

Dr. Jing Tao

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Climate and Ecosystem Sciences Division

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EDUCATION

- ❑ **Sep. 2009 – Sep. 2015** **Ph.D. in Hydrology and Fluid Dynamics**
Department of Civil & Environmental Engineering, Duke University, Durham, NC, USA
- ❑ **Sep. 2005 – Jul. 2008** **M. E. in Photogrammetry and Remote Sensing (RS)**
School of Geography, Beijing Normal University, Beijing, China
- ❑ **Sep. 2001 - Jul. 2005** **B. S. in Geographical Information System (GIS)**
School of Geography, Beijing Normal University, Beijing, China

PROFESSIONAL EXPERIENCE

- ❑ **PROJECT SCIENTIST.** Climate and Ecosystem Sciences Division, Lawrence Berkeley National Laboratory (LBNL), Berkeley, California, USA. Feb. 2022 to present.
- ❑ **POSTDOCTORAL RESEARCH ASSOCIATE.** Department of Civil and Environmental Engineering, University of Washington, affiliated at the Climate and Ecosystem Sciences Division, Lawrence Berkeley National Laboratory (LBNL), Berkeley, California, USA. Feb. 2019 to Feb. 2022.
- ❑ **POSTDOCTORAL ASSOCIATE.** The Global Modeling and Assimilation Office (GMAO), NASA/GSFC, affiliated at the Earth System Science Interdisciplinary Center (ESSIC), University of Maryland, College Park, Maryland, USA. Sep. 2015 to Aug. 2018.
- ❑ **RESEARCH ASSISTANT.** Department of Civil & Environmental Engineering, Pratt School of Engineering, Duke University, North Carolina, USA. Sep. 2009 to Sep. 2015.
- ❑ **VISITING RESEARCH ASSISTANT.** Hydrology and Remote Sensing Lab (HRSL) at Beltsville Agriculture Research Center (BARC), USDA, Maryland, USA. Jan. 2007 to Jan. 2008.

RESEARCH INTERESTS

- ❑ Hydroclimatology, Hydrobiogeochemistry, Hydrogeology, and Permafrost Carbon-Climate Feedback.

PEER-REVIEWED PUBLICATIONS

- ❑ **Tao, J.,** Zhu, Q., Riley, W. J., Neumann, R.B., **2021.** Improved ELMv1-ECA Simulations of Zero-Curtain Periods and Cold-season CH₄ and CO₂ Emissions at Alaskan Arctic Tundra Sites. *The Cryosphere*. 15(12), 5281-5307. (<https://doi.org/10.5194/tc-15-5281-2021>)
- ❑ **Tao, J.,** Zhu, Q., Riley, W. J., Neumann, R. B., **2021.** Warm-season net CO₂ uptake outweighs cold-season emissions over Alaskan North Slope tundra under current and RCP8.5 climate. *Environmental Research Letters*, 16(5), p.055012 (<https://doi.org/10.1088/1748-9326/abf6f5>).
- ❑ Nergui, N., Wu, H., **Tao, J.,** Maggioni, V., Beck, et al., **2021.** Assessment of Precipitation Error Propagation in Discharge Simulations over the Contiguous United States. *Journal of Hydrometeorology*. 22(8), pp.1987-2008. (<https://doi.org/10.1175/JHM-D-20-0213.1>).
- ❑ Jiang, L., Wu, H., **Tao, J.,** Kimball, J. S., Alfieri, L. and Chen, X., **2020.** Satellite-Based Evapotranspiration in Hydrological Model Calibration. *Remote Sensing*, 12(3), p.428. (<https://doi.org/10.3390/rs12030428>)
- ❑ Yan, Y., Wu, H., Gu, G., Ward, P. J., Luo, L., Li, X., Huang, Z., **Tao, J., 2020.** Exploring the ENSO Impact

on Basin - Scale Floods Using Hydrological Simulations and TRMM Precipitation. *Geophysical Research Letters*: e2020GL089476. (<https://doi.org/10.1029/2020GL089476>)

