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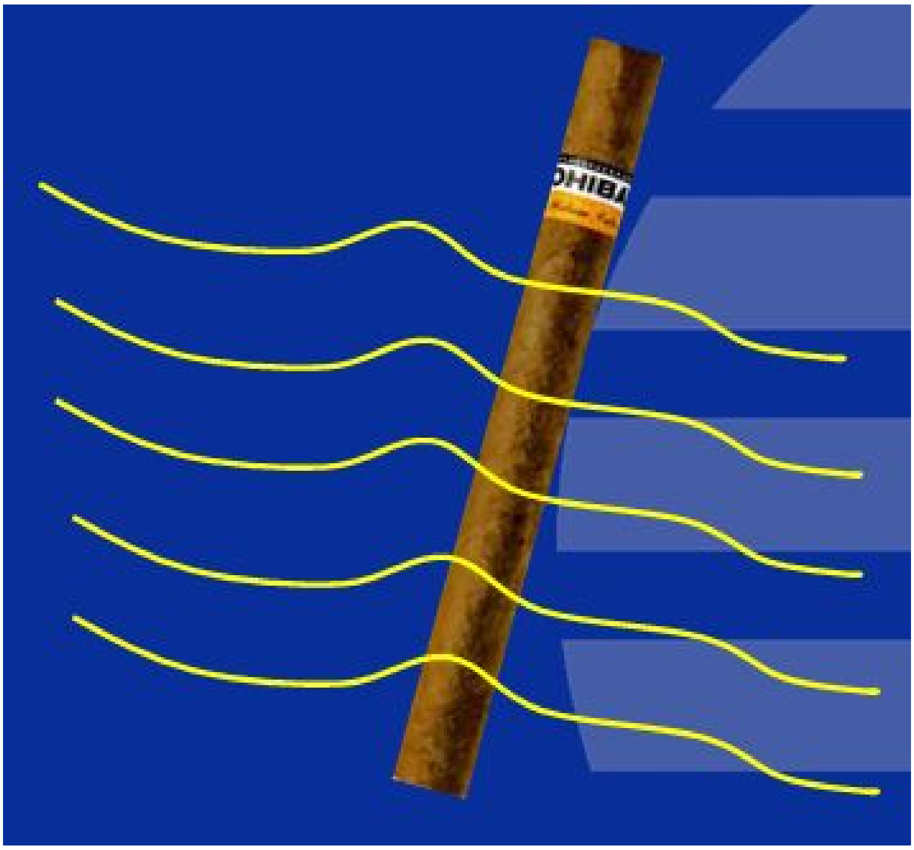
Note

COHIBA user manual version 1.0



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Norwegian Computing Center

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Contents

Abstract

This document describes all the functionality within the COHIBA depth conversion software. All required input and all optional input parameters are described with default values where appropriate. This document is produced in two identical versions; one text-based version, and one interactively web-based version in html-format.

This user manual first describes how to start and set up a COHIBA project. The following section lists, and in a brief manner describes, all possible model file parameters. Finally, the output of the COHIBA result files are described and discussed.

Keywords	kriging, depth conversion
Target group	
Availability	
Project	
Project number	
Research field	
Number of pages	36

1 Introduction

Consider the general problem of mapping the depth to subsurfaces separating different zones within a petroleum reservoir. The top and base of the reservoir are often visible on seismic lines so geophysicists can provide detailed depth maps from interpreted travel-time maps using seismic depth conversion. The internal subsurfaces separating different zones will only occasionally exhibit reliable seismic reflections, so geologists try to map the thickness of each reservoir zone based on bore-hole observations and an understanding of the depositional processes. These thickness maps are less detailed than the depth maps based on seismic data. The total mapped thickness of the internal reservoir zones will generally not add up to the thickness depicted in the detailed depth maps for the top and base of the reservoir. This ambiguity must be resolved to provide the final depth maps describing the depth to the internal subsurfaces. The specific problem considered here is to merge the detailed depth maps provided by the geophysicists with the cruder zone thickness maps provided by the geologists.

We build a model using a combination of zone thickness maps and depth maps based on seismic data. The result is one stochastic model and one associated predictor for each subsurface. The large scale geometry of petroleum reservoirs is deffined by subsurfaces separating mainly homogeneous geological layers. A stochastic model for the depth to the subsurfaces is constructed by specifying stochastic models for the thickness of intervals between the subsurfaces.

2 Getting started

A COHIBA project consists of a model file and a set of input surfaces and well data. We start by running a very simple example, with constant surfaces and one well point. We follow the steps:

1. Create a directory `test` and copy `cohiba.exe` into this directory.
2. Create a file `model_file.xml` using the following XML model file:

```
<cohiba version="1.0">
  <project-settings>
    <messages>
      <screen>
        <detail-level>
          <overall> 5 </overall>
        </detail-level>
      </screen>
    </messages>
    <output-grid format="irapclassic">
      <xstart> 448300.0  </xstart>
      <xend>   449300.0  </xend>
      <ystart> 6736000.0 </ystart>
      <yend>   6739000.0 </yend>
      <nx>     30        </nx>
      <ny>     40        </ny>
    </output-grid>
  </project-settings>
  <modelling-settings>
    <mode>           prediction </mode>
    <kriging-method> bayesian   </kriging-method>
  </modelling-settings>
  <welldata>
    <surface-points>
      <files format="cohiba"> wellpoints.coh </files>
    </surface-points>
  </welldata>
  <surfaces>
    <!--Surfaces must be listed in stratigraphic order -->
    <surface>
      <name>                         top    </name>
      <travel-time>
        <value format="constant">     1.2    </value>
        <variogram>
          <range>                     300    </range>
          <stddev format="constant">  0.01   </stddev>
        </variogram>
      </travel-time>
      <output>
<depth>  yes  </depth>
      </output>
```

```
    </surface>
  </surfaces>
  <interval-models>
    <interval>
      <name>          MSL-to-top    </name>
      <top>           MSL           </top>
      <base>          top           </base>
      <interval-type> velocity      </interval-type>
      <trend>
        <coefficient-mean>        1         </coefficient-mean>
        <coefficient-stddev>      0.1     </coefficient-stddev>
        <value format="constant"> 1000      </value>
      </trend>
      <variogram>
         <range>                         500       </range>
         <stddev format="constant">        5       </stddev>
      </variogram>
    </interval>
  </interval-models>
</cohiba>
```

