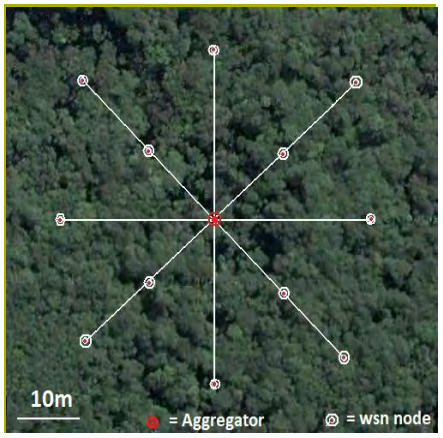
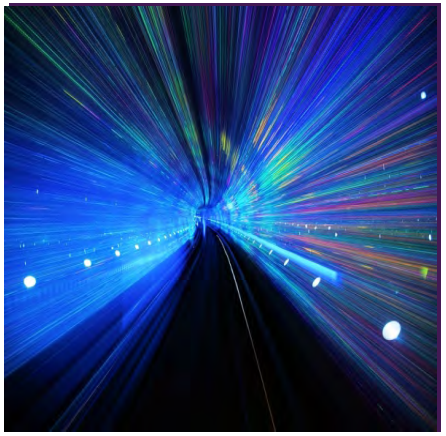
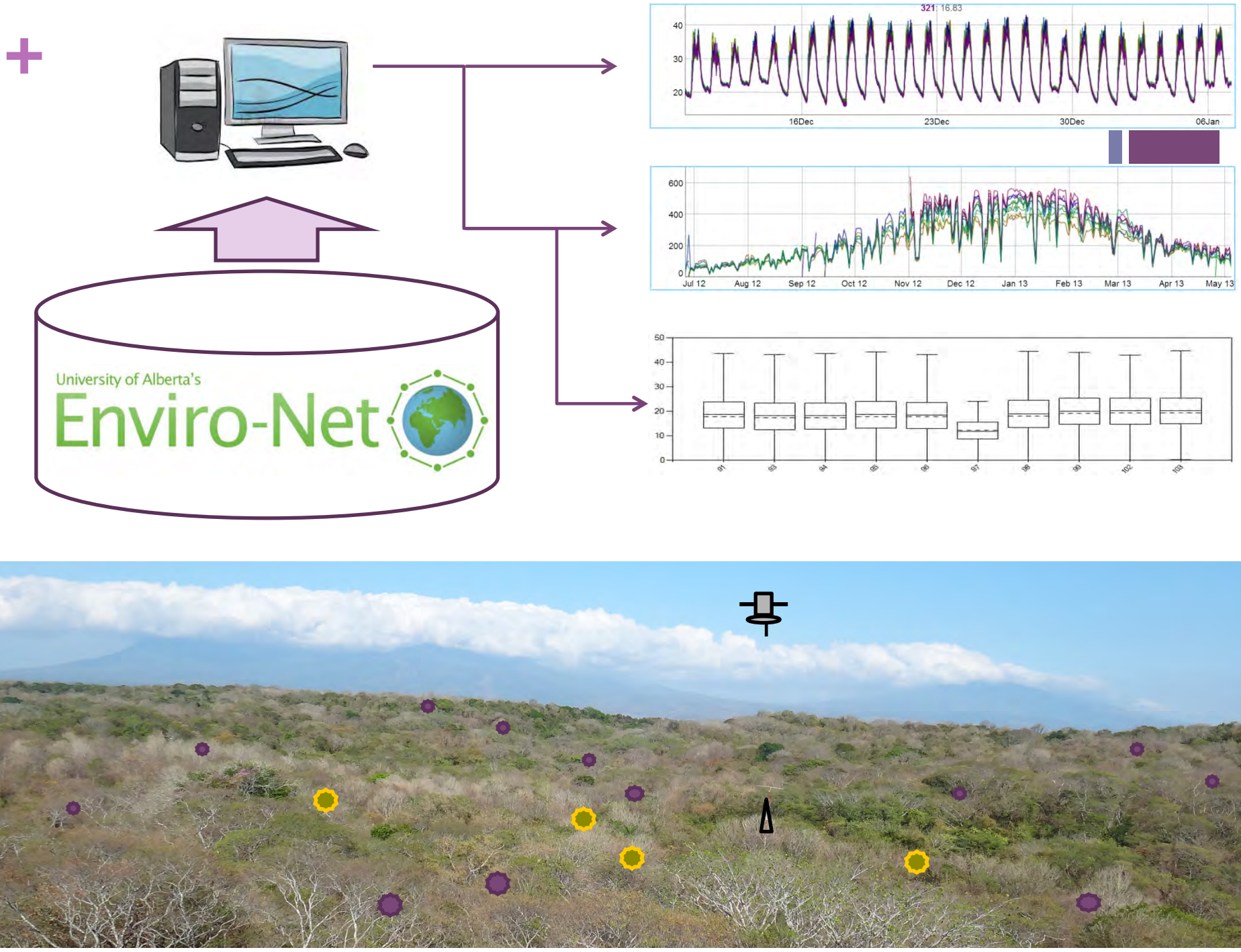
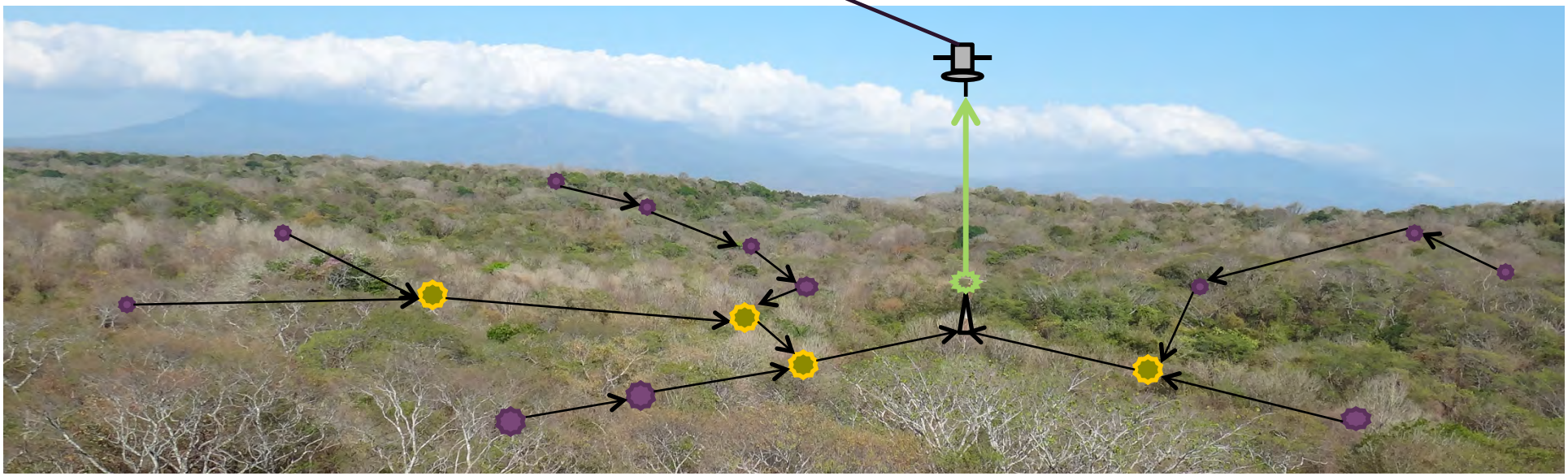




