

Progress in Developing the Surface Current Data Product

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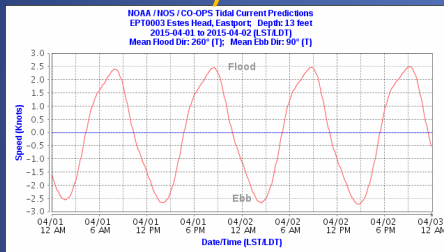
Silver Spring, Maryland, USA

- Common Data Organization Types
- Digital Tidal Atlas Data
- The SC Data Product Structure
- Data Update Frequency
- Product Spec: Data and Format Issues

Common Data Organization Types

A. TIME SERIES:

Single Point, Multiple Times
(R/T Obs, Historical Obs,
Predictions)

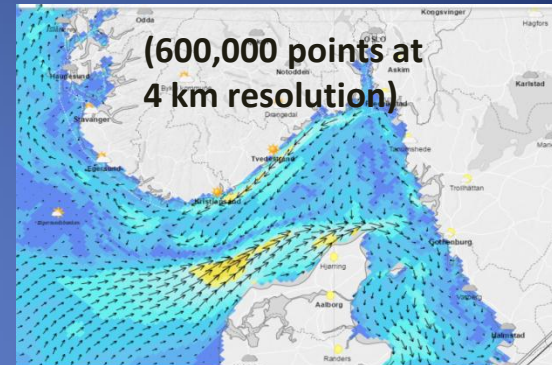


```
# Station ID:      cb1101
## Orientation:    Down (Buoy-Mounted)
## Time Zone:      UTC
## Approx. Depth:  Near Surface
## Blank rows indicate missing data. See our data
## disclaimer online.
## Date   Time   Speed (knots) Dir (true)
# 2014-12-01 00:00:00   1.08   215
# 2014-12-01 00:06:00   1.00   225
# 2014-12-01 00:12:00   0.83   226
# 2014-12-01 00:18:00   0.73   230
# 2014-12-01 00:24:00   0.80   223
# 2014-12-01 00:30:00   0.77   236
# 2014-12-01 00:36:00   0.73   229
# 2014-12-01 00:42:00   0.61   224
```

B. GRIDDED

FIELDS:

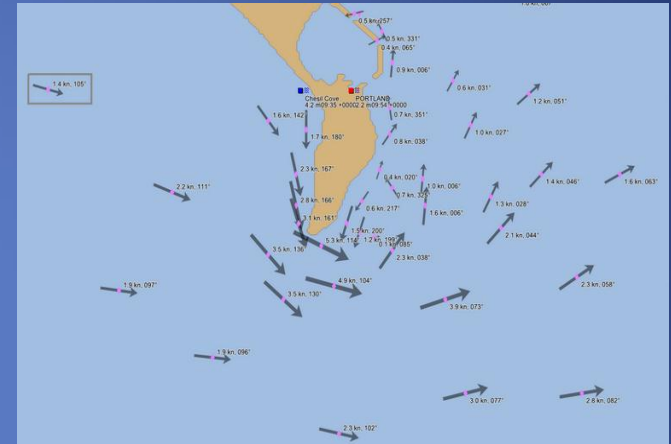
Multiple Points,
Single Time
(Forecasts,
Analysis,
Codar Data)



```
Dataset 'speed(knots)'
Size: 500x325
MaxSize: 500x325
Datatype: H5T_IEEE_F32LE (single)
ChunkSize: 1x325
Filters: deflate(9)
FillValue: 0.000000
Attributes:
  'organization': 'Center Canadian Meteorological Service -
Montreal (RSMC) (54)'
  'Delta_Longitude': '0.02993999933078885'
  'Delta_Latitude': '0.019938461092802194'
  'forecastDateTime': '20140611_180000'
  'Product': 'Type: Forecast products Status: Operational
products'
  'Minimum_Latitude': '45.5'
  'Maximum_Latitude': '51.97999985516071'
  'Maximum_Longitude': '-56.030000334605575'
  'Number_Of_Cells_South_North': '325'
  'Minimum_Longitude': '-71.0'
  'Number_Of_Cells_West_East': '500'
  'generatedDateTime': '20140611_000000'
  'units': 'mm/s'
speed(knots) =
0, 0, 0, 0.5191959, 0.5159838, 0.5159435, 0.5186388,
0.5209069, 0.5167338, 0.5114825, 0.4738558, 0.378551,
0.2911682,
0.204335, 0.1294665, ...
```

