



Use of remote sensing for crop yield and area estimates in Southern Brazil

Denise Cybis Fontana
Faculdade de Agronomia - UFRGS

Remote Sensing support to crop yield forecast and area estimates
30th November to 1th December 2006 - Stresa - Italy

Brazil



General information:

Area: 8.514.204,8 km²

Population: 184.739.395 people

Main biomes

Foresta Amazônica (Amazon Forest)

Catinga

Pampa (Rangelands)

Parque Nacional (Pantanal)

Mata Atlântica (Atlantic forest)

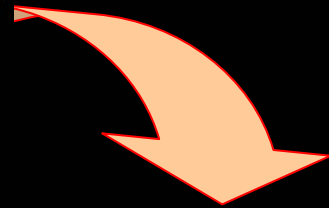
5,533,261 ton)

30,504 ton)

,733 ton)

Wheat (4,620,679 ton)

Agricultural production
17% (grain)



→ Soybean, maize
(spring-summer)
Wheat
(winter)

→ Rice
(spring-summer)
Rangelands

Rio Grande do Sul State

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL



- Dimension

- 2.120 professors and researchers (50 % PhD)
- 2.880 technicians
- 22.100 undergraduate students
- 6.970 graduate students
- 1.800 basic education students

- Organization

- 54 undergraduate courses
- 200 graduate courses
- 376 extension courses
- Research groups - 355

Faculdade de Agronomia



Graduate courses - CROP SCIENCE
<http://www.ufrgs.br/ppgfitotecnia/>

CEPSRM

Centro Estadual de Pesquisa em Sensoriamento
Remoto e Meteorologia



Graduate course - REMOTE SENSING
<http://www.ufrgs.br/srm>

Infra-structure available

- Computers and softwares (Envi, Erdas, Idrisi, SPRING, ArcGIS, SAS,...)
- Research equipments (experimental area):
 - Automatic meteorological station,
 - Micrometeorological equipments;
 - Plant equipments (LAI, photosynthesis,...)
 - Soil equipments (tensiometer, lisimeter,...)
- Radiometry Laboratory
- NOAA/AVHRR receiving station

GeoSafras Project

- Project coordinated by **CONAB**
(*Companhia Nacional de Abastecimento*)
and supported by **UNDP**
- Multi-institutional network
UFRGS, EMBRAPA, IBGE,
INMET, INPE, UNICAMP,
IAC, IAPAR, SIMEPAR,...



Objective of GeoSafras

To improve Brazilian crop area and yield estimation system through a multi-institutional network for the development of methodologies, looking for an harvest forecasting system with higher objectivity.

TEAM at UFRGS:

- Ana Paula Wagner, M.Sc. (Physics)
- Anibal Gusso, M.Sc. (Physics)
- Denise Cybis Fontana, D.Sc. (Agronomy)
- Eliana Lima da Fonseca, D.Sc. (Agronomy)
- Eliana Klering, M.Sc. (Meteorology)
- Eliseu Weber, M.Sc. (Agronomy)
- Gilca Marques Alves, B.Sc. (Agronomy)
- Homero Bergamaschi, D.Sc. (Agronomy)
- Jorge Ricardo Ducati, D.Sc. (Physics)
- Laurindo Guasselli, D.Sc. (Geography)
- Moacir Antonio Berlato, D.Sc. (Agronomy)
- Mônica Tagliari Kreling, M.Sc. (Geography)
- Ricardo Wanke de Melo, D.Sc. (Agronomy)
- Rita Marques Alves, D.Sc. (Meteorology)

Methodology

Segments: estimates of crop area, estimates of crop yields and crop monitoring activities

Remote Sensing - measurement of the surface dynamics (imagery);

Geoprocessing - location and quantification;

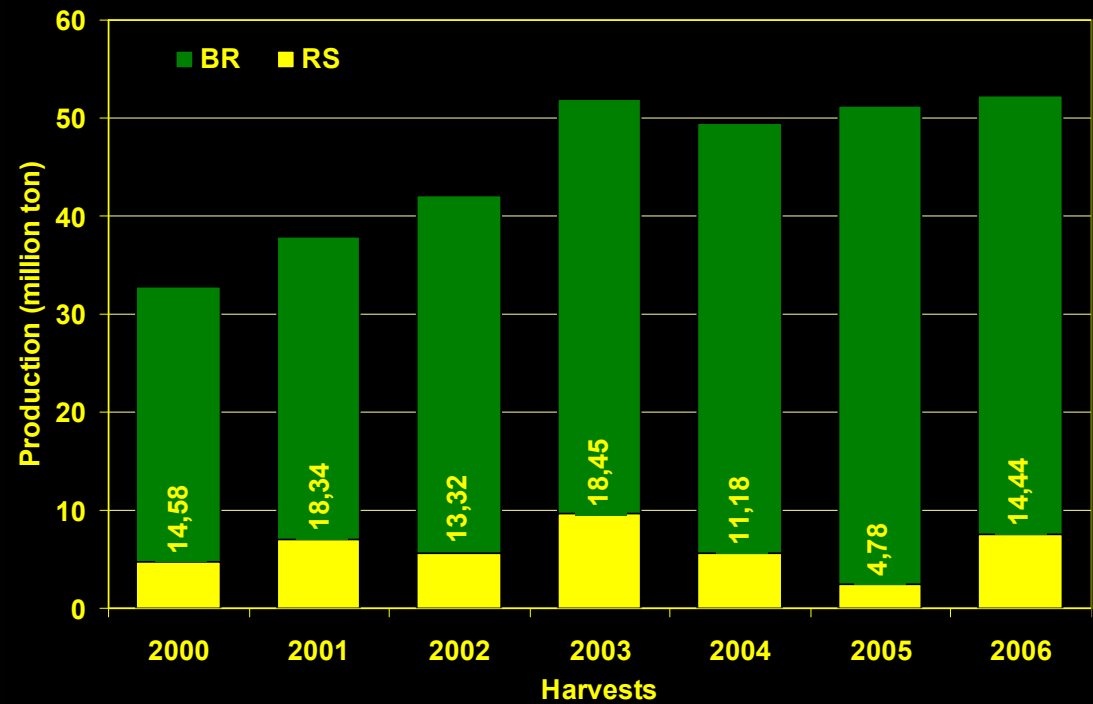
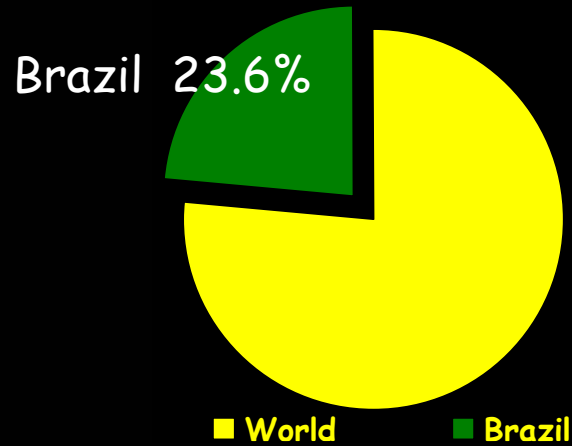
Agrometeorology - crop yield modeling.

Crops: wheat (winter)

soybean and rice (spring-summer)

SOYBEAN

(Spring-summer crop; Non-irrigated)



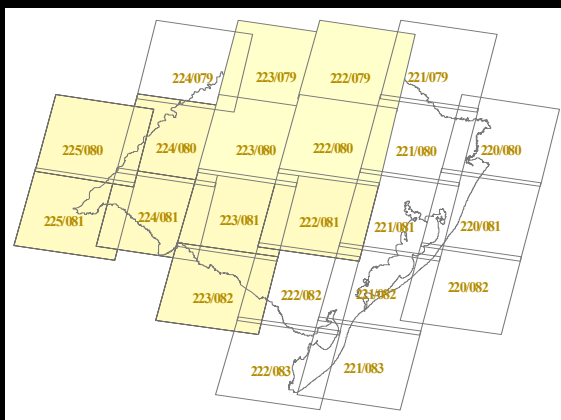
Remote Sensing at UFRGS (GeoSafras)

The use of a combination of satellite images
with different resolutions:

- LANDSAT/TM (30m, 16 days)
- TERRA/MODIS (250m, 2 days or
MVC 16 days)
- NOAA/AVHRR (1100m, 1 day or
MVC 15/30days)

