Detailed notes about the SCARDEC method

• Data: Broadband data from stations affiliated to the FDSN, belonging more specifically to the following networks: IU, II, G, GE, GT, (IC).

• The ~45 minutes time - required to provide the results - takes into account the 32 minutes required to record the teleseismic P and S body waves, as well as the ~12 minutes necessary for data processing and analysis.

• The analyzed earthquakes are those which have a preliminary magnitude equal or larger than 5.5 in the NEIC catalog (http://earthquake.usgs.gov/earthquakes/feed/v1.0/summary/4.5_week.atom).

• Other reasons causing some earthquakes not to be present on this list could mainly be:

- multiple large events occurring in a short time range ; this causes the waveforms to be noisy, preventing from a precise analysis

- moderate earthquakes, which do not generate waves with a good signal-to-noise ratio at enough teleseismic locations

- very complex earthquakes, including a strong focal mechanism change inside the rupture process, or several subevents with very different depths, or a strong non-double-couple component

- earthquakes occurring in a complex medium which strongly affects the body-wave periods longer than 25s could also be problematic to analyze

- earthquakes with a large error in their preliminar location (NEIC) ; for example, depth determined with an error of more than 50km

- troubles in real-time data acquisition

- (very rare) exceptionally long earthquakes (>200-250s) , that cannot be analysed accurately with the SCARDEC method

• The SCARDEC fit (given in the upper left of the map) represents the waveform agreement (variance reduction) to the body waves used in the SCARDEC method [teleseimic P and SH waves, with the inclusion of PcP and ScS(H) waves for stations in the 60-90° epicentral distance range, and the inclusion of PP wave for stations in the 60-90° epicentral distance range recording dip-slip earthquakes]. It gives an indicator of the reliability of the focal mechanism, depth and magnitude determination (not of the source time function). Fits above 70-75% implies that the solution should be reliable while lower values make the solution more questionable. Solutions with fits below 60-65% (which can occur for the reasons listed in the points above) are not presented.

• The SCARDEC fit can be visually evaluated by clicking on the link "See the seismic waveforms used for mechanism, depth and magnitude determination". The GMT "psmeca" file can be downloaded on the related link.

• Source time function determination has a quality criterion more severe than the source parameters (Mw,depth, focal mechanism) determination. In particular, it requires that the signal-to-noise ratio

remains good up to 1Hz. Therefore, the solution may be posted without the source time function, and this case is frequent for earthquakes with magnitudes close or lower than 6.

• Precisions on the depth determination : when the source time function cannot be evaluated precisely, we do not present the optimal depth, but only the range of acceptable depths. On the other hand, for large earthquakes (magnitude >7), the spatial extent of the source results in an inherent uncertainty for the depth : therefore, in this case also, we only present the range of acceptable depths. Finally, when the depth is determined close to the shallowest depth permitted in the analysis (which varies between 6 and 12km depending on the magnitude), the word "(max)" is added after the optimal depth. It means that shallower depths than the presented one are likely to be realistic.

• SCARDEC method retrieves the relative source time functions (RSTFs) for each station and wavetype. The grey-filled source time function presented on the map is one of these RSTFs, deduced from P-wave deconvolution. Its choice is based on quality criteria, and on its similarity to the average of the RSTFs (shown by the red curve).

• Small differences between the selected RSTF and the average of the RSTFs imply that the RSTFs have been reliably determined, and that the selected RSTF is close the absolute source time function. Large differences may be due to large spatio-temporal source complexity. However, because directivity effects for teleseismic P waves are moderate, large differences are more likely related to difficulties in evaluating precisely the source time functions. Reasons for that can typically be large depth extension of the source, changes in focal mechanism during rupture (which is particularly problematic for strike-slip earthquakes), or poor signal-to-noise ratio.

• About the start and shape of the source time function : the beginning time of the presented source time function is determined using the theoretical time of the P wave, and the first significative moment release retrieved by deconvolution. When the source time function does not have an impulsive start, it may be difficult to discriminate between real moment release, or noise contamination. This uncertainty is of the order of a few seconds, which has to be taken into account when interpreting the duration of moderate earthquakes.

• The highpass frequency is dependent on the earthquake magnitude and duration, ranging from 0.0125Hz for a Mw=6 earthquake to 0.003Hz for a very large and long earthquake. As a result, the solution should be little affected by magnitude underestimation, even for very large and long earthquakes.

• The solution is first posted without manual review. If necessary, some modifications could be added in the day(s) following the earthquake.

* **Réference:** Vallée, M., J. Charléty, A.M.G. Ferreira, B. Delouis, and J. Vergoz, SCARDEC : a new technique for the rapid determination of seismic moment magnitude, focal mechanism and source time functions for large earthquakes using body wave deconvolution, Geophys. J. Int., vol.184, pp.338-358, 2011.