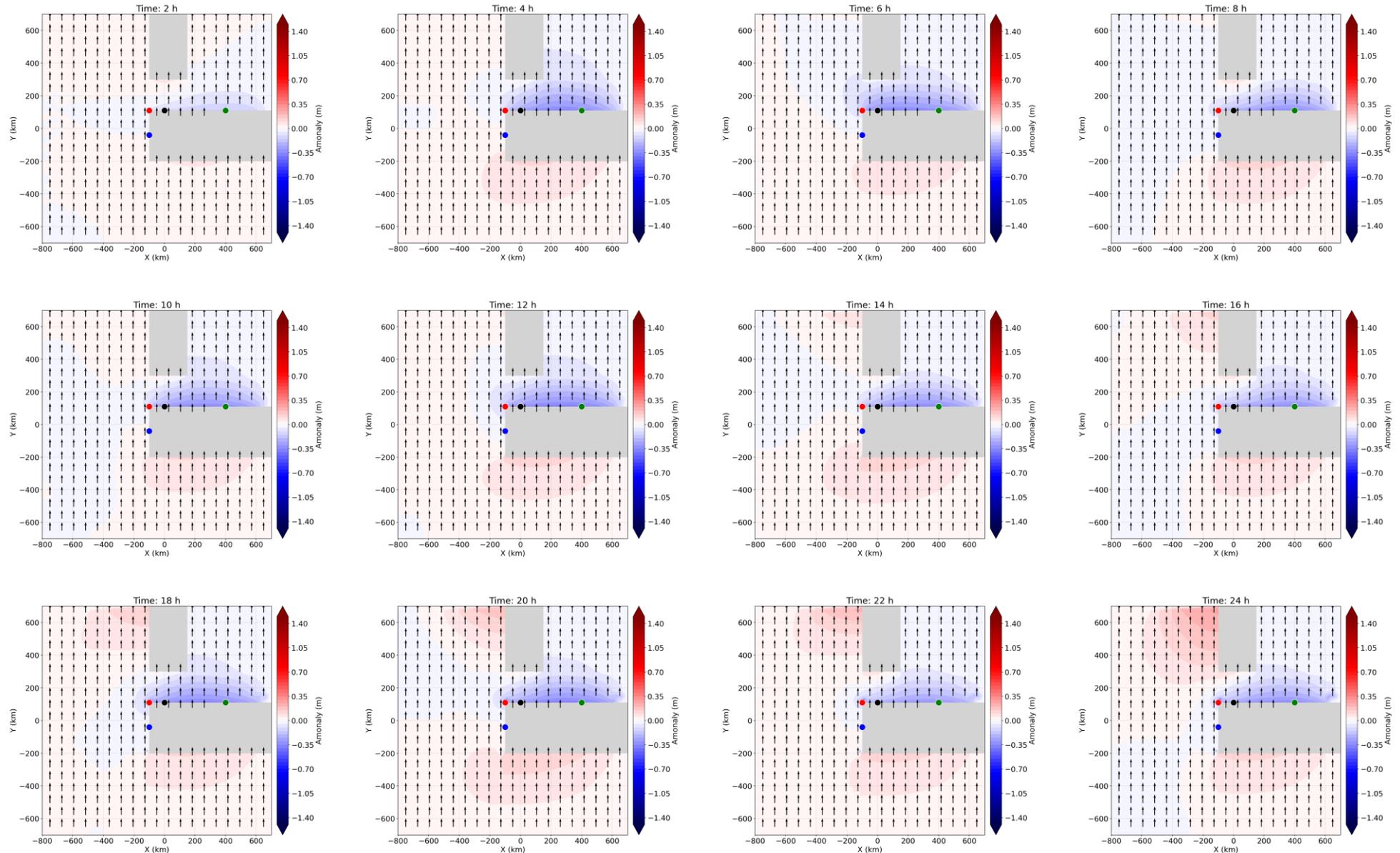
