Geosci. Model Dev. Discuss.,
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Geoscientific Model Development Discussions

Interactive comment on "Quasi-hydrostatic equations for climate models and the study on linear instability" *by* Robert Nigmatulin and Xiulin Xu

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Dear Authors,

> *Thank you for your consistent attention to our paper.*

Not at all, since your theorem directly contradicts the existence of convection and gravity waves (except for the long ones), you can count on my constant attention further on.

> *Although we have answered your questions in a lot of conferences.*

Actually you (the first Author) did not. I did not get the answers to my questions. Instead, I am being fired by the first Author. And I will show below, that although now you have put some formulas, you reply just does not contain anywhere the answers to my direct questions.

1 The main question

Even now you did not answer the question about the proof of the statement in your theorem, that for small vertical acceleration (normalized by gravity), the hydrostatic approximation (with equation for change of vertical momentum being replaced by hydrostatic balance) is asymptotically exact. *Please, give a proof, or otherwise can you tell that it is your secret know-how?*

This is the most important question I ask you for more than 3 years, since I consider such a theorem to be very harmful in the walls of a University. All other mistakes are of minor importance, because nowadays nobody uses L.F. Richardson's framework for weather prediction, and it is important mostly for historical reasons.

2 About your 1-st answer on the question *1. They estimate the scale of the divergence of first term by the scale of only one component. But the divergence itself is by order(s) of magnitude less than scale its components.*

Again in your "answer" you continue to estimate $div_{hor}(\rho\vec{v}_{hor})$ as $\hat{\rho}\,\dfrac{V_{hor}}{L_{hor}}$, so as a scale of one component without any explanation. Is it so? Do not put other formulas, just answer this question, that I have asked. I repeat again that this estimation is not correct for large-scale atmospheric dynamics.

You begin B, γ, M and other quantities for estimation of pressure advection, but it was not a part of the question.

So, to count down this question as answered, please answer directly only about the estimation of the divergence of the horizontal mass flux, that is $\text{div}_{hor}(\rho \vec{v}_{hor})$.

3 About your 2-d answer on the question *2. They estimate the* $\nabla_{hor} p$ dynamically *as* $\rho U^2/L$*.*

I've made a misprint by omitting ρ, sorry for that. Yes, I've meant exactly what you put in your "answers" again and again, that $\frac{\partial p}{\partial x}, \frac{\partial p}{\partial y} = \rho O \left(\frac{V_{hor}^2}{L_{hor}} + \frac{V_{hor}^2}{L_{hor}} \right)$. For a general case of large-scale atmospheric dynamics this estimation is wrong for the reasons, I've mentioned in my previous message.

Do you want one of the counter-examples? Take the geostrophic balance

$$f \cdot v = \frac{1}{\rho} \frac{\partial p}{\partial x} f \cdot u = -\frac{1}{\rho} \frac{\partial p}{\partial y}$$

Here $\frac{\partial p}{\partial x} = \rho f O(V_{hor})$. But not only that what is important. The atmosphere accumulates the mechanical energy, so the velocity in the zonal winds and motion of the air masses can not always be explained straightforwardly just due to the pressure gradients, as if it had appeared from a state of rest.

4 > *About the violation of energy conservation, please refer to our reply to Anonymous Referee* $\#1$*.*

Your reply to Anonymous Referee $\#1$ does not contain the answer the problem of the conservation of the full energy, if $\frac{dp}{dt}$ is not correctly computed.

5 Finally, *And we have to point out that in the stationary state when your wagon moves with a constant velocity v = const, the pressure gradient always equals to zero* $\left(\frac{\partial p}{\partial x} = 0\right)$*.*

I would recommend to read some books on mathematical physics about the concepts of total and partial derivative.

In the picture I attach again the pressure somewhere on the bottom of the wagon is roughly equal to height of the column of sand above it (it works better if the wagon is very long). I've tried to show that it is the total derivative of pressure that is equal to zero, since the form of the surface of sand does not change with respect to the wagon.

But the partial derivative of the pressure over x is not equal to zero, since the level of sand near the borders is much less than in the center.

I'm sorry, that you can not get the idea even from the such an illustration.

To make the illustration more vivid, imagine an action movie, and that somebody tries to escape a prison in a wagon with sand. If you hide below the sand on the bottom near the right border, the weight of the sand over you will be bearable, and there are chances that you will survive. But if a humankind will hide at the bottom at the center of the wagon, he can be smashed by the weight of the tons of sand above him. So the pressure is different along the wagon, and $\frac{\partial p}{\partial x} \Delta x$ is the drop of pressure over Δx.

Now, if the wagon will move along the railway, but you will stay on the bottom without any motion with respect to the wagon, the total derivative of pressure $\frac{dp}{dt}$ will be exactly ZERO. Now we remember that $\frac{dp}{dt} = \frac{\partial p}{\partial t} + v\frac{\partial p}{\partial x} = 0$, $\frac{\partial p}{\partial t} = -v\frac{\partial p}{\partial x}$, so partial derivative of pressure is equal to its advection, and can take quite a big value. So if you now "neglect" advection of pressure $v\frac{\partial p}{\partial x}$ you will get some strange and may be quite a big value of $\frac{dp}{dt}$ instead of ZERO.

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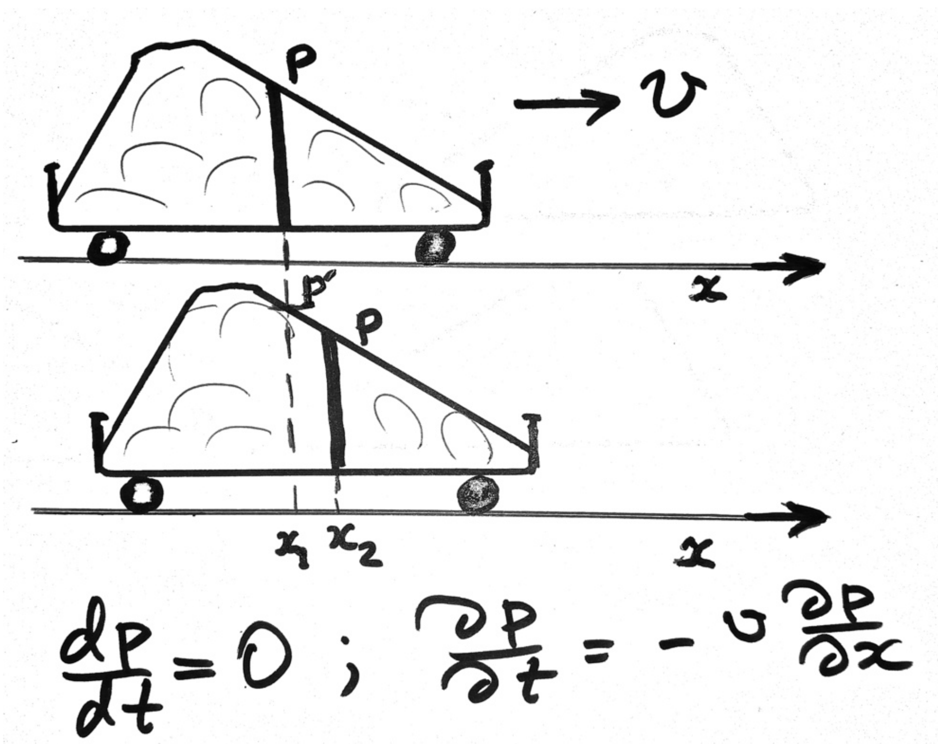

Fig. 1.