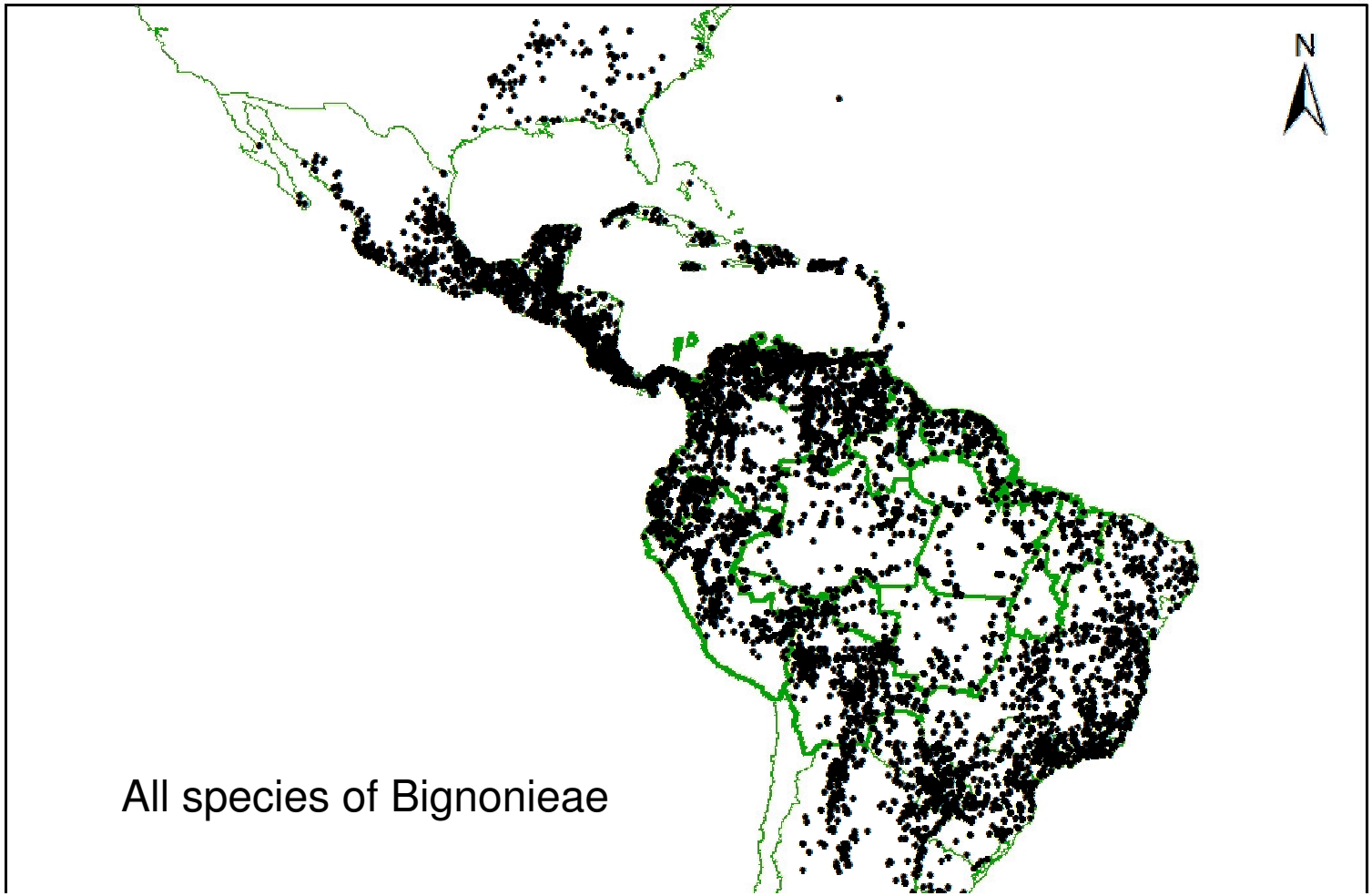
CODATA 2007 - ***Strategies for Open and Permanent Access to Scientific Information in Latin America: Focus on Health and Environmental Information for Sustainable Development***

Environmental satellite data: Applications for the study of the physical environment and biodiversity

