The following is my review of manuscript 2010GL043834R, "Horizontal atmospheric pressure gradients associated with condensation of water vapor," by Makarieva et al. This paper is demonstrably false and must be rejected.

The source of error is the definition of S in the first paragraph of section 2 and equation (3). This equation is incorrect. It is simple to see this: in the limit of $N_d = 0$, we get $N = N_v$ and this definition of S is zero regardless of how large the actual sink of water vapor is.

I should not have to say anything more about this paper, but I will for pedagogical reasons. If $\partial N_v/\partial x = 0$ as assumed by the authors, then we can start with the continuity equations for N_d and N_v to obtain

$$\begin{aligned} \frac{\partial u}{\partial x} &= -\frac{1}{N_d}\frac{\partial(N_d w)}{\partial z} - u\frac{1}{N_d}\frac{\partial N_d}{\partial x} \\ N_v\frac{\partial u}{\partial x} + \frac{\partial(N_v w)}{\partial z} &= S\,. \end{aligned}$$

Substituting the first equation into the second gives a correct version of equation (3),

$$S = \frac{\partial(N_v w)}{\partial z} - \frac{N_v}{N_d}\frac{\partial(N_d w)}{\partial z} - u\frac{N_v}{N_d}\frac{\partial N_d}{\partial x}\,. \tag{3}$$

Note that this is quite different from the equation (3) given in the paper. Nevertheless, we can try to make this look more like the authors' equation (3) by assuming that we are at a point in space at which $u = 0$ (but not necessarily $\partial u/\partial x = 0$) and $\partial w/\partial z = 0$. In that case, we can write

$$S = w\left(\frac{\partial N_v}{\partial z} - \frac{N_v}{N_d}\frac{\partial N_d}{\partial z}\right)\,.$$

Equations (4–5) then become

$$\frac{\partial(N_d u)}{\partial x} + \frac{\partial(N_d w)}{\partial z} = 0\,, \tag{4}$$

$$\frac{\partial(N_v u)}{\partial x} + \frac{\partial(N_v w)}{\partial z} = w\left(\frac{\partial N_v}{\partial z} - \frac{N_v}{N_d}\frac{\partial N_d}{\partial z}\right)\,. \tag{5}$$

Assuming that the saturated atmosphere is isothermal in the horizontal ($\partial T/\partial x = 0$), we can assume that $\partial N_v/\partial x = 0$. With this assumption, we can obtain from the corrected equation (5) the corrected equation (7), which is obtained by multiplying by N_d/N_v instead of N/N_v:

$$N_d\frac{\partial u}{\partial x} + N_d\frac{\partial w}{\partial z} + w\frac{\partial N_d}{\partial z} = 0\,. \tag{7}$$

This equation does not give us anything we did not already know from the continuity equation for N_d and the assumption of $u = 0$. If we conveniently forgot that $u = 0$, then we could continue with the same type of logic used by the authors to conclude that combining equations (4) and (7) gives $\partial N_d/\partial x = 0$. Since, by assumption, $\partial N_v/\partial x = 0$, we get that $\partial N/\partial x = 0$. Since $p = NRT$, and since $\partial T/\partial x = \partial N/\partial x = 0$, we would conclude that $\partial p/\partial x = 0$. In other words, there is no pressure gradient – but this is all gibberish anyway because we divided by zero!

Let me go through these steps from one more angle. Let us again take $\partial N_v/\partial x = 0$ as assumed by the authors, but this time we will begin with the continuity equations for N and N_v, which we can rearrange to get

$$\begin{aligned} \frac{\partial u}{\partial x} &= \frac{1}{N}S - \frac{1}{N}\frac{\partial(Nw)}{\partial z} - u\frac{1}{N}\frac{\partial N_d}{\partial x} \\ N_v\frac{\partial u}{\partial x} + \frac{\partial(N_v w)}{\partial z} &= S\,. \end{aligned}$$

Substituting the first equation into the second gives a correct version of equation (3),

$$(1 - N_v/N)S = \frac{\partial(N_v w)}{\partial z} - \frac{N_v}{N}\frac{\partial(Nw)}{\partial z} - u\frac{N_v}{N}\frac{\partial N_d}{\partial x}\,. \tag{3}$$

If we once again assume that $u = 0$ and $\partial w/\partial z = 0$, then we can make this look a bit more like the authors' equation (3) as follows:

$$S = \frac{w}{1 - N_v/N}\left(\frac{\partial N_v}{\partial z} - \frac{N_v}{N}\frac{\partial N}{\partial z}\right)\,.$$

Then, equations (4–5) become

$$\frac{\partial(N_d u)}{\partial x} + \frac{\partial(N_d w)}{\partial z} = 0\,, \tag{4}$$

$$\frac{\partial(N_v u)}{\partial x} + \frac{\partial(N_v w)}{\partial z} = \frac{w}{1 - N_v/N}\left(\frac{\partial N_v}{\partial z} - \frac{N_v}{N}\frac{\partial N}{\partial z}\right)\,. \tag{5}$$

Using the authors' assumption of $\partial N_v/\partial x = 0$, we can multiply the corrected equation (5) by N/N_v to get the corrected equation (7):

$$N\frac{\partial u}{\partial x} + N\frac{\partial w}{\partial z} - \frac{w}{1 - N_v/N}\frac{\partial N_v}{\partial z} + \frac{w}{1 - N_v/N}\frac{\partial N}{\partial z} = 0\,. \tag{7}$$

Multiplying by $1 - N_v/N$ gives

$$N\frac{\partial u}{\partial x} + N\frac{\partial w}{\partial z} - N_v\frac{\partial u}{\partial x} - N_v\frac{\partial w}{\partial z} - w\frac{\partial N_v}{\partial z} + w\frac{\partial N}{\partial z} = 0\,.$$

Using $N - N_v = N_d$, we get

$$N_d\frac{\partial u}{\partial x} + N_d\frac{\partial w}{\partial z} + w\frac{\partial N_d}{\partial z} = 0\,.$$

This is the same equation we got before, which contains no new information. The theme here is simple: if you do not add any new equations, you are not going to get any new piece of information. If, in the future, the authors wish to study pressure gradients, I encourage them to use the momentum equations.