Personal information

Name: Christian Folberth
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ORCID: 0000-0002-6738-5238
Scopus ID: 35483580300

Current position

2016 –   **Research Scholar**, since 2024 **Senior Research Scholar**
                Agriculture, Forestry, and Ecosystem Services Research Group (AFE), Biodiversity and Natural Resources Program (BNR), International Institute for Applied Systems Analysis, Austria

Professional experience

2015 – 2016   **Research Fellow and Co-Group Leader**
                Research and Teaching Unit Human-Environment Relations, Department of Geography, Ludwig Maximilian University of Munich, Germany
2015 – 2016   **Guest Research Scholar**
                Agro-Environmental Systems Group, Ecosystem Services and Management Program, International Institute for Applied Systems Analysis, Austria
2013 – 2015   **Research Scholar**
                Agro-Environmental Systems Group, Ecosystem Services and Management Program, International Institute for Applied Systems Analysis, Austria
2009 – 2013   **Research Assistant**
                Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland

Education

2014   PhD (Doctor of Sciences ETH Zurich)
                Modeling crop yield and water use in the context of global change with a focus on maize in sub-Saharan Africa
                Department of Environmental Systems Science, ETH Zurich, Switzerland
2008   M.Sc. (with distinction) Environmental Planning and Ecological Engineering
                Technical University of Munich, Germany
2005   B. Sc. (with distinction) Horticultural Sciences
                Technical University of Munich, Germany

Fellowships and (partner-)PI grants

2023 – 2026   ANFOS - Advanced ensemble projections for indirect impacts of nuclear conflict in global food systems, Future of Life Institute, PI (EUR 426k)
2023 – 2026   MACROS - Machine-learning crop meta-models for climate adaptation, FWF (EUR 360k)
2021 – 2023   Sustainable Agriculture Matrix consortium, Funder Belmont Forum/FWF (EUR 70k)
2015 – 2016   LMUexcellent Research Fellowship of the Center for Advanced Studies, Ludwig Maximilian University of Munich, Germany (EUR 120k)

Organization of scientific meetings

2019 - Session "Modeling agricultural systems under global change", EGU General Assembly. Co-convener with C. Müller, S. Minoli (PIK, Germany), Katharina Waha (Uni Augsburg, Germany).
2018   Session "Agricultural management in ecosystem models for biogeochemical and agricultural assessments", EGU General Assembly. Co-convener with C. Müller, F. Lutz, S. Minoli (PIK, Germany).
2016   Workshop "Sustainable Phosphorus Management for Future Food Security", Center for Advanced Studies, LMU Munich. Co-convener with Prof. Caroline Gutjahr (LMU Munich)
2015   Dialogue session "Soil and land information: How to support decision making?", Global Soil Week 2015. Co-planner with partners from IIASA, JRC, ICRAF, and ISRIC among others

Professional societies

2018 – European Geoscience Union

Editorial board services

2019 – Editorial Board member, Geoscientific Model Development

Peer-review and refereeing

Reviewer for journals: Agricultural and Forest Meteorology; Agriculture, Ecosystems and Environment; Agricultural Systems; Agronomy; Archives of Agronomy and Soil Science; Climatic Change; Earth System Dynamics; Ecological Modelling; Environmental Research Letters; Frontiers in Nutrition; Global Food Security; Nature Sustainability; Resources, Conservation and Recycling; Science of the Total Environment

Reviewer for research grants: Agence Nationale de la Recherche (France), Swiss National Science Fund (Switzerland), European Research Commission (EU)

Other professional activities (selected)

2021   Invited speaker at Cropbooster-P (H2020 project) workshop
2019   Invited participant, Sustainable Agricultural Matrix pursuit project, SESYNC, MD, USA
2019   Invited participant, Footprint methodologies and their role in policy development and communication, German Development Institute, Bonn, Germany
2018   Invited participant, Sustainable Agricultural Matrix pursuit project, SESYNC, MD, USA
2017   Invited speaker, ISRIC Special Session, Wageningen World Soil Conference, NL
2015   Invited speaker, Land use workshop of Heinrich-Böll-Foundation stipends, Munich, Germany
2012 – Member of the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) and Global Gridded Crop Model Intercomparison (GGCMI) initiative
2011 – Invited guest lectures and seminars on crop modelling, tropical agriculture, and agricultural climate change impacts at University of Kassel (Germany, 2010), University of Bonn (Germany, 2011), University of Basel (Switzerland, 2012, 2014), Technical University of Munich (Germany, 2015, 2015), and University of Natural Resources and Life Sciences Vienna (Austria, 2016, 2018)

