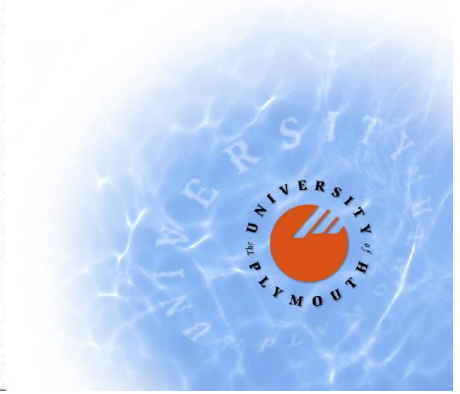
Ensemble prediction of waves and surge for storm conditions

Shunqi Pan & Yongping Chen
School of Marine Science & Engineering, University of Plymouth

Richard Hewston & Ian Cluckie
School of Engineering, University of Swansea

Outline

- Introduction
- 2004 Storm
- Model Setup
- Model Results
- Conclusions

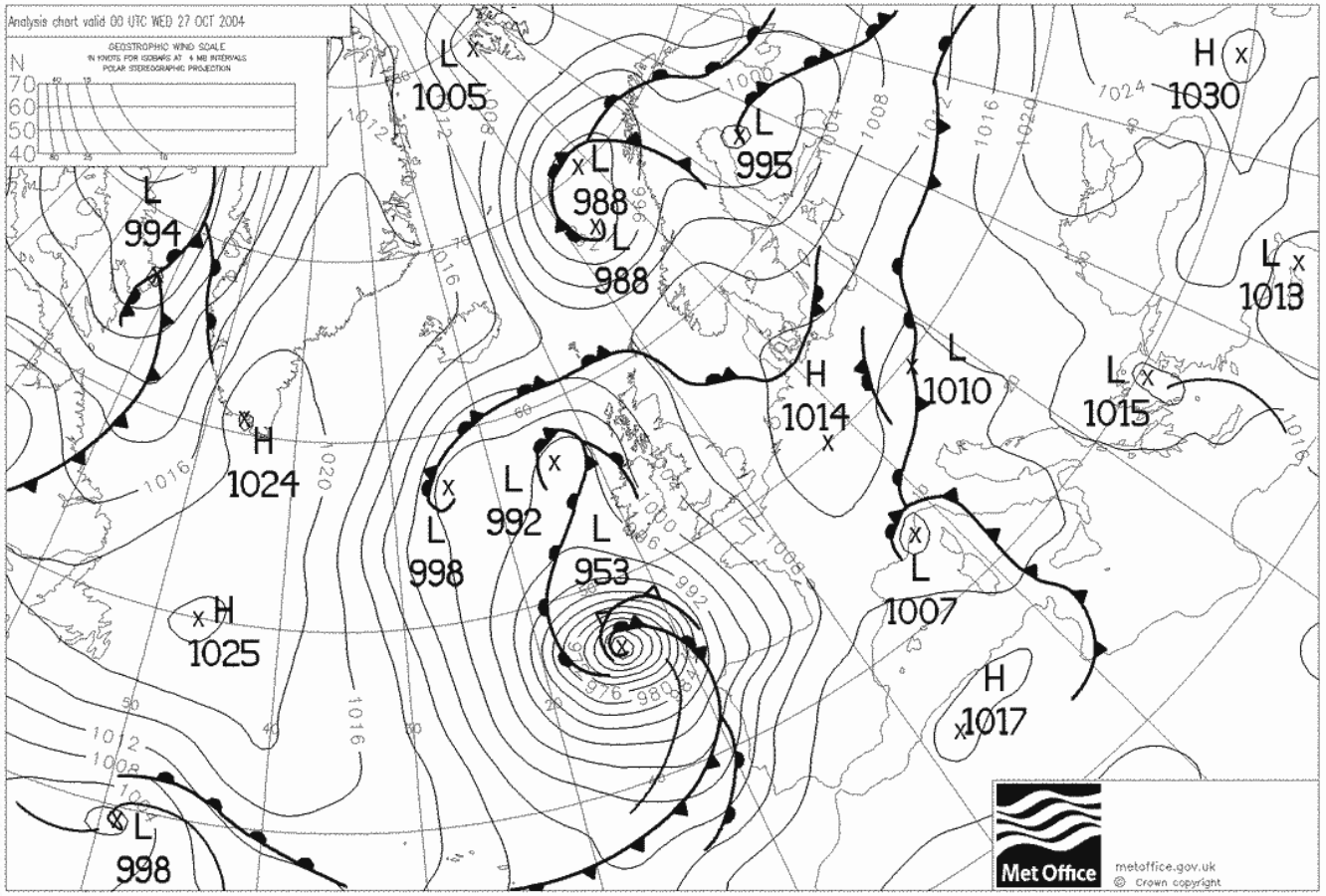


EPIRUS project

- Funded by NERC under FREE programme
- Collaboration between Universities of Plymouth & Swansea
- Use of “Clouds to Coast” approach
- Use of an integrated modelling system
- Use of nested models for downscaling
- Assessment of risk of coastal flood and erosion
- Assessment how uncertainty propagating during downscaling
- Use of ensemble approach to quantify the uncertainty

2004 Storm Event

- 27-28 Oct 2004 / Devon and Cornwell
- Strong wind / High water level



2004 Storm Damage

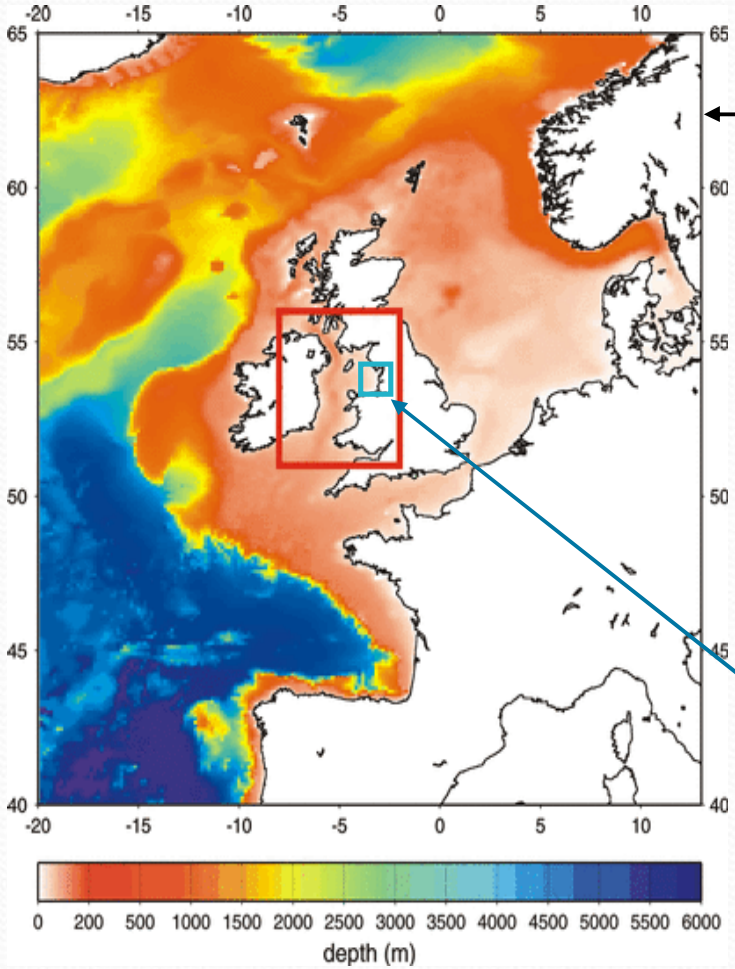
Clouds to Coast Approach

- Downscaling

Meteorological Models

Tide, Surge and Wave Models

Surf Zone Models



Continental Model
WAM
[Grid size ~ 12km]

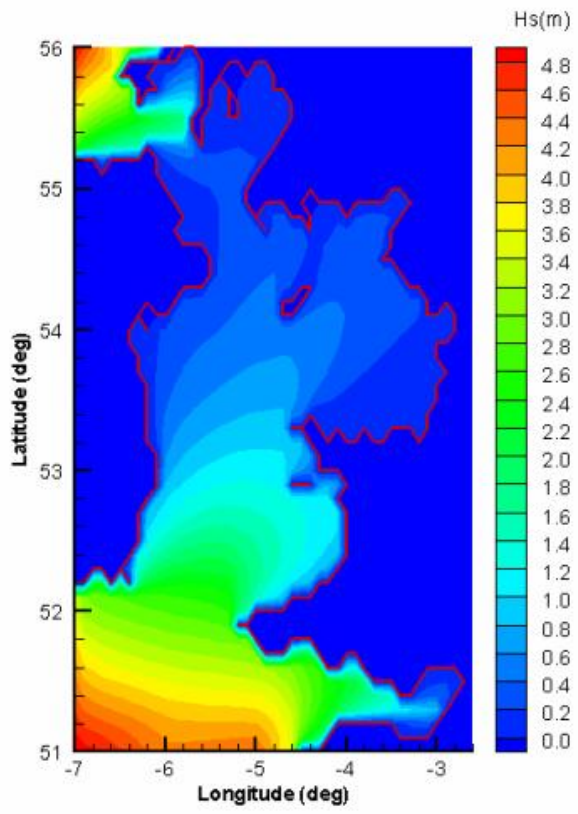
Regional Model
POLCOMS
[Grid size ~1.8km]

Coastal Zone Model
COAST2D
[Grid size ~250m]

