Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN) Report

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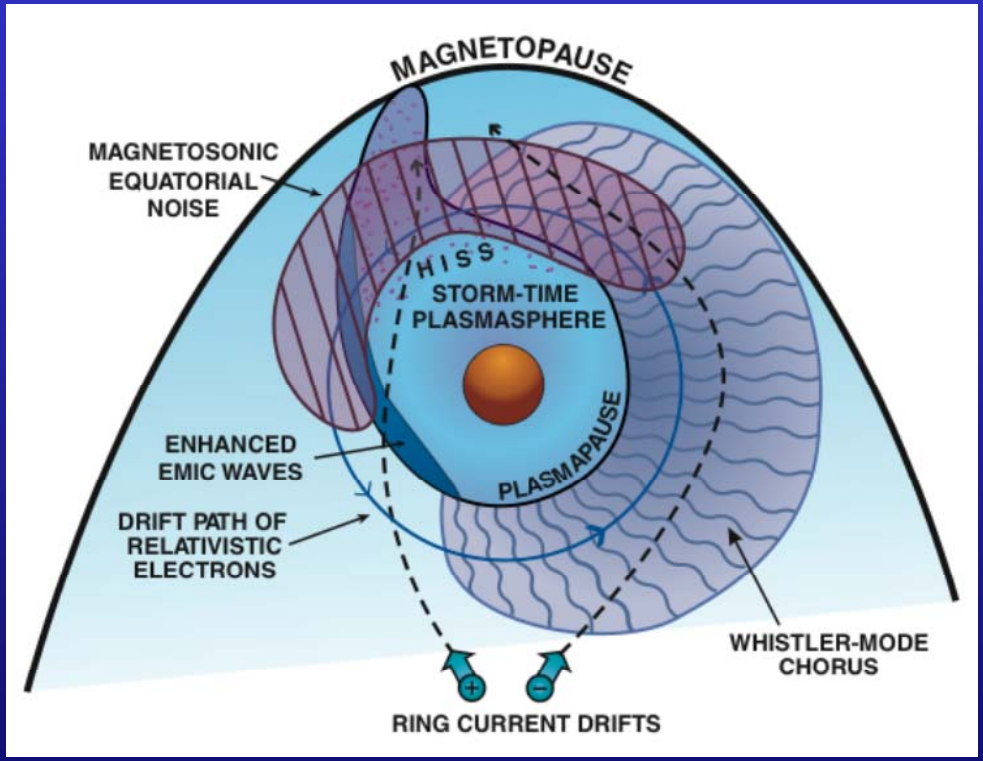
SCOSTEP's STP13 Symposium
Xi'an, China
Session 3: SCOSTEP Scientific Program
15:00-15:50 Monday 13 October 2014

SPeCIMEN Objective

Prediction and specification of the Earth's inner magnetospheric environment

1. To high accuracy,
2. Based on inputs from the Sun and solar wind,
3. Employing a combination of physical and statistical predictive modeling.



Thorne [2011] GRL "frontiers" review

SCOSTEP's SPeCIMEN Project Summary (2014-2018 inside VarSITI programme)

Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)

Goals and objectives: The quantitative prediction and specification of the Earth's inner magnetospheric environment based on Sun/solar wind driving inputs.

Primary Question: How does the inner magnetosphere respond as a coupled system to Sun/solar-wind driving?

Data/theory/modelling: A combination of physical and statistical (machine learning) modelling, theory, and observations from various platforms – both satellite & ground.

Anticipated outcome: A series of coupled, related models that quantitatively predict the dynamical evolution of the inner magnetospheric state (radiation belts, ring current, cold plasma distribution, plasmasheet, convection electric field, and so on).

