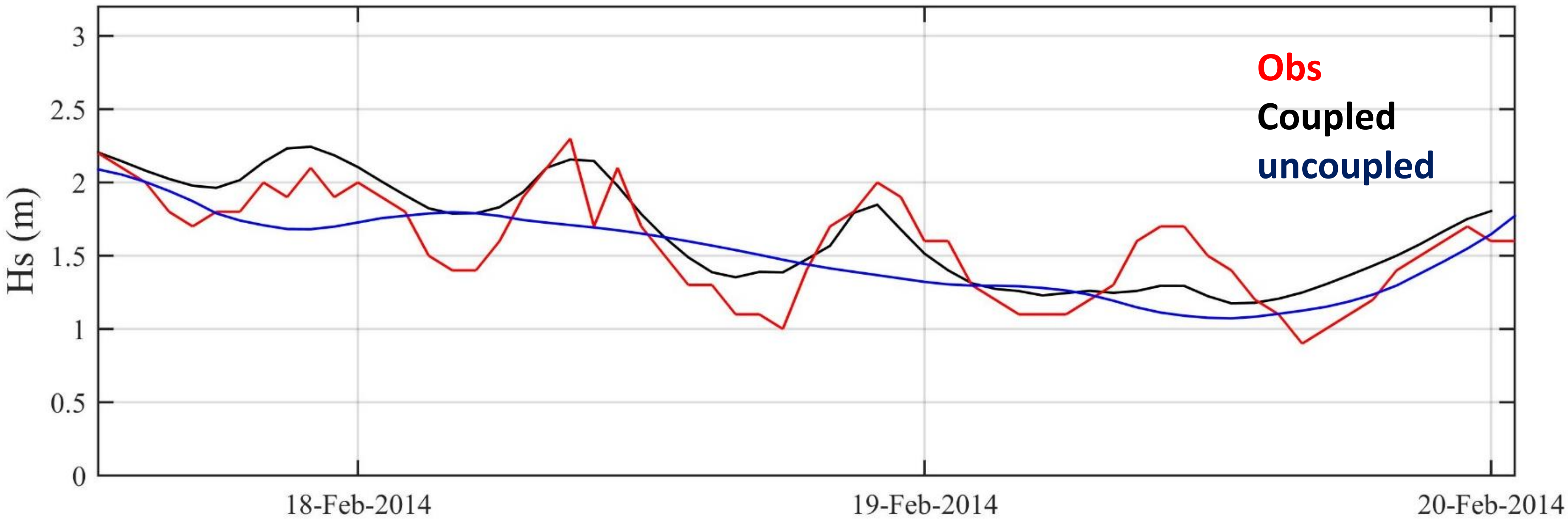
Coupled wave-tide modelling



Lewis M[1], Lewis H[2], Saulter A[2], Palmer T[2], Robins P[1], Chang W, Neill S[1].

