Essam HEGGY, PhD. ***Remote Sensing of Earth and Planetary Env.***
Understanding Water & Ice Evolutions in Deserts & Planetary Environments
Qatar Environment and Energy Research Inst., Chief Scientist & Research Program Director of the Earth Science Program

University of Southern California (USC), *Affiliate*
NASA's Jet Propulsion Laboratory (JPL), *Affiliate*
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Biography. Dr. Essam Heggy is the Chief Scientist of the Qatar Environment and Energy Research Institute at Hamad Ben Khalifa University in Qatar Foundation and the founder and Program Research Director of its Earth Science Program. He is also a research scientist at the Microwave Systems, Sensors, and Imaging Lab (MiXIL) at the Viterbi School of Engineering at the University of Southern California and an Affiliate of the Radar Science & Engineering Section (3340) at NASA's Jet Propulsion Laboratory (JPL). He is also a tenured Associate Professor of Geophysics at the Institute of Earth Physics of Paris (IPGP) at the University of Paris in France. Heggy obtained both MSc. and Ph.D., respectively, in 1999 and 2002 with distinguished honors from the Sorbonne University in France (UPMC-ParisVI). His research focuses on understanding water and ice evolution in Earth's arid areas and planetary environments using radar surface and subsurface characterization methods. His work involves imaging and probing structural, hydrological, and volcanic elements in terrestrial and other planetary environments using different types of radar techniques and measuring the electromagnetic properties of rocks, meteorites, and ices in the radar frequency range. Heggy's research expertise spans from laboratory electromagnetic characterization of terrestrial samples and planetary analog materials, radar sounding of aquifers in hyper-arid environments, SAR and InSAR image analysis, GPR surveys in desertic, volcanic, and ice-rich environments, FDTD numerical simulations of wave propagation, and data analysis from different terrestrial and planetary radar missions. He is currently a member of the science teams of the MARSIS instrument aboard the Mars Express orbiter (2003-present), the Mini-SAR experiment aboard Chandrayaan-1, the Mini-RF experiment on board the Lunar Reconnaissance Orbiter (2008-present), the CONSERT radar experiment aboard the Rosetta mission (2004-present) and the WISDOM Ground Penetrating Radar onboard the ESA EXOMARS Mars Rover to be launched in July 2022. Heggy is the Principal Investigator of the NASA mission concept OASIS, currently under formulation at JPL, which aims to use sounding radar reflectometry and probing to assess the thickness of the ice sheets in Greenland and Antarctica and the occurrence and spatial distribution of shallow aquifers in the aridest desertic regions on Earth and how both systems respond to climatic and anthropogenic stresses.

Heggy is also a contributing scientist to several proposed planetary and terrestrial radar imaging and soundings experiments and participated in several NASA & ESA missions concepts designs. For instance, he led the concept development for the Mars-2020 Ground Penetrating Radar (SubEx) as the US Science Lead and the Experiment Deputy Principal Investigator. He also participated in the performance studies for both RIME and REASON sounding radars onboard the ESA JUICE mission and the NASA Europa clipper mission and the sounding radar instrument onboard the ESA ENVISION mission. Heggy served as a panel member for several NASA programs, including the Planetary Instrument Definition and Development program, Planetary Geology and Geophysics program, Mars Data Analysis program, Planetary Data System – Small Bodies Node, Lunar Data Analysis program, Astrobiology program and the Educational and Public Outreach program in addition to being a panel member on the groundwater studies and the committee on radio frequencies in the US National Academies for Science and Engineering and expert reviewer for the IPCC special report on climate change and land. He is also a guest editor for JGR-Planets (AGU) for the volume on terrestrial and planetary radars and on the founding editorial board of Springer Nature Applied Sciences (Springer-Nature) and National Geographic (Arabic version). Heggy also chaired several sessions in international meetings on *Terrestrial and Planetary Studies*. He was the co-chair of the American Geophysical Union's terrestrial and planetary radar session from 2004 to 2014 and *Exploring Planetary Sub-surfaces* session from 2014 to the present. He also chaired the session on monitoring of deserts in the UN-COP18. Heggy has taught academic classes on geophysical and remote sensing methods and mentored postdocs and graduate students at UCLA, USC, Caltech, Cambridge University, Paris universities, *Institut de Physique du Globe, Ecole Normale Superieure*, University of Houston, Trento University, University of Torino, Cornell University, *Ecole Polytechnique (l'X)* and Columbia University. Heggy authored and co-authored more than **114 peer review scientific papers** in the top tier Q1 journals in Earth and Planetary Sciences, including *Science* and *Nature,* and more than **200 proceedings** and abstracts in international conferences with review committees **(H index=32, I index=67, 4450 citations).**

