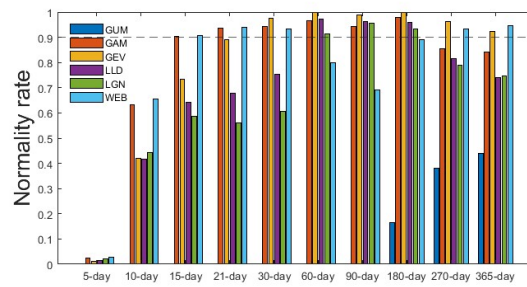
(a) Spring



(b) Summer

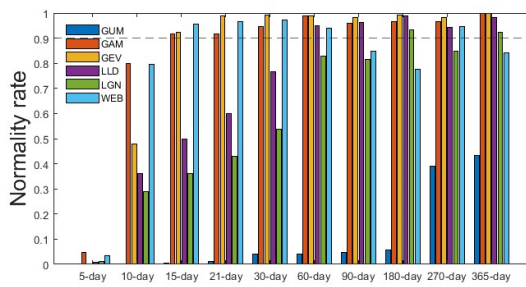


(c) Fall

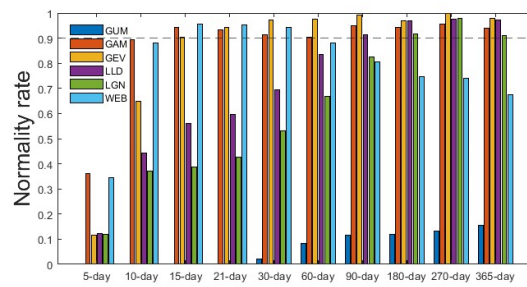


(d) Winter

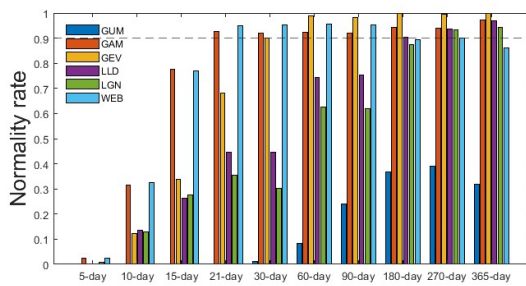
Figure S25. Normality ratio for 6 candidate PDFs in all seasons in the Honam region. (a) Spring, (b) Summer, (c) Fall, (d) Winter



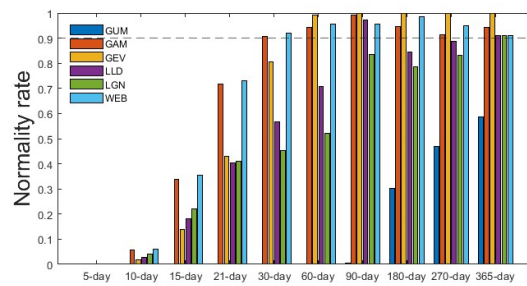
(a) Spring



(b) Summer



(c) Fall



(d) Winter

Figure S26. Normality ratio for 6 candidate PDFs in all seasons in the Chungcheong region. (a) Spring, (b) Summer, (c) Fall, (d) Winter

