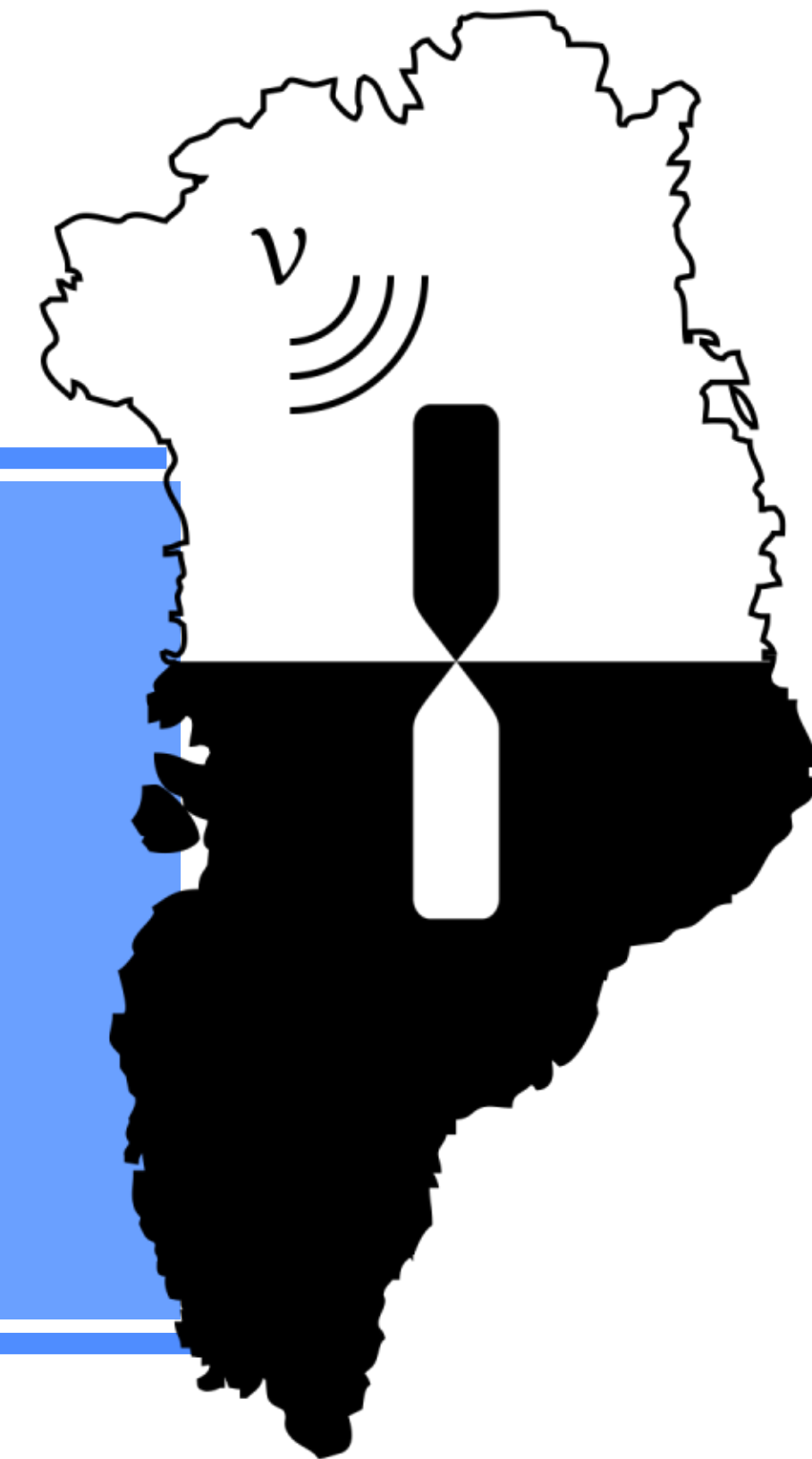




Acoustic & Radio
EeV Neutrino
Detection Activities

Triboelectric events in RNO-G



Maddalena Cataldo, 07/10-06-2022, Santiago de Compostela

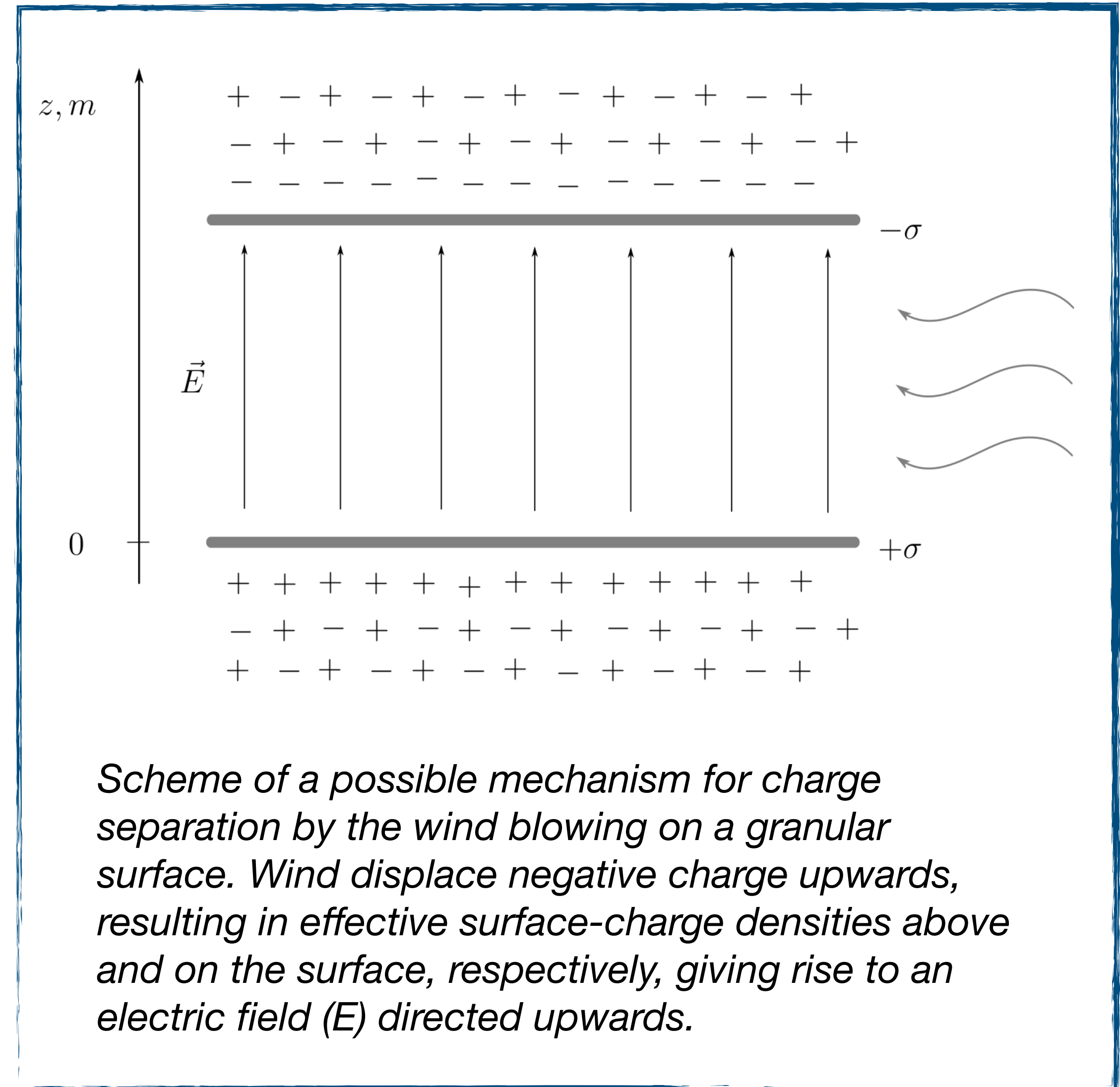


ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



What is the Triboelectric effect?

- Wind blowing on a granular surface such as the Greenlandic ice can produce a separation of charges and an electrostatic potential difference with a consequent coronal discharge.
- Discharges occurring on timescales as short as nanoseconds lead to radio-frequency emissions at MHz – GHz frequencies.
- These may generate events in radio detectors similar to neutrino events and constitute therefore background

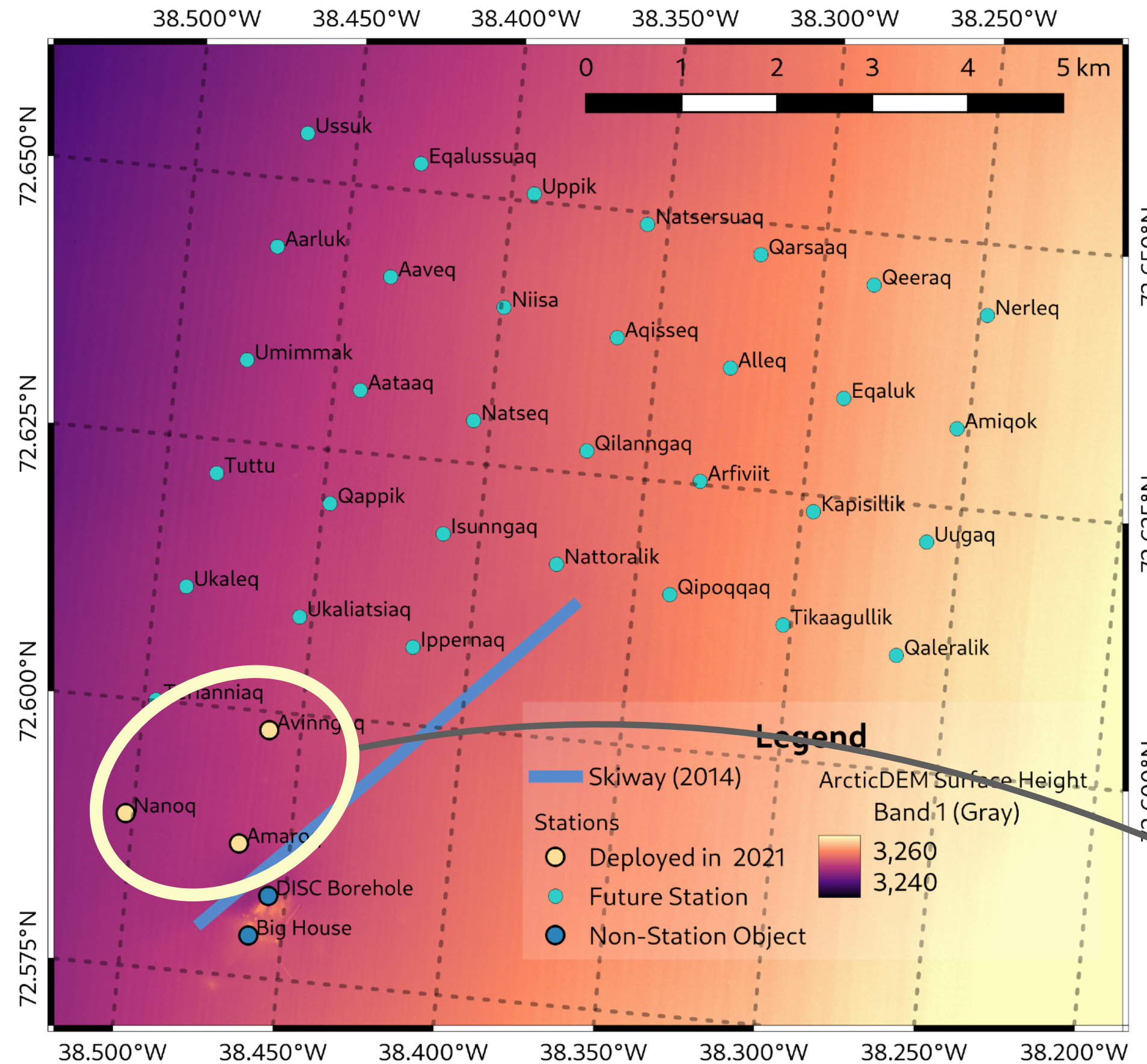


RNO-G: Radio Neutrino Observatory Greenland

For this analysis only the shallow channels are considered (related to LPDAs, 9 per station).