Co-Leaders:
Jacob Bortnik
(UCLA, USA)
Craig J. Rodger
(U. Otago, New Zealand)

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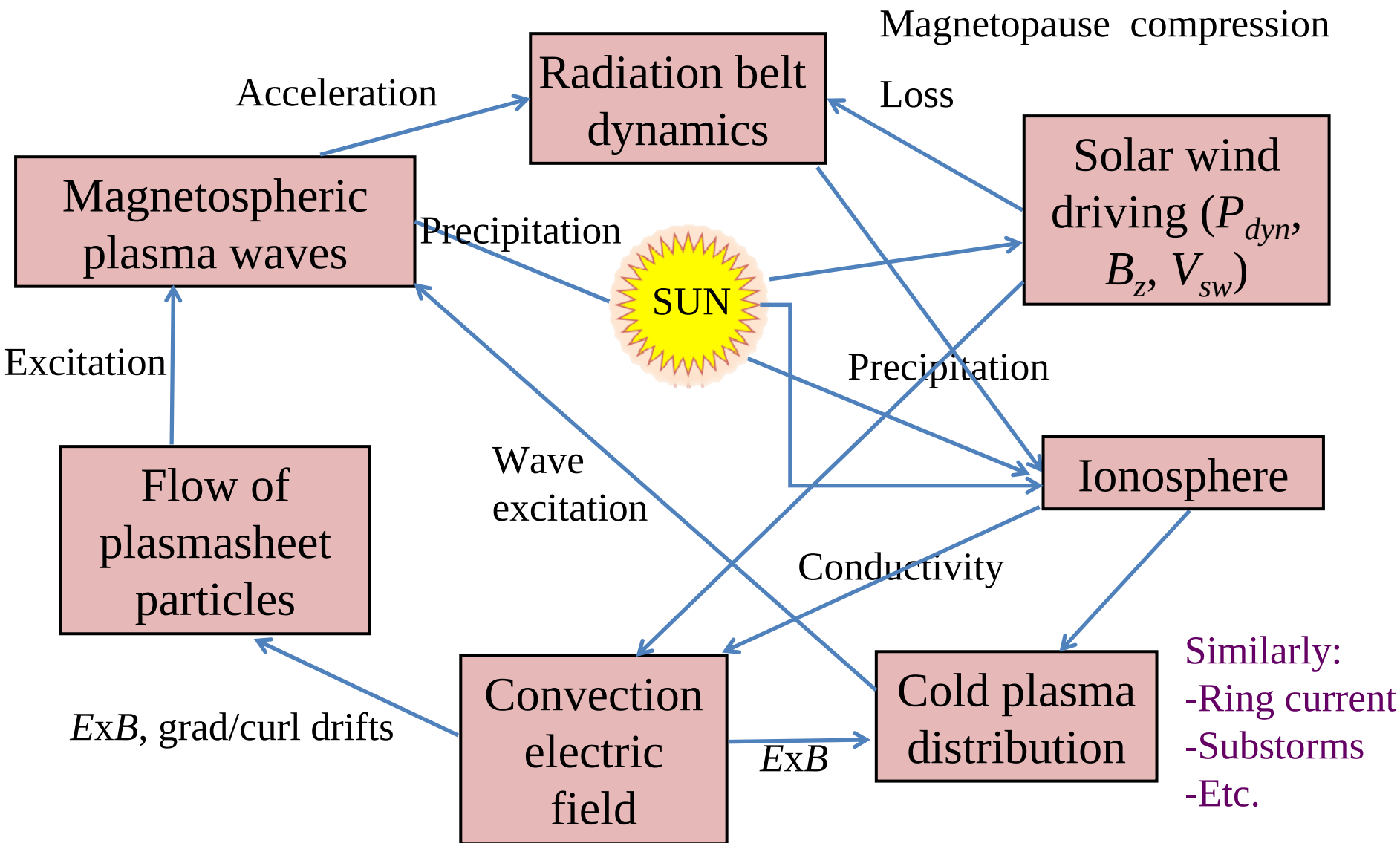
It's a complex system!

And understanding it will require a lot of people with different knowledge and different backgrounds (remember, we span ~6-orders of magnitude in Energy).



Planned SPeCIMEN Approach

Large scale collaboration between physical modelers, predictive modelers, and observationalists.

Four temporal phases (spanning roughly the 4-5 year project):

1. Improvement of predictive models & further development of theoretical models, with a view to integration
2. Fusion of predictive and physical models
3. First generation ‘complete’ model development, comparison with multiple data streams
4. Feedback and refinement

All of these phases must be informed by observations! Tools are being developed to help share and visualise experimental observations.

