Effect of resolved convection on the Maritime Continent precipitation and related physical processes in a regional model

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What's the problem with Maritime Continent rainfall?

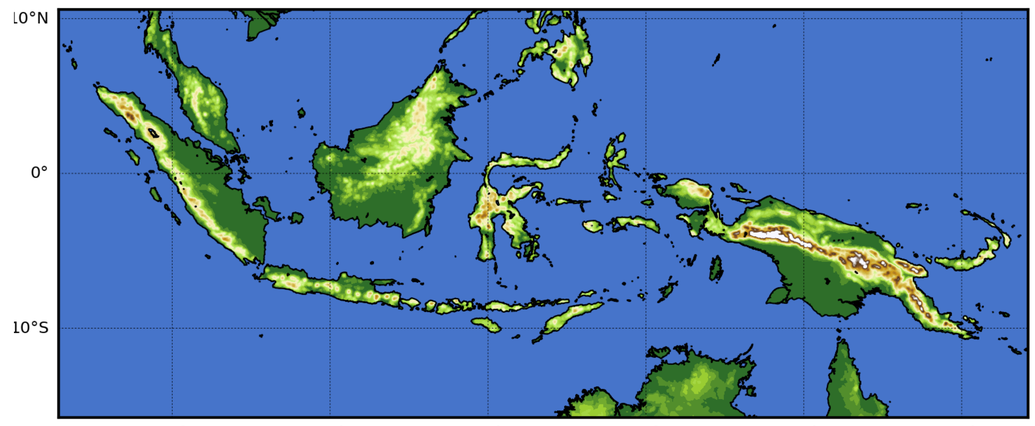
CHALLENGING REGION

- Precipitation dominated by deep convection
- Strong diurnal cycles
- Warmest ocean on Earth
- Thousands of islands and complex topography
- Model errors propagate through the entire earth system

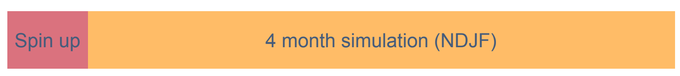
TYPICAL MODEL ISSUES (across models and resolutions)

1. Large biases:
   - Generally wet over land, dry over water
   - Not always, model-dependent
2. Weak diurnal cycle over islands
3. Too early diurnal cycle peak
4. Issues in complex topography (observational errors?)

The modelling system and experiments



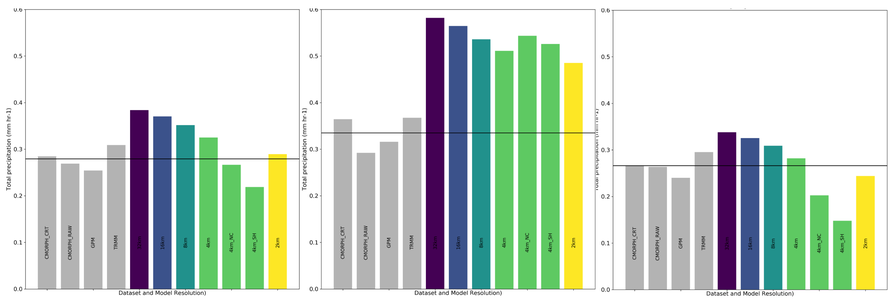
- WRF 3.9 (Hybrid vertical coordinates)
- Resolutions: 32, 16, 8, 4 and 2km (No nesting - independent)
- Convective scheme all: Betts-Miller-Janjic (profile adjustment)
- 4km: Explicit convection (NC) and Shallow convection only (SH)
- Boundaries: ERA5 Reanalysis
- 3 Austral summers (NDJF) + 10 days spinup. Total 12 months.



