16th Annual Asia Oceania Geosciences Society

Monitoring and Potential Downscaling of Aquifer Groundwater Storage Changes Using Space Gravimetry

Wei Feng[1], C.K. Shum[1,2],Orhan Akyilmaz[3],Vibhor Agarwal[2], Ehsaan Forootran[4], Chaoyang Zhang[2], Yu Zhang[2], Junyi Guo[2], Chung—Yen Kuo[5], Maike Schumacher[4]

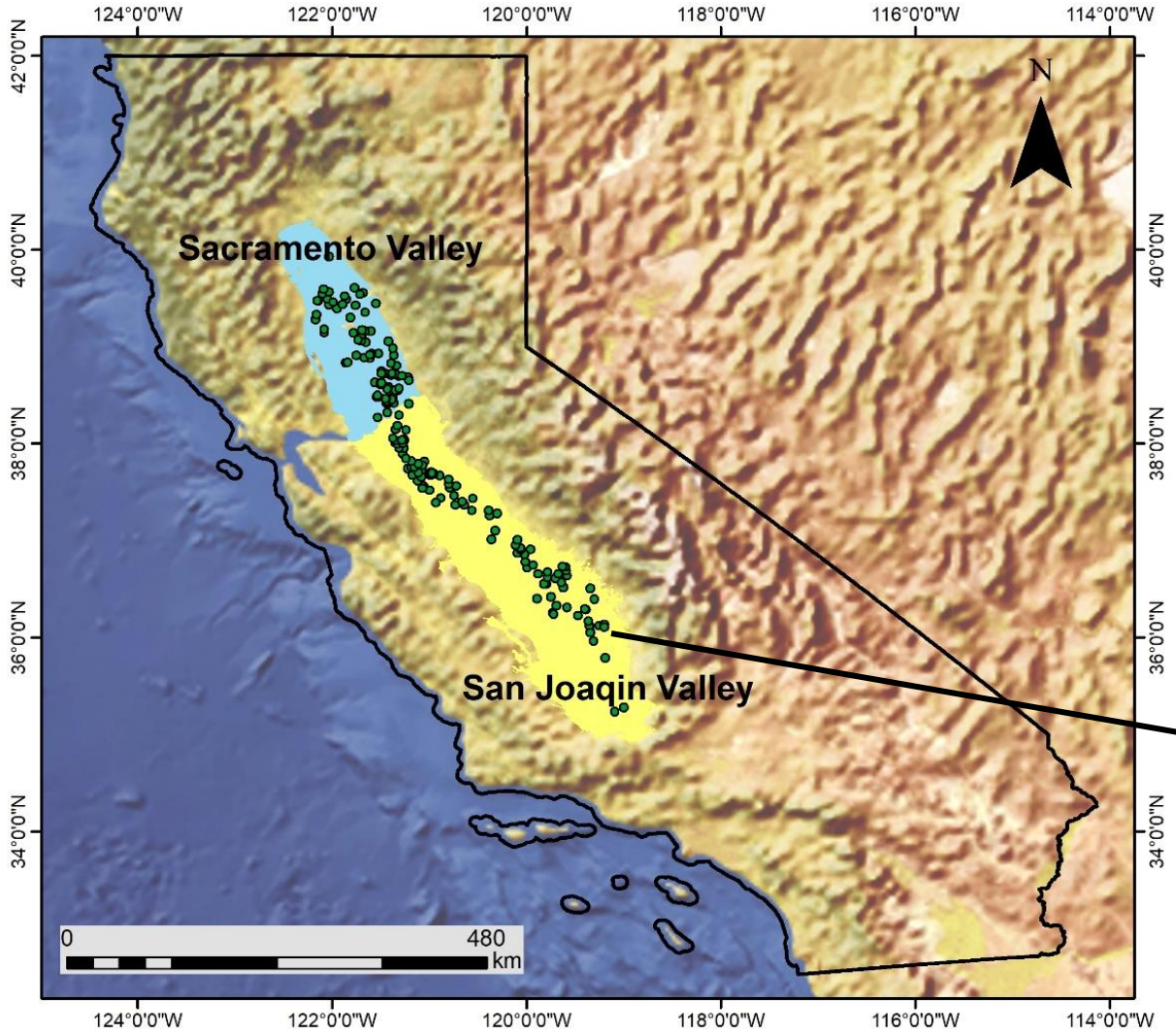
[1] Institute of Geodesy and Geophysics, Chinese Academy of Science, China

