Galactic cosmic rays as signatures of interplanetary transients

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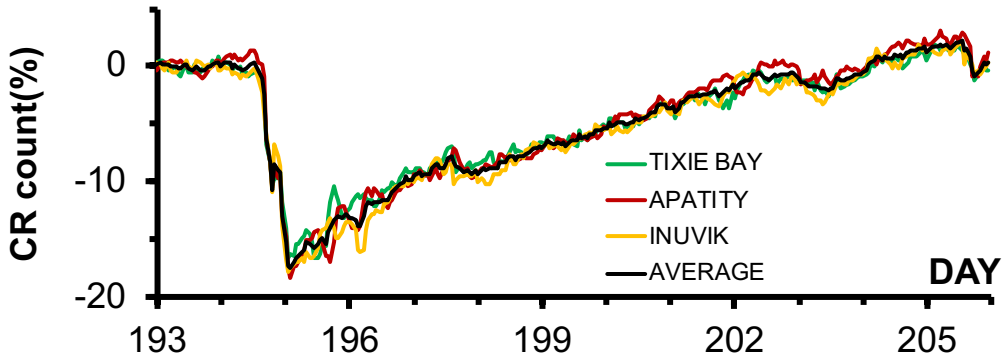
Forbush decreases

= short term decreases in GCR count

(*Forbush, 1937 and Hess & Demmelmair, 1937;*
overviews by Lockwod, 1971; Cane, 2000; Belov, 2009)

Example Forbush decrease detected in ground-based neutron monitor:

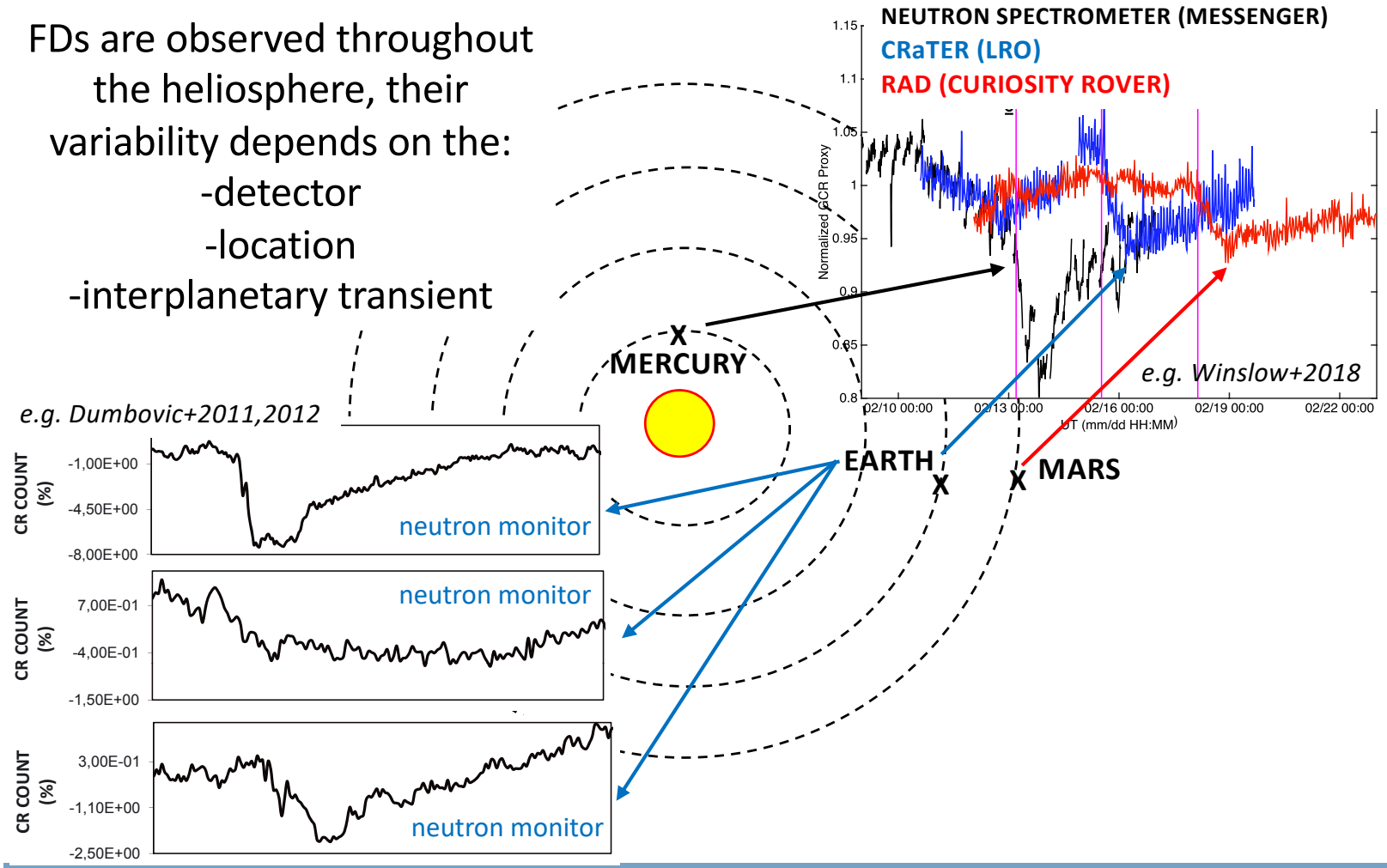
Dumbovic PhD thesis,2015 (adapted from Cane,2000)



