Sudhanshu Pandey, Ph.D.

Scientist, Earth Science Section
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Professional Experience

Scientist *Jan 2022 – Present*
NASA Jet Propulsion Laboratory (JPL), Pasadena, CA, USA
Methane Modeling Lead for the U.S. Greenhouse Gas Center (GHGC) at JPL

Scientist *Aug 2016 – Jan 2022*
SRON Netherlands Institute for Space Research, Utrecht, The Netherlands

Education

Ph.D. in Physics *Aug 2012 – Feb 2017*
Utrecht University, Utrecht, The Netherlands

BS-MS in Earth Sciences *Jul 2007 – May 2012*
Indian Institute of Science Education & Research, Kolkata, India

Research Interests

My research develops observation-driven methods to quantify greenhouse-gas emissions and carbon-cycle variability across scales, from facility-level plumes to the global budget. I integrate satellite remote sensing, atmospheric transport modeling, and statistical inference to produce robust, policy-relevant estimates of methane and carbon dioxide sources and sinks. A central focus of my work is building low-latency monitoring frameworks that improve attribution of anomalous growth events, enable independent verification of inventories, and strengthen predictive understanding of coupled carbon-climate dynamics.

- Satellite retrievals and multi-mission synthesis for CH_4 and CO_2
- Detection and quantification of point-source and regional emissions
- Atmospheric transport and inverse modeling (variational and Bayesian)
- Uncertainty quantification, bias correction, and observing-system design
- Machine learning for atmospheric transport improvement and emissions detection and quantification
- Near-real-time carbon-cycle monitoring and budget attribution

Awards and Grants

- NASA ROSES Early Career Investigator Program in Earth Science (ECIP-ES) Grant, 2023
- Best Oral Presentation Award, SRON Netherlands Science Day, 2019
- INSPIRE Fellowship, Department of Science & Technology (DST), India, 2008

Presentations

Invited Presentations

- **AGU Fall Meeting, 2025:** “Accurate, low-latency monitoring of whole-atmosphere CO_2 growth rates with satellite observations.”
- **The Methane Emissions Technology Alliance (META), 2025:** “Relating multi-scale plume detection and area estimates of methane emissions.”
- **NOAA, 2023:** Global growth-rate estimates of CO_2 from satellite observations
- **U.S. EPA, 2021:** Satellite reveals extreme leakage from a natural gas well blowout
- **Indian Institute of Tropical Meteorology (IITM), Pune, India, 2019:** Atmospheric monitoring using ESA’s TROPOMI satellite

- **NASA JPL, 2019:** Satellite reveals extreme CH_4 leakage from a natural gas well blowout
- **NASA GISS, 2018:** TROPOMI detection of CH_4 leakage from a gas well blowout
- **NASA JPL, 2018:** CH_4 monitoring using ESA's TROPOMI satellite

Selected Conference Presentations

- **American Geophysical Union (AGU) Fall Meetings:** 2015, 2018, 2019, 2021, 2022, 2023 & 2024
- **European Geosciences Union (EGU) General Assembly:** 2017, 2018 & 2019
- **ESA Living Planet Symposium:** 2013 & 2016
- **International Carbon Dioxide Conference (ICDC):** 2017
- **International Workshop on Greenhouse Gas Measurements from Space (IWGGMS):** 2014, 2018, 2021 & 2023

Mentoring and Supervision

- **Master's Thesis Project (9 months, full-time):** Main supervisor for Dr. Simon van Diepen (Delft University) and Dr. Maria Tsivilidou (Utrecht University). Co-supervisor for Peter Bijh (Delft University).
- **Internship Supervision at JPL:** Ansh Tiwari (Caltech), Julia Gao (Caltech), Kayley Butler (USC), Zijian Qiu (Harvard University), Monica Amezquita (Cal Poly Pomona via JPL's MSP Program).
- Supervised seven university student projects at SRON, Leiden, each lasting between 3–6 months.

