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Faculty Summit 2010

Guarujá, Brasil | May 12 – 14 | In collaboration with FAPESP

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The eFarms project: a two-way road from small farms into the networked world

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Faculty Summit 2010

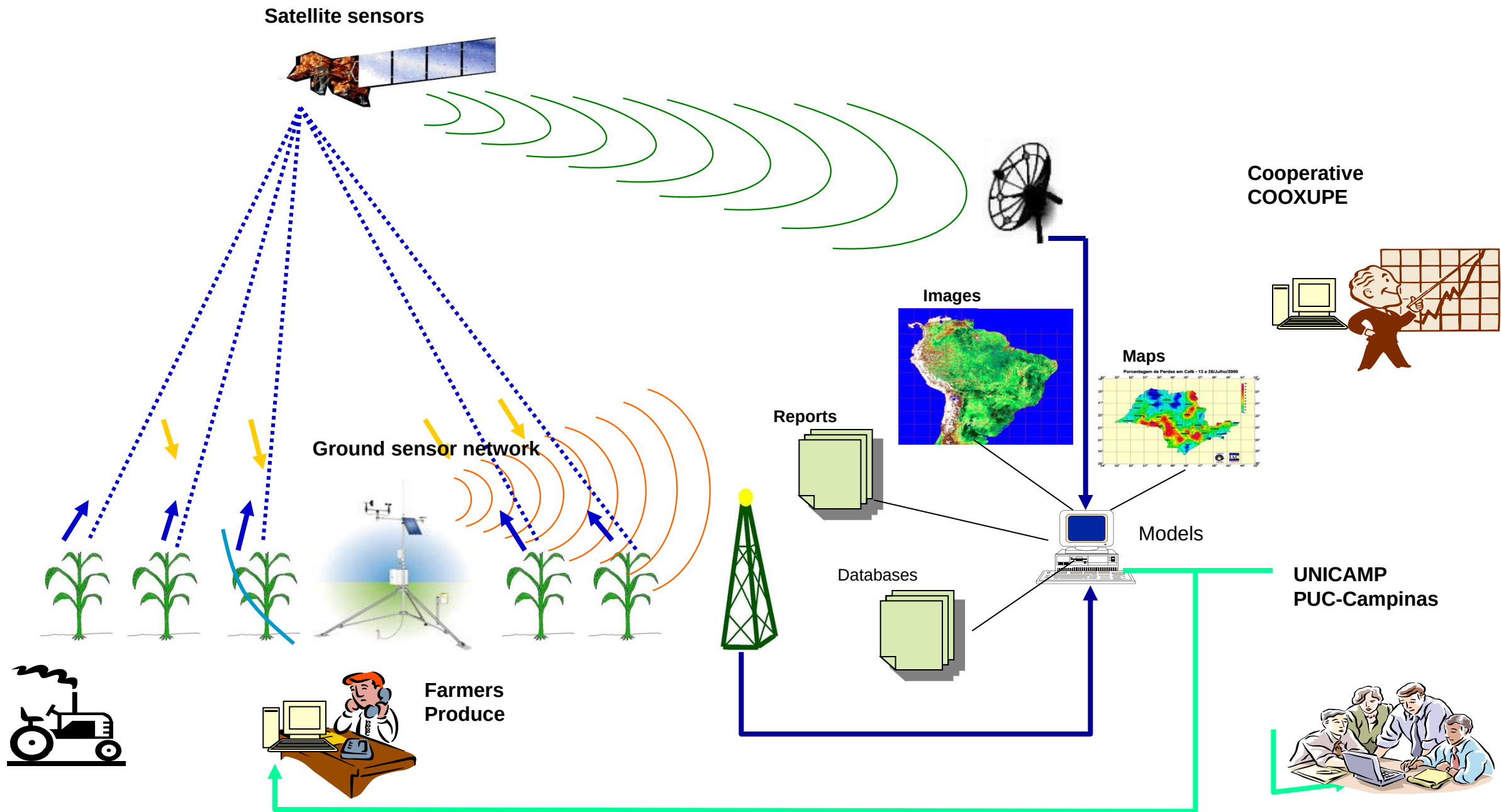
Guarujá, Brasil | May 12 – 14 | In collaboration with FAPESP

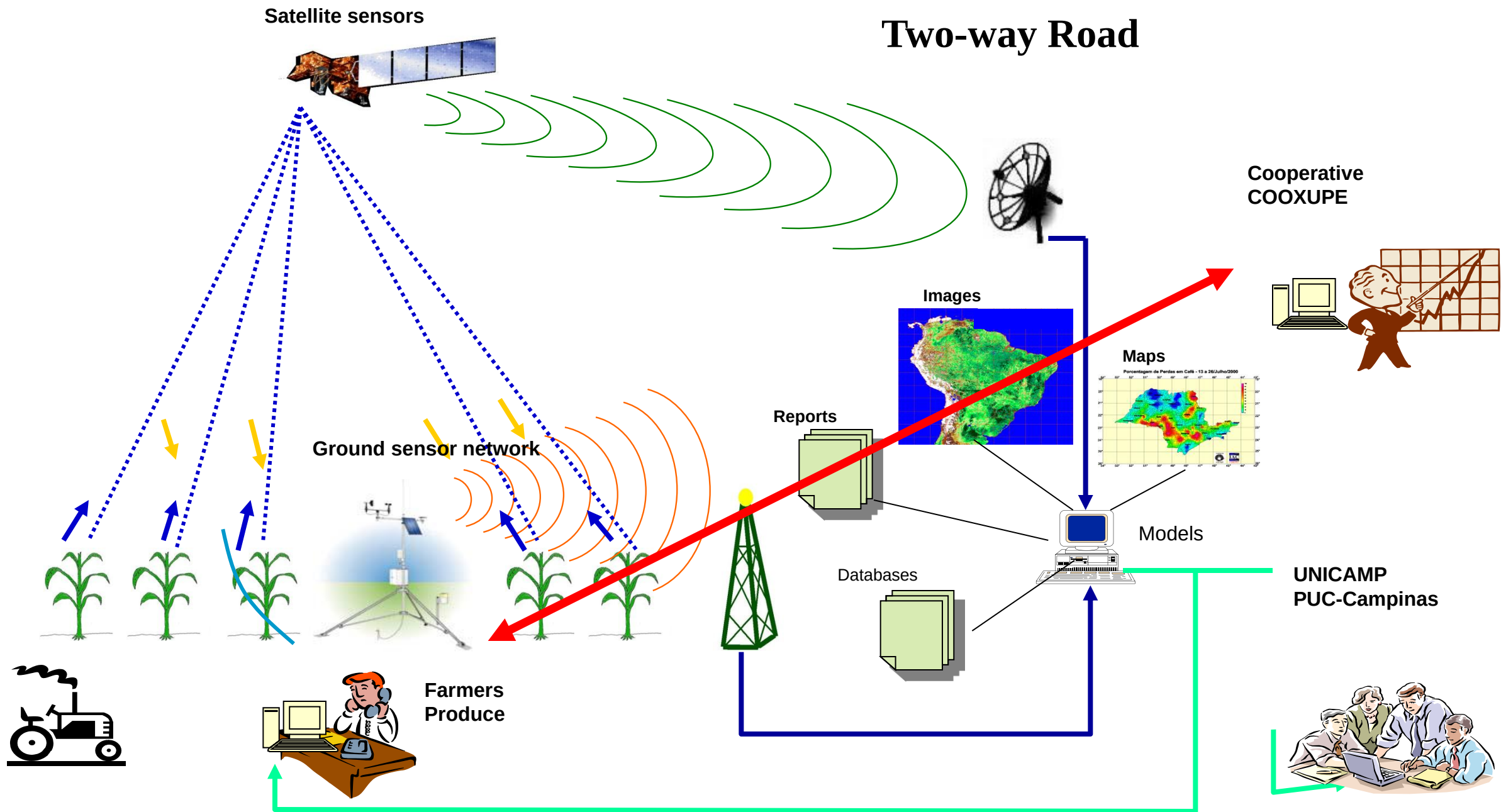
Cooxupé coffee cooperative

partner

Agenda

- Motivation and Goals
- Results
- Obstacles and detours
- Challenges and next steps





GOALS – Science & Technology

- **Sensor-based agricultural data management**

⇒ Models, methods, algorithms

⇒ Data management, integration, analysis, visualization

- **Low cost wireless data communications in rural areas**

=> Infrastructure

GOALS – Social Impact

- **Decision support in agriculture**

⇒ Models and software tools

- **Wireless data communications in rural areas**

=> Low cost digital inclusion

Expertise involved

- UNICAMP – Computer Science
(Databases)
(Image Processing)
(Compilers and computer architecture)
(Wireless networks)
- UNICAMP – Agriculture Engineering
(Agricultural model development)
(Soil Sciences)
(Remote Sensing)
- One (very) **large coffee cooperative** (COOXUPE)
 - 14,000 farms
 - Three states in Brazil

RESULTS

Demos

<http://proj.lis.ic.unicamp.br/efarms>

Papers (and Phd, MSc theses)

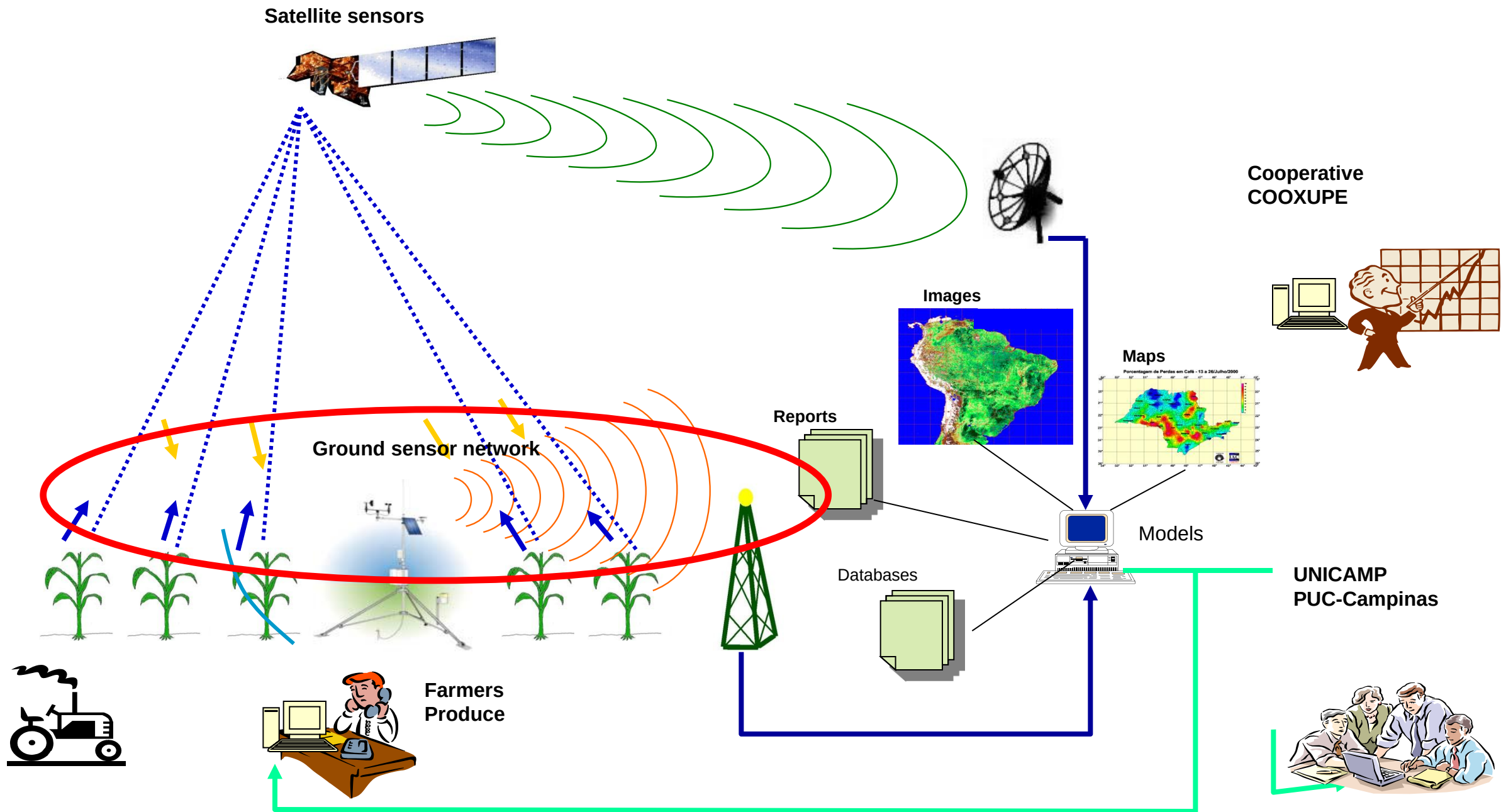
<http://www.lis.ic.unicamp.br/publications>

Main issues

- Sensor calibration and soil experiments
- Models for yield forecasting
- Image processing (with Genetic Programming)
- Databases and interoperability in eScience
 - Time series mining
 - Content annotation
 - Sensor data management
 - Escience infrastructure and interoperability

Results – Low Cost Networks

Brazilian Conf. on Soil Sciences '09



From sensors to Internet

Phase 1 - Indoors

- Laboratory experiments

Phase 2 - Outdoors

- Temperature sensor to base (antenna) and stability tests

Phase 3 - Internet

- Sensor -> (2.4GHz) "farm" -> (5.8GHz) "Coop" -> Internet

Phase 4 (ongoing)

- Extend to 3 "farms", temp, radiation, moisture -> Web site (2.4 GHz)

Phase 5 (began October)

- Extend to real farms

Phase 1 – Lab Tests



Phase 2-3 - Internet



Phase 4 – 3 “farms” in 2009



Phase 4 - Sensor – 3 m pole

(4 sensors)