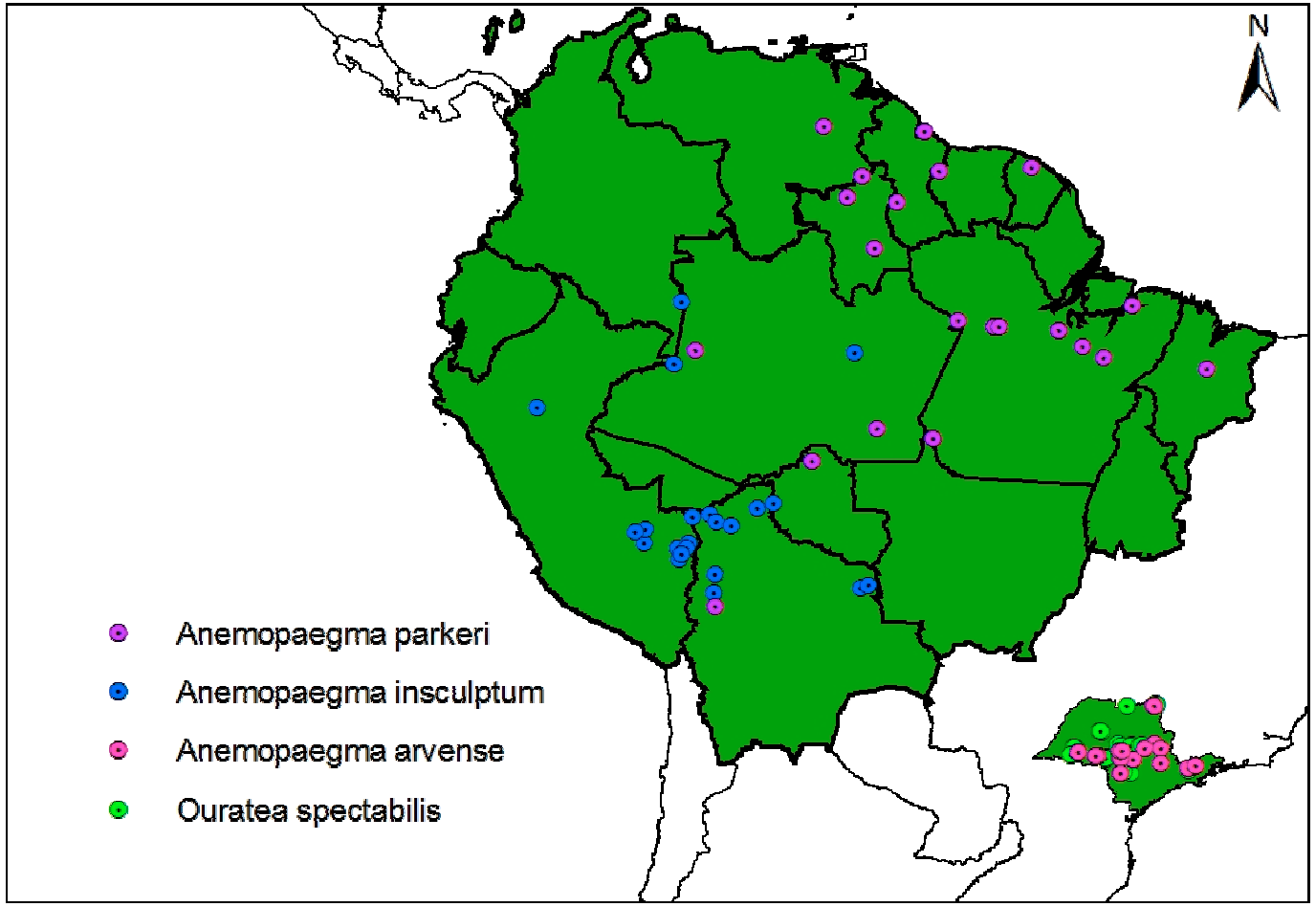
Marinez F. de Siqueira, *CRIA,*
Angélica Giarolla, *CPTEC/INPE,*
Lúcia G. Lohmann, *IB-USP, Brazil*

Biodiversity: Database of Bignonieae (Dr. Lúcia Lohmann – USP/Brazil)

~400 species >29.000 occurrence records



Biodiversity: database of Bignonieae (Dr. Lúcia Lohmann – USP/Brazil) 3 species of *Anemopaegma* and 1 species of *Ouratea* **Ochnaceae** (Dr Marinez Siqueira – CRIA/Brazil) were selected



Different species have different ecological/environmental needs. Amazonian species are inside an area with relatively homogeneous climatic and topographic conditions. Species from São Paulo (sub-tropical zone) are inside an area with variable temperature and precipitation throughout the year.

Biodiversity: database of Bignonieae (Dr. Lúcia Lohmann – USP/Brazil)
- 3 species of *Anemopaegma* and 1 species of *Ouratea* **Ochnaceae** (Dr. Marinez Siqueira CRIA/Brazil) were selected

Anemopaegma parkerii - Amazonian liana, especially common in humid and tall forests. Yet, it reaches the forest canopy where the conditions are quite dry and arid.

Anemopaegma insculptum - Amazonian liana, especially common in humid and tall forests. Yet, it reaches the forest canopy where the conditions are quite dry and arid.

Anemopaegma arvense - Shrubby species from dry areas. It is especially common in open vegetation types such as “cerrados” and rocky outcrops.

Ouratea spectabilis – Tree species from Brazilian savannahs (cerrado). Occurs preferentialy in open areas.

Experiment: verify which environmental layers are more important for the four species selected.

Environmental layers used in the experiment (Amazon and São Paulo):