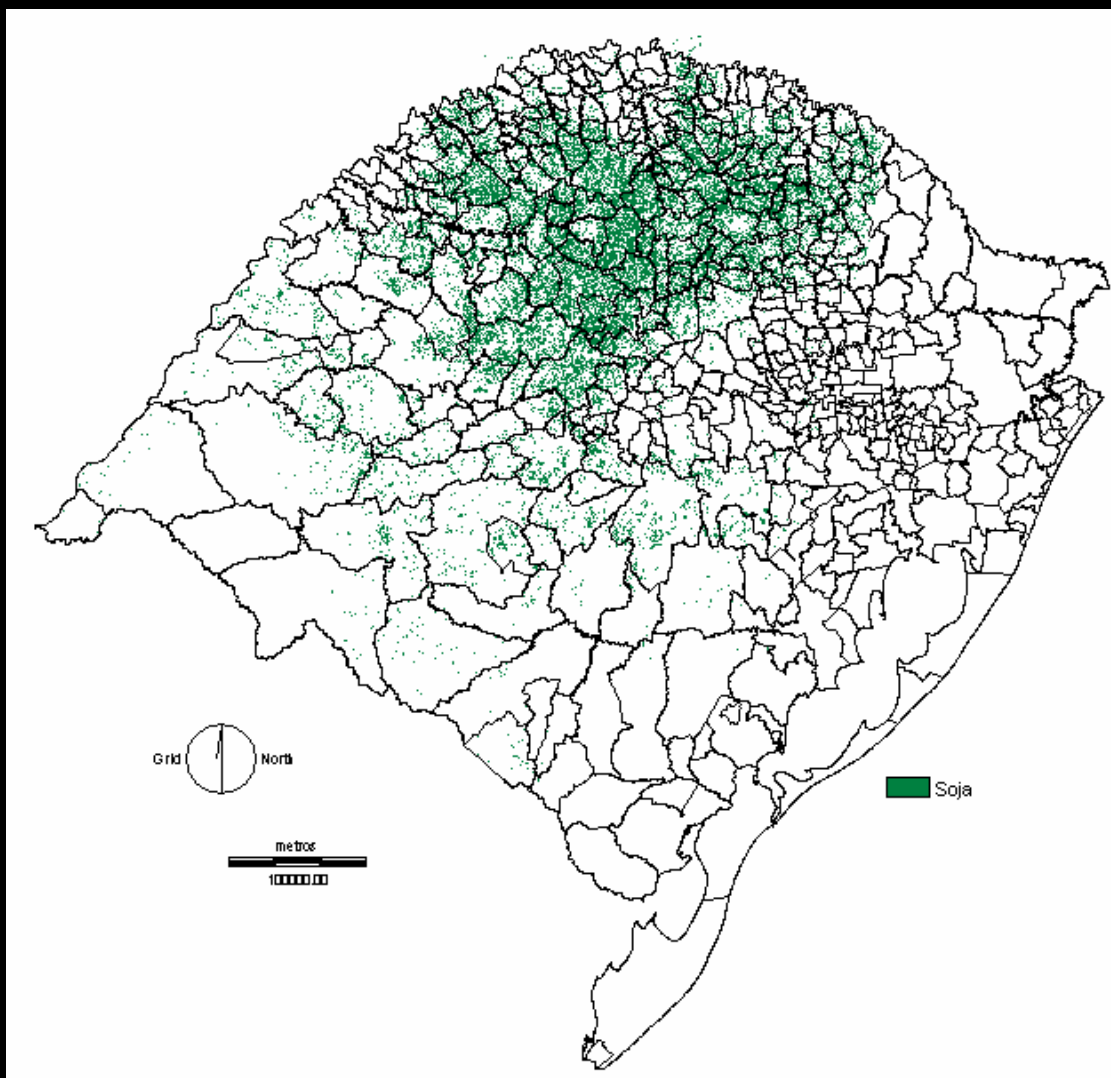
LANDSAT/TM

Crop area mapping



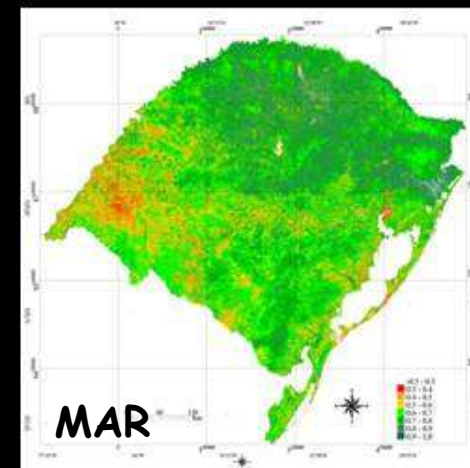
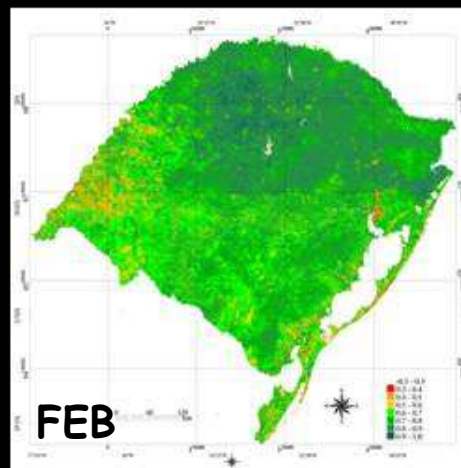
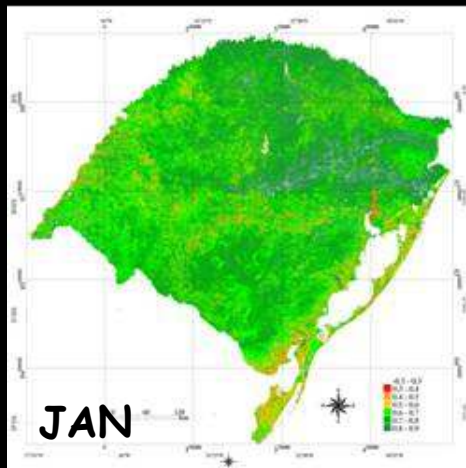
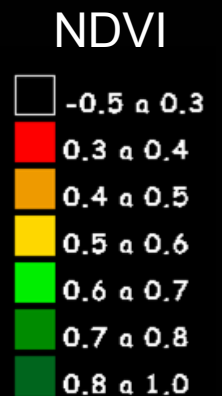
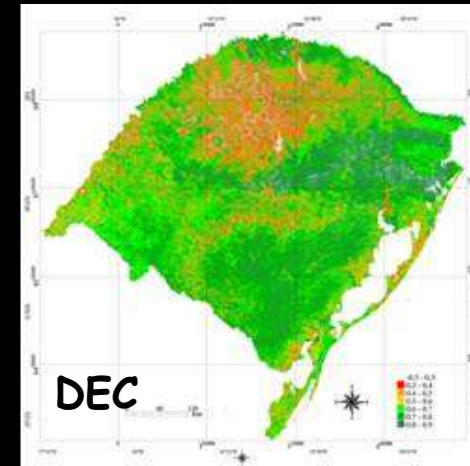
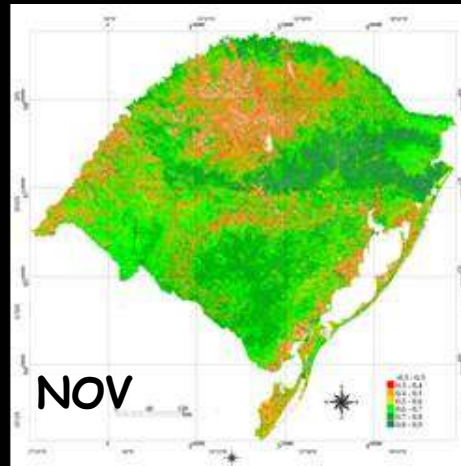
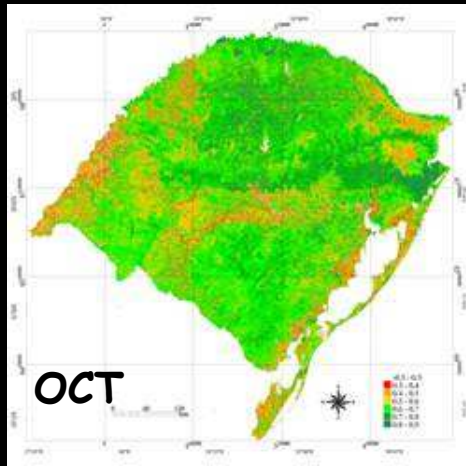
2006 Harvest

Soybean area estimation:
11 Landsat/TM images

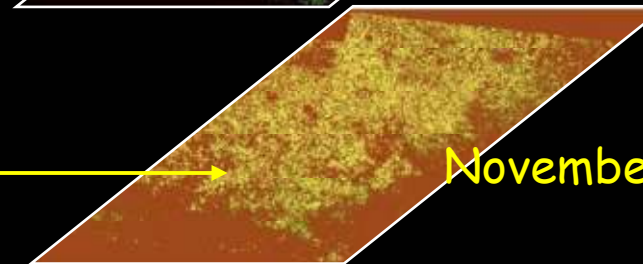
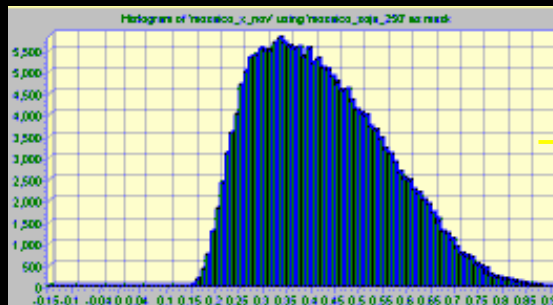
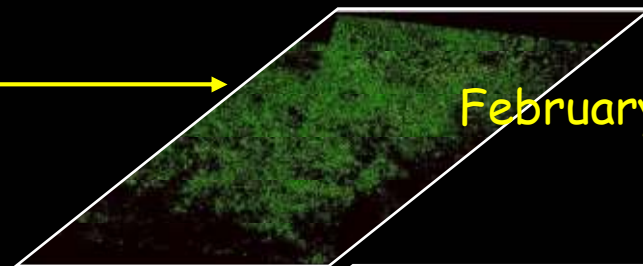
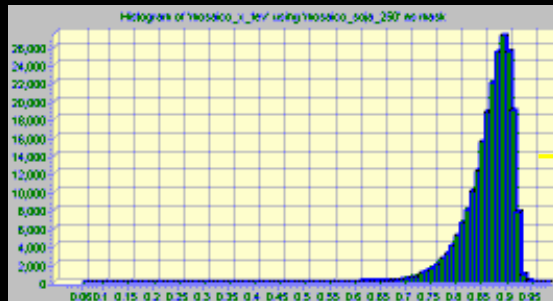


