SimAmazonia-2, a basin-wide simulation model of Amazon landscape dynamics

Hermann Rodrigues, Britaldo Silveira Soares-Filho
Daniel Nepstad, William Leles Costa
hermann@csr.ufmg.br, britaldo@csr.ufmg.br,
dnepstad@whrc.org, william@csr.ufmg.br

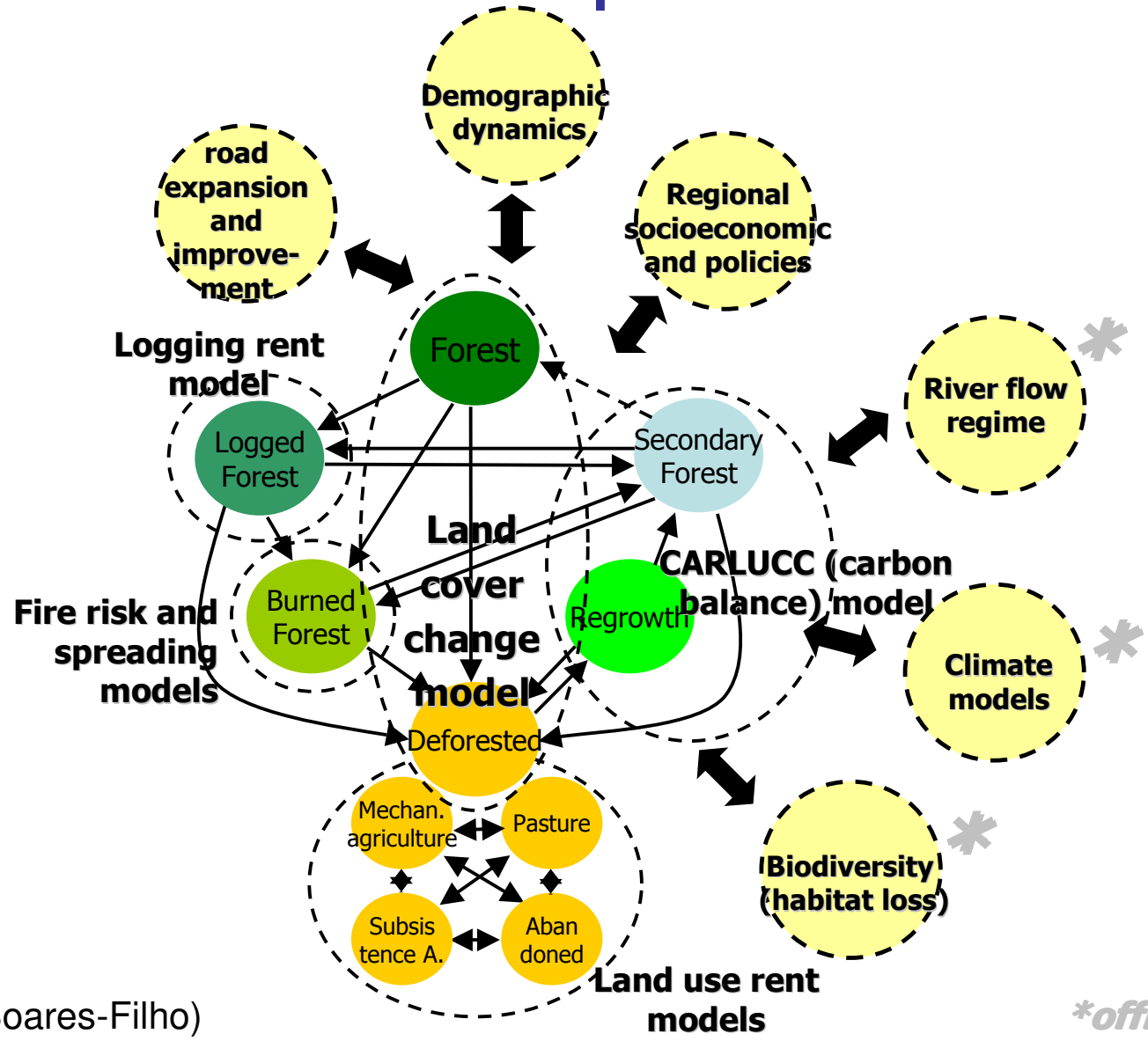
Universidade Federal de Minas Gerais

11th LBA-ECO Science Team Meeting in Salvador, Brazil, September 26-28, 2007

SimAmazonia 2

- SimAmazonia 2 consists of a series of models, which simulate the various processes that describe Amazon landscape dynamics

Concept View



(Source: Soares-Filho)

*offline interaction

Models

- **Deforestation model: responsive to public policies, migratory movements, infrastructure improvement, and cropland and cattle herd expansions ***
- Soybean crop rent model
- Cattle raising rent model

Models

- Economic logging model
- **Fire risk model** **
- CARLUCC: a model that simulates flows and sinks of carbon within the forest and from the forest to the atmosphere in response to climate change and forest disturbance

