The Value of High Time Resolution Data in Tropical Cyclone Studies

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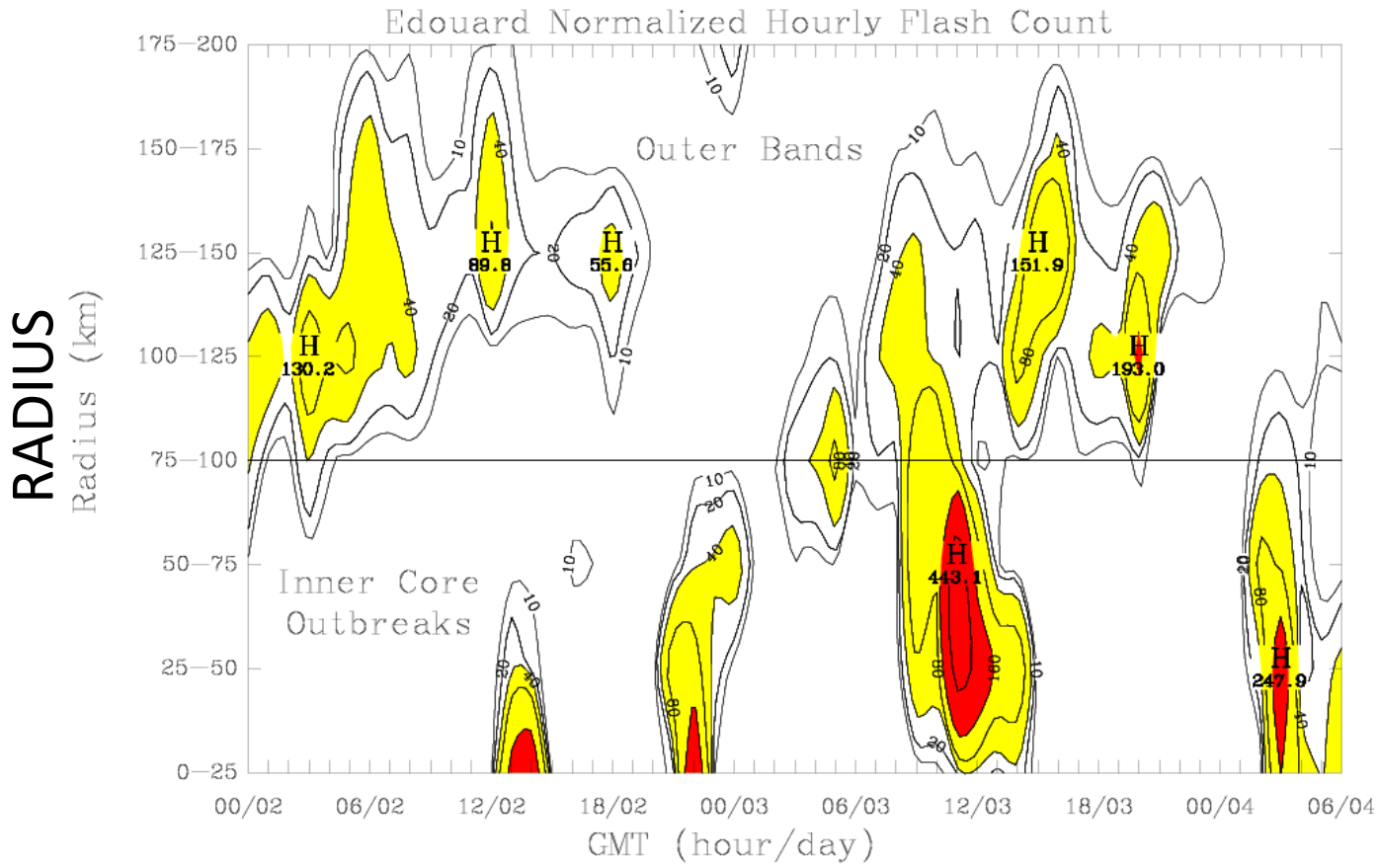
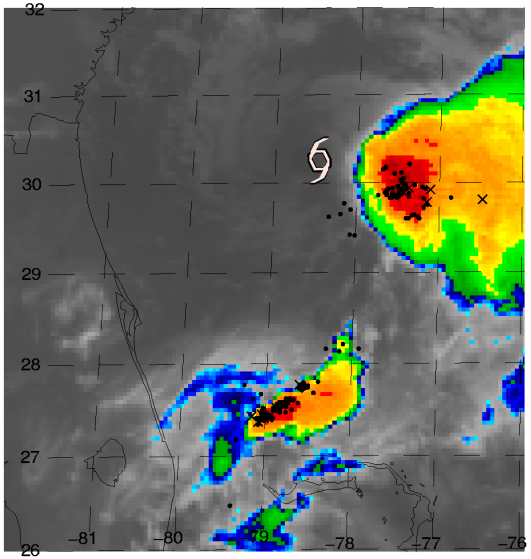
First half of talk: example of the value of high time resolution data in TS Edouard (2002), from the MS Thesis of Jacqueline Frank

Application of TS Edouard results to future field experiments, including use of the Global Hawk

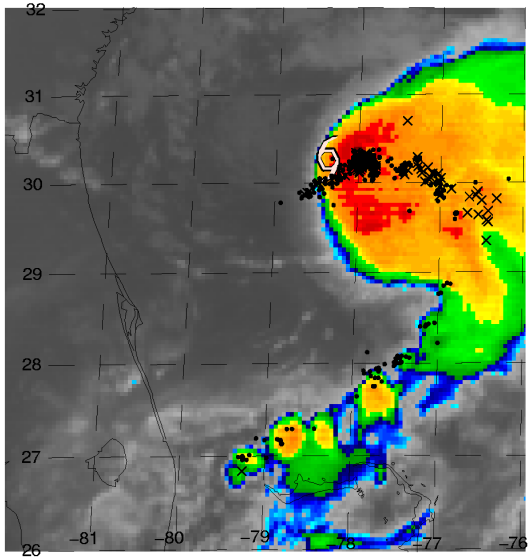
Second half: Examination of the vertical profiles of radial velocity during Earl's RI



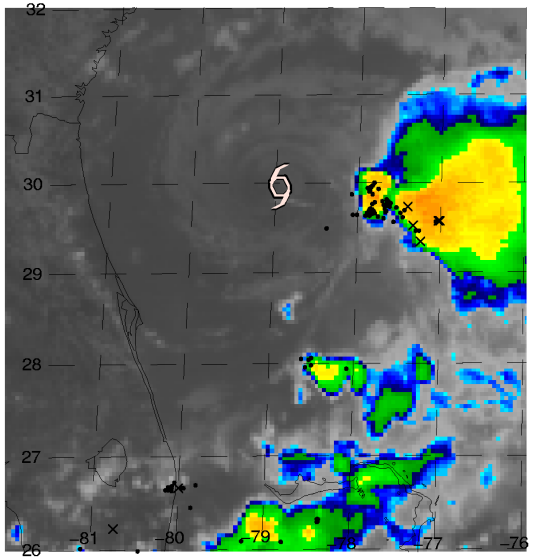
Radius-time plot of lightning frequency in TS Edouard (2002). Units: number of flashes (100 km)$^{-2}$ hour^{-1}.