TERRA/MODIS

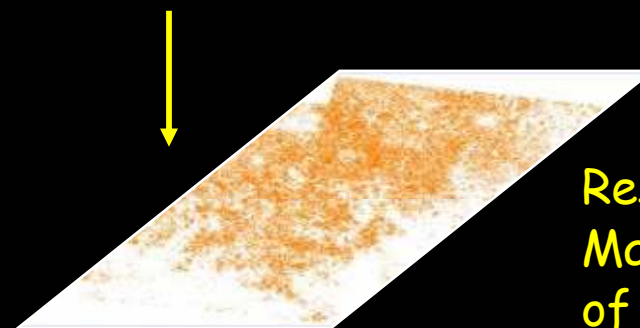
Crop area - mapping and monitoring



TERRA/MODIS - Soybean mapping

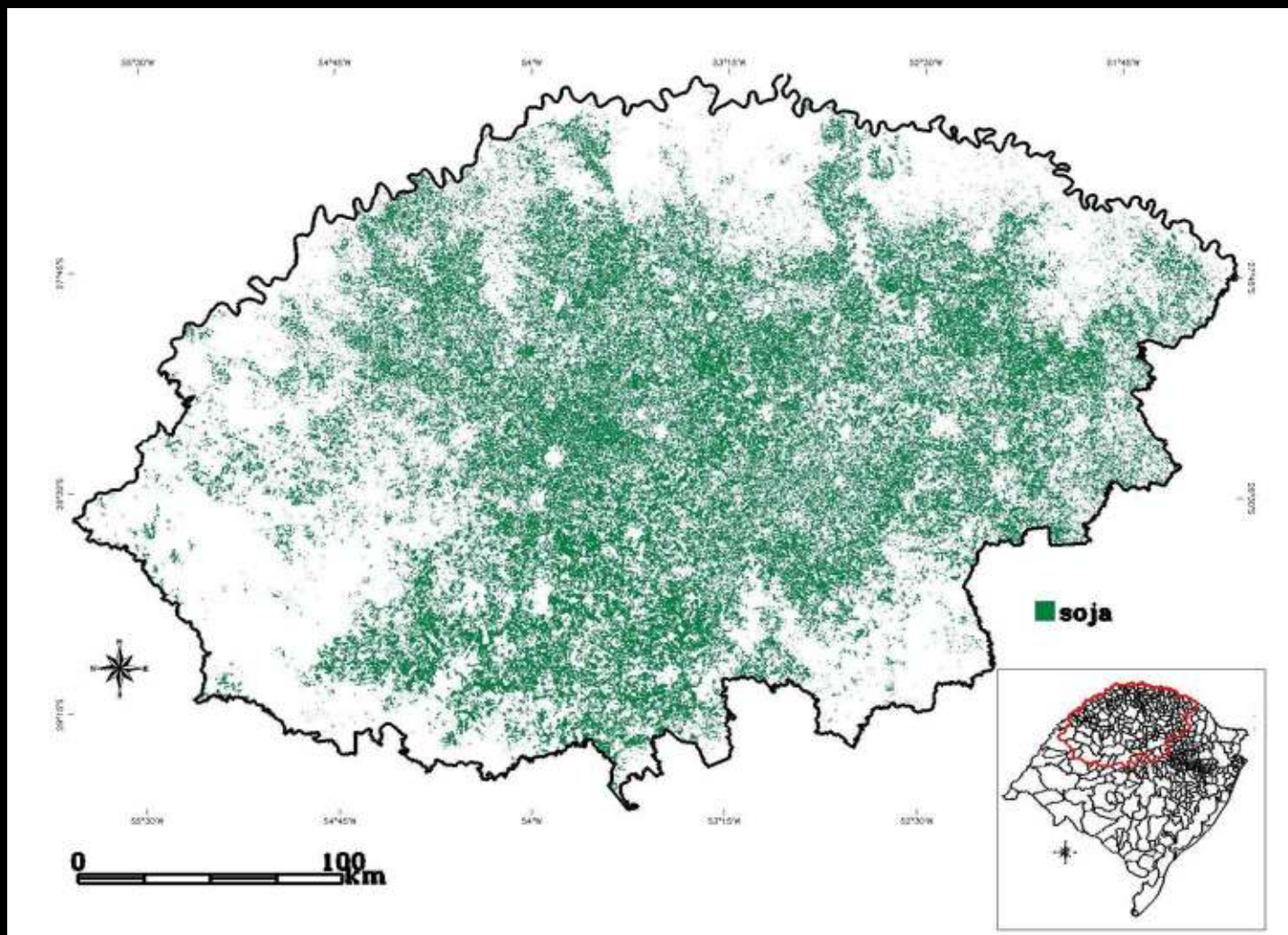


↑
Landsat image

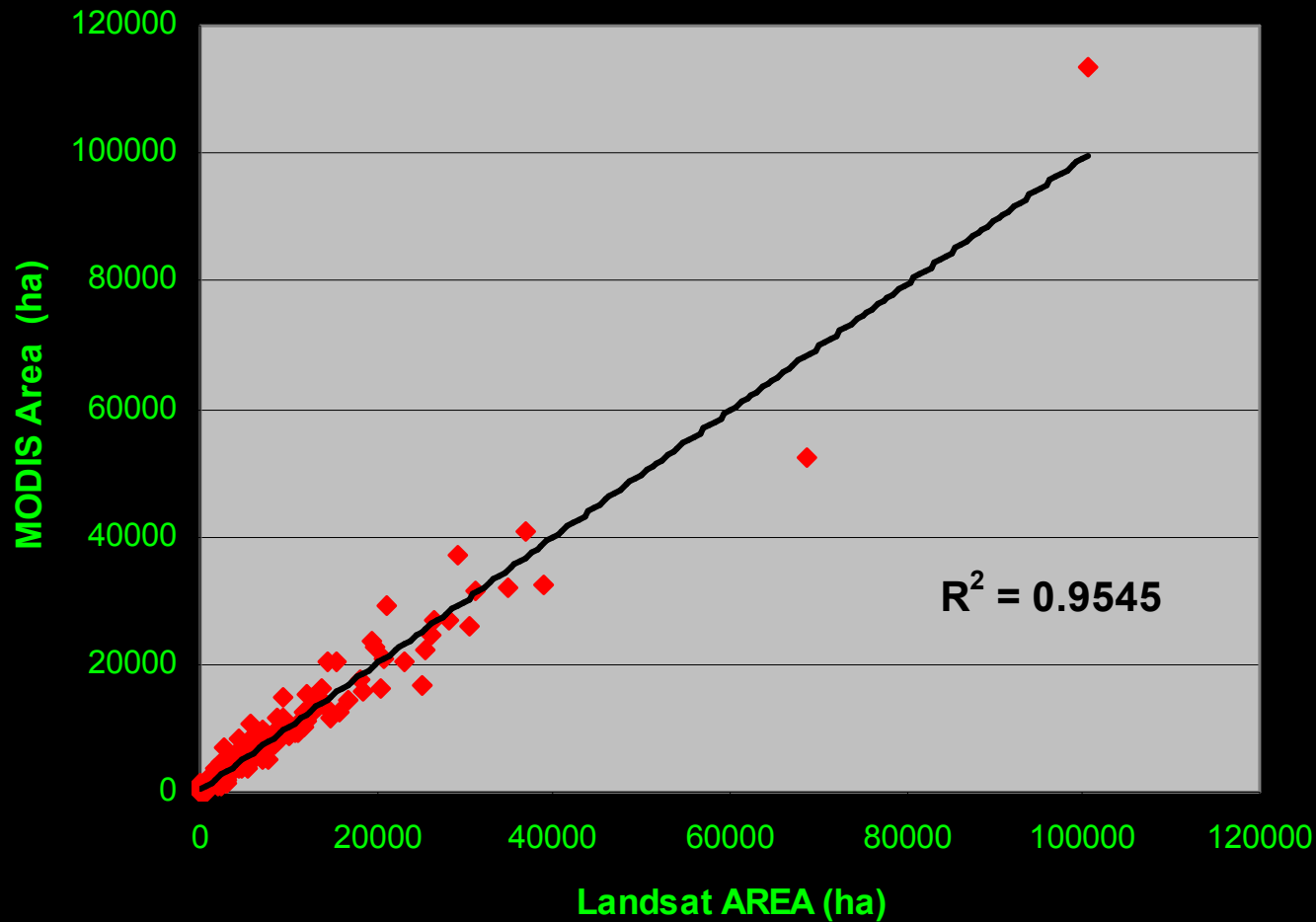


Resultant Image :
Mapping and quantification
of the soybean area

TERRA/MODIS - Soybean Mapping 2006



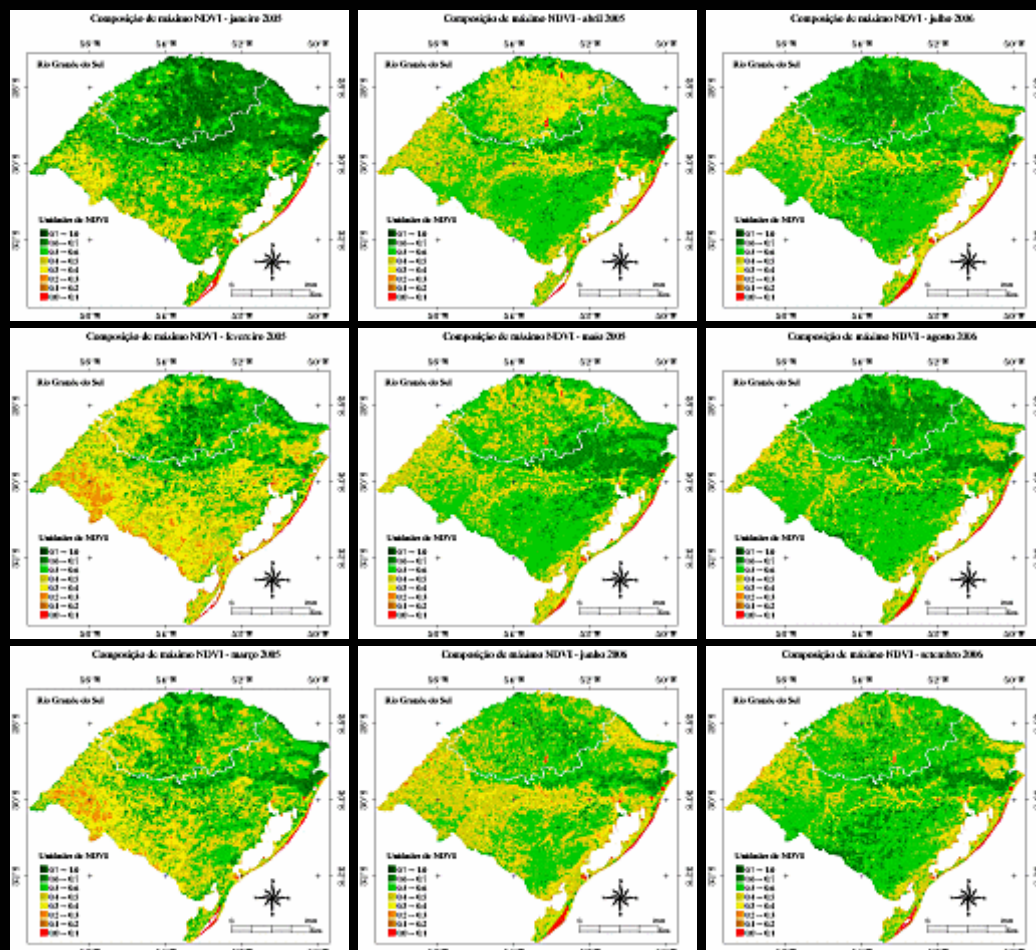
TERRA/MODIS - Soybean Mapping 2006



Counties 100% covered by images without clouds

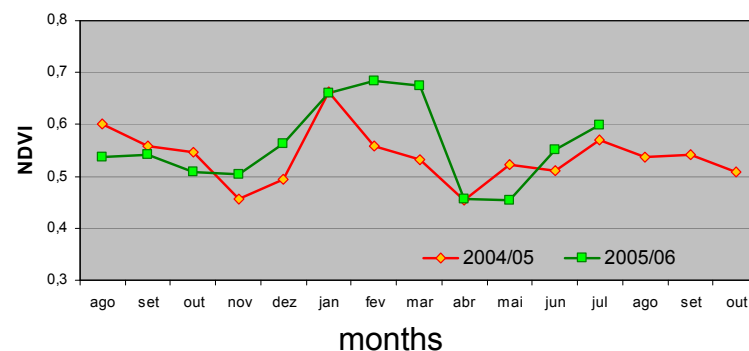
NOAA/AVHRR

Crop monitoring and yield estimations



Temporal NDVI profiles

PASSO FUNDO

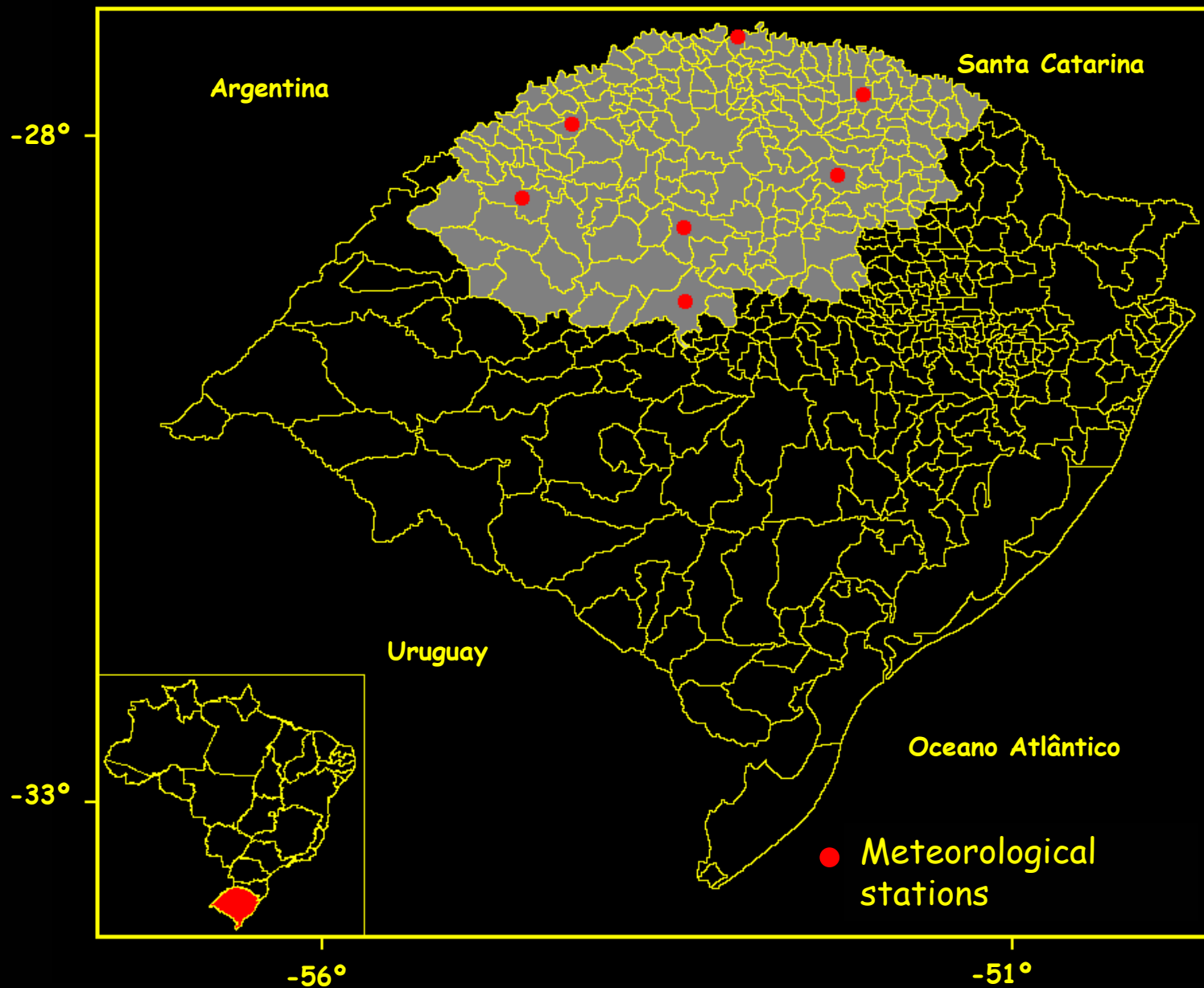


NOAA/AVHRR

Agrometeorological-Spectral Model

