Project **ISEST** (**I**nternational **S**tudy of **E**arth-affecting **S**olar **T**ransients)

1. Background

Our Sun is an active star. Flares and coronal mass ejections (CMEs) are the most violent phenomena of solar eruptive activity. CMEs drive shocks that accelerate particles to very high energies, producing harmful radiation in space. The shocks can compress Earth's magnetosphere causing sudden impulses. CMEs in the interplanetary medium (ICMES) are the main source of geomagnetic storms when heading towards Earth. Flares on the solar disk generate strong electomagnetic radiation that may severly change the environmental conditions in near-Earth space. High speed solar wind originating from coronal holes on the Sun can lead to corotating interaction regions (CIRs) in the heliosphere that can also produce geomagnetic storms. The effects of these transients on humanity span a range of sectors from satellite operations, radio communication problems, enhanced radiation risks for aircraft crew and passengers, to outages in electric power networks on the ground.

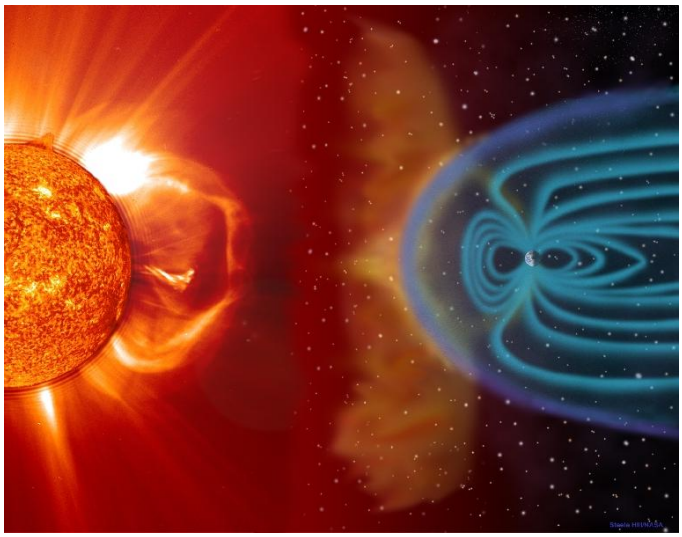

Fig. 1 Schematic of the Sun-Earth connection (credit: NASA)

The aim of ISEST is to understand the origin, propagation and evolution of these solar transients through the space between the Sun and the Earth, and improve the prediction capability for space weather. Particular emphasis will be placed on the weak solar activity prevailing in Solar Cycle 24 (MiniMax24).

2. Research Activity

The research of ISEST is enabled by continuous observations of the Sun and the heliosphere from an array of spacecraft and ground-based instruments, global numerical simulations of the system and theoretical analysis. Important issues and open research questions are the transit times of CMEs and shocks from the Sun to their arrival at Earth as well as their impact. The degree of impact is determined by various parameters, such as arrival speed, magnetic field orientation (Bs) and its complexity. To tackle all the different factors and put the results into a global picture, the ISEST project consists of several working groups (WGs), covering data analysis, theoretical interpretations, modeling and campaign event study. It also coordinates collaborative

international observations.

