



Navigation Overview (June 2011 Mtg)



- Develop common software and procedures for post-processing navigation data
- Automated fusing with standard science sensor data
- Develop NDSF-wide protocols for navigation data quality control and post-processing
- Preserve metadata on the source of the navigation data and parameters used in post-processing

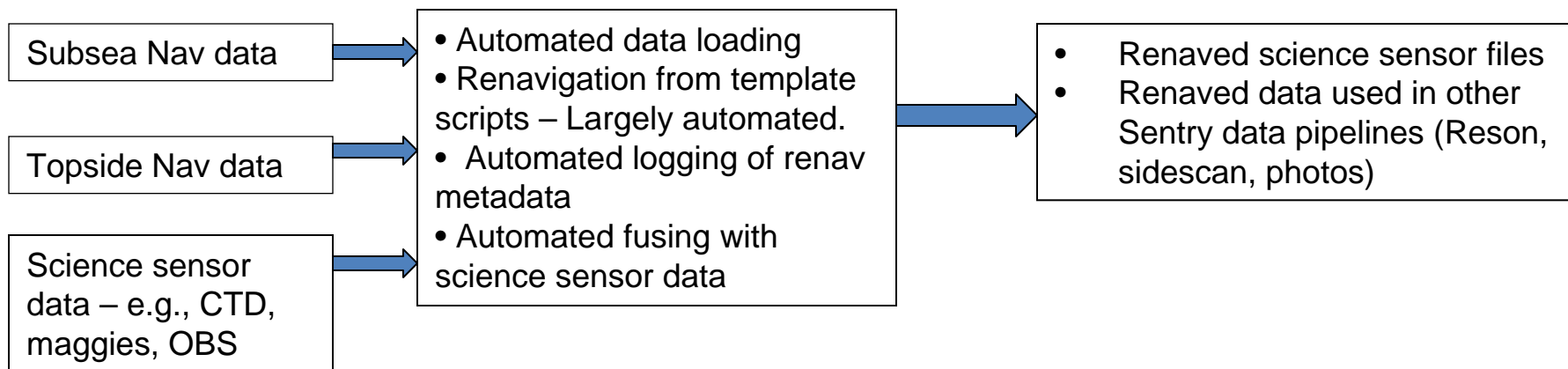


Renavigation



Existing Sentry Pipeline

- Topside and subsea fused in Matlab
- Renavigation scripts are generated based on templates and the user edits a limited number of dive-specific parameters
- The resulting renav data is saved along with all of the metadata and the renav script
- Code is mostly automated although some human interaction is always required
- Automated scripts provide data for the cruise report and data summary





Navigation Goals / Progress



- Merge existing nav post-processing software into a single standardized software package for use on all vehicles. **Completed – now working with a common software base.**
- Improved LBL and USBL post-processing tools. **USBL tools developed; need to complete LBL tools.**
- Automated fusing of post-processed navigation data and standard science sensor data. **Completed for most *Sentry* standard data products. Used on the 2011 Tominaga/Tivey cruise.**
- Ensure the source of the post-processed nav data is kept with the re-navigated data. **Completed on *Sentry* data products; tested on *Jason***
- Improved documentation. **In progress.**
- Automate the process as much as possible. ***Sentry* pipeline is largely automated. Prototyped on *Jason* data in Jan 2012.**
- A parallel effort is the porting of the navigation code used on *Sentry* and *Nereus* to *Jason* and the *Alvin* upgrade. **Significant work by Howland and Suman. Engineering testing on *Jason* in Jan 2012.**



Navigation

Jan 2012 MCR Cruise



- Kinsey, Howland, and Jordan Stanway participated in the Jan 2012 cruise to the Mid-Cayman Rise with the *Jason* ROV.
- Engineering work focused on testing new nav code on *Jason* and using *Sentry* post-processing tools
- Real time navigation:
 - Real time testing and GUI development
 - DVLNav was used for ops on 9 of the 10 dives but NavEst was run in background and worked on during dives
 - NavEst was used on last dive and tested with vehicle controller (e.g., auto XY)
- Post-processing
 - Worked on porting *Sentry* tools to *Jason*
 - Renaved dives and made maps using *Sentry* data pipeline
 - *Jason* ops team used regular data pipeline

