CCMC –Community Resource for Research and Education

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Thanks to CCMC scientists for providing materials and Modelers for talking to me.

Space Physics around 2000

Our research communities were very productive, but with strong disciple boundaries and limited cross disciple interactions!

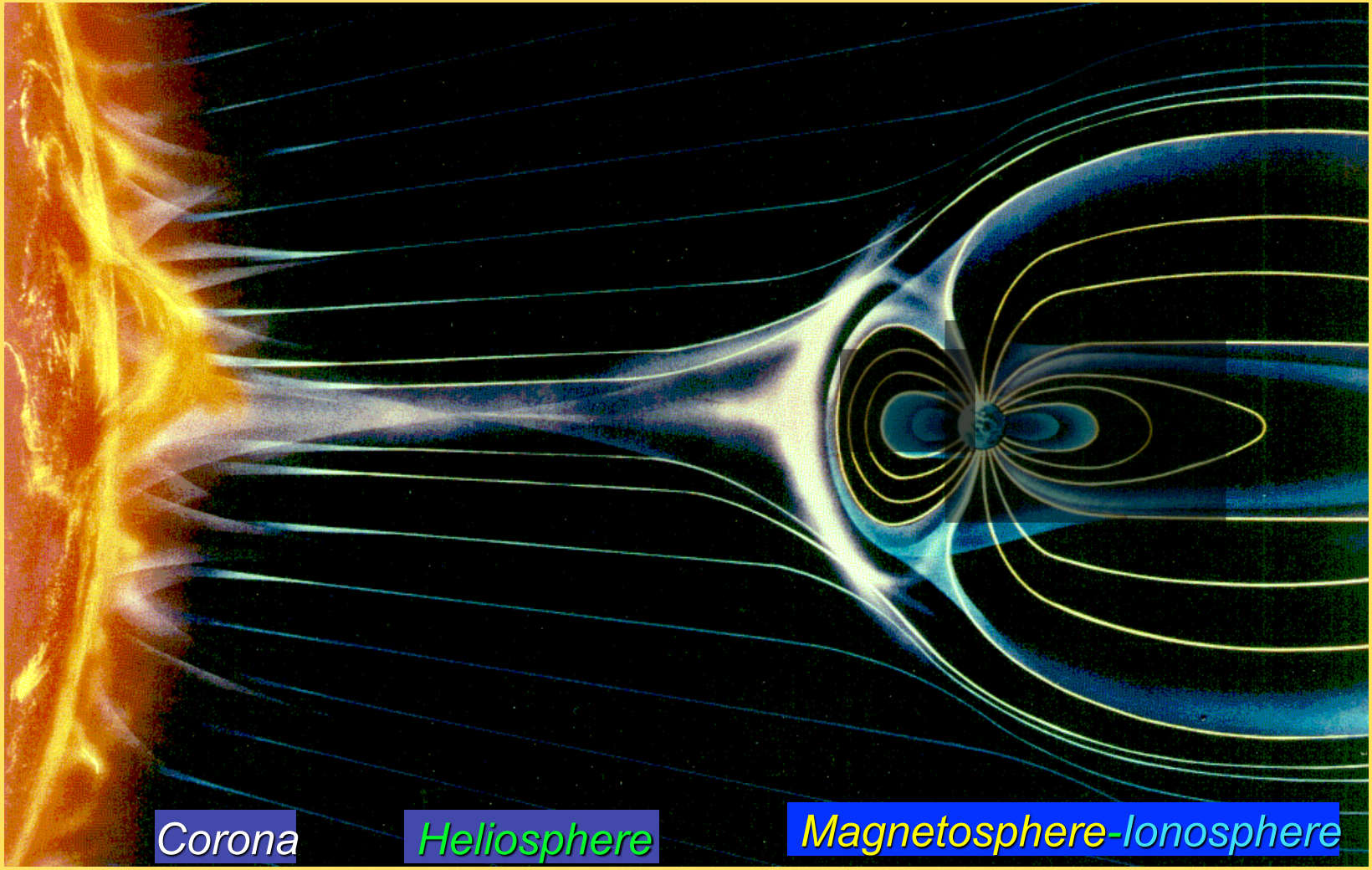
American Geophysical Union (AGU) Space Physics and Aeronomy section (SPA) hosted, and still does, SH, SM, and SA sections.

