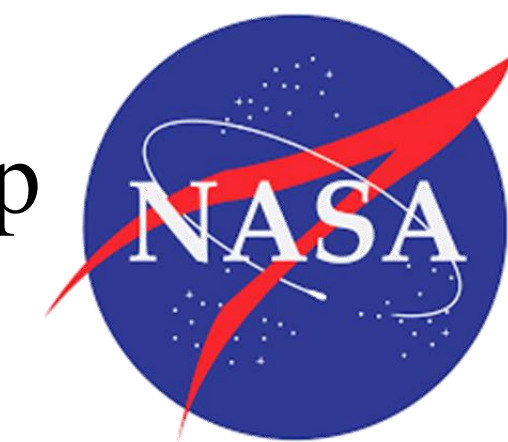


# Adaptive, Energy Efficient Spatiotemporal Monitoring Using Wireless Sensors



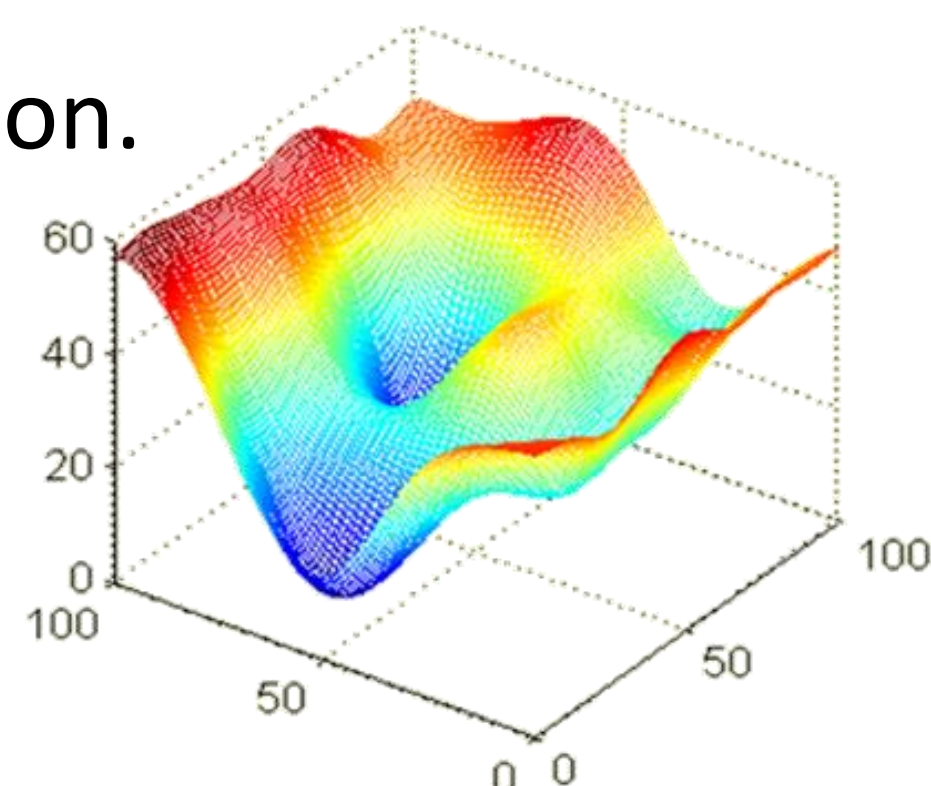
## Problem Statement

**Objective:** Energy efficiently monitor a correlated spatial distribution over time at fusion center, using sensor observations.