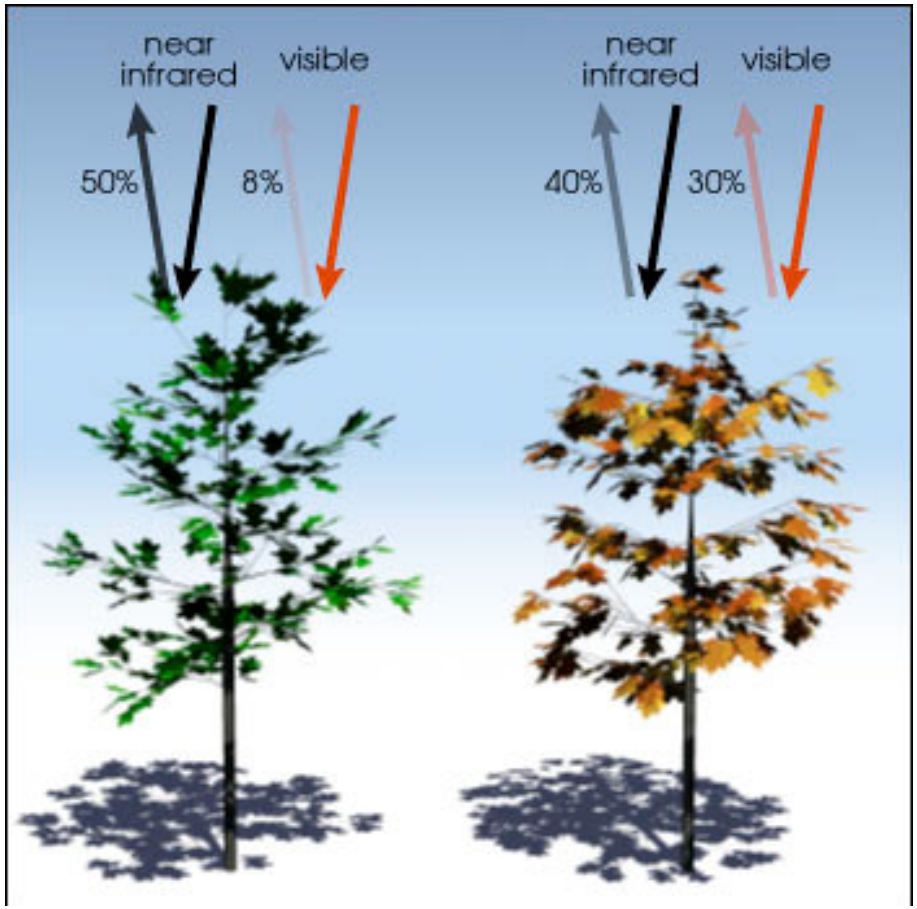
- Maximum temperature (monthly - 12 layers) resolution: ~800m (source Worldclim)
- Minimum temperature (monthly – 12 layers) resolution: ~800m (source Worldclim)
- Precipitation (monthly - 12 layers) resolution: ~800m (source Worldclim)
- Altitude (1 layer) resolution: ~800m (source Worldclim)
- Topographic (6 layers) resolution: ~1Km (source Hidro_1k)
- NDVI (mosaic of sixteen days - 22 layers) resolution: 250m (source (NASA/EOS) processed by (INPE)
- EVI (mosaic of sixteen days – 22 layers) resolution: 250m (source (NASA/EOS) processed by (INPE)

87 layers were used to model species niches

NDVI (Normalized Difference Vegetation Index): In order to determine the density of green in a particular area, researchers must observe distinct colors (wavelengths) of visible and near-infrared sunlight reflected by the plants.

EVI (Enhanced Vegetation Index): This index improves with the quality of the NDVI. EVI is calculated similarly to NDVI and corrects for some distortions in the reflected light caused by particles in the air as well as by the ground cover below the vegetation.

NDVI: it´s used to estimates vegetation biophysical parameters, such as leaf area index, biomass, productivity and photossintetic active



EVI: this index has better answers to the structural variations of the canopy, including leaf area index, canopy type, plant physiognomy, and canopy architecture.

NDVI x EVI

The Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Index (VI) products can be used to monitor photosynthetic activity.

Two MODIS VIs, the normalized difference vegetation index (NDVI) and the enhanced vegetation index (EVI), are produced globally over land at 1 km and 500 m resolutions, and over limited areas at 250m, every 16 days.

Whereas the NDVI is chlorophyll sensitive, the EVI is more responsive to canopy structural variations, including leaf area index (LAI), canopy type, plant physiognomy, and canopy architecture.

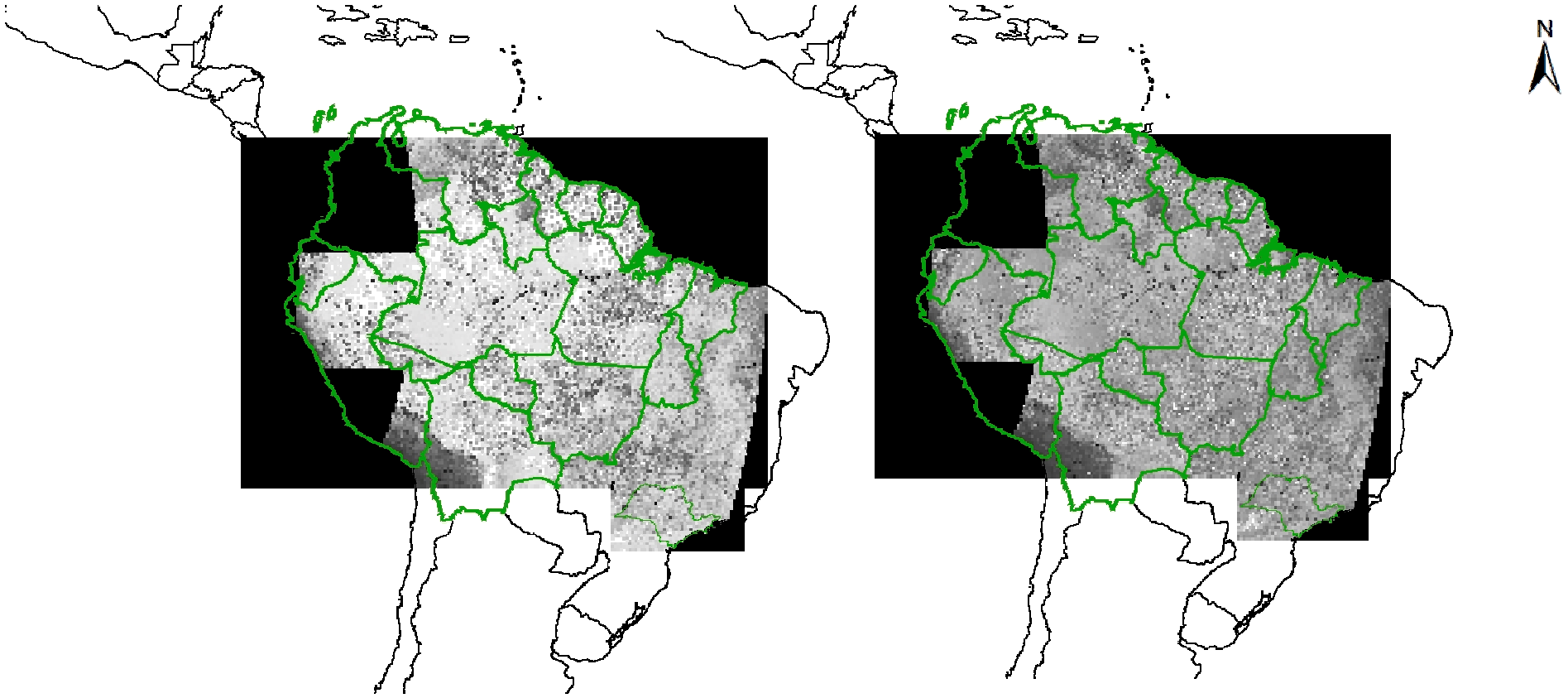
The two VIs complement each other in global vegetation studies and improve upon the detection of vegetation changes and extraction of canopy biophysical parameters.

