Non-Parametric Bayesian Networks (NPBN) versus Ensemble Kalman Filter (EnKF) in Reservoir Simulation with non-Gaussian Measurement Noise

Aurelius Zilko (TU Delft), Dr. Anca Hanea (TU Delft), Dr. Remus Hanea (TNO/TU Delft)

Seventh International EnKF Workshop, Bergen, Norway (18 - 20 June 2012)

Description

◆ **Objective :** To estimate the permeability field of an oil reservoir sized 700 x 700 meter

◆ **Model :** Two-Phase Flow Model

◆ **How :** Use Twin Experiment

◆ **Most Common Method :** EnKF

◆ **Idea :** Use Bayesian Networks (BN) as an alternative

Bayesian Networks

◆ **What :** A direct *acyclic* graph with nodes (the variables) and arcs (flow of influence).

◆ **Example :**
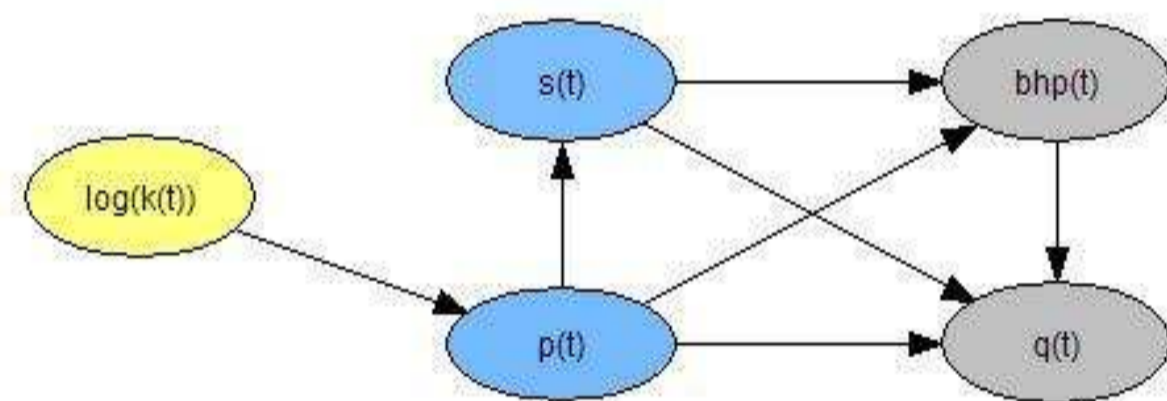
◆ The Assimilation Step : Conditioning on one (or some) of the nodes; and then sample the conditioned network

Assumption and Sampling Procedure

◆ **Assumption :** Normal (Gaussian) Dependence between variables

◆ **Sampling Procedure :**

- Transform each variable to normal
- Work (assimilate) with the "normalized" variables
- Transform the assimilated variables back to original margins

Previous Results

◆ Research by Maria Gheorghe (TU Delft), Dr. Anca Hanea (TU Delft), and Dr. Remus Hanea (TNO/TU Delft) in 2010.

◆ **Results**:

- NPBN appears to be a promising alternative to EnKF.
- Its performance is limited to only work on part of the reservoir due to dimensionality problem.
- Possible Solution: Interpolation.
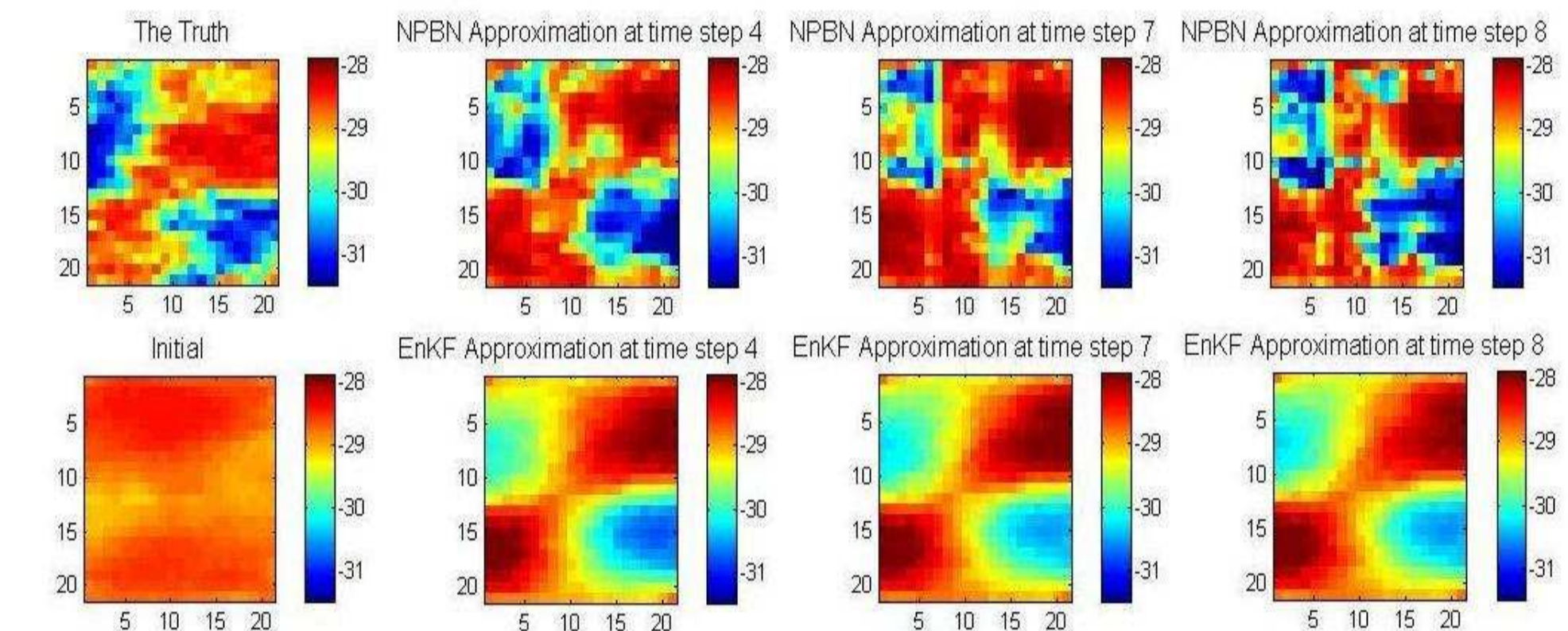
Objectives of Research