- Agrometeorological Term
Water and temperature conditions
- Spectral Term
Water and temperature conditions
and others: management, diseases,
pests, and other stress.

Rio Grande do Sul state and meteorological stations



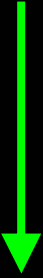
Agrometeorological-spectral Model

Bianchi et al. (2006)

$$Y = Y_m \times (aAT + bST)$$

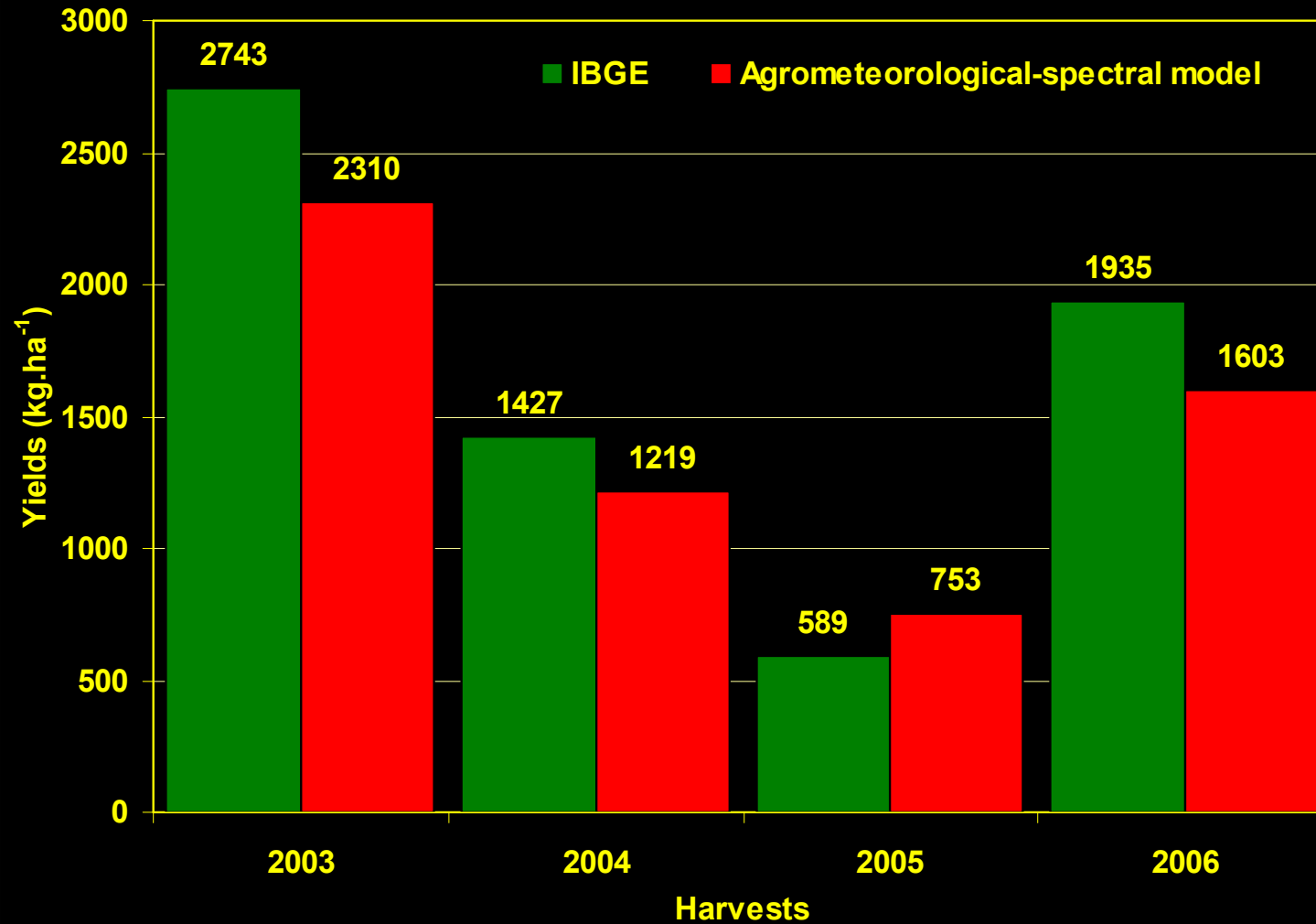


Agrometeorological Term



Spectral Term

Soybean yield estimates



Problem to crop yield estimations

Lack of meteorological data
to feed the model

Alternative

Simulation meteorological data

Results presented in JRC workshop Montevideo - October 2006

Melo e Fontana (2006)

Objective:

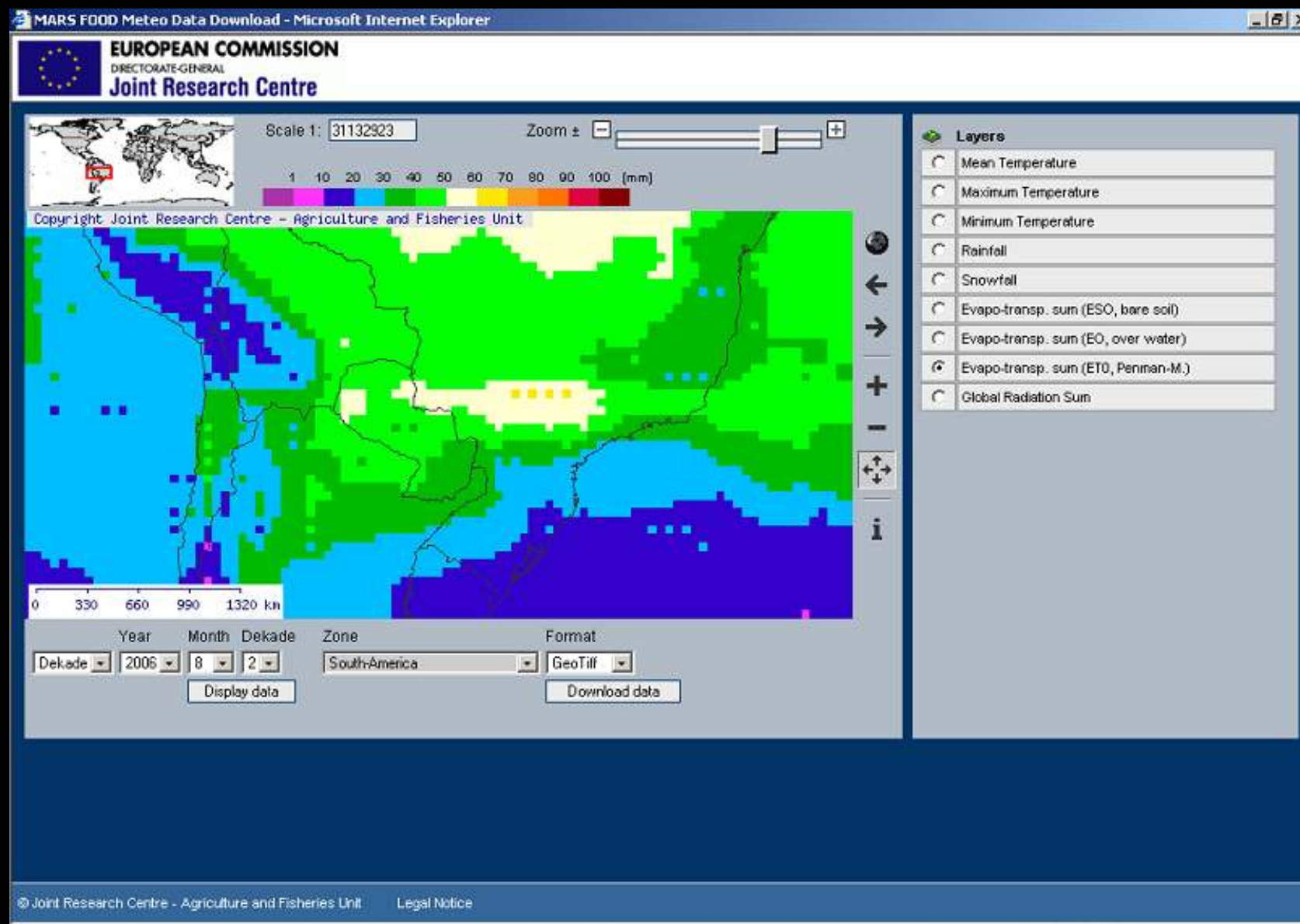
- a) to compare ECMWF simulated data to observed data at surface meteorological stations;
- b) to evaluate the use of simulated data in the soybean yield model in Rio Grande do Sul State, Brazil

Meteorological data:

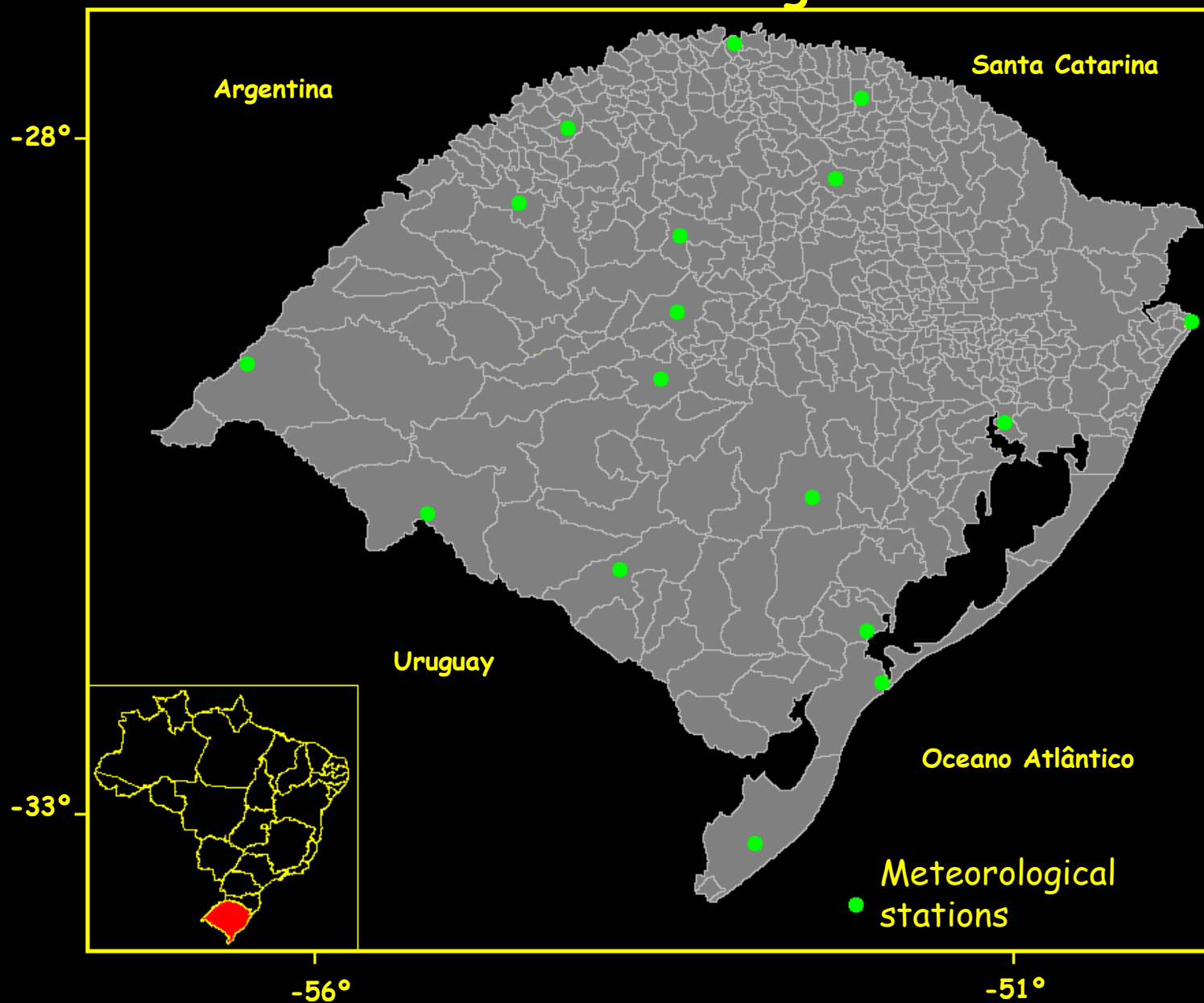
- Maximum Temperature ($^{\circ}\text{C}$)
- Minimum Temperature ($^{\circ}\text{C}$)
- Mean Temperature ($^{\circ}\text{C}$)
- Rainfall (mm)
- Evapotranspiration (mm)

