

Surface-atmosphere interactions from environmental radioactivity measurements

Susana Barbosa

INESC TEC

Outline

Introduction

- environmental radioactivity
- space-atmosphere-surface interaction
- radon
- field measurement

Gamma monitoring campaign (Azores)

- short-term variability & precipitation
- long-term variability & soil moisture

Atmospheric electricity and radioactivity campaign (Hyytiälä)

- atmospheric electricity
- soil radon
- gamma radiation

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Environmental radioactivity

Artificial sources

- fallout from atmospheric testing of nuclear weapons (<1970's)
- industrial activities (nuclear power plants, mining, fracking,...)
- nuclear accidents (Chernobyl, Fukushima,...)

Natural sources

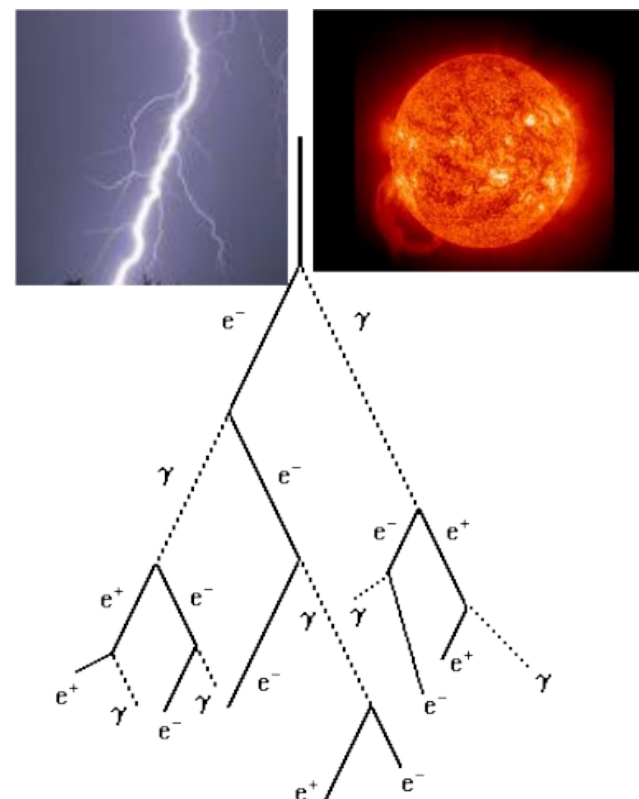
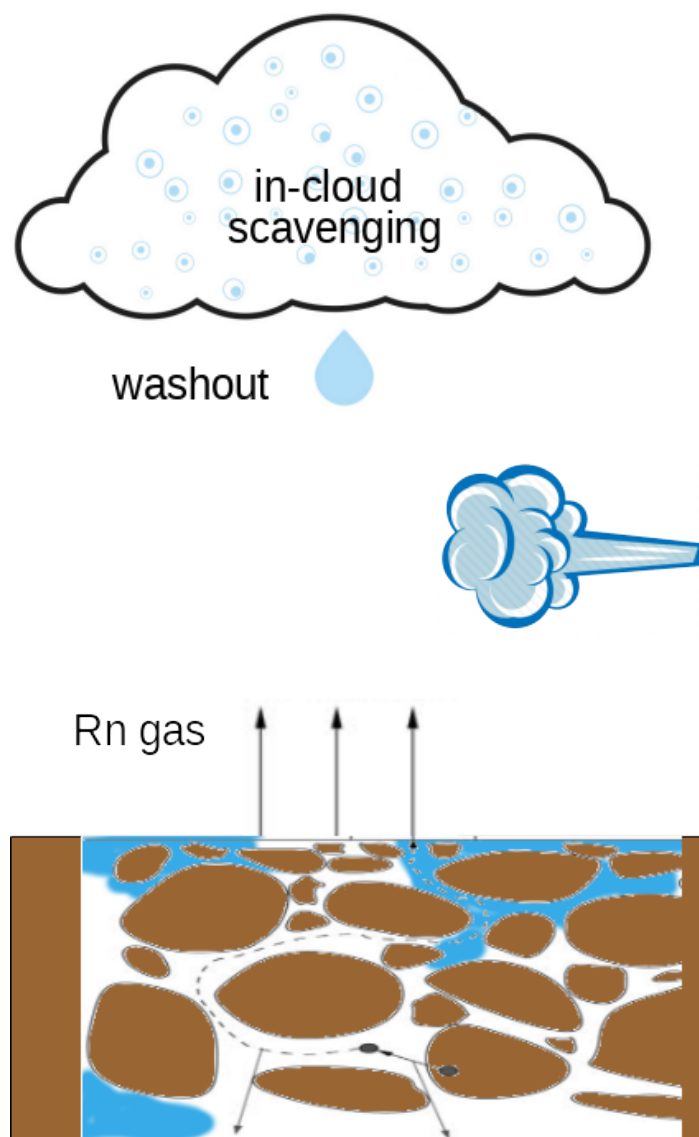
- primordial

[K40, U238, Th232,...]

- cosmogenic (from interaction of cosmic rays and upper atmosphere gases)

[Be7, H3, C14,...]

Natural radioactivity: space-atmosphere-surface



Environmental radioactivity: Radon

Radon (Rn-222)

- gas (highly mobile)
 - noble (non-reactive)
 - short half-life (3.8 days)
 - easily measurable by nuclear techniques
- > Unique geophysical proxy/tracer

Applications:

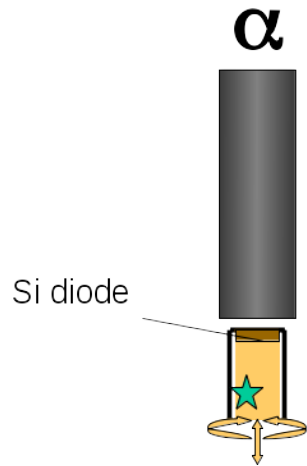
- volcanic monitoring
- CO2 monitoring
- tectonic indicator / earthquake precursor (?!?)
- hydrologic tracer (thermal waters, groundwater)
- atmospheric tracer (air masses)

Environmental radioactivity: measurement

Geophysical radon monitoring

- High-frequency (minutes), continuous measurements (rather than integrated)
- Automatic (monitoring rather than samples collection)
- Long-term (seasonal, trends,...)
- Passive sampling (undisturbed conditions, NO pumping)
- Gamma-ray counting (radon progeny – higher sensitivity)

Environmental radioactivity: measurement

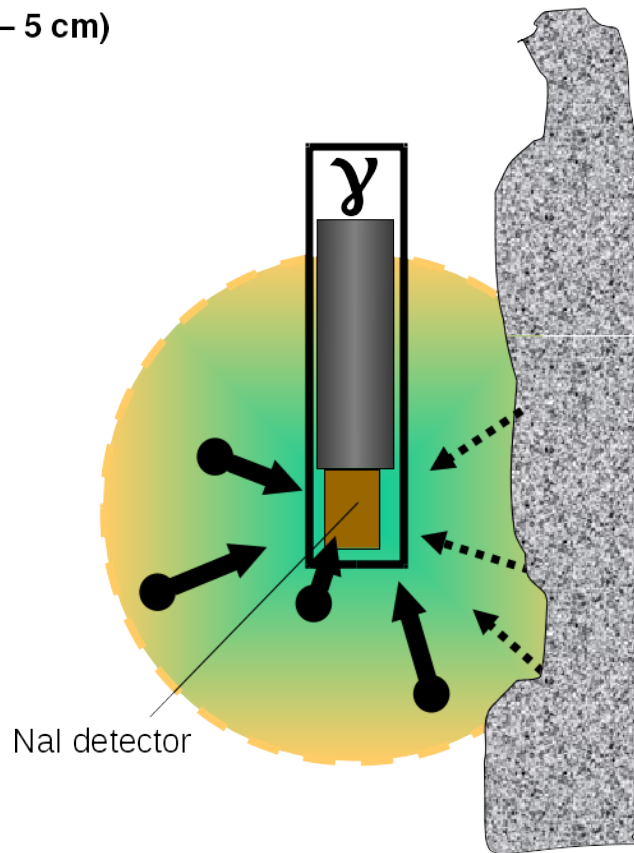


Emitted by Rn-222

Highly ionising radiation

Short range in air (3 – 5 cm)

Stopped by paper



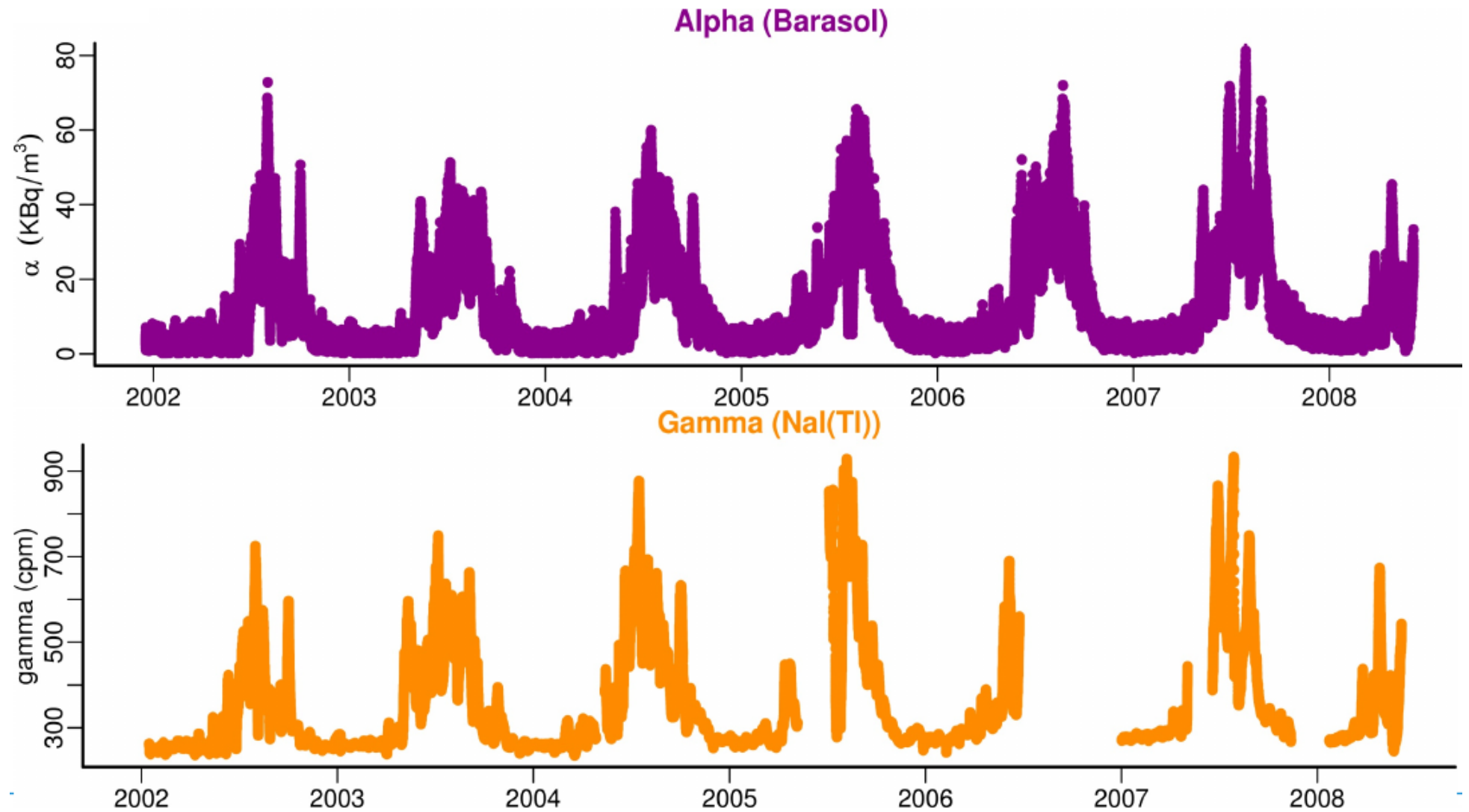
Emitted by Rn-222 progeny
(Bi-214, Pb-214, Pb-210) + KUT

