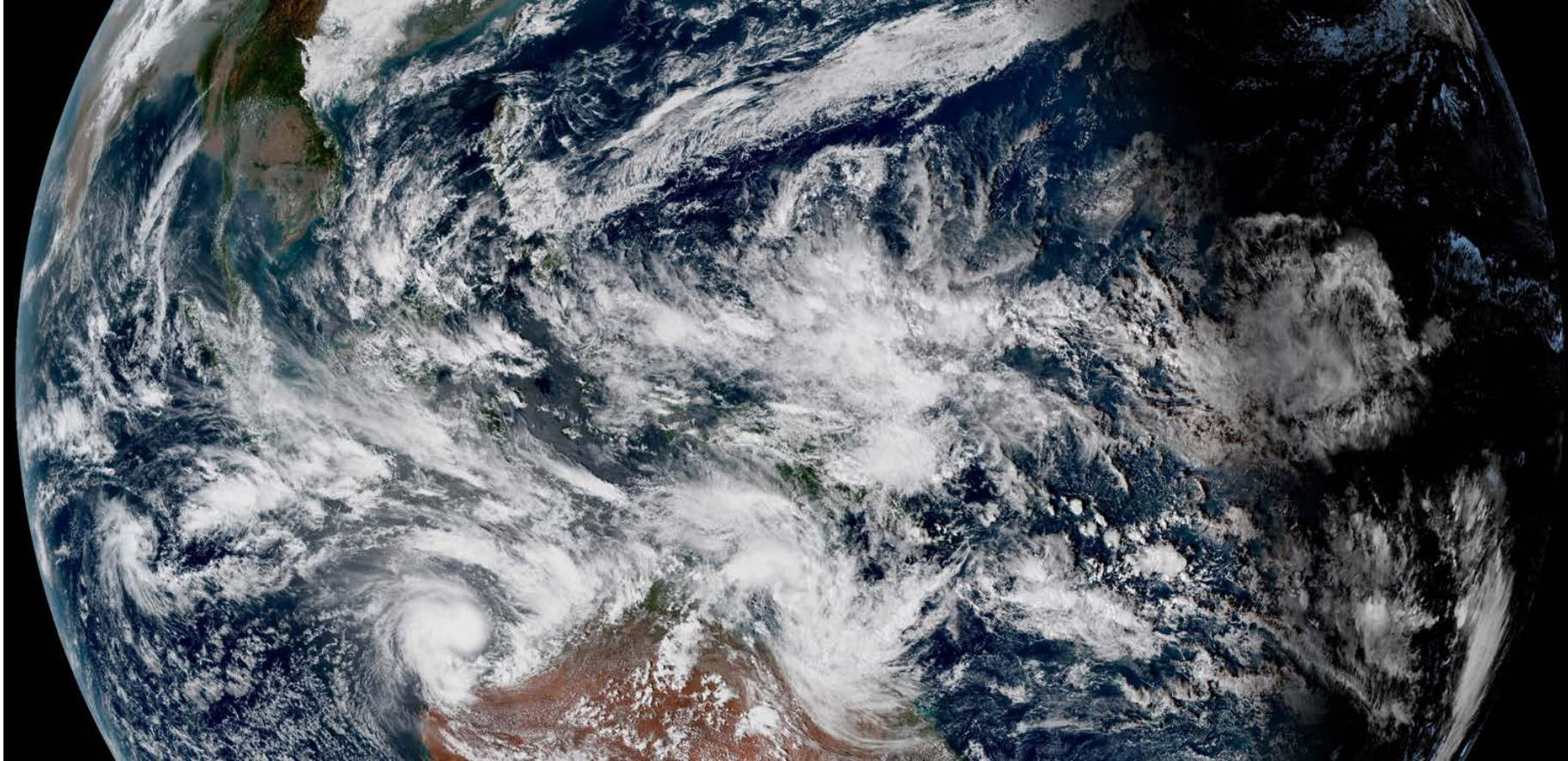


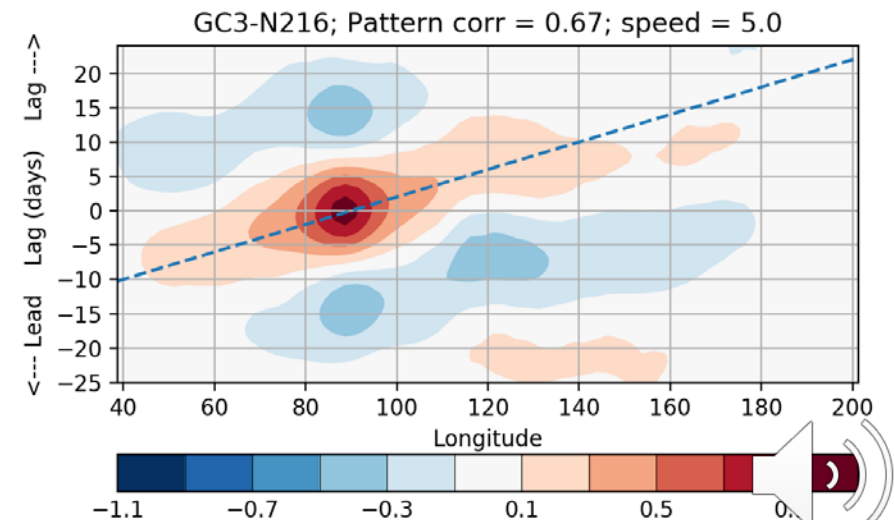
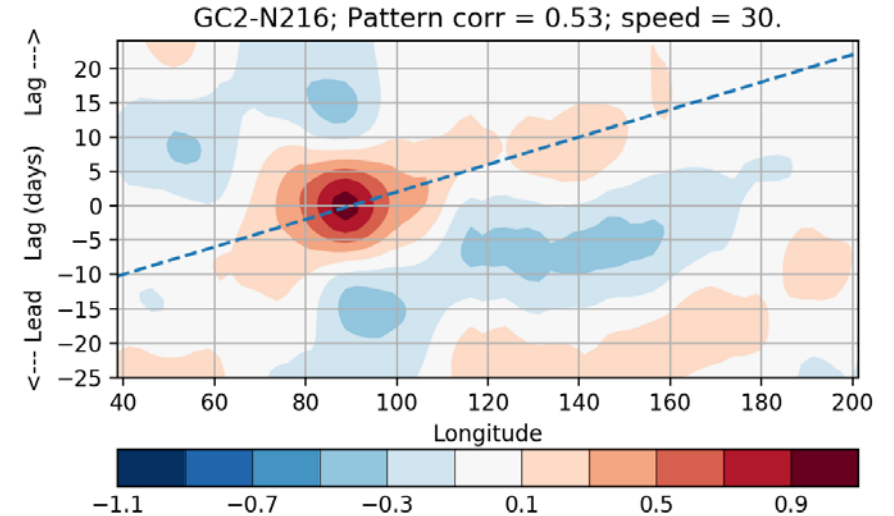
