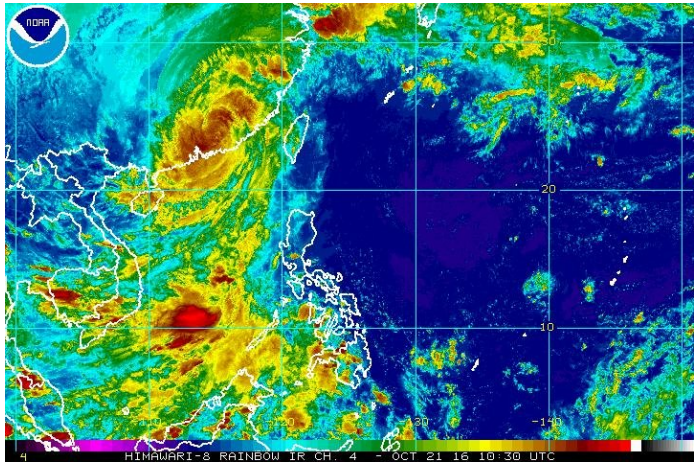
An extended-range weather forecast over two weeks using a Coupled WRF-ROMS model: A case study of Chao Phraya (CPY) river basin



Kritanai TORSRI
With contribution from my colleagues

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Bangkok, Thailand

THA 2022 International Conference on Moving Towards a Sustainable Water and Climate Change Management After COVID-19

Virtual Online: January 26th, 2022

CONTENTs

INTRODUCTION: HII's Weather Forecast Systems

OUR EVOLUTION

2011

- Operational WRF system for 7 days rainfall forecast

2012-2015

- Development of a coupled modeling system using **COAWST*** system

*** Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modeling System developed by USGS**

2016

- Official operational COAWST system (coupled models) for 7-day forecast

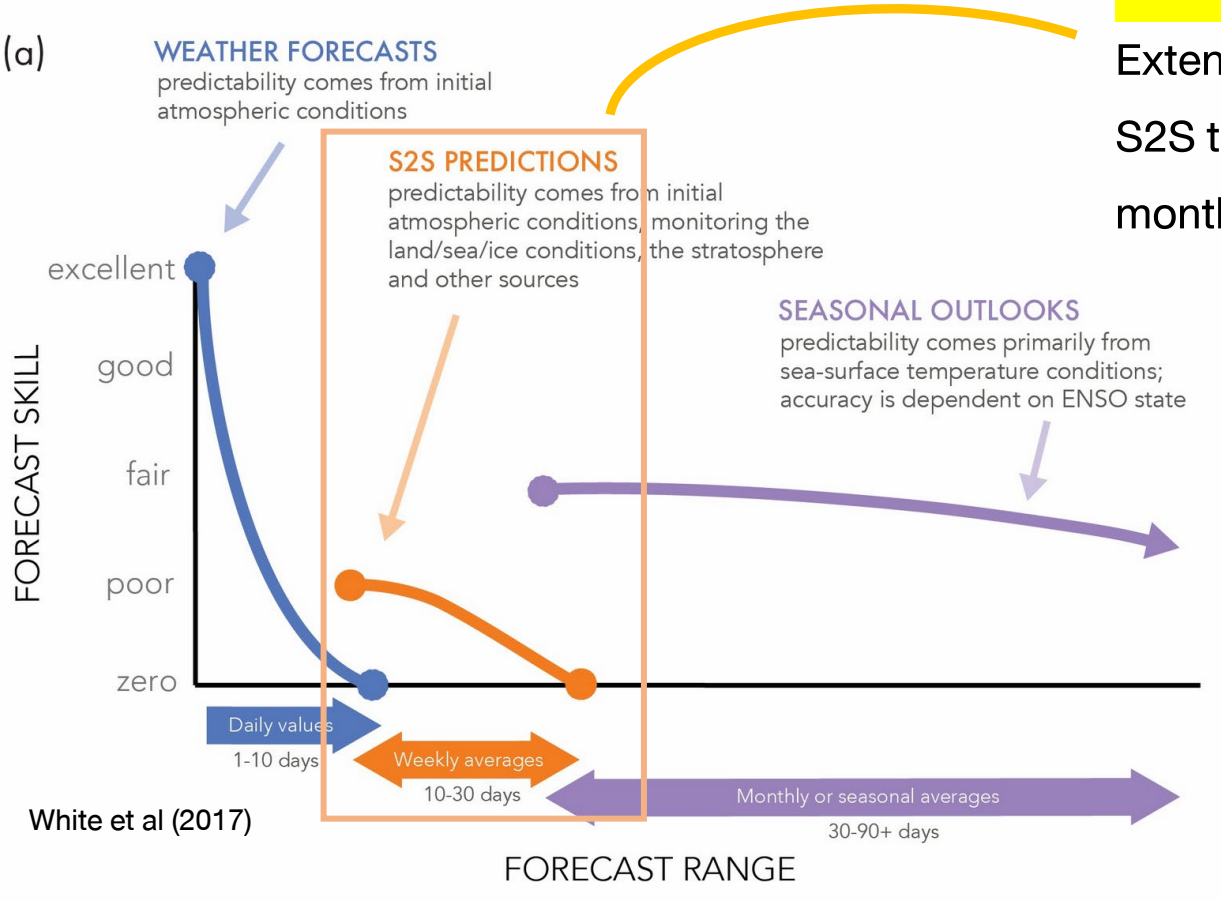
2017

- Improvement of **WRF Geogrid** (ThaiGeo) collaboration with the Joint Graduate School of Energy and Environment (JGSEE), King Mongkut's University of Technology Thonburi (KMUTT)

2019 ->>>

- Improving accuracy of the forecast system (e.g., DA, ML, AI, etc.)
- Extending range of forecast to S2S time scale (2 weeks to 2 months in advance)

INTRODUCTION: S2S



White et al (2017)