Weakly ionising radiation

Long range (inverse square law)

Attenuated by thick lead

Example I - stable environment



Barbosa et al 2010

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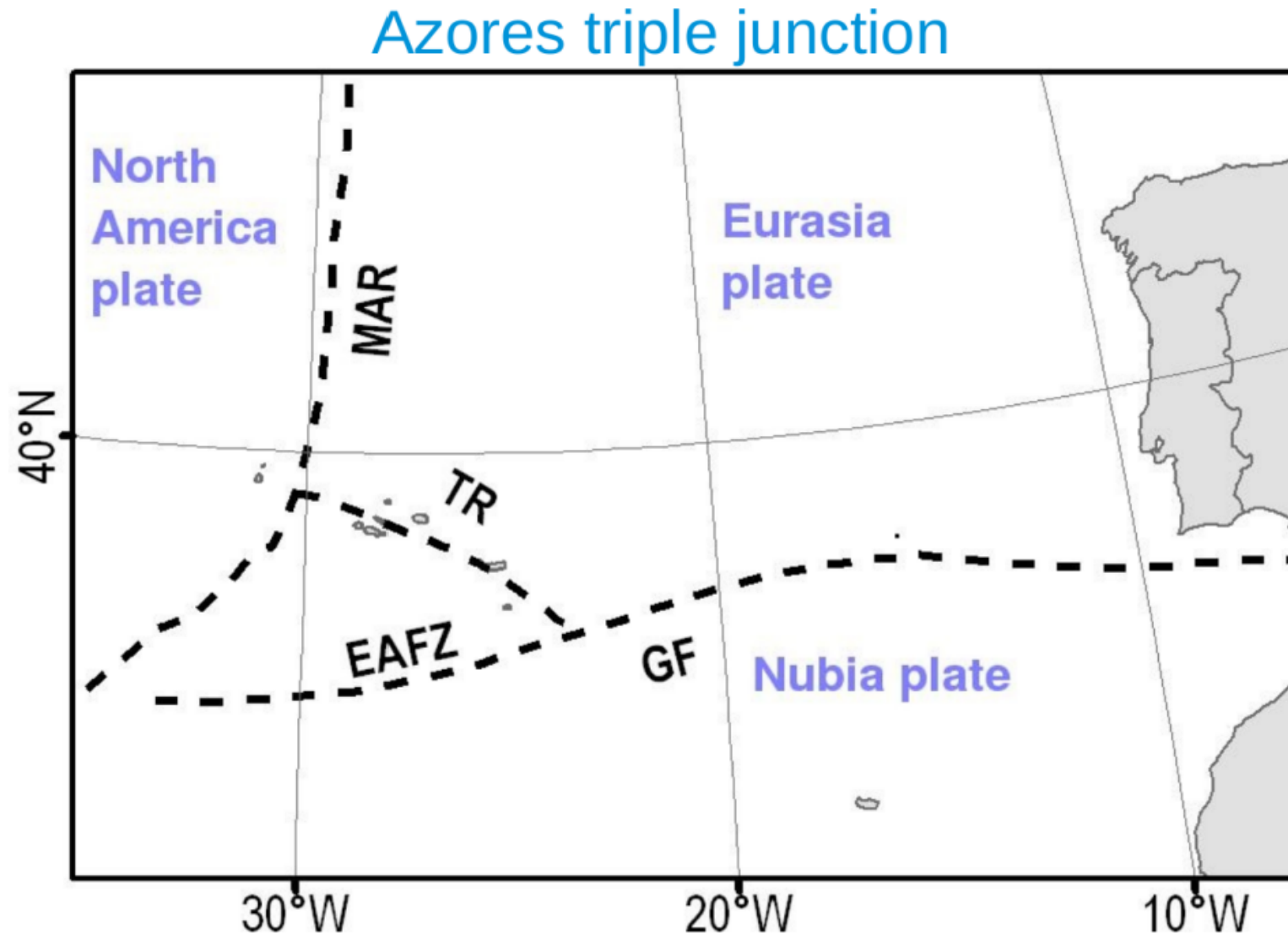
Concluding remarks

The gamma monitoring campaign - Azores

Geographic setting



The gamma monitoring campaign - Azores



The gamma monitoring campaign - Azores



U.S. Department of Energy
Eastern North Atlantic



Radars, radiometers, lidars, aerosols, trace gases,...

The gamma monitoring campaign - Azores

All data (15-min gamma counts) publicly available!

RESEARCH > CAMPAIGNS

GRM

<https://www.arm.gov/research/campaigns/ena2015grm>

BROWSE DATA

GAMMA RADIATION MONITORING

1 APRIL 2015 - 31 MARCH 2018
LEAD SCIENTIST: SUSANA BARBOSA
OBSERVATORY: [ENA](#)

This gamma radiation monitoring campaign focus on the study of the temporal variability of the concentration of the noble gas radon (Rn-222), aiming to examine how it's influenced by meteorological conditions, how it impacts the local atmospheric electric field, and its association with the atmosphere's ionization and aerosol's concentration.

CO-INVESTIGATORS

Pedro Miranda

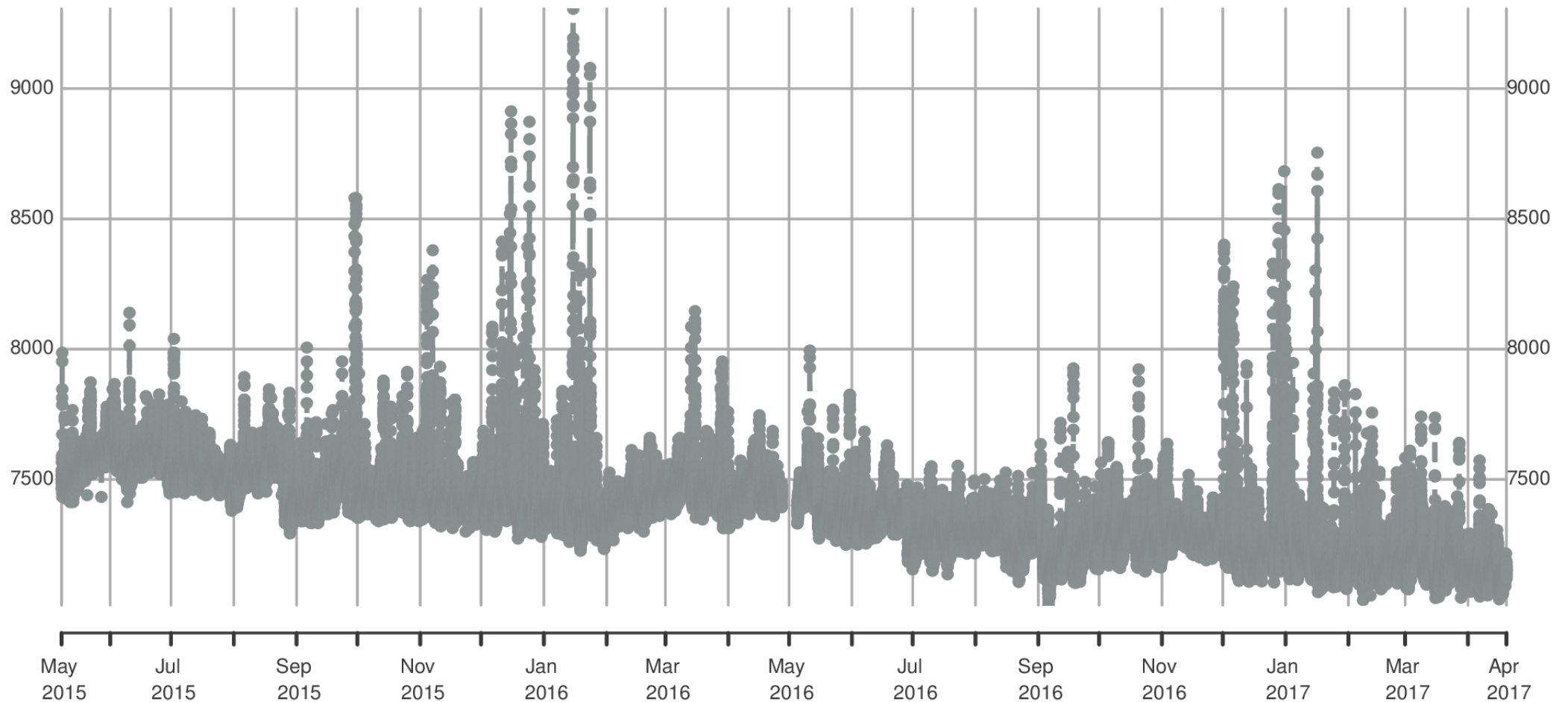
CAMPAIGN DATA SETS

IOP PARTICIPANT	DATA SOURCE NAME	FINAL DATA
Susana Barbosa	Gamma Ray Detector	Order Data

The gamma monitoring campaign - Azores

Gamma count rate (cpm)

