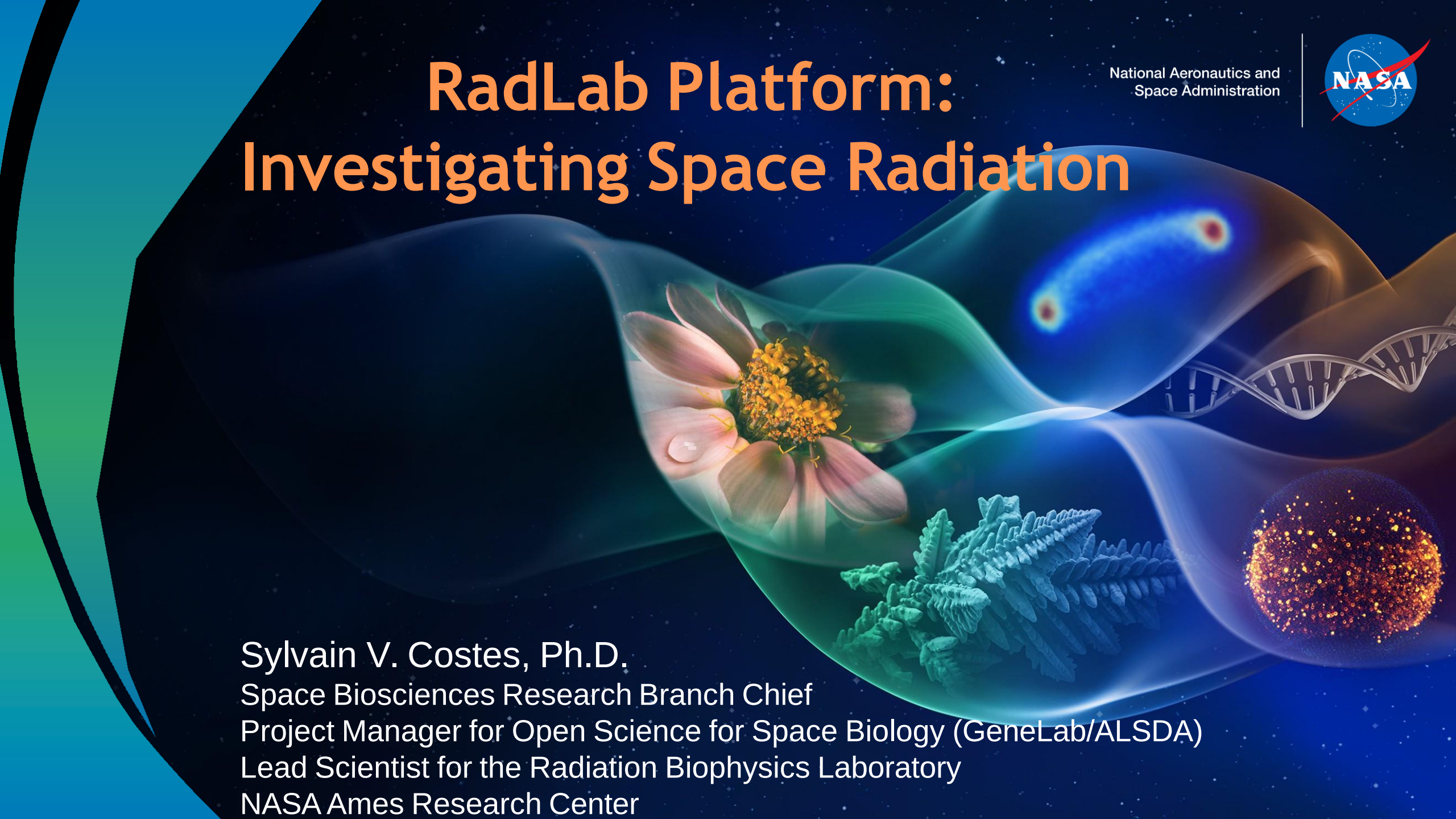
RadLab Platform: Investigating Space Radiation

National Aeronautics and Space Administration

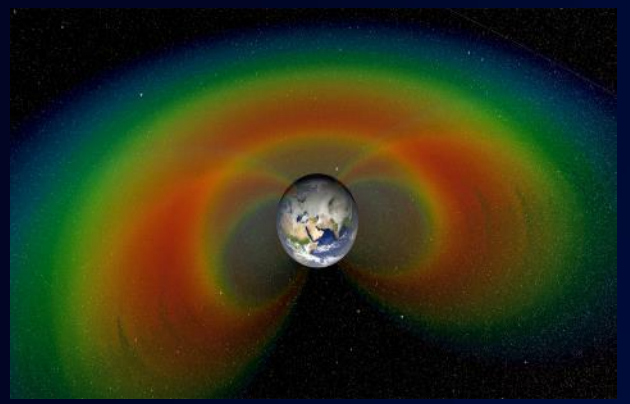


Sylvain V. Costes, Ph.D.
Space Biosciences Research Branch Chief
Project Manager for Open Science for Space Biology (GeneLab/ALSDA)
Lead Scientist for the Radiation Biophysics Laboratory
NASA Ames Research Center

Biologically Relevant Environmental Factors Encountered in Spaceflight

Microgravity/Reduced Gravity

Ionizing Radiation

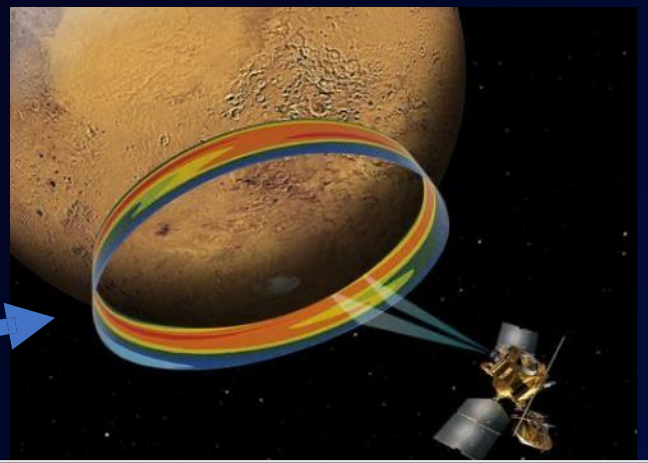


Credits: NASA/Goddard Space Flight Center/Scientific Visualization Studio

Altered Day/Night Cycles: Circadian Rhythm Changes

Altered Temperature and Atmosphere

- Elevated CO_2
- Reduced atmospheric pressure and elevated volumetric fraction of oxygen

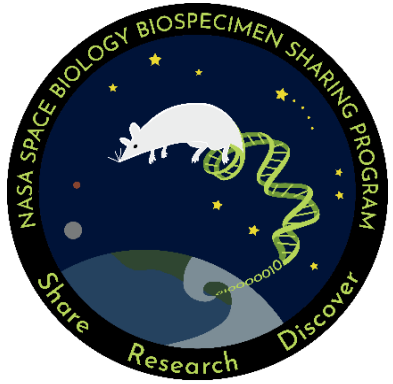


Isolation

COMBINATION OF MULTIPLE STRESSORS

NASA Biological Open Science Resources

Biospecimen Sharing Program (BSP)



Dissection and preservation of rodent tissues from Flight and Ground investigations.

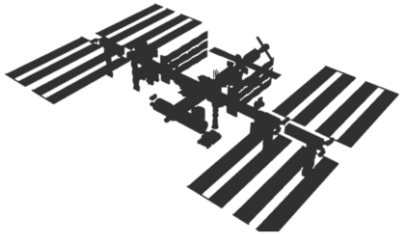
Coordination of internal tissue sharing

NASA Biological Institutional Scientific Collection (NBISC)

Collection of non-human specimens and space microbial culture

Ames Life Sciences Data Archive (ALSDA)

Collection and curation of mission, project, and imaging data



NASA GeneLab (GL)

