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**What a sudden shower reveals
about wind wave generation**

Rain on generative sea

or

are we sure the present physics is correct ?

(a discussion on something many people know)



Interest in waves exploded in 1942
with WW2 (1944, Normandy)

At the time the concept was only that
of H_s , T_m , mean direction

Then in 1952 Pierson and Marks suggested
the idea of spectral analysis for sea waves

This opened the door to mathematicians who
could work out 'simple' theories for wind
acting on a sinusoidal wave

Two theories proposed for wave generation
by wind, both in 1957:

Phillips – connected to turbulent wind

Miles – feed back between wind and wave,
the wave modifying the wind profile and
getting energy from the wind

Of course waves cannot grow indefinitely,
so a limit spectrum was conceived

This was rather artificial.

The general picture is that a wave field receives energy from the wind and loses energy by breaking (white-capping)

So in 1974 Hasselmann proposed an analytical expression for white-capping

A general picture of the physical situation.

Wave growth is a delicate balance (small difference) between two large quantities:

- 1) input by wind
- 2) loss by white-capping

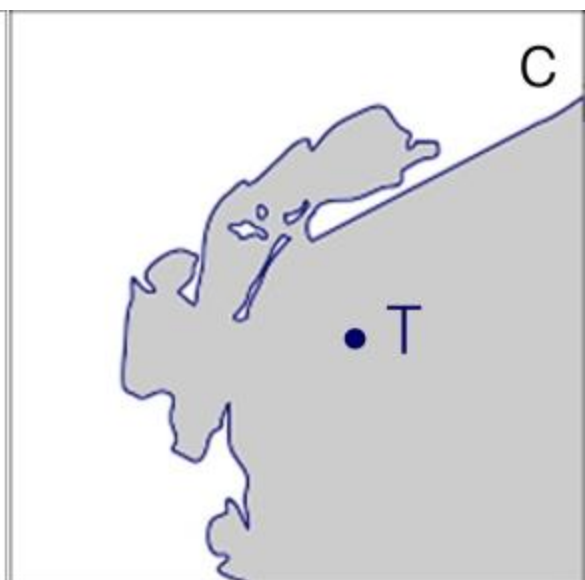
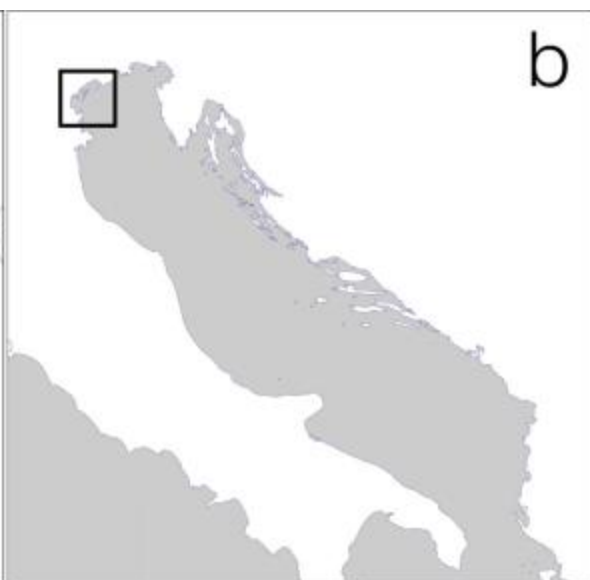
When we look at an active wind sea, 90-95% of the momentum, energy passed by wind to waves is rapidly lost by white-capping, so wave growth is estimated as a small difference between two large quantities

The problem is that we still do not have a satisfactory theory of white-capping.

Because we assume to know well the input by wind, white-capping has been for a long while the tuning knob of the system

The last piece of information is
what is a wave model:

it is a deterministic model
of statistical properties of the wave field





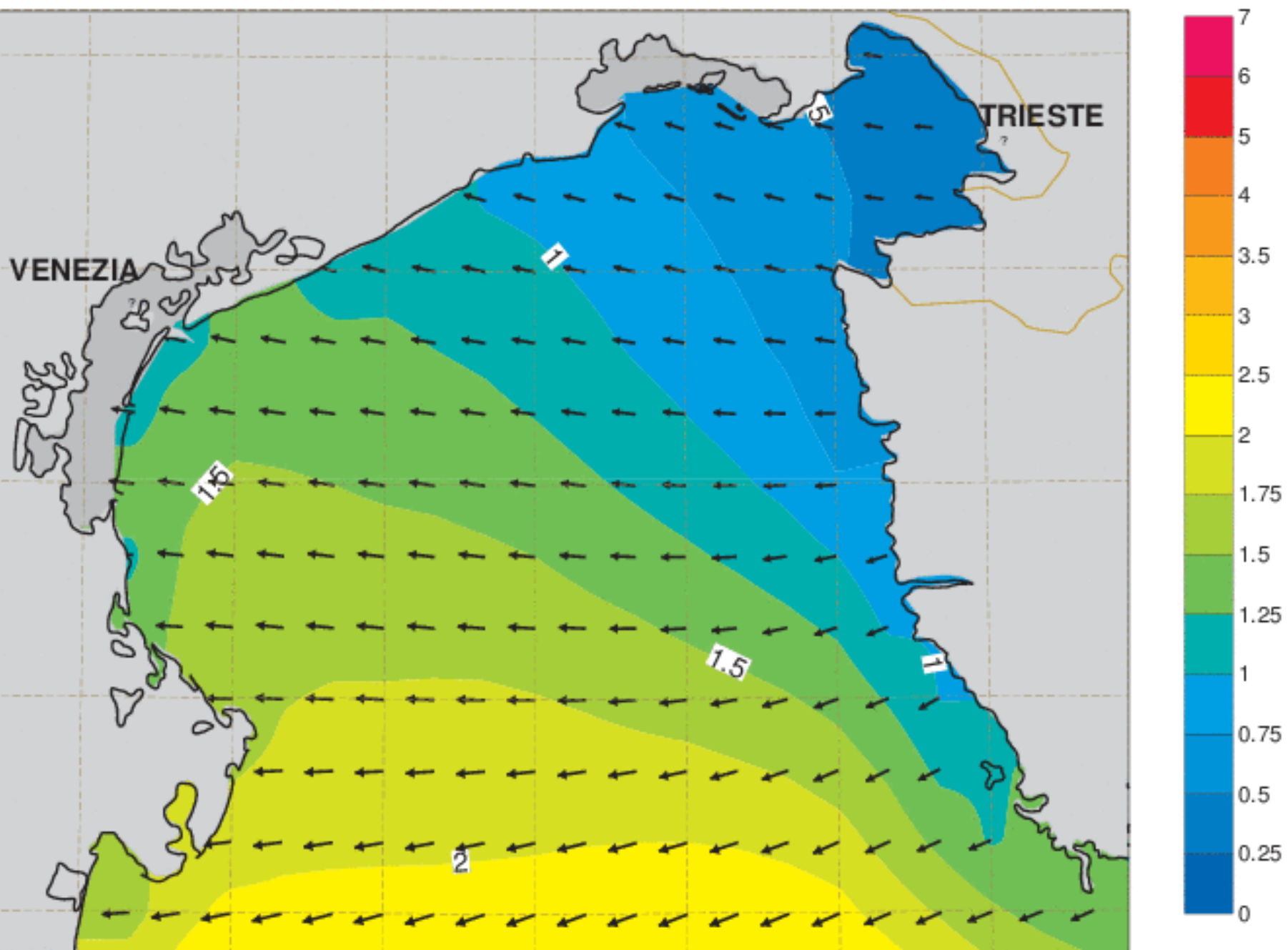






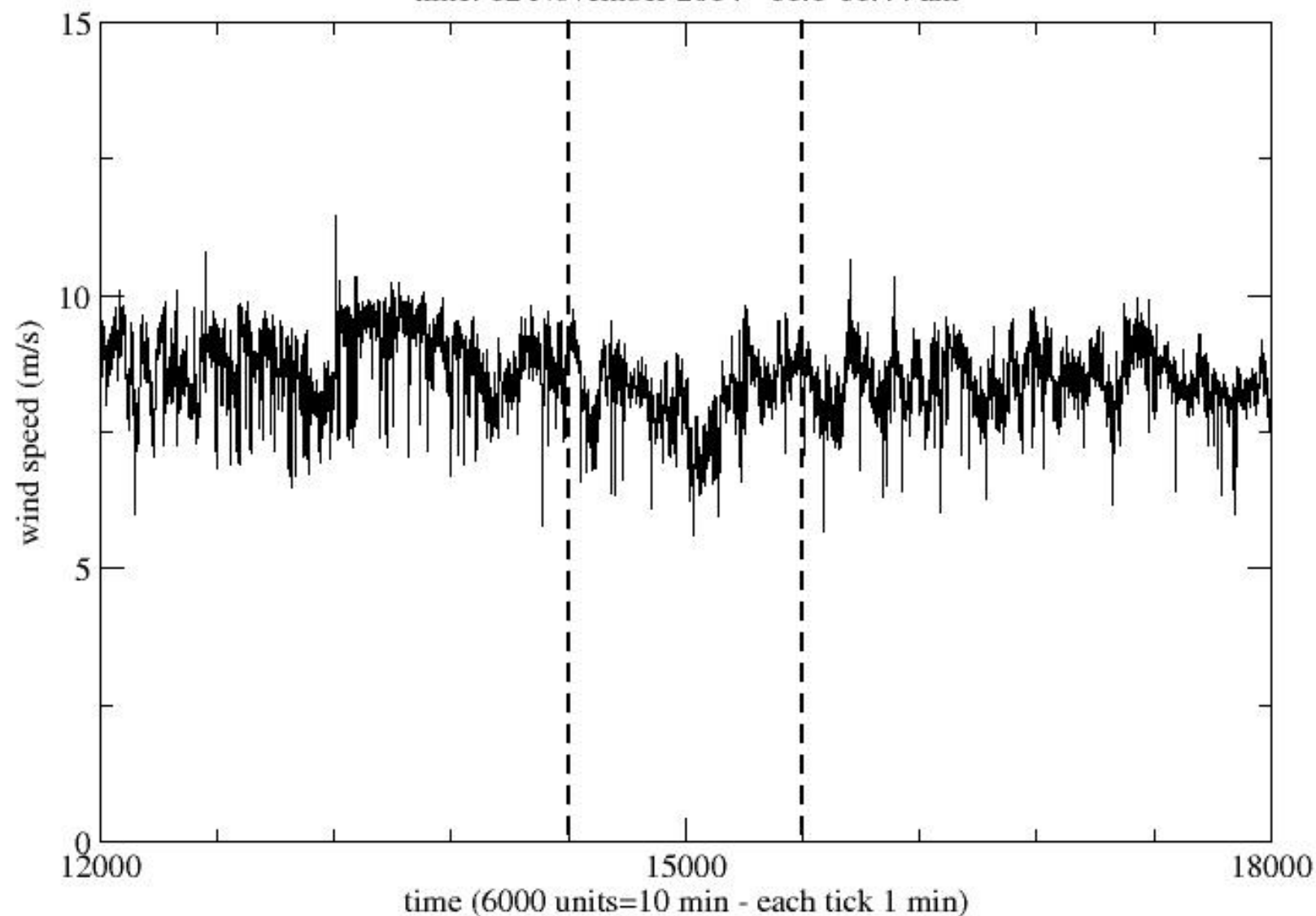






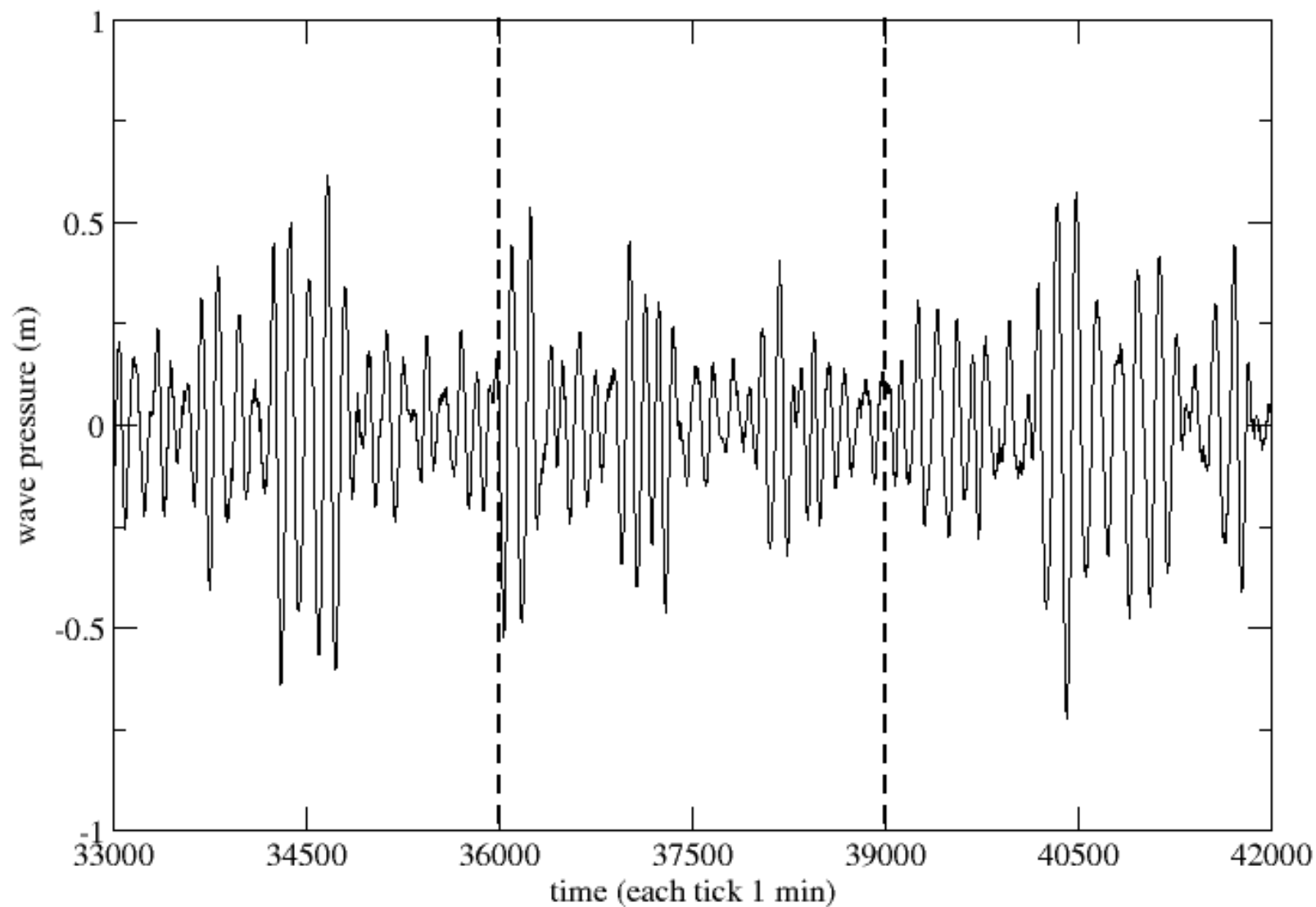
wind speed ISMAR oceanographic tower

time: 12 November 2014 - 11.1-11.44 am

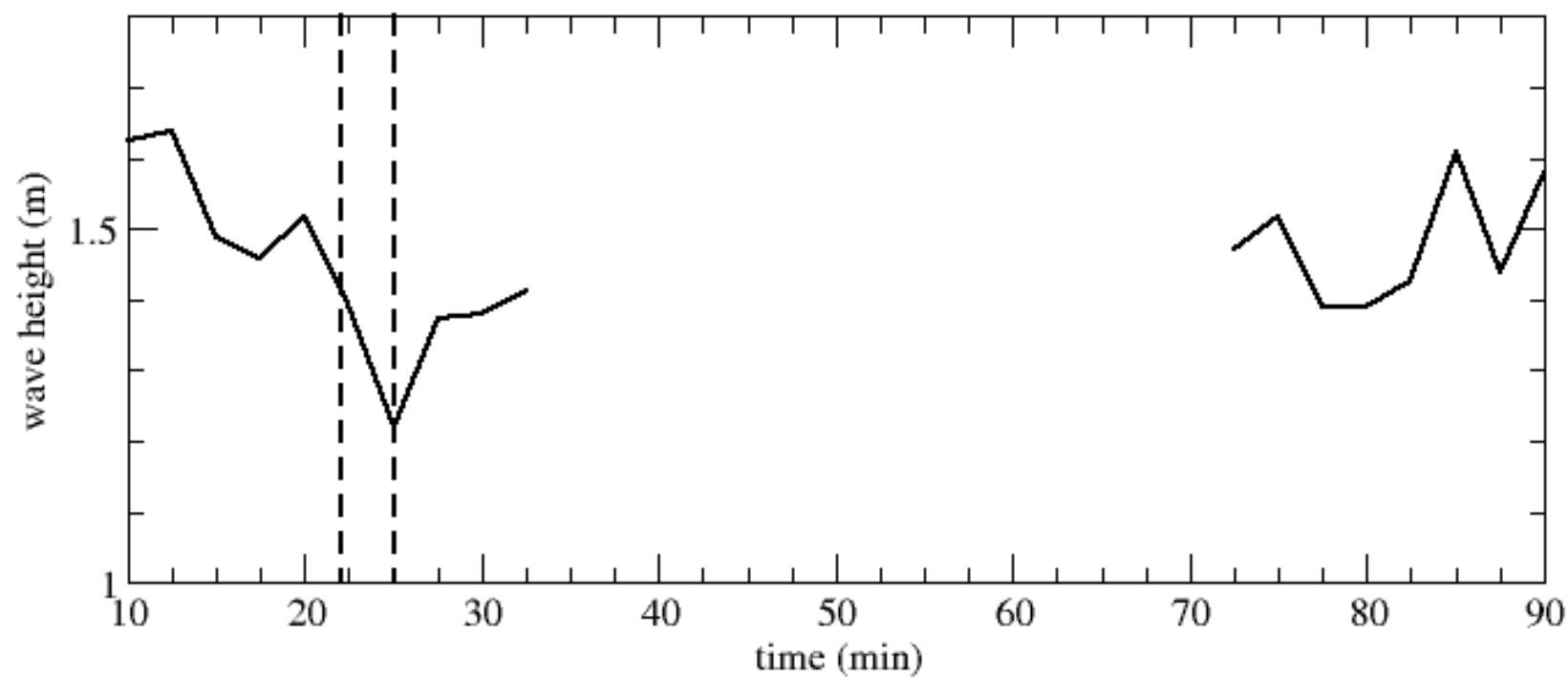


wave pressure ISMAR oceanographic tower

time: 12 November 2014 - 11.1-11.44 am

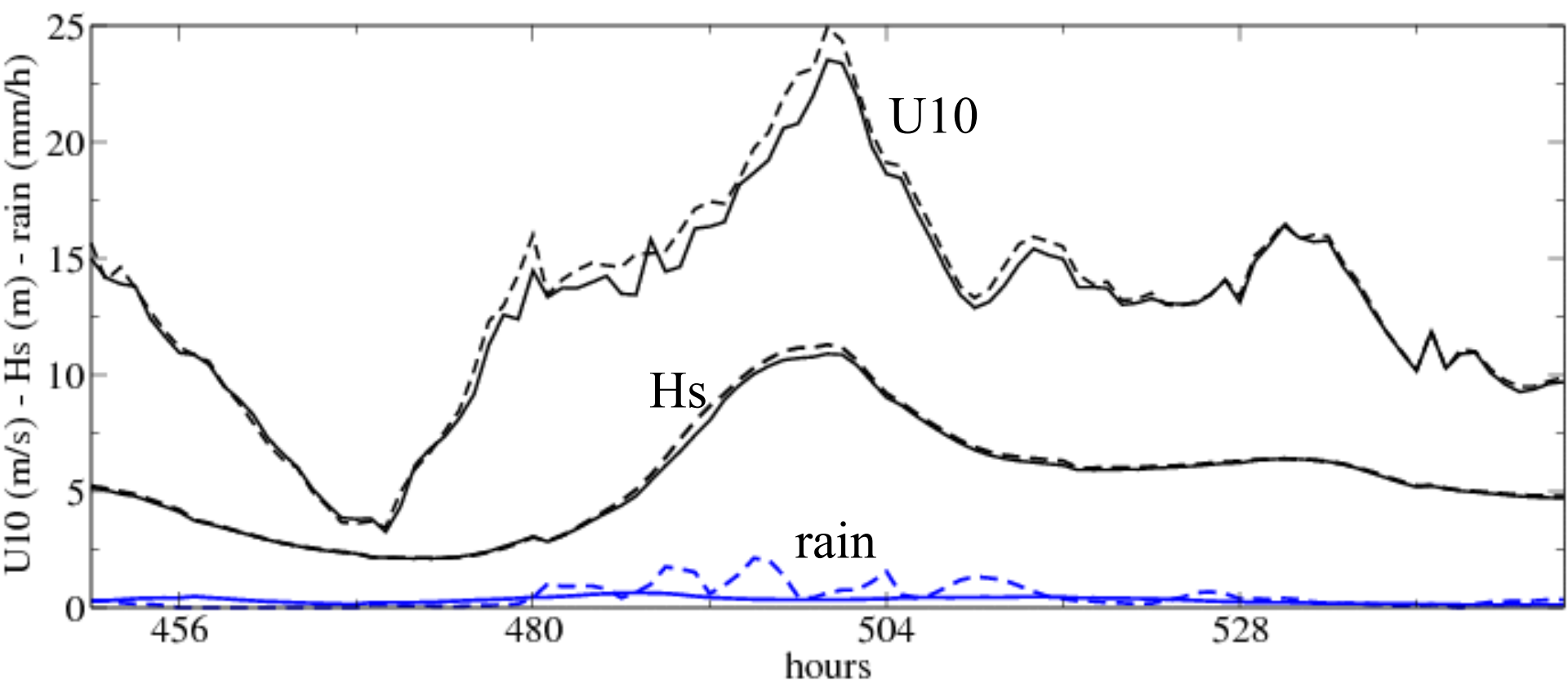


Hs on 12 November 2014



wave conditions are a dynamical equilibrium
among the situation, wind input, dissipation
(NL on a longer time scale)

- wind is actively blowing (4-5 s wave, wind 9 m/s)
- if we cancel the dissipation, waves should grow quickly
- this was not the case; H_s actually decreased
- conclusion: there was no input by wind



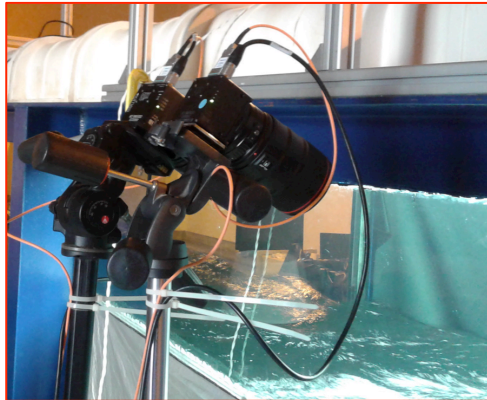
The 'footprint' of a whale
(whales sweeping biomaterial to the sea surface)



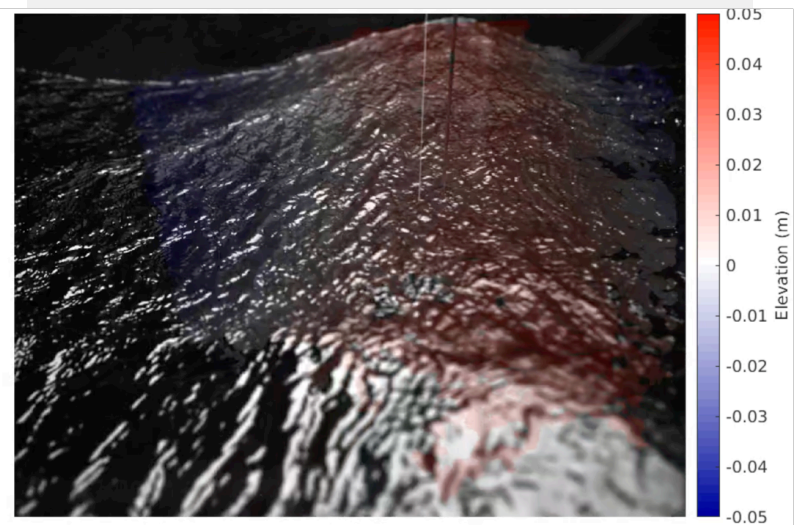
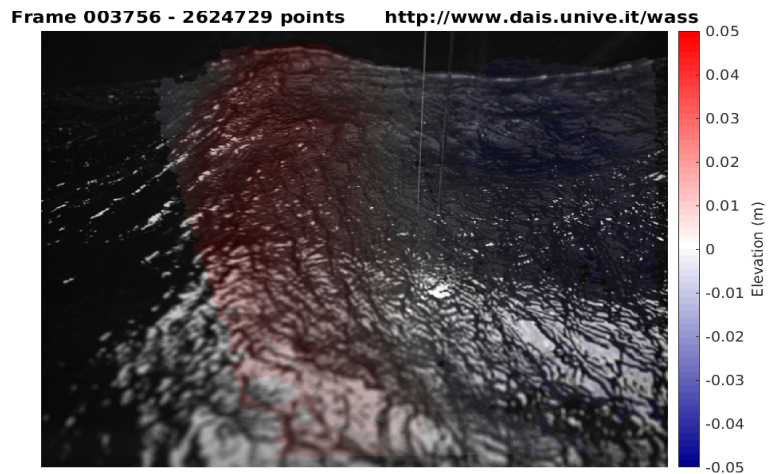
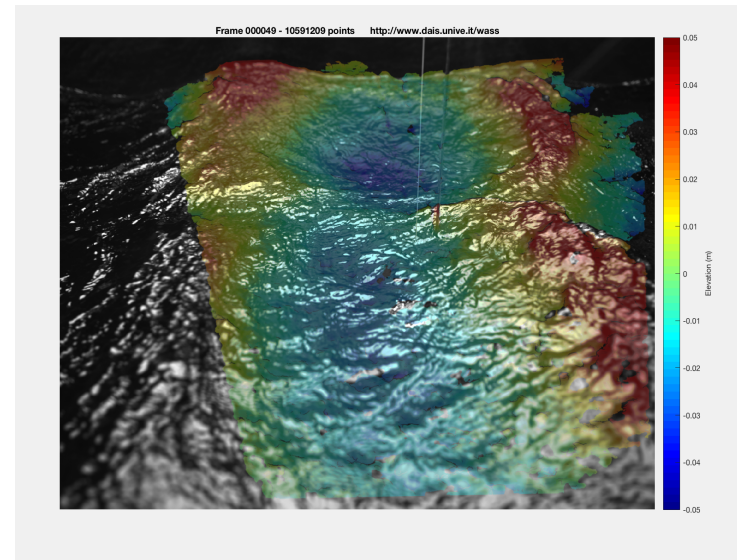
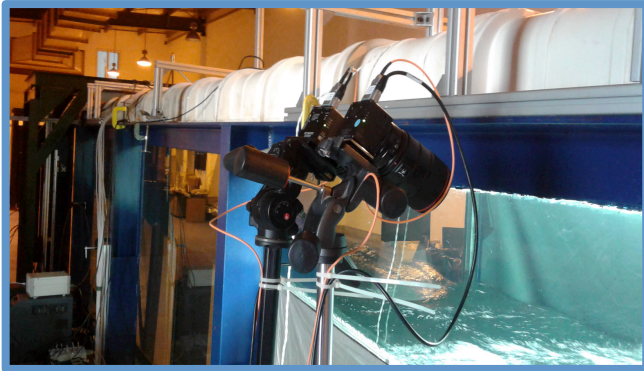
Context

➤ Experiments in a wind wave-paddle tank at the FIO, Qingdao (China)

- Wind fan + paddle
- Wave gauges (4)
- Pitot tubes (5)
- Stereo system (WG-4)