2015-05-08 / 2017-04-19 23:45:00

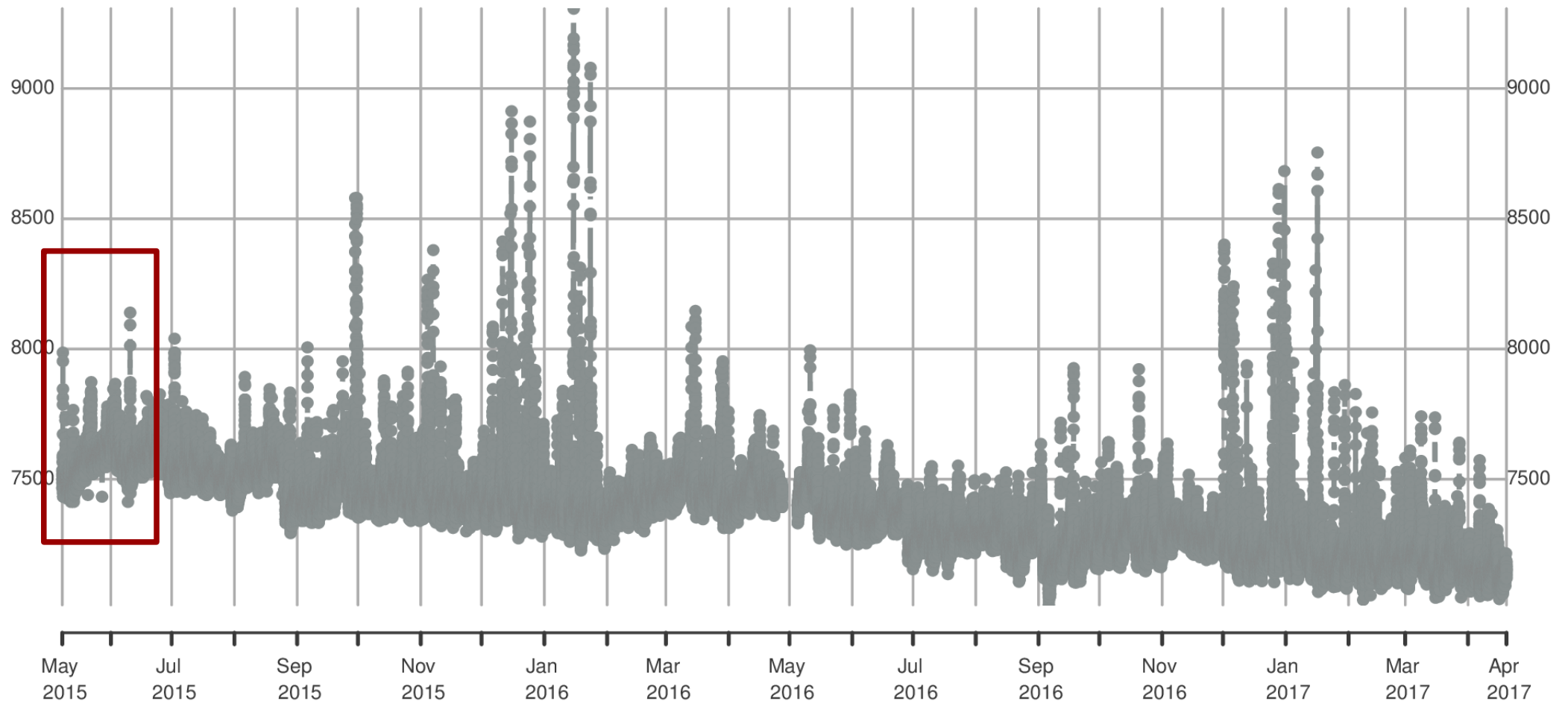


The gamma monitoring campaign - Azores

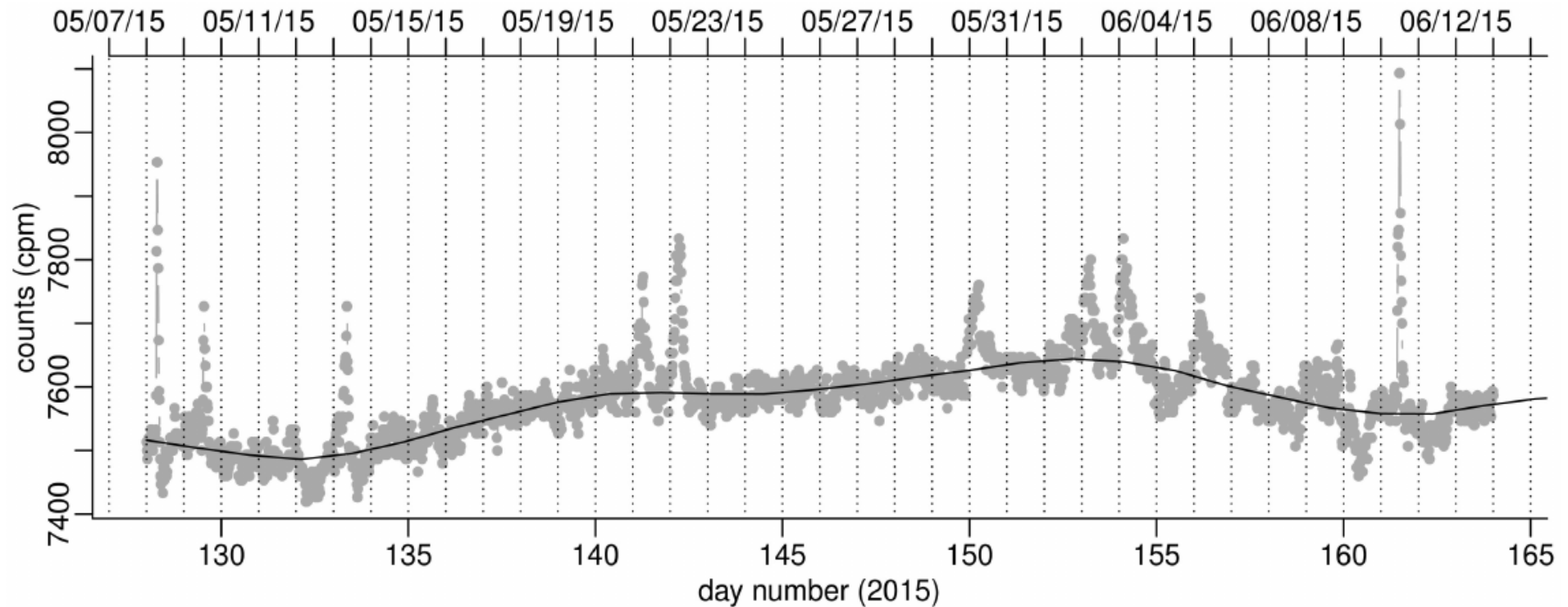
short-term variability

Gamma count rate (cpm)

2015-05-08 / 2017-04-19 23:45:00

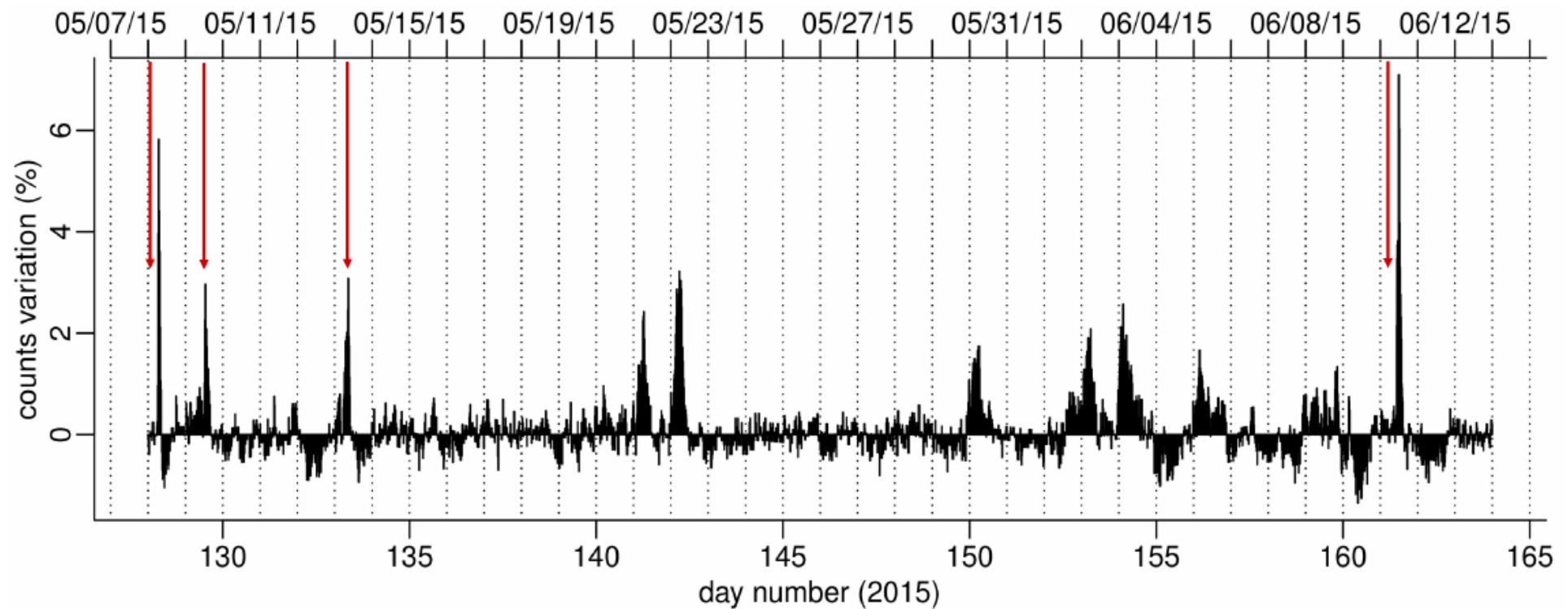


The gamma monitoring campaign - Azores



The gamma monitoring campaign - Azores

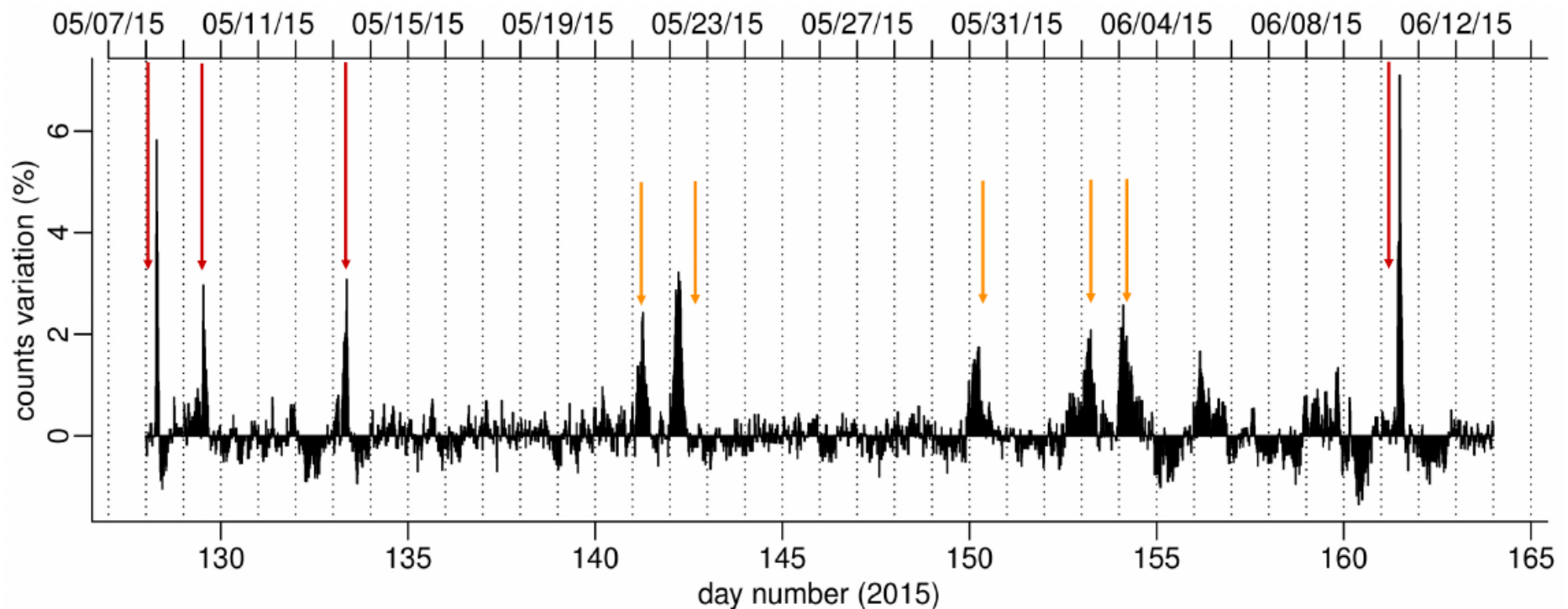
15-min counts



Sharp peaks (< 4 h)

