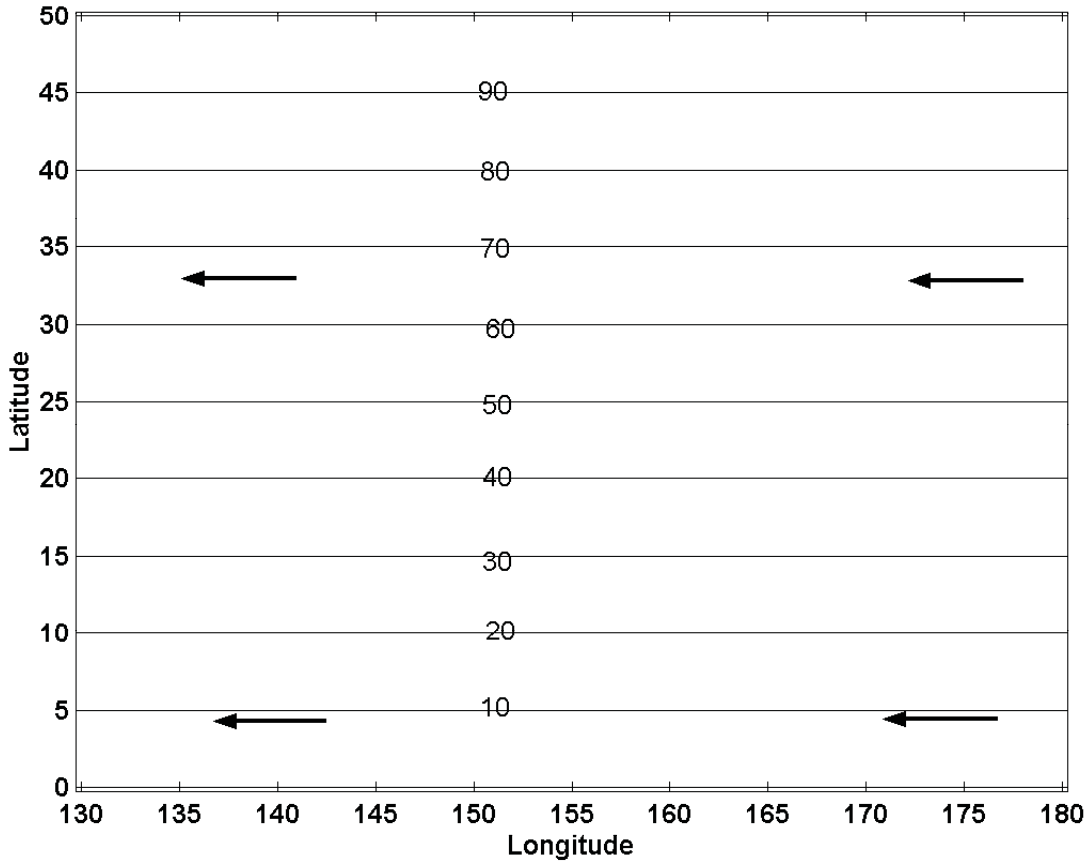
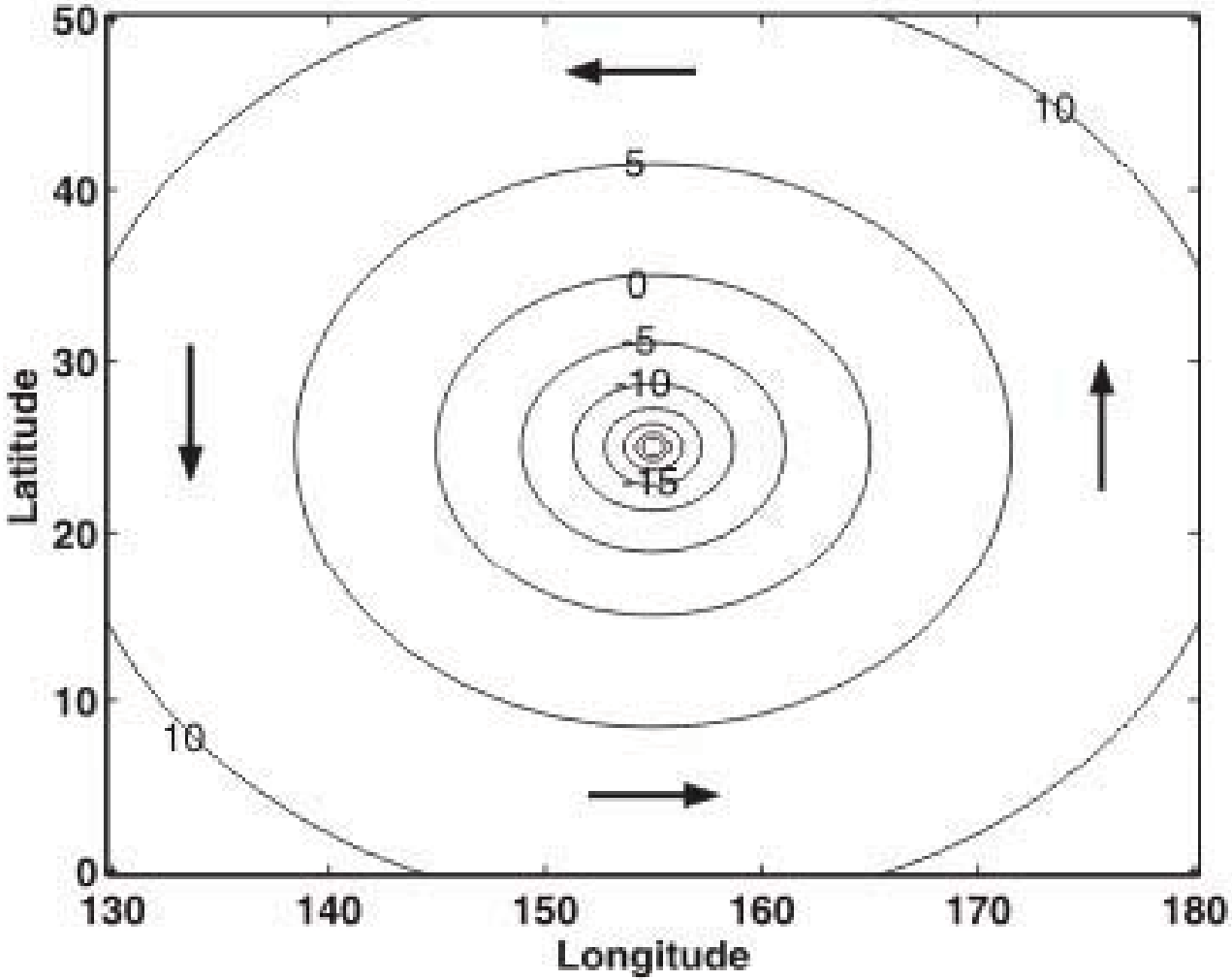
Tropical Cyclone Motion

