

## **Proposal for an IUSS Working Group: International Soil Modeling (WG ISM)**

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### **1. Motivation**

Soil is one of the most critical life-supporting compartments of the biosphere. Soil provides numerous ecosystem services such as a habitat for biodiversity, water and nutrients, as well as producing food, feed, fiber and fuel. To feed the rapidly growing world population in 2050, agricultural food production must be doubled using the same land resources footprint. At the same time, soil resources are threatened due to non-sustainable soil management practices. Soils are not only essential for establishing a sustainable bio-economy, but also play a key role in a broad range of societal challenges including 1) climate change mitigation and adaptation, 2) land use change, 3) water resource protection, 4) biotechnology for human health, 5) biodiversity and ecological sustainability, and 6) soil degradation, including by soil erosion, contamination, and combating desertification. Soils regulate and support water, mass and energy fluxes between the land surface, the vegetation, the atmosphere, and the deep subsurface, and the soil controls storage and release of organic matter thereby affecting climate regulation and biogeochemical cycles. Despite these vital important functions of soil, many fundamental knowledge gaps remain, hindering our ability to manage and improve soil quality and conditions, leading to higher function. Some of these gaps include the role of soil biota and biodiversity on ecosystem services, the structure and dynamics of soil communities, the interplay between hydrologic and biotic processes, the quantification of soil biogeochemical processes and soil structural processes, the resilience and recovery of soils from stress, as well as the prediction of soil development and the evolution of soils in the landscape, to name a few.

Soil models have long played an important role in quantifying and predicting soil processes and related ecosystem services. However, as our data collection from sensors to satellites continues to evolve and expand, we realize that the existing suite of models is not integrated sufficiently to assimilate the ever-increasing additional data and information. Consequently, we suggest that the status of current soil models is limiting our science progression and their broad application across disciplines and by decision makers. For that, a new generation of soil models is required, based on a whole systems approach comprising of all most relevant physical, mechanical, chemical and biological processes, is needed to. These models will fill critical knowledge gaps and thus contribute to the preservation of ecosystem services, improve our understanding of climate-change–feedback processes, bridge basic soil science research and management, and facilitate the communication between science and society.

## **2. International Soil Modeling Consortium**

Already, the International Soil Modeling Consortium (ISMC) is established with the main goal to be a focal point of soil modeling and data integration and benchmarking, and to collaborate with other related scientific disciplines and organizations that are likely to benefit from the defined systems-level modeling approach. The ISMC will be a platform for advancing soil modelling activities. It aims at improving scientific exchanges between the different soil modelling disciplines and to better the interaction with modelling communities in the Earth Sciences community. Key activities of the ISMC will include the development of inter-comparison platforms for soil model performance and providing data access for model development, validation and model application purposes. ISMC will enhance the integration of soil modelling expertise and state-of-the-art knowledge on soil processes in climate (IPCC-Modelling-IAMC), land surface (e.g., CLM, LPJ, and others), ecological, crop (e.g., AGMIP) and contaminant transport models. The ISMC will foster activities that link process models with new observation, measurement and data evaluation technologies to map and characterize soil properties across scales. Membership of the ISMC is currently at around 30, with expertises represented from a wide range of soil science disciplines.

## **3. Objectives of the IUSS Working Group on International Soil Modelling (ISM)**

To meet the challenges defined in (2), an international community effort is being proposed and patterned after similar initiatives in systems biology, hydrology, and climate and crop research. The IUSS Working Group (WG) in ISM should support and be the hub of this community effort by guiding and supporting the establishment of the ISMC and making it internationally visible.

A first workshop is already planned in Austin, Texas in 2016. This workshop is the first step in defining the concept and operation of the ISMC. During that workshop, we will: 1) bring together leading experts in modelling soil processes across disciplines, organizations and institutions; 2) address major scientific gaps in describing key processes and their long term impacts with respect to the different functions and ecosystem services provided by soil; and 3) identify interactions with other relevant platforms and scientific communities. The following topics will be addressed at the first meeting:

- Soil processes and climate models,
- Quantifying and predicting soil ecosystem services,
- Dealing with heterogeneity and uncertainty: from aggregate to landscape,
- Soil biodiversity, biology and biophysics across scales,
- Modelling hydrological and biogeochemical processes across scales,
- Soil mapping, sensing and soil modelling across scales

During and after the Austin workshop, the IUSS WG in ISM will further develop the following operational parameters of the ISMC:

- The development of the organizational structure and governance of ISMC,
- Formulation of its mission,
- The establishment of a model intercomparison and modeling platform,
- The establishment of a data platform, and
- Develop the outreach and connections to other communities, including a website.

Regarding the organizational and governance aspects of ISMC, the IUSS WG will develop a governance structure for the ISMC. Reviewing various existing consortia, we will analyze three possible structures: the Global Energy and Water Exchanges experiment, GEWEX (<http://www.gewex.org/>), the Agricultural Model Intercomparison and Improvement Project, AGMIP (<http://www.agmip.org/>), and the Integrated Assessment Modelling consortium, IAMC (<http://www.globalchange.umd.edu/iamc/>). Other organizational structures, however, may be explored, so that our WG establishes the most effective governance structure that serves the needs of the soil science modelling community.

The WG should be instrumental and promote the development of a model inter-comparison activity supported by a modeling and data platform for model development, calibration and validation. The WG should develop a road map on how to establish the inter-comparison activities and platforms, elaborate on the scientific justification, the scope of activities and actively involve the soil science modelling community in this effort.

The WG should establish links and contacts with other professional societies including national soil science societies, the EGU-SS soil science division, the AGU-SSCZP TC (Soil Systems and Critical Zone Processes Technical Committee), and the GSA-Soil Processes committee, amongst others. In addition, the WG should also explore deepening collaborations with other organizations outside soil sciences, such as the Water Climate Research Programme (WCRP) through GEWEX, FAO, the International Association for Landscape Ecology, and others. The IUSS WG will be the leading body for organizing international conferences such as Chapman or Gordon conferences, thus moving forward the field of soil modelling and strengthening the interaction and exchange with the Earth Science community as a whole.

In addition, the IUSS WG will develop and host the ISMC website. A first preliminary version has been developed and is now online (<https://www.soil-modeling.org/>). At present, its main purpose is to facilitate the communication amongst scientists interested in ISMC and to complete a first in a series of white papers on 'Challenges and Perspectives in Modelling Soil Processes.' The website will also host model inter-comparison activities, the modeling and data platforms, once developed.

### **Proposed Chair and Co-Chairs of the IUSS WG “international Soil Modelling”**

Chair: H. Vereecken

Co-Chairs: D. Or, M. Young, and J.W. Hopmans