0715 UTC 3 Sept.

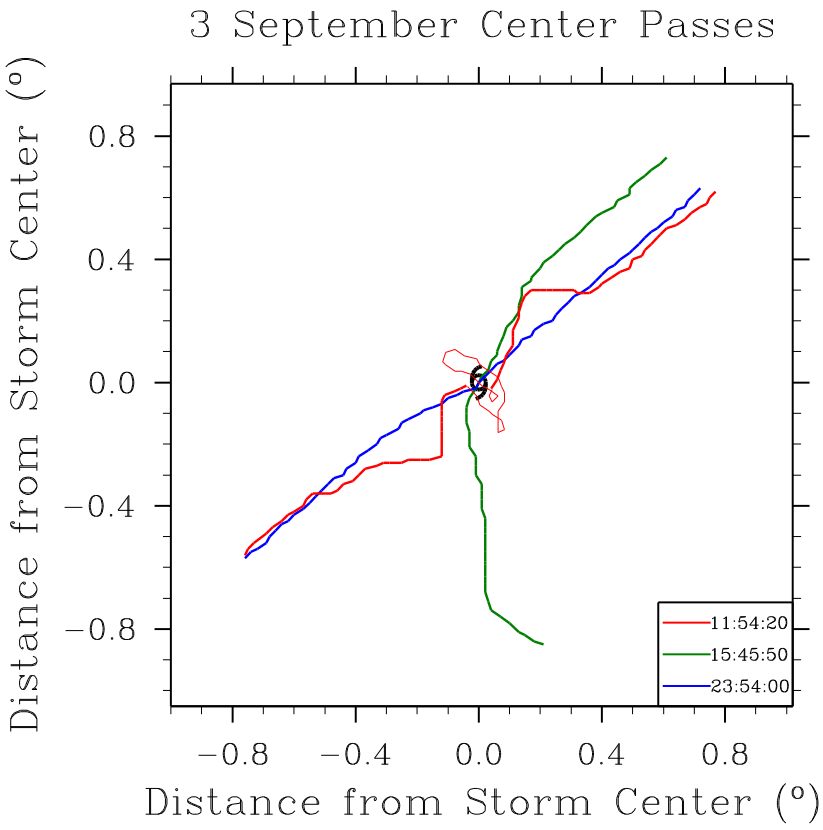


1115 UTC



1715 UTC

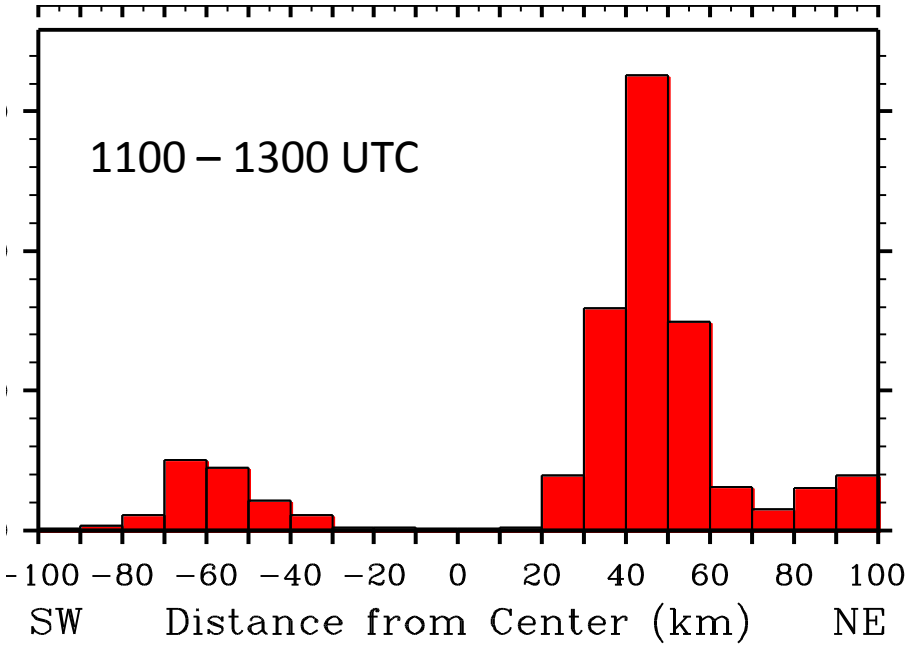
Infrared satellite images and cloud-to-ground lightning locations during 3 September in TS Edouard.



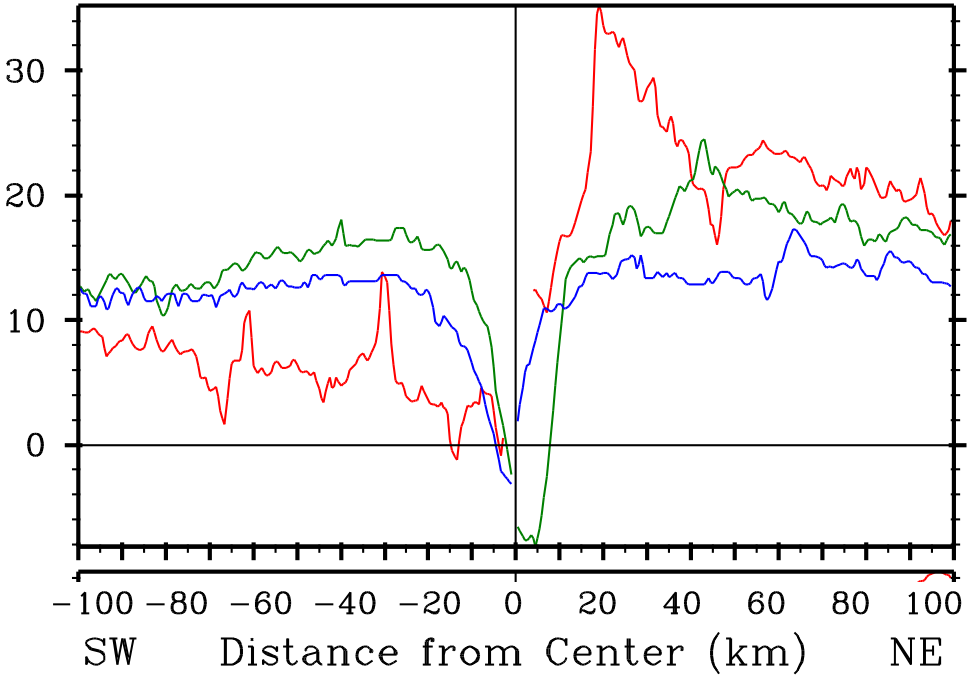
Red: 1120 – 1226 UTC 2 September
Green: 1529 – 1603 UTC 2 September
Blue: 2326 – 0011 UTC 2-3 September