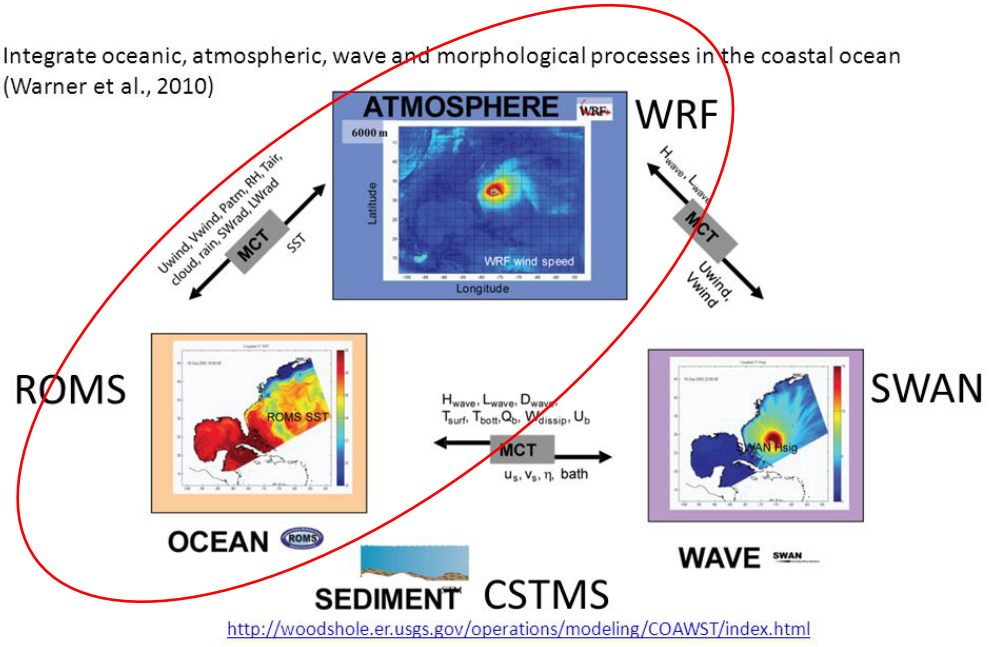
Our Goal:

Extending range of forecast to S2S time scale (2 weeks to 2 months in advance)

COAWST Modeling System

Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modeling System developed and freely available at USGS's site: https://www.usgs.gov/software/coupled-ocean-atmosphere-wave-sediment-transport-coawst-modeling-system

Integrate oceanic, atmospheric, wave and morphological processes in the coastal ocean (Warner et al., 2010)



http://woodshole.er.usgs.gov/operations/modeling/COAWST/index.html

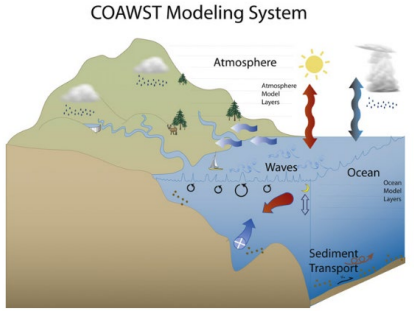
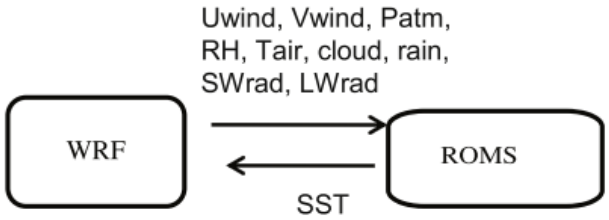


Fig. 1. The COAWST Modeling System comprising a coupler (MCT) that provides exchange between an ocean model, an atmosphere model, a waves model, and a sediment transport model.

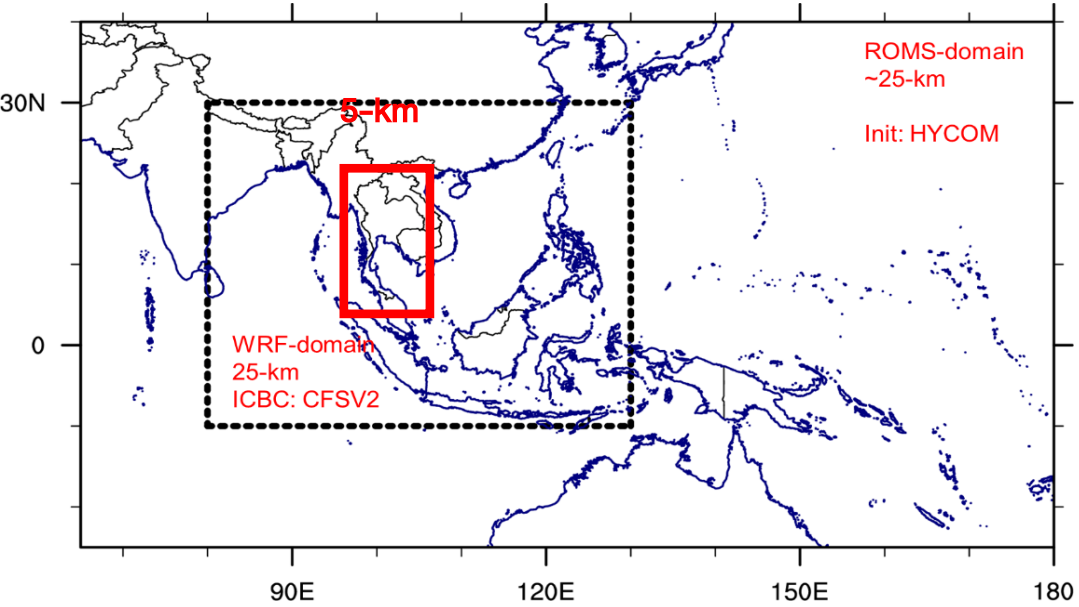
WRF + ROMS



Only WRF & ROMS are activated for HII's short-term weather forecast system.

Model Configurations

Modelling domains WRF-ROMS



WRF Model

Horizontal resolutions:

D01: 25 km and D02: 5 km with 38 vertical levels

CU: Grell 3D Ensemble Scheme

MP: Eta (Ferrier) Scheme

PBL: Yonsei University Scheme (YSU)

LSM: Noah-MP

ICBC: 6-hr NCEP CFS Reanalysis data

ROMS Model

Single domain: horiz. Res: 25 km with 15 vertical layers

Ocean States at initial time: HYCOM data

Exchanging momentum & heat variables between ATM & OCN Every 60 min.