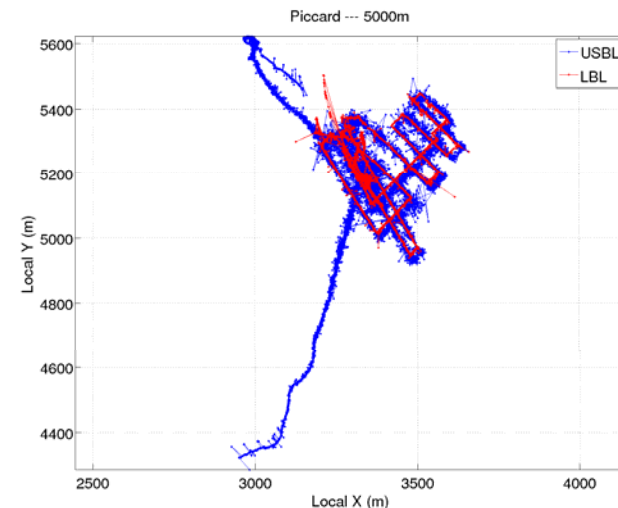
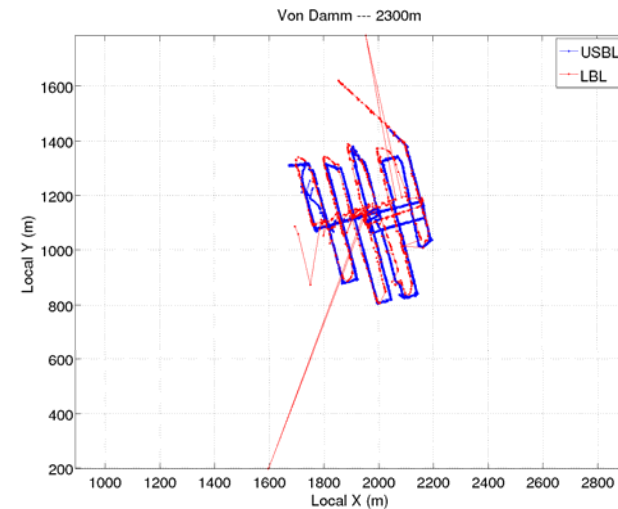


Navigation

MCR - LBL and USBL



- Used both USBL and LBL on the MCR mapping dives (2 dives)
 - At 2,300m, USBL and LBL have comparable precision, i.e., there is no significant advantage to using LBL at these depths (right, top)
 - At 5,000m, USBL exhibits significantly more noise compared to LBL (right, bottom)
 - Used LBL to generate the Piccard map
- LBL was not used on the 8 sampling dives on the cruise (payload) but USBL and DVL navigation combined with a good map of the site allowed for efficient and productive sampling operations
- Recent deep-water cruises demonstrate the limitations of USBL and need to retain LBL