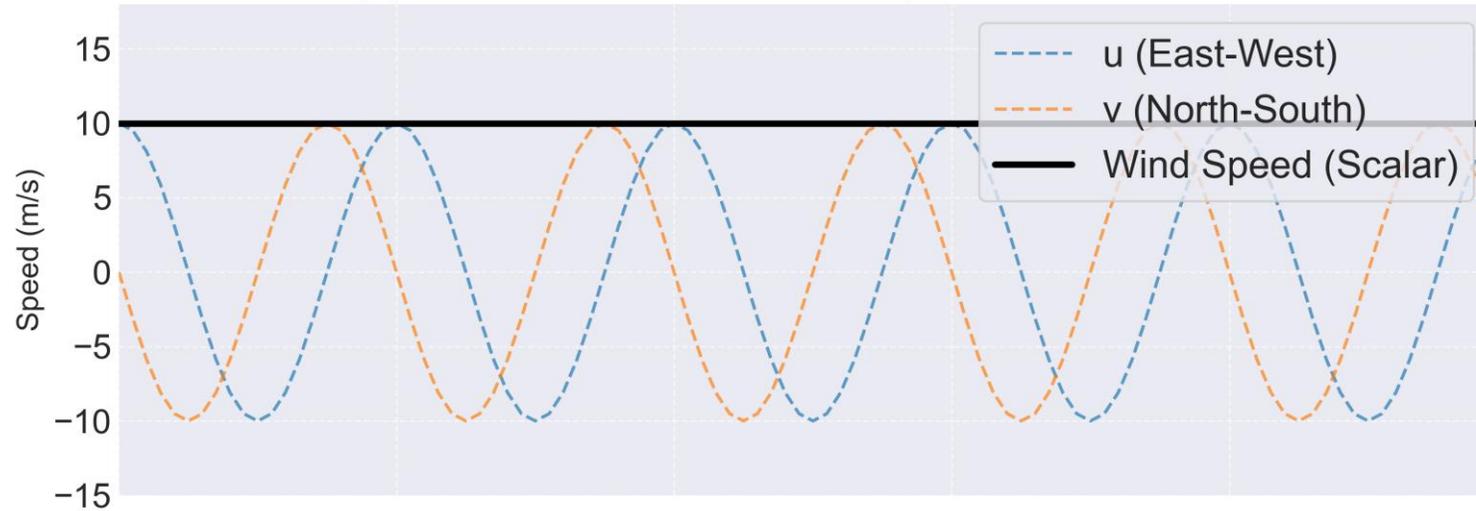