The enhanced vegetation index (EVI) is an 'optimized' vegetation index with improved sensitivity in high biomass regions and improved vegetation monitoring through a de-coupling of the canopy background signal and a reduction in atmosphere influences

Examples of images of NDVI and EVI

NDVI

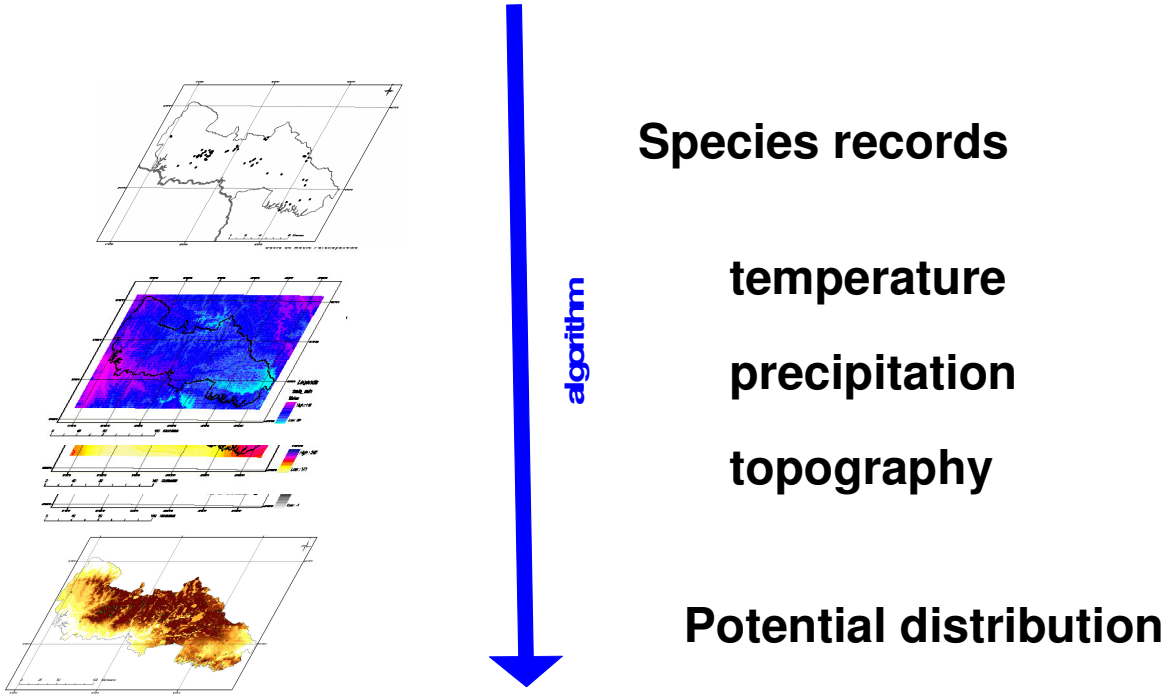
EVI



44 layers (NDVI and EVI) >25 GB of information only for this region

Methods

- Data were clipped for the study area (Amazonia and the state of São Paulo)
- All layers were reclassified in cell size ~ 9Km (for the Amazon) and ~5 Km (for São Paulo).
- Niche modeling techniques were applied for the selected species (see below)
- The main layers for each species were selected through jackknife (re-sampled techniques) Tukey (1958) available in Maxent software.

