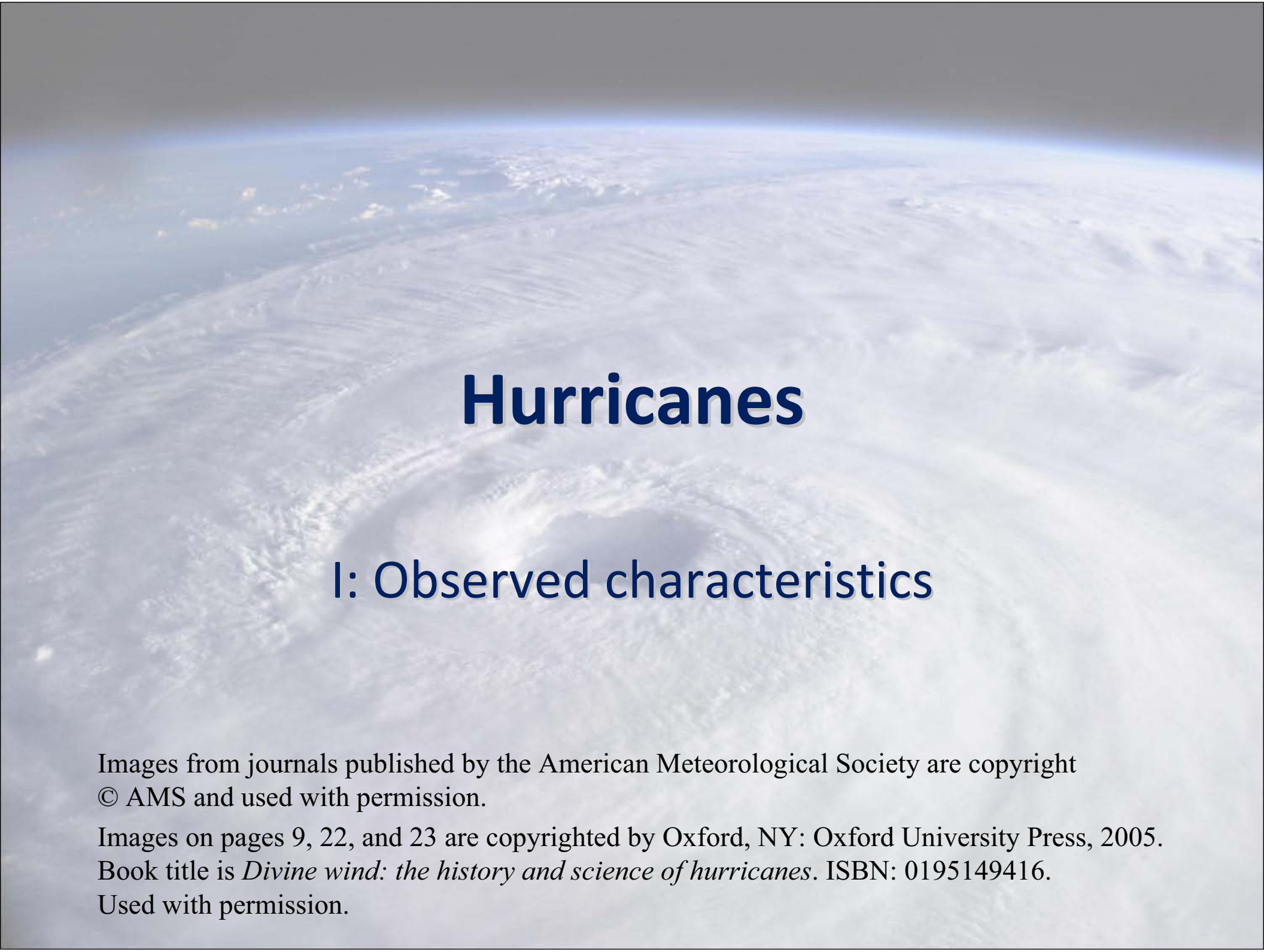


Hurricanes

I: Observed characteristics

What is a Hurricane?

