PERVASIVE SYSTEMS
RESEARCH GROUP

# Algorithms for energy efficient data extraction from wireless sensor networks for environmental monitoring applications


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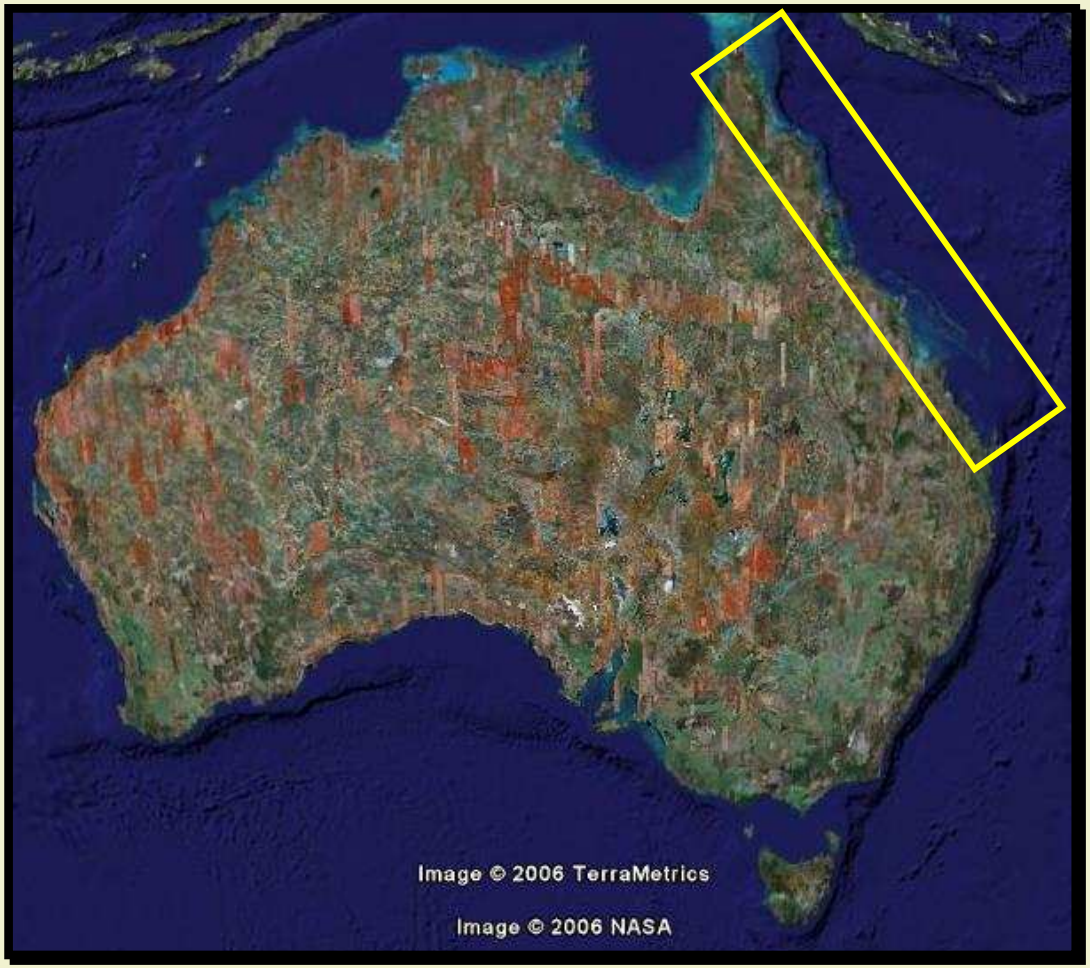
# Overview

- Motivating application
  - Great Barrier Reef (GBR)
  - Problems with current setup
  - Our solution: Wireless sensor networks (WSNs)
- Algorithms
  - Taking advantage of:
    - Spatial correlations
    - Temporal correlation
- Future work