Supplementary Fig. 1

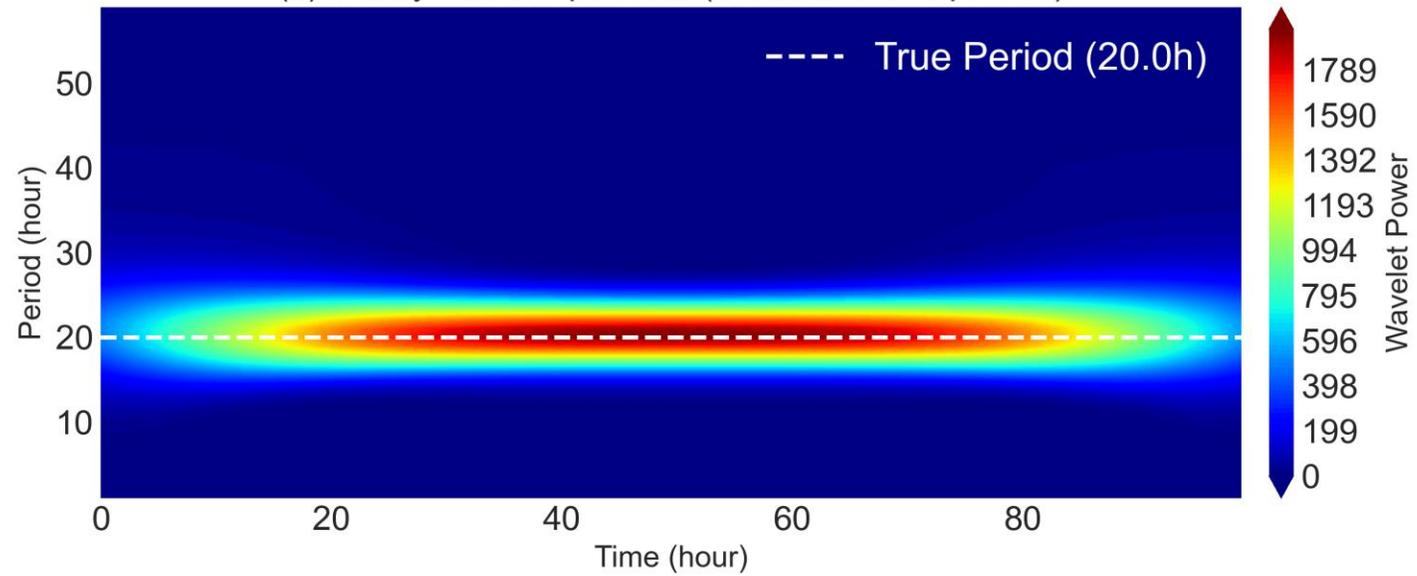


Supplementary Fig. 2

(a) Idealized Wind Data: Constant Speed with CW Rotation



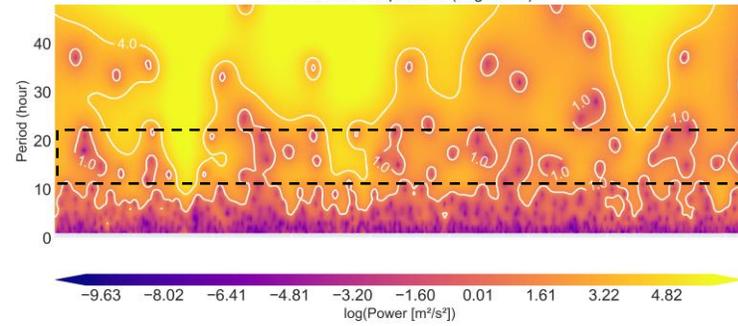
(b) Rotary Power Spectrum (Clockwise Component)



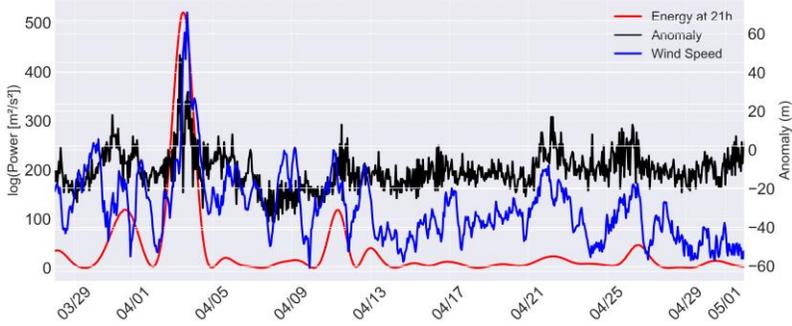
Supplementary Fig. 3

April 2012

Wavelet Power Spectrum (Log Scale)

