Highlighted Achievements in 2025

3. Bridging the Gap in Seasonal Prediction: Development of Integrated Subseasonal to Seasonal Forecasting Approaches

● Dr. Suryun Ham (suryun01@apcc21.org) ● Dr. Young-Mi Min (ymmin@apcc21.org)
● Dr. Bong-Geun Song (songbg@apcc21.org) ● Mr. Soonjo Yoon (sjyoon@apcc21.org)
● Dr. Sinil Yang (siyang@apcc21.org)

Since 2017, the APEC Climate Center (APCC) has established a robust collaborative framework to support the Korea Meteorological Administration (KMA)'s operational one-month forecast by collecting, processing, and providing the latest subseasonal prediction information. This study describes the stable operation of the subseasonal prediction system and the deep learning-based probabilistic temperature forecasting system tailored for this purpose. In addition, the migration and improvement of data collection and forecast production servers were carried out to enhance operational efficiency. Through a case study, the system's performance in predicting detailed weather variability—which cannot be identified through monthly mean values alone—was verified. The results demonstrate the high utility of subseasonal prediction information in capturing intra-monthly variability. To address the limitations of seasonal prediction information in a rapidly changing climate, APCC has pursued the development of a subseasonal prediction system designed to enhance its utilization value.

To develop the APCC subseasonal prediction system, a wide range of global subseasonal-to-seasonal (S2S) prediction datasets were systematically collected and standardized. Using these datasets, we confirmed that the Multi-Model Ensemble (MME) provides stable and superior performance within the subseasonal prediction range. We also confirmed that the APCC's own model, with its diverse component model composition, can further increase the overall contribution to the MME. Furthermore, we evaluated parametric probabilistic prediction methods for temperature and precipitation in order to identify methodologies optimized for the statistical characteristics of each variable. The results indicate that parametric methods outperform non-parametric approaches in terms of quantitative predictive skill and can effectively reduce spatial noise arising from an insufficient ensemble size. Building on these research findings, we established the model configuration and probabilistic methods required for the APCC subseasonal prediction system. The system ingests weekly forecast data from 10 models, including APCC's SCoPS, BOM, NCEP, and HMC, to generate subseasonal prediction products. For the final MME production, the Simple Composite Method (SCM) is used for deterministic forecasts, while the Hybrid Gamma method is employed for probabilistic forecasts. This integrated system allows for the production and display of MME prediction results, initialized to start every Monday. To diversify and enhance the usability of subseasonal information, the study also explored and identified seamless content that integrates subseasonal weekly and monthly forecast information. We identified products that can be delivered immediately, such as integrated monthly/weekly probability distributions and weekly variability information, as well as more advanced products requiring additional technical development, including probabilities of intra-monthly extreme events.

Meanwhile, to include SCoPS as one of the contributing models, we developed a real-time subseasonal forecast system that produces 60-day forecasts every week, based on monthly seasonal forecasts. However, given the relatively old development baseline of SCoPS and its lower skill compared to other MME participating models, there is a clear need to reduce its systematic errors. To reduce land-related initial errors, which are critical for subseasonal prediction, we developed a soil moisture initialization technique for SCoPS and quantitatively evaluated its impact. We also examined how improvements in oceanic and atmospheric initial conditions influence prediction performance on both subseasonal and seasonal time scales. On the basis of these results, we have initiated pilot operations of the newly established APCC subseasonal prediction system to provide enhanced forecast information. We plan to develop display systems for weekly prediction products and select highly useful content for operational dissemination.

Highlighted Achievements in 2025

Subseasonal prediction provides forecast information on timescales ranging from 2 to 8 weeks and is rapidly gaining value for applications across a wide range of sectors, including disaster prevention, agricultural management, and hydrological and energy operations. However, due to the inherent characteristics of the forecast lead time, subseasonal prediction remains highly challenging, as both sensitivity to initial conditions and signals from external forces are relatively weak. The newly developed APCC subseasonal prediction system is expected to play a vital role in climate information services for the Asia-Pacific region through sustained operation and improvement. In particular, the expanded subseasonal forecast information is anticipated to support disaster prevention efforts and climate risk management that relies on forecast-based decision-making..