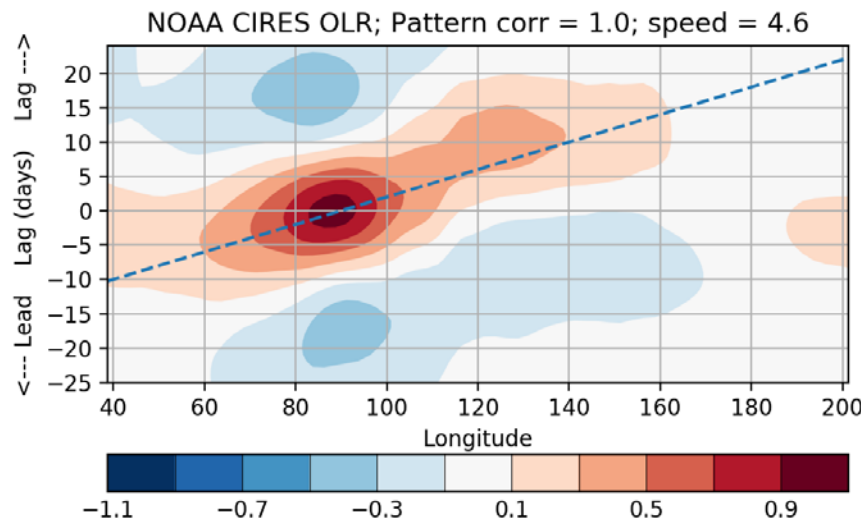
Why did the MJO improve in the Met Office Unified Model?



