Precision Measurement of the Monthly Boron, Carbon and Oxygen Fluxes in Cosmic Rays with the Alpha Magnetic Spectrometer on the International Space Station

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Università e INFN, Perugia

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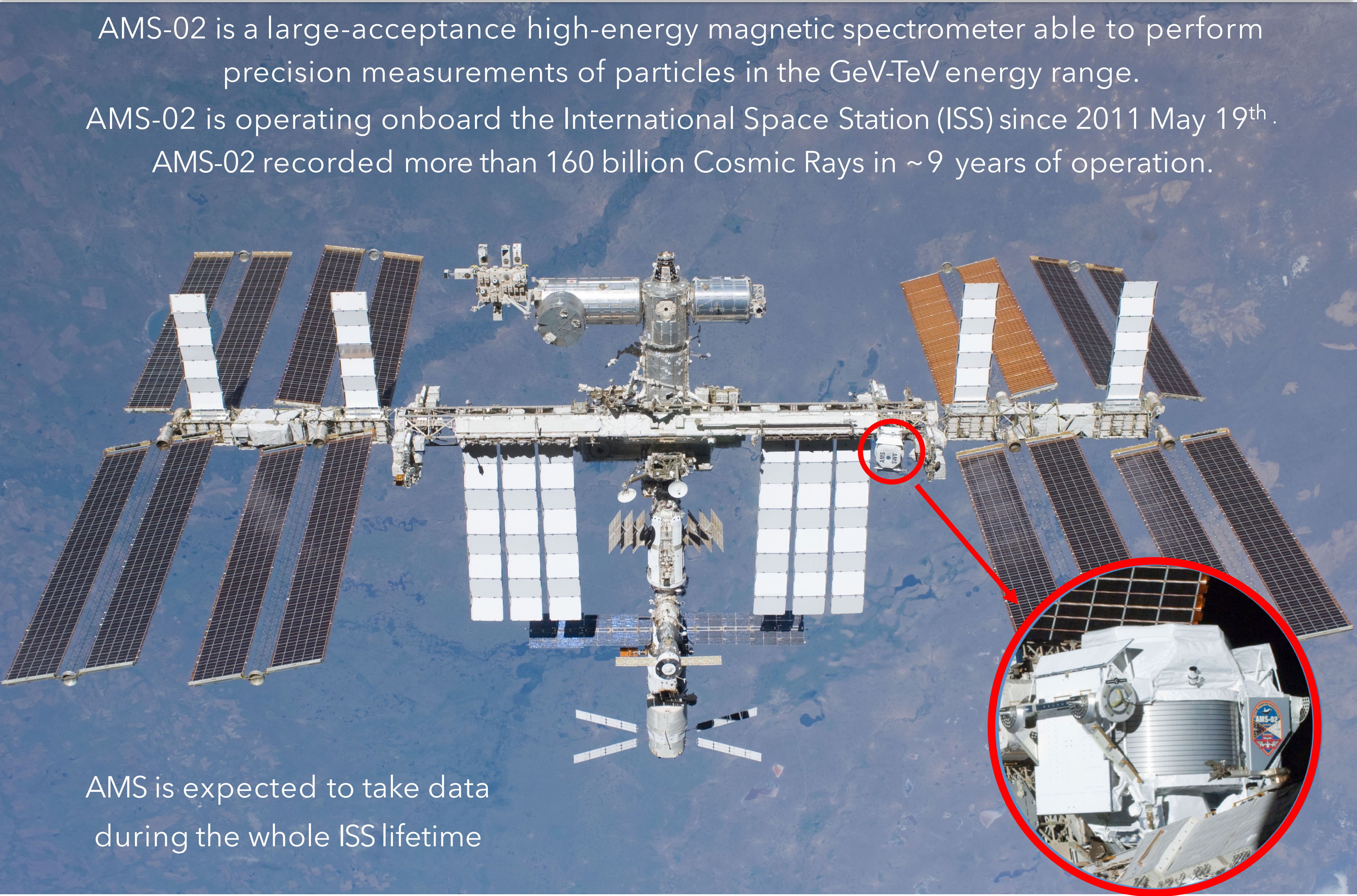
AMS-02 in orbit

AMS-02 is a large-acceptance high-energy magnetic spectrometer able to perform precision measurements of particles in the GeV-TeV energy range.

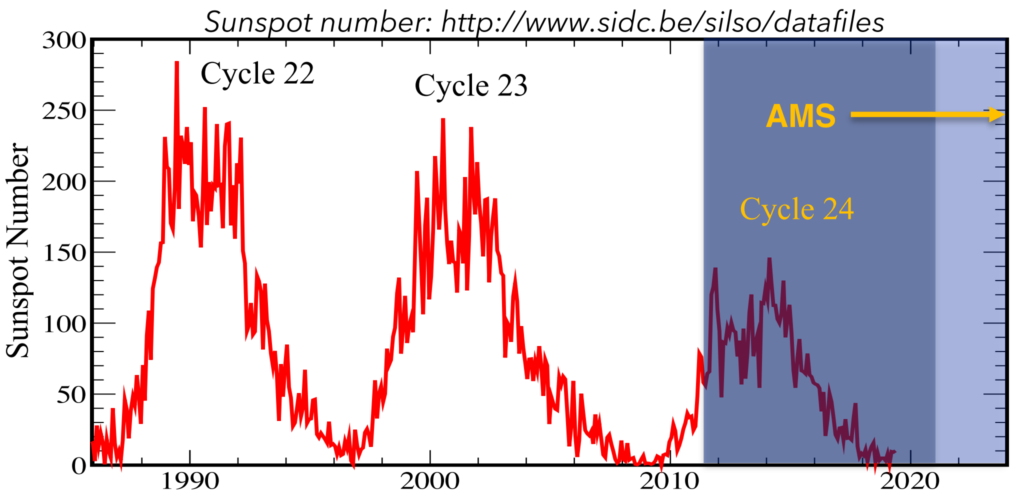
AMS-02 is operating onboard the International Space Station (ISS) since 2011 May 19th.

AMS-02 recorded more than 160 billion Cosmic Rays in ~9 years of operation.



AMS is expected to take data during the whole ISS lifetime

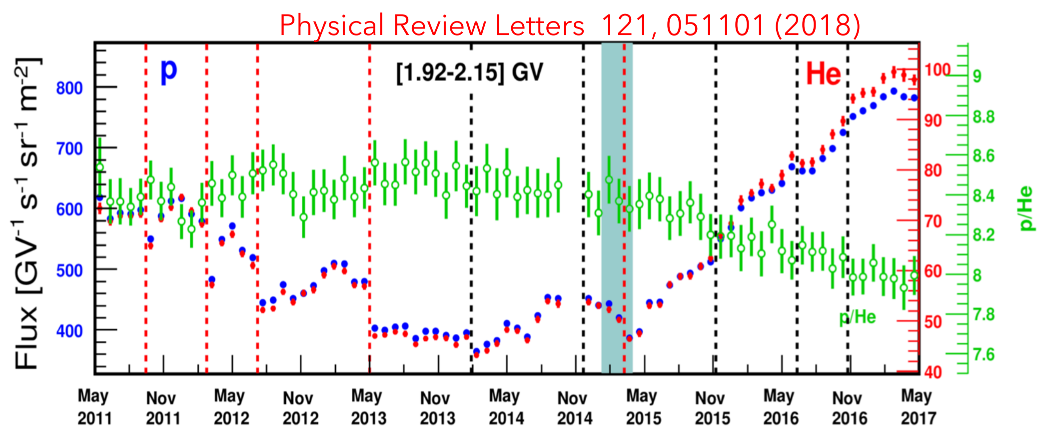
Monthly B, C and O fluxes: Physical Motivation



AMS-02 is able to study the time evolution of GCR during both periods of maximum and minimum of solar activity

Latest results from AMS show discrepancies on the spectral behavior of p and He, starting from February 2015

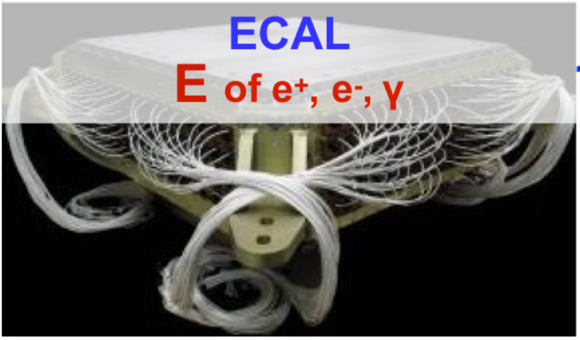
- Differences in diffusion coefficients?
- 3He and 4He isotopic composition?
- Differences in the local interstellar spectra?

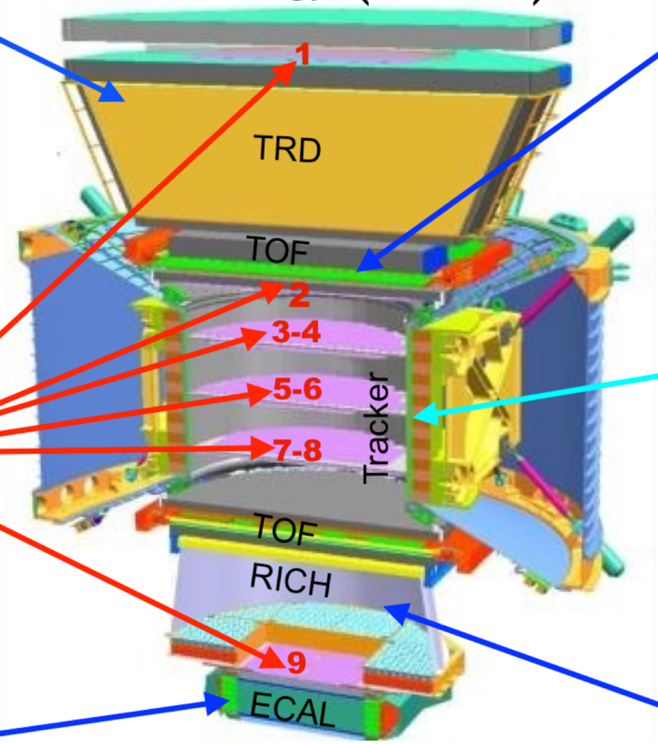


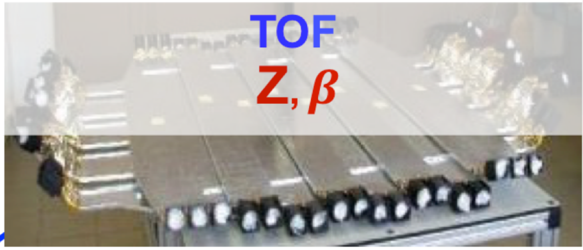
Boron, Carbon and Oxygen are the closest most abundant species, they can be used to understand the discrepancies on p and He, improving the knowledge of the nuclei propagation in the heliosphere

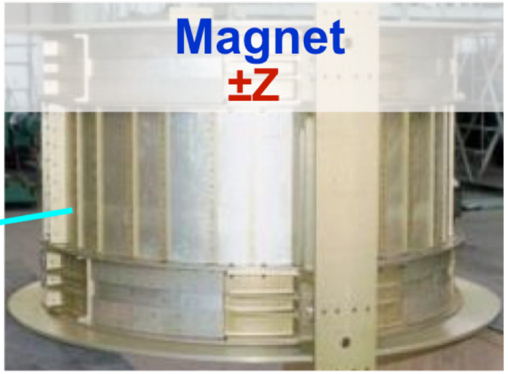
AMS-02

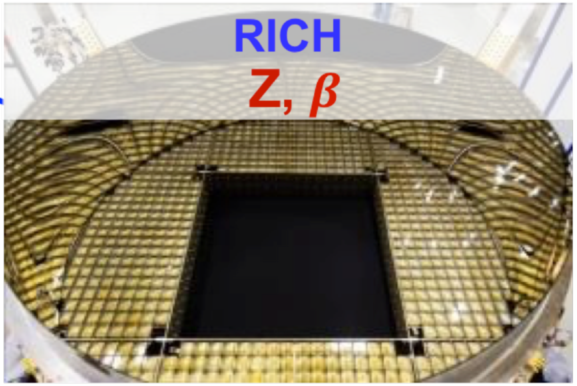
Particles and nuclei are defined by their charge (Z) and energy (E ~ P)