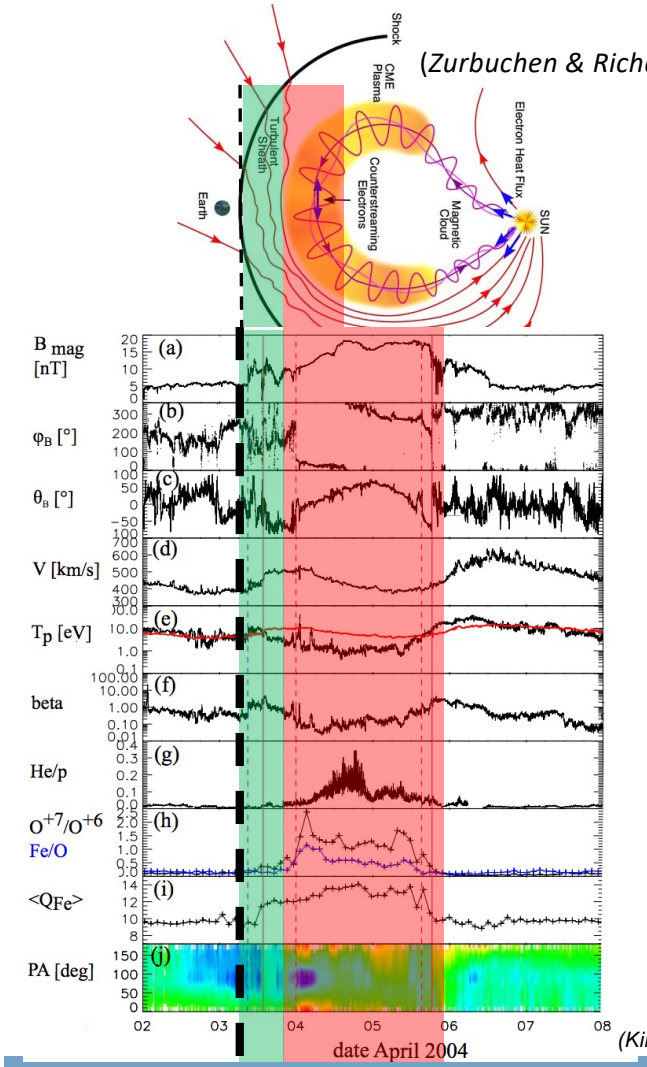
Typical duration - several days
Typical amplitudes - several %

Variability of Forbush decreases

FDs are observed throughout the heliosphere, their variability depends on the:
-detector
-location
-interplanetary transient