Tropical cyclones move approximately with a suitably defined vertical vector average of the flow in which they are embedded

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40
30
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10
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Latitude
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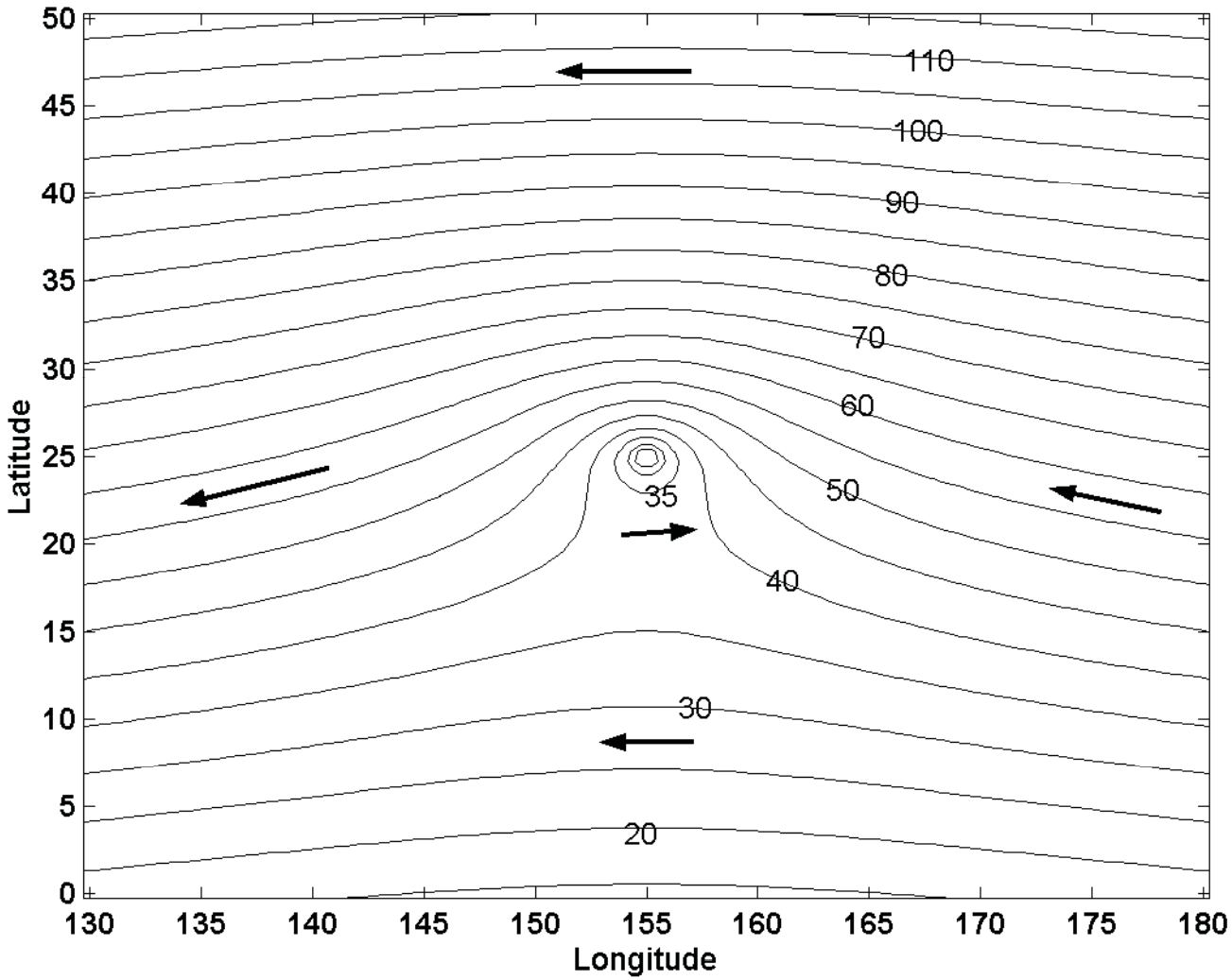
150
160
170
180
Longitude
10
5
0
-5
-10
-15
10