The National Science Foundation (NSF) supports researcher of SHINE, GEM, and CEDAR sections of space Physics.

BUT changes were occurring for Heliophysics:
1994 the agencies created the National Space Weather Program (NSWP)
2000 NASA created Community Coordinated Modeling Center (CCMC)
2002 NSF created Center for integrated Space weather Modeling (CISM)

These initiatives are programmatically different but are interdisciplary!

CCMC Collection of Models in 2000



from Sun to Earth and beyond

Heliophysics deals with the whole system!

But researchers were still primarily disciple scientists

Each disciple had developed representations of their piece of the heliosphere. Only a very few brave soles have attempted the Sun-to-Mud representation challenge.

A new generation of interdisciplinary scientists have difficulty in combining these representations into a single systems.

Often access to other representations was “impossible”

Also accurate knowledge of the other disciples is limited.

Glossary of terms:
Representation: a dynamic visualization of a physics system, or evolution of a measureable parameter of that system.
Model: a solution to equations, often numerical, and its associated tera-bytes of bits.

How does CCMC contribute to research?

A solar graduate student asks her major prof how much TEC can a Carrington white light flare directed at Earth produce?
Answer: Don't know, go read about it.

A magnetospheric grad student asks his major prof how much extra Hall conductivity will the ionosphere generate if I quadruple the solar wind speed?
Answer: Don't know, go read about it.

Other answers might be build a model!

An effective answer would be use models at the CCMC

Is the CCMC really that knowledgeable?

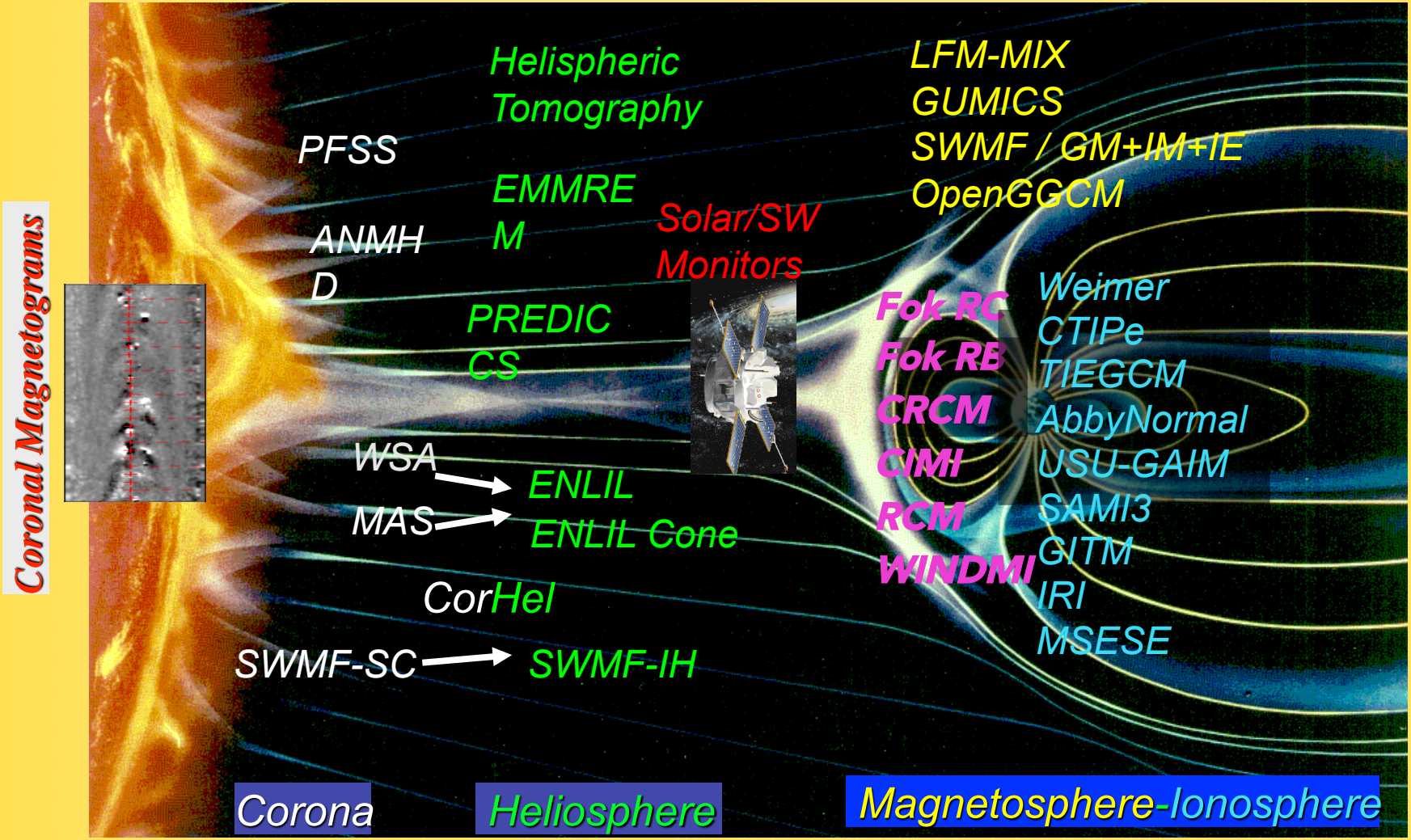
Well no, but in many ways it has the very best reconstructions of man(woman)kinds knowledge of heliophysics.

