Geophysical Research Abstracts
Vol. 15, EGU2013-9036, 2013
EGU General Assembly 2013

Satellite observed preferential states in soil moisture

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This study presents observational evidence for the existence of preferential states in soil moisture content.

Recently there has been much debate about the existence, location and explanations for preferential states in soil moisture. A number of studies have provided evidence either in support or against the hypothesis of a positive feedback mechanism between soil moisture and subsequent precipitation in certain regions.

Researchers who support the hypothesis that preferential states in soil moisture holds information about land atmosphere feedback base their theory on the impact of soil moisture on the evaporation process. Evaporation recycles moisture to the atmosphere and soil moisture has a direct impact on the supply part of this process but also on the partitioning of the available energy for evaporation.

According to this theory, the existence of soil moisture bimodality can be used as an indication of possible land-atmosphere feedbacks, to be compared with model simulations of soil moisture feedbacks. On the other hand, other researchers argue that seasonality in the meteorological conditions in combination with the non-linearity of soil moisture response alone can induce bimodality.

In this study we estimate the soil moisture bimodality at a global scale as derived from the recently available 30+ year ESA Climate Change Initative satellite soil moisture dataset. An Expectation-Maximization iterative algorithm is used to find the best Gaussian Mixture Model, pursuing the highest likelihood for soil moisture bimodality.

With this approach we mapped the regions where bi-modal probability distribution of soil moisture appears for each month for the period between 1979-2010. These bimodality areas are analyzed and compared to maps of model simulations of soil moisture feedbacks.

The areas where more than one preferential state exists compare surprisingly well with the map of land-atmosphere coupling strength from model simulations. This approach might therefore be useful as an additional tool to further enhance our knowledge on land-atmosphere interactions.