The gamma monitoring campaign - Azores

15-min counts

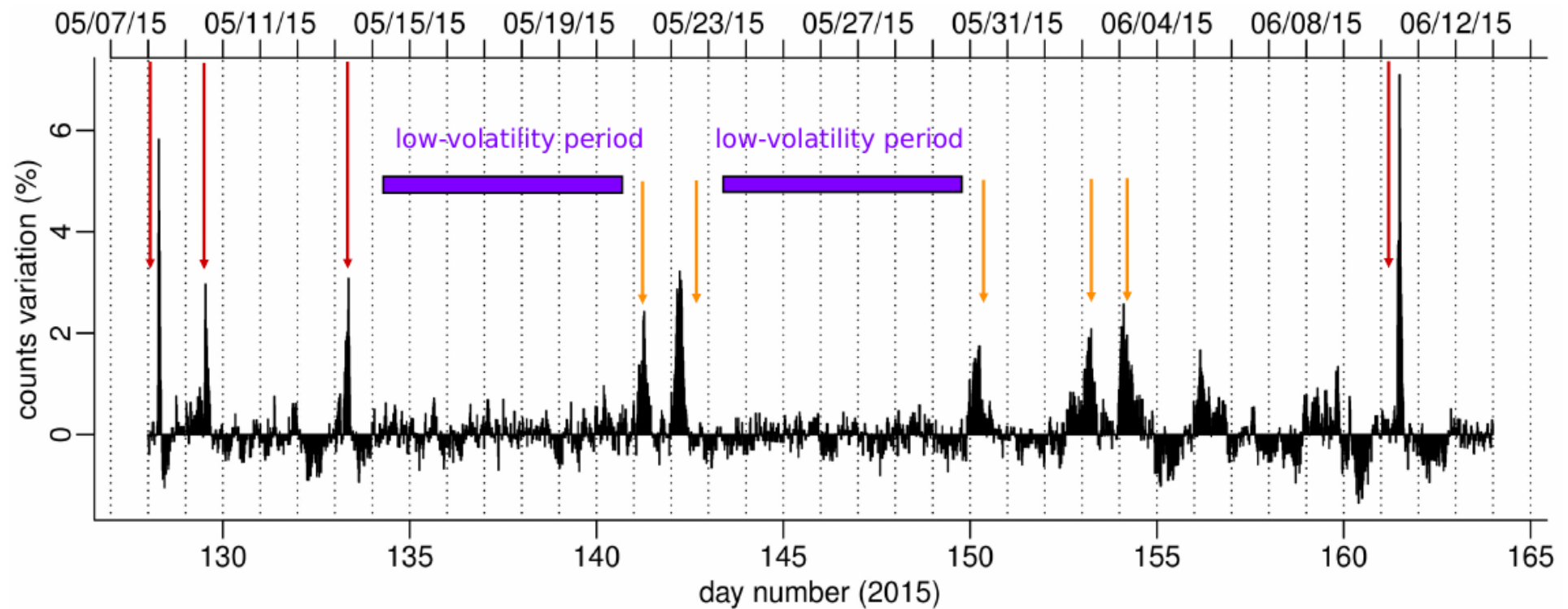


Sharp peaks (< 4 h)

“broad” anomalies (~1 day)

The gamma monitoring campaign - Azores

15-min counts

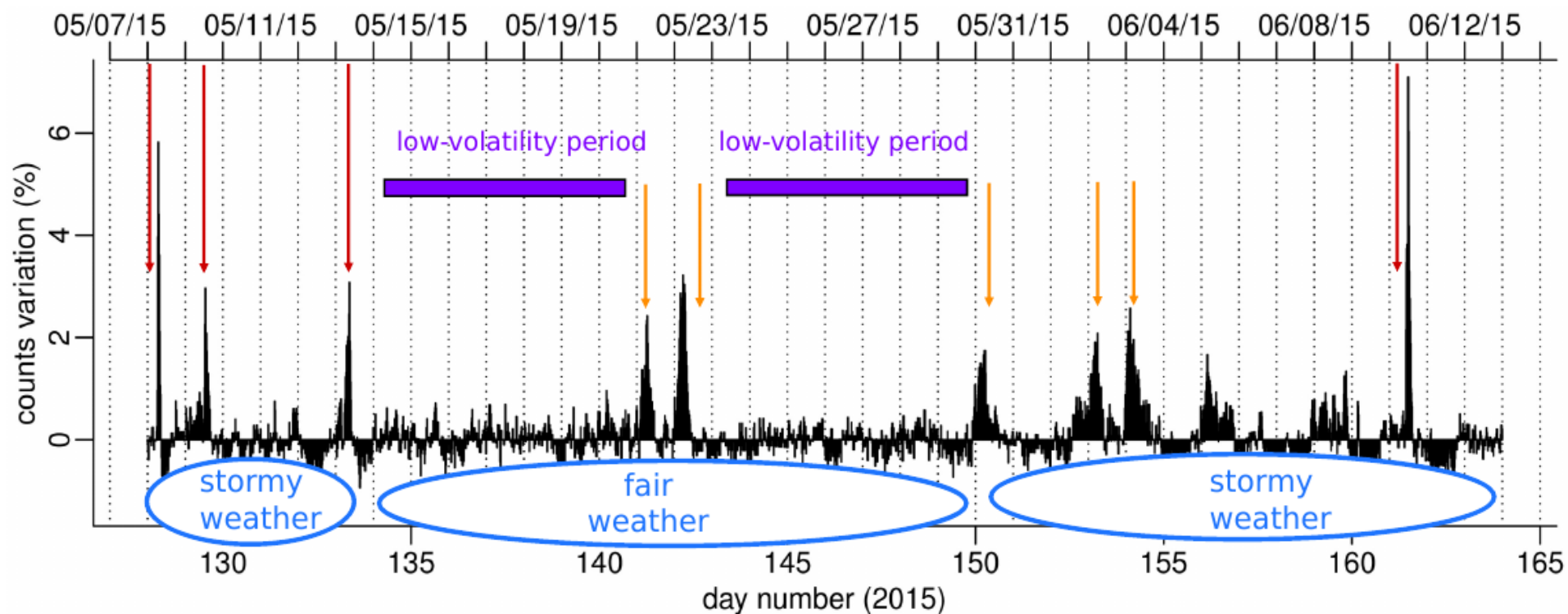


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The gamma monitoring campaign - Azores

