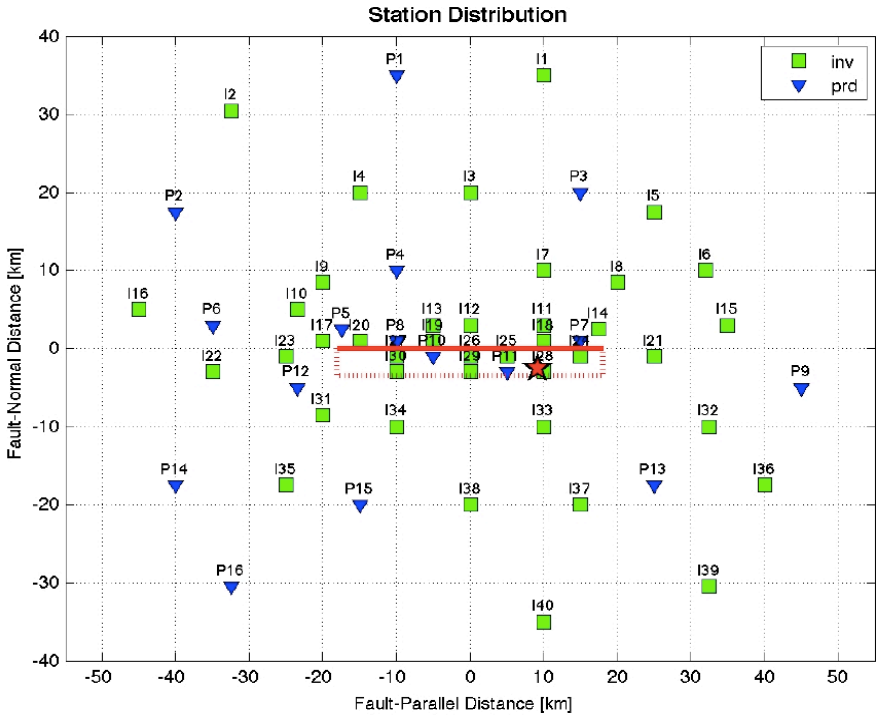
Source Inversion Validation (SIV)