Sensor and cornstalks

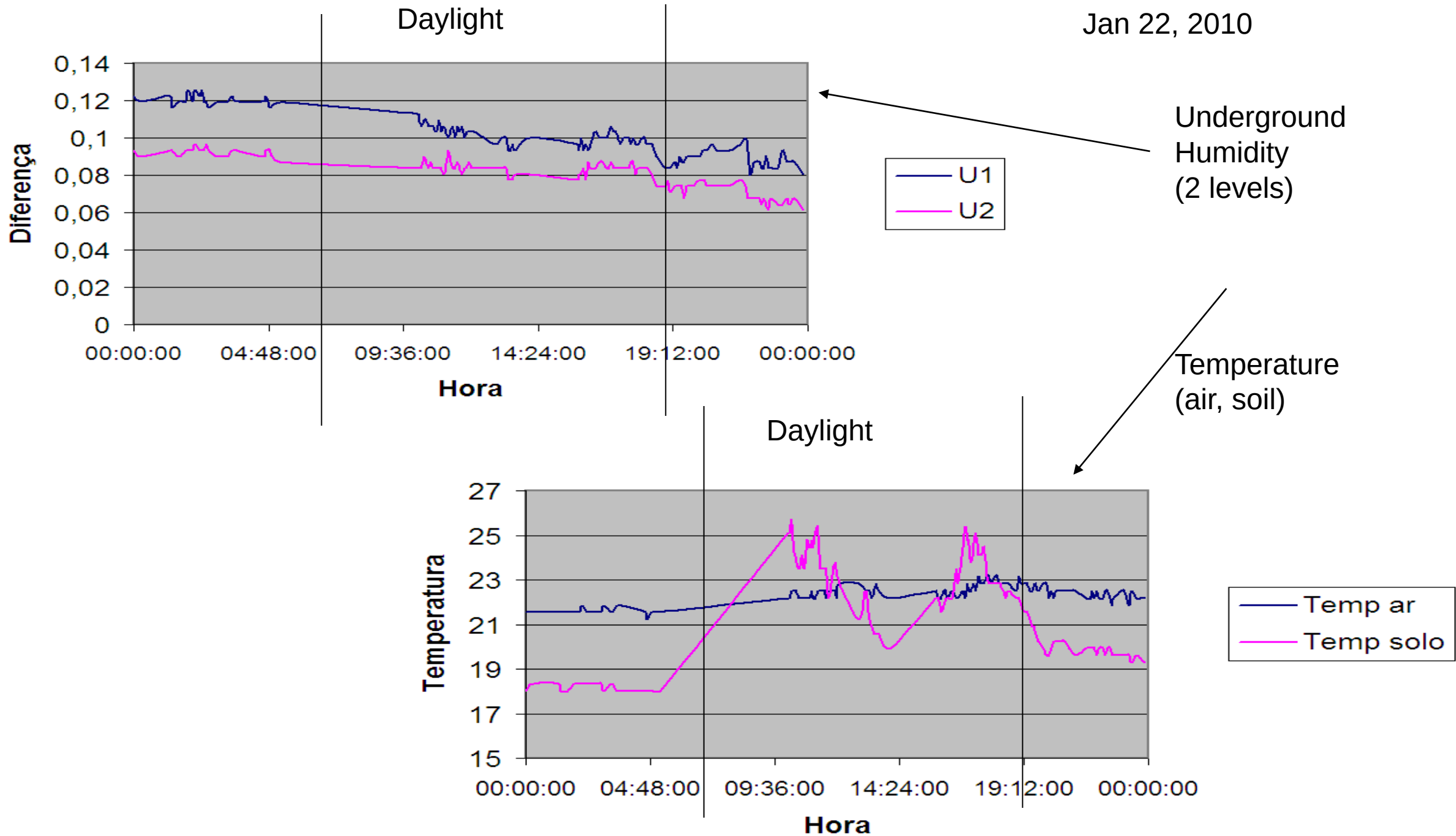


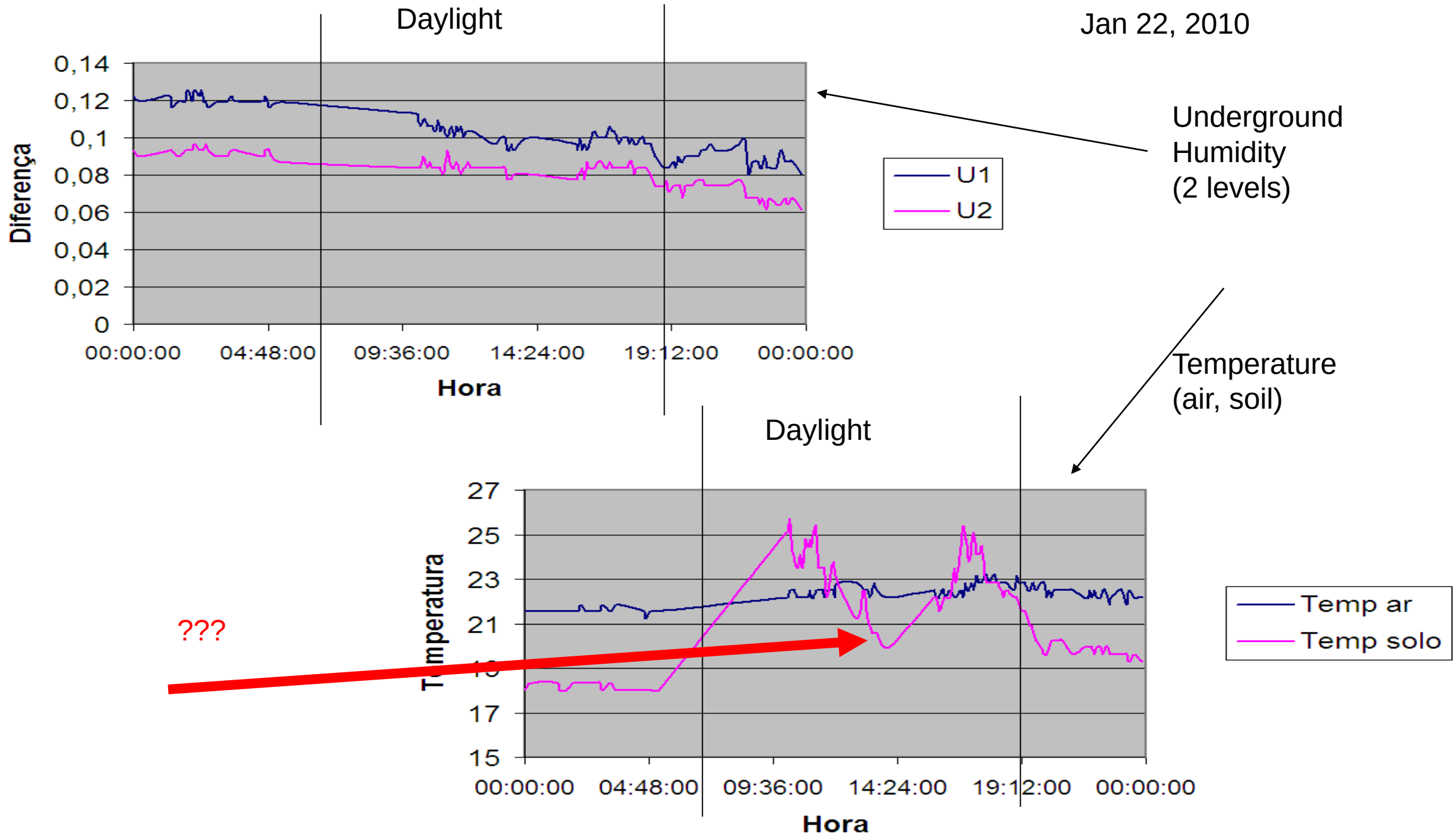
More sensors

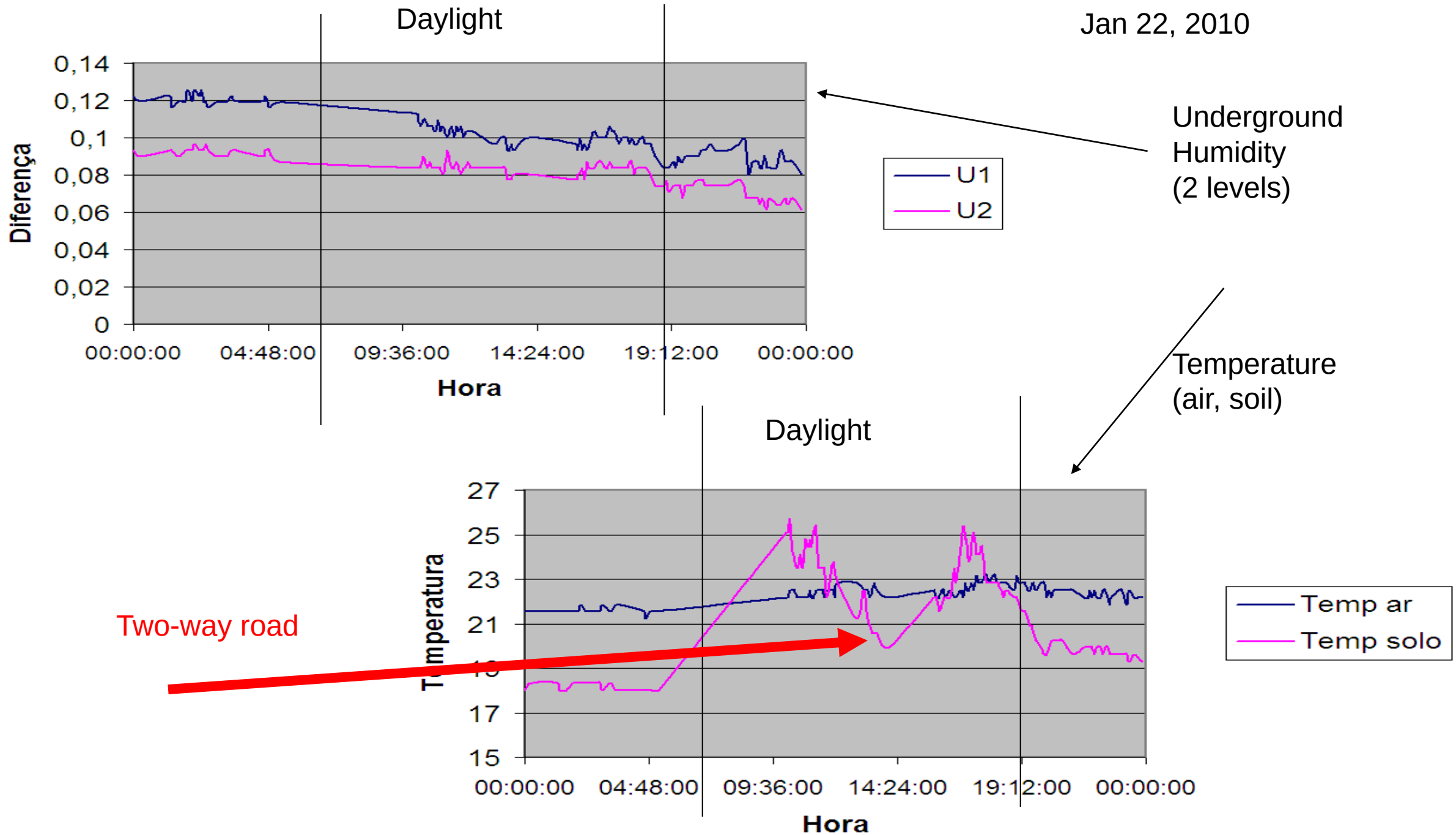


Visible sensor

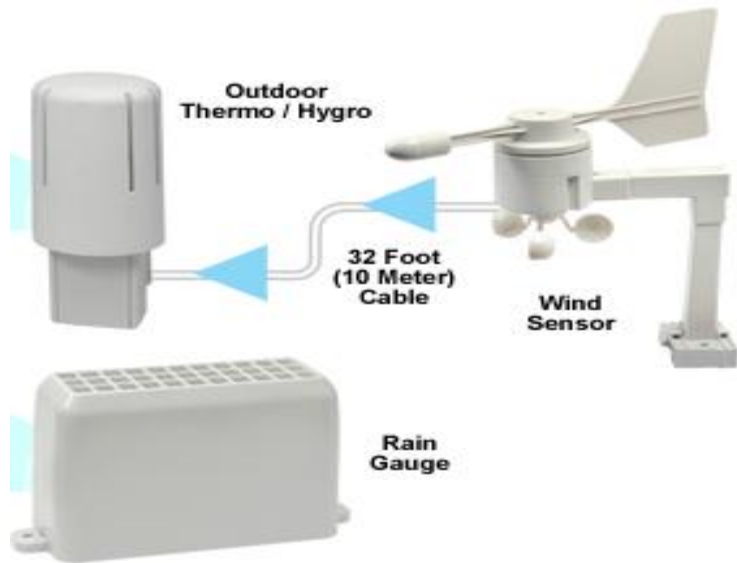


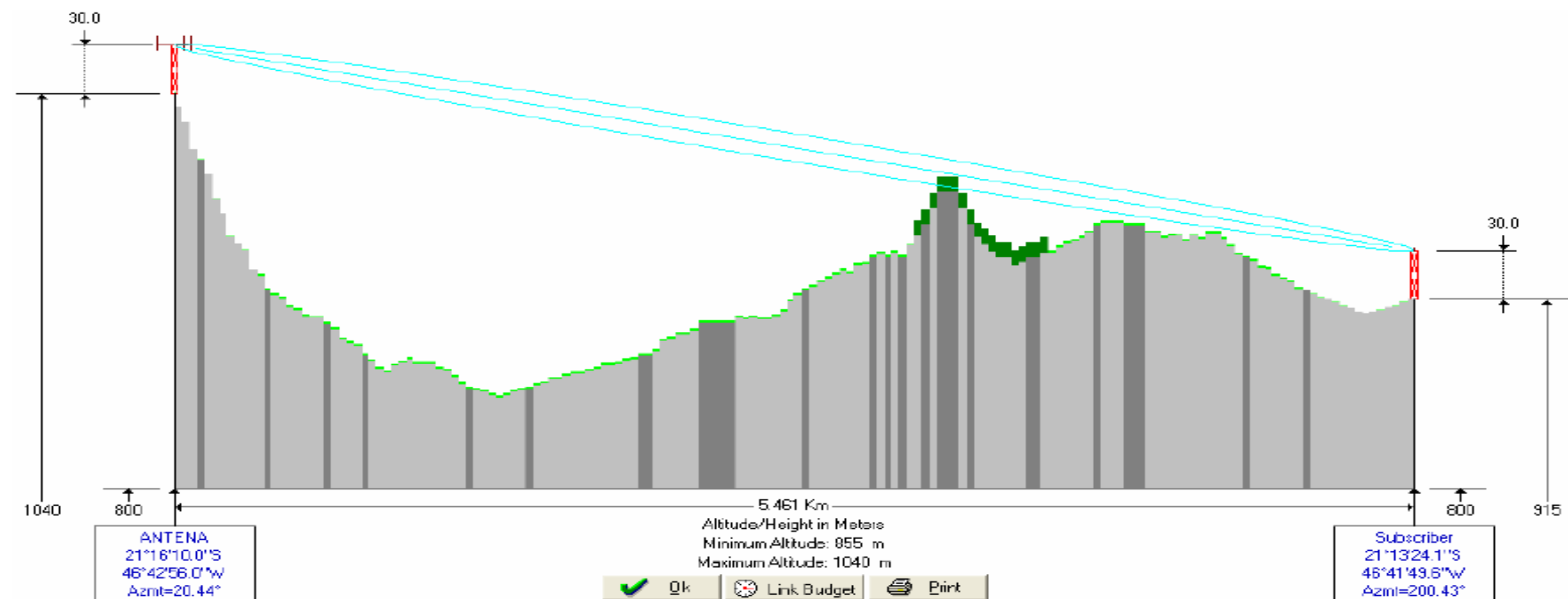




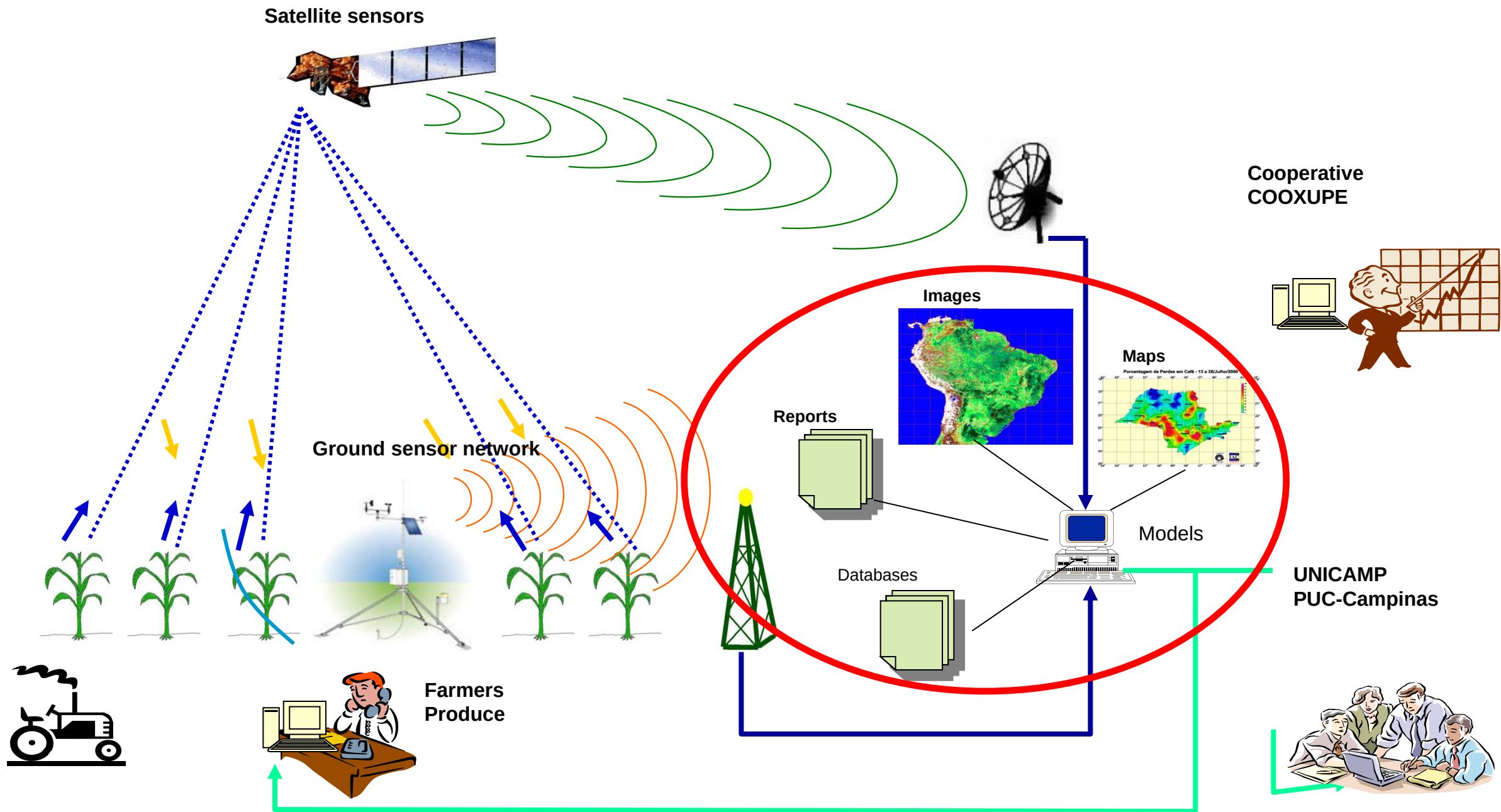


