An inter-comparison of hindcast and measured wave data: implications for beach recharge design.

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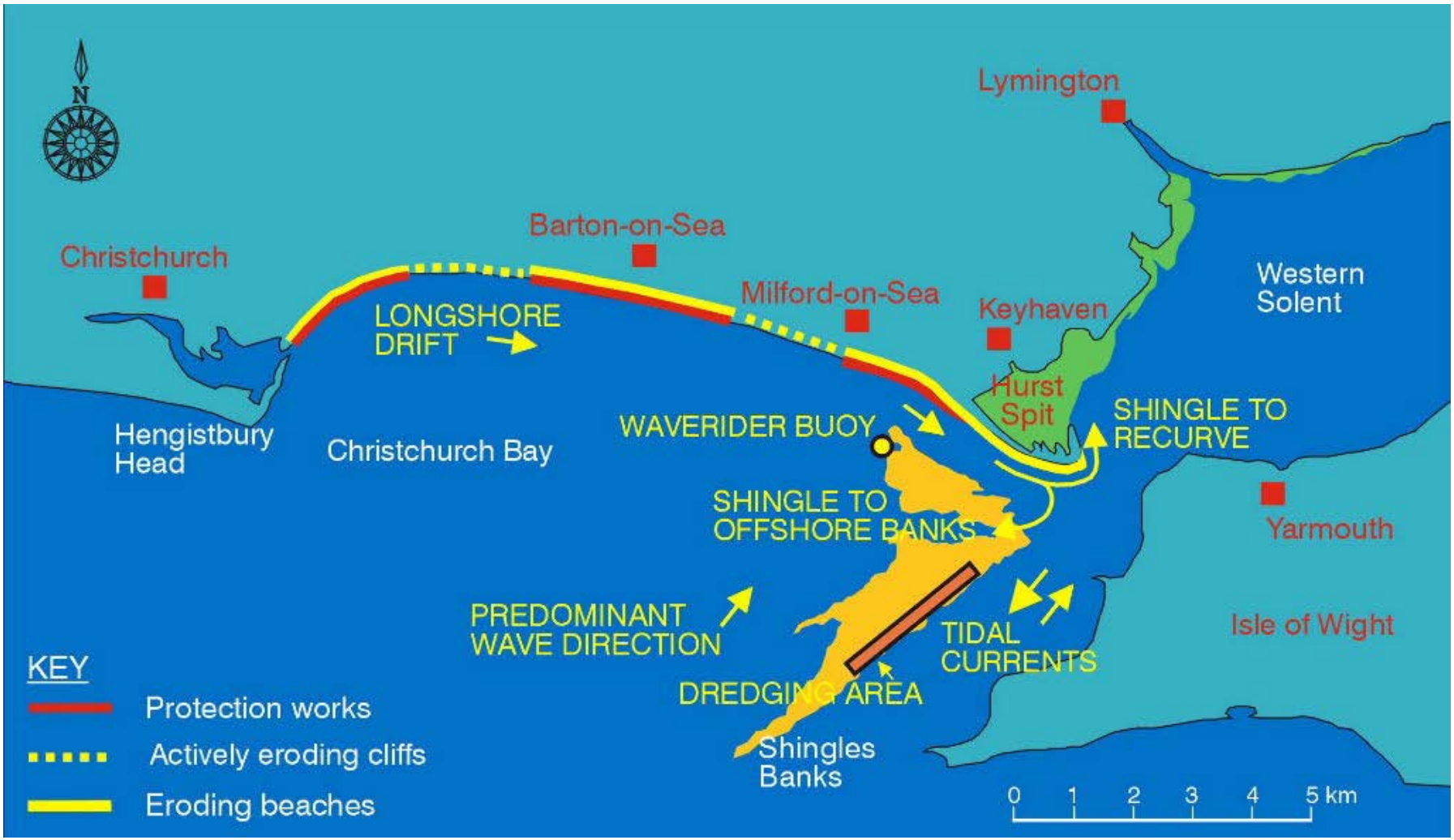
Conclusions

- Design of a beach management scheme has been based on data from a 17 year hindcast
- Beach management scheme performance monitored over 13 years has been better than projected
- This may be due to good fortune rather than good science
- Wave conditions measured differ significantly from those modelled in design
- Design methods appear to provide an over simplification over natural conditions
  - Longshore
  - Crosshore
- Unexpected beach responses seem to be linked with bimodal wave conditions



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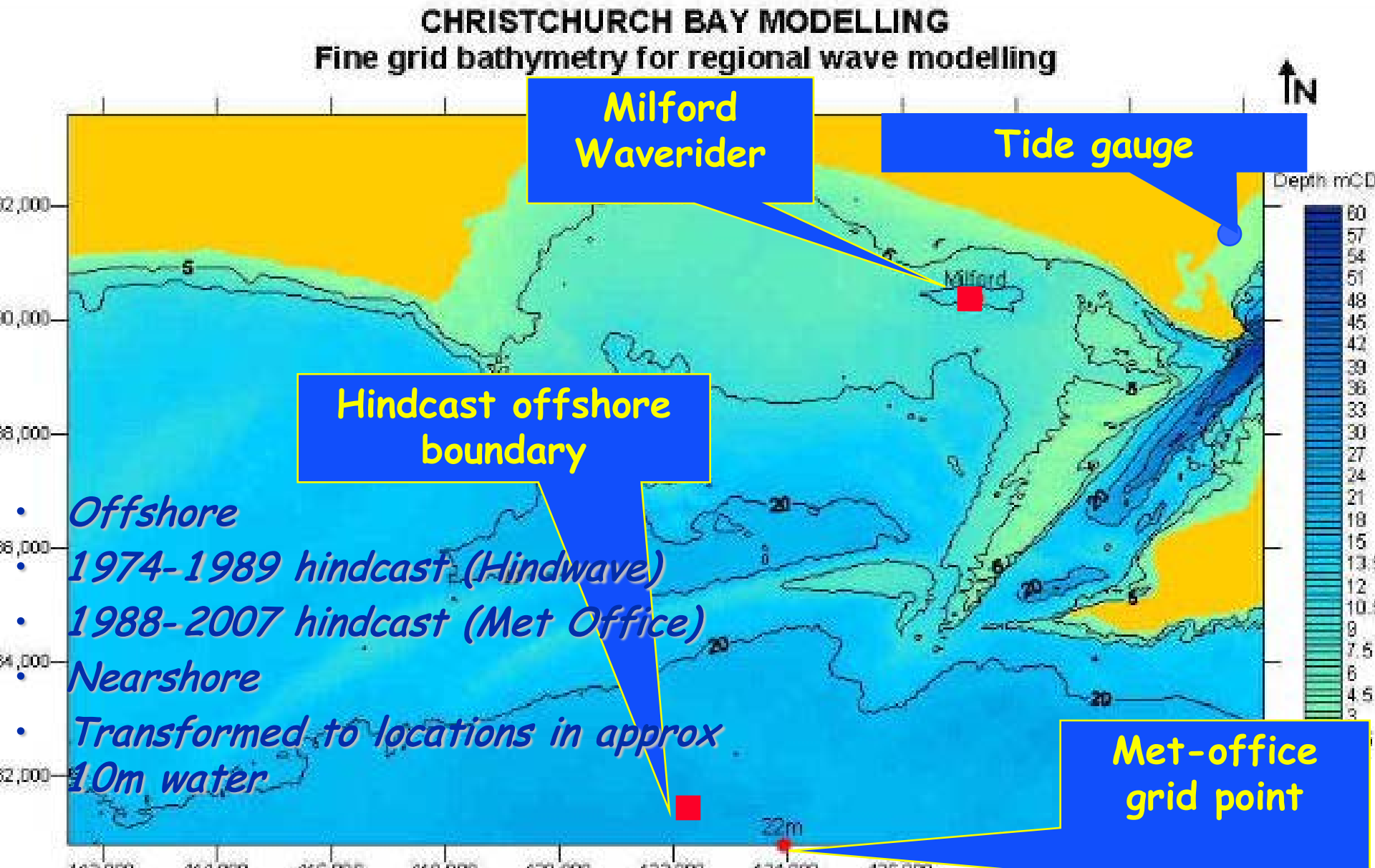
Design wave climate



- *Offshore*
- *1974-1989 hindcast (Hindwave)*
- *1988-2007 hindcast (Met Office)*
- *Nearshore*
- *Transformed to locations in approx 10m water*

Post construction monitoring 1996-2009

- Waverider buoy (10m water)
  - Realtime
  - Statistics
- Hindcasts (Met Office) transformed to waverider site