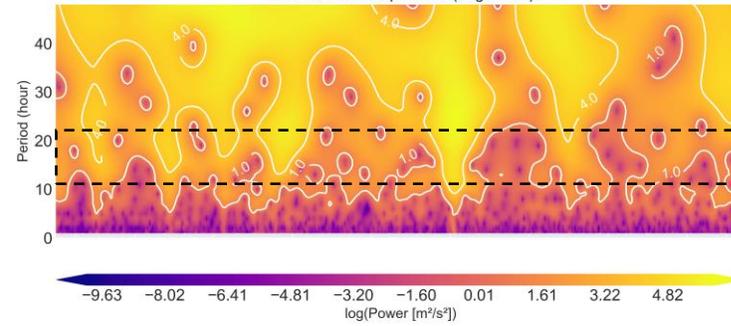


Time Series of Energy, Anomaly & Wind Speed

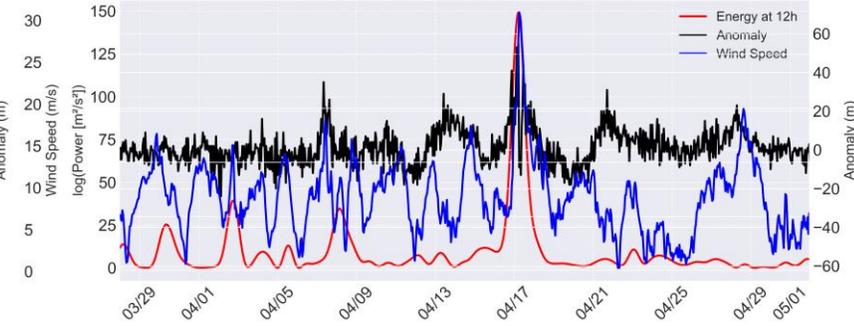


April 2016

Wavelet Power Spectrum (Log Scale)