[1] School of Ocean Sciences, Bangor University, UK
[2] Met Office, Exeter, UK

NERC SCIENCE OF THE ENVIRONMENT

Noddir gan Lywodraeth Cymru
Sponsored by Welsh Government

SEACAMS

Cyngor Cyllido Addysg Uwch Cymru
Higher Education Funding Council for Wales

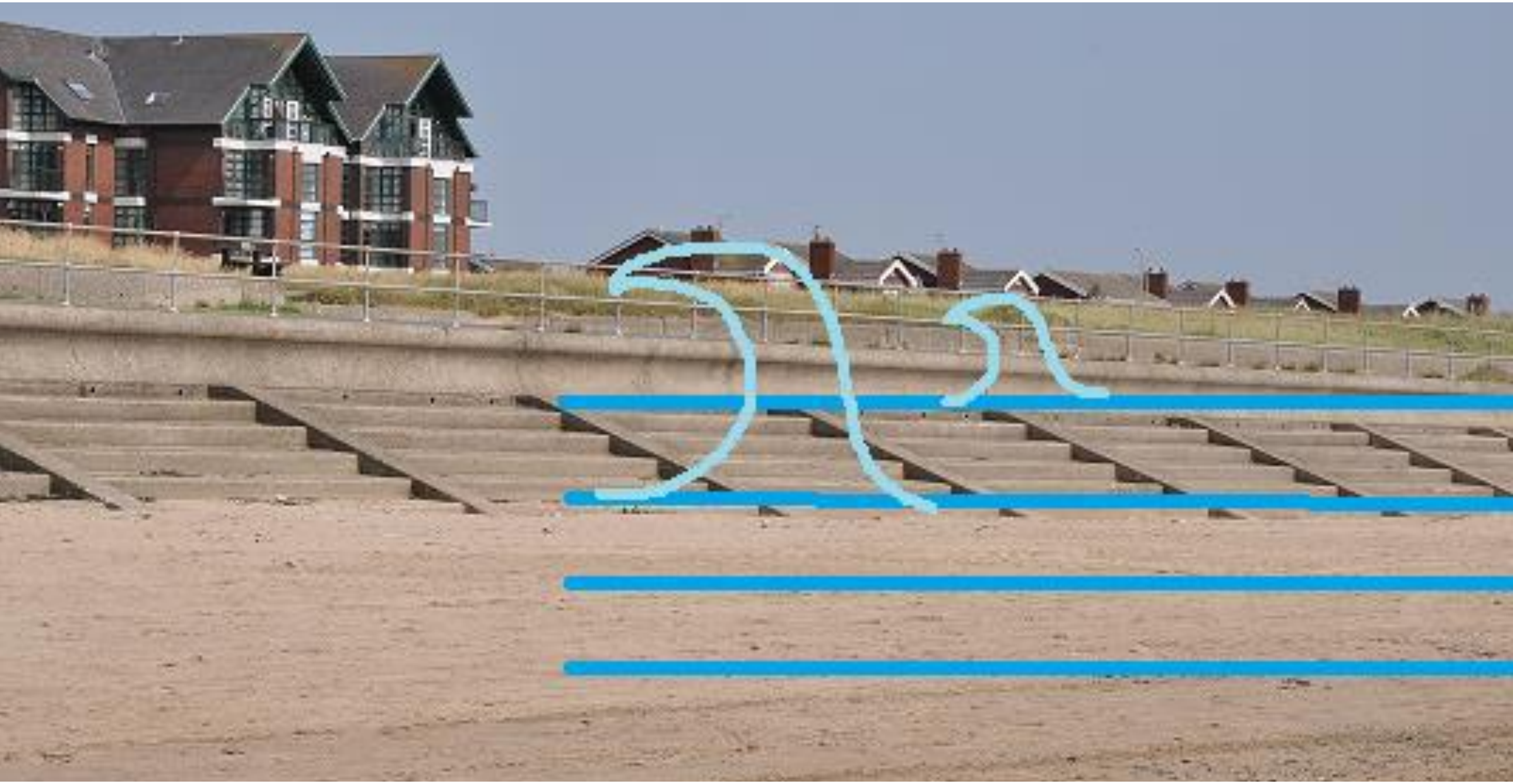
hefcw

HPC WALES • CYMRU

LOW CARBON, ENERGY & ENVIRONMENT RESEARCH NETWORK WALES RHWYDWAITH YMCHWIL CARBON ISEL, YNNI A'R AMGYLCHEDD CYMRU

PRIFYSGOL BANGOR UNIVERSITY

Joint probability wave and storm tide hazard (slides from Brown et al. 15)

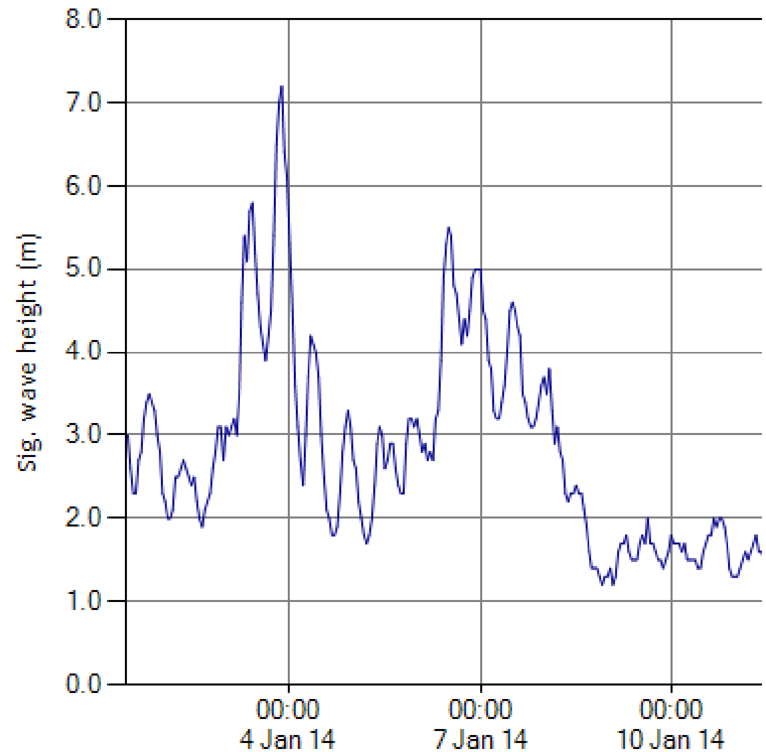


Large waves with smaller storm tide could be a much larger flood hazard “the waves will, **obviously**, drop off towards low tide” @westcoastsurf

Tides affect wave generation and propagation

U and η modulate:

- Hs *(wave breaking: depth & current)*
- Tz (*Doppler shift – apparent period*)
- Direction (current refraction)
- wave generation (e.g. effective wind stress)

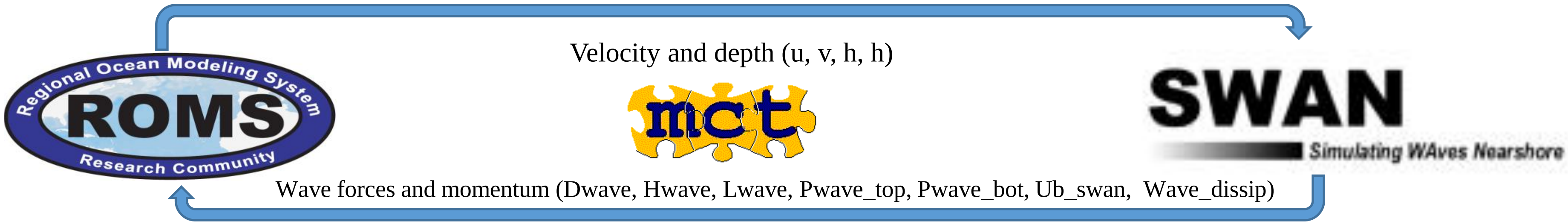


Waves affect tidal currents and elevation:

- Additional mass and momentum to flow with mean effect:
- Enhanced bottom friction reduces depth-mean U
- Stokes drift and wave radiation stress alter Uz

Waves following – reduce U in upper water-column (opp. if wave following).

