Meeting project deadlines through TUFLOW optimization, cloud computing.

Jacobs TUFLOW Flood Platform by Jacobs

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Agenda

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- Optimising the number of scenarios (Samantha)
- Minimising TUFLOW simulation run times (Chris)
- Utilising cloud for mass simulations (Sophia)
- Q&A

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Poll:

What is the largest number of scenarios you have modelled for a single project?

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Background

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AEPs

PMP

Peak Flows

Historic

Coincident Peaks

Time-space

Duration Independent

Durations

Sensitivity

ARFs

Joint probability

Climate Factors

Monte Carlo

Temporal patterns

Time Horizons

Representative Event

Stochastic

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Optimising the scenarios.

What questions should we be asking?

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What are the project requirements?

- What is the client is asking for?
- Which guidelines & standards apply?

What question or problem is the flood model being used to answer?

- Is there a single purpose of the flood model?
- Will the outputs be used in multiple contexts or by multiple stakeholders?
- How complex are these problems?

What questions should we be asking?

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How spatially varied is our problem?

- Is there a single point of interest?
- Are there multiple points of interest, or is the whole floodplain of interest?

What flood behaviour do we need to understand to solve the problem?

- Peak flow or level only
- Velocity or hazard
- Timing - duration of inundation, timing of flood arrival
- All of the above, or more!

Examples

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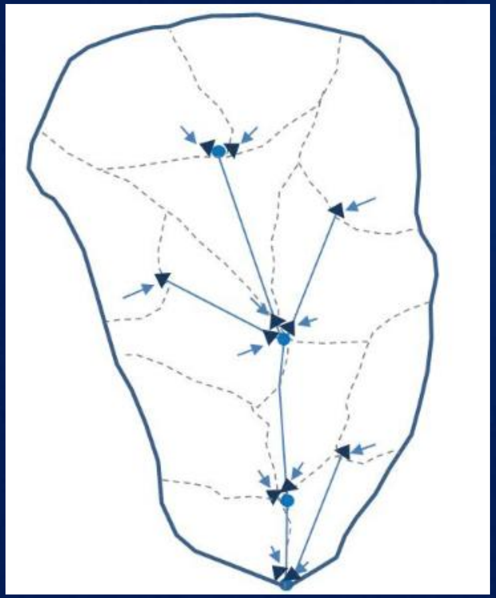
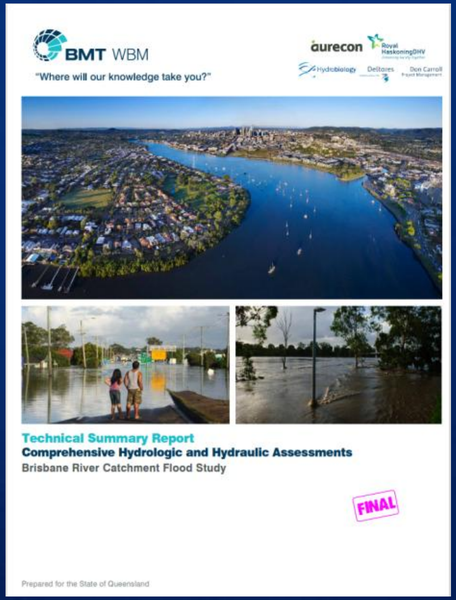
Full 2D with Ensembles

Hydrologic Simplification



Monte Carlo with Simplified model



Data Science

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Audience Input:

Any other considerations that impact number of simulations needed?

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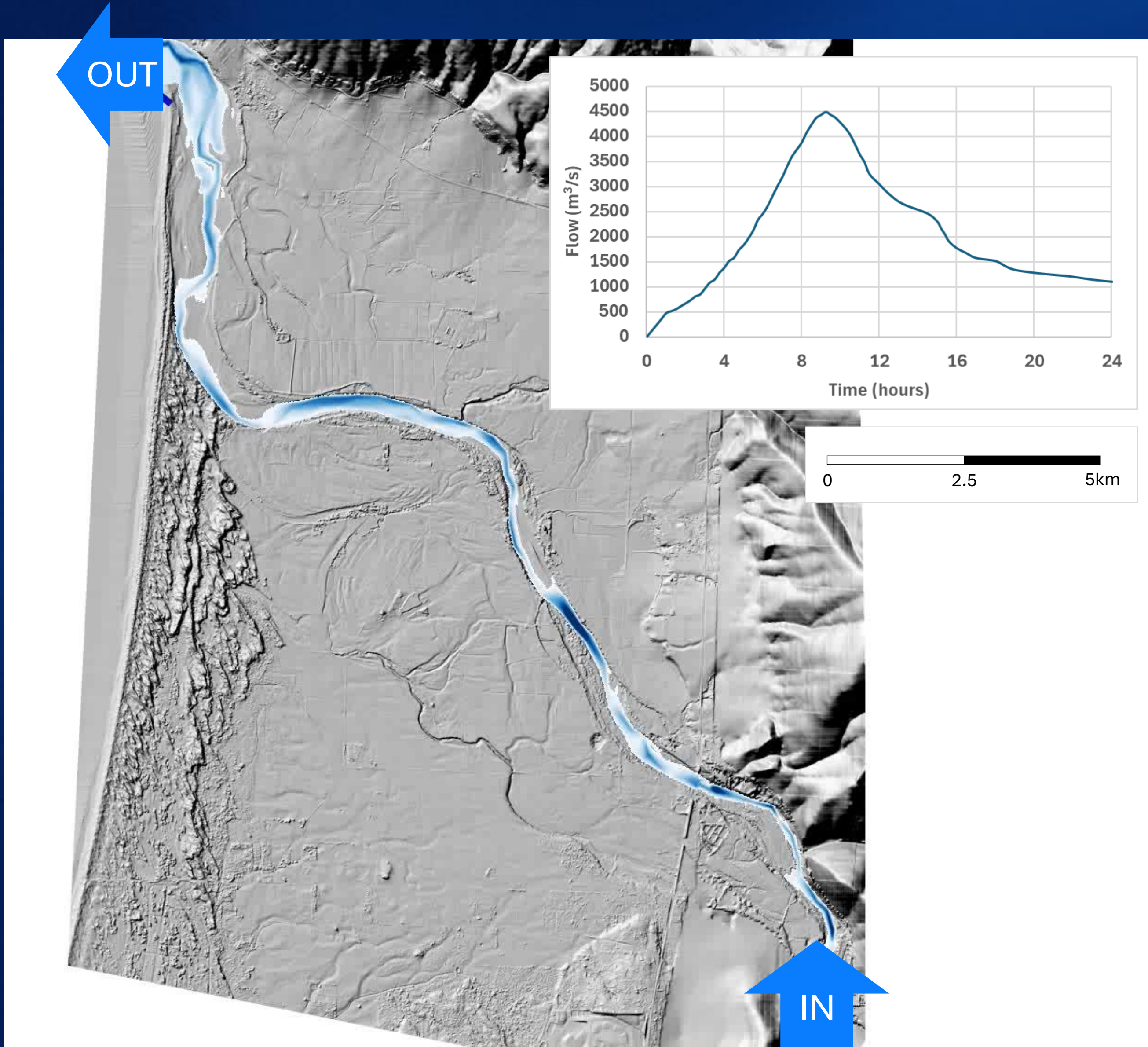
Tips for Reducing TUFLOW HPC Simulation Times

TUFLOW HPC Simulation Speed Optimisation

1. Domain extent specification
2. Minimum timestep result review
3. Sub-Grid Sample (SGS) distance
4. 2D cell size assumptions



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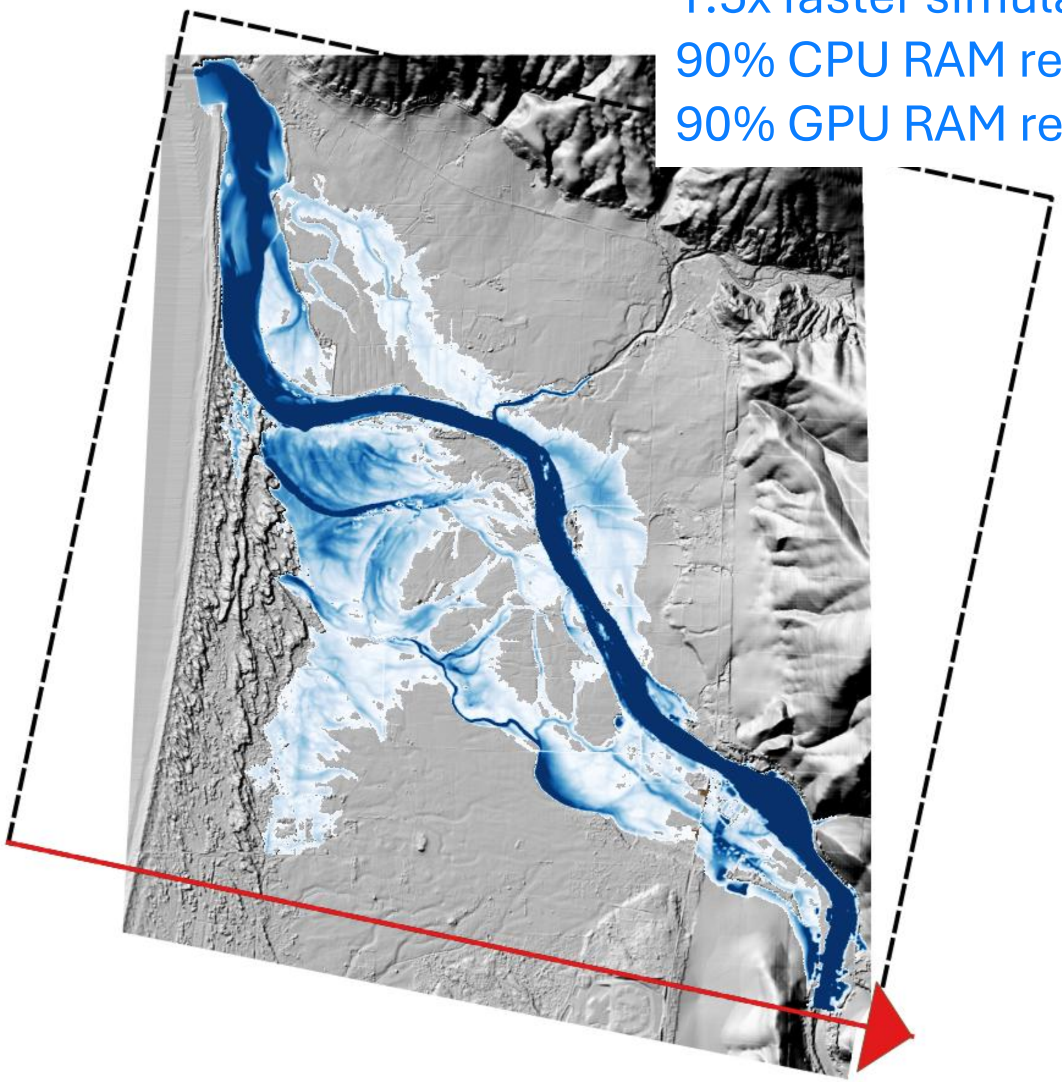
Domain Extent Review / Update

