Jet Propulsion Laboratory
California Institute of Technology

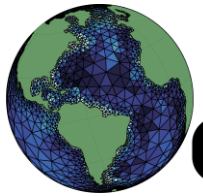
Generating optimized unstructured mesh grids using OM2D

2023 Delta-X Science Team Meeting and Open Data Workshop

June 5th, Boston University

Antoine Soloy

Jet Propulsion Laboratory
California Institute of Technology

What is  ceanMesh2D ?

- Automatic mesher for unstructured grids
- Handles complex geometries with multiple scale resolutions
- Iterative process maximizing quality metric
- CFL optimization
- Easy to use
- Fast computation
- Matlab: *https://github.com/CHLNDDEV/OceanMesh2D*
- Python: *https://github.com/CHLNDDEV/oceanmesh (under development)*

How to generate a mesh?

1. Import input files
   - Domain boundaries (required)
   - DEM (optional)
   - Land polygons (optional)
   - River centerlines (optional)

2. Initialize mesh parameters
   - Min & max resolution
   - Mesh grade
   - Min element count per feature width
   - Model computational delta t
   - …

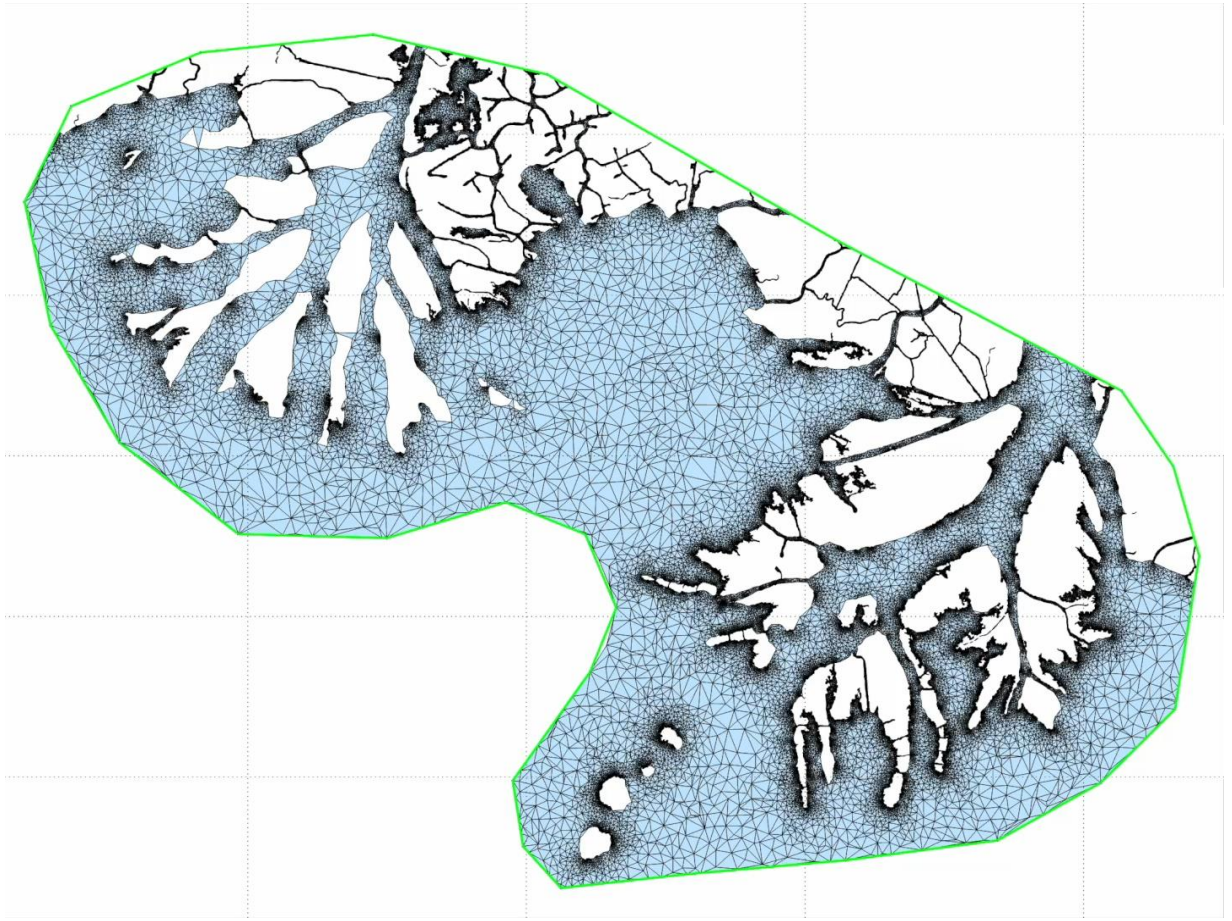
```
% Import necessary geographic information
dem       = '/Users/soloy/Documents/Data/DEMs/Merged_DeltaX_+_NOAA_DEM_2021_V20230424_EPSG_4326.nc';

% domain = readtable('/Users/soloy/Documents/Data/GIS/WLAD_model_domain_expanded_EPSG_4326.csv');
domain = readtable('/Users/soloy/Documents/Data/GIS/wax_lake_and_atchafalaya_deltas_EPSG_4326.csv');
domain.Properties.VariableNames = {'lat', 'long'};

coastline = '/Users/soloy/Documents/temp/WLAD_expanded_land_polygons_EPSG_4326'; % shapefile

% Initialize mesh parameters