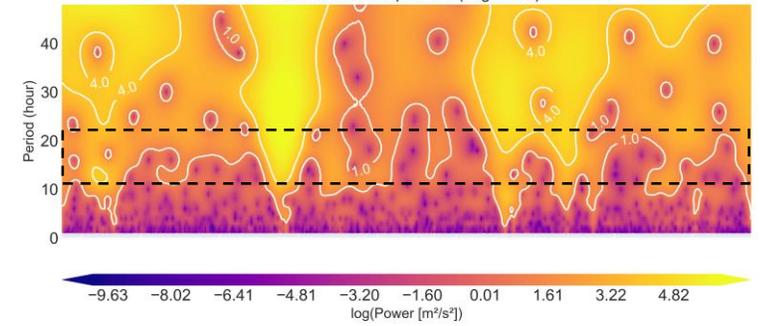


Time Series of Energy, Anomaly & Wind Speed

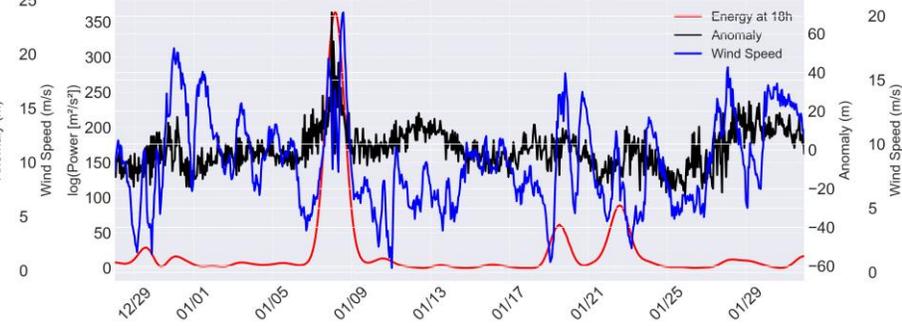


Jan 2020

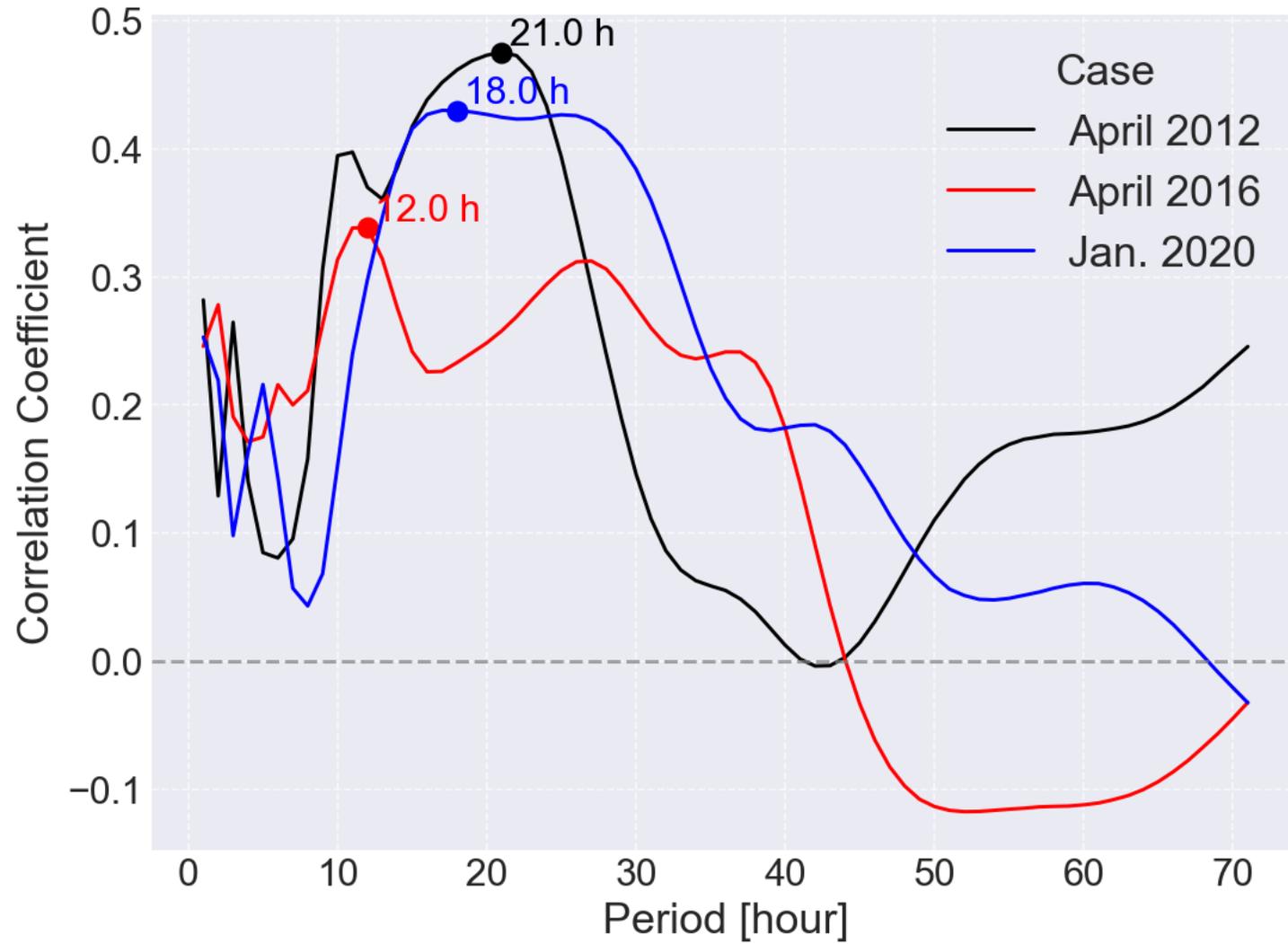
Wavelet Power Spectrum (Log Scale)