Exp. Design & Model Evaluation Methods

- Interested Area: CPY
- Events: 2011 Big Flood in Thailand

  EXP-01 during tropical storm

  Haima: 20-30 June 2011

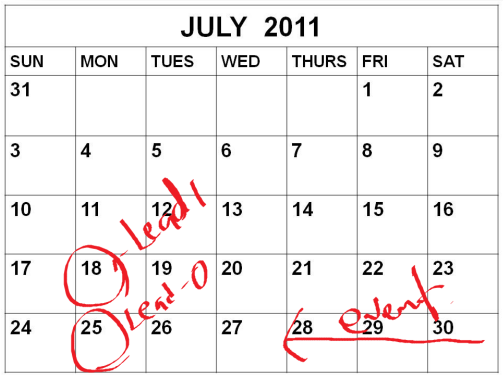
  EXP-02 during tropical storm and

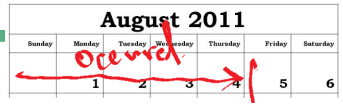
  Nockten: 28 July to 4

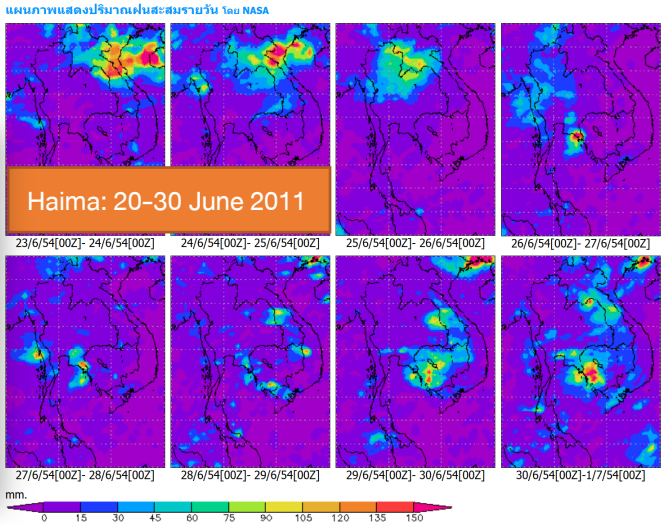
  Aug 2011

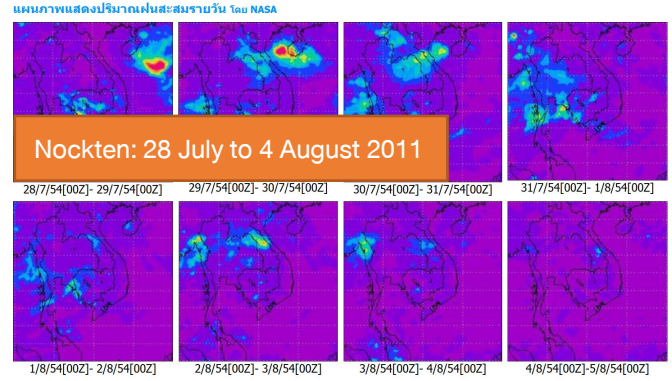
- Metrics: Mean Bias (MB), RMSE,

  and TCC

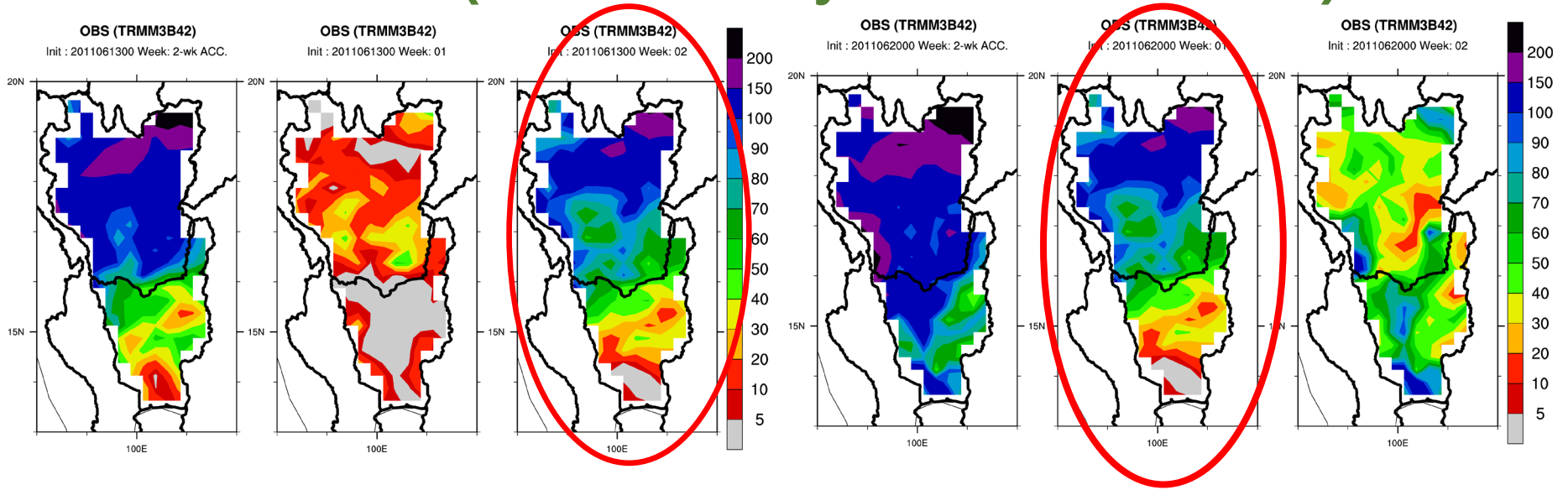








Haima Case (Rain Intensity from TRMM OBS)