ALL FLIGHTS ARE BETWEEN 350 AND 500 M ELEVATION (BOUNDARY LAYER)

Air Force reconnaissance flight tracks into TS Edouard on 3-4 September 2002. Only the track segments that extend SW-NE are shown. Ambient vertical wind shear was strong from the northwest.

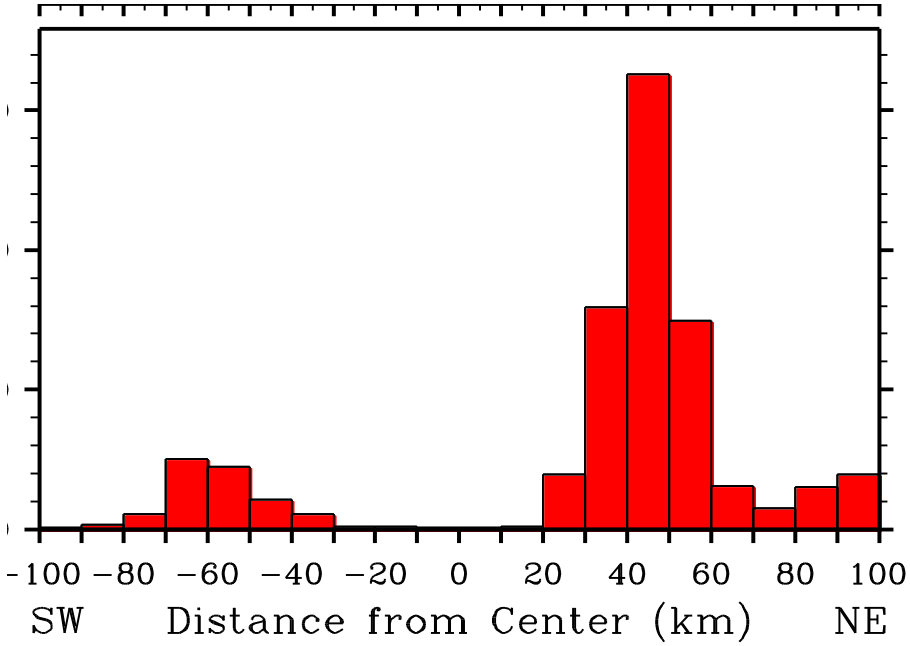


Lightning frequency cross-section

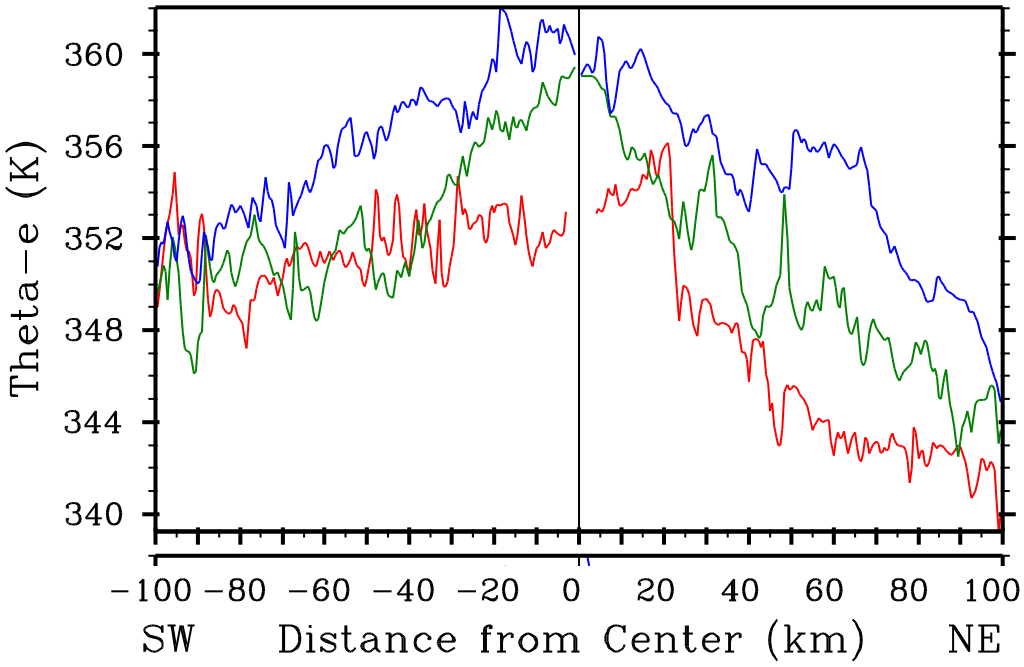


Tangential wind cross-section (m s^{-1})

Red: 1120 – 1226 UTC
Green: 1529 – 1603 UTC
Blue: 2326 – 0011 UTC



Lightning frequency cross-section



Equivalent potential temperature (K)

Red: 1120 – 1226 UTC
Green: 1529 – 1603 UTC
Blue: 2326 – 0011 UTC

AF reconnaissance flew in the boundary layer between 350 and 550 m elevation on a similar path for three storm crossings.