# WSN deployment at the Great Barrier Reef



# WSN deployment at the Great Barrier Reef

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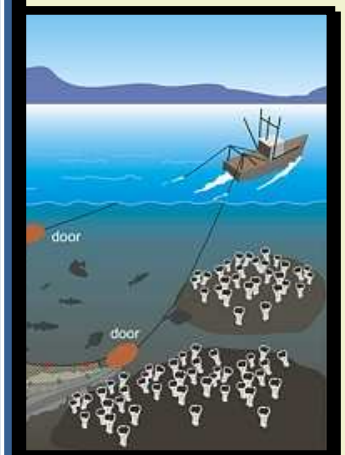
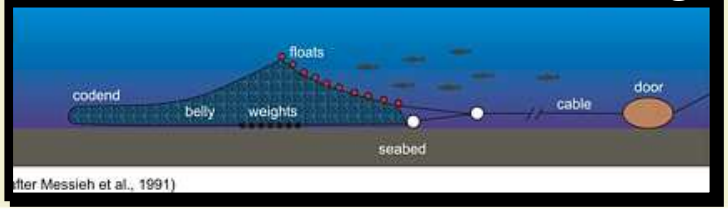
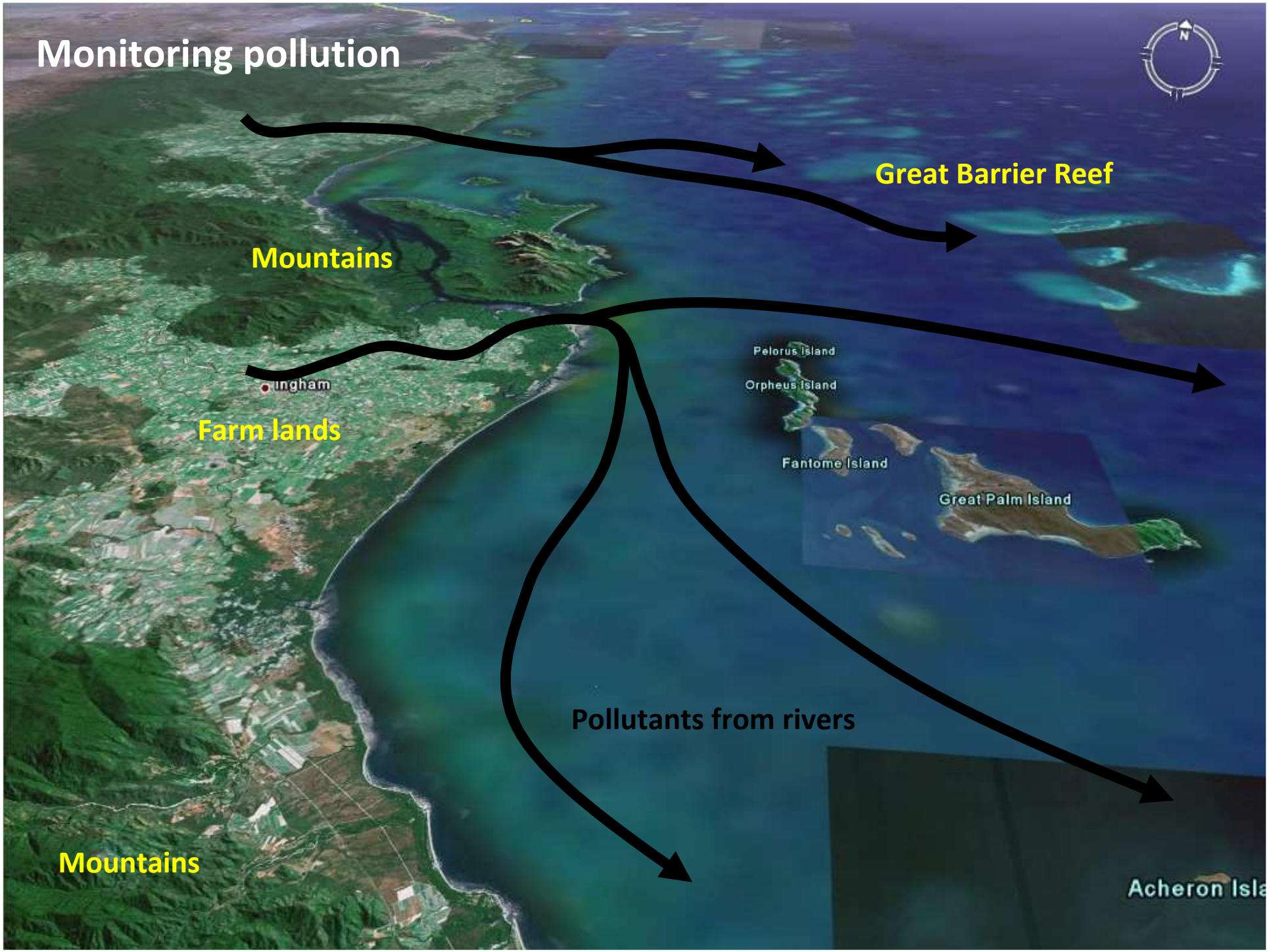
- Australian Institute of Marine Science (AIMS)
  - Temper
  - Effects c
  - Fisherie
  - Monitor


Trawling




Monitoring pollution
Great Barrier Reef
Mountains
Farm lands
Pelorus Island
Orpheus Island
Fantome Island
Great Palm Island
Pollutants from rivers
Mountains

# WSN deployment at the Great Barrier Reef

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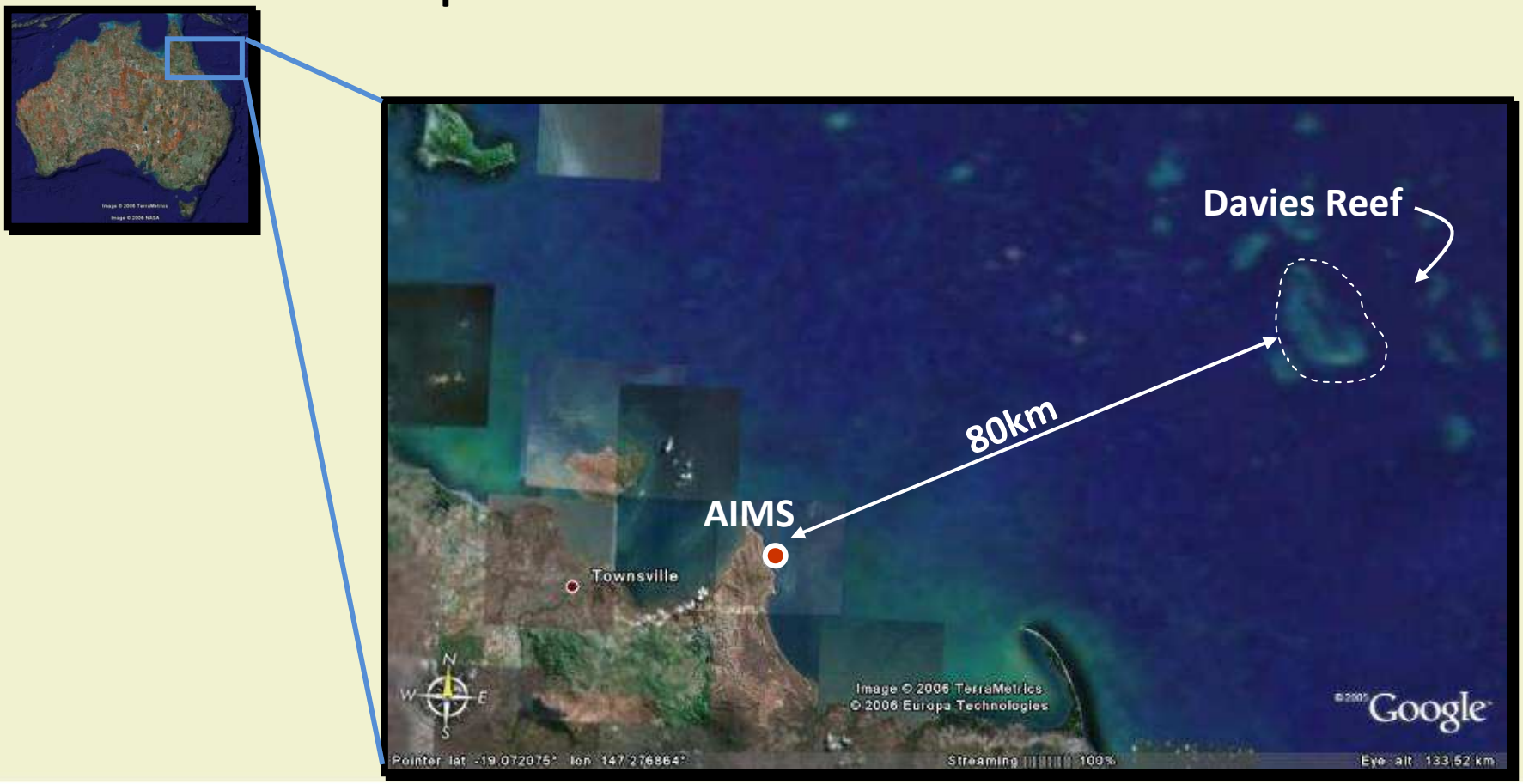
- Current setup at Davies Reef