MJO in MetUM

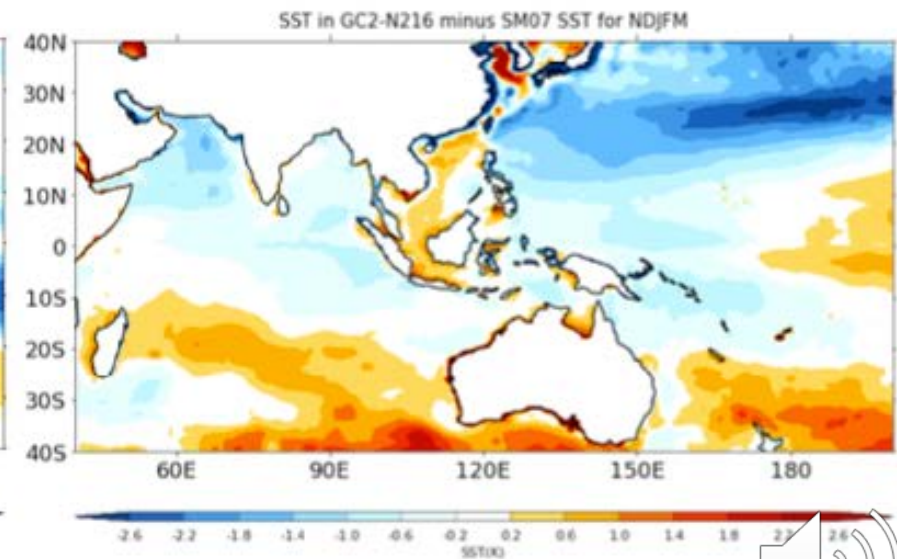
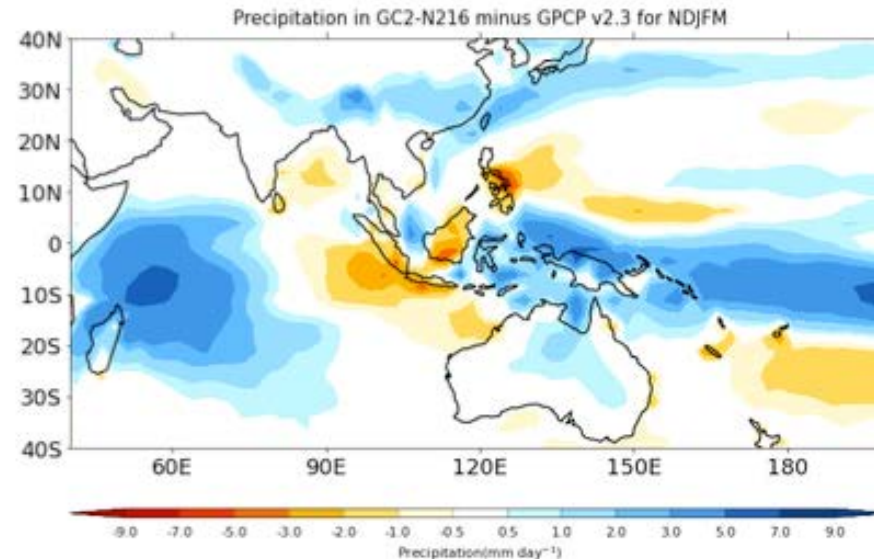
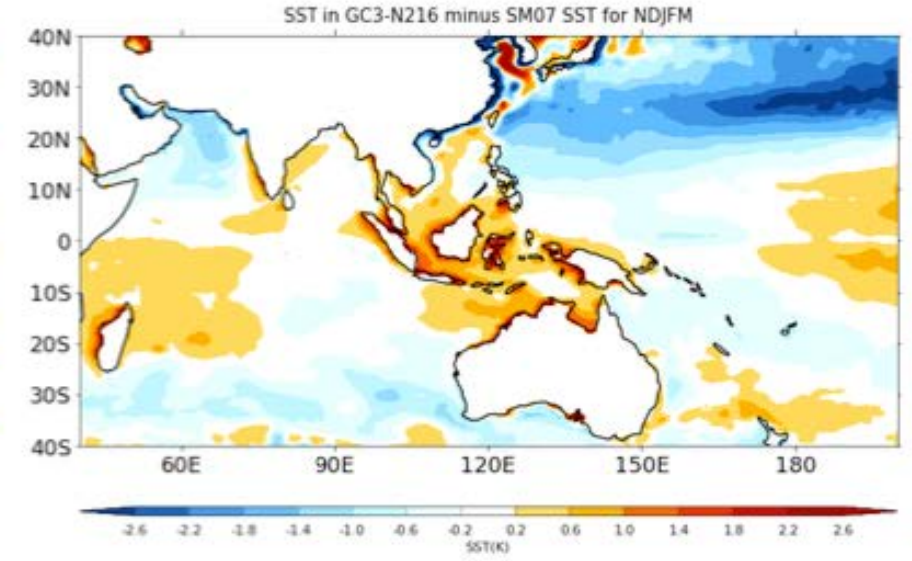
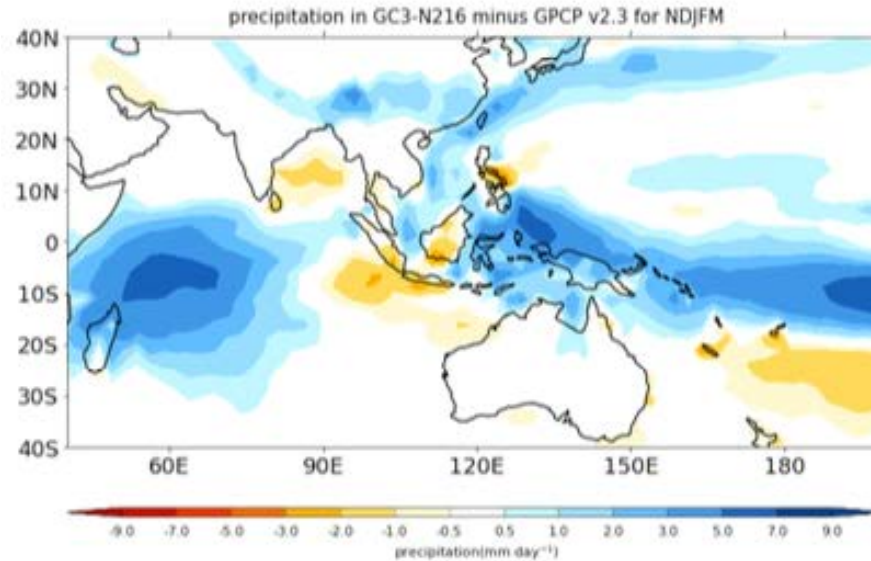
- Madden-Julian Oscillation in MetUM climate model (HadGEM3) has been poor for several model generations.
- The recent Global Coupled 3.0 (GC3) configuration showed a considerable improvement in MJO propagation over the previous configuration (GC2).
- Many physics changes between model configurations. MJO literature also suggests mean state may be important.