EDUCATION

Ph.D. Sorbonne University (UPMC-Paris VI), France, Ph.D. in Astronomy & Astrophysics, 2002
M.Sc. Sorbonne University (UPMC-Paris VI), France, Master's in Space Sciences and Technologies, 1999
B.Sc. Cairo University, Faculty of Sciences, Egypt, BSc in Natural Sciences, 1997

PROFESSIONAL EXPERIENCE

2016-Present Chief Scientist /Program Research Director, Earth Sciences Program, Qatar Foundation
2016-Present Affiliate Research Faculty, University of Southern California, Los Angeles, CA, USA
2016-Present Affiliate Radar Science & Eng. Sec, NASA' Jet Propulsion Lab, Pasadena, CA, USA
2015-2016 Full Professor of Geosciences, W. Michigan University, MI, USA
2008-2015 Research Scientist, Radar Science Group, NASA' Jet Propulsion Laboratory, CA, USA
2011-2015 Visiting Associate in Geology, California Institute of Technology, Pasadena, CA, USA
2006-2010* Tenure Assoc. Professor of Geophysics, *Institut de Physique du Globe de Paris*, France
2003-2006 Postdoctoral Fellow, NASA's Lunar and Planetary Institute, TX, USA
1999-2003 Research Assistant (French National Research Center), Bordeaux Observatory, France

***** *Permanent tenured position, on International research leave since 2010 (leave ends on June 30th, 2025)*

SELECTED HONORS AND AWARDS

- 2023: Hundred Best educational and outreach programs in MENA
- 2021: URSI Best conference paper/mentor for the young scientist award of Dr. Palmer
- 2021: FIFA medal for most influential Arab scientists with major societal impacts
- 2020: Nominated for NASA Exceptional Science Achievement Medal
- 2018: Associate Editor Springer-Nature Applied Sciences
- 2017: Springer-Nature Best Reviewer Award
- 2017: Nature Editor's Highlights: Dawn BSR Observation paper
- 2017: Rosetta European Space Agency Recognition Award
- 2013: NASA/JPL Mariner Award & NASA/JPL Recognition Award
- 2011-Present: Editorial Board of Geosciences (IF=3) & Remote Sensing (IF=5)
- 2010-Present: Editor Board of the National Geographic Magazine (UAE)
- 2010-2013: United Nations Development Program, UN Observer for MENA Water Studies
- 2009: Outstanding Researcher Award, Department of Education and Research, France (PEDR/PES)
- 2003: Postdoctoral Fellowship at the NASA's Lunar and Planetary Institute
- 1999: Doctoral Engineering Graduate Fellowship of the French National Research Center (BDI-CNRS)

EXTERNALLY FUNDED PROJECTS *(Total $ 6.1 Million of competitively funded opportunities)*

NASA Science Mission Directorate Funded Awards *(amounts allocated only to Heggy's effort)*:

- NASA Planetary Geology and Geophysics Program (2 funded projects, PI, 2006-2018, $610k)
- NASA Mars Analog Program (2 Funded Projects, Co-I, 2003-2006, $60k)
- NASA Moon and Mars Analog Mission Activities (3 funded projects, Co-PI, 2009 and 2016, $150k)
- NASA Rosetta Science Mission US Co-Investigator participation (PI, 2010-2018, $840k)
- NASA/JPL-Fugro GeoSAR mapping campaign for Sea-Ice in the Arctic (PI, 2015-2018, $120k)
- NASA-JPL President Research Fund (PI-2012-2013, $100k)

Other Funded Grants

- Keck Institute for Space Studies (Co-PI, 2011-2012, $100k)
- United State Agency for International Development (PI, 2013-2015, $732k)
- Kuwait Foundation for Advancement of Science, 2017-2018 (PI, Heggy, $50k)
- Qatar Foundation, 2019-2022, (Co-PI, Heggy, $ 1.1M)
- NASA-QF OASIS Mission Concept Study (PI, Heggy, total $ 2.9 M)

SELECTED INVITED TALKS

2004 Lunar and Planetary Institute, TX, USA	2016 Rutgers University, NJ, USA
2005 Southwest Research Institute, TX, USA	2016 Australian Academy of Science, Canberra
2005 European Geophysical Union, Austria	2017 University of Copenhagen, Denmark
2006 *Institut de Physique du Globe de Paris*, France	2017 Iowa State University, IO, USA
2008 *Ecole Normale Superieure*, France	2017 United Nations, World Science Forum, Jordan
2010 University of Alberta, Canada	2017 Microwave Mediterranean Symposium, France

2011 University of Bern, Switzerland	2018 Qatar National Library, Doha, Qatar
2011 USAID Water FABRI Initiative, Oman	2018 University of Toronto, Toronto, Canada
2012 United Nation 18th Climate Change Conf., Qatar	2019 Harvard University, Cambridge, USA
2013 California Institute of Technology, CA, USA	2019 Goethe University Frankfurt, Germany
2013 Texas A&M University, Qatar	2020 Jet Propulsion Laboratory, Caltech, USA
2013 Dubai University, UAE	2021 Cambridge University, UK
2014 Chapman University, CA, USA	2021 US National Academies CORF, USA
2014 Massachusetts Institute of Technology, MI, USA	2021 Geological Society of Africa
2014 Bibliotheca Alexandrina, Alexandria, Egypt	2022 Ministry of Environment & Climate Change, Qatar
2014 Bursa Museum of Natural History, Turkey	2022 University of California in Los Angeles, USA
2015 United Nation Knowledge Summit, Dubai	2022 Princeton University, USA
2015 Western Michigan University, MI, USA	2023 Georgetown University, USA

ACADEMIC EXPERIENCE IN TERRESTRIAL AND PLANETARY REMOTE SENSING

Teaching and Mentoring: Advanced graduate-level classes on: (1) Electromagnetic methods in geophysics, (2) Radar remote sensing of terrestrial and planetary surfaces, (3) Geophysical field surveys in volcanic and arid environments, (4) Geological processes in planetary surfaces, (5) Sensors and detectors in Earth and Planetary remote sensing, (6) Graduate research formulation & (7) Geoscience Introductory class. Served as advisor for eight Master and nine Ph.D. theses in US universities (e.g., UCLA, Caltech, Columbia, W. Michigan, and the University of Houston) and European universities (Paris Diderot, UPMC, *Ecole Normale Superieure*, IPGP, University of Grenoble, ENSCPB, University of Torino, Trento University and Gottingen University).

Laboratory Characterization: Parametric dielectric measurements to characterize the radar properties of rocks, soils, meteorites, and ices in both GPR and Synthetic Aperture Radar frequency ranges using capacitive and reflection methods.

