

## **Towards a convection-permitting global configuration of the Met Office Unified Model**

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## Philosophy of language

*“Language does not just describe reality. It creates the reality it describes.”*  
(Desmond Tutu)

In atmospheric models with kilometer-scale grids, the resolution approaches the scale of convection and convective clouds. As a consequence convection is partially resolved and partially unresolved. Both resolved and subgrid turbulent and convective fluxes are non-negligible.

The term “convection-permitting”, in distinction to “convection-resolving”, reflects this circumstance.

Has philosophy of language failed in the context of convection-permitting atmospheric modelling?



Global Atmosphere version 7 (GA7)

Fully parameterised convection  
as used in lower-resolution global simulations

“Convection-permitting”



- Reduced convection scheme that is allowed to start from the top of the boundary layer
- Reduced shallow convection scheme
- Turbulence scheme blended between one-dim parameterisation and three-dim Smagorinsky-Lilly

“Convection off”



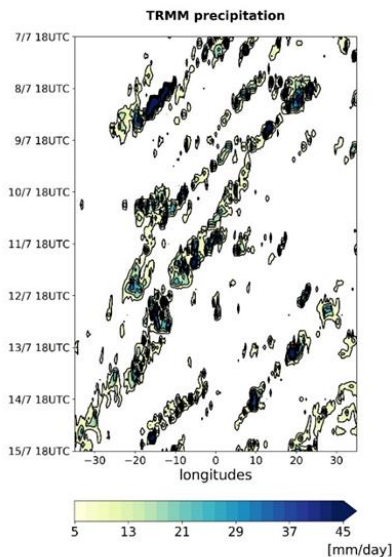
- Convection scheme switched off completely
- Turbulence scheme blended between one-dim parameterisation and three-dim Smagorinsky-Lilly
- Configuration similar to Regional Atmosphere version 2 (RA2)

## Assessment framework

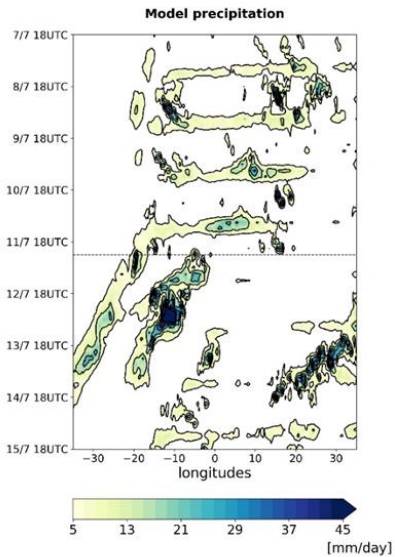
The simulations were run at global 5km resolution (N2560). Cases representing different meteorological conditions were selected, and initialised hindcast simulations performed, with 5 to 10 days lead time. This way the simulations can directly be compared to observations.

- Case of an African easterly wave and related mesoscale convective systems
- Structure of rainfall over the ocean near Darwin, Australia
- An extratropical case over the Atlantic region in October 2016
- Monthly means from several hindcast simulations covering the months of July 2016 and January 2018
- The progression of the Madden-Julian Oscillation in January 2018
- and more (not shown)

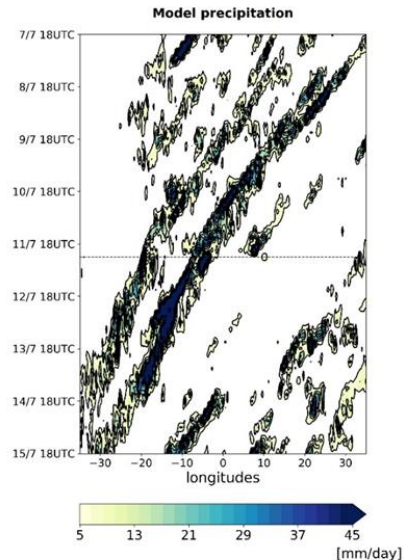
## AEW case over West Africa in July 2010 (two 5-day forecasts)



