Appendix C

Supplementary movie captions

C.1 Movies of quasi-geostrophic shallow-water simply-connected equilibria

Supplementary movies are available on the compact disc attached to this thesis in the folder SC.

MOVIE SC1. Examples of simply-connected vortex equilibria for γ=0.5, 3, and 8. For each case we begin at the aspect ratio $\lambda = 1$, and end at the smallest aspect ratio attained, $\lambda = \lambda_f$. Here, $|x|, |y| \leq 2.3$. In this and subsequent movies we are in a frame of reference rotating with the equilibria.

MOVIE SC2. An example of type 2 instability, filamentation. We show the case $\gamma = 0.5$ and $\lambda_c = 0.296$, for times between $18.12T_p$ and $45.31T_p$. Note that $|x|, |y| \leq 3.3$ in this and subsequent movies.

MOVIE SC3. An example of type 3i instability, asymmetric split. We show the case $\gamma = 2$ and $\lambda_c = 0.091$, for times between $74.78T_p$ and $100.04T_p$.

MOVIE SC4. An example of type 3ii instability, symmetric split. We show the case $\gamma = 10$ and $\lambda = 0.024$, for times between $43.50T_p$ and $50.00T_p$.

MOVIE SC5. An example of type 1 instability, vacillation. We show the case $\gamma = 5$ and $\lambda = 0.024$, for times between 0 and $40.02T_p$.

C.2 Movies of quasi-geostrophic shallow-water doubly-connected equilibria

Supplementary movies are available on the compact disc attached to this thesis in the folder DC. They are also available online, hosted on the *Journal of Fluid Mechanics* website at http://dx.doi.org/10.1017/jfm.2013.104.

MOVIE DC1. Examples of doubly-connected vortex equilibria for γ=0.02, 3, and 10 at $\alpha = 0.2$. For each case we begin at the distance $\delta_{min} = 0.8$, and end at the smallest distance attained, $\delta_{min} = \delta_f(\gamma)$, at which a sharp corner develops on the boundary of one of the vortices. The smallest distance decreases with γ. In this and subsequent movies we are in a frame of reference rotating with the equilibria, and $|x|, |y| \leq 3$.

MOVIE DC2. An example of the evolution of a state undergoing partial straining out $\mathrm{PSO_b}$. We show the case $\gamma = 1$, $\alpha = 0.4$, and $\delta_{min} = 0.339$, for times between $88.47T_p$ and $132.71T_p$.

MOVIE DC3. An example of the evolution of a state undergoing partial merger PM. We show the case $\gamma = 2$, $\alpha = 0.6$, and $\delta_{min} = 0.270$, for times between $150.28T_p$ and $254.31T_p$.

MOVIE DC4. An example of the evolution of a state having large γ which undergoes complete merger CM. We show the case $\gamma = 10$, $\alpha = 0.2$, and $\delta_{min} = 0.268$, for times between $121.70T_p$ and $135.22T_p$.

MOVIE DC5. An example of the evolution of a state having small γ which undergoes complete merger CM. We show the case $\gamma = 0.02$, $\alpha = 1.0$, and

$\delta_{min} = 0.266$, for times between $33.50T_p$ and $100.49T_p$.

MOVIE DC6. An example of the evolution of a state undergoing vacillations. We show the case $\gamma = 10$, $\alpha = 0.4$, and $\delta_{min} = 0.200$, for times between 0 and $115.68T_p$. Note, the boundary of stability occurs at $\delta_{min} = \delta_c = 0.265$.

C.3 Movies of shallow-water simply-connected quasi-equilibria

Supplementary movies are available on the compact disc attached to this thesis in the folder SW. They will also be available in a forthcoming paper.

MOVIE SW1. The curvature κ as a function of θ for the state $(\gamma, \mathcal{R}) = (1, 0.1)$ at $\lambda = 0.400$, for times between 0 and $11T_{ip}$ (recall, the ramp period has length $\Delta_\tau = 10T_{ip}$). Here, $\theta = 2\pi\xi(s)/\xi(P)$, where P is the arc length of the PV contour, s is the distance along the PV contour and $\xi(s) = \int_0^s |\kappa| \mathrm{d}s'$. When $\kappa > 0$, θ is the tangent angle. The shift along the x-axis arises from differences in what the numerical method specifies as the "first" point on each PV contour. Note that here the contour is discretised by 1200 points on a grid having a resolution of 1024^2.