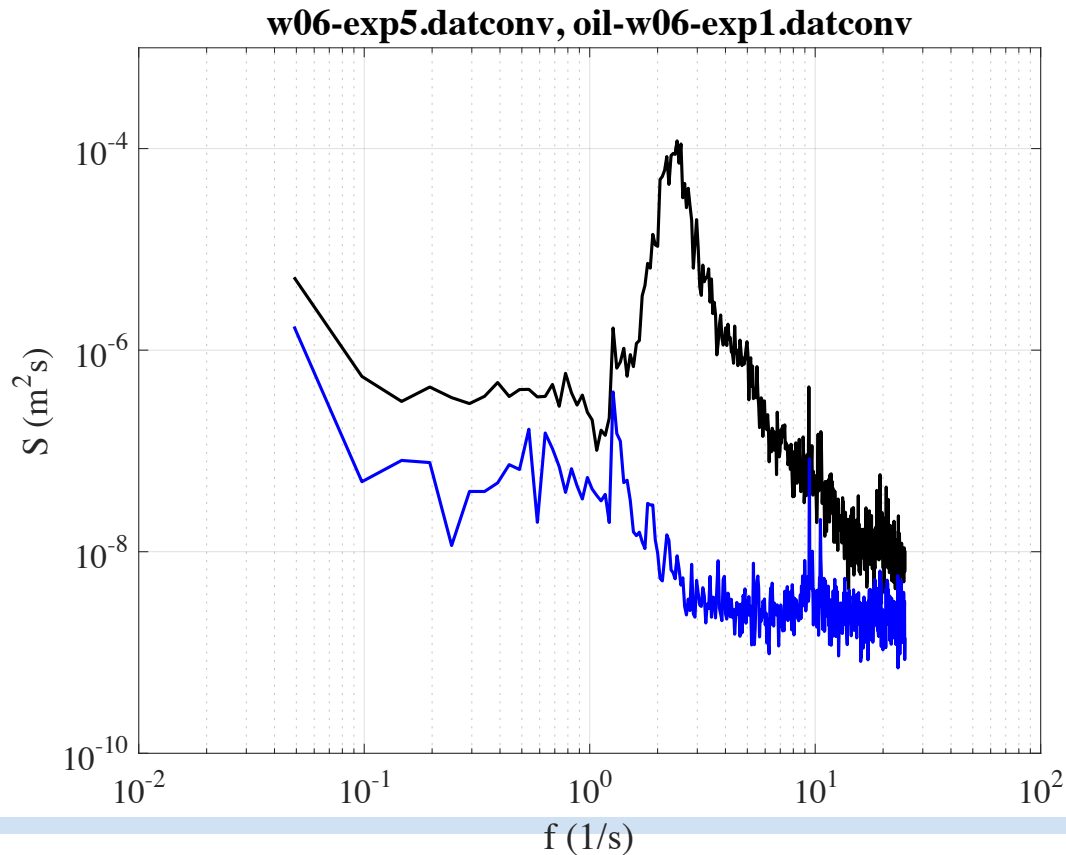


Stereo wave imaging @ FIO

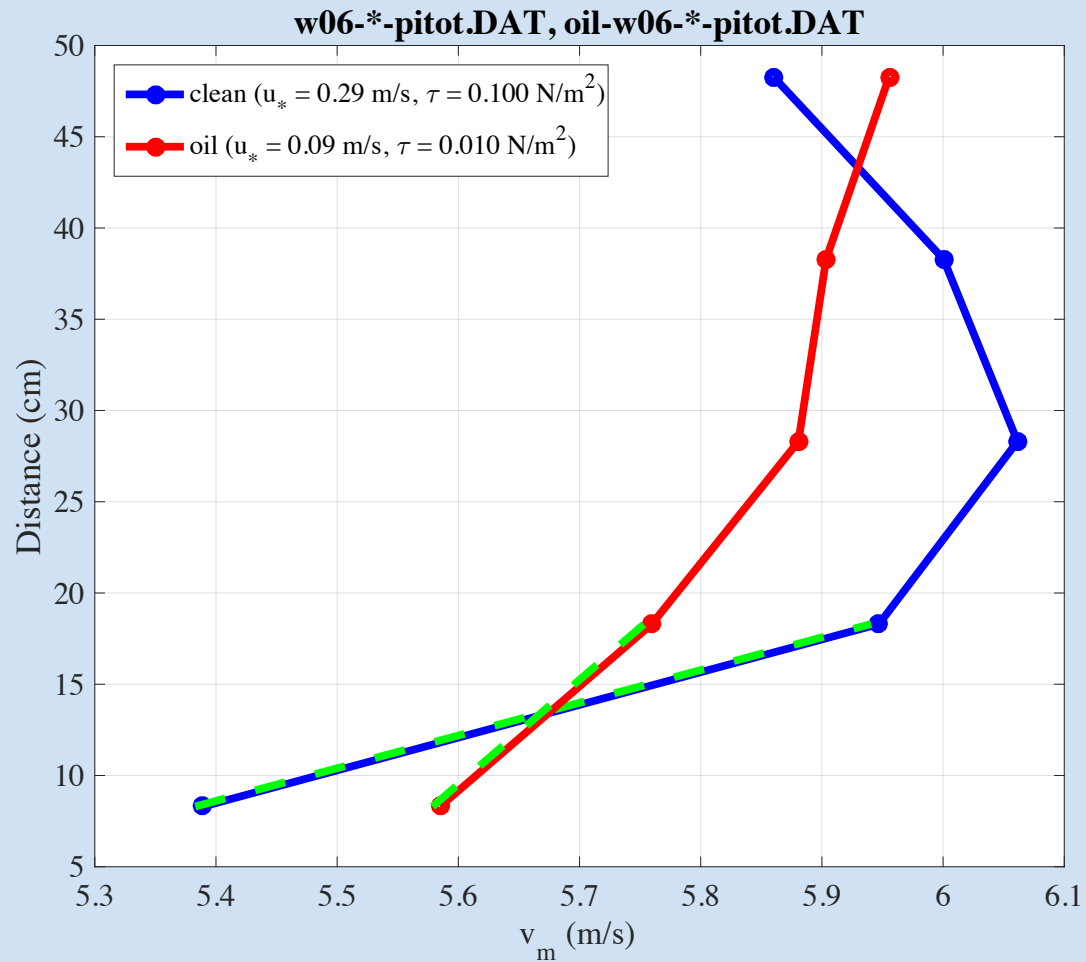


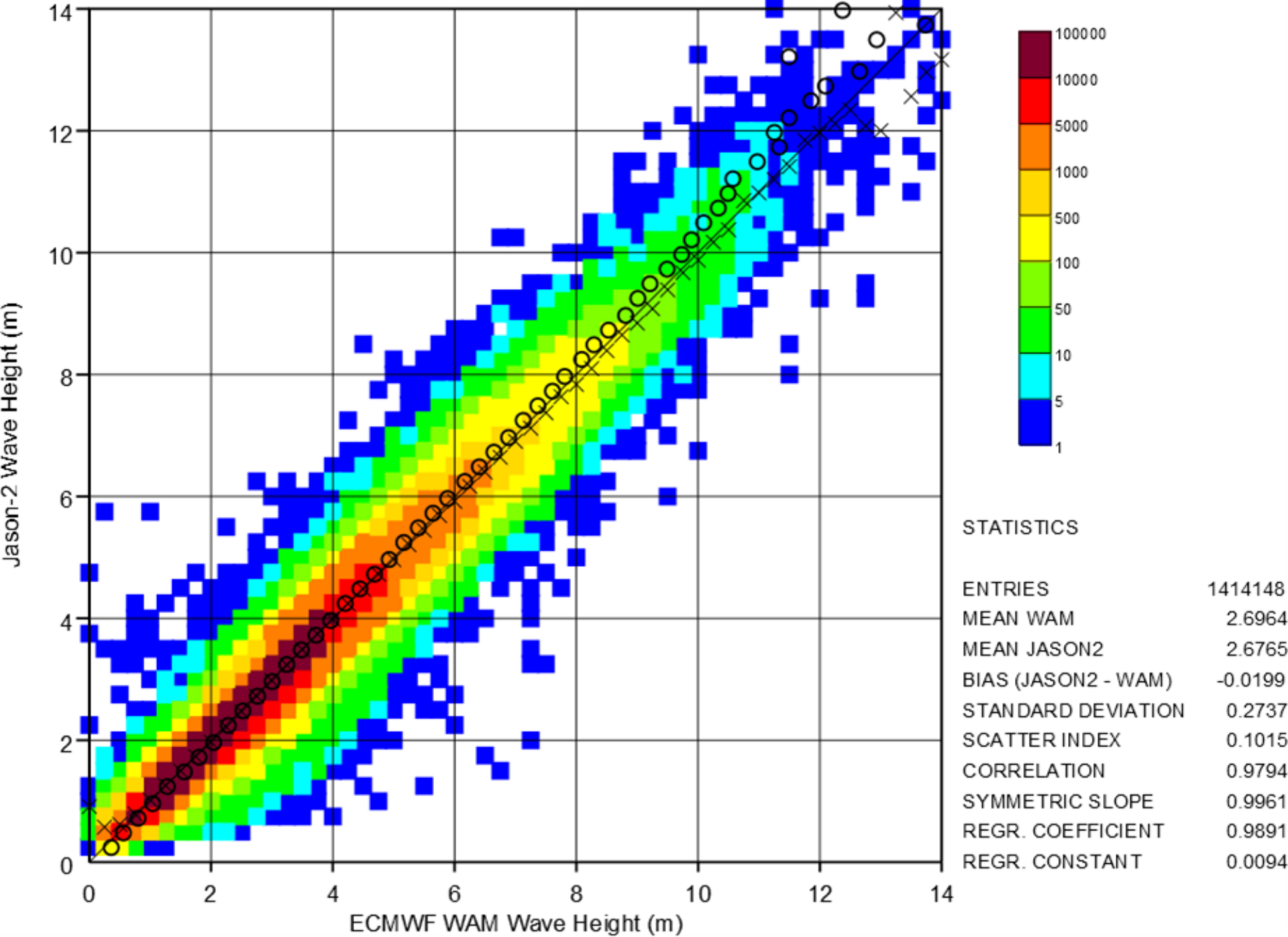
Suppression of the wave energy

→ WIND + OIL: No energy at all
frequencies (flat spectrum)



Stress on the airflow





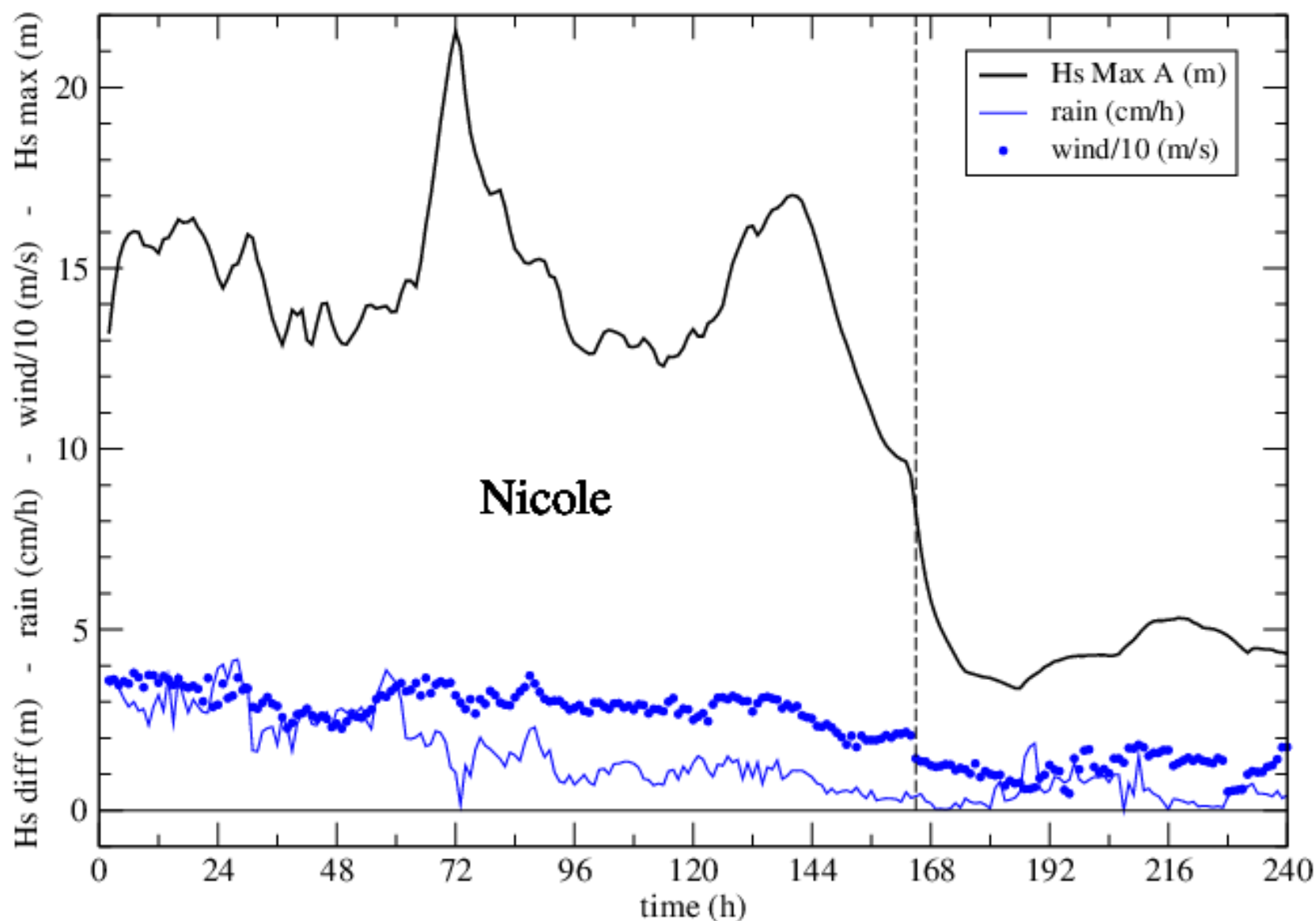
Do good results imply a model is correct,
or, in other words:
are we sure the model physics is correct?



