Coupling a solar interior MHD code to a coronal MHD code

… a part of the Solar MURI project

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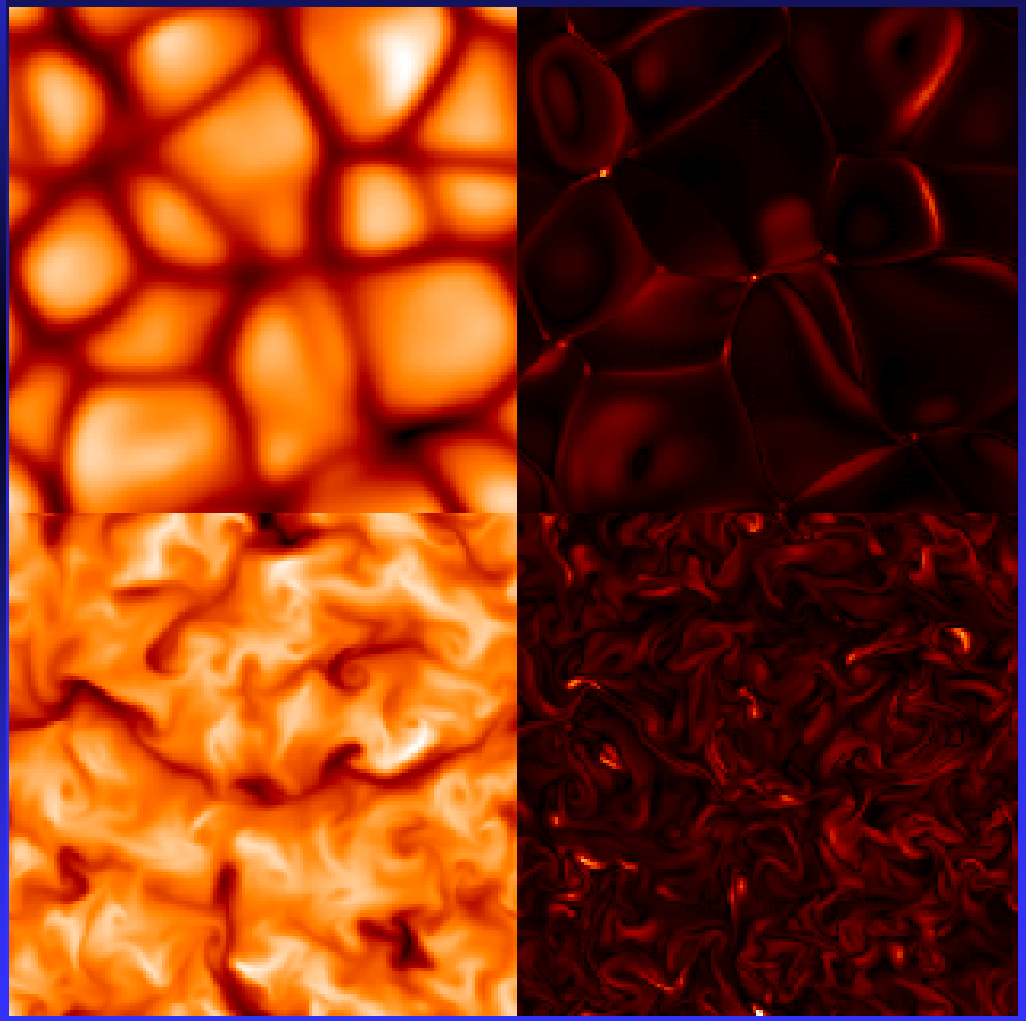
ANMHD: 3d anelastic MHD code, pseudo-spectral (Fan, Abbett)