**Application:** Planetary monitoring.

**Costs:** Communication, sensing and processing at sensors.

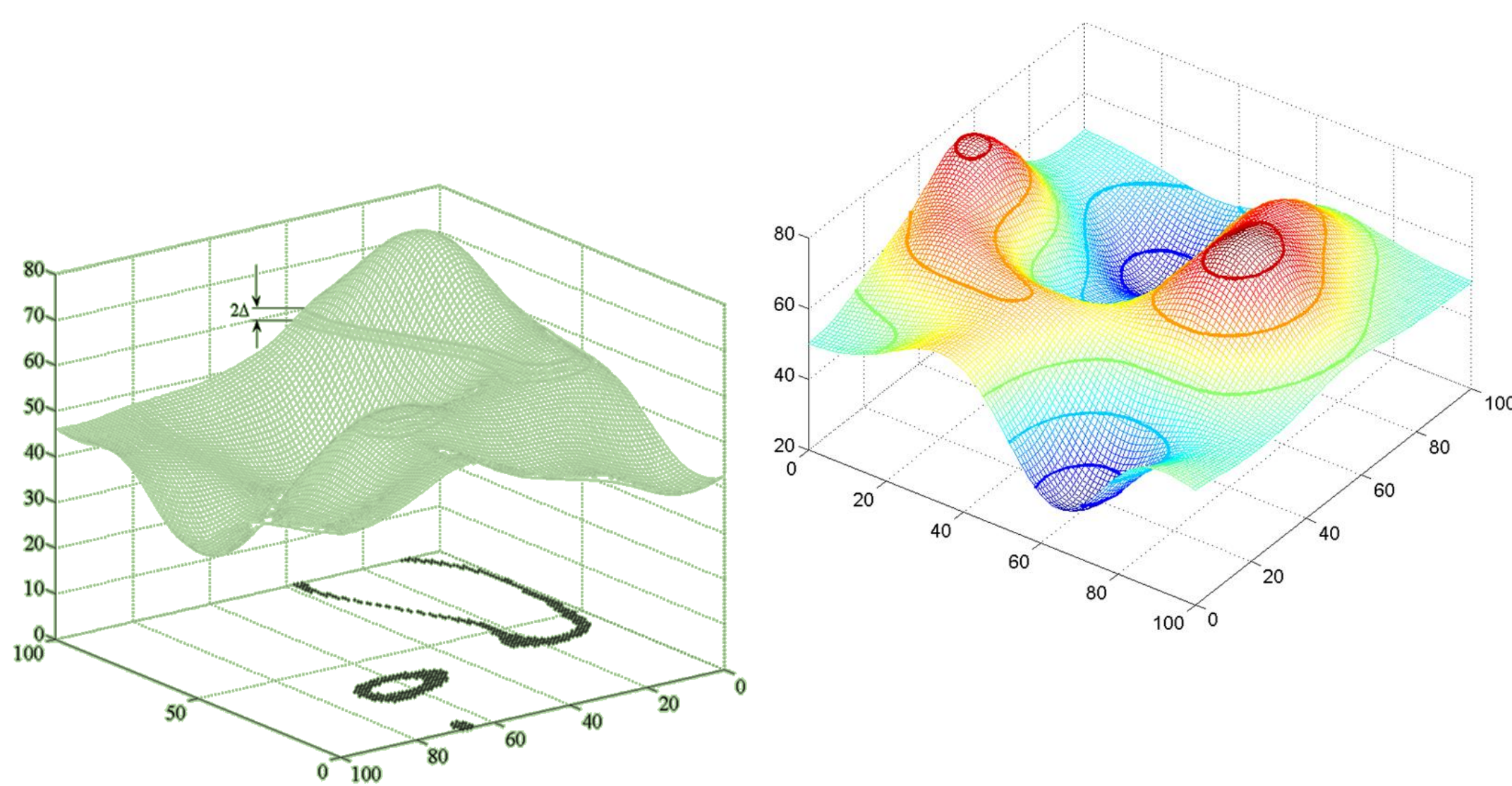
**Major cost:** Communication.



## Spatial Monitoring

To conserve energy in sensor network:

- ❖ Spatial distribution (2D) is modeled using contours (compressed sensing).
- ❖ Only the sensor observations in  $\Delta$  margin of the contours are reported.
- ❖ The optimal contours to minimize the 2D distribution is computed iteratively.
- ❖  $\Delta$  is adapted during iterations.



