(a) Physics-Based

calibration

model construction

Geoscientific Model	sparse Data (Meas.)

+ physical information, predictions

− limited complexity

(b) Data-Driven

as constraint

data enrichment

model construction

Geoscientific Model	Data (Meas. + Sim.)

+ state estimate that captures full complexity

− no physical information, no predictions

(c) Physics-Based Machine Learning

data enrichment

calibration

joint model construction

Geoscientific Model	Data ((Meas.) + Sim.)

+ Physical state estimate, captures full complexity

− computational more demanding
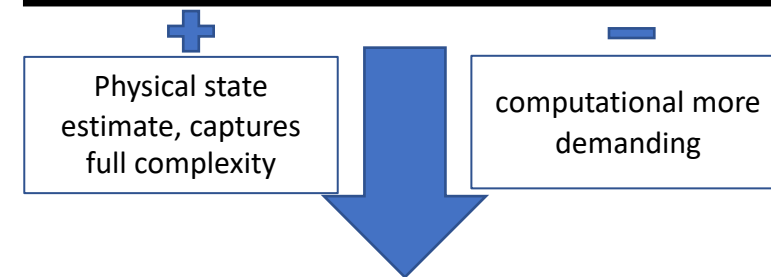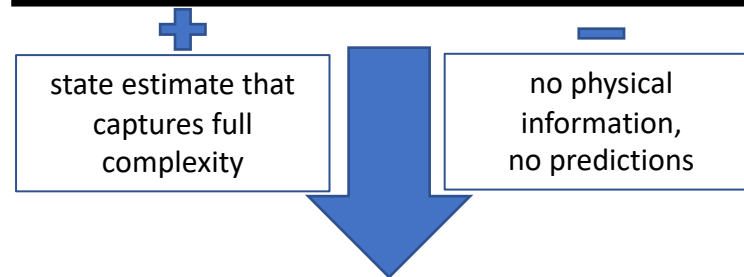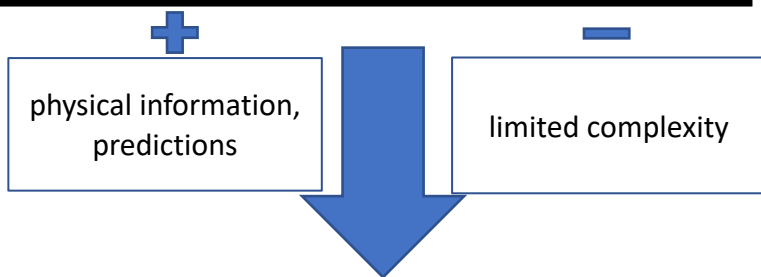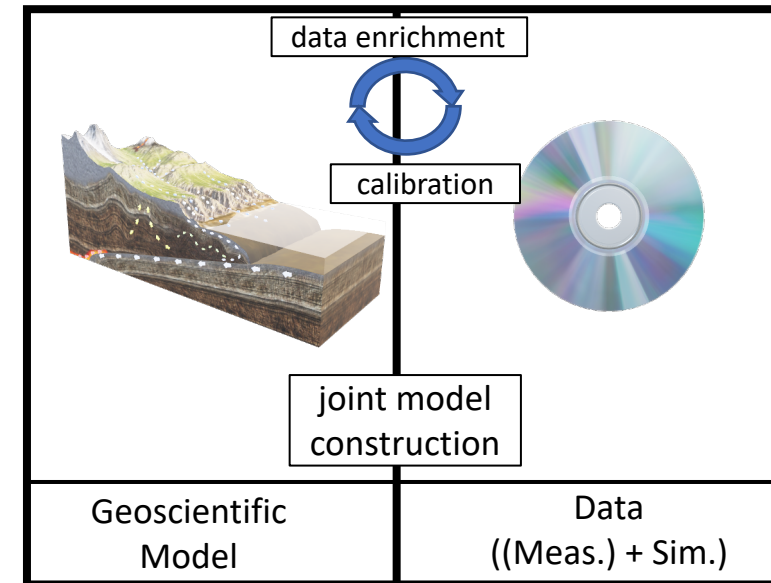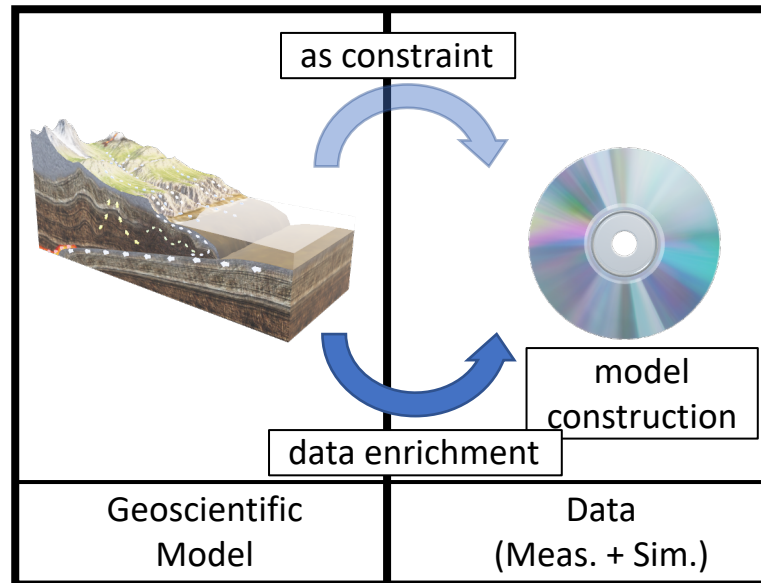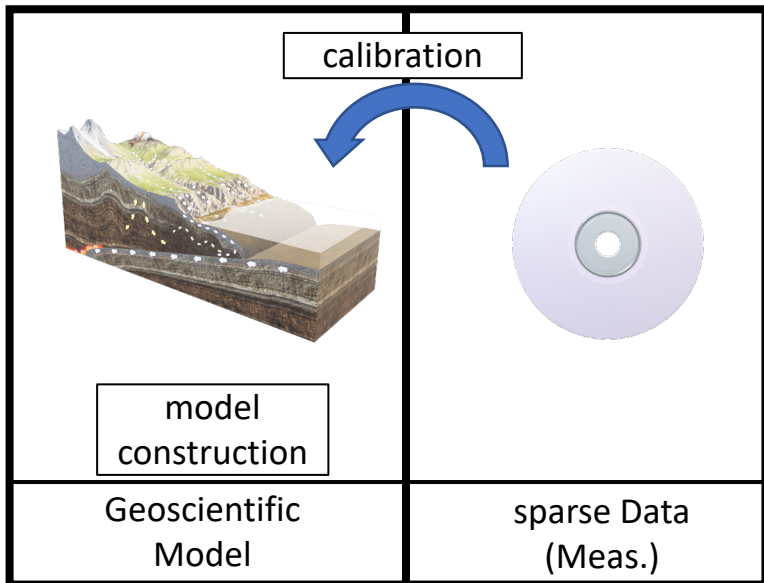
Inverse Processes, Predictions