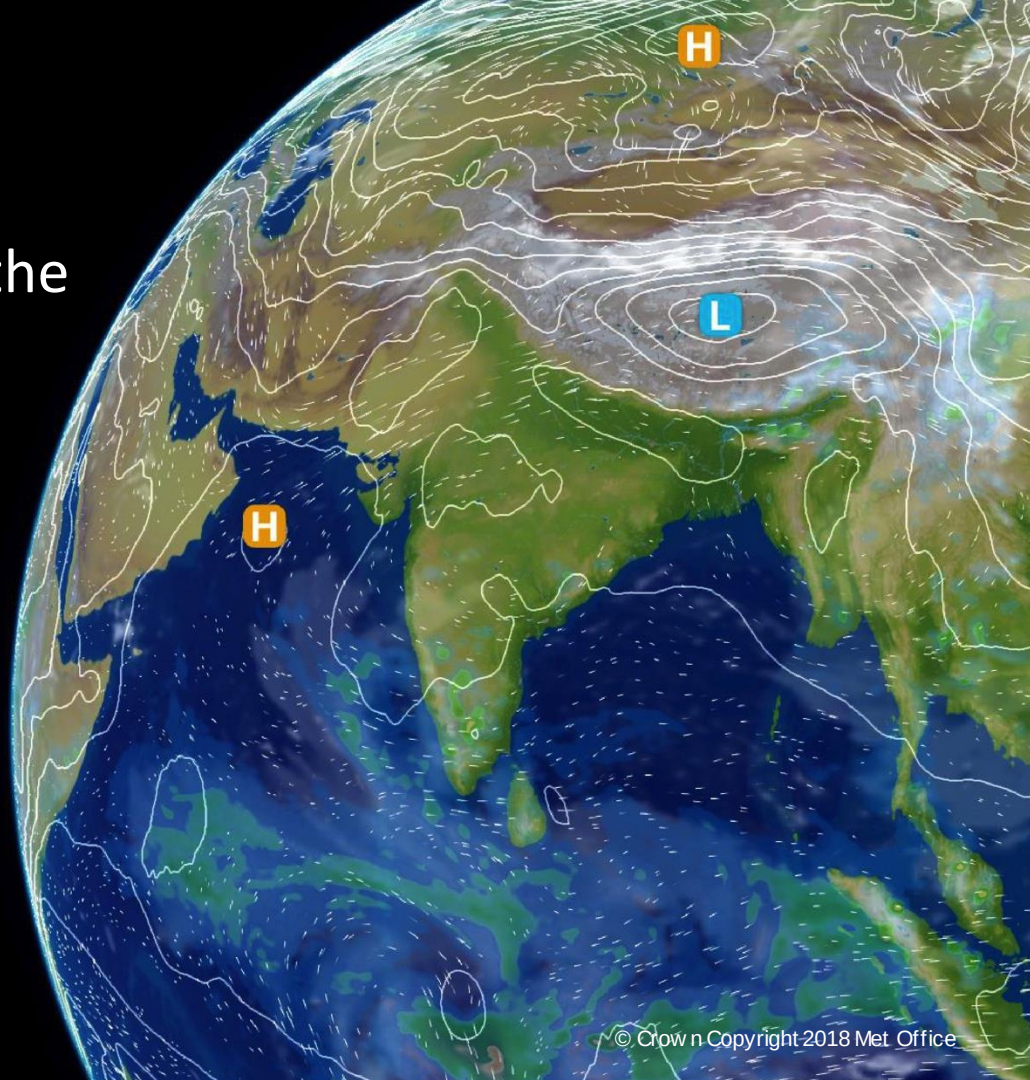
Adding wave model coupling to the Met Office GC5 global coupled modelling system

Nikesh Narayan

5th Workshop on waves and wave-coupled processes.

ECMWF 10-12 April 2024



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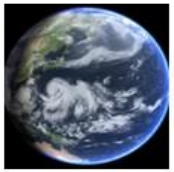
Global Seamless Physical Model

Hours — Days. — Weeks — Months — Seasons — Decades — Centuries

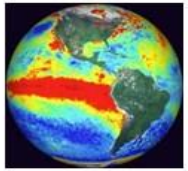


NWP

MOGREPS

Deterministic Atmosphere & Marine

Atmos. Ensemble



CLIMATE

UKESM

GloSea (Seasonal)

DePreSys (Decadal)