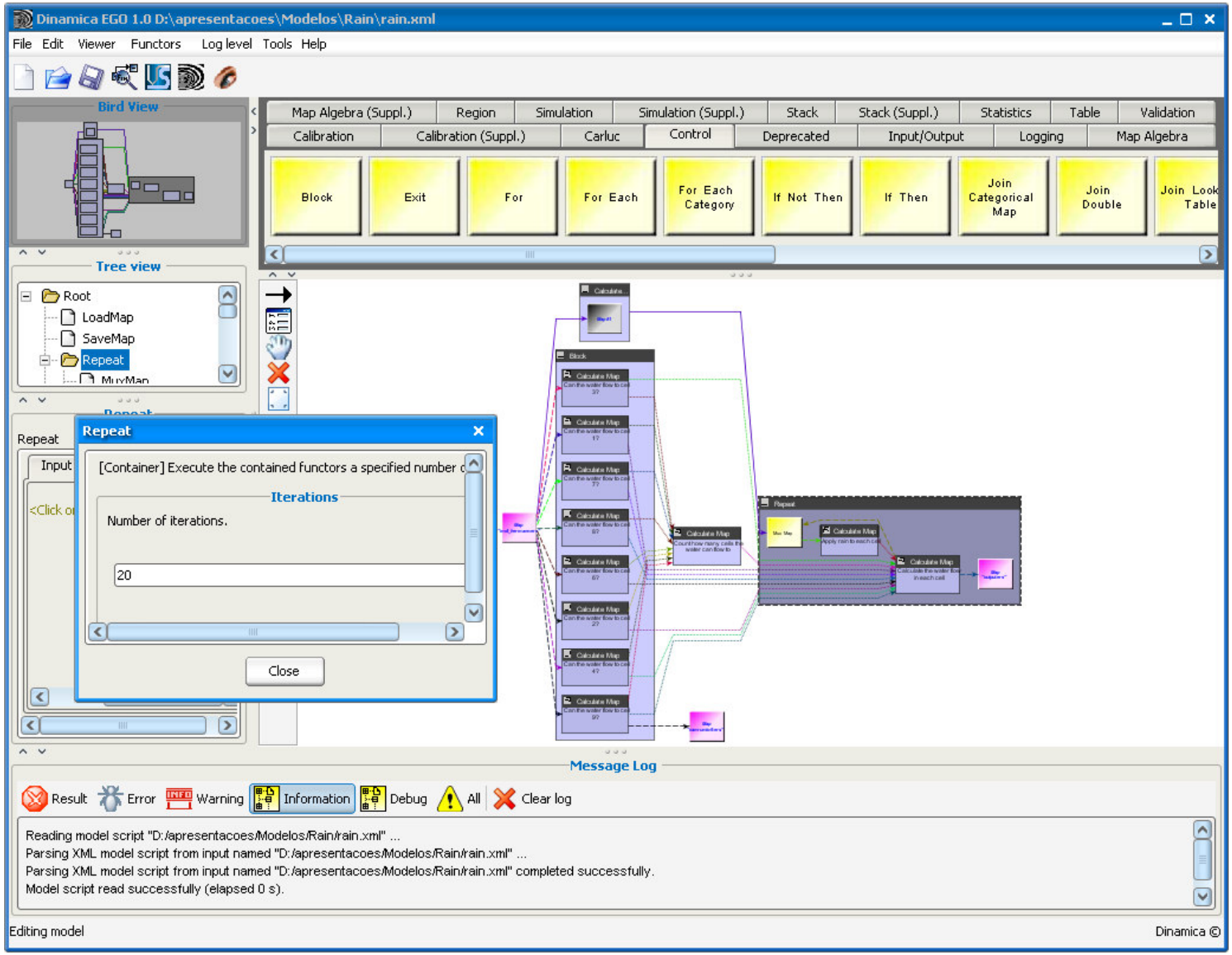
Implementation

- All models run simultaneously, exchanging data among themselves and employing together, as input, over a hundred maps at 2x2 km^2 raster resolution, each one composed of 2103x1561 cells
- Potential problems:
  - Complexity
  - Poor performance
  - Bad memory management
- Solution:
  - Choose the underlying simulation platform carefully.

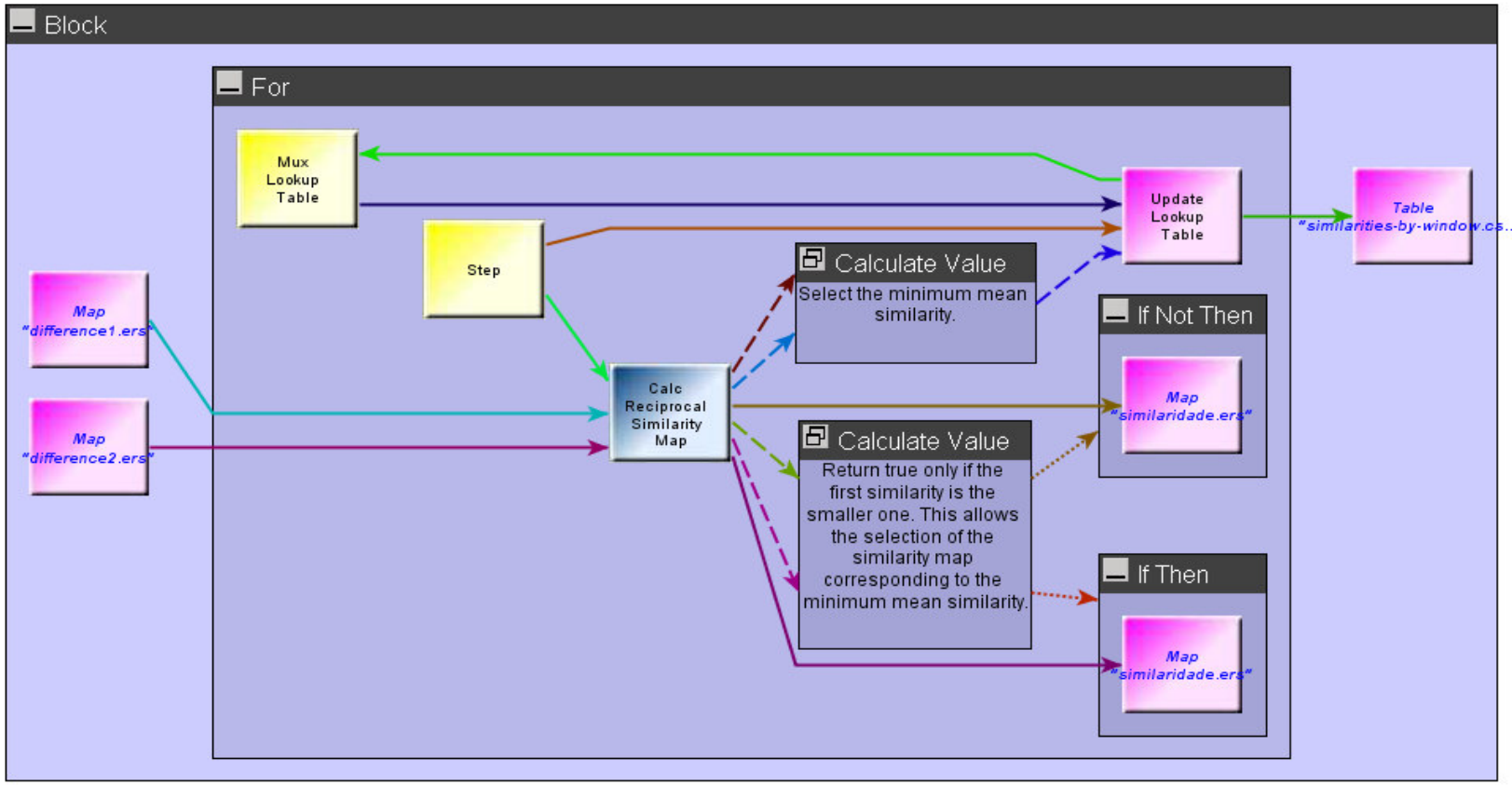
Dinamica EGO

- **E**nvironment for **G**eoprocessing **O**bjects.
- Spatially explicit simulation model of landscape dynamics.
- Tool to investigate trajectory of landscapes and dynamics of spatial phenomena.
- Platform used to implement SimAmazonia 2.