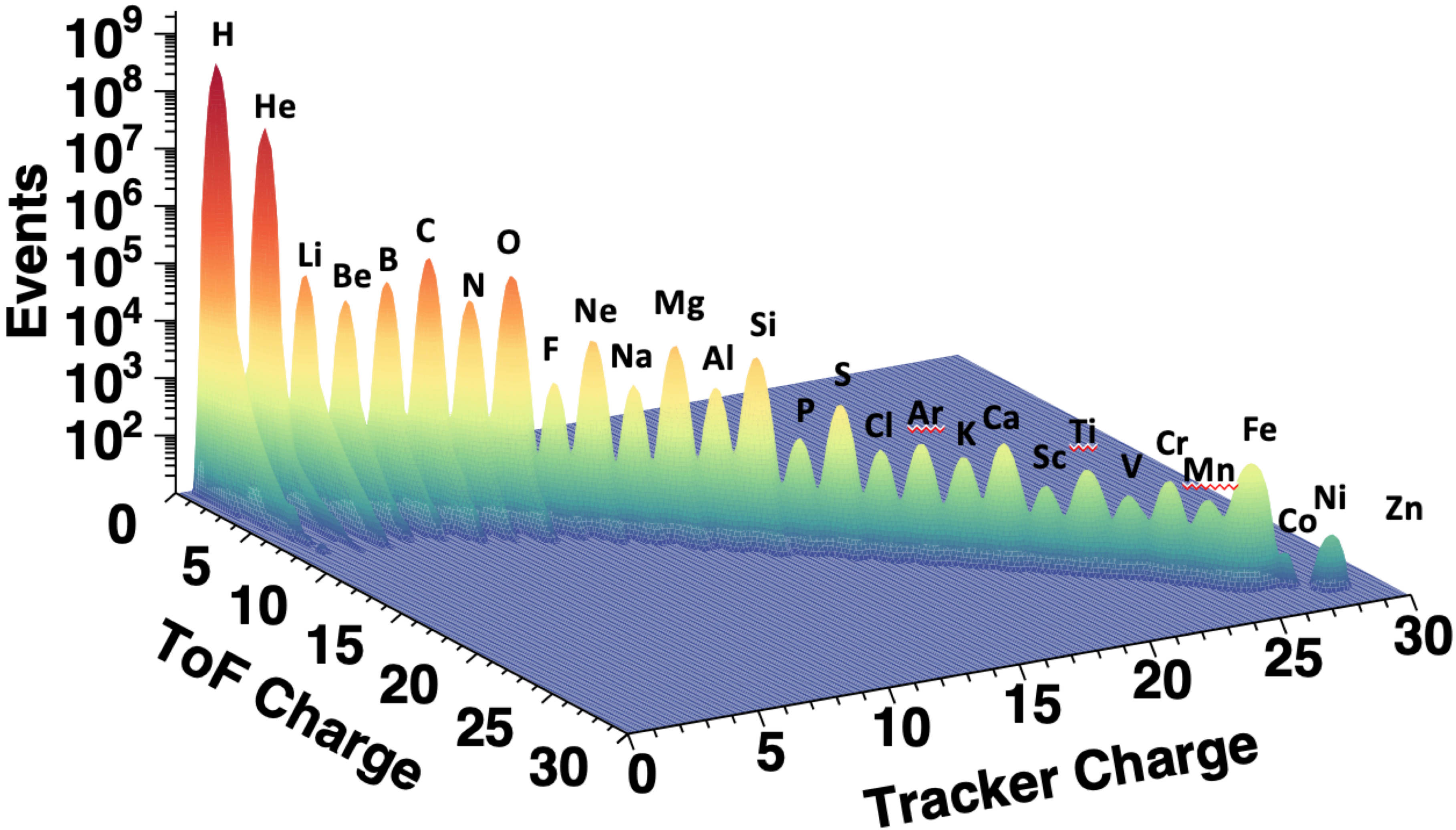






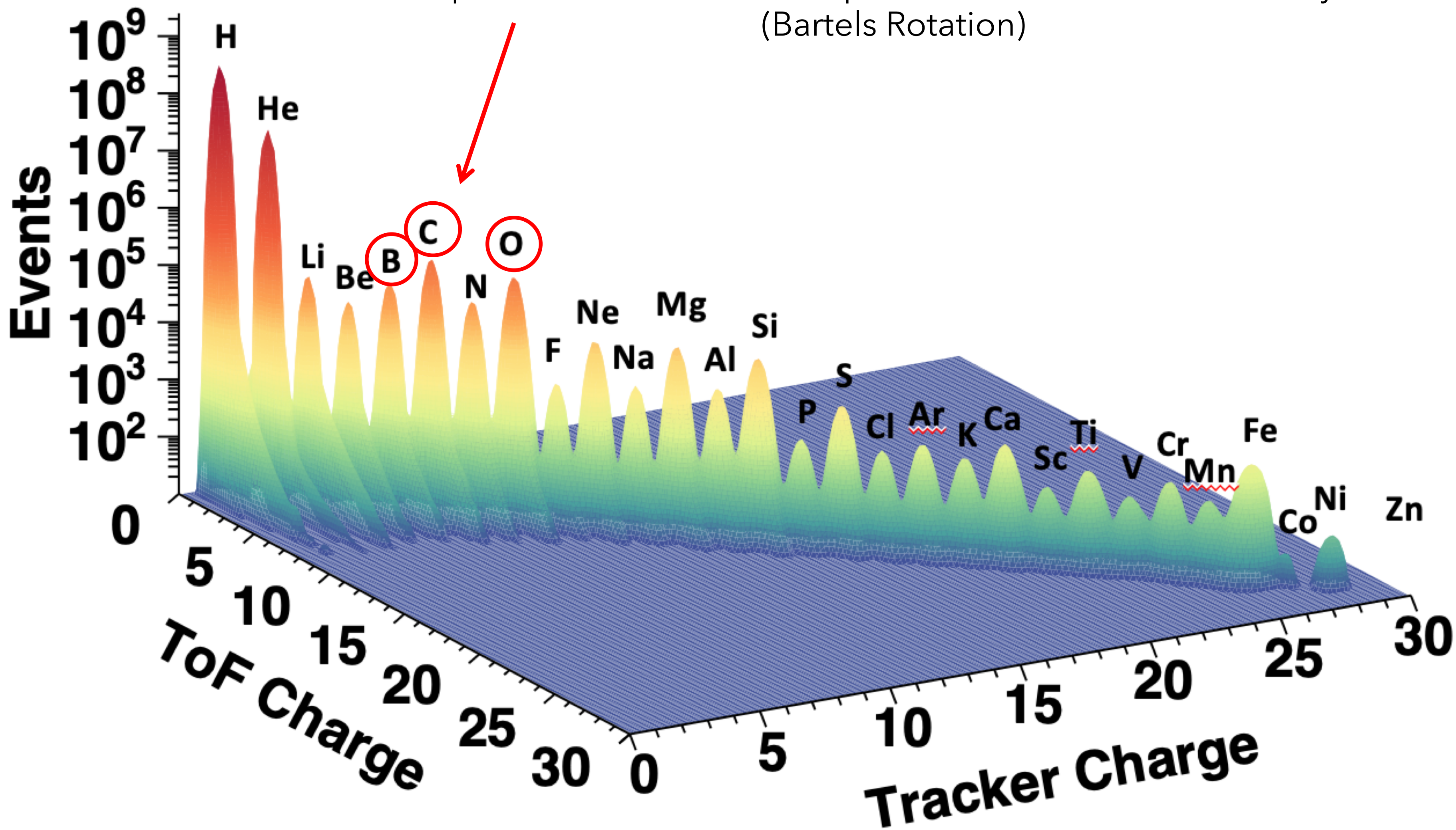
Z, P are measured independently by the Tracker, RICH, TOF and ECAL

Chemical composition measured by AMS-02



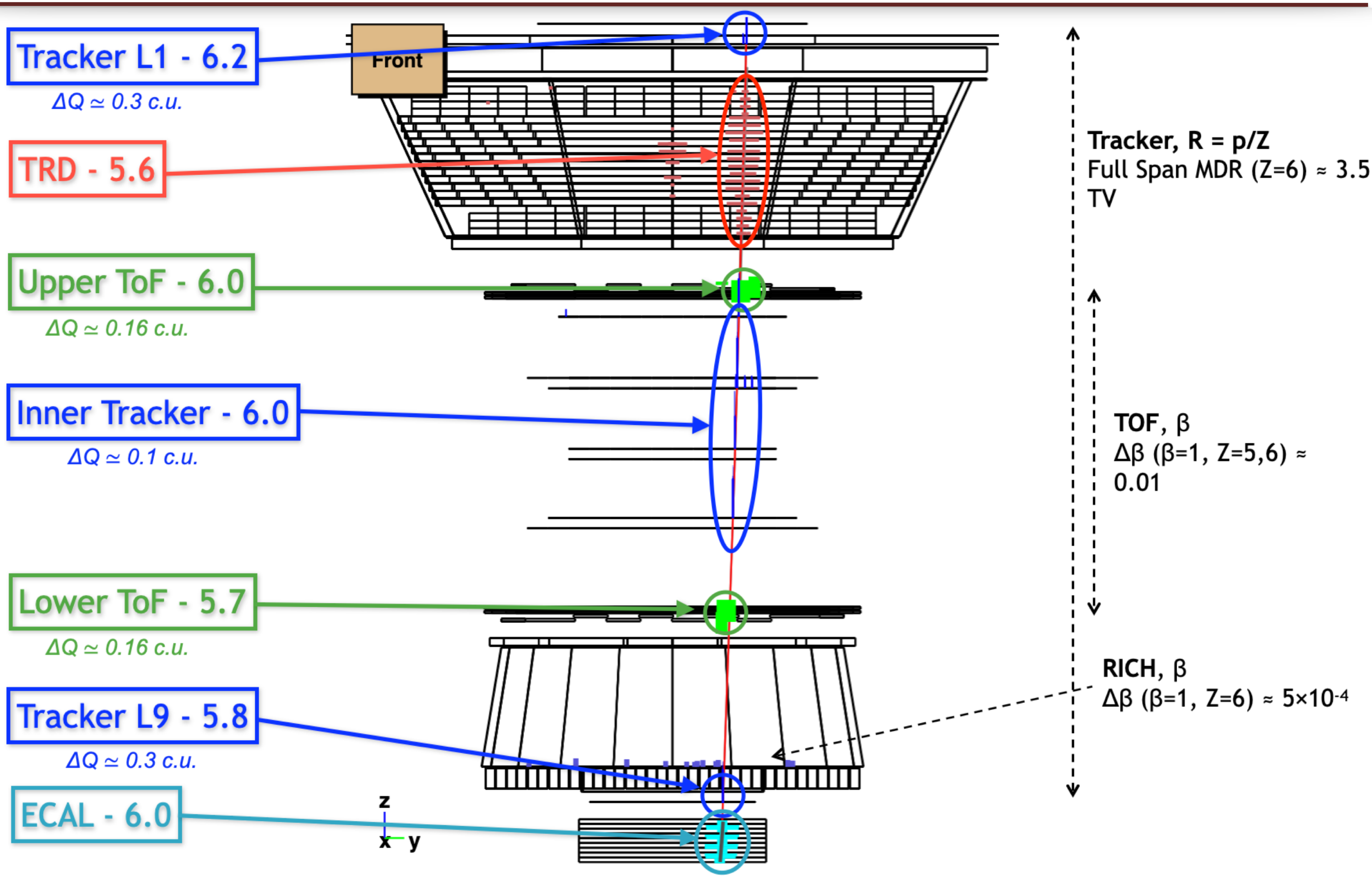
Chemical composition measured by AMS-02

This talk is focused on the time evolution of the B, C and O spectra from about 2 GV up to 60 GV in intervals of 27 days (Bartels Rotation)



Charge Measurement in AMS-02

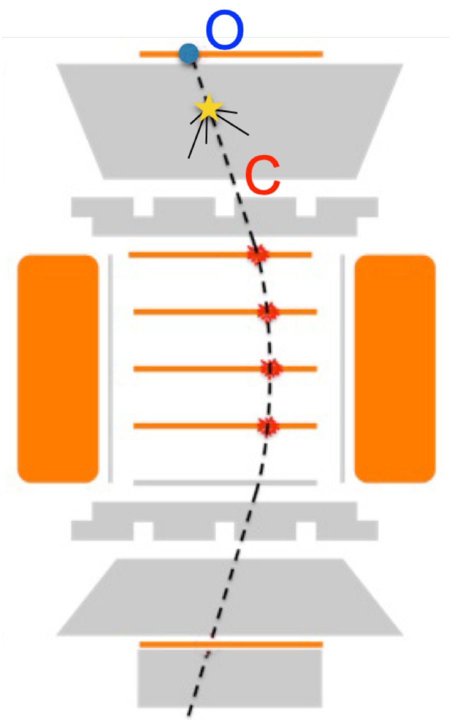
(e.g. Carbon nucleus: Z=6)

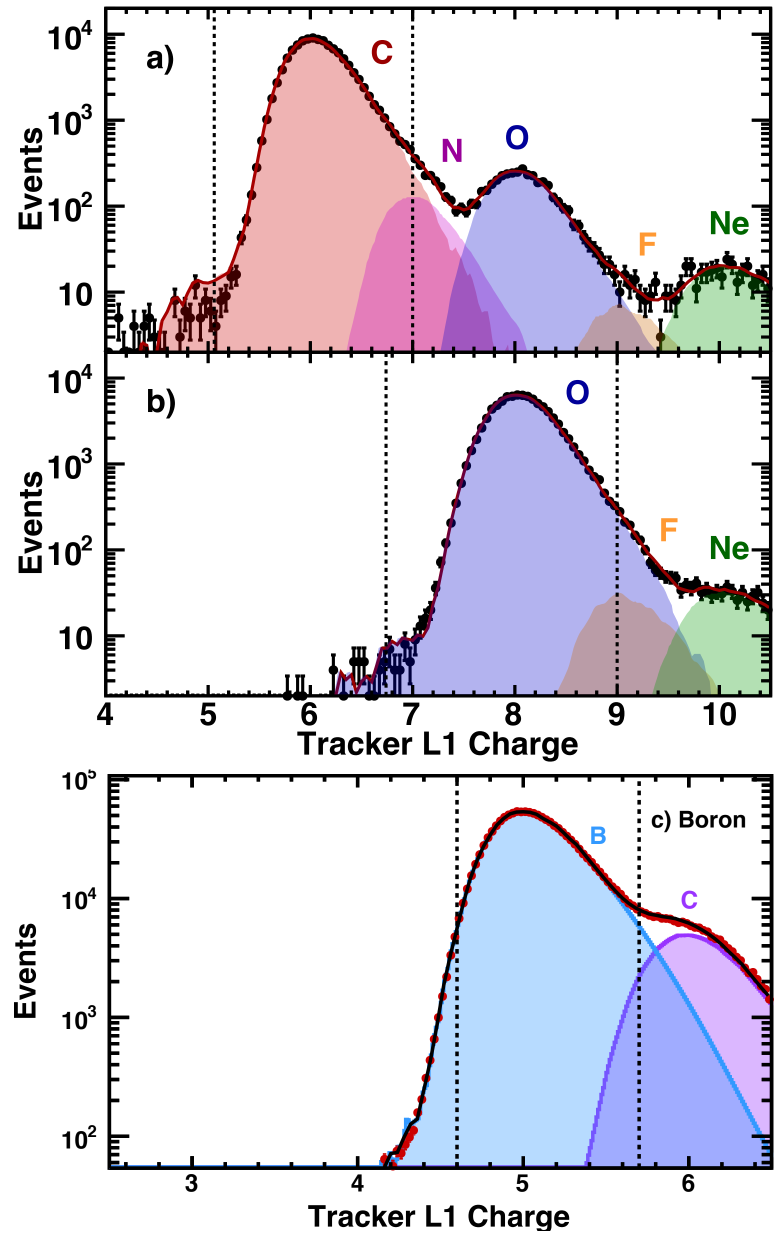


Data purity

With the track defined by the inner tracker (L2-L8), examine the charge distribution on the tracker L1.