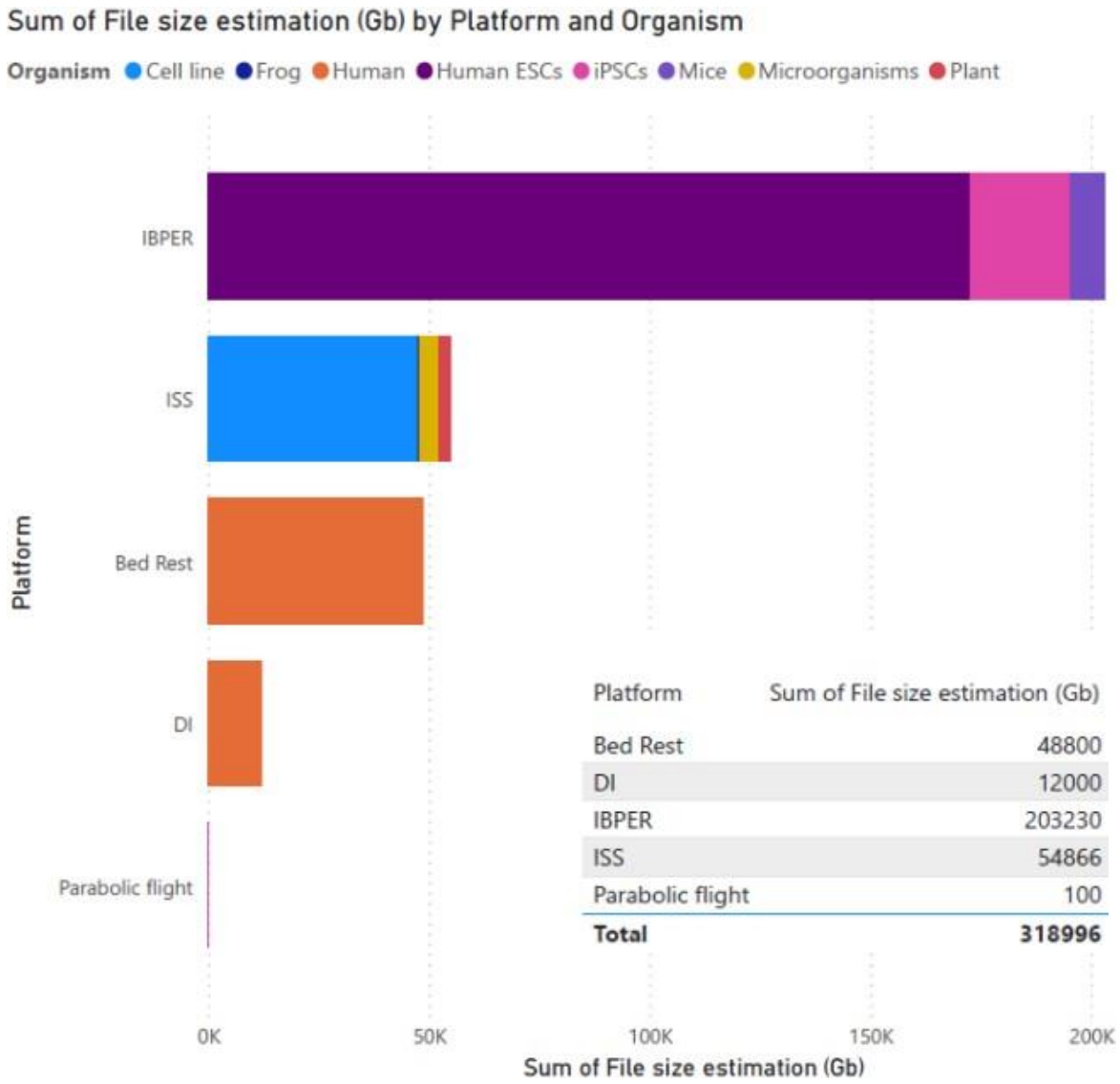
Collection and curation of omics data

NASA Internal Program

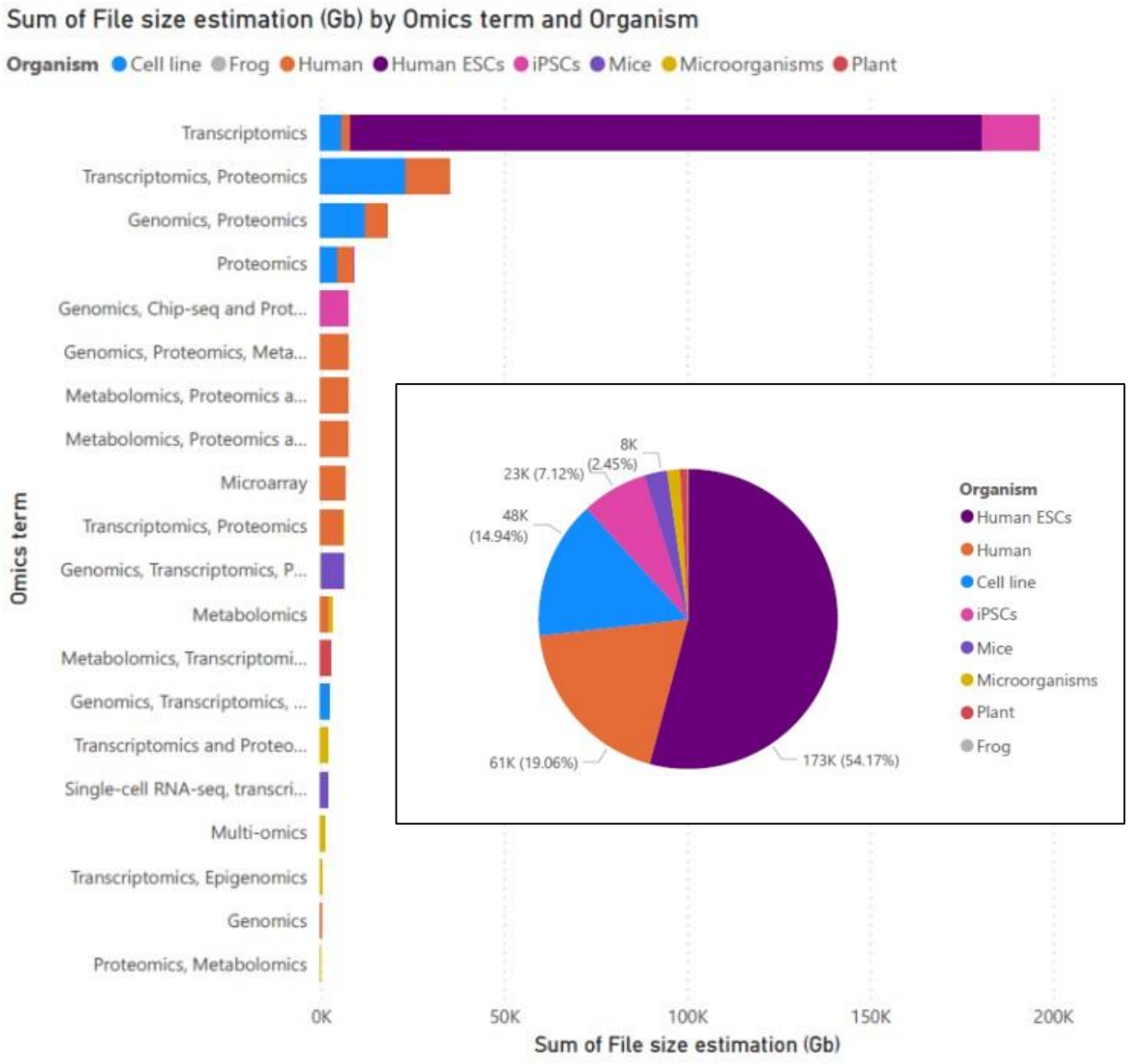
Open-Source Science Programs — Available Globally