Nesting your computational domain closely around your active model area will configure your model to best use its available compute resources

Geometry Control File (TGC):

- Set model origin and orientation
  Read GIS Location ==
- Set domain extent
  Grid Size (x,y) ==



1.5x faster simulation
90% CPU RAM reduction
90% GPU RAM reduction

Minimum Timestep Review

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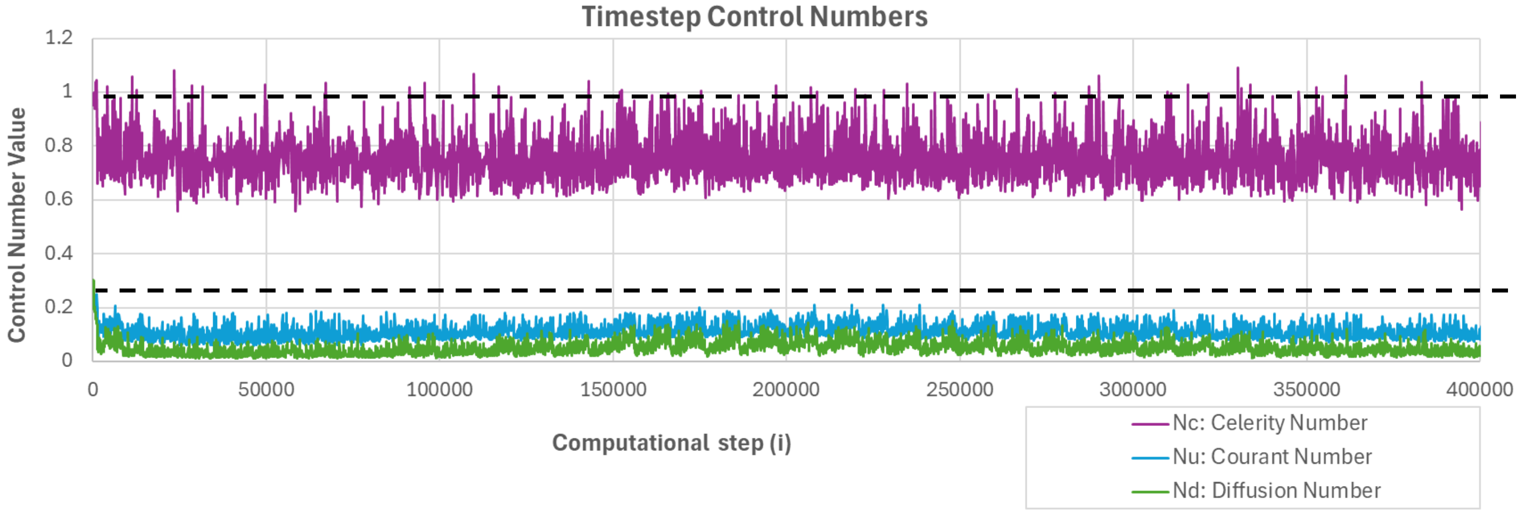
1. Enable dt output. TUFLOW Control File (TCF): *Map Output Data Types == dt, h…*
2. Review *.hpc.dt.csv* or *Flood Platform QA plots* to identify the dominant control number
   - Wave Celerity Number
   - Courant Number
   - Diffusion Number
3. Review computational timestep values
4. Review the model features and results at the location of minimum timestep
5. Fix the model input error + repeat steps until all errors are resolved

Learn more:

https://wiki.tuflow.com/HPC_Adaptive_Timestepping

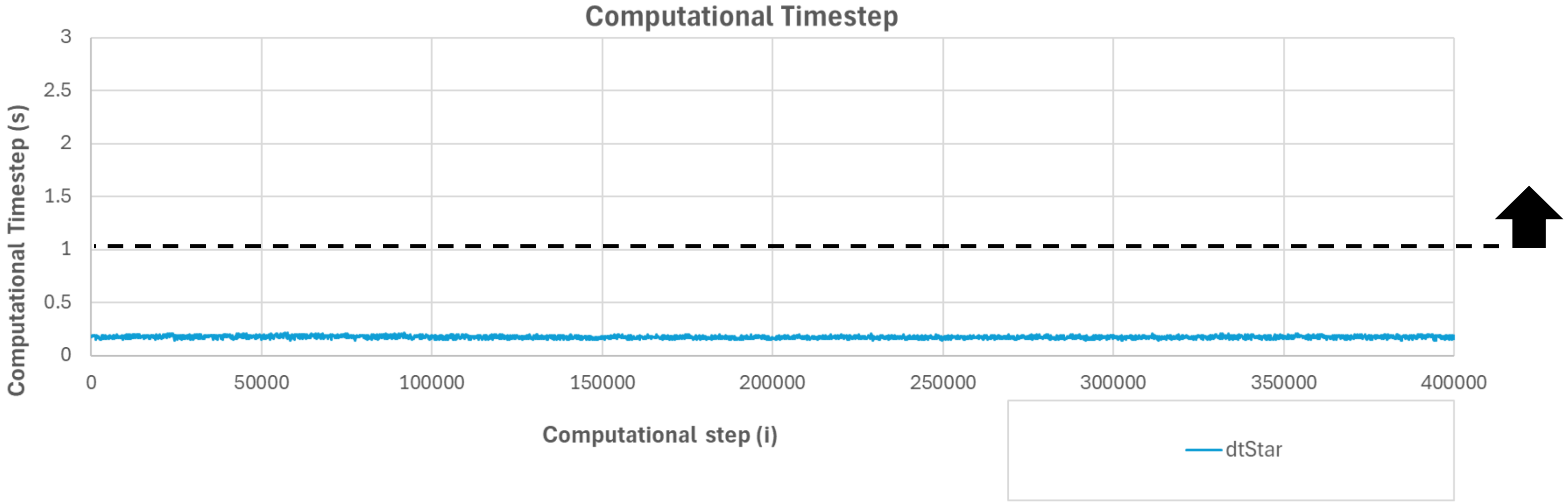
https://wiki.tuflow.com/HPC_Model_Review

Minimum Timestep Review



Nc: Celerity Number (Stability Limit = 1)
Nu: Courant Number (Stability Limit = 1)