SCOSTEP's SPeCIMEN Project
Highlights from 2014

Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)

2014 Meetings and Workshops

- presentations at the **6th VERSIM workshop** in Dunedin, New Zealand (20-23 January 2014)
- presentation at **Japan Geoscience Union Meeting**, Yokohama, Japan (28 April -2 May 2014).
- relevant session at the **Geospace Environment Modeling (GEM) workshop** in Portsmouth, Virginia, USA (15-20 June 2014)
- presentation at **Asia Oceania Geosciences Society 7th Annual General Meeting**, Sapporo, Japan (28 July - 1 August 2014)
- two sessions at the **URSI General Assembly and Scientific Symposium** in Beijing, China (16-23 August 2013) ⇐ **formally SPeCIMEN supported**
- splinter session at **Geospace Revisited Conference** in Rhodes, Greece (15-20 September 2014) ⇐ **formally SPeCIMEN supported**

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SCOSTEP's SPeCIMEN Project
Highlights from 2014

Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)

2014 Funding

- Digitisation of old analogue magnetograms spanning 1967-2006 from the Geophysical Observatory "Paratunka" in Kamchatka, Russia **(also supported by VarSITI).** For details see VarSITI newsletter vol 3.

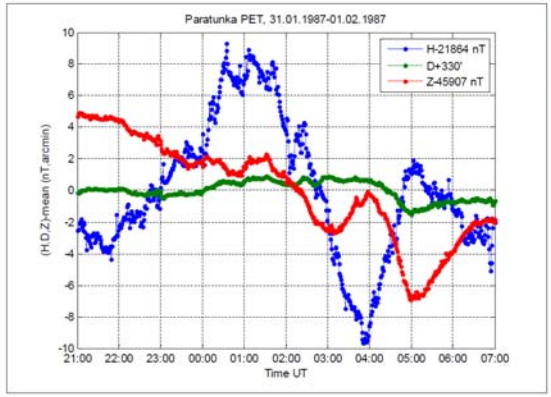

Figure 2. An example of digitization of the magnetogram image presented in Fig. 2: minute values of full H,D,Z components are presented.

- Sponsored the SPeCIMEN splinter session at the **Geospace Revisited Conference** in Rhodes, Greece (15-20 September 2014) . For details see VarSITI newsletter vol 3.

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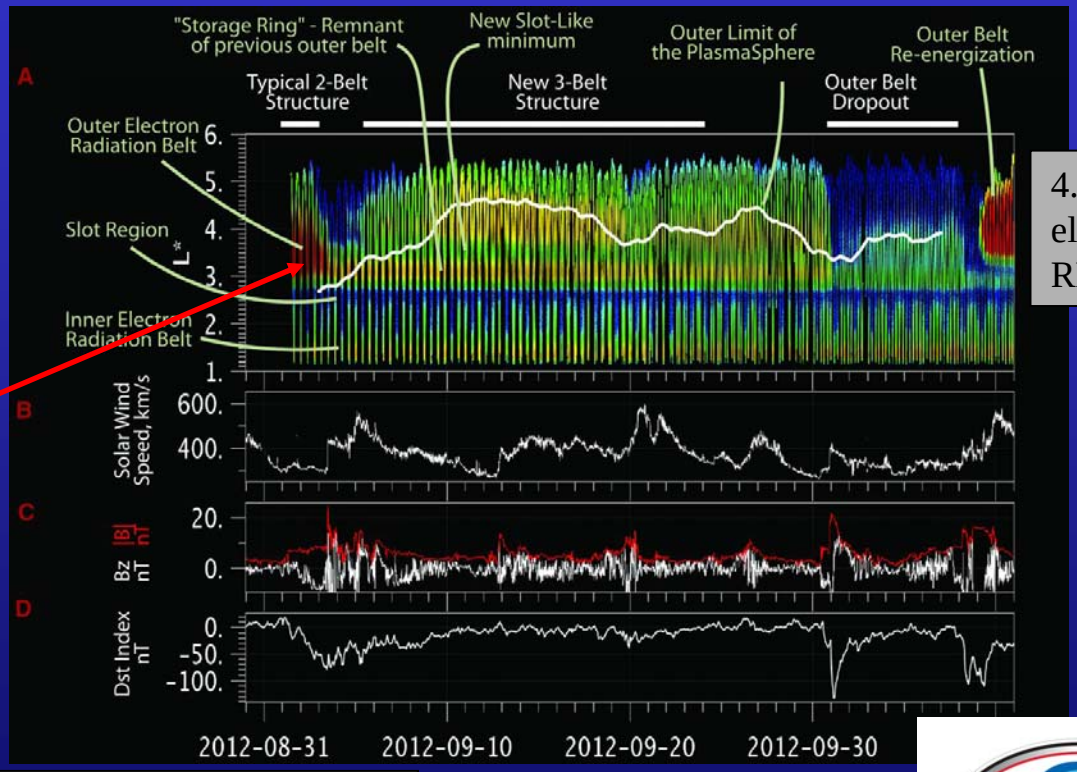
Recent science highlights