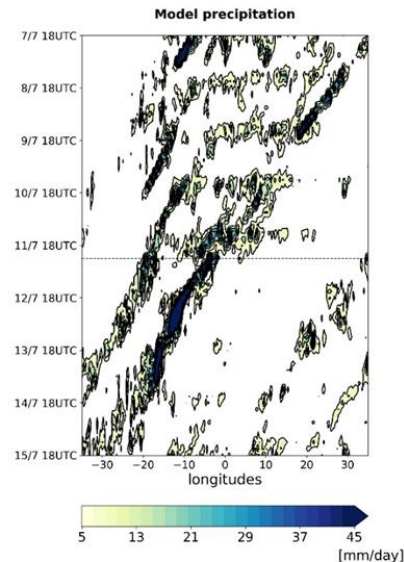
TRMM



GA7

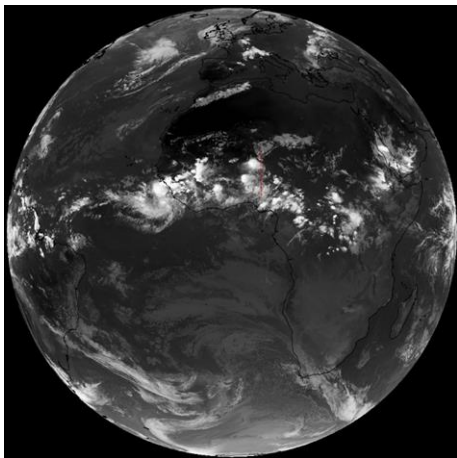


Convection-permitting

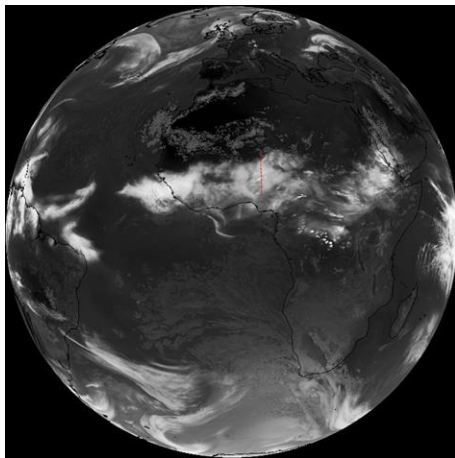


Convection off

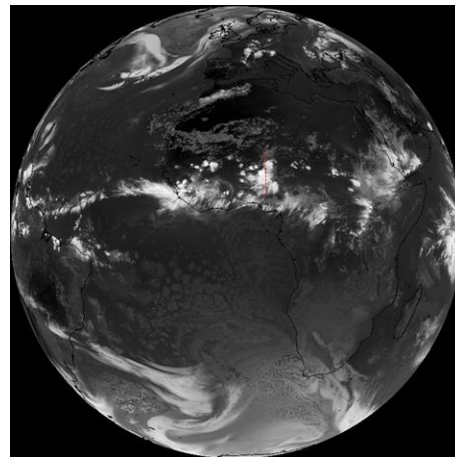
AEW case brightness temperature (4-day forecast)