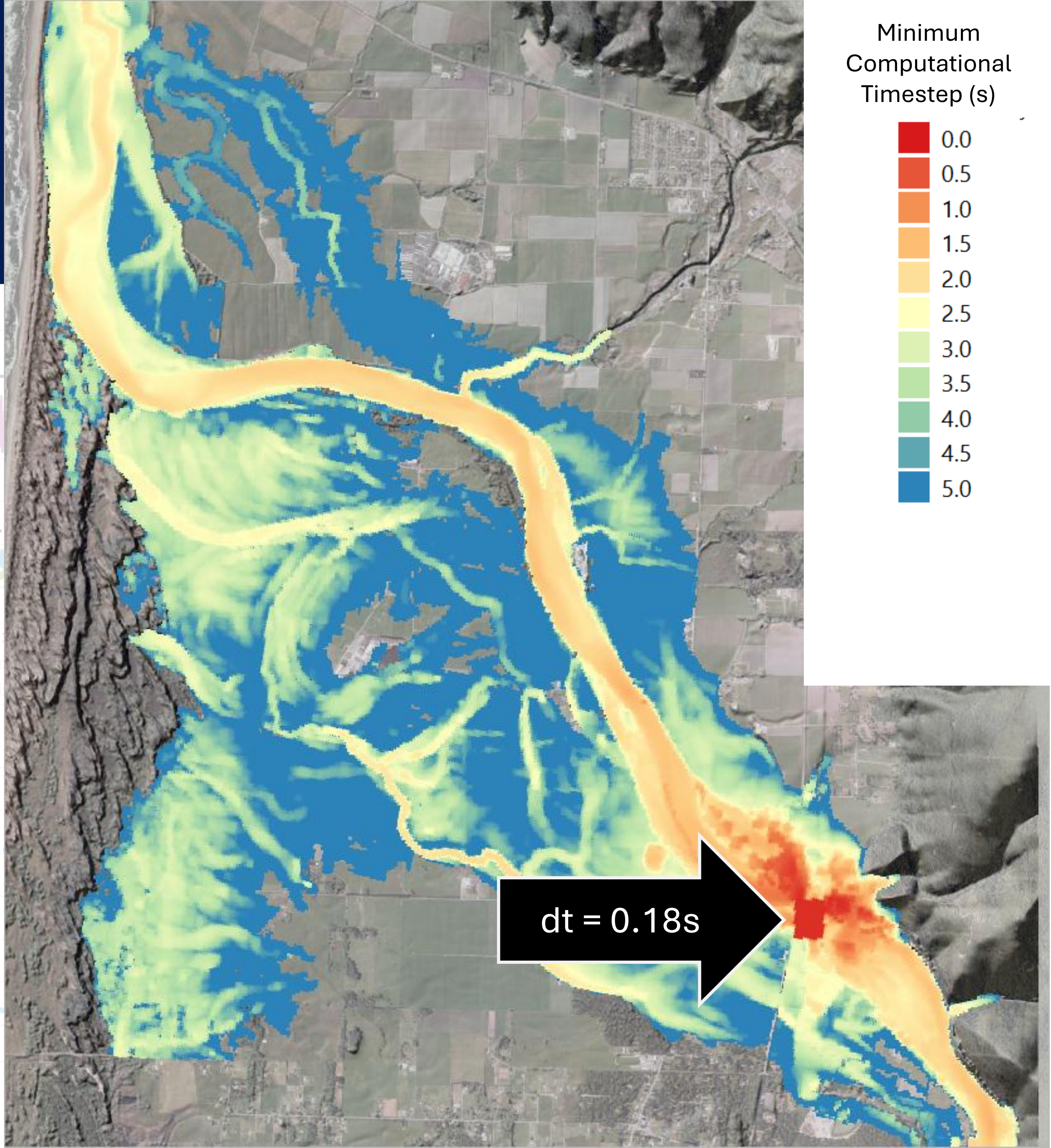
Nd: Diffusion Number (Stability Limit = 0.3)



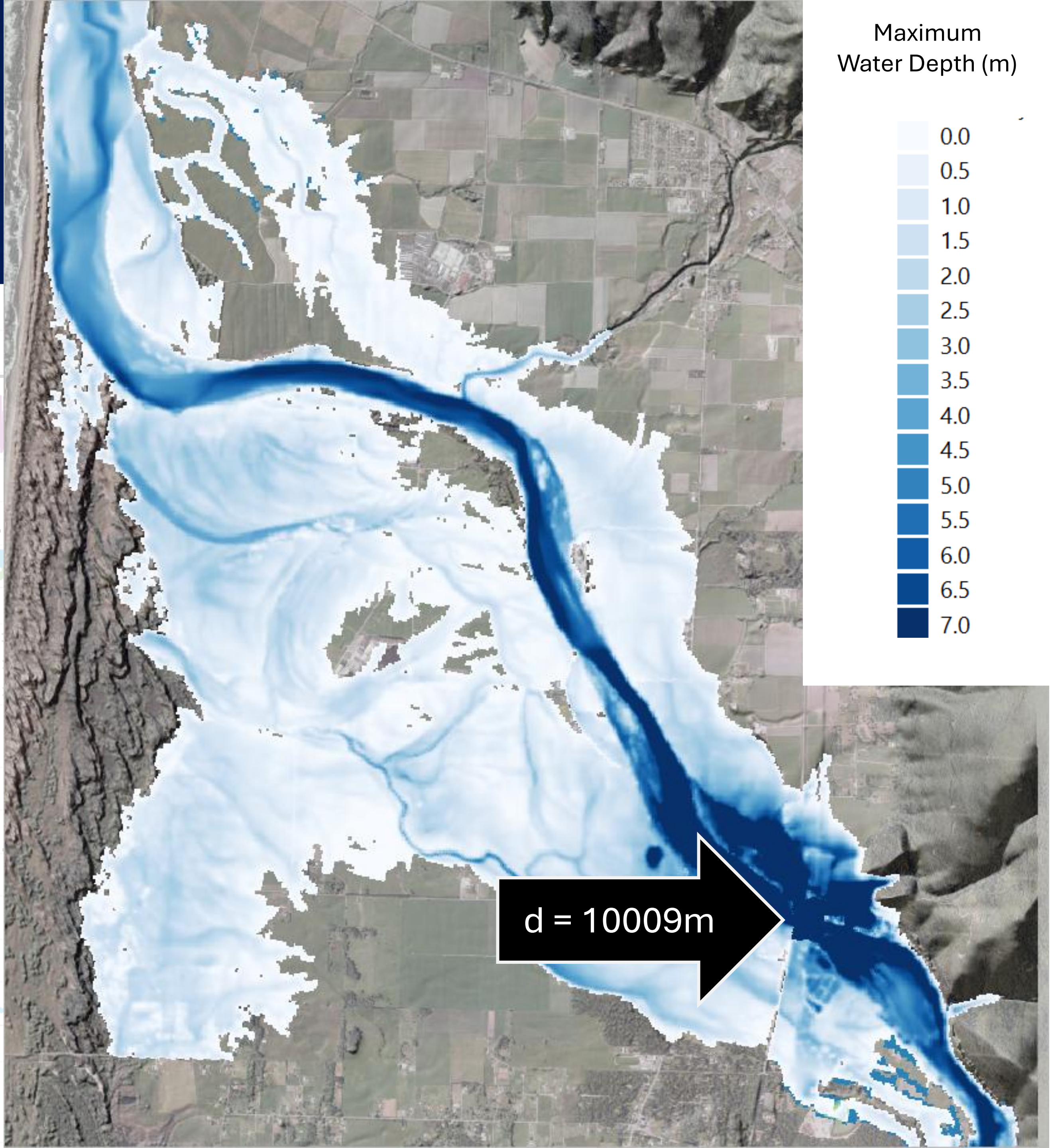
Celerity Controlled "Healthy" Timestep
~ >1/20 2D cell size (m)

20m 2D cell size: 1s

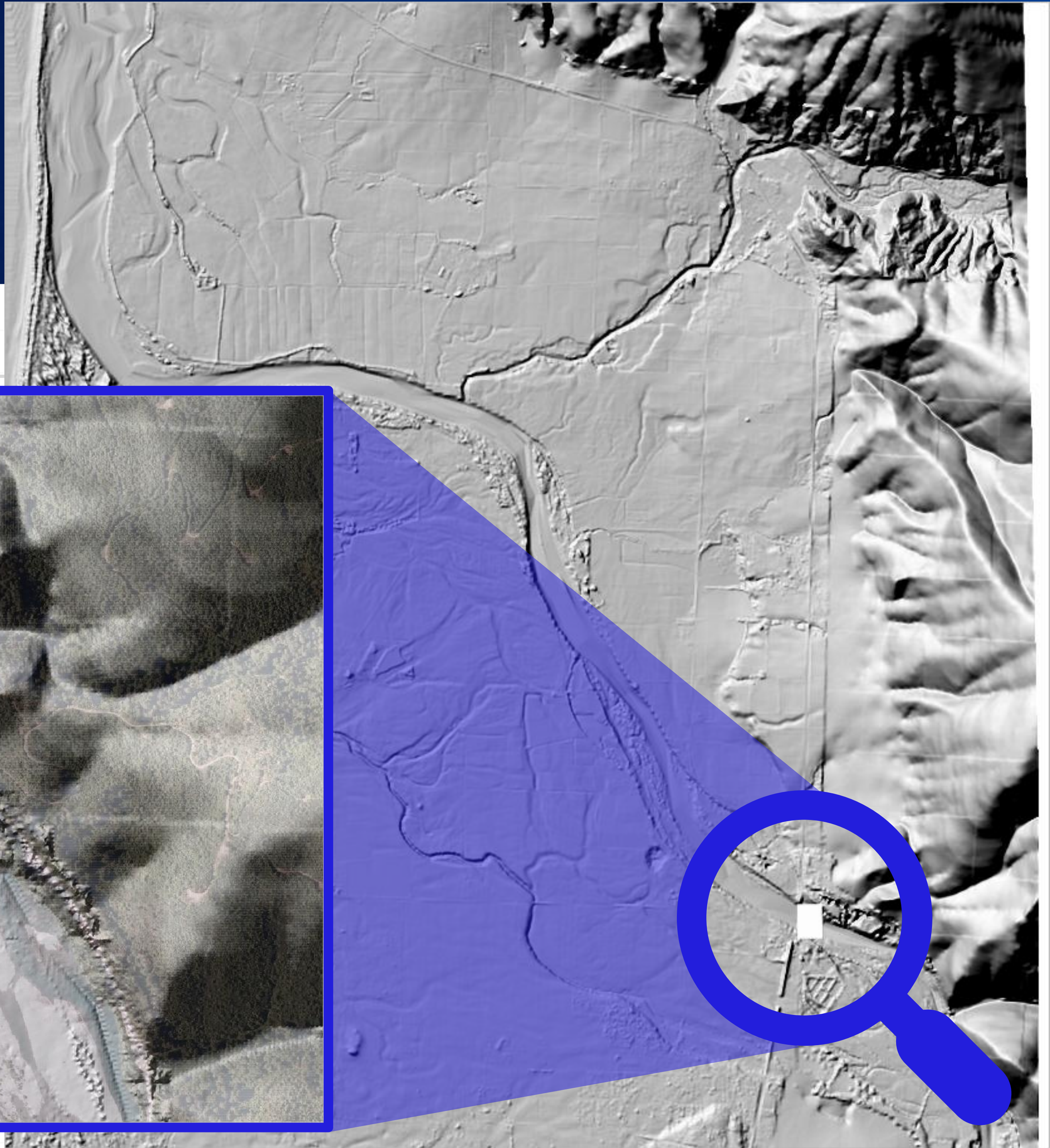
Minimum Timestep Review



Minimum Timestep Review



Minimum Timestep Review



Minimum Timestep Review

Nc: Celerity Number (Stability Limit = 1)