The recent observation and subsequent interpretation and modelling of the so-called "Third Radiation Belt" by the Van Allen probes has reminded us of the importance of plasmaspheric dynamics to the waves and particles of the radiation belts.



$4.0 \leq E \leq 5.0$ MeV electrons from REPT

The "third belt" of extremely relativistic electrons existing as a long-lived feature inside the plasmasphere.

From Dan Baker et al. (2013), *Science*, 340(6129), 186–190, doi:10.1126/science.1233518.

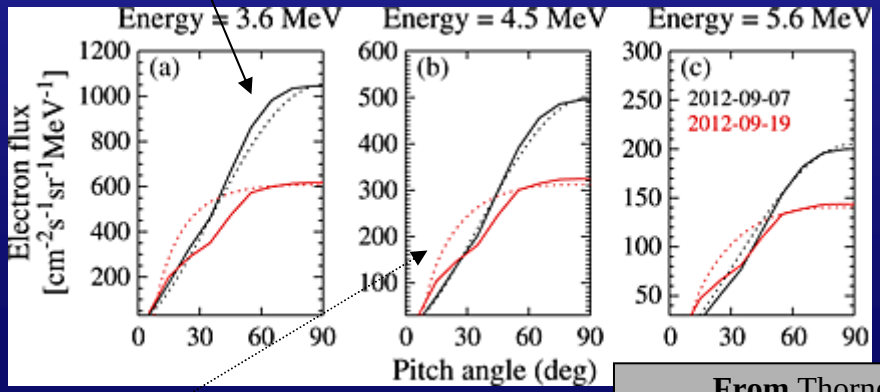
Exploring the Extremes of Space Weather
Van Allen Probes

Recent science highlights

The recent observation and subsequent interpretation and modelling of the so-called "Third Radiation Belt" by the Van Allen probes has reminded us of the importance of plasmaspheric dynamics to the waves and particles of the radiation belts.

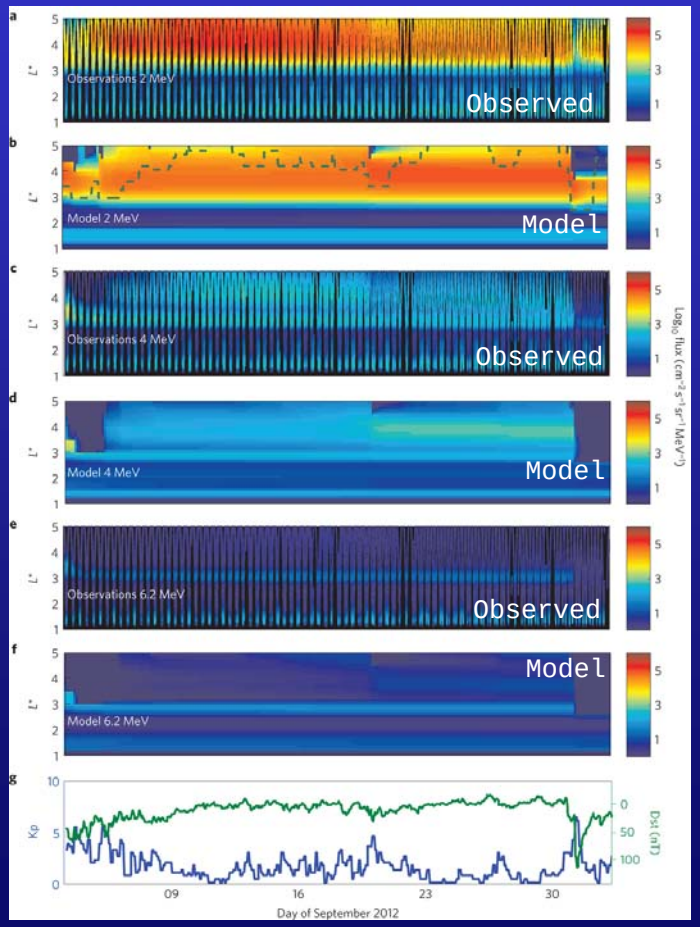
Initially the plasmapause was displaced inwards, and the third belt formed outside the plasmapause. Once the plasmapause moved outside the third belt, it remains with a very low decay rate, as plasmaspheric hiss is not very efficient!

