

Professional updates of Dr. Suresh Raju Chellappan Pillai

Dr. SURESH RAJU C.

Head, Microwave Remote Sensing Section

Scientist/Engineer-SG

Space Physics Laboratory (SPL),

Vikram Sarabhai Space Centre, ISRO (Post),

Thiruvananthapuram-695022, India.

Tel: +91-4712562563 (O), Mob: +91-9446492335 (Official);

+91-9446492335 (Personal).

c_sureshraj@vssc.gov.in (Office); sureshrajuspl@gmail.com (Personal)



Educational Qualifications

Ph.D. (Physics) **: University of Paris (VII), Paris, France

Post M.Sc. Dip. (Space Sciences & Applications), Gujarat University, Ahmedabad, India

M.Sc. (Physics): Bharkathulla (Bhopal) University, Bhopal, India

****Ph.D. Thesis Title:** “Influences of Soil moisture and Temperature vertical profiles on the soil microwave emission: consequence on soil Moisture estimation”.

****Specialization:** Physical Methods in Microwave Remote Sensing.

**** Thèses préparé at:** Institute Nationale de la Recherche Agronomique (INRA), France, fellowship by INRA, & Centre National d’études Spatiales (CNES), Paris, France.

Major Scientific Activities: Dr. Suresh Raju specialised in Microwave Radiometry for Earth-Planetary observations and Microwave Propagation studies. At present he is leading a team in the area of Microwave Radiometry for the studies of Earth/other planetary bodies and microwave propagation studies at SPL. His major research activities are:

1. Earth-based microwave probing (using GMRT-Radio telescope) of thermophysical properties of planetary surfaces.
2. Developing the payload ‘ChaSTE’ for Lander-based (Chandrayaan2) in-situ measurement of thermal properties of lunar surface regolith.
3. Microwave radiative transfer modeling for planetary atmospheric and terrain studies
4. Satellite microwave radiometric data analysis for Tropical deep convective cloud and Upper tropospheric humidity studies.
5. Ground-based microwave radiometer measurements of atmosphere, tropical convective clouds and boundary layer studies.
6. Ku- and Ka-band propagation studies with GSAT-14 satellite beacon.
7. Ray-tracing and Modeling of Tropospheric Delay for correction in GPS-based aircraft navigation (GAGAN) and GPS application for water vapor & atmospheric studies.

Technical Responsibilities

1. **Principal Investigator:** “ChaSTE Payload- Chandras Surface Thermophysical Experiment” aboard Lander of CHANDRAYAAN-3 MISSION.
2. **Principal Investigator:** “ChaSTE Payload- Chandras Surface Thermophysical Experiment” aboard Lander of CHANDRAYAAN-2 MISSION.
3. **Co-Principal Investigator:** MSSERR-Mars Shallow Subsurface Exploration using Radar and Radiometer, a proposal shortlisted by ADCOS for ISRO's second Mars Orbiter Mission-2 (MOM-2)
4. **Co- Principal Investigator:** “Thermophysical Characterization of Venus Surfaces Using GMRT-microwave radiometric Observation”.
5. **Principal Investigator:** Megha-Tropiques (M-T) Satellite Science Project “Modeling of land surface emissivity in the microwave regime for Megha-Tropiques”.
6. **Co-Investigator:** GAGAN project “Modeling of Tropospheric Delay Corrections for GPS-based Aircraft Navigation over the Indian Region”.
7. **Working Group Member:** Megha-Tropiques Satellite Calibration/Validation Program.
8. **Working Group Member (WG-B):** Enhancement of Performance of GNSS: developing reference documentation on models and algorithms for Tropospheric correction. **II meeting of ICG on GNSS**, Sept. 2007, Bangalore.
9. **Member:** Study Team for Solar System Exploration (STSSE)
10. **Convener:** URSI Asia-Pacific Radio Science Conference (AP-RASC, at New Delhi, 9-15 March, 2019) Commission F04: "Microwave and mm-wave remote sensing techniques including interferometry, SAR and RFI effect"

Research Supervision & Human Resource Development:

1. Ph.D. Thesis Supervised - 4;
2. M.Tech. Thesis Supervised – 8;

Summary of Publications:

1. Peer Reviewed International/National Journals - 30;
2. Refereed Proceedings – 16;
3. Scientific/Technical Reports – 8;