Autonomous Wireless Sensor Networks: from development to long term implementation

Prof. Dr. Arturo Sanchez-Azofeifa[1] (arturo.sanchez@ualberta.ca)
Saulo Castro[1], Mauricio Vega-Araya[2]
1. Alberta Centre for Earth Observation Sciences (CEOS)
University of Alberta
2. Univesidad Nacional de Costa Rica


University of Alberta's
Enviro-Net
321: 16.83
40
30
20
16Dec
23Dec
30Dec
06Jan
600
400
200
0
Jul 12
Aug 12
Sep 12
Oct 12
Nov 12
Dec 12
Jan 13
Feb 13
Mar 13
Apr 13
May 13
50
40
30
20
10
0


http://www.enviro-net.org/
University of Alberta's
Enviro-Net
321: 16.83
16Dec
23Dec
30Dec
06Jan
Jul 12
Aug 12
Sep 12
Oct 12
Nov 12
Dec 12
Jan 13
Feb 13
Mar 13
Apr 13
May 13

Applications of some WSN in the literature

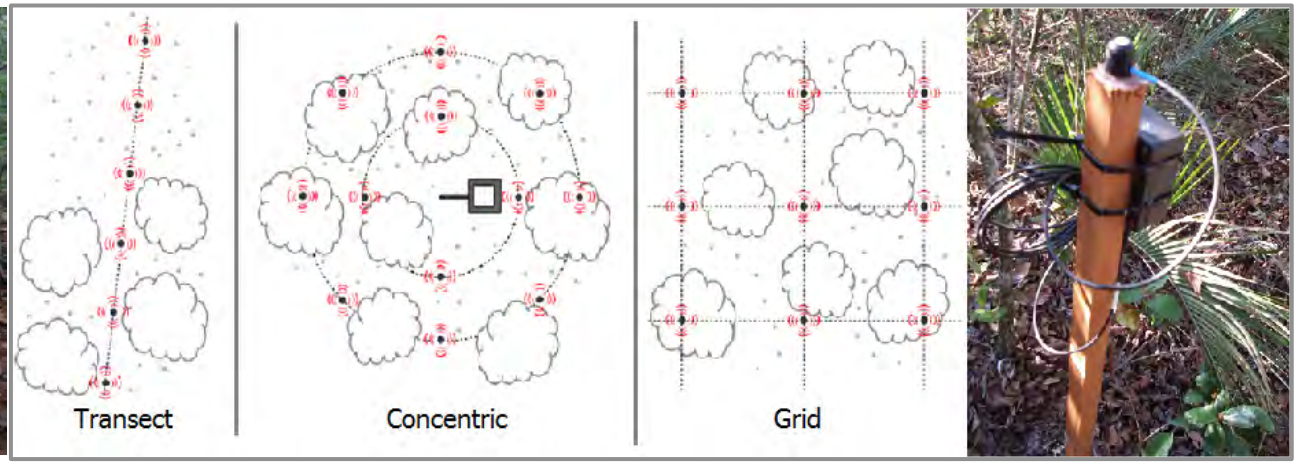
Application	Location	# sensor nodes	Institution	Year	Duration	Variables
Links between weather & hydrology: catchment-scale monitoring	Hawaii	not given	U Hawaii	2008	7 months	water: pH, temp, conductivity, pO2, turbidity, water level
Soil water content	Almkerk, Netherlands	18	Twente & Wageningen	2009	6 months	soil moisture (Decagon)
Climate, broadly	Amazon		UNAMA	2006		
Petrel nesting	Maine	32	Intel & UC Berkeley	2002	7 months	light, temp, IR, RH, barometric pressure
Sediment	Kansas	2	Kansas State	2008	8 months	opacity
Center-pivot irrigation	Texas	17	USDA	2008	1 month	IR thermometer for canopy temp, air temp, RH, solar radiation, windspeed, rainfall
Traveling irrigation	Montana	5	USDA	2008	4 months	temp, RH, wind speed, wind direction