Phase 5 Real Farms & the 2-way road



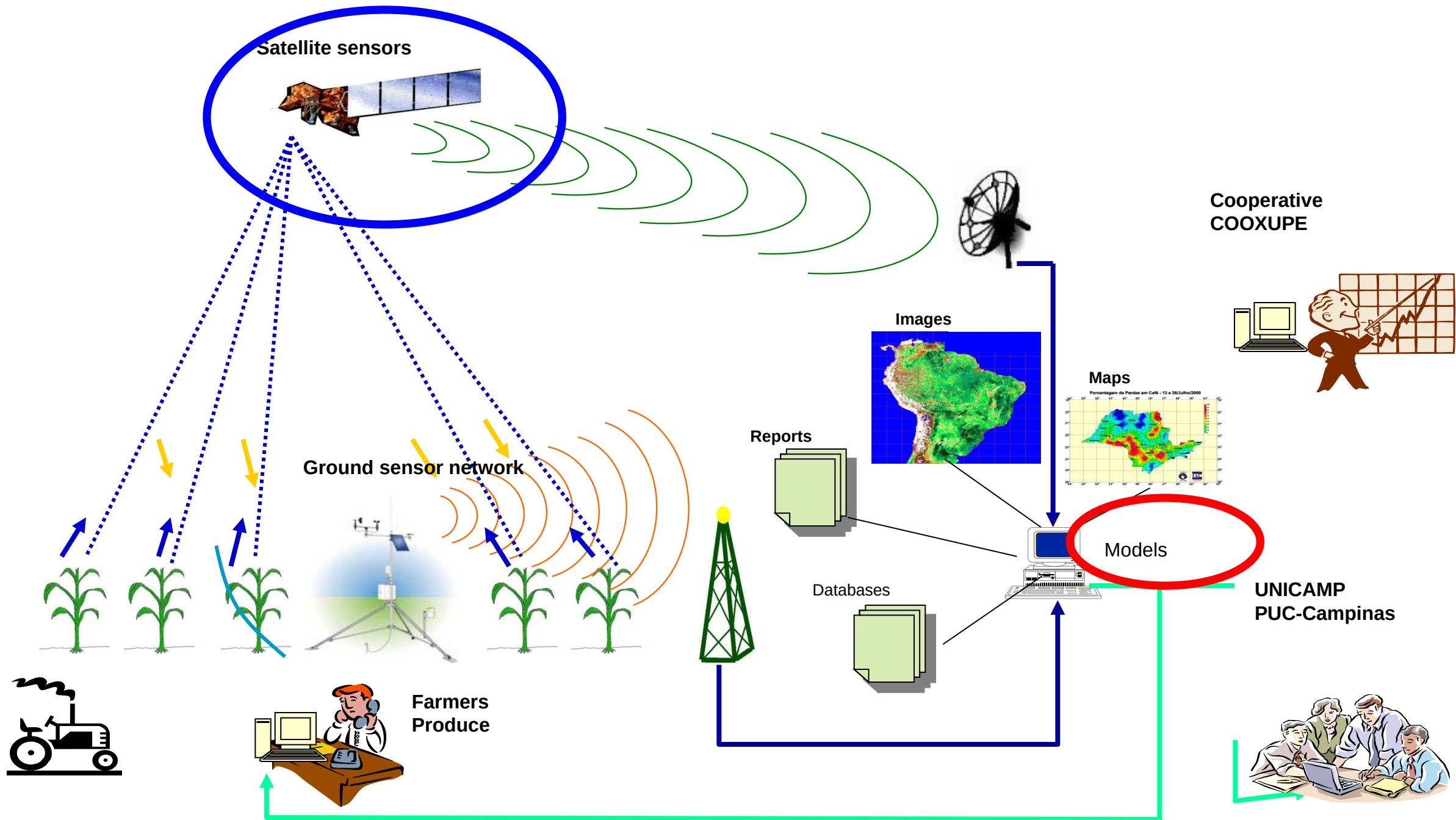


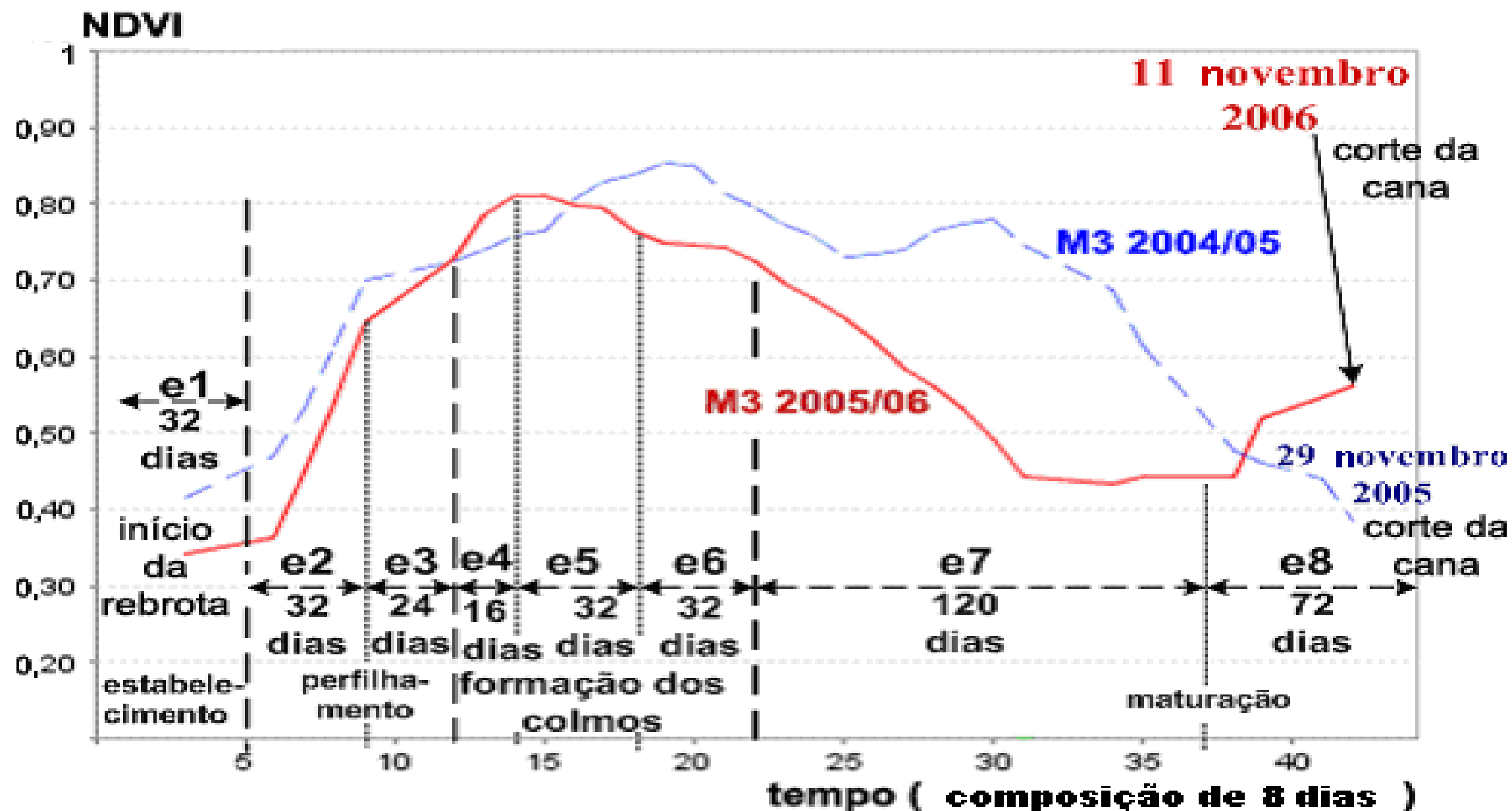
Results – Models, Image Processing, DB



MODELS

Brazilian Remote Sensing Conference 09





Models

NDVI

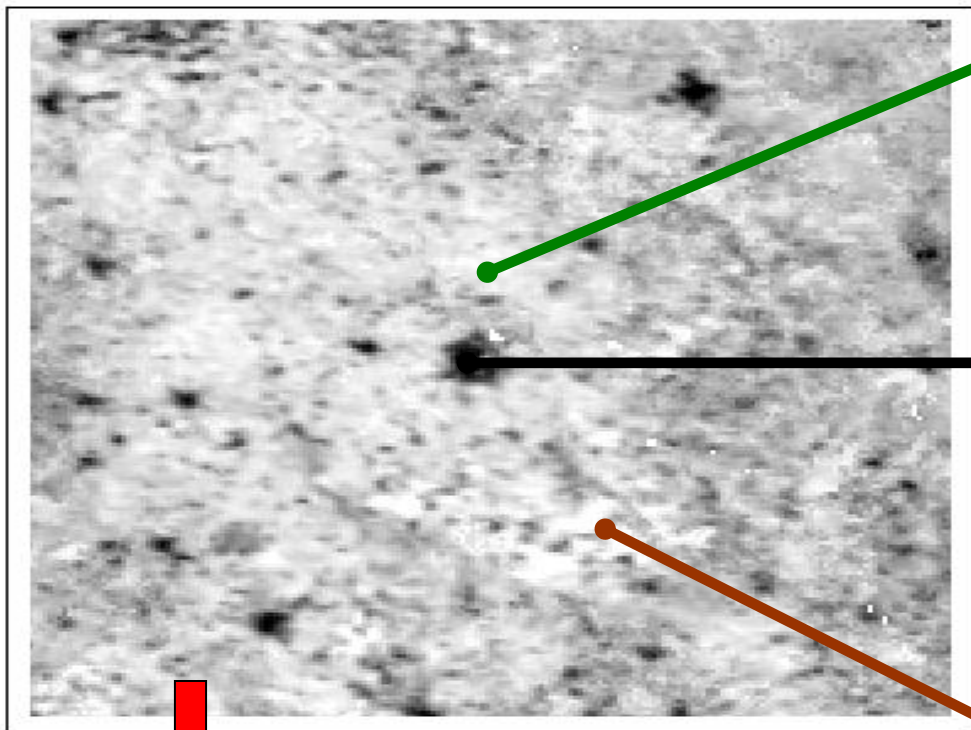
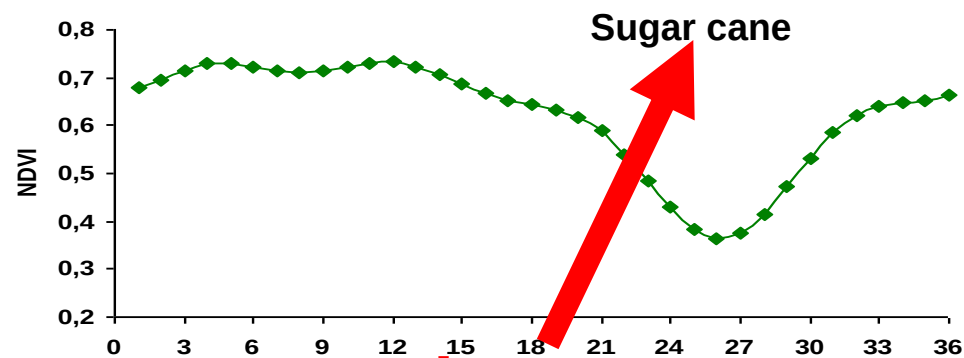


