Regionally Accessible Nested Global Shorelines

Rainer Feistel
Institut für Ostseeforschung, Warnemünde

Overview

Regionally Accessible Nested Global Shorelines (RANGS) are based on the Global *Self-consistent Hierarchical High-resolution Shorelines* (GSHHS) data set computed by WESSEL and SMITH (1996). Processed here is their version 1.1, from April 30, 1996, downloaded in January 1997 from their ftp internet site **ftp://kiawe.soest.hawaii.edu/pub/wessel/gshhs/**.
Details about these files can be obtained from their article mentioned above and the www site mentioned at the end.

GSHHS have been derived by WESSEL and SMITH (1996) from the widely used World Vector Shoreline (WVS) data set combined with additional CIA data. WVS was originally provided by the *US Defense Mapping Agency* (DMA) , now *National Imagery and Mapping Agency* (NIMA), see e.g. SOLURI and WOODSON (1990), DMA (1988). WVS data are organized in 1° x 1° cells covering the entire globe surface, which contain either only water or only land or coast lines. The lines consist of fractions of different length, i.e. sequences of coordinate pairs. They resolve structures smaller than 100m in size. Vertex coordinates are given on a 0.1" raster (or 3m), while their absolute accuracy is 500m. Although not officially stated for WVS we will assume its resolution in the following as 100m. The 64,800 cells of Earth's surface are grouped in ten different ocean basin area files.

WESSEL and SMITH have merged the separate WVS files and concatinated the various line fractions to closed polygon sequences, assigning its own ID number to each. They have assigned hierarchy level indices to these polygon tracks in order to distinguish ocean shore from lakes on land, islands in lakes etc. Using the DOUGLAS-PEUCKER (1973) algorithm they derived lower resolution versions (full resolution = 0.1, high = 0.2, intermediate = 1.0 , low = 5.0 and crude = 25 km) of the polygon sets. They called their corresponding files gshhs_f_, gshhs_h_, gshhs_i_, gshhs_l_, gshhs_c_. Their coordinates are expressed in integer micro-degree numbers (thus resolving 0.1m, theoretically).

Compared to WVS, these GSHHS data are of significant advantage in software applications for graphic visualization using masking or rendering methods. However, they still have two important shortcomings:

(i) Their mutual topological relations are not specified, i.e. it is not indicated whether two given polygons are disjunct or one is inside the other.

(ii) There is no local access to polygon parts as it was with WVS in cell bins. As an example, the Warnemünde Baltic Sea Research Institute is located at a shoreline polygon that starts from the Baltic, continues around the Iberian Peninsula, the Mediterranean, Africa, Arabia, India, China, Siberia, Scandinavia and eventually returns into the Baltic, all that with about 100m spatial resolution. Moreover, for drawing say an island in the Baltic the program has to process the full GSHHS file because there is no indication of whether or not any of the polygons intersects the given cell(s). Numerical processing or even only drawing of such huge

polygons is very time and memory consuming, especially if software applications in interactive graphical user surfaces are considered.

Regionally Accessible Nested Global Shorelines (RANGS) have been developed to overcome these disadvantages while preserving the benefits of GSHHS. Like WVS, RANGS is composed of 1°x 1° cells covering the globe. For each cell, the conjunction polygon between the GSHHS polygon and the cell square is computed. All these local RANGS polygons keep a reference to their global GSHHS parent polygons. RANGS polygons then were nested, i.e. it is determined and stored which polygon is the surrounding polygon of a given one, and which polygons are located in the interior of a given polygon. RANGS polygons are stored as additionally generated vertices in conjunction with pointers into GSHHS files. GSHHS itself is only slightly modified, as described below, compared to the original data given by WESSEL and SMITH.

Processing of GSHHS files

The construction of RANGS polygons required some preparation and modification steps applied to the original GSHHS files.

1. **Byte reversion** GSHHS comes in Unix/Mac number format (Motorola processor). For use on Windows PC (Intel processor) the byte sequence of the binary numbers need to be reversed. Because we could not get the byte reversion program working which was provided by WESSEL and SMITH we used an own program written for this purpose.

2. **Rim rotation**: For all GSHHS polygons not confined to a single cell the polygon rim points have been moved forward within the file while the resulting excess points have been appended at the end until the first and the last point of the polygon became located in different cells.

3. **Cleaning**: Restrict longitude coordinates to values between x>=0 and x<360. All duplicate vertices have been removed.

4.**Correcting levels**: Four polygons have been found to have wrong level index, ID 3087 in gshhs_f_ is level 2 but indicated was 1, ID 47992 in gshhs_f_ is level 2 but indicated was 3, ID 2418 in gshhs_h_ is level 2 but indicated was 1, ID 490 in gshhs_i_ is level 2 but indicated was 3.

5.**Renaming**: The processed GSHHS files gshhs_f_, gshhs_h_, gshhs_i_, gshhs_l_, gshhs_c_ have been named then to gshhs(0).rim, gshhs(1).rim, gshhs(2).rim, gshhs(3).rim, gshhs(4).rim.

Structure of GSHHS.RIM files

The file structure of the modified gshhs(?).rim files is identical with that described by WESSEL and SMITH(1996) for Version 1.1, April 30, 1996.

The files contain several successive logical blocks of the form

gshhs header
gshhs points

Each *gshhs header* consist of the following variables:

```
int id;                          /* Unique polygon id number, starting at 0 */
int n;                           /* Number of points in this polygon */
int level;                       /* 1 land, 2 lake, 3 island_in_lake, 4 pond_in_island_in_lake */
int west, east, south, north;    /* min/max extent in micro-degrees */
int area;                        /* Area of polygon in 1/10 km^2 */
short int greenwich;             /* Greenwich is 1 if Greenwich is crossed */
short int source;                /* 0 = CIA WDBII, 1 = WVS */
```

Here, *int* is 4-byte integers and *short* means 2-byte integers.

The *gshhs points* are stored as n successive records of the form

```
int    x;    /* longitude of a point in micro-degrees */
int    y;    /* latitude of a point in micro-degrees */
```

Processing of RANGS files

Assigning polygon parts to one-degree cells, reconnecting these fractions to polygons again and nesting the small polygons has been carried out in a number of subsequent processing steps.