Digital Tidal Current Atlas Data

| Hour | Speed (m/s) | | Direction (deg) | |
|------|-------------|--------|-----------------|--------|
| | Neap | Spring | Neap | Spring |
| 1 | 0.924 | 0.991 | 234.0 | 232.8 |
| 2 | 0.991 | 1.047 | 235.4 | 233.5 |
| 3 | 1.015 | 1.104 | 233.1 | 234.8 |
| 4 | 0.939 | 1.132 | 233.4 | 233.0 |
| 5 | 0.447 | 0.947 | 233.7 | 233.3 |
| 6 | 0.302 | 0.061 | 232.8 | 200.1 |
| 7 | 0.444 | 0.292 | 232.5 | 56.0 |
| 8 | 0.562 | 0.044 | 232.5 | 68.2 |
| 9 | 0.596 | 0.469 | 232.4 | 231.2 |
| 10 | 0.620 | 0.662 | 232.5 | 231.3 |
| 11 | 0.705 | 0.779 | 232.7 | 231.6 |
| 12 | 0.797 | 0.886 | 233.0 | 232.1 |
| 13 | 0.876 | 0.967 | 233.5 | 232.6 |



Typical current vector plot for one time

Using the predicted tide range/current for each day, these points can be converted into:

A time series at multiple points

or

A point set grid at multiple times

But on land or aboard ship?

Generalized Approach to Organization of Data: Multiple Regular Grids in HDF5 Format

Gridded Data:

Time =20141201+000000
Speed=0.519, 0.518, 0.515, ..
Dir=32.7, 30.3, 27.8, ...

Time=20141201+000600
Speed=0.523, 0.525, 0.516, ..
Dir=32.9, 30.4, 27.7, ...

(requires a sequencing rule to assign
values to specific grid points)

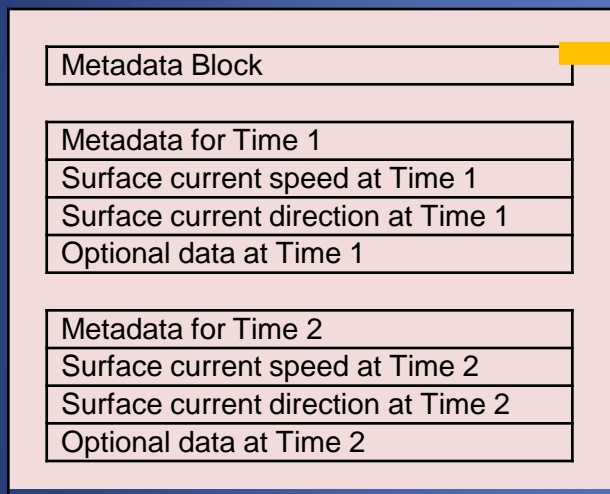
Single-Point Data: (a 1 x 1 grid)

Time =20141201+000000
Speed=1.08
Dir=215

Time=20141201+000600
Speed=1.00
Dir=225

Data Product Structure (Proposed)

Surface Current Data Product for multiple times at a single location or one forecast region



(Fig 10.1)

Optional data:

- Water level at current
- Speed uncertainty
- Direction uncertainty

Product Metadata

| N | DESCRIPTION | UNITS | DATA TYPE | PROPOSED VARIABLE NAME |
|----|--|-------------|-------------|------------------------|
| 1 | Country of Origin | NA | CodeList | Country |
| 2 | Primary Producing Agency Information | NA | CodeList | Producing_Agency |
| 3 | Secondary Producing Agency Information | NA | Text | Secondary_Agency |
| 4 | Name of Geographic Region | NA | Text | Geographic_Region |
| 5 | Name of Geographic Subregion | NA | Text | Geographic_Subregion |
| 6 | Minimum Longitude of Area | Arc Degrees | Real | West_Bound_Long |
| 7 | Maximum Longitude of Area | Arc Degrees | Real | East_Bound_Long |
| 8 | Minimum Latitude of Area | Arc Degrees | Real | South_Bound_Lat |
| 9 | Maximum Latitude of Area | Arc Degrees | Real | North_Bound_Lat |
| 10 | Time of Data Product Production | Y,M,D,H,M,S | Date-Time | T_product |
| 11 | Valid Time of First Value | Y,M,D,H,M,S | Date-Time | T_valid1 |
| 12 | Valid Time of Last Value | Y,M,D,H,M,S | Date-Time | T_valid2 |
| 13 | Number of Individual Time Values | None | Integer | K_Sets |
| 14 | Data Type (1=historical obs, 2=real-time observation, 3=astronomical prediction, 4=analysis, 5=hindcast, 6=forecast) | None | Enumeration | Index_Data_Type |
| 15 | Name of Station or Grid | NA | Text | - |
| 16 | Methodology: instrument or model | NA | Text | - |
| 17 | Grid Origin Longitude | Arc Degrees | Real | Origin_Longitude |
| 18 | Grid Origin Latitude | Arc Degrees | Real | Origin_Latitude |
| 19 | Grid Spacing Longitudinal | Arc Degrees | Real | Delta_Longitude |
| 20 | Grid Spacing Latitudinal | Arc Degrees | Real | Delta_Latitude |
| 21 | Land Mask/Missing Data Value (e.g., -1.0) | (Varies) | Real | Land_Mask_Value |
| 22 | Index for Layer Averaging or Depth of Current (1=layer, 2=depth below surf, 3=depth below fixed datum) | None | Enumeration | Index_Depth_Ref |
| 23 | Layer Thickness (if above index=1) or Depth of Current Below Datum (if above index=2,3) | Meters | Real | Surcur_Depth |
| 24 | Datum for Surface Elevation (if above index=3, then 0=unk, 1=LAT, 2=MLLW, 3=bottom, etc.) | None | Enumeration | Index_SurfDatum |
| 25 | Index for Surface Elevation (0=no,1=array) | None | Enumeration | Index_Surface_Elev |
| 26 | Datum for Surface Elevation (if above index=1, then 0=unk, 1=LAT, 2=MLLW, 3=bottom, etc.) | None | Enumeration | Index_ElevDatum |
| 27 | Horizontal Position Uncertainty | Meters | Real | Unc_Horizpos |
| 28 | Vertical Position Uncertainty | Meters | Real | Unc_Vertpos |
| 29 | Data Uncertainty Index (0=unk,1=const, 2=array) | None | Enumeration | Index_Data_Uncert |
| 30 | Speed Uncertainty Constant Value (Optional) | Meters | Real | Unc_Speed |
| 31 | Direction Uncertainty Constant Value (Optional) | Arc Degrees | Real | Unc_Direction |

Admin

Geography

Time

Grid Info

Depth Info

Uncertainty

(Table 10.2)

Update Frequency and Transmission Modes

| Type of Current Data | Update Period | Number of Geo. Locations | Mode |
|----------------------|---------------|--------------------------|------------|
| Real-time Obs. | 0.1 hr | 1 - 10 | Radio(AIS) |
| Tidal Prediction | 1 yr | 100 – 1,000 | Media |
| Model-based Forecast | 6 hr | 10,000 - 100,000 | Internet |

Real-Time Obs for UKC Systems: A Web-based System

Dynamic Under Keel Clearance System



PROTIDE Takes Forecasts of:

- Water levels
- Currents
- Waves and swell height and period
- Channel Depth
- Ship course
- Dimensions and
- Stability

(CO-OPS Astronomical Predictions)
(CO-OPS Astronomical Predictions)
(NWS NSWP and CDIP Observations)
(OCS 2013 Hydro Survey)

