

Peter B. Buhler

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Education:

2018 Ph.D., Planetary Science, California Institute of Technology
 Advisor: Profs. Andrew P. Ingersoll & Bethany L. Ehlmann
2015 M.S., Planetary Science, California Institute of Technology
2012 B.S., Geology with honors, California Institute of Technology

Competitive Awards:

2022 Outstanding Reviewer - JGR Planets
2019 JPL Planetary Science Summer Seminar Invited Participant
2018-2020 NASA Postdoctoral Program Fellow
2018 Caltech Leadership Award
2017 Caltech Space Challenge Winner
2016-2018 NASA Earth and Space Science Fellow
2016 NASA Mars Program Office Student Travel Grant Awardee
2015 Duncombe Prize, AAS Division on Dynamical Astronomy
2012-2013 Thomas J. Watson Fellow
2012 Caltech Athletic Director's Award; Caltech Sportsman of the Year
2009-2011 Caltech Summer Undergraduate Research Fellowship, Richter Scholar

Research Experience:

2020- Research Scientist, Planetary Science Institute
2018-2020 NASA Postdoctoral Program Fellow, Jet Propulsion Lab
2013-2018 Graduate Research Assistant, Caltech
2013 Visiting Scientist, University of Antofagasta, Chile
 Visiting Scientist, Centro de Astrobiología, Madrid, Spain
2012 Visiting Scientist, Meteorite Studies, Western Australian Museum
 Researcher, Joggins Fossil Cliffs, Nova Scotia, Canada
 Curator Assistant and Field Assistant, Royal Tyrrell Museum, Canada
2009-2011 Summer Undergraduate Research Fellow, Brown University/Caltech

Teaching Experience:

2020 Founder, Sirius Academic Institute
2018 Caltech Project for Effective Teaching, Certificate of Practice Recipient
2018 Guest Lecture, Formation & Evolution of Planetary Systems, Caltech Ge/Ay 133
2014-2015 Institute for Educational Advancement, Course Instructor
2011-2018 Caltech Teaching Assistant (6 courses)

Select Outreach:

2019 Invited Speaker at Caltech Geologic and Planetary Science Techer Talk
2017-2018 Caltech Reel Science host (program for school grades 3-12)
2017 Invited speaker at Caltech Geologic and Planetary Science 90th Anniversary

Projects:

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| 2020-2023 | PI, NASA SSW Grant 80NSSC21K0212 |
| 2021-2024 | PI, NASA MDAP Grant 80NSSC21K1088 |
| 2023 | Consultant, NASA NIAC Grant 22-NIAC23B-0125 |
| 2023-2026 | PI, NASA MDAP Grant 80NSSC23K1160 |
| 2023-2026 | CO-I, NASA MDAP Grant 80NSSC23K1076 |

Peer-Reviewed Articles:

- [16] **Buhler, P.B.**, 2023. A 510,000-Year Record of Mars' Climate. *Geophysical Research Letters*, 50(5), p.e2022GL101752.
- [15] Wynne, J.J., Mylroie, J.E., Titus, T.N., Malaska, M.J., Buczkowski, D.L., **Buhler, P.B.**, Byrne, P.K., Cushing, G.E., Davies, A.G., Frumkin, A. and 20 others, 2022. Planetary caves: A solar system view of processes and products. *Journal of Geophysical Research: Planets*, 127(11), p.e2022JE007303.
- [14] Becerra, P., Smith, I.B., Hibbard, S., Andres, C., Bapst, J., Bramson, A., **Buhler, P.B.**, Coronato, A., Diniega, S., Emmett, J., and 12 others, 2021. Past, Present, and Future of Mars Polar Science: Outcomes and outlook from the 7th International Conference on Mars Polar Science and Exploration. *Planetary Science Journal*, In press.
- [13] Titus, T.N., Wynne, J.J., Malaska, M.J., Agha-Mohammadi, A.A., **Buhler, P.B.**, Alexander, E.C., Ashley, J.W., Azua-Bustos, A., Boston, P.J., Buczkowski, D.L. and 32 others, 2021. A roadmap for planetary caves science and exploration. *Nature Astronomy*, 5(6), pp.524-525.
- [12] **Buhler, P.** and Piqueux, S., 2021. Obliquity-Driven CO₂ Exchange Between Mars' Atmosphere, Regolith, and Polar Cap. *Journal of Geophysical Research: Planets* 126, p. e2020JE006759. doi: 10.1029/2020JE006759
- [11] Diniega, S., Bramson, A.M., Buratti, B., **Buhler, P.**, Burr, D.M., Chojnacki, M., Conway, S.J., Dundas, C.M., Hansen, C.J., McEwen, A.S. and Lapôtre, M.G., 2021. Modern Mars' geomorphological activity, driven by wind, frost, and gravity. *Geomorphology*, p.107627. doi: 10.1016/j.geomorph.2021.107627
- [10] Moore, K., Courville, S., Ferguson, S., Schoenfeld, A., Llera, K., Agrawal, R., **Buhler, P.**, Brack, D., Connour, K., Czapinski, E. and 14 others, 2020. Bridge to the stars: A mission concept to an interstellar object. *Planetary and Space Science*, p.105137. doi: 10.1016/j.pss.2020.105137
- [9] Smith, I.B., Hayne, P.O., Byrne, S., Becerra, P., Kahre, M., Calvin, W., Hvidberg, C., Milkovich, S., **Buhler, P.B.**, Landis, M., and 28 others, 2020. The Holy Grail: A road map for unlocking the climate record stored within Mars' polar layered deposits. *Planetary and Space Science*, p. 104841. doi: 10.1016/j.pss.2020.104841
- [8] **Buhler, P.B.**, Piqueux, S., Ingersoll, A.P., Ehlmann, B.L., Hayne, P.O., 2019. Co-Evolution of Mars's Atmosphere and Massive South Polar CO₂ Ice Deposit. *Nature Astronomy*.doi:10.1038/s41550-019-0976-8
- [7] **Buhler, P.B.** and Ingersoll, A.P. (2018). Sublimation Pit Distribution Indicates Convection Cell Surface Velocities of ~10 Centimeters per Year in Sputnik Planitia, Pluto. *Icarus* 300, 327–340. doi:10.1016/j.icarus.2017.09.018

- [6] **Buhler, P.B.**, Ingersoll, A.P., Ehlmann, B.L., Fassett, C.I., Head, J.W. (2017). How the Martian Residual South Polar Cap Develops Quasi-Circular and Heart-Shaped Pits, Troughs, and Moats. *Icarus*, 286, 69-93. doi:10.1016/j.icarus.2017.01.012
- [5] **Buhler, P.B.** and Grey, M. (2016). Xiphosuran Digging Traces at the Late Carboniferous Joggins Fossil Cliffs UNESCO World Heritage Site, Nova Scotia, Canada. *Ichnos* 23, 1-12. doi:10.1080/10420940.2016.1244055
- [4] **Buhler, P.B.**, Knutson, H.A., Batygin, K., Fulton, B.J., Fortney, J.J., Burrows, A., Wong, I. (2016). Dynamical Constraints on the Core Mass of Hot Jupiter HAT-P-13b. *The Astrophysical Journal* 821, 26-37. doi:10.3847/0004-637X/821/1/26
- [3] Artieda, O., Davila, A.F., Wierzchos, J., **Buhler, P.B.**, Rodríguez-Ochoa, R., Pueyo, J.J. and Ascaso, C. (2015). Surface Evolution of Salt-Encrusted Playas under Extreme and Continued Dryness. *Earth Surface Processes and Landforms* 40 (14), 1939-1950. doi:10.1002/esp.3771
- [2] **Buhler, P.B.**, Fassett, C.I., Head, J.W., Lamb, M.P. (2014). Timescales of Fluvial Activity and Intermittency at Milna Crater, Mars. *Icarus* 241, 130-147. doi:10.1016/j.icarus.2014.06.028.
- [1] **Buhler, P.B.**, Fassett, C.I., Head, J.W., Lamb, M.P. (2011). Evidence for Paleolakes in Erythraea Fossa, Mars: Implications for an Ancient Hydrological Cycle. *Icarus* 213, 104-115. doi:10.1016/j.icarus.2011.03.004.

Technical Skills and Training:

Extensive experience (>10 yr) with Python, Mathematica, ESRI ArcMap, Adobe Illustrator, and Photoshop. Field experience: Sierra Nevada, California; Drumheller, Alberta; Rio Tinto, Spain; Atacama Desert, Chile. Languages: English (native), Spanish (highly proficient), Mandarin (intermediate). Former Caltech swimming record holder.