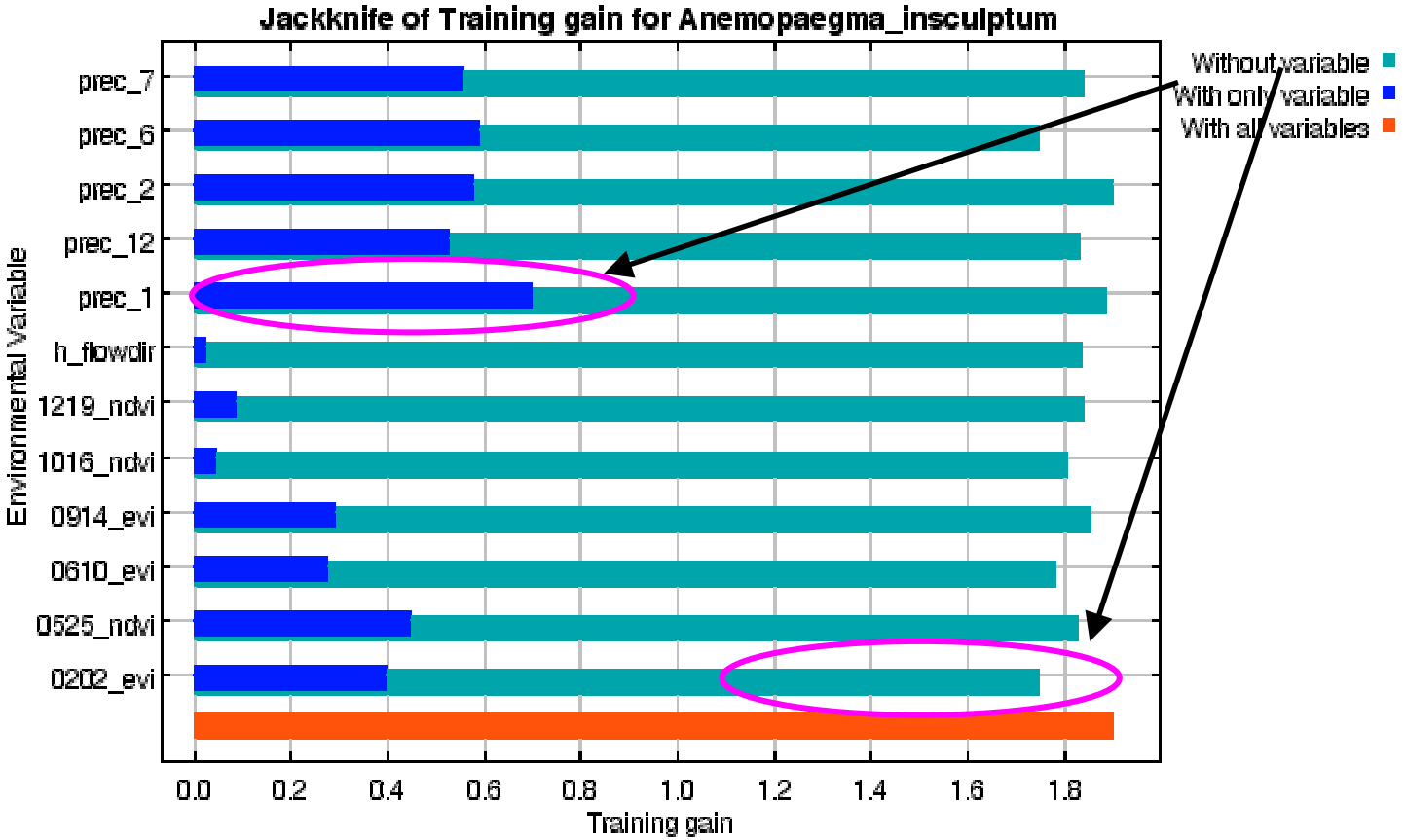


Analysis of variable importance

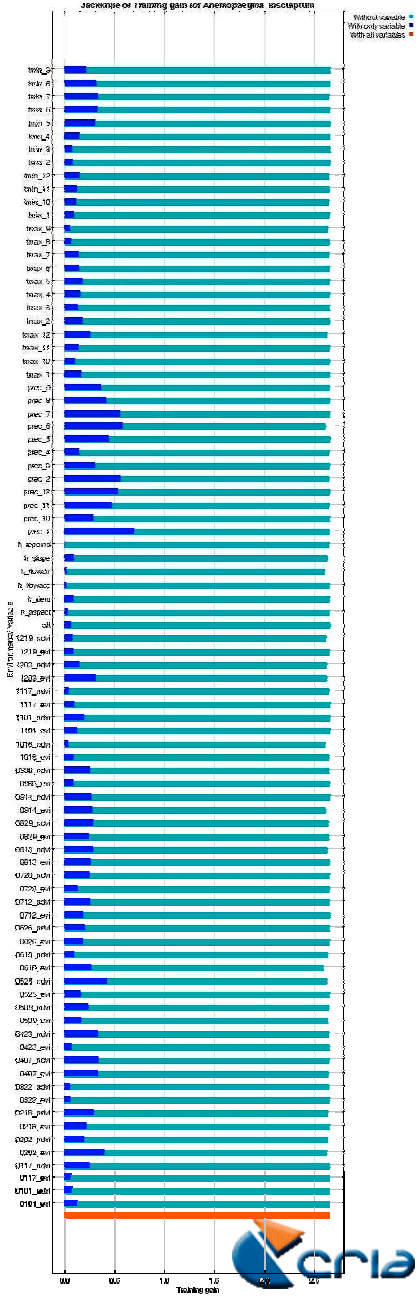
• The following picture shows the results of the Jackknife test relating to the analysis of variable importance. The environmental variable with the highest gain (when used in isolation) is **prec_1**, indicating that this variable appears to have the highest amount of information when used in isolation.

• On the other hand, the environmental variable that mostly decreases gain when omitted is **0202_evi**, indicating that this variable has the highest amount of information that is not present in other variables.