Community Service

- **Reviewer for scientific journals:** Nature, Science Advances, Nature Climate Change, Atmospheric Measurement Techniques, Atmospheric Chemistry and Physics, Carbon Management, Journal of Geophysical Research, Remote Sensing of Environment, Environmental Science & Technology, Environmental Research Letters, Geophysical Research Letters, and Remote Sensing.
- **Review Editor:** Frontiers
- **Proposal Review:** Scientific research proposals for NOAA and NASA.
- **Poster Judge:** EGU and AGU annual meetings.
- Hosted a remote sensing session at the CEOS-GHG (Paris) 2023 meeting.

Publications

Key Contributions

I developed satellite-derived whole-atmosphere CO_2 growth-rate methods now adopted in the Global Carbon Project workflow (Pandey et al., 2024, *AGU Advances*; Pandey, 2025, *AGU Advances*). I also led the first satellite detection of an unreported extreme methane leak, helping establish a technical template for remote-sensing-based methane-plume monitoring (Pandey et al., 2019, *PNAS*).

H-index: 27 (Google Scholar).

Peer-reviewed Publications

*Note: [M] denotes publications with tracked media mentions; * denotes manuscripts currently under review.*

[1] Ciais, P., et al. (2026). Low latency global carbon budget indicates reduced land carbon sink in the year 2024. *National Science Review*, *13*(2), nwaf594. doi:10.1093/nsr/nwaf594

[2] Varon, D. J., et al. (2025). Seasonality and declining intensity of methane emissions from the Permian and nearby U.S. oil and gas basins. *Environmental Science & Technology*, *60*(1), 425–435. doi:10.1021/acs.est.5c08745

[3] [M]Friedlingstein, P., ..., **Pandey, S.**, et al. (2025). Global Carbon Budget 2025. *Earth System Science Data Discussions* [preprint]. doi:10.5194/essd-2025-659

[4] *Dasgupta, B., **Pandey, S.**, et al. (2025). Global methane emission estimates from a dual-isotope inversion: New constraints from δD-CH_4. *EGUsphere* [preprint]. doi:10.5194/egusphere-2025-5571