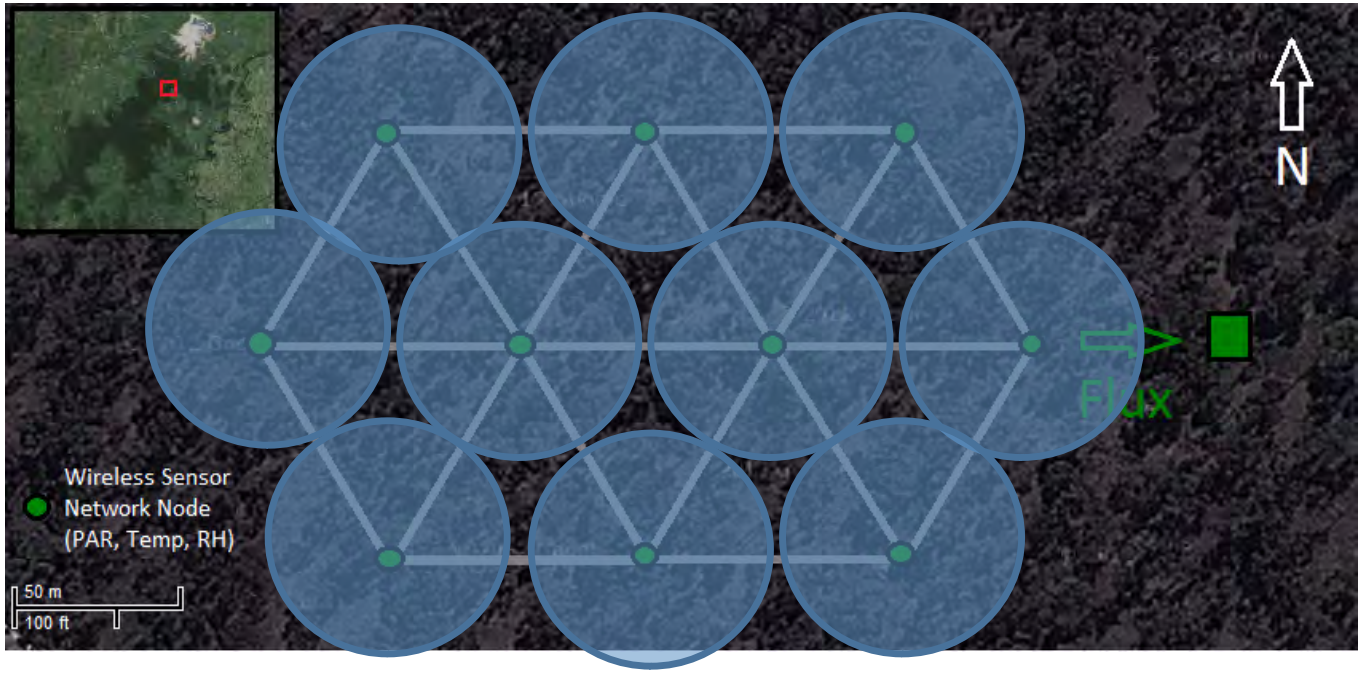
After MacGregor et al. 2013

Advantages of WSN in monitoring

- Measurements at many spatial and temporal scales
- Changing data needs (usually sparse)
- Increased spatial coverage in heterogeneous environments.
- Synchronized sampling across sensors.
- Real-time data retrieval capabilities.
- Landscape scale remote sensing validation of biophysical products.
- Reduced human effort with increased information output.
- Non-intrusive!