bbox = [domain.long, domain.lat]; % polygon boundary box
min_el    = 10;                   % minimum resolution in meters.
max_el    = 250;                % maximum resolution in meters.
max_el_ns = 30;                   % maximum nearshore resolution in meters.
grade     = 0.2;                  % mesh grade in decimal percent.
R         = 3;                    % Number of elements to resolve feature.
dt        = 0.9;                  % Automatically set timestep based on nearshore res
wl        = 10;                   % Minimum number of triangles to resolve tidal wavelengths;
slp       = 10;                   % Topographic gradient for resolution optimization according to slope

% Create the geodata and edgefx objects required to calculate the mesh
gdat = geodata('dem', dem, ...
                  'h0', min_el, ...
                  'bbox', bbox, ...
                  'shp', coastline);
fh = edgefx('geodata', gdat, ...
               'fs', R, ...
               'max_el', max_el, ...
               'g', grade, ...
               'dt', dt, ...
               'wl', wl);%,...
%                'slp', slp);

% Calculate the mesh
mshopts = meshgen('ef', fh, ...
                  'bou', gdat, ...
                  'plot_on', 1, ...
                  'proj', 'Mercator', ...
                  'itmax', 9999, ...
                  'improve_with_reduced_quality', 1, ...
                  'memory_gb', 30, ...
                  'pfix', bbox, ...
                  'enforceMin', 1, ...
                  'nscreen', 1);
mshopts = mshopts.build;
```

