

Enhancing Freshwater Monitoring through Earth Observation

The field scale soil moisture analysis using COSMOS-India network to explore water resource quantity and quality for water supply, agriculture and aquaculture over the Indian regions.



मिलिन्द मुजुमदार

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<http://www.tropmet.res.in>**

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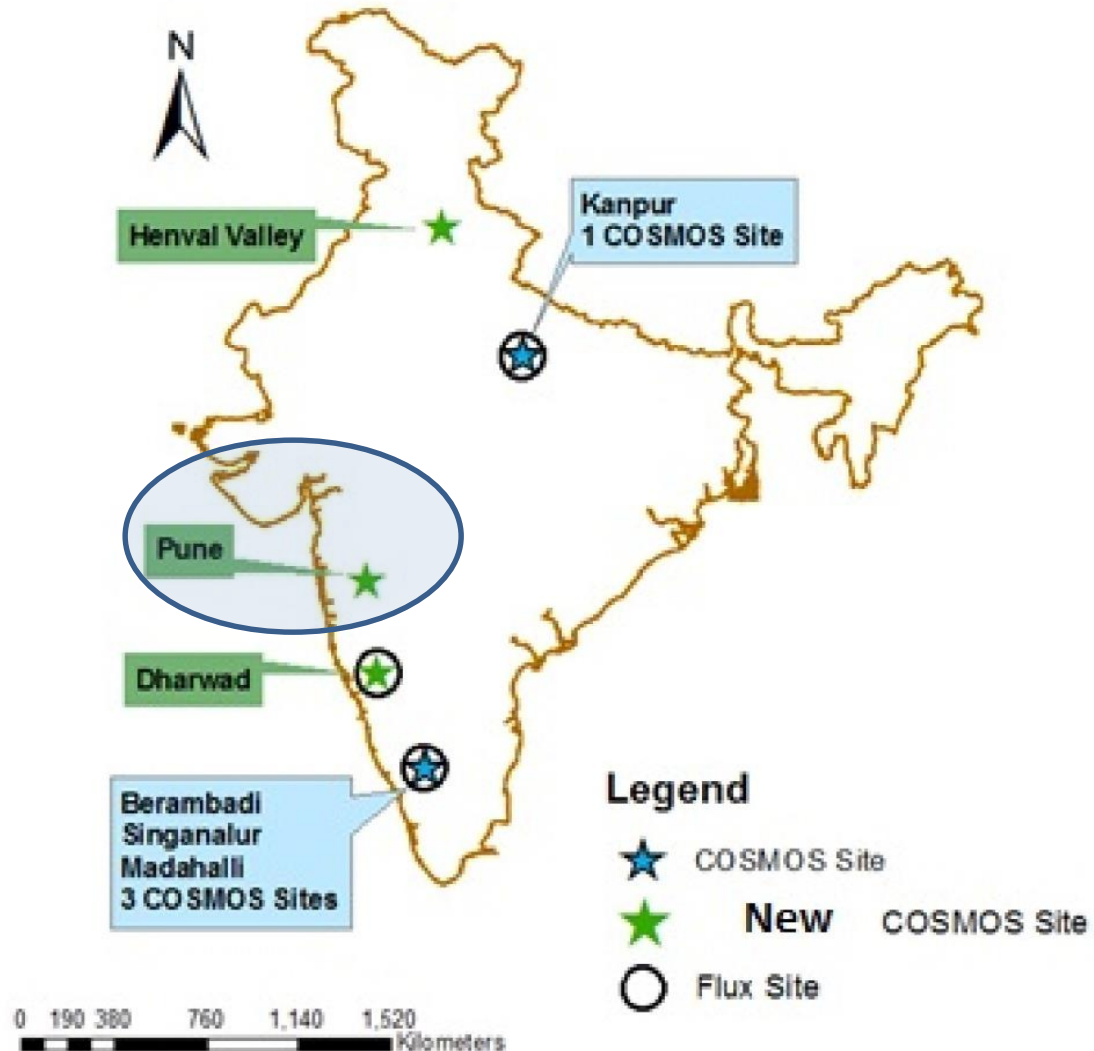
R. Morrison^{1*}, S. S. Angadi², L. Ball¹, T. Chakraborty³, H. Cooper¹, J. G. Evans^{1**}, S. Jain⁴, M. Krishnan³, R. Krishnan⁵, M. Mujumdar⁵, M. Nema⁴, D. Rylett¹, M. Sekhar^{6*}, R. Thayyen⁴, S. Tripathi^{3*} and A. Jenkins¹

COSMOS: COSMIC-ray soil moisture sensor (CRS) technology :