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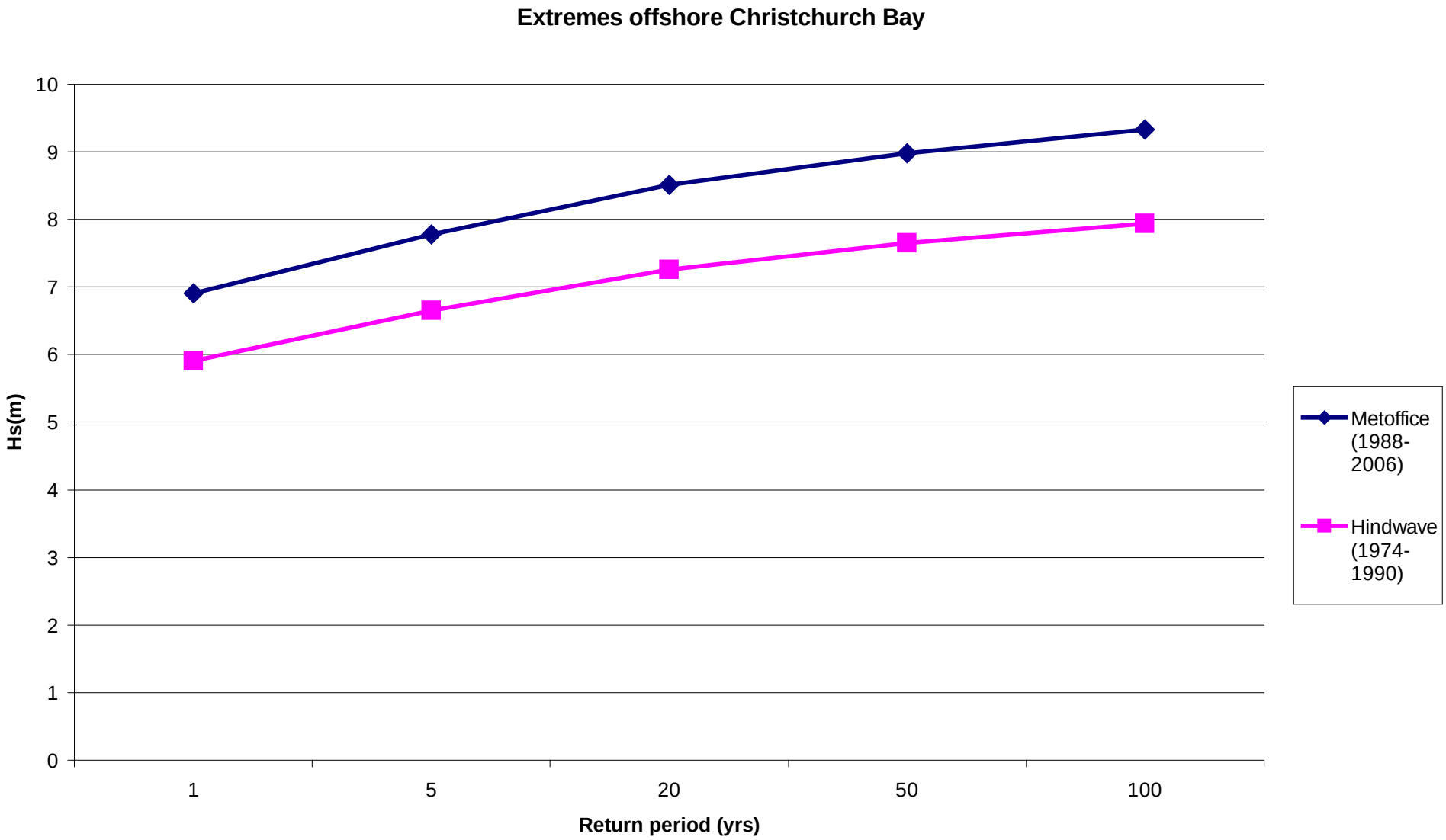
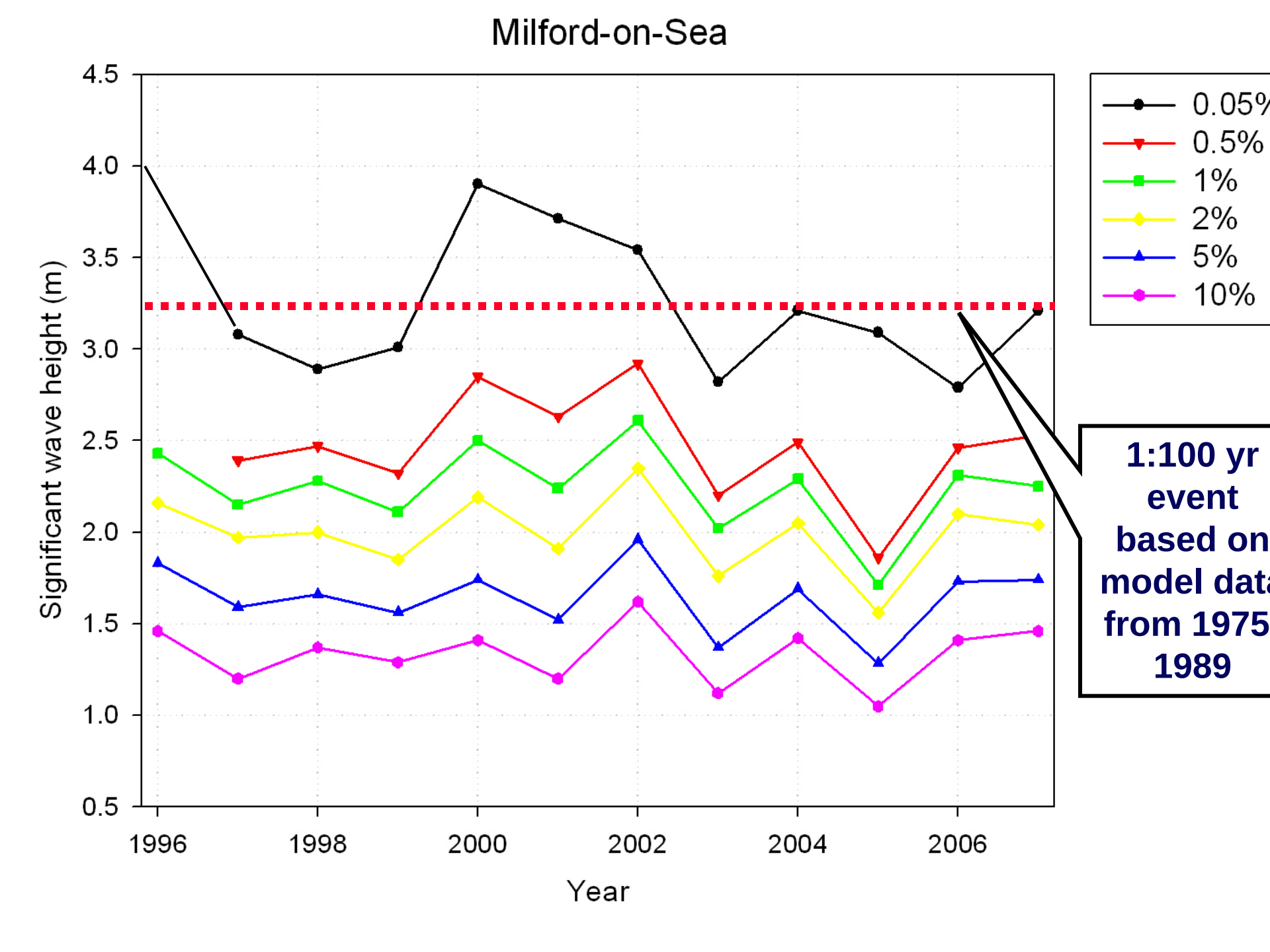
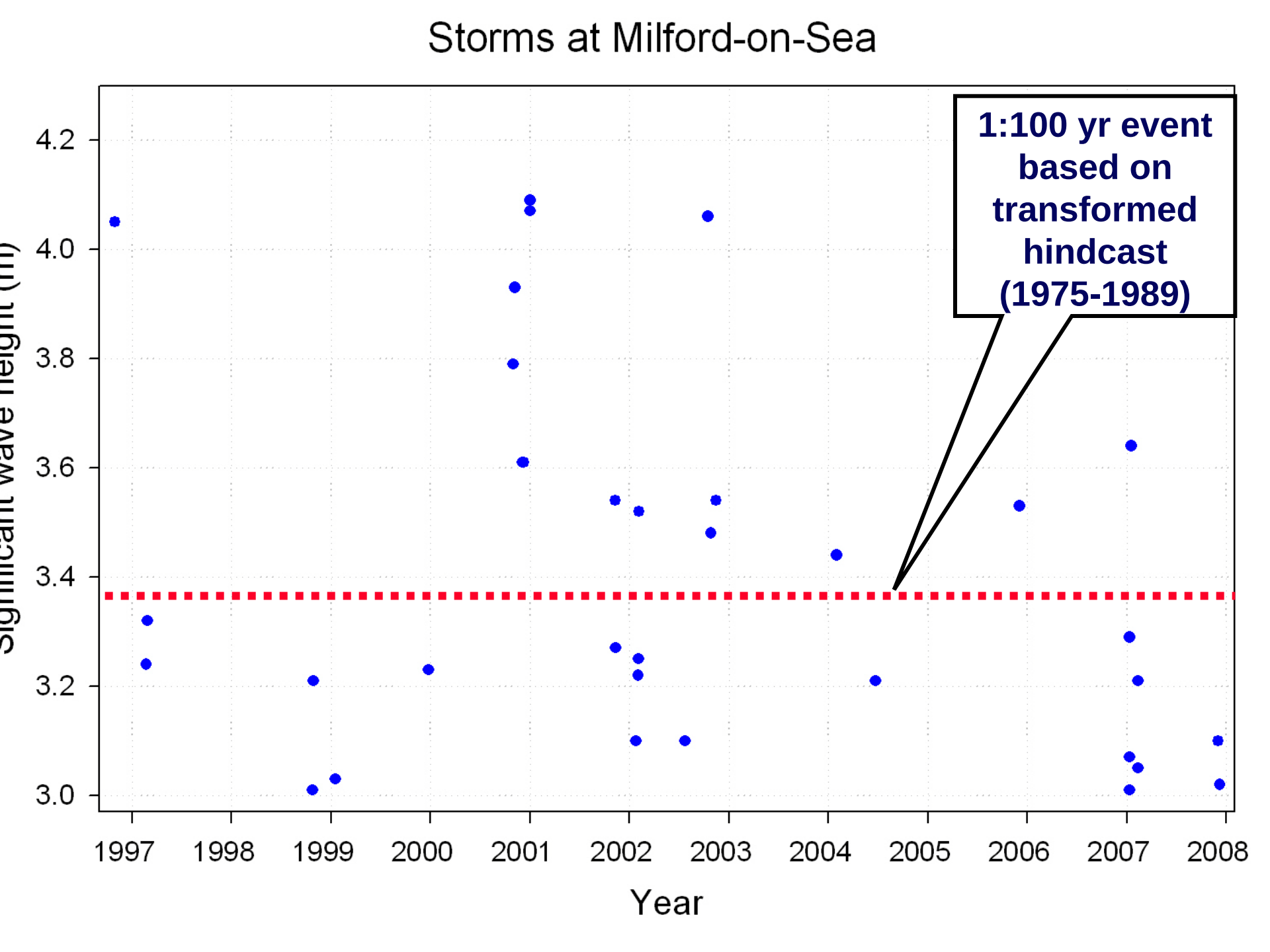
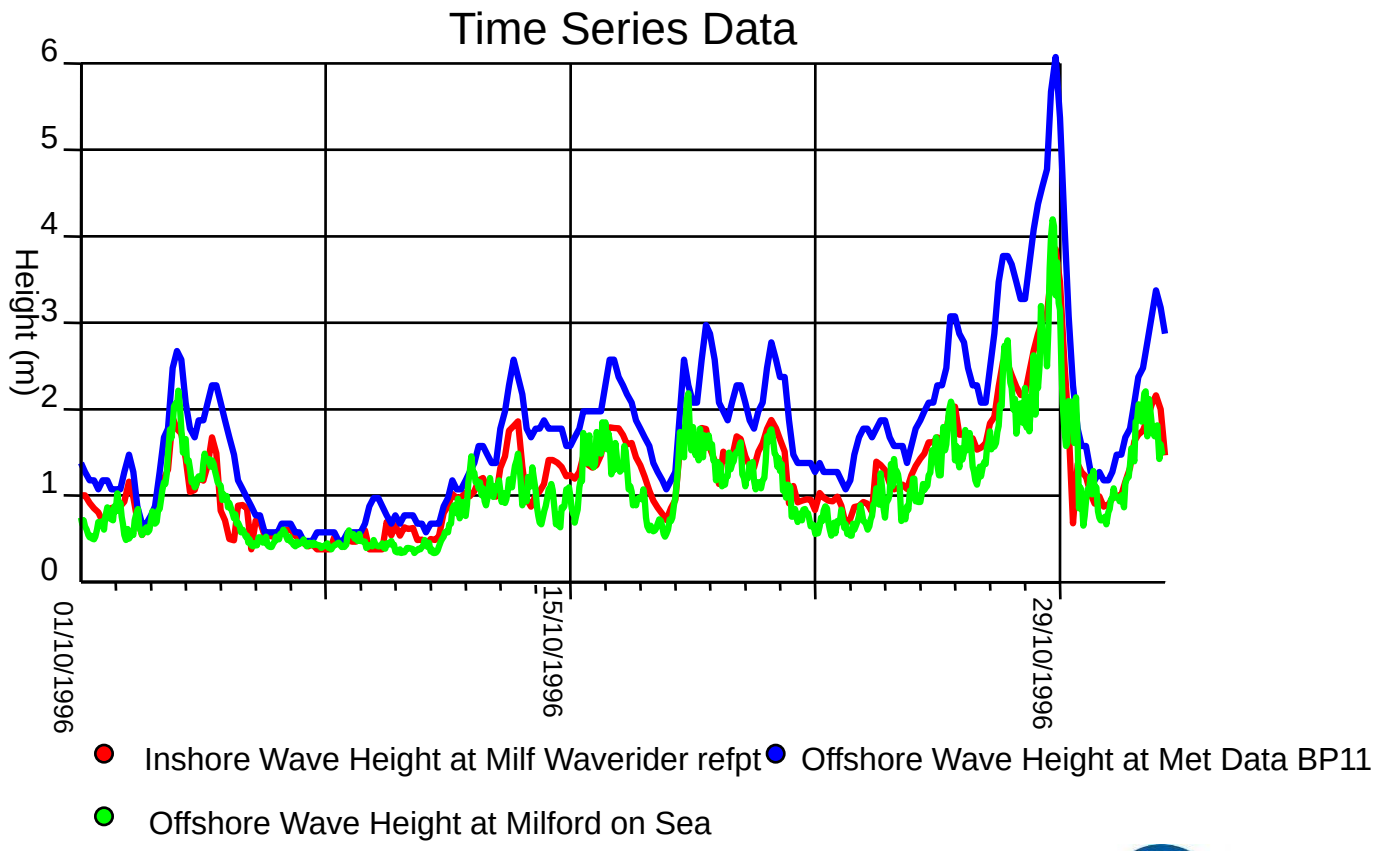



Milford-on-Sea
Significant wave height (m)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004
2006
Year
0.05%
0.5%
1%
2%
5%
10%
1:100 yr event based on model data from 1975 1989


Storms at Milford-on-Sea
Significant wave height (m)
4.2
4.0
3.8
3.6
3.4
3.2
3.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year
1:100 yr event based on transformed hindcast (1975-1989)

Time series comparison



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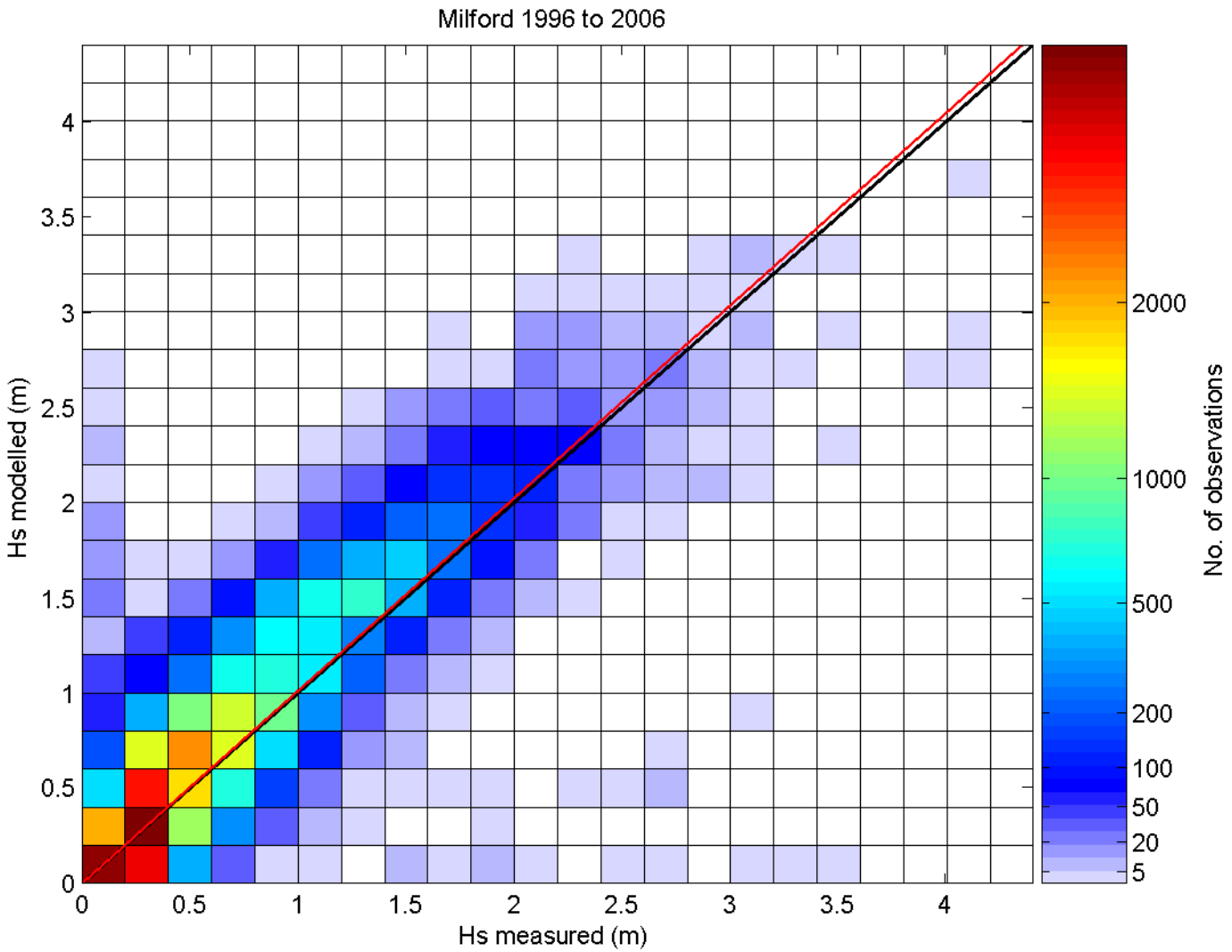