RNO-G Planned Layout

<https://rno-g.github.io/station-map/>

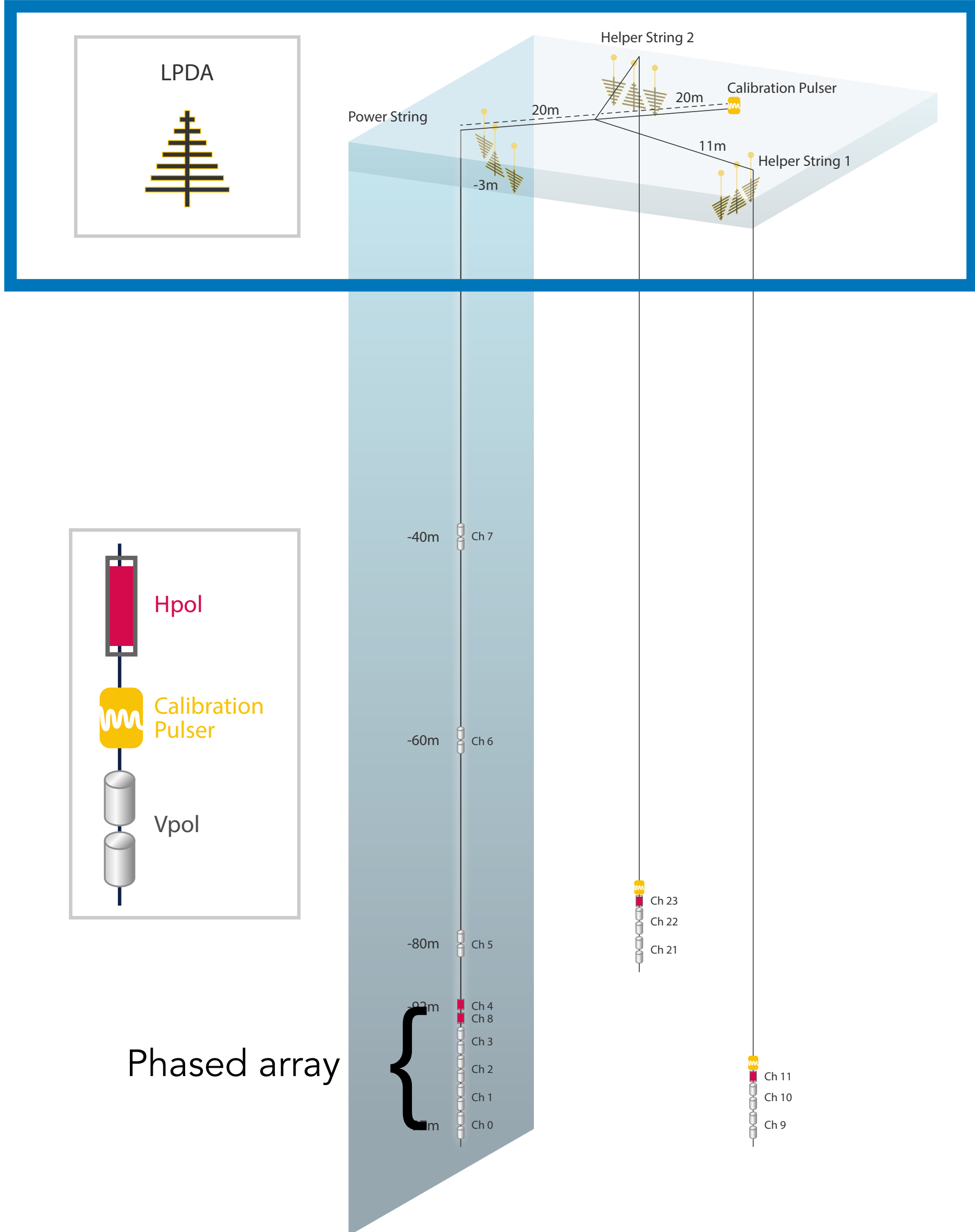


SUMMIT station

<https://geo-summit.org/summit-station>

First 3 Stations deployed in Summer 2021

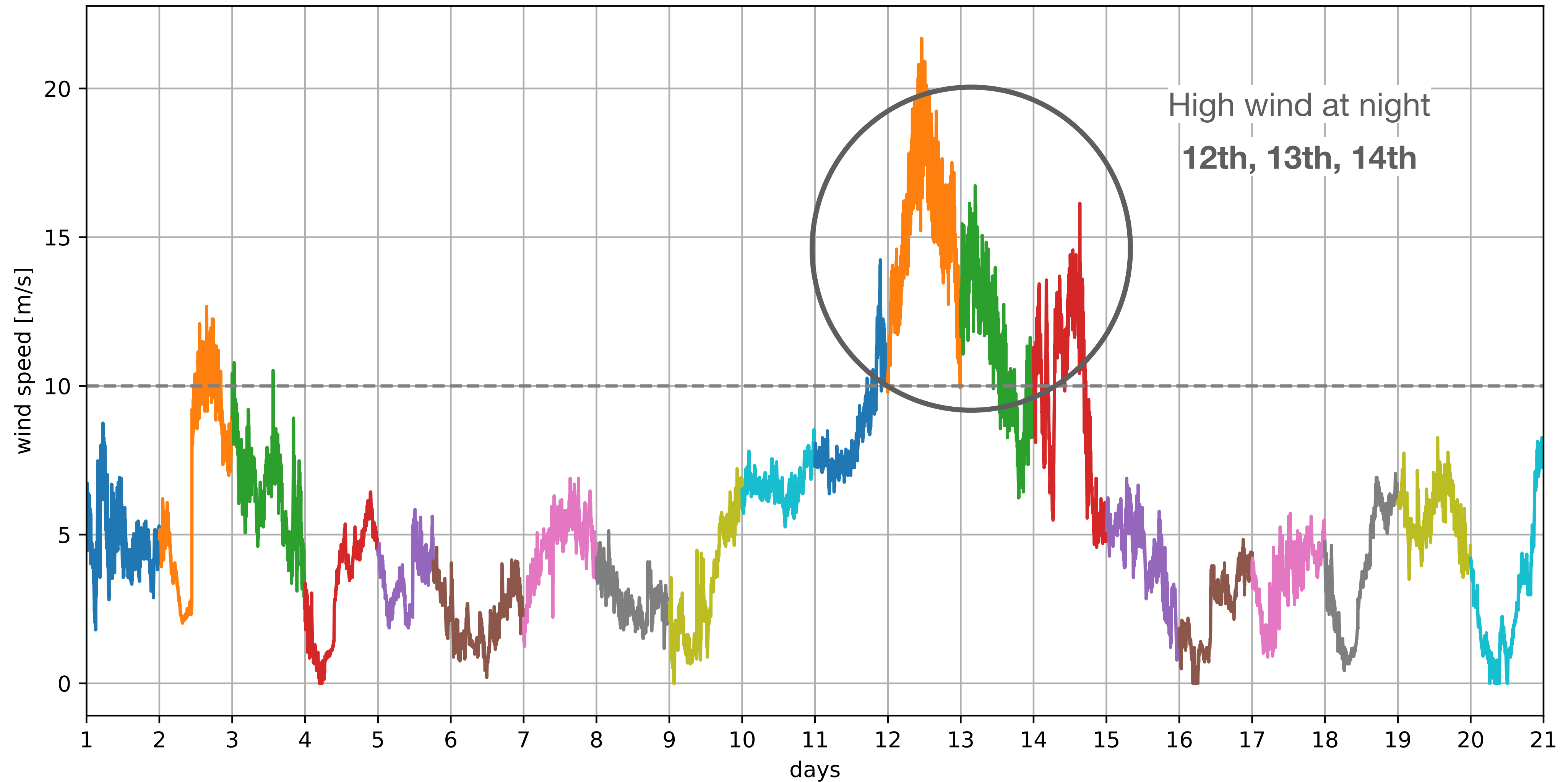
RNO-G Station



Wind speed measurements 2021

The runs considered here are from the 12th, 13th, 14th of September: high wind period

