

## Parallel iMOD-WQ (Seawat/MT3DMS) Announcement

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# Parallel solver for iMOD-WQ

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- iMOD 5.5: Parallel Krylov Solver (PKS) for SEAWAT and MT3DMS calculations with iMOD-WQ
- Dramatic reduction of calculation times
- Enabling model applications that before were out of reach

For all the details:



Advances in Water Resources

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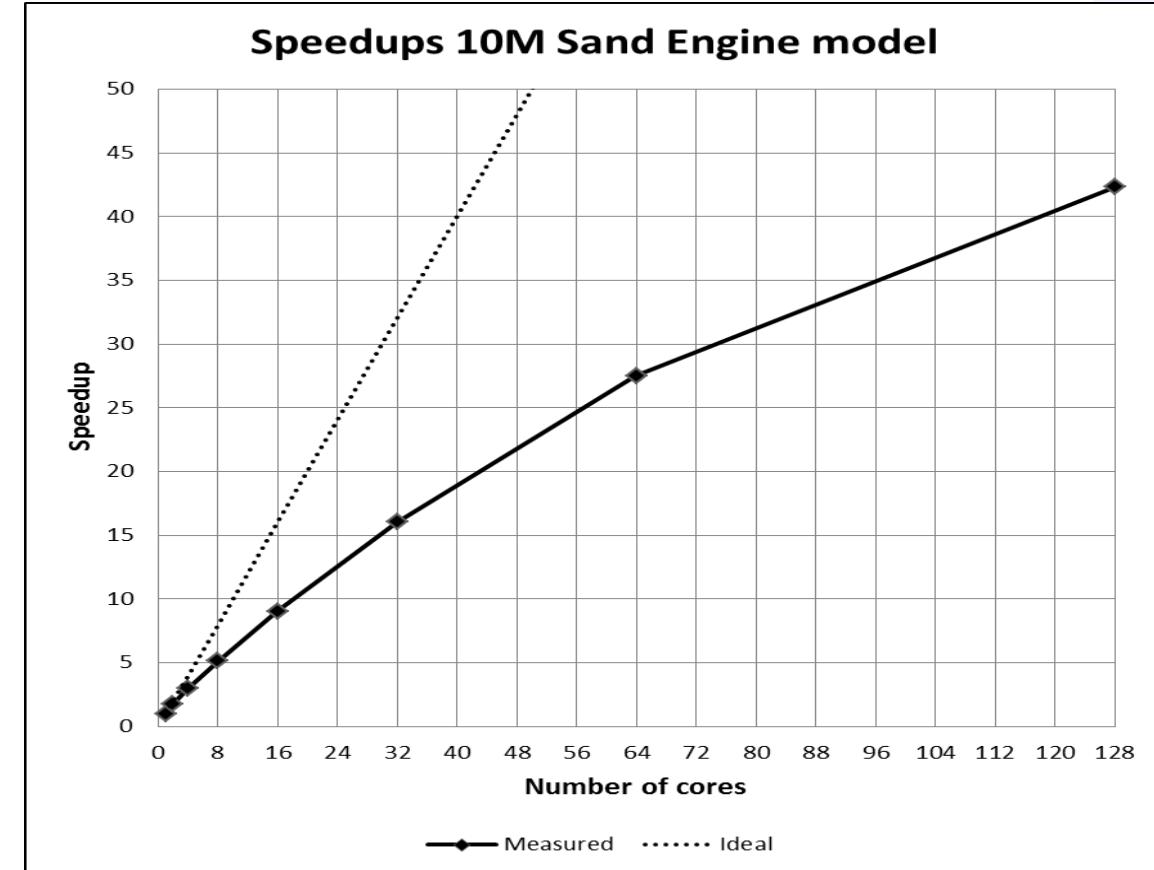
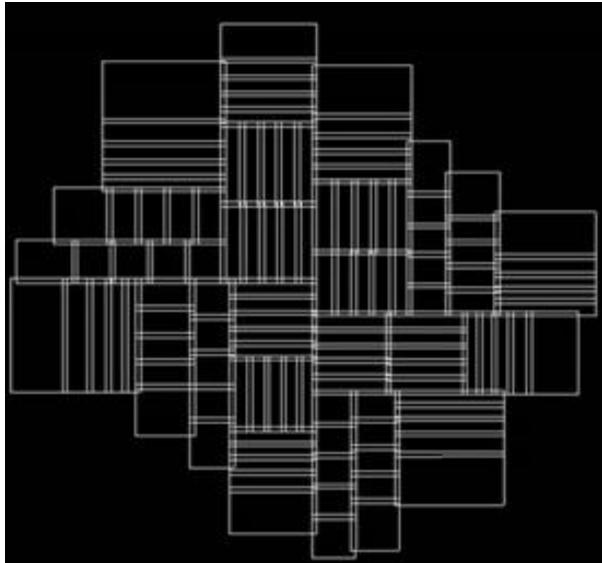


