New techniques in high res. coastal modelling

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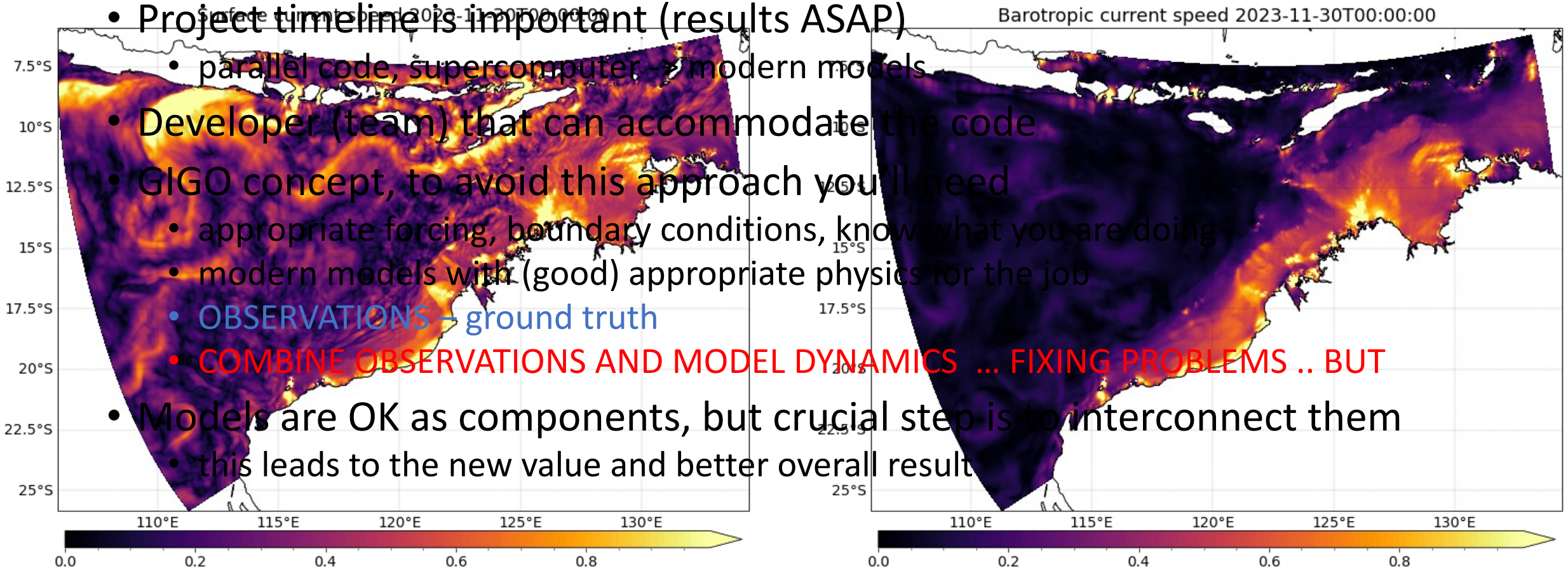
Next gen of high-res coastal modelling

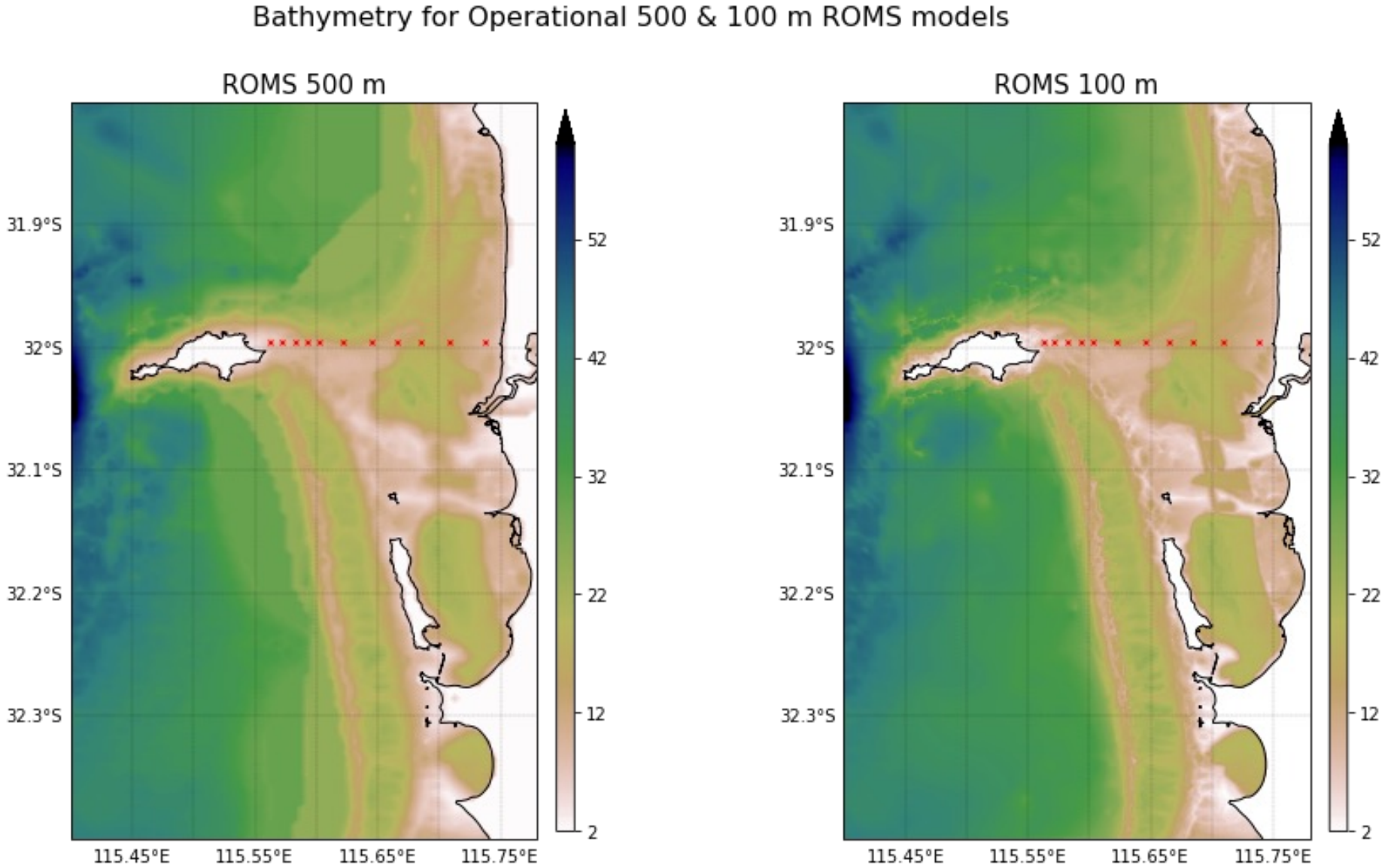
- New models already pushed boundaries (driven by hardware), git pull
- Project timeline is important (results ASAP)
  - parallel code, supercomputer -> modern models
- Developer (team) that can accommodate the code
- GIGO concept, to avoid this approach you'll need
  - appropriate forcing, boundary conditions, know what you are doing
  - modern models with (good) appropriate physics for the job
  - OBSERVATIONS – ground truth
  - COMBINE OBSERVATIONS AND MODEL DYNAMICS … FIXING PROBLEMS .. BUT
- Models are OK as components, but crucial step is to interconnect them
  - this leads to the new value and better overall result



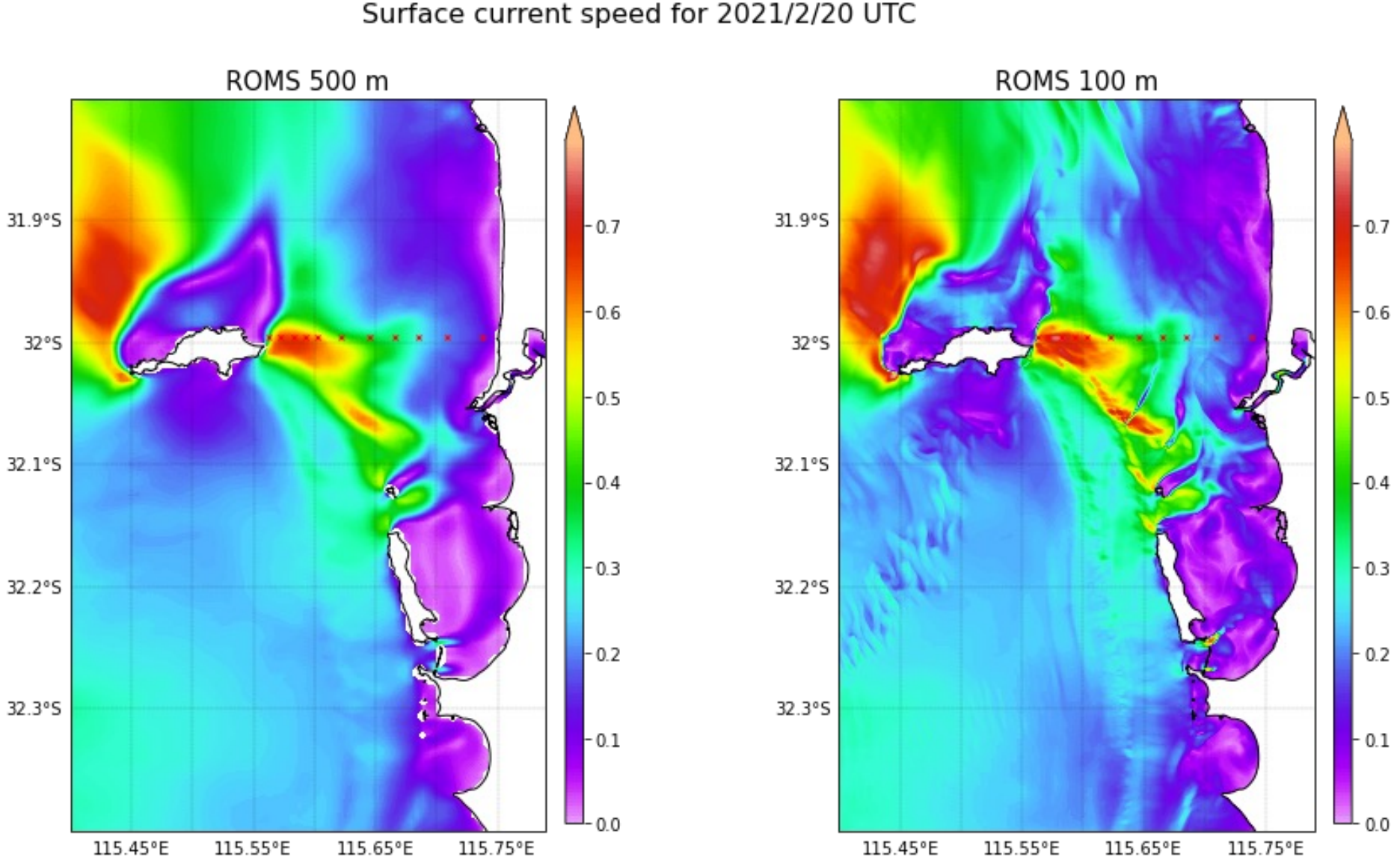
Different models – different approach
(All models are wrong, but some are useful … George Box)