European Space Agency data arriving in OSDR: ~318 TB

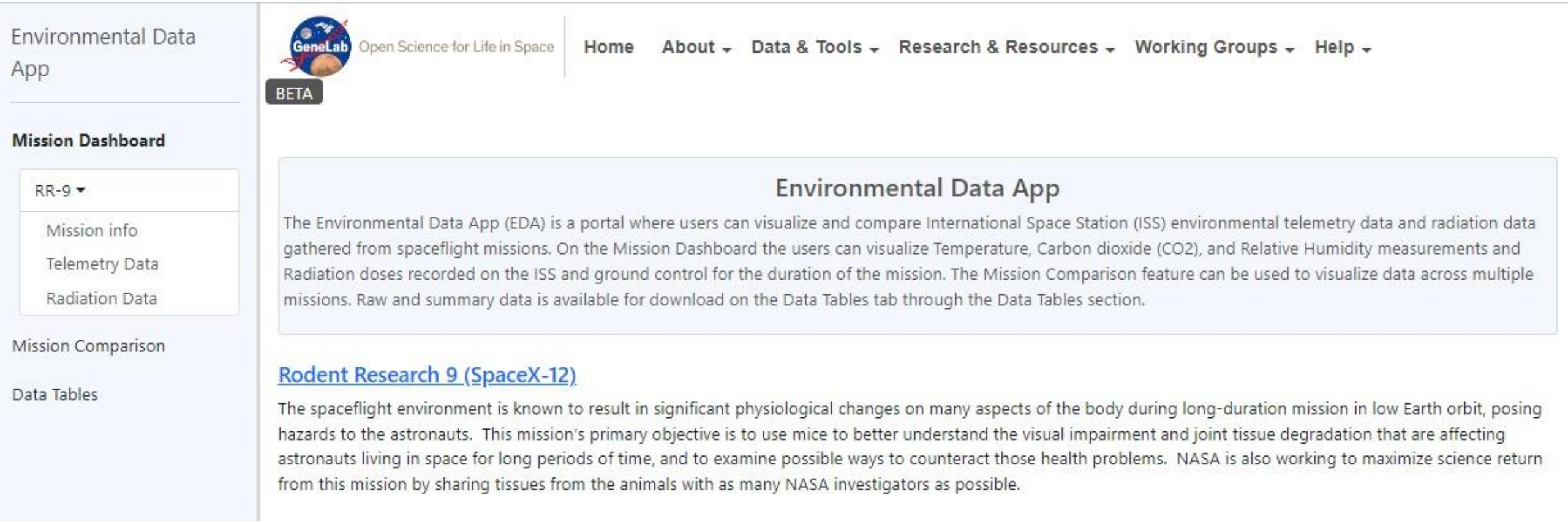
Total of 39 Omics experiments, of which 21 are Multi-omics



Platform	Sum of File size estimation (Gb)
Bed Rest	48800
DI	12000
IBPER	203230
ISS	54866
Parabolic flight	100
Total	**318996**



OSDR - Environmental Data App



OSDR - Environmental Data App

Mission Dashboard

RR-9

- Mission info
- Telemetry Data
- Radiation Data

Mission Comparison

Data Tables

Mission Milestone Dates

Display Mission milestones

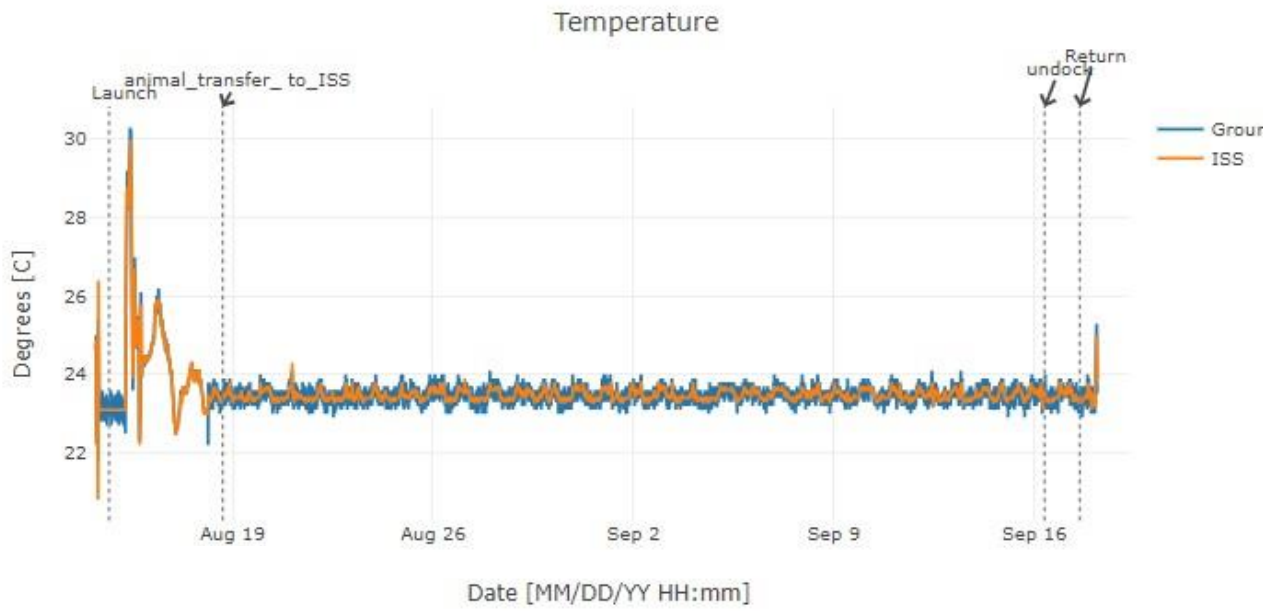
Launch: 8-14-2017 16:33:00

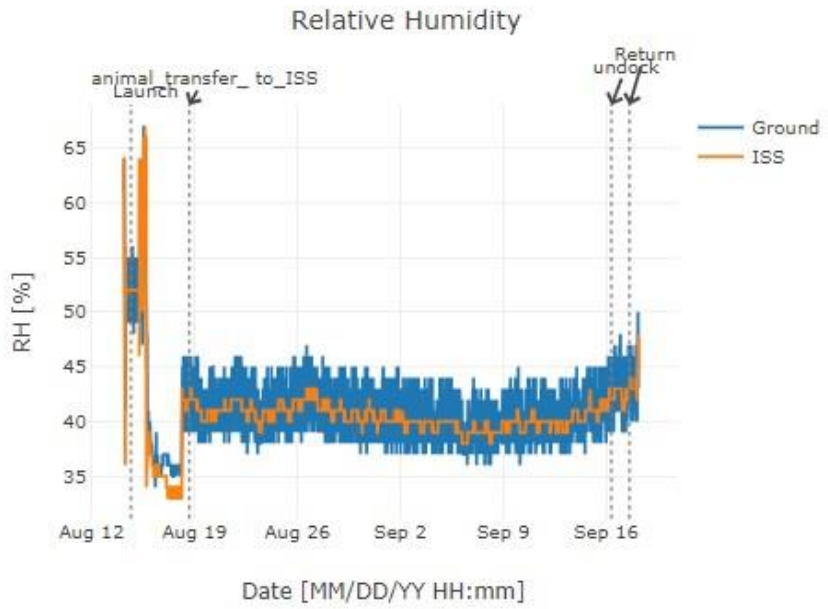
Animal transfer to ISS:
8-15-2017 15:43:00

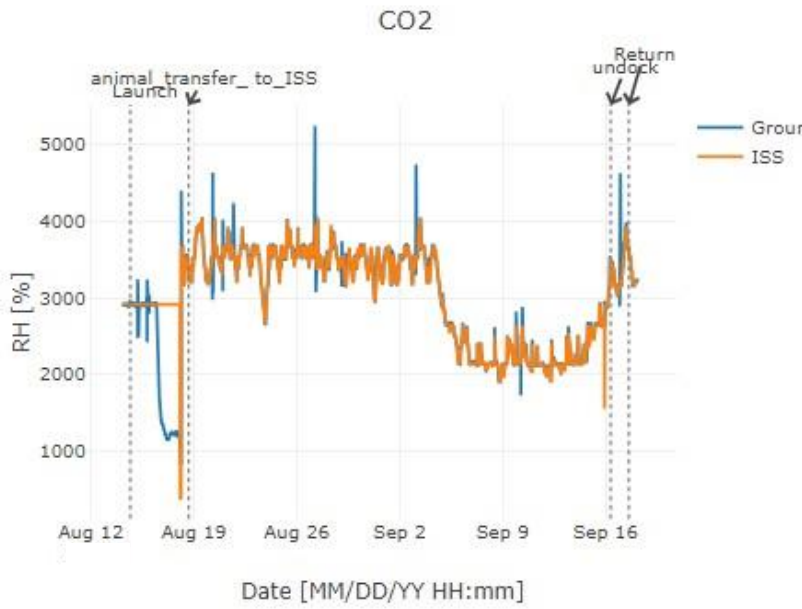
Undock: 9-16-2017 08:43:00

Return: 9-17-2017 14:13:00

Telemetry data







OSDR Environmental Data App

Radiation Tab
Breaks down GCR/SAA
Example of SPE

Environmental Data App

Mission Dashboard

RR-9

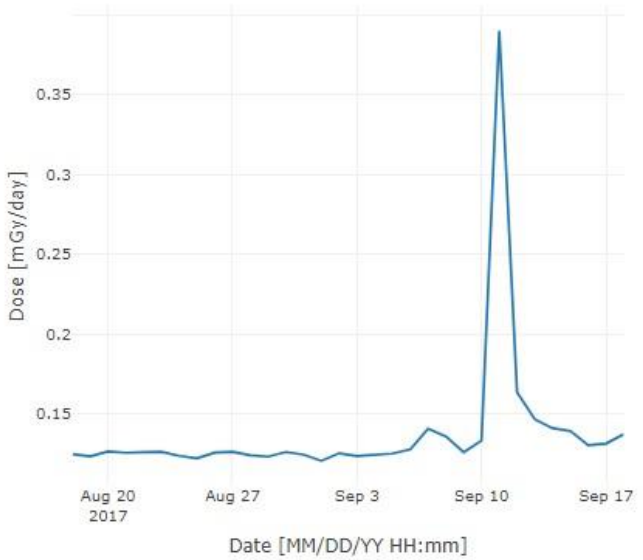
- Mission info
- Telemetry Data
- Radiation Data