Information & Solution to

Model dyn0

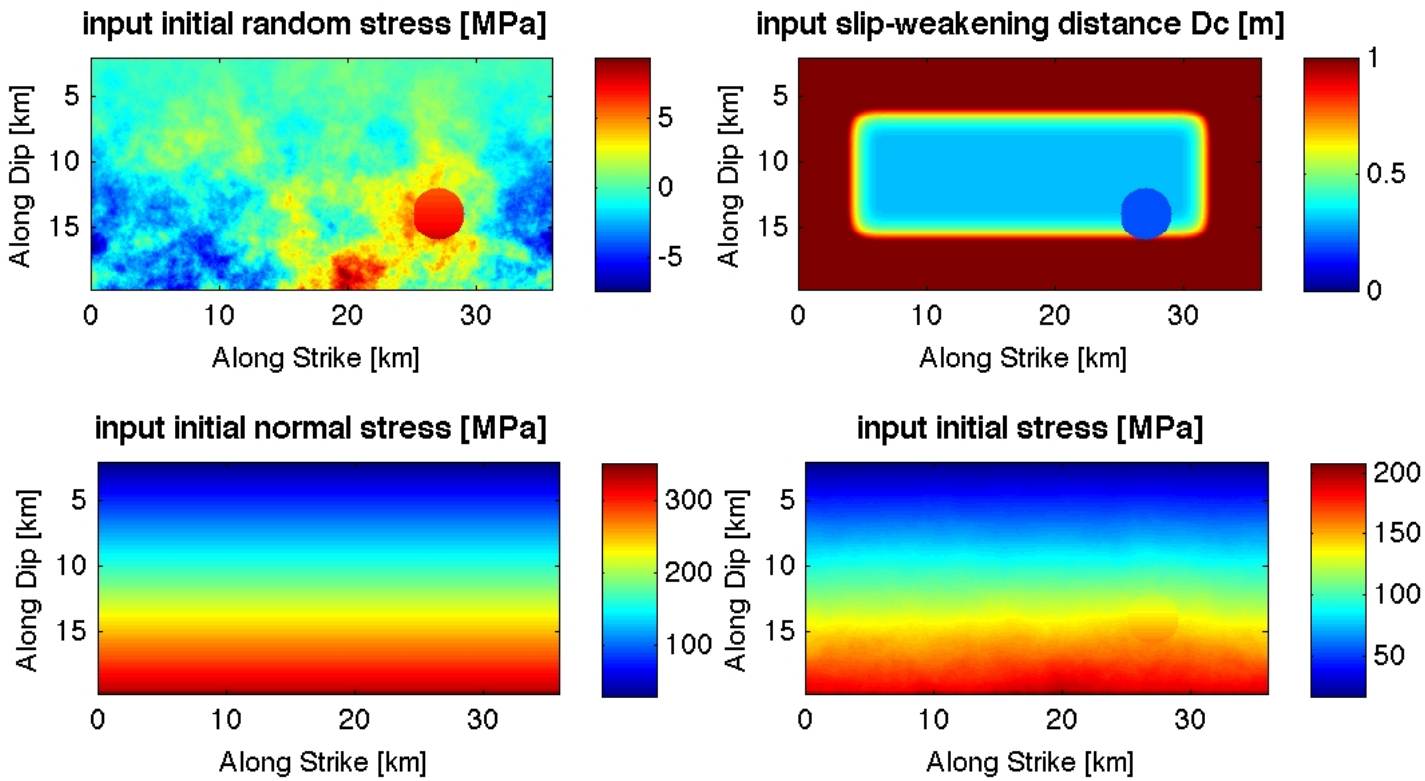
On model dyn0: general info

- Rupture occurs on an 80°-dipping strike-slip fault; slip is constrained to be right-lateral; the fault strike is 90°. Synthetics are generated at 40 sites (green squares), blind-predictions are requested at an additional 16 sites (blue triangles)
- The fault dimensions are roughly 30-35 km along-strike, and 15-20 km down-dip; the rupture remains buried, i.e. no surface-rupture occurs
- The hypocenter is located at X = 9.2km; Y = -2.5 km, and Z = 14.0 km; the final seismic moment is ~ $1x10^{19}$ Nm, or M_w 6.6



On model dyn0: general info

- The forward model for generating the synthetic seismograms uses a spontaneous dynamic rupture simulation with heterogeneous initial stress on the fault, assuming a linear slip-weakening friction model
- Dc is essentially constant (Dc = 0.4 m), aside from the nucleation region (Dc = 0.2) and the boundaries (linear increase to Dc = 1 m to smoothly stop the rupture)
- Depth-dependent normal stress; dynamic friction μ_d = 0.55; static friction μ_s = 0.6