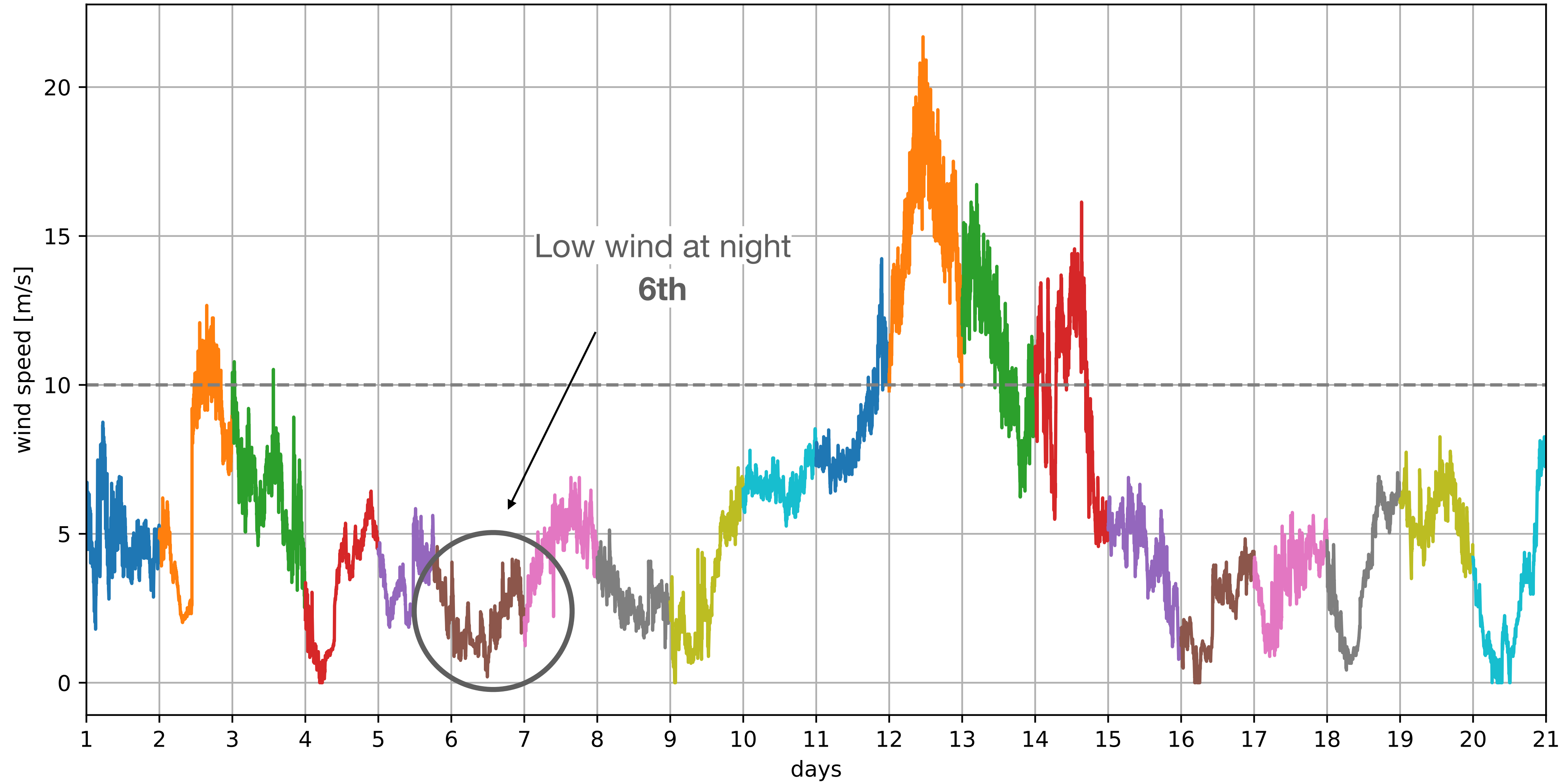
September



Wind speed measurements 2021

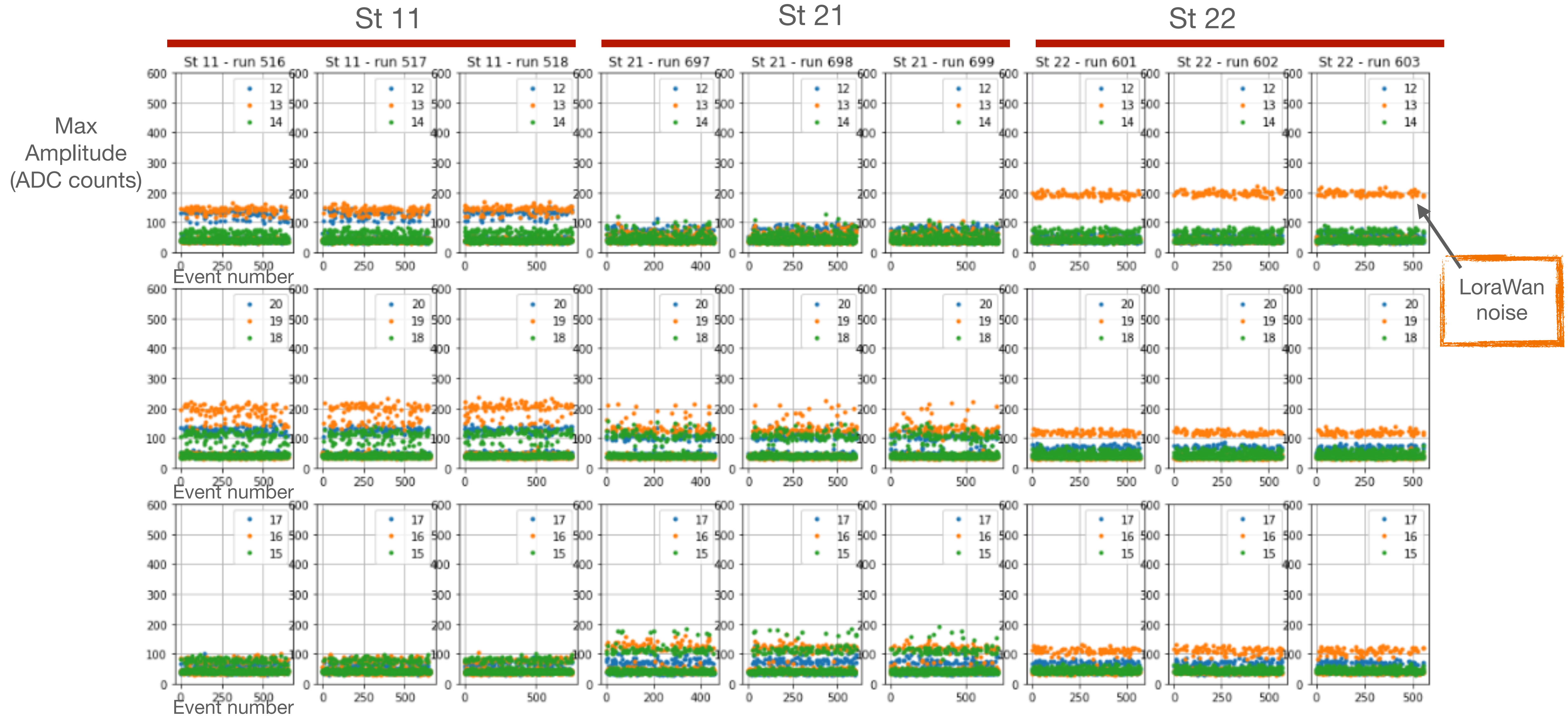
The runs considered here are from the 6th of September: low wind period

September



Comparison high-wind and low-wind: Sept 6th, Low Wind

Only night runs are considered (2 hrs each) because during the day there is noise due to solar panel's battery charging/discharging.



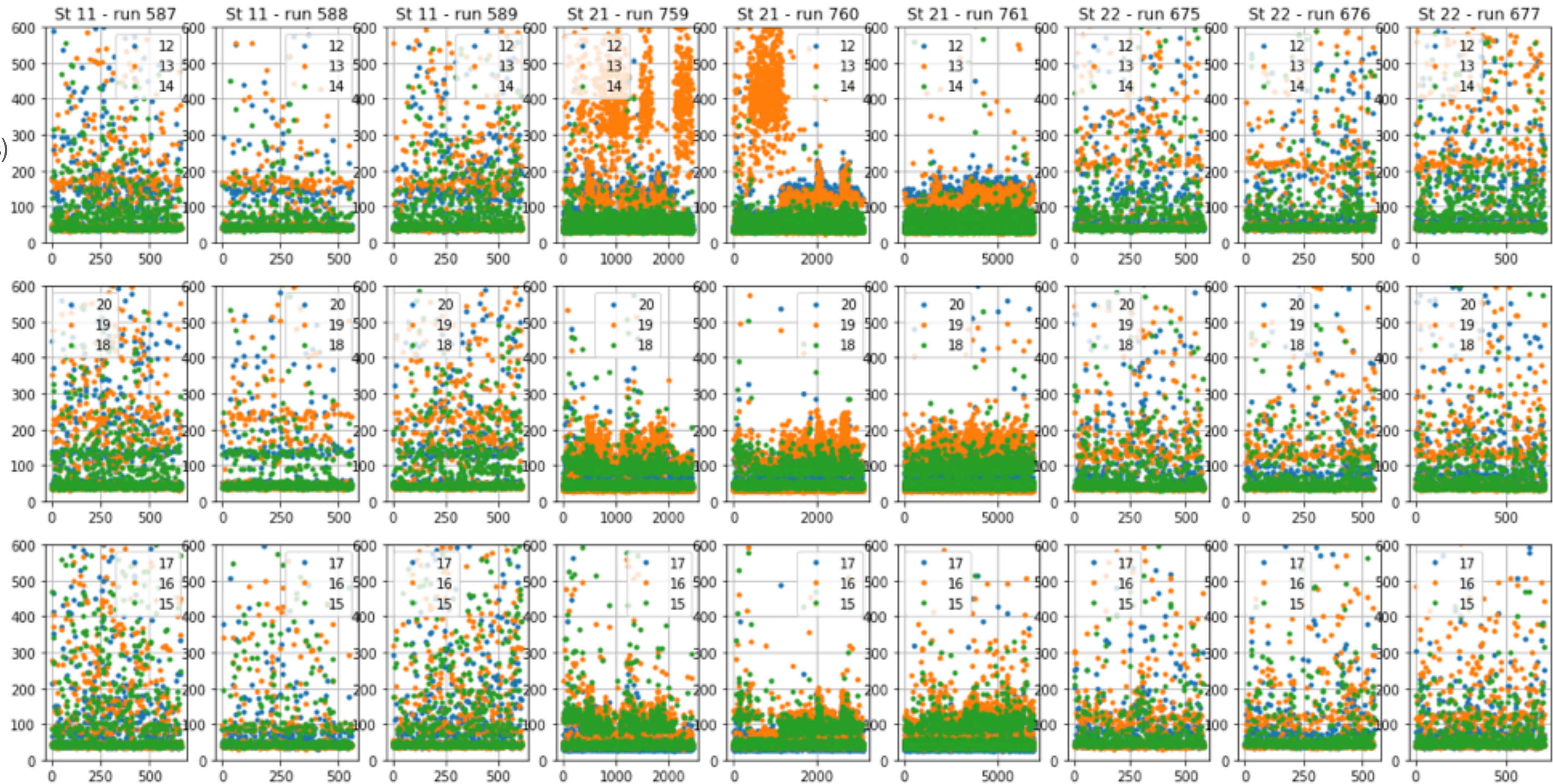
Comparison high-wind and low-wind: Sept 12th, High Wind