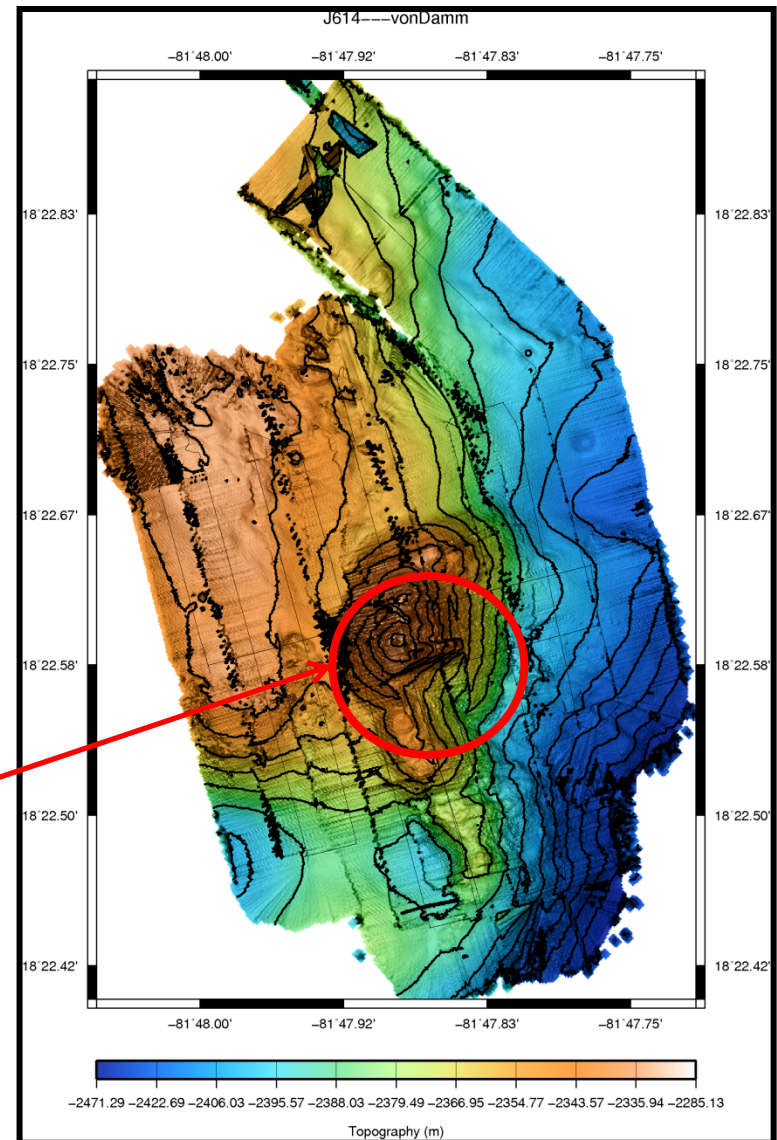
Navigation

MCR Mapping with Jason



- Used *Jason* for mapping at the Mid-Cayman Rise in January 2012
- Mapped 2 sites:
 - Von Damm at ~2,300m
 - Piccard at ~5,000m
- At Von Damm, *Jason* ops provided a first cut map (right) within 3 hours of being on deck. Subsequent post-processing corrected error resulting from DVL dropout.

