$-\vec{V} \cdot \nabla$ is pronounced "ADVECTION OF" (any **field** placed to the right, like T)
$-\nabla \cdot \vec{F}$ is pronounced "CONVERGENCE OF" (any **vector flux field F** to its right)

TRANSPORT is one of the **tendencies** in an Eulerian (local) time derivative $\frac{\partial}{\partial t}$:

$$\frac{\partial q}{\partial t} = TRANSPORTS_q + (SOURCES - SINKS)_q$$

TRANSPORTS include large-scale transport by wind plus small-scale transport.

- Small-scale **diffusion** involves the random swapping of neighboring molecules. Similar swapping of tiny puffs of air, which we don't care enough about to treat as "wind" patterns, is also treated the same way: as *eddy diffusion*. Notice that neighbor-swapping raises lower values and lowers higher values: it is **a flux down the gradient (from high to low values of the transported substance).**

- Large-scale transport can be written as either FLUX CONVERGENCE or ADVECTION as written above. Why choose one or the other? **Advection** is easier to understand at a point: *look immediately upwind, what condition is the wind bringing and how fast?* **Flux convergence** is useful because it integrates precisely to zero (vanishes) over area or volume of the whole unbounded atmosphere, because it integrates precisely to the *boundary flux* for a limited region of space.

Advection-diffusion equation for smoke concentration q_s:

$$\frac{\partial q_s}{\partial t} = -\vec{V} \cdot \nabla q_s - \nabla \cdot (-K \nabla q_s) = -\vec{V} \cdot \nabla q_s + K \nabla^2 q_s$$

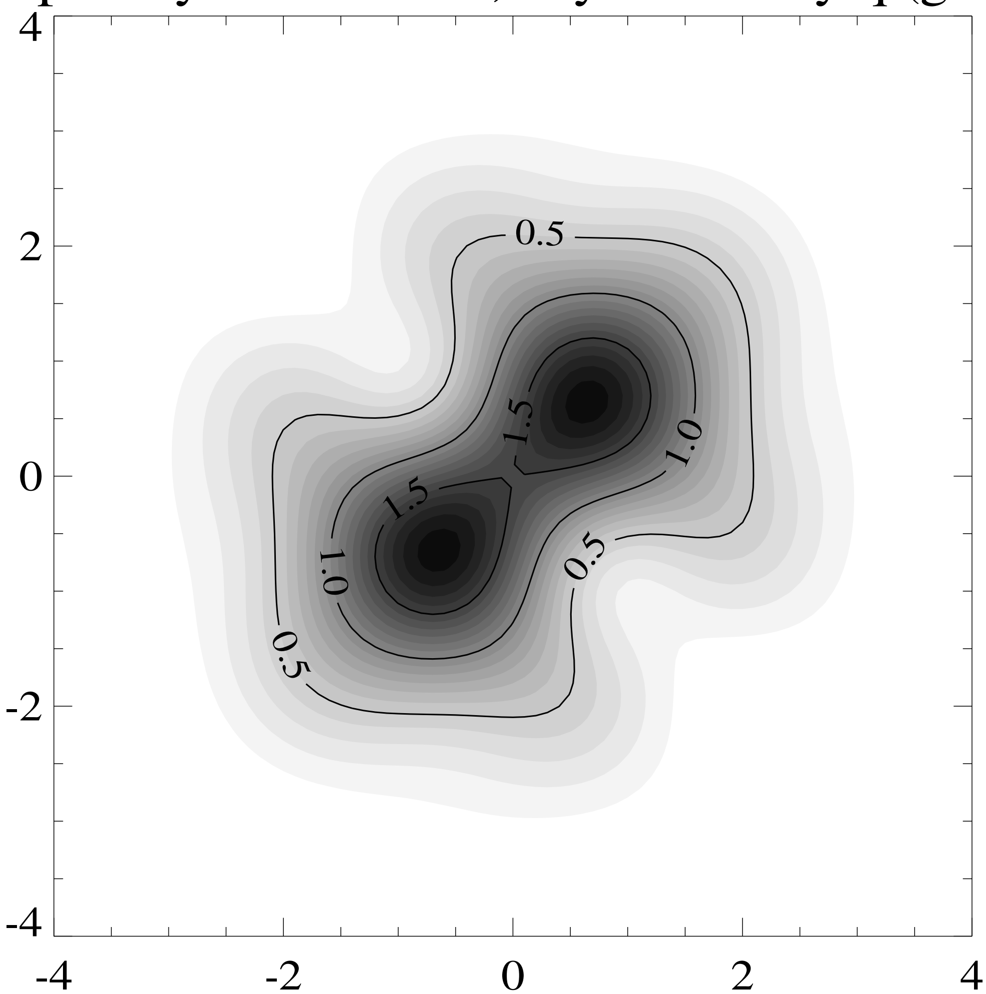
Prononunced: *the local rate of change of smokiness at any point is equal to the advective tendency brining conditions from upwind, plus the convergence of a down-gradient or "diffusive" flux*