[5] Dasgupta, B., ..., **Pandey, S.**, et al. (2025). Harmonisation of methane isotope ratio measurements from different laboratories using atmospheric samples. *Atmospheric Measurement Techniques*, *18*, 6591–6607. doi:10.5194/amt-18-6591-2025
[6] [M]**Pandey, S.** (2025). Taking Earth's carbon pulse from space. *AGU Advances*. doi:10.1029/2025AV002085
[7] *Yun, J., **Pandey, S.**, et al. (2025). Unprecedented role of Amazon fires in the record atmospheric CO_2 growth in 2024. Under review in *Science*. [Preprint]. doi:10.22541/essoar.175874118.83695562/v1
[8] **Pandey, S.**, et al. (2025). Reduction in Earth's carbon budget imbalance. *Nature Communications*, *16*, 6818. doi:10.1038/s41467-025-61588-2
[9] [M]Bilir, E., et al. (2025). Satellite-constrained reanalysis reveals CO_2 versus climate-process compensation across the global land carbon sink. *AGU Advances*. doi:10.1029/2025AV001689
[10] *Ke, X., et al. (2025). Low-latency global carbon budget reveals a continuous decline of the land carbon sink during the 2023/24 El Niño event. Under review at *National Science Review*. *arXiv preprint*. doi:10.48550/arXiv.2504.09189
[11] **Pandey, S.**, et al. (2025). Relating multi-scale plume detection and area estimates of methane emissions: A theoretical and empirical analysis. *Environmental Science & Technology*, *59*(16), 7931–7947. doi:10.1021/acs.est.4c07415
[12] Albuhaisi, A., et al. (2025). Integrating satellite observations and hydrological models to unravel large TROPOMI methane emissions in South Sudan wetlands. *Remote Sensing*, *16*, 4744. doi:10.3390/rs16244744
[13] [M]**Pandey, S.**, et al. (2024). Toward low-latency estimation of atmospheric CO_2 growth rates using satellite observations: Evaluating sampling errors of satellite and in situ observing approaches. *AGU Advances*, *5*, e2023AV001145. doi:10.1029/2023AV001145
[14] [M]Varon, D. J., et al. (2024). Quantifying NO_x point sources with Landsat and Sentinel-2 satellite observations of NO_2 plumes. *Proceedings of the National Academy of Sciences*, *121*, e2317077121. doi:10.1073/pnas.2317077121
[15] [M]Byrne, B., et al. (2024). Carbon emissions from the 2023 Canadian wildfires. *Nature*, *633*, 835–839. doi:10.1038/s41586-024-07878-z
[16] [M]**Pandey, S.**, et al. (2023). Daily detection and quantification of methane leaks using Sentinel-3: A tiered satellite observation approach with Sentinel-2 and Sentinel-5P. *Remote Sensing of Environment*, *296*, 113716. doi:10.1016/j.rse.2023.113716
[17] [M]Schuit, B. J., et al. (2023). Automated detection and monitoring of methane super-emitters using satellite data. *Atmospheric Chemistry and Physics*, *23*, 9071–9098. doi:10.5194/acp-23-9071-2023
[18] Worden, J. R., **Pandey, S.**, et al. (2023). Verifying methane inventories and trends with atmospheric methane data. *AGU Advances*, *4*. doi:10.1029/2023AV000871
[19] Naus, S., et al. (2023). Assessing the relative importance of satellite-detected methane super-emitters in quantifying total emissions for oil and gas production areas in Algeria. *Environmental Science & Technology*. doi:10.1021/acs.est.3c04746
[20] Varon, D. J., et al. (2023). Continuous weekly monitoring of methane emissions from the Permian Basin by inversion of TROPOMI satellite observations. *Atmospheric Chemistry and Physics*, *23*, 7503–7520. doi:10.5194/acp-23-7503-2023
[21] Maasakkers, J. D., et al. (2022). Reconstructing and quantifying methane emissions from the full duration of a 38-day natural gas well blowout using space-based observations. *Remote Sensing of Environment*, *270*, 112755. doi:10.1016/j.rse.2021.112755
[22] [M]Maasakkers, J. D., et al. (2022). Using satellites to uncover large methane emissions from landfills. *Science Advances*, *8*, 1–9. doi:10.1126/sciadv.abn9683
[23] Sadavarte, P., **Pandey, S.**, et al. (2022). A high-resolution gridded inventory of coal mine methane emissions for India and Australia. *Elementa*, *10*, 1–14. doi:10.1525/elementa.2021.00056
[24] **Pandey, S.**, et al. (2022). Order-of-magnitude wall-time improvement of variational methane inversions by physical parallelization: A demonstration using TM5-4DVAR. *Geoscientific Model Development*, *15*, 4555–4567. doi:10.5194/gmd-15-4555-2022
[25] **Pandey, S.**, et al. (2021). Using satellite data to identify the methane emission controls of South Sudan's wetlands. *Biogeosciences*, *18*, 557–572. doi:10.5194/bg-18-557-2021
[26] [M]Cusworth, D. H., et al. (2021). Multi-satellite imaging of a gas well blowout enables quantification of total methane emissions. *Geophysical Research Letters*, *48*(2), 1–9. doi:10.1029/2020GL090864
[27] [M]Sadavarte, P., **Pandey, S.**, et al. (2021). Methane emissions from super-emitting coal mines in Australia quantified using TROPOMI satellite observations. *Environmental Science & Technology*, *55*(24), 16573–16580. doi:10.1021/acs.est.1c03976
[28] [M]Mazzini, A., et al. (2021). Relevant methane emission to the atmosphere from a geological gas