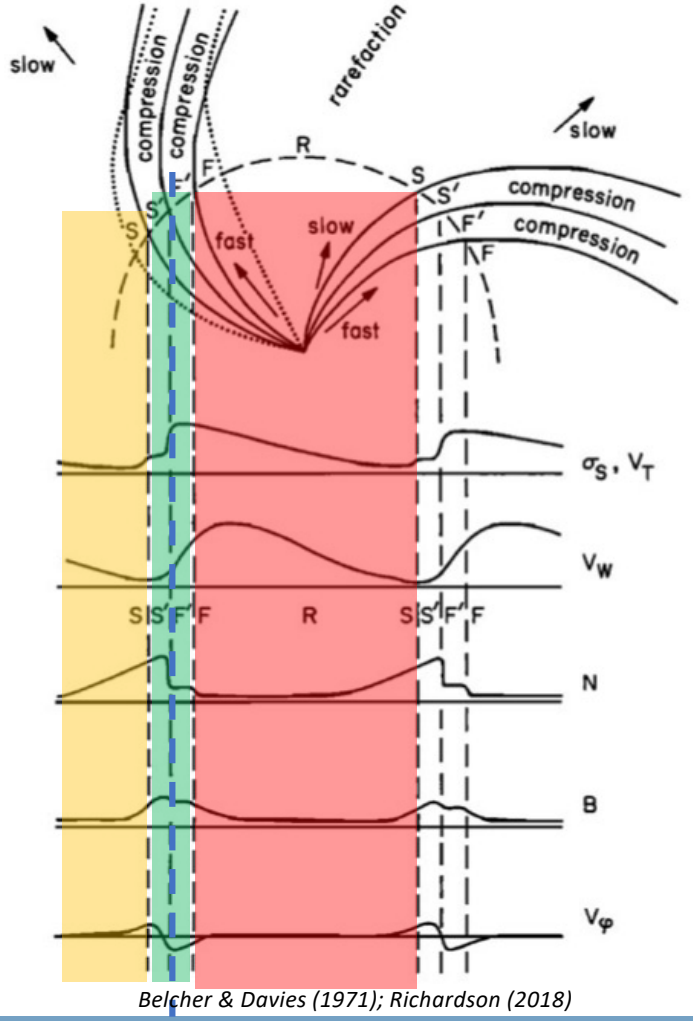


Interplanetary transients: ICMEs vs CIRs



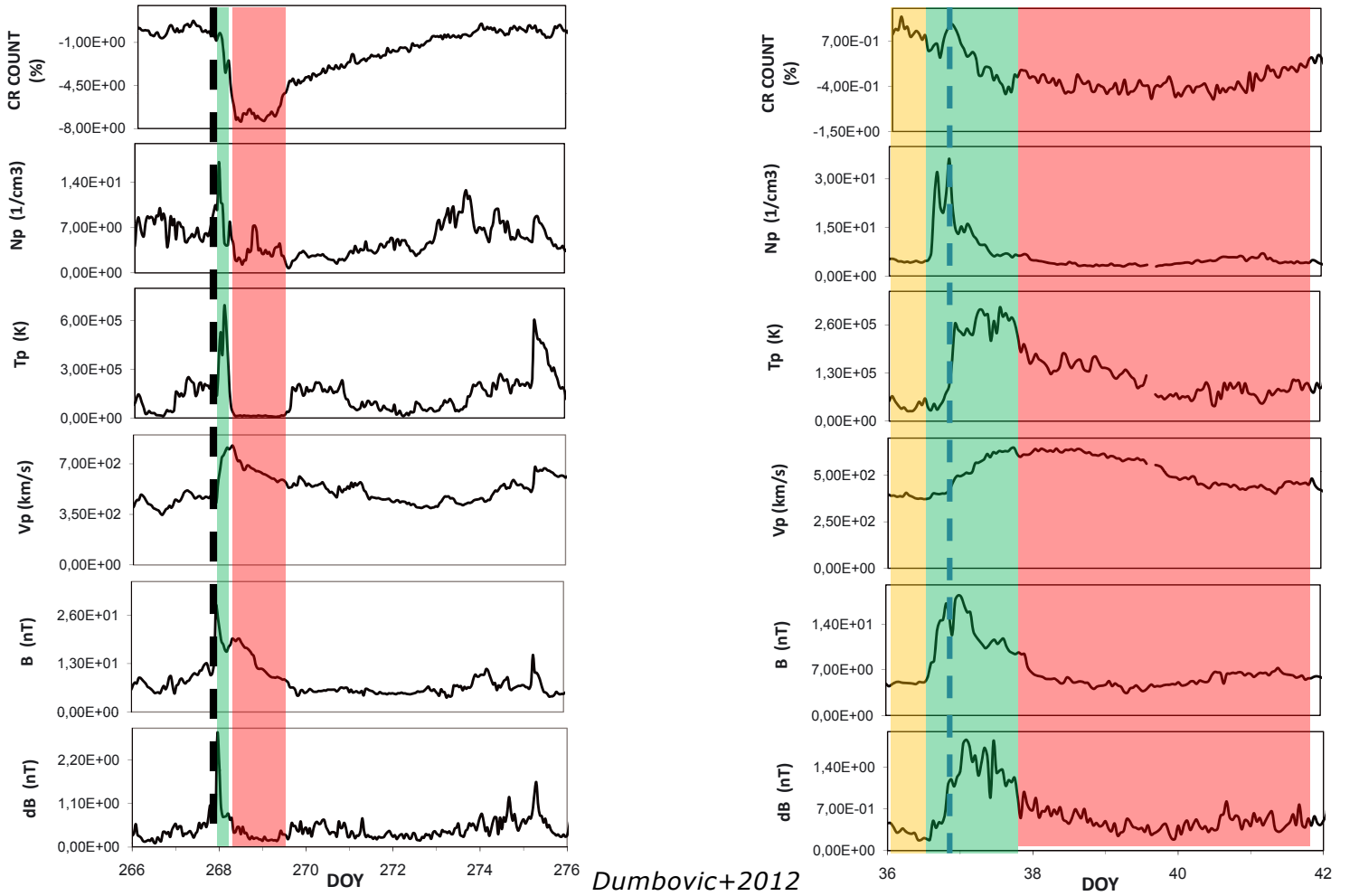
(*Zurbuchen & Richardson, 2006*)