DVL Dropout





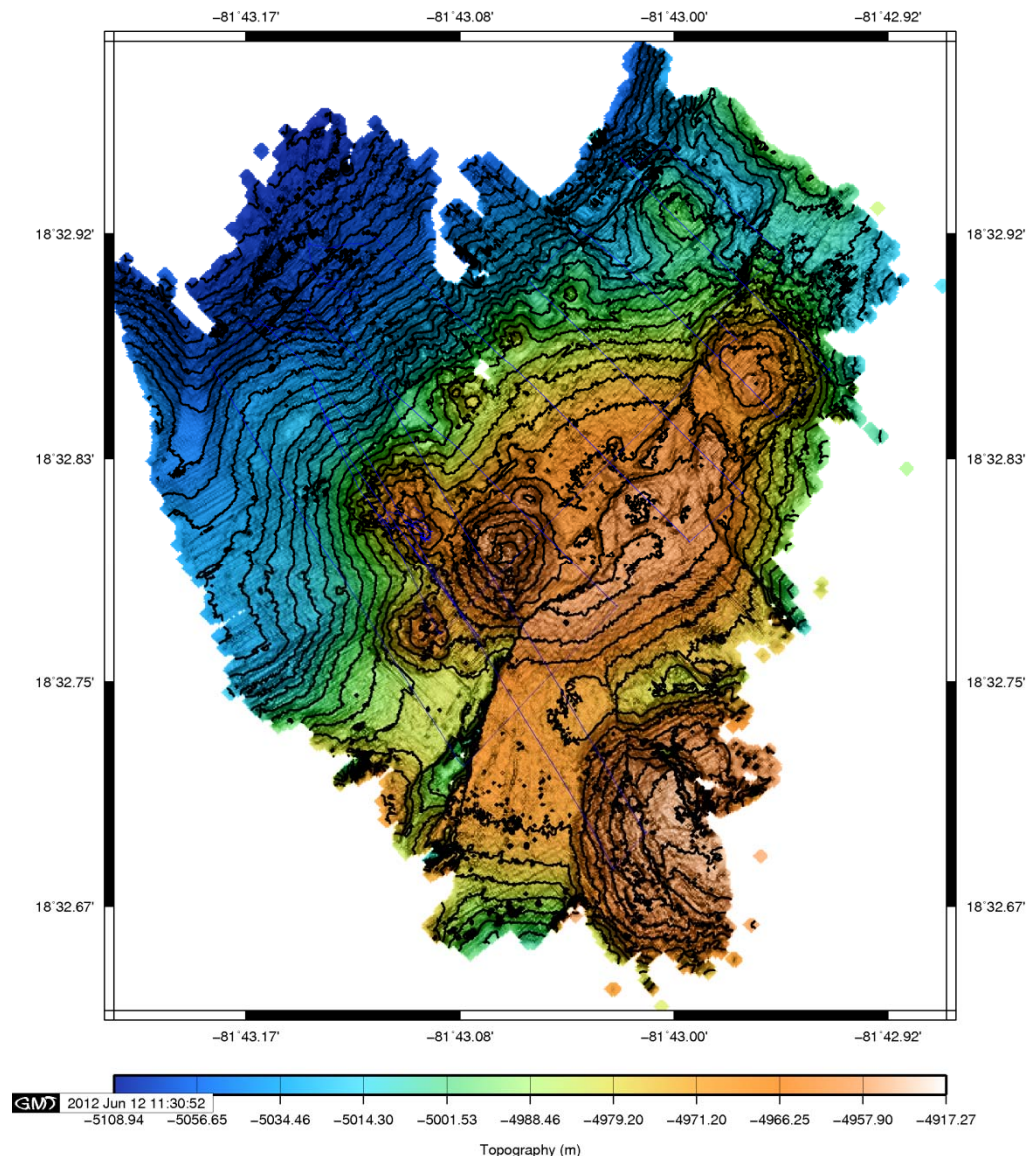
Navigation

MCR Mapping with Jason



Data File jason615_20120123_0413.grd

- Used Reson water column mode at Piccard to obtain both bathymetry and water column data
- Sentry data pipeline was used to generate this map. Some manual editing was required because of DVL dropouts on extreme terrain.
- Covered 0.2km^2 in 9 hours ($0.022\text{km}^2/\text{hour}$). Users need to remember that bathy mapping with Jason is a slow process – especially in deep water.





Navigation Upcoming Work



- Post-processing
 - Start employing fulltime on *Sentry* ops in September 2012
 - Continue ability to develop ROV and HROV science
 - Testing with data on shore
 - At-sea use as opportunities become available
 - Use on *Alvin* verification cruise in 2013
 - Start using on a TBD *Jason* cruise
 - Continue documentation and start training other NDSF personnel
- Real time
 - Continued work on supporting *Jason* ops
 - Have identified possible solutions to the DVL drift when *Jason* is near the bottom. Need to assess and develop on shore prior to implementation and testing on a TBD *Jason* engineering dive.
 - Next-generation capabilities
 - Implementing new navigation algorithms (e.g., single range nav; model-based techniques)
 - Adopting new data transmission techniques for communication between programs – will enable more robotics research
 - Nav code also being ported to other vehicles – will increase testing and development opportunities