

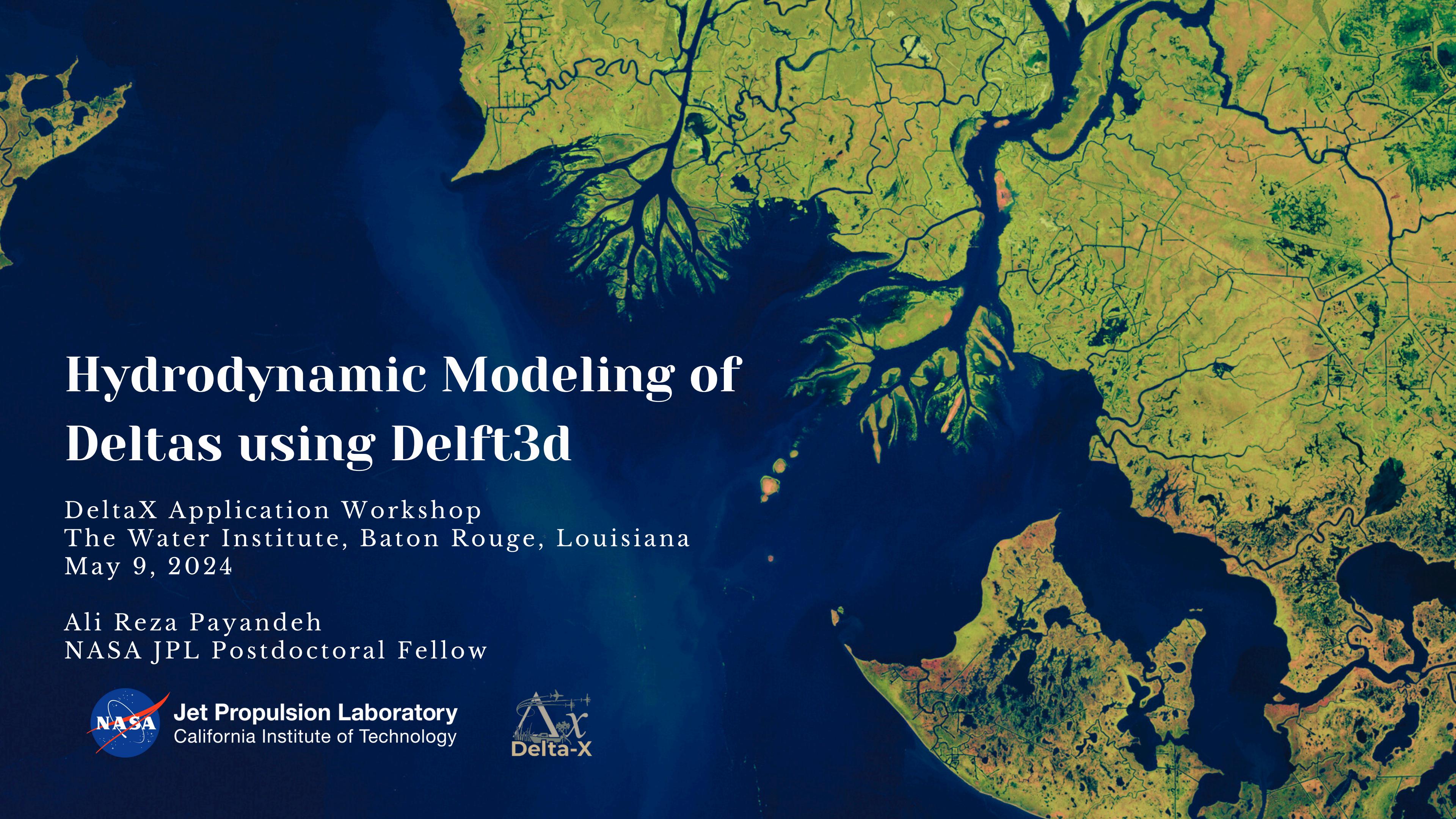
Hydrodynamic Modeling of Deltas using Delft3d

DeltaX Application Workshop
The Water Institute, Baton Rouge, Louisiana
May 9, 2024

Ali Reza Payandeh
NASA JPL Postdoctoral Fellow



Jet Propulsion Laboratory
California Institute of Technology



Role of the models in the DeltaX project?

Predict organic and inorganic accretion rates

- Anuga
- Delft3d
- TELEMAC and Caltech's MATLAB Sediment module
- NUMAR
- Dorado

3D/2D modelling suite for integral water solutions

DELF3D Hydro-Morphodynamics & Water Quality

Deltares systems



Version 4.03.00

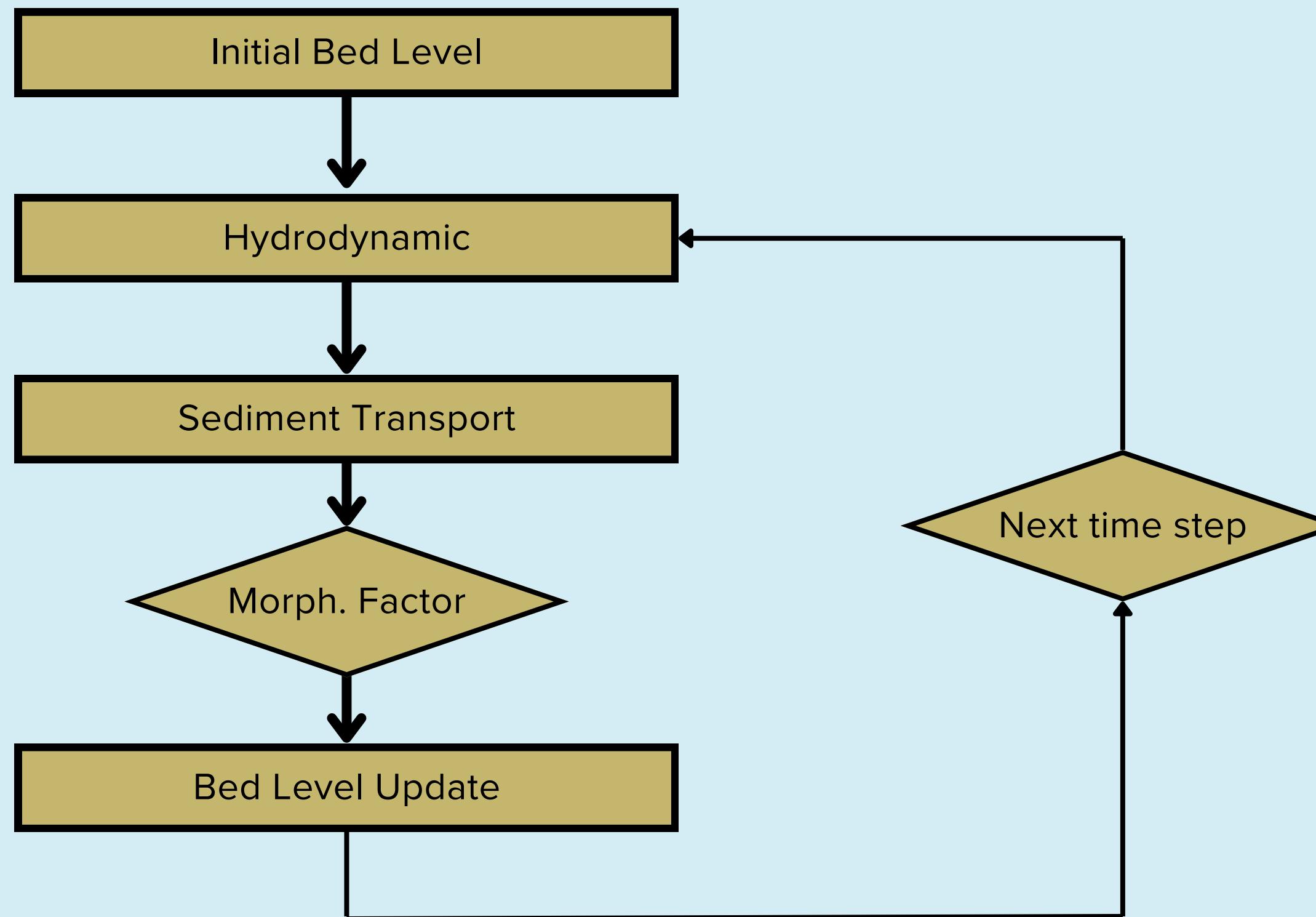
Company Deltares

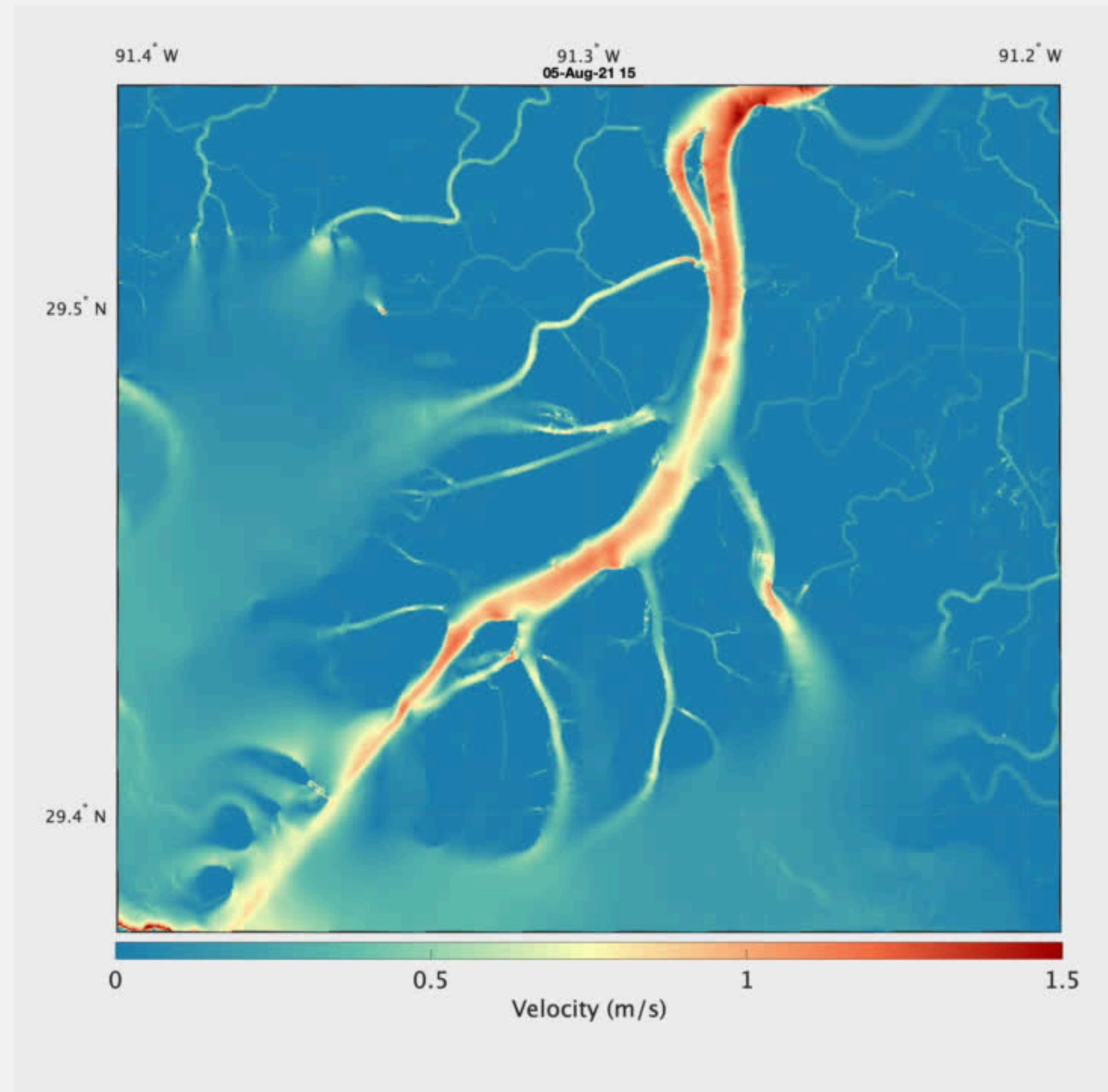
License Valid until 1-jan-0

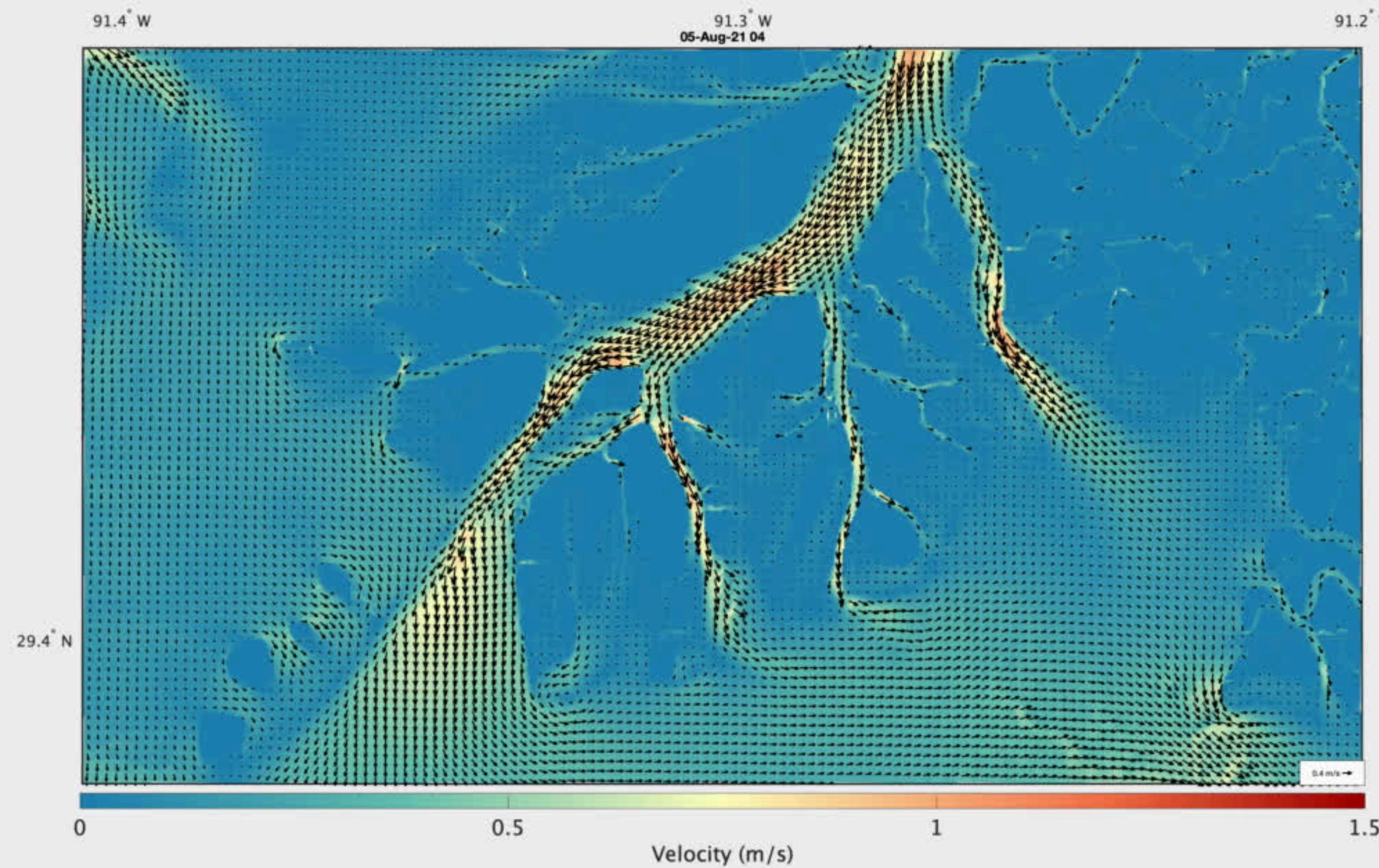
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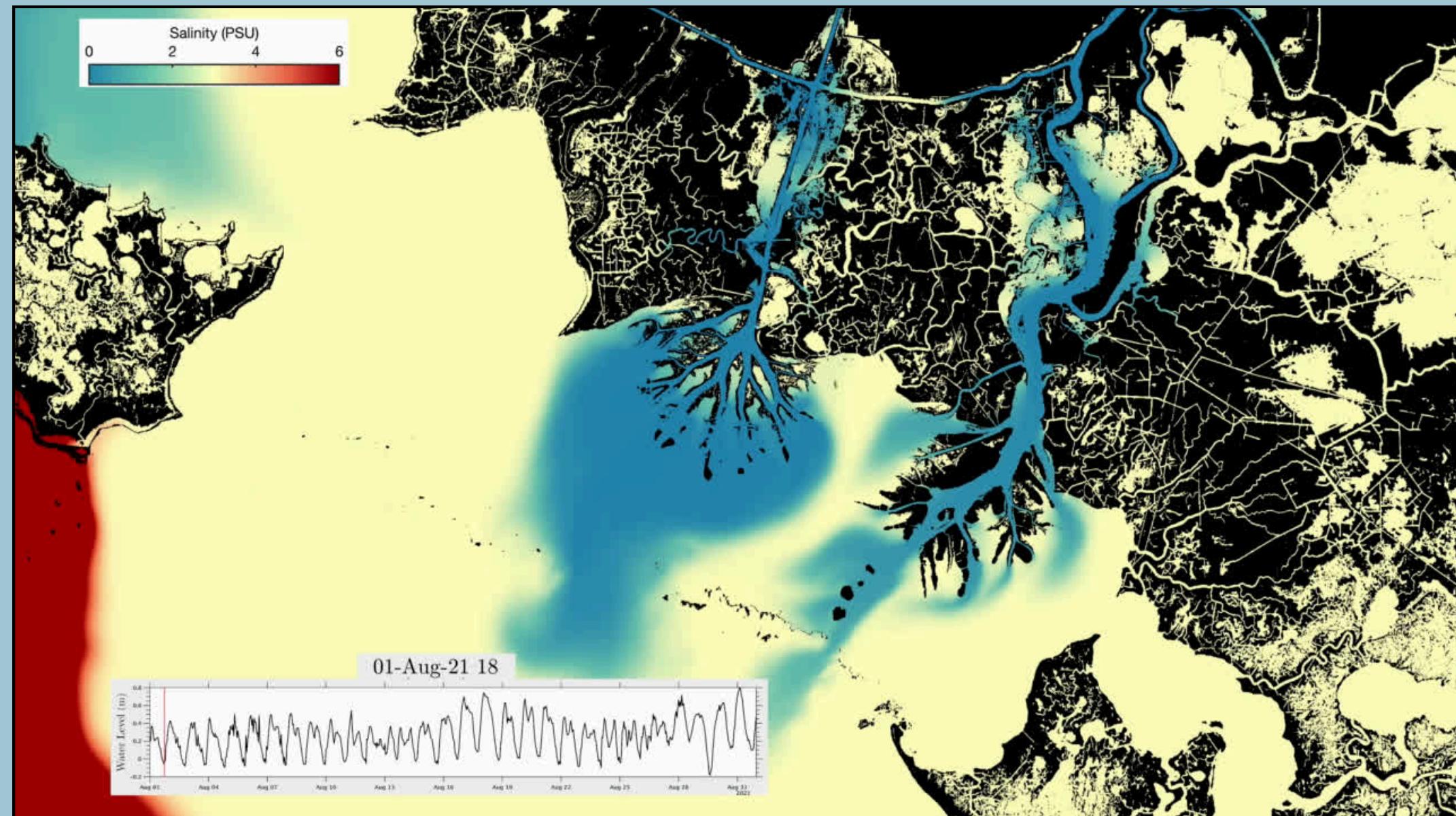