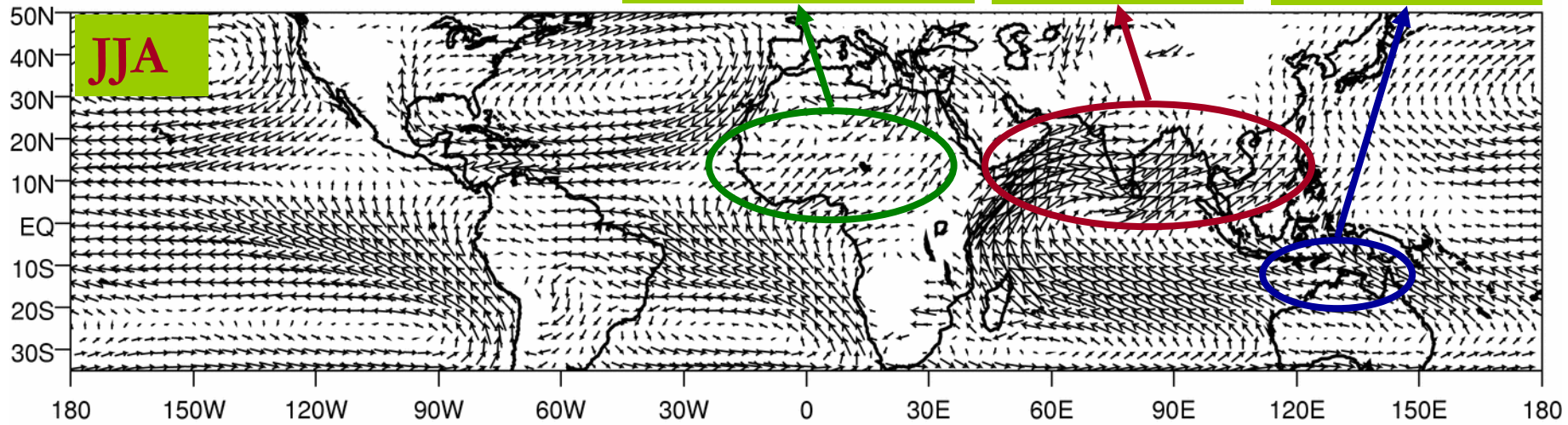
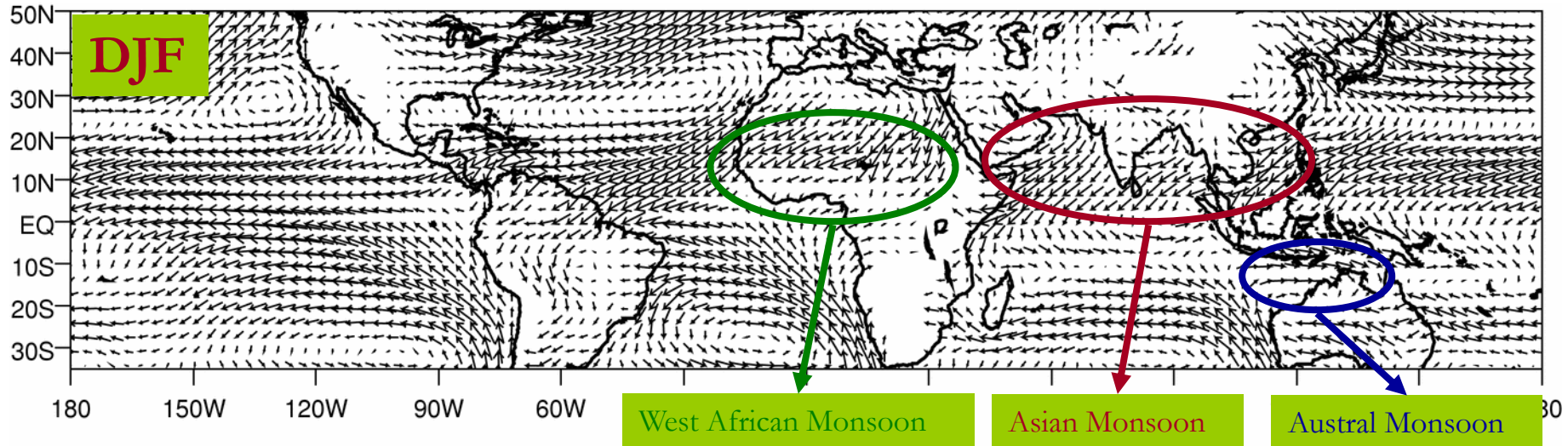
Soil moisture observations at intermediate spatial scale in near real-time.

- **Field scale (c. 200 m radius).** Average near-surface (to c.25 cm depth)
- **Volumetric soil water content (VWC)** over heterogeneous soils without contact (non-invasive).
- VWC is inferred by **counting fast neutrons which are naturally generated by incoming cosmic-rays**, and are slowed or captured by hydrogen atoms contained primarily within water residing in the upper soil profile.
- **CRS sensors are calibrated to local site conditions.** Data are telemetered over mobile networks and processed in near-real time.

