Finalized CSAR Surface Density and IHO Compliance Tool

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Introduction

The Density and IHO Compliance Tool computes basic statistics to assess compliance with sections 5.1.3 (Uncertainty Standards) and 5.2.2.1 (Object Detection Coverage) of the NOS Hydrographic Surveys Specifications and Deliverables. Specifically, this tool may be used to confirm that (i) at least 95% of the nodes in a finalized surface have a Total Vertical Uncertainty (TVU) within the maximum allowable error given by the appropriate IHO order as a function of depth (i.e., TVU QC = node uncertainty / node maximum allowable uncertainty <= 1.0) and (ii) at least 95% of the nodes are populated with at least 5 soundings.

This tool is meant to be used after data acquisition and processing in conjunction with other quality assurance tools. In particular, the tool gives the user the option to use any TVU QC layer that may be present in the Finalized CSAR (CARIS Spatial Archive, .csar) input file, as documented in the TVU QC SOP. Such a pre-calculated TVU QC layer is not required to use the Density and IHO Compliance Tool; the program has the ability to compute the maximum allowable uncertainty as a function of (node) depth, and the switch between IHO Order 1 & IHO Order 2 at 100 meters is handled seamlessly. Nonetheless, the visual review of the TVU QC layer is essential to identify the spatial location of any anomalous results that are otherwise summarized here in a pass/fail sense.

How it works

The program uses the Depth, Uncertainty, Density and an optional computed TVU QC layers from finalized BASE surfaces in the CARIS Spatial Archive file format (.csar) to create five or six plot files in PNG format: 1) Uncertainty Standards, 2) Object Detection Coverage, 3) Depth Distribution, 4) Node Depth vs. Sounding Density, 5) Node Depth vs. TVU QC (all data), and an optional 6) Node Depth vs. TVU QC < 1.0 – which is created if different from the "all data" plot in 5.

Instructions

I. Run the Finalized CSAR QA

1. Microsoft Windows: Start -> Pydro64 -> Contribs
2. Contribs Main Menu: File -> Finalized CSAR QA
3. Select the input file: the finalized surface .csar (or any .csar containing Depth, Uncertainty, and Density layers)
4. Select an output folder for the statistical analysis plots (.png)
5. Select your preference for the TVU QC (re)calculation:

   a. Yes – you will be prompted with the option to (re)calculate TVU QC layer, unless there are no TVU QC layers detected within a given CSAR file being processed
   b. No – you will not be prompted to (re)calculate the TVU QC layer, unless there are more than one TVU QC layers detected within a given CSAR file being processed
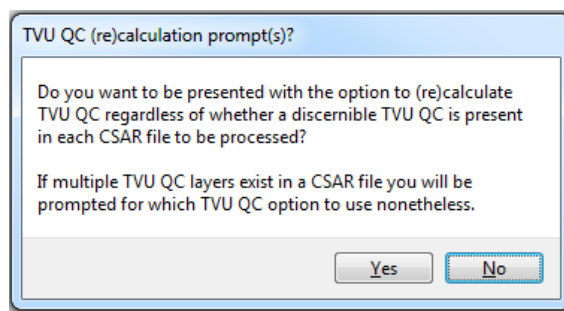
Note: The user is no longer required to pre-calculate the TVU QC layer in the .csar; see the Introduction.

II. The results will be five or six plots in .png format.

1. **Uncertainty Standards** – distribution and statistics to verify NOS Specifications compliance for node TVU as a fraction of maximum allowable uncertainty per the depth ("TVU QC"<=1.0), based on IHO Standards
2. **Object Detection Coverage** – distribution and statistics to verify NOS Specifications compliance for minimum number of soundings (5) contributing to a node
3. **Depth Distribution** – percentage of nodes at each depth to characterize the nominal bathymetry
4. **Node Depth vs. Sounding Density** – the number of soundings per node at each depth to further characterize the object detection coverage
5. **Node Depth vs. TVU QC (all data)** – the estimated uncertainties that exceed the NOAA specifications at each depth to further characterize the uncertainty standards
6. **Node Depth vs. TVU QC < 1.0** –a characterization of the estimated uncertainties that exceed the NOAA specifications at each depth as in plot 5., if different; i.e., a "zoom" of the fraction of "good" data where the TVU QC <=1.0

III. Open the .png files for analysis.

See plot examples below.