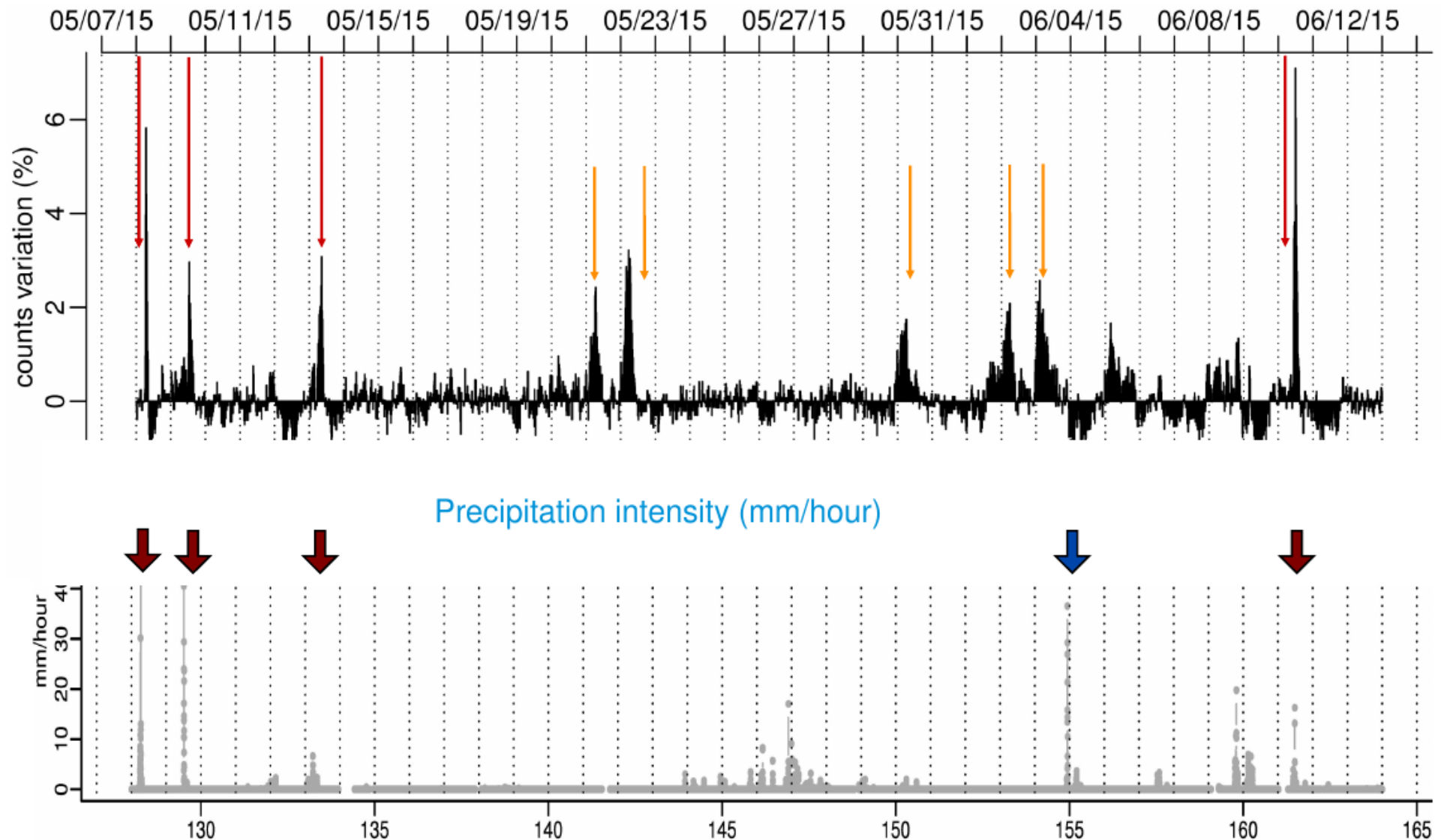
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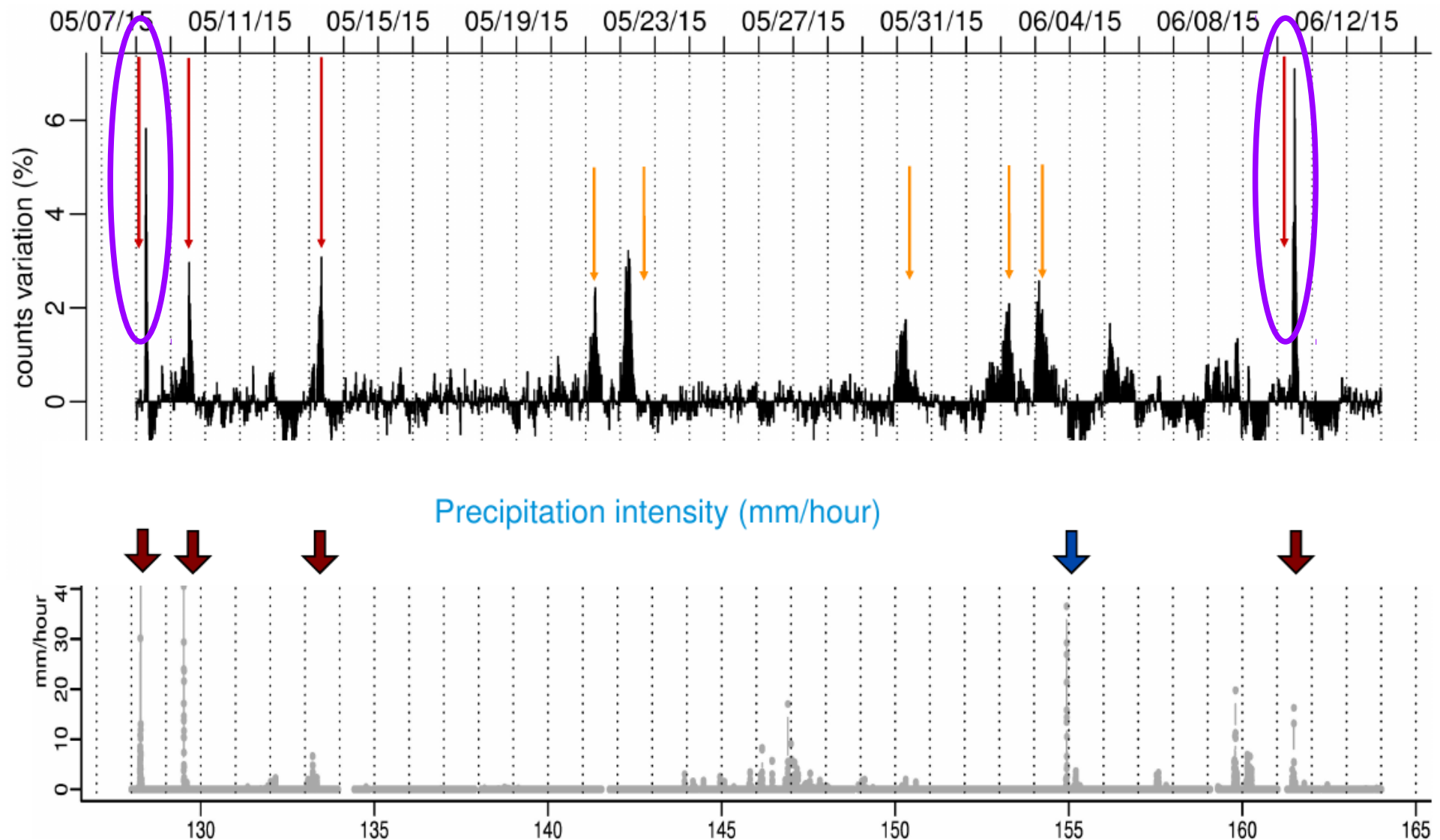
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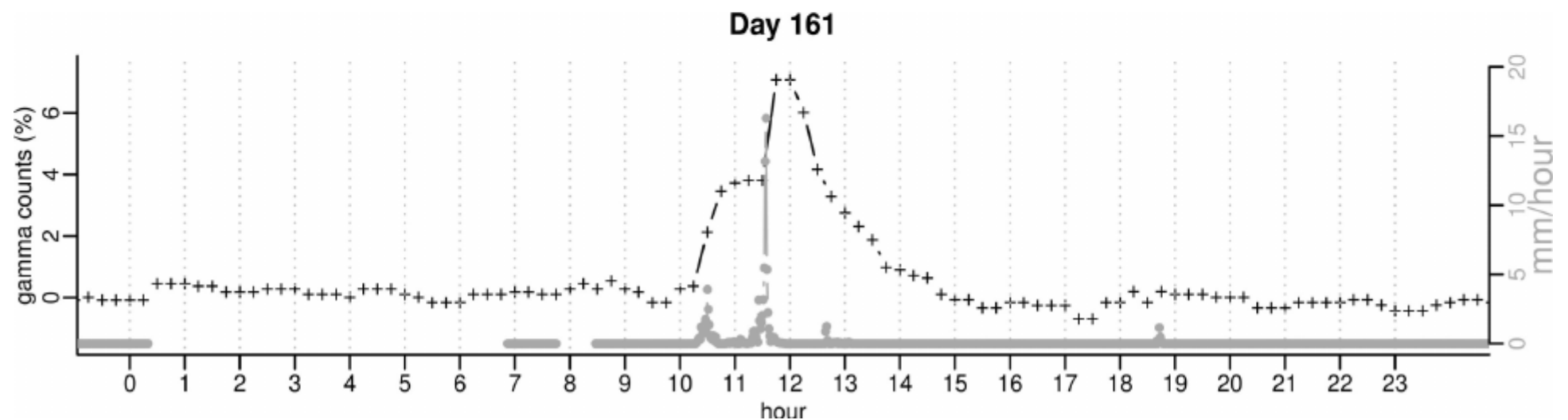
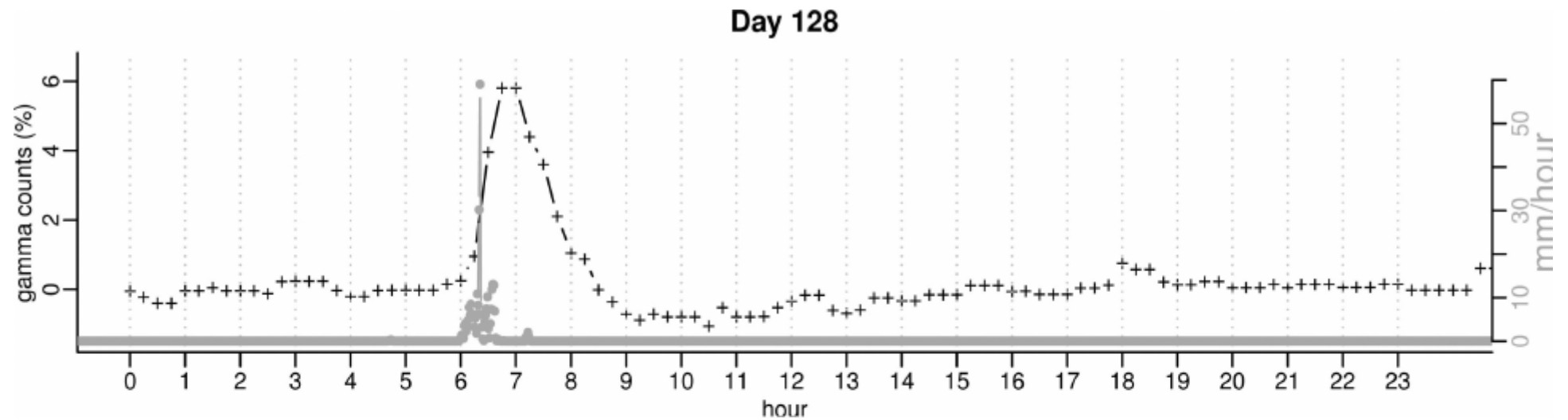
The gamma monitoring campaign - Azores