CEH INCOMPASS & COSMOS-India Sites



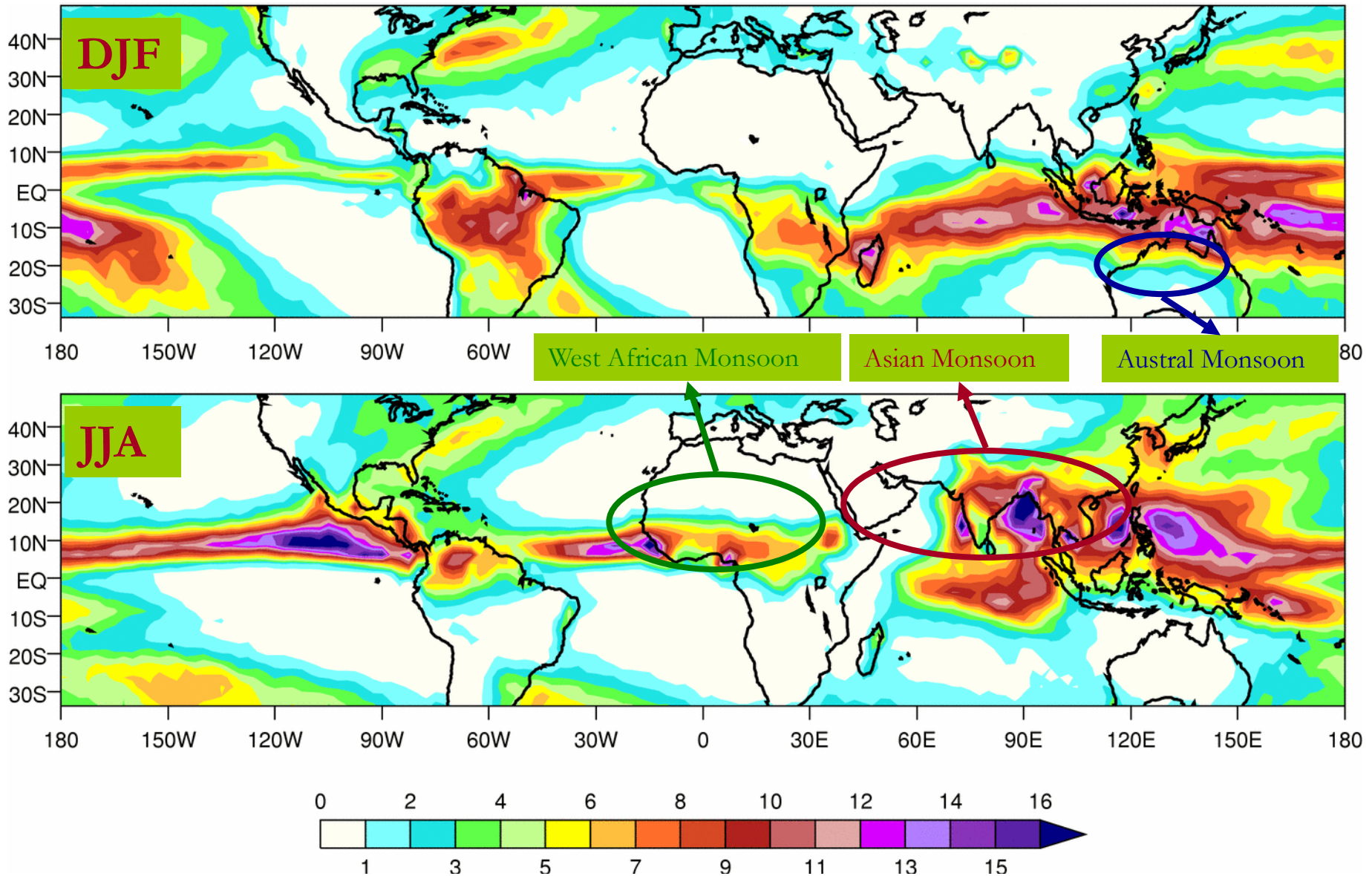
Winds at 925hPa



→
10

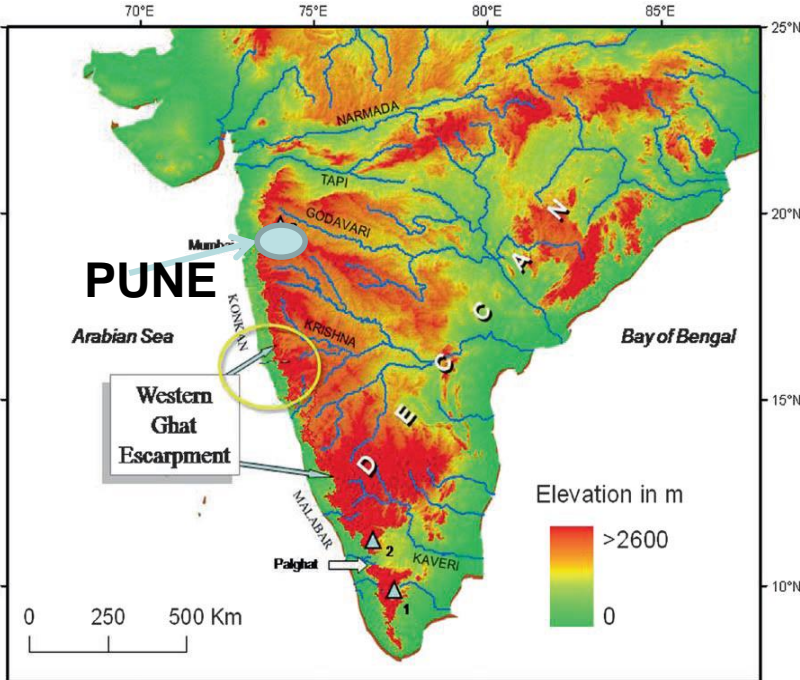
Courtesy: J.M. Slingo, Univ of Reading

Rainfall (mm/day)