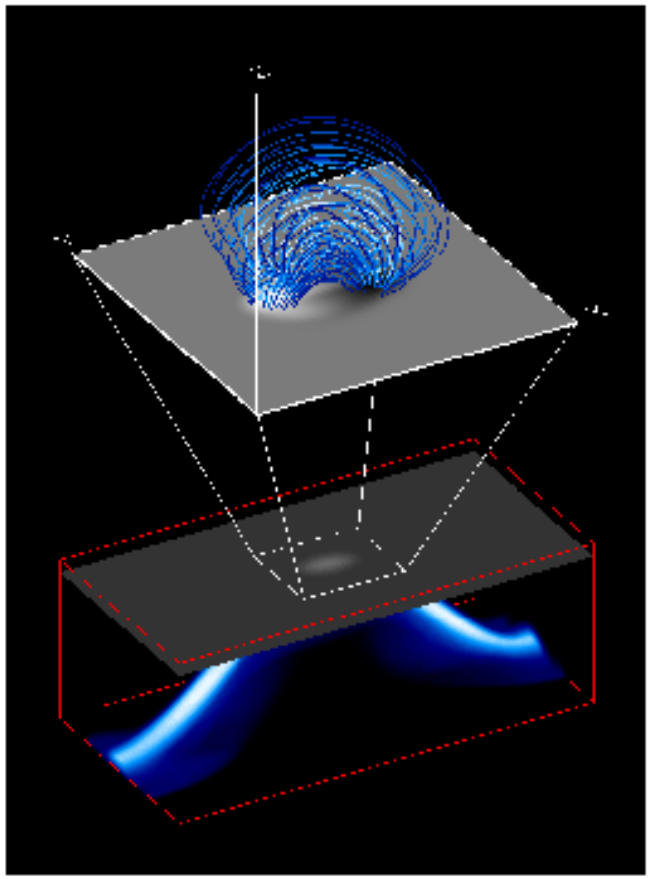


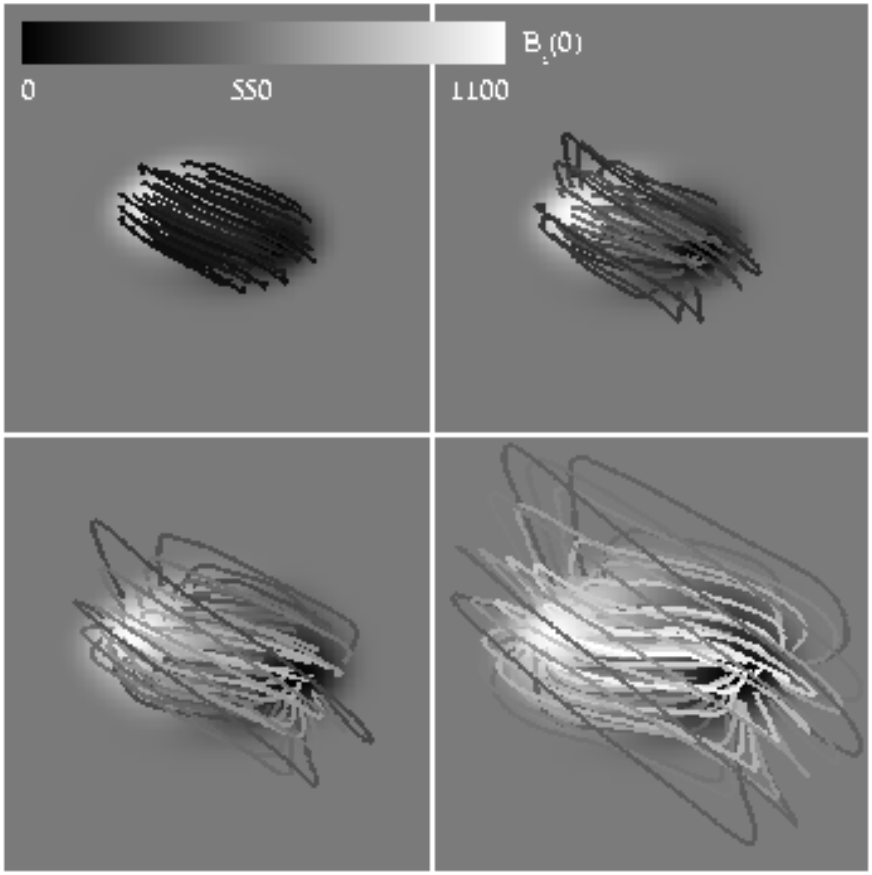
- Valid for $\beta >> 1$
- Includes gravity
- Large time steps
- Good for solar interior

The Zeus3D code: 3D, fully compressible MHD

- Robust, well known code
- Finite difference
- Large variety of possible boundary conditions
- Has been widely used in astrophysical, solar wind, and solar physics simulations

Use ANMHD simulation of emerging magnetic flux to drive a Zeus-3D simulation of the coronal response:





Coupling assumptions:

- No feedback of corona on solar interior is included
- Get **B**,**v** (and less importantly, P,ρ) from interior code and apply to lower boundary of coronal code
- Use derivatives of **B** from interior code in coronal boundary conditions

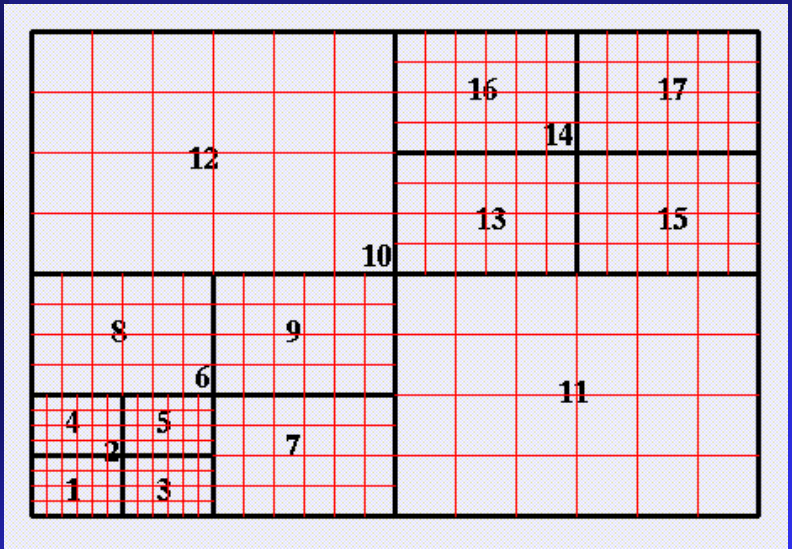
Advantages to this approach:

- Solar interior time scales >> corona dynamic time scales
- Can go to great depths in interior model
- Driving the coronal code with ANMHD is very similar to driving coronal code with vector magnetogram data (important)
- Easy way to get “big picture” of active region structure both above and below the photosphere

Problems with this approach:

- Corona can affect the deeper layers (Longcope & Welsch)
- Mass flows across the photosphere are not treated self-consistently

Possible future solution to these problems:



Use a general code coupling frame work (such as *paramesh*) to couple the codes self-consistently at the photospheric boundary.