(*Kilpua+2017*)



Belcher & Davies (1971); Richardson (2018)

Interplanetary transients: ICMEs vs CIRs



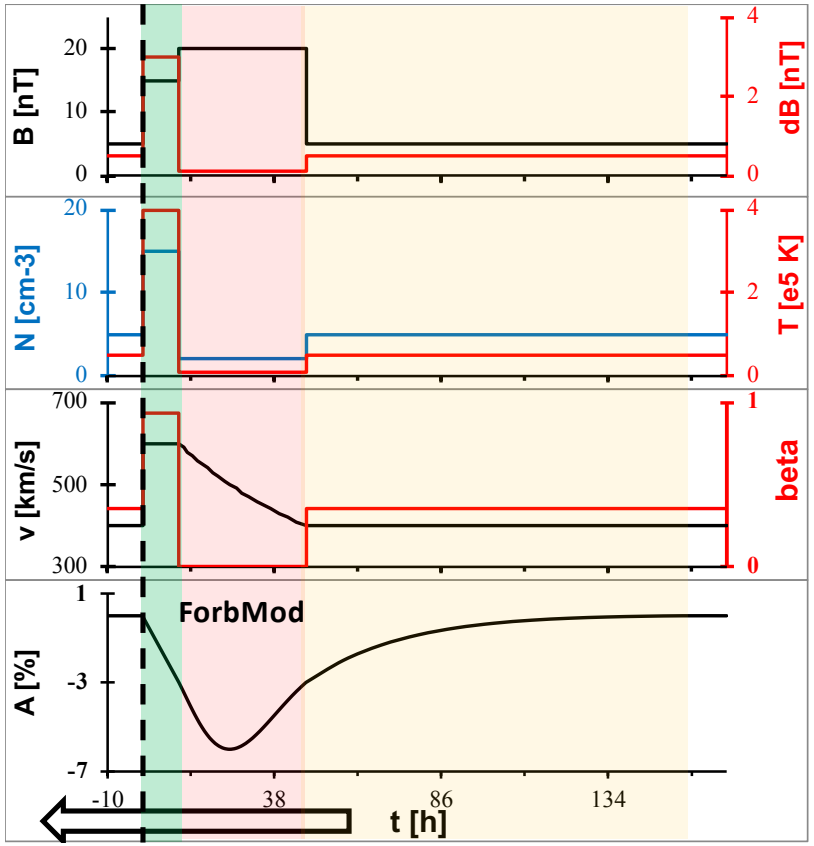
Dumbovic+2012
(see also e.g. Badruddin & Kumar, 2016, Melkumyan+2018)