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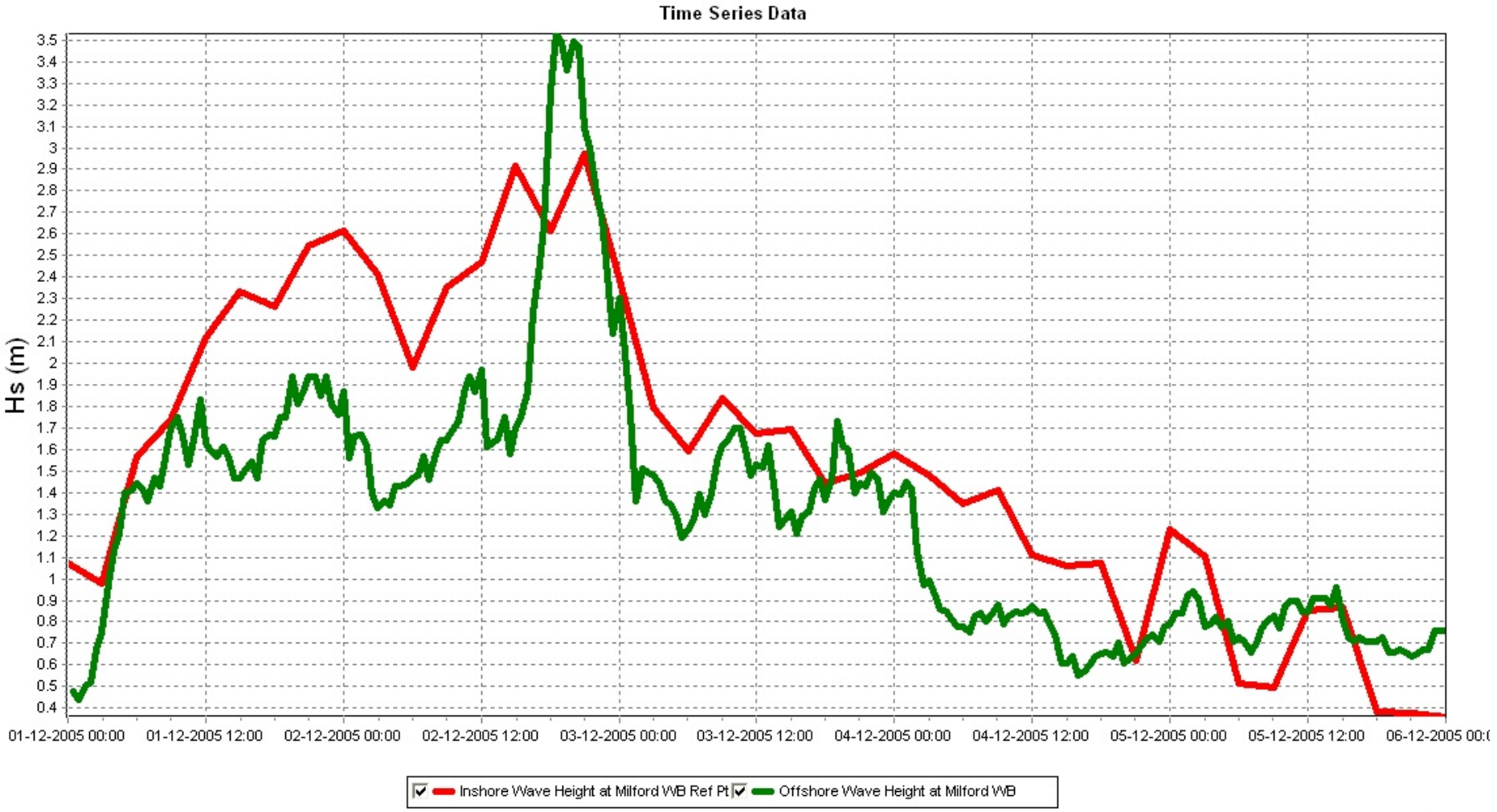

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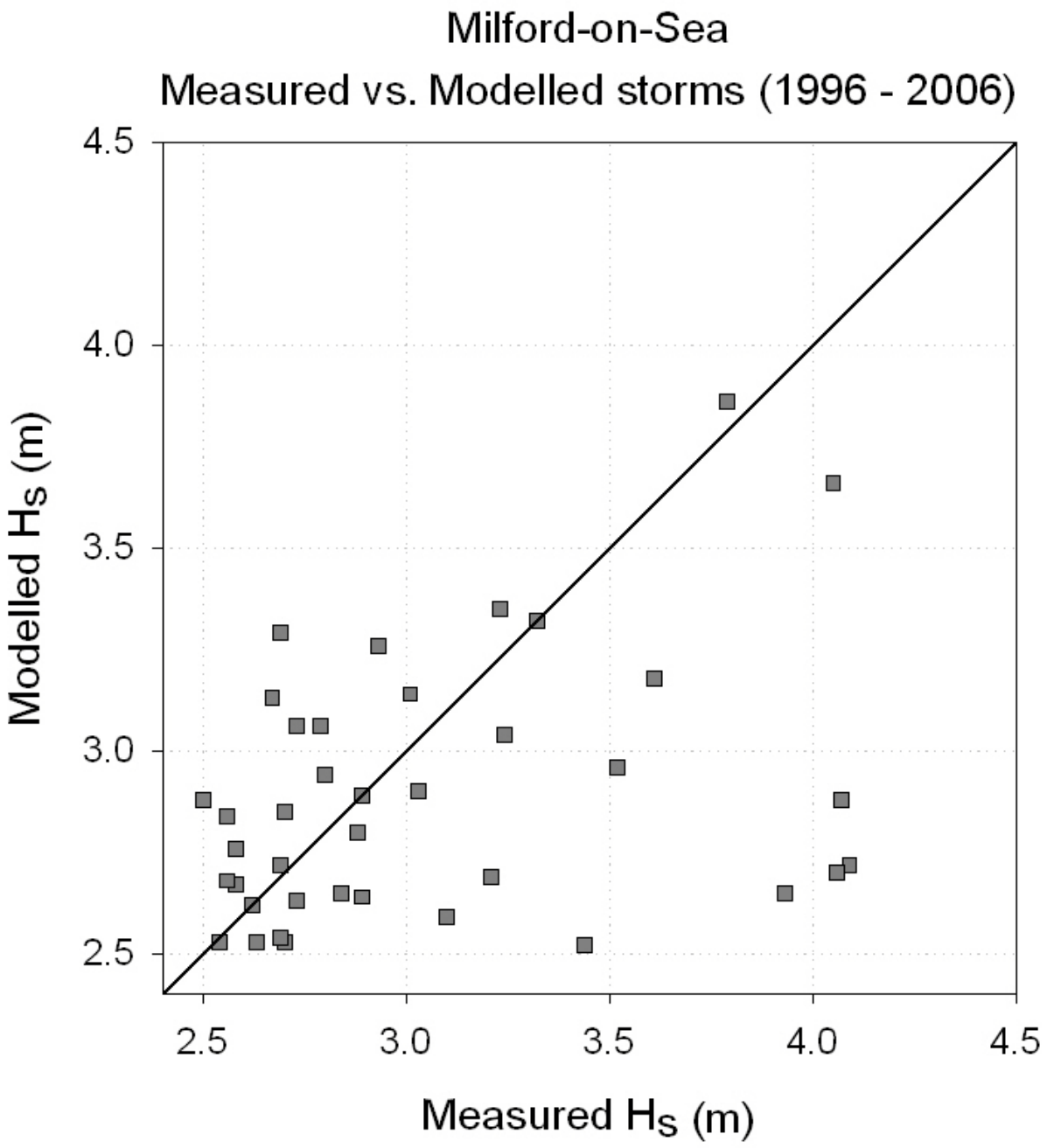

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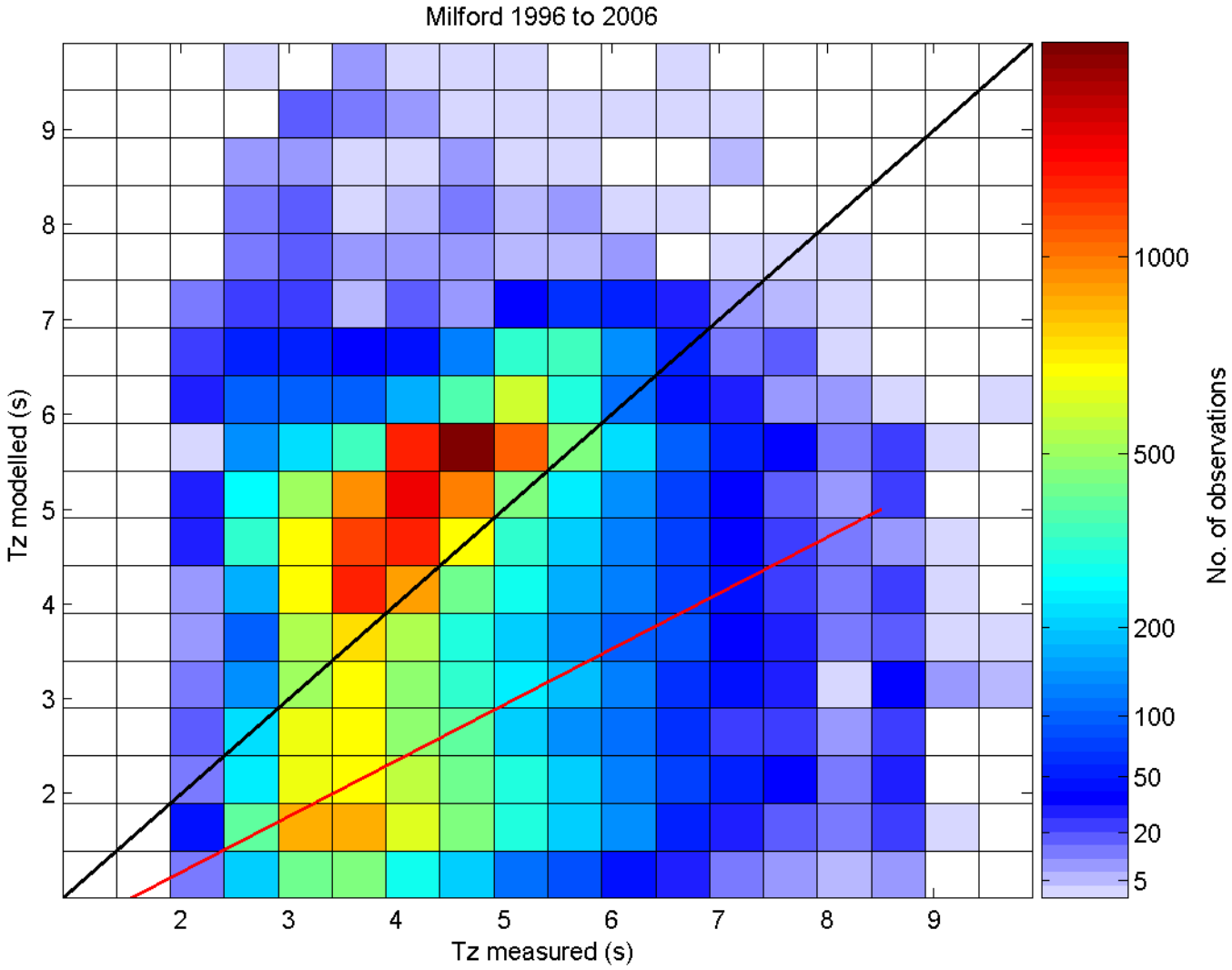

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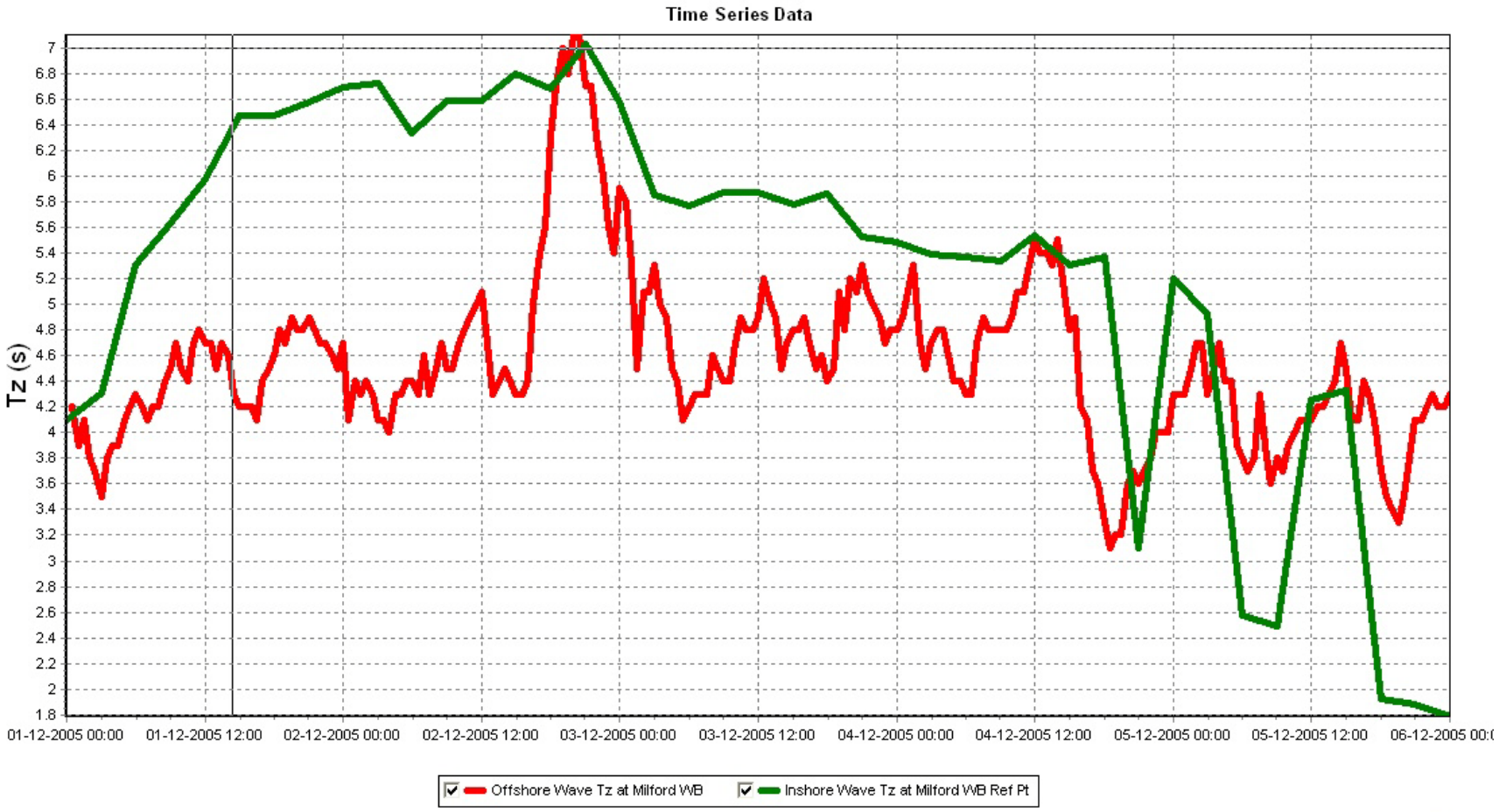