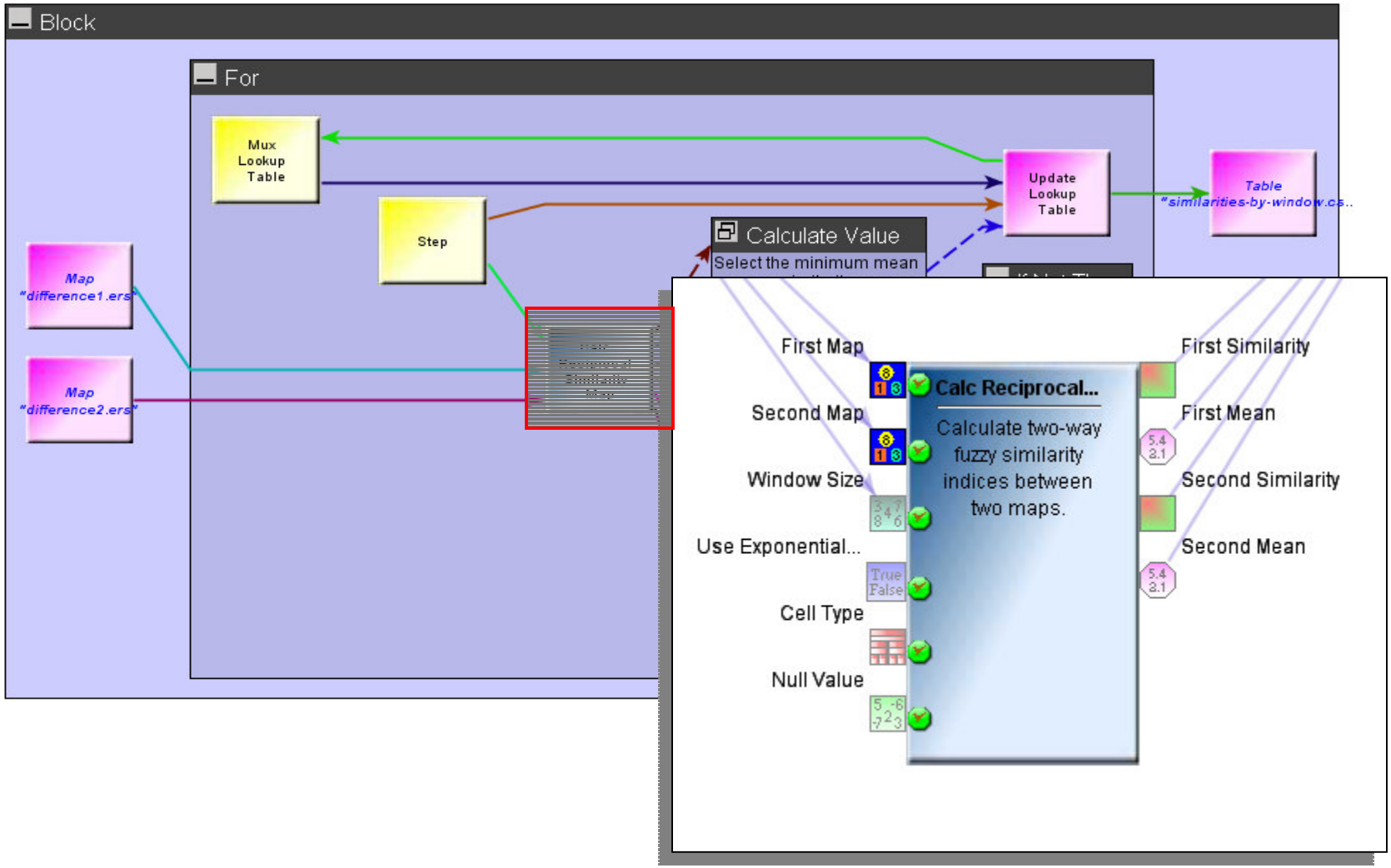
Dinamica EGO



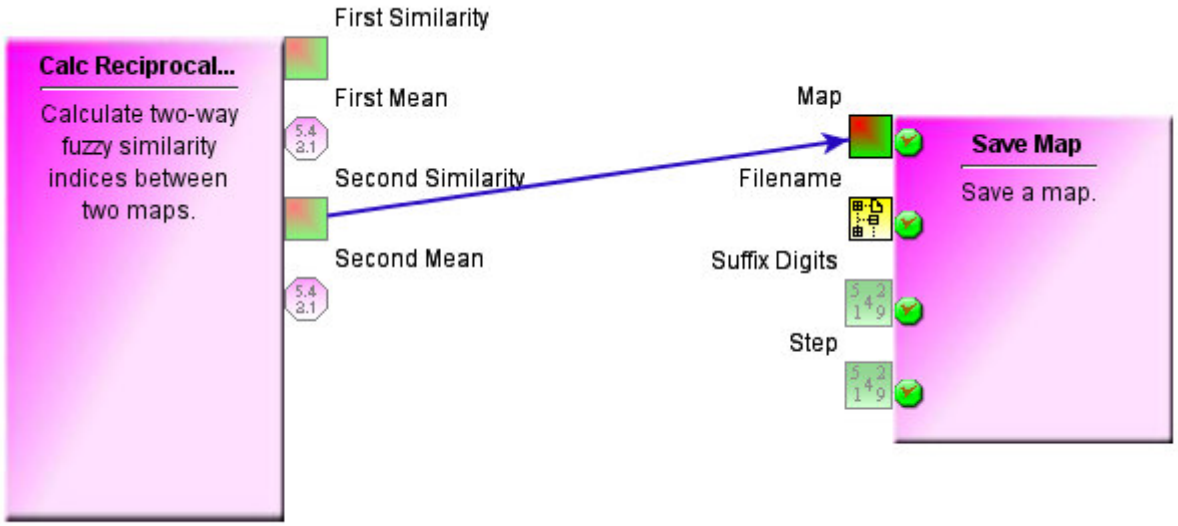
Dinamica EGO: In pratical terms is a dataflow programming language



