

GraS

An Environmental Application on Windows-HPC

Christian Terboven

terboven@rz.rwth-aachen.de

Center for Computing and Communication

RWTH Aachen University, Germany

Agenda

- HPC off the beaten track
 - GraS: Grassland Succession (HPC on Windows with Delphi)
- An HPC-Environment with Delphi?!

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HPC w/ Delphi

GraS: Simulation of Grassland Succession

- Institute for Environmental Research (Bio5) and Research Institute for Ecosystem Analysis and Assessment (GAIAC)
 - Simulation of grassland development under var. land use forms
 - decision support for grassland mgmt. on the landscape scale



Dataset: Eifel National Park
established in 2004, includes open
grasslands of former military training site
Vogelsang

Simulation tool developed at Bio5 /
GAIAC, developed in Delphi on and
for Windows.

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GraS: Model Concept

- GraS: Spatial Explicit Dynamic Model
 - Model is divided up into cell in which all processes take place
 - Species may immigrate from neighboring cells, or may spread over further distances via seed dispersal
 - Since not every species present can be modeled, a set of representatives was chosen:
 - 10 kinds of grasses or herbs
 - 3 kinds of bushes
 - 4 kinds of trees

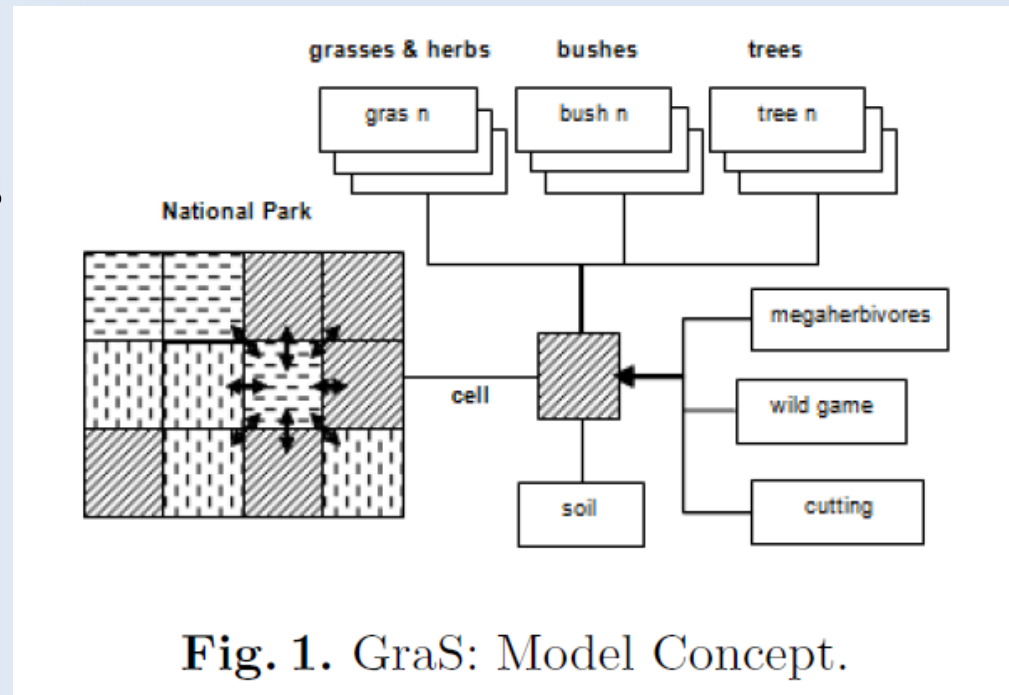
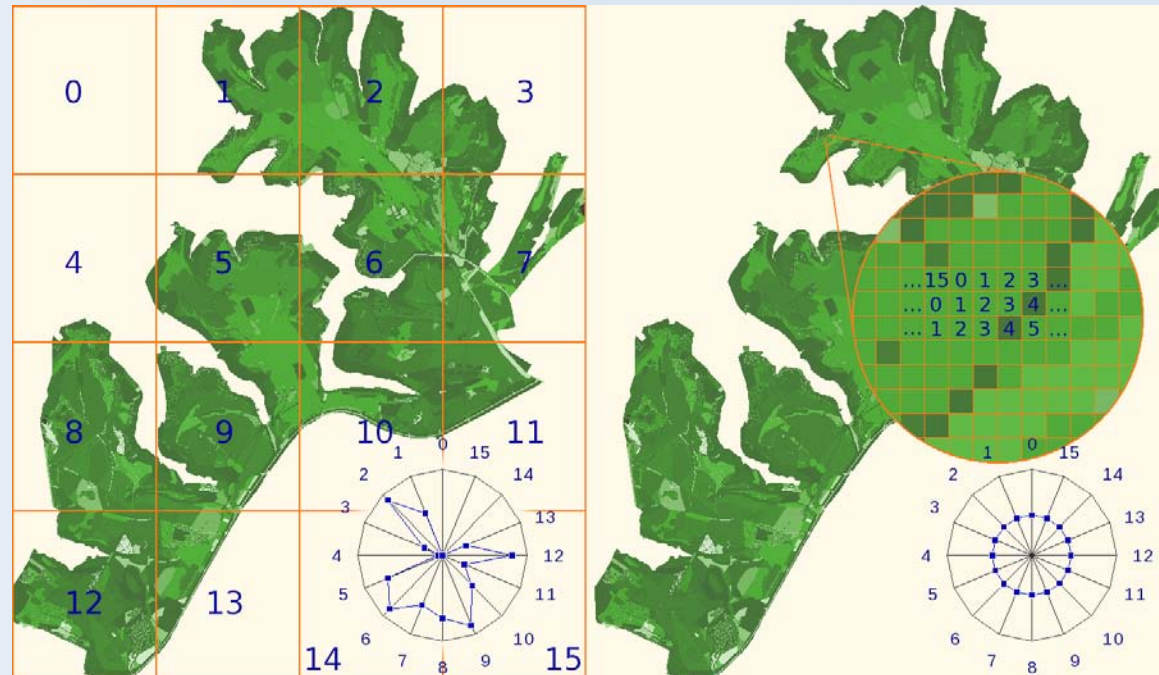