Major Research/Development Contributions:

- Dr. Suresh Raju, specialized in Microwave Radiometry, **initiated and proliferated** research activities on “**Microwave Remote Sensing** for Atmosphere/Terrain of Earth/Planetary bodies” at Space Physics Laboratory (SPL). This activity has grown to “**Microwave Remote Sensing SECTION**” having with 4 Scientists and JRFs/SRFs/RAs. This team contributes to ISRO’s planetary missions, microwave satellite missions, IRNSS/NAVIC and GAGAN programs.
- **ChaSTE is a payload** onboard Lander, Chandrayaan-2 mission, for measuring lunar regolith temperature profiles and thermal conductivity. ChaSTE uniqueness is the first ISRO’s payload

for planetary sub-surface in-situ probing, new concepts of methodology, deployment mechanism, and probe and material. Conceptualized and realized a space-worthy ChaSTE payload and integrated with lander-craft “VIKRAM” of Chandrayaan-2 and flown to Moon and operated successfully in the transit orbit and Lunar orbit.

- **In view of ISRO’s Venus mission, observations of Venus** subsurface thermal emission (Tb) at microwave/radiowave frequency regime using GMRT radio-telescope was conducted. Obtained images of Venus at 50cm and 90cm wavelengths for first-time and derived surface dielectric constant of ~ 4.5 . With aid of microwave Radiative-Transfer computation confirmed the decrease thermal emission at decimeter wavelengths and it is attributed to large abundance of mineral in the Venus subsurface causing higher dielectric loss-factor. *A Ph.D. has been submitted to CUSAT 2019 on this topic.*
- **In view of ISRO’s planetary mission established optimum frequency combinations for a mm/Submm-Wave Limb-Sounding radiometer** for measuring **Venus Atmospheric Constituents (H₂O, CO, CO₂, SO₂, HDO and HCl)** by conducting detailed simulation using **Atmospheric Radiative Transfer Simulator (ARTS)** and sensitivity of each of the measurement frequencies for each of the constituents are established.
- **Novel methodologies and techniques** are developed for deriving **new satellite products “SAPHIR-UTH”** and **identifying convective core** of very deep convective systems from Megha-Tropiques humidity sounder SAPHIR Level1 Tb data. This is **superior to IR-techniques and a surrogate for M-T MADRAS payload**, meant for cloud/precipitation studies. *A doctoral thesis is getting prepared on this topic.*
- Established the potentials of **ground-based Microwave radiometer (MRP) observations** for **tropical boundary-layer** studies, evolution of convective systems, land-sea breeze circulation, and utility of microwave radiometer during prolonged Indian monsoon period over the tropical region. *A doctoral thesis was awarded by University of Kerala on this topic.*
- In view of for **GPS based aircraft Navigation** for **GAGAN**, making use of ray-tracing of microwave propagation through neutral atmosphere highly accurate Tropospheric Delay Correction Models on Region-specific over the Indian Subcontinent and major Indian Airport-specific are developed besides extending GPS delay applications for estimating atmospheric water vapor and studying atmospheric tidal and intra seasonal oscillations. *A doctoral thesis was awarded by CUSAT on this topic.*
- **As a part of extending satellite radiometric data for continental surface studies** the microwave land surface emissivity maps at metrological satellite window channels are derived using an in-house developed RT based algorithm on Global basis. A methodology has been proposed to delineate flood affected area and different vegetation classification. *A doctoral thesis was awarded by CUSAT on this topic.*