Climate Change UKESM1, UKCP18

Component Models	Global Coupled	GC Model
GAL, GO, GSI, GW		GC.x

Met Office Unified Model™ Global Atmosphere

JULES Global Land

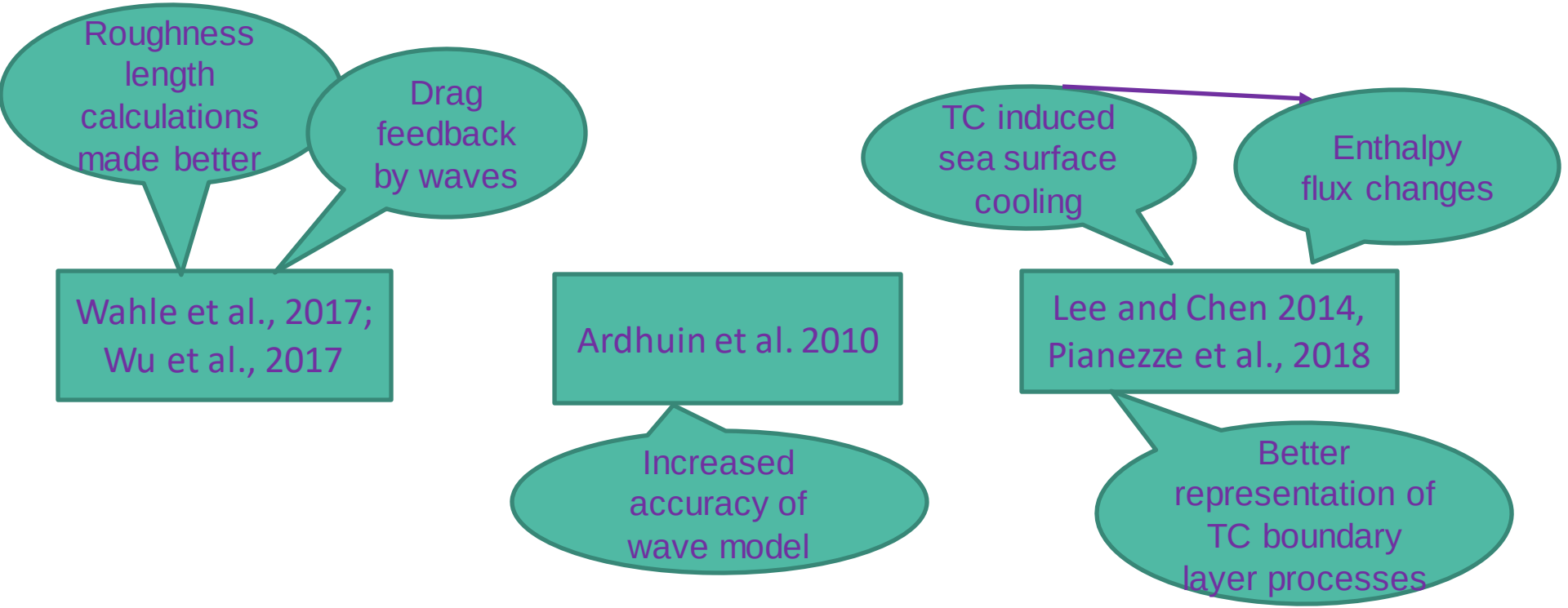
NEMO Global Ocean

CICE Global Sea Ice

WaveWatch III Global Waves

UKCA

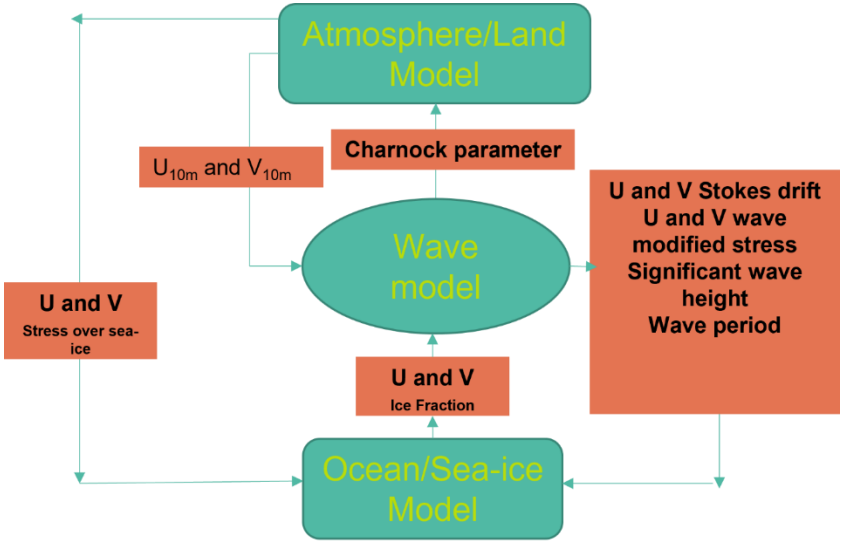
Why do OWA coupling.



