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# Complex Soil Systems

2014

## A Path to Improved Understanding of Complex Soil Systems

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**Abstracts**

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## On the Need to Establish an International Soil Modeling Consortium

H. Vereecken<sup>1,37</sup>, J. Vanderborght<sup>1,37</sup>, A. Schnepf<sup>1,37</sup>, N. Brüggemann<sup>1</sup>, W. Amelung<sup>1</sup>, M. Herbst<sup>1</sup>, M. Javaux<sup>1,2</sup>, S.E.A.T.M. Van der Zee<sup>3</sup>, D. Or<sup>4</sup>, J. Šimunek<sup>5</sup>, M.Th. van Genuchten<sup>6</sup>, J.A. Vrugt<sup>7a,b,c</sup>, J.W. Hopmans<sup>8</sup>, M. Young<sup>9</sup>, P. Baveye<sup>10</sup>, Y. Pachepsky<sup>11</sup>, M. Vanclooster<sup>12</sup>, P.D. Hallett<sup>13</sup>, A. Tiktak<sup>14</sup>, D. Jacques<sup>15</sup>, T. Vogel<sup>16</sup>, N. Jarvis<sup>17</sup>, P. Finke<sup>18</sup>, J.J. Jiménez<sup>19</sup>, P. Garnier<sup>20</sup>, C. Li<sup>21</sup>, J. Ogee<sup>22</sup>, A. Mollier<sup>22</sup>, F. Lafolie<sup>23</sup>, I. Cousin<sup>24</sup>, V. Pot<sup>25</sup>, P.A. Maron<sup>26</sup>, T. Roose<sup>27</sup>, D.H. Wall<sup>28</sup>, A. Schwen<sup>29</sup>, C. Doussan<sup>30</sup>, H.J. Vogel<sup>31</sup>, G. Govers<sup>32</sup>, W. Durner<sup>33</sup>, E. Priesack<sup>34</sup>, K. Roth<sup>35</sup>, R. Horn<sup>36</sup>, S. Kollet<sup>37,1</sup>, A. Rinaldo<sup>38</sup>, A. Whitmore<sup>39</sup>, K. Goulding<sup>39</sup>, and W.J. Parton<sup>40</sup>