- ❑ **Tao, J.**, Koster, R., Reichle, R. H., Forman, B. A., Xue, Y., Chen, R., Moghaddam, M., **2019**. Permafrost Variability over the Northern Hemisphere Based on the MERRA-2 Reanalysis. *The Cryosphere*. 13, 2087-2110. ([doi: 10.5194/tc-2018-119](https://doi.org/10.5194/tc-2018-119)).
- ❑ **Tao, J.** and Barros, A. P., **2019**. Multi-year surface radiative properties and vegetation parameters for hydrologic modeling in regions of complex terrain – Methodology and evaluation over the Integrated Precipitation and Hydrology Experiment 2014 domain. *Journal of Hydrology: Regional Studies*. 22 (100596). ([doi: 10.1016/j.ejrh.2019.100596](https://doi.org/10.1016/j.ejrh.2019.100596))
- ❑ **Tao, J.** and Barros, A. P., **2018**. Multi-year atmospheric forcing datasets for hydrologic modeling in regions of complex terrain–Methodology and evaluation over the Integrated Precipitation and Hydrology Experiment 2014 domain. *Journal of Hydrology*. 567: 824-842. ([doi: 10.1016/j.jhydrol.2016.12.058](https://doi.org/10.1016/j.jhydrol.2016.12.058))
- ❑ **Tao, J.**, Reichle, R. H., Koster, R. D., Forman, B. A. and Xue, Y., **2017**. Evaluation and Enhancement of Permafrost Modeling With the NASA Catchment Land Surface Model. *Journal of Advances in Modeling Earth Systems*. 9, 2771-2795. ([doi:10.1002/2017MS001019](https://doi.org/10.1002/2017MS001019)).
- ❑ **Tao, J.**, Wu, D., Gourley, J., Zhang, S., Crow, W., Peters-Lidard, C., and Barros, A.P., **2016**. Operational Hydrological Forecasting during the IPHEX-IOP Campaign – Meet the Challenge. *Journal of Hydrology*, 541(A): 434-456. ([doi:10.1016/j.jhydrol.2016.02.019](https://doi.org/10.1016/j.jhydrol.2016.02.019))
- ❑ **Tao, J.** and Barros, A. P., **2014**. Coupled prediction of flood response and debris flow initiation during warm-and cold-season events in the Southern Appalachians, USA. *Hydrology and Earth System Sciences*, 18(1): 367-388. ([doi: 10.5194/hess-18-367-2014](https://doi.org/10.5194/hess-18-367-2014))
- ❑ **Tao, J.** and Barros, A. P., **2013**. Prospects for flash flood forecasting in mountainous regions – An investigation of Tropical Storm Fay in the Southern Appalachians. *Journal of Hydrology*, 506(0): 69-89. ([doi: 10.1016/j.jhydrol.2013.02.052](https://doi.org/10.1016/j.jhydrol.2013.02.052))
- ❑ Cosh, M., **Tao, J.**, Jackson, T.J., McKee, L. G. and O’Neill, P., **2010**. Vegetation Water Content Mapping in a Diverse Agricultural Landscape: The National Airborne Field Experiment 2006. *Journal of Applied Remote Sensing*, 4(1):1-12. ([doi: 10.1117/1.3449090](https://doi.org/10.1117/1.3449090))
- ❑ Shi, J., Jackson, T. J., **Tao, J.**, Du, J., Bindlish, R., Lu, L. and Chen, K. S., **2008**. Microwave vegetation indices for short vegetation covers from satellite passive microwave sensor AMSR-E. *Remote sensing of Environment*, 112, 4285-4300. ([doi:10.1016/j.rse.2008.07.015](https://doi.org/10.1016/j.rse.2008.07.015))

PEER-REVIEWED BOOK CHAPTER

- ❑ Wu, H., **Tao, J.***, Yamazaki, D., Chen, W., Huang, Z., Li, C., Kimball, J., **2021**. Chapter 12 - Digital Elevation Model and Drainage Network Data Sets for Global Flood and Drought Modeling. *Geophysical Monograph Series Book << Global Drought and Flood: Observation, Modeling, and Prediction >>*. ISBN: 978-1-119-42730-8. (<https://doi.org/10.1002/9781119427339.ch12>)

PUBLISHED DATA SETS

- ❑ **Tao, J.**, Reichle, R. H., Koster, R. D., Forman, B. A. and Xue, Y., 2017. Soil temperature simulation results in Alaska (1980 - 2014) – Data archive for “Evaluation and enhancement of permafrost modeling with the NASA Catchment Land Surface Model.” Digital Repository at the University of Maryland (DRUM). ([doi: 10.13016/M2K649V0F](https://doi.org/10.13016/M2K649V0F))
- ❑ **Tao, J.** and Barros, A. P., 2013. The Integrated Precipitation and Hydrology Experiment. Part I: Quality

