DATA DRIVING OUR WAY TO 2032. Lucas A. Tarr[1a], Andrei Afanasev[1,2], Yuhong Fan[3], Maria Kazachenko[1,2], N. Dylan Kee[1], Valentin Pillet[1], and Thomas Rimmele[1], [1]National Solar Observatory, Boulder, CO and Maui, HI ([a]ltarr@nso.edu), [2]Department of Astrophysical and Planetary Sciences, University of Colorado, Boulder, [3]High Altitude Observatory, Boulder CO

Abstract: The main open questions in the physics of the solar atmosphere --- how the atmosphere above the temperature minimum region is heated, how and where the various types of solar wind arise, and what mechanisms trigger individual flare and CMEs --- all require knowledge of the 3D structure of the magnetic field and plasma properties above the photosphere. In principle, the magnetic field and plasma parameters can be measured using a suite of simultaneous spectral diagnostics that cover a range of locations in the solar atmosphere and are sensitive to a variety of physical parameters. In practice this is a highly model-dependent problem from two different angles: first, physical models that allow us to invert the combined diagnostics from broadband emission and polarized spectra to recover the physical characteristics of the emitting plasma; and second, computational extrapolation models that allow us to fill in gaps in the observational data, spatially, temporally, and in terms of variable sensitivity to each plasma property (magnetic field, density, temperature, ionization degree, etc.). Current extrapolation models are primarily static, where the individual 3D reconstructions are calculated independently at different times and have no dynamically-constrained relation. In the next decade we must support the development, from basic computational research techniques to viable operational forecasting models, of time-dependent data driven simulations using physically consistent boundary conditions that treat both the magnetic and plasma variables. These models will require routine global input from networks of ground-based synoptic facilities as well as robust validation using focused, multiplexed observations from the DKIST and other facilities.