3. Create a file `wellpoints.coh` with the following content:

```
top well 448800 6737500 1220 0.0
```

4. From the prompt line type: `cohiba.exe model_file.xml`

According to this model file, COHIBA was asked to run a bayesian predition on the surface `top`. Three directories are created under `test`: logfiles, surfaces and welldata. The ASCII IRAP CLASSIC trend surface `dt_top.irap` and depth surface `d_top.irap` are written in the directory `surfaces`. Logfiles are written under `logfiles` and `welldata` contains IRAP RMS wellpoint files.

Almost at the end of the screen output, the following table is displayed:

Interval	Parameter	PriorMean	PostMean	PriorStd	PostStd
MSL-to-top	1	1.0000	1.0165	0.1000	0.0097

This table shows prior and posterior mean and standard deviations.

3 The model file

The input model file is a text file in XML (Extensible Markup Language) format . The basic XML syntax for one element is:

```
<name attribute="attribute value">
 content
</name>
```

Figure 1. XML notepad editor: main menu

where the attribute is omitted in many cases. The `content` will typically contain data or further elements in a nested structure. The COHIBA model file is divided into 5 major sections with corresponding elements:

<project-settings>
<modelling-settings>
<welldata>
<surfaces>
<interval-models>

The sequence of the key words within a hierarchy is arbitrary but it is recommended to stick to the suggested pattern to avoid confusion. Here follows an example of the skeleton of a COHIBA model file:

```
  <cohiba version="1.0">
   <project-settings>
     ......
   </project-settings>
   <modelling-settings>
     ......
   </modelling-settings>
   <welldata>
     ......
   </welldata>
   <surfaces>
      <!--Surfaces must be listed in stratigraphic order -->
      <reference>
        ......
      </reference>
      <surface>
        ......
      </surface>
      <surface>
        ......
      </surface>
   </surfaces>
   <interval-models>
      <interval>
         .....
      </interval>
      <interval>
        ......
      </interval>
   </interval-models>
</cohiba>
```

An example of a COHIBA model file is given in Model File example. It is possible to visualize the content of this file using a so-called XML editor. The "Microsoft XML NotePad 2007" editor may be freely downloaded from: http://msdn2.microsoft.com/en-us/xml/default.aspx.

A detailed description of each of these main elements and their sub-elements is provided below. An element followed by a * means that it is optional, i.e., default values will be assigned in case the keyword is ommitted.

4 COHIBA model file reference

`<cohiba>`

Description: Wrapper for all other elements of the COHIBA model file..
Value: The five main elements in the model file.
Default: No default.

4.1 `<project-settings>`

4.1.1 `<project-title>`

Description: A COHIBA project title.
Value: String.
Default: empty string.

4.1.2 `<project-description>`

Description: Detailed description of the project.
Value: String.
Default: Empty string.

4.1.3 seeds

4.1.4 `<seed>`

Description: Sets the seed for random number simulations. It is also possible to set the seed with the option -s, for example: cohiba.exe -s 123 modelfile.xml
Value: Integer.
Default: 0

4.1.5 `<project-directory>`

Description: A relative or absolute path to a COHIBA project. For example, suppose that the project directory is `my-cohiba-project/` in the directory `projects` (`my-cohiba-project/` is relative to `projects`), and the COHIBA executable is located in `path/to/bin/cohiba.exe` . Then then the project is executed from the directory `projects` with the command line: `path/to/bin/cohiba.exe my-cohiba-project/model file.xml` .
Value: A valid path to a directory.
Default: Current directory (. in Linux).

4.1.6 `<input-directory>`

Description: Relative or absolute path to all COHIBA input. The relative path is relative to the project directory. For example, if input directory is `my-input/` , then COHIBA assumes that there is an input directory `projects/my-cohiba-project/my-input` .
Value: A valid path to a directory
Default: The project directory.

4.1.7 <output-directory>

Description: Relative or absolute path to the COHIBA output. The output consists of 3 directories: logfiles, surfaces and welldata. A more detailed description of the output is given in the section The COHIBA output.
Value: A valid path to a directory.
Default: The project directory.

4.1.8 <filename-tags>

The attribute **type** may take two values: prefix or suffix. For example, a depth surface called TopA with a prefix d will be assigned the name d_TopA.irap. Note that the underscore _ is always added to the name.

4.1.8.1 <depth>

Description: A tag describing the output depth.
Value: String.
Default: d

4.1.8.2 <depth-trend>

Description: A tag describing the output depth trend.
Value: String.
Default: dt

4.1.8.3 <depth-error>

Description: A tag describing the output depth error.
Value: String.
Default: de

4.1.8.4 <depth-trend-error>

Description: A tag describing the output depth trend error.
Value: String.
Default: dte

4.1.8.5 <depth-residual>

Description: A tag describing the output depth residual.
Value: String.
Default: dr

4.1.8.6 <thickness>

Description: A tag describing the interval thickness.
Value: String.
Default: t

4.1.8.7 <thickness-trend>

Description: A tag describing the interval thickness trend.
Value: String.
Default: tt

4.1.8.8 `<velocity>`

Description: A tag describing the interval velocity.
Value: String.
Default: v

4.1.9 `<messages>`

Level of output information to file in the logfiles directory, under the output-directory and monitor. The following are supported:

Table 1. **Logging levels in COHIBA. The output information accumulate so that level 3 includes everything reported on level 1 and 2.**

Number	Description
0	No messages reported.
1	Errors reported.
2	Warnings reported.
3	Information messages reported. (Default)
4	Detailed information reported.
5	Very detailed information reported (mainly for debugging purposes).