Distributed memory parallel computing of three-dimensional variable-density groundwater flow and salt transport

J. Verkaik <sup>a, b</sup>  , J. van Engelen <sup>a, b</sup>, S. Huizer <sup>b, c</sup>, M.F.P. Bierkens <sup>a, b</sup>, H.X. Lin <sup>d, e</sup>, G.H.P. Oude Essink <sup>a, b</sup>

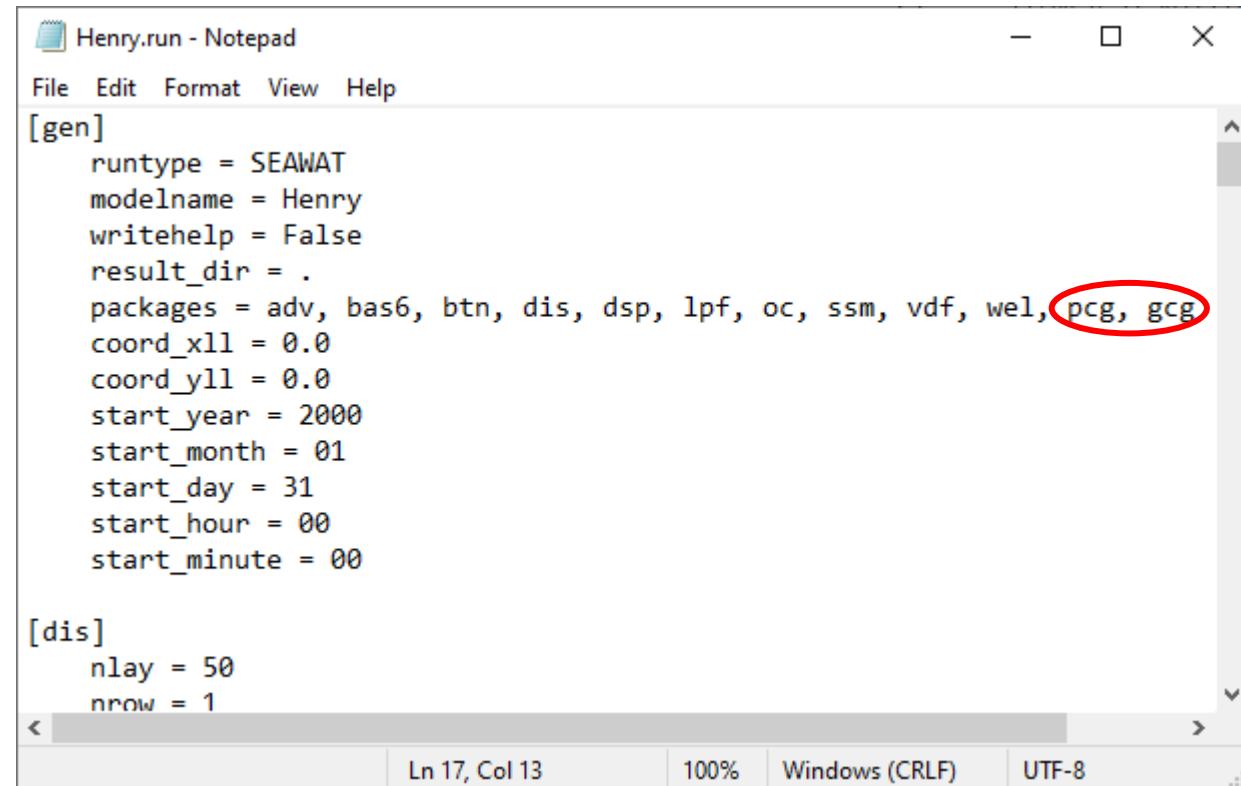


# Large scale testcase



# Runfile

**PCG / GCG (serial)**

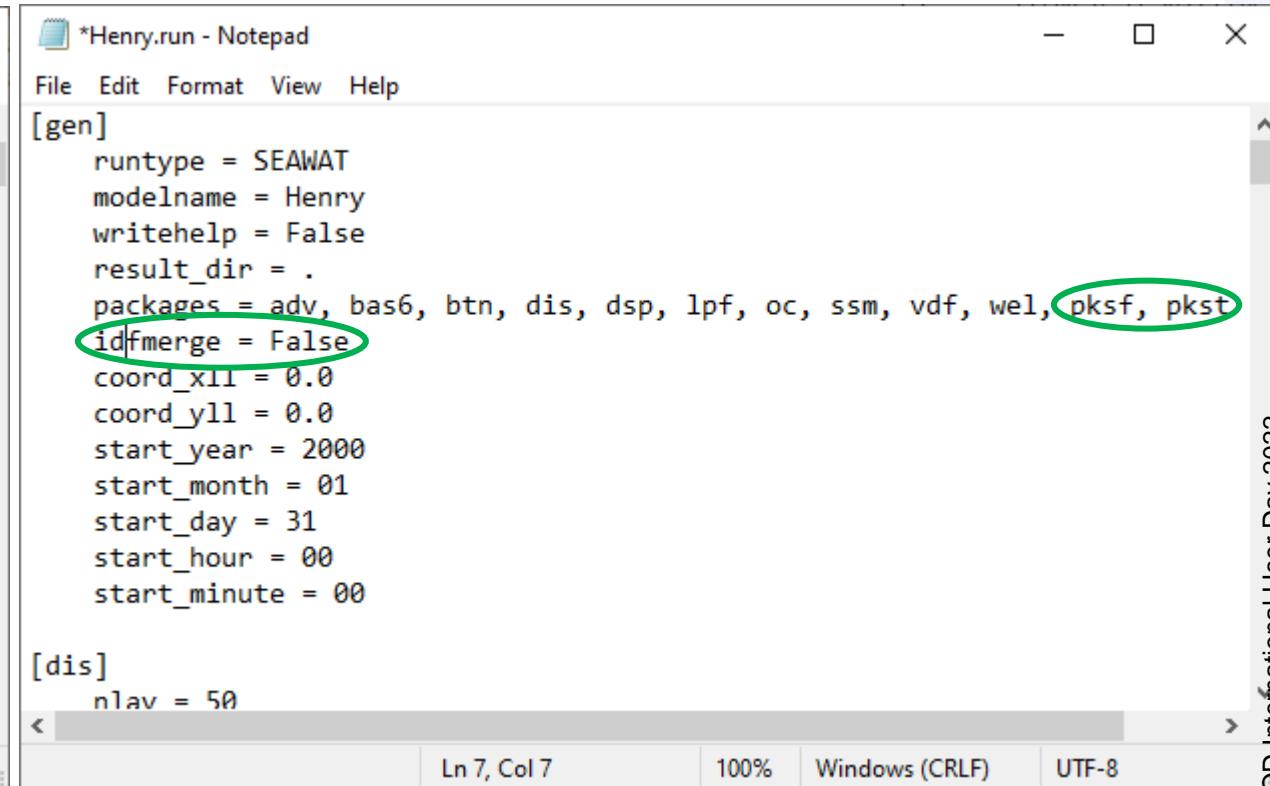


```
Henry.run - Notepad
File Edit Format View Help
[gen]
runtype = SEAWAT
modelname = Henry
writehelp = False
result_dir = .
packages = adv, bas6, btn, dis, dsp, lpf, oc, ssm, vdf, wel, pcg, gcg
coord_xll = 0.0
coord_yll = 0.0
start_year = 2000
start_month = 01
start_day = 31
start_hour = 00
start_minute = 00

[dis]
nlay = 50
nrow = 1
```