The high redundancy of charge measurements allows to keep under control interactions in the upper part of the detector (between Tracker L1 and L2)





Flux Measurement

Isotropic Differential Flux
$(m^2\ sr\ s\ GV)^{-1}$

Number of events
Corrected for Bin to Bin Migration due to Tracker Rigidity Resolution

$$\Phi(R_i) = \frac{N_i}{T_i\, A_i\, \varepsilon_i\, \Delta R_i}$$

Bin width

Exposure Time
Duty Cycle and Geomagnetic Cutoff

Effective Acceptance
Estimated with MC Simulation and validated from Data

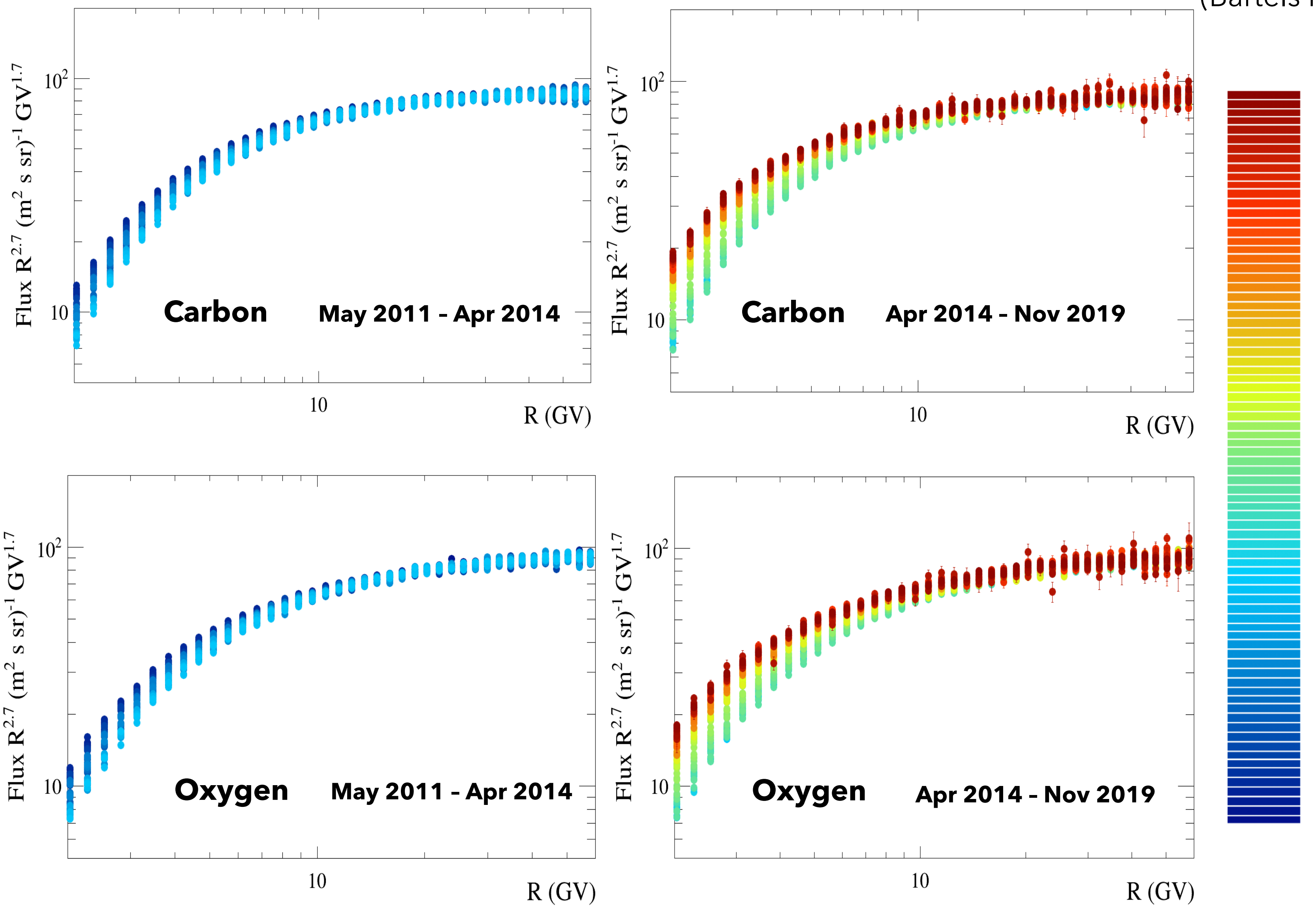
Trigger Efficiency
Estimated directly from Data

Monthly B, C and O Fluxes

Preliminary Data
Please refer to the AMS forthcoming publication

Monthly Carbon and Oxygen fluxes up to 60 GV

Time intervals of 27 days
(Bartels Rotation)



Monthly B, C and O Fluxes

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Monthly Boron fluxes up to 60 GV

Time intervals of 27 days
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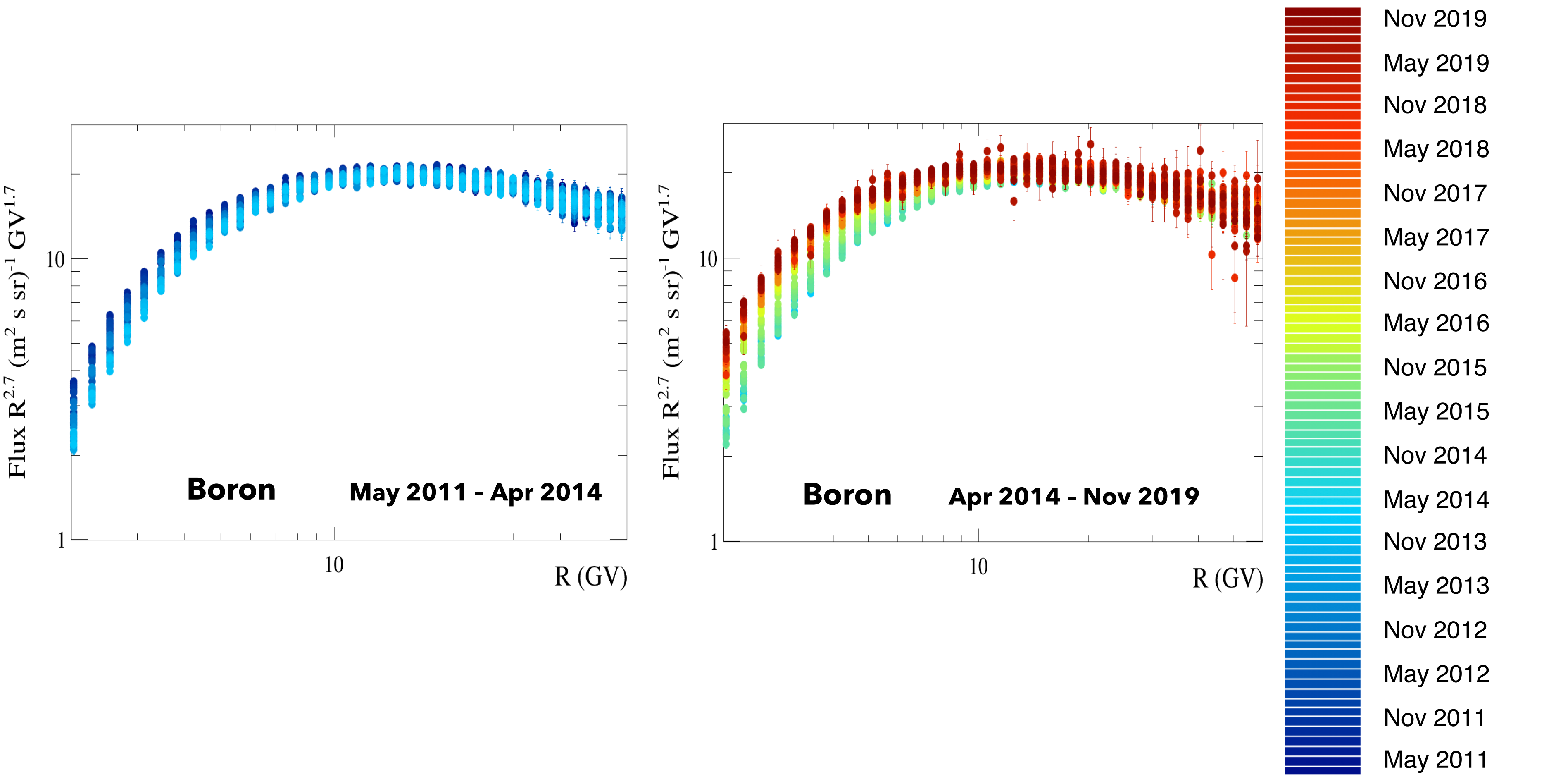
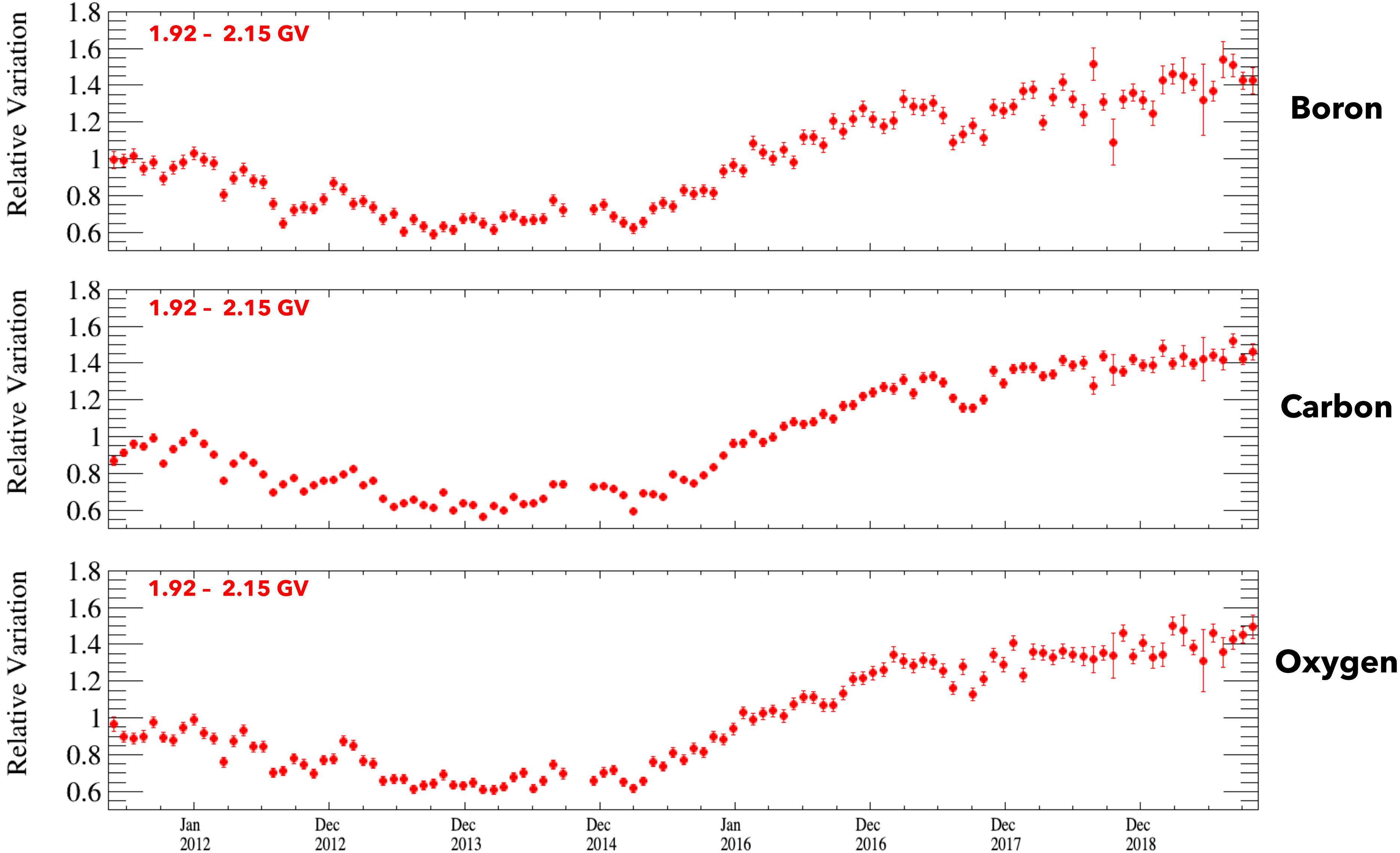


Monthly Fluxes Relative Variation

Relative variation of montly fluxes with respect to the overall period average flux



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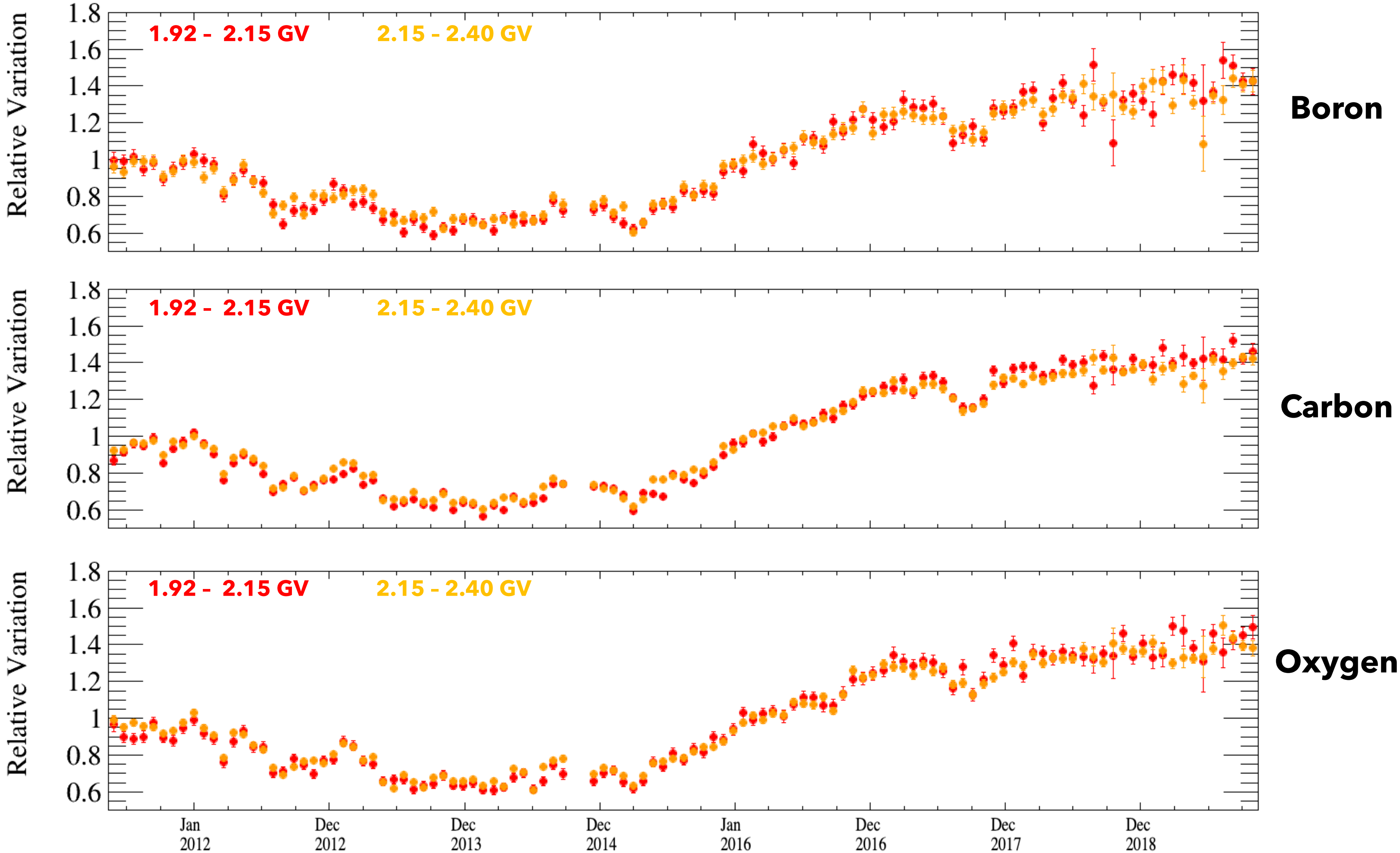