◆ **Introduce non-Gaussian Measurement Noise**
◆ **Introduce Saturation to the NPBN Method**
◆ **Perform Interpolation**
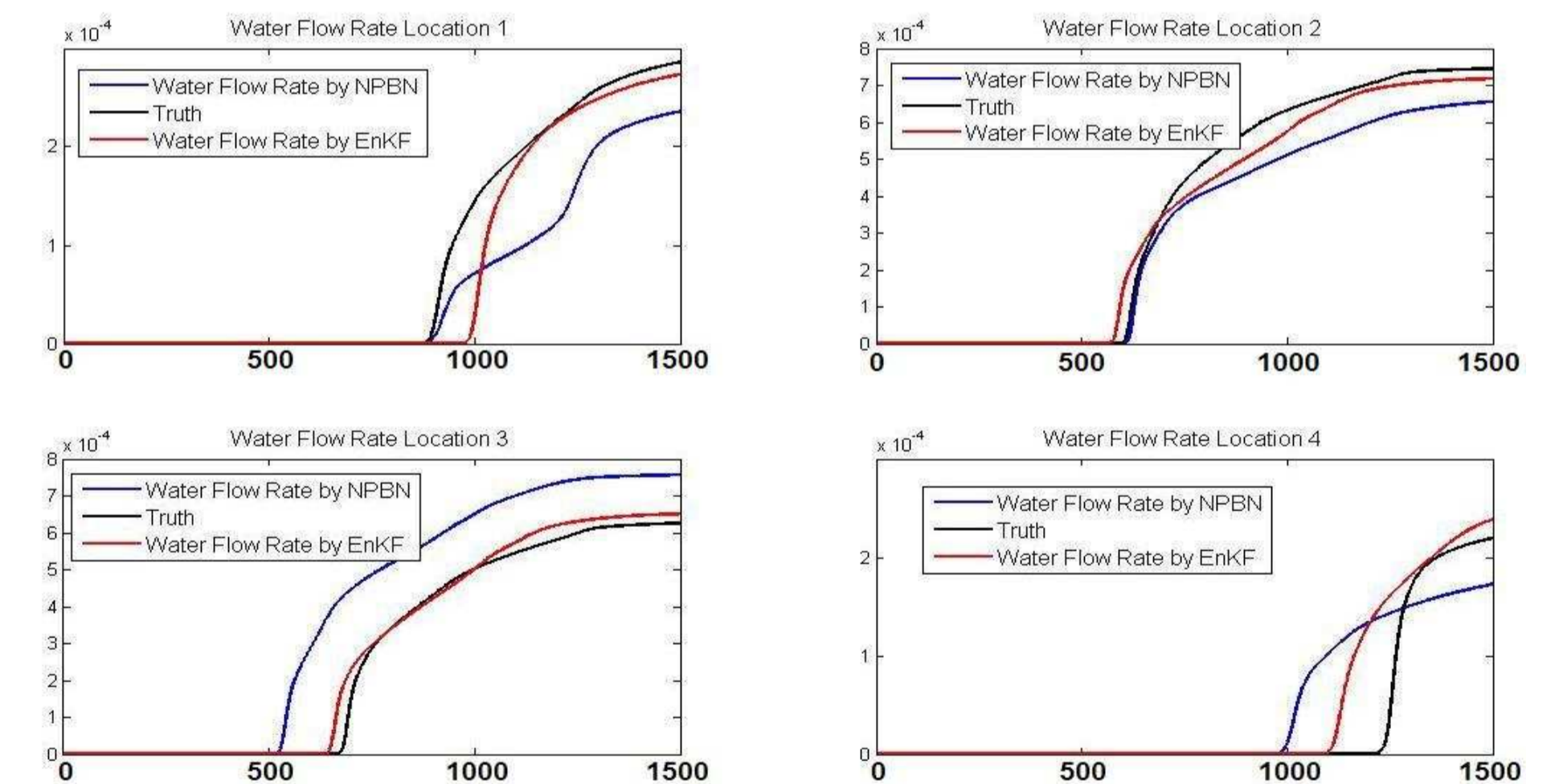
Result
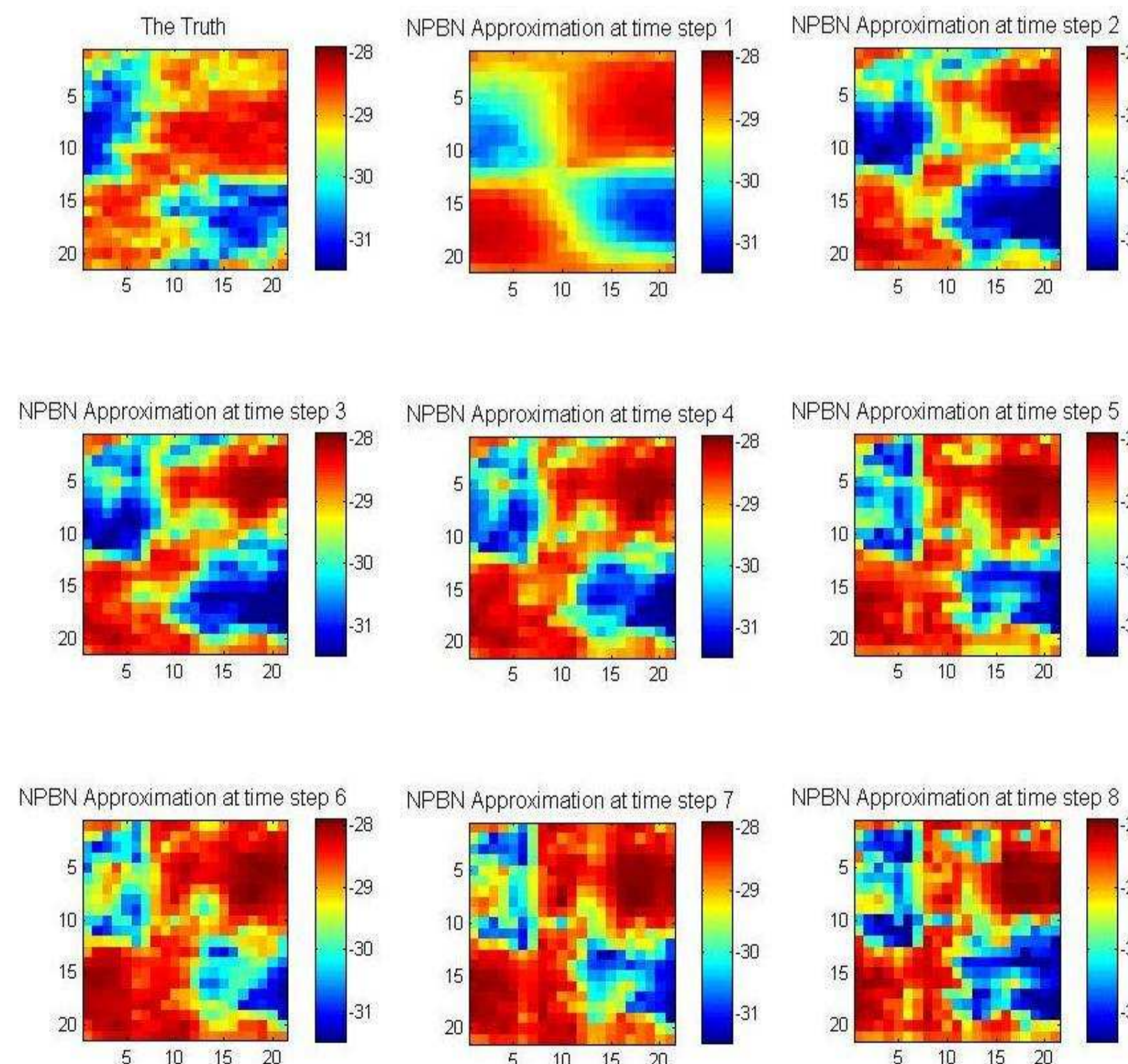
Comparison with EnKF

◆ **Visual Comparison**:

◆ **Forecast (Prediction)**:

Conclusions

◆ Visually, the recovered field by NPBN Method looks good and better than EnKF's.

◆ NPBN tends to over (or under) estimate the permeability at some cells much more than EnKF.

◆ Interpolation is a good way to combine the "partial" results by NPBN Method.