12 layers selected



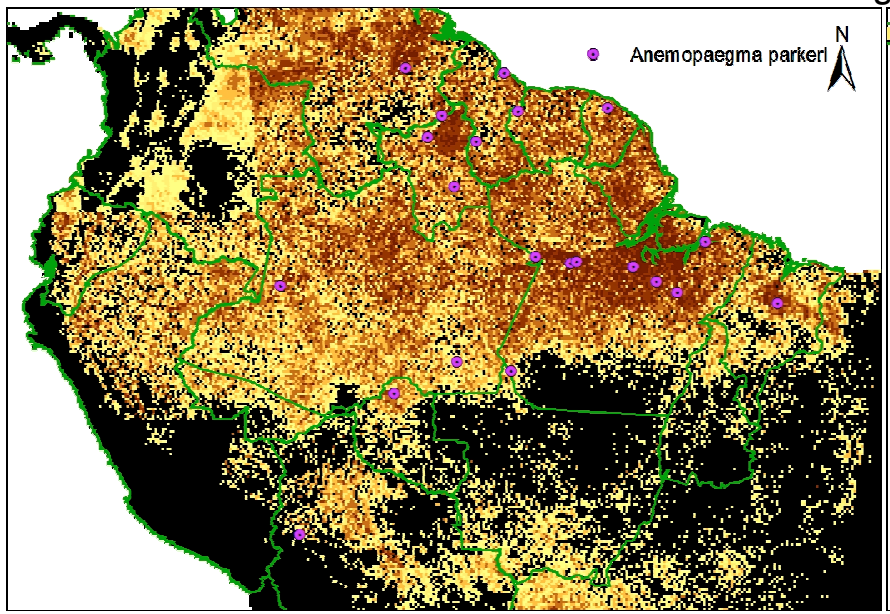
Jackknife (87 layers)



Anemopaegma parkerii – Amazonian species

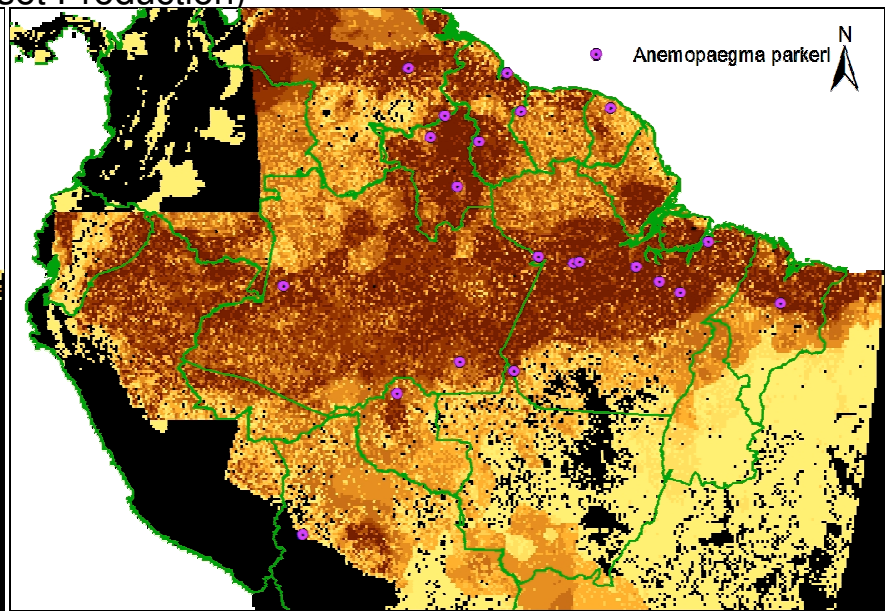
- 87 original layers (12 layers selected by jackknife techniques)
- 31 presence points used

Maxent (Maximum Entropy)



AUC=0.998

GARP - openmodeller (Genetic Algorithm for Rule-set Production)



AUC=0.90

Selected layers

Altitude	**Apr2_EVI**
Prec May	**Jun1_NDVI**
Tmin Apr	**Apr1_EVI**
Prec Nov	**Aspect**
Tmin May	**Dec1_NDVI**
May1_NDVI	**Water_flow_dir**

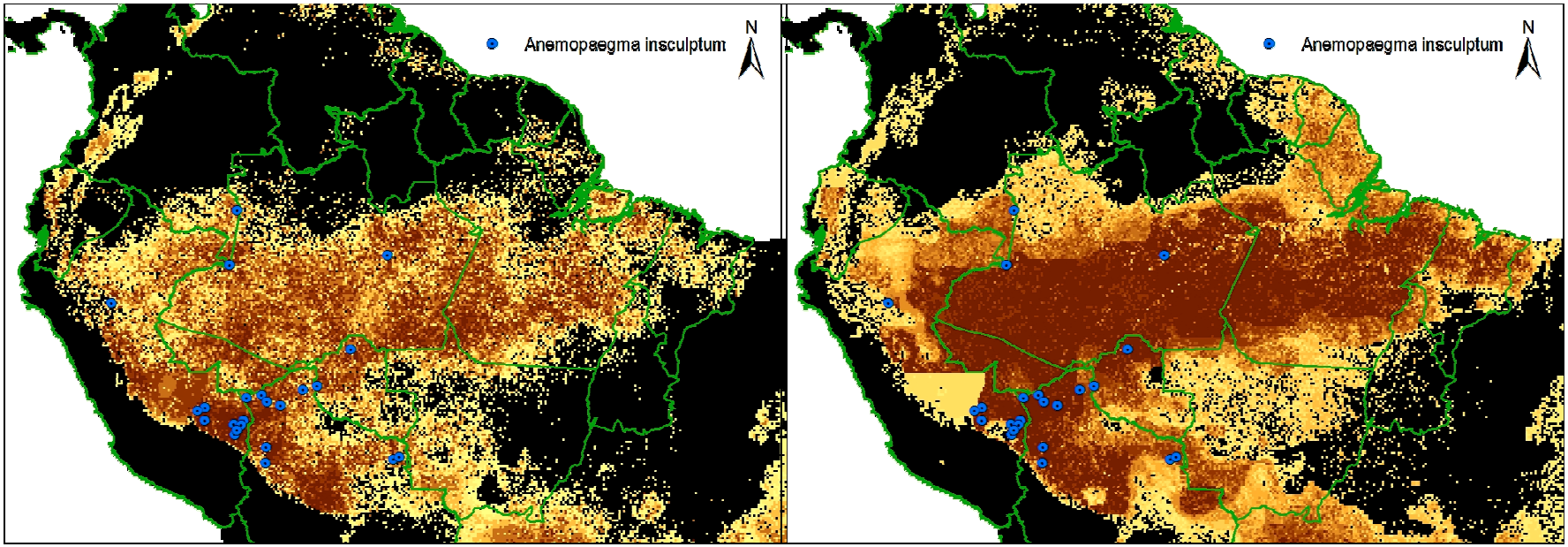
Five layers of vegetation index were selected for this species