Ln 17, Col 13 | 100% | Windows (CRLF) | UTF-8

**PKS (parallel)**



```
*Henry.run - Notepad
File Edit Format View Help
[gen]
runtype = SEAWAT
modelname = Henry
writehelp = False
result_dir = .
packages = adv, bas6, btn, dis, dsp, lpf, oc, ssm, vdf, wel, pkst
idfmmerge = False
coord_xll = 0.0
coord_yll = 0.0
start_year = 2000
start_month = 01
start_day = 31
start_hour = 00
start_minute = 00

[dis]
nlay = 50
```

Ln 7, Col 7 | 100% | Windows (CRLF) | UTF-8

# Runfile

## PCG / GCG (serial)

\*Henry.run - Notepad

```
File Edit Format View Help
iwelcb = 0
wel_p?_s1_1? = wel/wel.ipf

[pcg]
mxiter = 150
iter1 = 30
npcond = 1
hclose = 0.0001
rclose = 1.0
relax = 0.98
iprpcg = 1
mutpcg = 0
damp = 1.0

[gcg]
mxiter = 150
iter1 = 30
isolve = 3
ncrs = 0
cclose = 1e-06
iprgcg = 0

[btn]
ncomp = 1
```

100% Windows (CRLF) | UTF-8

## PKS (parallel)

Henry\_PKS.run - Notepad

```
File Edit Format View Help
iwelcb = 0
wel_p?_s1_1? = wel/wel.ipf

[pksf]
mxiter = 150
innerit = 30
hclosepks = 0.0001
rclosepks = 1.0
relax = 0.98
h_fstrictpks = 1.0
r_fstrictpks = 1.0
isolver = 1
partopt = 5
loadptr = pksf/load_balance_weight.asc

[pkst]
mxiter = 150
innerit = 30
cclosepks = 1e-06
relax = 0.98
isolver = 2
partopt = 5
loadptr = pkst/load_balance_weight.asc

[btn]
ncomp = 1
```

Ln 137, Col 19 | 100% | Windows (CRLF) | UTF-8

# Run command

```
"c:\MPICH2\bin\mpiexec.exe" -localonly 2 "imod-wq.exe" "Henry.run"
```



# Example 1

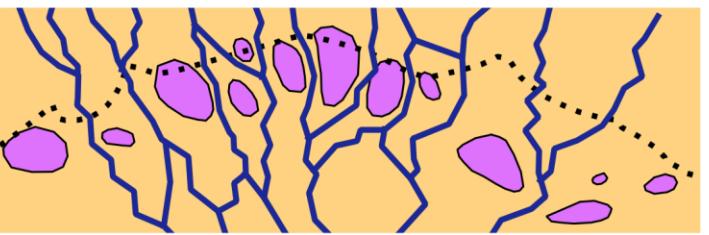


Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2019-151>

## A three-dimensional palaeo-reconstruction of the groundwater salinity distribution in the Nile Delta Aquifer

Joeri van Engelen<sup>1,2</sup>, Jarno Verkaik<sup>1,2</sup>, Jude King<sup>1,2</sup>, Eman R. Nofal<sup>3</sup>, Marc F.P. Bierkens<sup>1,2</sup>, Gualbert H.P. Oude Essink<sup>1,2</sup>