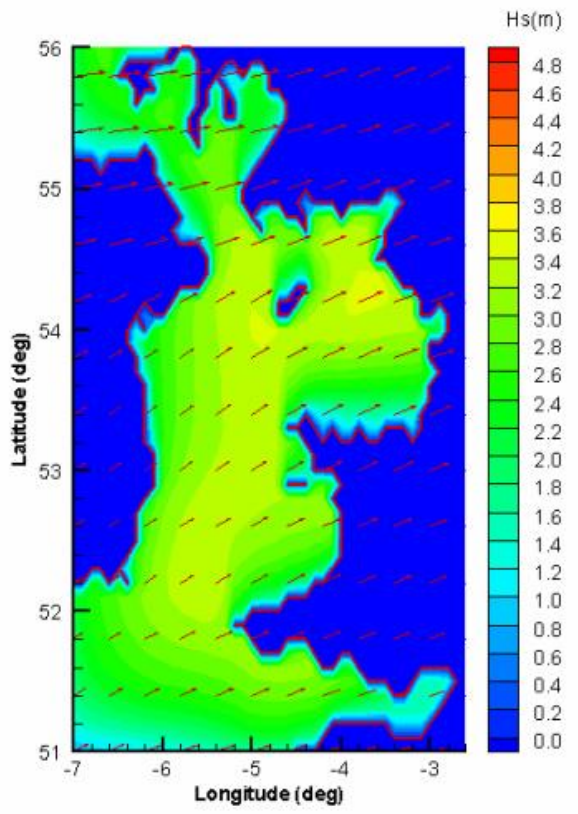
Predicting Tides, Waves & Surge

- Uncertainty Tests

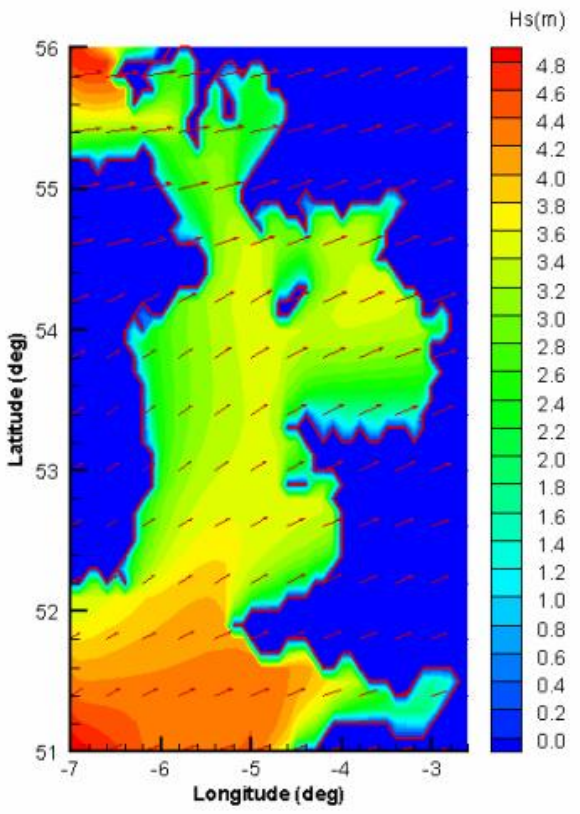
wave forcing only



wind forcing only

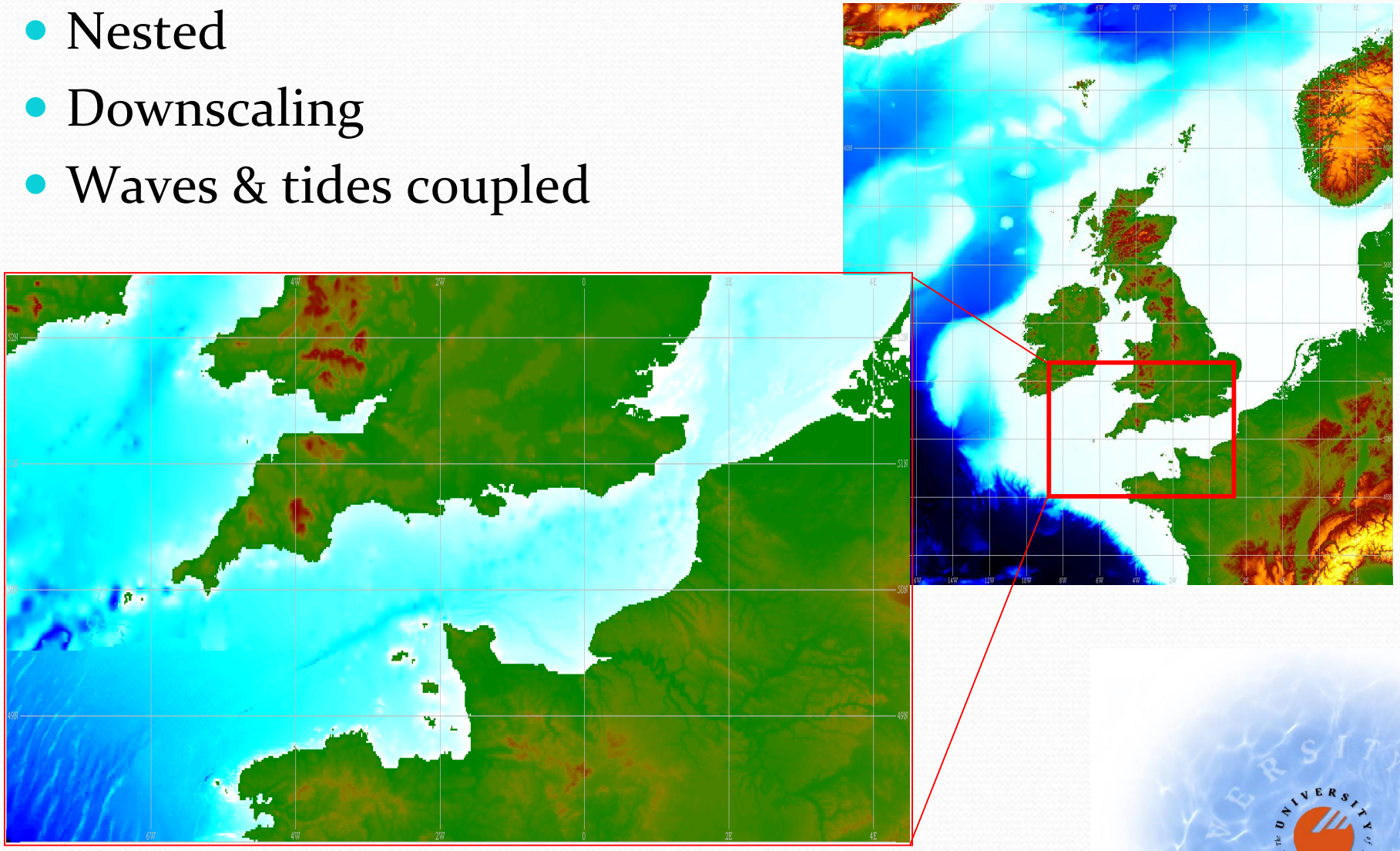


coupled wind and wave forcing



Computational Domains

- Nested
- Downscaling
- Waves & tides coupled



Model Inputs

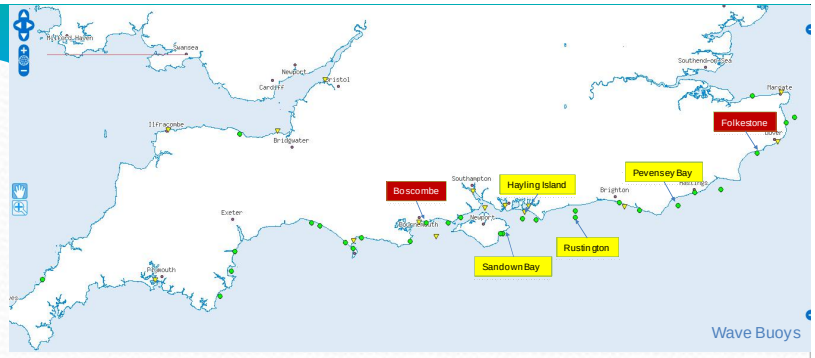
- Forcing
  - Wind speed & direction at 10m above mean sea level
  - Surface level pressure
- Boundary Conditions
  - Tides - CS3 Model Results (POL)
  - Waves – Nested WAM model
- Ensemble members
  - Control Case (16/10/2004 to 02/11/2004)
  - 50 Ensemble Cases (10 day prediction from 19/10/2004)
- Measurements
  - Tidal Gauges data(BODC)
  - Wave Buoys (CCO)

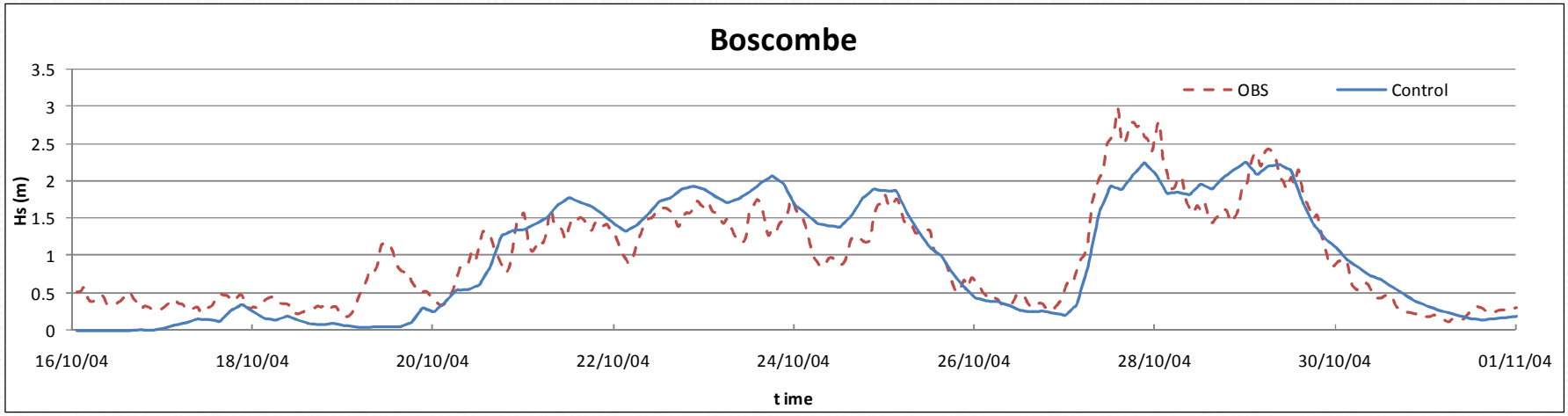
Modelling Scenarios

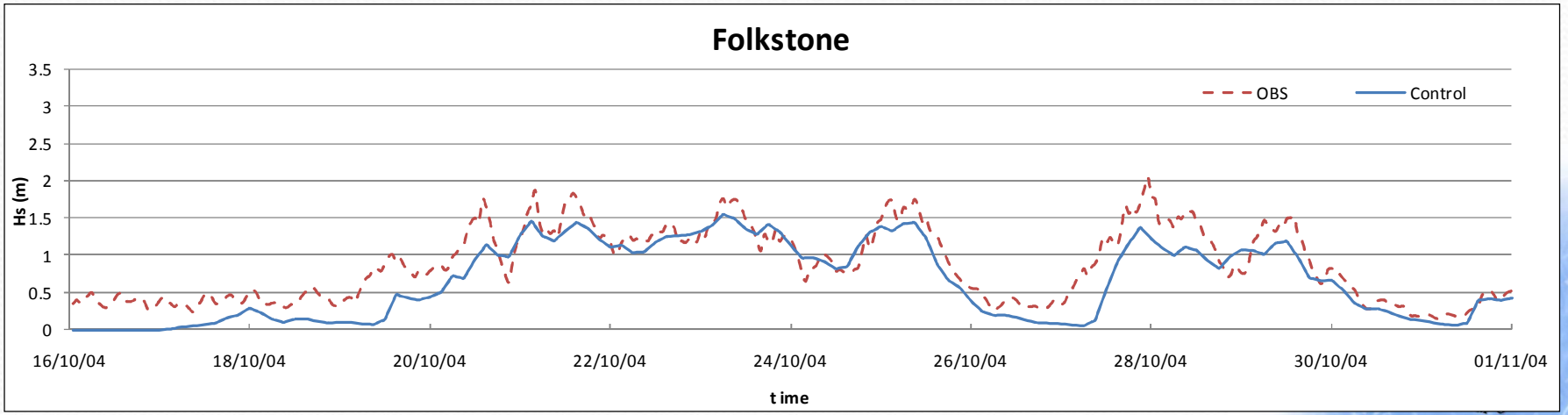
- Deterministic Modelling - Control Case
- Ensemble Modelling
  - Initial Date on 22/10/2004 (T+6 day)
  - Initial Date on 24/10/2004 (T+4 day)
  - Initial Date on 26/10/2004 (T+2 day)
  - Initial Date on 27/10/2004 (T+1 day)