Publications

A. Publications in Peer Reviewed Scientific Journals

1. Nizy Mathew, S. Sahoo, R. Renju and **C. Suresh Raju**, “Millimetre-Wave Radiometric Information Content Analysis for Venus Atmospheric Constituents Studies”, **Radio Science**, **2019**, **55**, e2019RS006913. <https://doi.org/10.1029/2019RS006913>.
2. Manoj Kumar Mishra, R. Renju, N. Mathew, **C. Suresh Raju**, M. R. Sujimol and K. Shahana, “Characterization of GSAT-14 satellite Ka-band microwave signal attenuation due to precipitation over a Tropical Coastal station over the southern peninsular region of the Indian subcontinent”, **Radio Science**, **2019**, <https://doi.org/10.1029/2019RS006910>.
3. Nithin Mohan, **Suresh Raju C.**, Govind Swarup, Divya Oberoi , “Polarization and Brightness Temperature Observations of Venus with the GMRT”, **Monthly Notes of the Royal astronomical Society–MNRAS**, 487,4819–4826, June 2019, [doi:10.1093/mnras/stz1556](https://doi.org/10.1093/mnras/stz1556).
4. Tinu Antony, **Suresh Raju C.**, Nizy Mathew, Krishna Moorthy K, “Microwave emissivity of arid regions at 10 GHz: Potential for sub-surface studies “, **International J. Remote Sensing**, doi.org/10.1080/01431161.2018.1458345, 2018.
5. Nithin Mohan, Subhashis Roy, Govind Swarup ,Divya Oberoi , Niruj Mohan Ramanujam, **Suresh Raju C.**, Anil Bhardwaj, “Radio observation of Venus at meter wavelengths using the GMRT”, **ICARUS**, Vol.297 119–125 doi.org/10.1016/j.icarus.2017.06.026, 2017.
6. Nizy Mathew and **Suresh Raju C.** , “Distribution of Tropical Deep Convective Clouds from Megha-Tropiques SAPHIR Data ”, **IEEE Trans. Geosciences and Remote Sensing.**, Vol. 54, Issue 11, DOI:10.1109/TGRS.2016.2584540, 2016.
7. R. Renju, **C. Suresh Raju**, Nizy Mathew, N. V. P. Kirankumar, and K. Krishna Moorthy, Tropical Convective Cloud Characterization Using Ground-Based Microwave Radiometric Observations", **IEEE Trans. Geosciences and Remote Sensing**, Vol. 54, Issue 6, DOI:10.1109/TGRS.2016.2527099, 2016.
8. Yan Feng, M. Cadeddu, V. R. Kottamarthi, R. Renju and **Suresh Raju C.**, “Humidity bias and effect on simulated aerosol optical properties during the Ganges Valley Experiment”, **Current Science**, Vol. 111, No.1, 93-100,DOI:10.18520/cs/v111/i1/93-100, 2016.
9. Renju R., **Suresh Raju C.**, Nizy Mathew, Tinu Antony and K. Krishna Moorthy, Microwave Radiometer observation of Inter-annual variability of water vapor and its vertical structure over an equatorial station, **J. Geophysical Research (Atmosphere)**, 22 May 2015, Vol. 120, 45854599, DOI:10.1002/2014JD022838, 2015.
10. Tinu Antony, **Suresh Raju C.**, Nizy Mathew and K. Krishna Moorthy, 'Flood Extent Analysis Over the Major River Basins in the Indian Subcontinent Using Satellite Microwave Radiometric Data' **IEEE JSTAR**, VOL. 8, NO. 9, SEPT. 2015.
11. Nizy Mathew, Viju Oommen John, **Suresh Raju C.** and K. Krishna Moorthy, “Upper Tropospheric Humidity from SAPHIR on board Megha-Tropiques”, **Current Science**,108 (10), 1915-1922, 25 May 2015.
12. Tinu Antony, **Suresh Raju C.**, Nizy Mathew, Korak Saha and K. Krishna Moorthy, “Detailed Analyses on Microwave Land Surface Emissivity of Indian Subcontinent”, **IEEE Trans. Geosciences and Remote Sensing**, VOL. 52, NO. 6, June 2014.