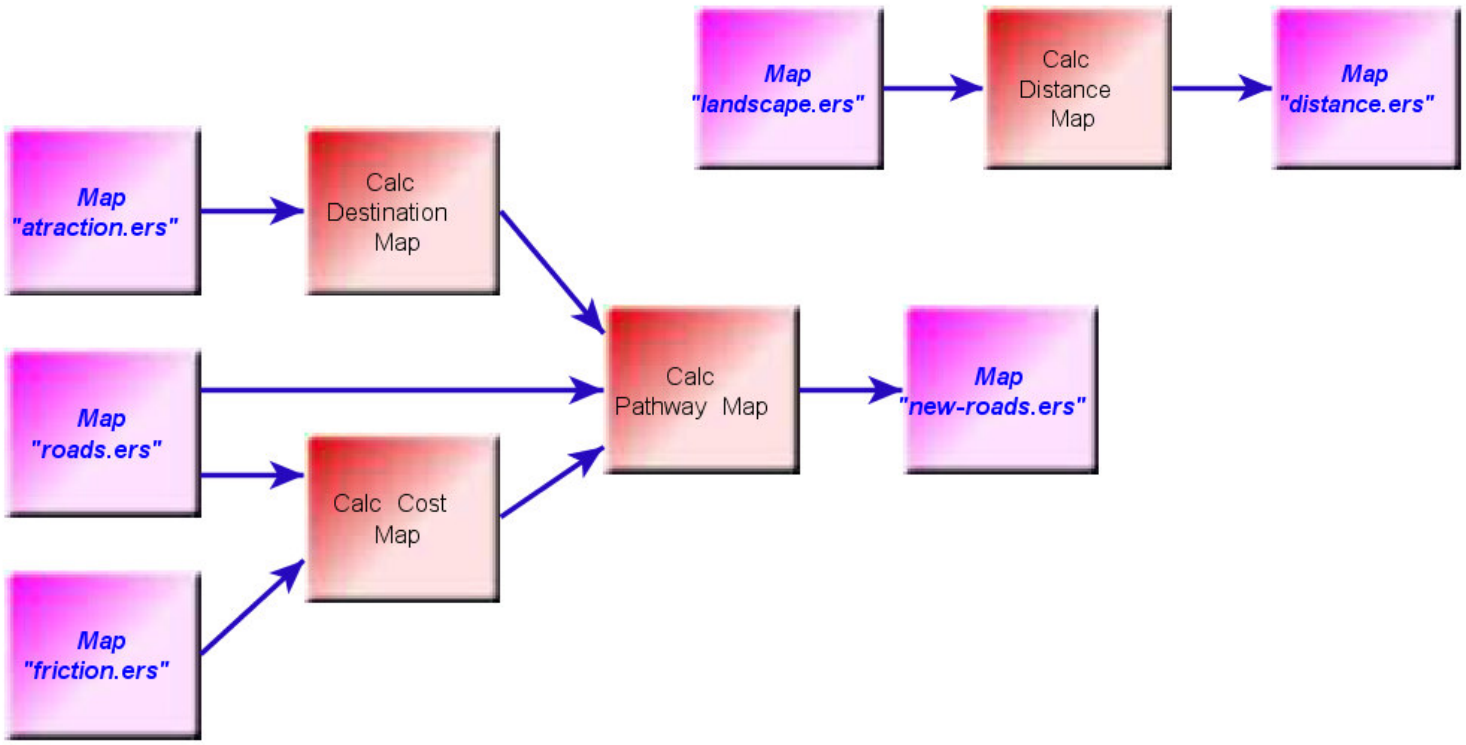
Operator


Block
For
Mux
Lookup
Table
Step
Update
Lookup
Table
Table
"similarities-by-window.cs..
Calculate Value
Select the minimum mean
Map
"difference1.ers"
Map
"difference2.ers"
First Map
Second Map
Window Size
Use Exponential...
Cell Type
Null Value
Calc Reciprocal...
Calculate two-way
fuzzy similarity
indices between
two maps.
First Similarity
First Mean
Second Similarity
Second Mean