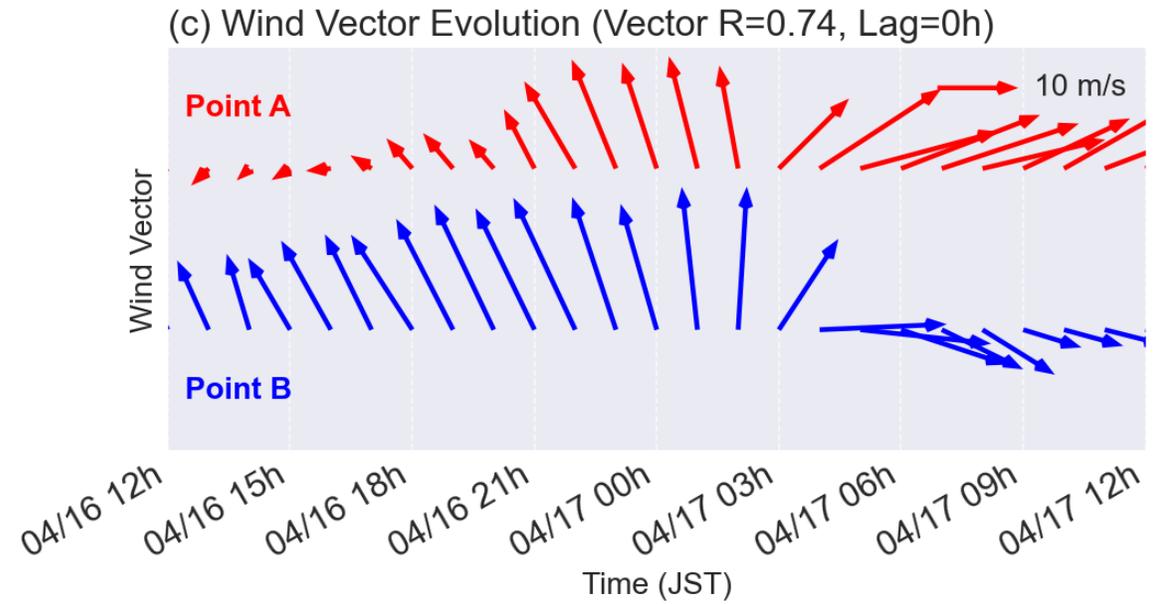
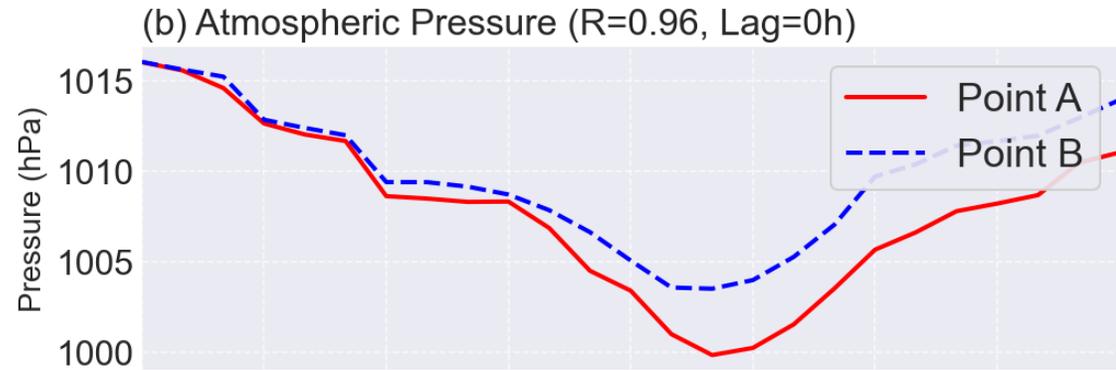
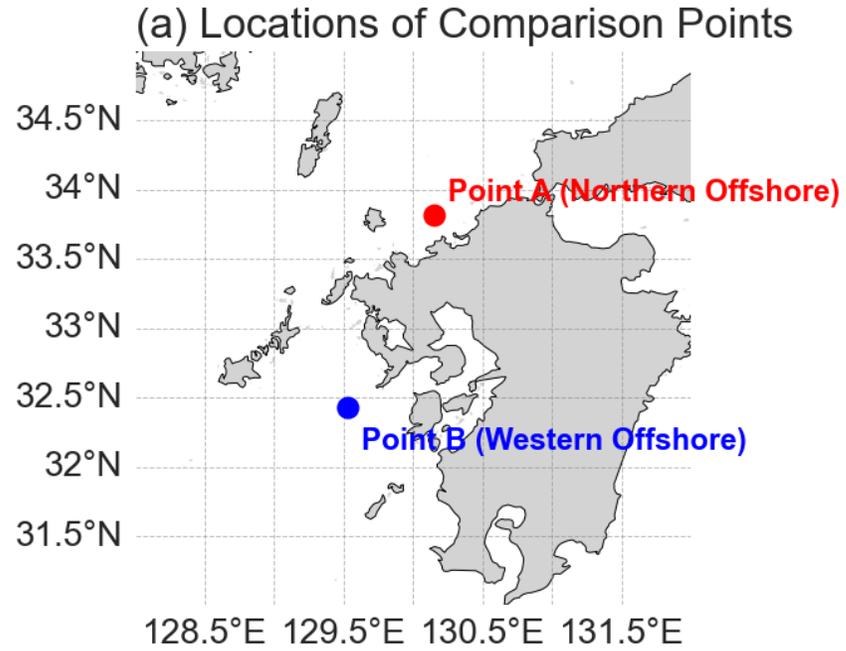
Time Series of Energy, Anomaly & Wind Speed



