**Comments** on the manuscript egussphere-2022-965 „Vortex streets in the lee of Madeira in a km-resolution regional climate model" by Gao et al.

## General comments

The paper deals with atmospheric vortex streets in the lee of the island Madeira. The phenonemon of vortex streets has obtained considerable interest in the last decades, since vortex streets have been observed by the first meteorological satellites. The studies on vortex streets have been of the types pure observational using satellite images, purely theoretical on the physical mechanism of vortex shedding, numerical simulations of idealized situations concerning obstacle forms and basic flow conditions, numerical simulations for concrete observed cases for real islands and climatological studies concerning frequency of vortex streets appearance. Various examples are listed in the quite comprehensive reference list of this paper. Hence one might wonder, which new aspect on this topic the authors can present to the readership.

To the knowledge of the reviewer it is the first time, that a climatological statistic of vortex shedding for a concrete island (here: Madeira) has been established based purely on numerical simulations. In order to manage this, the authors had to develop an automatic vortex identification scheme for the output of a high resolution climate model. As this identification scheme is quite universal it can be applied also to other models or for the same model concerning other islands where vortex streets are quite common. The choice of Madeira as first object for a model-based vortex street climatology is well founded, as many studies of vortex streets for Madeira have been published and also a vortex climatology is available based on satellite observations (Grubisic et al, 2015).

In summary, the paper adds quite new information on the problem of atmospheric vortex shedding by islands and the methods developed herein can be applied to other vortex climatologies from numerical model outputs. Hence the paper is well recommended for publication subject to some minor changes as listed below.

## Special comments

1.Vortex counting

The climatology of vortex shedding behind Madeira is obtained by hourly counting the vortices in the area shown in Fig. 15 applying the rules described in section 2.4. Now there are also daily counts, monthly counts etc. (see Figures 8, 16, 17). How are these obtained? Is the daily count the sum of the hourly counts etc.? The reason for this question is the following: Once a vortex is shed from the island, it will be counted every hour during its lifetime. During this time, it will move downstream and depending on its lifetime, the final position will vary in the counting area (Figure 15). The lifetime of all vortices during the 10 year period is reflected indirectly by the distribution of counted vortices shown in Figure 15. Now let us suppose, during one day only 1 vortex is shed from Madeira. This would appear in the hourly count as 1. In 24 hours it would be counted 24 times. Hence the daily count would be 24, but there is only this one vortex in the area. So the daily count would not give the number of different vortices identified during one day but the number of the hourly positions of all vortices during this day. The same could hold for weekly and monthly or total count(?).

The authors are asked for clarifying their "counting method".

2.Temperature profiles

From the current study (as well from other studies) it is apperant, that the location of the temperature inversion in the marine atmospheric boundary layer (MBL) plays a crucial role in the formation of vortex streets behind islands (i.e. the inversion height must be less than the island height). It would therefore of advantage, if a typical vertical profile of potential temperature (and also wind speed) in the MBL for Madeira would be presented as derived from observations and from the model output. This should be done for day 2010-08-06 of the case study, for which many Figures are shown. By this one could also judge the performance of the model concerning strong inversions in the MBL.

2.Froude number-dimensionless mountain height

It is apparent from the literature, that the frequency of vortex shedding from islands is not only dependent in the height of the temperature inversion but also on the upstream wind speed. The combined effect is usually characterized by a Froude-number Fr or the dimensionless mountain height $h_{dim}$ = 1/Fr (see section 2.3). Vortex shedding is favourable for say e.g. Fr ≤ 0.3 or $d_{dim}$ ≥ 3 or so. The authors show this for the case study in Figure 8, but it would be also of interest, if the relation is also valid for the whole climatology from the long term model runs. Hence if the data on Fr or $h_{dim}$ have been stored for the whole period, they should be presented e.g. in Figure 7, where the climatology for the inversion height is also shown. One could compare then $h_{dim}$ or Fr with the vortex counts in Figure 17b.

3.Inversion height and vortex shedding

From comparing Figure 7 with Figure 17b it seems apparent, that a low inversion height is favourable for vortex formation, whereas a high inversion is not. But in the discussion of the case study (shown in Figure 8) on page 14 the authors write:

*„In addition, a sudden increase of the inversion base over e3 in the solid blue line at 2010-08-06 05:00 UTC also precedes the increasing vortex shedding signal".*

Is this not a contradiction to Figs 7 and 17b? Or is the decrease of the wind speed during this period the reason for the increasing vortex signal?