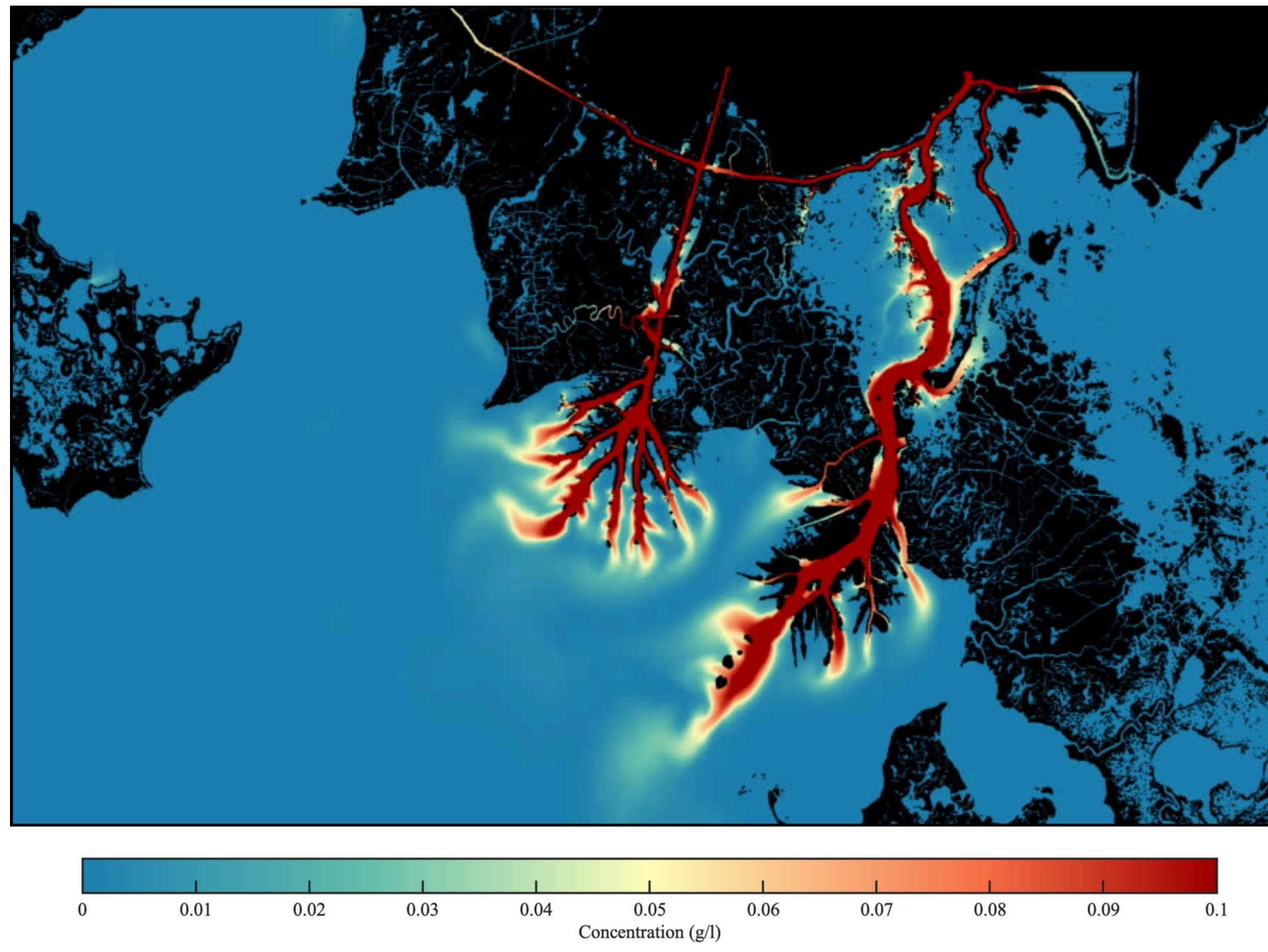
Process based morphological model

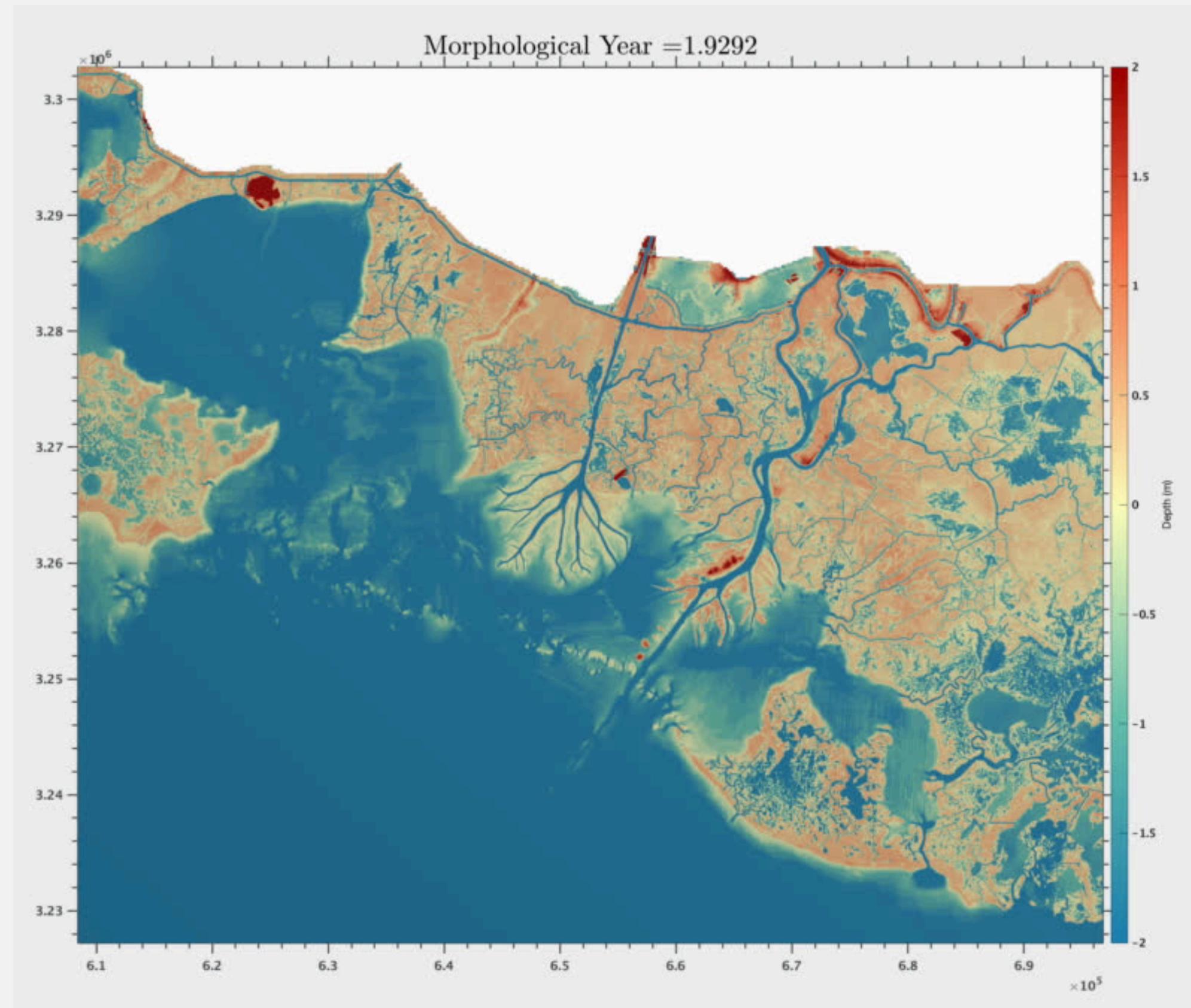




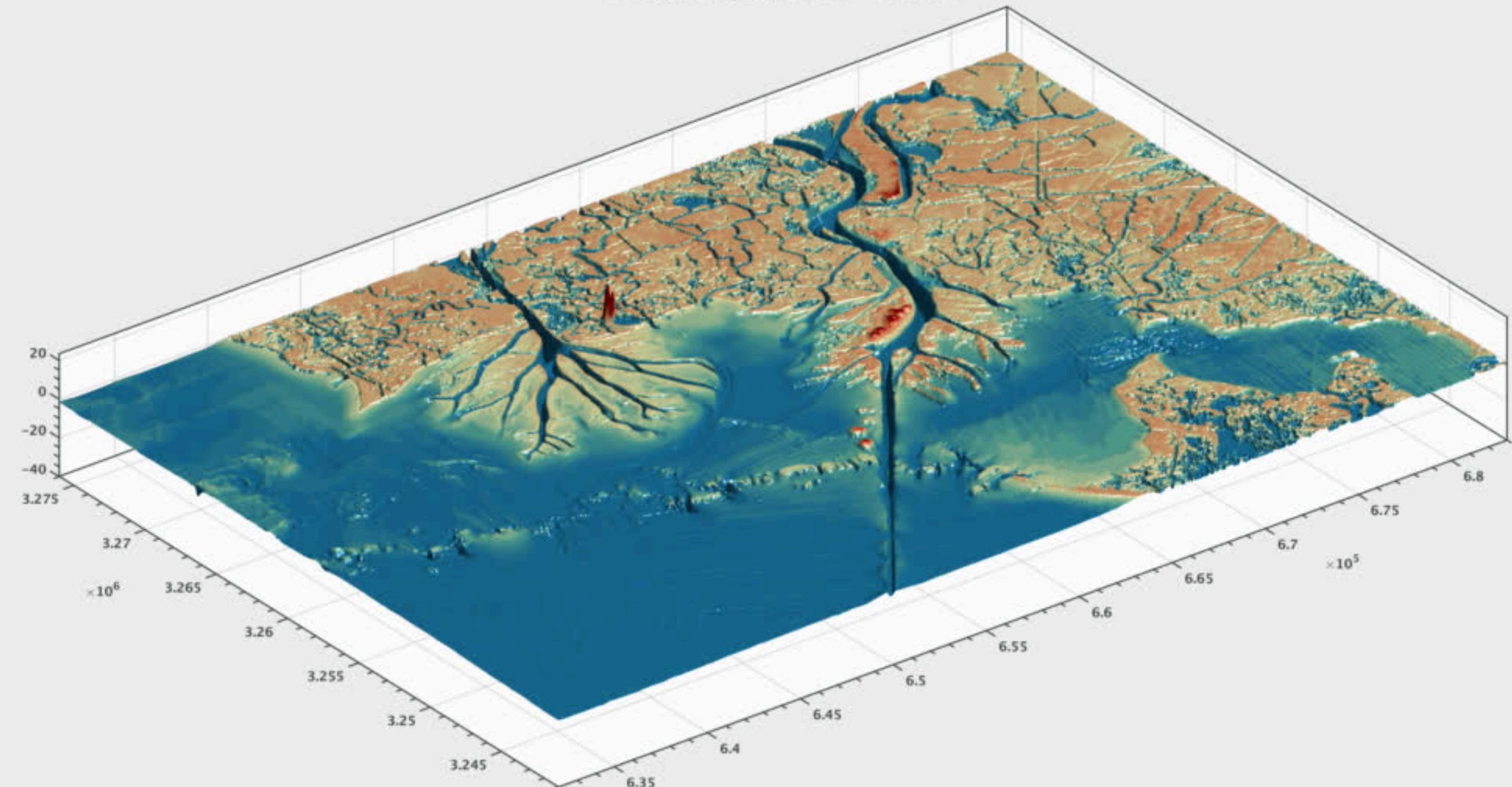








Morphological Year = 1.5639



- Case1 → Flow Only
- Case2 → Flow Only (Adjusted for Chezy Numbers)
- Case3 → Morphology model (Sand Only)
- Case4 → Morphology model (Sand & mud)

- Case1 → Flow Only
- Case2 → Flow Only (Adjusted for Chezy Numbers)
- Case2_V2 → Flow Only (All Boundaries)
- Case2_V3 → Flow + Salinity
- Case3 → Morphology model (Sand Only)
- Case4 → Morphology model (Sand & mud)

