

Introducing the new whatif- functionality and its application modes

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November 10, 2022: Delft-FEWS International User Days – break out

Outline

- Why a new what-if functionality?
 - What is the Computational Framework ?
- How does it look and work ?
- How to configure ?
- Let's try on your config

Scenario-analysis

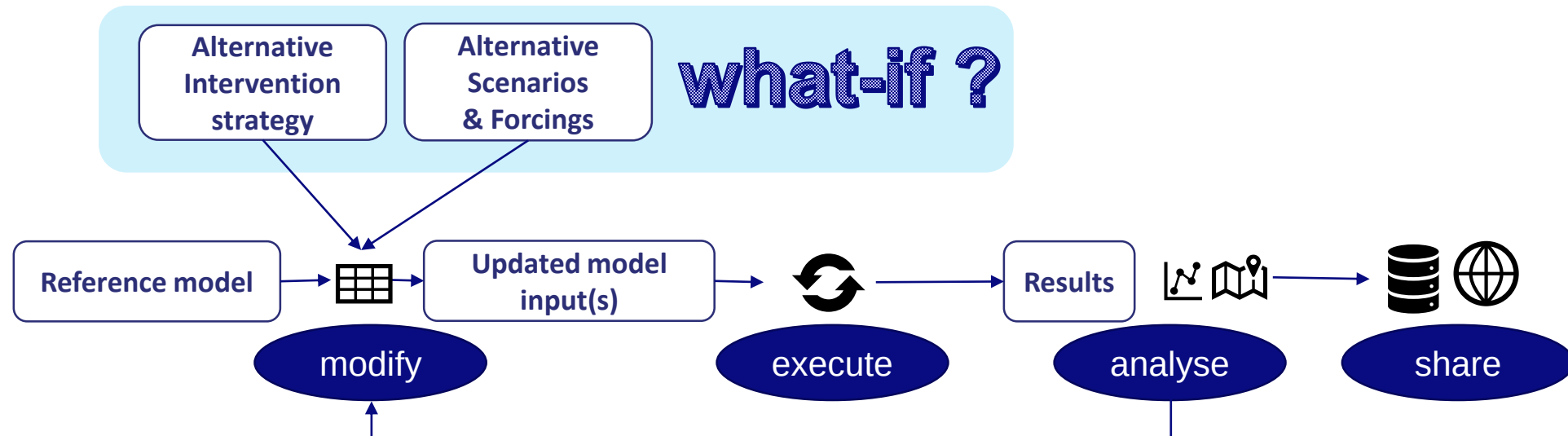


Why ?

Customers are interested in what-if scenario analysis:

- during real-time operations
- in model studies

Delft-FEWS is used for those purposes



Why ? Application characteristics:

Realtime Operations versus Model Studies

Realtime operations:

- multi-user system (OC/MC/DB/FSS)
- system time (and start time of runs) continuously updated
- automated data removal based on expiry times

Model studies:

- typically single user (Stand-alone)
- fixed system time/start time of the run
- desire for manual control over data removal
- sometimes wish to incorporate non-Fews displays



Why ?

What-if scenario

only applied when what-if **scenario** is **selected**
while dispatching a specific workflow

ability to change input data (legacy)

- typical profile timeseries
- module dataset selection
- module parameter selections/adjustments
- properties

Modifiers

always applied when modifier exists

ability to change input data

- timeseries
- location attributes
- spatial
- model parameters

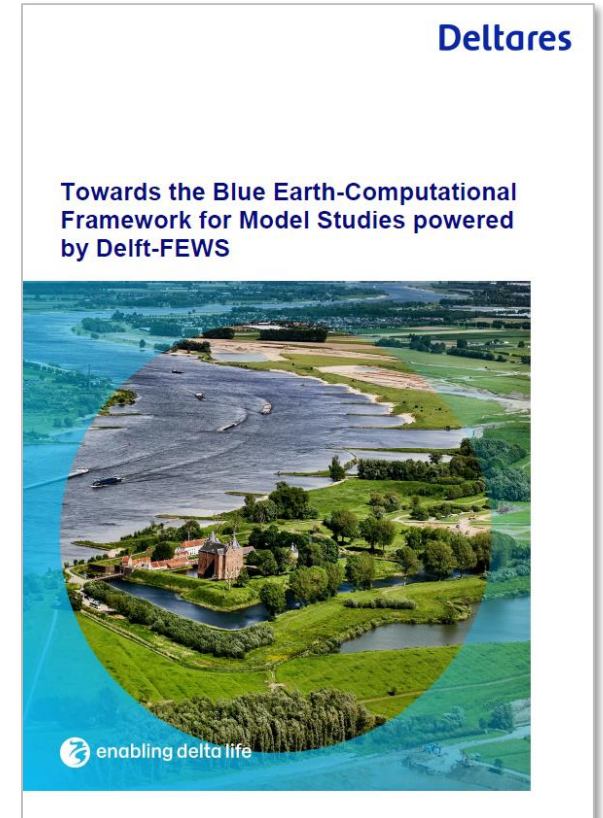
Why?

investigation study 2019

- Improvement wishes
 - Application of modifiers in what-if run only
 - What-if management and access
 - On-the-fly differences
 - Data management
- Renewal of legacy what-if functionality suites the Roadmap Code clean up

Decision

- End of 2019, Deltares decides to improve the existing Delft-FEWS capabilities to facilitate those needs.
- Introduce term 'Computational Framework' as an application mode (and architecture choice) for model studies



Computational
Framework mode

What has been achieved ?

Software enhancements implemented:

new what-if functionality

- editor allows combination of modifiers, properties, module datasets
- what-if access integrated in IFD
 - what-if editor
 - what-if visualization in TimeSeriesDisplay
 - what-if visualization in SpatialDisplay
- by default executed as non-approved runs

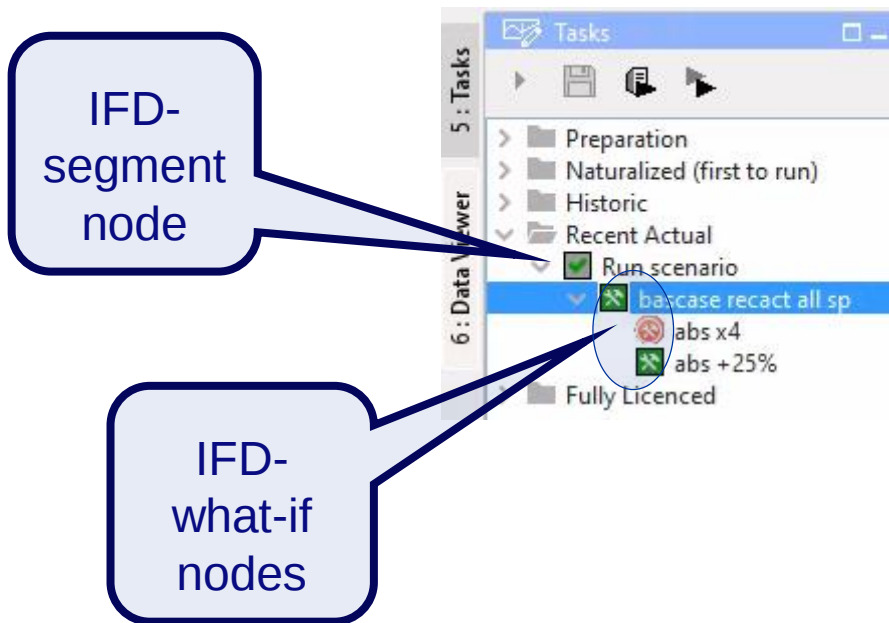
on-the-fly difference plots between selected runs:

- Spatial Display
- TimeSeriesDisplay after selecting function: difference plot

What-If access

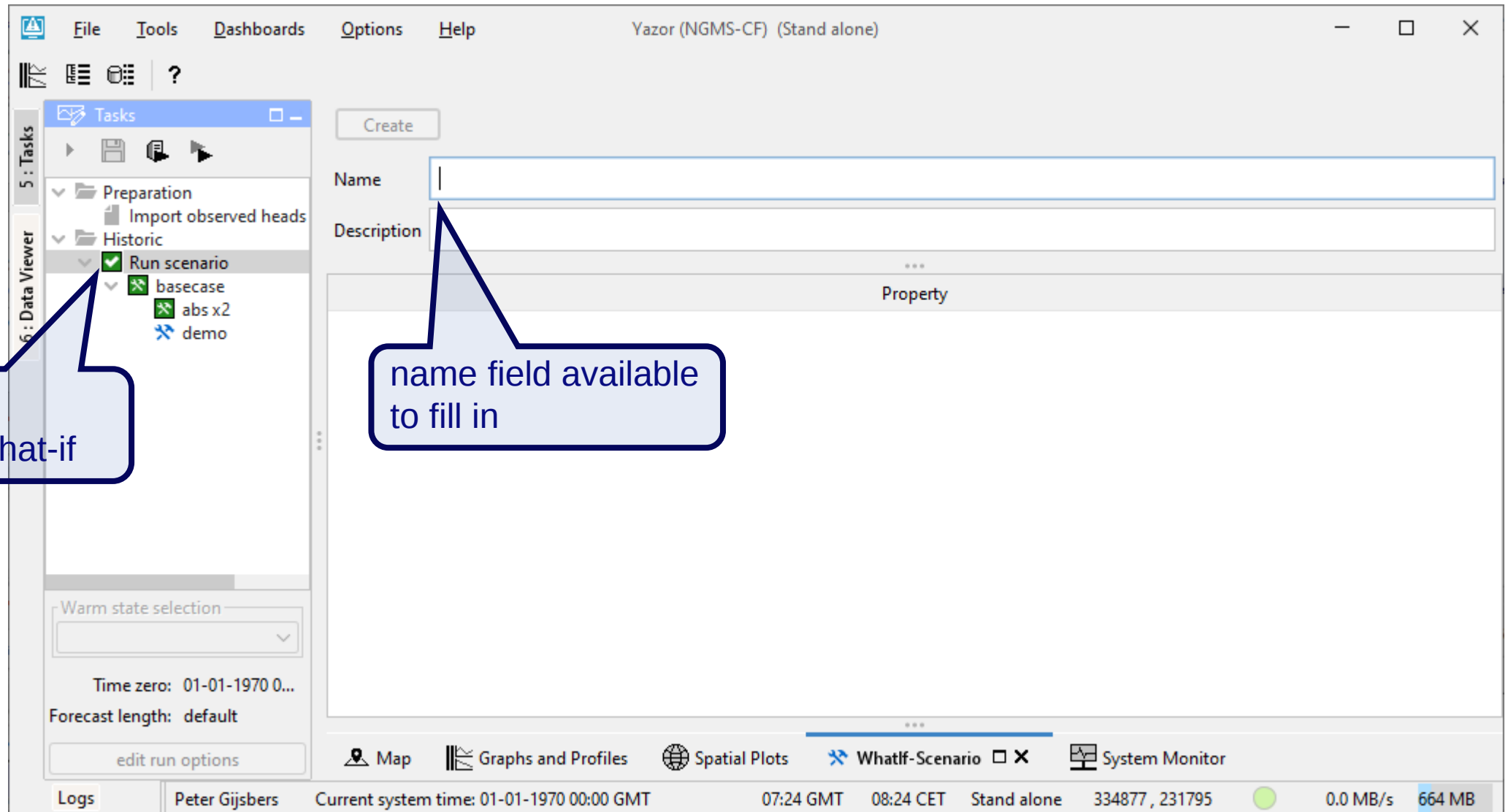
integrated in IFD

- What-if access via IFD (task/forecast tree)
 - Whatif Editor used for composition, comparing inputs, deleting

