

## From MPE2013 to MPE

“Mathematics of Planet Earth 2013” (MPE2013)---the year-long program created to encourage research on a range of topics related to Planet Earth---has been active for almost a year and will transition into “Mathematics of Planet Earth” (MPE) at the end of 2013. What has been accomplished and what are the plans for MPE?

MPE2013 was conceived to stimulate the mathematics research community to identify fundamental research questions about Planet Earth and to reach out to the general public to highlight the role of mathematics in global studies of the Earth. It has grown into an international effort, received the patronage of UNESCO, and involved more than 140 partners, including professional societies, academic institutions, research institutes, and teacher organisations. The distinctive MPE2013 logo has been featured at many conferences, workshops, and lectures, and MPE2013 has found its way among the public, the media, and schools worldwide.

Beginning in 2014, the program will continue as “Mathematics of Planet Earth” (MPE), with the same objectives, namely identify fundamental research questions about Planet Earth and reach out to the general public. As Christiane Rousseau, principal coordinator of MPE2013, observed, “MPE2013 has been a great start. But identifying the research problems is not enough. Mathematics moves slowly, the planetary problems are very challenging, and we start realizing how much remains to be done.”

### **MPE2013 (<http://mpe2013.org>)**

MPE2013 activities have included more than 15 long-term programs at mathematical research institutes all over the world, 60 workshops, dozens of special sessions at society meetings, two major public lecture series, summer and winter schools for graduate students, research experiences for undergraduates, an international competition, and an [Open Source MPE Exhibition](#). In addition, MPE2013 has supported the development of high-quality curriculum materials for all ages and grades available on the MPE2013 Web site.

### **Encouraging Research**

The scientific activities of MPE2013 were directed both to the mathematical sciences community, whose members are encouraged to identify fundamental research questions about Planet Earth and their potential collaborators in other disciplines. The program provides evidence that many issues related to weather, climate, sustainability, public health, natural hazards, and financial and social systems lead to interesting mathematical problems. Several summer and winter schools have offered training opportunities for junior researchers in these areas.

### **Reaching Out**

The outreach activities of MPE2013 were nearly as important as the scientific activities. More than sixty public lectures have been given with audience on all five continents. Particularly noteworthy were the MPE Simons Public Lectures, now posted on the MPE2013 Web site, which were supported financially by the Simons Foundation. MPE2013 has maintained a speakers bureau, supported the development of curriculum materials, maintained a collection of posters, and produced special issues of mathematical magazines and other educational materials. Many activities took place at schools in several countries. The permanent MPE Open Source Exhibition is now hosted on the website of IMAGINARY and can be used and adapted by schools and museums.

### **Daily Blog**

The dual mission of MPE2013---stimulating the mathematics research community and reaching out to the general public---is reflected in the Daily Blogs (one in English, the other in French), each of which has featured more than 250 posts on topics ranging from astronomy to uncertainty quantification. The blog gets several hundred hits a day.

### **Why has the MPE2103 movement been so popular?**

According to Brian Conrey, MPE coordinator in the United States, "The level of effort and cooperation demonstrated by MPE2013 is unprecedented in the community of mathematical scientists. Undoubtedly, one of the reasons is the increased awareness among the general public, shared by the mathematical and scientific communities, that our planet is in trouble. For too long, we have conducted an uncontrolled experiment, using natural resources as if they were infinite. The scientific community agrees that it is time to get a better understanding of our place and role within the Earth system, and mathematics has something to contribute to the discussion, whether on the subject of resource management, climate change, risk assessment, or any of the other issues related to Planet Earth."

MPE2013 has drawn the attention of other disciplines as well. Among its partners are the American Geophysical Union, the International Association for Mathematical Geosciences, and the International Union of Geodesy and Geophysics. The research on planetary issues is interdisciplinary, and collaboration and networking are essential for progress.

MPE2013 has presented the public, the schools and the media with challenging applications of mathematics, with significant answers to questions like "What is mathematics useful for?" and "Hasn't everything been discovered in mathematics?" According to Ferdinando Arzarello, President of the International Commission of Mathematical Instruction (ICMI):

MPE2013 wonderfully contributes to diffuse an informed culture of environment and helps to get a common mathematical toolkit necessary to deal the dramatic challenges faced today by our planet. According to Mary Lou Zeeman, MPE coordinator for Education, "The curriculum material developed for MPE2013 provides a wealth of material for schools and educators and will be used for many years to come."