Mission Comparison

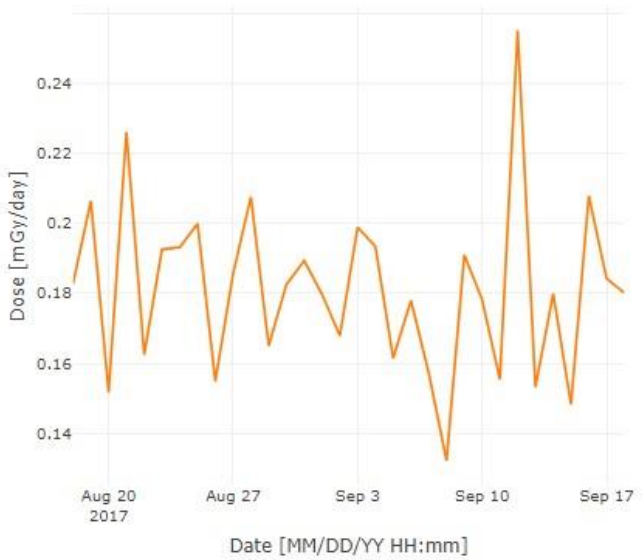
Data Tables

Radiation data

Galactic Cosmic Ray (GCR)

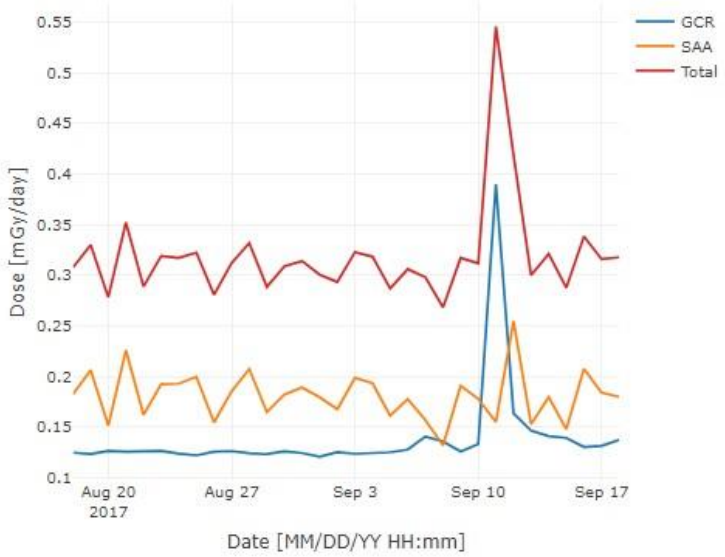


South Atlantic Anomaly (SAA)



Accumulated Radiation Dose

Total Radiation Dose



Mission Dashboard

Mission Comparison

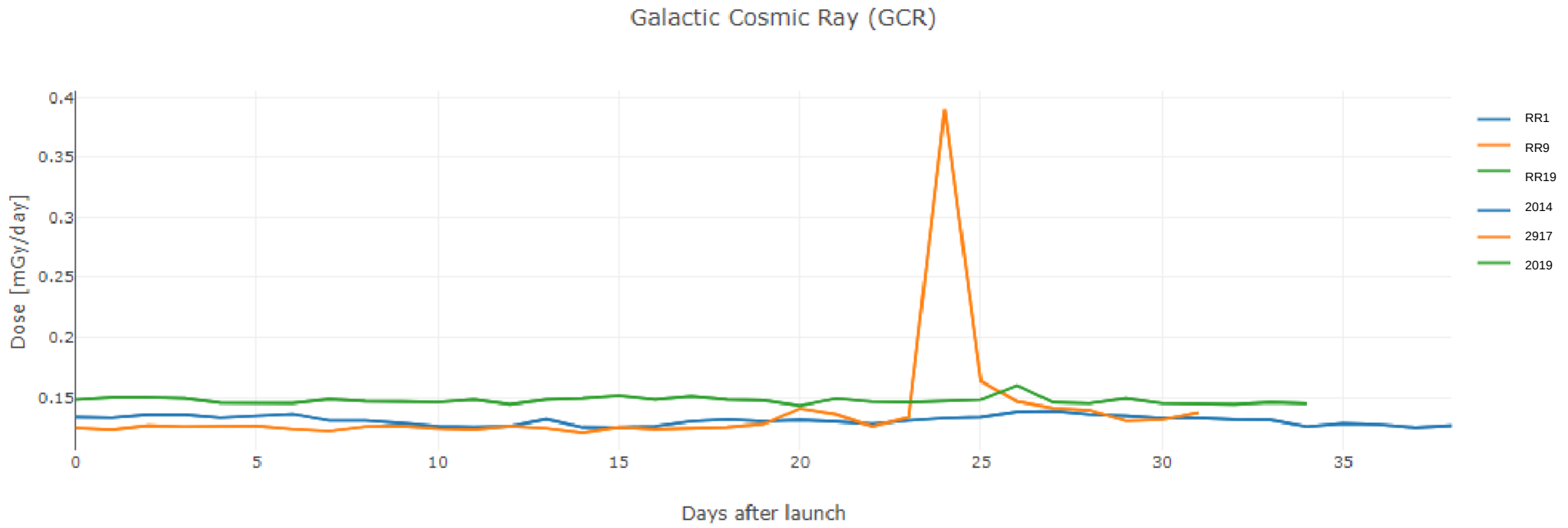
- Temperature
- Relative Humidity
- CO2
- **Radiation**
  - GCR
  - SAA
  - Total
  - Accumulated

Data Tables

Mission Comparison

Select missions to compare

☑ RR1 ☐ RR3 ☐ RR4 ☐ RR5 ☐ RR6 ☐ RR8 ☑ RR9 ☐ RR12 ☐ RR17 ☐ RR18 ☑ RR19



Copy | Excel | CSV | PDF | Print

Search:

Mission	Min GCR Dose [mGy/day]	Max GCR Dose [mGy/day]	Mean GCR Dose [mGy/day]	Standard Deviation GCR Dose [mGy/day]	Median GCR Dose [mGy/day]
RR1	0.13	0.14	0.13	0.00	0.13
RR9	0.12	0.39	0.14	0.05	0.13
RR19	0.14	0.16	0.15	0.00	0.15

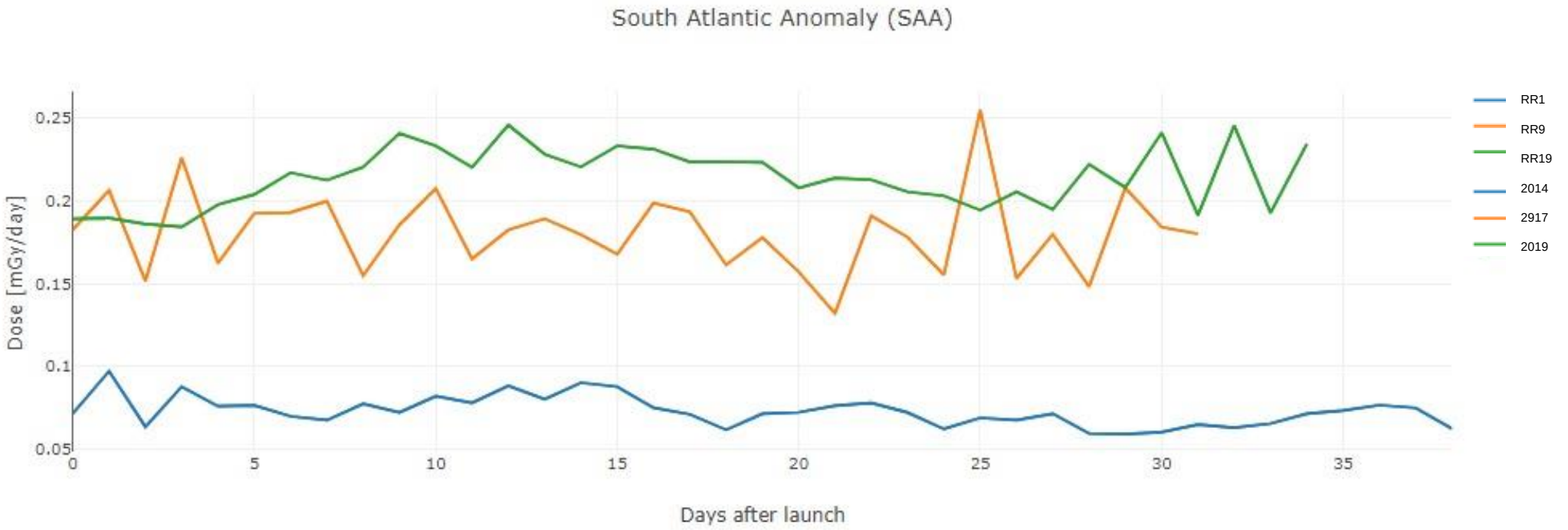
Environmental Data App

Mission Dashboard

Mission Comparison

- Temperature
- Relative Humidity
- CO2
- **Radiation**
  - GCR
  - SAA
  - Total
  - Accumulated