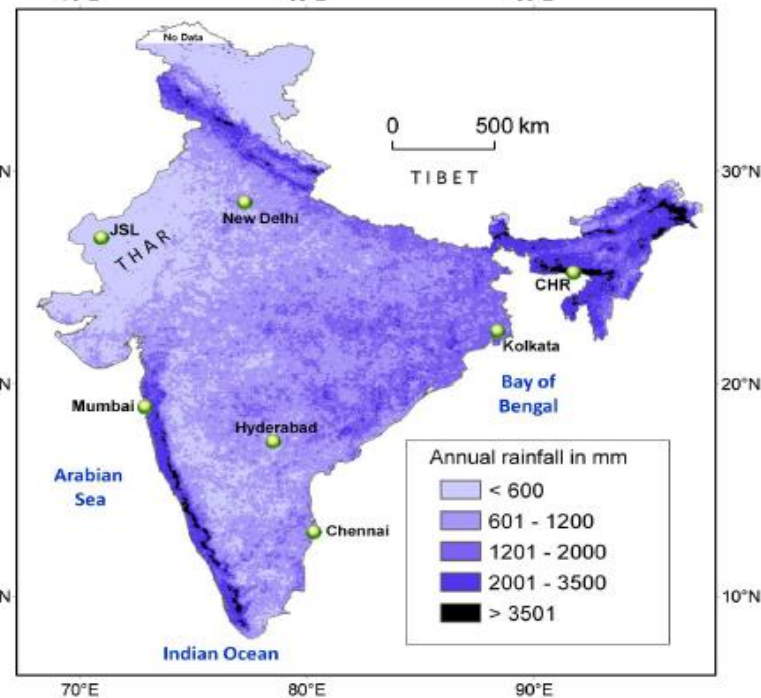


Courtesy: J.M. Slingo, Univ of Reading

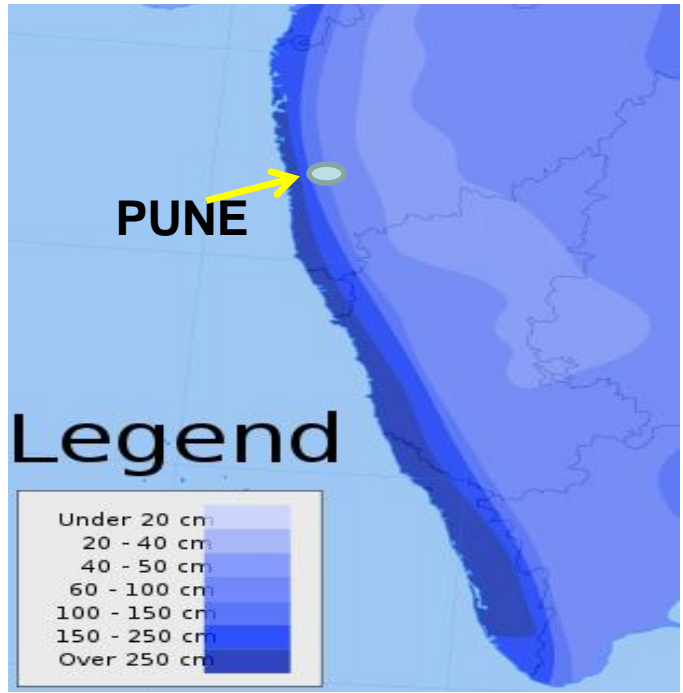
COSMOS-IITM, Pune, INDIA



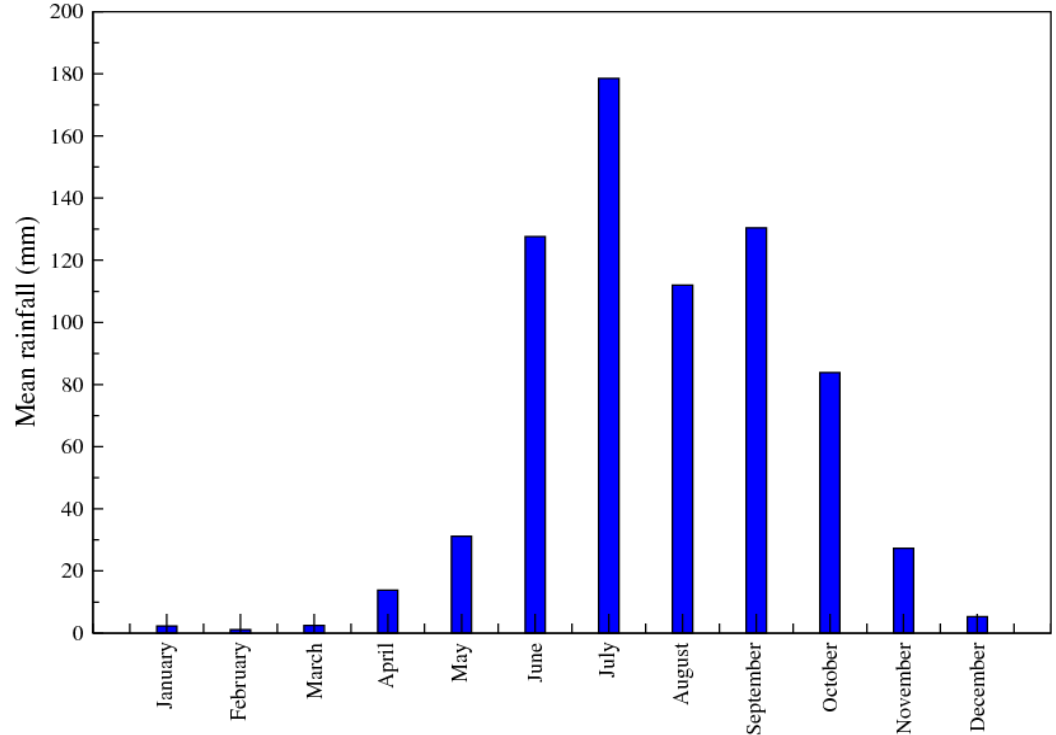
18.5374°N, 73.8054°E
Elevation – 560 m (1,840 ft)



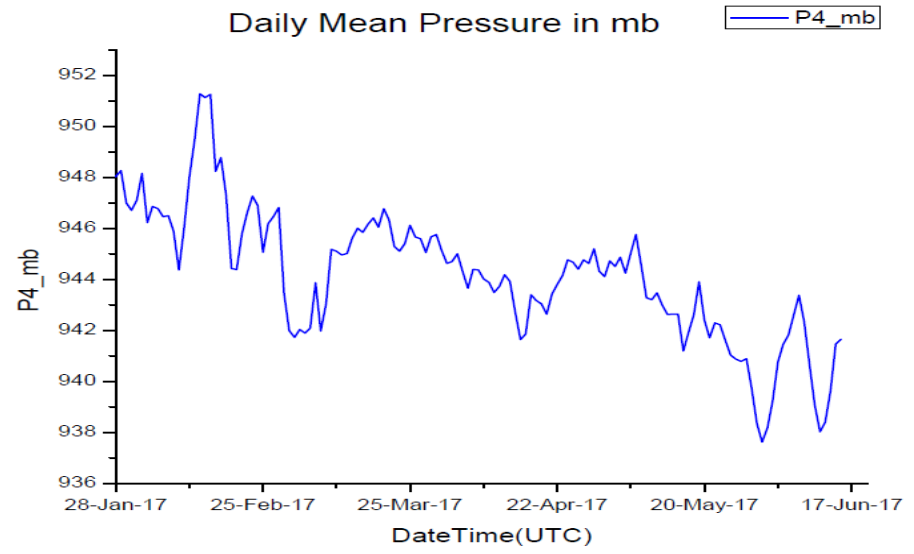
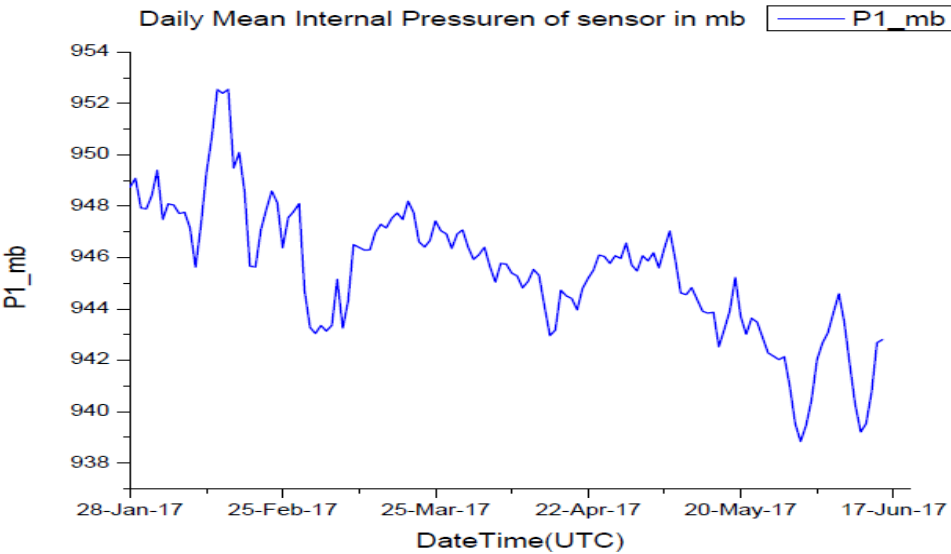
Annual rainfall over Western Ghats (cm)



Mean monthly rainfall of PUNE (Maharashtra-India) (Period 1871-2014)

