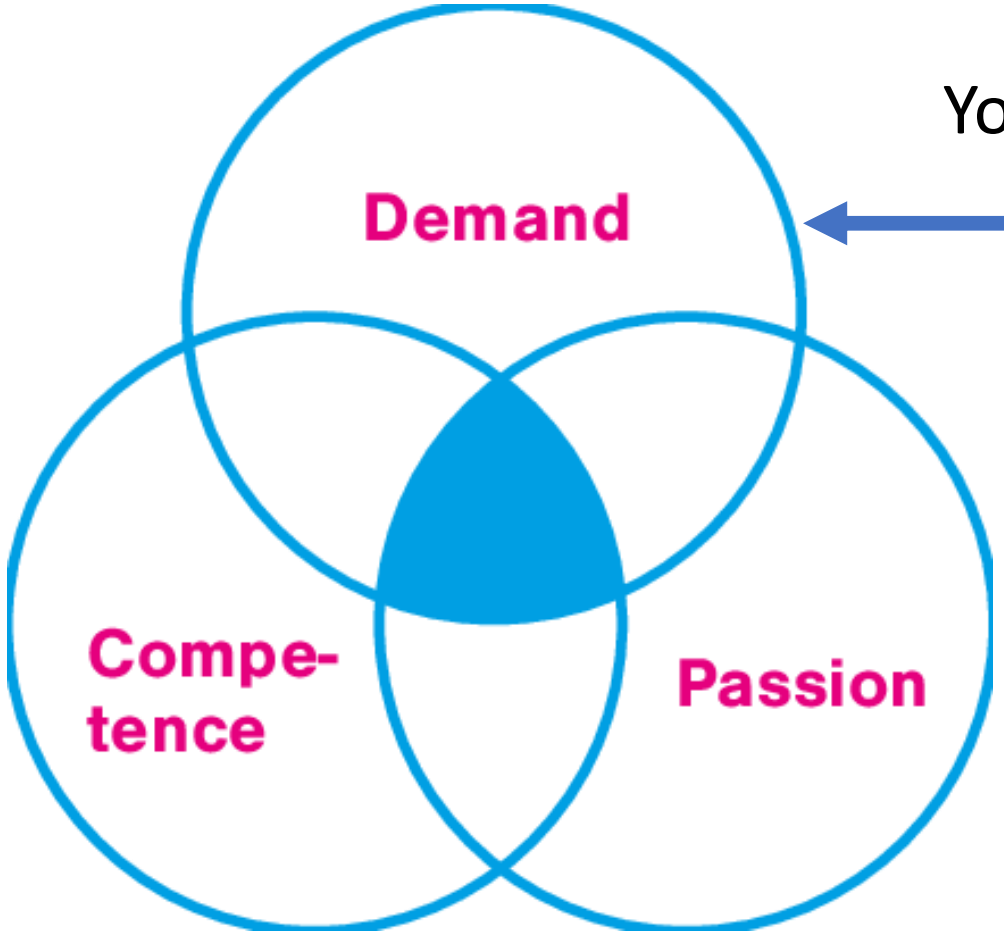
# How to Write an Effective White Paper

Sarah Gibson

# Pick your Topic




You're going to create this!

After Collins, 2001

# Build/Join a Team of Authors

LPI Helio White Paper Concept Forum (next presentation!)

Larry Kepko's list of Helio White Paper Working Groups

White Papers Submitted to Helio 2050

https://helionauts.org/

# Know your Audience — and Be Kind to Them!

# Decide on Your Take-Home Point(s).

Science for All: The benefits and continued need for crowd sourced science

Alexa Halford, Nathaniel A. Frissell, Lindsay Glesener, Michael Hartinger, Karl Battams, Elizabeth MacDonald

**Key Points:**

1. **Heliophysics as a transdisciplinary field requires solutions that address the cultural as well as the technical challenges (see white paper by McGranaghan, Thompson, Halford)**
2. **The Zooniverse model of an open platform, available to researchers for free, has been instrumental in enabling projects ranging from TESS to LSST, and ZTF to LIGO to apply a crowd sourced science approach to data analysis.**
3. **Crowd sourced science is a proven approach, is inherently diverse, inclusive, and provides a powerful path to moving beyond traditional connections enabling new scientific outcomes and science literacy.**

**Multi-vantage-point solar and heliospheric observations to advance physical understanding of the corona and solar wind**