St 11

St 21

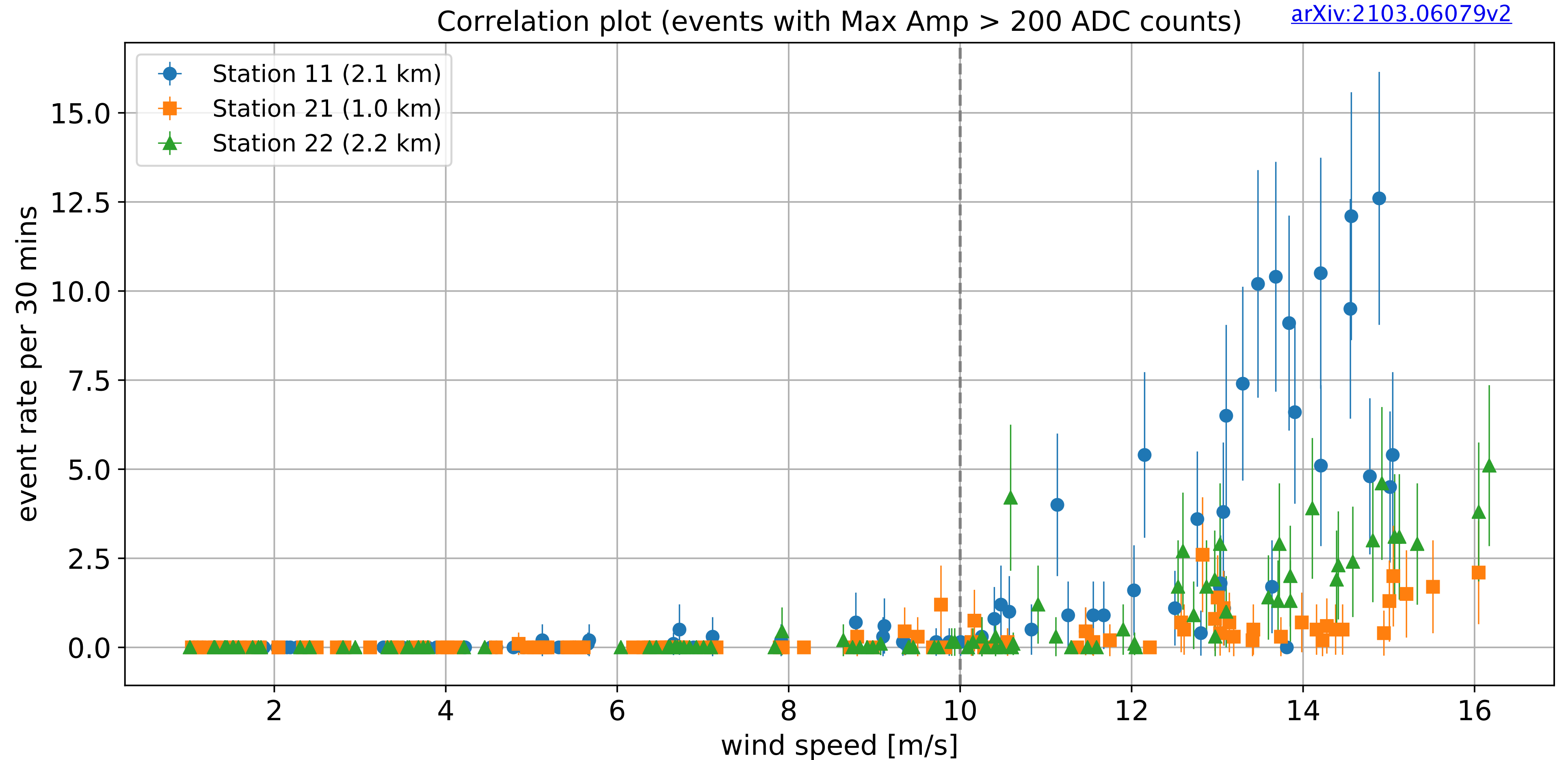
St 22

Max
Amplitude
(ADC counts)



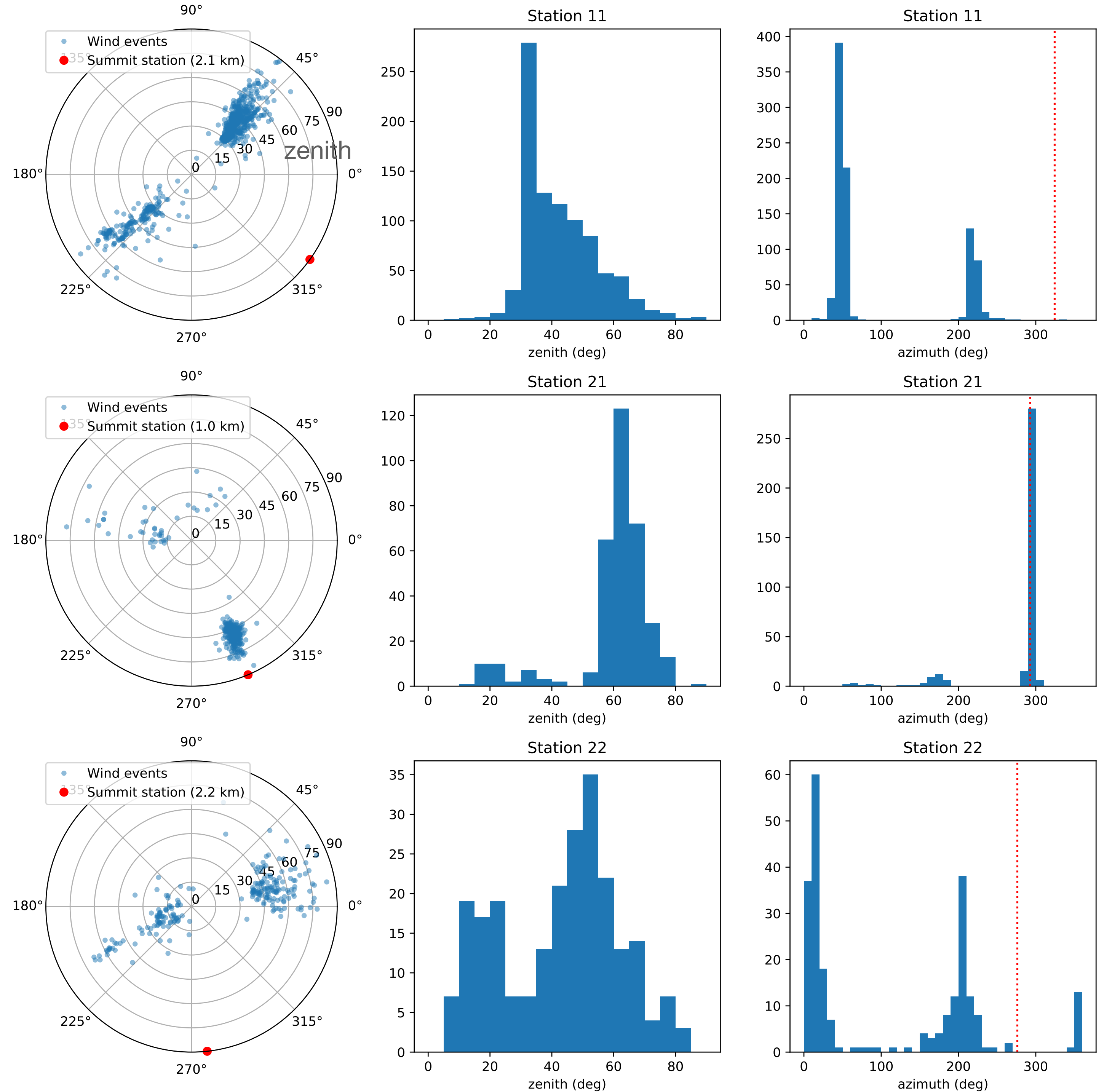
Correlation:

- Correlation plot of wind speed (m/s) and event rate (per 30 mins) for events above 200 ADC counts of some selected days of September (with wind speed values from 1 to 16 m/s)
- A “turn-on” behavior is observed with a threshold of 10 m/s



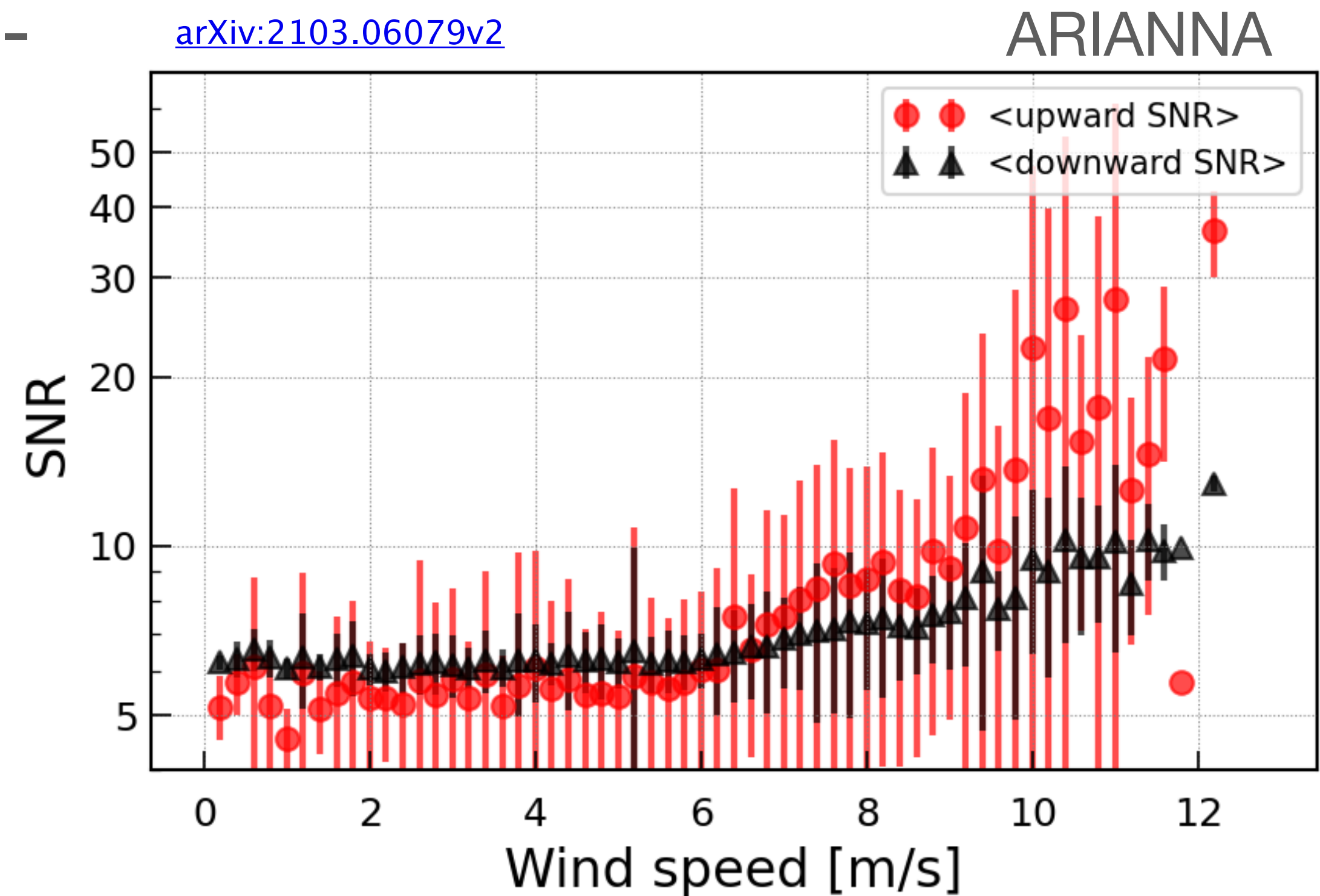
Direction reconstruction:

- Maps of zenith and azimuth reconstruction of events with > 200 ADC counts.
- In St. 21 (1.0 km distance to Summit Station) for one particular day, we observe an evident correlation with the Summit Station azimuth.
- In St. 11 and St. 22 (2.1-2.2 km distance to Summit Station) we observe an anisotropic source map with no clear correlation with known structures.