The histogram-type plots used for uncertainty standards compliance show the pass percentage in the sub-title and the descriptive statistics: minimum, mode (most frequent), and maximum values, and percentiles for 5%, 25% (1st quartile), 50% (median = 2nd quartile), 75% (3rd quartile) and 95%; e.g., 50% of the observed data lies between the 1st & 3rd quartiles; 90% of the data lies between percentiles 5 and 95.

The user should check that 95% or more of the nodes pass in the Uncertainty Standards histogram plot (see sub-title: % nodes with TVU QC <= 1). In addition, check that 95% or more of the nodes pass in the Object Detection Coverage histogram plot (see sub-title: %'s of nodes with soundings per node or "density" >= 5).
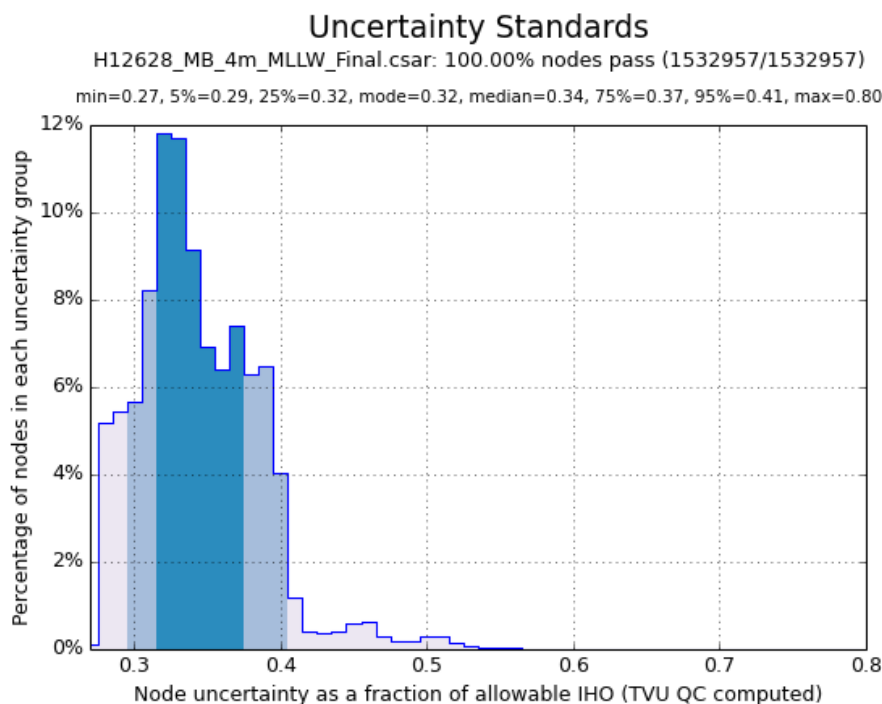
The Depth Distribution, Depth vs. TVU QC, and Depth vs. Density plots can be used for troubleshooting and general information. To identify the geographic location of any anomalous data, compute and review TVU QC layers in CARIS (see the TVU QC SOP).