Teaching experience

Resources and sustainability; Land use systems and land use conflicts; Transition paths towards sustainability; Introduction to human geography; Crop modelling across scales; Data processing and visualization

Capacity building

2023   Mentoring of IIASA Young Scientists Summer Program (YSSP) participant Whijin Kim (Korea University, Rep. of Korea)
2022   Co-Mentoring of IIASA Young Scientists Summer Program (YSSP) participant Tara Ippolito (University of Colorado, USA)
2021   Mentoring of IIASA Guest Researcher Xiaobo Wang (Chinese Academy of Sciences, CHN) continued from YSSP project
2021   Co-Mentoring of IIASA Young Scientists Summer Program (YSSP) participants Henrique Moreno Dumont Goulart (VU Amsterdam, NL) and Jincheng Li (Beijing University, CHN)
2020   Mentoring of IIASA Young Scientists Summer Program (YSSP) participant Xiaobo Wang (Chinese Academy of Sciences, CHN); continued as one year guest research stay at IIASA
2018   Co-Mentoring of IIASA Young Scientists Summer Program (YSSP) participant Tony Carr (University College London, UK)
2015   Co-Mentoring of B.Sc. student Leonie Keil at Ludwig Maximilian University of Munich, Germany
2014   External technical advisor to PhD student Liu Wenfeng (ETH Zurich and Eawag, Switzerland)

Technical expertise

Software: ArcGIS, QGIS, STAN, Vensim, Adobe CS, MS Office
Programming environments: R, Linux shell scripting, C, VBA, Fortran, Python
Data processing: handling of large data, visualization, machine learning applications, parallel computing

Languages

German   native
English   fluent
French   good written, moderate communication
Spanish   good written, moderate communication
Romanian   basic understanding

Publication summaries

Website: https://iiasa.ac.at/staff/christian-folberth
ORCID: 0000-0002-6738-5238
Scopus ID: 35483580300

Total publications (Scopus): 81
h-index (Scopus): 40

Full publication list

Peer-reviewed journal articles

Ermolieva, T., Havlik, P., Lessa-Derci-Augustynczik, A., Frank, S., Balkovic, J., Skalsky, R., Deppermann, A., Nakhavali, M. (Andrè), Komendantova, N., Kahil, T., Wang, G., Folberth, C., Knopov, P.S., 2024. Tracking the Dynamics and Uncertainties of Soil Organic Carbon in Agricultural Soils Based on a Novel Robust Meta-Model Framework Using Multisource Data. Sustainability 16, 6849. https://doi.org/10.3390/su16166849

Orlov, A., Jägermeyr, J., Müller, C., Daloz, A.S., Zabel, F., Minoli, S., Liu, W., Lin, T.-S., Jain, A.K., Folberth, C., Okada, M., Poschlod, B., Smerald, A., Schneider, J.M., Sillmann, J., 2024. Human heat stress could offset potential economic benefits of CO2 fertilization in crop production under a high-emissions scenario. One Earth 7, 1250–1265. https://doi.org/10.1016/j.oneear.2024.06.012

Folberth, C., Wood, S.A., Wironen, M., Jung, M., Boucher, T.M., Bossio, D., Obersteiner, M., 2024. Exploring the potential for nitrogen fertilizer use mitigation with bundles of management interventions. Environ. Res. Lett. 19, 044027. https://doi.org/10.1088/1748-9326/ad31d8

Couëdel, A., Falconnier, G.N., Adam, M., Cardinael, R., Boote, K., Justes, E., Smith, W.N., Whitbread, A.M., Affholder, F., Balkovic, J., Basso, B., Bhatia, A., Chakrabarti, B., Chikowo, R., Christina, M., Faye, B., Ferchaud, F., Folberth, C., Akinseye, F.M., Gaiser, T., Galdos, M.V., Gayler, S., Gorooei, A., Grant, B., Guibert, H., Hoogenboom, G., Kamali, B., Laub, M., Maureira, F., Mequanint, F., Nendel, C., Porter, C.H., Ripoche, D., Ruane, A.C., Rusinamhodzi, L., Sharma, S., Singh, U., Six, J., Srivastava, A., Vanlauwe, B., Versini, A., Vianna, M., Webber, H., Weber, T.K.D., Zhang, C., Corbeels, M., 2024. Long-term soil organic carbon and crop yield feedbacks differ between 16 soil-crop models in sub-Saharan Africa. European Journal of Agronomy 155, 127109. https://doi.org/10.1016/j.eja.2024.127109

