Exercise 2

Neus Agueda & Rami Vainio

August 3, 2016

Goals of this exercise:

- To get familiar with the results provided by interplanetary transport models that solve the focused transport equation.

- To understand how the effects of interplanetary propagation shape the profiles observed at 1 AU (the omni-directional intensities and the pitch-angle distributions).

- To understand what is the imprint of a short vs. long release episode of particles at the Sun in an event observed at 1 AU.

- To understand under which conditions it is possible to infer the temporal characteristics of the solar release mechanism from observations at 1 AU.

Getting started:

1. Download the data and software contained in
   http://www.am.ub.es/~nagueda/exercise2.tz.

2. Extract the files by typing in the terminal `tar -zxvf exercise2.tz`

3. The folder `idl/` contains a short IDL tutorial.

4. The folder `greens/` contains the results of an interplanetary transport model for hypothetical particles moving at the speed of light. The solar wind speed was assumed to be 400 km/s, the pitch-angle diffusion coefficient isotropic and the release instantaneous at the Sun. There are 3 Green's functions, for the values [0.10,0.35,1.08] AU of the particle mean free path. The files can also be downloaded from SEPServer (`server.sepserver.eu`).

5. The folder `routines/` provides you with routines to assist you with this exercise; e.g. read the Green's functions data from a file, perform a convolution, plot omnidirectional intensities and pitch-angle distributions.

6. The folder `data/` contains two data sets in IDL `.sav` files. To restore the data, type `restore,'datafile.sav',/verbose` in IDL.

Instructions:

1. Read the Green's functions for the three different values of the mean free path. Plot the omni-directional intensities for the three different values of the mean free path in one panel.

   - What differences do you see in onset time?

   - What differences do you see in peak time and peak intensity?

2. Assume an injection profile at the Sun starting at $t = 0$ and convolve the Green's functions to obtain the intensities expected at 1 AU. First assume a short injection profile (maximum duration 5 min), and second a long (2 h) release profile.

   - What differences do you see in the omni-directional intensity profiles?

   - How do the pitch angle distributions look like for each case?

3. Take the intensities stored in `data/event_omni.sav`. Assume that these are omni-directional intensities measured at 1 AU. Invert the event for each value of the mean free path.

   - How do the inferred injection profiles look like? Why?

   - Can the convolution of each Green's function with the corresponding injection profile explain the observations? Why?

4. Take the intensities stored in `data/event_pads.sav`. Assume that these are the pitch-angle distributions measured at 1 AU. Invert the event for each value of the mean free path.

   - How do the inferred injection profiles look like? Why?