observed (solid)



model (dotted)

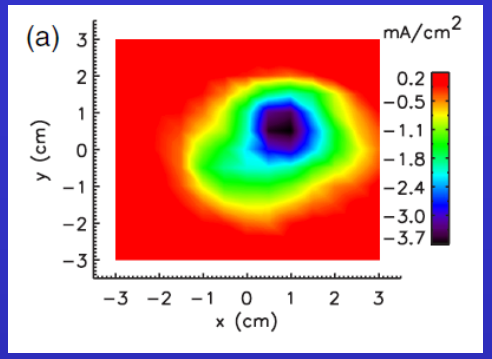
From Thorne et al. (2013), *Geophys. Res. Lett.*, 40, 3507–3511, doi:10.1002/grl.50627.

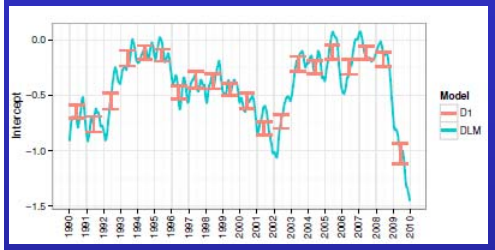


From Yuri Shprits et al. (2013), *Nature Physics*, 9, 699–703, doi:10.1038/nphys2760.

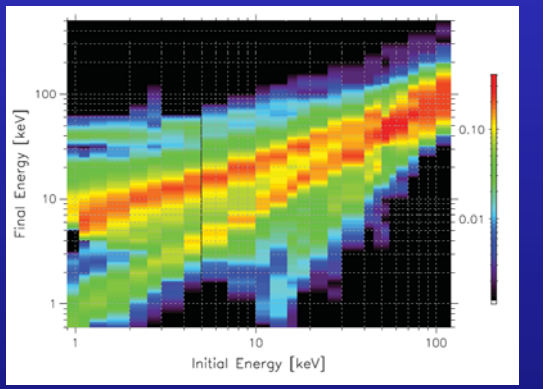
More Recent science highlights

The first direct observation of electron pitch angle scattering by whistler mode waves (used the LAPD laboratory experiment) [Phys. Rev. Lett. 112, 145006 (2014)]

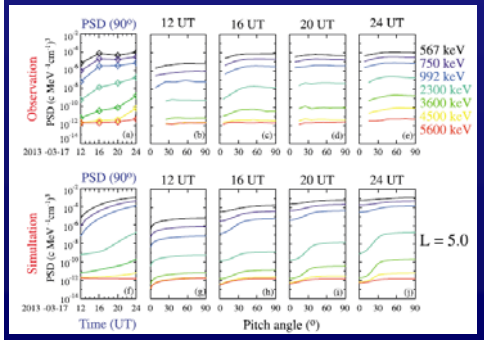




Testing of a dynamic linear model (DLM) against "static" models to forecast radiation belt fluxes [Space Weather, 12, 426–446, doi:10.1002/2014SW001057 (2014)].



