

CHC-NSC 2018

www.chc-nsc2018.ca

Victoria, B.C.
March 26-29, 2018

Victoria, C.B.
26 au 29 mars 2018



Land and Sea Shaping the World
Terre et Mer Façonnant le Monde

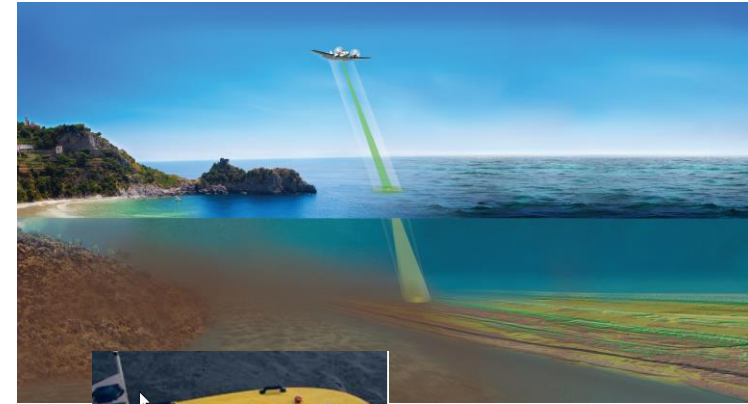
Bathymetric surfaces to charted features: Defining a smooth path to safety

Karen Cove
Stuart MacGillivray

[#chcnsc2018](https://twitter.com/chcnsc2018)

The problem

- More data coming into Hydrographic Offices
- Expectation of high turnaround and increased production
- Expectation around new high-resolution products
 - S-102 Bathymetric Surface
 - Bathymetric ENC overlays
- More work but less people to do it
- Hydrographic chart production remains rooted in manual compilation workflows



Automation is the solution!

Steady state production requires automation

- Automation for incorporating new survey data into a common source bathymetric surface and the production of S-102 can be achieved now
- Automation for the production of vector bathymetry for regular charts and high-resolution vector bENC is more challenging
 - What tools would be needed to achieve a fully automated workflow?
 - Could the results from an automated compilation process be trusted?
 - How much manual QC would be required?
 - How much time would be saved?

Constraints

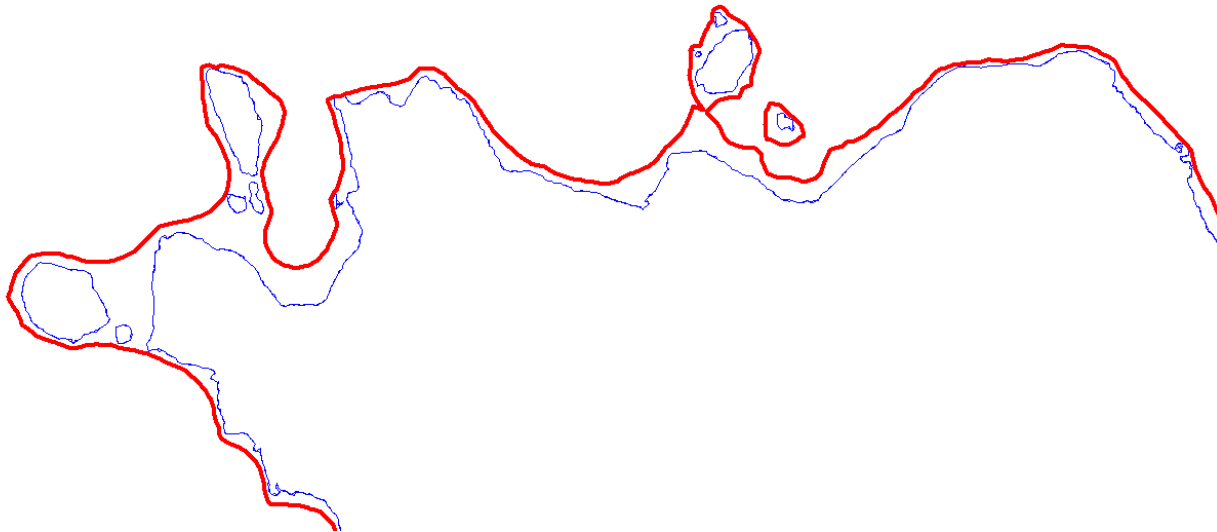
- Safety
 - Contours must represent something equivalent to or safer than reality
- Legibility
 - Maps should be readable
- Topology
 - The contour lines must describe a consistent elevation model
- Morphology
 - Contour lines will be more general than the original data, but should still represent the terrain as accurately as is feasible