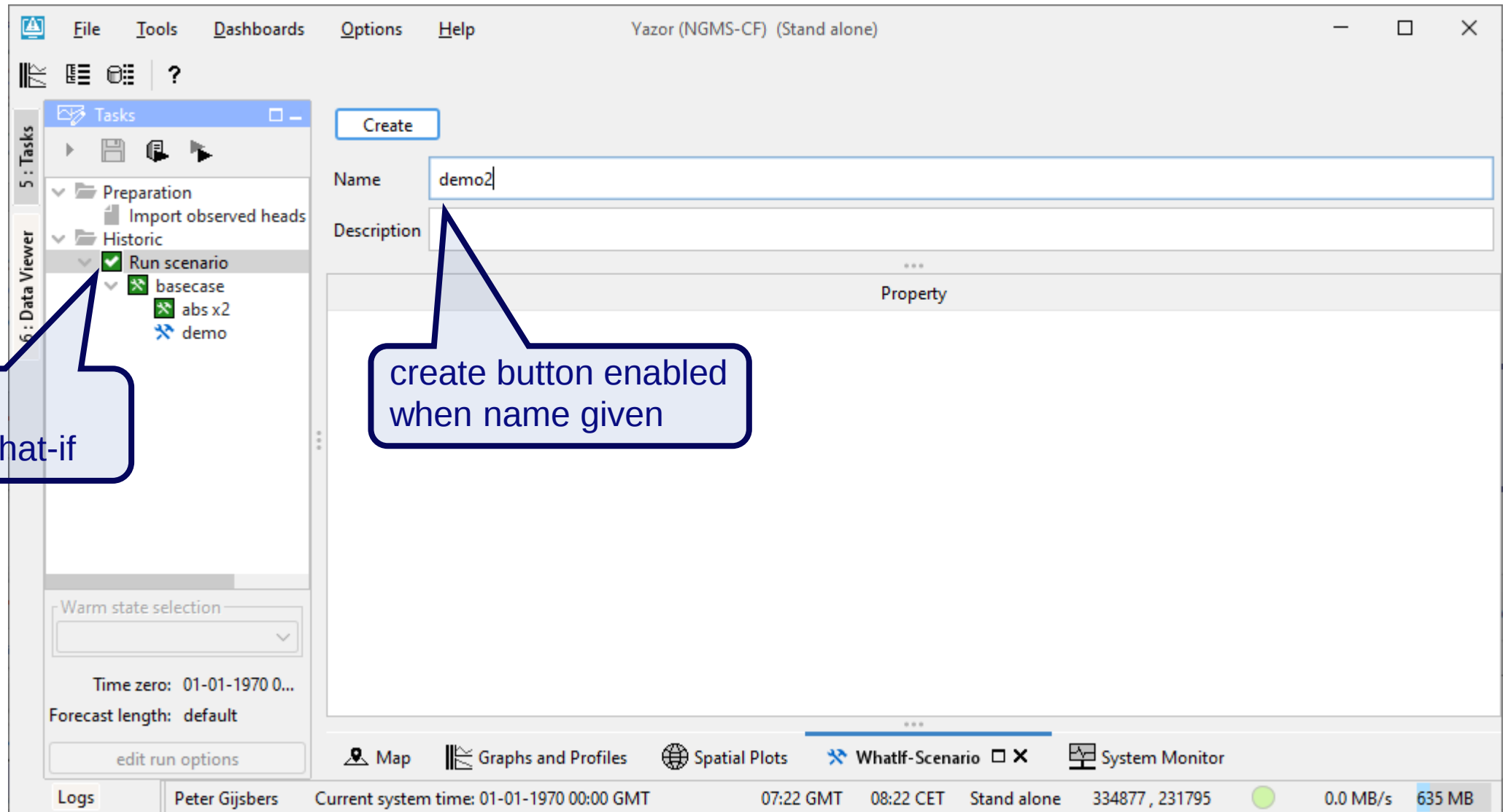


Icon	Meaning	Status
	whatif defined (not run yet)	Can be changed
	whatif run locally	Can be changed
	whatif run on server	Can not be changed
	whatif run failed	

What-If creation



What-If creation



IFD node
offering what-if

create button enabled
when name given

What-If composition

The screenshot shows the 'What-If Scenario Manager' interface. The main window displays a scenario named 'demo' with various properties and modifiers. Callouts highlight key features:

- what-if management**: Points to the 'Copy', 'Apply', 'Delete', 'Export', and 'Import' buttons at the top.
- modifiers:**: Lists 'edit', 'copy from', and 'delete' as available actions.
- properties:**: Lists 'select' and 'edit' as available actions.
- edit embedded modifiers**: Points to the 'Operation' dropdown menu, which includes options like 'Time series', 'Add', 'Subtract', 'Multiply', 'Divide', 'Replace', 'Missing', 'Ignore time series', and 'Typical Profile'.

The interface also includes a 'Data Viewer' on the left, a 'Warm state selection' dropdown, 'Time zero' and 'Forecast length' settings, and a 'Copy Historic abstraction series and recharge for reuse in what-if: [1] Run scenario (...)' button. A graph at the bottom shows 'Abstractions (m3)' over time, with a legend listing various wells and boreholes.

What-If composition

Yazor (NGMS-CF) (Stand alone)

File Tools Dashboards Options Help

Tasks

5 : Tasks

6 : Data Viewer

Preparation

Historic

Run scenario

basecase

abs x2

demo

Copy Apply Delete Export Import

Name demo

Description

Property demo

Historic Scenario

Abstraction adjustments

Change abstraction rates (Historic) ☒ abs + 50% ☐ No modifier defined ☐ No modifier defined

Add new abstraction wells ☐ No modifier defined ☐ No modifier defined

Specify abstractions rates for new wells (Historic) ☐ No modifier defined ☐ No modifier defined

Zonebudget

Override zonebudget setting Include all zonebudget (model boundary + qwunits) (slower)

Statistics

Override statistics setting Include all statistics (slower) - all layers H, Qsw

Difference to Naturalized scenario

Override differences setting Include all differences (slower) - all layers H, Qsw, Qxy, Qz

Number of stress periods from start (used for testing purposes)

Override number of stress periods (total=2844, timestep=semi-weekly, start=01-01-1970 00:00:00, ... All stress periods

Name Copy

Mod type	Scenario	Name	Summary ^	Locations	Start	End	Valid Time	User	Creation time
Change ...	abs x2	abs x2	Multiply 2.0	BOREHOLE NEAR LIN...	01-01-1970 00:00:00	02-01-2029 00:00:00	--	Peter Gijsbers	19-09-2022 07:10:...

Warm state selection

Time zero: 01-01-1970 ...

Forecast length: default

edit run options

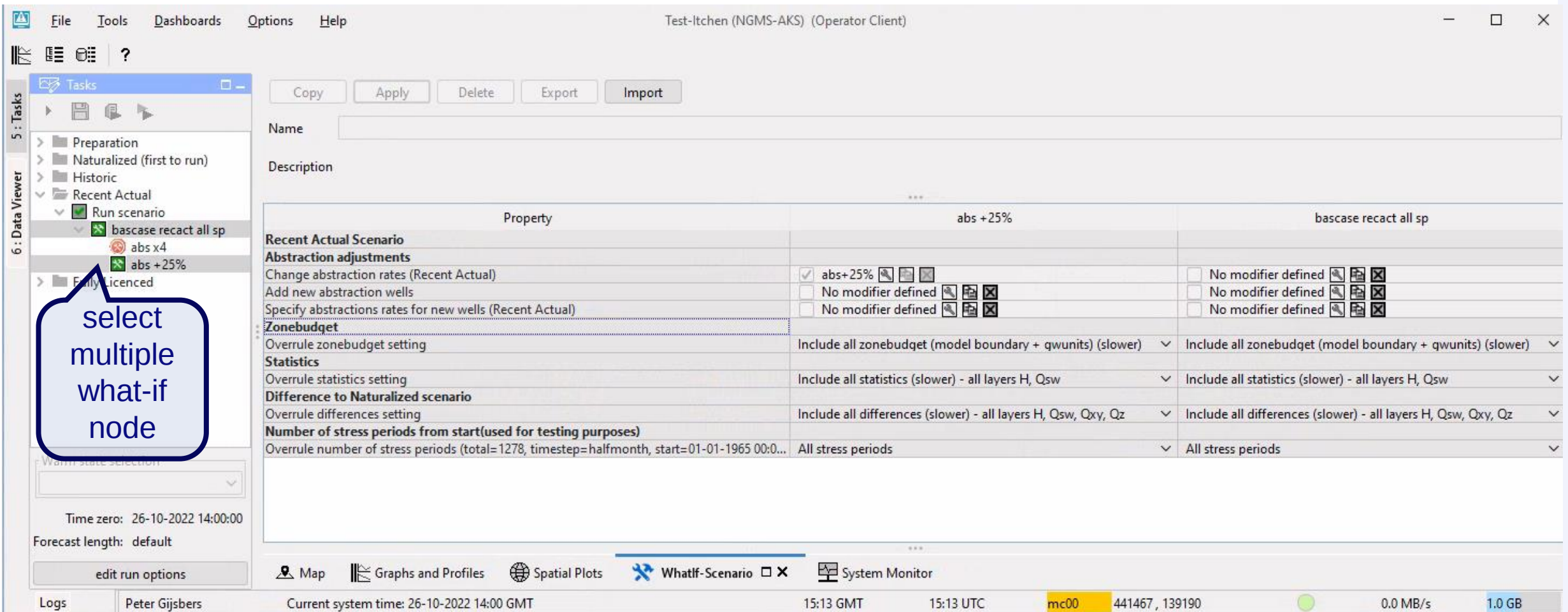
Map Graphs and Profiles Spatial Plots WhatIf-Scenario System Monitor Timeseries Lister

Logs Peter Gijsbers Current system time: 01-01-1970 00:00 GMT 07:06 GMT 09:06 CEST Stand alone 343259, 232690 0.0 MB/s 594 MB

copy modifiers from:

- spatial modifiers
- parameter modifiers

What-If composition and comparison



Test-Itchen (NGMS-AKS) (Operator Client)

File Tools Dashboards Options Help

Tasks

5: Data Viewer

6: Data Viewer

Preparation

Naturalized (first to run)

Historic

Recent Actual

Run scenario

bascase recact all sp

abs x4

abs +25%

Fully licenced

select multiple what-if node

Warm state selection

Time zero: 26-10-2022 14:00:00

Forecast length: default

edit run options

Copy Apply Delete Export Import

Name

Description

Property	abs +25%	bascase recact all sp
Recent Actual Scenario		
Abstraction adjustments		
Change abstraction rates (Recent Actual)	☒ abs+25%	☐ No modifier defined
Add new abstraction wells	☐ No modifier defined	☐ No modifier defined
Specify abstractions rates for new wells (Recent Actual)	☐ No modifier defined	☐ No modifier defined
Zonebudget		
Override zonebudget setting	Include all zonebudget (model boundary + qwunits) (slower)	Include all zonebudget (model boundary + qwunits) (slower)
Statistics		
Override statistics setting	Include all statistics (slower) - all layers H, Qsw	Include all statistics (slower) - all layers H, Qsw
Difference to Naturalized scenario		
Override differences setting	Include all differences (slower) - all layers H, Qsw, Qxy, Qz	Include all differences (slower) - all layers H, Qsw, Qxy, Qz
Number of stress periods from start(used for testing purposes)		
Override number of stress periods (total=1278, timestep=halfmonth, start=01-01-1965 00:00:00)	All stress periods	All stress periods

Map Graphs and Profiles Spatial Plots WhatIf-Scenario System Monitor

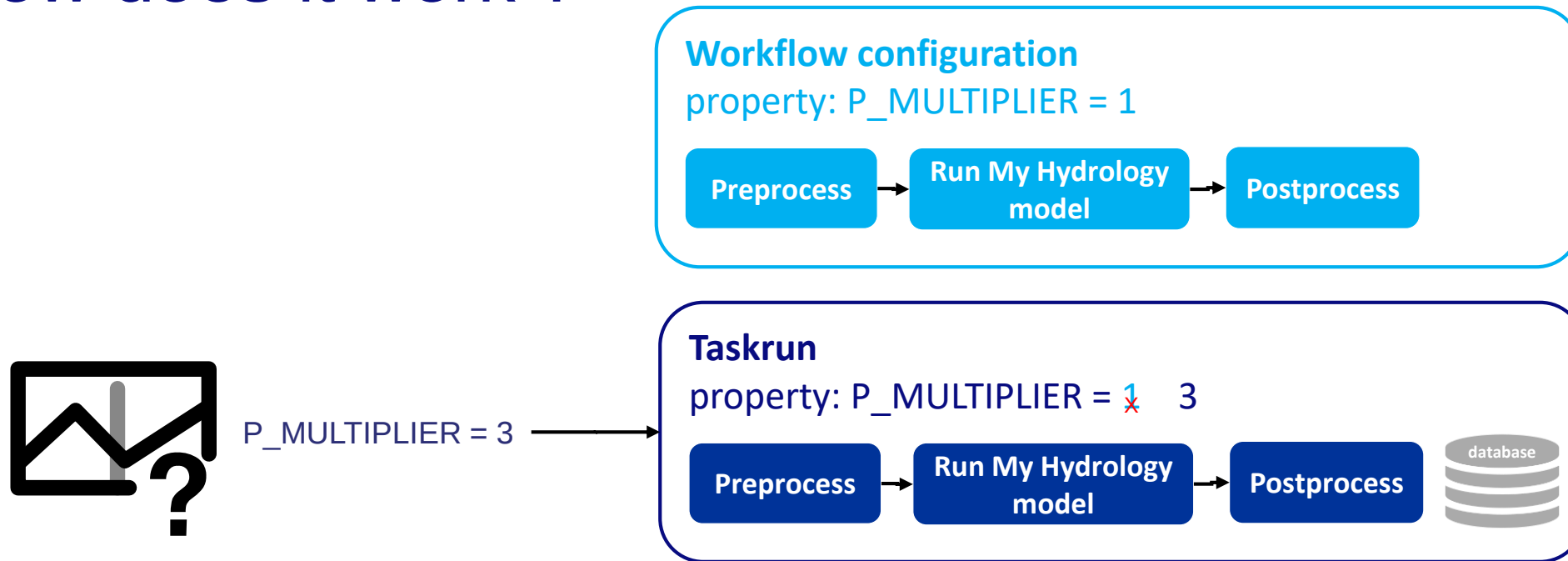
Logs Peter Gijbers Current system time: 26-10-2022 14:00 GMT 15:13 GMT 15:13 UTC mc00 441467, 139190 0.0 MB/s 1.0 GB

Accessibility in multi-user context

- What-if definitions are only visible in the IFD for all OCs if the what-if has been submitted to the server
- Permission control has not (yet) been implemented for what-if management (creation, deletion)
- Once created, what-ifs can also be selected from the Manual Forecast Display

What-if execution

How does it work ?



What-if runs are *unapproved* by default

What-if execution

Want to approve the what-if run ?

- Use the Approve option in the Forecast Management dialog

select
and
approve

Forecasts in Central Database

..	..	..	T0	Dispatch time	Workflow	What-if s...	Description	FDO	FS...	FSS Group ID	Runti...	Output Ti...	Approve
			01-01-1965 00:00:00	10-10-2022 12:12:28	Run Recent Actual	abs +25%	Run scenari...	Peter Gijbers	481	windows	5 h 47 ...	53 y 103 d	

- Auto-approve before submitting the run
 - configure the visibility of the 'Approve checkbox' of the IFD (Topology.xml):
`<enableAutoApprove>true</enableAutoApprove>`
 - Put a check in the box before submitting the what-if run

Time zero: 01-01-1965 00:00:00
Forecast length: default
Approve: ☐

Inspecting results

Access via IFD

Inspecting a what-if run

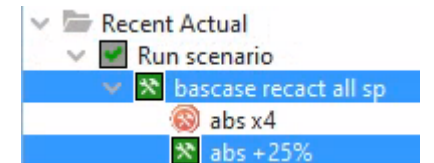
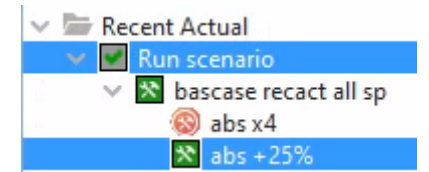
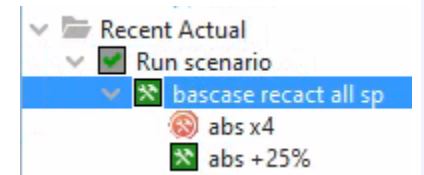
- Select the whatif-node in the IFD
 - The associated timeseries are visualized in the TimeSeries and SpatialDisplay
 - The Current Run is not shown