Other radio detectors:

- The same “turn-on” effect at the same wind-speed threshold has been also observed in other radio detectors: ARA, ARIANNA, ANITA, SATRA, AURA, RICE.
- Frequency spectra generally shifted to the low-end of the frequency regime to which current radio experiments are typically sensitive (100-200 MHz)
- For some experiments, a correlation is shown with position of nearby metallic structures indicating a preference for electric field discharge through ‘lightning rod’ effect. Not confirmed by other detectors.



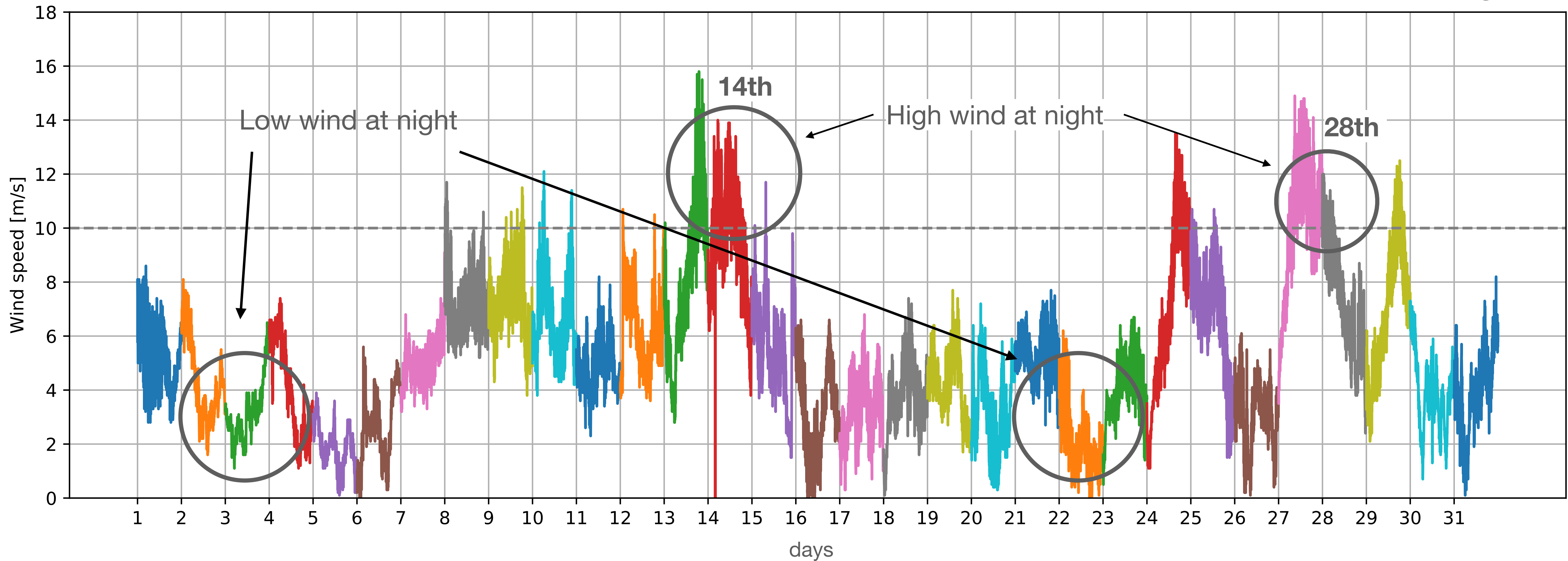
Conclusions & open questions

- For all detectors (located at both North/South Pole), it is observed a “turn-on” behavior at wind speed around 10 m/s; the origin is still not clear.
- The exact process of electric charging and discharging that produces triboelectric events in radio detectors is still not clear (“lighting-rod” effect, or charge build-up on the snow surface)
- RNO-G: Future study with more data will be performed to better look into their characteristics such as arrival direction, and to determine whether there are lower amplitude events correlated with increased wind-speed.

Backup

Wind speed measurements

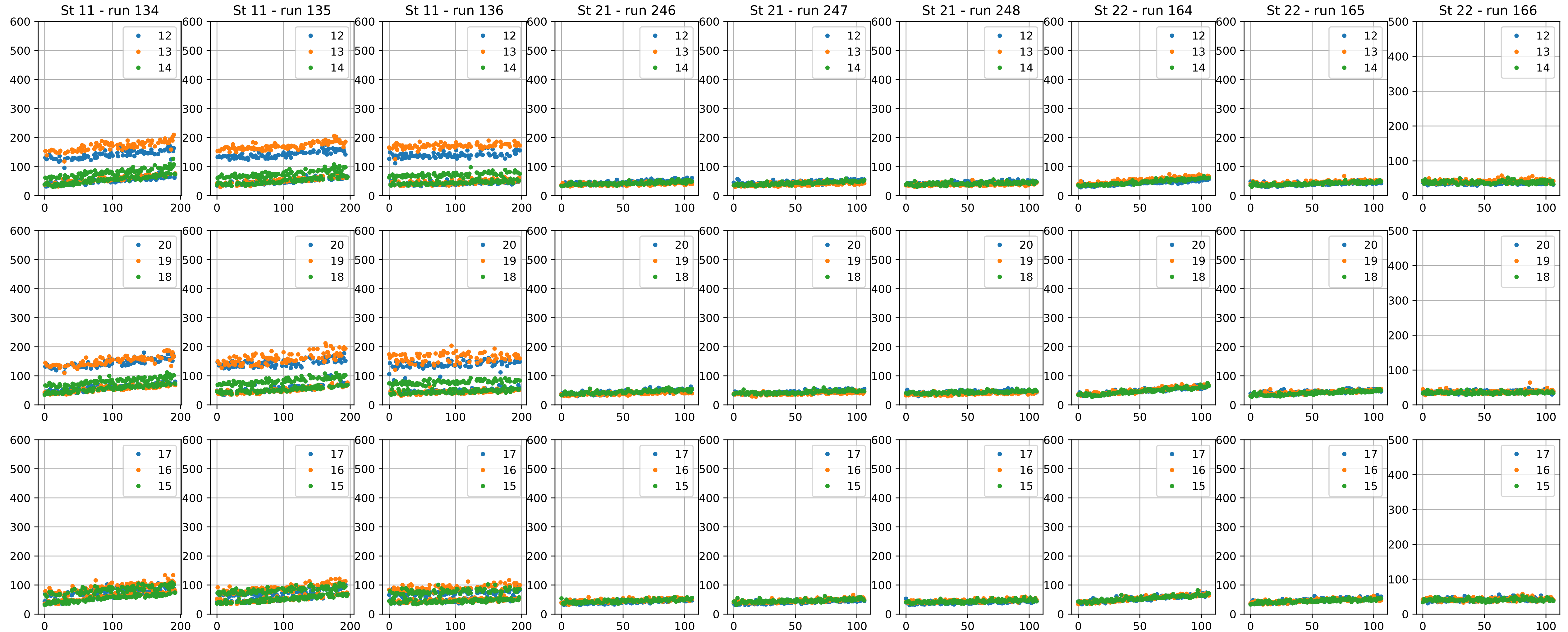
August



Low wind

3rd of August (1 am - 6, 7 am)

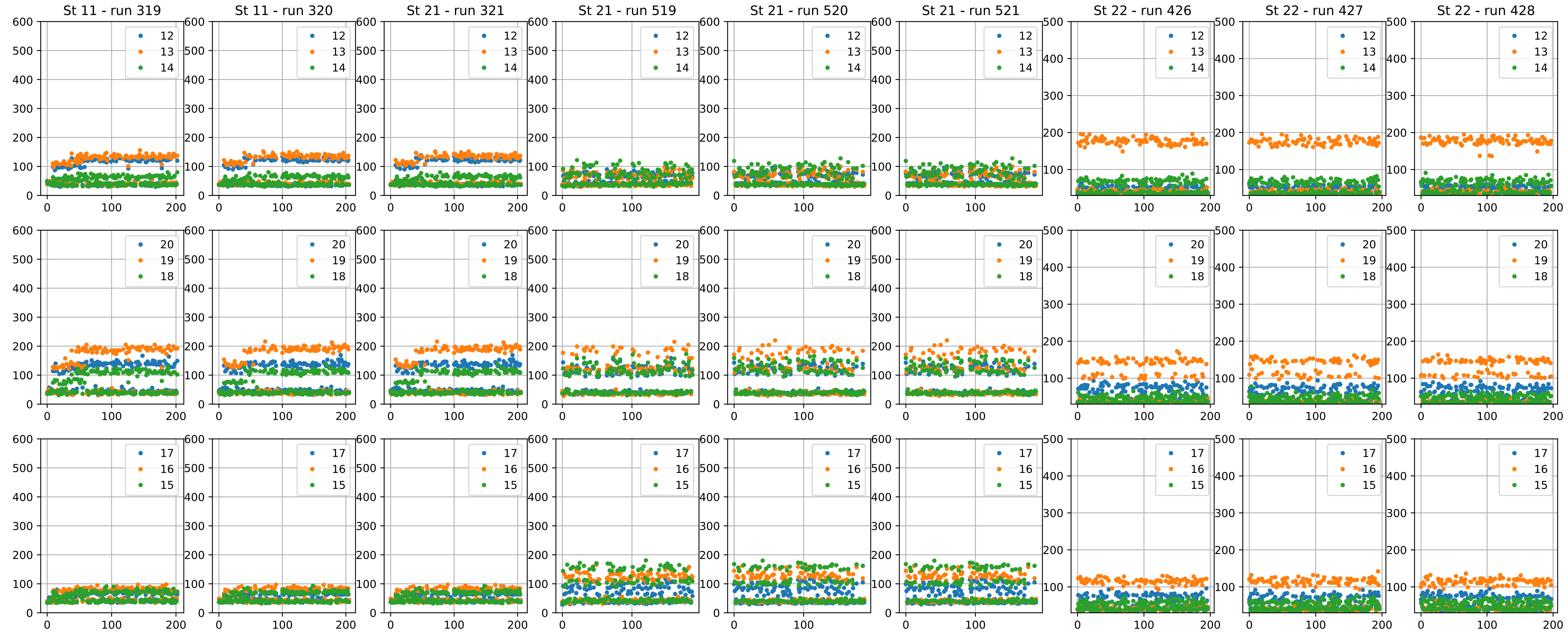
Maximum Amplitude



Low wind

22th of August (1 am - 6, 7 am)