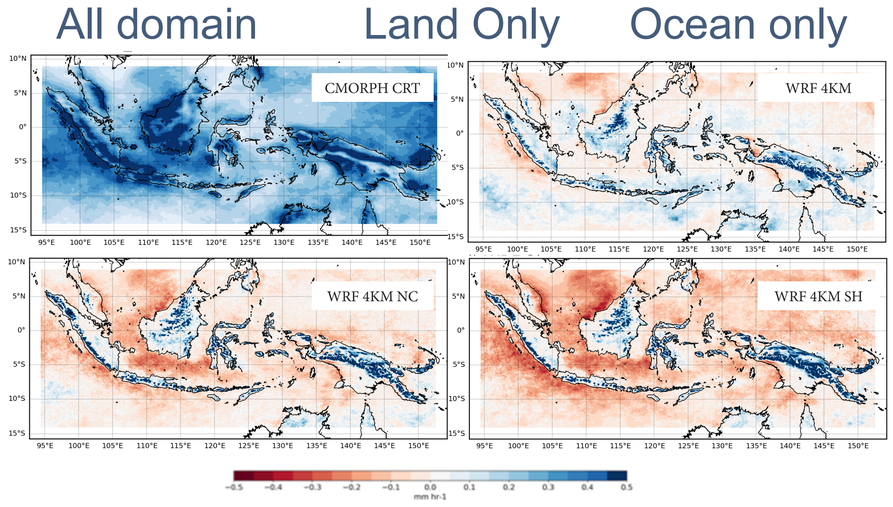
Questions:

1) Does resolution alone improve precipitation characteristics such as the diurnal cycle and the total amounts?
2) What is the role of explicit convection and shallow convection schemes in simulating precipitation?
3) How explict convection modifies physical mechanisms that generate precipitation?

