

Modeling the evolution of large river floodplains



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River Chulym

Lat 57.5° Long 85.9°

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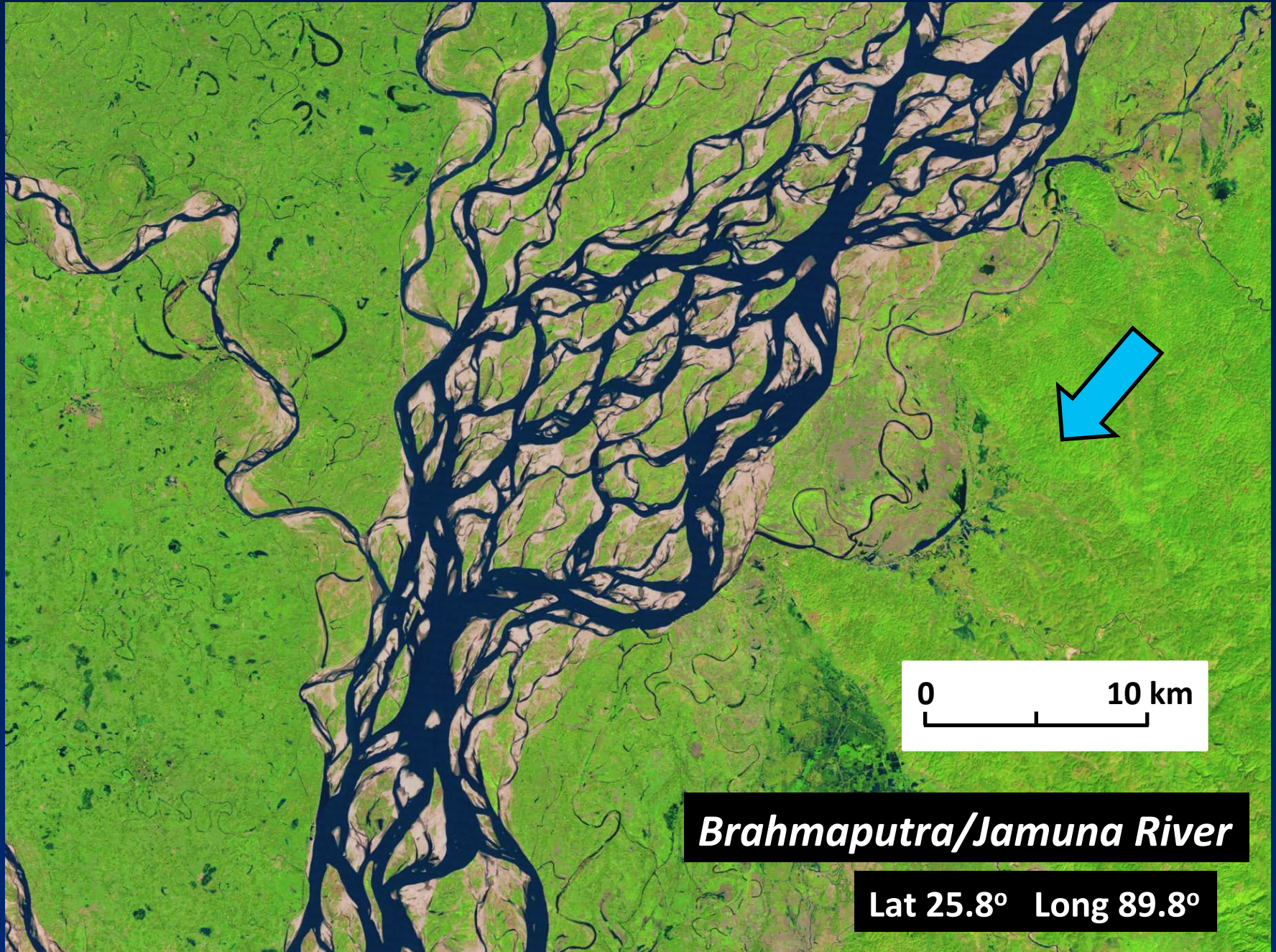
Image © 2014 Digital Globe

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Rio Beni

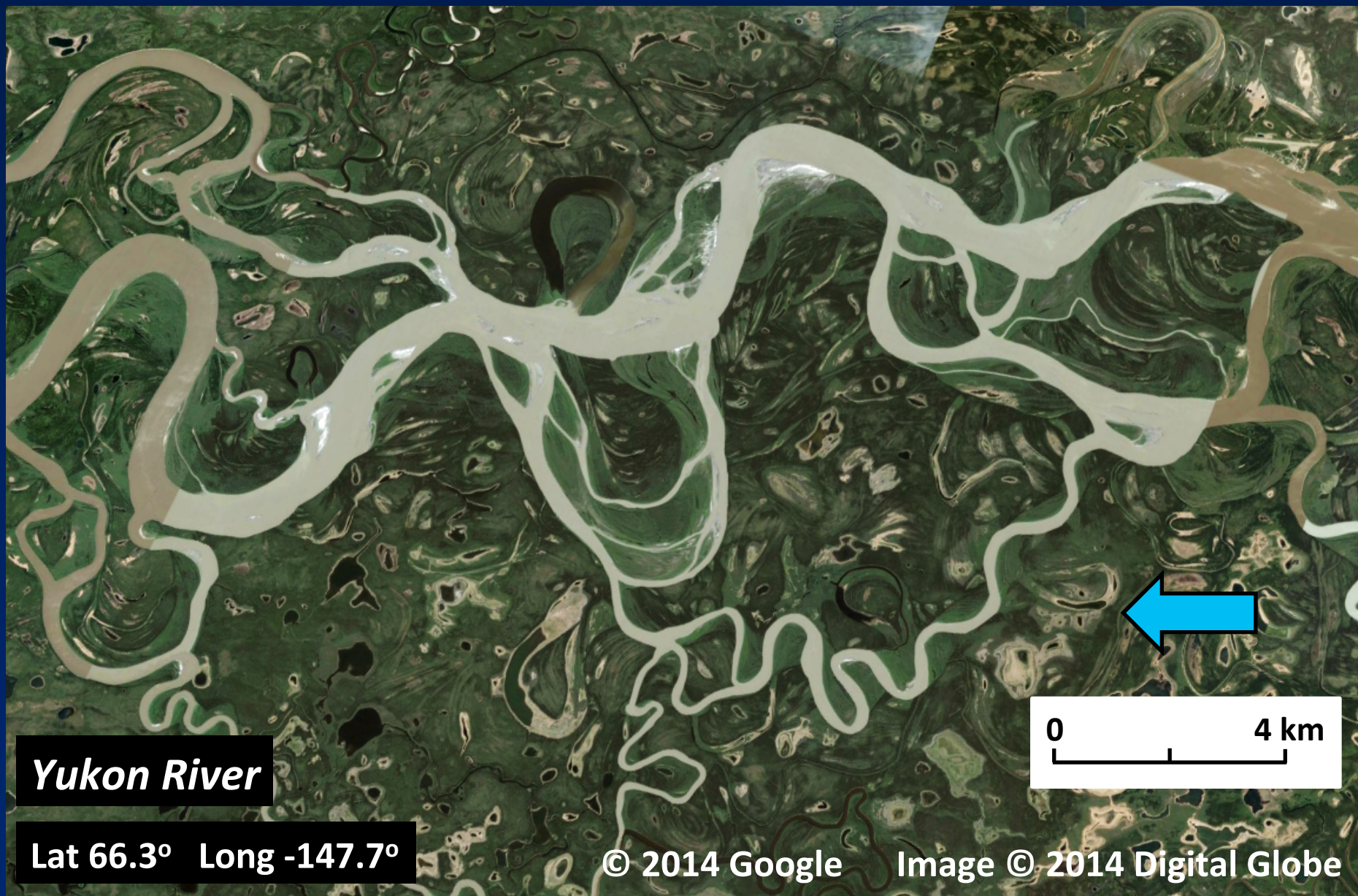
Lat -14.0° Long -67.5°



0 10 km

Brahmaputra/Jamuna River

Lat 25.8° Long 89.8°



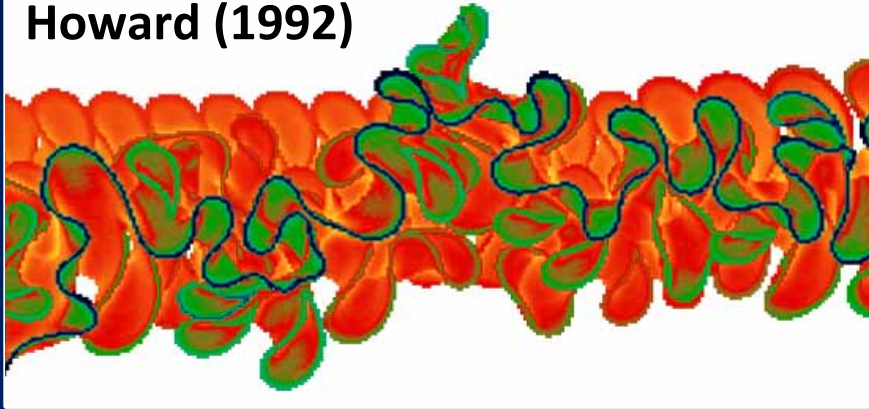
Yukon River

Lat 66.3° Long -147.7°

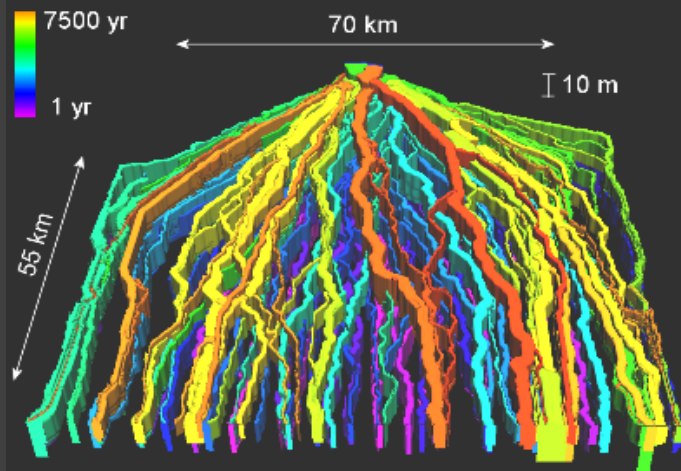
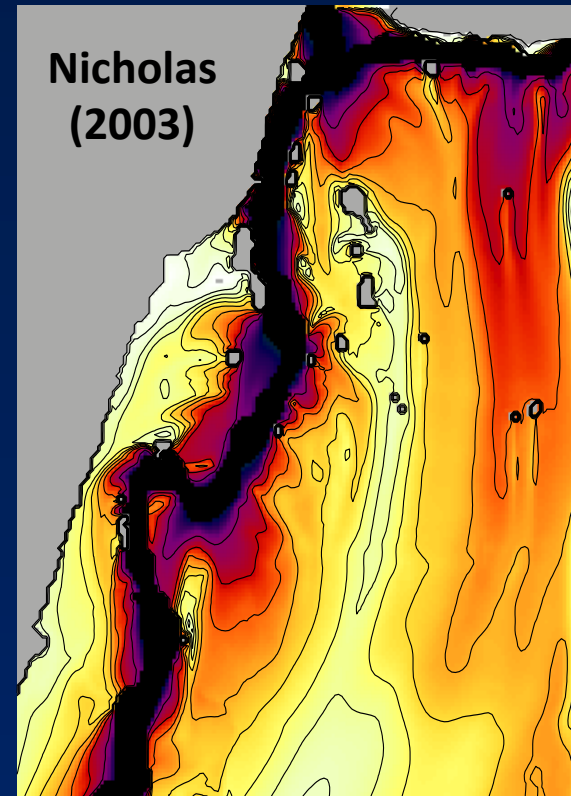
© 2014 Google Image © 2014 Digital Globe

River and floodplain models

Howard (1992)

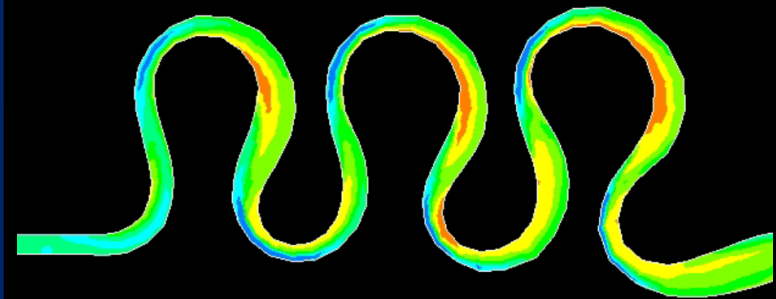


Nicholas
(2003)



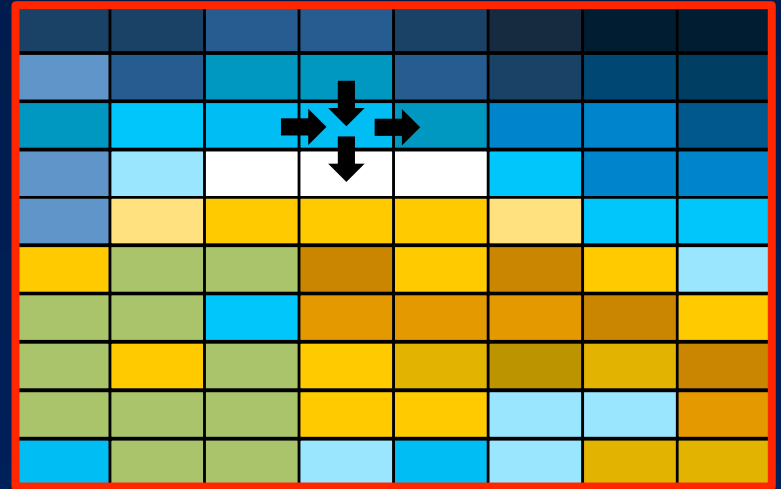
Karssenbergh & Bridge (2008)

Shimizu (2013)



High resolution approaches

- Structured and unstructured meshes
- PDEs for fluid flow and sediment transport



Models

CCHE3D

Delft3D

MIKE 21C

STREMR HySeD

HSTAR

Numerical model overview (HSTAR)

Hydrodynamics:

- 2D depth-averaged shallow water equations (with secondary circulation correction)

Sediment transport (2 size fractions):

- Total sand transport (Engelund-Hansen)
- Secondary circulation & lateral slope correction
- Silt (advection-diffusion equation)

Additional processes:

- Bank erosion (floodplain → channel)
- Vegetation growth (channel → floodplain)

