The importance of Ocean – Atmosphere – Wave interactions in tropical cyclones with focus on ocean response

(example TC Olwyn)

Janekovic Ivica, Babanin Alexander, Pattiaratchi Charitha and John Warner

Email: ivica.janekovic@uwa.edu.au
Tropical cyclones (TCs)

- To have correct ocean dynamics we have to have a correct atmospheric forcing
- Prediction of the TCs path is improved but still we have problem with intensity
- They use available heat from the upper ocean, depend on the ocean roughness, sea spray etc
- Still we have “decent” results, errors canceling?!
Ocean – atmosphere during TC

- Boundary layer - the extreme conditions
  - Winds > 30 m/s
  - Waves > 10 m
  - U10 ???
  - Heat flux > 1000 W/m²
  - Moisture flux
  - Mixing and turbulence
  - Violent dynamics
  - Bulk flux COARE?

Sydney Hobart 1998
Uncoupled systems?!  

- Many models have “constant Charnock”?  
- Ocean is static, unlimited source of heat?  
- We “know the physics”  
  -> need to exchange info btw models
Coupled system COAWST

- Atmosphere – WRF ARW model
- Ocean – ROMS model
- Waves – WW3 model
- All linked together using MCT
TC Olwyn 12/03/2015

Magnus 480 CPUs
WRF 240 (10-2.5 km)
ROMS 120 (~3 km)
WW3 120 (~3 km)
Wall clock ~10min/day
WRF-ARW - atmosphere

57 levels, 2 way 10/2.5 km, adaptive dt, RRTMG, WSM 3 class, Monin-Obukhow, Betts-Miller-Janjic
ROMS – ocean

3D, 25 levels ~3 km, realistic bathymetry, internal tides/waves, Mercator bry
WW3 - waves

Sign. Wave Height

13:00 (UTC) 10/Mar/2015

(m)

8°S
10°S
12°S
14°S
16°S
18°S
20°S
22°S

115°E
120°E
125°E
130°E
135°E
140°E

Darwin
Broome
Prelude
NRC
P.Hedland
Exmouth
WW3 Hs
Charnock 0.0185?
Olwyn TC COAWST

WRF 2-way coupled with ROMS and WW3 (10min)
Olwyn TC

WRF uncoupled from ocean, heat, surf drag....
Olwyn TC COAWST

WRF 2-way 10min coupled ROMS and WW3
Olwyn TC

ROMS forced with WRF uncoupled ocean
Fully coupled vs standard way

2-way

uncoupled
Fully coupled vs standard way
Comparison with ASCAT/alt.

11/3/2015 @ 12
ASCAT 25km
JASON2, CRYOSAT

12/3/2015 @ 12
ASCAT 25km
JASON2
Global models GFS (Marcus)
Global models IFS (Marcus)
Global models GFS (Marcus)
Global models IFS (Marcus)
Conclusions

Modelling TC and ocean dynamics

- They are approximation of the real world (numeric, grids, params)
- We all relay on them (FCST/Climatology/SAR)
- Correct physics -> better path AND intensity of TC
- Need ocean part for all ocean-atmosphere interactions
- Winds > 30 m/s needs new parametrization (sea spray)
- Heat and moisture flux important (we had errors cancelling)
- Global models like IFS@ECMWF (NEMO + WAM)
- Yes we can improve TC, and possible in real-time (10min/day)