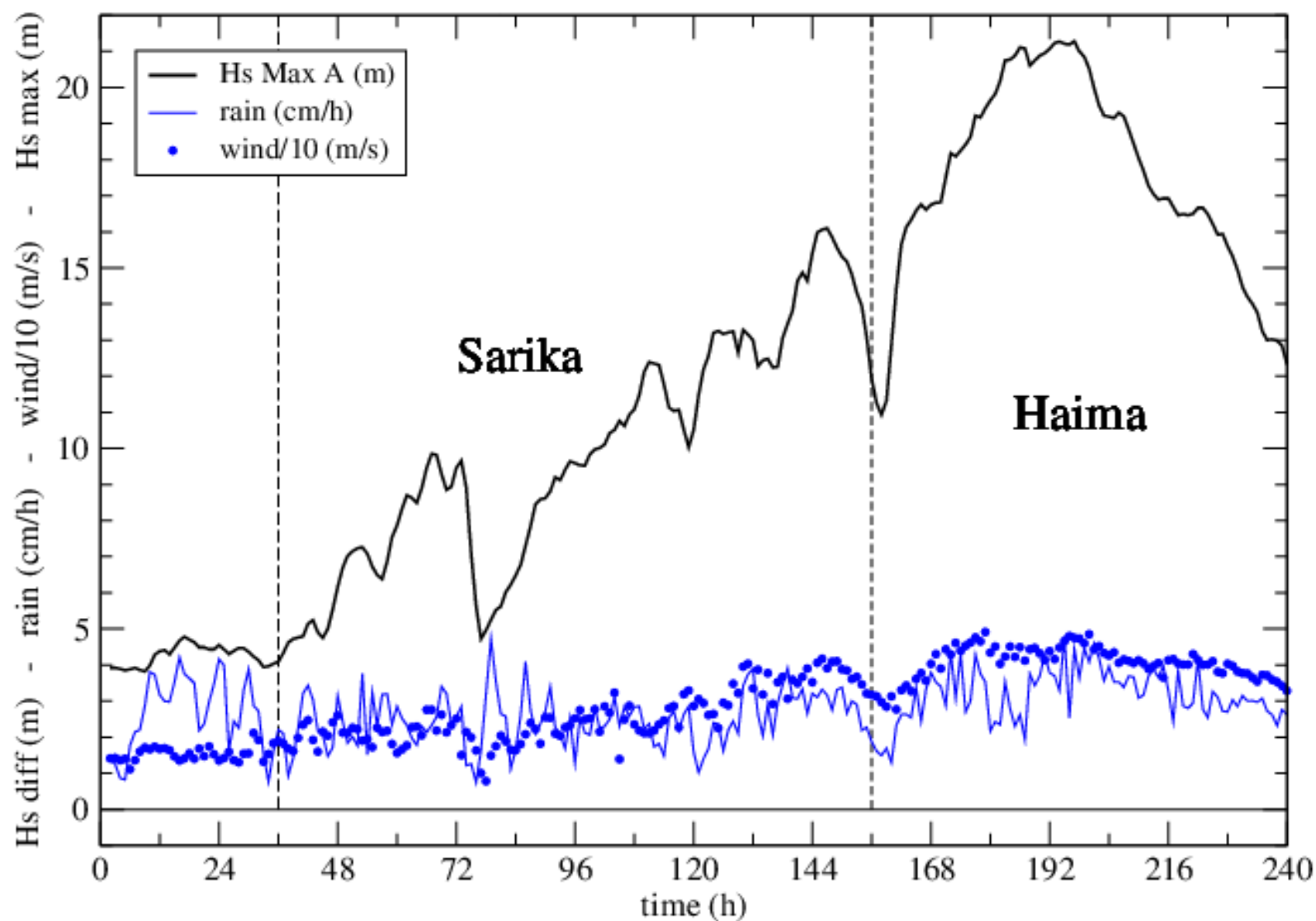
Basic point:

under strong rain both white-capping and
input by wind disappear

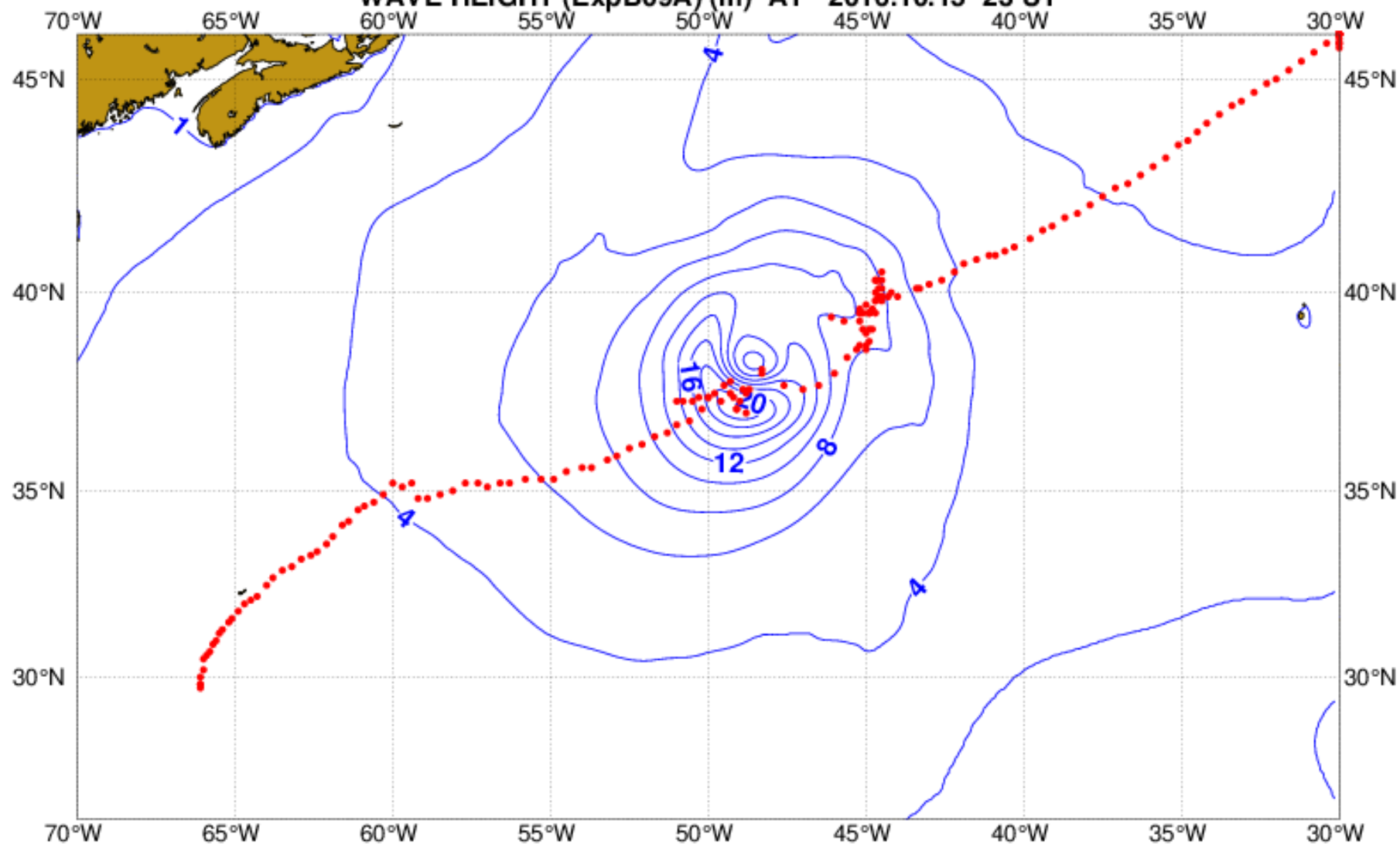
significant wave height - wind - rain
hurricane Nicole - 13-23 Oct. 2016



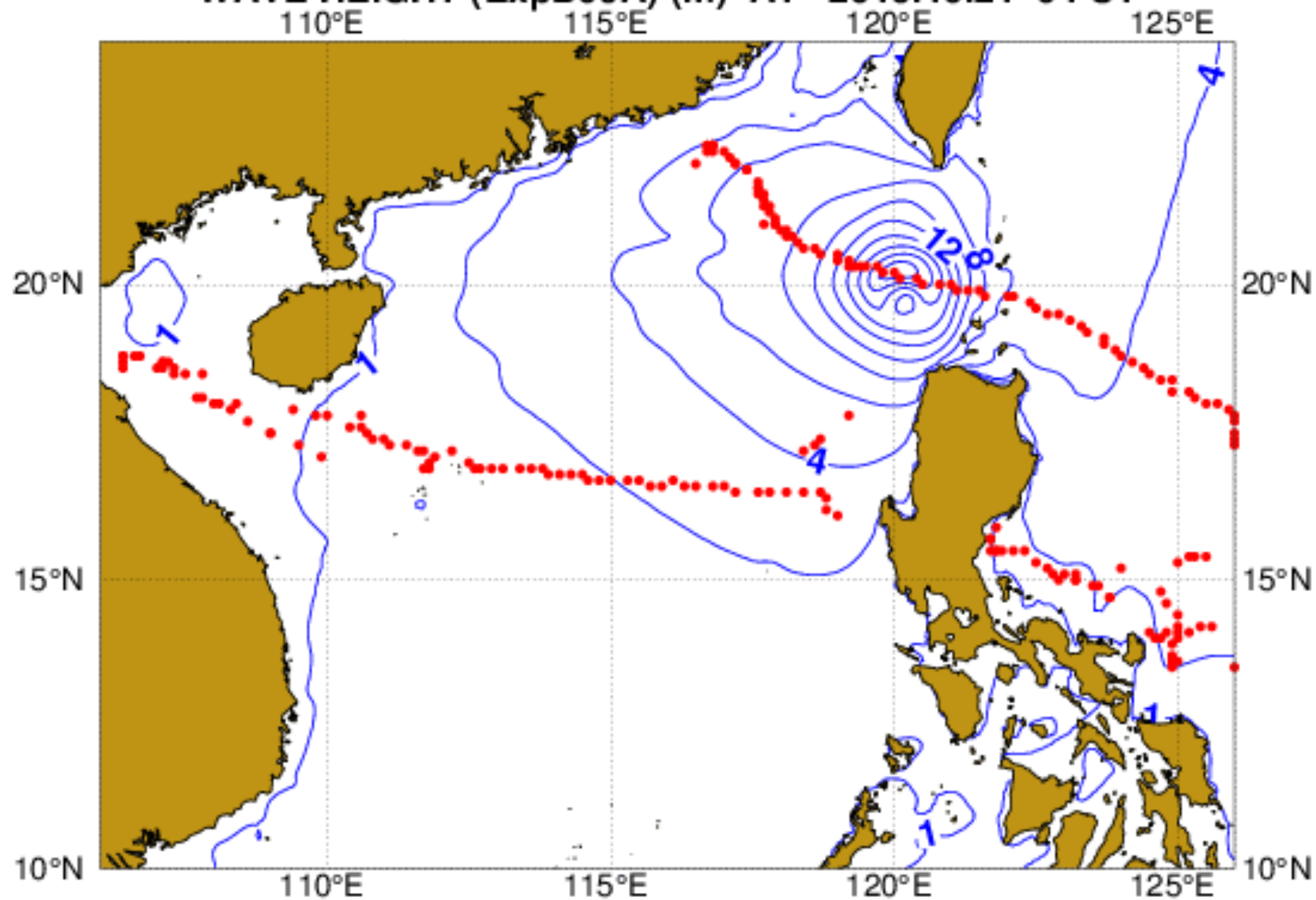
significant wave height - wind - rain
typhoons Sarika & Haima - 13-23 Oct. 2016



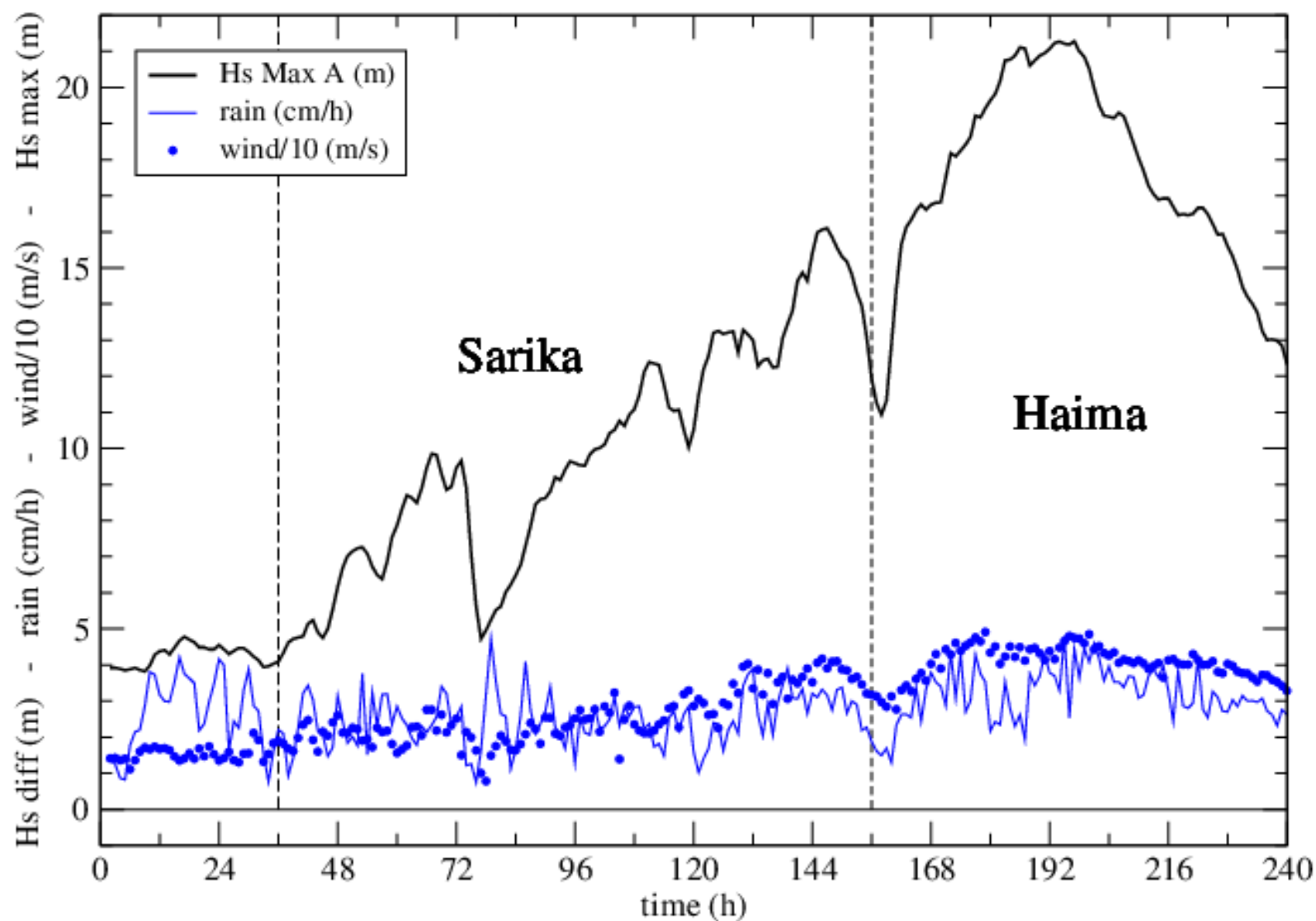
WAVE HEIGHT (ExpB09A) (m) AT 2016.10.15 23 UT