The workflow

1. Generate digital elevation model (DEM) from cleaned survey points
2. Generalize the DEM
3. Generate raw contours from DEM
4. Clean noise from raw contours (delete small deeps, exaggerate or combine small shoals)
5. Generalize cleaned contours for legibility
6. Integrate generalized contours into product

Smooth the Surface

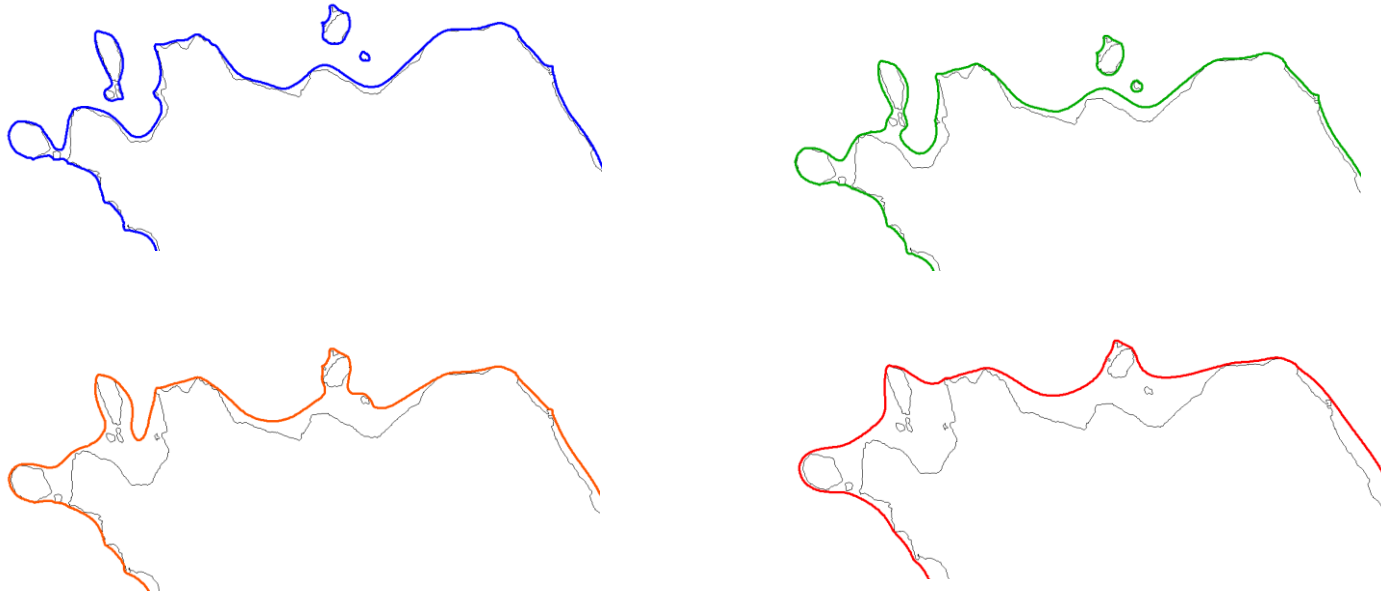
- Double-buffered smoothing



Contours derived from a surface generalized using the Smith algorithm. Generalized at 1:10000 scale.

