Manual for Earth's Stress Change Database

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Apart from tectonic causes, stress changes on the Earth could also be caused by many external forces. This is a preliminary database of the loading-induced stress changes on the Earth from 2003 to 2014, by considering five external forces that would generate stress changes on the Earth: hydrological loading, atmospheric pressure, ocean tides, solid Earth tides and postglacial rebound (PGR). The five loading forces are quantified using the terrestrial water storage (TWS) inferred from GRACE solutions, the ECMWF surface atmospheric pressure model, the TPXO 7.2 ocean tide solutions, tidal forces computed by the SPOTL package, and the ICE-5G glacial history model. The loading masses are assumed to distribute within a thin layer (relative to the Earth's radius) on the Earth's surface, and are used to calculate the Earth's stress responses through a spherical spectral method. Based on the different time scales of the loading forces, an incompressible viscoelastic Earth model is adopted for PGR and a compressible elastic one is adopted for the other forces. Please refer to Lu et al. (2018) for details about the methods and the parameters used in the stress calculation.

1. Stress changes caused by hydrological water

tar file name: **hydro_yyyy.tar**, where yyyy represents year.

Each of the above tar file contains stress changes at different depths (0 km, 19 km, 50 km, and 100 km), with directory named as "**stress.GB.dep_x**", where x represent depth in unit of kilometer.

Each of the depth directory contains the stress fields at each month of a year, with file named as "**stress.hydro.yyyy_mm.dat**", where yyyy and mm represent year and month respectively.

Each of the above stress file contains stress fields at discrete grids (5^ox5^o) on the Earth. The data in the columns, from left to right, of the file represent:

longitude	latitude	σ_{rr}	$\sigma_{\theta\theta}$	$\sigma_{\phi\phi}$	$\sigma_{r\theta}$	$\sigma_{r\phi}$	$\sigma_{\theta\phi}$

where σ_{ij} is stress (in unit of Pa), and θ and ϕ represent colatitude and longitude variables, respectively.

2. Stress changes caused by air pressure

tar file name: **air_pres_yyyy.tar**, where yyyy represents year.

The other directories, files and data are the same as those of hydrological water described above.

3. Stress changes caused by ocean tides

tar file name: **ocean_tide.tar**

The above tar file contains stress changes at different depths, similar with those of hydrological water.

Each of the depth directory contains real and image parts of the stress induced by ocean tide, with the phase being Greenwich phase with lags positive. Stresses for four diurnal (K_1, O_1, P_1, and Q_1) and four semidiurnal (K_2, M_2, N_2, and S_2) tidal constituents are

calculated. The files are named as: **stress.oc_tide.tt.xxxx.dat**, where tt represents tidal constituent, and xxxx represent "real" (four real part) or "imag" (for image part).

The data in each column of stress.oc_tide.tt.xxxx.dat has the same meaning as those of hydrological water.

The real and image parts of the tidal stress can be easily used to calculated stress fields at any time using packages such as SPOTL (Agnew, 2012), which is available from https://igppweb.ucsd.edu/~agnew/Spotl/spotlmain.html.

4. Stress rate caused by postglacial rebound (PGR)

tar file name: **PGR.tar**

The above tar file contains stress rates caused by PGR at different depths (0 km, 19 km, 50 km, and 100 km). The files are named as **stress_rate.PGR.dep_x.dat**, where x represents depth in unit of kilometer.

Each stress_rate.PGR.dep_x.dat file contains stress rate caused by PGR at discrete grids (5^ox5^o) on the Earth. The data in the columns, from left to right, of the file represent:

longitude	latitude	$\dot{\sigma}_{rr}$	$\dot{\sigma}_{\theta\theta}$	$\dot{\sigma}_{\phi\phi}$	$\dot{\sigma}_{\theta\phi}$

where $\dot{\sigma}_{ij}$ is stress rate (in unit of Pa/year), and θ and ϕ represent colatitude and longitude variables, respectively.

References

Agnew, D. C. (2012). SPOTL: Some Programs for Ocean-Tide Loading.
Lu, Z., Yi, H., Wen, L. (2018). Earth's stress change over time.