
Polar-SFT GitHub repository.

The code in this repository solves the radial component of the magnetic flux transport equation (induction equation) on the solar surface in the 1D (axisymmetric) case, including a heuristic decay term -B_r/tau on the right hand side. Results are then analysed from the point of view of compliance with observational constraints on the spatiotemporal variation of the polar magnetic field, marking the allowed domain in parameter space.

This code was used to obtain the results published in

Petrovay K. and Talafha M.:
Optimization of surface flux transport models for the solar polar magnetic field,
Submitted to Astronomy and Astrophysics (2019)

Further details regarding the code are in Polar-SFT.pdf.

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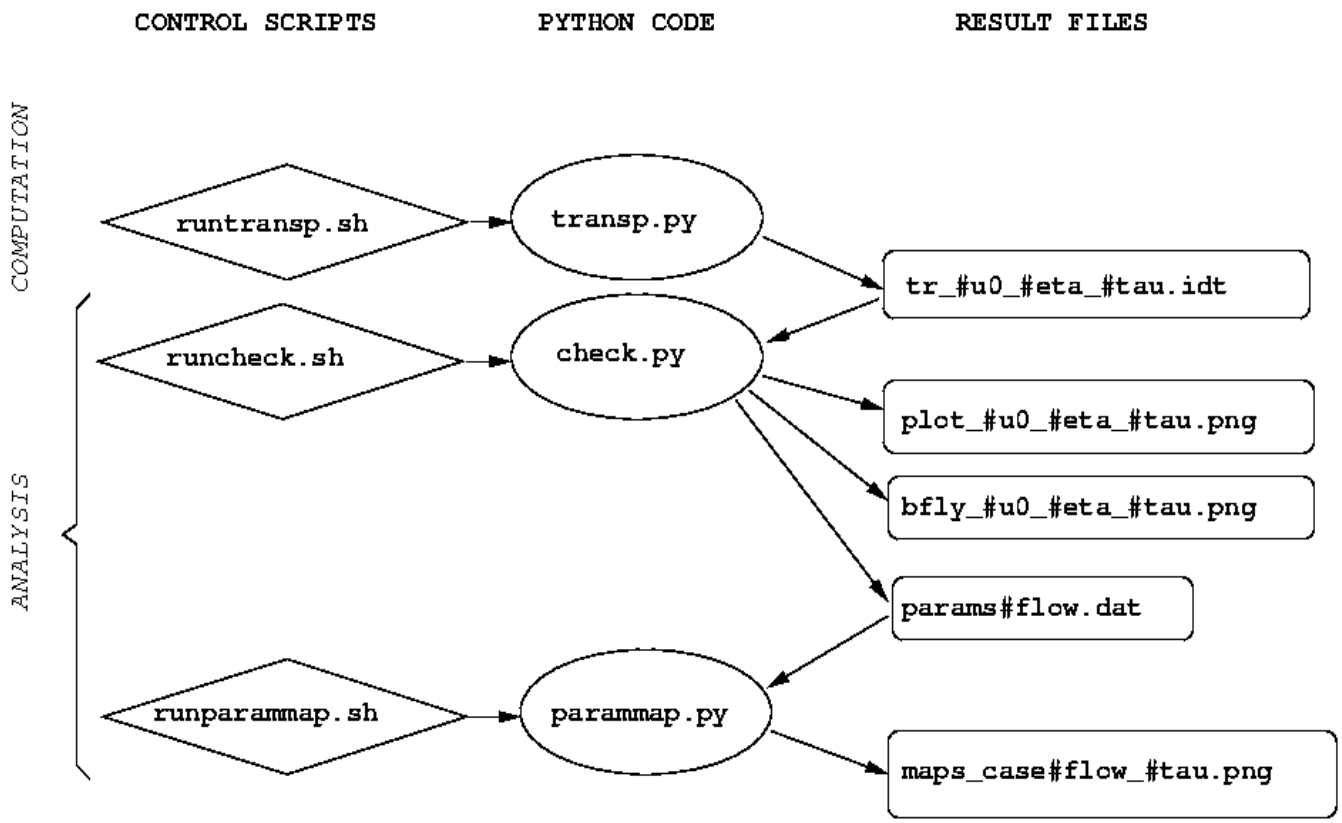
The following flow chart summarizes the interdependence of various elements of the code:



Here, #varname refers to a value taken by the variable ‘varname’, which can be any of

flow	meridional flow profile chosen. Can take values 1, 2 or 3
u0	flow amplitude [m/s]
eta	turbulent magnetic diffusivity [km^2/s]
tau	decay time scale [year]

Computation part:

- runtransp.sh -runs transp.py for a grid of params
  (flow profile and output dir res_case# must be selected in transp.py first)

- transp.py -solves 1D transport eq. with 1st order FTCS timestepping
  Result written into tr_#u0_#eta_#tau.idt : time followed by B values
  at 1 deg lat.intervals, once a month, in last 22 yrs of run.

Analysis part:

- runcheck.sh -runs check.py for a grid of params and all flow types

- check.py -reads in output of transp.py (tr_... files) and
  computes & plots WSOB, dipmom; plots bfly.dgr.;
  finds and prints reversals, maxima etc.
  Output plots: bfly_#u0_#eta_#tau.png -butterfly dgr.
  plot_#u0_#eta_#tau.png -polar field/dipmom variation;
  B profile in min. and at maximum of dip.mom or of WSO field
  Printout: 11 numbers in a row,, appending them to the table
  params#.dat, where #=1,2 or 3 is the flow type:.
  u0, eta,tau, revBpol, revWSOB, revdipmom, (reversal times)
  relWSOB, reldipmom, (value at min./maximal value)
  halfmaxcycmin, halfmaxnpolarb, halfmaxWSOB
  (HWHM of B at cycle min., maximum of polar B, maximum of WSO field)
  (9 numbers for each model + 3 params.)

- runparammap.sh -runs parammap.py for all flow types and all tau values

- parammap.py -reads in output of check.py (params#.dat) and
  maps parameter space: maps of parameters on u0, eta plane
  for each flow type and tau value, saved in files
  maps_case#/maps_case#_$tau.png etc.
  Darkest area on the 4th map is the best fit to
  obs.constraints from polar fields.

Note that the form of the source term (linear or quadratic) must be set (uncommented) manually in the relevant sections of transp.py.

Python version 2.7; Bourne shell scripts.