High-Resolution Landscape Attributes Datasets. DukeSpace of the Duke University Libraries. ([doi: 10.7924/G8H41PBG](https://doi.org/10.7924/G8H41PBG))

- ❑ **Tao, J.** and Barros, A. P., 2013. The Integrated Precipitation and Hydrology Experiment. Part II: Atmospheric Forcing and Topographic Corrections. DukeSpace of the Duke University Libraries. ([doi: 10.7924/G8RN35S6](https://doi.org/10.7924/G8RN35S6)).

PROCEEDING PUBLICATIONS

- ❑ **J. Tao**, J.C. Shi, T.J. Jackson, J. Du, R. Bindlish, and L.X. Zhang, “Monitoring Vegetation Water Content Using Microwave Vegetation Indices,” *IEEE International Geoscience and Remote Sensing Symposium*, vol.1, no., pp.I-197-I-200, July 7-11, 2008. ([doi: 10.1109/IGARSS.2008.4778827](https://doi.org/10.1109/IGARSS.2008.4778827)).
- ❑ Li. Chai, J.C. Shi, J. Du, **J. Tao**, T.J. Jackson, P.E. O'Neill, Li. Zhang, Y. Qu, J. Wang. "A study on estimation of aboveground wet biomass based on the microwave vegetation indices," *IEEE International Geoscience and Remote Sensing Symposium*, vol.3, no., pp.III-924-III-927, July 12-17, 2009. ([doi: 10.1109/IGARSS.2009.5417923](https://doi.org/10.1109/IGARSS.2009.5417923)).
- ❑ T. J. Jackson ; J. C. Shi ; R. Bindlish ; M. Cosh ; L. Chai ; J. Du ; S. Zhao and **J. Tao** "Validation of microwave vegetation indices using field experiment data sets", *Proc. SPIE 7454, Remote Sensing and Modeling of Ecosystems for Sustainability VI*, 745406, August 20, 2009. ([doi:10.1117/12.823891](https://doi.org/10.1117/12.823891)).
- ❑ T.J. Jackson, J.C. Shi, and **J. Tao**, “Microwave vegetation indices derived from satellite microwave radiometers,” *Proc. SPIE 7083, Remote Sensing and Modeling of Ecosystems for Sustainability V*, vol. 7083, p. 708302. September 10, 2008. ([doi: 10.1117/12.790529](https://doi.org/10.1117/12.790529)).
- ❑ J.C. Shi, T.J. Jackson, **J. Tao**, J. Du, R. Bindlish, “Microwave Vegetation Indices Derived from Satellite Microwave Radiometers,” *IEEE International Geoscience and Remote Sensing Symposium*, vol., no., pp.1412-1415, July 23-28, 2007. ([doi: 10.1109/IGARSS.2007.4423071](https://doi.org/10.1109/IGARSS.2007.4423071) 1412-1415).

INVITED TALK

- ❑ “Ecosystem Resilience and Carbon Emissions over pan-Arctic Permafrost Region”, Woodwell Climate Research Center, Falmouth, MA, USA. February 5, 2021
- ❑ “Water Resources and Water-related Natural Hazards in a Changing Climate”, School of Atmospheric Sciences, Sun Yat-sen University, Zhuhai, Guangdong Province, China. January 7, 2019.
- ❑ “Water Resources and Water-related Natural Hazards in a Changing Climate”, School of Geography and Ocean Science, Nanjing University, Nanjing, Jiangsu Province, China. December 24, 2018.
- ❑ “Natural Hazards in a Changing Climate: Floods, Landslides, and Permafrost Degradation”, School of Geography, Beijing Normal University, Beijing, China. October 17, 2018.
- ❑ “Natural Hazards in a Changing Climate: Floods, Landslides, and Permafrost Degradation”, Earth System Science Programme, Faculty of Science, The Chinese University of Hong Kong, Hong Kong, China. September 14, 2018.
- ❑ “Water-related challenges under a warming climate: floods, landslides, and permafrost degradation.” Hydrology and Remote Sensing Lab (HRSL) at Beltsville Agriculture Research Center (BARC), United States Dept. of Agriculture (USDA). Maryland, USA. June 14, 2018.