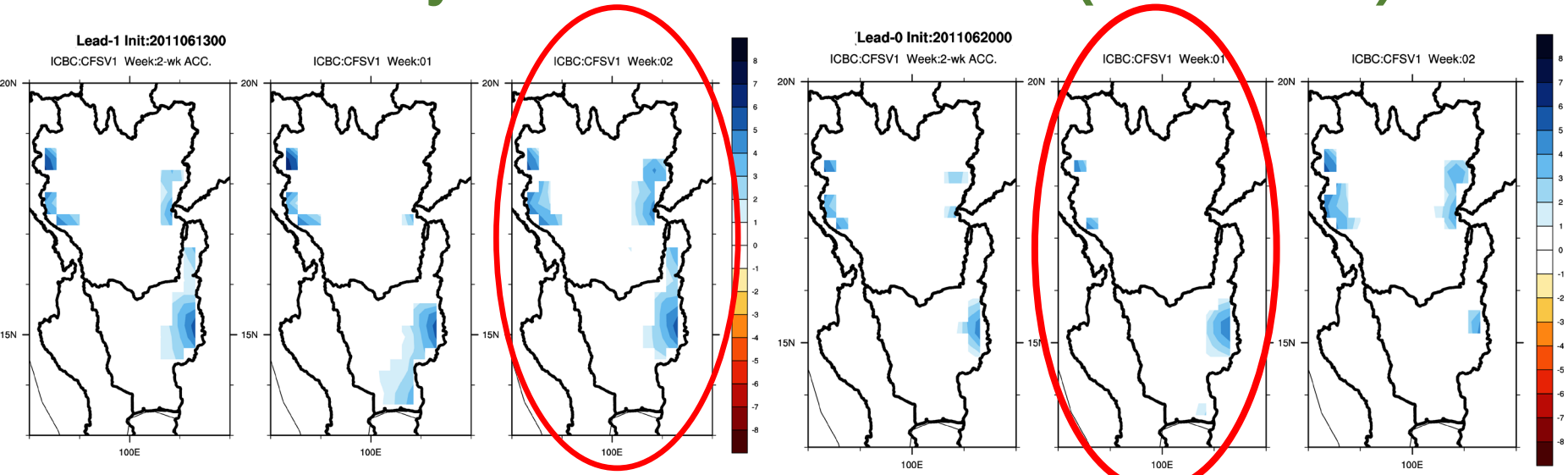
Before event occurred 1 week (Week-02)

Init: 2011-06-13-00 (Lead-1)

Event occurred at the 1st week (Week-01)

Init: 2011-06-20 (Lead-0)

Preliminary Results –Haima Case (Mean Bias)



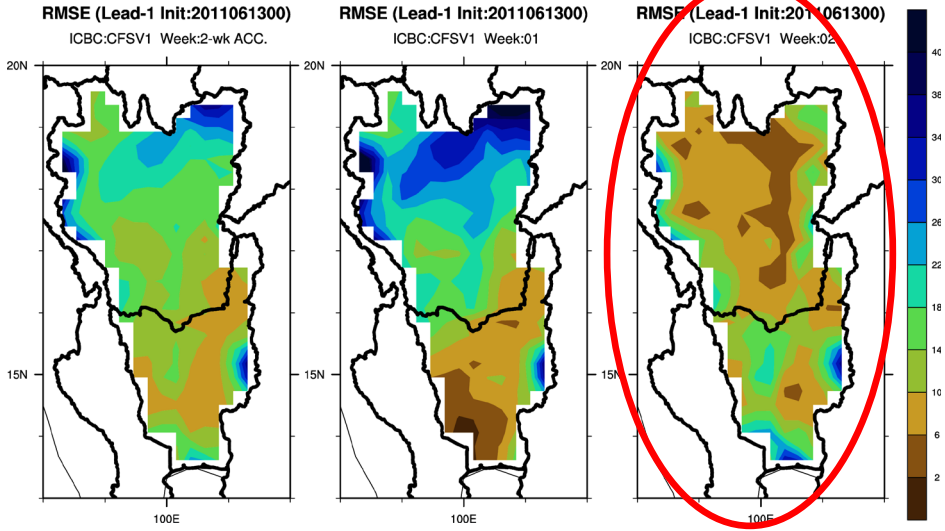
Before event occurred 1 week (Week-02)

Lead-1

Event occurred at the 1st week (Week-01)

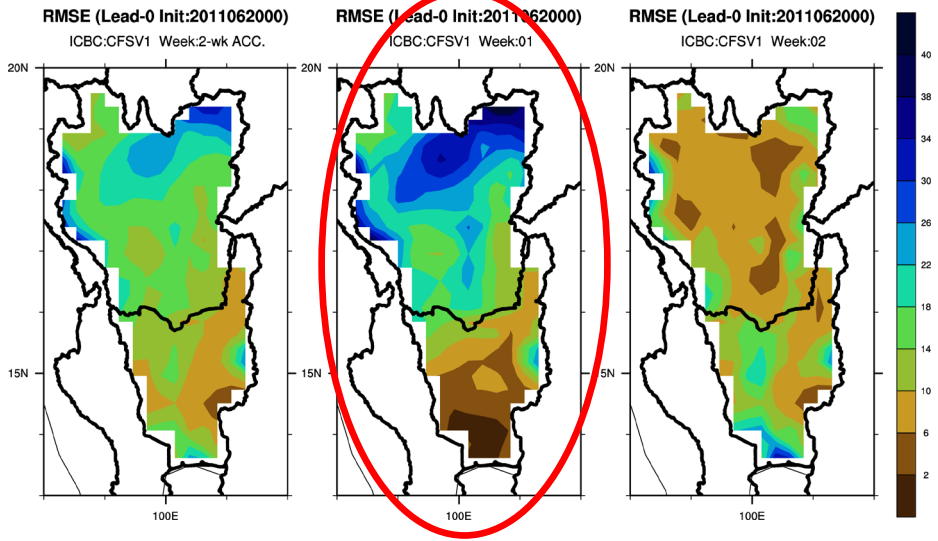
Lead-0

Preliminary Results–Haima Case (RMSE)



Before event occurred 1 week (Week-02)