Deterministic Modelling

- Waves

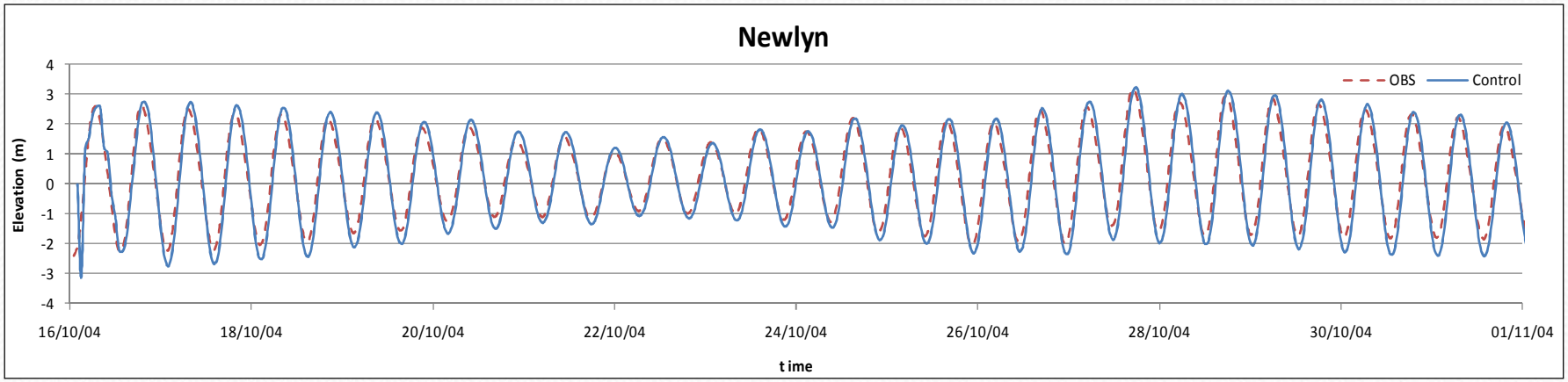




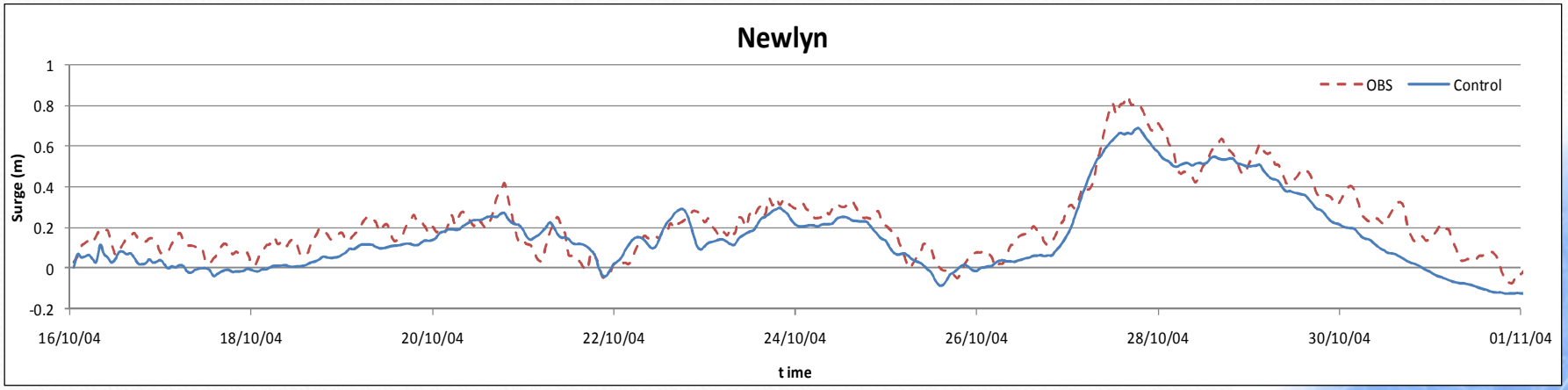


Deterministic Modelling

- Tides



- Surge

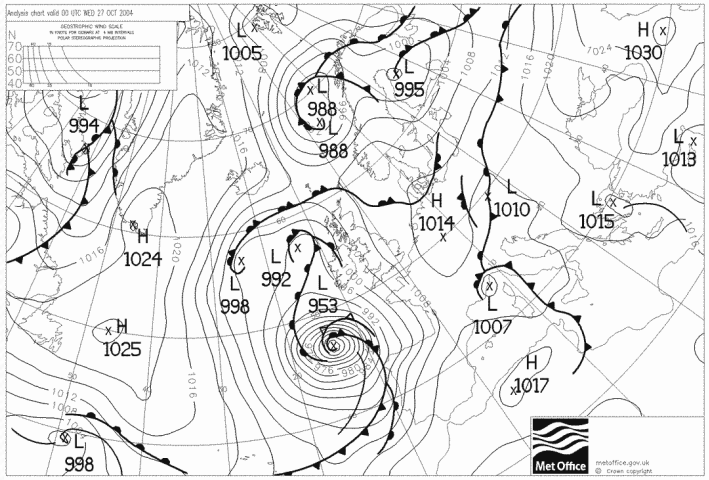


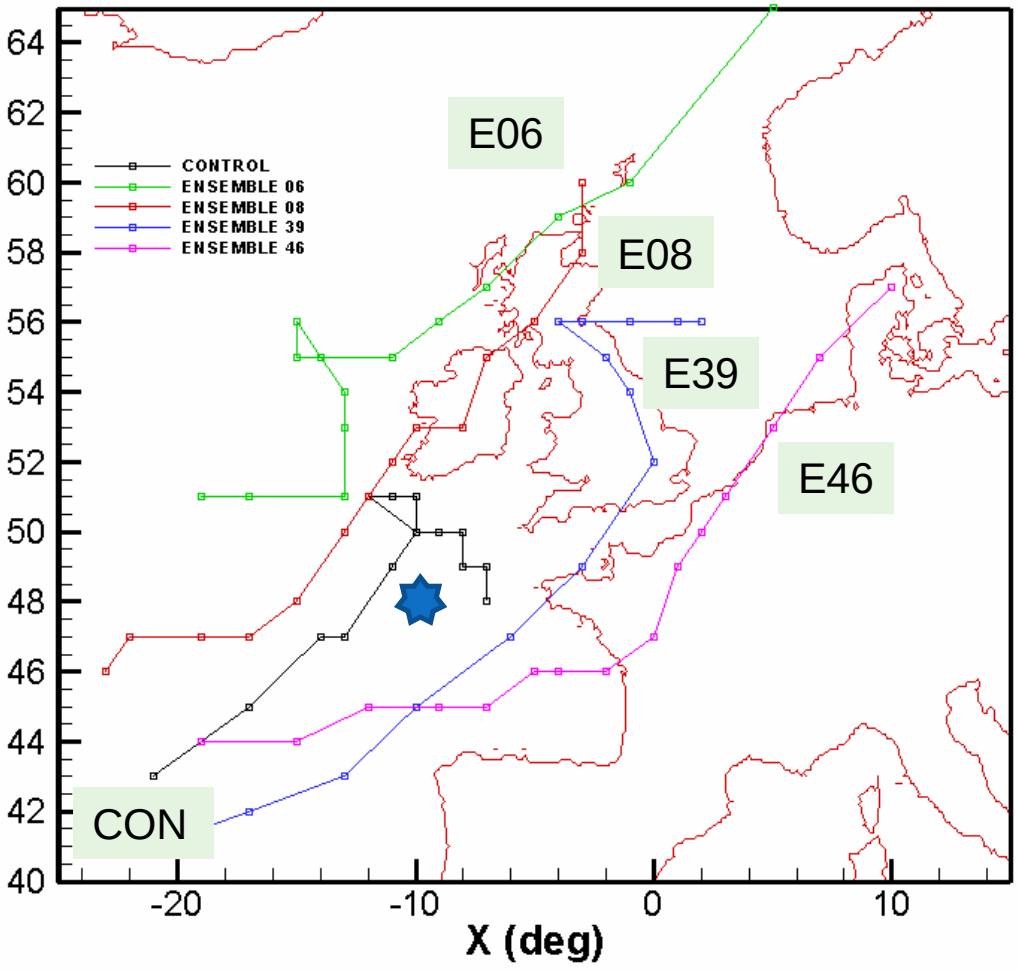
Modelling Scenarios

- Deterministic Modelling - Control Case
- Ensemble Modelling
  - Initial Date on 22/10/2004 (T+6 day)
  - Initial Date on 24/10/2004 (T+4 day)
  - Initial Date on 26/10/2004 (T+2 day)
  - Initial Date on 27/10/2004 (T+1 day)