Inspecting a what-if run and the Current Run

- Select the segment node of the IFD as well as a what-if node

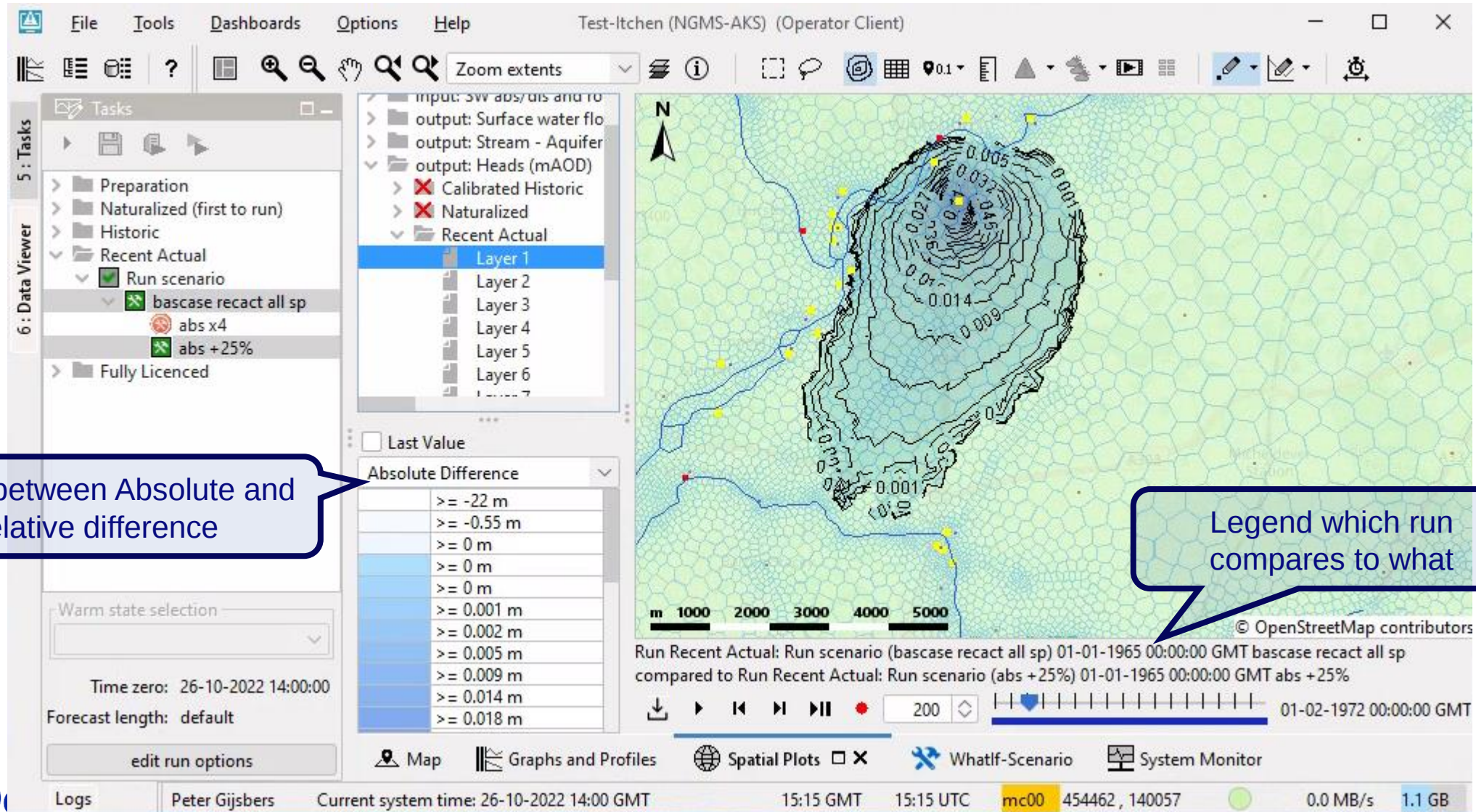
Inspecting multiple what-if runs

- Select multi what-if nodes



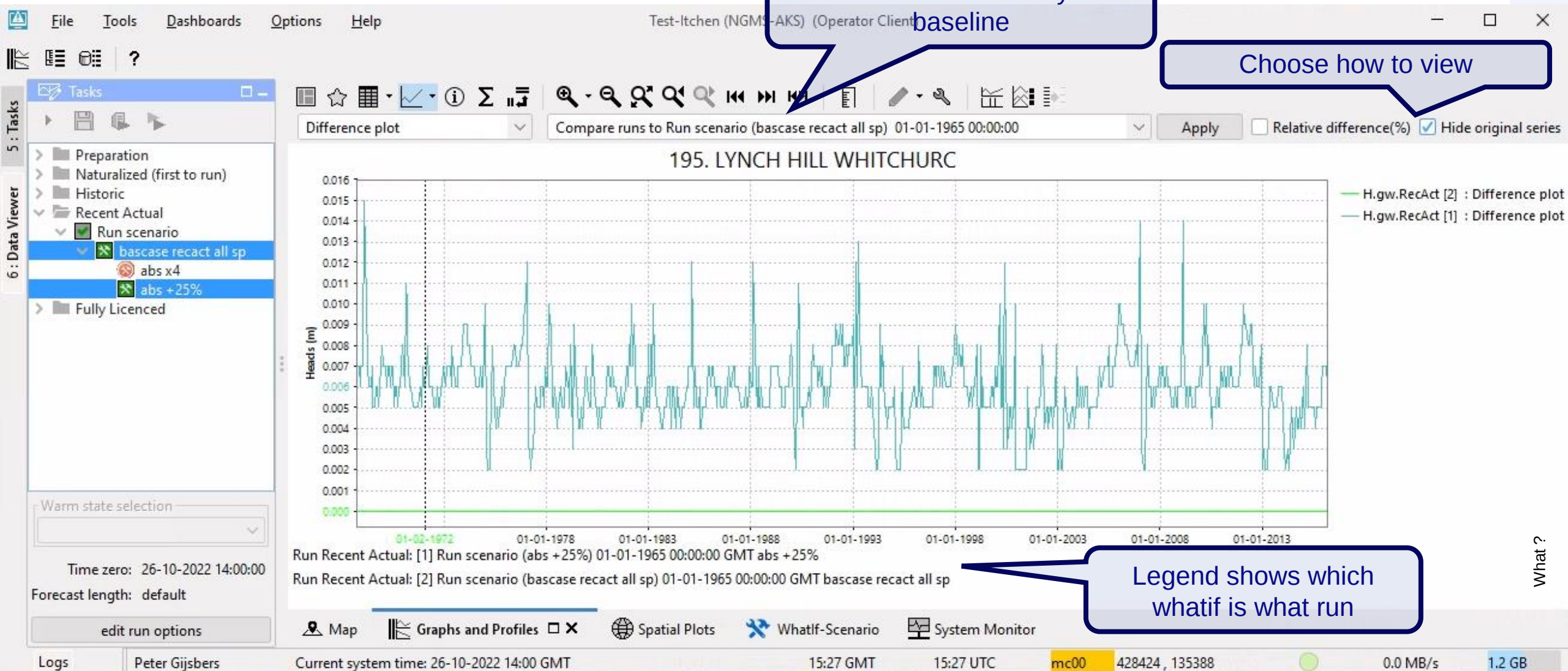
What-If comparison: Spatial Display

access via IFD



What-If comparison: Time Series Display

access via IFD

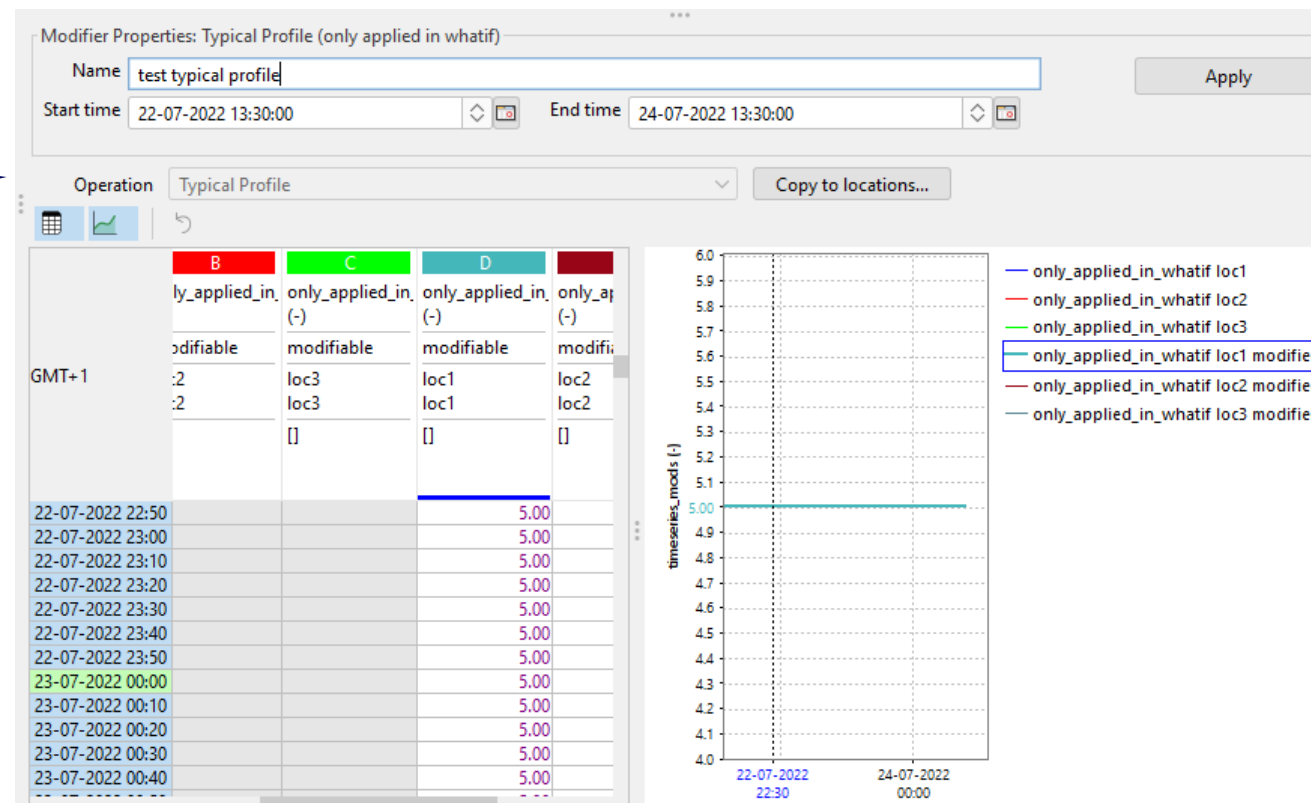


typicalProfile Modifier

- A typical Profile modifier applies a timeseries array relative to T0 ('fixed' when creating the modifier)
- Timeshift applied to the array when applying at a different T0 (as is common in live systems)