Maximum Amplitude



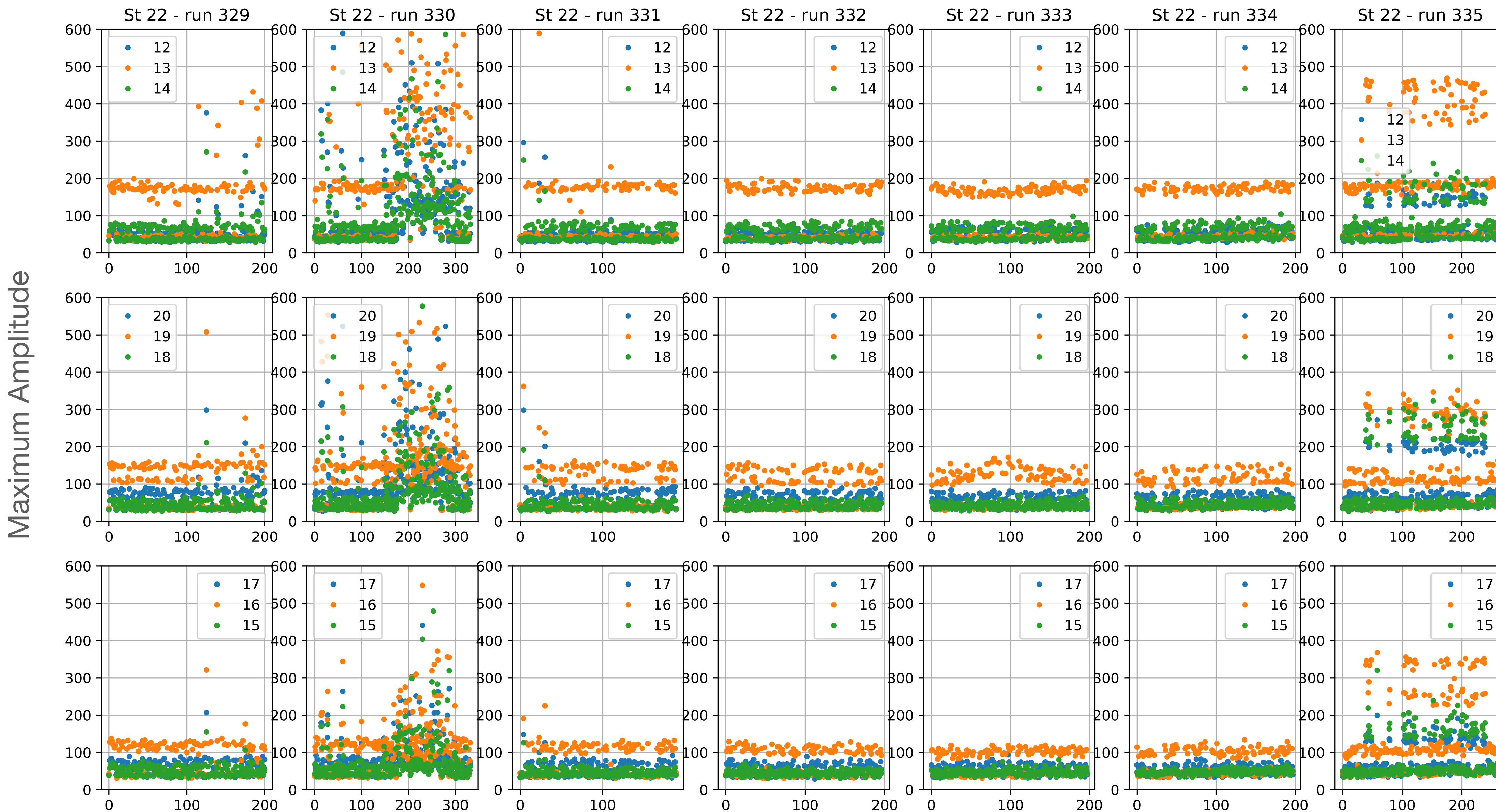
14th of August

High wind

(10:30 pm - 6:30 am)

Rain (7:00 am - 2:00 am)

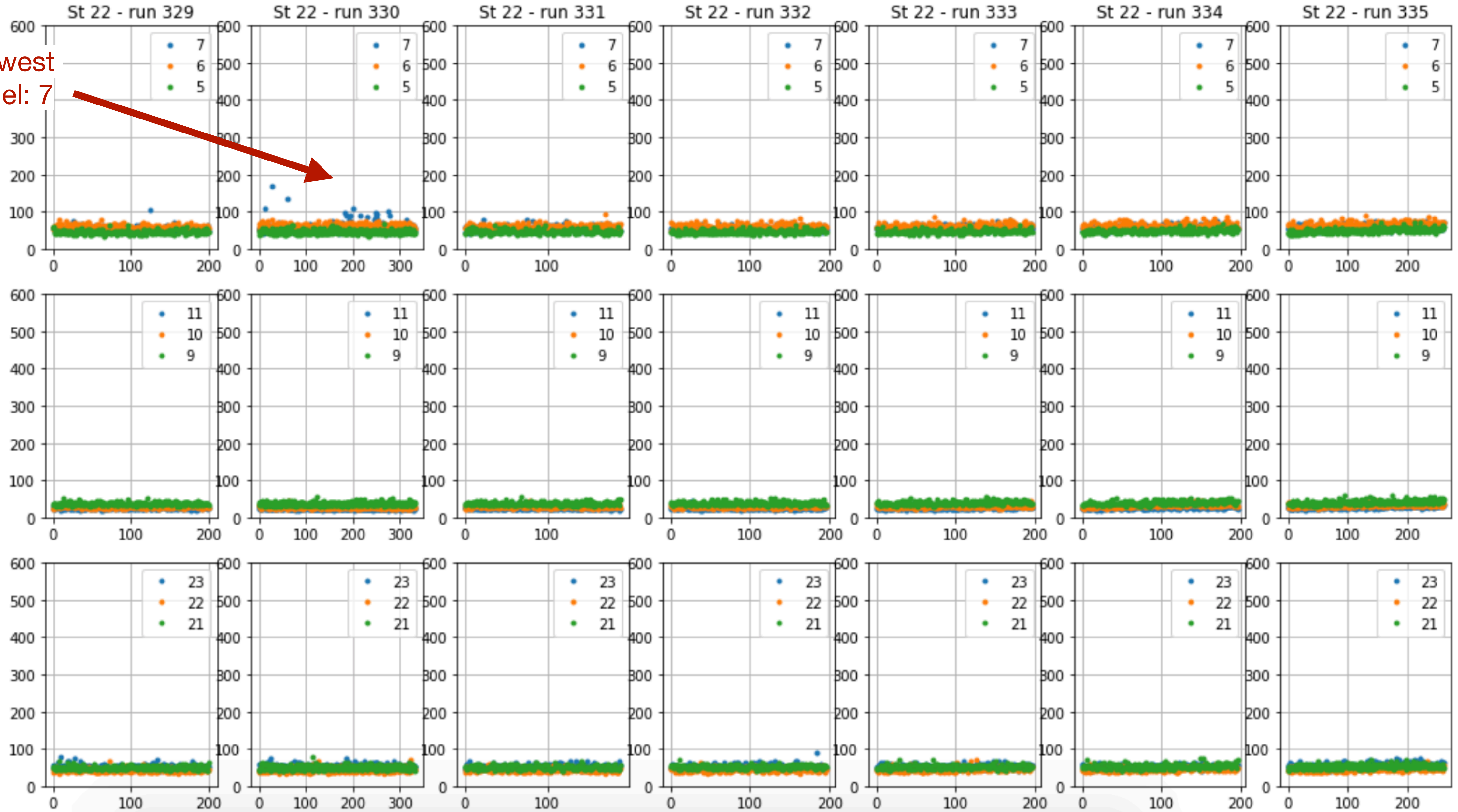
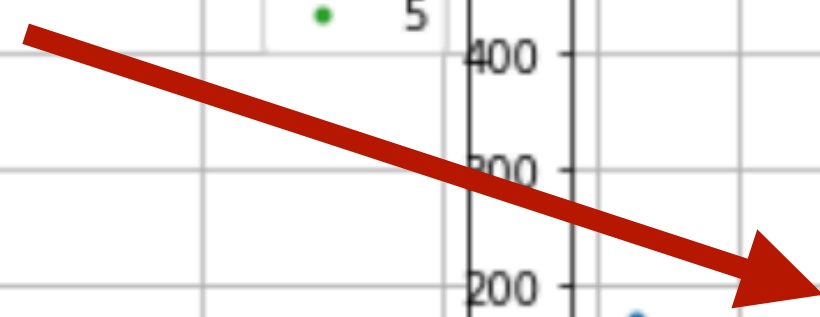
(6:30 am - 12:30 am)