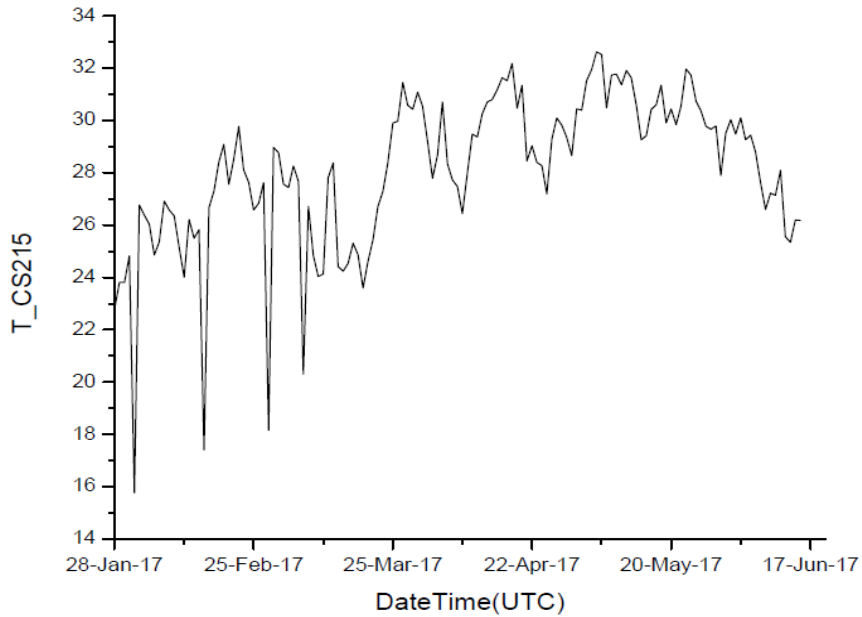


COMOS-IITM Preliminary Analysis January – June 2017

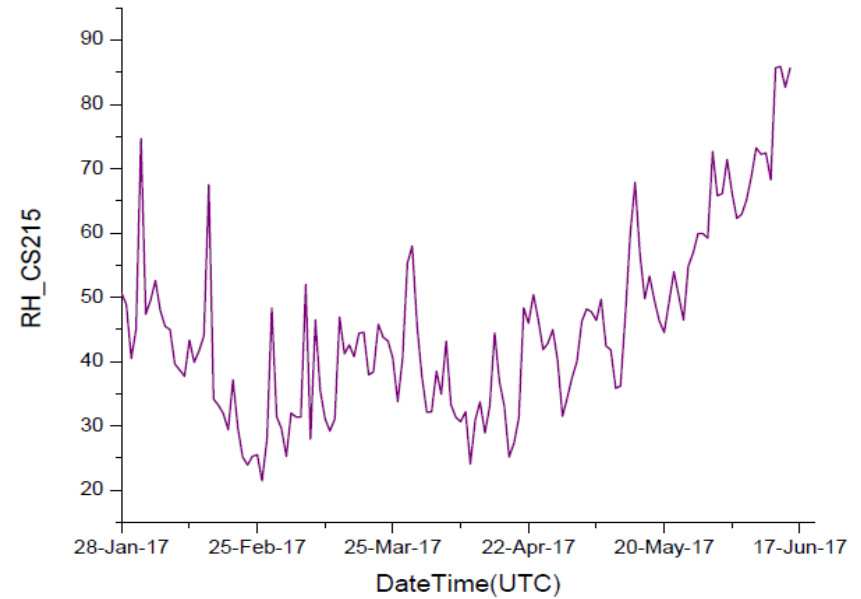


COMOS-IITM Preliminary Analysis January – June 2017

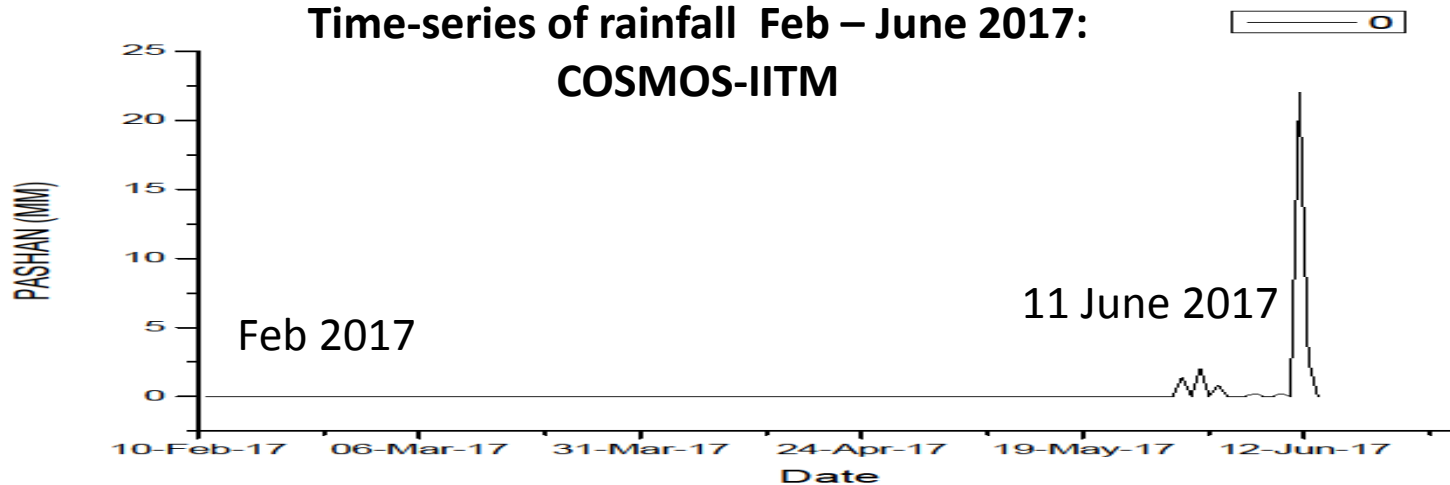
Daily Mean Temperature Inside the Sensor in Deg.C — T_CS215