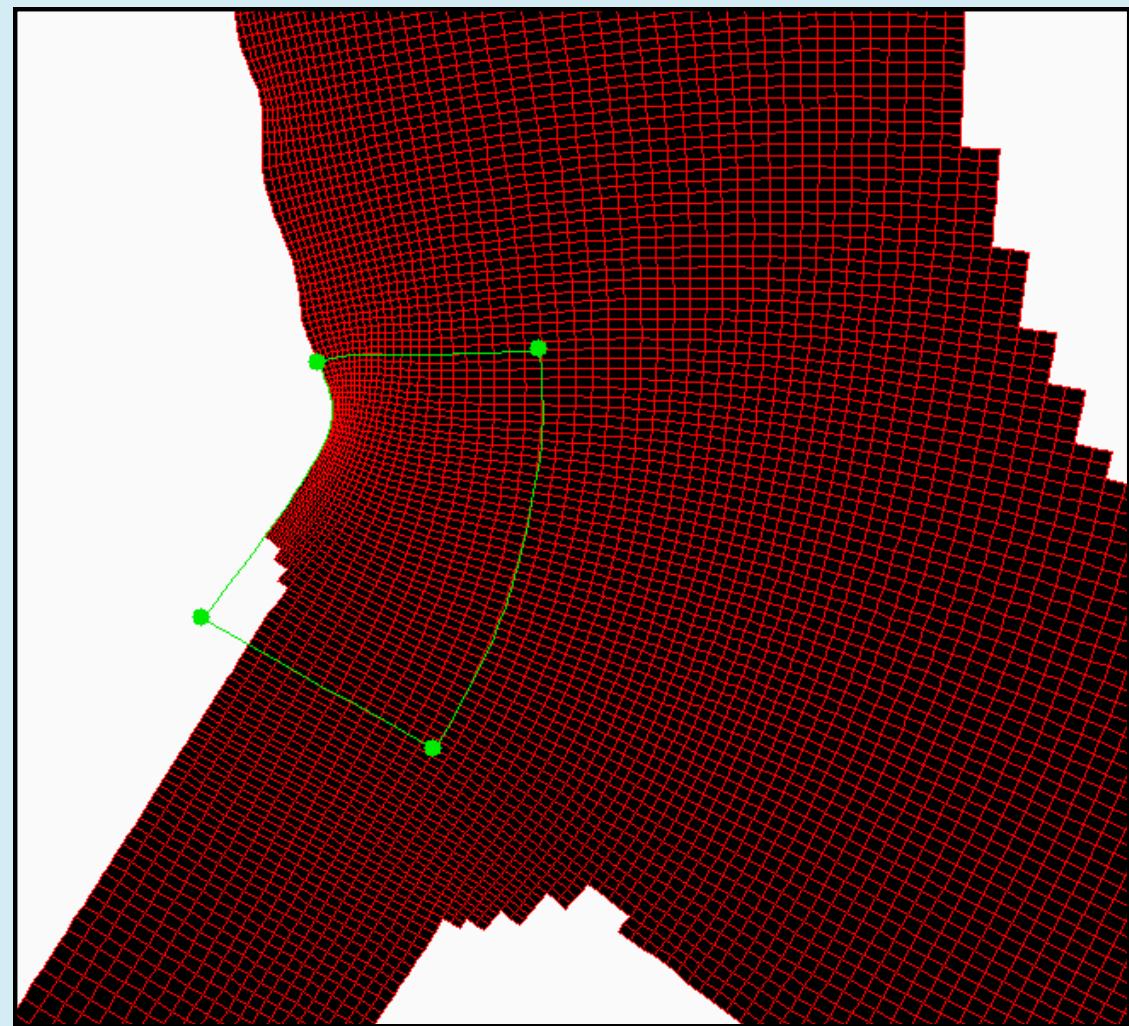
Installing Delft3d

Windows Options?

Delft3d 4

Finite difference scheme

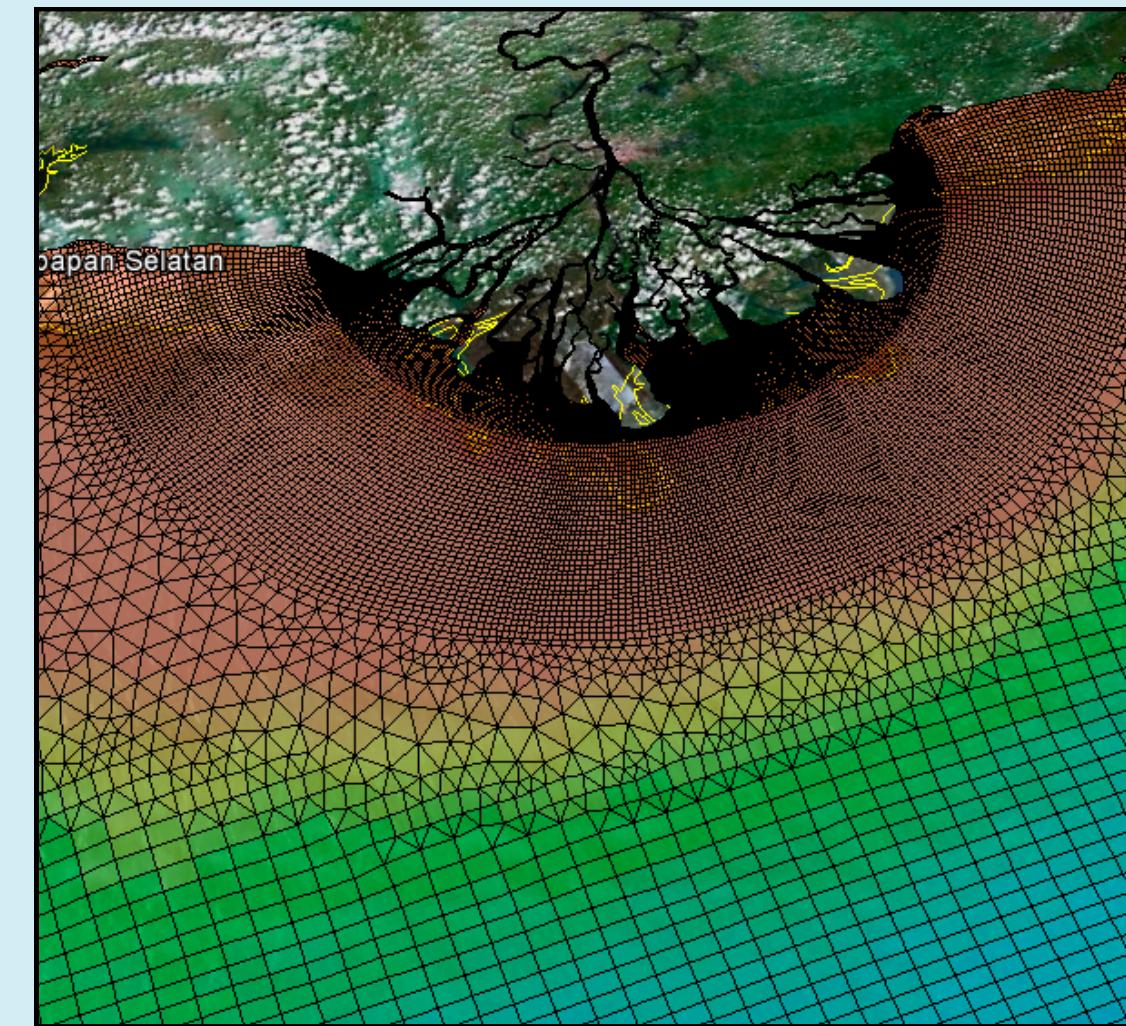
Rectilinear or a curvilinear grid



Delft3d FM

Finite volume scheme

Flexible Grid



You can access Delft3D in one of two ways

- Compile Delft3D yourself
- Install precompiled Delft3D

Deltares USA

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Delft3D for Delta-X Workshop

Deltares USA has made available a limited-use license for Delta-X Workshop participants to be able to download and use the precompiled version of Delft3D4 for Windows. The license file will be valid until July 9, 2024.

To download the software and license file, please continue:

[Terms and Conditions](#)

<https://www.deltares-usa.us/delta-x-workshop>

Case1

Flow Model

Flow model (Hydrodynamic)

Shallow Water Equations

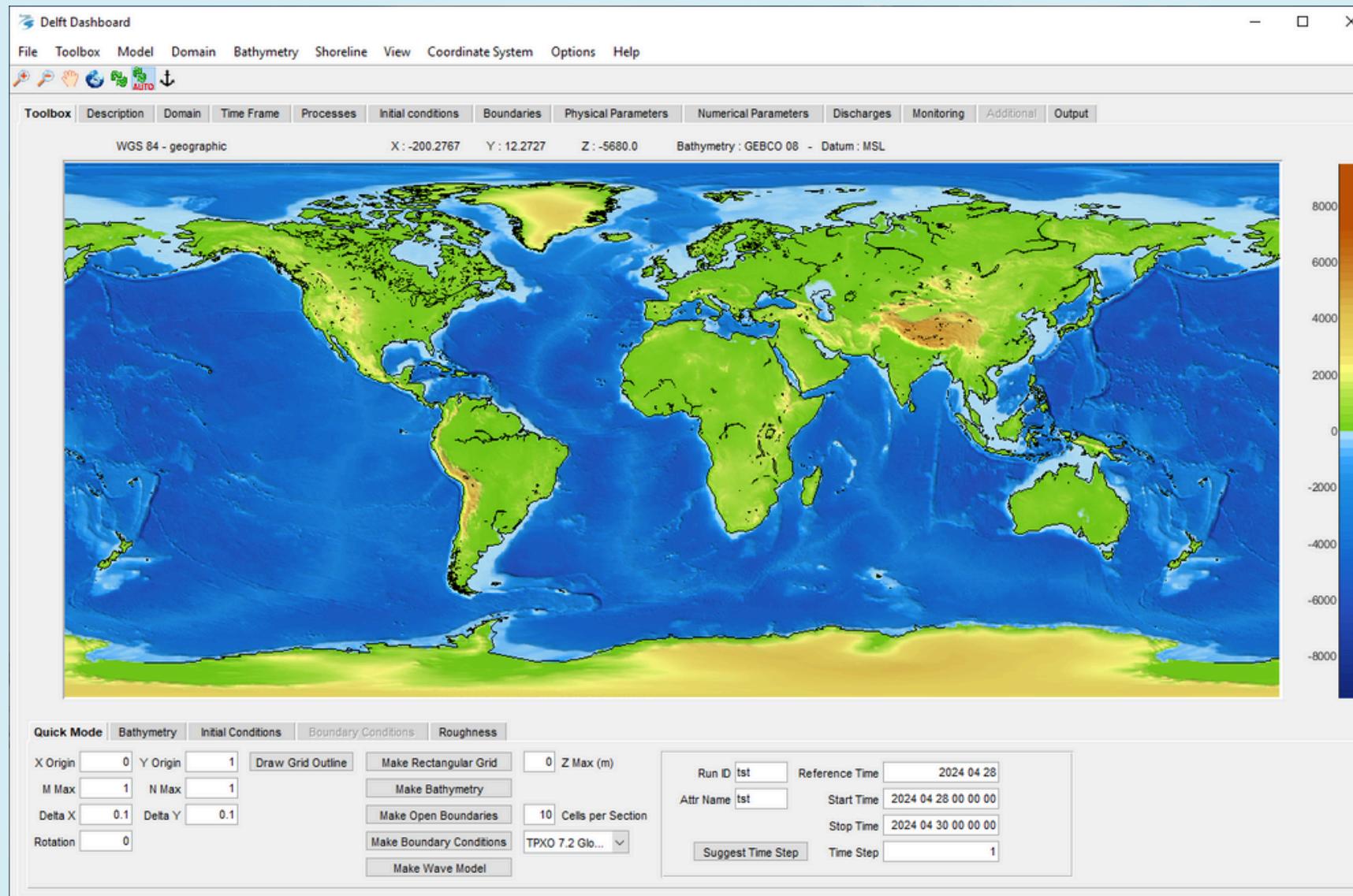
$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} - fv = -g \frac{\partial \eta}{\partial x} + \frac{F_x}{\rho h} + R_x - \frac{\tau_{bx}}{\rho h}$$

$$\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + fu = -g \frac{\partial \eta}{\partial y} + \frac{F_y}{\rho h} + R_y - \frac{\tau_{by}}{\rho h}$$

$$\frac{\partial \zeta}{\partial t} + \frac{\partial h\bar{u}}{\partial x} + \frac{\partial h\bar{v}}{\partial y}$$