Müller, C., Jägermeyr, J., Franke, J.A., Ruane, A.C., Balkovic, J., Ciais, P., Dury, M., Falloon, P., Folberth, C., Hank, T., Hoffmann, M., Izaurralde, R.C., Jacquemin, I., Khabarov, N., Liu, W., Olin, S., Pugh, T.A.M., Wang, X., Williams, K., Zabel, F., Elliott, J.W., 2024. Substantial Differences in Crop Yield Sensitivities Between Models Call for Functionality-Based Model Evaluation. Earth's Future 12, e2023EF003773. https://doi.org/10.1029/2023EF003773

Jung, M., Boucher, T.M., Wood, S.A., Folberth, C., Wironen, M., Thornton, P., Bossio, D., Obersteiner, M., 2024. A global clustering of terrestrial food production systems. PLoS ONE 19, e0296846. https://doi.org/10.1371/journal.pone.0296846

Wang, X., Wang, S., Folberth, C., Skalsky, R., Li, H., Liu, Y., Balkovic, J., 2024. Limiting global warming to 2 °C benefits building climate resilience in rice-wheat systems in India through crop calendar management. Agricultural Systems 213, 103806. https://doi.org/10.1016/j.agsy.2023.103806

Molina Bacca, E.J., Stevanović, M., Bodirsky, B.L., Karstens, K., Chen, D.M.-C., Leip, D., Müller, C., Minoli, S., Heinke, J., Jägermeyr, J., Folberth, C., Iizumi, T., Jain, A.K., Liu, W., Okada, M., Smerald, A., Zabel, F., Lotze-Campen, H., Popp, A., 2023. Uncertainty in land-use adaptation persists despite crop model projections showing lower impacts under high warming. Commun Earth Environ 4, 1–13. https://doi.org/10.1038/s43247-023-00941-z

Ippolito, T., Balkovič, J., Skalsky, R., Folberth, C., Krisztin, T., Neff, J., 2023. Predicting spatiotemporal soil organic carbon responses to management using EPIC-IIASA meta-models. Journal of Environmental Management 344, 118532. https://doi.org/10.1016/j.jenvman.2023.118532

De Vos, K., Janssens, C., Jacobs, L., Campforts, B., Boere, E., Kozicka, M., Havlík, P., Folberth, C., Balkovič, J., Maertens, M., Govers, G., 2023. Rice availability and stability in Africa under future socio-economic development and climatic change. Nat Food 1–10. https://doi.org/10.1038/s43016-023-00770-5

Ermolieva, T., Ermoliev, Y., Havlik, P., Lessa-Derci-Augustynczik, A., Komendantova, N., Kahil, T., Balkovic, J., Skalsky, R., Folberth, C., Knopov, P.S., Wang, G., 2023. Connections between Robust Statistical Estimation, Robust Decision-Making with Two-Stage Stochastic Optimization, and Robust Machine Learning Problems. Cybern Syst Anal. https://doi.org/10.1007/s10559-023-00573-3

Goulart, H.M.D., van der Wiel, K., Folberth, C., Boere, E., van den Hurk, B., 2023. Increase of Simultaneous Soybean Failures Due To Climate Change. Earth's Future 11, e2022EF003106. https://doi.org/10.1029/2022EF003106

Cinner, J.E., Caldwell, I.R., Thiault, L., Ben, J., Blanchard, J.L., Coll, M., Diedrich, A., Eddy, T.D., Everett, J.D., Folberth, C., Gascuel, D., Guiet, J., Gurney, G.G., Heneghan, R.F., Jägermeyr, J., Jiddawi, N., Lahari, R., Kuange, J., Liu, W., Maury, O., Müller, C., Novaglio, C., Palacios-Abrantes, J., Petrik, C.M., Rabearisoa, A., Tittensor, D.P., Wamukota, A., Pollnac, R., 2022. Potential impacts of climate change on agriculture and fisheries production in 72 tropical coastal communities. Nature Communications 13. https://doi.org/10.1038/s41467-022-30991-4

Li, J., Chen, Y., Cai, K., Fu, J., Ting, T., Chen, Y., Folberth, C., Liu, Y., 2022. A high-resolution nutrient emission inventory for hotspot identification in the Yangtze River Basin. Journal of Environmental Management 321. https://doi.org/10.1016/j.jenvman.2022.115847