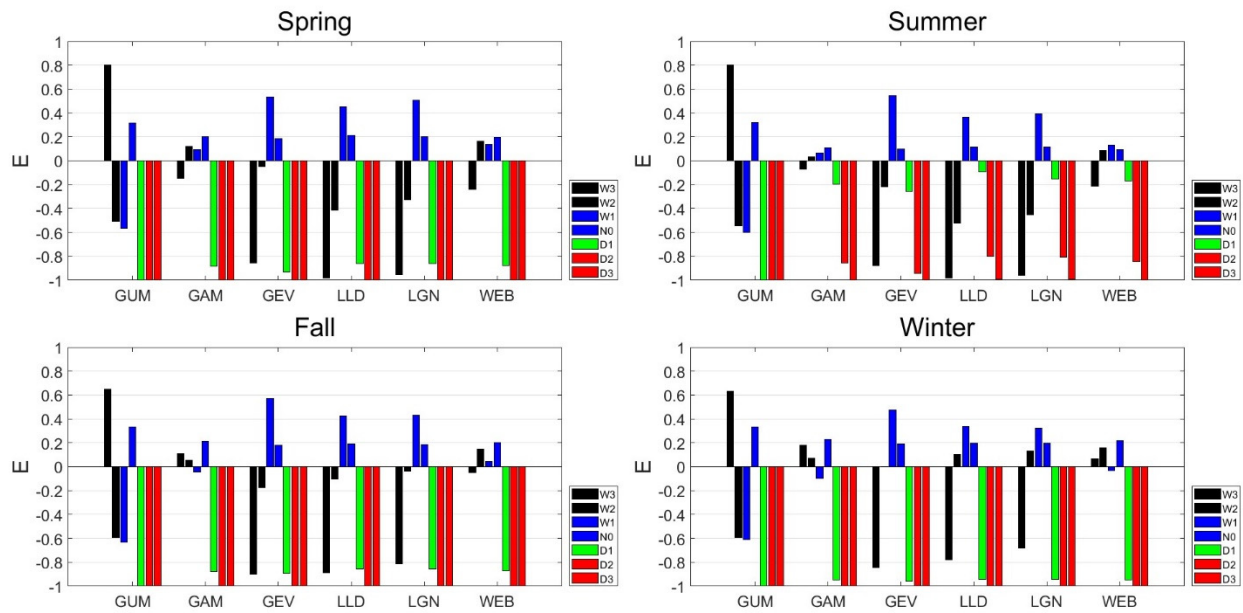


Figure S27. Error rate of SPI at 5-day calculated per drought class in all seasons across all sites.

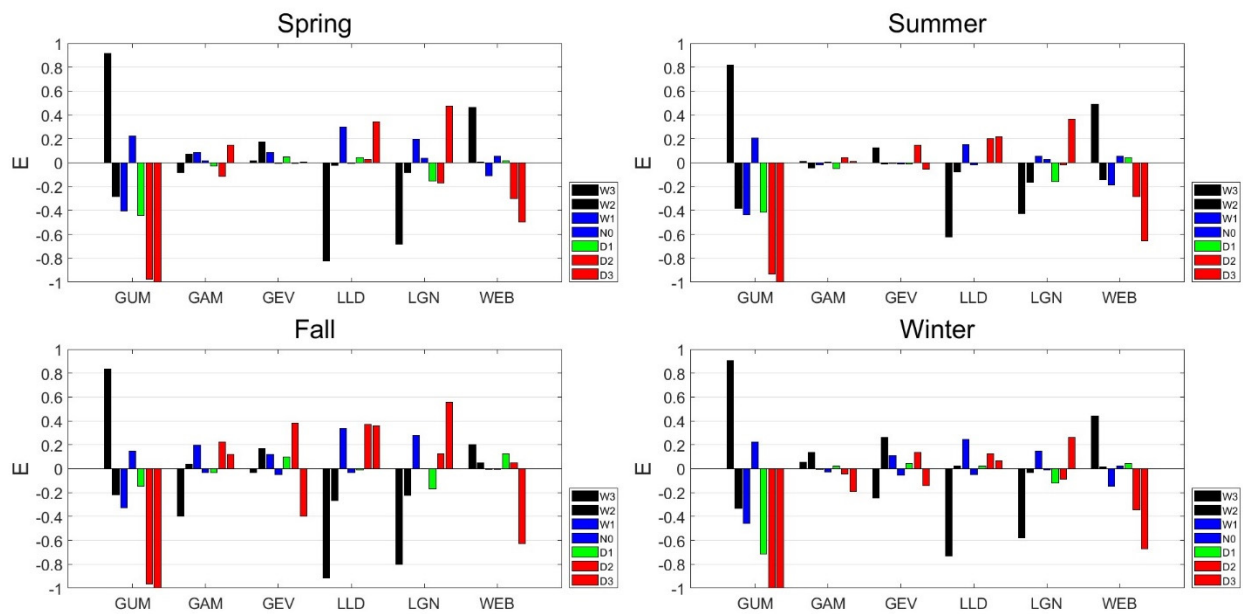


Figure S28. Error rate of SPI at 90-day calculated per drought class in all seasons across all sites.