10-days periods from 2003/01/01 to 2005/12/31

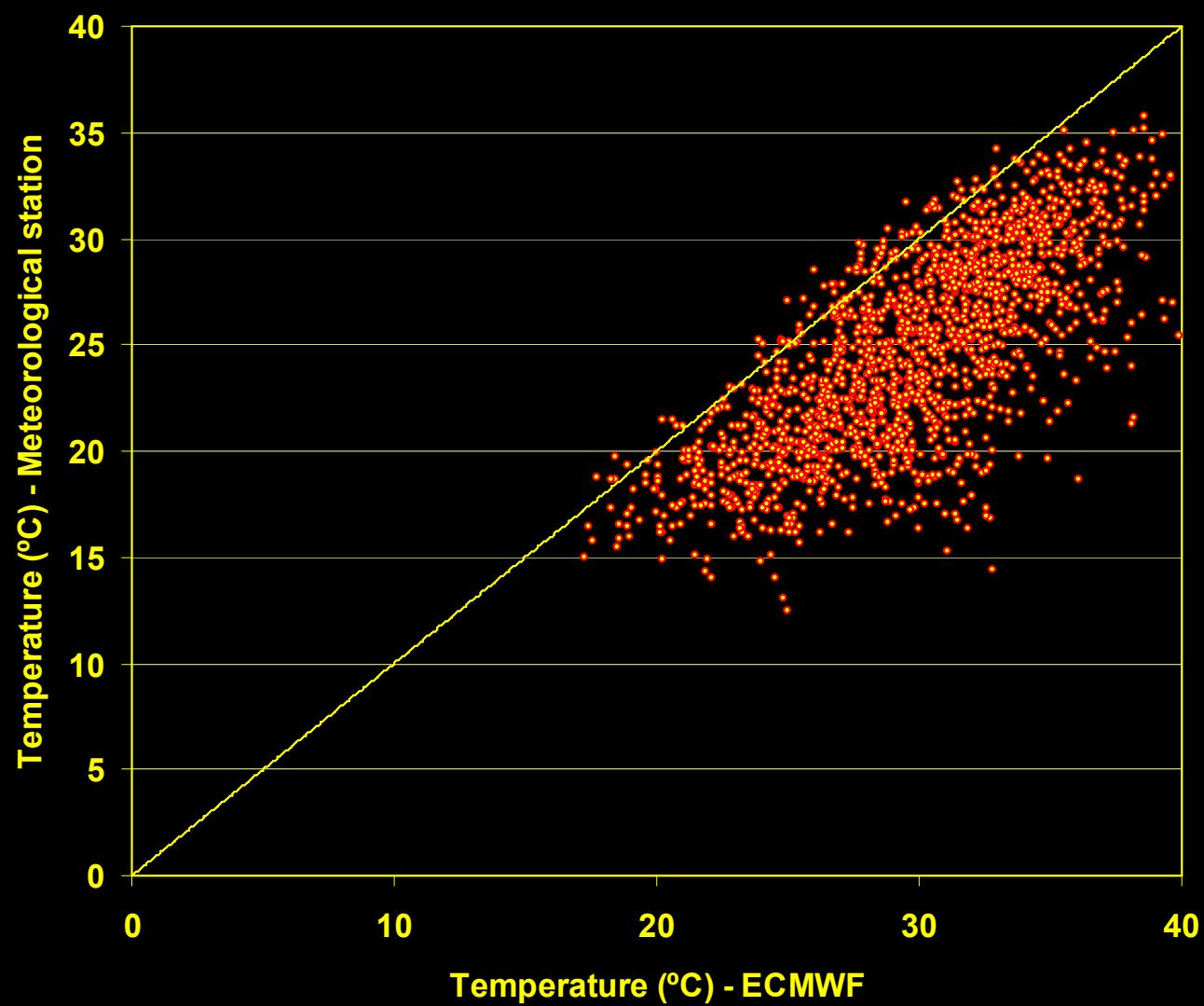
Simulated ECMWF data



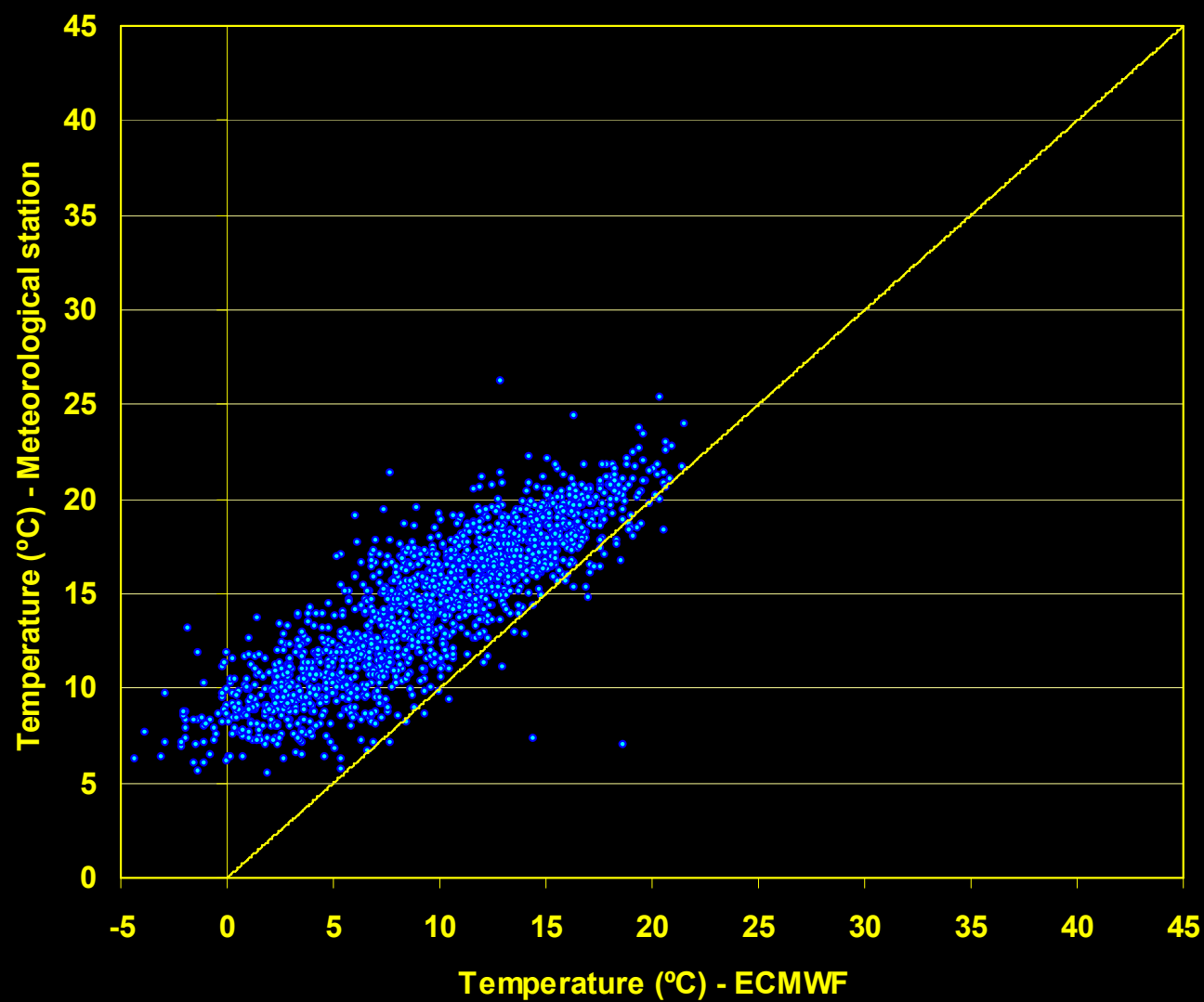
Observed meteorological data



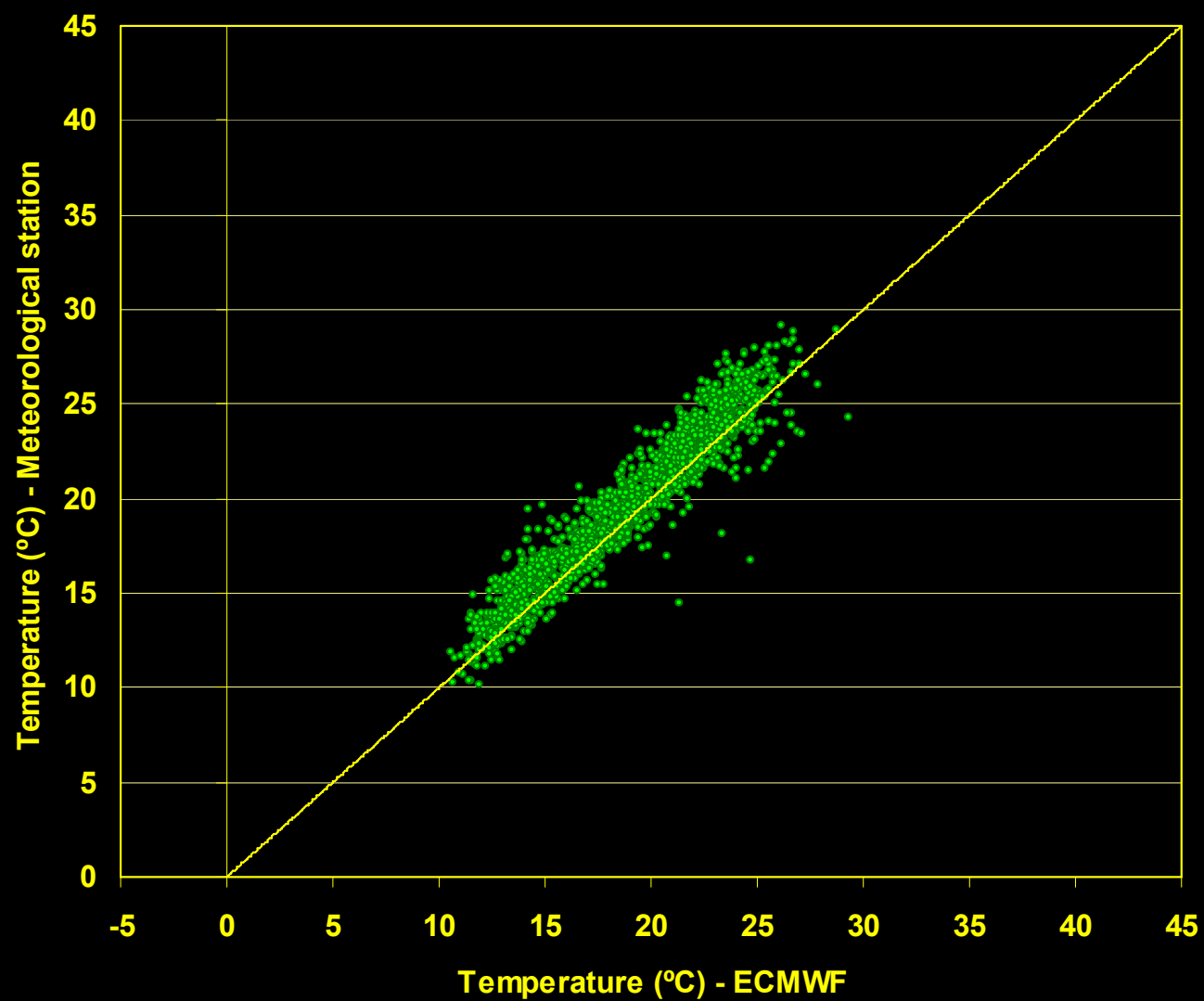
MAXIMUM TEMPERATURE



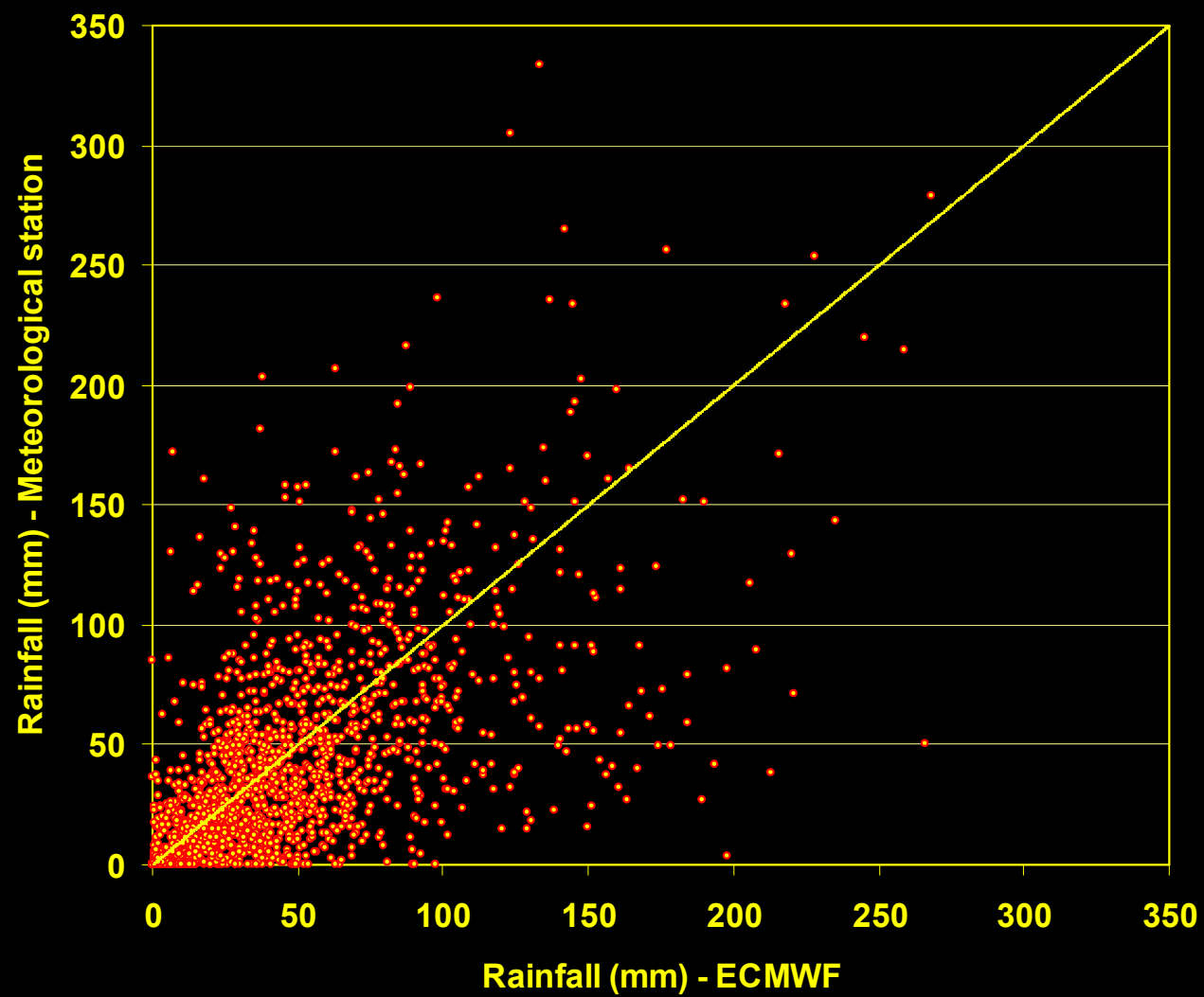