OWA climate and NWP workflows and variables exchanged.

OWA **climate model**.

1. UM 13.2 NEMO 4.04 and WavewatchIII 7.13 (GC5) cylc8
2. N96(~150km)-ORCA025-GS256A (~50km)



NWP case study workflows.

1. N320 (~40km)-ORCA025-GS256A (
2. N1280(~10km)-ORCA-025-G512L3A (~25km)

Latest changes

1. N216 (60km) UM for climate
2. Replacing 10 m winds in UM->WWIII coupling with neutral winds.

WAVEWATCH III modifications in GC5

Affects surface momentum

NEMO

Wave modified stress

GC5 + WWIII

Variable Charnock coefficient

UM

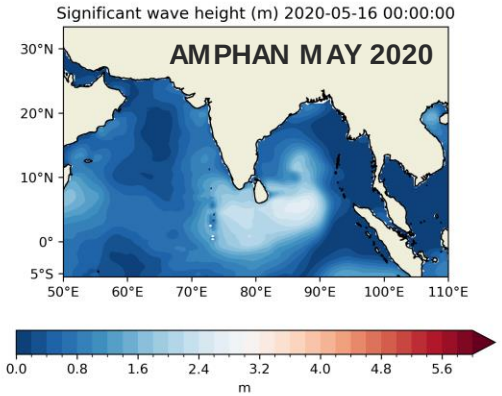
Sea state dependant wind stress

Modification of momentum equation and tracer advection equation

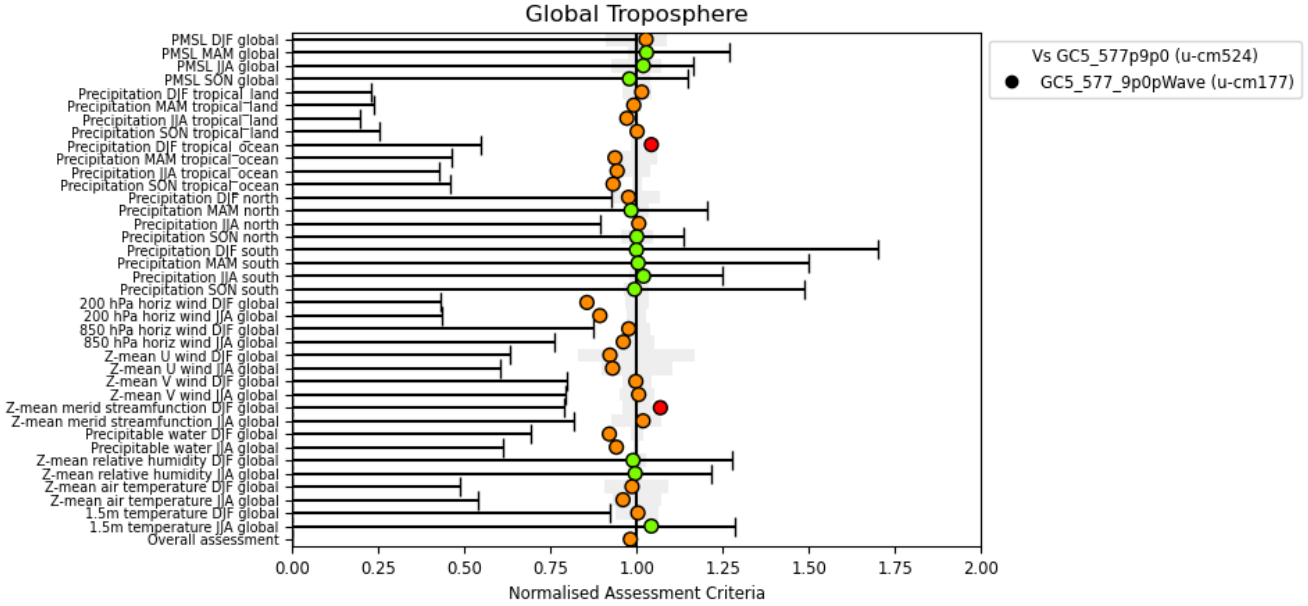
Stokes-Coriolis effect

Affects Ekman turning of surface current

Changes SSH



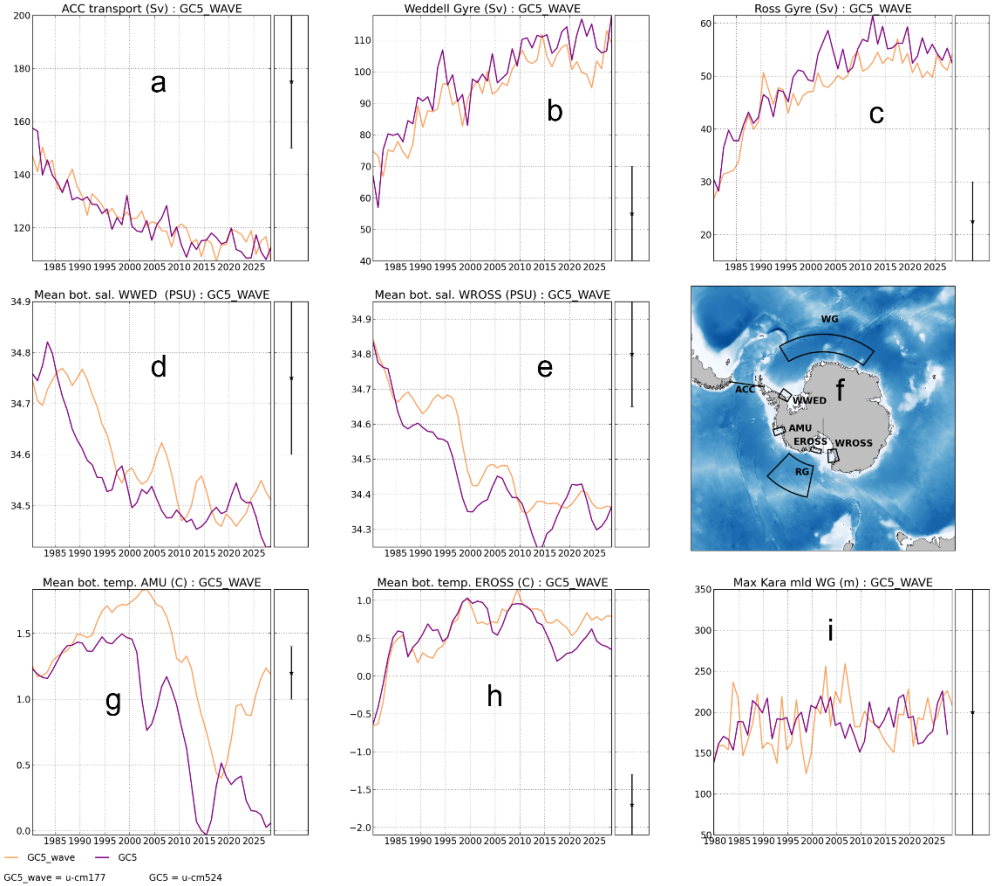
Tropospheric metrices from climate simulation.



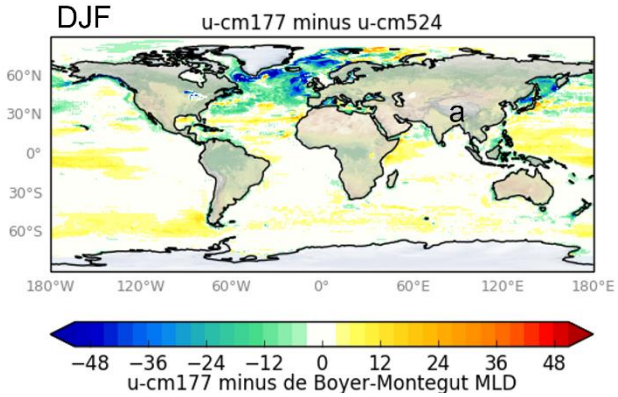
- Most changes are neutral.
- Slightly better seasonal precipitation.