IV. Insert the plots into the DR

Insert the Uncertainty Standards and Object Detection .png plots into the DR. The remaining plots do not need to be included in the DR.
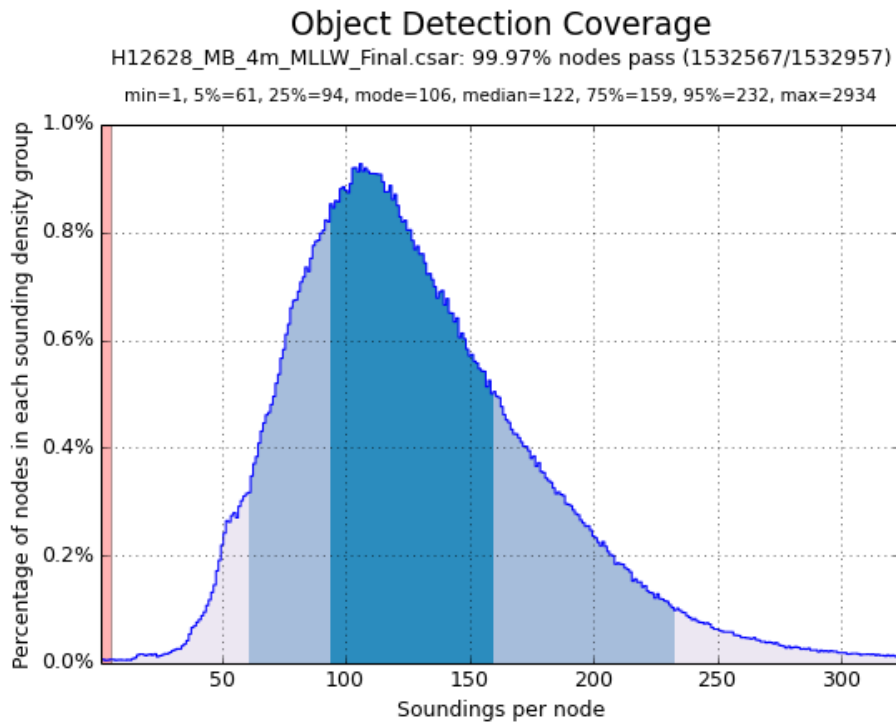
Plot Examples:

1) Uncertainty Standards

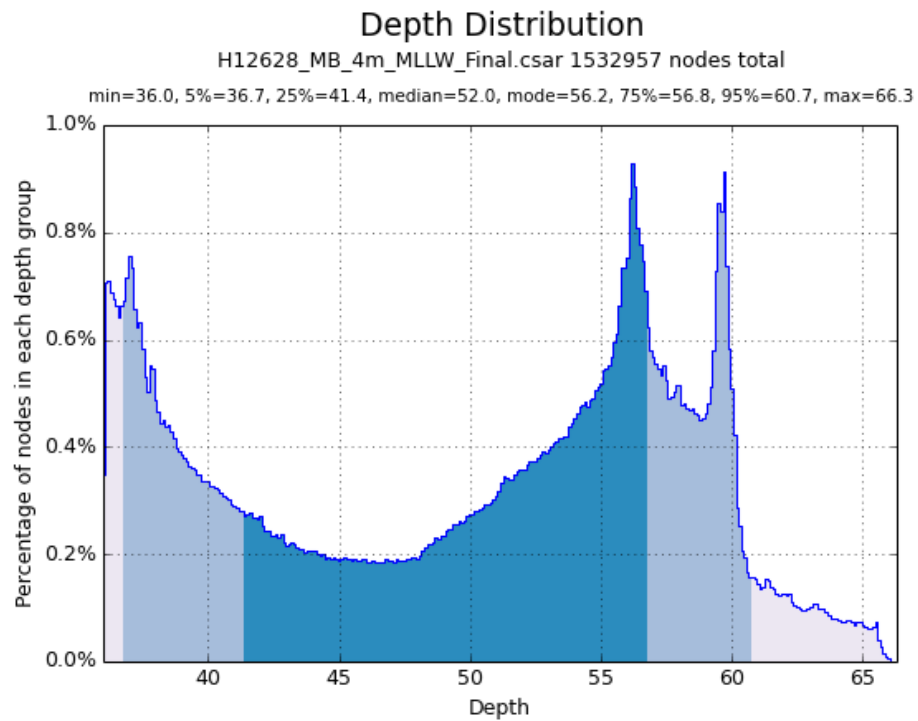## Plot Examples (con't):