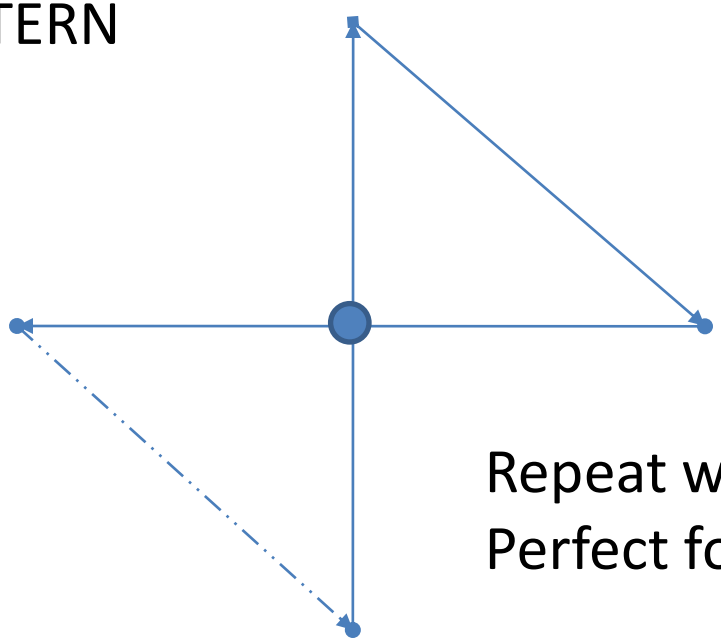
An intense localized convective outbreak lasted for two hours, then all core convection ceased.

Near the convection, the boundary layer dramatically cooled, almost certainly as a result of cold downdrafts. Maximum tangential wind inside the region of heating rose rapidly to above hurricane force.

Over the following 12 hours, the wind field axisymmetrized and weakened while the boundary layer θ_e recovered. A new convective outbreak followed.

This was observable only because similar flight legs were flown over three consecutive periods.