- Different models (resolving physics) need different setup (and forcing)
  - Wave models use only winds (ERA-5? BARRA? Local WRF?)
  - 3D Ocean models – need heat, moisture, momentum flux, turbulence
  - Sediment models - need sediment types (maps), additional params,…
  - Vegetation models - need map and new set params (stem length, density etc)
- Information exchange btw models
  - Wave model needs ocean currents and sea level (vegetation module …)
  - Hydro model needs wave stress, surface stress - drag, (vegetation)
  - Atmosphere model receives feedback to modify BBL (adding sea spray)

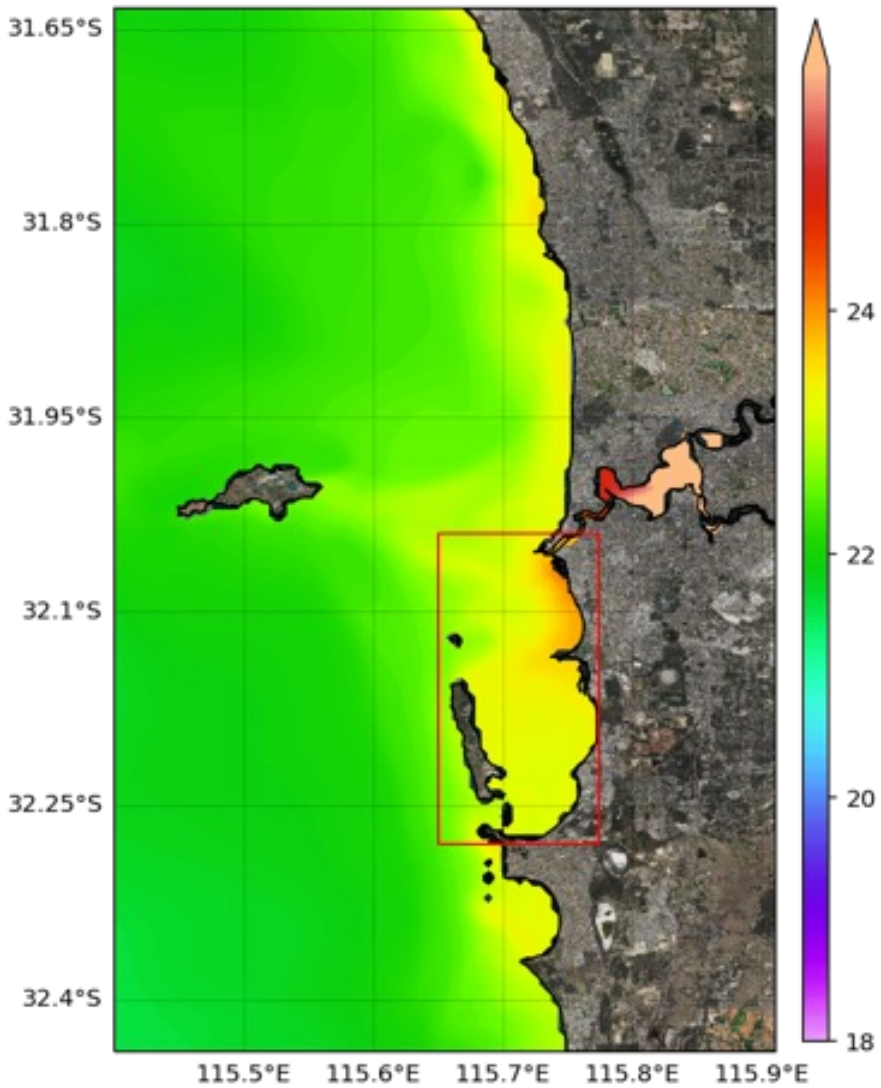
Example: 8y of ROMS 500m vs 100m?