# WSN deployment at the Great Barrier Reef

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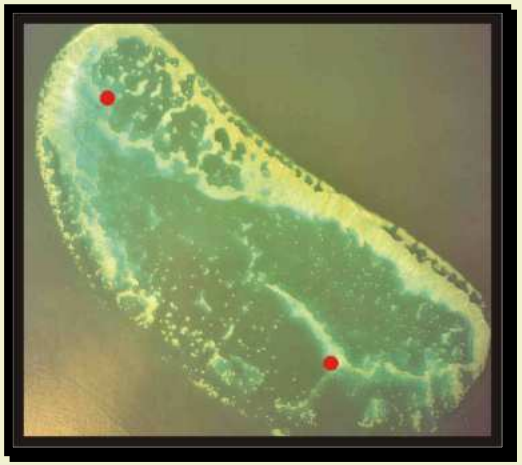
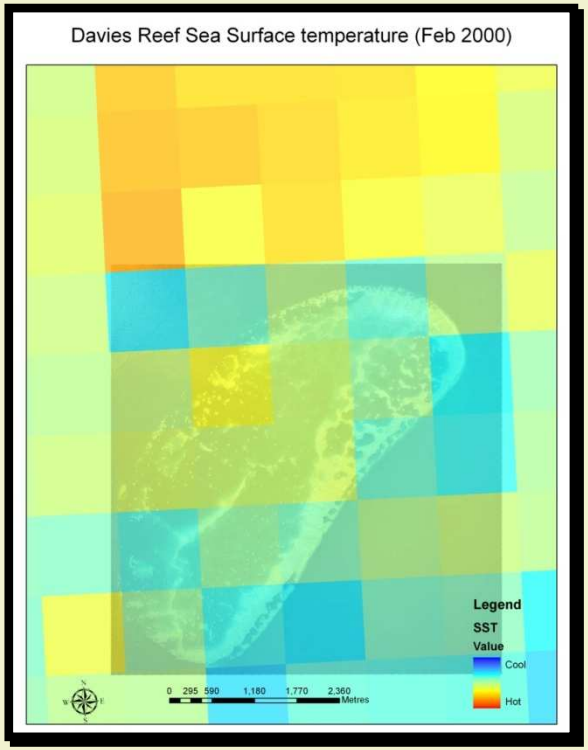
- Current setup at Davies Reef
  - Two points of data collection
  - Data is collected on a half hourly basis at the weather station and is stored on a logger
  - Data is retrieved manually periodically



# WSN deployment at the Great Barrier Reef

- Problems with current setup
  - Unable to perform
    - Fine-grained monitoring
    - Real-time monitoring
  - Labour intensive
    - Data needs to be retrieved manually
  - Low resolution



