A Global Three-Dimensional MHD Model of the Solar Corona, Solar Wind and Global Heliosphere

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- Global three-dimensional MHD model of the solar corona, solar wind and global heliosphere, which incorporates transport of turbulence and turbulent heating.
- Based on solutions of Reynolds-averaged solar wind equations coupled with turbulence transport equations in the region from the coronal base to the interstellar medium.
- Specify boundary conditions at the coronal base using either synoptic solar magnetograms or a dipole field.
- Model takes into account effects of Reynolds stresses, eddy viscosity, turbulent heating, electron heat conduction, Coulomb collisions between protons and electrons, and (beyond 5 AU) pickup protons.

- Model agrees “reasonably well” with numerous observations: PSP, Helios, ACE, Voyager…

- Self consistently includes effects of turbulence described by several statistcal parameters

- May be useful in supplying context and intetrpretation for PUNCH

Global simulation with turbulence modeling – Schematic of Reynolds-Averaging Approach

- Global simulation of corona/solar wind cannot explicitly resolve turbulence
- Reynolds decomposition splits fields (ã) into mean (a) and fluctuation (a'; arbitrary amplitude)

Resolve large-scale/mean flow explicitly

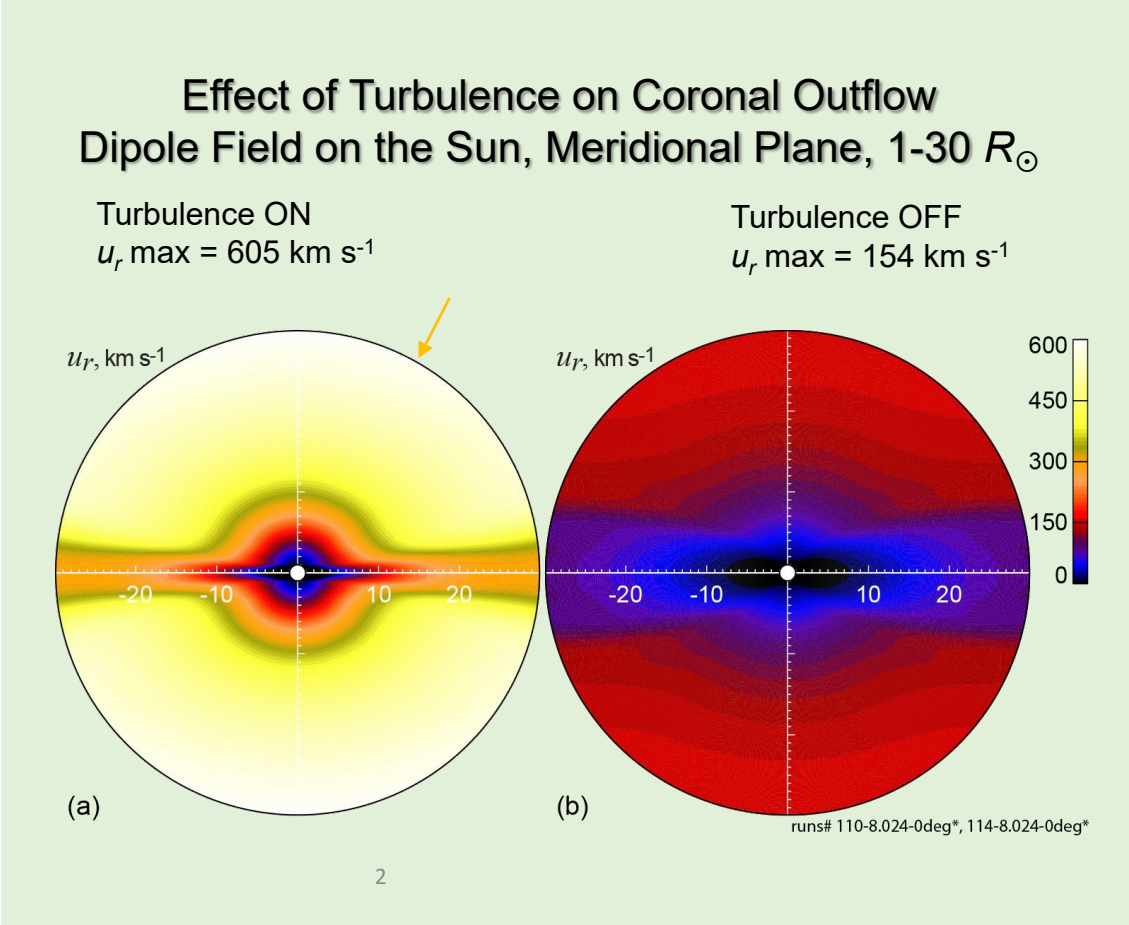
Large-scale (mean field) model equations (MHD):
- Density
- Momentum
- Magnetic field
- internal energies (Te & Tp)

$$\tilde{\mathbf{a}} = \mathbf{a} + \mathbf{a}'$$

Describe "subgrid" fluctuations statistically

Equations for energy, cross helicity, correlation scale

- Two-way coupling – turbulence accelerates and heats wind, and gradients in large-scale fields drive turbulence
- Well-tested, good agreement with observations (Usmanov+ 2018, Chhiber+ 2021)



WIND (OMNI) Observations from Aug 28 to Oct 27, 2020 in Comparison with Simulation Results based on ADAPT map for Sep 27, 2020, 12:00