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AN EXTENDED-RANGE WEATHER FORCAST OVER TWO WEEKS USING A COUPLED WRF-ROMS MODEL: A CASE STUDY OF CHAO PHRAYA (CPY) RIVER BASIN

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Abstract- This study is focusing on validating 2-week heavy rainfall events in 2011 to see how well the model can estimate rainfall in the next two weeks over the CPY river basin.

Keywords: 2-week rainfall forecast, Coupled WRF-ROMS, Rainfall prediction, Thailand

1. Introduction

It is acknowledged that, nowadays, short- term weather forecasts (3-7 days in advance) are becoming even more accurate and showing significant skill, but not too perfect. However, looking beyond the first seven days of model prediction, speaking of 14 days or 2 weeks is far more challenging and would yield better benefits for weather forecast and water resources management in Thailand.

2. Methodology

This study is focusing on validating how well a dynamical modeling system can reproduce extreme rainfall over two weeks. In this case, a modeling system called Coupled- Ocean-Atmosphere-Wave-Sediment Transport (COAWST) that was originally developed by the U.S. Geological Survey (USGS) was used [1]. It represents a complex interaction between several components of the Earth System (e.g., atmosphere, ocean, wave, sediment transport, and sea-ice). The prediction skill of the couple modeling system was showed to be reliable over Thailand and, then has been officially operating for 3-7-days weather forecasting at the HII since 2016 [2]. Here, we focus on synoptic to meso-scale weather phenomena, specifically heavy rainfall events with extending period for a 2-week prediction. An atmospheric model (WRF) and a regional oceanic model (ROMS) embedded in the COAWST system were activated for this study by which the models were concurrently coupled for exchanging momentum and heat fluxes.

In 2011, Thailand suffered from severe flooding, mainly due to moisture surplus transported from the Indian Ocean into the region by the southwest monsoon causing above-average rainfall in March and April. Heavy rains continued throughout the summer together with overland flow crossing over the north of the Chao Phraya River basin (CPY) during the rainy season (July to September) due to several tropical storms. The study, therefore, selected two heavy rainfall events that occurred over the CPY during 20-30 June 2011 (EXP-01) and 28 July to 4 Aug 2011 (EXP-02) which were associated with the tropical storms Haima and Nockten, respectively.

For model configurations, two experiments were designed by following the selected heavy rainfall events. Each experiment was setup for a 15-day simulation (one day for model spin- up) with two different lead times (i.e., initialized at 1-week and 2-week before an event occurred) to investigate whether the model can see the upcoming heavy rainfall events in the first and second weeks. To obtain a high spatial resolution of rainfall, double-nested domains were employed for WRF with a horizontal resolution of 25 km and 5 km with 38 vertical levels. To include the impact of SST from Indian Ocean and Pacific Ocean into the model integration, a single domain of ROMS was setup with a horizontal resolution of 25 km and with 16 layers for vertical depths (Figure 1).