Data Tables

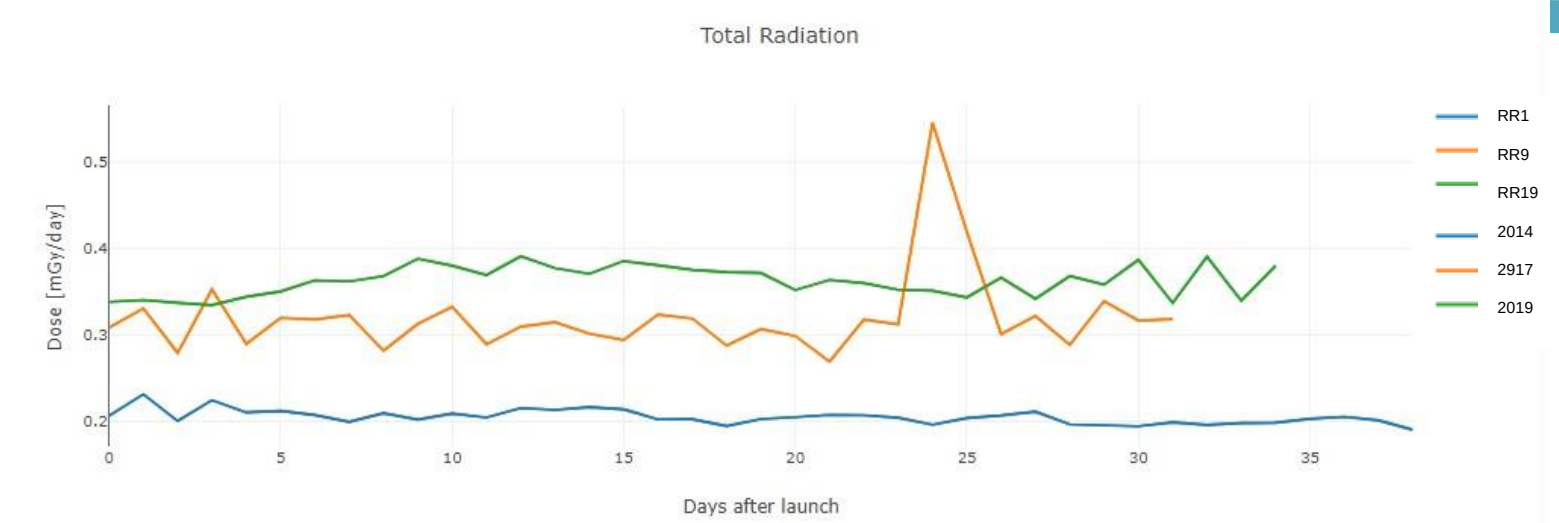


Copy Excel CSV PDF Print

Search

Mission	Min SAA Dose [mGy/day]	Max SAA Dose [mGy/day]	Mean SAA Dose [mGy/day]	Standard Deviation SAA Dose [mGy/day]	Median SAA Dose [mGy/day]
RR1	0.06	0.10	0.07	0.01	0.07
RR9	0.13	0.26	0.18	0.02	0.18
RR19	0.18	0.25	0.21	0.02	0.21

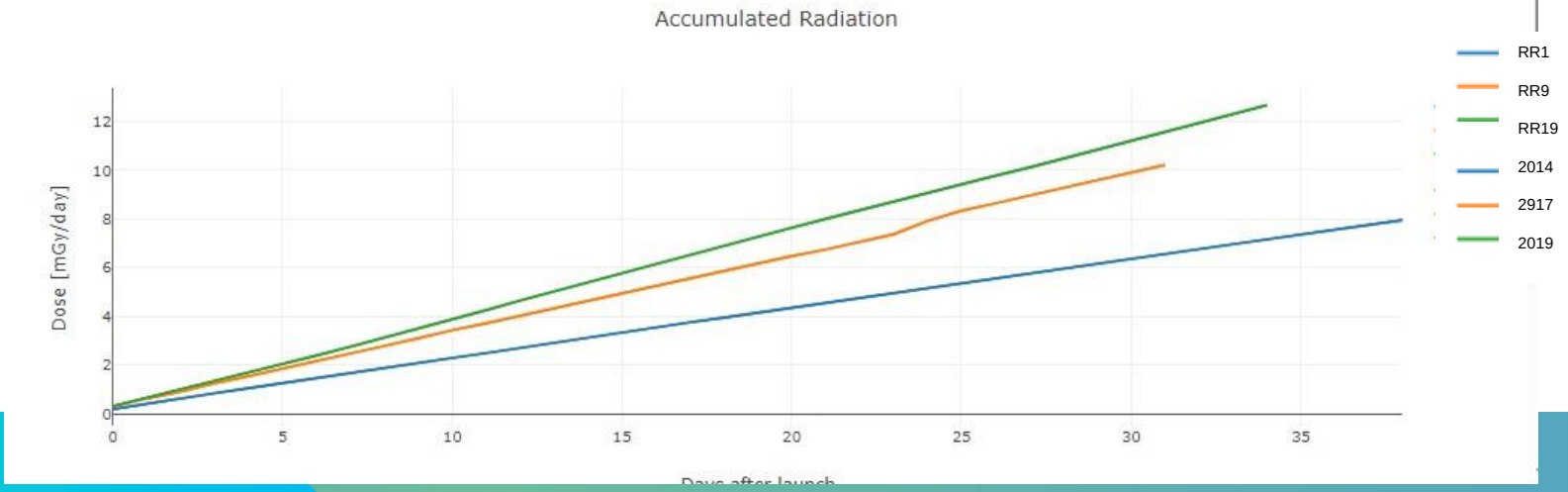
Radiation Tab
Mission comparison
Relative time scale
Impact of solar min/max on dosimetry



Copy Excel CSV PDF Print Search:

Mission	Min Total Dose [mGy/day]	Max Total Dose [mGy/day]	Mean Total Dose [mGy/day]	Standard Deviation Total Dose [mGy/day]	Median Total Dose [mGy/day]
RR1	0.19	0.23	0.20	0.01	0.20
RR9	0.27	0.55	0.32	0.05	0.31
RR19	0.33	0.39	0.36	0.02	0.36
	Min	Max	Mean	Standard Deviation	Median

Showing 1 to 3 of 3 entries



Radiation Tab
Mission comparison
Relative time scale
Impact of solar min/max on dosimetry

GeneLab Open Science for Life in Space

Home About Data & Tools Research & Resources Working Groups Help ALPHA

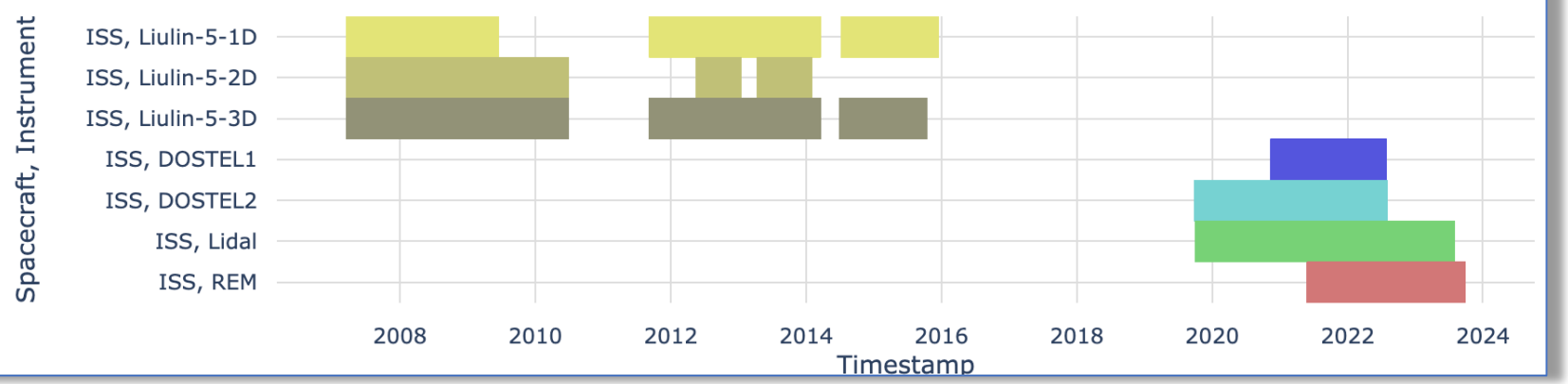
The RadLab portal and the RadLab data API