13. **Suresh Raju C.**, Renju. R, Tinu Antony, Nizy Mathew, K. Krishna Moorthy, “Microwave radiometric observation of an intense convective system that formed waterspout over the coastal Arabian Sea”, **IEEE Trans. Geosciences and Remote Sensing Letter**, 10, 1075-1079,2013, doi: 10.1109/LGRS.2012.2229960.
14. **Suresh Raju, C.**, T. Antony, N. Mathew, K. N. Uma, and K. K. Moorthy, “MT MADRAS brightness temperature analysis for terrain characterization and land surface microwave estimation”, **Current Science**, “SPECIAL ISSUE ON MEGHA TROPIQUES”, 104 (12), 1643–1649, 2013.
15. Andre Chanzy, **C. Suresh Raju**, Jean-Pierre Wigneron, “Estimation of Soil Microwave Effective Temperature at L and C bands”, **IEEE Trans. Geosciences & Remote Sensing**, Vol. 35(3), pp.570-580, May1997.
16. Calvet J. C., J. P. Wigneron, A. Chanzy, **C. Suresh Raju**, and L. Laguerre, “Microwave dielectric properties of a silt-loam at high frequencies”, **IEEE Trans. Geosciences & Remote Sensing**, Vol.33(3), pp.634-642, 1995.
17. **Suresh Raju C**, Andre Chanzy, Jean-Pierre Wigneron, Jean-Christophe Calvet, Yann Kerr, and Laurent Laguerre, “Soil moisture and temperature profile effects on microwave emission at low frequencies, **Remote Sensing of Environment**, 54, 85-97, 1995.
18. Rao, K. S., **C. Suresh Raju**, Wang, J. R., “Estimation of soil moisture and surface roughness parameters from backscattering coefficient”, **IEEE Trans. Geosciences and Remote Sensing**, Vol.31(5), pp.1094-1099, Sept..1993.
19. Narasimha Rao, P.V., **C. Suresh Raju**, and Rao K. S., “Microwave remote sensing of soil moisture: elimination texture effect”, **IEEE Trans. Geosciences & Remote Sensing**, 38(1), pp.148-151, 1990.
20. Korak Saha, **Suresh Raju C.**, and K. Parameswaran, “A New Hydrostatic Mapping Function for Tropospheric Delay Estimation”, **J. Atmosphere and Solar Terrestrial Physics**, Vol.72, 125-134, 2010.
21. **Suresh Raju C.**, Korak Saha and K. Parameswaran, “Signature of atmospheric oscillations in GPS-measured tropospheric delay”, **J. Atmosphere and Solar Terrestrial Physics**, doi:10.1016/j.jastp.2009.06.011, 2009.
22. K. Parameswaran, Korak Saha, and **Suresh Raju C.** “Development of Regional Tropospheric Delay Model for Tropospheric Correction in GAGAN”, **RADIO SCIENCES**, 43, RS4007, doi:10.1029/2007RS003782, 2008.
23. Rajeev, K., K. Parameswaran, S. Meenu, S. V. Sunilkumar, Bijoy V. Thampi, **C. Suresh Raju**, B. V. Krishna Murthy, K. S. Jagannath, Sanjay K. Mehta, D. Narayana Rao, and Kusuma G. Rao, ‘Observational assessment of the potential of satellite-based water vapor and thermal IR brightness temperatures in detecting semitransparent cirrus’, **Geophysical Research Lett.**, 35, (2008) L08808, doi:10.1029/2008GL033393, 2008.
24. Mehta, S.K., Krishna Murthy, B.V., Narayana Rao, D., Venkat Ratnam, M., Parameswaran, K., Rajeev, K., **Suresh Raju, C.**, Rao, K.G. “Identification of tropical convective tropopause and its association with cold point tropopause”, **J. Geophysical Research A: Space Physics**, V.113, issue 14, 2008.
25. **Suresh Raju C.**, K. Saha, B. V. Thampi and K. Parameswaran, Empirical Model for Mean Temperature for Indian Zone and Estimation of Precipitable Water Vapor from Ground

- Based GPS Measurements”, *Annales Geophysicae*, Vol.25, pp. 1935-1948, 2007, (SRef-ID: 1432-0576/angeo/2007-25-1935), 2007.
26. KorakSaha, K. Parameswaran, and **C. Suresh Raju**, “Tropospheric delay in Microwave propagation in tropical atmosphere based on data from Indian Subcontinent”, *J. Atmospheric and Solar Terrestrial Physics.*, 69, 875–905, 2007.
 27. Meenu, S., K. Rajeev, K. Parameswaran, and **C. Suresh Raju**, “Characteristics of Double ITCZ over the Tropical Indian Ocean”, *J. Geophysical Research*, 112, D11106, 2007, doi: 10.1029/2006JD007950.
 28. K. Rajeev, Sandhya K Nair, K. Parameswaran, and **C. Suresh Raju**, “Satellite observations of the regional aerosol distribution and transport over the Arabian Sea, Bay of Bengal, and Indian Ocean”, *Indian J. Marine Sciences*, 33, 11-29, 2004.
 29. **Suresh Raju. C.**, V. K. Yadhav, V. K. Malhotra, and Rao K. S., “Simulating the radar back scattering coefficients of grasslands”, *Asian-Pacific Remote Sensing*, 3(2), pp.49-58, 1991.
 30. Rao K. S, Narasimha Rao, P.V., Y.S. Rao, G. Chandra, **C. Suresh Raju**, and M.V. Bapat “A study on the effect of the soil texture on passive microwave remote sensing”, *J. Indian Society of Remote Sensing*. 16(3), pp 55-63, 1989.