Latitude
Longitude
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35
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35
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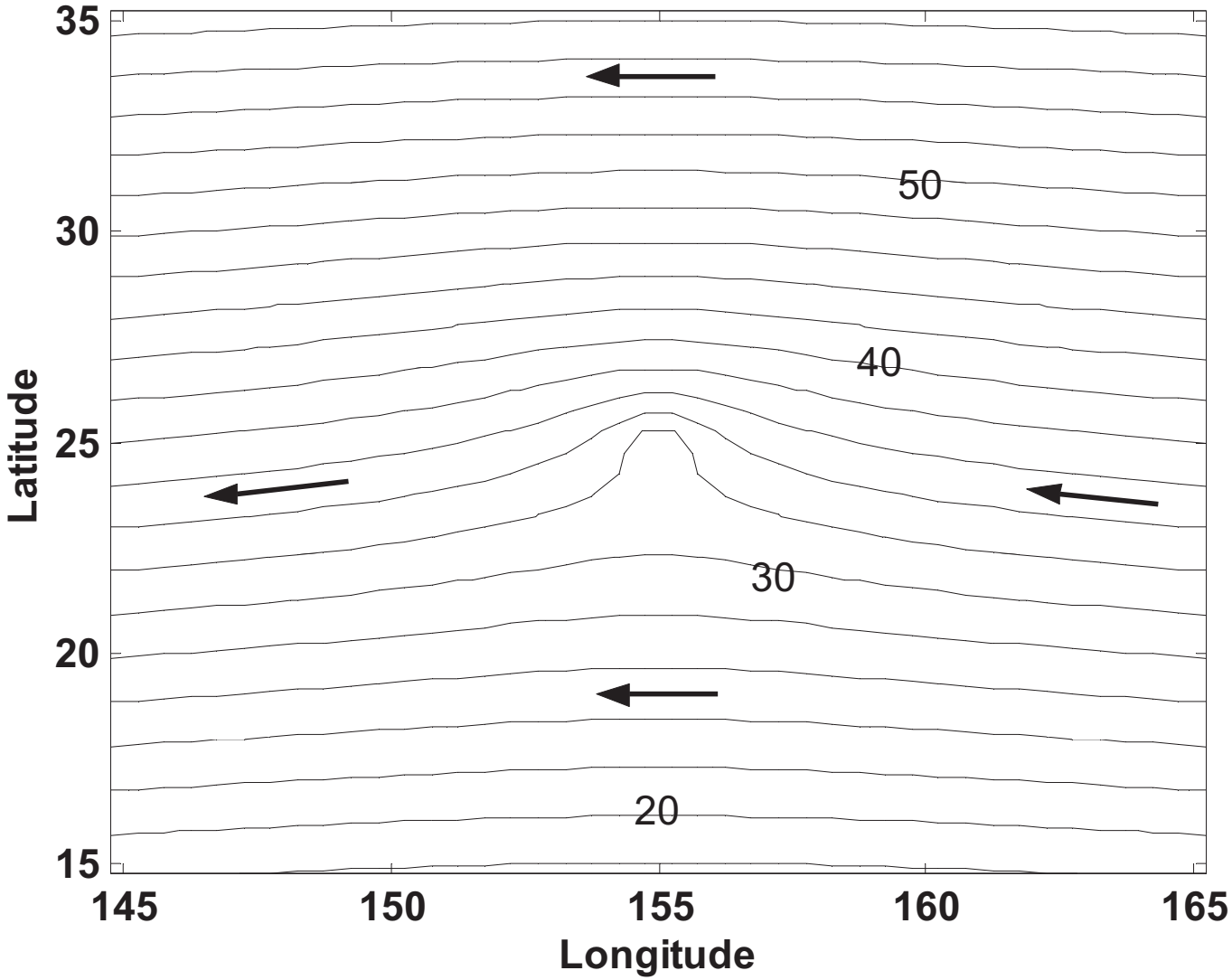
35
30
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Latitude
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160
165
Longitude
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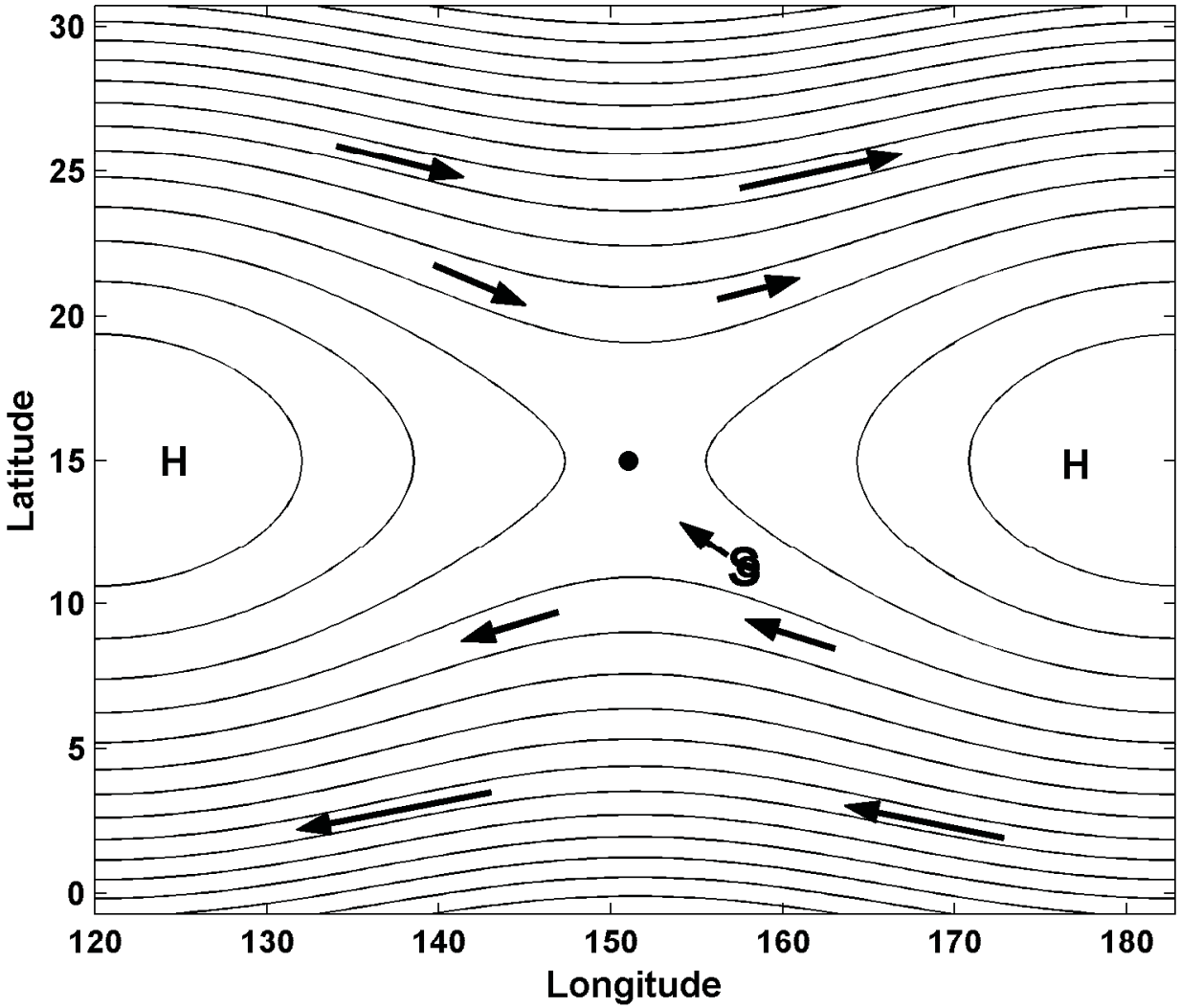
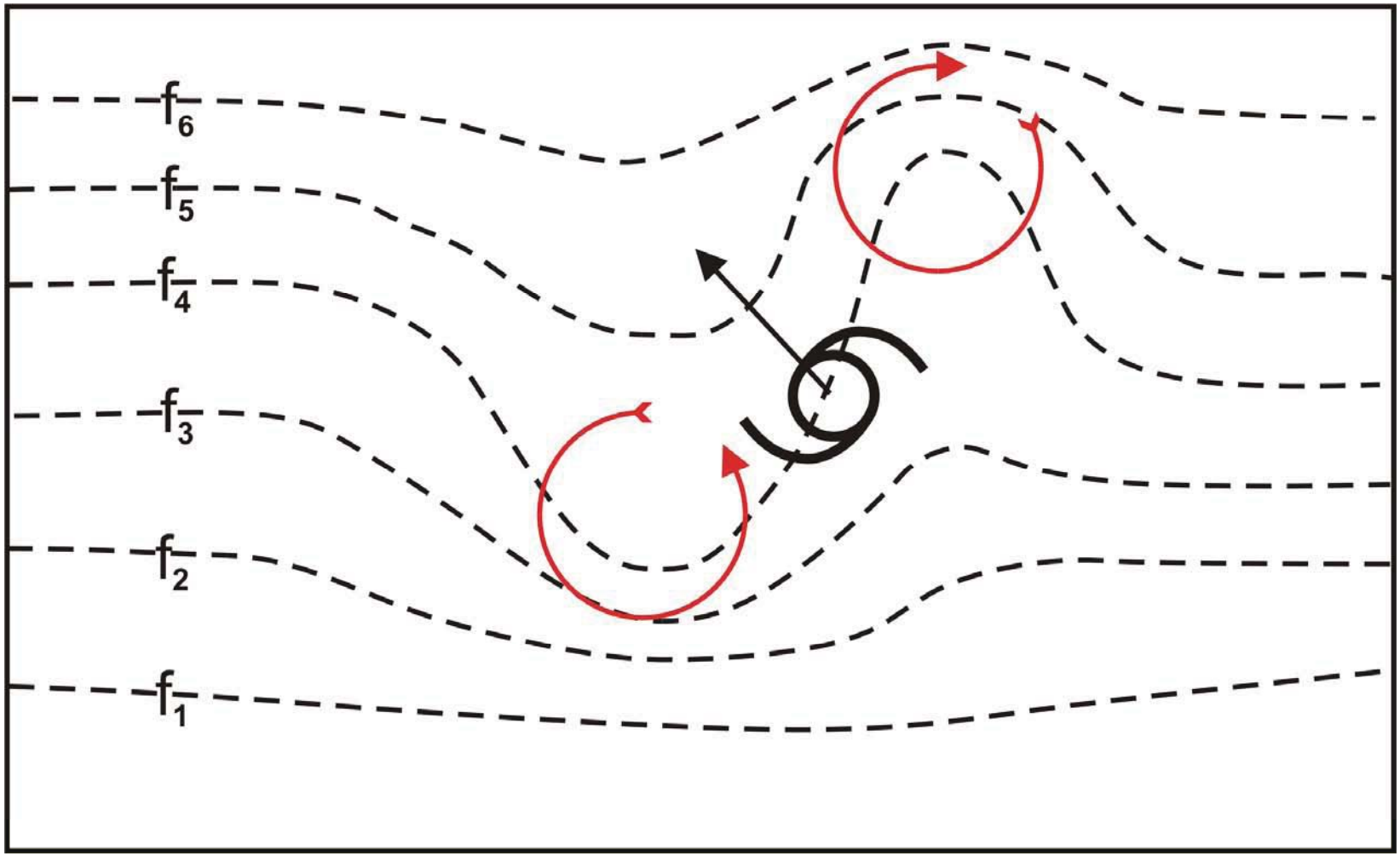
30
20