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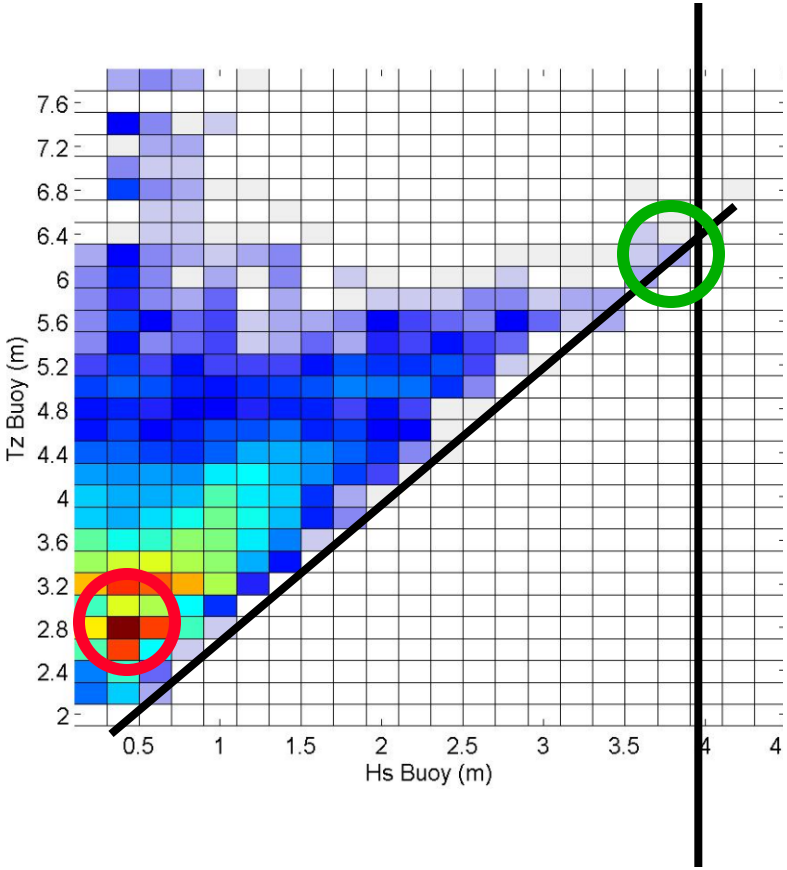

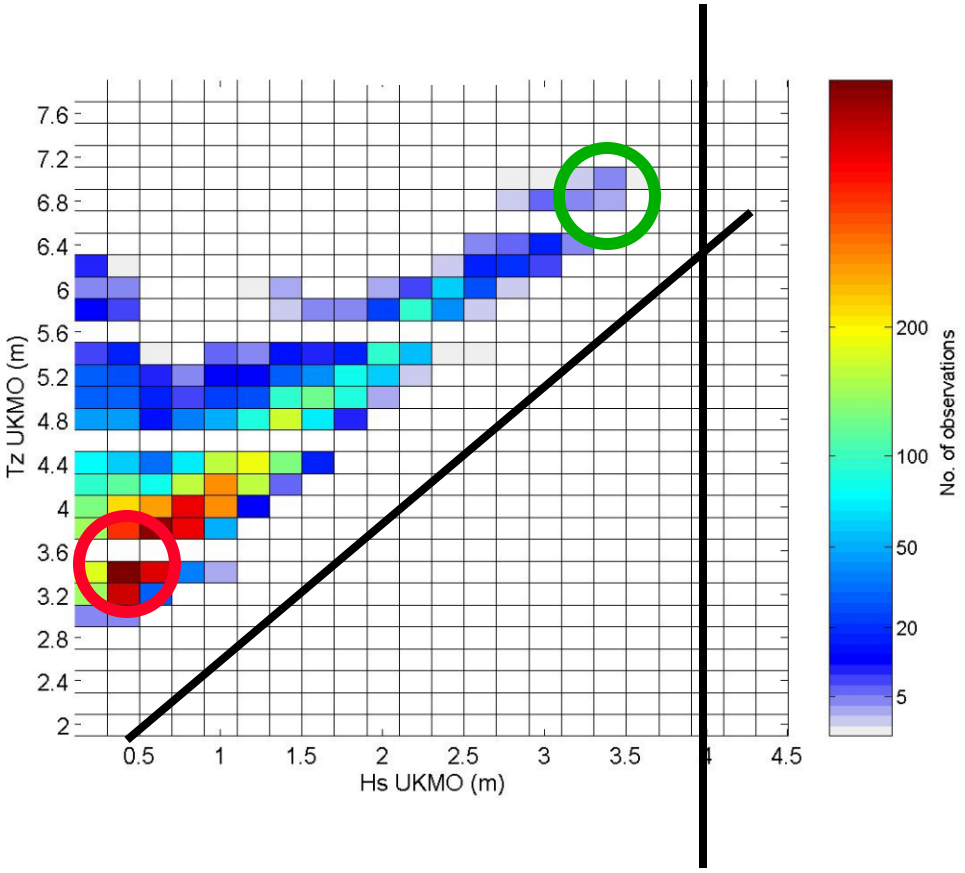

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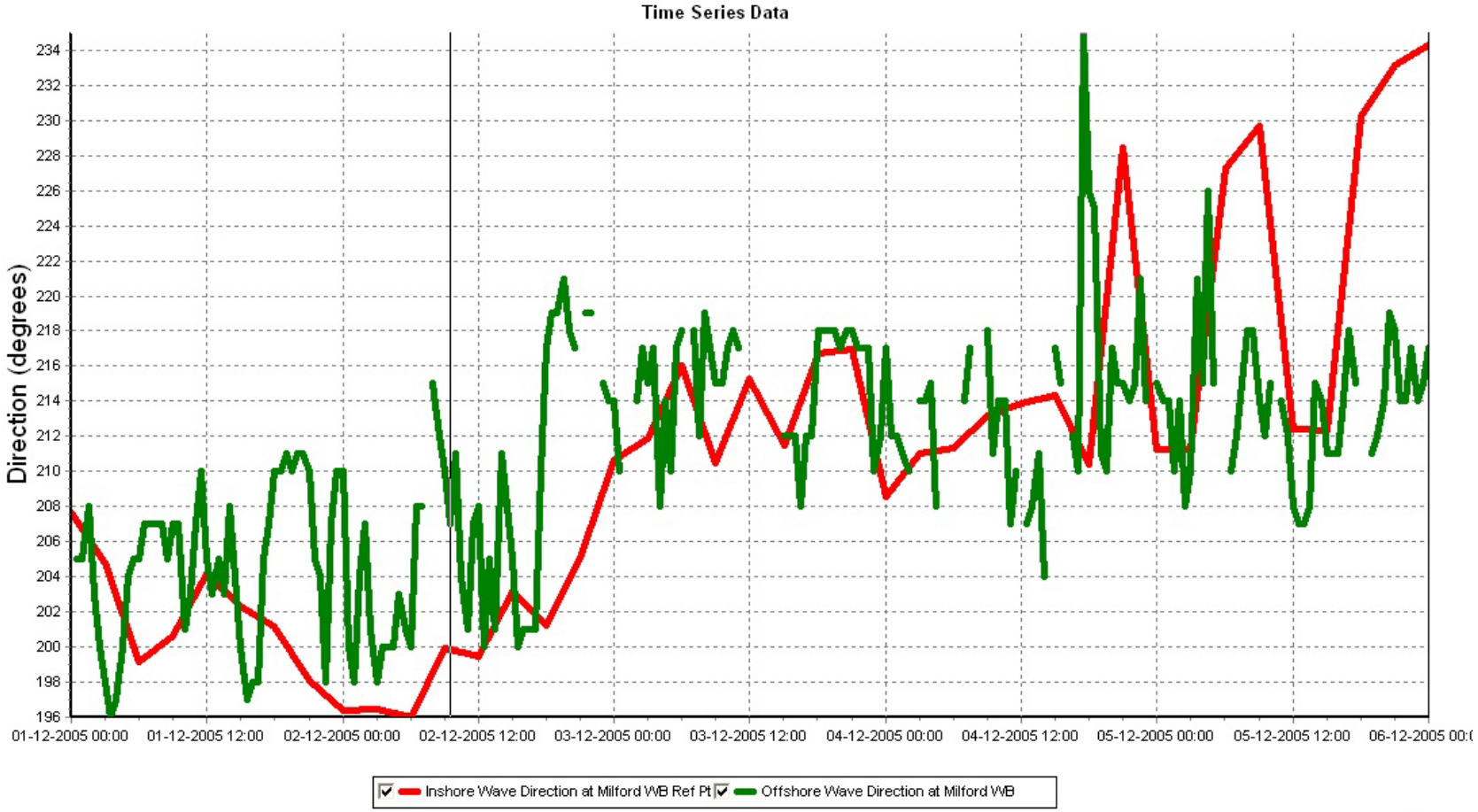

Summary of wave climate differences

- More frequent severe events than anticipated pre-construction
- Wave period often shorter than expected (20-30%)
- Nearshore waves usually steeper than expected
- Phasing of direction changes slower response in model

Design approach
Physical / numerical models

Focus

- Breaching
- Overwash features
- Profile response
- Plan shape
- Impact headland structure
- Longshore transport

Conditions

• Hs	1.0 to 4.1m
• Tz	7.4 to 10.9s
• Incident wave angle	0 to15^{o}
• Freeboard	-0.4 to 7.8m
• Beach width	0 to110m
• Cross section area	0 to 400m^{2}

