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Reconstruction of regional mean sea level anomalies from tide gauges using the neural network approach

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Regional mean sea level anomalies (SLA) are estimated from tide gauge values directly using the neural network approach. A neural network is an artificial neural system, a computational model inspired by the notion of neurophysical processes. It consists of several processing elements called neurons, which are interconnected with each other exchanging information. In this presentation a backpropagation network (BPN) is used. In this type of network the neurons are ordered into layers: an input layer on the top, one or more hidden layers below and an output layer at the bottom. The connection strength between the neurons are estimated in a training phase, i.e. the BNP learns from given examples.

For our purpose 56 tide gauges are selected from the PSMSL data set that comply with the following conditions: 1) there are more than 11 annual mean values given in [1993,2005] 2) more than 50 annual mean values are given in [1900,2007] and 3) the tide gauge is neighboured by at least one ocean point on a 1x1 degree grid. The selected tide gauges are GIA corrected using the Peltier ICE5G_VM4_L90 dataset available on the PSMSL web site.

For each ocean region (trop. Indian, ... South Atlantic to Global Ocean) a separate BPN is trained that uses all tide gauges to compute the regional mean SLA's. To avoid possible problems with the local reference frame all computations are done in the space of temporal derivatives. Beyond that, this makes the data more suitable for the BPN because it better limits the possible range of the numerical values. Furthermore, known regional mean target values are needed to train the BPN. These are derived from gridded satellite altimetry data either processed by GFZ Potsdam (TOPEX/Poseidon data only) and/or the dataset available on the CSIRO sea level web side (combined TOPEX and Jason data).

Although every tide gauge has more then 50 years of data, many values are missing, especially prior to 1950. To fill these data gaps at the input layer of the BPN several alternatives are tested. This includes a reconstruction using an EOF basis estimated from all timesteps that have a complete tide gauge dataset. Furthermore a "forecast" network is build, that is trained to compute the values at all tide gauge positions for timestep (n+1) from all values at the steps (n) and (n-1). Additionally an equivalent "backcast" network is constructed that computes the values for step (n-1) from the steps (n) and (n+1).

The resulting SLA's are presented. The results appear to be relatively insensitive against what is filled into the data gaps as far as the amount of missing input data does not exceed 20%, i.e. after 1950. Nearly all regions show a sea level rise with a multidecadal/interannual variability superimposed.