Anemopaegma insculptum – Amazonian species

- 87 original layers (12 layers selected by jackknife techniques)
- 27 presence points used

Maxent (Maximum Entropy)

GARP - openmodeller (Genetic Algorithm for Rule-set Production)



AUC=0.957

AUC=0.86

Selected layers

Prec Jan	**Feb1_EVI**
Prec Jun	**Jun1_EVI**
Prec Feb	**Oct1_EVI**
Prec Jul	**Oct2_NDVI**
Prec Dec	**Sep1_EVI**
May2_NDVI	**Water_flow_dir**

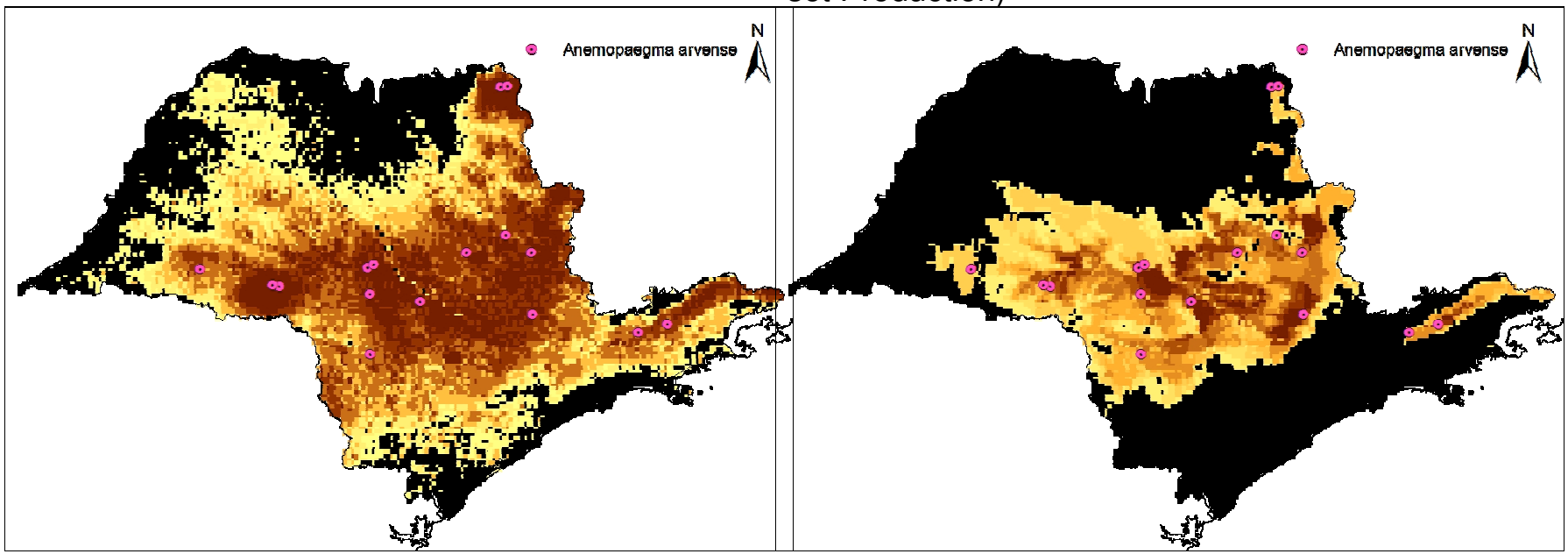
Six layers of vegetation index were selected for this species

Anemopaegma arvense – Species from São Paulo

- 87 original layers (12 layers selected by jackknife techniques)
- 17 presence points used

Maxent (Maximum Entropy)

GARP - openModeller (Genetic Algorithm for Rule-set Production)



AUC=915

Selected layers

Tmax_sep	**Prec_apr**
Tmax_jul	**Prec_feb**
Tmax_ago	**Prec_jan**
Tmin_apr	**Water_flow_dir**
Tmin_nov	**Prec_jun**
Tmax_may	**Water_flow_acc**

