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### Inter-comparison of wheat models to identify knowledge gaps and improve process modeling

*E. Wang*<sup>1</sup> – *P. Martre*<sup>2</sup> – *S. Asseng*<sup>3</sup> – *F. Ewert*<sup>4</sup> – *Z. Zhao*<sup>1</sup> – *A. Maiorano*<sup>2</sup> –  
*R. P. Rötter*<sup>5</sup> – *B. A. Kimball*<sup>6</sup> – *M. J. Ottman*<sup>7</sup> – *G. W. Wall*<sup>6</sup> – *J. W. White*<sup>6</sup> –  
*P. K. Aggarwal*<sup>8</sup> – *P. D. Alderman*<sup>9</sup> – *J. Anothai*<sup>10</sup> – *B. Basso*<sup>11</sup> – *C. Biernath*<sup>12</sup> –  
*D. Cammarano*<sup>3</sup> – *A. J. Challinor*<sup>13,14</sup> – *G. De Sanctis*<sup>15</sup> – *J. Doltra*<sup>16</sup> – *E. Fereres*<sup>17,18</sup> –  
*M. Garcia-Vila*<sup>17,18</sup> – *S. Gayler*<sup>19</sup> – *G. Hoogenboom*<sup>10</sup> – *L. A. Hunt*<sup>20</sup> –  
*R. C. Izaurralde*<sup>21,22</sup> – *M. Jabloun*<sup>23</sup> – *C. D. Jones*<sup>21</sup> – *K. C. Kersebaum*<sup>24</sup> – *A.-K. Koehler*<sup>13</sup>  
– *C. Müller*<sup>25</sup> – *L. Liu*<sup>26</sup> – *S. Naresh Kumar*<sup>27</sup> – *C. Nendel*<sup>24</sup> – *G. O’Leary*<sup>28</sup> – *J.E. Olesen*<sup>23</sup>  
– *T. Palosuo*<sup>5</sup> – *E. Priesack*<sup>12</sup> – *M. P. Reynolds*<sup>9</sup> – *E. Eyshi Rezaei*<sup>4</sup> – *D. Ripoche*<sup>15</sup> –  
*A. C. Ruane*<sup>29</sup> – *M. A. Semenov*<sup>30</sup> – *I. Shcherbak*<sup>11</sup> – *C. Stöckle*<sup>31</sup> – *P. Stratonovitch*<sup>30</sup> –  
*T. Streck*<sup>32</sup> – *I. Supit*<sup>33</sup> – *F. Tao*<sup>5,34</sup> – *P. Thorburn*<sup>35</sup> – *K. Waha*<sup>25</sup> – *D. Wallach*<sup>35,36</sup> –  
*J. Wolf*<sup>33</sup> – *Y. Zhu*<sup>26</sup>

<sup>1</sup> CSIRO Agriculture, Black Mountain ACT 2601, Australia, e-mail: enli.wang@csiro.au

<sup>2</sup> INRA, UMR0759 LEPSE, F-34 060 Montpellier, France, e-mail: pierre.martre@supagro.inra.fr

<sup>3</sup> ABE Department, University of Florida, Gainesville, FL 32611, USA.

<sup>4</sup> INRES, University of Bonn, D-53115, Germany.

<sup>5</sup> Luke, FI-00790 Helsinki, Finland <sup>6</sup> ARS-USDA, ALARC, Maricopa, AZ 85138, USA.

<sup>7</sup> The School of Plant Sciences, University of Arizona, Tucson, AZ 85721, USA

<sup>8</sup> CGIAR Research Program on Climate Change, Agriculture and Food Security, IWMI, New Delhi 110012, India

<sup>9</sup> CIMMYT, 06600 Mexico, D.F., Mexico

<sup>10</sup> AgWeatherNet Program, Washington State University, Prosser, Washington 99350, USA

<sup>11</sup> GS and W.K. Kellogg Biological Station, Michigan State University East Lansing, MI 48823, USA

<sup>12</sup> ISE, Helmholtz Zentrum München, Neuherberg, D-85764, Germany

<sup>13</sup> ICAS, School of Earth and Environment, University of Leeds, Leeds LS29JT, UK

<sup>14</sup> CGIAR-ESSP Program on Climate Change, Agriculture and Food Security, CIAT, A.A. 6713, Cali, Colombia