Ensemble Modelling – Storm Tracks

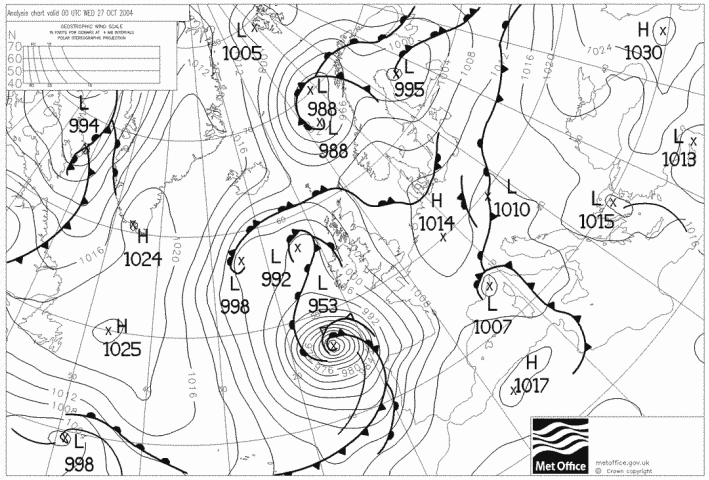
- Initial date:
  22/10/2004

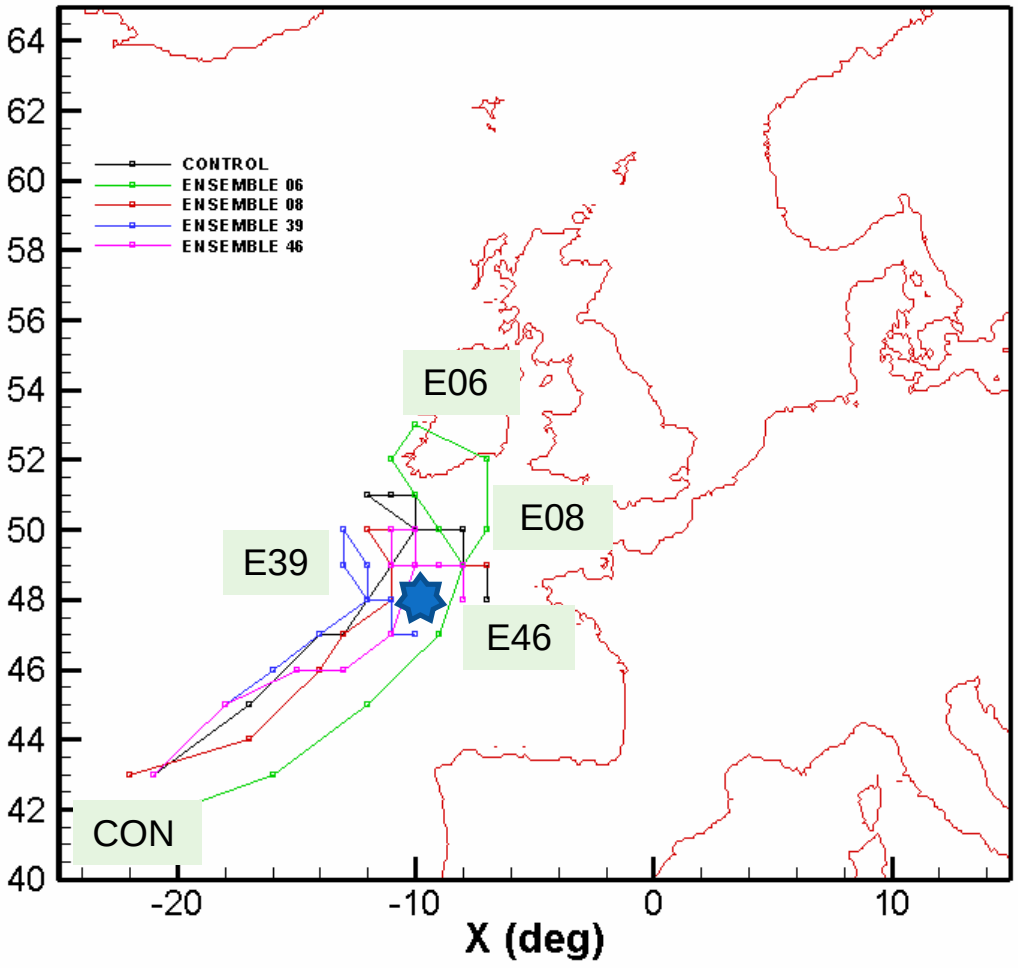




Ensemble Modelling – Storm Tracks

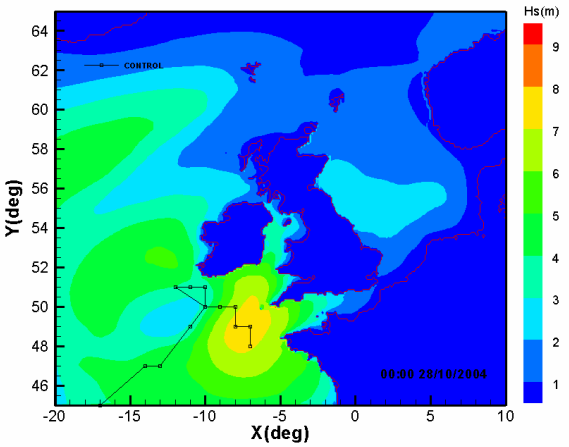
- Initial date: 26/10/2004



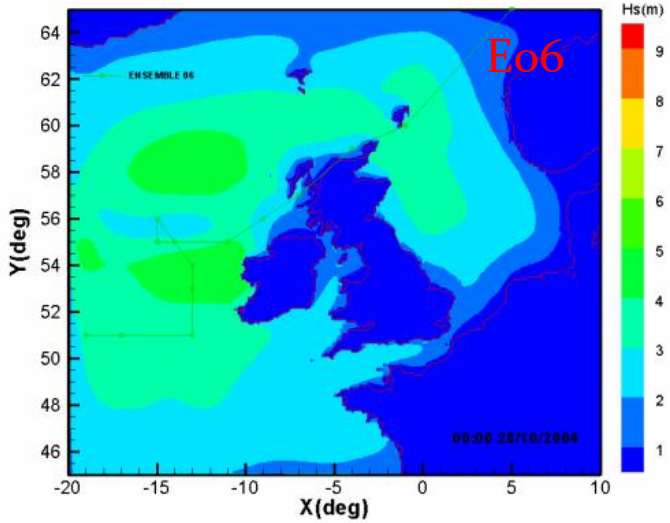


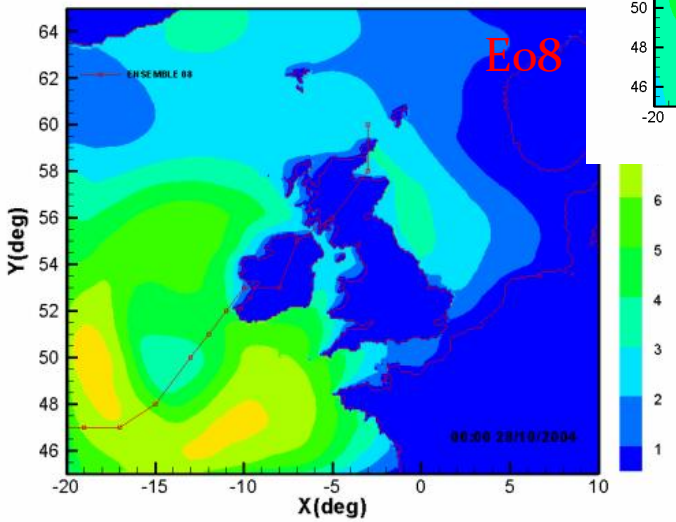
Ensemble Modelling - Waves

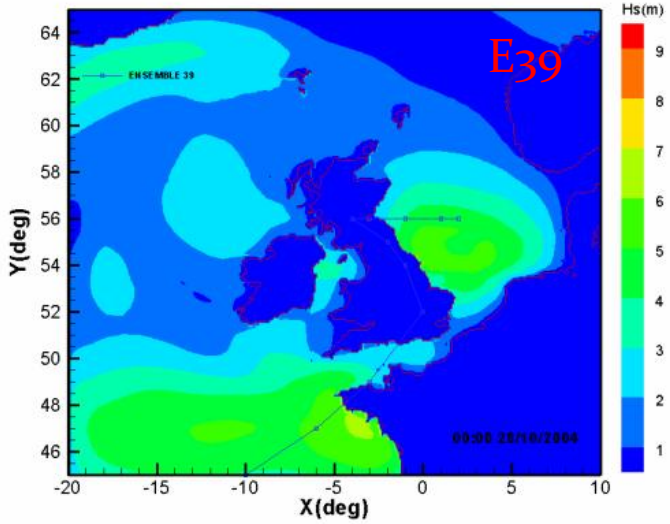
- Initial date on 22/10/2004

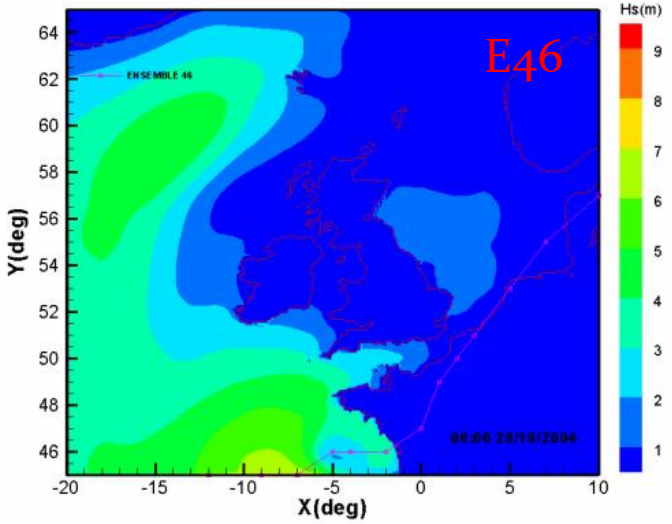


Control Case



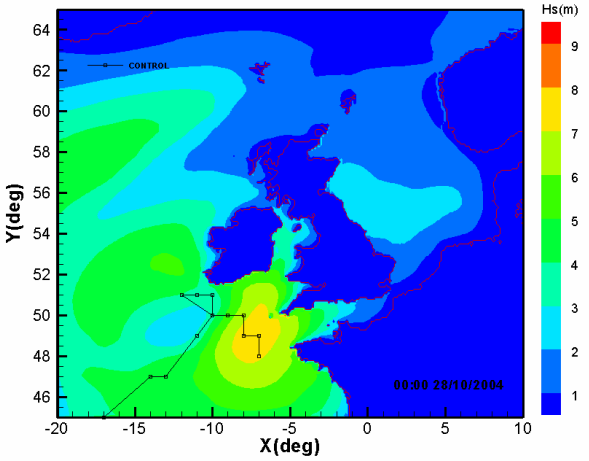




