(3 pages)

Ref: ITMT/R/E/22/00012

[Note: Communicated on 20th Sept 2022, after consultation with Dr. Gopal Iyengar. The points of deviation from the discussion as indicated **with bold underlined letters]**

All details below are regarding the latest cloud observational campaign conducted over Solapur, which ended in 2018. The campaign was conducted by the Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) team at IITM, Pune.

The CAIPEEX IV airborne experiment was conducted until the end of monsoon season of 2019. The program requires to construct climatological data of clouds, aerosol and precipitation over the region. The ground based observations are continued.

1) **Please share the total duration, in days and hours, along with the period (months) when the cloud observational campaign was undertaken over Solapur**

Cloud observations were undertaken over Solapur with aircraft, from 14rd July to 5th Oct 2018 and 29th July to 15th Oct 2019 under suitable conditions called by the program for a total of 480 hours of observations. All ground based observations were conducted during the whole monsoon season of 2018 and 2019. This is over 8 months period of intensive observations. Surface observations are continuing in Solapur to construct climatological data over the region.

2) **Please provide information on total data generated (in Gigabytes / Terabytes or more) from the entire duration of the cloud observational campaign over Solapur**

Total data generated include the observations and corresponding numerical simulations, which is around 200 terabytes.

3) **Please provide total expenses (in Indian Rupees) spent for the entire cloud observational campaign over Solapur region**

100 crores

4) **Please list the key parameters under study from the observations obtained from the cloud observational campaign over Solapur**

Cloud and precipitation microphysical (droplet size distribution, radius of cloud and rain drops, liquid water content, rain water content, rain rates, etc) and morphological parameters (cloud depth, volume, precipitation mass etc.), thermodynamics of the atmosphere (wind, temperature and humidity vertical variation in the atmosphere), aerosol size distribution, cloud condensation nuclei, black carbon, wind velocity in the atmosphere, etc A list of several research investigations (topic wise) may be found below from CAIPEEX observations at Solapur

1. ***Rain drop microphysics***

Konwar, M., Raut B. A., Rao Y. J., Prabhakaran, T. (2022) Rain microphysical properties over the rain shadow region of India, Atmospheric Research, https://doi.org/10.1016/j.atmosres.2022.106224

Samanta S., Prabhakaran Thara, Murugavel P., Suneetha P., Rainfall types in the lifecycle of a stationary cloud cluster during the Indian Summer Monsoon: An investigation with numerical simulations and radar observation, Atmospheric Research, 263: 105794, December 2021, DOI:10.1016/j.atmosres.2021.105794, 1-15

Bhupendra A. Raut Mahen Konwar P. Murugavel Dhananjay Kadge Dinesh Gurnule Imran Sayyed Kiran Todekar Neelam Malap Shivdas Bankar Thara Prabhakaran (2021). Microphysical origin of raindrop size distributions during the Indian monsoon. Geophysical Research Letters, 48, e2021GL093581. https://doi.org/10.1029/2021GL093581

Samanta S., Prabhakaran Thara, Murugavel P., Suneetha P., Rainfall types in the lifecycle of a stationary cloud cluster during the Indian Summer Monsoon: An investigation with numerical simulations and radar observation, Atmospheric Research, 263: 105794, December 2021, DOI:10.1016/j.atmosres.2021.105794, 1-15

Soumya Samanta, P. Murugavel, D. Gurnule, Y Jayarao, J Vivekanandan, Thara V. Prabha, 2021 "The lifecycle of a stationary cloud cluster during the Indian Summer Monsoon: A microphysical investigation using polarimetric C-Band radar", Monthly Weather Review (https://doi.org/10.1175/MWR-D-20-0274.1)

2. Cloud seeding decision support system and impact

K. Gayatri, J. Sandeep, P. Murugavel, S. Chowdhuri, M. Konwar, G. Dinesh, Kiran Todekar, Shivdas Bankar, Shivsai Ajit Dixit, Neelam Malap, T. Prabhakaran, Evaluation of high-resolution WRF model forecasts and their use for cloud seeding decisions, Journal of Atmospheric and Solar-Terrestrial Physics, 2022,105825,ISSN 1364-6826,https://doi.org/10.1016/j.jastp.2022.105825

(https://www.sciencedirect.com/science/article/pii/S1364682622000025)

3. Aerosol and black carbon observations

V. Jayachandran, Sudarsan Bera, Shivdas P. Bankar, Neelam Malap, Mercy Varghese, P.D. Safai, Mahen Konwar, Kiran S. Todekar, Y. Jaya Rao, P. Murugavel, Thara V. Prabha,Hygroscopic growth and CCN activation of aerosols during Indian Summer Monsoon over a rain-shadow region,Atmospheric Research, 2021,105976,ISSN 0169-8095, https://doi.org/10.1016/j.atmosres.2021.105976