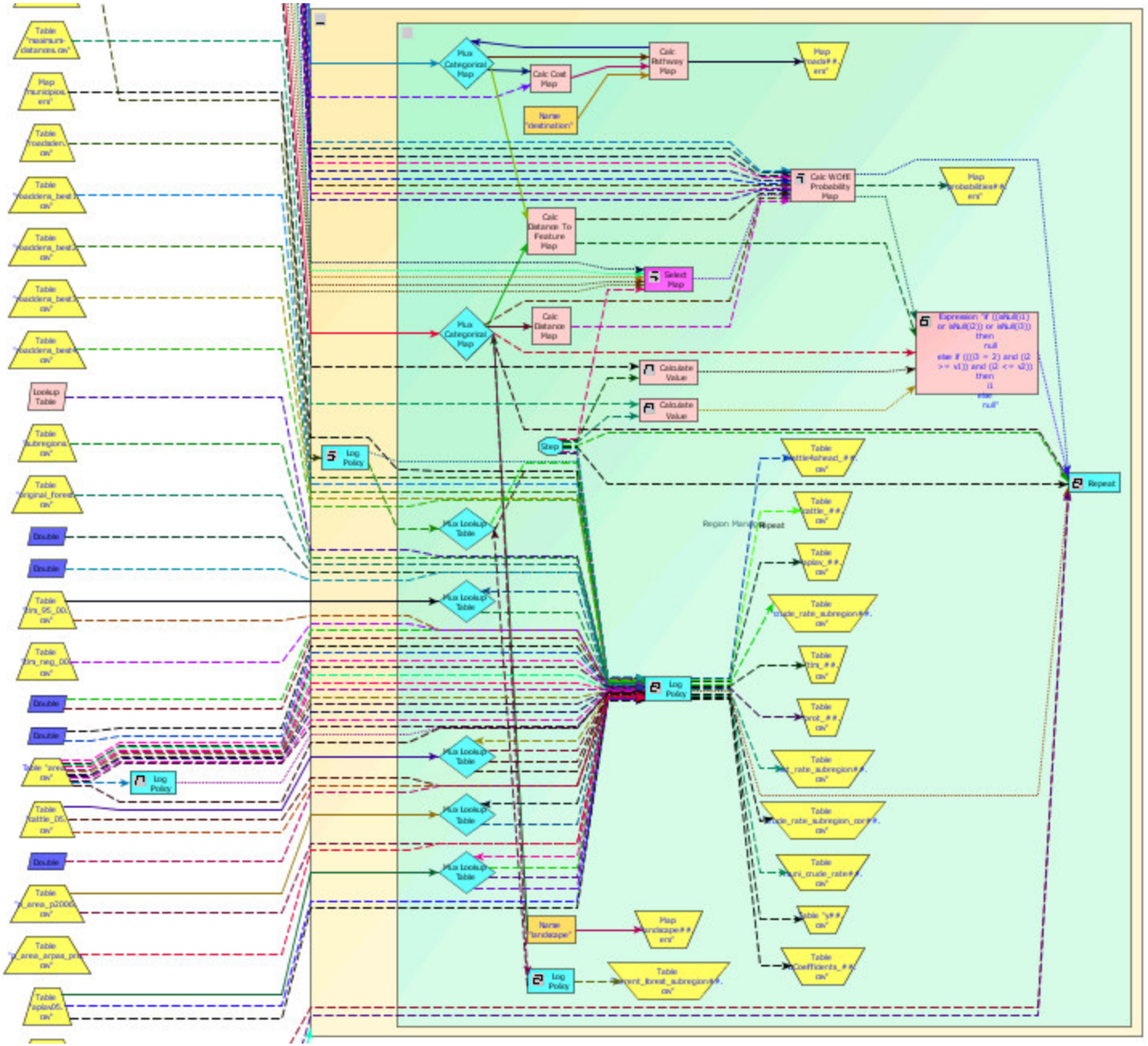
Operator Chaining



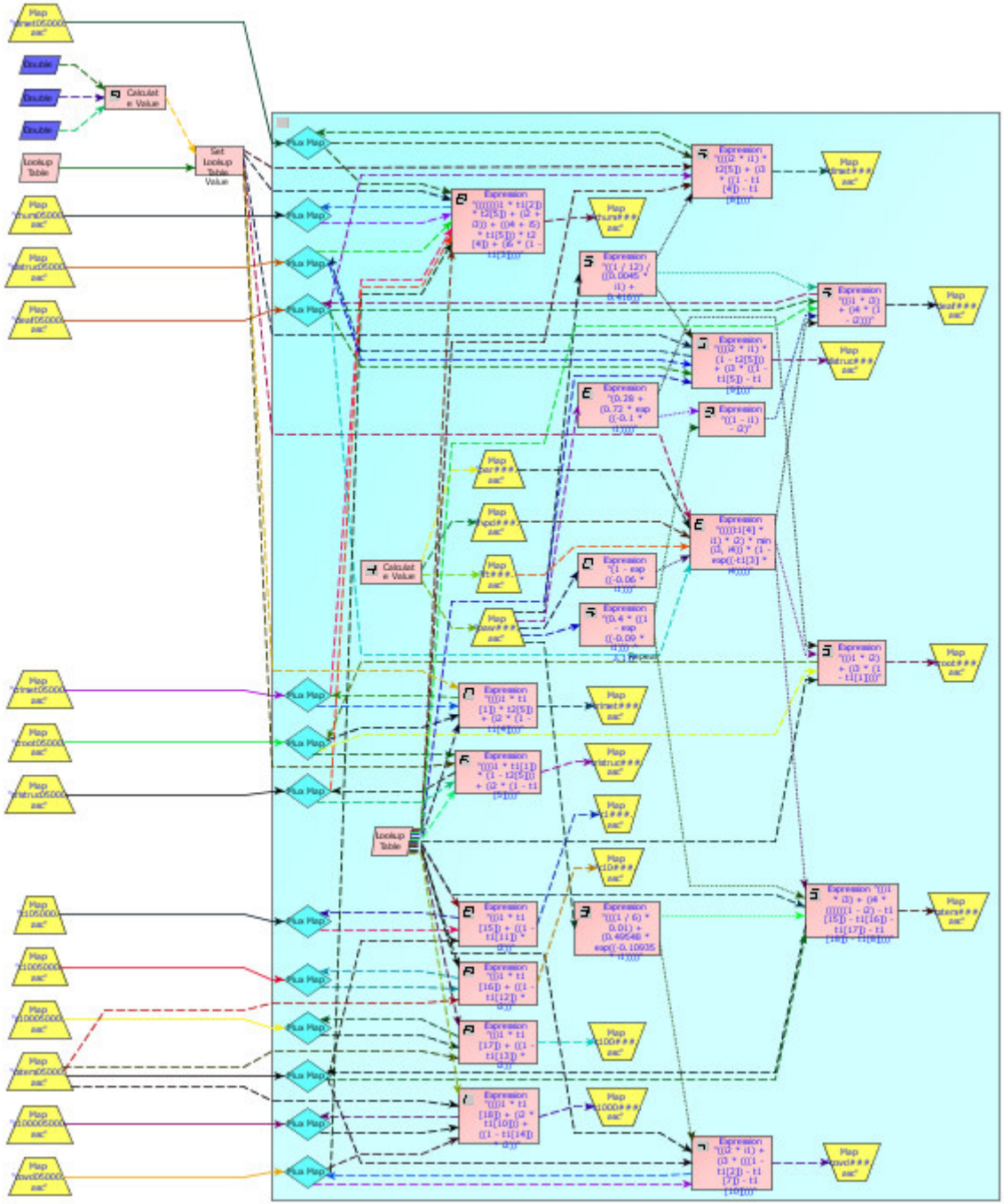
Operator chaining (Example)