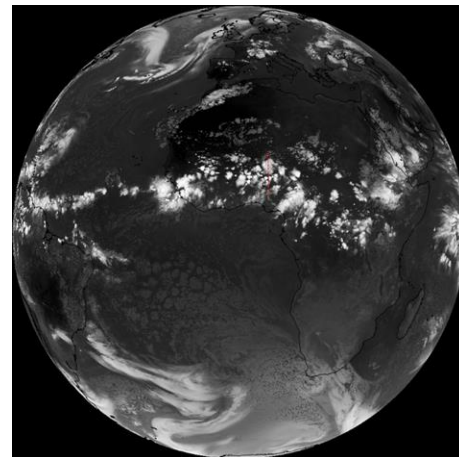
MSG satellite



GA7

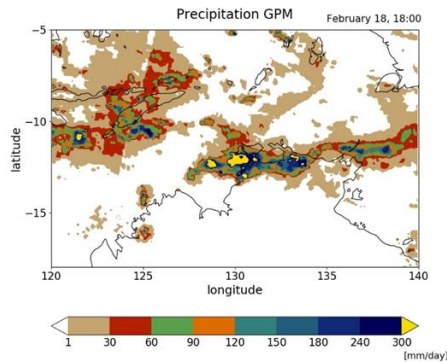


Convection-permitting

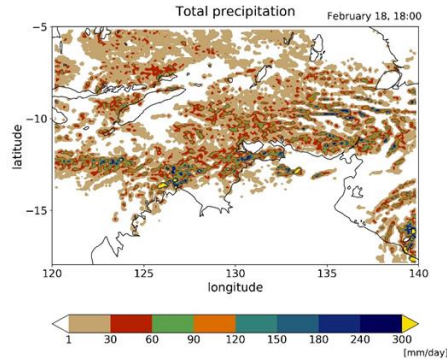


Convection off

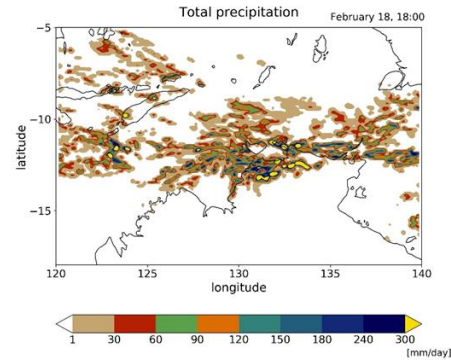
## Rainfall near Darwin (Australia), February 2014 (2-day forecast)



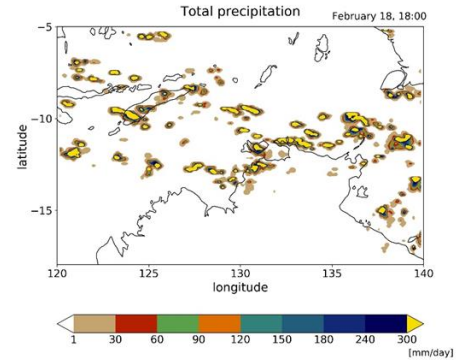
GPM



GA7



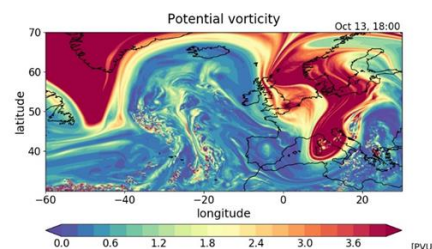
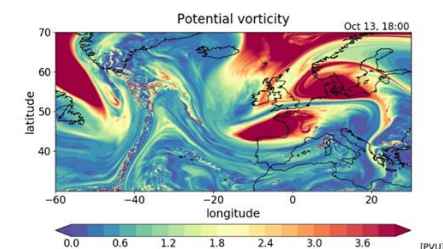
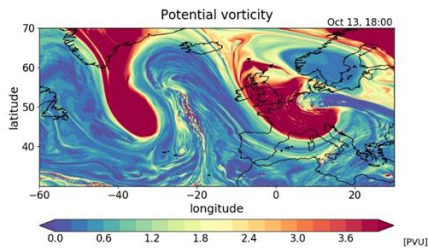
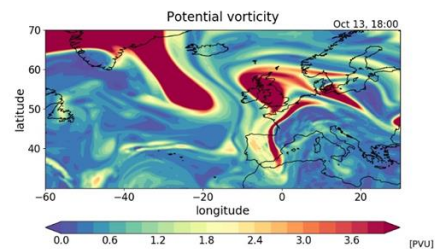
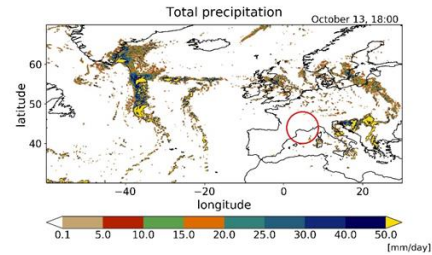
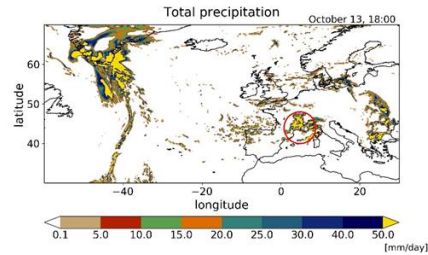
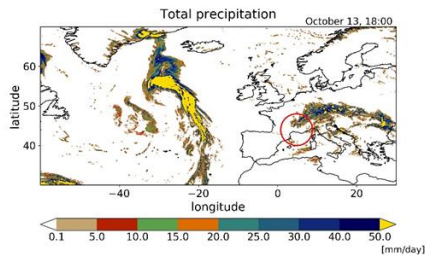
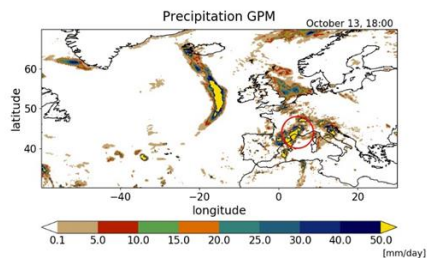
Convection-permitting



