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Nonlinear Processes in Geophysics Discussions
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Interactive comment on "Local finite time Lyapunov exponent, local sampling and probabilistic source and destination regions" *by* A. E. BozorgMagham et al.

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The authors have proposed a method to calculate a local FTLE using temporal variations of the velocity field at a point. The application to field experiments that the authors discuss are interesting. While the underlying ideas in this paper are interesting, I have some concerns about their formulation.

The definition proposed in equation (5) and the corresponding theorem are not soundly formulated and not properly proved. It is unclear why the two conditions specified are necessary or sufficient. It is merely stated that they are sufficient. The proof that follows makes many assumptions and statements without evidence. For example how large is the Lagrangian time scale compared with δt or compared with the integration time T. How is the Lagrangian time scale defined? The separation between the source points

$\delta(x, T, t, \delta t)$ is assumed to be close to the maximum separation between the particles in the past. Is this the maximum separation over the Lagrangian time scale or is it the maximum for any time scale. Does such a maximum even exist? Why is it guaranteed that in an aperiodic flow, the average velocity at the sampling time during the small time interval δt is in fact not zero.

The proposed alternative method to calculate the FTLE is for time dependent flows. The method does not work for time independent flows, which should be mentioned by the authors. This raises the question of its validity for periodic flows. Is there a relationship between the time period of the flow, the Lagrangian time scale and δt for which the proposed definition is (in)valid?

In the last paragraph of page 909, point (iii) it is stated that, that as δt becomes smaller, errors in equations (5) and (6) decrease. However it is not clear what δ^* converges to when $\delta t = 0$. Point (iv) in the same paragraph is also stated without any proof or reason.

The authors should consider illustrating the definition and proof through the calculation of the FTLE field for simple time dependent flows and a comparison with the standard approach. The statements in the last paragraph of page 909 should also be supported with such simple examples.

The results in figures 4 and 5 are obtained through setting $\delta t = 0.1$h. The temporal resolution of the data set is stated to be 3 hours. Is the average velocity on the interval of 0.1h obtained through numerical interpolation? It is nice to note that the FTLE values in figure 4(b) do not seem to be very sensitive to the choice of δt. However this may be an artifact of the numerical interpolation. This robustness or sensitivity should be demonstrated with a simple analytical example.

On page 912, it is stated that, '*(i) by choosing smaller sampling period time, δt, the recovered local FTLE time-series converges to the true one*'. However the 'true' FTLE is not plotted in figure 4(b) for such a comparison.

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In summary, section 2 on which the paper hinges, is poorly reasoned. The proposed method to calculate the FTLE bears some resemblance to the Eulerian approach suggested in the paper 'An Eulerian approach to computing the finite time Lyapunov exponent', 2011, by S. Leung in the Journal of Computational Physics. I believe that, that the kernel of the idea on which this paper is based on, is interesting. However the definition, proof and reasoning have to improve significantly. The validity of the method and the claims in the paper should also be demonstrated with simpler analytical examples.

Interactive comment on Nonlin. Processes Geophys. Discuss., 2, 903, 2015.