1. **Cell segments**. For each 1°x1° cell, the rim segments of all polygons inside this cell have been determined. (A given polygon can lie entirely inside a cell, or it can enter and exit the same cell one or several times, it can touch the cell border with one or more vertices without really crossing it, and it can cross the cell without having a single vertex within the cell). For polygons passing more than one cell, all entry and exit vertices on the cell border have been computed and stored. Address and number of points in GSHHS.RIM of sequences inside the cell have been stored (number can be zero). For polygons not passing the cell's border, the first polygon point is used as entry and exit vertex, its address is noted and the number of its points, and a 'closed-loop' flag is set indicating that entry/exit need not to be on the cell border. For all such segments described this way by entry point, rim segment address, rim segment length and exit point, the rotation sense (clockwise./counterclockwise) of the original entire polygon is computed and flagged. Together with the parity of the polygon level index, this flag tells whether on the right or on the left hand side along the sequence we find land or water.

2.**Cell polygons**: Cell segments must be concatinated to form little polygons (“cell polygons”), the conjunctions of the global parent polygons with the cell. For this purpose, fractions of the cell border (with or without cell corner points) must be inserted in between the isolated polygon rim segments.

3. **Polygon Nesting**: For each cell polygon of a given cell it has to be determined which of them is inside which other cell polygon. This is done by checking all rim points of one polygon for being in the interior of another polygon.

4. **Cell Nesting**: For each cell it must be determined whether it is at least partially in the world ocean or entirely inside one global polygon. For all cell borders lines not crossed by shore lines its surrounding polygon must be found. This can be done, knowing that the north pole is ocean and the south pole is land, by handing over the information of a given cell to its adjacent cells.

Structure of RANGS files

There are two different kinds of RANGS files, rangs(?).cat and rangs(?).cel, where the question mark is placeholder for 0,1,2,3,4 denoting the different resolution levels.

The **Cell Address Table rangs(?).cat** contains one long (4 byte) integer for each cell of the globe's surface. Its value is the address of description in the rangs(?).cel file.

Note that for all addresses here and in the following address means byte address starting with 1 for the first byte in the file.
If *lon* (0 to 359) is the longitude and *lat* (89 to -90) the latitude of the lower left corner of the cell, then *addr = 1 + 4 * ((89 - lat) * 360 + lon)* is the address of this cell in **rangs(?).cel**.

The **Cell Extraction List rangs(?).cel** contains pointers to all gshhs shoreline segments belonging to a particular cell together with information how these segments are to be connected to form a closed, simple (non-self-crossing) cell polygon, and how these polygons with different ID numbers are nested inside each other.

The outmost polygon, where the pointer of the rangs(?).cat file points to, is always the cell border square with 4 vertices and polygon ID -1. Whether it is embedded in ocean or land is specified in its *SegmentByte* (see below). If a cell does not contain any shoreline then this cell border is the only description of that cell.

There is a recursive data structure *PolygonList* at each address in rangs(?).cel where the rangs(?).cat file points to:

PolygonList:=
PolygonByte (= 1 or 2)
SegmentLoop
PolygonList
PolygonList
...
PolygonList
PolygonByte (= 0)

Here the values of the byte *PolygonByte* have the meaning

1	*Begin_Polygon_CCW*	(Counterclockwise)
2	*Begin_Polygon_CW*	(Clockwise)
0	*End_PolygonList*	

SegmentLoop describes a single polygon. It is immediately followed by the set of all polygons (*PolygonList)* it directly encloses (the "holes" in the polygon).

SegmentLoop :=
PolygonID
SegmentByte
SegmentData
SegmentByte
SegmentData
...
SegmentData
SegmentByte (with *End_SegmentLoop* flagged)

PolygonID is the 4 byte integer *gshhs header* ID number of the original GSHHS polygon we refer to in gshhs(?).rim.

SegmentByte is a single byte composed as follows

SegmentByte = *DataType* + 8 * *Clockwise* + 16 * *Interior*

DataType =	0	*End_SegmentLoop*
	1..6 = n	*SegmentData* is an n-vertex *cell border segment*
	7	*SegmentData* is a *rim segment*
Clockwise =	1	clockwise polygon, interior is on the right
	0	counterclockwise polygon
Interior =	0	inside is ocean
	1	inside is land
	2	inside is lake on land
	3	inside is island in lake
	4	inside is pond on island

SegmentData can be one of two possibilities depending on *DataType*:

a) A *cell border segment* with n vertices consists of 1 to 6 vertices on the cell border. The first and the last vertex are the polygon exit point and the polygon entry point (which may be just one point if the border is touched but not crossed), in between are 0 to 4 corner points of the cell square. Each vertex is explicitly given as a pair (lon, lat) of coordinates in microdegrees (4 byte integers). This *SegmentData* is 8n bytes long. Interior and exterior are the same.

b) A *rim segment* is 8 bytes long and consists of a 4 byte integer segment address in gshhs(?).rim and a 4 byte integer segment length (number of vertices). The exterior is one less the interior.

References:

Douglas, D.H. and T K. Peucker, 1973, Algorithms for the Reduction of the Number of Points Required to Represent a Digitized Line or Its Caricature,
The Canadian Cartographer **10**(2), 112-122

Soluri, E.A. and V.A. Woodson, 1990, World Vector Shoreline. International Hydrographic Review, **LXVII**(1), 27-36,

DMA 1988, Defense Mapping Agency Product Specifications for World Vector Shoreline, PS/2GC/030, First Edition, May 1988, DMA Hydrographic / Topographic Center, Washington DC 20315-0030

Wessel, P., and W. H. F. Smith, 1996, A global self-consistent, hierarchical, high-resolution shoreline database, Journal of Geophysical.Research, **101**, 8741-8743.