# WSN deployment at the Great Barrier Reef

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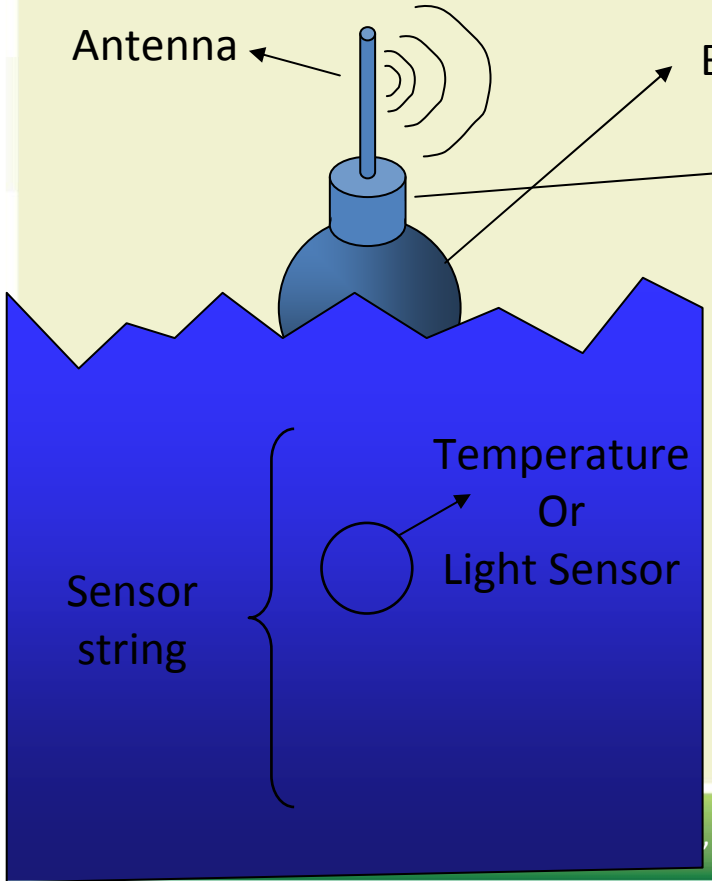
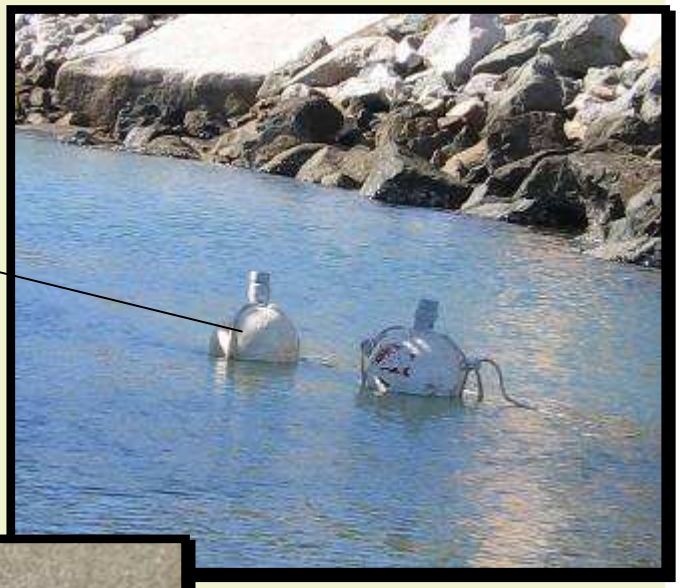
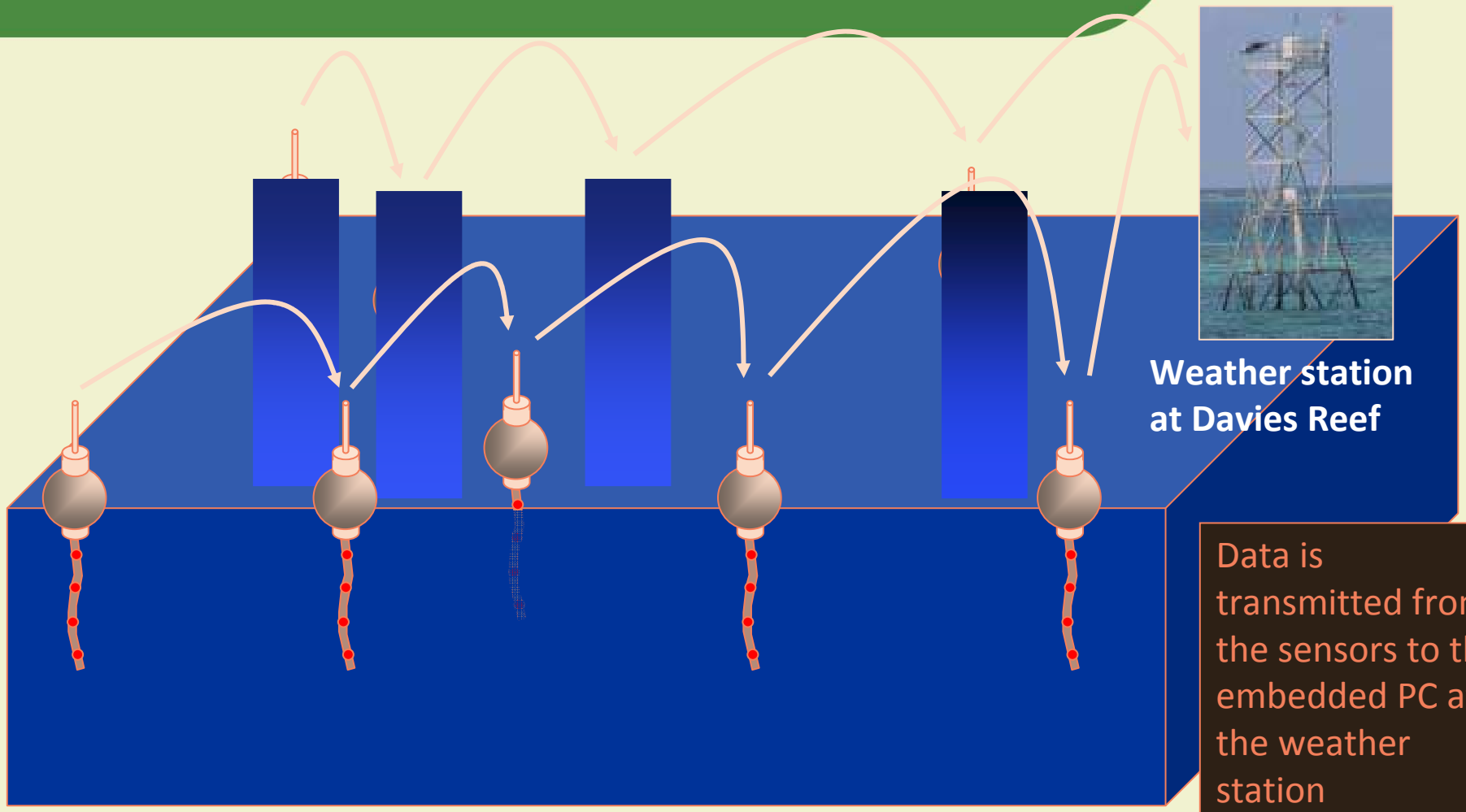
- Proposed WSN deployment at AIMS
  - Sensor network on GBR