3. Generate both a ”*geodata*” and an “*edgefx*” objects populated with mesh parameters

4. Generate a meshgen object using objects from (3) and run the build() function

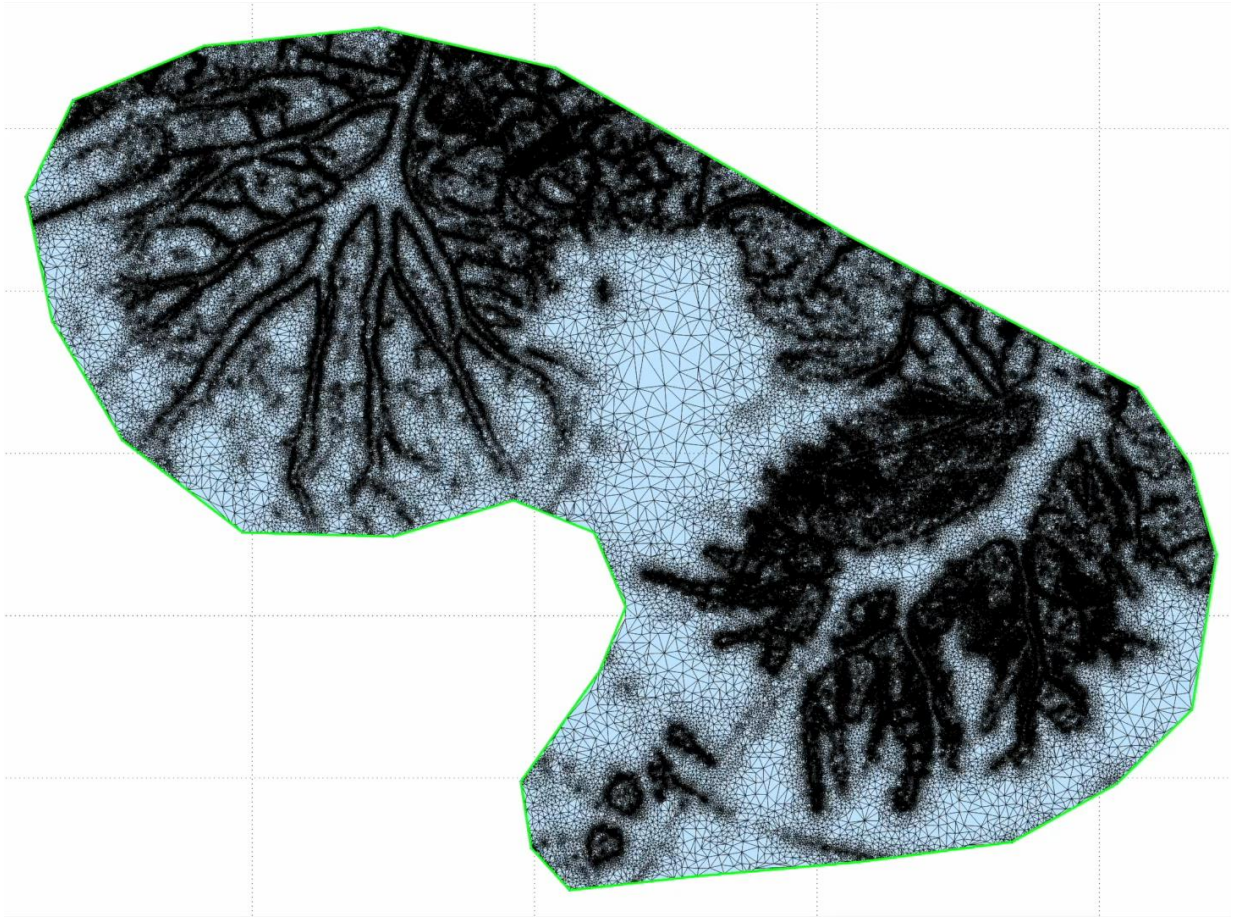
Mesh types: Shore proximity-based

- Boundaries: Deltas
- Land polygons: Active
- Min resolution: 10m
- Max resolution: 300m
- Min elements per feature width: 3
- Grade: 0.2
- Slope optimization: Inactive
- Computation time: ~5 min



Mesh types: Bathymetry slope-based

- Boundaries: Deltas
- Land polygons: Inactive
- Min resolution: 10m
- Max resolution: 300m
- Min elements per feature width: 3
- Grade: 0.2
- Slope optimization: Active
- Computation time: ~5 min