CONFERENCE PRESENTATIONS

❑ **Oral Presentations:**

- **J. Tao**, Q. Zhu, W.J. Riley, R.B. Neumann. “How Snow-to-Rain Shift Regulates Cold-Season Carbon

Emissions from Arctic Tundra”, *the 35th Conference on Hydrology at the AMS 101st Virtual Annual Meeting*. Jan. 13, 2021.

- **J. Tao**, Q. Zhu, W.J. Riley, R.B. Neumann. “The increasing trend in warm-season net CO₂ uptake outweighs that in cold-season emissions from the Alaskan Arctic tundra under a warming climate”. *2020 AGU Fall Meeting*. Dec. 14, 2020.
- **J. Tao**, Q. Zhu, W.J. Riley, R.B. Neumann and G. Bisht. “Improved Simulation of Cold-season Methane Emissions over Alaska’s Permafrost with the E3SM Land Model (ELM)”. *2019 AGU Fall Meeting*. San Francisco, California, USA. Dec. 9-13, 2019.
- **J. Tao**, R.D. Koster, R.H. Reichle, B.A. Forman, Y. Xue, R.H. Chen and M. Moghaddam. “Permafrost Variability over the Northern Hemisphere Based on the MERRA-2 Reanalysis”. *2018 AGU Fall Meeting*. Washington, D.C., USA. Dec.10-14, 2018.
- **J. Tao**, R.H. Reichle, R. Koster, B.A. Forman, Y. Xue. “Impact of Vegetation and Snow on Permafrost Variability,” *75th Annual Eastern Snow Conference*, Maryland, USA. Jun. 5-8, 2018.
- **J. Tao**, R.H. Reichle, R. Koster, B.A. Forman, Y. Xue. “Improving thermodynamic representation in permafrost modeling within the NASA Catchment Land Surface Model,” *2016 AGU Fall Meeting*, San Francisco, California, USA. Dec. 12-16, 2016.
- **J. Tao** and A.P. Barros. “Improving river discharge estimation by assimilating GRACE terrestrial water storage (TWS) retrievals into a distributed hydrological model: Water budget analysis in the Upper Zambezi River Basin (UZRB) and the Northern Kalahari Aquifer (NKA) in Southern Africa”, *the 28th Conference on Hydrology at the 94th AMS Annual Meeting*, Atlanta, Georgia, USA. Feb. 2-6, 2014.
- **J. Tao** and A.P. Barros. “Toward Quantitative Flash-Floods Forecast (QFF) in Complex Terrain – A Demonstration of Satellite Observations Utility for Operational QFF in the Southern Appalachians,” *2012 Great Smoky Mountains National Park Science Colloquium*, Gatlinburg, Tennessee, USA. Mar. 22-24, 2012.
- **J. Tao**, J.C. Shi, T.J. Jackson, J. Du, R. Bindlish, and L.X. Zhang. “Monitoring Vegetation Water Content Using Microwave Vegetation Indices,” *IEEE International Geoscience and Remote Sensing Symposium*, Boston, Massachusetts, USA. Jul. 6-11, 2008.
- **J. Tao** and J.C. Shi. “New Microwave Vegetation Indexes: Characteristic and Application,” *Detecting the Atmospheric Response to the Changing Face of the Earth: A Focus on Human-Caused Regional Climate Forcing, Land-Cover/Land-Use Change, and Data Monitoring*, Boulder, Colorado, USA. Aug. 27-29, 2007.
- **J. Tao**, J.C. Shi, and H. Yang. “The Development of Soil Moisture Retrieval Algorithm of FY-3 MWRI”, *the 2nd workshop on science and technology of Microwave*, Shenzhen, China. Dec. 18–22, 2006.
- **J. Tao** and J.C. Shi. “Comparisons of AMSR-E Soil Moisture Products over Tibet with In-situ Data,” *the 1st International workshop on energy and water cycle over the Tibetan Plateau*, Lhasa, Xizang, China. Sep. 3-6, 2006.