Image Processing

Series Mining



Annotations

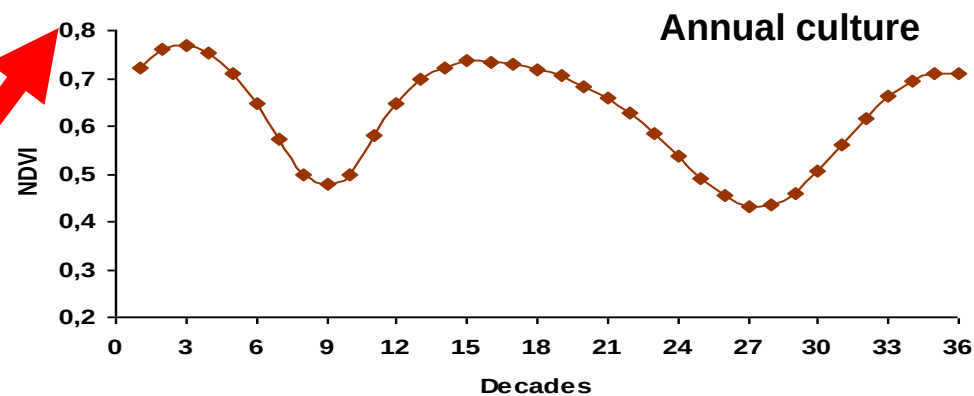
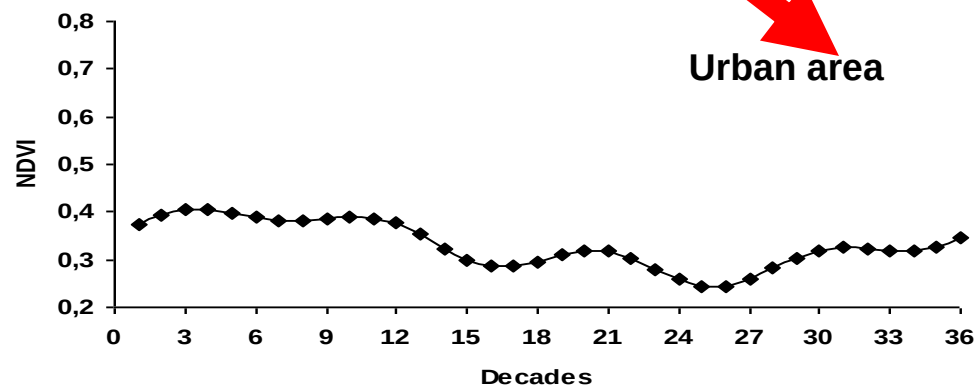
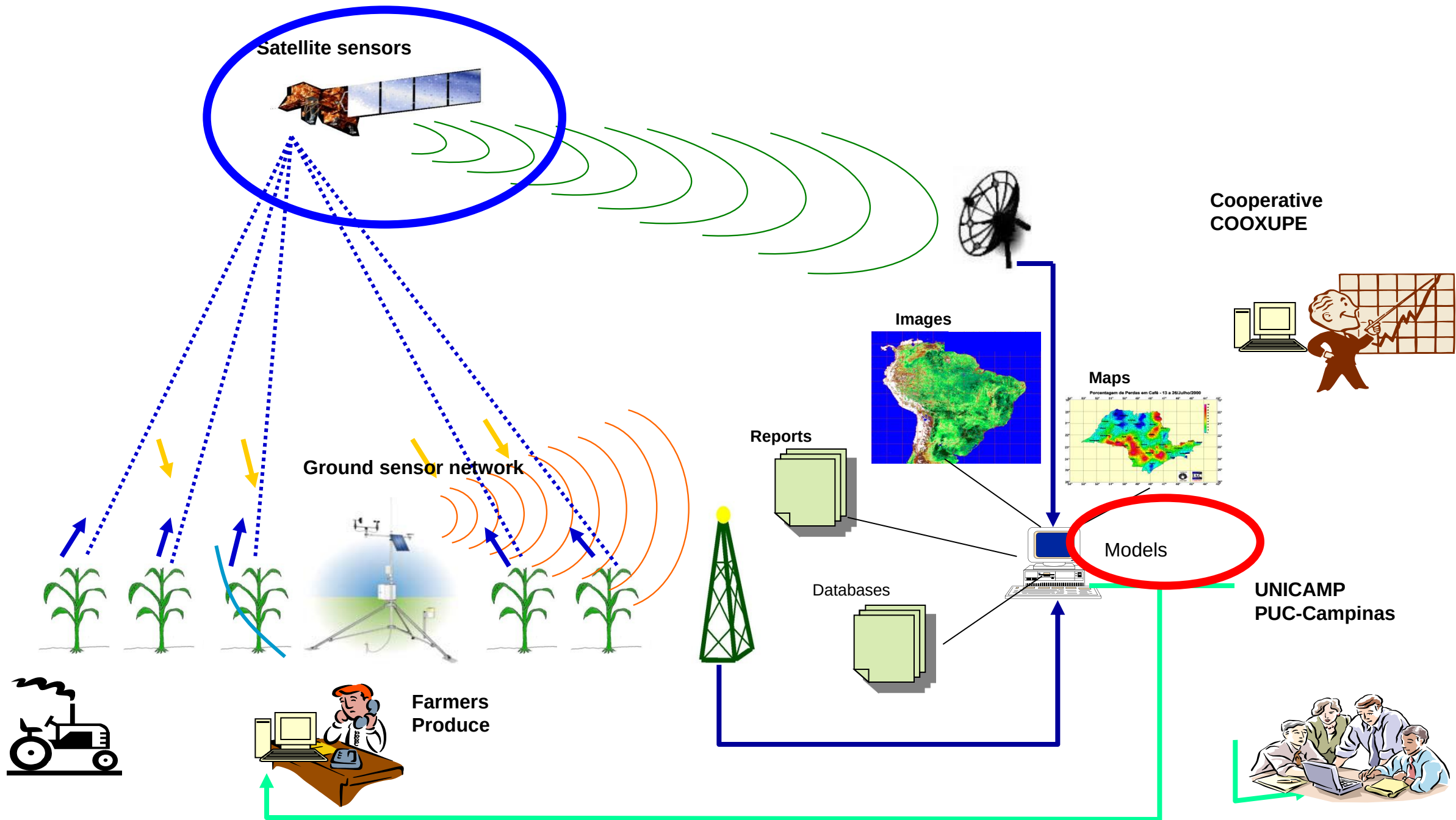


Image Processing

Information sciences ´10

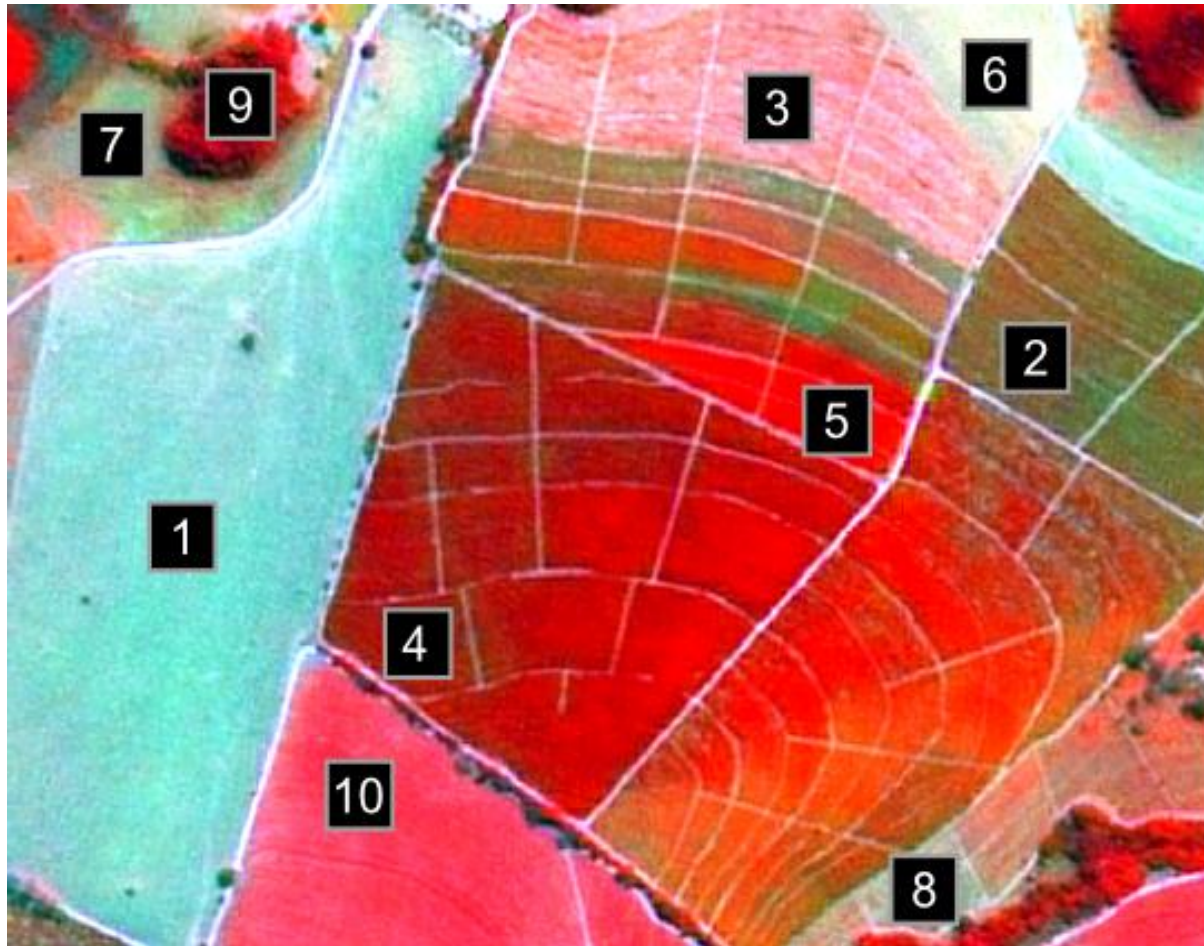
Braz. Image processing conf (SIBGRAPI) ´08
VISAPP ´10