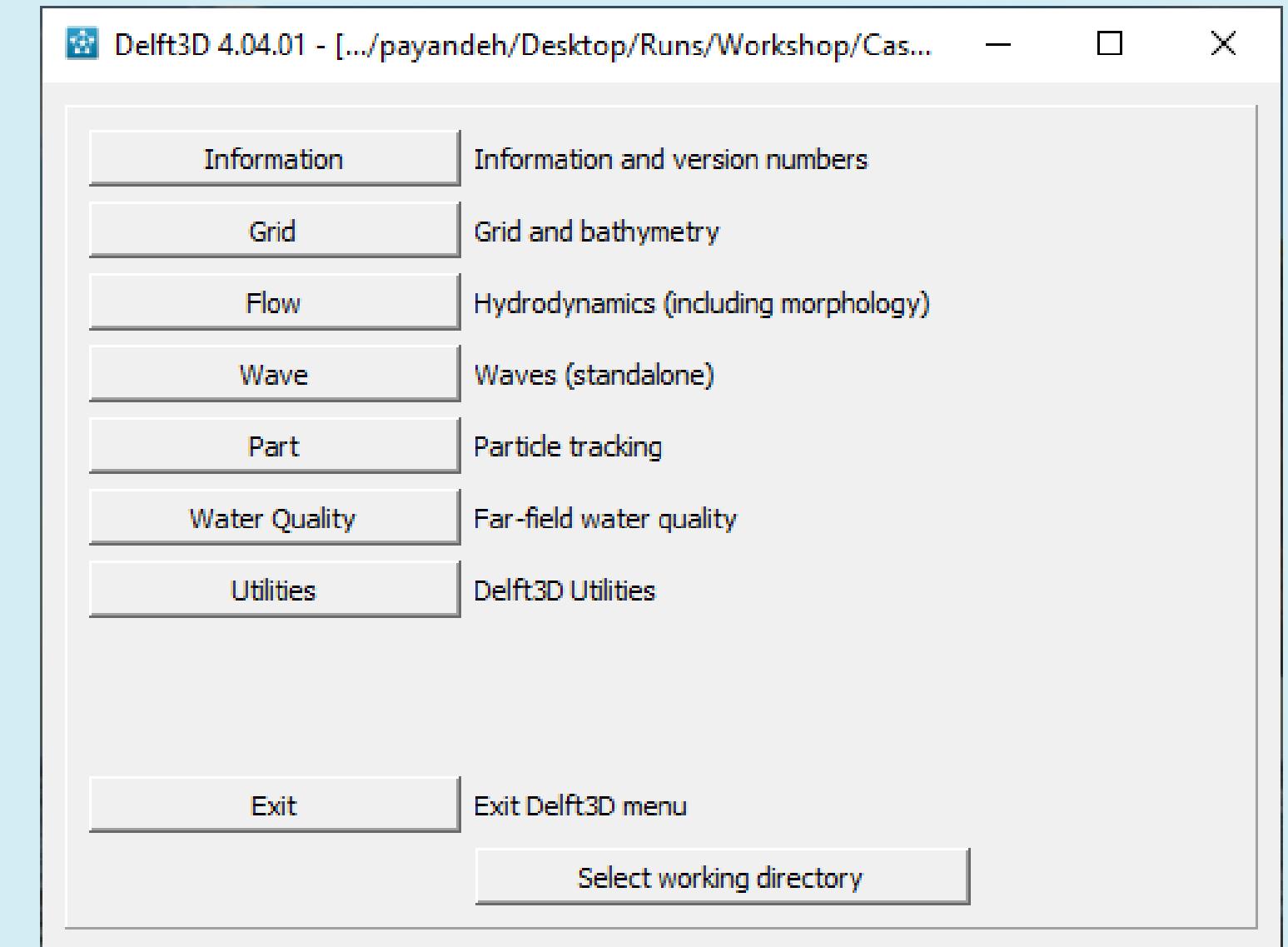
Two tools to setup a model

Delft3d Dashboard



Casel

Delft3d main menu

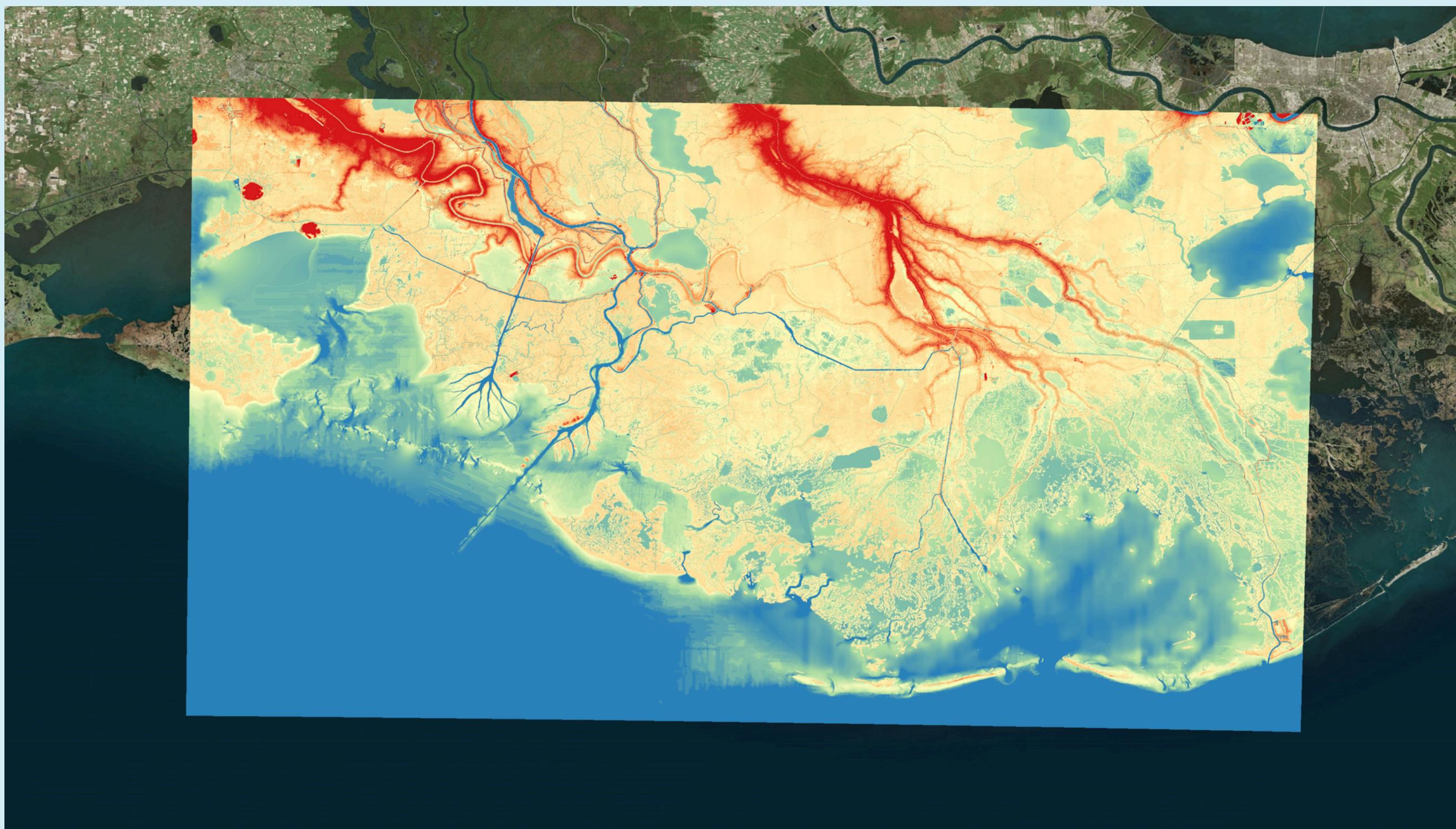


Case2 & Case3 & Case4

Steps to setup a model in Delft3d Dashboard

- select working directory
- select coordinates system
- set the Run ID
- change bathymetry to DeltaX

DeltaX DEM link on ORNL

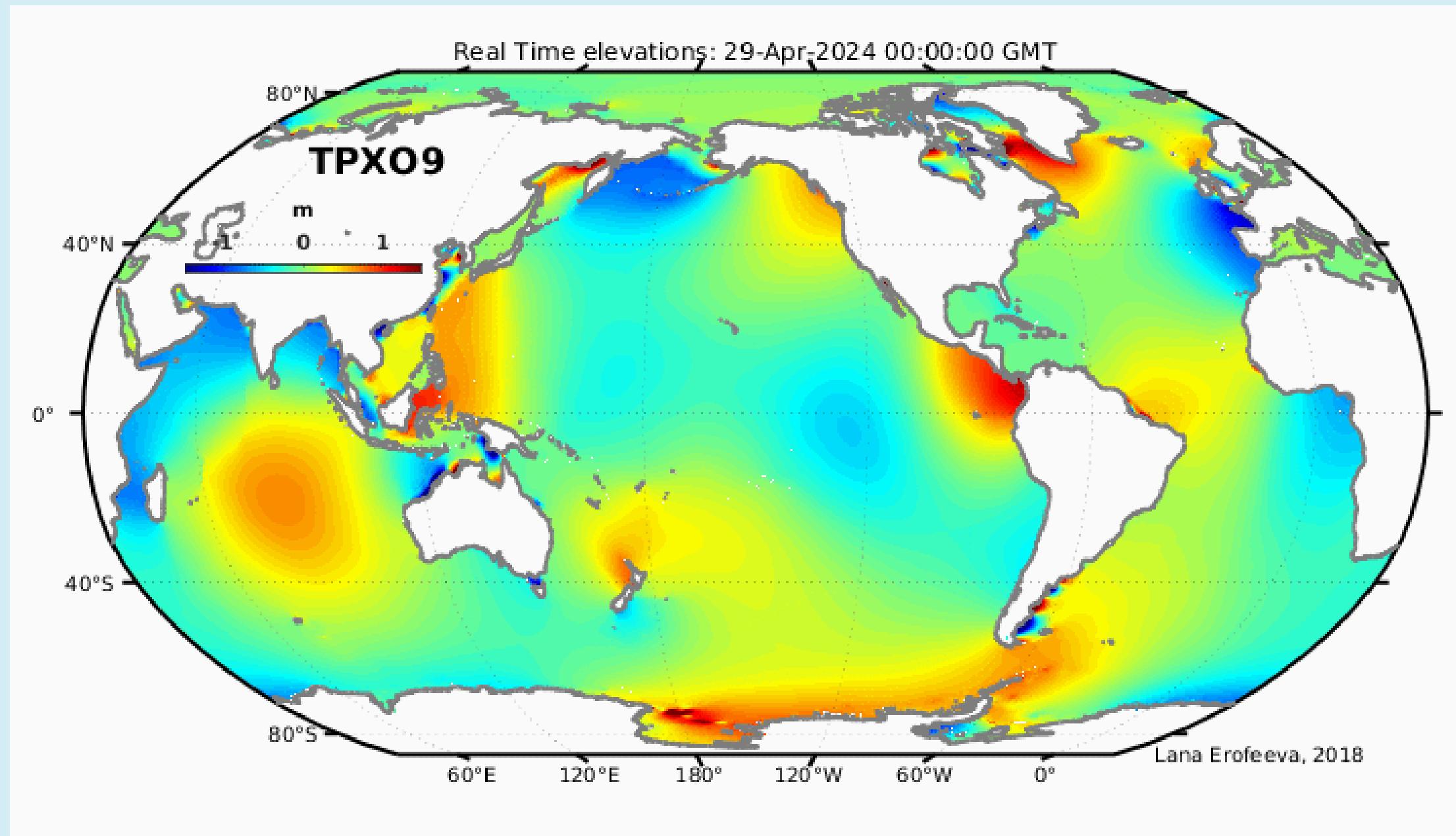


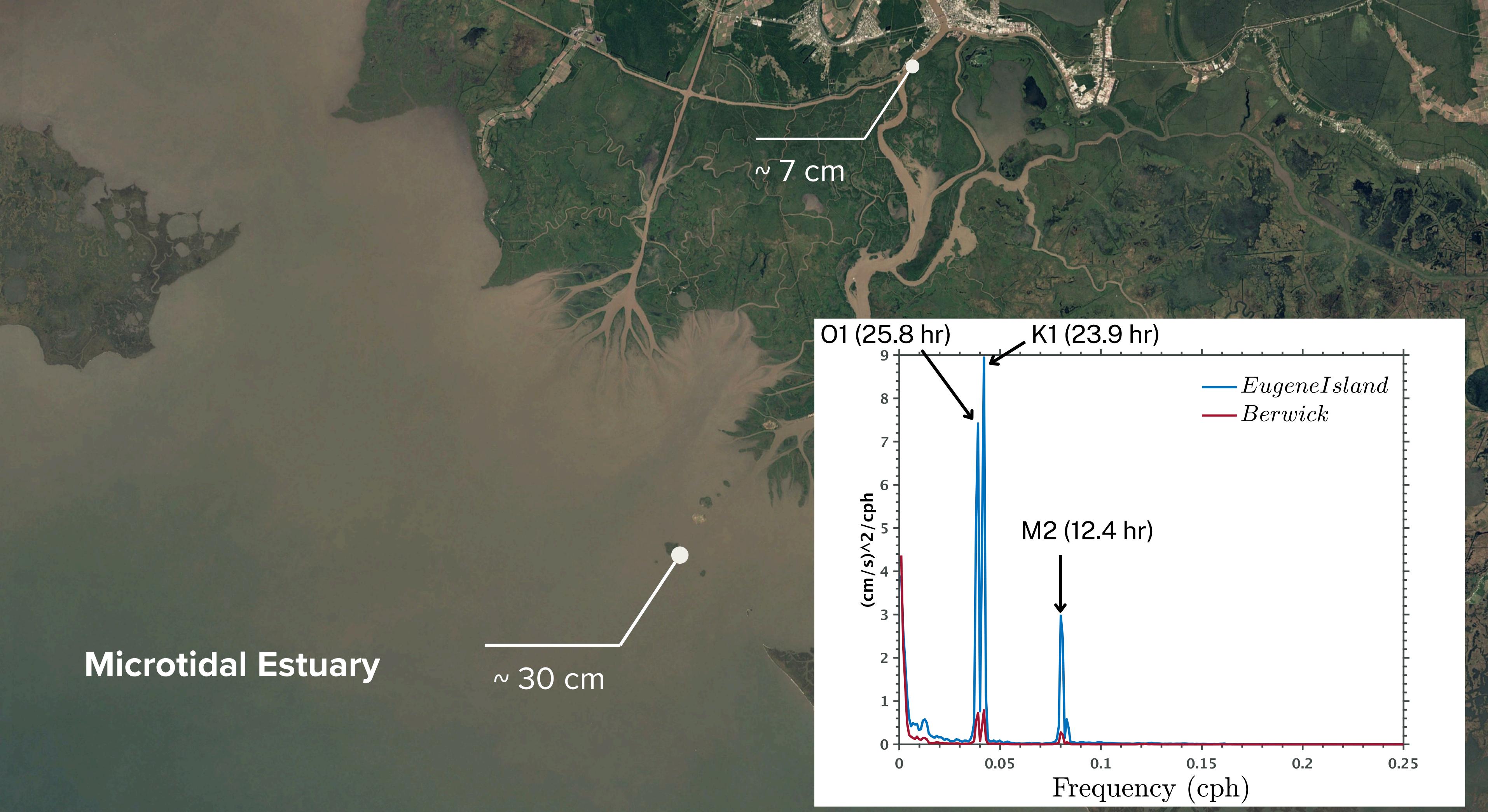
Christensen et al., (2021)

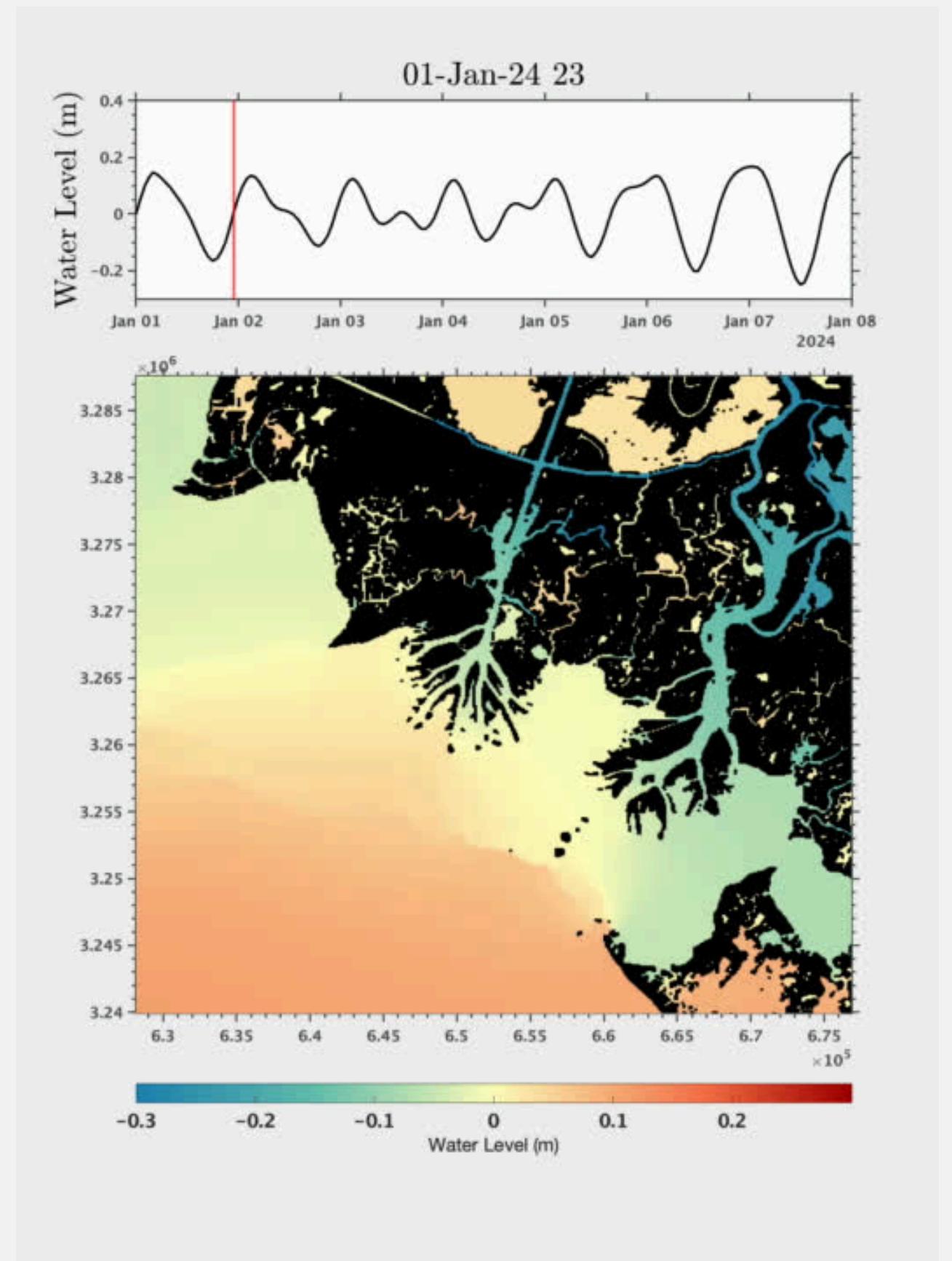
Steps to setup a model in Delft3d Dashboard

- select working directory
- select coordinates system
- set the Run ID
- change bathymetry to DeltaX
- make the grid
- make the bathymetry file
- make open boundaries
- make boundary condition using TPXO Tide Models
- set time step, start and end time
- Save the mdf file