Lagrangian chaos:



Vortices in PV gradients:

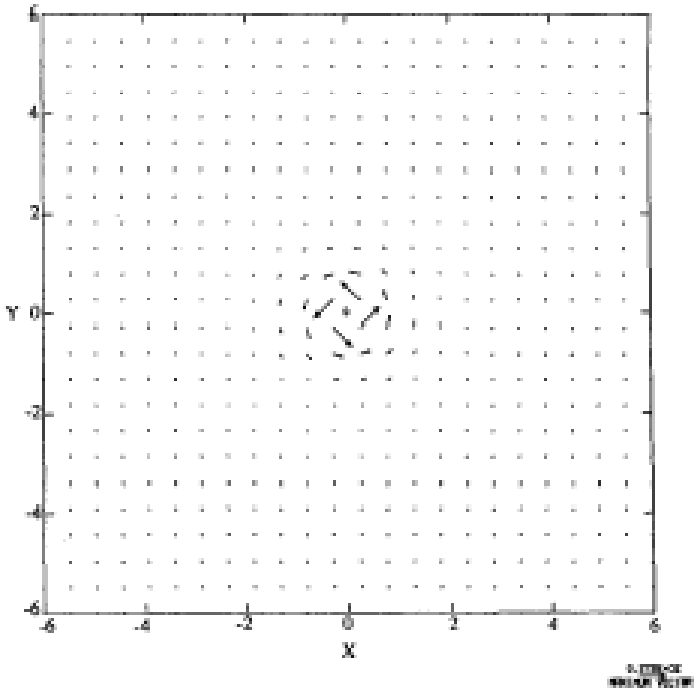


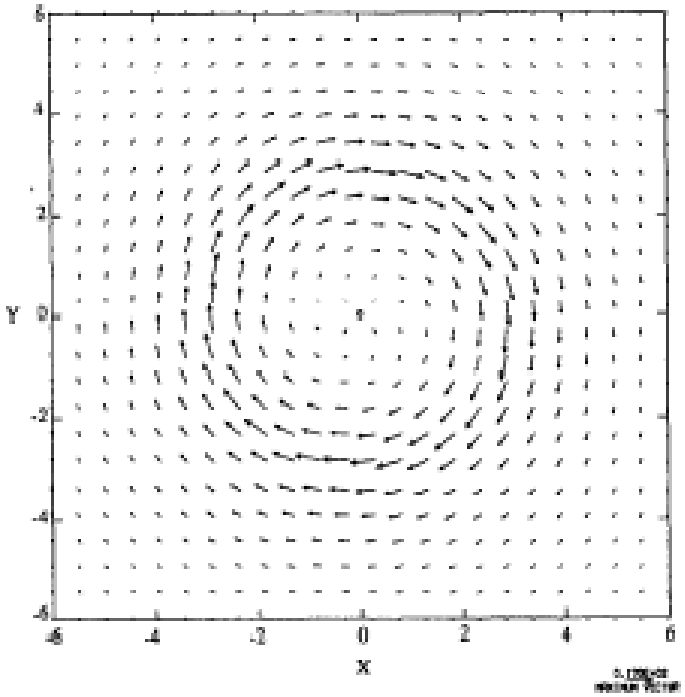
Baroclinic vortices in shear: A simple model