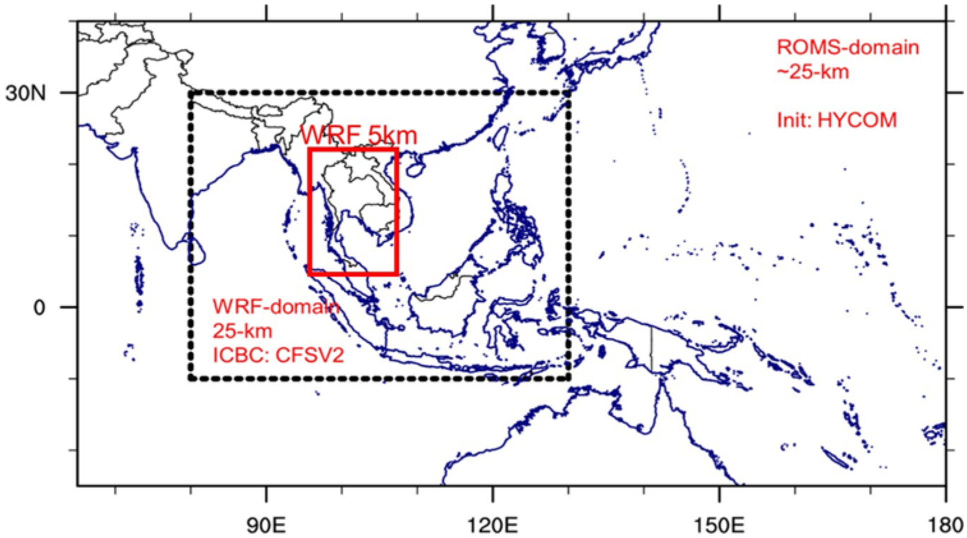

Figure 1 Modeling domains with a 2-nested WRF and a single ROMS domain

For the initial and boundary conditions of WRF, 6-hr NCEP Climate Forecast System (CFS) Reanalysis data was used to update meteorological fields. The simulated net surface heat and momentum fluxes were then transferred to the ROMS model, which in turn, feeds sea surface temperature (SST) information back to WRF model by which the exchanging interval between two models is hourly. In this case, states of the ocean (i.e., SST, salinity, and ocean currents) were initiated by using near-real-time global ocean hindcast (analysis) data provided by the Hybrid Coordinate Ocean Model (HYCOM) and the Navy Coupled Ocean Data Assimilation (NCODA). For statistical analysis, weekly simulated rainfall over the CPY during the selected events were compared with observation considering mean bias (MB) and root mean square error (RMSE).

3. Results and discussion

As a result, the model generally shows reasonable agreement with observation for both week-1 and week-2 in both cases (Figure 2).

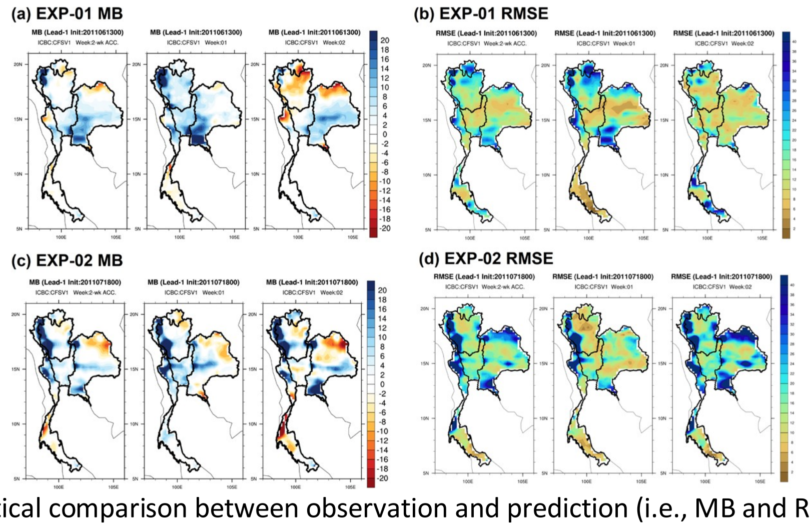

Figure 2 Statistical comparison between observation and prediction (i.e., MB and RMSE) with two different lead-times (week-1 and week-2).

Overall, the simulated rainfall is spatially and temporally varying also depending on case by case. For the EXP-01, at lead-1, two- week simulations yield better results compared to weekly predictions with absolute MB ≤ 6 mm/day and RMSE ≤ 20 mm/day. However, in this case, the model tends to overestimate and underestimate rainfall over the CPY region in week-1 and week-2, respectively. For the EXP-02, lead-1, the model is generally comparable to the observation, but an overestimation of rainfall can also be seen in both weeks with MB up to 20 mm/day and RMSE up to 40 mm/day in the western part of the upper CPY.

4. Conclusions

This study shows an effort in developing a modeling system weather prediction over two weeks, still, there are gaps opened for future research and more challenge for further model development. Currently, the modeling system has also been routinely operating at the HII for 2-week weather forecasting over the CPY basin and available online at https://live1.hii.or.th/product/latest/forecast/rainfall/cpy/wrfroms_cfsv2_cpy.html.

5. Acknowledgement

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6. **References**

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