It also enables scientists to generate and assess heliophysics representations of their own choosing.

These scenarios can be realistic in the space weather sense, or hypothetical in an exoplanet Earth sense.

These representations also provide a glimpse of how imperfect our efforts at reproducing heliophysics are.

CCMC today



> 60, from Sun to Earth and beyond

How is the CCMC research infrastructure created?

These 60 “models” have been created by our individual disciples very best modelers, and whoes research spans several decades.

These “models” are themselves continually evolving.

At CCMC the significant task of creating user friendly wrap-around software provides the key to converting a “model” into a heliophysics “representation”.

In addition CCMC has the resources to enable these models to generate the tera-bytes of bits.

But none the less it must remain an active partnership between modelers and CCMC.

Examples of these Models and Researchers

Solar-CORHEL/ENLIL	Jon & Dusan
Magnetosphere plus-SWMF/BATSRUS	Tamas
Magnetosphere-OpenGGCM	Jimmy
Ionosphere Thermosphere-CTIPe	Tim
Ionosphere-GAIM-DA	Bob & Ludger

Even with just first names you have visualized the researchers!

But from the model name
Do you have more than a qualitative vision of that model?

I talked to them asking about their experiences.

Overall these modelers had favorable feedback, but also justified concerns:

Several mentioned that they realized that they were creating their own competition, since other scientists were now writing proposals using their models.

Similarly as their models improved resources were not always available to transition them to CCMC.

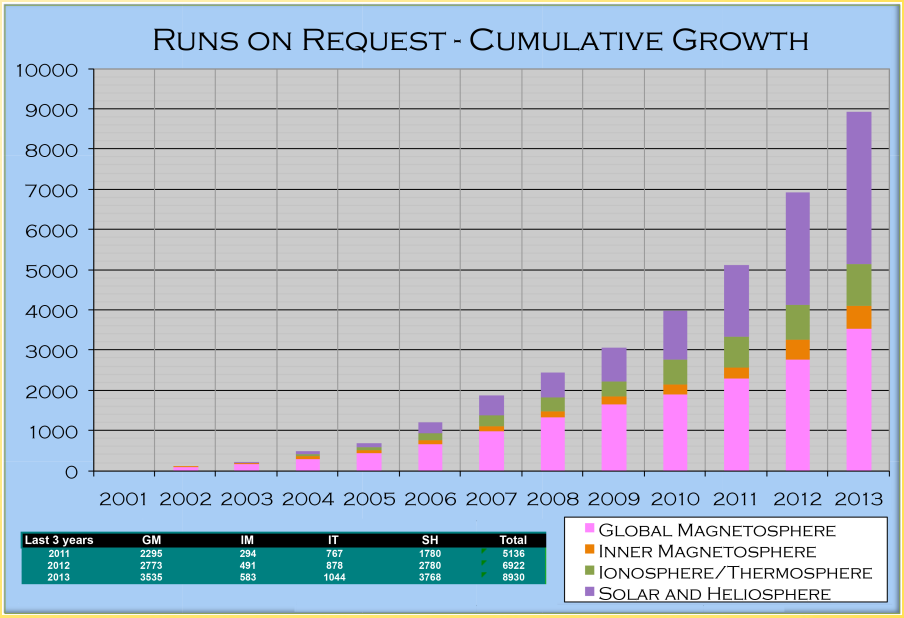
Examples of scientists contacting them after using their model either produced useful failure modes, or new collaborative science topics.