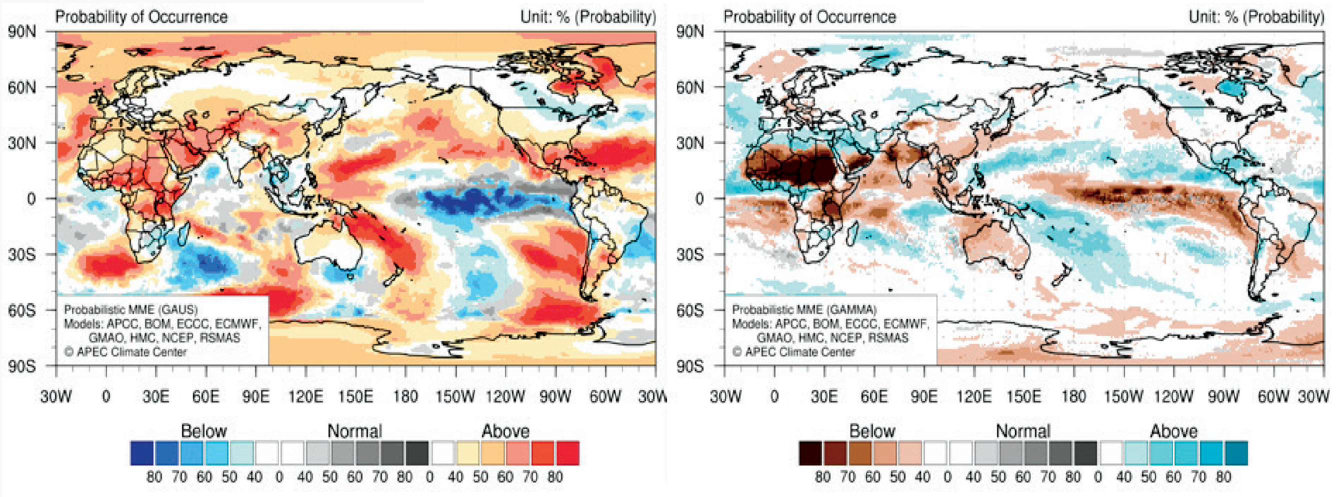

Fig 12 Probabilisic forecasts of 3-4 week mean temperature and precipitation produced by the subseasonal prediction system

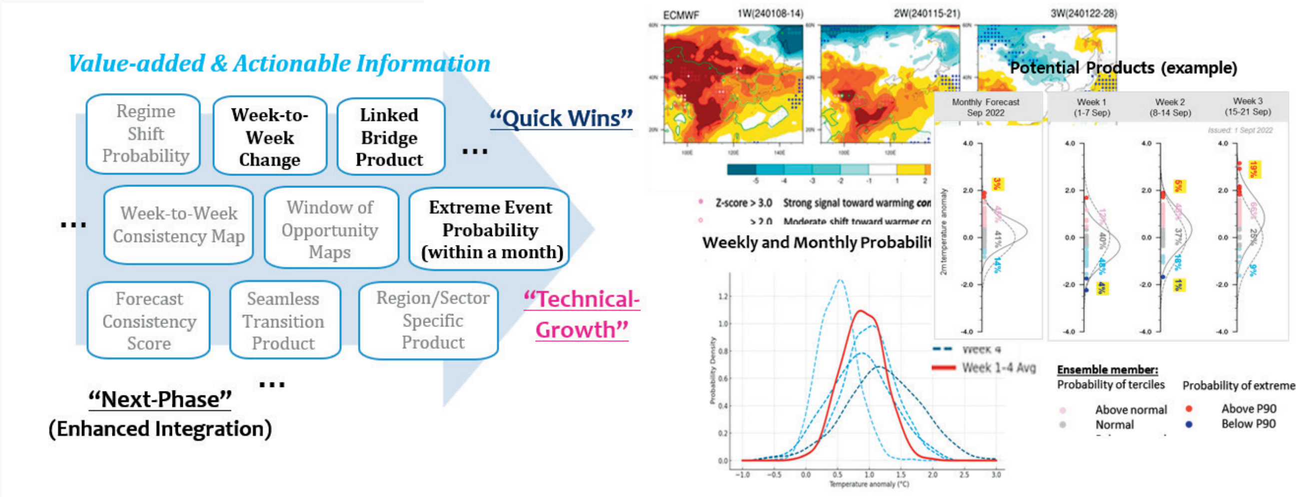

Fig 13 Example of potential contents to bridge subseasonal and seasonal (monthly) forecasts.