Related Internet addresses:

Information about WVS data can be found at
http://crusty.er.usgs.gov/coast/wvs.html
and
http://www.ngdc.noaa.gov/mgg/fliers/93mgg01.html
and about GSHHS files at
http://www.soest.hawaii.edu/wessel/gshhs/gshhs.html
RANGS can be downloaded from
http://www.io-warnemuende.de/public/phy/rfeistel/index.htm

Appendix: RANGS Cell Examples

Case 1: Cell in ocean, Baltic Sea at 19°E, 55°N

Resolution: rangs(3), drawing cell at lon= 19 lat= 55

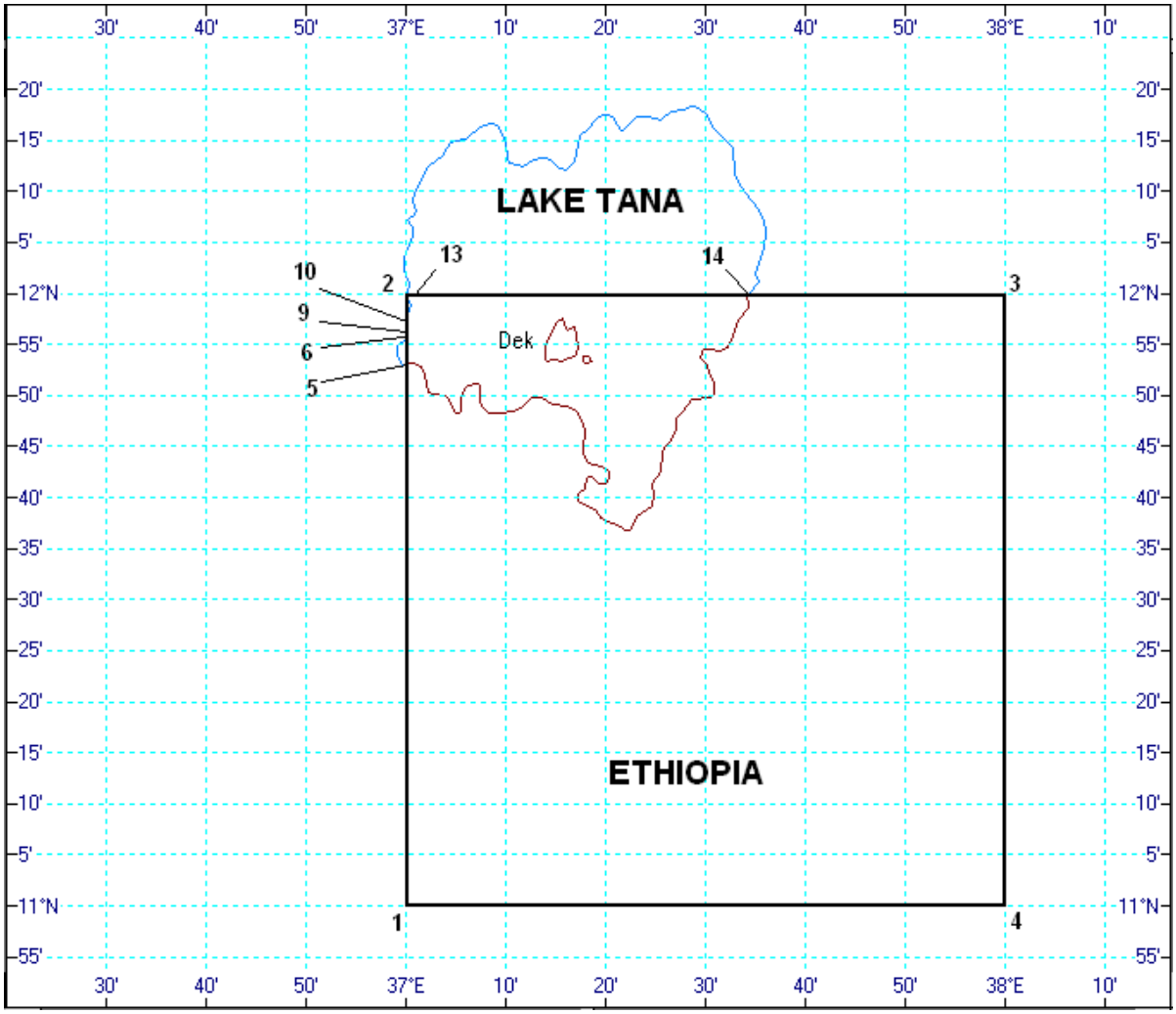
```
File    Address    Contents    Comment

CAT     49037      833157      Address in CEL file

CEL     833157     2           PolygonByte: Begin_Polygon_CW
CEL     833158    -1             Polygon ID
CEL     833162     4             SegmentByte: Cell Segment, CCW, Ocean
CEL     833163     19000000        Longitude Vertex 1
CEL     833167     55000000        Latitude  Vertex 1
CEL     833171     19000000        Longitude Vertex 2
CEL     833175     56000000        Latitude  Vertex 2
CEL     833179     20000000        Longitude Vertex 3
CEL     833183     56000000        Latitude  Vertex 3
CEL     833187     20000000        Longitude Vertex 4
CEL     833191     55000000        Latitude  Vertex 4
CEL     833195     128           SegmentByte: End_SegmentLoop
CEL     833196     0           PolygonByte: End_PolygonList
```

Case 2: Cell on land, United Kingdom at 2°W, 52°N

Resolution: rangs(3), drawing cell at lon= 358 lat= 52

File	Address	Contents	Comment
CAT	54713	939948	Address in CEL file
CEL	939948	2	PolygonByte: Begin_Polygon_CW
CEL	939949	-1	Polygon ID
CEL	939953	20	SegmentByte: Cell Segment, CCW, Land
CEL	939954	358000000	Longitude Vertex 1
CEL	939958	52000000	Latitude Vertex 1
CEL	939962	358000000	Longitude Vertex 2
CEL	939966	53000000	Latitude Vertex 2
CEL	939970	359000000	Longitude Vertex 3
CEL	939974	53000000	Latitude Vertex 3
CEL	939978	359000000	Longitude Vertex 4
CEL	939982	52000000	Latitude Vertex 4
CEL	939986	128	SegmentByte: End_SegmentLoop
CEL	939987	0	PolygonByte: End_PolygonList