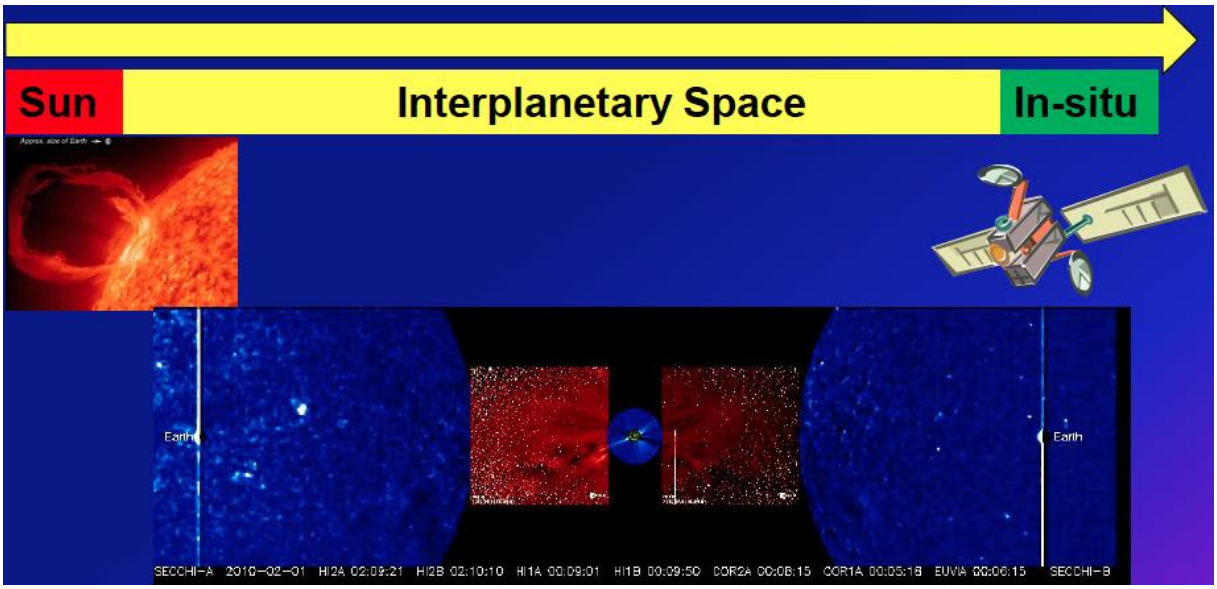

Fig.2 The observations from the Sun to the Earth: solar activity, evolution of the transients in the heliosphere and effects on Earth's space environment (credit: Jie Zhang).

The Working Groups are:

(1) Working Group 1 (Data Group): The goal of WG1 is to identify all Earth-affecting ICMEs during the STEREO era (2007 to present) and their solar sources. Track these events from the Sun to the Earth, and fully measure, characterize and quantify their properties and evolution from the Sun to the Earth. Provide a comprehensive event database for other working groups, other projects, and the entire community. Identify and characterize other Earth-affecting transients, including solar flares, SEPs (Solar Energetic Particles) and CIRs.

(2) Working Group 2 (Theory Group): WG2 aims to understand the structure and evolution of CMEs as well as their origin and their magnetic rope structure. What is the cause of Bs and how can we model it? Are CMEs deflected in the heliosphere? How do the ambient conditions affect CME structure, propagation and dynamics? How long does the Lorentz force dominate over the aerodynamic drag force? How can we estimate the drag parameter and/or the dimensionless drag coefficient? WG2 will compare the results produced by different analytic and numerical models with observations, e.g., 1 AU transit time, kinematics, impact speed, impact magnetic field, etc.

(3) Working Group 3 (Simulation Group): WG3 will provide a global context for CME events investigated by WG1. WG3 will investigate processes of CME initiation, heliospheric propagation, and CME interaction. WG3 also aims to develop tools to assist collaboration among modelers, theoreticians, and observers. WG3 will use existing 3D MHD models inlcuding ENLIL, COIN-TVD, H3DMHD and SWMF.

(4) Working Group 4 (Campaign Group): WG4 is dedicated to campaign events. The participants will integrate theory, simulations and observations in order to understand the chain of cause-effect activities from the Sun to Earth for a small number of carefully selected events. Textbook cases (standard events) from the Sun to the Earth are provided to the community. WG4 will also examine controversial events, such as stealth CMEs and problem ICMEs to complete the understanding. WG4 will interact with other varSITI projects for varSITI-wide campaign studies.

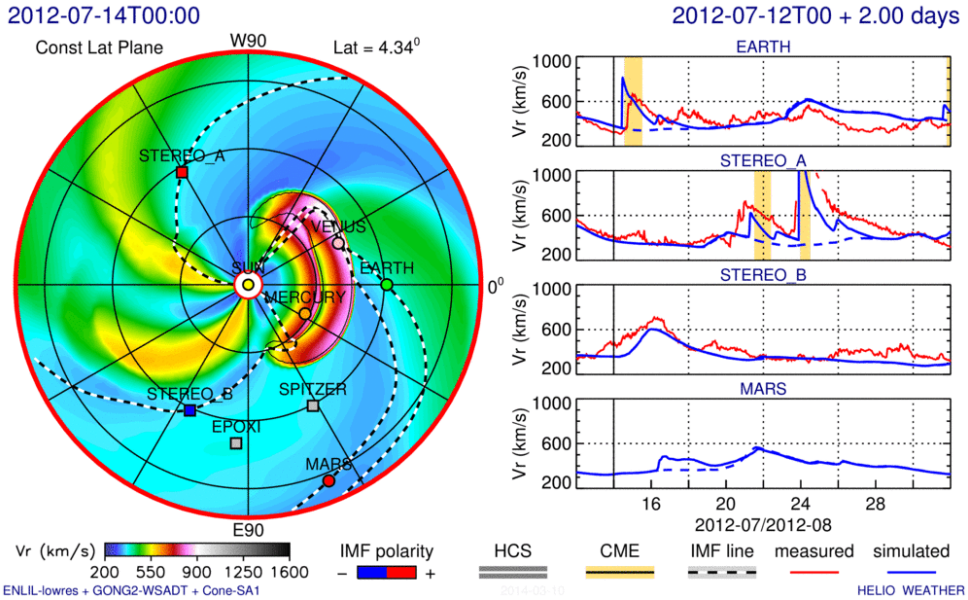

Fig.3 Example of an ENLIL model run and results (credit: Dusan Odstrcil)