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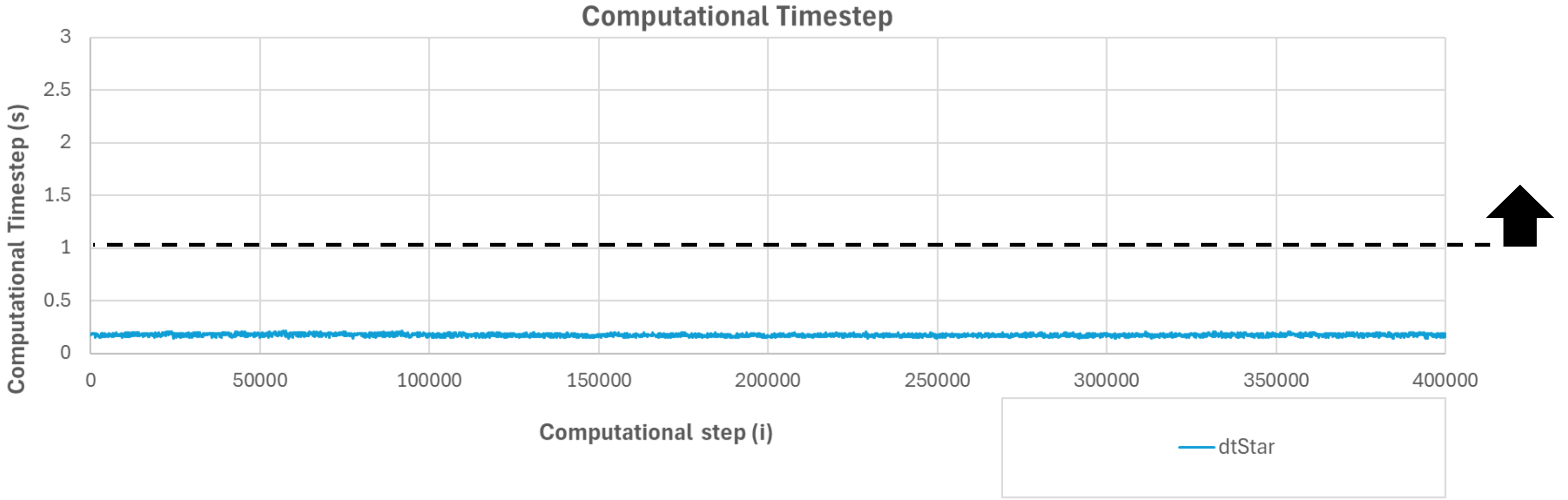
Nd: Diffusion Number (Stability Limit = 0.3)

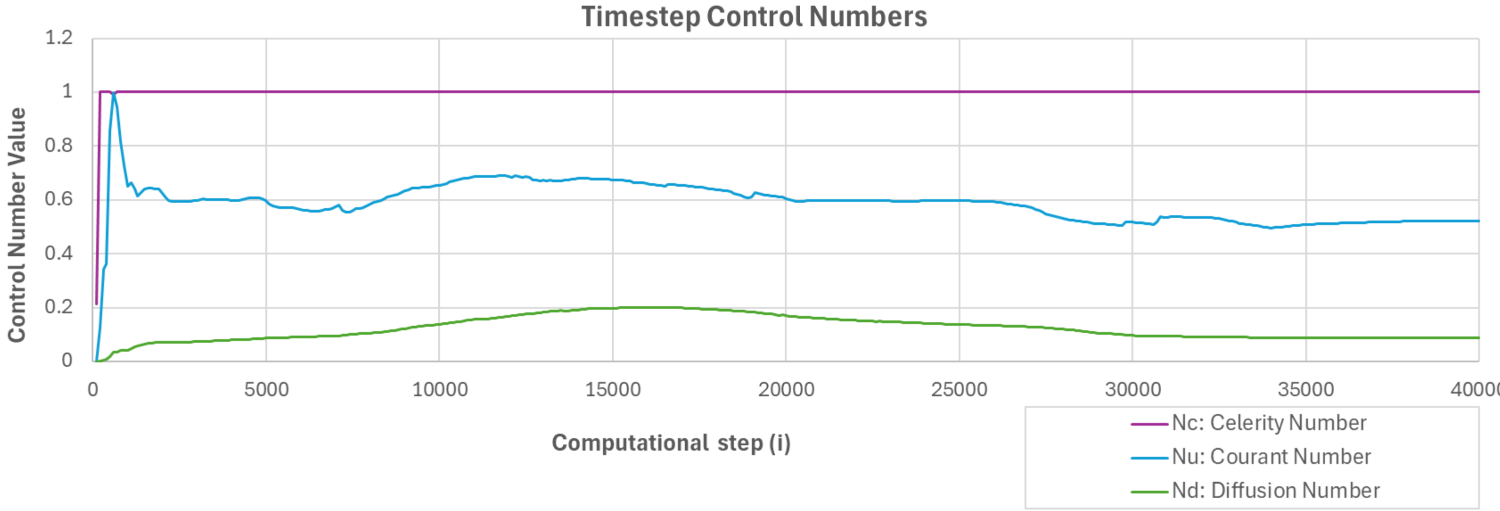


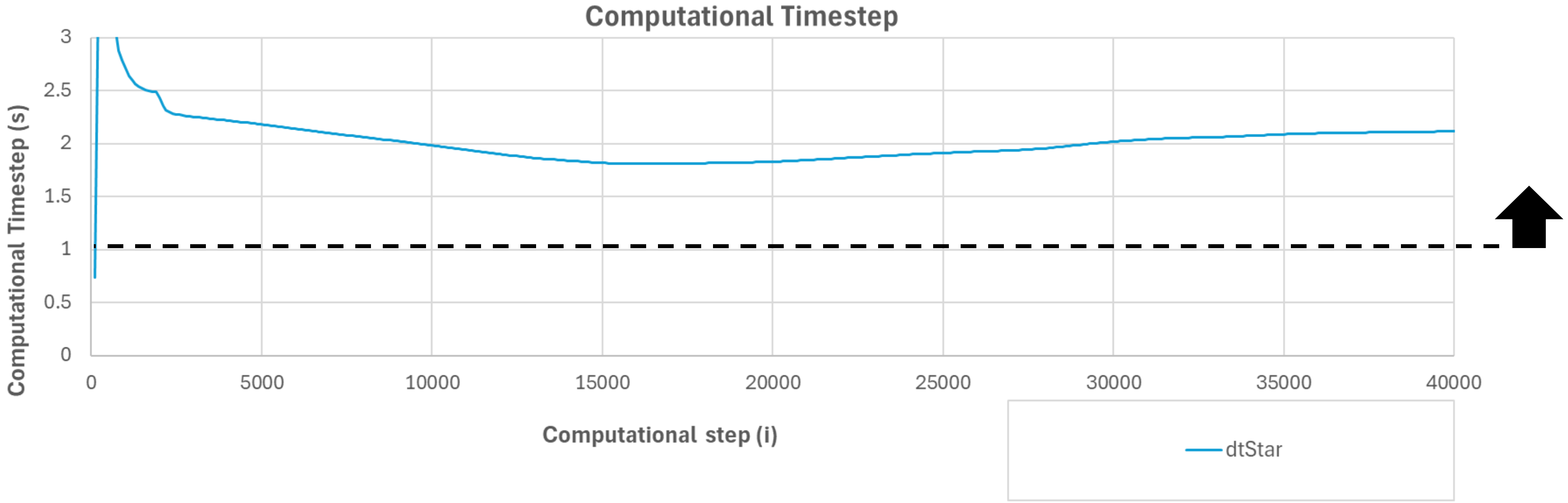
Celerity Controlled "Healthy" Timestep

>1/20 2D cell size (m)

20m 2D cell size: 2s

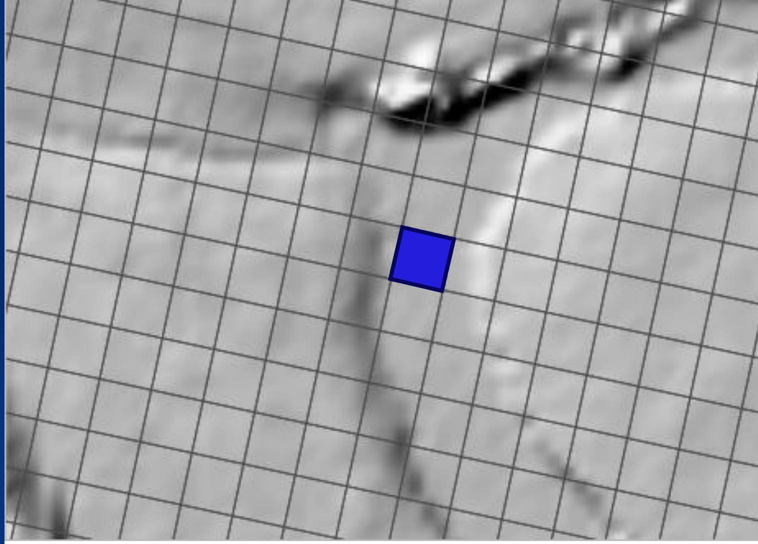
Minimum Timestep Review





Celerity Controlled "Healthy" Timestep
~> 1/20 2D cell size (m)