4.1.9.1 `<logfile>`

4.1.9.1.1 `<name>`

Description: A string describing the name of the logfile.
Value: String.
Default: cohiba.log

4.1.9.1.2 `<detail-level>`

`<overall>`
Description: Level of detail in output to logfile. This level can be overruled within each output section mentioned below.
Value: 0 – 5
Default: 3

`<model-settings>`
Description: Level of detail in model settings output.
Value: 0 – 5
Default: 3

`<data-loading>`
Description: Level of detail in data loading. For example, time grids, velocity grids, wellpick files, etc.
Value: 0 – 5
Default: 3

`<wellpoints>`
Description: Level of detail in reading wellpoints, translating, etc.
Value: 0 – 5
Default: 3

`<wellpaths>`
Description: Level of detail in reading wellpaths, translating, etc.

Value: 0 – 5
Default: 3

`<trend-parameters>`
Description: Level of detail in reading trend parameters.
Value: 0 – 5
Default: 3

`<outliers>`
Description: Level of detail in processing outliers.
Value: 0 – 5
Default: 3

`<wellpoint-conditioning>`
Description: Level of detail in kriging with wellpoints (exact data).
Value: 0 – 5
Default: 3

`wellpath-conditioning`
Description: Level of detail in kriging along wellpaths (additional surface constraints).
Value: 0 – 5
Default: 3

`post-processing`
Description: Level of detail in postprocessing. The postprocessing handles erosion and pinch outs.
Value: 0 – 5
Default: 3

4.1.9.2 `<screen>`

4.1.9.2.1 `<detail-level>`

`<overall>`
Description: Level of detail in output to screen. This level can be overruled within each output sections described in logfile.
Value: 0 – 5
Default: 3

4.1.10 `<measurement-units>`

Units of the input grids.

Table 2. Supported input units in COHIBA

Unit	**Description**
m	Meter
in	Inch
ft	Foot
s	Second
ms	Millisecond
m/s	Meters per Second
in/s	Inches per Second
ft/s	Feet per Second

4.1.10.1 `<depth>`

Description: Unit of depth.
Value: m, in, ft.
Default: m

4.1.10.2 `<time-unit>`

Description: Unit of time.
Value: s, ms.
Default: s

4.1.10.3 `<velocity-unit>`

Description: Unit of velocity.
Value: m/s, in/s, ft/s.
Default: m/s

4.1.10.4 `<angle-unit>`

Description: Unit of angle.
Value: deg, rad.
Default: deg.

4.1.10.5 `<two-way-time>`

Description: A flag controlling whether the input time grids are given in two-way times or not.
Value: `yes/no`
Default: `no`

4.1.11 `<output-grid>`

Description: Grid dimensions for the lateral output grid. The input grids must share these dimensions. The following grid consistency equations must be satisfied:

$$x_{end} = x_{start} + x_{inc} \times (n_x - 1)$$

$$y_{end} = y_{start} + y_{inc} \times (n_y - 1)$$

Value: The attribute format is either of storm or irap-classic. The arguments are xstart, ystart, xend, yend, xinc, yinc, nx, ny.
Default: no default.

4.1.11.1 `<xstart>`

Description: Minimum X value.
Value: Real.
Default: No default.

4.1.11.2 `<xend>`

Description: Maximum X value.
Value: Real satisfying the consistency equations.
Default: No default.

4.1.11.3 `<ystart>`

Description: Minimum Y value.
Value: Real.
Default: No default.

4.1.11.4 `<yend>`

Description: Maximum Y value.
Value: A real satisfying the consistency equations.
Default: No default.

4.1.11.5 `<xinc>`

Description: X increment; not obligatory if nx is given.
Value: Positive real.
Default: No default.

4.1.11.6 `<yinc>`

Description: Y increment; not obligatory if ny is given.
Value: Positive real.
Default: No default.

4.1.11.7 `<nx>`

Description: Number of grid nodes in X; not obligatory if xinc is given.
Value: Positive integer.
Default: No default.

4.1.11.8 `<ny>`

Description: Number of grid nodes in Y; not obligatory if yinc is given.
Value: Positive integer.
Default: No default.

4.2 `<modelling-settings>`

4.2.1 `<mode>`

Description: The modelling mode, see (2).
Value: `prediction/simulation`
Default: `prediction`

4.2.2 `<kriging-method>`

Description: The kriging method to be used, see (2). Briefly, when conditioning to observations, `Simple Kriging` maintains the model parameters, `Bayesian Kriging` updates the parameters that are subject to some uncertainty to reflect the arrival of new information, whereas `Universal Kriging` assumes no uncertainty restriction and updates the parameters based on the observations.
Value: `simple/bayesian/universal`
Default: `bayesian`

4.2.3 `<simulate-trend-uncertainty>`

Description: Under simulation mode and simple kriging, this flag forces uncertainty in the simulated parameters.
Value: `yes/no`

Default: `no`

4.2.4 `<advanced-settings>`

4.2.4.1 `<kriging-in-segments-for-more-observations-than>`

Description: If the number of input observations is larger than this number, a kriging in segments algorithm is switched on. This algorithm runs faster and gives a good approximation.
Value: Positive integer.
Default: `100`