Segment image

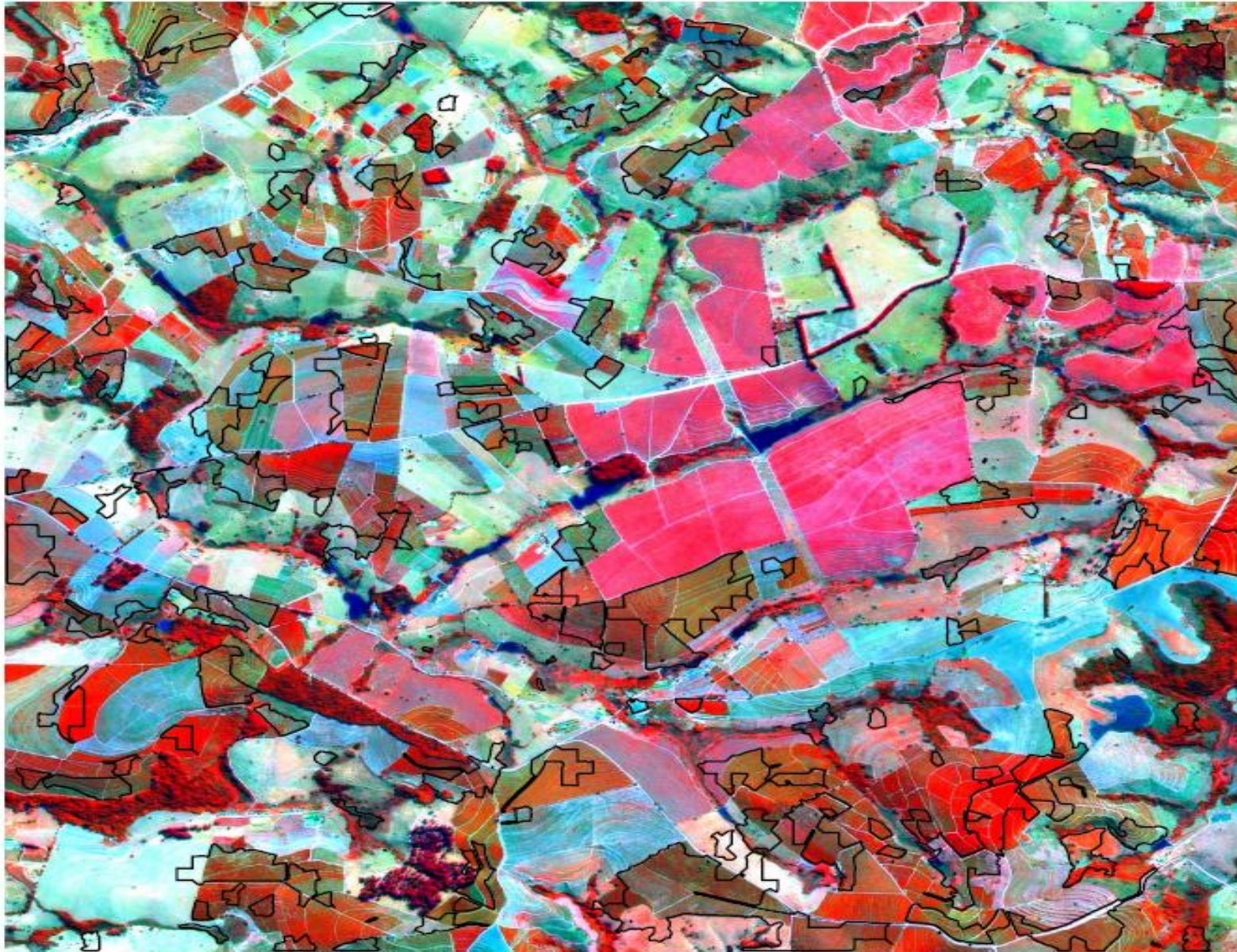


Segment and classify



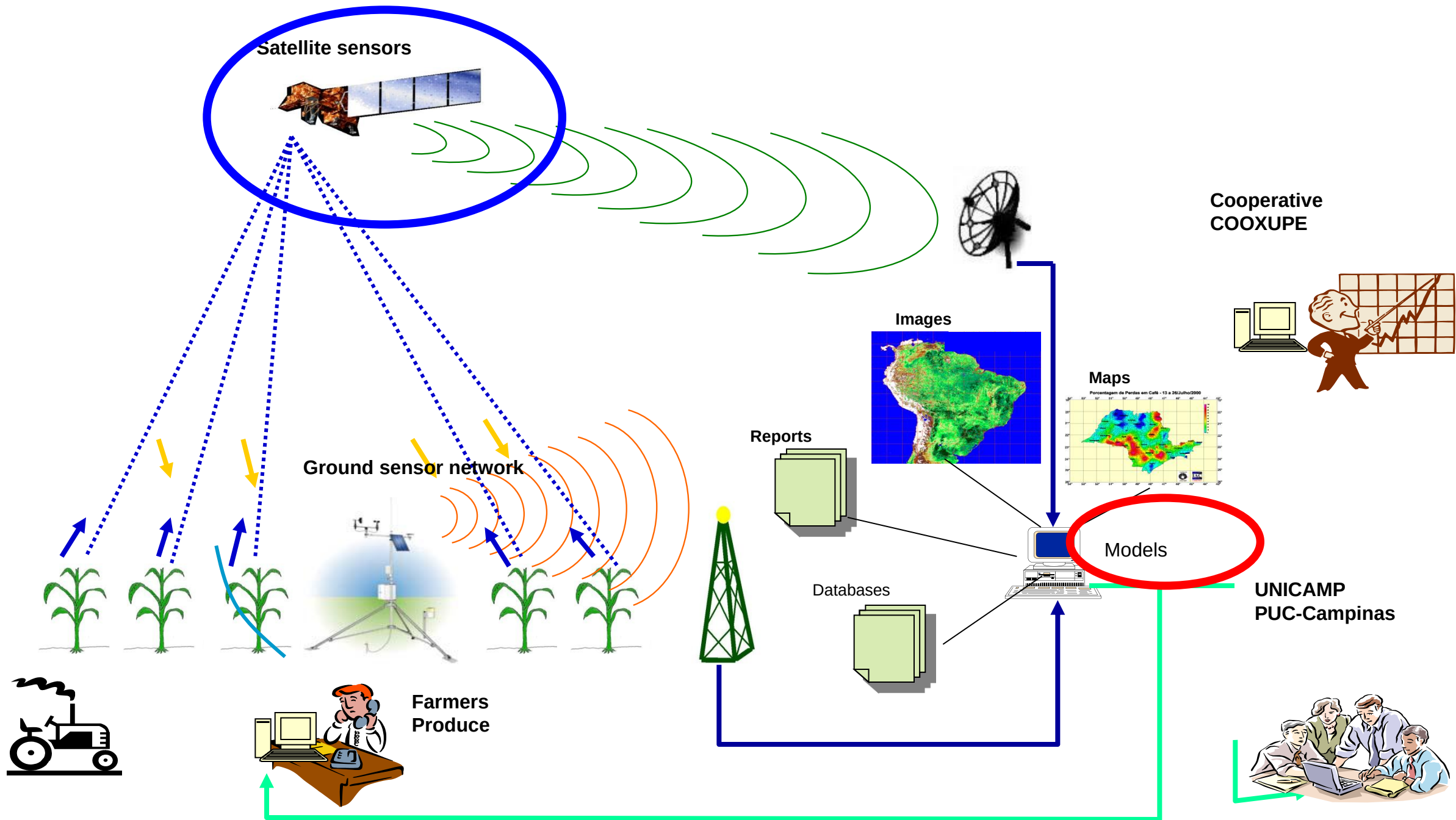
Café	Não-café
1	6
2	7
3	8
4	9
5	10

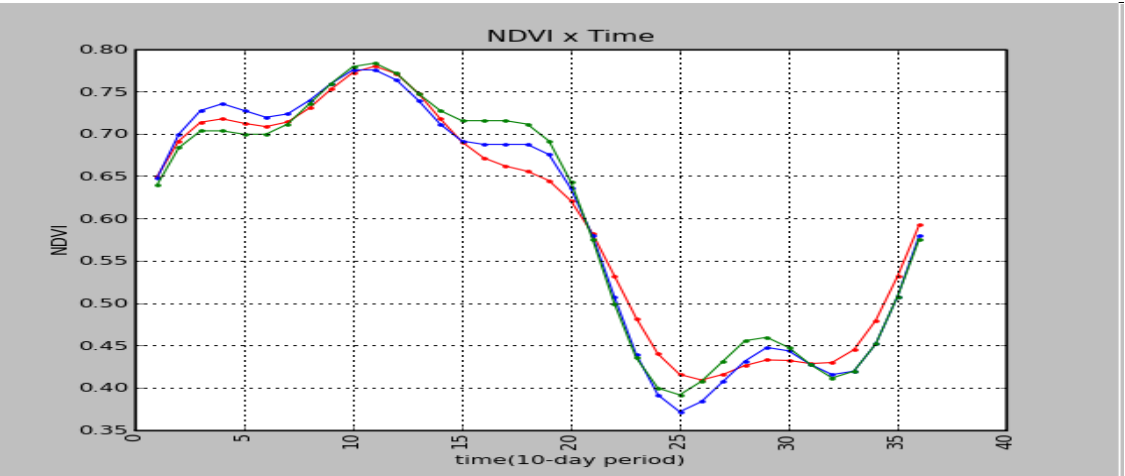
COFFEE IDENTIFICATION (Genetic programming)

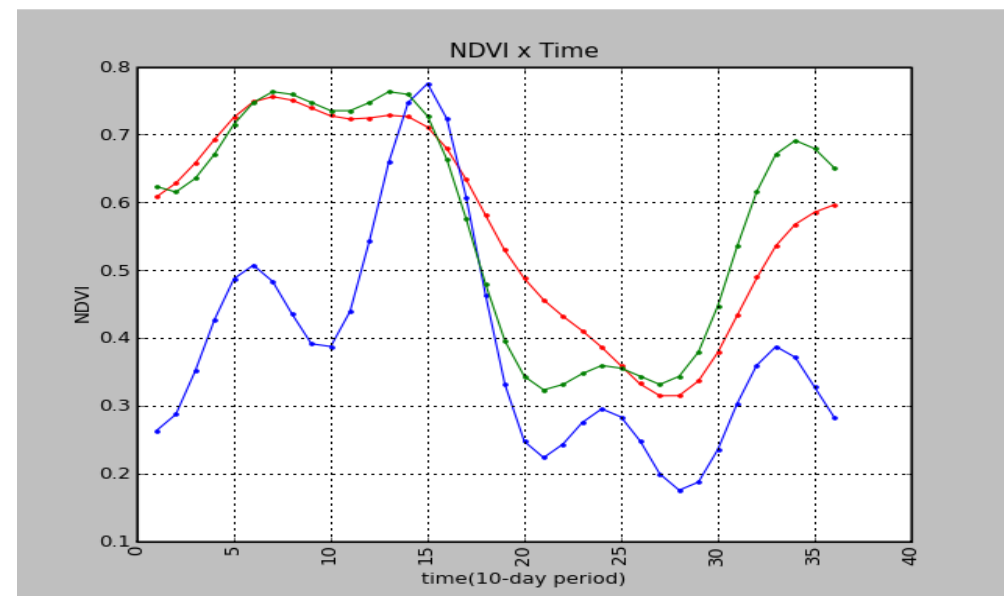
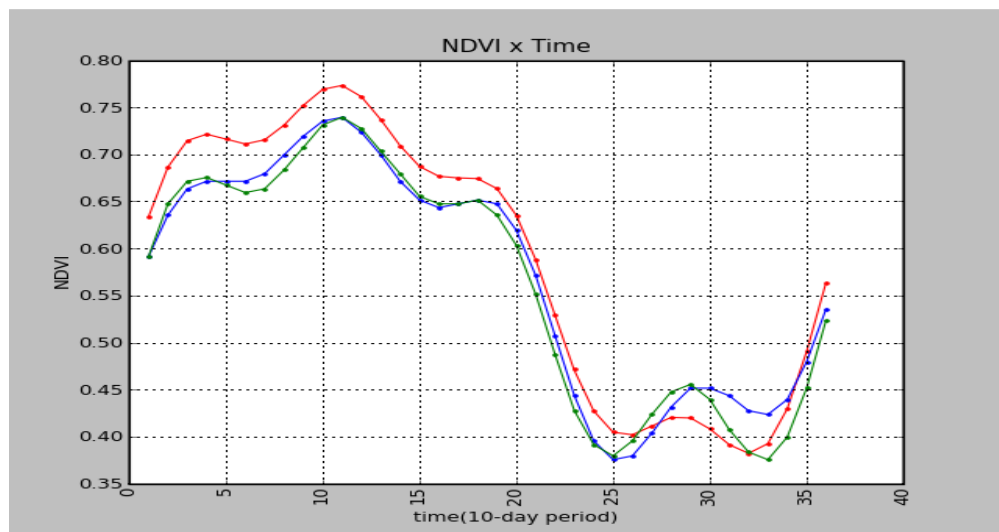
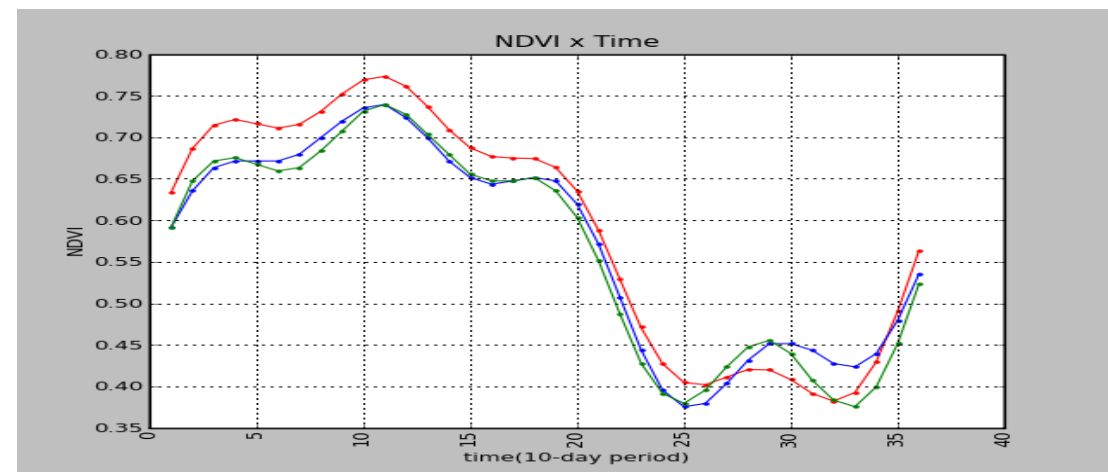
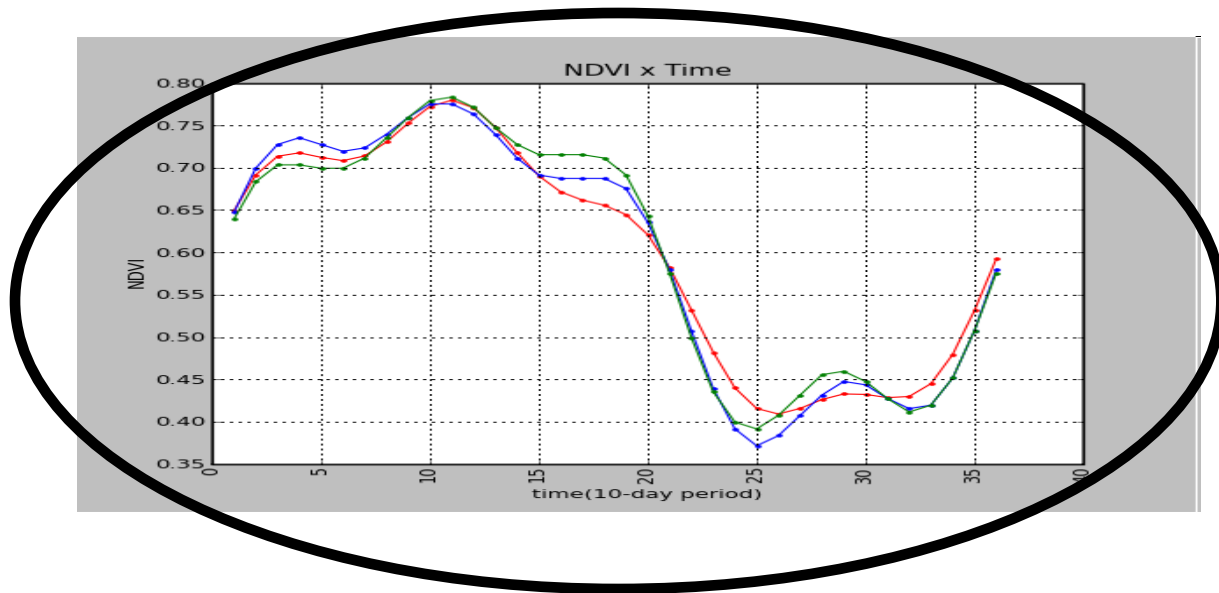