2) Object Detection Coverage

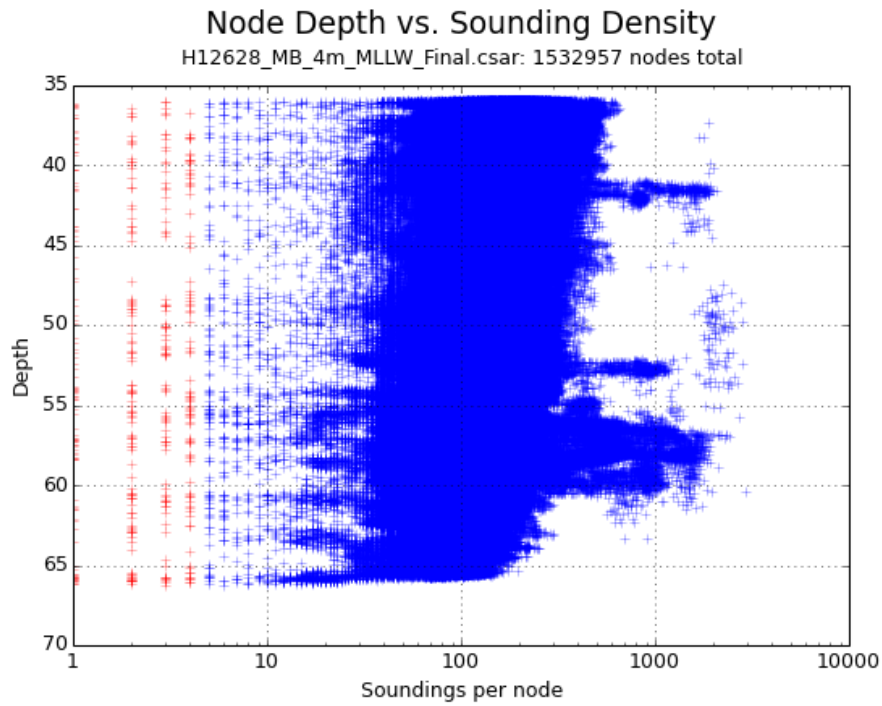### Object Detection Coverage
H12628_MB_4m_MLLW_Final.csar: 99.97% nodes pass (1532567/1532957)

min=1, 5%=61, 25%=94, mode=106, median=122, 75%=159, 95%=232, max=2934

3) Depth Distribution

Depth Distribution
H12628_MB_4m_MLLW_Final.csar 1532957 nodes total

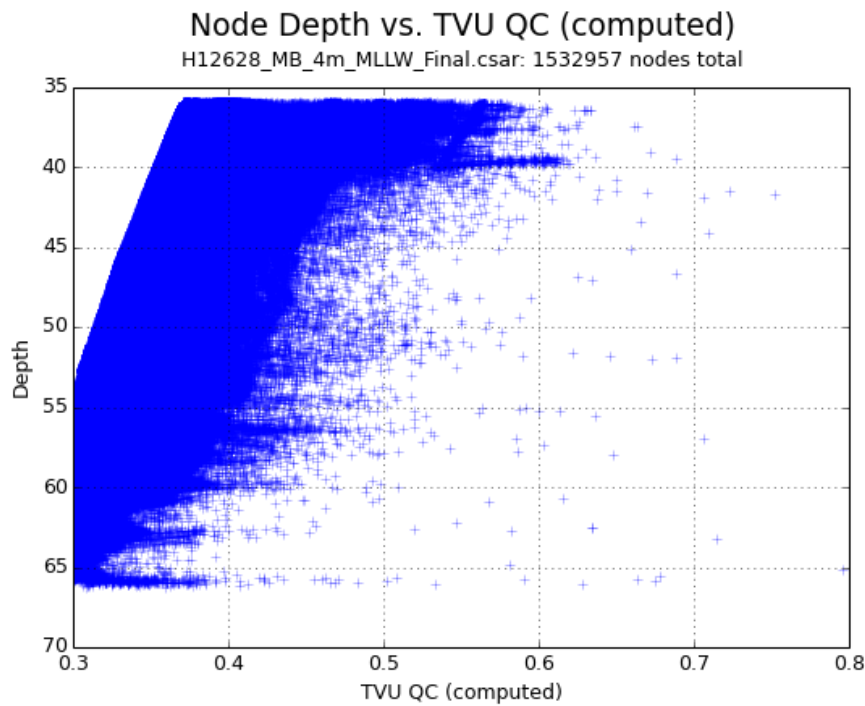min=36.0, 5%=36.7, 25%=41.4, median=52.0, mode=56.2, 75%=56.8, 95%=60.7, max=66.3

# Plot Examples (con't):

4) Node Depth vs. Sounding Density


5) Node Depth vs. TVU QC Layer

Note: If an a priori TVU QC layer is selected by the user for analysis, the name "CalculatedTVU QC" used in the plot will be replaced with the specific name present in the CSAR file.