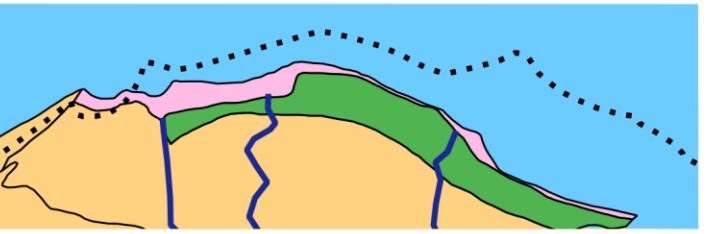
32 – 13.5 ka BP



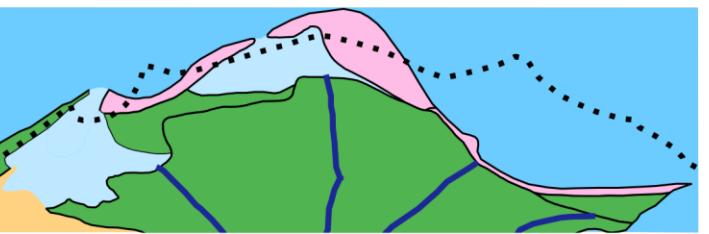
Geography

- sea
- lagoon
- sabkha
- clay
- sand
- river
- dune/  
beach

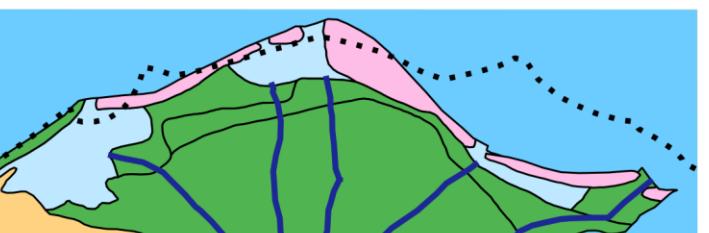
13.5 – 8 ka BP



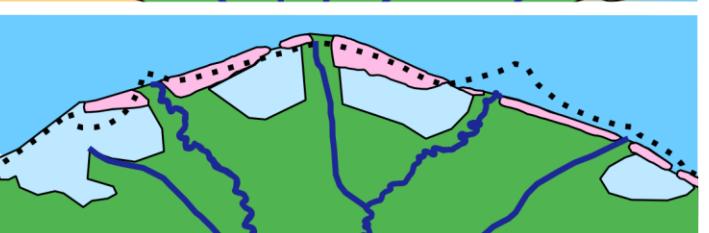
8 – 6 ka BP



6 – 3 ka BP



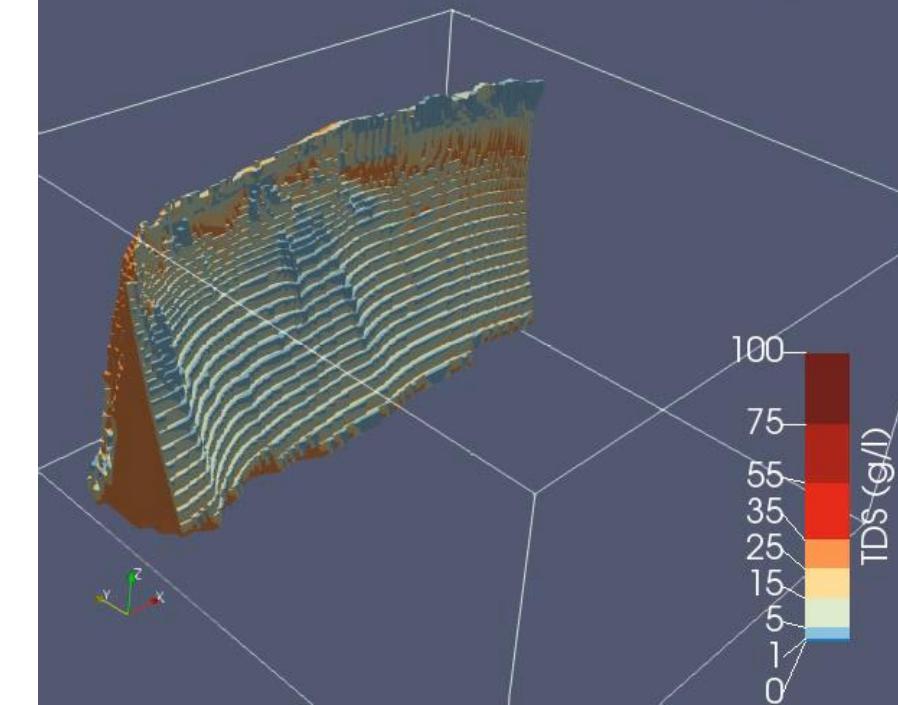
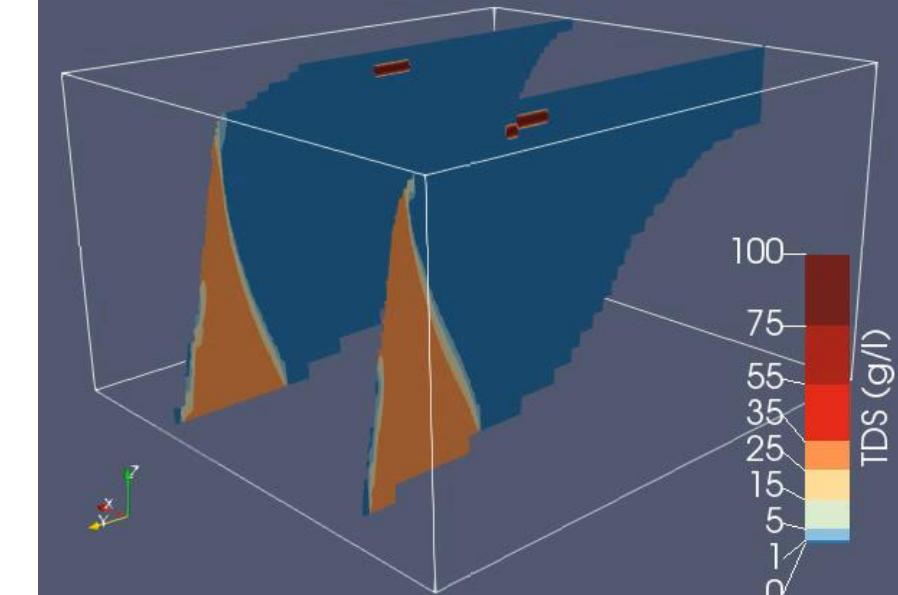
3 – 1 ka BP