‘fixed’ version of a
timeseriesModifier
(also available as operation
choice in normal
timeseriesModifier)

'T0' timestamp of the typical profile



Configuration

- The **structure** of a WhatIf is specified in a WhatIfTemplate:
 - RegionConfigFiles/**WhatIfTemplates.xml**
- A WhatIfTemplate is workflow specific
 - **connection** defined in **WorkflowDescriptors.xml**
- Modifiers can be made whatif-specific:
 - **modifier behavior** defined in **ModifierTypes.xml**

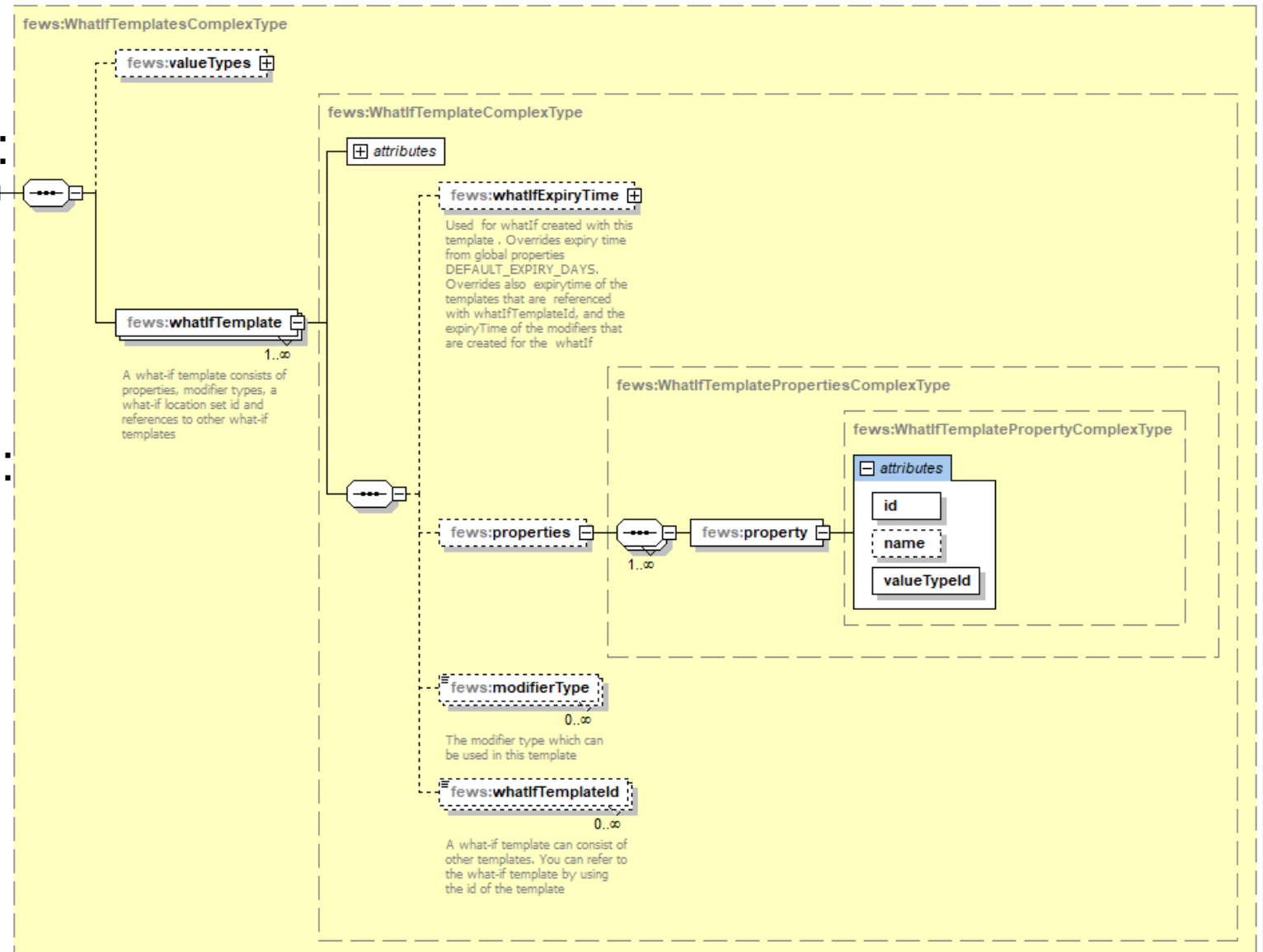
Configuration: WhatIfTemplates.xsd

A **whatif-instance** can hold:

- property values
- references to modifiers included

A **WhatifTemplate** can hold:

- property keys
- Modifier types
- whatif-template nesting

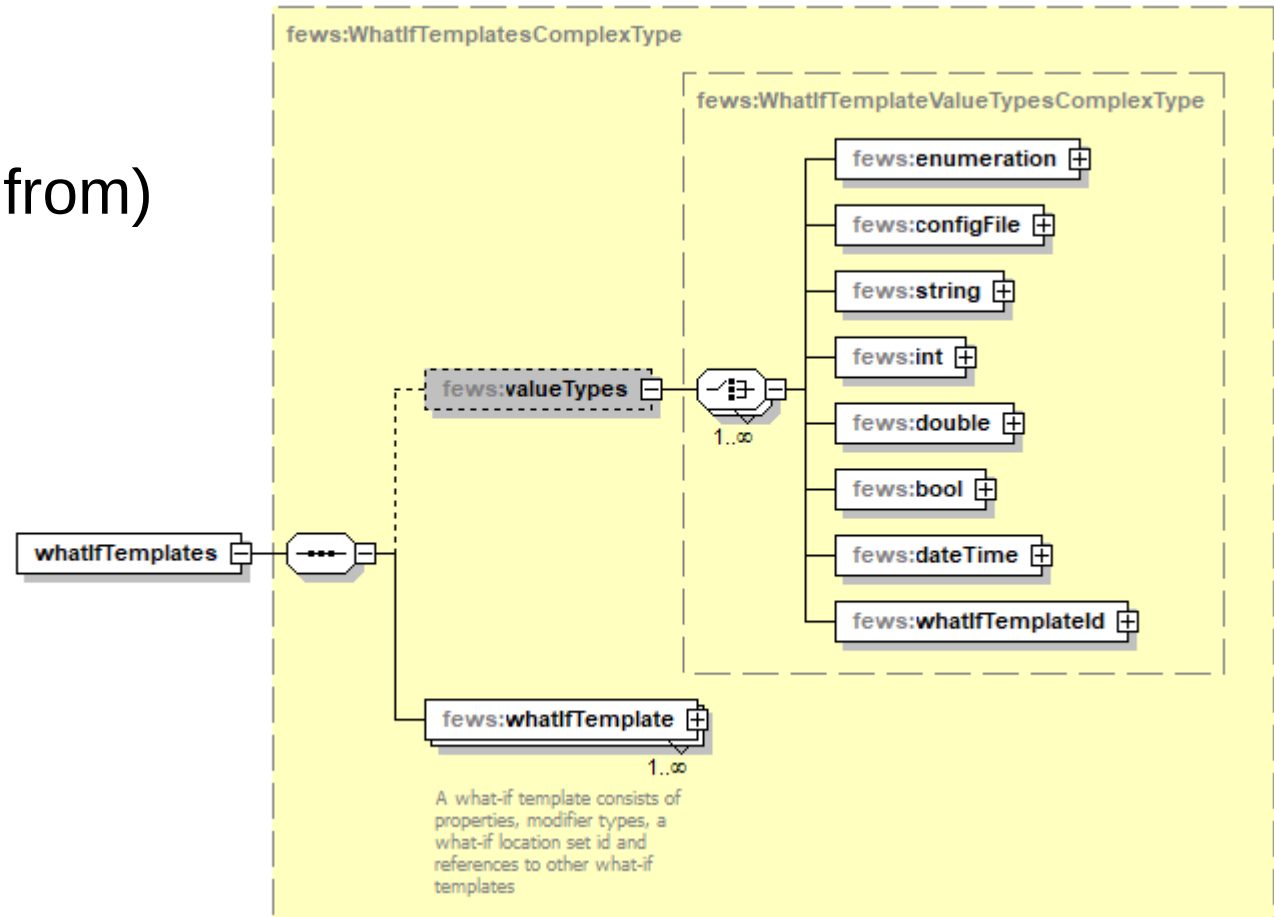


Configuration: WhatIfTemplates.xsd

valueTypes define property keys
(and possibly its values to select from)

Available configuration options:

- string (entry)
- enumeration (selection)
- int (entry)
- double (entry)
- configFile (selection)
- whatIfTemplateId
 - parameter file
 - moduledataset
 - cold state
- whatIfTemplateId
 - can be used to reference an existing what-if instance to pass on associated timeseries



Configuration: WhatIfTemplates.xml example

- Example property

```
<whatIfTemplate id="$MODELID$_n_stress_hist" name="Number of stress periods from start (used for testing purposes)">
  <properties>
    <property id="N_STRESS_PERIOD" valueType="n_stress_period_selection" name="Overrule number of stress periods"/>
  </properties>
</whatIfTemplate>
```

```
<valueTypes>
  <enumeration id="n_stress_period_selection" default="1000000">
    <value code="24" label="24 stress periods"/>
    <value code="48" label="48 stress periods"/>
    <value code="96" label="96 stress periods"/>
    <value code="1000000" label="All stress periods"/>
  </enumeration>
</valueTypes>
```

Property based
on ValueType

ValueType
definition

Workflow
property key

Number of stress periods from start (used for testing purposes)	
Overrule number of stress periods (total=2844, timestep=semi-weekly, start=01-01-1970 00:00:00, ...	All stress periods
	24 stress periods
	48 stress periods
	96 stress periods
	All stress periods

Configuration: WhatIfTemplates.xml example

- Example modifier

```
<whatIfTemplate id="$MODELID$_change_abstractions_hist" name="Abstraction adjustments">  
  <modifierType>change_abstraction_rates_hist</modifierType>  
  <modifierType>add_new_wells</modifierType>  
  <modifierType>new_wells_abstraction_rates_hist</modifierType>  
</whatIfTemplate>
```

Property based
on ValueType

WhatIfTemplate
header

Abstraction adjustments	
Change abstraction rates (Historic)	☒ abs + 50%   
Add new abstraction wells	☐ No modifier defined   
Specify abstractions rates for new wells (Historic)	☐ No modifier defined   

Configuration: WhatIfTemplates.xml example

- Example whatif-template nesting

```
<whatIfTemplate id="$MODELID$_whatif_hist" name="Historic Scenario">
  <whatIfTemplateId>$MODELID$_change_abstractions_hist</whatIfTemplateId>
  <whatIfTemplateId>$MODELID$_zb_hist</whatIfTemplateId>
  <whatIfTemplateId>$MODELID$_n_stress_hist</whatIfTemplateId>
</whatIfTemplate>
```