## Optimization & Adaptation

- ❖ The optimal contour levels (Lloyd-Max) are calculated based on sensor observations, iteratively at fusion center.

$$L_i = \frac{\int_{y_i}^{y_{i+1}} x f_X(x) dx}{\int_{y_i}^{y_{i+1}} f_X(x) dx}, \quad i = 1, 2, \dots, M$$

$$y_i = \frac{L_i + L_{i-1}}{2}, \quad i = 1, 2, \dots, M - 1$$

- ❖ The contour margin ( $\Delta$ ) is adapted for:
  - Energy consumption reduction
  - Modeling error reduction ( $e$ )

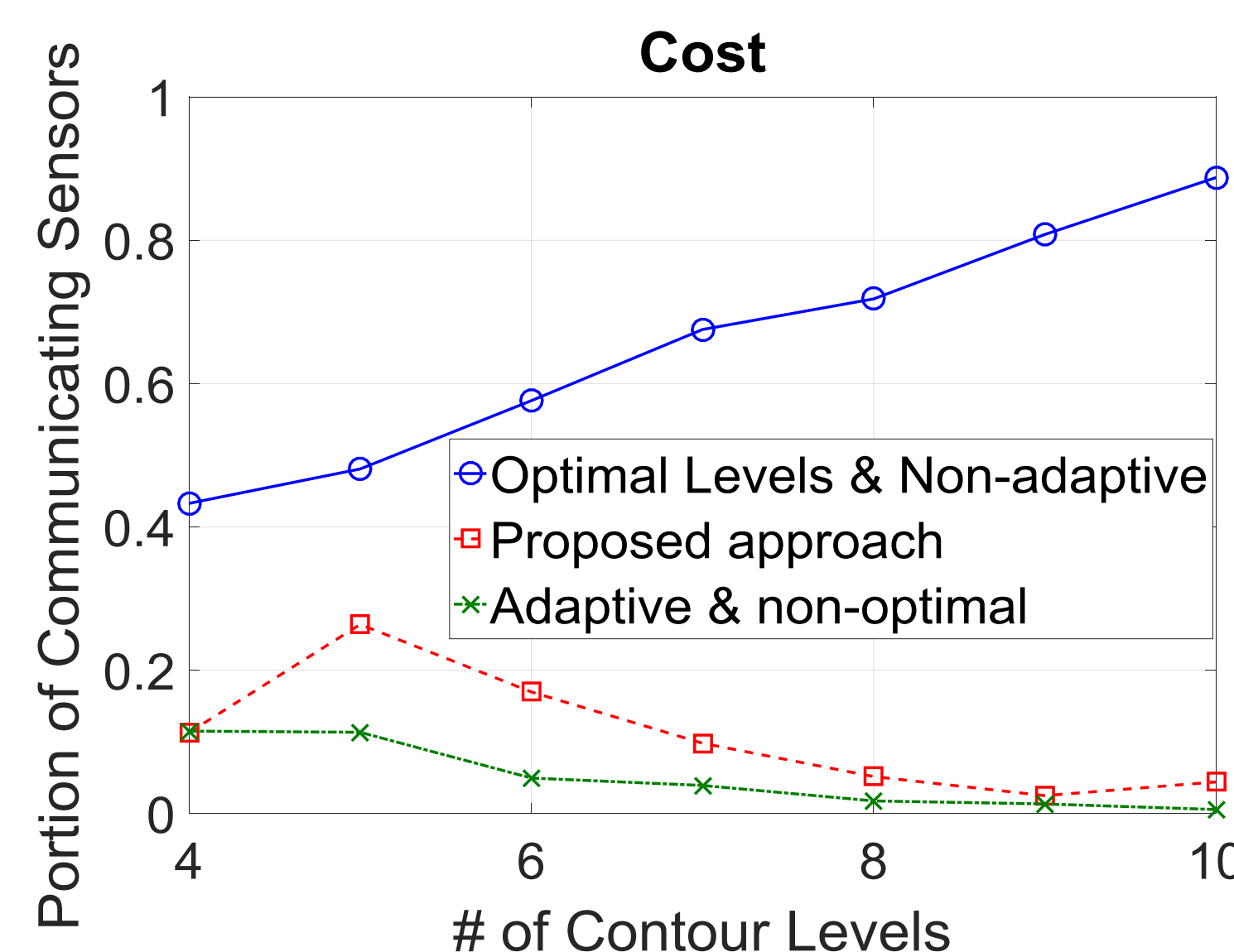
$$\Delta_{n+1} = \Delta_n \frac{\mu}{1 + \frac{(e_{n-1} - e_n)}{e_n}}$$