[2] Division of Geodetic Science, School of Earth Sciences, The Ohio State University, USA

[3] Department of Geomatics Engineering, Istanbul Technical University, Turkey

[4] Institute of Physics and Meteorology, University of Hohenheim, Germany

[5] Deparment of Geomatics, National Cheng Kung University, Taiwan



Groundwater data for 336 wells during 2006-2008 used for training ANN has been obtained from http://www.water.ca.gov/waterdatalibrary/

Long term Groundwater observations available at this well location

STUDY AREA

APPROACH AND RESULTS

Prepare the inputs: Grid the input data to the same Target Resolution, 4km.

Compute Average of Precipitation of n, (n-1) and (n-2) months for Precipitation value of n^{th} month

Set up the Artificial Neural Network (ANN) Architecture in MATLAB Deep Learning Toolbox

Train the ANN model and see which parameters are essential.

Retrain the ANN with essential Parameters.

Check for internal consistency by comparing the storage changes from wells and the model

Simulate the ANN model for points for all the points in Central Valley at Target 4 km resolution

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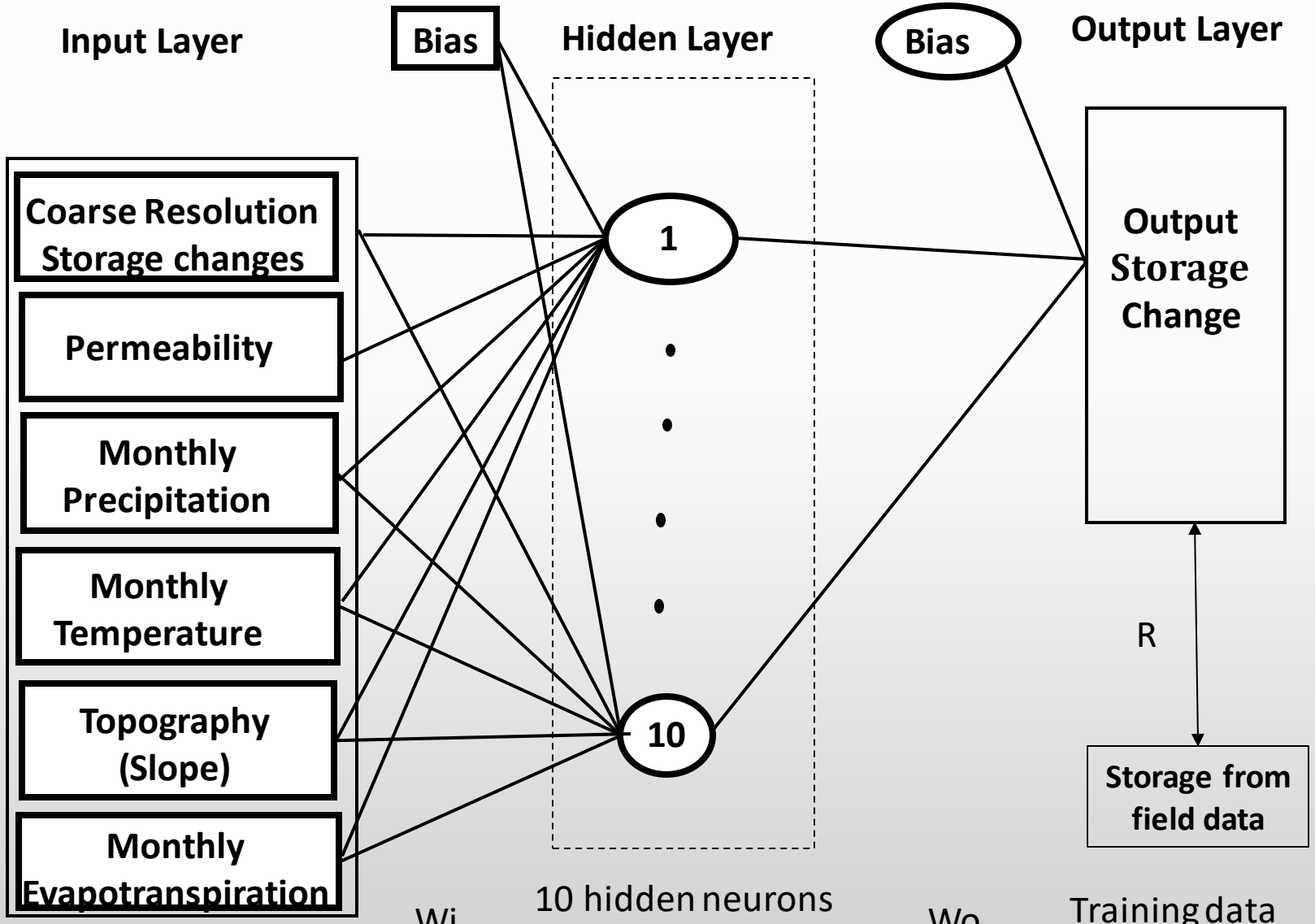
DOWNSCALING TECHNIQUES