Everyone was very satisfied with the work done by CCMC, as well as their own interaction with CCMC.

And what about the CCMC

If I specified how many CPUs and 10^n th bits of storage CCMC has I would already be short, the CCMC is a dynamic structure that has continually grown to meet demand.

The Demand is quantifiable



Last 3 years	GM	IM	IT	SH	Total
2011	2295	294	767	1780	5136
2012	2773	491	878	2780	6922
2013	3535	583	1044	3768	8930

The CCMC is itself an inspiring interdisciplinary project developed by scientist.

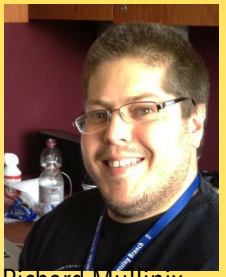
CCMC staff and affiliates


Sarabjit Bakshi


Anna Chulaki


Michael Hesse


Leila Mays


Richard Mullinix


Masha Kuznetsova


Marlo Maddox


Peter Macneice

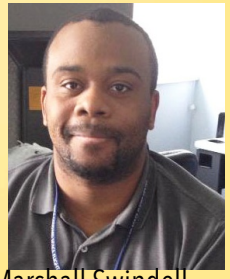

Michelle Mendoza


Kiran Patel


Antti Pulkkinen


Lutz Rastaetter


Ja Soon Shim

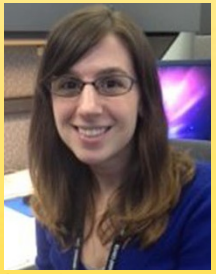

Marshall Swindell


Aleksandre Taktakishvili

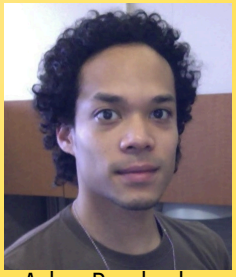

Chiu Wiegand


Yihua Zheng

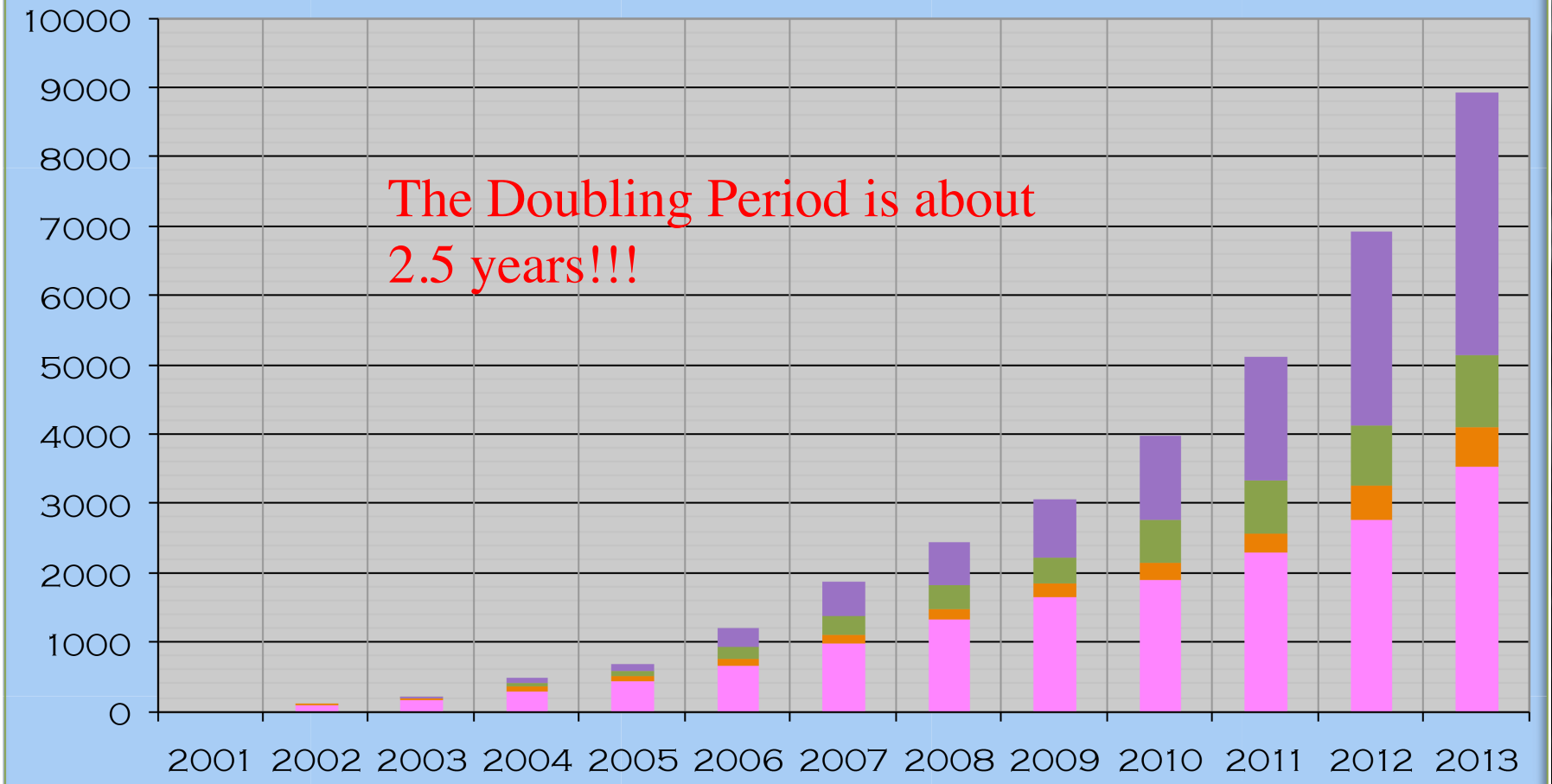
Postdocs:


Rebekah Evans


Chigomezyo Ngwira


Asher Pembroke

Runs on Request - Cumulative Growth



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9000 RUNS TOTAL

Research Access for the CCMC User

Anyone can be a user, the present day user e-mail list is evidence of this.

The start-up investment is negligible:

1) User interface to CCMC is a common standard.
2) The user using science vocabulary readily finds the required menu page with descriptive documentation.
3) The tutorials are kept current with the available representations.
4) Prior executions of representations are all available, and readily accessed.