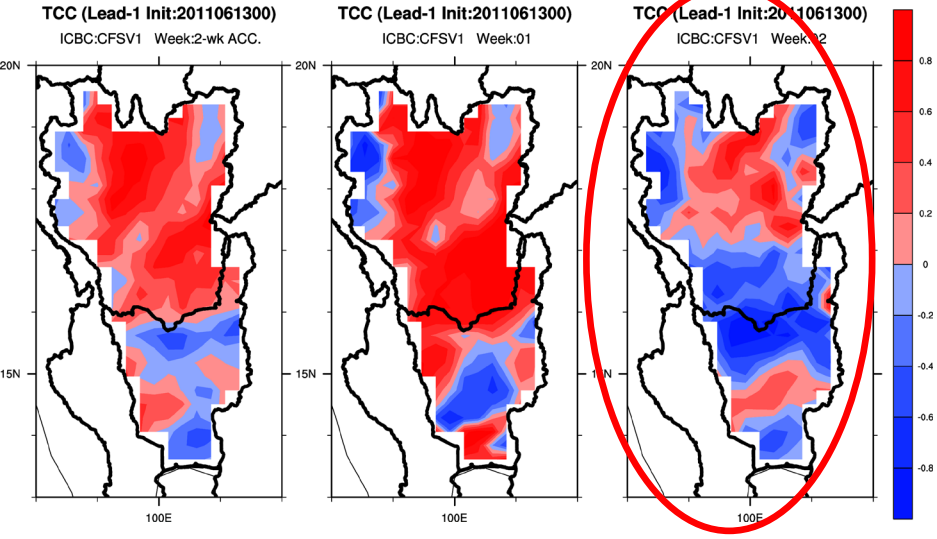
Lead-1



Event occurred at the 1st week (Week-01)

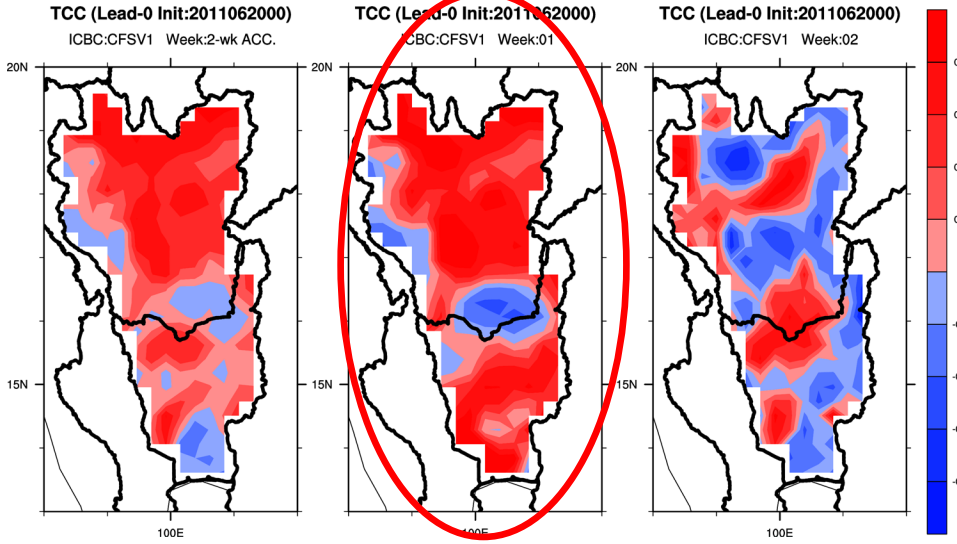
Lead-0

Preliminary Results–Haima Case (TCC)



Before event occurred 1 week (Week-02)

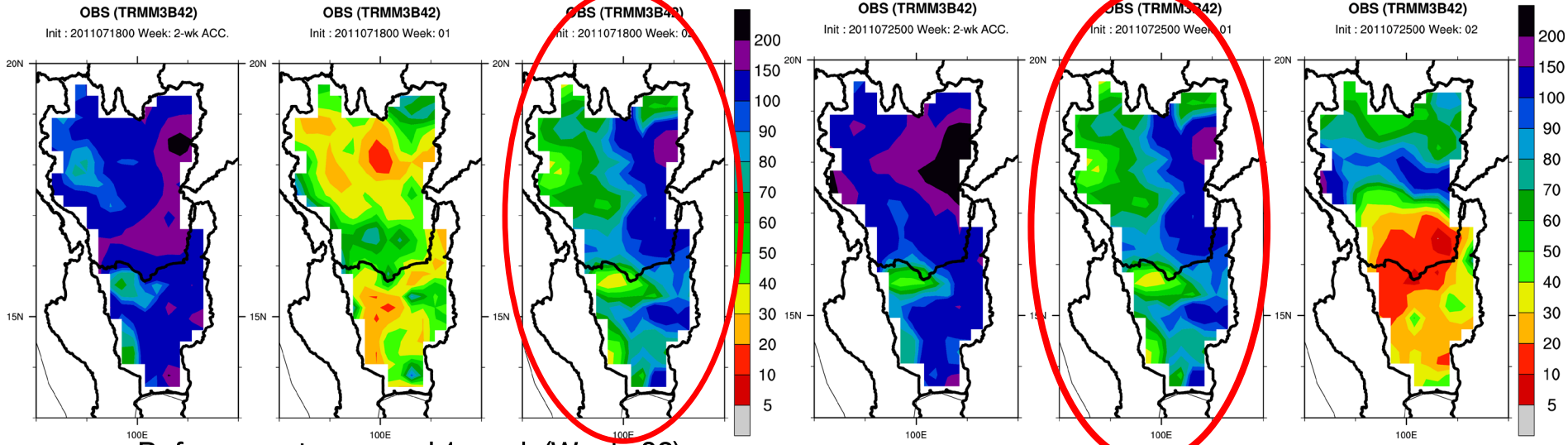
Lead-1



Event occurred at the 1st week (Week-01)

Lead-0

Nockten Case (Rain Intensity from TRMM OBS)