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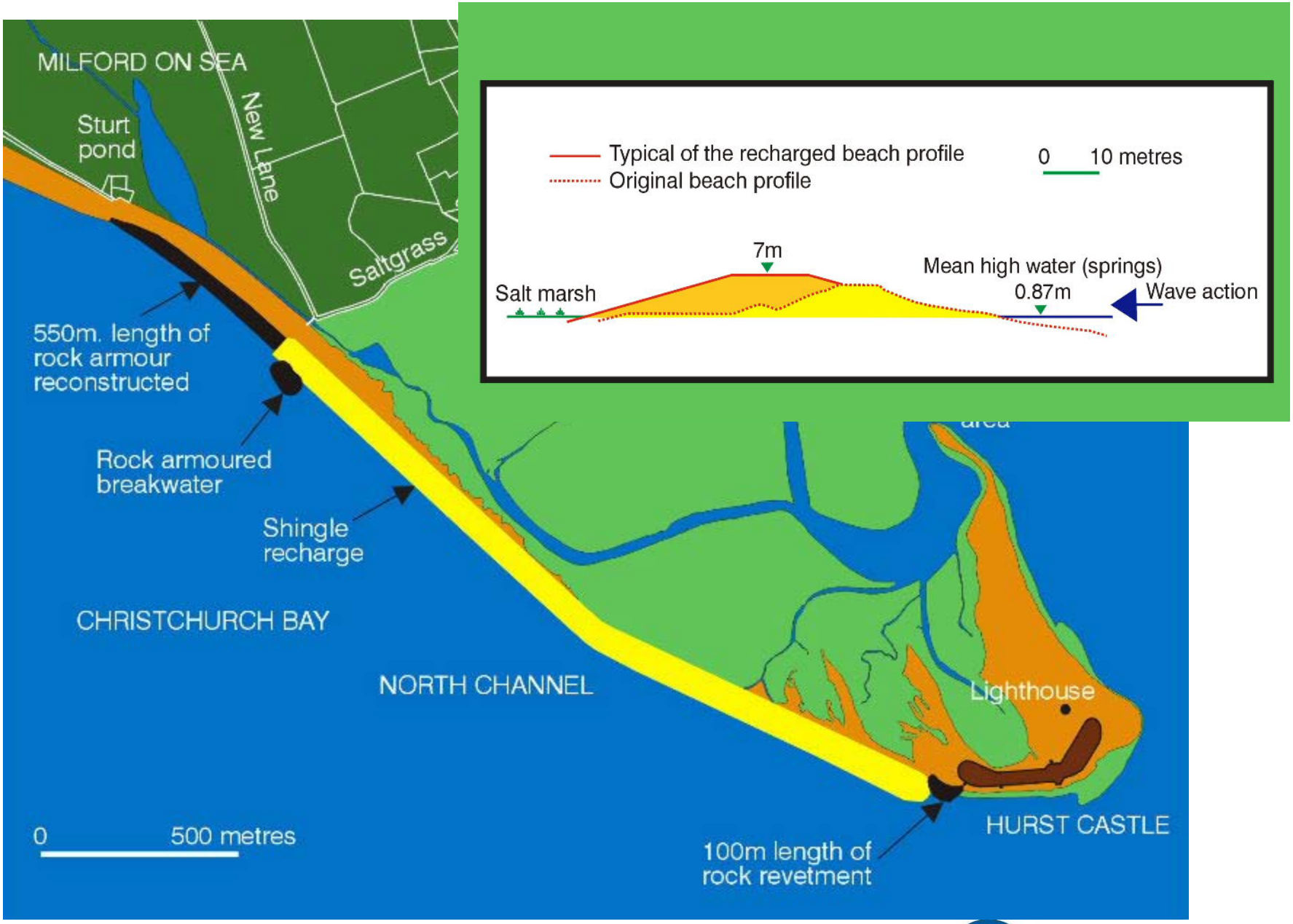
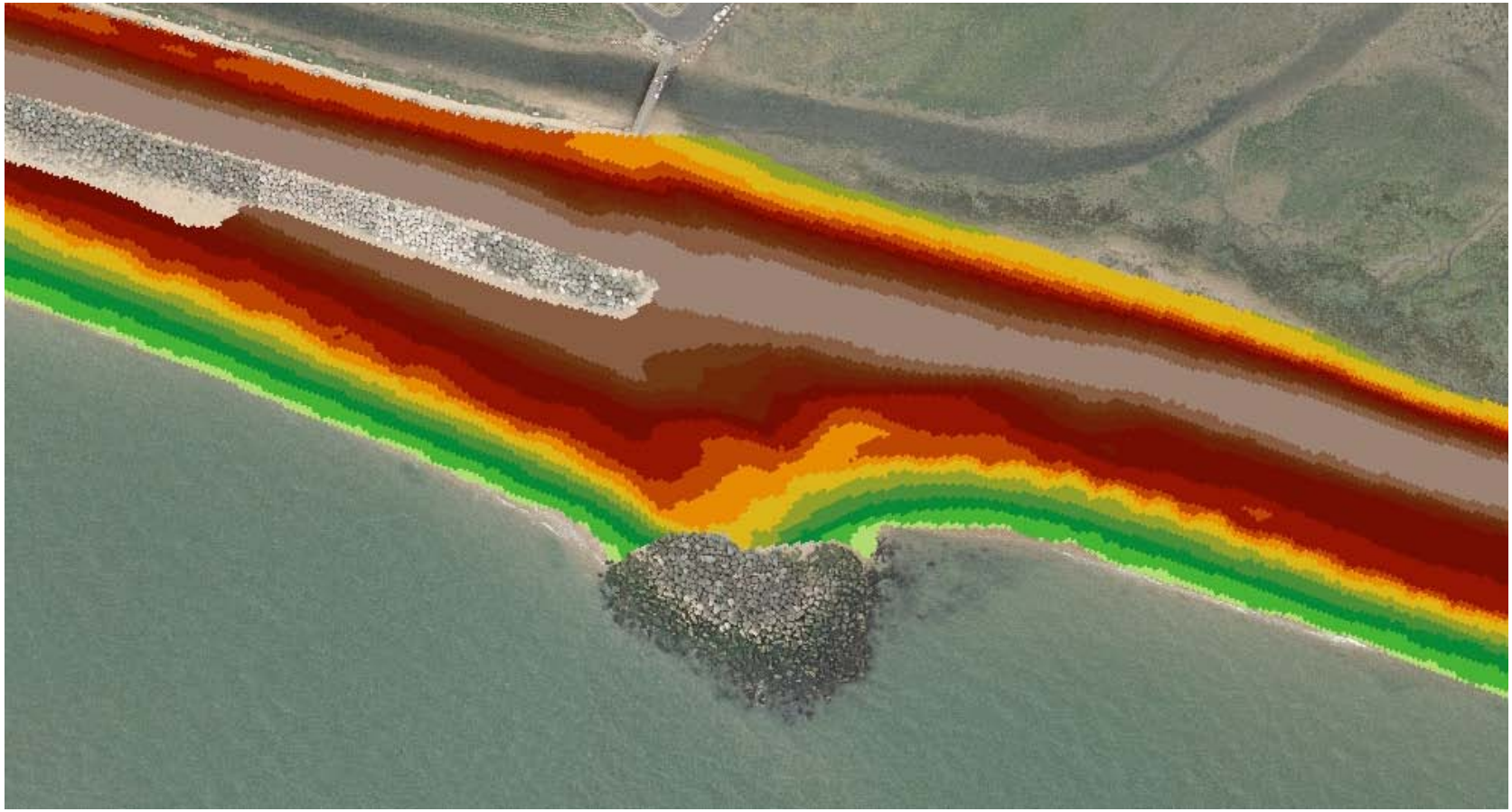


Plan shape evolution



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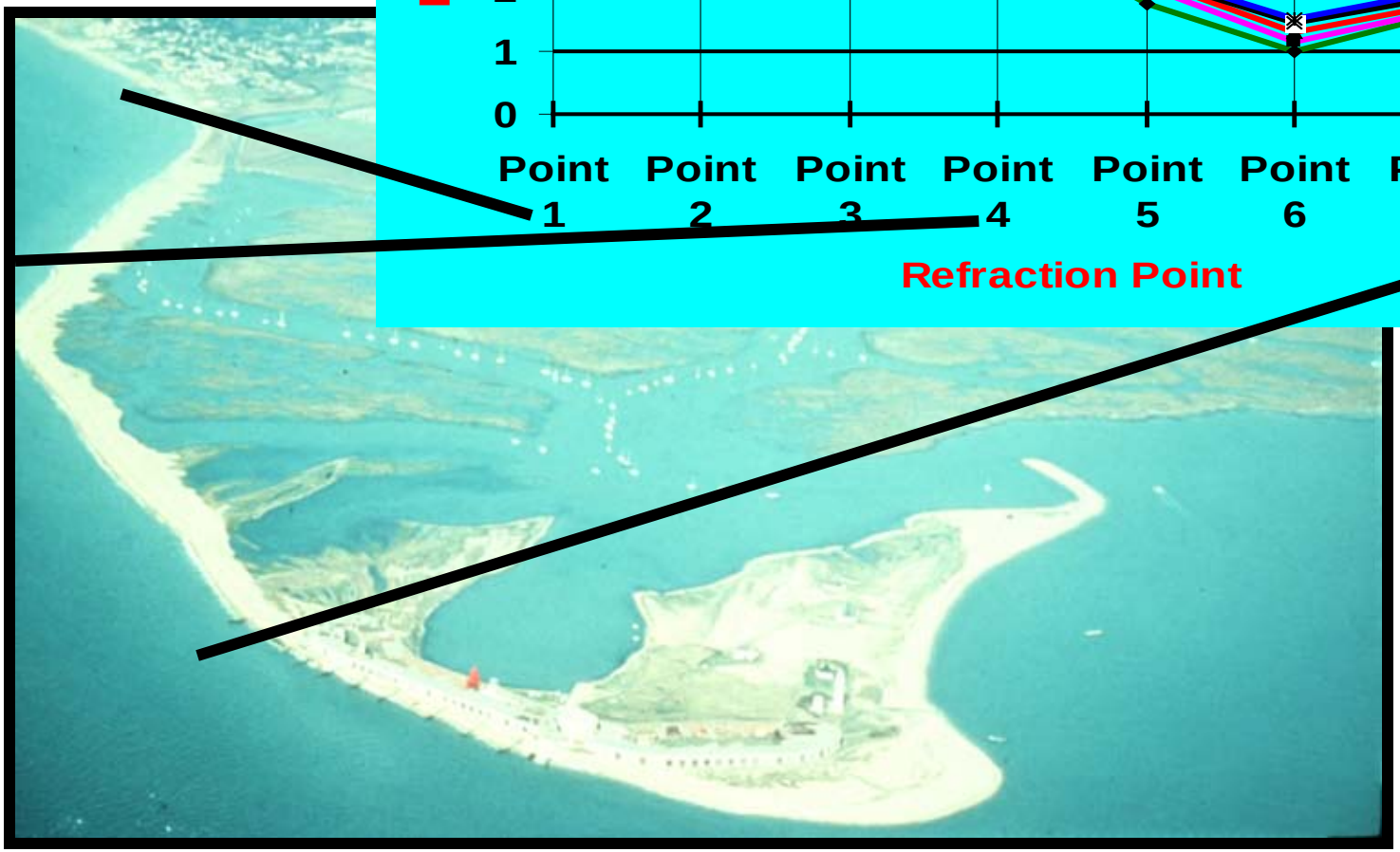

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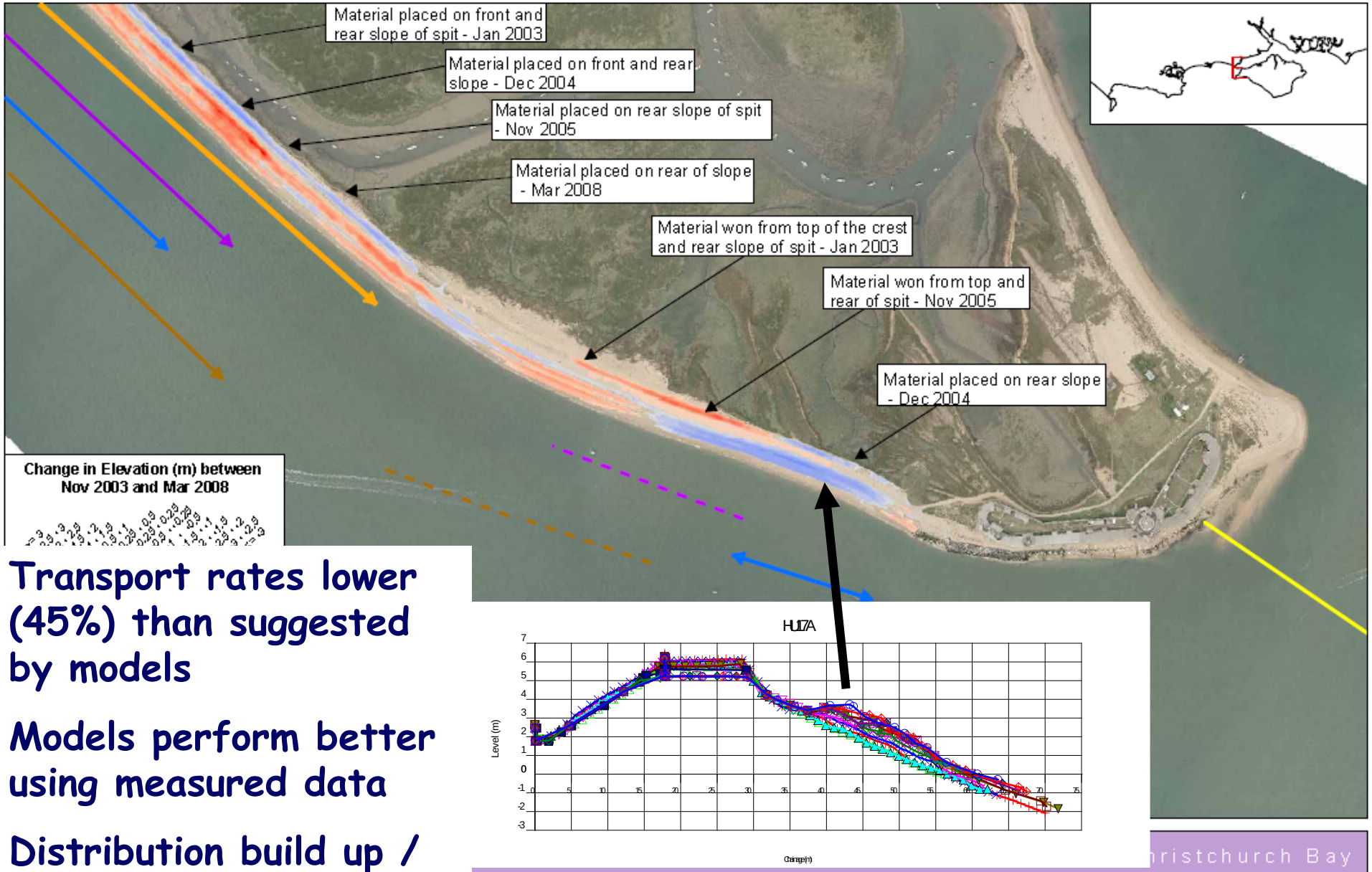