Wang, X., Folberth, C., Skalsky, R., Wang, S., Chen, B., Liu, Y., Chen, J., Balkovic, J., 2022. Crop calendar optimization for climate change adaptation in rice-based multiple cropping systems of India and Bangladesh. Agricultural and Forest Meteorology 315. https://doi.org/10.1016/j.agrformet.2022.108830

Franke, J.A., Müller, C., Minoli, S., Elliott, J., Folberth, C., Gardner, C., Hank, T., Izaurralde, R.C., Jägermeyr, J., Jones, C.D., Liu, W., Olin, S., Pugh, T.A.M., Ruane, A.C., Stephens, H., Zabel, F., Moyer, E.J., 2022. Agricultural breadbaskets shift poleward given adaptive farmer behavior under climate change. Global Change Biology 28, 167–181. https://doi.org/10.1111/gcb.15868

Goulart, H.M.D., Van Der Wiel, K., Folberth, C., Balkovic, J., Van Den Hurk, B., 2021. Storylines of weather-induced crop failure events under climate change. Earth System Dynamics 12, 1503–1527. https://doi.org/10.5194/esd-12-1503-2021

Carr, T.W., Balkovič, J., Dodds, P.E., Folberth, C., Skalský, R., 2021. The impact of water erosion on global maize and wheat productivity. Agriculture, Ecosystems and Environment 322. https://doi.org/10.1016/j.agee.2021.107655

Wang, X., Müller, C., Elliot, J., Mueller, N.D., Ciais, P., Jägermeyr, J., Gerber, J., Dumas, P., Wang, C., Yang, H., Li, L., Deryng, D., Folberth, C., Liu, W., Makowski, D., Olin, S., Pugh, T.A.M., Reddy, A., Schmid, E., Jeong, S., Zhou, F., Piao, S., 2021. Global irrigation contribution to wheat and maize yield. Nature Communications 12. https://doi.org/10.1038/s41467-021-21498-5

Jägermeyr, J., Müller, C., Ruane, A.C., Elliott, J., Balkovic, J., Castillo, O., Faye, B., Foster, I., Folberth, C., Franke, J.A., Fuchs, K., Guarin, J.R., Heinke, J., Hoogenboom, G., Iizumi, T., Jain, A.K., Kelly, D., Khabarov, N., Lange, S., Lin, T.-S., Liu, W., Mialyk, O., Minoli, S., Moyer, E.J., Okada, M., Phillips, M., Porter, C., Rabin, S.S., Scheer, C., Schneider, J.M., Schyns, J.F., Skalsky, R., Smerald, A., Stella, T., Stephens, H., Webber, H., Zabel, F., Rosenzweig, C., 2021. Climate impacts on global agriculture emerge earlier in new generation of climate and crop models. Nature Food 2, 873–885. https://doi.org/10.1038/s43016-021-00400-y

Zhang, X., Yao, G., Vishwakarma, S., Dalin, C., Komarek, A.M., Kanter, D.R., Davis, K.F., Pfeifer, K., Zhao, J., Zou, T., D'Odorico, P., Folberth, C., Rodriguez, F.G., Fanzo, J., Rosa, L., Dennison, W., Musumba, M., Heyman, A., Davidson, E.A., 2021. Quantitative assessment of agricultural sustainability reveals divergent priorities among nations. One Earth 4, 1262–1277. https://doi.org/10.1016/j.oneear.2021.08.015

Zabel, F., Müller, C., Elliott, J., Minoli, S., Jägermeyr, J., Schneider, J.M., Franke, J.A., Moyer, E., Dury, M., Francois, L., Folberth, C., Liu, W., Pugh, T.A.M., Olin, S., Rabin, S.S., Mauser, W., Hank, T., Ruane,

A.C., Asseng, S., 2021. Large potential for crop production adaptation depends on available future varieties. Global Change Biology 27, 3870–3882. https://doi.org/10.1111/gcb.15649

Vittis, Y., Folberth, C., Bundle, S.-C., Obersteiner, M., 2021. Restoring Nature at Lower Food Production Costs. Frontiers in Environmental Science 9. https://doi.org/10.3389/fenvs.2021.672663