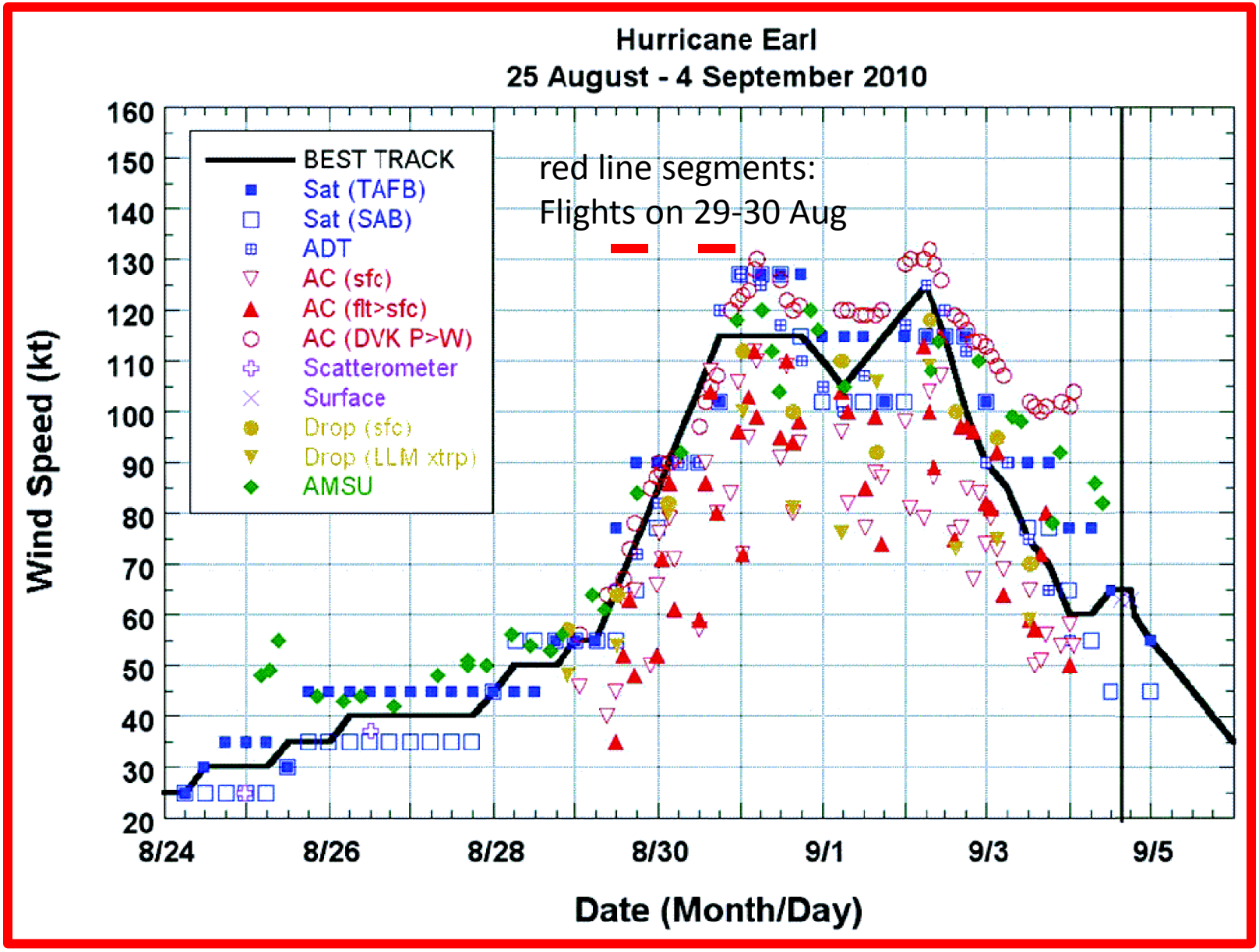
FIGURE 4 PATTERN



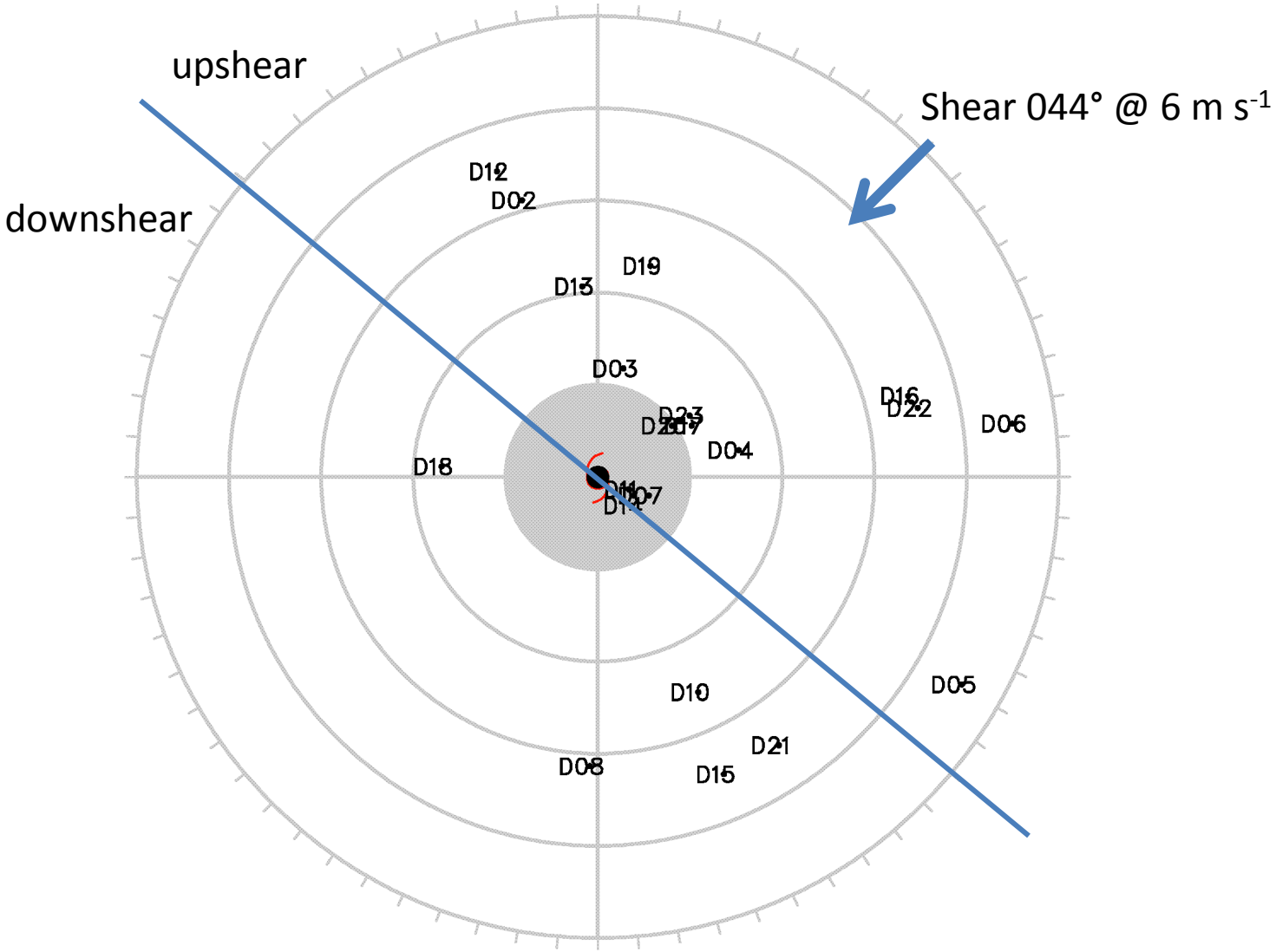
Repeat without rotation
Perfect for Global Hawk!

Assume DC-8 speed of 425 knots:
Out to 100 km radius: 1 hour return time
Out to 200 km radius: 2 hour return time
Out to 300 km radius: 3 hour return time

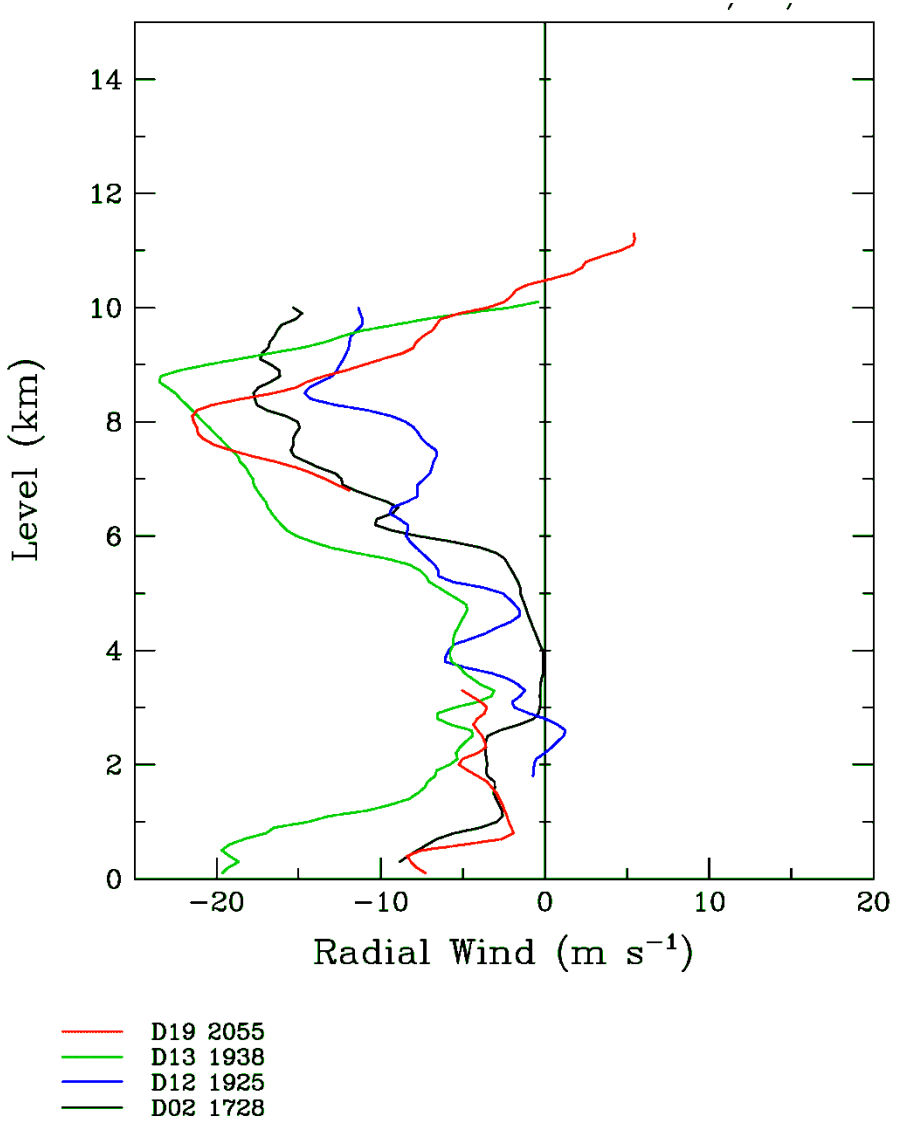
Sacrifice spatial coverage for time resolution!