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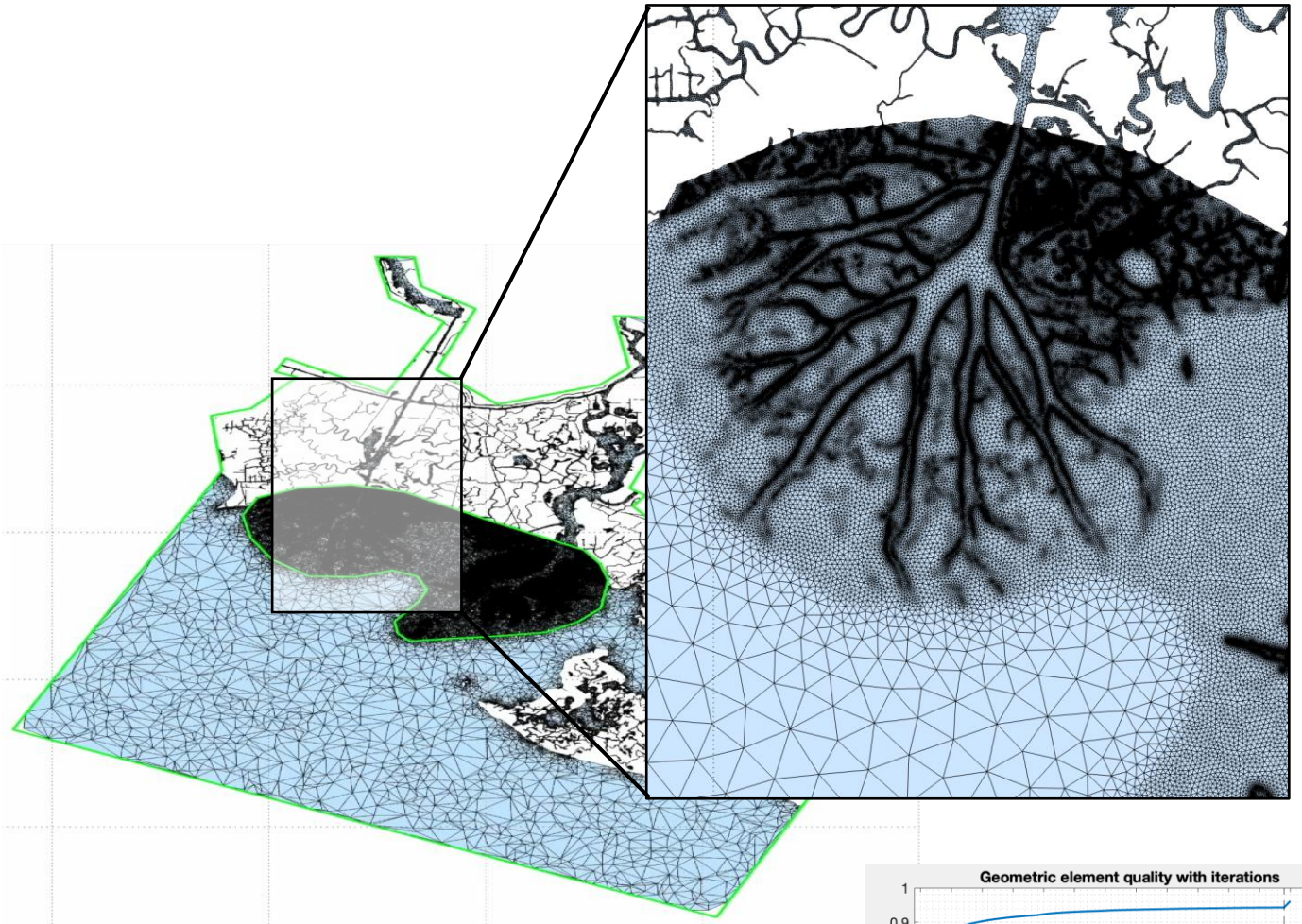
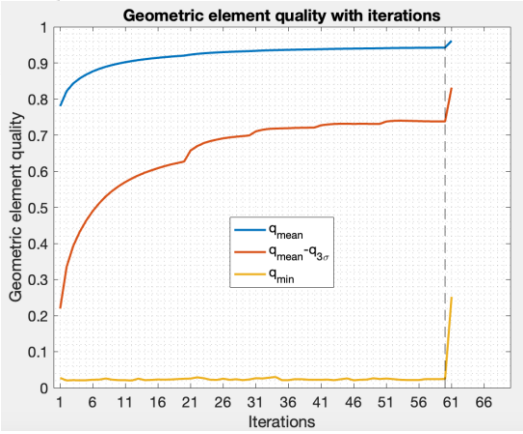
Combining types

- Boundaries :
  1. WLAD
  2. Deltas
- Land polygons:
  1. Active
  2. Inactive
- Min resolution:
  1. 100 m
  2. 10 m
- Max resolution: 300m
  - 1000 m
  - 30 m
- Min elements per feature width:
  1. 3
  2. 5
- Grade:
  1. 0.2
  2. 0.3
- Slope optimization:
  1. Inactive
  2. Active
- Computation time: ~10 min





Example of use: Large model domain

- "High Resolution" mesh with refined deltas
  - 5M+ triangles
  - Max resolution out of deltas = 30m
  - Max resolution in deltas = 10m
- Tide = Eugene Island MLLW – 36cm
- Discharges = Calumet & Morgan City
- Friction map based on vegetation map
  - Vegetation inputs from in situ data
- DEM = v 2023/05/11