- Two layers, with zero effective PV gradient, but upper layer moving with respect to lower layer
- Lower layer contains point potential vortex, whose circulation projects outward and upward
- Upper layer has point source of zero PV air co-located with lower point vortex; zero PV air separated from surroundings by a single, expanding contour
- Flow owing to upper level PV anomaly solved by contour dynamics

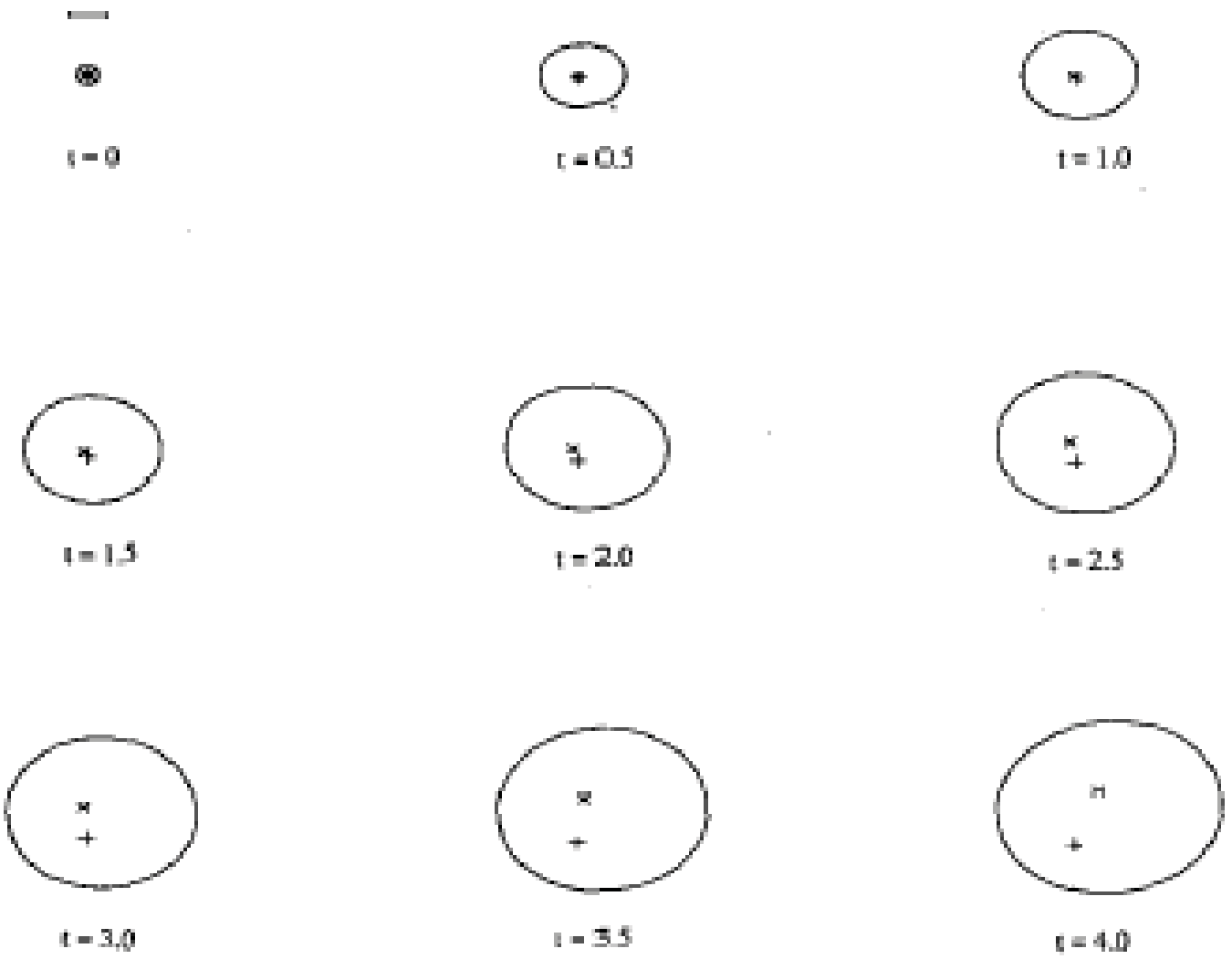
(From Wu and Emanuel, 1993)

Lower (left) and upper (right) flows for zero shear:

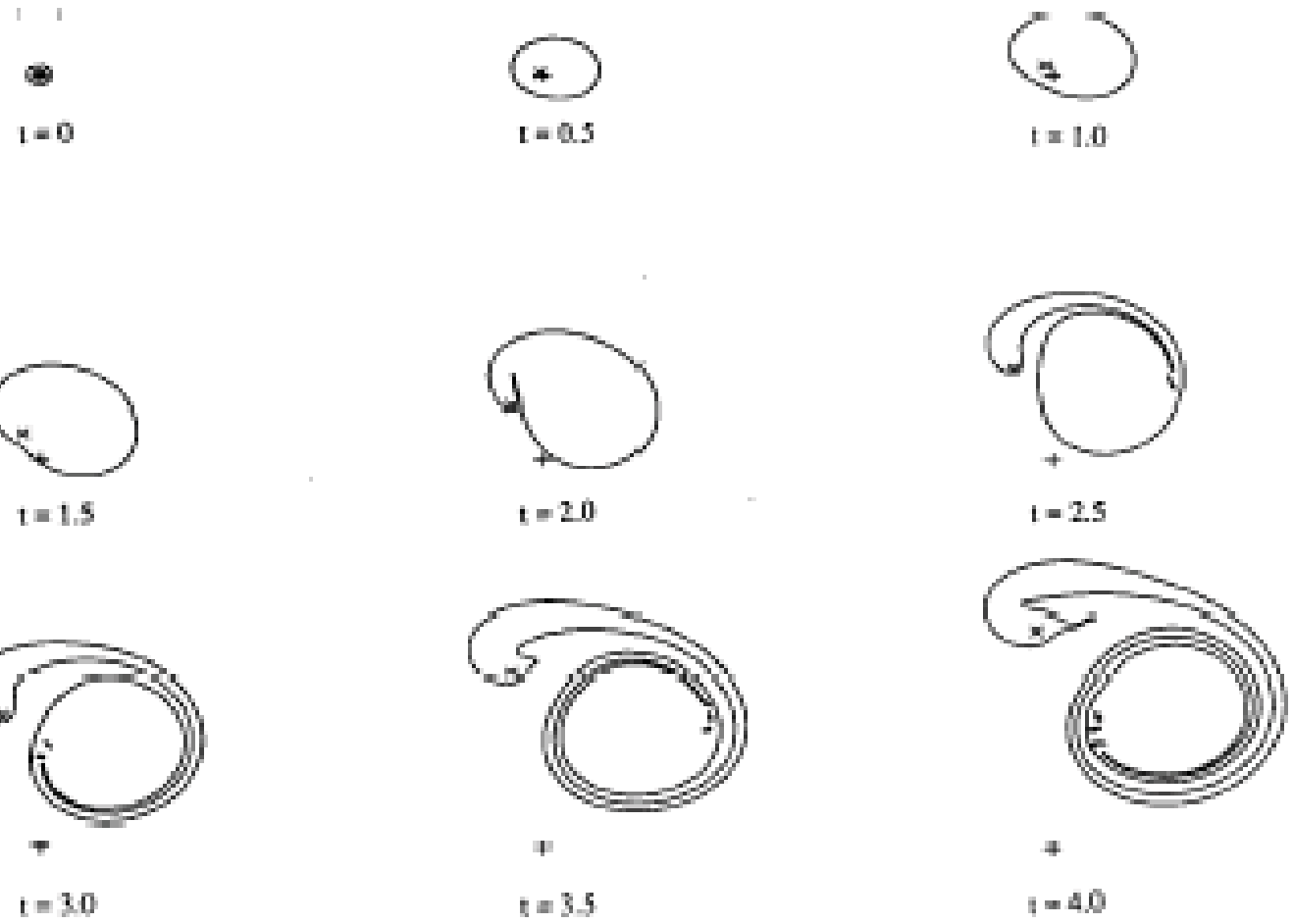




Evolution of upper layer vortex patch when weak shear is present



Evolution of upper layer vortex patch when moderate shear is present



Evolution of upper layer vortex patch when strong shear is present

t = 0

t = 0.5

t = 1.0

t = 1.5

t = 2.0

t = 2.5

t = 3.0

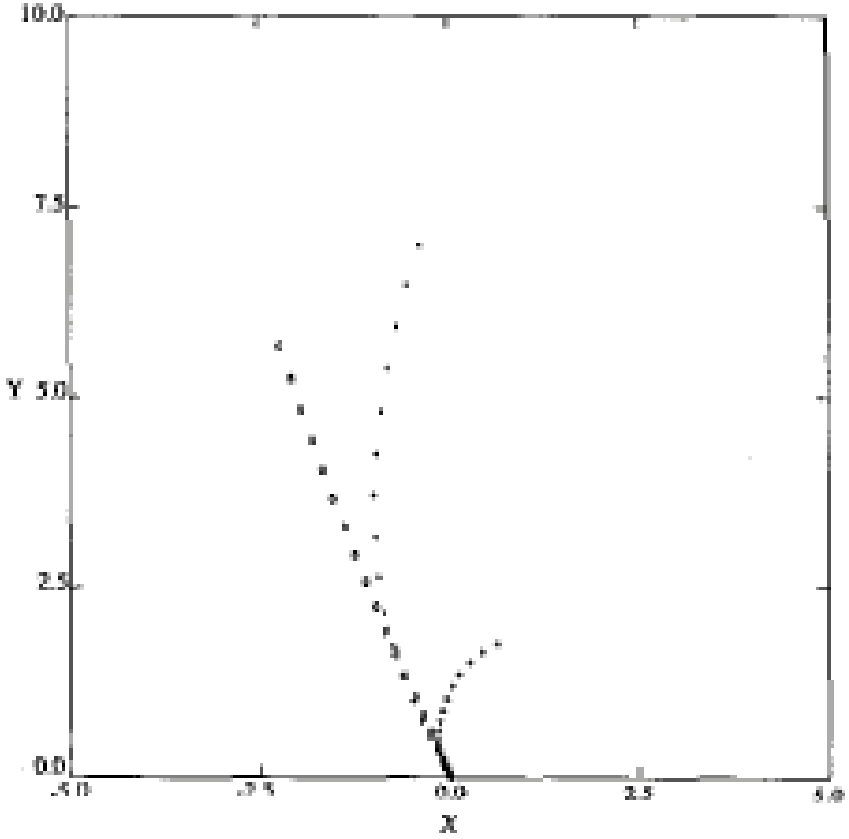


FIG. 11. Trajectories (units of 500 km) of the lower-layer vortex for $\epsilon = 0.25$, $\gamma = 0.79$, and $\chi = 0.25$ (shown as "+"); $\chi = 1.25$ (shown as "*"); and $\chi = 5$ (shown as "O").