B. Publications in the Proceedings/Books

1. R. Renju, **C. Suresh Raju**, E. V. Davis, N. Mathew and K. K. Moorthy, "Validation of ground-based microwave radiometer measurements over a tropical coastal station," *2019 URSI Asia-Pacific Radio Science Conference (AP-RASC)*, New Delhi, India, 2019, pp. 1-5, doi: 10.23919/URSIAP-RASC.2019.8738615.
2. Mishra, M. K., R. Renju, N. Mathew, **C. Suresh Raju**, M. Sujimol and K. Shahana, "Rain attenuation of Ka-band signal over a Tropical station," *2019 URSI Asia-Pacific Radio Science Conference (AP-RASC)*, New Delhi, India, 2019, pp.1-3; doi: 10.23919/URSIAP-RASC.2019.8738301.
3. Koraksaha, **C. Suresh Raju**, and K. Parameswaran, “Neutral atmospheric refraction on microwave propagation and its implications on GPS based ranging systems”, *Proc. Commission F: XXVIII International Union of Radio Science (URSI) General Assembly (GA), New Delhi, India, 24 - 29, Oct. 2005.*
4. **Suresh Raju. C.**, Koraksaha, Bijoy V. Thampi and K. Parameswaran, “Measurement of Integrated water vapor over Bangalore using ground based GPS data”, *Proc. Commission F: XXVIII International Union of Radio Science (URSI) General Assembly (GA), New Delhi, India, 24 - 29, Oct. 2005.*
5. K. Rajeev, **C. Suresh Raju**, K. Parameswaran, Characteristics of the fractional cloud cover and its altitude distribution over the Indian ocean region derived from NOAA_AVHRR, *IASTA Bulletin 16 (No. 1 & 2)*, 140-144, 2004.
6. **Suresh Raju. C.**, K. Rajeev, K. Parameswaran, and K. S. Jagannath, and C. G. Patil, Cloud studies using KALPANA-1 data: Potential and Possibilities, *IASTA Bulletin, 16 (No. 1&2)*, 145-149, 2004.
7. Chanzy A., J.-P. Wigneron, J.-C. Calvet, L. Laguerre and **C. Suresh Raju**, "Surface emissivity data from PORTOS-Avignon experiment", *Radiative Transfer Models For Microwave Radiometry* COST 712: Final Report of Project 1, p. 171. 2000.