Forbush decrease modelling: ICMEs vs CIRs

ICMEs:

3 different models – 3 different regions

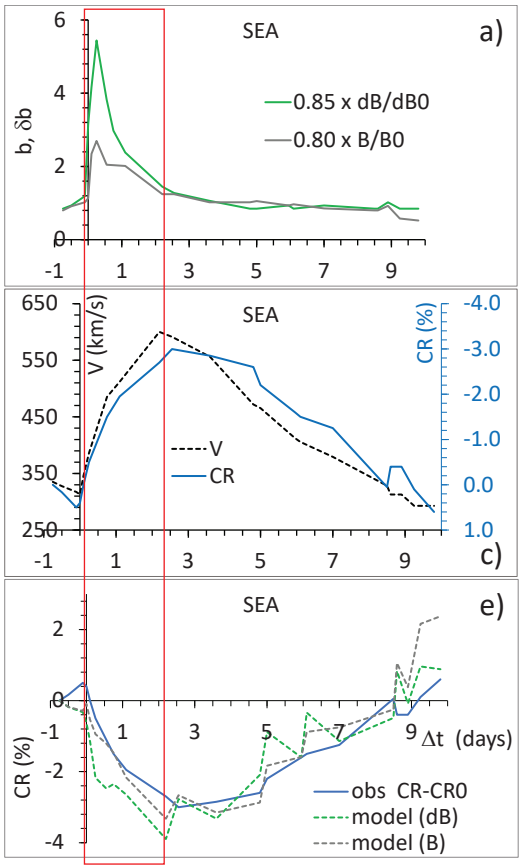
Flux rope region: diffusion based model



Dumbovic+2020

CIRs:

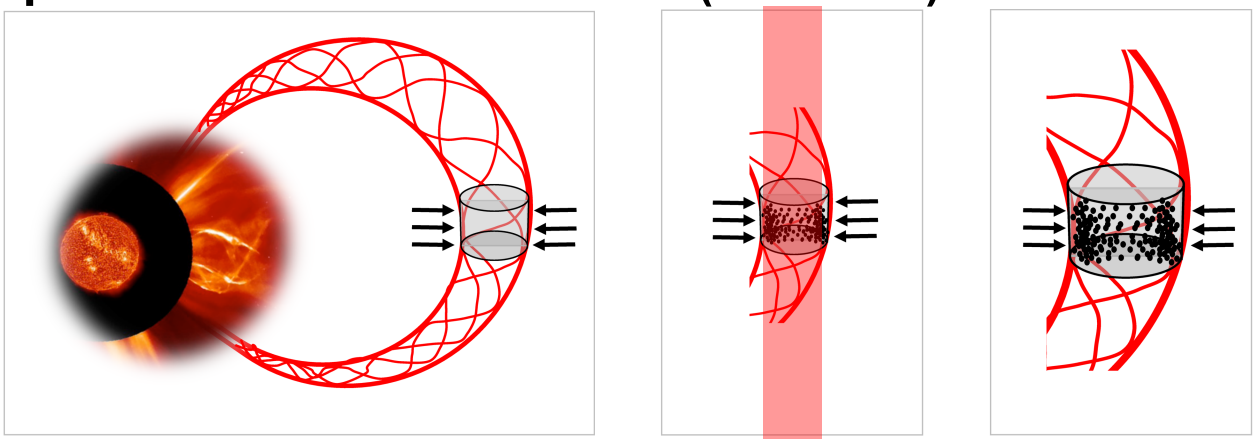
convection-diffusion based model

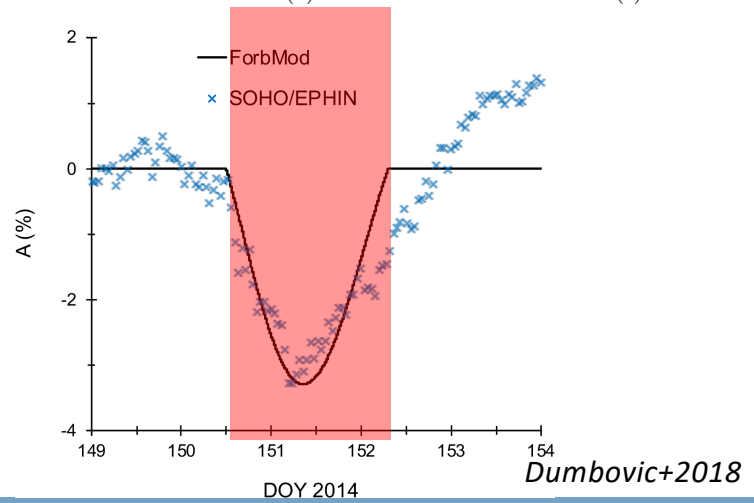


Vrsnak+2021

Forbush decrease modelling: evolution

Flux rope Forbush decrease model (ForbMod)