Smooth the Surface

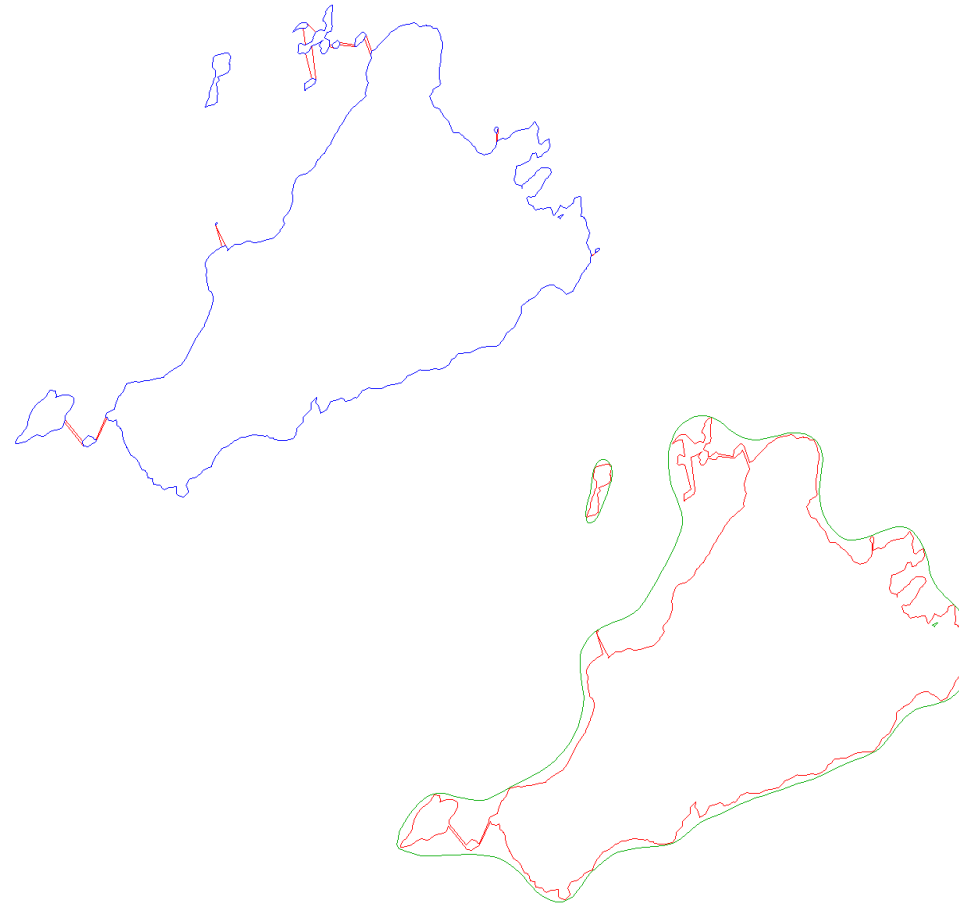
- Laplacian smoothing



Contours generated from an iteratively smoothed surface at a single level, compared with the same contour level on the original surface. Number of iterations shown is 20 (top left), 50 (top right), 100 (bottom left), 300 (bottom right).

Clean the Contours

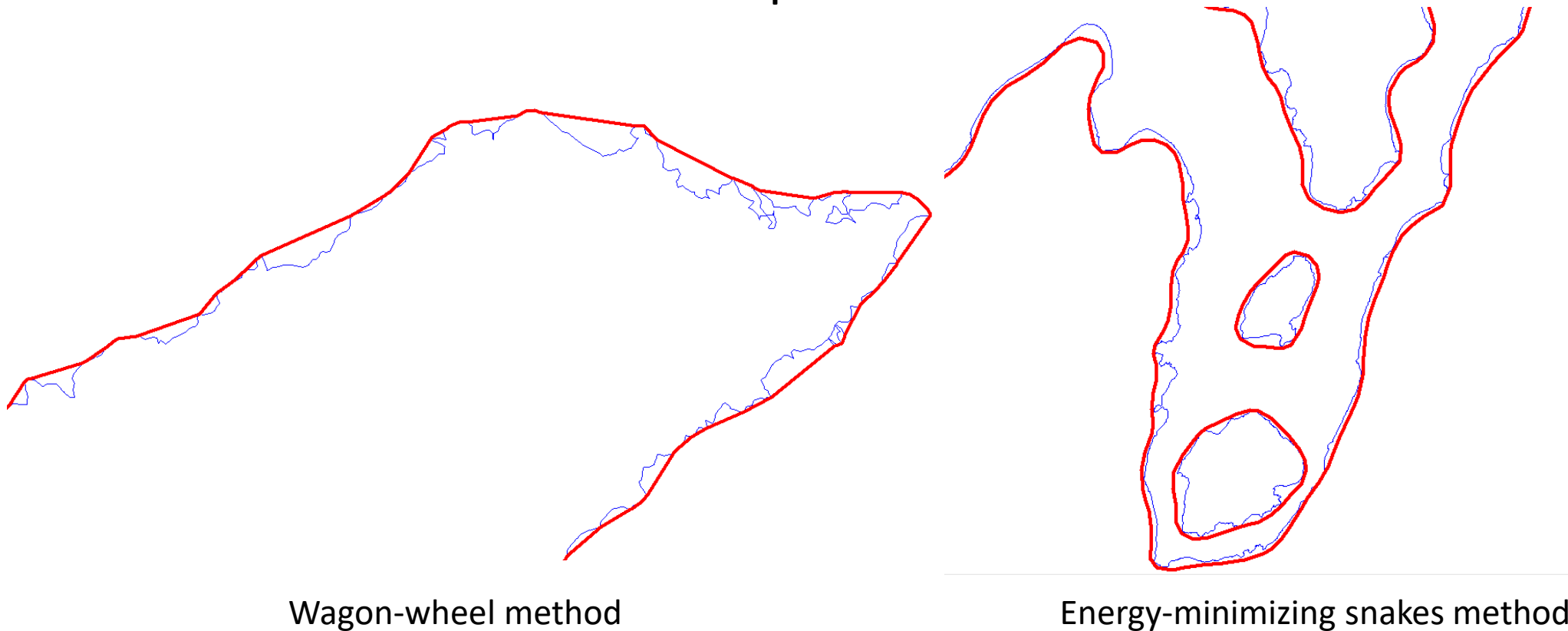
- Delete small deeps
- Aggregate small shoals
 - Bridge strategy
 - Maintain shape