8. Laguerre, L., Calvet, J. C., Kerr, Y. H., Chanzy, A., Wigneron, J. P., and **Suresh Raju, S.**, "Influence of Surface Roughness on the Microwave Emission from Bare Soils for Surface Soil Moisture Retrieval Algorithms." **PIERS'94**, Noordwijk, Netherlands, 1994.
9. Laguerre, L., **Suresh Raju C.**, Chanzy, A., Kerr, Y. H., Calvet, J. C., and Wigneron, J. P., "Physical modeling of microwave emission from bare soils. Inter-comparison of models and ground data." Proc. 6th International Symposium "Physical Measurements and Signatures in Remote Sensing", Val d'Isère, France, PP.527-534. 1994.
10. Laurent Laguerre, **C. Suresh Raju**, Andre Chanzy, Yann Kerr, Jean-Christophe Calvet, Jean-Pierre Wigneron, "Physical modeling of microwave emission from bare soils. Inter-comparison of models and ground data", *6th Internat. Symp. On Physical measurements Signatures and Remote Sensing*, **CNES, Paris, pp 527-534, 1994.**
11. Costes, F., **C. Suresh Raju**, A. Chanzy, Chenerie, I., and Lemorton. J., "Microwave radiometry on bare soils: Comparison of various emission models of layered media with measurements", *Proc. IEEE Geosciences and Remote sensing Symp. (IGARSS 94); Vol. III IEEE, Seabrooke, TX*, pp. 1579-1581, 1994. (Surface and atmospheric remote sensing: Technologies Data Analysis and Interpretation, Pasadena 1994/08/8-12, Volume III., pp. 1579-1581 (1994).
12. Rao K.S., **C. Suresh Raju** and Y.S. Rao, Model for the retrieval of soil moisture and surface roughness parameters from multifrequency backscattering coefficients, **Proc. of IGARSS '91, IEEE symposium**, Espoo, Finland, 397-400, 1991.
13. Supriya M Mathew, Kusuma G Rao, Manjusha Chourasia, K. Parameswaran, D Narayana Rao, K. S. Jaganath, B. V. Krishna Murthy, K. Rajeev, **C. Suresh Raju**, S.C. Chakravarthy, "Links Between tropopause variations and the Boundary layer processes during the transition to southwest monsoon onset", CAWSES-India- Scientific Results (Phase-1), ISRO publications, Eds. Kusuma G Rao and R. Sridharan, 169-186, 2009
14. S. Meenu, K. Rajeev, K. Parameswaran, and **C. Suresh Raju**, "Regional distribution of the high-altitude cloud over the Indian subcontinent and surrounding oceanic regions based on seven years of satellite observations", *Proce. of SPIE*, 6408, doi:10.1117/12.694036., 2006.
15. Meenu, K. Rajeev, **C. Suresh Raju**, and K. Parameswaran, "Double ITCZ observed over the tropical Indian Ocean: Characteristics derived from cloud properties and OLR", *Proceedings of SPIE*, 6408, 10.1117/12.694055, 2006.
16. KorakSaha, **Suresh Raju. C**, Tinu Antony, and K. Krishna Moorthy, "Land-Surface Microwave Emissivity Map of Indian Region: Megha-Tropiques Perspective" *IEEE Applied Electromagnetics Conf. AEMC 2009*, Paper No: WPR-3-7807, 2009. **Special Issue – IEEE-PEER Journal-B Applied Electromagnetic.2009.**

C. Scientific/Technical Reports

1. **Suresh Raju. C., and ChaSTE team**, Chandras Surface Thermophysical Experiment (ChaSTE) PDR report, Doc.No.SPL-VSSC-PRL-ChaSTE-PDR-V3, July 2014.
2. **Suresh Raju C.**, K. Parameswaran and K. Rajeev, "A Simple Model for Tropospheric Correction in Microwave Ranging for Trivandrum and Bangalore". *Scientific Report, SPL: SR: 001:02, September 2002.*

3. **Suresh Raju C.** and K. Parameswaran, "Tropospheric Range error estimation for Trivandrum and Bangalore Based on Hopfield model". *Scientific report, SPL: SR: 001:03, September 2003.*
4. **Suresh Raju C.,** K. Rajeev, K. Parameswaran (SPL) and K. S. Jagannath, C.G.Patil, (MCF, Hassan, 573 201), "Cloud Studies Using Kalpana-1 VHRR: Scientific Potential and Possibilities", *Scientific Report, SPL: SR: 001:04, June 2004.*
5. **Suresh Raju C.,** Parameswaran K., and Korak Saha. "Tropospheric Models Over Indian Subcontinent for GPS Aided Geo-Augmented Navigation (GAGAN)", *Scientific Report; SPL: SR: 001:05; December 2005.*
6. **Suresh Raju C.,** Parameswaran K., and Korak Saha "A Summary Report On Tropospheric Correction Model for GAGAN", *Scientific Report: SPL:SR:001; Jan. 2007*
7. **Suresh Raju C.,** Tinu Antony, Nizy Mathew, Uma K.N, Krishna Moorthy, K., Kishore Kumar K, Venkata Subrahmanyam, K. Rajeev and Anish Kumar M Nair, " First Results of Megha-Tropiques data and its inter-comparison with other radiometers and sounders", *Scientific Report: No.1; January 2012.*
8. Chanzy, A., Wigneron, J. P., Calvet, J. C., Laguerre, L., **Suresh Raju C.,** Kerr, Y. H., and Grosjean, O. "Téledétection micro-ondes passives : utilisation combinée de plusieurs configurations de mesure pour l'estimation des paramètres de surface des sols nus et de la végétation." INRA HQ., Paris, 1995.