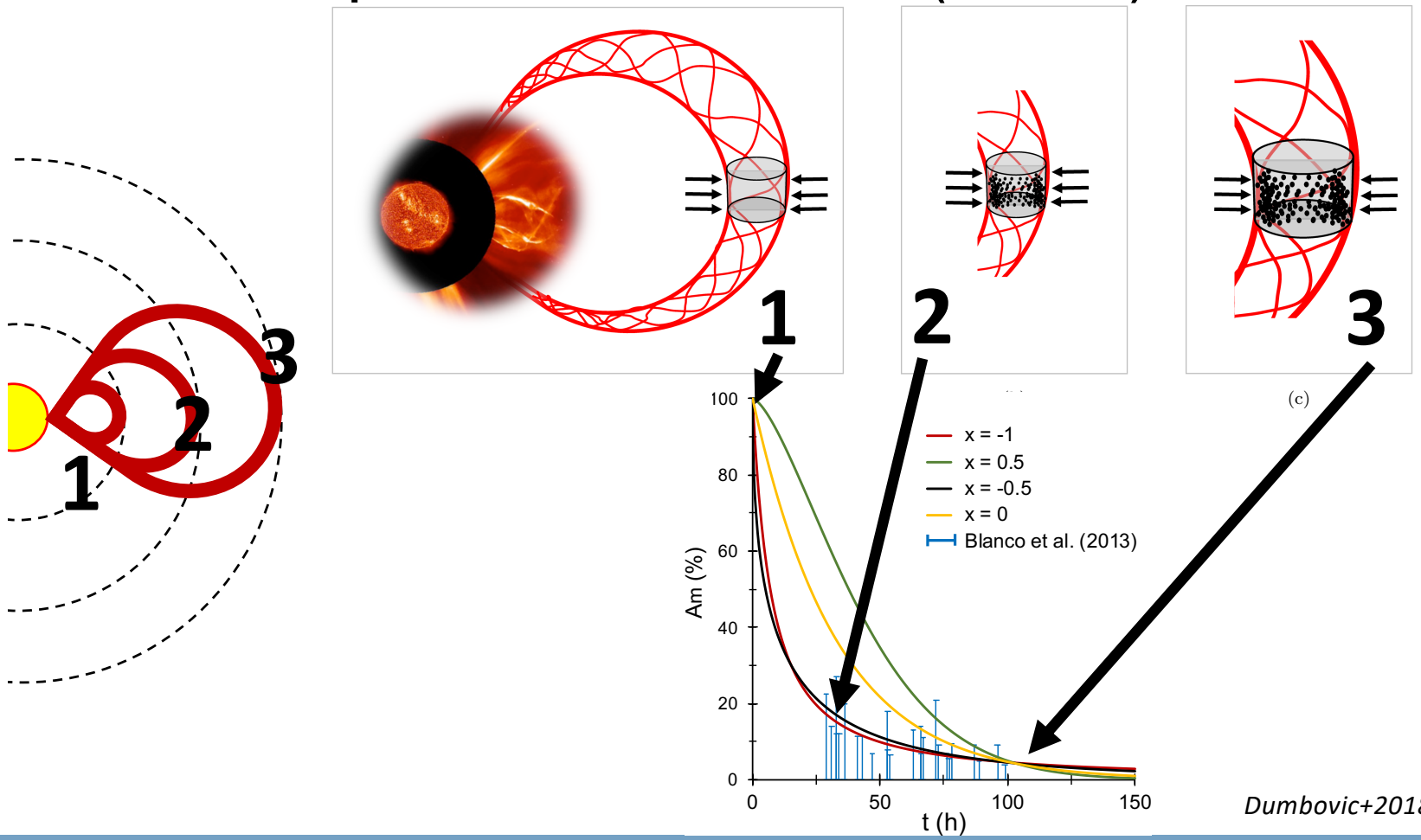




Dumbovic+2018

Forbush decrease modelling: evolution

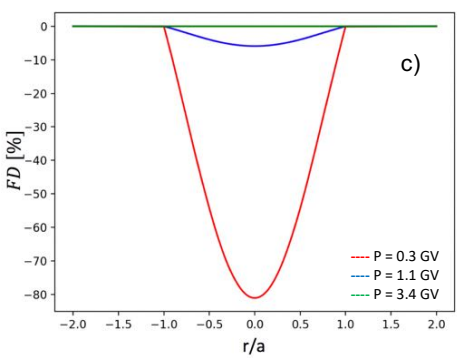
Flux rope Forbush decrease model (ForbMod)

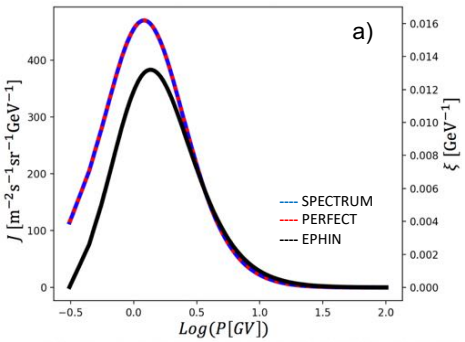


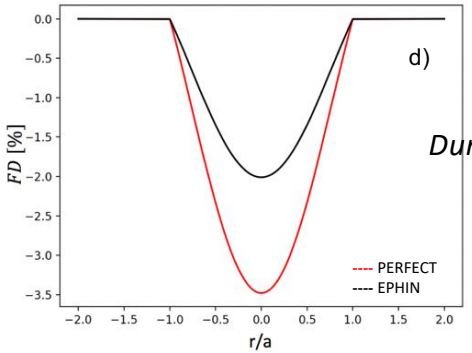
Dumbovic+2018

Forbush decrease modelling: energy dependence

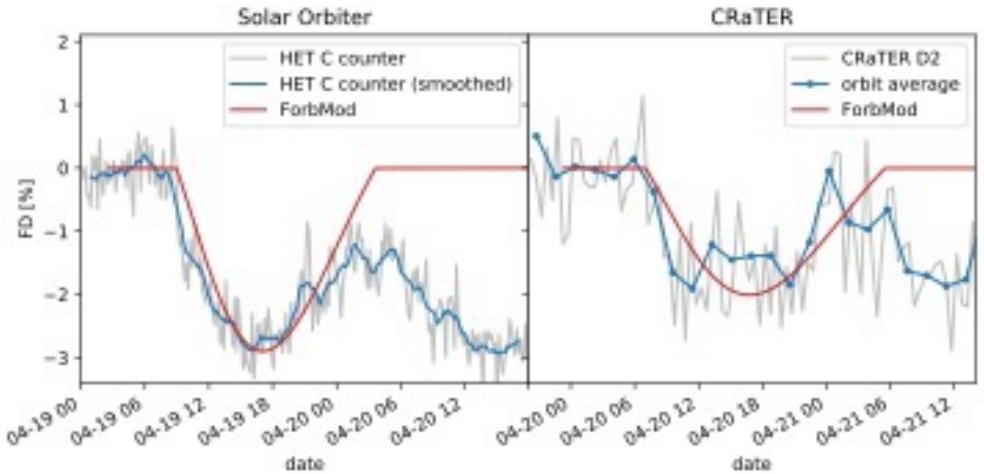
Particles of different energies diffuse differently –> energy response of the detector also governs the FD amplitude





