

# WG1-1: Sub-surface Structure and Evolution

## Motivation:

- A research program on space weather that ignores the sub-photospheric evolution of magnetic fields is destined to treat the emergence of active regions as random, statistical events. To predict the emergence and evolution of active regions requires a more complete scientific understanding of magnetic field evolution in the interior than we now have.

## Speakers:

- Yuhong Fan
  - Presented a new spherical anelastic simulation of flux emergence through the convection zone
  - The new model verifies many predictions of the thin flux tube model and is an advance over Cartesian models.
  - This model is a major breakthrough in realism in the MHD description of magnetic flux emergence.

- Chip Manchester:
  - Performed simulations of active region flux emergence through the many pressure scale heights of the photosphere into the corona.
  - He argued that the observed photospheric shear flows in ARs (e.g., AR 10486) can be explained by Lorentz forces acting on emerging flux.
- Junwei Zhao:
  - Applied time distance helioseismology to MDI observations of AR 8210 to determine the sub-surface flow field roughly 6Mm below the visible surface.
  - He found a general clockwise rotation in the primary negative polarity of the active region which is consistent with surface flows inferred by ILCT. However that was the extent of the agreement between the two techniques.

- **Doug Braun:**
  - Reviewed farside imaging capability: demonstrated that AR 10486 was visible on the backside of the Sun half a rotation before the Halloween events
  - Consistent with time-distance results, acoustic holography finds outflows around sunspots (~3 Mm below the surface), and inflows around other smaller magnetic features. This was true for every sunspot in the sample.
  - Found a signature of sub-surface supergranulation
- **Aad VanBallegooijen:**
  - Flux tubes that erupt as CMEs in the corona are not necessarily the same as sub-surface flux tubes that emerge as active regions
  - Presented a 3D extension of the 2D flux transport (Wang Sheely) model. After mathematically emerging an active region from the base of the convection zone, he showed that photospheric diffusivity led to flux cancellation. Using a magneto-frictional method to model the corona, he showed that a flux rope formed and subsequently erupted, then reformed.