4.2.4.2 `<postprocess-erosive-and-onlapping-surfaces>`

Description: Overrides all input flags related to erosive and onlapped surfaces.
Value: `yes/no`
Default: `no`

4.2.4.3 `<postprocess-crossing-surfaces>`

Description: Postprocess surfaces to produce a sequence of stratigraphically correct surfaces. This algorithm does not take into account wells.
Value: `yes/no`
Default: `no`

4.2.4.4 `<condition-to-wellpaths>`

Description: Starts a kriging algorithm that attempts to correct surfaces to honor the wellpaths. The algorithm computes surfaces that define correct zones for each input wellpath.
Value: `yes/no`
Default: `no`

4.3 `<welldata>`

4.3.1 `<zone-log>`

4.3.1.1 `<logname>`

Description: Zone log identifier to be imported (A well file may contain several identifiers).
Value: A string.
Default: Empty string.

4.3.1.2 `<files>`

Description: The well trajectory files to be imported. This keyword maybe repeated in order to import different files in different locations.
Value: For attribute set: format="rms", see (1). For content any valid path relative to input directory. Wildcards are also supported, for example /path/to/mywells/*
Default: Empty string.

4.3.2 `<surface-points>`

4.3.2.1 `<files>`

Description: The wellpick files to be imported. This keyword maybe repeated in order to import different files in different locations.
Value: For attribute set: format="cohiba", see The COHIBA wellpick format. For content any valid path relative to input directory. Wildcards are also supported, for example /path/to/mywellpicks/*
Default: Empty string.

4.3.3 <ignore-points>

4.3.3.1 <files>

Description: The well-points that should be excluded if found in the zone logs.
Value: For attribute set: format="cohiba", see The COHIBA wellpick format. For content any valid path relative to input directory. Wildcards are also supported, for example /path/to/ignorepoints/*
Default: Empty string.

4.4 <surfaces>

A list of surfaces in stratigraphical order. The input grid must be the same as the output grid specified in output-grid. A valid model must contain at least one surface different from the reference surface and one interval. Each surface is defined as follows.

4.4.1 <reference>

A reference surface. This is typically MSL.

4.4.1.1 <name>

Description: A reference surface name.
Value: String.
Default: MSL

4.4.1.2 <depth>

The attribute format may take either of constant, storm or irap-classic.

Description: A reference surface name.
Value: A float number in case of constant format or a grid with floats in the given format.
Default: 0

4.4.2 <surface>

The surfaces must be defined in a common rectangular grid $[x_{start}, x_{end}] \times [y_{start}, y_{end}]$. The input grid must be the same as the output grid specified in output-grid. This entry may be repeated.

4.4.2.1 <name>

Description: A surface name. All output concerning this surface will use this name.
Value: String.
Default: Empty string.

4.4.2.2 <erosive>

Description: A flag controlling whether this surface is going to erode the surfaces below. To override this flag for all surfaces use postprocess-erosive-and-onlapping-surfaces.
Value: `yes/no`
Default: `no`.

4.4.2.3 <onlapped>

Description: A flag controlling whether this surface is going to onlapp the surfaces above. The erosion rules are carried out before the onlapping rules. To override this flag for all surfaces use postprocess-erosive-and-onlapping-surfaces.
Value: `yes/no`
Default: `no`.

4.4.2.4 `<top-of-zone>`

Description: This defines a remapping of the zone log in case the zone log contains more zones that the zones defined by the surfaces. If zone numbers increase with increasing depth, it is sufficient to take the first zone after *this surface*. For details see (3).
Value: A sequence of strings, for example A' B' C'.
Default: Empty if no zone log is specified, otherwise it is required, see zone-log.

4.4.2.5 `<travel-time>` If we specify a travel time, this surface becomes a reflector.

4.4.2.5.1 `<value>`

Description: The travel time value or grid.
Value: format: constant, storm or irap-classic, content: a path to a grid in the given format.
Default: format=constant, time = 0.

Table 3. Supported variograms in COHIBA

Variogram	**Correlation**
constant	$f(x) = 1.0$
white noise	$f(x) = 1$ if $x = 0$, 0 otherwise
exponential	$f(x) = \exp(-3x)$
gaussian	$f(x) = \exp(-3x^2)$
generalized_exponential	$f(x) = exp(-3x^p)$
spherical1	$f(x) = 1 - x$ if $x < 1$, 0 otherwise.
spherical2	$f(x) = 1 - 2(x\sqrt{1-x^2} + \arcsin(x))/\pi$ if $x < 1$, 0 otherwise
spherical	$f(x) = 1 - x(1.5 - 0.5x^2)$ if $x < 1$, 0 otherwise
spherical5	$f(x) = 1 - x(1.875 - 1.25x^2 + 0.375x^4)$ if $x < 1$, 0 otherwise
rational_quadratic	$f(x) = 1/((1.0 + scale * x^2)^p)$

4.4.2.5.2 `<variogram>`

type*
  Description: The type of variogram.
  Value: The variograms in Supported variograms in COHIBA .
  Default: `spherical`

range*
  Description: The variogram range.
  Value: A positive float.
  Default: `0`

subrange*
  Description: The variogram subrange.
  Value: A positive float.
  Default: range

azimuth*
  Description: The variogram azimuth.
  Value: A float.
  Default: `0`

stddev*
  Description: The standard deviation value or grid.
  Value: format: constant, storm or irap-classic, content: a path to a grid in the given format.

Default: format=constant, stddev = 0.

4.4.2.6 <output>

4.4.2.6.1 <depth>

Description: The output depth surface.
Value: yes/no.
Default: no.

4.4.2.6.2 <depth-trend>

Description: The output depth trend surface.
Value: yes/no.
Default: yes.