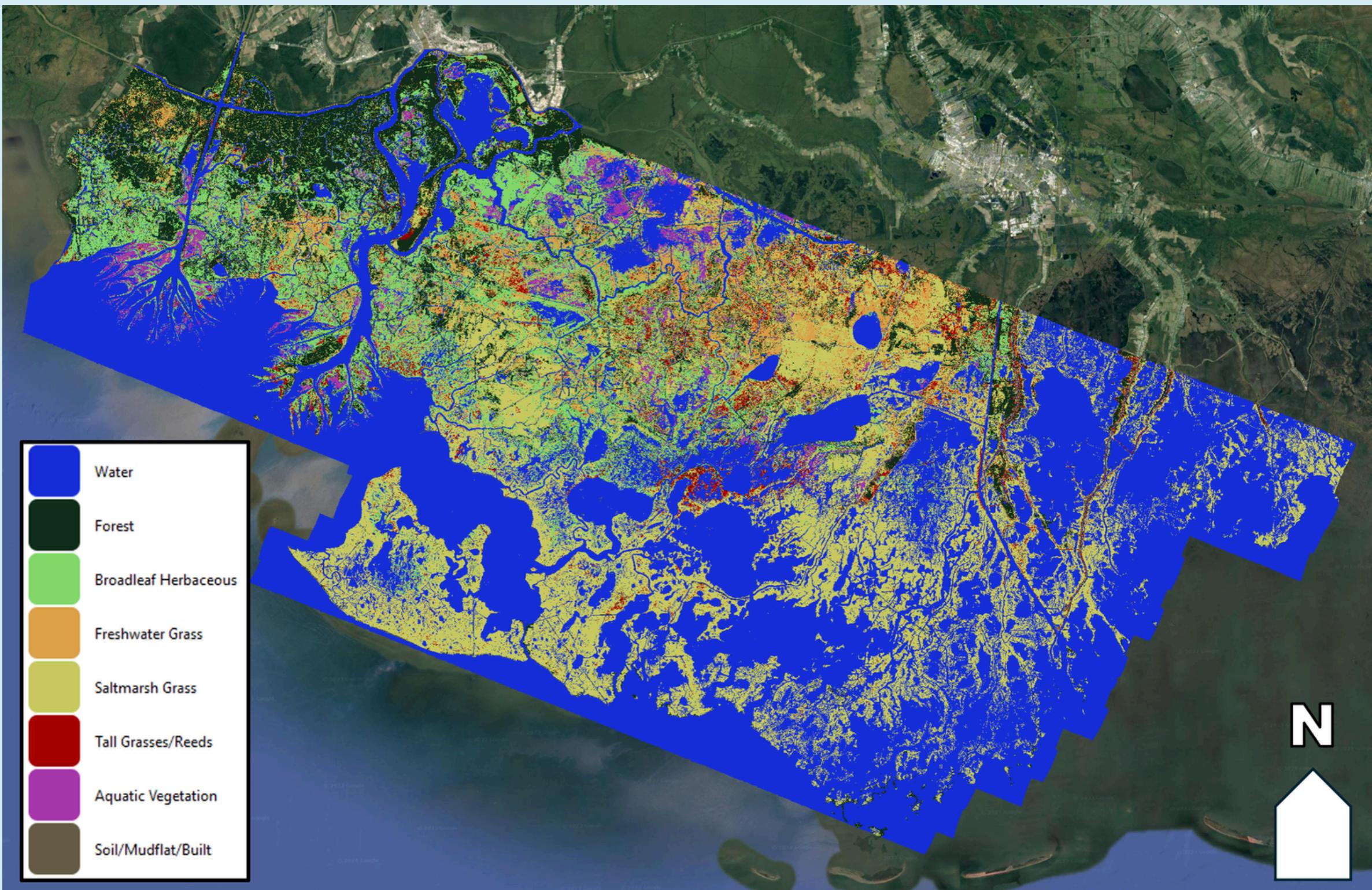
OSU TPXO Tide Models



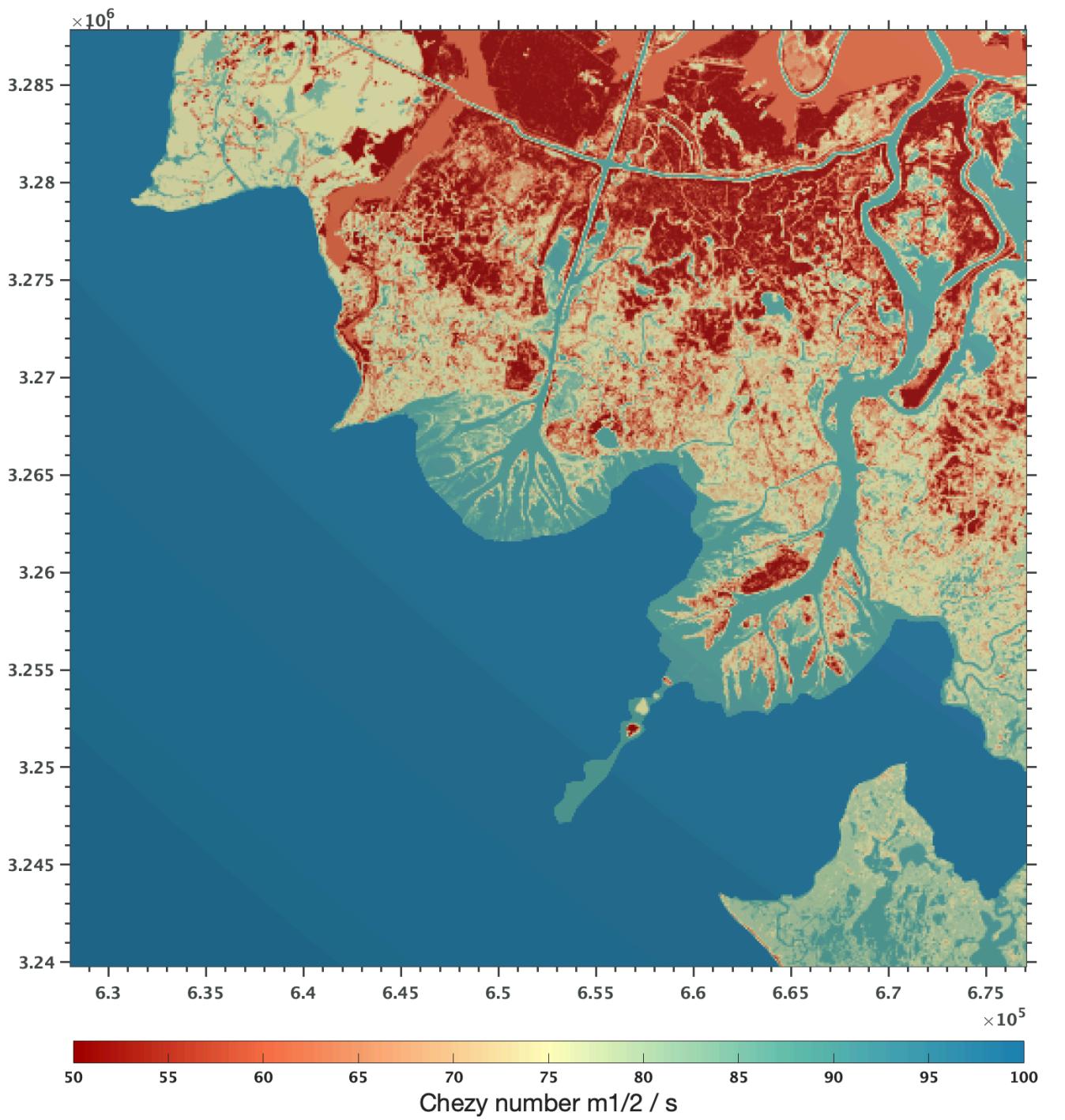


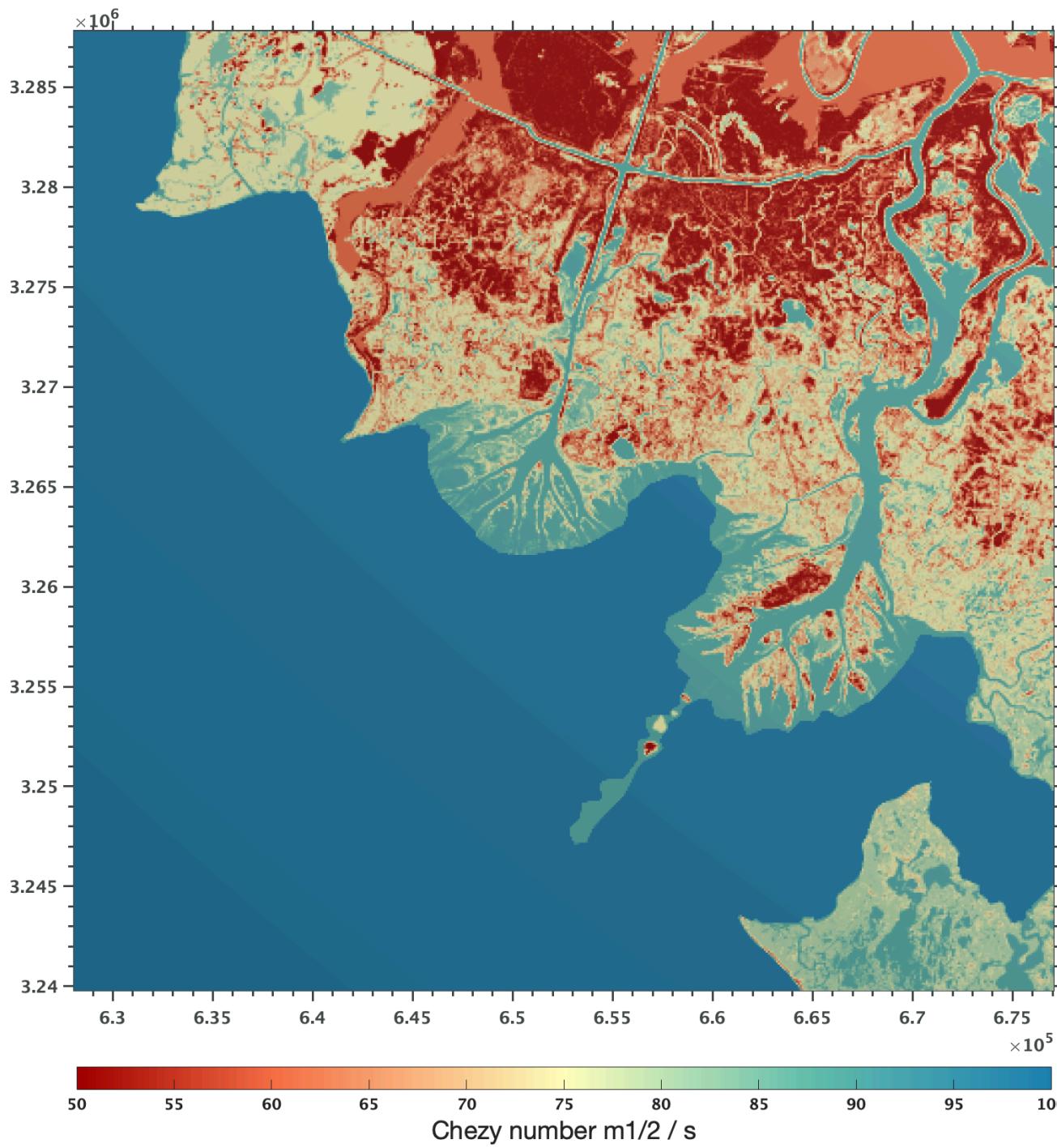
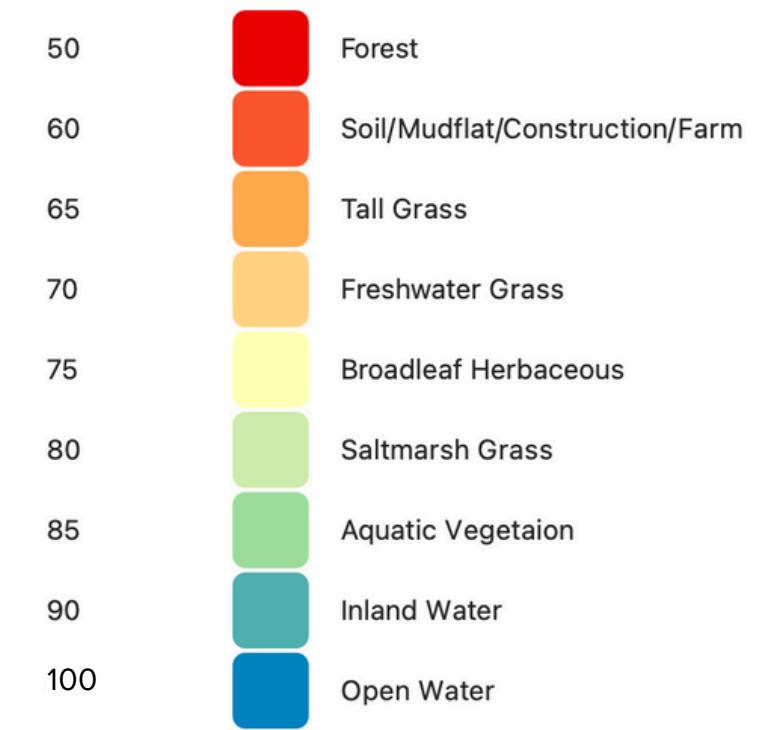


Case1
Flow Model
Adjusting Chezy numbers



Jensen et al. (2024)





Case3

Flow Only with all Boundaries

How to make Chezy file

- In Qgis, open the Vegetaion Map file
- Use raster calculator to set chezy value for each vegetation type:

```
("VegetationMapLayer@1" = 0) * 100 + ("VegetationMapLayer@1" != 0) * "VegetationMapLayer@1"
```

- Do above for all values
- Convert your raster file to xyz file:

Raster>Extraction>Clip raster by extent

- Open the sample file (.xyz file) in Delft3d>QUICKIN
- Open grid and interpolate Chezy values (.xyz file) to the grid. Just like making a bathymetry (.dep file)
- Export the .dep file. Copy all values and paste them in the last line (U and V roughness coefficients!)
- change the extention from .dep to .rgh
- Now you can introduce the rgh file in your model



The fate of Deltas – Delft3d Morphodynamic modeling

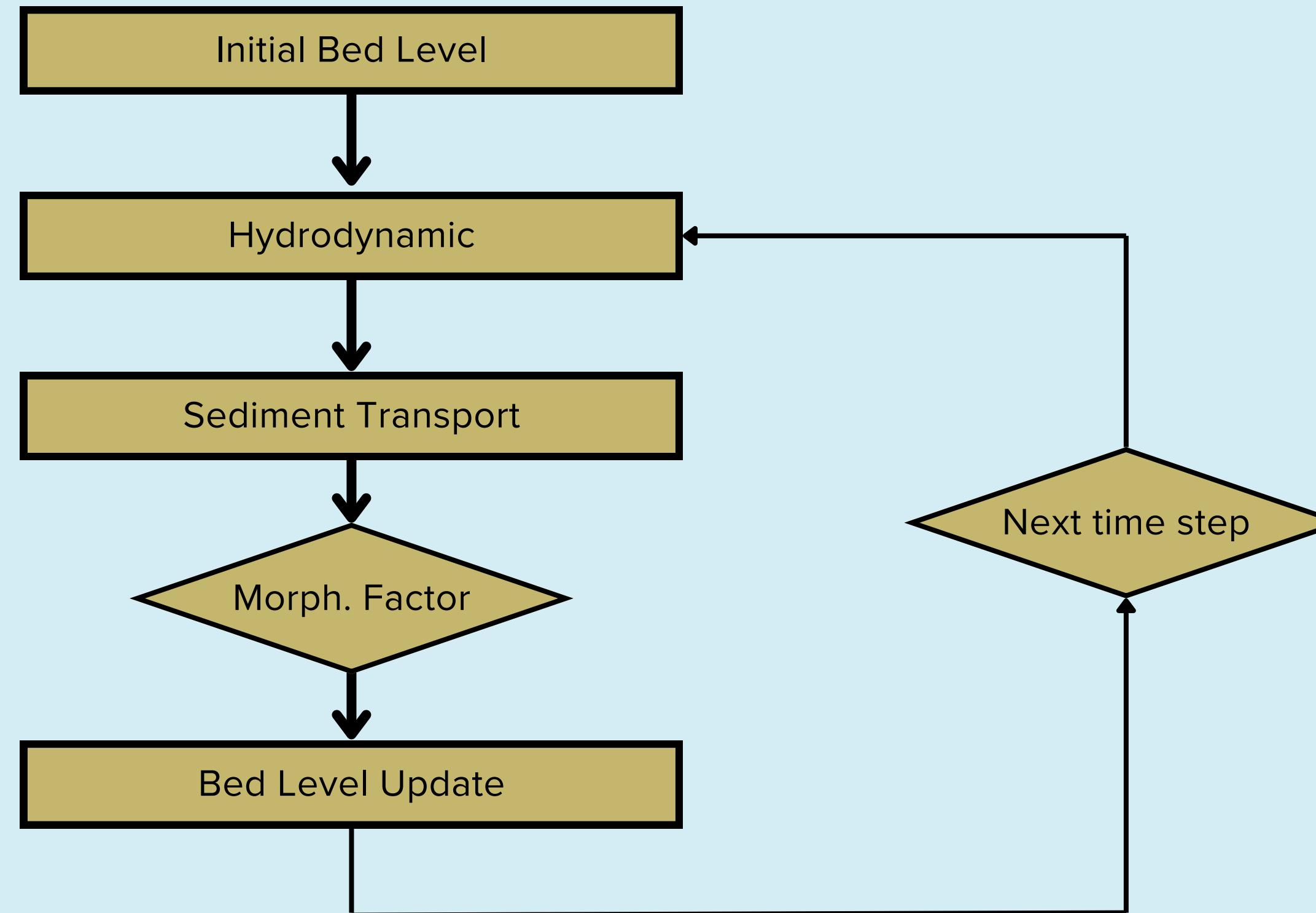
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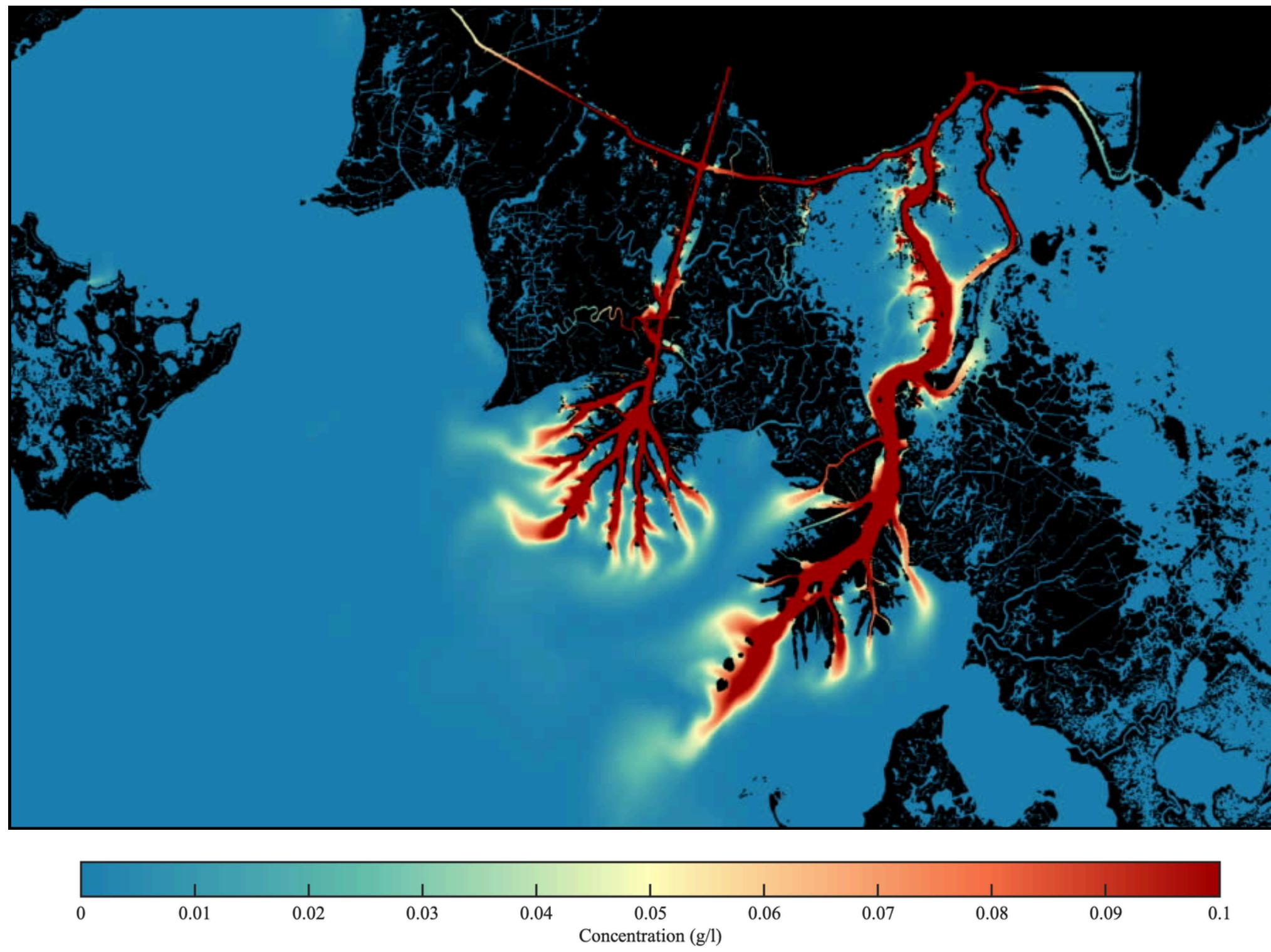