Model description: Nicholas (2013) *ESPL*; Nicholas *et al.* (2013) *JGR*

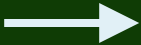
Simulation Time: 0 yr

Vegetation Age: 0 yr  200 yr

Elevation: 0 m  5 m

Depth: 0 m  20 m

D = 0.4 mm / S = 0.00005 / C = 55 / Strong banks / Slow vegetation growth

Flow 

D = 0.4 mm / S = 0.0001 / C = 40 / Weak banks / Slow vegetation growth


10 km

D = 0.2 mm / S = 0.0001 / C = 40 / Weak banks / Fast vegetation growth

Simulation Time: 0 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m



5 m

Depth: 0 m



20 m



Simulation Time: 2 yr

Vegetation Age: 0 yr  200 yr

Elevation: 0 m  5 m

Depth: 0 m  20 m



Simulation Time: 4 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m



5 m

Depth: 0 m



20 m



Simulation Time: 6 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

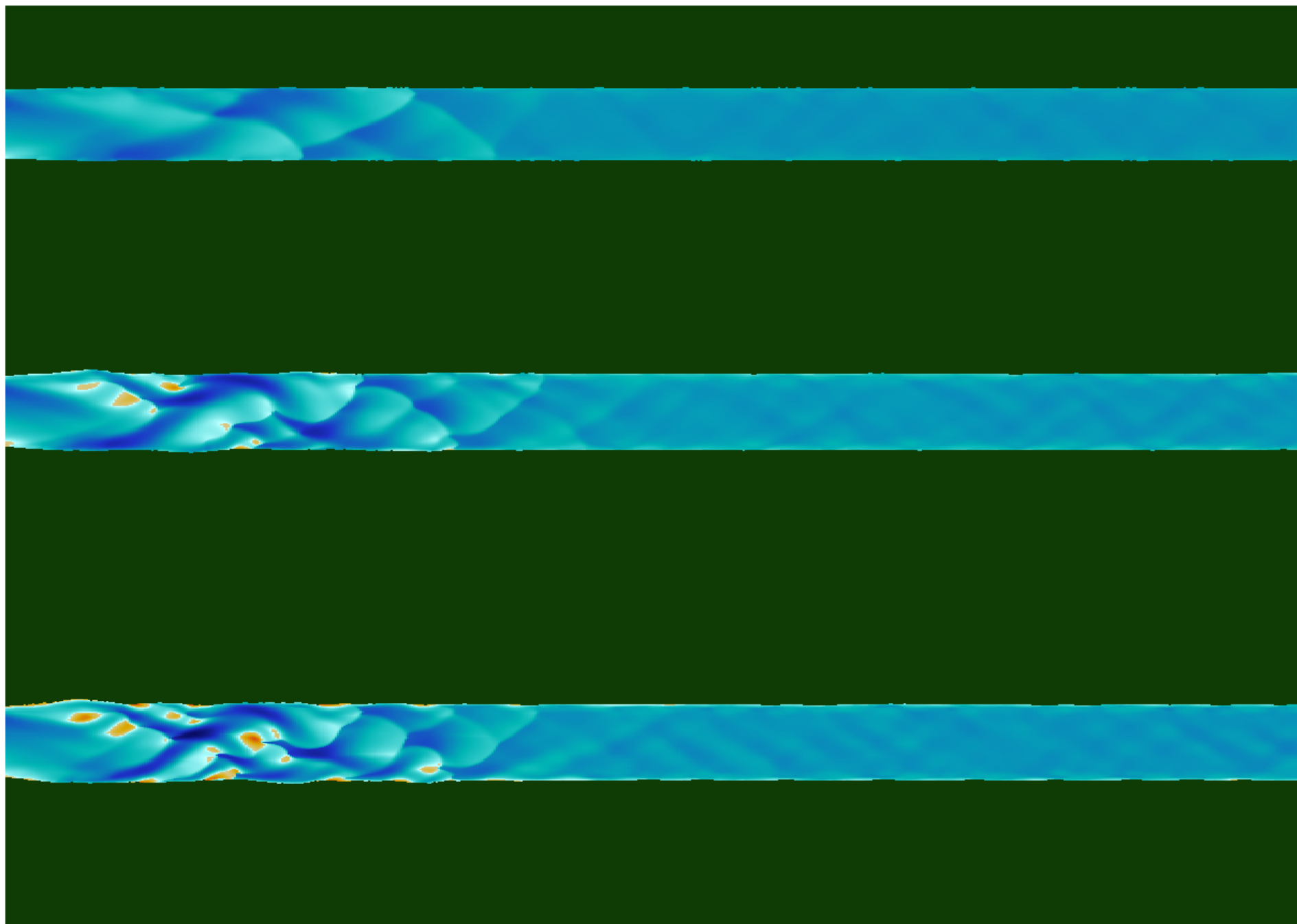


5 m

Depth: 0 m



20 m



Simulation Time: 8 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

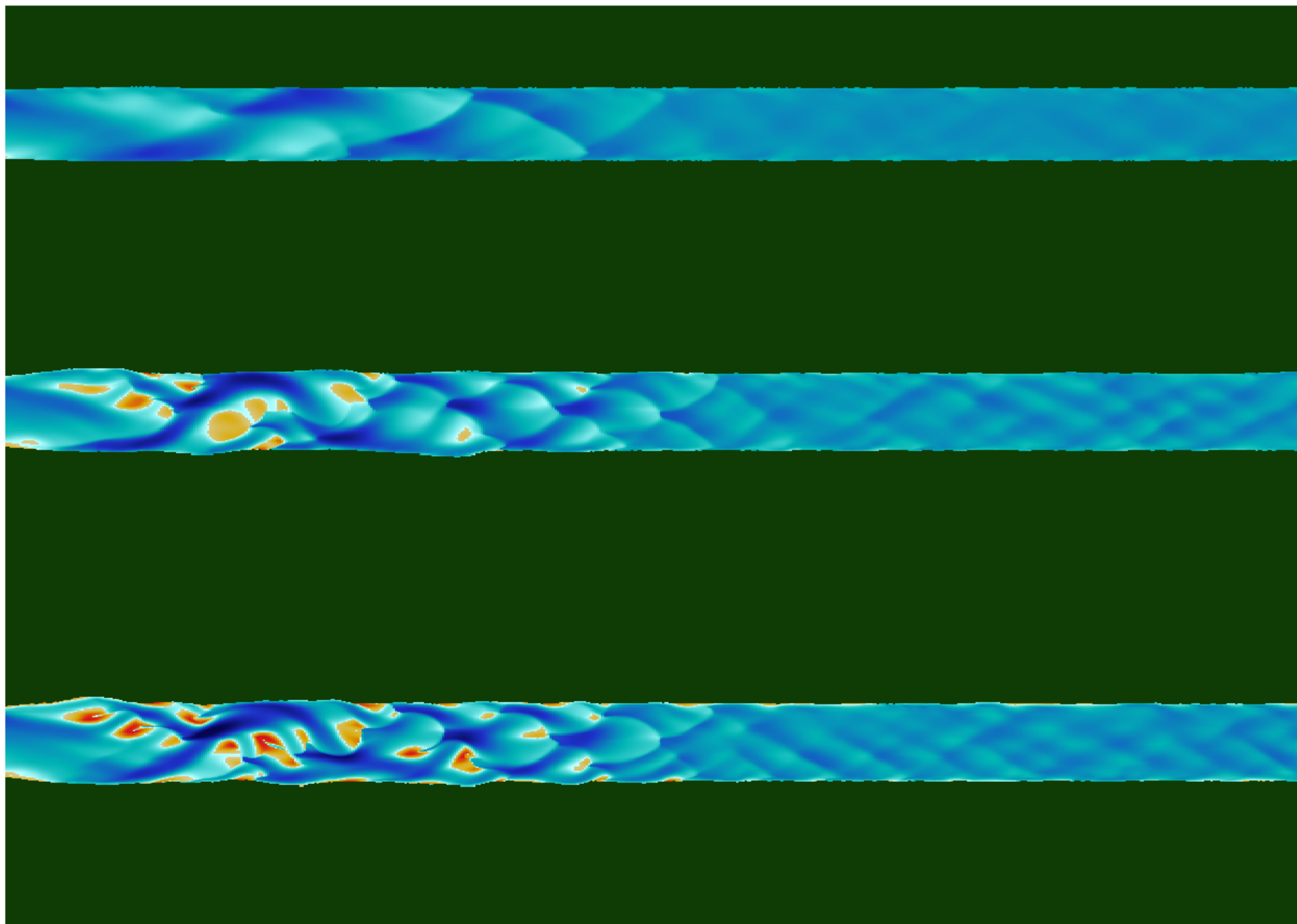


5 m

Depth: 0 m



20 m



Simulation Time: 10 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

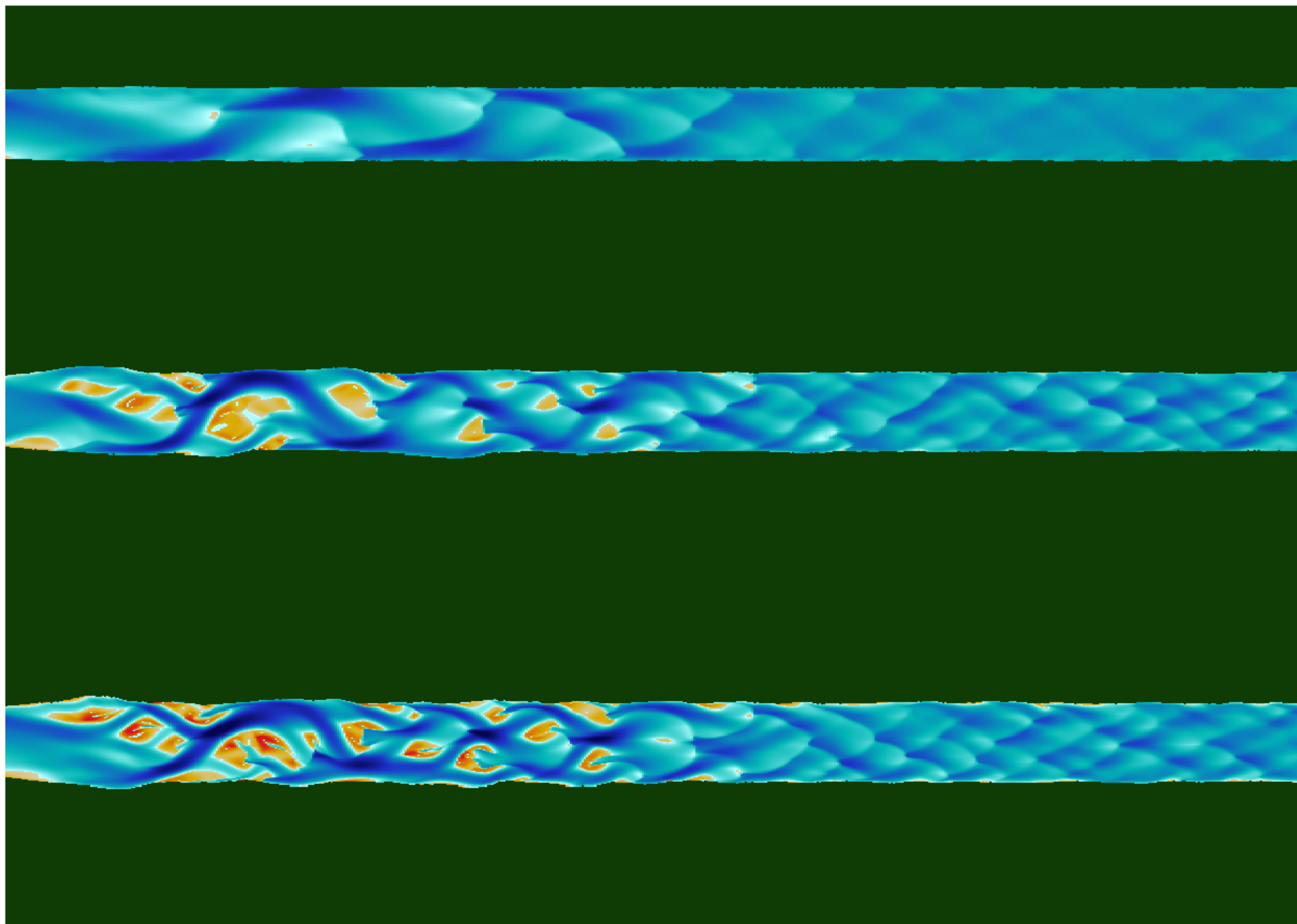


5 m

Depth: 0 m



20 m



Simulation Time: 12 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

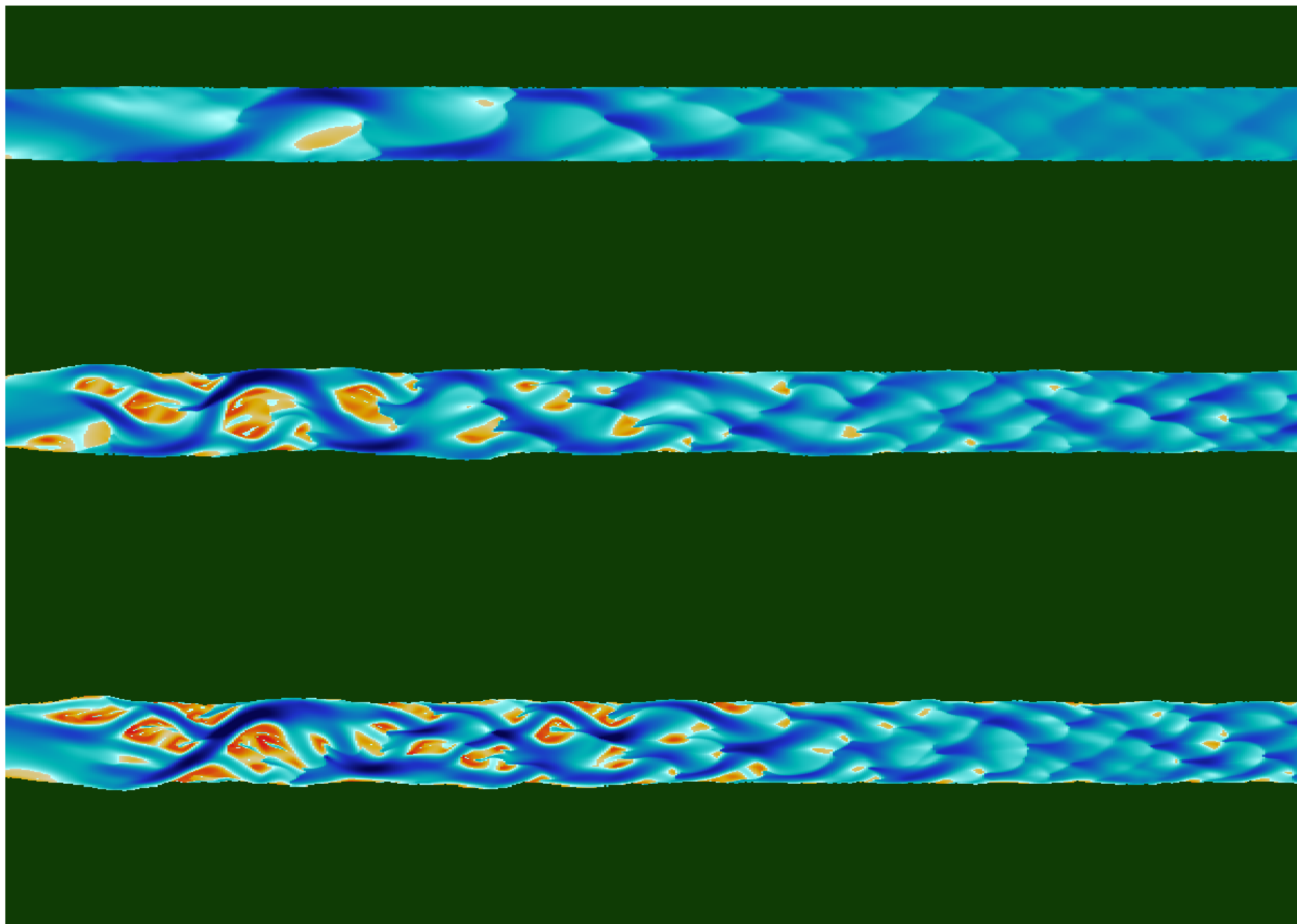


5 m

Depth: 0 m



20 m



Simulation Time: 14 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

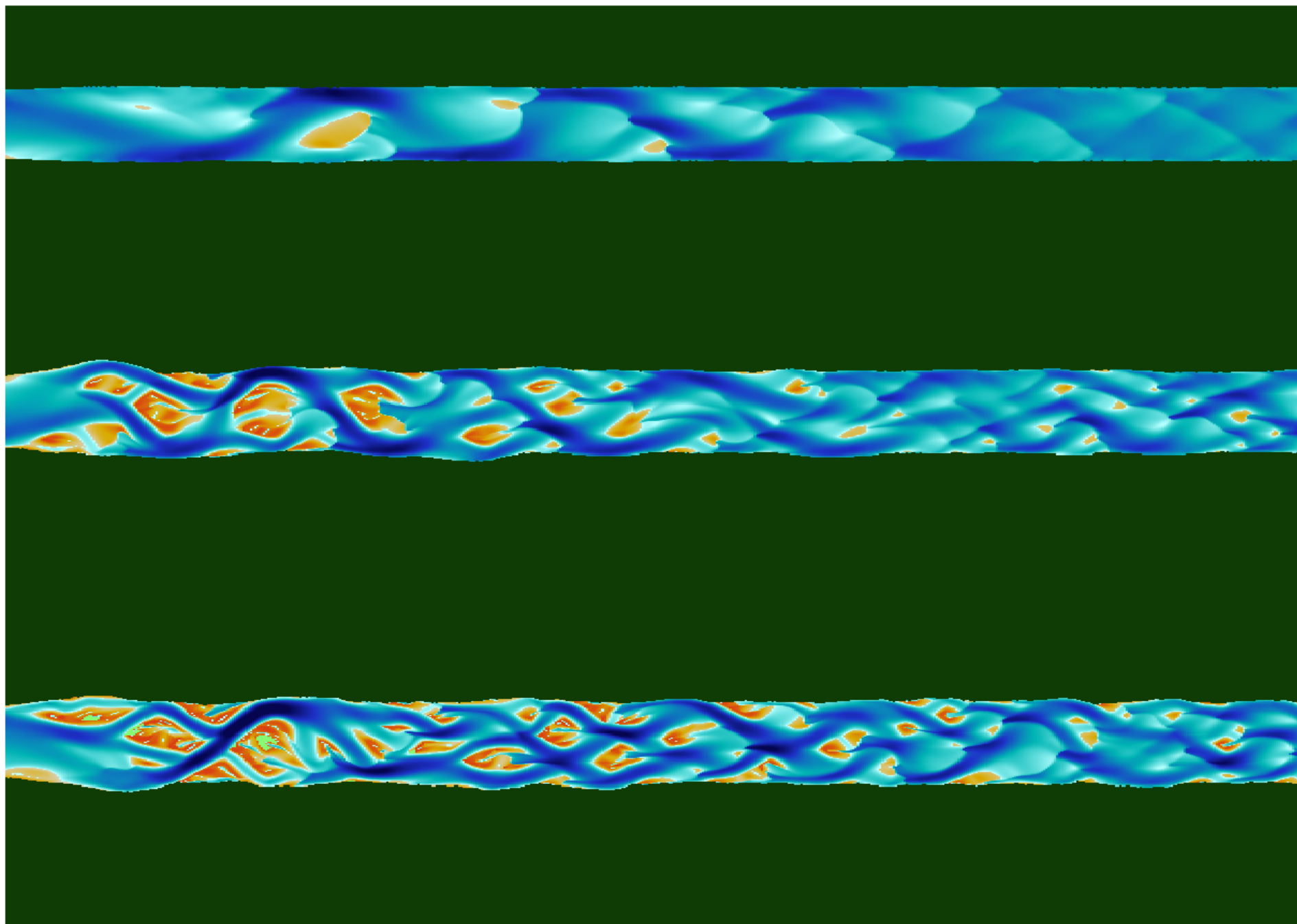


5 m

Depth: 0 m



20 m



Simulation Time: 16 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

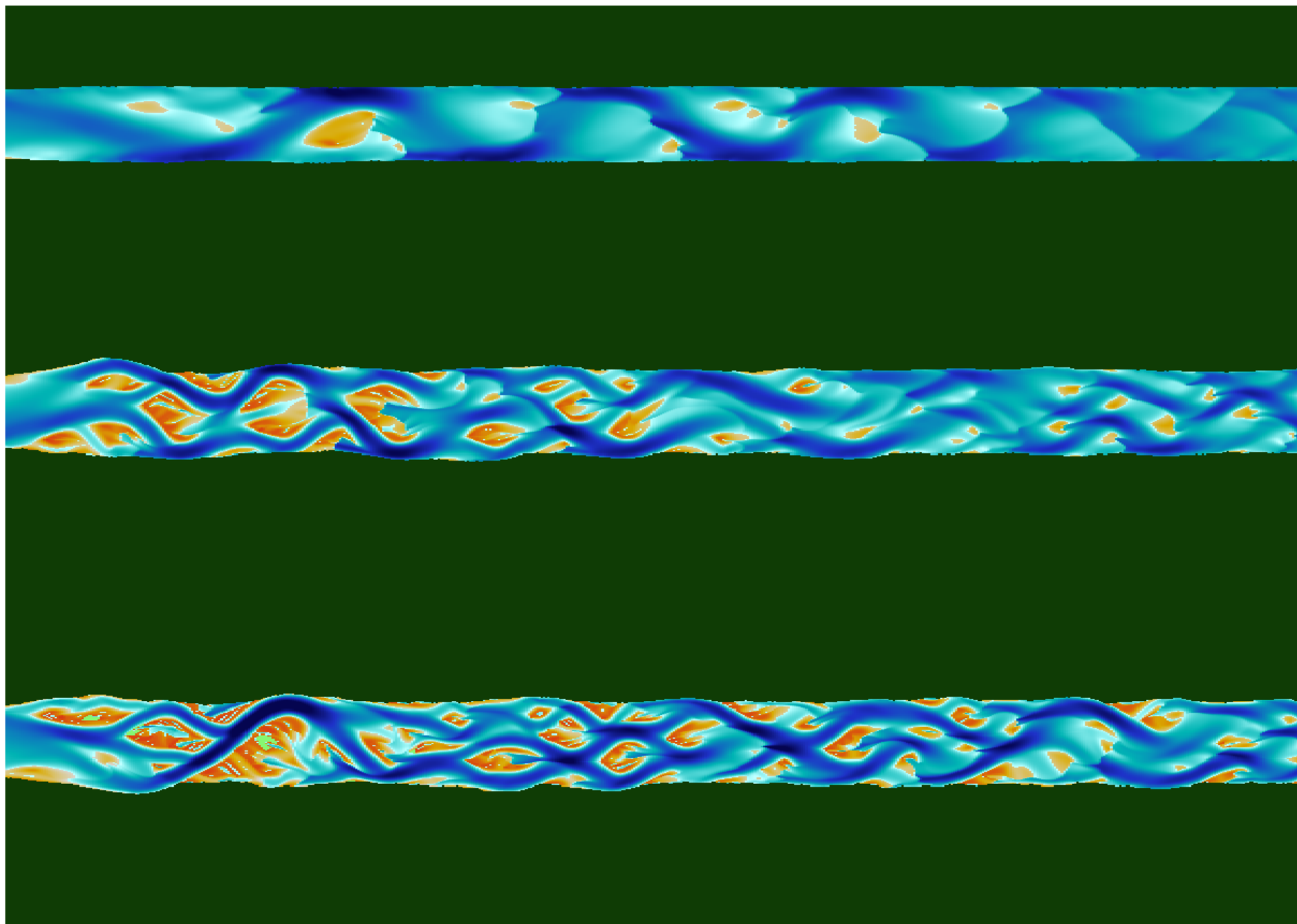


5 m

Depth: 0 m



20 m



Simulation Time: 18 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

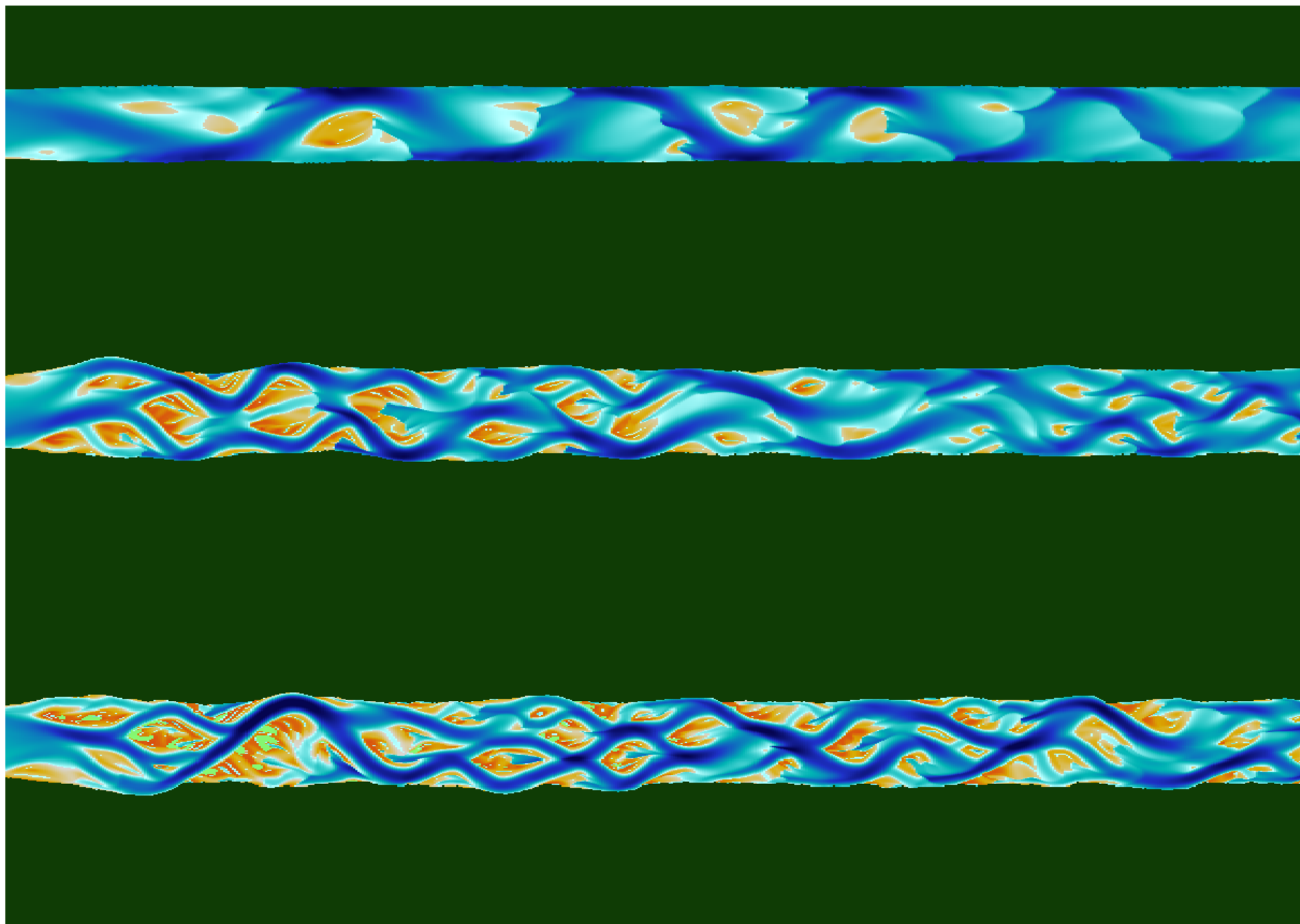


5 m

Depth: 0 m



20 m



Simulation Time: 20 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

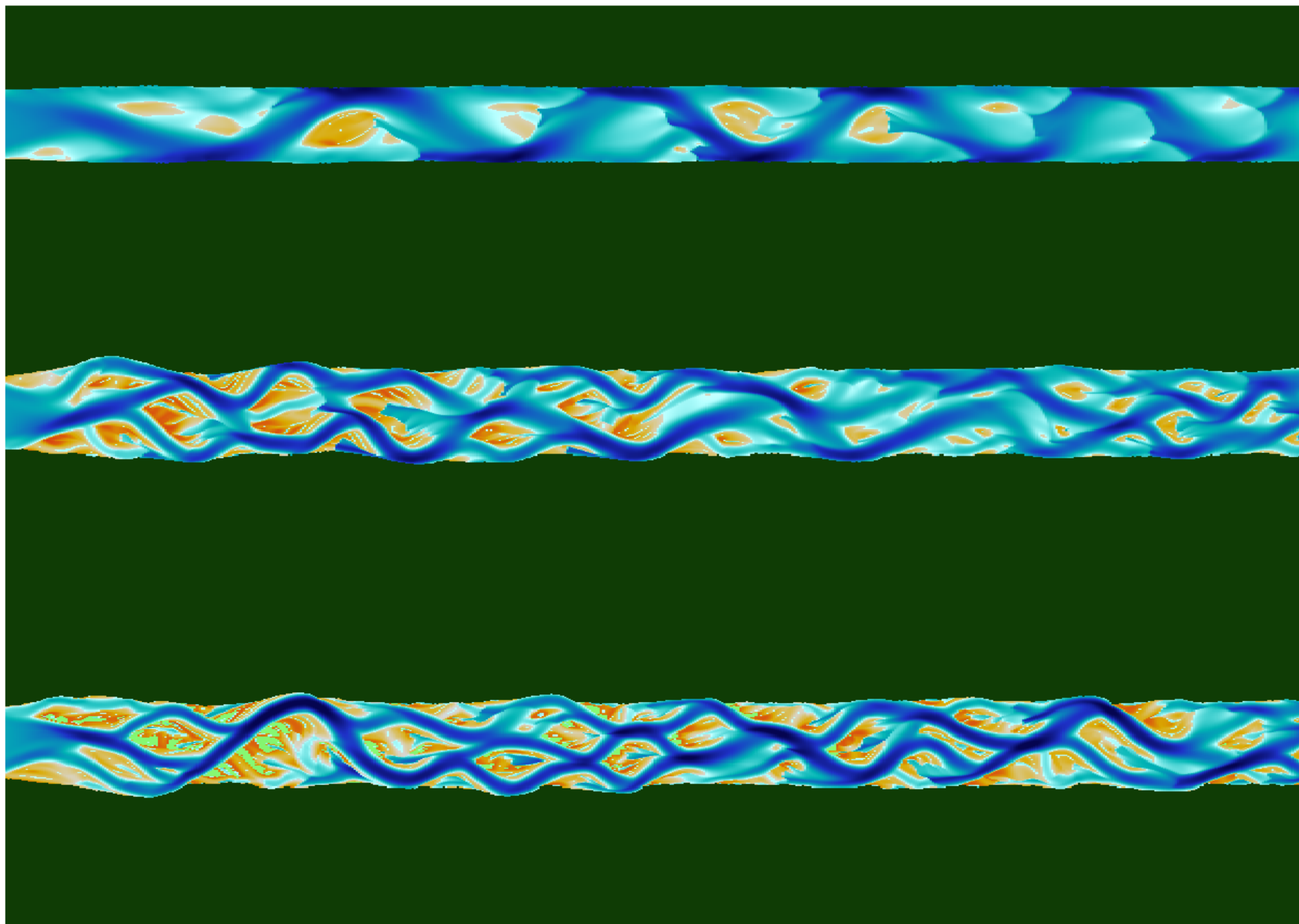


5 m

Depth: 0 m



20 m



Simulation Time: 22 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

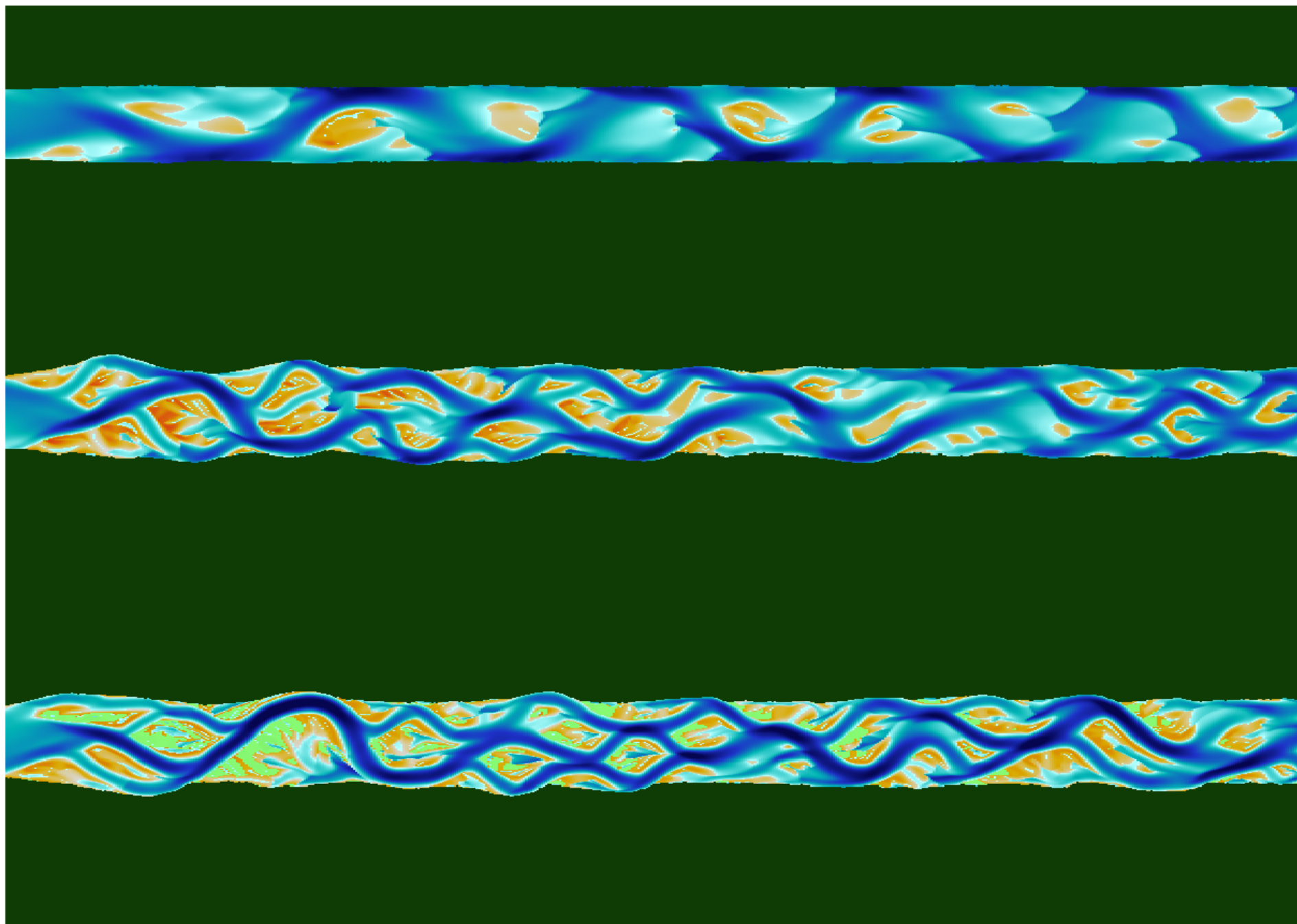


5 m

Depth: 0 m



20 m



Simulation Time: 24 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

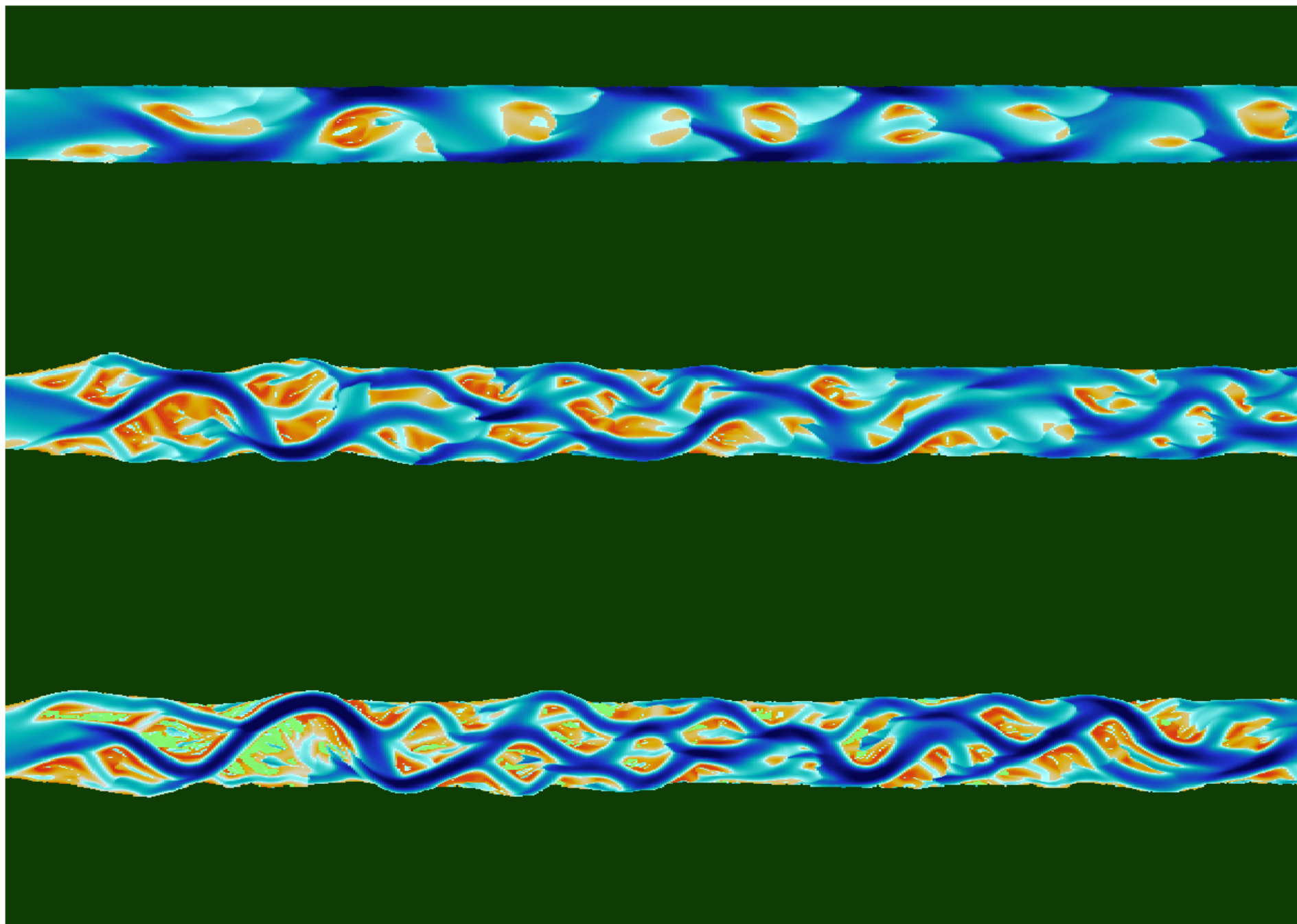


5 m

Depth: 0 m



20 m



Simulation Time: 26 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

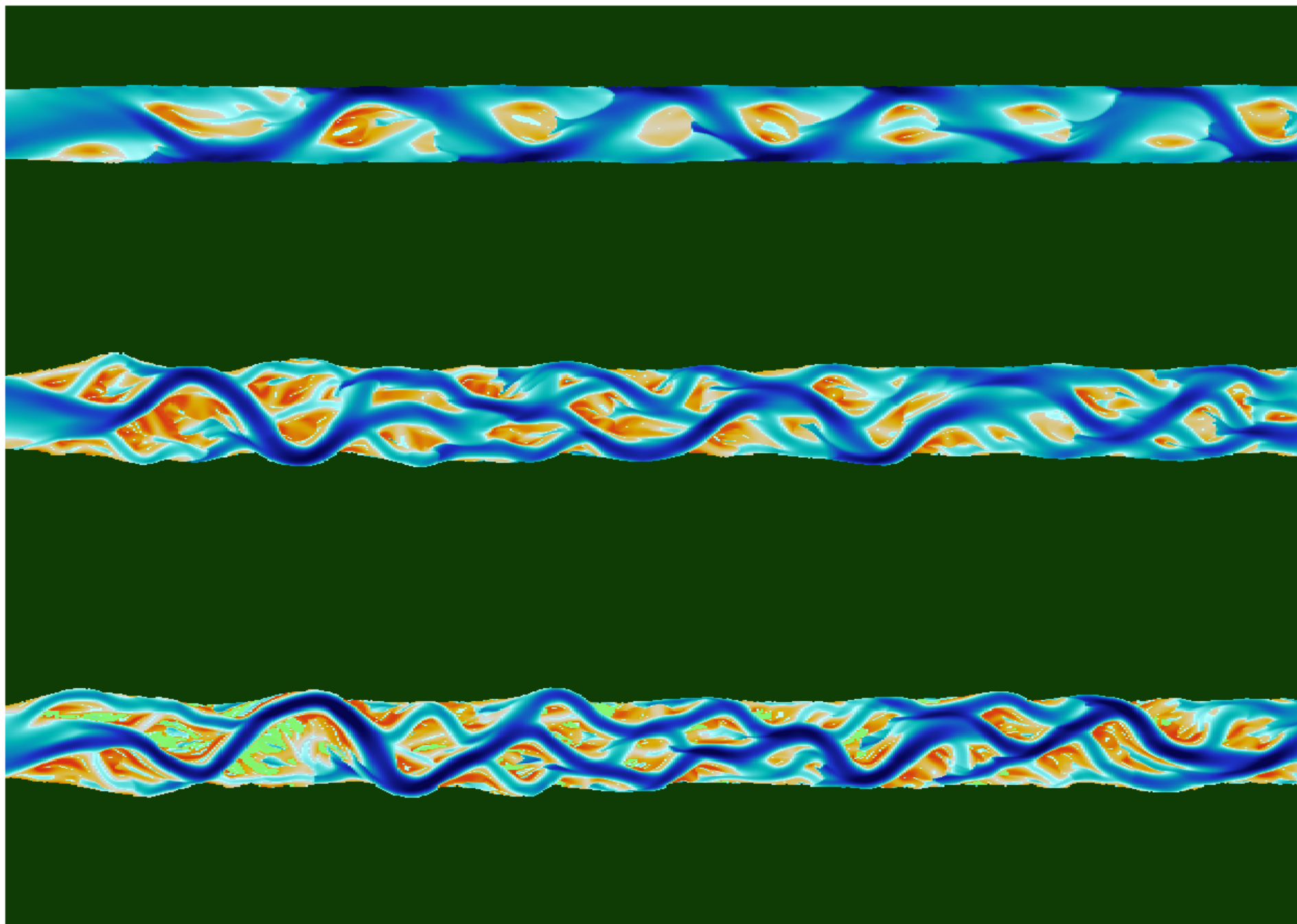


5 m

Depth: 0 m



20 m



Simulation Time: 28 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

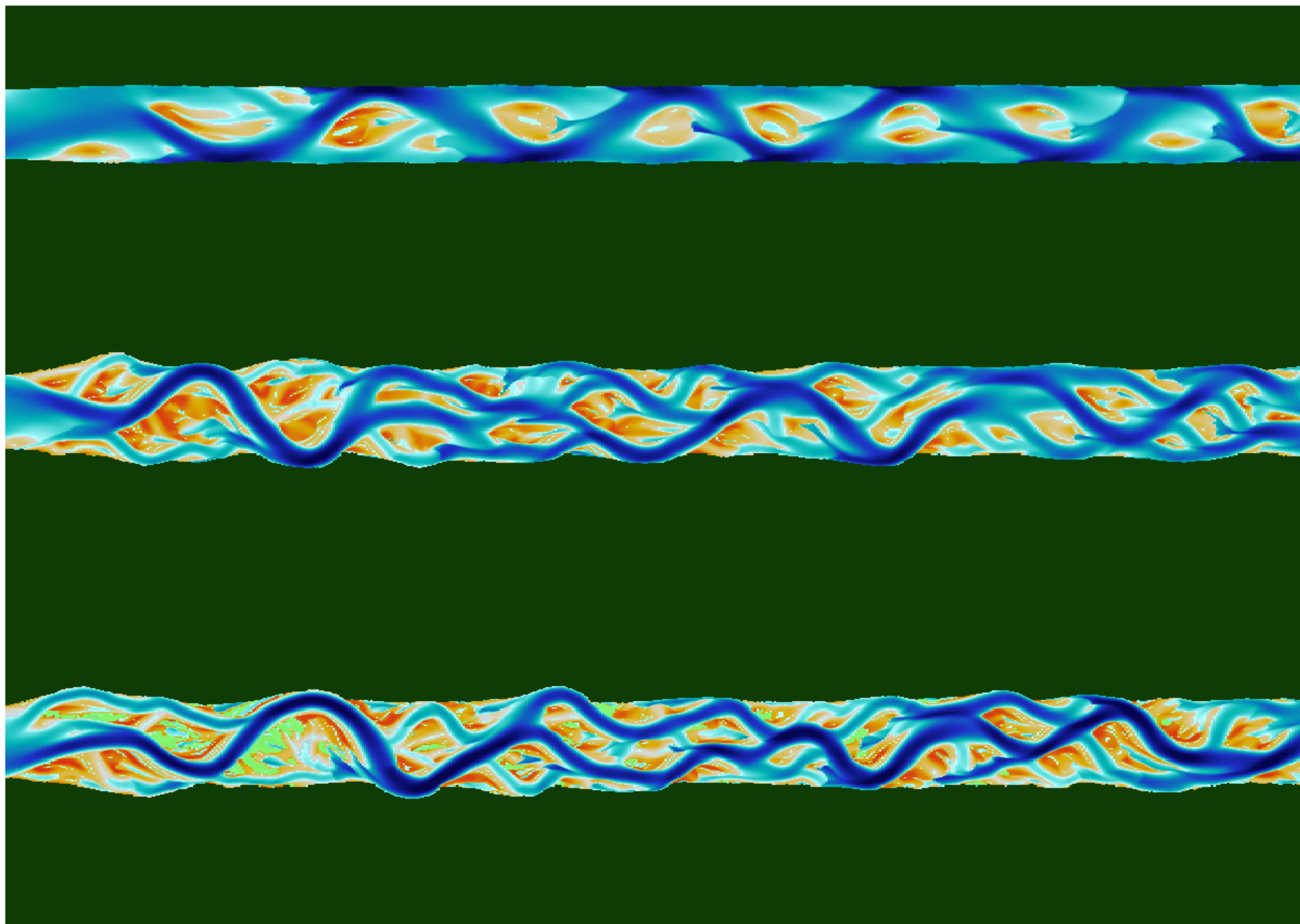


5 m

Depth: 0 m



20 m



Simulation Time: 30 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

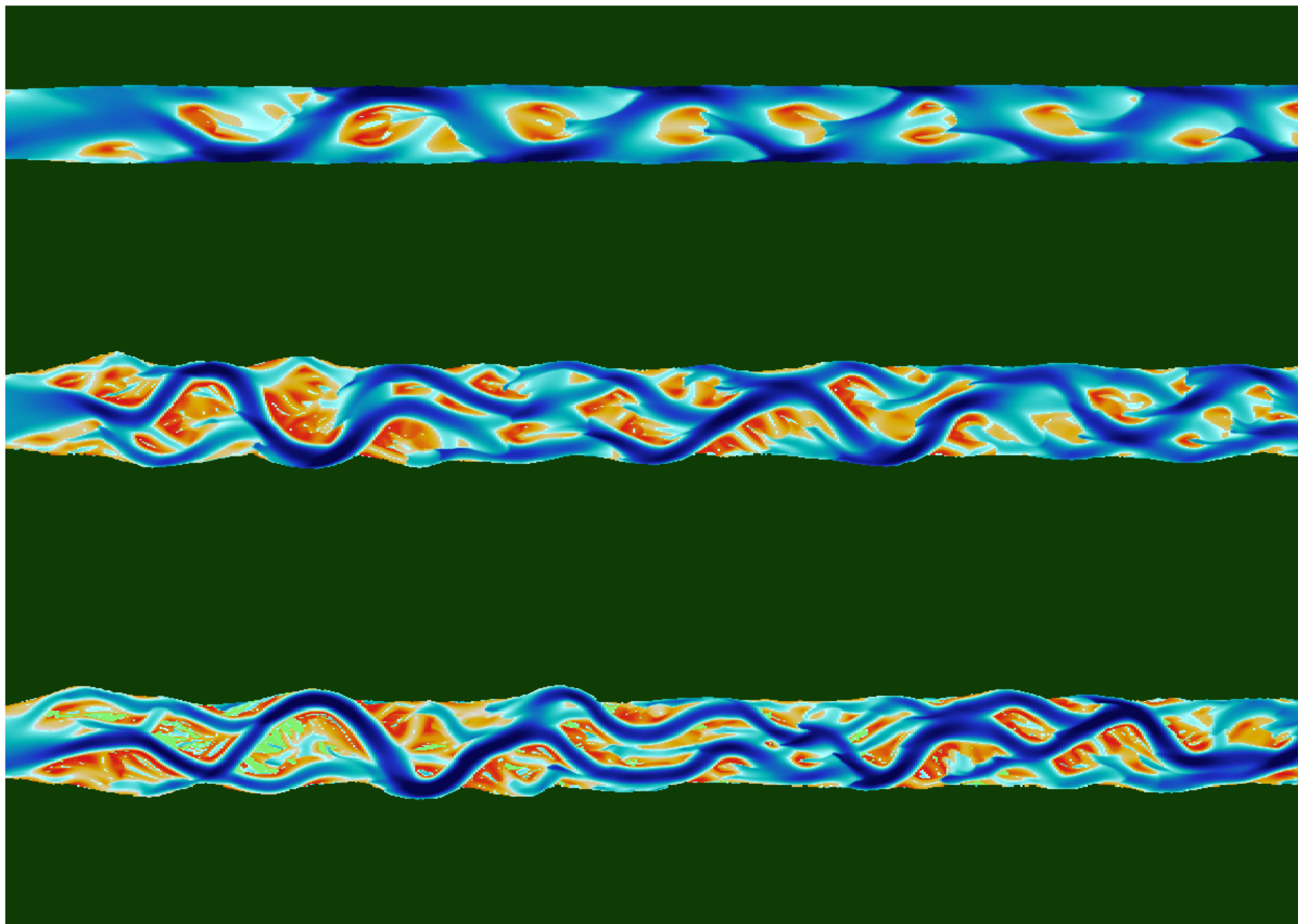


5 m

Depth: 0 m



20 m



Simulation Time: 32 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

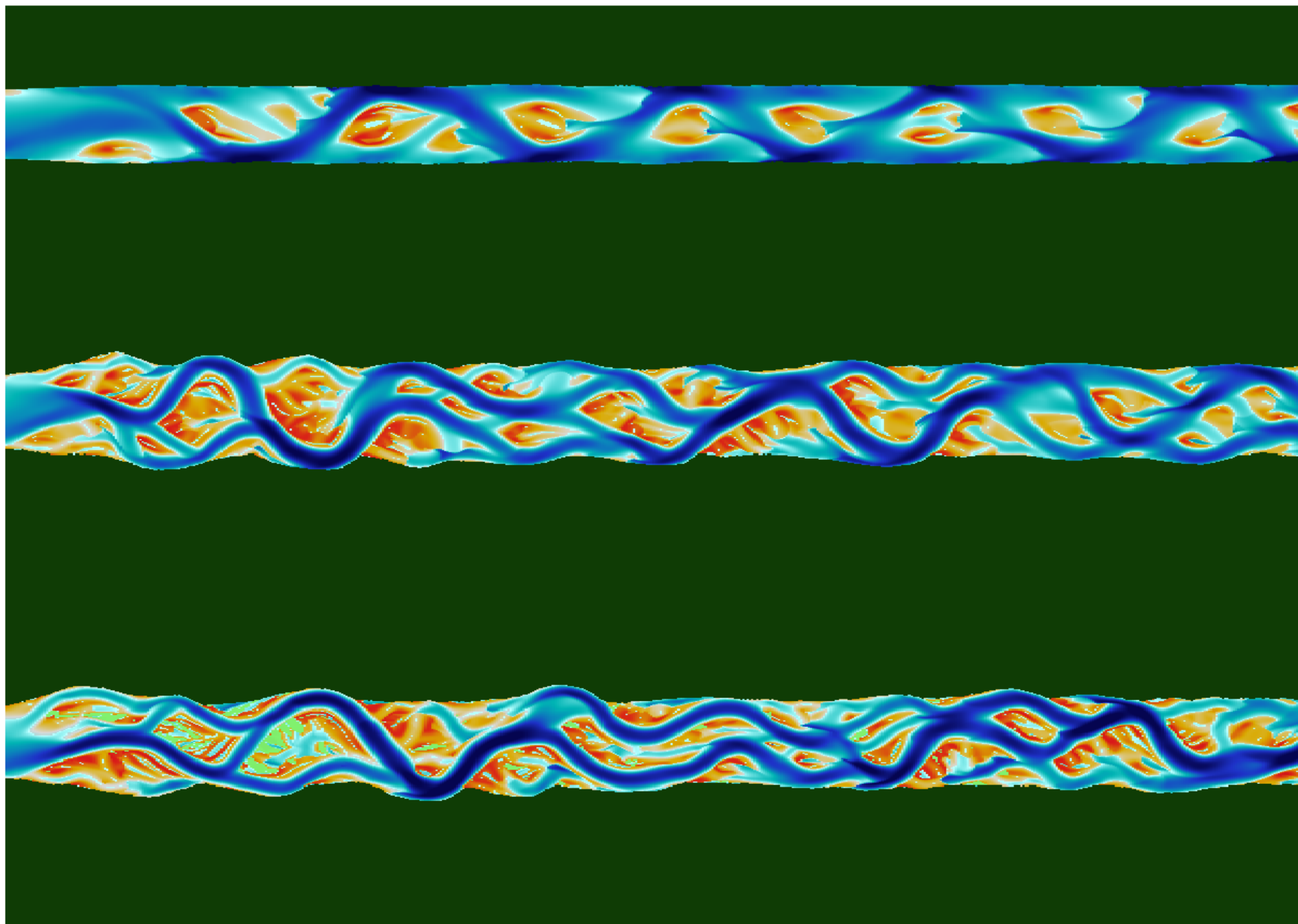


5 m

Depth: 0 m



20 m



Simulation Time: 34 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

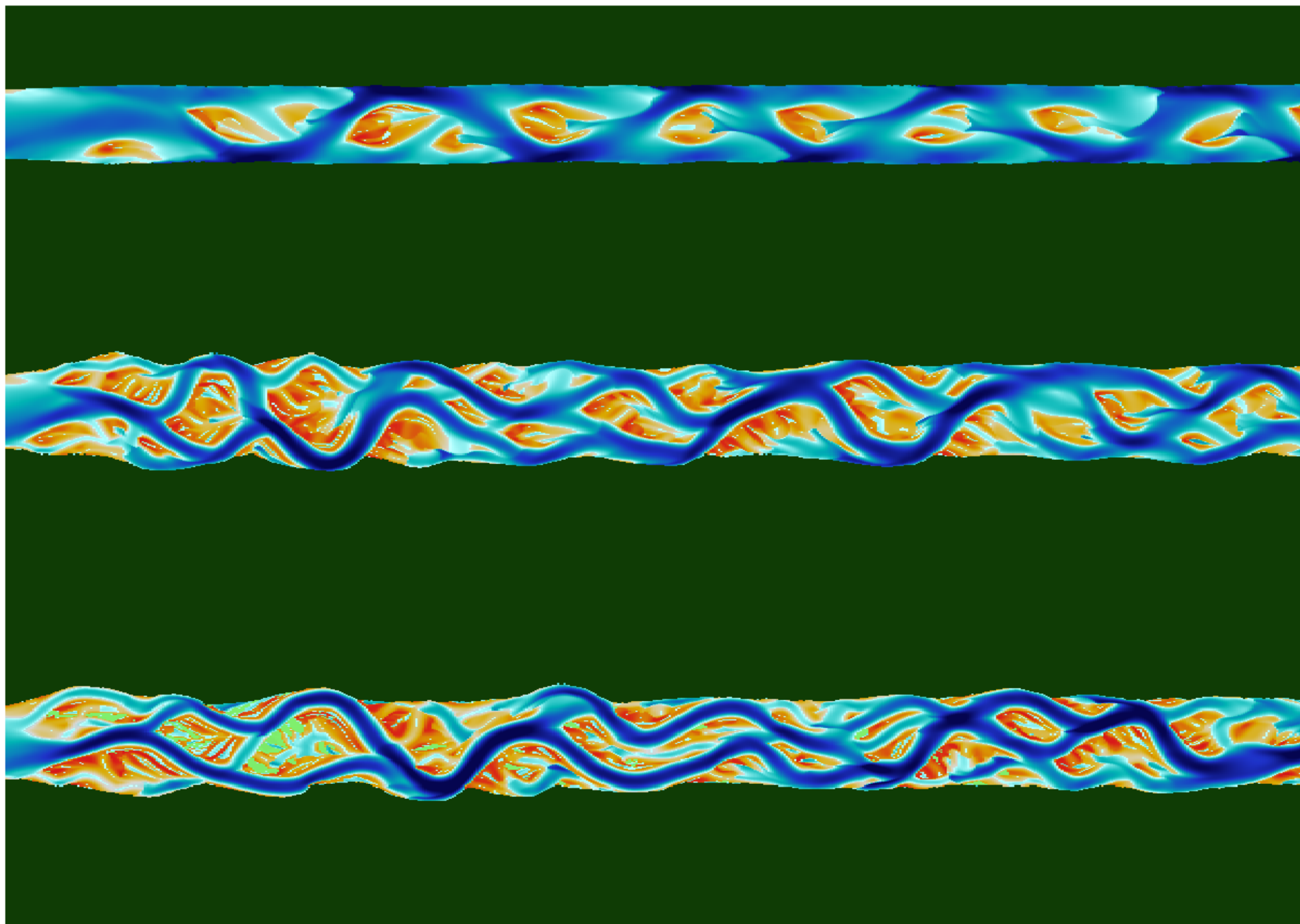


5 m

Depth: 0 m



20 m



Simulation Time: 36 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

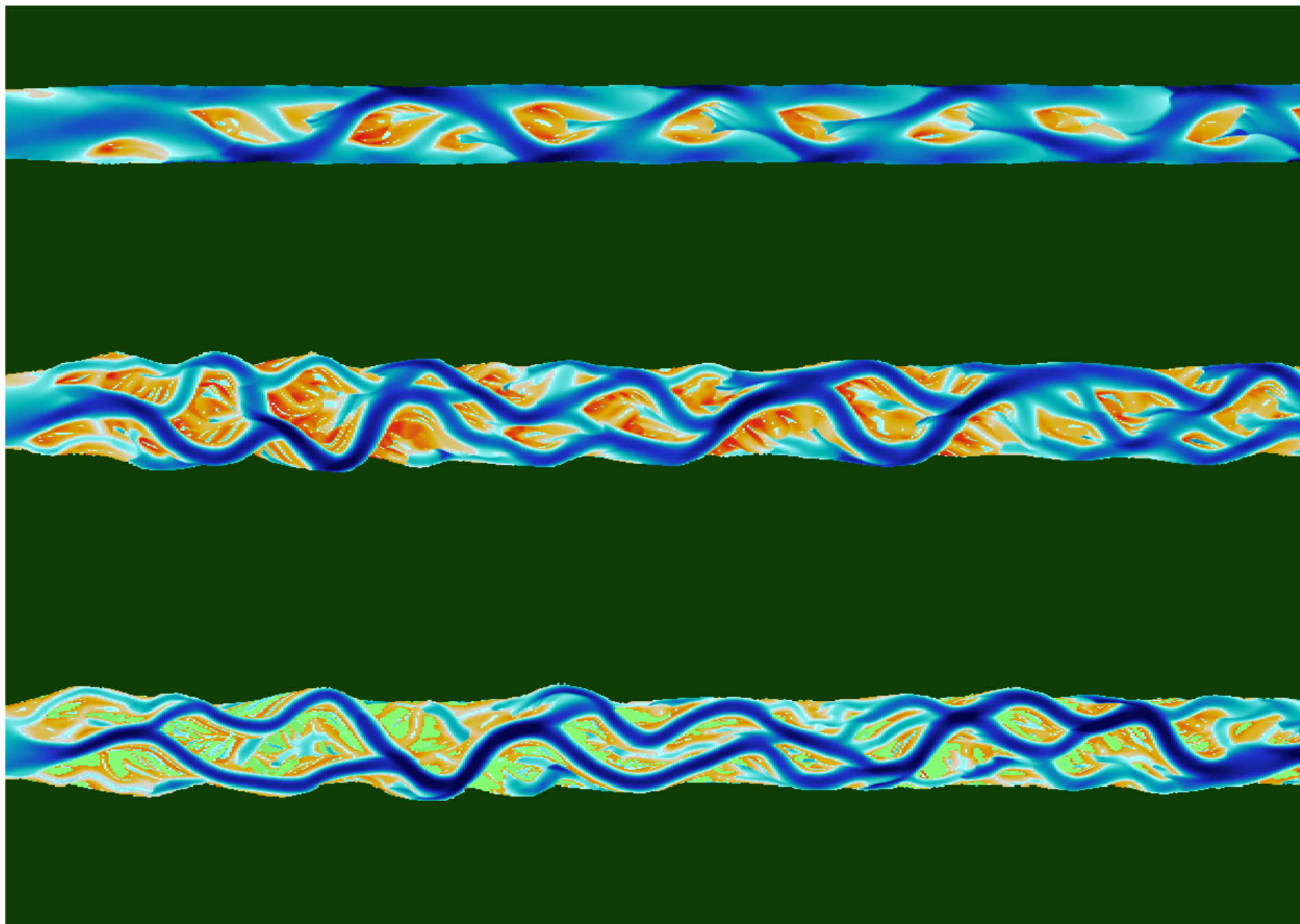


5 m

Depth: 0 m



20 m



Simulation Time: 38 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

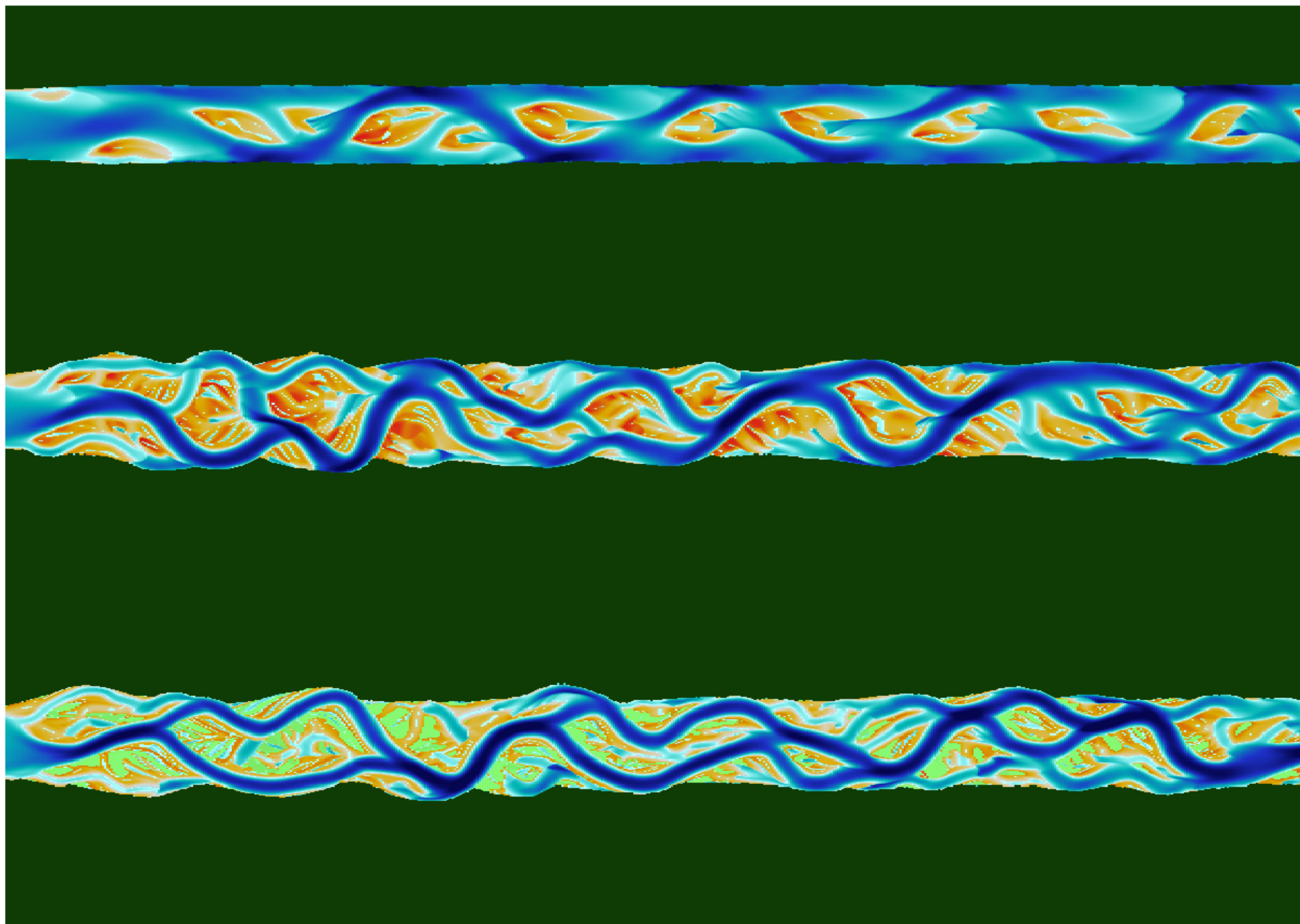


5 m

Depth: 0 m



20 m



Simulation Time: 40 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

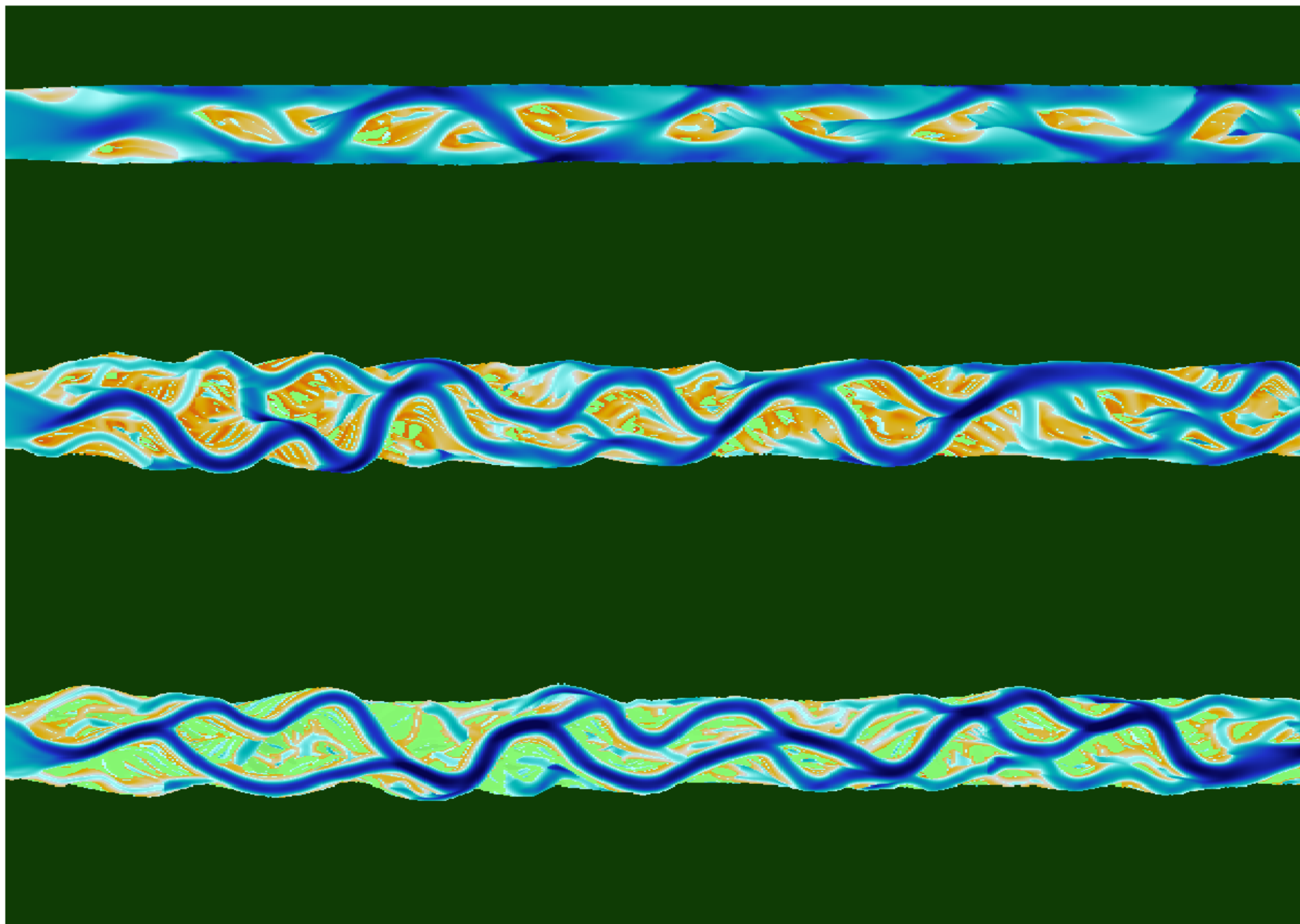


5 m

Depth: 0 m



20 m



Simulation Time: 42 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

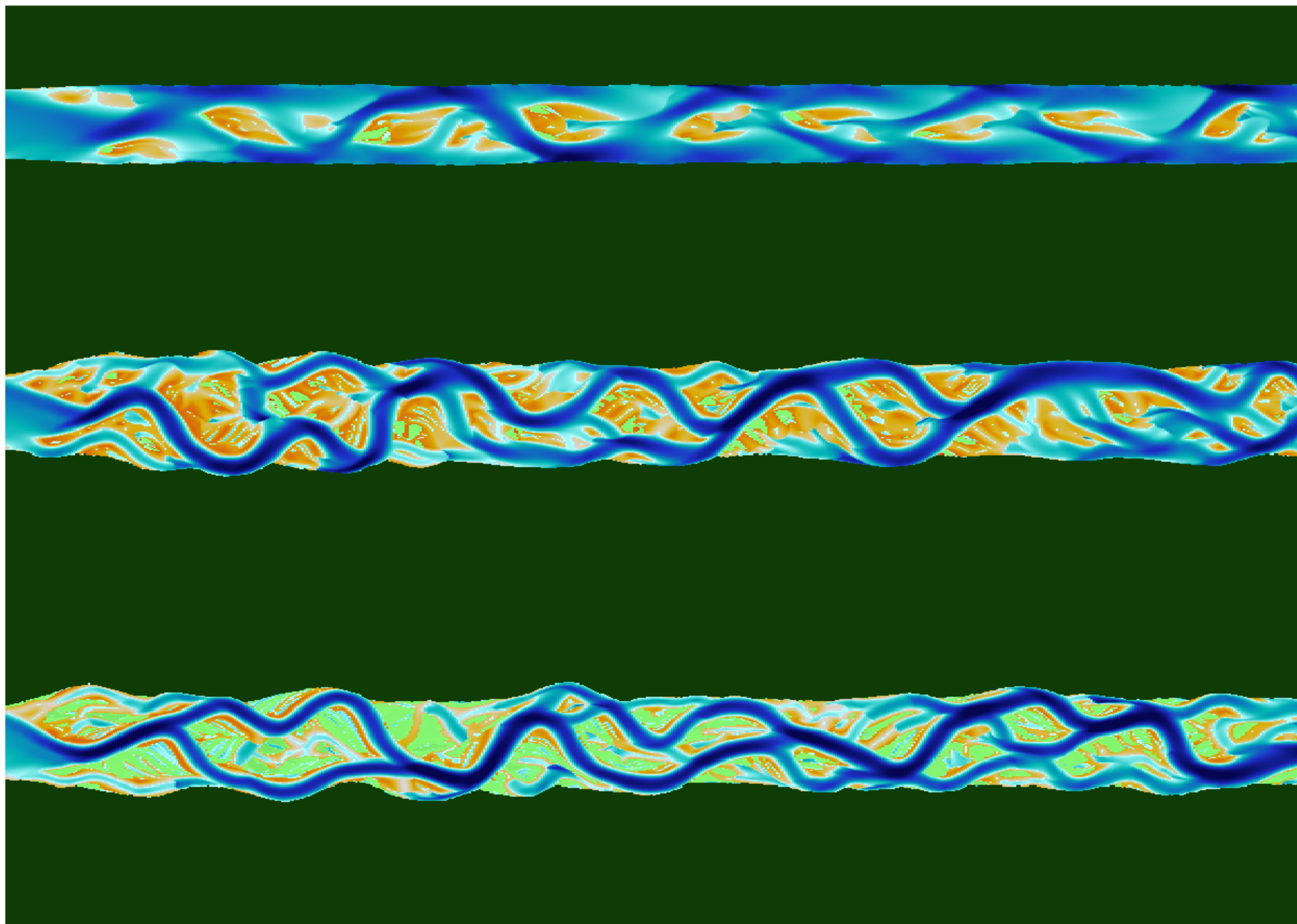


5 m

Depth: 0 m



20 m



Simulation Time: 44 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

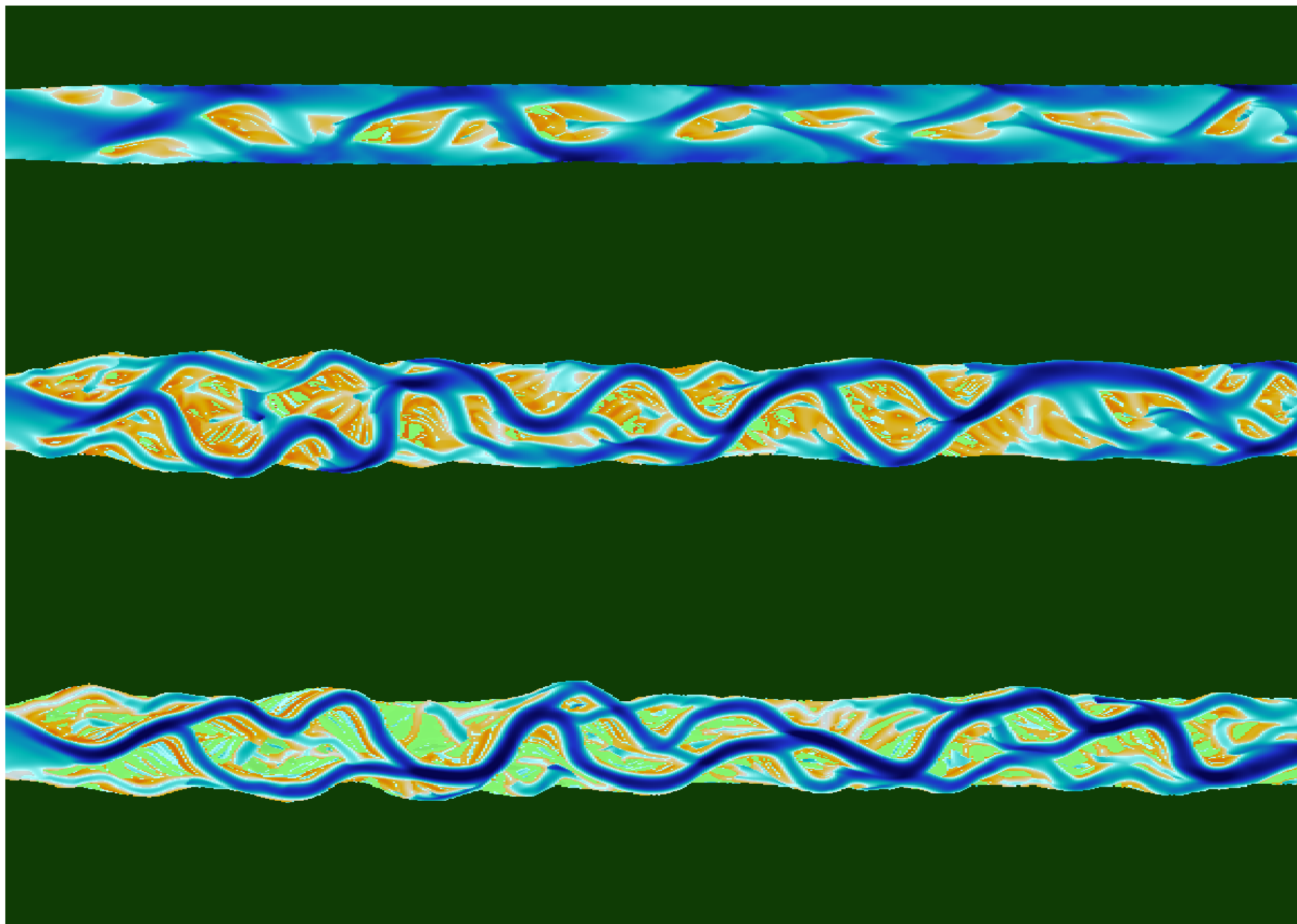


5 m

Depth: 0 m



20 m



Simulation Time: 46 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

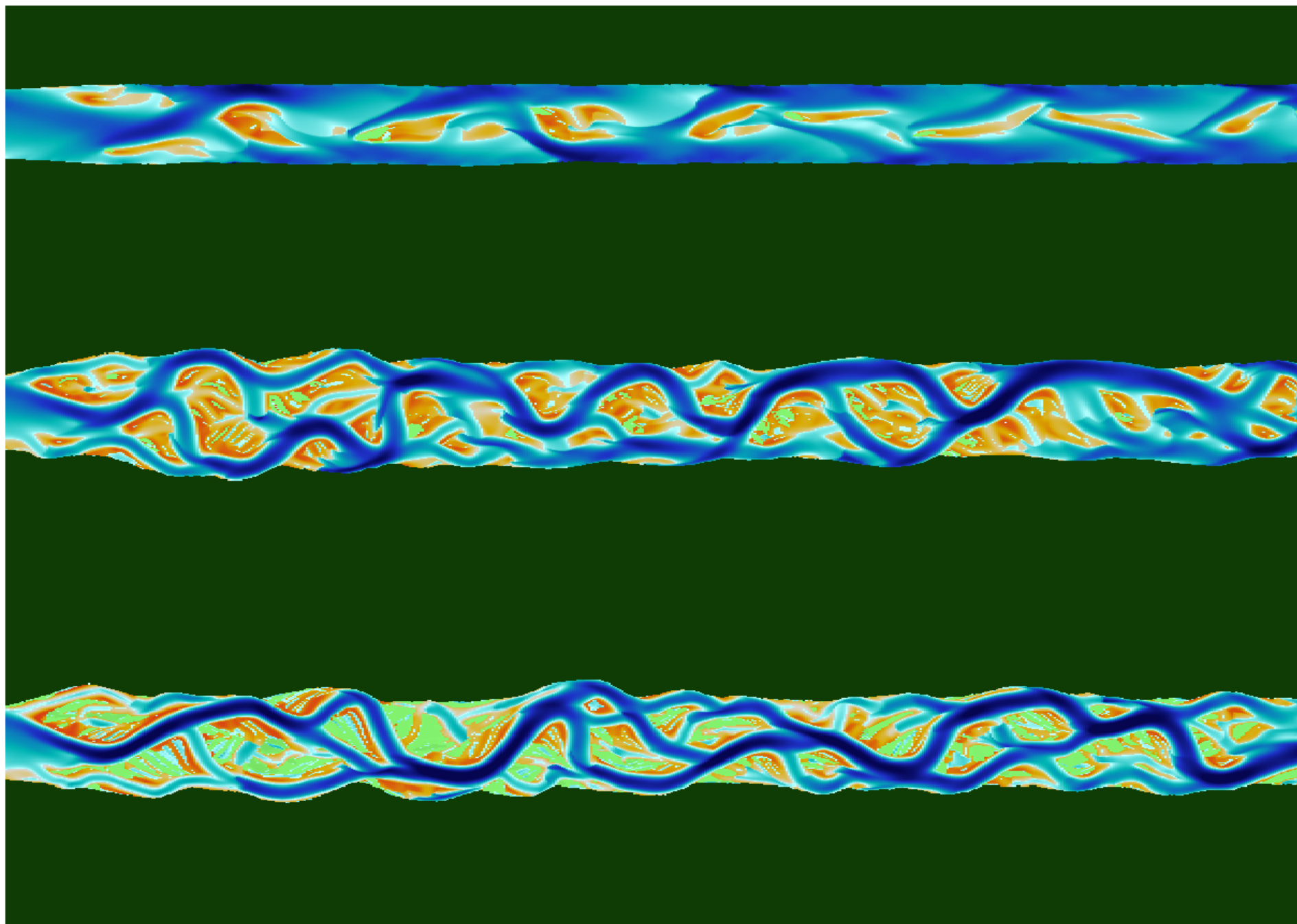


5 m

Depth: 0 m



20 m



Simulation Time: 48 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

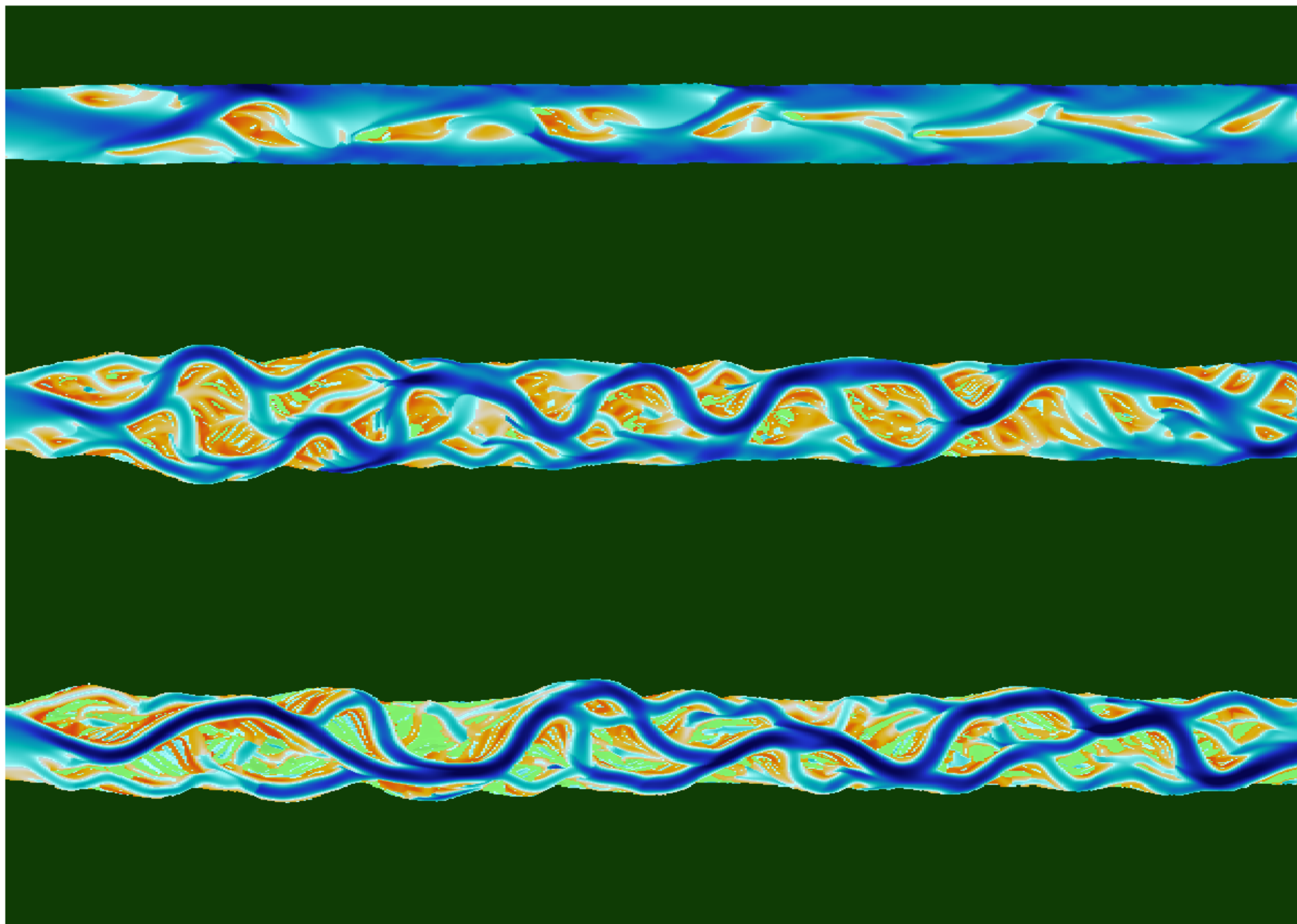


5 m

Depth: 0 m



20 m



Simulation Time: 50 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

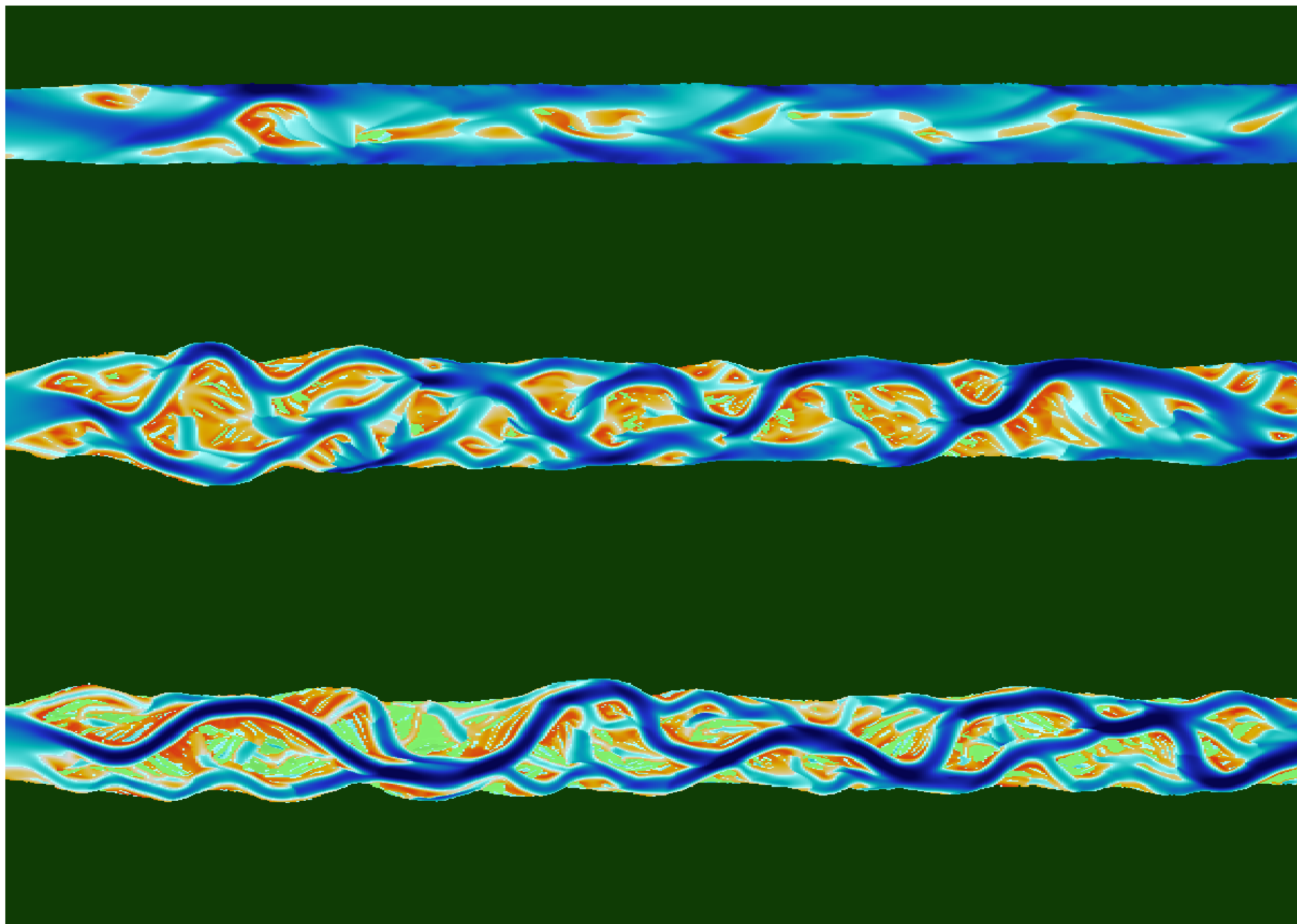


5 m

Depth: 0 m



20 m



Simulation Time: 52 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

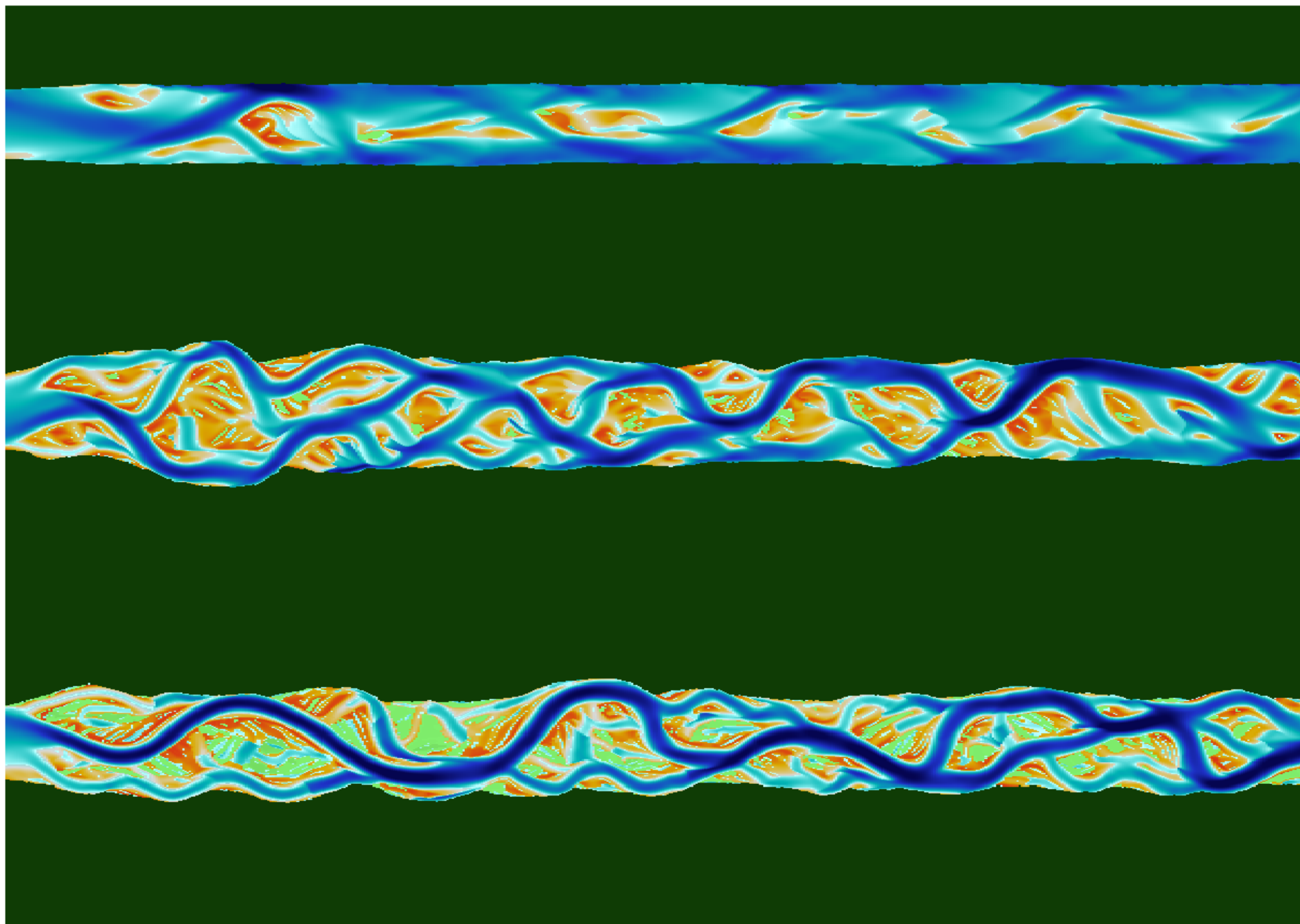


5 m

Depth: 0 m



20 m



Simulation Time: 54 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

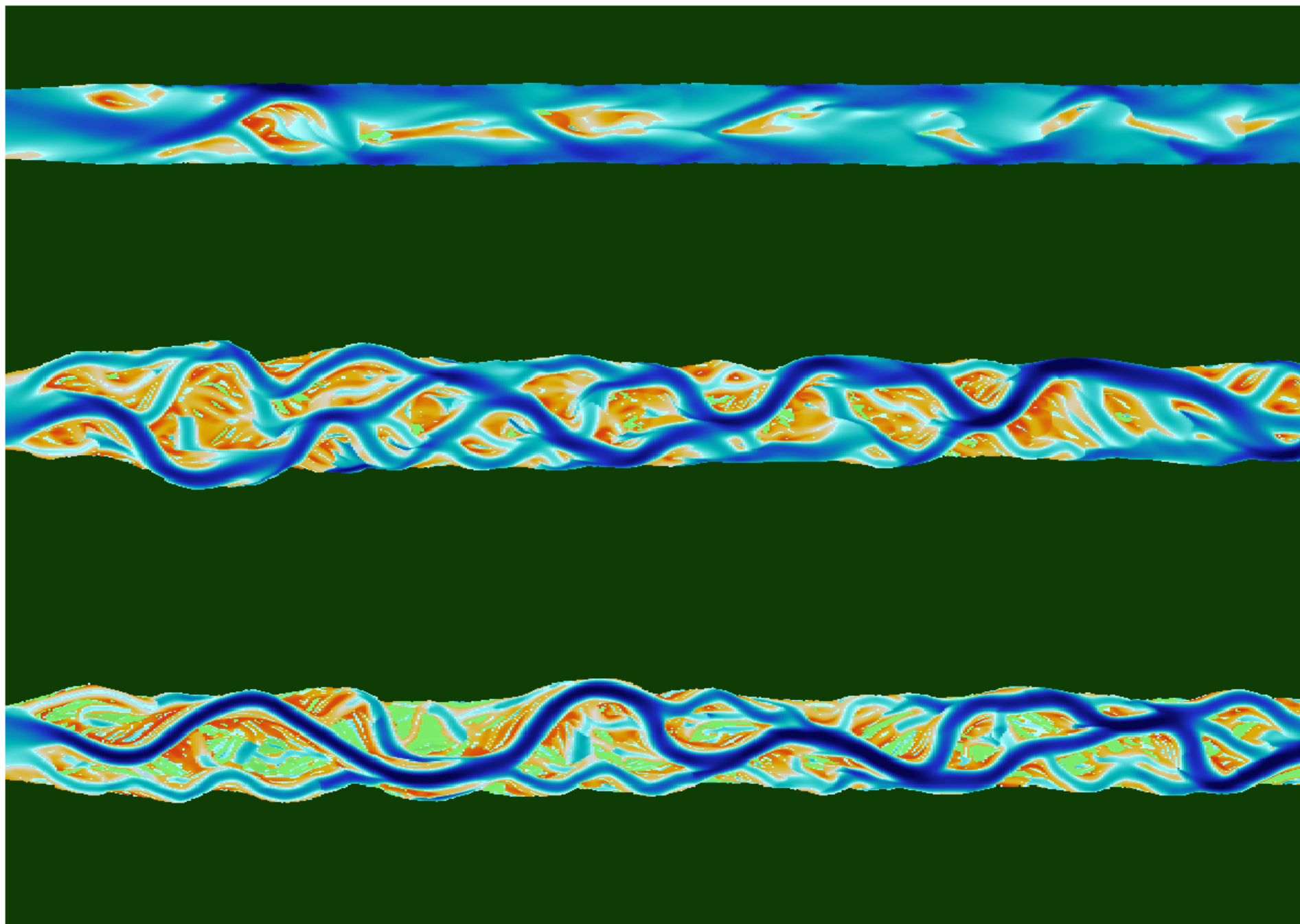


5 m

Depth: 0 m



20 m



Simulation Time: 56 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

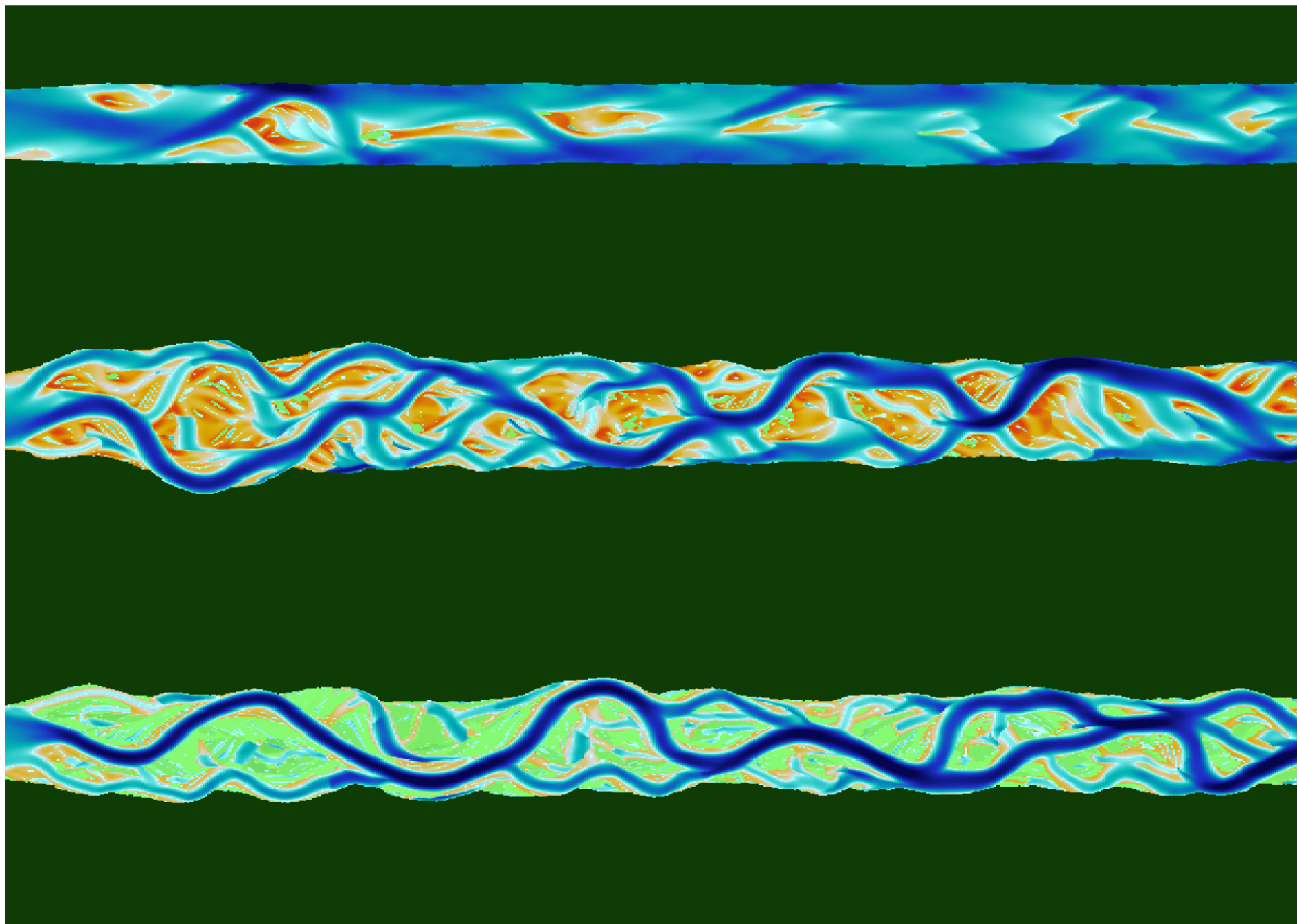


5 m

Depth: 0 m



20 m



Simulation Time: 58 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

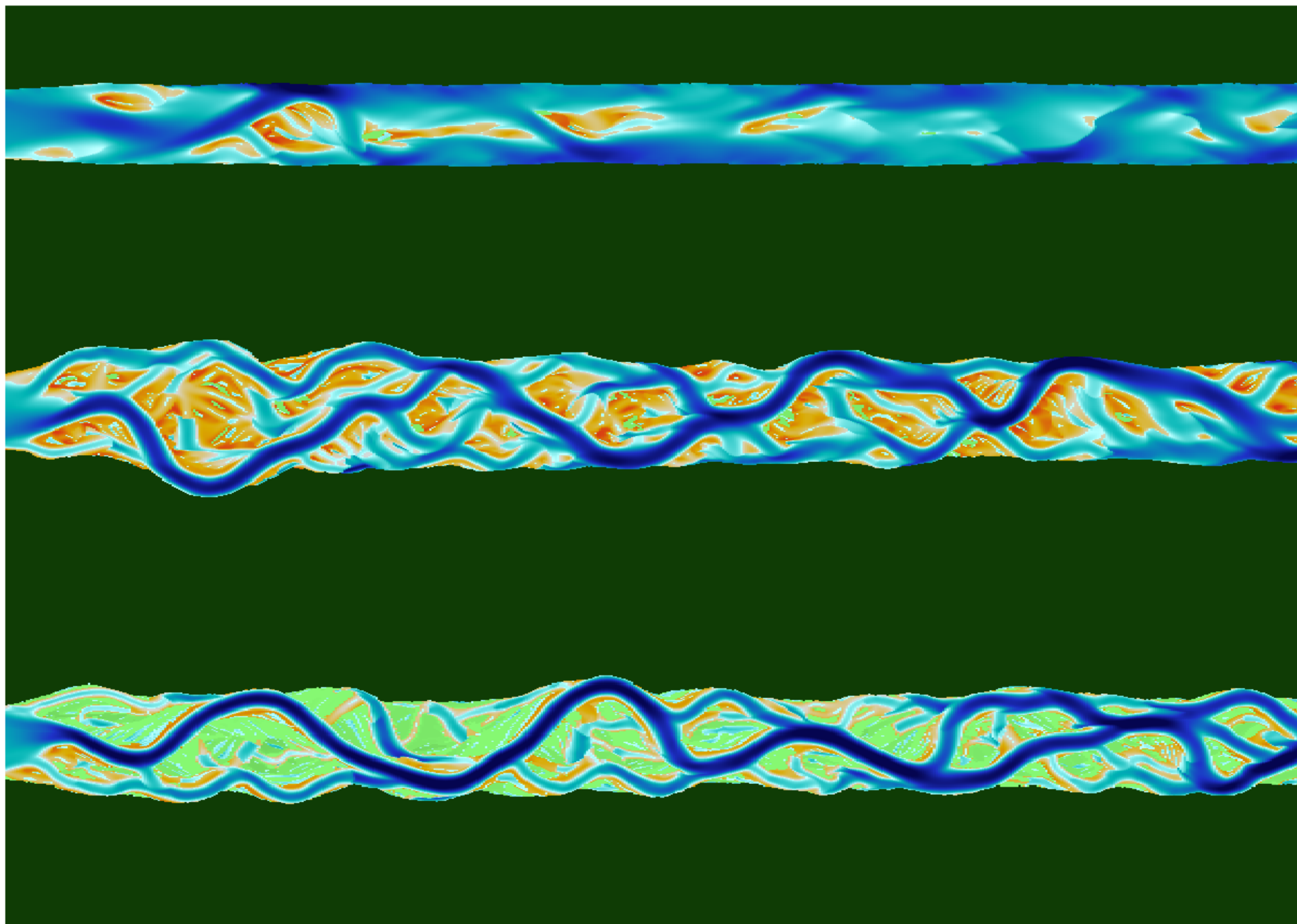


5 m

Depth: 0 m



20 m



Simulation Time: 60 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

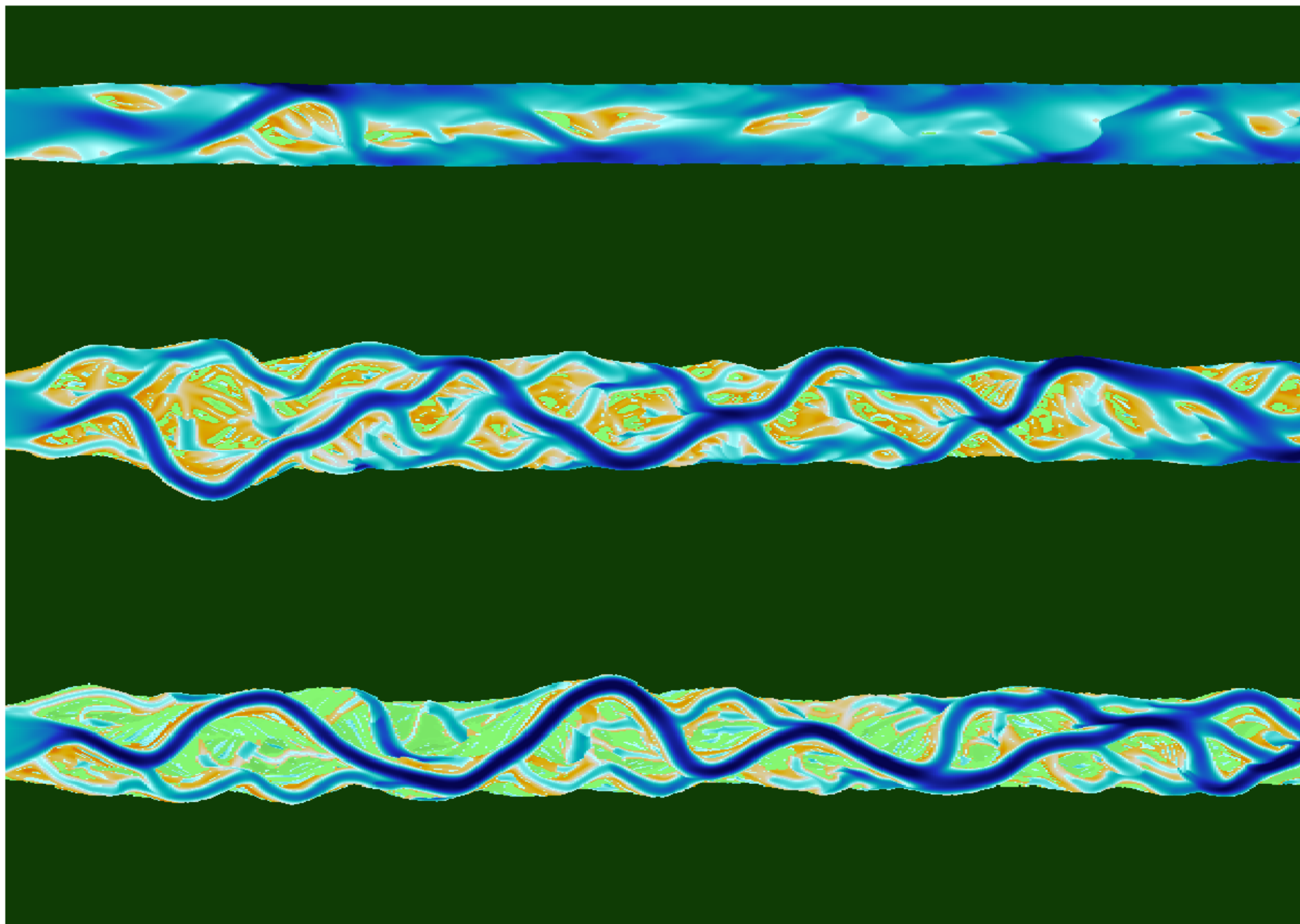


5 m

Depth: 0 m



20 m



Simulation Time: 62 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