1 – 0 ka BP

**Deltares**

Time: 32030 year BP

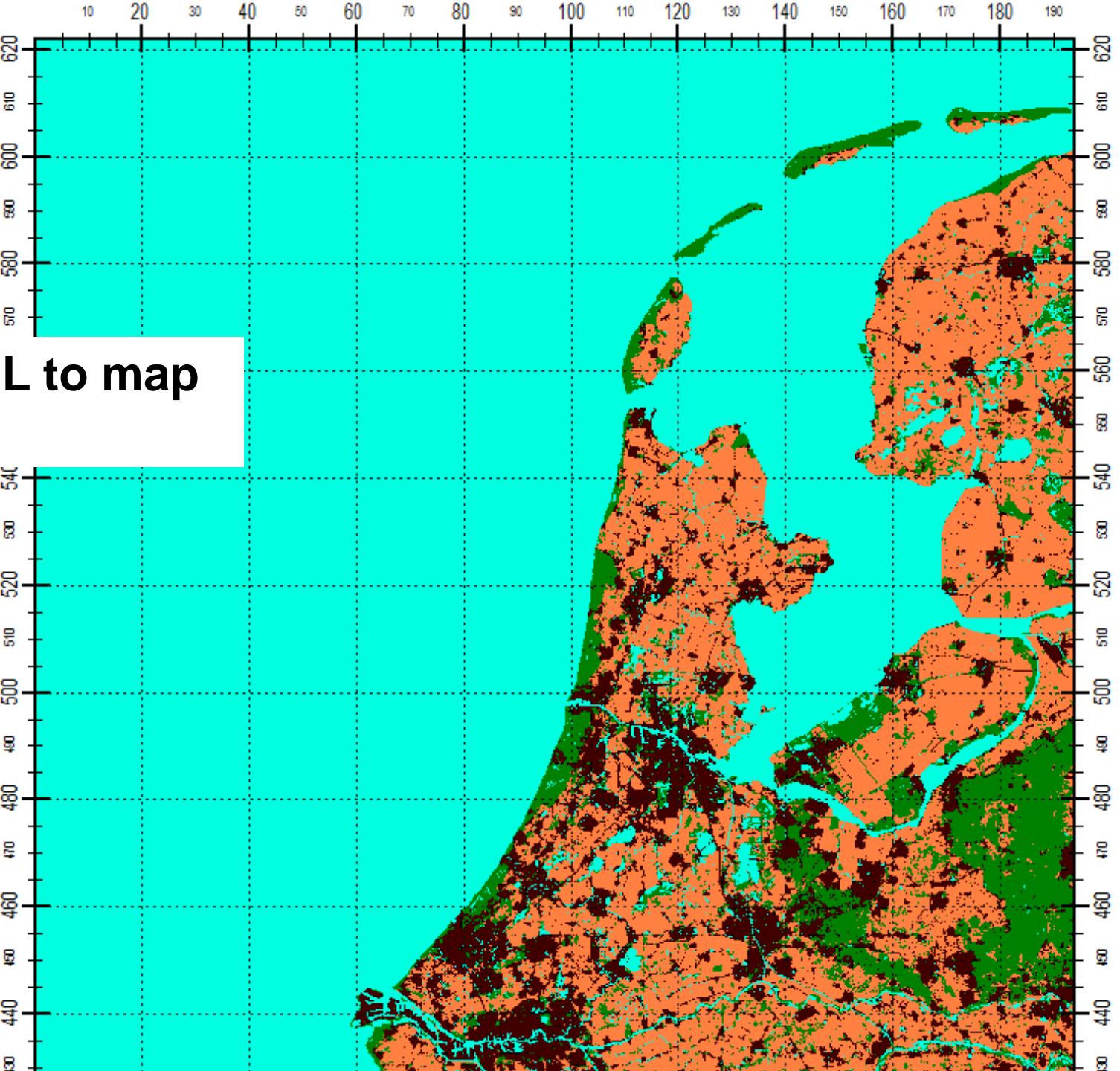


# Specs

- Simulation time: 2 – 5 days (on 48 cores)