# WSN deployment at the Great Barrier Reef





**Weather station at Davies Reef**

Data is transmitted from the sensors to the embedded PC at the weather station

# WSN deployment at the Great Barrier Reef

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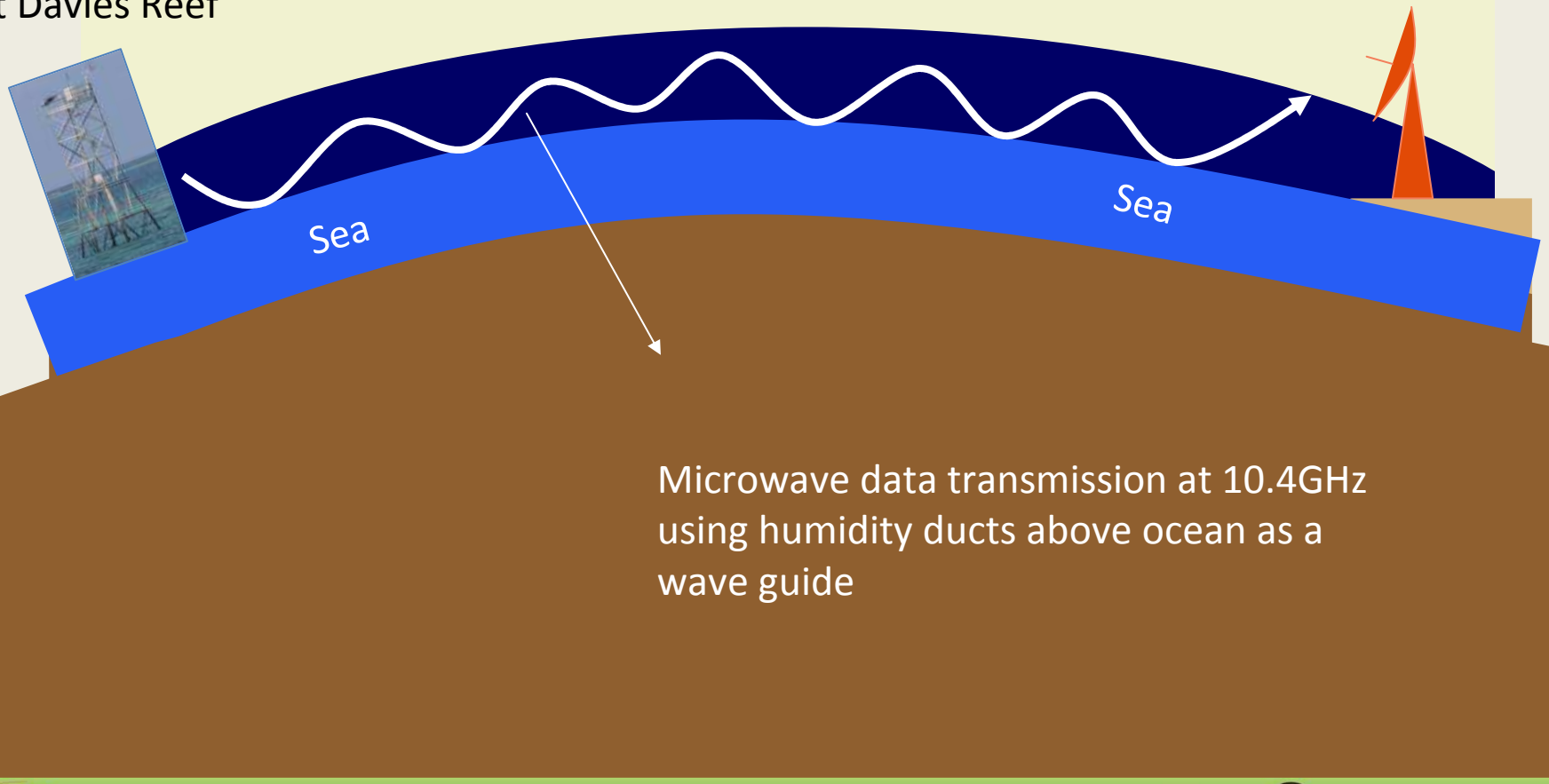
Weather station
at Davies Reef

AIMS
Base station



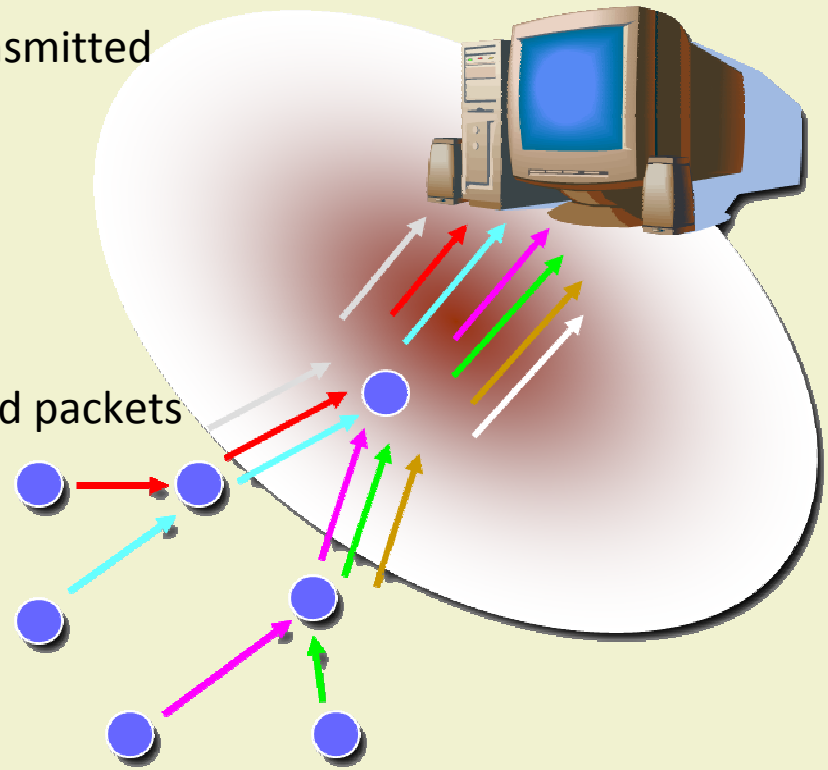

Microwave data transmission at 10.4GHz using humidity ducts above ocean as a wave guide

# Challenges of WSN deployment

- Limited energy supply
  - Battery-operated
- Limited transmission capability
  - Devices sleep most of the time
- Large numbers + Harsh environment
  - Impossible for people to manage manually

