Interactive comment on “Variability of sea ice deformation rates in the Arctic and their relationship with basin-scale wind forcing” by A. Herman and O. Glowacki

This paper investigates the relationship between basin scale averaged variabilities in ice deformation rate magnitudes and basin scale averaged wind stress magnitudes. Quantitative estimates of the correlation in time between wind stress magnitudes and deformation magnitudes are provided using data that present high spatio-temporal resolution and large spatial covering.

In my opinion, the strength of this study is that a systematic analysis is performed over days, seasons and years considering a highly resolved dataset such as the RGPS dataset. The results independently confirm previous observations such as the one reported by Thorndike, A.S. and R. Colony (1982) or by Rampal et al. (2009). The paper is clearly written and well structured.

However, I have two major remarks:

1- Firstly, the main result of the authors, that consists in showing that, at synoptic scales, about 70% of the variance of the ice deformation is explained by geostrophic winds, is not new and was already shown in a robust manner by

Thorndike, A.S. and R. Colony (1982) Sea ice Motion in Response to Geostrophic Winds, 87, C8, pp 5845-5852.

While Thorndike, A.S. and R. Colony (1982) mainly based their discussion on the variance of sea ice velocities, they report that about half of the variance of the ice deformation is explained as a linear response to the geostrophic wind. These observations made by Thorndike, A.S. and R. Colony (1982) have been obtained over a spatial scale of about 500km, which is of the order of the basin scale average performed in this present study.

At least, the authors should cite the study of Thorndike, A.S. and R. Colony (1982) and discuss about the new insights and improvements that the present study provides with respect to this later.

2- Secondly, the variation of the correlation coefficient C(L) computed at various spatial average scales L is not discussed in this study, and would be the source of great improvements of the paper.

Indeed, this study reports large correlations in time between averaged deformation rates and wind stress magnitude at the spatial scale of the basin. As discussed above, this aspect is not new. I agree that the authors consider various spatial scales to compute the strain, but I do not figure out the objective in doing this, as the correlation with wind stress amplitude remains performed at the scale of the basin. Indeed, as argued by the authors in line 18 of page 3356, since a linear relationship between log(<ε>) and log(L) is obtained (cf also Marsan et al. (2004)), no strong dependance of C on L is reported. So, Figure 4 of the paper does not bring further insight.

However, in my mind, a new insight in the physics of sea ice deformation should be provided in this study by evaluating the correlation between wind stress magnitudes and ice deformation rates magnitudes at smaller spatial scales. As the coarse graining method has already been developped by the authors, this may not imply to much work. Indeed, we can expect to identify a characteristic spatial scale under which the correlation between wind stress magnitudes and ice deformation rate magnitudes is lost. At these small scales, we expect the deformation patterns to not reflect wind stress anymore, but to rather result from the intrinsec multi-fractal fracturing process of deformation of the ice cover.

This could be achieved by correlating wind stress and ice deformation amplitudes for each given cell box size L prior to average the correlation coefficient over the whole Arctic basin.

Minor Comments:

- On Figure 1 (c), the shape of scalings the authors obtain seems to deviate from power law scaling at large scales, which is not observed by Marsan et al. (2004). Do the authors have any comment on this ?

- Moreover, on Figure 1 (c), variation of $<\varepsilon>$ versus scale L for considering low values of q cannot be visible, since the slopes are much smaller than for larger values of q.
  I suggest to add another Figure in Fig 1 that would show a zoom on scalings obtained considering q=1 in both february and april, in order to precisely see an exemple of scaling shapes obtained for small values of q.

- Figures 1c and 4 : a log binning on the spatial scales L would have been better to consider in order to compute deformation rates at various spatial scales, i.e. considering for exemple L that successively takes the following values : 12,5 km – 20 km - 33 km - 55 km - 90 km – 145 km - 230 km – 380 km - 615 km – 1000 km. Indeed, the dots on Figure 1(c) and the X coordinate of Figure 4 has to be logarithmically scaled. As is, we majoritarily see the behaviour at large scales and do not figure out what happens at smaller scales, where the dynamics is much larger.

- 3353 – 6. Can the authors briefly qualitatively discuss about the correlation coefficients C obtained in summer. These later should be larger, as expected from a situation closer to 'free drift' behaviour ? This is basically what is reported by Thorndike, A.S. and R. Colony (1982) who found, at a spatial scale of 400 km, a correlation coefficient of 0,75 in winter and spring and 0,80 in summer and fall when looking to ice displacements variability.

- 3354- line 13 to 16 : I don't understand this statement. I think more details have to be provided.

- 3354 - 8 What happens if Δt is considered greater than 2 days ? Is the correlation lost ?

- 3356-20 : What do you mean by a 99% confidence level ?

 - 3360-1 : The positive trend in the inertial-motion intensity in the Arctic over the last decade is reported in

> Gimbert, F., Marsan, D., Weiss, J., Jourdain, N. C., and Barnier, B.: Sea ice inertial oscillation magnitudes in the Arctic basin, The Cryosphere Discuss., 6, 2179-2220, doi:10.5194/tcd-6-2179-2012, 2012.

while the interpretation in term of mechanical weakening is reported in

> Gimbert, F., N. C. Jourdain, D. Marsan, J. Weiss, and B. Barnier (2012), Recent mechanical weakening of the Arctic sea ice cover as revealed from larger inertial oscillations, *J. Geophys. Res.*, 117, C00J12, doi:10.1029/2011JC007633.