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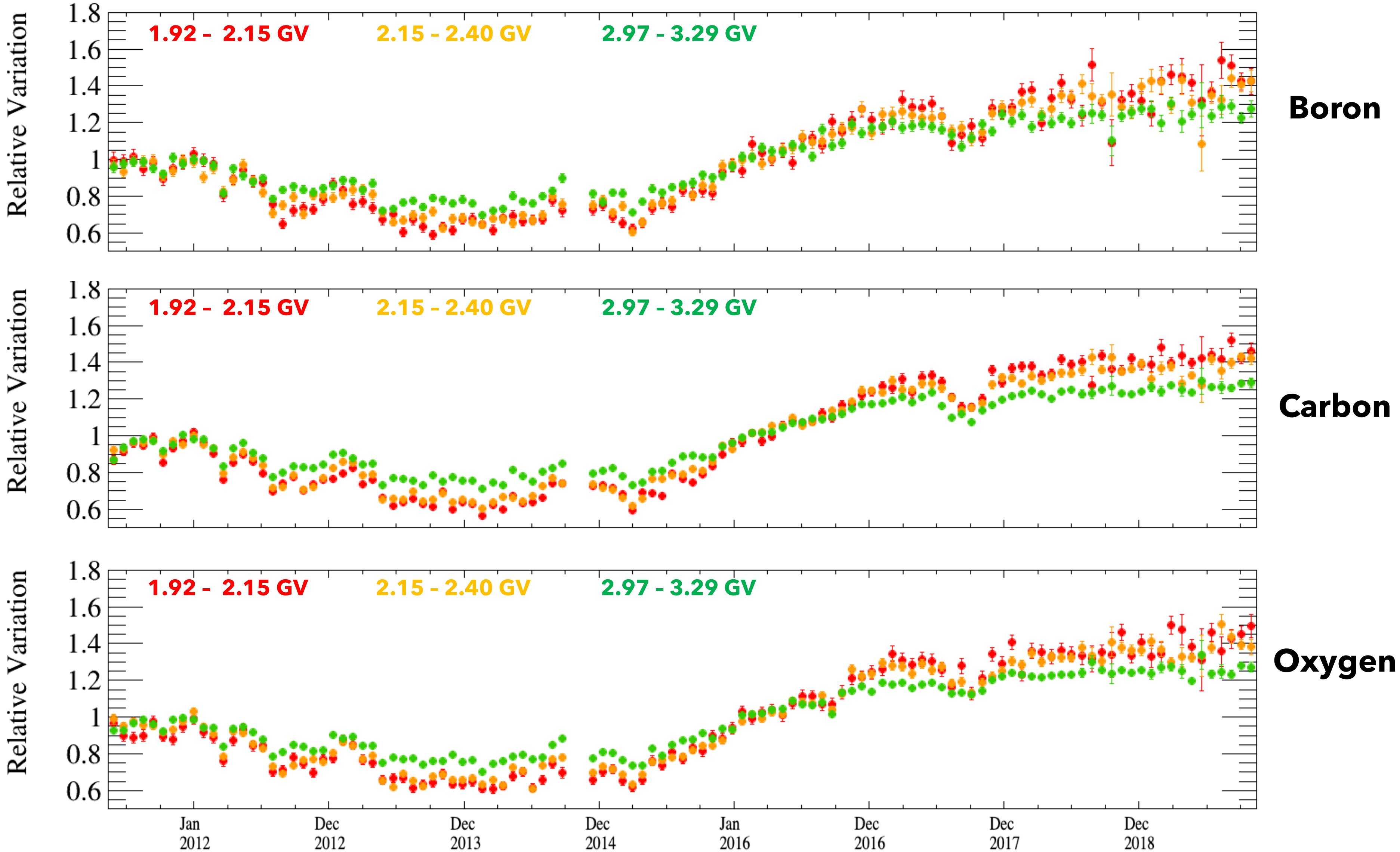

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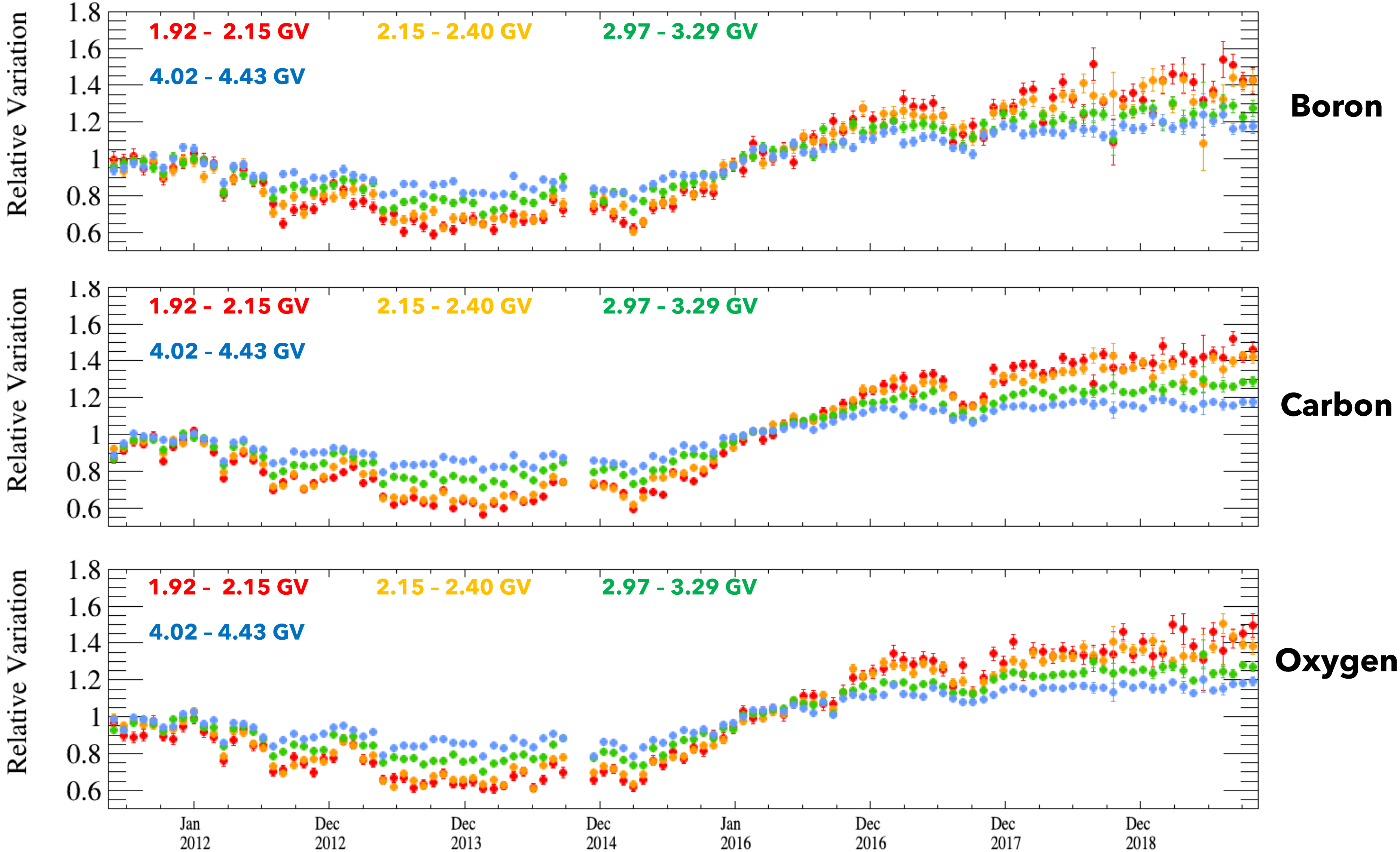

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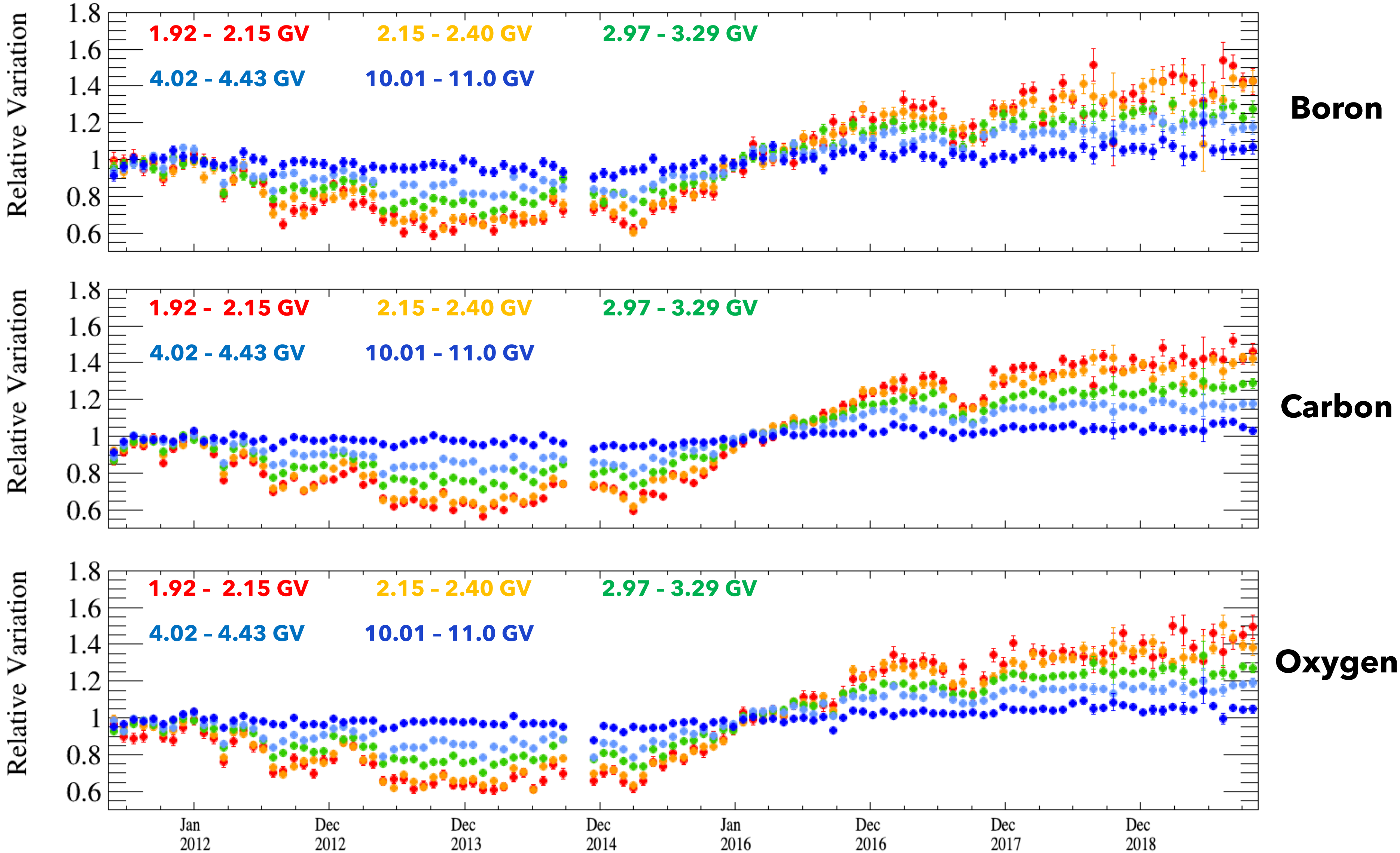