- Would be: 60 – 150 days without PKS
  - (estimated speedup factor of 30)

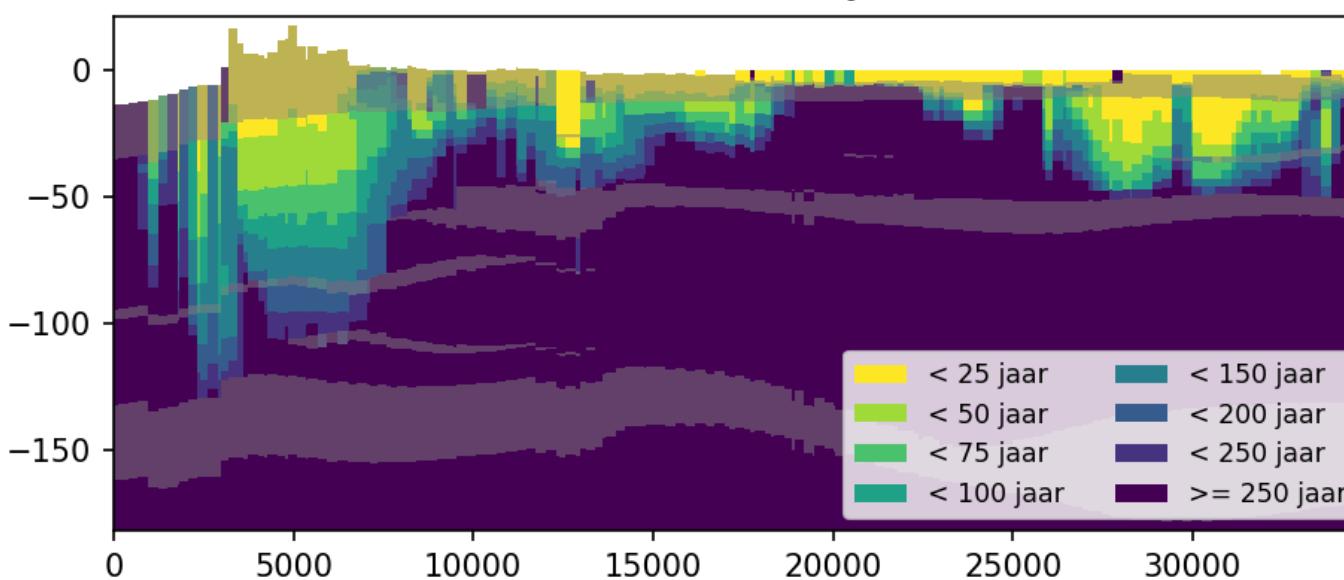
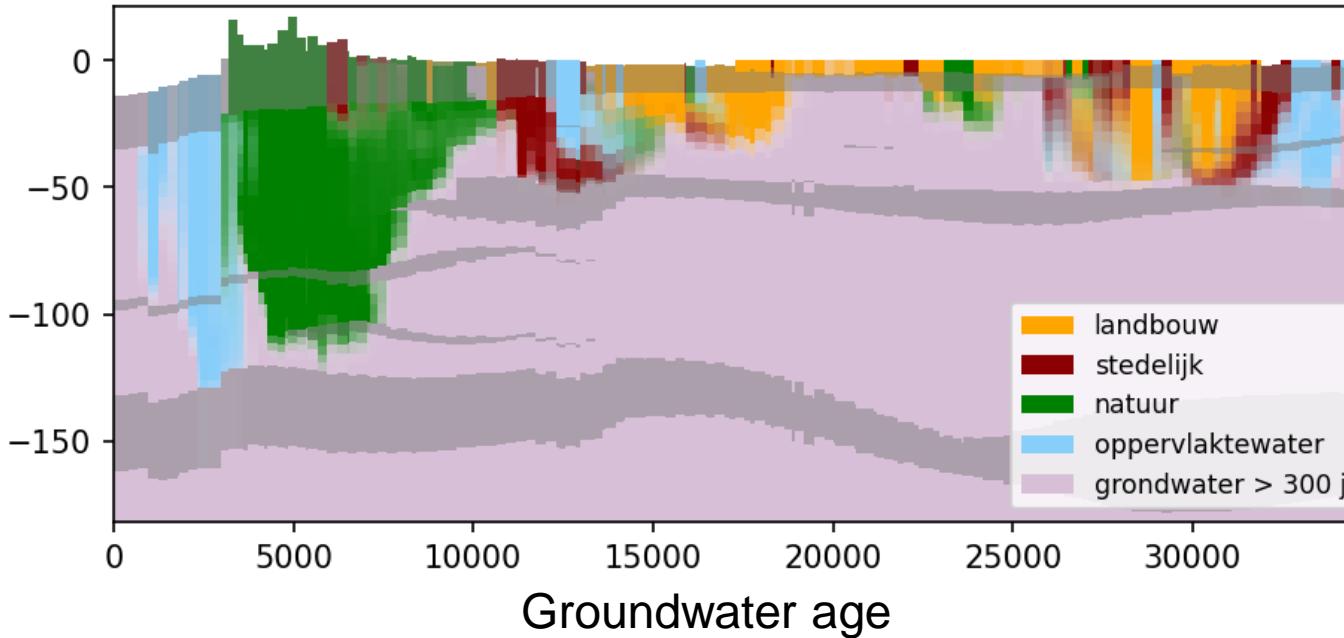
## Example 2