RadLab is a portal that aims to provide a single point of access to radiation telemetry data from multiple databases maintained by multiple space agencies.
The Web interface provides the ability to query, visualize, inspect, and download data; for example, time series plots of readings from multiple radiation detectors, pairwise comparisons of detector readings, and geospatial visualizations of radiation dose and flux registered by the detectors.
The underlying API enables data selection and retrieval at a programmatic level.
The demo version of RadLab contains the data obtained from four detectors included in the DORELI project (DOSTEL1, DOSTEL2, Lidal, REM; Italian Space Agency) and the data from three Liulin-5 detectors (Bulgarian Academy of Sciences). All seven detectors are/were located on the International Space Station (ISS).

RadLab Platform Capabilities

- ▸ Data overview
- Time series plots
- Data comparison
- Geographical plots
- Data access / API

Time span of available detector readings



Data overview

▸ Time series plots

Data comparison

Geographical plots

Data access / API

Spacecraft, Instrument

ISS, DOSTEL1

ISS, DOSTEL2

ISS, Lidal

ISS, REM

ISS, Liulin-5-1D

ISS, Liulin-5-2D

ISS, Liulin-5-3D

Measurement

Total dose rate

Total flux

Scale

Linear

Log

Update

Retrieved data

Formats:

CSV, TSV, JSON, HTML

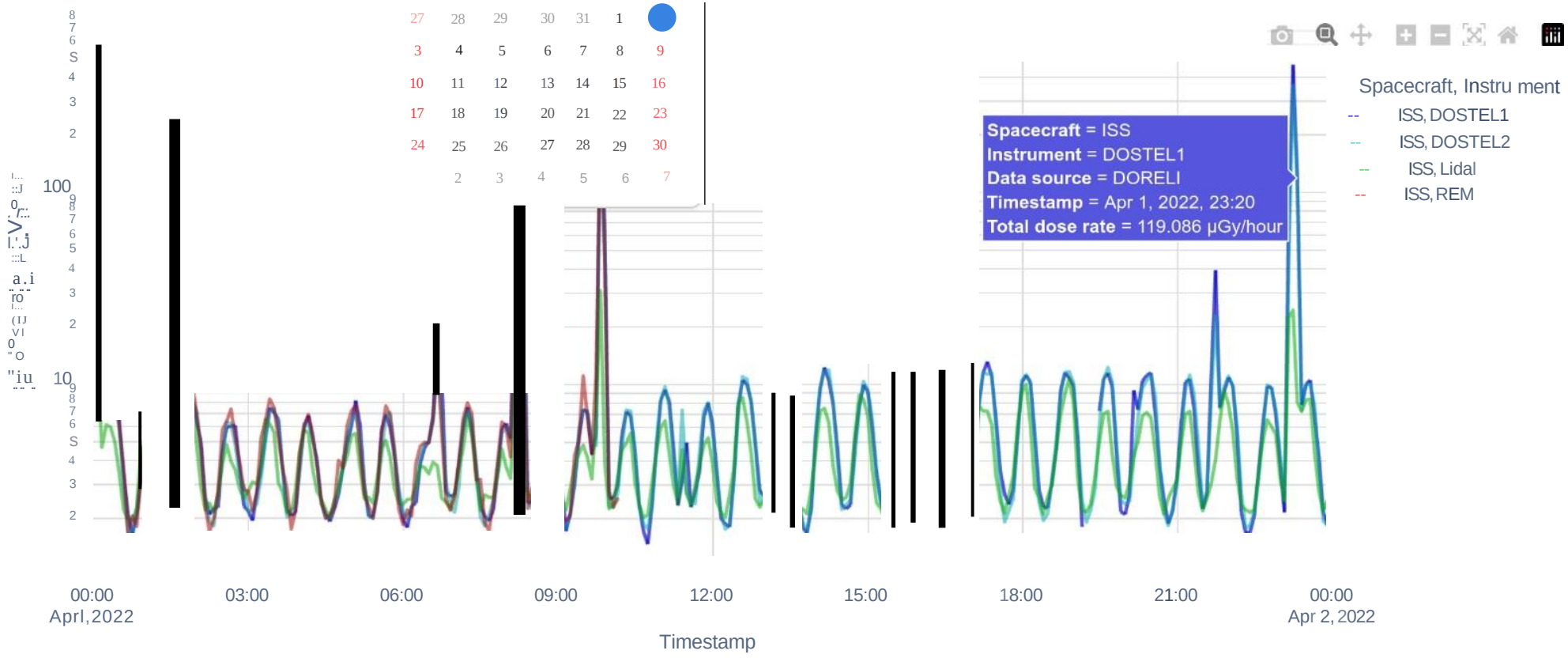
Time period

Start: 04/01/2022, 12:00 AM

End: 04/02/2022, 12:00 AM

April 2022

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	31	1	
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
2	3	4	5	6	7	