14th of August

Deep channels

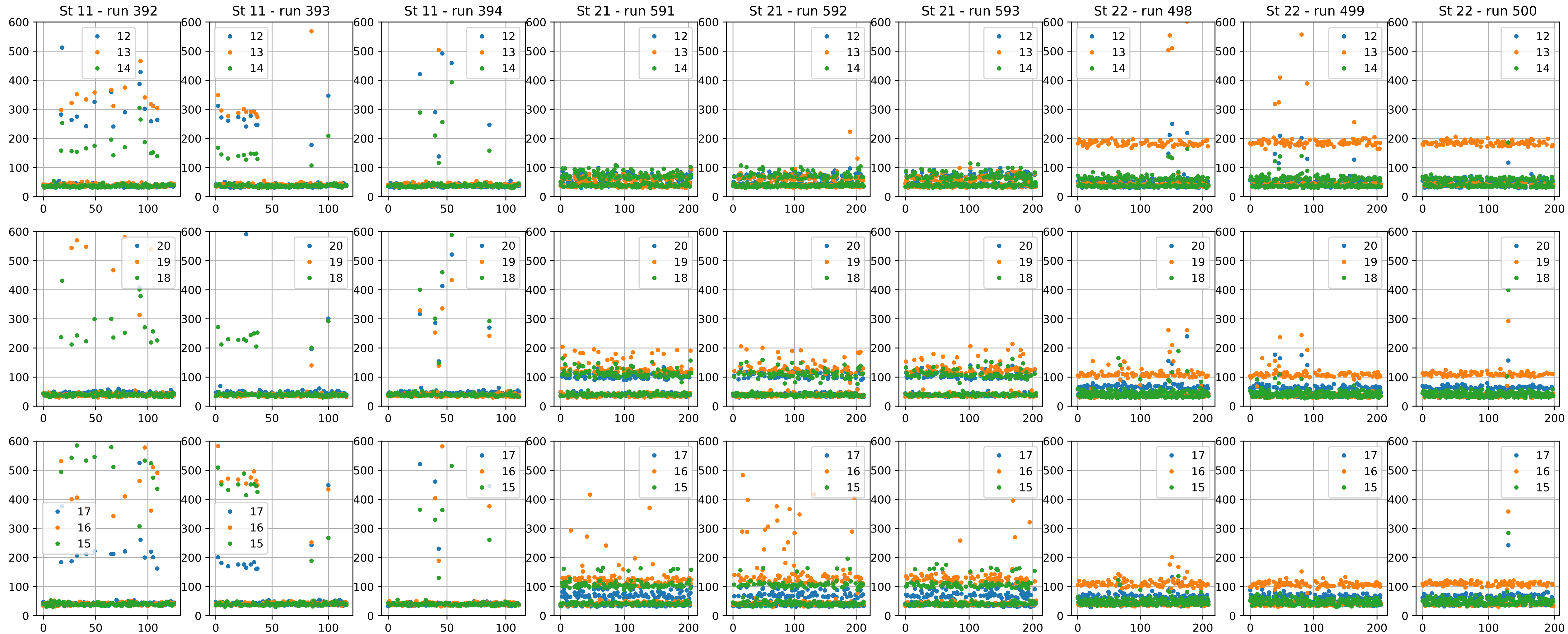
Shallowest
Channel: 7



High wind

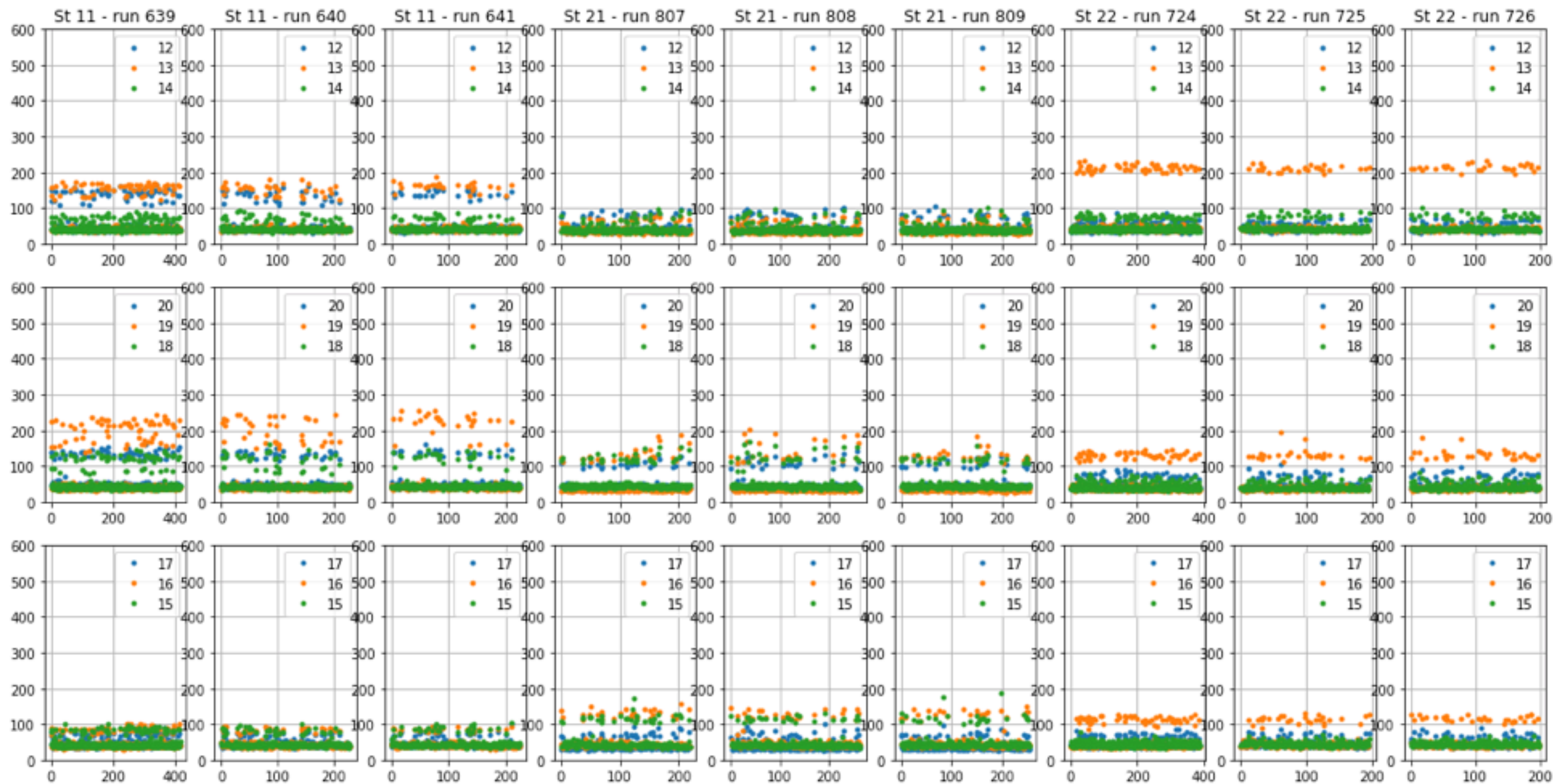
28th of August (1 am - 7 am)