Each whatIfTemplate
in bold

Historic Scenario
Abstraction adjustments
Change abstraction rates (Historic)
Add new abstraction wells
Specify abstractions rates for new wells (Historic)
Zonebudget
Overrule zonebudget setting
Statistics
Overrule statistics setting
Difference to Naturalized scenario
Overrule differences setting
Number of stress periods from start (used for testing purposes)
Overrule number of stress periods (total=2844, timestep=semi-weekly, sta

Configuration: connecting to a workflow

A WhatIfTemplate is connected to a workflow in the WorkflowDescriptors.xml

```
> <workflowDescriptor id="RunHistoric" name="Run Scenario" forecast="true" visible="true" autoApprove="false">
  <workflowFileName>RunModelWorkflow</workflowFileName>
  <runExpiryTime unit="hour" multiplier="6"/>
  <properties>
    <string key="REFTYPE" value="hist"/>
    <string key="ZBLEVEL" value="all"/>
    <string key="STATPROCLEVEL" value="All"/>
    <string key="DIFPROCLEVEL" value="All"/>
    <string key="N_STRESS_PERIOD" value="1000000"/>
  </properties>
  <timeOut unit="hour" multiplier="12"/>
  <whatIfTemplateId>$MODELID$_whatif_hist</whatIfTemplateId>
</workflowDescriptor>
```

reference to
what-if template

Configuration: modifierTypes.xsd

Modifier behavior:

- always apply in workflow (=default)
- only apply if referenced in what-if workflow
- never apply in what-if workflow

Specified using:

- whatIfModifierType (optional)

```
<timeSeriesModifier id="change_abstraction_rates_hist" name="Change abstraction rates (Historic)">
  <expiryTime unit="day" multiplier="3650"/>
  <expiryTimeDeletedModifiers unit="day" multiplier="365"/>
  <whatIfModifierType>a</whatIfModifierType>
  <timeSeries>
    <moduleInstanceId>always apply in workflow
    <moduleInstanceId>apply if referenced in what-if workflow</moduleInstanceId>
    <parameterId>QSF never apply in what-if workflows
    <locationSetId>$MODELID$_wells_all_shape</locationSetId>
    <timeSeriesType>simulated forecasting</timeSeriesType>
  </timeSeries>
  <defaultStartTime>time zero</defaultStartTime>
  <defaultEndTime>end run</defaultEndTime>
  <resolveInWorkflow>true</resolveInWorkflow>
  <resolveInPlots>false</resolveInPlots>
</timeSeriesModifier>
```

Configuration: Explorer.xml

- Add the what if editor to your displays in the Explorer.xml

```
<explorerTask name="WhatIf">
  <predefinedDisplay>what if editor</predefinedDisplay>
  <toolbarTask>true</toolbarTask>
  <menubarTask>true</menubarTask>
  <loadAtStartup>true</loadAtStartup>
</explorerTask>
```

Data administration

What-if holds:

- id
- name
- property values

Modifier tables holds:

- modifier-whatif relation

Mod type	Name ^	Summary	...	Start	End	...	User	...	Cre...	Act...	Priority	De...	Copy	Scenario
Change abstraction rates...	abs +50%	Multiply 1.5	...	01-01-19...	01-04-20...	...	Peter...	...	28-...	☒		☒		demo
Change abstraction rates...	abs x2	Multiply 2.0	...	01-01-19...	02-01-20...	...	Peter...	...	19-...	☒		☒		abs x2

Thank you

- Available in Release 2022.01
 - We are finetuning the some GUI items
- Questions ?
- Opportunities ?
- Concerns ?
- Let's try on your configuration

Let's try it on your configuration

Make your own plan:

- Choose a **workflow** in your configuration for which you would like to make a scenario variant
 - e.g. a multiplier on precipitation
- Choose which choices you want to offer to the user:
 - as a fixed multiplier using a property
 - as a timeseries multiplier using a (typical profile) modifier

Let's try it on your configuration

Adjust your configuration:

- WhatIfTemplates.xml:
 - create a valueType for your property (most likely an double)
 - create a WhatIfTemplate where you include this valueType
- WorkflowDescriptors.xml
 - add the default value of the property to your workflow
 - add the whatifTemplate reference
- Explorer.xml
 - Add the whatif editor as a display
- adjust your processing steps (Module Config Files)
 - use the property in your preprocessing of the precipitation

WhatIfTemplates.xml

```
<valueTypes>
  <double id="p_multiplier" min="0" default="1"/>
</valueTypes>
<whatIfTemplate id="whatif_p_multiplier" name="WhatIf Precipitation multiplier">
  <properties>
    <property id="P_MULTIPLIER" name="Precipitation multiplier" valueTypeId="p_multiplier"/>
  </properties>
</whatIfTemplate>
```

WorkflowDescriptors.xml

```
<workflowDescriptor id="Run_Hydro_model" name="Run my Hydrology model" forecast="true" visible="true" autoApprove="true">
  <properties>
    <double key="P_MULTIPLIER" value="1"/>
  </properties>
  <whatIfTemplateId>whatif_p_multiplier</whatIfTemplateId>
</workflowDescriptor>
```

Explorer.xml

```
<explorerTask name="WhatIf">
  <predefinedDisplay>what if editor</predefinedDisplay>
  <toolbarTask>true</toolbarTask>
  <menubarTask>true</menubarTask>
  <loadAtStartup>true</loadAtStartup>
</explorerTask>
```

Let's try it on your configuration

Adjust your configuration:

- ModifierTypes.xml
 - create a typicalProfileModifier (or SpatialModifier)
- WhatIfTemplates.xml:
 - create a WhatIfTemplate where you include this modifierType
- WorkflowDescriptors.xml
 - add the whatifTemplate reference

ModifierTypes.xml

```
<typicalProfileModifier id="typical_profile_p_multiplier" name="P multiplier profile">
  <whatIfModifierType>apply if referenced in what-if workflow</whatIfModifierType>
  <timeSeries>
    <moduleInstanceId>preprocess_Hydrology_model</moduleInstanceId>
    <parameterId>P</parameterId>
    <qualifierId>multiplier</qualifierId>
  </timeSeries>
  <defaultStartTime>start run</defaultStartTime>
  <offsetDefaultStartTime unit="hour" multiplier="-1"/>
  <defaultEndTime>end run</defaultEndTime>
  <resolveInWorkflow>true</resolveInWorkflow>
  <resolveInPlots>false</resolveInPlots>
</typicalProfileModifier>
```

WhatIfTemplates.xml

```
<whatIfTemplate id="whatif_p_multiplier" name="WhatIf Precipitation multiplier">
  <modifierType>typical_profile_p_multiplier</modifierType>
</whatIfTemplate>
```

WorkflowDescriptors.xml

```
<workflowDescriptor id="Run_Hydro_model" name="Run my Hydrology model" forecast="true" visible="true" autoApprove="true">
  <whatIfTemplateId>whatif_p_multiplier</whatIfTemplateId>
</workflowDescriptor>
```

- Explorer.xml
 - Add the whatif editor as a display
- adjust your processing steps (Module Config Files)
 - use the timeseries in your preprocessing of the precipitation

Explorer.xml

```
<explorerTask name="WhatIf">
  <predefinedDisplay>what if editor</predefinedDisplay>
  <toolbarTask>true</toolbarTask>
  <menubarTask>true</menubarTask>
  <loadAtStartup>true</loadAtStartup>
</explorerTask>
```

Contact

- | | | | | | |
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