

GNSS Based Vertical Control for Hydrographic Survey: NOAA Office of Coast Survey Implementation and Implications for Navigation

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Why use GNSS for Vertical Control?

- Better

Improve data quality: tides and vessel draft are big sources of error

- Easier

Operational decoupling of real-time water levels from survey operations

- Faster

Final vertical-control solution in real time



How: 3D GNSS Methods

- **RTK:** Real Time Kinematic- in widespread use for real-time positioning using nearby reference stations
- **NTRIP:** Networked Transport of RTCM via Internet Protocol, used for RTK via the internet
- **PPK:** Post Processed Kinematic: Just like RTK, but done after the fact
- **IAPPK:** PPK with inertial aiding thrown in
- **PPP:** Precise Point Positioning, “GPS done right”, uses better estimates of satellite orbits, clocks and often a model of atmospheric errors



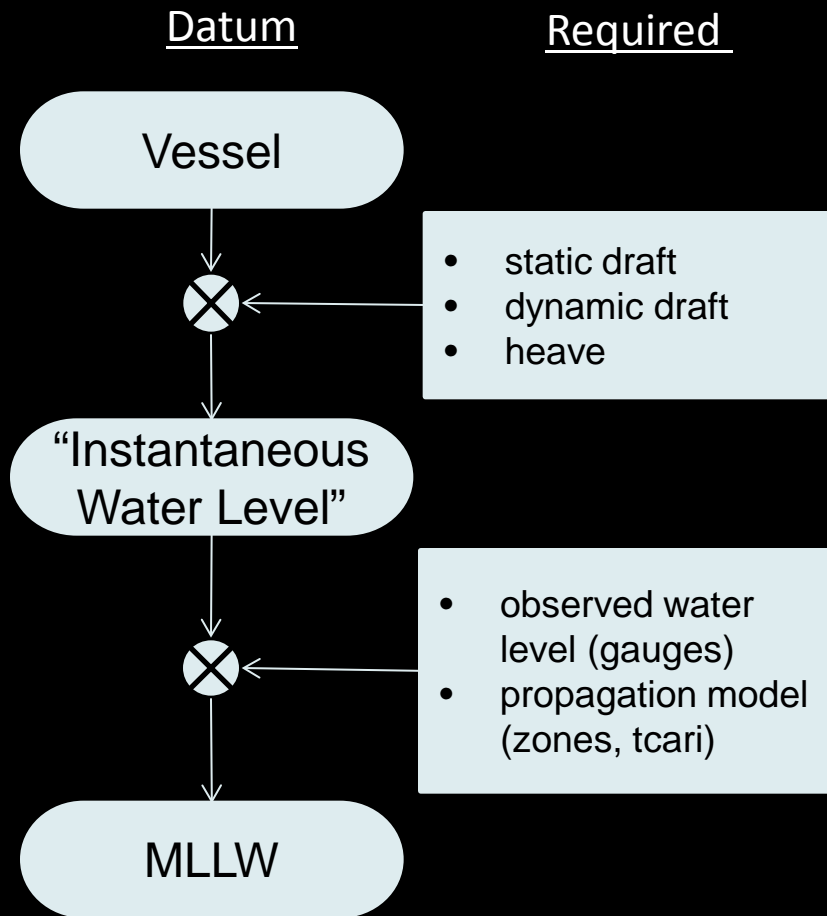
How: 3D GNSS Methods

	Real-Time	Post-Processed
Differential	<ul style="list-style-type: none">• DGPS (USCG)• RTK	<ul style="list-style-type: none">• PPK• IAPPK
State	<ul style="list-style-type: none">• WAAS (FAA)• PPP	<ul style="list-style-type: none">• Post Processed PPP