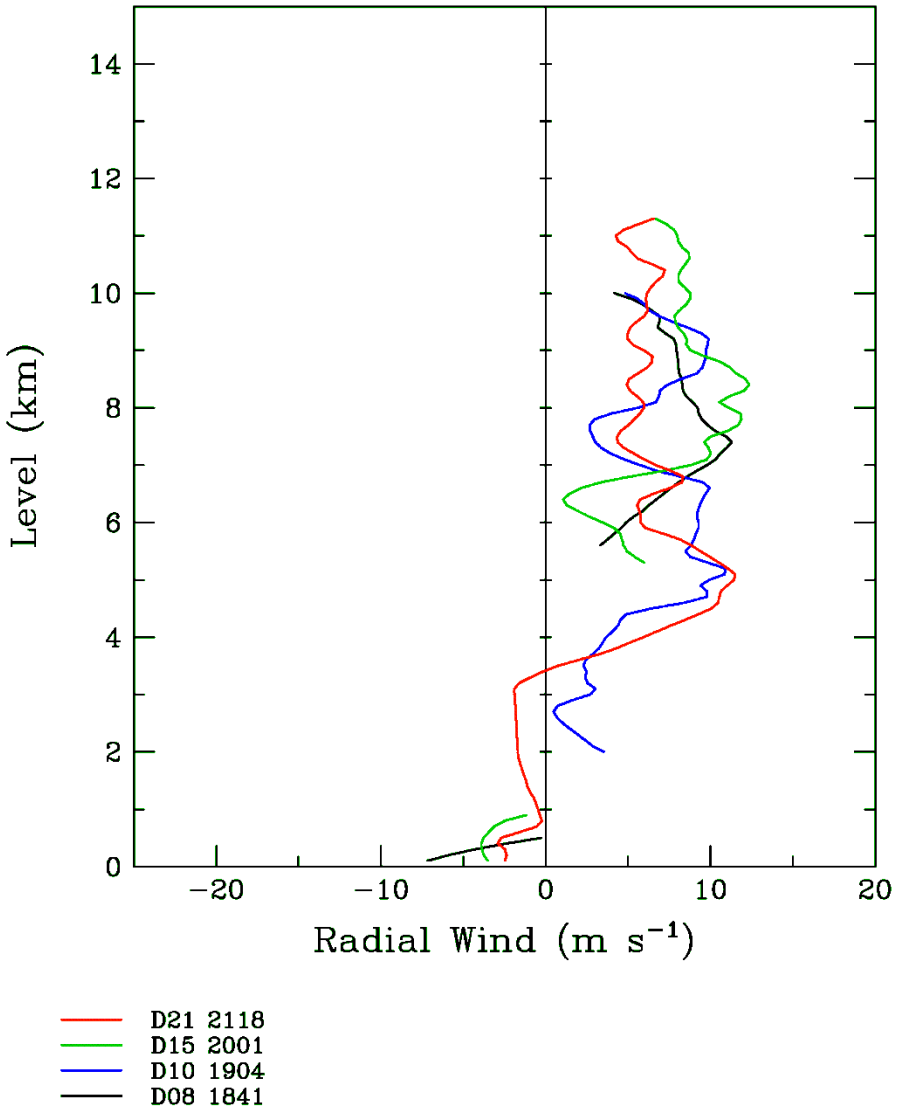
Maximum surface wind speed in Hurricane Earl, from the National Hurricane Center.



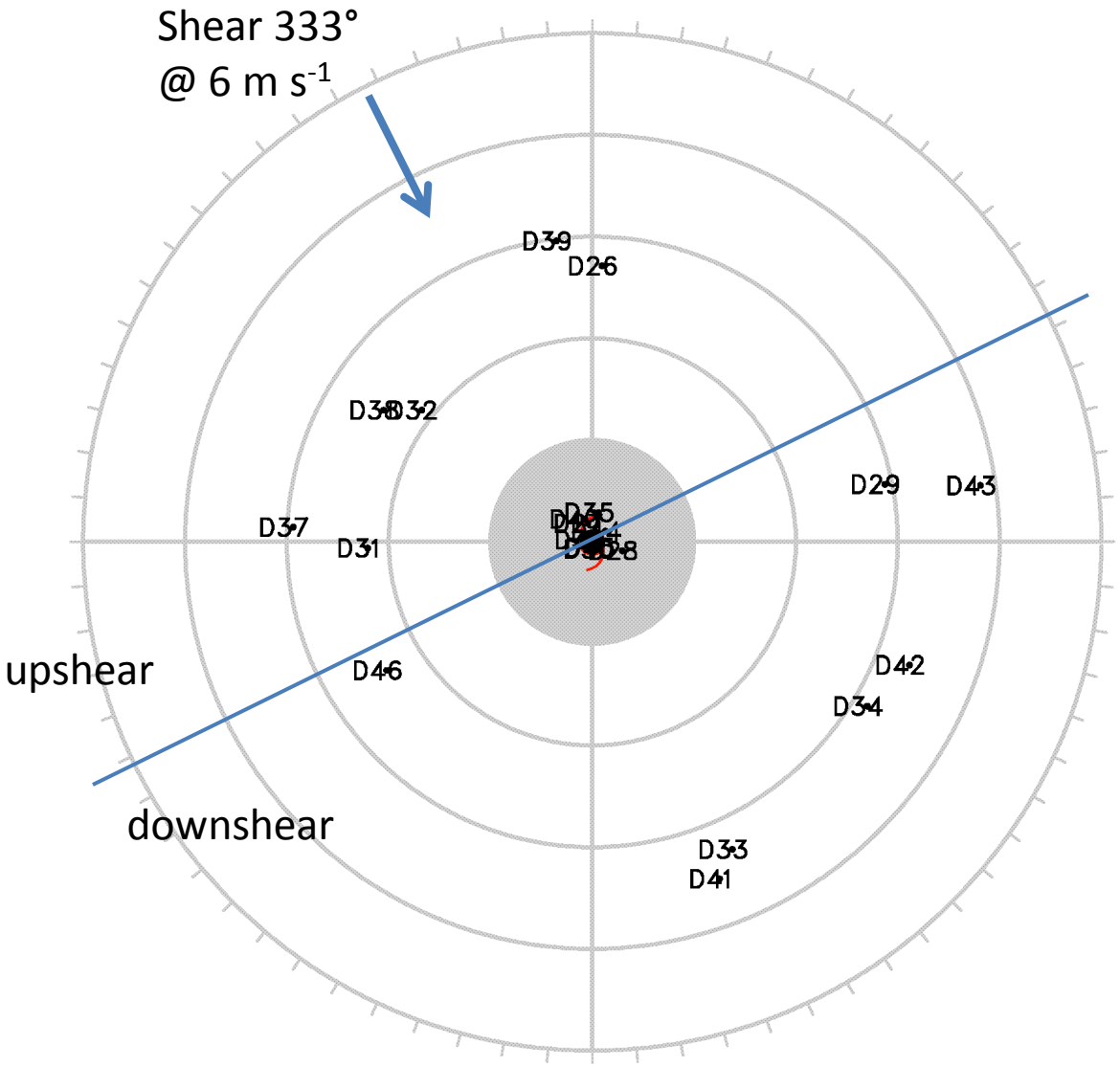
Locations at splashdown of sondes in Hurricane Earl on 29 August 2010.