4.4.2.6.3 <depth-trend-error>

Description: The output depth trend error surface.
Value: yes/no.
Default: no.

4.4.2.6.4 <depth-residual>

Description: The output depth residual surface.
Value: yes/no.
Default: no.

Example:

```
<surface>
    <name>                     TopA              </name>
    <erosive>                  no                </erosive>
    <onlapped>                 no                </onlapped>
    <top-of-zone>              IsochoreA         </top-of-zone>
    <output>
      <depth>                  yes               </depth>
      <depth-trend>            yes               </depth-trend>
      <depth-error>            yes               </depth-error>
      <depth-trend-error>      yes               </depth-trend-error>
      <depth-residual>         yes               </depth-residual>
    </output>
    <travel-time>
      <value format="storm">   T_TopA.storm      </value>
      <variogram>
        <type>                 spherical         </type>
        <range>                1000              </range>
        <subrange>             2000              </subrange>
        <azimuth>             .3491              </azimuth>
        <stddev format="storm"> dT_TopA.storm    </stddev>
      </variogram>
    </travel-time>
  </surface>
```

4.5 <interval-models>

Give a list of intervals. Each surface is defined as follows.

4.5.1 <interval>

4.5.1.1 <name>

Description: An interval name. All output concerning this interval will use this name.
Value: String.
Default: Empty string.

4.5.1.2 <top>

Description: The top surface defining the interval top->base.
Value: A surface name that already exists. Top and base surfaces must be different.
Default: No default.

4.5.1.3 <base>

Description: The base surface defining the interval top->base.
Value: A surface name that already exists. Top and base surfaces must be different.
Default: No default.

4.5.1.4 <interval-type>

Description: The type of interval: a thickness interval uses only depth values and velocity interval that uses travel times. Velocity intervals require two reflectors to be well defined.
Value: thickness/velocity.
Default: no default.

4.5.1.5 <trend>

Description:
Value:
Default:

4.5.1.6 <output>

4.5.1.6.1 <thickness>

Description: The thickness of the interval, i.e., the difference between top and base depth surfaces.
Value: `yes`/`no`.
Default: `no`.

4.5.1.6.2 <thickness-trend>

Description: The thickness trend of the interval, i.e., the difference between the top trend and the base trend surfaces.
Value: `yes`/`no`.
Default: `no`.

4.5.1.6.3 <velocity>

Description: The output interval velocity, i.e., the interval thickness divided by the time difference.
Value: `yes`/`no`.
Default: `no`.

5 Formats

5.1 Surface formats

The following surface formats are supported:

constant Allows to easily define a constant surface with just the value.
storm The STORM BINARY format, see (1).
irap-classic The ASCII IRAP CLASSIC format, see (1).

5.2 Well formats

rms The RMS WELL format for well trajectories, see (1).
cohiba A new format for well picks. Here follows one example:

```
TopA   w1  3001.0  2275.0  1015.90   0.00
TopB   w1  3001.0  2275.0  1035.34   0.1
TopC   w1  3001.0  2275.0  1062.93   0.00
#---------------------------------------
TopA   w2   900.0  2001.0  1052.50   0.00
TopB   w2   900.0  2001.0  1072.63   0.3
TopC   w2   900.0  2001.0  1109.46   0.00
#---------------------------------------
TopA   w3  2225.0  3101.0  1085.21   0.5
TopB   w3  2225.0  3101.0  1115.44   0.00
TopC   w3  2225.0  3101.0  1143.62   0.00
```

A more detailed description is given in The COHIBA wellpick format

Table 4. The COHIBA wellpick format

Surface name	Well name	X lateral value	Y lateral value	Z depth value	Uncertainty in depth Z
string	string	float	float	float	float

6 The COHIBA `output`

COHIBA creates the directories logfiles, surfaces and welldata under the user specified output-directory:

6.1 logfiles

The following logfiles are created:

A logfile specified in logfile, with the level of details required by the user. The default name is `cohiba.log`.

`trend_estimation.log` : Prior and posterior trend parameters and goodness of trend estimation. For a detailed description of the entries in this file consult The logfile trend_estimation.log.

posterior_covariance_matrix.dat : Posterior covariance matrix $C = (C_{ij})_{i,j}$, where C_{ij} is the covariace between trend parameters i and j. The diagonal of C is the square of the posterior uncertainty **PostUncert** given in file trend_estimation.log.

welldata.log: Summary of actions taken on wellpoints. This report gives information on how well wellpoints and surfaces fit together.

cohiba.debug : This file contains matrices and vectors, only of interest to the COHIBA devel-

Table 5. The logfile trend_estimation.log

Column	Description
Interval	Interval name
TopSurface	Interval top surface
NumObs	Number of observations in top surface
BaseSurface	Interval base surface
NumObs	Number of observations in base surface
Trend	Trend parameter
PriorMean	A-priori trend parameter mean
EstimMean	
PostMean	
SimMean	
PriorUncert	
EstimUncert	
PostUncert	
UncertRed	
tPrior	
tEstim	
tPost	

opers. In order to generate this file, the COHIBA code must be compiled with the compiler flag DEBUG and DEBUGGING detail level must be selected.