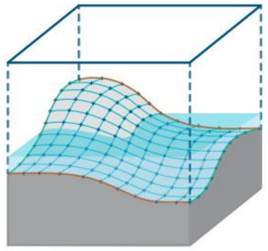
Sub-Grid Sample (SGS) Distance / Frequency



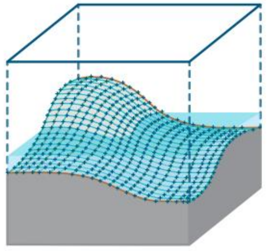
SGS Approach == Method C (default)

SGS Sample Target Distance = Minimum DEM input resolution

1. Review Sample Frequency in the TUFLOW Log File (*.tlf)
2. Set SGS Sample Target Distance / SGS Sample Frequency



SGS Sample Frequency = 11



SGS Sample Frequency = 21

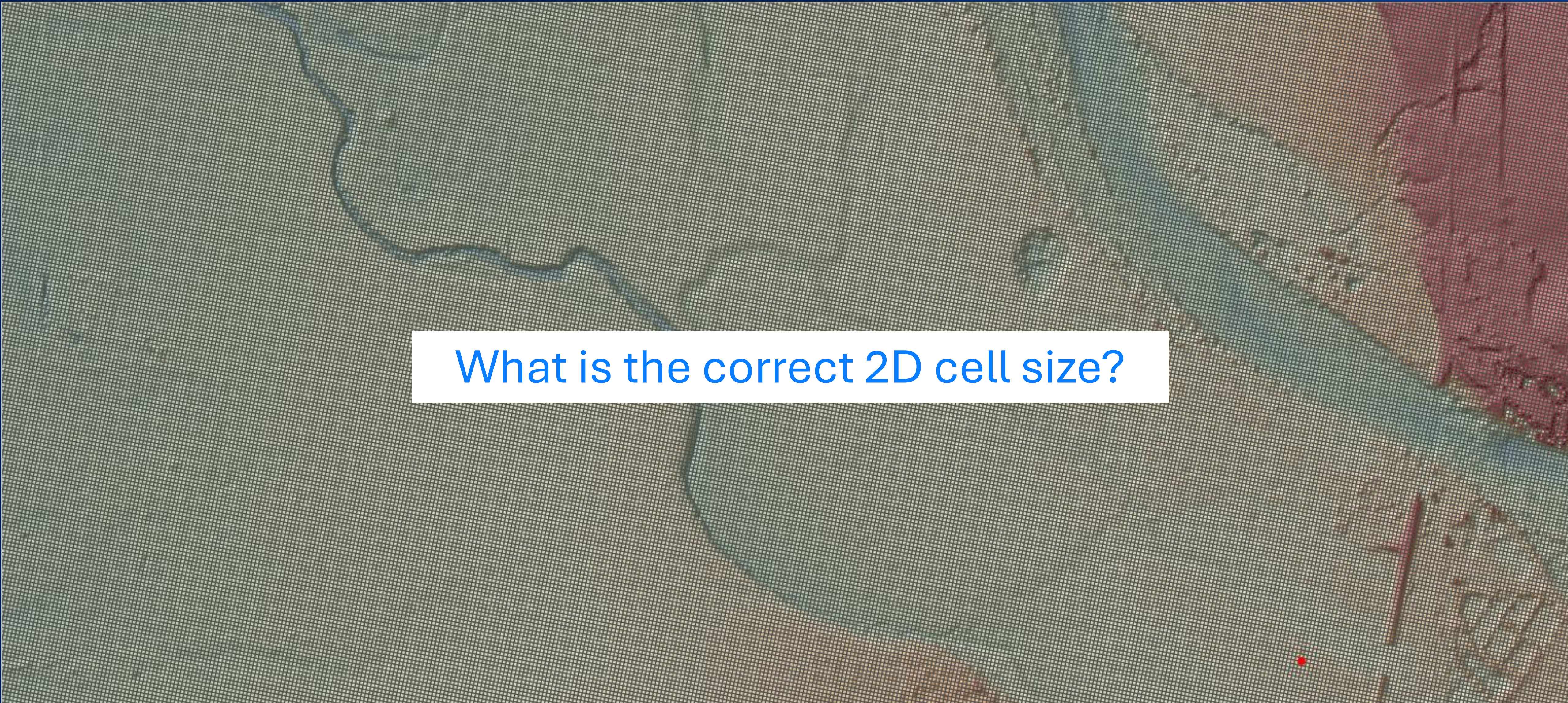
FMA_TSB_30m_Q100_007.tlf | FMA_TSB_30m_Q100_008.tlf

```

Allocating memory (RAM) for storing elevations at SGS sampling points (SGS Approach == Method C)
Checking SGS Sample Frequency for memory allocation...

SGS sampling:
Domain 1, Cell Size 30., Sample Frequency 11, Sample Distance 3.

SGS Sample Frequency == 11
```

1.3x faster simulation than previous model iteration

Further 80% CPU RAM reduction

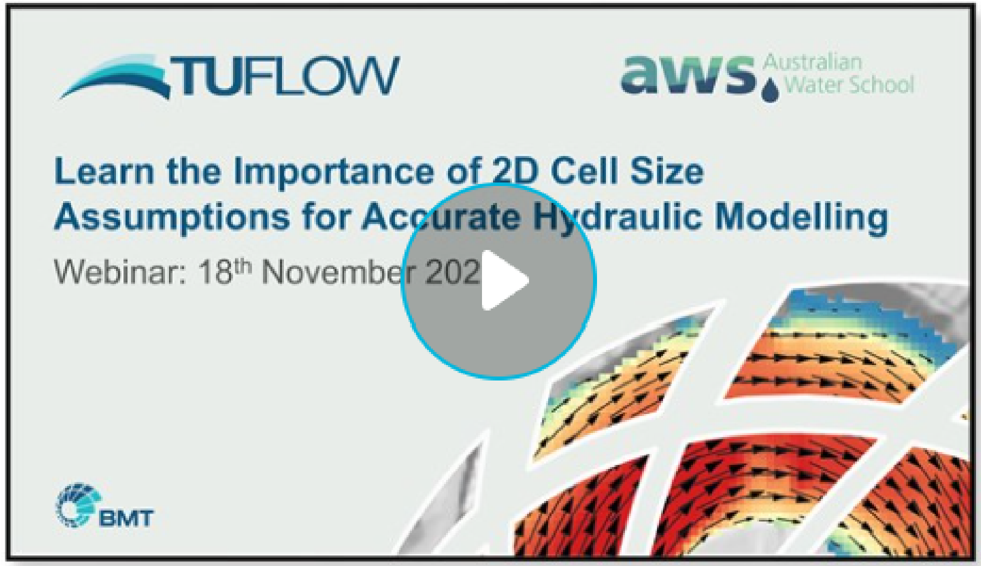
2D Cell Size Selections



2D Cell Size Selections

Nov, 2020: 2D Cell Size Selection for Accurate Hydraulic Modelling

One size does not fit all. Hydraulic models need to be designed to suit the site-specific topography, hydrology and also study purpose. Chris Huxley leads this webinar stepping through a best practice workflow to guide your 2D hydraulic model design and build.