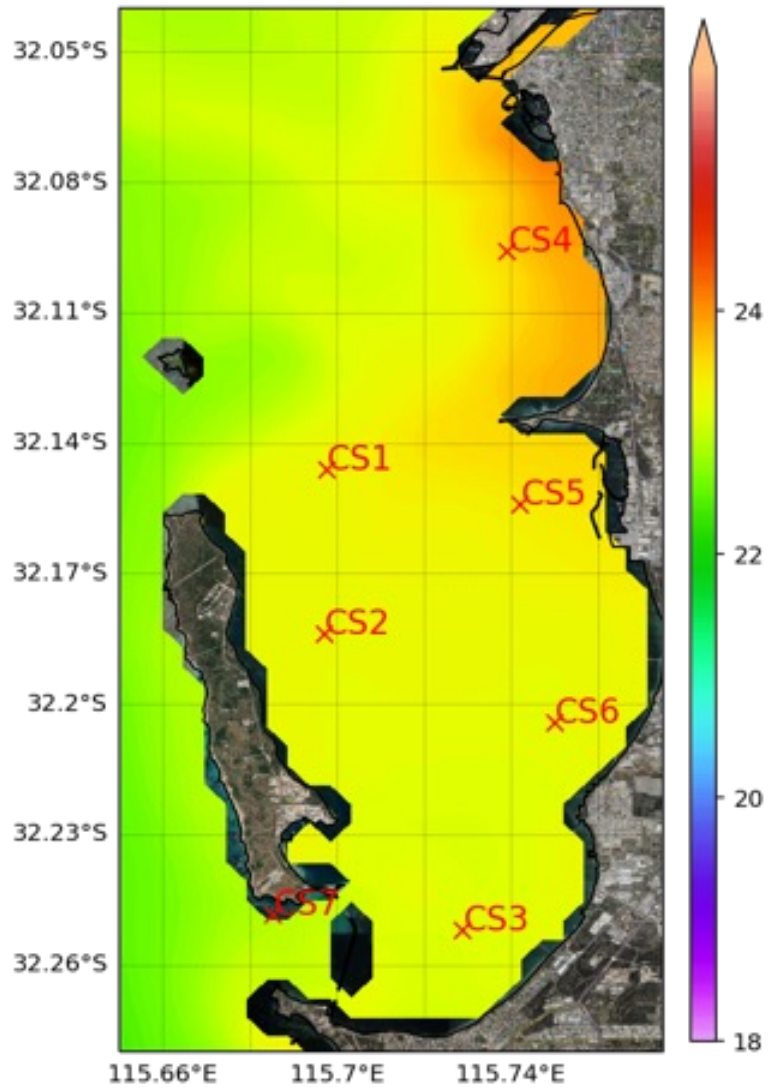


Example: Rottnest swim ROMS 500m vs 100m

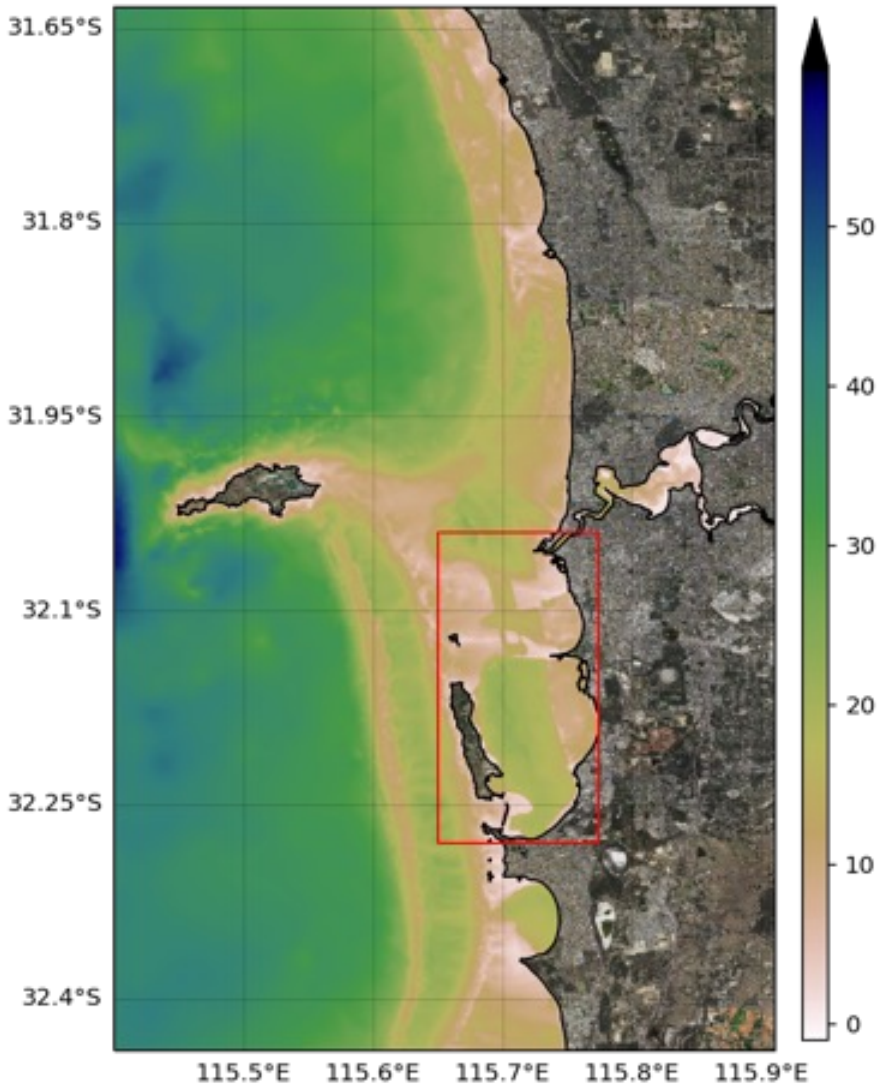


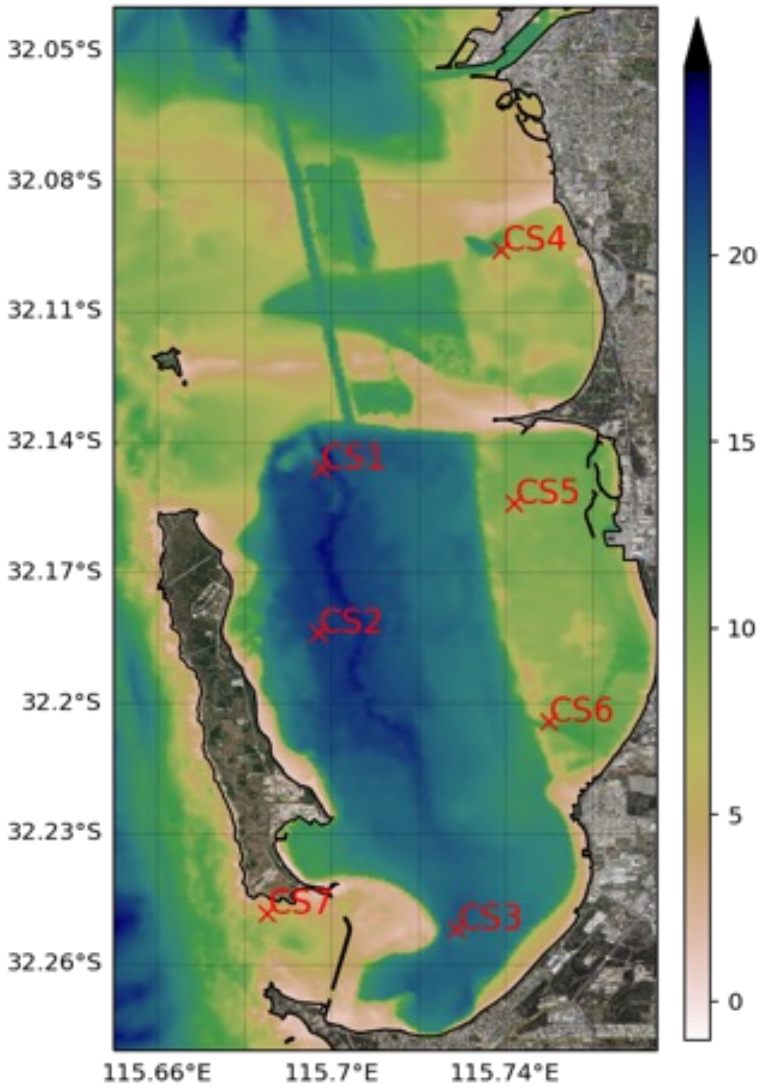
ROMS Surface temperature 2020-01-29 13



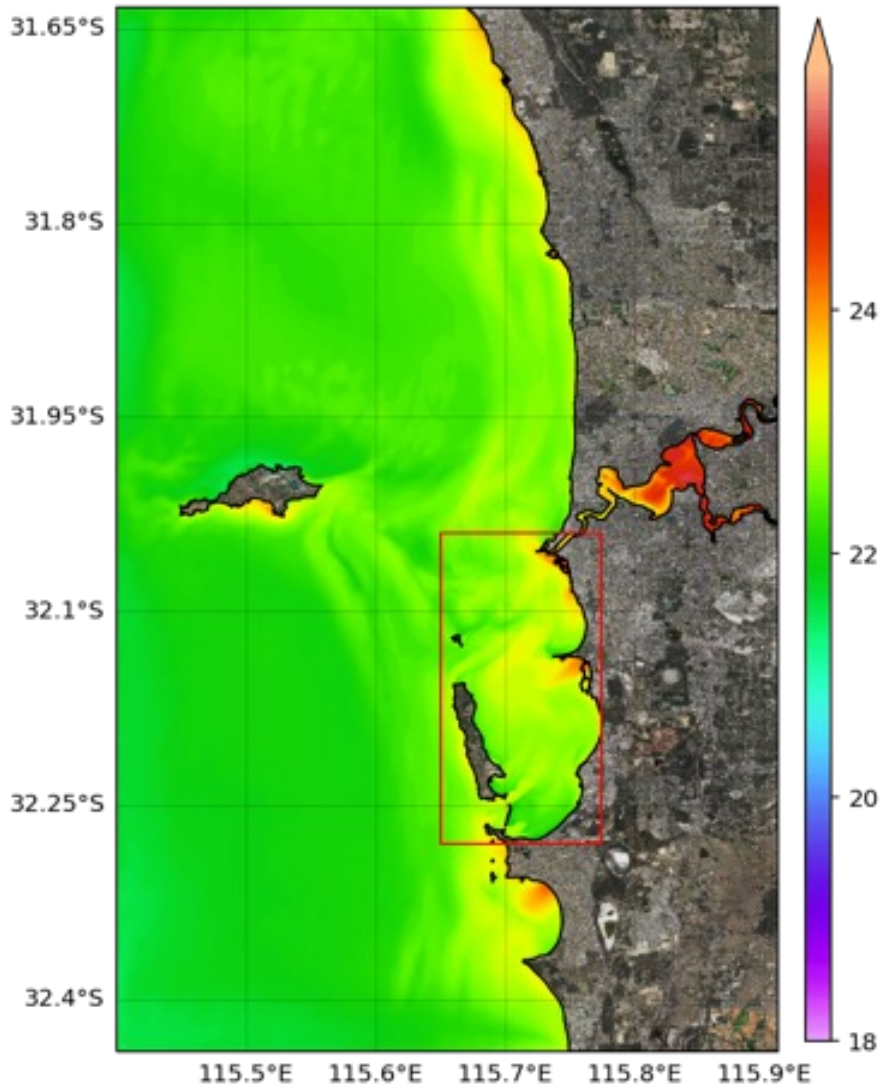


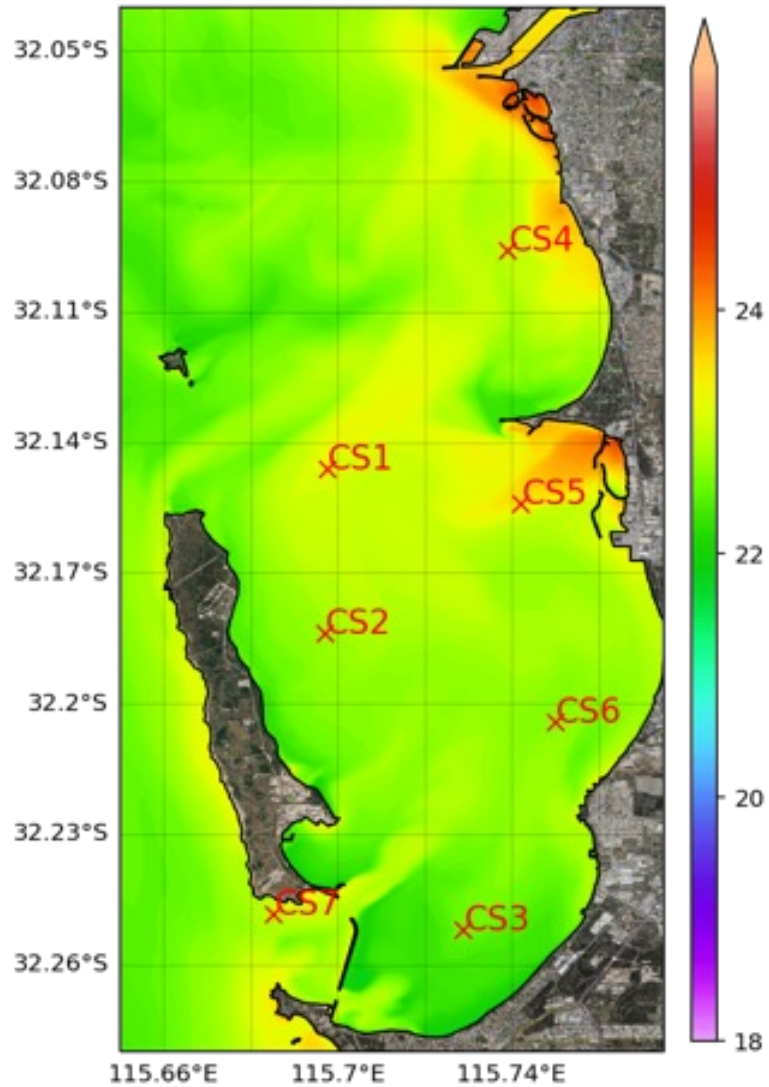
SCHISM unstructured (nested inside ROMS)