6.2 surfaces

6.3 welldata

7 Model File example

```
<cohiba version="0.1" >
<project-settings>
  <project-title>
   Synthetic
   </project-title>
  <project-description>
   This example used non-constant surfaces and surfaces without UNDEFs
   </project-description>
  <seed>
   345
   </seed>
  <project-directory>            syntetic-vilje-multimodel-pred </project-directory>
  <input-directory>              input/surfaces  </input-directory>
  <output-directory>             output          </output-directory>

  <filename-tags type="prefix" >
    <depth>                     d       </depth>
    <depth-trend>               dt      </depth-trend>
    <depth-error>               de      </depth-error>
```

Table 6. The logfile welldata.log

Column	Description
Surface	The surface name
Wellname	
X-coordinate	
Y-coordinate	
Depth	
Merged	
Conflict	
AddUncert	
Pinchout	
LevPoint	
Outlier	
Deleted	
PriorTrend	
EstimTrend	
PostTrend	
TrendUncertRed	
MeasUncert	
TotMeasUncert	
Residual	
ResidualUncert	
TotUncert	
GriddingError	
h	
t	
tStud	

```
      <depth-trend-error>         dte     </depth-trend-error>
      <depth-residual>            dr      </depth-residual>
      <thickness>                 t       </thickness>
      <thickness-trend>           tt      </thickness-trend>
      <thickness-residual>        tr      </thickness-residual>
    </filename-tags>
    <messages>
      <logfile>
        <name>                    cohiba.log</name>
        <detail-level>
<overall>6</overall>
</detail-level>
      </logfile>
      <screen>
        <detail-level>
<overall>5</overall>
</detail-level>
      </screen>
    </messages>
```

```
    <measurement-units>
      <depth>                     m        </depth>
      <time-unit>                 s        </time-unit>
      <velocity-unit>             m/s      </velocity-unit>
      <angle-unit>                rad      </angle-unit>
      <two-way-time>              no       </two-way-time>
    </measurement-units>
    <output-grid format="irapclassic">
      <xstart>                    0.0      </xstart>
      <xend>                   4800.0      </xend>
      <ystart>                    0.0      </ystart>
      <yend>                   3800.0      </yend>
      <xinc>                       25      </xinc>
      <yinc>                       25      </yinc>
      <nx>                        193      </nx>
      <ny>                        153      </ny>
      <azimuth>                   0.0      </azimuth>
    </output-grid>
  </project-settings>

  <modelling-settings>
    <mode>                                  prediction </mode>
    <kriging-method>                        bayesian   </kriging-method>
    <simulate-trend-uncertainty>            no         </simulate-trend-uncertainty>
    <advanced-settings>
      <kriging-in-segments-for-more-observations-than>      200        </kriging-in-segments-for-m
    </advanced-settings>
  </modelling-settings>

  <welldata>
    <surface-points>
      <files format="cohiba" >    ../welldata/synthetic_markers.dat </files>
    </surface-points>
  </welldata>

  <surfaces>
<!--Surfaces must be listed in stratigraphic order -->
    <reference>
      <name>MSL</name>
      <depth format="constant" >  0                  </depth>
    </reference>

    <surface>
      <name>                      TopA               </name>
      <erosive>                   no                 </erosive>
      <onlapped>                  no                 </onlapped>
      <top-of-zone>               IsochoreA          </top-of-zone>
      <output>
        <depth>                   yes                </depth>
```

```
    <depth-trend>              yes                 </depth-trend>
    <depth-error>              yes                 </depth-error>
    <depth-trend-error>        yes                 </depth-trend-error>
    <depth-residual>           yes                 </depth-residual>
  </output>
  <travel-time>
    <value format="storm">     T_TopA.storm        </value>
    <variogram>
      <type>                   spherical           </type>
      <range>                  1000                </range>
      <subrange>               2000                </subrange>
      <azimuth>               .3491                </azimuth>
      <stddev format="storm"> dT_TopA.storm        </stddev>
    </variogram>
  </travel-time>
</surface>

<surface>
  <name>                       TopB                </name>
  <erosive>                    no                  </erosive>
  <onlapped>                   no                  </onlapped>
  <top-of-zone>                IsochoreB           </top-of-zone>
  <output>
    <depth>                    yes                 </depth>
    <depth-trend>              yes                 </depth-trend>
    <depth-error>              yes                 </depth-error>
    <depth-trend-error>        yes                 </depth-trend-error>
    <depth-residual>           yes                 </depth-residual>
  </output>
</surface>

<surface>
  <name>                       TopC                </name>
  <erosive>                    no                  </erosive>
  <onlapped>                   no                  </onlapped>
  <top-of-zone>                UNDEF               </top-of-zone>
  <output>
    <depth>                    yes                 </depth>
    <depth-trend>              yes                 </depth-trend>
    <depth-error>              yes                 </depth-error>
    <depth-trend-error>        yes                 </depth-trend-error>
    <depth-residual>           yes                 </depth-residual>
  </output>
  <travel-time>
    <value format="storm">     T_TopC.storm        </value>
    <variogram>
      <type>                   spherical           </type>
      <range>                  1000                </range>
      <subrange>               2000                </subrange>
```

```
      <azimuth>              .3491              </azimuth>
      <stddev format="constant"> 0.001          </stddev>
    </variogram>
  </travel-time>
 </surface>
</surfaces>

<interval-models>
 <interval>
  <name>                      MSL-to-TopA       </name>
  <top>                       MSL               </top>
  <base>                      TopA              </base>
  <interval-type>             velocity          </interval-type>
  <trend>
   <coefficient-mean>         2500              </coefficient-mean>
   <coefficient-stddev>        200              </coefficient-stddev>
   <value format="constant"> 1                  </value>
  </trend>
  <trend>
   <coefficient-mean>         25.0              </coefficient-mean>
   <coefficient-stddev>       12.5              </coefficient-stddev>
   <value format="storm"> Vcorr_Overburden.storm</value>
  </trend>
  <variogram>
   <type>                     spherical         </type>
   <range>                    1000              </range>