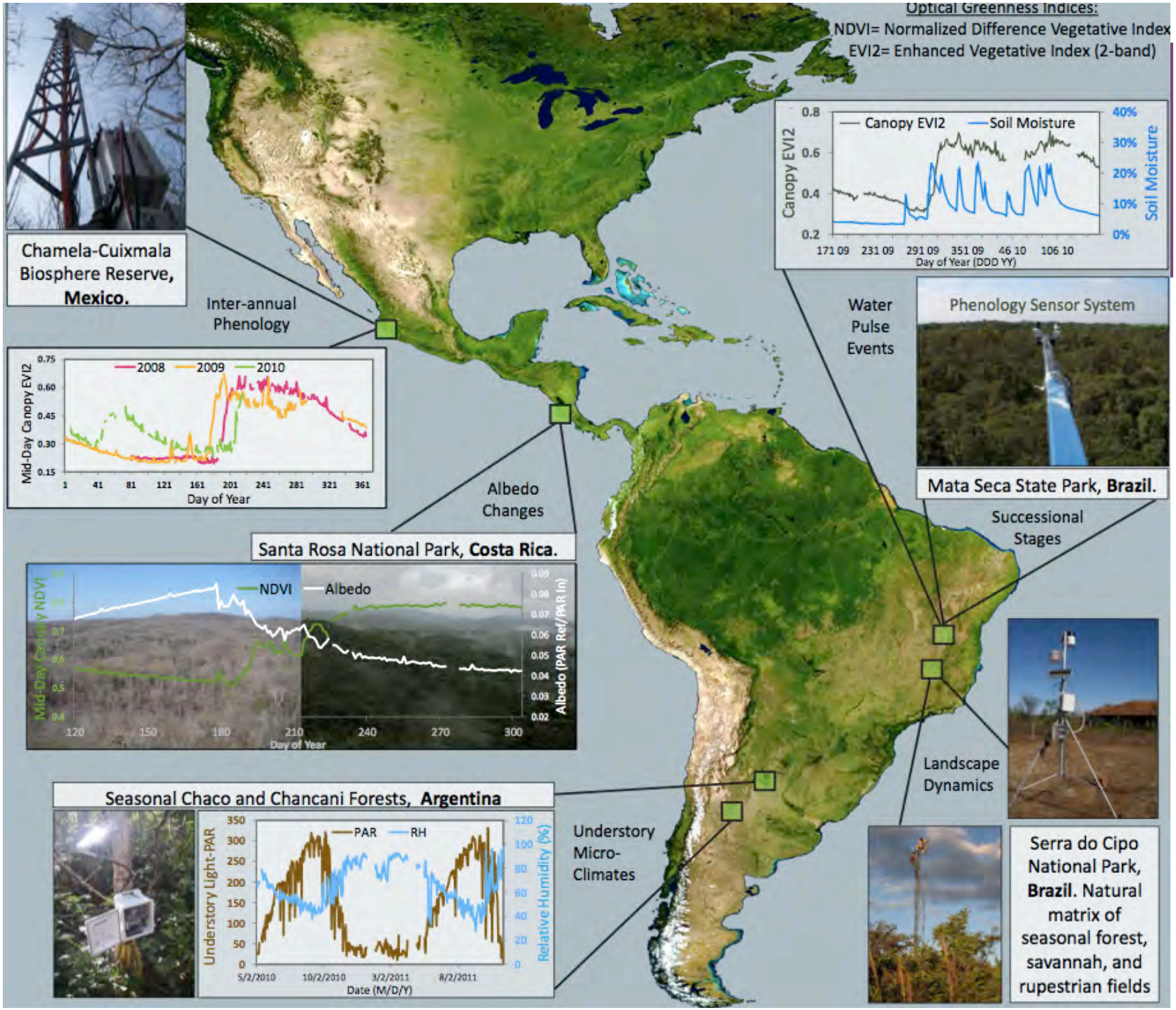
+ Network Topologies and spatial design



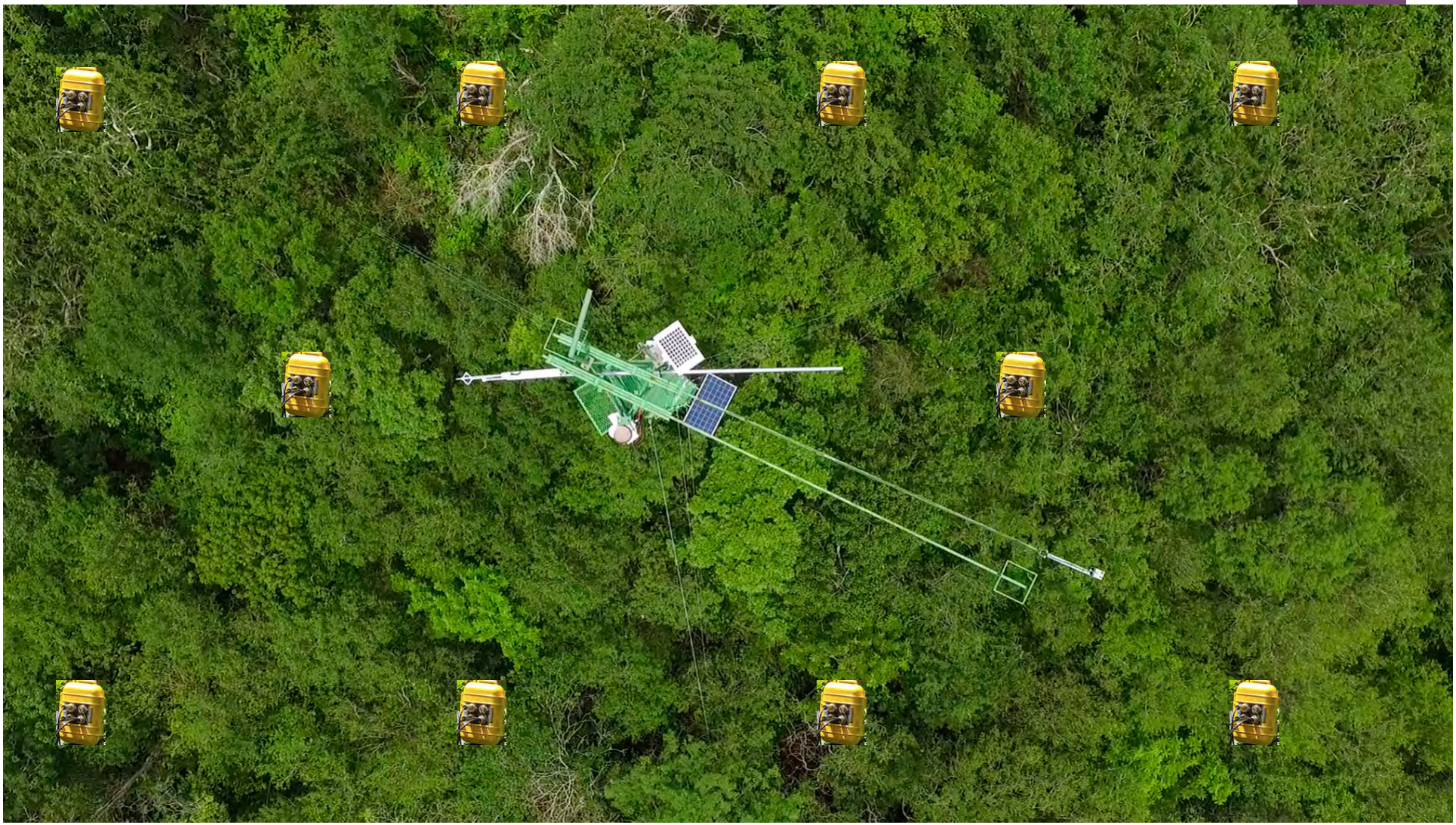


Sensor Network Cyberinfrastructure

- Near real-time data management for Wireless Sensor Networks
- Simplified data/trend visualization
- Data mining: web data/metadata for cross-discipline social network research cooperation and analysis


Optical Greenness Indices:
NDVI= Normalized Difference Vegetative Index
EVI2= Enhanced Vegetative Index (2-band)
Canopy EVI2
Soil Moisture
Day of Year (DDD YY)
Chamela-Cuixmala Biosphere Reserve, Mexico.
Inter-annual Phenology
2008
2009
2010
Mid-Day Canopy EVI2
Day of Year
Water Pulse Events
Phenology Sensor System
Mata Seca State Park, Brazil.
Albedo Changes
Santa Rosa National Park, Costa Rica.
NDVI
Albedo
Mid-Day Canopy NDVI
Albedo (PAR Ref/PAR In)
Successional Stages
Landscape Dynamics
Seasonal Chaco and Chancani Forests, Argentina
PAR
RH
Understory Light-PAR
Relative Humidity (%)
Date (M/D/Y)
Understory Micro-Climates
Serra do Cipo National Park, Brazil. Natural matrix of seasonal forest, savannah, and rupestrian fields