Case 3: Cell with nested polygons: Lake Tana, Ethiopia, at 37°E, 11°N



Resolution rangs(1), drawing cell at lon= 37 lat= 11

```
File    Address    Contents    Comment

CAT     112469     3614142      Address in CEL file

CEL     3614142    2           PolygonByte: Begin_Polygon_CW          (Cell Square)
CEL     3614143   -1             Polygon ID
CEL     3614147    20            SegmentByte: Cell Segment
CEL     3614148    37000000        Longitude Vertex 1
CEL     3614152    11000000        Latitude  Vertex 1
CEL     3614156    37000000        Longitude Vertex 2
CEL     3614160    12000000        Latitude  Vertex 2
CEL     3614164    38000000        Longitude Vertex 3
CEL     3614168    12000000        Latitude  Vertex 3
CEL     3614172    38000000        Longitude Vertex 4
CEL     3614176    11000000        Latitude  Vertex 4
CEL     3614180    16            SegmentByte: End_SegmentLoop
CEL     3614181    2             PolygonByte: Begin_Polygon_CW          (Tana Shore)
CEL     3614182    702             Polygon ID
CEL     3614186    34              SegmentByte: Cell Segment
CEL     3614187    37000000          Longitude Vertex 5
CEL     3614191    11884823          Latitude  Vertex 5
CEL     3614195    37000000          Longitude Vertex 6
CEL     3614199    11926986          Latitude  Vertex 6
CEL     3614203    39              SegmentByte: Rim Segment
CEL     3614204    6384685           Segment Address
CEL     3614208    2                 Segment Length
```

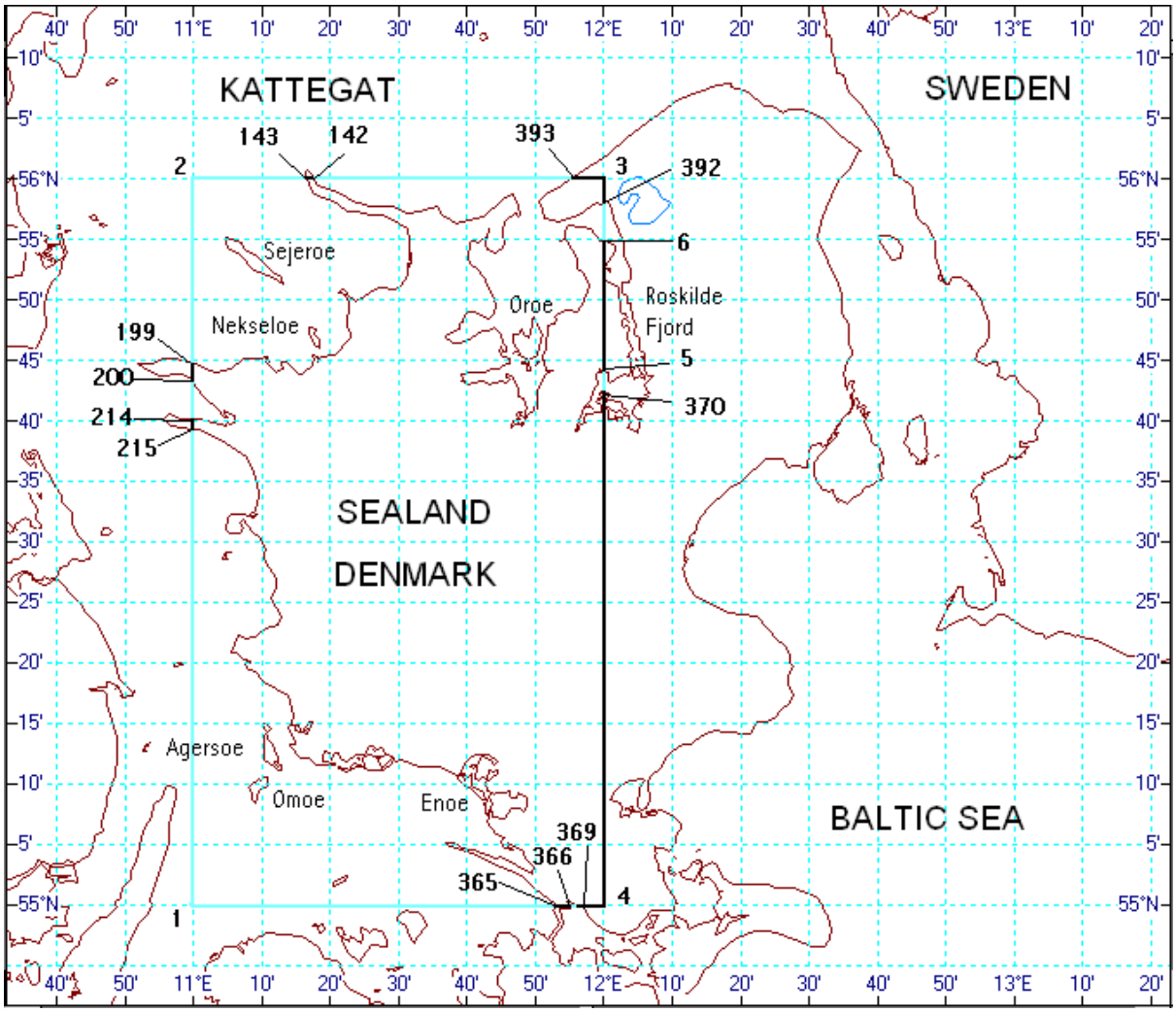
```
RIM     6384685    37000556           Longitude Vertex 7
RIM     6384689    11927500           Latitude  Vertex 7
RIM     ...                           1 more Vertex 8

CEL     3614212    34               SegmentByte: Cell Segment
CEL     3614213    37000000           Longitude Vertex 9
CEL     3614217    11942575           Latitude  Vertex 9
CEL     3614221    37000000           Longitude Vertex 10
CEL     3614225    11956447           Latitude  Vertex 10
CEL     3614229    39               SegmentByte: Rim Segment
CEL     3614230    6384709            Segment Address
CEL     3614234    2                  Segment Length

RIM     6384709    37006389           Longitude Vertex 11
RIM     6384713    11982222           Latitude  Vertex 11
RIM     ...                           1 more Vertex 12

CEL     3614238    34               SegmentByte: Cell Segment
CEL     3614239    37002666           Longitude Vertex 13
CEL     3614243    12000000           Latitude  Vertex 13
CEL     3614247    37569824           Longitude Vertex 14
CEL     3614251    12000000           Latitude  Vertex 14
CEL     3614255    39               SegmentByte: Rim Segment
CEL     3614256    6385165            Segment Address
CEL     3614260    83                 Segment Length

RIM     6385165    37566667           Longitude Vertex 15
RIM     6385169    11996667           Latitude  Vertex 15
RIM     ...                           82 more vertices 16-97

CEL     3614264    32               SegmentByte: End_SegmentLoop
CEL     3614265    1                PolygonByte: Begin_Polygon_CCW      (Dek)
CEL     3614266    10856              Polygon ID
CEL     3614270    63                 SegmentByte: Rim Segment
CEL     3614271    9606477              Segment Address
CEL     3614275    15                   Segment Length

RIM     9606477    37232500             Longitude Vertex 98
RIM     9606481    11893889             Latitude  Vertex 98
RIM     ...                             14 more Vertices 99-112

CEL     3614279    48                 SegmentByte: End_SegmentLoop
CEL     3614280    0                PolygonByte: End_PolygonList        (Dek)
CEL     3614281    1                PolygonByte: Begin_Polygon_CCW      (Small Island)
CEL     3614282    32349              Polygon ID
CEL     3614286    63                 SegmentByte: Rim Segment
CEL     3614287    12007353             Segment Address
CEL     3614291    7                    Segment Length

RIM     12007353   37294444             Longitude Vertex 113
RIM     12007357   11891667             Latitude  Vertex 113
RIM     ...                             6 more Vertices 114-119

CEL     3614295    48                 SegmentByte: End_SegmentLoop
CEL     3614296    0                PolygonByte: End_PolygonList        (Samall Island)
CEL     3614297    0              PolygonByte: End_PolygonList          (Tana Shore)
CEL     3614298    0            PolygonByte: End_PolygonList            (Cell Square)
```