Plot Examples (con't):

5) Node Depth vs. TVU QC; repeat—different surface data from that used above, to demonstrate the motivation for the optional Plot 6.
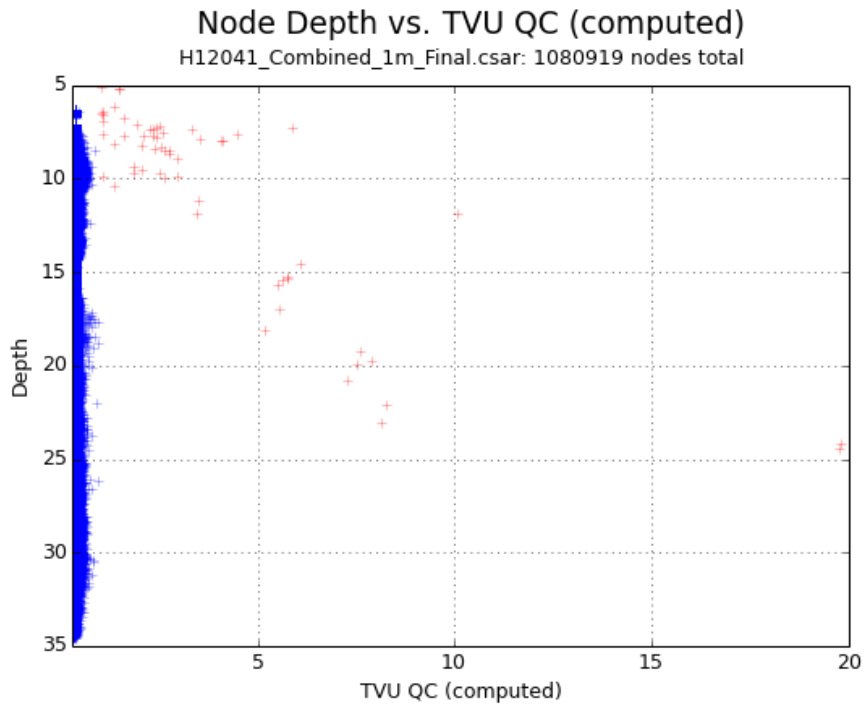
6) Node Depth vs. TVU QC < 1.0; generated if and only if dfferent from Plot 5.
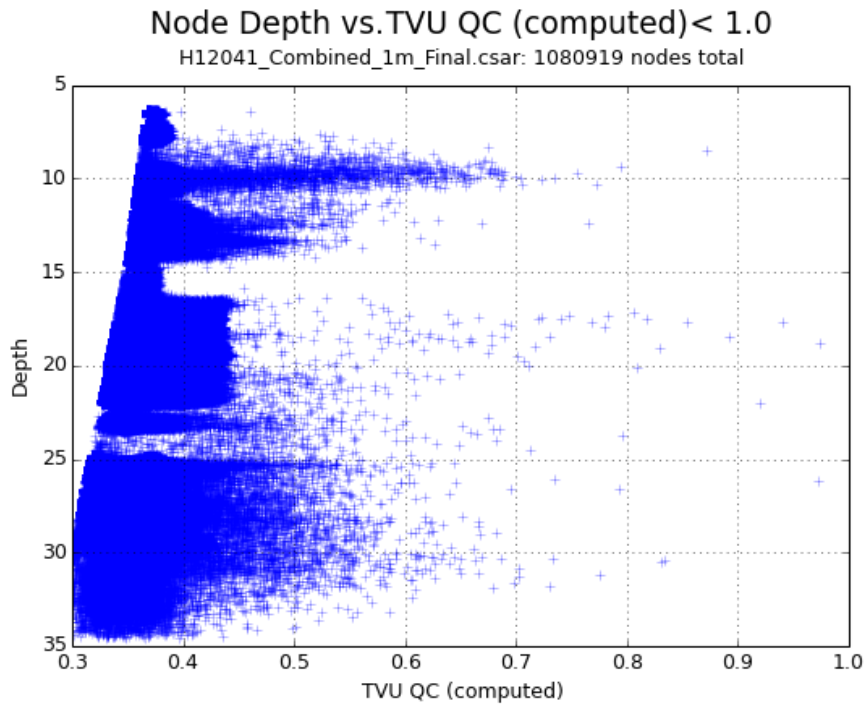
Reference
Total Vertical Uncertainty QC SOP