Daily Mean Relative Humidity — RH_CS215

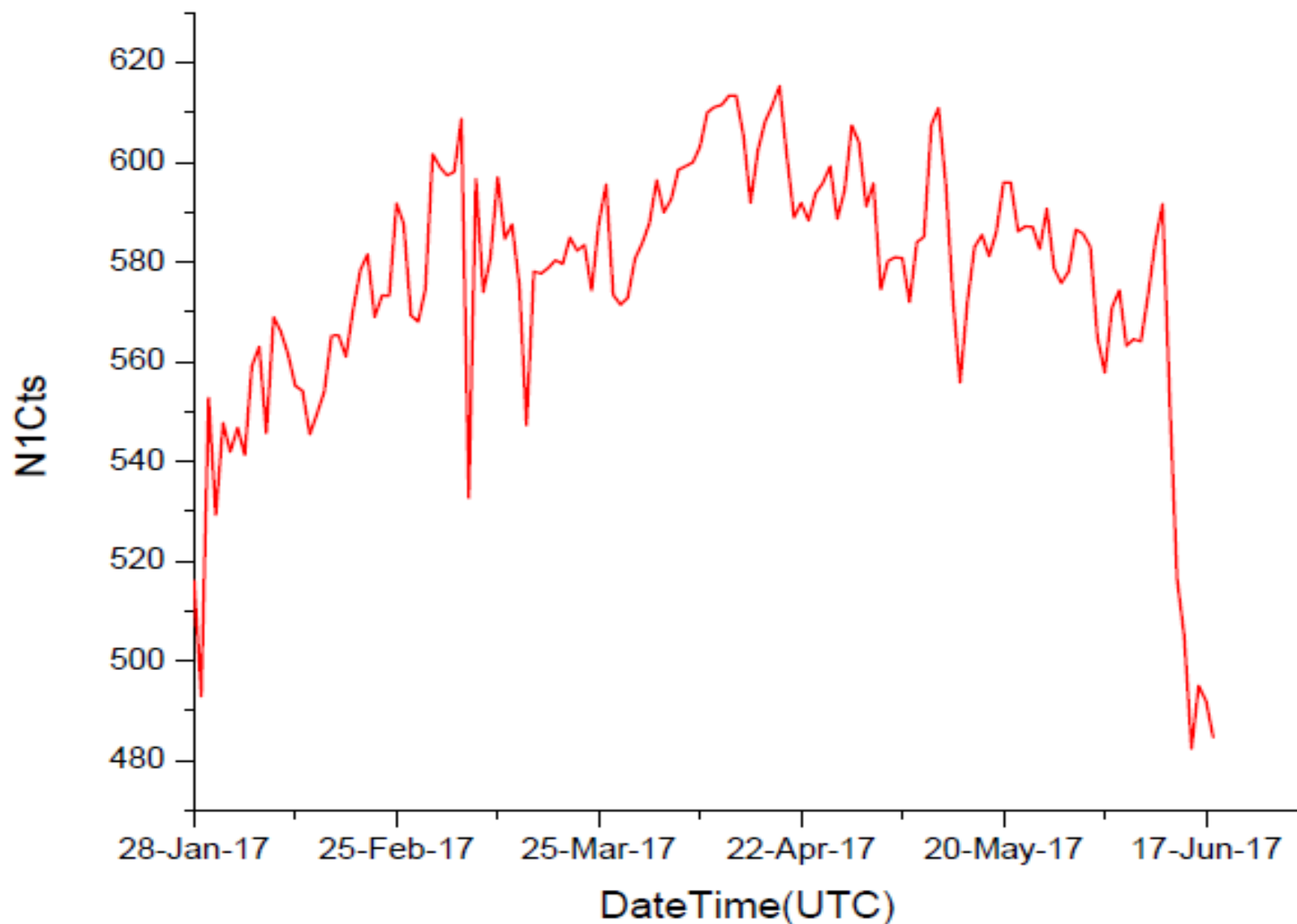


Time-series of rainfall Feb – June 2017:
COSMOS-IITM



Daily Mean Neutron Count

N1Cts

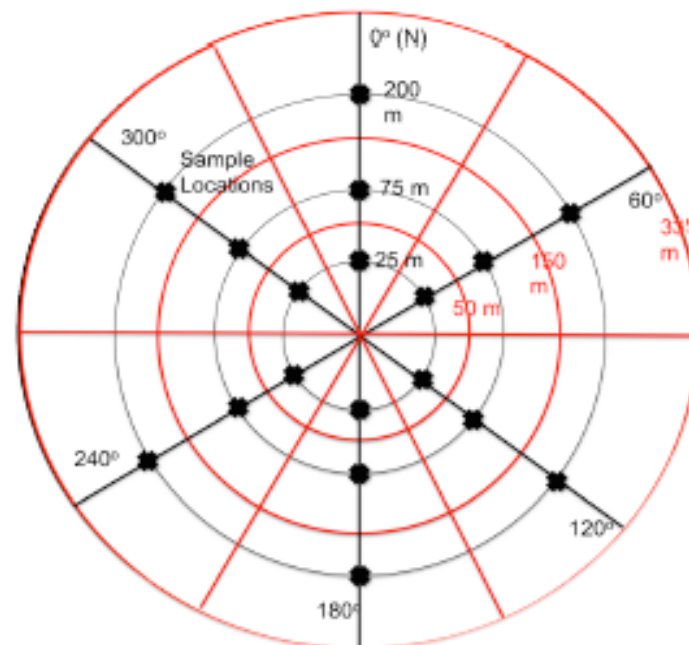


1. Apply pressure, incoming high neutron intensity correction (Zreda et al. 2012), and water vapor correction factors to neutron counts (Rosolem et al. 2013), need local measurements of surface air temperature, pressure, and relative humidity (**not currently implemented in COSMOS database!**)

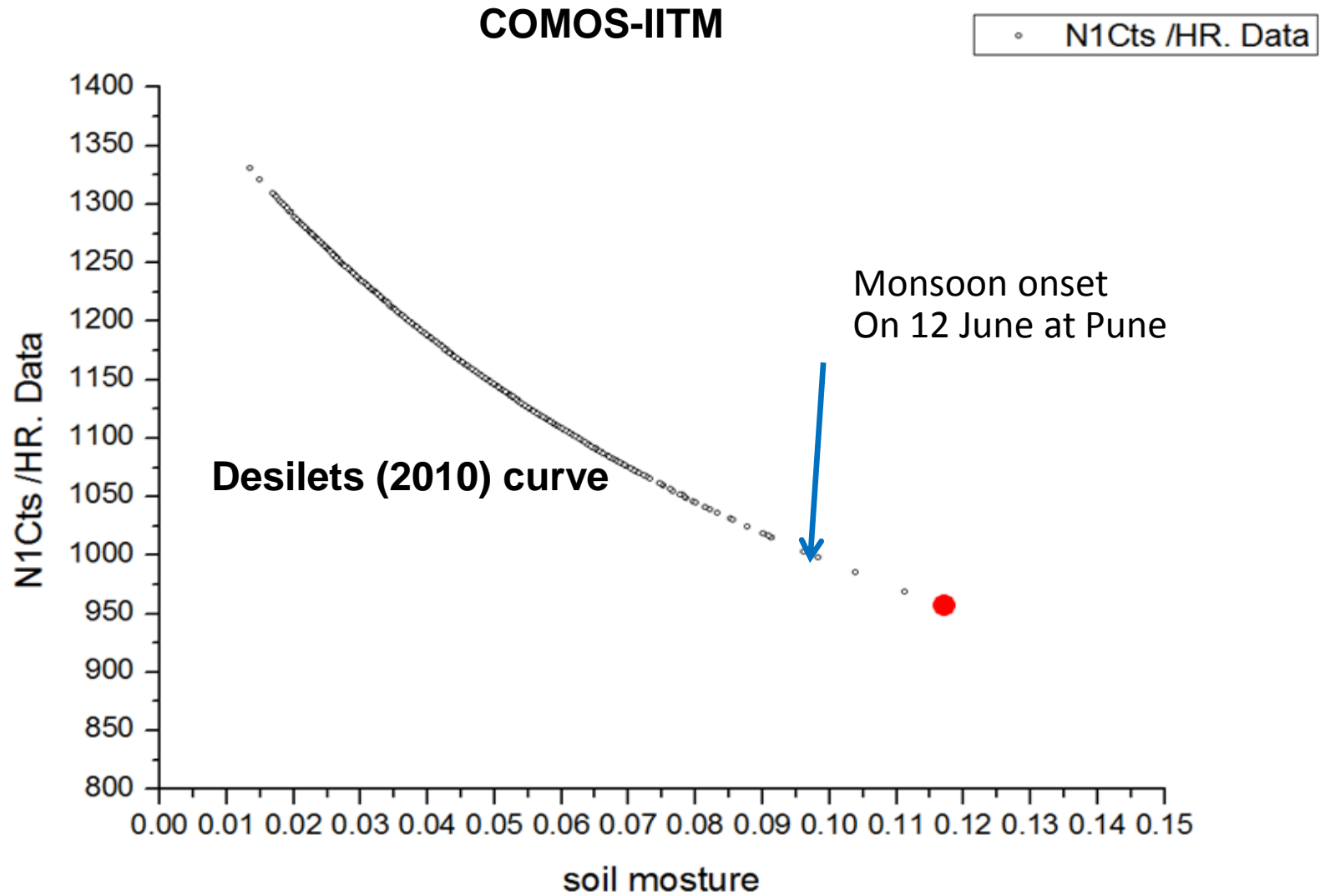
$$N = N^* CP * CI * CWV \left\{ \begin{array}{l} CP = \exp\left(\frac{P_i - P_o}{130}\right) \\ CI = \frac{N_n^i}{N_n^o} \\ CWV = 1 + 0.0054(\rho_v^o - \rho_v^{ref}) \end{array} \right.$$