Maximum Amplitude



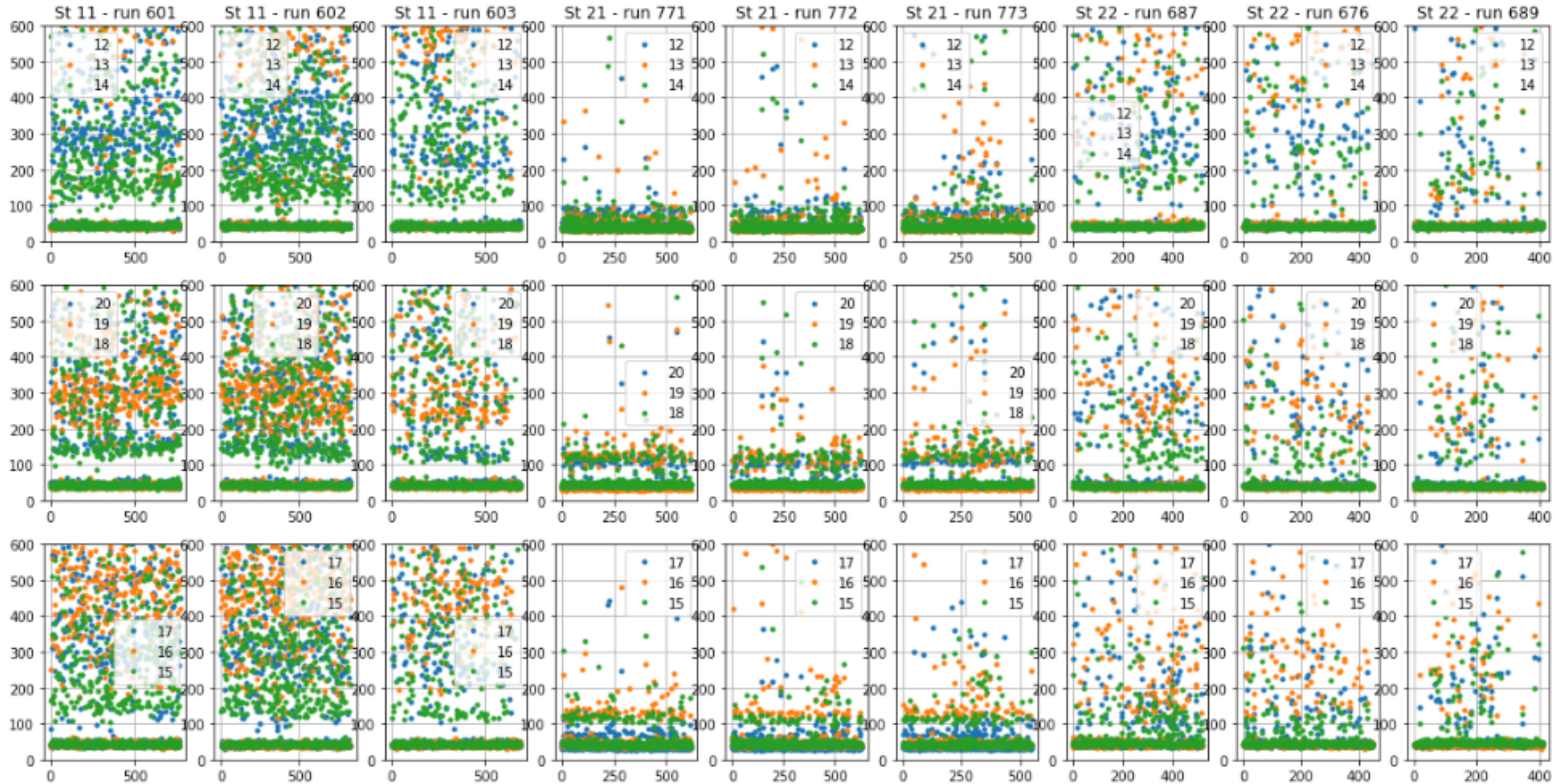
16th of September

Low wind



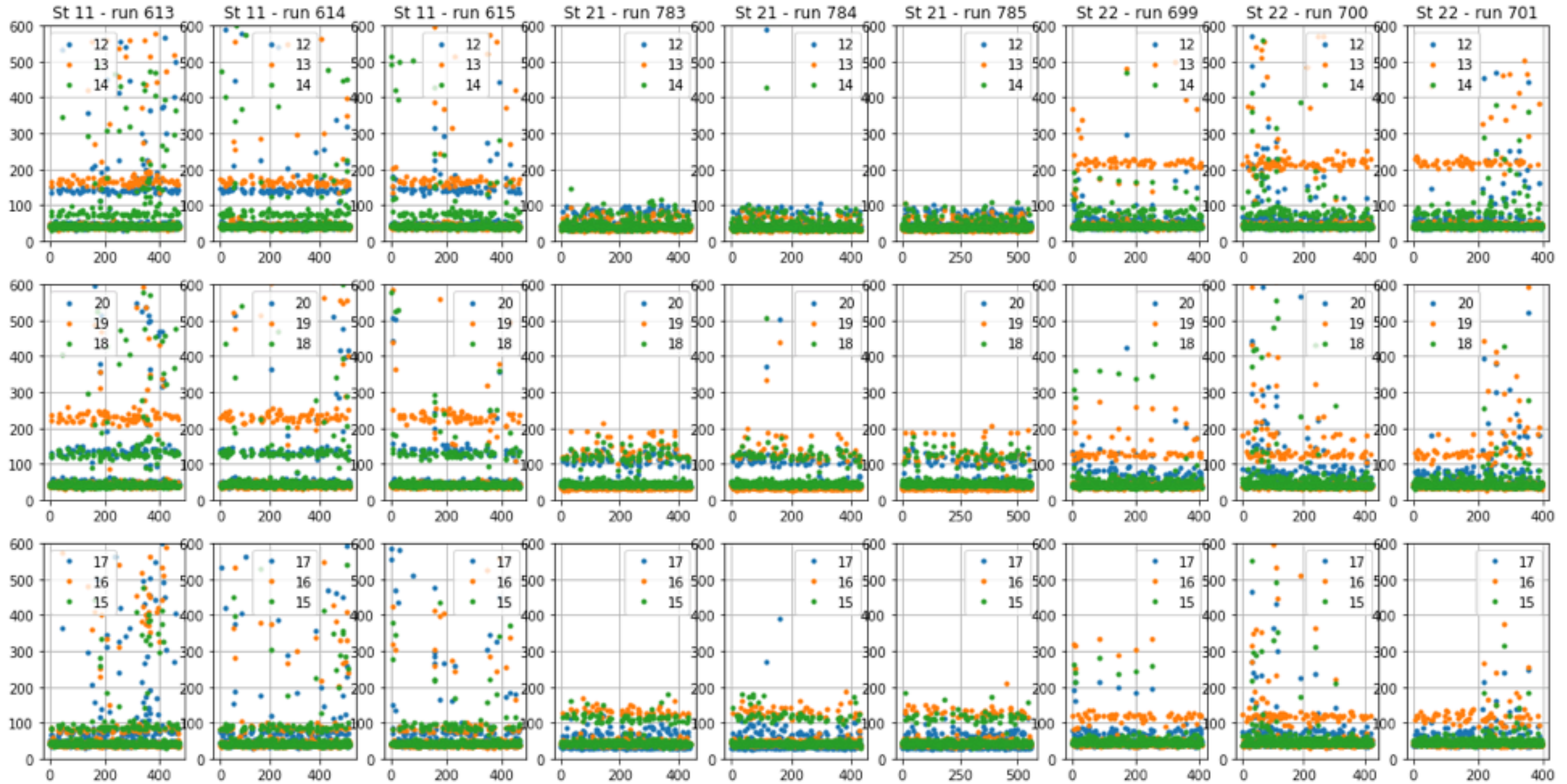
13th of September (High wind)

(23:30 pm - 5:00 am)



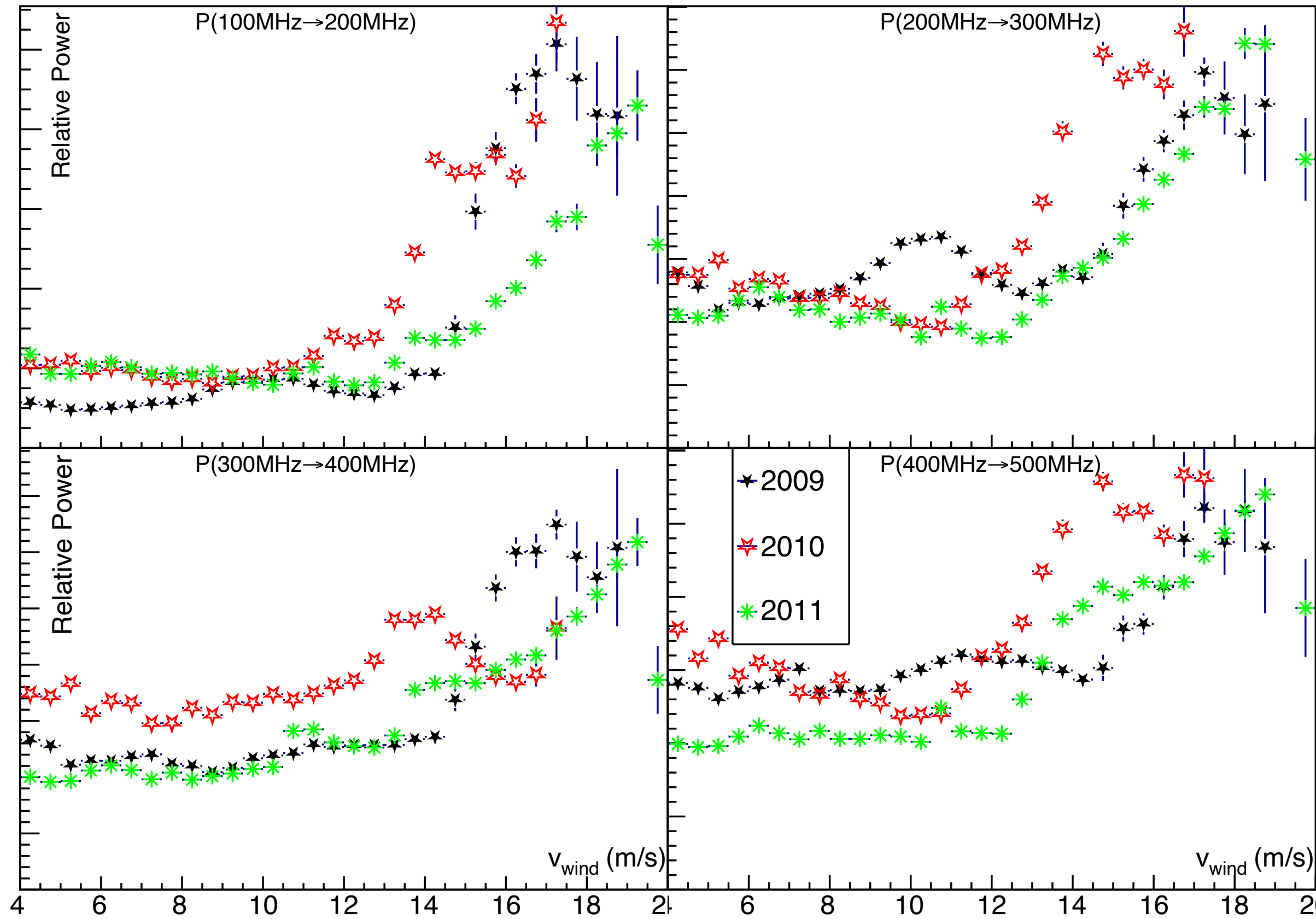
14th of September (High wind)

(23:30 pm - 5:00 am)



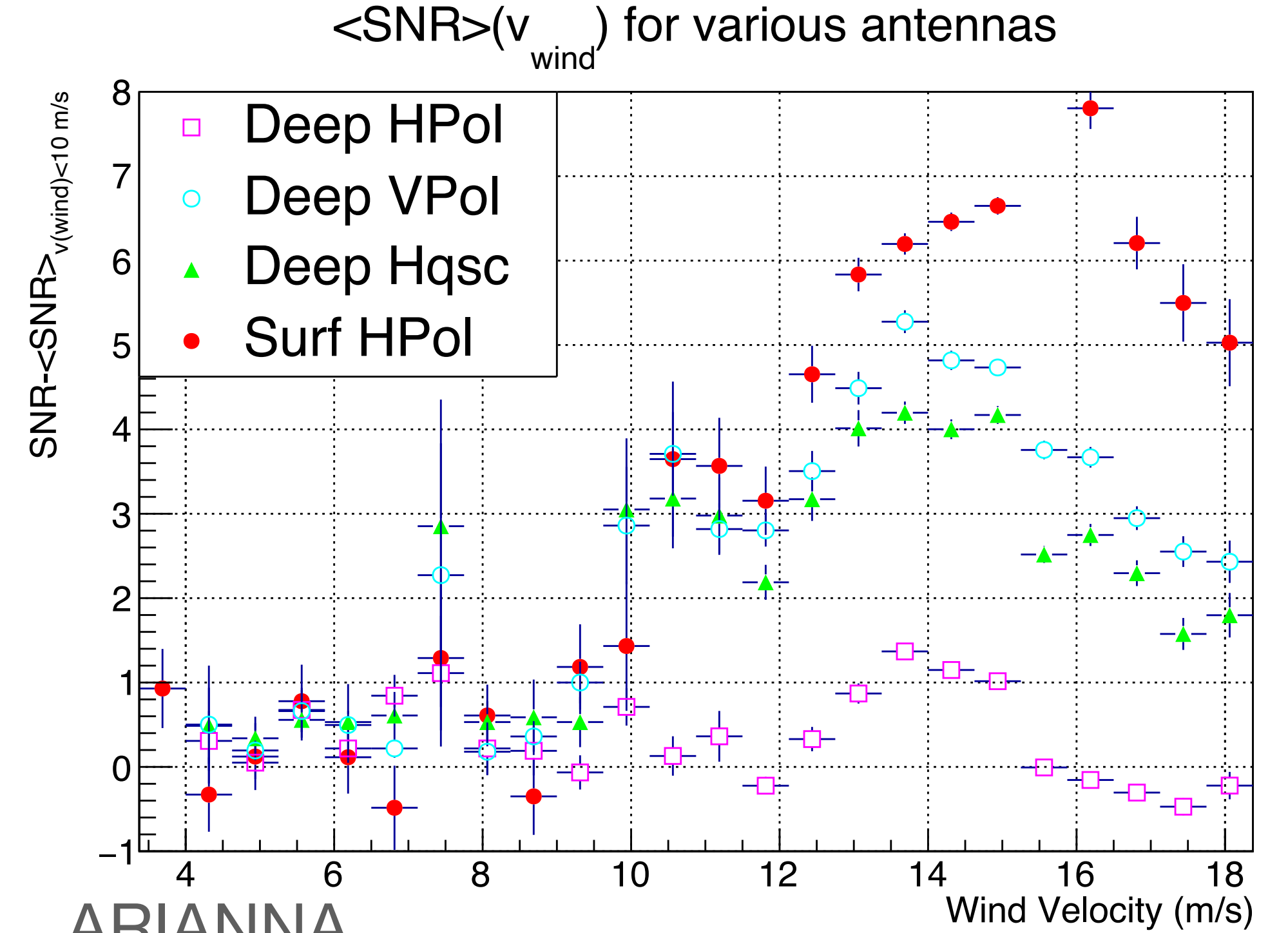
Triboelectric events in other detectors

RICE



Average RICE waveform signal power dependence on local wind velocity, for indicated frequency bins. We observe enhanced signal power in all frequency bins, with the largest relative increase at the lowest frequencies to which RICE is sensitive.

ARA



ARIANNA