Examples of shoal isolations being aggregated to a larger area within a distance tolerance, and the result of performing generalization on the aggregated area.

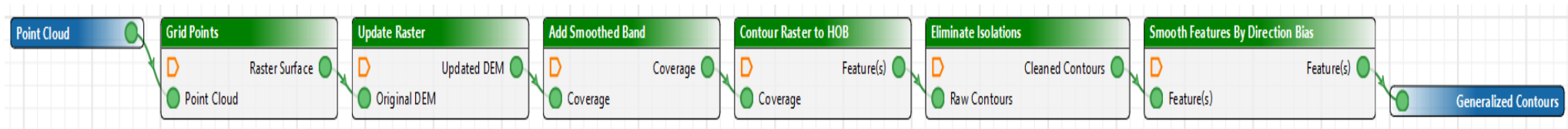
Smooth the Contours

- Smooth the contours and depth areas

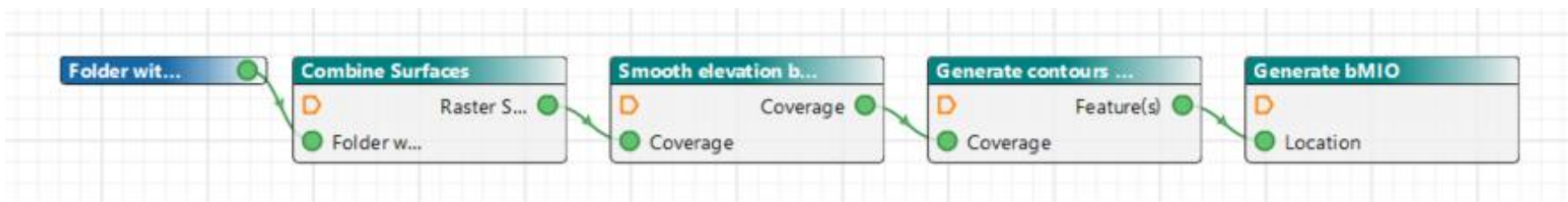


Production Considerations

- Sample of a fully automated workflow to generate a smooth contour set