Transport rates lower (45%) than suggested by models

Models perform better using measured data

Distribution build up / erosion comparable

Crosshore response, overwash, breach

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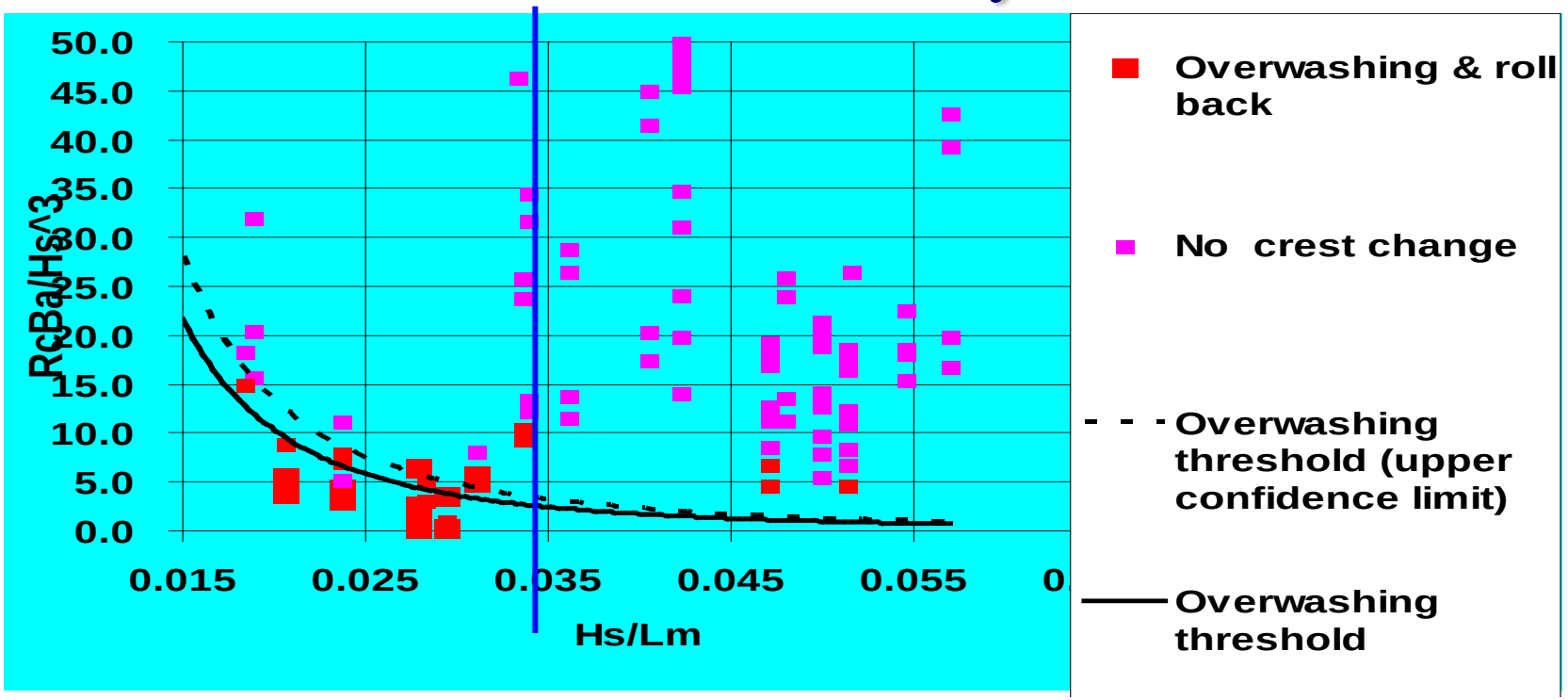
Storm event monitoring

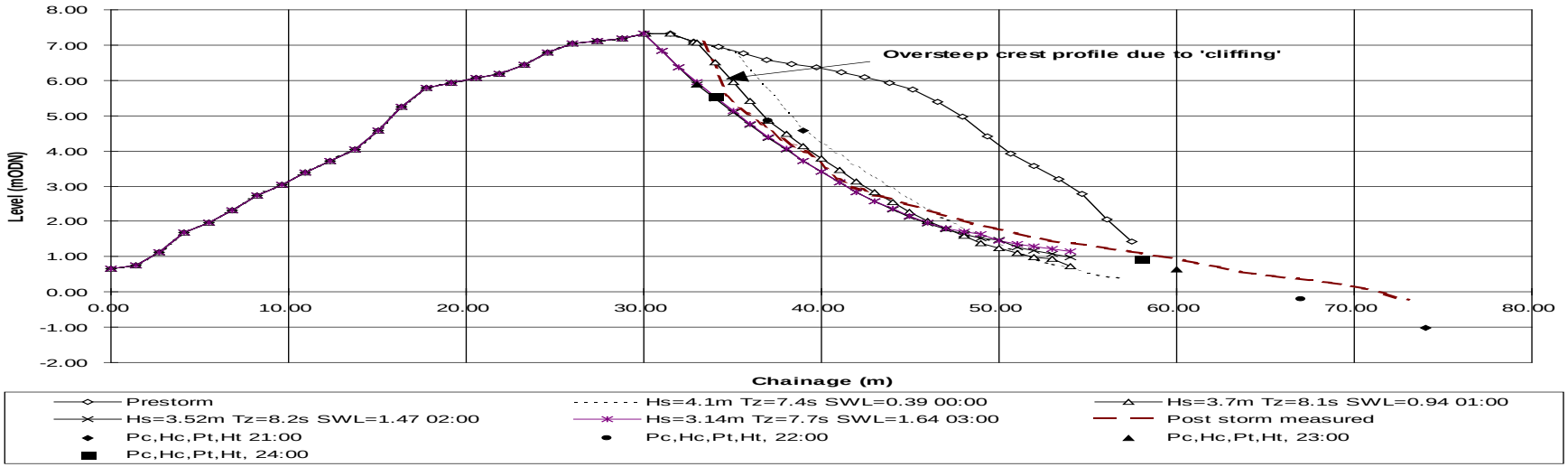
- Profile performance
  - Comparison with cross shore profile models
  - Comparison with breach prediction framework
- Conditions – time series H_s, T_z, T_p, dirn SWL

Barrier inertia parameter



- Measured conditions regularly steeper than modelled
- Many actual conditions not tested (steeper range)
- Predictions work well for some events
- Overwash threshold curve under predicts – some conditions

Increased crest cut back and runup



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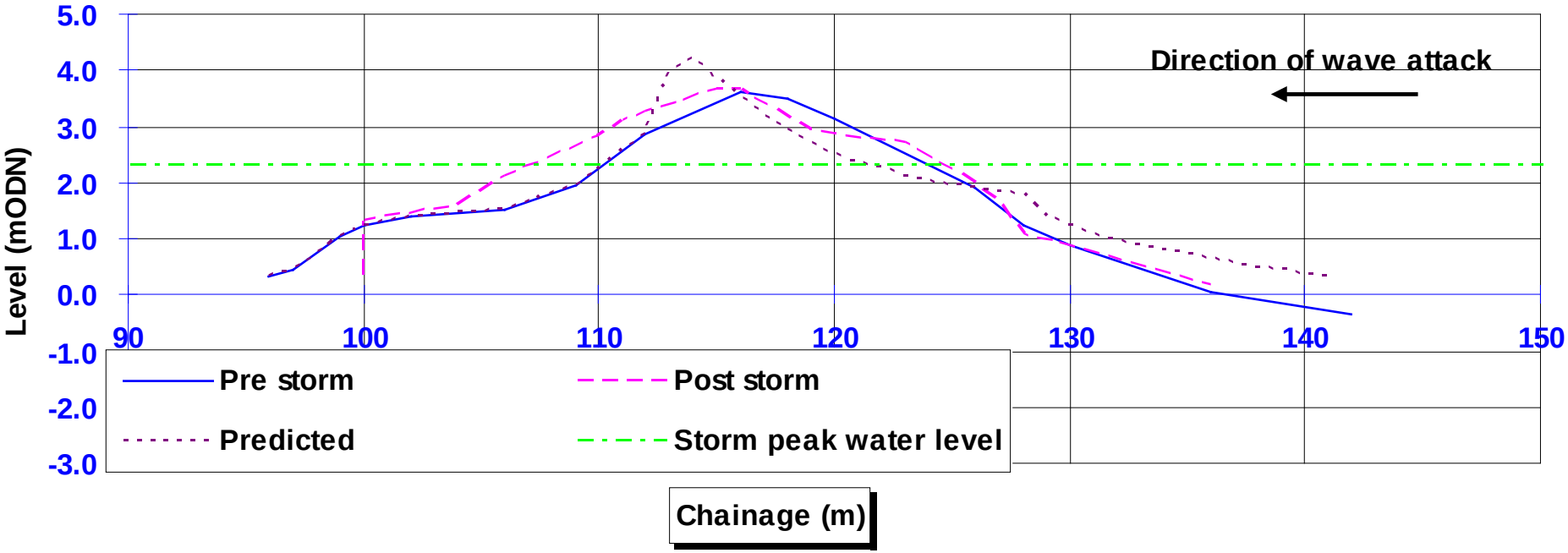
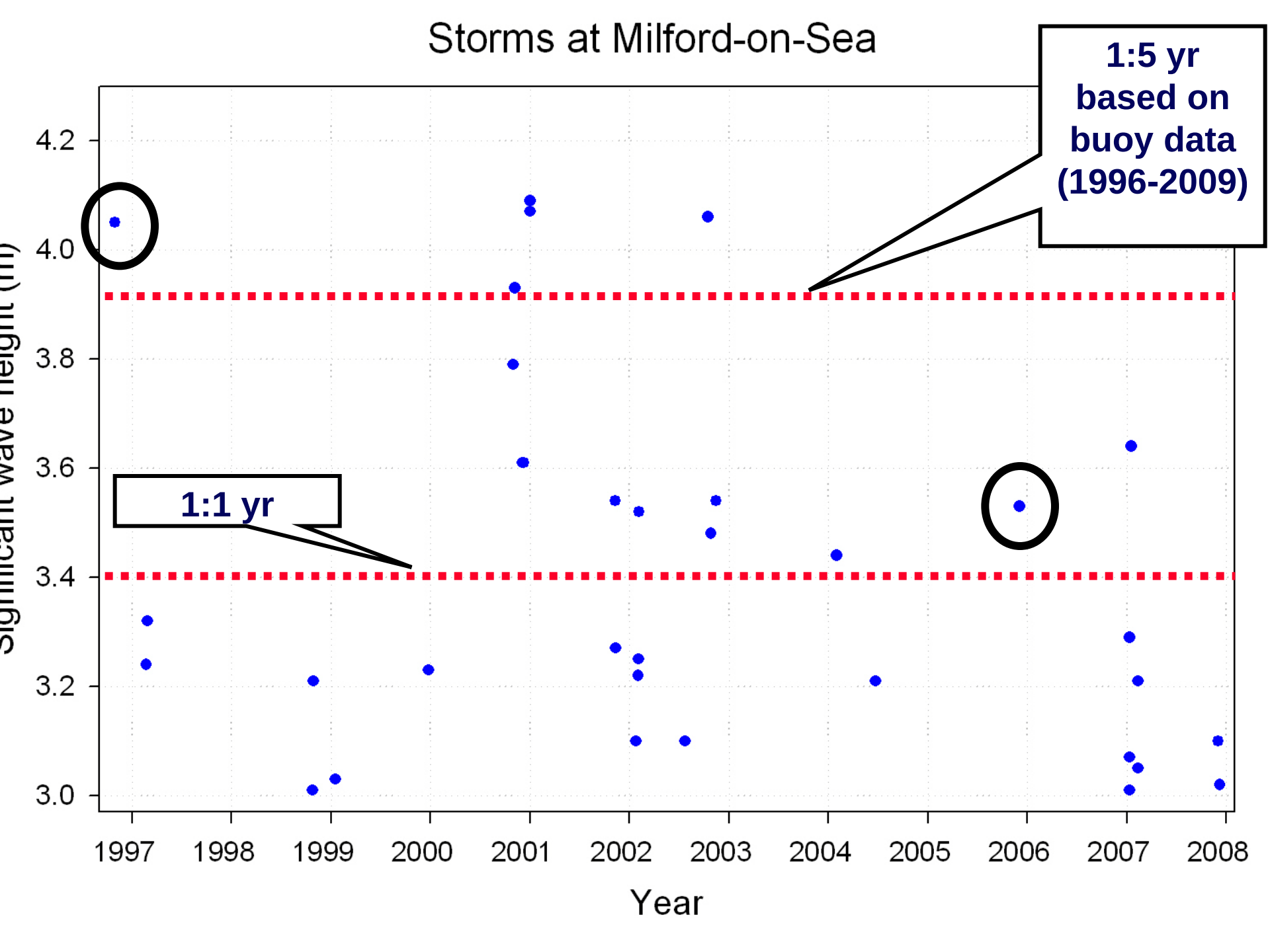
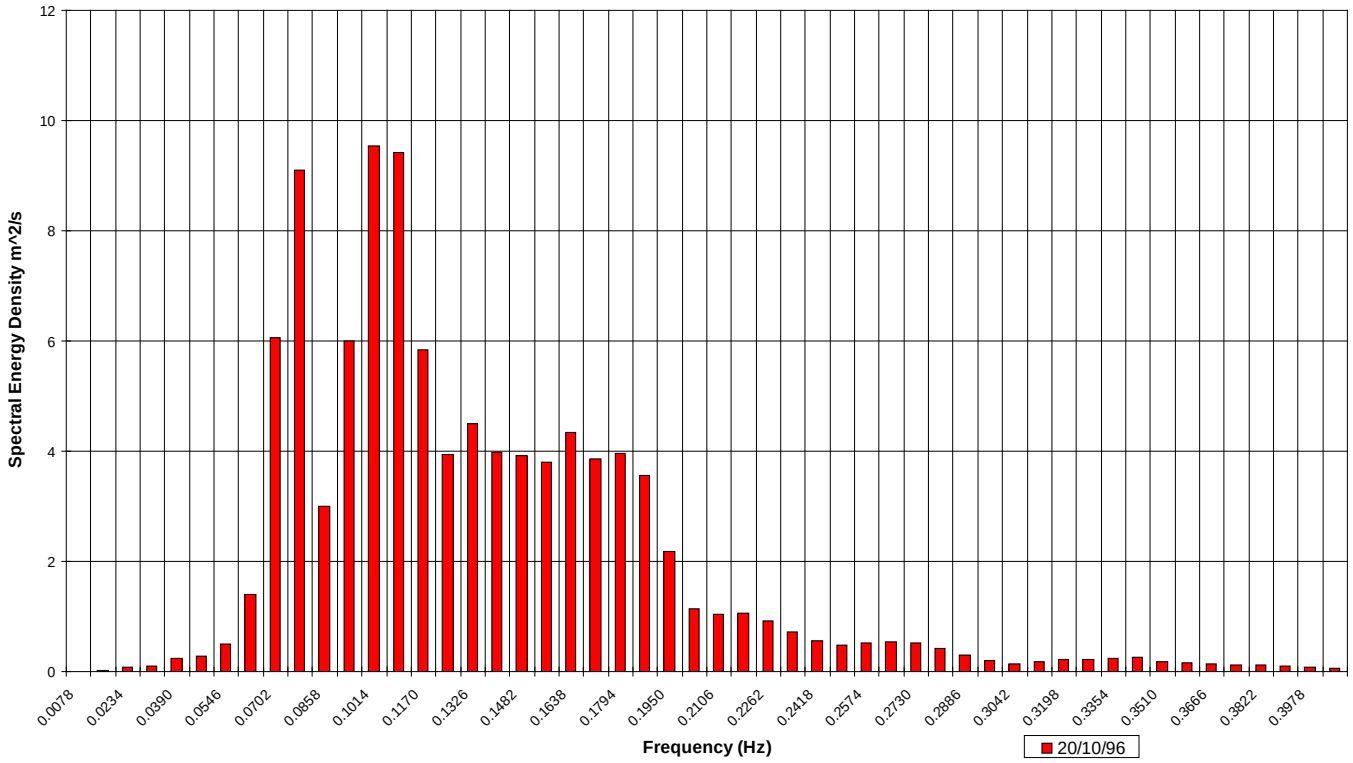
Overwashing not predicted November 2005