Geophysical Field Surveys: 20 years' experience in field surveys using Ground Penetrating Radar (GSSI, MALA & Pulsekko), Transient Electromagnetic Method and TDEM (Geonics & Protem), Electromagnetic profiler (GSSI), Vertical Electric Resistivity (AGI) and Lidar profile meter (OPTEC to assess surface roughness). Survey performed on sea ice, permafrost, volcanic & desertic terrains.

Terrestrial and Planetary Data Analysis: Experience in P-L-C-X band Polarimetric Synthetic Aperture Radar image processing and analysis from different orbital and airborne systems. Radiometric, interferometric, and polarimetric analysis, modeling, inversion, and interpretation for hydrogeological, geomorphological, and natural hazard applications. Processing using different SAR software tools: SARSCAPE, ENVI, ROIPAC, and others. Processing, modeling, inversion, and analysis of low-frequency orbital and airborne sounding radar data for both terrestrial and planetary applications.

Radar System Engineering: Lead and participated in the system engineering and concept design of several robotic, orbital and airborne radar systems: SubEx (onboard the NASA 2020 Mars Rover), MARSIS (onboard ESA/NASA Mars Express mission), SHARAD (onboard the NASA Mars Reconnaissance Orbiter Mission), Mini-SAR (onboard the Chandrayaan-1 Mission), CONSERT (onboard the Rosetta mission) & RIME (onboard the JUICE mission).

Earth and Planetary Missions Design: Led and participated in terrestrial and planetary radar missions design and concept studies for radar sounding at the Radar Science Group at JPL (334H). For instance, he was the Principal Investigator of the Orbiting Arid Subsurface and Ice Sheet Sounder (OASIS), a NASA Earth Venture mission concept. The mission will be implemented on low-earth sun-synchronous satellites on the Surrey SSTL-150 Bus. Served as a Deputy Principal Investigator for the SubEx proposed polarimetric GPR for the Mars 2020 Rover (selected category 2 proposal). Also participated in the radar performance study and data analysis of several selected planetary radar experiments such as Mini-RF (Lunar Reconnaissance Orbiter), MARSIS (Mars Express), SHARAD (Mars Reconnaissance Orbiter), and RIME (Jupiter Icy Moons Explorer, JUICE), CONSERT (Rosetta Mission) & WISDOM (ExoMars Rover). Expertise in managing feasibility studies and risk assessment teams with experience in mission costing and programmatic negotiations with international agencies (ESA, ASI, and Qatar Foundation).

Environmental studies: Worked on environmental assessment studies in arid areas, including (1) downstream impacts of damming in the Nile basin and the Mejadra River in Tunisia. (2) Impacts of groundwater abstraction in coastal aquifers on water quality and shoreline retreat in Qatar Peninsula. (3)

Impacts of the Salwa canal on groundwater dynamic in the eastern Arabian Peninsula (4) Erosion in sandy beaches in Tunisia, Egypt, downstream impact of Nile damming and Qatar (5) Assessing island disappearance in the Persian Gulf as a function of coastal erosion and sea level rise forecasts and others.

International Partnership: Worked in several collaborative projects and studies with NASA, ESA, ASI, CNES, and JAXA on Earth and Planetary radar missions' teams as well as other research and academic institutes in the field of Earth sciences, remote sensing, and natural hazards in Europe: ONERA, ESRIN, IPAG, INSU, and IPGP. Formulated joint research agreements, joint projects, and exchange programs and hosted scientists and engineers from the above institutions in extended academic visits to perform joint research.

Editorial Roles: Serving on the editorial board of the SN Applied Sciences (Springer), Journal of Arctic Geosciences: Arktos (Springer), Geosciences (MDPI), and National Geographic. Edited a special volume in the Journal of Geophysical Research (AGU) on Terrestrial and Planetary Radars (JGR-Planets). Chaired the International Conference on Terrestrial and Planetary Radar in 2006 in Houston, Texas, and co-chaired several sessions in international meetings on terrestrial and planetary radar. He is also co-chairing the American Geophysical Union's Terrestrial and Planetary Radar session from 2004 to 2014 and Subsurface Investigation sessions from 2014 to the present.