C. N. Arge, S. Jones, C. J. Henney, S. Schonfeld, A. Vourlidas, K. Muglach, J. G. Luhmann, & S. Wallace

The launch of the twin STEREO spacecraft in 2007 allowed for the first simultaneous global views of the Sun in the extreme ultraviolet (EUV). It also permitted simultaneous sampling of the solar wind (SW) from widely spaced points in the ecliptic, as well as stereoscopic views of the Sun's corona in white light (WL) and EUV. Virtually all corona and solar wind models are driven by global estimates of the photospheric magnetic field. Other data sources, such as EUV, WL, and in situ plasma data are essential for both validating and constraining these models. Unfortunately, the STEREO (ST) mission payload did not include magnetographs, so the opportunity to simultaneously measure the Sun's global magnetic field has not been possible until the recent launch of Solar Orbiter (SolO). Vector magnetographs onboard the Solar Dynamics Observatory (SDO) and SolO spacecraft will, on rare occasions, allow for nearly complete 360° coverage of the Sun's surface magnetic field. ***It is argued in this white paper that to significantly advance basic understanding of the corona and solar wind, it is essential to have continuous monitoring of the Sun's global magnetic field distribution, along with equivalent coverage in EUV and WL, as well as in situ monitoring of the solar wind from multiple and widely spaced vantage points.***

# Pose a Problem.

## Science Platforms for Heliophysics Data Analysis

Monica G. Bobra (Stanford University), Will T. Barnes (NRC Postdoc residing at the Naval Research Laboratory), Mark C. M. Cheung (Lockheed Martin Solar and Astrophysics Laboratory), Laura A. Hayes (NASA Goddard Space Flight Center), Jack Ireland (NASA Goddard Space Flight Center), Miho Janvier (Institut d'Astrophysique Spatiale), Michael S. F. Kirk (NASA Goddard Space Flight Center and ASTRA llc.), James P. Mason (University of Colorado Boulder), Stuart J. Mumford (The University of Sheffield and Aperio Software), Paul J. Wright (Stanford University)

### Introduction: What is the problem with data analysis in heliophysics today?

In 2020, we live in an era rich with data. NASA instruments designed to study the heliosphere take more data, at faster rates than ever before. For example, the Solar Dynamics Observatory (SDO) mission data set currently totals 19 petabytes. The heliophysics community also conducts coordinated campaigns, where many instruments observe the same target for the same time, that yield a wide variety of data—image data, spectral data, time series data, and *in situ* data on local particle and field conditions. Heliophysics is a naturally multi-messenger discipline, and many studies rely on using these varied data sets together.

**In-situ Investigations of the Structure of Ionospheric Closure Currents**

Ian Cohen, Brian Anderson, Sarah Vines (JHU/APL); John Bonnell (Berkeley) Marc Lessard (UNH); Bob Lysak (Minnesota); Robert Michell (UMD); and Roger Varney (SRI)

Close consultation with NASA/WFF has led to the conclusion that **the technology necessary to meet the requirements to obtain the high-precision magnetic field measurements critical to obtain science closure for such a mission do not exist within the current deployed sub-payload capabilities of NASA/WFF.** Although miniature sub-payloads have been developed for previous missions,

**The Ongoing Development and Support of Atomic Physics in Solar and Heliospheric Science**

*White paper for the Heliophysics 2050 workshop*

***Authors:*** Y. J. Rivera[1,4], W. Barnes[2], A. Higginson[3], E. Landi[1], J. C. Raymond[4], J. W. Reep[5]
***Cosigners:*** B. L. Alterman[6], P. Byrans[7], S. Chhabra[3,8], G. Del Zanna[9], P. Judge[7], E. Lichko[10], S. Schonfeld[11], S. A. Spitzer[1], R. Smith[4], H. Uitenbroek[12], J. L. Verniero[13], S. Wallace[3], M. J. Weberg[5], P. Wright[14], P. Young[3]
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atomic data and transition rates used to interpret solar emission. Because of this, ***there are severe limitations on the scientific return of solar and heliospheric missions which rely on the availability and accuracy of atomic data and modeling codes for physical interpretation.*** Therefore, it is critical for technological advances to be coupled with the improvement and development of atomic physics repositories and analysis tools through explicit funding to these projects and ongoing community level collaboration in the upcoming decades.