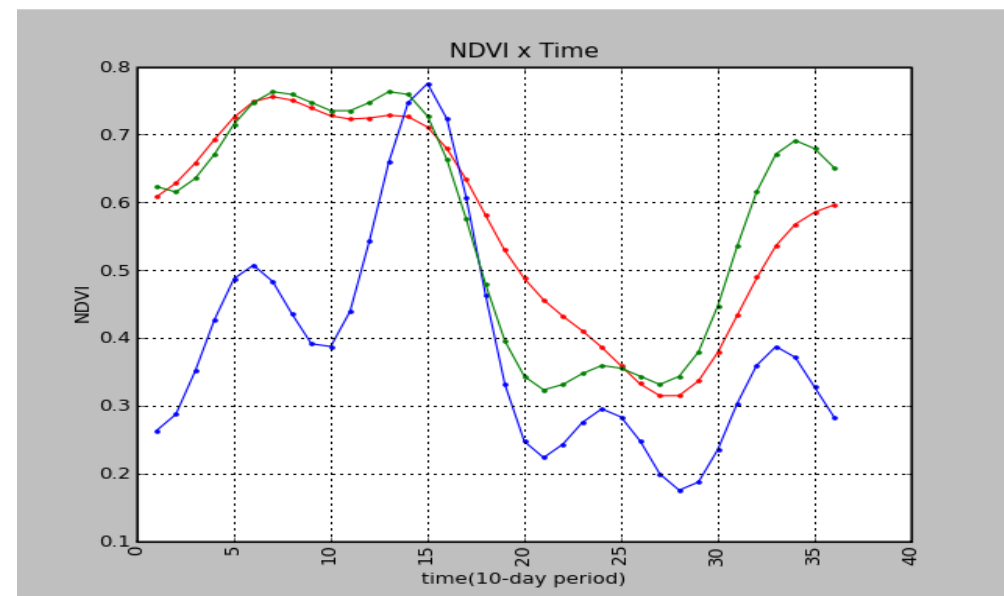
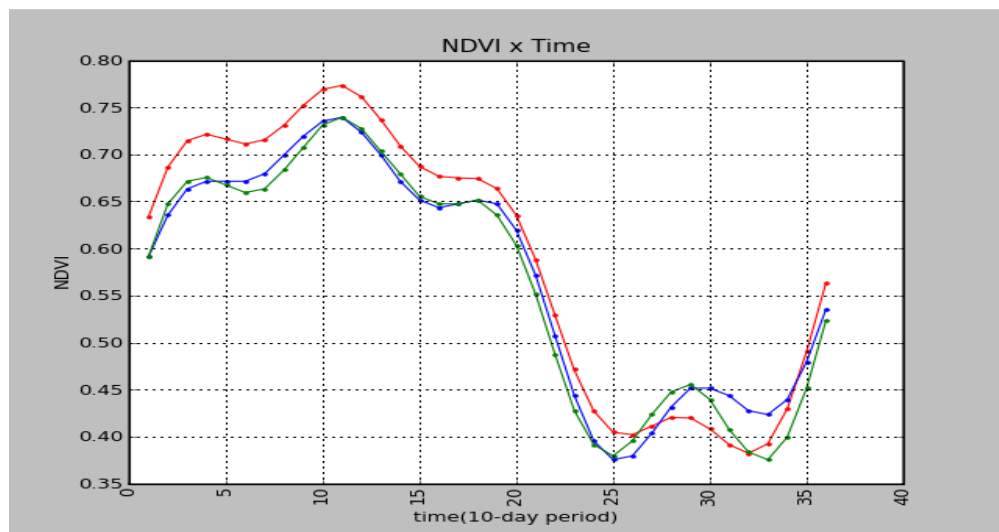
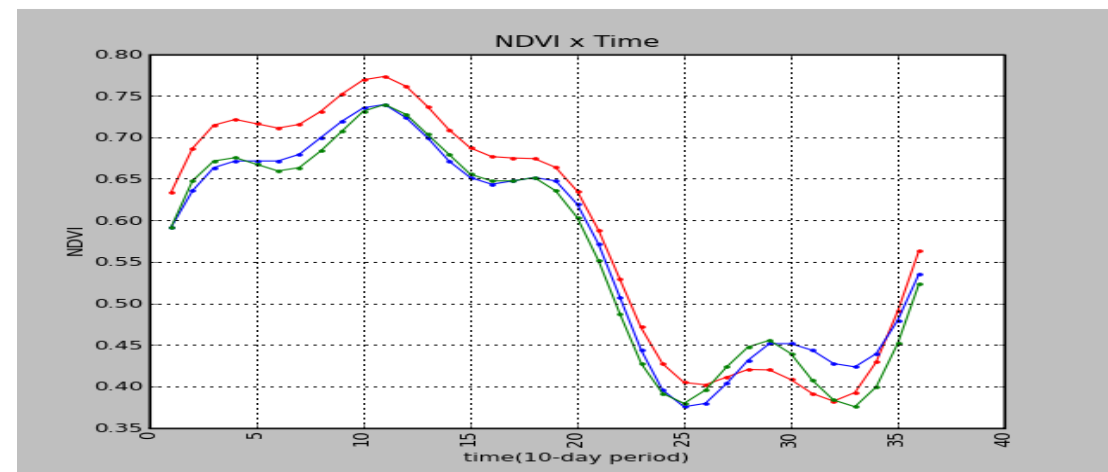
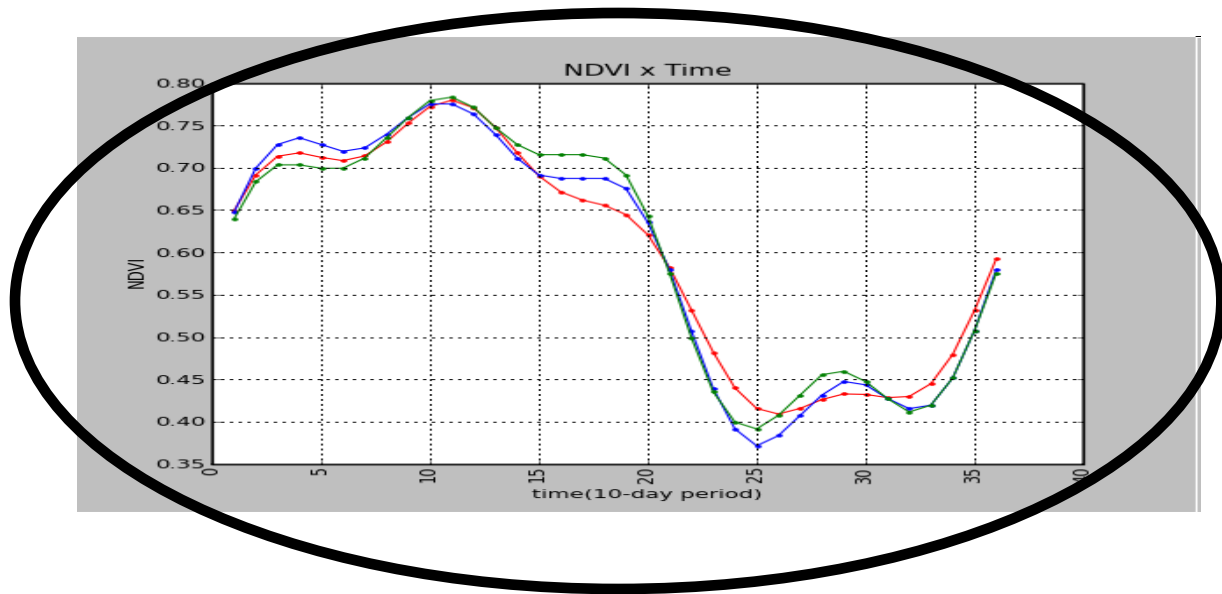
Series Mining