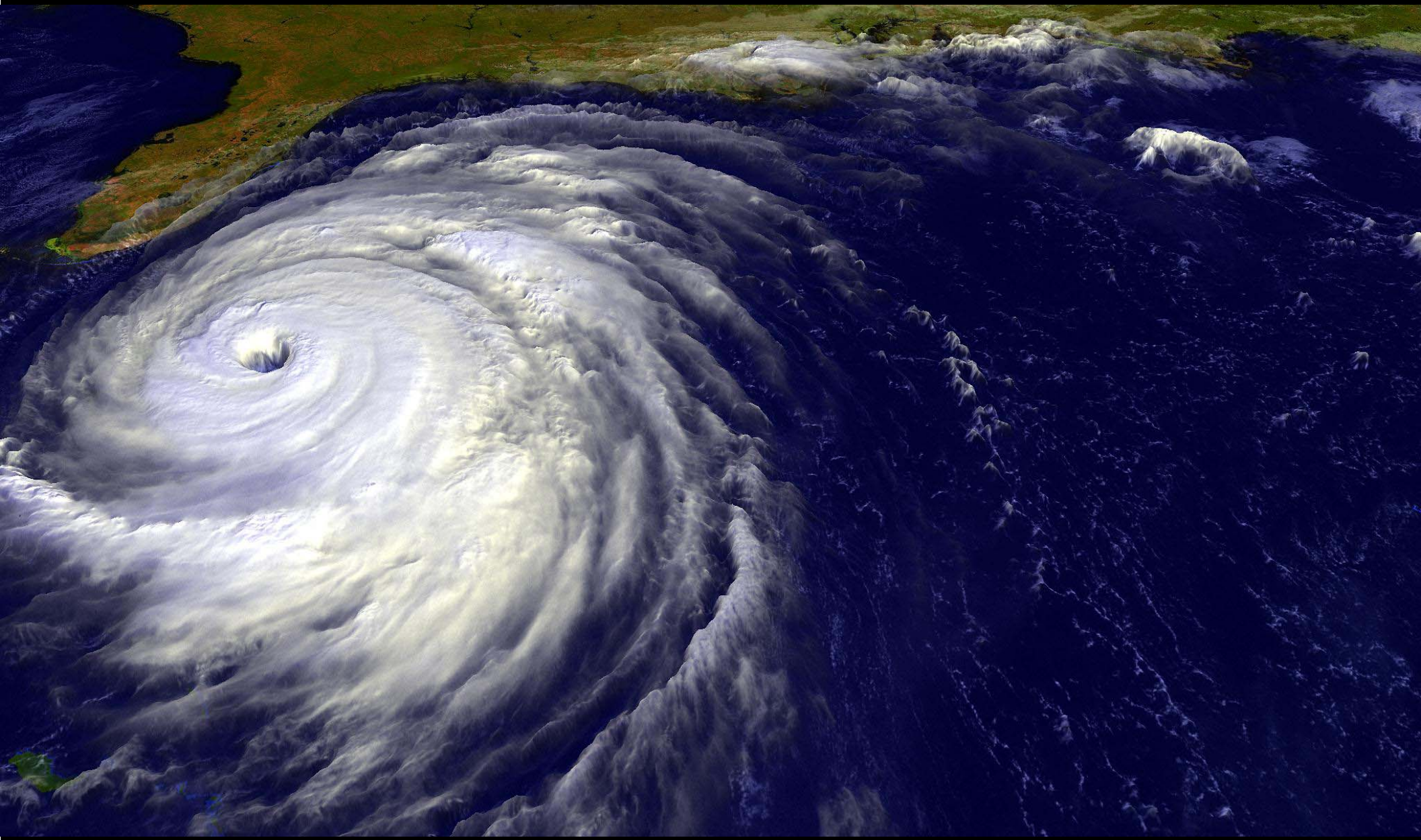
Formal definition: A *tropical cyclone* with 1-min average winds at 10 m altitude in excess of 32 m/s (64 knots or 74 MPH) occurring over the North Atlantic or eastern North Pacific

The word *Hurricane* is derived from the Mayan word *Huracan* and the Taino and Carib word *Hunraken*, a terrible God of Evil, and brought to the West by Spanish explorers

This image has been removed due to copyright restrictions.