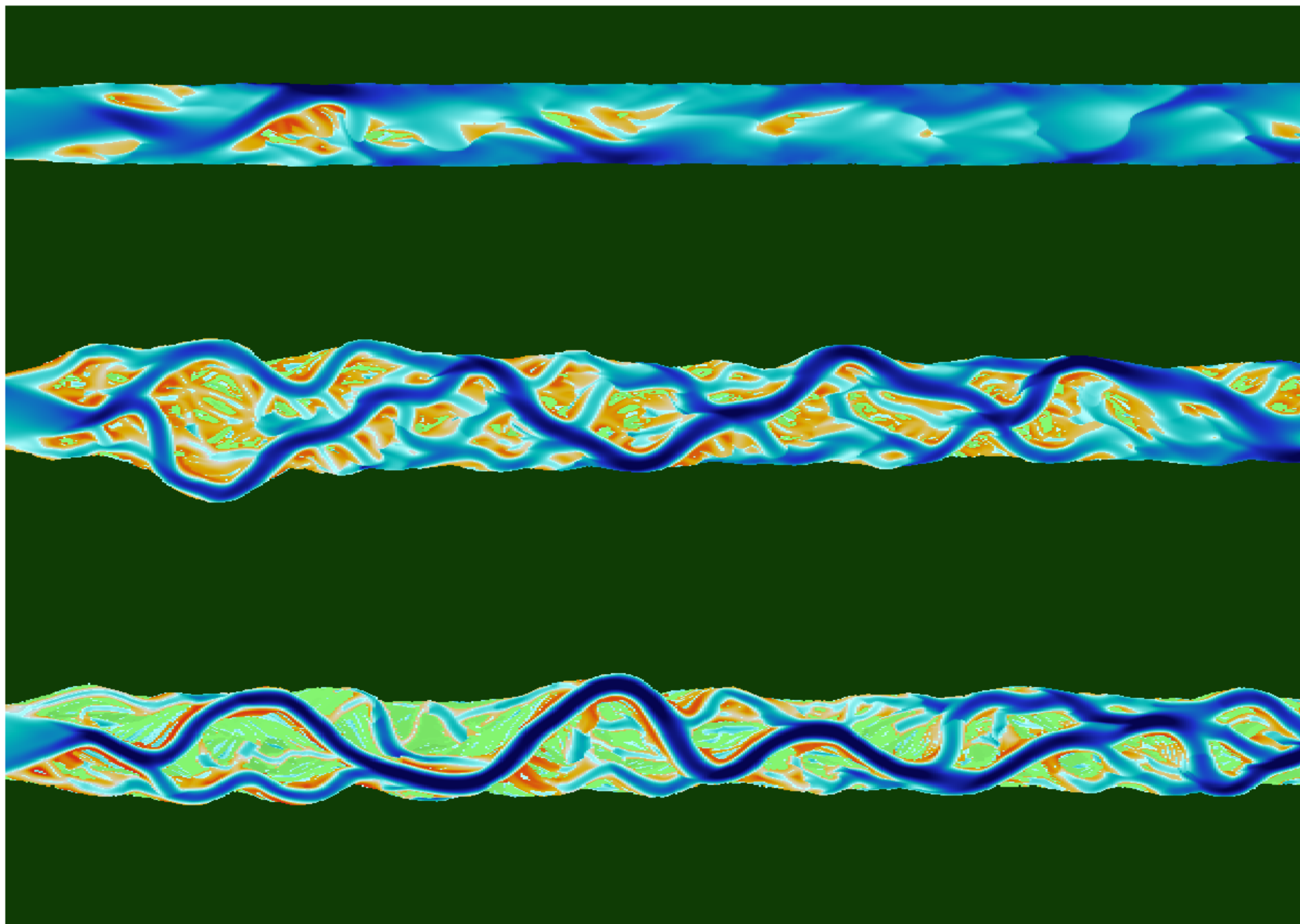


5 m

Depth: 0 m



20 m

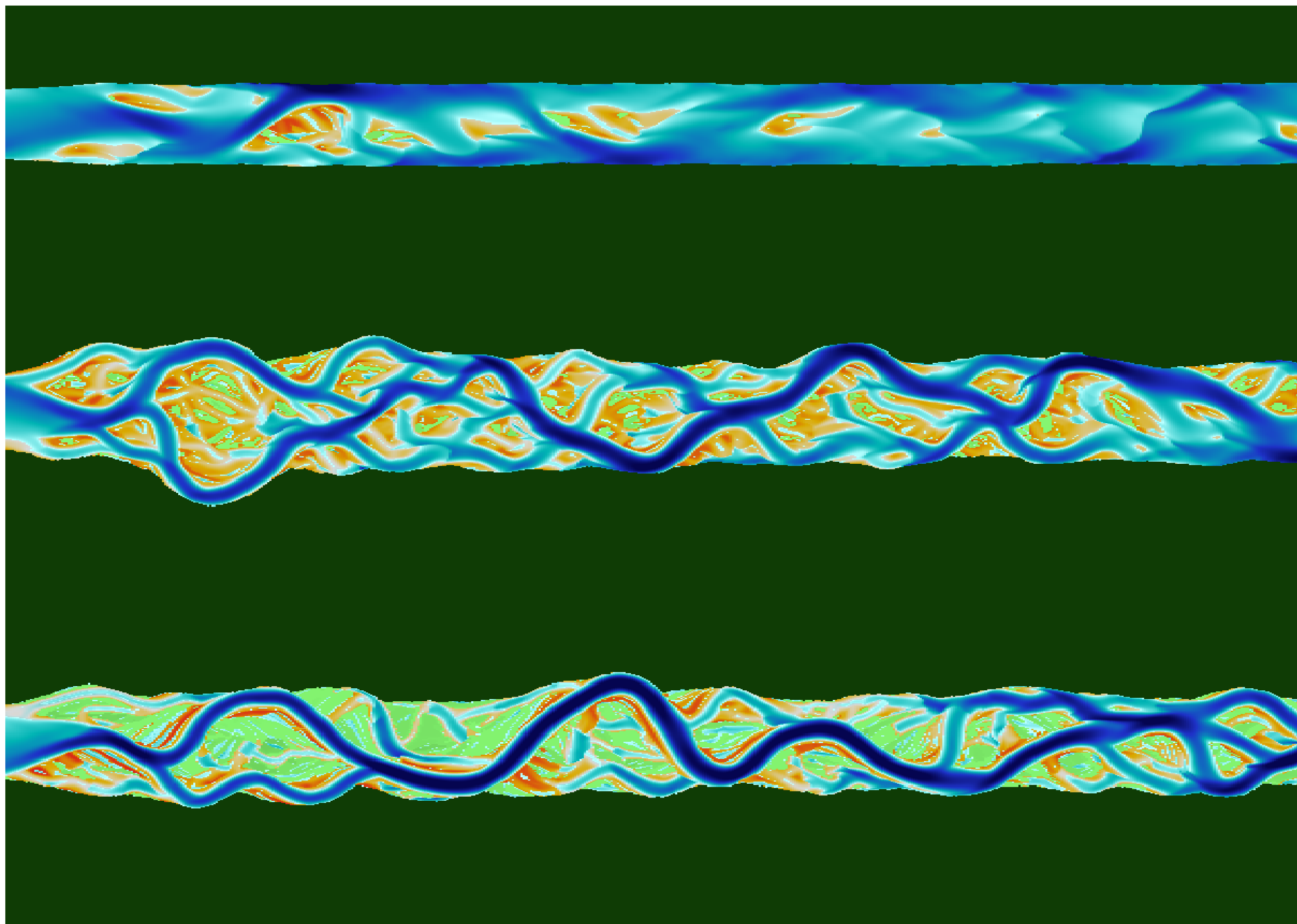


Simulation Time: 64 yr

Vegetation Age: 0 yr  200 yr

Elevation: 0 m  5 m

Depth: 0 m  20 m



Simulation Time: 66 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

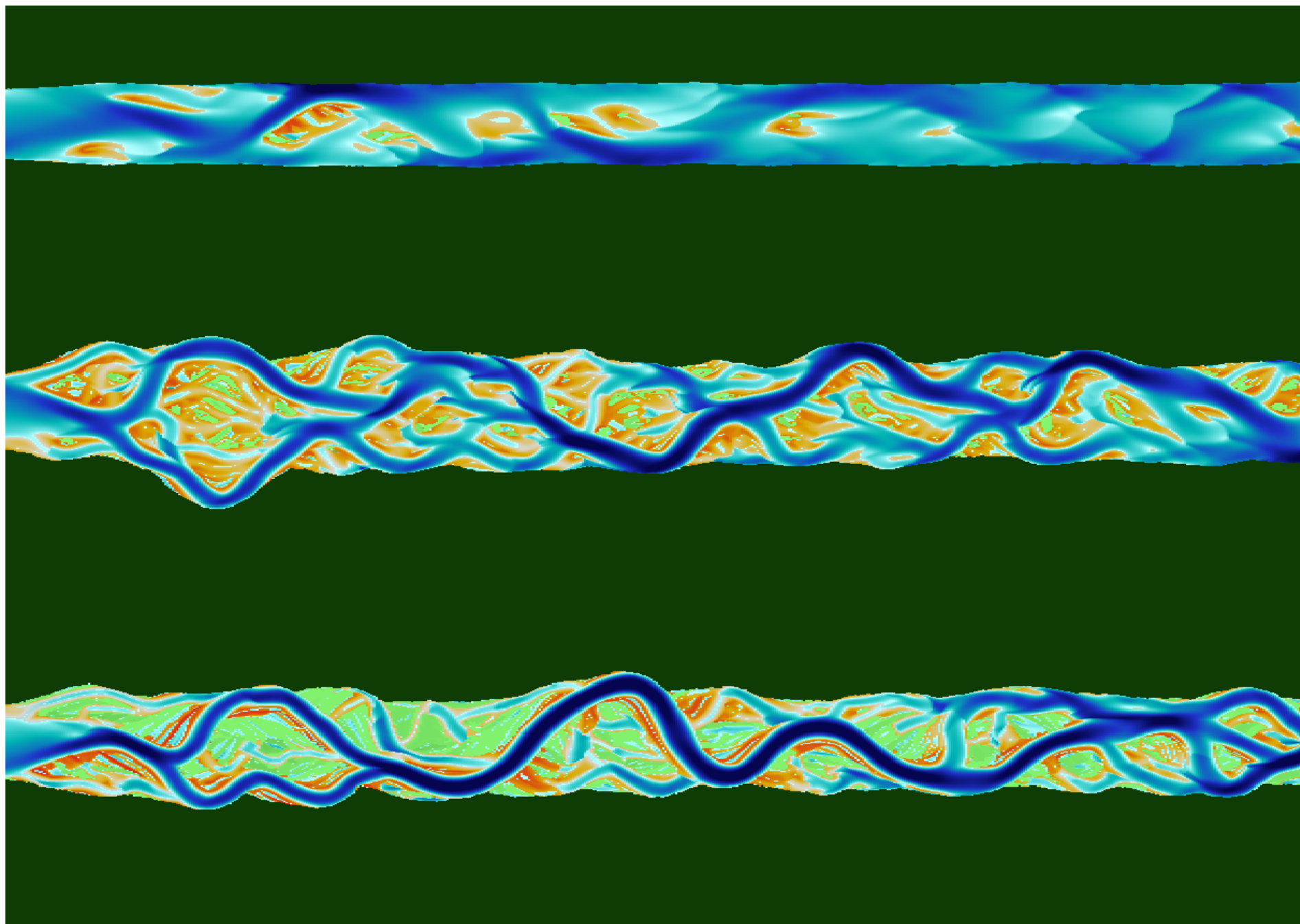


5 m

Depth: 0 m



20 m



Simulation Time: 68 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

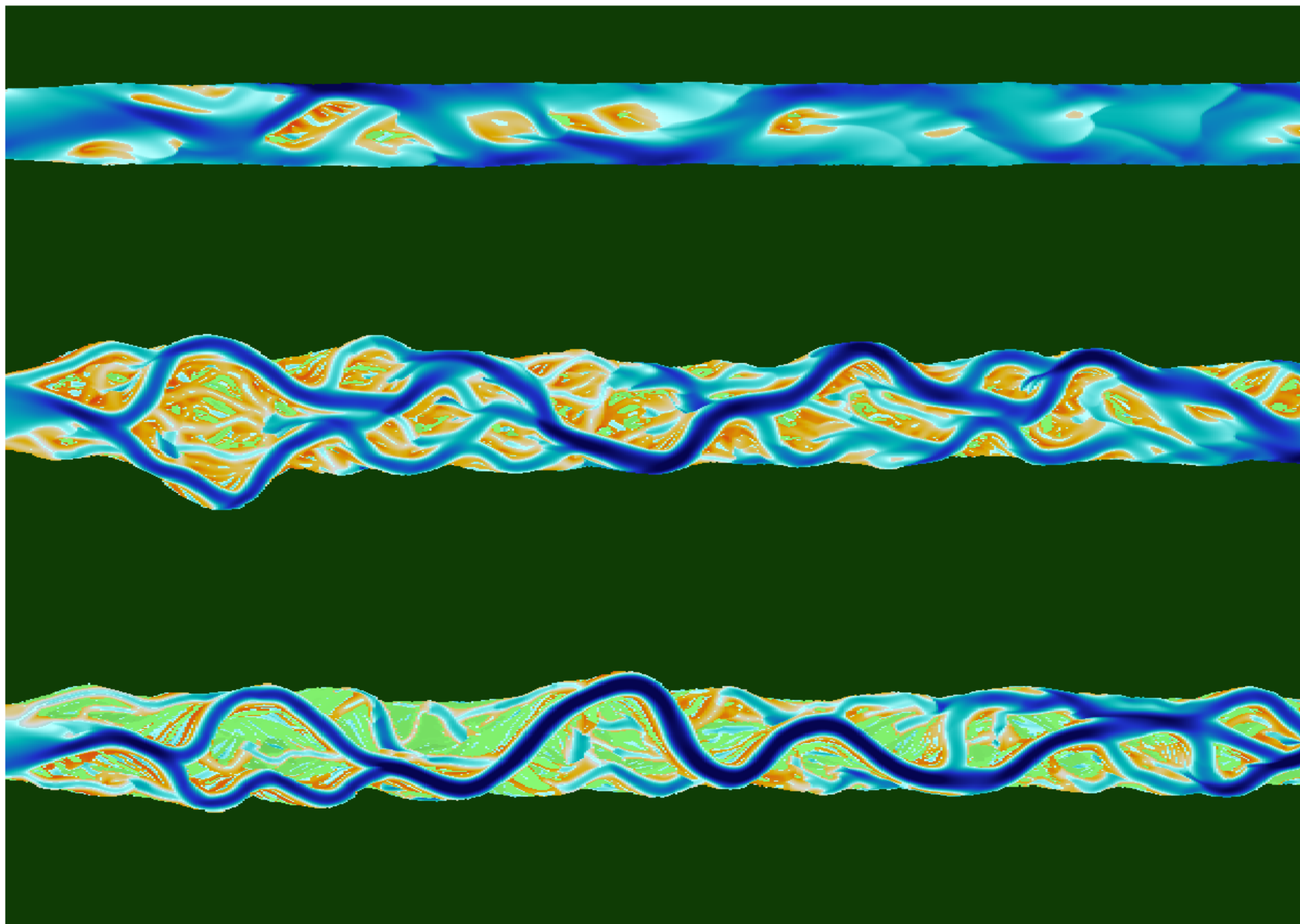


5 m

Depth: 0 m



20 m



Simulation Time: 70 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

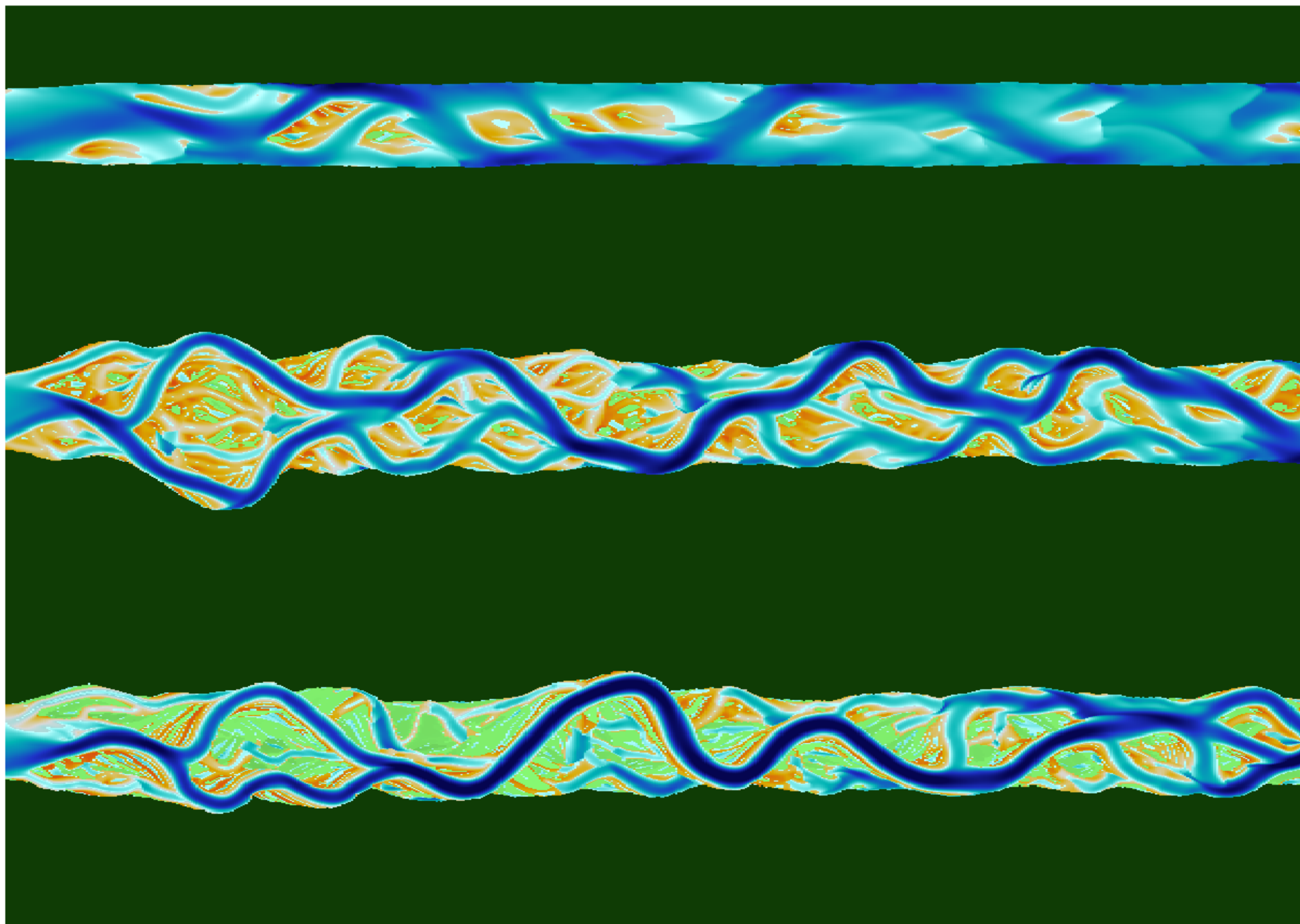


5 m

Depth: 0 m



20 m



Simulation Time: 72 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

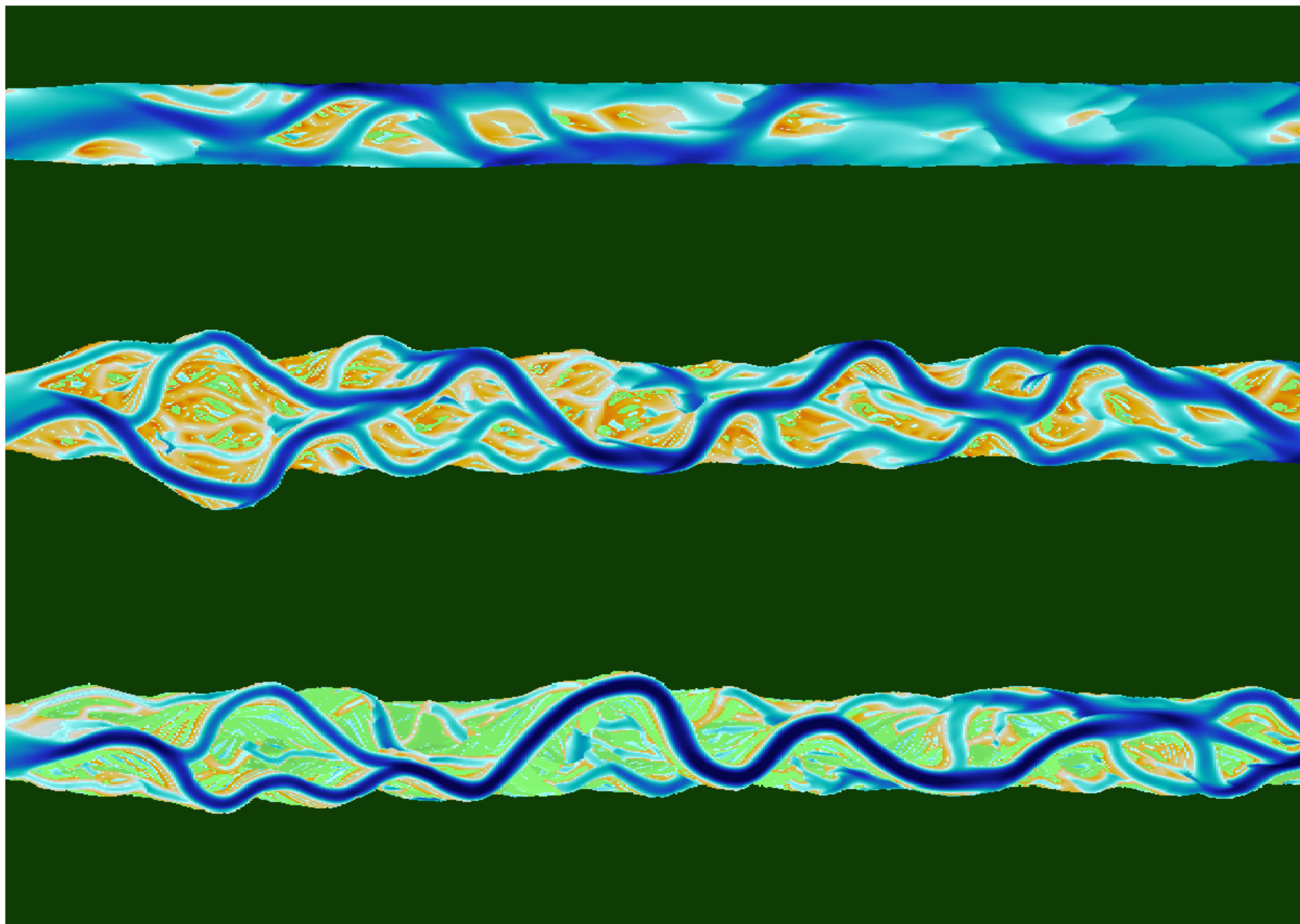


5 m

Depth: 0 m



20 m



Simulation Time: 74 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

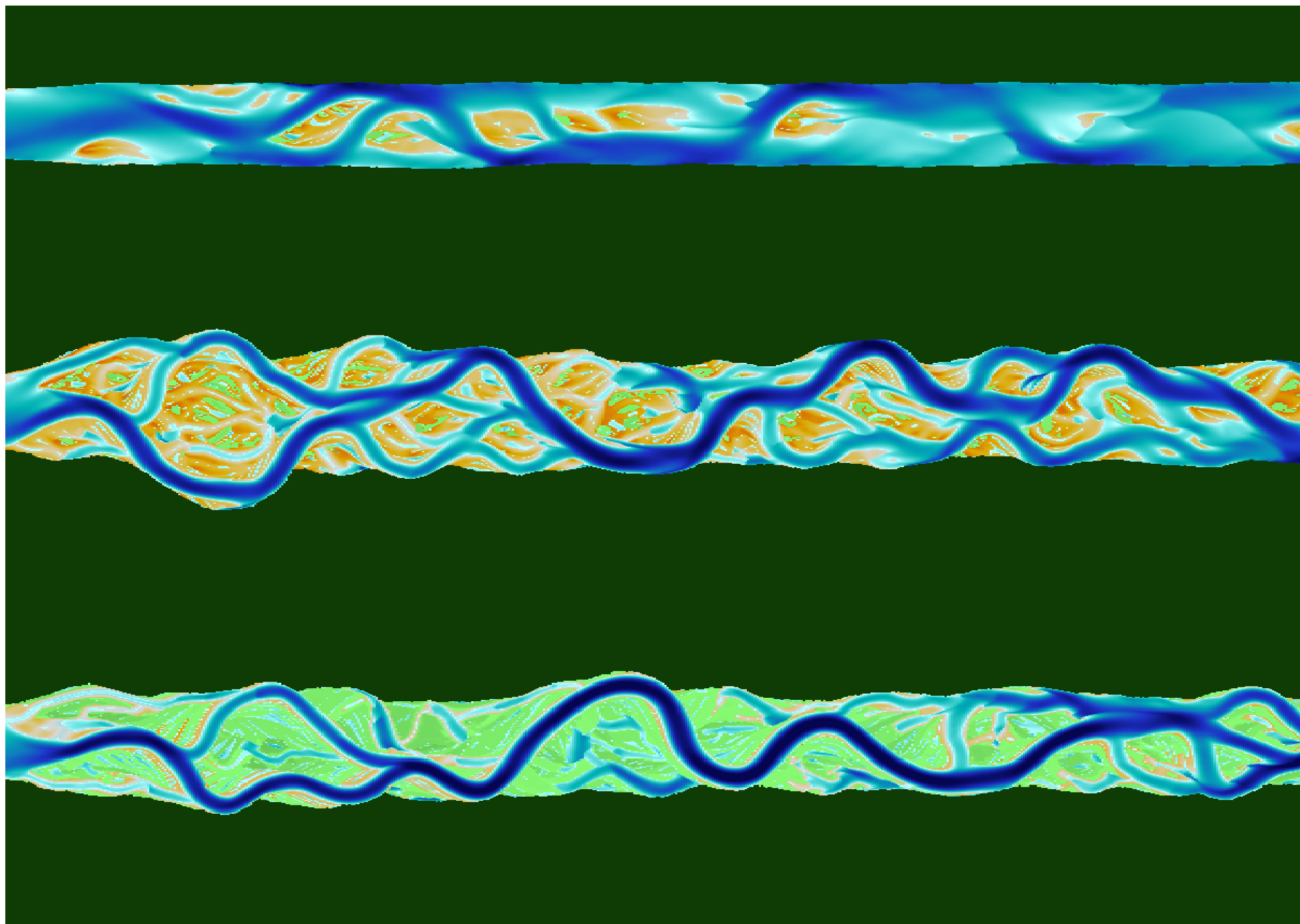


5 m

Depth: 0 m



20 m



Simulation Time: 76 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

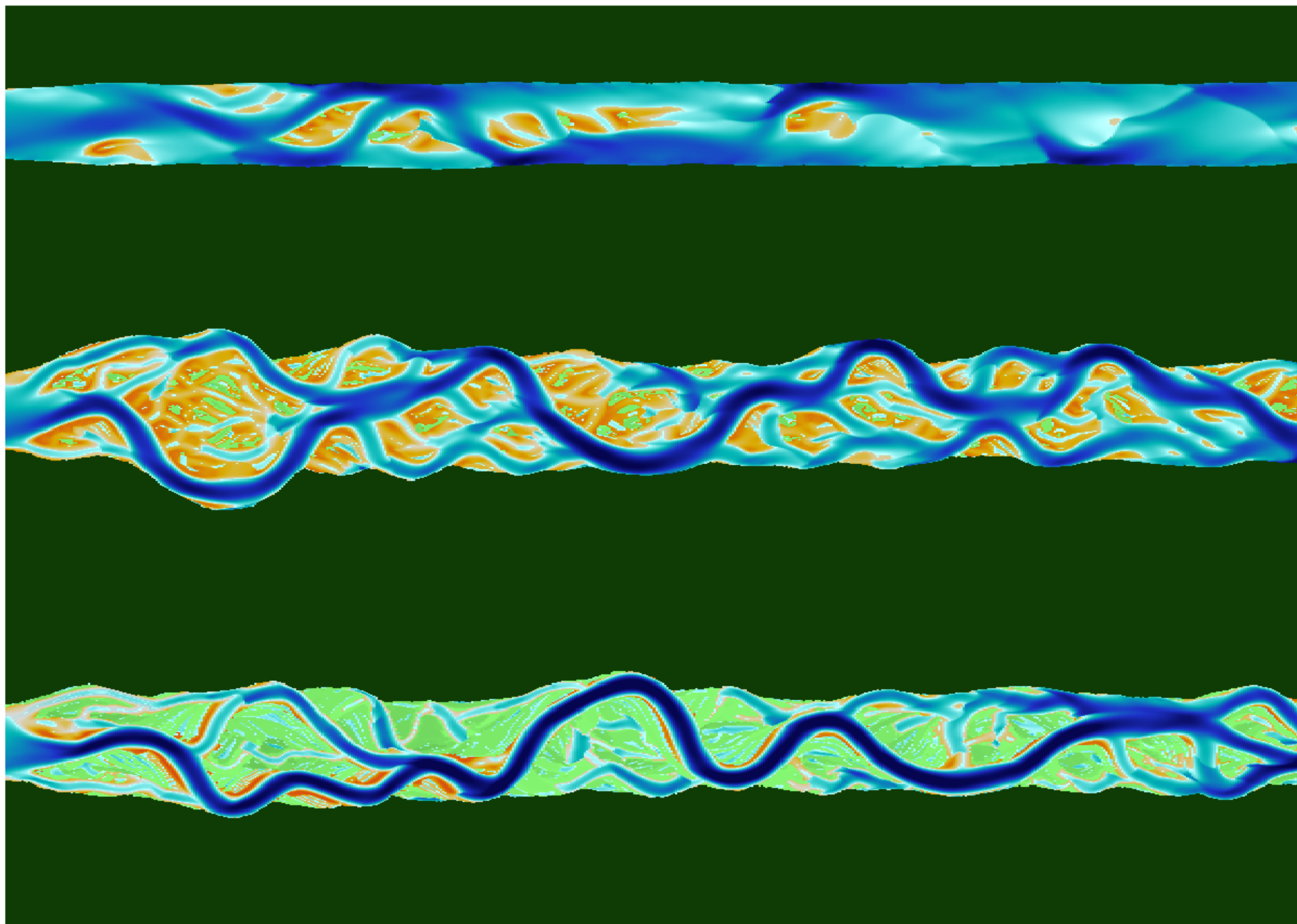


5 m

Depth: 0 m



20 m



Simulation Time: 78 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

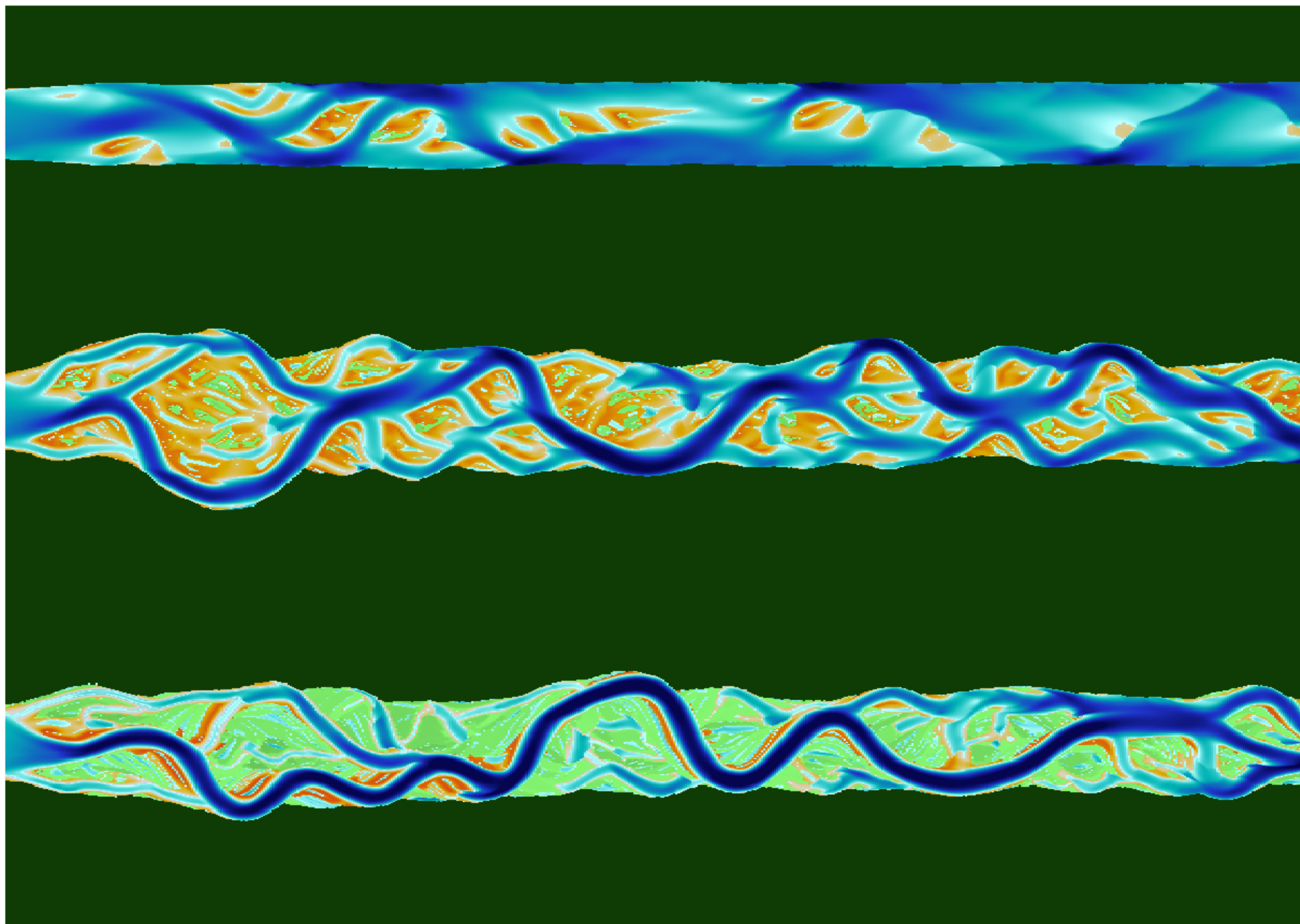


5 m

Depth: 0 m



20 m



Simulation Time: 80 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

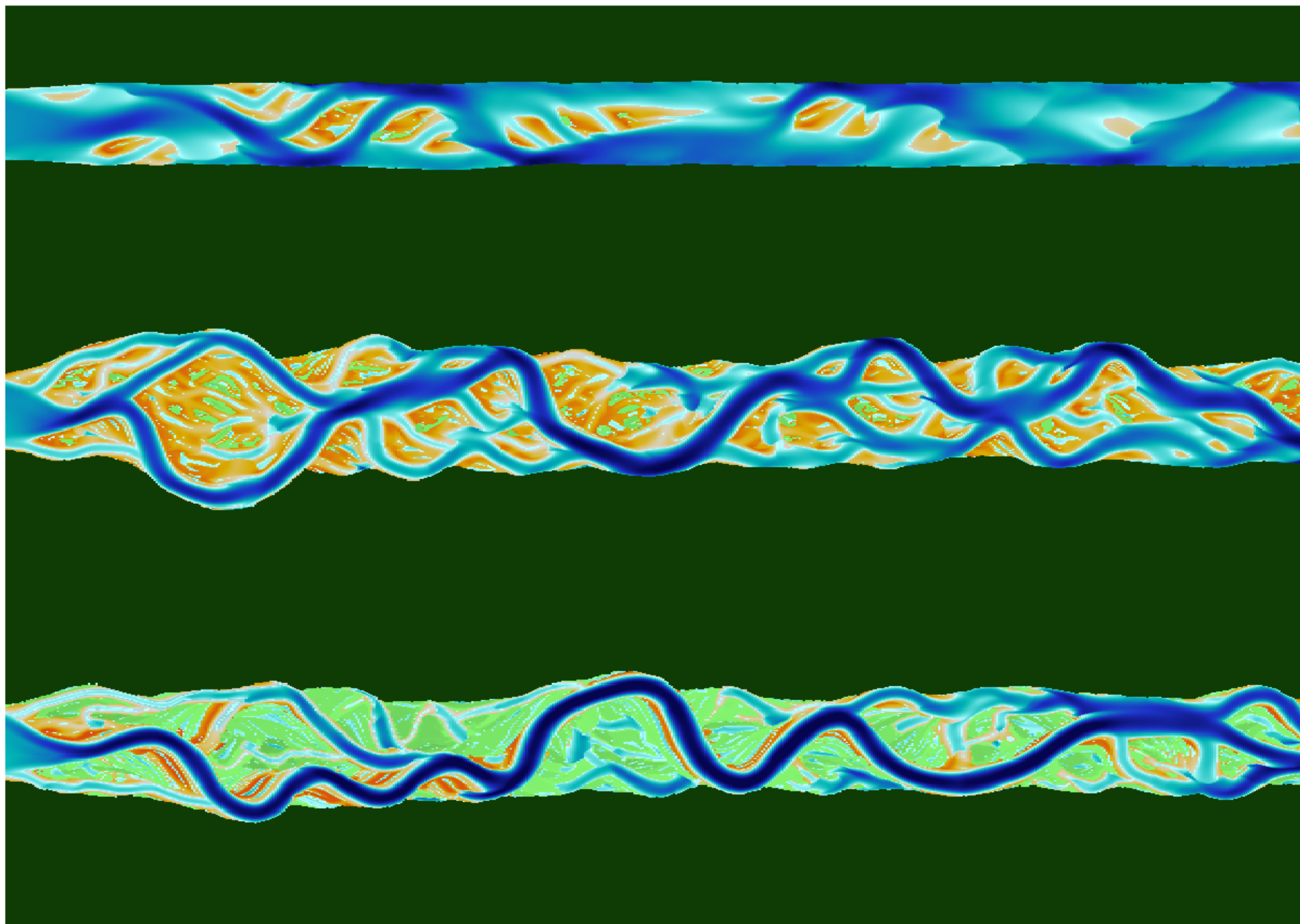


5 m

Depth: 0 m



20 m



Simulation Time: 82 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

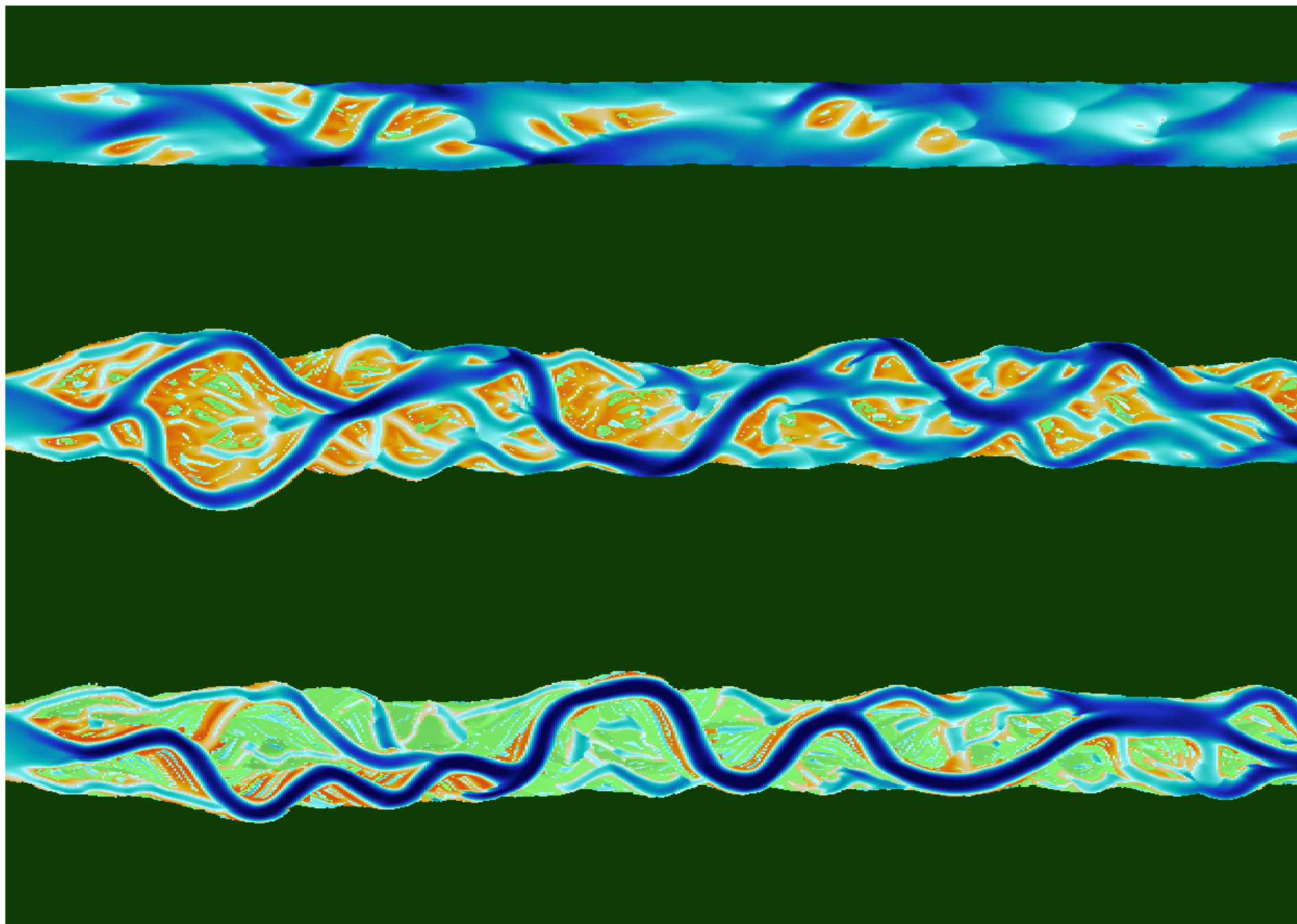


5 m

Depth: 0 m



20 m



Simulation Time: 84 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

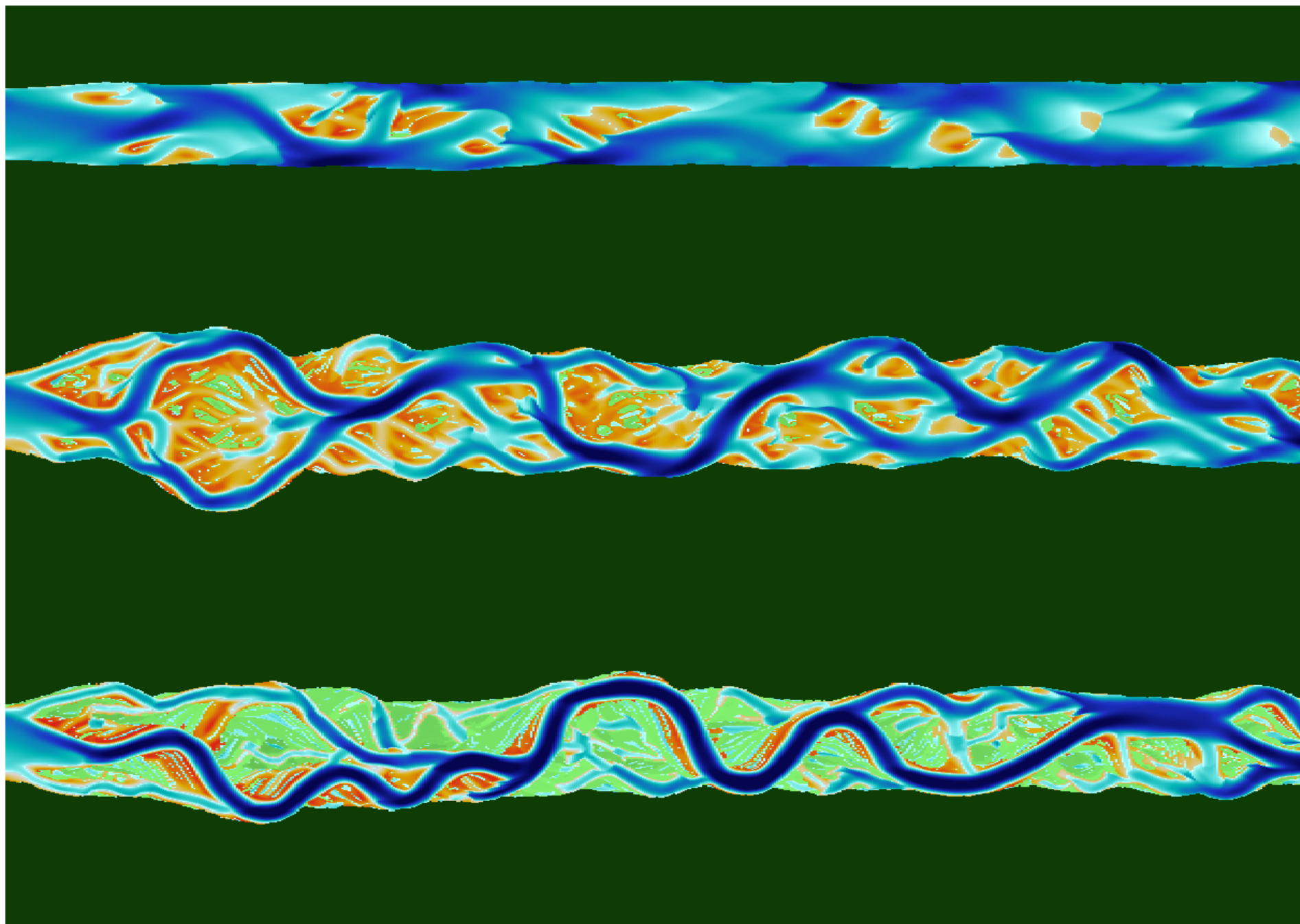


5 m

Depth: 0 m



20 m



Simulation Time: 86 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

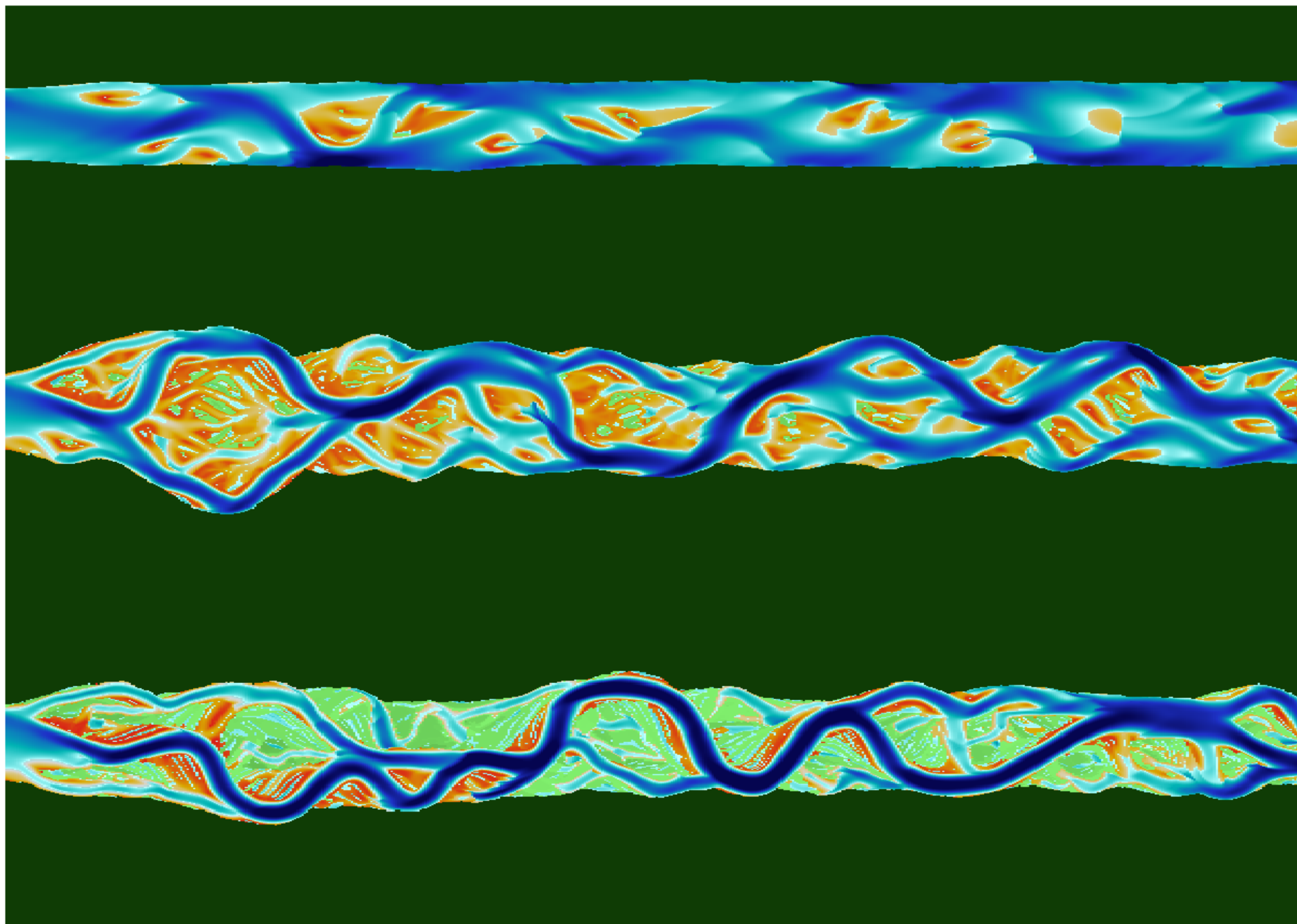


5 m

Depth: 0 m



20 m



Simulation Time: 88 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

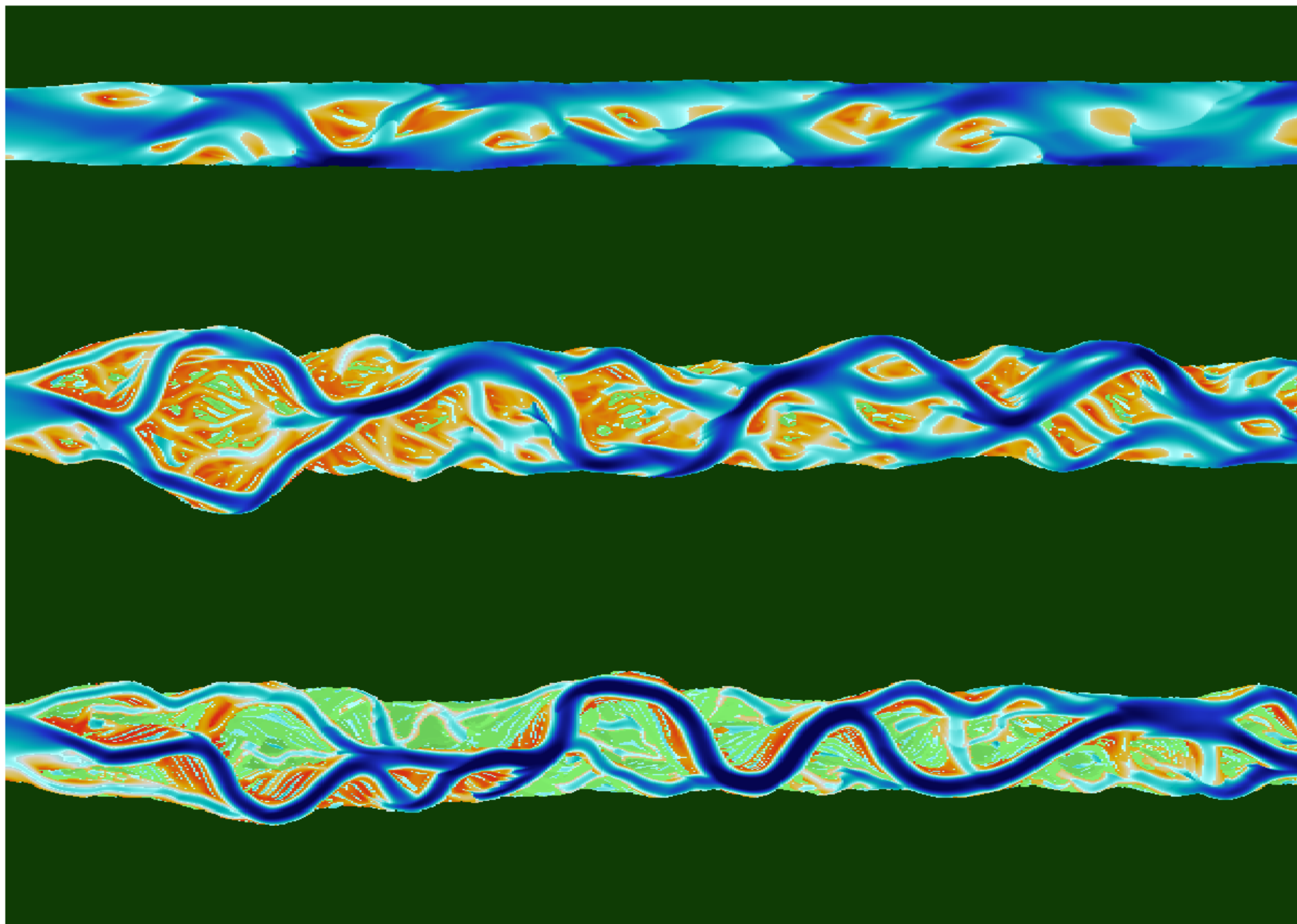


5 m

Depth: 0 m



20 m



Simulation Time: 90 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

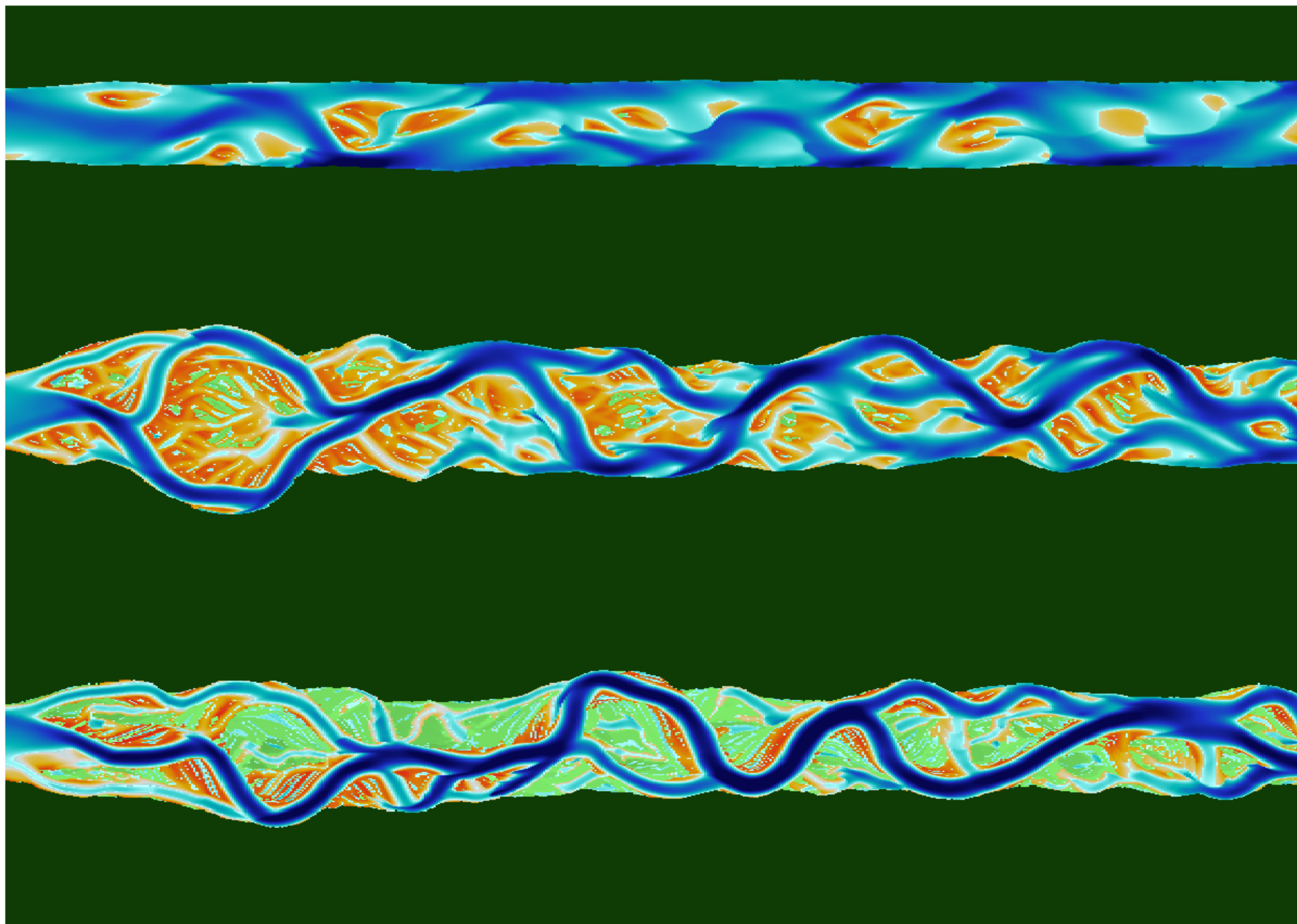


5 m

Depth: 0 m



20 m



Simulation Time: 92 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

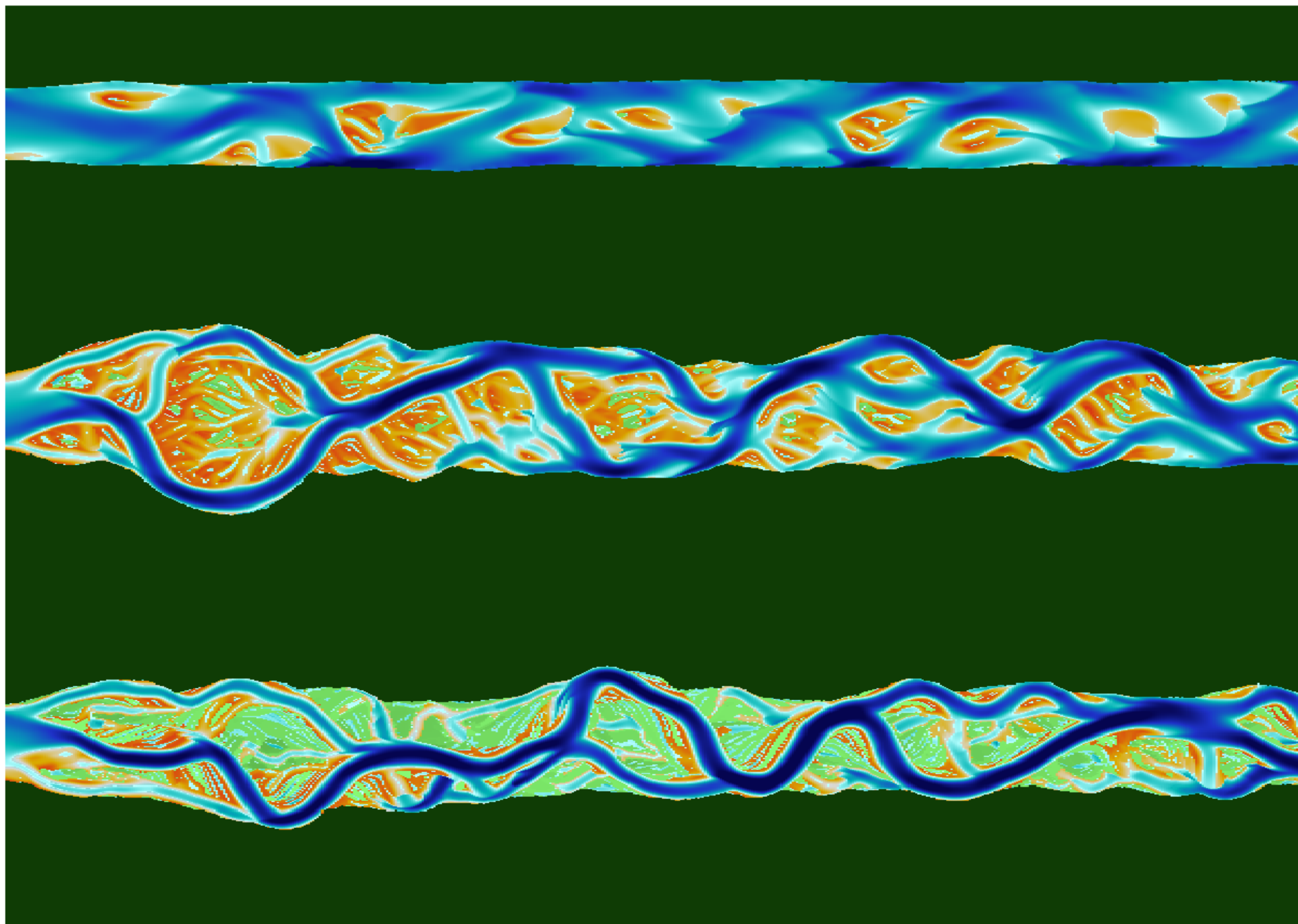


5 m

Depth: 0 m



20 m



Simulation Time: 94 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

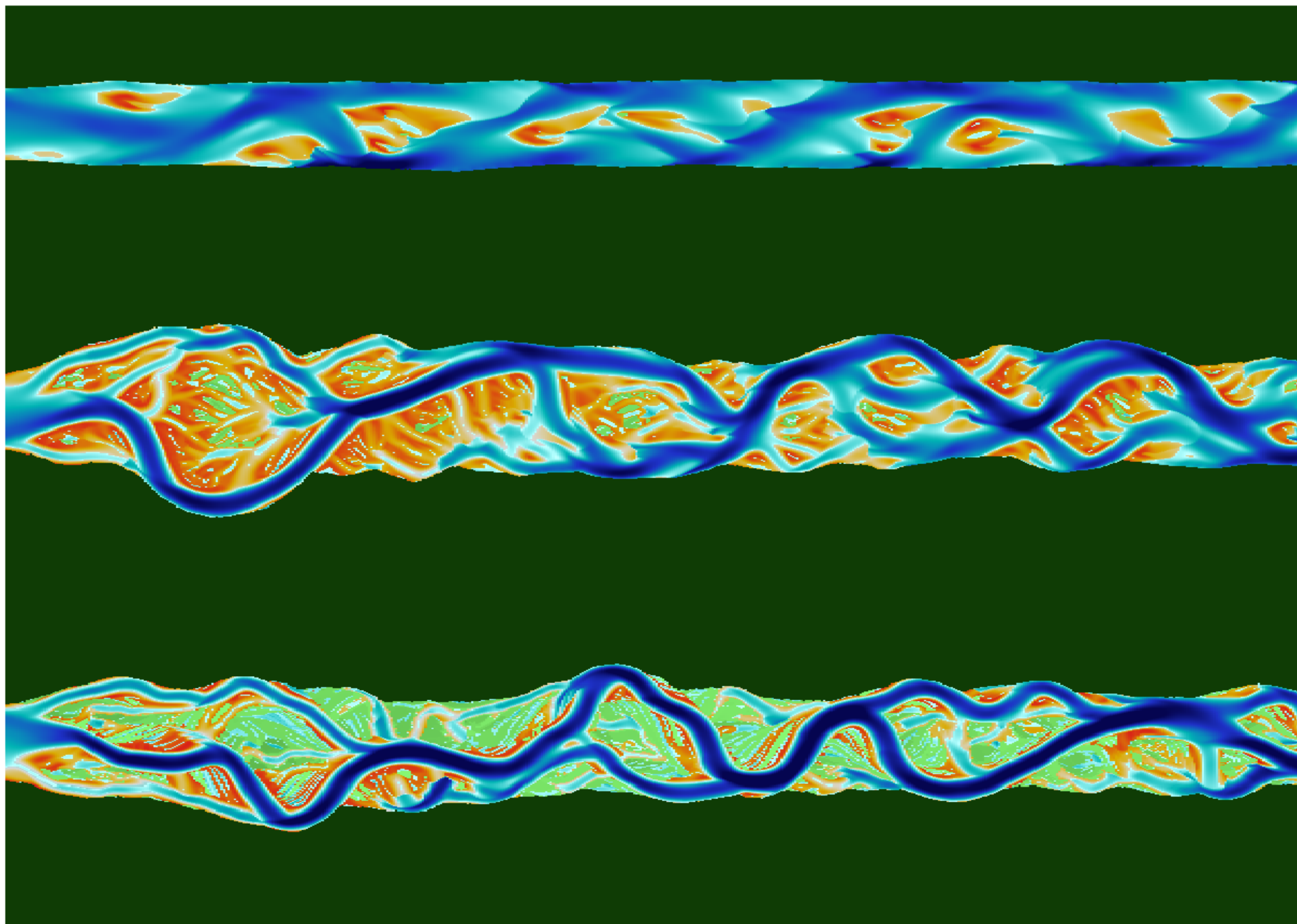


5 m

Depth: 0 m



20 m



Simulation Time: 96 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

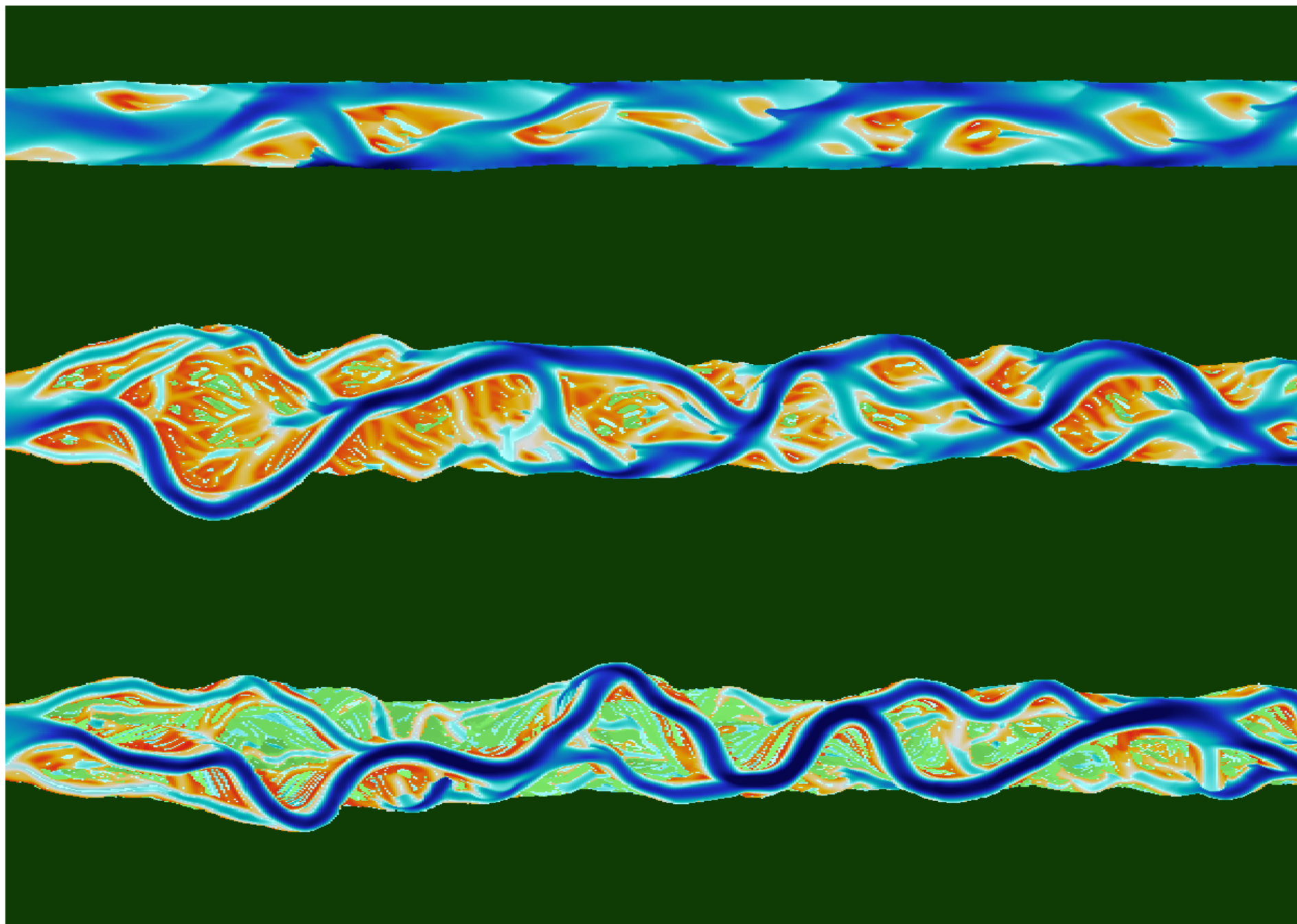


5 m

Depth: 0 m



20 m



Simulation Time: 98 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

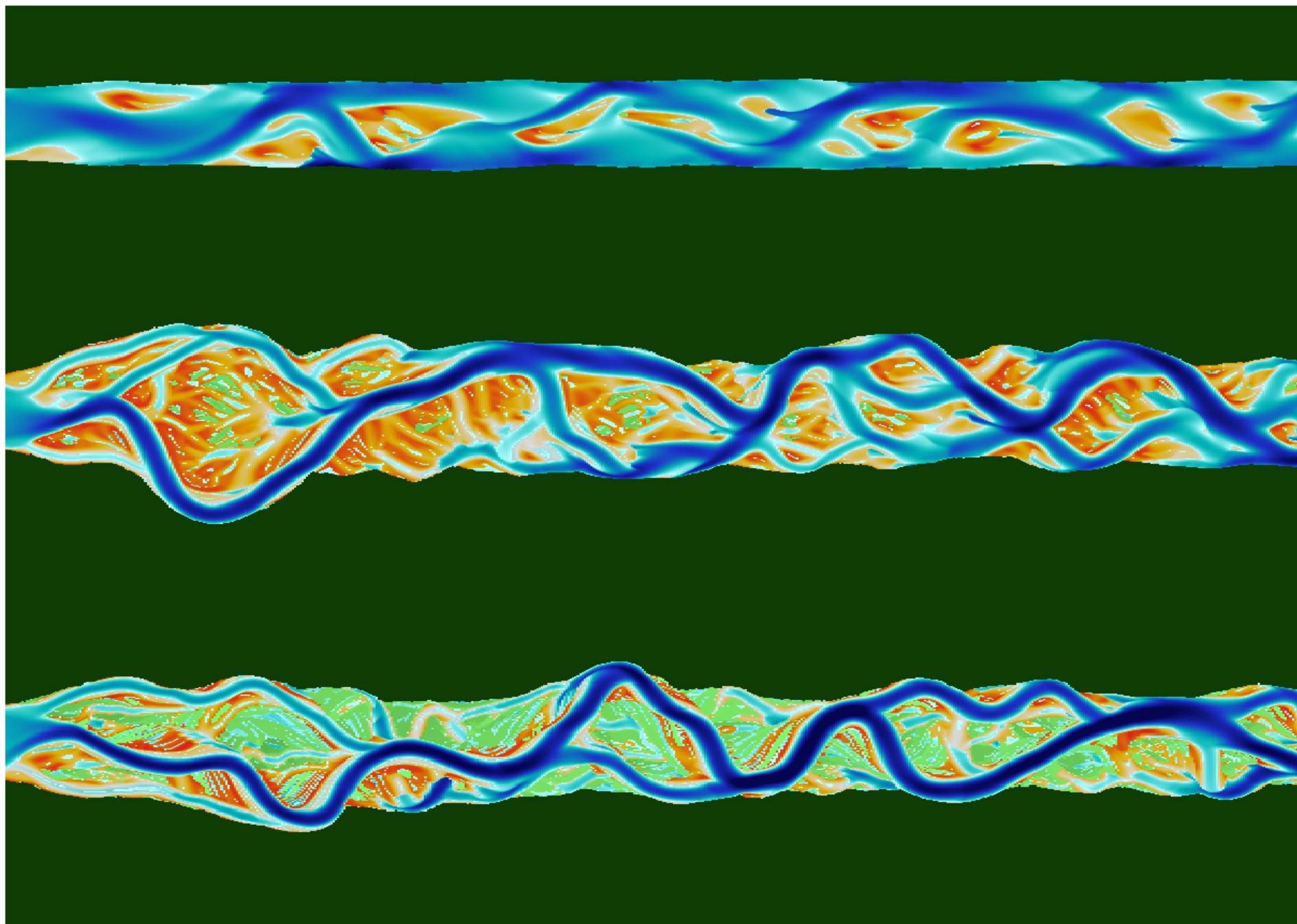


5 m

Depth: 0 m



20 m



Simulation Time: 100 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

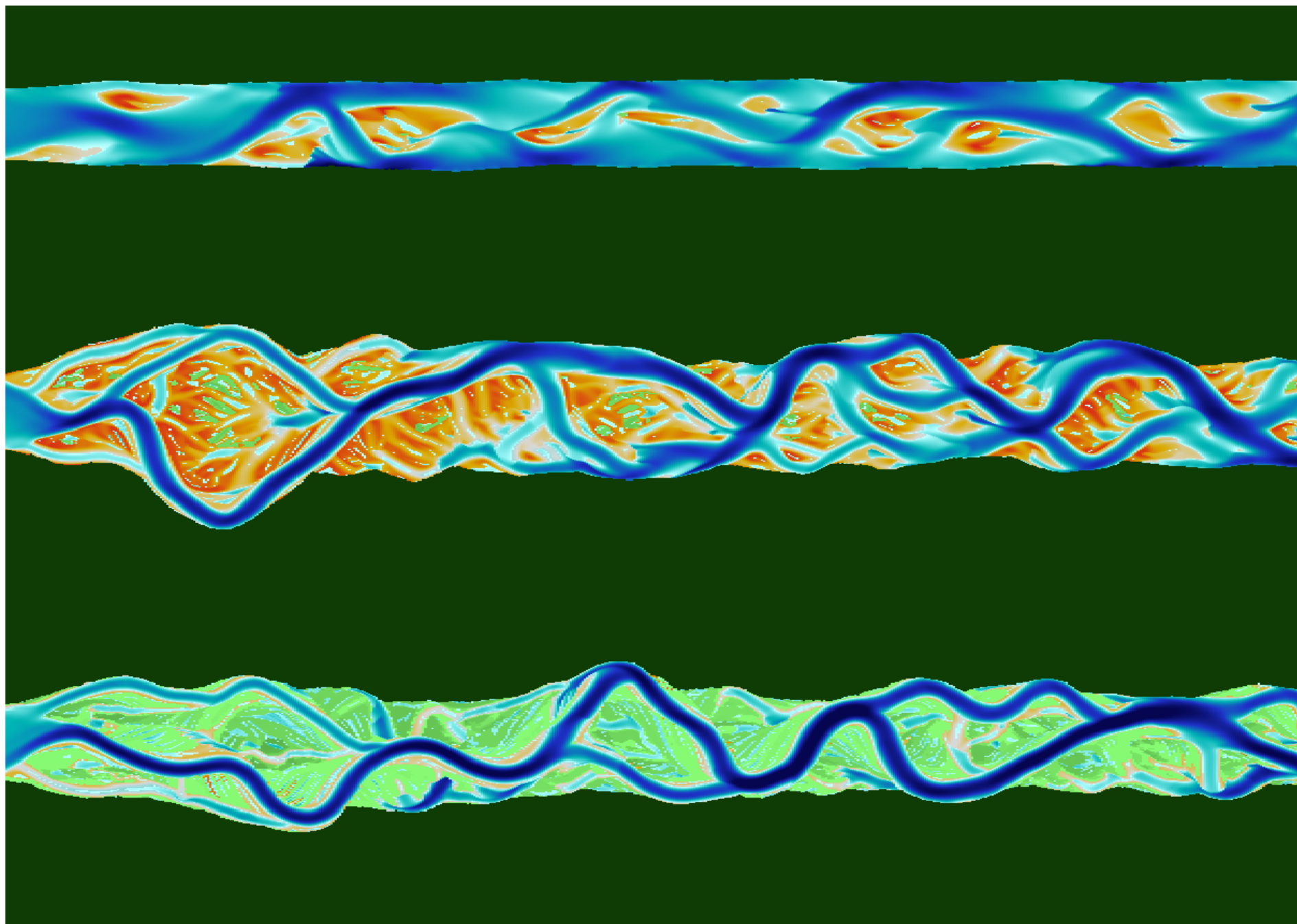


5 m

Depth: 0 m



20 m



Simulation Time: 102 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

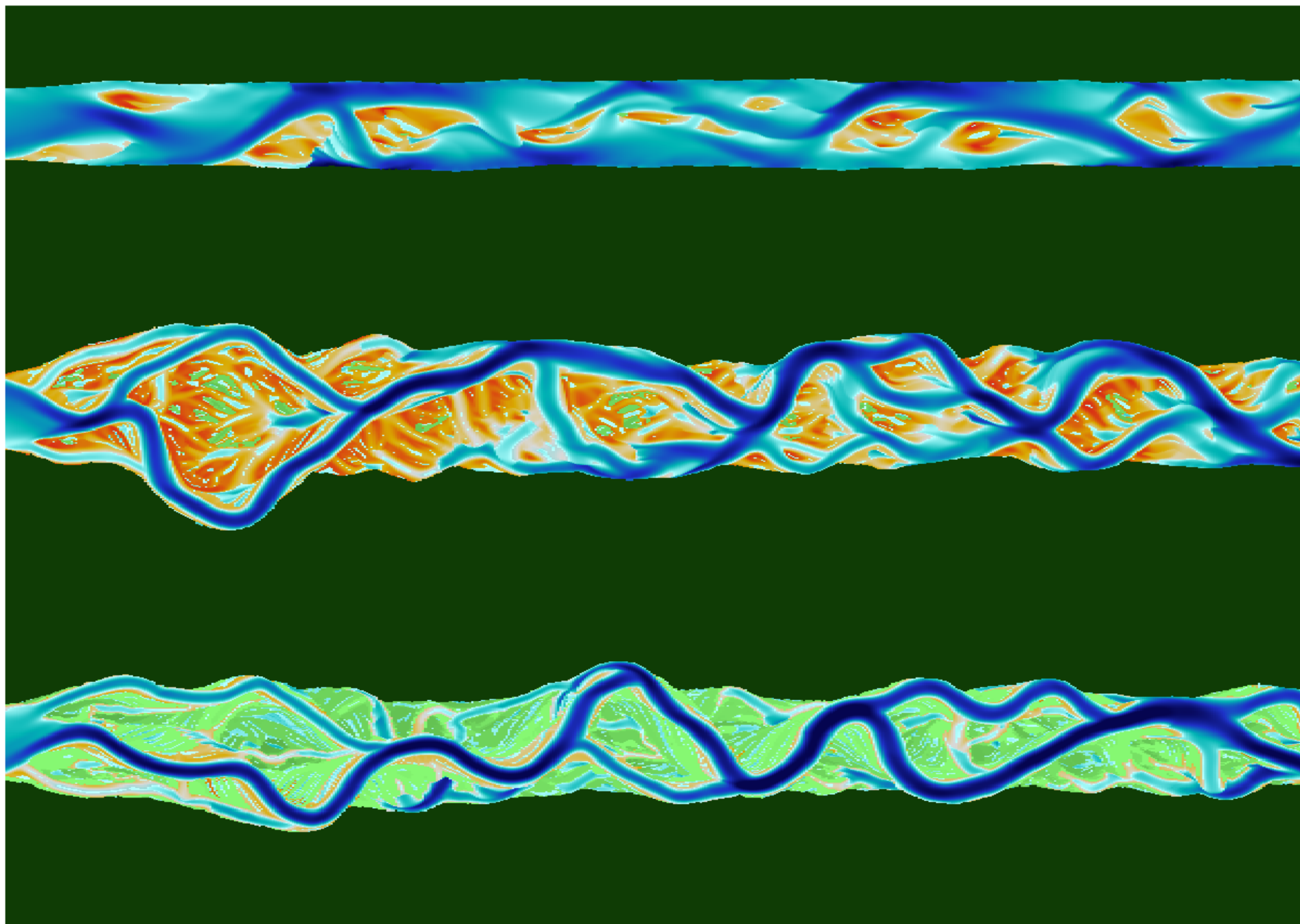


5 m

Depth: 0 m



20 m



Simulation Time: 104 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

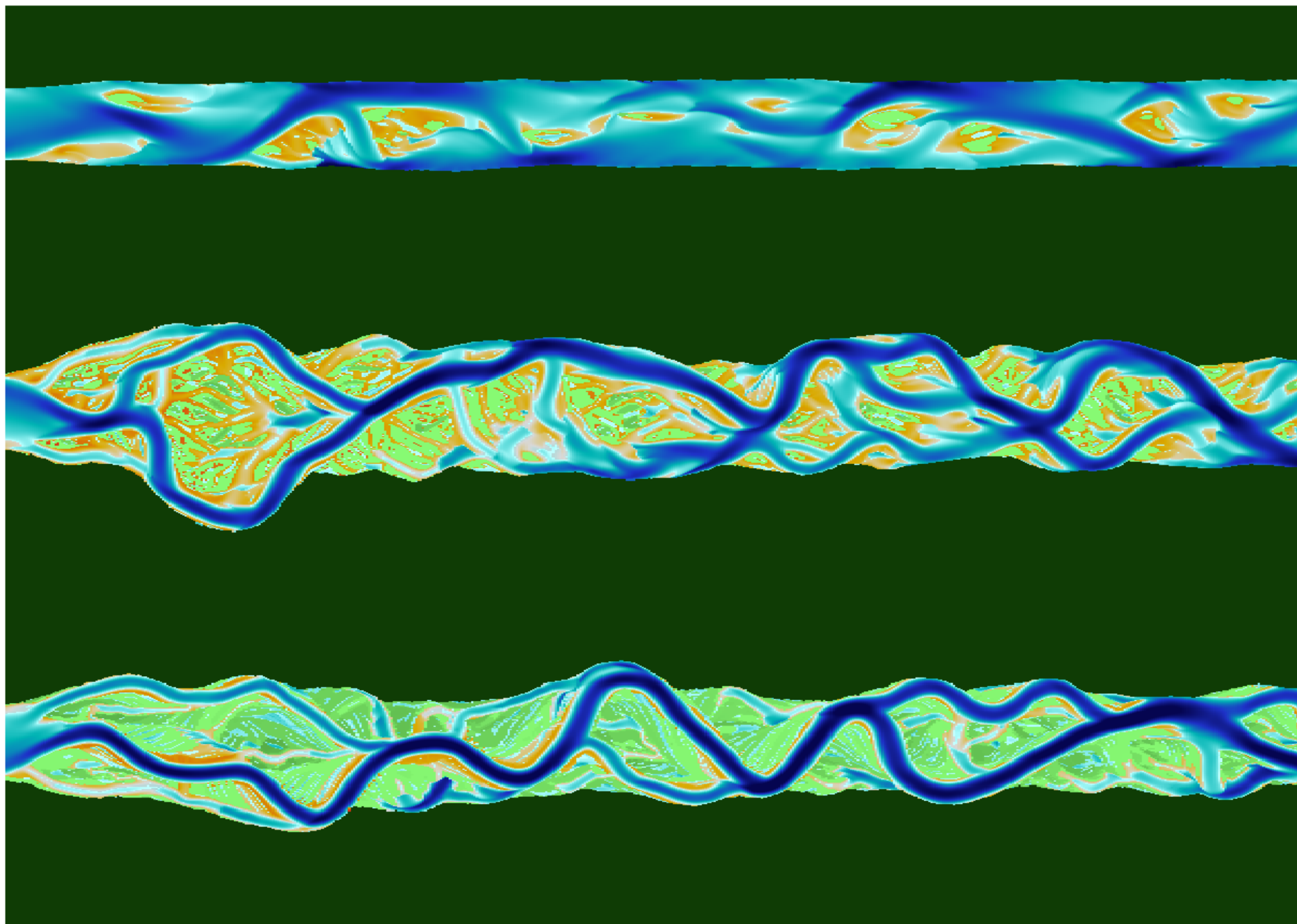


5 m

Depth: 0 m



20 m



Simulation Time: 106 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

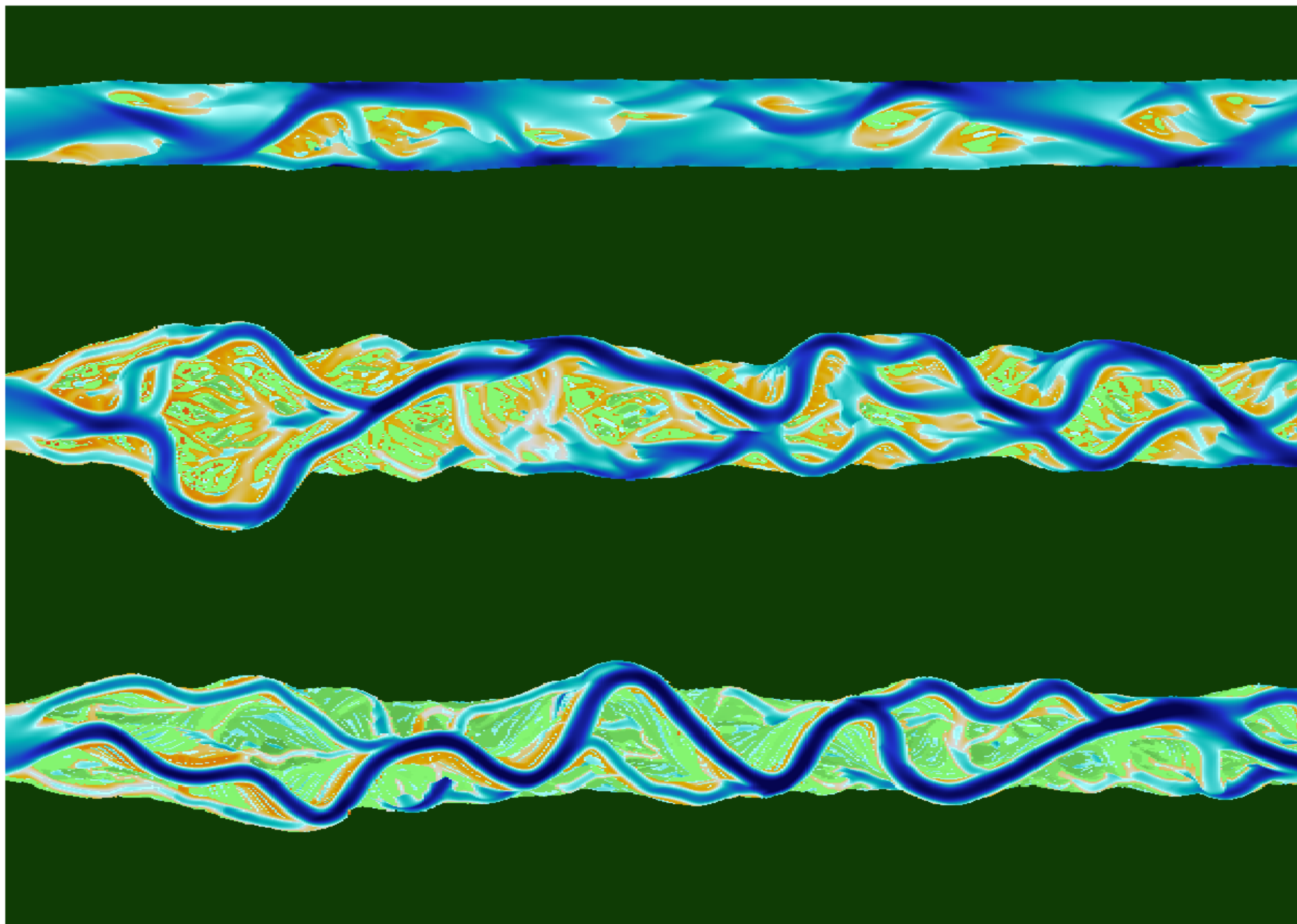


5 m

Depth: 0 m



20 m



Simulation Time: 108 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

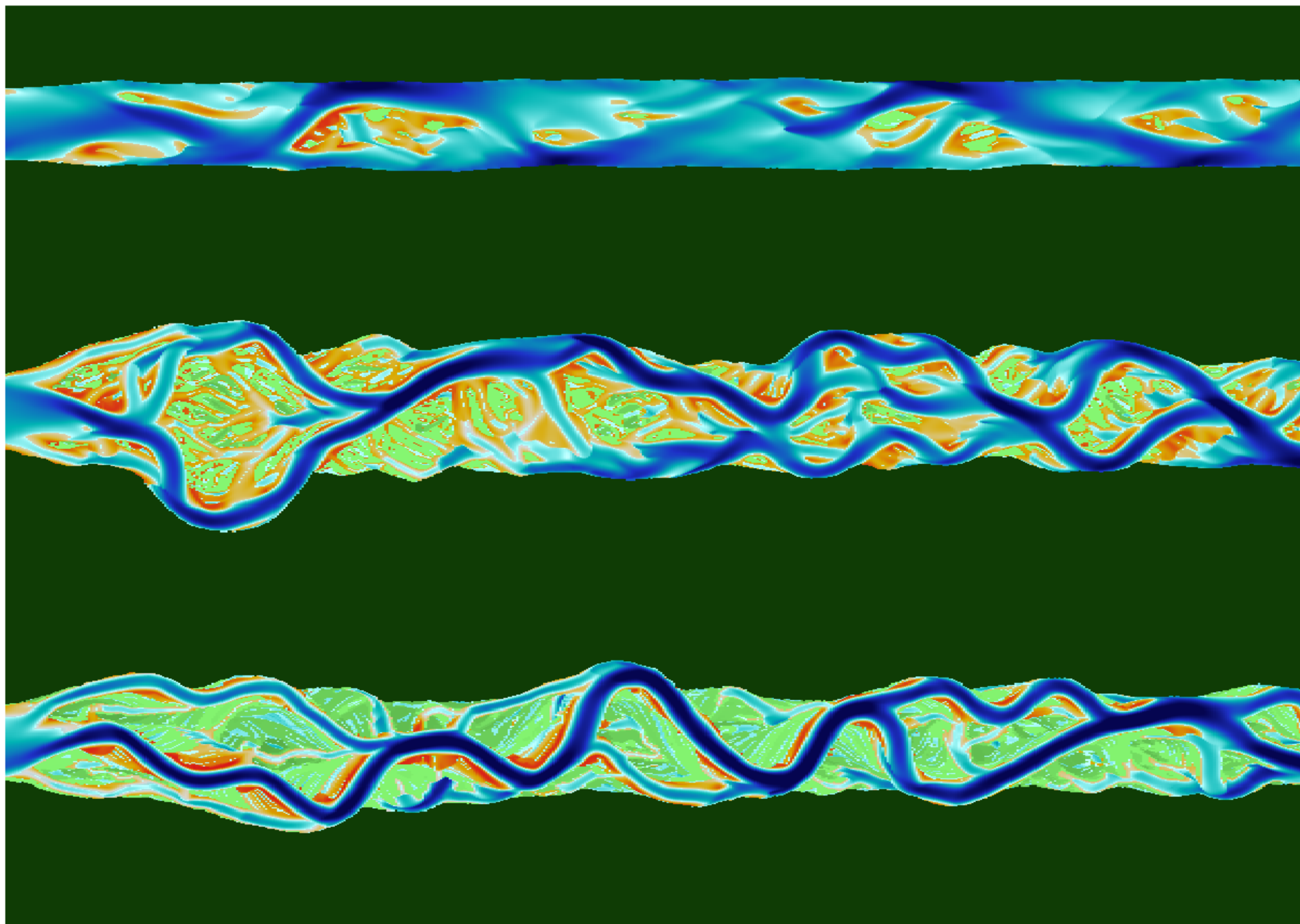


5 m

Depth: 0 m



20 m



Simulation Time: 110 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

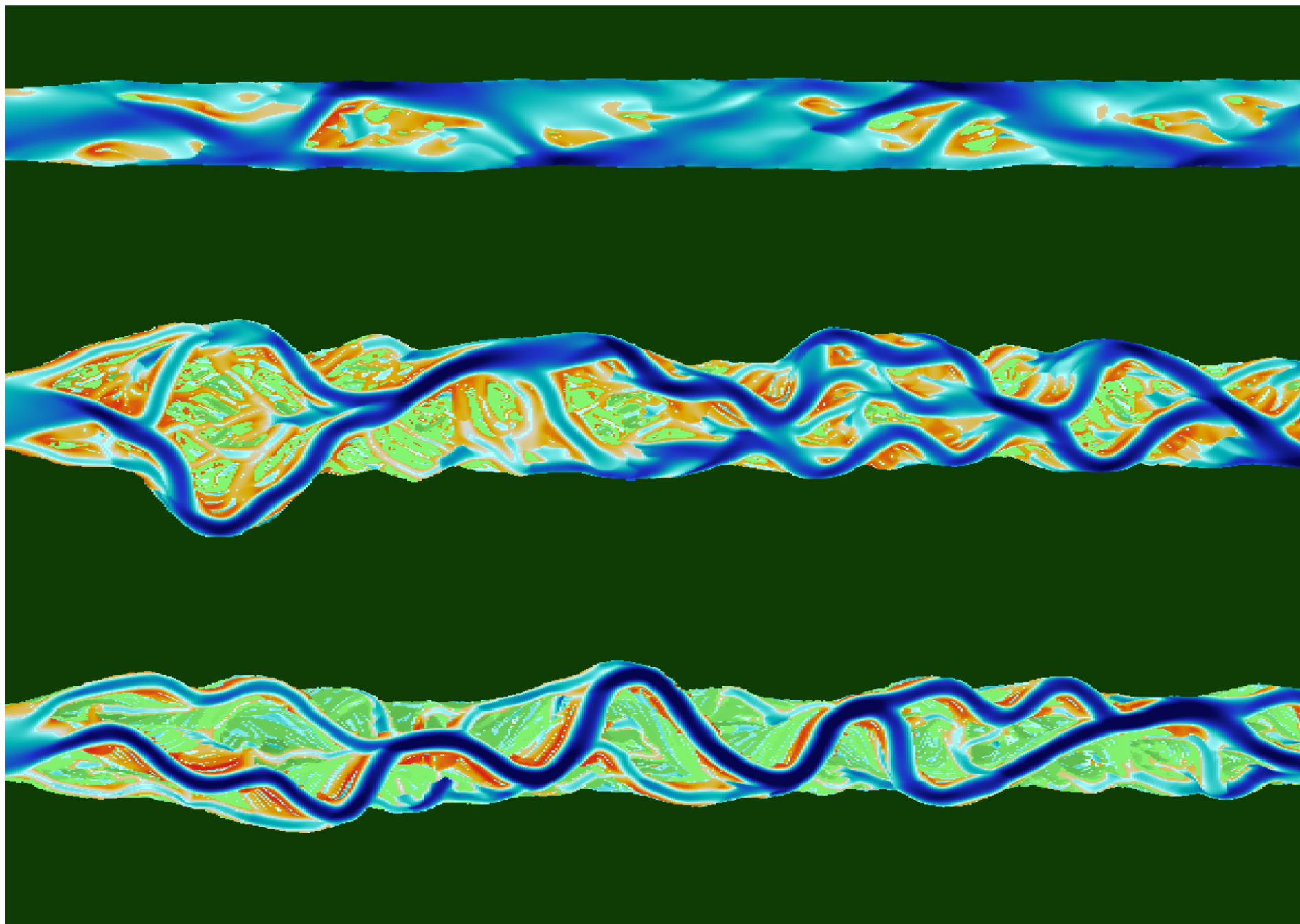


5 m

Depth: 0 m



20 m



Simulation Time: 112 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

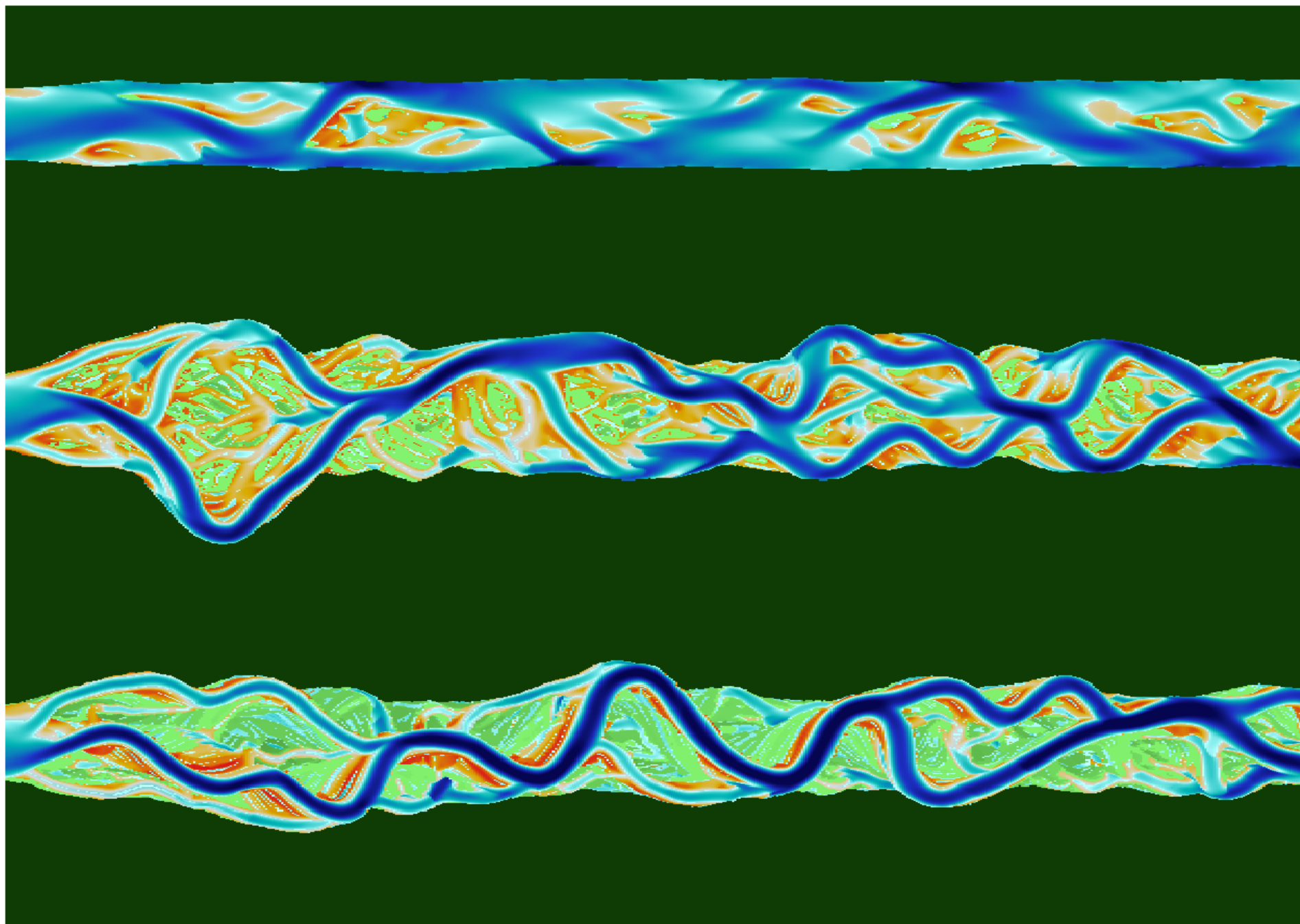


5 m

Depth: 0 m



20 m



Simulation Time: 114 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

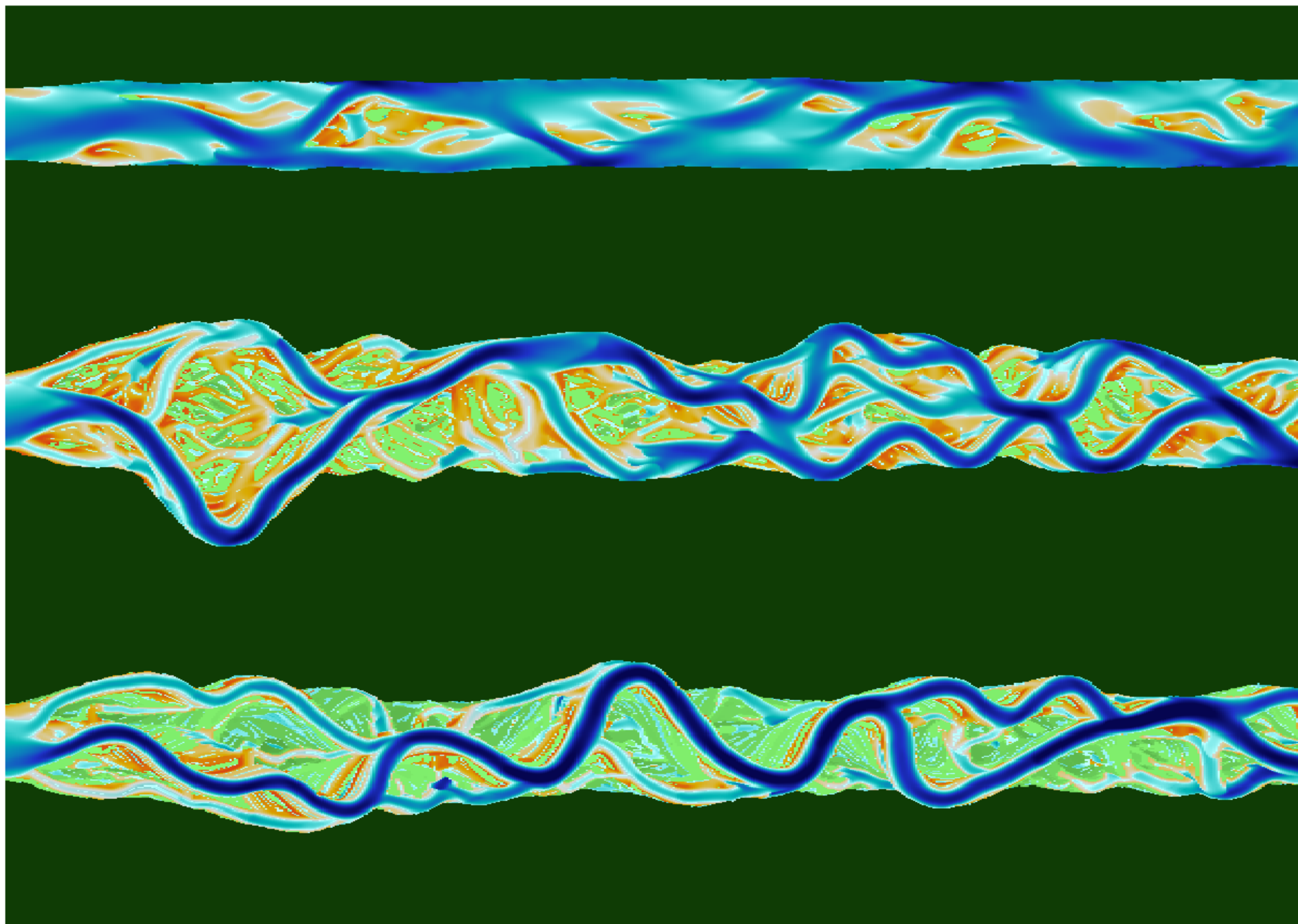


5 m

Depth: 0 m



20 m



Simulation Time: 116 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

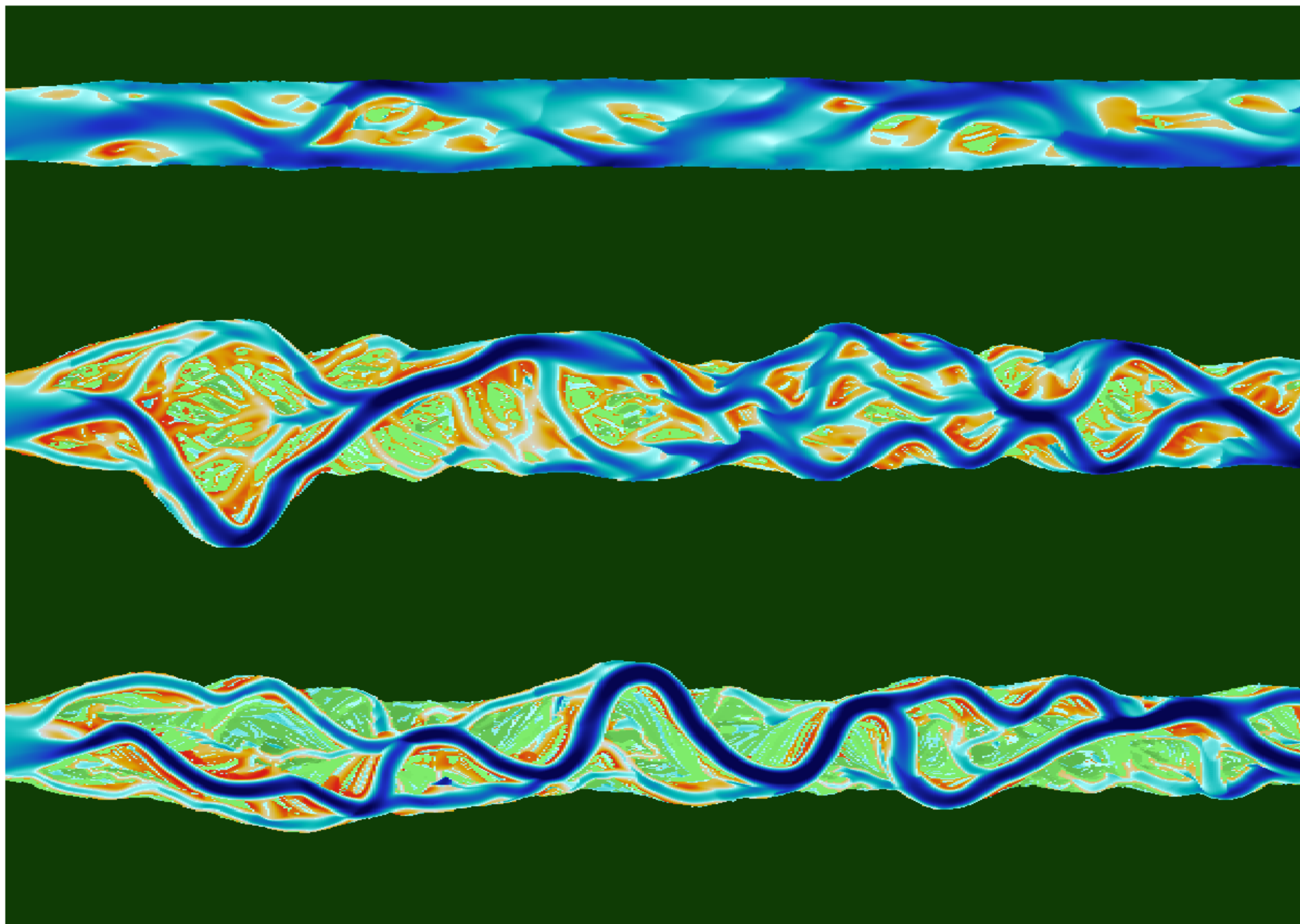


5 m

Depth: 0 m



20 m



Simulation Time: 118 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

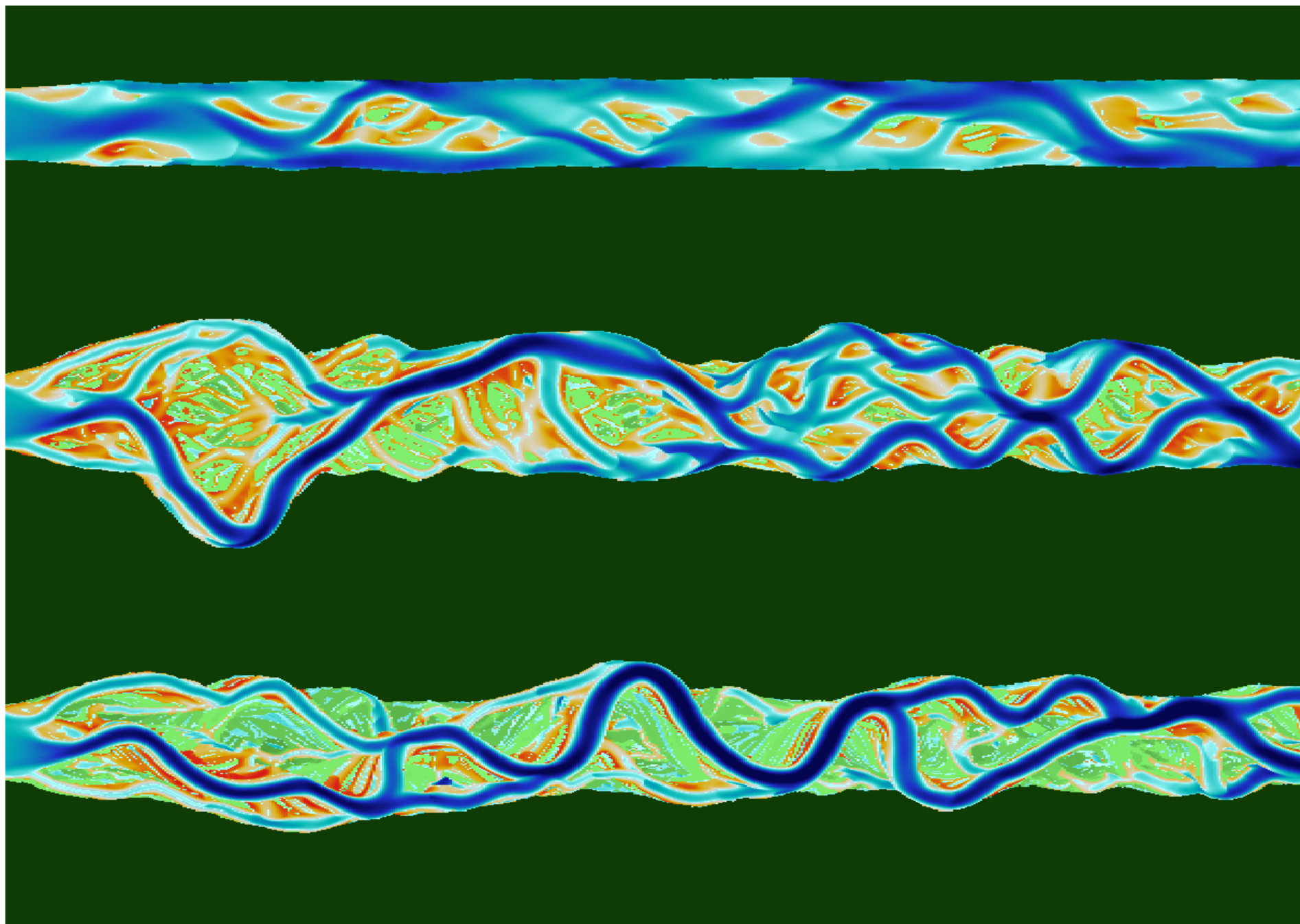


5 m

Depth: 0 m



20 m



Simulation Time: 120 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

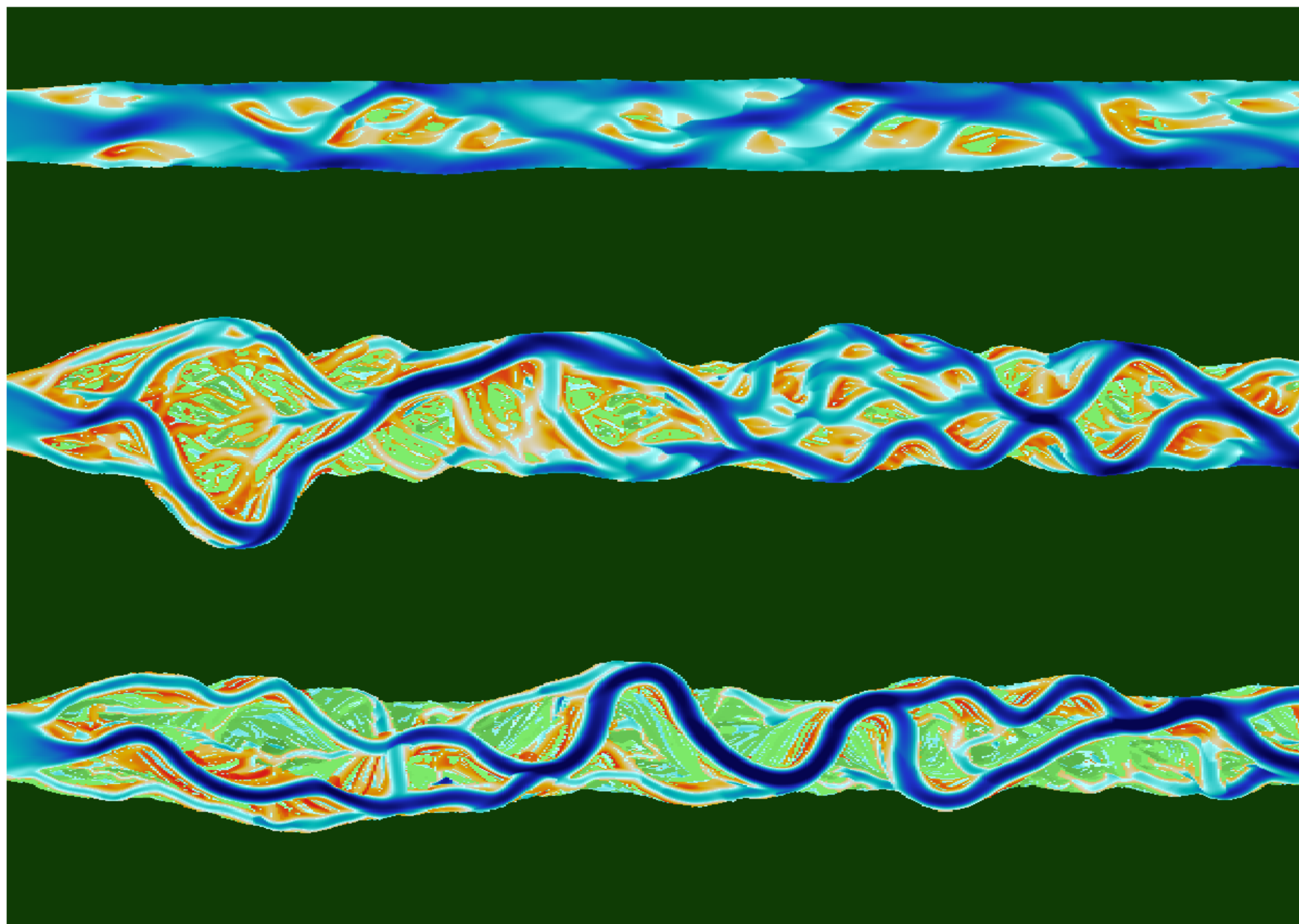


5 m

Depth: 0 m



20 m



Simulation Time: 122 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

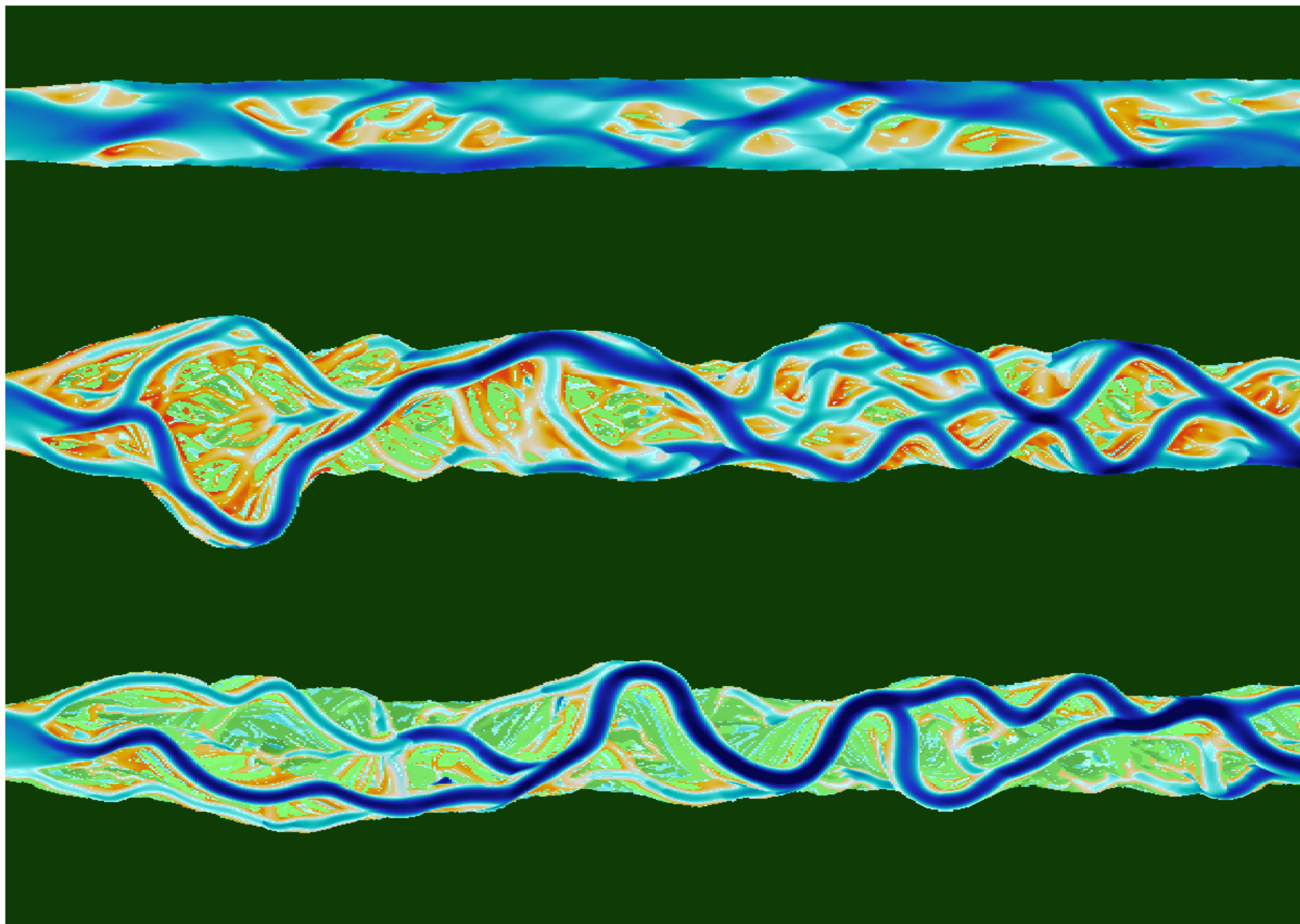


5 m

Depth: 0 m



20 m



Simulation Time: 124 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

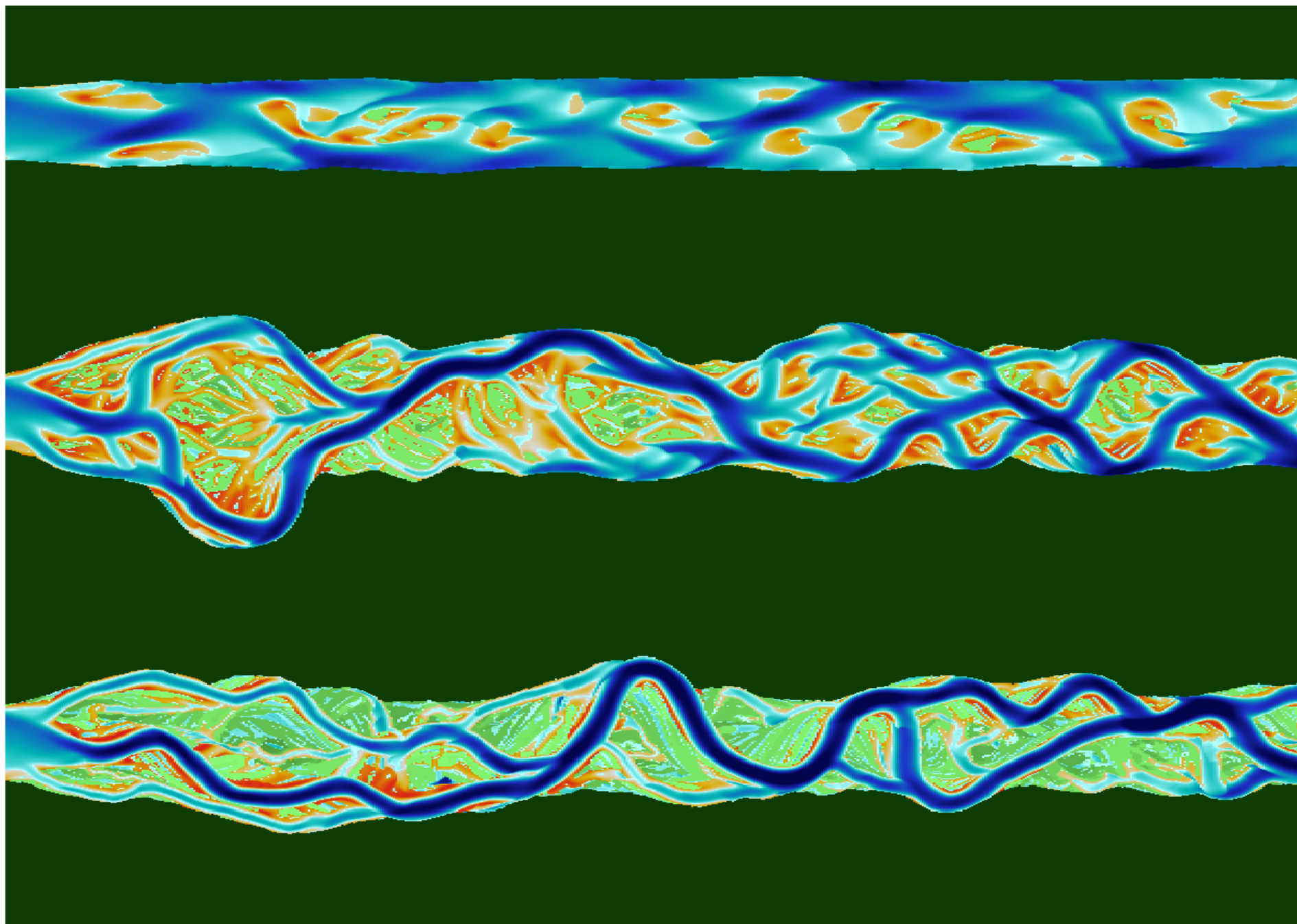


5 m

Depth: 0 m



20 m



Simulation Time: 126 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

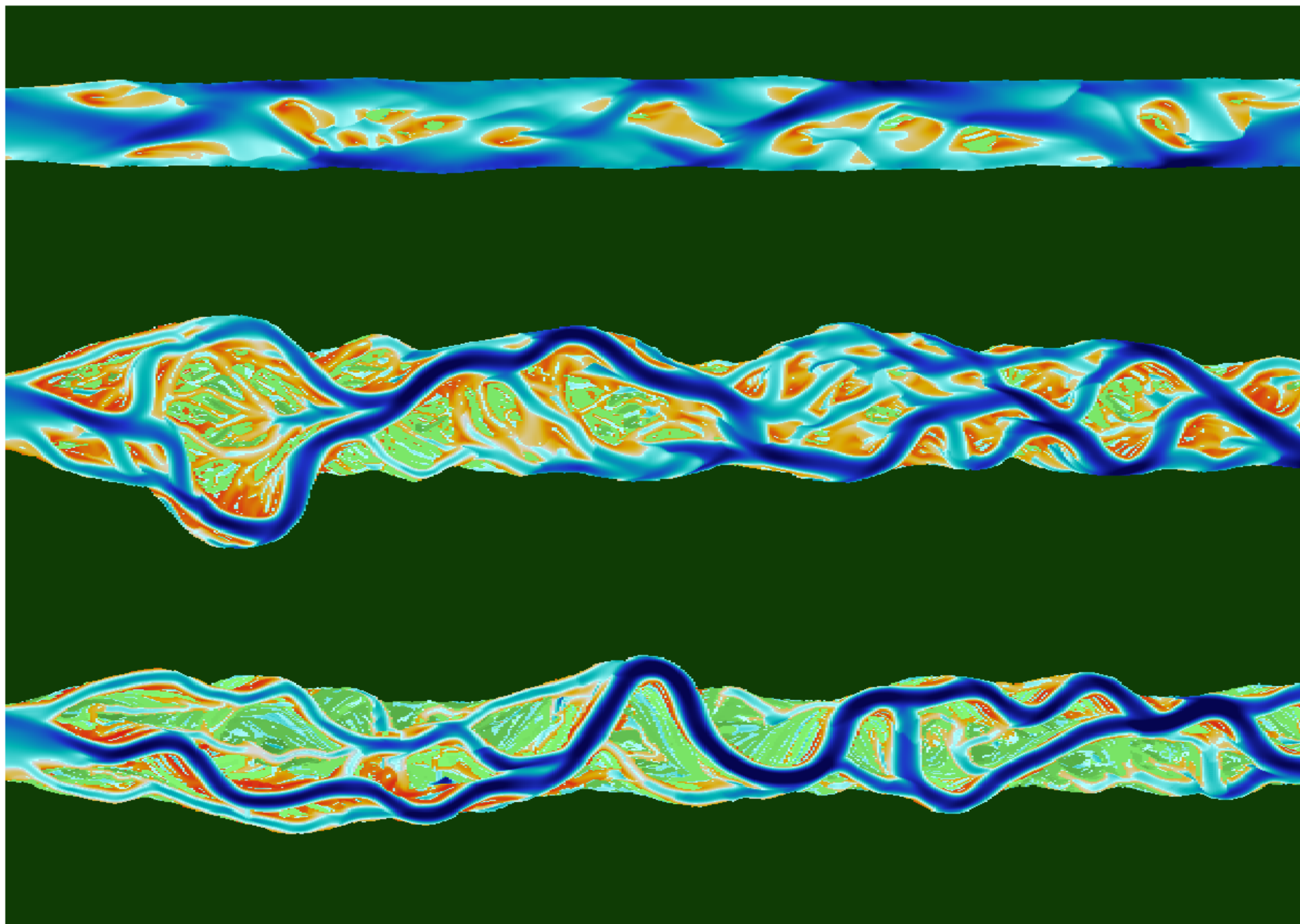


5 m

Depth: 0 m



20 m



Simulation Time: 128 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

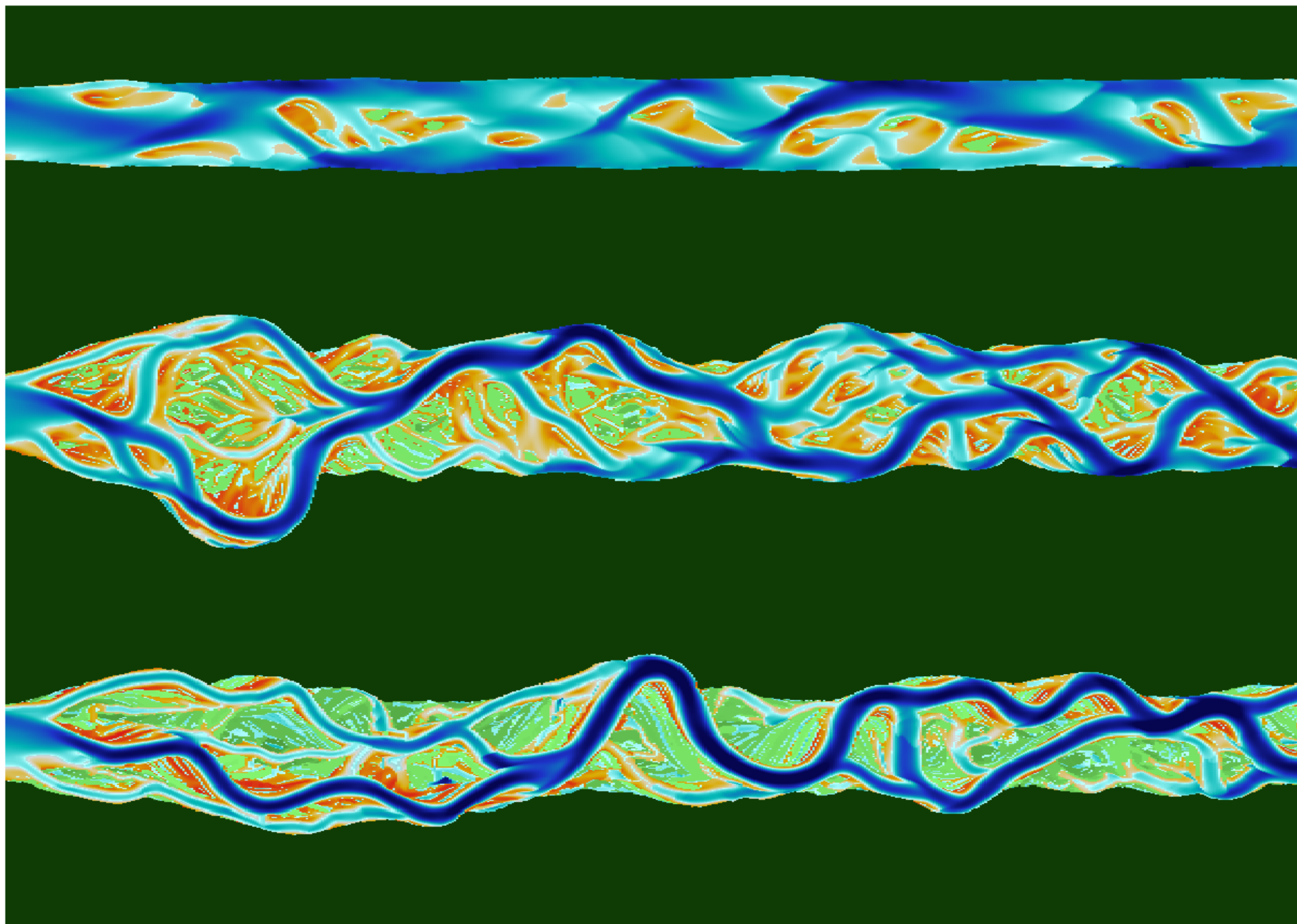


5 m

Depth: 0 m



20 m



Simulation Time: 130 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