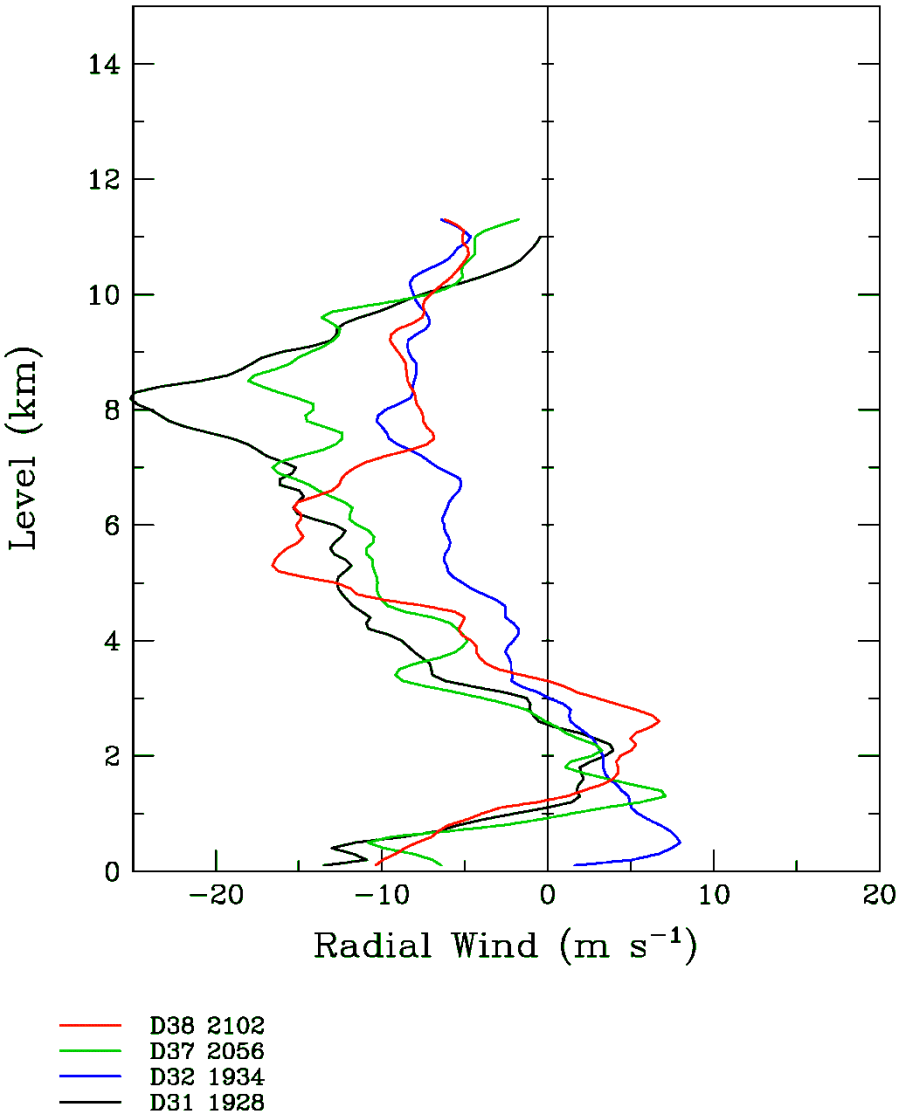
Storm-relative radial wind profiles for four sondes north of the center of Hurricane Earl (upshear right) on 29 August 2010.



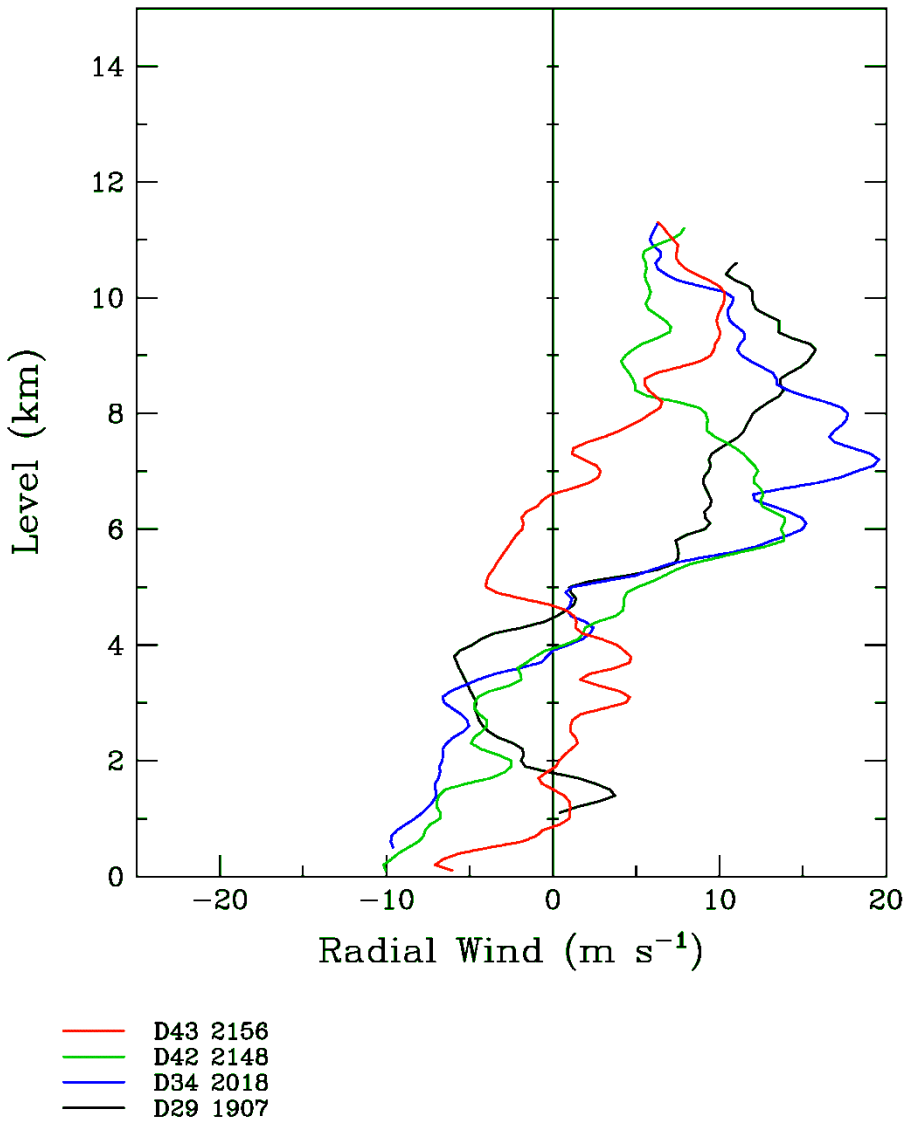
Storm-relative radial wind profiles for four sondes south of the center of Hurricane Earl (downshear left) on 29 August 2010.