Submitted to GeoInformatica '08
Tech Report Available







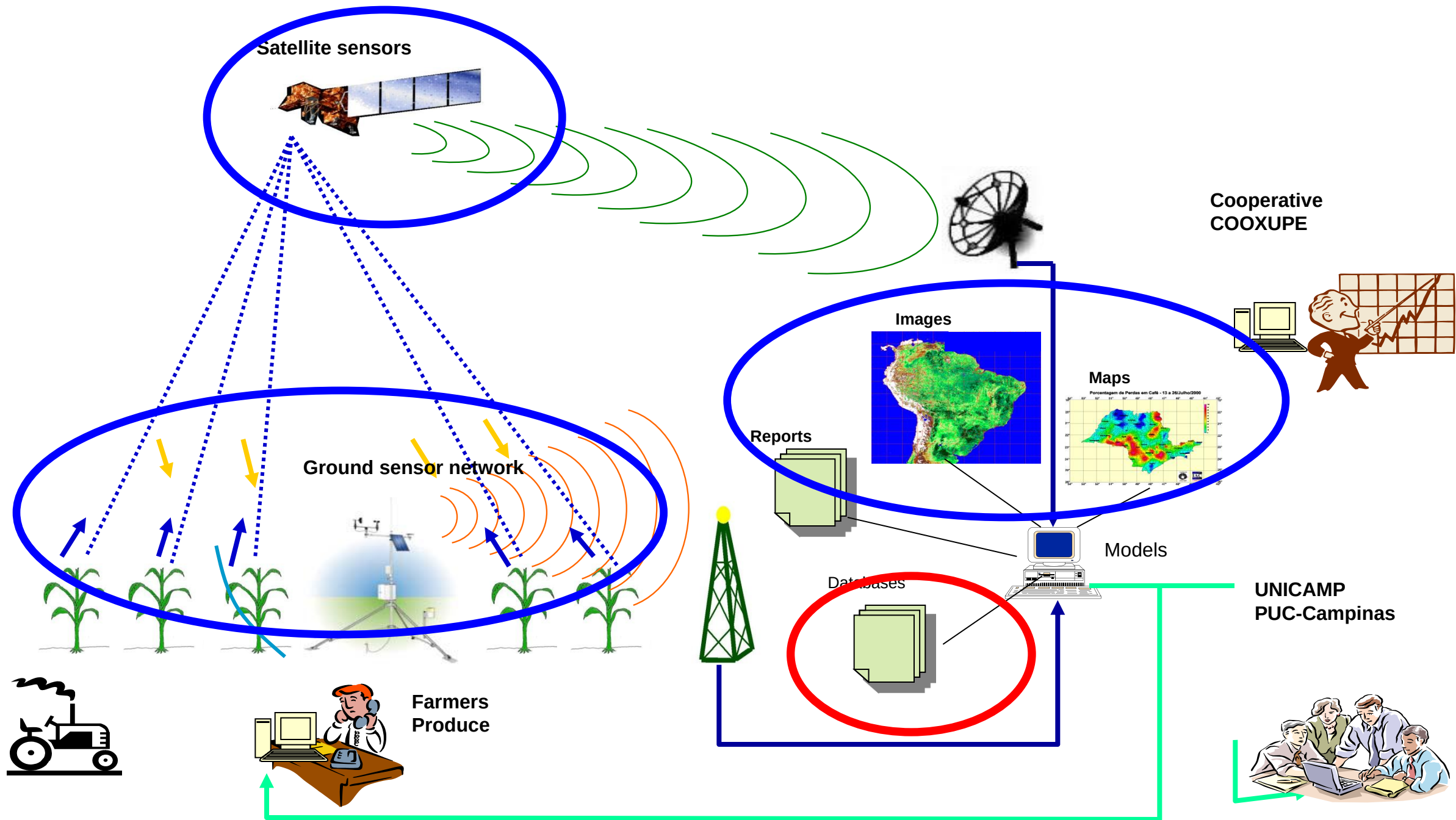


What yield in future? What is happening, and why? – 2 way road

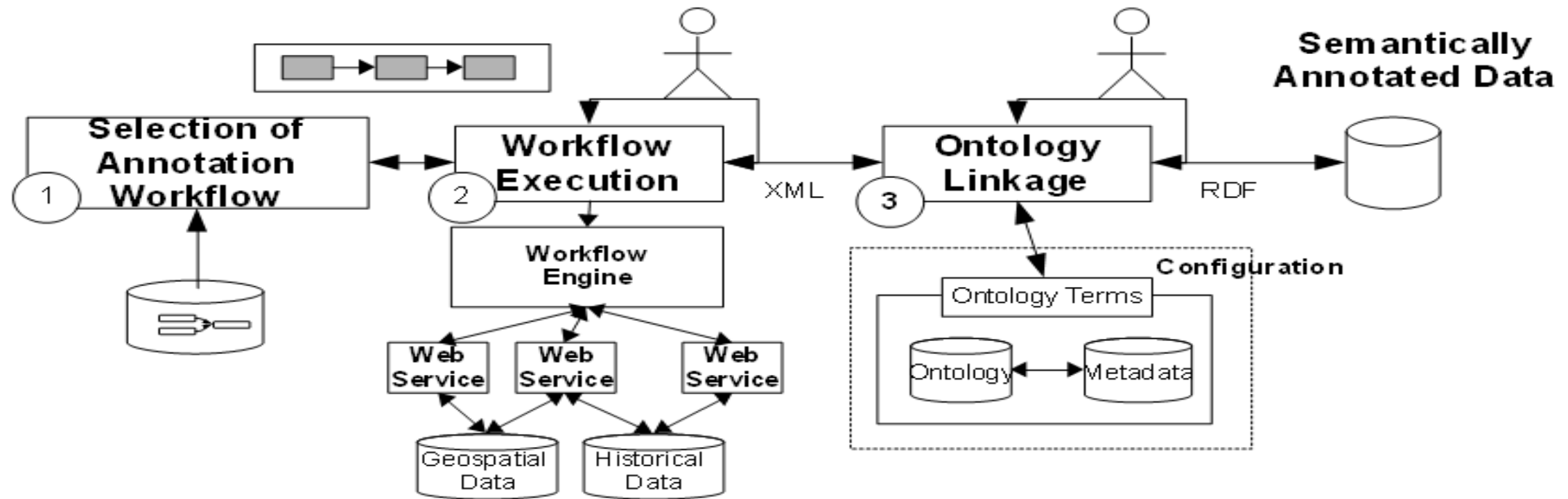
Annotations

Intl Jrnl Metadata, Semantics and Ontologies '09
Journal of Multimedia '10

IEEE Intl Wk on Data Semantics for Multimedia Systems '08
ACM SIG Spatial conf '09
Webist '09
SeCoGIS '09
ACM GIR '10

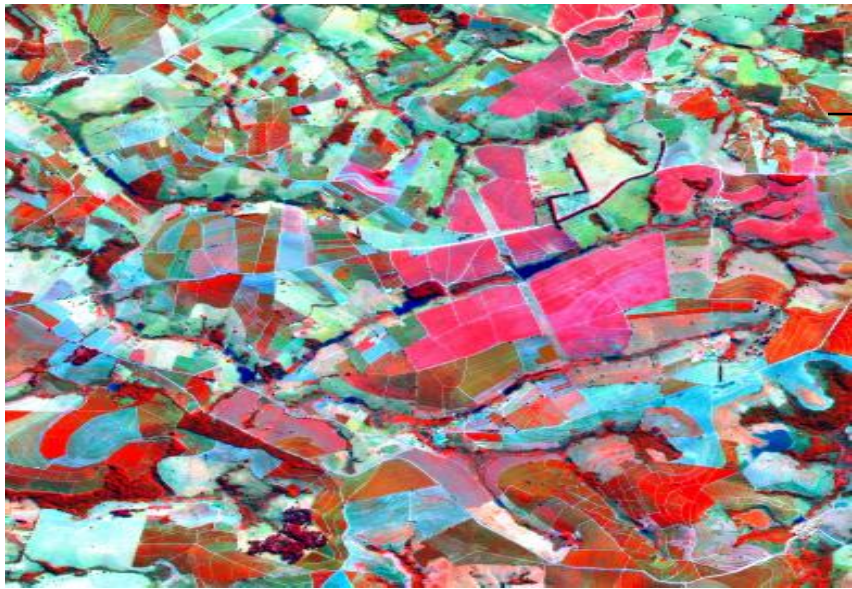


Workflow-driven annotations

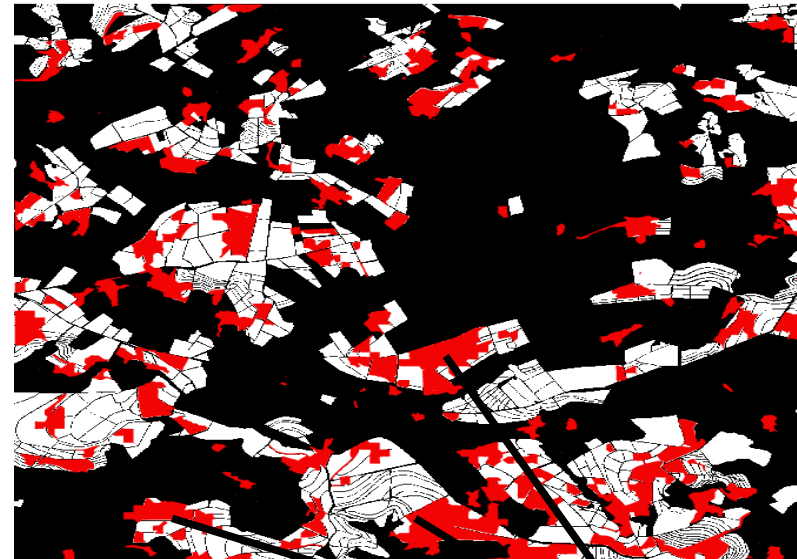
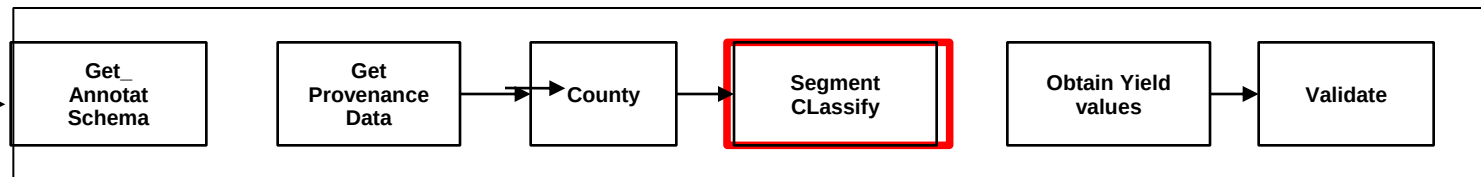


A Case Study

- Remote Sensing Image for Arabica Coffee in Monte Santo



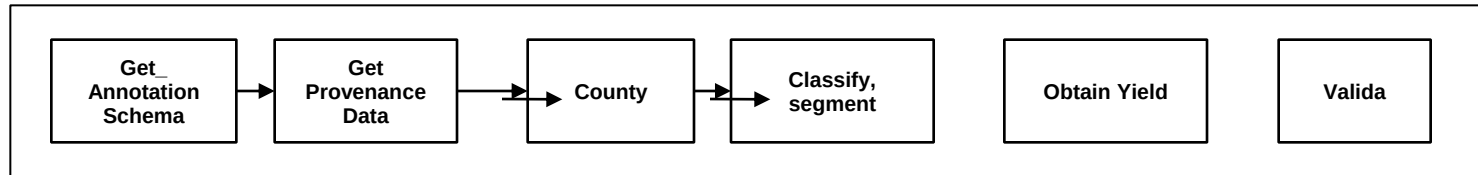
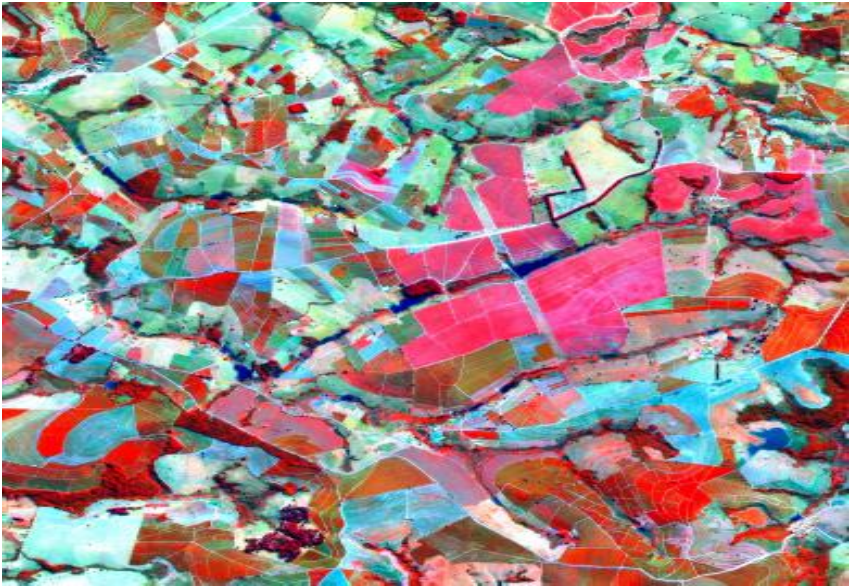
Coffee



Coffee

A Case Study

•Remote Sensing Image for Arabica Coffee in Monte Santo



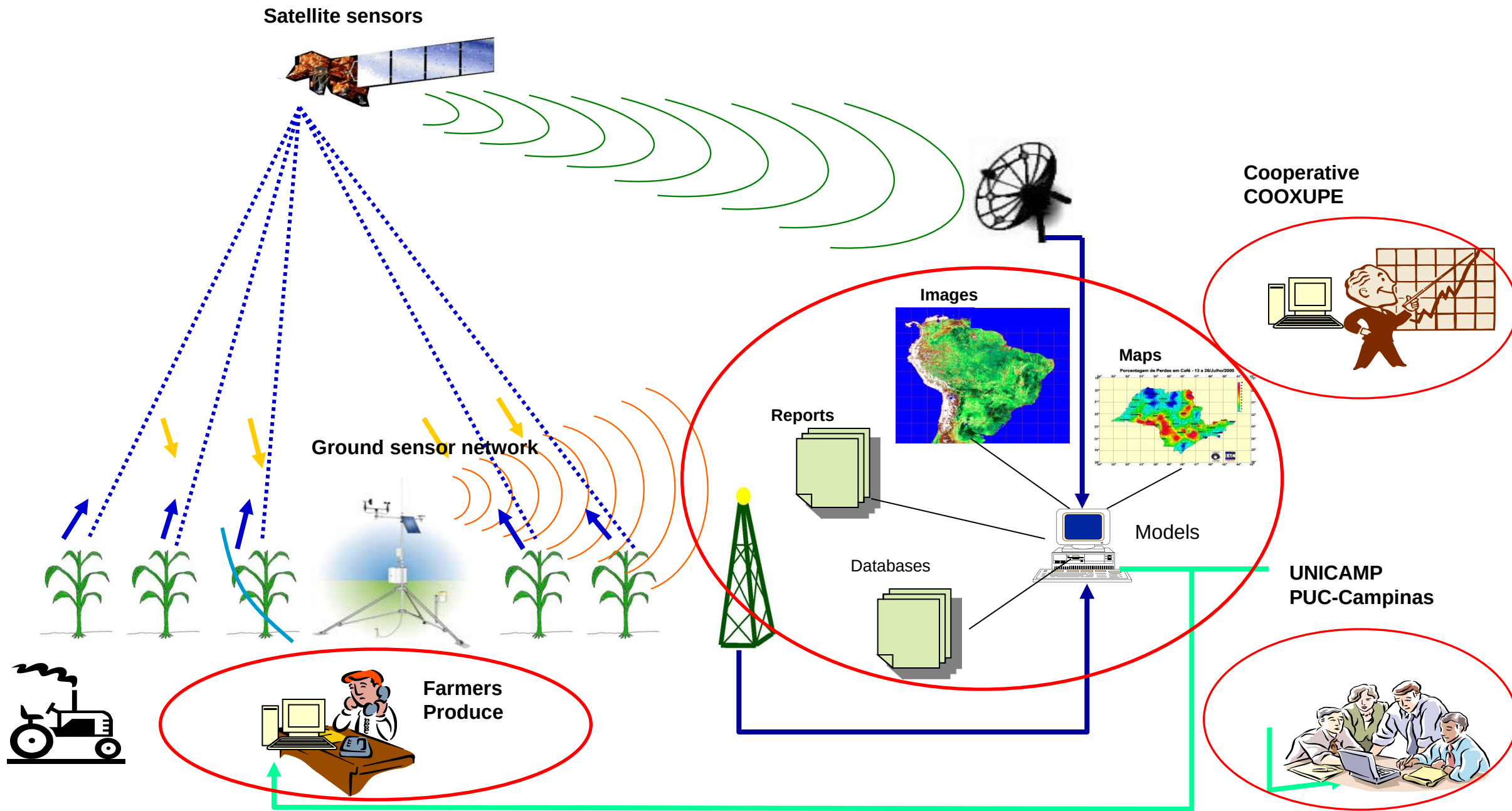
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Interoperability