Surface temperature 2020-01-29 13



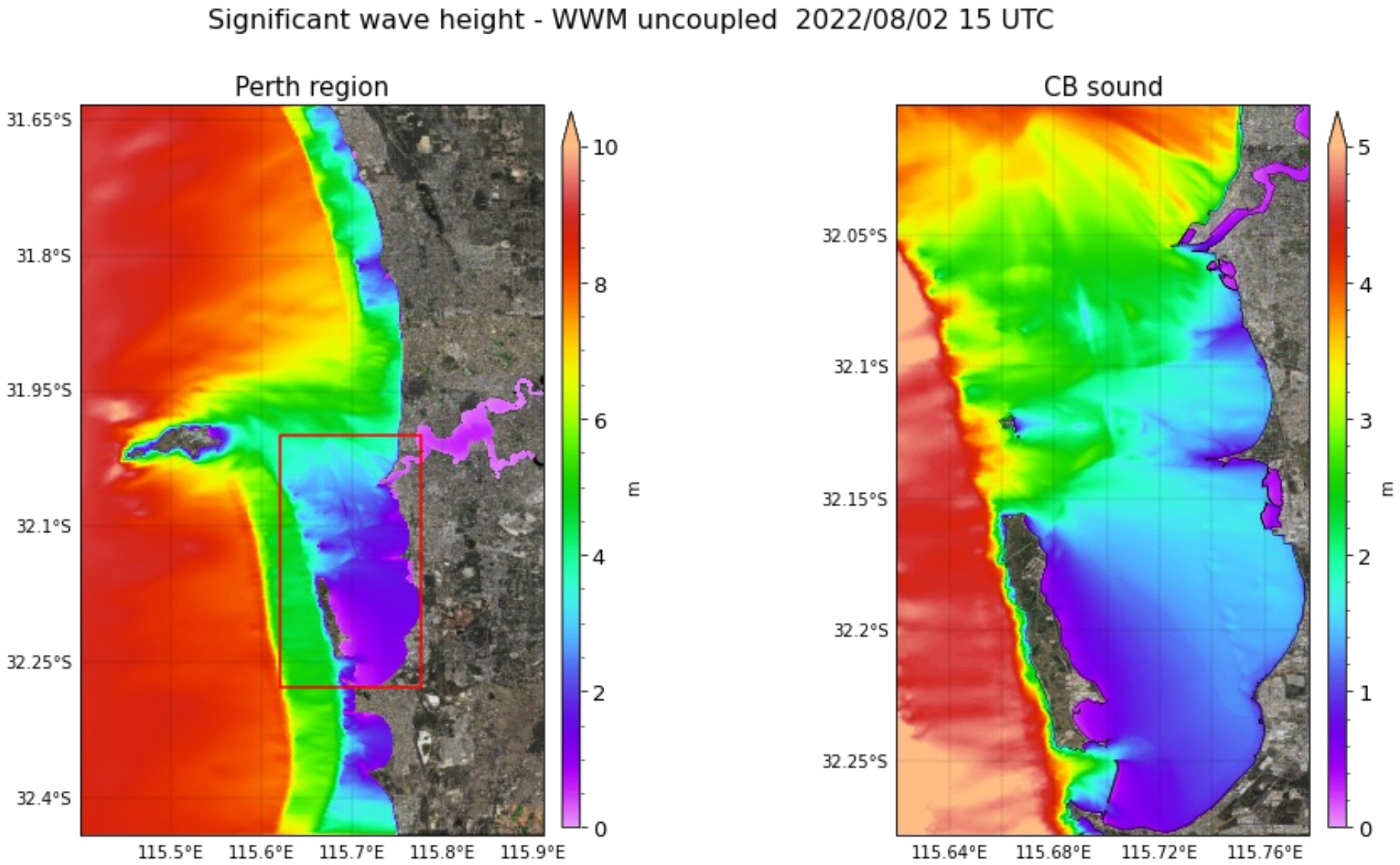


Coupling models – 3D hydro & wave & atmo

- Integrating (2 or more) models in parallel and exchanging info
  - Wave model receives SSH and ocean currents from ocean model
  - Ocean model receives wave effects (stress, 3d Stokes – vortex formulation)
  - Models use different time steps (need exchange time step), MPI cost
  - In our case they use the same numerical grid (no need for remapping)

- During extreme events (needed for design criteria)
  - Effects because **no-coupling can be larger** than from different physics/forcing
  - You can have a “perfect” model but still getting things wrong
  - Or you can have good result because of wrong reason

Significant Wave Height ? (2022-Aug storm)