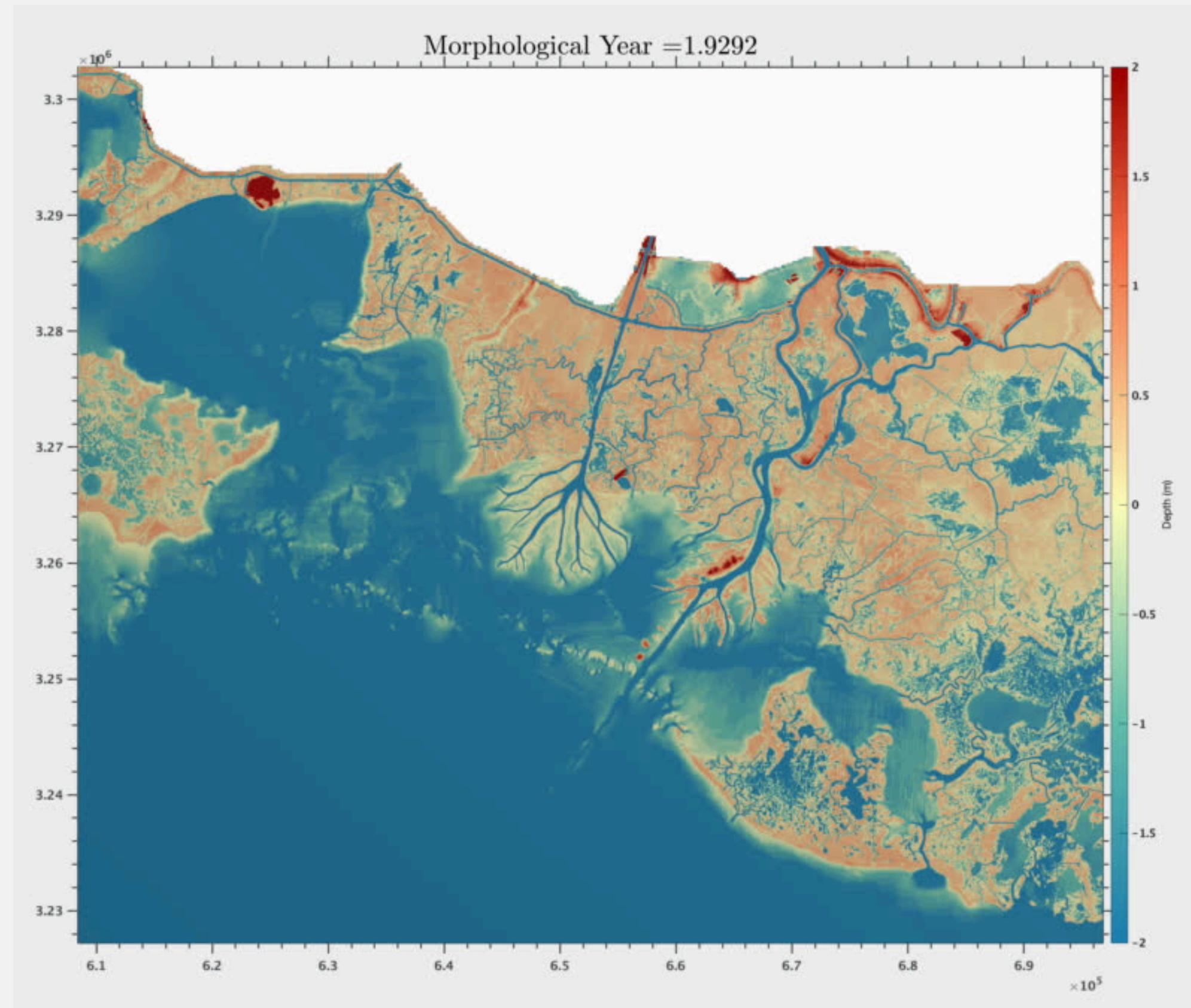
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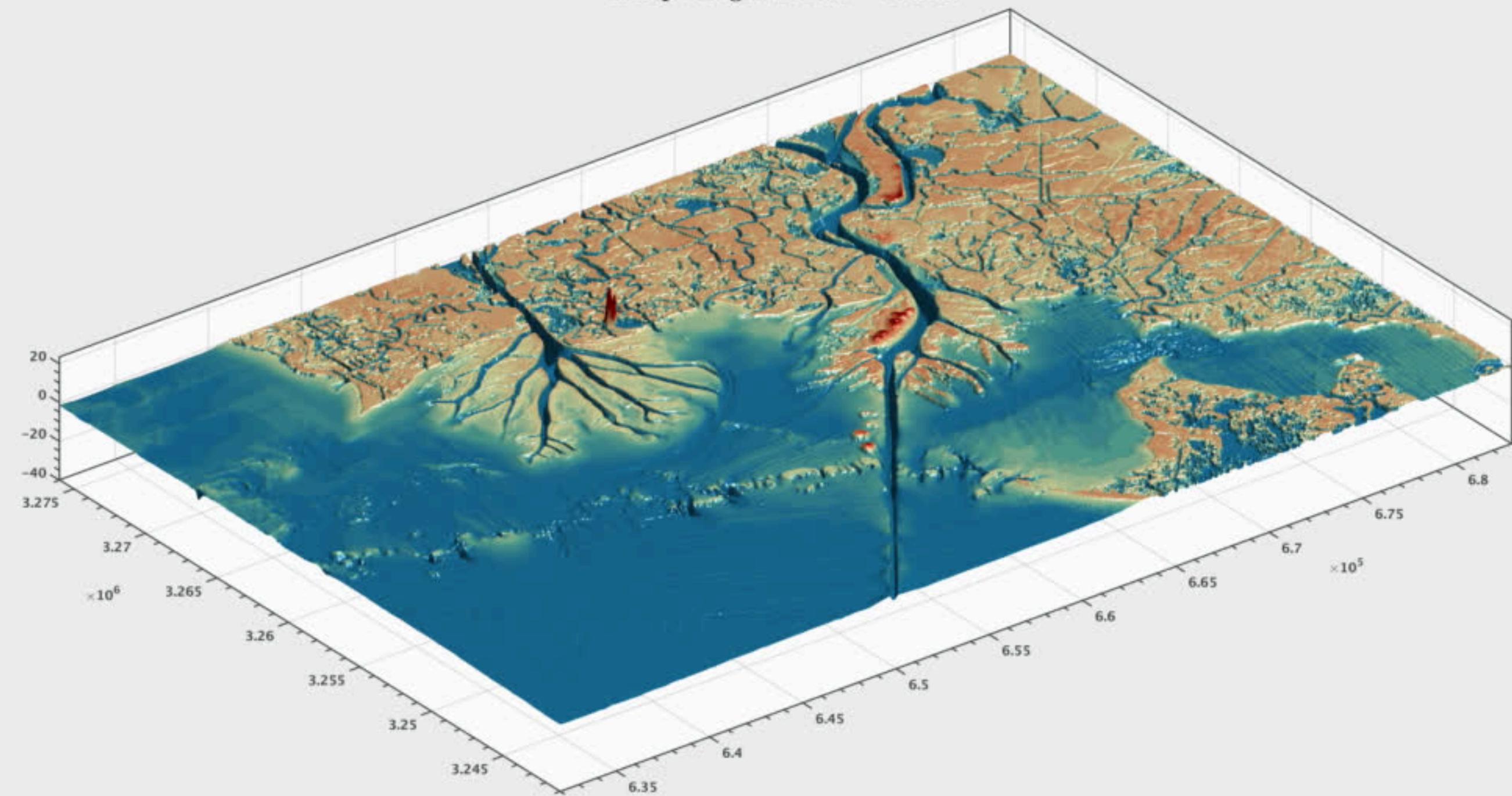


10 (days) * 365 ~ 3650 (10 years)





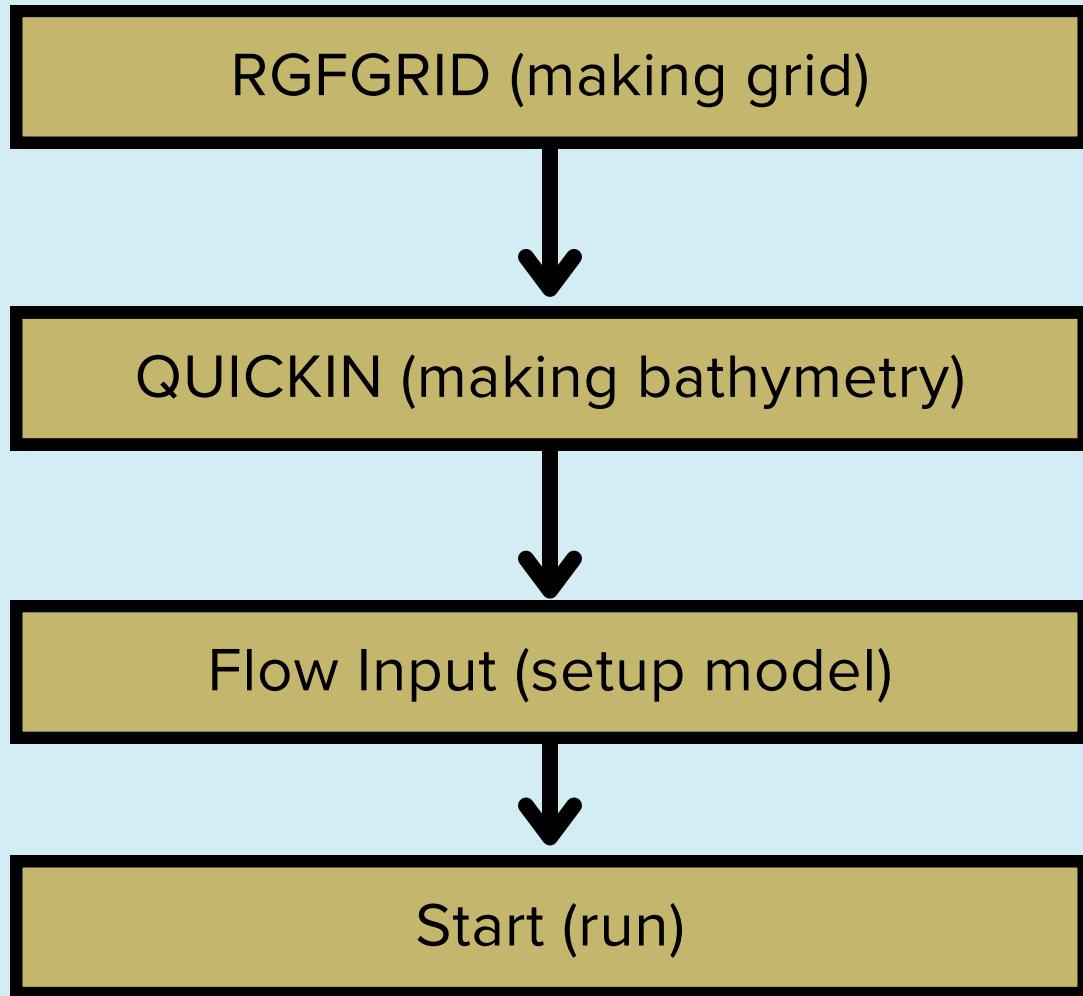
Morphological Year = 1.5639



Morphodynamic Model

$$(1 - \varepsilon_p) \frac{\partial z_b}{\partial t} + \frac{\partial S_x}{\partial x} + \frac{\partial S_y}{\partial y} = \frac{dz_{ref}}{dt} + \varphi_{dep} + \varphi_{er}$$

- Porosity
- Bed Level
- Transport in X direction
- Transport in Y direction
- Subsidence
- Nourishment/Dumping
- Dreging



Checking Courant number in QUICKIN

$$\text{Courant} = 2\Delta T c \sqrt{\frac{1}{\Delta x^2} + \frac{1}{\Delta y^2}}$$

$$C_{adv} = \max \left(\frac{u \Delta t}{\Delta x}, \frac{v \Delta t}{\Delta y} \right) \leq 1$$