Select Invited Talks and Workshop Participation:

Pitting Evolution, Distribution, and Timescales in Sputnik Planitia. 2018. New Horizons Pluto Climate Workshop.

Unlocking the Climate Record Stored within Mars' Polar Layered Deposits. 2017. Keck Institute for Space Science Workshop.

Professional Service:

Reviewer: *Icarus*, *Planetary and Space Science*, *Planetary Science Journal*, *Journal of Geophysical Research*; NASA MDAP, DDAP

Press Releases:

Mystery at Mars's Pole Explained. <https://www.caltech.edu/about/news/mystery-marss-pole-explained>

Mars' 100,000-Year 'Deep Breaths' Are Even Deeper than Expected. www.psi.edu/news/marssurfaceice

Layering History Shows How Water and Carbon Dioxide Have Moved Across Mars.

<https://www.psi.edu/news/marswatermovementhistory>

Conference Abstracts:

[31] Buhler, P.B., 2023, Paleo-Extent of Mars' Massive CO₂ Ice Deposit. LPSC 2023, #1223

[30] Buhler, P.B., 2023. A 510,000-Year History of Mars' Global Water Transport. LPSC 2023, #1222

[29] Smith, I.B., Schlegel, N., Larour, E., Isola, I., Buhler, P., Putzig, N. E., and Greve, R. 2022. CO₂ Glaciers on the South Polar Layered Deposits of Mars. LPSC 2022, #2511

- [28] Buhler, P. B., 2022. Mars' Noachian-Hesperian Intensive Fluvial Activity Driven by Atmospheric Collapse. LPSC 2022, #1013
- [27] Buhler, P. B. and Smith, I. B., 2022. Mars' South Polar Carbon Dioxide Glacier Crevasses. LPSC 2022, #1014
- [26] Buhler, P. B. and Piqueux, S., 2021. Mars' Obliquity-Driven Mobile CO₂ Inventory Derived from Polar Stratigraphy. LPSC 2021, #2218
- [25] Smith, I. B., Schlegel, N., Larour, E., Isola, I., Buhler, P., Putzig, N. E., and Greve, R. 2021. CO₂ Glaciers on the South Polar Layered Deposits of Mars. LPSC 2021, #2573
- [24] Buhler, P.B. and Piqueux, S., 2020. Mars' Massive CO₂ Ice Deposit Stratigraphy Indicates Mars' Exchangeable CO₂ inventory is ≤ 33 mbar. LPSC 2020, #1549
- [23] Courville, S.W., Moore, K., Connour, K., Ferguson, S., Agrawal, R., Brack, D., Buhler, P., Czaplinski, E., DeLuca, M., Deautsch, A., and 14 others, 2020. Bridge to the Stars: A Mission Concept to an Interstellar Object. LPSC 2020, #1766
- [22] Buhler, P.B., Piqueux, S., Ingersoll, A.P., Ehlmann, B.L., Hayne, P.O., 2020. Co-Evolution of the Martian Atmosphere and South Polar Massive CO₂ Deposit. 7th Int. Conf. Mars Polar Sci. #6006
- [21] Buhler, P.B., Piqueux, S., Ingersoll, A.P., Ehlmann, B.L., Hayne, P.O., 2019. The Co-Evolution of Mars' Atmosphere and Massive South Polar CO₂ Deposit. AGU P51C-01
- [20] Buhler, P.B., Piqueux, S., Ingersoll, A.P., Ehlmann, B.L., Hayne, P.O., 2019. The Co-Evolution of Mars' Atmosphere and South Polar Massive CO₂ Ice Deposit. 51st DPS-EPSC. #31
- [19] Buhler, P.B., Piqueux, S., Ingersoll, A.P., Ehlmann, B.L., Hayne, P.O., 2019. The Co-Evolution of Mars' Atmosphere and Massive South Polar CO₂ Ice Deposit. 9th Int. Conf. Mars. #6008
- [18] Buhler, P.B., Piqueux, S., Ingersoll, A.P., Ehlmann, B.L., Hayne, P.O., 2019. The Origin, Age, and Stratigraphy of Mars' Massive South Polar CO₂ Deposit and Its Control of Mars' Atmospheric Pressure. 50th LPSC. #1031
- [17] Buhler, P.B., Dickson, J., Ehlmann, B.L., Ingersoll, A.P., Byrne, S., Tao, Y., Muller, J-P., 2018. Prospects for Measuring Vertical Change on the Martian Residual South Polar Cap Using HiRISE Digital Elevation Models. 49th LPSC. #2908
- [16] Buhler, P.B., Piqueux, S., Ingersoll, A.P., Ehlmann, B.L., Hayne, P.O., 2018. EnTOMBR: An Energy Balance Model for Exploring the Sequestration of the Massive Martian Buried CO₂ Ice Deposit. 49th LPSC. #2878
- [15] Buhler, P.B. & Ingersoll, A.P., 2017. Sputnik Planitia, Pluto Convection Cell Surface Velocities of ~10 Centimeters per Year Based on Sublimation Pit Distribution. 49th DPS. #102.04
- [14] Buhler, P.B., Fassett, C.I., Head, J.W., Lamb, M.P., 2017. Fluvial Volumes, Timescales, and Intermittency in Milna Crater, Mars. 4th Early Mars. #3053