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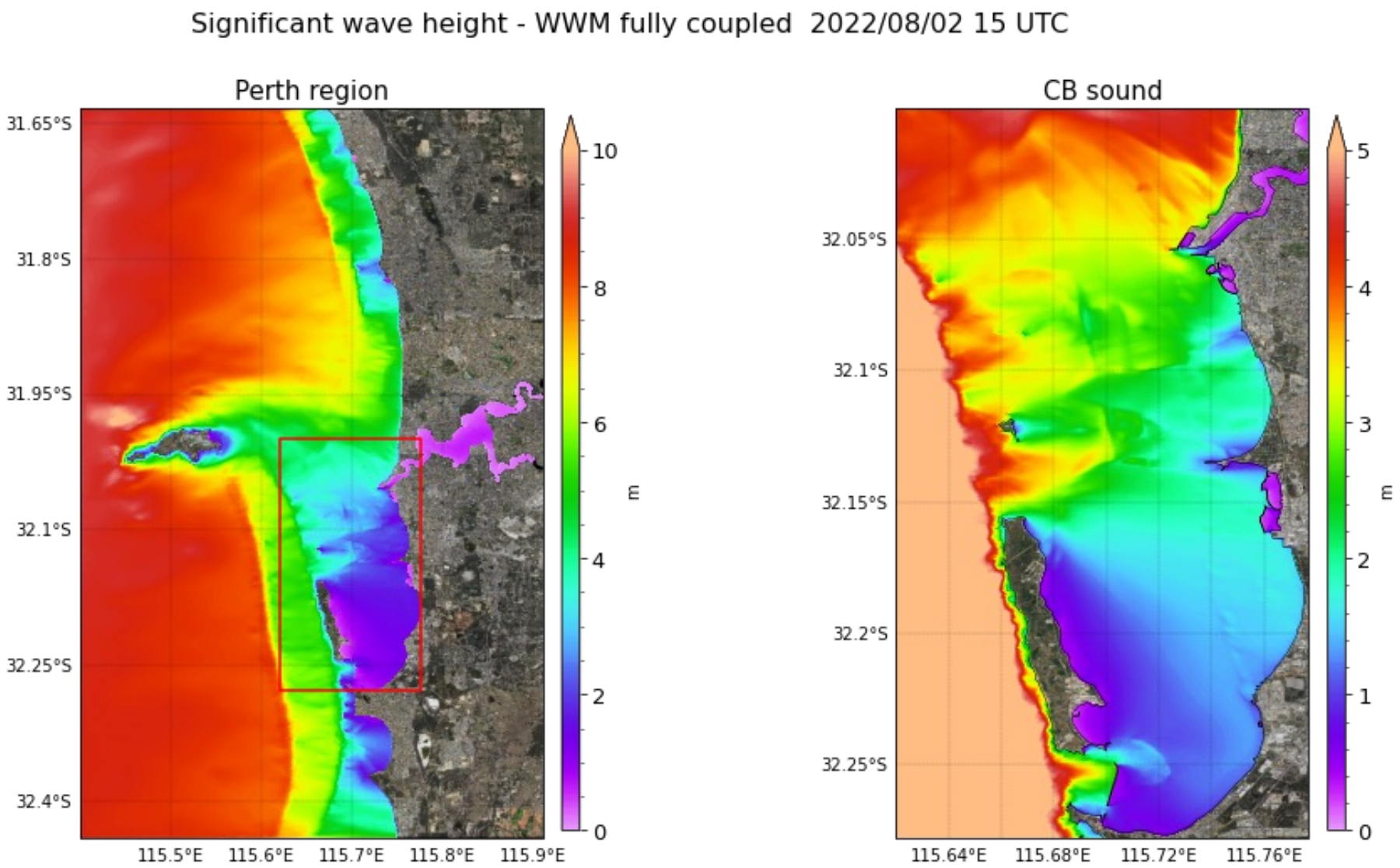
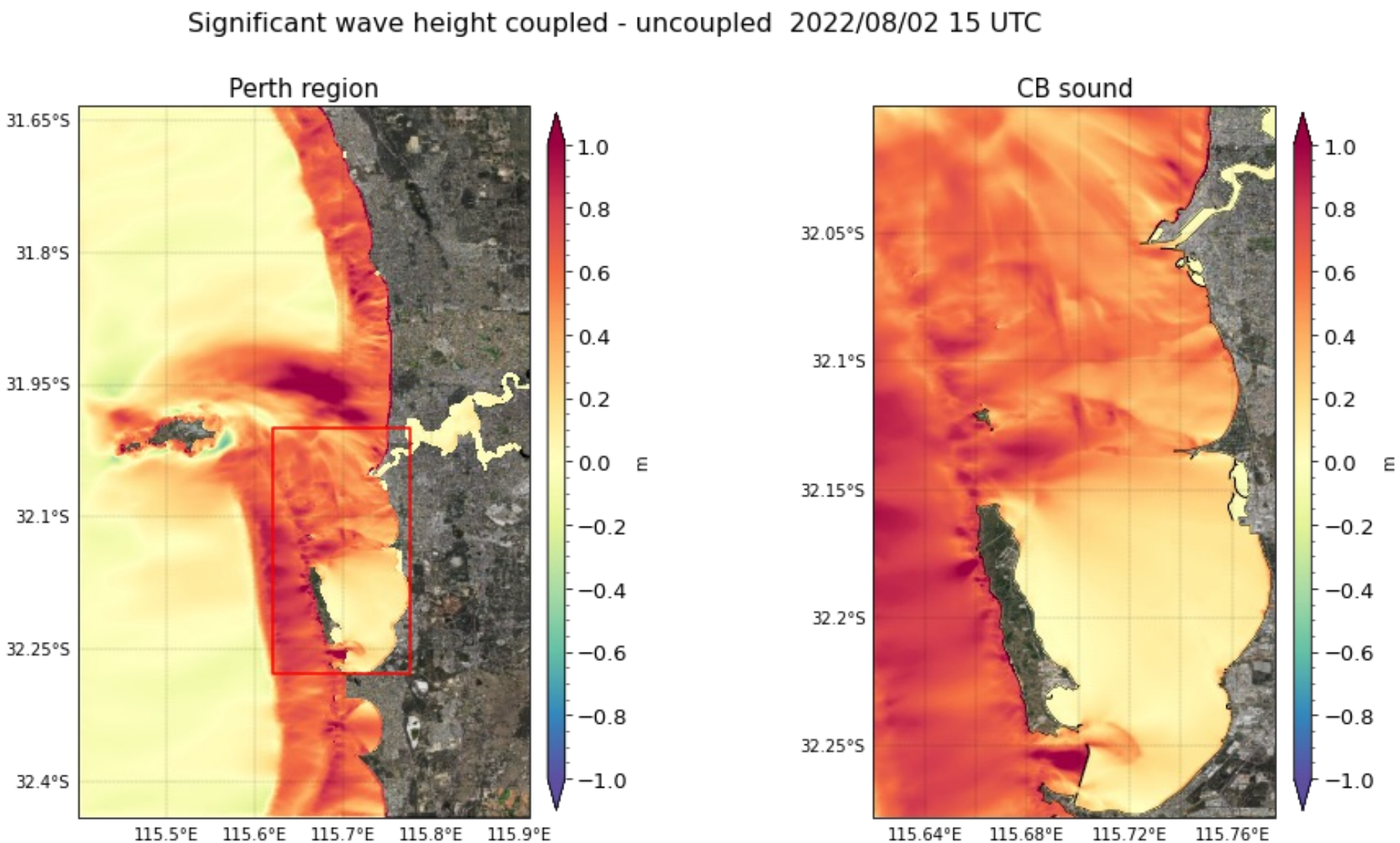
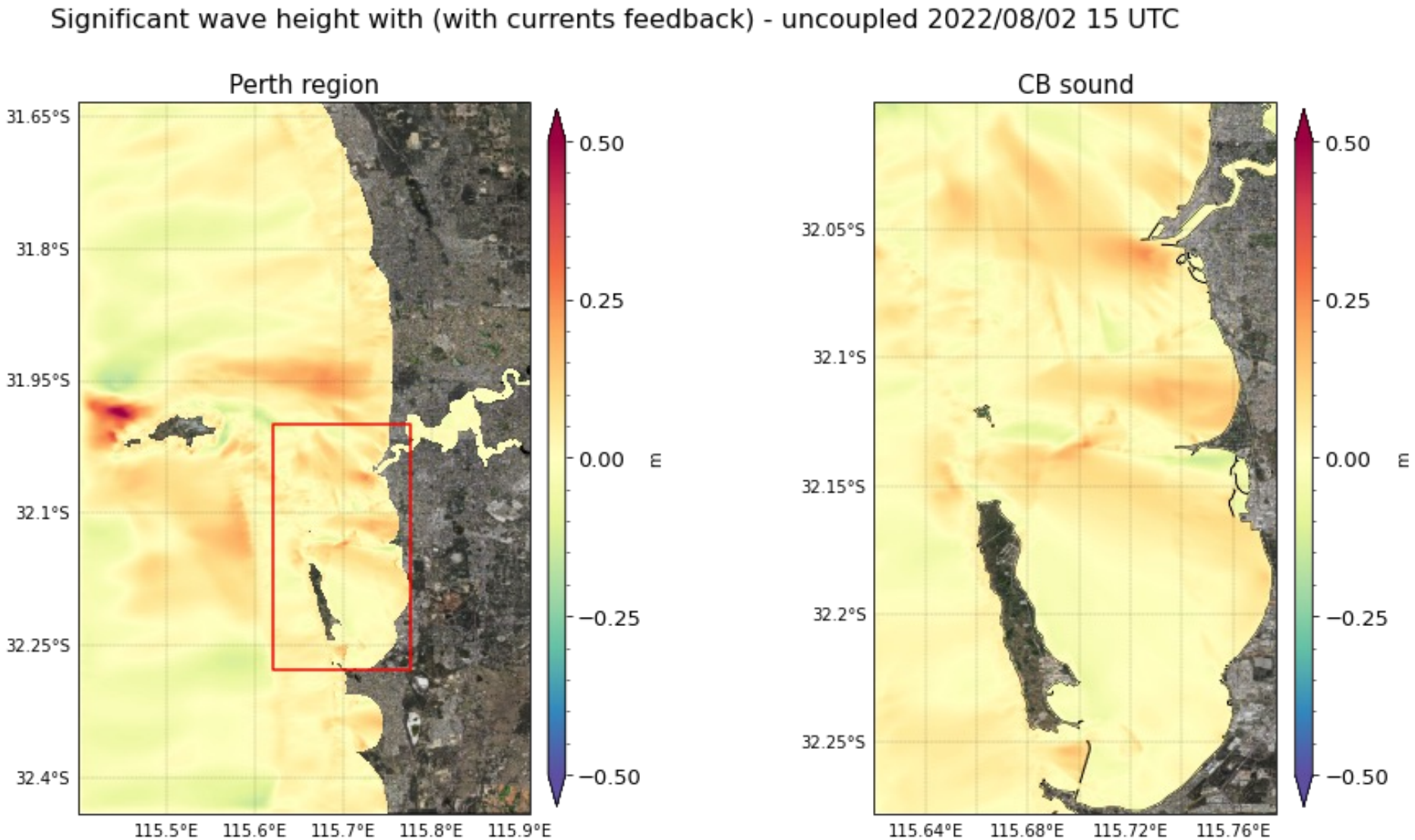


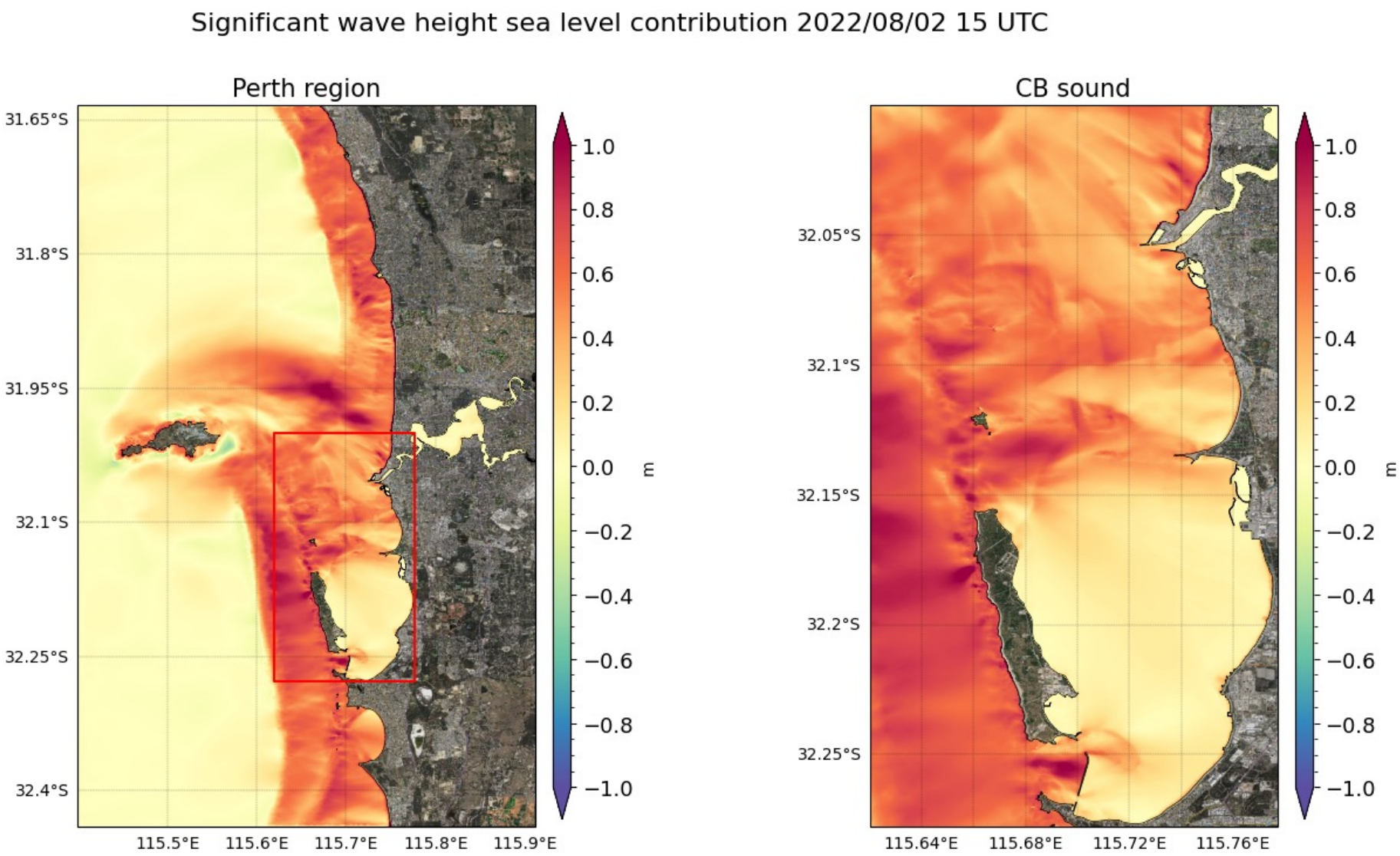
Hs difference (coupled – uncoupled)