**Tracer simulation for whole NL to map groundwater age and origin**

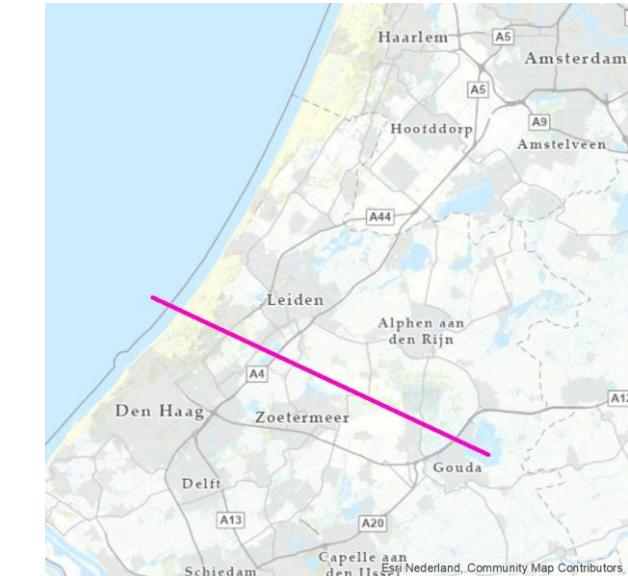


## Transect Meijendel - Reeuwijkse plassen

### Groundwater origin type



- Entire Netherlands 250x250m
- 39 model layers
- 300 year simulation period
- Parallelized over 16 cores
- 4 day runtime
- Would be: > 40 days without PKS



# To sum up

- Parallel iMOD-WQ is out
- That is awesome
- You should try it