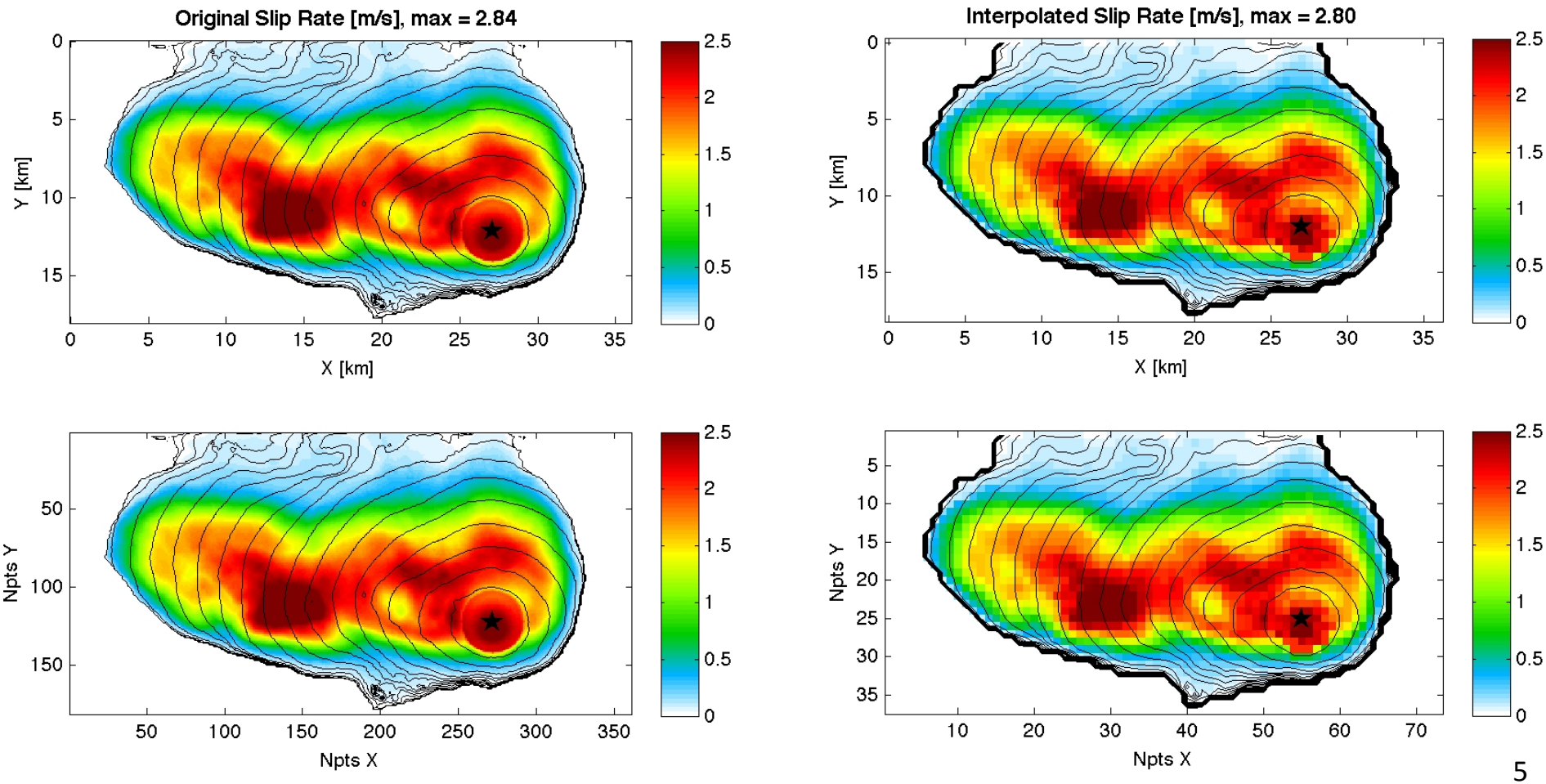
On model dyn0: general info

- The dynamic rupture was computed on a 0.1 x 0.1 km grid, using n0 = 7500 time steps (dt0 = 0.008 s); to disseminate the complete final solution, the output of the dynamic rupture calculation has been down-sampled onto a 0.5 x 0.5 km grid, using ni = 2500 points (dti = 0.04 s).
- The accuracy of the interpolation is documented by the subsequent plots that show slip-rate and slip on the fault plane, as well as local slip-rate functions (SVF) at a set of points (in the time and frequency domain)
- The dynamic rupture calculation was constrained to be right-lateral; contributions of thrust/normal faulting and fault-opening motion are about a factor of 10^{-4} – 10^{-3} smaller, and hence can been neglected
- The down-sampled complete solution is distributed as a MATLAB structure of 6.2 Mb (see page 9)

- ***NOTE: the coordinate definitions as specified in the exercise description (Description_inv1_updated.pdf) do not exactly represent a right-handed coordinate system as Z is given as positive downward (instead of upward). This will be remedied/changed in subsequent benchmarks.***