- [13] Carberry Mogan, S.R., Kurzrok, A., Anand, A., Ben Hamida, S., Buhler, P.B., and 11 others, 2017. Caltech Space Challenge – Lunarport: Lunar Extraction for Extraterrestrial Prospecting (LEEP). AIAA SPACE Forum. #2017-5373
- [12] Buhler, P.B. & Ingersoll, A.P., 2017. Sublimation Pit Distribution Indicates Convection Cell Surface Velocity of ~10 Centimeters per Year in Sputnik Planitia, Pluto. 48th LPSC. #1746
- [11] Buhler, P.B., Ingersoll, A.P., Ehlmann, B.L., Fassett, C.I., Head, J.W., 2016. New Observations Reveal How the Martian Residual South Polar Cap Develops Quasi-Circular Pits, Heart-Shaped Pits, Troughs, and Moats. DPS 48. #513.01
- [10] Buhler, P.B., Ingersoll, A.P., Ehlmann, B.L., Fassett, C.I., Head, J.W., 2016. New Observations Reveal How the Martian South Polar Residual Cap Develops Heart-Shaped and Quasi-Circular Pits, Troughs, and Moats. 6th Int. Conf. Mars Pol. Sci. #6070
- [9] Buhler, P.B., Fassett, C.I., Head, J.W., Lamb, M.P., 2016. Timescales of Fluvial Activity and Intermittency in Milna Crater, Mars. 47th LPSC. #2587
- [8] Buhler, P.B., Knutson, H.K., Batygin, K., Fulton, B.J., Burrows, A., Fortney, J., 2016. Dynamical Constraints on the Core Mass of Hot Jupiter HAT-P-13b. 227th AAS. #406.07
- [7] Buhler, P.B., Ingersoll, A.P., Ehlmann, B.L., Fassett, C.I., Head, J.W., 2016. How the Martian South Polar Residual Cap Loses Mass. 47th LPSC. #2550
- [6] Buhler, P.B., Knutson, H.K., Batygin, K., 2015. Dialing the Love Number of Hot Jupiter HAT-P-13b. 2015 Division on Dynamical Astronomy Meeting. #46
- [5] Wong, M.L., Ingersoll, A.P., Ehlmann, B.L., Pilorget, C., Buhler, P.B., 2014. The Case for Stable Entombed CO₂ in Mars' South Polar Layered Deposits. 8th Int. Conf. Mars. #1472.
- [4] Buhler, P.B., Day, K., Grotzinger, J.P., Calef, F., 2011. The Search for Fresh Craters in the MSL Landing Ellipses. Fifth Mars Science Laboratory Landing Site Workshop.
- [3] Day, M.D., Calef, F.J., Buhler, P.B., Grotzinger, J.P., 2011. Small Crater Analysis of the Mars Science Laboratory Landing Site. 42nd LPSC. #P33C-1773
- [2] Buhler, P.B., Hydrological Context for Holden and Eberswalde Craters: A Study of Erythraea Fossa, 2010. Fourth Mars Science Laboratory Landing Site Workshop.
- [1] Buhler, P.B., Head, J.W., Lamb, M.P., 2009. Fluvial Activity in Erythraea Fossa: A System of Three Open Basin Paleolakes. Brown-Vernadsky Microsymposium.