## Temporal Monitoring

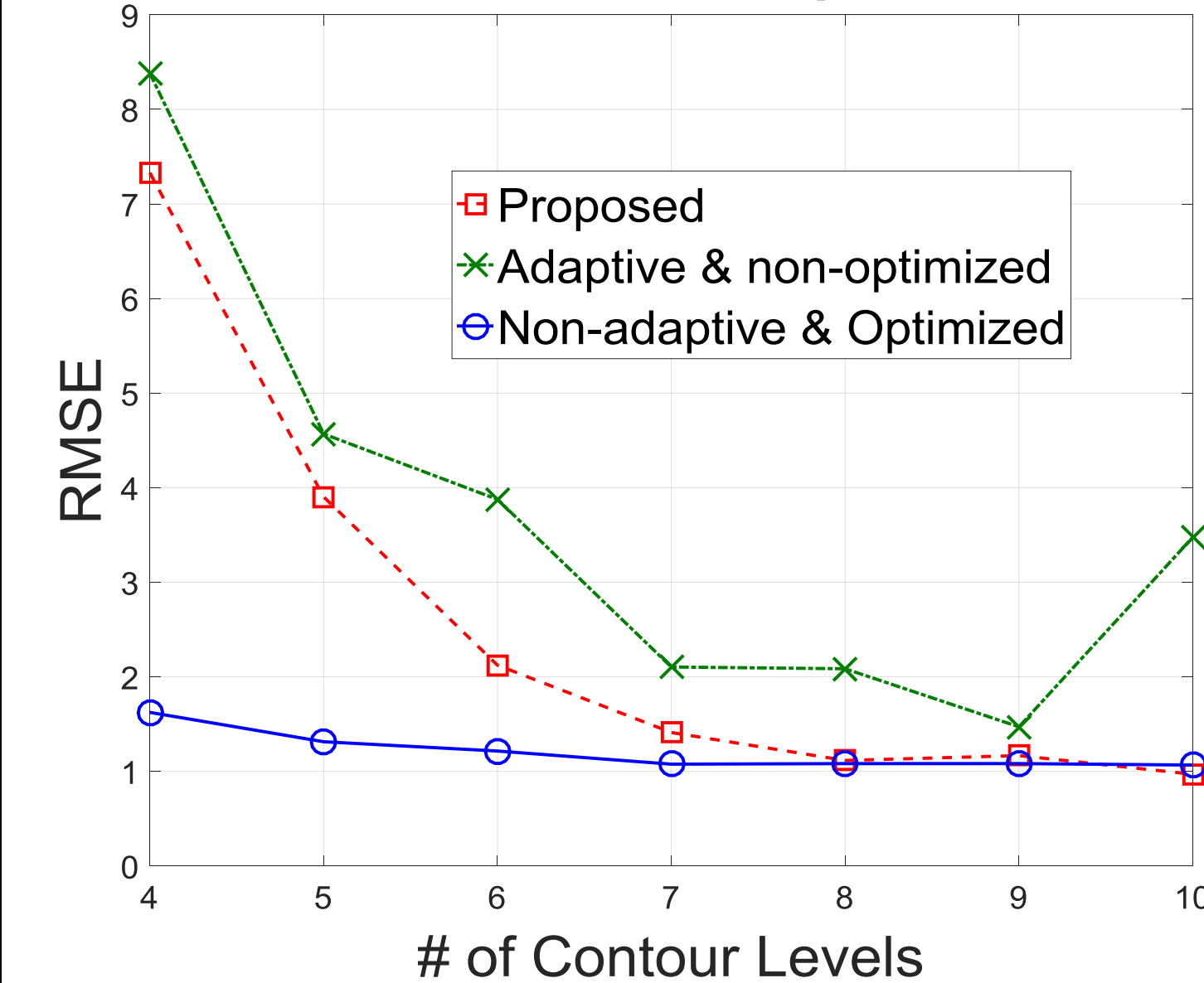
- ❖ Correlation between successive time frames is used to reduce cost.
- ❖ All sensors monitor their local variations by applying **moving average** process.