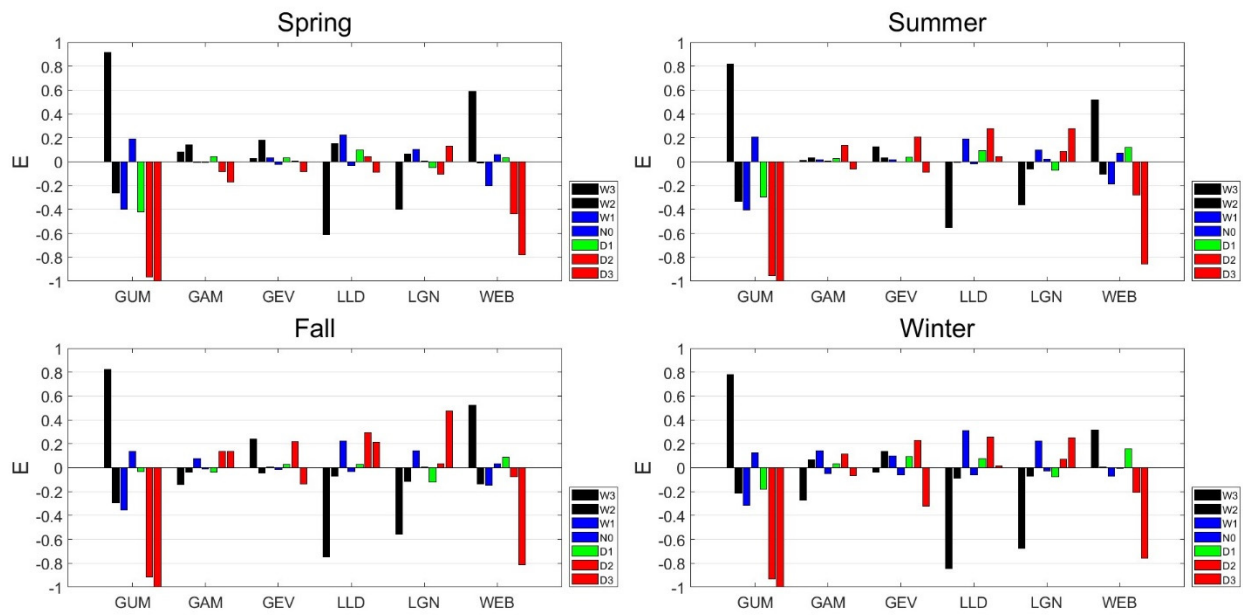


Figure S29. Error rate of SPI at 180-day calculated per drought class in all seasons across all sites.

