Project Details

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Project Title:
Medium Range Thermosphere Ionosphere Storm Forecasts

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Summary:

We are on the threshold of a new era of scientific understanding of the connected Sun- Earth system, ushered in by the development of first-principles coupled models spanning the solar corona to the Earth s upper atmosphere (thermosphere and ionosphere). The community is now ready to develop a space weather forecasting system for the upper atmosphere. We propose to develop the first system to forecase storm conditions in the upper atmosphere caused by solar high speed events up to 4 days in advance. Our objectives are to:
1) Develop space weather forecasts for adverse conditions that arise in the upper atmosphere (thermosphere and ionosphere) resulting from coronal mass ejections (CMEs) and high speed streams (HSS), using the most advanced first-principles models, combined with ensemble-based forecasting methods that have proven their value in terrestrial weather forecasting;
2) Perform system science investigations using the first principles model chain from the solar corona to the Earth s upper atmosphere;
3) Deliver advanced models of the heliosphere and upper atmosphere to the Community Coordinated Model Center (CCMC) for their use in Heliophysics scientific investigations and to improve space weather forecasting; and
4) Deliver the forecast capability to the community via CCMC to establish space weather forecasting as a new science;

Our approach is to assemble an inter-disciplinary team of space physicists, modelers, applied mathematicians and numerical weather prediction experts who have the knowledge needed to create an effective forecasting system. We will use the proven ensemble forecasting method to create forecasts with uncertainties, rigorously based on careful comparisons of forecasts with measurements spanning Sun to Earth. It is widely known that attaching realistic uncertainties to forecasts is important to create useful forecasts. Upon completion of this project, the full capability of the forecasting system will be delivered to CCMC for community use.

To increase forecasting accuracy and for science investigations, we will deliver first- principles models to CCMC. The Space Weather Modeling Framework (SWMF) two- temperature heliosphere model will be upgraded with a module that tracks CME propagation. The Global Ionosphere Thermosphere Model (GITM) will be upgraded with a plasmaspheric component, and adapted to run in real-time for CCMC.

Our effort is directly aligned with Living With a Star objectives to develop first principles models as tools for science investigations and as prototypes for predictive capabilities. The inter-disciplinary nature of our team will make progress that transforms the field.

We cannot over-emphasize that new scientific results will emerge from our effort. We will use first-principles models and observations to study the Sun-to-Earth as an integrated system. The expertise of our team spans the entire physical domain from Sun to upper atmosphere. In the proposal, we outline how we will address systems science questions that are directly relevant to the LWS program. The observationalists on our team will provide the necessary measurements to conduct our scientific investigations, and also to ensure that the forecast system is rigorously calibrated against all relevant observations.

Two graduate students will be trained as part of this effort. This is an important aspect of our broader impacts, because these young individuals may forge pioneering careers in space weather and Heliophysics science.

Now is the time for an effort such as ours. The first principles models exist now, the scientific understanding is sufficiently advanced, and the need has never been greater. We are supplying the needed ingredient: an inter-disciplinary team with the necessary skills to advance Heliophysics science and create a new science of space weather forecasting.

Publication References:

Summary: no summary

Reference: Wang, Chunming; Rosen, Irvin Gary; Tsurutani, Bruce T.; Verkhoglyadova, Olga P.; Meng, Xing; Mannucci, Anthony J.; (2016), Statistical characterization of ionosphere anomalies and their relationship to space weather events, Journal of Space Weather and Space Climate, Volume 6, id.A5, 16 pp, doi: 10.1051/swsc/2015046

Summary: no summary

Reference:
Mannucci, Anthony J.; Hagan, Maura E.; Vourlidas, Angelos; Huang, Cheryl Y.; Verkhoglyadova, Olga P.; Deng, Yue; (2016), Scientific challenges in thermosphere-ionosphere forecasting - conclusions from the October 2014 NASA JPL community workshop, Journal of Space Weather and Space Climate, Volume 6, id.E01, 10 pp, doi: 10.1051/swsc/2016030