Mercy Varghese, Jerry Jose, A.S. Anu, Mahen Konwar, P. Murugavel, Nandakumar Kalarikkal, Medha Deshpande, Thara V. Prabha, Vertical profile of aerosol characteristics including activation over a rain shadow region in India, Atmospheric Environment, Volume 262, 2021, 118653, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2021.118653

Mercy Varghese · Jerry Jose· A. S. Anu · P. Murugavel · E. A. Resmi · Sudarsan Bera · Sabu Thomas · Mahen Konwar · Nandakumar Kalarikkal · Thara V. Prabha,, Jun 2021, Cloud and aerosol characteristics during dry and wet days of southwest monsoon over the rain shadow region of Western Ghats, India, DOI : 10.1007/s00703-021-00811-3
https://link.springer.com/content/pdf/10.1007/s00703-021-00811-3.pdf

Jayachandran, V., M. Varghese, P. Murugavel, K. S. Todekar, S. P. Bankar, N. Malap, G. Dinesh, P. D. Safai, J. Rao, M. Konwar, S. Dixit, T. V. Prabha, (2020), Cloud condensation nuclei characteristics during the Indian summer monsoon over a rain-shadow region, Atmospheric Chemistry and Physics, https:// doi.org/10.5194/acp-20-7307-2020

5) Provide quantify data (obtained from cloud observational campaign over Solapur) which has been fully analysed and reports prepared. And also share the remaining data which is under processing

There are a total of 276 cases from the two years of the randomized experiment. In each case aircraft has executed the procedure of seeding/no seeding on the basis of the protocols developed by CAIPEEX program in a chosen cloud. The cloud can be seen in the radar observations and after seeding either cloud dissipates or grow taller and make more rainfall. The cloud can also travel to further downwind distances and can rain. Both raingauge and radar data evaluations of the experiment are done and a report prepared. Results from the experiment is to be peer reviewed, before its publication.

6) Please share the report, if prepared and submitted to MoES, on the Solapur cloud observational campaign

The report will be released after an internationally peer reviewed publication, which is under preparation.

Thara Prabhakaran
(CAIPEEX, Project Director)

Administrative Officer, IITM

23/9/22

CPIO, IITM

INDIAN INSTITUTE OF TROPICAL METEOROLOGY

Ref No. RTI/ART-Bhopal/2022 Date: 20-09-2022

Sub: RTI applications No. IITMT/R/E/22/00013 dated 28.08.2022 from Ms. Anjali Marar, The Indian Express, Shirole Road, Shivajinagar,, Pune, Pin:411004, which has been received at CPIO, IITM on 29.08.2022.

All details below are regarding the test bed facility proposed to be setup in Bhopal by IITM, Pune, as on August 28, 2022.

1) Please share the number of instruments established / installed at the testbed facility at Bhopal

i. Dual-polarization C-band Doppler Weather Radar: 3-dimensional structure of precipitation over 150 km diameter over this region
ii. Microwave radiometric profiler: Temperature, humidity, water vapor and cloud liquid water profiles upto 10 km.
iii. Impact disdrometer: rain drop size distributions and rain rate at every 1 min time interval
iv. Microrain radar: vertical profiles of rain drop size distribution
v. Laser Ceilometer: cloud base heights and its depth
vi. Ka-band cloud radar: Vertical structure of clouds
vii. CCN counter: Cloud condensation nuclei at different supersaturation
viii. Aethalometer: Black carbon aerosol measurements
ix. Total carbon aerosol analyzer: Total carbonaceous aerosol measurements

2) Enlist the total number of instruments to be installed, their purposes and the current status of their installation

About 25 instruments (some systems will have multiple instruments for eg. tower and radiation system

i. **Radiation measurement system: solar (direct, diffuse, and total), terrestrial radiation (incoming and outgoing) (under procurement process)**
ii. 75 m tower with instrumentation for atmospheric and greenhouse gas measurements. (will be installed after monsoon rains)
iii. Automatic weather station (to be installed after monsoon rains)
iii. wind profiler for vertical profiles of all components of winds. (planning stage and in collaboration with ISRO)
iv. sun/sky radiometer
v. Soil temperature and moisture measurements
vii. Aerosol chemical speciation monitor
viii. Single particle soot photometer

PTO

3) Please share the total cost of setting up the testbed facility, including the cost of the land, instrument, and their procurement (indigenous or imported), installation costs.

The cost of the project is 125 Crores which includes the upcoming and planned measurement and infastrucutre facilities.

4) Kindly share the commissioning date for the part or full operations of the test bed, as decided at the time of MoU signing between the Institute of Tropical Meteorology (IITM) and Madhya Pradesh Council of Science and Technology held at Prithvi Bhavan, New Delhi on January 11, 2018.

The commissioning date of the facility with the first phase of the facility will be in Dec 2022.

5) If full-scale operations of the test bed have not commenced, please provide the month and year of the nearest commissioning.
The complete realization of the facility will be in March 2026, depending on budget provisions.

Concerned Officer (Head HACPL/ART-Bhopal)

Administrative Officer, IITM

CPIO, IITM