Convection off



## Extra-tropics: 9-day forecast in October 2016 (NAWDEX field campaign)



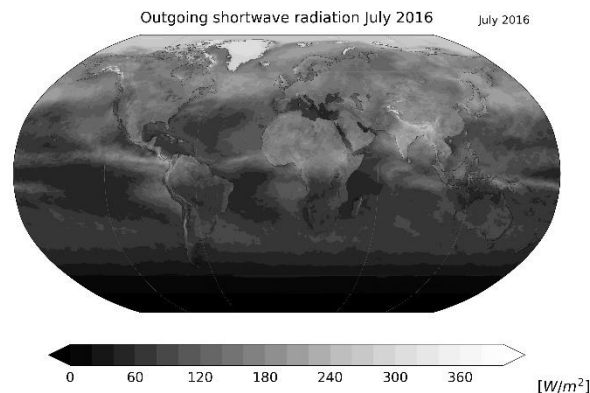
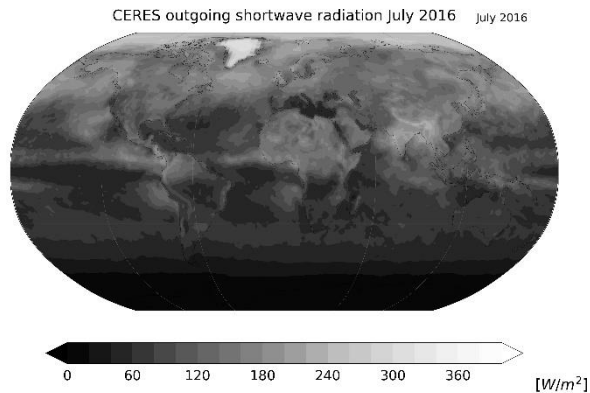
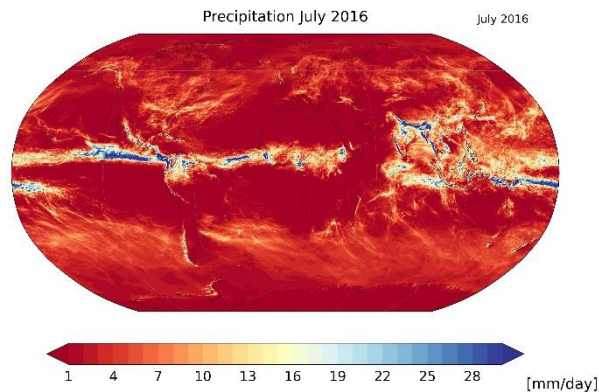
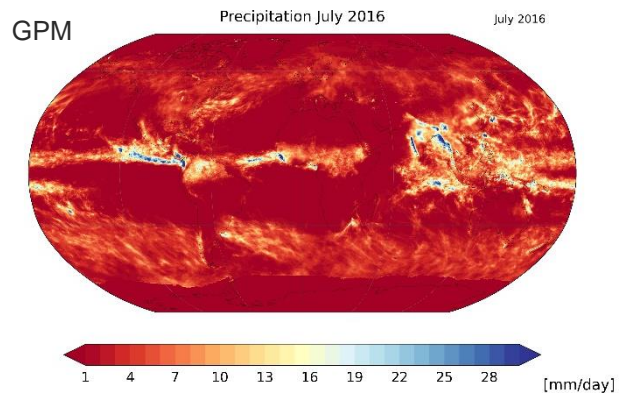
GPM/ERA5