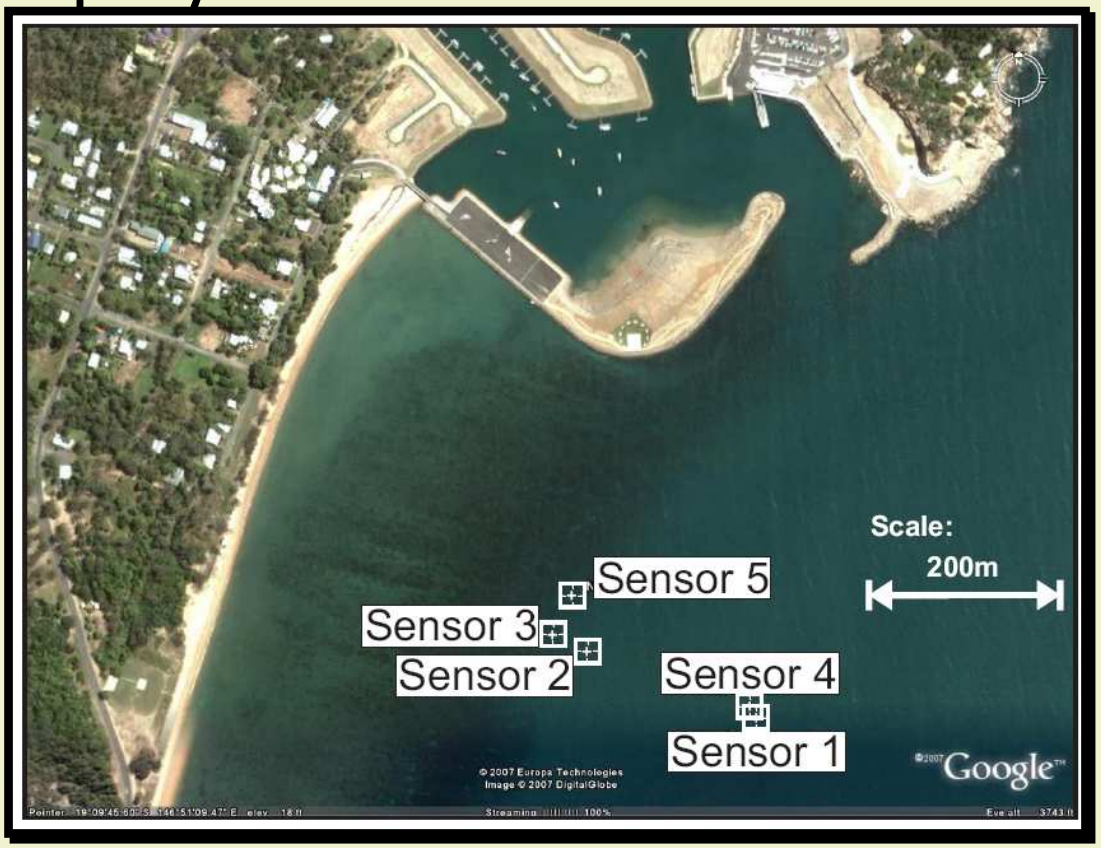
# Challenges of WSN deployment

- Raw data collection
  - High energy-consumption
    - Large amount of data needs to be transmitted
    - Sensor sampling
  - Bottlenecks
    - Especially close to the sink node
  - Poor data quality
    - Limited bandwidth can lead to dropped packets