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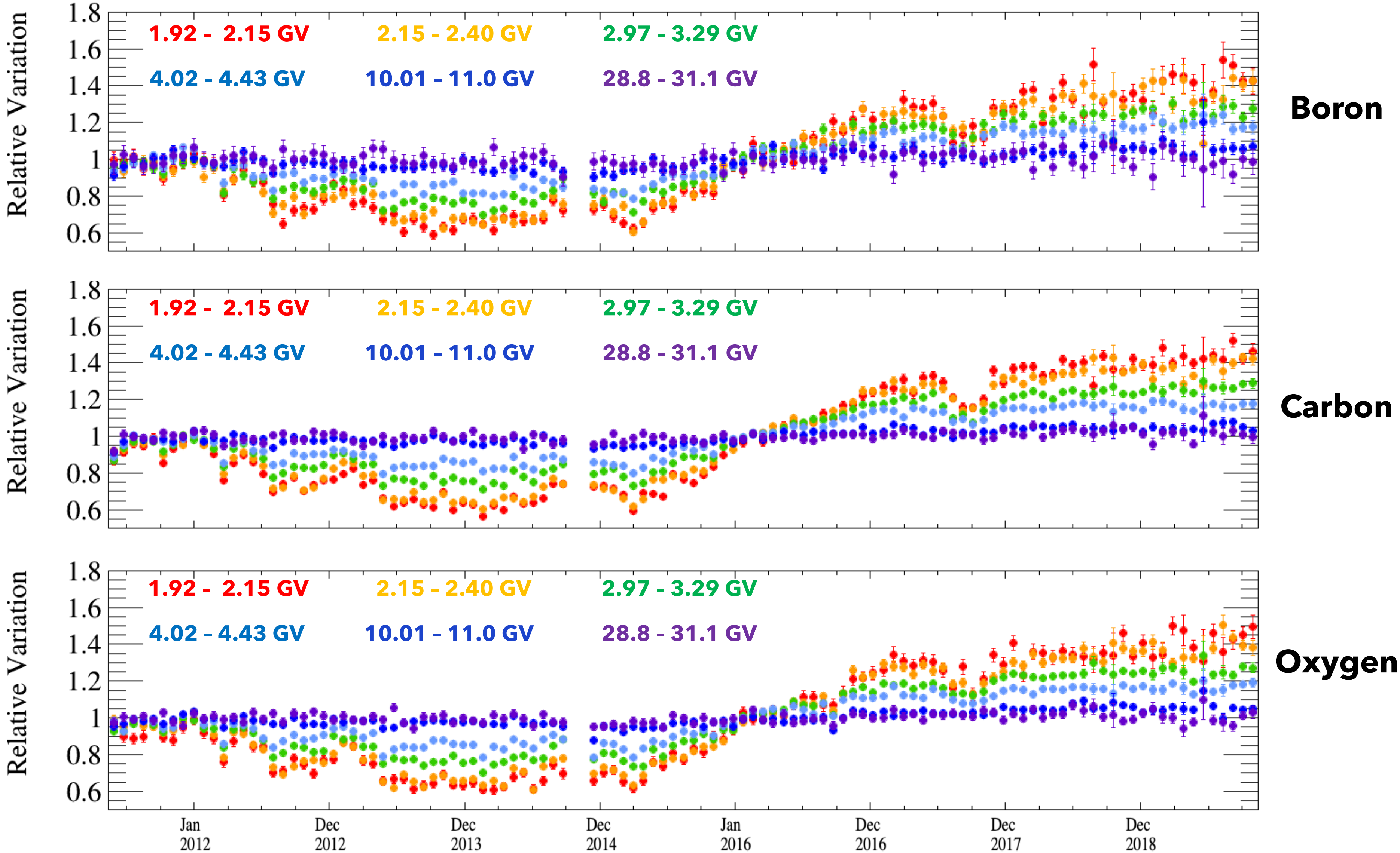

Results: B, C and O

Preliminary Data
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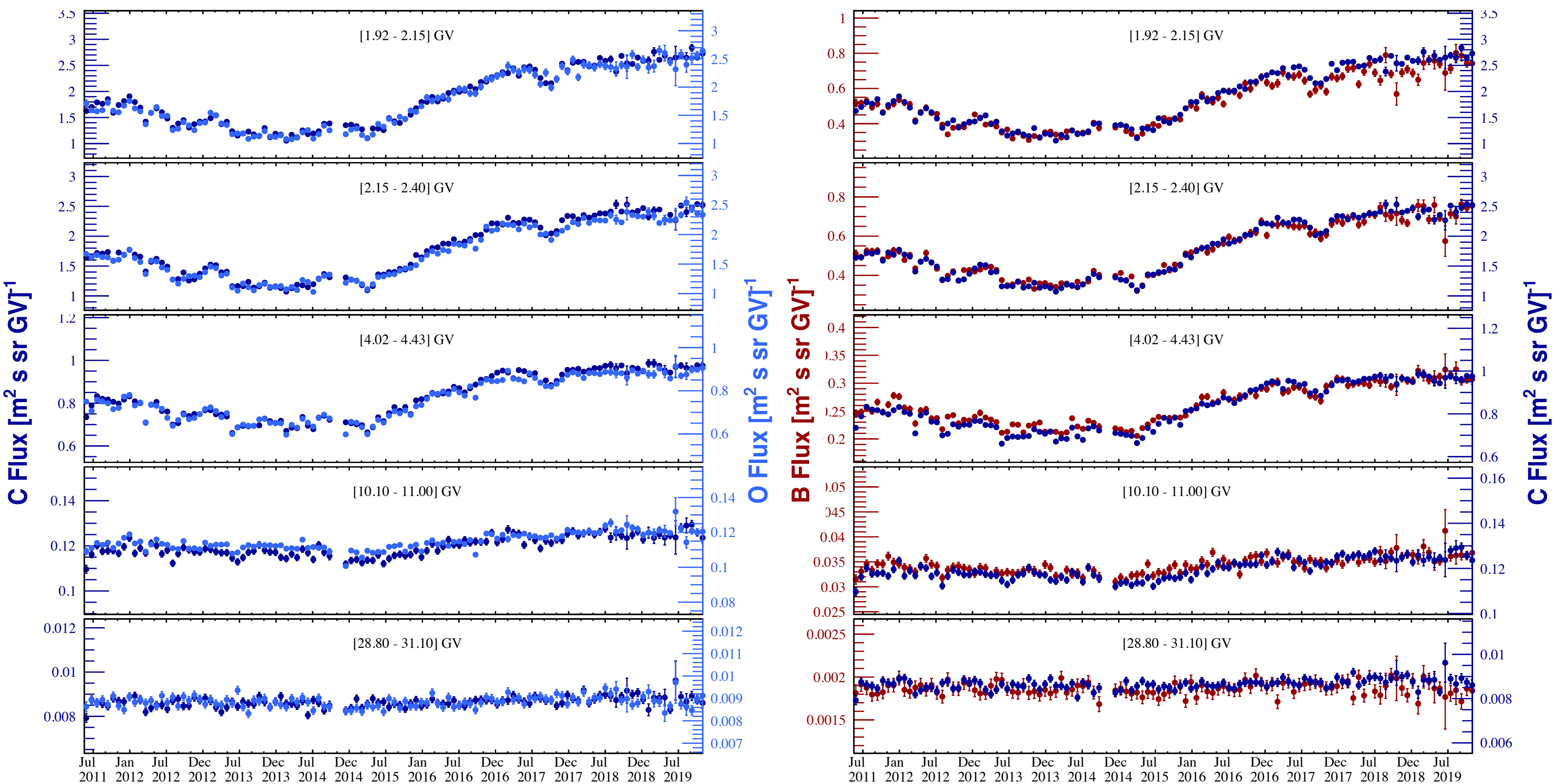
B, C and O monthly fluxes (total errors) up to Nov 2019

➢ All the fluxes show time structures similar to the ones observed on p and He



Monthly C and O Fluxes Comparison

Preliminary Data
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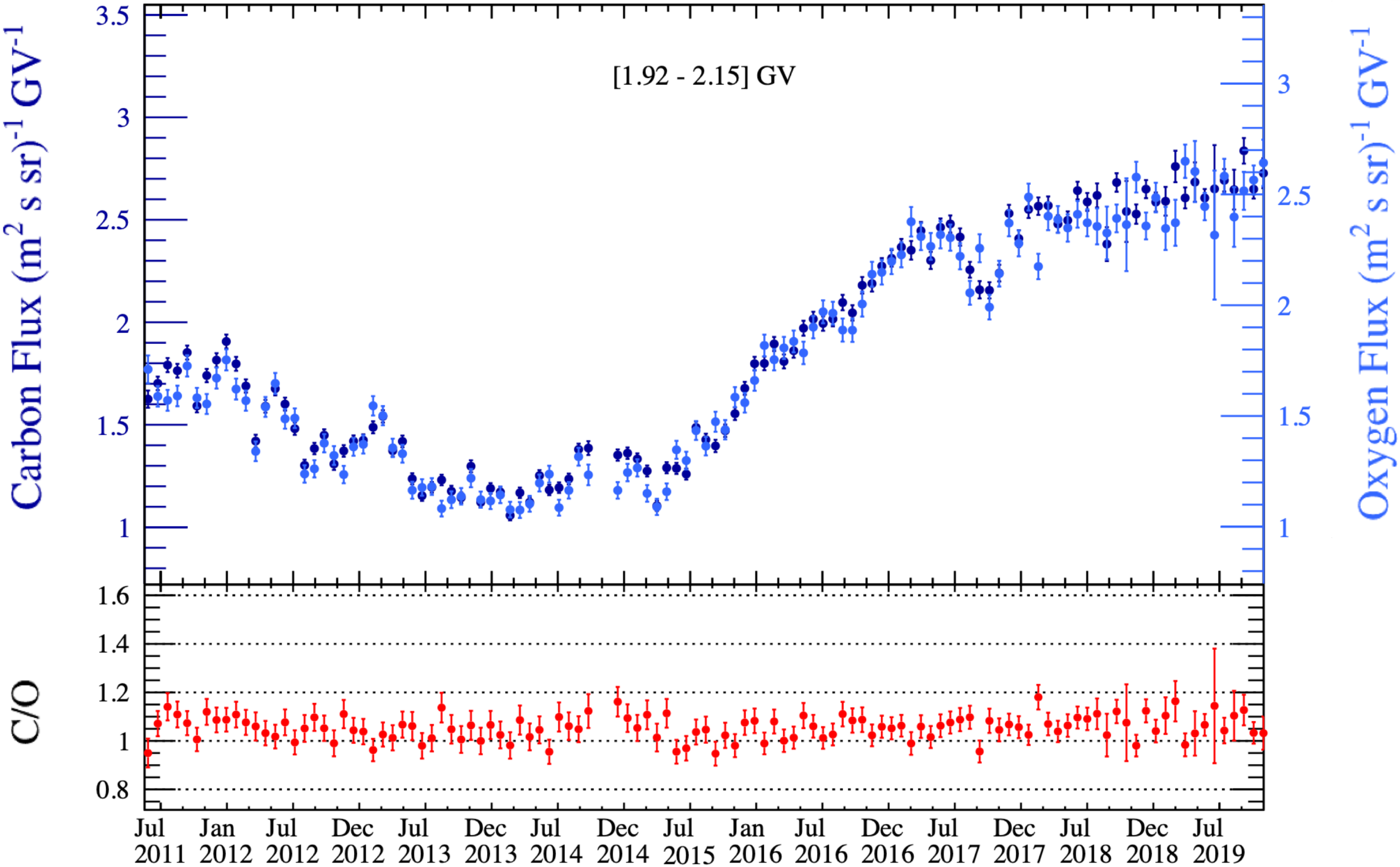

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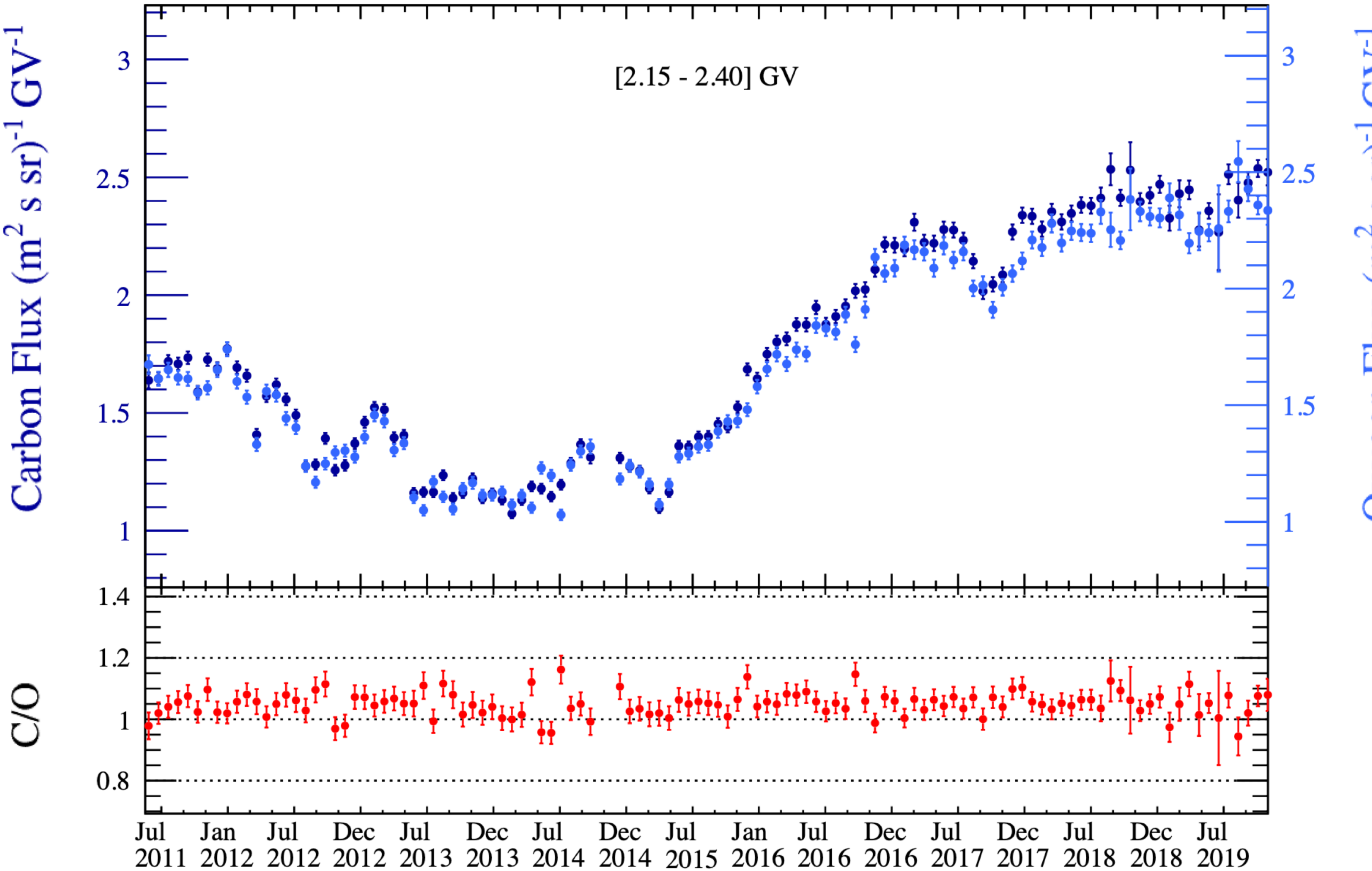