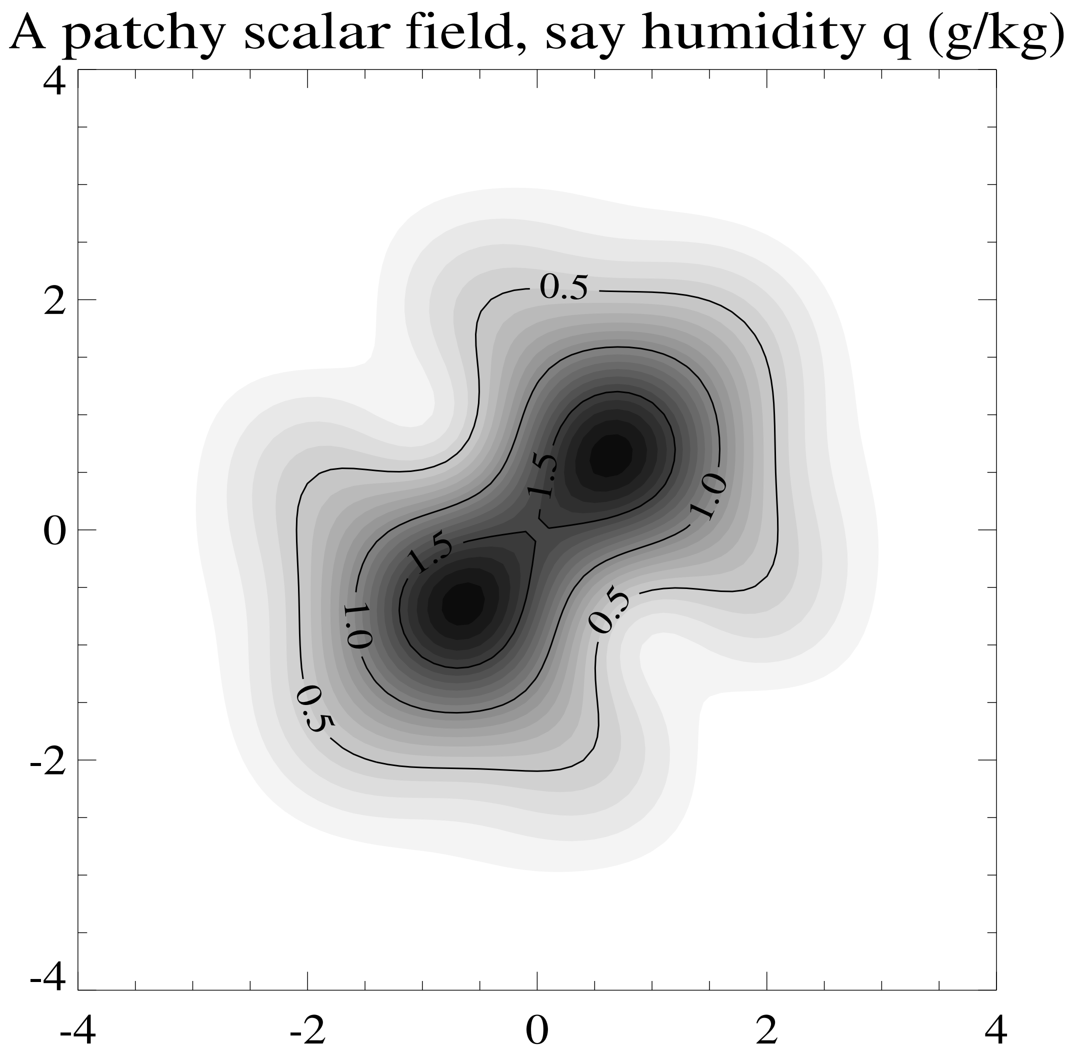
Sometimes written most compactly as:

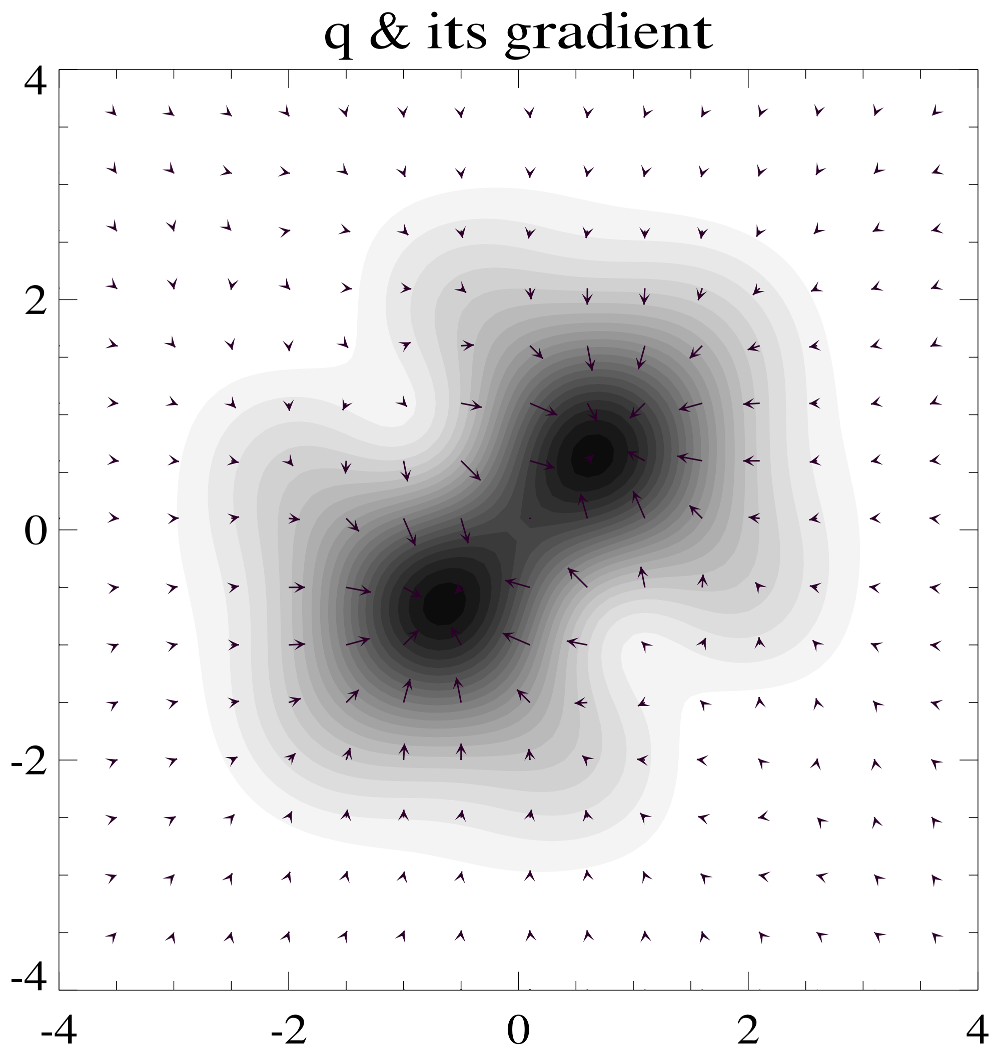
$$\frac{d}{dt}(q_s) = K \nabla^2 q_s$$

Smoke mass concentration qs

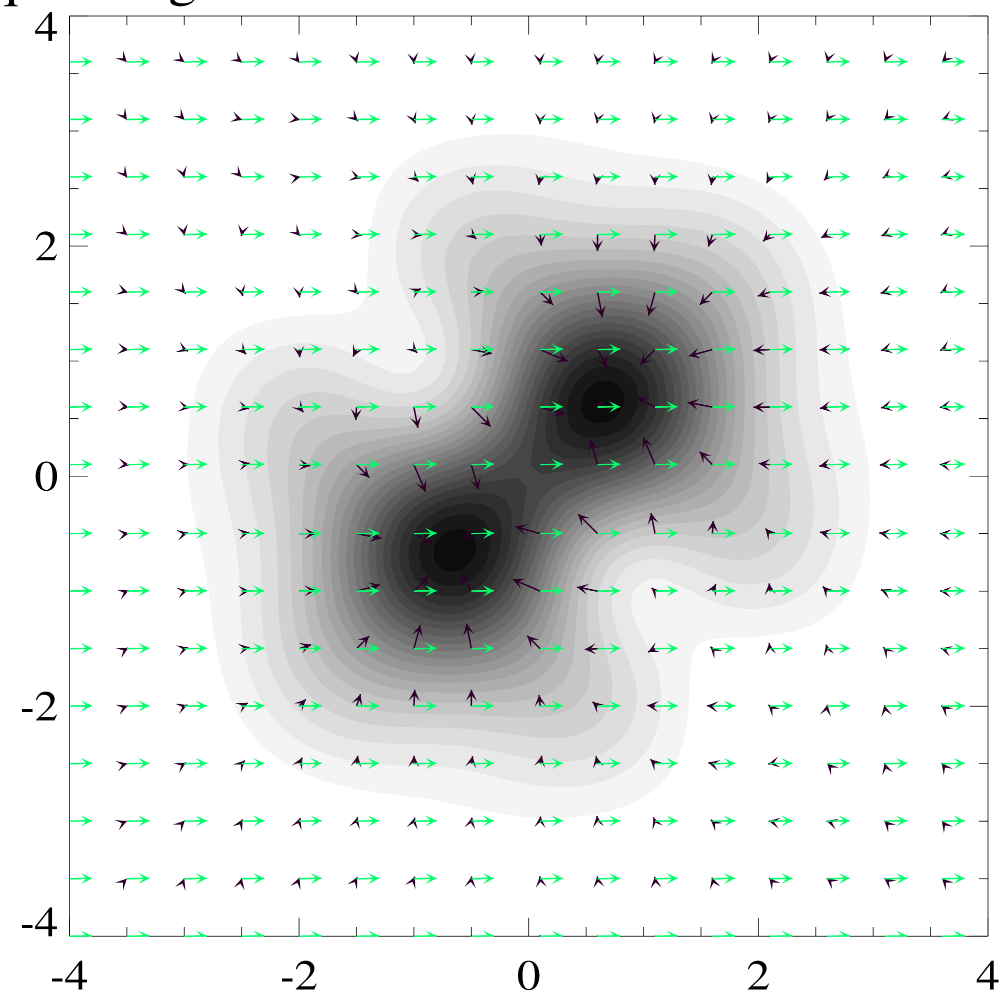
A patchy scalar field, say ~~humidity~~ q (g/kg)