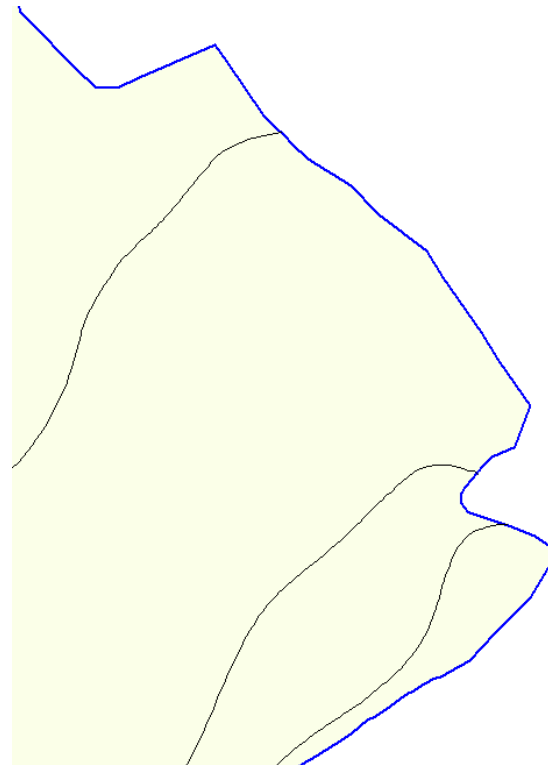
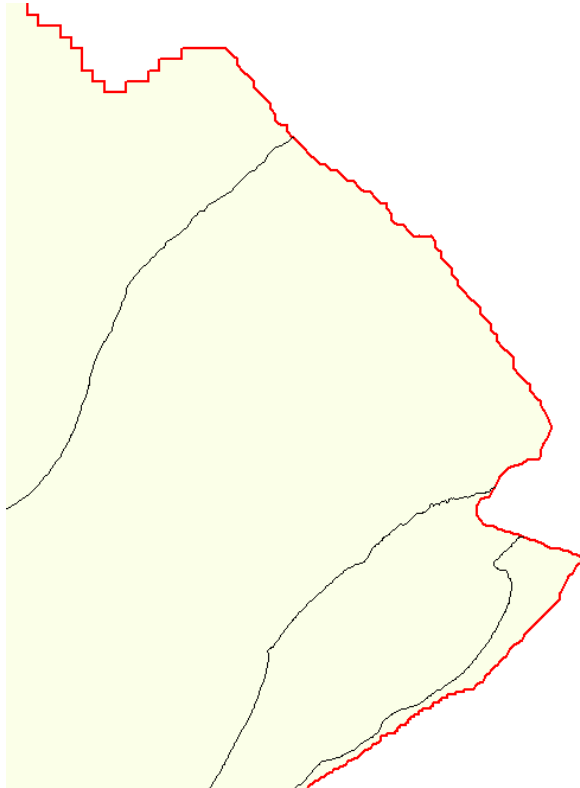


- Sample of a fully automated workflow to generate .000 bMIO product



Production Considerations

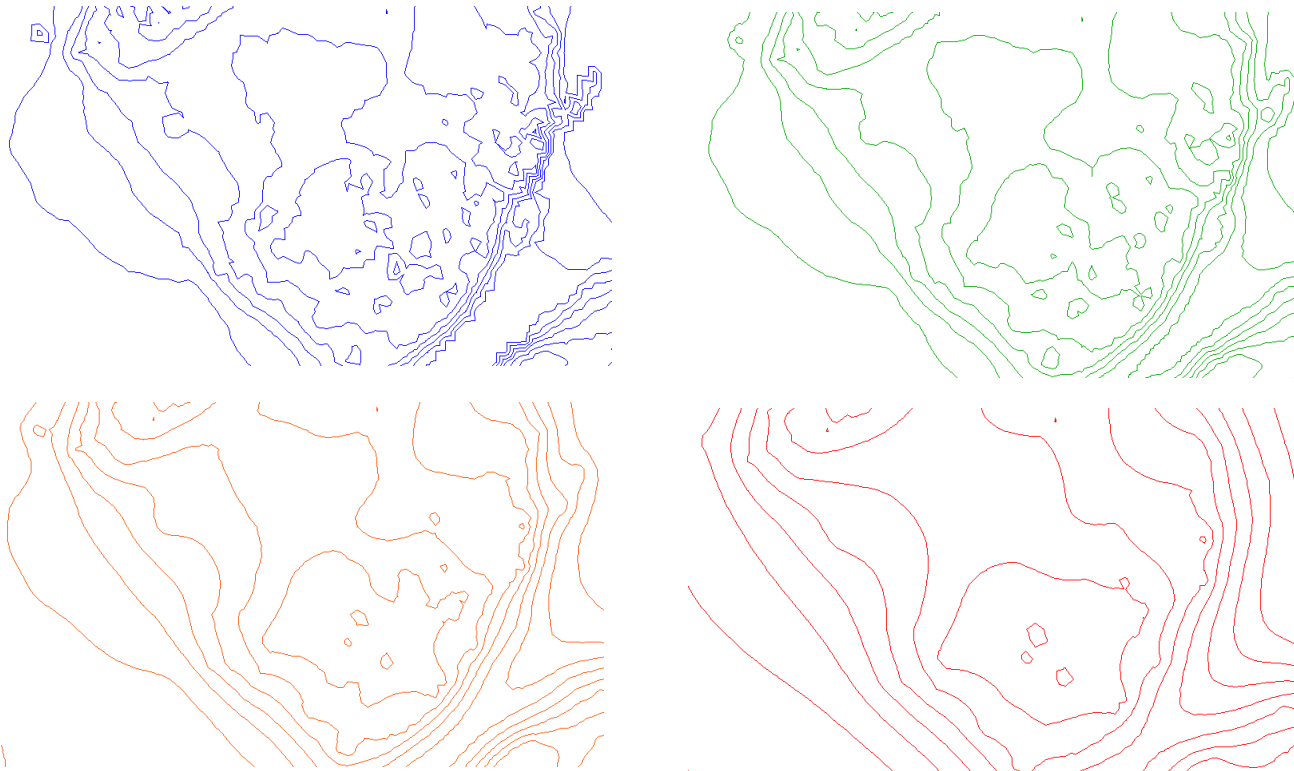
- Simplify the boundary



Illustrating the difference between a raw generated boundary and contour set, versus a trimmed boundary and generalized contour set.