Case 4: Cell with multiple entry/exit points: Sealand, Denmark, at 11°E, 55°N

- Multiple islands appear as “holes” in the cell border polygon at the same level

- The same global polygon (Sealand, ID 105) appears as 2 cell polygons (Sealand Main, from CEL 1982162 till 1982332, and Sealand Halsnaes, from CEL 1982333 till 1982373

- The sequence of rim points along the cell border is in general different from the sequence of appearance of the same points along the global polygon



Resolution rangs(1), drawing cell at lon= 11 lat= 55

```
File    Address    Contents      Comment

CAT     49005      1982123      Address in CEL file

CEL     1982123    2            PolygonByte: Begin_Polygon_CW          (Cell Square)
CEL     1982124   -1              Polygon ID
CEL     1982128    4              SegmentByte: Cell Segment
CEL     1982129    11000000         Longitude Vertex 1
CEL     1982133    55000000         Latitude  Vertex 1
CEL     1982137    11000000         Longitude Vertex 2
CEL     1982141    56000000         Latitude  Vertex 2
CEL     1982145    12000000         Longitude Vertex 3
CEL     1982149    56000000         Latitude  Vertex 3
```

```
CEL     1982153    12000000         Longitude Vertex 4
CEL     1982157    55000000         Latitude  Vertex 4
CEL     1982161    0              SegmentByte: End_SegmentLoop
CEL     1982162    1              PolygonByte: Begin_Polygon_CCW        (Sealand, Main)
CEL     1982163    105              Polygon ID
CEL     1982167    26               SegmentByte: Cell Segment
CEL     1982168    12000000           Longitude Vertex 5
CEL     1982172    55731361           Latitude  Vertex 5
CEL     1982176    12000000           Longitude Vertex 6
CEL     1982180    55913776           Latitude  Vertex 6
CEL     1982184    31               SegmentByte: Rim Segment
CEL     1982185    5009457            Segment Address
CEL     1982189    135                Segment Length

RIM     5009457    11991611           Longitude Vertex 7
RIM     5009461    55913778           Latitude  Vertex 7
RIM     ...                           134 more Vertices 8-141

CEL     1982193    26               SegmentByte: Cell Segment
CEL     1982194    11295120           Longitude Vertex 142
CEL     1982198    56000000           Latitude  Vertex 142
CEL     1982202    11279339           Longitude Vertex 142
CEL     1982206    56000000           Latitude  Vertex 143
CEL     1982210    31               SegmentByte: Rim Segment
CEL     1982211    5010561            Segment Address
CEL     1982215    55                 Segment Length

RIM     5010561    11290833           Longitude Vertex 144
RIM     5010565    55981639           Latitude  Vertex 144
RIM     ...                           54 more vertices 145-198

CEL     1982219    26               SegmentByte: Cell Segment
CEL     1982220    11000000           Longitude Vertex 199
CEL     1982224    55745373           Latitude  Vertex 199
CEL     1982228    11000000           Longitude Vertex 200
CEL     1982232    55718857           Latitude  Vertex 200
CEL     1982236    31               SegmentByte: Rim Segment
CEL     1982237    5011065            Segment Address
CEL     1982241    13                 Segment Length

RIM     5011065    11024139           Longitude Vertex 201
RIM     5011069    55699139           Latitude  Vertex 201
RIM     ...                           12 more Vertices 202-213

CEL     1982245    26               SegmentByte: Cell Segment
CEL     1982246    11000000           Longitude Vertex 214
CEL     1982250    55669003           Latitude  Vertex 214
CEL     1982254    11000000           Longitude Vertex 215
CEL     1982258    55655361           Latitude  Vertex 215
CEL     1982262    31               SegmentByte: Rim Segment
CEL     1982263    5011209            Segment Address
CEL     1982267    149                Segment Length

RIM     5011209    11013361           Longitude Vertex 216
RIM     5011213    55654583           Latitude  Vertex 216
RIM     ...                           148 more Vertices 217-364

CEL     1982271    26               SegmentByte: Cell Segment
CEL     1982272    11883435           Longitude Vertex 365
CEL     1982276    55000000           Latitude  Vertex 365
CEL     1982280    11917002           Longitude Vertex 366
CEL     1982284    55000000           Latitude  Vertex 366
CEL     1982288    31               SegmentByte: Rim Segment
CEL     1982289    5006857            Segment Address
CEL     1982293    2                  Segment Length

RIM     5006857    11907500           Longitude Vertex 367
RIM     5006861    55004167           Latitude  Vertex 367
RIM     ...                           1 more Vertex 368

CEL     1982297    27               SegmentByte: Cell Segment
CEL     1982298    11928543           Longitude Vertex 369
CEL     1982302    55000000           Latitude  Vertex 369
CEL     1982306    12000000           Longitude Vertex 4
CEL     1982310    55000000           Latitude  Vertex 4
CEL     1982314    12000000           Longitude Vertex 370
CEL     1982318    55702942           Latitude  Vertex 370
CEL     1982322    31               SegmentByte: Rim Segment
CEL     1982323    5009097            Segment Address
CEL     1982327    21                 Segment Length

RIM     5009097    11993306           Longitude Vertex 371
RIM     5009101    55706222           Latitude  Vertex 371
```

```
RIM     ...                         20 more Vertices 372-391

CEL     1982331     16              SegmentByte: End_SegmentLoop
CEL     1982332     0             PolygonByte: End_PolygonList          (Sealand, Main)
CEL     1982333     1             PolygonByte: Begin_Polygon_CCW        (Sealand, Halsnaes)
CEL     1982334     105             Polygon ID
CEL     1982338     27              SegmentByte: Cell Segment
CEL     1982339     12000000          Longitude Vertex 392
CEL     1982343     55966766          Latitude  Vertex 392
CEL     1982347     12000000          Longitude Vertex 3
