



## **Low-dimensional models for cereal crop cycles observed from space in semi-arid region at different geographic locations and scales**

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A low dimensional model (three variables) was recently obtained for the cycle of cereal crops in north Morocco [1, 2]. This model is chaotic, toroidal and weakly dissipative. These characteristics were unexpected since such systems were previously found only in few theoretical cases. A detailed analysis of the model's flow also reveals that a double direction extension can occur locally in the flow of the cereal crops attractor resulting from this model. Such behavior of the flow was not reported before.

In order to investigate the generality of these results, it was tried to obtain models for other sites. Several models presenting similar properties were obtained in other provinces, providing a strong argument for the existence of weakly dissipative chaos in nature. One four-dimensional model could be also obtained. This model was conservative, but it could be transformed into a chaotic model by adding dissipative terms.

[1] Mangiarotti S., Coudret R., Drapeau L. & Jarlan L., 2012. Polynomial search and Global modelling: two algorithms for modeling chaos. *Physical Review E*, 86(4), 046205.

[2] Mangiarotti S., Drapeau L. & Letellier C., 2014. Two chaotic global models for cereal crops cycles observed from satellite in Northern Morocco. *Chaos*, 24, 023130.