   - Convolute each Green's function with the corresponding injection profile. Can you explain the observations? Why?
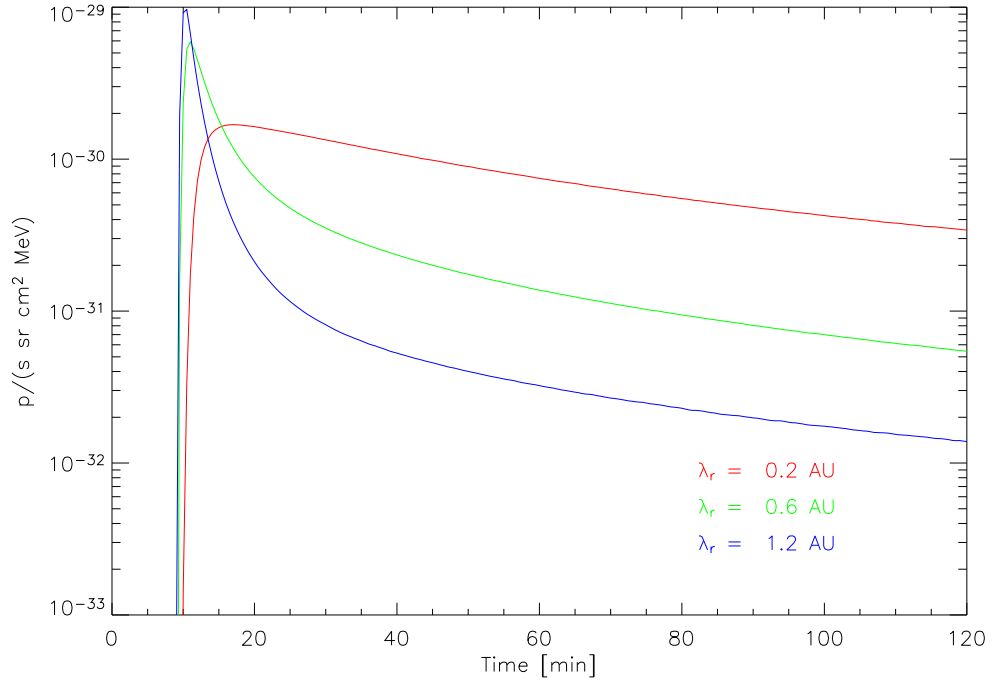
Figure 1: Green's functions at 1 AU for three different values of the radial mean free path λ_r=0.2 AU, 0.6 AU and 1.2 AU.
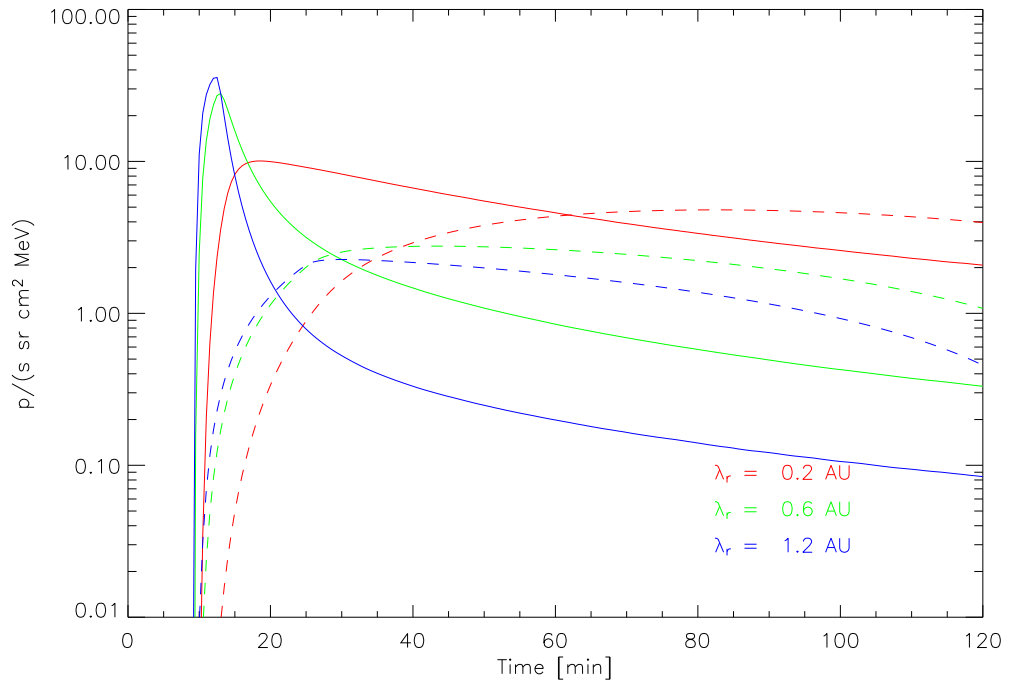