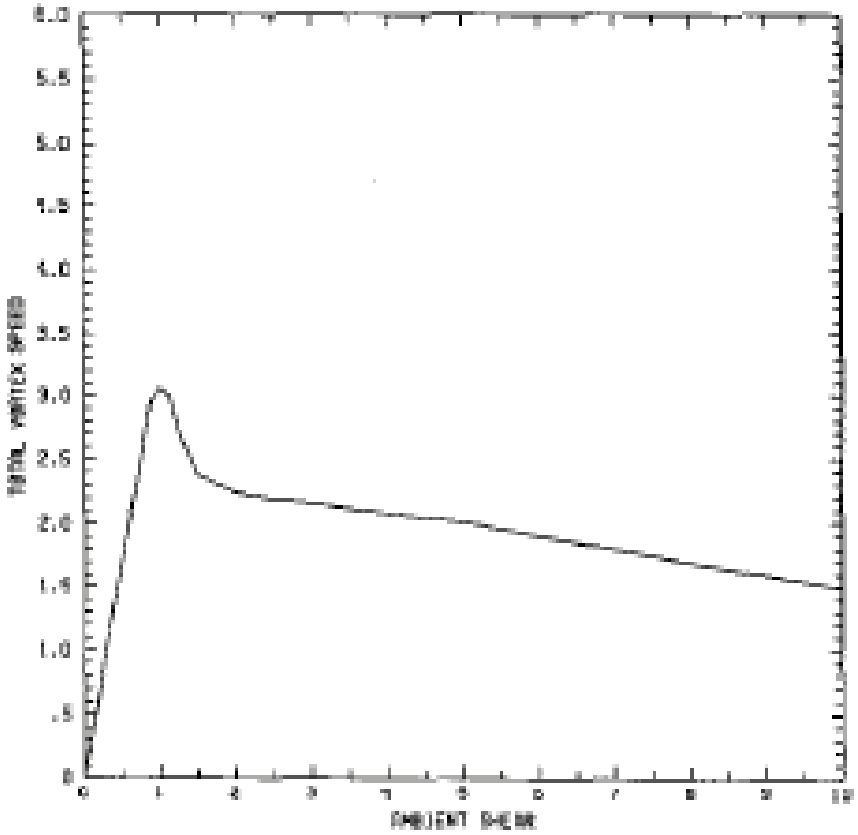
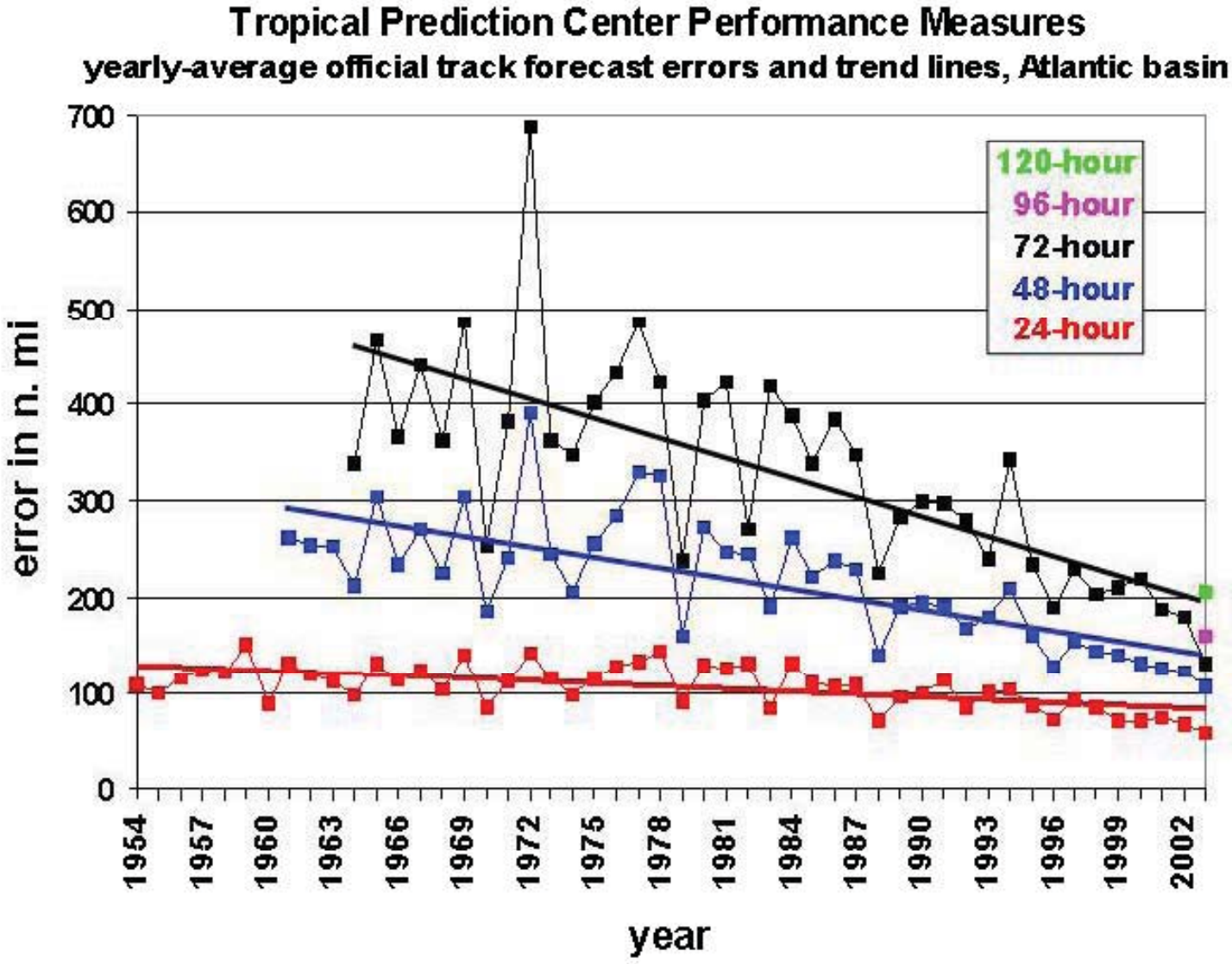
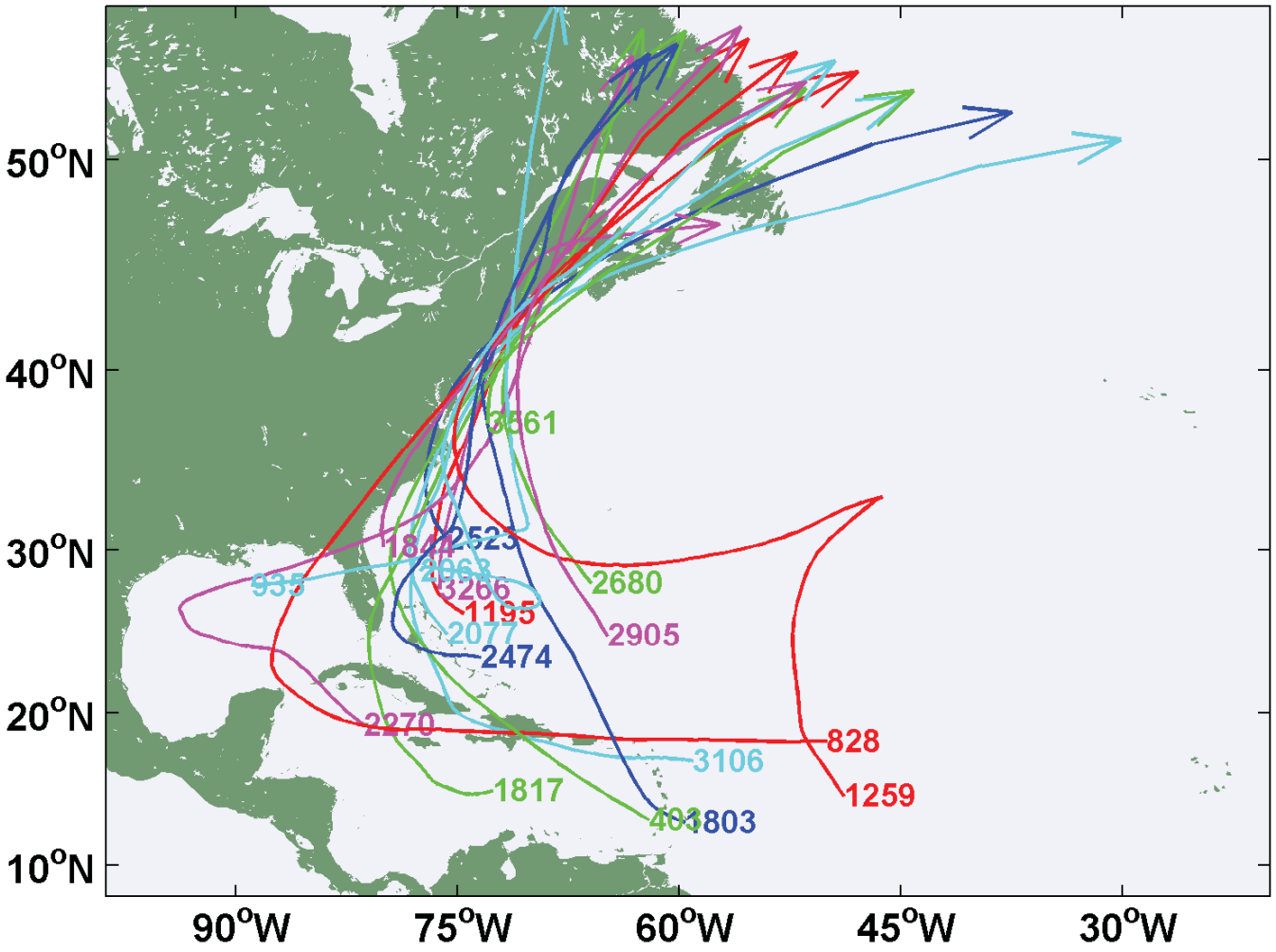