https://www.tuflow.com/library/webinars/

2D Cell Size Selections

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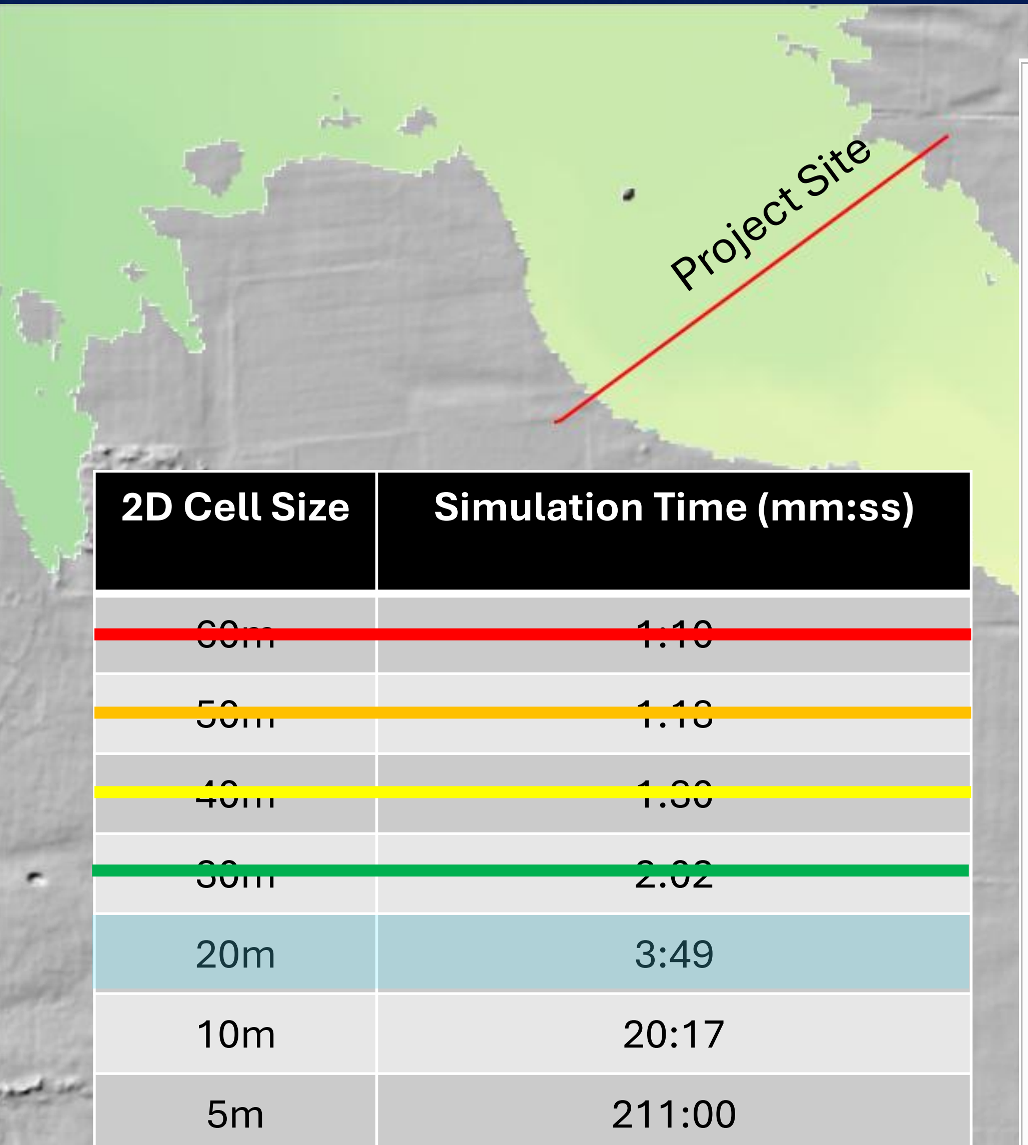
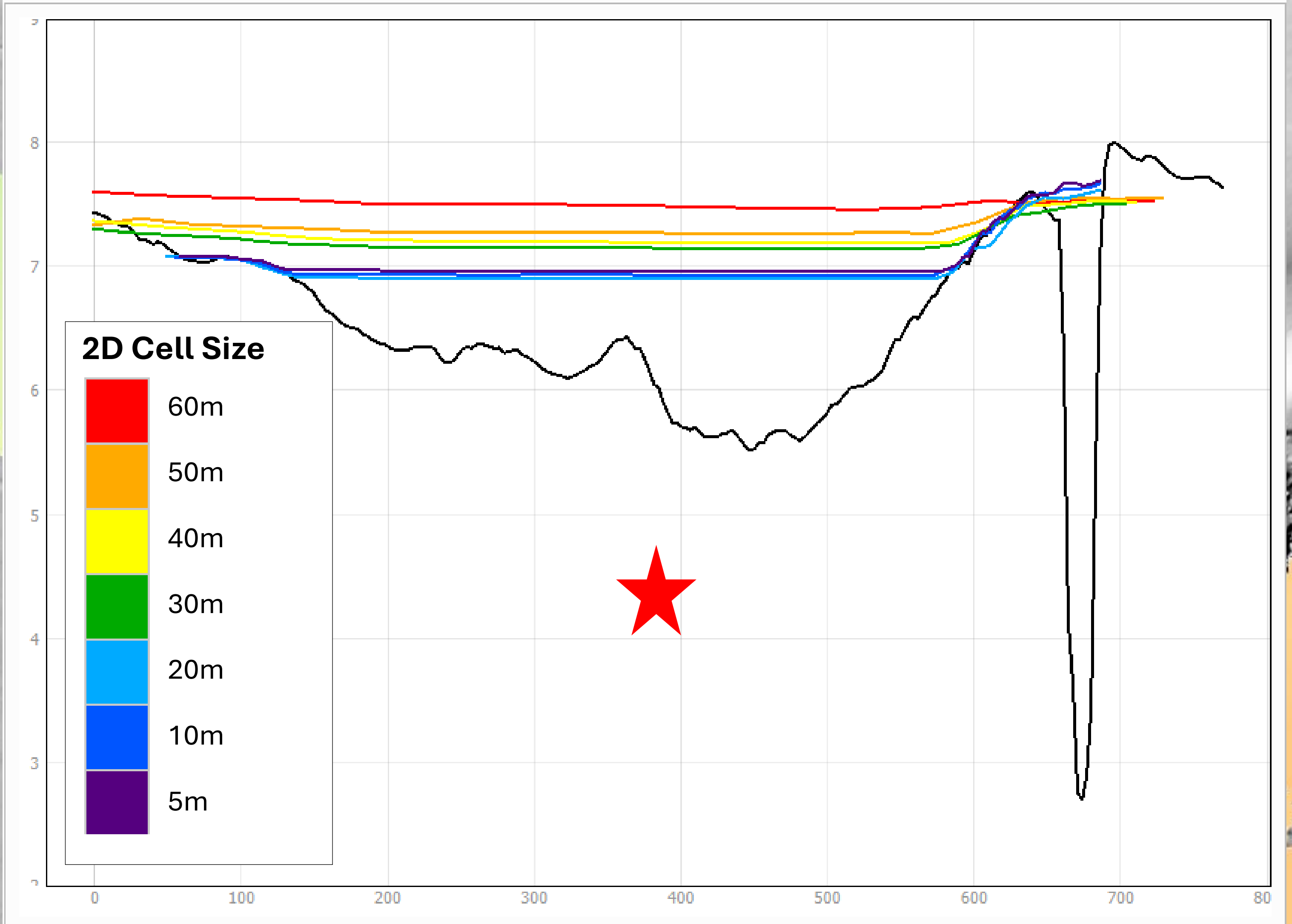


2D Cell Size	Simulation Time (mm:ss)
60m	1:10
50m	1:18
40m	1:30
30m	2:02
20m	3:49
10m	20:17
5m	211:00



FMA_TSB_20m_Q100_008

#2392 - 01 Dec 2025 | Delete run | Export simulation | View results | Add to queue

ESTRY 1D & TUFLOW 2D | Input File | Logs | Simulation Processing Events | Solver Events | Run Processing Events

Solver	Version	Arguments	Description	Bdy
ESTRY 1D & TUFLOW 2D	008	-s1 20m -e1 Q100	Time 0:03:49	Q100
AEP%	**Scenario**	**End Time**	**Timestep**	**Solution Scheme**
1%	Unknown	24	1	HPC
Hardware	**TUFLOW Version**	**TUFLOW Precision**	**Simulation Status**	**Simulation Time**
GPU	2025.1.2	Single Precision	FINISHED	24

Simulation
7 minutes (AU$0.12)

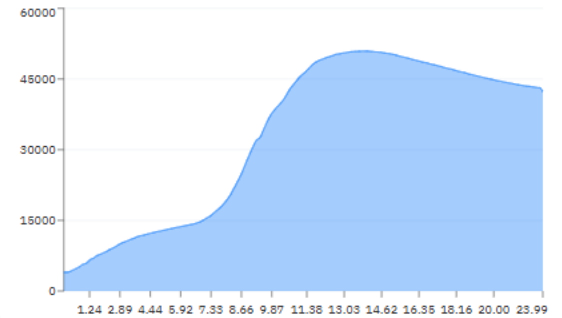
Processing
6 minutes (AU$0.02)

100%
Complete

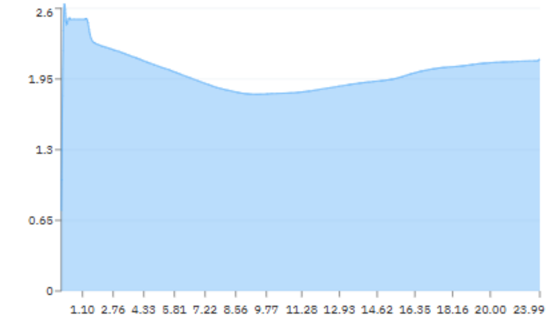
Simulation performance data

Computational Steps	42,921
Total Volume In (m³)	177,855,453
Total Volume Out (m³)	164,630,125
Volume At Start (m³)	1,072,835
Volume At End (m³)	14,300,887
Volume Error (m³)	2,725
Volume Error (%)	n/a
Warnings (Simulation)	n/a
Warnings (Pre-Simulation)	2

Wet cells

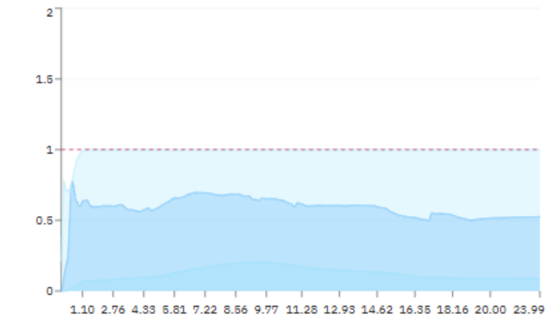


Calculated 2D timestep (dtStar)



Volume and flow

Control numbers



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Utilising cloud for mass simulations.

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Poll:

Do you have experience with cloud computing for flood simulations?