White Papers

Brown, A.J., Videen, G., Zubko, E., Heavens, N., Schlegel, N-J., Beccera, P., Meyer, C., Harrison, T., Hayne, P., Obbard, R., Michaels, T., Wolff, M., Guzewich, S., Newman, C., Grund, C., Sim, C., Spiga, S., Buhler, P., Landis, M., Stubbs, T., Jha, D., 2020. The case for a multi-channel polarization sensitive LIDAR for investigation of insolation-driven ices and atmospheres Planetary Science Decadal Survey White Paper. Earth and Space Science Open Archive ESSOAr

Smith, I., Paul O Hayne, Shane Byrne, Patricio Becerra, Melinda Kahre, Wendy Calvin, Christine Hvidberg, Sarah Milkovich, Peter Buhler, Margaret Landis, BrionyHorgan, Armin Kleinböhl, Matthew R Perry, Rachel Obbard, Jennifer Stern, Sylvain Piqueux, Nicolas Thomas, Kris Zacny, Lynn Carter, Lauren Edgar, Jeremy Emmett, Thomas Navarro, Jennifer Hanley, Michelle Koutnik, Nathaniel Putzig, Bryana L Henderson, John W Holt, Bethany Ehlmann, Sergio Parra, Daniel Lalich, Candice Hansen, Michael Hecht, Don Banfield, Ken Herkenhoff, David A Paige, Mark Skidmore, Robert L Staehle, Matthew Siegler, A Soto, F Foss, S Lewis, J Whitten, E Vos, PA Johnson, JC Johnson, C Gallagher, A Brown, T Bertrand, C Phillips-Lander, N Oliveira, E Kite, T Thorsteinsson, L Tamppari, E Hauber, L Fanara, J Oberst, S Ulamec, S Cartwright, T Harrison, S Hibbard, A Portyankina, and TN Titus, 2021.Unlocking the Climate Record Stored within Mars' Polar Layered Deposits. *Bulletin of the American Astronomical Society* 53(4), 378.

Diniega, S., Ali Bramson, Bonnie Buratti, Peter Buhler, Devon Burr, Matt Chojnacki, Susan Conway, Ingrid Daubar, Cynthia L Dinwiddie, Anna GrauGalofre, Brian Jackson, Alfred McEwen, Mathieu Lapôte, Joseph Levy, Lauren McKeown, Sylvain Piqueux, Anya Portyankina, Scot Rafkin, Simone Silvestro, Isaac Smith, Christy Swann, and Jacob Widmer, 2021. Mars as a " natural laboratory" for studying surface activity on a range of planetary bodies. *Bulletin of the American Astronomical Society* 53(4), 123.

Smith, I.B., WM Calvin, DE Smith, C Hansen, S Diniega, A McEwen, N Thomas, D Banfield, TN Titus, P Becerra, M Kahre, F Forget, M Hecht, S Byrne, CS Hvidberg, PO Hayne, M Mellon, B Horgan, J Mustard, JW Holt, A Howard, D McCleese, C Stoker, P James, NE Putzig, J Whitten, P Buhler, A Spiga, M Crismani, KM Aye, A Portyankina, R Orosei, A Bramson, J Hanley, M Sori, O Aharonson, S Clifford, H Sizemore, G Morgan, B Hartmann, N Schorghofer, R Clark, D Berman, D Crown, F Chuang, M Siegler, EN Dobreá, K Lynch, RW Obbard, MR Elmaary, D Fisher, A Kleinboehl, M Balme, B Schmitt, M Daly, RC Ewing, KE Herkenhoff, L Fenton, SD Guzewich, M Koutnik, J Levy, R Massey, A Łosiak, V Eke, D Goldsby, A Cross, T Hager, S Piqueux, A Kereszturi, K Seelos, S Wood, E Hauber, C Amos, P Russell, R Jaumann, G Michael, S Conway, A Khayat, S Lewis, G Luizzi, G Martinez, K Mesick, L Montabone, A Johnsson, A Pankine, C Phillips-Lander, P Read, L Edgar, K Zacny, A McAdam, A Rutledge, T Bertrand, J Widmer, D Stillman, A Soto, Z Yoldi, R Young, A Svensson, L Sam, and M Landis, 2021.Solar-System-Wide Significance of Mars Polar Science. *Bulletin of the American Astronomical Society* 53(4), 301.