### **MPE (<http://mathofplanetearth.org>)**

On January 1, 2014, MPE2013 will continue as "Mathematics of Planet Earth" (MPE). The objectives remain unchanged---identify fundamental research questions about Planet Earth and reach out to the general public. With support from the U.S. National Science Foundation, MPE will maintain a website where additional educational and outreach materials will be posted. New modules will be developed and added to the MPE Exhibition. Plans for more MPE activities exist in several countries in the form of workshops, summer schools, and even the creation of new graduate programs in Mathematics of Planet Earth.

## Appendix

### Some highlights from MPE2013 and future plans for MPE

#### Plans in the US

Funds are available to support “early career” participants from the United States (graduate student, postdoctoral and new faculty) to attend this workshop and to participate in follow-up activities. Non-U.S. applicants are not eligible for MPE 2013+ travel funds, but are encouraged to apply for acceptance to attend.

The Mathematics of Planet Earth 2013-Plus ([MPE 2013+](#)) program was initiated to build on the momentum of Mathematics of Planet Earth 2013 (MPE 2013) to propel it beyond the year 2013. MPE 2013+ aims to involve scientists in laying the groundwork for a long-term effort to surmount the sustainability problems facing our planet. Its goal is workforce development, preparing a new generation of mathematical scientists, exposed to and prepared to work in the new multidisciplinary environment of science in the future, as reflected by but by no means limited to the problems explored in MPE2013+. MPE 2013+ activities will be organized around six clusters of topic: management of natural resources, sustainable human environments, natural disasters, data-aware energy use, global change, and education for planet earth of tomorrow. The overall kickoff workshop for MPE2013+, “[Mathematics of Planet Earth: Challenges and Opportunities](#)” will take place at Arizona State University on January 7-10, 2014.

It aims to expose students and junior researchers to the challenges facing our planet, the role of the mathematical sciences in addressing those challenges, and the opportunities to get involved in the effort. There will be an introduction to the six major themes of MPE 2013+: global change, natural disasters, sustainable human environments, data-aware energy use, management of natural resources, and education for the planet earth of tomorrow. Each cluster will then have a kickoff workshop held in 2014 or 2015. Follow-up activities will include focused research workshops, small group meetings, collaborative programs, educational efforts, etc., each organized by one of the six cluster organizing committees. MPE2013+ is sponsored by the U.S. National Science Foundation and the kickoff workshops will be held in the U.S., but non-U.S. partners for cluster activities are invited to join and some of these activities are already scheduled for outside the U.S. For more information see [MPE2013+ program](#) or contact Dr. Eugene Fiorini at [mpe2013p@dimacs.rutgers.edu](mailto:mpe2013p@dimacs.rutgers.edu).

#### MPE in Canada

The pan-Canadian year in epidemiology, ecology and public health has been very successful in networking the community and started a tradition of yearly summer school for young researchers. There is a project of a second pan-Canadian year for 2017. MPE was also the kernel of the high profile Climate Change Seminar at the Fields Institute, which has been initiated by Ron Denbo. The workshops in celestial mechanics have given a real push to the subject. There have been MPE workshops all over the country: AARMS, BIRS, CRM, Fields, PIMS, as well as several summer schools. CRM organized a long program on biodiversity and evolution, and the Fields Institute organized one on the mathematics of the oceans. The Canadian Mathematical Society organized a series of MPE public lectures in all regions of the countries. Special MPE issues of the magazines *Accromath* and *Pi in the Sky* were produced and the first MPE issue of *Accromath* was even distributed in 14 francophone African countries. Several teachers associations held their annual congress on the theme.

**MPE in Portugal until June 2014:** see [www.mpt2013.pt](http://www.mpt2013.pt)

MPE2013 in Portugal has been a great success due to a major interest from the media and to a huge involvement from several institutions and the population. The interdisciplinary activities were really prepared in collaboration. An impressive number of finds in the media are collected at [Media coverage in Portugal](#)

Past activities include scientific conferences and workshops, several initiatives for schools and general public, a [session](#) in collaboration with the Real Academia de Ciencias de Madrid, an afternoon special [session](#) at the Academia de Ciências de Lisboa, and [several exhibitions](#). In particular, [three modules of the MPE2013 competition](#), including the winning "The Sphere of the Earth", have been exhibited permanently at the National Museum of Natural History and Science of the University of Lisbon.