(5) Working Group 5 (Bs-challenge Group): The presence of southward magnetic fields in ICMEs are the most important factor in producing geomagnetic storms. The challenge is that direct observations of magnetic fields near the Sun are extremely limited: currently possible only in the photosphere/chromosphere at the solar end and by in-situ observations at 1 AU. WG5 aims to understand and reconstruct the possible flux rope magnetic structure of CMEs/ICMEs from observations and models. It also aims to predict the intensity and the duration of the Bs in ICMEs upon arriving at the Earth.

(6) MiniMax24 Campaign: MiniMax24 coordinates international observations and acts as a long-term campaign providing daily updates on solar and geospace events through a network of international participants. It also serves as a "come-into-contact platform" with a broad range of experts.

3. Anticipated Outcomes

The ISEST project will create a comprehensive database of Earth-affecting solar transients contributed by both observers and modelers. The effort will improve the understanding of the origin, propagation and Earth impact of solar transient events. It will significantly improve the space weather prediction of CME arrival with a lead time 24+ hours and an accuracy of a few hours. It will aso develop ways to predict the strength and duration of the southward interplanetary magnetic field and thus the intensity of expected geomagnetic storms. The ISEST will collaborate with other VarSITI groups to improve the global understanding of the Sun-Earth system.

4. Scientific Organization Committee (SOC)

Ayumi Asai	Kyoto University (Japan)
Mario M. Bisi	RAL (UK)
Kyungsuk Cho	KASI (South Korea)
Peter Gallagher	Trinity College Dublin (Ireland)
Manolis K. Georgoulis	Academy of Athens (Greece)
Nat Gopalswamy (co-leader)	NASA (USA)
Alejandro Lara	National Autonomous University (Mexico)
Noe Lugaz,	University of New Hampshire (USA)
Alexis Rouillard	CNRS/IRAP (France) (confirmed)
Nandita Srivastava	Physical Research Lab (India)
Manuela Temmer (co-leader)	University of Graz (Austria)
Yuri Yermolaev	Space Research Institute (Russia)
Yu-Ming Wang	Univ. of Science and Technology (China)
David Webb	Boston College (USA)
Bojan Vrsnak	Hvar Observatory (Croatia)
Jie Zhang (co-leader)	George Mason University (USA)

5. Working Group Leaders (WG Leaders)

WG1 (Data Group):	Jie Zhang (George Mason University, USA)
WG2 (Theory Group):	Bojan Vrsnak (Hvar Observatory, Croatia)
WG3 (Simulation Group):	Fang Shen (CSSAR, China)
WG4 (Campaign Group):	David Webb (Boston College, USA)
WG5 (Bs Challenge Group):	Manolis Georgoulis (Academy of Athens, Greece)
WG6 (MiniMax24 Group):	Manuela Temmer (University of Graz, Austria)

6. Planned Workshops and Schedule (as of April 02, 2014):

This list will be updated incrementally.

- A mini ISEST workshop in University of Science and Technology of China (USTC) (April 18 - 19, 2014, China), co-organized by Jie Zhang & Yuming Wang
- A special session in SHINE conference (June 23-27, 2014, USA), titled as "Earth-affecting CMEs", co-organized by Jie Zhang & Noe Lugaz)
- 14th European Solar Physics Meeting (September 8-12, 2014, Ireland). Provide partial financial support for students and young scholars from developing countries
- Participate in VarSITI campaign study at the STP-13 conference (Oct. 12-18, 2014, Xian, China)

- One-day ISEST/MiniMax24 workshop held together with STP-13 conference (Oct. 18, 2014, Xian, China)
- ISEST/MiniMax24 workshop. 2015. Time and location to be determined
- ISEST/MiniMax24 workshop 2016. Time and location to be determined
- ISEST/MiniMax24 workshop 2017. Time and location to be determined
- ISEST/Minimax24 workshop 2018. Time and location to be determined

7. Web Resources

- VarSITI: http://www.varsiti.org/
- ISEST/MiniMax24 Event and Data repository: http://solar.gmu.edu/heliophysics/index.php/Main_Page
- MiniMax24 Campaign webpage: http://igam07ws.uni-graz.at/mediawiki/index.php/Main_Page
- ISEST 2013 Workshop Webpage: http://spaceweather.gmu.edu/meetings/ISEST/