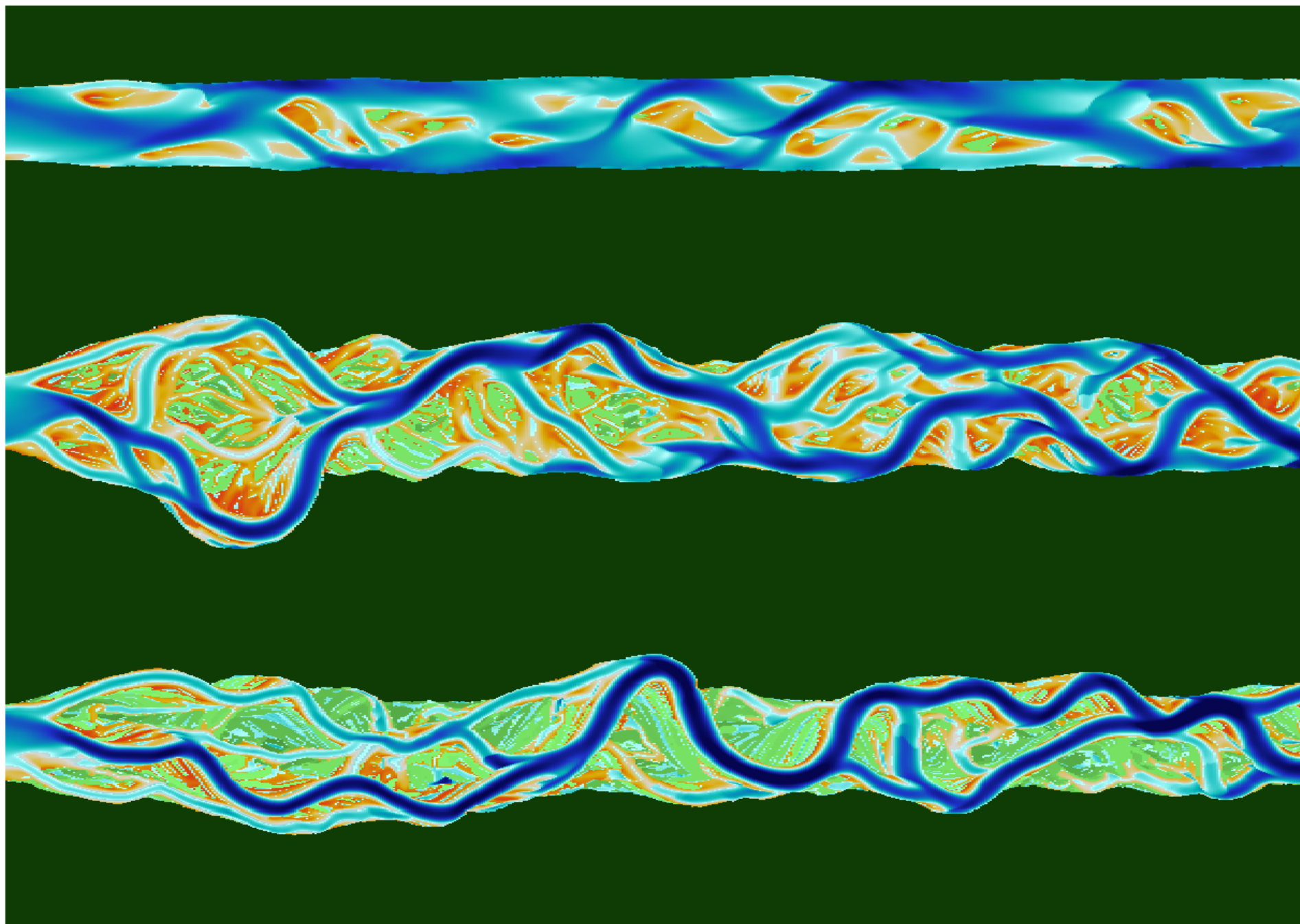


5 m

Depth: 0 m



20 m



Simulation Time: 132 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

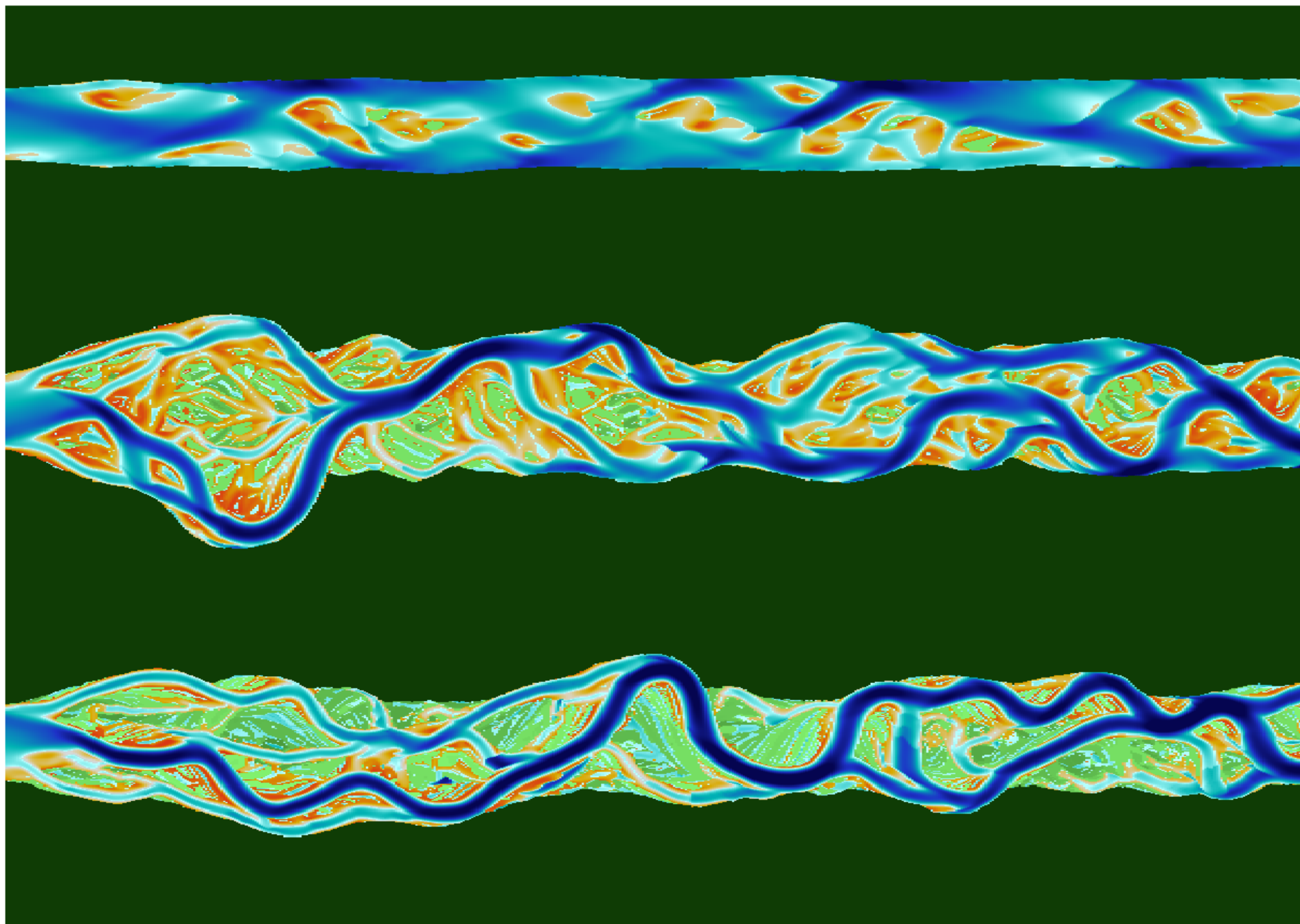


5 m

Depth: 0 m



20 m



Simulation Time: 134 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

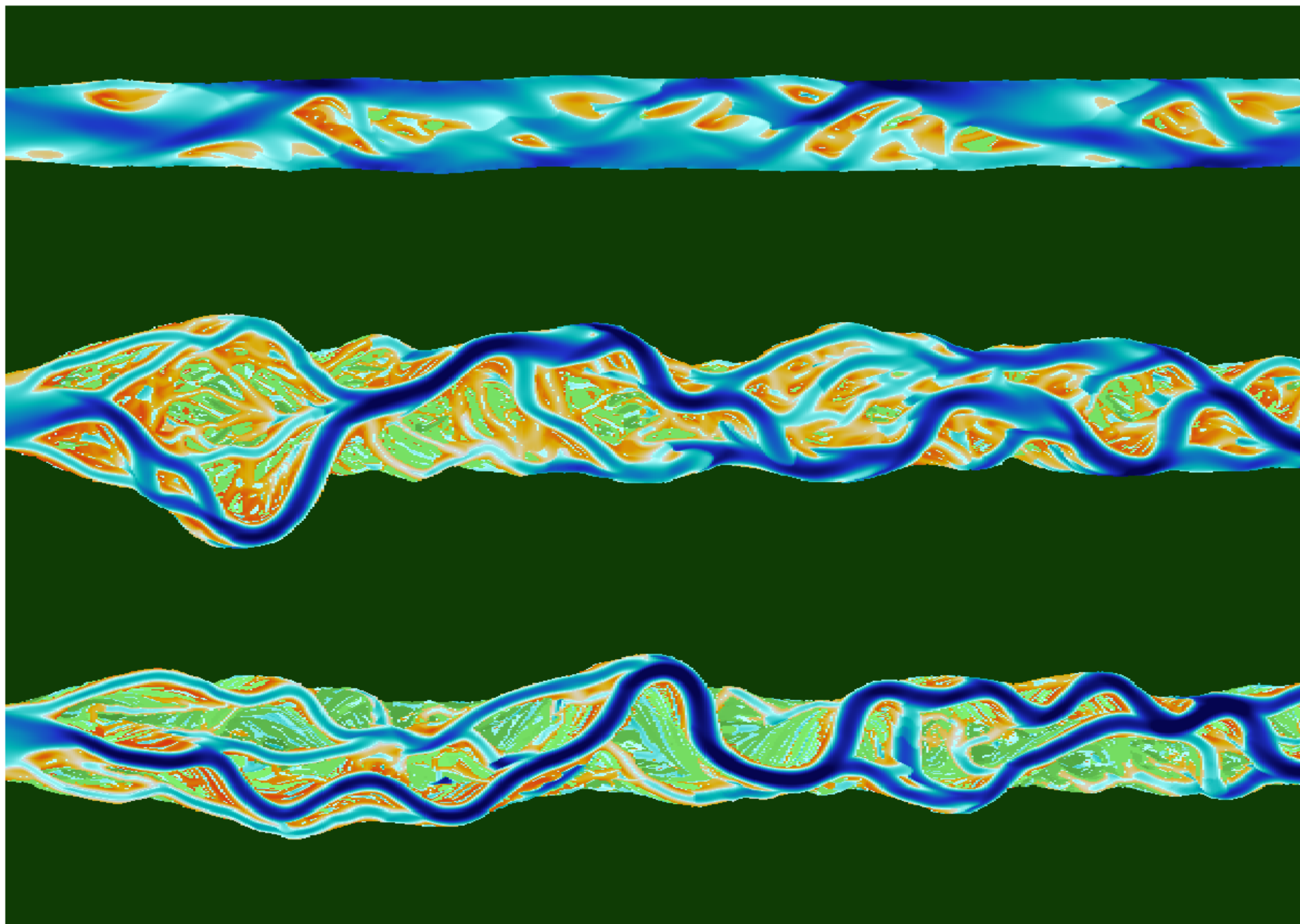


5 m

Depth: 0 m



20 m



Simulation Time: 136 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

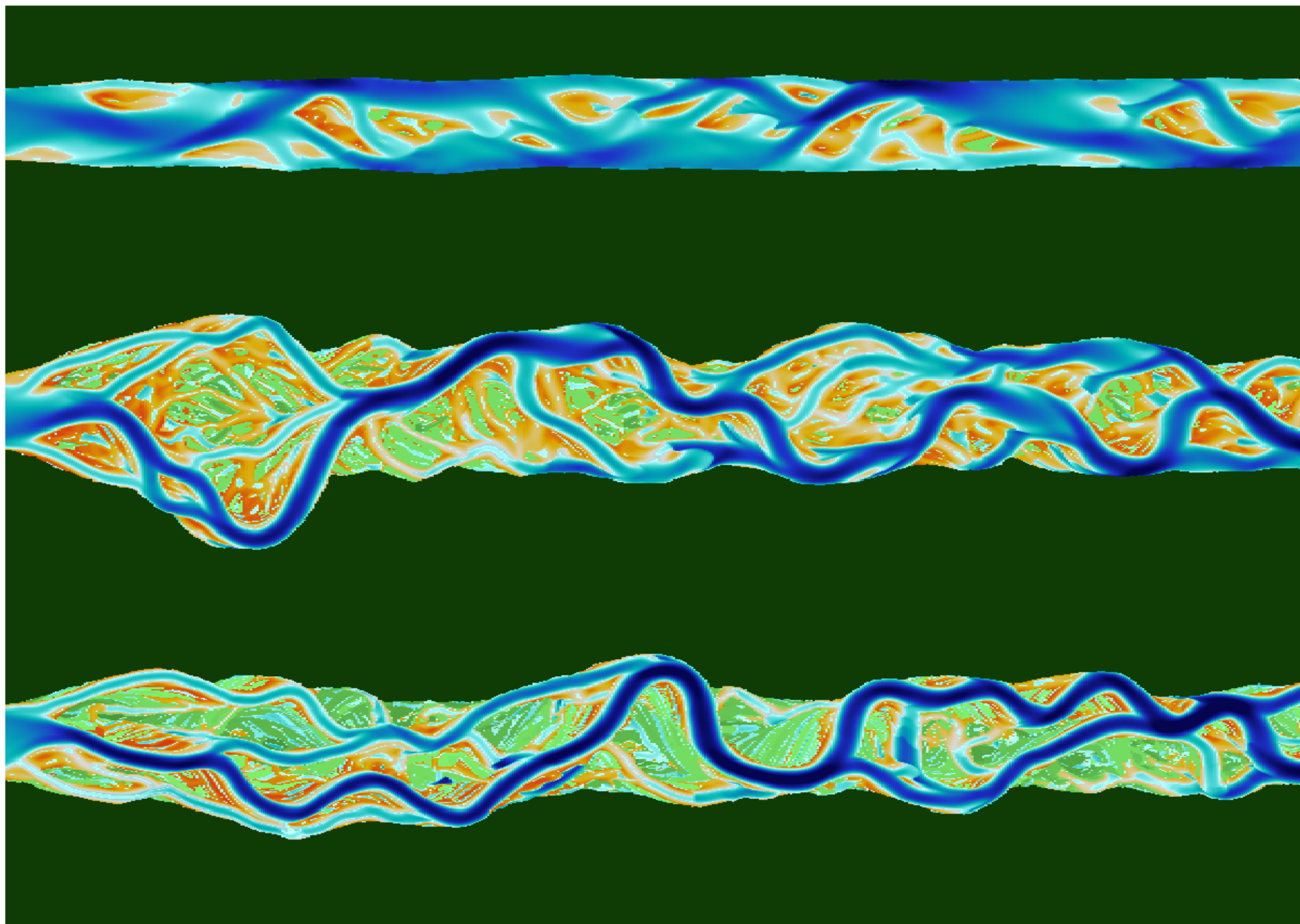


5 m

Depth: 0 m



20 m



Simulation Time: 138 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

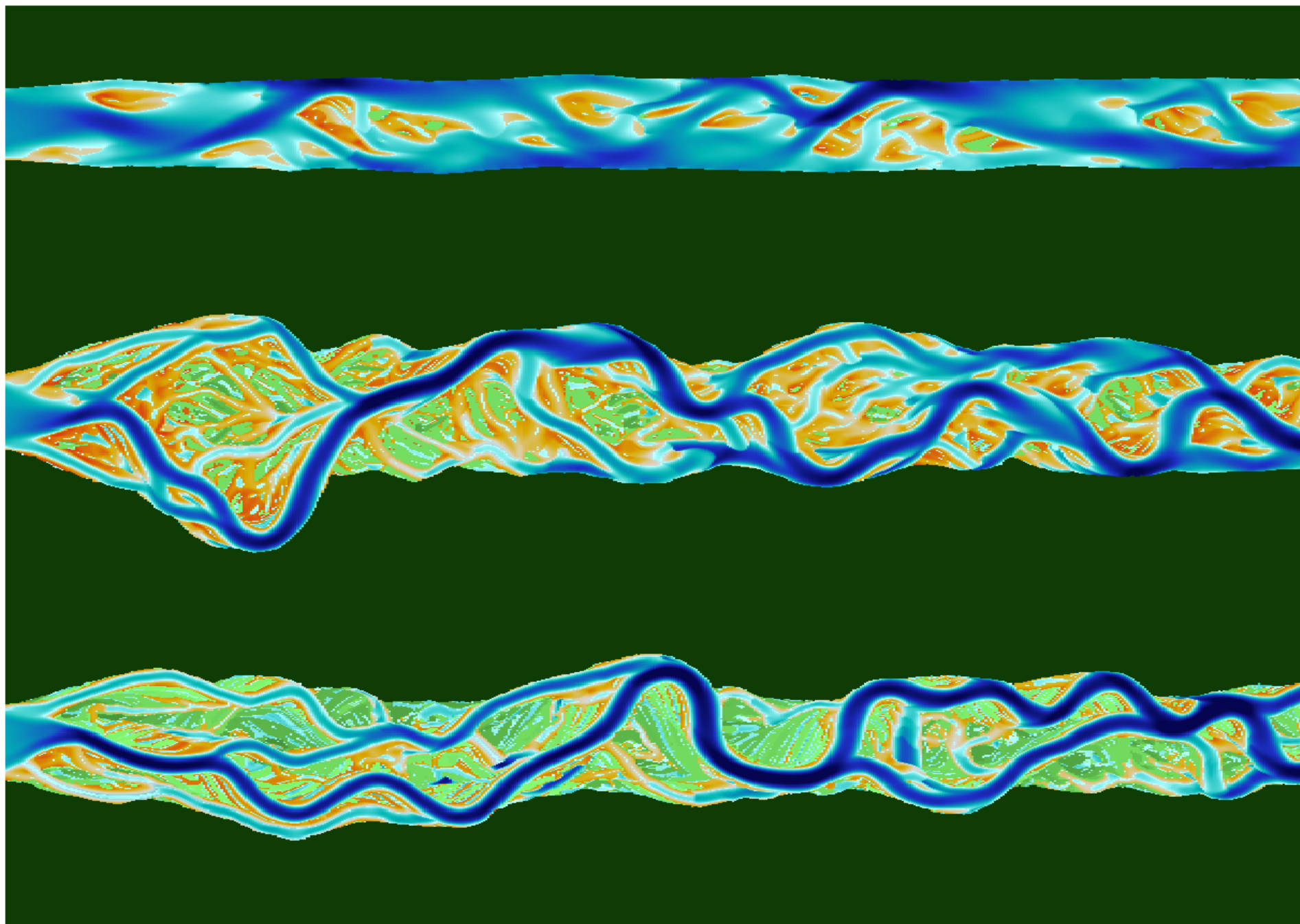


5 m

Depth: 0 m



20 m



Simulation Time: 140 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

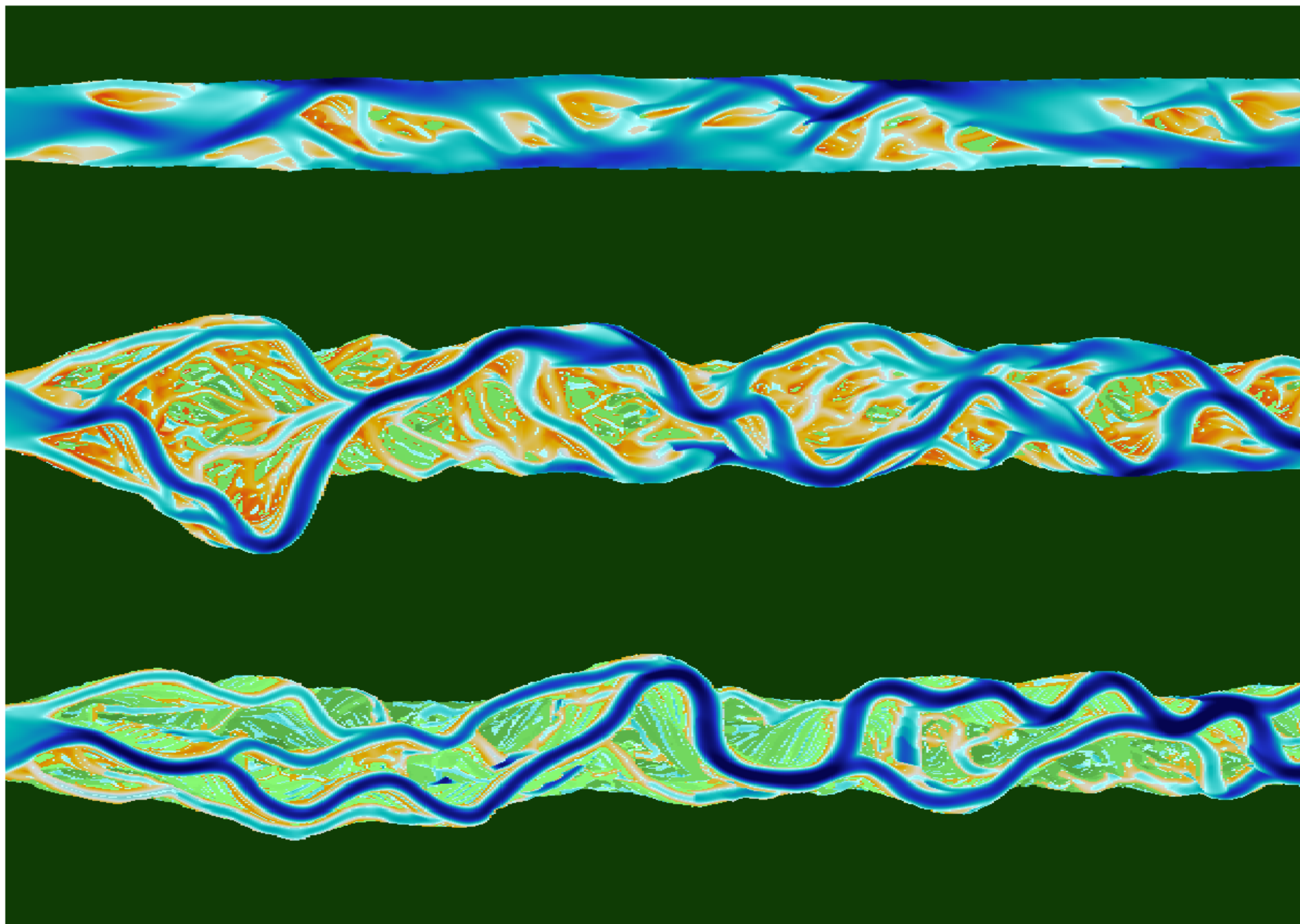


5 m

Depth: 0 m



20 m



Simulation Time: 142 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

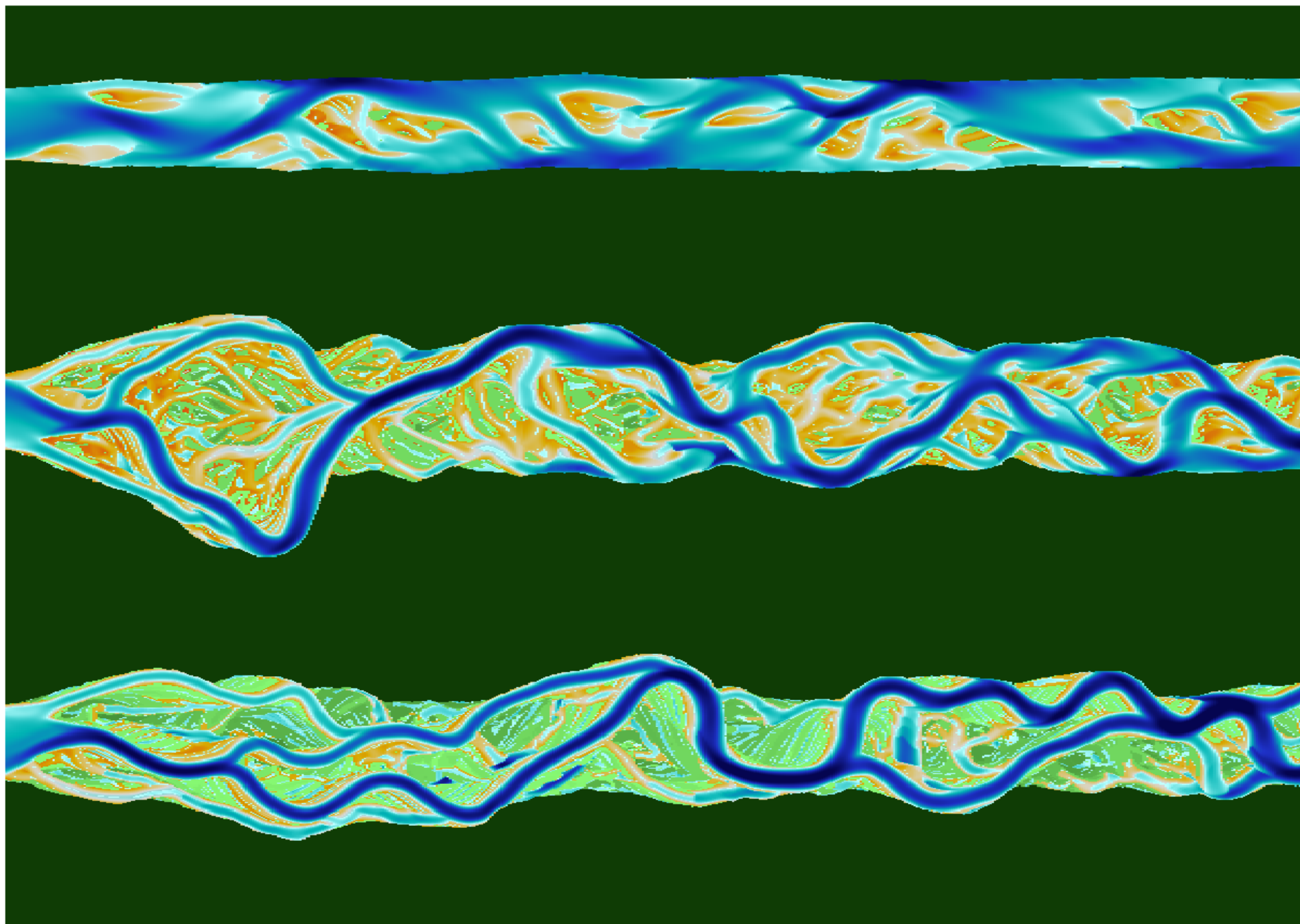


5 m

Depth: 0 m



20 m



Simulation Time: 144 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

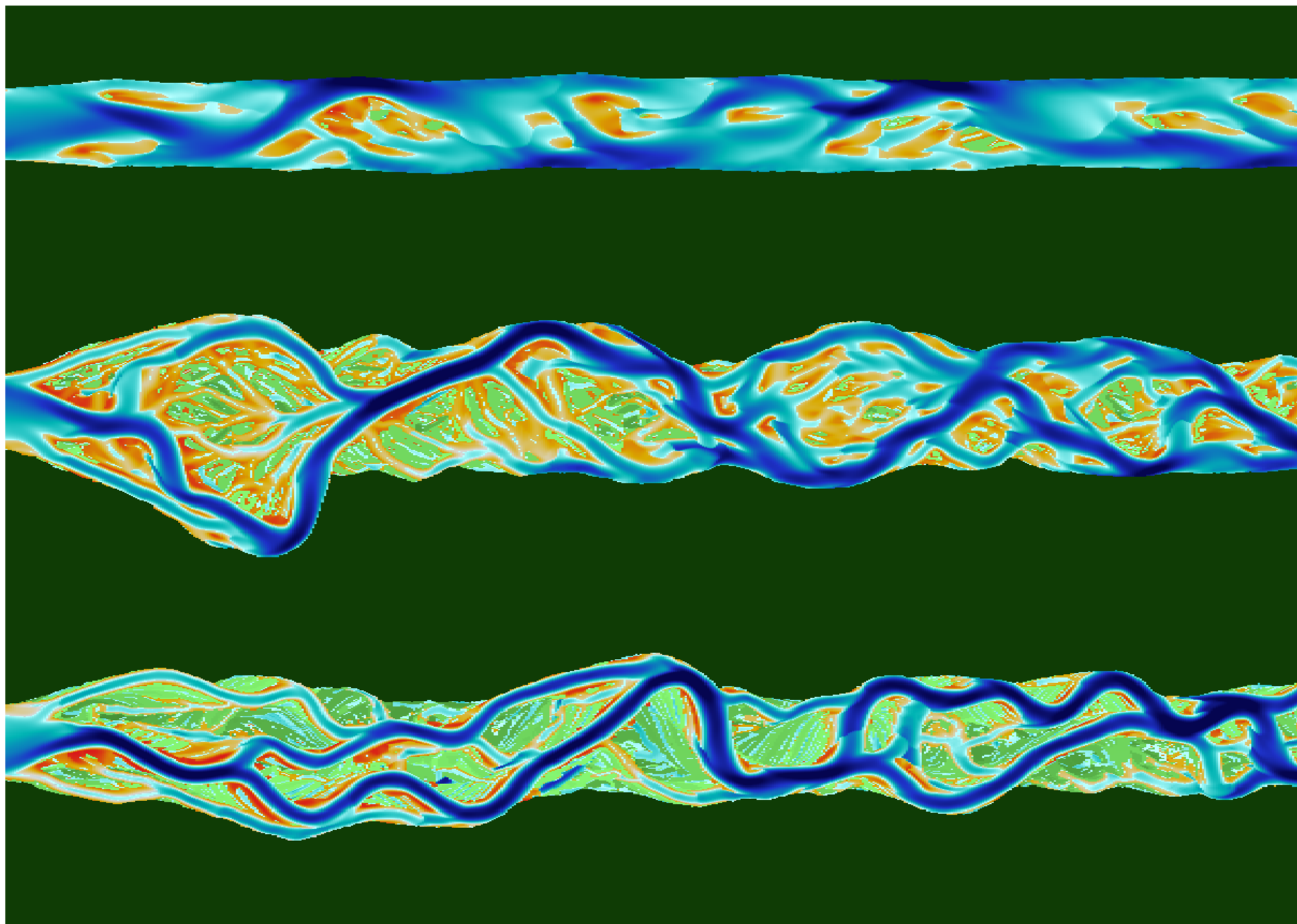


5 m

Depth: 0 m



20 m



Simulation Time: 146 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

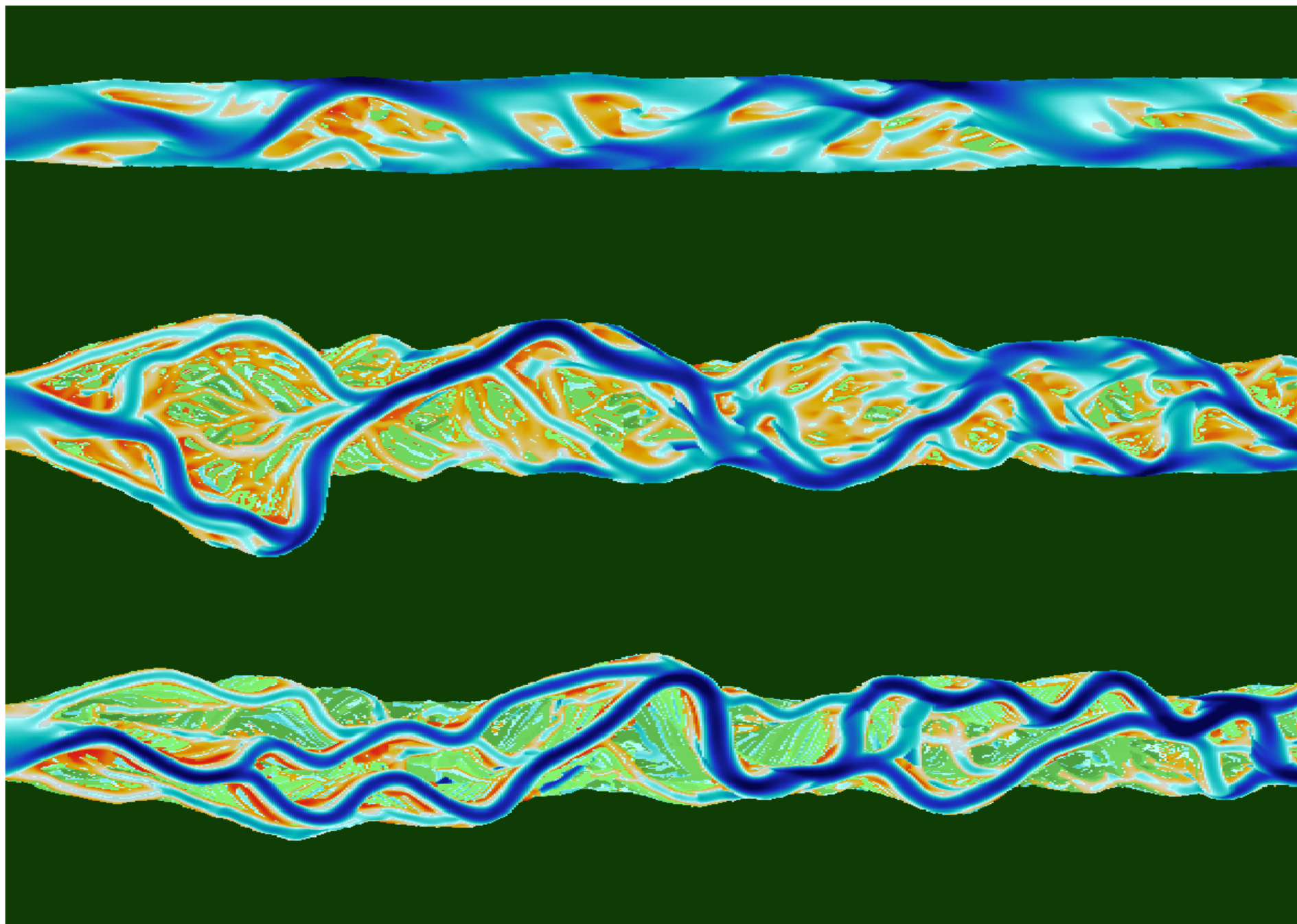


5 m

Depth: 0 m



20 m



Simulation Time: 148 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

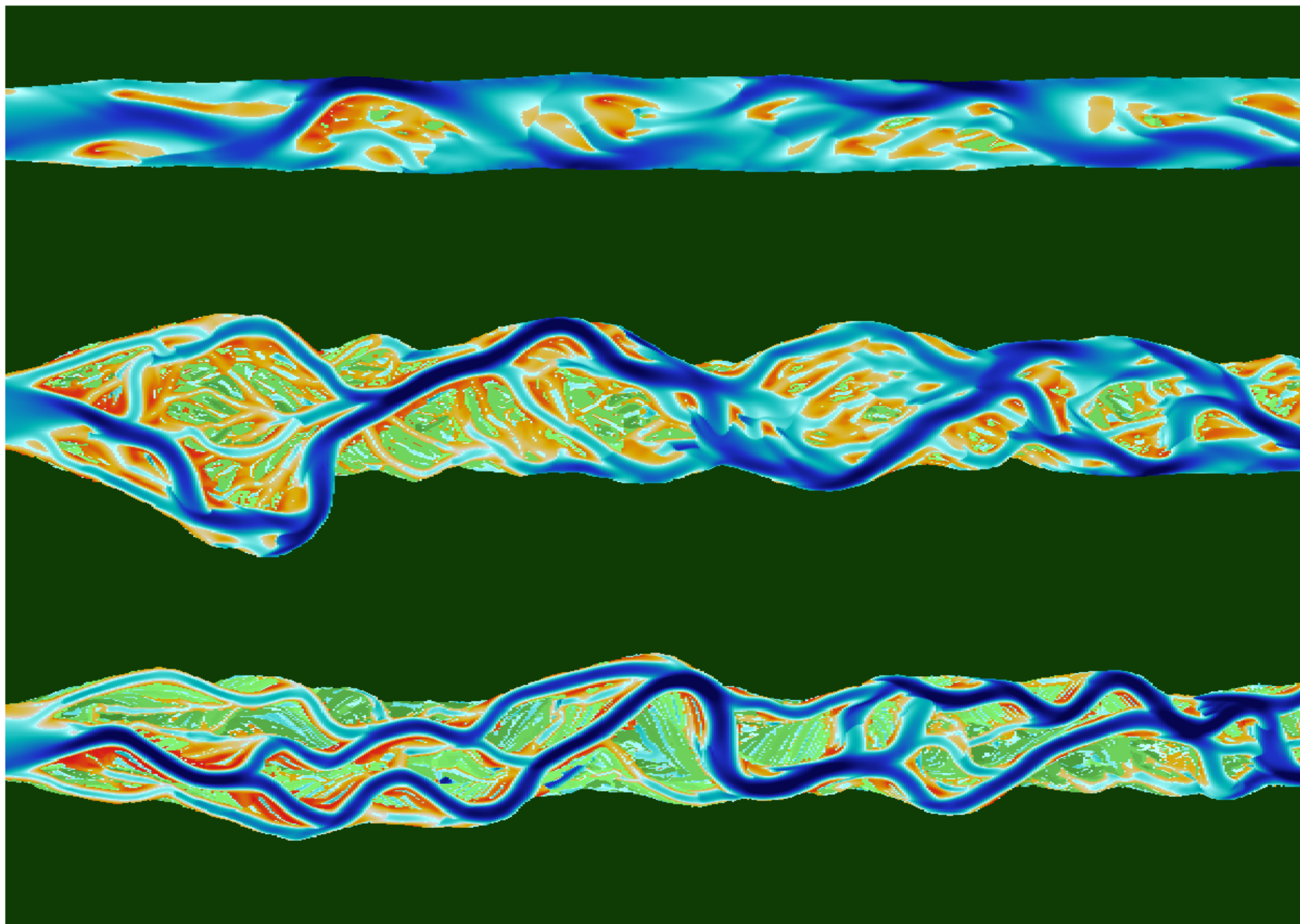


5 m

Depth: 0 m



20 m



Simulation Time: 150 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

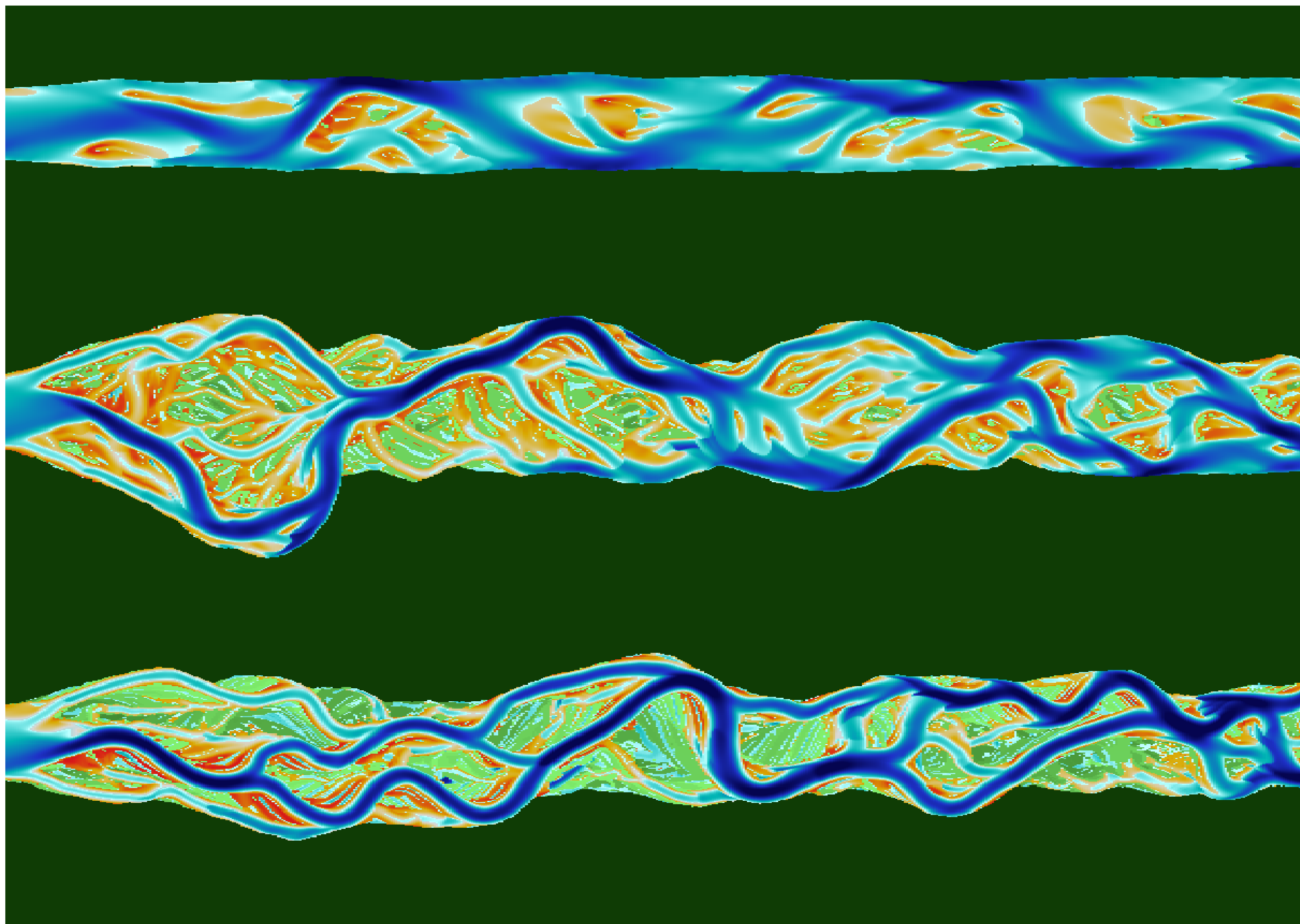


5 m

Depth: 0 m



20 m



Simulation Time: 152 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

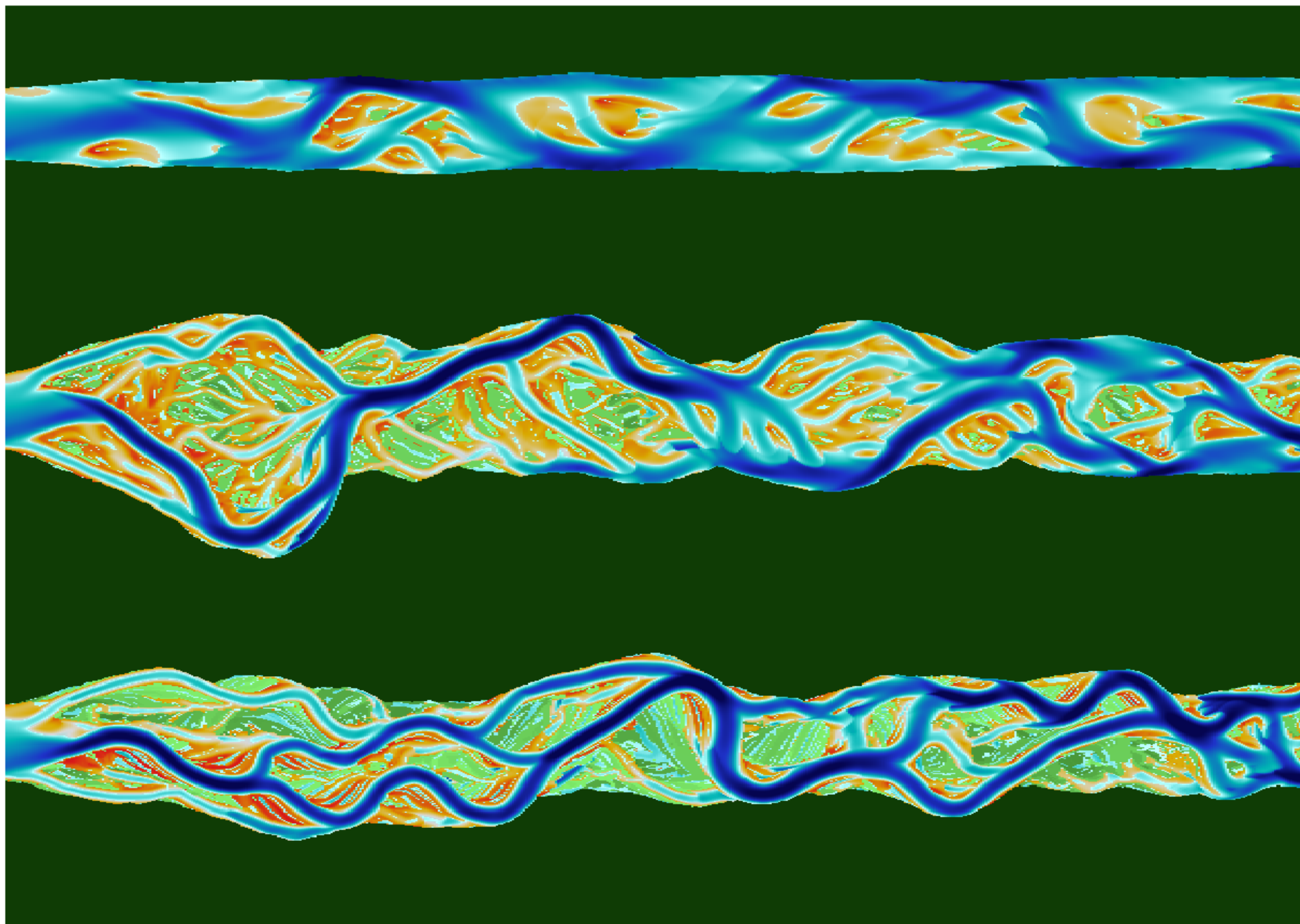


5 m

Depth: 0 m



20 m



Simulation Time: 154 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

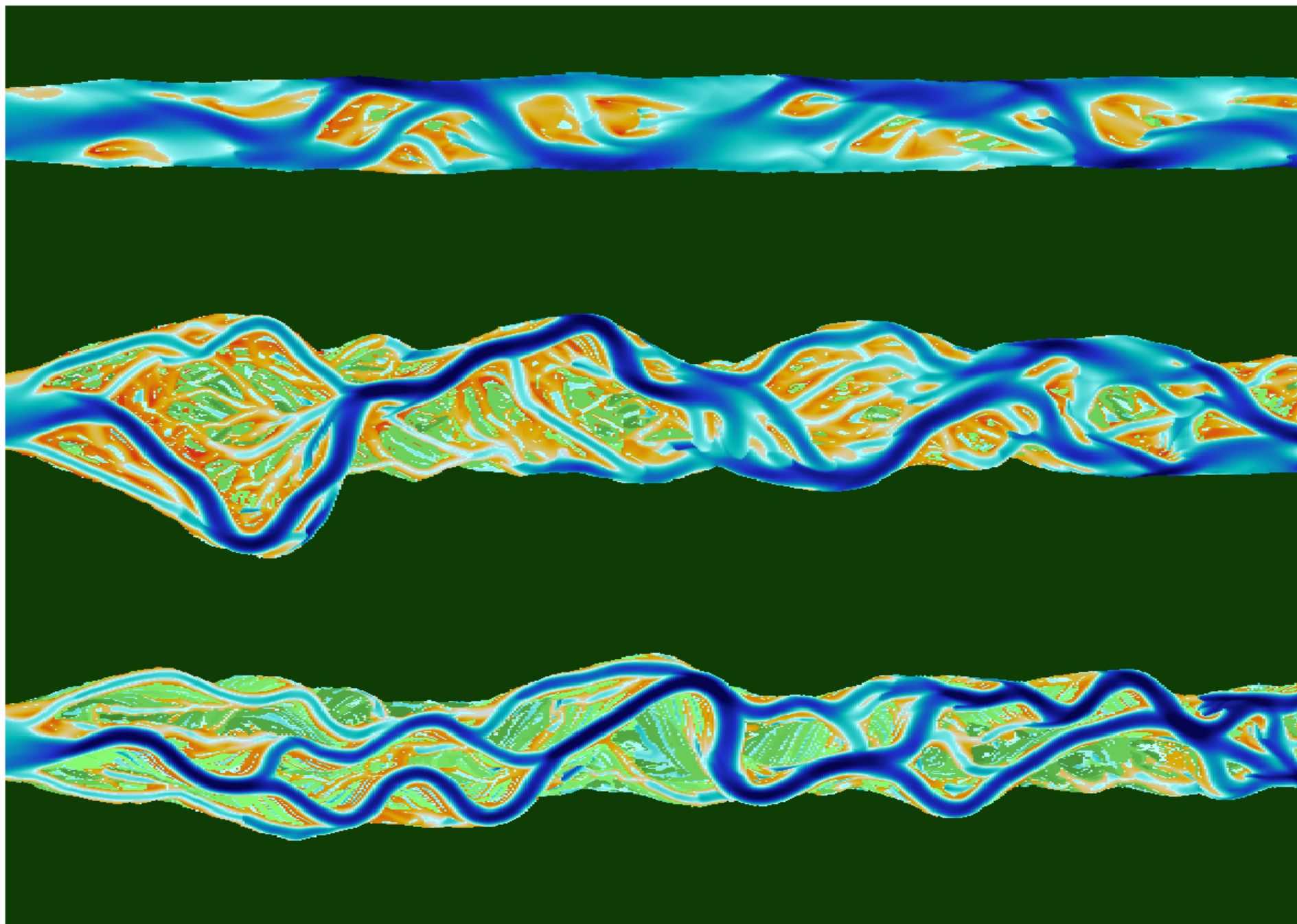


5 m

Depth: 0 m



20 m



Simulation Time: 156 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

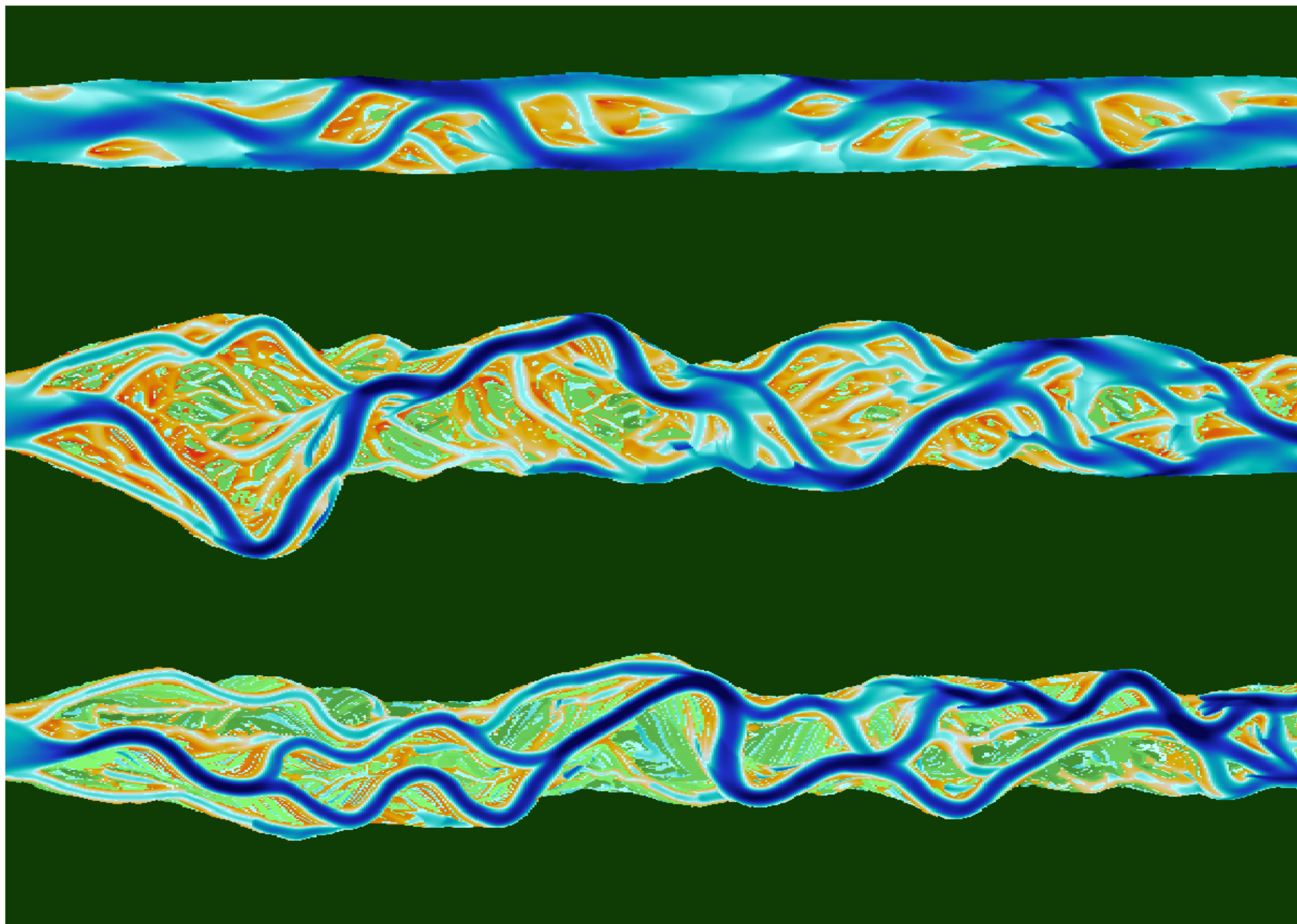


5 m

Depth: 0 m



20 m



Simulation Time: 158 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

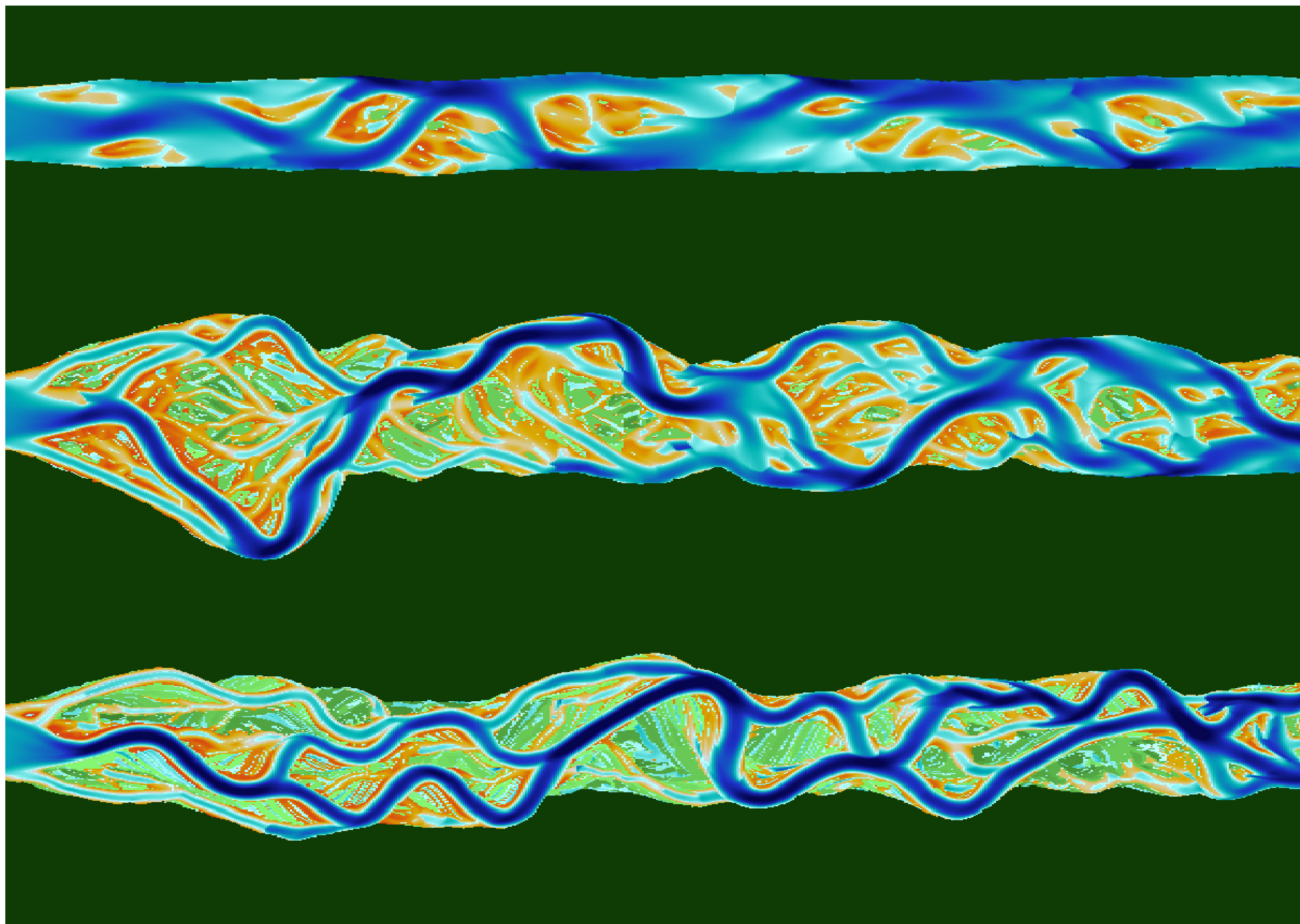


5 m

Depth: 0 m



20 m



Simulation Time: 160 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

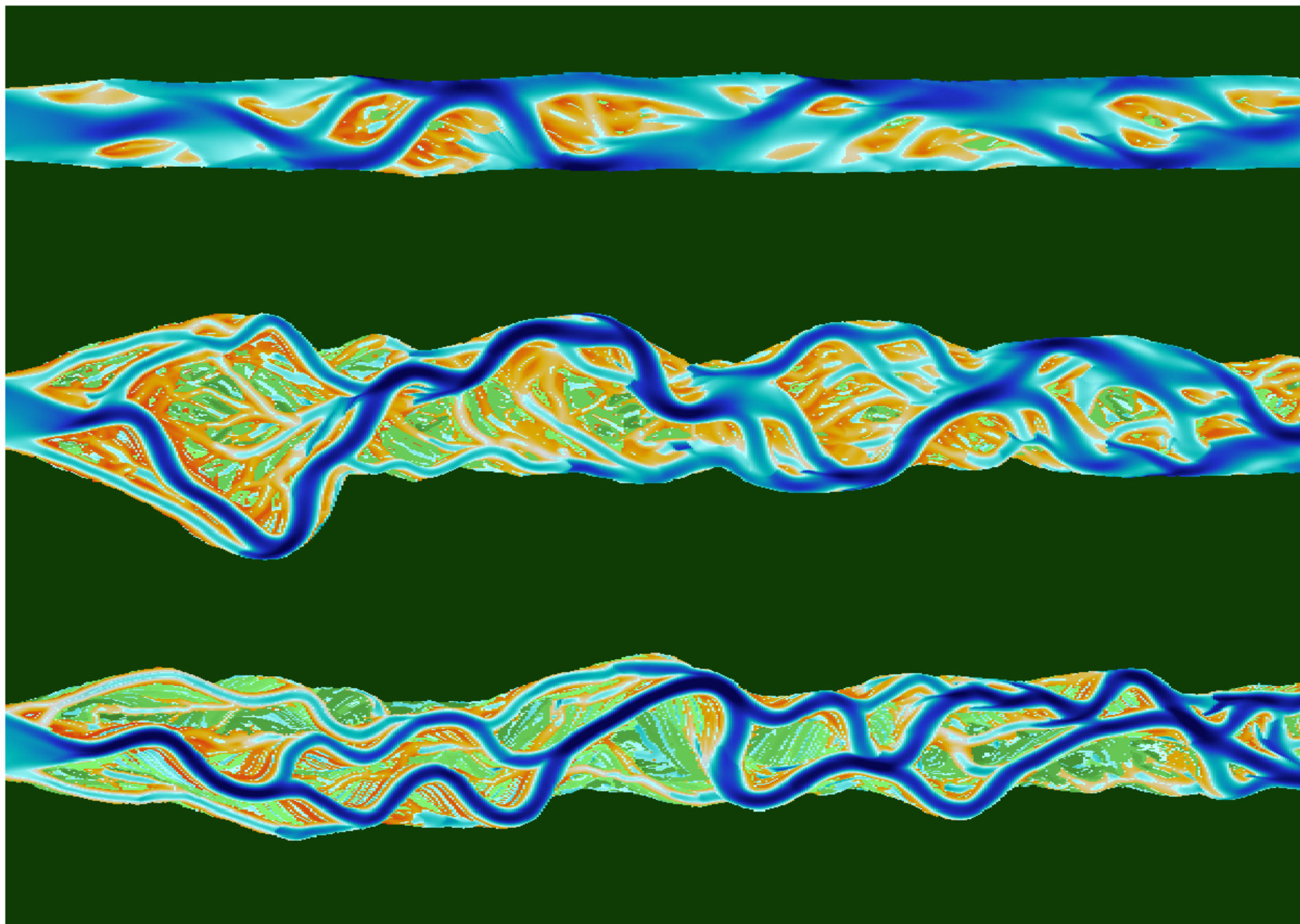


5 m

Depth: 0 m



20 m



Simulation Time: 162 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

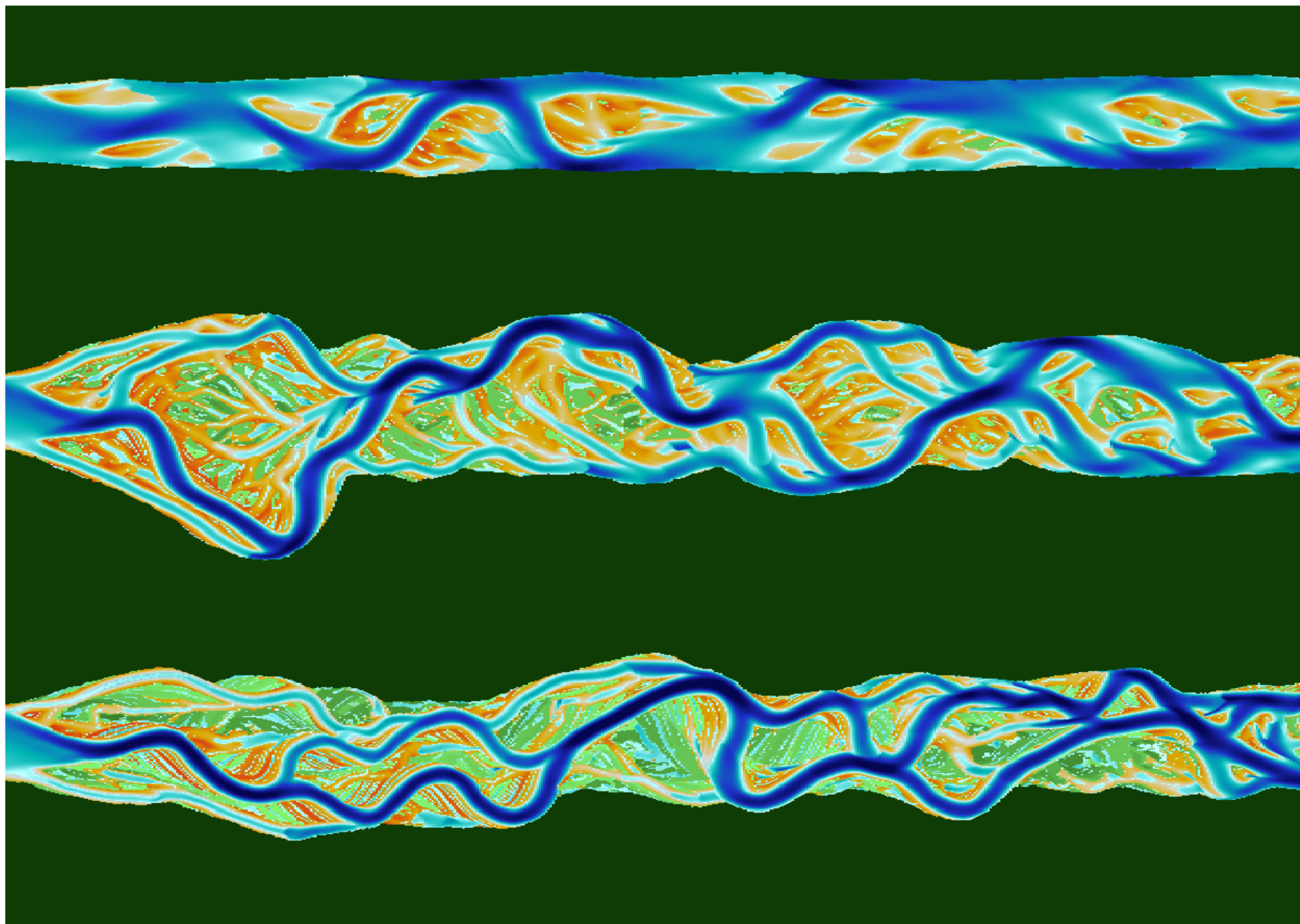


5 m

Depth: 0 m



20 m



Simulation Time: 164 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

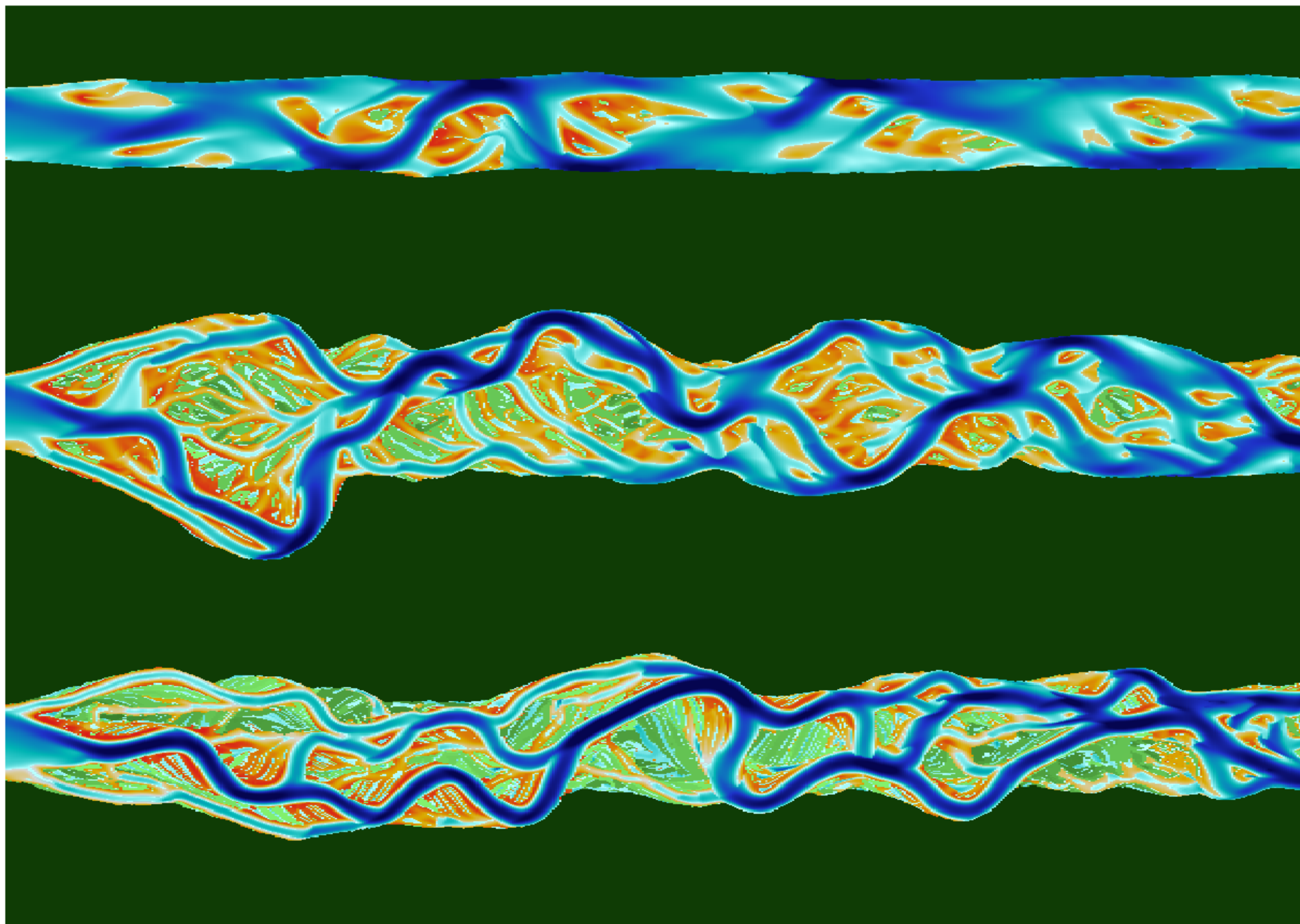


5 m

Depth: 0 m



20 m



Simulation Time: 166 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

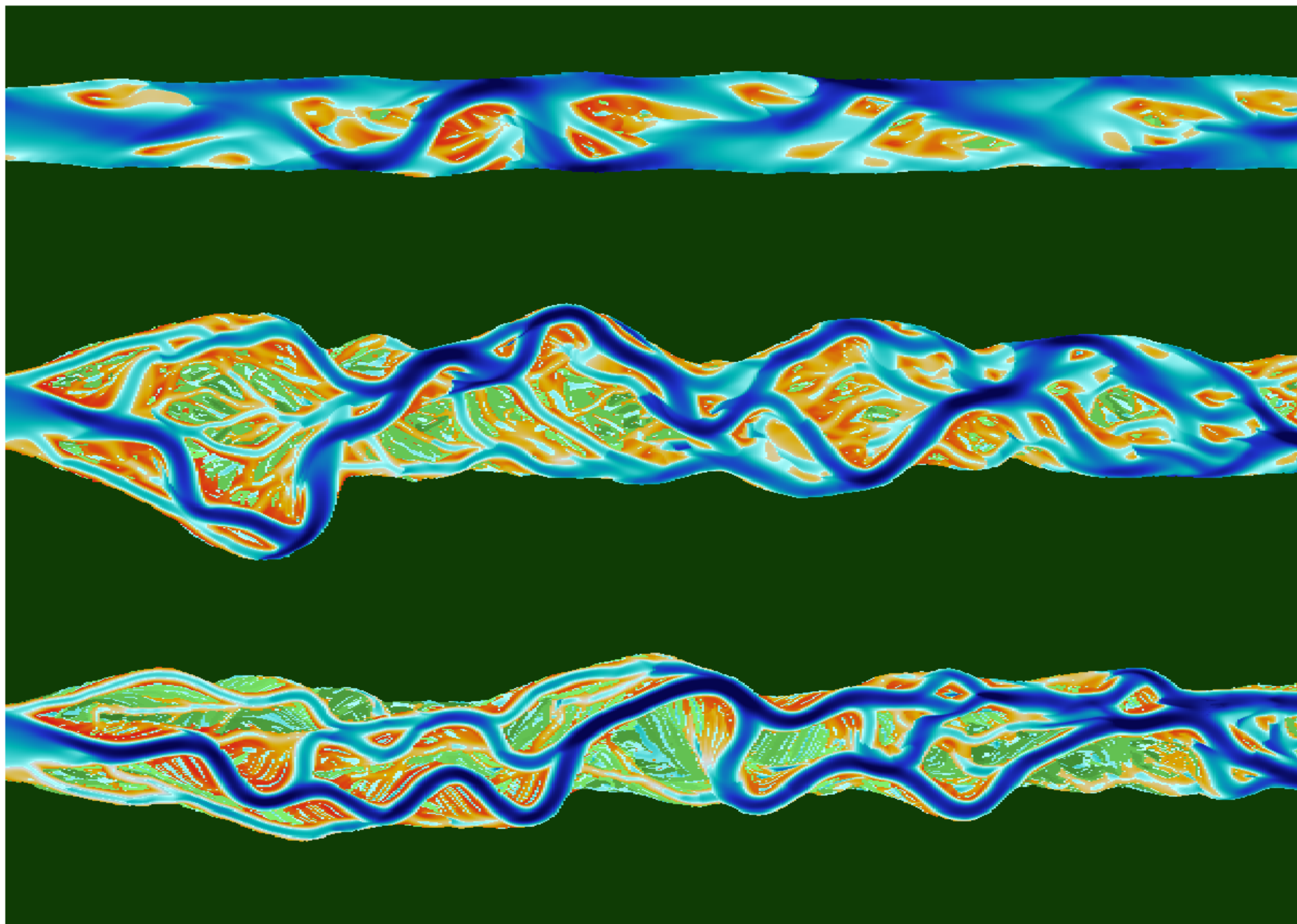


5 m

Depth: 0 m



20 m



Simulation Time: 168 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

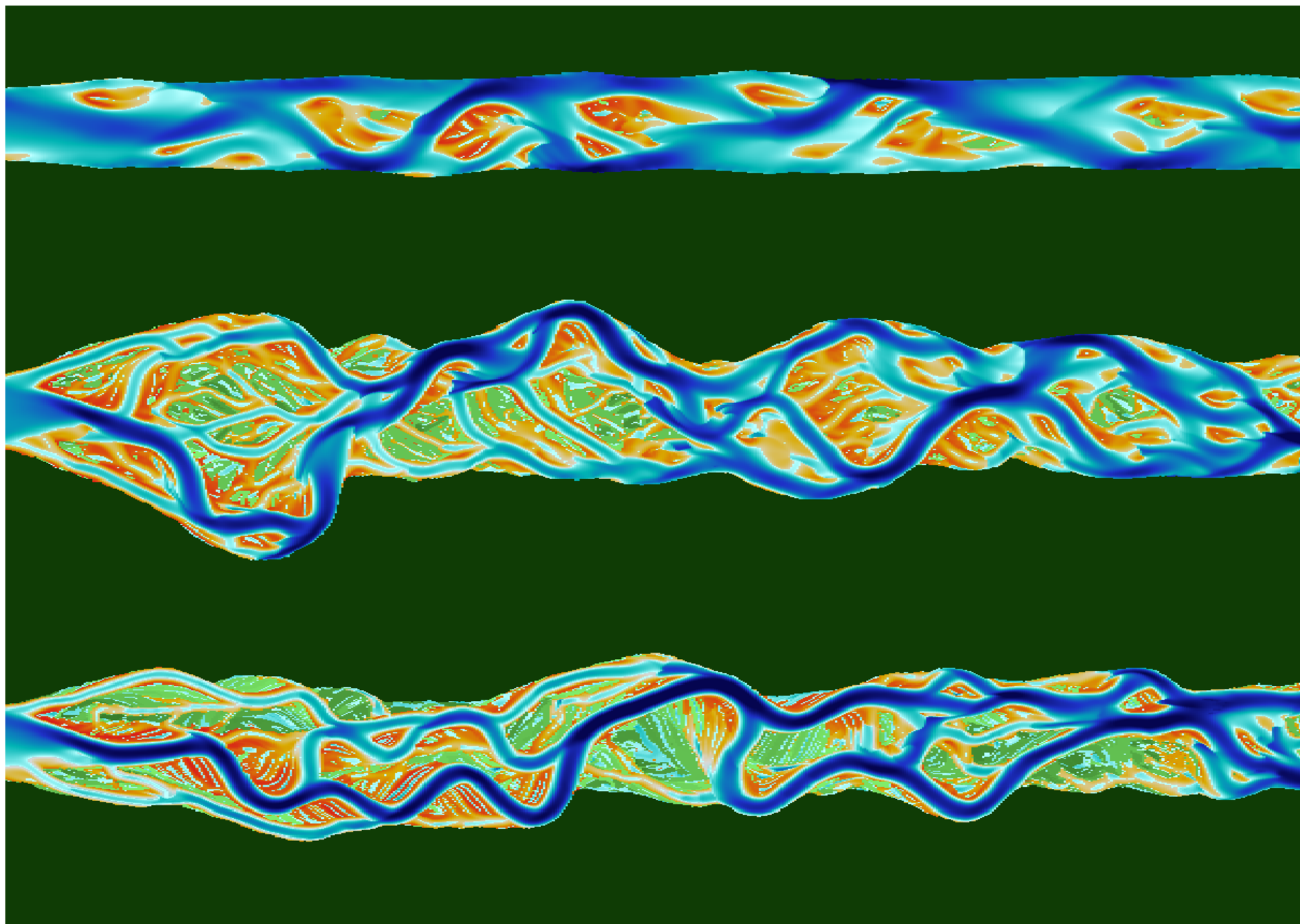


5 m

Depth: 0 m



20 m



Simulation Time: 170 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

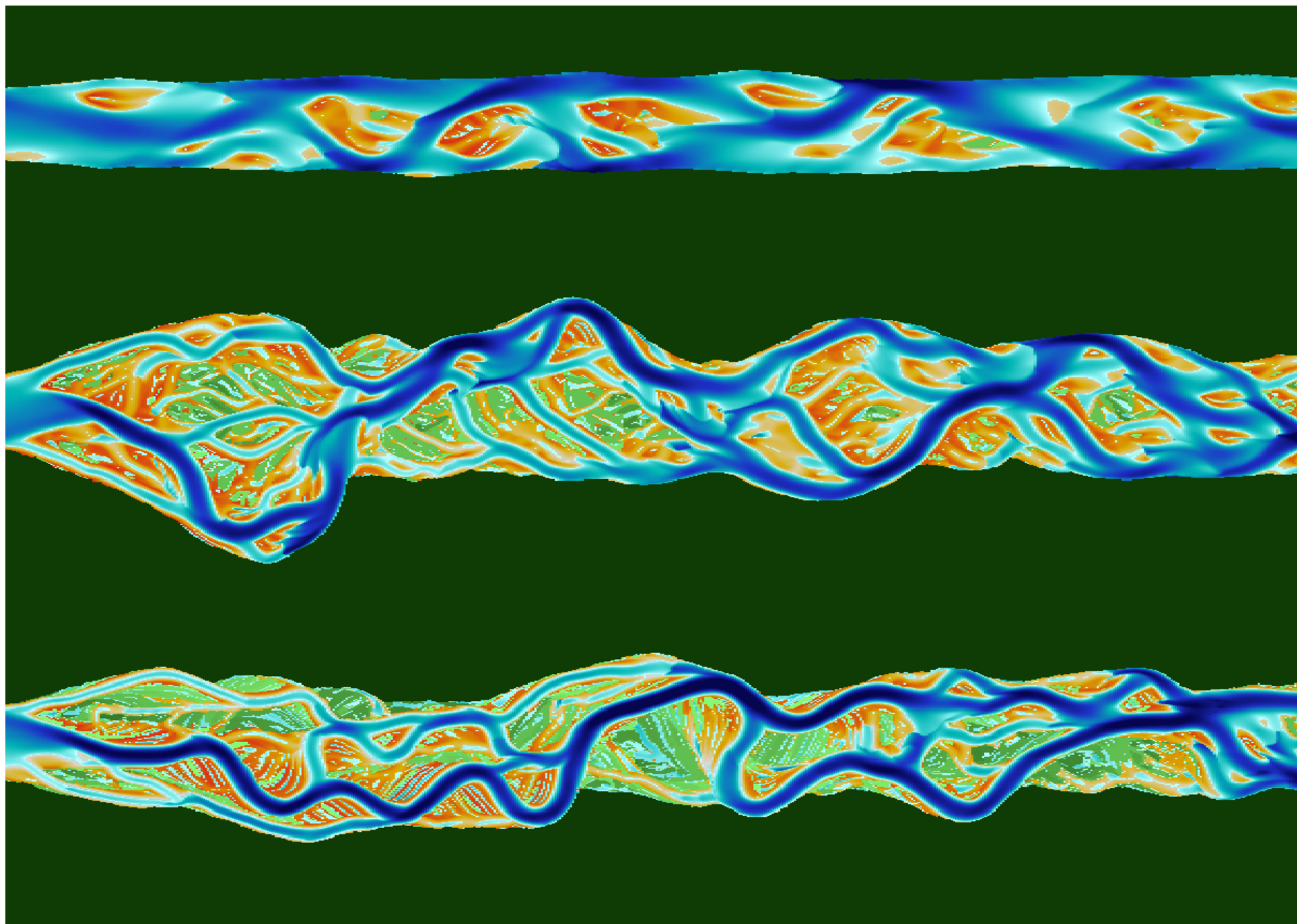


5 m

Depth: 0 m



20 m



Simulation Time: 172 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

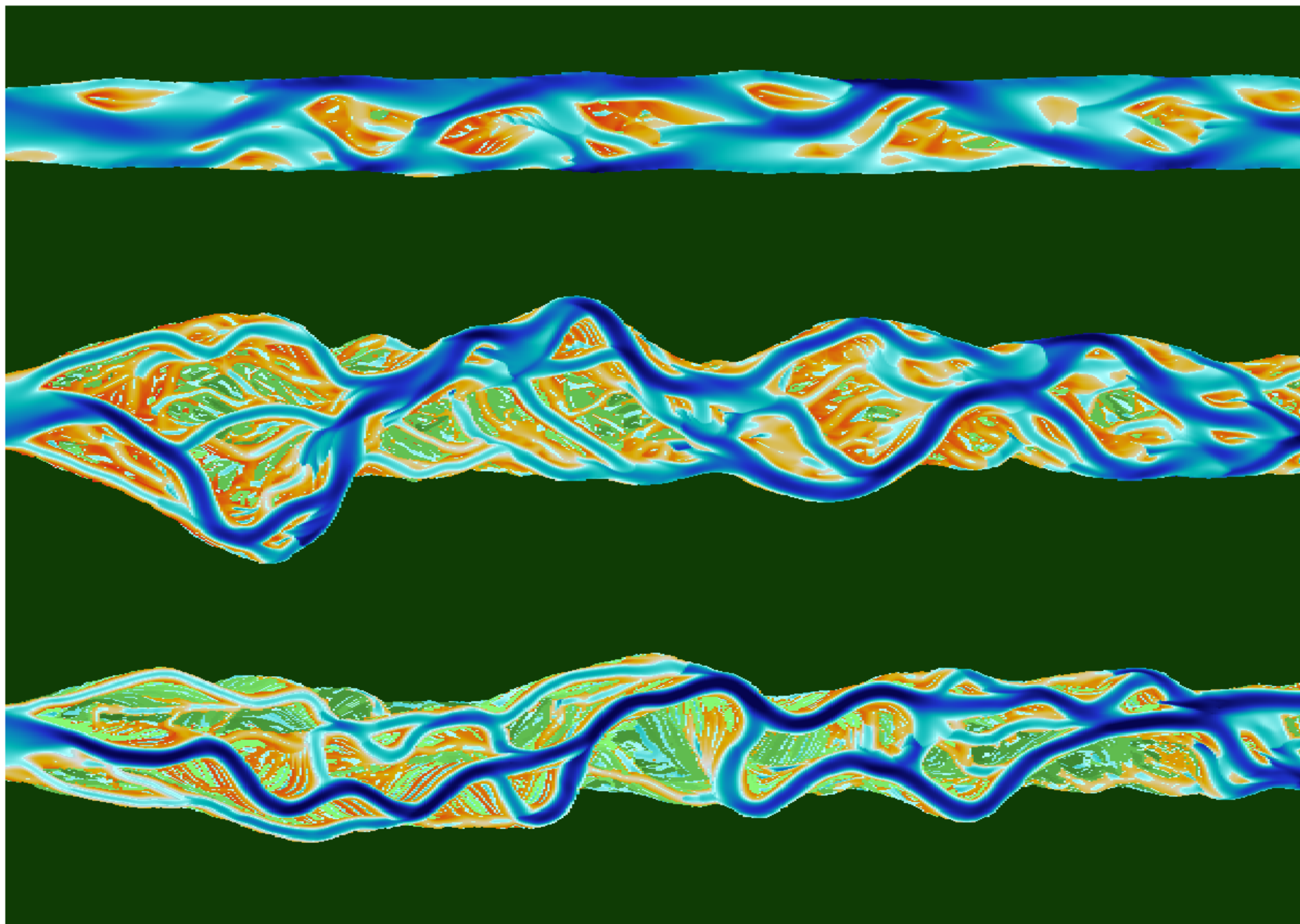


5 m

Depth: 0 m



20 m



Simulation Time: 174 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

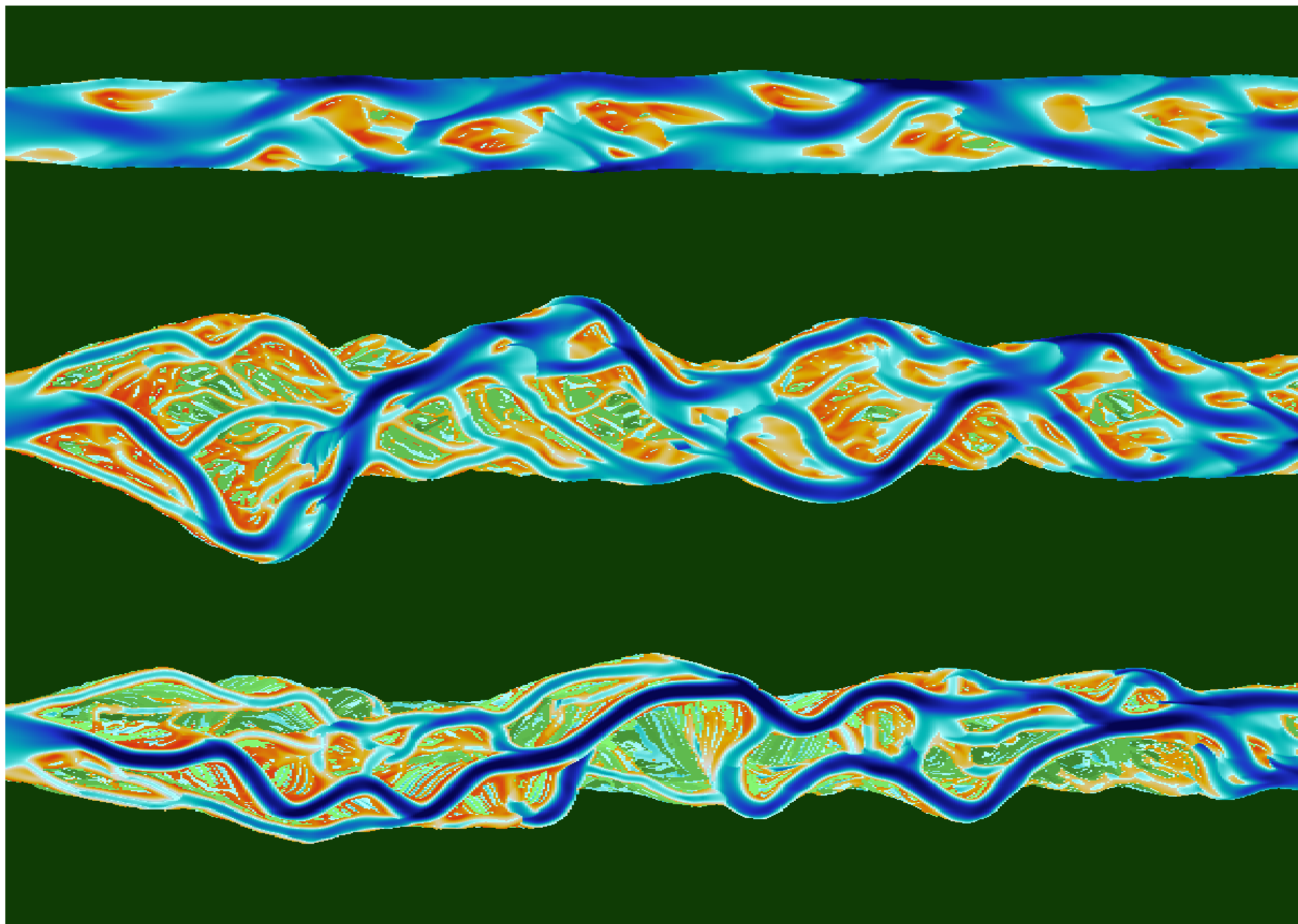


5 m

Depth: 0 m



20 m



Simulation Time: 176 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

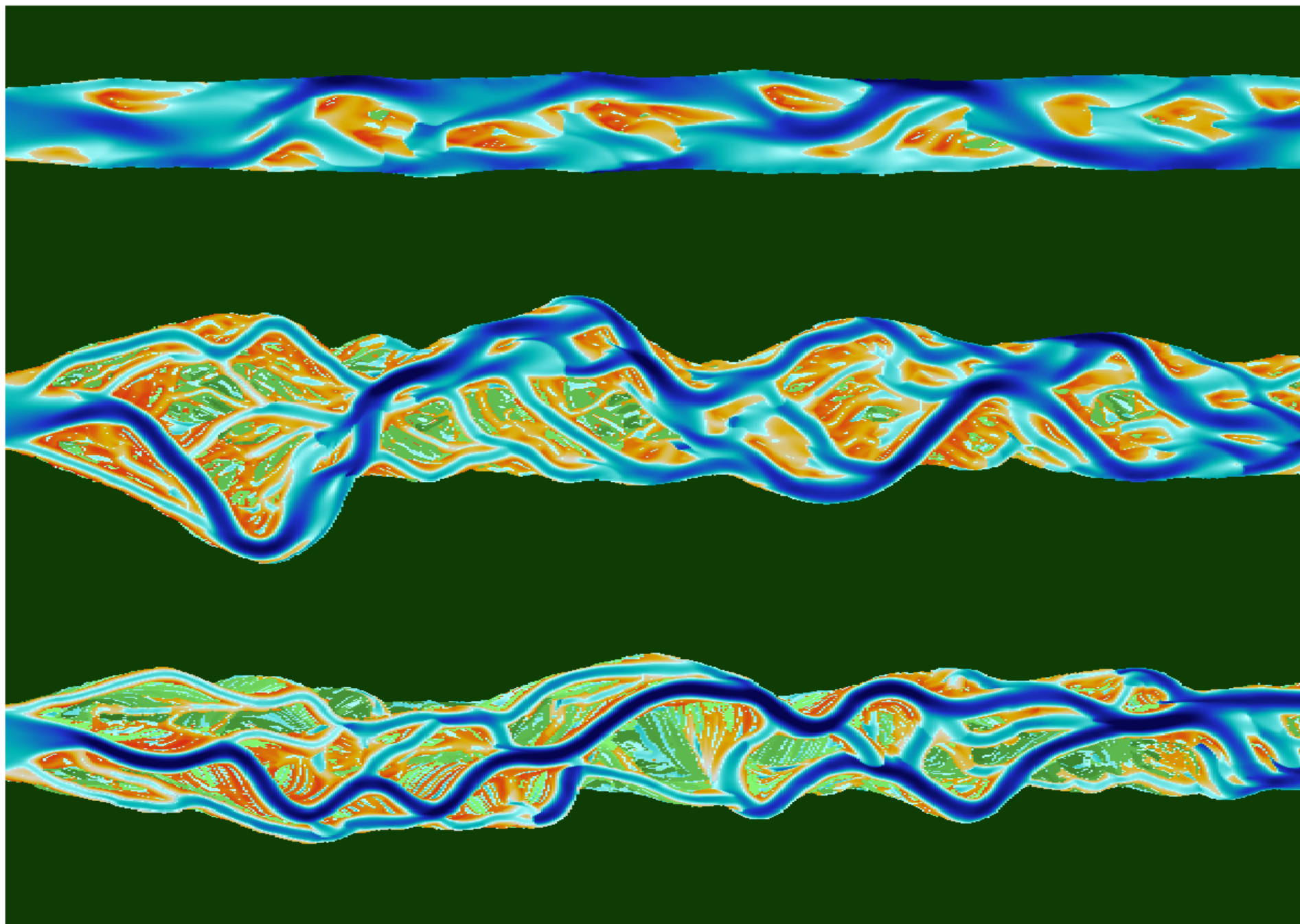


5 m

Depth: 0 m



20 m



Simulation Time: 178 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

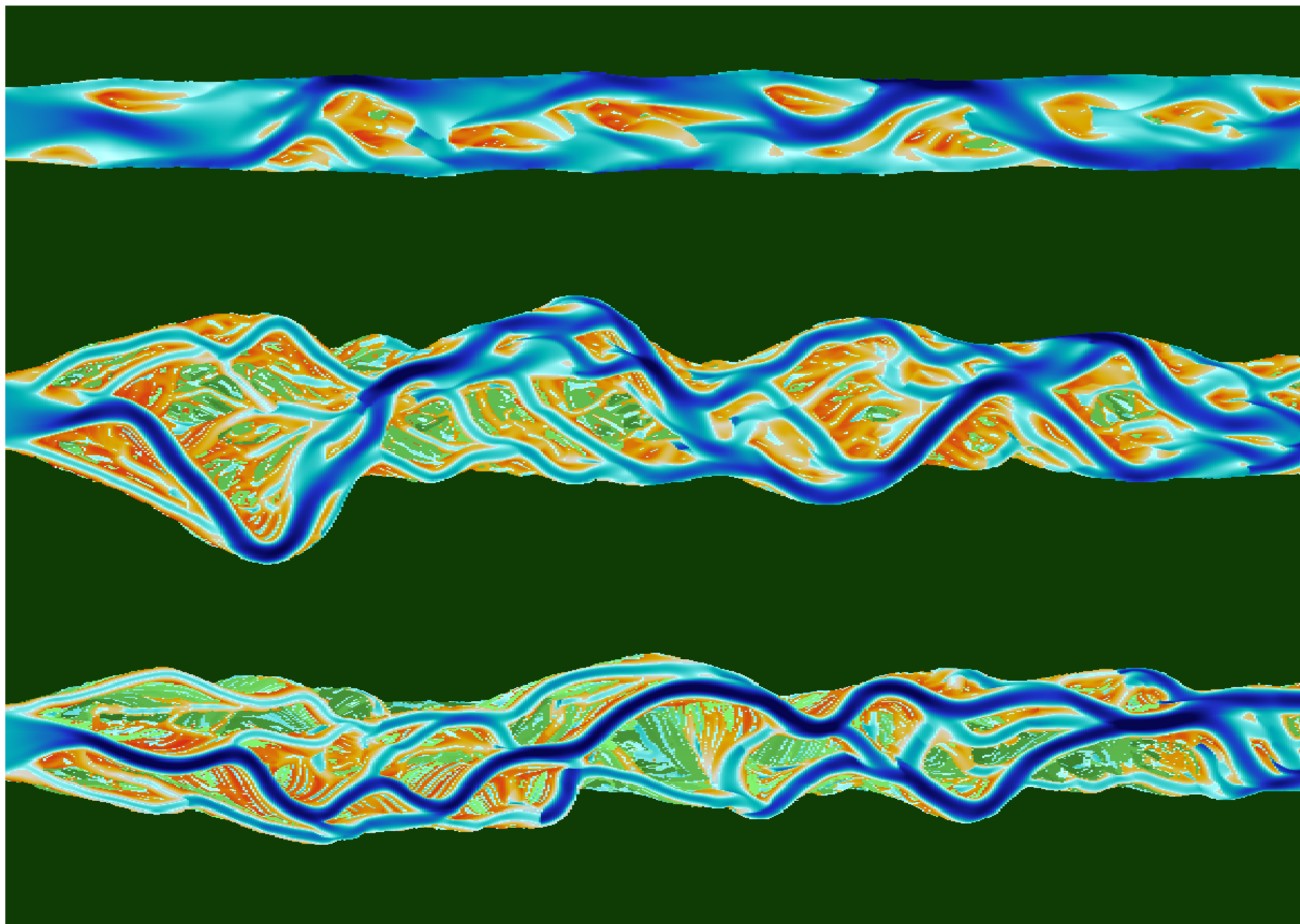


5 m

Depth: 0 m



20 m



Simulation Time: 180 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

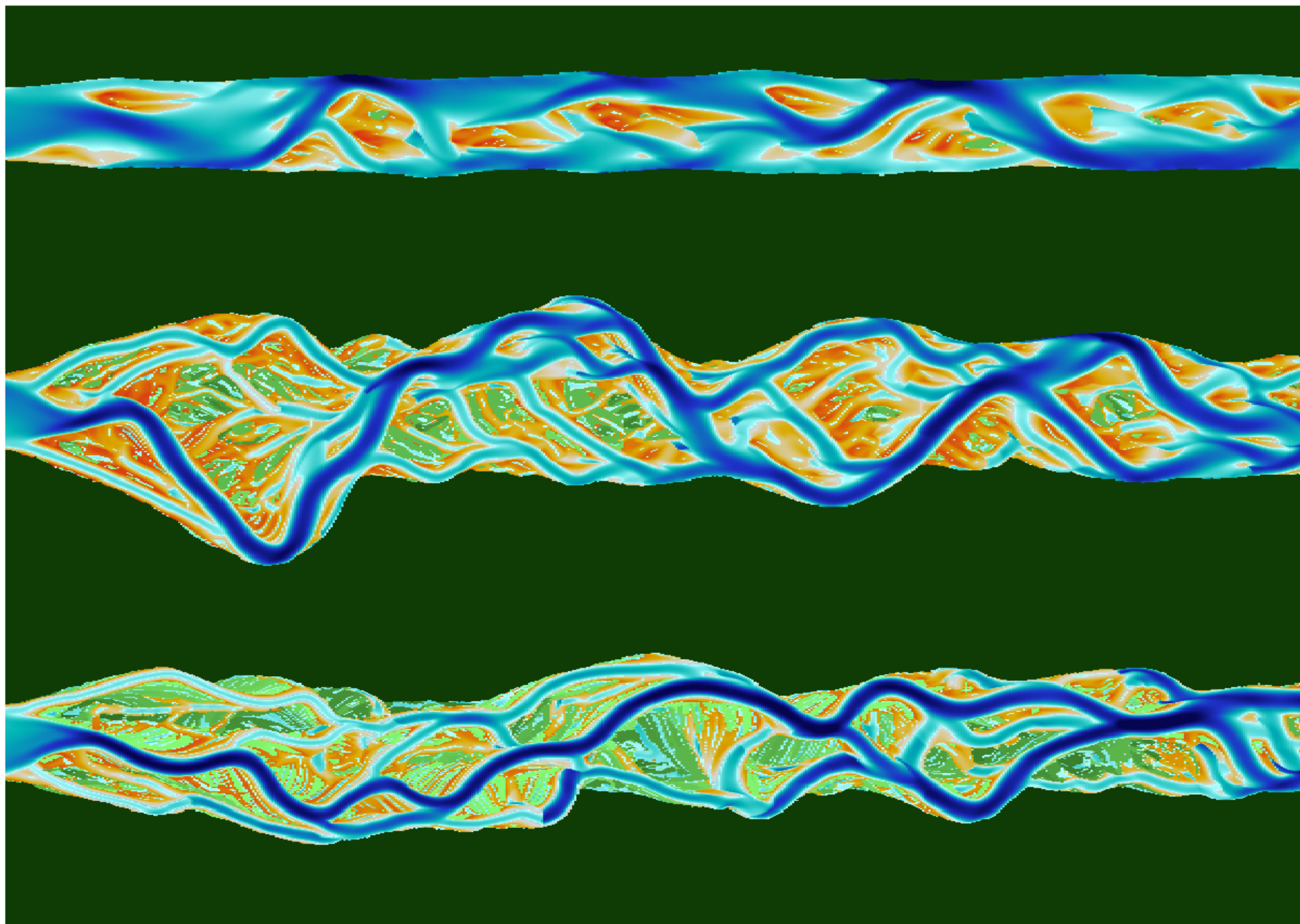


5 m

Depth: 0 m



20 m



Simulation Time: 182 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

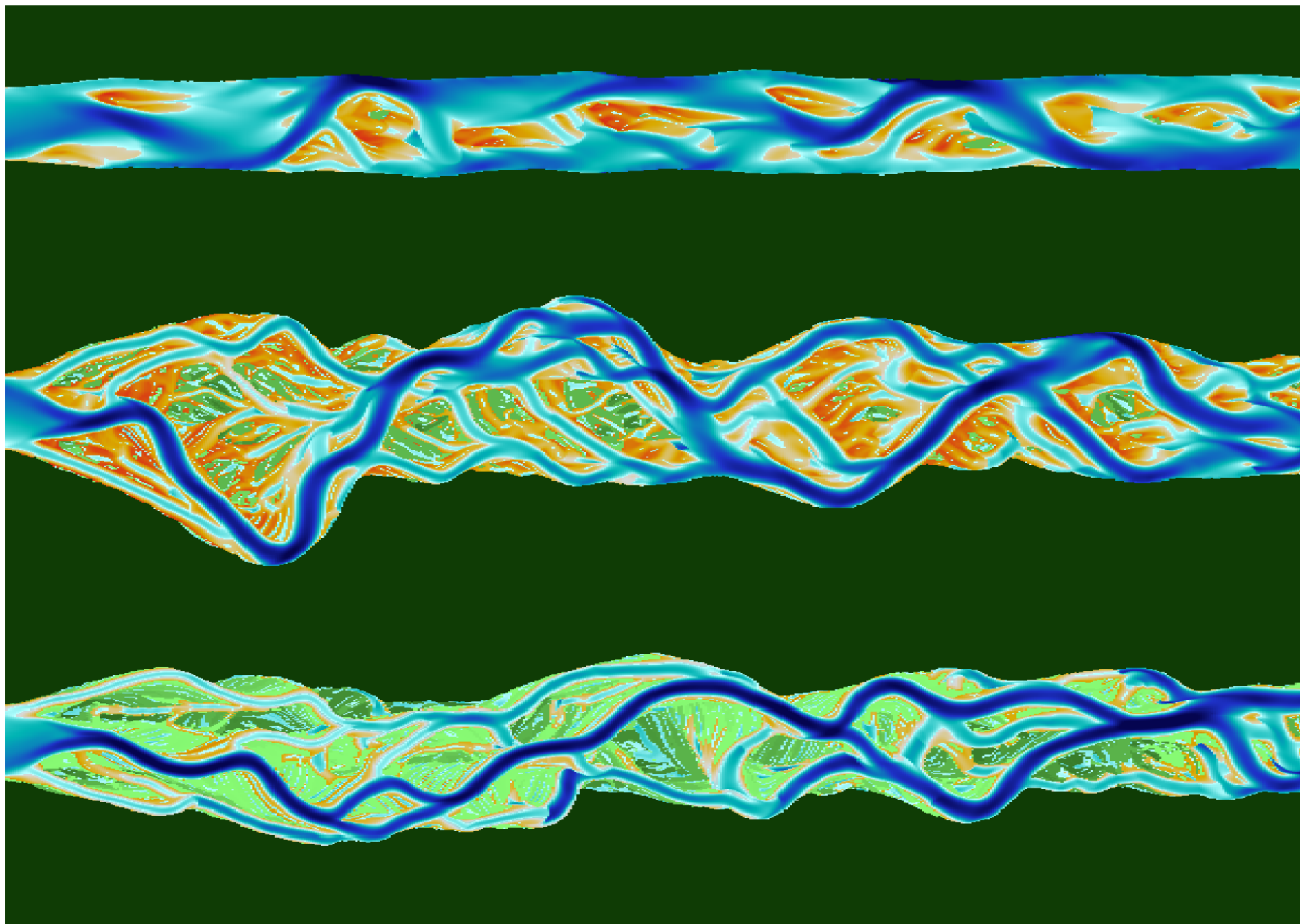


5 m

Depth: 0 m



20 m



Simulation Time: 184 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

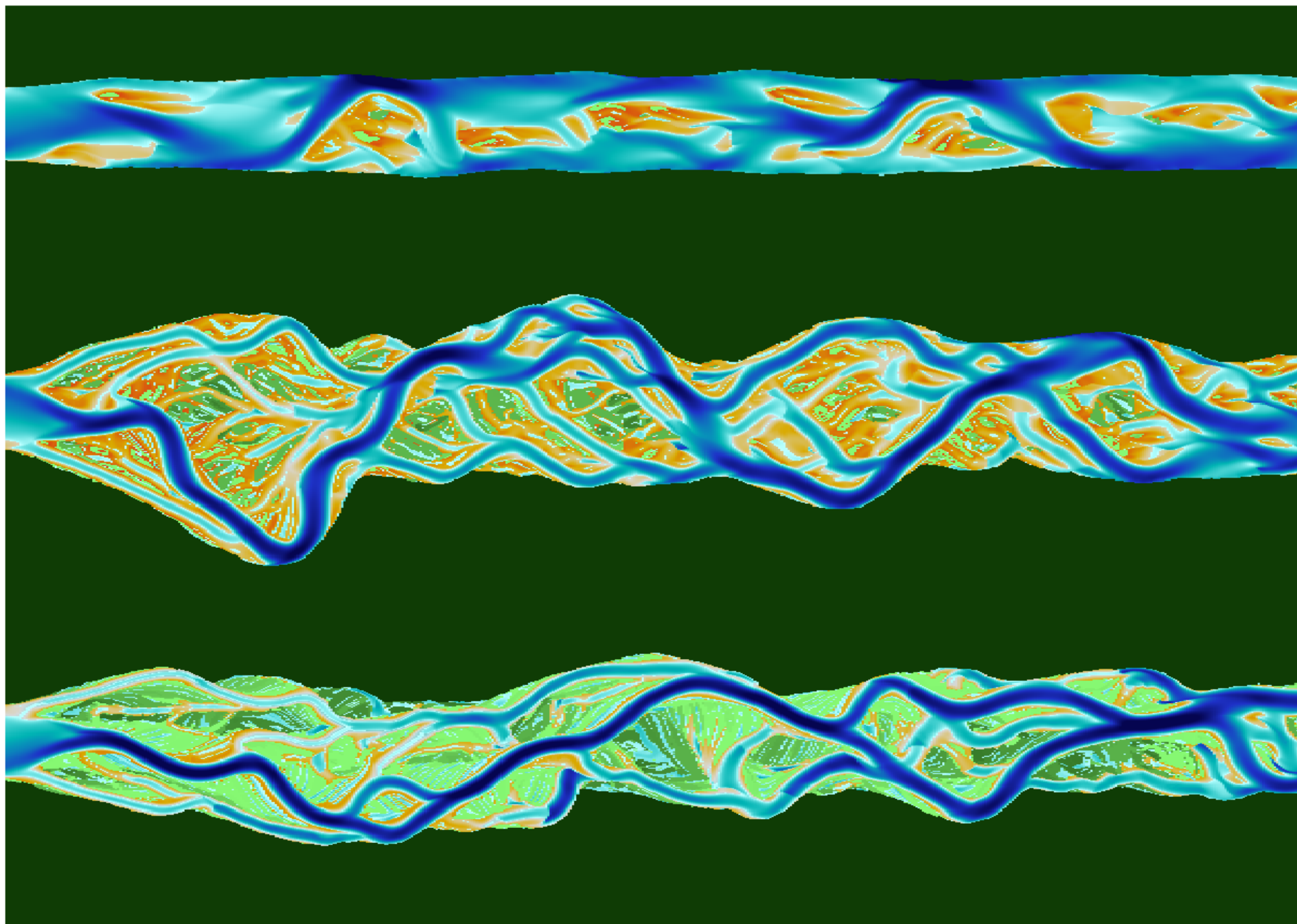


5 m

Depth: 0 m



20 m



Simulation Time: 186 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

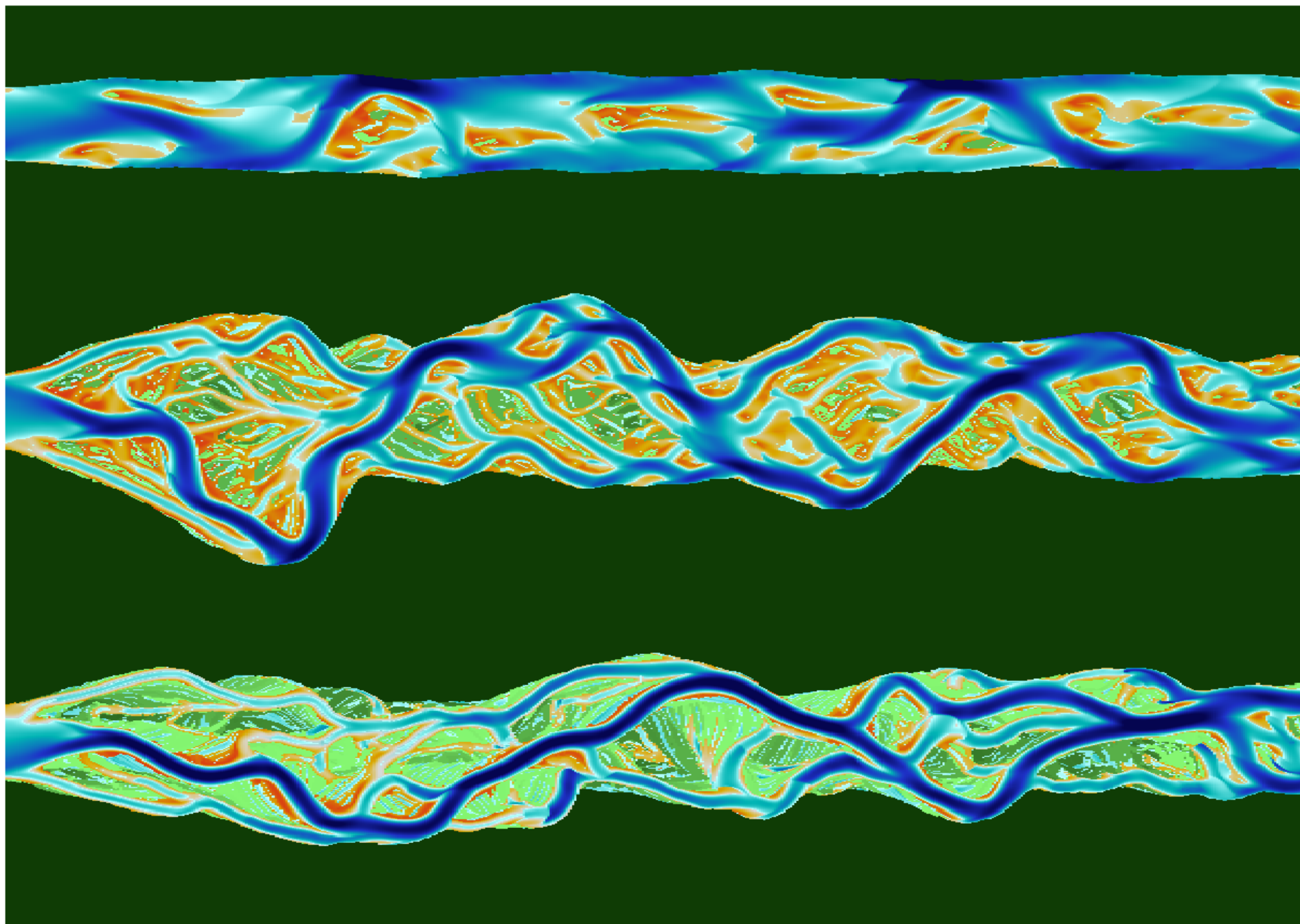


5 m

Depth: 0 m



20 m



Simulation Time: 188 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

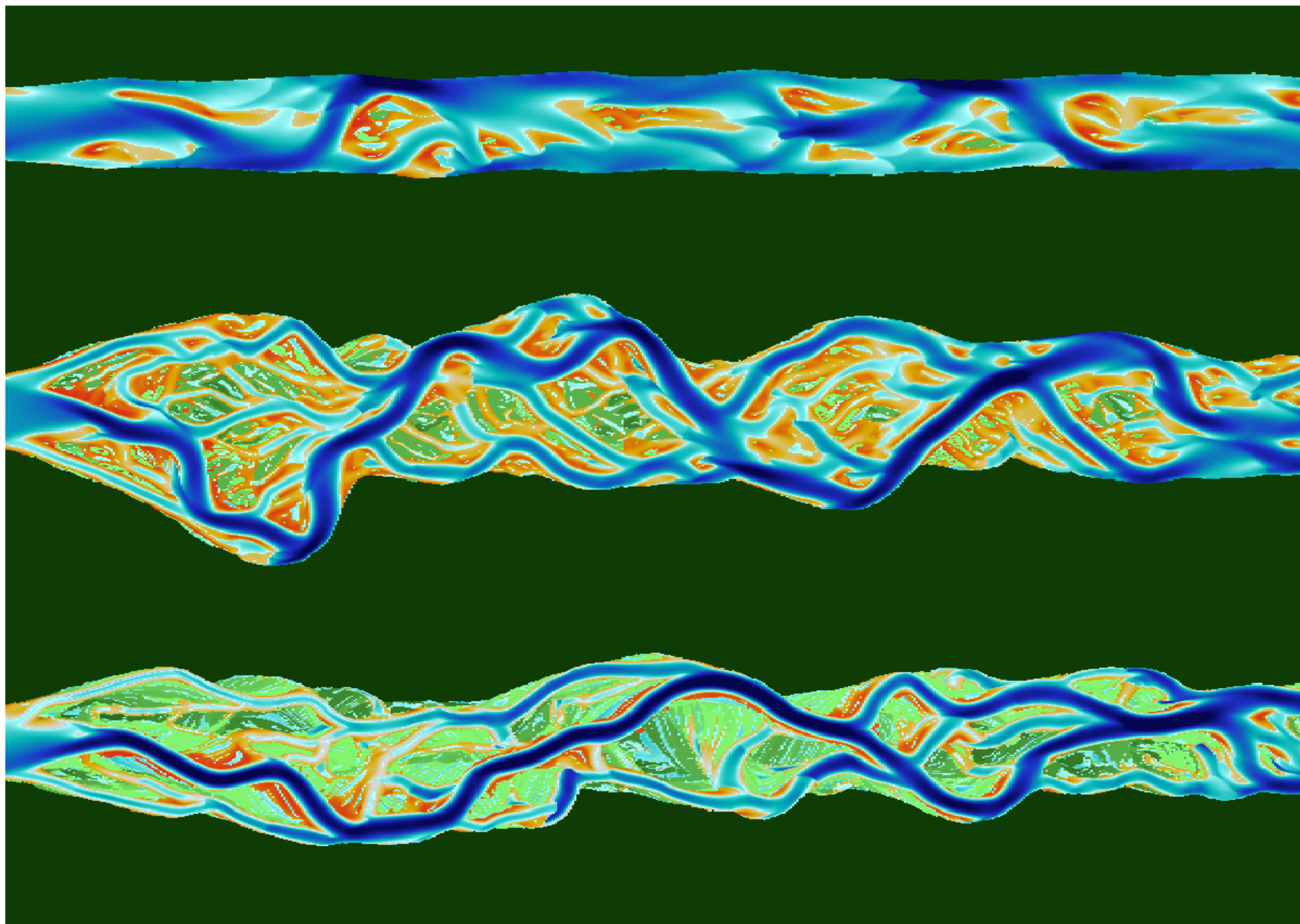


5 m

Depth: 0 m



20 m



Simulation Time: 190 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

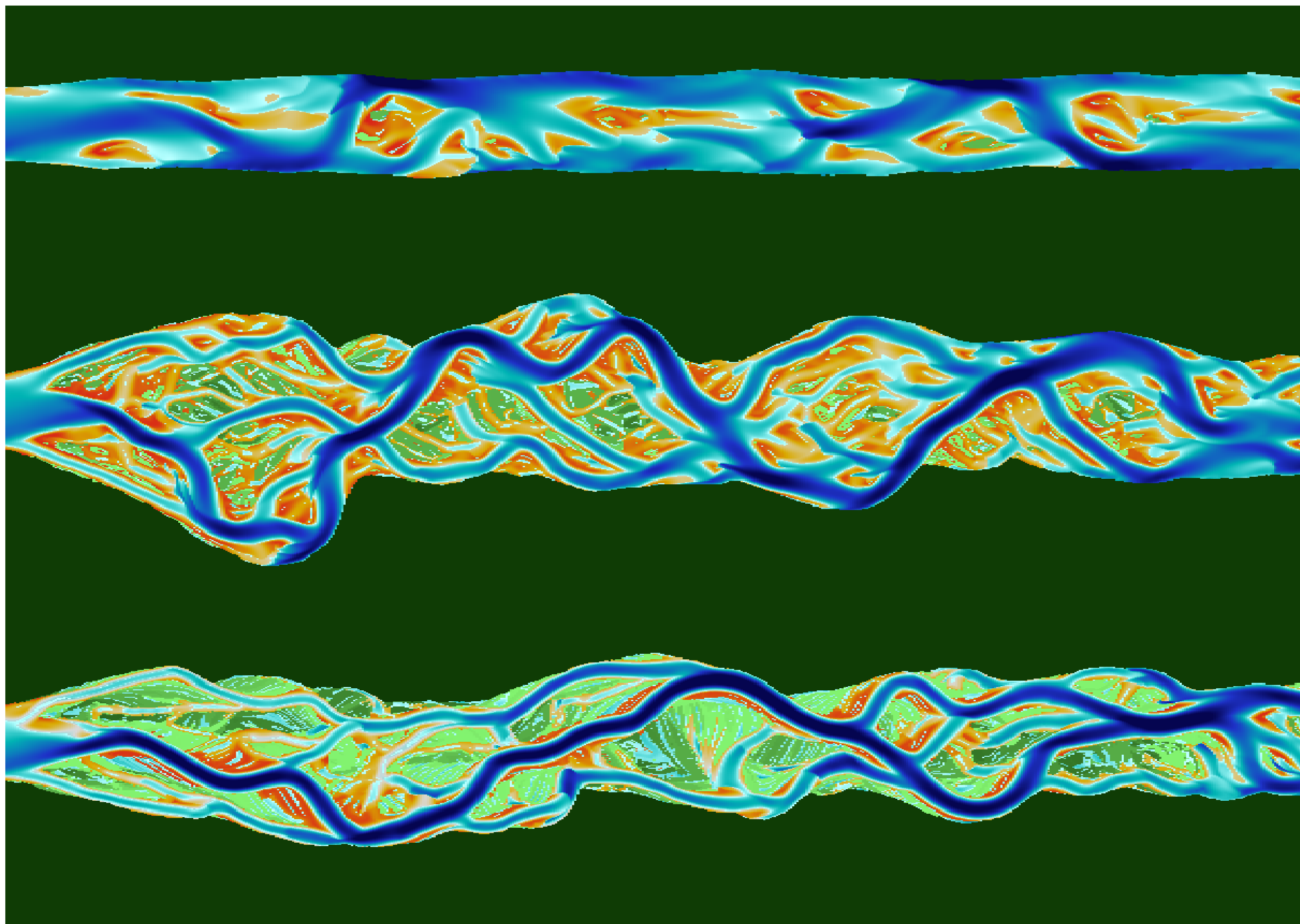


5 m

Depth: 0 m



20 m



Simulation Time: 192 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

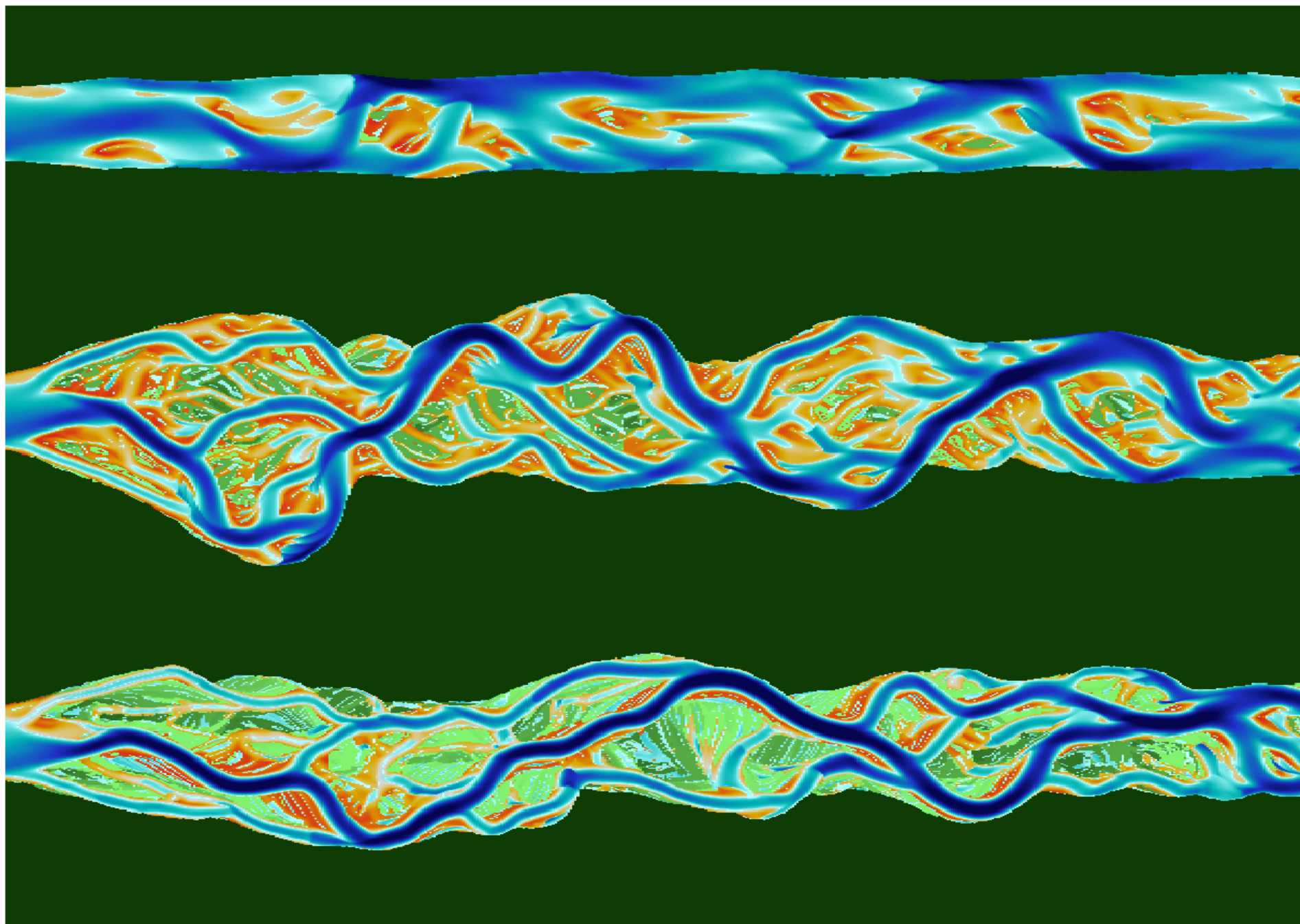


5 m

Depth: 0 m



20 m



Simulation Time: 194 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

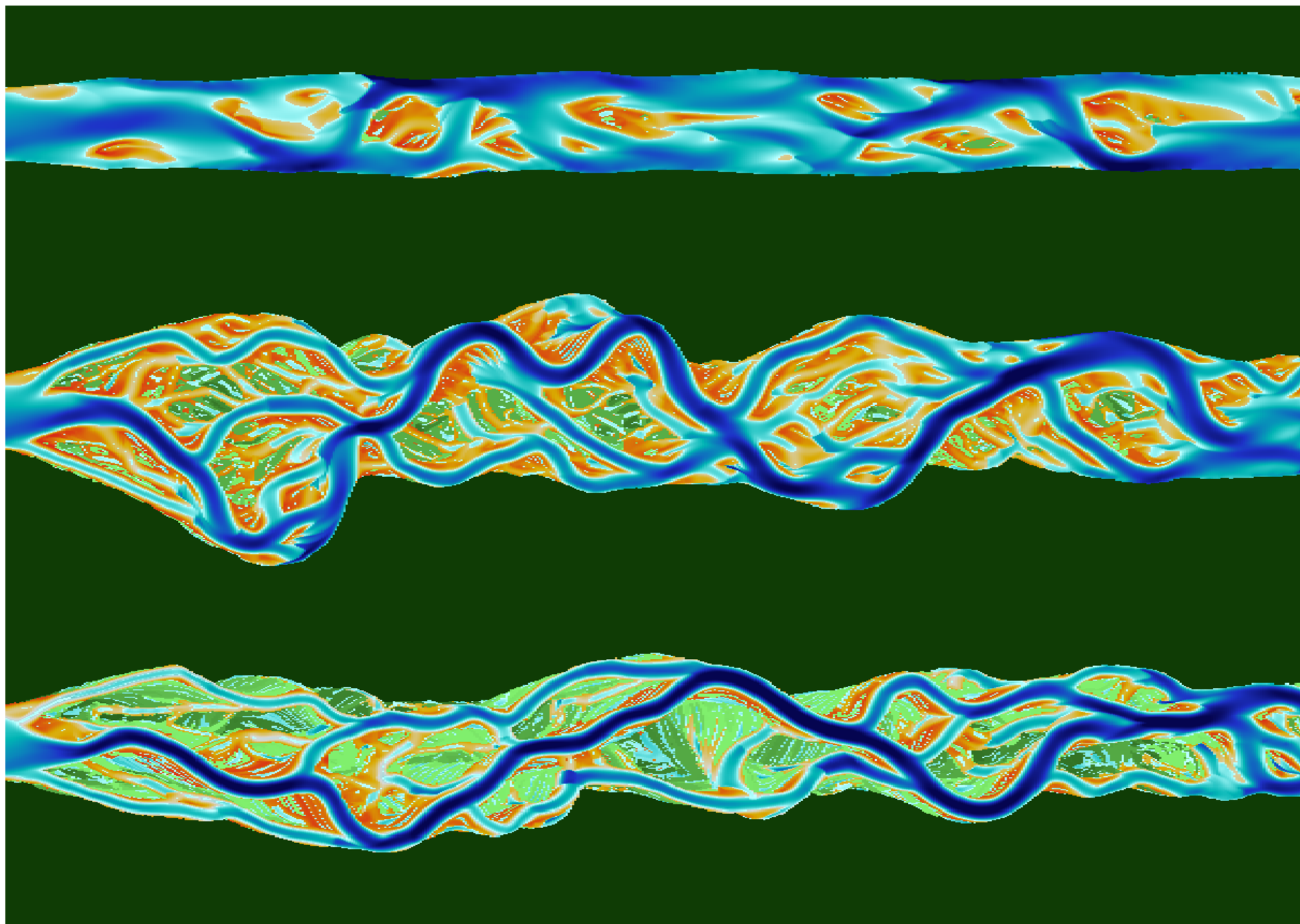


5 m

Depth: 0 m



20 m



Simulation Time: 196 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

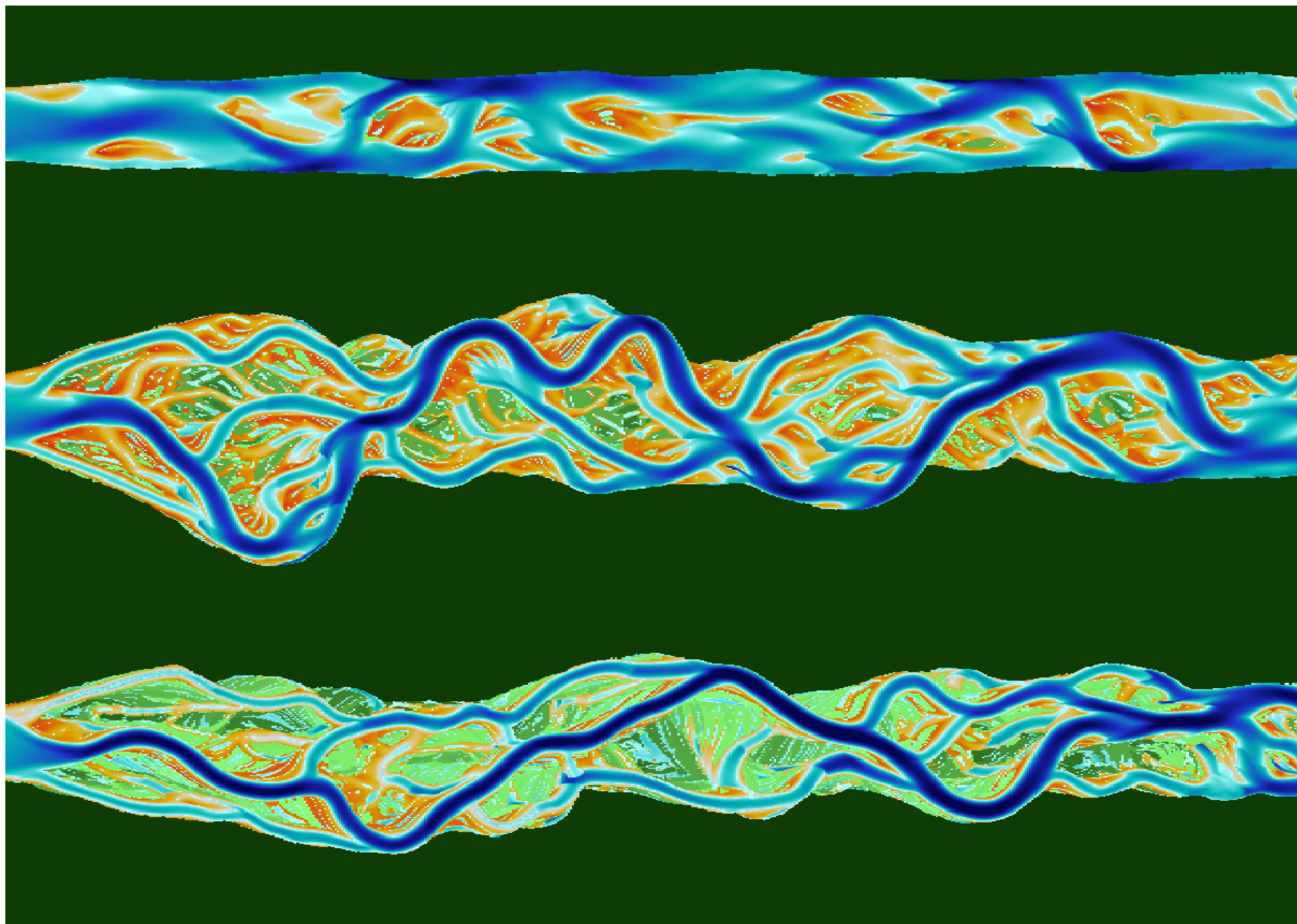


5 m

Depth: 0 m