5) Software tools are phenomenal (personal experience).
6) Help is always available.
7) Jan Sojka has done it, anyone should be able to.

CCMC as a Heliophysics Educational Resource

From earlier remarks Heliophysics is truly interdisciplinary over disciplines that are still highly focused on their own science. Hence CCMC has an opportunity to provide the first level of interdisciplinary, ie., Solar storm propagation from Sum-to-Mud.

The student body is diverse, needing tailored products

K-12
Undergraduate students
Graduate students – Post Docs
Professionals " space weather operators" policy makers
Educated public

Defining the CCMC Tailored Products

Consider the Graduate Student case.
The student knowledge is excellent within his/her disciple.

BUT!
Very few Universities can deliver an in depth graduate core curriculum in heliophysics.

(*I received my crash course in advanced plasma physics in a three week summer school held at Culham, England before becoming an ionospheric Physicist.*)

Hence one solution to resolve this educational problem is the creation of summer schools.
Then the question is how does CCMC contribute!

What is CCMC unique contributions to Graduate student Summer schools

Heliophysics is not like solving "Maxwells Equations" for a specific problem (ie., overcoming a Jackson problem).

Rather the beauty of heliophysics is that the representations evolve across regions where the boundary conditions (*often observations*) as well as the appropriate use of the equations (*assumptions*) are changing.

Hence the immediate role of CCMC is to provide students access to the dynamics and evolution of heliophysics.

CCMC is the **second** Heliophysics environment, a laboratory.

