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Chaotic Order of the Indonesian Seasonal Rainfall Predictability

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Lorenz (1969) found that each scale of motion possesses an intrinsic finite range of predictability. A small error in the initial state of a nonlinear system will grow and will render a forecast useless after some time, regardless of the model error. We analyze the long-term climatic data from the rain gauge observation, two reanalyses, a global atmospheric model (ECHAM4) and a regional climate model (REMO) to investigate the seasonal predictability of the Indonesian rainfall. The ECHAM4 was run at the T42 and T106 resolution, while REMO was run at the 0.5o degree resolution and was driven by the forcing of two reanalyses from the European Centre for Medium-range Weather Forecast and the National Centers for Environmental Prediction and National Center for Atmospheric Research and an ECHAM4 simulation, which the two reanalyses were also studied for its predictability characters. All simulation were performed for the climate from 1979 - 1993. For the REMO simulations using ERA15 and ECHAM4 forcing there are six ensemble members on each. Although coming from different sources of data, the analysis show that the predictability of the Indonesian rain has homogenous characters of regional and seasonal dependence. Furthermore, there is also dependence of the ENSO event, where during El Nino year the predictability is high. Regional wise, the predictability of the rainfall is higher in the ENSO sensitive regions than in the less sensitive region. Seasonal wise, the predictability is the highest during June/July/August and the lowest during March/April/May. The other two seasons or September/October/November and December/January/February have the predictive skill in between those two. The highest predictability in June/July/August is very fortunate especially during strong El Nino year, when all ENSO indicators develop into maturity and the peak of ENSO impact on the Indonesian rainfall is in August/September. The REMO study utilizes two ensemble simulations with two lateral boundary conditions from the European Centre Medium-range Weather Forecast reanalyses (ERA15) from 1979-1993 and from the ECHAM4 simulation from 1979 – 1988. Similar to previous result, this experiment shows seasonal dependence of the predictability, which is high in JJA, followed by SON and DJF. MAM is the lowest predictable season with several kinds of analyses including the internal and external predictability of REMO. Interestingly this seasonal dependence does not vary with different boundary conditions. The study suggests that an ensemble simulation has similar characters (low internal variances) to a single simulation. It is found that for the two reanalyses themselves and the global climate model simulation the seasonal skill is the highest in June/July/August, followed by September/ October/November, December/January/February

and March/April/May. The correlations usually break down in April (for monthly analysis) or in boreal spring (for seasonal analysis). This period seems to carry the persistent barrier for Indonesian rainfall predictability and skill. The study shows better seasonal than monthly model skills and shows the breakdown of the correlation in spring (MAM). The highest skill occurs in JJA, followed by SON, DJF and MAM. The rainfall data predictability study represents variability of rainfall data and the REMO study represents skills of a regional model. While the reanalysis predictability study, on the other hand, represents skills of a global climate model and two reanalyses over the region. The same reanalyses were used as the lateral boundary conditions for REMO study. From all works discussed here, MAM seems to carry the persistent barrier for Indonesian rainfall predictability and skill that may be related to the known spring predictability barrier and seems to relate strongly to ENSO events, especially the starting of an ENSO event. The predictability barrier exists especially in the eastern regions.