❑ **Poster Presentations:**

- **Tao, Jing**, Qing Zhu, William J. Riley, Gautam Bisht, Joel Eklof, and Rebecca Bergquist Neumann. "The role of advective heat transfer in affecting permafrost thaw and methane emissions at a hillslope thermokarst bog." In AGU Fall Meeting 2021. AGU, 2021.
- Eklof, Joel, Mark P. Waldrop, Baptiste Dafflon, Benjamin M. Jones, **Jing Tao**, and Rebecca Bergquist Neumann. "High-Resolution Thaw Dynamics of Two Latitudinally Distant Alaska Thermokarst Sites: A Field Study." In AGU Fall Meeting 2021. AGU, 2021.

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- **J. Tao**, Q. Zhu, W.J. Riley, R.B. Neumann. “Snow-to-Rain Shifts Regulate Carbon Emissions From pan-Arctic Permafrost Regions”. Regional Conference on Permafrost (RCOP) and 19th International Conference on Cold Regions Engineering (ICCRE), Oct., 2021.
 - J. Eklof, M. Waldrop, **J. Tao**, B. Neumann. “Watershed Effects on Local Carbon Emissions in Subarctic Bogs”. *2020 AGU Fall Meeting*. Dec. 14, 2020.
 - **J. Tao**, Q. Zhu, W.J. Riley, R.B. Neumann. “Improved Simulation of Cold-season CH₄ and CO₂ emissions over Alaska North Slope Tundra with the E3SM Land Model”, ABoVE Science Team Meeting, June 1st-4th, 2020.
 - Q. Zhu, R. Neumann, W. J. Riley, **J. Tao**, and G. Bisht. “Evaluation of high-latitude CH₄ emissions and their functional responses in the E3SM land model”, *DOE-ESS PI meeting*, Potomac, Maryland, USA. Apr. 30 -May 1, 2019.
 - **J. Tao**, K. N. Musselman, M. P. Clark, R. D. Koster, R. H. Reichle, and B. A. Forman. “Towards a General Snow Thermal Conductivity Scheme in Land Models”, *the 99th American Meteorological Society Annual Meeting*, Phoenix, Arizona, USA. Jan. 6 – 10, 2019.
 - **J. Tao**, R. H. Reichle, R. Koster, B. A. Forman, Y. Xue, R. Chen and M. Moghaddam. “Permafrost degradation in high-latitude regions in recent decades,” *2017 American Geophysical Union Fall Meeting*, New Orleans, Louisiana, USA. Dec. 11-15, 2017.
 - **J. Tao**, D. Wu, J. J. Gourley, S. Zhang, W. Crow, C. D. Peters-Lidard, and A. P. Barros. “Operational Hydrological Forecasting during the IPHEX-IOP Campaign – Meet the Challenge,” *the 30th Conference on Hydrology at the 96th American Meteorological Society Annual Meeting*, New Orleans, Louisiana, USA. Jan. 10-14, 2016.
 - **J. Tao** and A.P. Barros. “Assimilating discharge observation to improve operational hydrological forecast in the Southern Appalachians during the IPHEX-IOP”, *the joint workshop of the 6th International Workshop on Catchment Hydrological Modeling and Data Assimilation (CAHMDA-VI) and the 3rd International Workshop on Data Assimilation for Operational Hydrology and Water Management of the Hydrologic Ensemble Prediction Experiment (HEPEX-DAFOH III)*, Austin, Texas, USA. Sep. 8-12, 2014.
 - **J. Tao**, M. Nogueira, D. Wu, Y. Duan, L. Lowman, C.D. Peters-Lidard and A.P. Barros. “H4SE - Operational Hydrological Forecasting during the IPHEX-IOP”, *2014 NASA Precipitation Measurement Missions (PMM) Science Team Meeting*, Baltimore, Maryland, USA. August 4-8, 2014.
 - **J. Tao**, A.P. Barros, E. Bryant and C.D. Peters-Lidard. “A High-Resolution Hydrometeorological Forcing and Landscape Attributes Data Set for Hydrological Applications over the Southeastern United States”, *2012 American Geophysical Union Fall Meeting*, San Francisco, California, USA. Dec. 3-7, 2012.
 - **J. Tao**, A. Wilson, A.P. Barros, and R. Wooten. “Using a Spatially Dense, High Elevation Rain Gauge Network and a Hydrologic Model to Enhance Predictability of Landslides in the Southern Appalachians,” *the Geological Society of America's 124th Annual Meeting*, Charlotte, North Carolina, USA. Nov. 4-7, 2012.
 - **J. Tao** and A.P. Barros. “Water Budget Analysis of the Upper Zambezi River Basin (UZRB) and the Northern Kalahari Aquifer (NKA),” *the 26th Conference on Hydrology at the 92nd American Meteorological Society Annual Meeting*, New Orleans, Louisiana, USA. Jan. 22-26, 2012.
 - **J. Tao** and A.P. Barros. “A Demonstration of GPM Utility for Operational QFF Applications in Complex Terrain,” *the 18th Conference on Satellite Meteorology, Oceanography and Climatology/First Joint AMS-Asia Satellite Meteorology Conference at the 92nd American Meteorological Society Annual Meeting*, New Orleans, Louisiana, USA. Jan. 22-26, 2012.
 - **J. Tao** and A.P. Barros. “Summertime Flash Floods in the Southern Appalachians,” *the 25th Conference on Hydrology at the 91st American Meteorological Society Annual Meeting*, Seattle, Washington, USA. Jan.