<sup>15</sup> INRA, US1116 AgroClim, F- 84 914 Avignon, France

<sup>16</sup> CIFA, 39600 Muriedas, Spain

<sup>17</sup> Departement of Agronomia, University of Cordoba, Apartado 3048, 14080 Cordoba, Spain

<sup>18</sup> IAS CSIC, Cordoba 14080, Spain

<sup>19</sup> WESS Competence Cluster, University of Tübingen, D-727074 Tübingen, Germany

<sup>20</sup> Department of Plant Agriculture, University of Guelph, Guelph, ON N1G 2W1, Canada

<sup>21</sup> Department of Geographical Sciences, University of Maryland, College Park, MD 20742, USA

<sup>22</sup> Texas A&M AgriLife Research and Extension Center, Texas A&M University, Temple, TX 76502, USA

<sup>23</sup> Department of Agroecology, Aarhus University, 8830 Tjele, Denmark

<sup>24</sup> Institute of Landscape Systems Analysis, ZALF, D-15374 Müncheberg, Germany

<sup>25</sup> Potsdam Institute for Climate Impact Research, D-14473 Potsdam, Germany

<sup>26</sup> College of Agriculture, Nanjing Agricultural University, Nanjing, Jiangsu, 210095, China

<sup>27</sup> Centre for Environment Science and Climate Resilient Agriculture, IARI PUSA, New Delhi 110 012, India

<sup>28</sup> Landscape & Water Sciences, Department of Environment and Primary Industries, Horsham 3400, Australia

<sup>29</sup> NASA Goddard Institute for Space Studies, New York, NY 10025, USA

<sup>30</sup> Computational and Systems Biology Department, Rothamsted Research, Harpenden, Herts, AL5 2JQ, UK

<sup>31</sup> BSE Departement, Washington State University, Pullman, WA 99164-6120, USA

<sup>32</sup> Institute of Soil Science and Land Evaluation, University of Hohenheim, D-70599 Stuttgart

<sup>33</sup> PPS and ESS, Wageningen University, 6700AA Wageningen, The Netherlands

<sup>34</sup> Institute of Geographical Sciences and Natural Resources Research, CAS, Beijing 100101, China

<sup>35</sup> CSIRO Agriculture, Brisbane, Queensland 4102, Australia

<sup>36</sup> INRA, UMR 1248 AGIR, F-31 326 Castanet-Tolosan, France

## **Introduction**

An intercomparison of wheat models revealed that the uncertainty in simulated yield increases with rising temperature (Asseng et al., 2013) and the mean of the multi-model ensemble (MME) simulations best matched the observations (Martre et al., 2015). These findings highlight the need for MME approach to better address yield projection uncertainty. However, the MME approach itself does not lead to improvement in process understanding. Here we extend the model intercomparison to investigate how the uncertainties in simulation results arise from process-level algorithms and parameterization in the models and to identify knowledge gaps.

## **Materials and Methods**

We systematically compared 29 wheat models (Asseng et al., 2015) in terms of how key temperature-responsive physiological processes are simulated. We extracted the algorithms used in these models and categorized the temperature response equations into four types based on how the cardinal temperatures are defined. To demonstrate the impact of the different temperature equations on simulated phenology, total above ground biomass and grain yield, we implemented the four types of temperature responses in the APSIM and *SiriusQuality* models and tested the modified models against the Hot Serial Cereal field experiment (Wall et al., 2011).

## **Results and Discussion**

Our analysis revealed contrasting temperature response functions used for the same physiological process among different models. These differences impacted directly on the sensitivity of simulated yield to temperature changes, particularly at high temperature range. The range of simulated yield caused by variations of temperature response functions in APSIM and *SiriusQuality* was on average 52 % and 64 % of the uncertainty of the MME, respectively. These results demonstrate that the contrasting temperature response functions implemented in the models is a major cause of the uncertainty in the simulated yield. Finally, we developed improved temperature response functions for key processes. Their implementation into APSIM and *SiriusQuality* led to improved yield simulations.

## **Conclusions**

The contrasting temperature response functions for simulating key physiological processes in current wheat models are a major cause of the uncertainty in simulated yield. Inter-comparison of modeling approaches enabled to identify knowledge gaps and improvement in process modeling.

## **References**

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