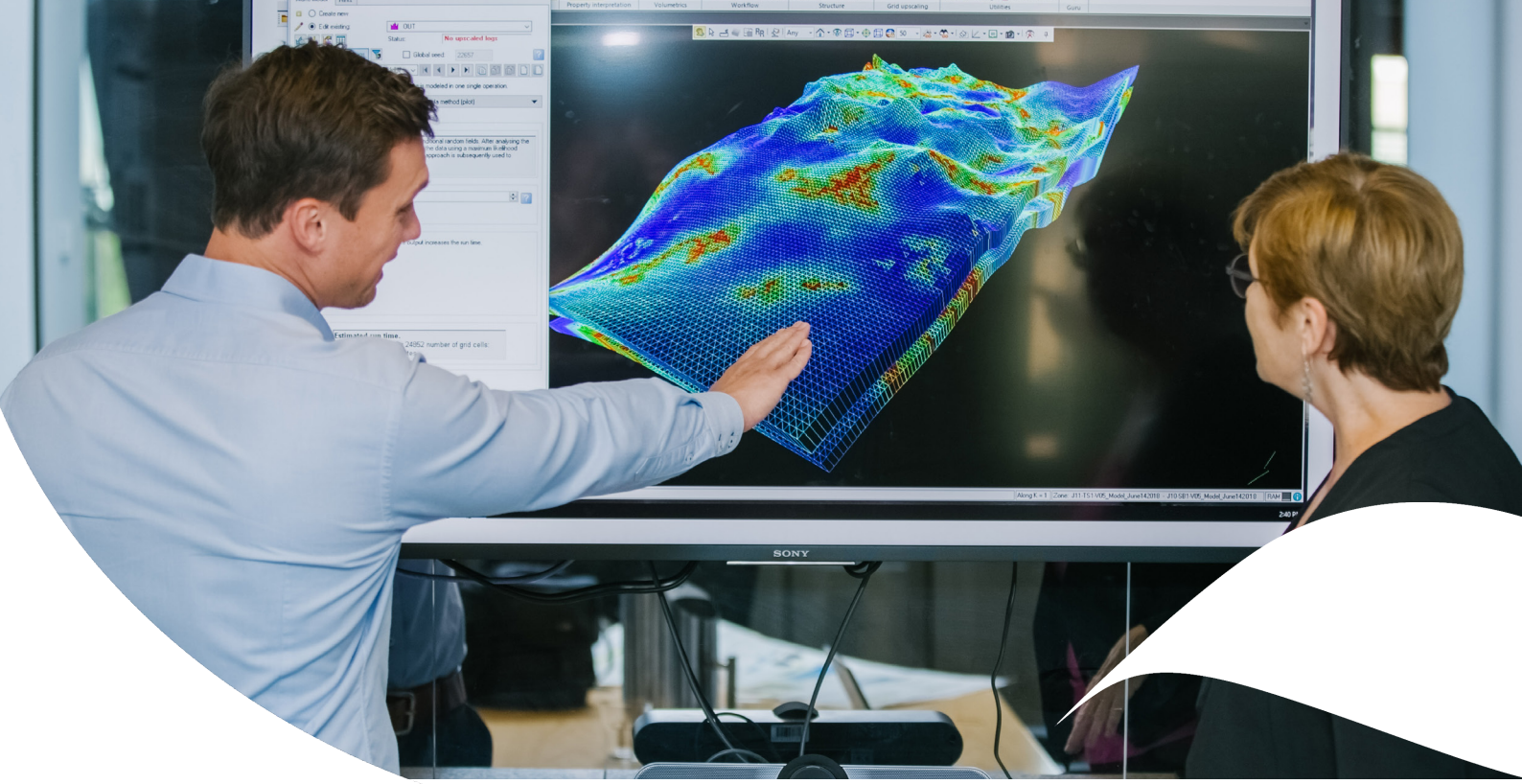


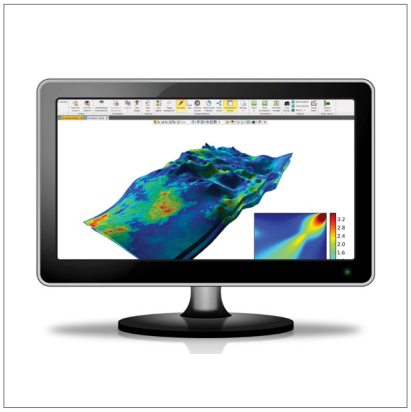
UQ Copula Plug-in for Petrel

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

New plug-in designed to improve predictive confidence in very complex and highly heterogeneous reservoirs and aquifers, aimed at more cost-effective resource planning

New technology developed by researchers at the **UQ Centre for Natural Gas**

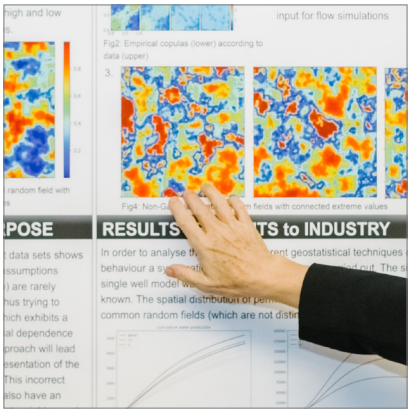


PREDICTIVE CONFIDENCE

This new technique from The University of Queensland's Centre for Natural Gas is designed to improve predictive confidence in very complex and highly heterogeneous reservoirs and aquifers.

This includes, but not be limited to, fluvial systems, carbonates and coal beds (CBM).

The technique is applicable for improved subsurface modelling, production history matching and forecasting where these are consistently problematic.



MORE REALISTIC ESTIMATES

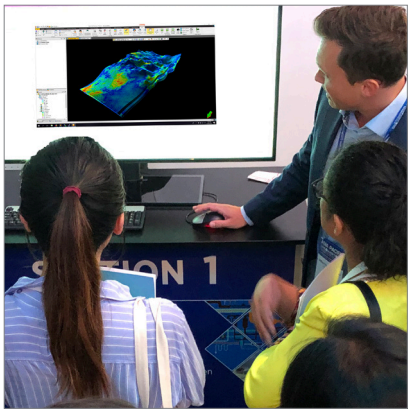
The Copula technique works because it better represents the spatial continuity (or discontinuity) of "high" (or low) values.

This is important because the essential characteristics of a heterogeneous reservoir (e.g. recovery factors, flow rates or pressure decline factors) are dominated by end-members of key properties, such as permeability, rather than an average bulk property, which current conventional geostatistical methods tend to handle.

AT A GLANCE

EASY ACCESS TO COPULA GEOSTATISTICS FOR IMPROVED SPATIAL MODELLING

- Compatible with industry standard Schlumberger Petrel® software (2017-2019 editions).
- Available at no charge for a trial period.
- Online and remote training options available from UQ.
- Access to the copula technology on one of the most widely used modelling platforms, Petrel.



CONNECTED EXTREME VALUES

The plug-in adds another dimension to the geological and dynamic flow models used by the resources industry to forecast or history match oil and gas production.

It has been current practice to use conventional (linear) geostatistical algorithms for parameter estimation between data points (well data) such as Kriging or Sequential Gaussian Simulation in these models. The Kriging matrix assumes a linear relationship between adjacent locations in a random field, which may not necessarily be representative of the underlying data. The main drawback of the linearity assumption is the spatial continuity of different ranges of a continuous variable, i.e. the symmetry of values.

Symmetry of values leads to maximally disconnected extremes. Fluid flow in the subsurface is generally controlled, not by the distribution of mean values of the regional variable, but by the distribution of extreme values; the high permeability regions and the low permeability barriers. Non-linear geostatistics based on copulas go one step beyond this symmetry assumption, enabling modelling of connected extreme values without the need of a training image. Thus, for example permeability, a critical parameter for forecasting, can be spatially analysed and modelled more realistically.