Early historical encounters: The Mongol invasions of Japan in 1274 and 1281

Scene from the 13th century Mongol invasion scrolls, based on a narrative written by the Japanese warrior Takezaki Suenaga.

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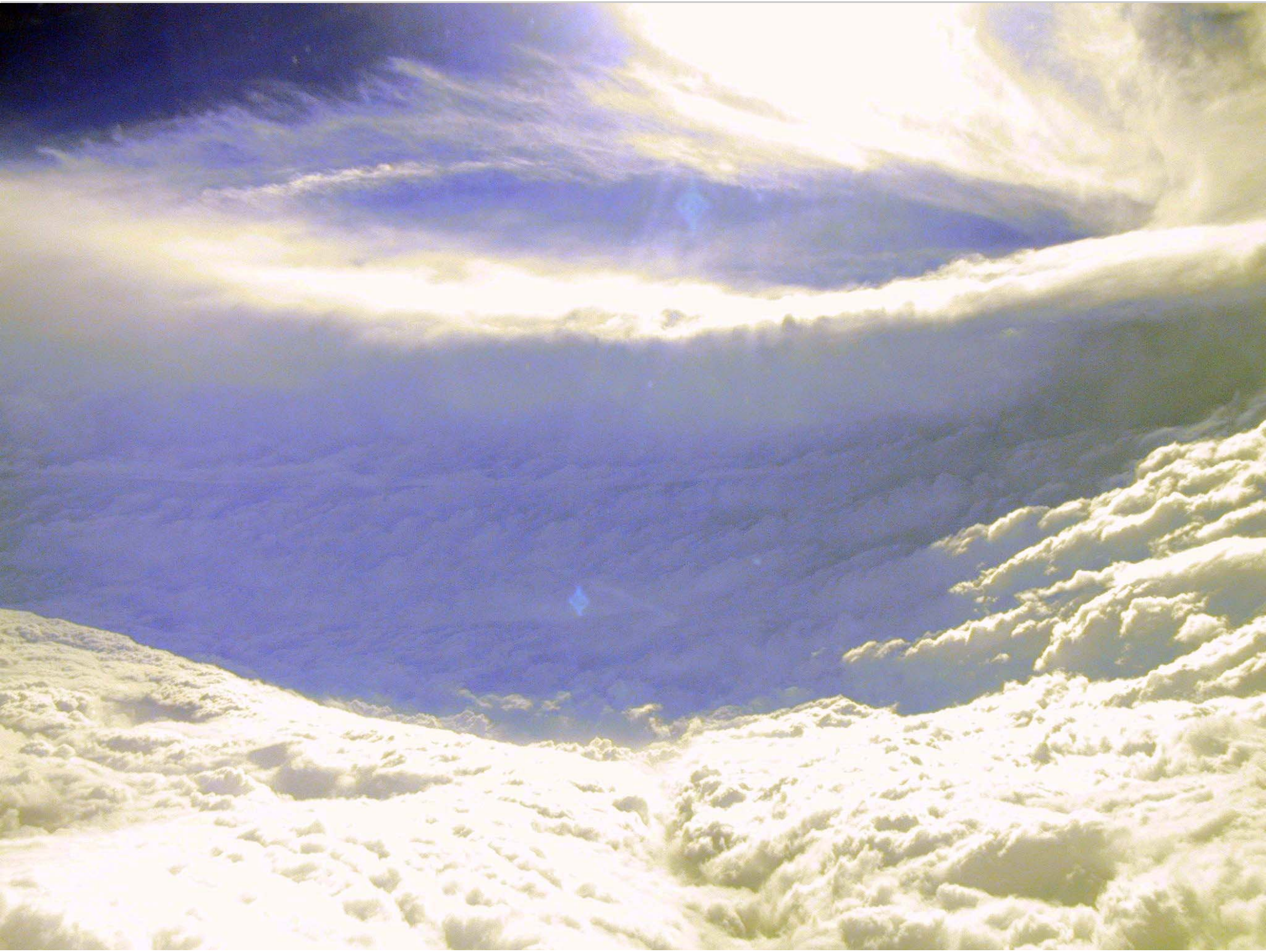