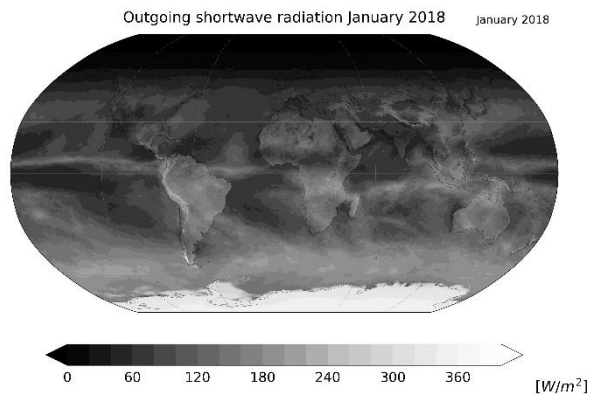
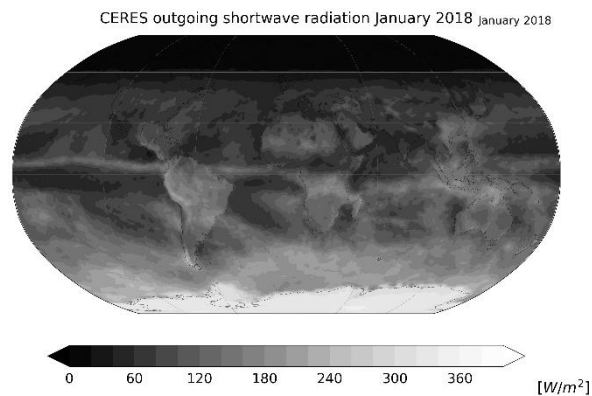
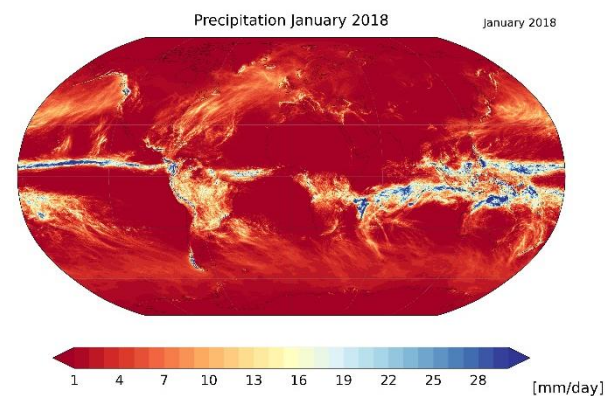
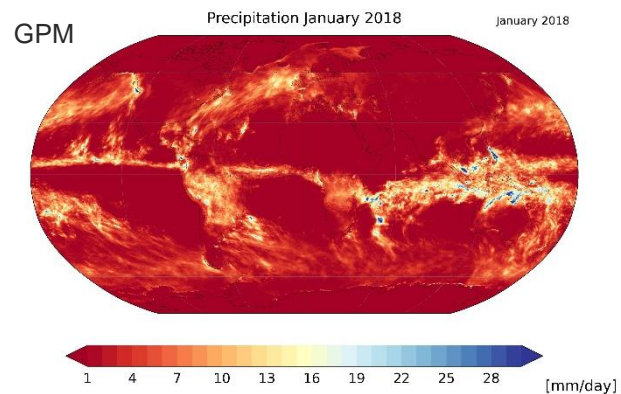
GA7