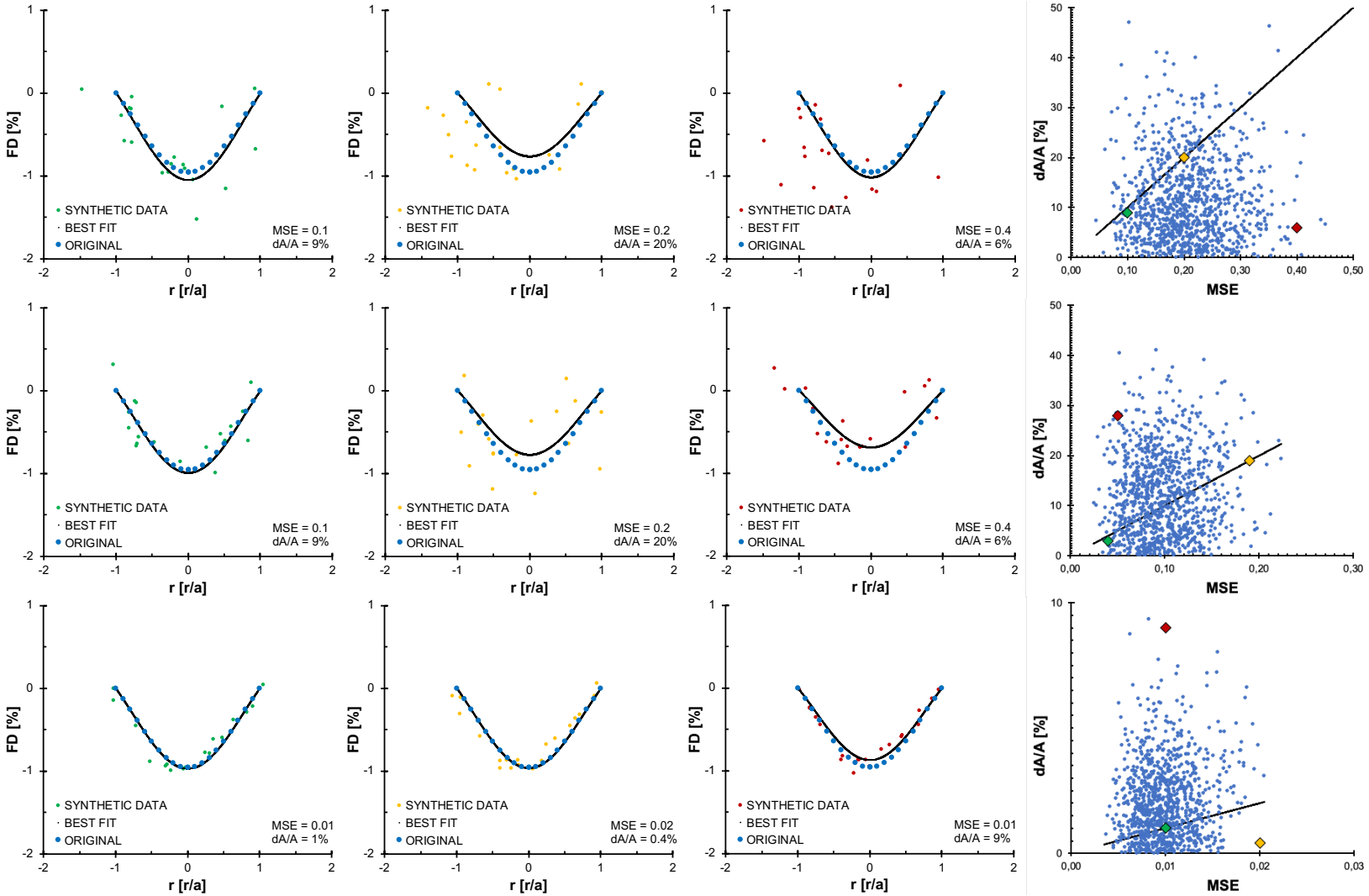


Dumbovic+2020



Forstner+2021

Future perspective: FD best-fit procedure: in development



Dumbovic+2022Inprep