Public Services: Heggy served as a panel member in several NASA programs, notably, the Planetary Instrument Definition and Development program, Planetary Geology and Geophysics program, Mars Data Analysis program, Lunar Data Analysis program, Astrobiology program, Planetary Data System review and the Educational and Public Outreach program in addition to being a panel member on groundwater studies for the US National Academy of Engineering (Division 11).

SELECTED COMMUNITY SERVICES, SOCIAL AND PUBLIC OUTREACH ACTIVITIES

- Guest speaker at the National Endowment for Democracy, Washington DC, 2016.
- Chair of the United Nations Board on the Knowledge Index, UN General Assembly, New York, USA, 2015.
- United Nations Observer in the UN Conference for Climate Change, 2012, Doha, November 2012.
- Scientific advisor for UNDP Middle East and North African Initiative for Climate Change, 2010-2011, New York, USA.
- Blog writer on educational, environmental, and societal reforms in the Middle East and North Africa (550k+ Facebook & 500k+ Twitter Followers).
- Contributed to several scientific expositions in National Science Museums (New York, Houston, Berlin, Kuwait, Qatar, Tunisia, and Egypt).
- Panel member on the NASA Educational and Public Outreach Program, Washington DC, 2006-2008.
- Member of the science advisory board of National Geographic (Arabic Edition).
- Science Advisor of the Qatar National Library and chair of the Science Book Forum.
- Chief Science Advisor for the president of the Arab Republic of Egypt, 2013-2014

MEMBERSHIPS IN PROFESSIONAL SOCIETIES

American Geophysical Union (AGU): 2004 to Present
American Association for Advancement of Science (AAAS): 2010 to Present
Institute of Electrical and Electronics Engineers (IEEE): 2010 to Present
Geological Society of America (GSA): 2015 to Present

PUBLICATIONS

Google Scholar profiles: https://scholar.google.com/citations?user=-7gOKmwAAAAJ&hl=en
ORCID Profile: https://orcid.org/0000-0001-7476-2735
Scopus Profile: https://www.scopus.com/authid/detail.uri?authorId=6602810646
ResearchGate profile (RG Score 37.3): https://www.researchgate.net/profile/Essam_Heggy

REFERENCES

PROF. MAHTA MOGHADDAM (PRESENT MANAGER) Dean of Research, Viterbi School of Engineering Distinguished Professor, Electrical and Computer Engineering, Member of the US National Academies Director, Microwave Systems, Sensors, and Imaging Lab (MiXIL), Editor-in-Chief, IEEE Antennas and Propagation Magazine, NASA AirMOSS Principal Investigator. **University of Southern California** 3737 Watt Way, PHE 634, Los Angeles, CA 90089 Tel: 213-740-4712, Email: mahta@usc.edu	**DR. ART CHMIELEWSKI** (PRESENT MANAGER) *Project manager* **NASA Jet Propulsion Laboratory** 4800 Oak Grove Drive, MS 300-243, Pasadena, CA, 91109, USA Tel: + 1 (818) 687-7910 & +1 (818) 354-1218 Email: Artur.B.Chmielewski@jpl.nasa.gov
DR. STEPHEN CLIFFORD (FORMER POSTDOC ADVISOR) *Senior Scientist* **Planetary Science Institute** 1700 East Fort Lowell, Suite 106 Tucson, AZ Tel: +1 (713) 859-5760 Email: sclifford@psi.edu	**PROF. JEAN PHILIPPE AVOUAC** (FORMER MANAGER) *Earle C. Anthony Professor of Geology and Mechanical and Civil Engineering* **California Institute of Technology** Geological and Planetary Science Division 1200 E. California Blvd., Pasadena, CA, 91125 Telephone: +1 (626) 395-4239 Email: avouac@gps.caltech.edu