CEL     1982351     56000000          Latitude  Vertex 3
CEL     1982355     11919798          Longitude Vertex 393
CEL     1982359     56000000          Latitude  Vertex 393
CEL     1982363     31              SegmentByte: Rim Segment
CEL     1982364     5008505           Segment Address
CEL     1982368     9                 Segment Length

RIM     5008505     11893333          Longitude Vertex 394
RIM     5008509     55988722          Latitude  Vertex 394
RIM     ...                         8 more Vertices 395-402

CEL     1982372     16              SegmentByte: End_SegmentLoop
CEL     1982373     0             PolygonByte: End_PolygonList          (Sealand, Halsnaes)
CEL     1982374     1             PolygonByte: Begin_Polygon_CCW        (Agersoe)
CEL     1982375     9414            Polygon ID
CEL     1982379     31              SegmentByte: Rim Segment
CEL     1982380     9370853           Segment Address
CEL     1982384     17                Segment Length

RIM     9370853     11170806          Longitude Vertex 403
RIM     9370857     55204139          Latitude  Vertex 403
RIM     ...                         16 more Vertices 404-419

CEL     1982388     16              SegmentByte: End_SegmentLoop
CEL     1982389     0             PolygonByte: End_PolygonList          (Agersoe)
CEL     1982390     1             PolygonByte: Begin_Polygon_CCW        (Oroe)
CEL     1982391     10033           Polygon ID
CEL     1982395     31              SegmentByte: Rim Segment
CEL     1982396     9474561           Segment Address
CEL     1982400     16                Segment Length

RIM     9474561     11777472          Longitude Vertex 420
RIM     9474565     55777500          Latitude  Vertex 420
RIM     ...                         15 more Vertices 421-435

CEL     1982404     16              SegmentByte: End_SegmentLoop
CEL     1982405     0             PolygonByte: End_PolygonList          (Oroe)
CEL     1982406     1             PolygonByte: Begin_Polygon_CCW        (Glaenoe)
CEL     1982407     11184           Polygon ID
CEL     1982411     31              SegmentByte: Rim Segment
CEL     1982412     9657645           Segment Address
CEL     1982416     15                Segment Length

RIM     9657645     11384139          Longitude Vertex 436
RIM     9657649     55186639          Latitude  Vertex 436
RIM     ...                         14 more Vertices 437-450

CEL     1982420     16              SegmentByte: End_SegmentLoop
CEL     1982421     0             PolygonByte: End_PolygonList          (Glaenoe)
CEL     1982422     1             PolygonByte: Begin_Polygon_CCW        (Sejeroe)
CEL     1982423     12823           Polygon ID
CEL     1982427     31              SegmentByte: Rim Segment
CEL     1982428     9898905           Segment Address
CEL     1982432     13                Segment Length

RIM     9898905     11080750          Longitude Vertex 451
RIM     9898909     55914167          Latitude  Vertex 451
RIM     ...                         12 more Vertices 452-463

CEL     1982436     16              SegmentByte: End_SegmentLoop
CEL     1982437     0             PolygonByte: End_PolygonList          (Sejeroe)
CEL     1982438     1             PolygonByte: Begin_Polygon_CCW        (Enoe)
CEL     1982439     14573           Polygon ID
CEL     1982443     31              SegmentByte: Rim Segment
CEL     1982444     10137129          Segment Address
CEL     1982448     12                Segment Length

RIM     10137129    11645833          Longitude Vertex 464
RIM     10137133    55173306          Latitude  Vertex 464
RIM     ...                         11 more Vertices 465-475

CEL     1982452     16              SegmentByte: End_SegmentLoop
CEL     1982453     0             PolygonByte: End_PolygonList          (Enoe)
```

```
CEL     1982454    1              PolygonByte: Begin_Polygon_CCW        (Omoe)
CEL     1982455    15216            Polygon ID
CEL     1982459    31               SegmentByte: Rim Segment
CEL     1982460    10222005           Segment Address
CEL     1982464    12                 Segment Length

RIM     10222005   11132444           Longitude Vertex 476
RIM     10222009   55160833           Latitude  Vertex 476
RIM     ...                           11 more Vertices 477-487

CEL     1982468    16               SegmentByte: End_SegmentLoop
CEL     1982469    0              PolygonByte: End_PolygonList          (Omoe)
CEL     1982470    1              PolygonByte: Begin_Polygon_CCW        (Nekseloe)
CEL     1982471    20118            Polygon ID
CEL     1982475    31               SegmentByte: Rim Segment
CEL     1982476    10804365           Segment Address
CEL     1982480    9                  Segment Length

RIM     10804365   11280833           Longitude Vertex 488
RIM     10804369   55789167           Latitude  Vertex 489
RIM     ...                           8 more Vertices 490-497

CEL     1982484    16               SegmentByte: End_SegmentLoop
CEL     1982485    0              PolygonByte: End_PolygonList          (Nekseloe)
CEL     1982486    1              PolygonByte: Begin_Polygon_CCW        (Dybsoe)
CEL     1982487    20174            Polygon ID
CEL     1982491    31               SegmentByte: Rim Segment
CEL     1982492    10810413           Segment Address
CEL     1982496    9                  Segment Length

RIM     10810413   11707417           Longitude Vertex 498
RIM     10810417   55137472           Latitude  Vertex 498
RIM     ...                           8 more Vertices 499-506

CEL     1982500    16               SegmentByte: End_SegmentLoop
CEL     1982501    0              PolygonByte: End_PolygonList          (Dybsoe)
CEL     1982502    1              PolygonByte: Begin_Polygon_CCW        (Musholm)
CEL     1982503    34539            Polygon ID
CEL     1982507    31               SegmentByte: Rim Segment
CEL     1982508    12196497           Segment Address
CEL     1982512    6                  Segment Length

RIM     12196497   11070806           Longitude Vertex 507