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Understanding Cloud - Benefits

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- Scalability
- No high upfront costs
- No maintenance costs
- Reduced IT management
- Resilient to power outages
- Security & backup*
- Collaborative environment*
- Access updates from anywhere*

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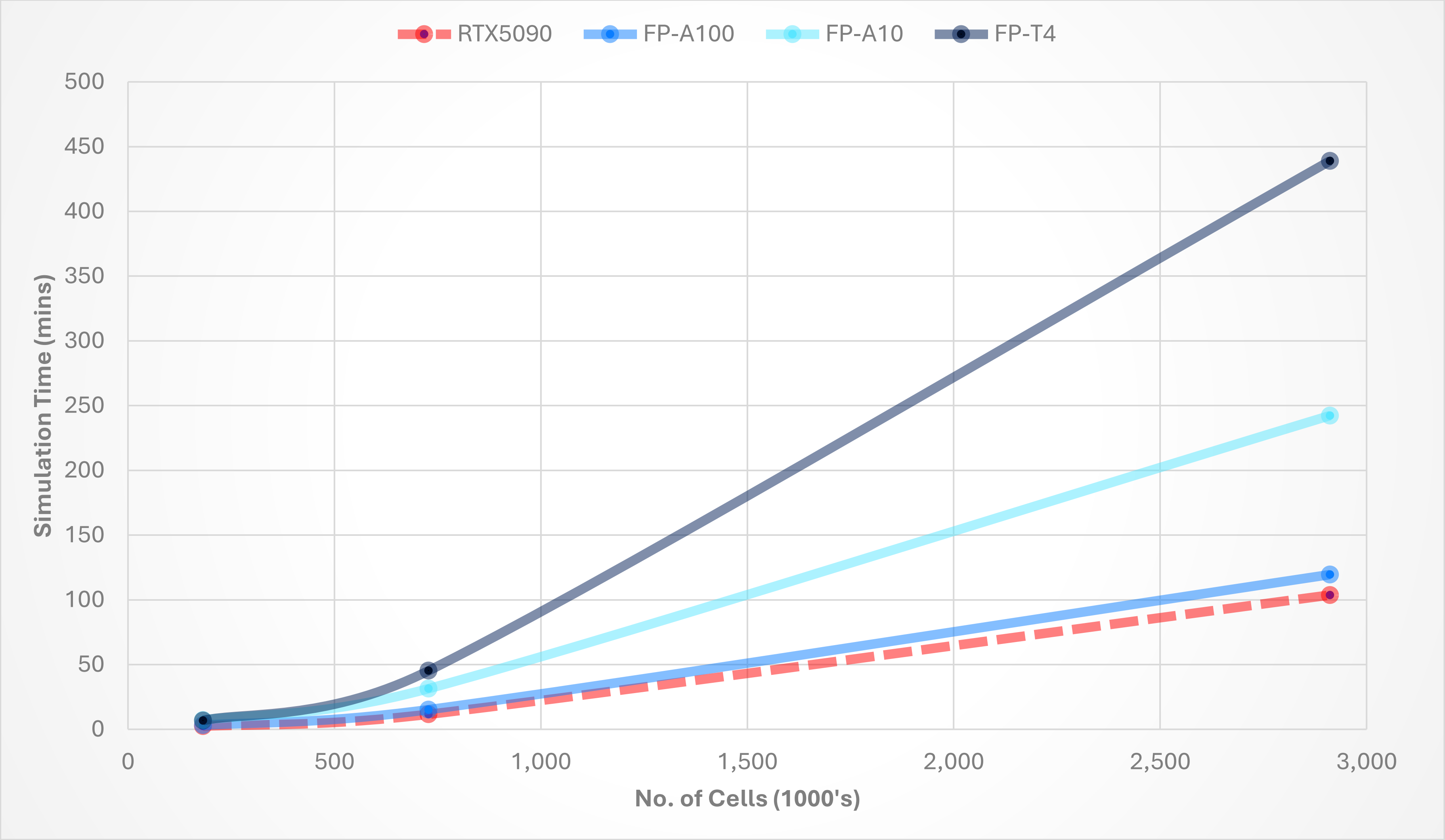
Understanding Cloud - Limitations

- Commercial hardware only
- Requires internet for data transfer
- Reliant on 3rd party platforms (ie. Azure)
- Configuration overheads*

Performance of a Simulation



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Performance of a Simulation

High End GPU Results

A number of additional benchmarking tests have been completed on a 5m and 2.5m model on a single GPU card.

Processor Name	Graphics Card**	GPU RAM (GB)	Number of CUDA Cores*	Runtime 5m (mins)	Runtime 2.5m (mins)	Combined Runtime (mins)	System Name
AMD Ryzen 9 9950X3D 16-Core Processor (32 CPUs), ~4.3GHz	NVIDIA GeForce RTX 5090	32	21760	73.3	568.7	642.0	JW3
13th Gen Intel(R) Core(TM) i9-13900KS (32 CPUs) @ 3.2GHz	NVIDIA GeForce RTX 4090	24	16384	103.3	811.2	914.5	JB1
13th Gen Intel(R) Core(TM) i9-13900K (32 CPUs) @ 3.0GHz	NVIDIA GeForce RTX 4090	24	16384	105.9	813.7	919.6	TA1
13th Gen Intel(R) Core(TM) i7-13700KF (24 CPUs), @ 3.4GHz	NVIDIA GeForce RTX 4090	24	16384	103.7	824.3	928.0	JW1
AMD Ryzen 9 7950X 16-Core Processor (32 CPUs) @ 4.5GHz	NVIDIA GeForce RTX 4090	24	16384	108.2	821.5	929.7	PSM
AMD Ryzen 9 3900X 12-Core Processor (24 CPUs) @ 3.8GHz	NVIDIA GeForce RTX 4090	24	16384	106.8	875.5	982.3	CR4
AMD Ryzen Threadripper 2950X 16-Core Processor (32 CPUs) @ 3.5GHz	NVIDIA RTX 6000 Ada Generation	48	18176	119.6	877.8	997.4	JG3
12th Gen Intel(R) Core(TM) i9-12900 (24 CPUs) @ 2.4GHz	NVIDIA GeForce RTX 4080	16	9728	139.5	1115.1	1254.6	JM3
Intel(R) Xeon(R) CPU @ 2.30GHz	NVIDIA Tesla V100	16	5120	155.2	1172.9	1328.1	FM-NODE: Tesla V100
AMD Ryzen 9 5900X 12-Core Processor	NVIDIA GeForce RTX 3090	24	10496	155.5	1176.2	1331.7	JMM
AMD Ryzen 9 3900X 12-Core Processor	NVIDIA GeForce RTX 3090	24	10496	158	1192.2	1350.2	CH3
Intel(R) Core(TM) i9-10900F CPU @ 3.70GHz	NVIDIA GeForce RTX 3090	24	10496	162.3	1192.4	1354.7	LJA
AMD Ryzen 9 5900X 12-Core Processor	NVIDIA GeForce RTX 3080 Ti	12	10240	159.7	1216.2	1375.9	GP1
12th Gen Intel(R) Core(TM) i9-12900K	NVIDIA GeForce RTX 3090	24	10496	160.9	1240	1400.9	DD2
Intel(R) Xeon(R) Silver 4114 CPU @ 2.20GHz	NVIDIA GeForce RTX 3090	24	10496	172.9	1249.8	1422.7	SIP
AMD Ryzen 9 3900X 12-Core Processor	NVIDIA GeForce RTX 3080	10	8704	178.9	1363.9	1542.8	KW2
Intel(R) Core(TM) i9-9900KF CPU @ 3.60GHz	NVIDIA GeForce RTX 2080 Ti	11	4352	203.8	1523.9	1727.7	ACH
AMD Ryzen Threadripper 2950X 16-Core Processor	NVIDIA TITAN RTX	24	4608	201.2	1548.1	1749.3	JGR
Intel(R) Core(TM) i9-9900K CPU @ 3.60GHz	NVIDIA GeForce RTX 2080 Ti	11	4352	220.0	1634.5	1854.5	MA1
Intel(R) Core(TM) i7-7820X CPU @ 3.60GHz	NVIDIA GeForce RTX 2080 Ti	11	4352	222.2	1648.7	1870.9	JPI
Intel(R) Core(TM) i7-9700K CPU @ 3.60GHz (8 CPUs), ~3.6GHz	NVIDIA GeForce RTX 2080 Ti	11	4352	215.9	1678.7	1894.6	PA2
AMD EPYC 74F3 24-Core Processor (36 CPUs), ~3.2GHz	NVIDIA A10-24Q	22	9216	242.3	1856.5	2098.8	YW1
Intel(R) Core(TM) i9-9900K CPU @ (5.10GHz)	NVIDIA GeForce RTX 2080 (core 2100MHz, mem 8000MHz)	8	2944	241.2	1863.5	2104.7	RRB
AMD Ryzen 9 5950X 16-Core Processor	NVIDIA GeForce RTX 3070	8	5888	248.7	1928.6	2177.3	JG2
Intel(R) Core(TM) i9-9900KF CPU @ 3.60GHz	NVIDIA GeForce RTX 2080 SUPER	8	3072	257.3	1957.7	2215.0	RH2
Intel(R) Core(TM) i7-7700K CPU @ 4.20GHz	NVIDIA GeForce RTX 2080	8	2944	275.1	2147.4	2422.5	PM2
AMD Ryzen Threadripper 2990WX 32-Core Processor	NVIDIA TITAN Xp	12	3840	296.0	2218.4	2514.4	FLC
Intel(R) Xeon(R) CPU E5-1620 v3 @ 3.50GHz	NVIDIA GeForce GTX 1080 Ti	11	3584	298.9	2290.1	2589.0	JS1
Intel(R) Core(TM) i7-6800K CPU @ 3.40GHz	NVIDIA GeForce GTX 1080 Ti	11	3584	311.3	2345.1	2656.4	615
Intel(R) Core(TM) i7-6850K CPU @ 3.60GHz	NVIDIA GeForce GTX 1080 Ti	11	3584	310.3	2377.2	2687.5	RCD
Intel(R) Core(TM) i7-8700K CPU @ 3.70GHz	NVIDIA GeForce GTX 1080 Ti	11	3584	308.7	2384.7	2693.4	RH1
Intel(R) Core(TM) i7-7700K CPU @ 4.20GHz	NVIDIA GeForce GTX 1080 Ti	11	3584	311.9	2404.9	2716.7	PM1
Intel(R) Core(TM) i7-7820X CPU @ 3.60GHz	NVIDIA GeForce GTX 1080 Ti	11	3584	324.8	2475.3	2800.1	HNM
Intel(R) Core(TM) i7-6900K CPU @ 3.20GHz	NVIDIA GeForce GTX 1080	8	2560	439.0	3379.3	3818.2	BLK
Intel(R) Core(TM) i7-7700K CPU @ 4.20GHz	NVIDIA GeForce GTX 1070	8	1920	475.5	3788.2	4263.7	SKI