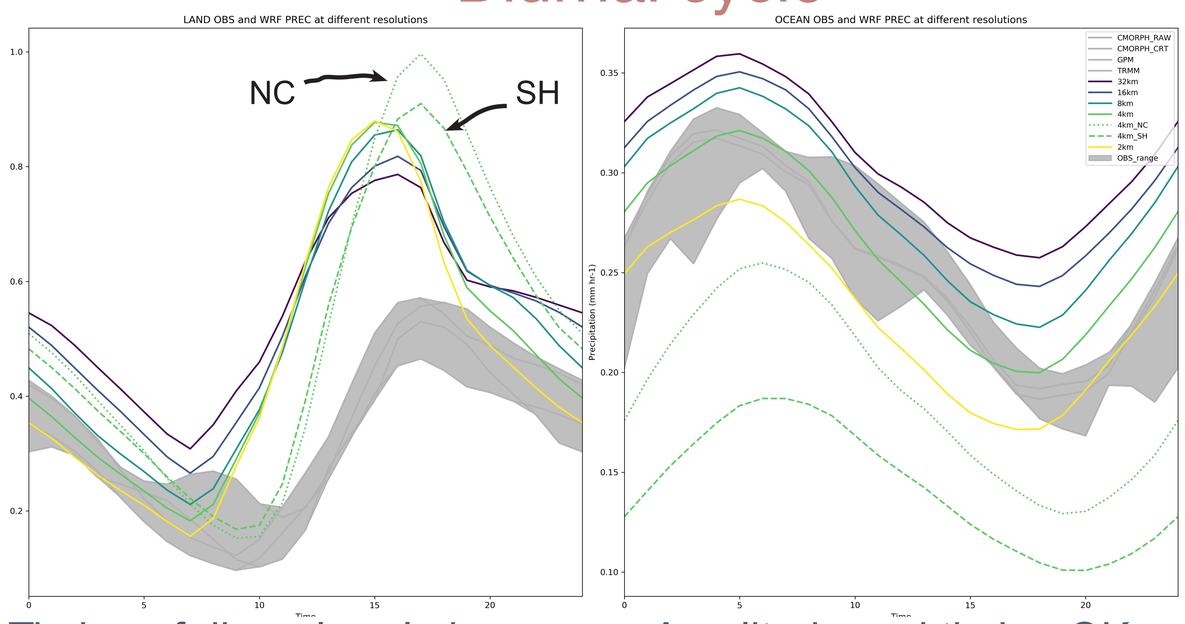
Ocean and land total rainfall



All domain Land Only Ocean only



Diurnal cycle



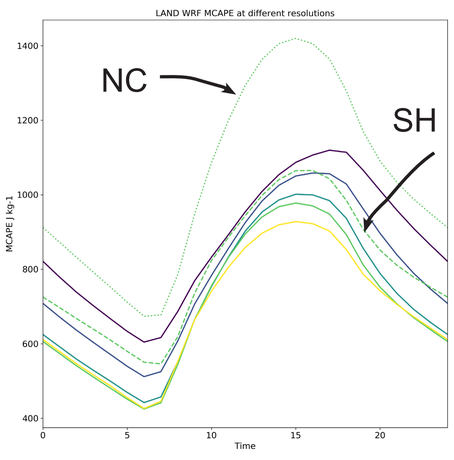
Timing of diurnal cycle improves with explicit convection
But amplitude too strong
Land too wet

Amplitude and timing OK
Too dry with explicit convection

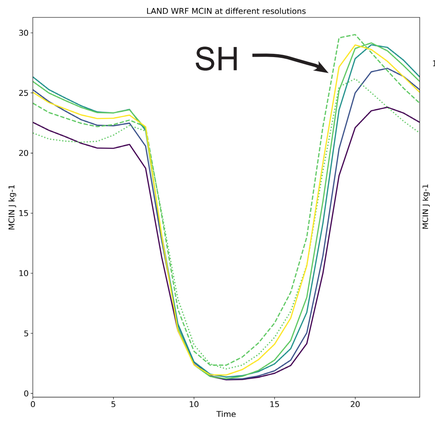
Physical mechanisms

10h LST (03UTC) - 1-17 Dec 2015
Pre-YMC Campaing (R/V Mirai)

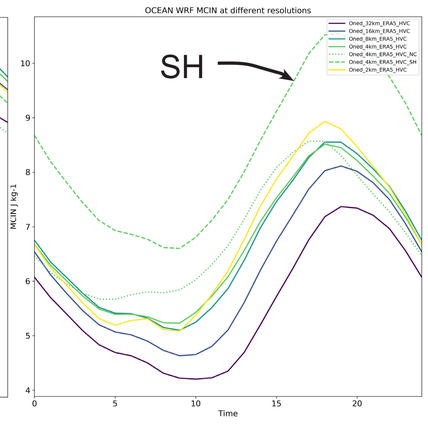
Land Only CAPE

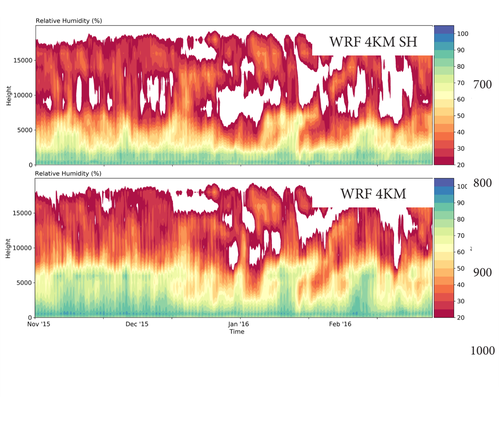


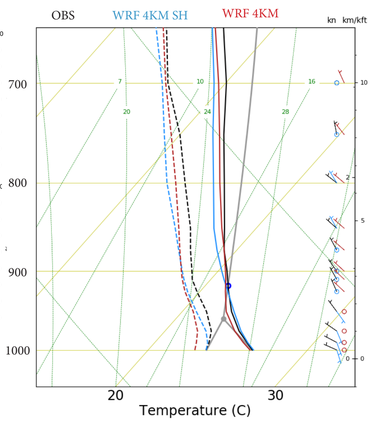
Land CIN



Ocean CIN







Fully-explicit: accumulates too much CAPE
CAPE removal by convective schemes
BMJ triggers too quick, while explicit deep convection delays rainfall generation (better cycle)

Shallow convection: Larger CIN - Needs more energy to activate convection (contributes to delay)
Very large CIN in Ocean (drier)

Too little rain over the ocean in explicit convection runs:
Not enough vertical mixing
Mostly shallow convection - doesn't produce rain.

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