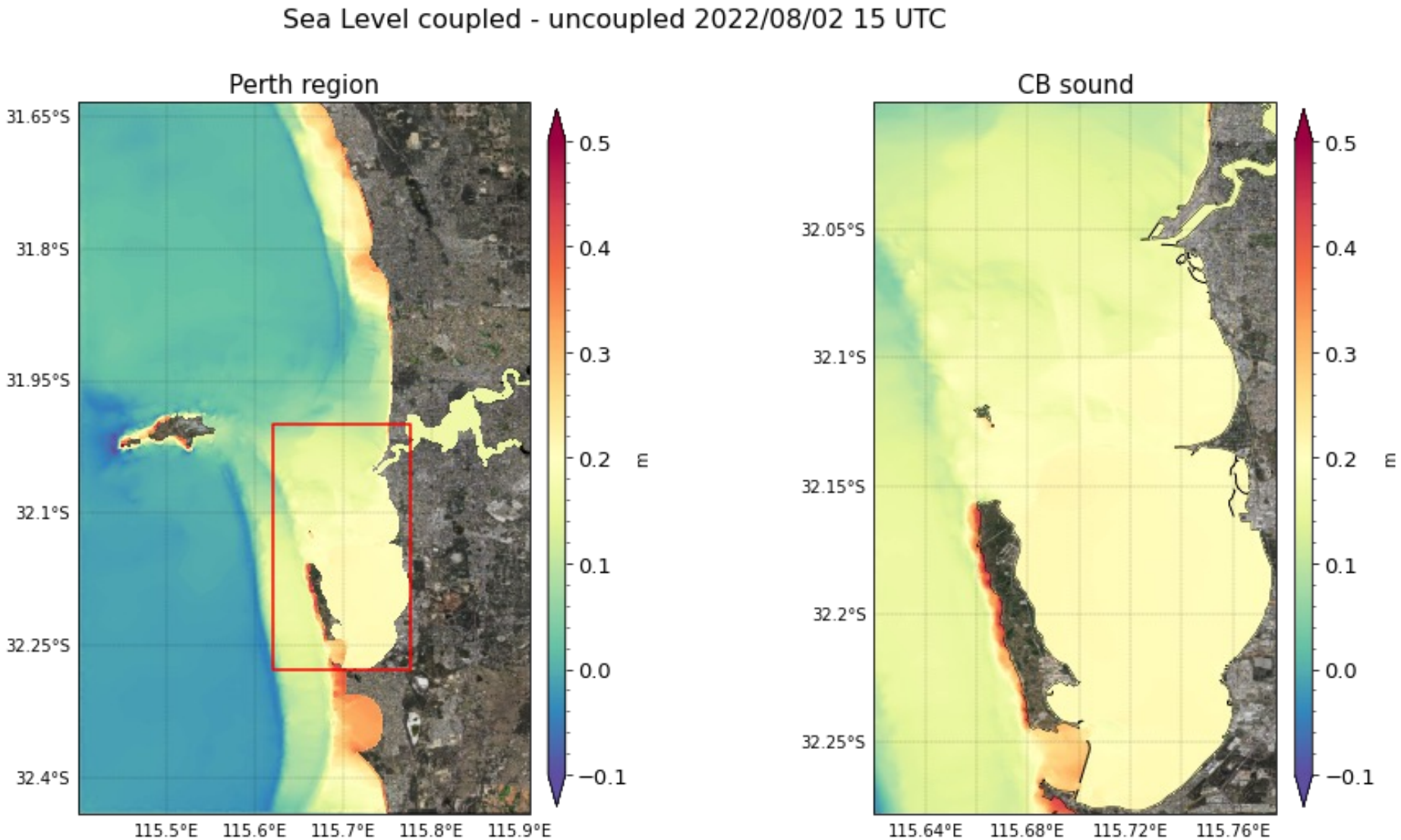
Hs difference (with currents and without)



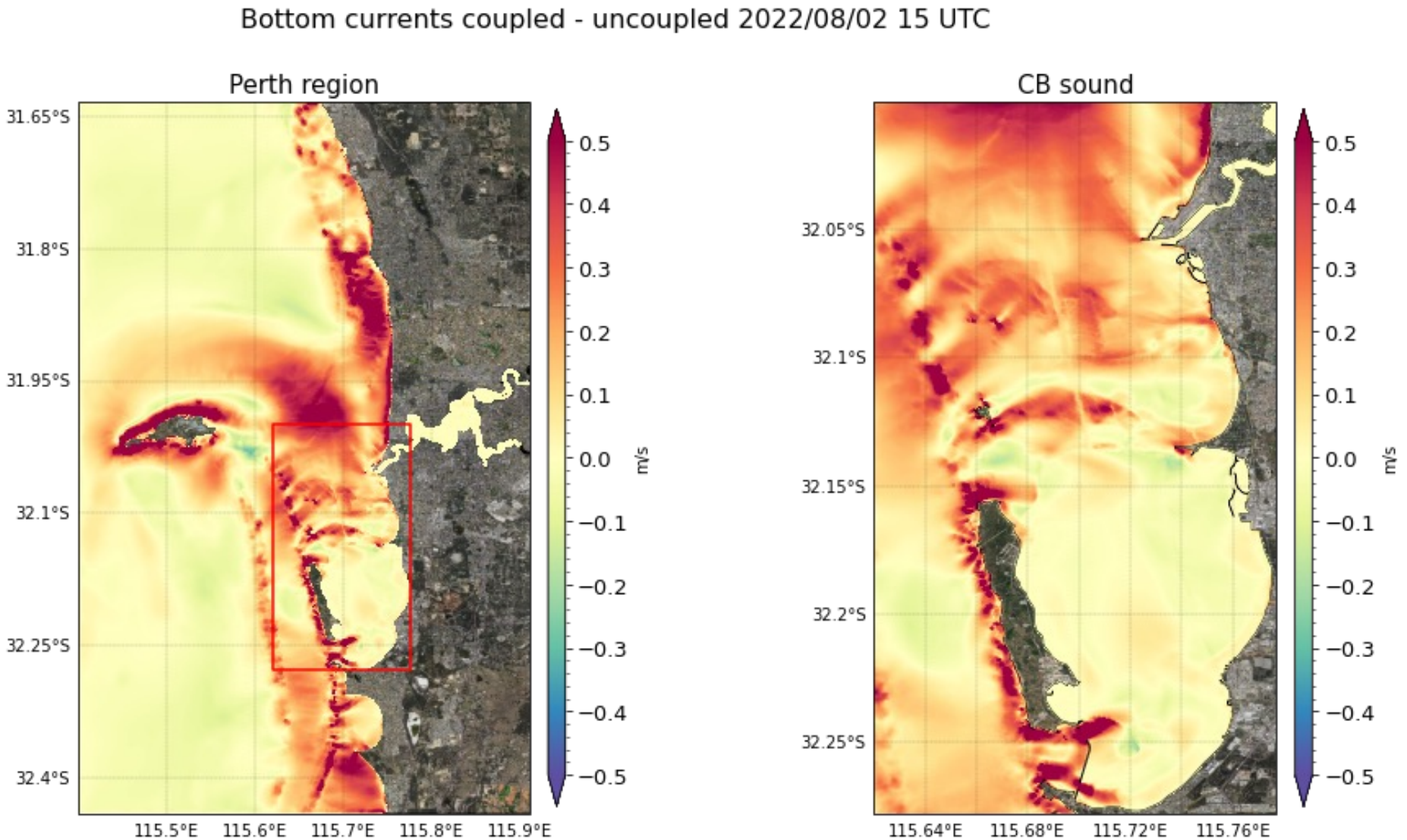
Hs difference (with ssh feedback and without)