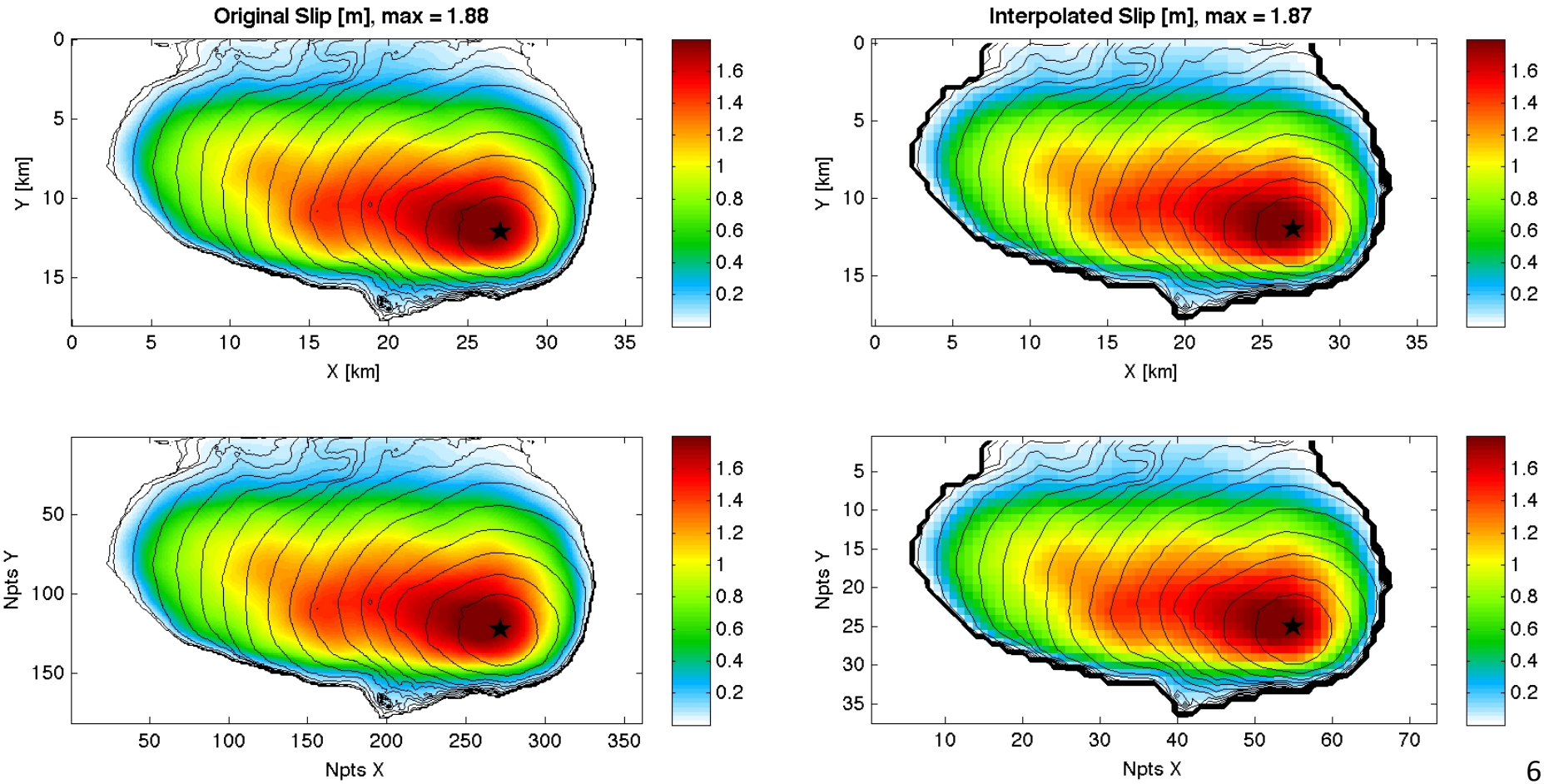
On model dyn0: original and interpolated slip-rate

- **Left:** original high-resolution slip-rate, in on-fault Cartesian coordinates (x, y; top) and number of points (Npts X, Npts Y; bottom); contour lines show rupture time (in sec), the star indicates the hypocenter; **Right:** interpolated slip-rate