COAWST



ROMS

- **WEC_VF** (3D **vortex force** from Uchiyama et al., 2010)
- **WDISS_WAVEMOD wave-dissipation** from a wave model
- **SW_BBL** wave-τ parameterised as **artificial bed roughness** (D_{50} 3mm).

SWAN

- **BSBT** used, with **water-levels and current grids** input into SWAN at each *dt (40s)*

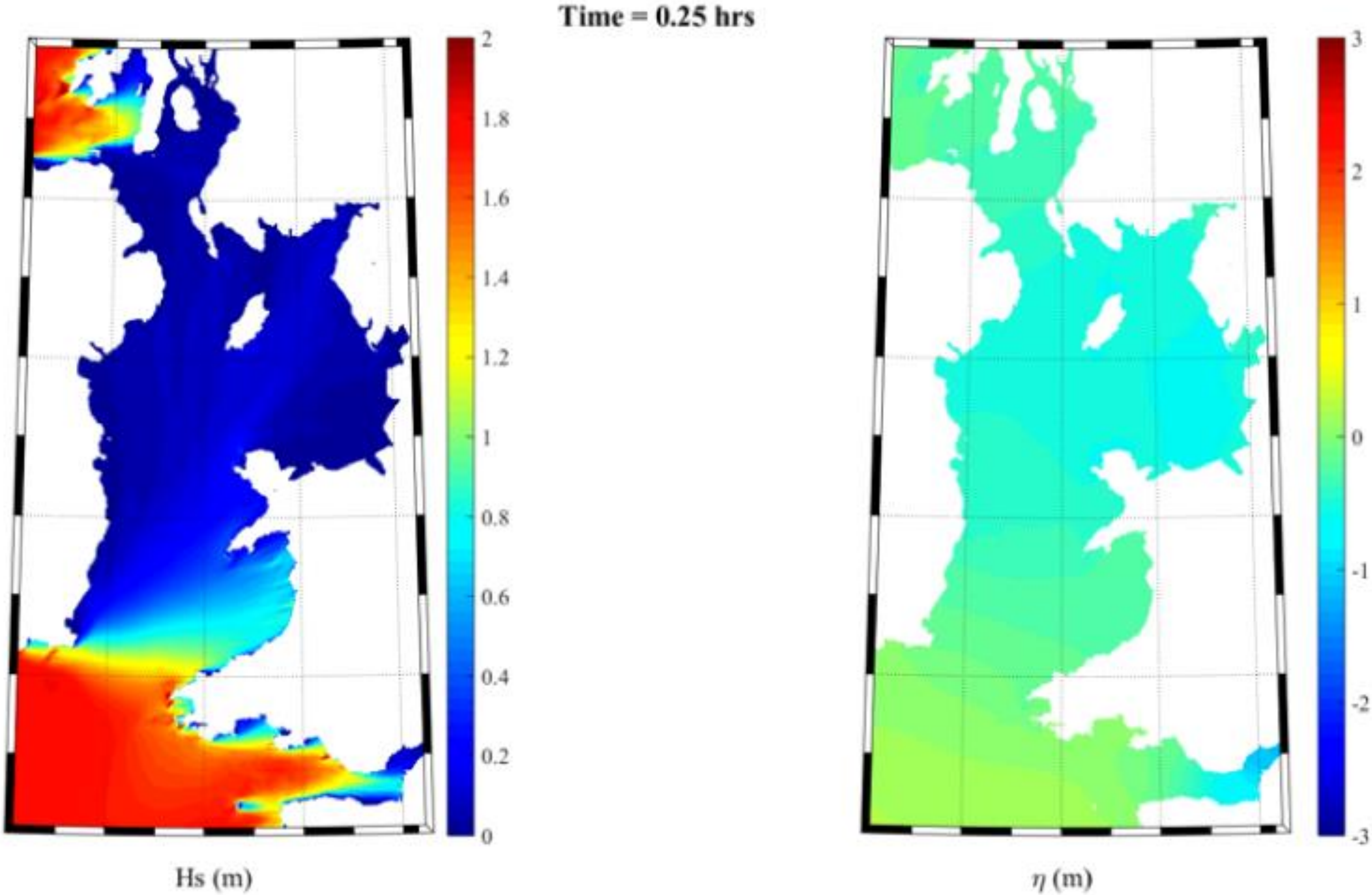
MCT

- Exchange information every 600s (no difference if *dt* 200s or 800s)