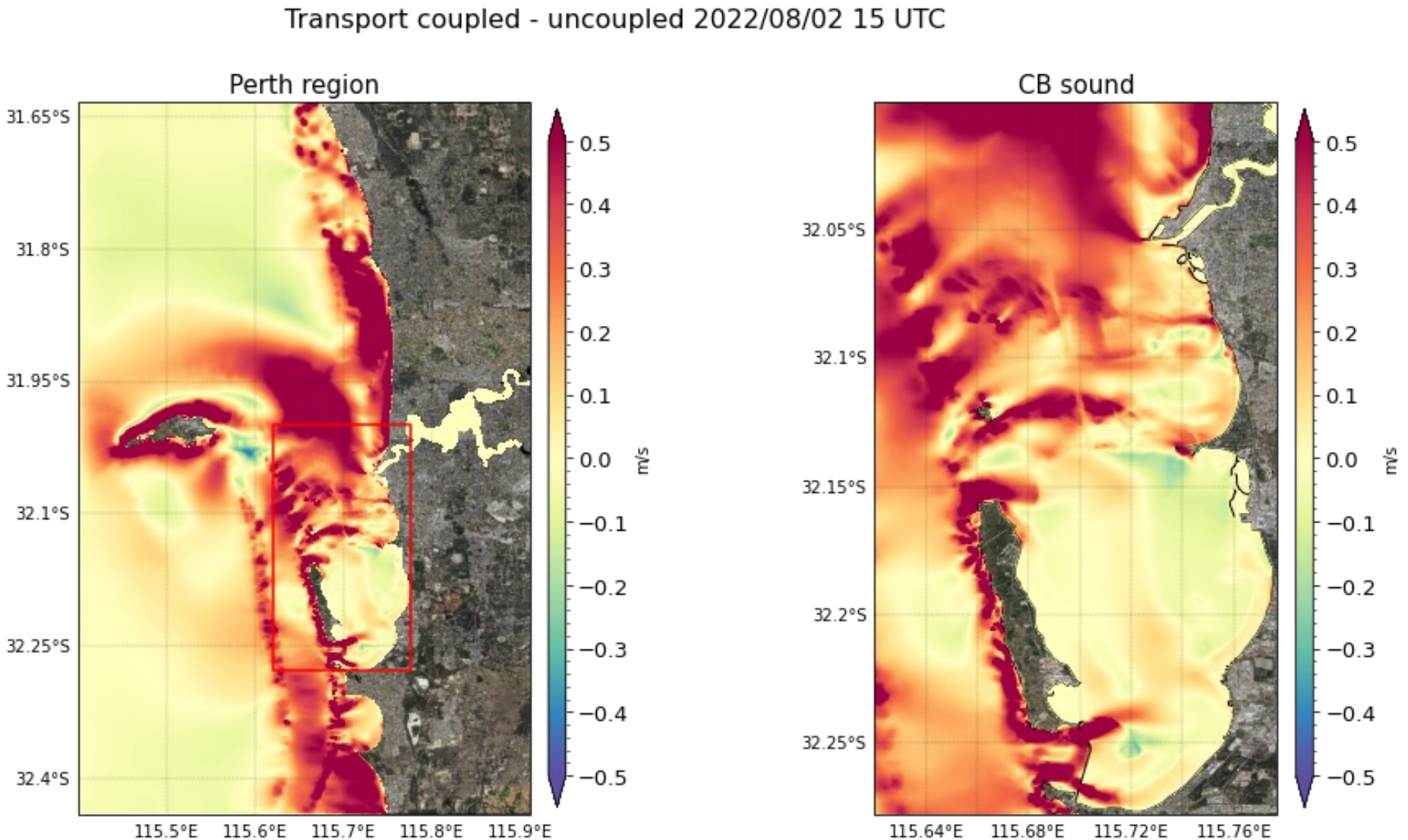
SSH difference (wave feedback and without)



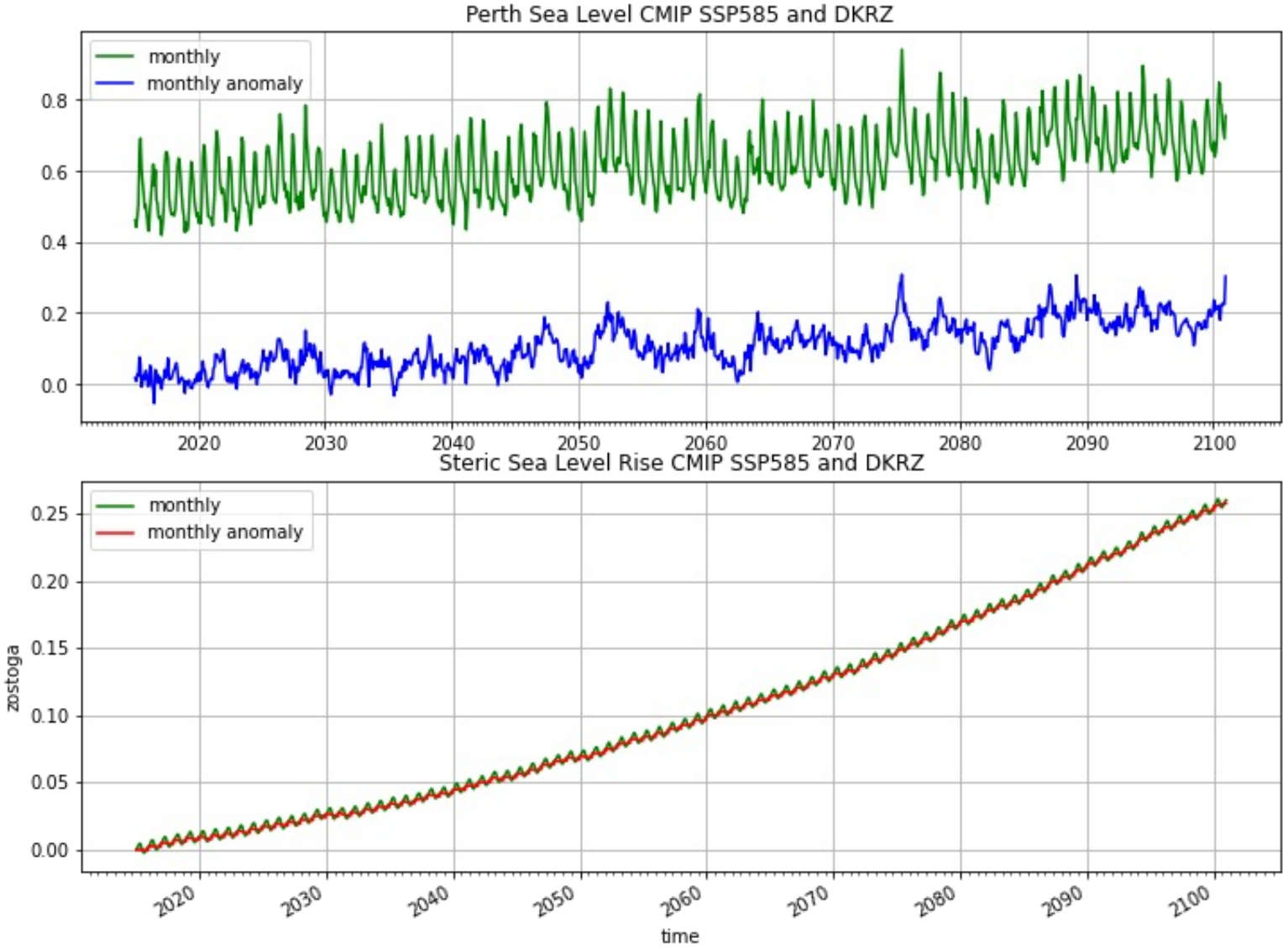
Bottom current difference (w/o feedback)



Transport difference (w/o feedback)