Deforestation model implemented in Dinamica EGO 1.2

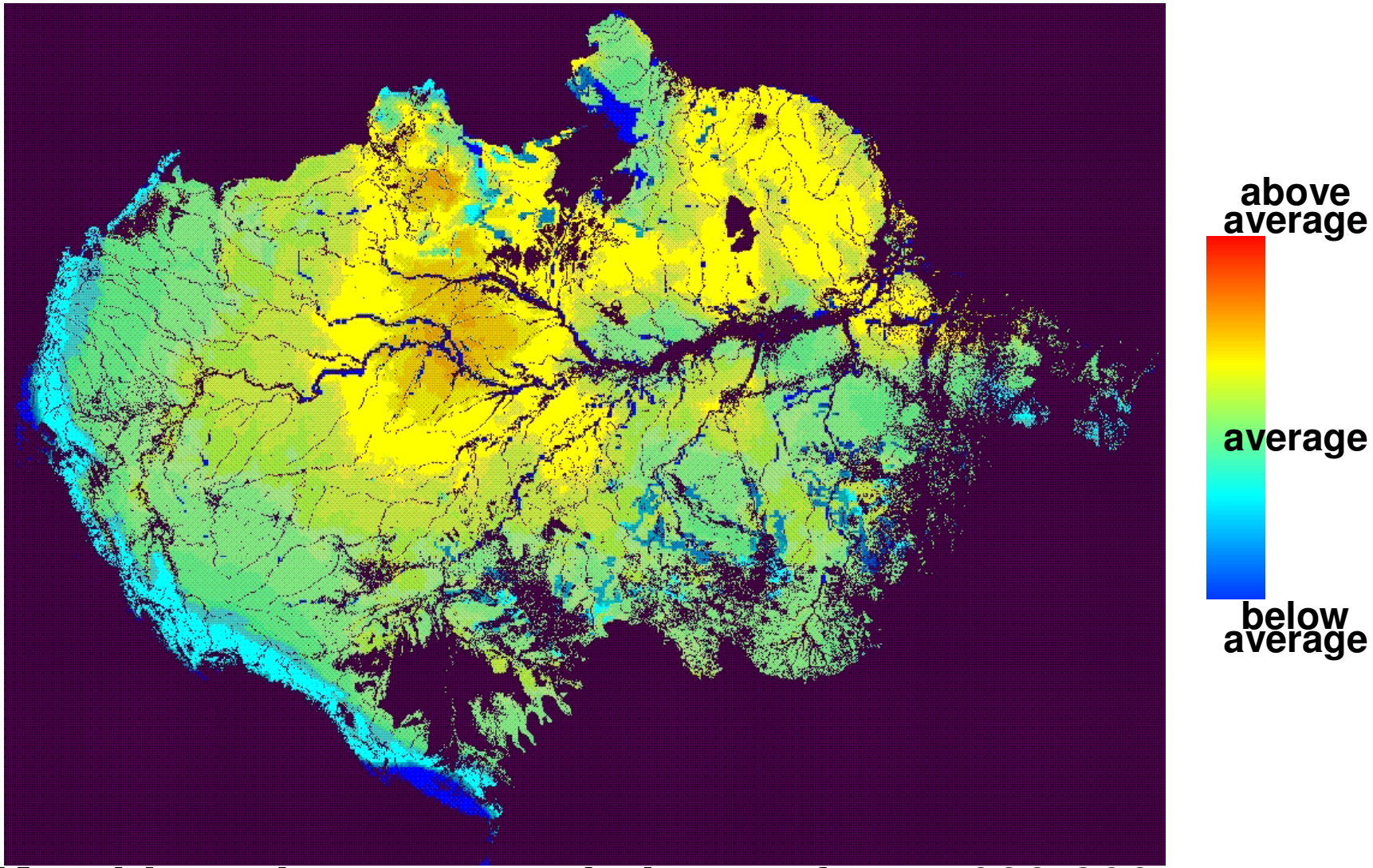


CARLUCC Implemented in Dinamica EGO 1.2



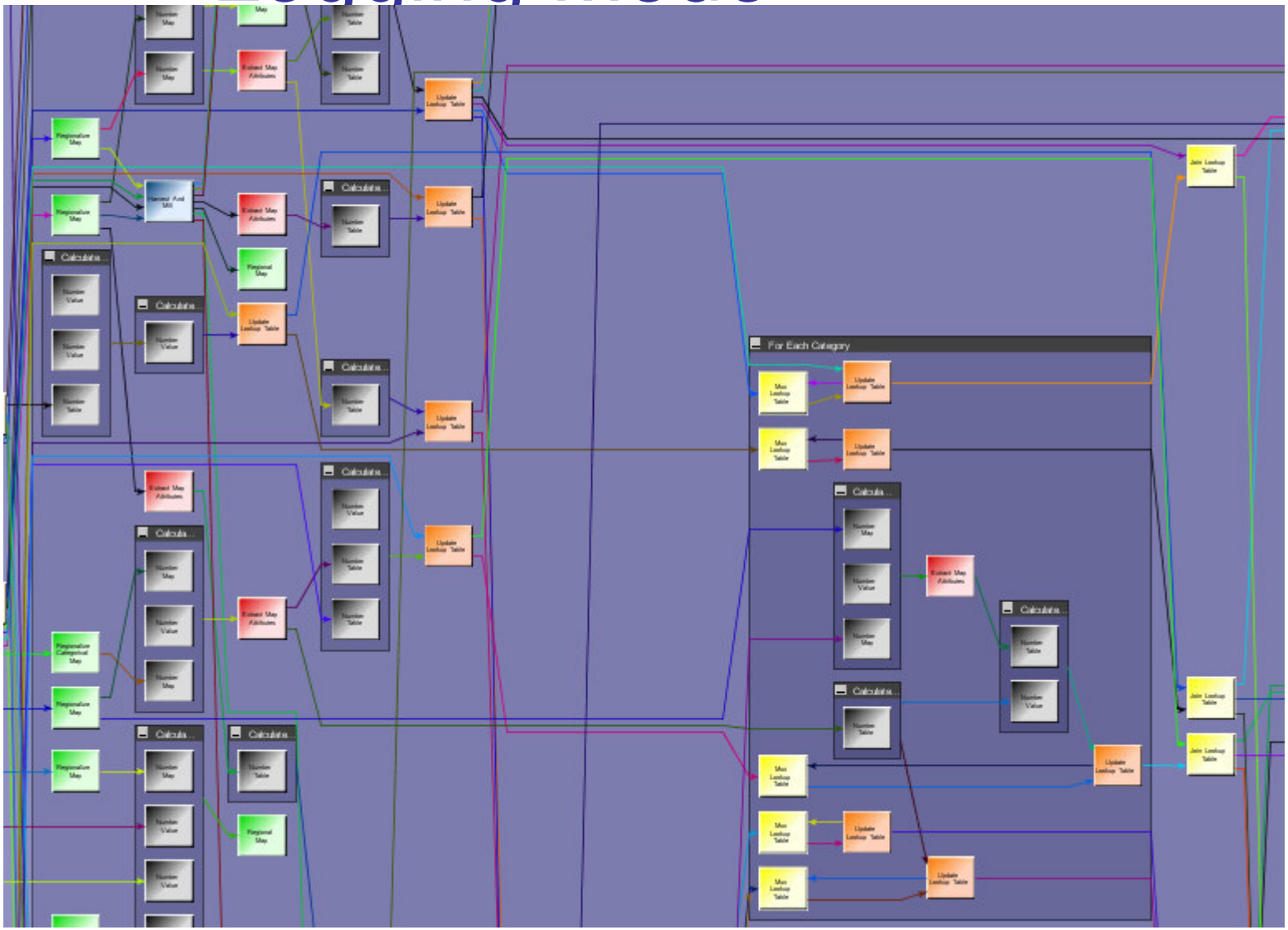
CARLUCC, simulating carbon flows

Hirsch *et al*., 2004

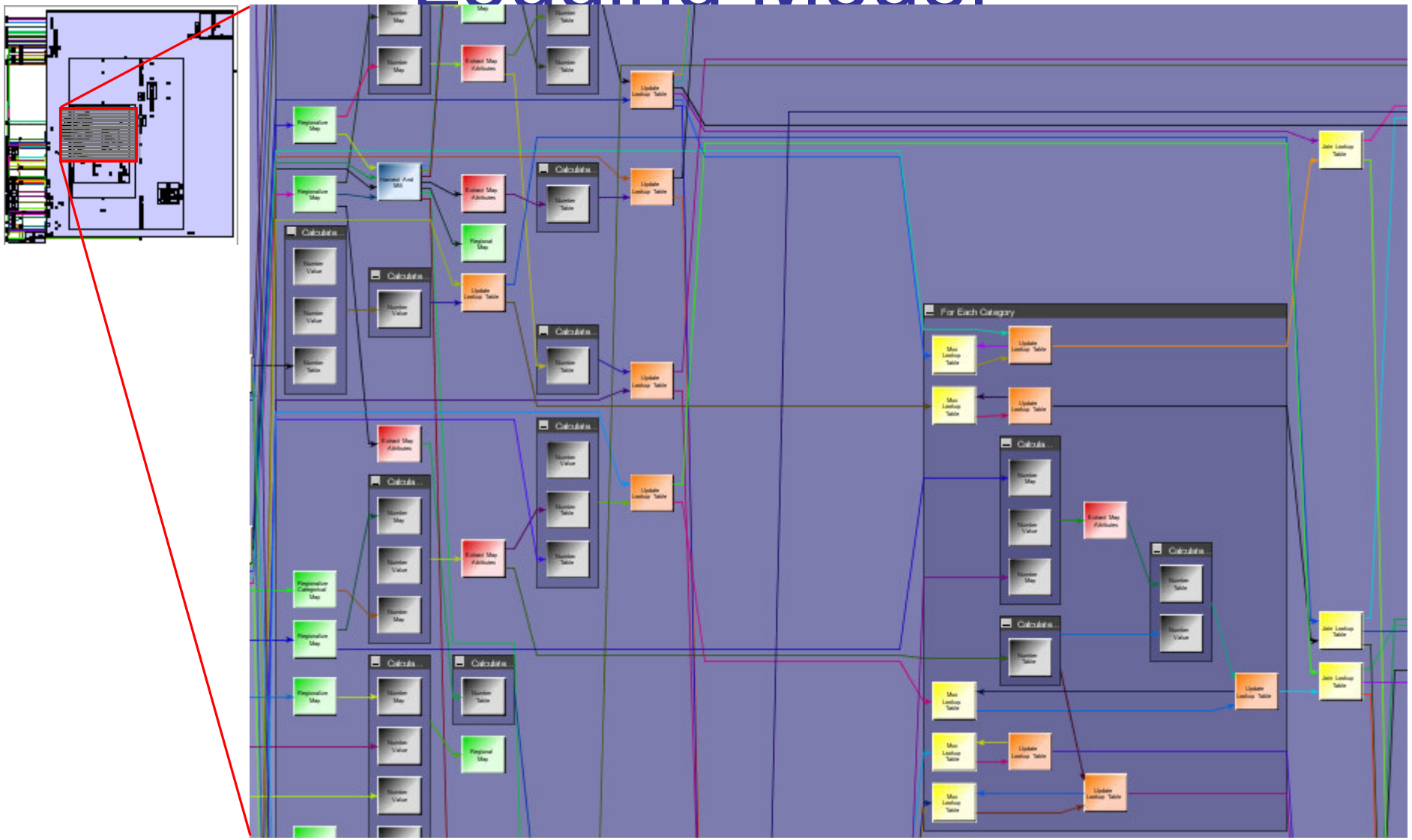


Monthly carbon content in leaves from 1999-2005

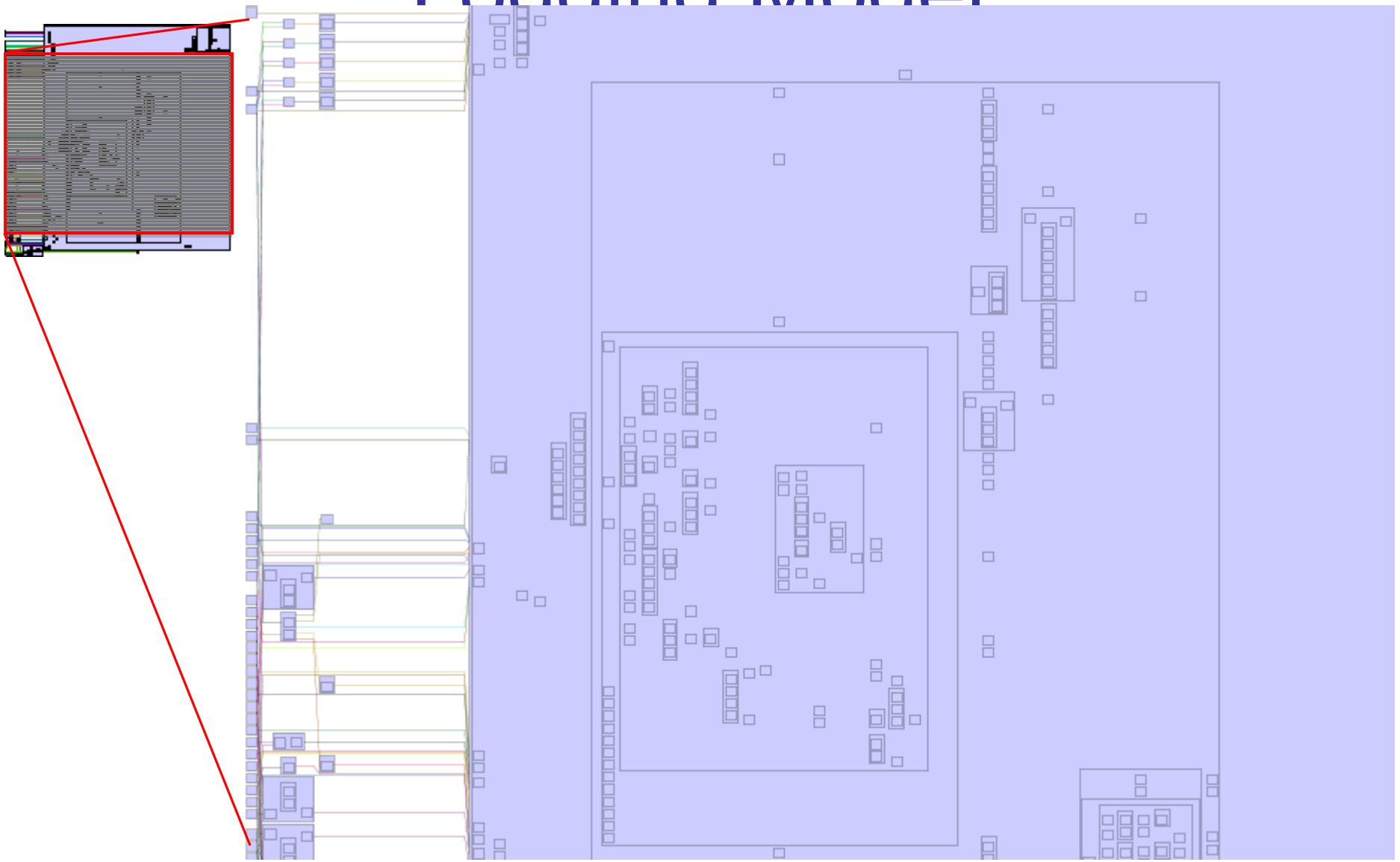
Model Complexity– Economic Logging Model



Model Complexity – Economic Logging Model



Model Complexity – Economic Logging Model



Text Version - Economic Logging Model

```
.....

 // Faz a divisão das áreas de domínio de cada polo. Isso permite que os mapas
  // correspondentes a cada polo sejam tratados individualmente.
  RegionManager regions {{

    // Analisa cada polo ativo individualmente.
    ForEachCategory activePoles2 {{
      // Guarda o passo corrente como o número do polo atual.
      pole = step;

      // Re-injeta as tabela já preenchidas por outros polos nos passos anteriores nesse
      // passo.