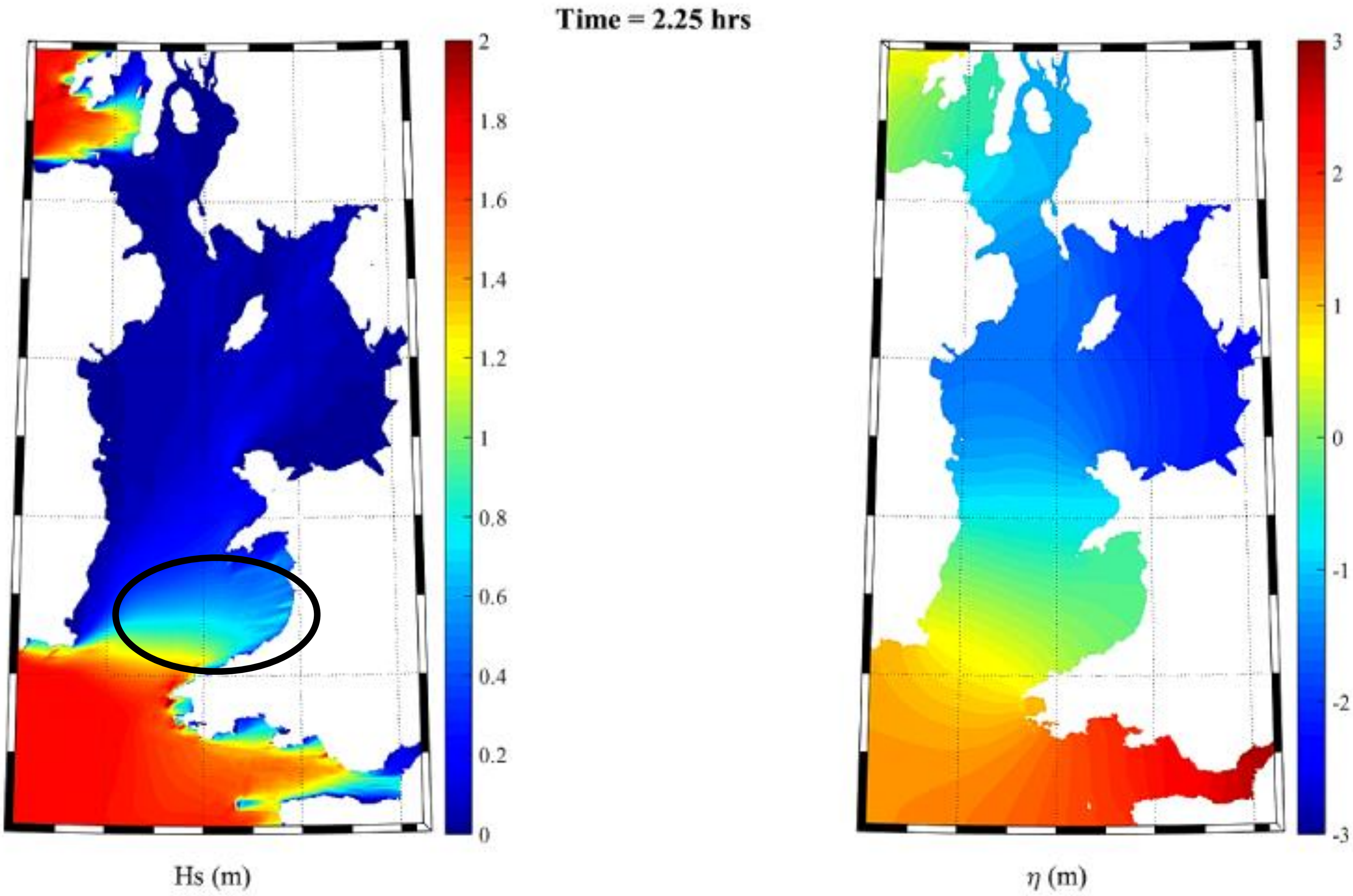
FORCINGS

- ECMWF 3 hourly wind fields and outer N.Atlantic nested SWAN model
- 10 FES2012 tide constituents and Digimap bathymetry
- 10σ layers, no wetting / drying.
- ~280m, **~550m**, ~1100m spatial resolution