Case3

Morphology Model

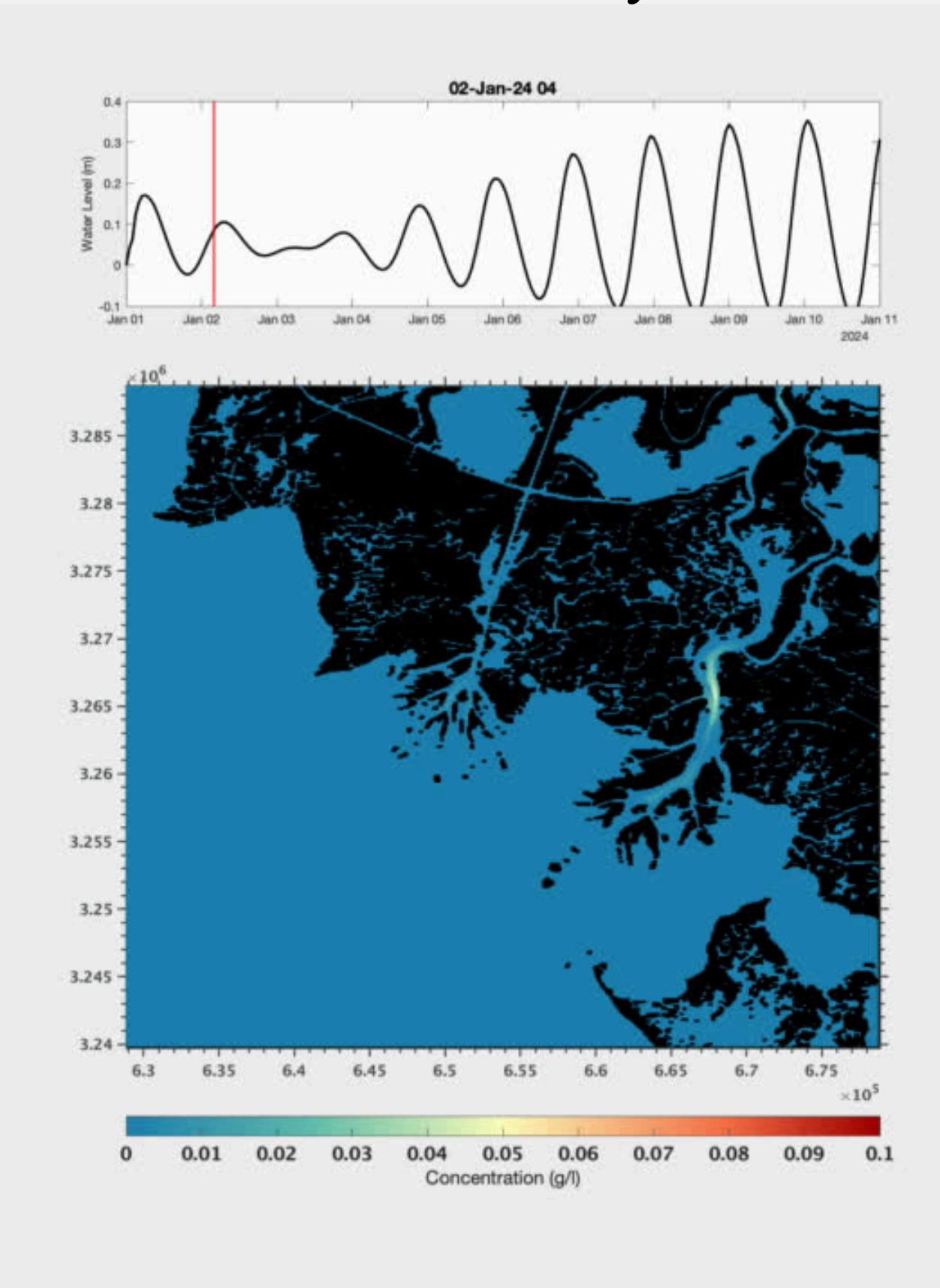
Sand Only

Case4

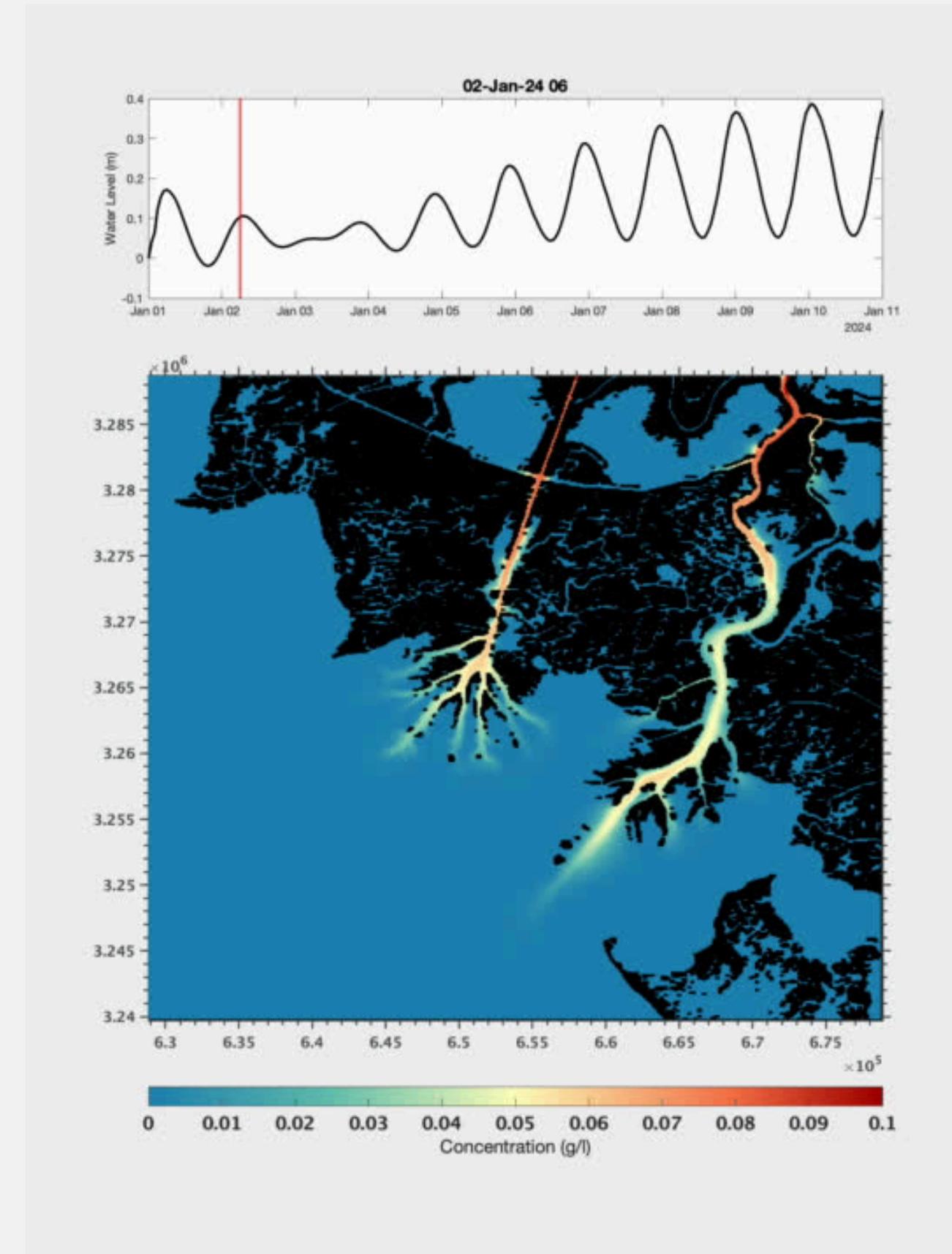
Morphology Model

Sand & Mud

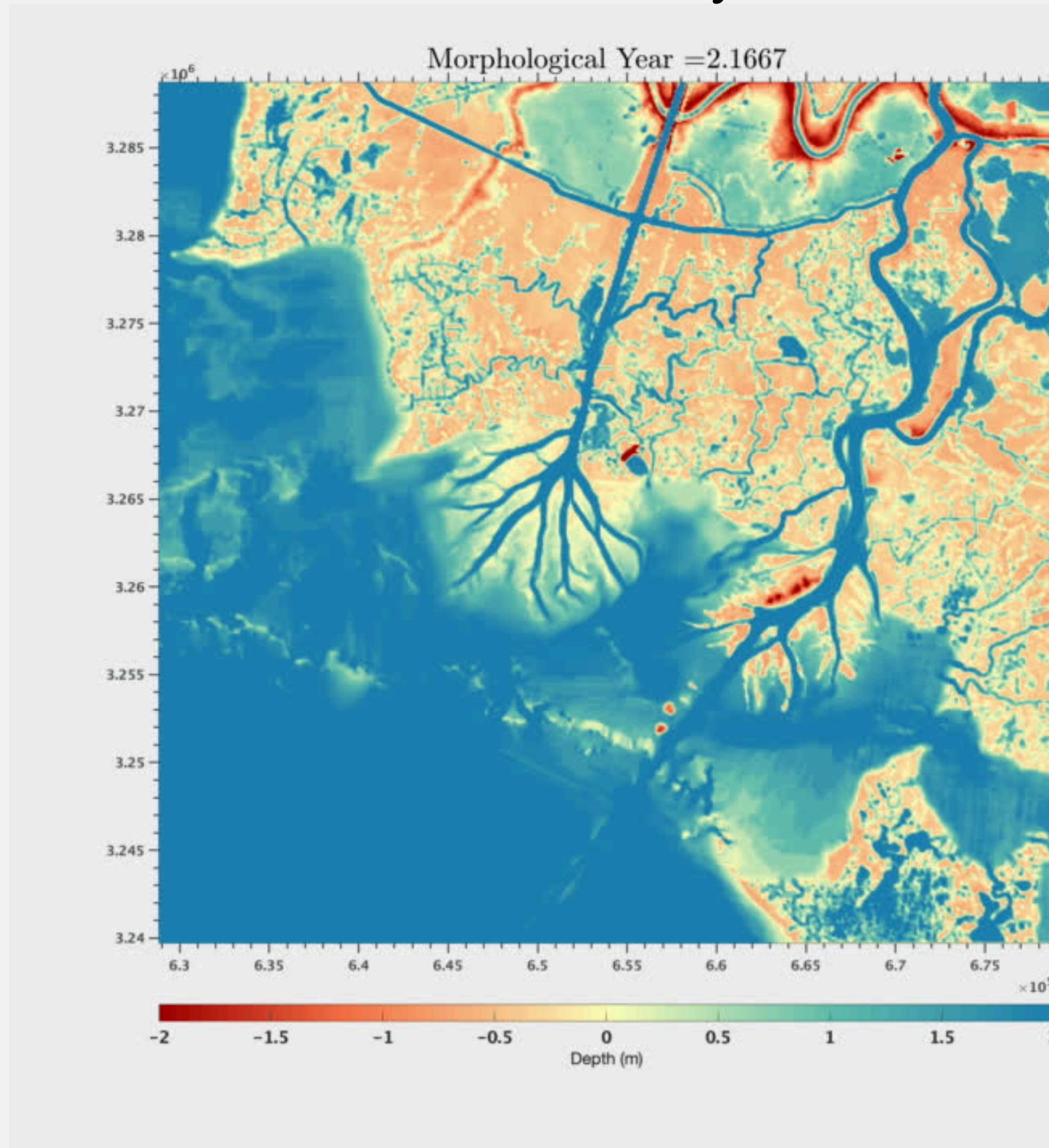
Sand Only



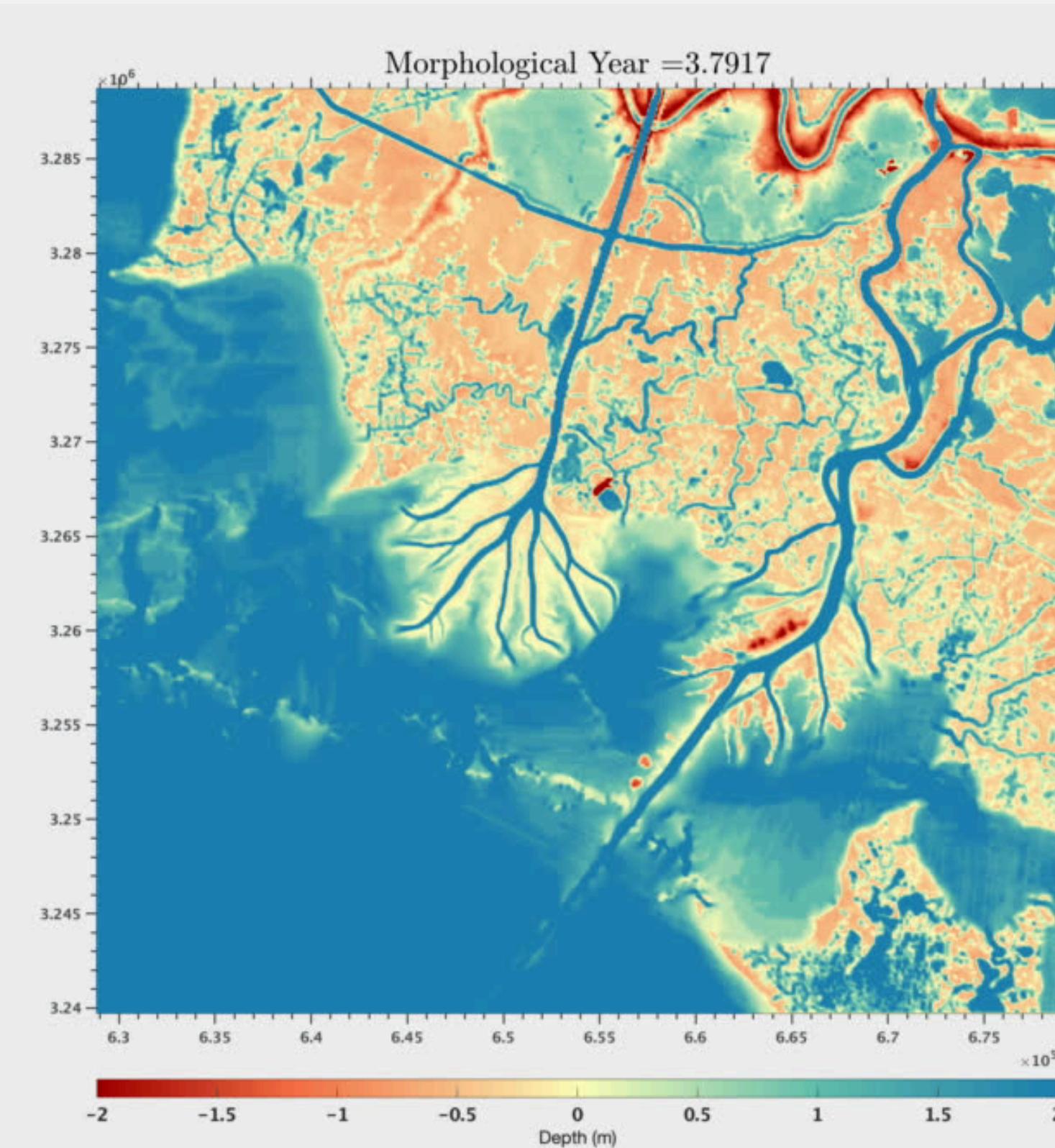
Sand & Mud



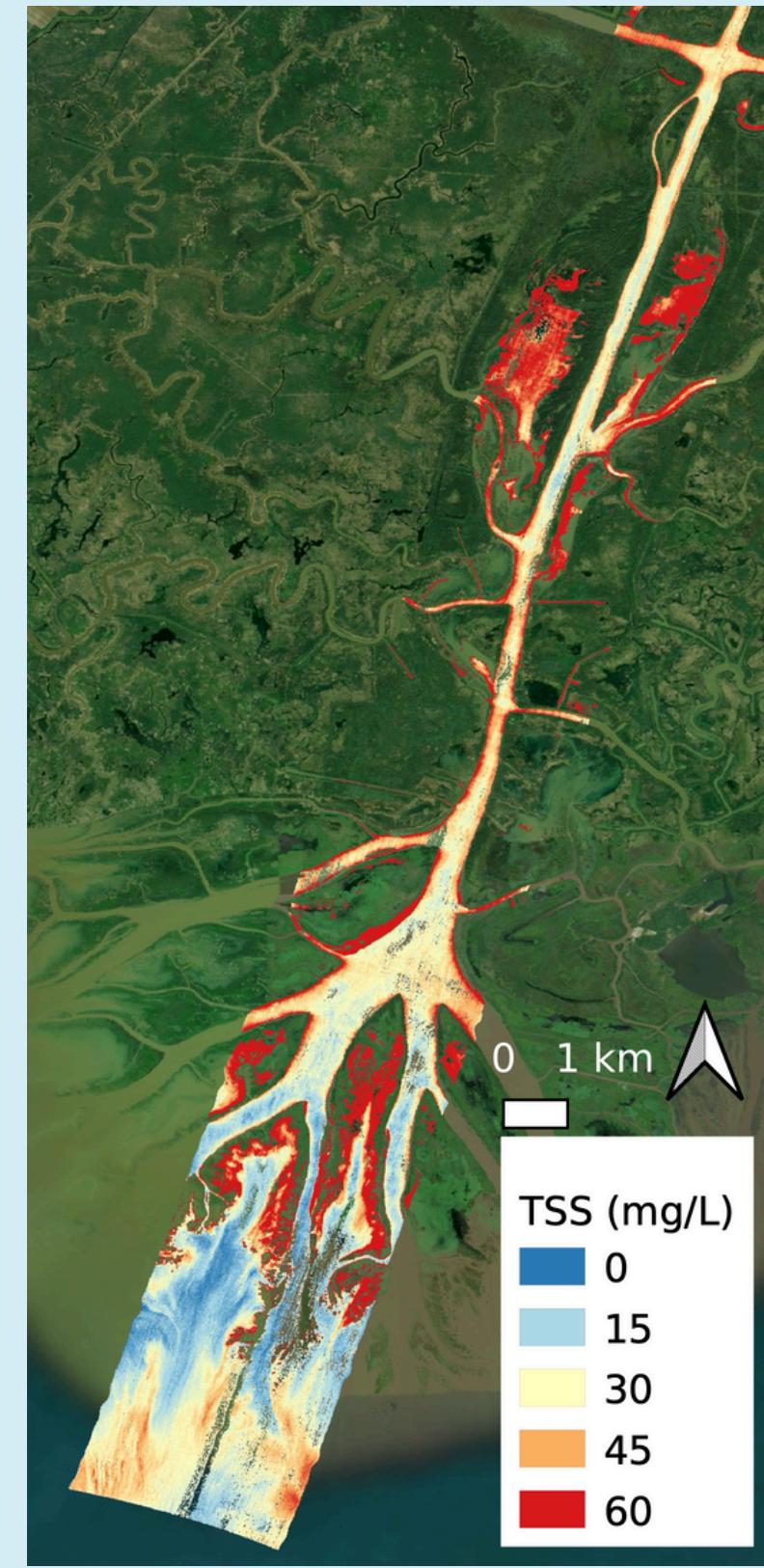
Sand Only



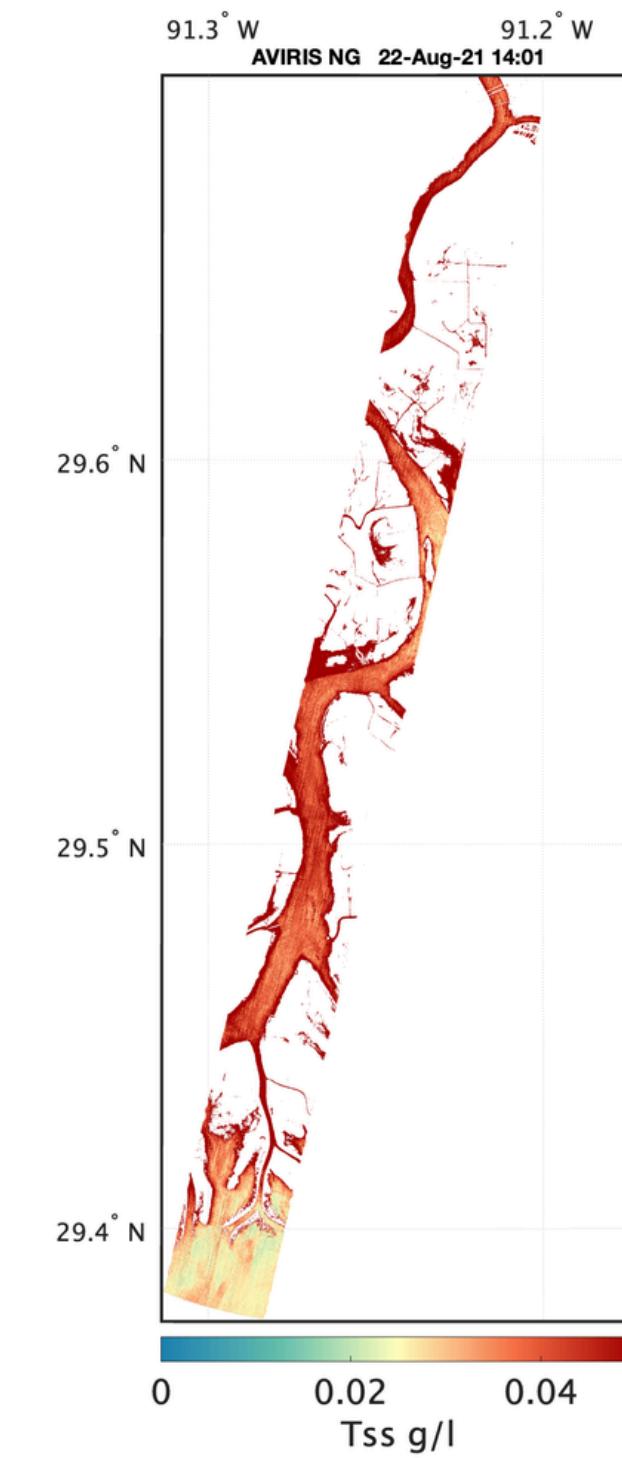