20 m



Simulation Time: 198 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

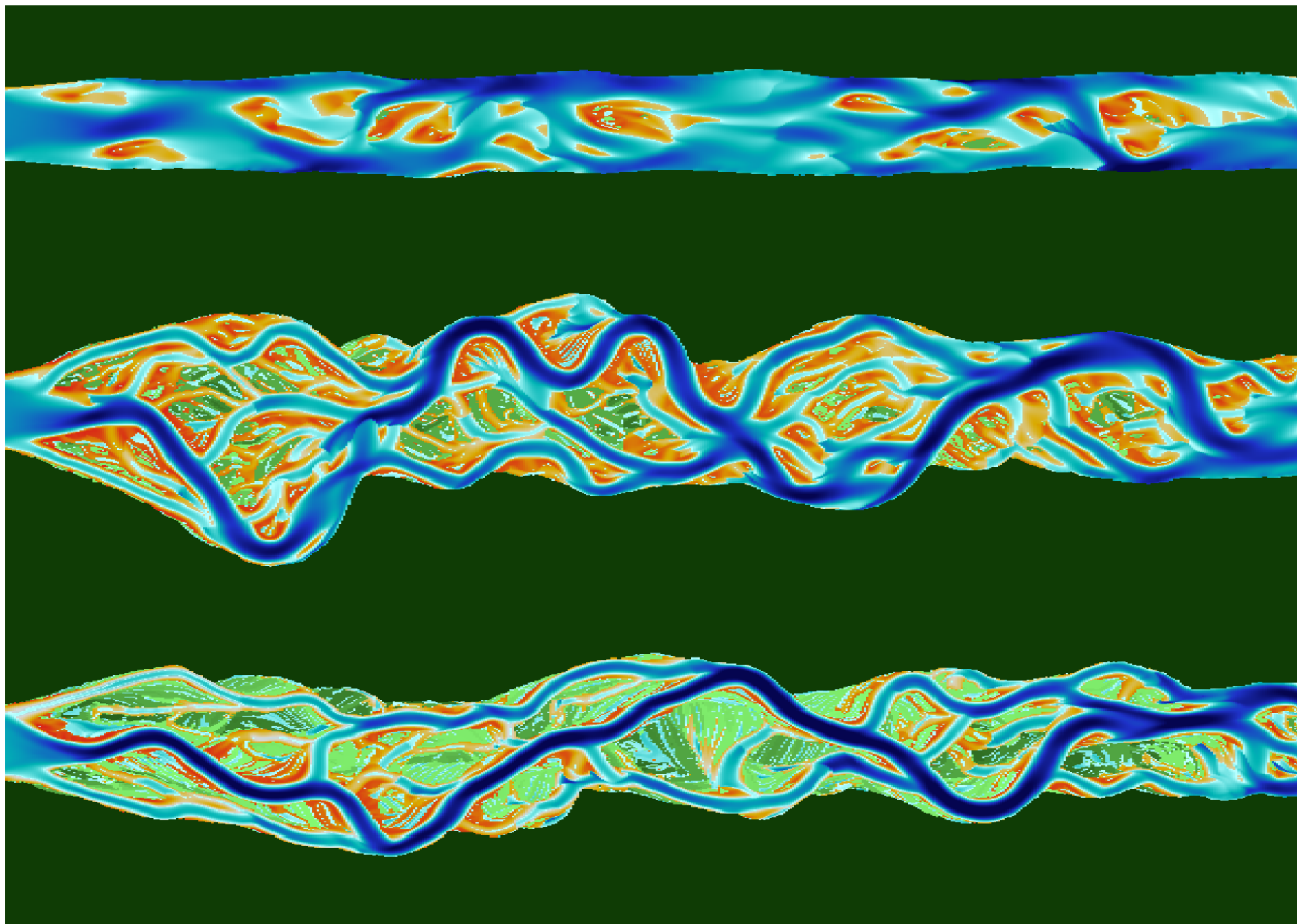


5 m

Depth: 0 m



20 m



Simulation Time: 200 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

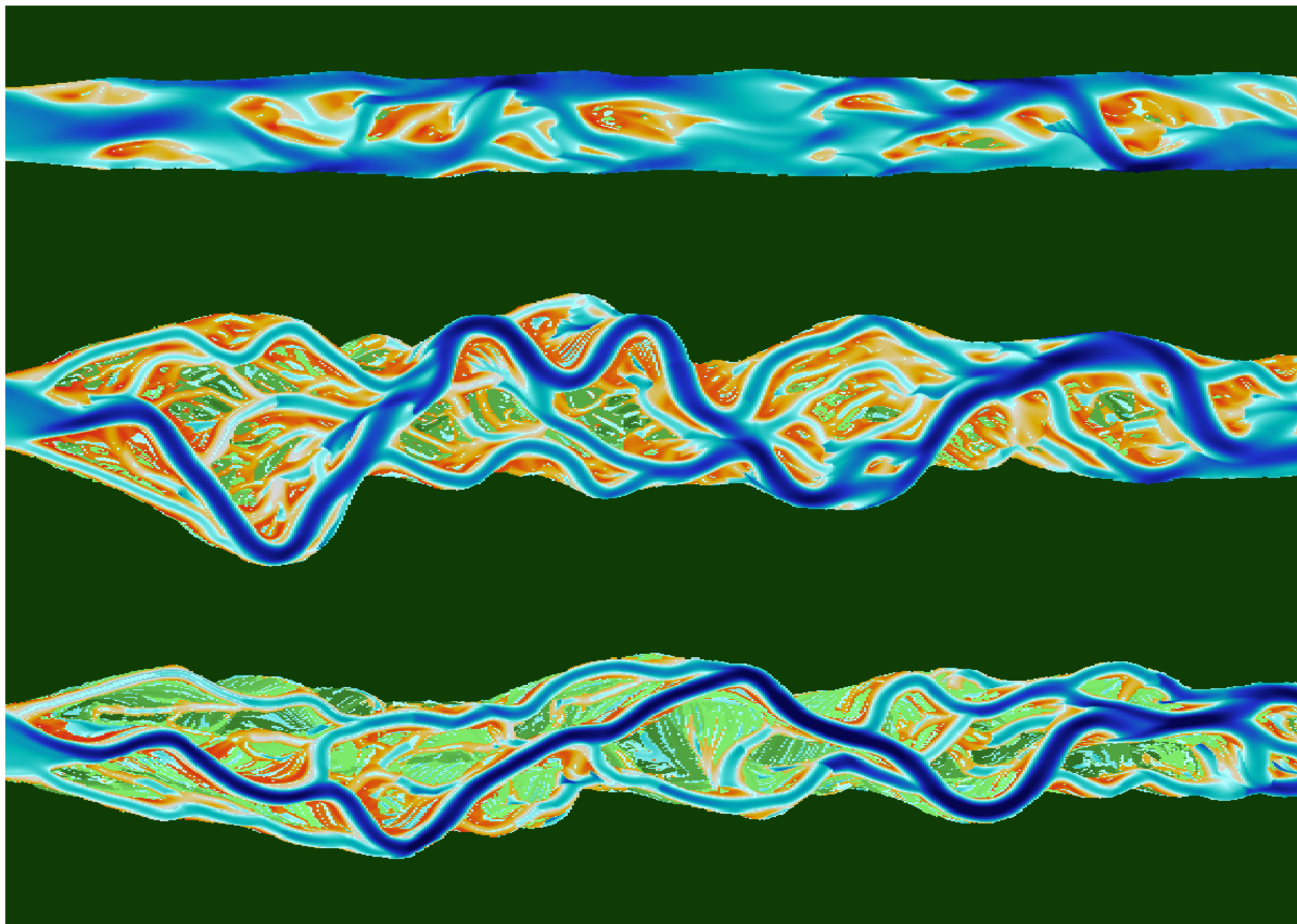


5 m

Depth: 0 m



20 m



Simulation Time: 202 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

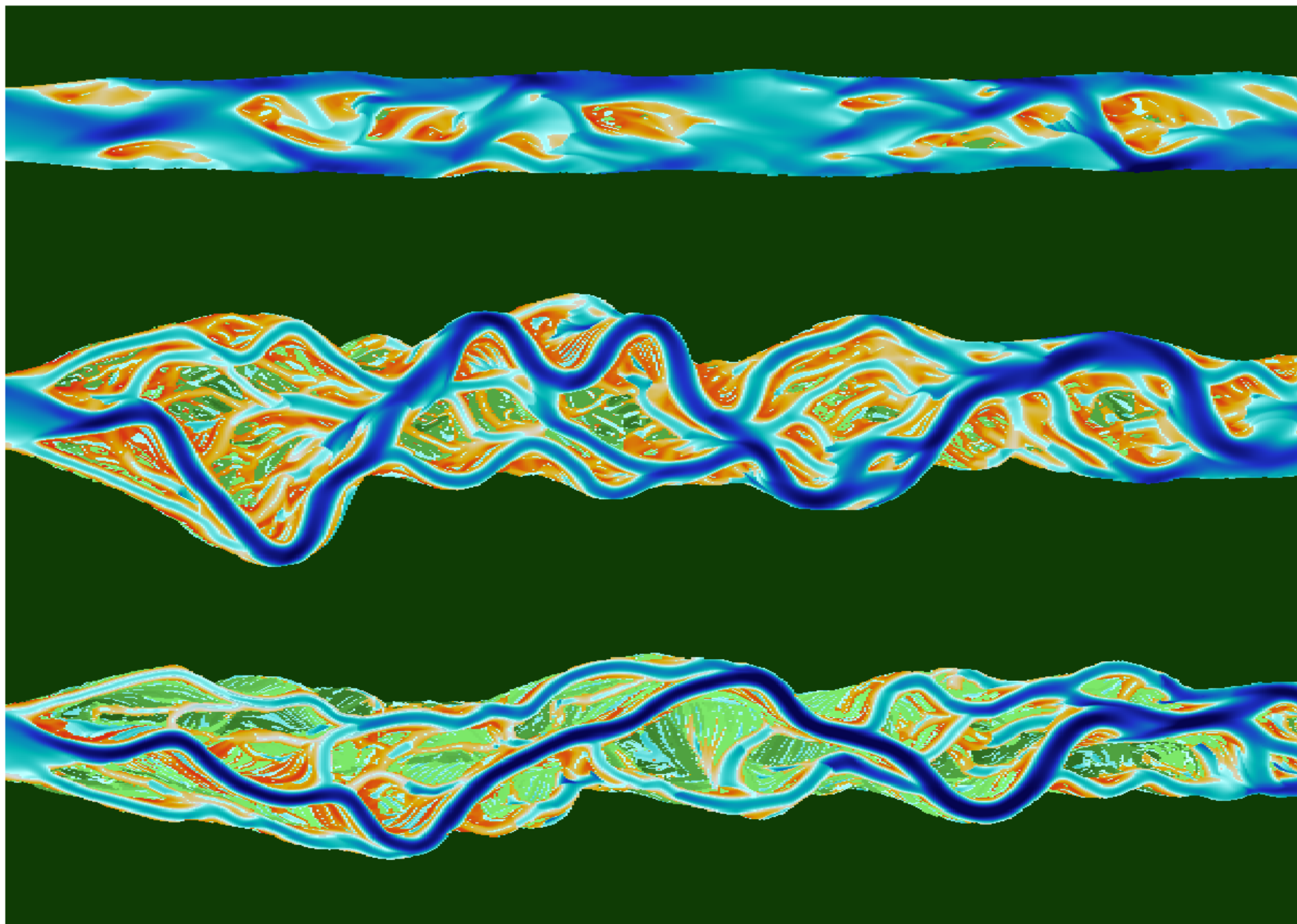


5 m

Depth: 0 m



20 m



Simulation Time: 204 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

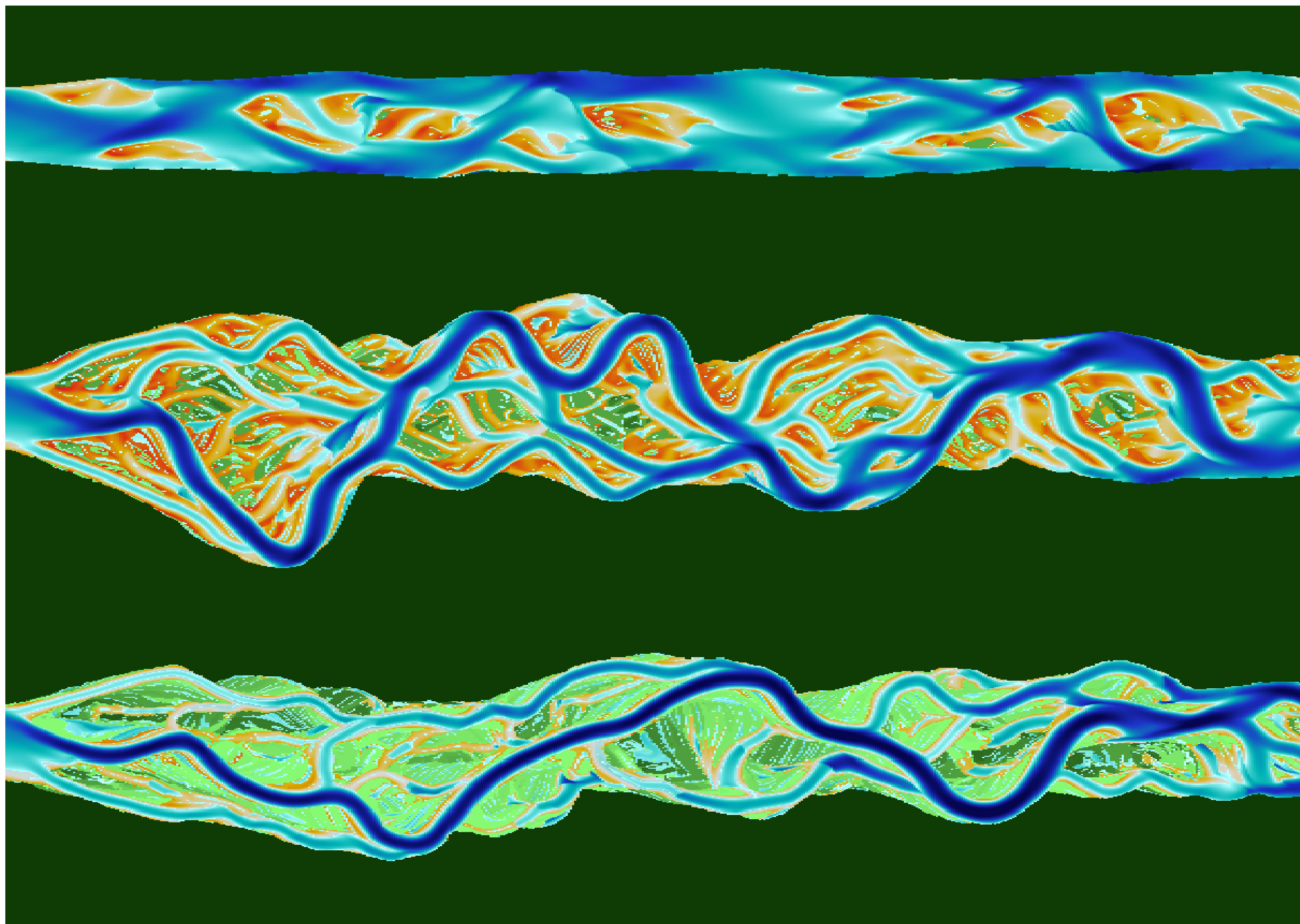


5 m

Depth: 0 m



20 m



Simulation Time: 206 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

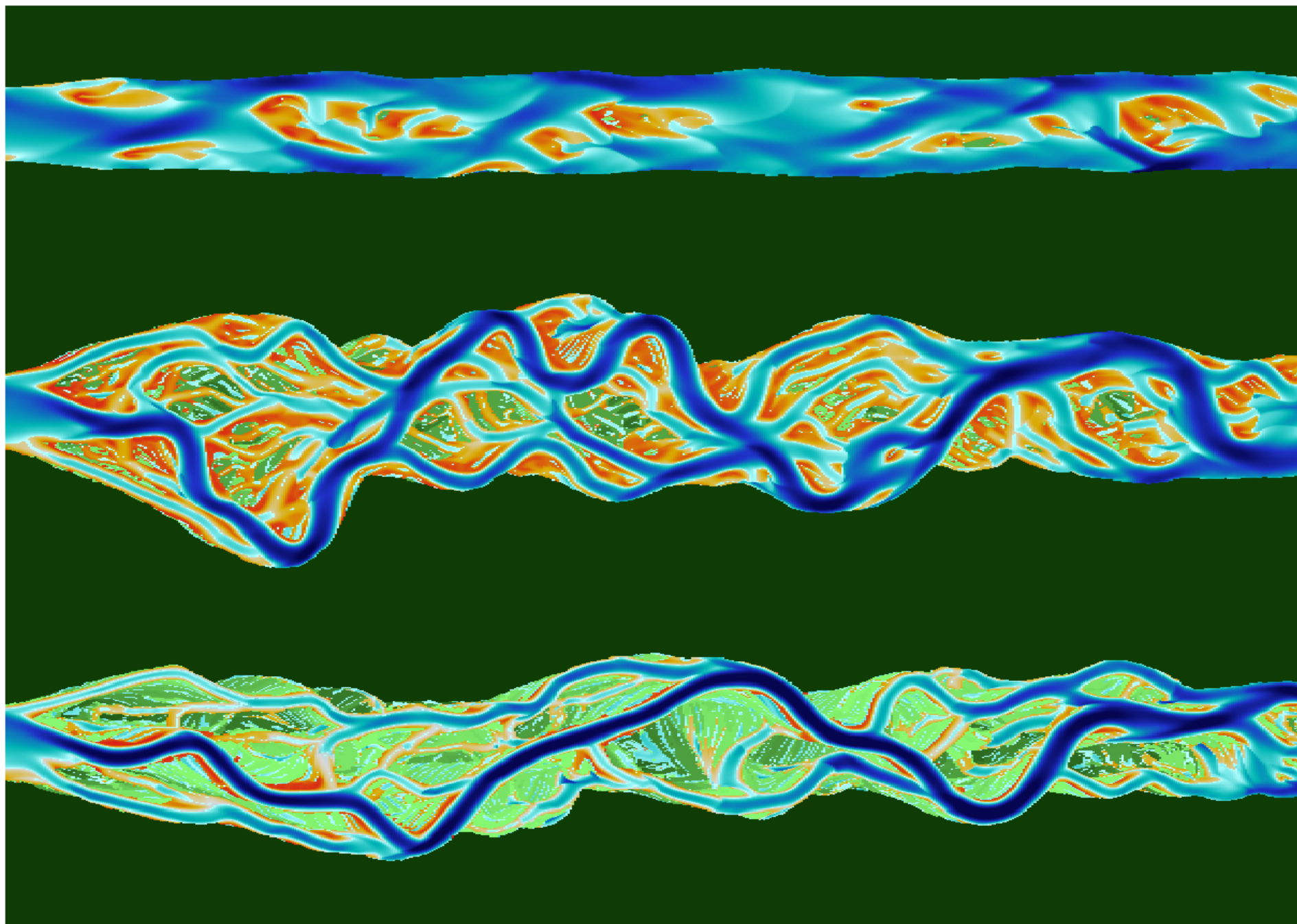


5 m

Depth: 0 m



20 m



Simulation Time: 208 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

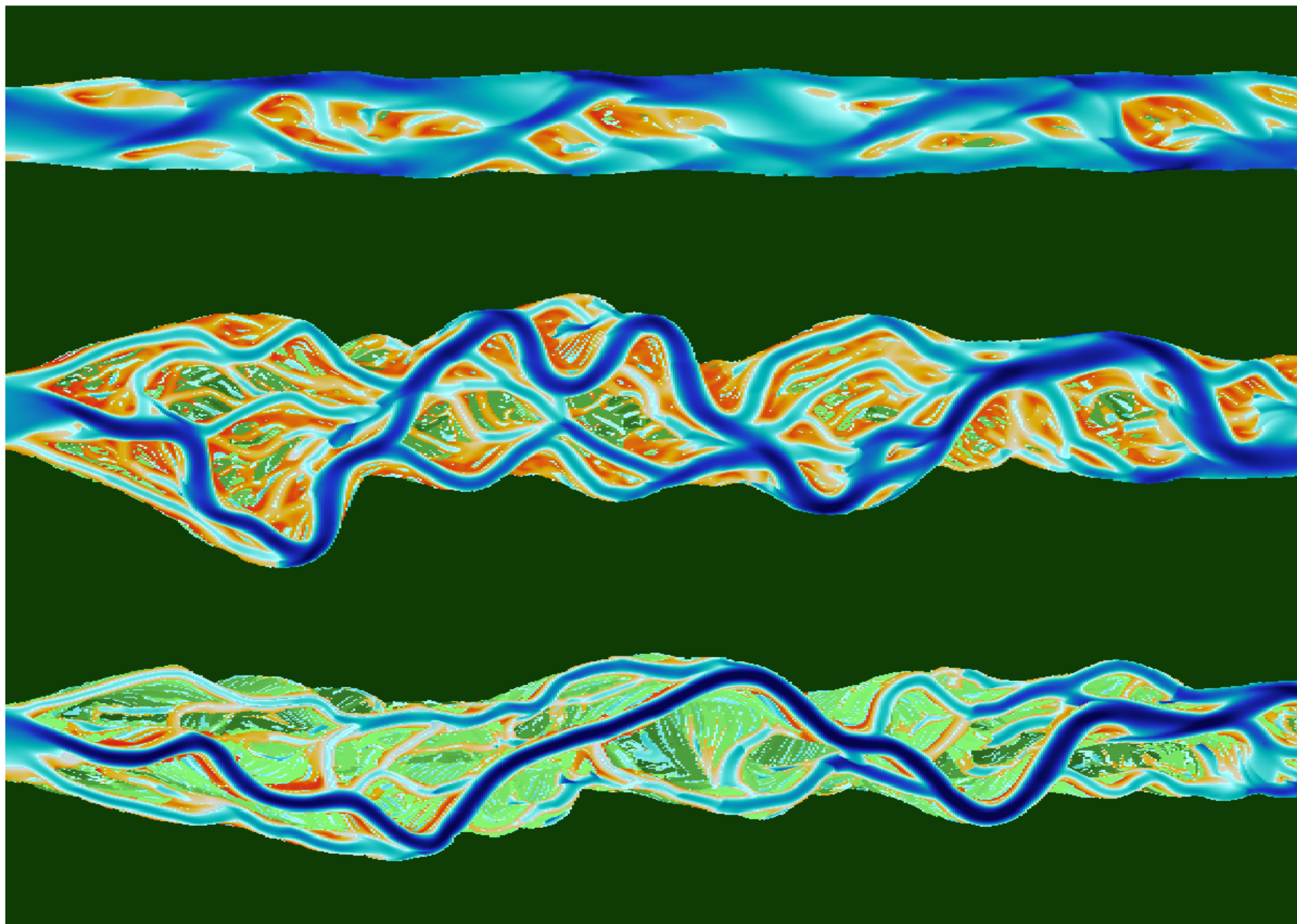


5 m

Depth: 0 m



20 m



Simulation Time: 210 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

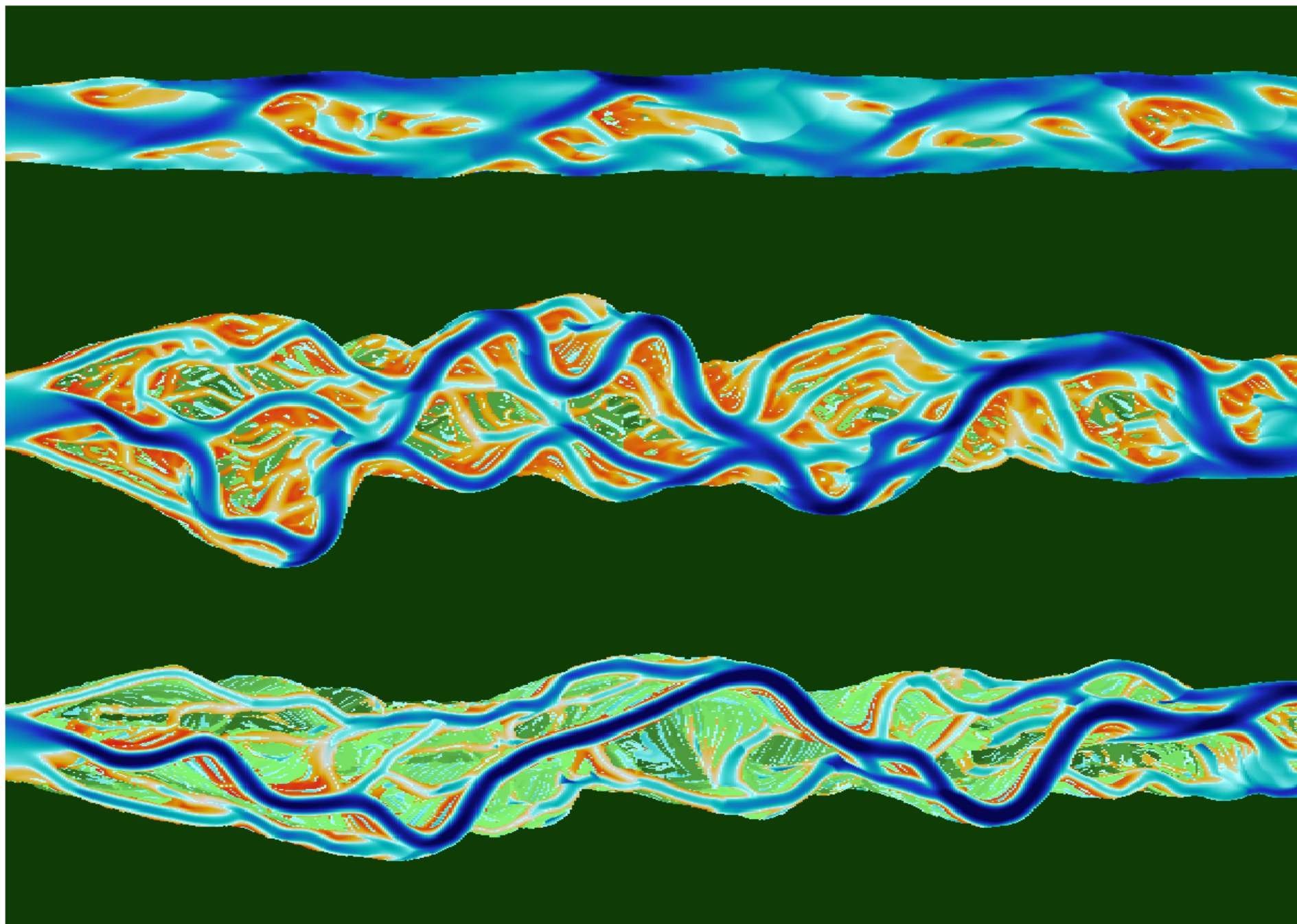


5 m

Depth: 0 m



20 m



Simulation Time: 212 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

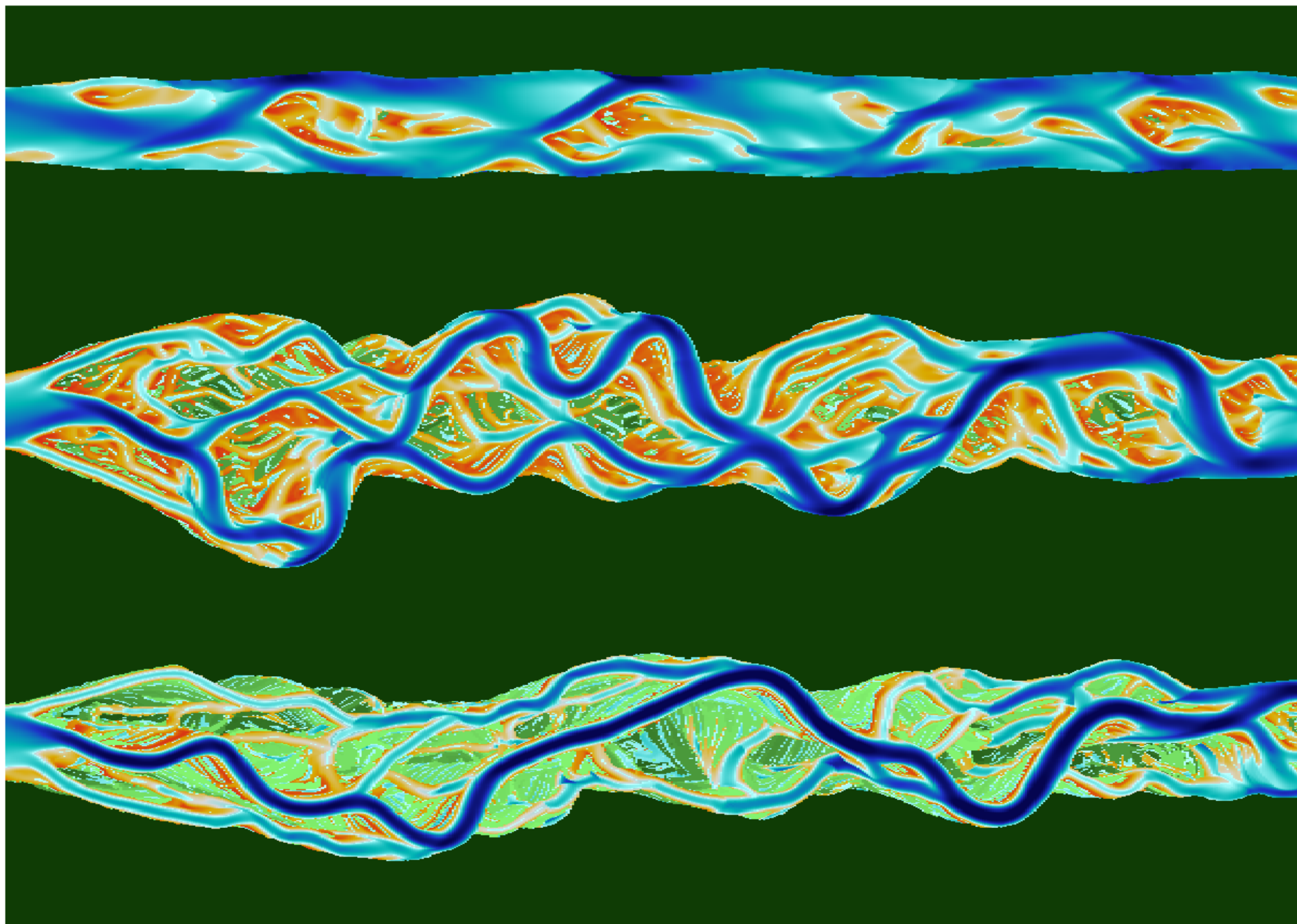


5 m

Depth: 0 m



20 m



Simulation Time: 214 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

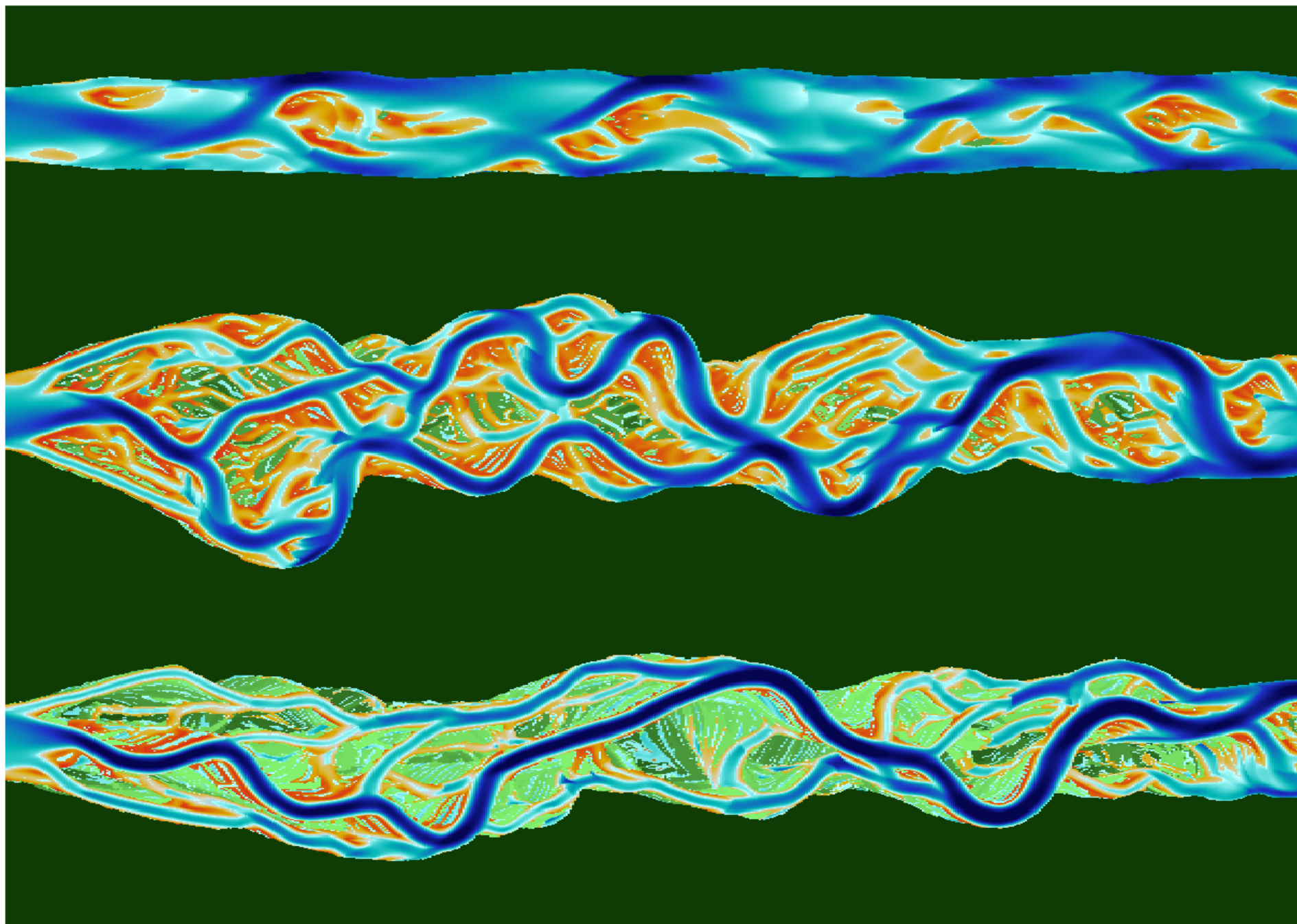


5 m

Depth: 0 m



20 m



Simulation Time: 216 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

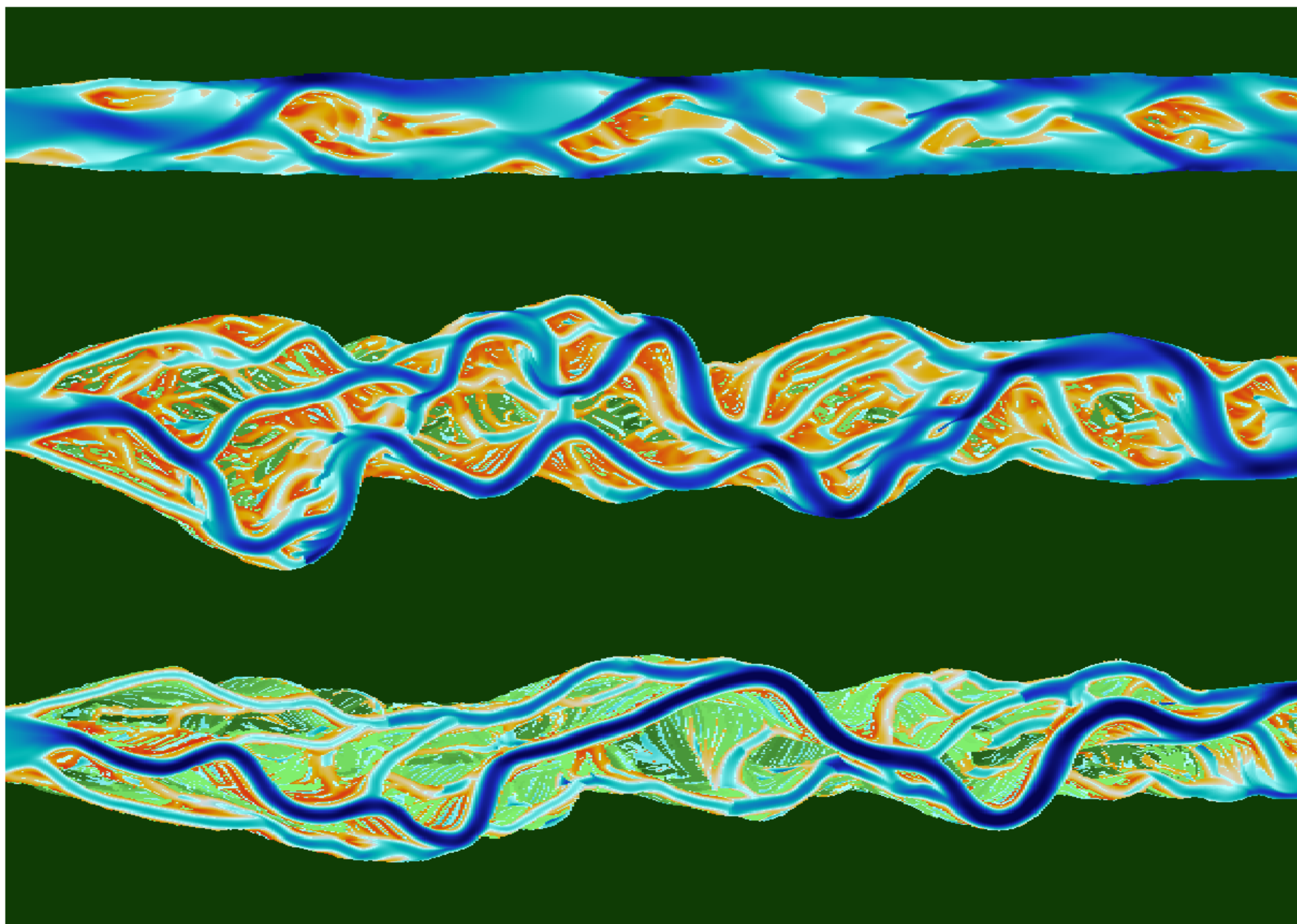


5 m

Depth: 0 m



20 m



Simulation Time: 218 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

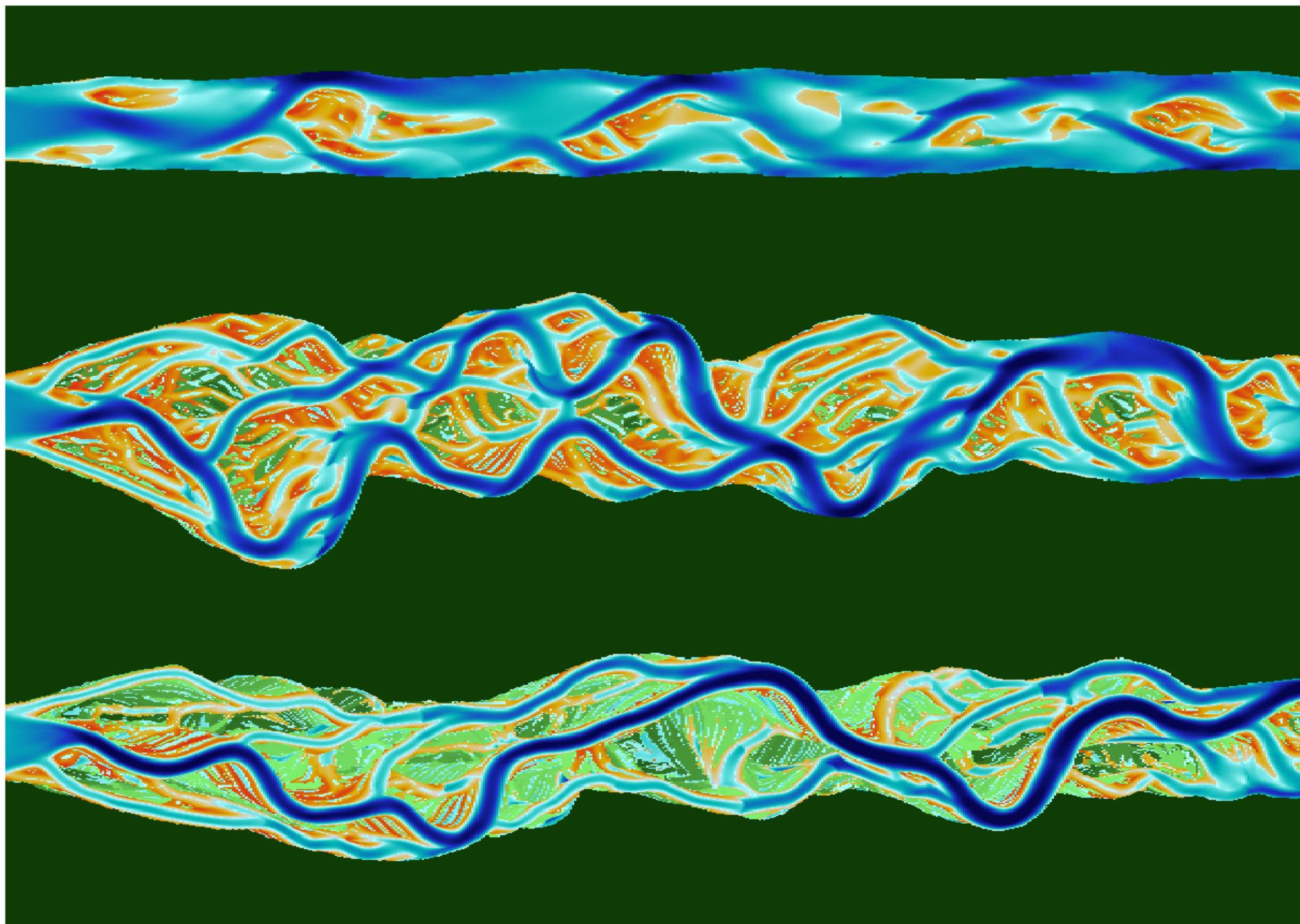


5 m

Depth: 0 m



20 m



Simulation Time: 220 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

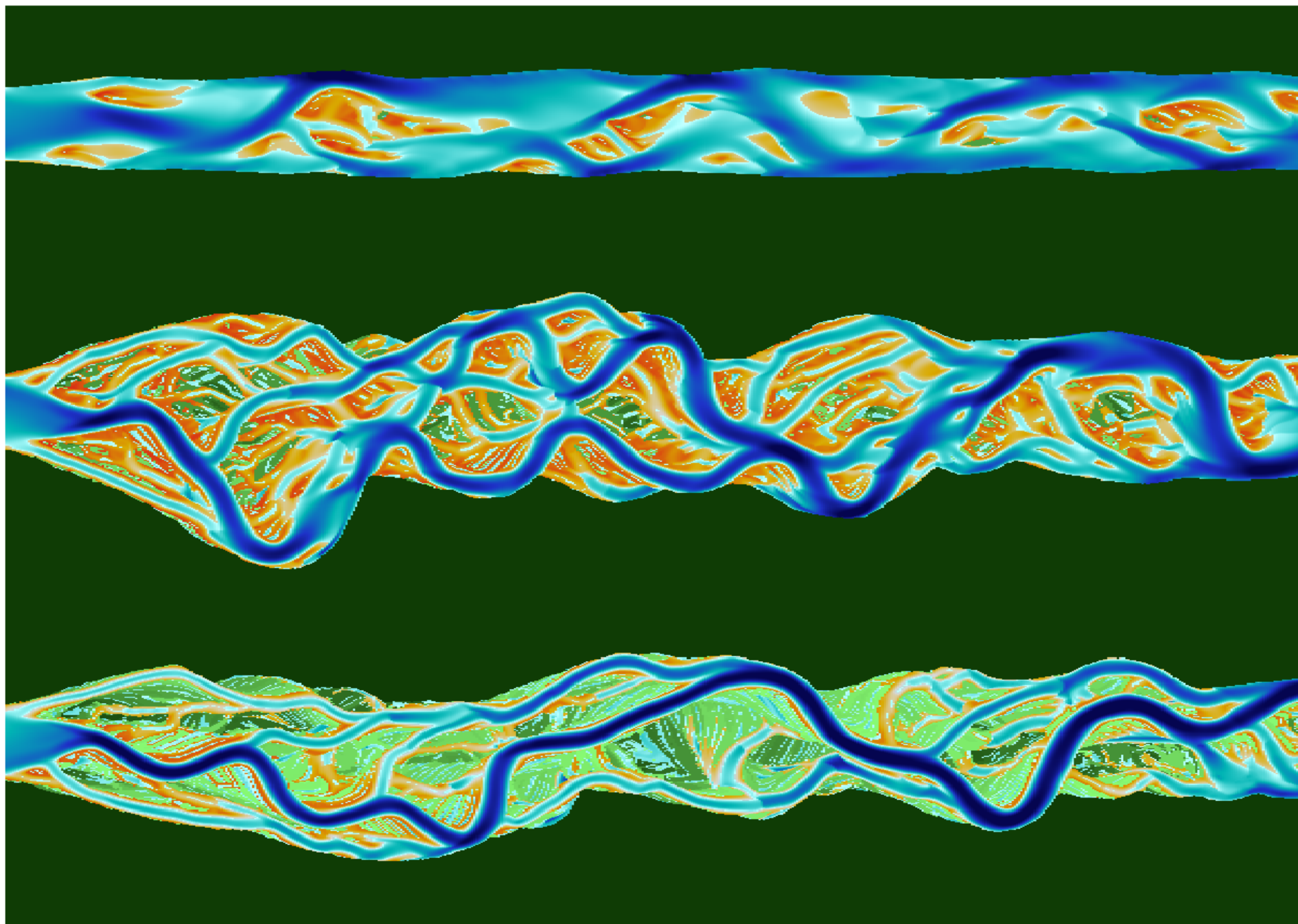


5 m

Depth: 0 m



20 m



Simulation Time: 222 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

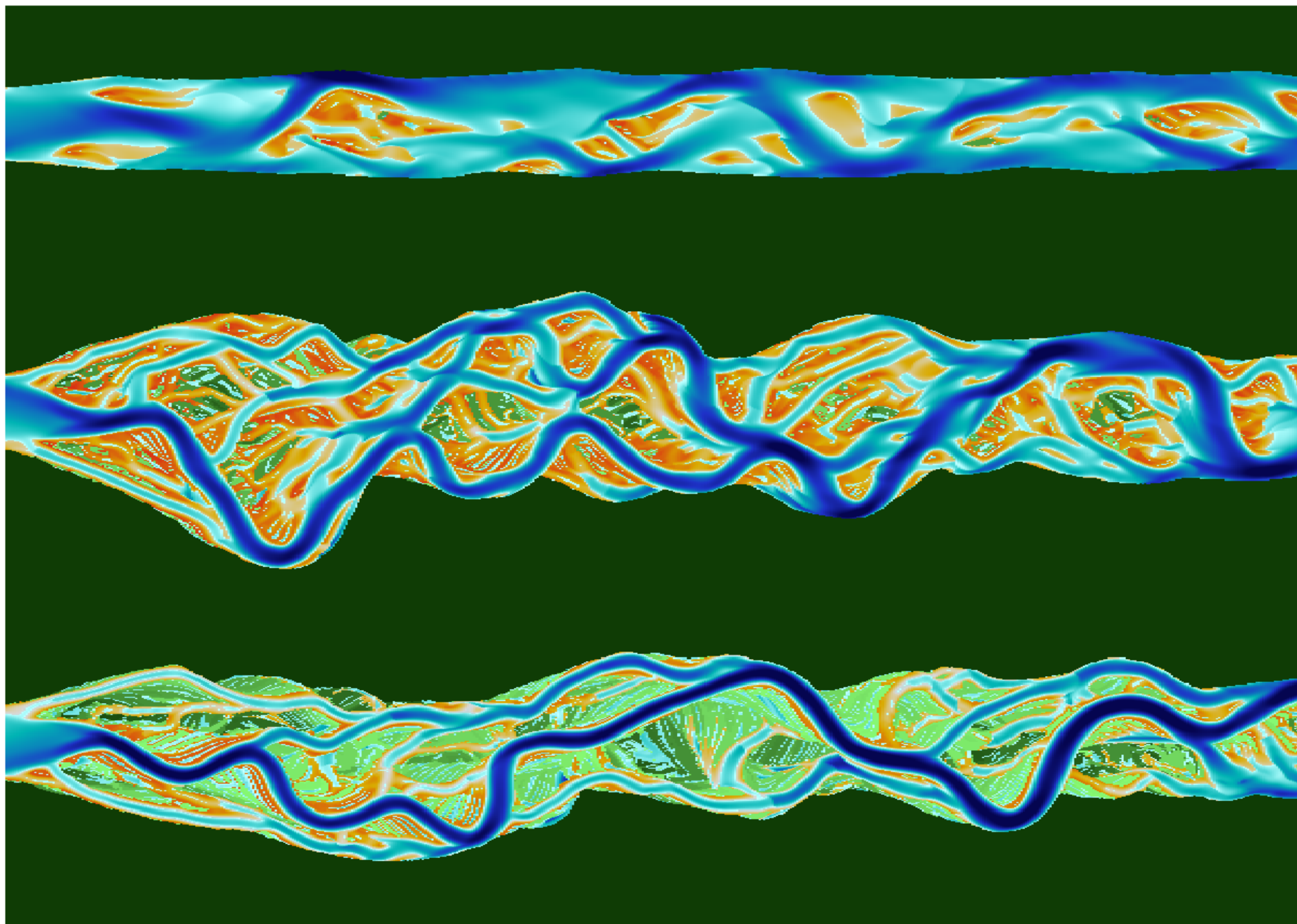


5 m

Depth: 0 m



20 m



Simulation Time: 224 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

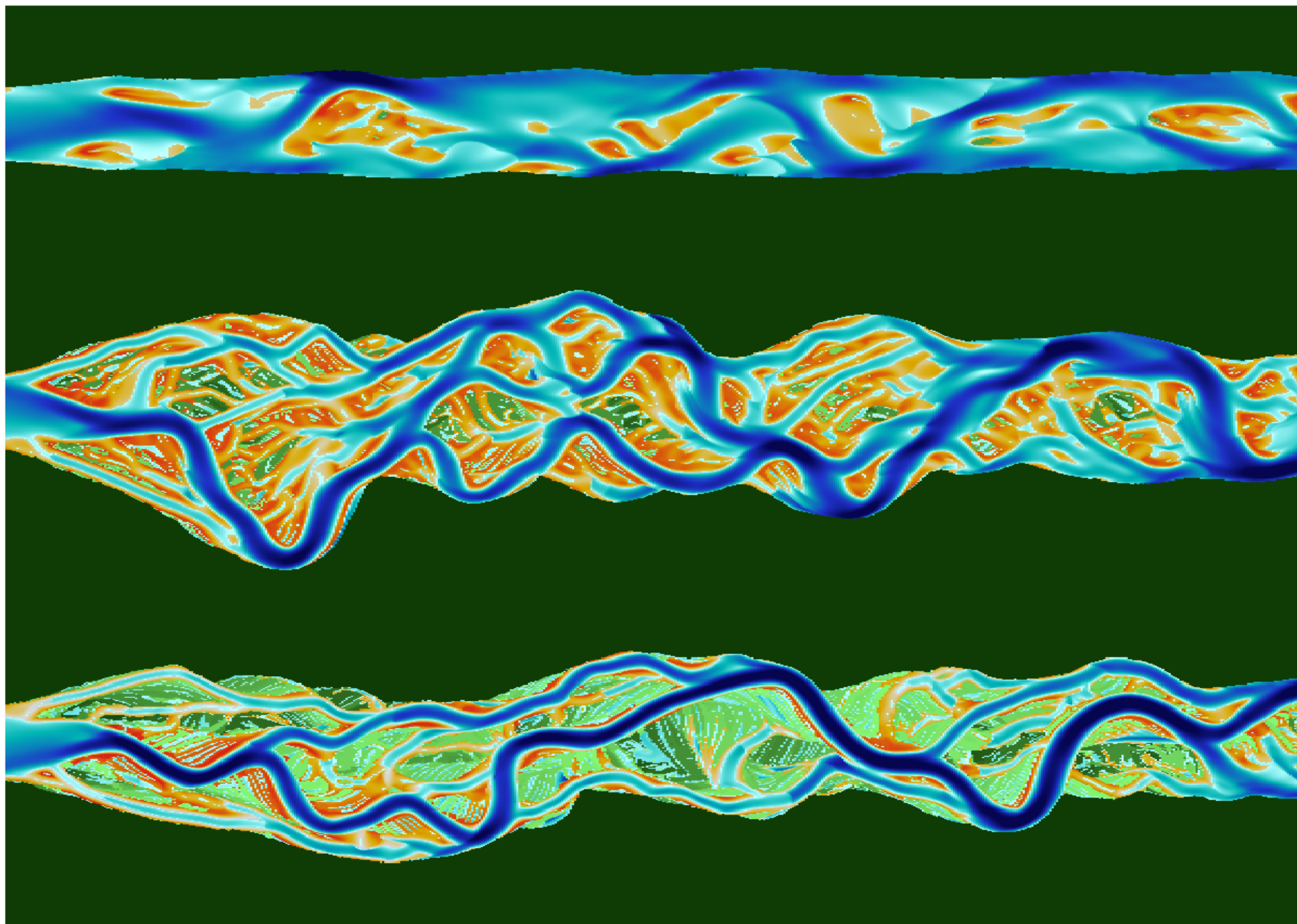


5 m

Depth: 0 m



20 m



Simulation Time: 226 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

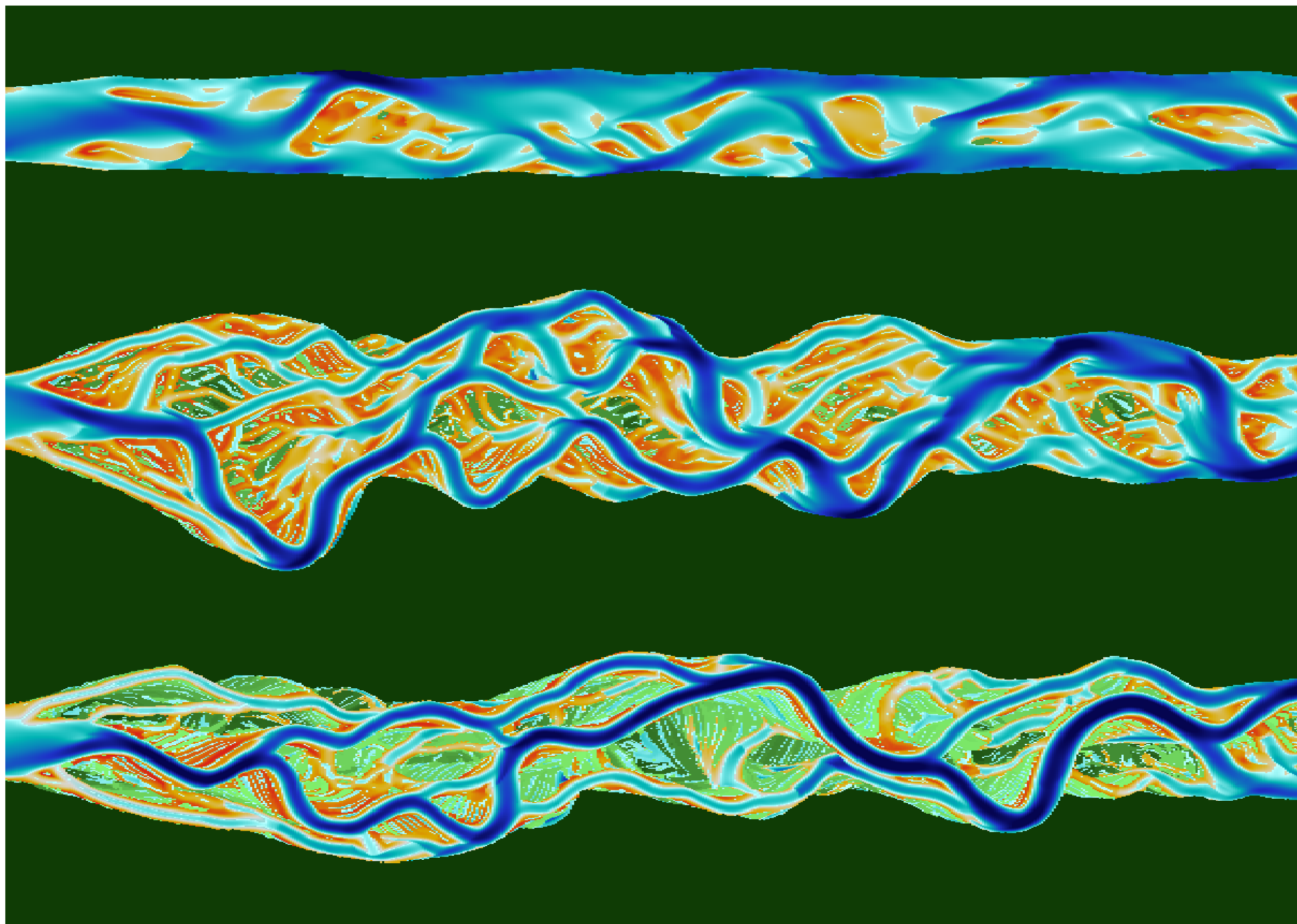


5 m

Depth: 0 m



20 m



Simulation Time: 228 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

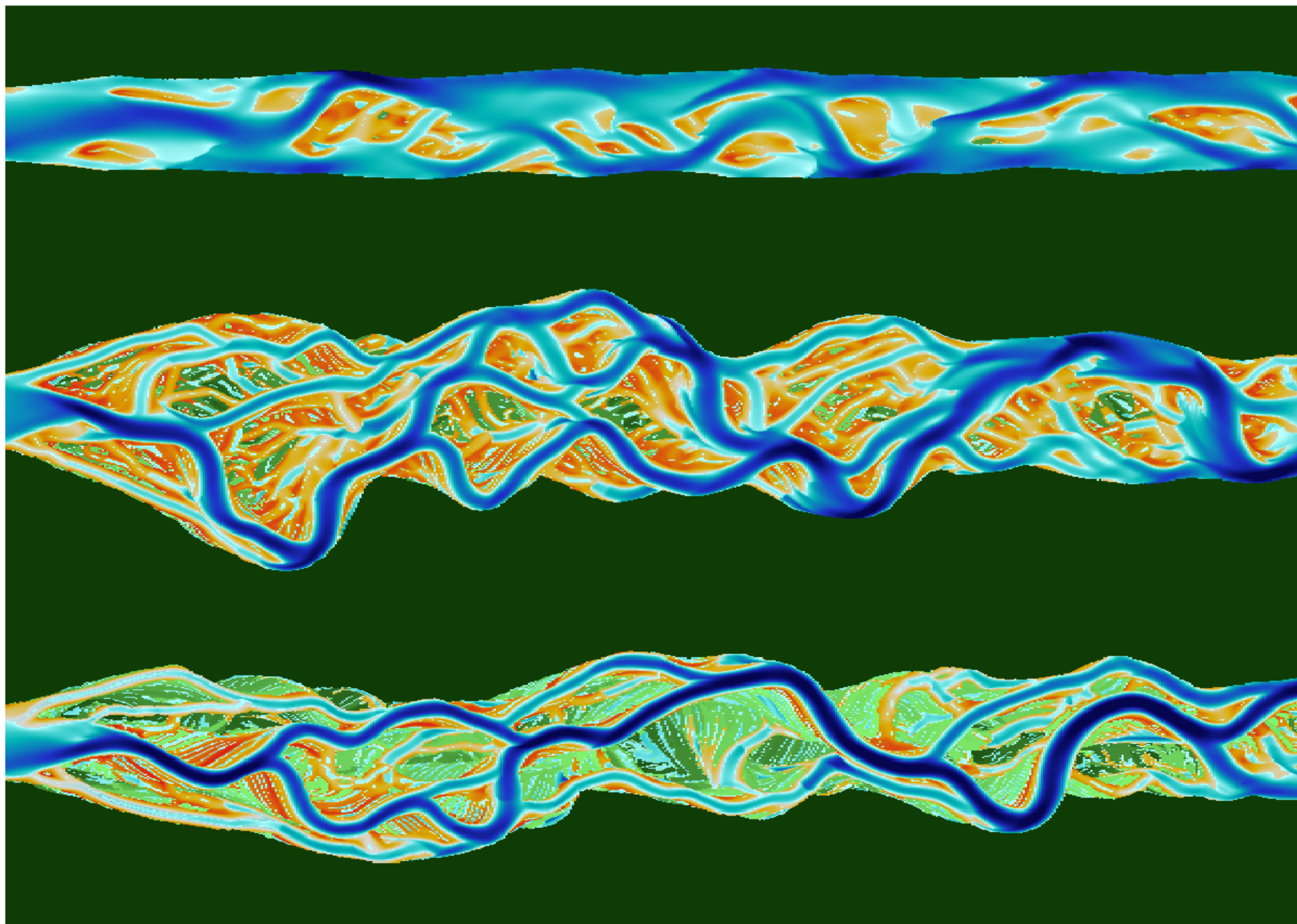


5 m

Depth: 0 m



20 m



Simulation Time: 230 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

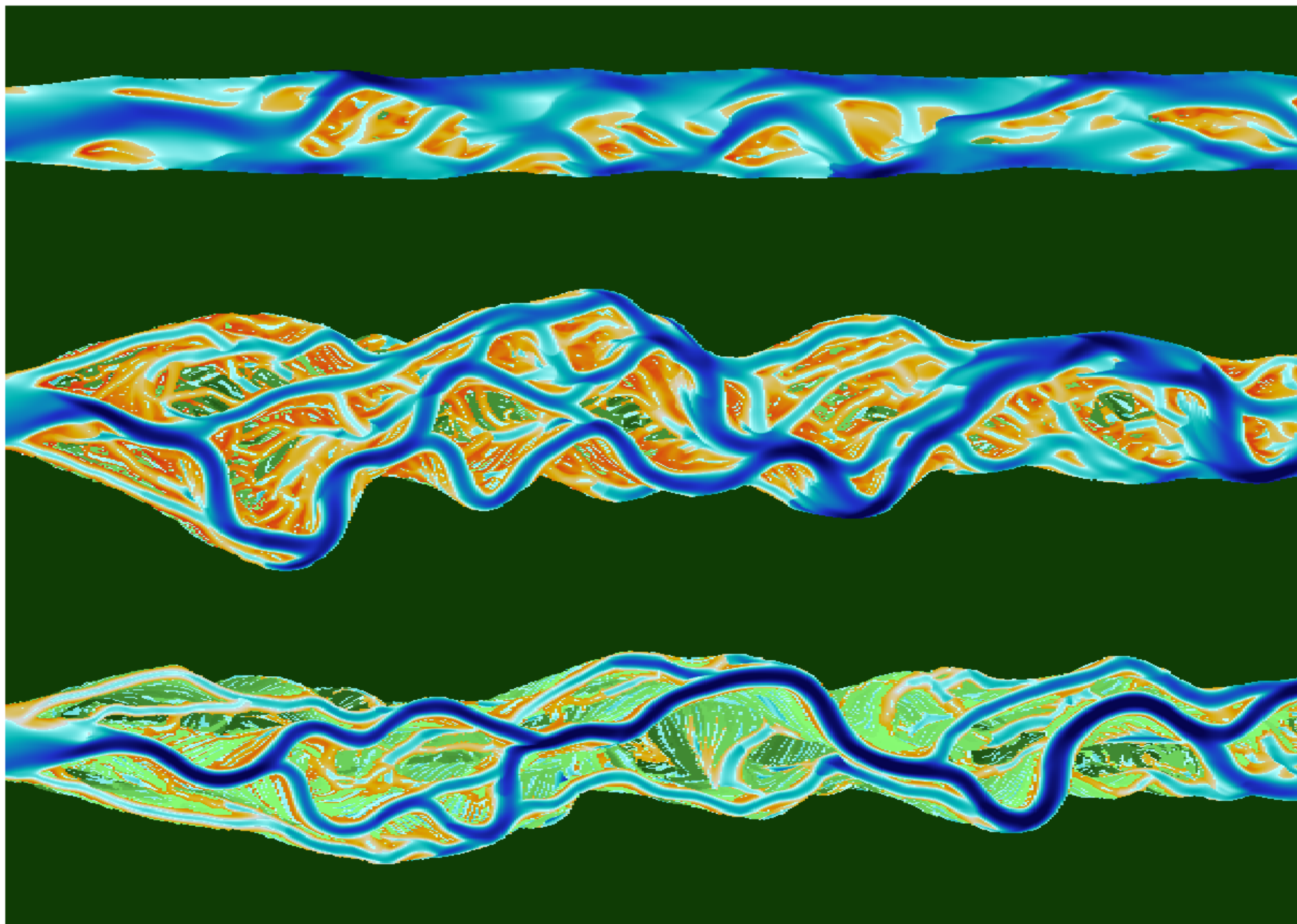


5 m

Depth: 0 m



20 m



Simulation Time: 232 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

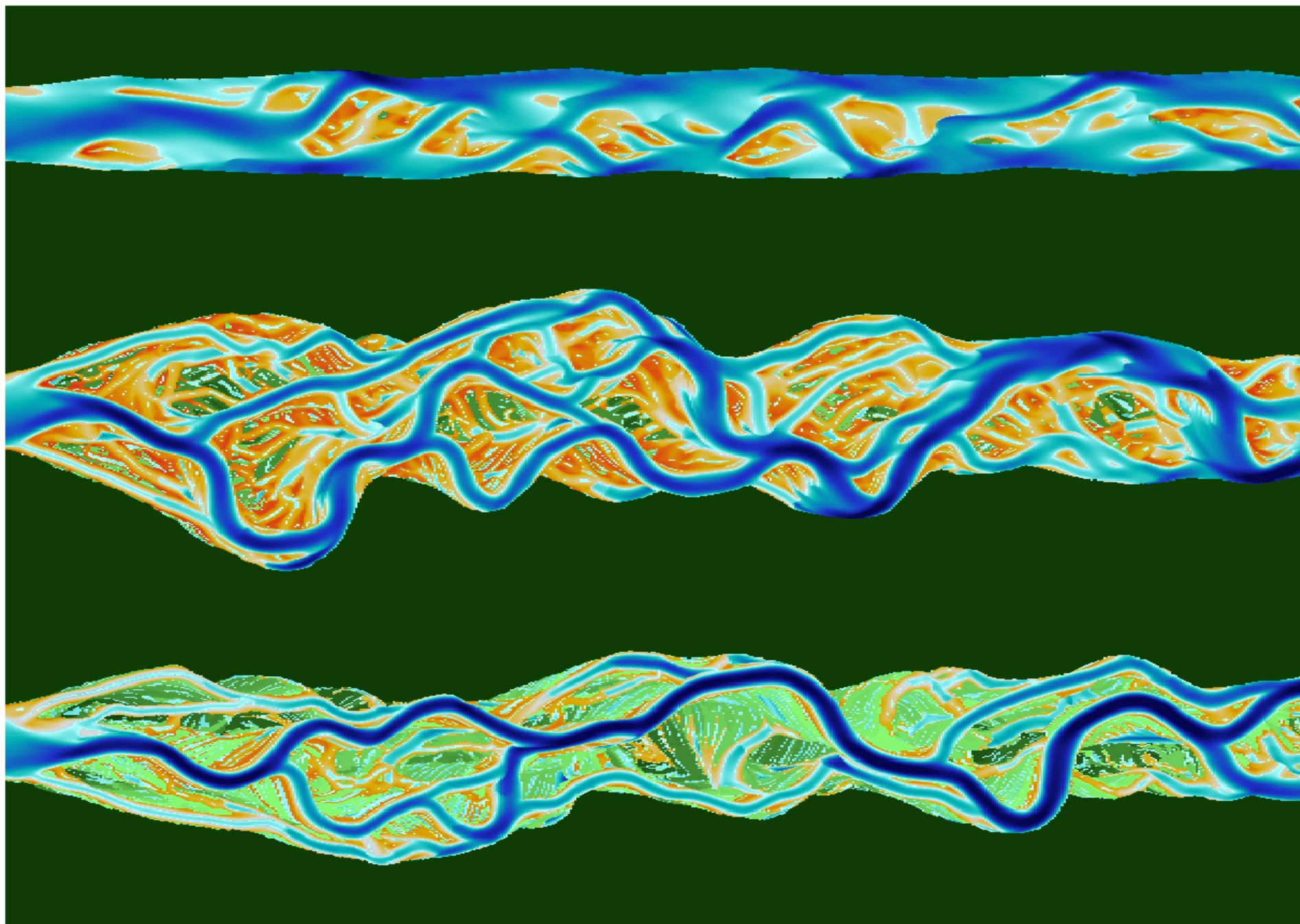


5 m

Depth: 0 m



20 m



Simulation Time: 234 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

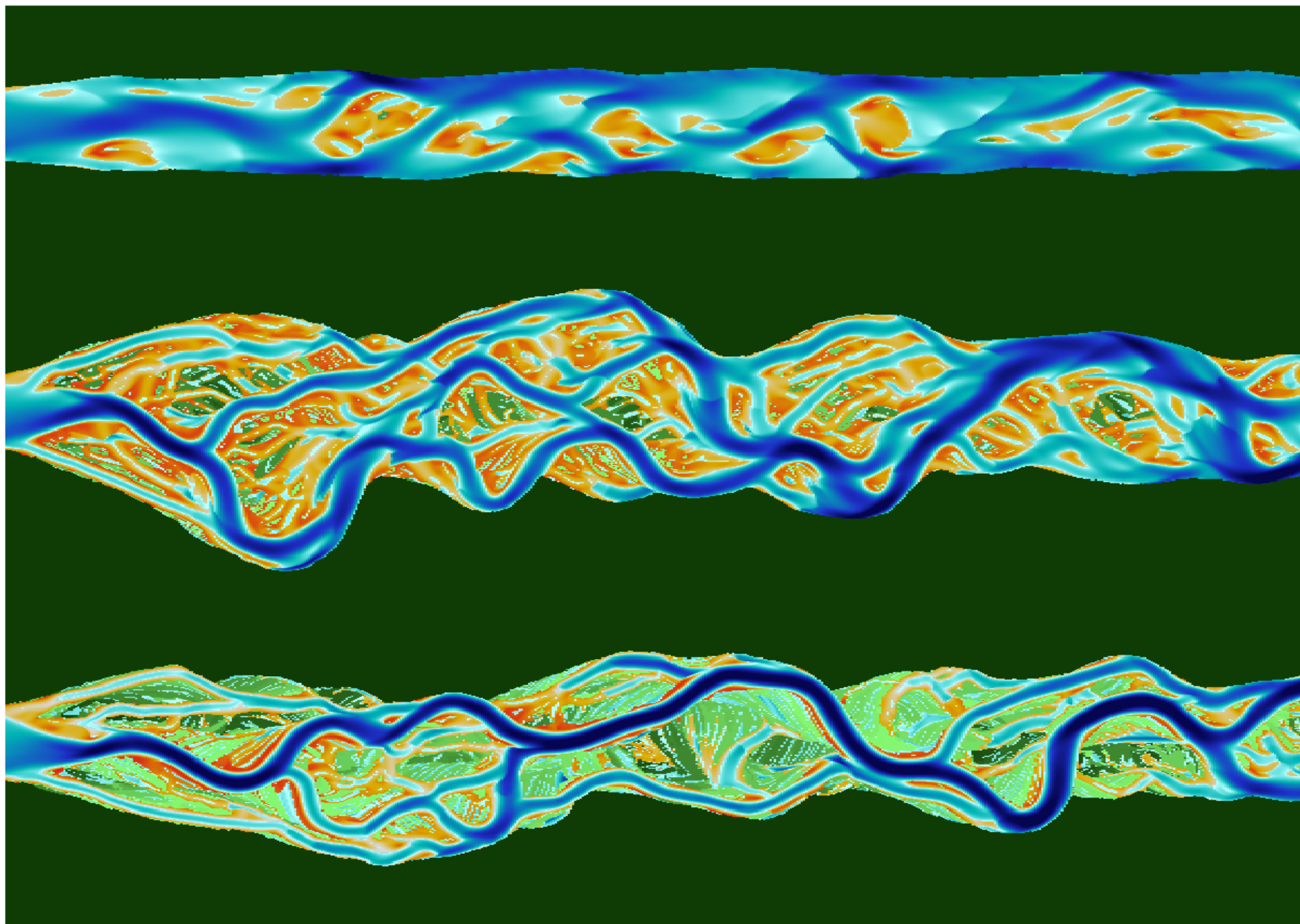


5 m

Depth: 0 m



20 m



Simulation Time: 236 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

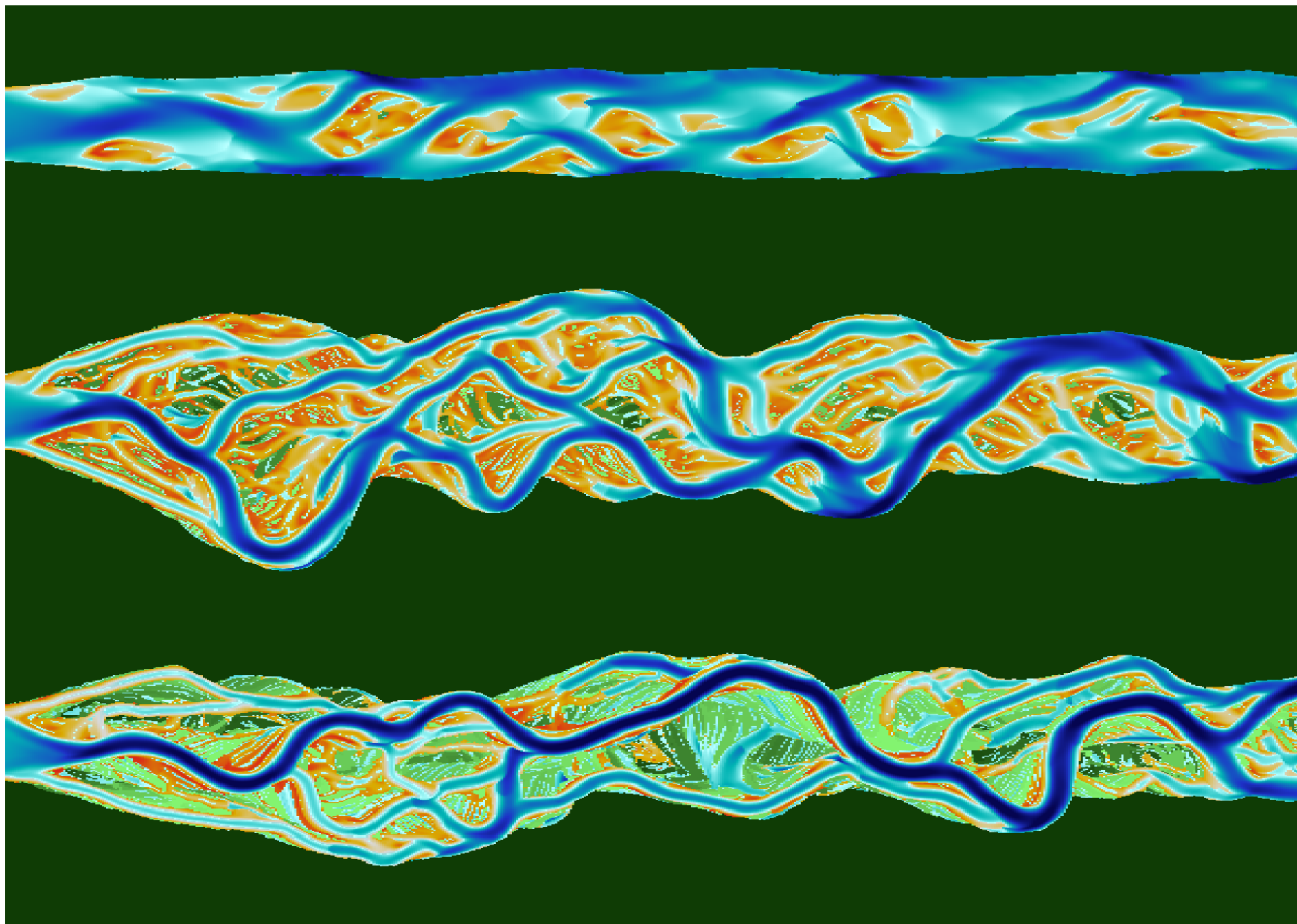


5 m

Depth: 0 m



20 m



Simulation Time: 238 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

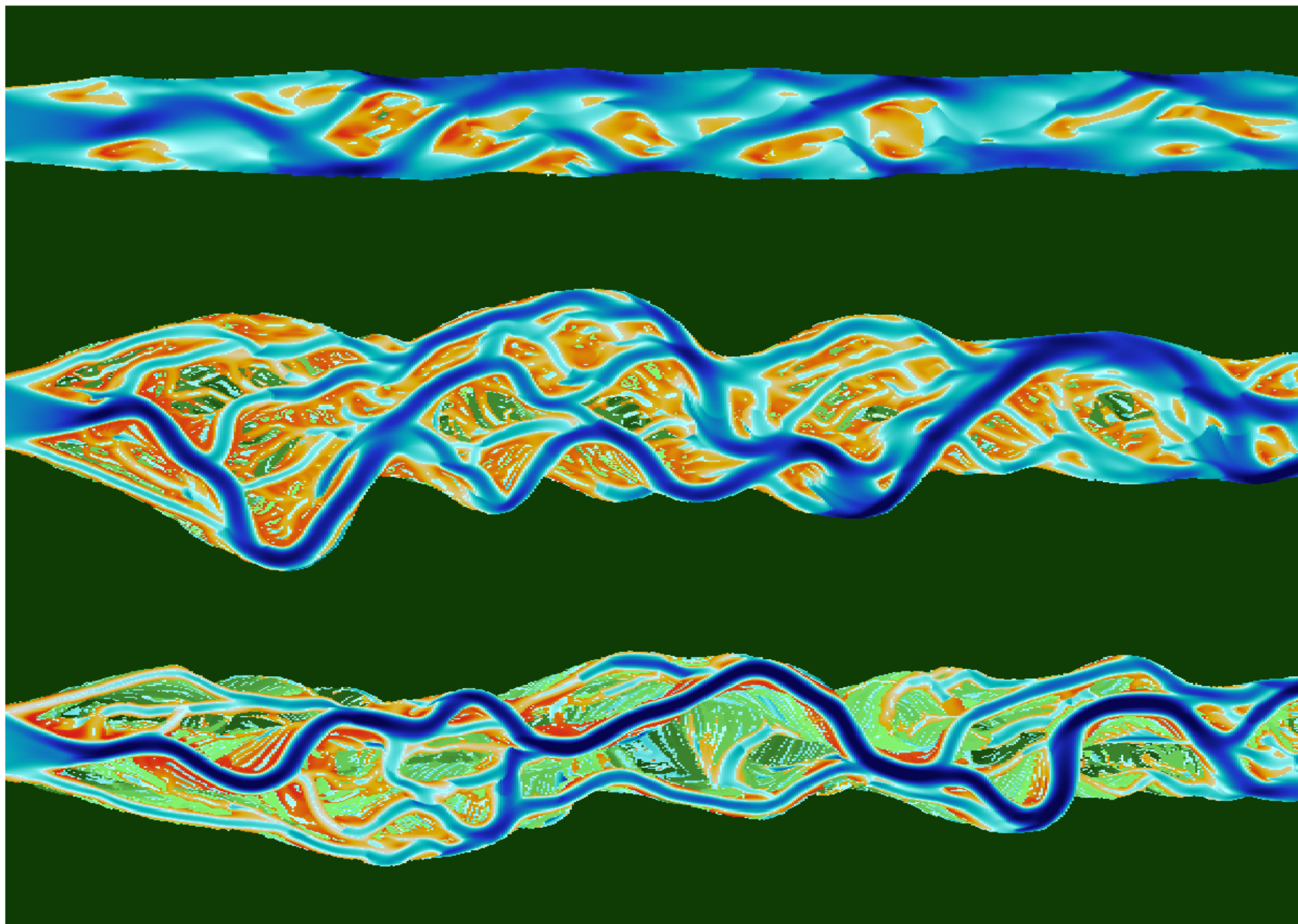


5 m

Depth: 0 m



20 m



Simulation Time: 240 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

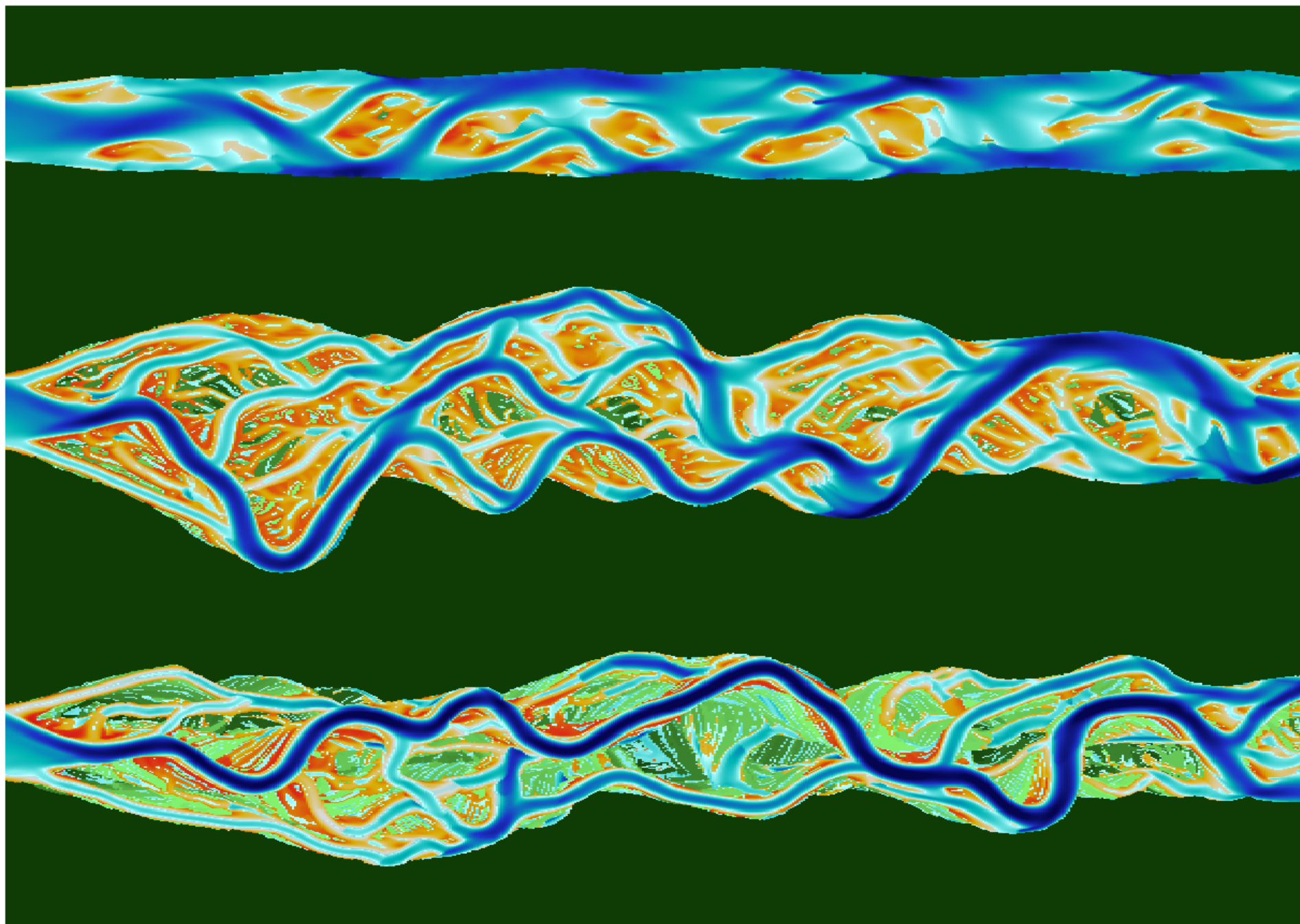


5 m

Depth: 0 m



20 m



Simulation Time: 242 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

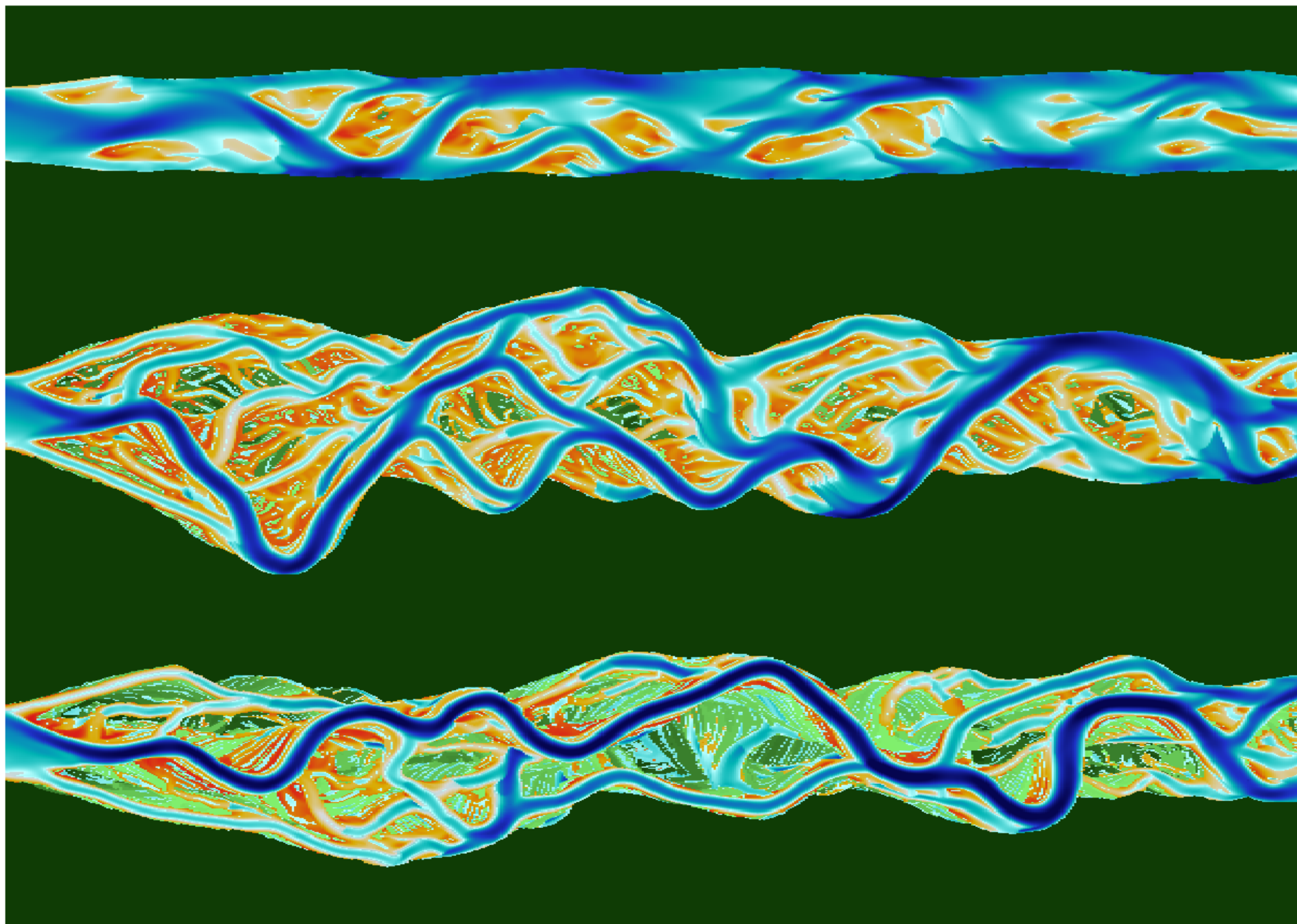


5 m

Depth: 0 m



20 m



Simulation Time: 244 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

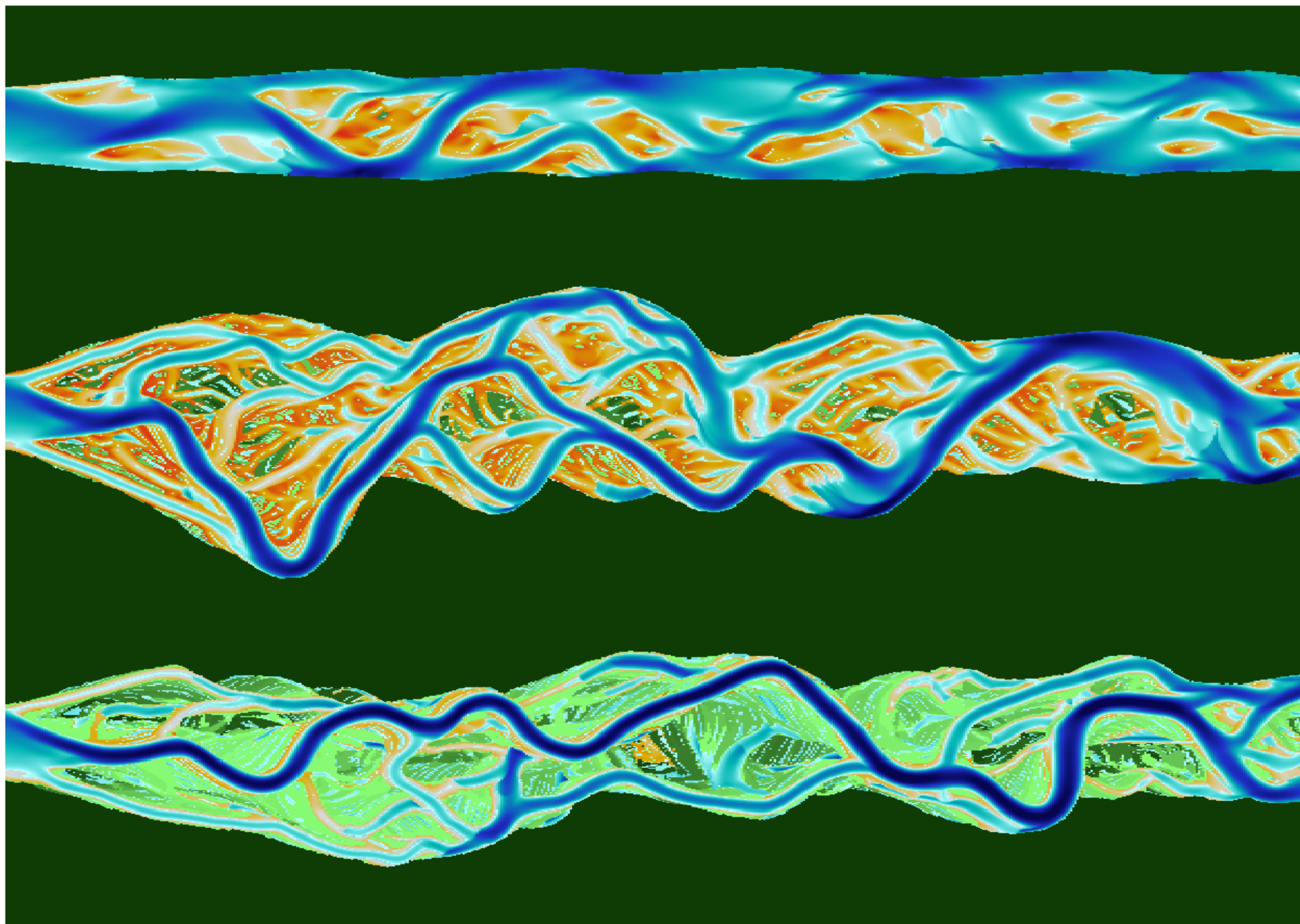


5 m

Depth: 0 m



20 m



Simulation Time: 246 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

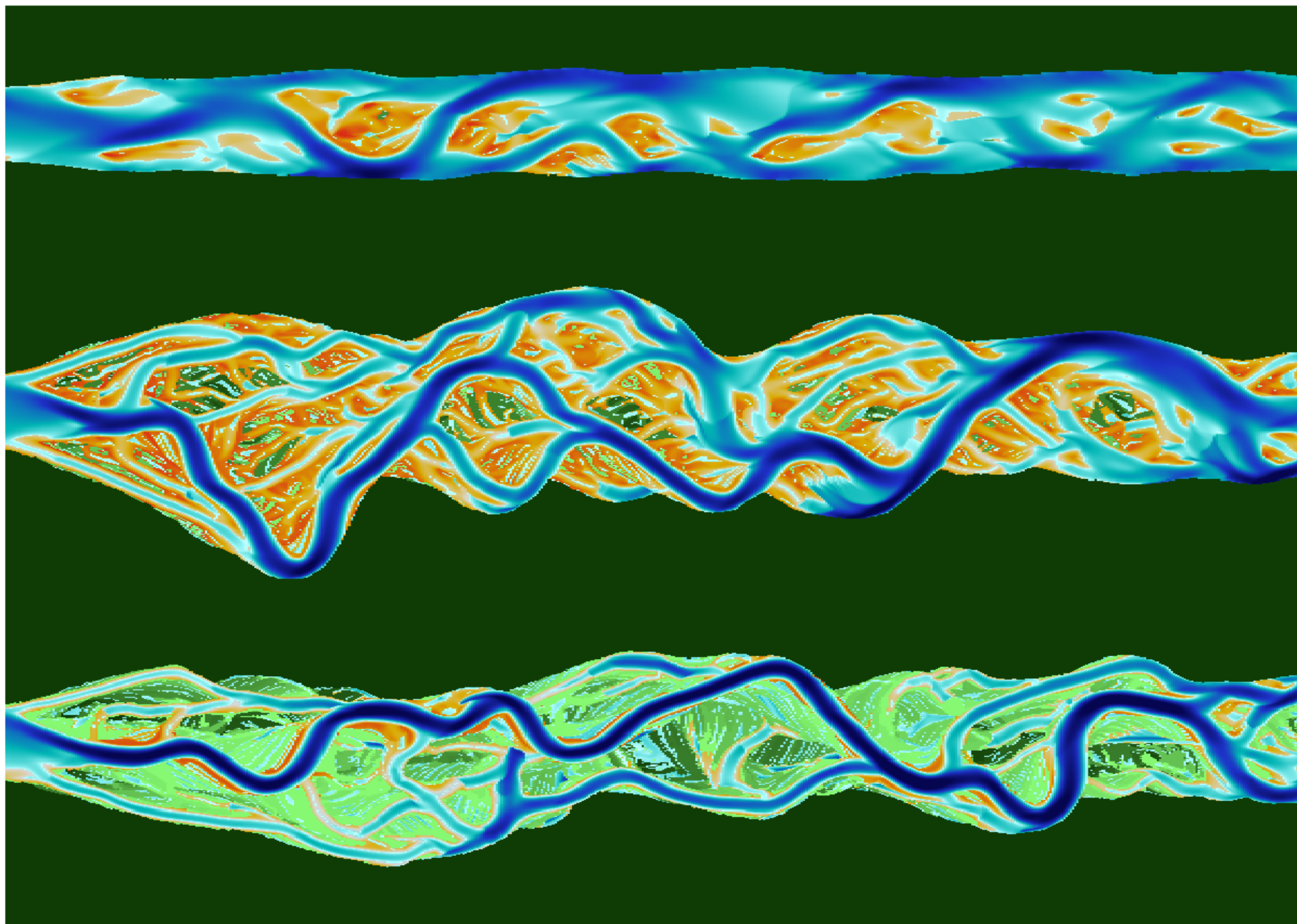


5 m

Depth: 0 m



20 m



Simulation Time: 248 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

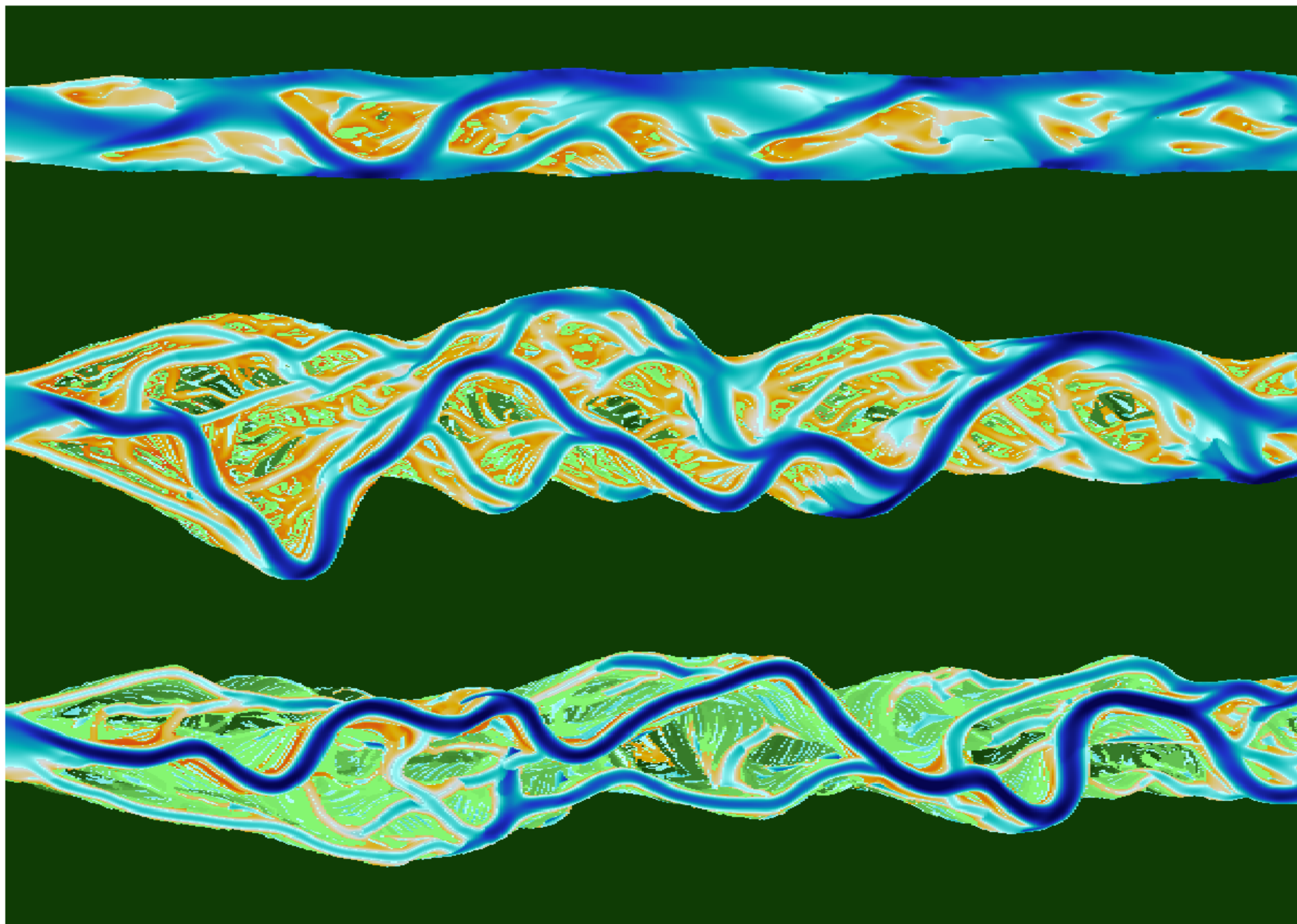


5 m

Depth: 0 m



20 m



Simulation Time: 250 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

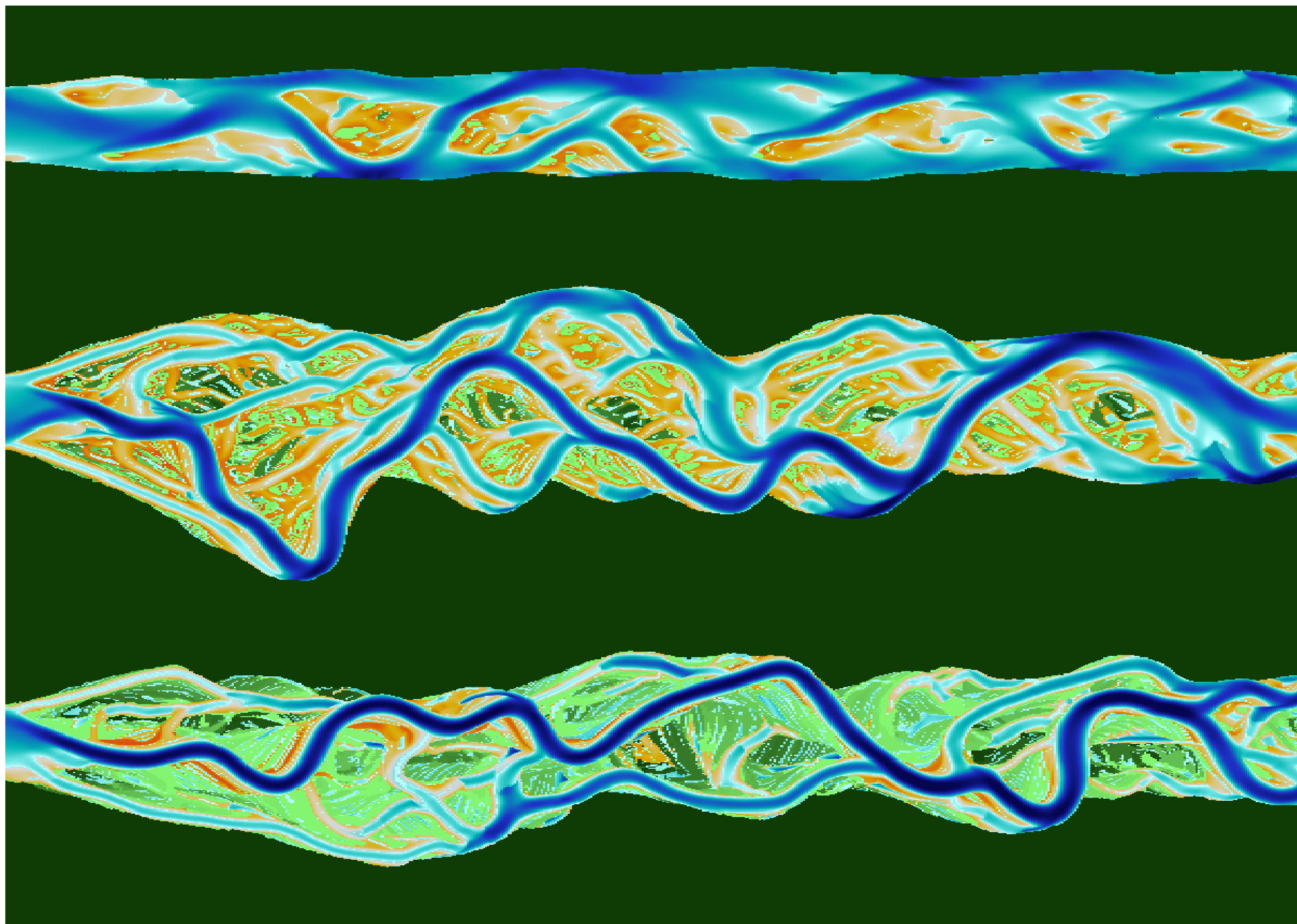


5 m

Depth: 0 m



20 m



Simulation Time: 252 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

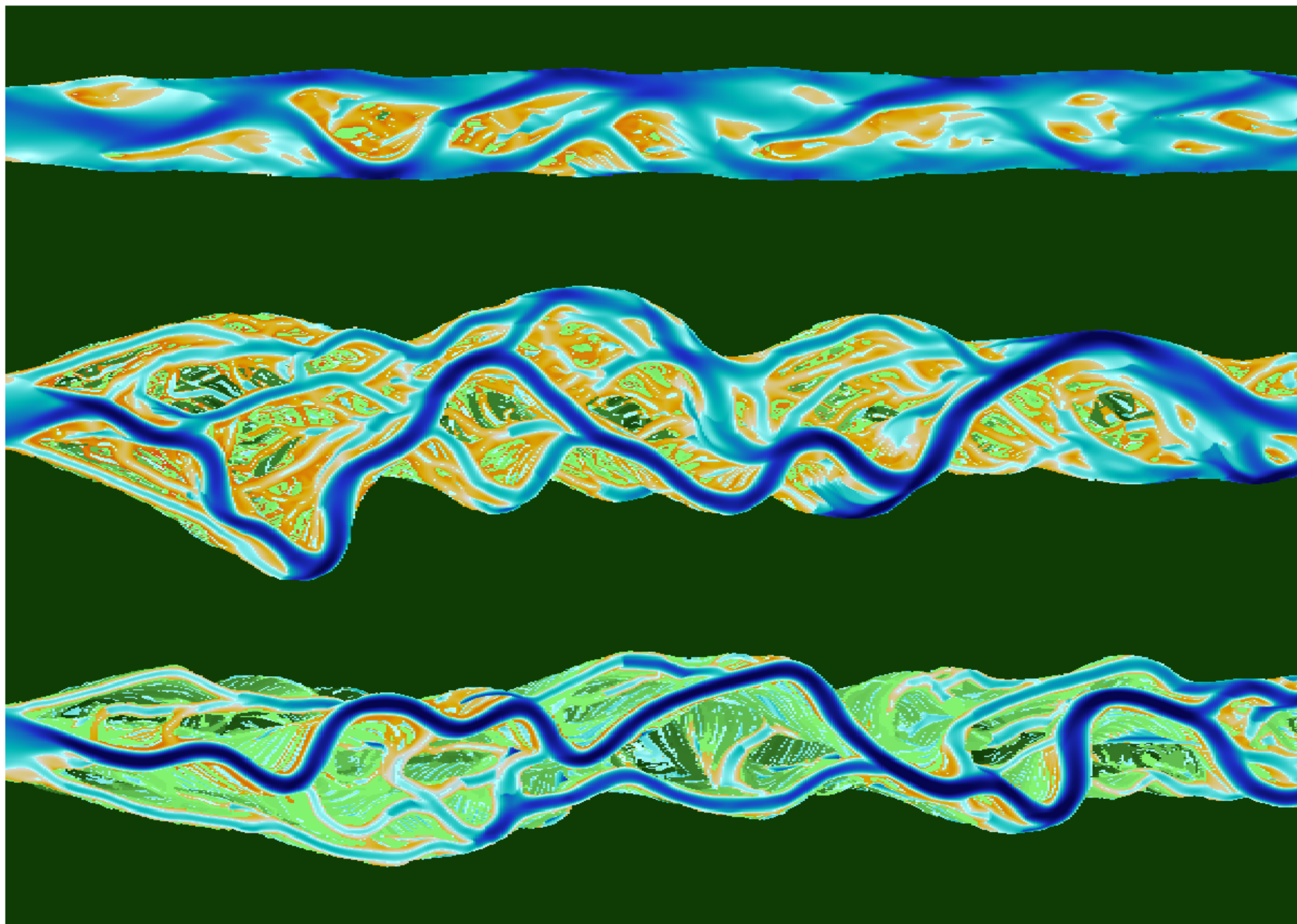


5 m

Depth: 0 m



20 m



Simulation Time: 254 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

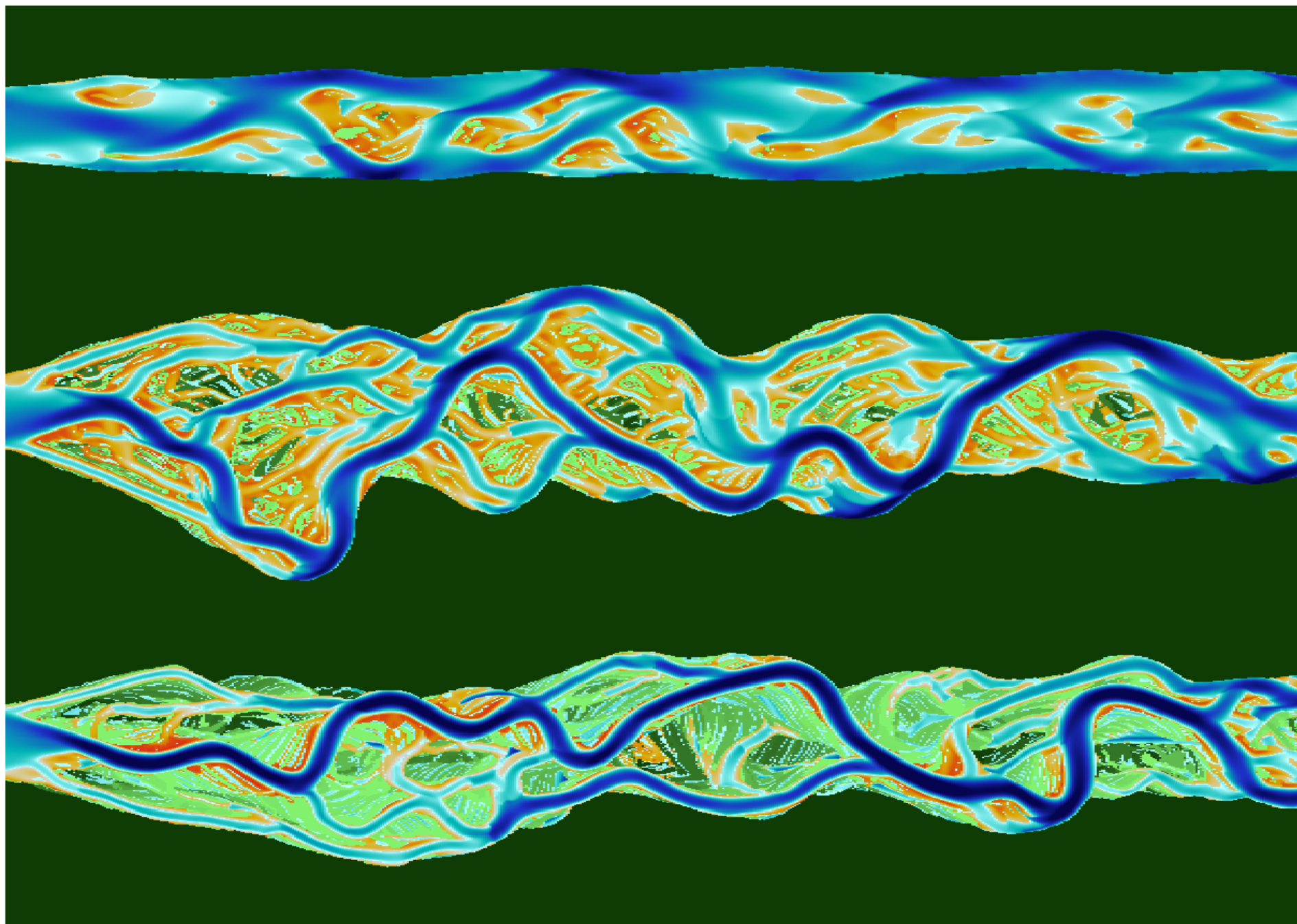


5 m

Depth: 0 m



20 m



Simulation Time: 256 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

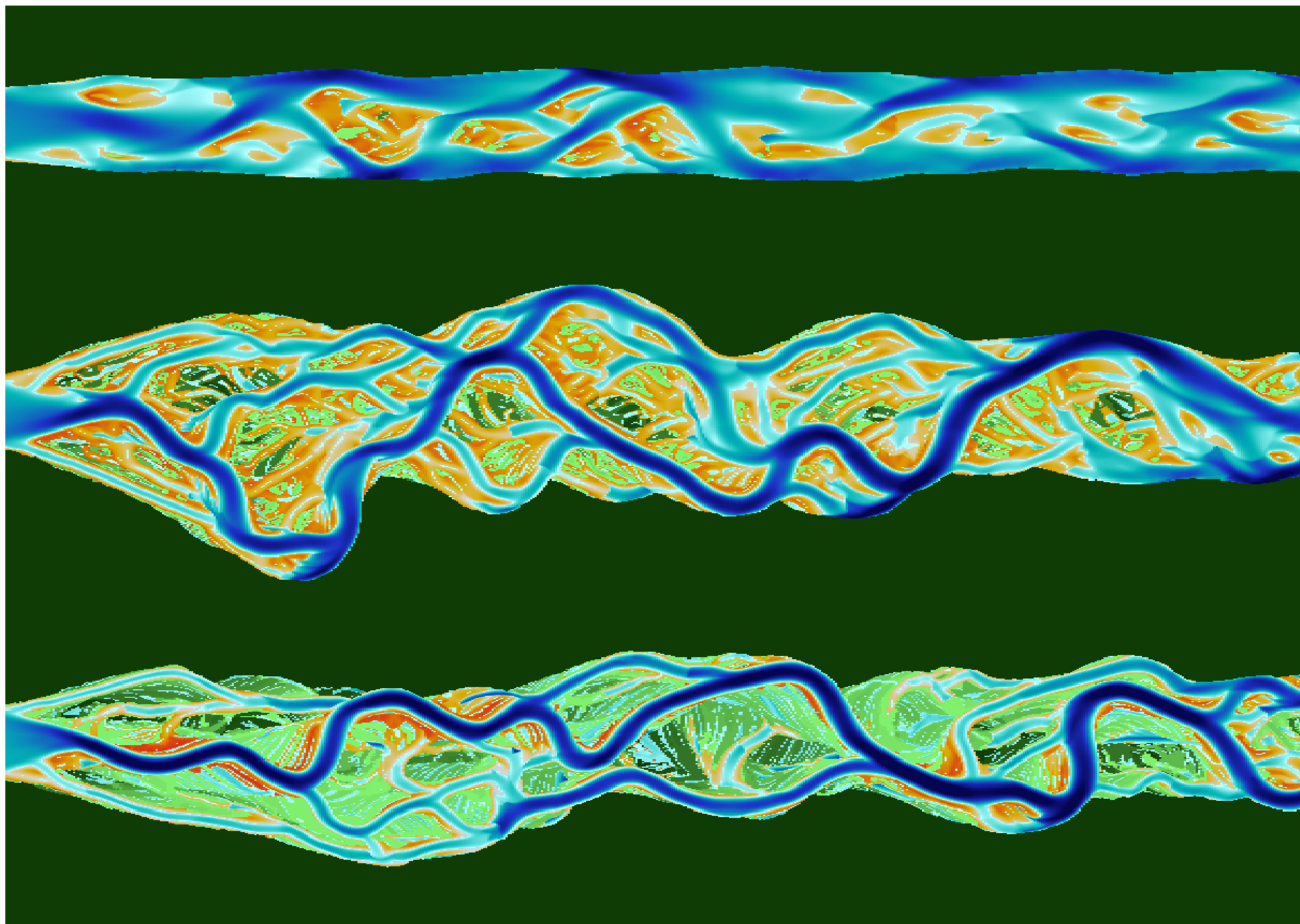


5 m

Depth: 0 m



20 m



Simulation Time: 258 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

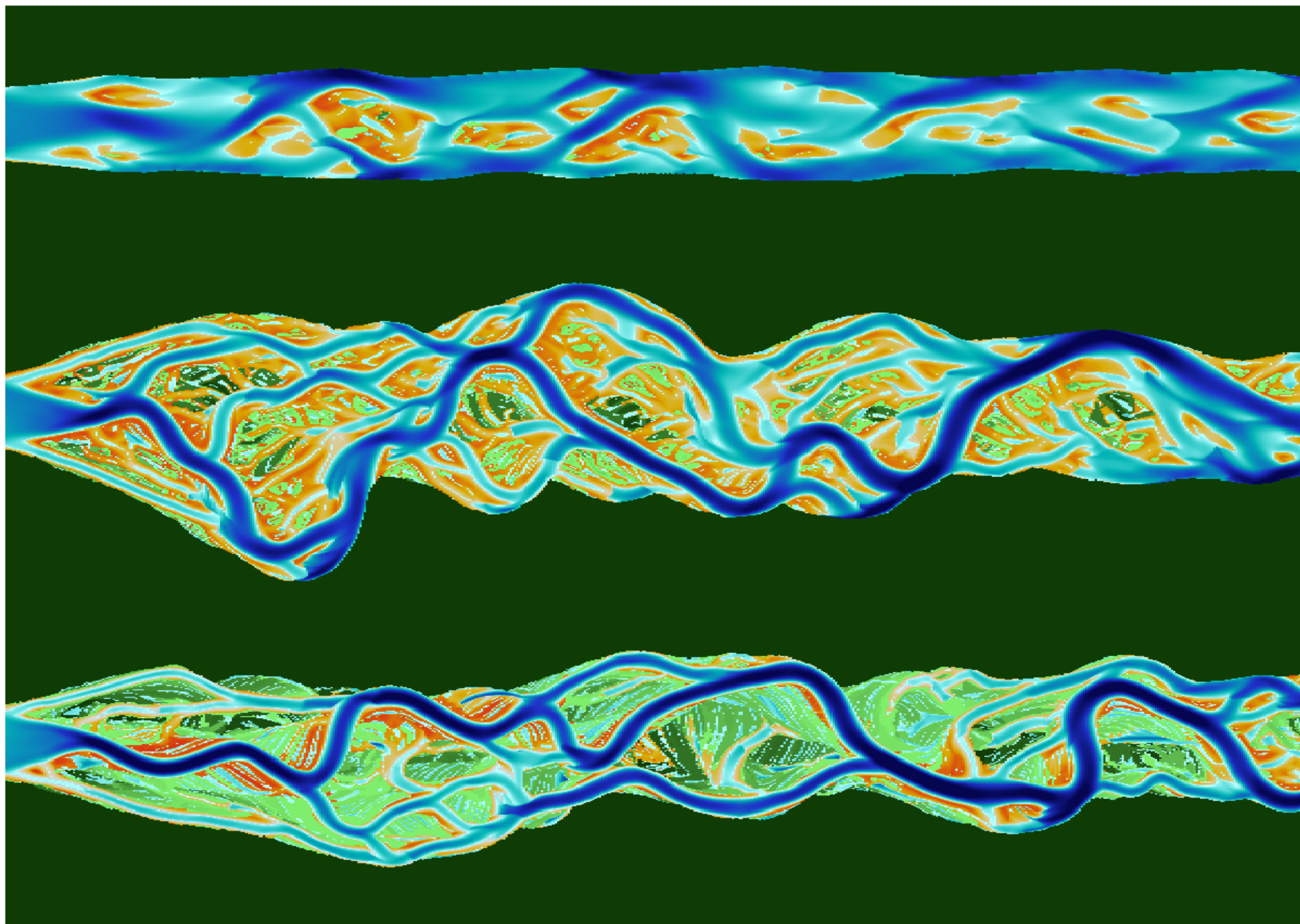


5 m

Depth: 0 m



20 m



Simulation Time: 260 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

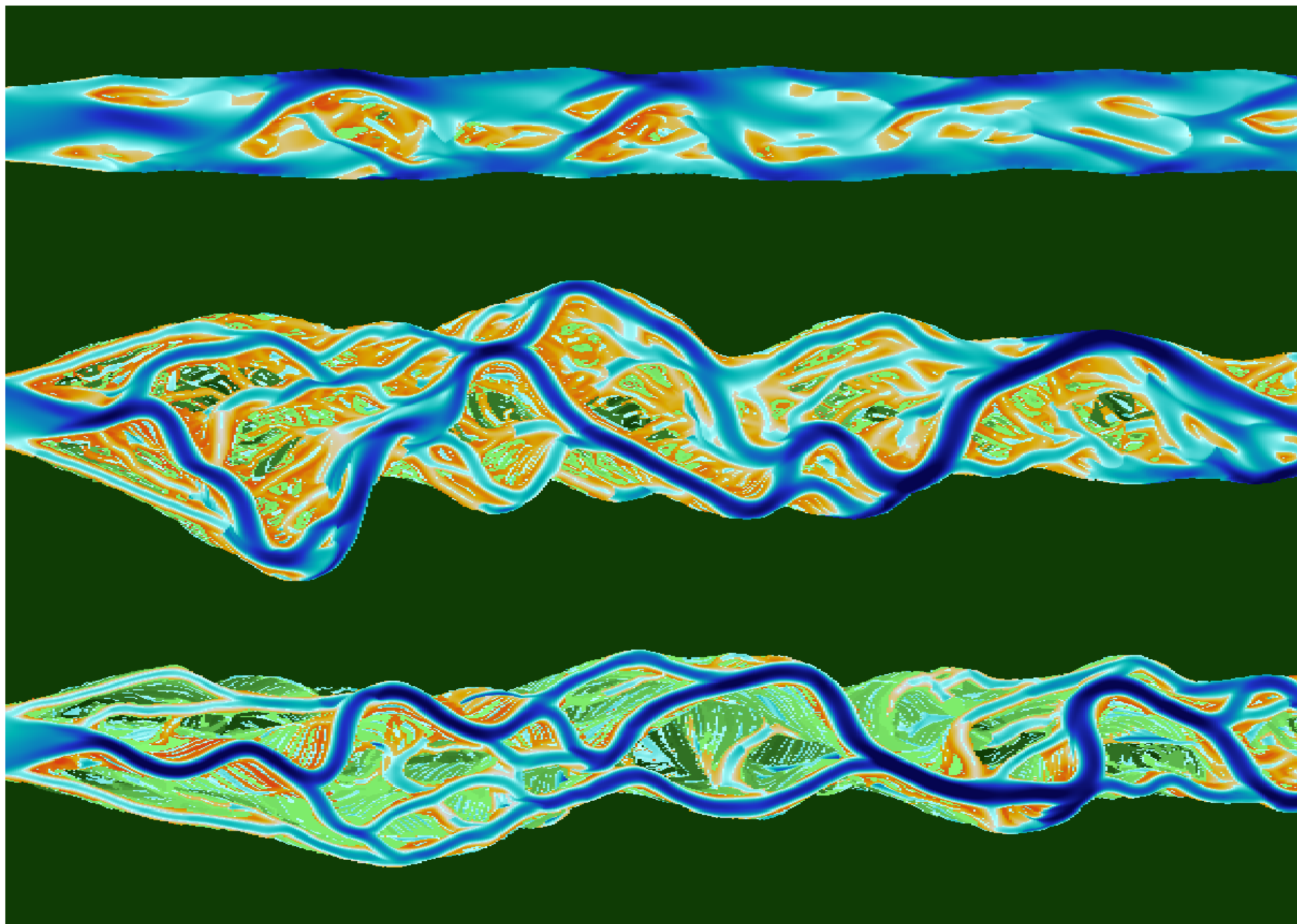


5 m

Depth: 0 m



20 m



Simulation Time: 262 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

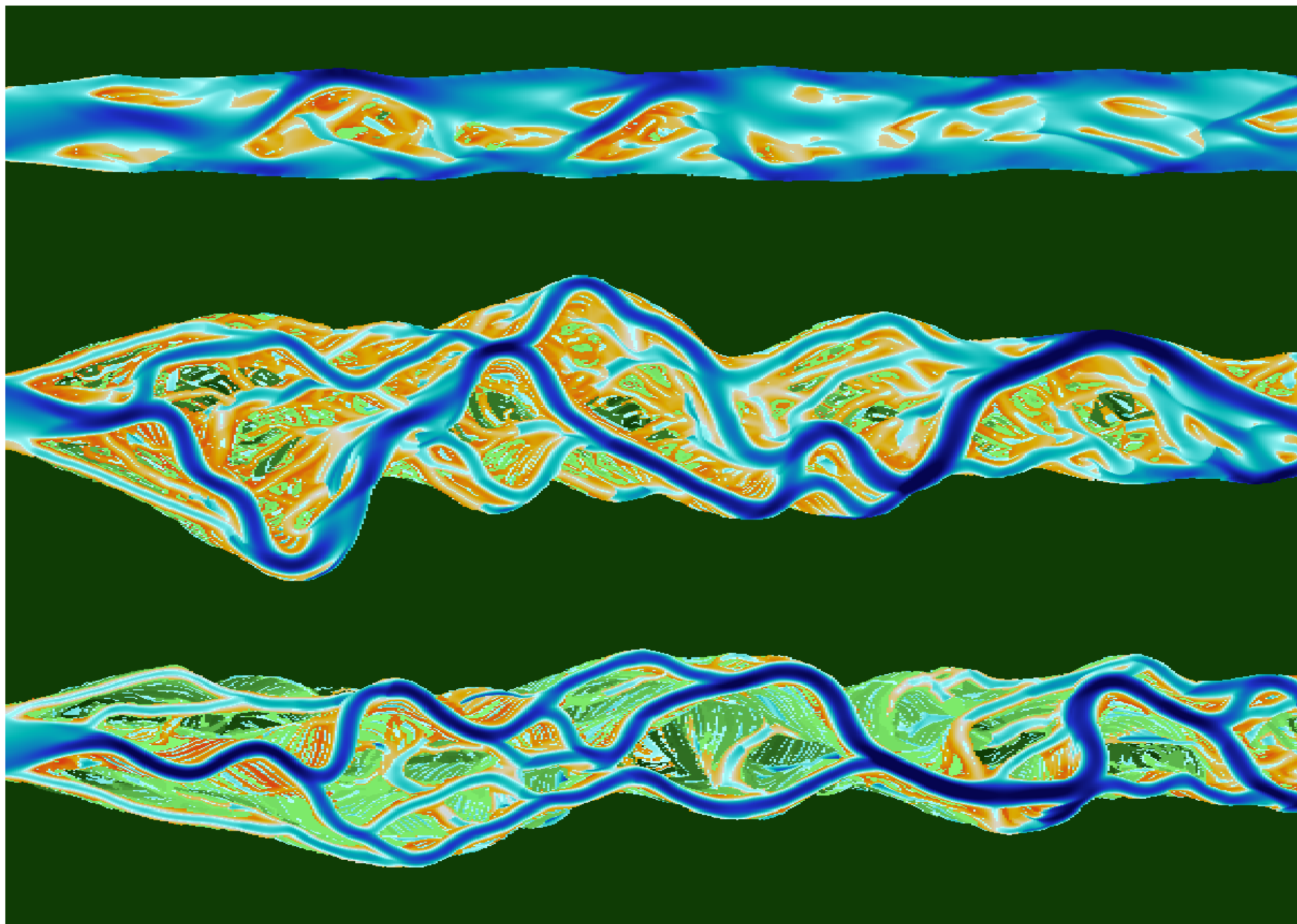


5 m

Depth: 0 m



20 m



Simulation Time: 264 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