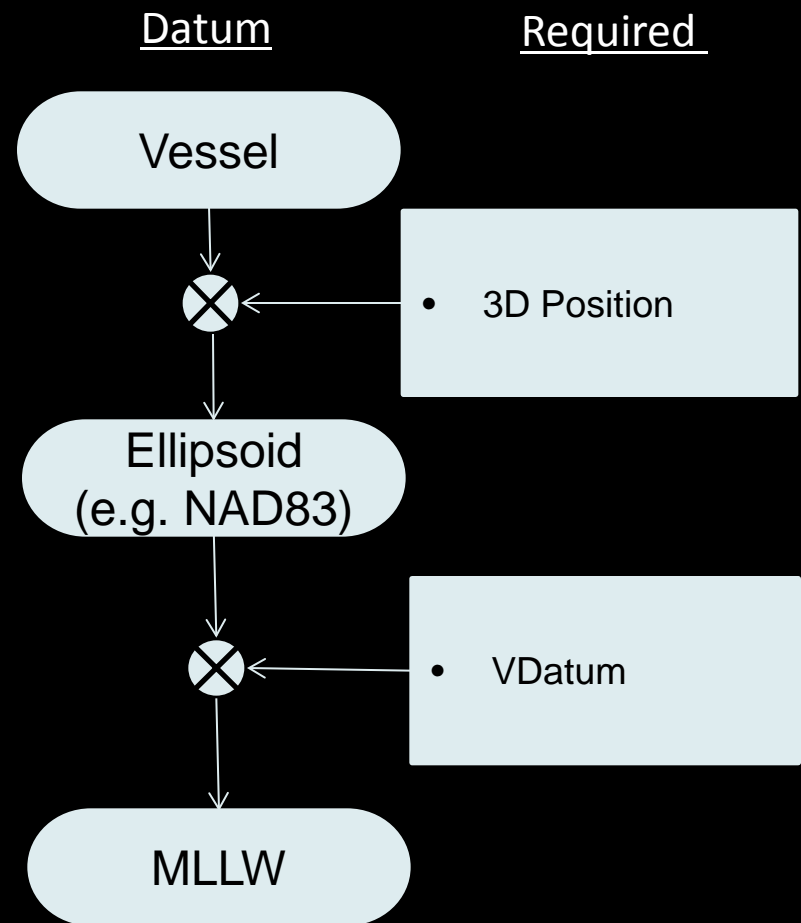


How: Transfer Reference Frames

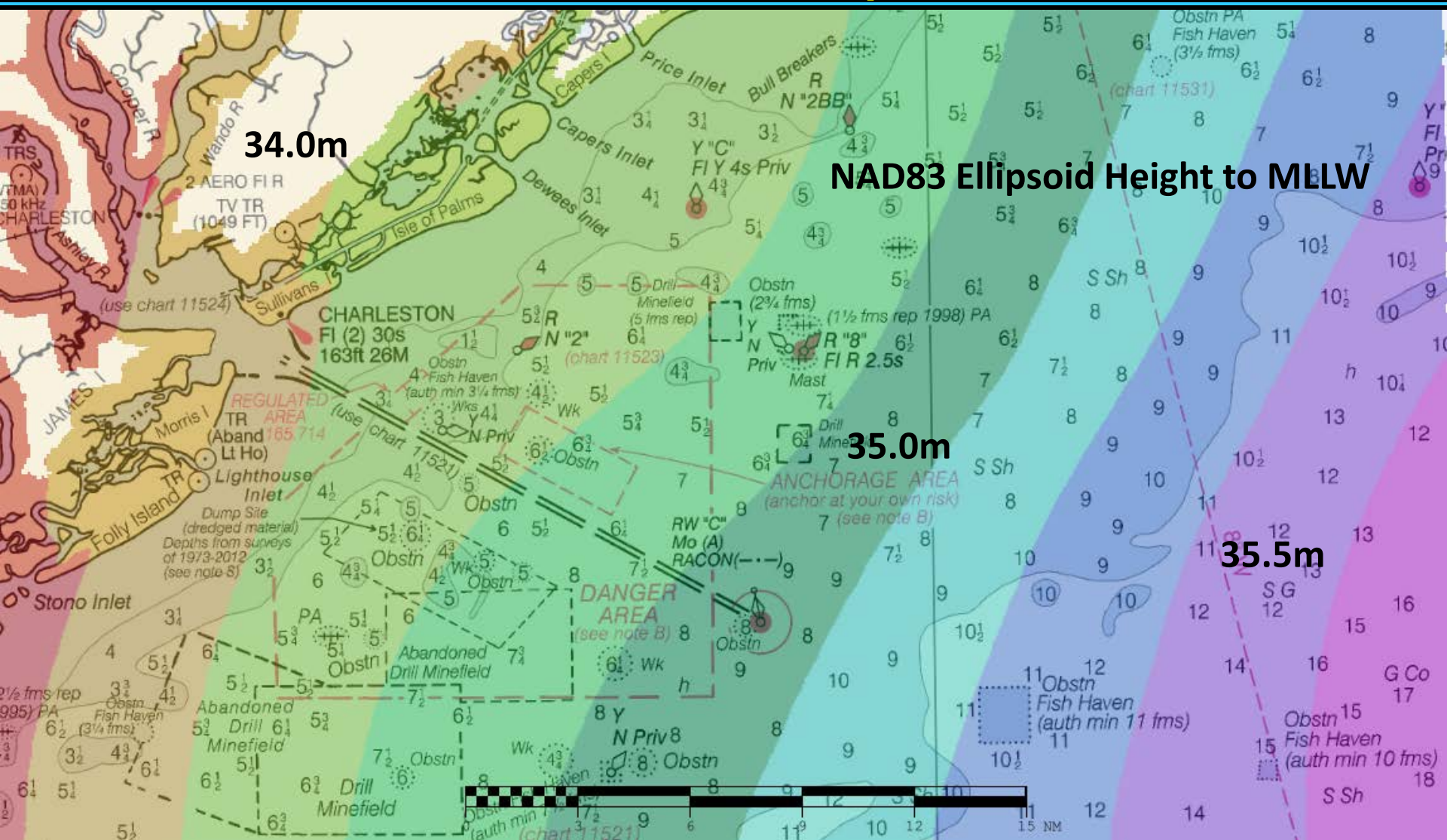
Traditional Tides Approach



ERS Approach



How: Datum Relationships



Datum Relationships and Navigation



Photo: Connor Radnovich, The Chronicle



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Challenges

- Getting a good position:
 - Differential services (e.g. RTK) are inherently local
 - State based services (e.g. satellite based augmentation services) are improving rapidly, but many are hardware specific
- Appropriately transforming between datums
 - Relationships between vertical datums must be known
 - AND clearly communicated
 - Vessel offsets from the antenna must be known



Conclusions

- Real-time GNSS vertical control for both survey work and navigation is close to a widespread reality
- 3D GNSS positioning methods need harmonization and simplification
- Datum relationships are critical
 - All navigational products need to be tied to common datum
 - VDatum
- All of this should ultimately be transparent to the navigator