Lead-lag regressions of bandpass-filtered OLR averaged 15S-15N against a base point at 90E.



MetUM mean-state biases

- Substantial changes in mean-state SST and rainfall biases between GC2 and GC3 configurations.
- Cold SST biases over most of the Indo-Pacific Warm Pool in GC2, replaced by warm SST biases in GC3.
- These biases may enhance propagation of the MJO across the Maritime Continent.



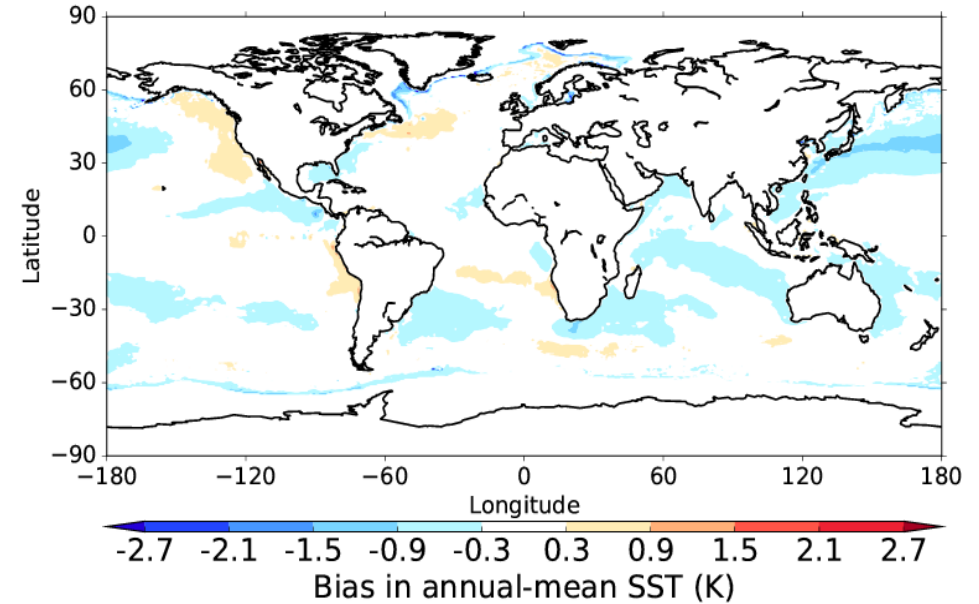
NDJFM biases in rainfall (left) and SST (right) in GC3 (top) and GC2 (bottom)



MetUM-GOML experiments

- Experiments with the Global Ocean Mixed Layer MetUM configuration (MetUM-GOML)
 - Same atmospheric model at GC3, at same resolution
 - Ocean is many columns of a 1D mixed-layer
- MetUM-GOML ocean mean state can be controlled by heat and salt corrections.
- We can mimic the observed climatology, a coupled-model climatology, or a hybrid blend of the two.