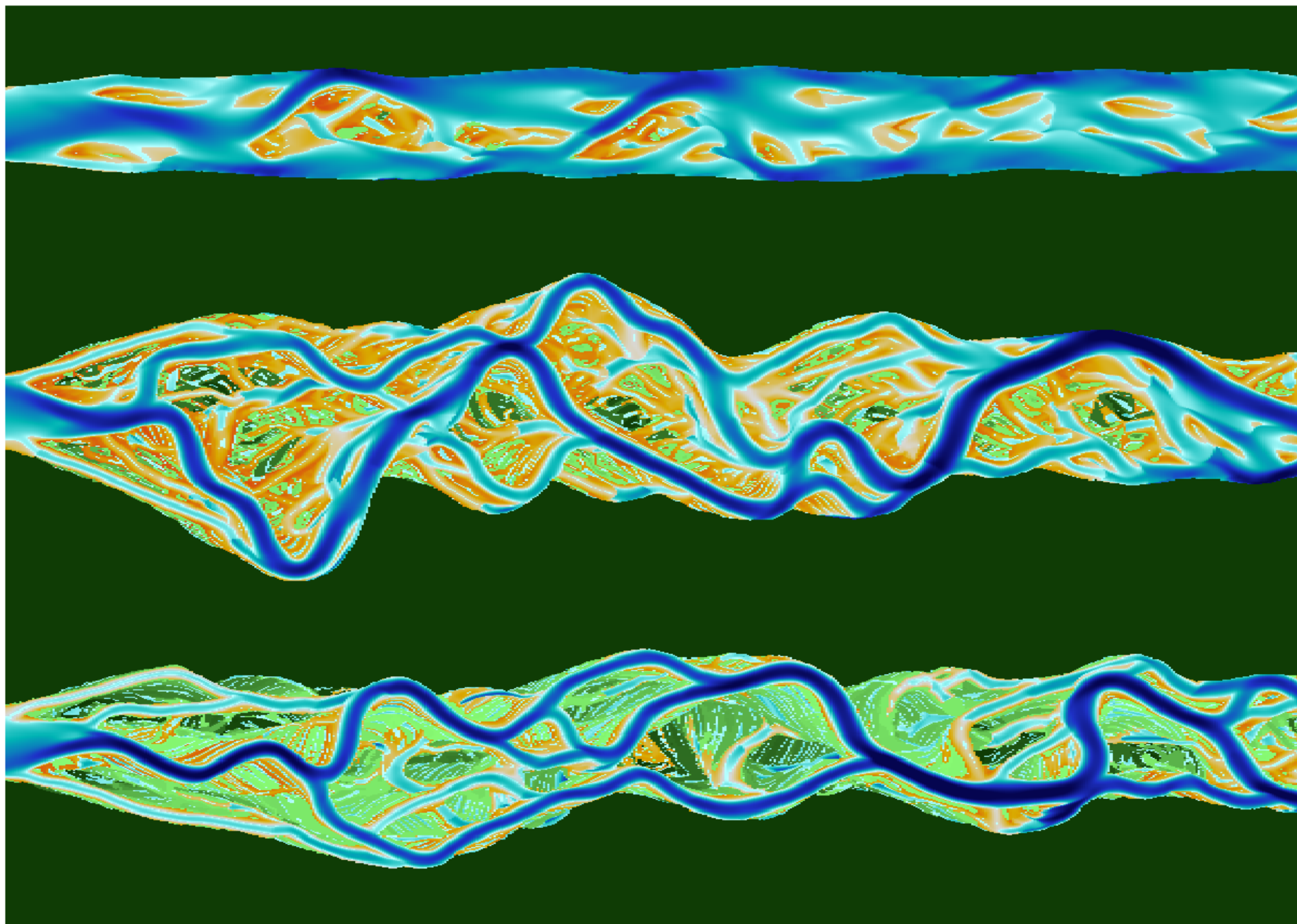


5 m

Depth: 0 m



20 m



Simulation Time: 266 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

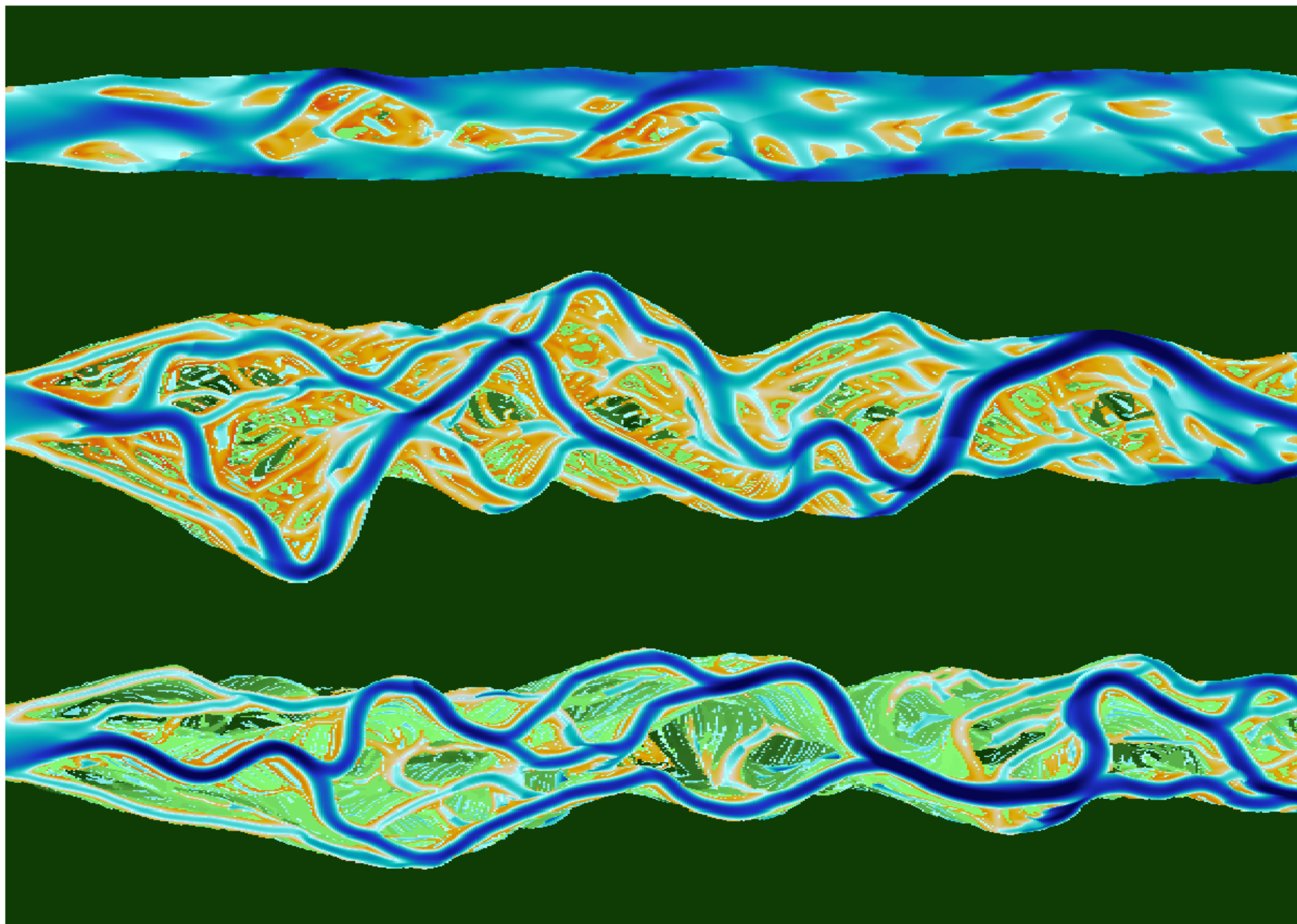


5 m

Depth: 0 m



20 m



Simulation Time: 268 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

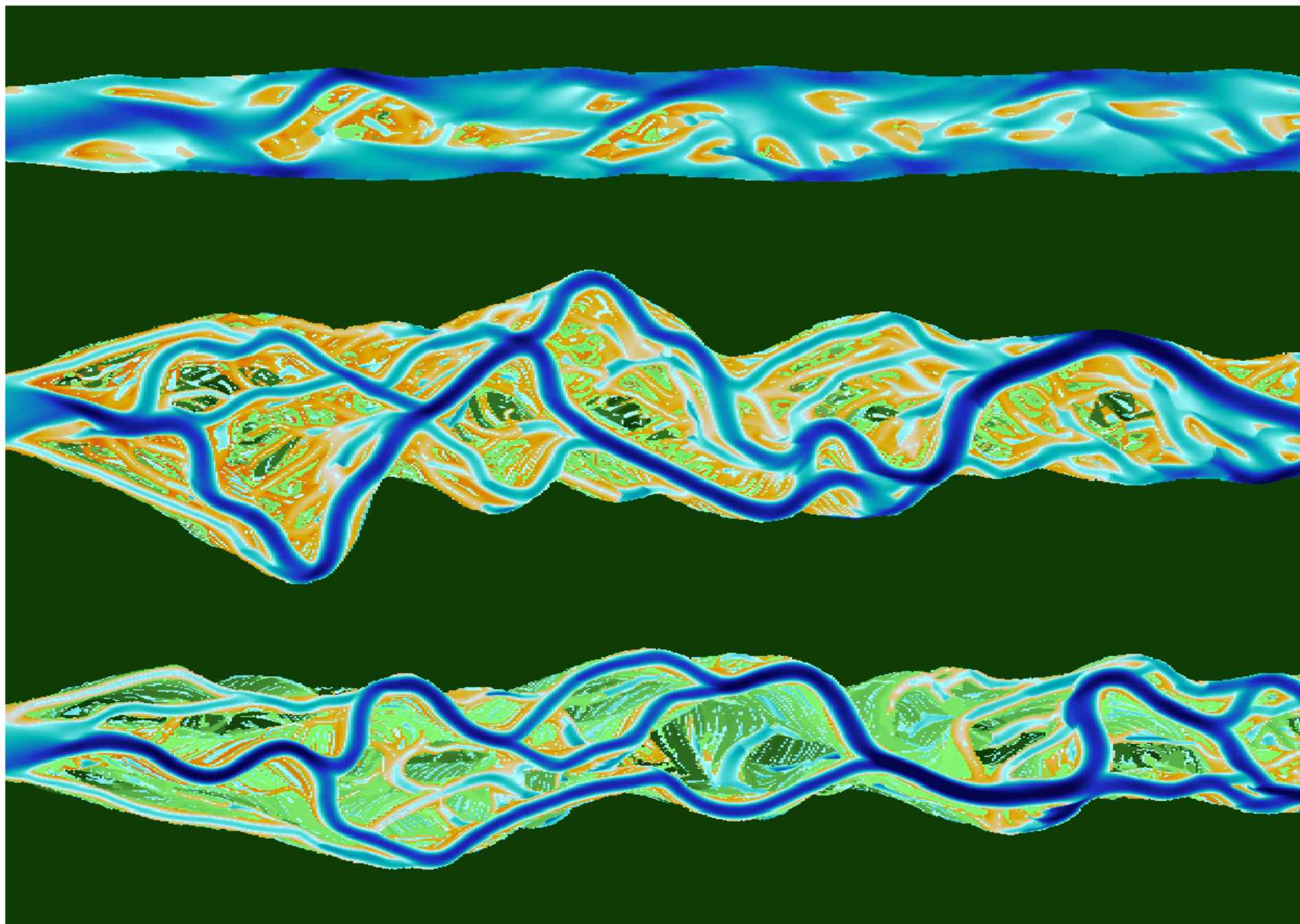


5 m

Depth: 0 m



20 m



Simulation Time: 270 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

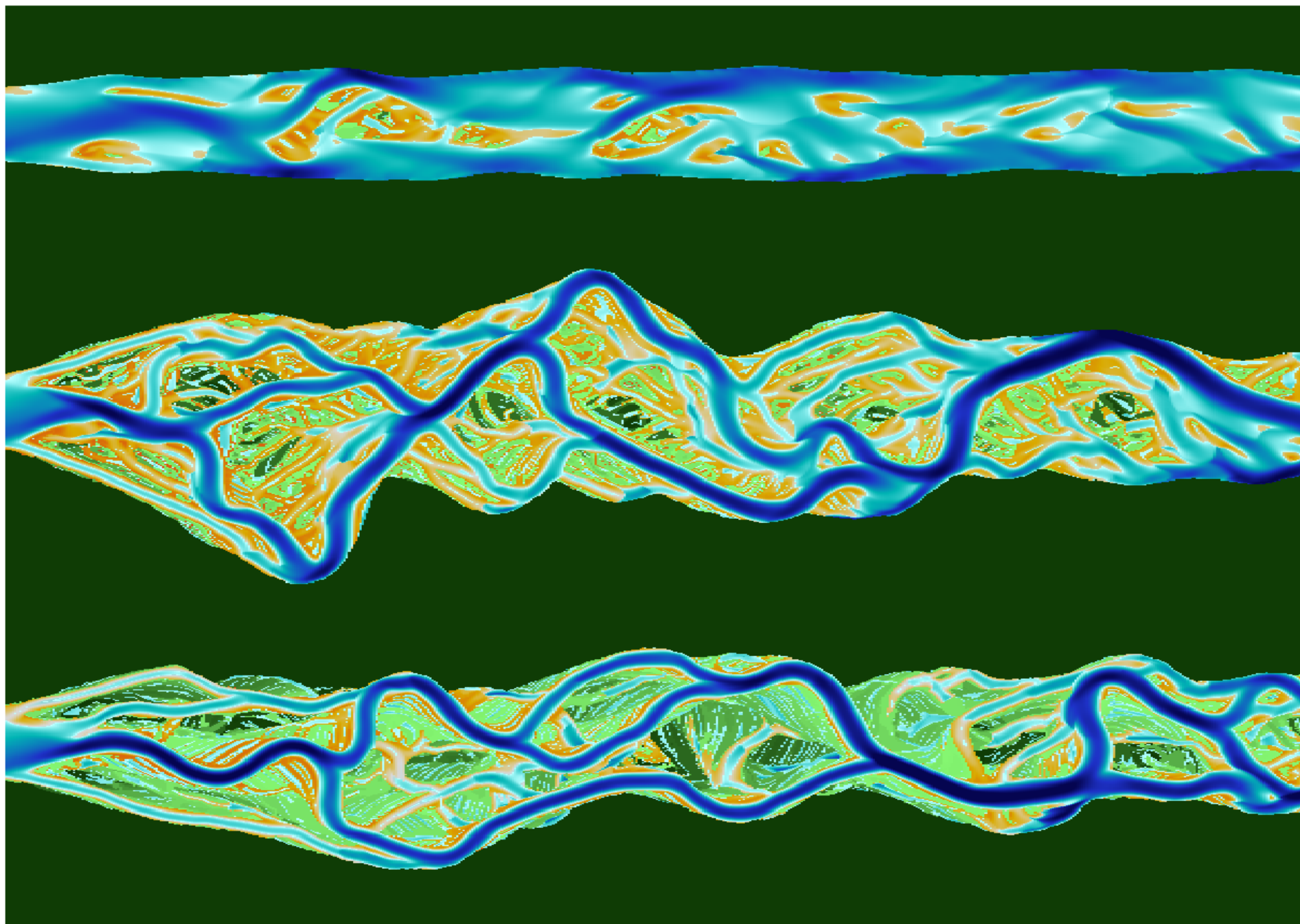


5 m

Depth: 0 m



20 m



Simulation Time: 272 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

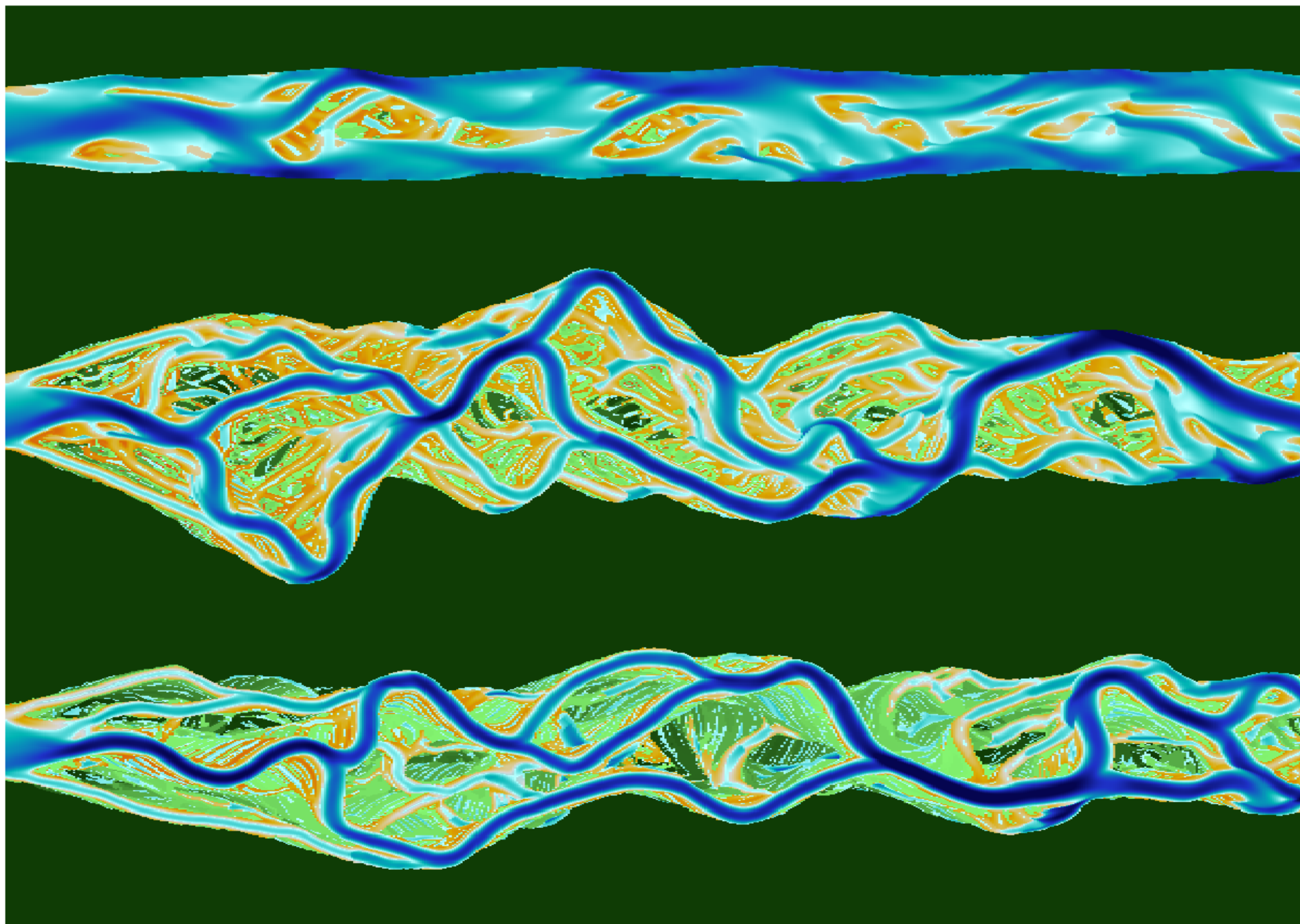


5 m

Depth: 0 m



20 m



Simulation Time: 274 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

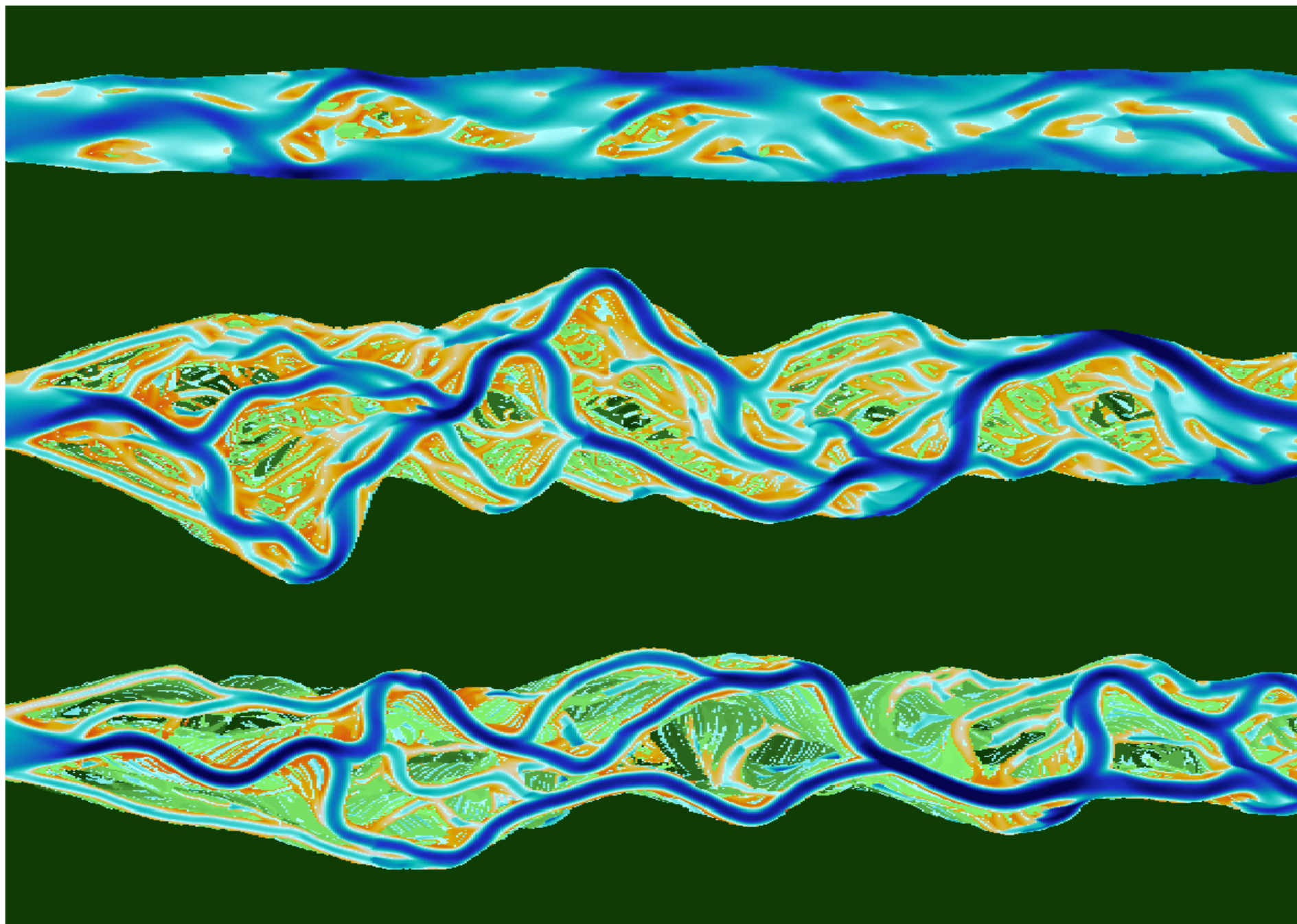


5 m

Depth: 0 m



20 m



Simulation Time: 276 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

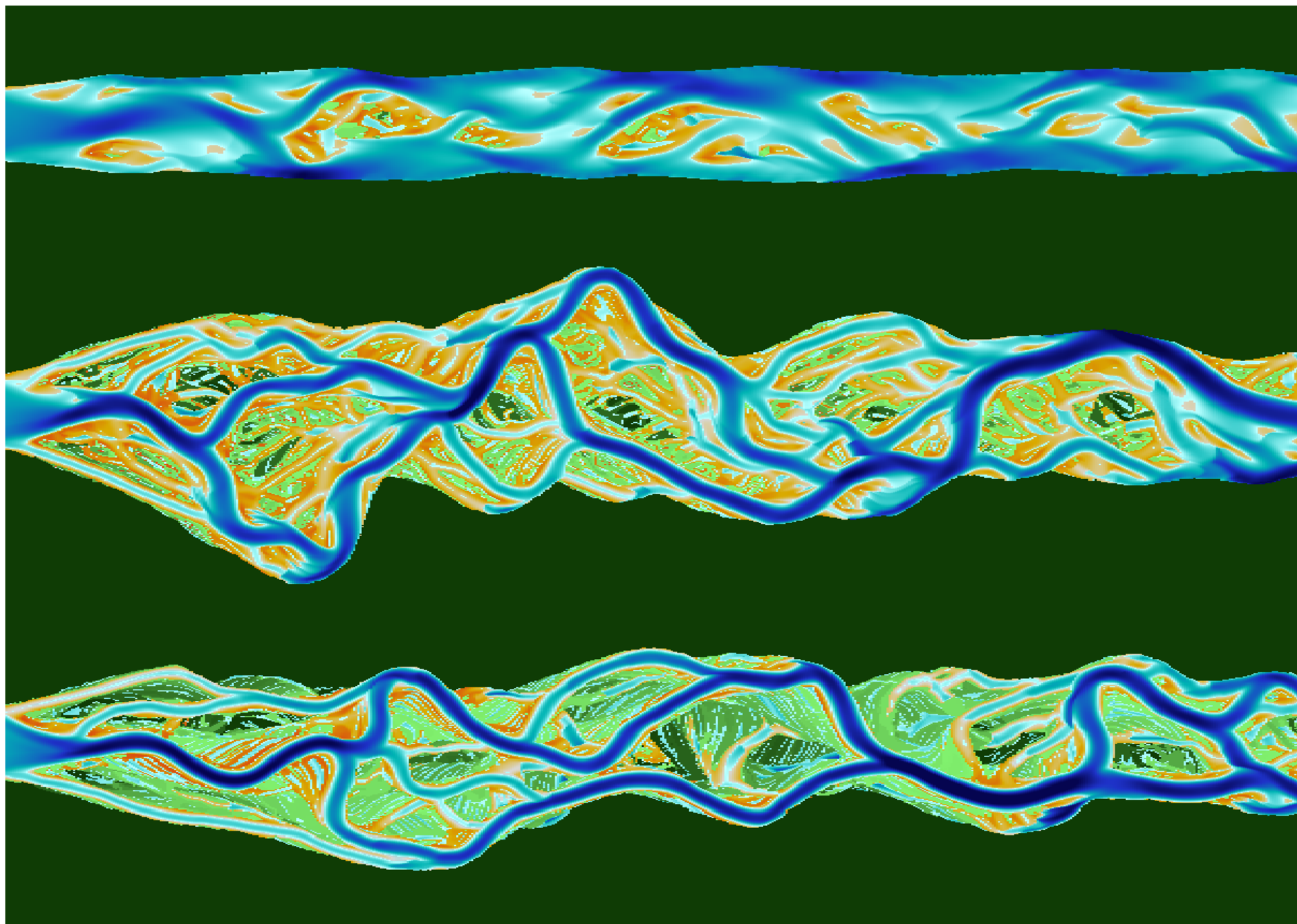


5 m

Depth: 0 m



20 m



Simulation Time: 278 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

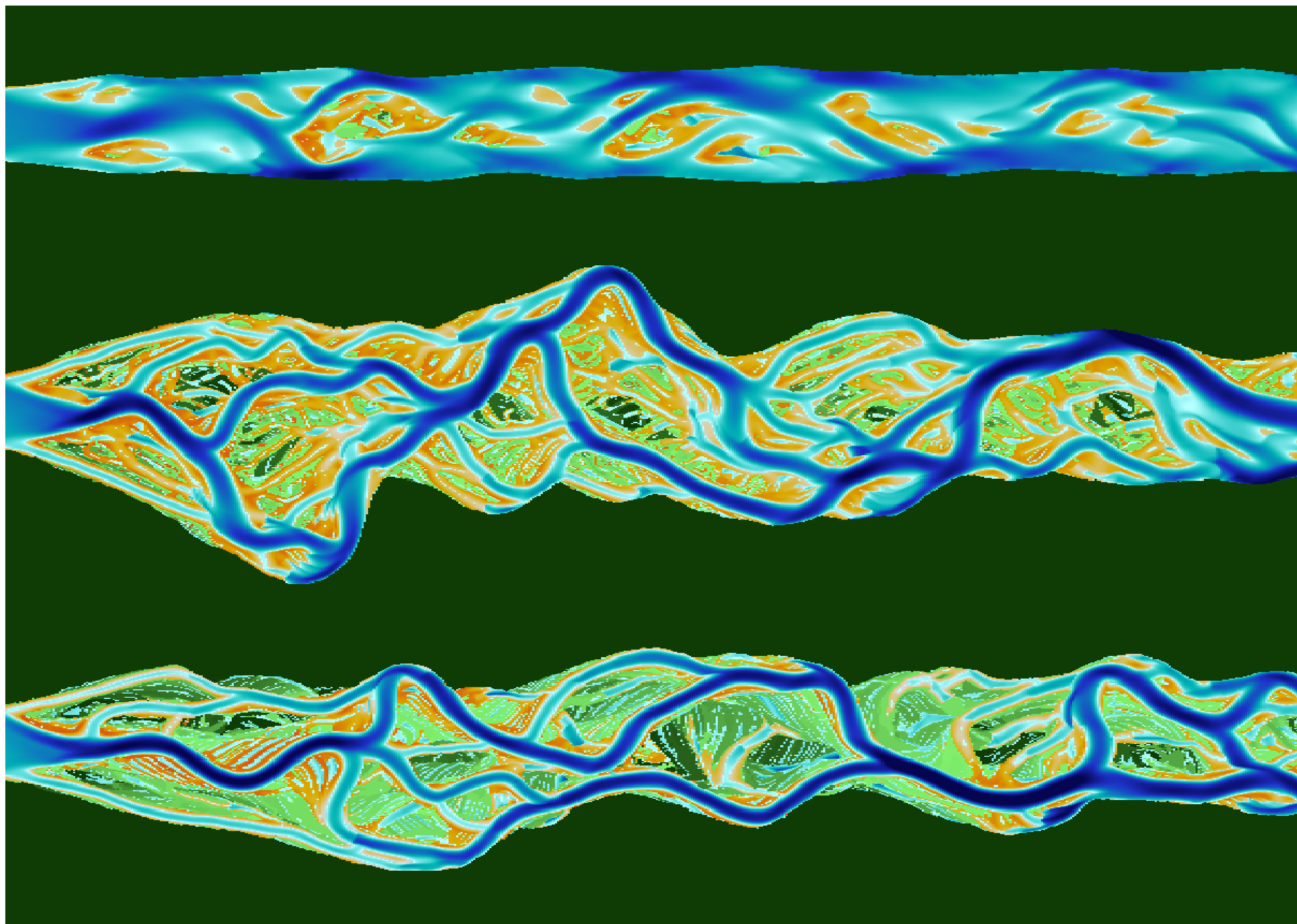


5 m

Depth: 0 m



20 m



Simulation Time: 280 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

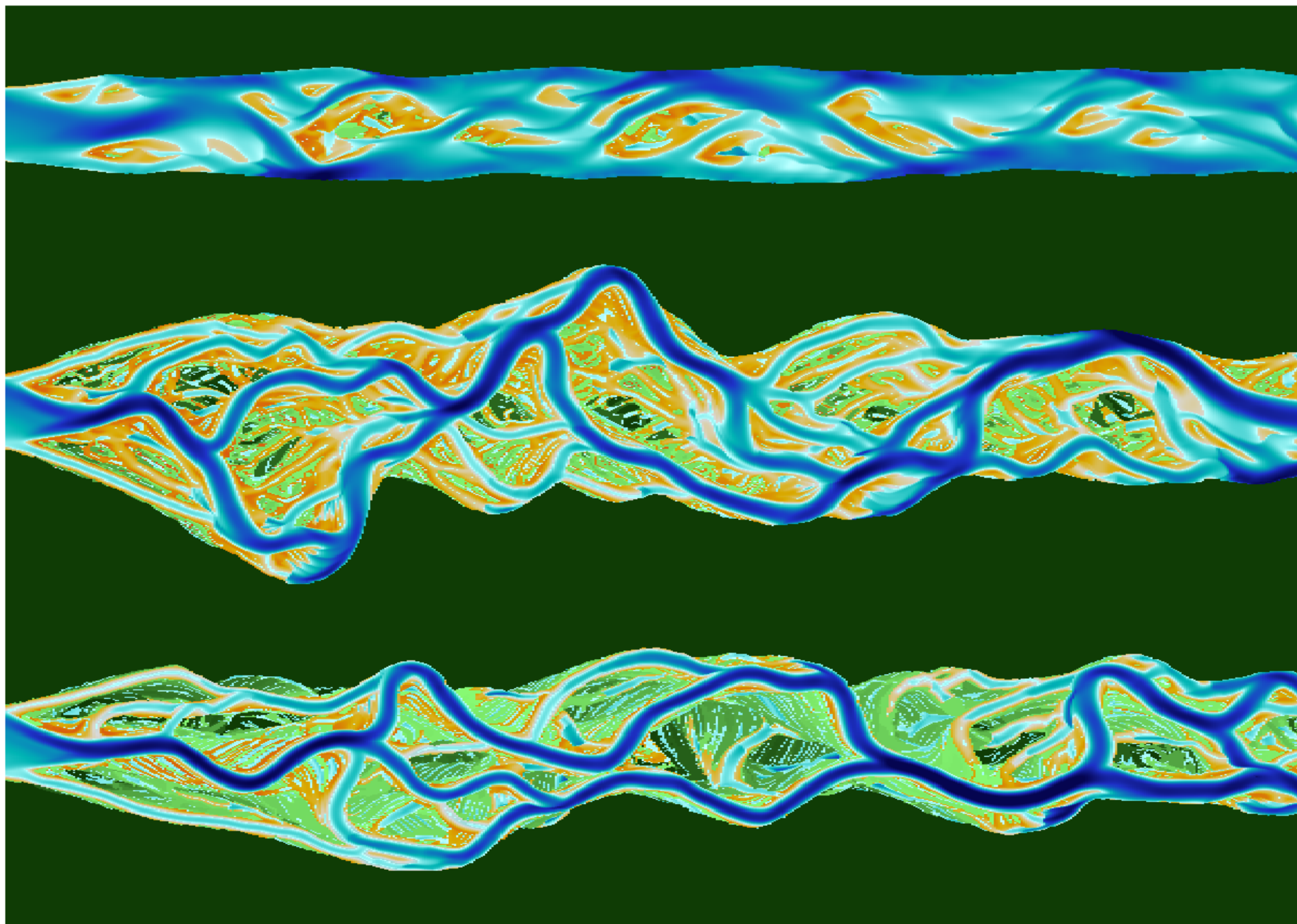


5 m

Depth: 0 m



20 m



Simulation Time: 282 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

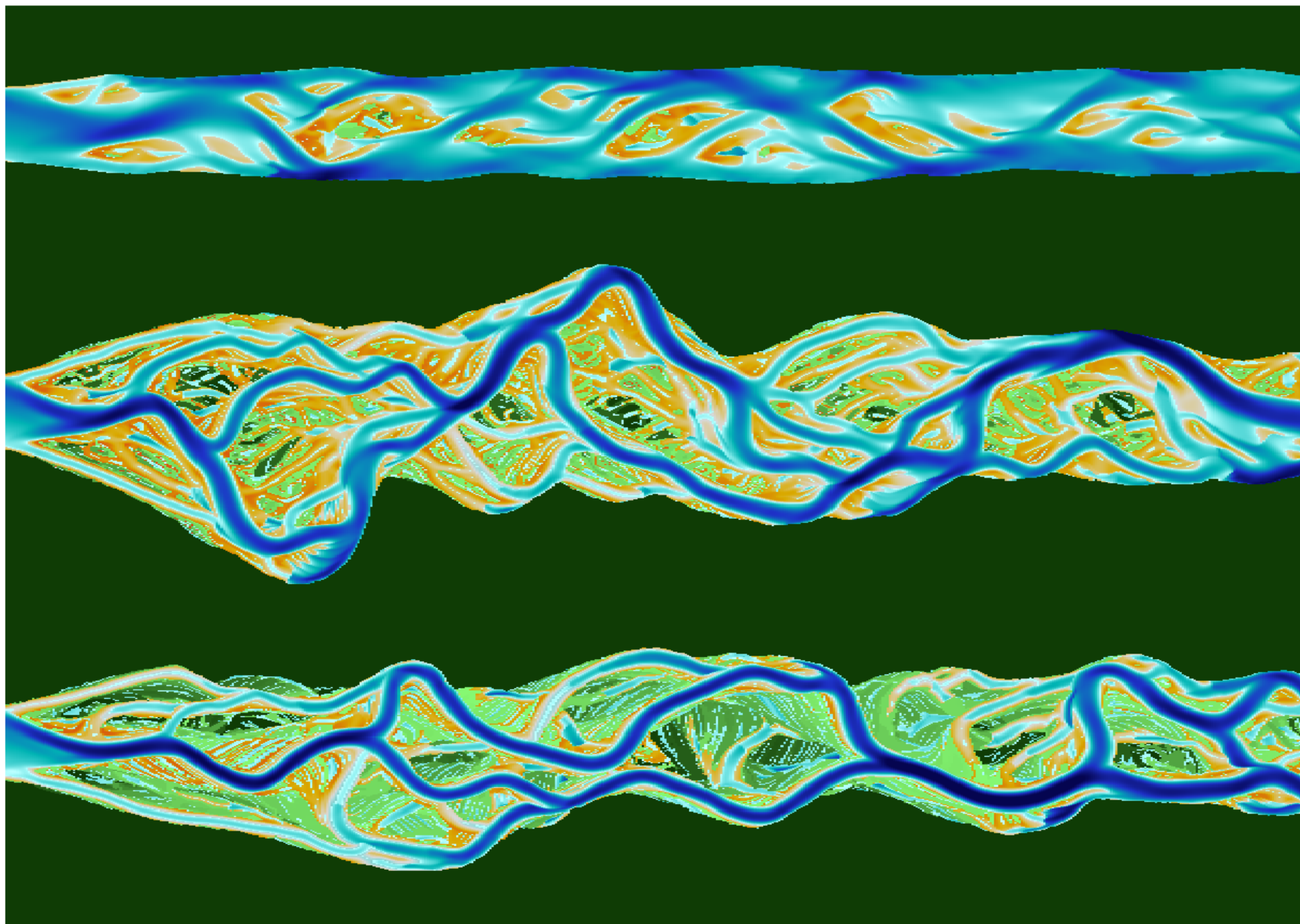


5 m

Depth: 0 m



20 m



Simulation Time: 284 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

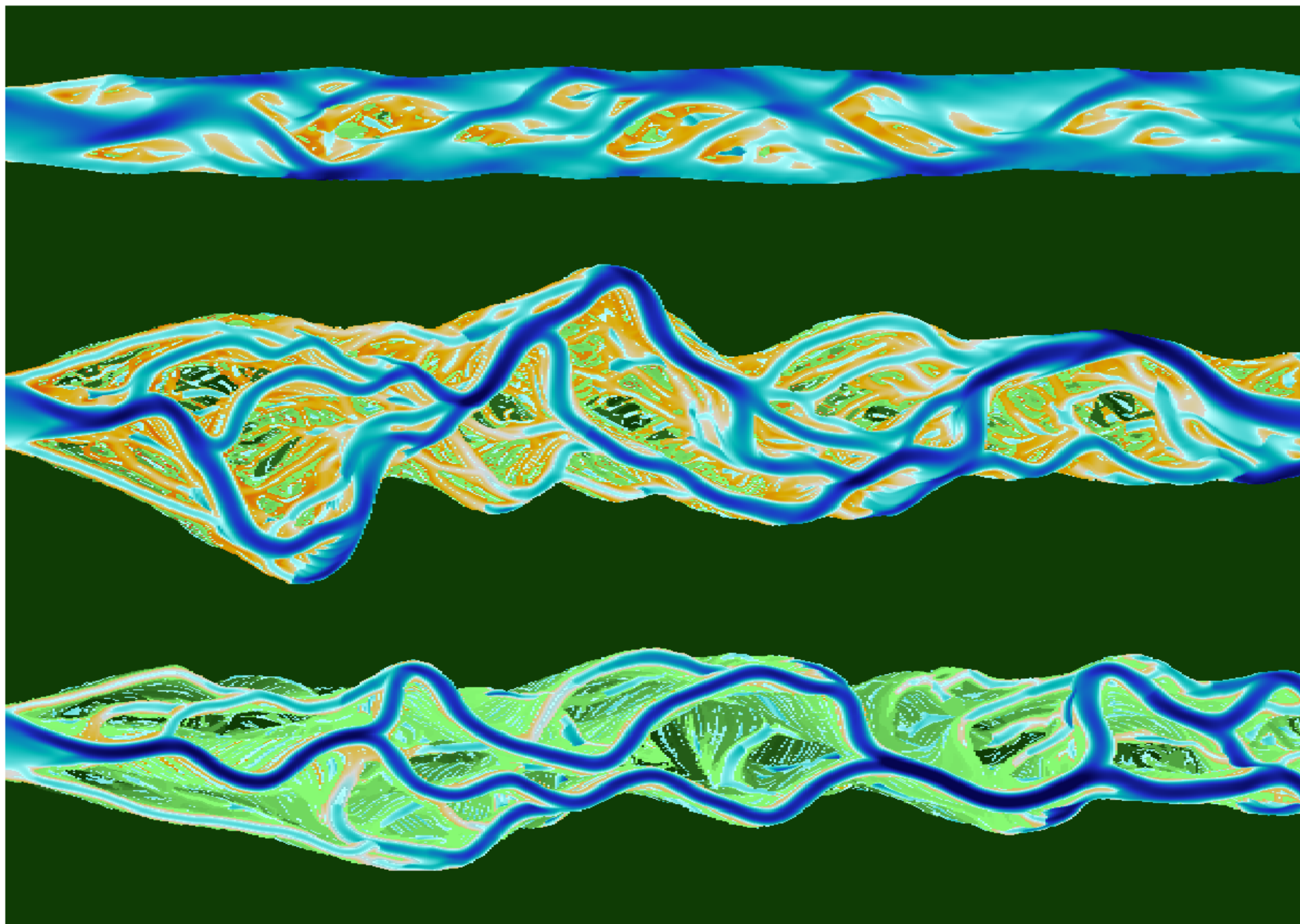


5 m

Depth: 0 m



20 m



Simulation Time: 286 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

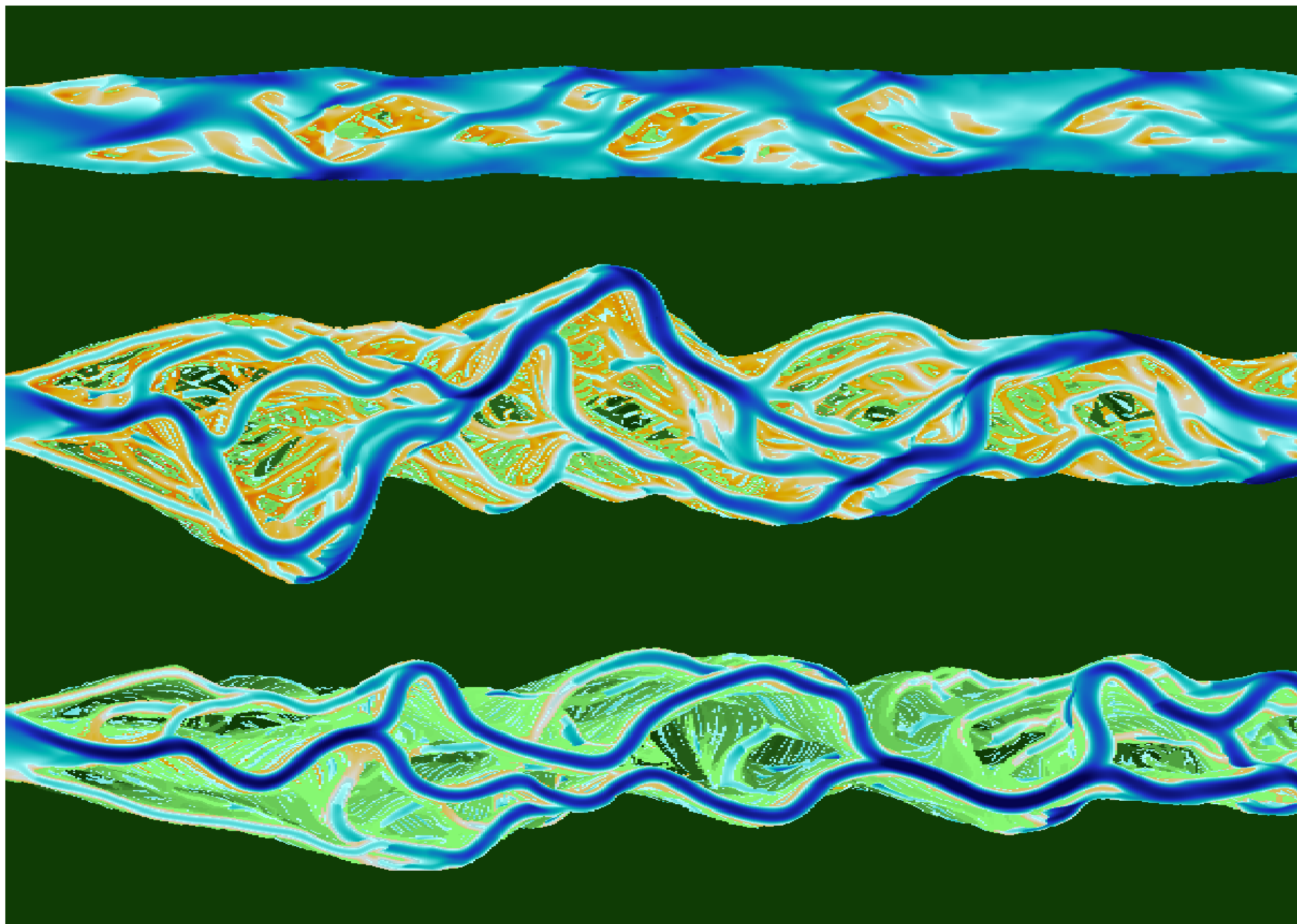


5 m

Depth: 0 m



20 m



Simulation Time: 288 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

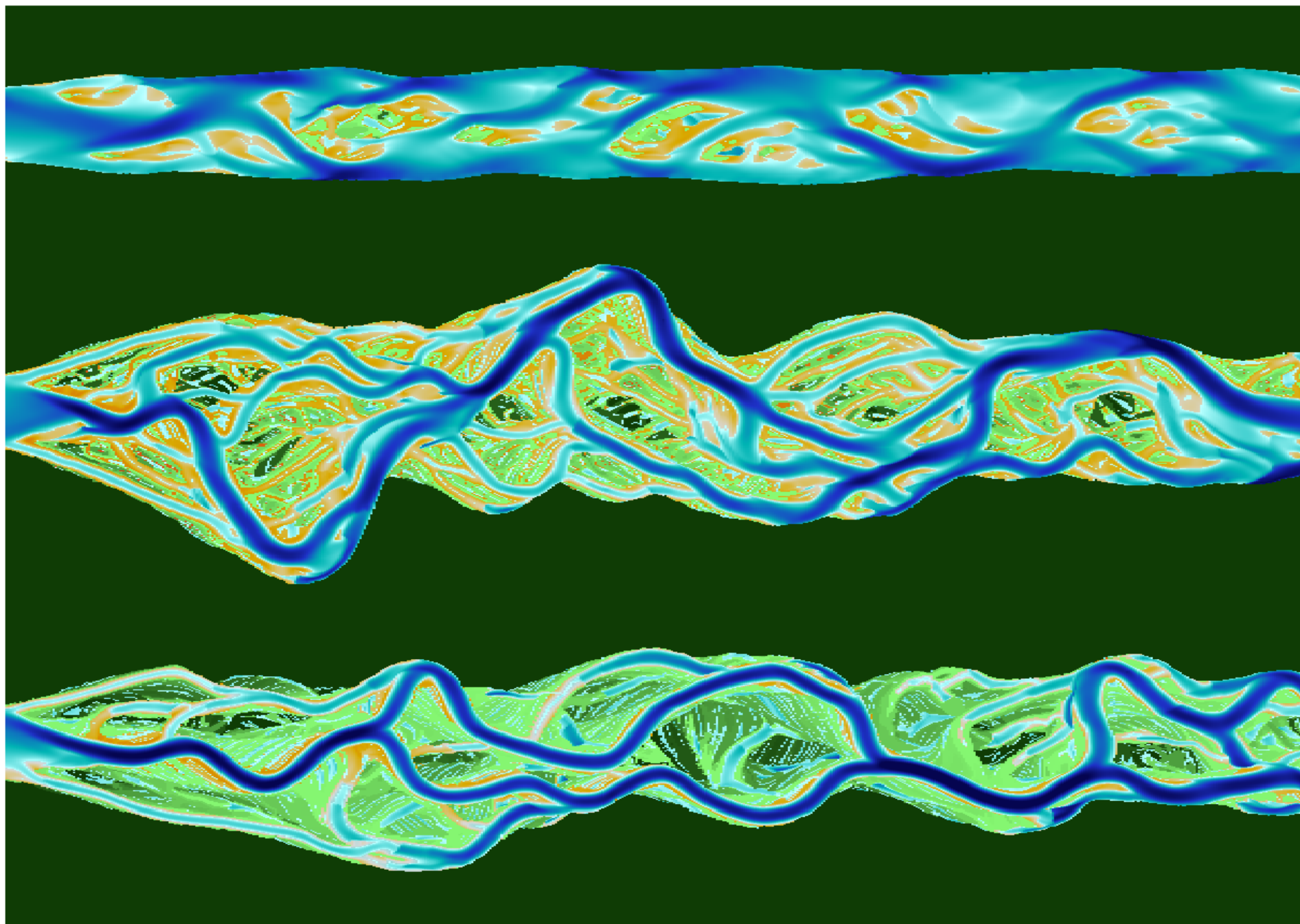


5 m

Depth: 0 m



20 m



Simulation Time: 290 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

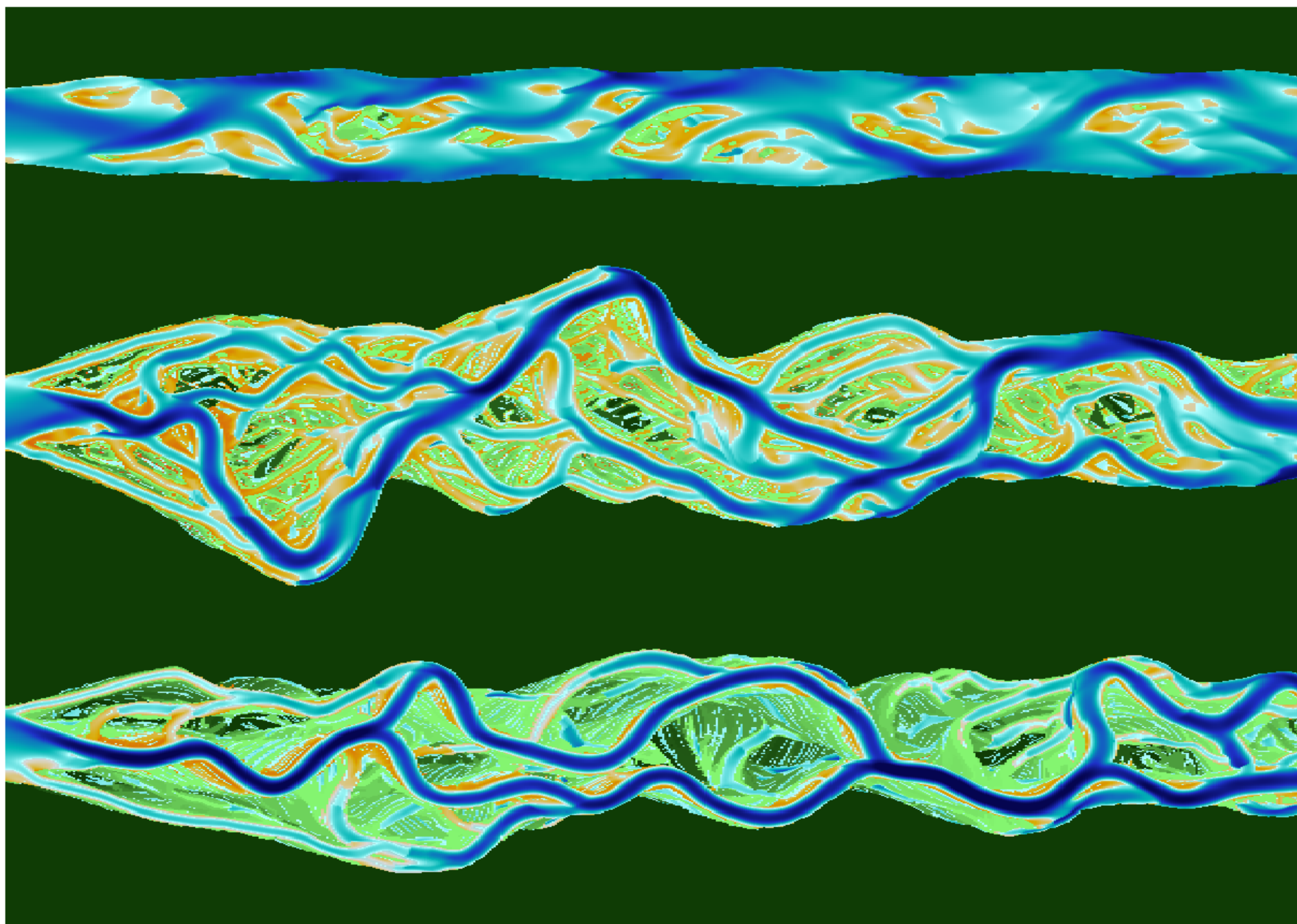


5 m

Depth: 0 m



20 m



Simulation Time: 292 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

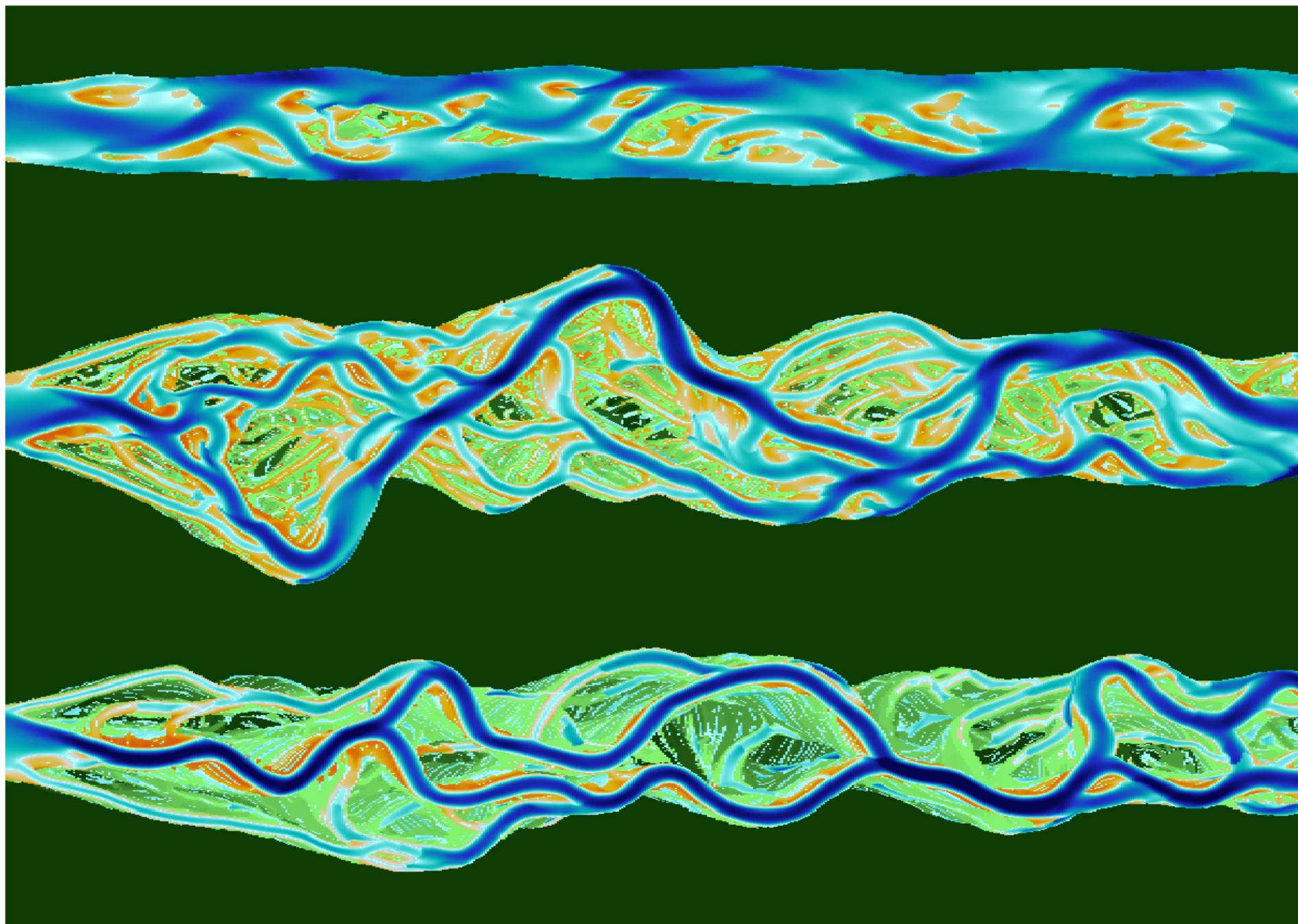


5 m

Depth: 0 m



20 m



Simulation Time: 294 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

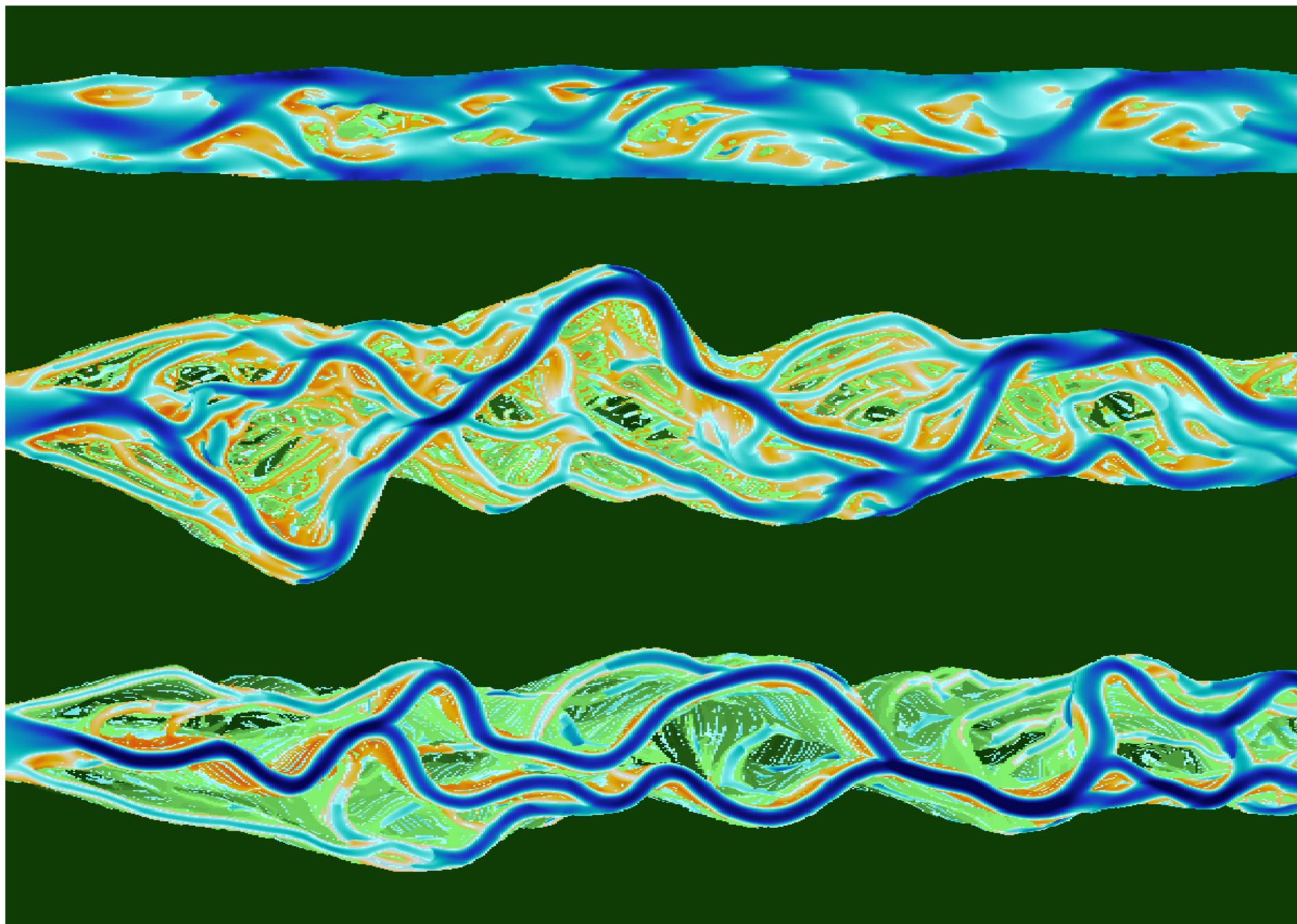


5 m

Depth: 0 m



20 m



Simulation Time: 296 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

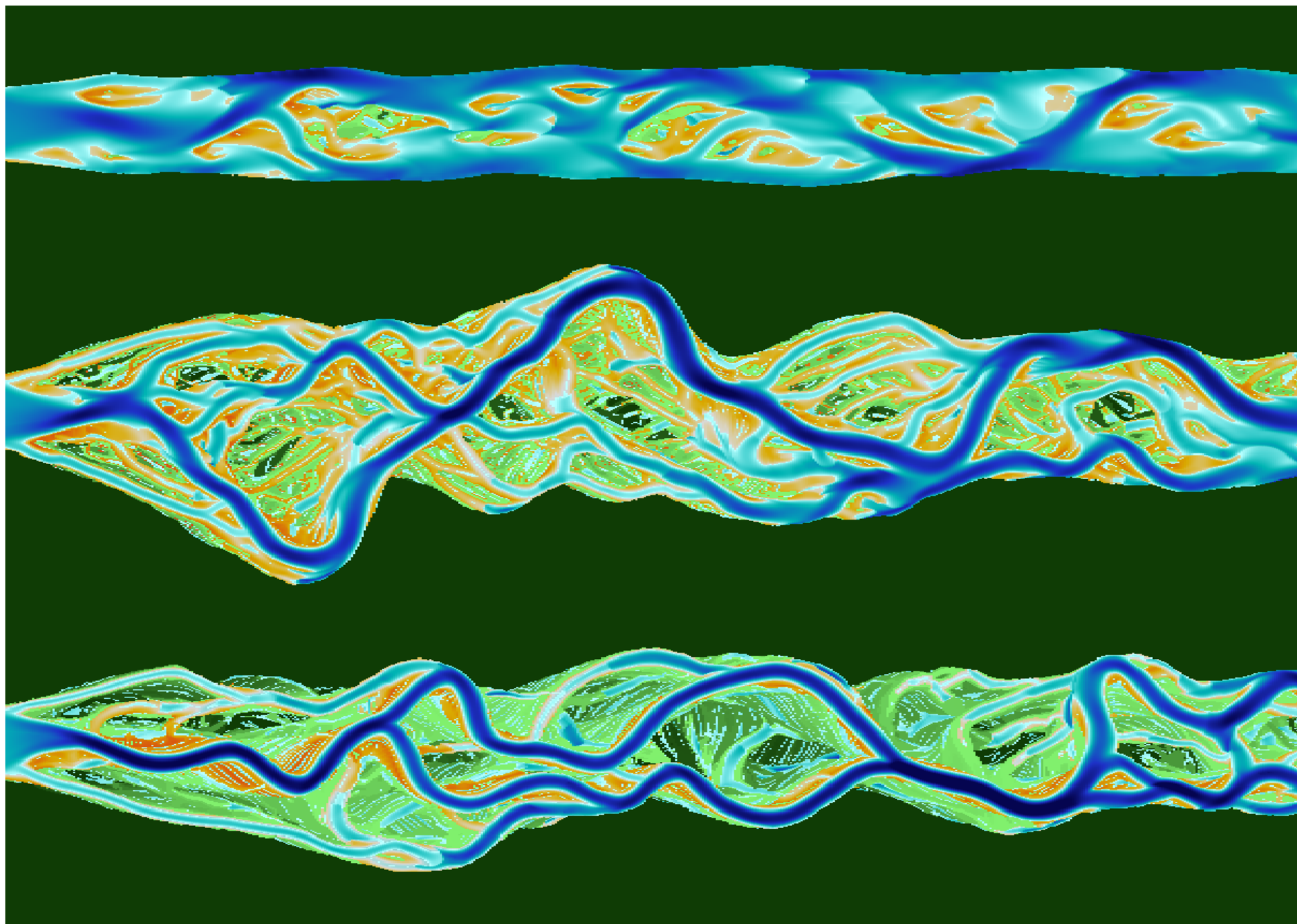


5 m

Depth: 0 m



20 m



Simulation Time: 298 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

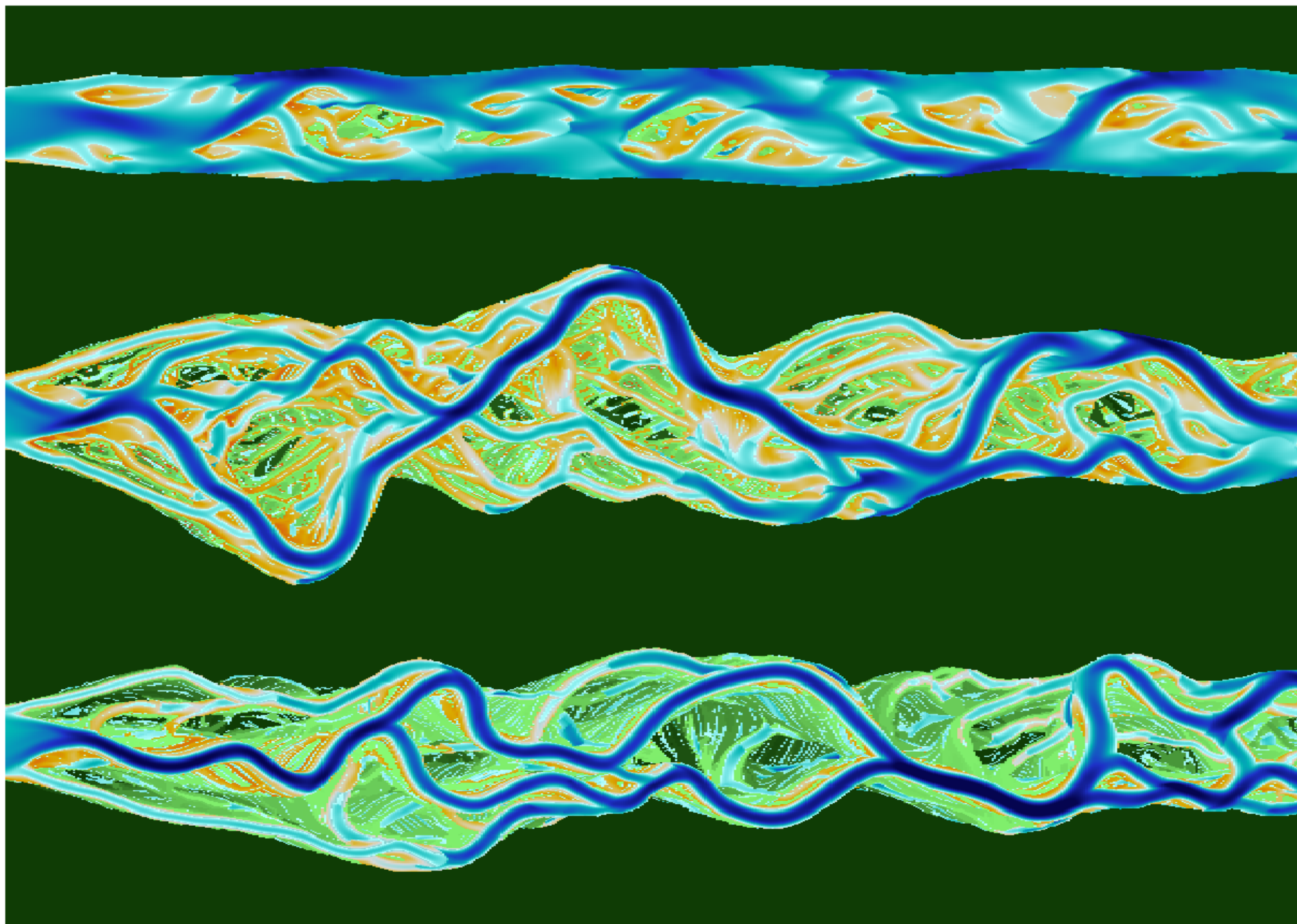


5 m

Depth: 0 m



20 m



Simulation Time: 300 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

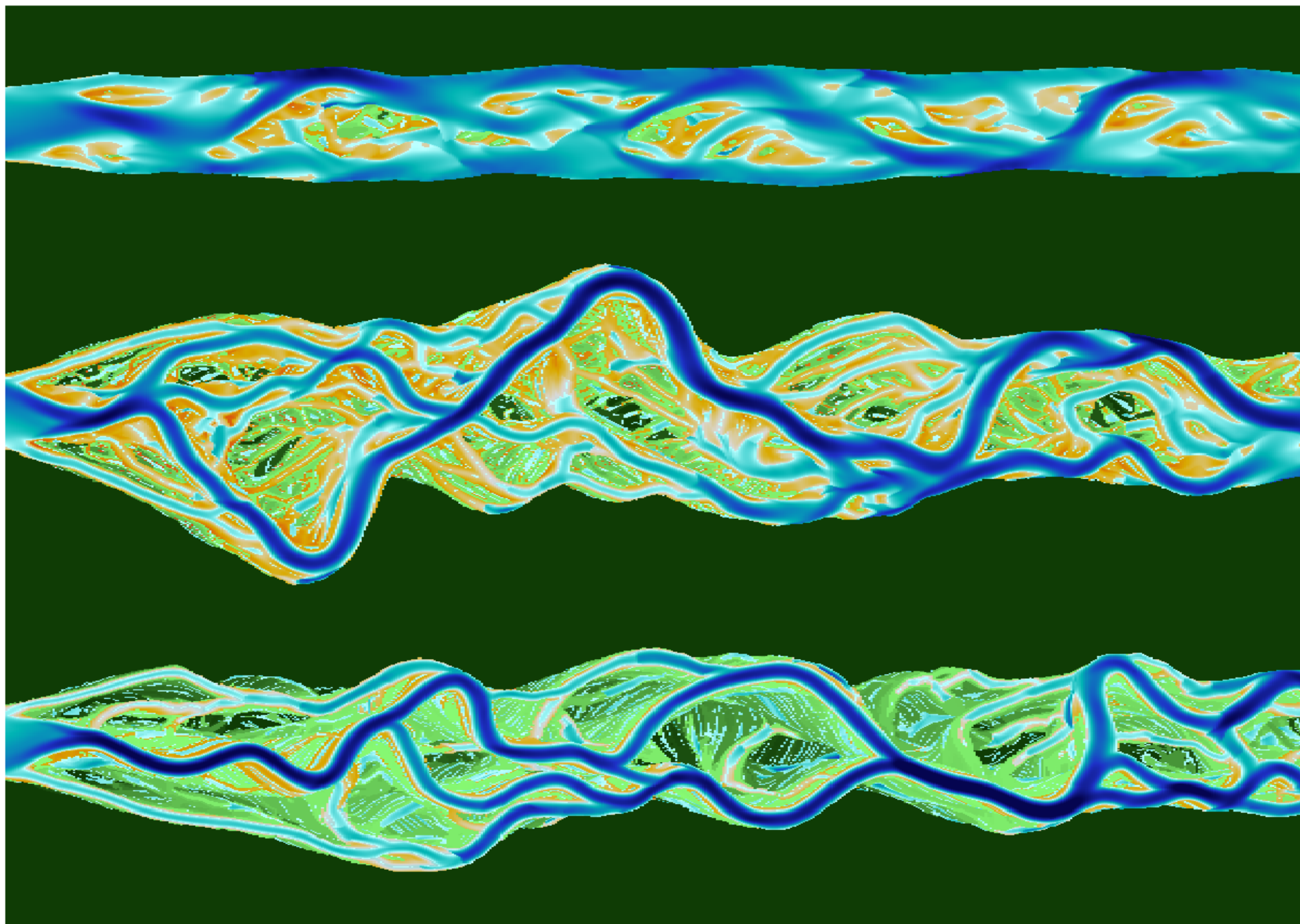


5 m

Depth: 0 m



20 m



Simulation Time: 302 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

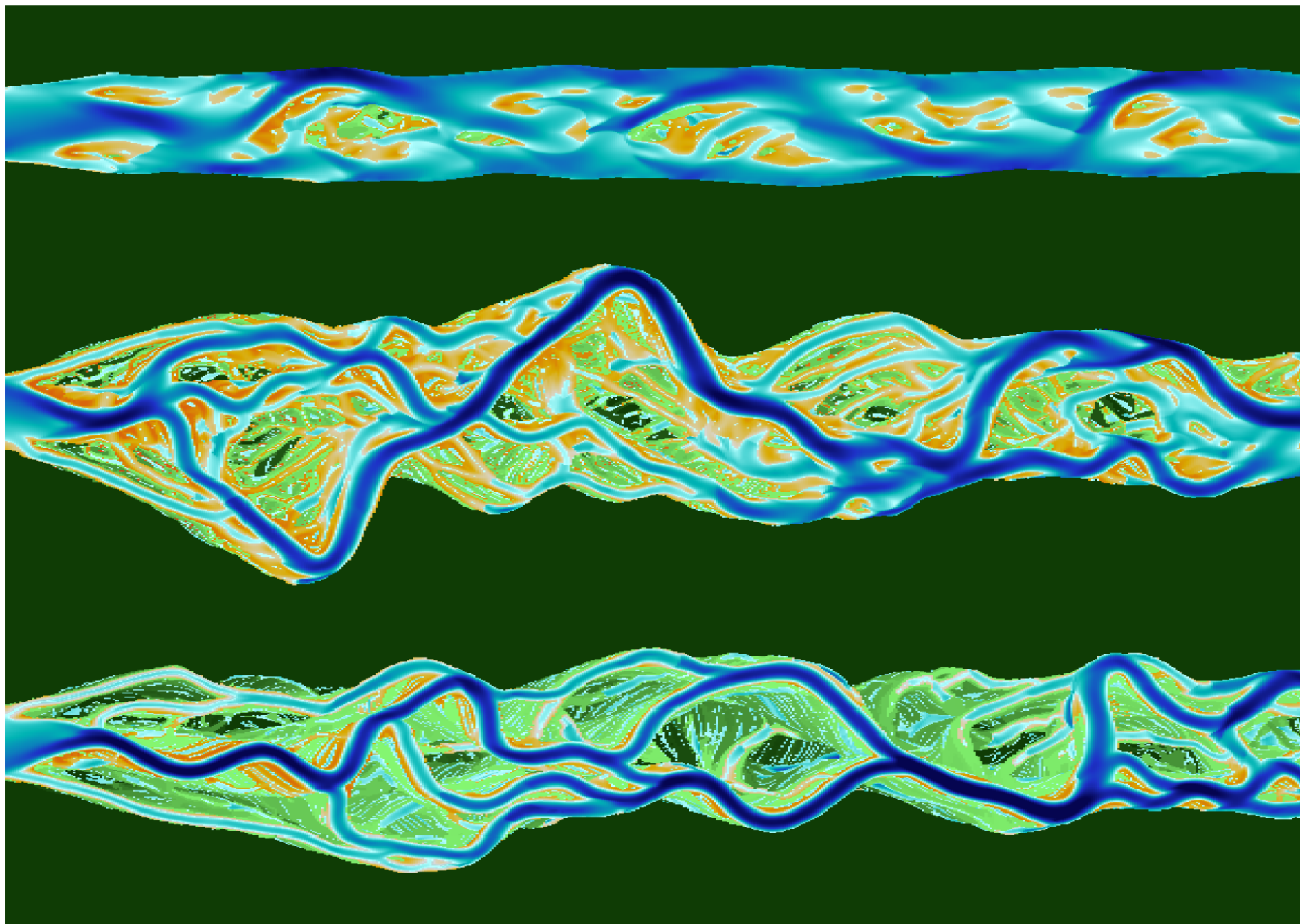


5 m

Depth: 0 m



20 m



Simulation Time: 304 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

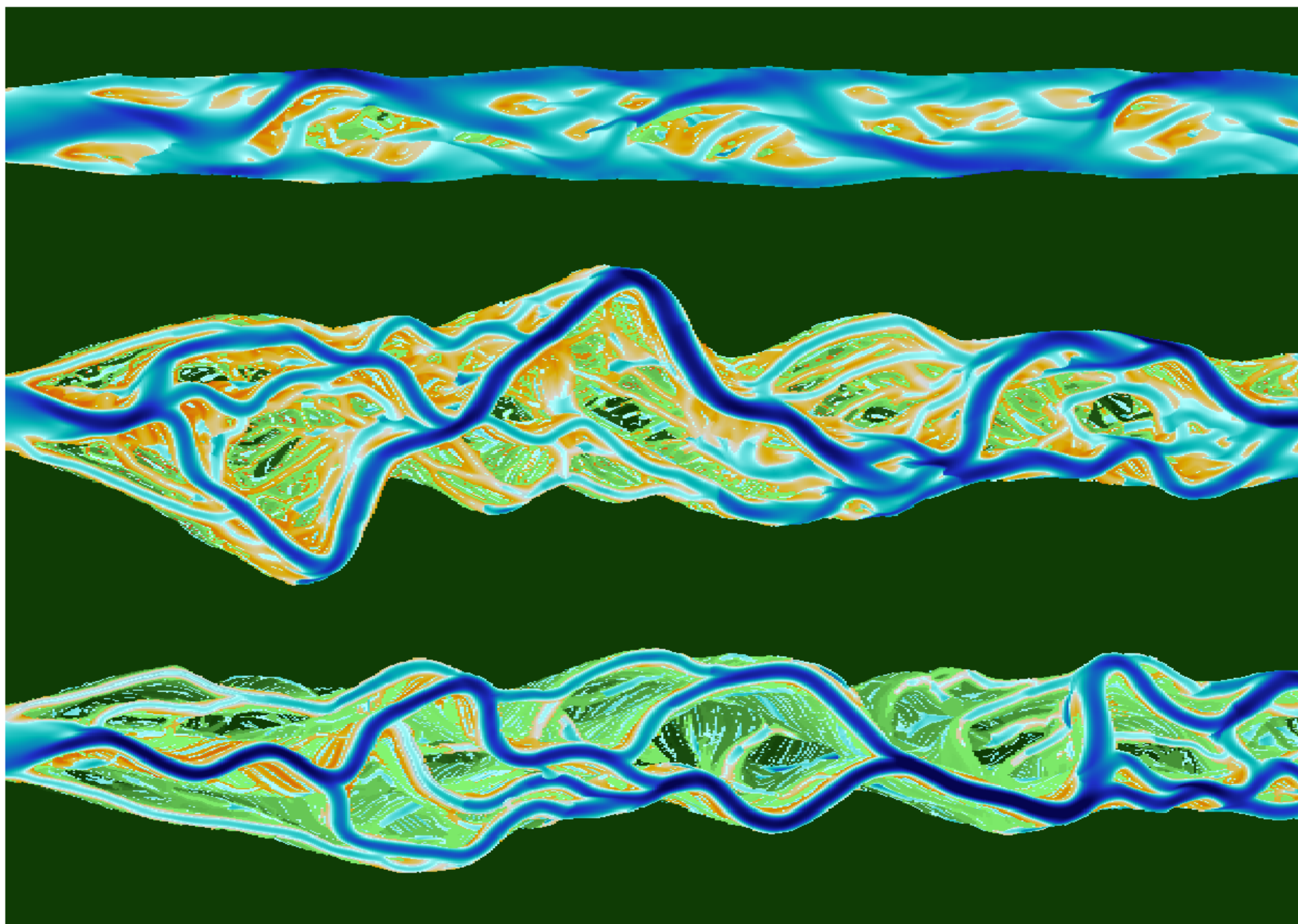


5 m

Depth: 0 m



20 m



Simulation Time: 306 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

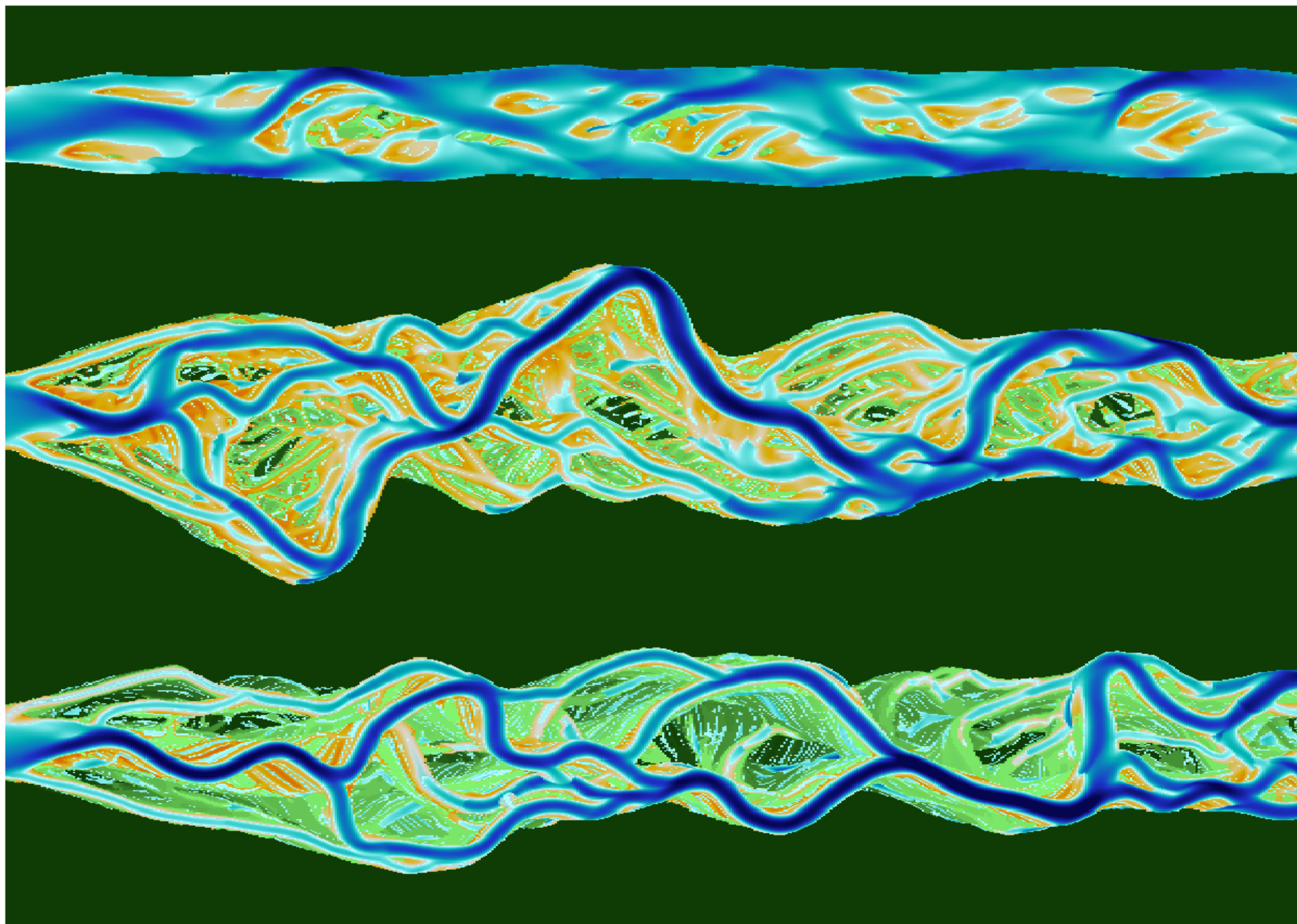


5 m

Depth: 0 m



20 m



Simulation Time: 308 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

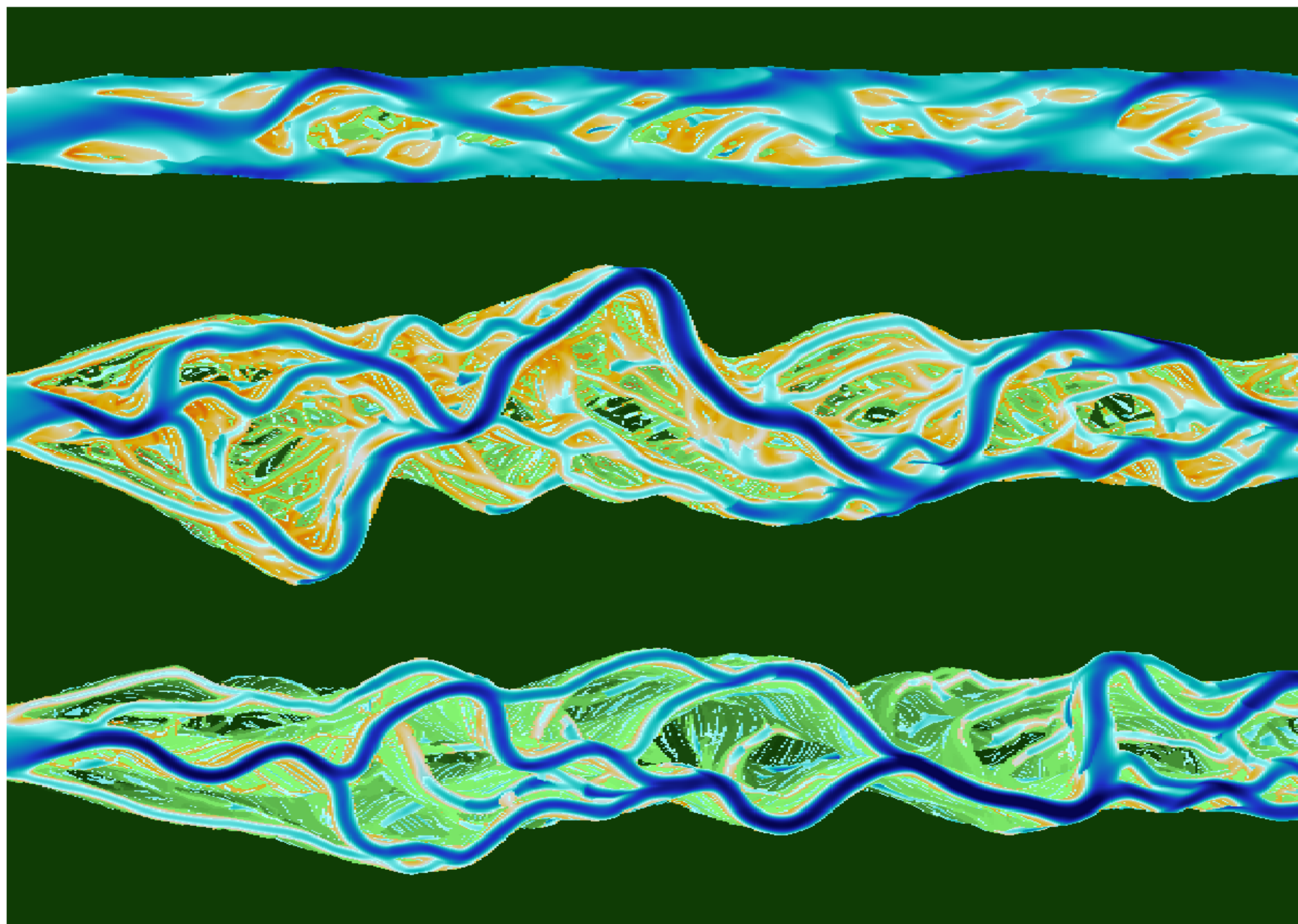


5 m

Depth: 0 m



20 m



Simulation Time: 310 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

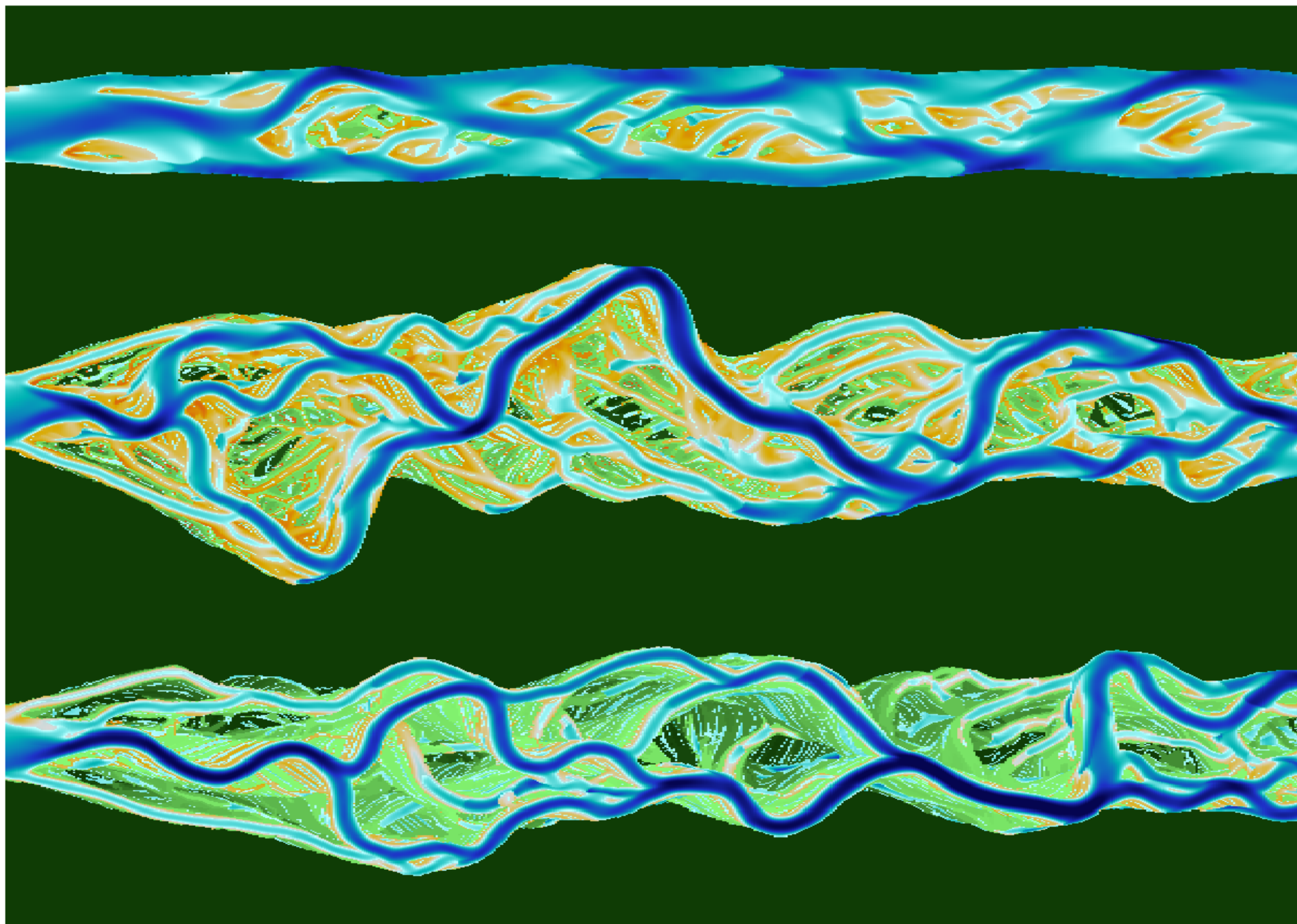


5 m

Depth: 0 m



20 m



Simulation Time: 312 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

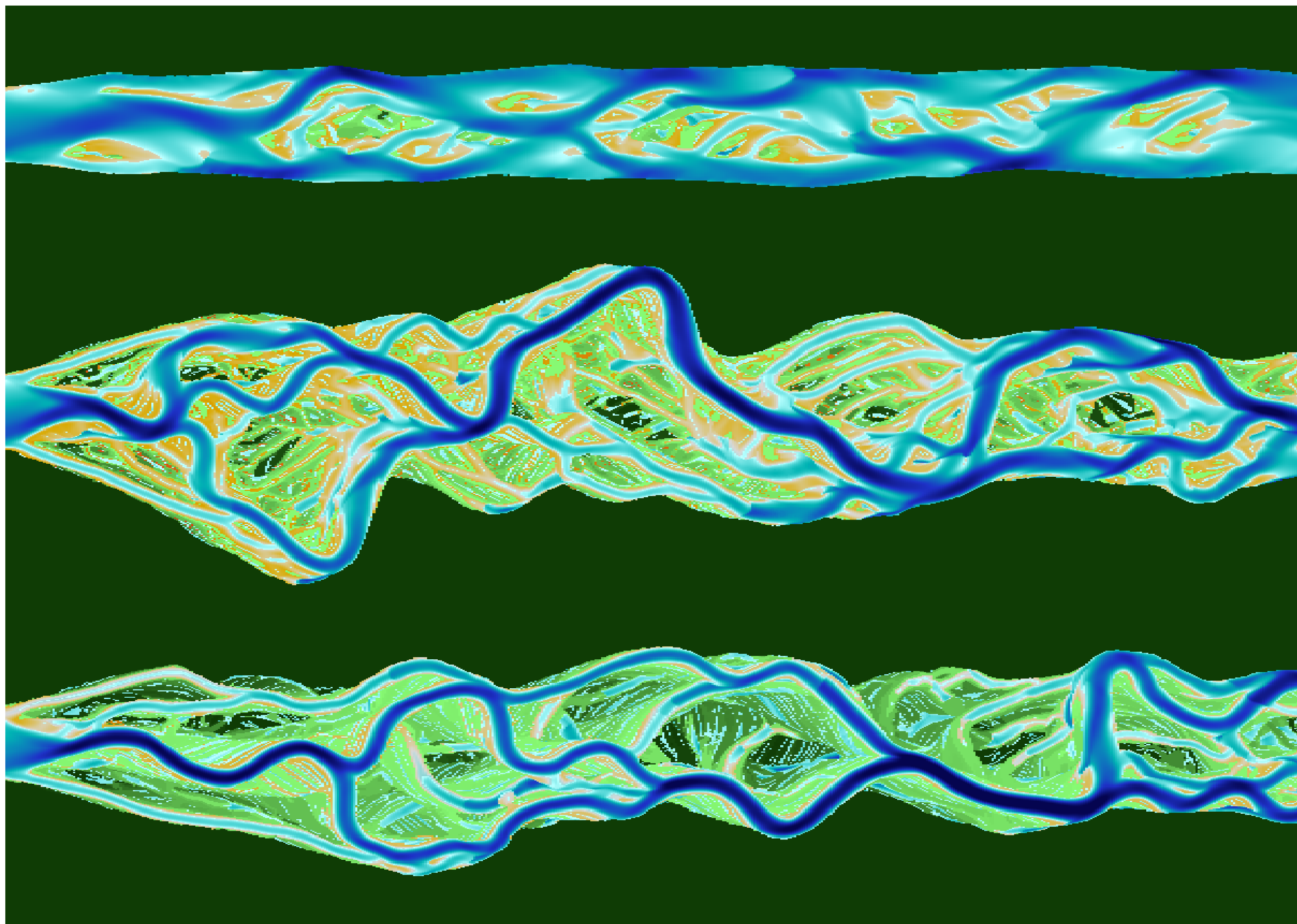


5 m

Depth: 0 m



20 m



Simulation Time: 314 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

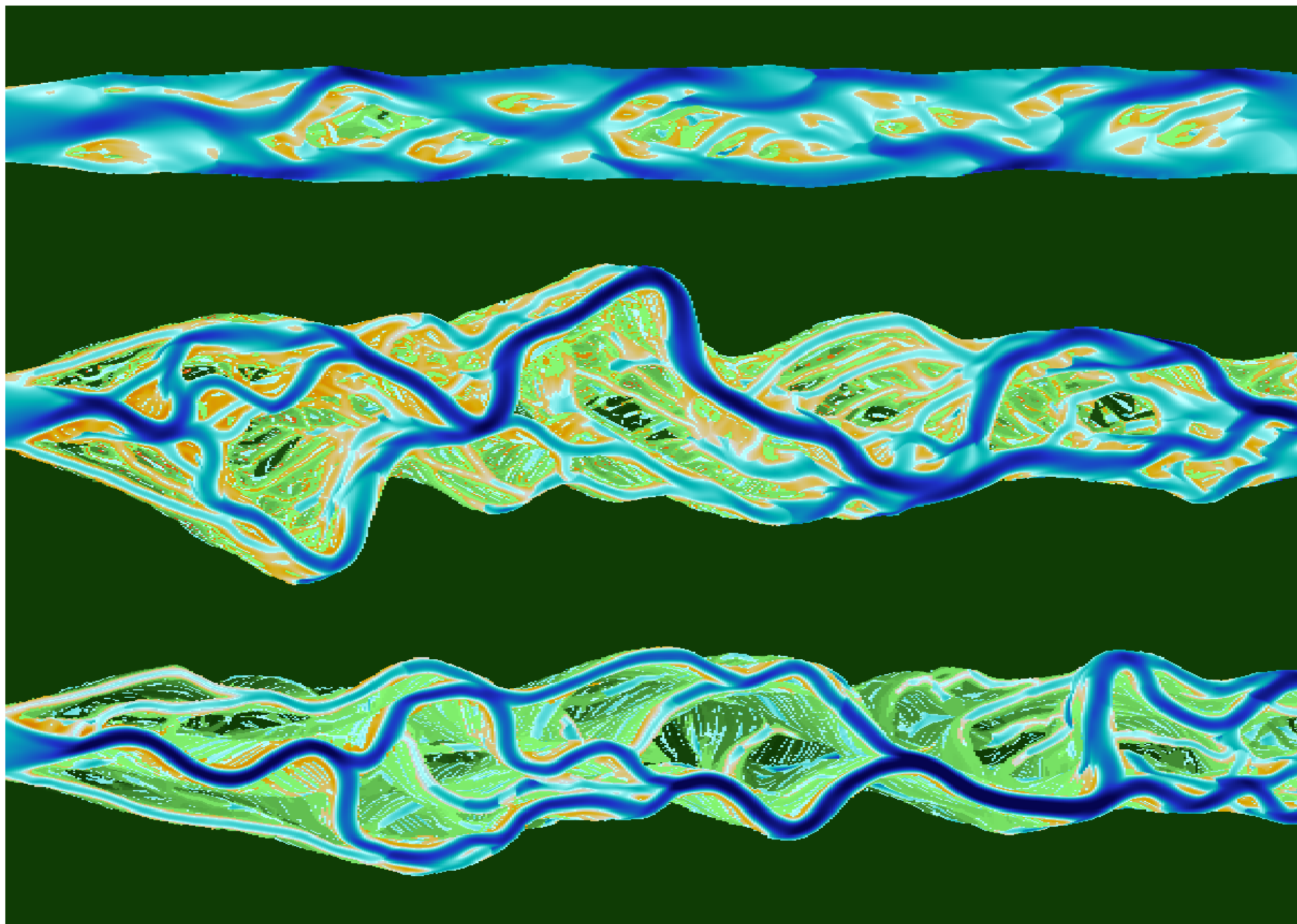


5 m

Depth: 0 m



20 m



Simulation Time: 316 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

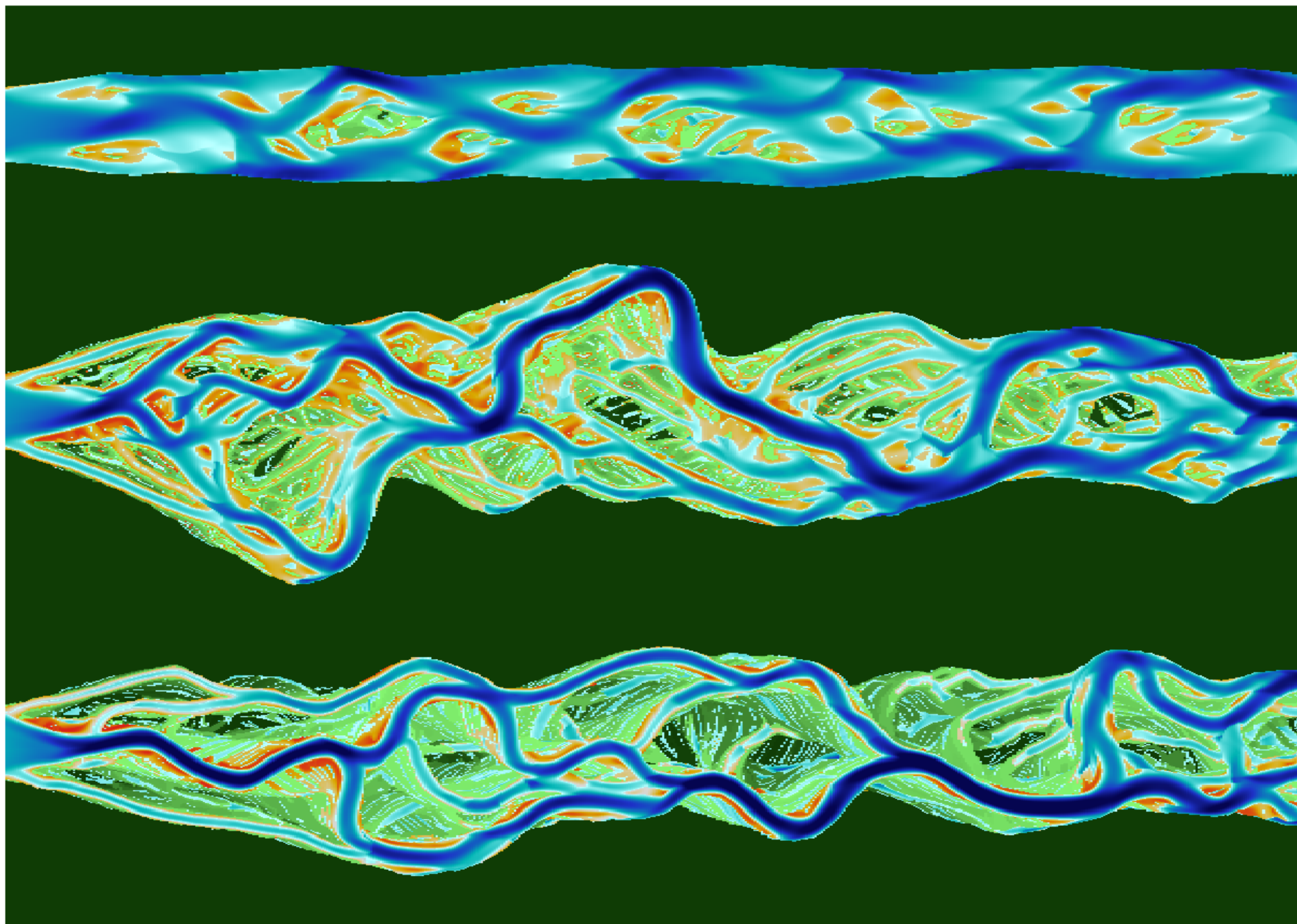


5 m

Depth: 0 m



20 m



Simulation Time: 318 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

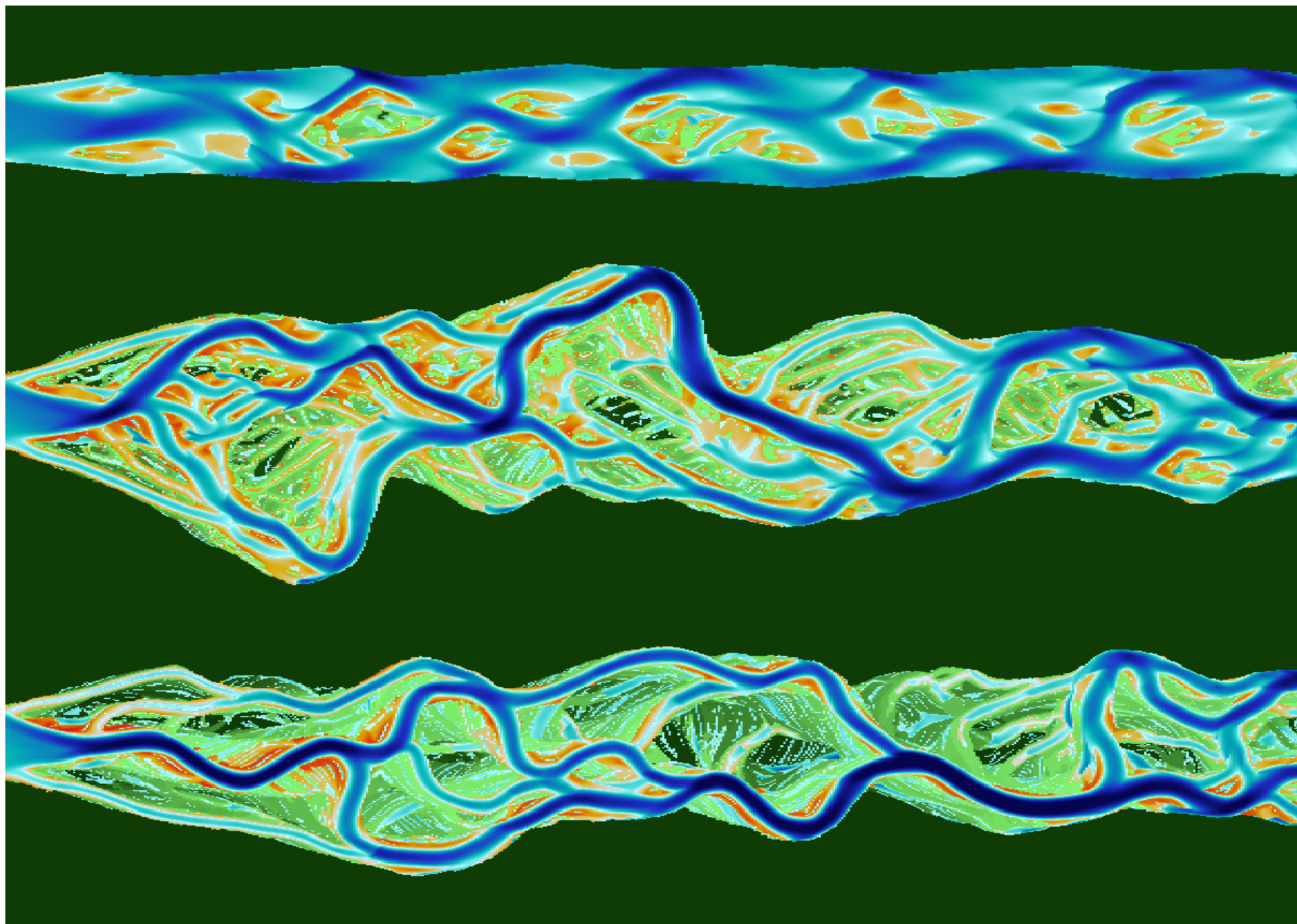


5 m

Depth: 0 m



20 m



Simulation Time: 320 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

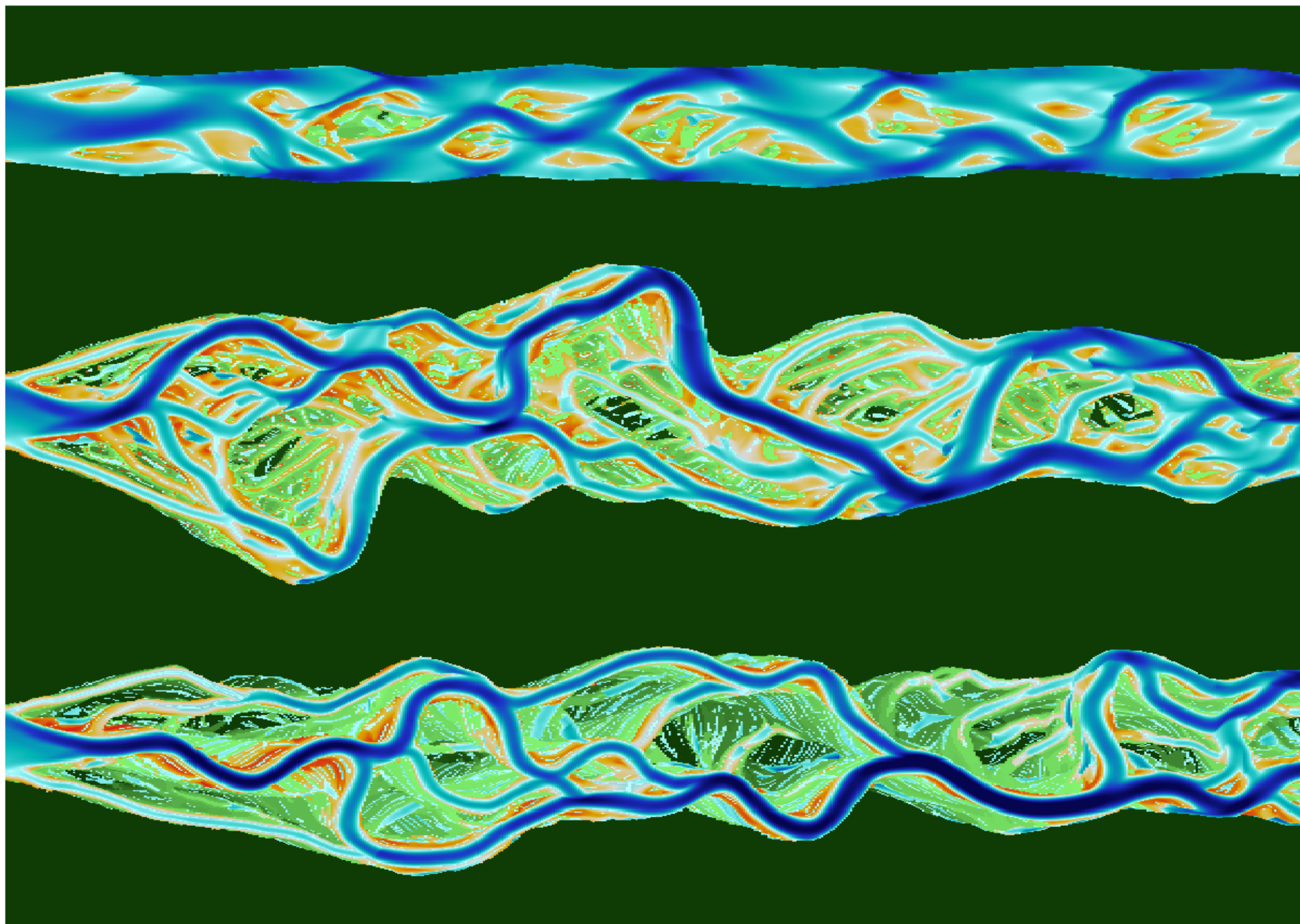


5 m

Depth: 0 m



20 m



Simulation Time: 322 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

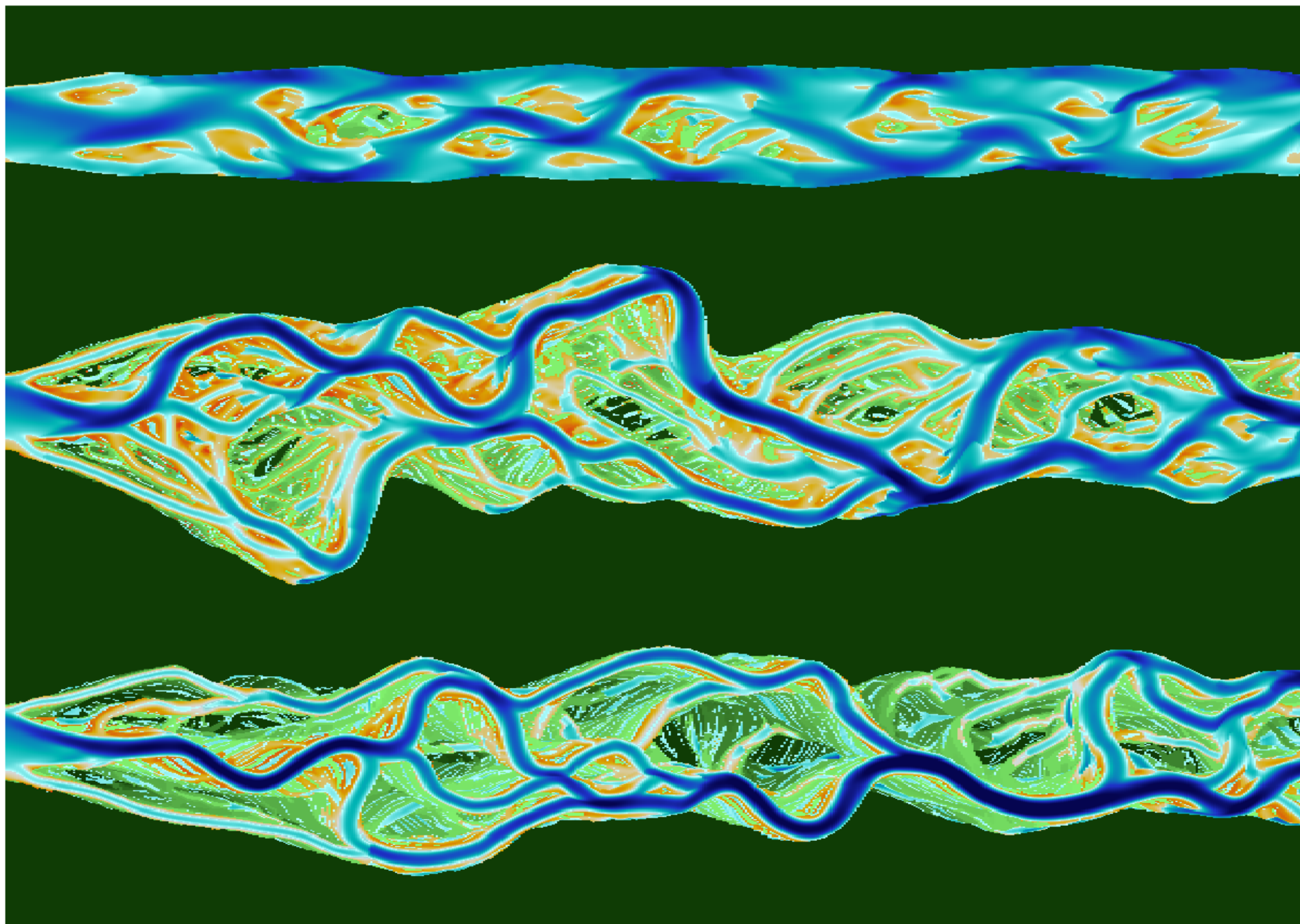


5 m

Depth: 0 m



20 m



Simulation Time: 324 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

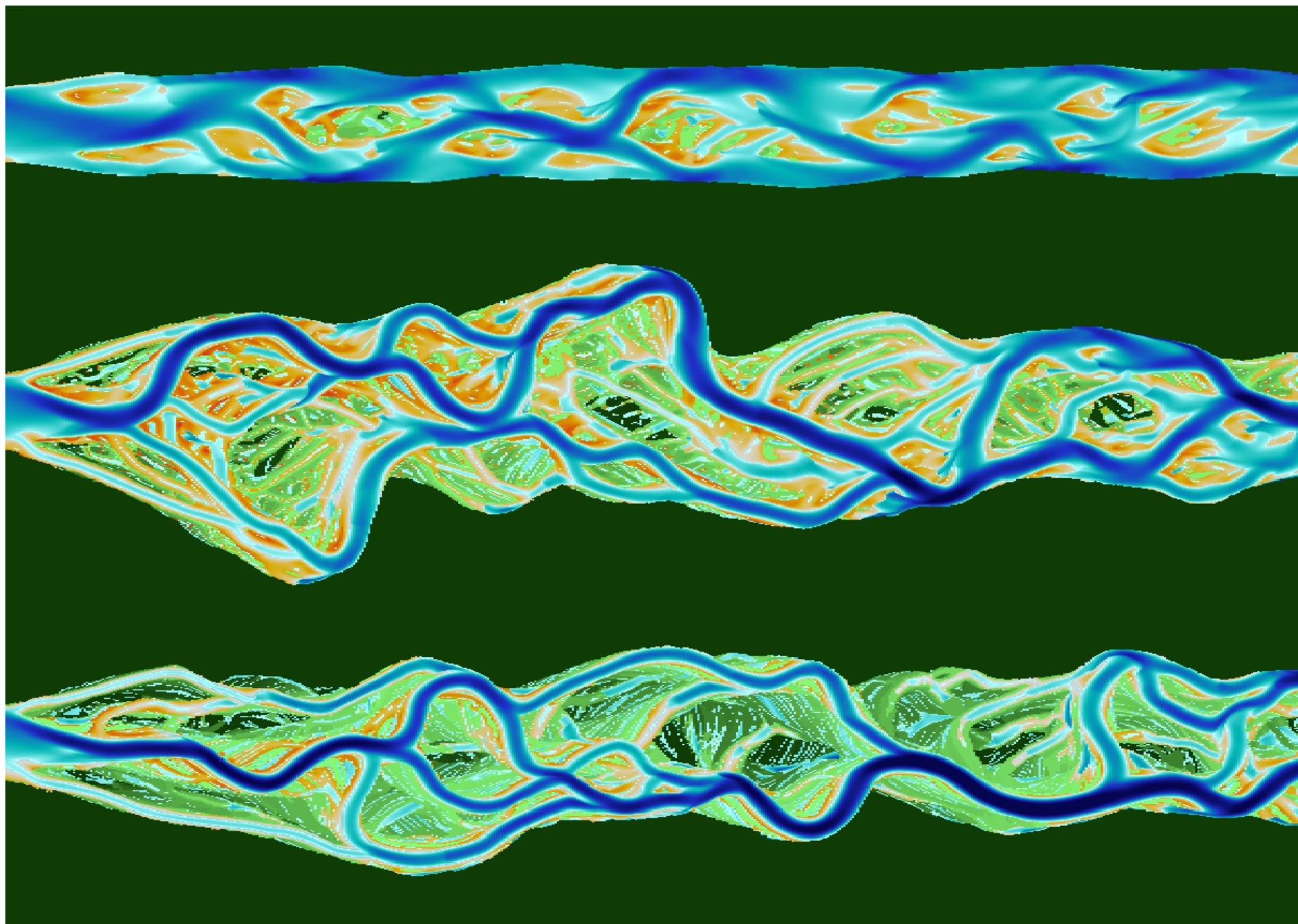


5 m

Depth: 0 m



20 m



Simulation Time: 326 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

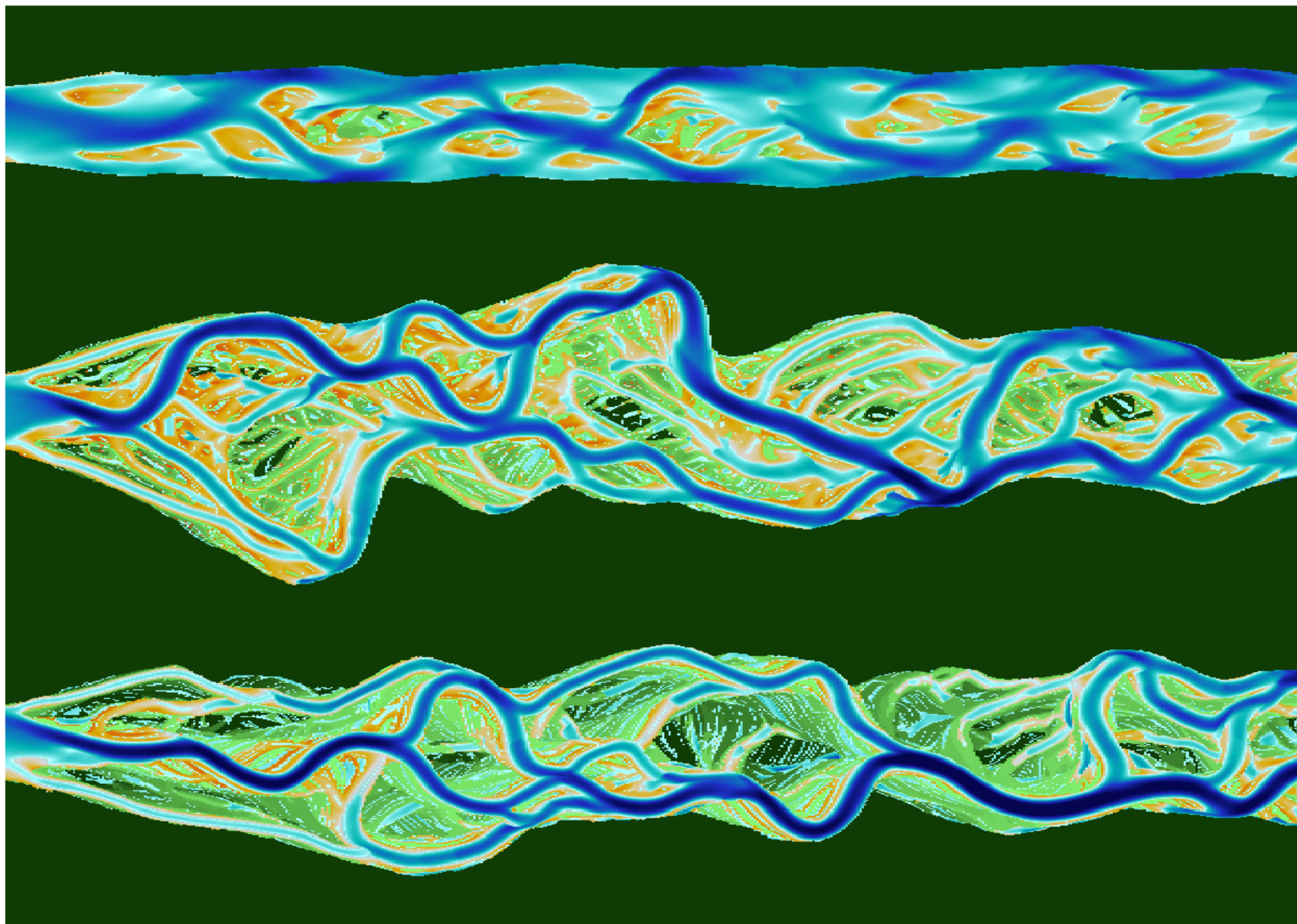


5 m

Depth: 0 m



20 m



Simulation Time: 328 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

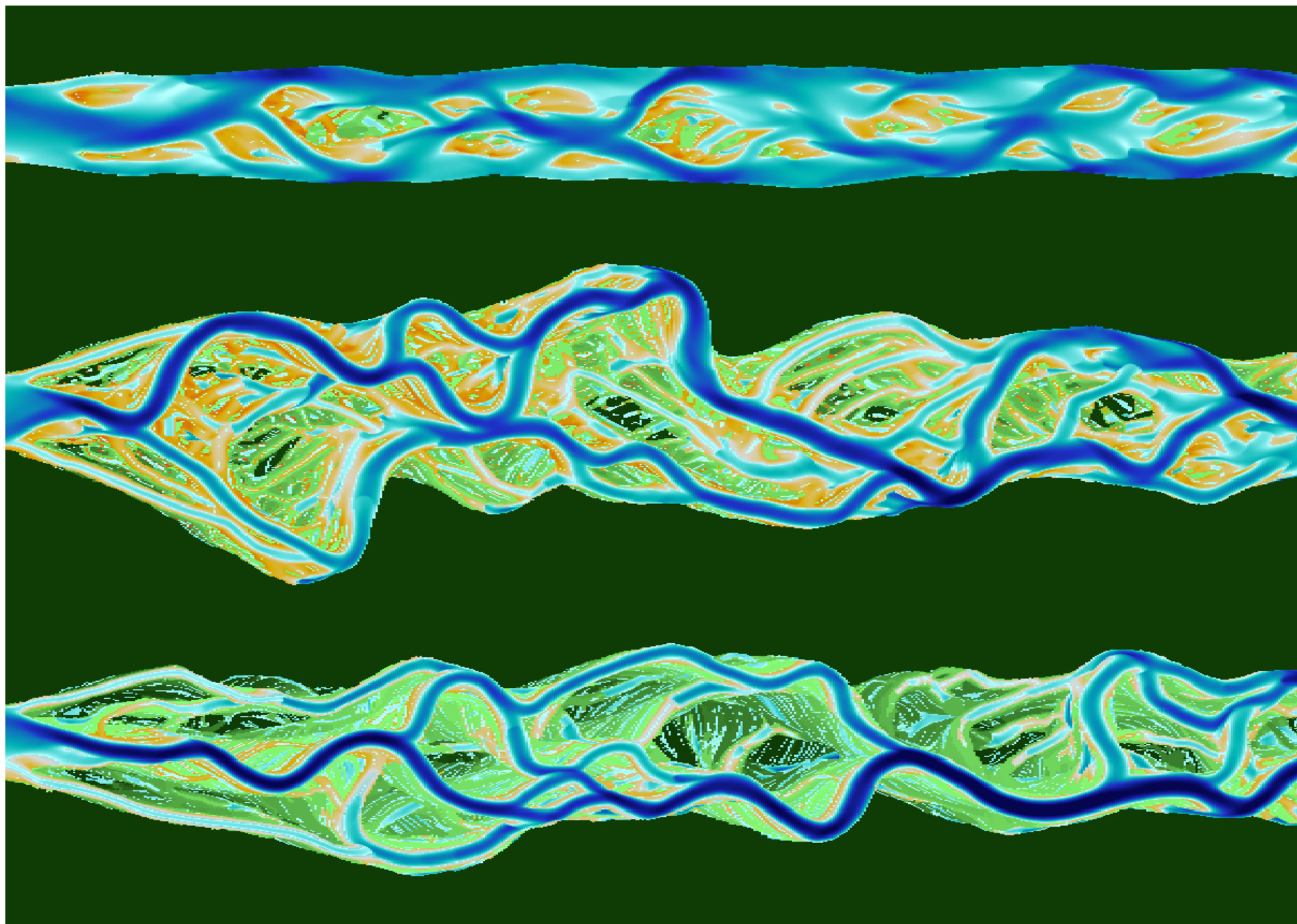


5 m

Depth: 0 m



20 m



Simulation Time: 330 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

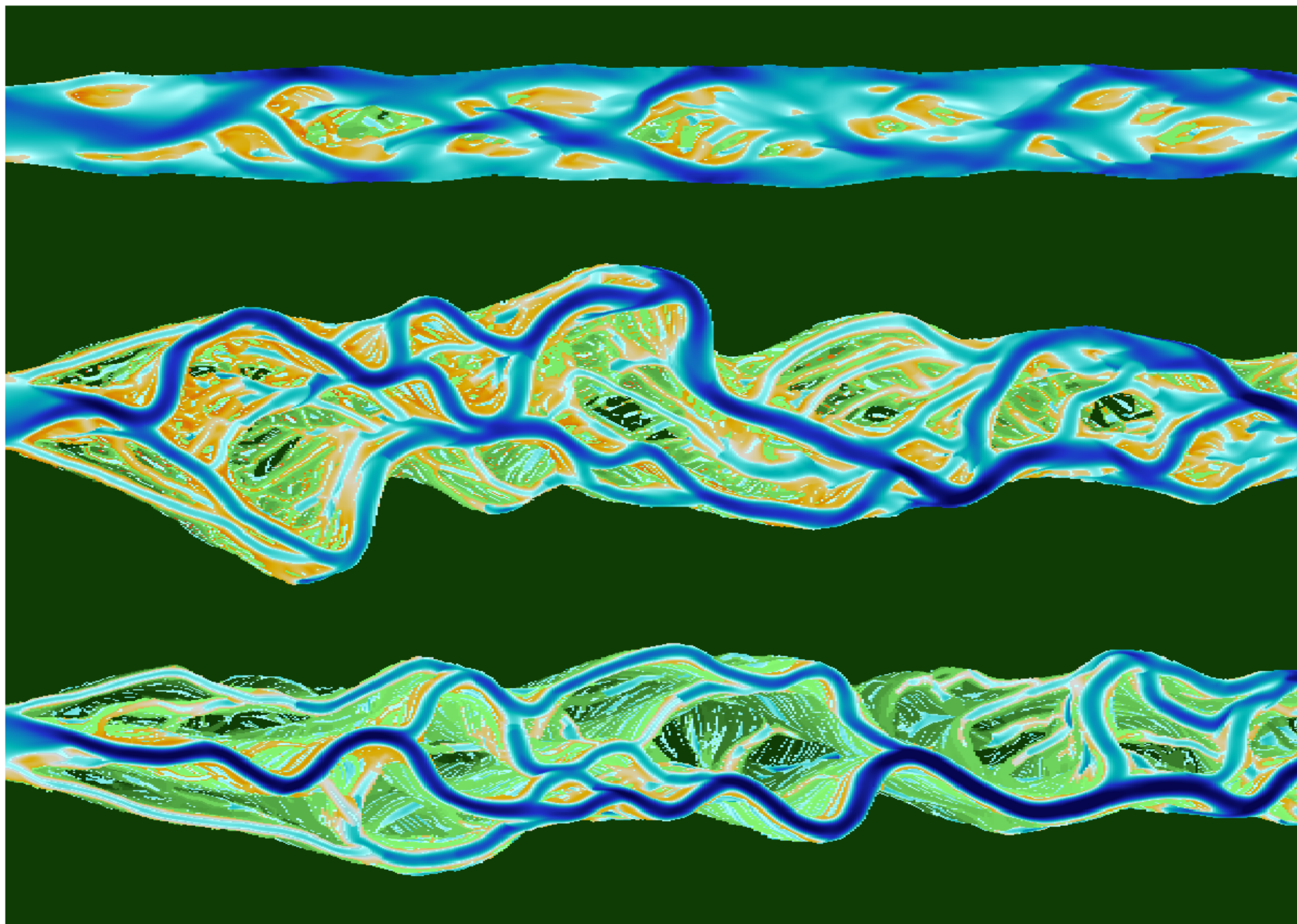


5 m

Depth: 0 m



20 m