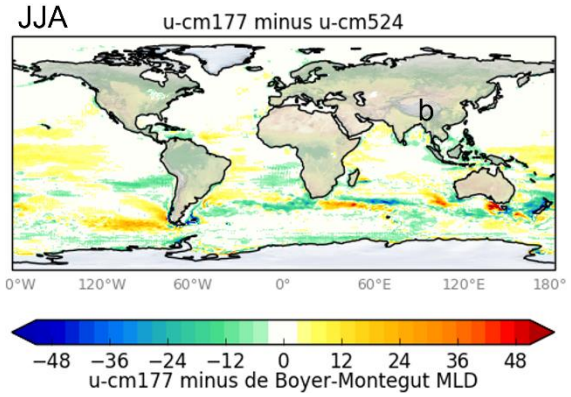
Southern Ocean Metrices (climate)

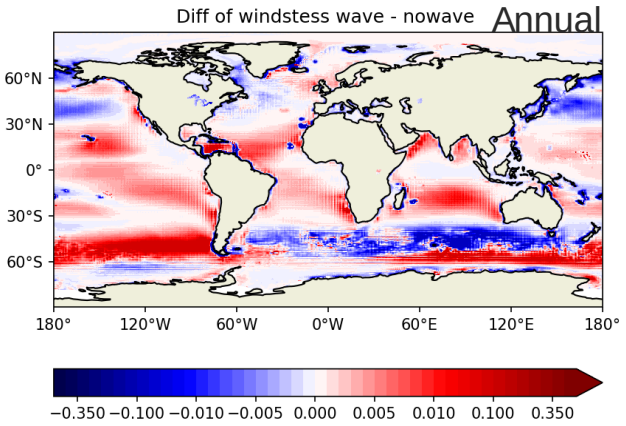
- Southern Ocean metrices also doesn't show significant changes.
- Noticeably MLD in the Weddel Gyre show increased variabililty in the OWA coupled model.



Winter hemisphere seasonality in MLD (Climate simulation GC5W-GC5)

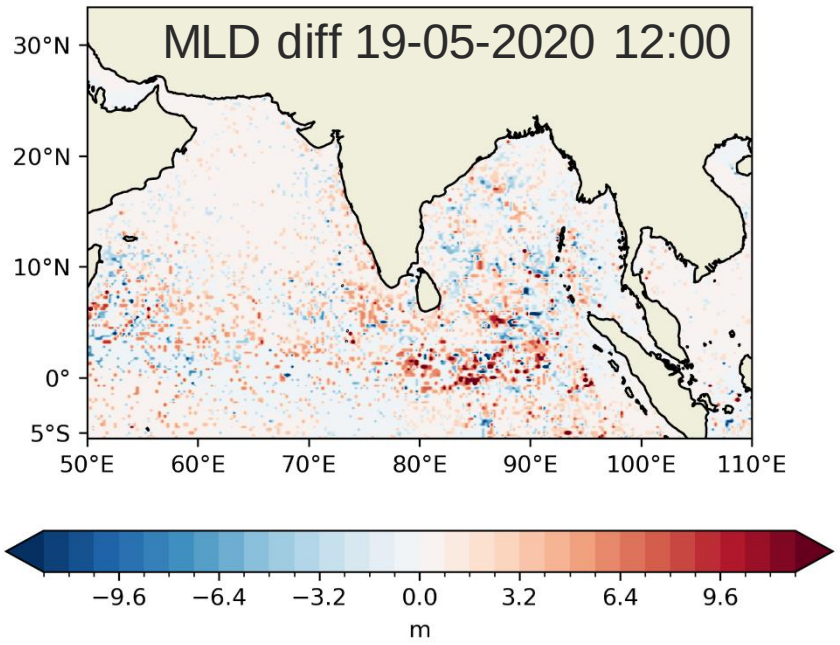


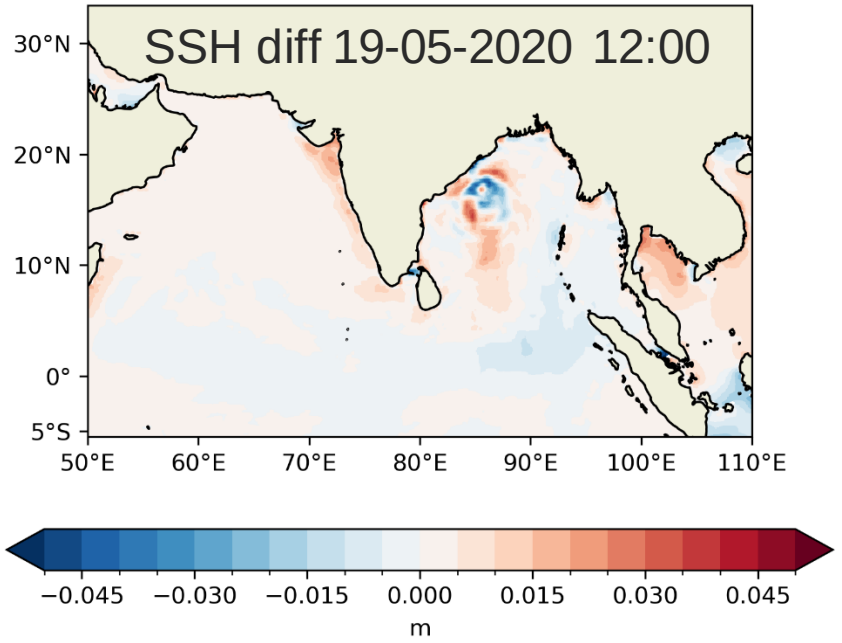




- Effect of Stokes-Coriolis term and wave modified wind stress.