Sea level rise CMIP6 + storm surge + …



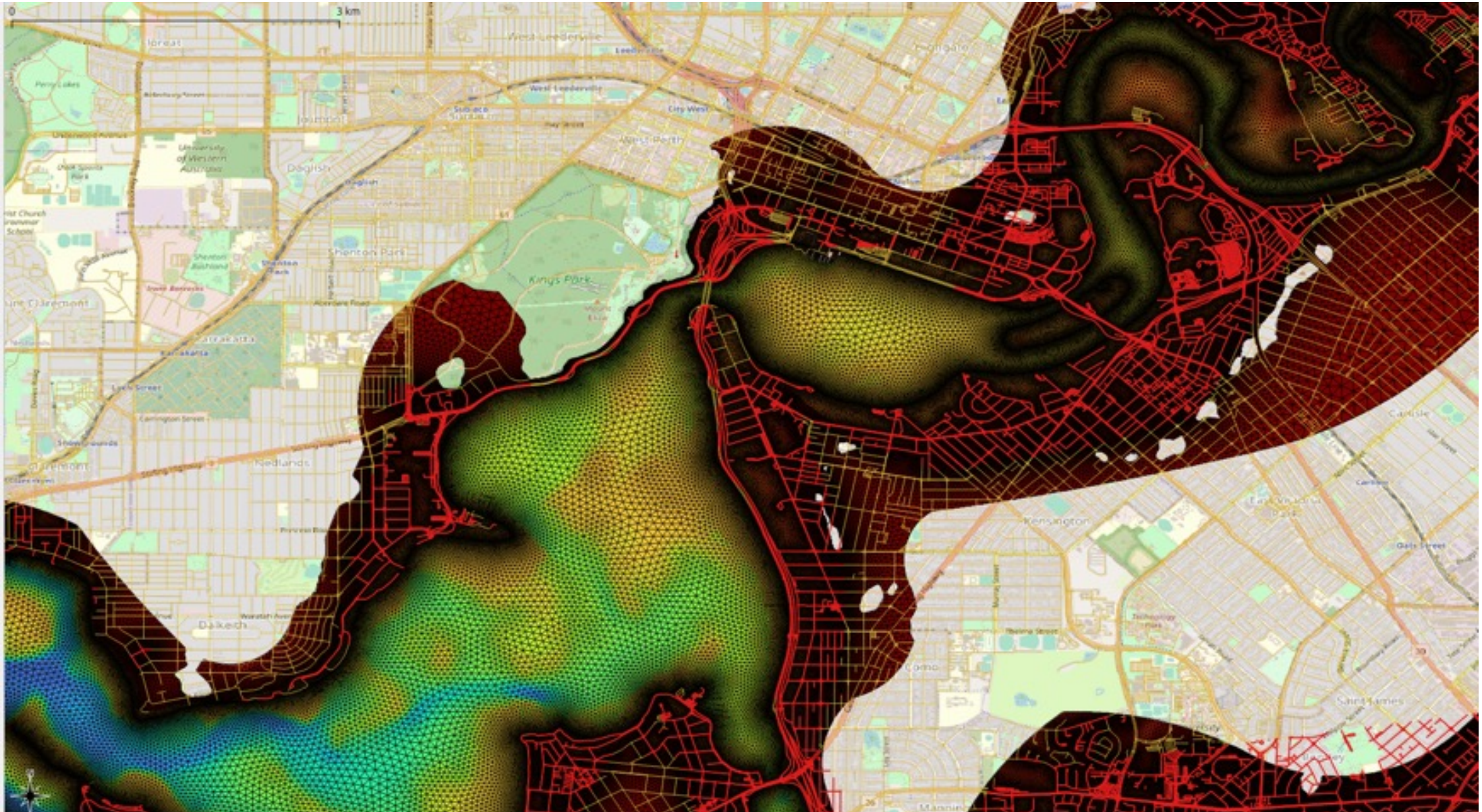
EV

Sea level trend
Pressure effect
Wave setup
Coastal trapped wave
Tides
Running models for long time to get idea

Still, we need high resolution
to propagate effect to 1m resolution

…. work in progress ….

Swan river model (~1m) work in progress



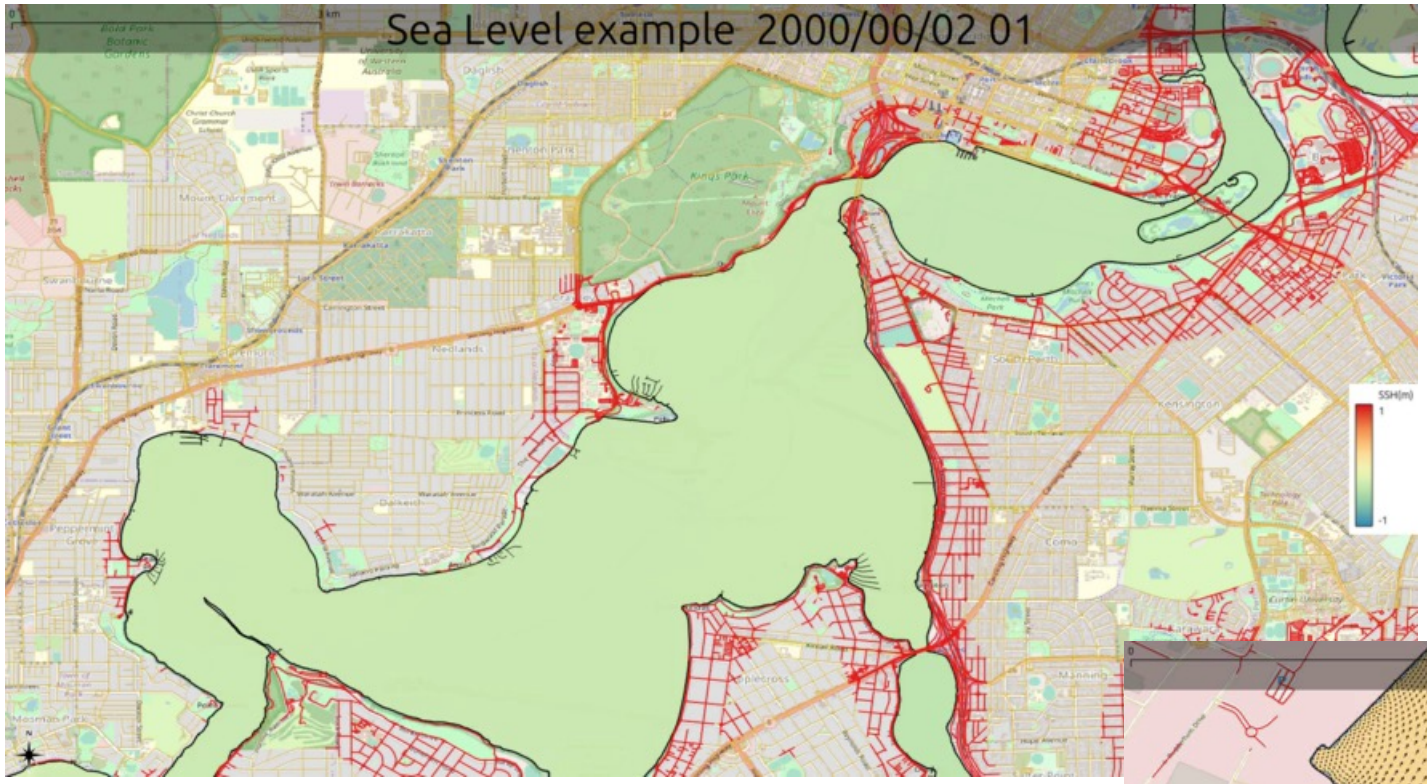
1,7 mil elements
20 s time step
LIDAR 5m data
swath bathy

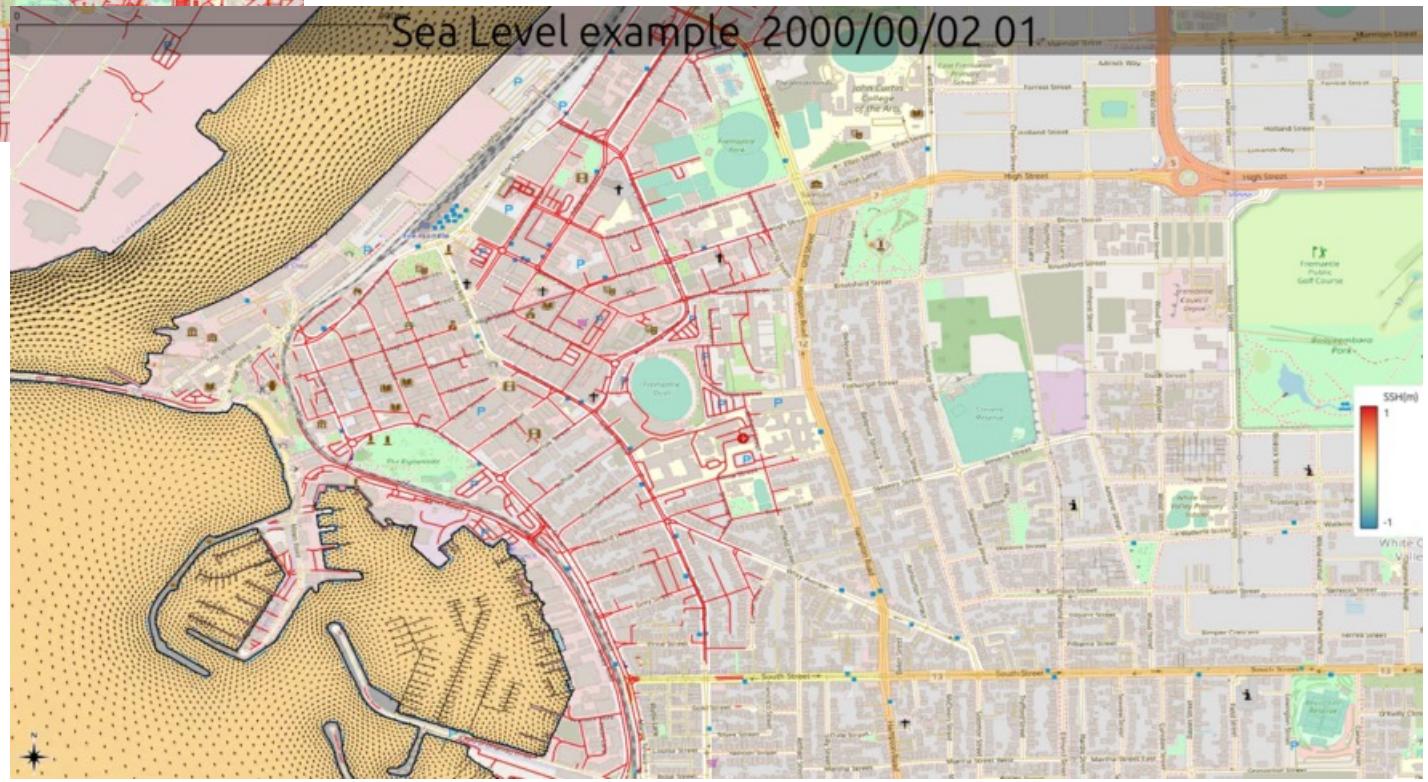
… change Cd ..
… rain …

wet/dry natural

grid is the key

6d in 2h CPU


Sea Level example 2000/00/02 01
SSH(m)
1
-1


Sea Level example 2000/00/02 01
SSH(m)
1
-1

Kind of Conclusions …

- Propagating information in/through models is the key
  - From outer models (nesting) & between models if needed
  - Identify main players – system/phenomena sensitivity
  - Perfect modelling system can be still too expensive (in real-time)

- Extreme events (engineering, floods, insurance)
  - Extreme events, frequency and intensity, redesign needed (1/100 years?)
  - Effects **no-coupling can be larger** than from physics or forcing?!
  - Even if you have “perfect” model -> still get things wrong not perfect
  - Cancelling errors is a dangerous game (good res because of wrong reason)