Simulation Time: 332 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

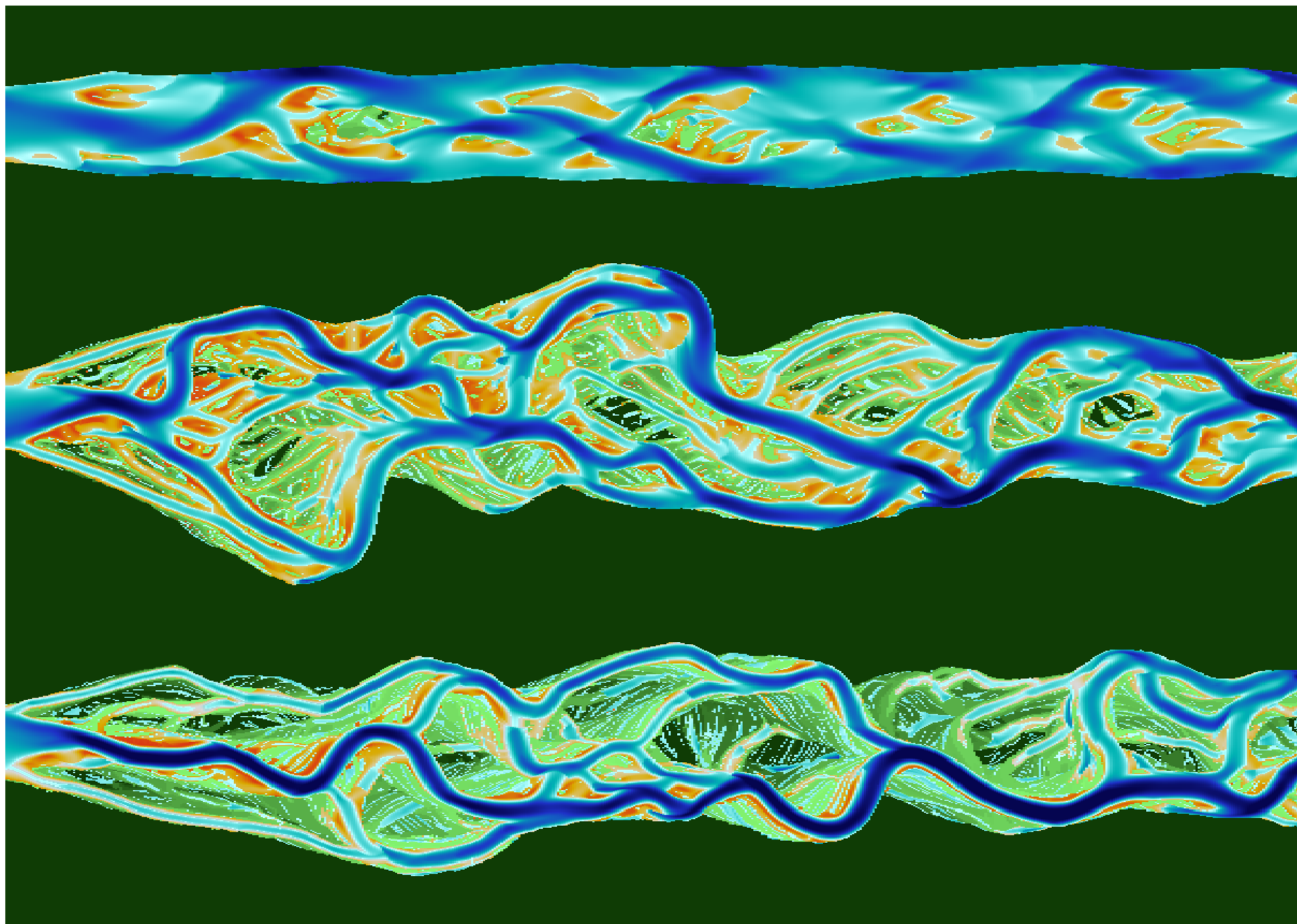


5 m

Depth: 0 m



20 m



Simulation Time: 334 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

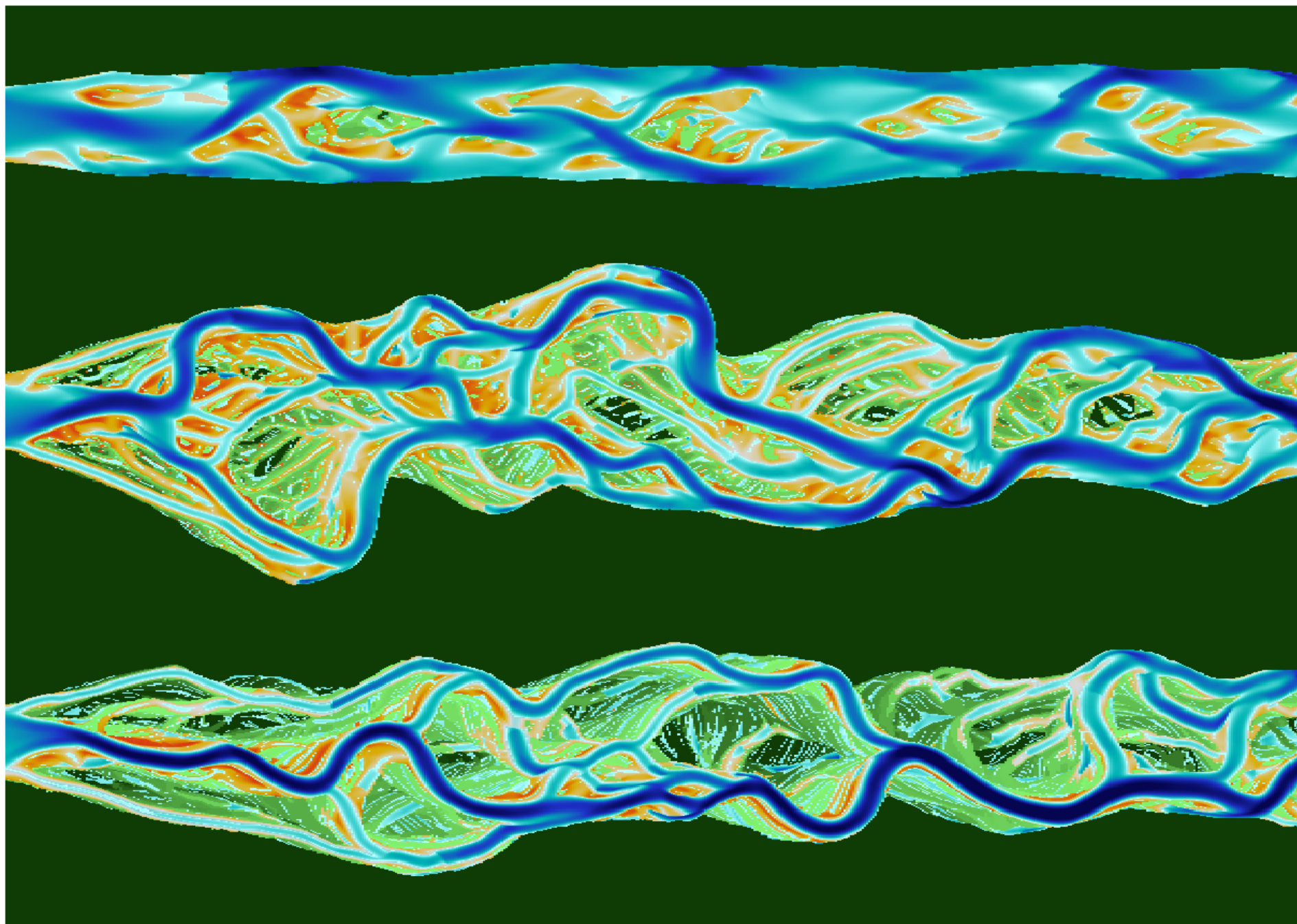


5 m

Depth: 0 m



20 m



Simulation Time: 336 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

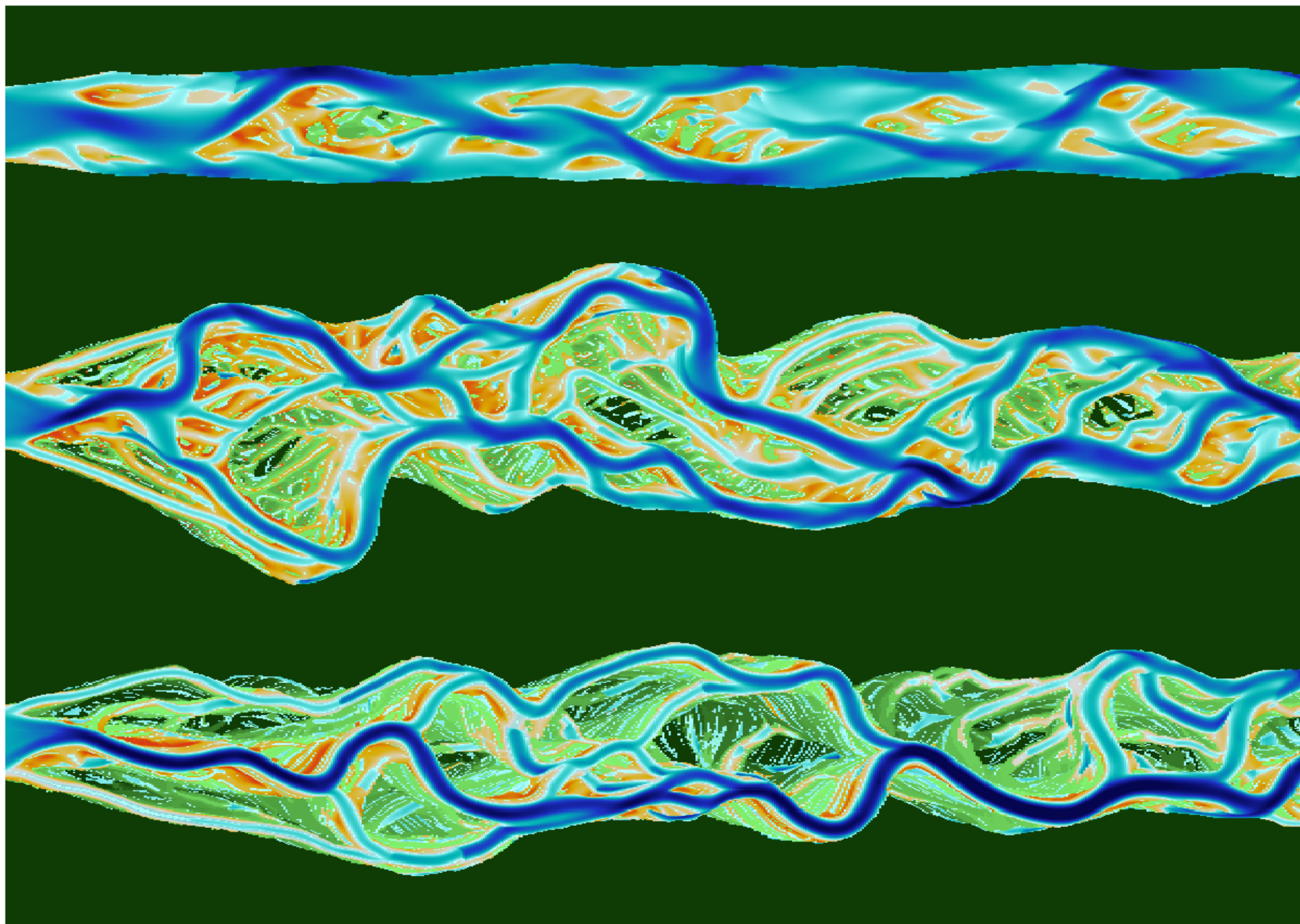


5 m

Depth: 0 m



20 m



Simulation Time: 338 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

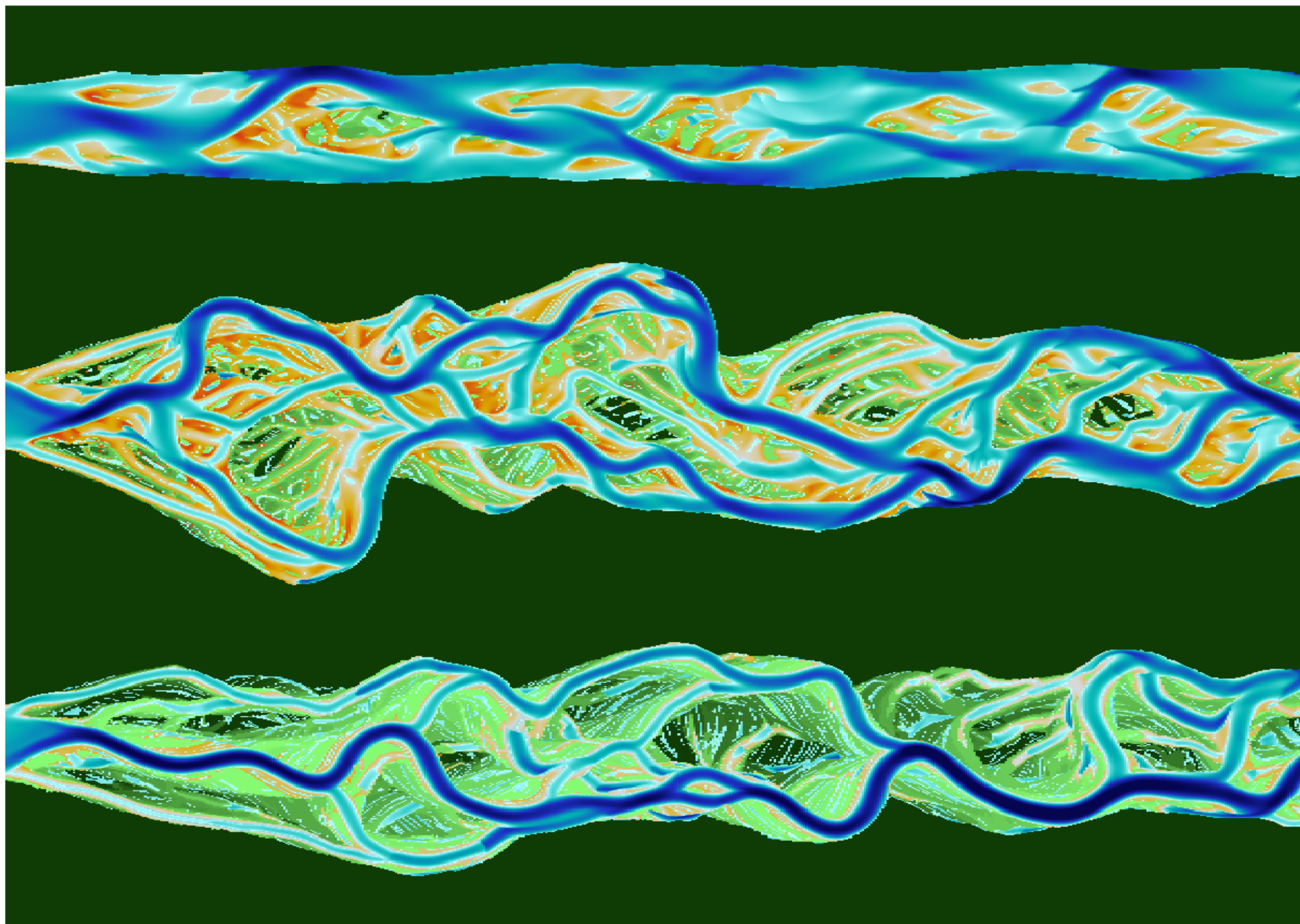


5 m

Depth: 0 m



20 m



Simulation Time: 340 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

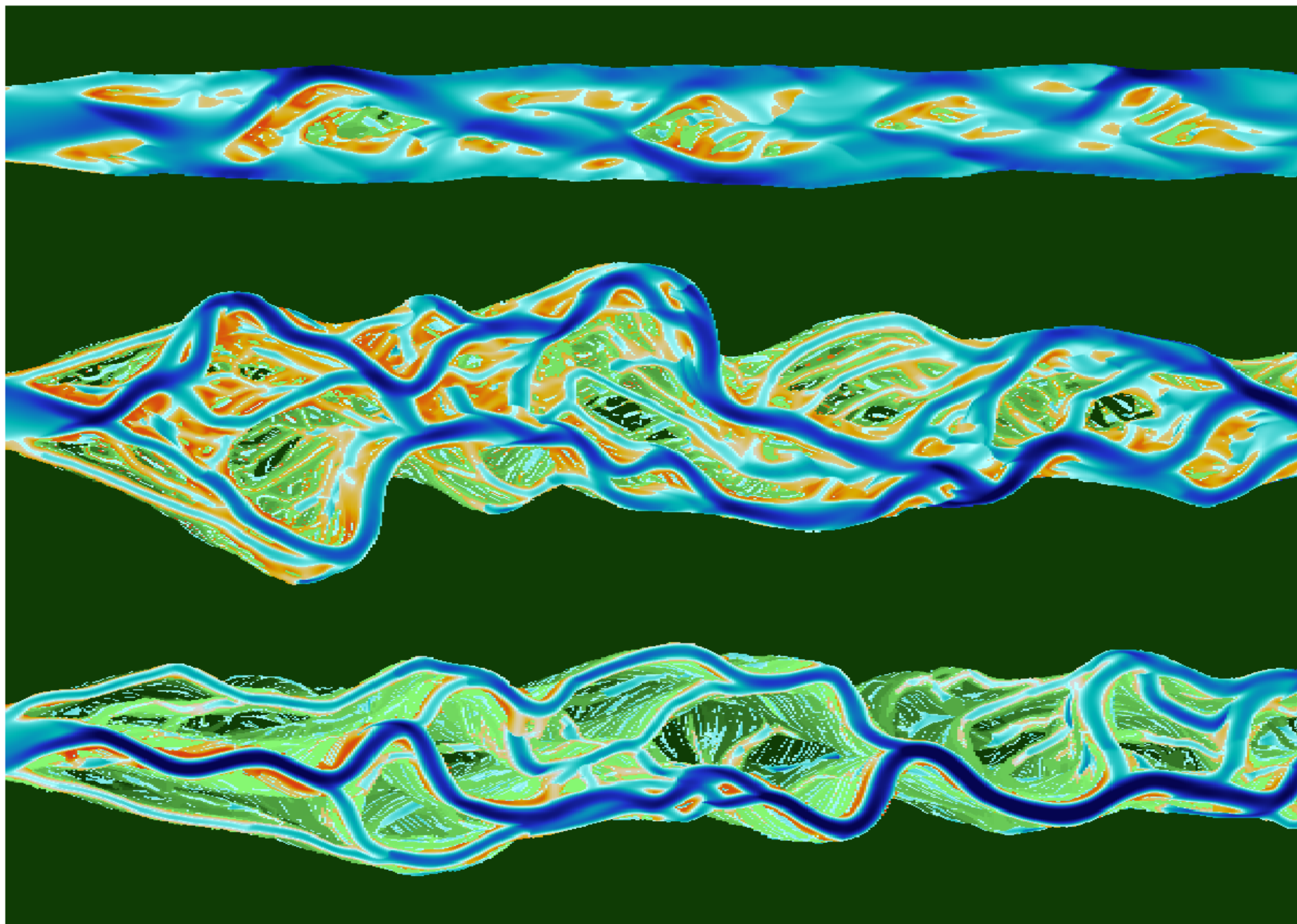


5 m

Depth: 0 m



20 m



Simulation Time: 342 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

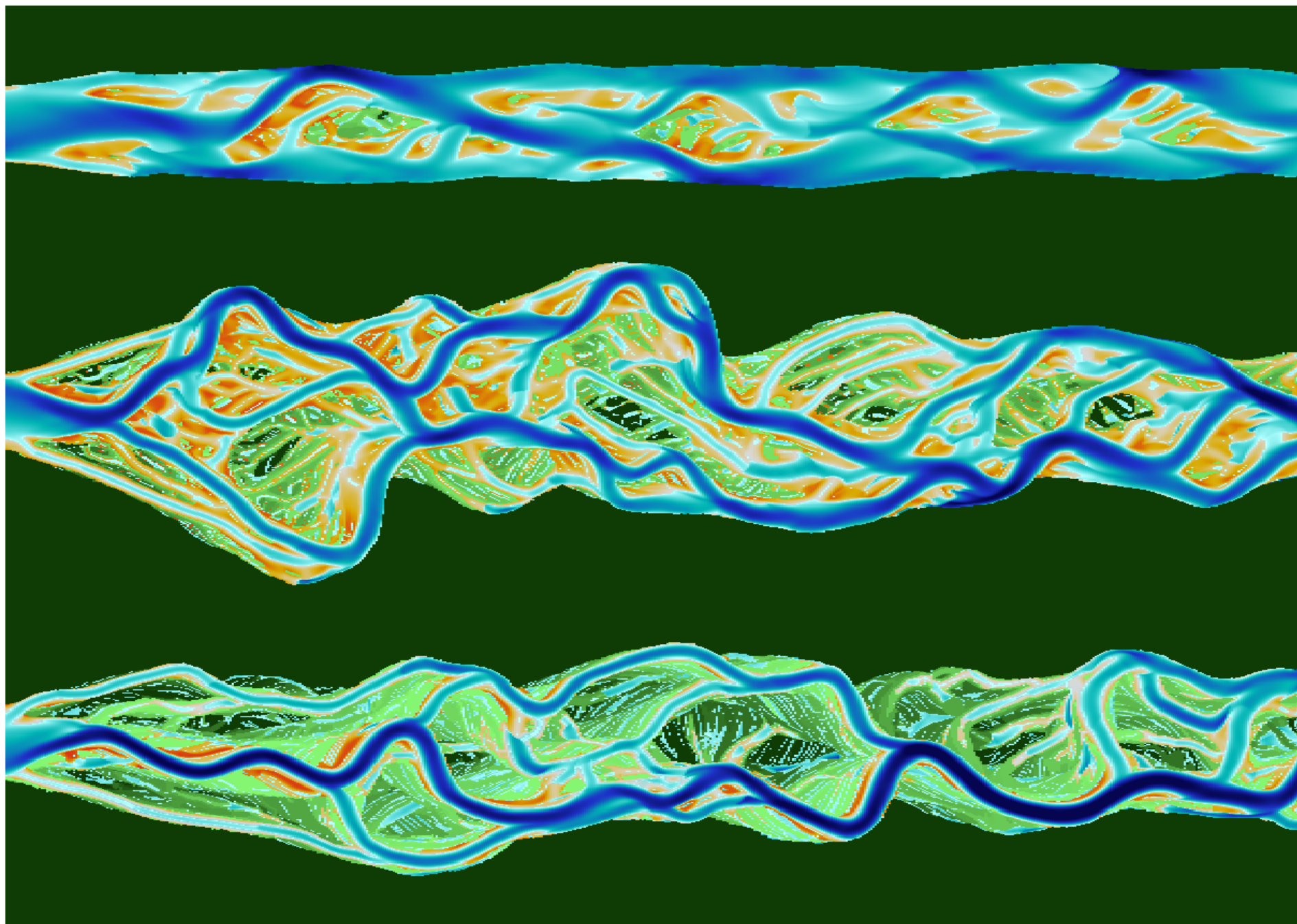


5 m

Depth: 0 m



20 m



Simulation Time: 344 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

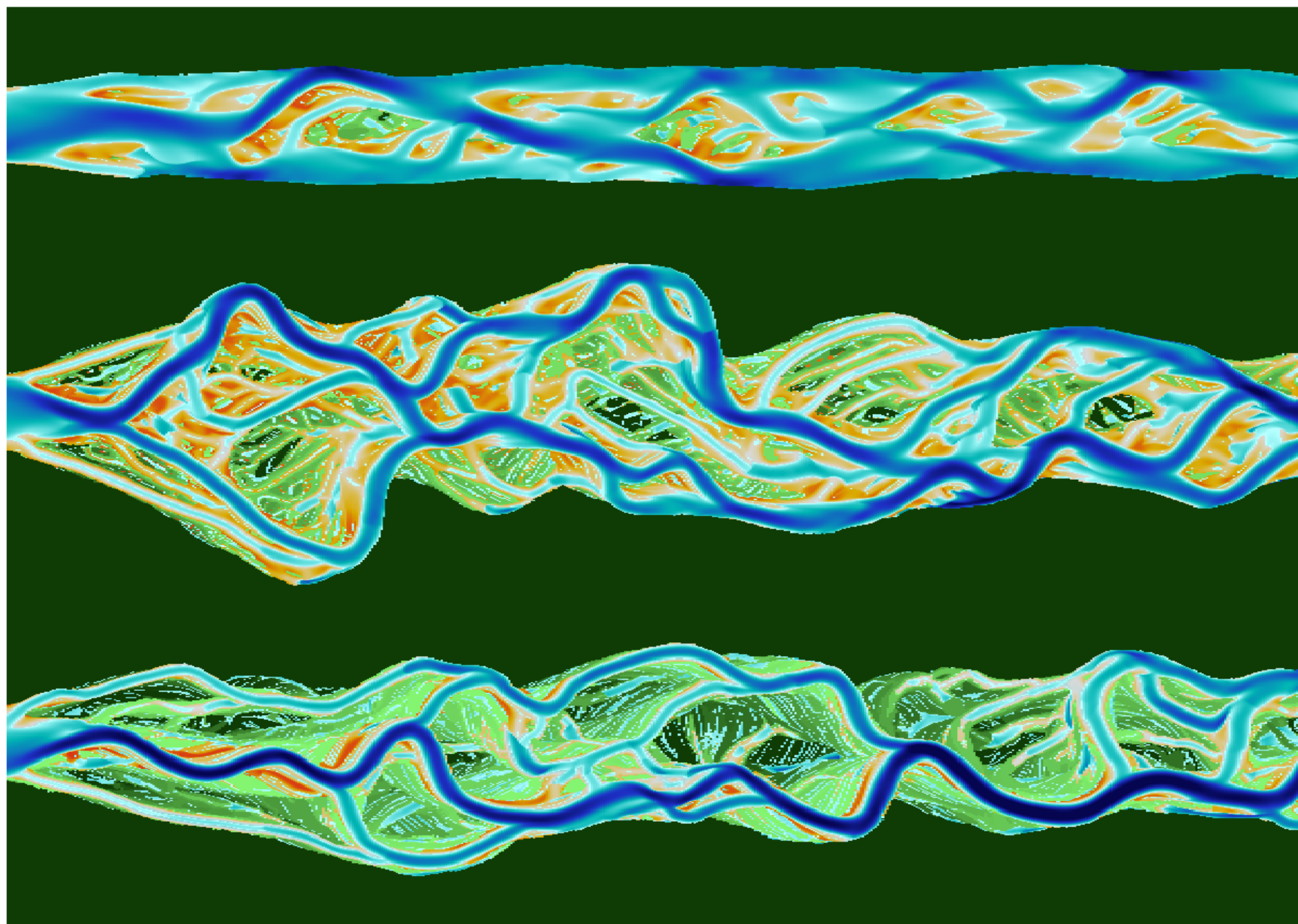


5 m

Depth: 0 m



20 m



Simulation Time: 346 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

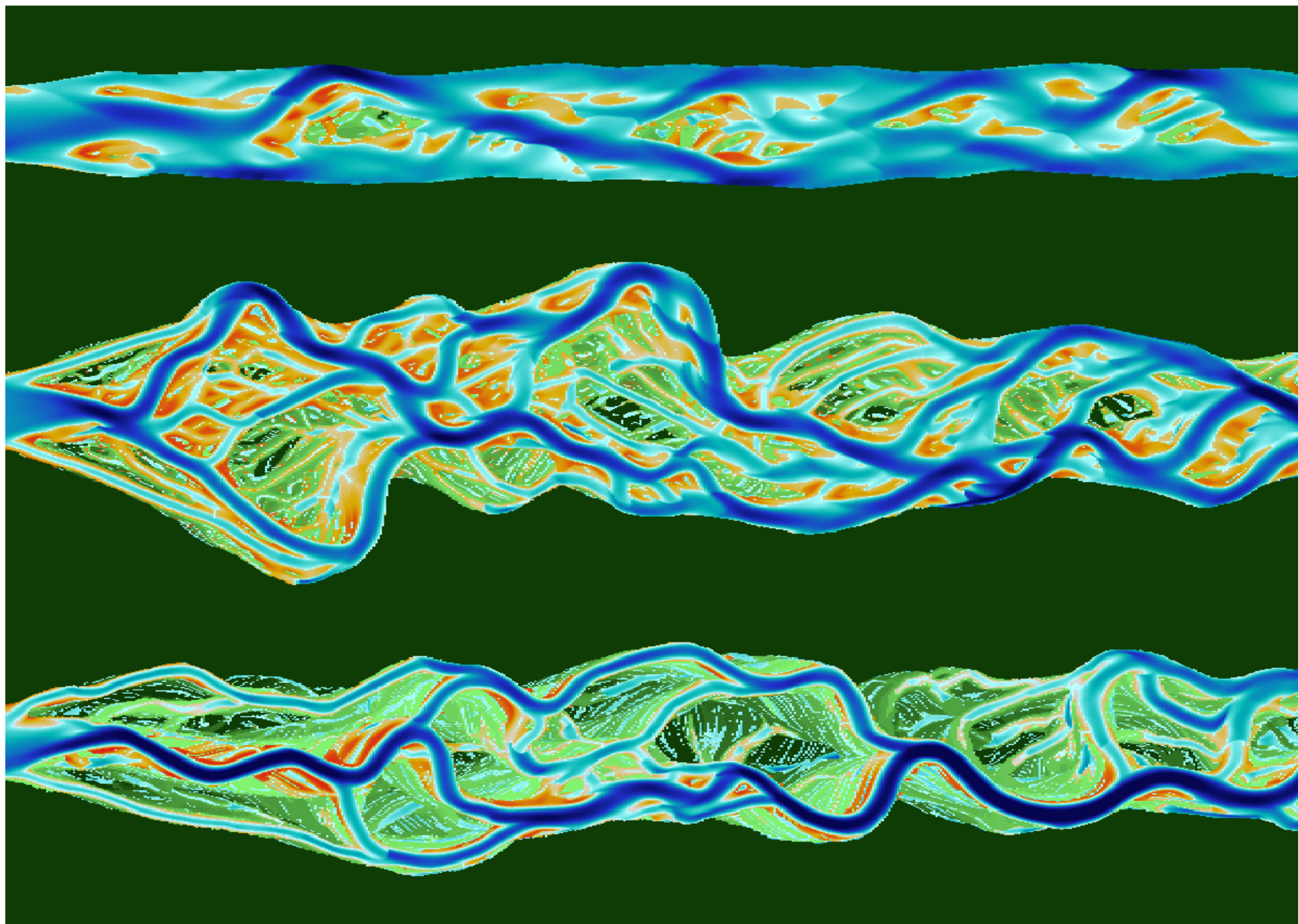


5 m

Depth: 0 m



20 m



Simulation Time: 348 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

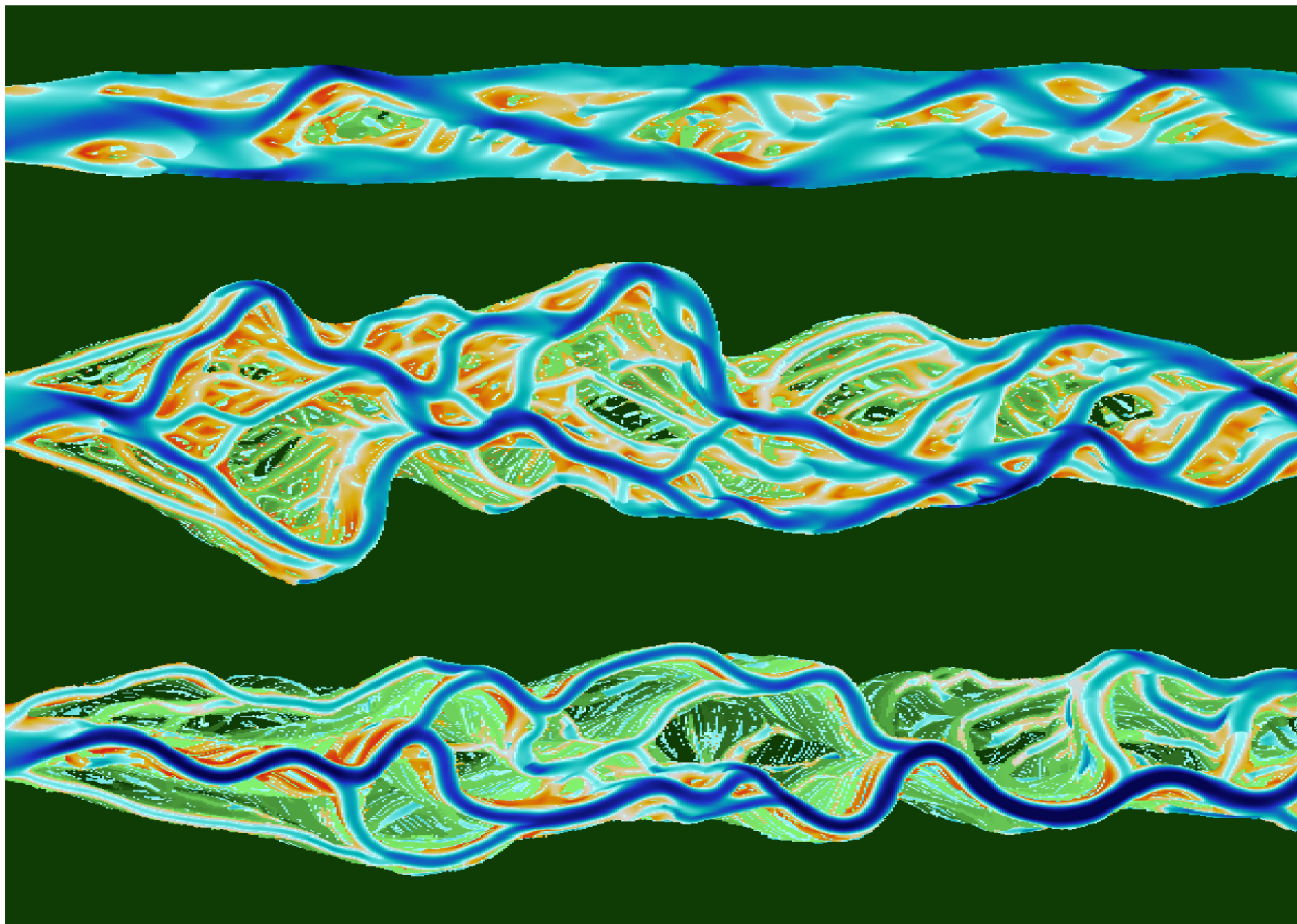


5 m

Depth: 0 m



20 m



Simulation Time: 350 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

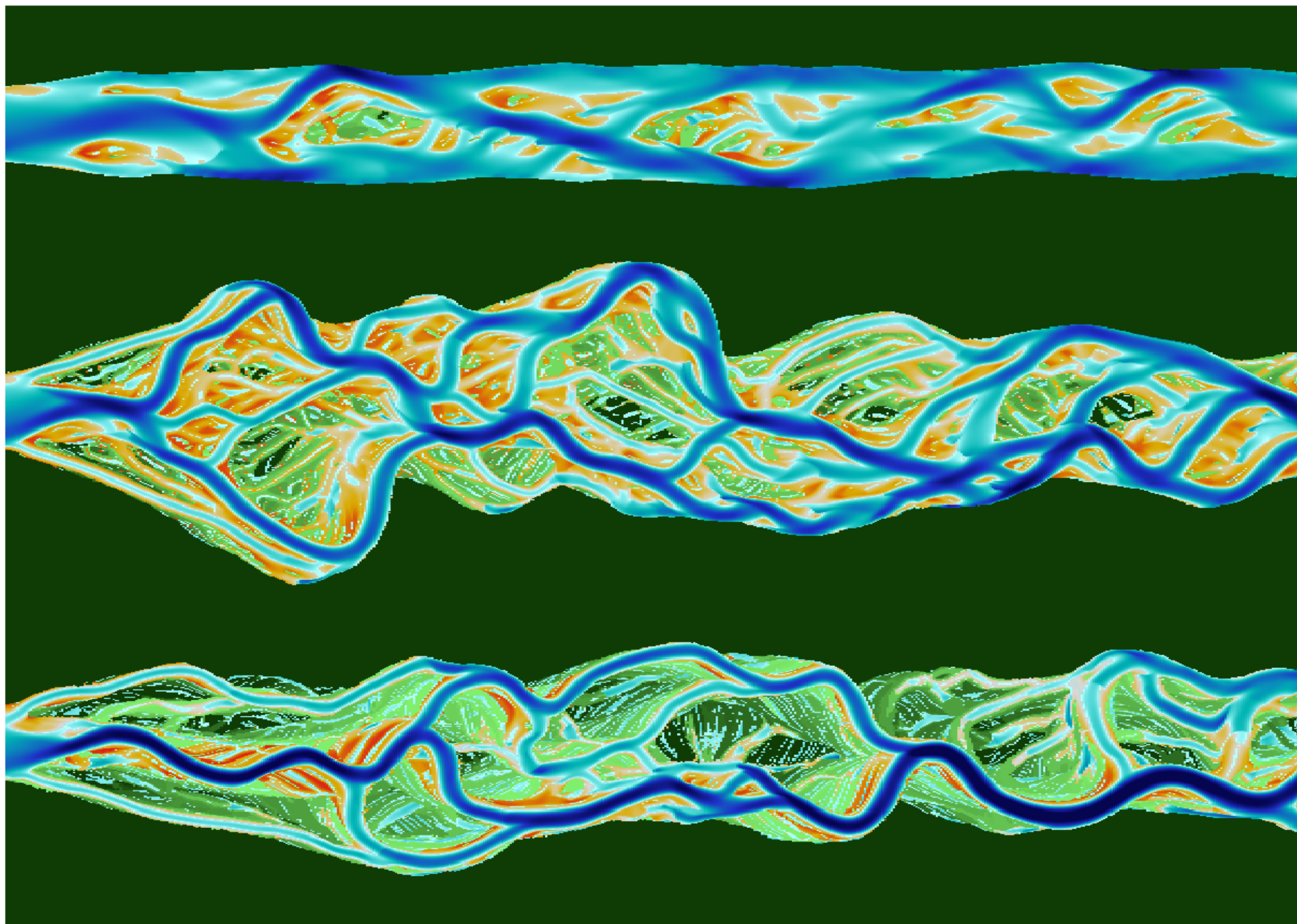


5 m

Depth: 0 m



20 m



Simulation Time: 352 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

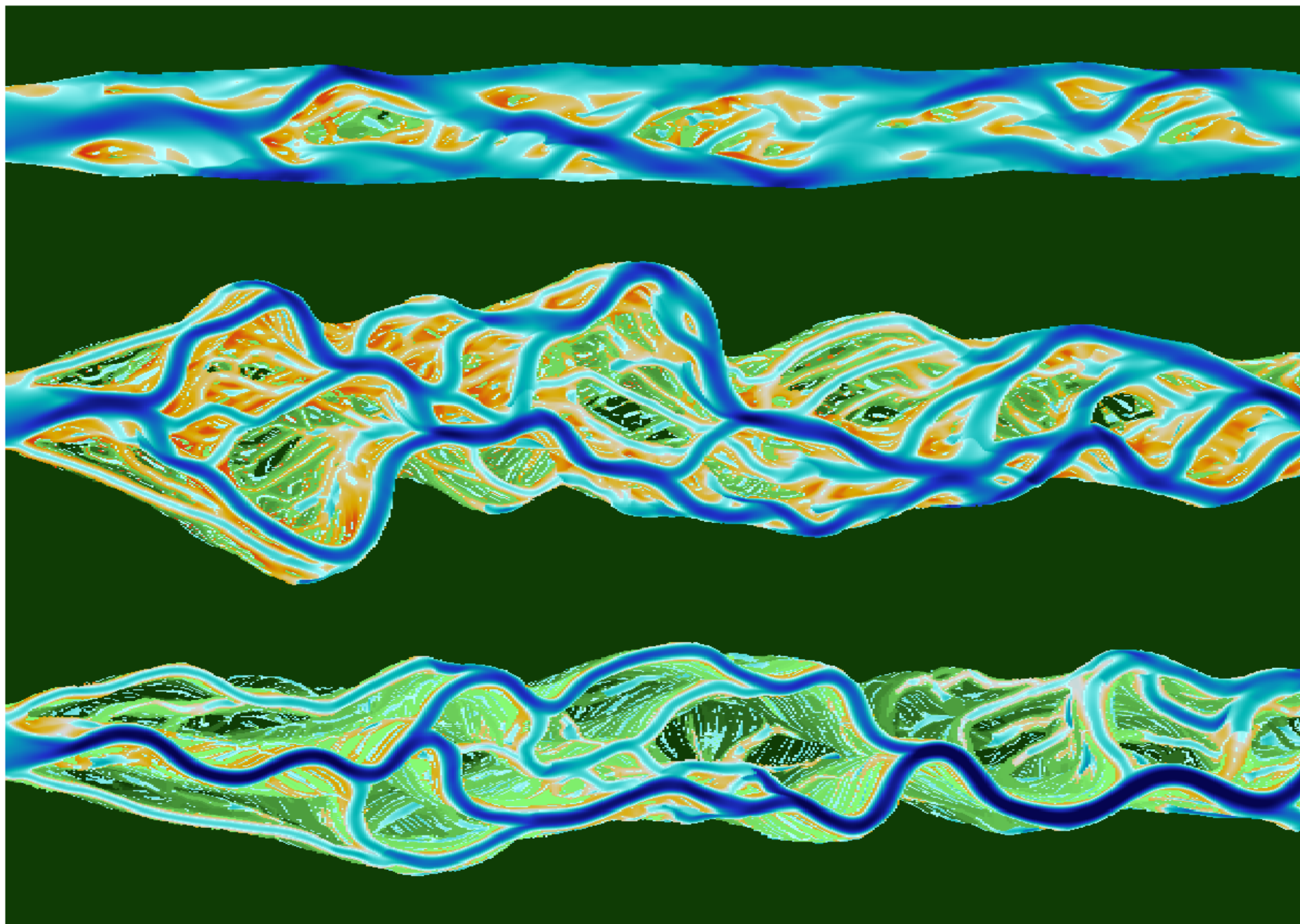


5 m

Depth: 0 m



20 m



Simulation Time: 354 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

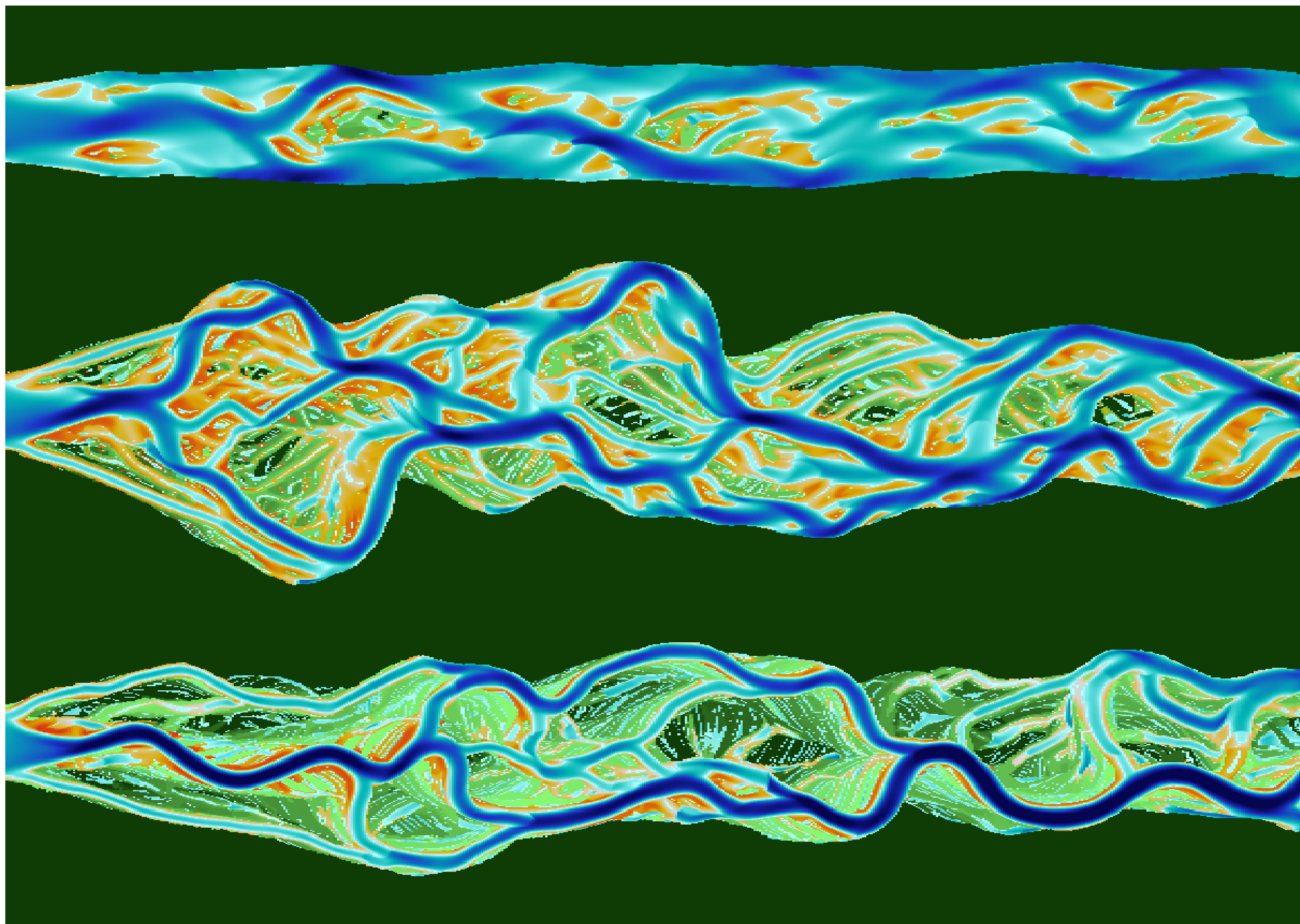


5 m

Depth: 0 m



20 m



Simulation Time: 356 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

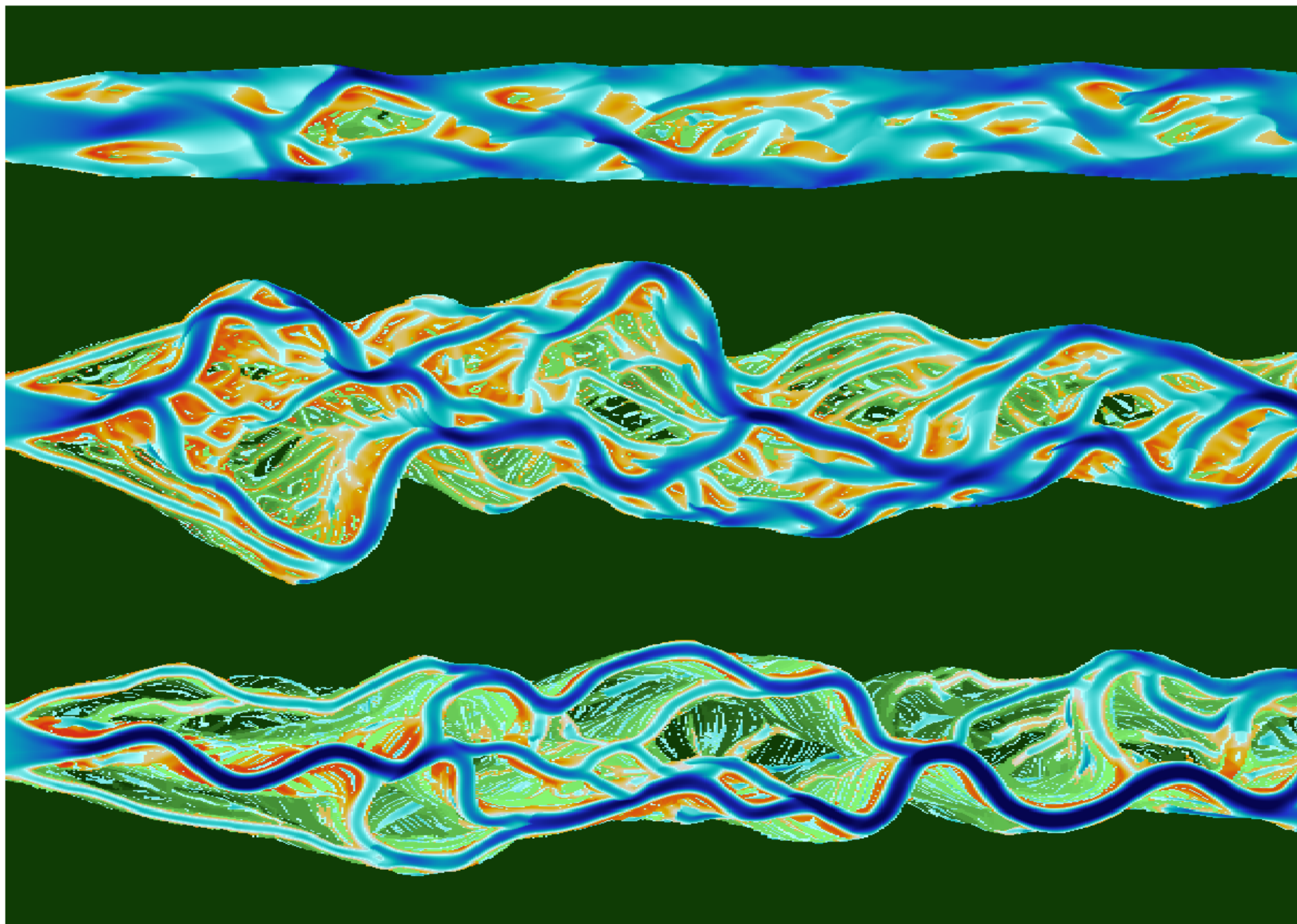


5 m

Depth: 0 m



20 m



Simulation Time: 358 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

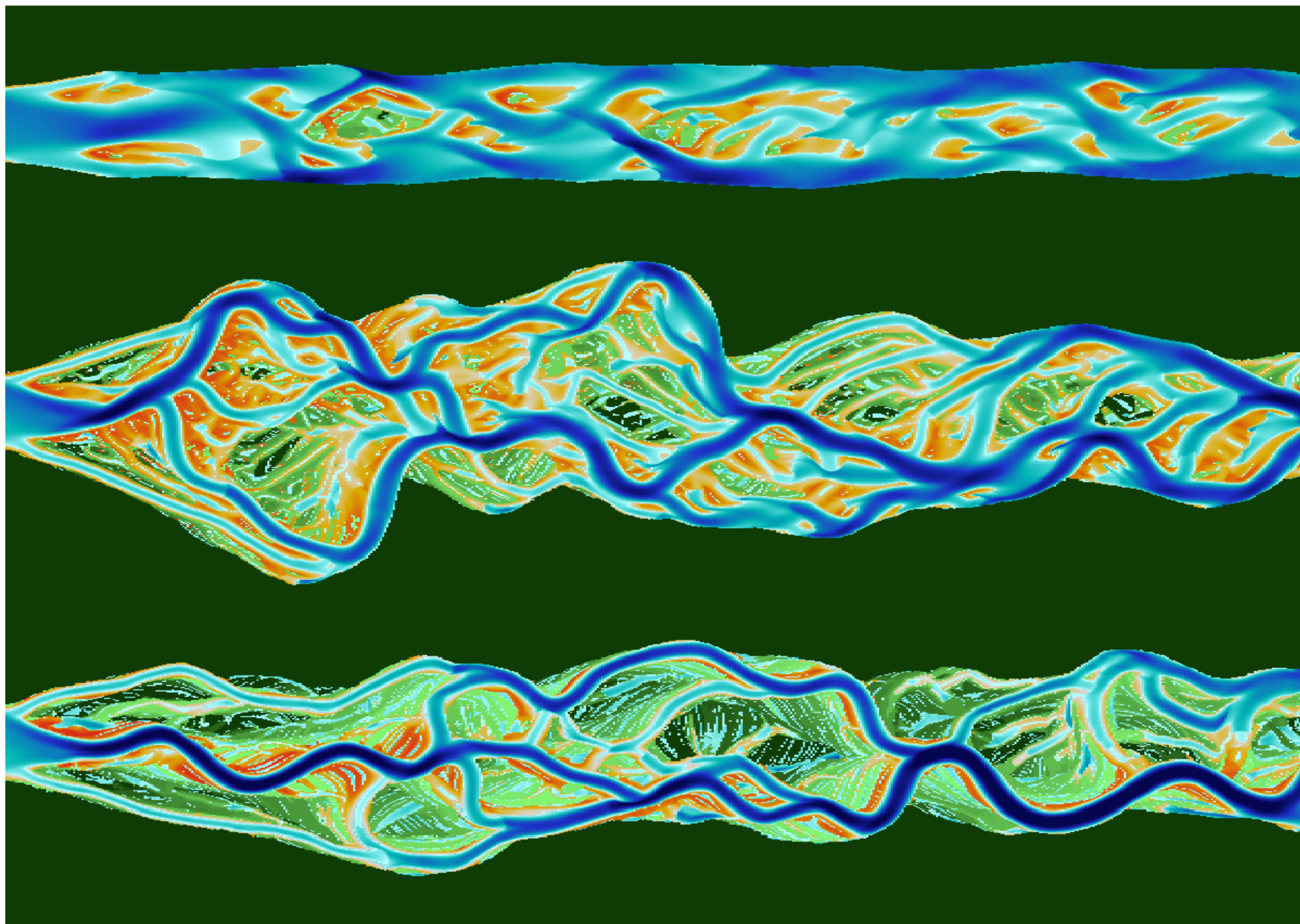


5 m

Depth: 0 m



20 m



Simulation Time: 360 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

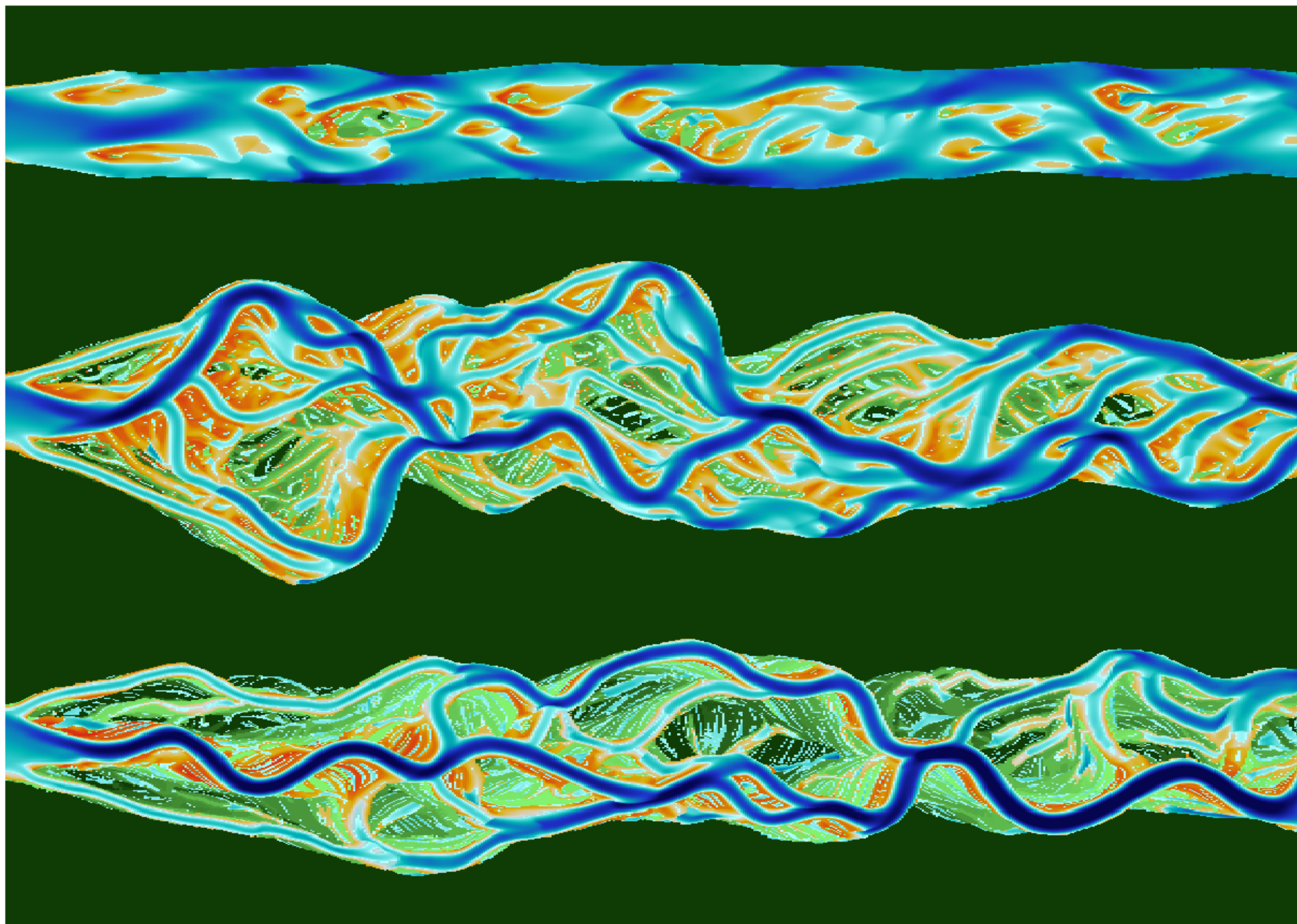


5 m

Depth: 0 m



20 m



Simulation Time: 362 yr

Vegetation Age: 0 yr



200 yr

Elevation: 0 m

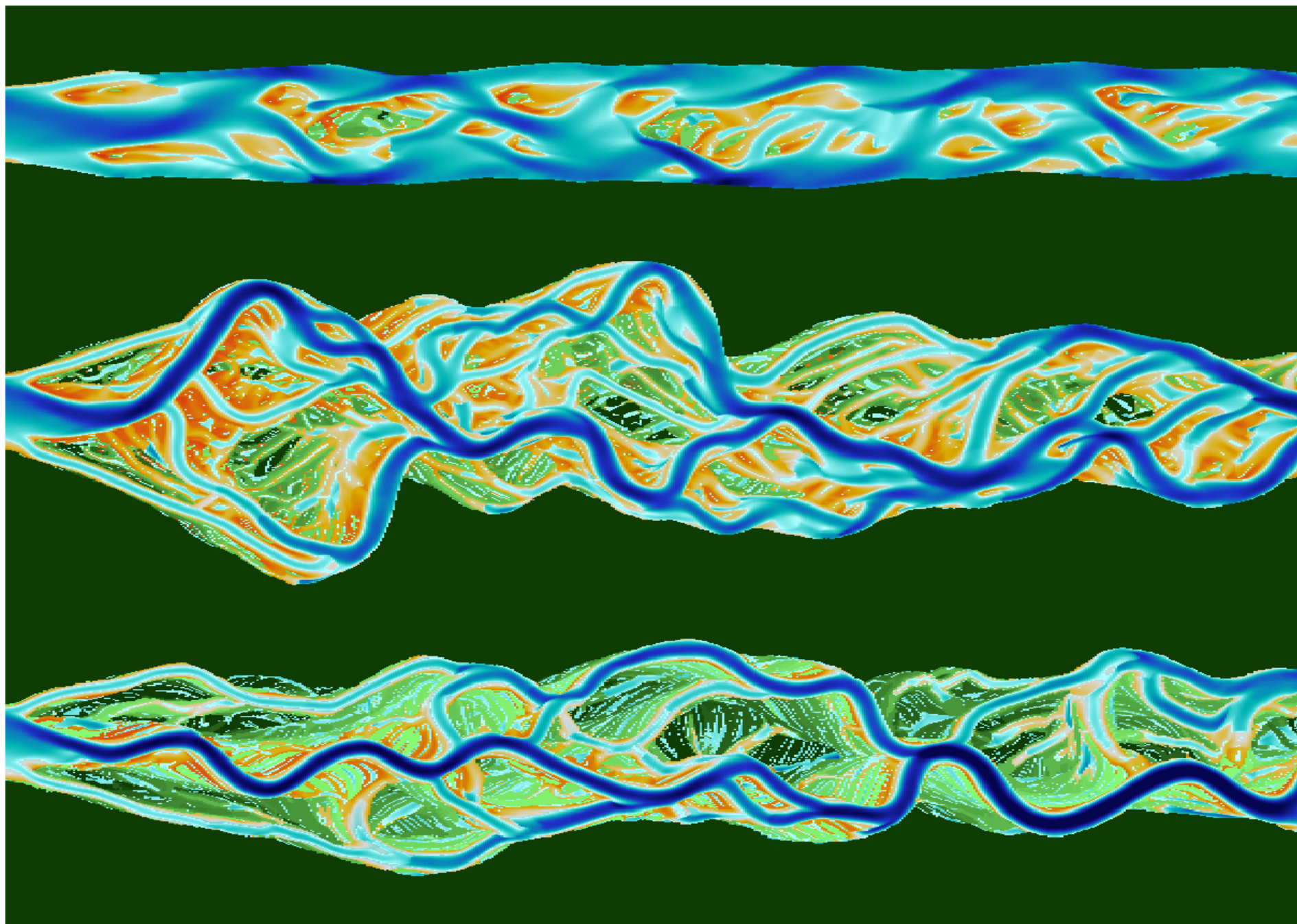


5 m

Depth: 0 m



20 m

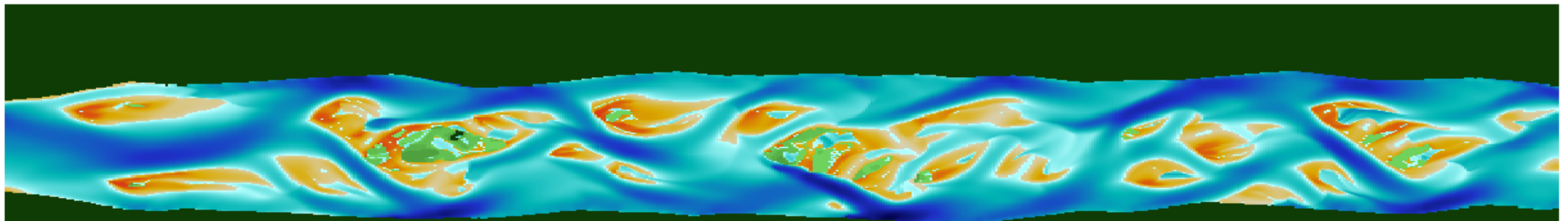


Simulation Time: 364 yr

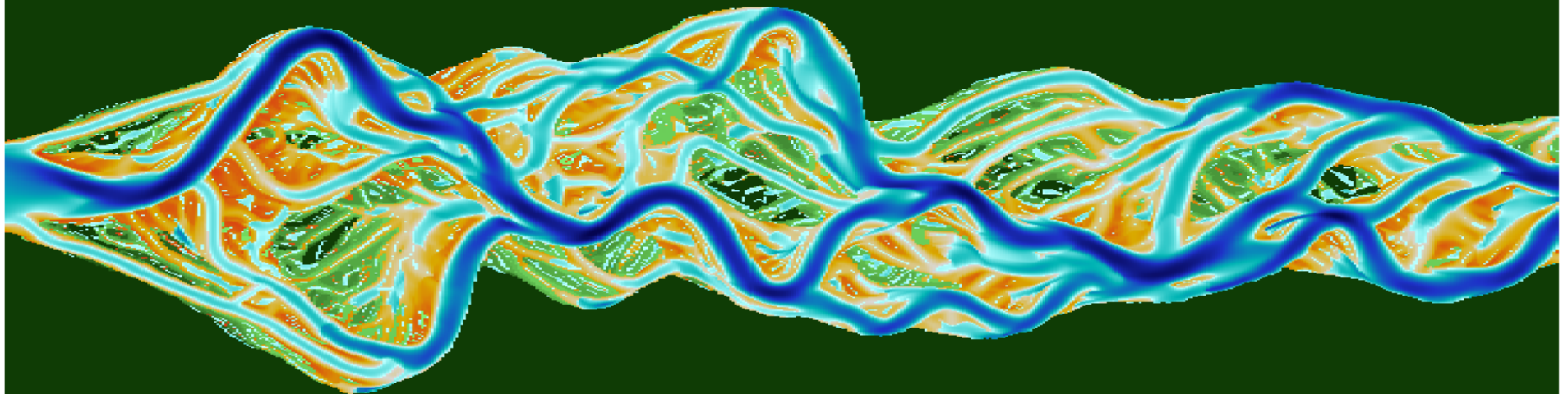
Vegetation Age: 0 yr  200 yr

Elevation: 0 m  5 m

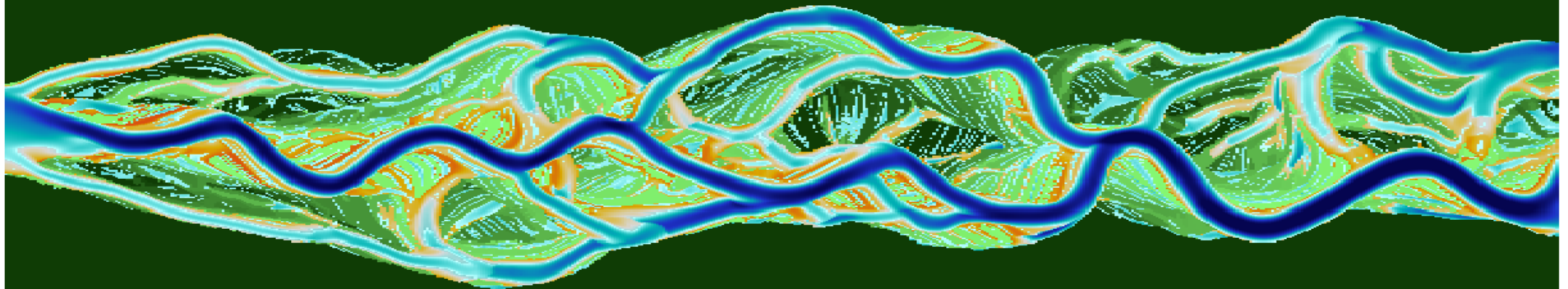
Depth: 0 m  20 m



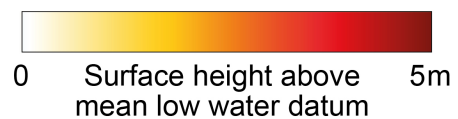
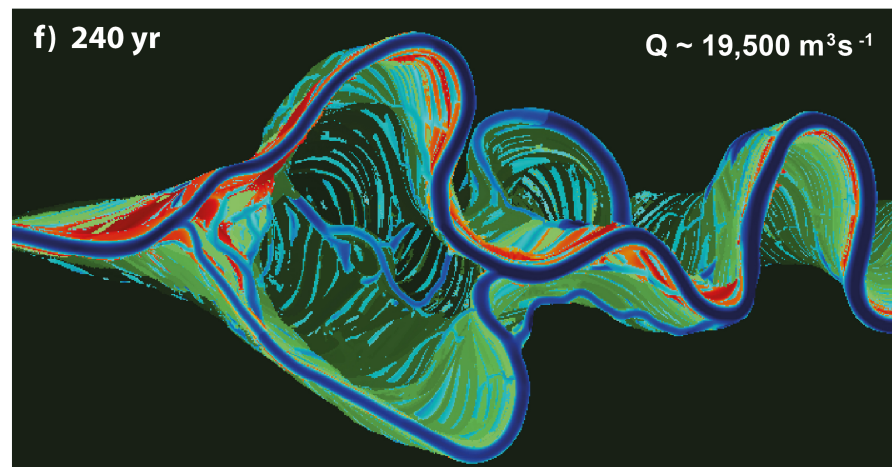
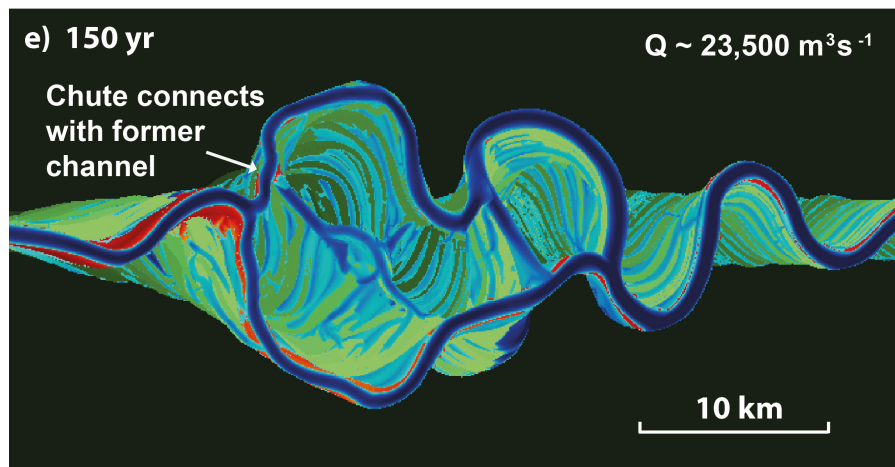
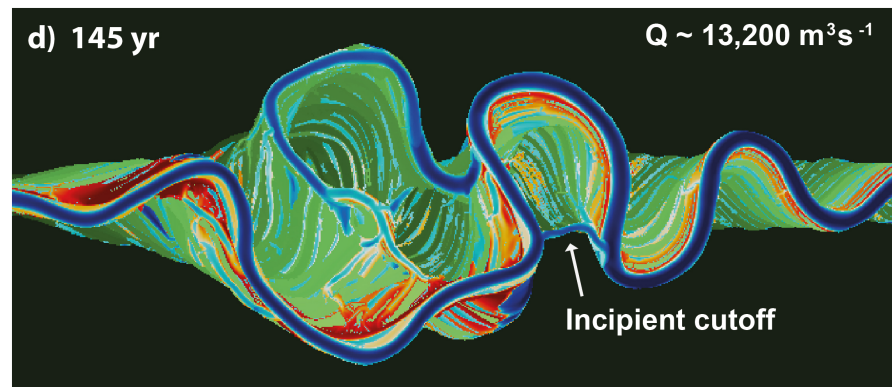
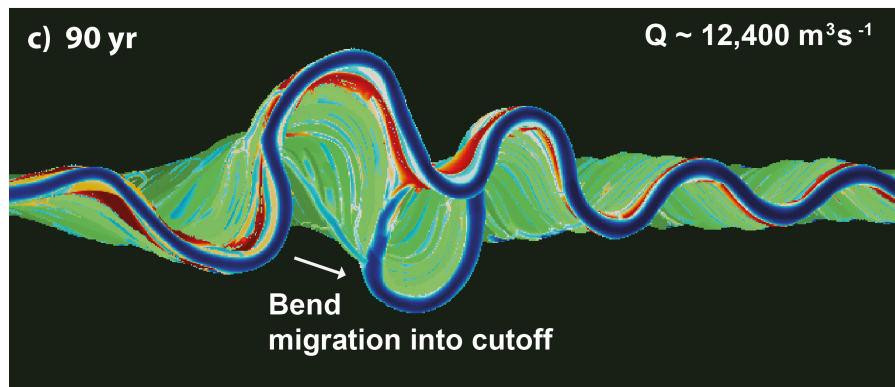
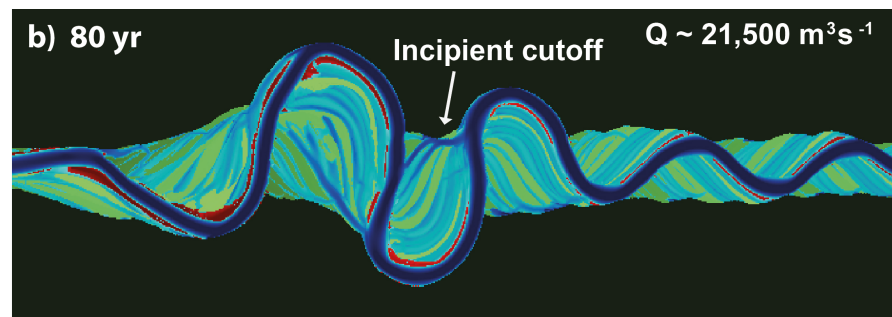
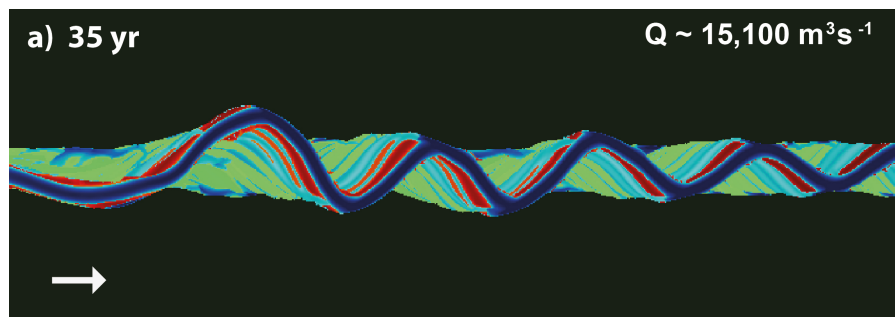
$D = 0.4 \text{ mm}$ / $S = 0.00005$ / $C = 55$ / Strong banks / Slow vegetation growth



$D = 0.4 \text{ mm}$ / $S = 0.0001$ / $C = 40$ / Weak banks / Slow vegetation growth



$D = 0.2 \text{ mm}$ / $S = 0.0001$ / $C = 40$ / Weak banks / Fast vegetation growth

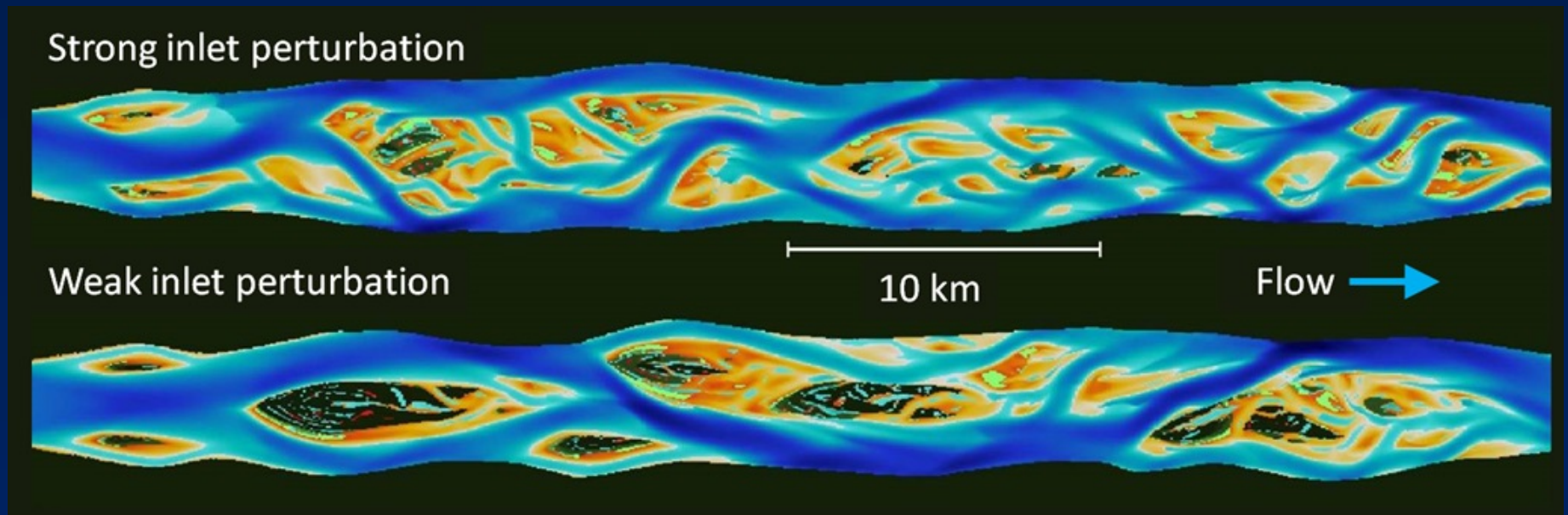


Model uncertainty – Process representation



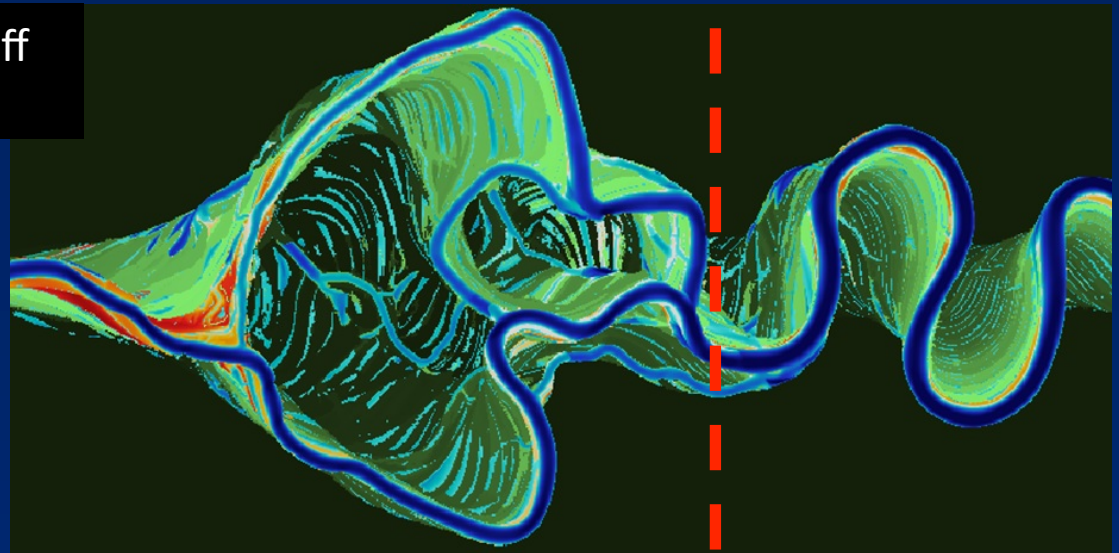
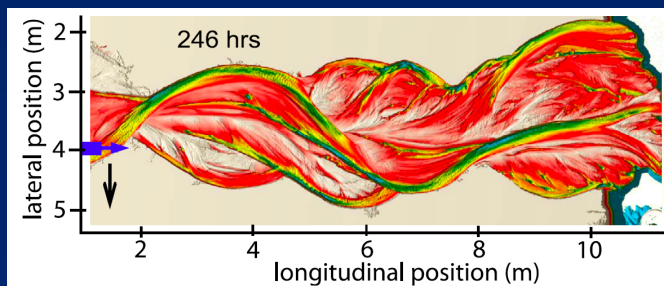
- Mode sediment transport (bedload vs suspension)
- Controls on sediment transport direction (2ndry flow, lateral side slopes)
- Adaption length of fine sediment (and damping of bar topography)
- Bedform effects: Influence on topographic steering of sediment
 Non-uniform, unsteady roughness
- Evolution of floodplain vegetation (resistance, soil development, hydrology)

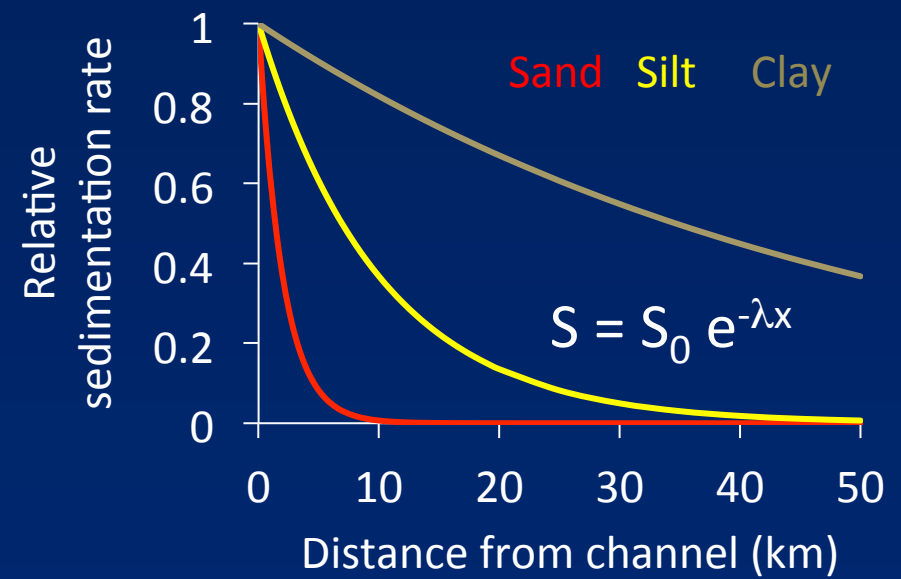
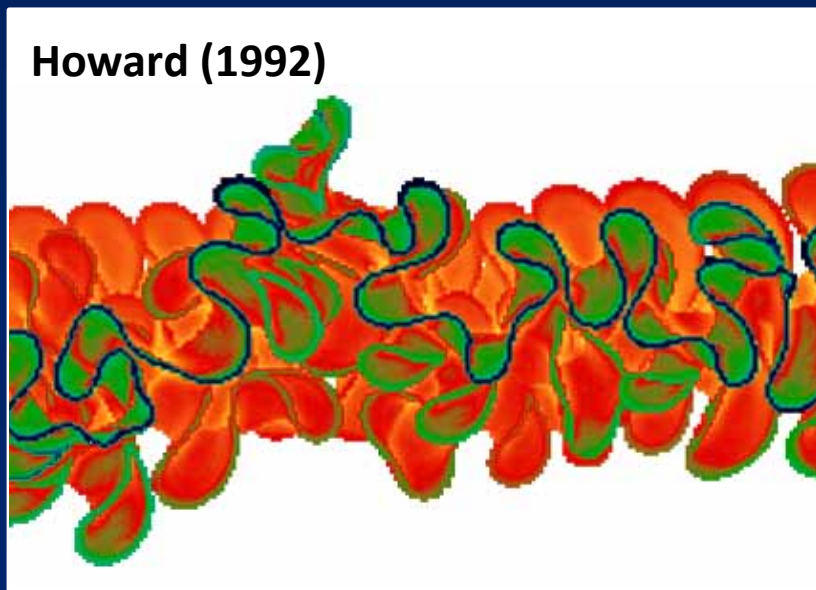
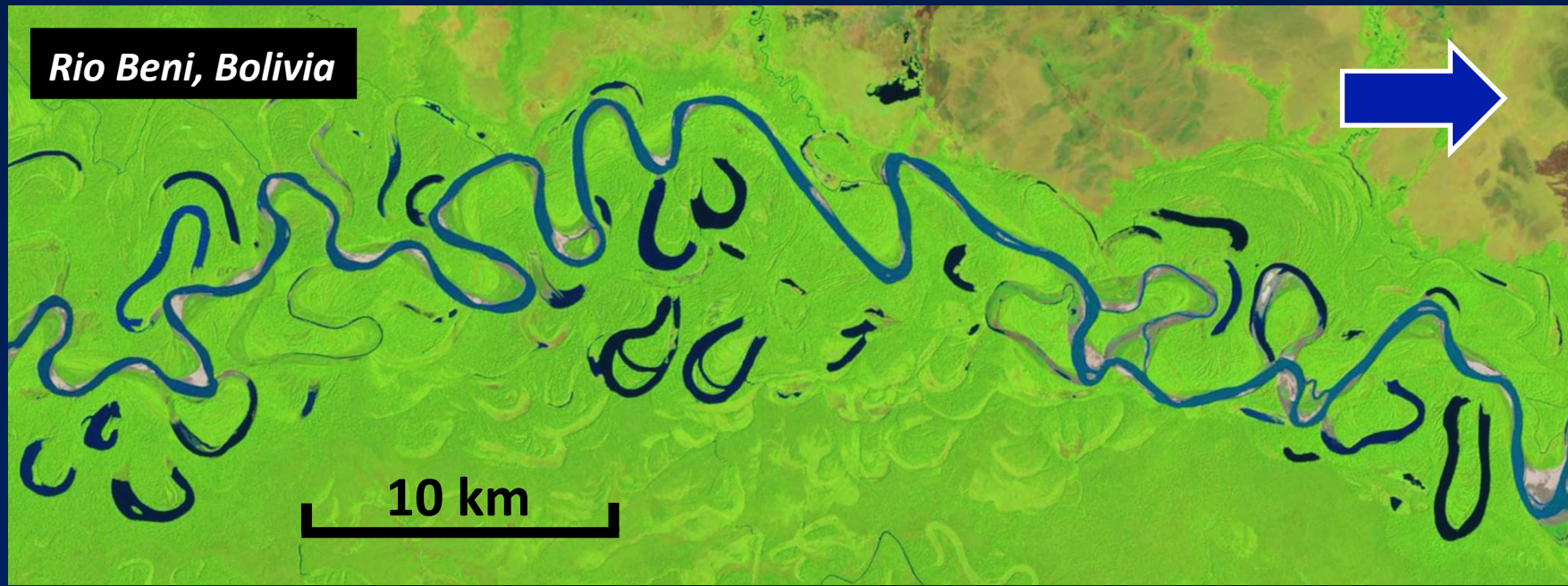
Boundary condition uncertainty



Inlet perturbation drives bend cutoff in upstream portion of domain...

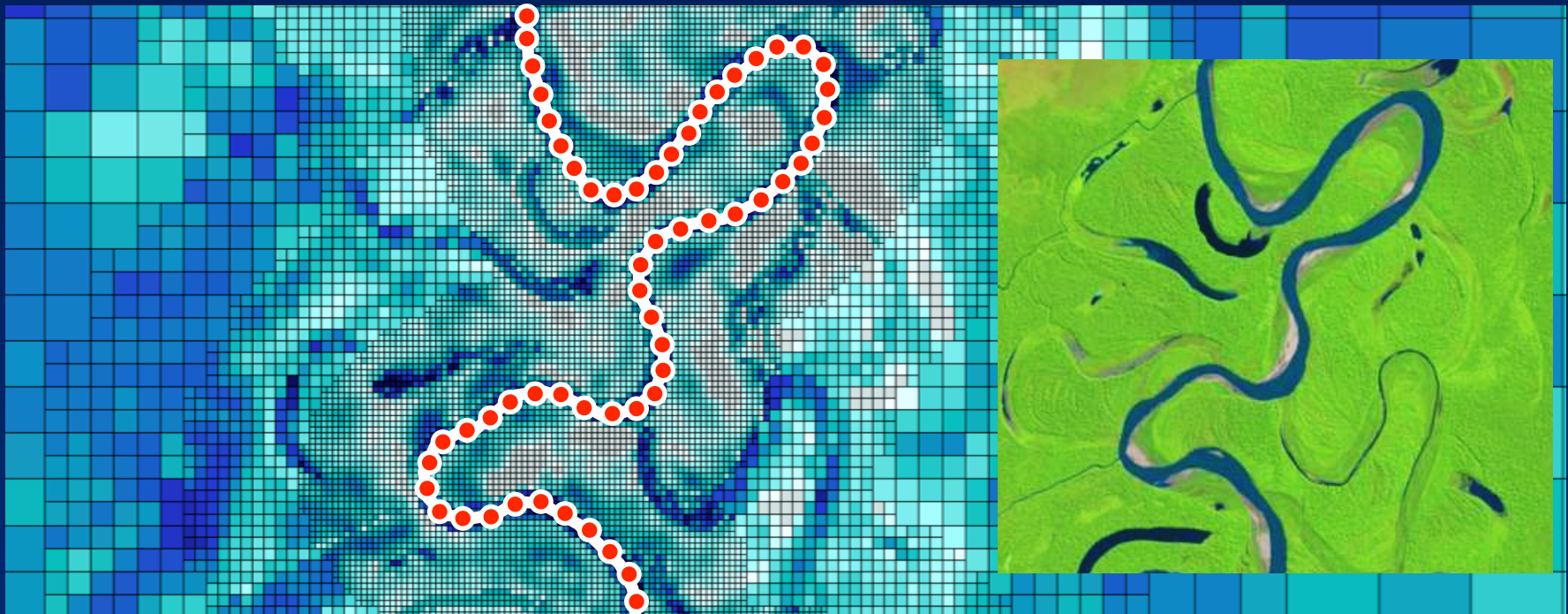
Van Dijk et al (2012)





Physically-based approach to floodplain construction

- Coupled 1D (channel) & 2D (floodplain) approach
Shallow water equations with advection-diffusion sediment transport model
 - Implemented on a quadtree grid
 - First order accurate solution
- } Enhancing model efficiency



Modeled sediment dispersion for 6 month hydrograph



Flow direction →

Modeled sediment dispersion for 6 month hydrograph



Flow direction →

Modeled sediment dispersion for 6 month hydrograph



Flow direction →

Modeled sediment dispersion for 6 month hydrograph



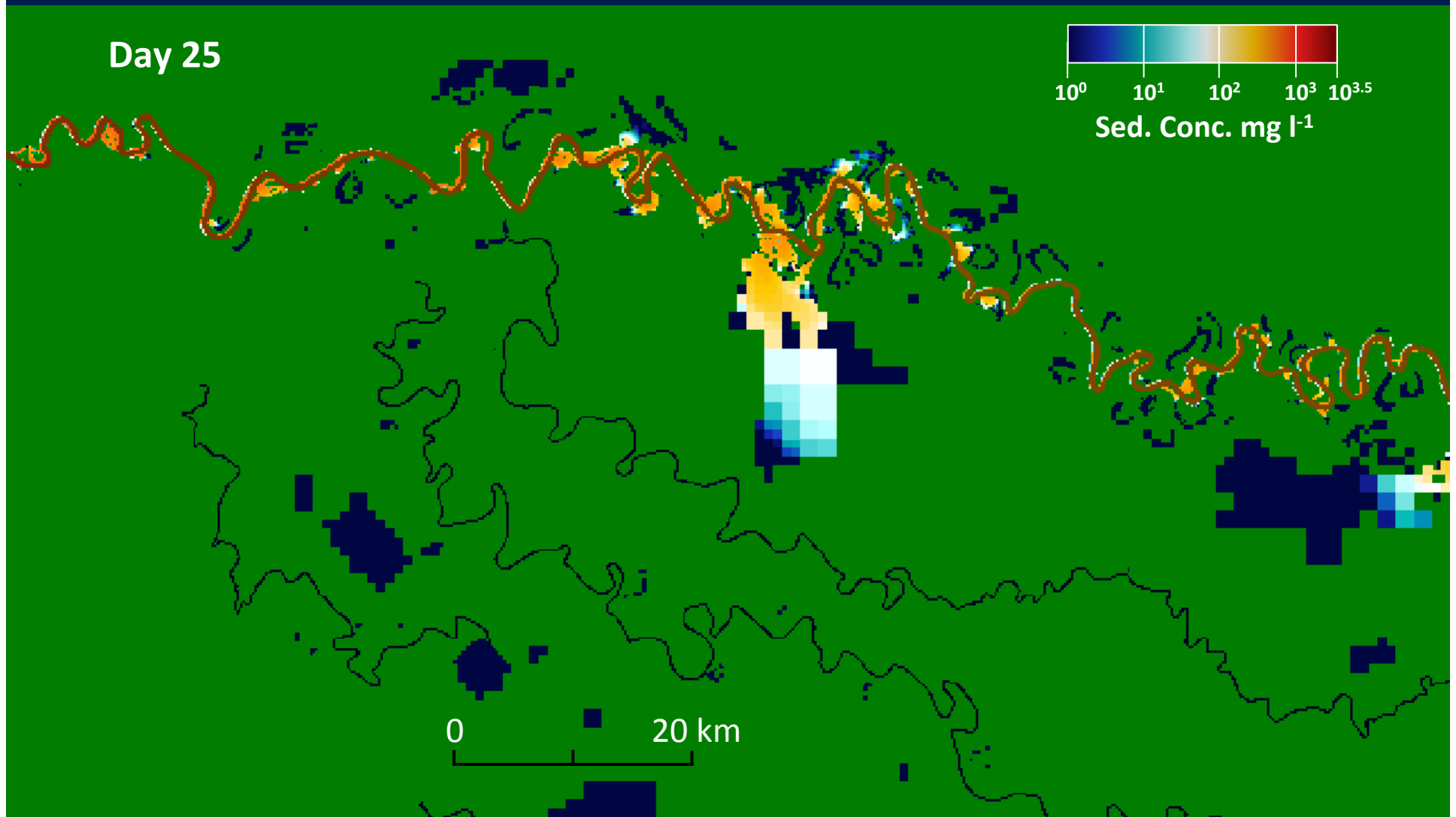
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



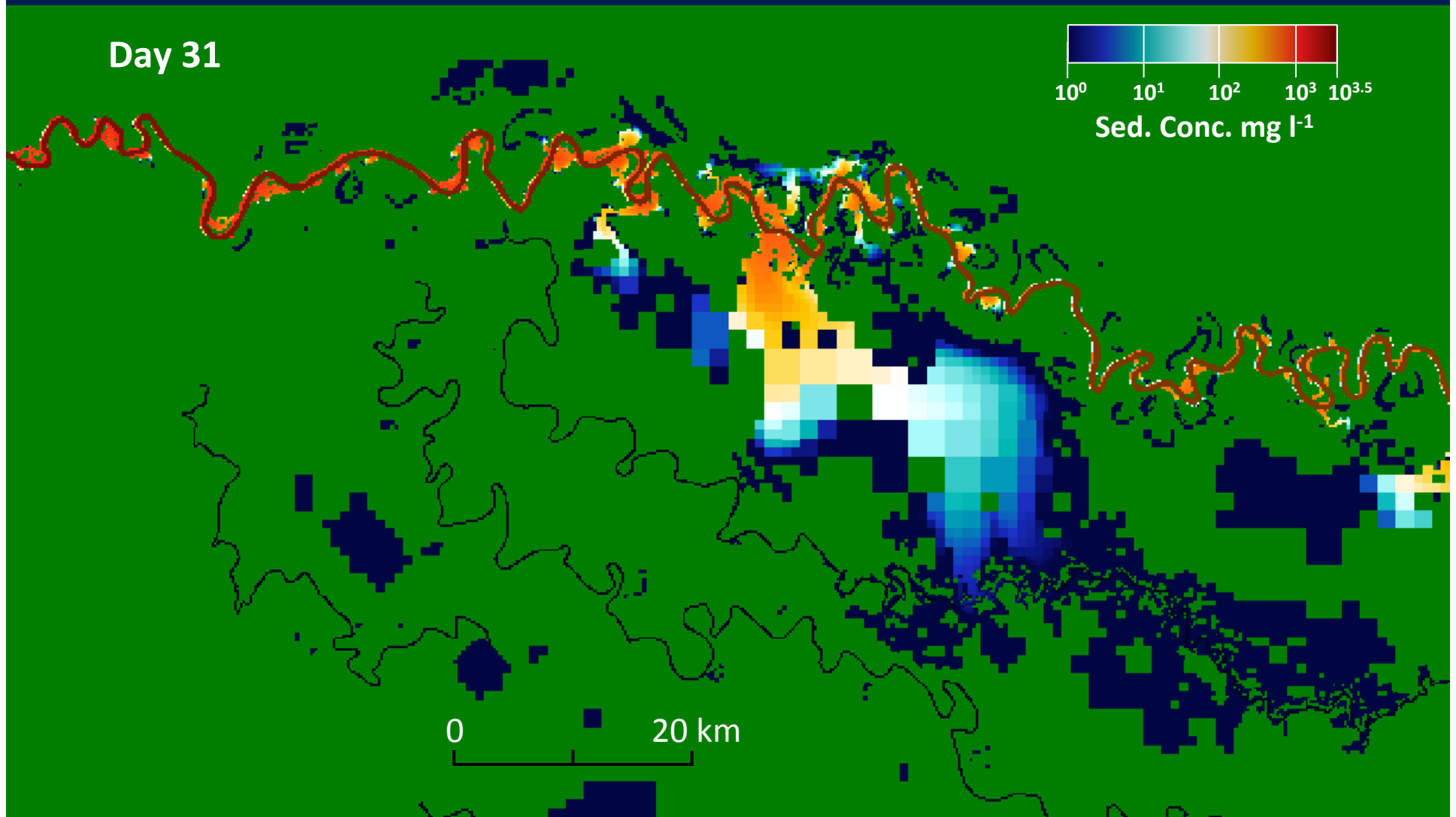
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



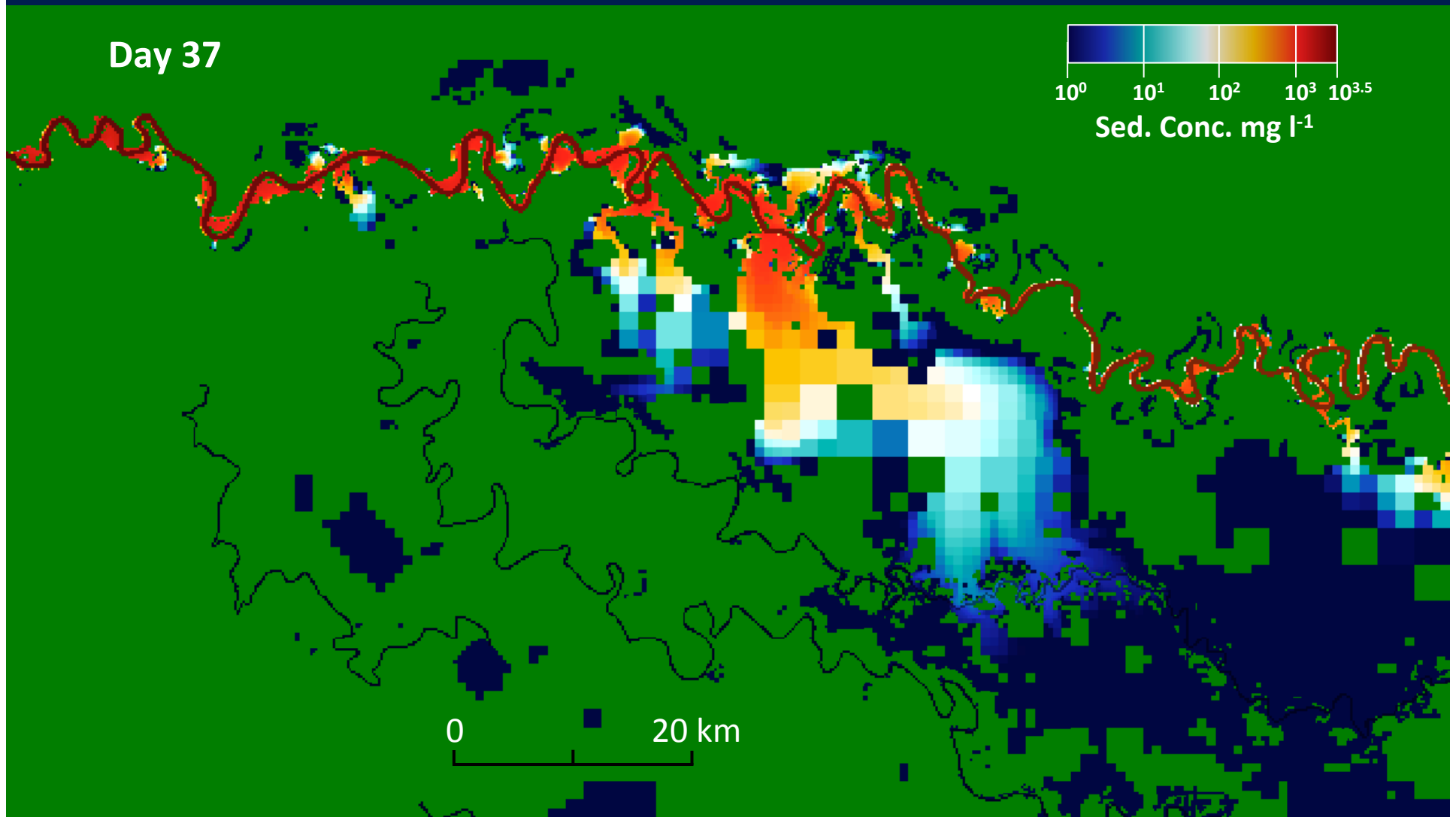
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



Flow direction →

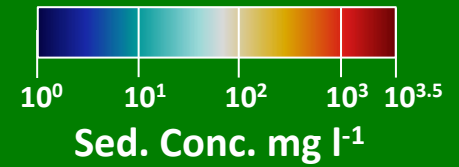
Modeled sediment dispersion for 6 month hydrograph