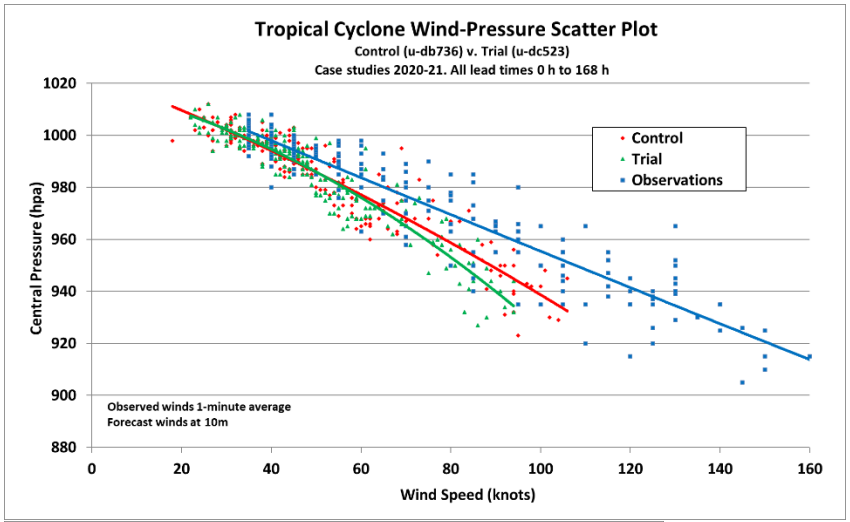
GC5W – GC5 coupled Amphan case study



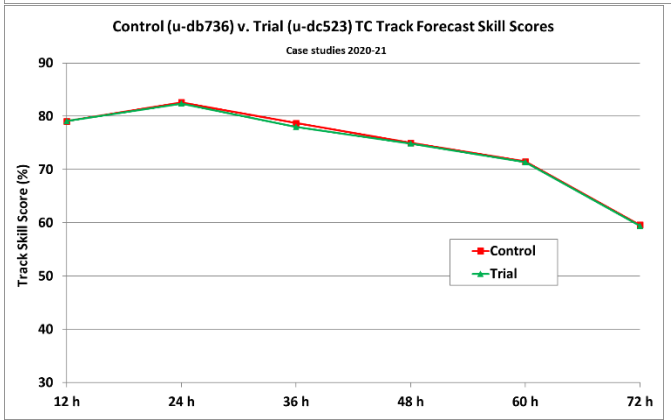


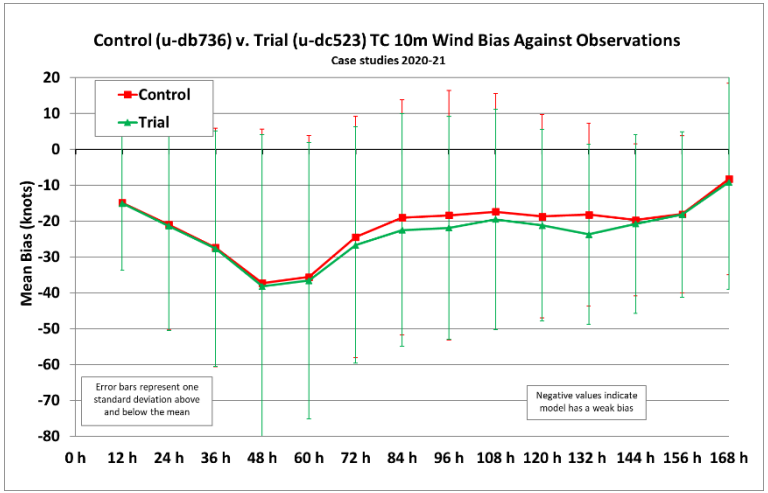
~10kmUM-ORCA025-~25km WWIII

14 TC case studies. GC5W vs GC5

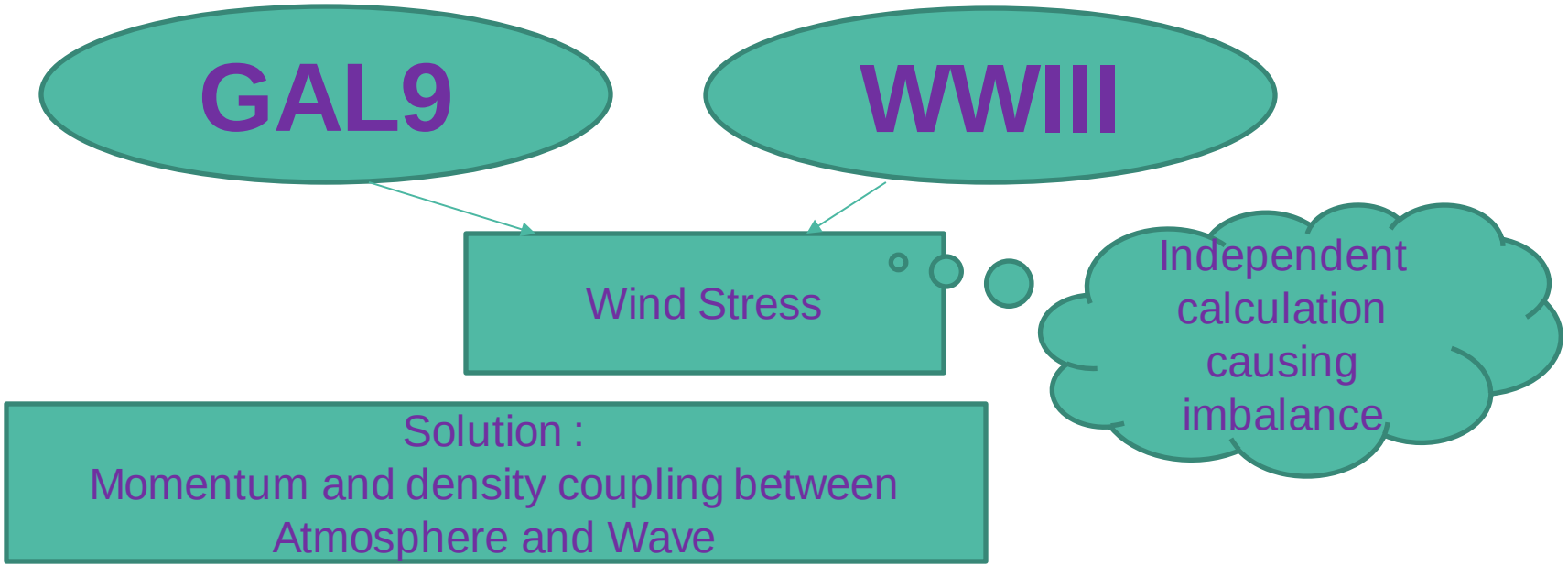


- Weaker TCs in GC5W
- Negative wind bias

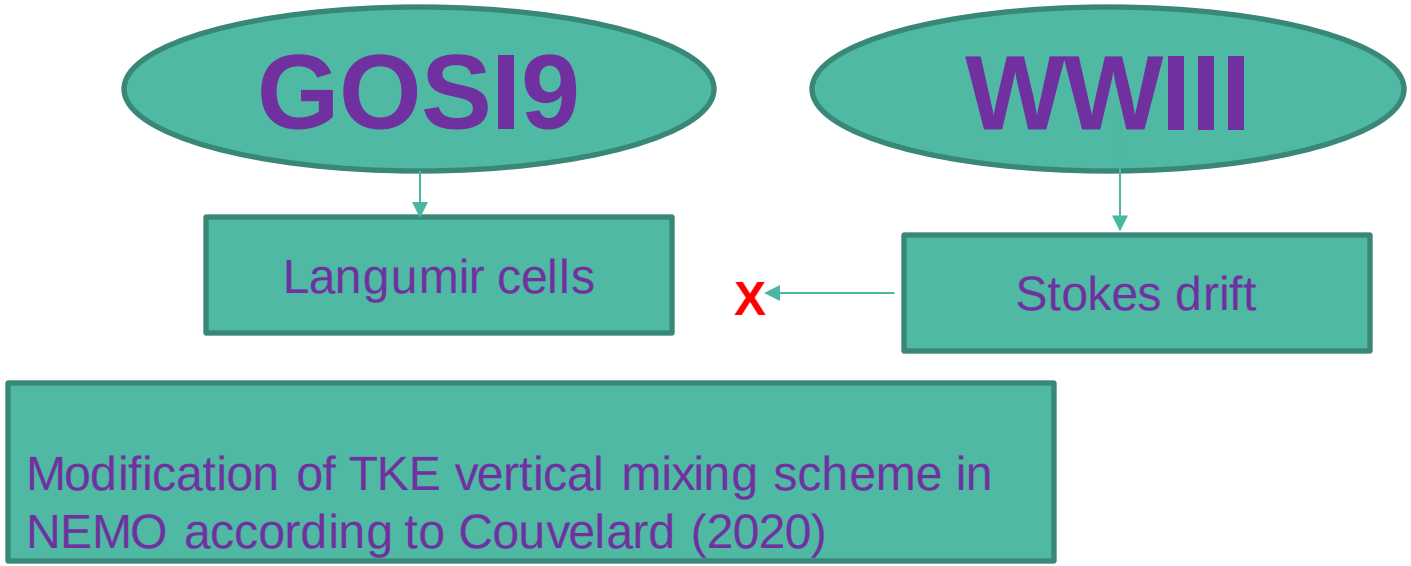




What is lacking in Atmosphere-Wave coupling?



What is lacking in Ocean-Wave coupling?



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Summary