MINIMUM TEMPERATURE



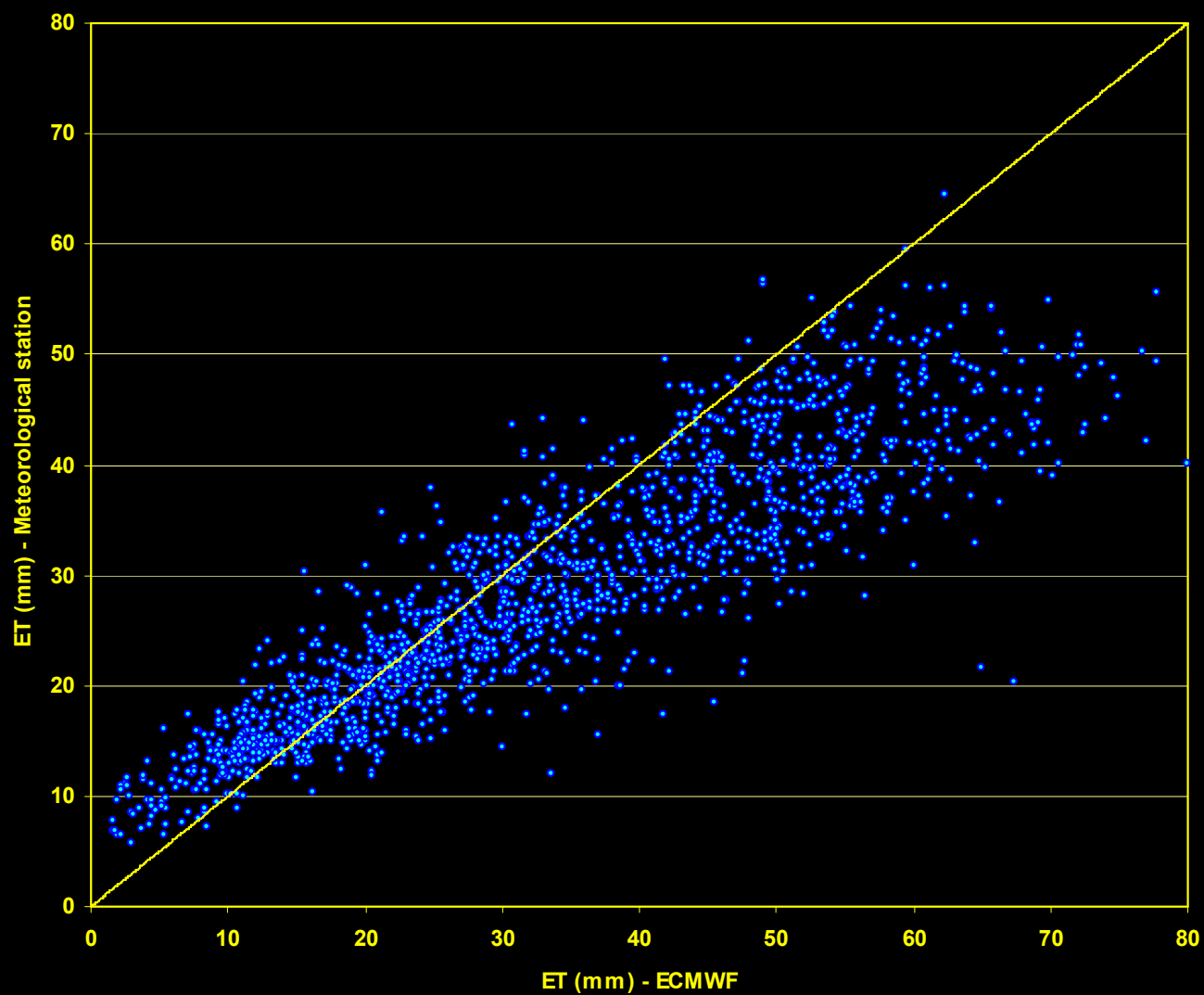
MEAN TEMPERATURE



RAINFALL

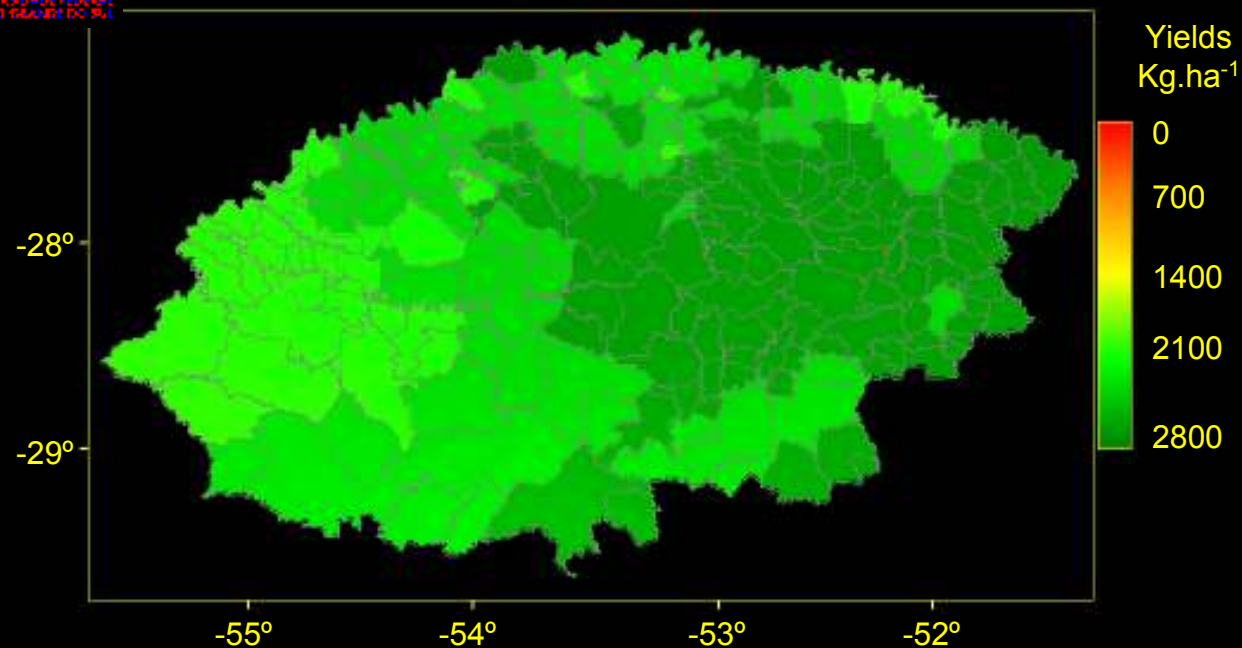


EVAPOTRANSPIRATION





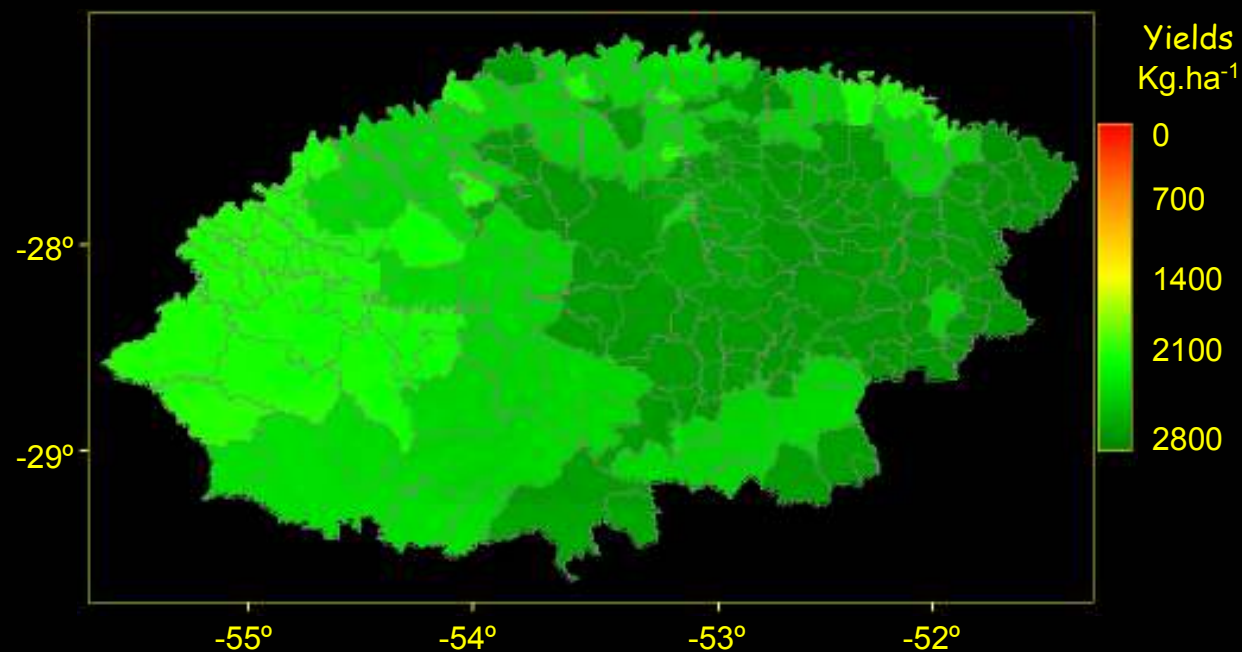
Soybean yield estimations using ground and ECMWF data