Multi-format raw data download capabilities

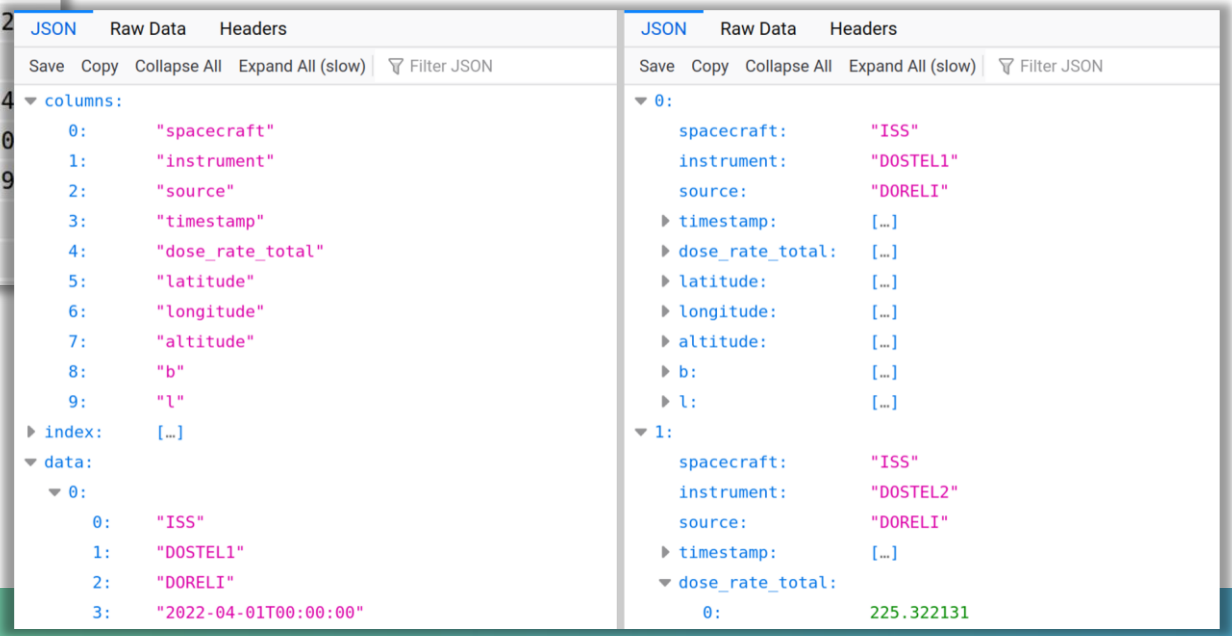
HTML

spacecraft	instrument	source	timestamp	dose_rate_total
ISS	DOSTEL1	DORELI	2022-04-01T00:00:00	290.826900363636
ISS	DOSTEL2	DORELI	2022-04-01T00:00:00	225.322131
ISS	Lidal	DORELI	2022-04-01T00:00:00	49.921313777676
ISS	REM	DORELI	2022-04-01T00:00:00	304.45104
ISS	DOSTEL1	DORELI	2022-04-01T00:05:00	576.20498774359
ISS	DOSTEL2	DORELI	2022-04-01T00:05:00	441.191662057508
ISS	Lidal	DORELI	2022-04-01T00:05:00	12.4811198675547
ISS	REM	DORELI	2022-04-01T00:05:00	394.68912
ISS	DOSTEL1	DORELI	2022-04-01T00:10:00	42.0836981052632
ISS	DOSTEL2	DORELI	2022-04-01T00:10:00	17.2710316875
ISS	Lidal	DORELI	2022-04-01T00:10:00	4.666333096772
ISS	REM	DORELI	2022-04-01T00:10:00	12.599346
ISS	DOSTEL1	DORELI	2022-04-01T00:15:00	8.081070962264
ISS	DOSTEL2	DORELI	2022-04-01T00:15:00	7.874416256410
ISS	Lidal	DORELI	2022-04-01T00:15:00	6.100163333799
ISS	REM	DORELI	2022-04-01T00:15:00	11.334756
ISS	DOSTEL1	DORELI	2022-04-01T00:20:00	9.307428

CSV

#instrument	spacecraft	source	timestamp	flux_total
DOSTEL2	ISS	DORELI	2021-01-01T	0.25882892
DOSTEL2	ISS	DORELI	2021-01-01T	0.39735477
DOSTEL2	ISS	DORELI	2021-01-01T	0.43372988
DOSTEL2	ISS	DORELI	2021-01-01T	0.29760066
DOSTEL2	ISS	DORELI	2021-01-01T	0.16540546
DOSTEL2	ISS	DORELI	2021-01-01T	0.1251464
DOSTEL2	ISS	DORELI	2021-01-01T	0.11808112

Multiple JSON formats



Spacecraft, Instrument (X axis)

- ISS, DOSTEL1
- ISS, DOSTEL2
- ISS, Lidal
- ISS, REM
- ISS, Liulin-5-1D
- ISS, Liulin-5-2D
- ISS, Liulin-5-3D

Spacecraft, Instrument (Y axis)

- ISS, DOSTEL1
- ISS, DOSTEL2
- ISS, Lidal
- ISS, REM
- ISS, Liulin-5-1D
- ISS, Liulin-5-2D
- ISS, Liulin-5-3D

Measurement

- Total dose rate
- Total flux

Time period

Start: 01 / 01 / 2023 , 12 : 00 AM

End: 01 / 03 / 2023 , 12 : 00 AM

Time series scale

- Linear
- Log

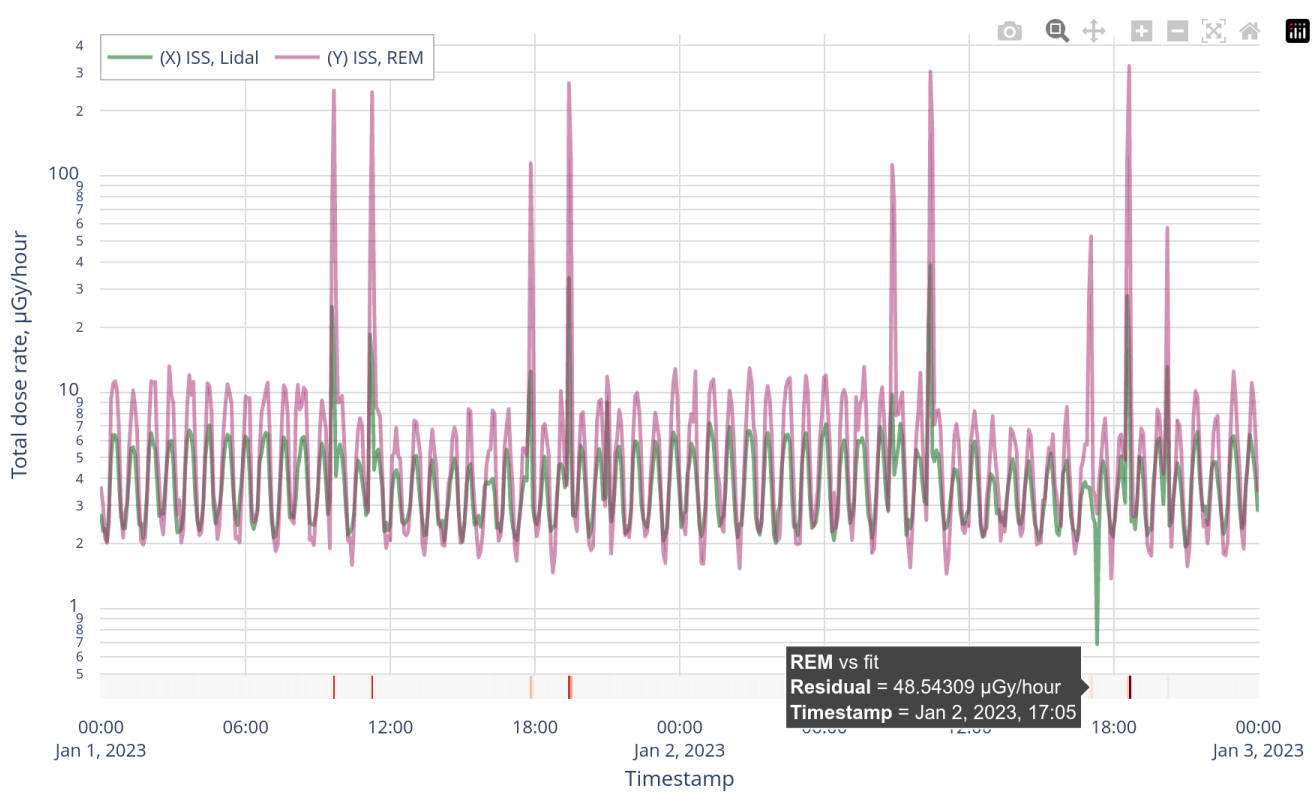
Pair plot scale

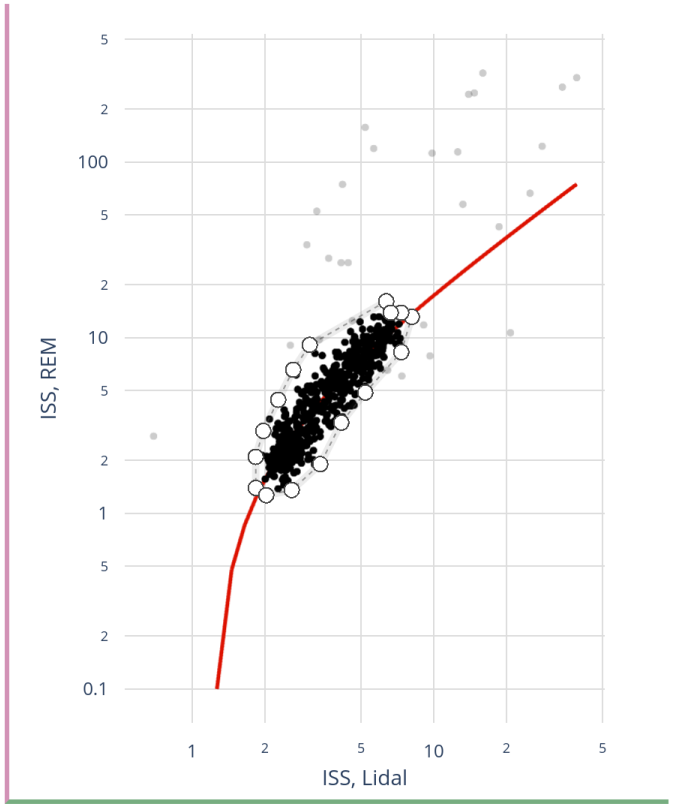
- Linear
- Log

Update

Retrieved data

Formats:
CSV, TSV, JSON, HTML





ⓘ In **selection mode**, double-click anywhere on the plot to remove the selection

Data overview

Time series plots

Data comparison

▸ Geospatial plots

Data access / API

Spacecraft, Instrument

- ISS, DOSTEL1
- ISS, DOSTEL2
- (•) ISS, Lidal
- ISS, REM
- ISS, Liulin-5-1D
- ISS, Liulin-5-2D
- ISS, Liulin-5-3D