Fig. 1. GraS: Model Concept.

GraS: Delphi for HPC

- The simulation code was not suitable for the Eifel dataset:
 - Delphi currently supports only 32bit (not enough memory)
 - Dataset was manually partitioned to conduct simulation
 - No means of interaction between the partitions
- Work done so far: Creation of an MPI application including seed exchange for the whole Eifel dataset.
- Seed-funded by JARA-SIM.



Left: bad
GraS

Right: good

load balancing.
HPC w/ Delphi

GraS: Current state of the Parallelization

- Landscape map is flattened and separated in squared cells of 10 meters edge length → rectangular grid. Several fields are empty, since the Eifel NP is not of a rectangular shape.
- A simulated day consists of steps, performed independently for every cell:
 1. Growth simulation for every plant contained in the cell
 2. Calculation of the amount of seeds to be exchanged with other cells
 3. Execution of the seed exchange
 4. Calculation of the impact of seed received by other cells

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Tooling for Delphi (1/2)

- Well, obviously we cannot use Visual Studio ☹.
- For Delphi there is a Sampling Profiler: It shows the time spent per time (not quite mapped to the source code), see the image on the right.
- No support for any kind of parallelism.

The screenshot shows the Sampling Profiler interface for 'Modell.exe'. The table below displays the execution statistics for various code entities. Line 443 is highlighted as the most time-consuming entity.

Entity	Samples	Local Ratio	Global Ratio
... Line 436	296	3.92 %	0.16 %
... Line 437	372	4.92 %	0.20 %
... Line 438	375	4.96 %	0.20 %
... Line 439	367	4.86 %	0.20 %
... Line 440	420	5.56 %	0.23 %
... Line 441	241	3.19 %	0.13 %
... Line 443	1416	18.75 %	0.77 %
... Line 445	211	2.79 %	0.12 %
... Line 446	213	2.82 %	0.12 %
... Line 449	49	0.65 %	0.03 %
... Line 450	30	0.40 %	0.02 %
... Line 451	9	0.12 %	0.00 %
... Line 452	20	0.26 %	0.01 %
... Line 455	73	0.97 %	0.04 %
... Line 456	22	0.29 %	0.01 %
... Line 457	12	0.16 %	0.01 %
... Line 458	26	0.34 %	0.01 %
... Line 460	9	0.12 %	0.00 %
... Line 462	176	2.33 %	0.10 %
TCell.calculate_growth	418	4.23 %	0.23 %
TCell.growthfromanothercell	1599	16.17 %	0.87 %
TCell.growthfromseed	40	0.40 %	0.02 %
unitEcoEntity	5784	4.04 %	3.16 %


```
442
443   cover_layer[vventity.covertyp] :=cover_layer[vventity.covertyp];
444
445   mittleres_alter:=mittleres_alter+vventity.alter; //wird für
446   a treelike:=vventity.count_treelike(a_treelike); //alle hab
447   end;
448
449   cover_all_layers:=cover_layer[tbgras]+cover_layer[tbbusch]+cove
450   covergrade:=cover_all_layers;
451   cover_layer_competition[tbkbusch] :=cover_layer[tbbusch]+cover_
452   cover_layer_competition[tbkbaum] :=cover_layer[tbbaum];
453
454   //Sicherheitsabfragen
455   if covergrade>100 then covergrade:=100; //showmessage('Covergr.
456   if covergrade<0.1 then covergrade:=0.1;
457   if cover_layer_competition[tbkbusch]>100 then cover_layer_compe
458   if cover_layer_competition[tbkbusch]<0.1 then cover_layer_cor
459
```

Tooling for Delphi (2/2)