# Our approach

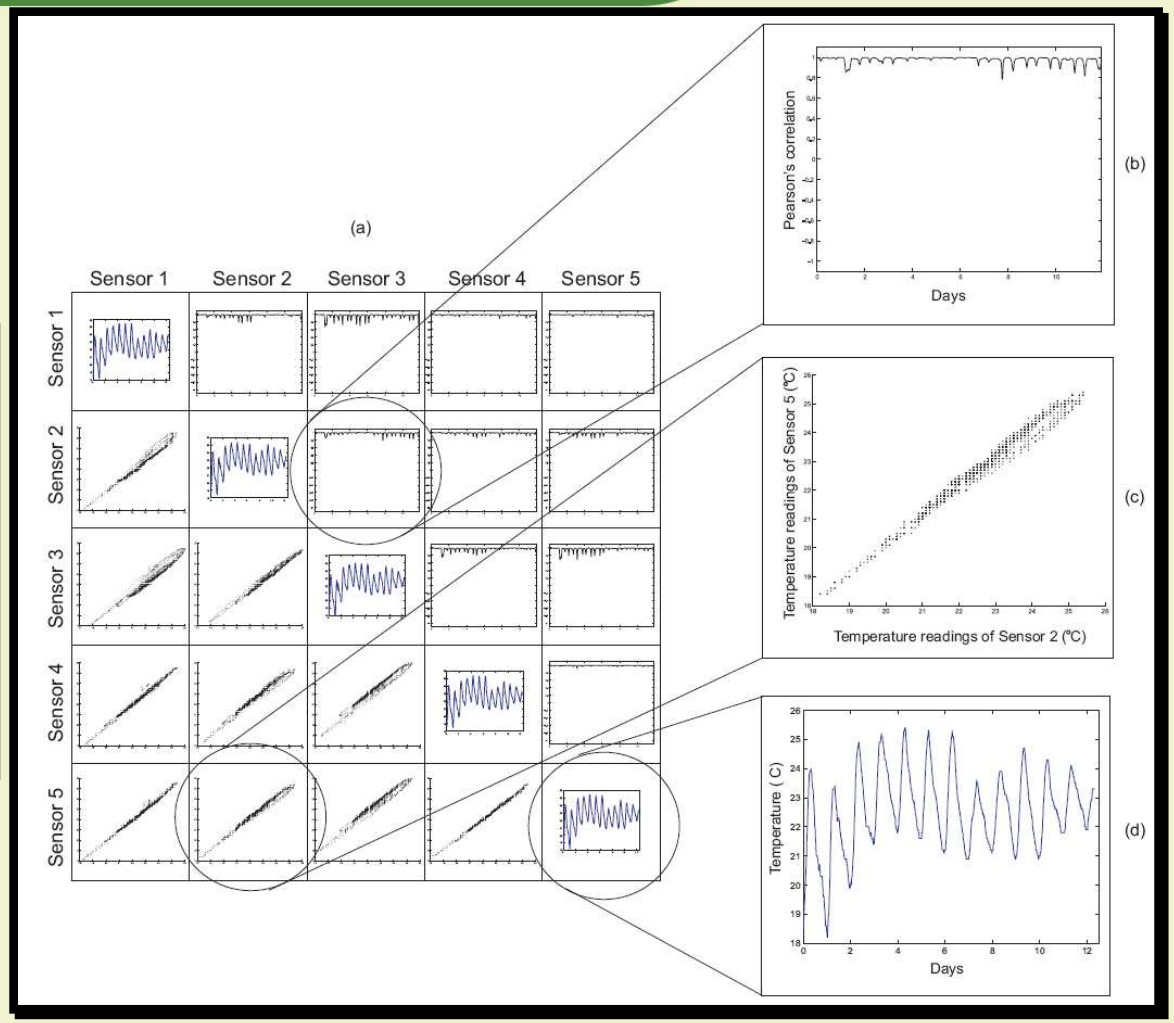
- Initial deployment




Nelly Bay, Great Barrier Reef

# Our approach

- Initial deployment

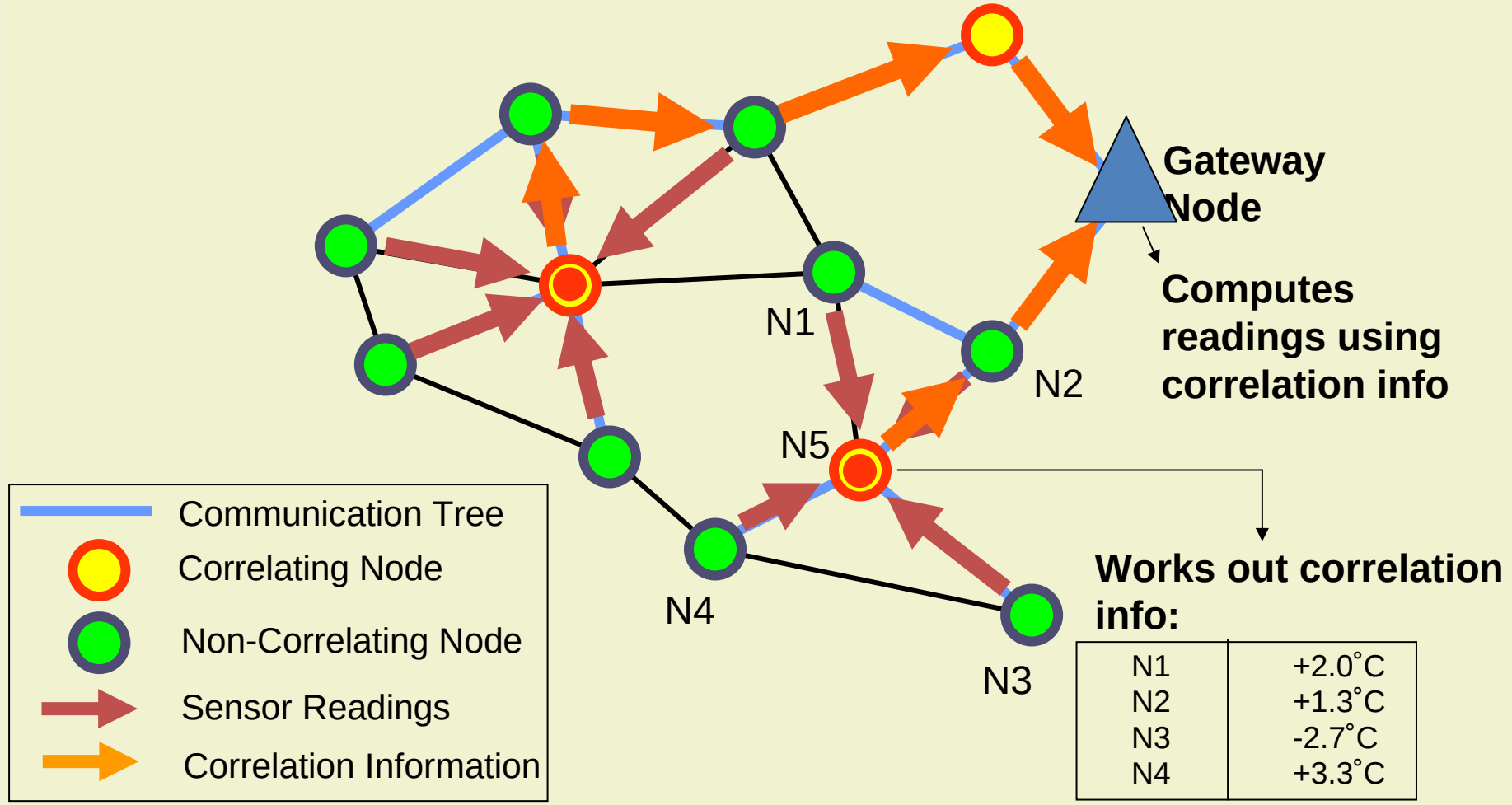



# Our approach

- Algorithms to take advantage of
  - Spatial correlations
    - Between sensor readings of adjacent sensor nodes
  - Temporal correlation
    - Between consecutive sensor readings of a single sensor

# Spatial correlation

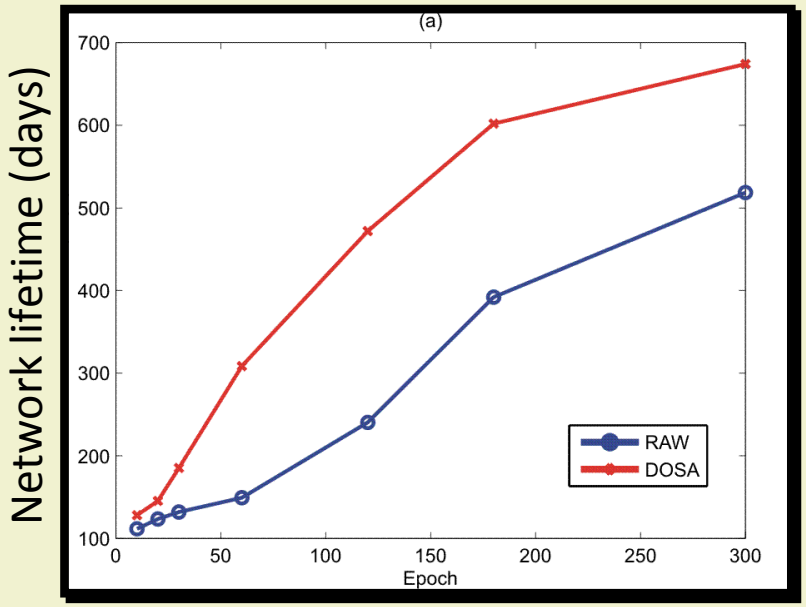
*DOSA*: Distributed and Self-Organizing Scheduling Algorithm for Data Aggregation

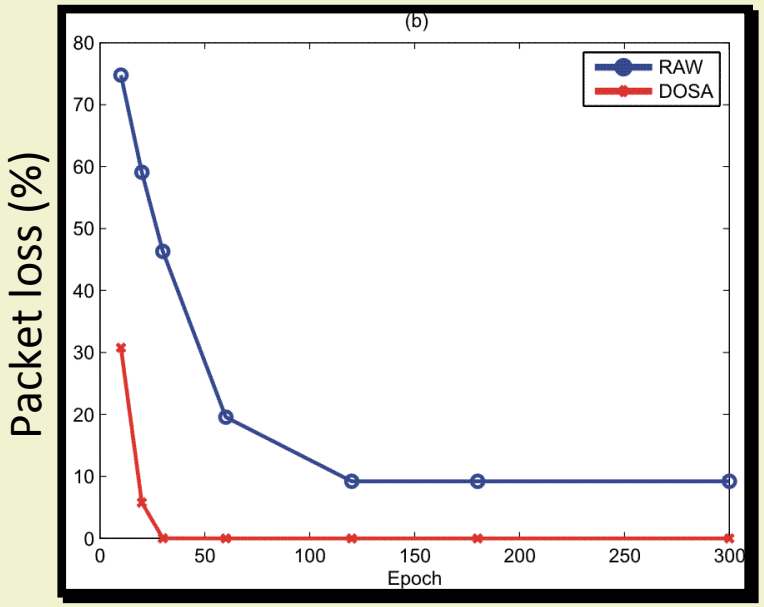


# Spatial correlation - Results

*DOSA*: Distributed and Self-Organizing Scheduling Algorithm for Data Aggregation