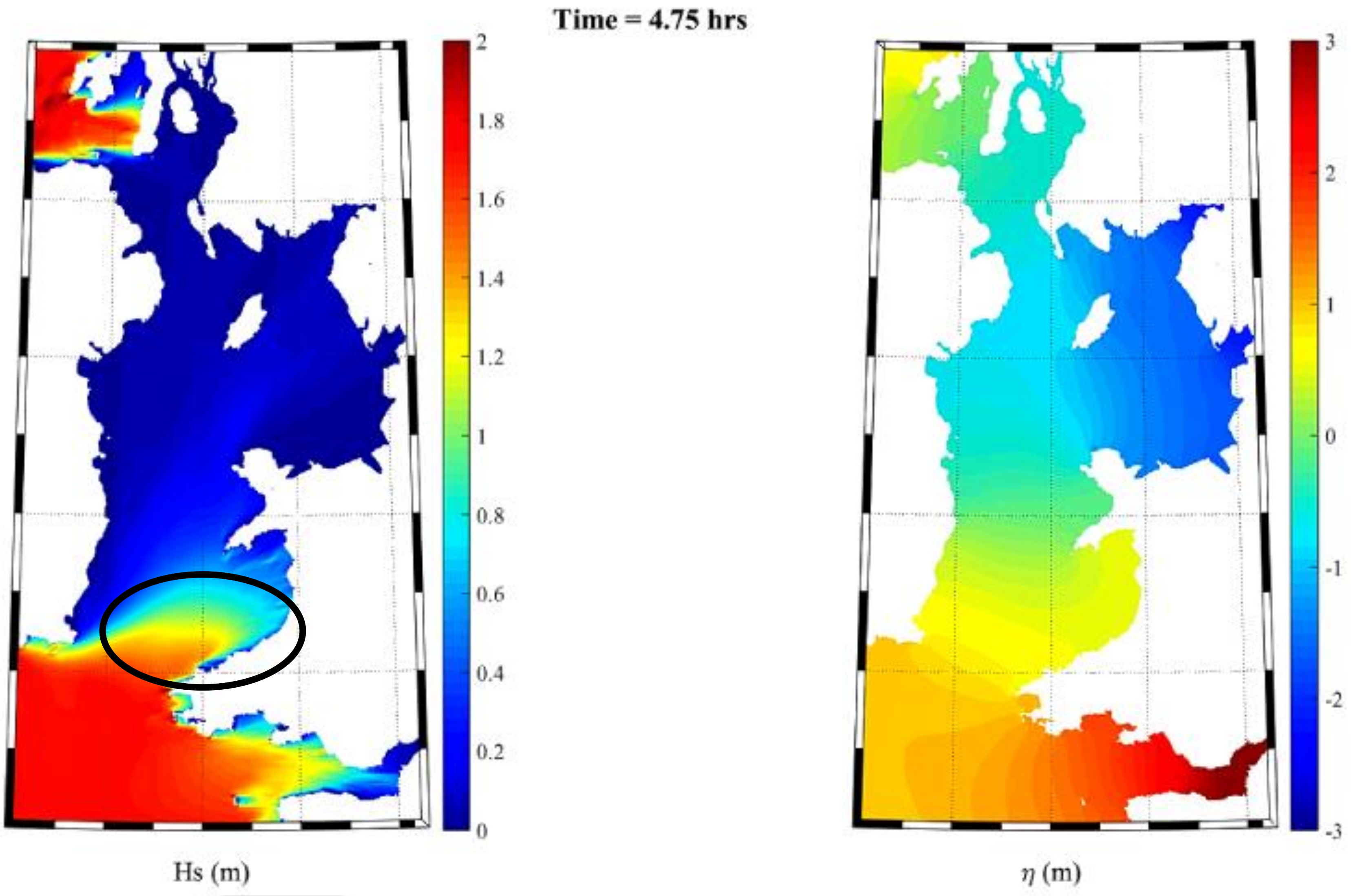
Animation…



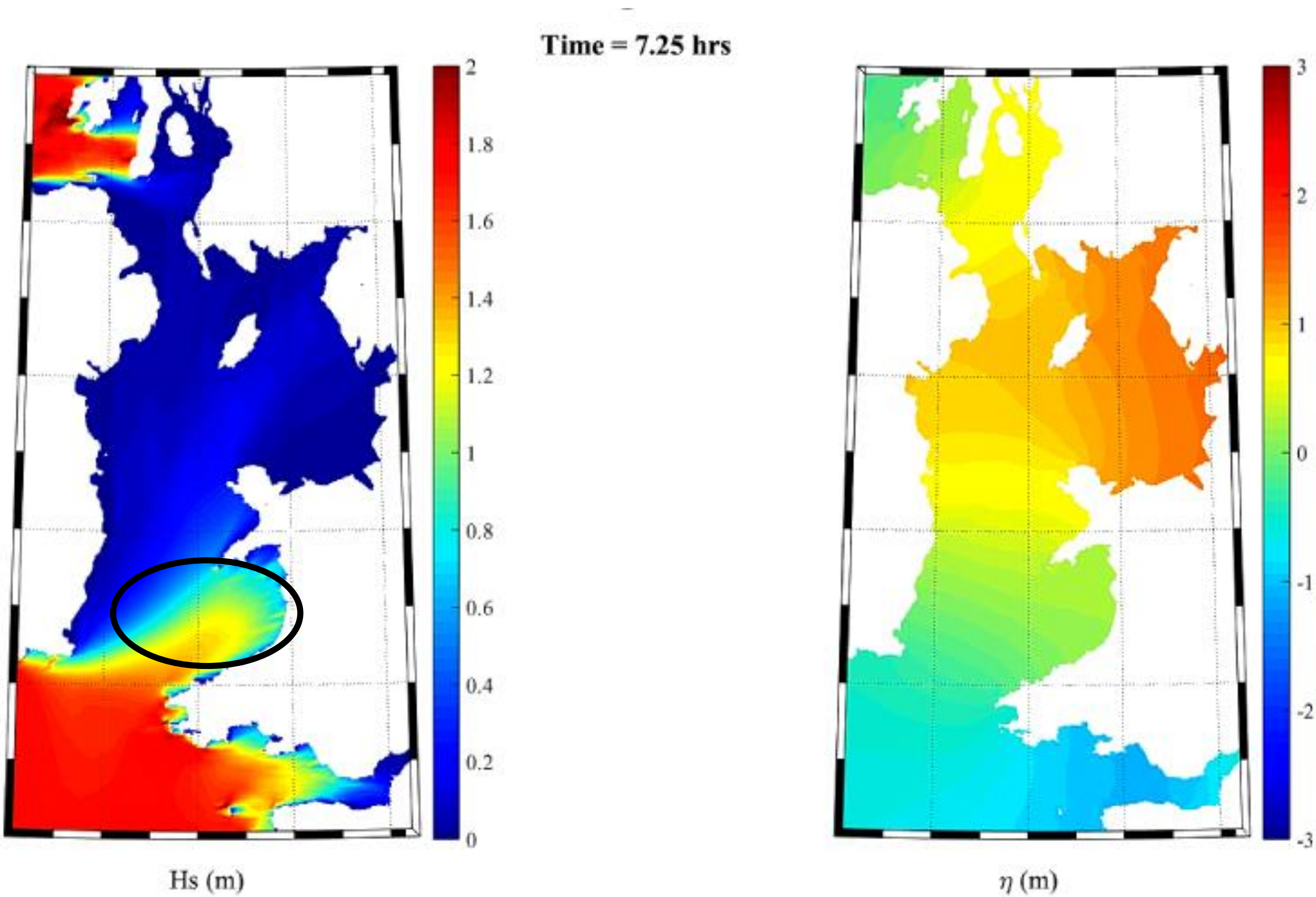
Flooding tide Bristol Channel..