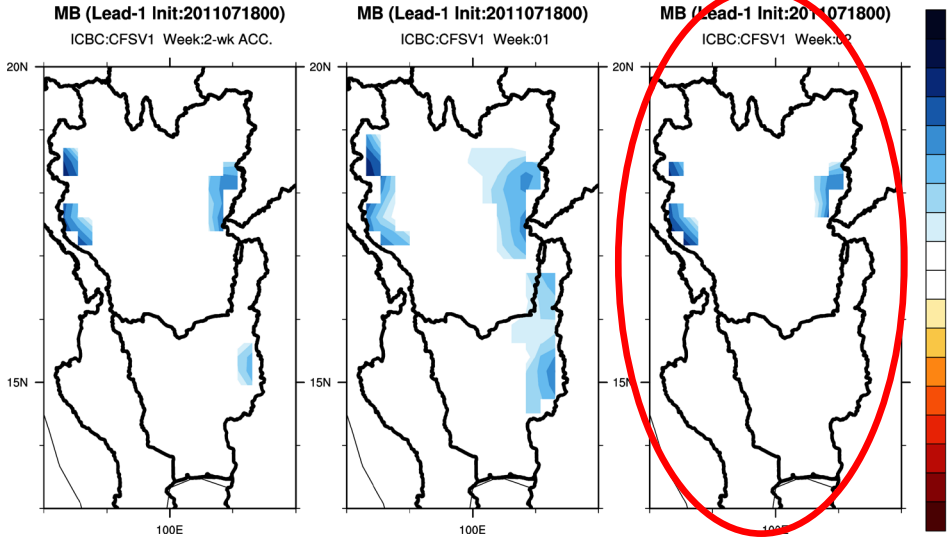
Before event occurred 1 week (Week-02)

Init: 2011-07-18-00 (Lead-1)

Event occurred at the 1st week (Week-01)

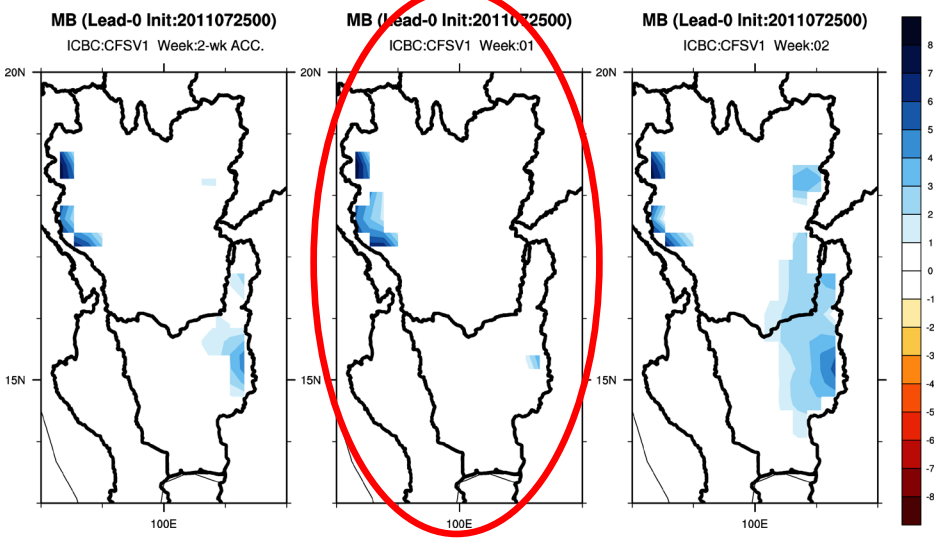
Init: 2011-07-25-00 (Lead-0)

Preliminary Results–Nockten Case (Mean Bias)



Before event occurred 1 week (Week-02)

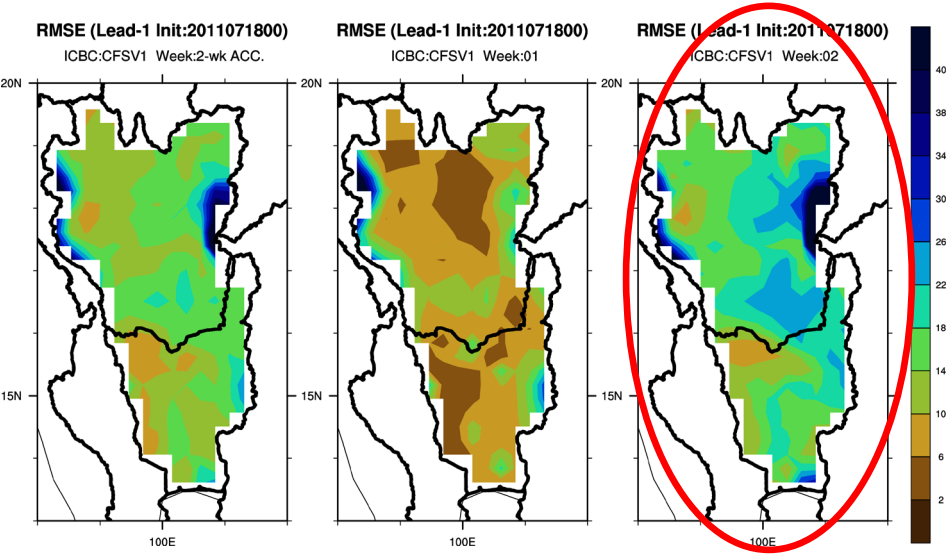
Lead-1



Event occurred at the 1st week (Week-01)