AT A GLANCE

EASY ACCESS TO COPULA GEOSTATISTICS FOR IMPROVED SPATIAL MODELLING

UQ developed new "research code" that connects extreme values in static models to help better model factors which are critical to understanding the rate and volume of subsurface gas and water flows.

This complex code is now being made broadly available to industry and other users as a plug-in for the widely used Petrel modelling software.

Petrotechnical Data Systems created the plug-in for the UQ Centre for Natural Gas.

PRODUCTION PERFORMANCE, MORE REALISTIC SCENARIOS

Using copulas reveals distinct differences in the spatial structures of fields.

This is clearly shown in the below permeability example (Figure 1). While both fields share identical values and exhibit almost identical variograms and covariograms, applying copulas (right) gives the model greater definition than traditional models (left).

The left field exhibits a Gaussian spatial dependence while the right field exhibits a non-Gaussian spatial dependence.

Gaussian spatial dependence, due to the symmetry of the values, means that the structures formed by high (red) and low (blue) values are similar.

Highs and lows form disconnected structures (maximally disconnected extremes) surrounded by mean values.

This can also be seen in the corresponding asymmetry function which is zero for all separation distances.

Non-Gaussian spatial dependence (shown on the right) forms large 'blobs' of low values and a fine connected network of high values, i.e. connected extremes.

Again, this can be seen in the corresponding asymmetry function which exhibits deviations from the zero (symmetry) line.

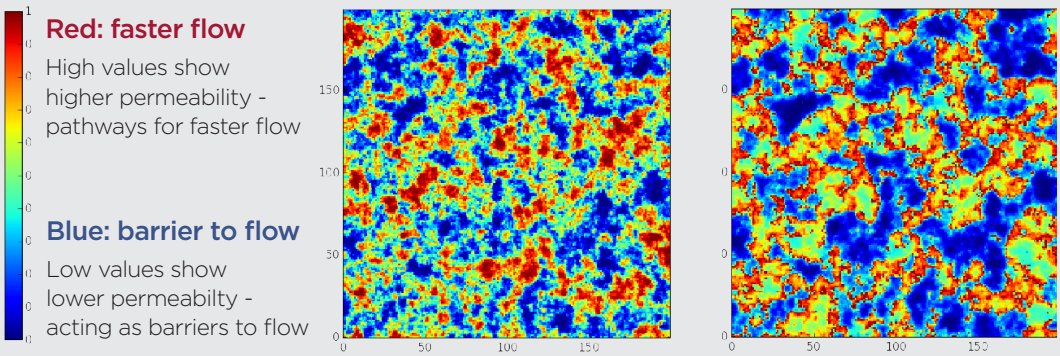
Figure 1: Greater definition using copulas: **permeability** example

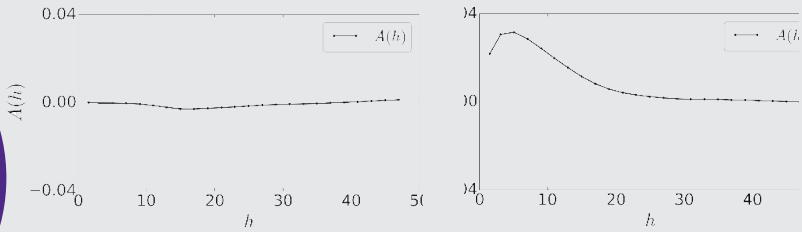
Current models

Current model using the Gaussian field. Due to its disconnected extremes, **the model exhibits 'average' flow behavior.**

With copulas

Using the non-Gaussian field forms distinct preferential flow paths. **Clear pathways and barriers are visualised.**





Testing by researchers at the UQ Centre for Natural Gas showed that there can be an up to 100% difference in travel time between the two different types of fields which cannot be distinguished by traditional geostatistical measures.

The differences revealed by copulas can impact production performance and are desirable in modelling more realistic scenarios.