- A working OWA coupled model based on GC5 is now functional
- Effects of wave coupling are mostly neutral in climate mode
- Drag from the waves exasperate the negative wind bias during TC's
- Further improvements in coupling strategy is needed.

Works in progress.

- Dampening of wave drag in WaveWatchIII
- Momentum closure coupling (Nieves et al 2021). Initial coupling is done. Currently investigating model crashes.
- Upgrading NEMO version to 4.2 which has capability of TKE mixing scheme modifications. Additional coupling of wave vortex force and wave induced pressure. Stokes drift from wave model in Langmuir cell calculation.
- We are hoping to have Global Wave model coupling as an optional feature in GC7.

Questions?

For more information please contact


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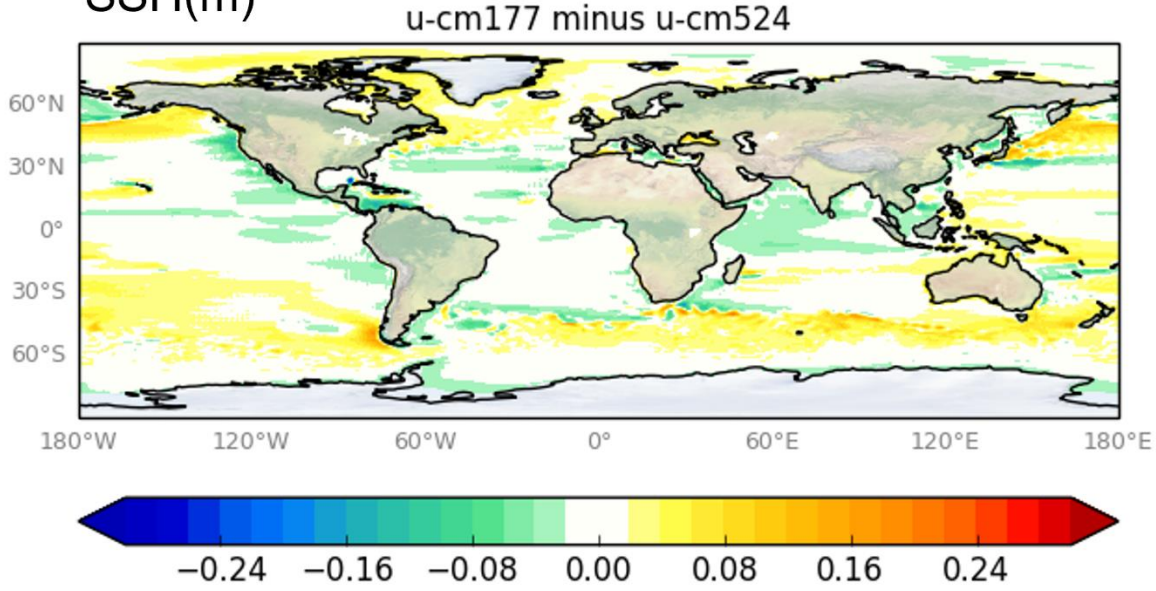
Hadley Centre

SSH(m)



- Obvious changes in high wave activity/ eddy activity regions.
- Influence of Stokes drift entering momentum equation.