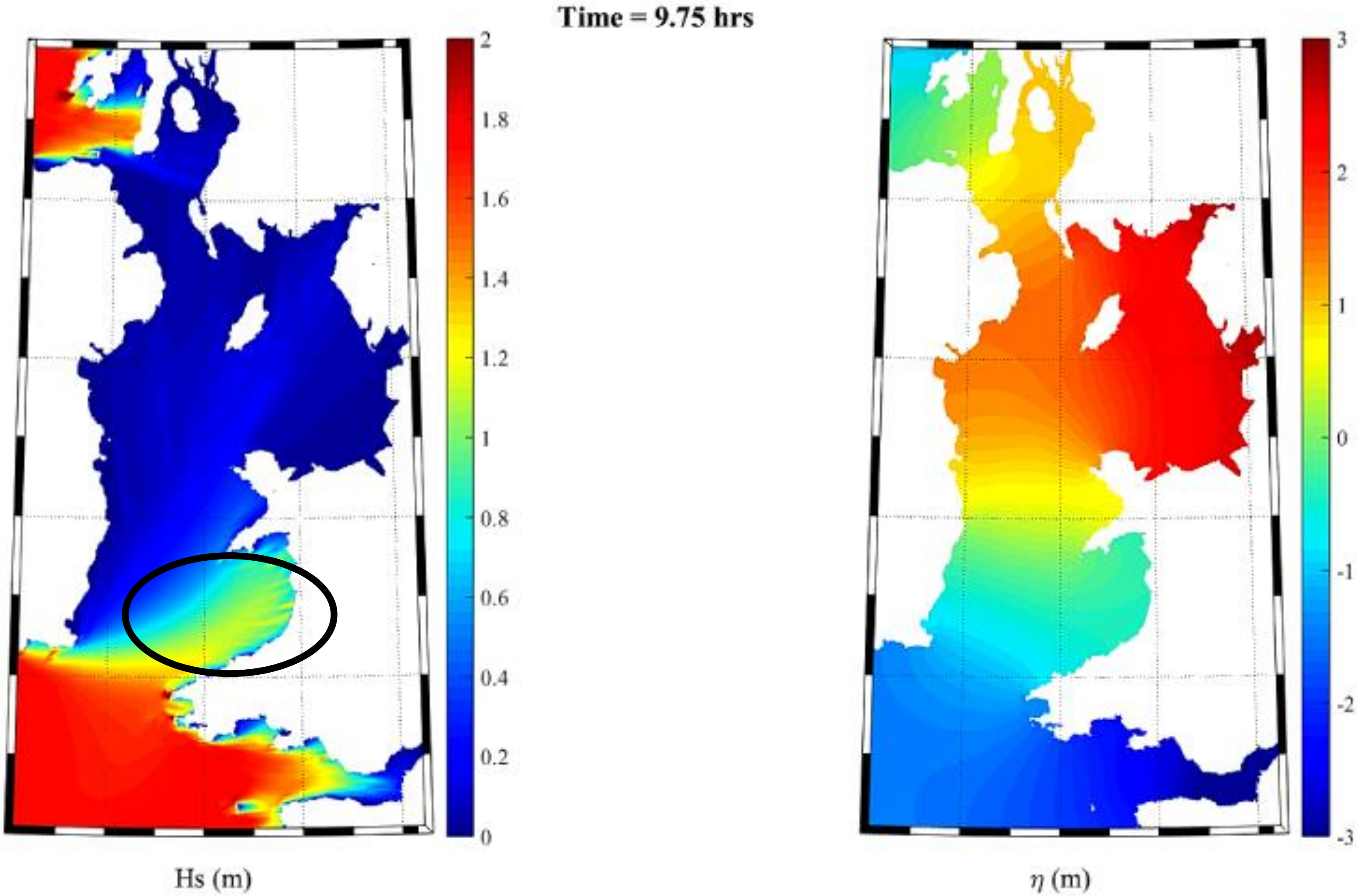
~HW Avonmouth

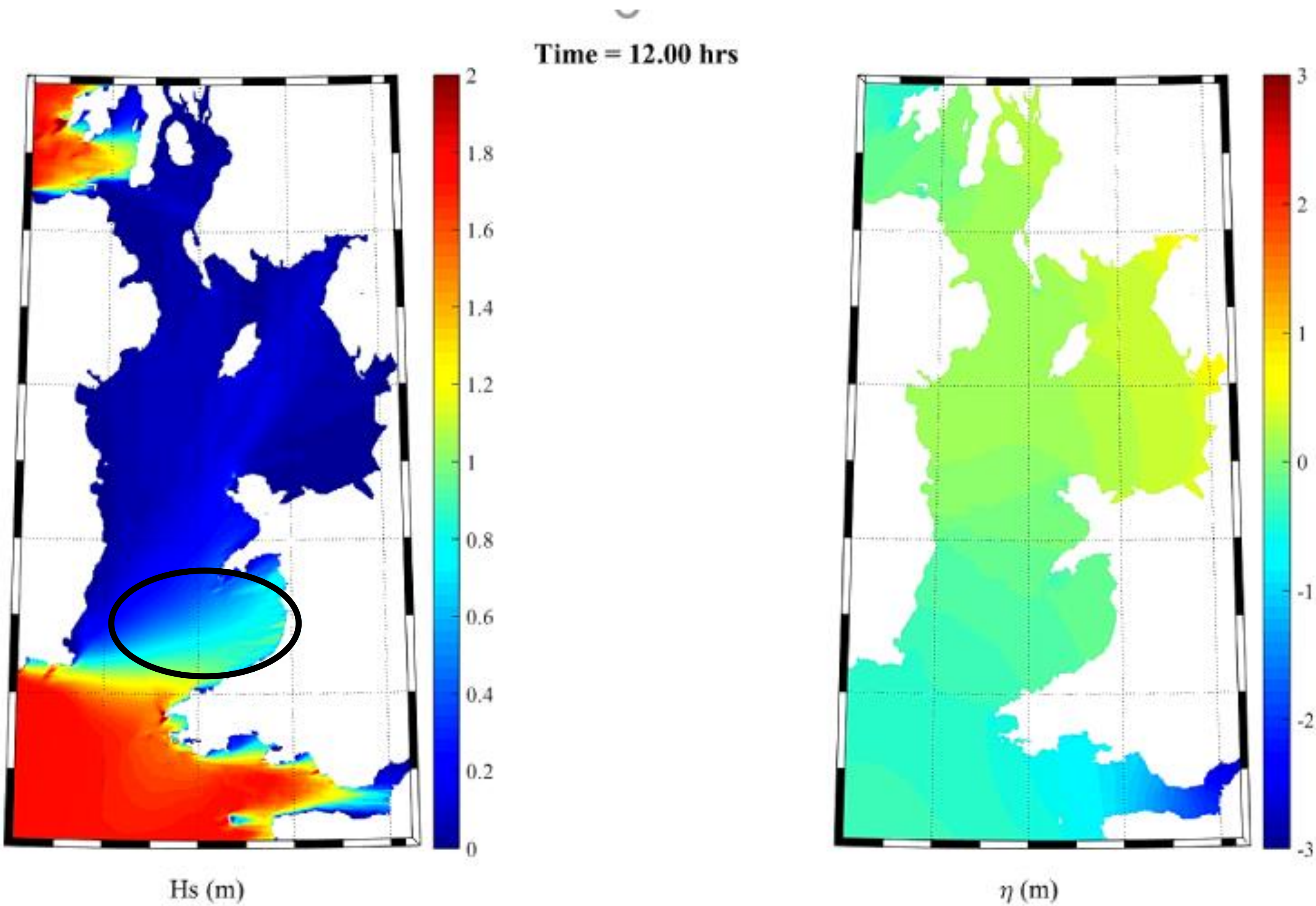


Ebb Bristol Channel, flooding Liverpool



LW Bristol Channel, HW Liverpool



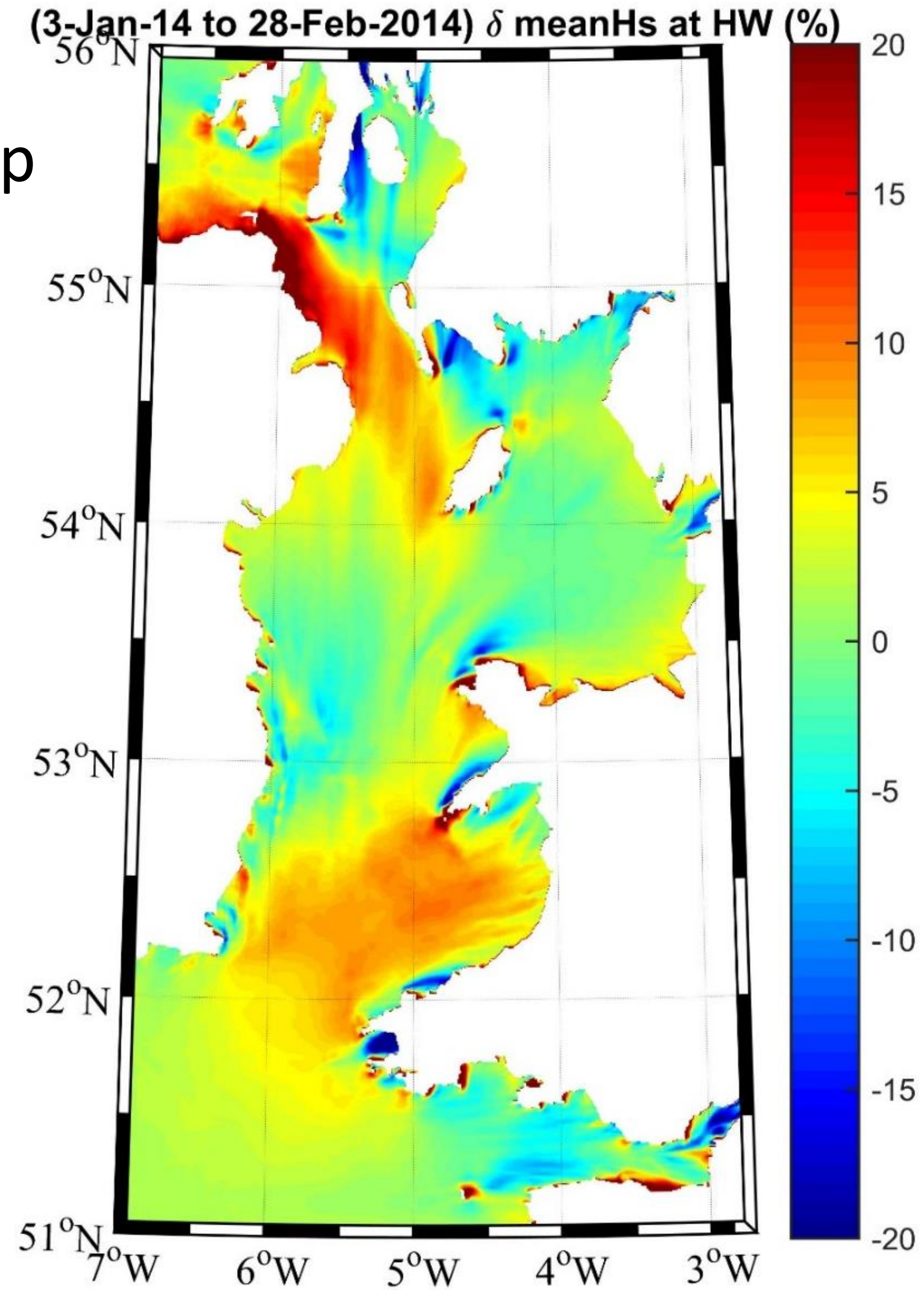

Time = 12.00 hrs
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Hs (m)
3
2
1
0
-1
-2
-3
η (m)

Results