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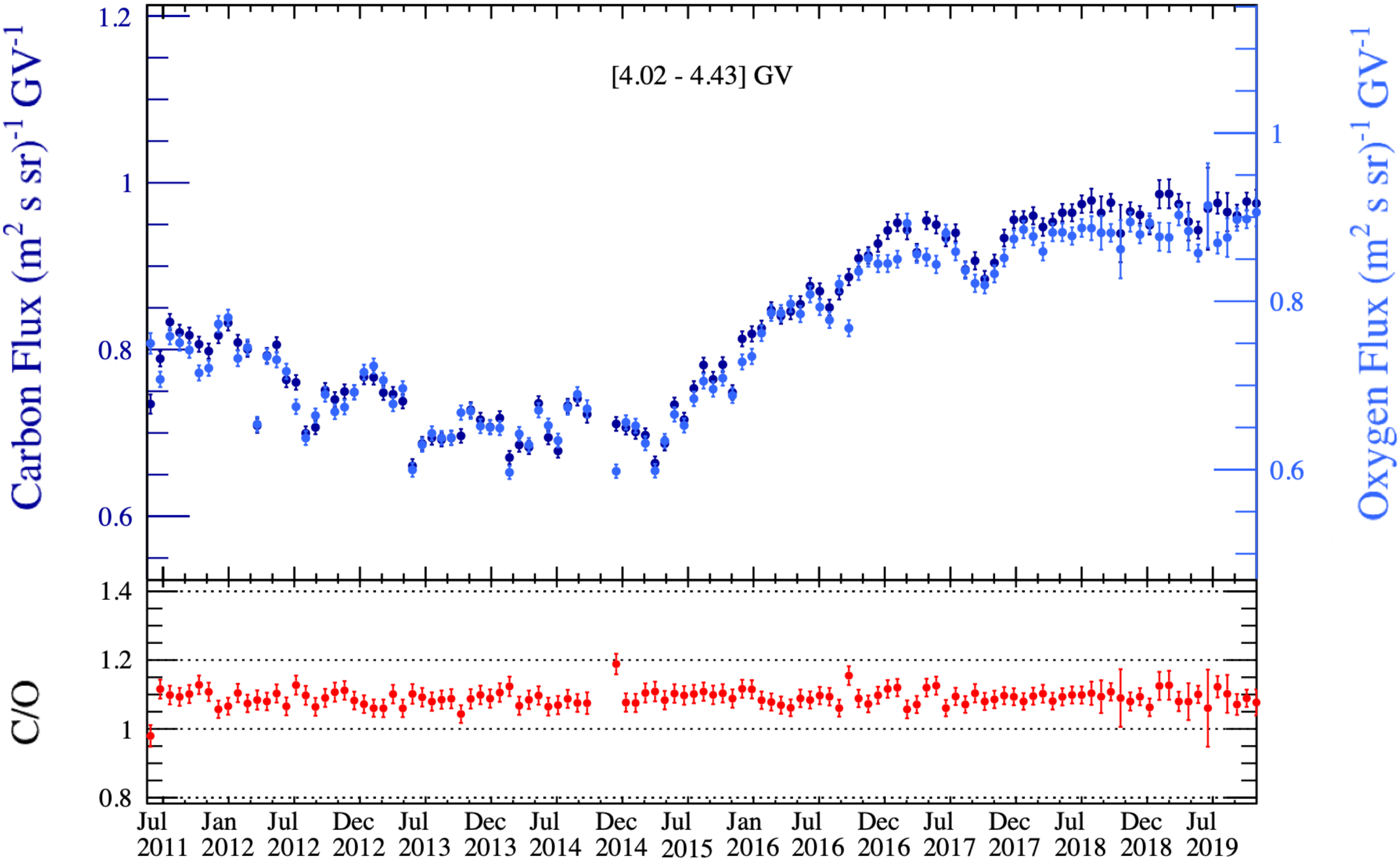

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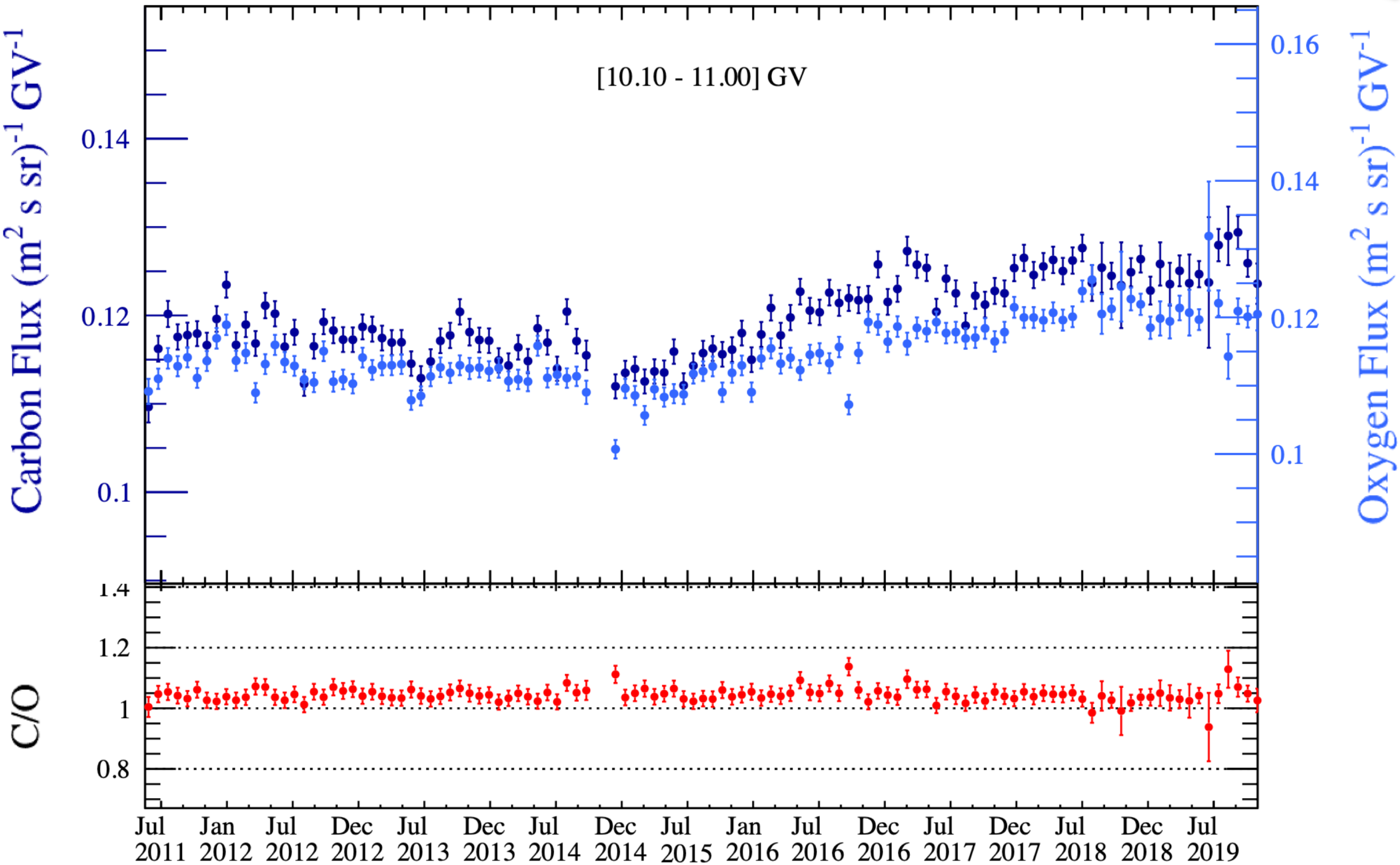

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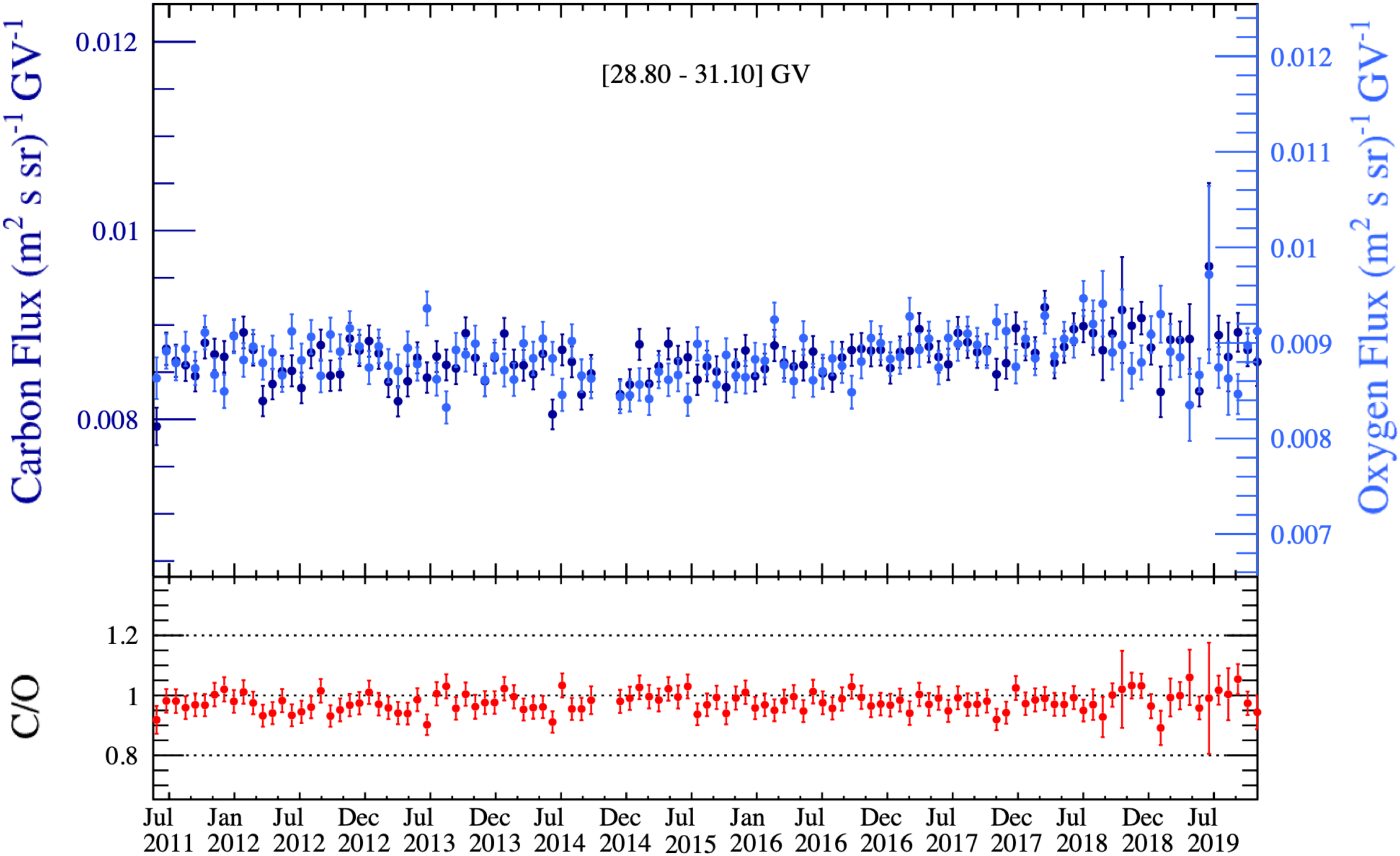
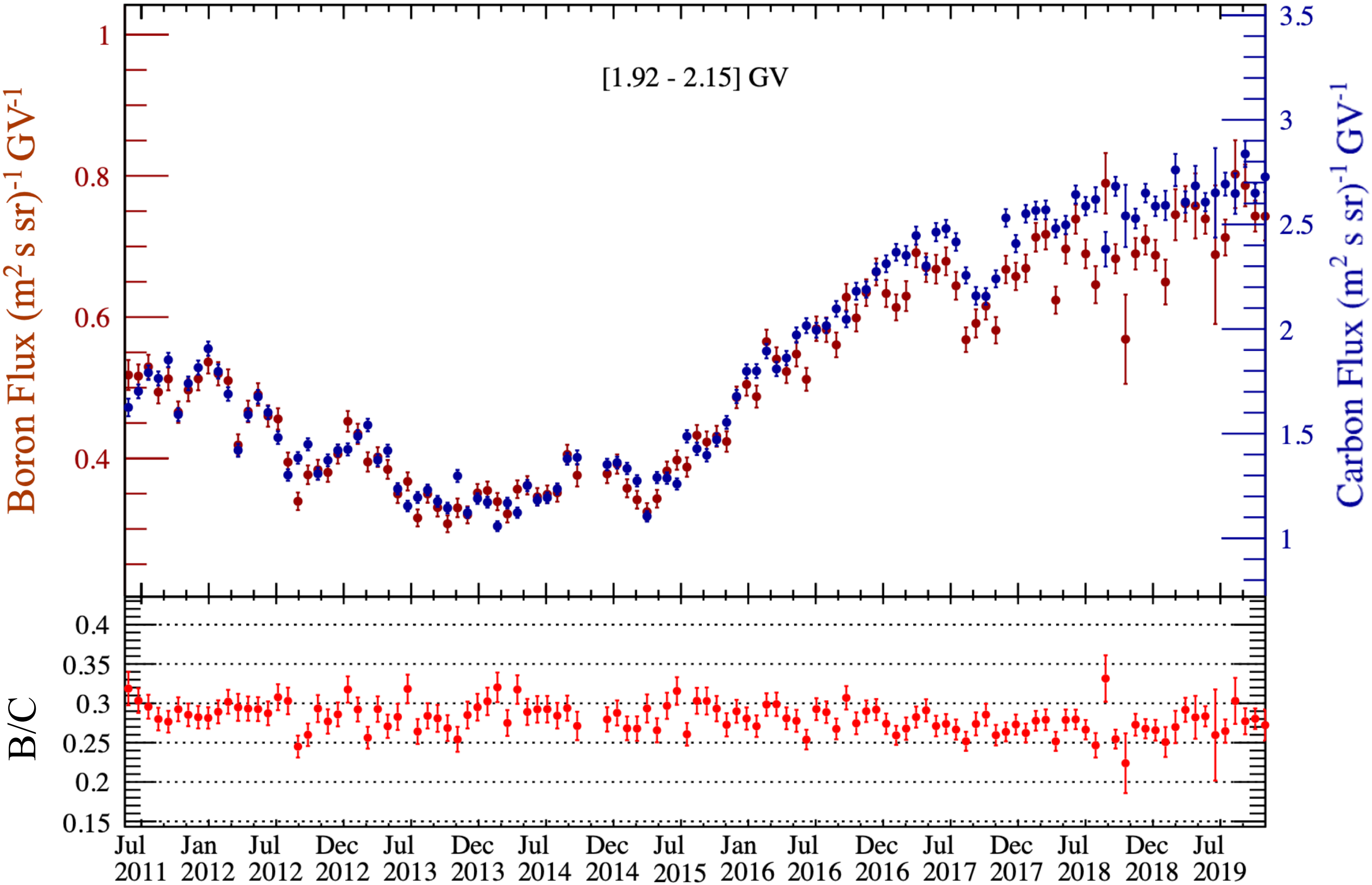