On Sunday, November 3rd, there was a solar eclipse visible as total in the island of Príncipe (a former Portuguese colony). This is a very fortunate coincidence, because it has happened at the same place as the total solar eclipse of May 29, 1919, photographed by the expedition of Arthur Eddington, and used to test Einstein's general theory of Relativity. The Portuguese MPE2013 and several institutions, in cooperation with astronomers and physicists, prepared a series of events, both in Portugal and in Príncipe, under the name "ECLIPSE2013 -Science and History in Príncipe Island". The success of ECLIPSE2013 is due mainly to the fact that we could count with the partnership of the former committees of both International Year of Astronomy 2009 and International Year of Physics 2005. Activities of [ECLIPSE2013](#).

MPE2013 in Portugal will officially continue till June 2014 with activities linking MPE2013 with the International Year of Crystallography 2014.

Portuguese MPE2013 official website: [www.mpt2013.pt/eclipse-2013.html](http://www.mpt2013.pt/eclipse-2013.html).

## **MPE in Australia**

Mathematics of Planet Earth 2013 has been the largest sustained mathematical theme program in Australia to date. The Australian Mathematical Science Institute coordinated Australian participation in the year with 18 partner organisations.

### *Highlights from the year.*

- A [dedicated website](#) which has had over 65,000 visits from 150 countries to date.
- Hosting the first Simons Foundation MPE Public Lecture with 400 attendees
- 17 [MPE scientific events](#) funded with 3235 attendees
- 2000+ people engaged through [social media](#)
- An international MPE Australia conference in Melbourne in July
- 150 entries to mathematics and statistics themed [photography competitions](#)
- 2500 subscribers to the MPE Australia Monthly newsletter
- 332 MPE blog posts from 48 contributors
- 1000+ students participated in MPE Pi Day

*Beyond 2013.* MPE Australia will be used as a model for national programs to be delivered by the planned National Mathematical Sciences Research Centre. A MPE partnership network has been established between Australian government agencies and universities. Young agency staff will

engage with university students and academics to increase awareness of the work they do across the maths of planet earth spectrum.

### **MPE in India**

“Explore and Exhibit” was an Intercollegiate All-India Exhibition Competition for MPE exhibit modules. It generated a lot of enthusiasm and awareness around the country. The jury will decide the winners soon. The International Centre for Theoretical Sciences (ICTS) and Center for Applicable Mathematics (CAM) of Tata Institute of Fundamental Research (TIFR) are now preparing an MPE exhibition (based on four major themes: Waves, Networks, Optimization, Structures) to be held at Visvesvaraya Industrial & Technological Museum, Bangalore of National Council of Science Museums (NCSM), between November 22 and Dec 1 2013 (see also [MPE Exhibition networks, optimization and waves](#)). During the exhibition, there will be various outreach activities for school students and teachers like open quiz, hands on astronomy based activities (since Comet ISON is a large Sun-grazing comet whose perihelion will occur on November 29, 2013 exactly during the exhibition dates), Comet ISON poster exhibition, Mathematics workshops, demonstration of Mathematical models, puzzles etc. We have already held two workshops on MPE, which have generated a lot of enthusiasm amongst college students and school teachers. ICTS is also in talks with the National Council of Science Museums in India to explore if this exhibition can travel around India during the coming year(s) to some of the museums in their network. We will aim to add some of the Indian modules to the permanent Open Source MPE exhibition.

### **MPE at CANP in Tanzania**

An important MPE component will be integrated to the fourth Capacity and Network Project (CANP) organized by the International Commission of Mathematical Instruction (ICMI) in Tanzania on September 1-12, 2014 in Dar es Salaam, Tanzania. CANP 4 aims to build capacity in mathematics education and create a sustainable regional network with a common goal of improving mathematics education. It is anticipated that more than 50 participants from Tanzania, Kenya, Uganda and Rwanda will attend the two-week program to be held at the Aga Khan University Institute for Educational Development East Africa, in Dar es Salaam Tanzania. Participants will mostly be mathematics teachers, teacher educators and curriculum developers with some representation from the international mathematics education community.

Capacity development in mathematics will be around three integrated themes: a) Mathematics for Planet Earth; b) ICT in mathematics education; c) Language and culture in mathematics.

Program include a variety of highly relevant activities including public lecture(s) demonstrating mathematical modeling on real life issues related to mathematics for planet Earth; keynote address(es) on significant aspects of mathematics education in the region; teacher development workshops on mathematics topics drawn from the regional high school curriculum; media engagement sessions; and opportunities for the wider community to participate in mathematical activities.