   <subrange>                 2000              </subrange>
   <azimuth>                 .3491              </azimuth>
   <stddev format="storm">    dV_Overburden.storm</stddev>
  </variogram>
  <output>
   <thickness>                yes                </thickness>
   <thickness-trend>          yes                </thickness-trend>
   <thickness-residual>       no                </thickness-residual>
  </output>
 </interval>

 <interval>
  <name>                      TopA-to-TopB      </name>
  <top>                       TopA              </top>
  <base>                      TopB              </base>
  <interval-type>             thickness         </interval-type>
  <trend>
   <coefficient-mean>         1                 </coefficient-mean>
   <coefficient-stddev>       0.2               </coefficient-stddev>
   <value format="storm">     S_IsochoreA.storm  </value>
  </trend>
  <variogram>
   <type>                     spherical         </type>
```

```
    <range>                    1000              </range>
    <subrange>                 2000              </subrange>
    <azimuth>                 .3491              </azimuth>
    <stddev format="storm">    dS_IsochoreA.storm </stddev>
  </variogram>
  <output>
    <thickness>                no                </thickness>
    <thickness-trend>          no                </thickness-trend>
    <thickness-residual>       no                </thickness-residual>
  </output>
</interval>

<interval>
  <name>                       TopB-to-TopC      </name>
  <top>                        TopB              </top>
  <base>                       TopC              </base>
  <interval-type>              thickness         </interval-type>
  <trend>
    <coefficient-mean>         1                 </coefficient-mean>
    <coefficient-stddev>       0.2               </coefficient-stddev>
    <value format="storm">     S_IsochoreB.storm </value>
  </trend>
  <variogram>
    <type>                     spherical         </type>
    <range>                    1000              </range>
    <subrange>                 2000              </subrange>
    <azimuth>                 .3491              </azimuth>
    <stddev format="storm">    dS_IsochoreB.storm </stddev>
  </variogram>
  <output>
    <thickness>                no                </thickness>
    <thickness-trend>          no                </thickness-trend>
    <thickness-residual>       no                </thickness-residual>
  </output>
</interval>

<interval>
  <name>                       TopA-to-TopC      </name>
  <top>                        TopA              </top>
  <base>                       TopC              </base>
  <interval-type>              velocity          </interval-type>
  <trend>
    <coefficient-mean>         1                 </coefficient-mean>
    <coefficient-stddev>       0.2               </coefficient-stddev>
    <value format="constant">  2500              </value>
  </trend>
  <variogram>
    <type>                     spherical         </type>
    <range>                    1000              </range>
```

```
        <subrange>                2000              </subrange>
        <azimuth>                .3491              </azimuth>
        <stddev format="constant"> 75              </stddev>
      </variogram>
      <output>
        <thickness>               no                </thickness>
        <thickness-trend>         no                </thickness-trend>
        <thickness-residual>      no                </thickness-residual>
      </output>
    </interval>

  </interval-models>

</cohiba>


<cohiba version="0.1" >
  <project-settings>
    <project-title>
     Synthetic
     </project-title>
    <project-description>
     This example used non-constant surfaces and surfaces without UNDEFs
     </project-description>
    <seed>
     345
     </seed>
    <project-directory>           syntetic-vilje-multimodel-pred </project-directory>
    <input-directory>             input/surfaces  </input-directory>
    <output-directory>            output          </output-directory>

    <filename-tags type="prefix" >
      <depth>                     d       </depth>
      <depth-trend>               dt      </depth-trend>
      <depth-error>               de      </depth-error>
      <depth-trend-error>         dte     </depth-trend-error>
      <depth-residual>            dr      </depth-residual>
      <thickness>                 t       </thickness>
      <thickness-trend>           tt      </thickness-trend>
      <thickness-residual>        tr      </thickness-residual>
    </filename-tags>
    <messages>
      <logfile>
        <name>                    cohiba.log</name>
        <detail-level>
<overall>6</overall>
</detail-level>
      </logfile>
      <screen>
```

```
        <detail-level>
<overall>5</overall>
</detail-level>
      </screen>
    </messages>
    <measurement-units>
      <depth>                     m        </depth>
      <time-unit>                 s        </time-unit>
      <velocity-unit>             m/s      </velocity-unit>
      <angle-unit>                rad      </angle-unit>
      <two-way-time>              no       </two-way-time>
    </measurement-units>
    <output-grid format="irapclassic">
      <xstart>                    0.0      </xstart>
      <xend>                   4800.0      </xend>
      <ystart>                    0.0      </ystart>
      <yend>                   3800.0      </yend>
      <xinc>                       25      </xinc>
      <yinc>                       25      </yinc>
      <nx>                        193      </nx>
      <ny>                        153      </ny>
      <azimuth>                   0.0      </azimuth>
    </output-grid>
  </project-settings>

  <modelling-settings>
    <mode>                                 prediction </mode>
    <kriging-method>                       bayesian   </kriging-method>
    <simulate-trend-uncertainty>           no         </simulate-trend-uncertainty>
    <advanced-settings>
      <kriging-in-segments-for-more-observations-than>      200        </kriging-in-segments-for-m
    </advanced-settings>
  </modelling-settings>

  <welldata>
    <surface-points>
      <files format="cohiba" >    ../welldata/synthetic_markers.dat </files>
    </surface-points>
  </welldata>

  <surfaces>
<!--Surfaces must be listed in stratigraphic order -->
    <reference>
      <name>MSL</name>
      <depth format="constant" >  0                  </depth>
    </reference>

    <surface>
      <name>                      TopA               </name>
```

```
  <erosive>                 no               </erosive>
  <onlapped>                no               </onlapped>
  <top-of-zone>             IsochoreA        </top-of-zone>
  <output>
    <depth>                 yes              </depth>
    <depth-trend>           yes              </depth-trend>
    <depth-error>           yes              </depth-error>