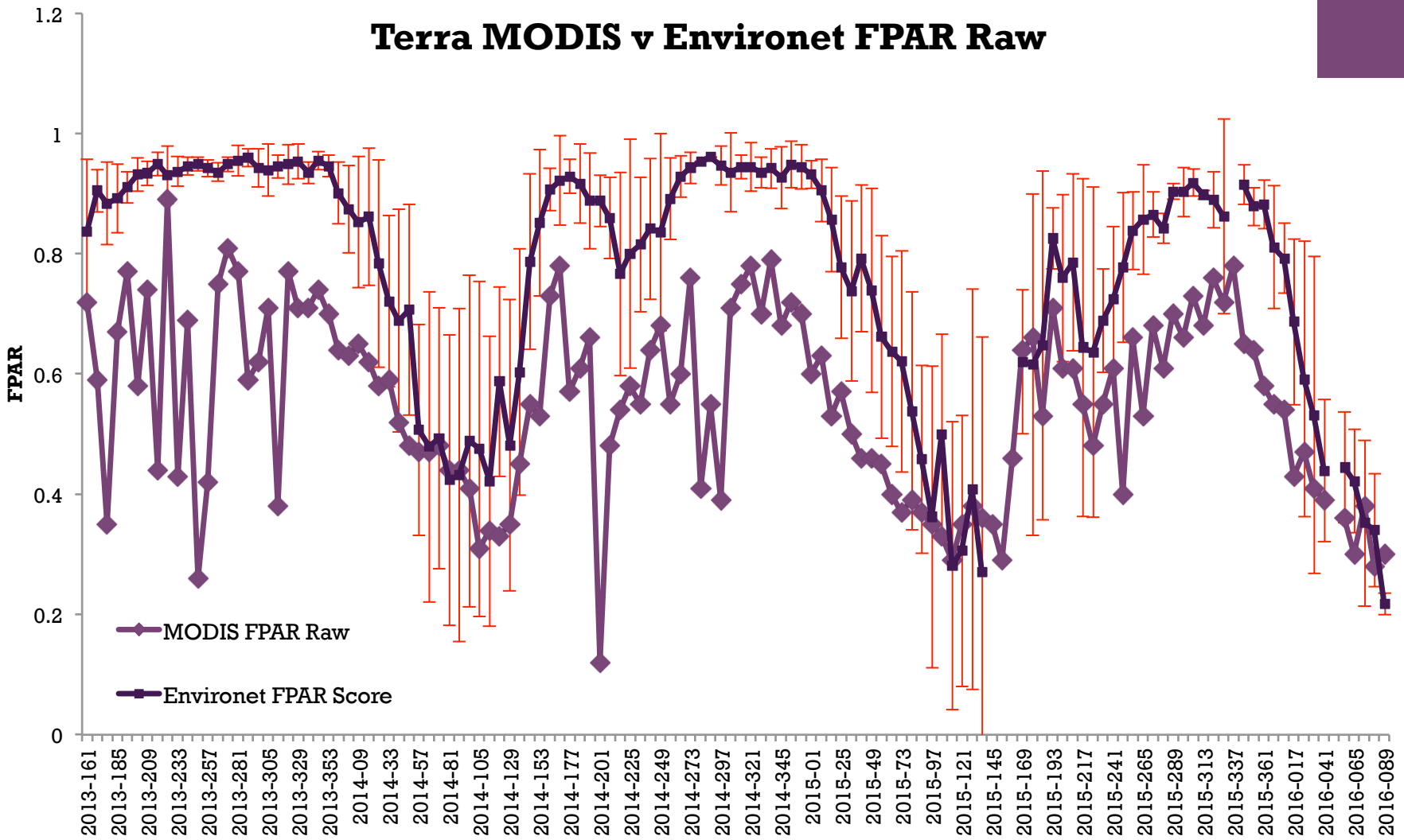
Santa Rosa Environmental Monitoring Super Site, Costa Rica



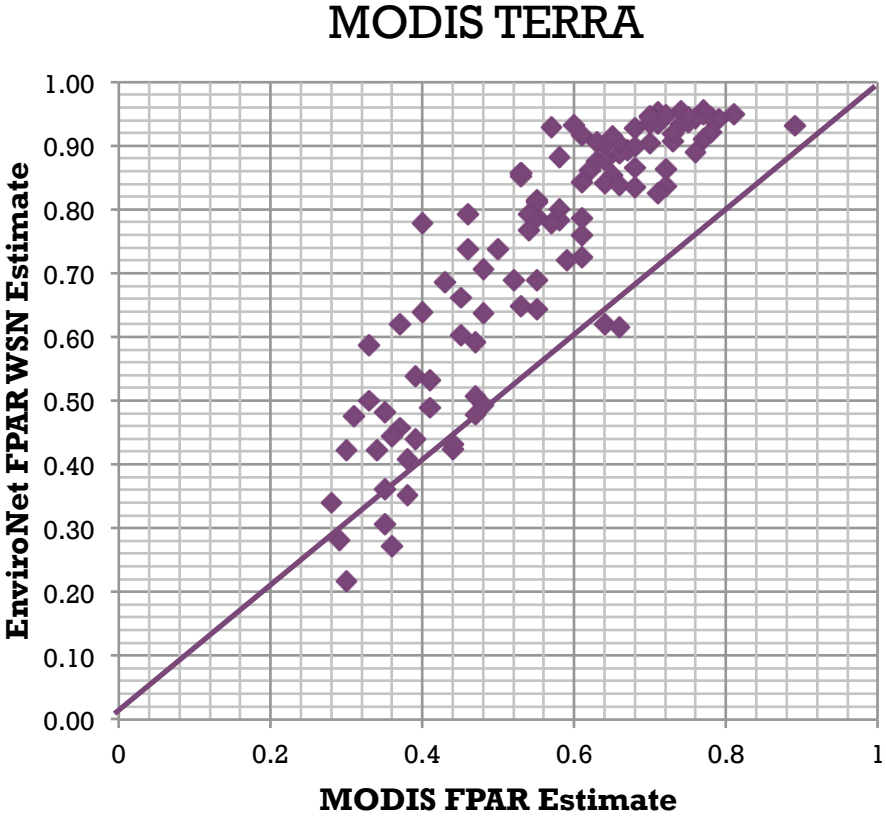
Santa Rosa National Park, Environmental Monitoring Super Site, Guanacaste, Costa Rica:

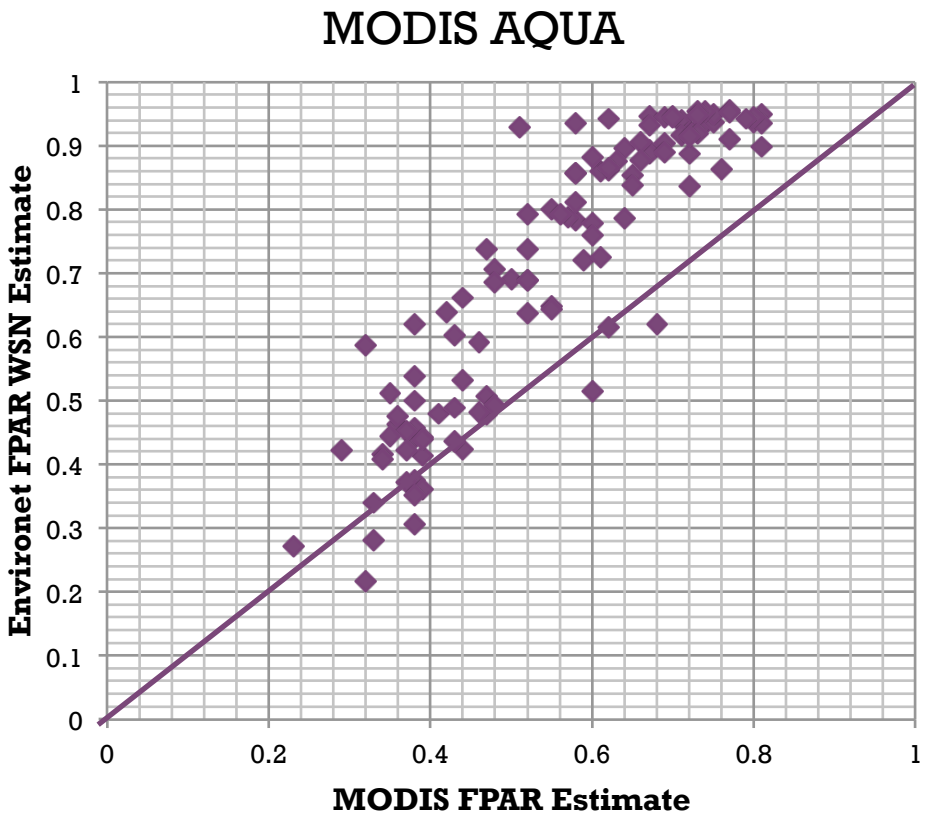
- 10 billion data points/year
- CO_2/H_20 fluxes (vegetation and soil)
- Hyperspectral canopy observations
- Wireless Sensor Networks
- On-line/Real time communication via satellite technology
- Drone research
- Micro-Satellite testing site (AlbertaSat)
- Atmospheric Sounding calibration site
- NASA Calibration/Validation site
- Airborne and ground-based LiDAR

Santa Rosa Environmental Monitoring Super Site: NEE and APAR from WSNs.