WAVE HEIGHT (ExpB09A) (m) AT 2016.10.21 04 UT



significant wave height - wind - rain
typhoons Sarika & Haima - 13-23 Oct. 2016



Sin Swc

$$Sin = Sin[1 - rain/r1]$$

$$Sin = Sin[1 - (rain/r1) * (U10/U1)]$$

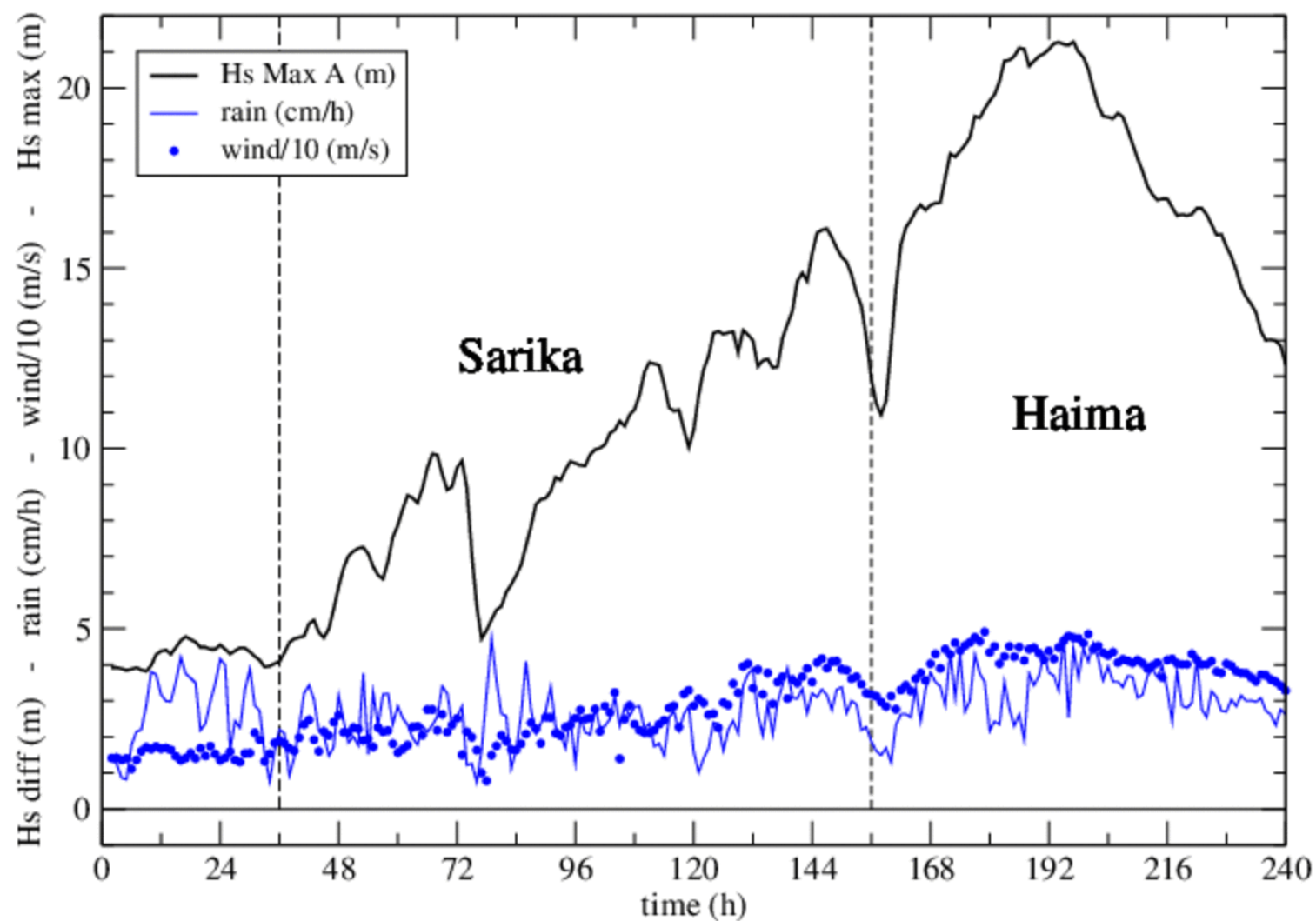
$$Swc = Swc[1 - (rain/r2) * (U10/U2)]$$

we have explored various ranges of values:

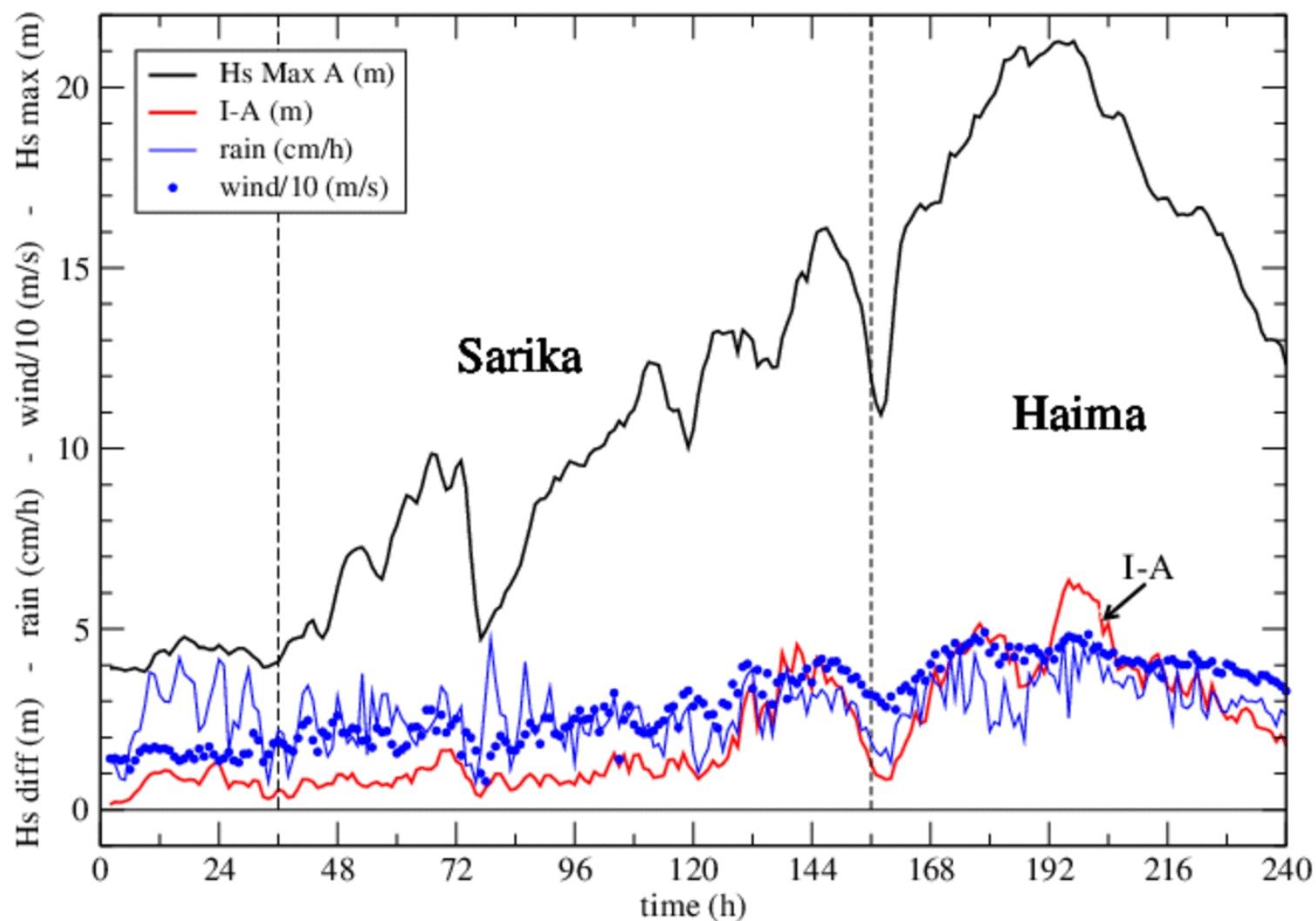
r1, r2 60-100 mmh-1

U1, U2 60-80 ms-1

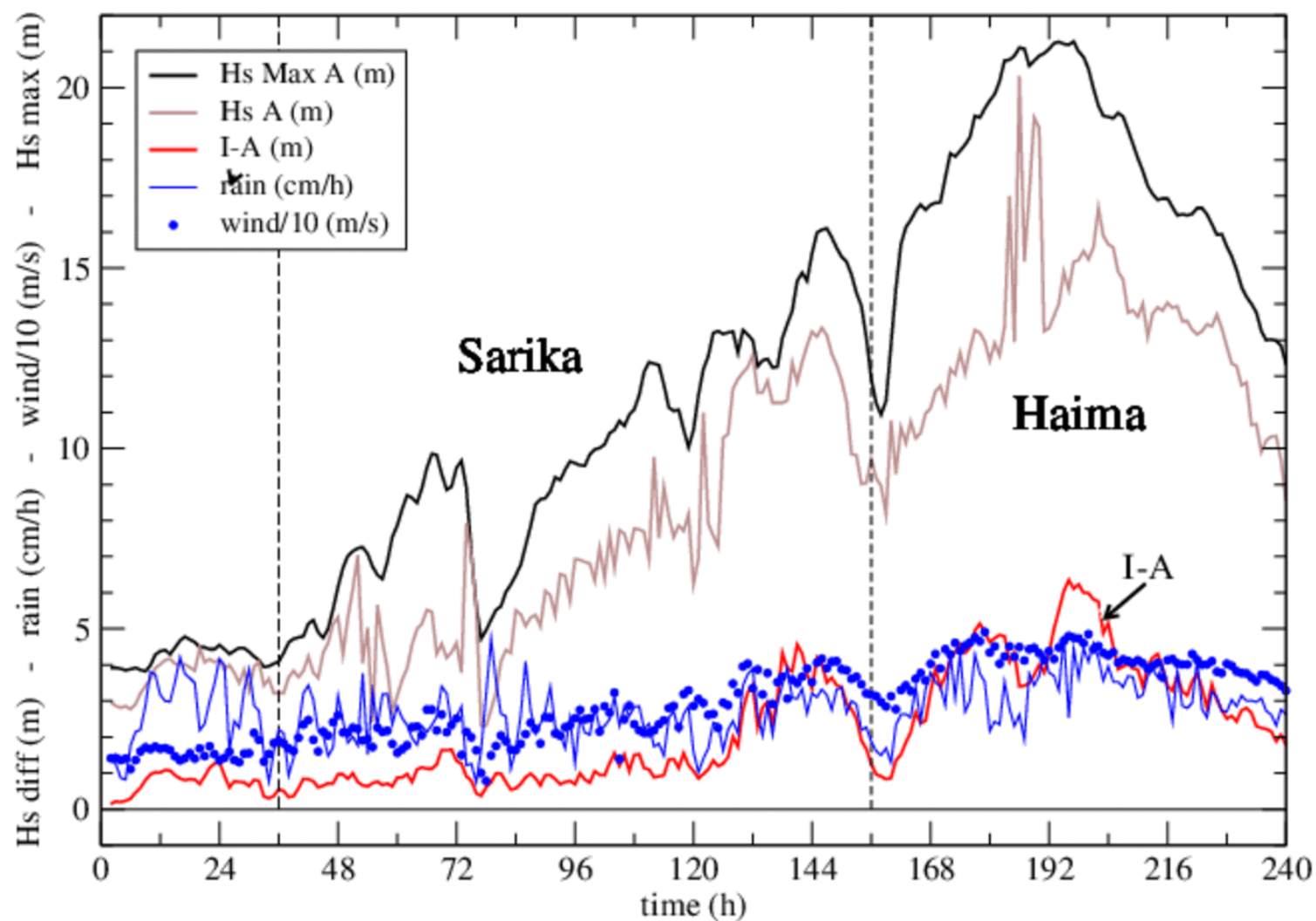
significant wave height - wind - rain
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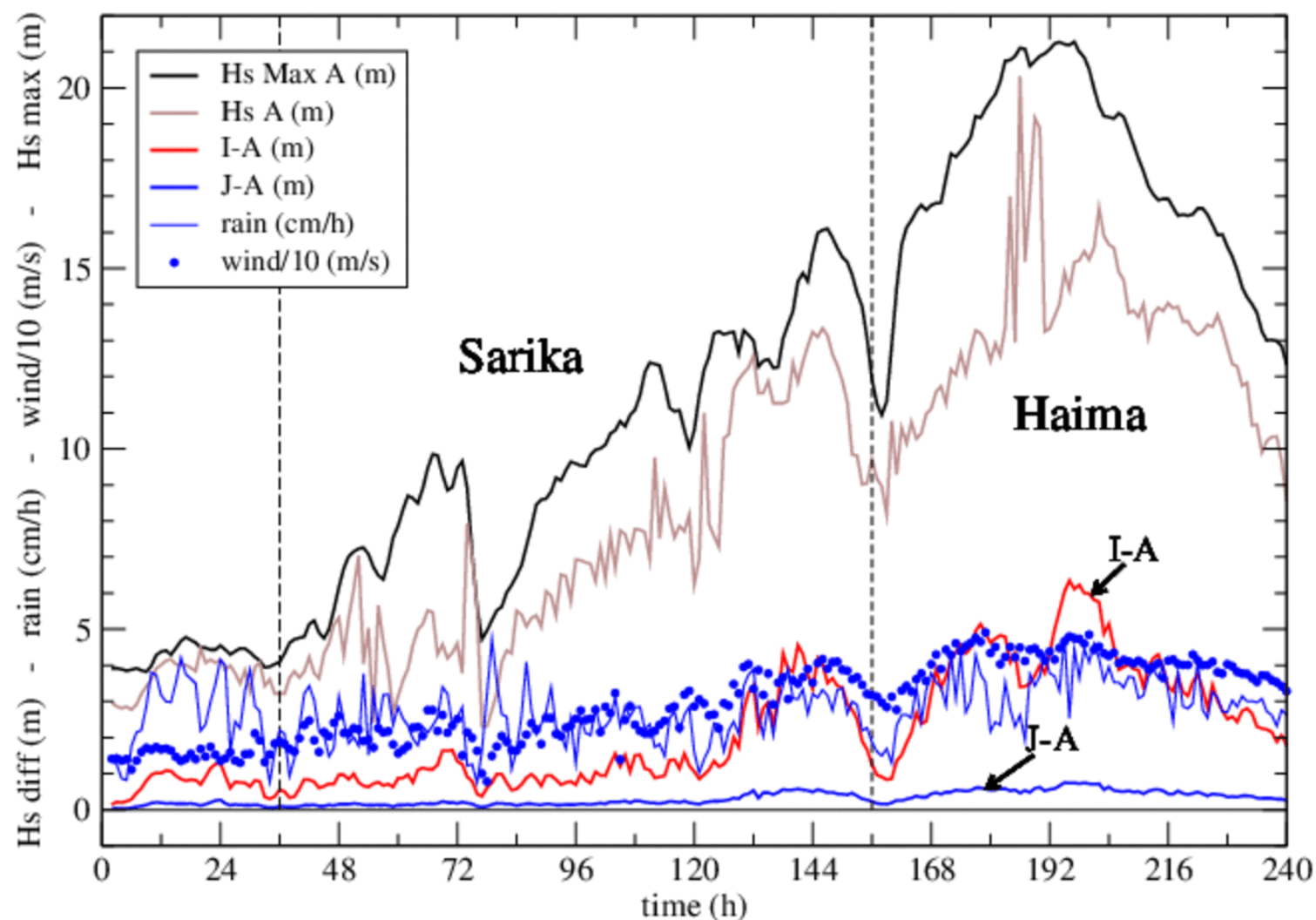
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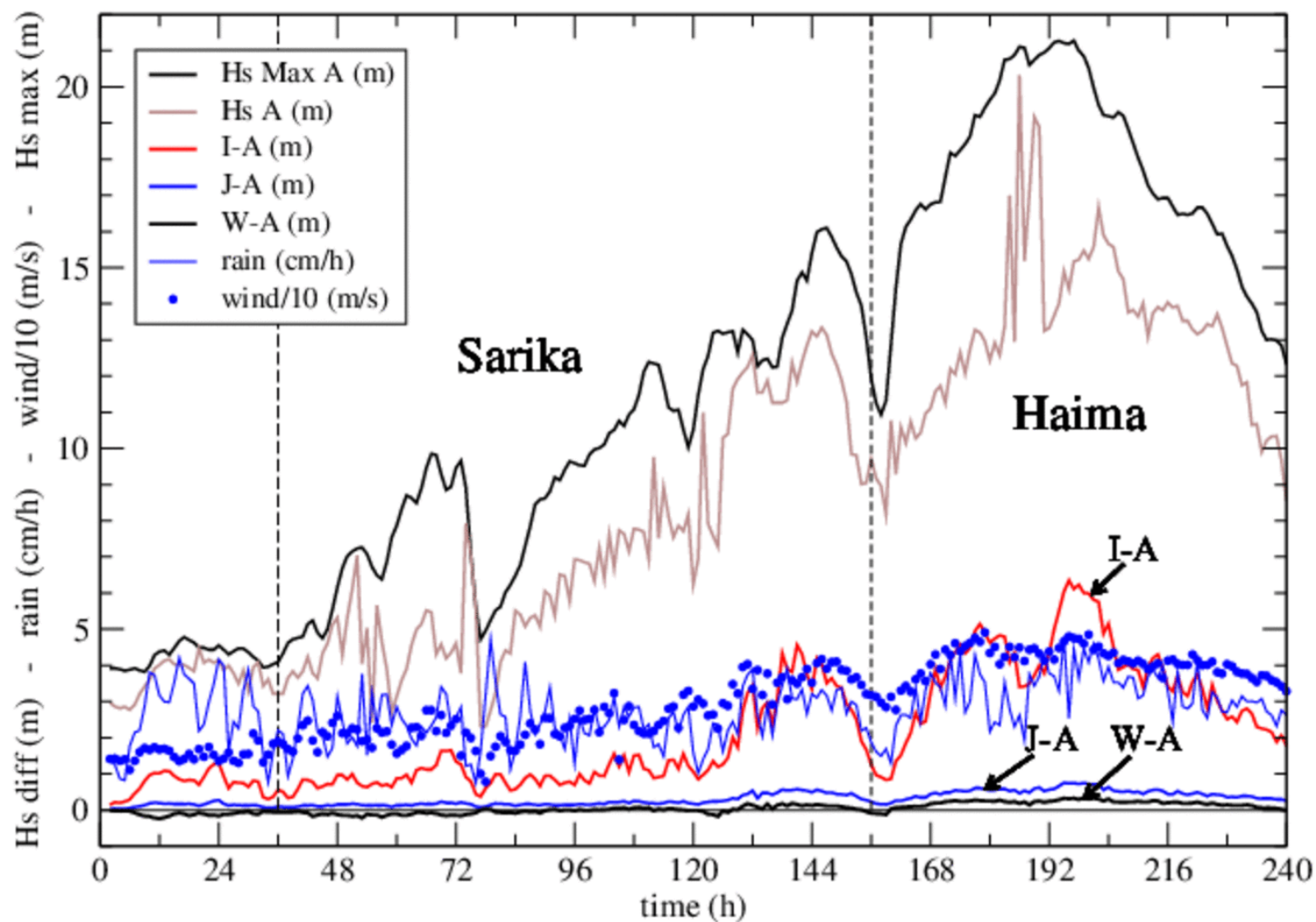
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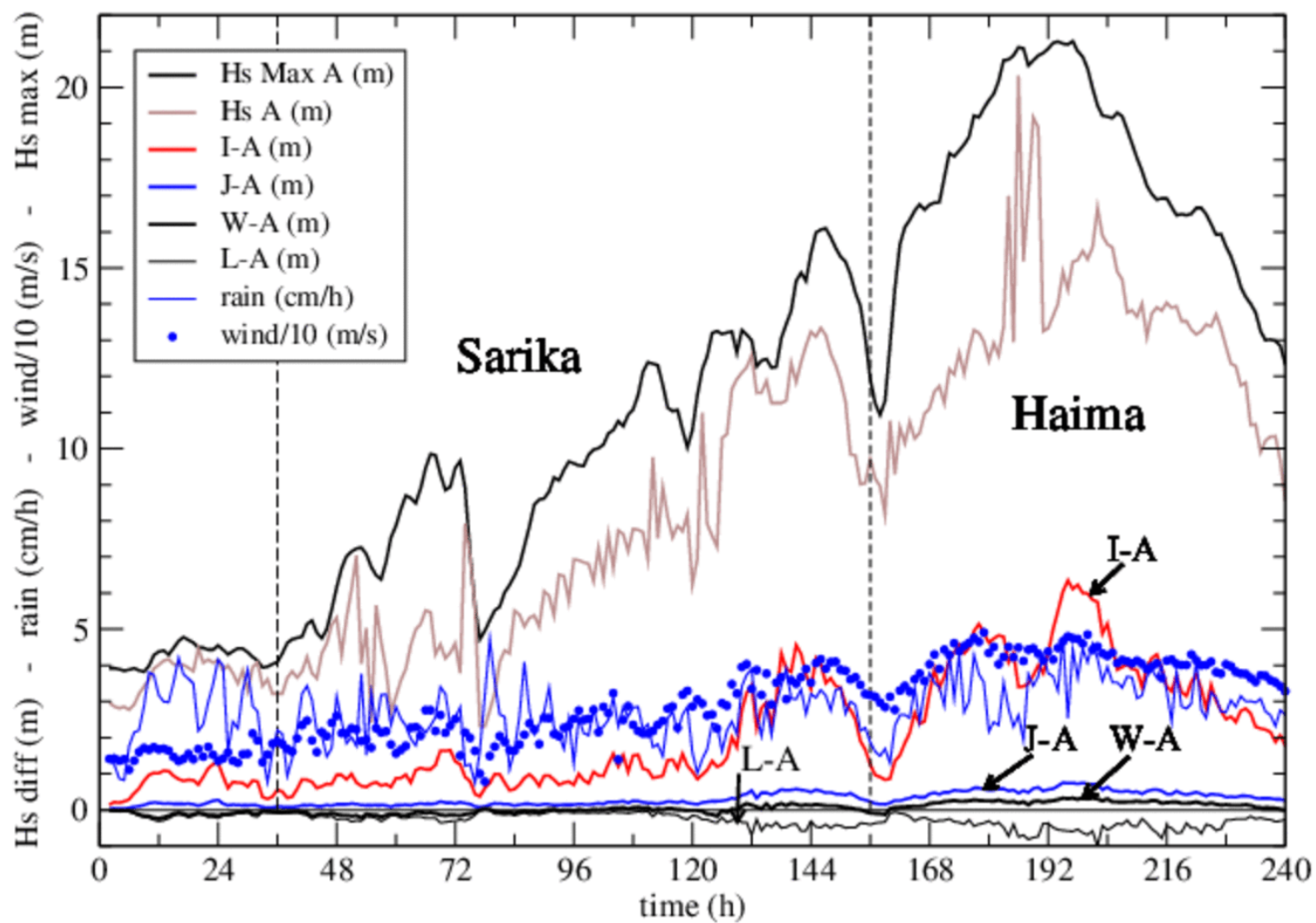
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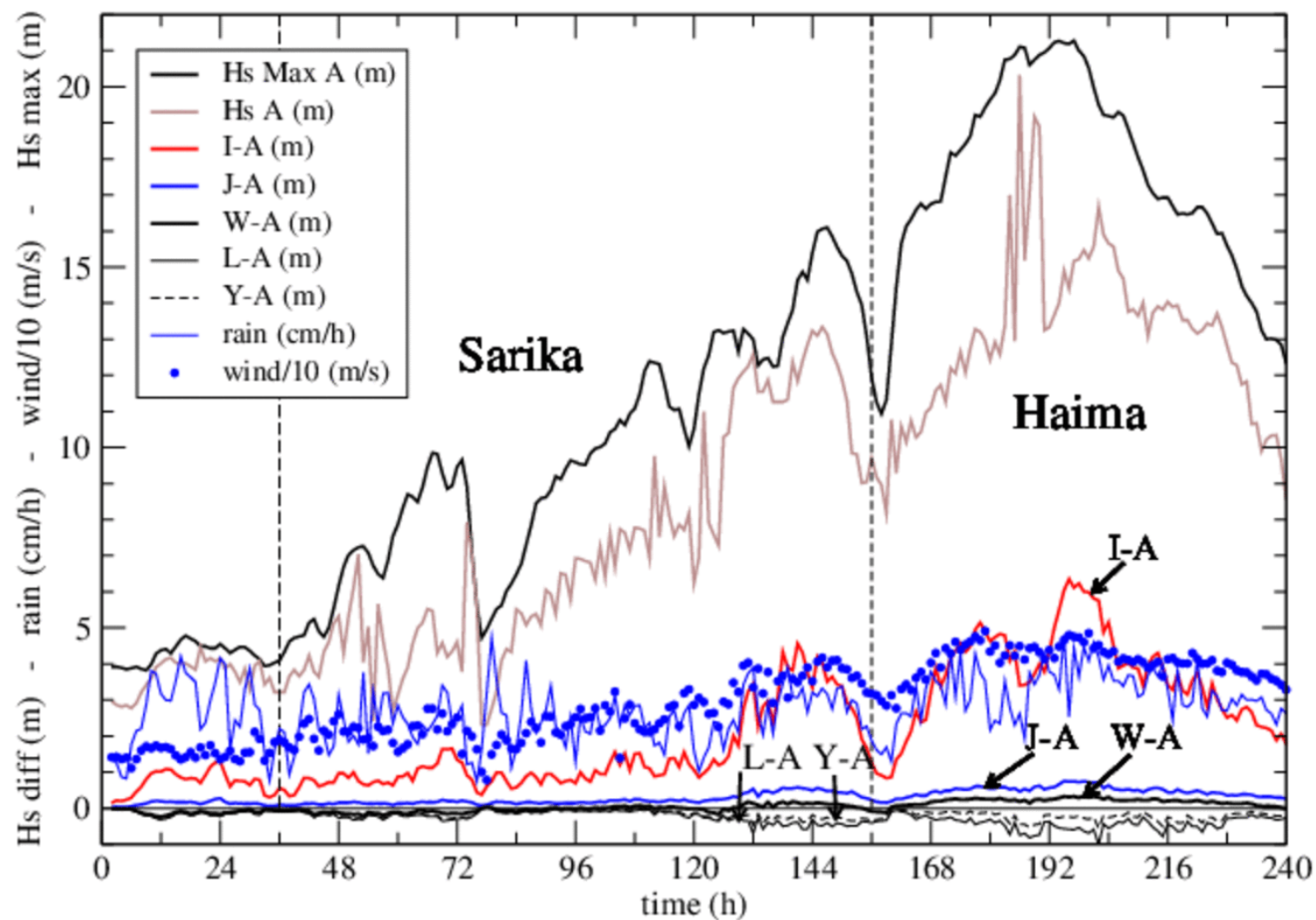
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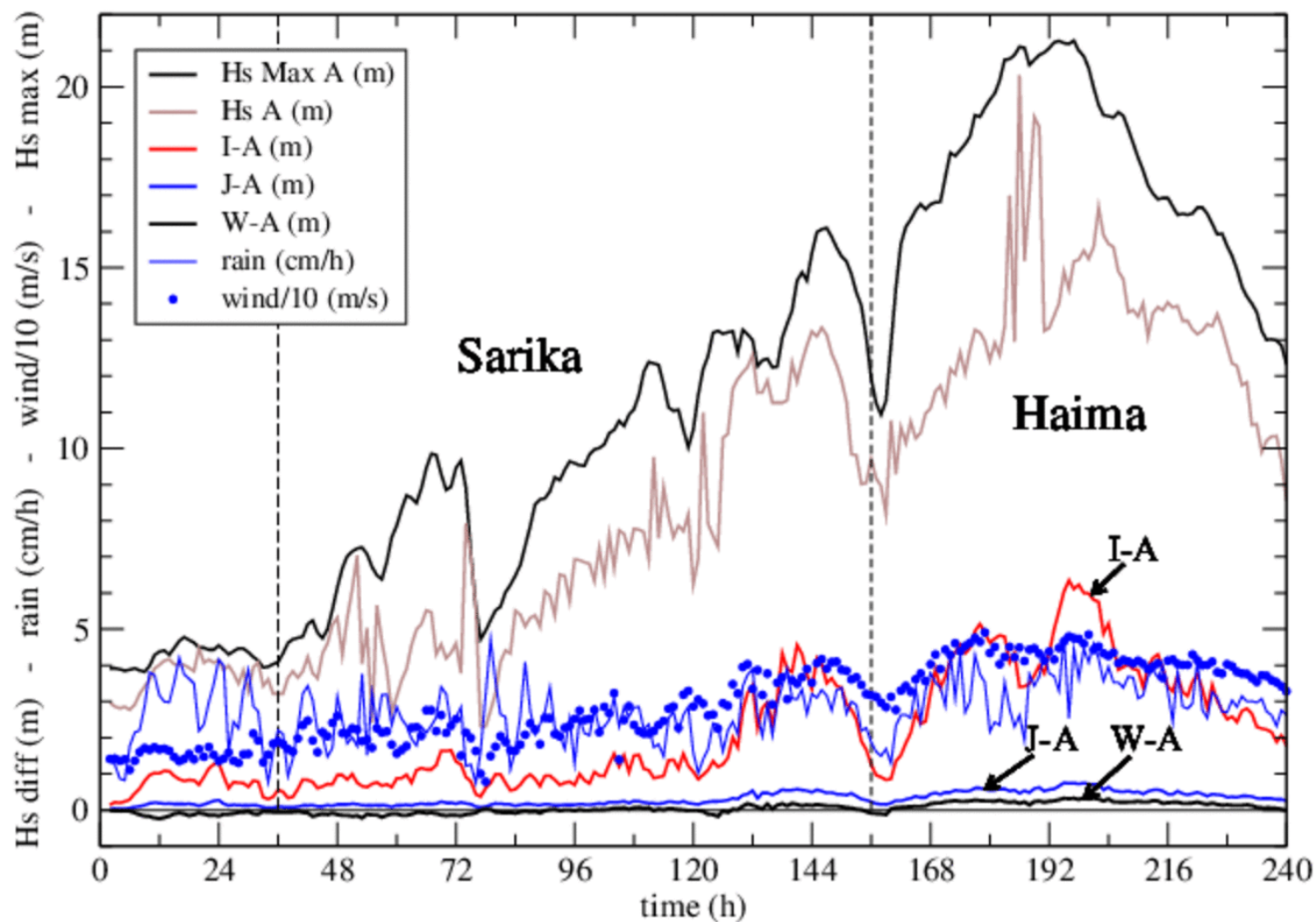
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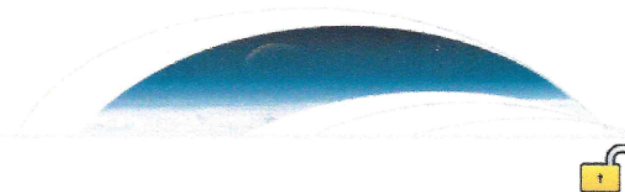
significant wave height - wind - rain
 typhoons Sarika & Haima - 13-23 Oct. 2016



area	<u>H_s Sarika/Haima</u>				<u>H_s Nicole</u>				<u>H_s global</u>			
	<u>bf</u>	SI	<u>bias</u>	<u>corr</u>	<u>bf</u>	SI	<u>bias</u>	<u>corr</u>	<u>bf</u>	SI	<u>bias</u>	<u>corr</u>
I-A	1.051	0.085	0.095	0.999	1.017	0.019	0.041	0.997	1.004	0.012	0.005	0.998
J-A	1.012	0.016	0.020	1.000	1.004	0.004	0.011	0.997	1.001	0.003	0.001	0.999
W-A	1.000	0.007	0.001	1.000	0.999	0.003	0.003	0.998	1.000	0.002	0.000	1.000



Charles "Chip" Cox.



