Terrestrial Ecology Observing Systems at the James Reserve

Overview of Engineering Test Bed and Science Activities

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Goals: To support the development of *Embedded Networked Sensing* of terrestrial ecosystems that integrate multimodal observations and measurements suitable for mechanistic modeling and forecasting of ecological patterns and processes from the microbial to the landscape scale

TECHNOLOGY DRIVERS AND ENGINEERING TESTBED

Mobile Sensing platforms:

NIMS: cable-based multimodal sensing systems for multi-scale, adaptive sampling from canopy to ground and water surfaces. System measurements include micromet sensors, lightweight instruments such as gas analysis, acoustic sensors, grab samplers, visible light and thermal imagers.

AMR: Automated Minirhizotron: underground, networked, robotic microscope designed to provide coordinated, adaptively sampled time-series multispectral imagery down to 1 micron resolution to discern temporal and spatial patterns in root growth, mycorhizal fungal hyphae, and soil organisms.

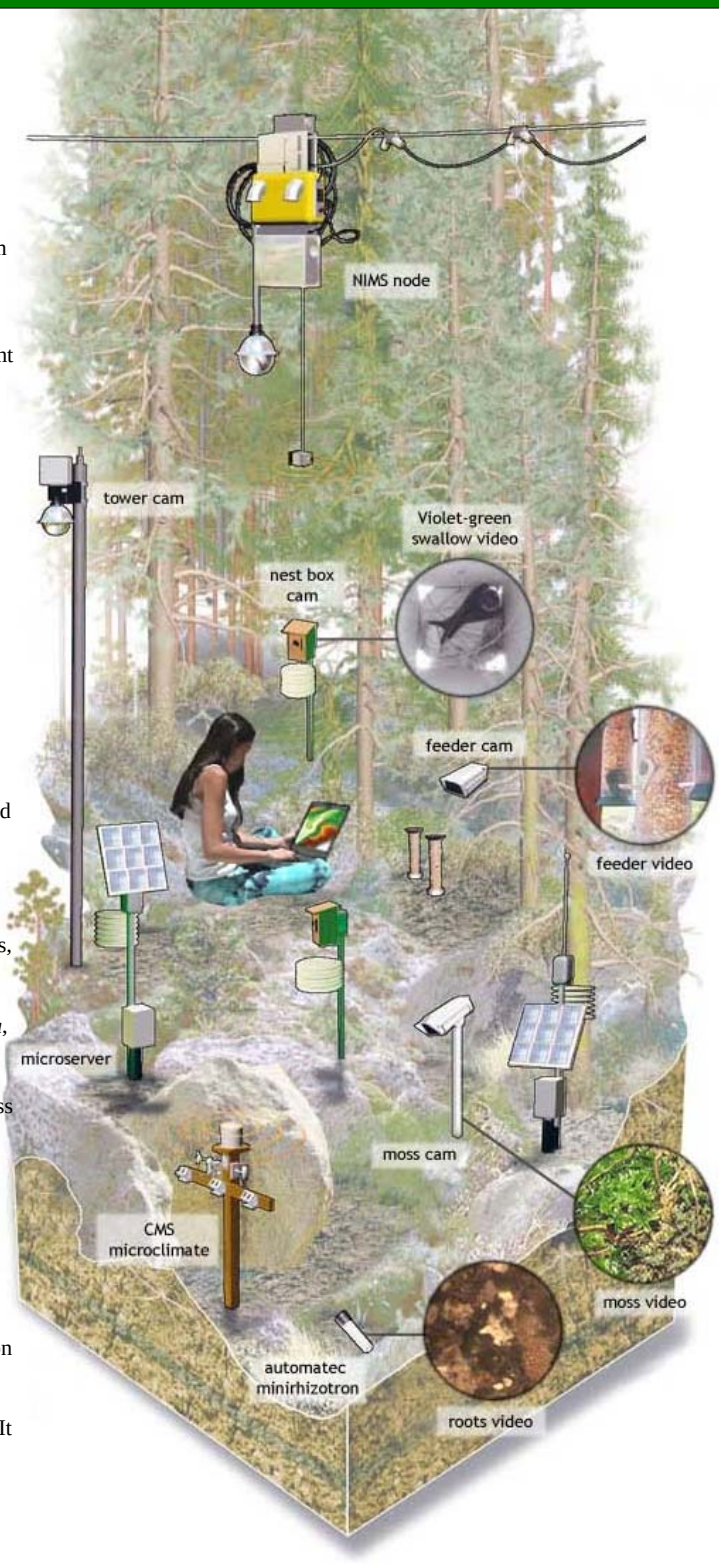
Tower-based imagers: pan-tilt-zoom networked imagers for real-time and programmed observations, time series studies, object recognition, and coordinated multimodal sampling

Fixed Sensor, Acoustic and Imager Networks:

CMS/ESS ENS Systems: wireless, low-power mote and microserver architecture with adaptive routing and systems monitoring for *in-situ*, spatially coordinated time-series environmental measurements. Systems include wired and wireless microvideo-based imagers and acoustic sensors for time-series, spectroscopic, and object content analysis of real-time data streams.

Data Access and programming:

EMISSARY GUI: a web and field-portable interface for real-time and archival data visualization and geospatial modelling of space/airborne imagery and sensormicronets and instruments. It also provides field guidance and facilitates the process of sensor configuration, calibration, testing, and debugging.



SCIENCE DRIVERSAND OBSERVING SYSTEM EXPERIMENTS

Microclimate Research: Transects of spatially explicit sensormicronets provide environmental measurements scaled to the size of organisms, sampling variables at frequencies that organisms encounter, and dispersed in patterns that capture the full range of environmental exposures providing the fine grain information needed for accurate modeling and prediction.

Plant Ecological Research: Time-series imagery of plant phenology and associated microclimate measurements provide an important means of understanding the relationship between periodic phenomena, such as leaf flush or flowering, and microenviornmental and climatic conditions. Phenology relates strongly to primary productivity and the energy that enters into ecological food webs, and thus is vital in understanding ecosystem function and the effects of climate and climate change.

Avian Research: Nest boxes, feeding stations, and in-habitat video, acoustical, proximity and environmental sensing systems are defining the range of conditions that regulate the life history and reproductive activities of species of birds that depend upon tree cavities for nesting. Species studied include Acorn Woodpeckers, Western Bluebird and Violet Green Swallows.

Soil microbial Research: arrayed system of wireless sensors and mobile imagers in the soil environment measure small-scale soil dynamics and integrate these spatially and temporally with larger-scale measurements of soil roots and mycorrhizae with soil CO_2 flux using emission and understory eddy-covariance flux measurements.