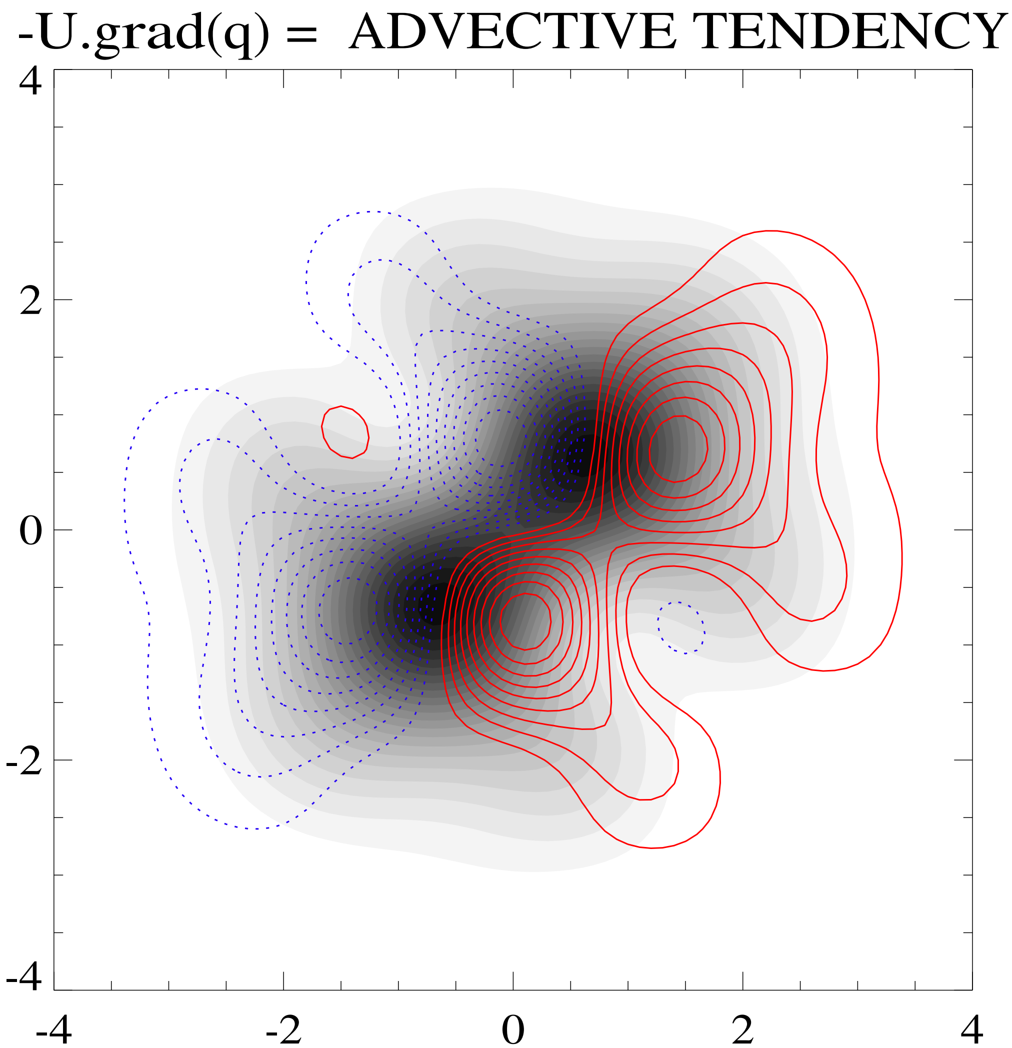


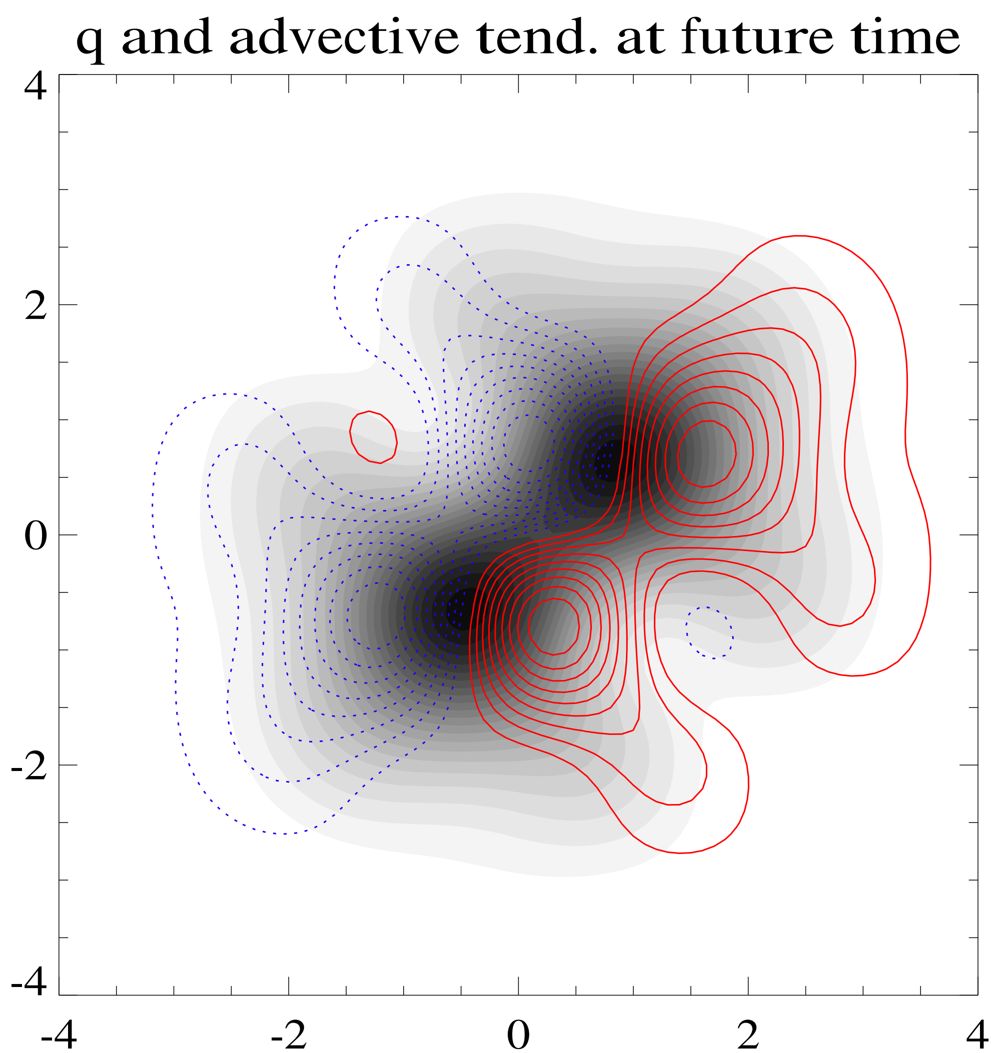

A patchy scalar field, say humidity q (g/kg)
0.5
1.0
1.5
4
2
0
-2
-4
-4
-2
0
2
4

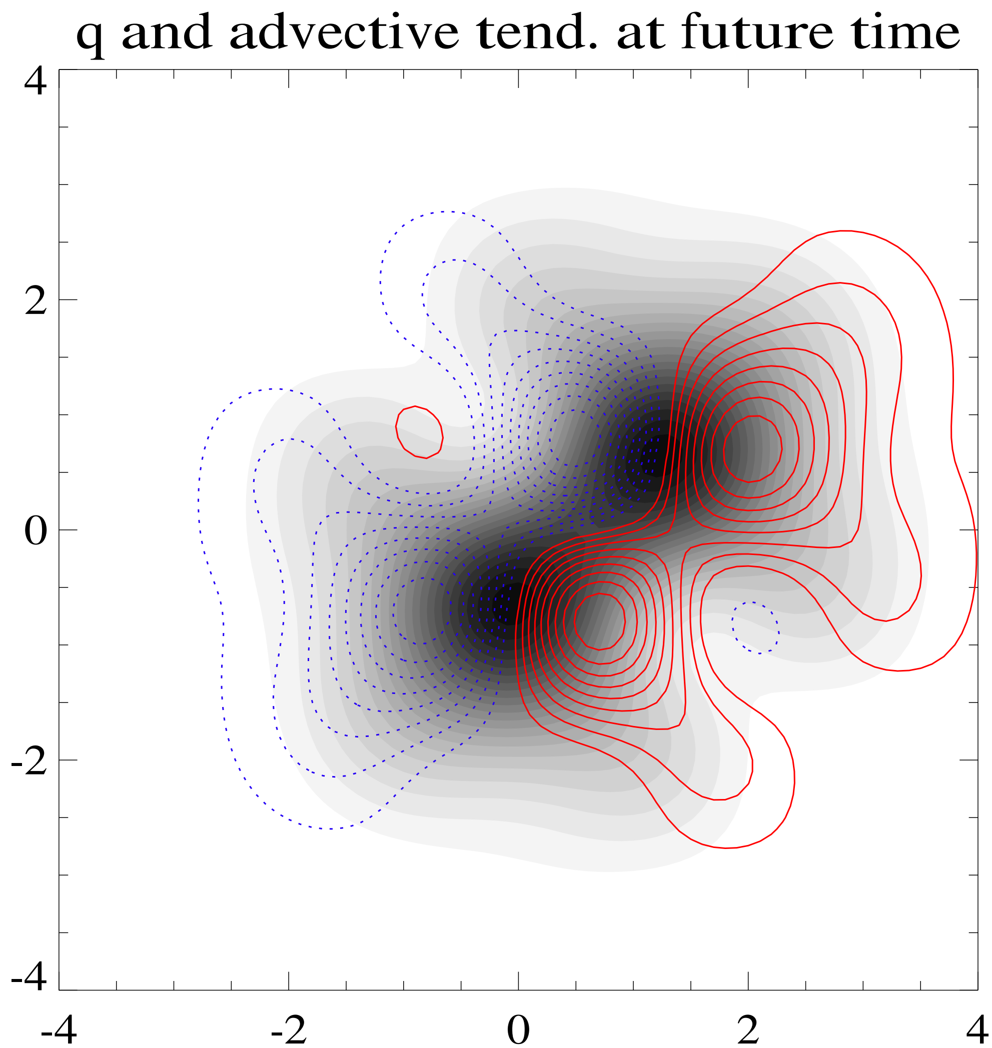