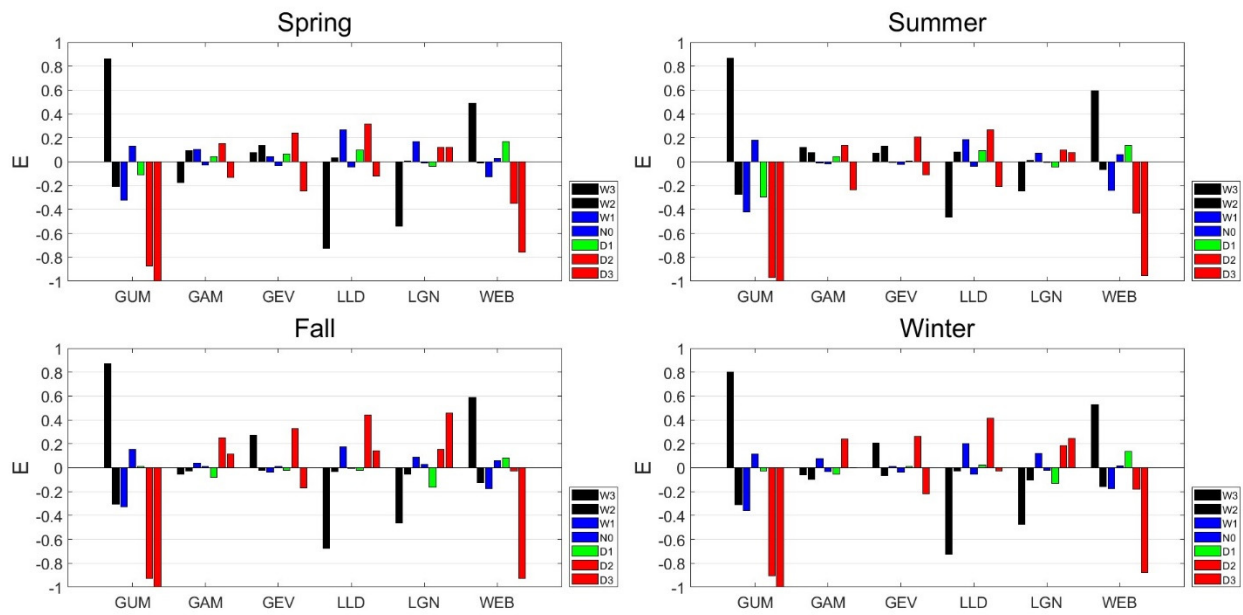


Figure S30. Error rate of SPI at 270-day calculated per drought class in all seasons across all sites.

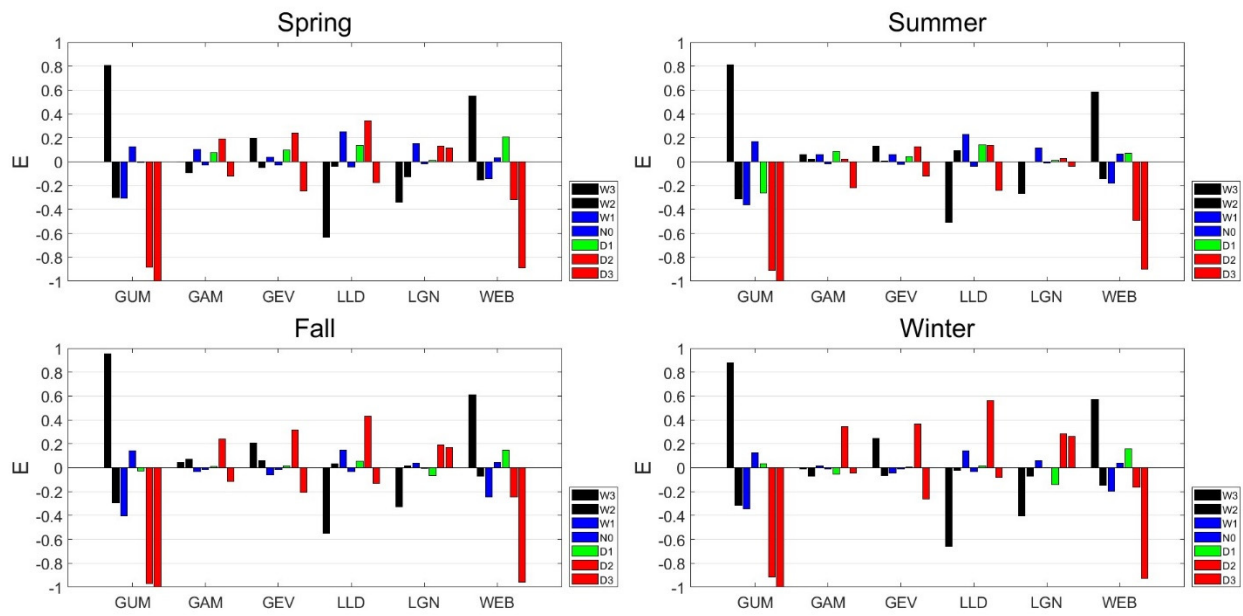
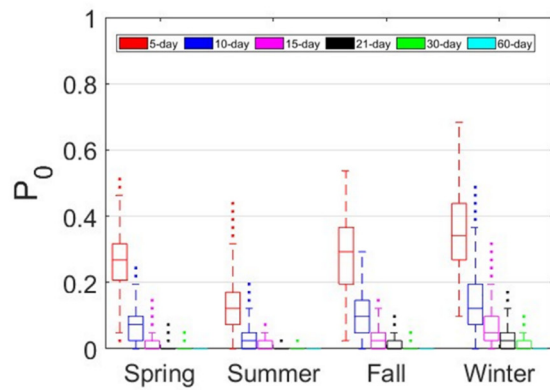
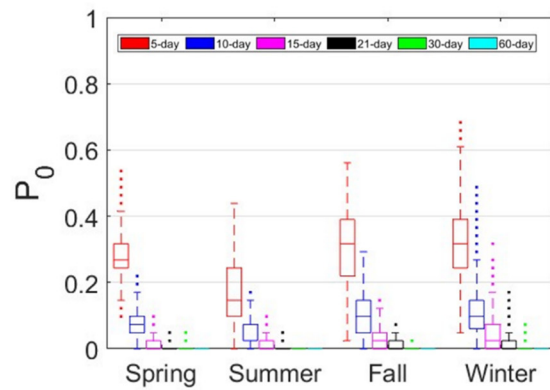