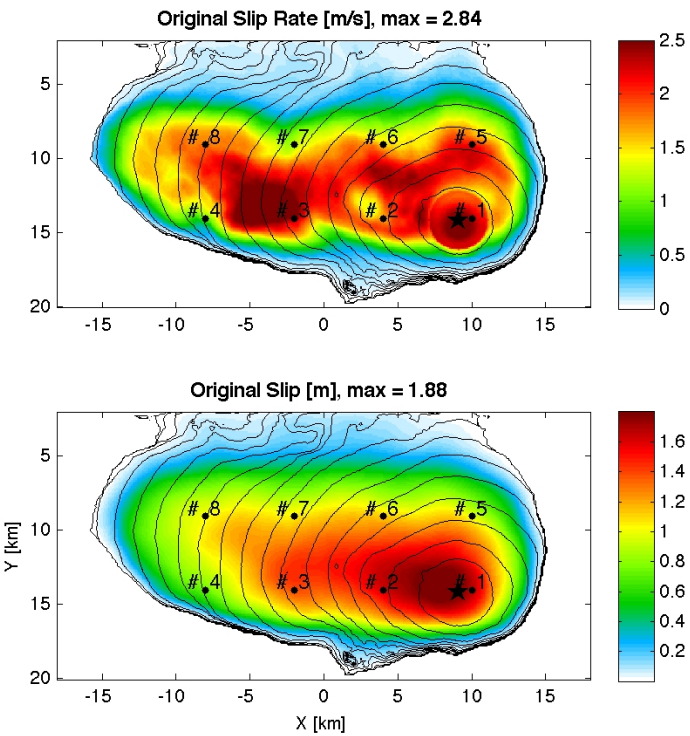
On model dyn0: original and interpolated slip

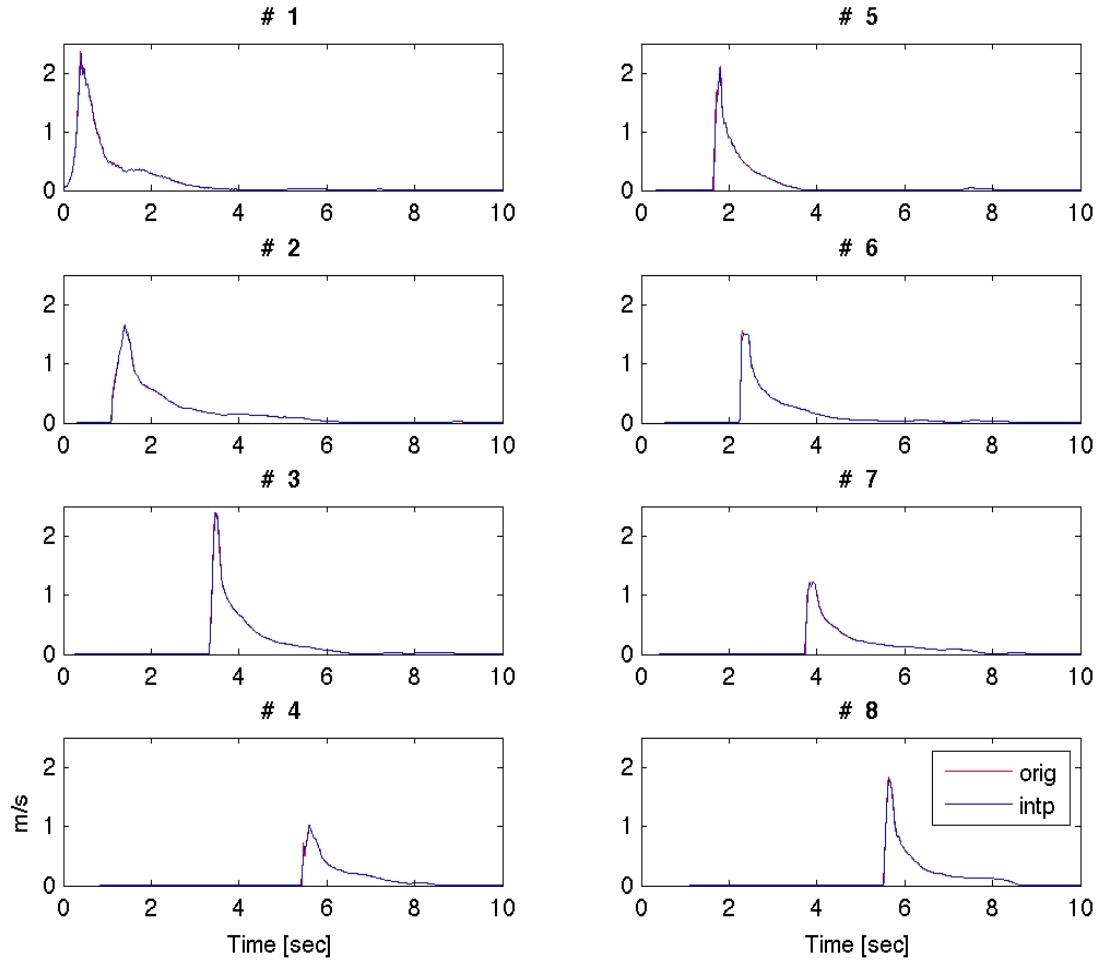
- **Left:** original high-resolution slip, in on-fault Cartesian coordinates (x, y; top) and number of points (Npts X, Npts Y; bottom); contour lines show rupture time (in sec), the star indicates the hypocenter; **Right:** interpolated slip