RIM     12196501   55475000           Latitude  Vertex 507
RIM     ...                           5 more Vertices 508-512

CEL     1982516    16               SegmentByte: End_SegmentLoop
CEL     1982517    0              PolygonByte: End_PolygonList          (Musholm)
CEL     1982518    1              PolygonByte: Begin_Polygon_CCW        (Vejroe)
CEL     1982519    34915            Polygon ID
CEL     1982523    31               SegmentByte: Rim Segment
CEL     1982524    12228081           Segment Address
CEL     1982528    6                  Segment Length

RIM     12228081   11342417           Longitude Vertex 513
RIM     12228085   55025000           Latitude  Vertex 513
RIM ...                               5 more Vertices 514-518

CEL     1982532    16               SegmentByte: End_SegmentLoop
CEL     1982533    0              PolygonByte: End_PolygonList          (Vejroe)
CEL     1982534    1              PolygonByte: Begin_Polygon_CCW        (Egholm)
CEL     1982535    39573            Polygon ID
CEL     1982539    31               SegmentByte: Rim Segment
CEL     1982540    12619353           Segment Address
CEL     1982544    6                  Segment Length

RIM     12619353   11169111           Longitude Vertex 519
RIM     12619357   55246639           Latitude  Vertex 519
RIM     ...                           5 more Vertices 520-524

CEL     1982548    16               SegmentByte: End_SegmentLoop
CEL     1982549    0              PolygonByte: End_PolygonList          (Egholm)
CEL     1982550    1              PolygonByte: Begin_Polygon_CCW        (Gavnoe)
CEL     1982551    41902            Polygon ID
CEL     1982555    31               SegmentByte: Rim Segment
CEL     1982556    12814989           Segment Address
CEL     1982560    6                  Segment Length

RIM     12814989   11674111           Longitude Vertex 525
RIM     12814993   55189167           Latitude  Vertex 525
RIM     ...                           5 more Vertices 526-530

CEL     1982564    16               SegmentByte: End_SegmentLoop
```

```
CEL    1982565    0             PolygonByte: End_PolygonList          (Gavnoe)
CEL    1982566    1             PolygonByte: Begin_Polygon_CCW
CEL    1982567    51640           Polygon ID
CEL    1982571    31              SegmentByte: Rim Segment
CEL    1982572    13615357          Segment Address
CEL    1982576    5                 Segment Length

RIM    13615357   11812528          Longitude Vertex 531
RIM    13615361   55736639          Latitude  Vertex 531
RIM    ...                         4 more Vertices 532-535

CEL    1982580    16              SegmentByte: End_SegmentLoop
CEL    1982581    0             PolygonByte: End_PolygonList
CEL    1982582    1             PolygonByte: Begin_Polygon_CCW
CEL    1982583    51769           Polygon ID
CEL    1982587    31              SegmentByte: Rim Segment
CEL    1982588    13625161          Segment Address
CEL    1982592    5                 Segment Length

RIM    13625161   11354111          Longitude Vertex 536
RIM    13625165   55188306          Latitude  Vertex 536
RIM    ...                         4 more Vertices 537-540

CEL    1982596    16              SegmentByte: End_SegmentLoop
CEL    1982597    0             PolygonByte: End_PolygonList
CEL    1982598    1             PolygonByte: Begin_Polygon_CCW
CEL    1982599    72140           Polygon ID
CEL    1982603    31              SegmentByte: Rim Segment
CEL    1982604    15173357          Segment Address
CEL    1982608    5                 Segment Length

RIM    15173357   11399139          Longitude Vertex 541
RIM    15173361   55200778          Latitude  Vertex 541
RIM    ...                         4 more Vertices 542-545

CEL    1982612    16              SegmentByte: End_SegmentLoop
CEL    1982613    0             PolygonByte: End_PolygonList
CEL    1982614    1             PolygonByte: Begin_Polygon_CCW
CEL    1982615    72475           Polygon ID
CEL    1982619    31              SegmentByte: Rim Segment
CEL    1982620    15198817          Segment Address
CEL    1982624    5                 Segment Length

RIM    15198817   11800778          Longitude Vertex 546
RIM    15198821   55744944          Latitude  Vertex 546
RIM    ...                         4 more Vertices 547-550

CEL    1982628    16              SegmentByte: End_SegmentLoop
CEL    1982629    0             PolygonByte: End_PolygonList
CEL    1982630    1             PolygonByte: Begin_Polygon_CCW
CEL    1982631    86419           Polygon ID
CEL    1982635    31              SegmentByte: Rim Segment
CEL    1982636    16211577          Segment Address
CEL    1982640    4                 Segment Length

RIM    16211577   11452444          Longitude Vertex 551
RIM    16211581   55202472          Latitude  Vertex 551
RIM    ...                         3 more Vertices 552-554

CEL    1982644    16              SegmentByte: End_SegmentLoop
CEL    1982645    0             PolygonByte: End_PolygonList
CEL    1982646    1             PolygonByte: Begin_Polygon_CCW
CEL    1982647    92613           Polygon ID
CEL    1982651    31              SegmentByte: Rim Segment
CEL    1982652    16632769          Segment Address
CEL    1982656    4                 Segment Length

RIM    16632769   11780778          Longitude Vertex 555
RIM    16632773   55759972          Latitude  Vertex 555
RIM    ...                         3 more Vertices 556-558

CEL    1982660    16              SegmentByte: End_SegmentLoop
CEL    1982661    0             PolygonByte: End_PolygonList
CEL    1982662    1             PolygonByte: Begin_Polygon_CCW
CEL    1982663    92614           Polygon ID
CEL    1982667    31              SegmentByte: Rim Segment
CEL    1982668    16632837          Segment Address
CEL    1982672    4                 Segment Length

RIM    16632837   11785833          Longitude Vertex 559
RIM    16632841   55665833          Latitude  Vertex 559
RIM ...                           3 more Vertices 560-562
```

```