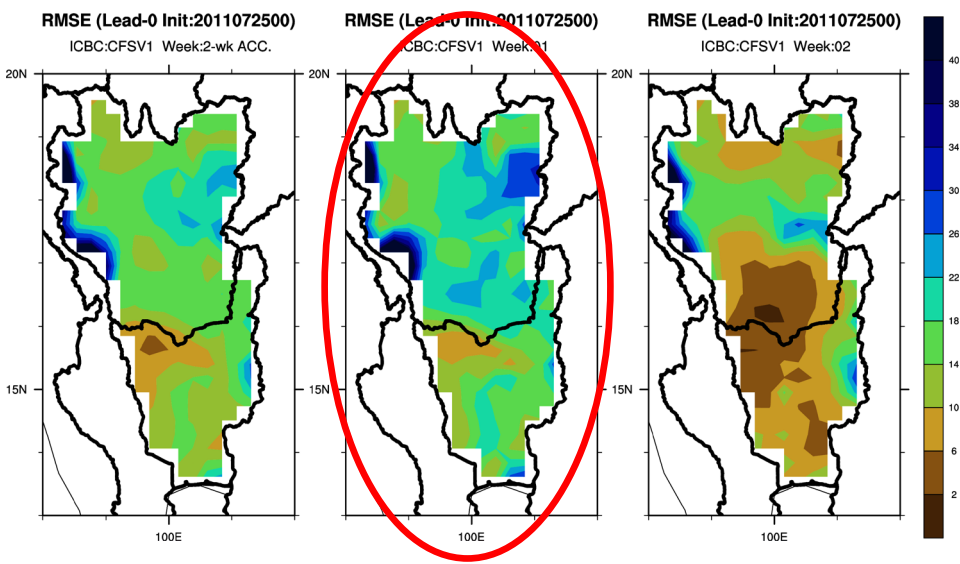
Lead-0

Preliminary Results–Nockten Case (RMSE)



Before event occurred 1 week (Week-02)

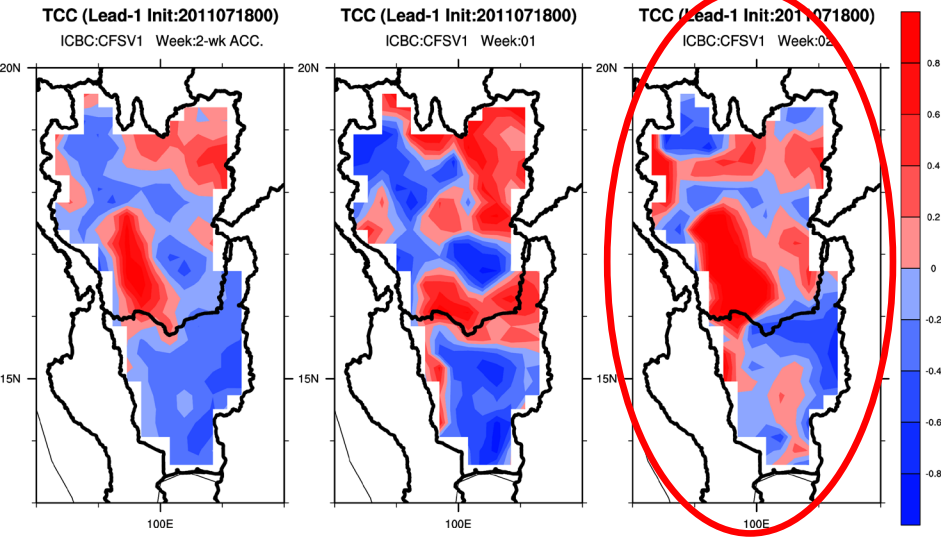
Lead-1



Event occurred at the 1st week (Week-01)

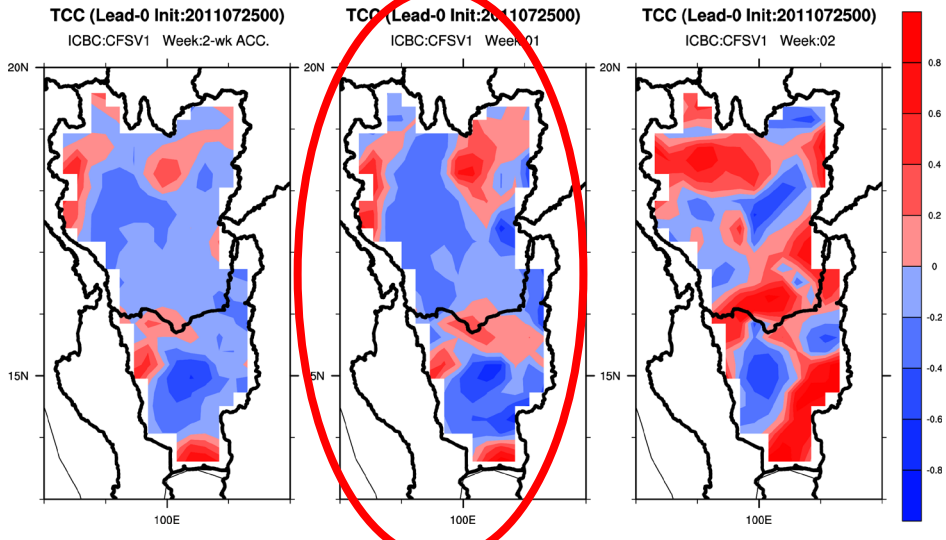
Lead-0

Preliminary Results –Nockten Case (TCC)



Before event occurred 1 week (Week-02)

Lead-1



Event occurred at the 1st week (Week-01)

Lead-0

S2S Weather Forecast (Pilot System for 2-week prediction)

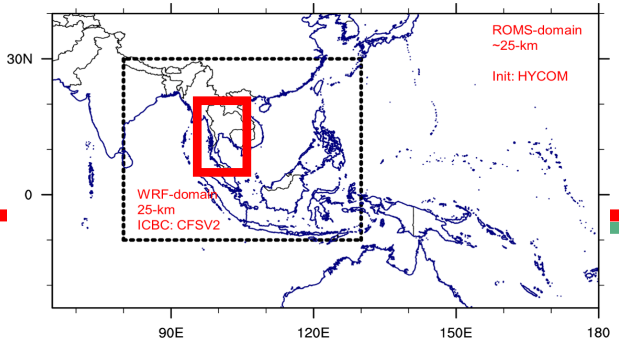
PRE-PROCESSING

Meteorological Initialization/ boundary condition

6-hr CFSv2 (0.5 deg)

Ocean Initialization

HYCOM Output (1/12 deg) provided at initial time (only for nudging)
+ SST
+ Salinity
+ Currents