On model dyn0: slip-rate function comparison

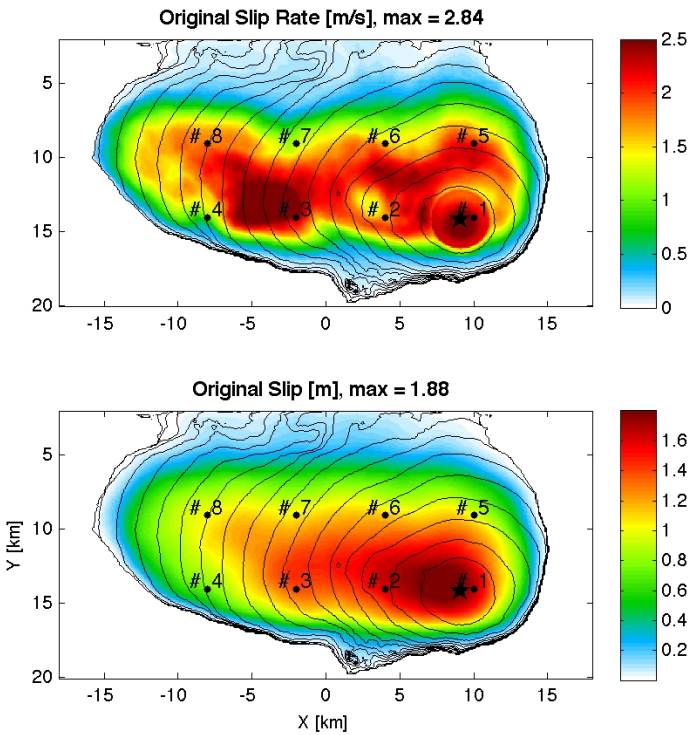
- **Left:** on-fault locations of slip-rate function used for comparison; **Right:** original (**red**) and interpolated (**blue**) slip-rate functions at selected points; they are visually almost indistinguishable