# If Possible, Recommend a Solution.

**Communications Enabling Science from the 2050 Heliophysics System Observatory**

**Authors:** S. J. Schonfeld[1], W. D. Pesnell[2], J. L. Verniero[3], Y. J. Rivera[4], A. J. Halford[2], S. K. Vines[5], S. A. Spitzer[4]
**Cosigners:** A. K. Higginson[2], B. L. Alterman[6], M. J. Weberg[7]

**Recommendations:**
**To enable Heliophysics science in 2050, it is essential that NASA ensures the accessibility of science data returned from future Heliophysics System Observatory missions by advocating for and investing in existing communications infrastructure and embracing the communications technologies of the future.**

**A call for interdisciplinary science focusing on how particle precipitation from the magnetosphere affects Earth's atmosphere**

**We need a comprehensive, continuous set of these measurements to fully understand this last link in the Sun-Earth system. It requires researchers from both the magnetospheric and atmospheric fields working together. And it will require support from the greater communities and funding agencies to help build and maintain those bridges.**

*From Jaynes et al.*

# Make Your White Paper Readable — and Visually Appealing

**Mesoscale dynamics – the key to unlocking the universal physics of multiscale feedback**
*L. Kepko, S. Merkin, N. Viall, A. Vourlidas, and S. McIntosh*

| Characteristics | | Regime: Kinetic | Mesoscale | Synoptic |
|---|---|---|---|---|
| Temporal Scale | Solar | <0.1 s | Hours to days | Days to decades |
| | Solar wind | seconds | 10s of seconds to hours | Days to weeks |
| | M'sphere | <seconds | 10s of seconds to minutes | 10s of minutes to days |
| | MIT | seconds | Few minutes to hours | Hours to days |
| Spatial Scale | Solar | <1 km | 1 Mm – 100 Mm | Solar radius (700 Mm) |
| | Solar wind | <1 Mm | 10 Mm-thousands of Mm | 1 AU (150,000 Mm) |
| | Magneto-sphere | <hundreds of km | Up to few RE | >few RE |
| | MIT | <meters | <100s km | <1000s km |
| Simulation | | PIC | MHD, hybrid, mixed models, plug-ins | MHD, hybrid, mixed |
| Example | | Wave particle interactions, ohmic heating, magnetic re-connection, plasma instabili-ties, small-scale gravity waves | Bursty bulk flows, FTEs, streamer blobs, solar bright points, ionosphere polar cap patches, gravity waves | Solar dynamo, streamer belt, CMEs, CIRs, substorms, plan-etary waves, atmospheric tides |
| Measurement approach | | In situ fast instrumentation; spectroscopy | Constellations, coordinated system sci-ence measurements; spectral imaging | Widely separated, moderate temporal resolution; imaging |

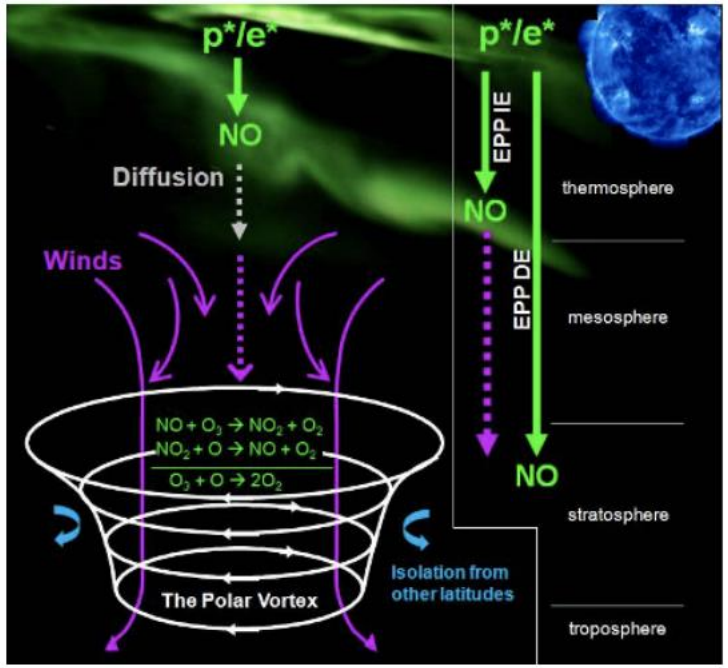



Figure 1: Direct and indirect effect of EPP on the atmosphere. Polar vortex and dynamics play a strong role.