q & its gradient
4
2
0
-2
-4
-4
-2
0
2
4

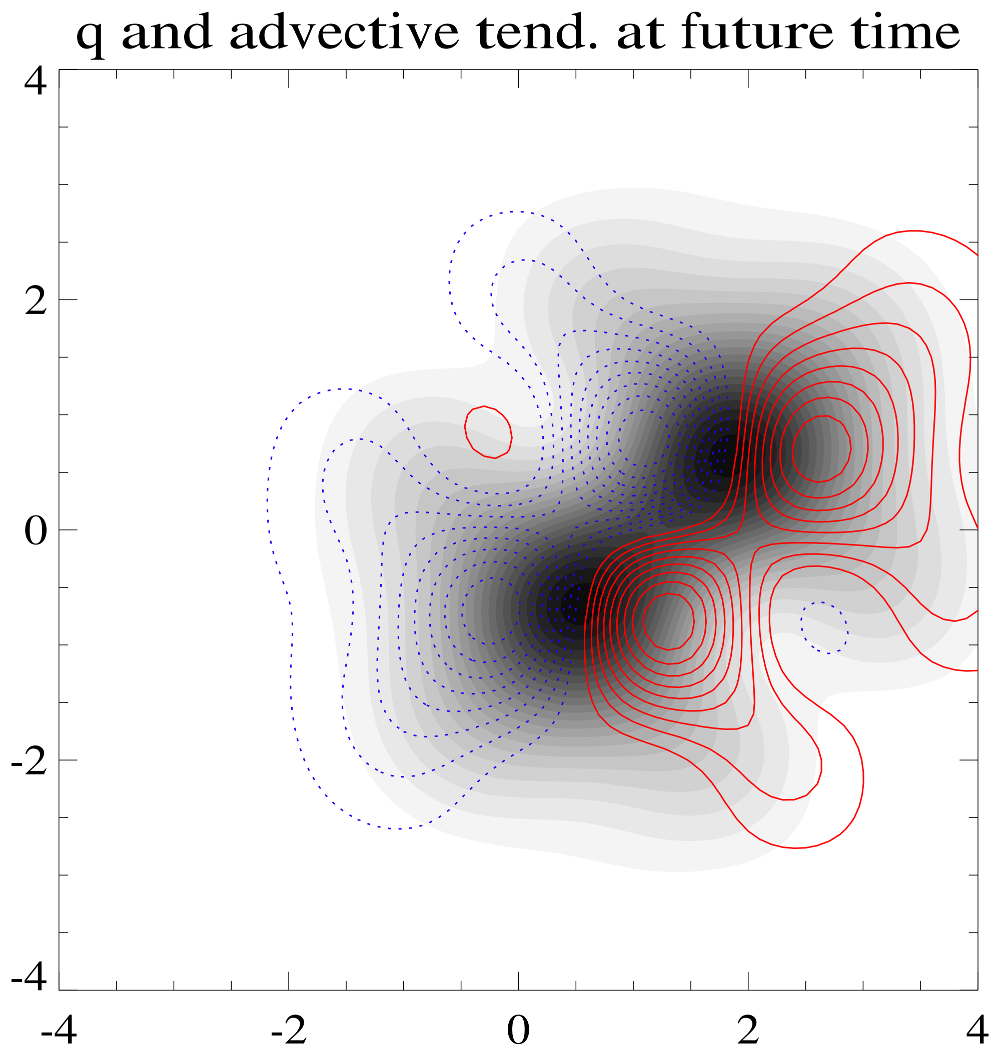
q & its gradient AND A CONSTANT WIND



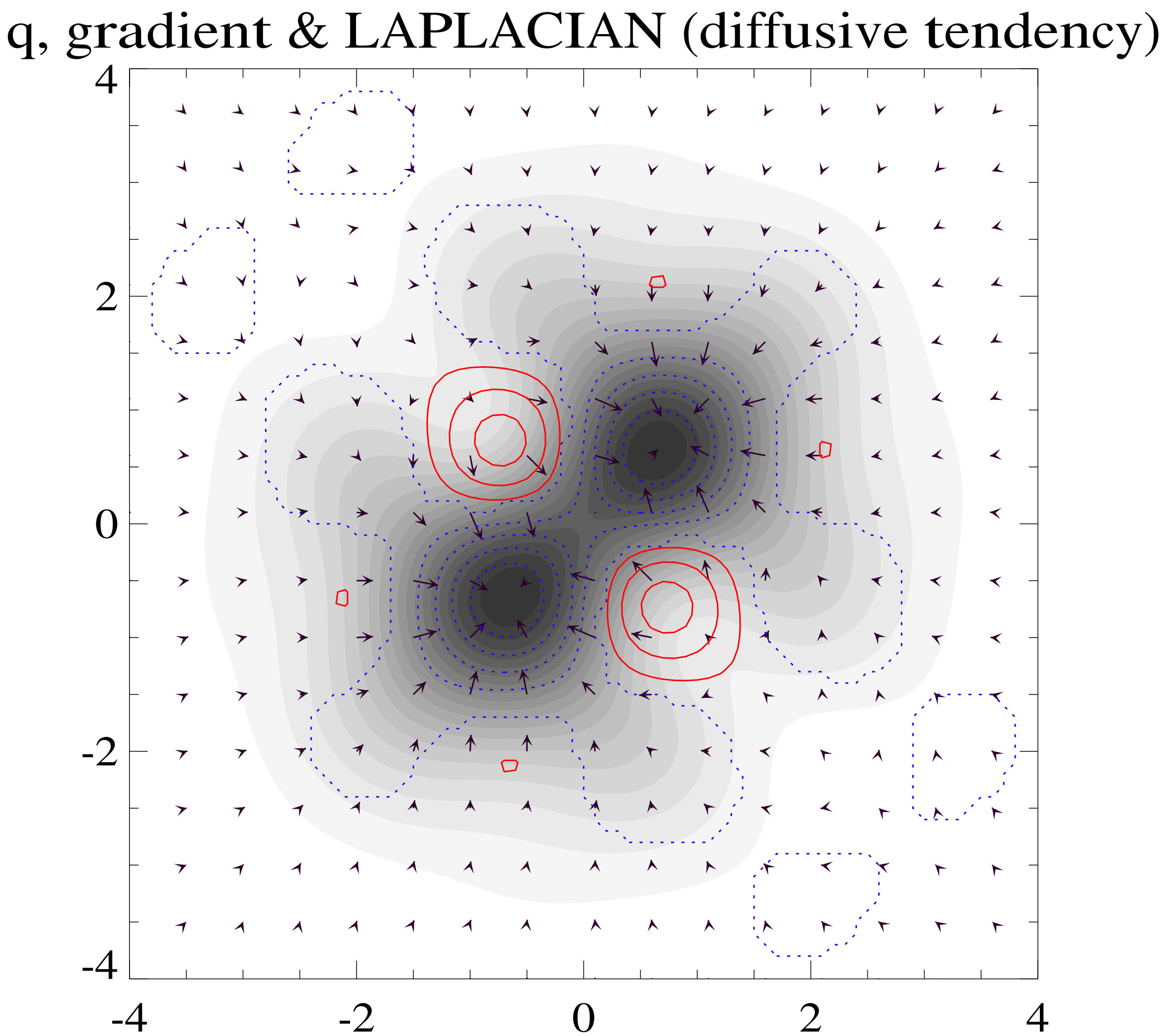

-U.grad(q) = ADVECTIVE TENDENCY
4
2
0
-2
-4
-4
-2