Ruane, A.C., Phillips, M., Müller, C., Elliott, J., Jägermeyr, J., Arneth, A., Balkovic, J., Deryng, D., Folberth, C., Iizumi, T., Izaurralde, R.C., Khabarov, N., Lawrence, P., Liu, W., Olin, S., Pugh, T.A.M., Rosenzweig, C., Sakurai, G., Schmid, E., Sultan, B., Wang, X., de Wit, A., Yang, H., 2021. Strong regional influence of climatic forcing datasets on global crop model ensembles. Agricultural and Forest Meteorology 300. https://doi.org/10.1016/j.agrformet.2020.108313

Ringeval, B., Müller, C., Pugh, T.A.M., Mueller, N.D., Ciais, P., Folberth, C., Liu, W., Debaeke, P., Pellerin, S., 2021. Potential yield simulated by global gridded crop models: Using a process-based emulator to explain their differences. Geoscientific Model Development 14, 1639–1656. https://doi.org/10.5194/gmd-14-1639-2021

Müller, C., Franke, J., Jägermeyr, J., Ruane, A.C., Elliott, J., Moyer, E., Heinke, J., Falloon, P.D., Folberth, C., Francois, L., Hank, T., Izaurralde, R.C., Jacquemin, I., Liu, W., Olin, S., Pugh, T.A.M., Williams, K., Zabel, F., 2021. Exploring uncertainties in global crop yield projections in a large ensemble of crop models and CMIP5 and CMIP6 climate scenarios. Environmental Research Letters 16. https://doi.org/10.1088/1748-9326/abd8fc

Lange, S., Volkholz, J., Geiger, T., Zhao, F., Vega, I., Veldkamp, T., Reyer, C.P.O., Warszawski, L., Huber, V., Jägermeyr, J., Schewe, J., Bresch, D.N., Büchner, M., Chang, J., Ciais, P., Dury, M., Emanuel, K., Folberth, C., Gerten, D., Gosling, S.N., Grillakis, M., Hanasaki, N., Henrot, A.-J., Hickler, T., Honda, Y., Ito, A., Khabarov, N., Koutroulis, A., Liu, W., Müller, C., Nishina, K., Ostberg, S., Müller Schmied, H., Seneviratne, S.I., Stacke, T., Steinkamp, J., Thiery, W., Wada, Y., Willner, S., Yang, H., Yoshikawa, M., Yue, C., Frieler, K., 2020. Projecting Exposure to Extreme Climate Impact Events Across Six Event Categories and Three Spatial Scales. Earth's Future 8. https://doi.org/10.1029/2020EF001616

Balkovič, J., Madaras, M., Skalský, R., Folberth, C., Smatanová, M., Schmid, E., van der Velde, M., Kraxner, F., Obersteiner, M., 2020. Verifiable soil organic carbon modelling to facilitate regional reporting of cropland carbon change: A test case in the Czech Republic. Journal of Environmental Management 274. https://doi.org/10.1016/j.jenvman.2020.111206

Carr, T.W., Balkovič, J., Dodds, P.E., Folberth, C., Fulajtar, E., Skalsky, R., 2020. Uncertainties, sensitivities and robustness of simulated water erosion in an EPIC-based global gridded crop model. Biogeosciences 17, 5263–5283. https://doi.org/10.5194/bg-17-5263-2020

Bayas, J.C.L., Gardeazabal, A., Karner, M., Folberth, C., Vargas, L., Skalský, R., Balkovič, J., Subash, A., Saad, M., Delerce, S., Cuaresma, J.C., Hlouskova, J., Molina-Maturano, J., See, L., Fritz, S., Obersteiner, M., Govaerts, B., 2020. Agrotutor: A mobile phone application supporting sustainable agricultural intensification. Sustainability (Switzerland) 12, 1–10. https://doi.org/10.3390/su12229309

Franke, J.A., Müller, C., Elliott, J., Ruane, A.C., Jägermeyr, J., Snyder, A., Dury, M., Falloon, P.D., Folberth, C., François, L., Hank, T., Cesar Izaurralde, R., Jacquemin, I., Jones, C., Li, M., Liu, W., Olin, S., Phillips, M., Pugh, T.A.M., Reddy, A., Williams, K., Wang, Z., Zabel, F., Moyer, E.J., 2020b. The GGCMI Phase 2 emulators: Global gridded crop model responses to changes in CO2, temperature, water, and nitrogen (version 1.0). Geoscientific Model Development 13, 3995–4018. https://doi.org/10.5194/gmd-13-3995-2020