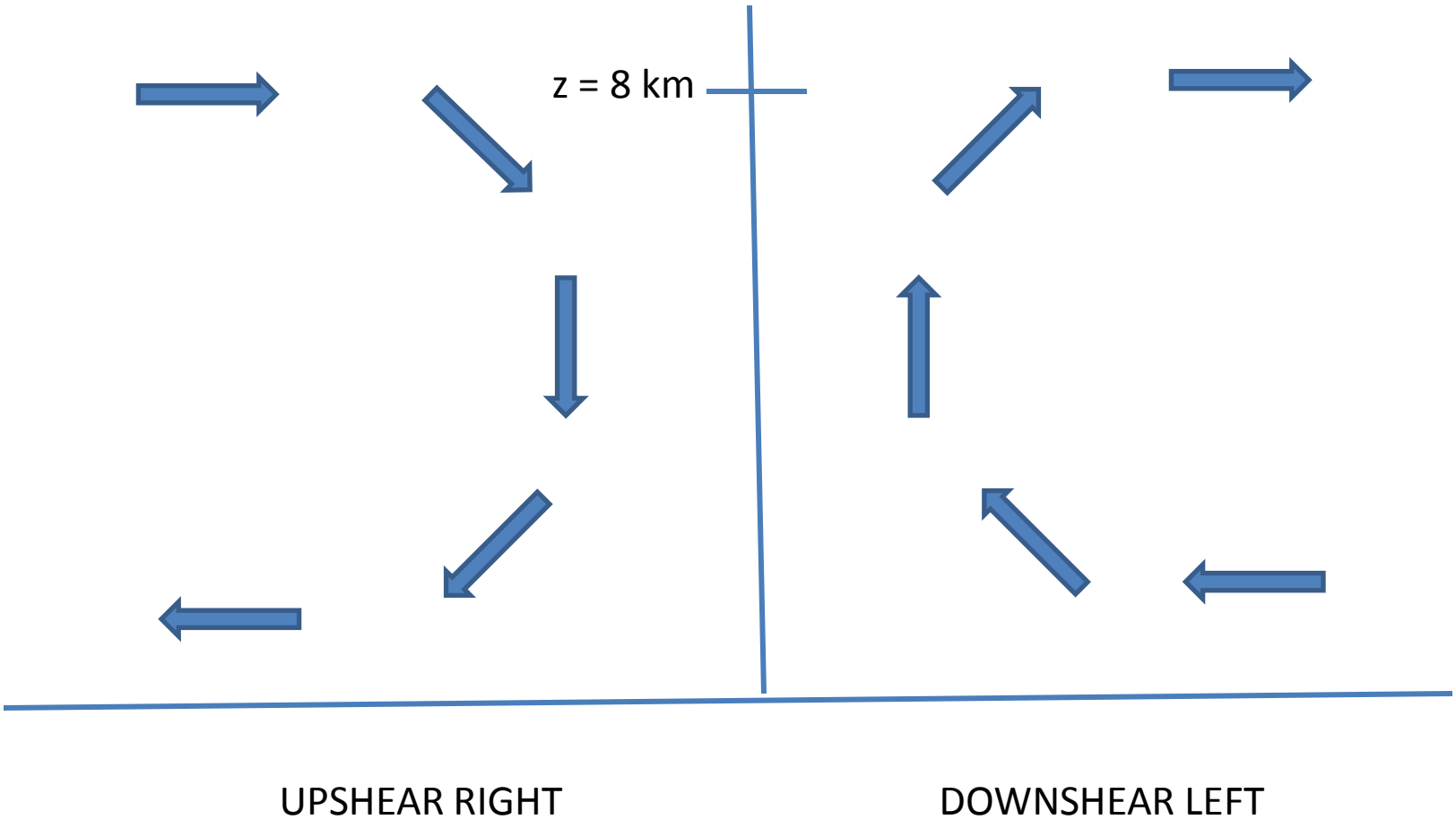
Sonde splashdown locations on 30 August 2010.



Storm-relative radial wind profiles for four sondes west of the center of Hurricane Earl (upshear right) on 30 August 2010.



Storm-relative radial wind profiles for four sondes east of the center of Hurricane Earl (downshear left) on 30 August 2010.



Schematic radial-vertical flow (perturbation from azimuthal mean) during the early rapid intensification period of Hurricane Earl on 29 August 2010.

Earl rapid intensification

• Moderate vertical wind shear near the beginning and at the end of RI, with ambient shear rotating from NE to NW

• Near the 100 km radius, strong inflow near 8 km downshear right, and strong outflow near 8 km downshear left, at both times.

• Represents enhanced in-up-out flow DSL, and in-down-out USR.

• Shear signature is strong despite RI.

• DC-8 flight level winds in Hurricane Earl will be examined following the same procedure as in TS Edouard earlier.

3 September SW–NE Boundary Layer Flights