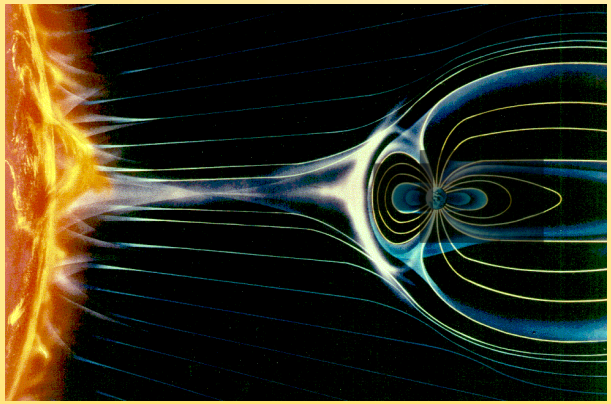
The CCMC Heliophysics Laboratory at Work

The NASA Living With a Star (LWS) program sponsors the Heliophysics Summer School (HSS) which is in its 8th year.

The summer school has an annual theme, this year a contrast between our heliosphere, including planets and Astrospheres including their exoplanets.

Other magnetospheres

Other stars



Other atmospheres and ionospheres

Other planets

Other solar winds

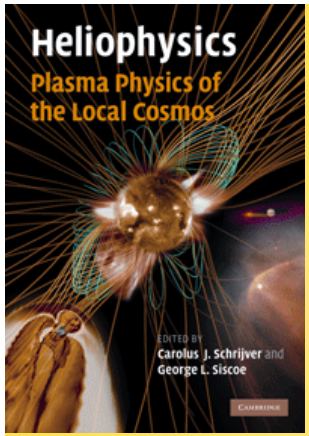
Structure of HSS Meeting

Year	Days	Lectures	Laboratories	Discussion/Homework
2007	8	20	8	8
2008	7	15	9	4
2009	7	15	4	9
2010	7	14	5	5
2011	7	13	5	6

Typical lecture is 1.5 hours.

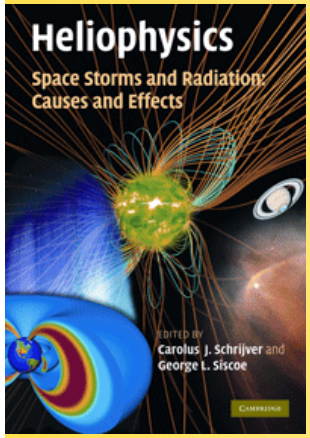
Typical laboratory is 2 hours.

Typical discussion/homework is 1.5 hours.



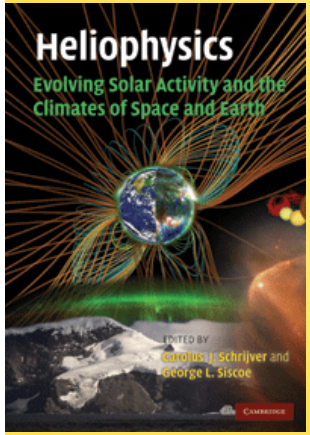
Book 1

Heliophysics: Plasma Physics of the Local Cosmos



Book 2

Heliophysics: Space Storms and Radiation Causes and Effects



Book 3

Heliophysics: Evolving Solar Activity and the Climates of Space and Earth

Heliophysics Text Books

Solar-Heliosphere

Magnetosphere

Ionosphere-Thermosphere

Expert lecturers from our disciplines

Advanced level space physics

The CCMC Student Laboratory

Maria Kuznetsova (Masha) and her CCMC team has provided modeling support to all seven HSS.

As the capability of CCMC to support student learning evolved a number of joint CCMC-HSS developments took place. These have generated a CCMC product that can provide the heliophysics community both educational and research access via "PRIMERS" to CCMC models.

In addition the user interfaces have been continually improved making the CCMC models more accessible for educational use.

Runs on-demand enable workshop students to set-up their own simulations to address summer school questions.

Additional features like the real-time iSWA product is very valuable.