Flach, R., Fader, M., Folberth, C., Skalský, R., Jantke, K., 2020a. The effects of cropping intensity and cropland expansion of brazilian soybean production on green water flows. Environmental Research Communications 2. https://doi.org/10.1088/2515-7620/ab9d04

Franke, J.A., Müller, C., Elliott, J., Ruane, A.C., Jägermeyr, J., Balkovic, J., Ciais, P., Dury, M., Falloon, P.D., Folberth, C., François, L., Hank, T., Hoffmann, M., Izaurralde, R.C., Jacquemin, I., Jones, C., Khabarov, N., Koch, M., Li, M., Liu, W., Olin, S., Phillips, M., Pugh, T.A.M., Reddy, A., Wang, X., Williams, K.,

Zabel, F., Moyer, E.J., 2020a. The GGCMI Phase 2 experiment: Global gridded crop model simulations under uniform changes in CO2, temperature, water, and nitrogen levels (protocol version 1.0). Geoscientific Model Development 13, 2315–2336. https://doi.org/10.5194/gmd-13-2315-2020

Herrero, M., Thornton, P.K., Mason-D'Croz, D., Palmer, J., Benton, T.G., Bodirsky, B.L., Bogard, J.R., Hall, A., Lee, B., Nyborg, K., Pradhan, P., Bonnett, G.D., Bryan, B.A., Campbell, B.M., Christensen, S., Clark, M., Cook, M.T., de Boer, I.J.M., Downs, C., Dizyee, K., Folberth, C., Godde, C.M., Gerber, J.S., Grundy, M., Havlik, P., Jarvis, A., King, R., Loboguerrero, A.M., Lopes, M.A., McIntyre, C.L., Naylor, R., Navarro, J., Obersteiner, M., Parodi, A., Peoples, M.B., Pikaar, I., Popp, A., Rockström, J., Robertson, M.J., Smith, P., Stehfest, E., Swain, S.M., Valin, H., van Wijk, M., van Zanten, H.H.E., Vermeulen, S., Vervoort, J., West, P.C., 2020. Innovation can accelerate the transition towards a sustainable food system. Nature Food 1, 266–272. https://doi.org/10.1038/s43016-020-0074-1

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Jägermeyr, J., Robock, A., Elliott, J., Muller, C., Xia, L., Khabarov, N., Folberth, C., Schmid, E., Liu, W., Zabel, F., Rabin, S.S., Puma, M.J., Heslin, A., Franke, J., Foster, I., Asseng, S., Bardeen, C.G., Toon, O.B., Rosenzweig, C., 2020. A regional nuclear conflict would compromise global food security. Proceedings of the National Academy of Sciences of the United States of America 117, 7071–7081. https://doi.org/10.1073/pnas.1919049117

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Müller, C., Elliott, J., Kelly, D., Arneth, A., Balkovic, J., Ciais, P., Deryng, D., Folberth, C., Hoek, S., Izaurralde, R.C., Jones, C.D., Khabarov, N., Lawrence, P., Liu, W., Olin, S., Pugh, T.A.M., Reddy, A., Rosenzweig, C., Ruane, A.C., Sakurai, G., Schmid, E., Skalsky, R., Wang, X., de Wit, A., Yang, H., 2019. The Global Gridded Crop Model Intercomparison phase 1 simulation dataset. Scientific Data 6. https://doi.org/10.1038/s41597-019-0023-8

Schewe, J., Gosling, S.N., Reyer, C., Zhao, F., Ciais, P., Elliott, J., Francois, L., Huber, V., Lotze, H.K., Seneviratne, S.I., van Vliet, M.T.H., Vautard, R., Wada, Y., Breuer, L., Büchner, M., Carozza, D.A., Chang, J., Coll, M., Deryng, D., de Wit, A., Eddy, T.D., Folberth, C., Frieler, K., Friend, A.D., Gerten, D., Gudmundsson, L., Hanasaki, N., Ito, A., Khabarov, N., Kim, H., Lawrence, P., Morfopoulos, C., Müller, C., Müller Schmied, H., Orth, R., Ostberg, S., Pokhrel, Y., Pugh, T.A.M., Sakurai, G., Satoh, Y., Schmid, E., Stacke, T., Steenbeek, J., Steinkamp, J., Tang, Q., Tian, H., Tittensor, D.P., Volkholz, J., Wang, X., Warszawski, L., 2019. State-of-the-art global models underestimate impacts from climate extremes. Nature Communications 10. https://doi.org/10.1038/s41467-019-08745-6

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