Power Law method:
x corresponds to a discretization of a solution on a grid. Suppose the grid is two dimensions:

$$||x|| = \sqrt{\sum_{i=0}^{N}\sum_{j=0}^{M} x_{ij}^2/(NM)} \tag{1}$$

$$Ax = \lambda x \tag{2}$$

$$given\ x^{(0)}, ||x^{(0)}|| = 1 \tag{3}$$

for $k = 0, 1, 2, 3, \ldots,$

$$\lambda^{(k)} = ||Ax^{(k)}|| \tag{4}$$

$$x^{(k+1)} = Ax^{(k)}/\lambda^{(k)} \tag{5}$$

Let $q^{(n)}$ be some "base state" at time t^n.
The nonlinear operator, $N(q)$, advances q from t^n to t^{n+1}:

$$q^{(n+1)} \equiv N(q^{(n)}) \tag{6}$$

Define the following, approximately linear, operator:

$$L(x) \equiv \frac{1}{\epsilon}(N(q^{(n)} + \epsilon x) - q^{(n+1)}) \approx \tag{7}$$

$$\frac{1}{\epsilon}(N(q^{(n)}) + \epsilon\frac{\partial N}{\partial q}\cdot x - N(q^{(n)})) \rightarrow \tag{8}$$

$$\frac{\partial N}{\partial q}\cdot x \text{ as } \epsilon \rightarrow 0 \tag{9}$$

Applying the perturbation (just on the initial step of the evaluation of $N()$)
For reference, see Jemison, Sussman, Arienti, JCP (7 equation model, see Saurel and Remi Abgrall)
Conservation of mass (materials $m = 1, \ldots, M$:

$$\frac{\partial \rho_m F_m}{\partial t} + \nabla\cdot(\rho_m F_m u) = \epsilon(\delta(\rho_m))F_m \tag{10}$$

Conservation of energy (materials $m = 1, \ldots, M$:

$$\frac{\partial \rho_m E_m F_m}{\partial t} + \nabla\cdot((pu + \rho_m u E_m)F_m) = \epsilon(\delta(\rho_m E_m))F_m \tag{11}$$

Conservation of momentum:

$$\frac{\partial \rho u}{\partial t} + \nabla\cdot(pI + \rho u u^T) = \epsilon(\delta(\rho u)) - \sum_{m=1}^{M}\delta(\phi_m)\nabla H(\phi_m) \tag{12}$$

ϕ_m corresponds to the signed distance function for material m.
ϕ_m is positive if $\vec{x} \in \Omega_m$ and negative otherwise.
$H(\phi) = 1$ if $\phi > 0$ and $H(\phi) = 0$ otherwise.

Outline of the code modifications:

- read in the checkpoint of the base state $q^{(n)}$ and save it.
- compute $q^{n+1} = N(q^n)$ and save it. (no regridding!)
- initialize $x^{(0)}$
- carry out the power law algorithm.