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D-C4.4.3 Evaluation of different approaches for probabilistic assessment of climate change impacts on crop production using regional cases

Nina K. Pirttioja[1], Stefan Fronzek[1], Tim Carter[1], 47 others and Reimund Rötter[2]*

[1] Finnish Environment Institute (SYKE), Helsinki, Finland
[2] Natural Resources Institute Finland (Luke), Vantaa, Finland

*reimund.rotter@luke.fi

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A crop model ensemble analysis of temperature and precipitation effects on wheat yield across a European transect using impact response surfaces

Nina Pirttioja[1*], Timothy R. Carter[1], Stefan Fronzek[1], Marco Bindi[2], Holger Hoffmann[3], Taru Palosuo[4], Margarita Ruiz-Ramos[5], Fulu Tao[4], Miroslav Trnka[6,7], Marco Acutis[8], Senthold Asseng[9], Piotr Baranowski[10], Bruno Basso[11], Per Bodin[12], Samuel Buis[13], Davide Cammarano[14], Paola Deligios[15], Marie-France Destain[16], Benjamin Dumont[16], Frank Ewert[3], Roberto Ferrise[2], Louis François[16], Thomas Gaiser[3], Petr Hlavinka[6,7], Ingrid Jacquemin[16], Kurt Christian Kersebaum[17], Chris Kollas[17], Jaromir Krzyszczak[10], Ignacio J. Lorite[18], Julien Minet[16], M. Ines Minguez[5], Manuel Montesino[19], Marco Moriondo[20], Christoph Müller[21], Claas Nendel[17], Isik Öztürk[22], Alessia Perego[8], Alfredo Rodríguez[5], Alex C. Ruane[23,24], Françoise Ruget[13], Mattia Sanna[8], Mikhail A. Semenov[25], Cezary Slawinski[10], Pierre Stratonovitch[25], Iwan Supit[26], Katharina Waha[21], Enli Wang[27], Lianhai Wu[28], Zhigan Zhao[27,29], Reimund P. Rötter[4]

[1]Finnish Environment Institute (SYKE), 00251 Helsinki, Finland
[2]University of Florence, 50144 Florence, Italy
[3]INRES, University of Bonn, 53115 Bonn, Germany
[4]Natural Resources Institute Finland (Luke), 00790 Helsinki, Finland
[5]CEIGRAM-AgSystems, Universidad Politecnica de Madrid, 28040 Madrid, Spain
[6]Institute of Agrosystems and Bioclimatology, Mendel University in Brno, Brno 613 00, Czech Republic
[7]Global Change Research Centre AS CR,v.v.i., 603 00 Brno, Czech Republic
[8]University of Milan, 20133 Milan, Italy
[9]University of Florida, Gainesville, FL 32611, USA
[10]Institute of Agrophysics, Polish Academy of Sciences, 20-290 Lublin, Poland
[11]Michigan State University, East Lansing, MI 48824, USA
[12]Lund University, 223 62 Lund, Sweden
[13]INRA, UMR 1114 EMMAH, F-84914 Avignon, France
[14]James Hutton Institute, Invergowrie, Dundee, DD2 5DA, Scotland
[15]University of Sassari, 07100 Sassari, Italy
[16]Université de Liège, 4000 Liège, Belgium
[17]Leibniz Centre for Agricultural Landscape Research (ZALF), 15374 Müncheberg, Germany
[18]IFAPA Junta de Andalucia, 14004 Córdoba, Spain
[19]University of Copenhagen, 2630 Taastrup, Denmark
[20]CNR-IBIMET, 50145 Florence, Italy
[21]Potsdam Institute for Climate Impact Research, 14473 Potsdam, Germany
[22]Aarhus University, 8830 Tjele, Denmark
[23]NASA Goddard Institute for Space Studies, New York, NY 10025, USA
[24]Columbia University Center for Climate Systems Research, New York, NY 10025, USA
[25]Rothamsted Research, Harpenden, Herts, AL5 2JQ, UK
[26]Wageningen University, 6700AA Wageningen, The Netherlands
[27]CSIRO Agriculture Flagship, 2601 Canberra, Australia
[28]Rothamsted Research, North Wyke, Okehampton, EX20 2SB, UK
[29]China Agricultural University, 100094 Beijing, China
*Corresponding author. Email: nina.pirttioja@ymparisto.fi

Abstract

Impact response surfaces (IRSs) of spring and winter wheat yields were constructed from a 26-member ensemble of process-based crop simulation models for sites in Finland, Germany and Spain across a latitudinal transect in Europe. The sensitivity of modelled yield to systematic increments of changes in temperature (-2 to +9°C) and precipitation (-50 to +50%) was tested by modifying values of 1981–2010 baseline weather.
In spite of large differences in simulated yield responses to both baseline and changed climate between models, sites, crops and years, several common messages emerged. Ensemble average yields decline with higher temperatures (3–7% per 1°C) and decreased precipitation (3–9% per 10% decrease), but benefit from increased precipitation (0-8% per 10% increase). Yields are more sensitive to temperature than precipitation changes at the Finnish site while sensitivities are mixed at the German and Spanish sites. Precipitation effects diminish under higher temperature changes. Inter-model variability is highest for baseline climate at the Spanish site, but relatively insensitive to changed climate. Modelled responses diverge most at the Finnish and German sites for winter wheat under temperature change. The IRS pattern of yield reliability tracks average yield levels. Inter-annual yield variability is more sensitive to precipitation than temperature, except at the Spanish site for spring wheat.

Optimal temperatures for present-day cultivars are close to the baseline under Finnish conditions but below the baseline at the German and Spanish sites. This suggests that adoption of later maturing cultivars with higher temperature requirements might already be advantageous, and increasingly so under future warming.

Keywords: climate change, crop model, impact response surface (IRS), sensitivity analysis, wheat, yield

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