DECADAL CLIMATE PREDICTION (DCP) MODELS SKILL OVER SOUTHEAST ASIA

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Bogor, January 2025

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SUMMARY

DARA KASIHAIRANI. Decadal Climate Prediction (DCP) Models Skill Over Southeast Asia. Supervised by RAHMAT HIDAYAT and SUPARI.

Decadal Climate Predictions (DCPs) have emerged as a crucial component of the latest Coupled Model Intercomparison Project (CMIP6), offering valuable insights into climate variability over 10-year periods. These predictions are particularly significant for understanding Pacific Ocean variability and its influence on Southeast Asia climate patterns. This study evaluates the predictive capabilities of six General Circulation Model (GCM) DCPs through an Ensemble model approach, focusing on surface temperature and precipitation predictions across Southeast Asia. The evaluation utilizes the dcpp-A hindcast product and employs multiple assessment metrics, including Anomaly Correlation Coefficient (ACC), Root Mean Square Error (RMSE), Normalized Standard Deviation (NSD), and Taylor Diagram Skill Score (TDSS) to conclude the model skill objectively. The analysis encompasses 51 hindcast datasets from 1960 to 2010, with ERA5 reanalysis data serving as the reference benchmark. The evaluation was conducted for single-year evaluation, Lead Year 2 (LY2) to Lead Year 9 (LY9). Multi-year evaluation named FHDecad (average of LY2-LY5), SHDecad (average of LY6-LY9), and Decad (average of LY2-LY9).

Surface temperature predictions show robust temporal consistency with strong ACC values and minimal RMSE across lead years, primarily driven by anthropogenic factors. While spatial distribution is generally uniform across Southeast Asia, the northern mainland subregion (MLSEA) exhibits lower performance with reduced ACC values and elevated RMSE.

The maritime continent subregion (MCSEA) presents a complex picture - stronger correlation coefficients but high RMSE and underestimated variability. These precipitation prediction challenges likely stem from varying model capabilities in capturing regional climate dynamics and internal variability patterns, which significantly influence rainfall compared to temperature.

Precipitation predictions vary considerably across temporal and spatial domains, with peak performance during Lead Year 2 (particularly in winter months) and correlation skill in LY8-LY9. The decadal segmentation approach improves hindcast skill, with FHDecad consistently outperforming SHDecad according to TDSS metrics.

Keywords: decadal, dcpp-A hindcast, CMIP6, internal variability, evaluation.

RINGKASAN

DARA KASIHAIRANI. Kemampuan Model Prediksi Iklim Dekadal di Asia Tenggara. Dibimbing RAHMAT HIDAYAT dan SUPARI.

Prediksi Iklim Dekadal (DCPs) telah muncul sebagai komponen penting dalam *Coupled Model Intercomparison Project Phase 6* (CMIP6) terbaru, memberikan wawasan berharga tentang variabilitas iklim selama periode 10 tahun. Prediksi ini sangat penting untuk memahami variabilitas Samudra Pasifik dan pengaruhnya terhadap pola iklim Asia Tenggara. Penelitian ini mengevaluasi kemampuan prediktif enam *Global Circulation Model* (GCM) DCPs melalui pendekatan model Ensemble, yang berfokus pada prediksi suhu permukaan dan curah hujan di Asia Tenggara. Evaluasi ini menggunakan produk hindcast dcpp-A dan menerapkan beberapa metrik penilaian, termasuk *Anomaly Correlation Coefficient* (ACC), Akar *Root Mean Square Error* (RMSE), *Normalized Standard Deviation* (NSD), dan *Taylor Diagram Skill Score* (TDSS). Analisis ini mencakup 51 dataset hindcast dari tahun 1960 hingga 2010, dengan data reanalisis ERA5 sebagai acuan. Evaluasi dilakukan untuk periode tahunan tunggal, *Lead Year* 2 (LY2) hingga *Lead Year* 9 (LY9), serta evaluasi multi-tahun yang disebut FHDecad (rata-rata LY2-LY5), SHDecad (rata-rata LY6-LY9), dan Decad (rata-rata LY2-LY9).

Prediksi suhu permukaan menunjukkan konsistensi temporal yang kuat dengan nilai ACC tinggi dan RMSE minimal sepanjang tahun prediksi, terutama dipengaruhi oleh faktor antropogenik. Meskipun distribusi spasial umumnya seragam di Asia Tenggara, wilayah daratan utara (MLSEA) menunjukkan performa lebih rendah dengan nilai ACC yang berkurang dan nilai RMSE meningkat.

Wilayah maritim (MCSEA) menunjukkan hasil yang lebih kompleks - koefisien korelasi lebih kuat tetapi nilai RMSE juga tinggi dan variabilitas yang diperkirakan terlalu rendah. Tantangan prediksi curah hujan ini kemungkinan berasal dari kemampuan model yang bervariasi dalam menangkap dinamika iklim regional dan pola variabilitas internal, yang sangat mempengaruhi pola curah hujan dibandingkan suhu.

Prediksi curah hujan bervariasi secara temporal dan spasial, dengan kinerja puncak selama LY2 (terutama di musim dingin) dan muncul beberapa performa korelasi yang cukup baik di LY8-LY9. Pembagian periode dekadal meningkatkan kemampuan prediksi *hindcast*, dengan FHDecad secara konsisten menunjukkan kinerja lebih baik dibandingkan SHDecad berdasarkan metrik TDSS.

Kata Kunci: dekadal, hindcast dcpp-A, CMIP6, variabilitas internal, evaluasi.

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While acknowledging its limitations, I hope this work contributes meaningfully to the scientific community and serves as a valuable resource for future research.

Bogor, January 2025

Dara Kasihairani

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