- On average, *Hs* could be up to 20% larger at HW for some regions
- Why?

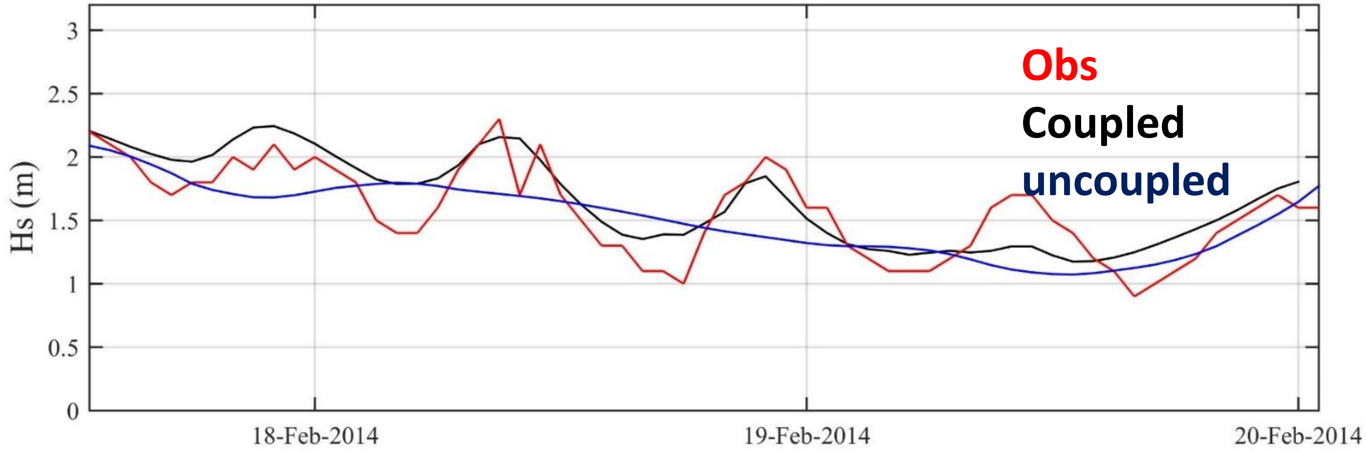
  Apparent wave-period change impact to refraction and local *Hs*

- Effect appears to increase with SLR as tide increases
- Process important for: transport, flood risk, etc



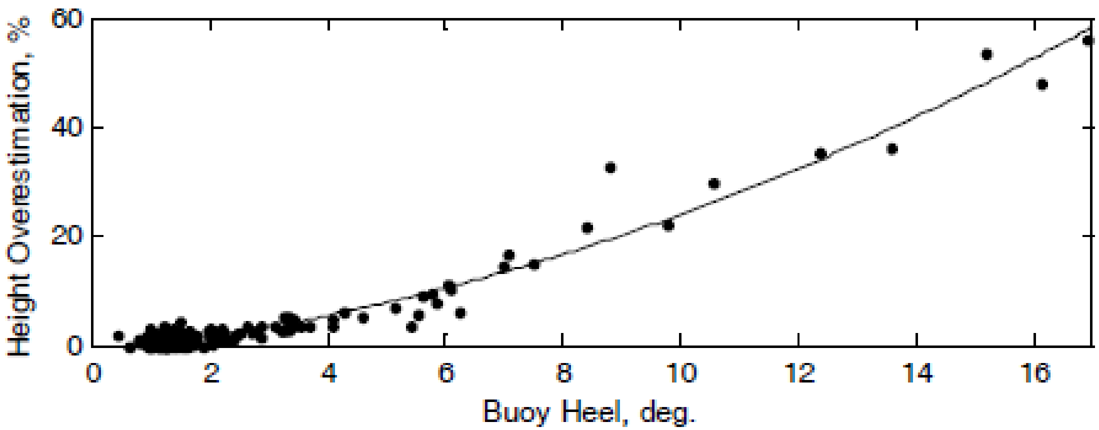
doi.org/10.1007/s10236-018-01245-z

“COAWST validates well, with improved model skill (e.g. R^2) compared to SWAN, but both coupled and uncoupled models have similar validation , yet large differences in wave-tide interaction”



Validation and/or observation problems?

Bender moment? “Two buoys next to each other don’t measure the same thing” Jensen et al. 2017.



Current induced Bender moment?