Figure 2: Intensities expected at 1 AU assuming a short ($<$5 min) injection profile at the Sun (solid curves), and a long ($\sim$ 2 h) injection profile (dashed curves).
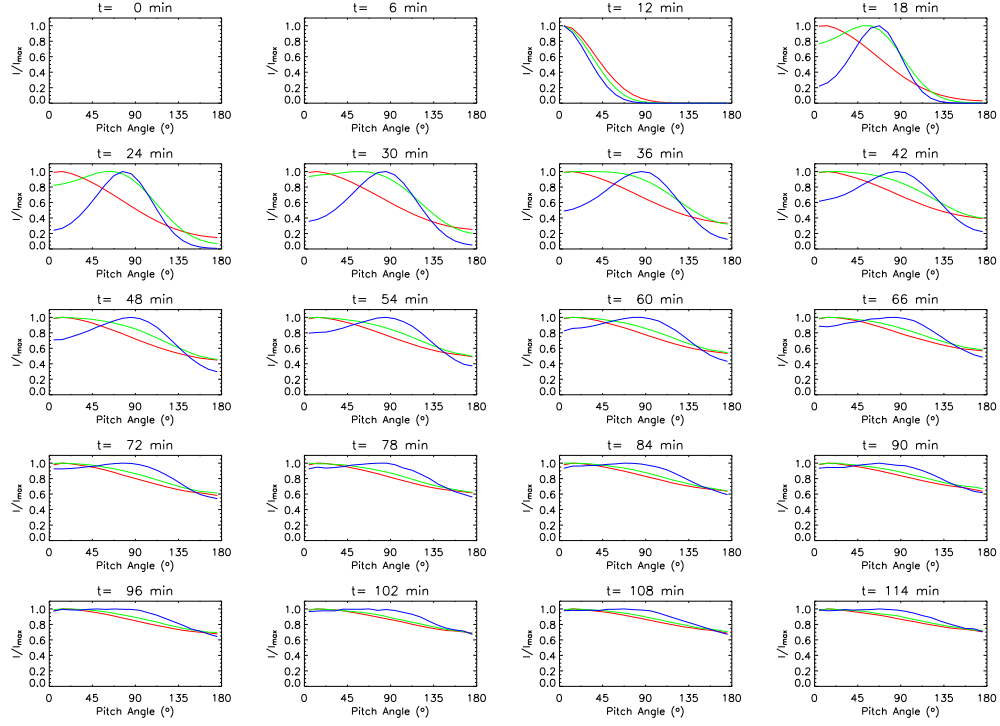
Figure 3: Evolution of the pitch-angle distributions at 1 AU for a short (<5 min) injection profile at the Sun.
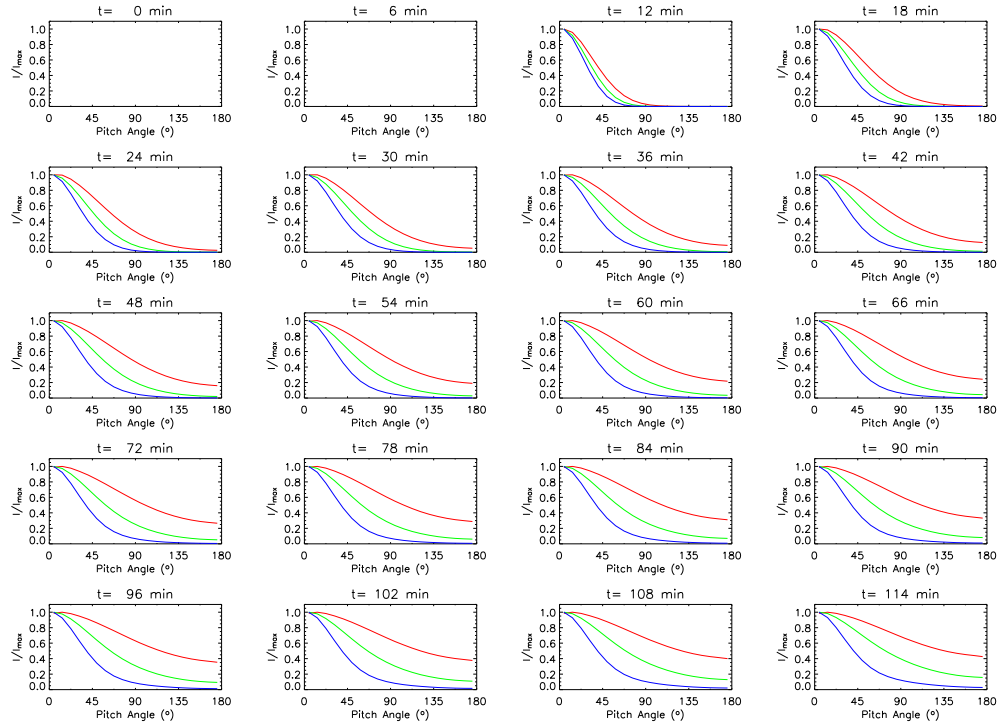