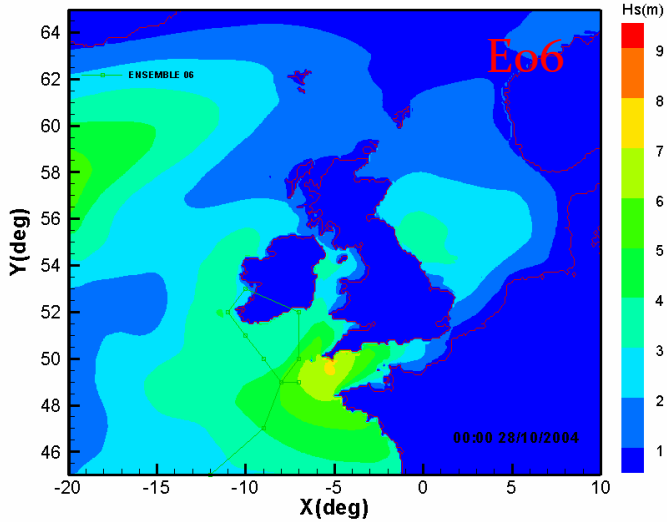


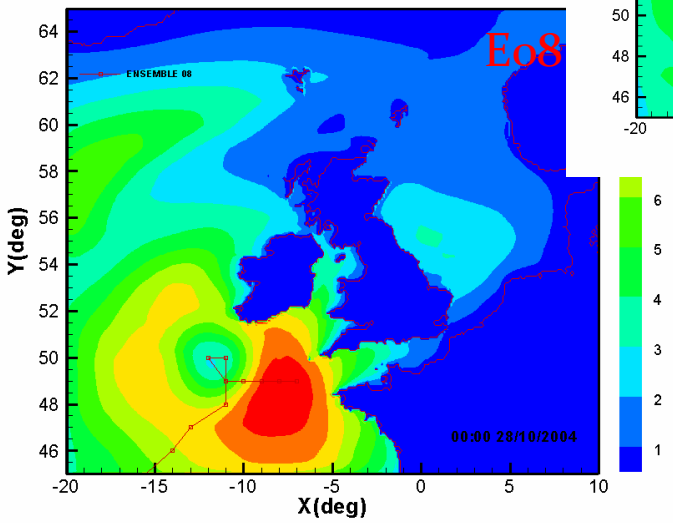
Ensemble Modelling - Waves

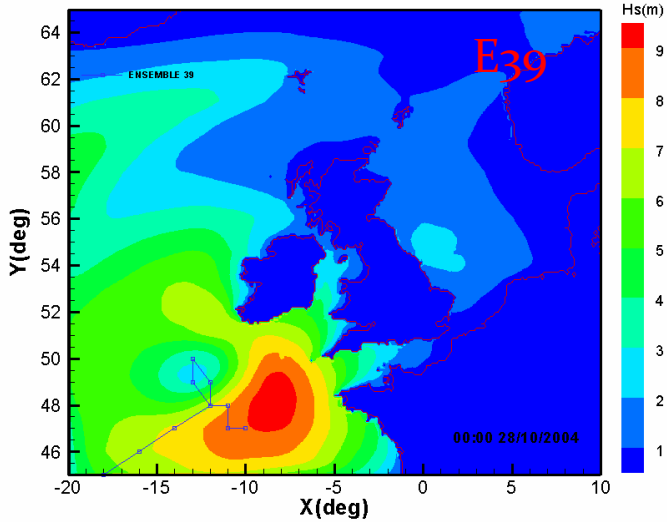
- Initial date on 26/10/2004

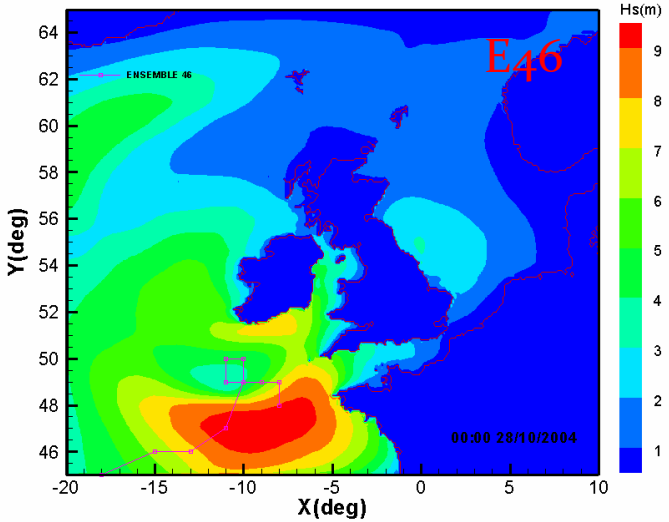


Control Case



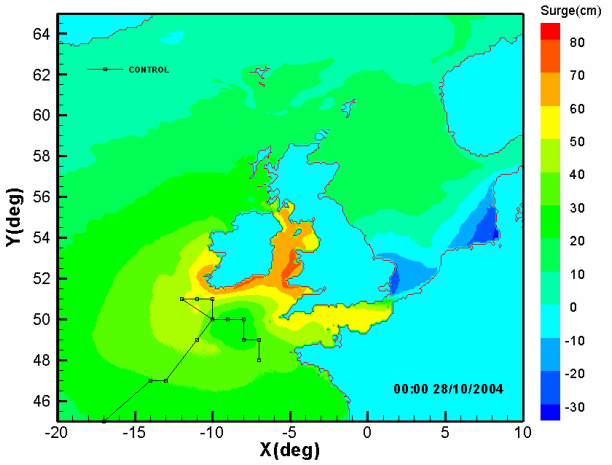




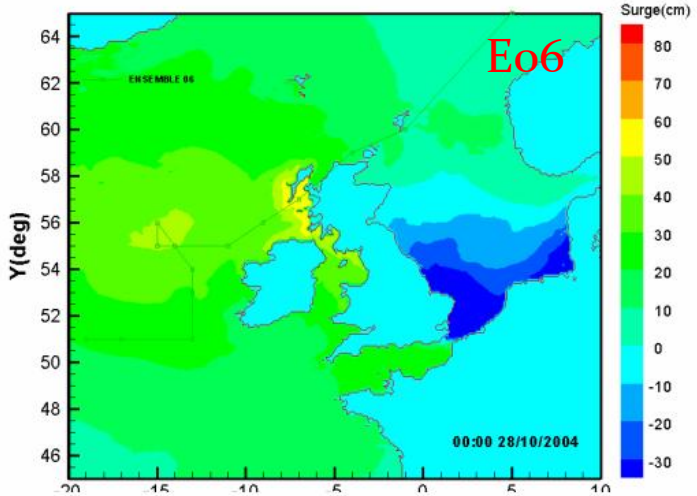


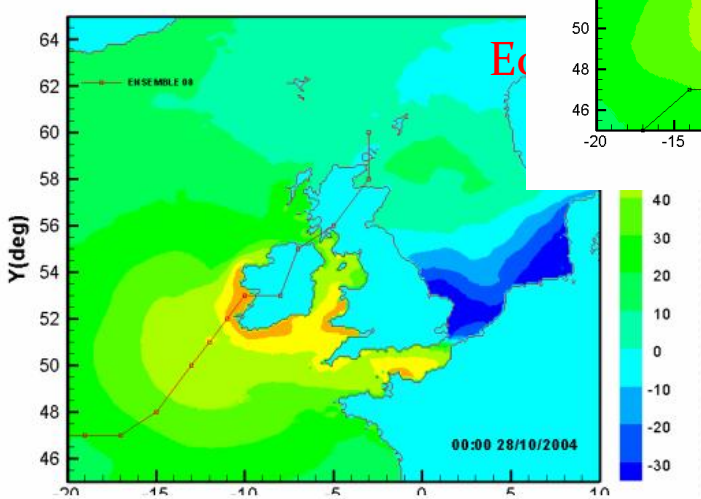
Ensemble Modelling - Surge

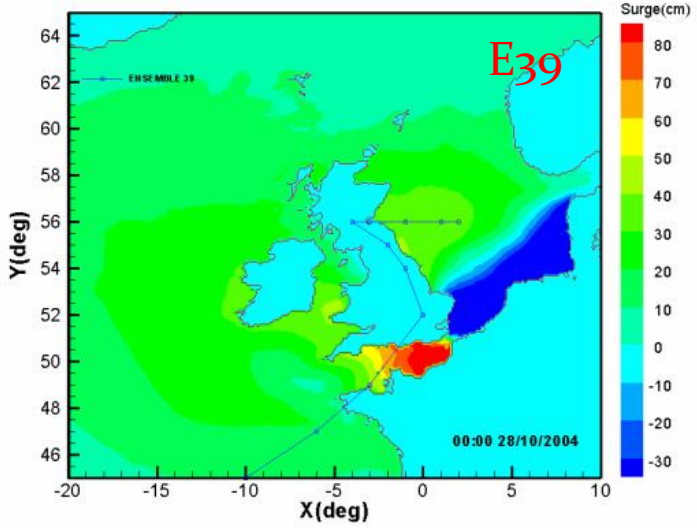
- Initial date on 22/10/2004

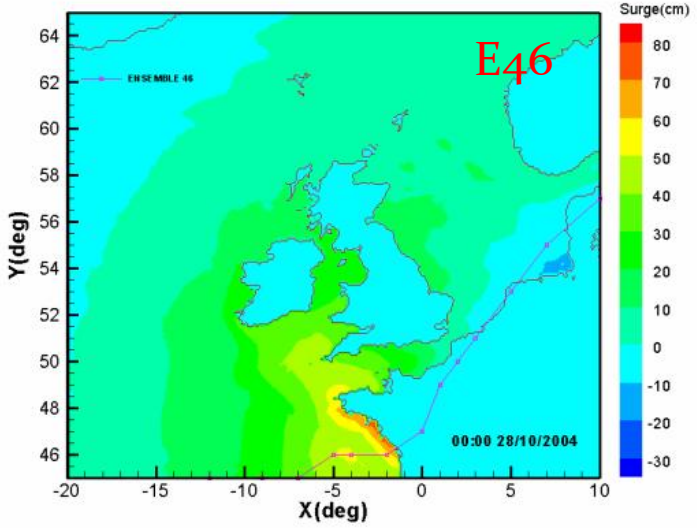