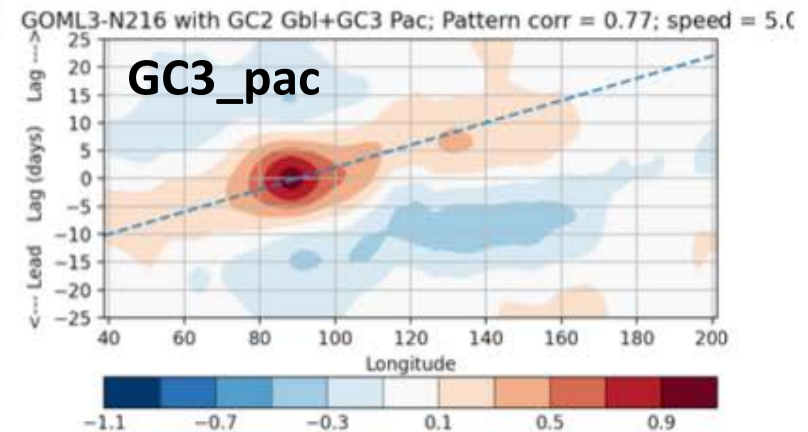
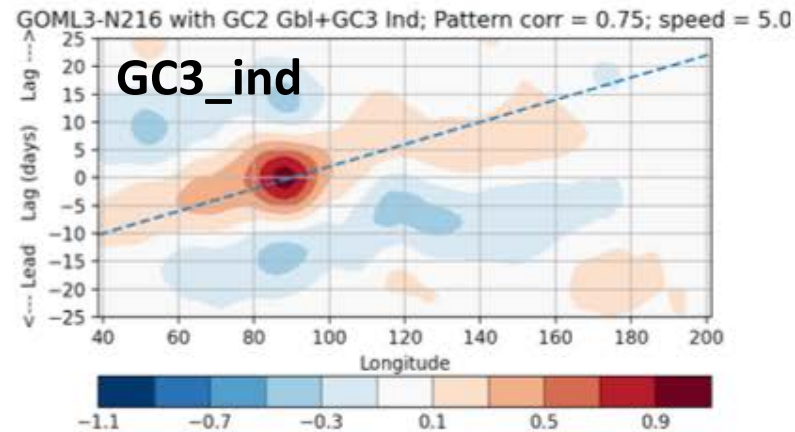
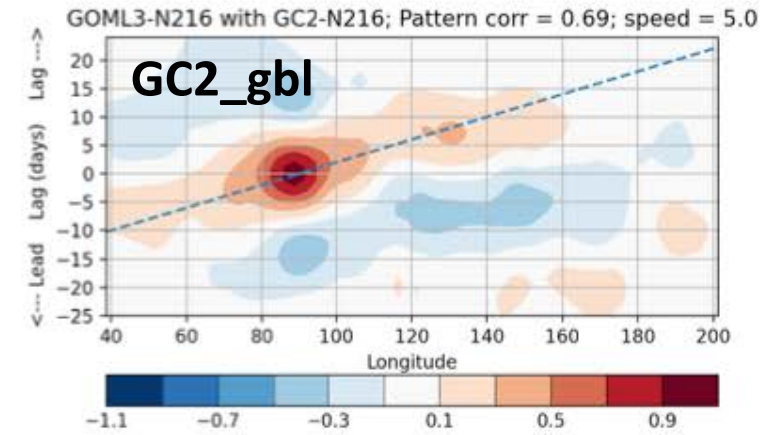
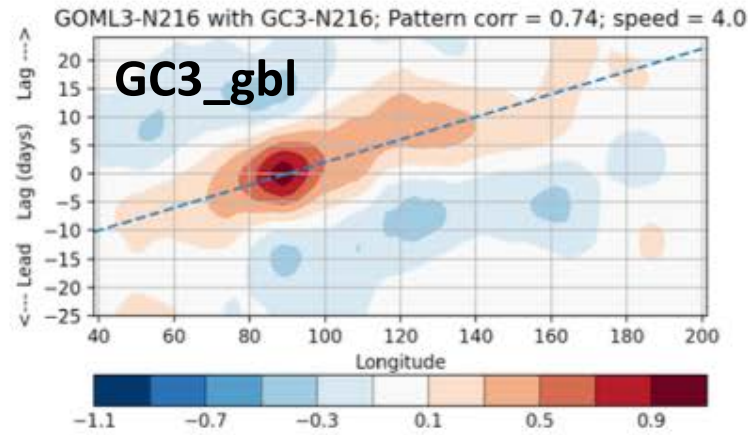