Figure 4: Evolution of the pitch-angle distributions at 1 AU for a long (∼ 2 h) injection profile at the Sun.
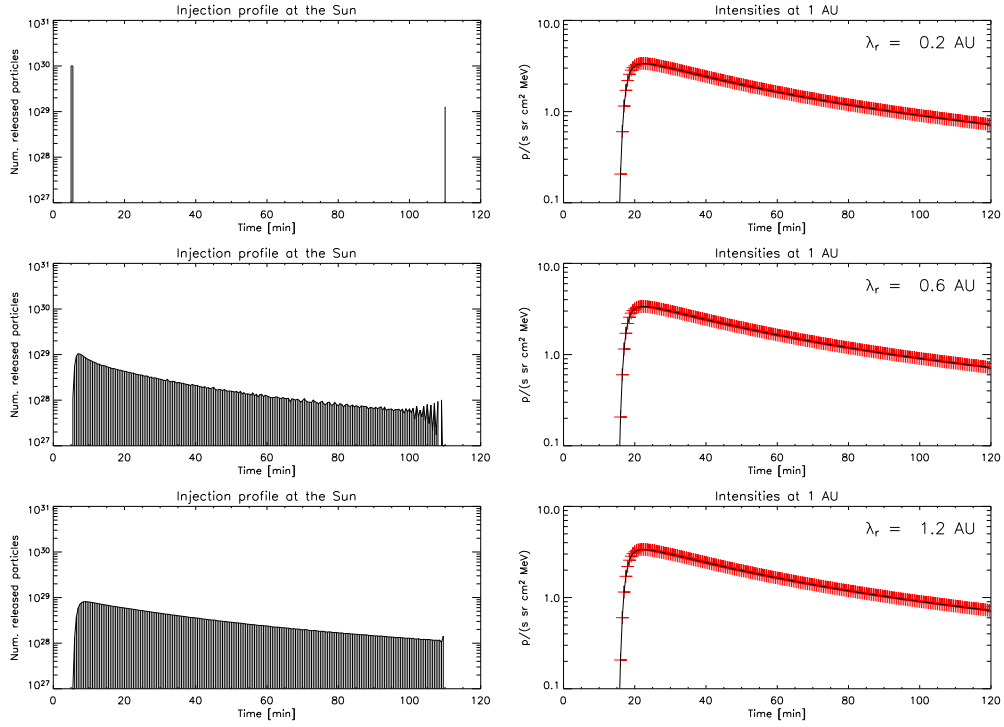
Figure 5: Injection profiles (left) inferred by inverting the omni-directional data (right panels, red symbols) for three different values of the mean free path. Diverse scenarios can fit the data. The black curve (right panels) shows the fit.
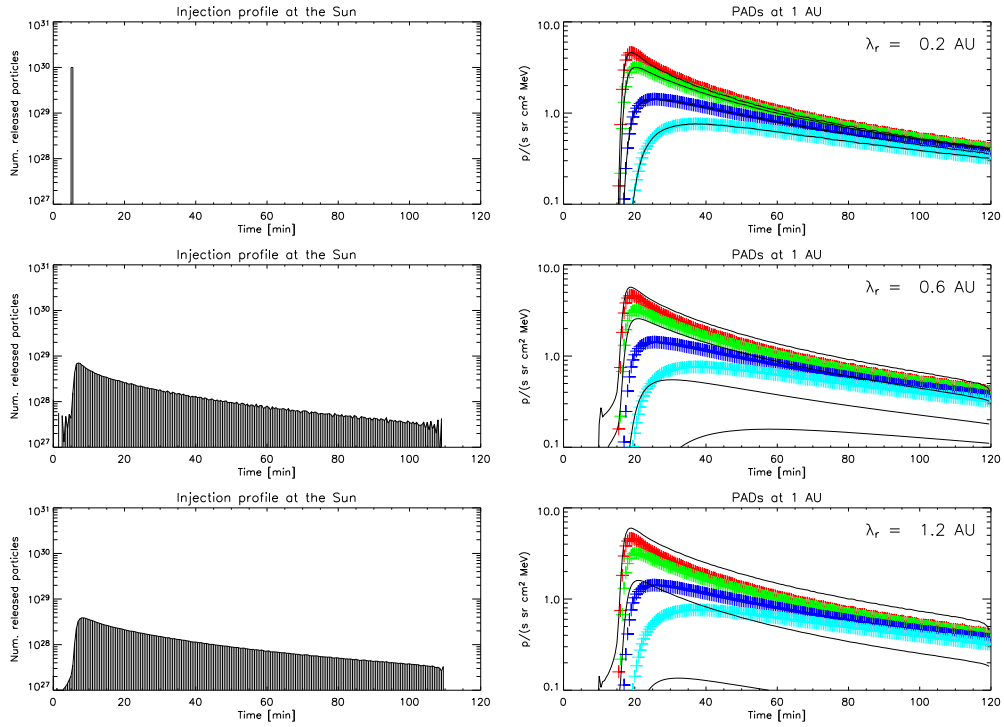

Figure 6: Same as in Fig. 5 using the PADs to perform the inversion. Only the first scenario (short injection profile and $\lambda_r = 0.2$ AU) can explain the data.