0
2
4

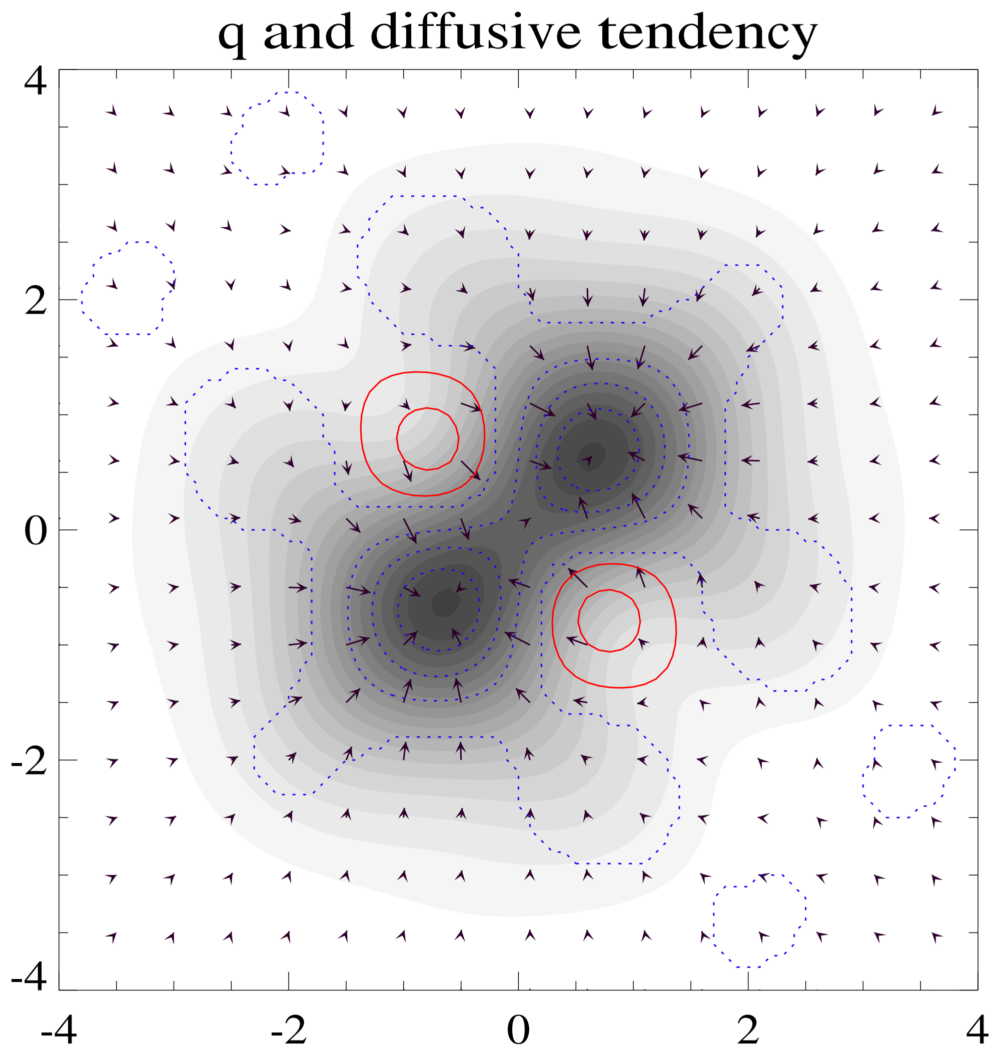

q and advective tend. at future time
4
2
0
-2
-4
-4
-2
0
2
4

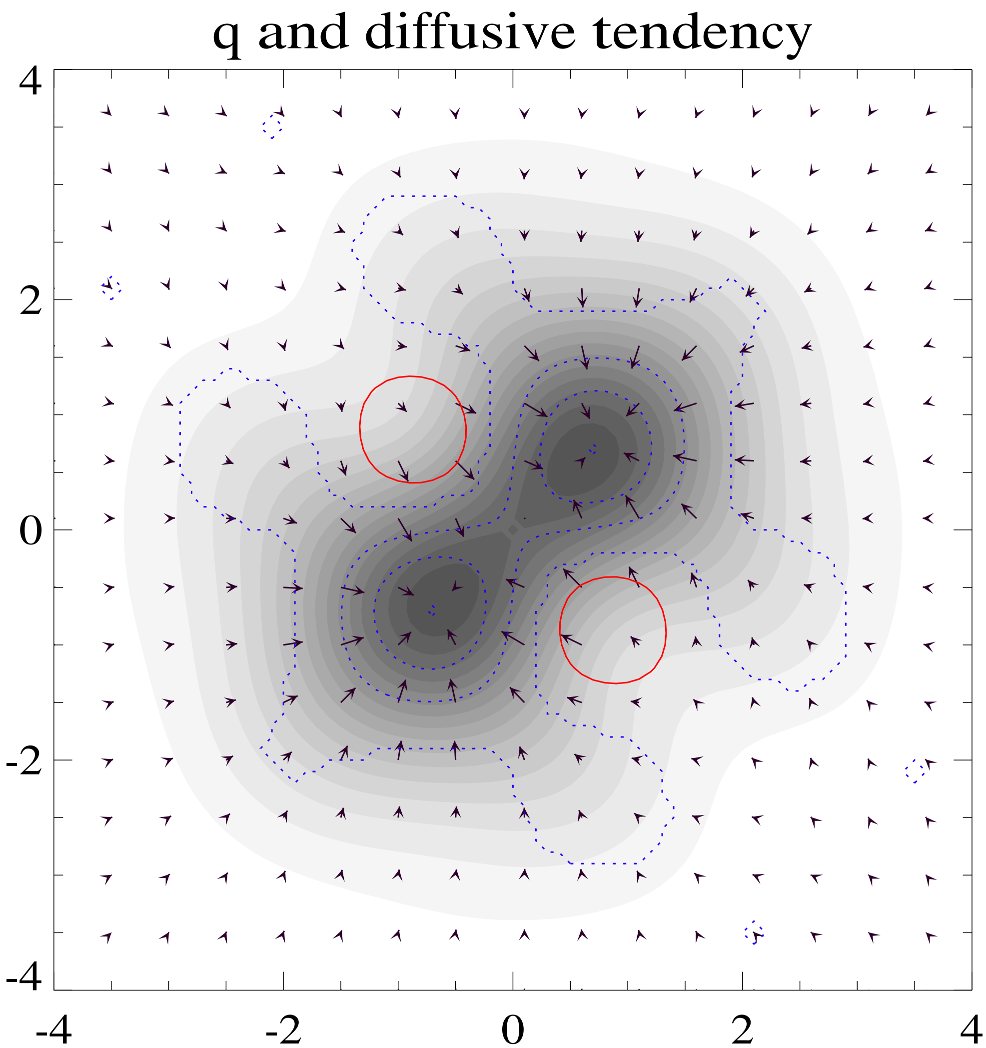


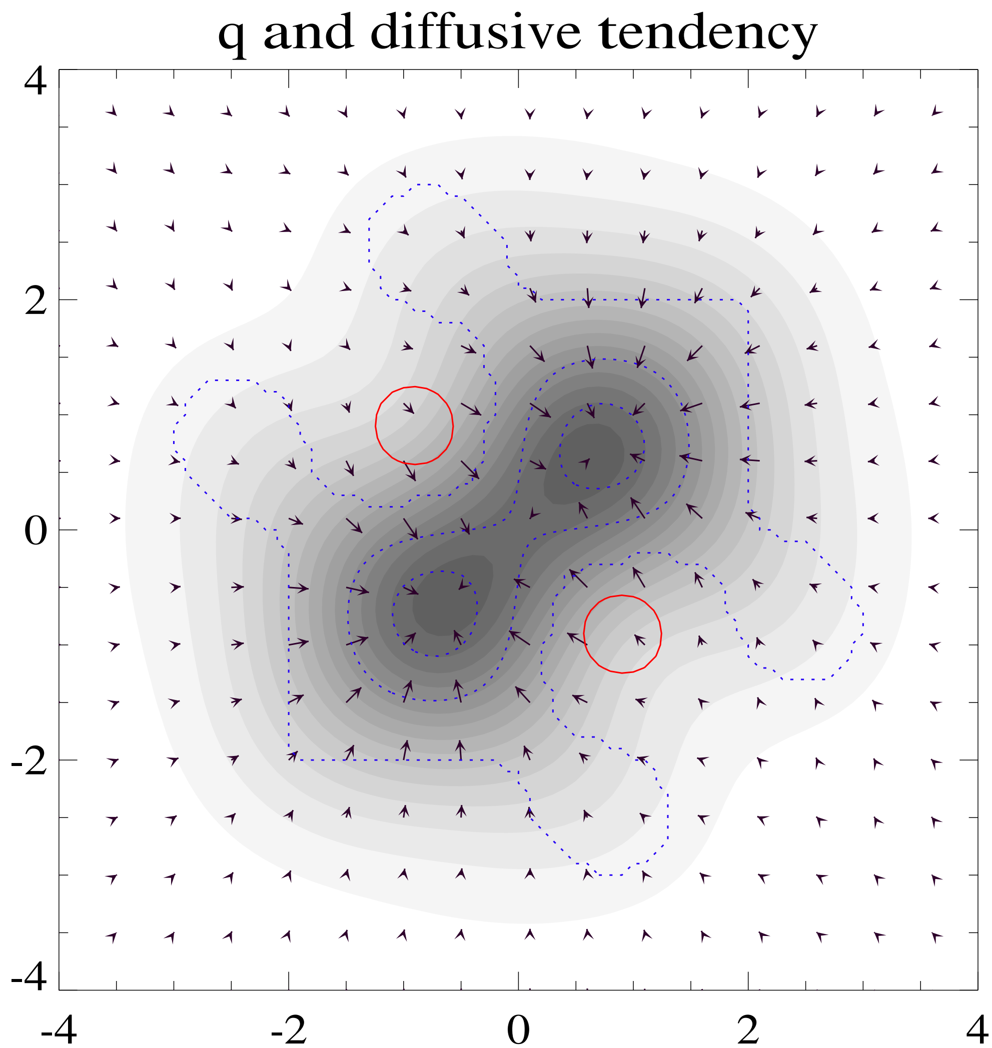