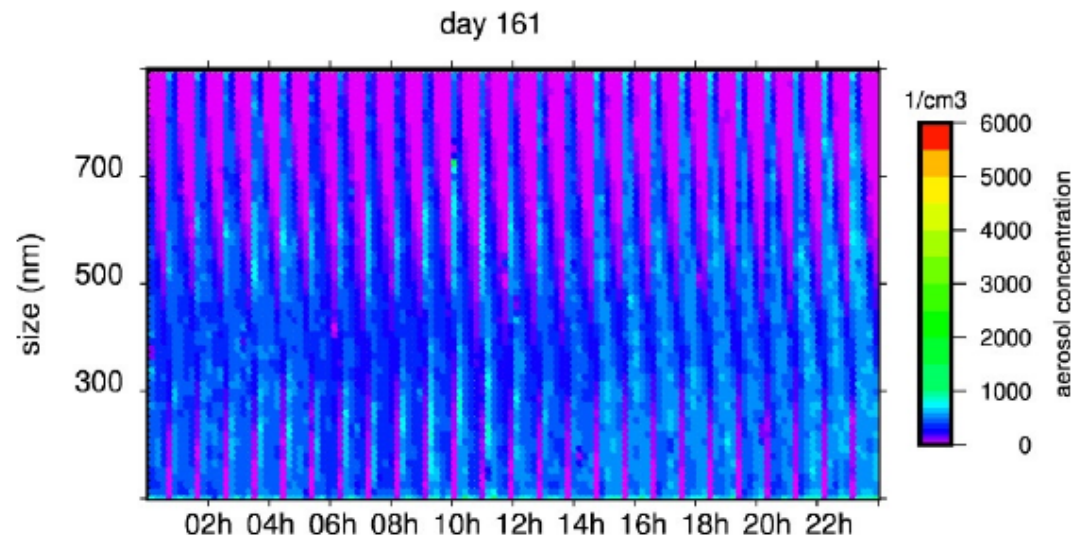
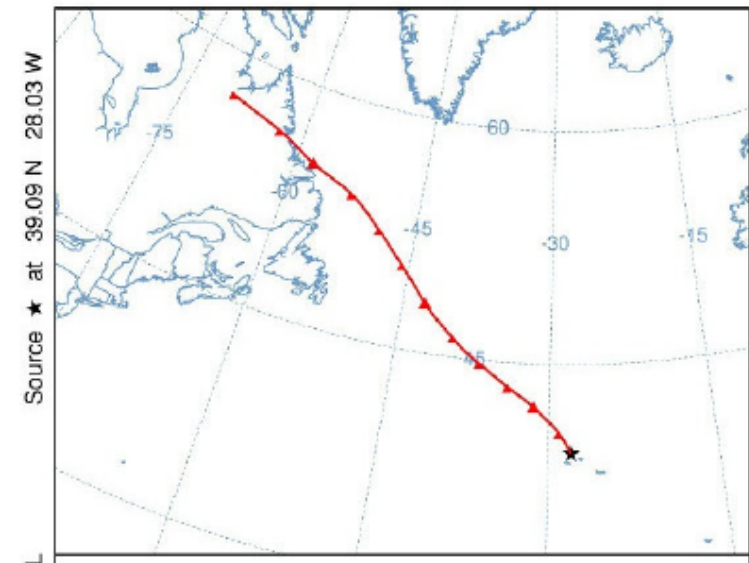
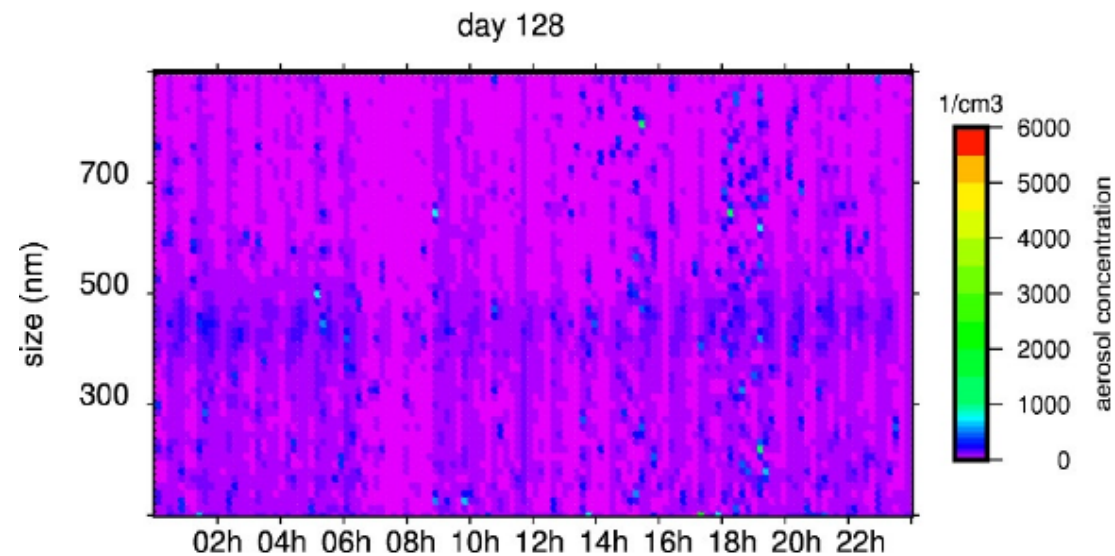
The gamma monitoring campaign - Azores



The gamma monitoring campaign - Azores



The gamma monitoring campaign - Azores

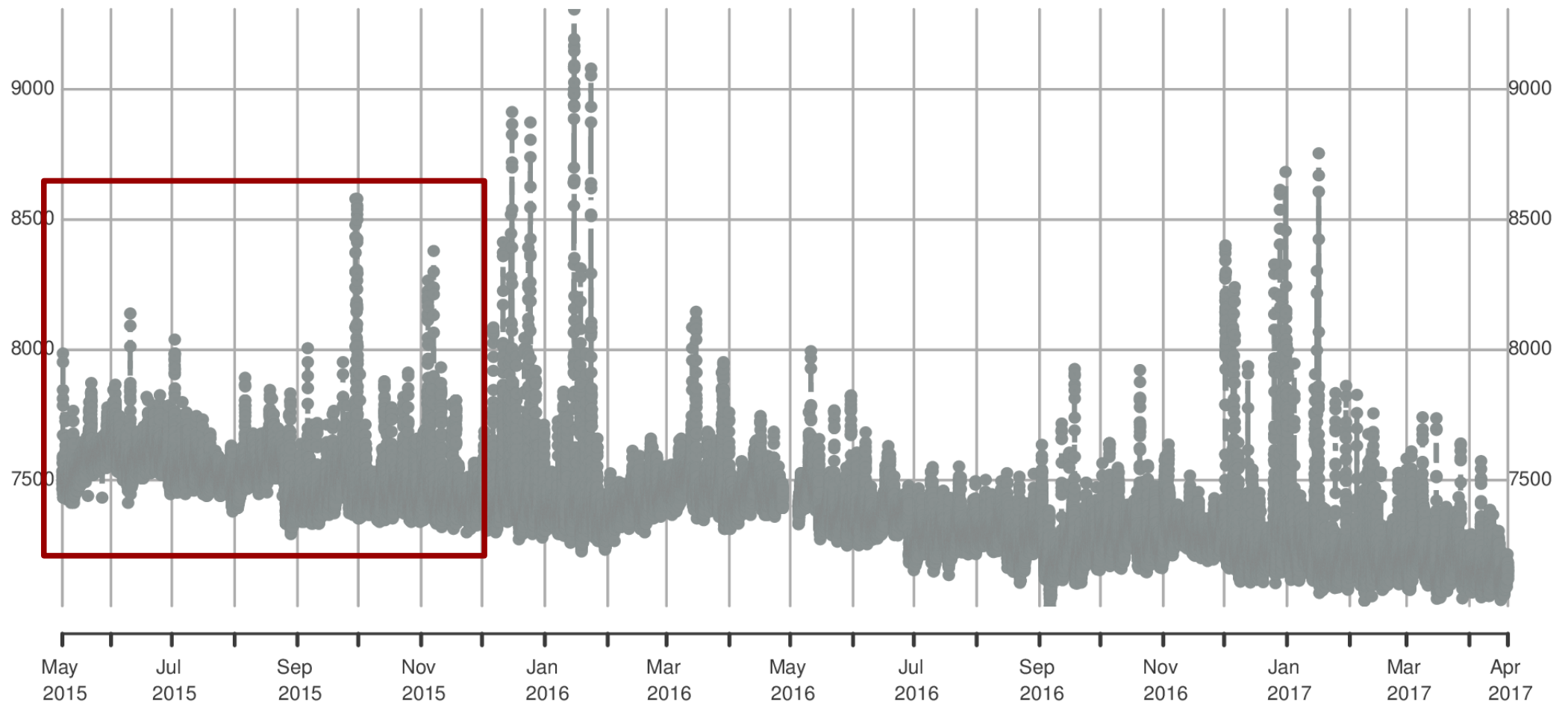


The gamma monitoring campaign - Azores

long-term variability

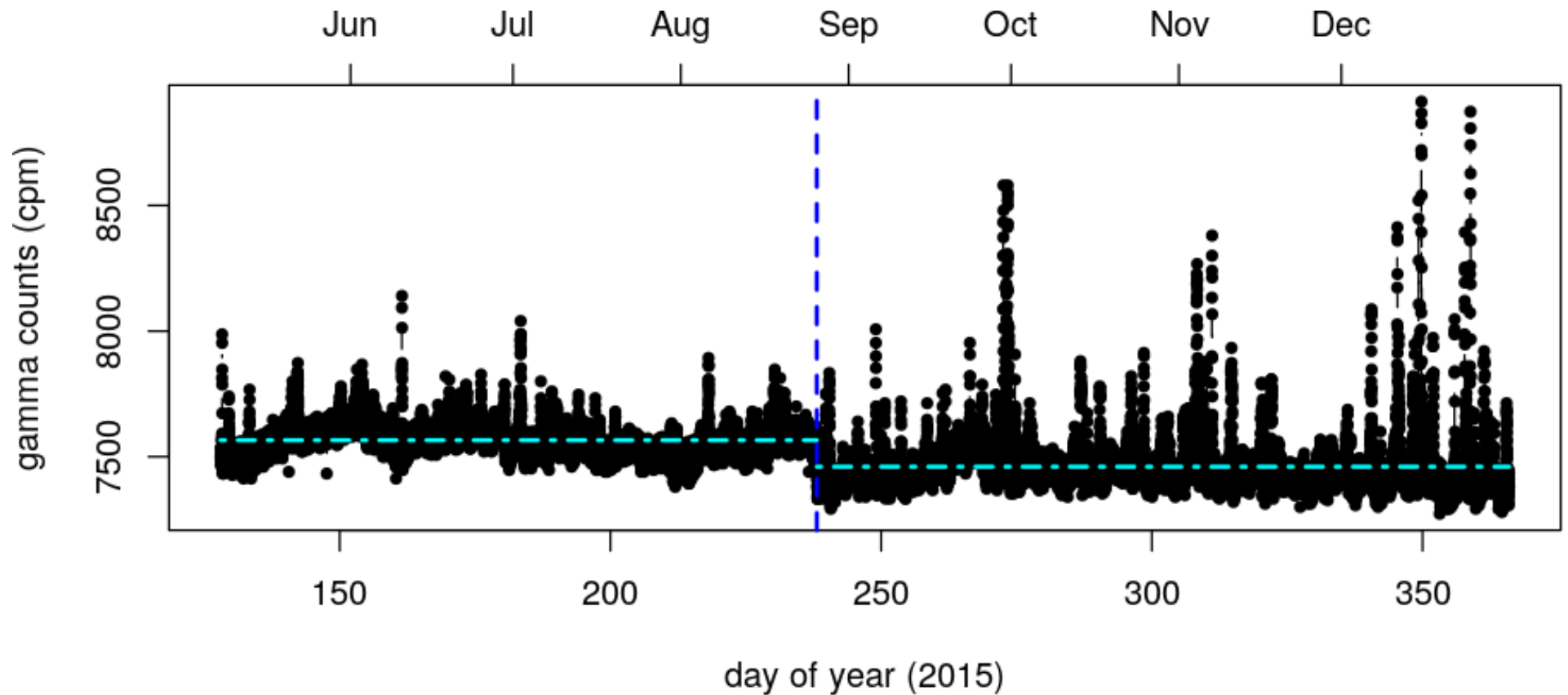
Gamma count rate (cpm)