      poleVolumes2 := MuxLookupTable poleVolumes feedbackPoleVolumes;
      poleRemainingVolumes2 := MuxLookupTable poleRemainingVolumes feedbackPoleRemainingVolumes;
      poleConsumptionCostRatios2 := MuxLookupTable poleConsumptionCostRatios feedbackPoleConsumptionCostRatios;

      nextPole2 := MuxDouble nextPole feedbackNextPole;

      newPoleCounting2 := MuxLookupTable [] newPoleCounting;
      nextPoles2 := MuxLookupTable [] nextPoles;

      // Determina a região do polo atual.
      Region pole {{

        // Obtem versões dos mapas que RHV, lucro e polos inicial que abragem somente os
        // domínios do polo atual
        localRhv := RegionalizeMap rhv;
        localProfit := RegionalizeMap profit;

....
```

What we expect from SimAmazonia 2

- Simulation of future deforestation, under a set of policy and economic scenarios, and the assessments of its impacts on habitat loss and fragmentation.
- Study of the feedbacks between climate change, agricultural expansion, and forest impoverishment due to increasing fire regimes under an warmer and drier Amazon climate.
- The evaluation of the level of endangerment for protected areas.

What we expect from SimAmazonia 2

- The calculation of logging potential of forest concessions.
- The calculation of opportunity and marginal costs, taking into consideration an emergent carbon credit market for reduced deforestation.
- …

Partnerships

- INPA
- INPE
- YALE
- University of East Anglia
- USP
- UFRN (Rio Grande do Norte)
- UFSC (Santa Catarina)
- UFA (Acre)
- Woods Hole Research Center
- IPAM
- Florida University
- Santa Fe Institute
- UNAM
- Museu Humboldt (Colombia)

Acknowledgements

- LBA
- Gordon and Betty More Foundation
- CNPQ - Conselho Nacional de Desenvolvimento Ciêntifico e Tecnológico
- Hewlett Packard Foundation

Thank you, Obrigado

Hermann Rodrigues, Britaldo Silveira Soares-Filho
Daniel Nepstad, William Leles Costa
hermann@csr.ufmg.br, britaldo@csr.ufmg.br,
dnepstad@whrc.org, william@csr.ufmg.br

Universidade Federal
de Minas Gerais