RESEARCH LETTER

10.1002/2016GL071505

Key Points:

- An 1883 sea rescue that used oil to reduce breakers provides the basis for a wave energy model
- We model responses to reduced wind energy input; results consistent with the rescue suggest that this reduced input suppressed breakers
- A possible cause of this reduced energy input is modified surface roughness that alters energy flow

Supporting Information:

- Supporting Information S1

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Citation:

Suppressing breakers with polar oil films: Using an epic sea rescue to model wave energy budgets

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¹Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California, USA, ²Deceased 30 November 2015, ³Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA

Abstract Oil has been used to still stormy seas for centuries, but the mechanisms are poorly understood. Here we examine the processes by using quantitative information from a remarkable 1883 sea rescue where oil was used to reduce large breakers during a storm. Modeling of the oil film's extent and waves under the film suggests that large breakers were suppressed by a reduction of wind energy input. Modification of surface roughness by the film is hypothesized to alter the wind profile above the sea and the energy flow. The results are central to understanding air-sea momentum exchange, including its role in such processes as cyclone growth and storm surge, although they address only one aspect of the complex problem of wind interaction with the ocean surface.

1. Introduction

In summary:

the introduction of drastic changes (where it rains) to S_{in} , S_{wc} leads to potentially large local differences
(not only on hurricanes and typhoons)

However, the overall statistics does not change appreciably

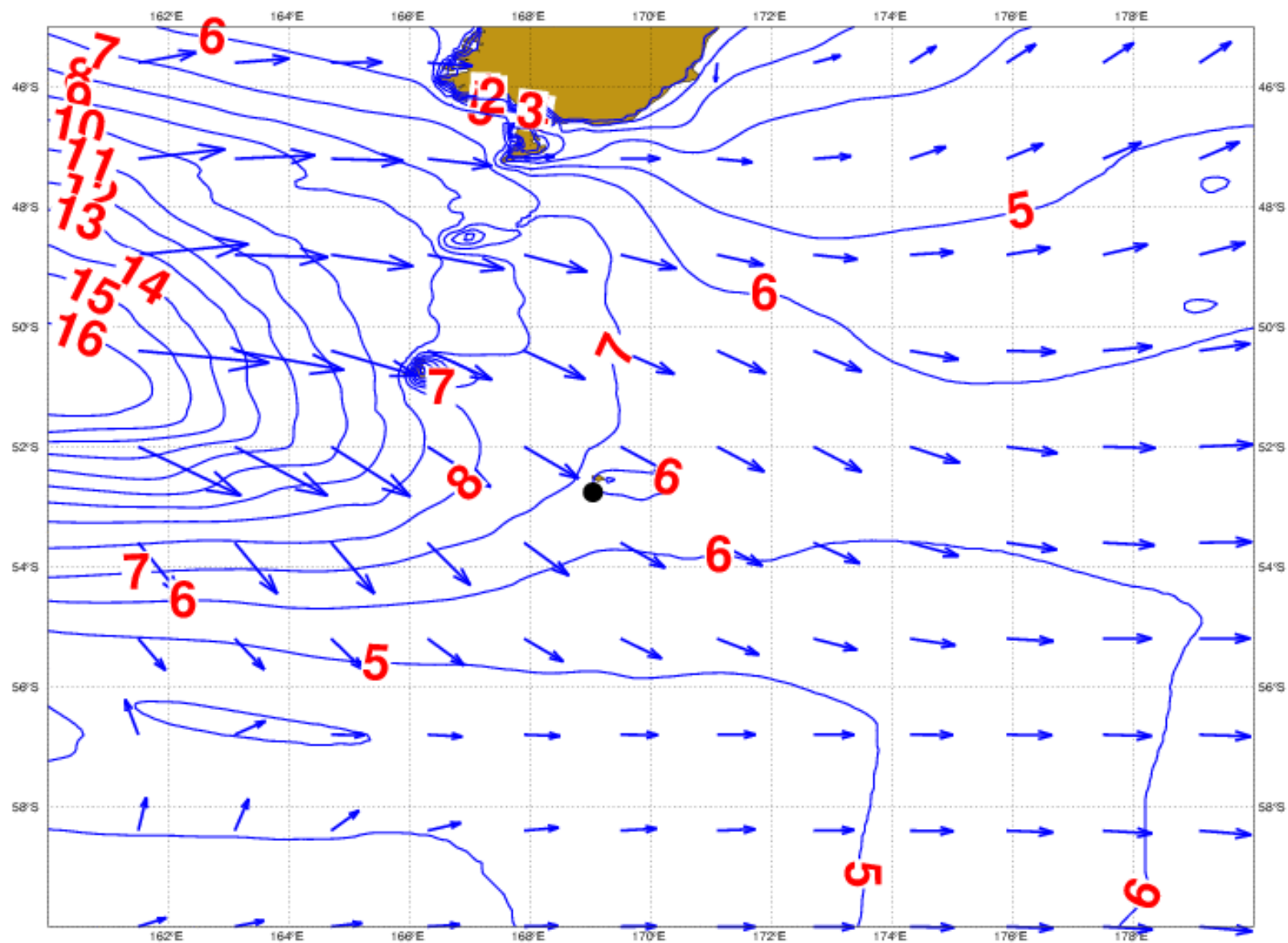
Is a good statistics enough reason to claim that a model is correct?



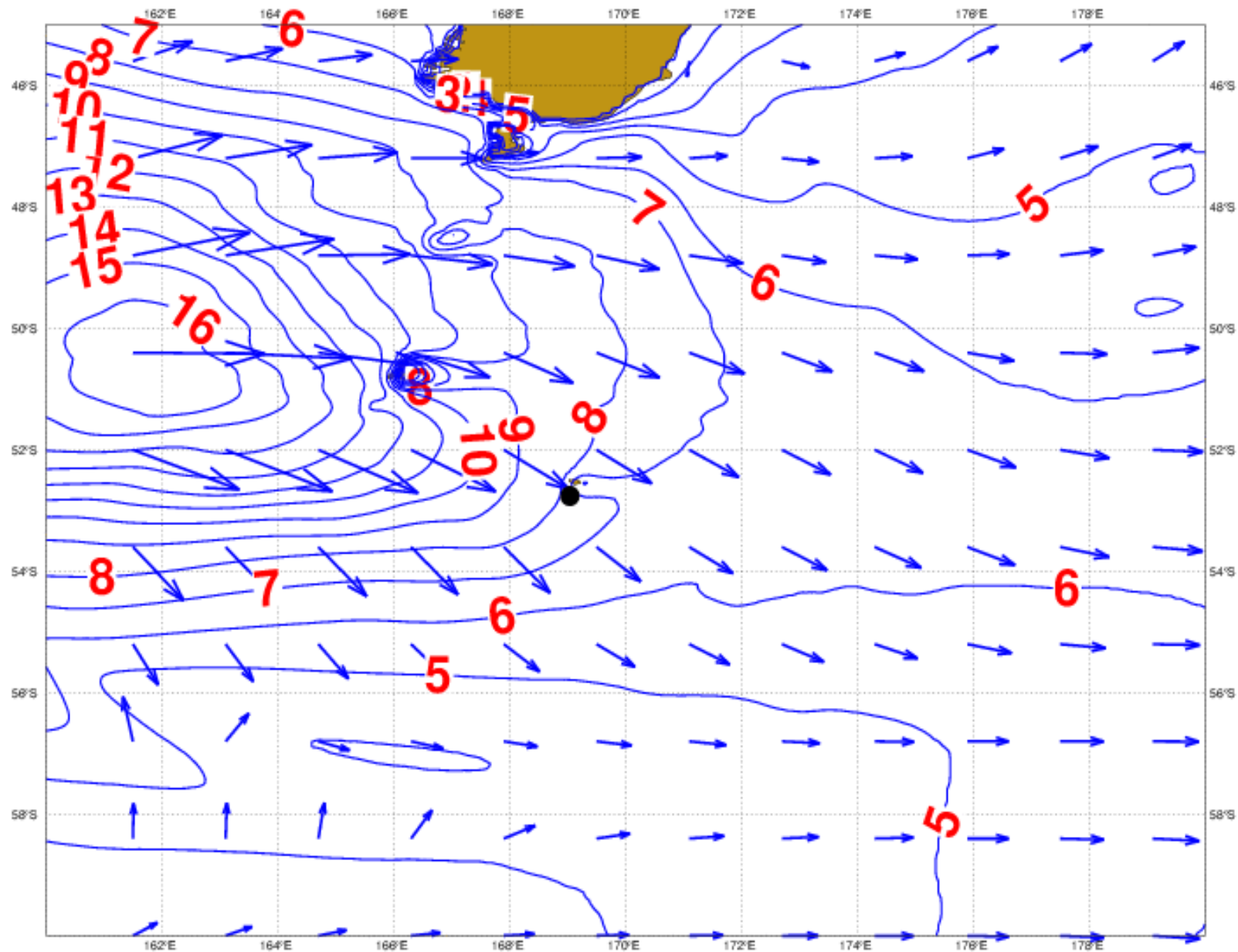
Let us conclude with something
interesting and amusing

You remember the 15 cm swell
with a long period (about 17 s)
happened a few days ago

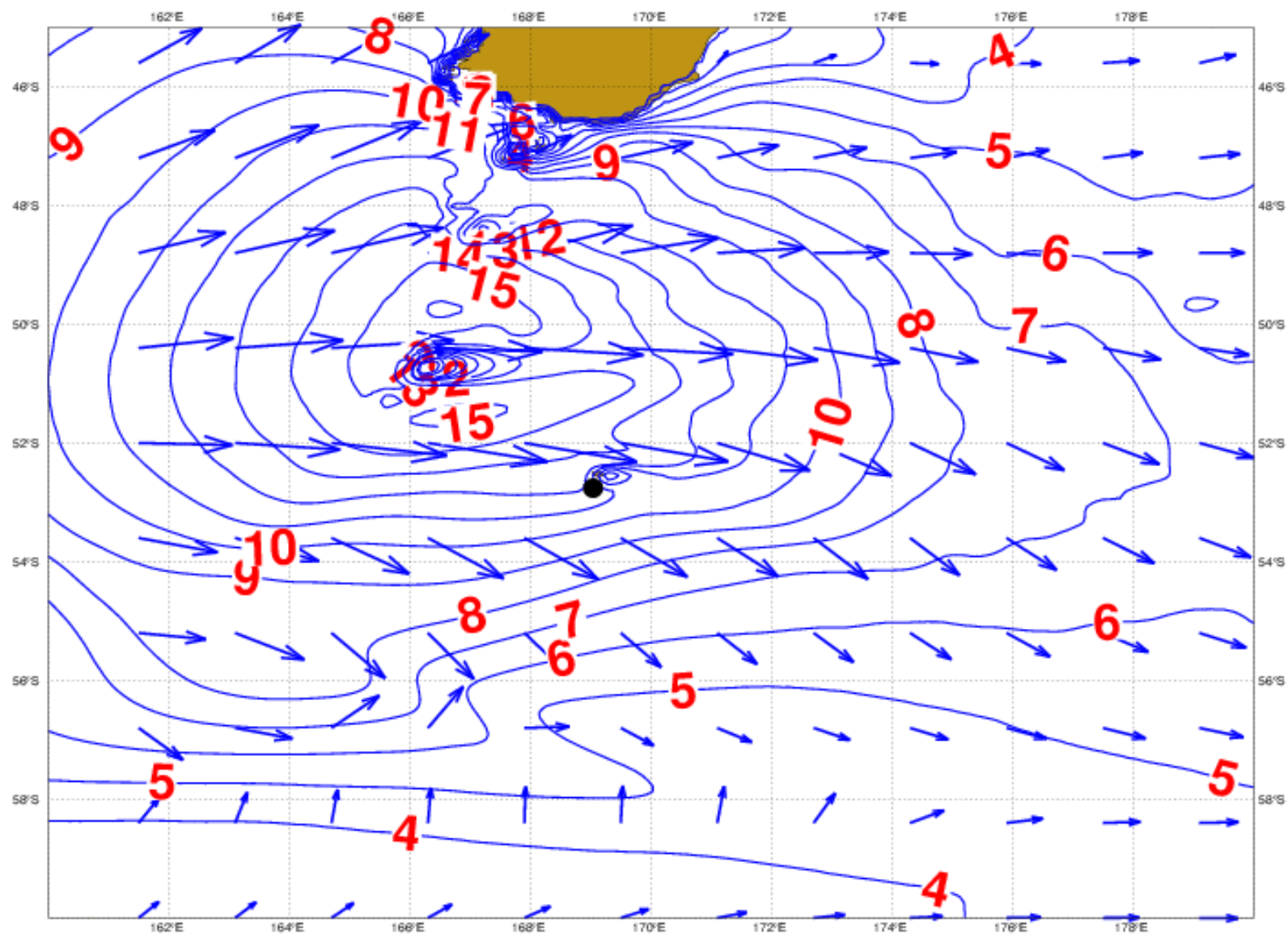
WAVE HEIGHT AT 2018.05.08 04 UT - Hs MAX 16.89