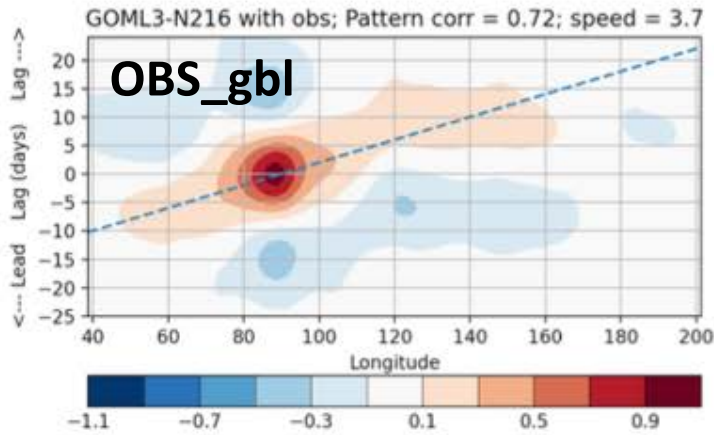
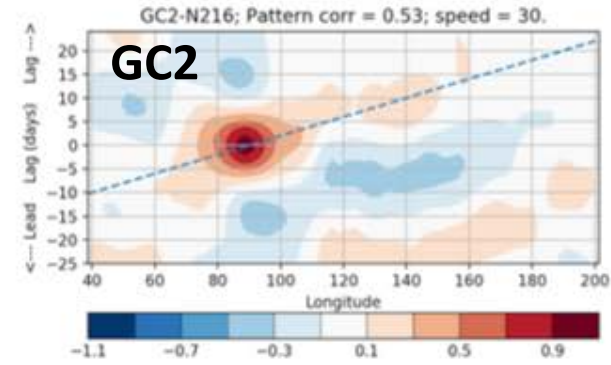
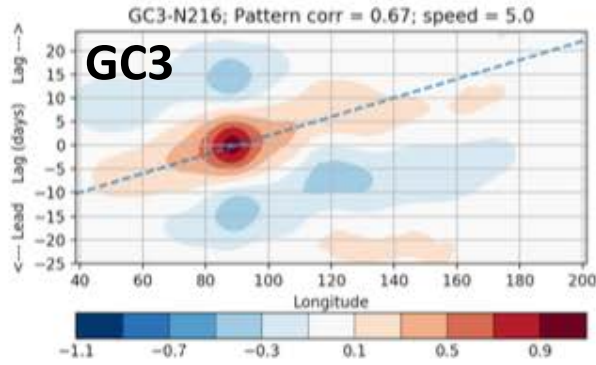
Typical SST biases in MetUM-GOML against target climatology