<sup>1</sup>Agrosphere Institute, IBG-3, Institute of Bio-geosciences, Forschungszentrum Jülich GmbH, Jülich, Germany; <sup>2</sup>Earth and Life Institute-Environmental Sciences, Université catholique de Louvain, Croix du Sud, 2, Belgium; <sup>3</sup>Department Soil Physics and Land Management, Environmental Sciences Group, Wageningen University, Wageningen, The Netherlands; <sup>4</sup>Soil and Terrestrial Environmental Physics, ETH-Zürich, Zürich, Switzerland; <sup>5</sup>Department of Environmental Sciences, University of California Riverside, Riverside, CA; <sup>6</sup>Department of Mechanical Engineering, Federal University of Rio de Janeiro, Brazil and Department of Earth Sciences, Utrecht University, The Netherlands; <sup>7</sup>(a,b,c,a) Department of Civil and Environmental Engineering, University of California, Irvine, California, USA., (b) Department of Earth System Science, University of California, Irvine, California, USA., (c) Institute for Biodiversity and Ecosystem dynamics, University of Amsterdam, The Netherlands; <sup>8</sup>Department of Land, Air, and Water Resources, College of Agricultural and Environmental Sciences, University of California, Davis, CA; <sup>9</sup>Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin; <sup>10</sup>Soil and Water Laboratory, Department of Civil and Environmental Engineering, Rensselaer Polytechnic Institute, Jonsson Engineering Center, Troy, New York, USA; <sup>11</sup>Environmental Microbial and Food Safety Laboratory, USDA ARS Beltsville Agricultural Research Center, Beltsville, MD, USA; <sup>12</sup>Earth and Life Institute - Environmental Sciences, Université catholique de Louvain, Louvain-la-Neuve, Belgium; <sup>13</sup>Institute of Biological and Environmental Sciences, University of Aberdeen, Aberdeen, UK; <sup>14</sup>PBL Netherlands Environmental Assessment Agency, Leeuwenhoeklaan, MA, AH, Bilthoven; <sup>15</sup>Institute for Environment, Health and Safety, Belgian Nuclear Research Centre (SCK-CEN), Mol, Belgium; <sup>16</sup>Department of Hydraulics and Hydrology, Faculty of Civil Engineering, Czech Technical University in Prague, Thakurova, Prague, Czech Republic; <sup>17</sup>Dept. Soil & Environment, Swedish University of Agricultural Sciences, Uppsala, Sweden; <sup>18</sup>Department of Geology and Soil Science, Ghent University, Ghent, Belgium; <sup>19</sup>IPE-CSIC, Avda., Jaca (Huesca), Spain; <sup>20</sup>INRA, UMR 1091 EGC, F-78850 Thiverval Grignon, France; <sup>21</sup>Institute for the Study of Earth, Oceans, and Space University of New Hampshire Durham, NH, USA; <sup>22</sup>INRA, UMR 1391 ISPA, F-33140 Villenave d'Ornon, France; Bordeaux Sciences Agro, UMR Gradignan, France; <sup>23</sup>INRA, UMR1114 EMMAH, F-84914 Avignon, France; <sup>24</sup>INRA, UR0272 USS, F-45075 Orléans, France; <sup>25</sup>INRA, UMR1091 EGC, F-78850 Thiverval-Grignon, France; <sup>26</sup>INRA, UMR1347 Agroécologie, F-21065 Dijon, France; <sup>27</sup>Bioengineering Sciences Research Group, Faculty of Engineering and Environment, University of Southampton, University Road, Southampton, UK; <sup>28</sup>School of Global Environmental Sustainability, Colorado State University, Fort Collins, CO; <sup>29</sup>Institute of Hydraulics and Rural Water Management, University of Natural Resources and Life Sciences (BOKU), Muthgasse 18, 1190 Vienna, Austria; <sup>30</sup>INRA - UMR 1114 EMMAH-Avignon, France; <sup>31</sup>Department Soil Physics, Helmholtz Centre for Environmental Research, UFZ, Halle, Germany; <sup>32</sup>Department of Earth and Environmental Sciences, Division of Geography, KU Leuven, Leuven, Belgium; <sup>33</sup>Technische Universität Braunschweig, Institute for Geoecology, Soil Science and Soil Physics, Braunschweig, Germany; <sup>34</sup>Institute of Soil Ecology, Helmholtz Zentrum München - German Research Center for Environmental Health, Neuherberg, Germany; <sup>35</sup>Institute of Environmental Physics, Im Neuenheimer Feld, Heidelberg, Germany; <sup>36</sup>Institute for Plant Nutrition and Soil Science, Hermann Rodewaldstr, Kiel, Germany; <sup>37</sup>Centre for High-Performance Scientific Computing in Terrestrial Systems, HPSC TerrSys, Geoverbund ABC/J, Forschungszentrum Jülich GmbH, Germany; <sup>38</sup>Dipartimento IMAGE, and International Centre for Hydrology "Dino Tonini", Università di Padova, Padova, Italy; <sup>39</sup>Department of Sustainable Soils and Grassland Systems, Rothamsted Research Harpenden, Hertfordshire, UK; <sup>40</sup>Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

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 energy. 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 improper management and climate change.

Soil is not only essential for establishing a sustainable bio-economy, but also plays 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) combating desertification. Soils regulate and support water, mass and energy fluxes between the land surface, the vegetation, the atmosphere, and the deep subsurface and control storage and release of organic matter affecting climate regulation and biogeochemical cycles. Despite the many important functions of soil, however, many fundamental knowledge gaps remain regarding 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, a new generation of soil models based on a whole systems approach—comprising all physical, mechanical, chemical, and biological processes—is now required to address these 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 . To meet these challenges, an international community effort is required, similar to initiatives in systems biology, hydrology, and climate and crop research.

We therefore propose to establish an international soil modeling consortium with the aims of 1) bringing together leading experts in modeling soil processes within all major soil disciplines, (2) addressing major scientific gaps in describing key processes and their long-term impacts with respect to the different functions and ecosystem services provided by soil, (3) intercomparing soil-model performance based on standardized and harmonized data sets, (4) identifying interactions with other relevant platforms related to common data formats, protocols, and ontologies, (5) developing new approaches to inverse modelling, calibration, and validation of soil models, (6) integrating soil modeling expertise and state of the art knowledge on soil processes in climate, land surface, ecological, crop, and contaminant models, and (7) linking process models with new observations, measurements, and data evaluation technologies for mapping and characterizing soil properties across scales. Our consortium will bring together modelers and experimental soil scientists at the forefront of new technologies and approaches to characterize soils. By addressing these aims, the consortium will contribute to improving the role of soil modeling as a knowledge dissemination instrument in addressing key global issues and stimulating the development of translational research activities. This presentation will provide a compelling case for this much-needed effort, with a focus on tangible benefits to the scientific and food-security communities.