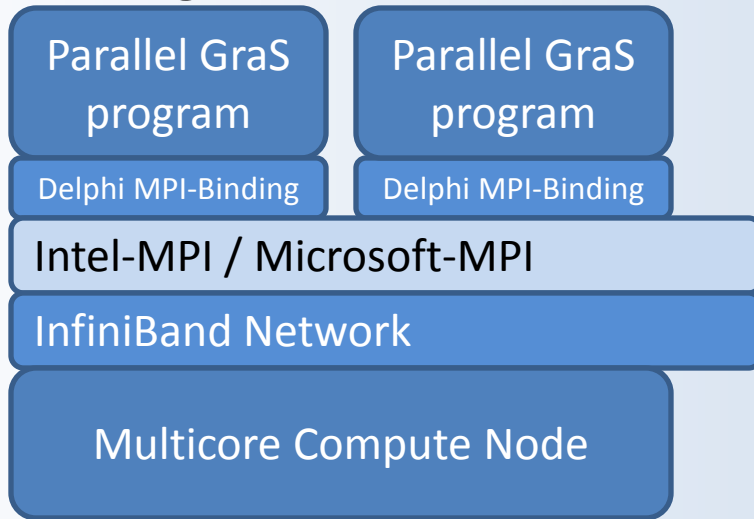
- Intel VTune works with any binary (when using Sampling) and can event map results to source code, as long as there is a PDB file... → good to get a hardware-oriented overview.

The screenshot shows the Intel VTune tooling interface. The main window displays source code for a Delphi application, with columns for Address, Line, Source, CPU, and INST. The code includes various procedures and functions, such as `calculate_color` and `growthfromanothercell`. The CPU and INST columns show performance metrics for each line of code.

Address	Size	Function	Class	CPU_CLK_UNHALTED.CORE (76)	INST_RETIRED.ANY (76)	Clocks per Ins.
-----	-----	--- Selected Range ---	-----	133	153	...
0x130E64	0x11C4	calc_biotoptyp	__linkproc__ TCell	0	1	...
0x132028	0x398	calculate_cover	__linkproc__ TCell	745	824	...
0x1323C0	0x84	calculate_color	__linkproc__ TCell	22	35	...
0x132444	0x364	calculate_growth	__linkproc__ TCell	55	36	1....
0x1327A8	0x114	growthfromanothercell	__linkproc__ TCell	163	66	2.4...
0x1328BC	0x3D4	growthfromseed	__linkproc__ TCell	5	7	...

GraS: An HPC-Environment for Delphi

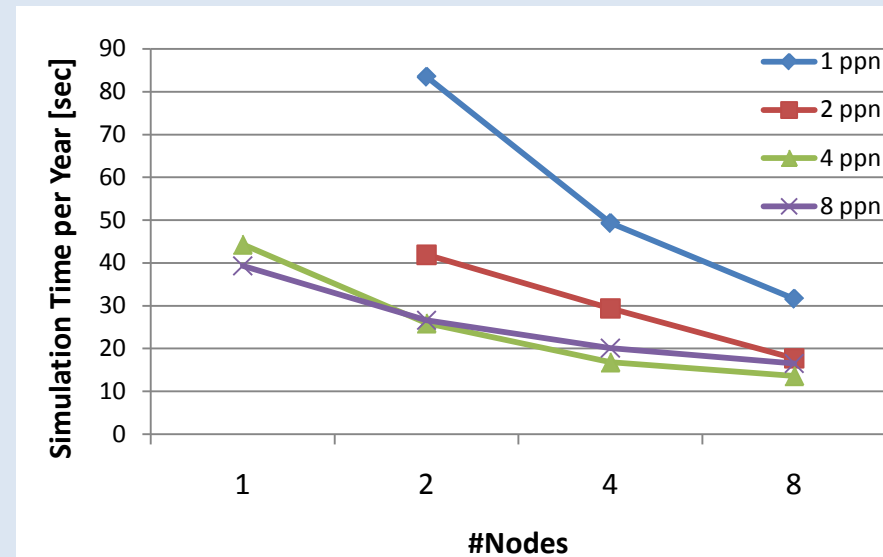
- o Delphi comes with virtually no support for parallel programming, so we created / modified a suitable environment:



MPI Performance Analysis:

- I-MPI: Intel Trace Analyzer and Collector
- MS-MPI (w/ Tracing): Vampir on Windows

- o No support for Shared-Memory parallelization, we are thinking of re-writing some components in C++ ...



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Open Questions

- Shall they continue to bet on Delphi?
 - Tool support for Delphi is limited
 - There is no „real“ Delphi for Linux
- How to handle Monte-Carlo verification runs, where a model is evaluated a 1000 times in parallel?
 - Use MPI?
 - Use SOA?
 - Use parametric sweep / array job + „collection tool“?
- Note: The Windows HPC Server 2008 enabled HPC as a tool for this user community.

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The End

Thank you for
your attention!

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