    <depth-trend-error>     yes              </depth-trend-error>
    <depth-residual>        yes              </depth-residual>
  </output>
  <travel-time>
    <value format="storm">  T_TopA.storm     </value>
    <variogram>
      <type>                spherical        </type>
      <range>               1000             </range>
      <subrange>            2000             </subrange>
      <azimuth>            .3491             </azimuth>
      <stddev format="storm"> dT_TopA.storm  </stddev>
    </variogram>
  </travel-time>
</surface>

<surface>
  <name>                    TopB             </name>
  <erosive>                 no               </erosive>
  <onlapped>                no               </onlapped>
  <top-of-zone>             IsochoreB        </top-of-zone>
  <output>
    <depth>                 yes              </depth>
    <depth-trend>           yes              </depth-trend>
    <depth-error>           yes              </depth-error>
    <depth-trend-error>     yes              </depth-trend-error>
    <depth-residual>        yes              </depth-residual>
  </output>
</surface>

<surface>
  <name>                    TopC             </name>
  <erosive>                 no               </erosive>
  <onlapped>                no               </onlapped>
  <top-of-zone>             UNDEF            </top-of-zone>
  <output>
    <depth>                 yes              </depth>
    <depth-trend>           yes              </depth-trend>
    <depth-error>           yes              </depth-error>
    <depth-trend-error>     yes              </depth-trend-error>
    <depth-residual>        yes              </depth-residual>
  </output>
  <travel-time>
```

```
      <value format="storm">    T_TopC.storm       </value>
      <variogram>
        <type>                  spherical          </type>
        <range>                 1000               </range>
        <subrange>              2000               </subrange>
        <azimuth>              .3491               </azimuth>
        <stddev format="constant"> 0.001           </stddev>
      </variogram>
    </travel-time>
  </surface>
</surfaces>

<interval-models>
  <interval>
    <name>                      MSL-to-TopA        </name>
    <top>                       MSL                </top>
    <base>                      TopA               </base>
    <interval-type>             velocity           </interval-type>
    <trend>
      <coefficient-mean>        2500               </coefficient-mean>
      <coefficient-stddev>       200               </coefficient-stddev>
      <value format="constant"> 1                  </value>
    </trend>
    <trend>
      <coefficient-mean>        25.0               </coefficient-mean>
      <coefficient-stddev>      12.5               </coefficient-stddev>
      <value format="storm"> Vcorr_Overburden.storm</value>
    </trend>
    <variogram>
      <type>                    spherical          </type>
      <range>                   1000               </range>
      <subrange>                2000               </subrange>
      <azimuth>                .3491               </azimuth>
      <stddev format="storm">   dV_Overburden.storm</stddev>
    </variogram>
    <output>
      <thickness>               yes                 </thickness>
      <thickness-trend>         yes                 </thickness-trend>
      <thickness-residual>      no                 </thickness-residual>
    </output>
  </interval>

  <interval>
    <name>                      TopA-to-TopB       </name>
    <top>                       TopA               </top>
    <base>                      TopB               </base>
    <interval-type>             thickness          </interval-type>
    <trend>
      <coefficient-mean>        1                  </coefficient-mean>
```

```
    <coefficient-stddev>     0.2                </coefficient-stddev>
    <value format="storm">   S_IsochoreA.storm  </value>
  </trend>
  <variogram>
    <type>                   spherical          </type>
    <range>                  1000               </range>
    <subrange>               2000               </subrange>
    <azimuth>               .3491               </azimuth>
    <stddev format="storm">  dS_IsochoreA.storm </stddev>
  </variogram>
  <output>
    <thickness>              no                 </thickness>
    <thickness-trend>        no                 </thickness-trend>
    <thickness-residual>     no                 </thickness-residual>
  </output>
</interval>

<interval>
  <name>                     TopB-to-TopC       </name>
  <top>                      TopB               </top>
  <base>                     TopC               </base>
  <interval-type>            thickness          </interval-type>
  <trend>
    <coefficient-mean>       1                  </coefficient-mean>
    <coefficient-stddev>     0.2                </coefficient-stddev>
    <value format="storm">   S_IsochoreB.storm  </value>
  </trend>
  <variogram>
    <type>                   spherical          </type>
    <range>                  1000               </range>
    <subrange>               2000               </subrange>
    <azimuth>               .3491               </azimuth>
    <stddev format="storm">  dS_IsochoreB.storm </stddev>
  </variogram>
  <output>
    <thickness>              no                 </thickness>
    <thickness-trend>        no                 </thickness-trend>
    <thickness-residual>     no                 </thickness-residual>
  </output>
</interval>

<interval>
  <name>                     TopA-to-TopC       </name>
  <top>                      TopA               </top>
  <base>                     TopC               </base>
  <interval-type>            velocity           </interval-type>
  <trend>
    <coefficient-mean>       1                  </coefficient-mean>
    <coefficient-stddev>     0.2                </coefficient-stddev>
```

```
      <value format="constant"> 2500                 </value>
    </trend>
    <variogram>
      <type>                   spherical          </type>
      <range>                  1000               </range>
      <subrange>               2000               </subrange>
      <azimuth>               .3491               </azimuth>
      <stddev format="constant"> 75              </stddev>
    </variogram>
    <output>
      <thickness>              no                 </thickness>
      <thickness-trend>        no                 </thickness-trend>
      <thickness-residual>     no                 </thickness-residual>
    </output>
  </interval>

</interval-models>

</cohiba>
```

References

[1] Irap RMS, 2007. User Guide. ROXAR ASA, Stavanger, Norway, http://www.roxar.com/.

[2] Formulas and notation for COHIBA, Norwegian Computing Center, Oslo, Norway, http://www.nr.no/.

[3] COHIBA specification and design document, Norwegian Computing Center, Oslo, Norway.

17, 22

Index