Supplementary Fig. 4



Supplementary Fig. 5



Supplementary Fig. 6

Table 1. Chronological ranking of the top storm surge anomalies at Hirado Seto, Karatsu, and Hakata (2012–2020). Extratropical cyclones and typhoons are indicated, with specific typhoon names provided.

Date (Month/Year)	Meteorological Event	Hirado Seto			Karatsu			Hakata		
		Peak Time (JST)	Anom. (m)	Rank	Peak Time (JST)	Anom. (m)	Rank	Peak Time (JST)	Anom. (m)	Rank
⁽¹⁾ Apr 2012	Extratropical cyclone	–	–	–	–	–	–	Apr 03 08:00	0.50	3
Sep 2012	Typhoon Sanba*	Sep 17 06:00	0.70	4	Sep 18 04:00	0.68	1	–	–	–
		–	–	–	Sep 17 17:00	0.63	3	–	–	–
Jul 2015	Typhoon Nangka	–	–	–	Jul 17 03:00	0.55	8	–	–	–
Aug 2015	Typhoon Goni	–	–	–	Aug 25 08:00	0.60	4	Aug 25 09:00	0.44	9
⁽²⁾ Apr 2016	Extratropical cyclone	Apr 17 02:00	0.71	3	Apr 17 03:00	0.65	2	Apr 17 05:00	0.55	2
Feb 2017	Extratropical cyclone	–	–	–	–	–	–	Feb 20 11:00	0.44	6
Feb 2018	Extratropical cyclone	Feb 28 17:00	0.64	7	Feb 28 18:00	0.54	9	Feb 28 19:00	0.45	5
Jul 2018	Typhoon Prapiroon	Jul 03 16:00	0.68	5	–	–	–	–	–	–
Oct 2018	Typhoon Kong-rey	–	–	–	Oct 06 17:00	0.55	7	Oct 06 17:00	0.44	8
Feb 2019	Extratropical cyclone	Feb 08 17:00	0.63	8	–	–	–	–	–	–
Mar 2019	Extratropical cyclone	–	–	–	–	–	–	Mar 16 00:00	0.44	7
Sep 2019	Typhoon Tapah	Sep 22 19:00	0.62	9	–	–	–	–	–	–
⁽³⁾ Jan 2020	Extratropical cyclone	Jan 07 23:00	0.65	6	Jan 07 23:00	0.55	6	Jan 08 00:00	0.71	1
<u>Sep 2020</u>	<u>Typhoon Maysak</u>	<u>Sep 03 00:00</u>	<u>0.77</u>	<u>1</u>	<u>Sep 03 17:00</u>	<u>0.58</u>	<u>5</u>	<u>Sep 03 17:00</u>	<u>0.49</u>	<u>4</u>
Sep 2020	Typhoon Haishen	Sep 07 05:00	0.72	2	–	–	–	–	–	–

*For Typhoon Sanba at Karatsu, two distinct peaks separated by 11 hours are listed. They are treated as independent events because they were driven by different mechanisms (Ozaki et al. (2025)).