manifestation. *Scientific Reports*. doi:10.1038/s41598-021-83369-9
[29] Zavala-Araiza, D., et al. (2021). A tale of two regions: Methane emissions from oil and gas production in offshore/onshore Mexico. *Environmental Research Letters*. doi:10.1088/1748-9326/abceeb
[30] Ma, S., et al. (2021). Satellite constraints on the latitudinal distribution and temperature sensitivity of wetland methane emissions. *AGU Advances*, *2*(3), 1–12. doi:10.1029/2021AV000408
[31] [M]Zhang, Y., et al. (2020). Quantifying methane emissions from the largest oil-producing basin in the United States from space. *Science Advances*. doi:10.1126/sciadv.aaz5120
[32] [M]**Pandey, S.**, et al. (2019). Satellite observations reveal extreme methane leakage from a natural gas well blowout. *Proceedings of the National Academy of Sciences*, *116*(52), 26376–26381. doi:10.1073/pnas.1908712116
[33] **Pandey, S.**, et al. (2019). Influence of atmospheric transport on estimates of variability in the global methane burden. *Geophysical Research Letters*, *46*, 2302–2311. doi:10.1029/2018GL081092
[34] [M]Ganesan, A. L., et al. (2019). Advancing scientific understanding of the global methane budget in support of the Paris Agreement. *Global Biogeochemical Cycles*, *33*(12), 1475–1512. doi:10.1029/2018GB006065
[35] [M]Varon, D. J., et al. (2019). Satellite discovery of anomalously large methane point sources from oil/gas production. *Geophysical Research Letters*. doi:10.1029/2019GL083798
[36] Dekker, I. N., et al. (2019). What caused the extreme CO concentrations during the 2017 high pollution episode in India? *Atmospheric Chemistry and Physics*, *19*, 3433–3445. doi:10.5194/acp-19-3433-2019
[37] Borsdorff, T., et al. (2019). Carbon monoxide air pollution on sub-city scales and along arterial roads detected by the Tropospheric Monitoring Instrument. *Atmospheric Chemistry and Physics*, *19*, 3579–3588. doi:10.5194/acp-19-3579-2019
[38] Naus, S., et al. (2019). Constraints and biases in a tropospheric two-box model of OH. *Atmospheric Chemistry and Physics*, *19*(1), 407–424. doi:10.5194/acp-19-407-2019
[39] Nechita-Banda, N., et al. (2018). Monitoring emissions from the 2015 Indonesian fires using CO satellite data. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1760), 20170307. doi:10.1098/rstb.2017.0307
[40] [M]Bruhwiler, L. M., et al. (2017). U.S. CH_4 emissions from oil and gas production: Have recent large increases been detected? *Journal of Geophysical Research: Atmospheres*, *122*(7), 4070–4083. doi:10.1002/2016JD026157
[41] [M]Worden, J. R., et al. (2017). Reduced biomass burning emissions reconcile conflicting estimates of the post-2006 atmospheric methane budget. *Nature Communications*, *8*(1), 2227. doi:10.1038/s41467-017-02246-0
[42] **Pandey, S.**, et al. (2017). Enhanced methane emissions from tropical wetlands during the 2011 La Niña. *Scientific Reports*, *7*. doi:10.1038/srep45759
[43] **Pandey, S.**, et al. (2016). Inverse modeling of GOSAT-retrieved ratios of total column CH_4 and CO_2 for 2009 and 2010. *Atmospheric Chemistry and Physics*, *16*(8), 5043–5062. doi:10.5194/acp-16-5043-2016
[44] **Pandey, S.**, et al. (2015). On the use of satellite-derived CH_4:CO_2 columns in a joint inversion of CH_4 and CO_2 fluxes. *Atmospheric Chemistry and Physics*, *15*(15), 8615–8629. doi:10.5194/acp-15-8615-2015

Other Publications

[1] Varon, D. J., et al. (2025). Reply to Chen et al.: Coarse simulations overestimate the distance to recover NO–NO_2–O_3 photochemical steady state in fresh NO_x plumes. *Proceedings of the National Academy of Sciences*, *122*(7), e2425976122. doi:10.1073/pnas.2425976122
[2] Sadavarte, P., et al. (2024). Rebuttal to Correspondence on "Methane emissions from super-emitting coal mines in Australia quantified using TROPOMI satellite observations." *Environmental Science & Technology*. doi:10.1021/acs.est.4c01510
[3] Maity, A., et al. (2024). Atmospheric CO_2 inversion models overestimate northern extratropical land and ocean carbon uptake as assessed at background in situ sites. **Preprint**. *Research Square*. Under review. doi:10.21203/rs.3.rs-3960558/v1
[4] Bergamaschi, P., et al. (2018). Atmospheric monitoring and inverse modeling for verification of greenhouse gas inventories. *Publications Office of the European Union*. doi:10.2760/759928
[5] **Pandey, S.** (2017). Advancing the use of satellites to constrain atmospheric methane fluxes. Ph.D. dissertation, Utrecht University. link
[6] Chevallier, F., et al. (2017). Climate assessment report for the GHG-CCI project of ESA's Climate

Change Initiative. *Publications Office of the European Union*. link