2015-05-08 / 2017-04-19 23:45:00



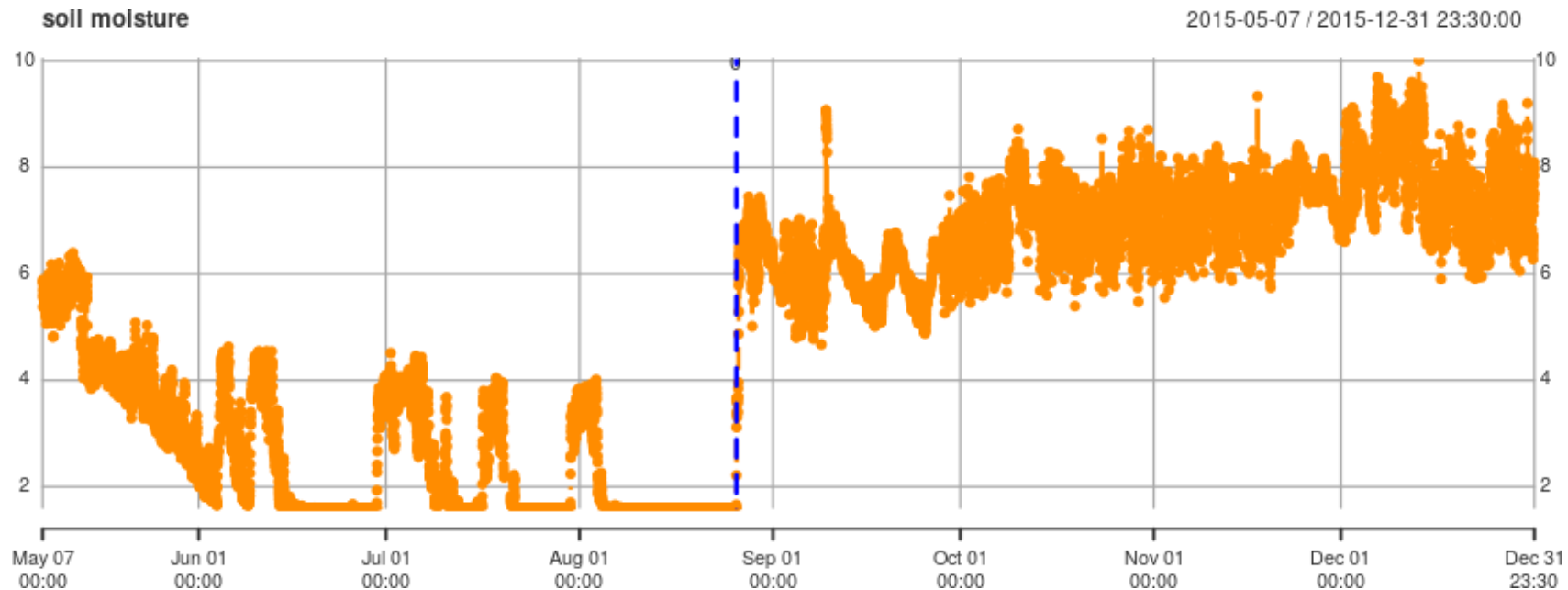
The gamma monitoring campaign - Azores

long-term variability



The gamma monitoring campaign - Azores

long-term variability



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RELECT campaign

Radioactivity and **ELECT**ric field monitoring campaign at Hyytiälä

Funding: ENVRIplus TransNational Access to Research Infrastructures)

How

soil radon + gamma radiation + electric field

When

June 2017 - November 2017

Where

Hyytiälä (high latitude + atmospheric & surface station)

RELECT campaign



RELECT campaign – Electric field

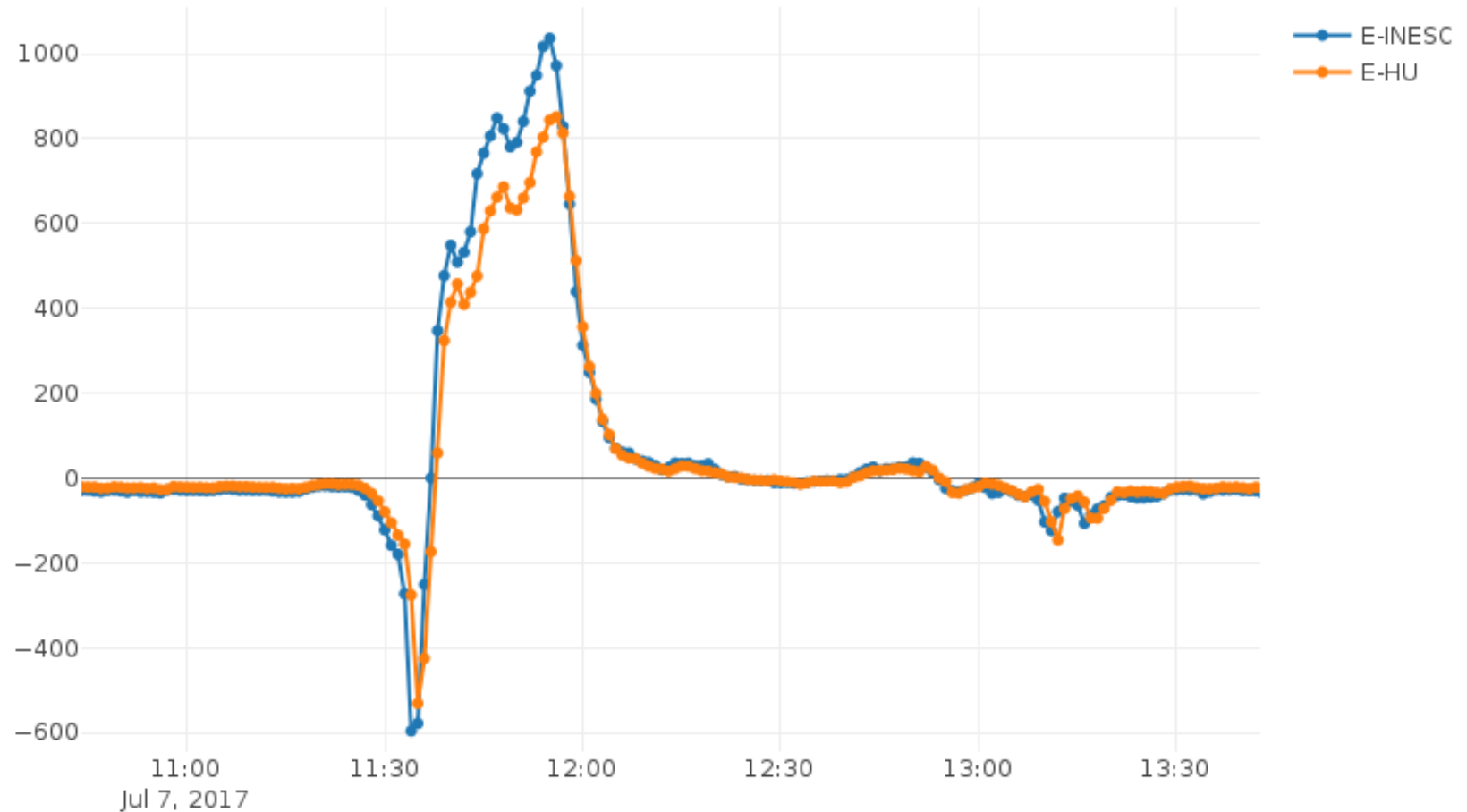
Atmospheric electric field (CS110)



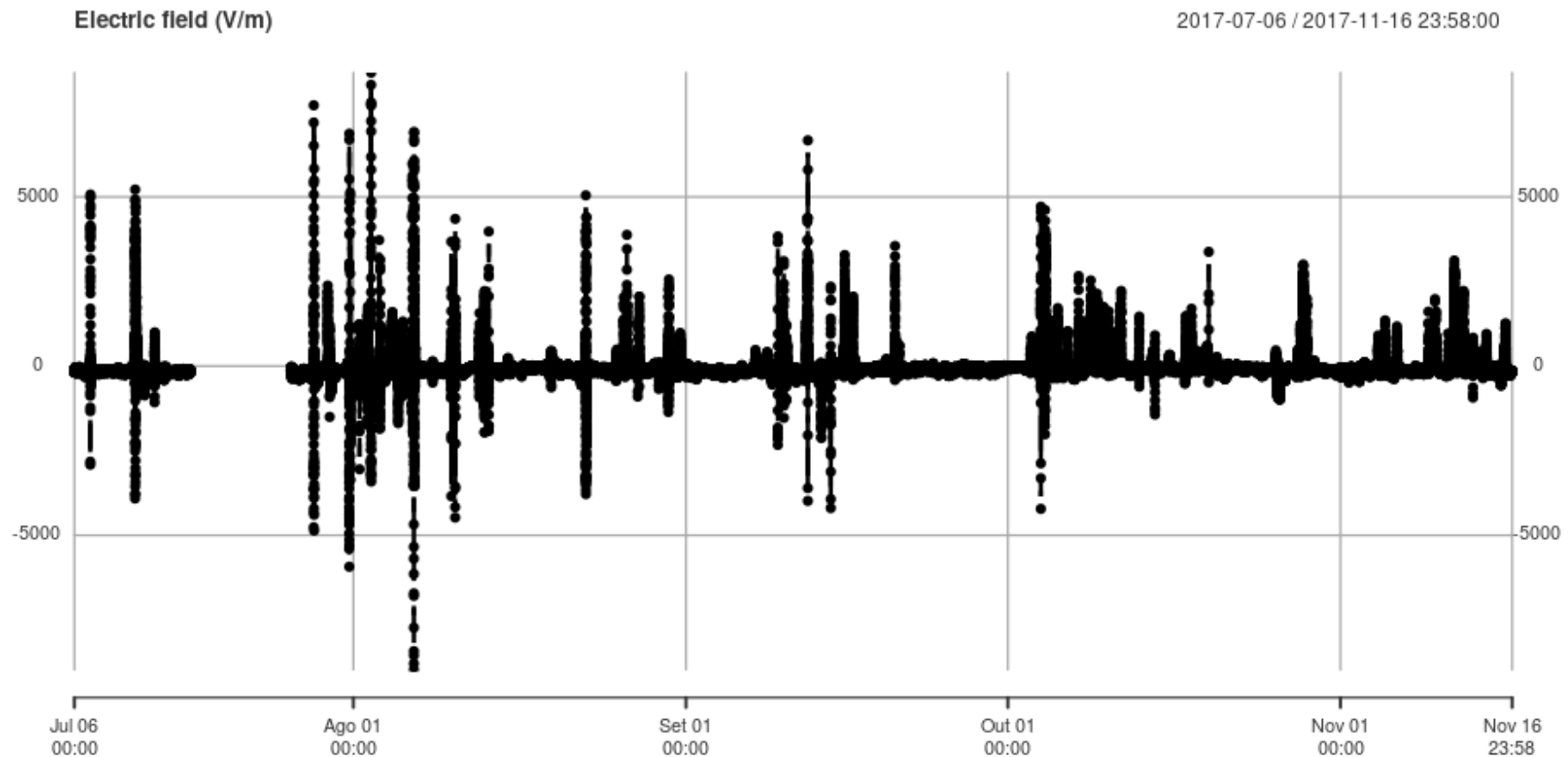
CS-110
INESC TEC

CS-110
FMI/HU

RELECT campaign – Electric field



RELECT campaign – Electric field



RELECT campaign – Electric field

<https://rdm.inesctec.pt/dataset/cs-2017-009>

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Electric field data from ENVRIplus TNA campaign RELECT at SMEAR II – HYYTIÄLÄ multi-disciplinary RI platform

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 Dataset  Groups  Activity Stream

Electric field data from ENVRIplus TNA campaign RELECT at SMEAR II – HYYTIÄLÄ multi-disciplinary RI platform

Vertical electric field measurements (in V/m), 1-min averages. Under construction (weekly datafiles added as the campaign progresses).