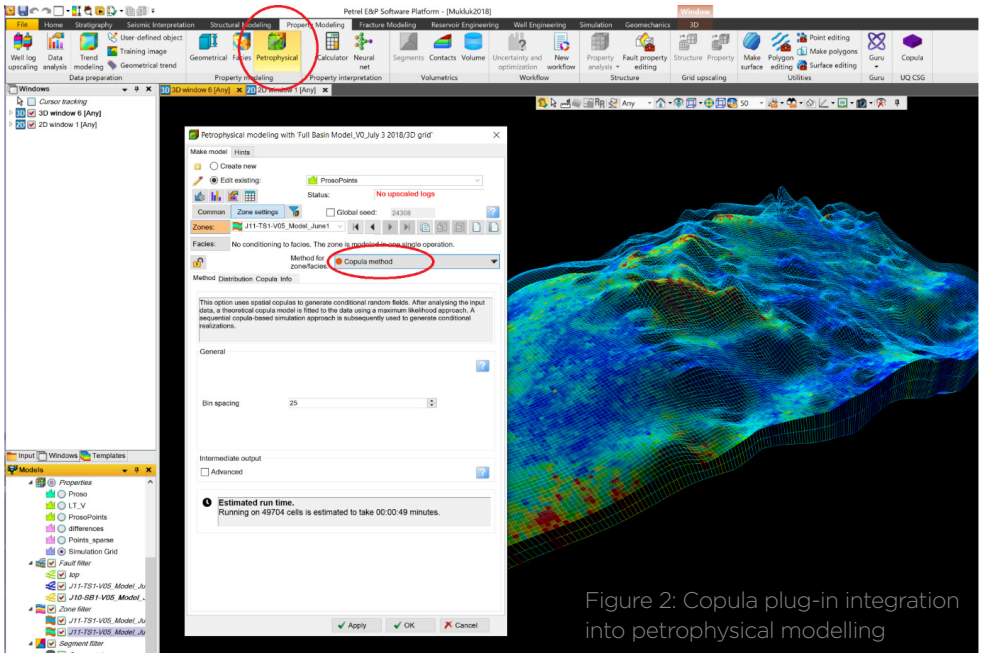


Figure 2: Copula plug-in integration into petrophysical modelling

AT A GLANCE

USER PACKAGE AVAILABLE FROM UQ CENTRE FOR NATURAL GAS

- Installers for the desktop version of Petrel (2017/2018/2019).
- Installation guides.
- User guide.
- Video demos.
- Test projects (useful to check that the plug-in is installed and operating correctly).

WORKS IN TWO MODES

The plug-in works in two modes:

- Integrated into the petrophysical modelling function (Figure 2 above).
- 'Stand-alone' mode in property modelling, which does not require a license for petrophysical modelling.

Using the Copula Plug-in follows a similar workflow as the standard petrophysical modelling functionality in Petrel.

First, a copula 'model' and a marginal distribution has to be fitted to the available data. If no data or insufficient date is available, a copula model and a marginal distribution can be freely selected.

Second, the fitted model and marginal distribution is used for a sequential simulation and the result is added as a new Petrel variable (see video demos to see this workflow).

TRAINING AVAILABLE

Training is available remotely from the UQ Centre for Natural Gas.

Geostatistically aware professional geologists and reservoir engineers will benefit from the short 1/2 day training course.

MORE INFORMATION

For more information or to arrange training, please contact the lead researcher on this project:

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A WORD FROM THE LEAD RESEARCHER

Recent studies have shown many data sets exhibit significant spatial asymmetry. Representing this asymmetry in spatial random field simulations can be a crucial step towards improving modelling results. However, traditional geostatistical techniques implemented in Petrel, such as Kriging or Sequential Gaussian Simulation are not able to describe or model spatial asymmetry.

The UQ Copula Plug-in is a geostatistical tool which allows Petrel users to analyse data for spatial asymmetry and to model spatial random fields honouring this asymmetry.

> It enables easy access to copula geostatistics which can potentially improve spatial modelling results as they provide a better representation of the input statistics.

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The University of Queensland AUSTRALIA
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CREATE CHANGE