FP-A100

FP-A10

FP-T4

Image: https://wiki.tuflow.com/Hardware_Benchmarking_-_Results#GPU_Results

Costs of a Simulation

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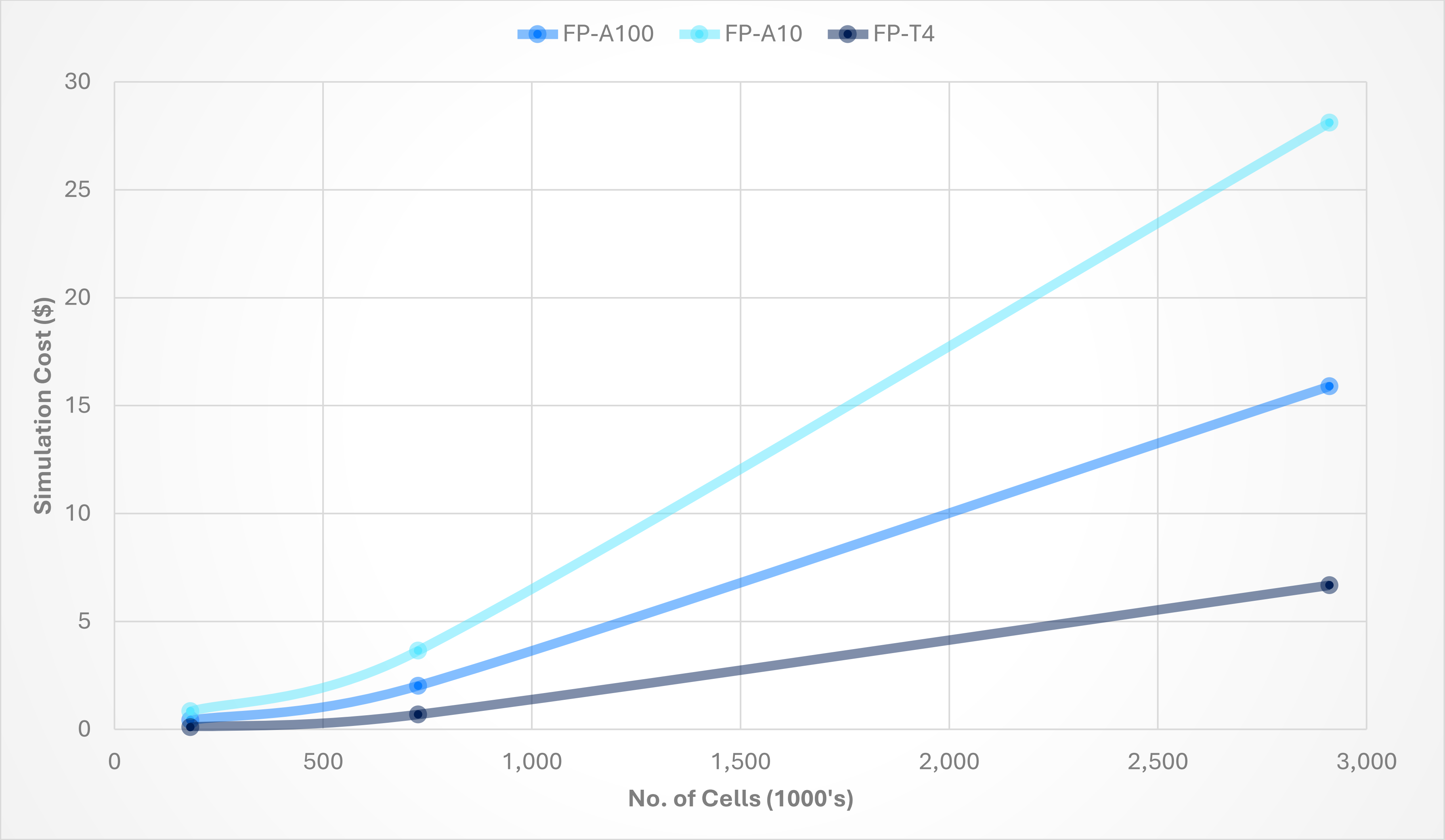
T4 ~$1/hr

A10 ~ $6/hr

A100 ~$7/hr



Performance at Scale

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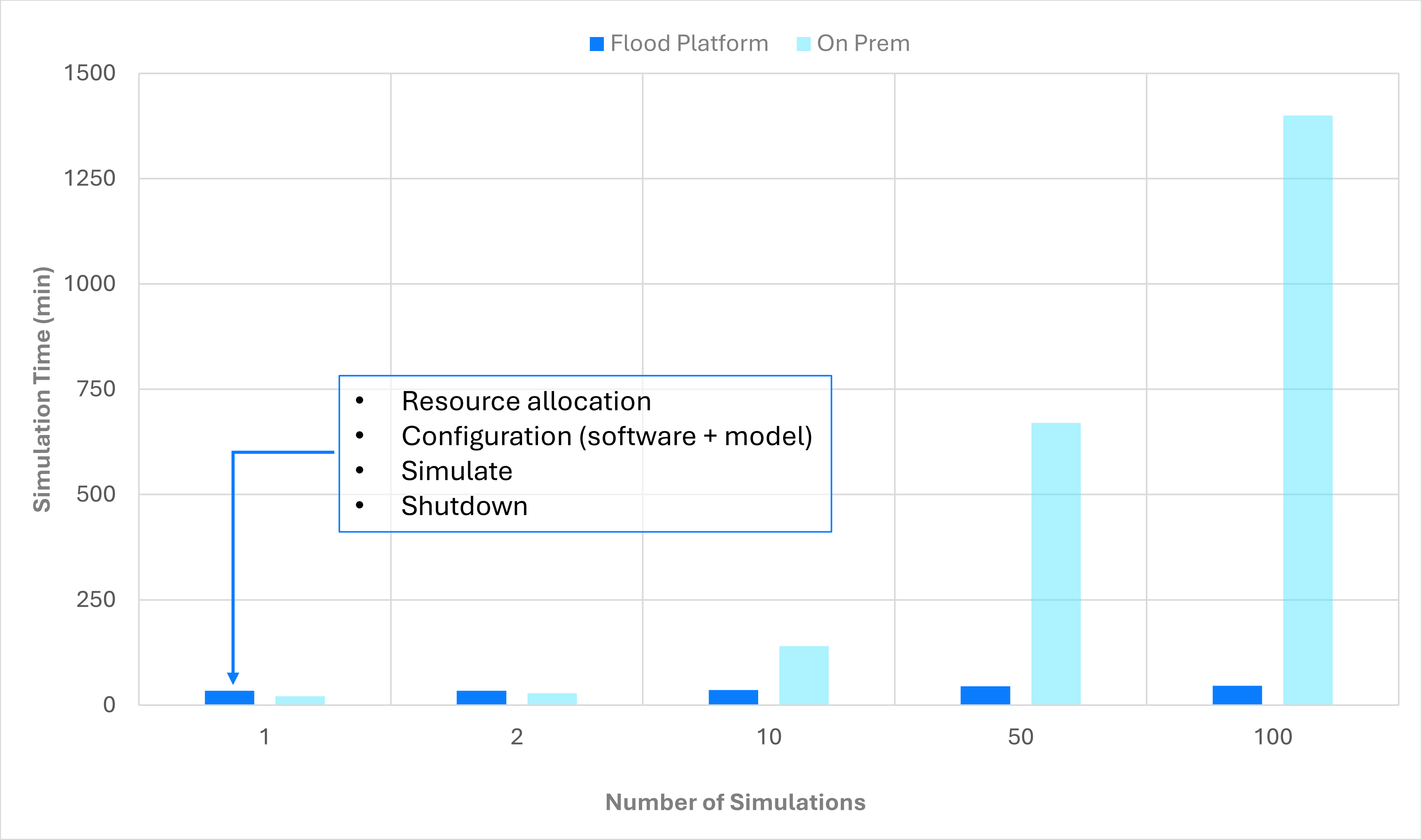

Demo.

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Webinar :: Flood Platform

https://app.floodplatform.com/projects/webinar

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- Home
- Teamspace
- Sim Queue
- Sandbox
- AUS Training 26_11_2025
- Jacobs
- Jacobs (AUS)

Sophia Buchanan

Webinar

Model Categories | Trash

+ Add model category

	Name	Description	Software Package	Spatial Resolution	Methodology	Updated	Created
☐	TUFLOW-Pluvial-1D/2D	Kirra ARR19	TUFLOW	1D/2D	Pluvial	03/12/2025	03/12/2025
☐	TUFLOW-Pluvial-2D	SGS Model Examples	TUFLOW	2D	Pluvial	03/12/2025	03/12/2025
☐	TUFLOW-Combined-1D/2D	Queanbeyan ARR19	TUFLOW	1D/2D	Combined	03/12/2025	01/12/2025

0 of 3 row(s) selected.

Rows per page 20

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CASE STUDY

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Thames Flood Mapping

THE CHALLENGE

1.4 million people and **£321 billion** of property at flood risk

100km of highly complex estuary, including barriers and defences

Robust flood risk mapping needed to support investment decisions through to 2100

THE SOLUTION

Flood Platform will enable **~250,000** simulations to be run

Provide a platform to host results for collaboration between client, stakeholders and suppliers

Facilitate review of data across all 23 Pus and 15,000 breach locations

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Q&A