Project Details

ROSES ID: NNH18ZDA001N
Selection Year: 2018
Program Element: Focused Science Topic

Topic: Origins, Acceleration and Evolution of the Solar Wind

Project Title:
Understanding solar wind acceleration from global models, remote sensing and in-situ observations

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Summary:
Science goals and objectives
In the present investigation we will study solar wind heating and acceleration through Alfven waves by combining existing in-situ measurements obtained with the SWICS instrument on board the ACE and Ulysses spacecraft, high resolution spectra and narrow band images of the solar atmosphere with Hinode, SDO and SoHO, and the 3D MHD AWSoM model of the solar corona and the solar wind. This work will encompass cycles 23 and 24 through the use of multiple in-situ and remote sensing instruments, and can be extended, capitalizing on the results obtained with existing observations, to data from the Parker Solar Probe and the upcoming Solar Orbiter mission.

Methodology
This methodology will combine the AWSoM model predictions of the 3D distribution of plasma speed, temperature and density with 1) the SPECTRUM module, which calculates line-of-sight images and high resolution spectra of the solar corona from any user-defined line of sight, and 2) the Michigan Ionization Code (MIC), which allows to calculate the evolution of the charge state distribution of the wind plasma with distance. Individual wind source regions, such as polar and equatorial coronal holes, streamers, active regions, will be connected to ACE and Ulysses positions through AWSoM magnetic field calculations; comparison of AWSoM/MIC/SPECTRUM predictions of spectra, images and plasma properties of the wind source regions with remote sensing observations and measurements, and AWSoM/MIC predictions of wind charge state distribution with the measurements magnetically connected to the wind source at the Sun, will allow us to 1) assess AWSoM s ability at predicting plasma heating and acceleration, 2) carry out empirical modeling of the wind evolution, to determine the plasma temperature, density and speed before the freeze-in point, to be compared with AWSoM predictions, and 3) characterize Alfven wave properties through comparison of predicted and observed line widths.

Proposed contributions to the focus science team effort
Relevance to FST Scientific objectives: This combination of observation and modeling provides unique contributions to the FST: it will allow the determination of which observables (individual spectral line intensities and profiles, charge states etc) are critical towards understanding the effects of Alfven waves on heating and acceleration; it will allow us to determine how the solar wind charge state composition is set; it will provide vital input towards improving the AWSoM model, enhancing its space weather and solar wind predictive capabilities; it will allow us to understand how the effects of observational and modeling uncertainties on wind diagnostics can be mitigated.
Potential contributions to FST effort: This investigation combines observations and numerical modeling to directly address several Types of Investigations such as: minor ions and their role in the origin and the evolution of the solar wind, solar wind source models based on charge state and elemental composition, evolution of solar wind properties through the solar cycle.

Metrics and milestones to success: During the first year, remote sensing and in-situ observations will be used to identify the best diagnostics of wind heating and acceleration. In year 2, high resolution spectra and charge states will be used to determine, together with the diagnostic techniques identified during year 1, , the ability of AWSoM to match measurements for a few select Carrington Rotations across the solar cycle. Years 3 and 4 will apply these diagnostics on predictions from the fine-tuned model, and investigate the evolution of the source regions, the Alfven wave properties, and the plasma properties in the solar atmosphere during cycles 23 and 24.

Publication References:

no references