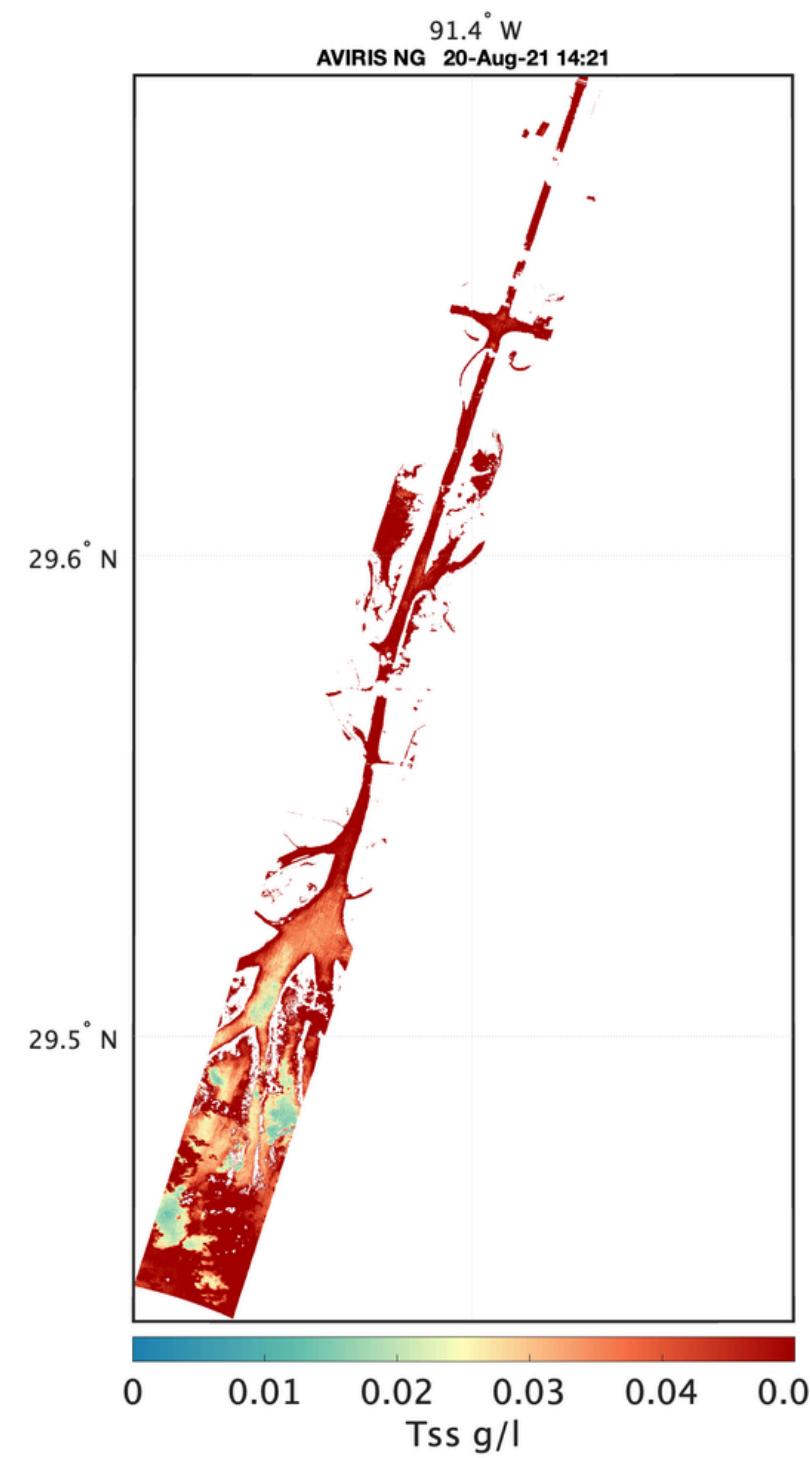
Sand & Mud

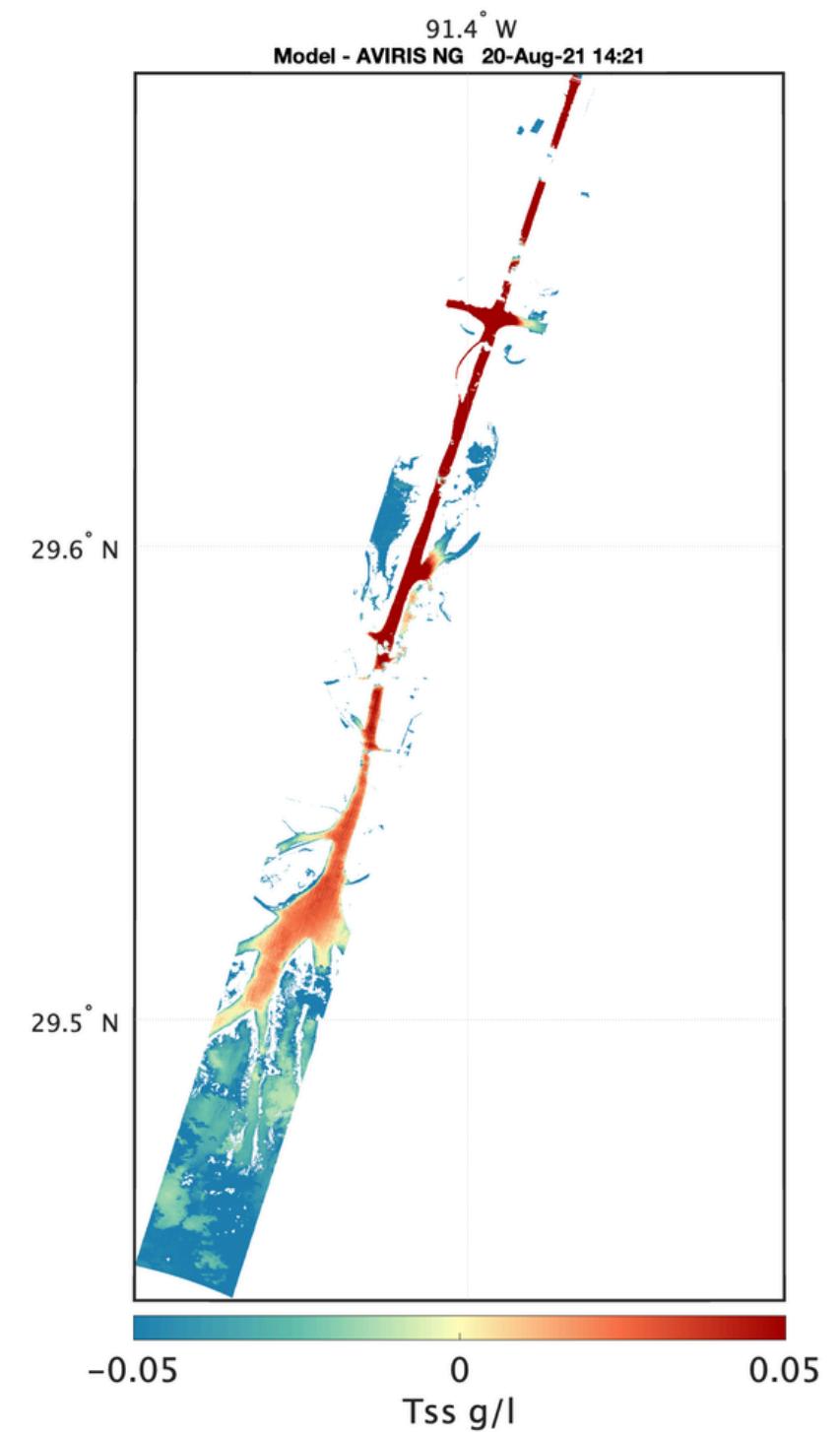


Using AVIRIS-NG TSS data
to calibrate model

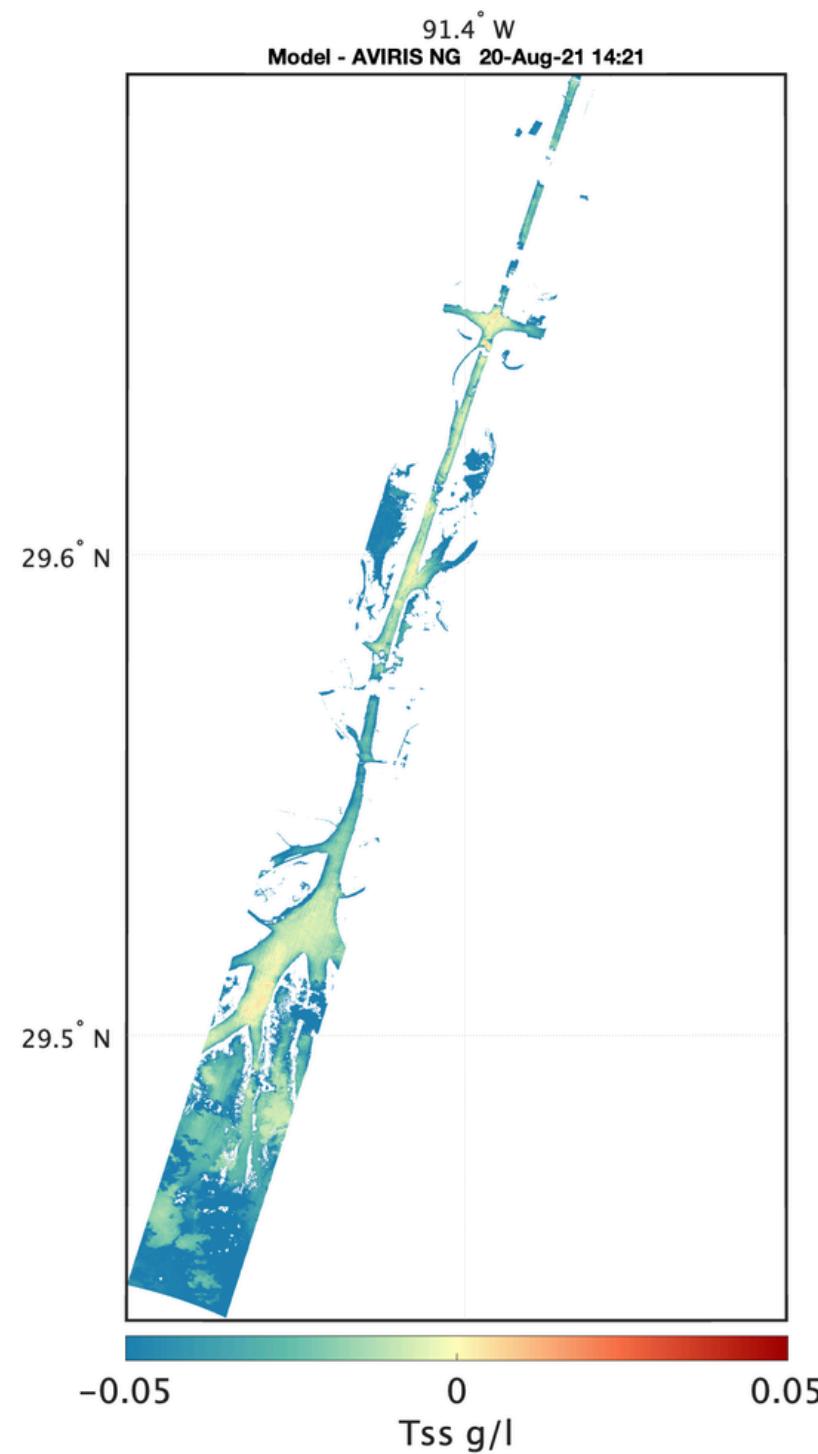


Using AVIRIS-NG TSS data to calibrate model





Calibration →



Running on HPC?

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