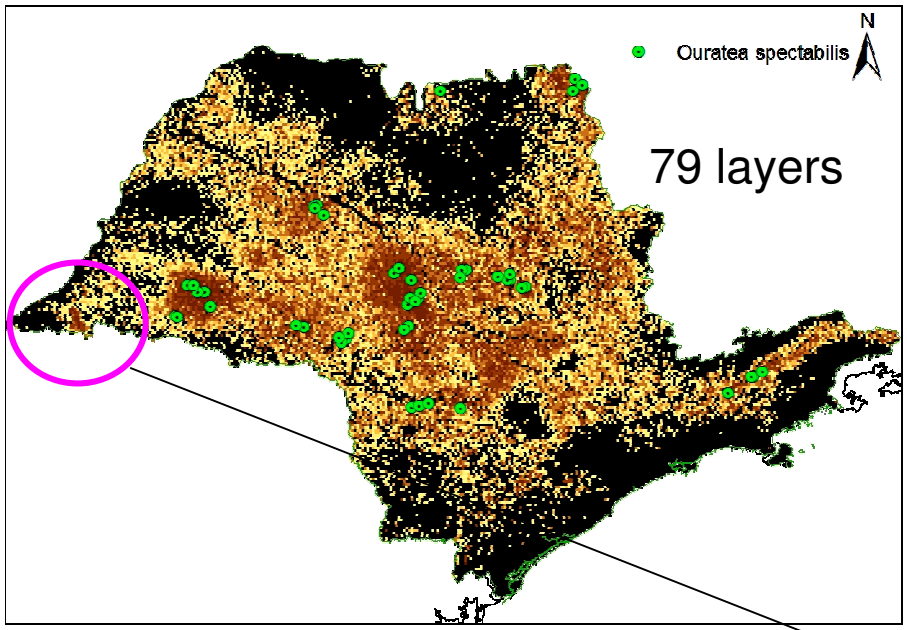
AUC=0.950

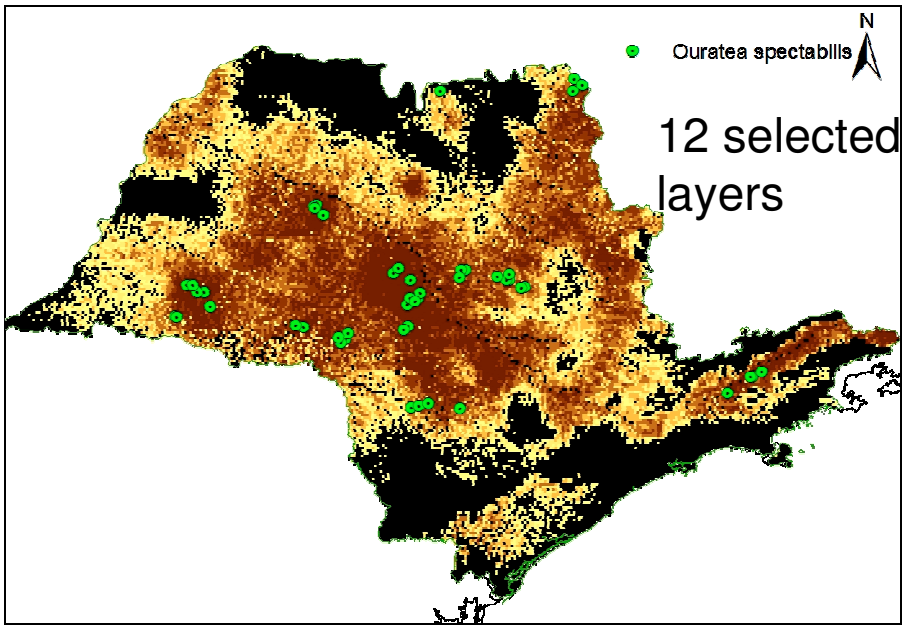
No layers of vegetation index for this species

Ouratea spectabilis – Cerrado species - São Paulo

- 79 original layers (12 layers selected by jackknife techniques)
- 49 presence points used

Maxent (Maximum Entropy)

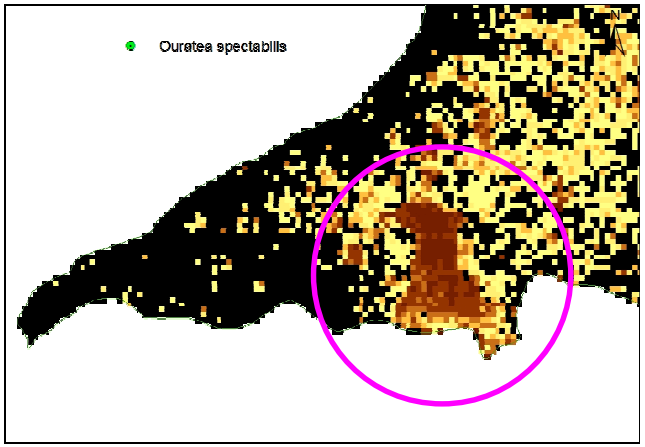




AUC=980

Selected layers

Tmean_jun	**Prec_jan**
Tmean_may	**Prec_apr**
Prec_sep	**017_evi**
Tmean_jul	**Prec_oct**
Tmean_apr	**Water_flow_acc**
Tmean_sep	**Aspect**



O. Spectabilis occurs in open areas in the Brazilian savannahs (cerrado)

The dark area represents Rain Forest (*O. spectabilis* doesn't occur there)

Take Home Messages

- Data from vegetation indexes are clearly needed in order to produce appropriate niche models for Amazonian species. Yet, additional tests are still necessary to confirm our results.

- The decision of which environmental layers are adequate for modeling varies a lot according on the study organism, question of interest, and scale of the study.

- In the case of Bignonieae (a group with nearly 400 species) we still have a lot of work to do!

- We currently need more comprehensive datasets. We will need better and better computers to be able to keep all the data and analyze it properly.

- We still need better tools to help decide which environmental layers are more suitable for particular studies. Ideally, openModeller should be able to automate the entire process (currently, we might take several days for a single species).

- A good selection of appropriate environmental layers is critical for niche modeling and for appropriate conservation decisions in the Amazon.

Thank you!!!

Questions?

marinez@cria.org.br

http://www.cria.org.br

http://openmodeller.sourceforge.net/