- **Dynamic downscaling**
  - regional numerical model at higher spatial resolution
  - applied in local areas at smaller scale
- **Statistical downscaling**
  - empirical relationships between large-scale variables (predictors) and local-scale variables of interest (predictands).

ARTIFICIAL NEURAL NETWORK

TRAINING PHASE



Feedforward Back-Propagation network

Propagation of the error in the backward direction to adjust the network weights and biases

Bayesian Regularization Training algorithm

Good generalization for difficult datasets. Training stops according to adaptive weight minimization

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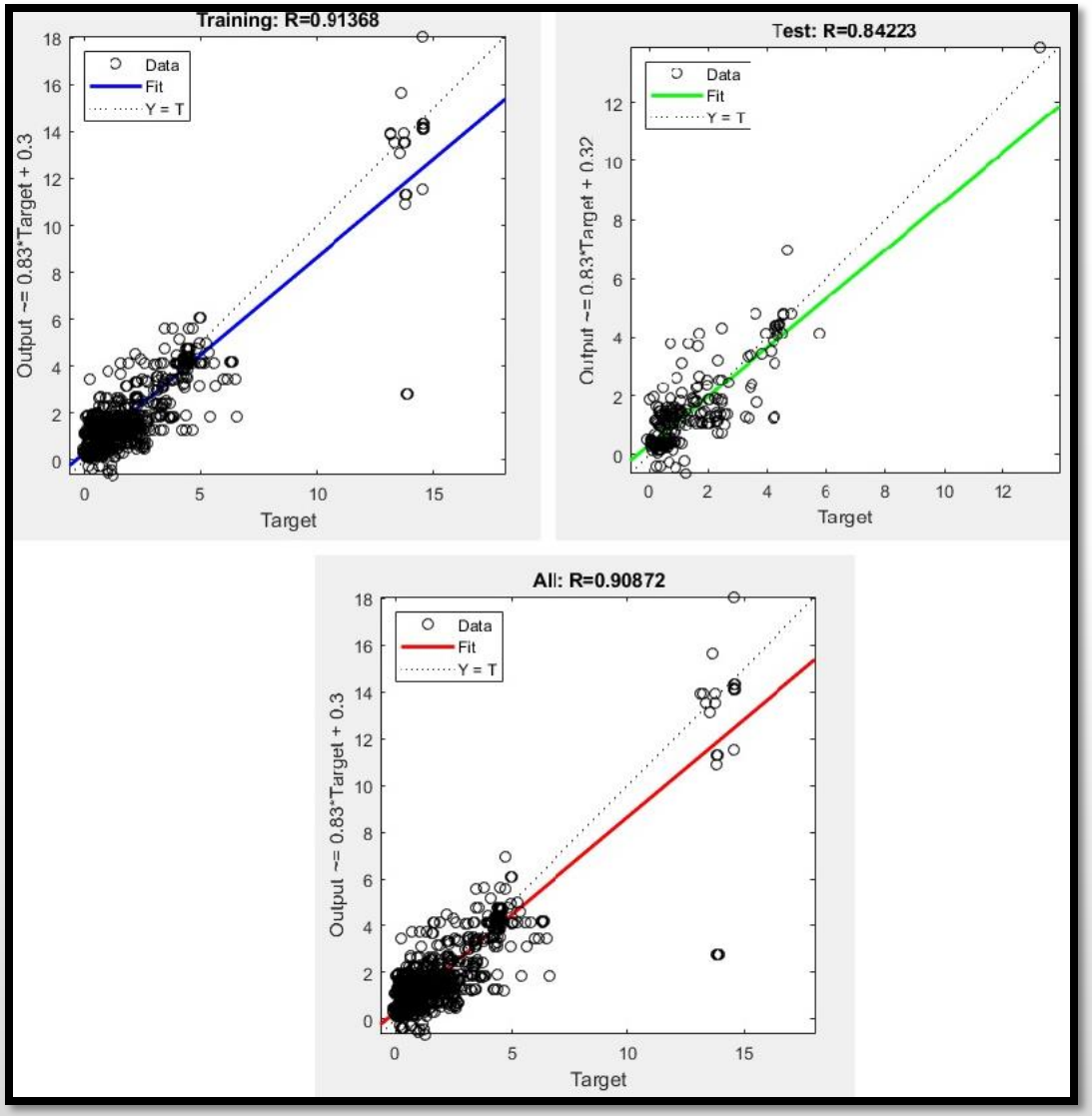
WORKING OF THE ANN