A novel way to accelerate electrons from eV to MeV through nonlinear interactions with oblique whistler mode waves [Phys. Rev. Lett. 113, 035001 (2014)]



Quantitatively evaluate chorus-driven electron acceleration with the Van Allen Probes, with simulations showing show remarkable agreement in magnitude, timing, energy dependence, and pitch angle distribution [J. Geophys. Res., 119, 4681–4693, doi:10.1002/2014JA019945 (2014)].

PROGRESS

PRediction Of Geospace Radiation Enviroment and Solar wind parameterS

New EC Horizon 2020 funded project currently at Grant Agreement Preparation phase.

PARTICIPANTS

- U. Sheffield 
- FMI 
- U.Warwick 
- UCLA SkolTech 
- U. Michigan 
- SRI NASU 
- CNRS-LPC2E 
- IRF-L 

AIMS

- Development of a European Solar Wind model
- Models for the evolution of geomagnetic indices
- Statistical Wave models of wave activity
- Development and coupling of systems methodologies with physically based models
- Tools for robust, reliable forecasts for
  - geomagnetic indices
  - particle environment of the inner magnetosphere

SCOSTEP's SPeCIMEN Project Information for 2015

Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN)

2015 Meetings and Workshops

- relevant session "Low frequency wave processes in space plasmas" Quantitative Assessment of Radiation Belt Modeling in the **Plasma Physics in Solar System workshop** in Moscow, Russia (16-20 February 2015)
- relevant focus group "Quantitative Assessment of Radiation Belt Modeling" in the **Geospace Environment Modeling (GEM) workshop** in Snowmass, Colorado, USA (15-19 June 2015)
- multiple sessions at the **26th IUGG General Assembly** in Prague, Czech Republic (22 June - 2 July 2015) ⇐ **formally SPeCIMEN supported**
- **Unsolved problems of magnetospheric physics** workshop in Scarborough, UK (6-11 September 2016)

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From the "Dawn of the Space Age" to Today

Explorer 1 – post launch press briefing (1 Feb. 1958).

The original discovery of the Radiation Belts, right at the start of the Space Age, was an example of research undertaken by international scientists from different background.

SPeCIMEN seeks to create a new international research project under SCOSTEP to produce new understanding and give us predictive power in the inner magnetosphere.

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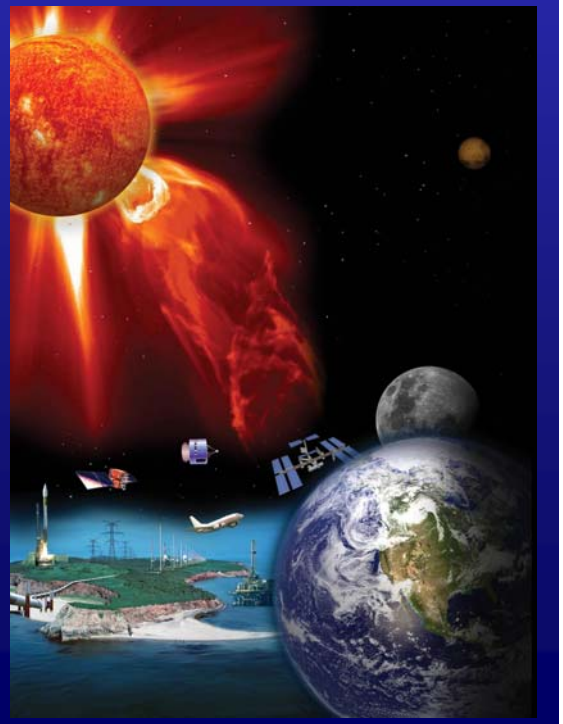
SPeCIMEN - Specification and Prediction of the Coupled Inner-Magnetospheric Environment

Through SPeCIMEN we seek to produce a frame-work where international scientists can work collaboratively on inner magnetospheric physics.

Think about joining us.



SPeCIMEN - Specification and Prediction of the Coupled Inner-Magnetospheric Environment

Jacob Bortnik

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UCLA

Craig J. Rodger

Department of Physics

University of Otago

Dunedin

Thankyou!

Jacob could not join us in Xi'an as he has another important role in life

Jonah Bortnik
born 4 October 2014 at 1103 EST!

Weighing 7 lb, 9 oz (3.4 kg), and measuring 19.5 in (49.5 cm) in length.

Everyone is doing well!