Control Case



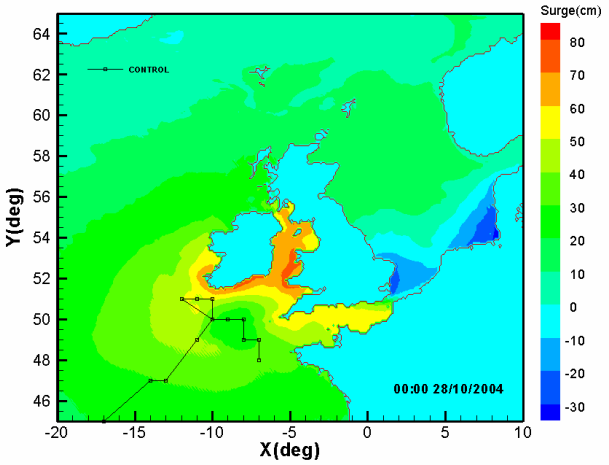




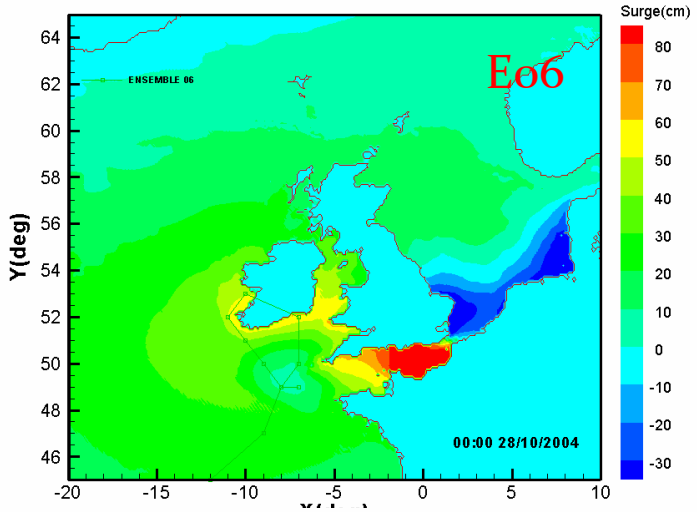


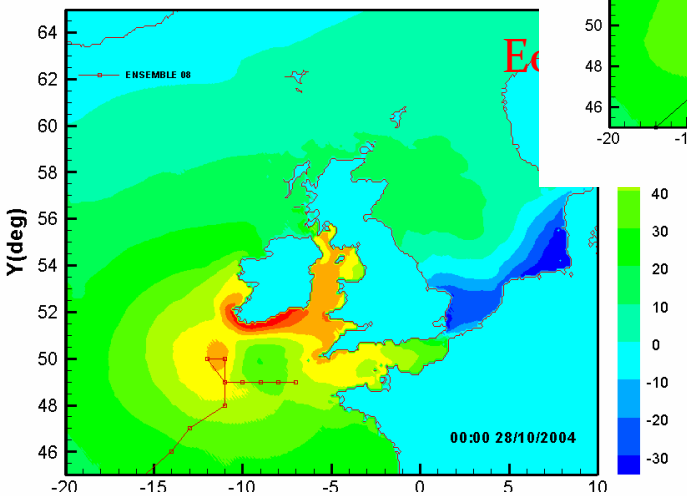
Ensemble Modelling - Surge

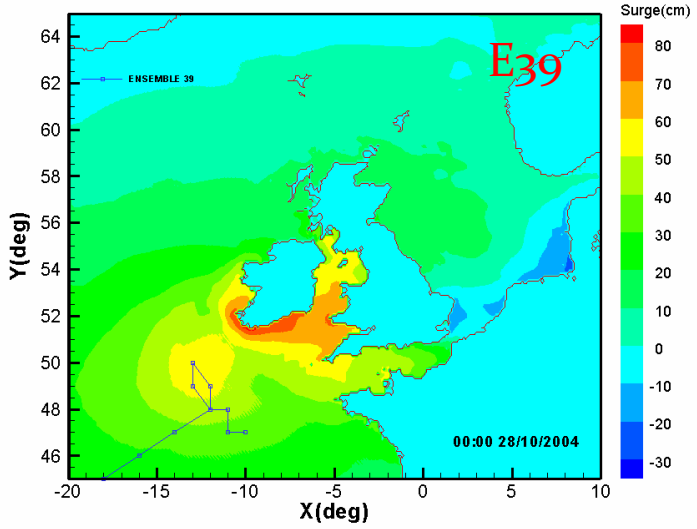
- Initial date on 26/10/2004

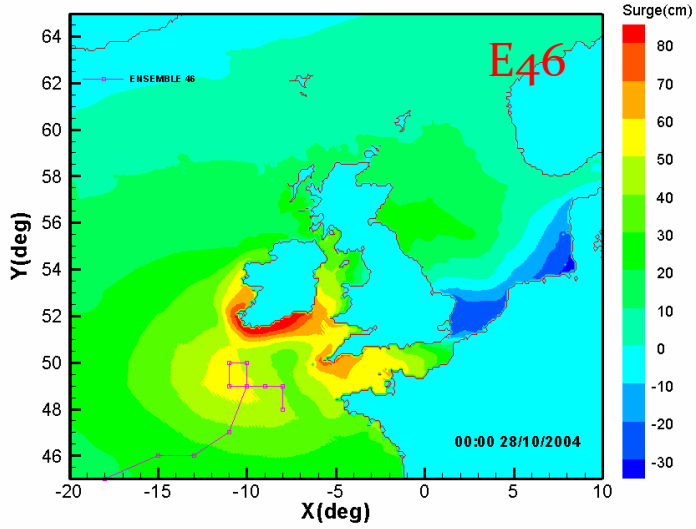


Control Case



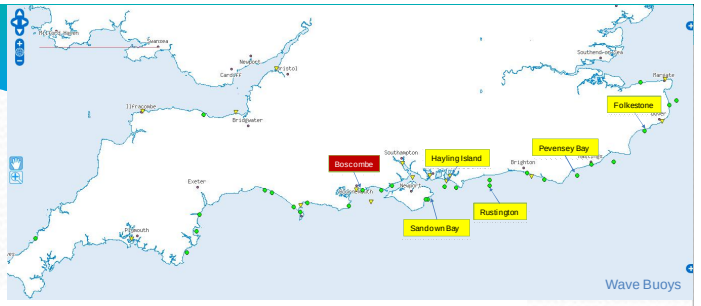


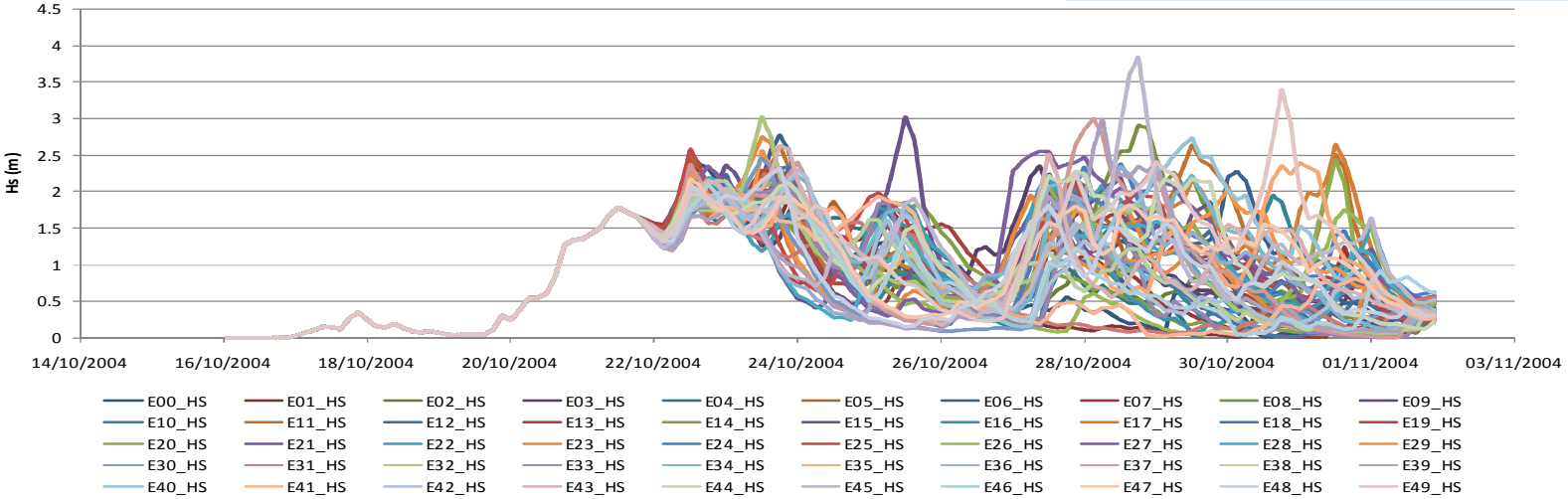


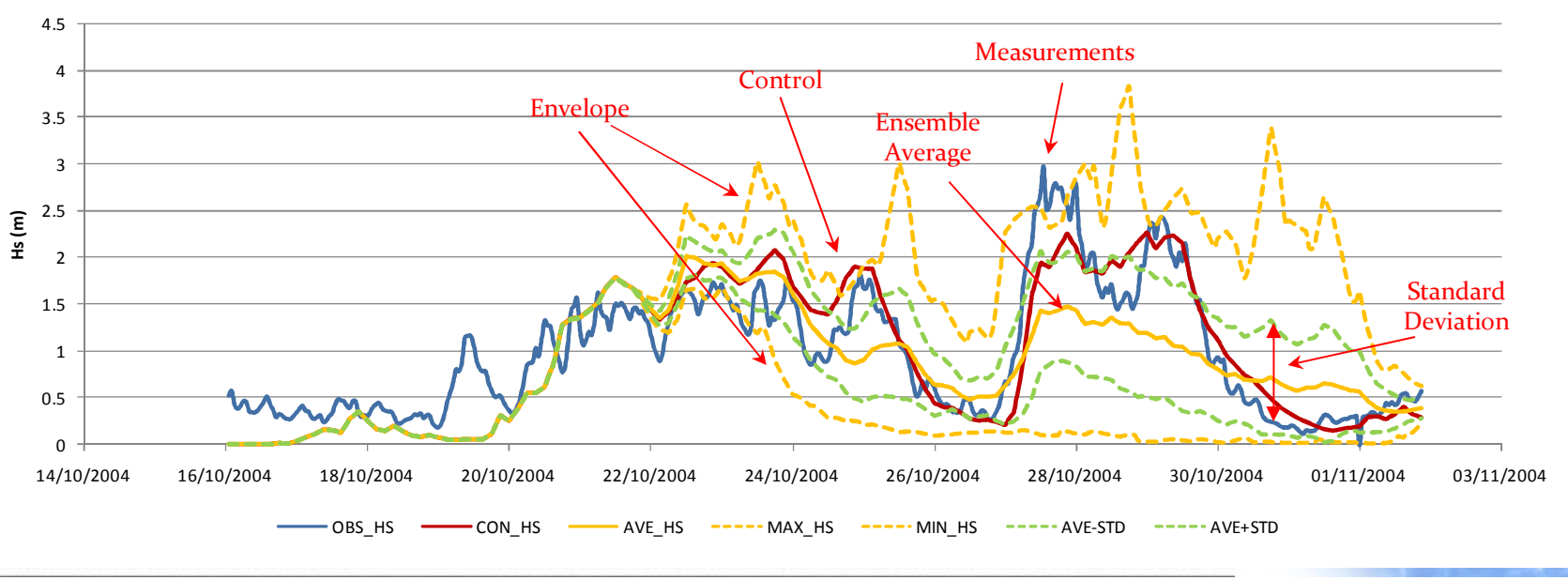


Ensemble Modelling – Waves

- Time Series

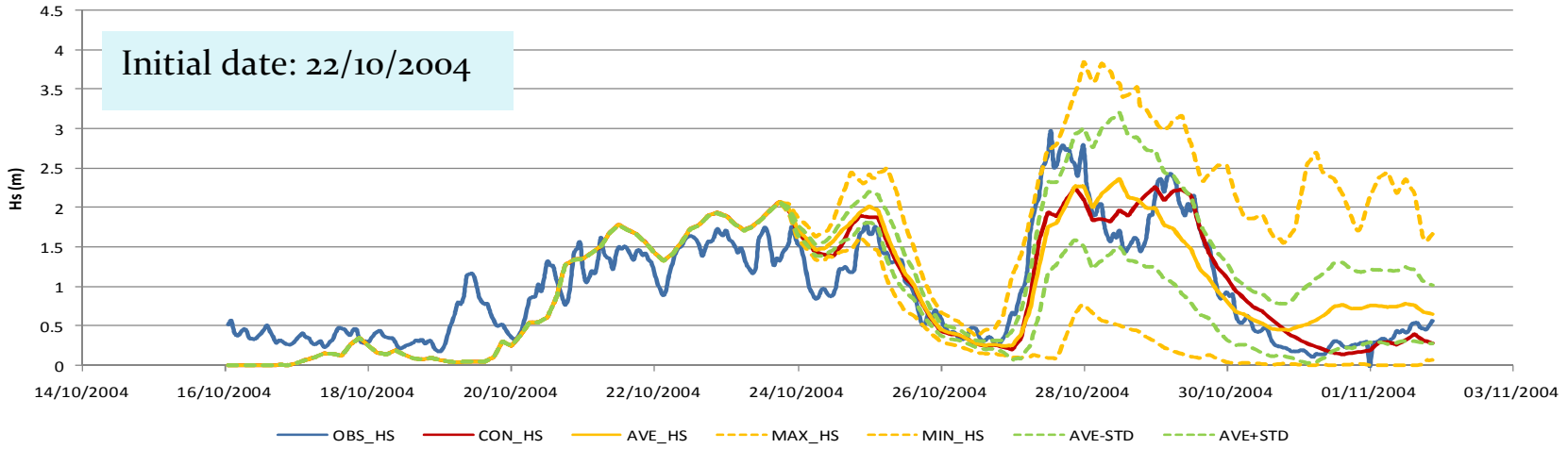