Regression Coefficient – 90 % correlation between ANN Output and Target well data

Nash–Sutcliffe efficiency (NSE) Predictive power of ANN model

$$NSE = 1 - \frac{\sum_{t=1}^{T}(Q_m^t - Q_o^t)^2}{\sum_{t=1}^{T}(Q_o^t - \overline{Q_o})^2}$$

Q_m and Q_o represent simulated and observed data respectively, whereas $\overline{Q_o}$ represent mean of observed data

Value obtained: 0.83
(Excellent predictions)

Order of importance of variables:

Based on Connection weight approach as suggested by Olden et al., 2004.

Following are the variables in order of importance:

1. GRACE 2. Permeability 3. Monthly Precipitation

Other variables (Monthly Temperature, Slope, Monthly evapotranspiration) were discarded for ANN training.

References

Olden, J.D., Joy, M.K., Death, R.G. 2004. An accurate comparison of methods for quantifying variable importance in artificial neural networks using simulated data. Ecological Modelling. 178:389-397.

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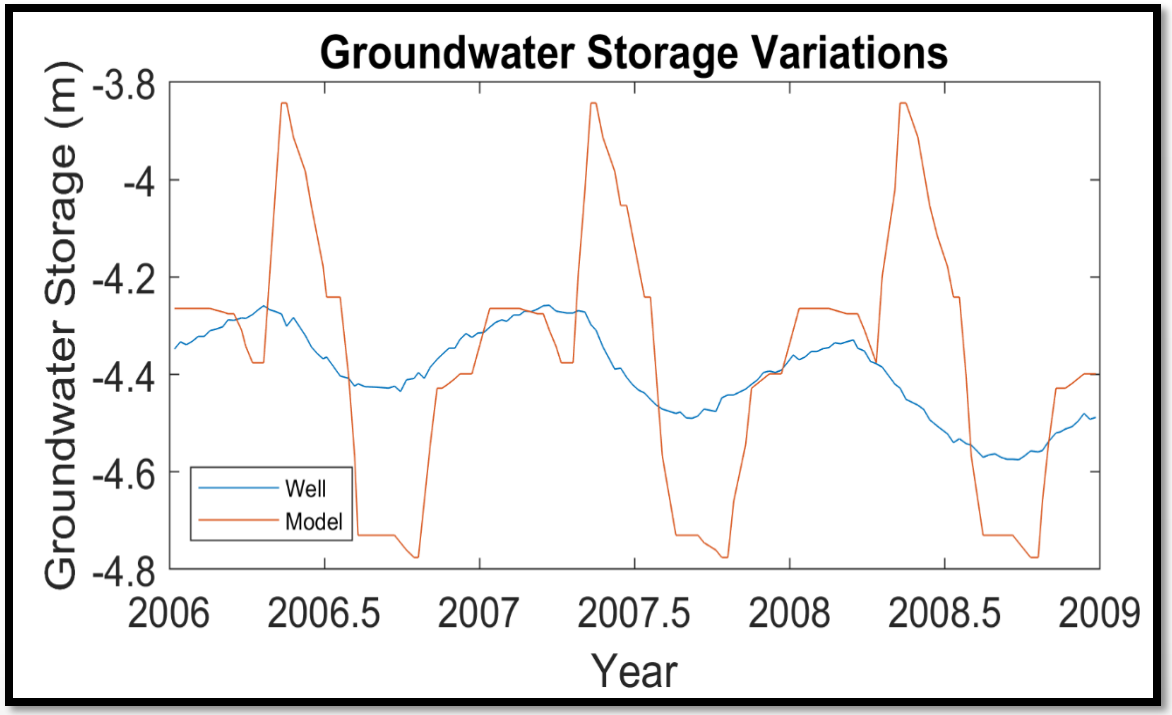
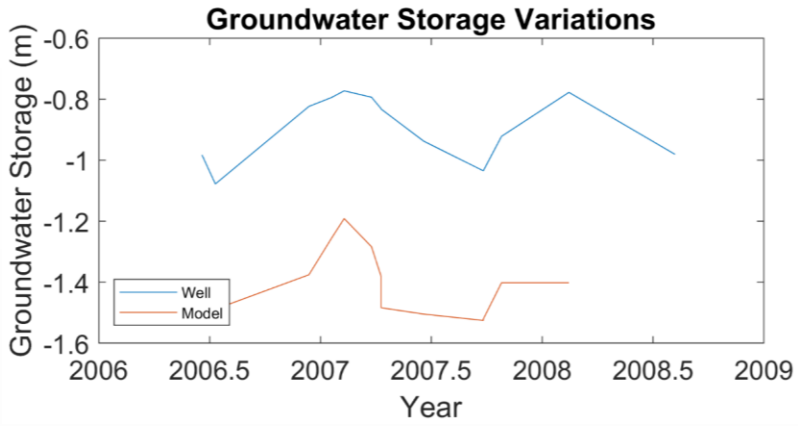
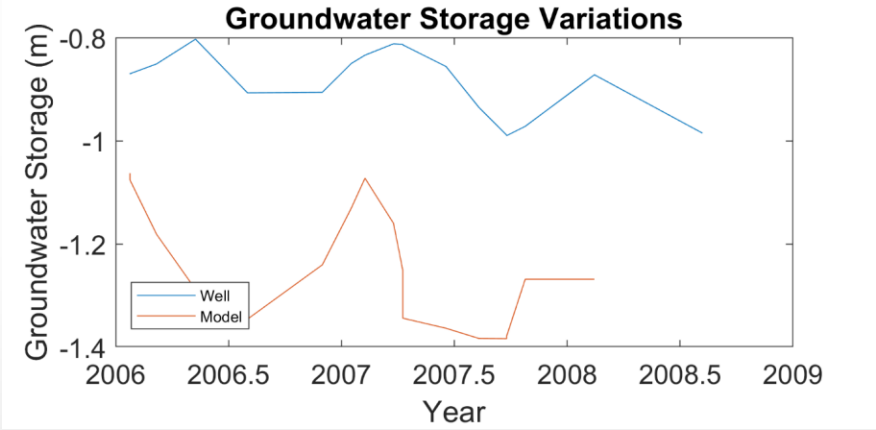
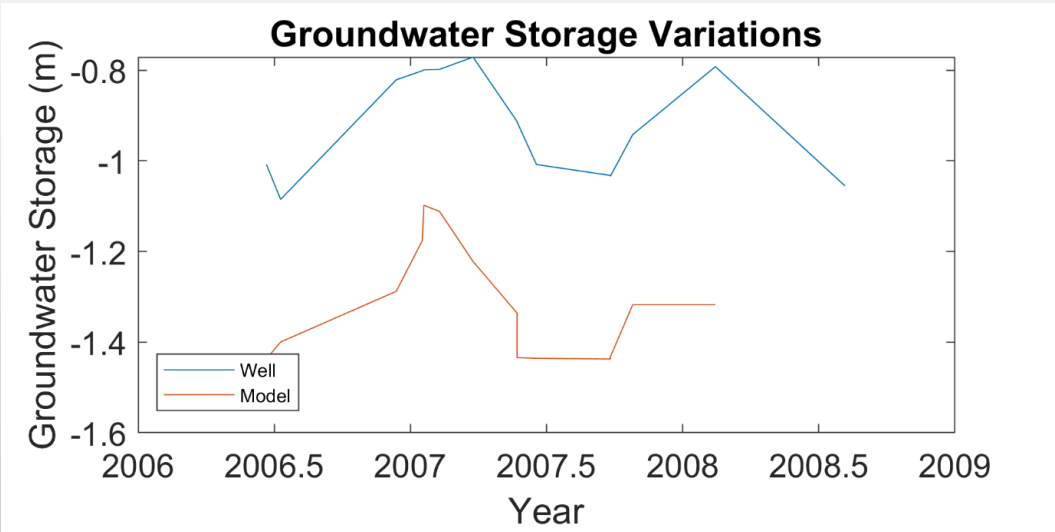
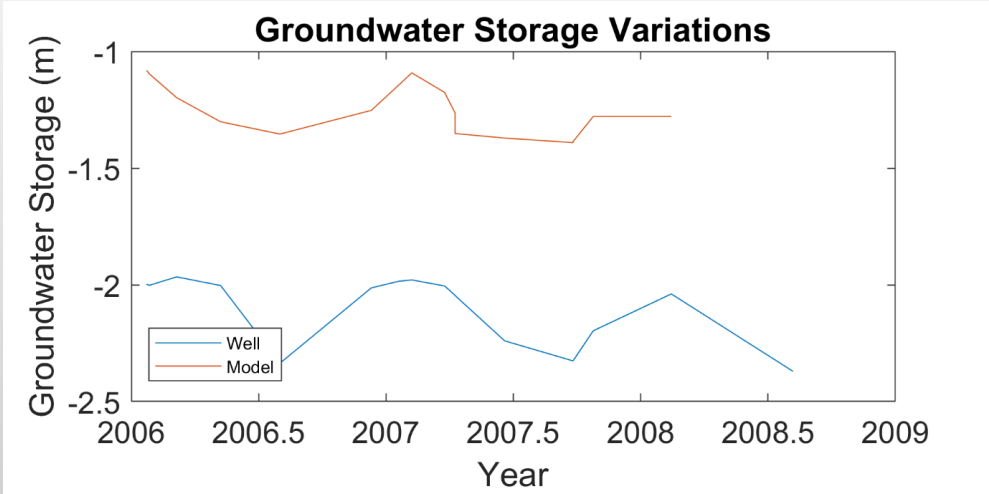
INTERNAL CONSISTENCY