Laboratory Examples

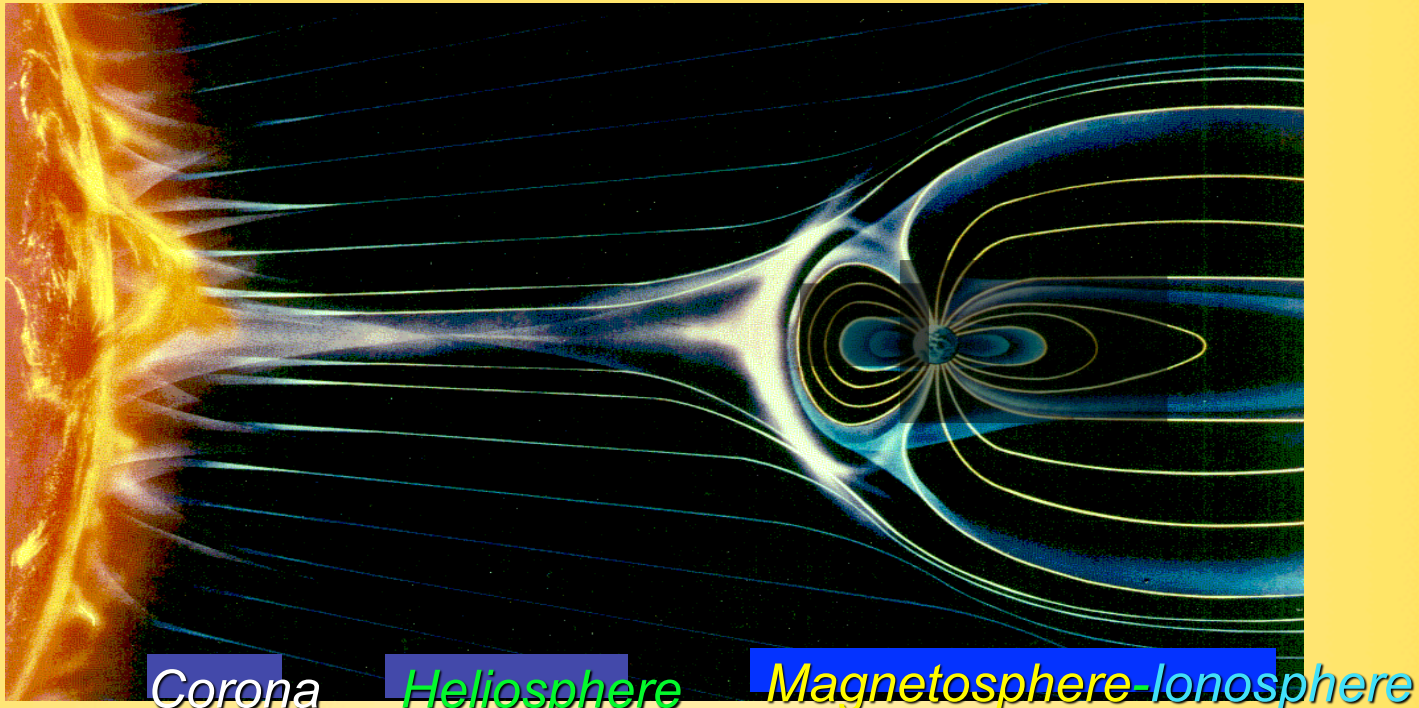
Space Weather Scenarios

1) The quiescent heliosphere
2) A specific solar storm propagating through the heliosphere
3) Reponses of the magnetosphere and ionosphere to the storm

What if Laboratory Representations

1) Move the Earth, closer or further away
2) Increase and decrease the Earths dipole moment
3) What happened when the Earths dipole North pole is located at 40 degrees geographic latitude
4) Planets have different atmospheres and magnetic fields.

Closing Remarks



CCMC provides the second representation of Heliophysics and is a very accessible Labortory for research and education.

The heliophysics research and education communities need both CCMC and the Disciple Model Developers (DMD) to be an on-going resource.

Thank You

Date of HSS	Overarching Theme
1. July 30 - Aug. 7, 2007	Plasma Physics of the Local Cosmos
2. July 23 - 30, 2008	Space Storms and Radiation: Causes and Effects
3. July 22 - 29, 2009	Evolving Solar Activity and the Climates of Space and Earth
4. July 28 - Aug. 4, 2010	Space Storms
5. July 27 - Aug. 3, 2011	Long-Term Solar Activity and the Climates of Space and Earth
6. May 31 - June 7, 2012	Heliophysics Exploration

Participants at HSS

Year	Teachers	Students (Total)	Students (International)
2007	21	38	16
2008	15	30	13
2009	13	29	14
2010	17	35	14
2011	12	33	14
Totals:	78	165	71
Average:	15ish	33	14ish (42%)
Repeats:	~30%	≤5%	