2003

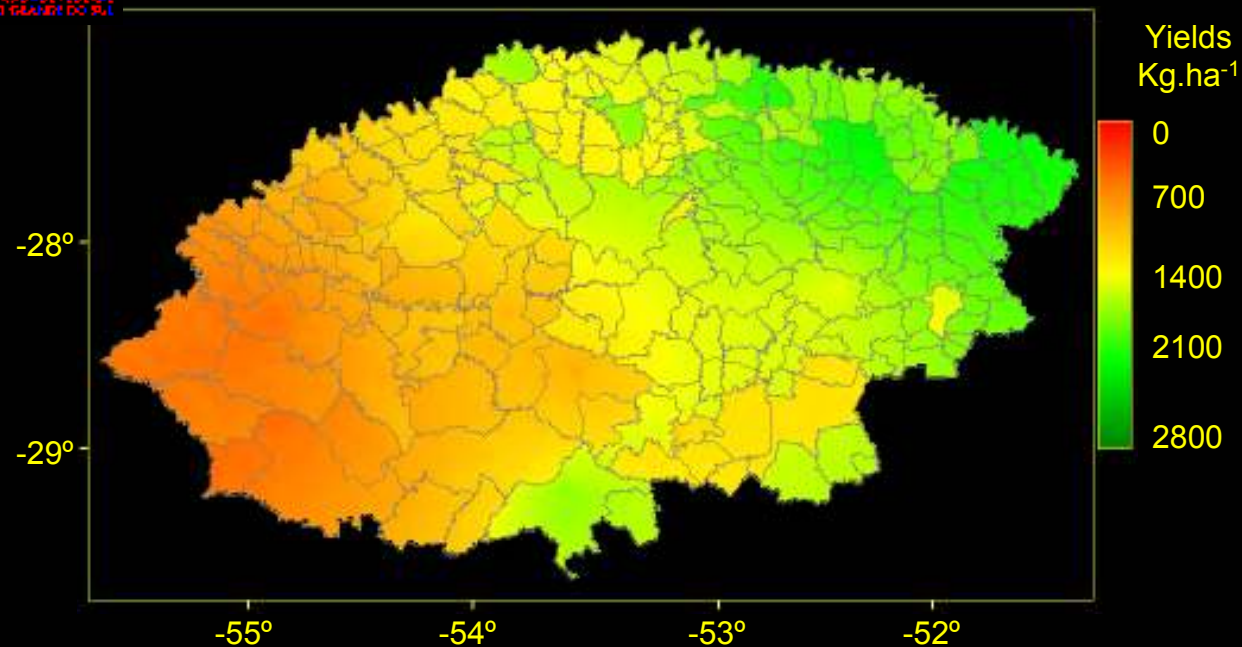
Meteorological data

Mean Yield
2310 kg.ha⁻¹



ECMWF

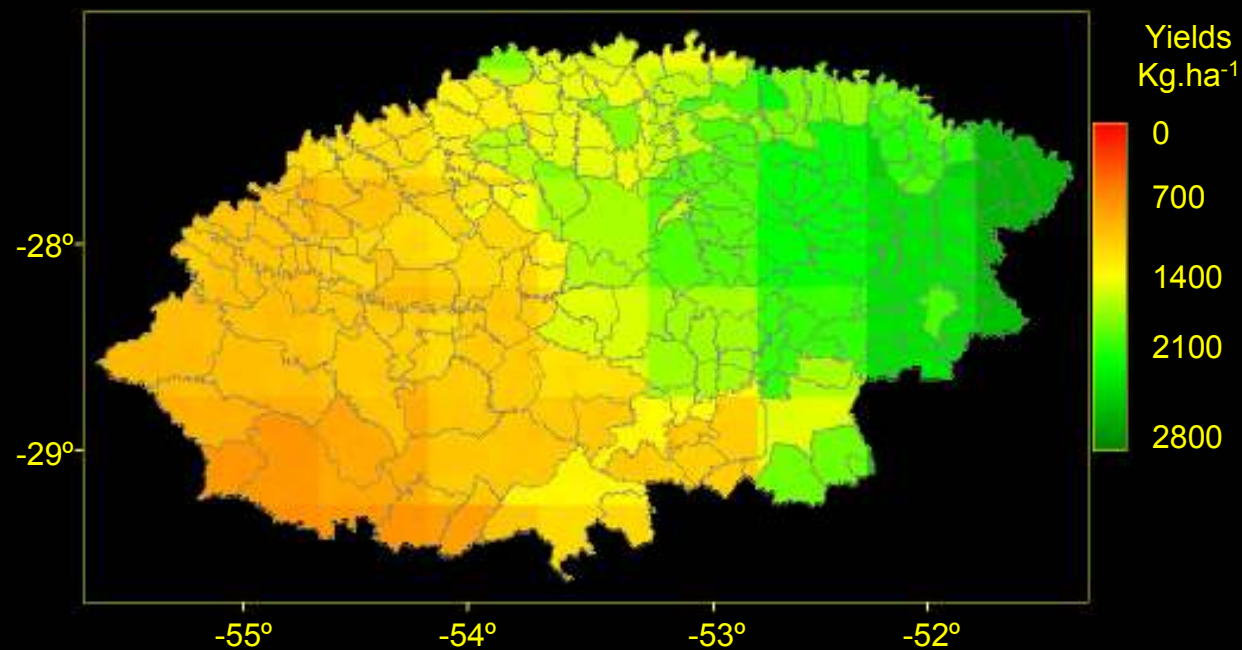
Mean Yield
2359 kg.ha⁻¹



2004

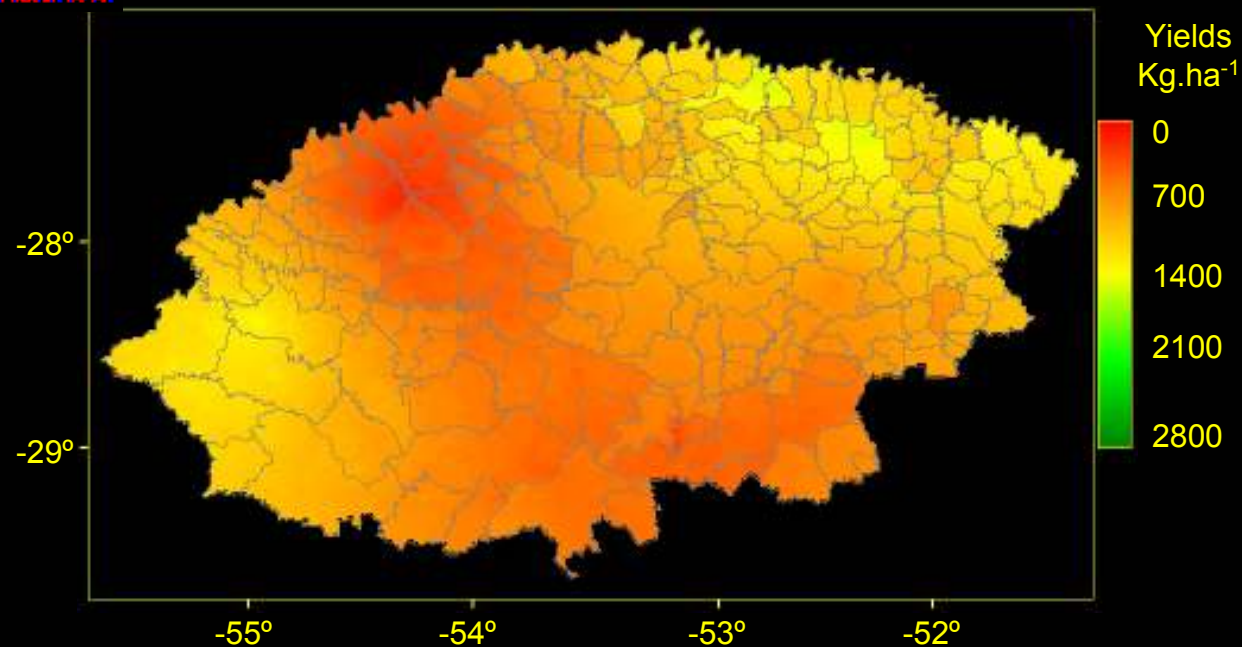
Meteorological data

Mean Yield
1219 kg.ha⁻¹



ECMWF

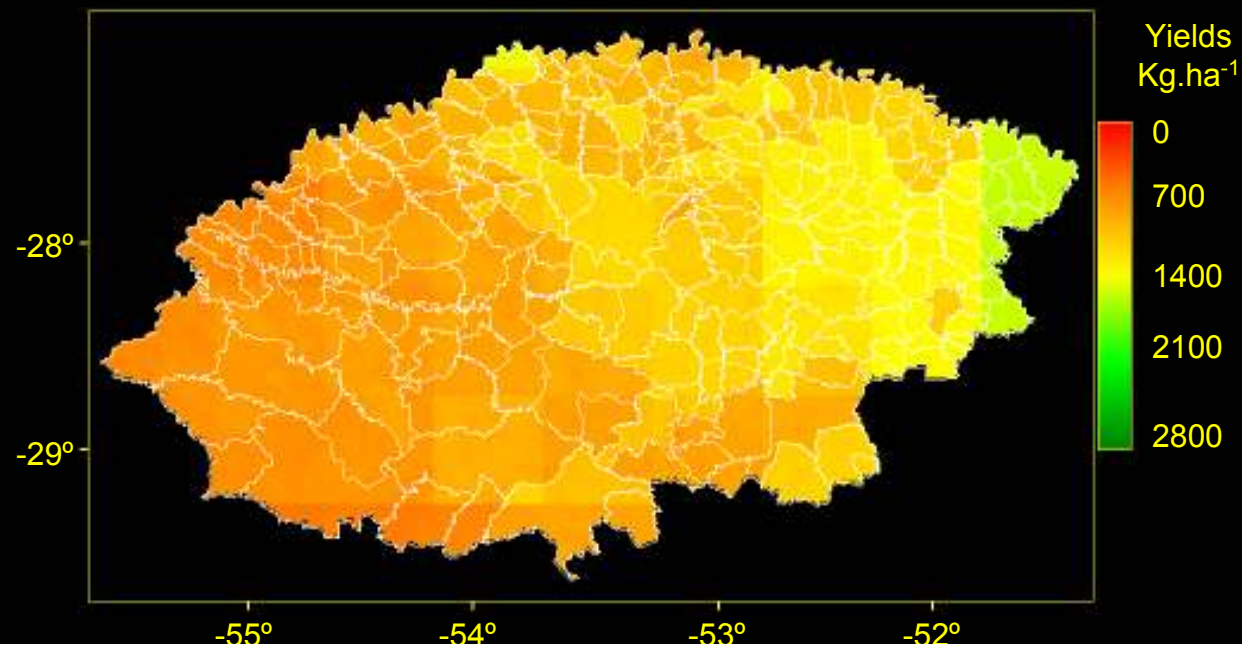
Mean Yield
1379 kg.ha⁻¹



2005

Meteorological data

Mean Yield
753 kg.ha^{-1}



ECMWF

Mean Yield
920 kg.ha^{-1}

Final Considerations

- Success of the Geosafras project (UFRGS - CONAB)
- Objectivity, accuracy, low cost and practicality of the estimations
- Need of continued improvement
- Experience exchanges are welcome

Thanks!