Convection-permitting

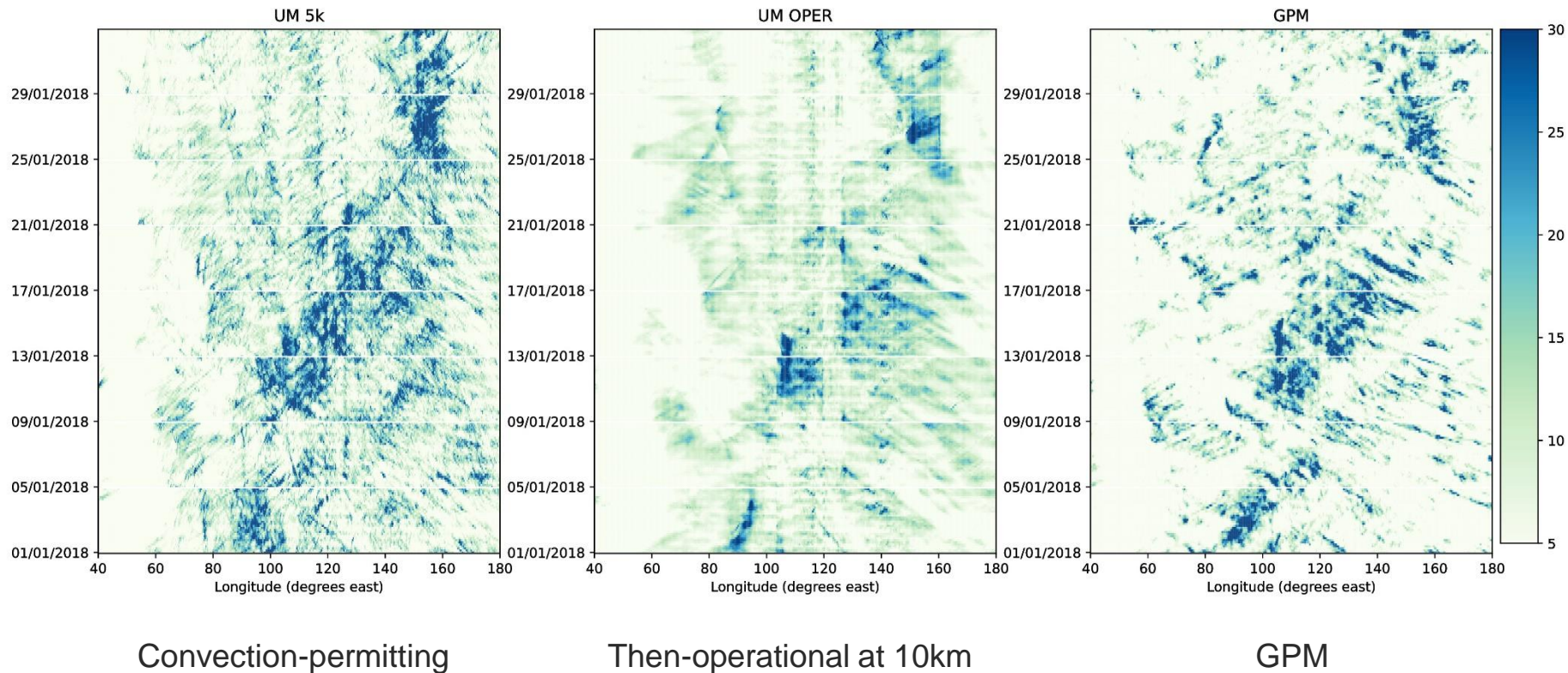
Convection off







## Progression of MJO in January 2018







## Summary

- The representation of turbulence and convection in the convective grey zone is investigated at global 5km resolution based on a case study approach.
- In the examined context a reduced mass-flux convection scheme is beneficial.
- The assessment is more conclusive with regard to convective organization and tropical variability than extratropical predictability.
- Model development is ongoing (dynamical core, microphysics, convection, clouds). Development of scale-aware schemes is endorsed.
- Model development benefits from insights using regional model.
- Some cloud tuning needed to improve radiation budget.
- Season- and year-long simulations, SST+4K experiments, and coupling to ocean model are planned.
- Implementation in numerical weather prediction alongside lower-resolution ensemble forecasts.

**Thank you very much!**