2. Where θ are all in units of g/g and $\theta_{SOC_{eq}} = (TC - 12/44 * CO_2) * 0.5556$

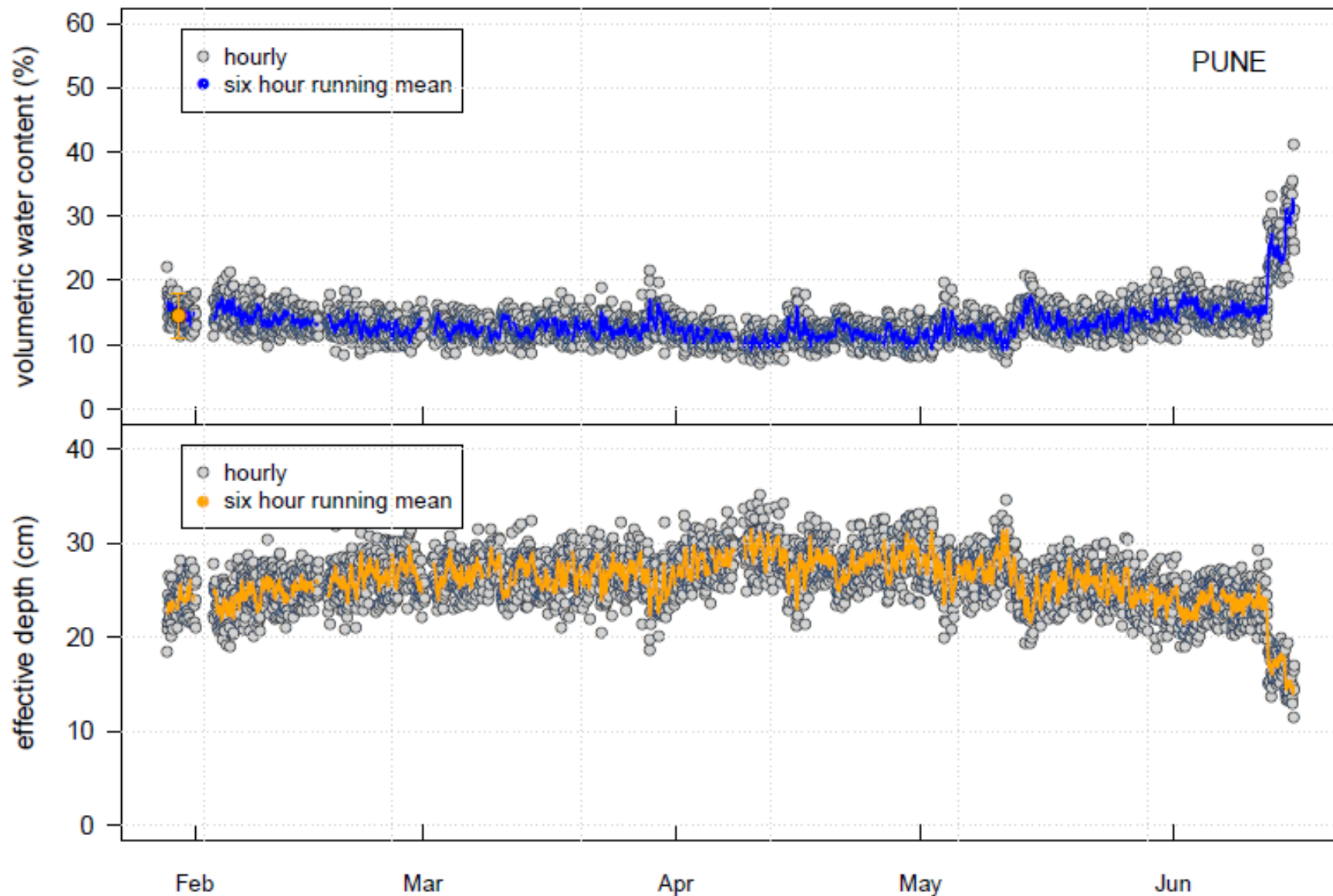
$$(\theta_p + \theta_{LW} + \theta_{SOC_{eq}}) \rho_{bd} = \frac{0.0808}{\frac{N}{N_o} - 0.372} - 0.115$$



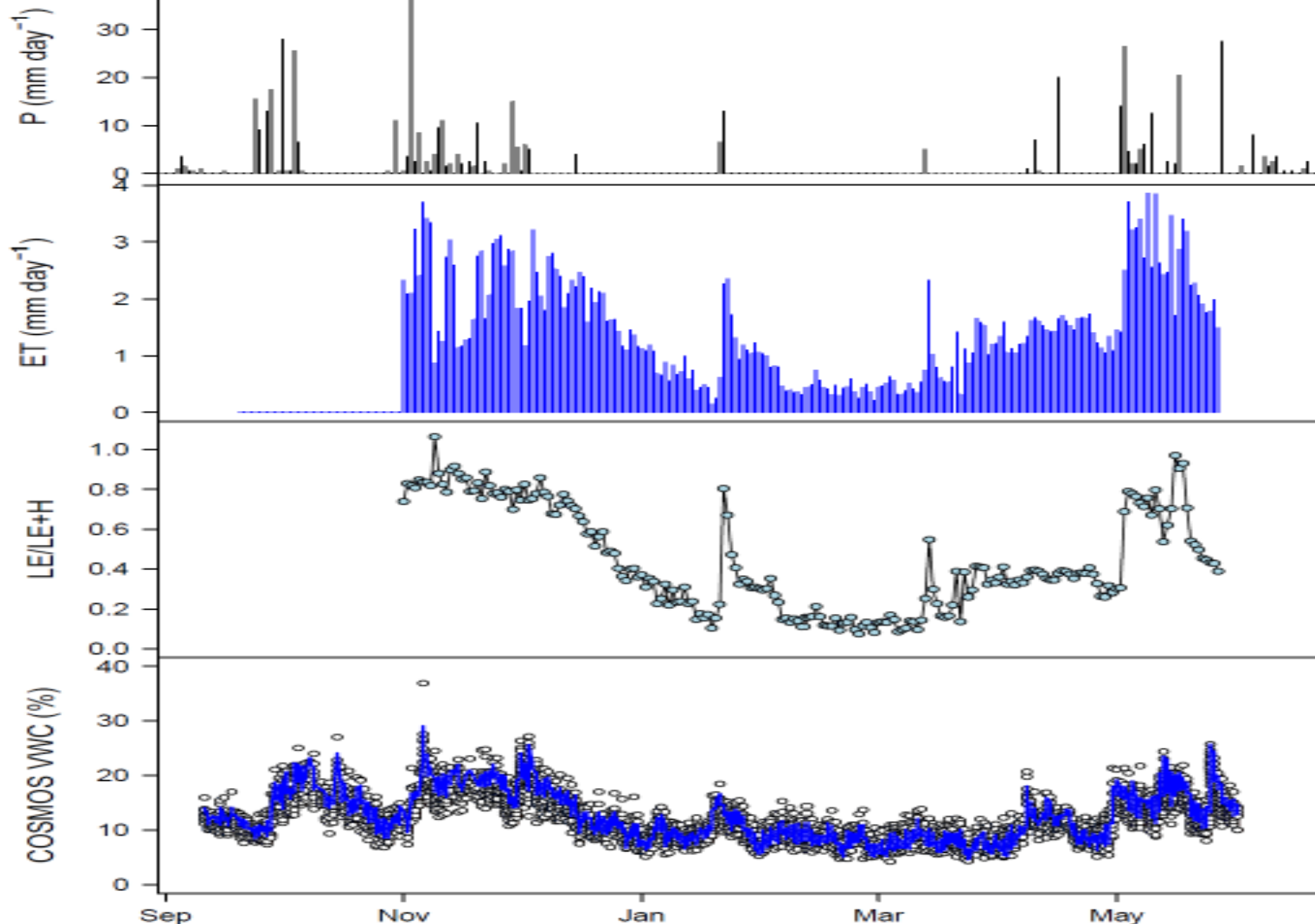
Neutron Counts vs Soil moisture (g/g) February – June 2017