FIG. 12. The relation between the maximum induced vortex speed and the magnitude of the vertical shears (χ) for $\epsilon = 0.25$ and $\gamma = 0.79$.

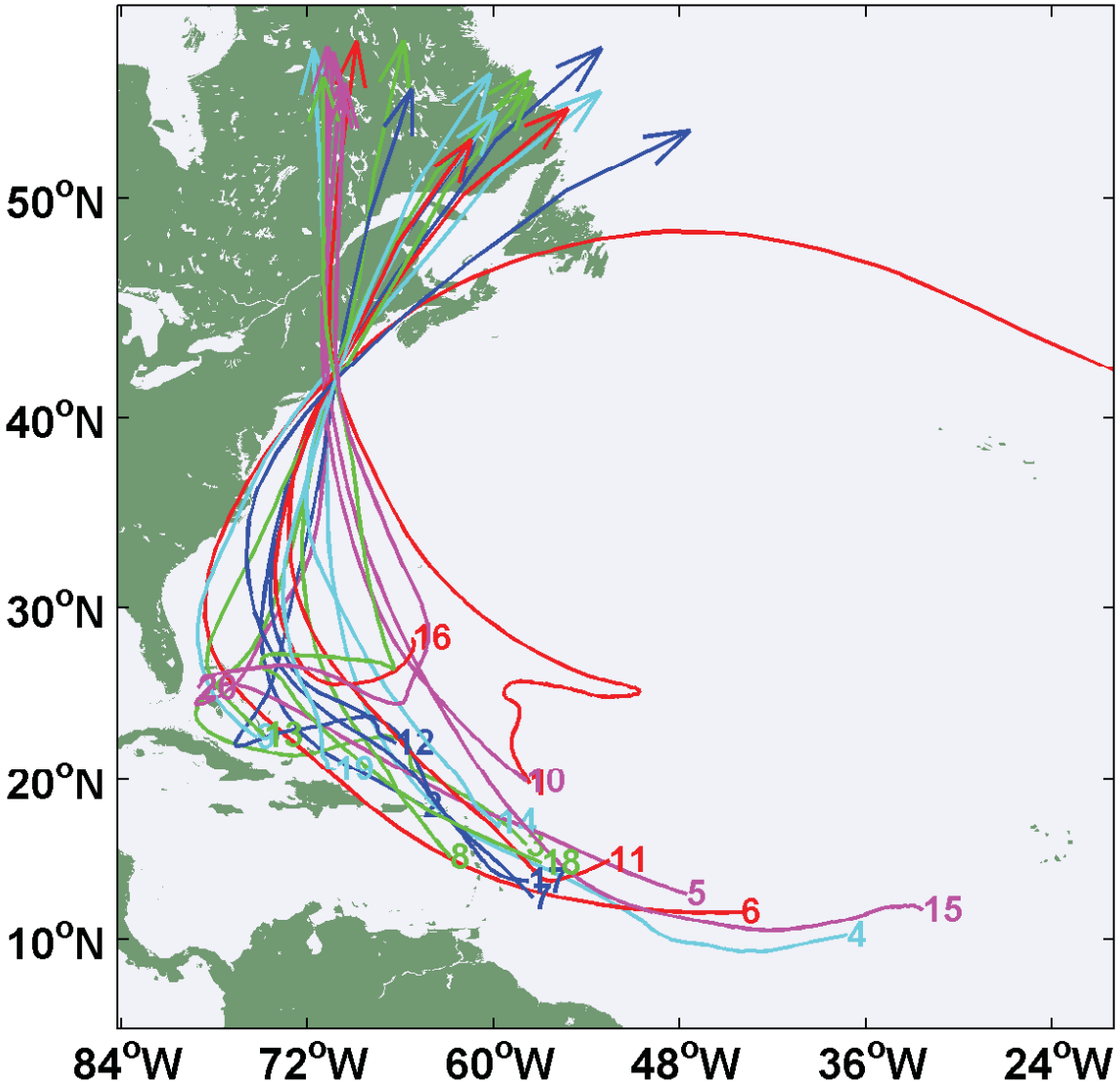
Operational prediction of tropical cyclone tracks:



Example: 20 random tracks passing within 100 km of Boston



20 “worst” tracks:



12.811 Tropical Meteorology

Spring 2011