Monthly B and C Fluxes Comparison



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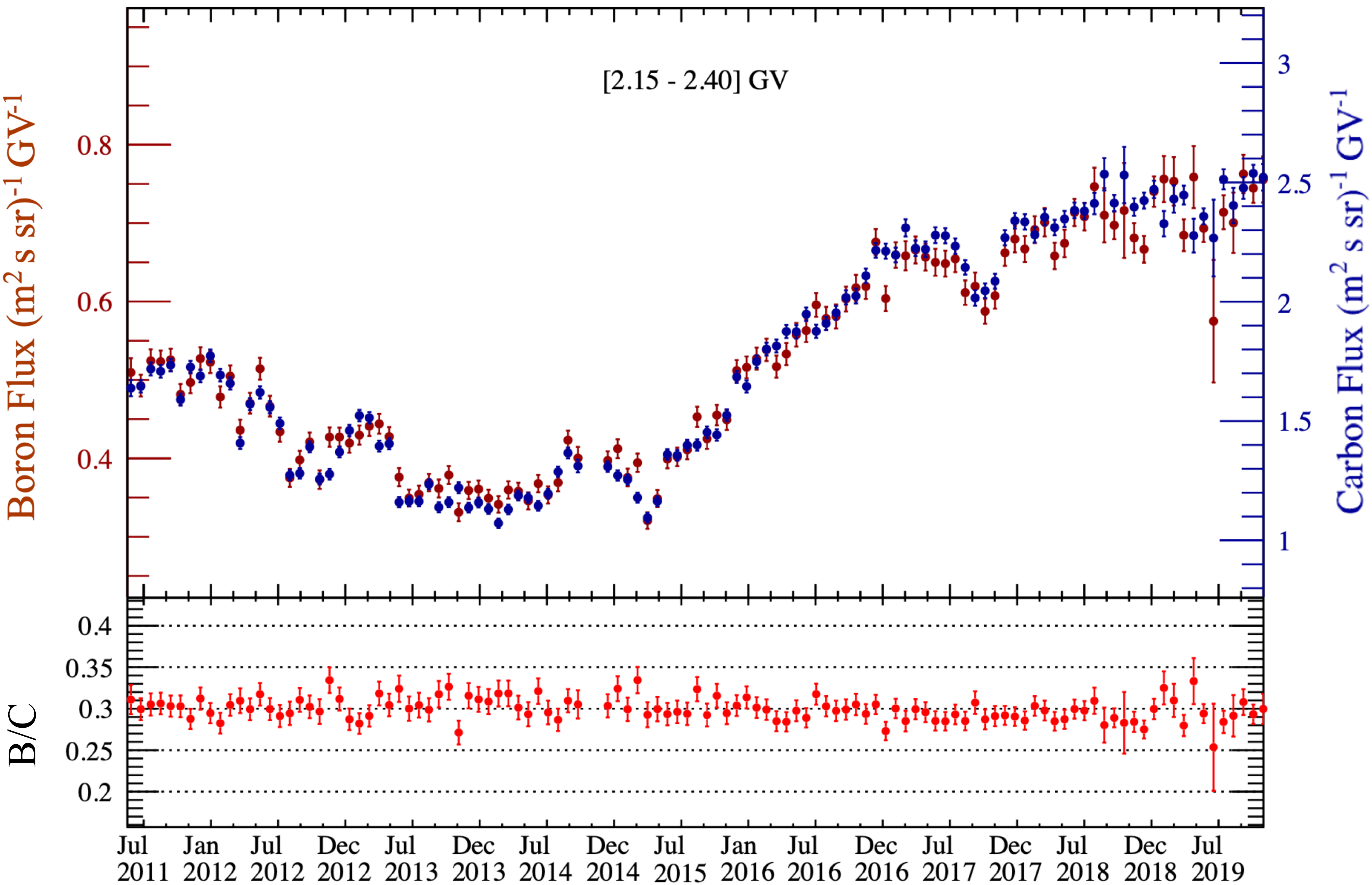

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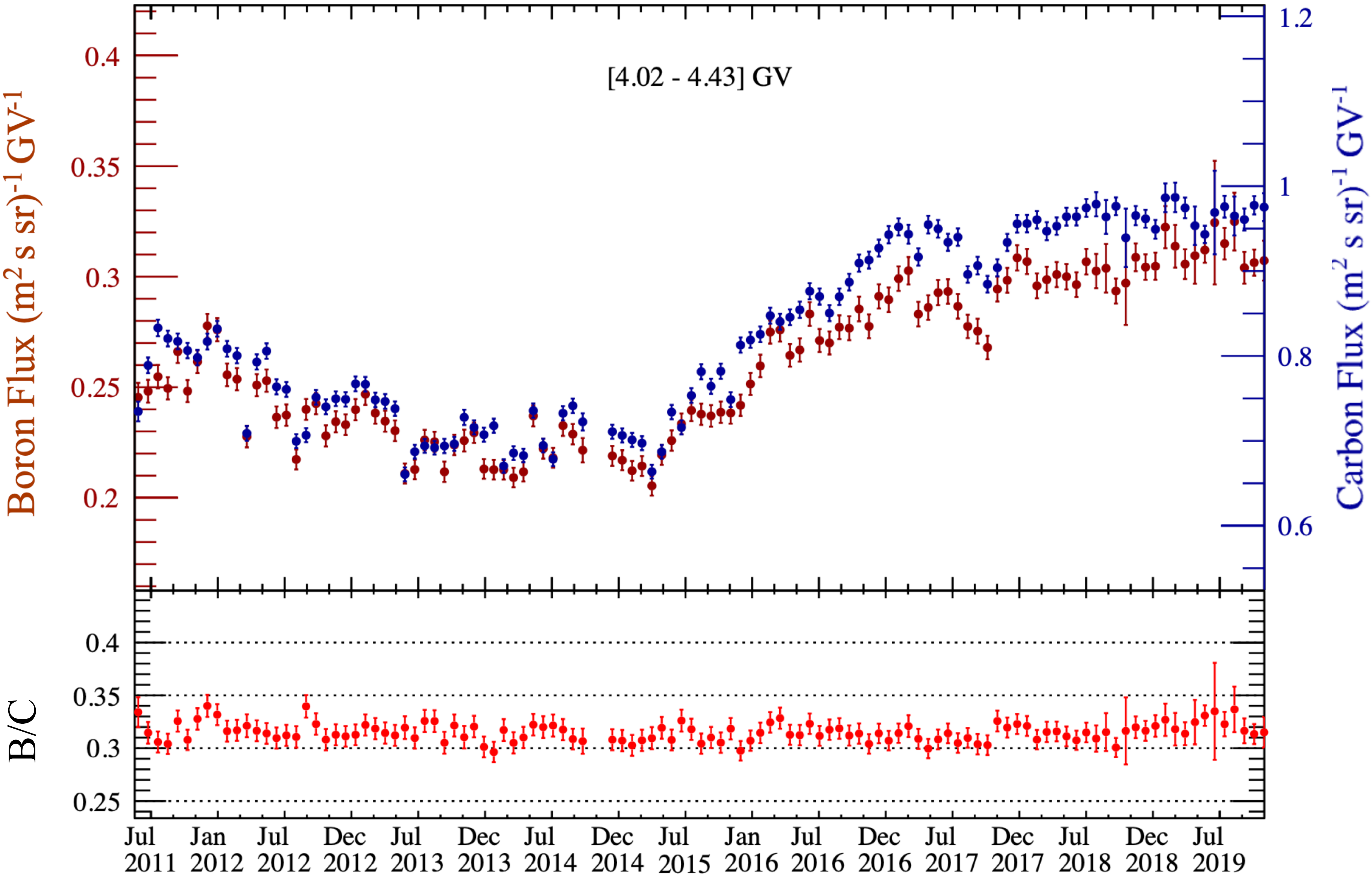

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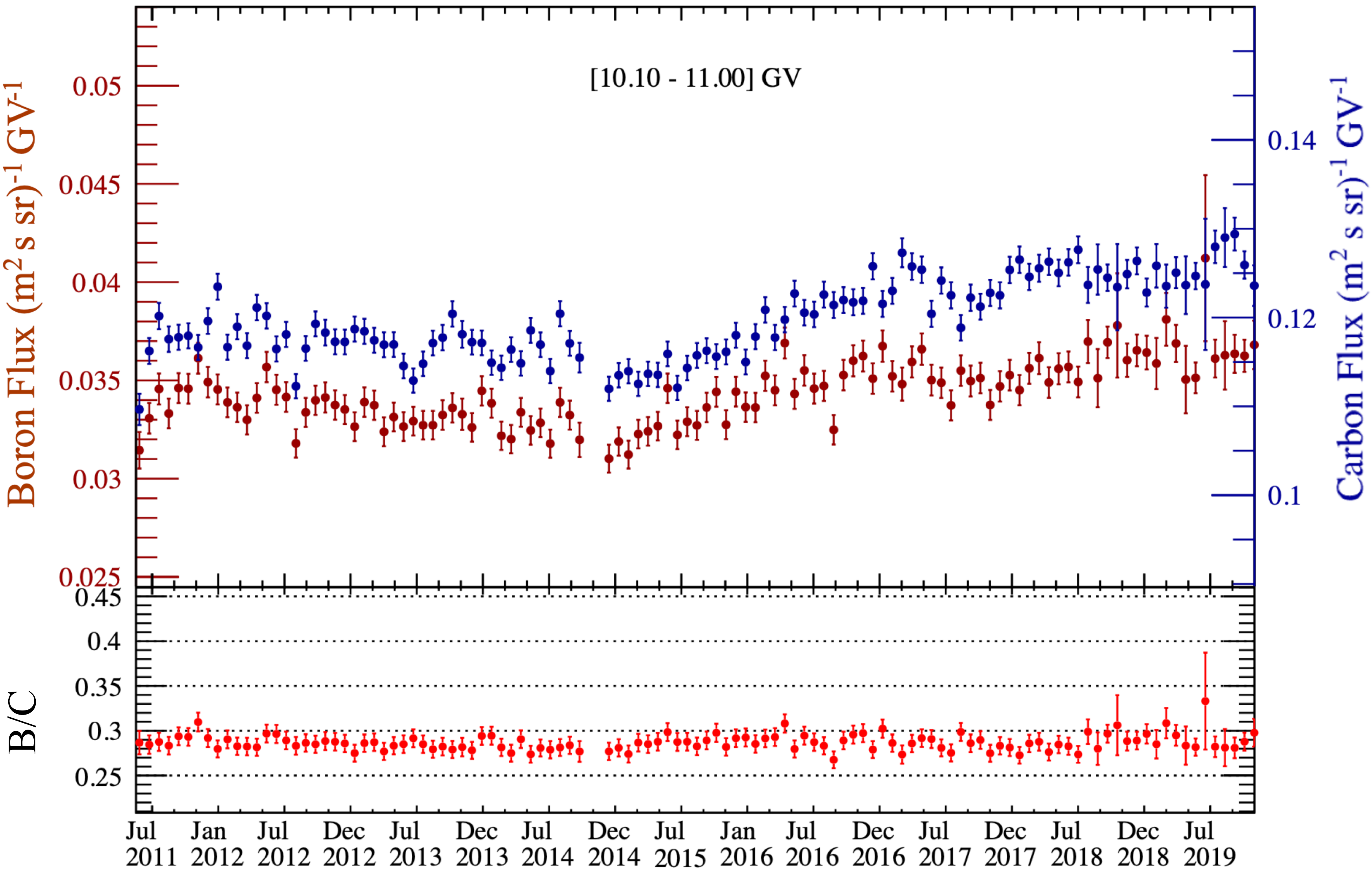