Data and Resources

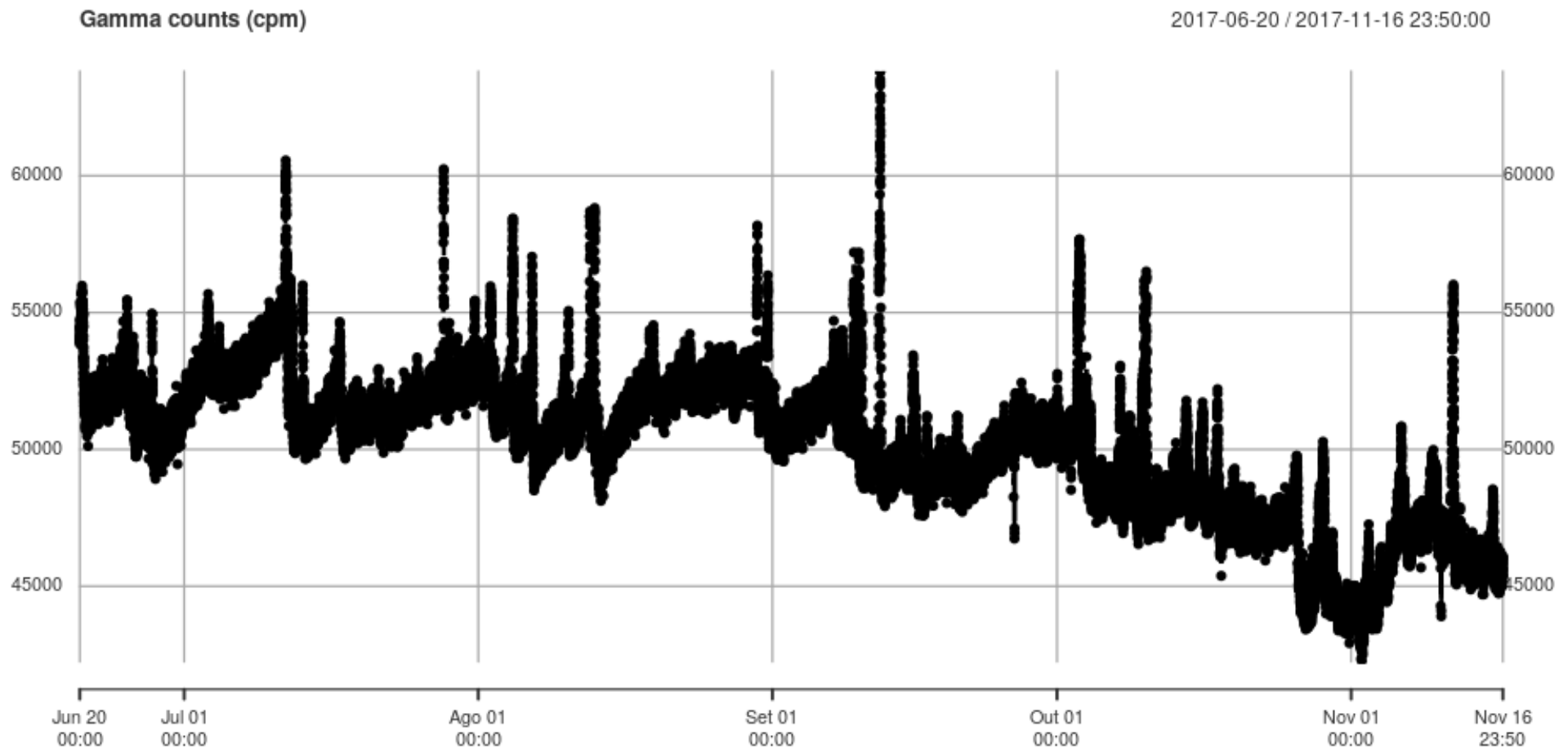
	ElecField_week27 Electric field measurements (1-minute averaged) for week 27 (2017, ISO week...	Explore
	ElecField_week28 Electric field measurements (1-minute averaged) for week 28 (2017, ISO week...	Explore
	ElecField_week30 Electric field measurements (1-minute averaged) for week 30 (2017, ISO week...	Explore
	ElecField_week31 Electric field measurements (1-minute averaged) for week 31 (2017, ISO week...	Explore
	ElecField_week32 Electric field measurements (1-minute averaged) for week 32 (2017, ISO week...	Explore

RELECT campaign – Gamma radiation

Gamma radiation in air (5-min)



RELECT campaign – Gamma radiation



RELECT campaign – Gamma radiation

<https://rdm.inesctec.pt/dataset/cs-2017-010>

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Dataset Groups Activity Stream

Gamma radiation data from ENVRIplus TNA campaign RELECT at SMEAR II – HYYTIÄLÄ multi-disciplinary RI platform

Gamma radiation measurements in counts/minute (cpm) every 5-minutes. Under construction (weekly datafiles added as the campaign progresses).

Data and Resources

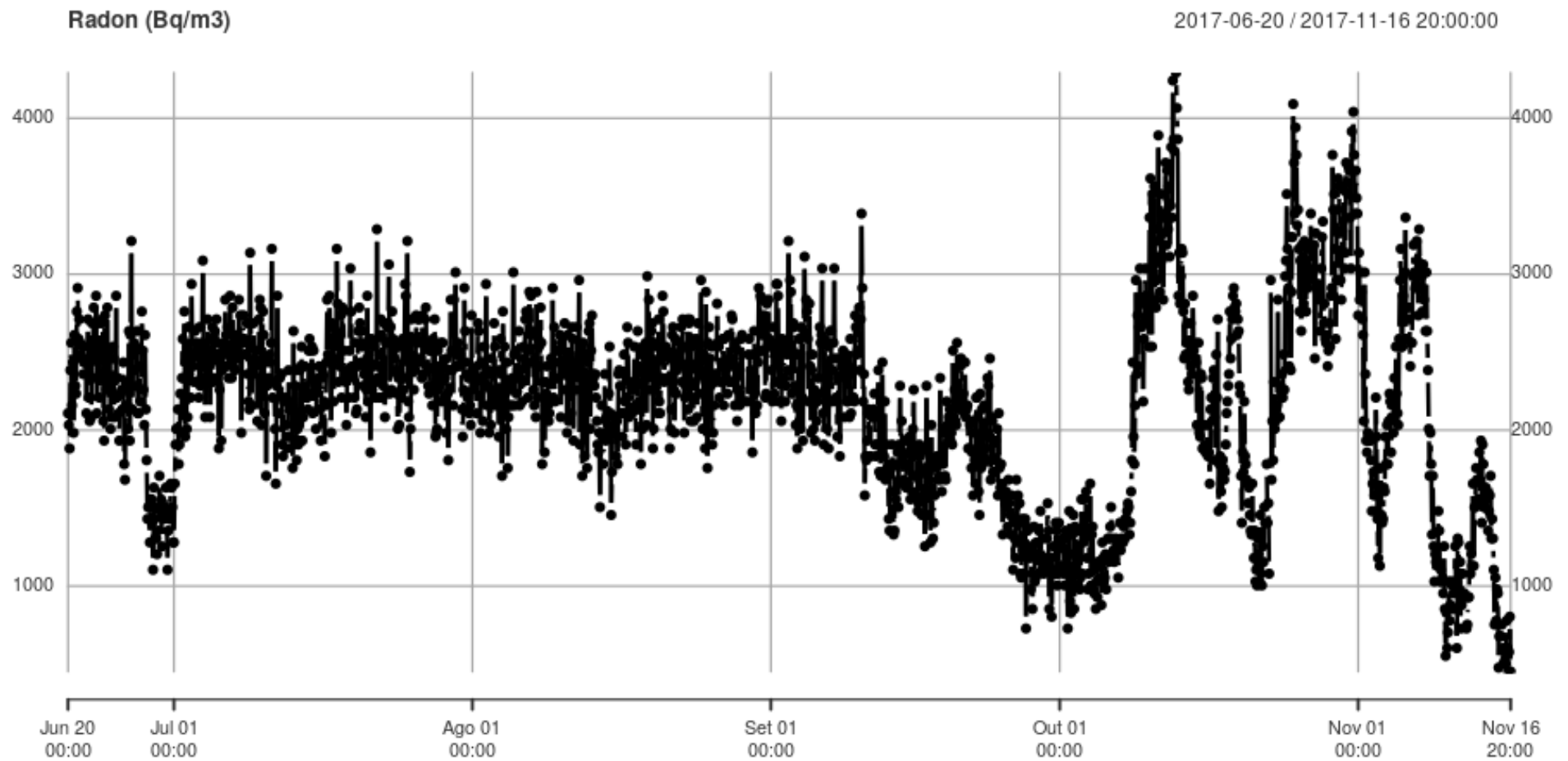
	GammaAir_week25 Gamma measurements every 5-minutes for week 25 (2017, ISO week date standard...)	Explore
	GammaAir_week26 Gamma measurements every 5-minutes for week 26 (2017, ISO week date standard...)	Explore
	GammaAir_week27 Gamma measurements every 5-minutes for week 27 (2017, ISO week date standard...)	Explore
	GammaAir_week28 Gamma measurements every 5-minutes for week 28 (2017, ISO week date standard...)	Explore
	GammaAir_week29 Gamma measurements every 5-minutes for week 29 (2017, ISO week date standard...)	Explore

RELECT campaign – Radon

Radon concentration in soil (2-hour)



RELECT campaign – Radon



RELECT campaign – Radon

<https://rdm.inesctec.pt/dataset/cs-2017-011>

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Radon data from ENVRIplus TNA campaign RELECT at SMEAR II – HYYTIÄLÄ multi-disciplinary RI platform

Radon concentration measurements (In Bq/m3) every 2-hours. Under construction (weekly datafiles added as the campaign progresses).

Data and Resources

 **RadonSoil_week25**
Measurements of radon concentration every 2-hours for week 25 (2017, ISO week...

 **RadonSoil_week26**
Measurements of radon concentration every 2-hours for week 26 (2017, ISO week...

 **RadonSoil_week27**
Measurements of radon concentration every 2-hours for week 27 (2017, ISO week...

 **RadonSoil_week28**
Measurements of radon concentration every 2-hours for week 28 (2017, ISO week...

 **RadonSoil_week29**
Measurements of radon concentration every 2-hours for week 29 (2017, ISO week...

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2017-11-21

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RELECT campaign – Radon (& CO₂)