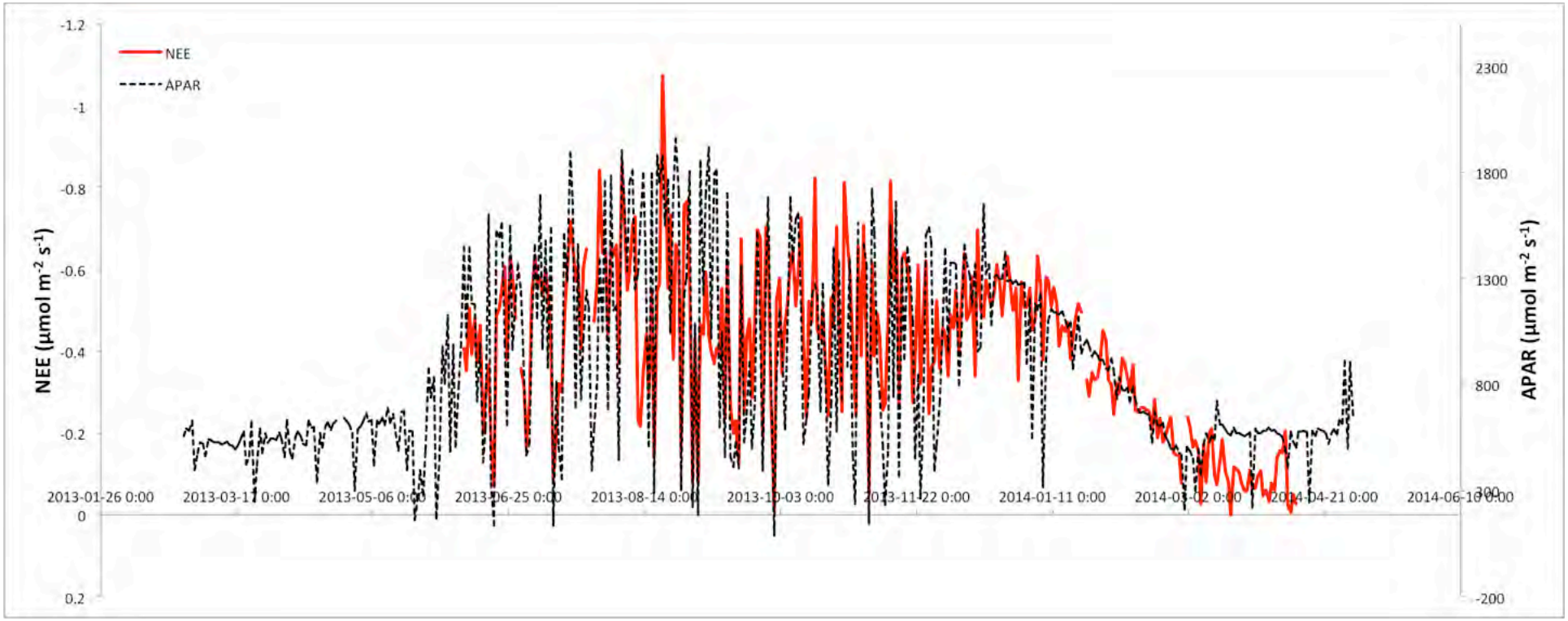


Santa Rosa Environmental Monitoring Super Site: FPAR MODIS Comparison

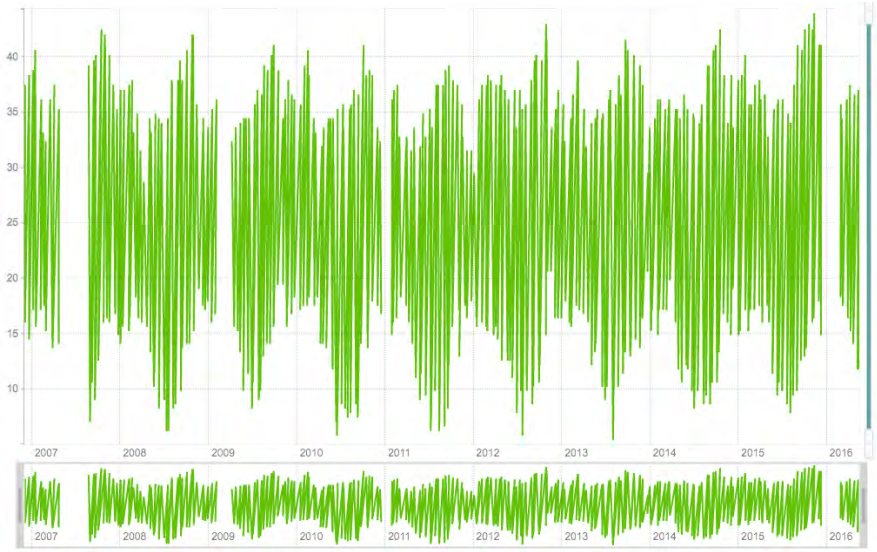




Santa Rosa Environmental Monitoring Super Site: NEE and APAR from WSNs.



Long term deployment of a WSN: Brazil, 10 –years (2006-2016).



Temperature/RH

Photosynthetic Active Radiation (PAR)

Final remarks: Challenges with Environmental WSNs

- Standardization
- Durability of Hardware
- Power Management
- Data Management!!!

Final Remarks: Changes on the environmental monitoring paradigm

INSTRUMENTED

Forests can be fully Instrument at all levels

INTERCONNECTED

Monitoring systems can be interconnected in entirely new ways

INTELLIGENT

Intelligent interaction is possible with external elements

SMARTER

Information is shared to improve decision making on conservation and management

Stream computing – Analyzing data in motion

Traditional Computing

Historical fact finding

Find and analyze information stored on disk

Batch paradigm, pull model

Query-driven: submits queries to static data

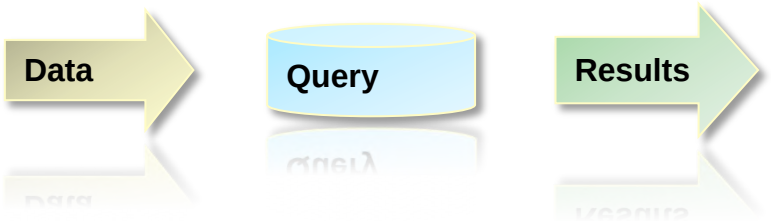
Stream Computing

Current fact finding

Analyze data in motion – before it is stored

Low latency paradigm, push model

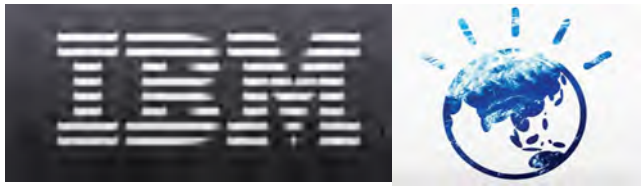
Data driven – bring the data to the query



Thank You!


TROPI
DRY


INTER-AMERICAN INSTITUTE FOR GLOBAL CHANGE RESEARCH
IAI


IBM


Alberta
Innovates
Technology
Futures