Storms at Milford-on-Sea
1:5 yr based on buoy data (1996-2009)
1:1 yr
Significant wave height (m)
4.2
4.0
3.8
3.6
3.4
3.2
3.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year

Construction phase storm 28 Oct 1996



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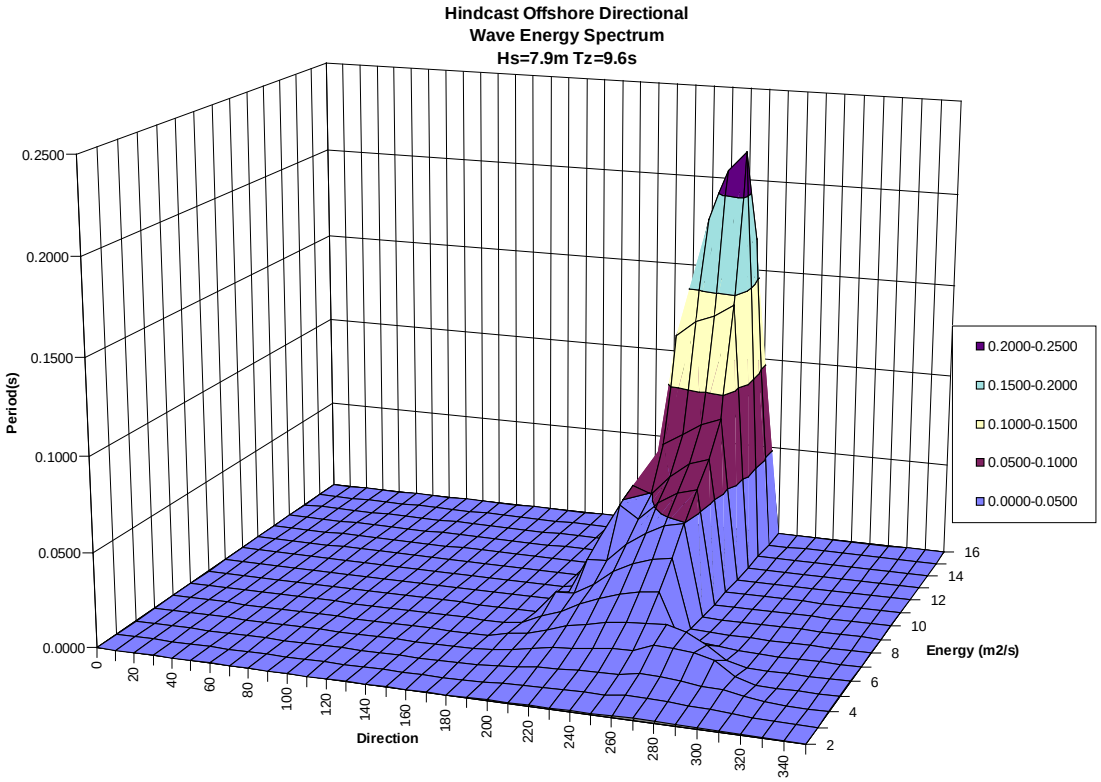
Model assumptions

- Design based on physical model where:
  - Simple sea state spectral shape assumed
  - Typically JONSWAP



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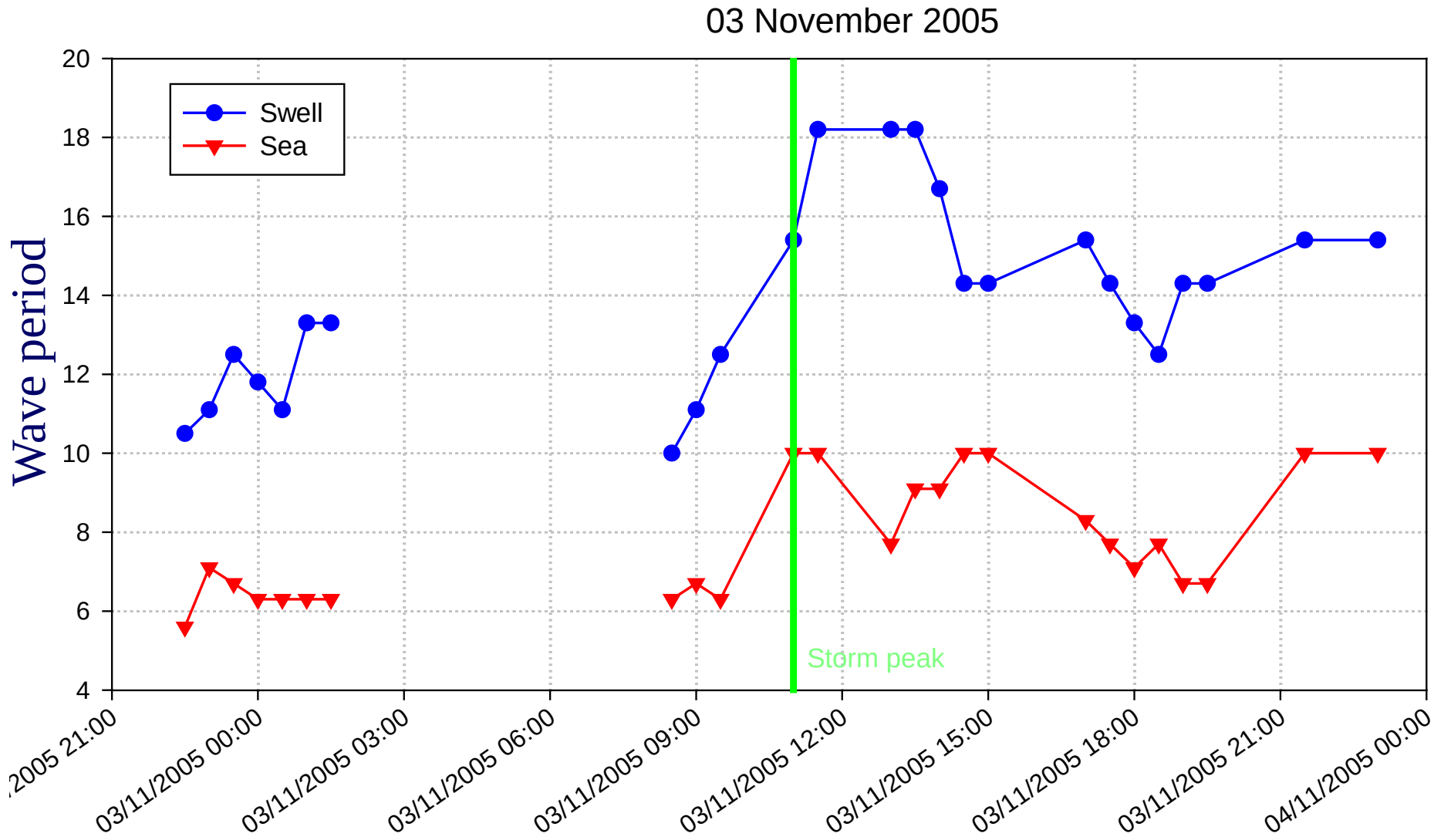
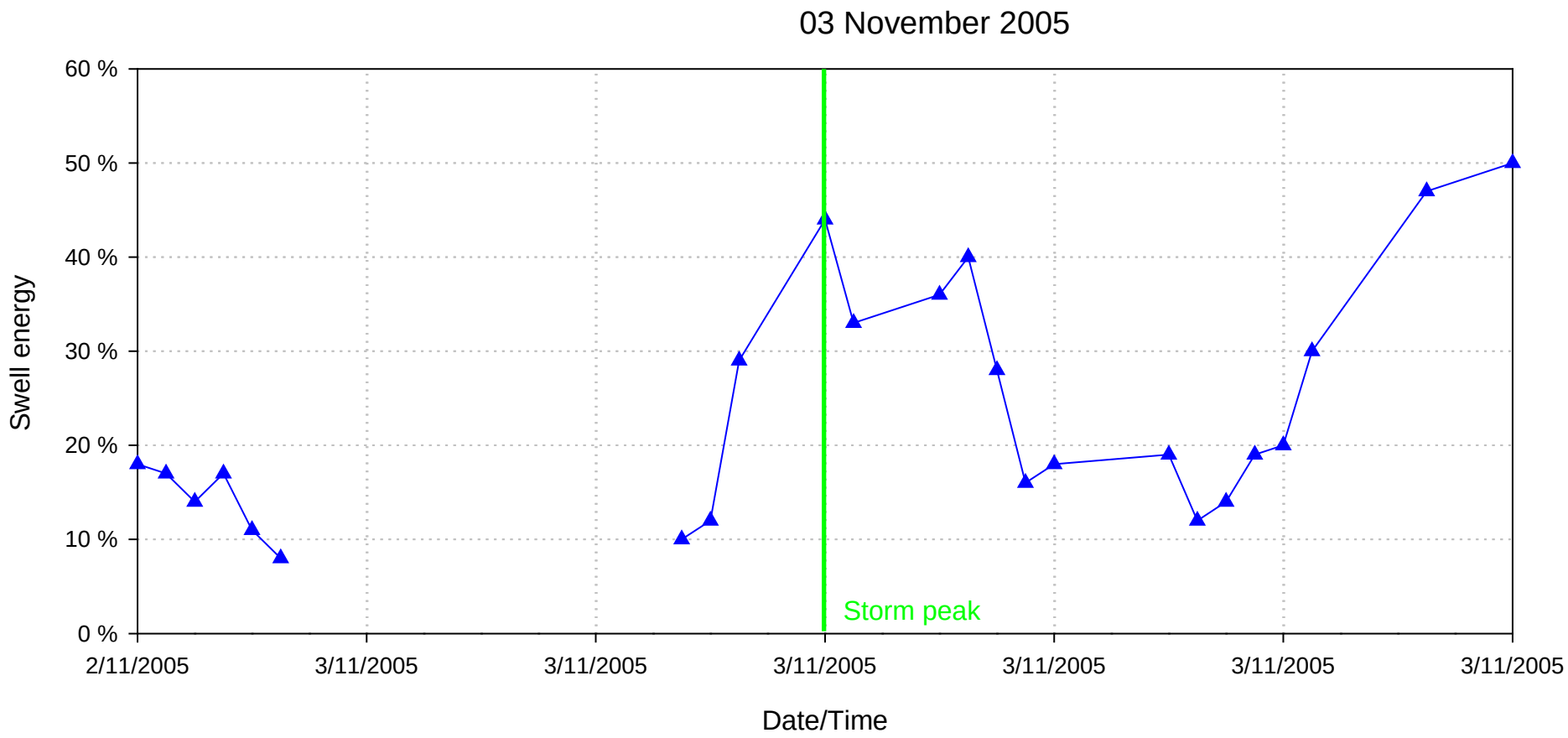
Wave period