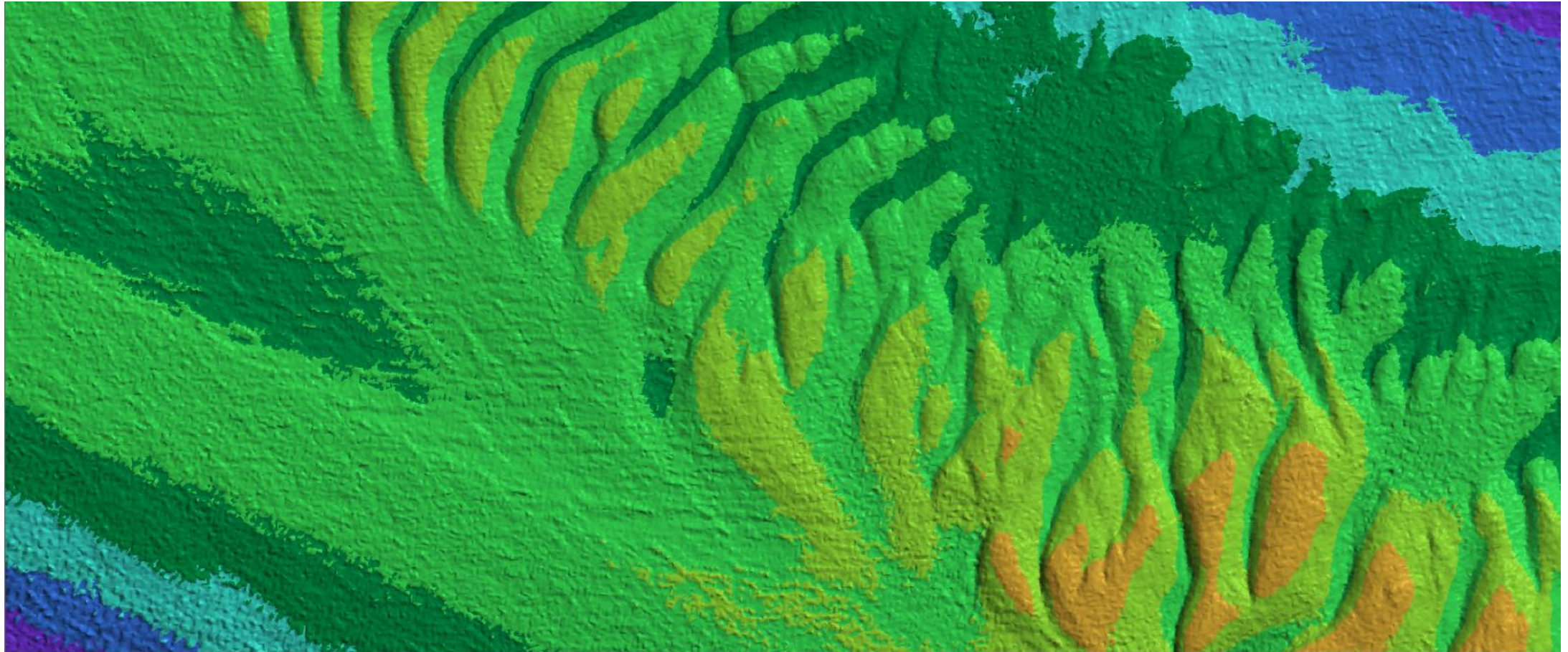
Production Considerations

- Laplacian smoothing for noise reduction

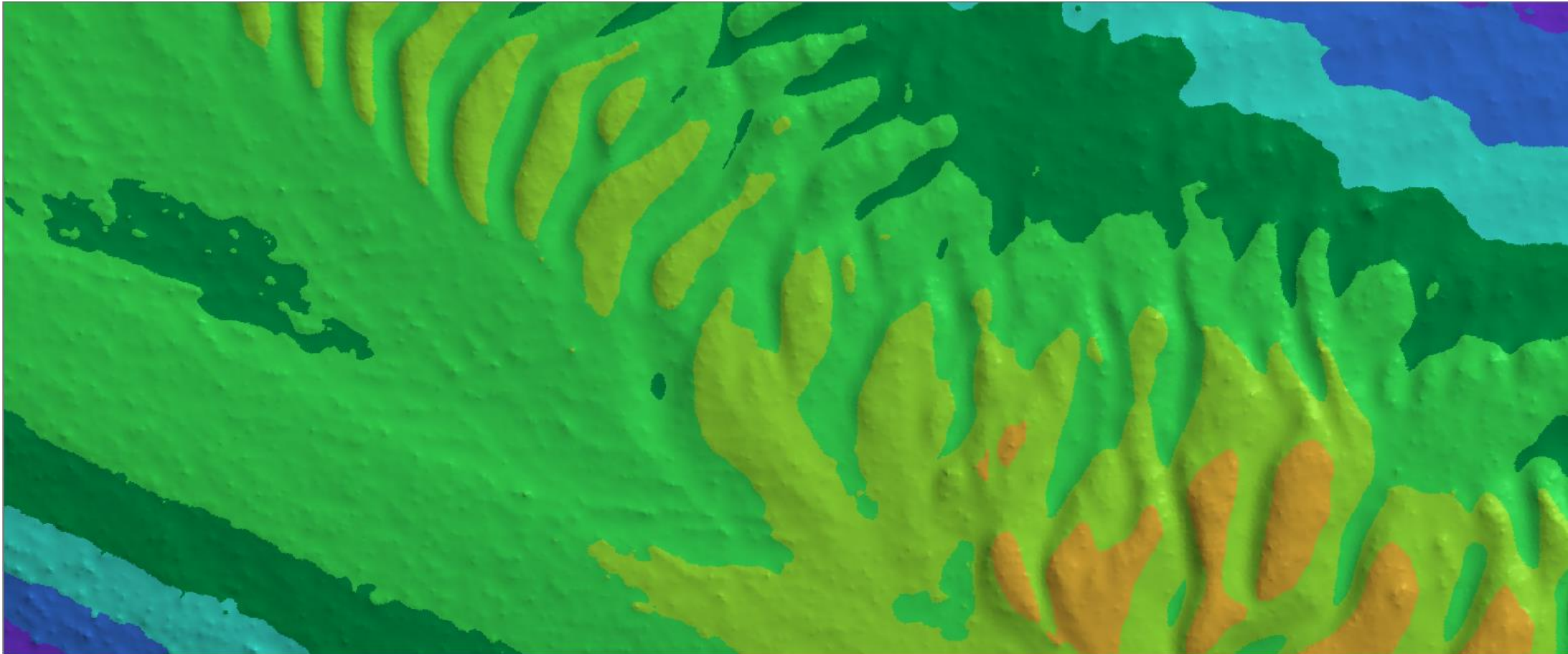


Contours generated from an iteratively smoothed surface at 1m intervals. Number of iterations is 0 (top left), 1 (top right), 5 (bottom left), 20 (bottom right). Data from UKHO.