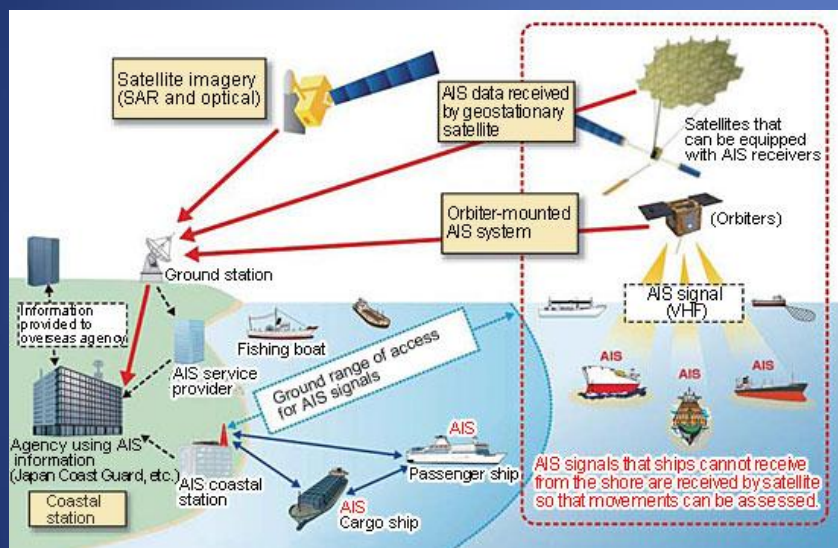
Ports of Los Angeles and Long Beach, US

Calculates anticipated roll/pitch/squat using Monte Carlo simulation to determine under keel clearance and bottom touch probability

CURRENTS:

- Astronomical predictions
- Model-based forecasts

II. An AIS-based system (Automatic Information System)



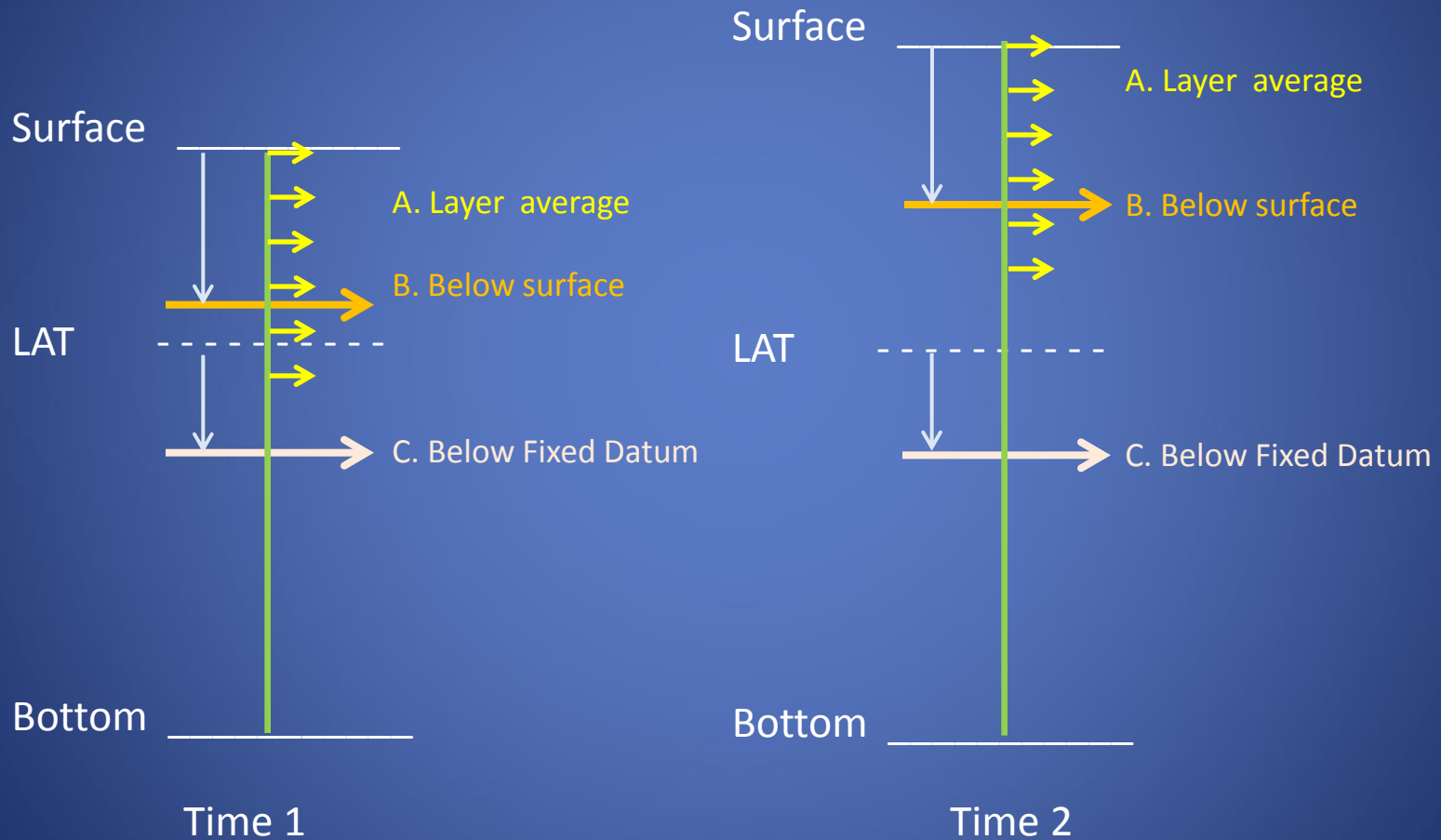
Portion of “Meteorological and Hydrographic Data AIS Application Specific Message”