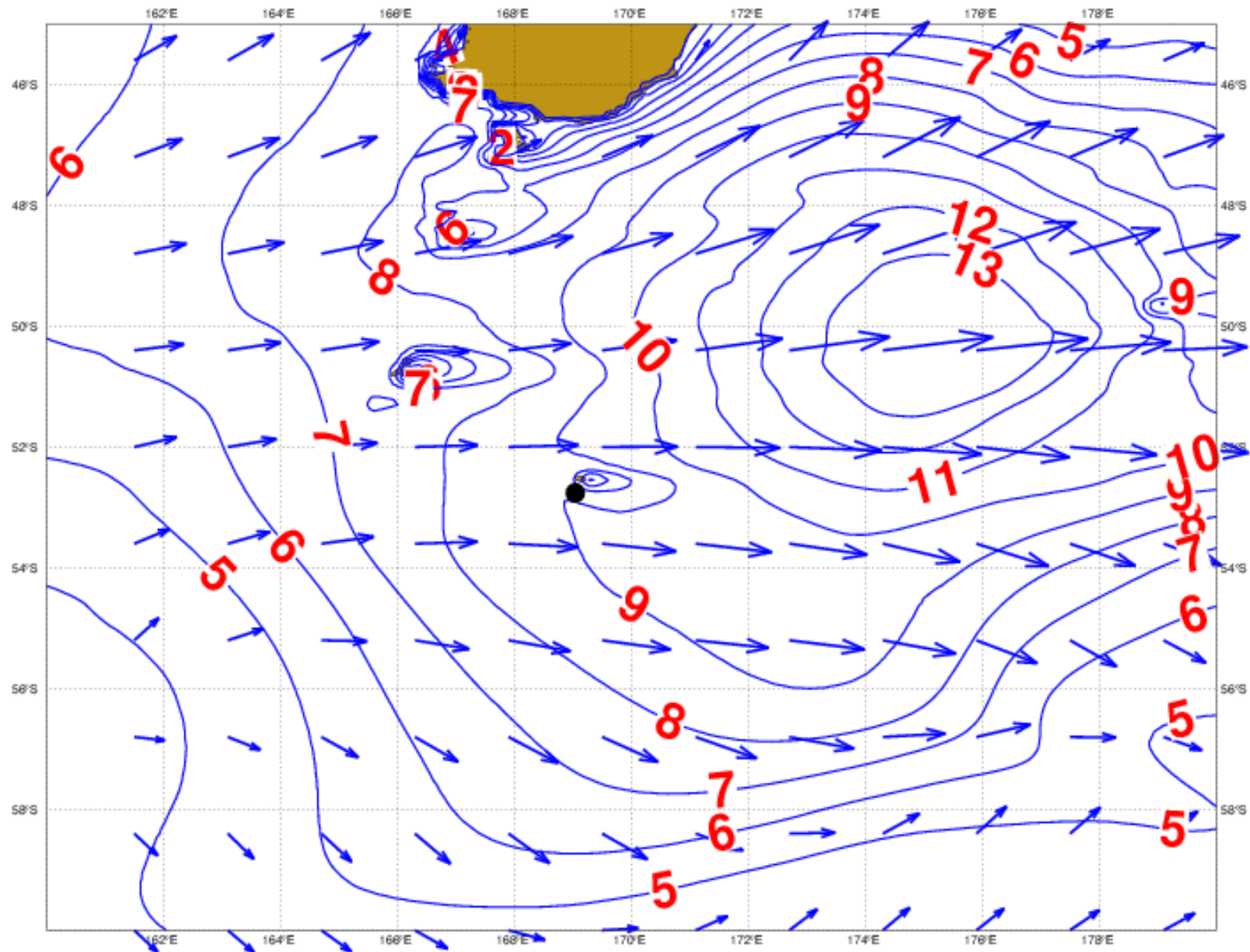
WAVE HEIGHT AT 2018.05.08 06 UT - Hs MAX 16.77



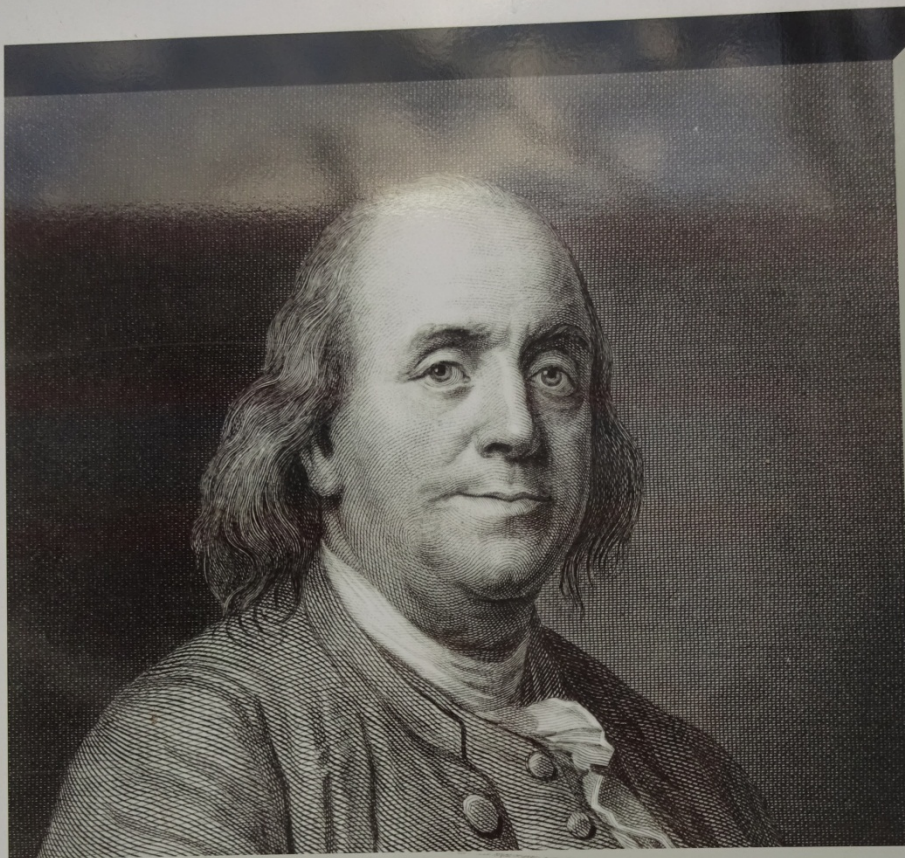
WAVE HEIGHT AT 2018.05.08 12 UT - Hs MAX 15.56



WAVE HEIGHT AT 2018.05.08 21 UT - Hs MAX 13.92



Second, something about Benjamin Franklin

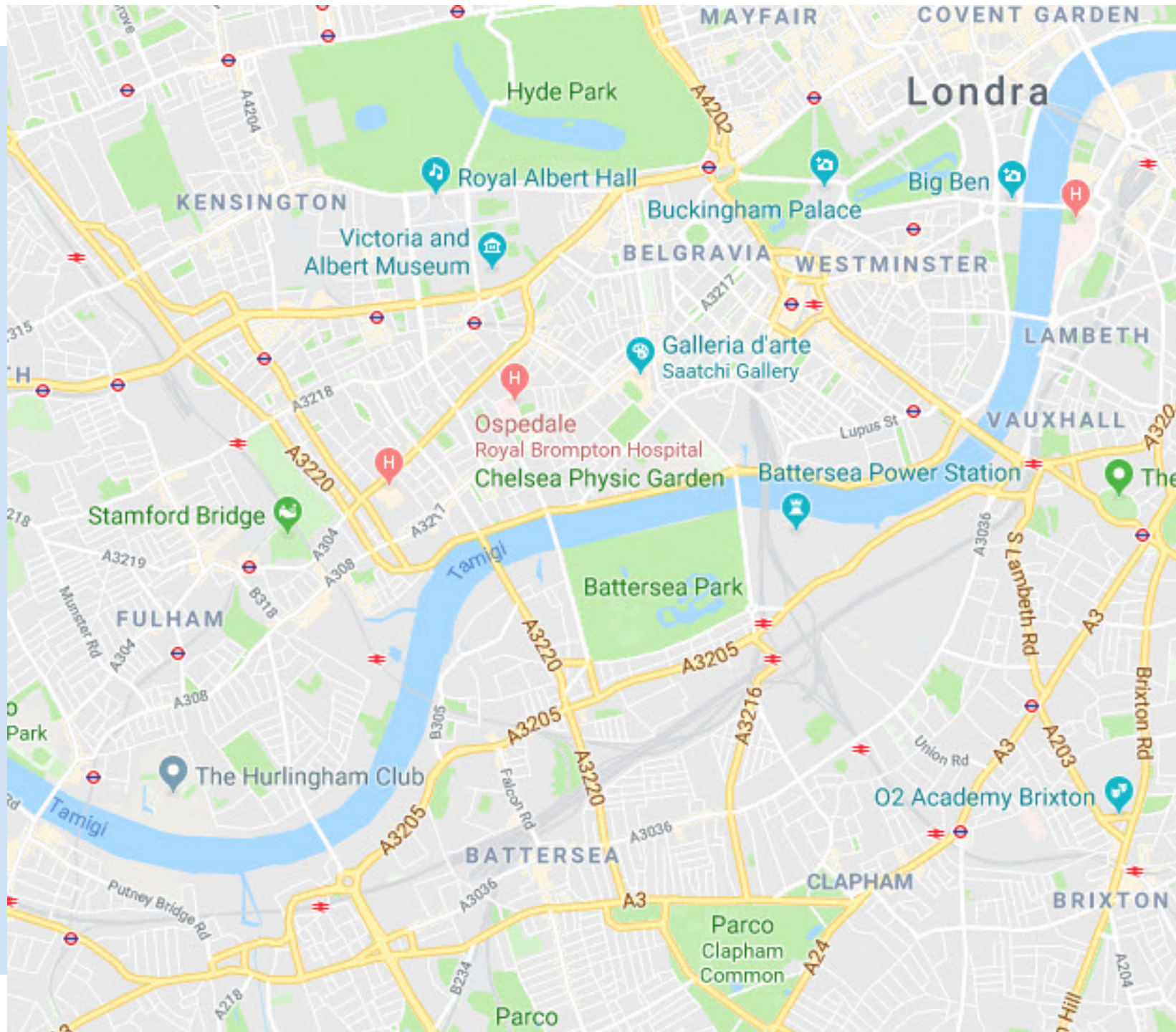


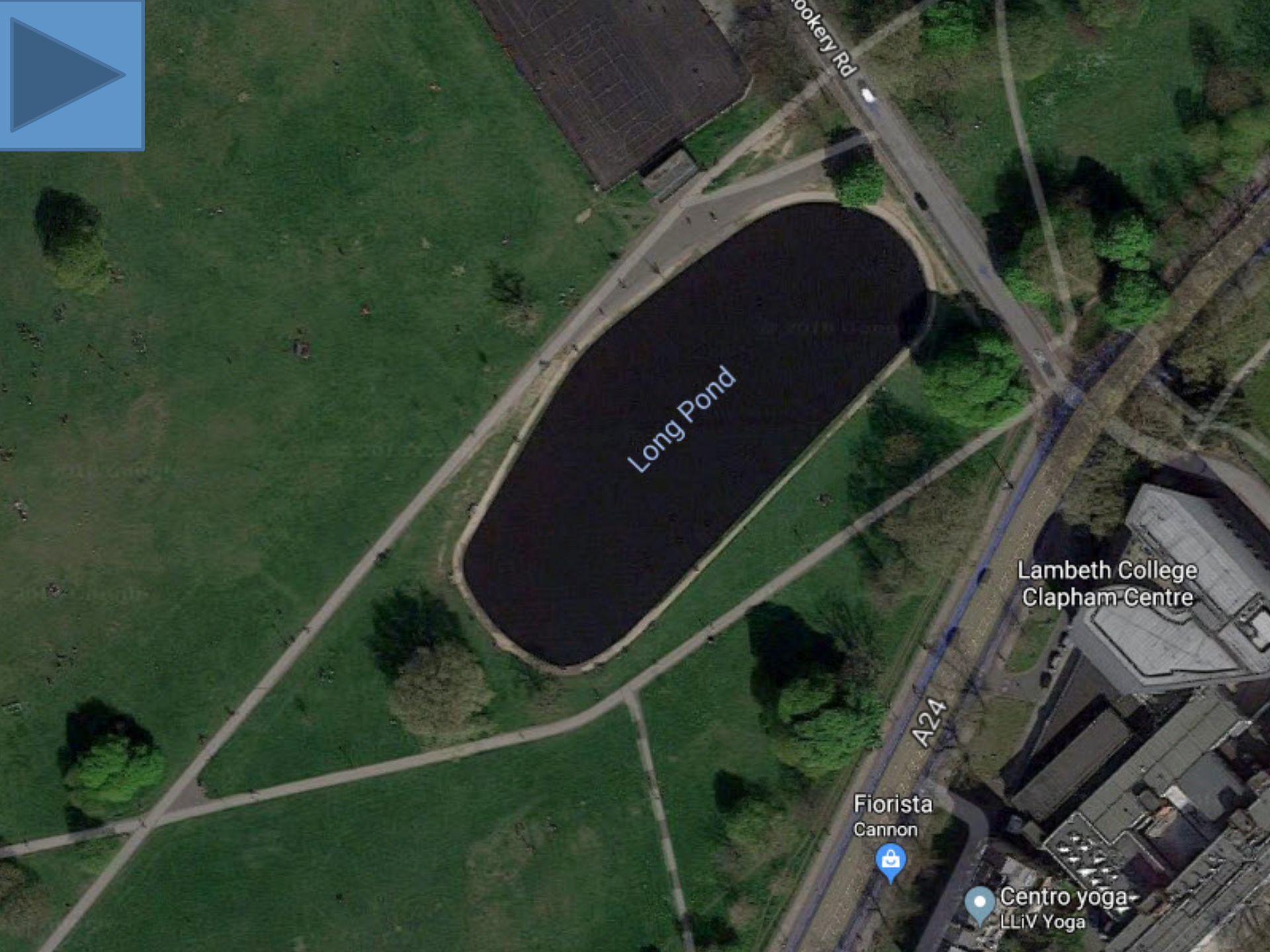
BENJAMIN FRANKLIN

One of the Founding Fathers of the United States, Franklin was a leading author, politician, statesman and diplomat. He was also an outstanding experimental scientist and during the 1760s initiated his 'oil on water' experiments on the ponds of Clapham Common, an important moment in the study of surface chemistry.

Let us conclude with something
interesting and amusing

In the second half of 18th century Benjamin Franklin
poured a tea spoon of oil on the surface of
Clapham pond, a small lake just out of London





Long Pond

Lambeth College
Clapham Centre

A24

Fiorista
Cannon

Centro yoga
LLiV Yoga

A middle-aged man with grey hair, wearing a bright blue jacket and dark blue cargo pants, stands on a gravel path next to a large body of water. He is holding a small, round object in his right hand and looking towards the camera. A black backpack is on his back. The background shows a calm lake reflecting the sky, with trees and a park area in the distance. The word "Questions ?" is overlaid in large black text across the center of the image.

Questions ?