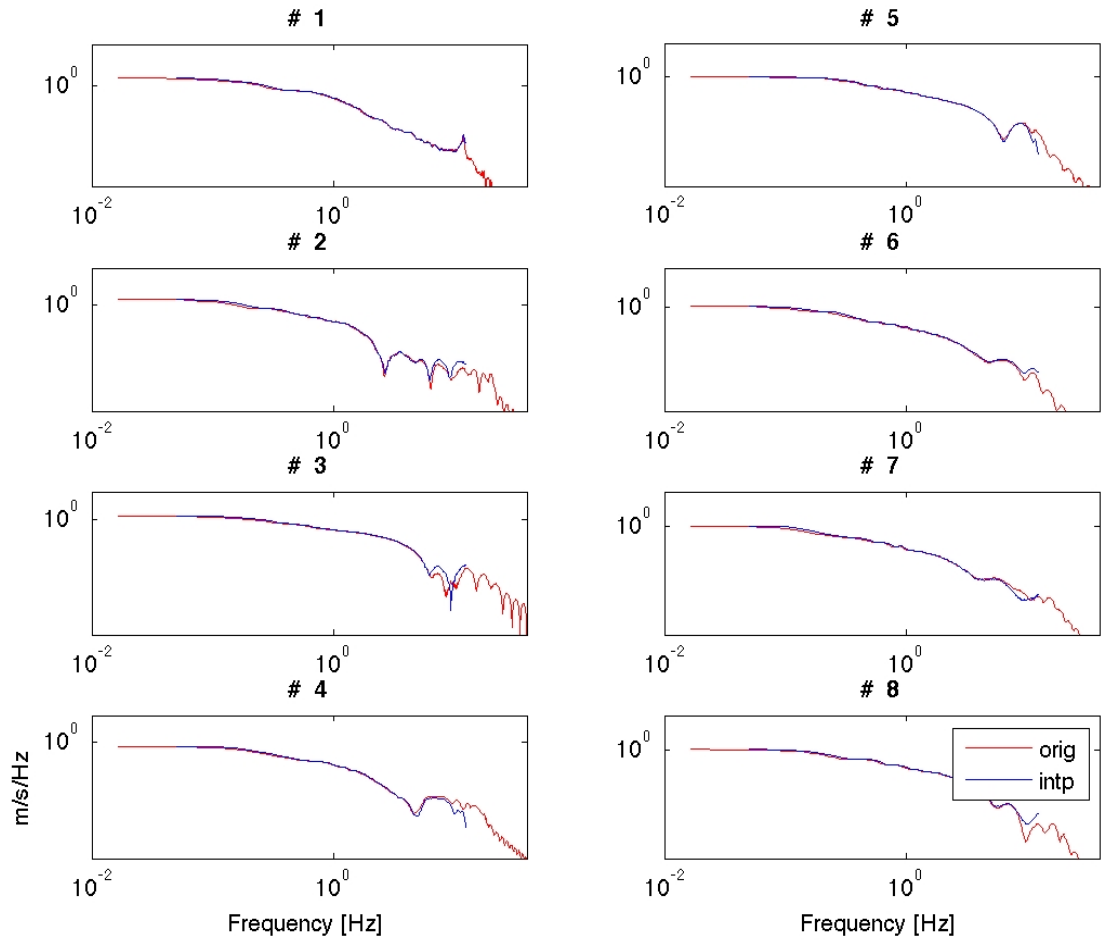




On model dyn0: slip-rate function comparison

- **Left:** on-fault locations of slip-rate function used for comparison; **Right:** amplitude spectra of original (**red**) and interpolated (**blue**) slip-rate functions at selected points; minor difference are visible for f < 0.1 Hz, and for f > 10Hz; resampled SVFs are good up to f~10 Hz





On model dyn0: structure of solution array

- The solution is distributed as a MATLAB *mat structural array; arrays are arranged as [along-dip along-strike (time)]; dx = dz = 0.5 km; (FN: fault-normal; FP: fault-parallel)
- Regions of the fault that did not slip (slip-rate < 0.01 m/s) are flagged with a constant value of τ_r = 20 s in the rise-time array, and with tr = 10s in the rupture-time array

```
solution =

          slip: [37x73 double]
          rise: [37x73 double]
          rupt: [37x73 double]
         svmax: [37x73 double]
        xcoord: [1x73 double]
        ycoord: [1x37 double]
        zcoord: [1x37 double]
    hypo_plane: [9.1000 12.1000]
       hypo_3D: [9.1000 -1.5802 13.9618]
          rake: 180
          SVFs: [37x73x500 double]
           dip: 80
            Mw: 6.6092
            M0: 1.0203e+19
       RupTopZ: 2.0456
       RupTopY: -0.3607
         SVFdt: 0.0400
       SVFtime: [1x500 double]
```

- Array of slip [in m/s] in [along-dip along-strike] direction
- Array of rise time
- Array of rupture-front arrival times
- Array of peak slip-rate on the fault
- Along-strike coordinates
- Along-dip coordinates
- Absolute-depth coordinates
- Rupture nucleation point on the plane (in X, Y system)
- Rupture nucleation in [FP FN Z] system of fault-system geometry
- Rake angle (right-lateral strike slip)
- Array of slip-rate functions on the fault
- Dip of the fault
- Moment magnitude
- Seismic moment
- Depth to the top-edge of the rupture plane
- FN coordinate of the top-edge of the rupture plane
- Time-sampling of slip-rate functions
- Time vector of slip-rate functions

On model dyn0: additional information

- Input parameters for dynamic rupture calculation are available upon request; send email to ***martin.mai@kaust.edu.sa*** (also for any additional questions, comments, suggestions you may have)

- Want to know more the SIV project, and existing benchmarks?
  - http://equake-rc.info/sivdb
  - http://equake-rc.info/sivdb/wiki
- Want to participate, and don't know how?
  - http://equake-rc.info/sivdb/faq/
- Want to know more about finite-fault source images of past earthquakes?
  - http://equake-rc.info/srcmod