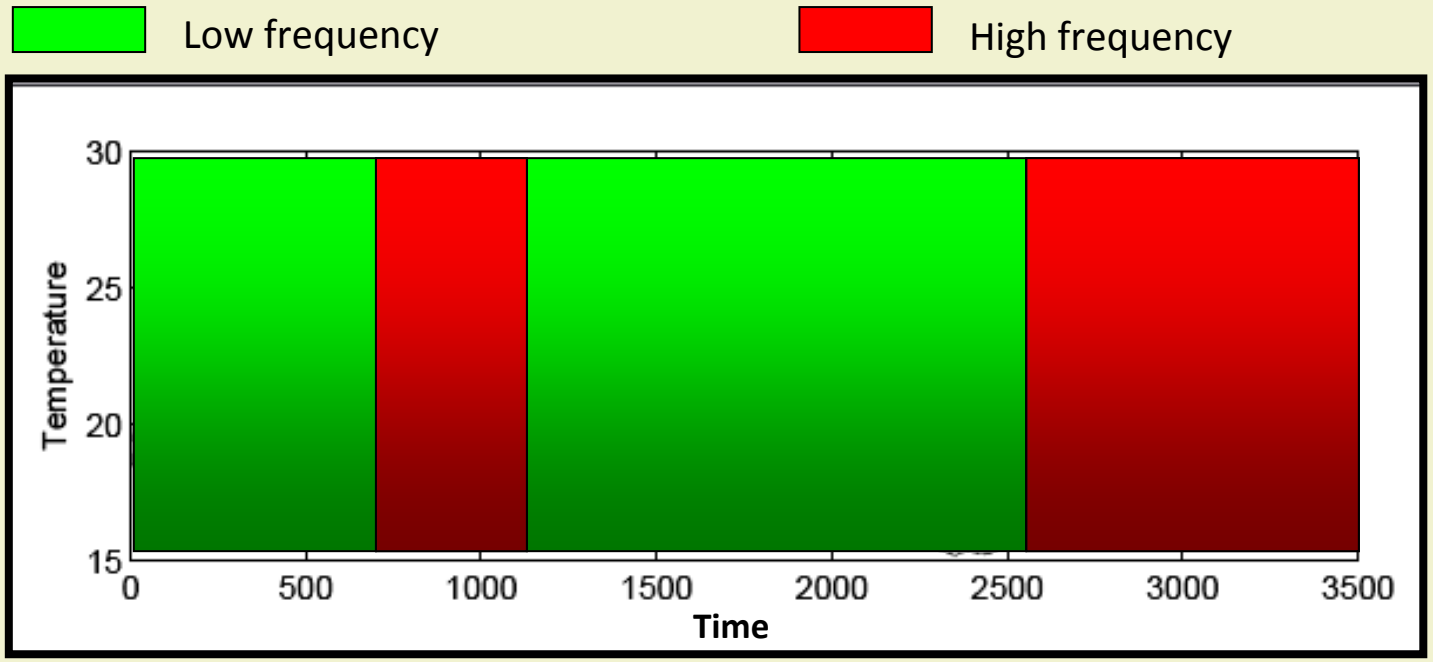
- Improvement of network lifetime and data quality



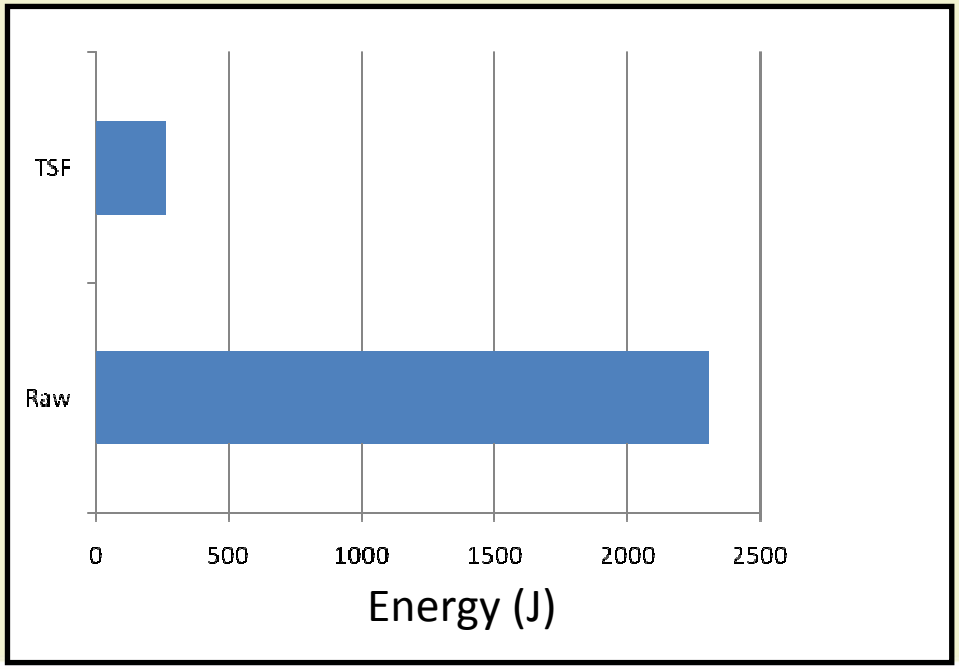
# Temporal correlation

- Nodes predict readings locally using *time-series forecasting*
  - Constant trend → Predictable → Reduce sampling & transmission
  - Changing trend → Unpredictable → Increase sampling & transmission



# Temporal correlation - Results

- Overall: Sensor sampling (EXCELL salinity sensor) + Transceiver operation (RFM TR1001)
- > 90% data within user-specified threshold



# Future work

- Communication protocols
  - Disturbance due to waves
- Combining algorithms
  - Take advantage of spatio-temporal correlations at the same time


Thank you!