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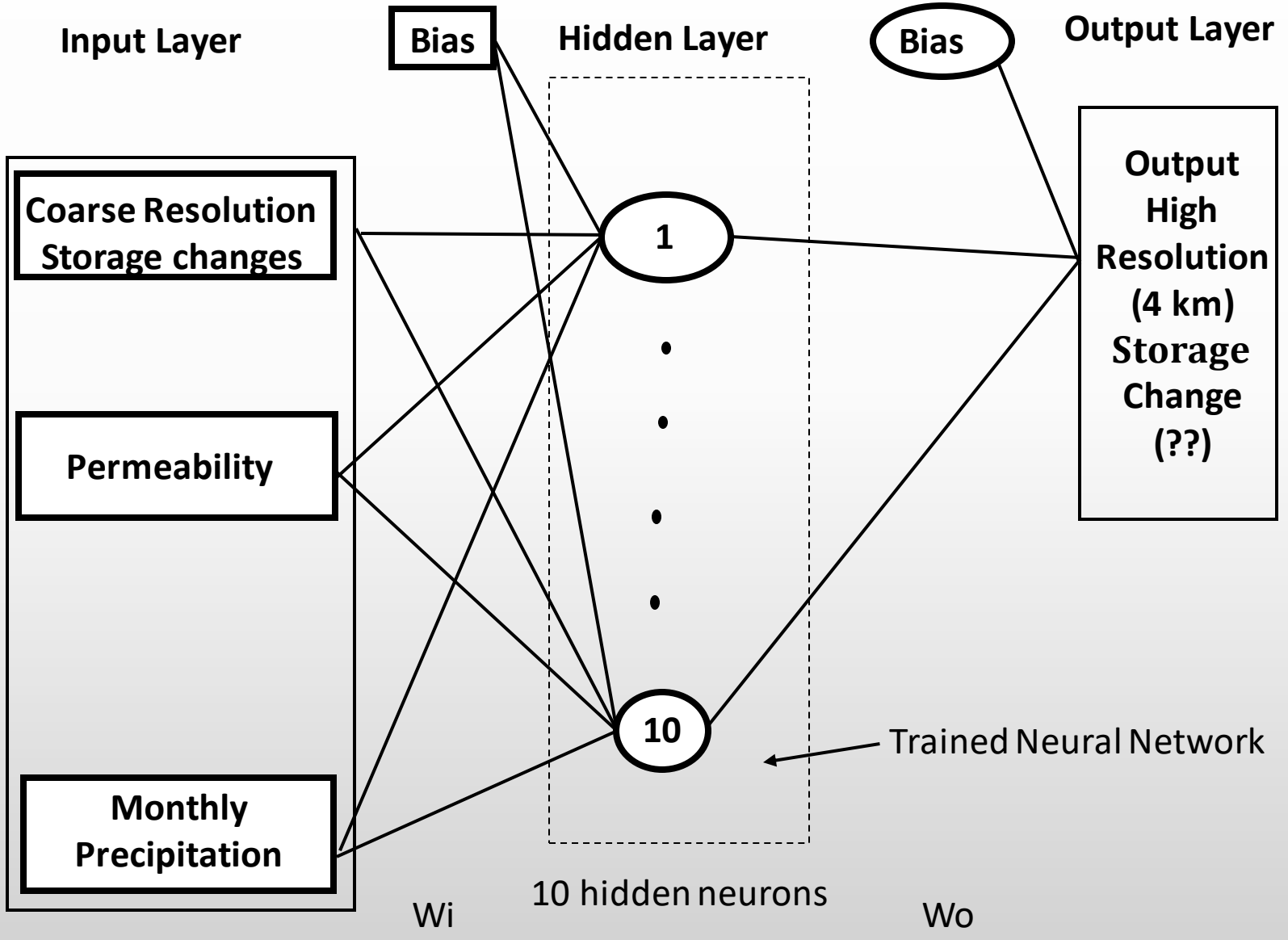
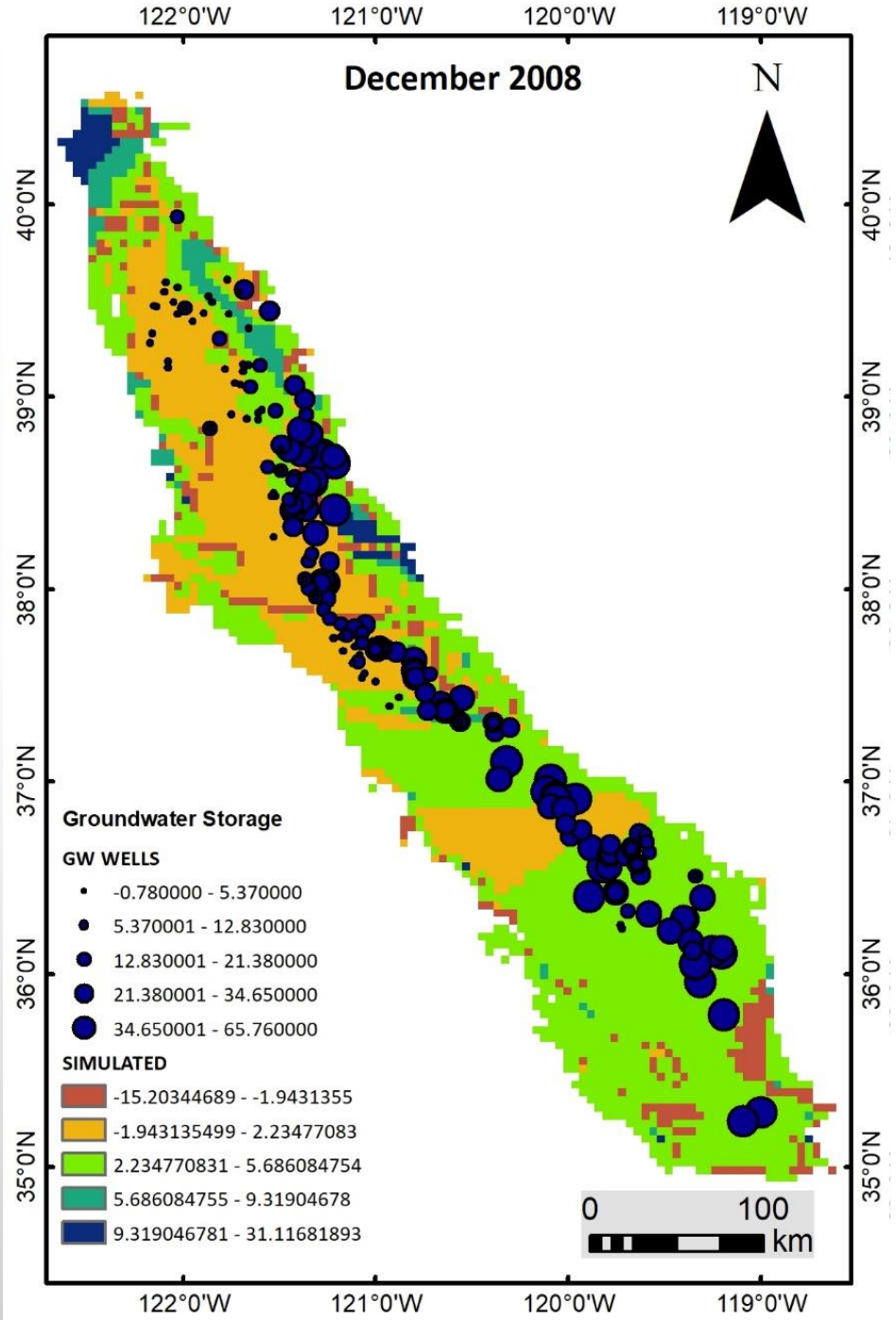
ARTIFICIAL NEURAL NETWORK

SIMULATION PHASE



SIMULATED GROUNDWATER STORAGE MAPS

Based on the predictive properties of the ANN model


December 2008
N
122°0'W
121°0'W
120°0'W
119°0'W
40°0'N
39°0'N
38°0'N
37°0'N
36°0'N
35°0'N
Groundwater Storage
GW WELLS
-0.780000 - 5.370000
5.370001 - 12.830000
12.830001 - 21.380000
21.380001 - 34.650000
34.650001 - 65.760000
SIMULATED
-15.20344689 - -1.9431355
-1.943135499 - 2.23477083
2.234770831 - 5.686084754
5.686084755 - 9.31904678
9.319046781 - 31.11681893
0
100
km

Thanks for your interest

QUESTIONS
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