Original Surface



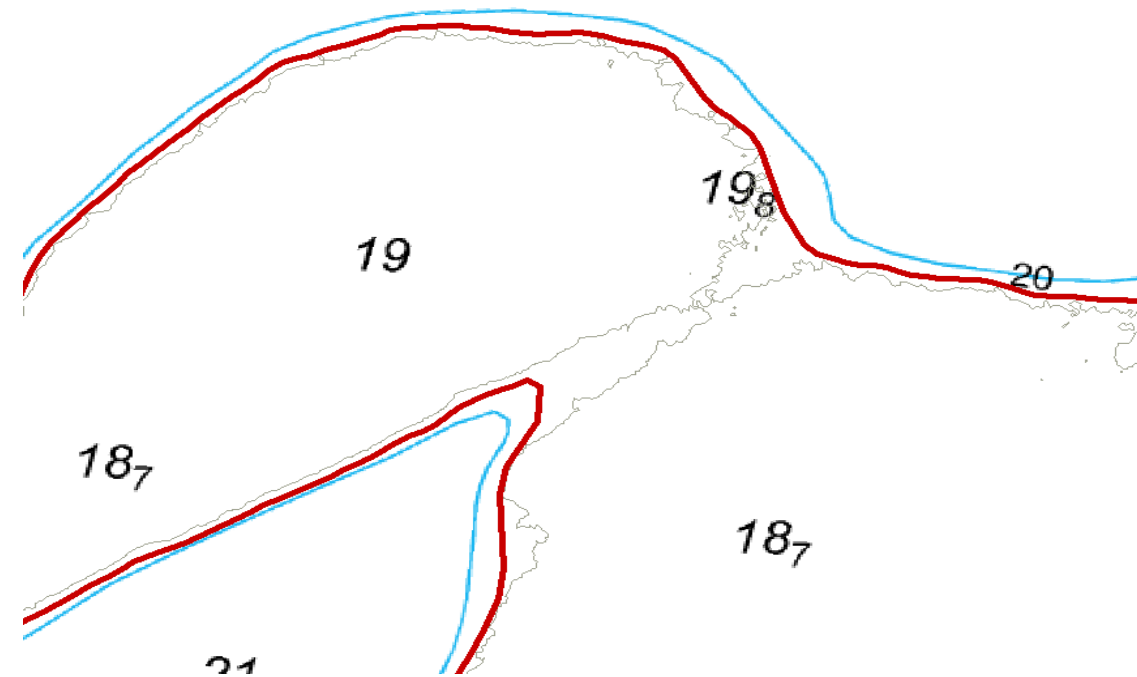
Smoothed Surface



Production Considerations

- Automation
- Reliability
- Efficiency
 - In generating the bathymetry
 - In incorporating the bathymetry into a vector product
- Correct answer, different aesthetic

UKHO charted contour in blue, Auto generated contour in red



Conclusions

Optimizing the process:

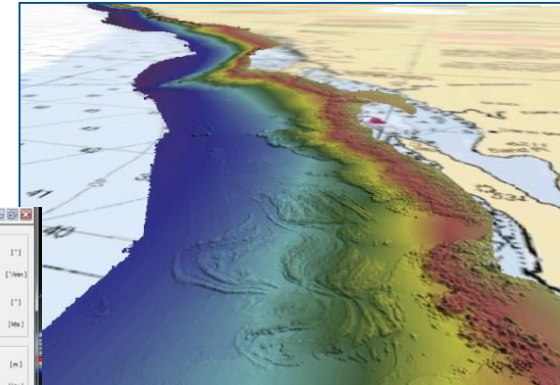
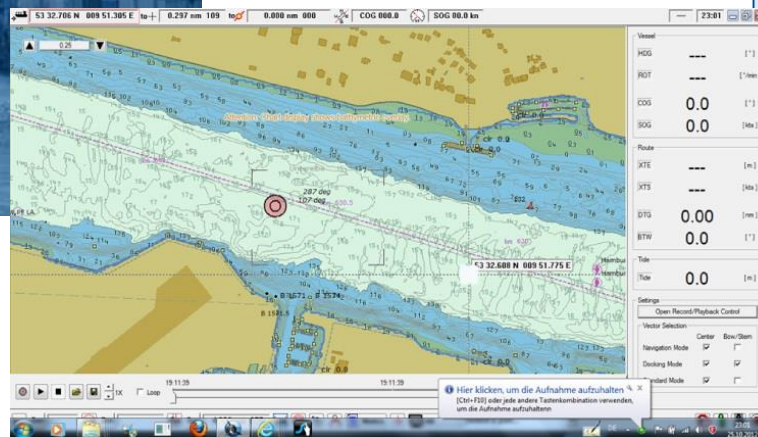
- Automating the entire process is ideal
- Manual QC possible throughout the process or just at the end
- Some compromise on aesthetics

Ideal toolkit:

- Smoothing the surface is a good fit for automation, provides efficiencies and excellent results for high resolution products
- Smoothing and manipulating contours gives the user more control on the overall look of the contours but at the cost of achieving maximum efficiencies

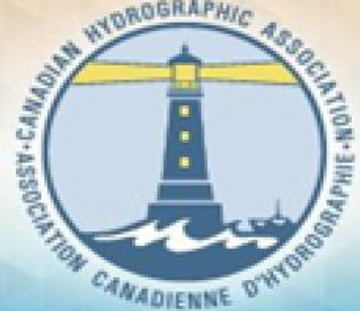
Conclusions

- Chart production and dissemination is evolving
- Need to develop tools and workflows for the future



CHC-NSC 2018

www.chc-nsc2018.ca



Special thanks extended to the UK Hydrographic Office for providing the data that was used to prepared the images

#chcns2018