## Performance Results

The proposed approach has very low cost.

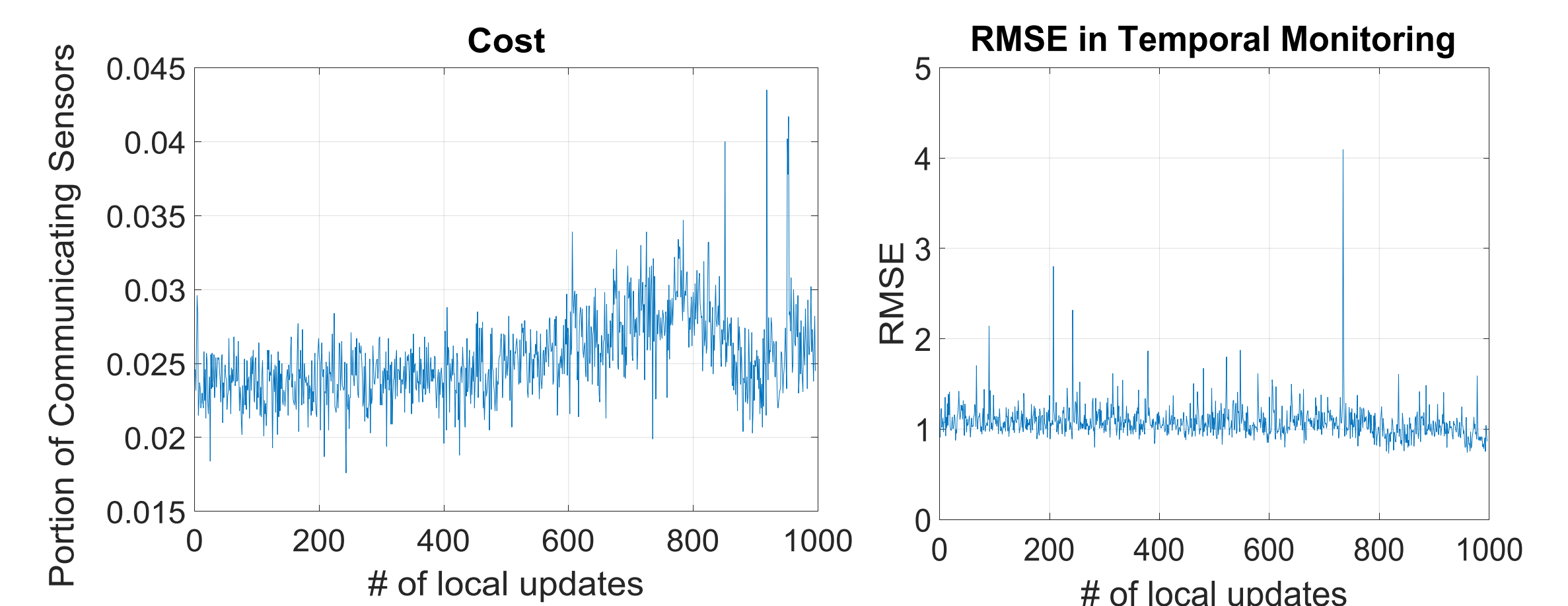


## Reconstruction Mean Square of Error



The proposed approach tracks the optimal RMSE

The proposed temporal approach tracks The RMSE of Spatial with less than 5% of sensors.



## Conclusion

An adaptive, energy efficient approach is proposed for spatiotemporal monitoring of 2D distributions in wireless sensor field. Performance results shows a tangible cost reduction against non-adaptive-optimal and a major modelling improvement against modeling with equally spaced contour set.

## Acknowledgement

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