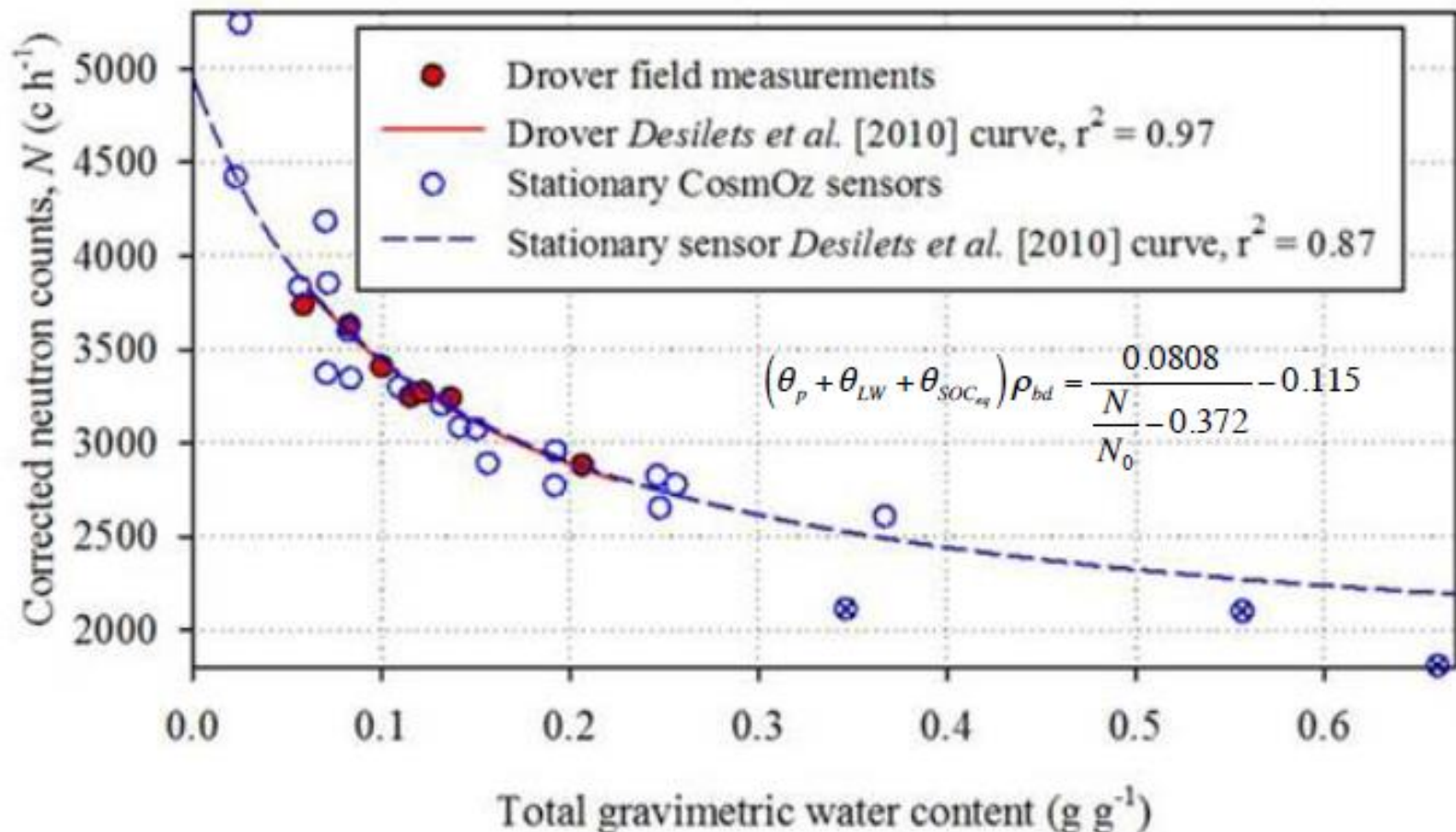
Time-series of calibrated soil moisture Feb – June 2017: COSMOS-IITM



COSMOS - Berambadi (Karnata)



Sample sites with biomass $> \sim 20 \text{ kg/m}^2$ diverge from line



COSMOS-India network development

Calibration - more details of local soil characteristics and samples for dry and wet conditions

The influence of Monsoon rainfall variations on soil moisture (feedback)

Development of COSMOS-IITM, Pune site - Observations of latent heat (evapotranspiration) and sensible heat fluxes, as well as net ecosystem CO₂ exchange, micrometeorology and soil physics. BIO-MASS above and below the ground.

Example applications

- ☐ Water resources, groundwater, irrigation scheduling
- ☐ Hydro-meteorological, land surface and ecological studies
- ☐ Ground-truth for remotely sensed soil moisture products Flood and drought forecasting
- ☐ Water use efficiency of crop production

Thank you