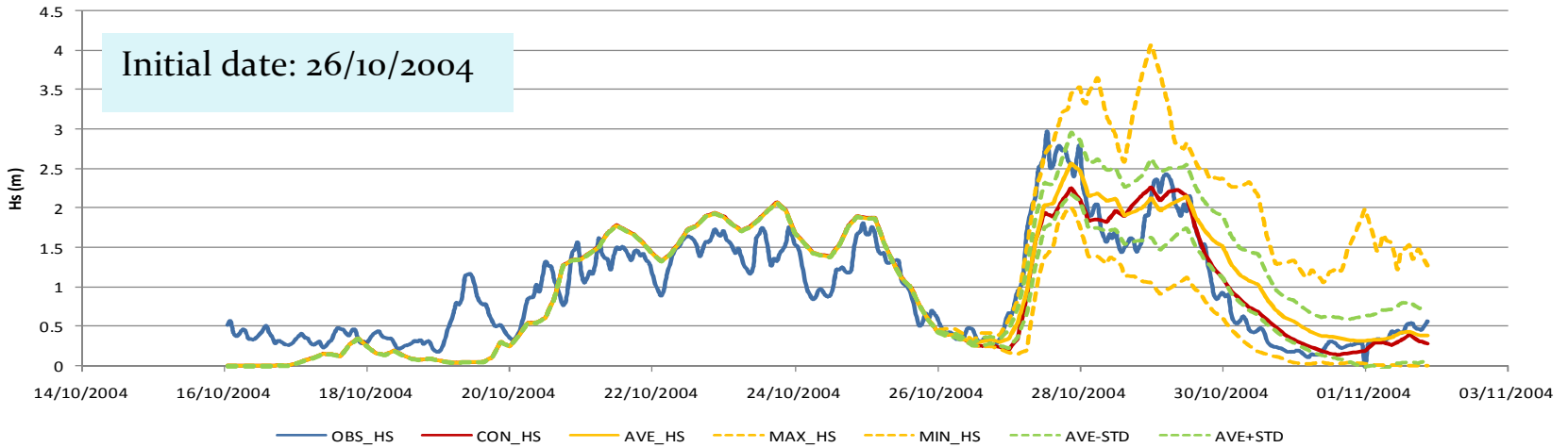




Ensemble Modelling – Waves

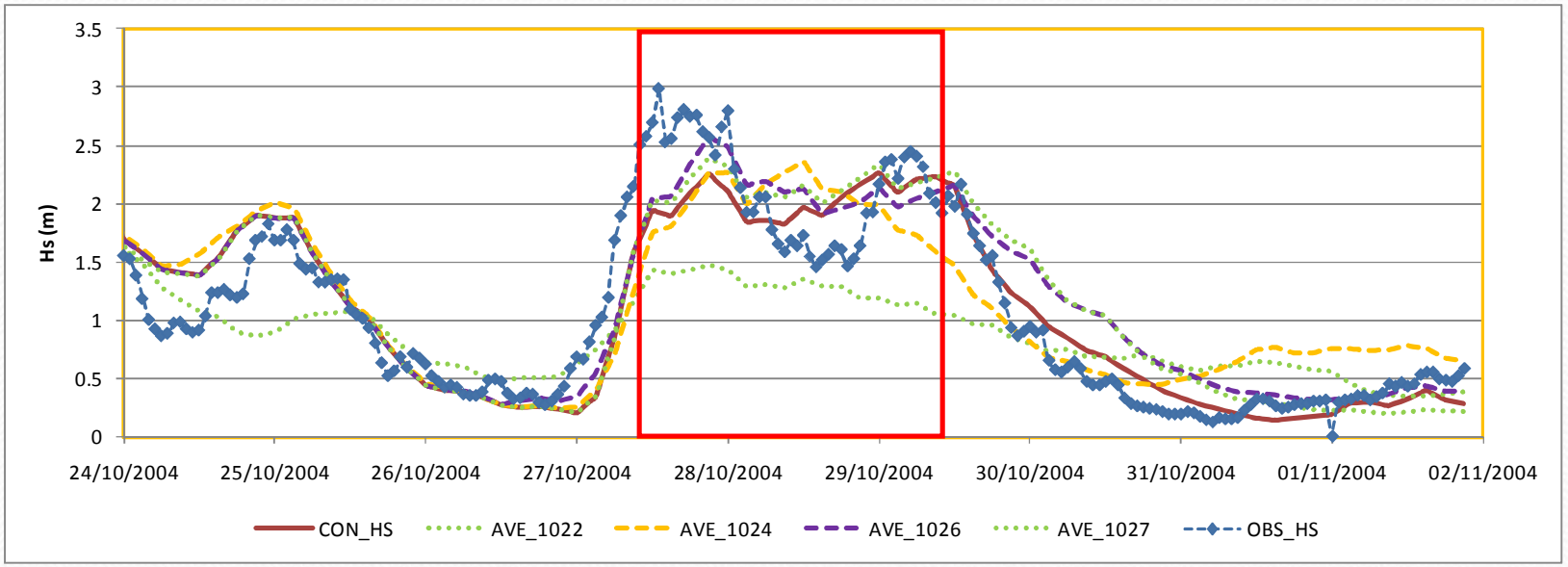
- Time Series

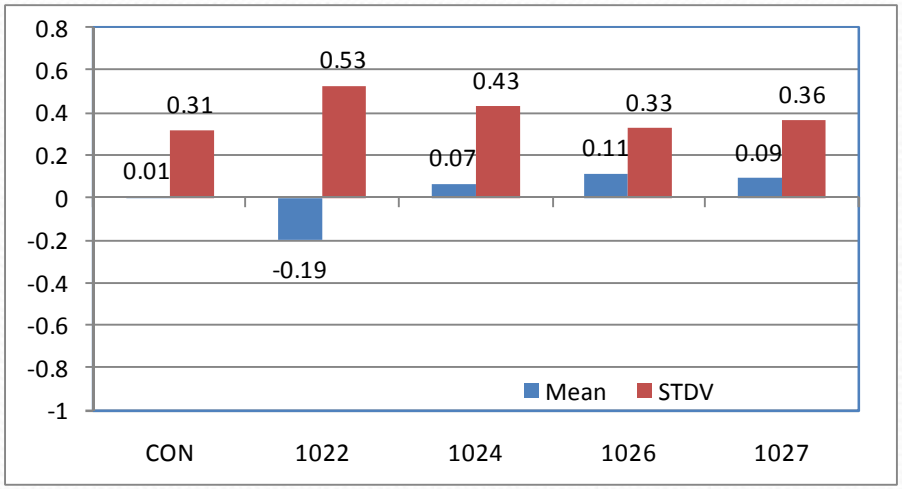


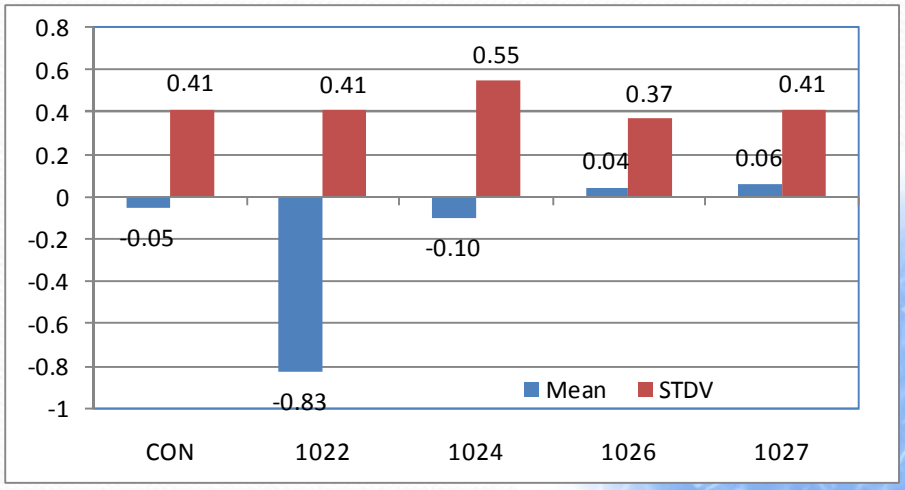


Ensemble Modelling – Waves

- Statistics/Analysis

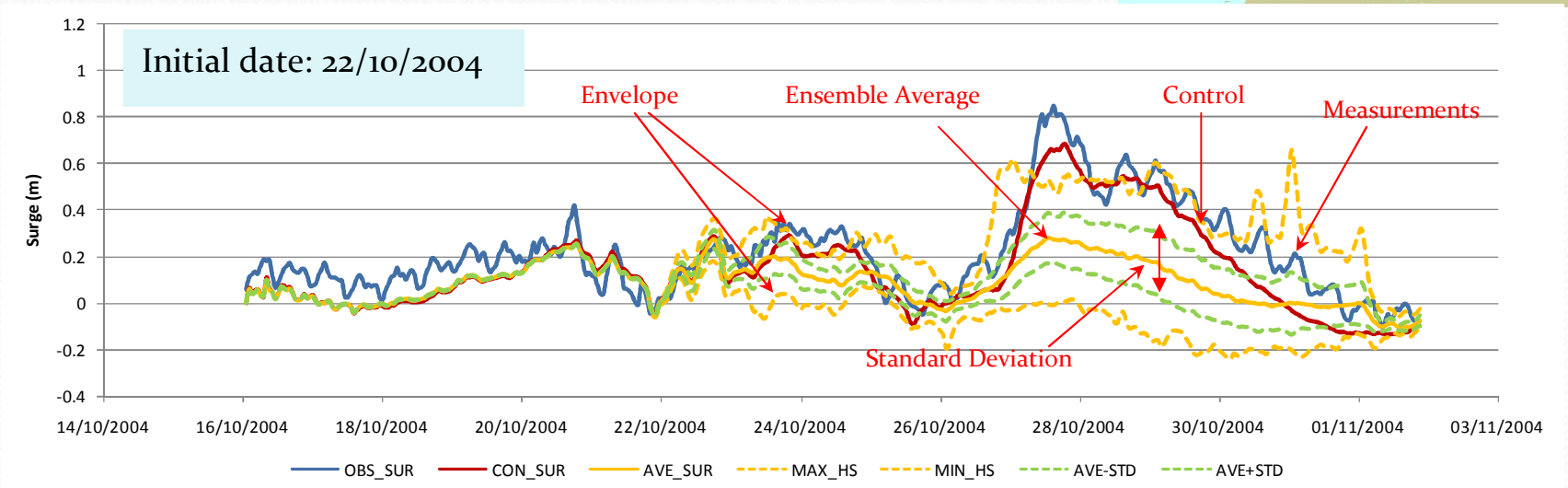


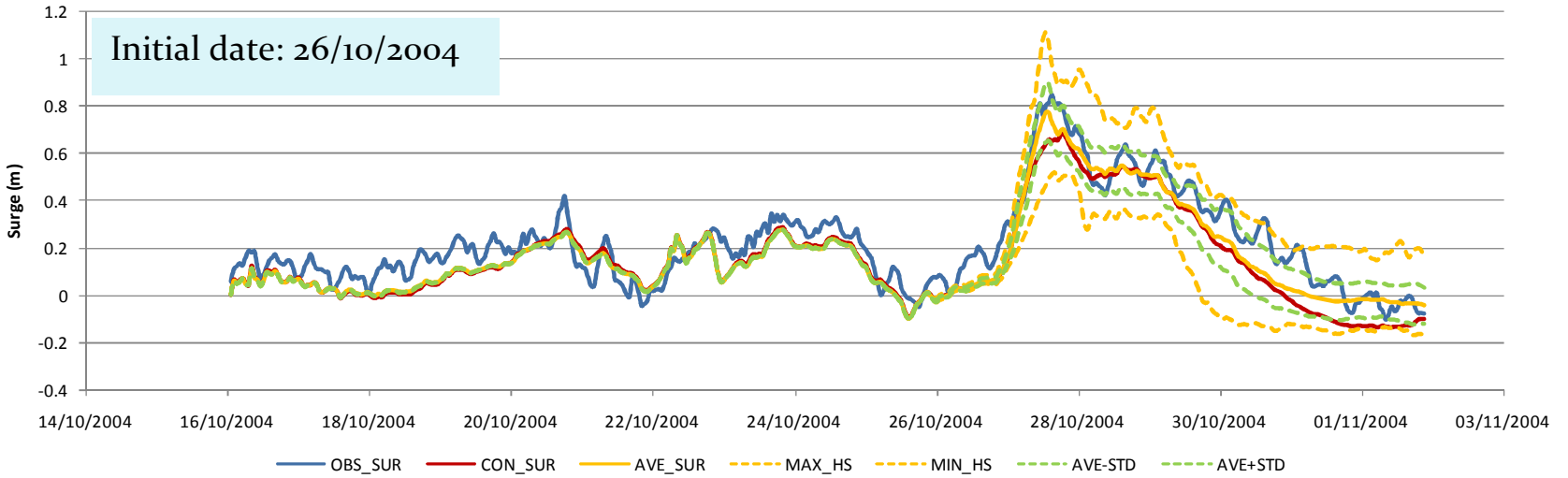




Ensemble Modelling - Surge

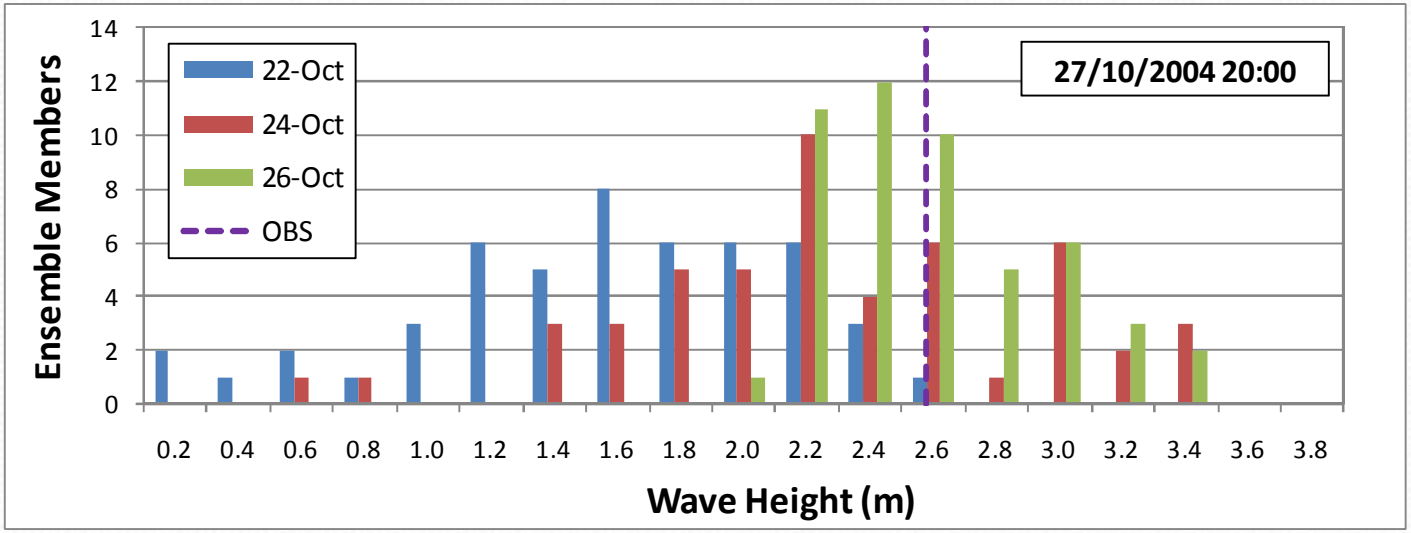
- Time Series



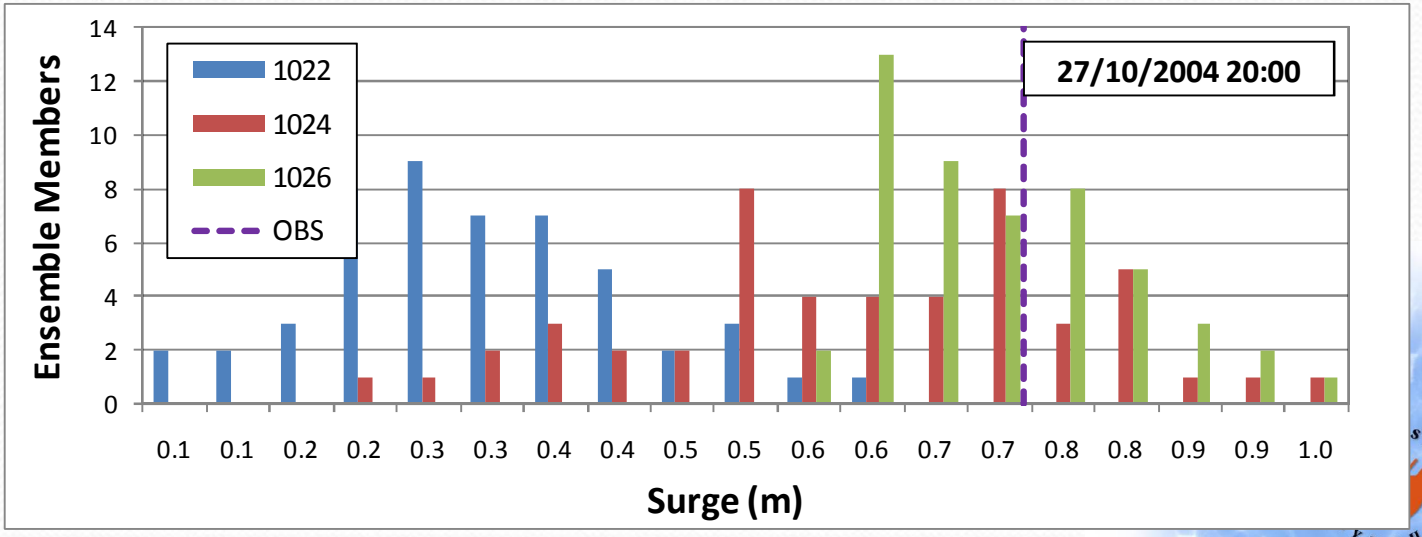


Ensemble Modelling – Probability

- Waves



- Surge



Conclusions

- The integrated tide-surge-wave model has been successfully set up at the English & Bristol Channels
- Results from ***deterministic modelling*** are in good agreement with the measurement data
- Ensemble results are sensitive to the initial date. The accuracy of the predictions of waves and surge can be significantly improved by using ensemble approach closer to the storm events.
- For storm peaks, the accuracy of T+2 day ensemble results is generally better than that of deterministic results