Measurement

- (•) Total dose rate
- Total flux

Time period

Start: 01 / 01 / 2022 , 12 : 00 AM

End: 01 / 01 / 2023 , 12 : 00 AM

Scale

- Linear
- (•) Log

Projection

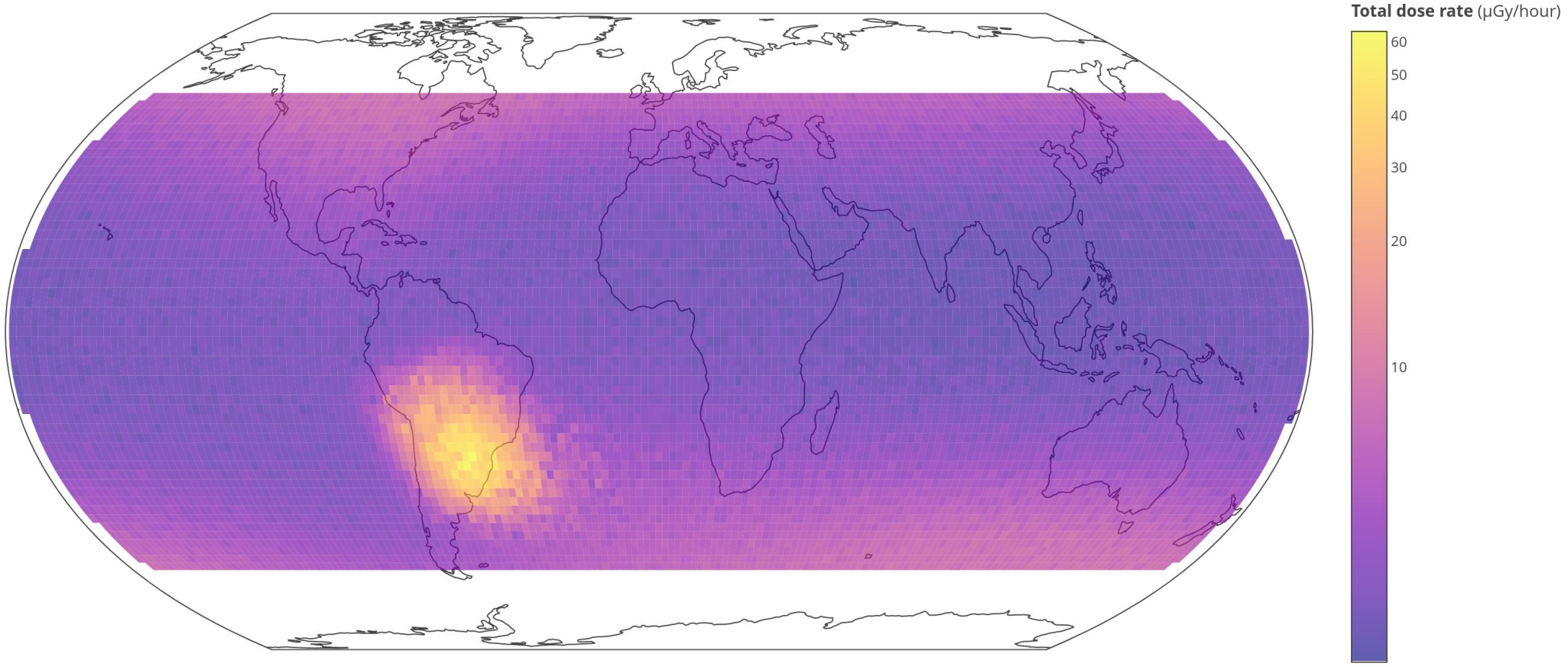
Equal Earth

Update

Retrieved data

Formats:

CSV, TSV, JSON, HTML



Spacecraft, Instrument

- ISS, DOSTEL1
- ISS, DOSTEL2
- ISS, Lidal
- ISS, REM
- ISS, Liulin-5-1D
- ISS, Liulin-5-2D
- ISS, Liulin-5-3D

Measurement

- Total dose rate
- Total flux

Time period

Start: 01 / 01 / 2021 , 12 : 00 AM

End: 01 / 02 / 2021 , 12 : 00 AM

Scale

- Linear
- Log

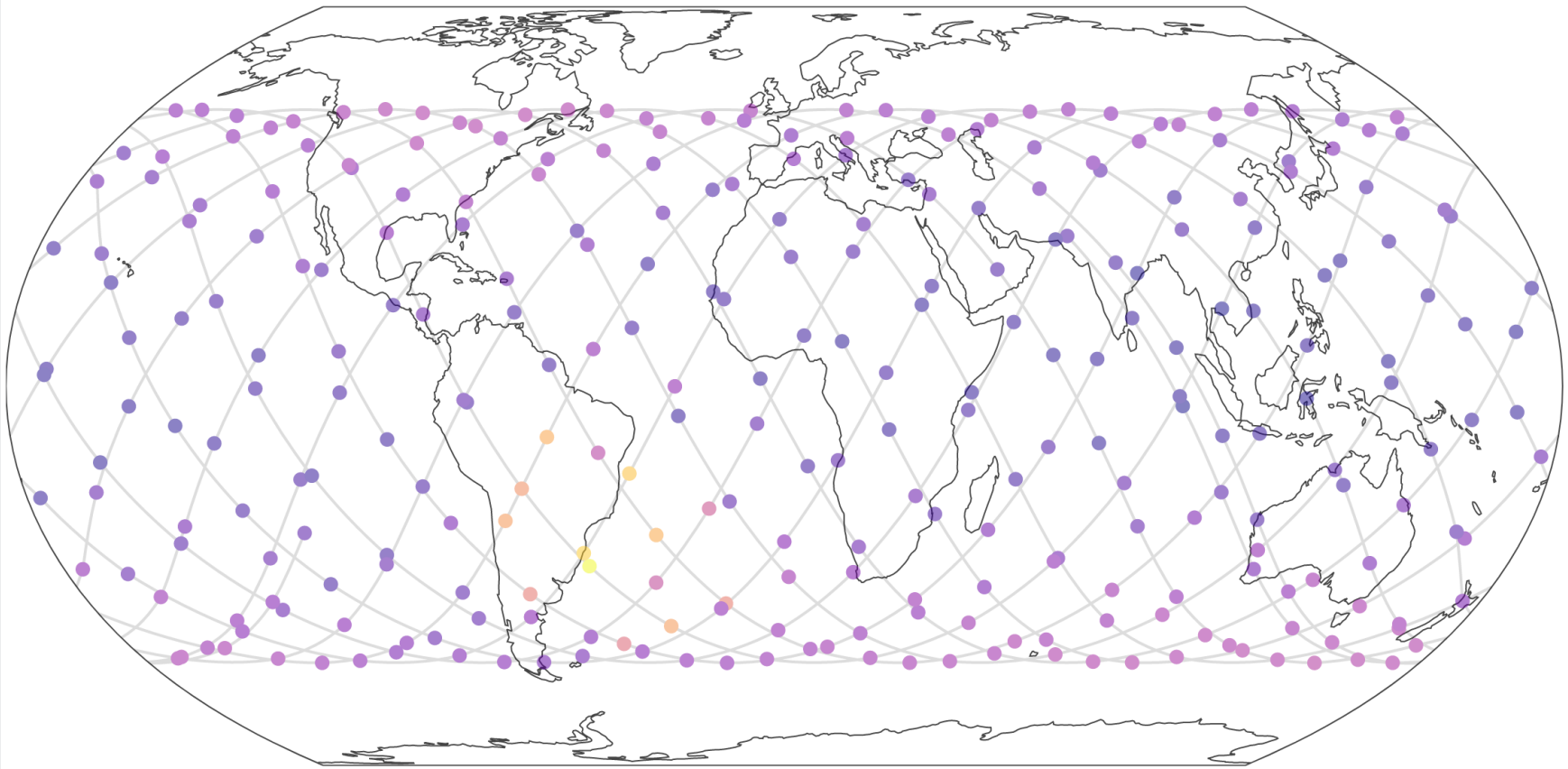
Projection

Equal Earth

Update

Retrieved data

Formats:
CSV, TSV, JSON, HTML



Acknowledgments

RadLab Team:

Kirill Grigorev, Jack Miller, Livio Narici, Lauren Sanders, Ana Uriarte Acuna

Space Biosciences
NASA AMES RESEARCH CENTER

NASA FUNDING: HRP

HUMAN RESEARCH PROGRAM

OSDR: Open Science Data Repository
FUNDING: Biological and Physical Sciences

GeneLab

ALSDA