Swell as percentage of total energy



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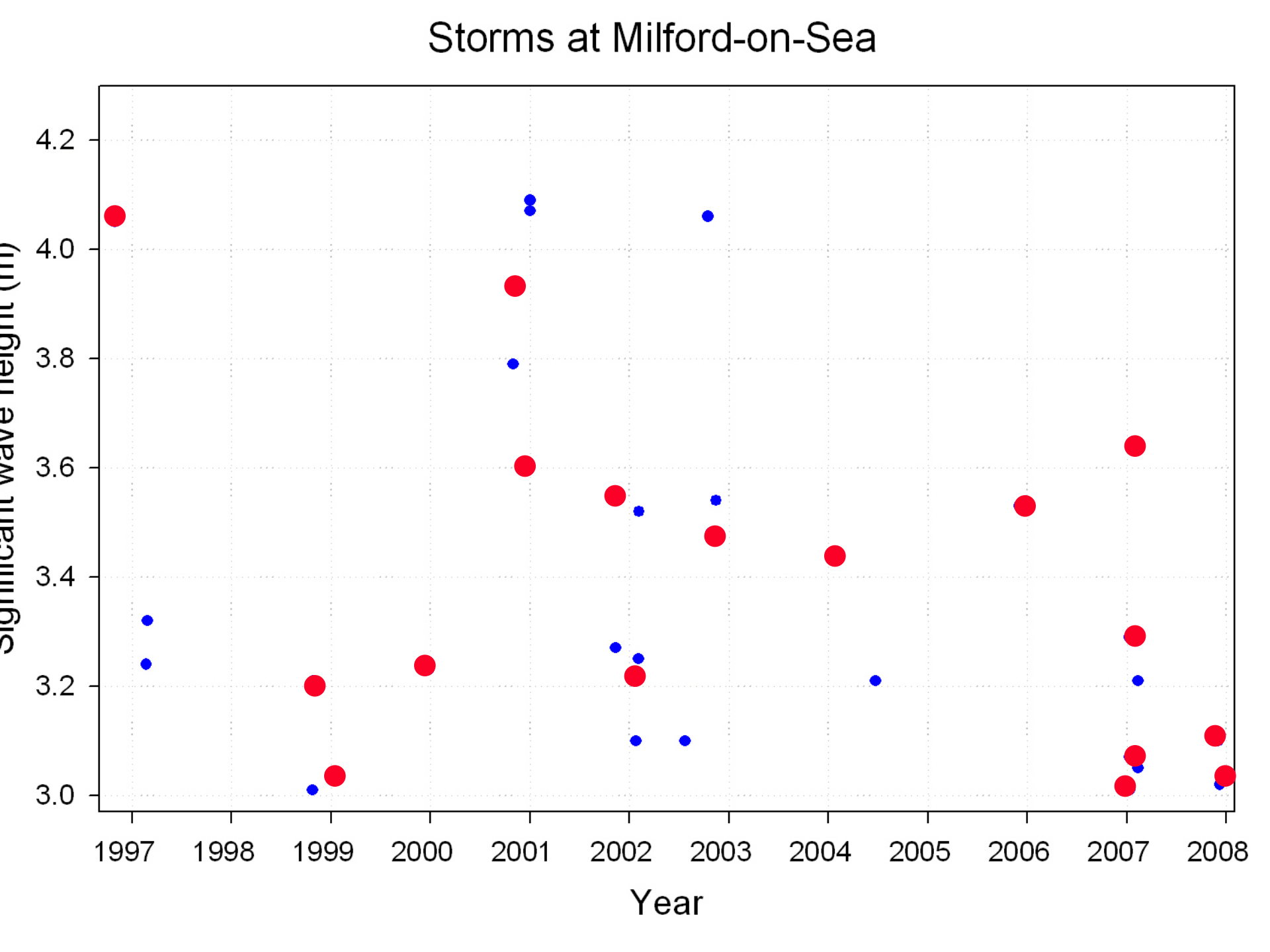
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Significant wave height (m)
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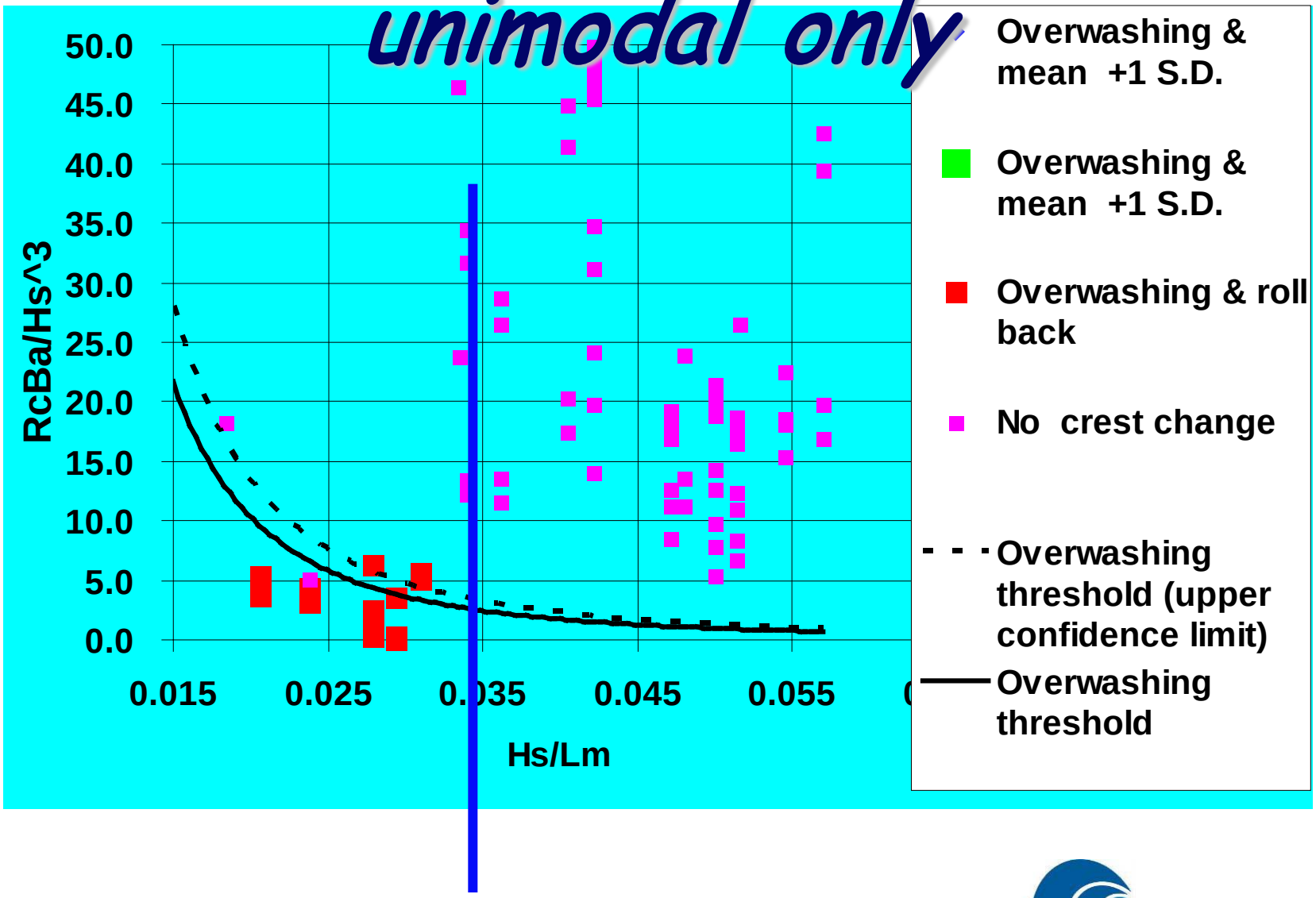
3.6
3.4
3.2
3.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year

Barrier inertia parameter unimodal only



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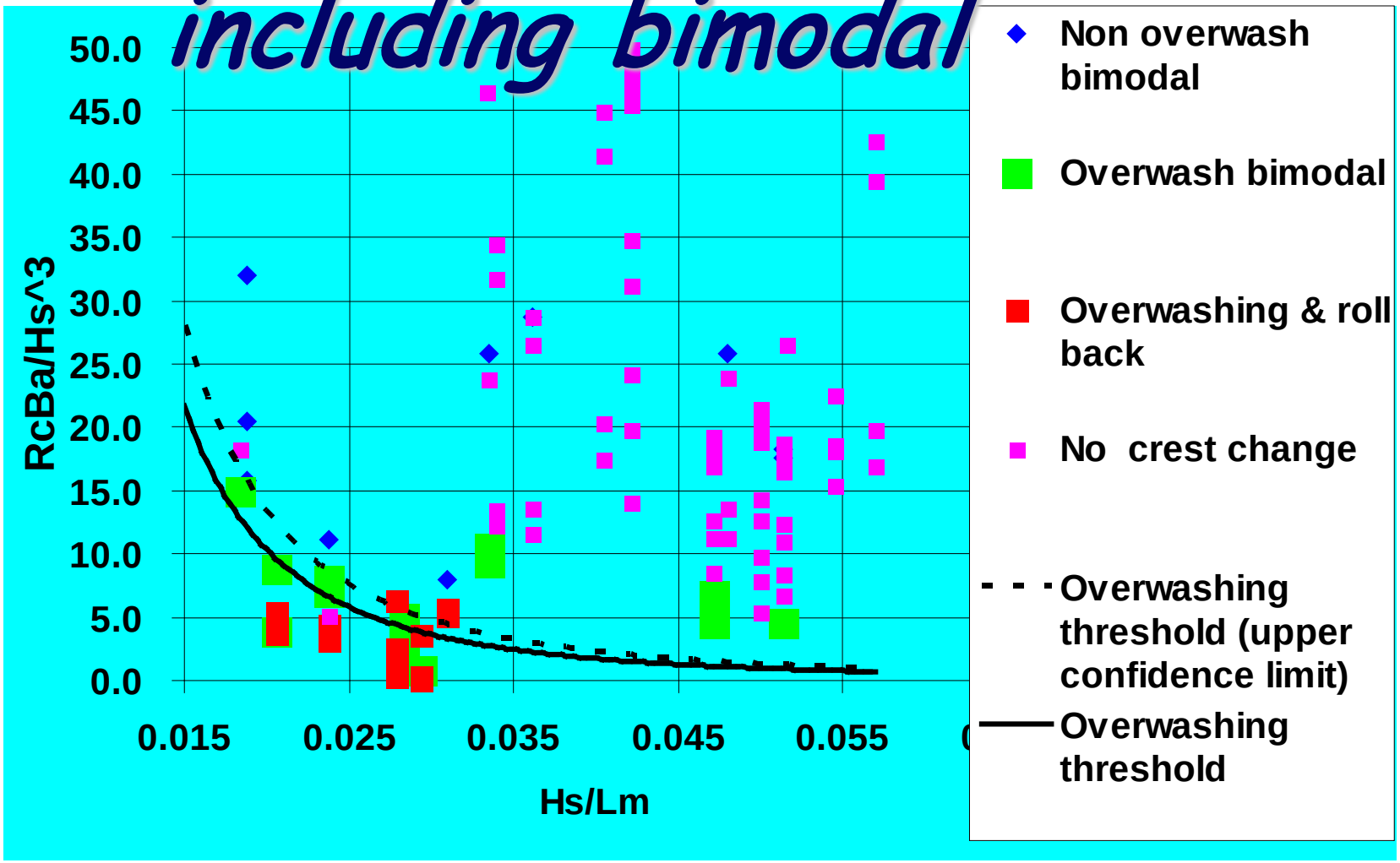
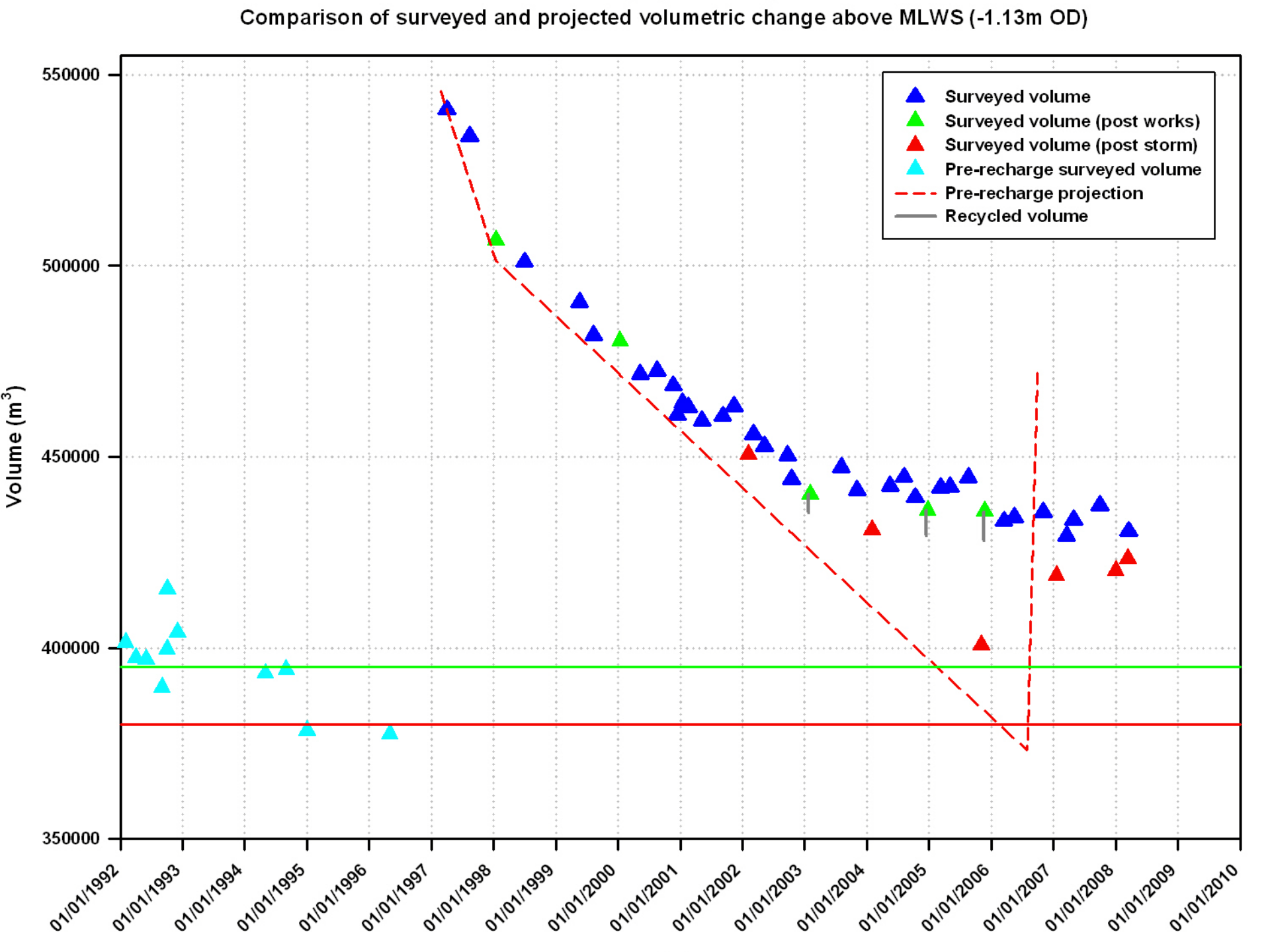
Barrier inertia parameter including bimodal



Impact on wave run-up and profile response (prelim. observations)

- Wave run up typically 1-2m higher than predicted by conventional models
- Crest typically 5-8m further landwards than predicted

- Implication – our beaches may be seriously underdesigned when considered in bimodal conditions
- This is a large scale regional problem


Comparison of surveyed and projected volumetric change above MLWS (-1.13m OD)
Volume (m3)
550000
500000
450000
400000
350000
01/01/1992
01/01/1993
01/01/1994
01/01/1995
01/01/1996
01/01/1997
01/01/1998
01/01/1999
01/01/2000
01/01/2001
01/01/2002
01/01/2003
01/01/2004
01/01/2005
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
Surveyed volume
Surveyed volume (post works)
Surveyed volume (post storm)
Pre-recharge surveyed volume
Pre-recharge projection
Recycled volume

Conclusions

- Wave conditions measured differ significantly from those modelled
- Design methods appear to provide an over simplification over natural conditions
  - Longshore
  - Crosshore
- Unexpected beach responses seem to be linked with bimodal wave conditions
  - Need for design variables to consider bimodal period
- Scheme performance better than projected