23-27, 2011.

– **J. Tao** and A.P. Barros. “An Observing System Simulator for GPM Precipitation Products in Regions of Complex Terrain: Initial development and QPE Applications in the Southern Appalachians,” *2010 American Geophysical Union Fall Meeting*, San Francisco, California, USA. Dec. 13-17, 2010.

GRANTS AND AWARDS

- ❑ “High-resolution coastal land-aquatic system biogeochemical cycle modelling.” DOE Office of Science, BER, Earth and Environmental Systems Sciences Division (DE-FOA-0002593), 2022. (Submitted)
- ❑ “Improving ELM representations of thermokarst landscapes and associated hydro-biogeochemical and ecosystem dynamics over pan-Arctic permafrost regions.” DOE Office of Science, BER, Earth and Environmental Systems Sciences Division (DE-FOA-0002392), 2021. (Declined)
- ❑ NASA Earth and Space Science Fellowship (NESSF), 2010-2012, Funded.
- ❑ Graduate Student Fellowship and Research Assist., Dept. of CEE, Duke University, 2009-2015
- ❑ Travel Award, Department of Civil & Environmental Engineering, Duke University, 2014
- ❑ IEEE Geoscience and Remote Sensing Symposium (IGARSS) Travel Award, 2008
- ❑ Travel Award from an NSF-sponsored workshop on Human-Caused Regional Climate Forcing, Land-Cover/Land Use Change, and Data Monitoring, 2007

TEACHING CERTIFICATE AND EXPERIENCE

- ❑ **LECTURER** for [ENSP340 Water: Science, Ethics, and Policy](#), Environmental Science, and Policy (ENSP) Program, University of Maryland. Fall Semester in 2016.
- ❑ **TEACHING ASSISTANT** for [CE123 Water Resources Engineering](#) at the Department of Civil and Environmental Engineering, Duke University. Spring and Fall Semester in 2011.
- ❑ [Certificate in College Teaching](#) (Sep. 2015), Certificate Program, Duke University.

PROFESSIONAL SERVICES

- ❑ Proposal reviewer for NASA ROSES, USAID MERC, and NSF Hydrologic Sciences Program.
- ❑ Reviewer for Water Resources Research (WRR), Hydrology and Earth System Sciences (HESS), Hydrological Processes (HYP), Journal of Hydrometeorology (JHM), Journal of Hydrology (HYDROL), Environmental Research Letters (ERL), Permafrost and Periglacial Processes (PPP), Environmental Science & Technology (ES&T), etc.
- ❑ AMS Hydrology Committee, 2020 to present
- ❑ AGU Hydrology Section, Research Grant Committee, 2021 to present.
- ❑ AGU OSPA Judge, AGU Fall meeting, 2017 to Present.
- ❑ AGU Session Chair and Co-convener, AGU Fall meeting, 2019 and 2021.
- ❑ 2021 Regional Conference on Permafrost (RCOP) and 19th International Conference on Cold Regions Engineering (ICCRE), Program/Technical Committee, 2021.

PROFESSIONAL MEMBERSHIPS

- ❑ American Geophysical Union (AGU)
- ❑ American Meteorological Society (AMS)
- ❑ International Permafrost Association (IPA)
- ❑ US Permafrost Association (USPA)

- ❑ Permafrost Carbon Network (PCN)
- ❑ Permafrost Young Researchers Network (PYRN)