| Variable | Bits | Coding |
|------------------------------------|------|---|
| Surface Current Speed (incl. tide) | 8 | Speed of Current measured at the sea surface, in 0.1 knot steps. 0.0 - 25.0 knots 251 = speed 25.1 knots or greater 255 = not available = default 252-254 (reserved for future use) |
| Surface Current Direction | 9 | Direction of Current at the sea surface, in 1 degree steps. 0 - 359 degrees 360 = not available = default 361 - 511 (reserved for future use) |
| Current Speed, #2 | 8 | Speed of Current 2 measured at a chosen level below the sea surface, in 0.1 knot steps. (Same as Surface Current Speed) |
| Current Direction, #2 | 9 | Direction of Current 2, in 1 degree steps. (Same as Surface Current Direction) |
| Current Measuring level, #2 | 5 | Measuring level below sea surface, in 1 metre increment. 0 - 30 metres 31 = not available = default |
| Current Speed, #3 | 8 | Speed of Current 3 measured at a chosen level below the sea surface, in 0.1 knot steps. (Same as Surface Current Speed) |
| Current Direction, #3 | 9 | Direction of Current 3, in 1 degree steps. (Same as Surface Current Direction) |
| Current Measuring level, #3 | 5 | Measuring level below sea surface, in 1 metre steps. 0 - 30 metres 31 = data not available = default |

Review of Product Data and Format Issues

- Water Level Vertical Reference
- Uncertainty Calculations
- Real-Time Observations
- Product Format
- Reformatting

Reference to Surface



Data Issues (1)

■ Water Level Reference

- Do we need WL at location of current?
 - If so, what vertical datum to use?
- Do we need a depth of surface current?
 - If so, do we need to define 'sea surface'?
- Do we need to be able to reference current to height above bottom?

Data Issues (2)

- Uncertainty

- How to calculate
- Will a spatially-constant value do?
- If not, how to portray spatial variation

- Real-Time Observations

- Is the proposed data product format sufficient?
- How to get to ship (AIS, internet)

Data Issues (3)

Surface Current Data from Selected National Organizations

| N | NATION | CURRENT TYPE | COVERAGE TYPE | DATA FORMAT | SPATIAL REFERENCE | TIME INTVL (HR) |
|---|----------------|-----------------|--------------------|-----------------------|----------------------|--------------------|
| 1 | Australia | Forecast | Gridded (Reg) | NetCDF | Lat, Lon | 3 |
| 2 | Canada | Forecast | Gridded (Reg) | HDF5 | Lat, Lon | 6 |
| 3 | France | Forecast | Gridded (Irr) | NetCDF | Lat, Lon | 1 |
| | | Tidal Atlas | Point Set | ASCII, Shape, Geotiff | RGF93 | 1 |
| | | R/T Obs (radar) | Gridded (Reg) | ? | ? | 0.17 |
| 4 | Netherlands | Tidal Atlas | Point Set | ASCII, HDF5 | Lat, Lon | 1 |
| 5 | Norway | Forecast | Gridded (Reg) | NetCDF | Lat, Lon | 1 |
| 6 | United Kingdom | Tidal Atlas | Point Set | ? | ? | 1 |
| 7 | United States | Forecast | Gridded (Reg, Irr) | NetCDF | Lat, Lon | 1 |
| | | R/T Obs (meter) | Point Set | NetCDF | Lat, Lon | 0.1 |

■ Product Format

- Need either a single land mask code value or an array?
- HDF5 only? Add NetCDF?
- Add point sets?

■ Reformatting

- Who is to do this? ONA or industry?
- Digital tidal atlas reformatting