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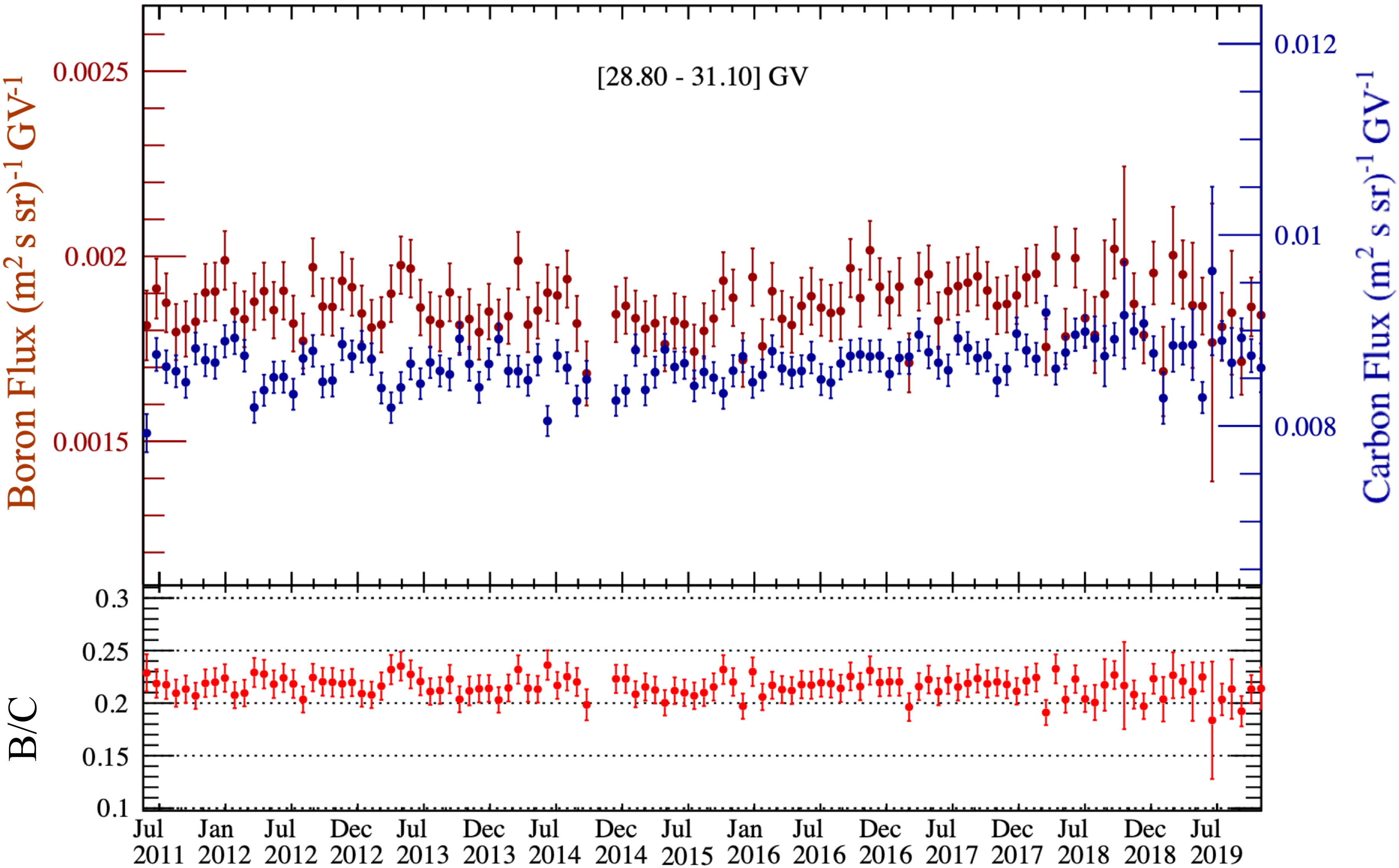

Monthly B and He Fluxes Comparison

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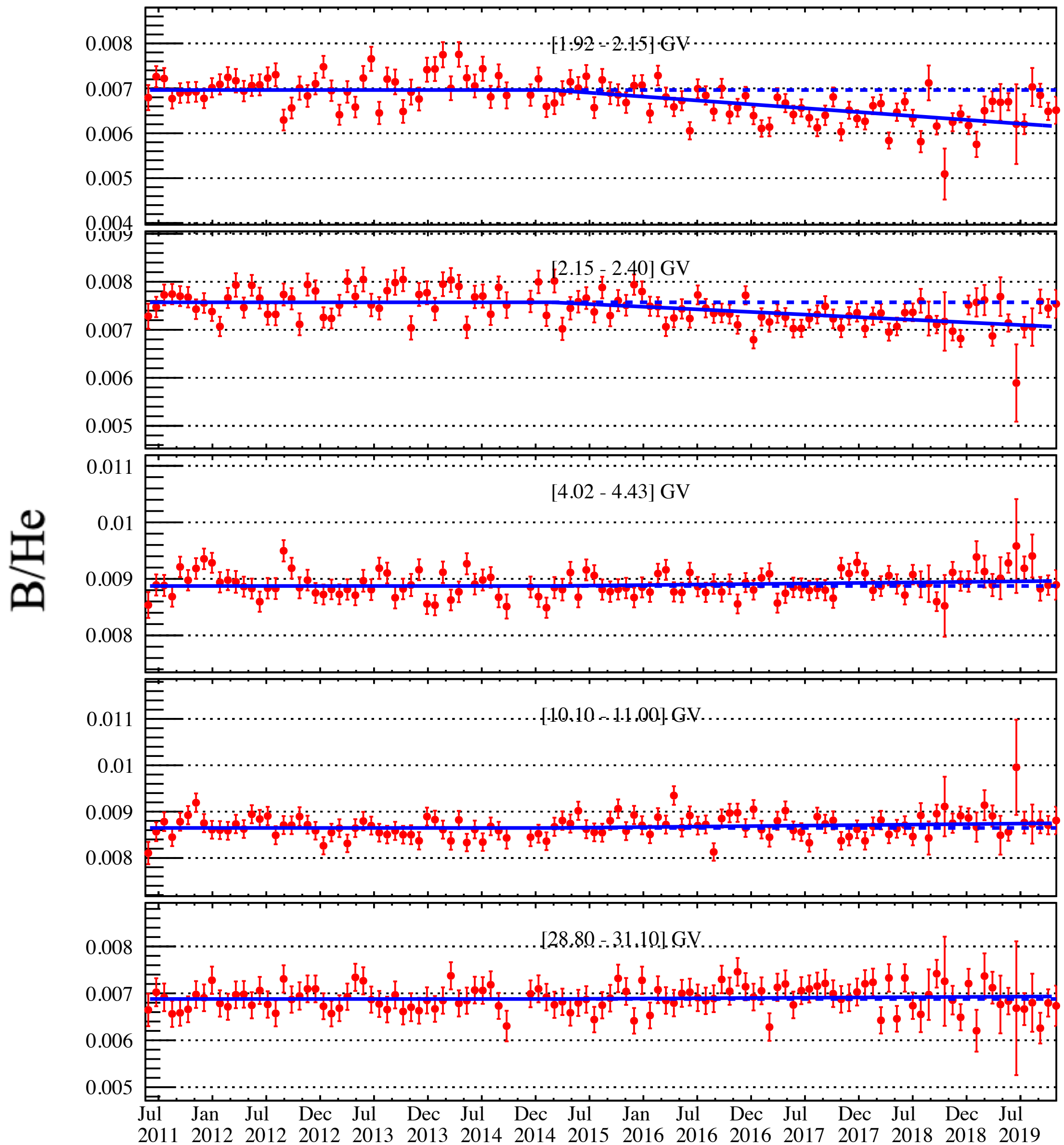

Monthly C and He Fluxes Comparison

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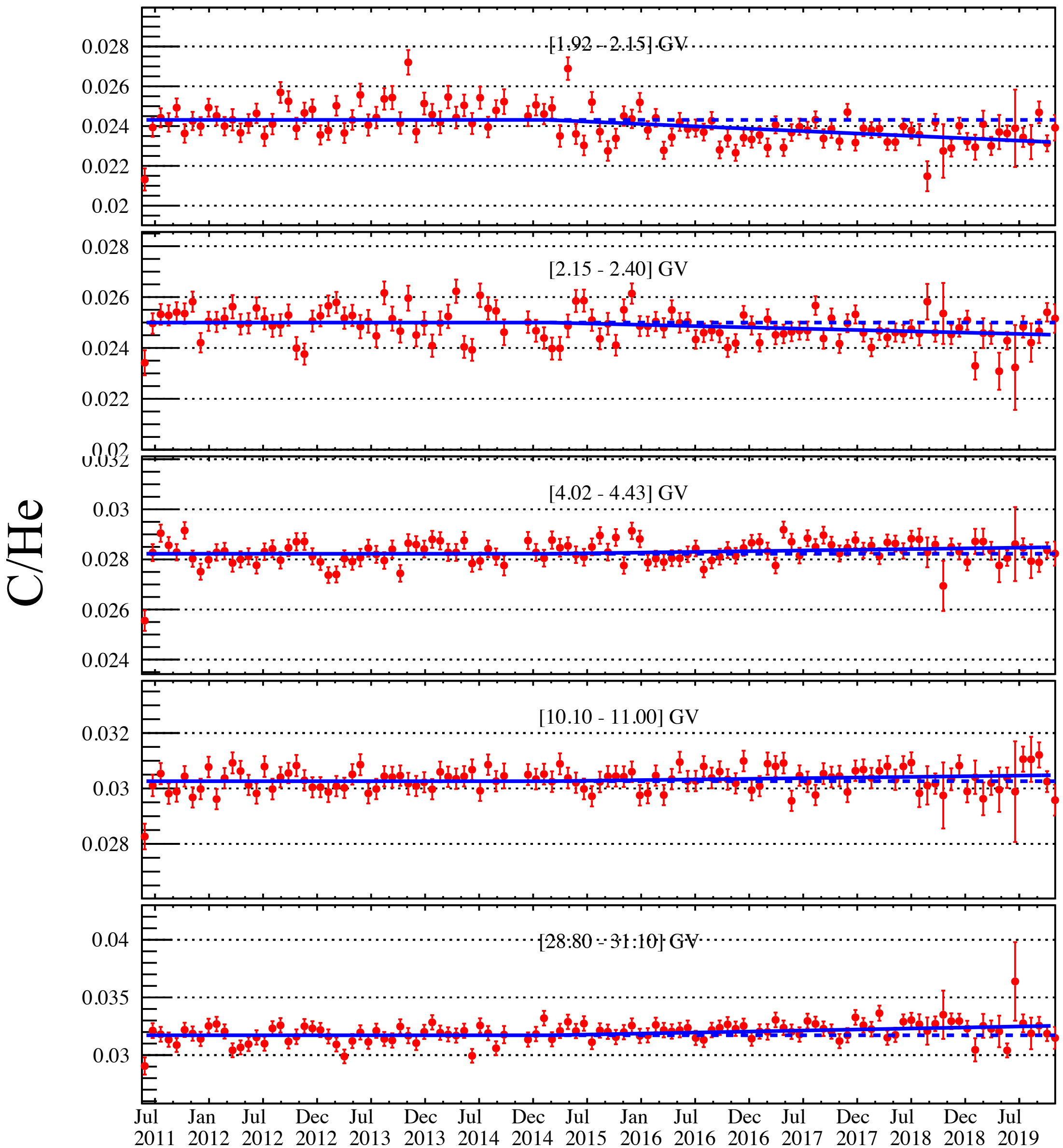

Monthly O and He Fluxes Comparison

Preliminary Data
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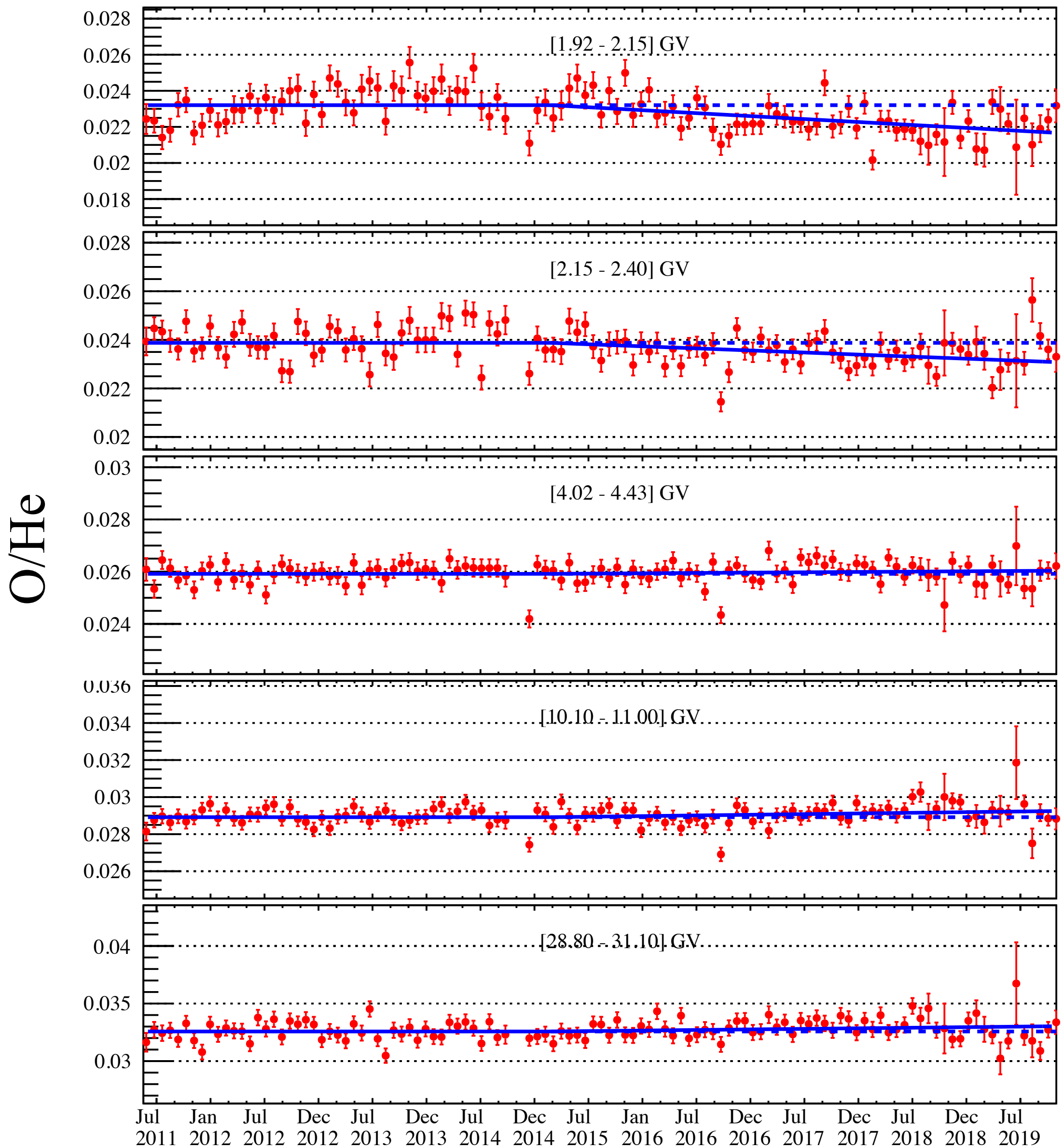

Conclusions

- AMS measurements provide information on the propagation of charged particles in the heliosphere

- Boron, Carbon and Oxygen time dependent fluxes have a similar behavior. The ratio of C/O are constant with time for all the rigidity bin from 1.92GV to 60 GV. The ratio of B/C is not constant in the low rigidity bins.

- The ratio of B/He, C/He and O/He are also presented. In the low rigidity bins, the ratio is not constant for the overall period from 2011 to 2019. While for the higher rigidity bins, the ratio is constant with time.