Flow direction →

Modeled sediment dispersion for 6 month hydrograph

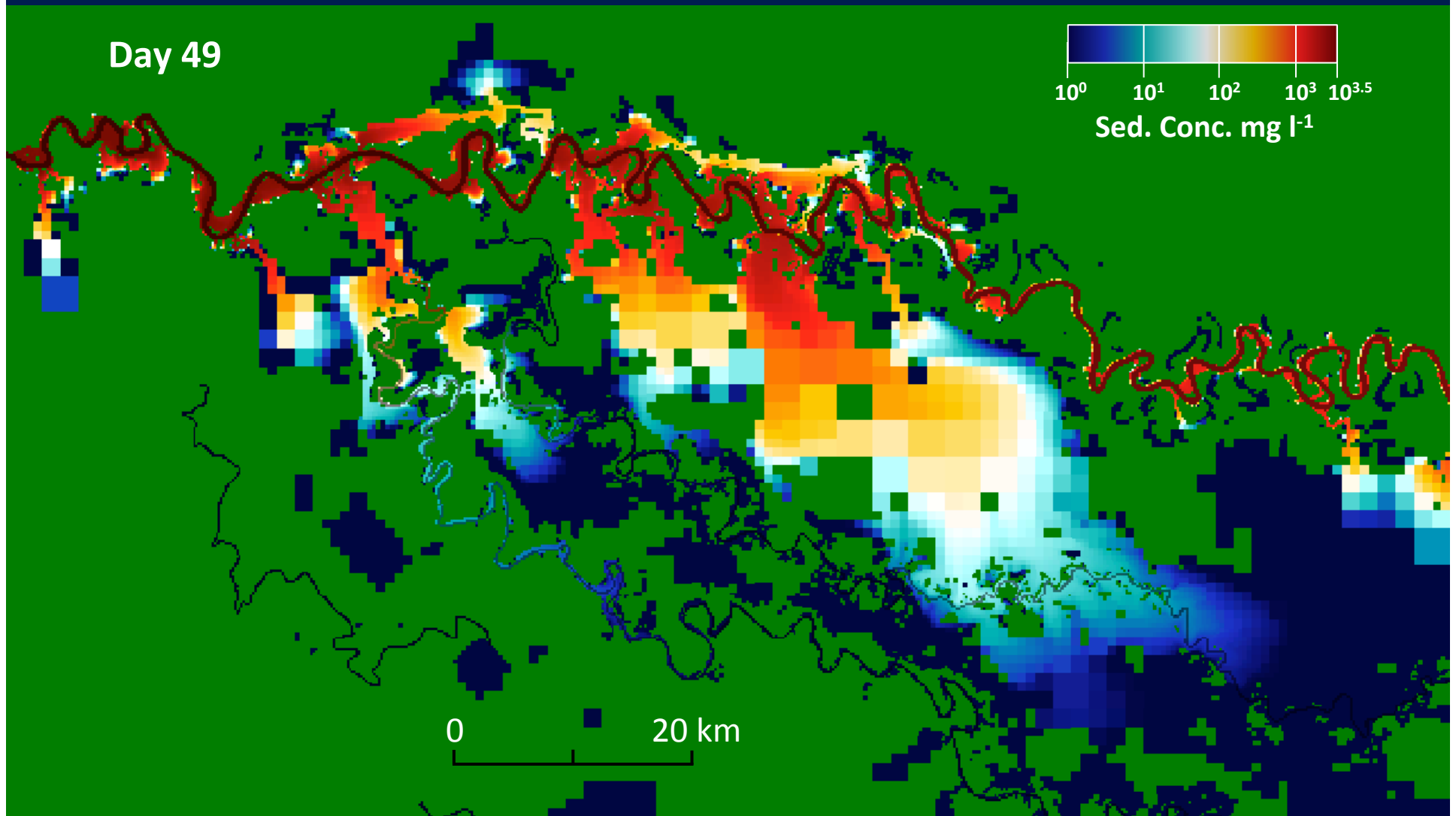
Day 43



0 20 km

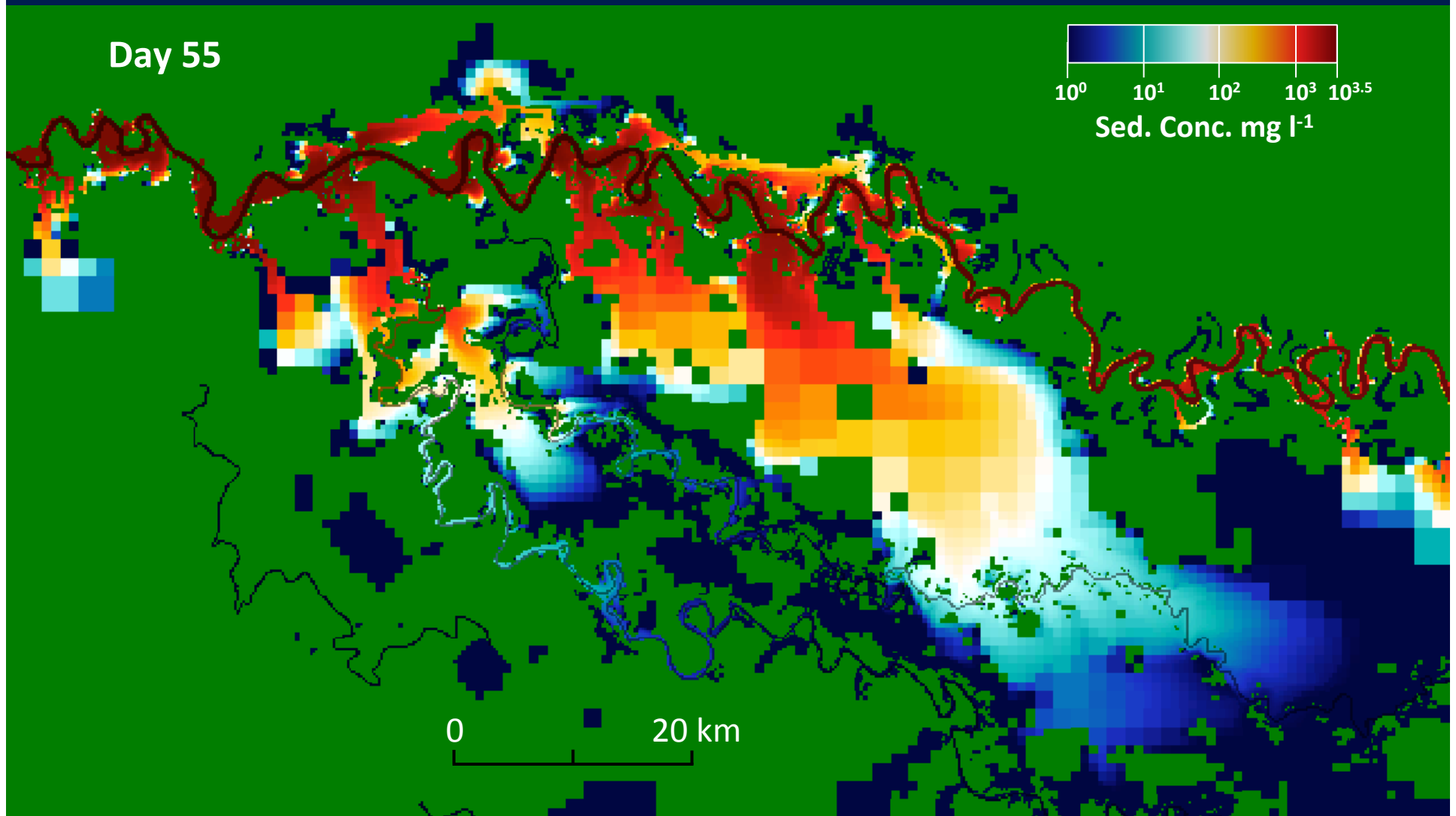
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



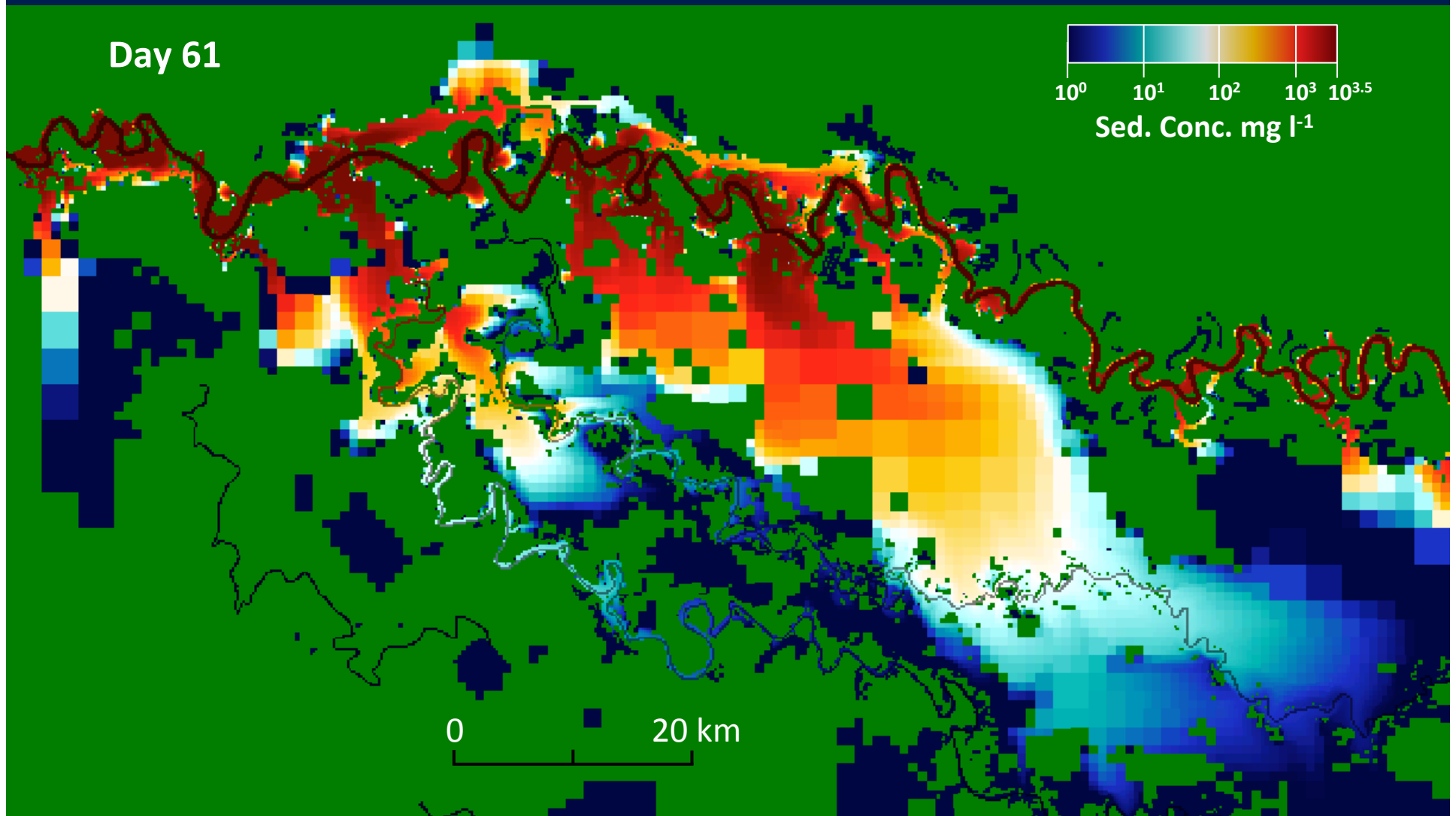
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



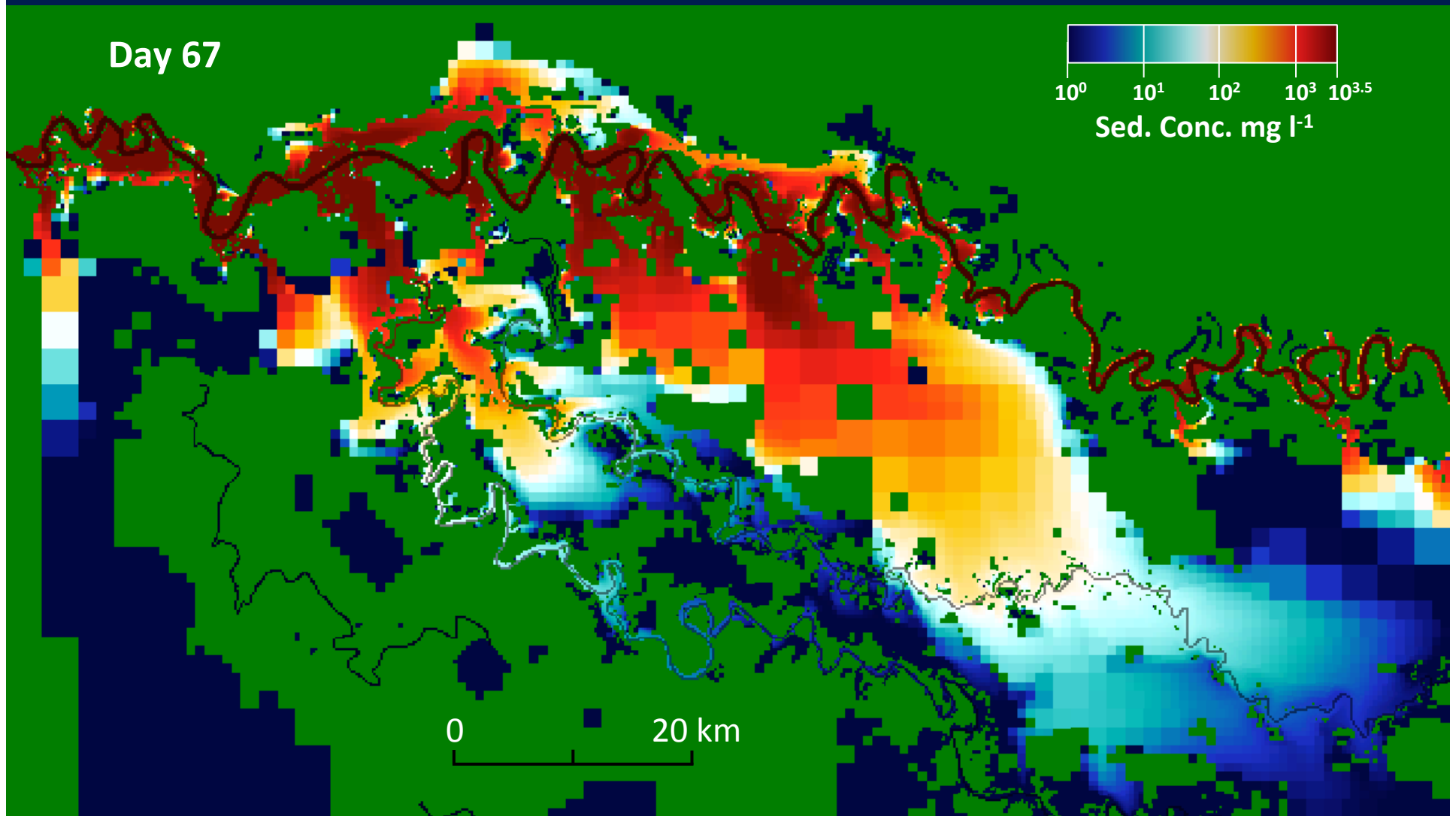
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



Flow direction →

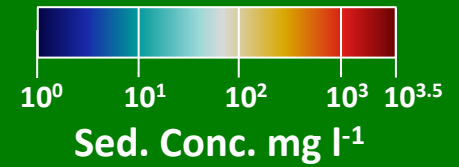
Modeled sediment dispersion for 6 month hydrograph



Flow direction →

Modeled sediment dispersion for 6 month hydrograph

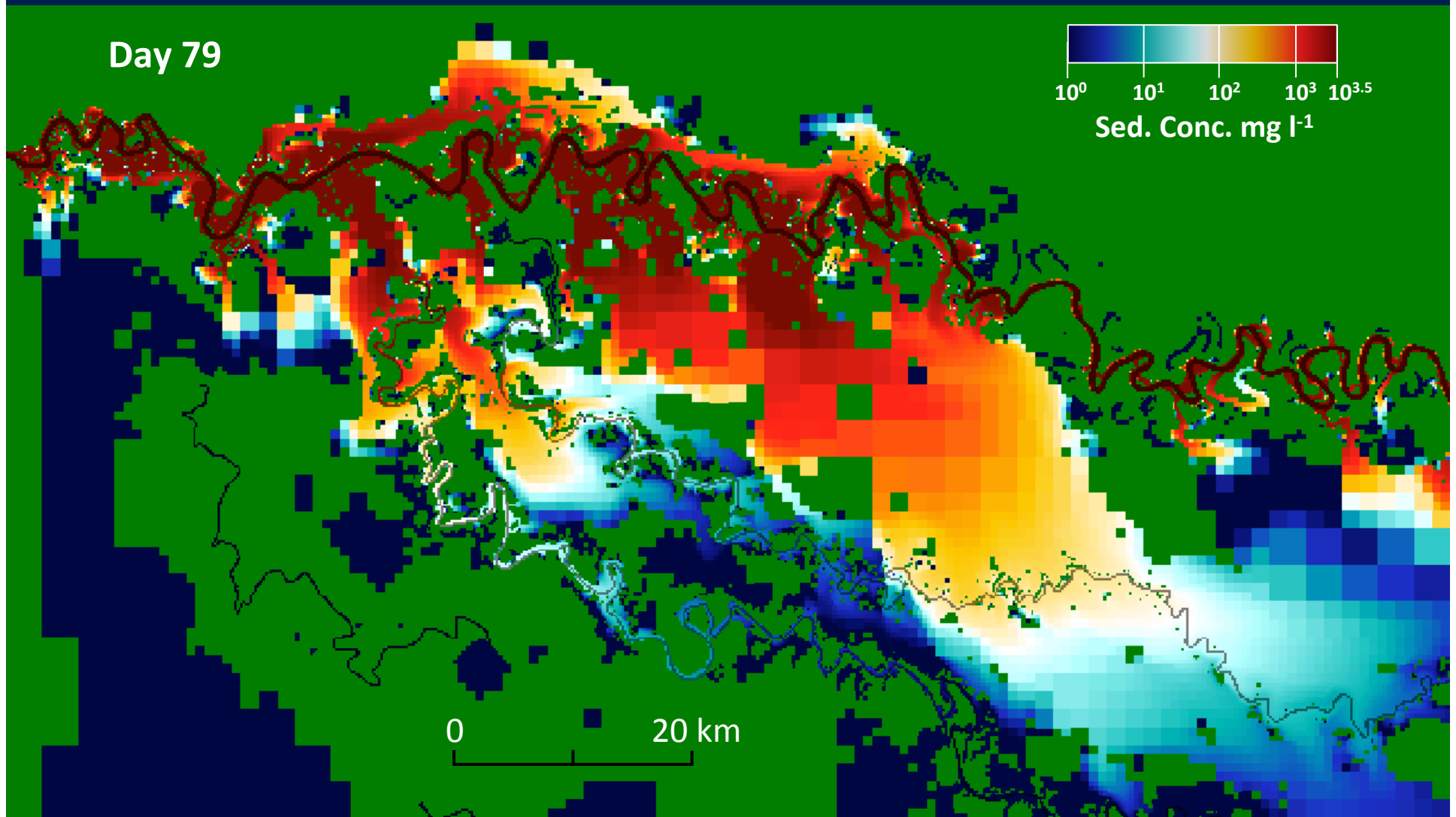
Day 73



0 20 km

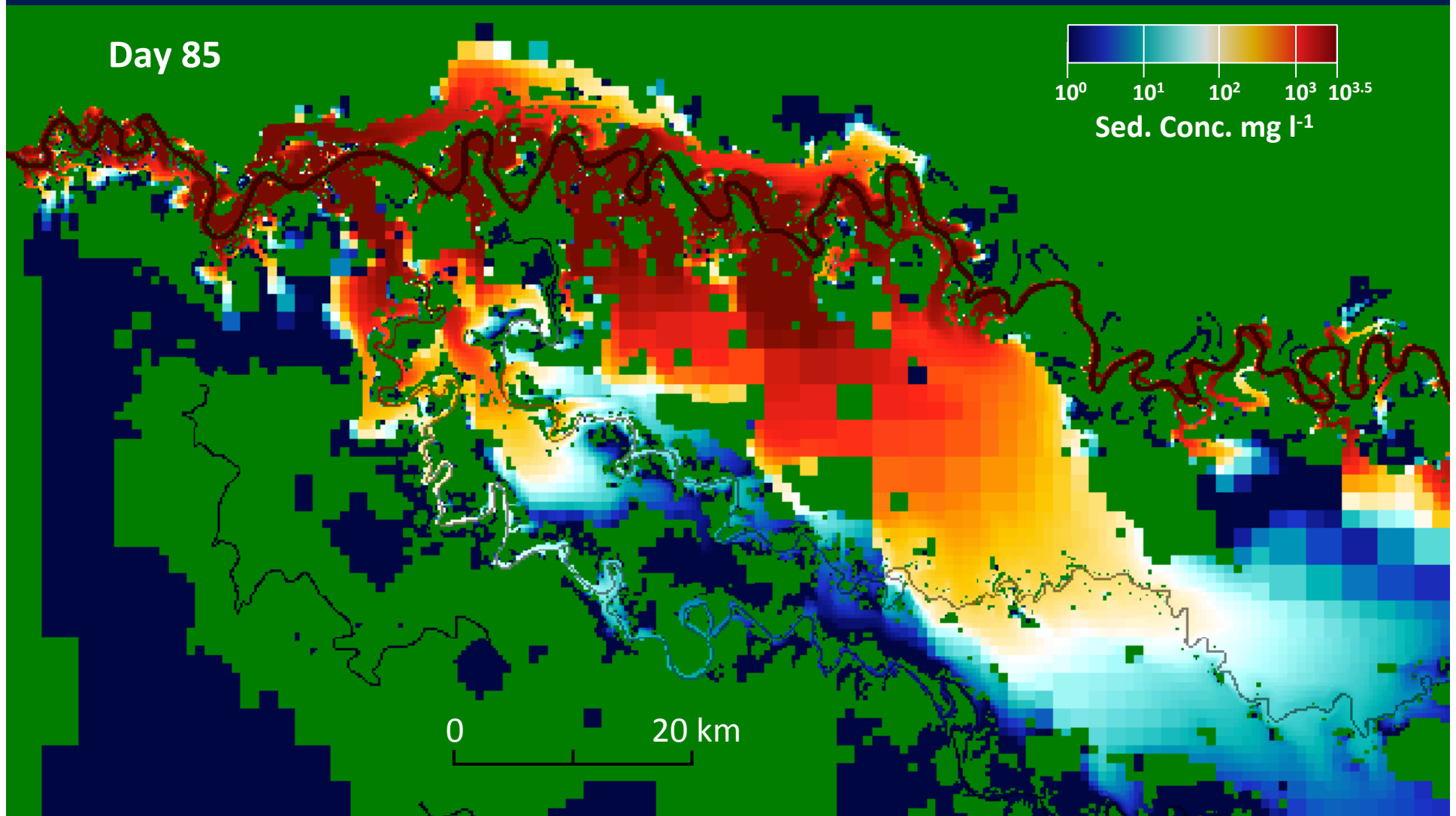
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



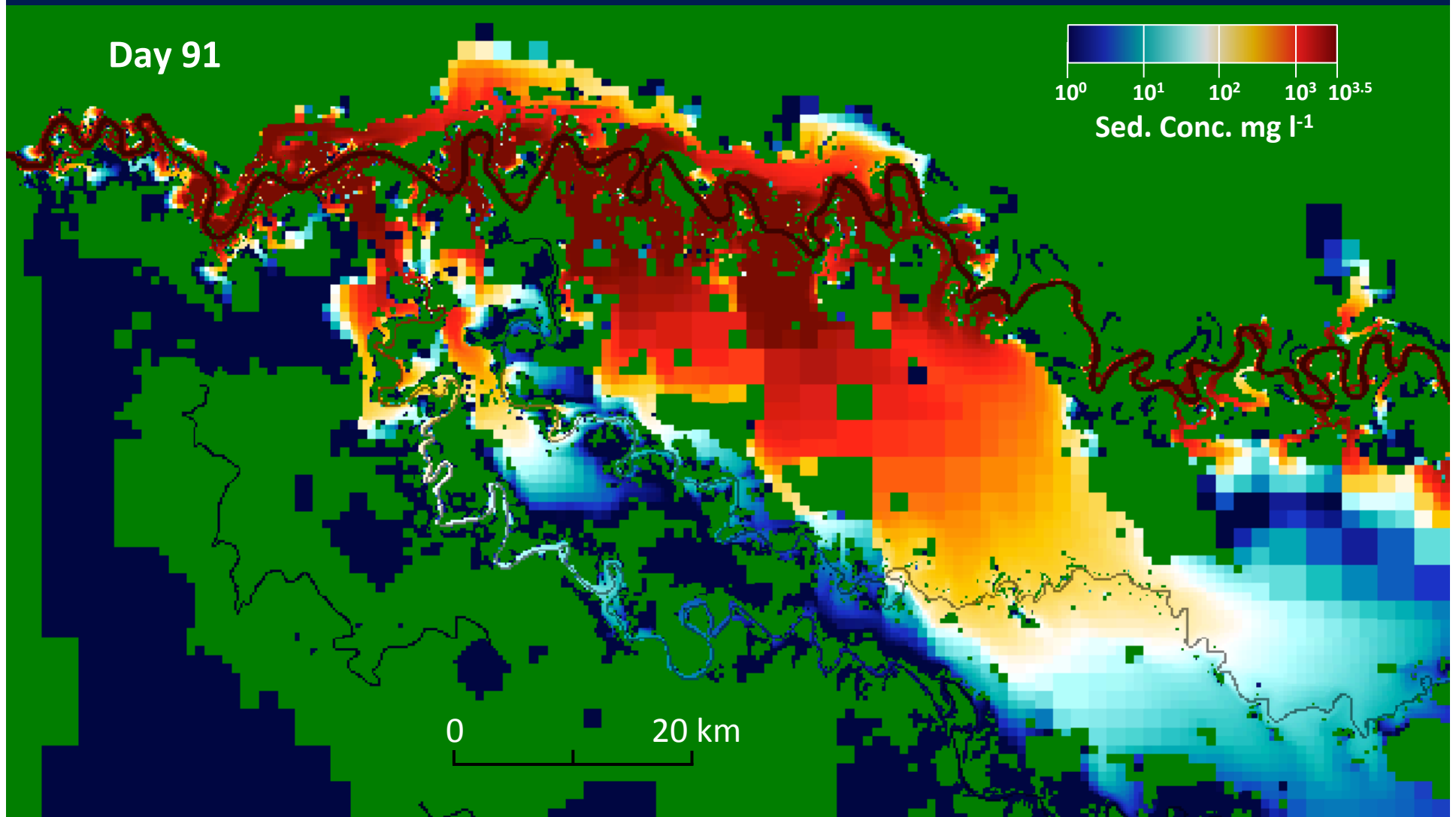
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



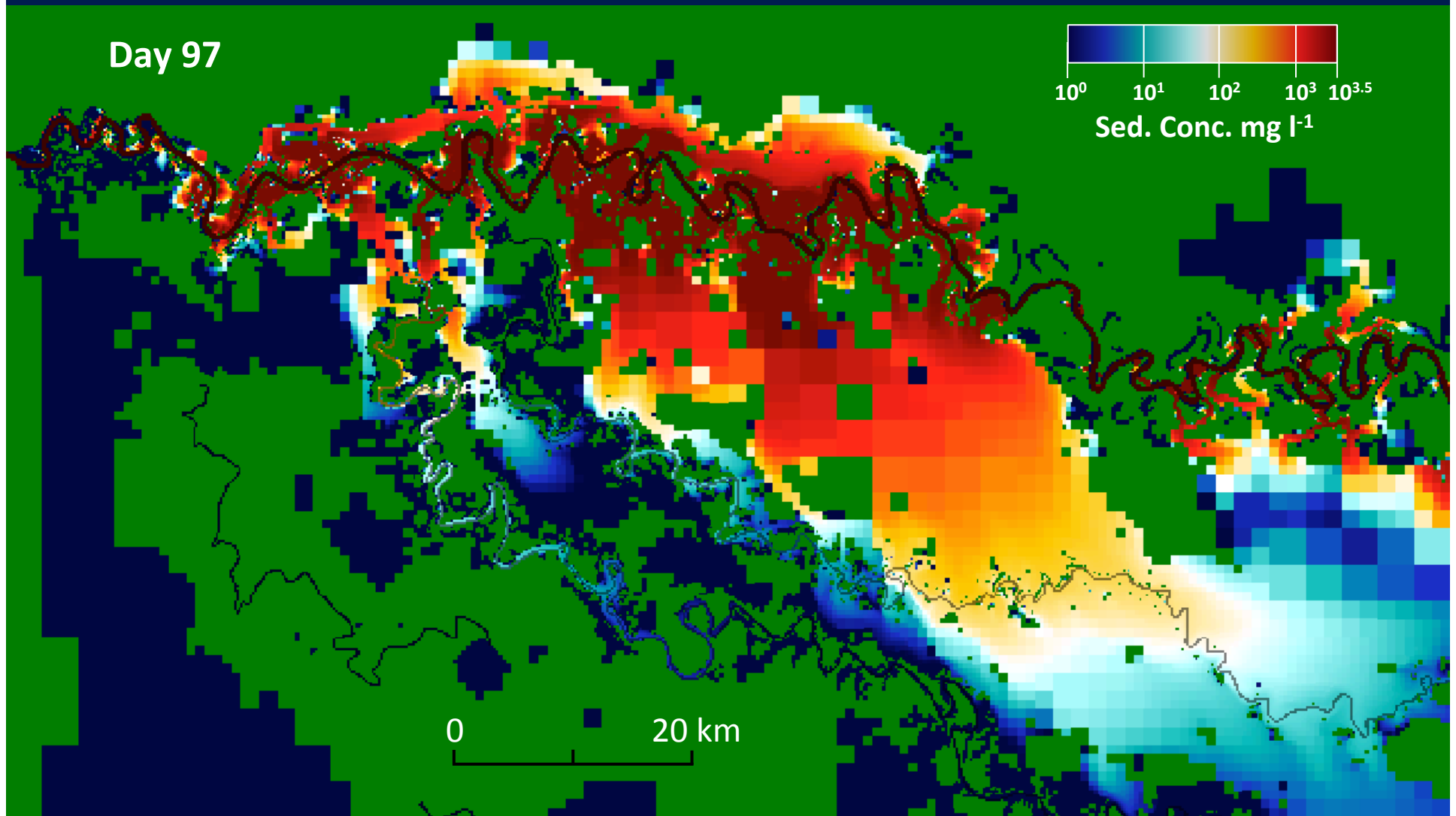
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



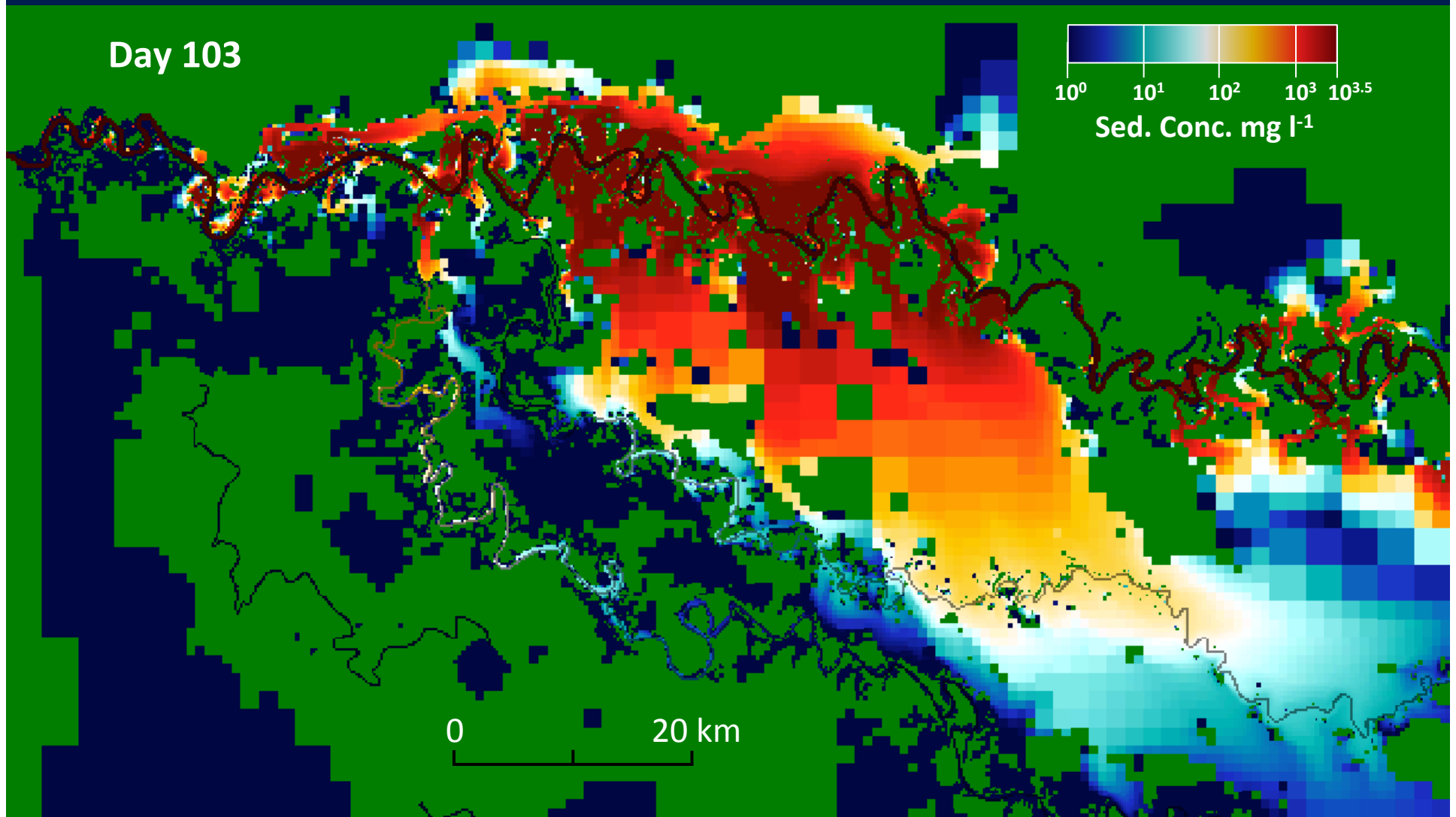
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



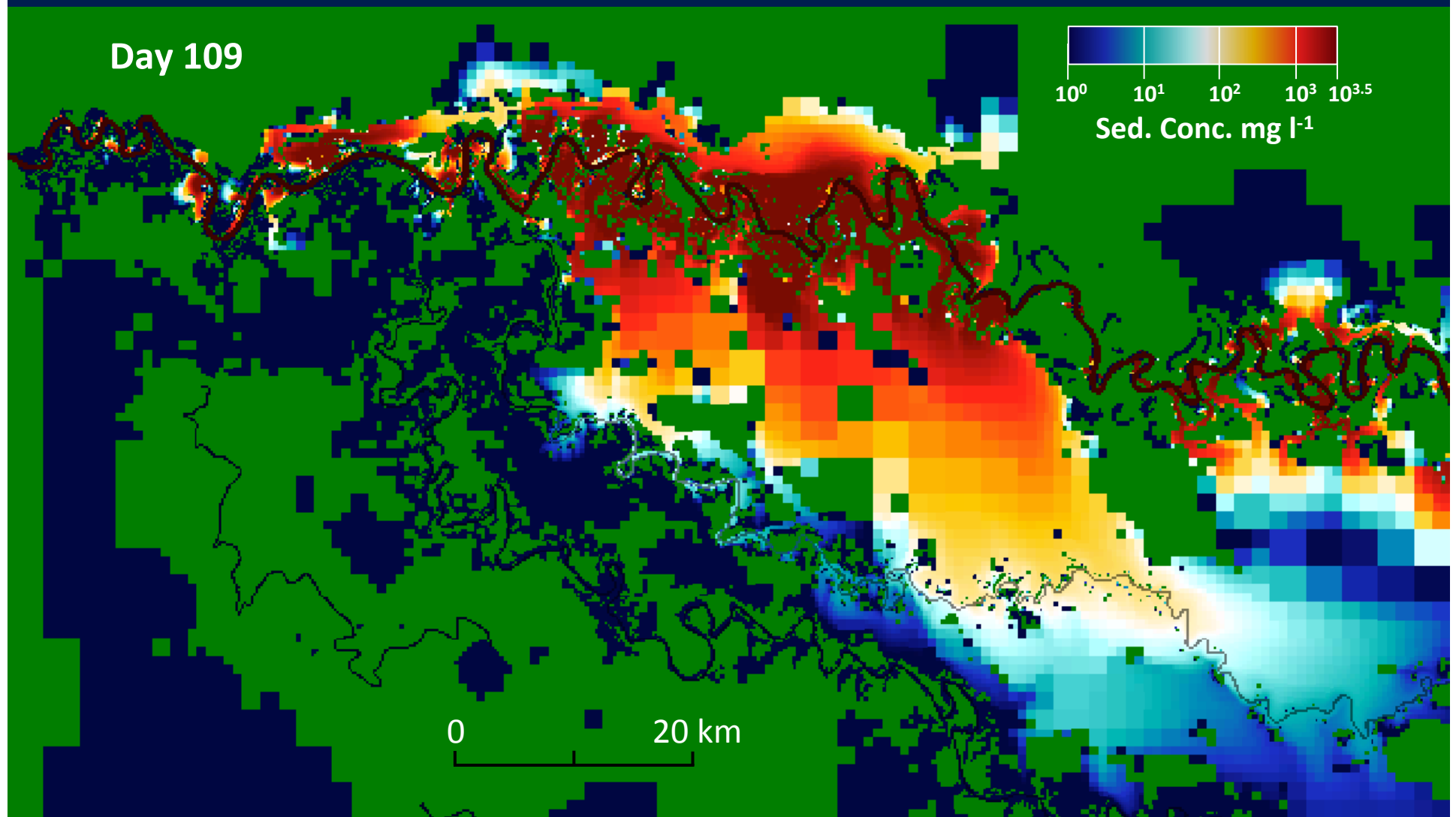
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



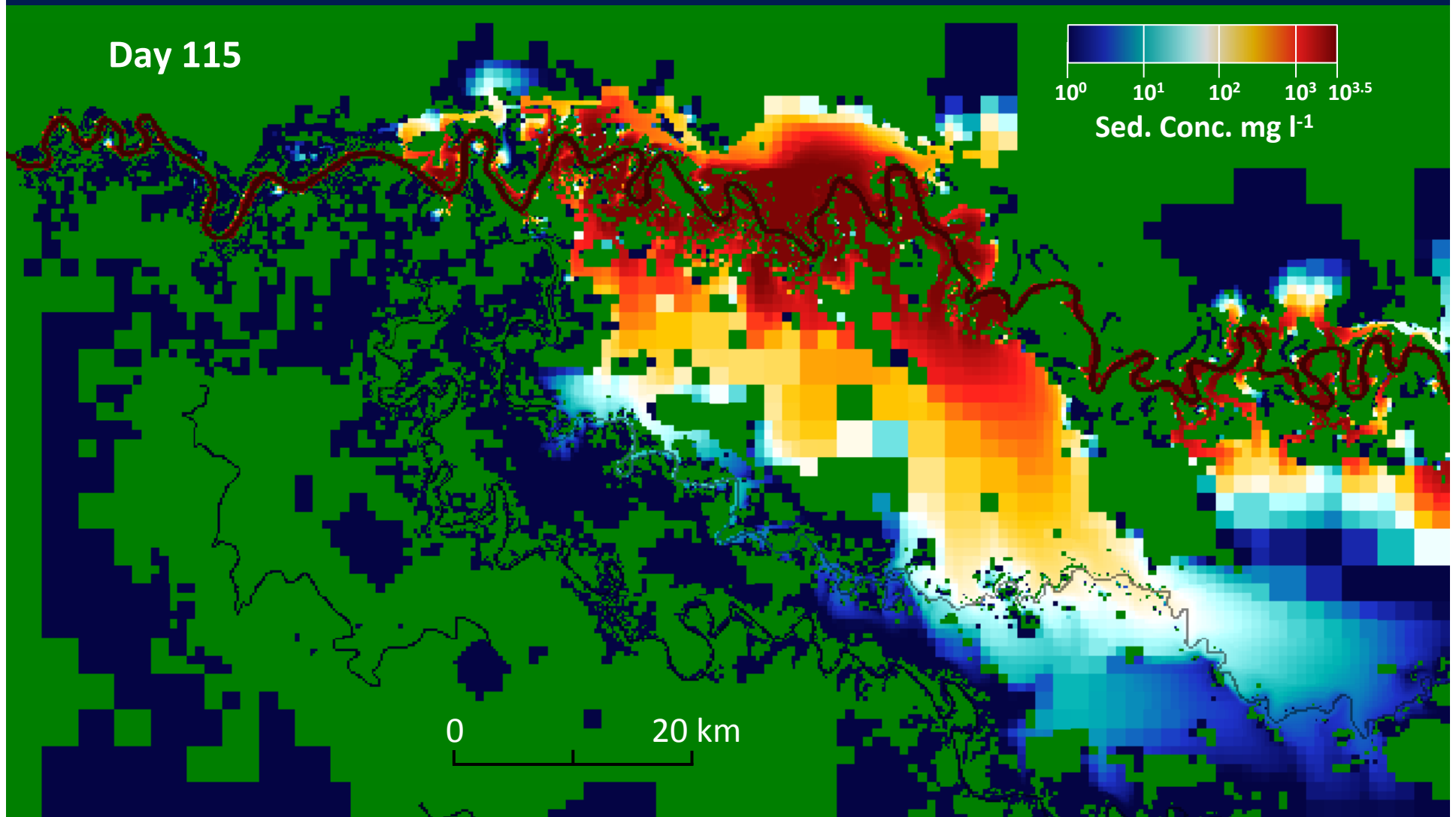
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



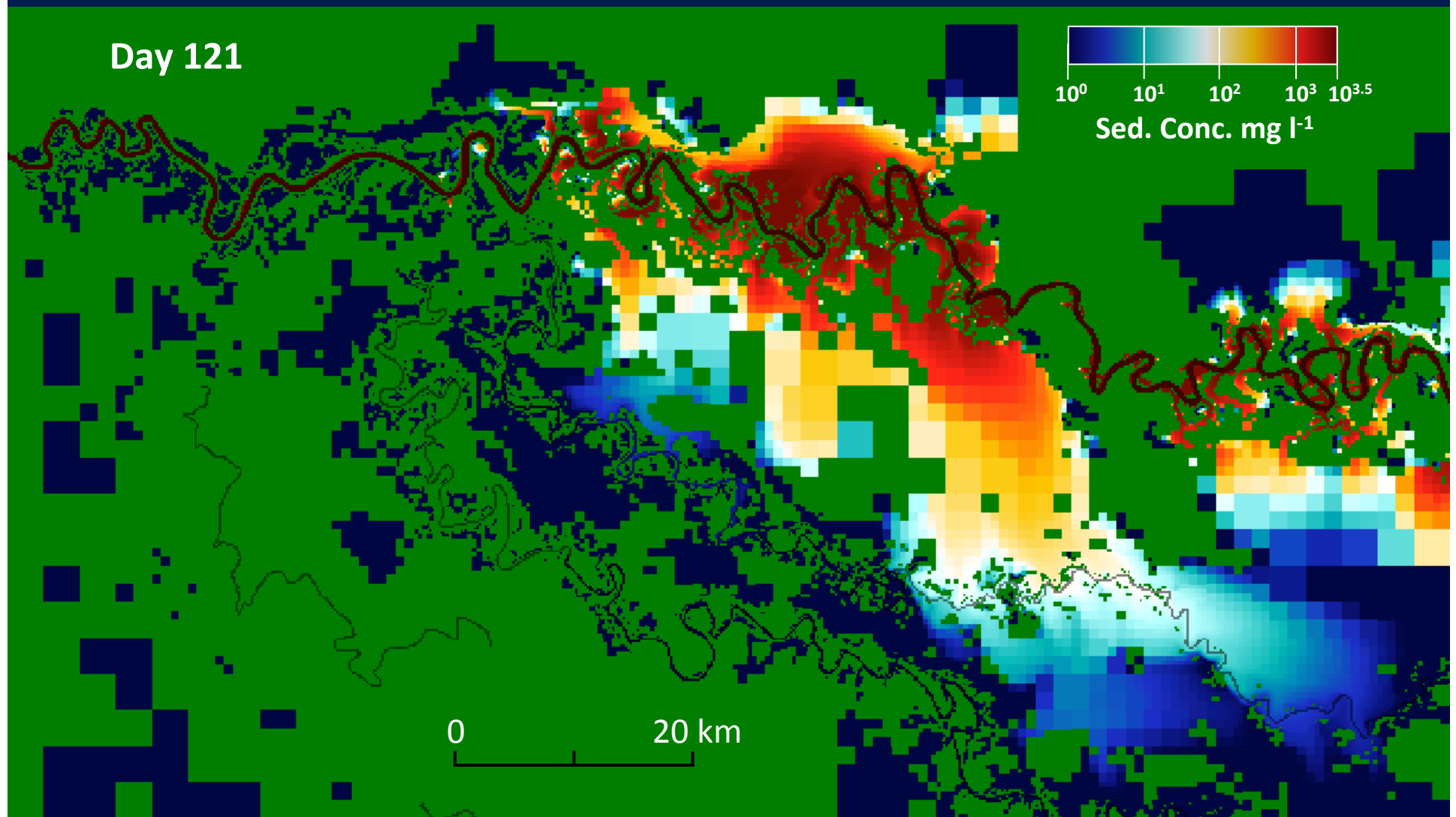
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



Flow direction →

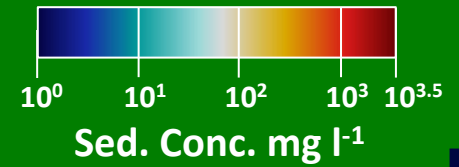
Modeled sediment dispersion for 6 month hydrograph



Flow direction →

Modeled sediment dispersion for 6 month hydrograph

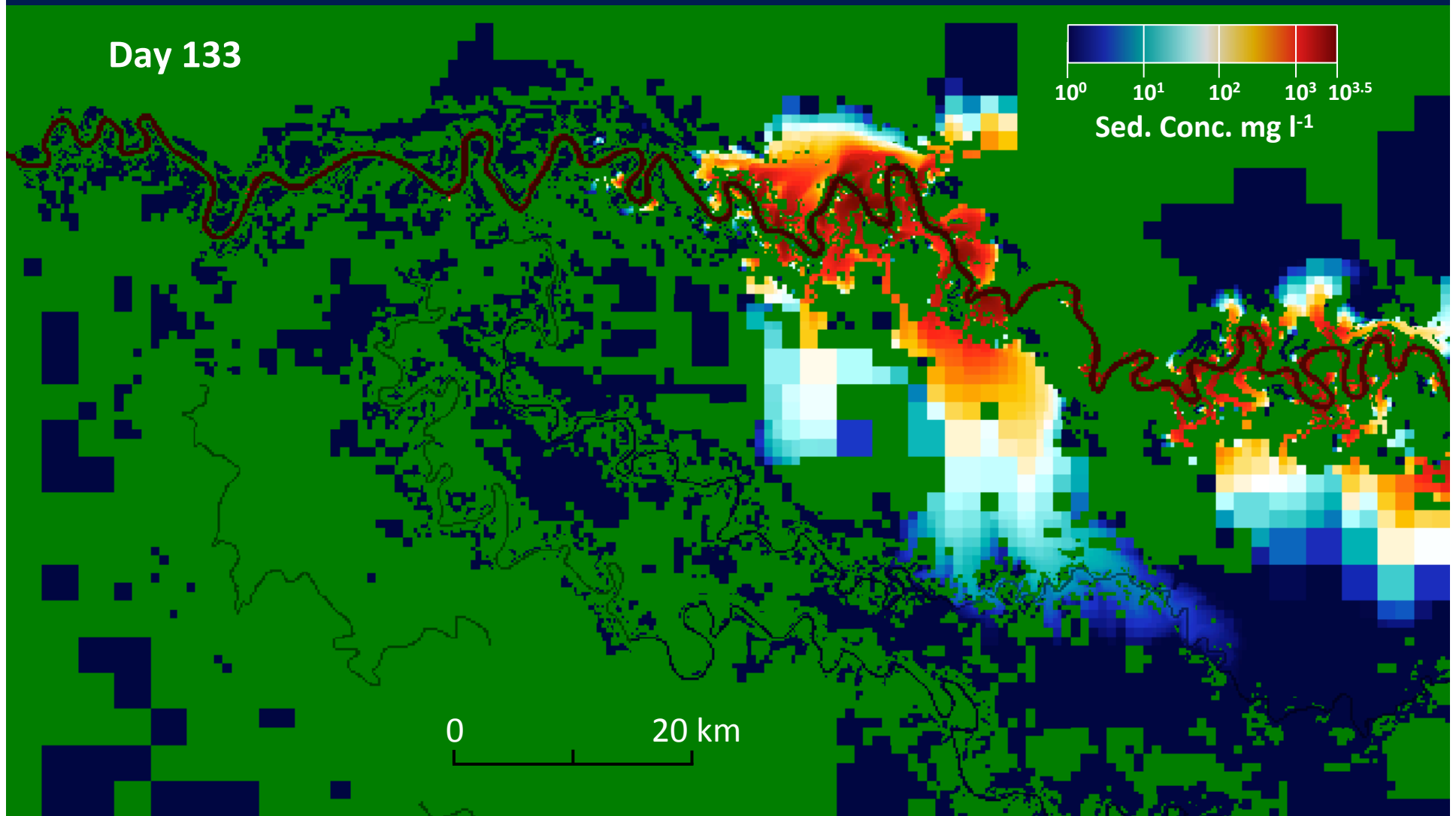
Day 127



0 20 km

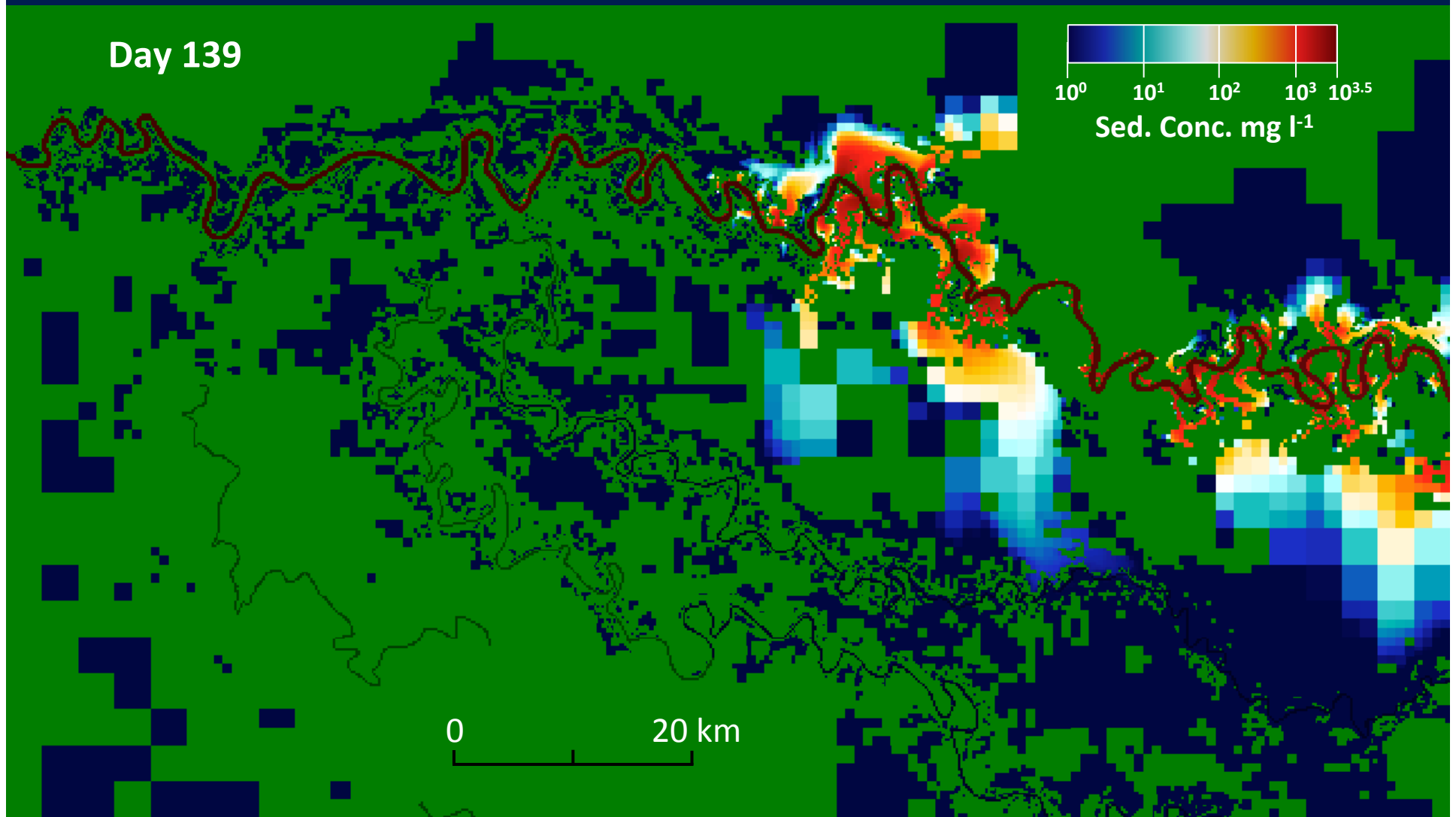
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



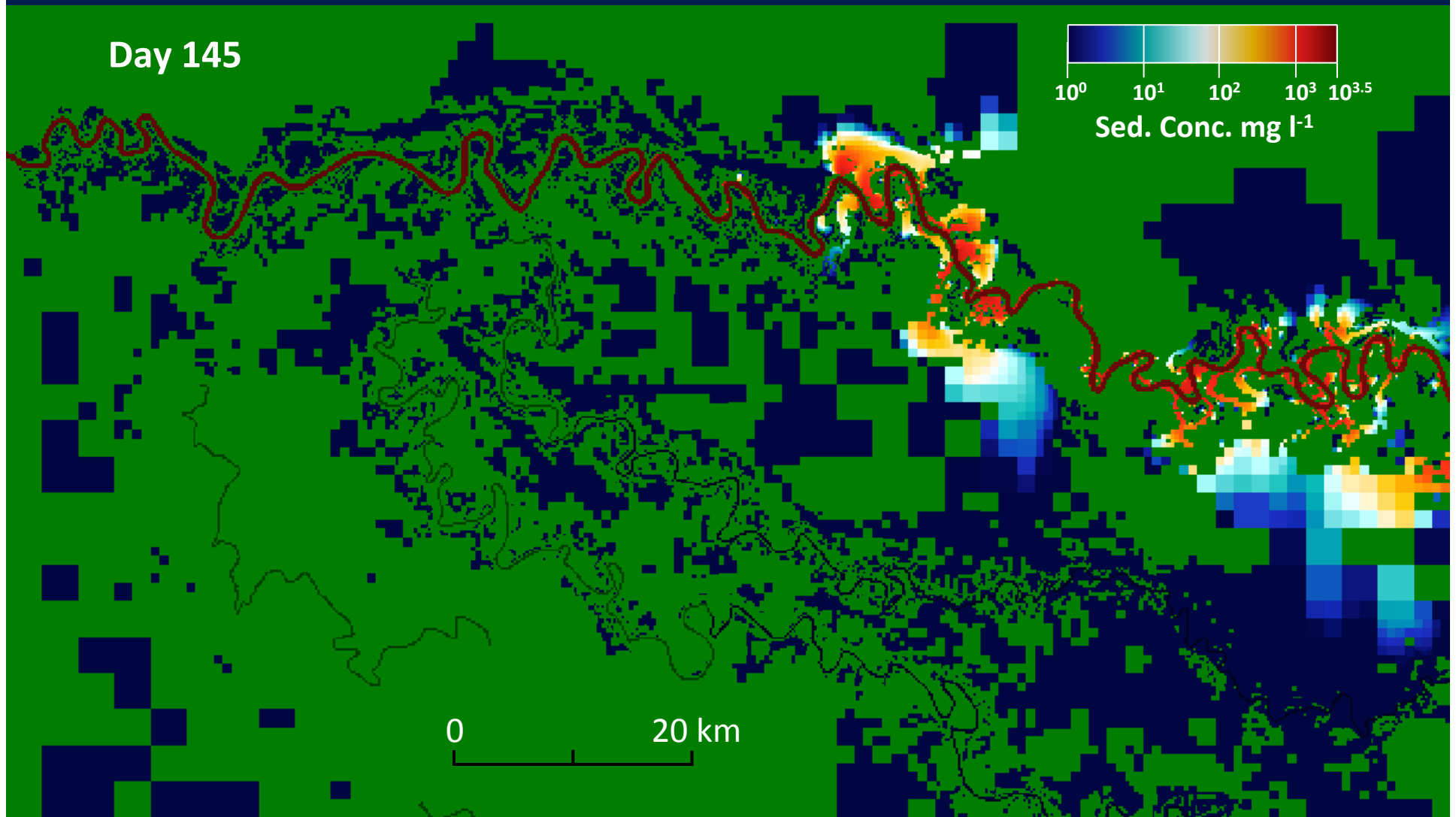
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



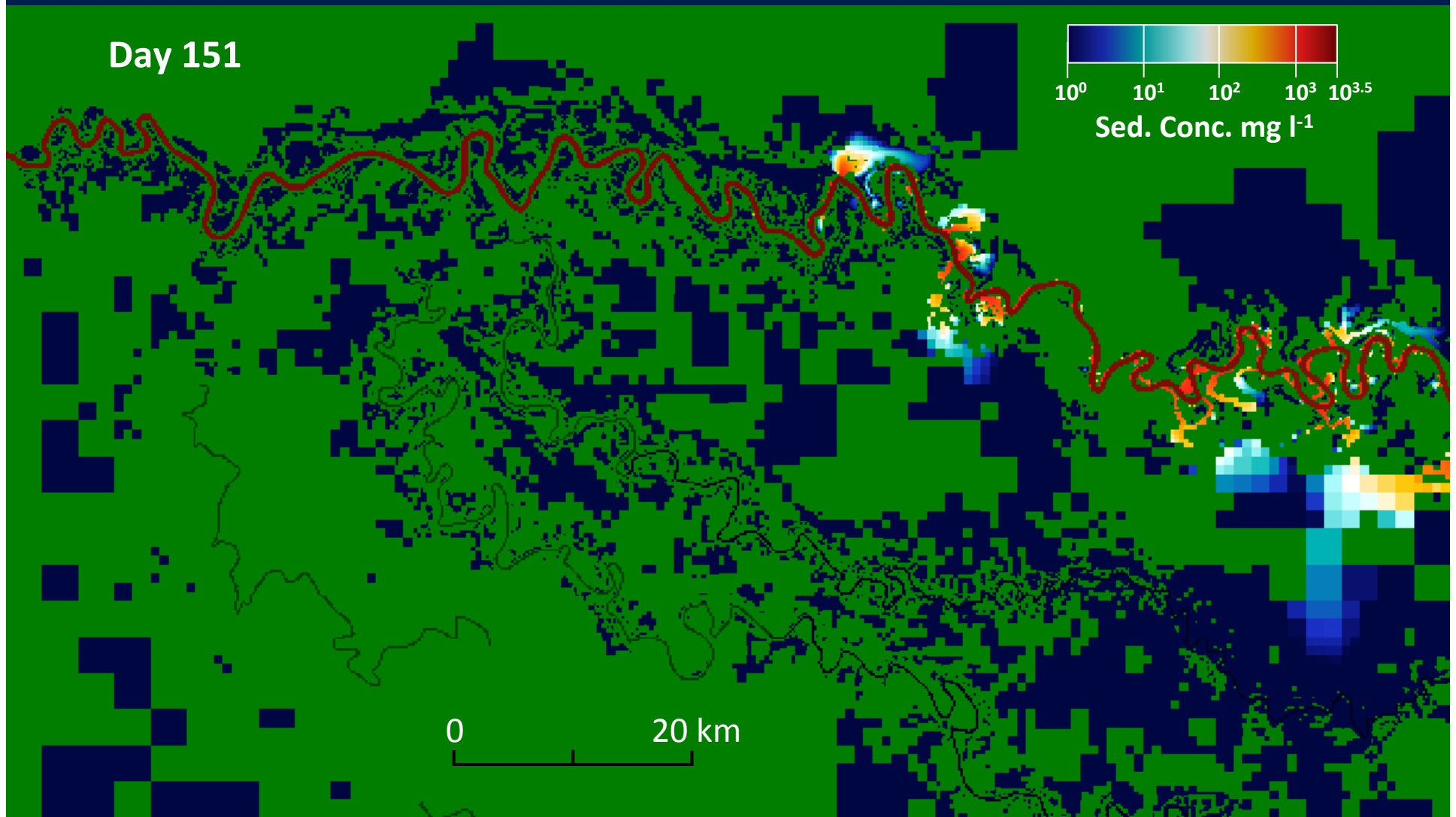
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



Flow direction →

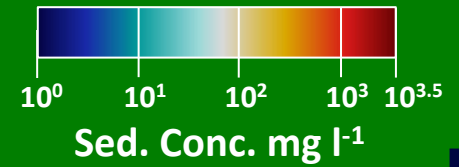
Modeled sediment dispersion for 6 month hydrograph



Flow direction →

Modeled sediment dispersion for 6 month hydrograph

Day 157



0 20 km

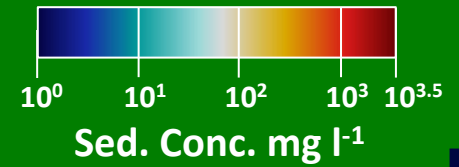


A horizontal scale bar with a vertical tick at the left end labeled '0' and another at the right end labeled '20 km'.

Flow direction →

Modeled sediment dispersion for 6 month hydrograph

Day 163



0 20 km

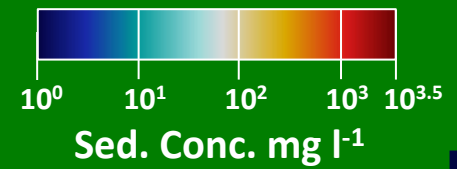


A horizontal scale bar with a vertical tick at the left end and a vertical tick at the right end, with the text '0' and '20 km' above the respective ends.

Flow direction →

Modeled sediment dispersion for 6 month hydrograph

Day 169



0 20 km

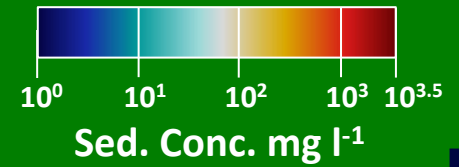


A horizontal scale bar with a vertical tick at the left end and a vertical tick at the right end, with the text '0' and '20 km' above the respective ends.

Flow direction →

Modeled sediment dispersion for 6 month hydrograph

Day 175



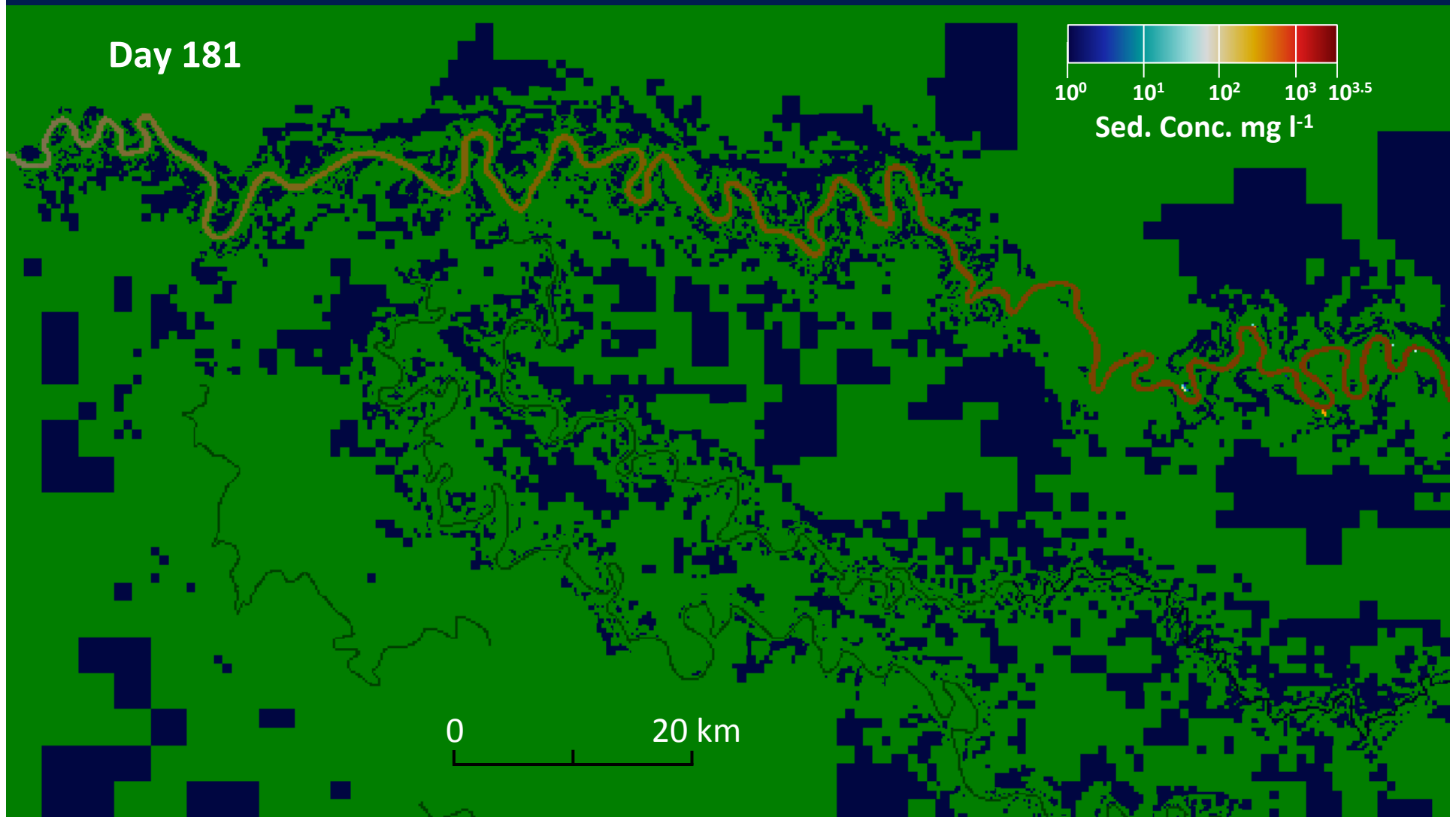
0 20 km



A horizontal scale bar with a vertical tick at the left end labeled '0' and another at the right end labeled '20 km'.

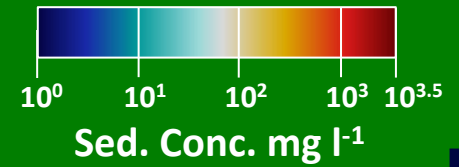
Flow direction →

Modeled sediment dispersion for 6 month hydrograph



Modeled sediment dispersion for 6 month hydrograph

Day 187



0 20 km

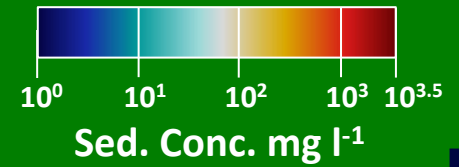


A horizontal scale bar with a vertical tick at the left end labeled '0' and another at the right end labeled '20 km'.

Flow direction →

Modeled sediment dispersion for 6 month hydrograph

Day 187



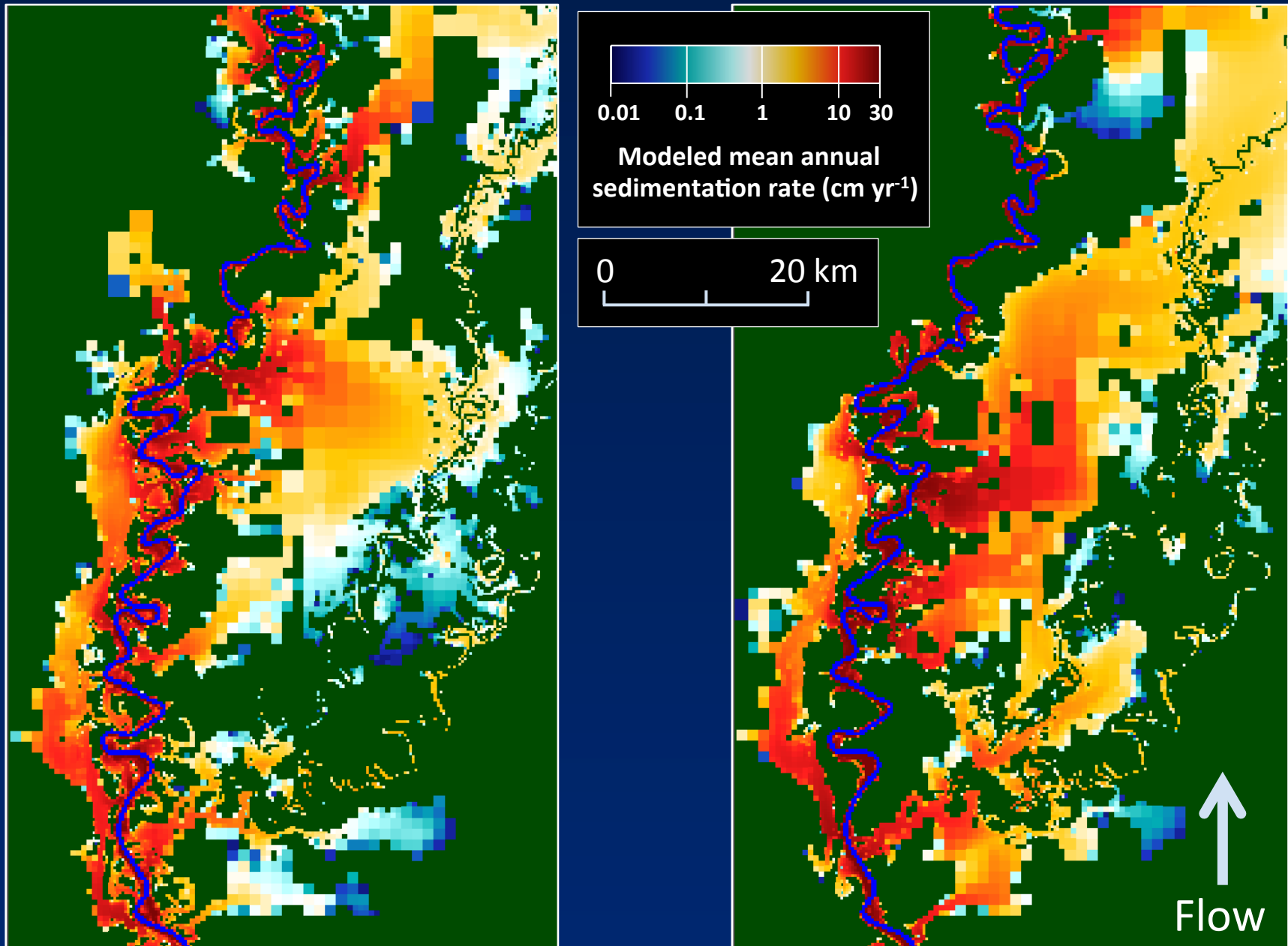
0 20 km



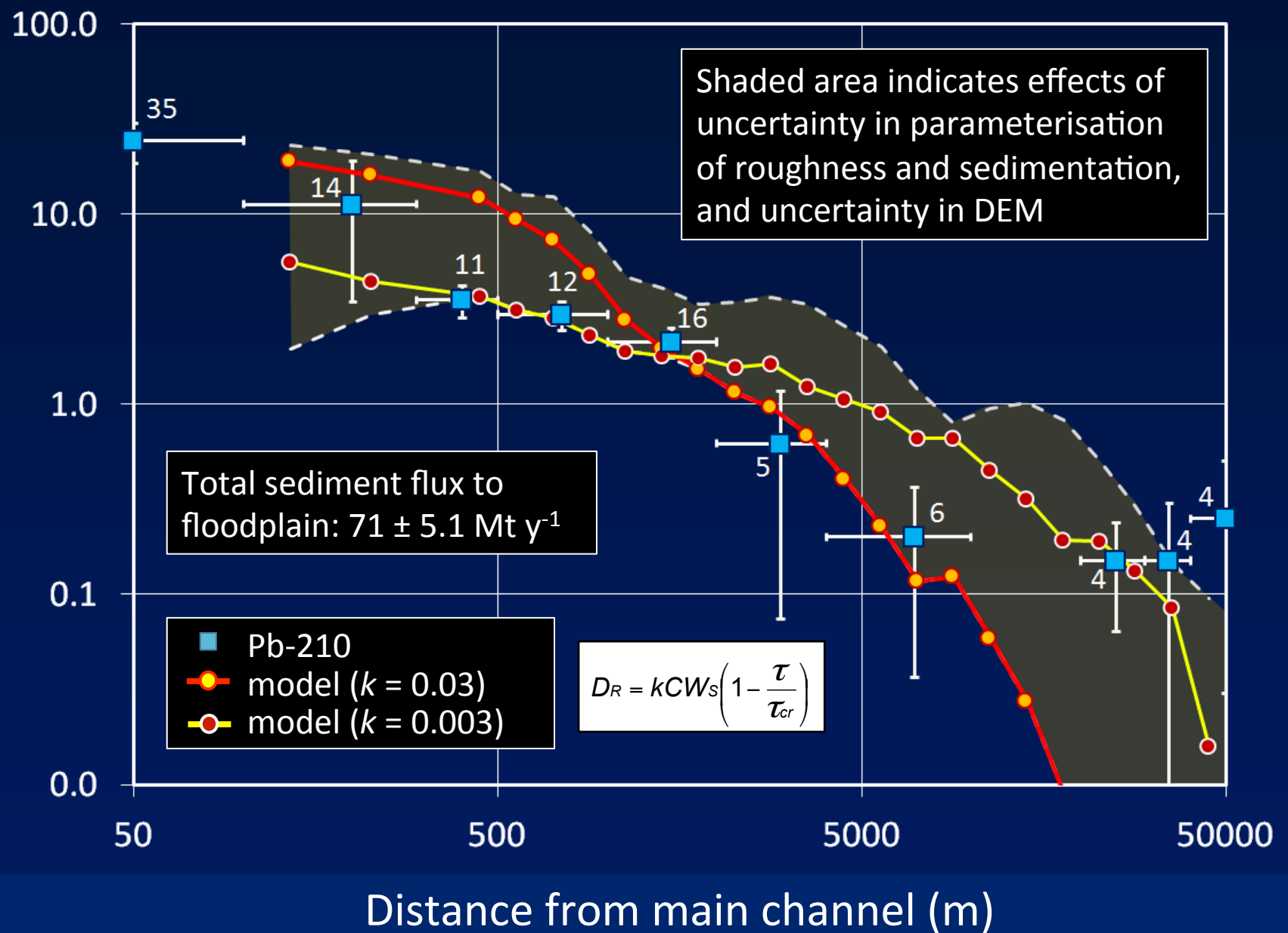
A horizontal scale bar with a vertical tick at the left end and a vertical tick at the right end, with the text '0' and '20 km' above the respective ends.

Flow direction →

Sensitivity to floodplain DEM (SRTM vegetation removal scheme)



Mean annual sedimentation rate (cm y⁻¹)



T = 50 floods



T = 100 floods

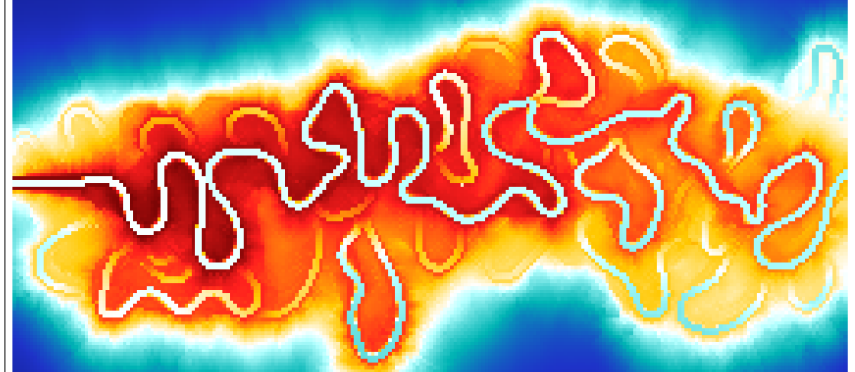


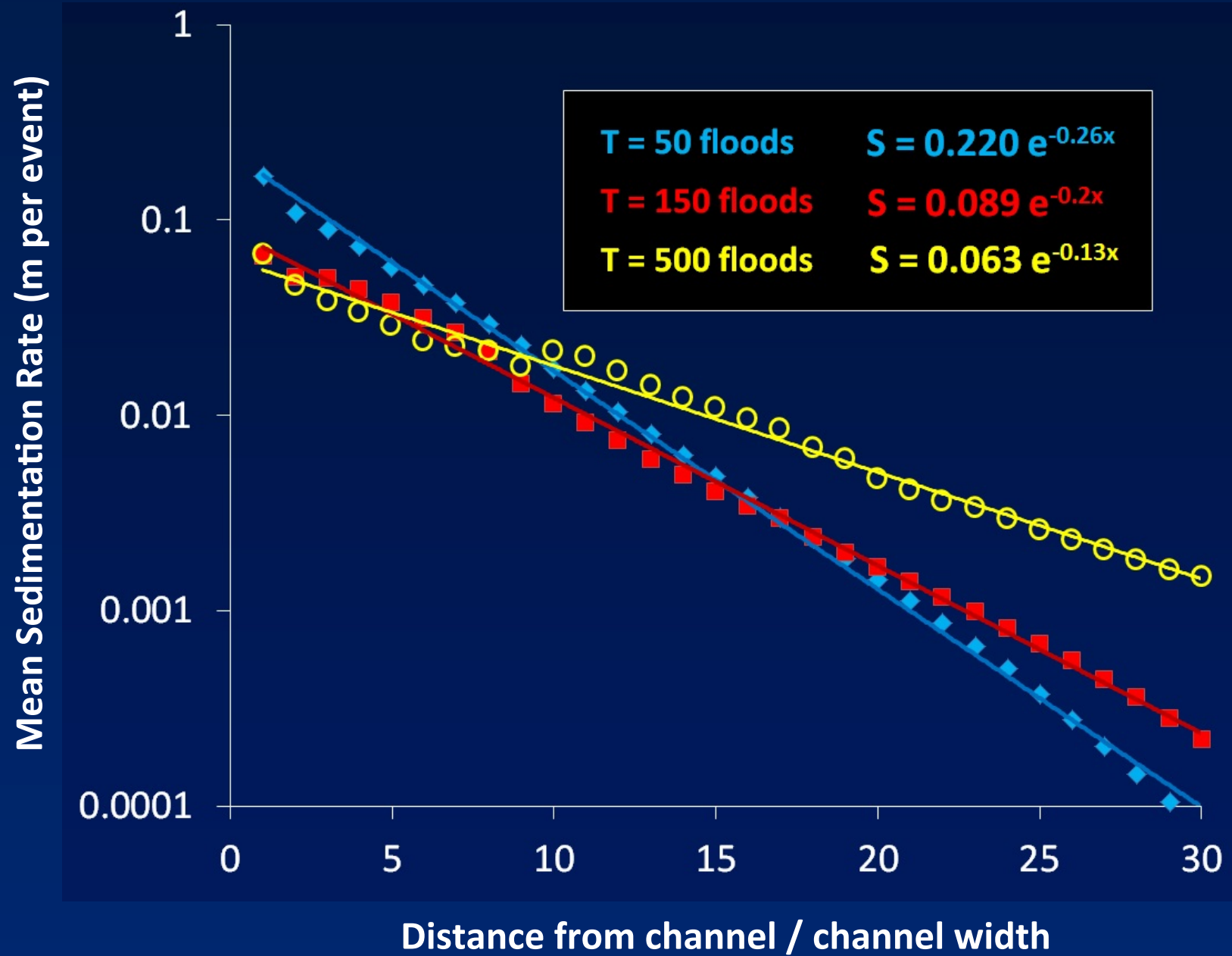
Hydrodynamically-driven sedimentation model coupled to meander migration model (Howard & Knutson, 1984)

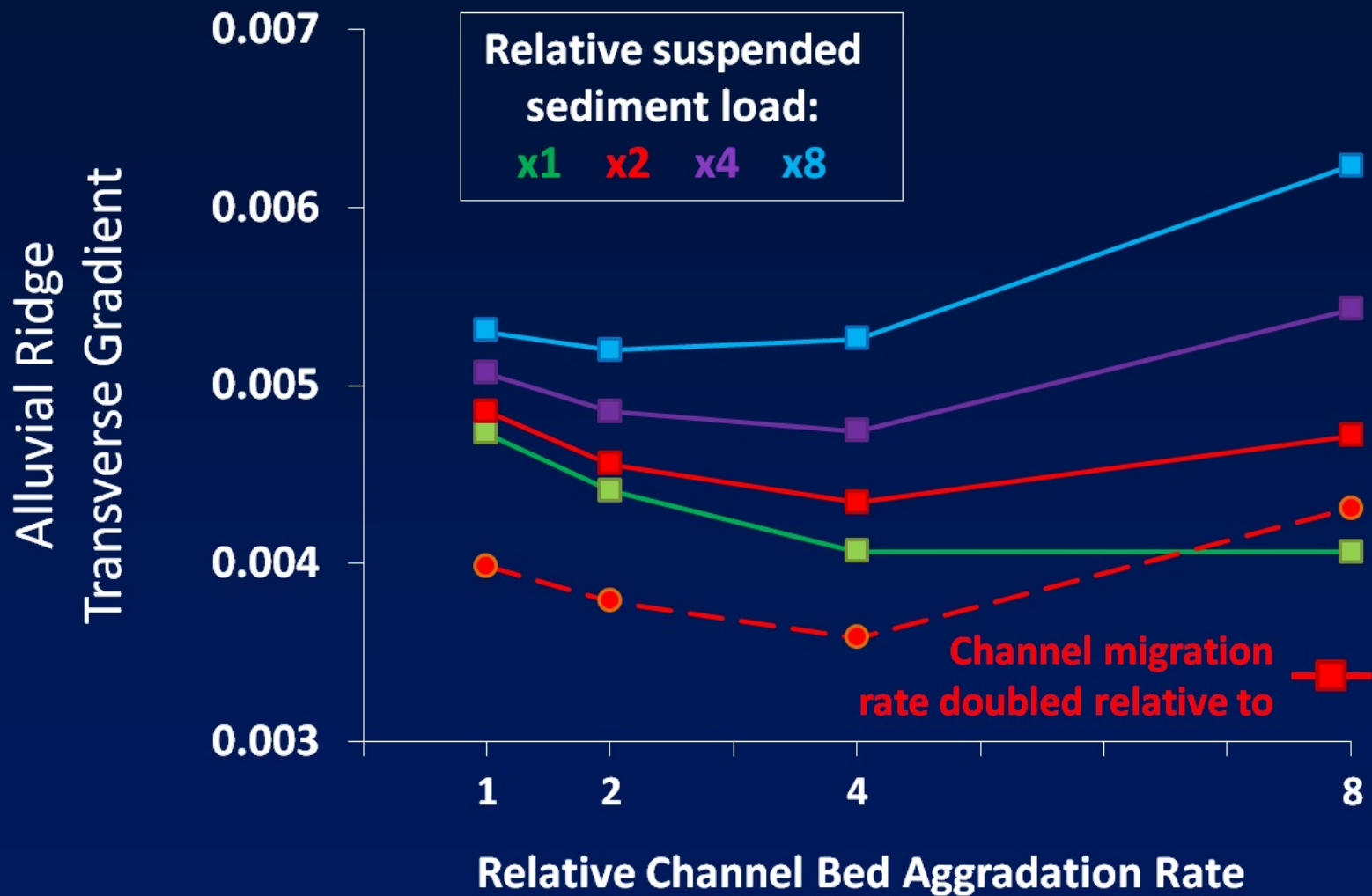
T = 200 floods

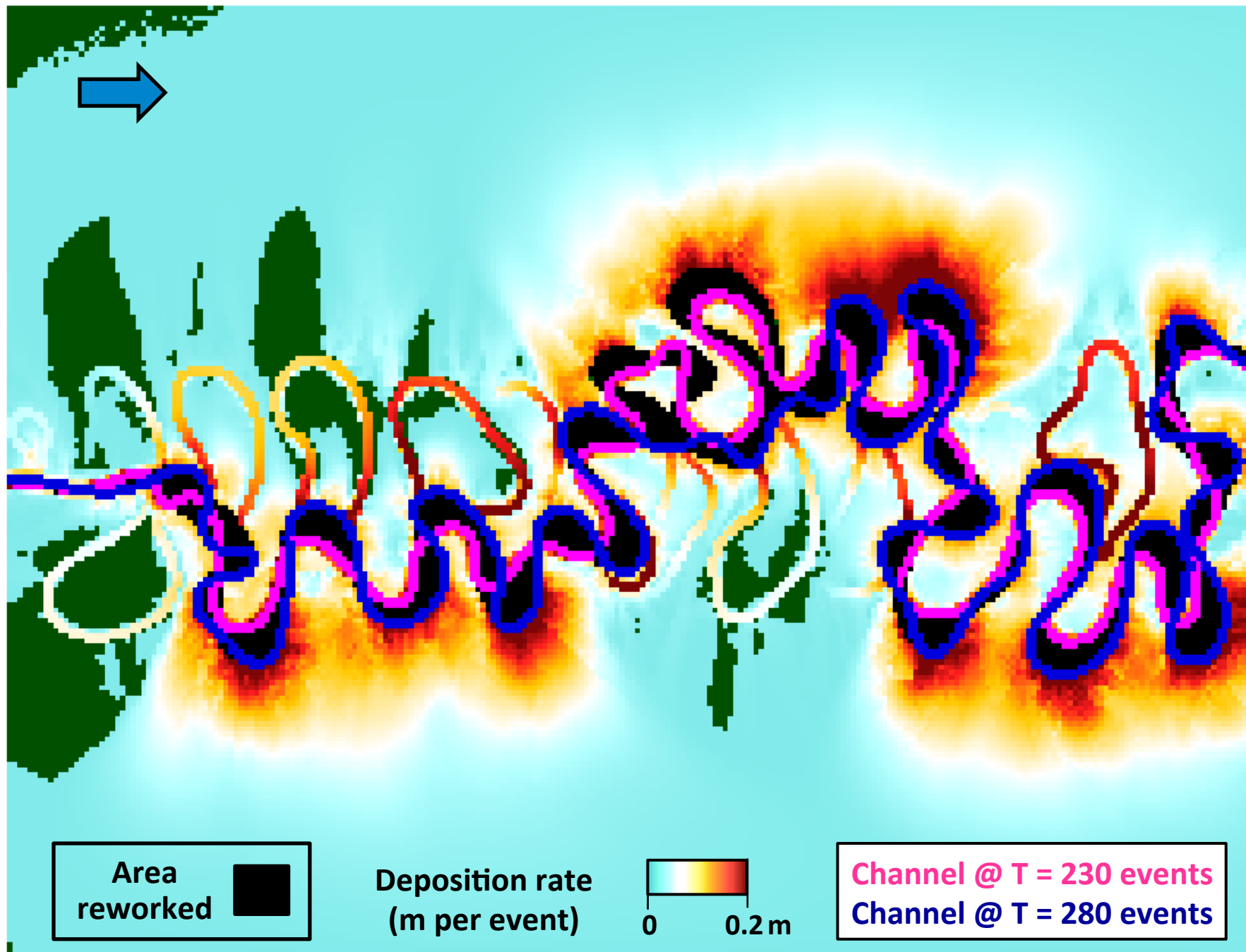


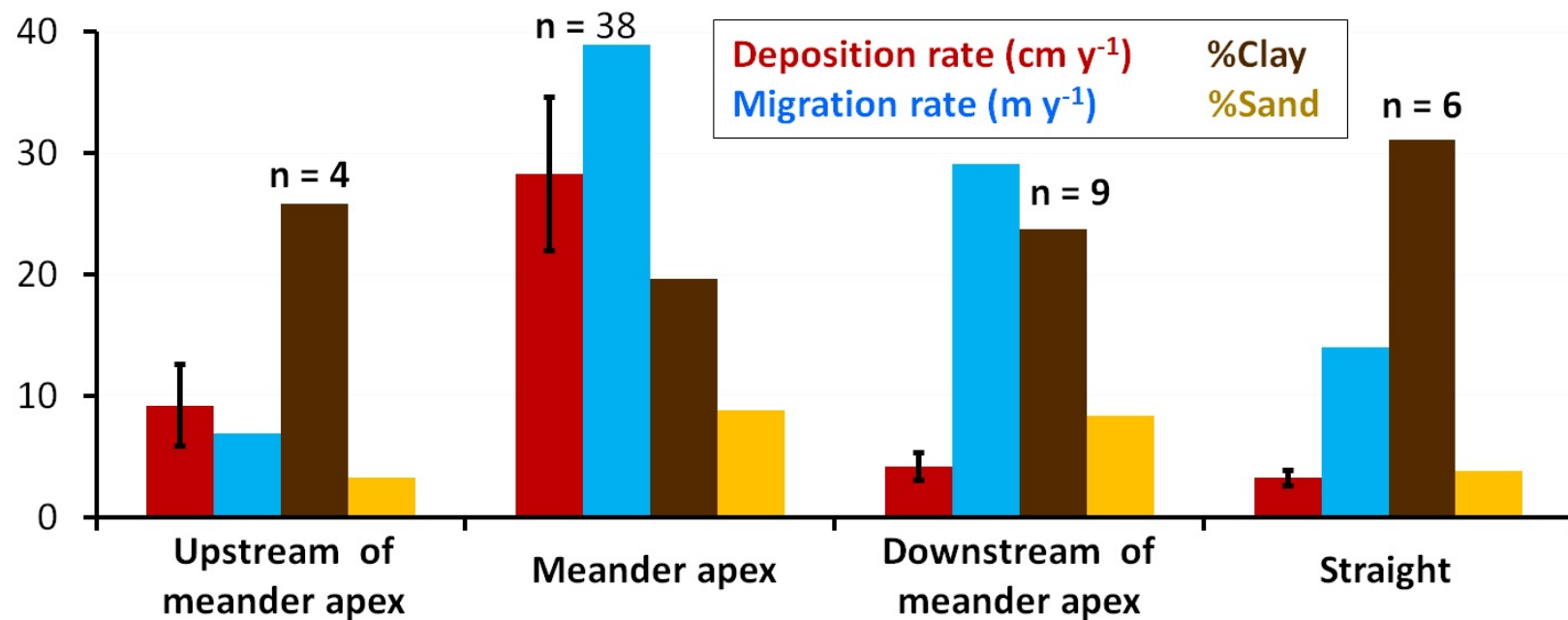
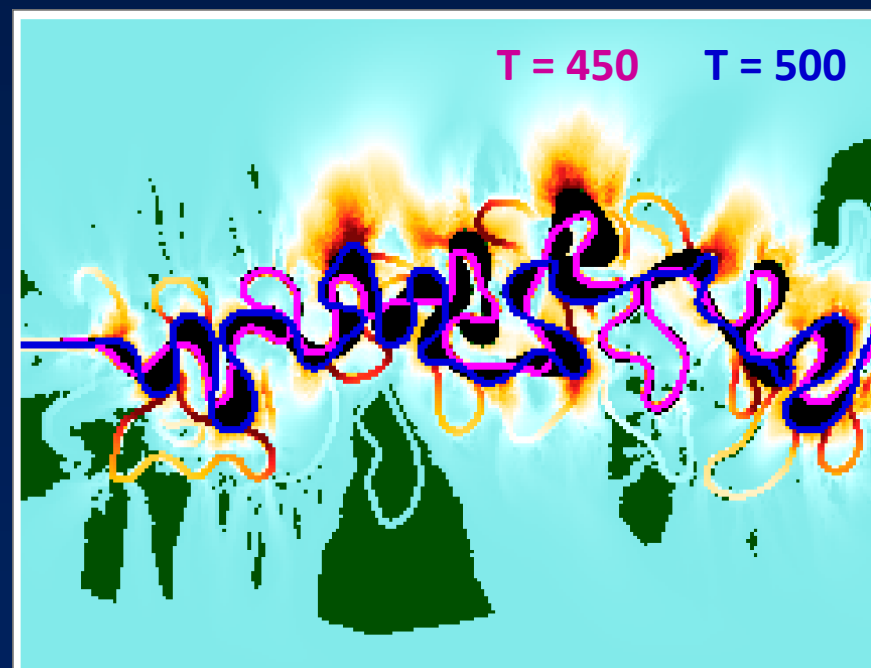
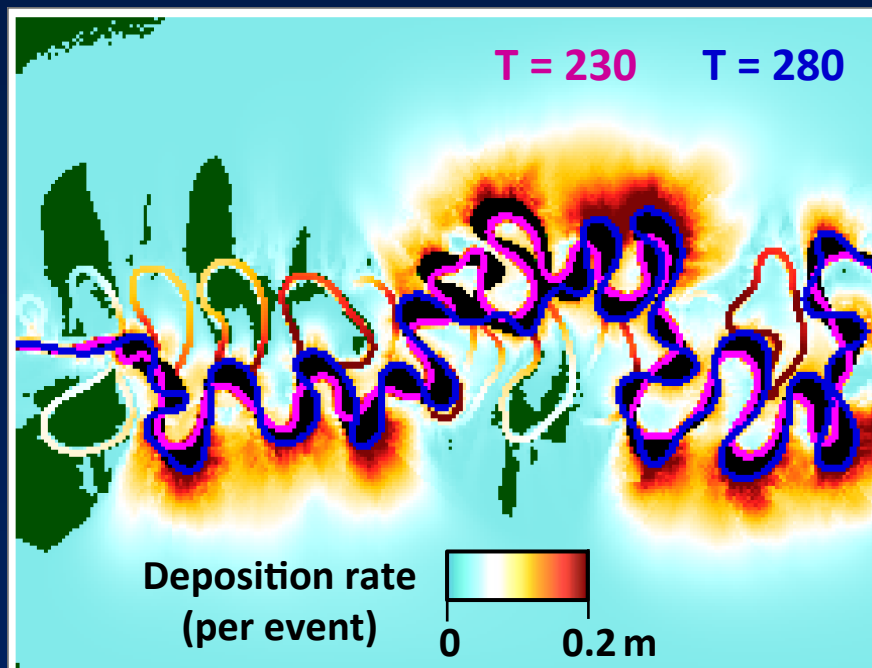
T = 500 floods

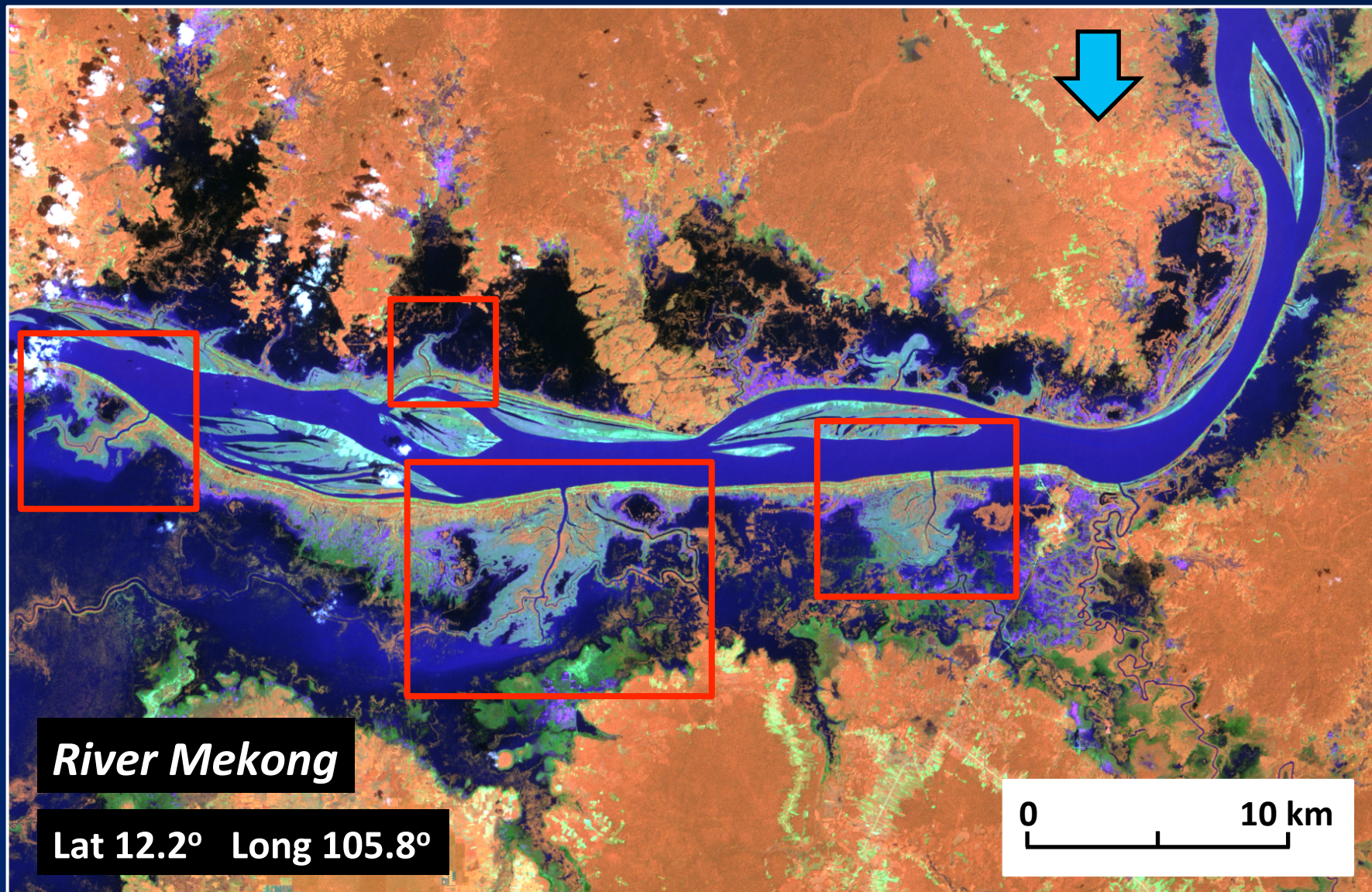


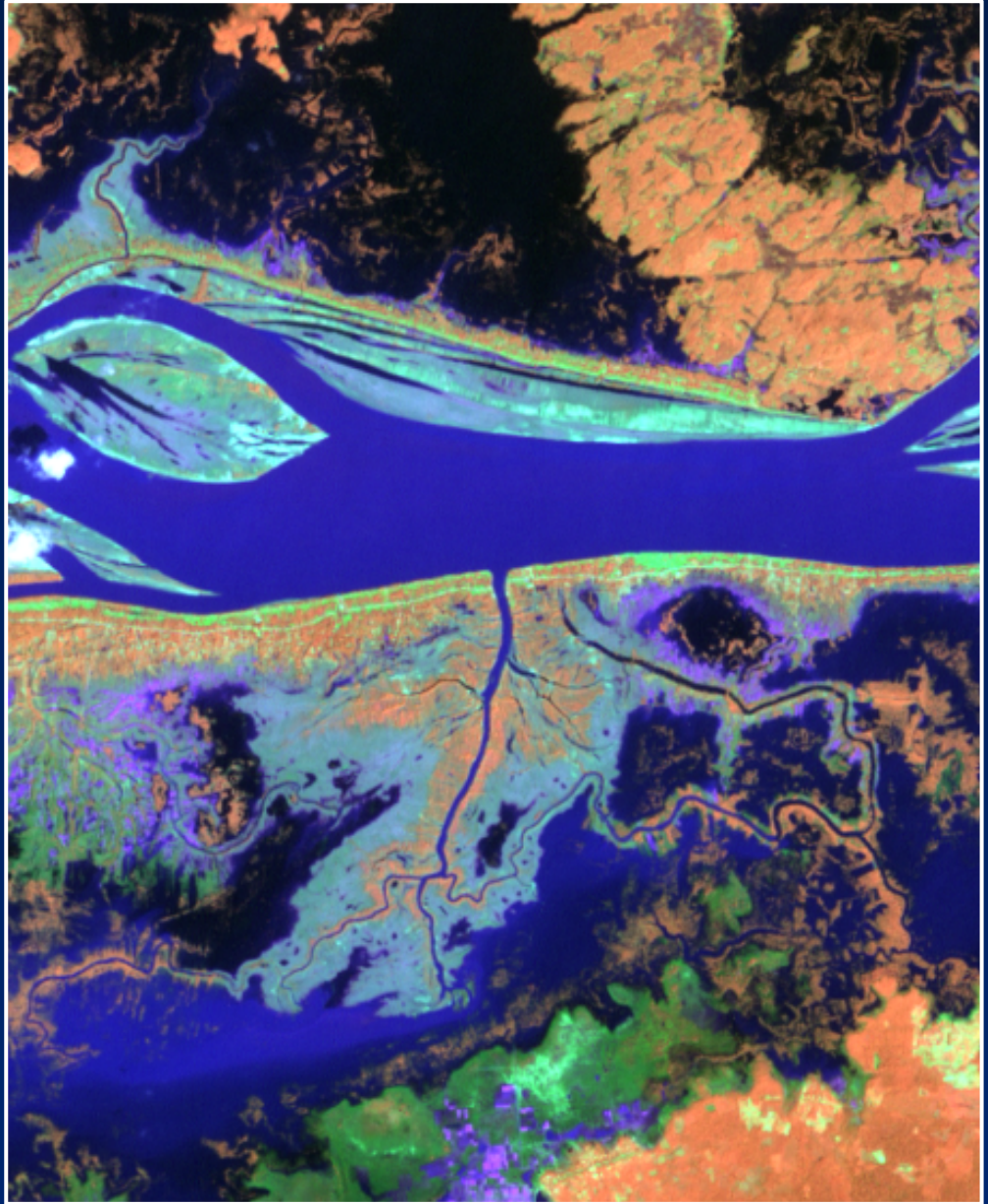
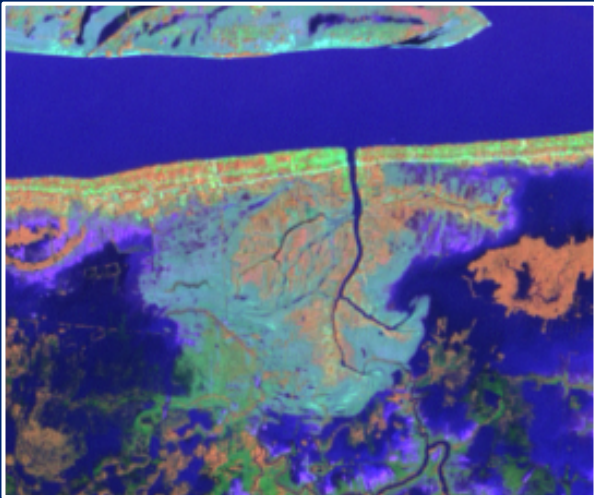
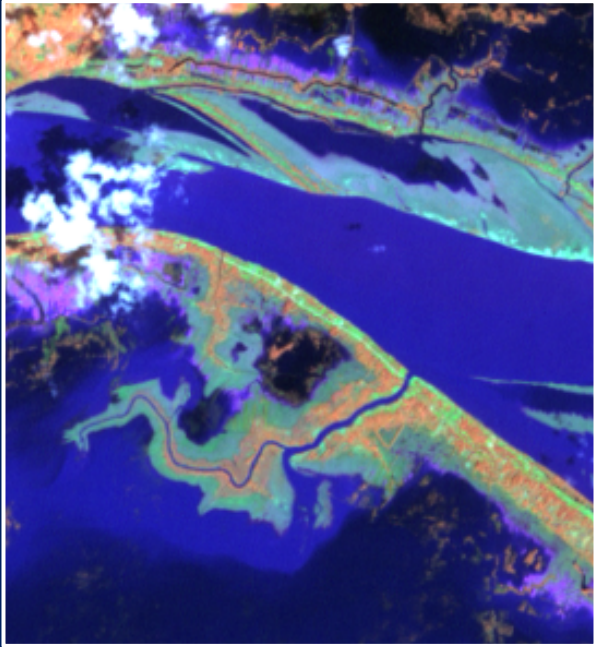


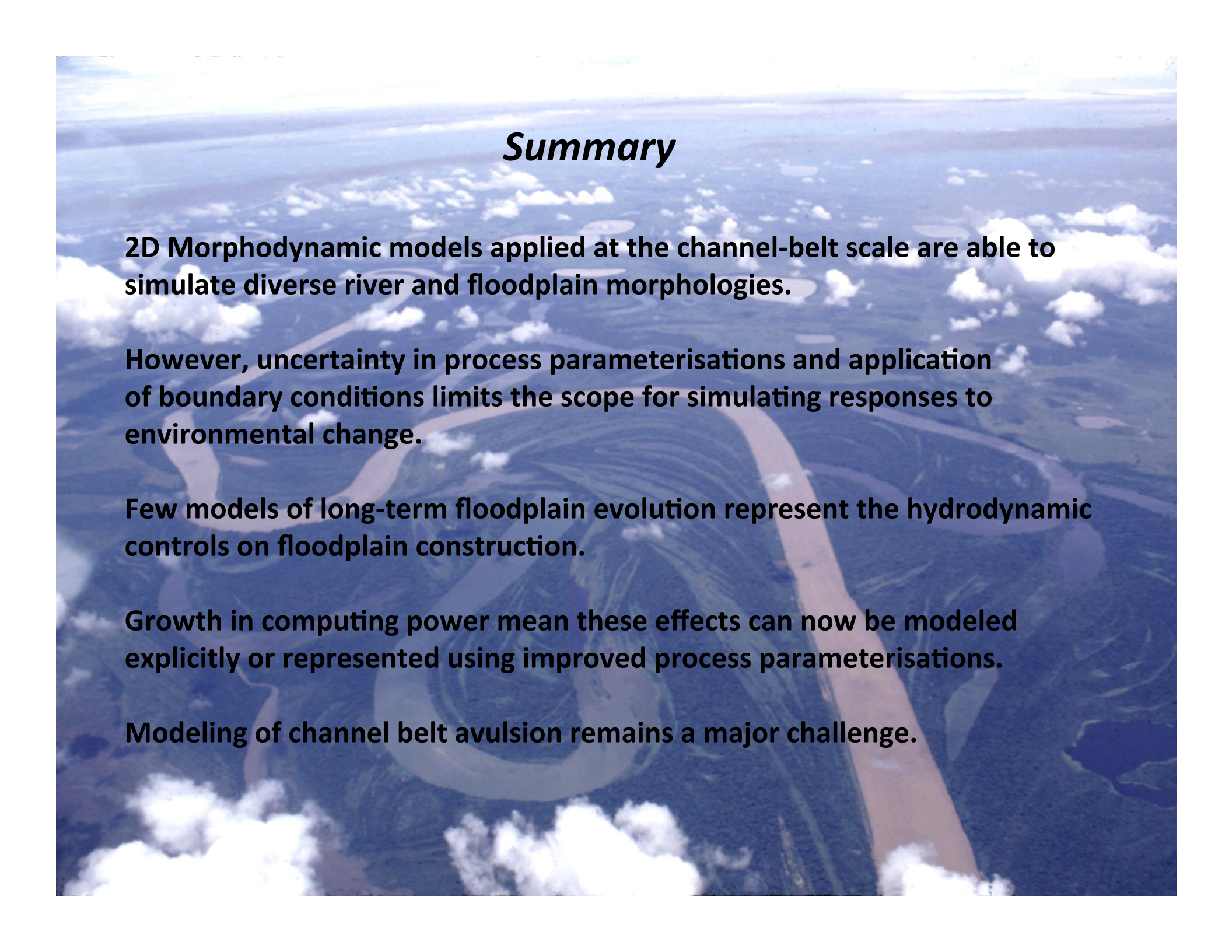










An aerial photograph of a river delta system, showing a main channel branching into several distributaries that spread out over a vast, flat floodplain. The water in the channels is a light brown color, contrasting with the green and brown of the land. The sky is blue with scattered white clouds.

Summary

2D Morphodynamic models applied at the channel-belt scale are able to simulate diverse river and floodplain morphologies.

However, uncertainty in process parameterisations and application of boundary conditions limits the scope for simulating responses to environmental change.

Few models of long-term floodplain evolution represent the hydrodynamic controls on floodplain construction.

Growth in computing power mean these effects can now be modeled explicitly or represented using improved process parameterisations.

Modeling of channel belt avulsion remains a major challenge.