CEL     1982676    16              SegmentByte: End_SegmentLoop
CEL     1982677    0             PolygonByte: End_PolygonList
CEL     1982678    2             PolygonByte: Begin_Polygon_CW
CEL     1982679    93556           Polygon ID
CEL     1982683    31              SegmentByte: Rim Segment
CEL     1982684    16696893          Segment Address
CEL     1982688    4                 Segment Length

RIM     16696893   11892444          Longitude Vertex 563
RIM     16696897   55914139          Latitude  Vertex 563
RIM     ...                          3 more Vertices 564-566

CEL     1982692    16              SegmentByte: End_SegmentLoop
CEL     1982693    0             PolygonByte: End_PolygonList
CEL     1982694    1             PolygonByte: Begin_Polygon_CCW
CEL     1982695    102493          Polygon ID
CEL     1982699    31              SegmentByte: Rim Segment
CEL     1982700    17304609          Segment Address
CEL     1982704    4                 Segment Length

RIM     17304609   11834139          Longitude Vertex 567
RIM     17304613   55743333          Latitude  Vertex 567
RIM     ...                          3 more Vertices 568-570

CEL     1982708    16              SegmentByte: End_SegmentLoop
CEL     1982709    0             PolygonByte: End_PolygonList
CEL     1982710    1             PolygonByte: Begin_Polygon_CCW
CEL     1982711    103120          Polygon ID
CEL     1982715    31              SegmentByte: Rim Segment
CEL     1982716    17347245          Segment Address
CEL     1982720    4                 Segment Length

RIM     17347245   11965778          Longitude Vertex 571
RIM     17347249   55685833          Latitude  Vertex 571
RIM     ...                          3 more Vertices 572-574

CEL     1982724    16              SegmentByte: End_SegmentLoop
CEL     1982725    0             PolygonByte: End_PolygonList
CEL     1982726    2             PolygonByte: Begin_Polygon_CW
CEL     1982727    105295        Polygon ID
CEL     1982731    31              SegmentByte: Rim Segment
CEL     1982732    17495145          Segment Address
CEL     1982736    4                 Segment Length

RIM     17495145   11984194          Longitude Vertex 575
RIM     17495149   55696611          Latitude  Vertex 575
RIM     ...                          3 more Vertices 576-578

CEL     1982740    16              SegmentByte: End_SegmentLoop
CEL     1982741    0             PolygonByte: End_PolygonList
CEL     1982742    1             PolygonByte: Begin_Polygon_CCW
CEL     1982743    105320          Polygon ID
CEL     1982747    31              SegmentByte: Rim Segment
CEL     1982748    17496845          Segment Address
CEL     1982752    4                 Segment Length

RIM     17496845   11660833          Longitude Vertex 579
RIM     17496849   55178333          Latitude  Vertex 579
RIM     ...                          3 more Vertices 580-582

CEL     1982756    16              SegmentByte: End_SegmentLoop
CEL     1982757    0             PolygonByte: End_PolygonList
CEL     1982758    2             PolygonByte: Begin_Polygon_CW
CEL     1982759    115789          Polygon ID
CEL     1982763    31              SegmentByte: Rim Segment
CEL     1982764    18208737          Segment Address
CEL     1982768    4                 Segment Length

RIM     18208737   11722444          Longitude Vertex 583
RIM     18208741   55151639          Latitude  Vertex 583
RIM     ...                          3 more Vertices 584-586

CEL     1982772    16              SegmentByte: End_SegmentLoop
CEL     1982773    0             PolygonByte: End_PolygonList
CEL     1982774    1             PolygonByte: Begin_Polygon_CCW
CEL     1982775    115840          Polygon ID
CEL     1982779    31              SegmentByte: Rim Segment
CEL     1982780    18212205          Segment Address
CEL     1982784    4                 Segment Length

RIM     18212205   11435833          Longitude Vertex 587
RIM     18212209   55213361          Latitude  Vertex 587
RIM     ...                          3 more Vertices 588-590
```

```
CEL     1982788    16               SegmentByte: End_SegmentLoop
CEL     1982789    0              PolygonByte: End_PolygonList
CEL     1982790    2              PolygonByte: Begin_Polygon_CW
CEL     1982791    115906           Polygon ID
CEL     1982795    31               SegmentByte: Rim Segment
CEL     1982796    18216693           Segment Address
CEL     1982800    4                  Segment Length

RIM     18216693   11274083           Longitude Vertex 591
RIM     18216697   55239139           Latitude  Vertex 591
RIM     ...                           3 more Vertices 592-594

CEL     1982804    16               SegmentByte: End_SegmentLoop
CEL     1982805    0              PolygonByte: End_PolygonList
CEL     1982806    2              PolygonByte: Begin_Polygon_CW
CEL     1982807    134013           Polygon ID
CEL     1982811    31               SegmentByte: Rim Segment
CEL     1982812    19447969           Segment Address
CEL     1982816    4                  Segment Length

RIM     19447969   11957389           Longitude Vertex 595
RIM     19447973   55685806           Latitude  Vertex 595
RIM     ...                           3 more Vertices 595-598

CEL     1982820    16               SegmentByte: End_SegmentLoop
CEL     1982821    0              PolygonByte: End_PolygonList
CEL     1982822    1              PolygonByte: Begin_Polygon_CCW
CEL     1982823    134015           Polygon ID
CEL     1982827    31               SegmentByte: Rim Segment
CEL     1982828    19448105           Segment Address
CEL     1982832    4                  Segment Length

RIM     19448105   11085806           Longitude Vertex 599
RIM     19448109   55484944           Latitude  Vertex 599
RIM     ...                           3 more Vertices 600-602

CEL     1982836    16               SegmentByte: End_SegmentLoop
CEL     1982837    0              PolygonByte: End_PolygonList
CEL     1982838    0            PolygonByte: End_PolygonList (Cell Square)
```