PROCESSING

WRF

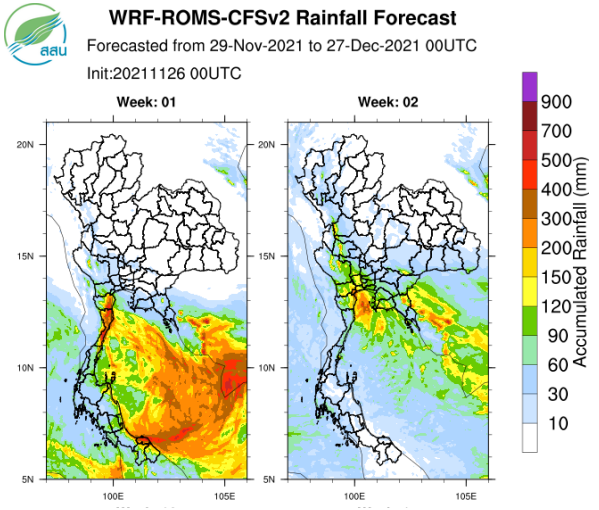
2-nested domains WRF 25/5 km

ROMS (Regional Ocean Modeling System, Research Community)

with single domain 25 km

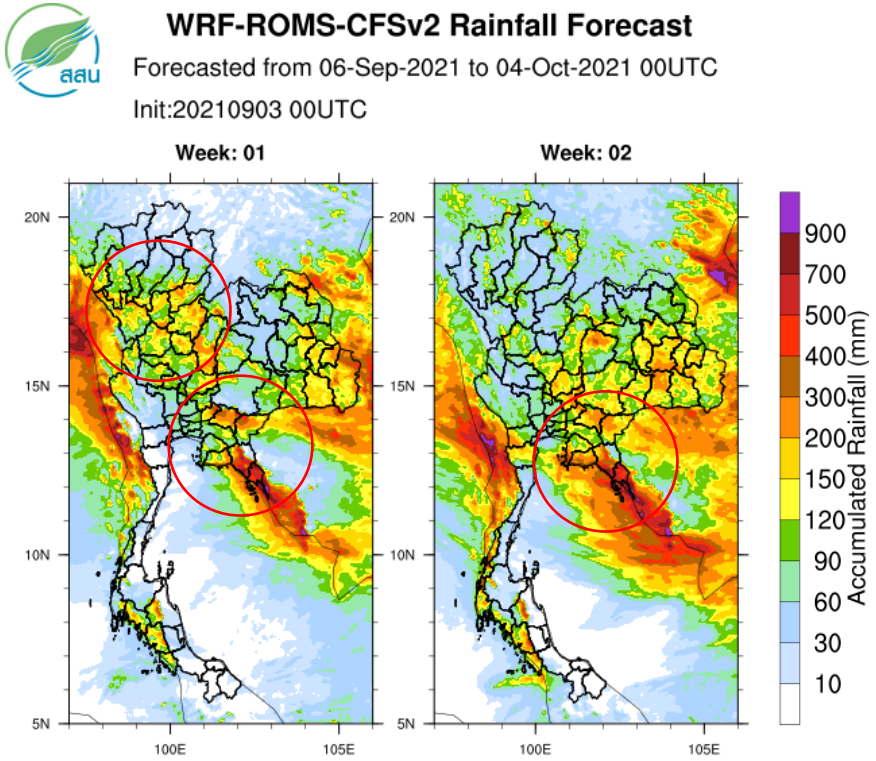
Utilized 288 CPUs, take about 10 hrs

POST-PROCESSING

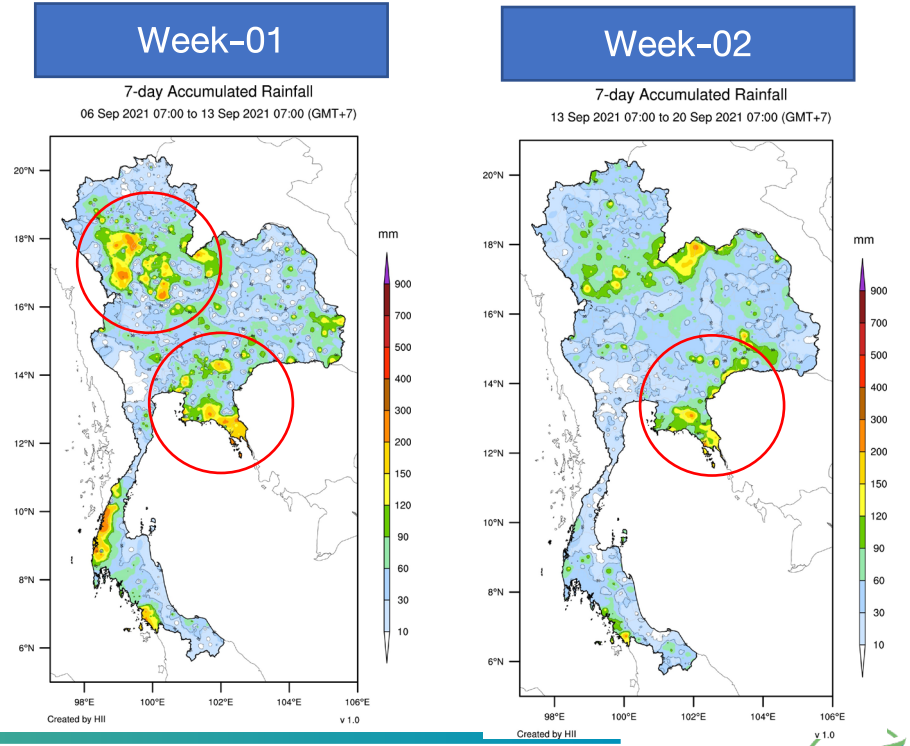


Web Service

Skill of 2-week WRF-ROMS Forecast (preliminary)



Interpolated NHC rainfall stations



Summary

- Based on the experiments, the model well estimates rain intensity over the CPY for week-1 & 2 with acceptable MB & RMSE.
- Overestimation of rainfall can be found in areas where heavy to very heavy rainfall events occurred.
- The TCC skill for rainfall vary depending on lead-time, events, and area, however, the model shows some skill with the highest TCC up to 0.8, particularly in the areas where heavy to very heavy rainfall occurred.

Acknowledgement

- Thailand Science Research and Innovation (TSRI)
- National Research Council of Thailand (NRCT)
- NRCT-TSRI Spearhead Research Program on Water

Thank you!!