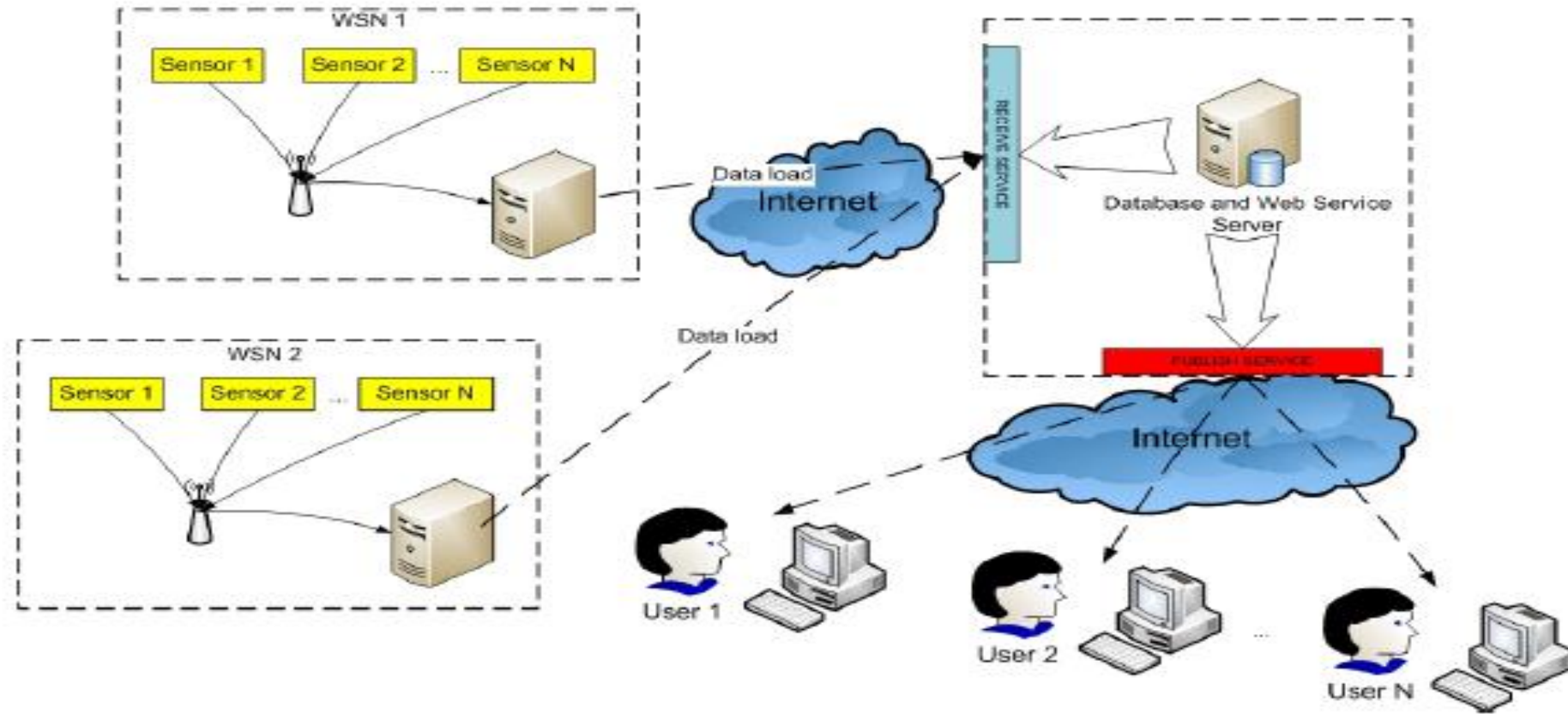
Journal Braz. Comp. Soc '09

Brazilian eScience conf '09

IEEE Latin American Regional Conference
on the Engineering of Computer Based
Systems (ECBS-LARC) – Springer '10



Interoperability solutions



Temp Tabular View

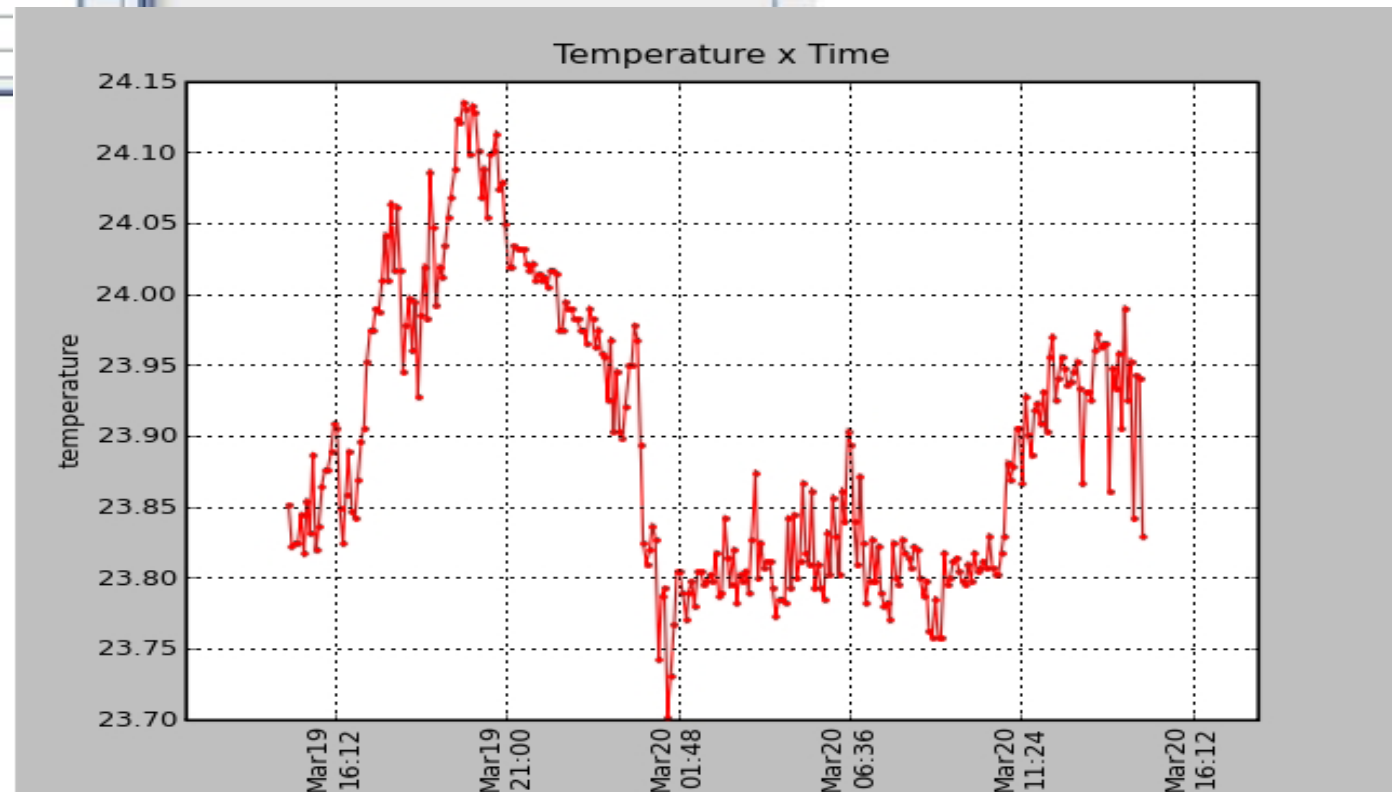
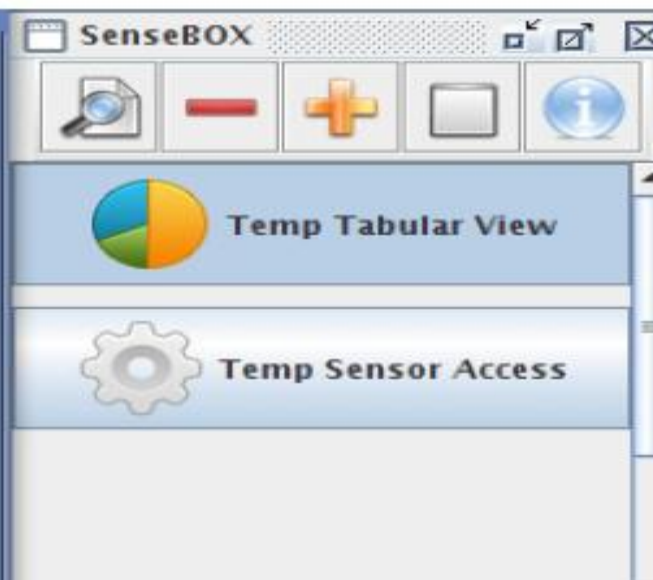
Service: <http://proj.lis.ic.unicamp.br/tomcat/axis2/services/L>

Start Time: 20/02/2010 01:00:00

End Time: 20/02/2010 02:00:00

Request

sensorID	timestamp	value
0	20/02/2010 01:01:18	24.543209
0	20/02/2010 01:06:21	24.538271
0	20/02/2010 01:11:24	24.530865
0	20/02/2010 01:16:26	24.533333
0	20/02/2010 01:21:29	24.533333
0	20/02/2010 01:26:32	24.501234
0	20/02/2010 01:31:35	24.503704
0	20/02/2010 01:36:35	24.516048
0	20/02/2010 01:41:38	24.511111
0	20/02/2010 01:46:41	24.508642



Research Challenges and Ongoing Work

Obstacles

- Sensor network deployment
 - EXPERT in team
 - Behavior depends on crop – 2.4GHz is bad!
- CS + agriculture
 - Long term COOPERATION
- Migration from lab to outside world
 - ADJUST and ADAPT - prototypes

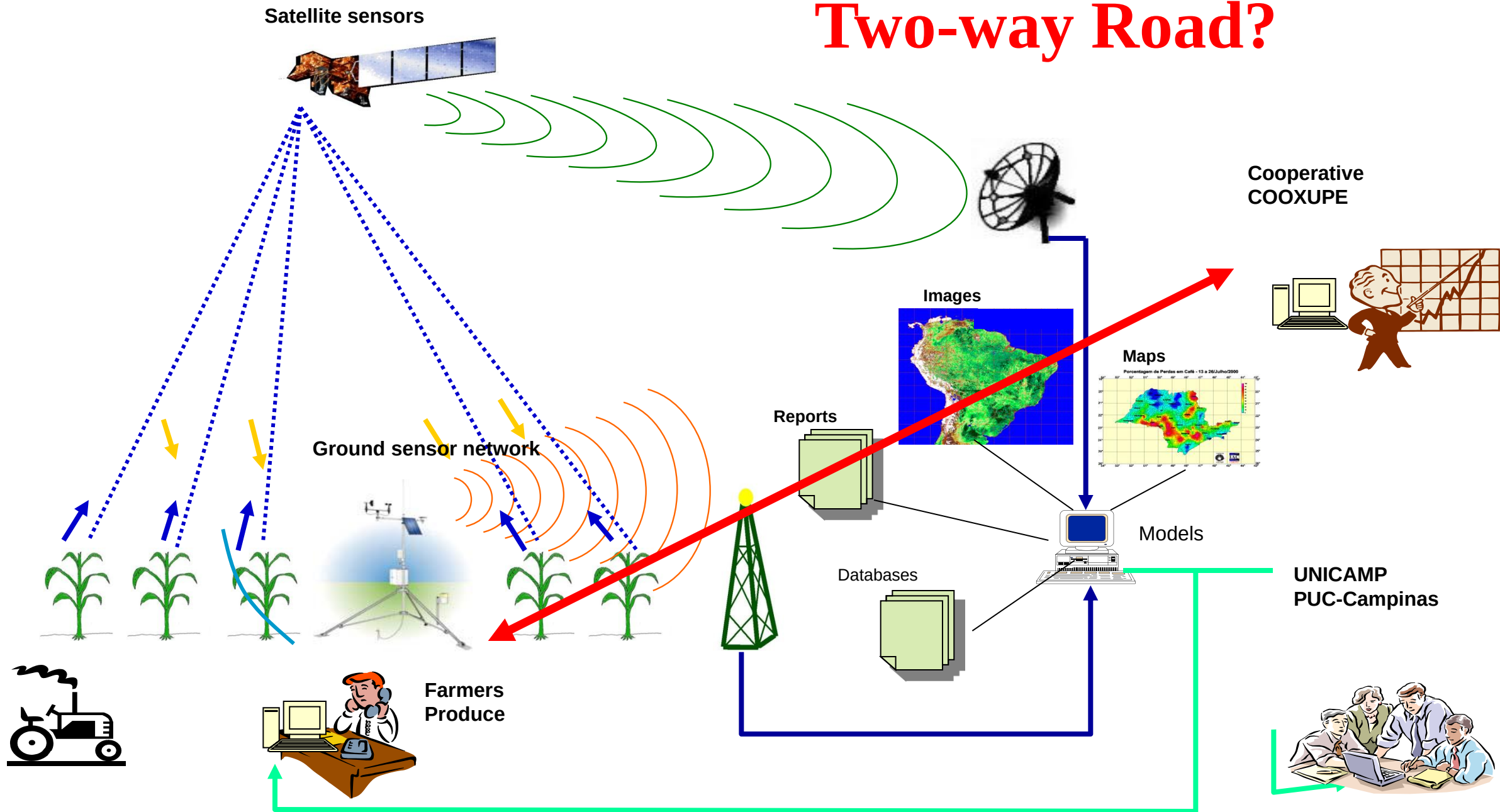
DETOURS

- Delay in getting real time data
 - Use historical sensor data (30+ yrs time series)
 - Use indoors sensors
- Delay in deployment in coffee farms
 - Test with corn in experimental farm
- Ground sensor + satellite data for models
 - Most results based on satellite data
 - Ground sensors starting now...

Challenges

- In the domain (agricultural sciences)
 - Models combining sensors
- In CS (databases, networks, image processing, software engineering)
 - Heterogeneity
- A combination of both

Two-way Road?



Some lessons

- Multidisciplinary projects need long-time cooperation
- Deployment of sensor networks need LOTS of expertise in telecommunications and electronics
- Real users need real systems

Result overview

Publications

- **4 journal papers**
- **14 conference papers**
- **1 poster, 1 short paper**
- **Submitted – 3 journal, 2 conf**

Technological results

- **Low cost networks**
- **Prototypes (software and hardware)**
- **Crop yield models**

Training in multidisciplinary research

- **Financed by project - 4 undergrad, 1 MSc**
- **Involved – Agriculture – 3 PhD, 1 MSc**
- **Involved – CS – 4PhD, 2 MSc, 6 undergrad**

Social impact – rural areas

- **Digital inclusion**
- **Communication infrastructure (farm -> Internet)**

Acknowledgements

- FAPESP and Microsoft Research
the Virtual Institute
- UNICAMP
 - IC, FEAGRI, CEPAGRI
 - AND STUDENTS
- CNPq and CAPES
- COOXUPÉ

from small farms
into the networked world