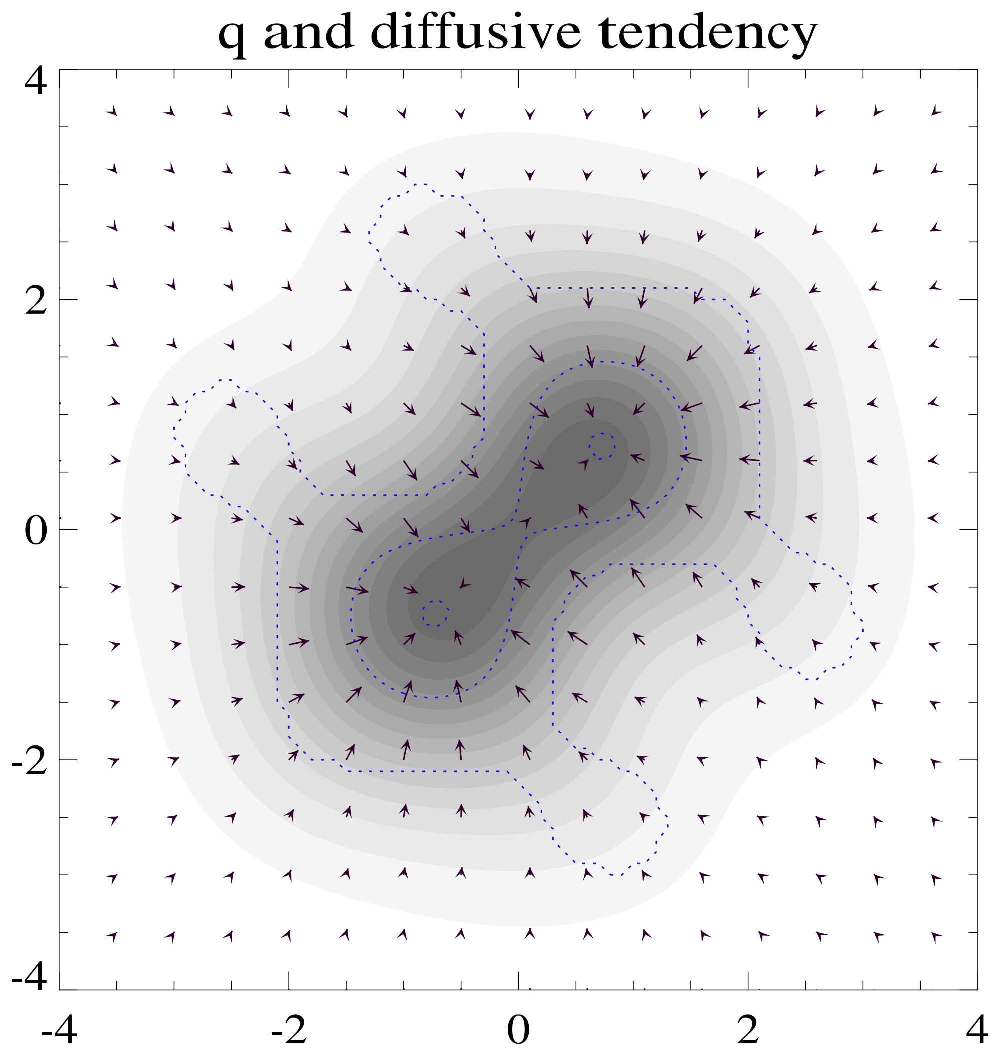
Next:
diffusion
(back to page 2)

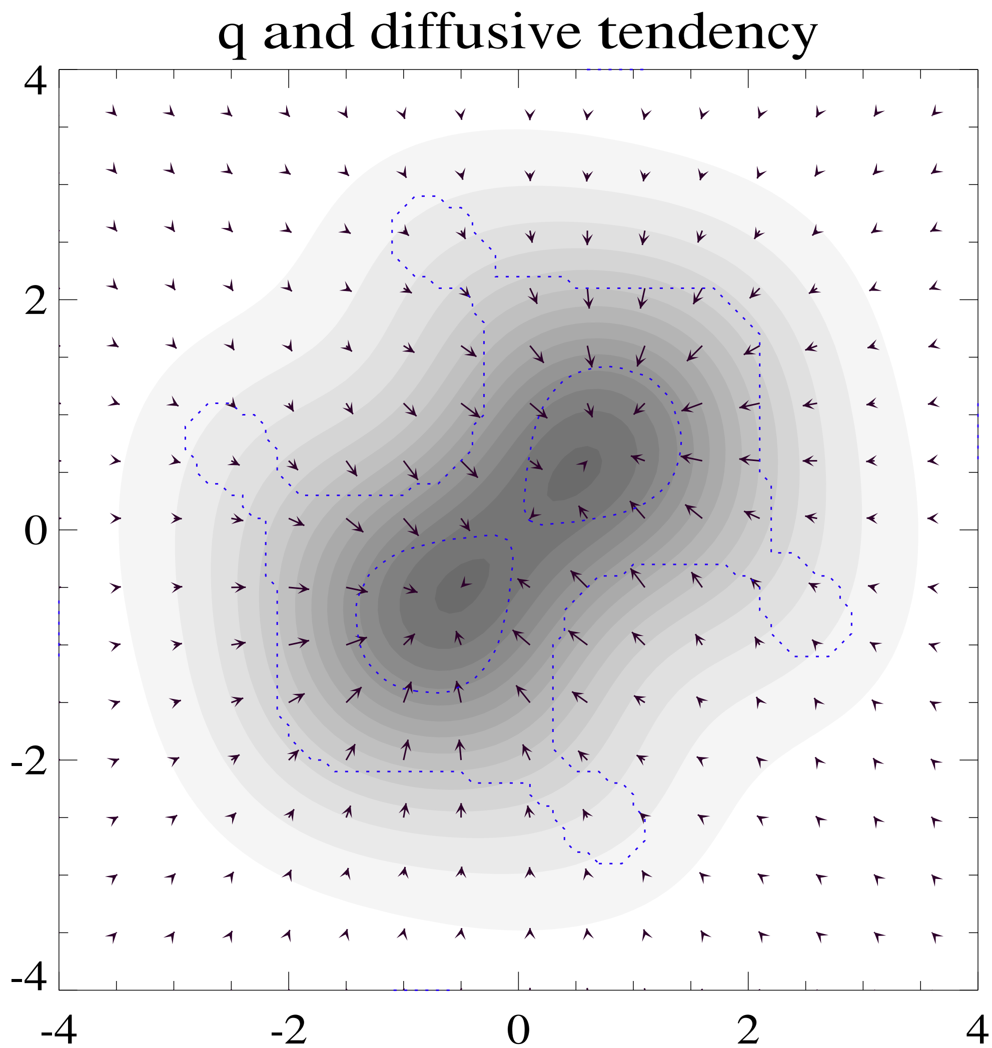

q, gradient & LAPLACIAN (diffusive tendency)
4
2
0
-2
-4
-4
-2
0
2
4


q and diffusive tendency
4
2
0
-2
-4
-4
-2
0
2
4


q and diffusive tendency
4
2
0
-2
-4
-4
-2
0
2
4


q and diffusive tendency
4
2
0
-2
-4
-4
-2
0
2
4


q and diffusive tendency
4
2
0
-2
-4
-4
-2
0
2
4


q and diffusive tendency
4
2
0
-2
-4
-4
-2
0
2
4