Experiment	Ocean mean state
OBS_gbl	Observed climatology globally
GC3_gbl	GC3 climatology globally
GC2_gbl	GC2 climatology globally
GC3_ind	GC3 climatology in Indian Ocean, GC2 climatology elsewhere
GC3_pac	GC3 climatology in Pacific Ocean, GC2 climatology elsewhere



MJO in MetUM-GOML



Summary

- **Key message:** Model physics changes may affect MJO through changes in background state, not only changes in the physics of the MJO itself.
- Improvement in MetUM climate model representation of the MJO in the latest configuration, GC3. These improvements coincide with a change from a cold SST bias in the Warm Pool to a warm SST bias.
- MetUM-GOML can separate the effects of changes in model physics from those of the ocean mean state.
 - Running the GC3 atmosphere with the GC2 ocean state produces a slightly better MJO than running the GC2 atmosphere with the GC2 ocean state. This suggests some role for physics changes affecting the MJO directly.
 - However, running the GC3 atmosphere with the GC3 ocean mean state produces an even larger improvement in the MJO than using the GC2 ocean mean state. This suggests that the effect of the physics changes on the mean state also improves the MJO.
 - The role of SST biases appears to be local: Indian Ocean GC3 SSTs improve the MJO in the Indian Ocean, while Pacific Ocean GC3 SSTs improve the MJO in the Pacific.