*From Jaynes et al.*

# Leave a Trail of Bread Crumbs.

**Fundamentals of impulsive energy release in the corona**

Heliophysics 2050 Workshop white paper

A. Y. Shih (NASA Goddard Space Flight Center), L. Glesener (UMN), S. Krucker (UCB), S. Guidoni (Amer. Univ.), S. Christe (GSFC), K. Reeves (SAO), S. Gburek (PAS), A. Caspi (SwRI), M. Alaoui (GSFC/CUA), J. Allred (GSFC), M. Battaglia (FHNW), W. Baumgartner (MSFC), B. Dennis (GSFC), J. Drake (UMD), K. Goetz (UMN), L. Golub (SAO), I. Hannah (Univ. of Glasgow), L. Hayes (GSFC/USRA), G. Holman (GSFC/Emeritus), A. Inglis (GSFC/CUA), J. Ireland (GSFC), G. Kerr (GSFC/CUA), J. Klimchuk (GSFC), D. McKenzie (MSFC), C. Moore (SAO), S. Musset (Univ. of Glasgow), J. Reep (NRL), D. Ryan (GSFC/AU), P. Saint-Hilaire (UCB), S. Savage (MSFC), R. Schwartz (GSFC/AU), D. Seaton (NOAA), M. Stęślicki (PAS), T. Woods (LASP)

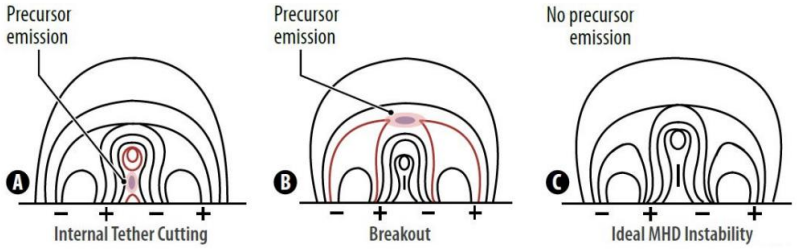



*Figure 1: Different models of the initiation of solar eruptive events can be distinguished during the early rise phase of the eruption by the differences in the timing and locations of X-ray sources from accelerated electrons and X-ray and extreme-ultraviolet (EUV) emission from heated plasma. The cartoons of possible magnetic configurations are adapted from [4].*

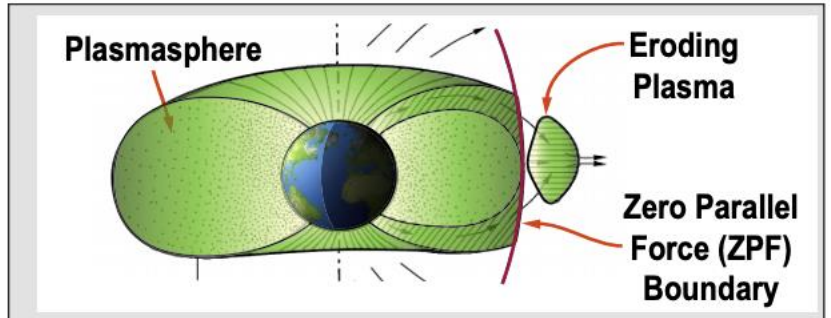
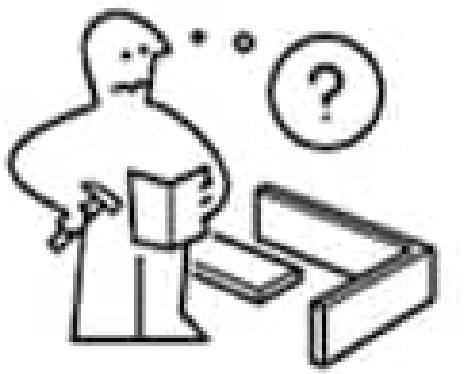



*Fig 3. The interchange hypothesis predicts that during erosion events the new plasmapause forms along the Zero-Parallel Force (ZPF) surface [Lemaire and Gringauz 1998]*

*From Goldstein et al.*

# Read the Instructions.



Astro2020 had different flavors of white papers:

- Activities, Projects, or State of the Profession
- Science

Helio might do something different!

# Make it Easy on Your Reader (Be Kind)

- Easy to pick up your take home point(s)
- Easy to understand (and find!) the problem(s) you are posing
- Easy to understand (and find!) the solution(s) you are posing
- Easy to follow up and dig deeper in the future (bread crumbs)
- Easy to steal your material
- Easy to pick out your response to any instructions given


Let the experience enrich you!