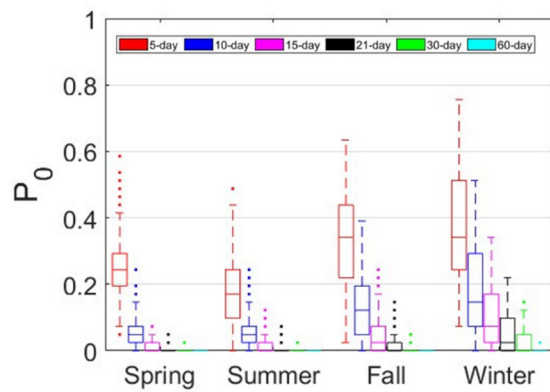
Figure S31. Error rate of SPI at 365-day calculated per drought class in all seasons across all sites.



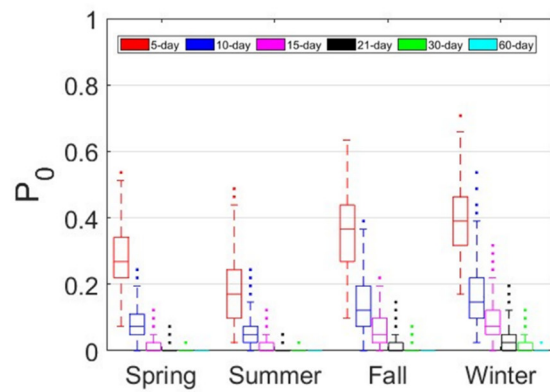
(a)Capital



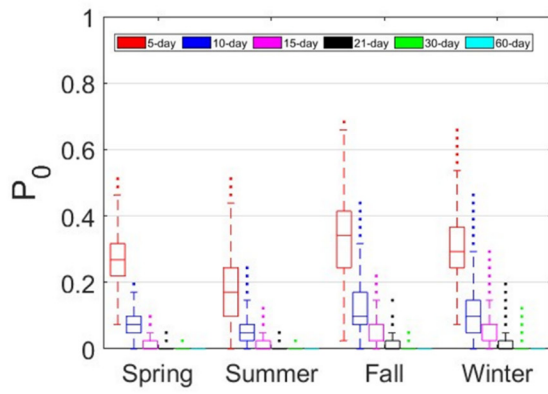
(b)Gangwon



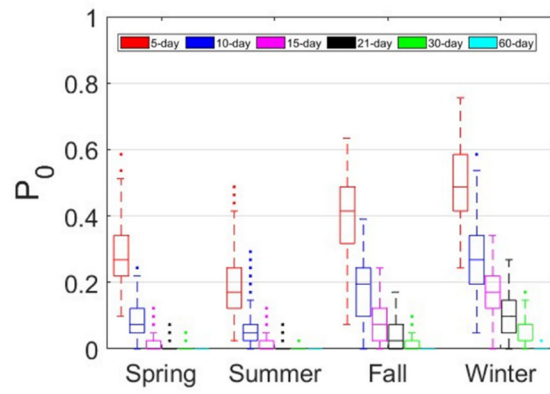
(c)Chungcheong



(d)Daegyeong



(e) Honam



(f) Buulgyeong

Figure S32. Rate of cumulative time series having zero value in all seasons of each time-scale (5-day, 10-day, 15-day, 21-day, 30-day, 60-day) for each region. (a) Capital, (b) Gangwon, (c) Chungcheong, (d) Daegyeong, (e) Honam, (f) Buulgyeong