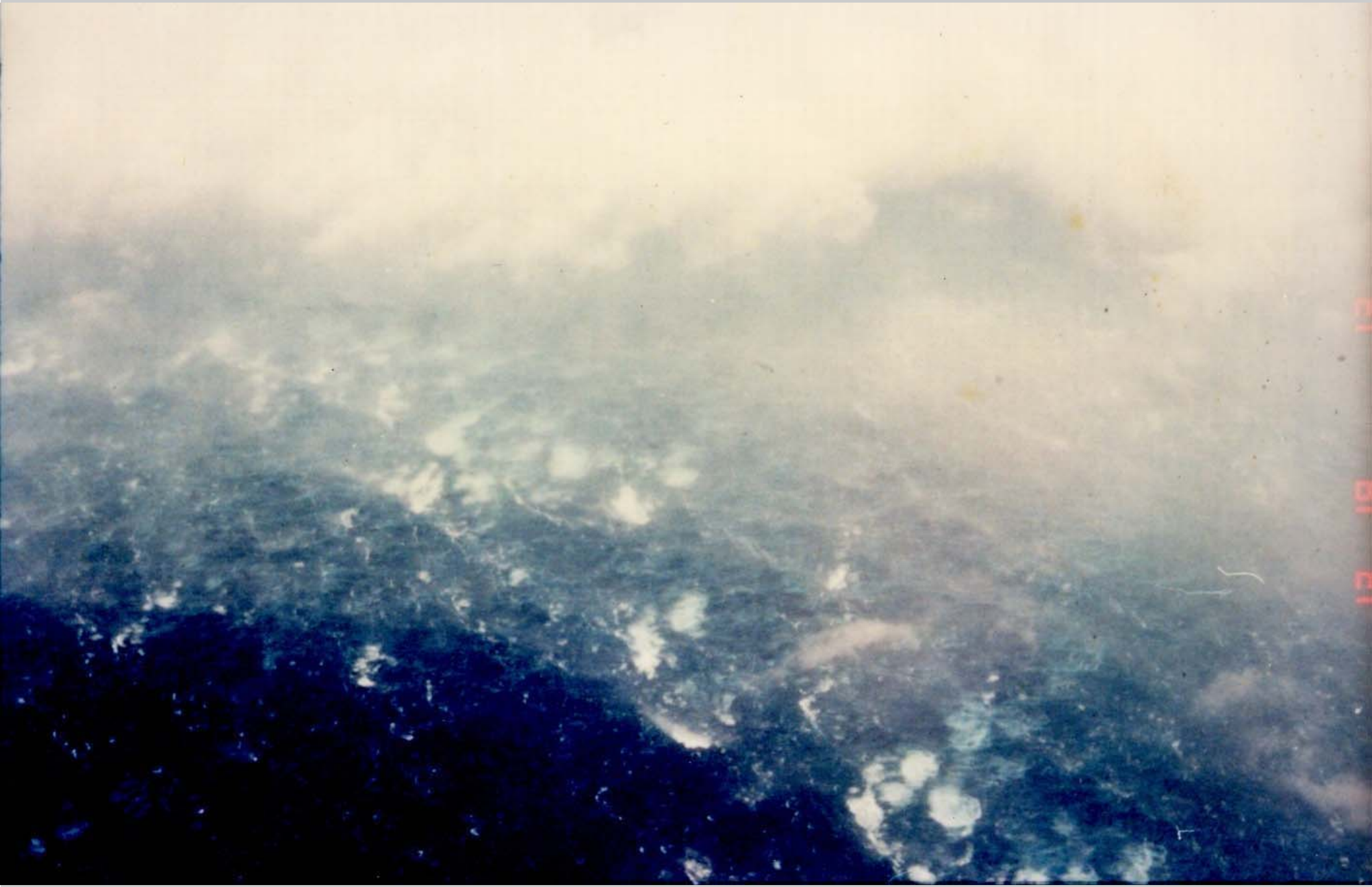
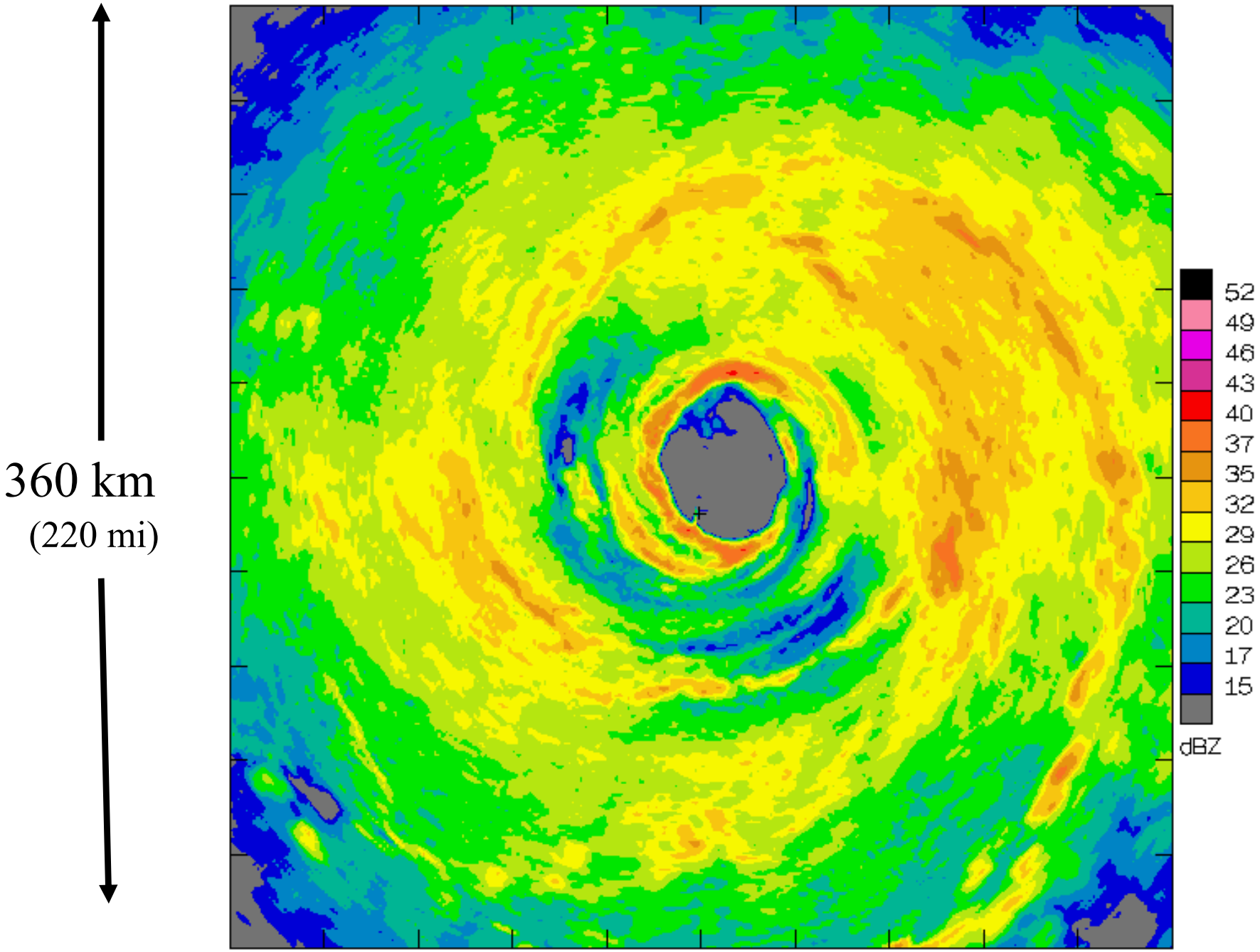
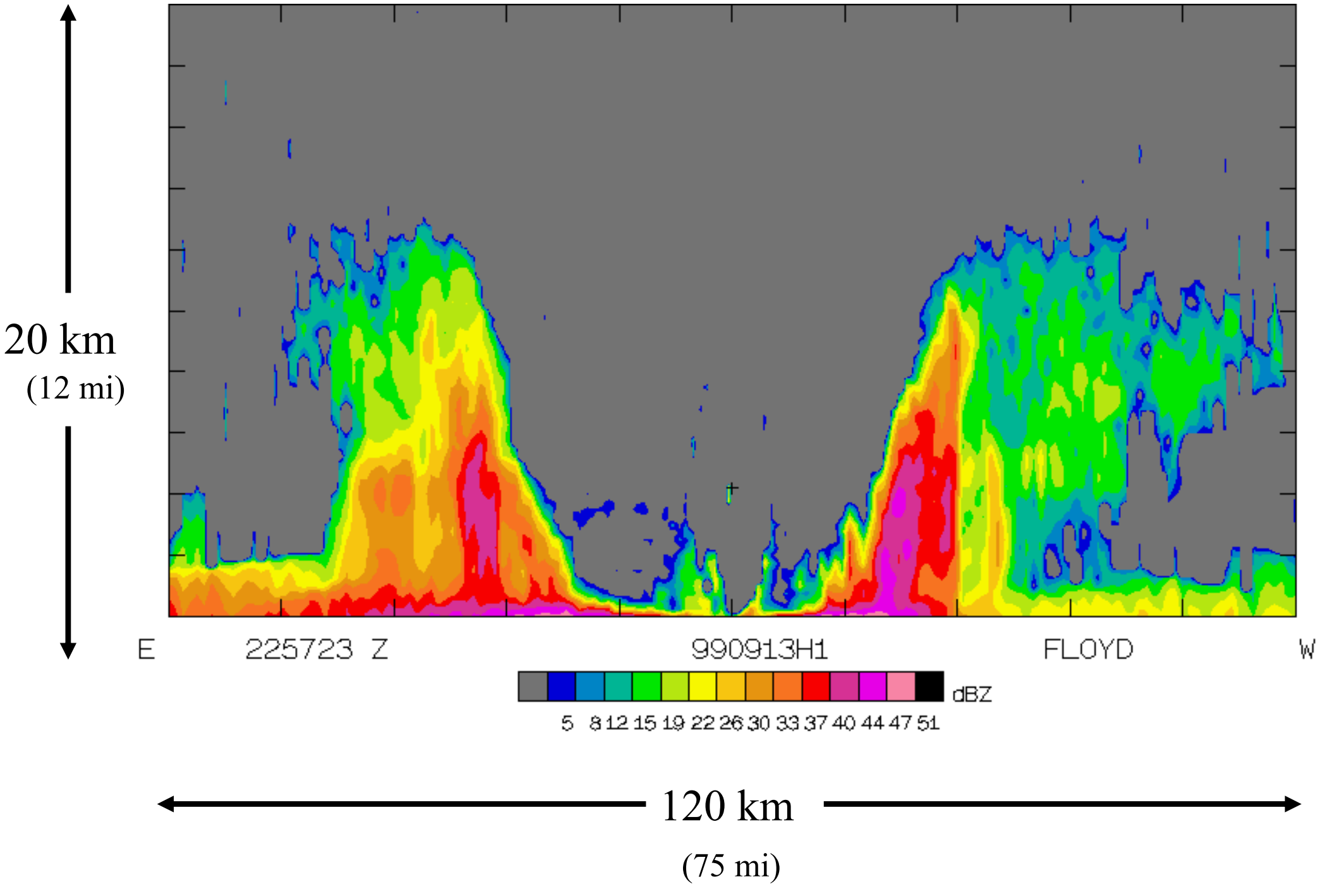


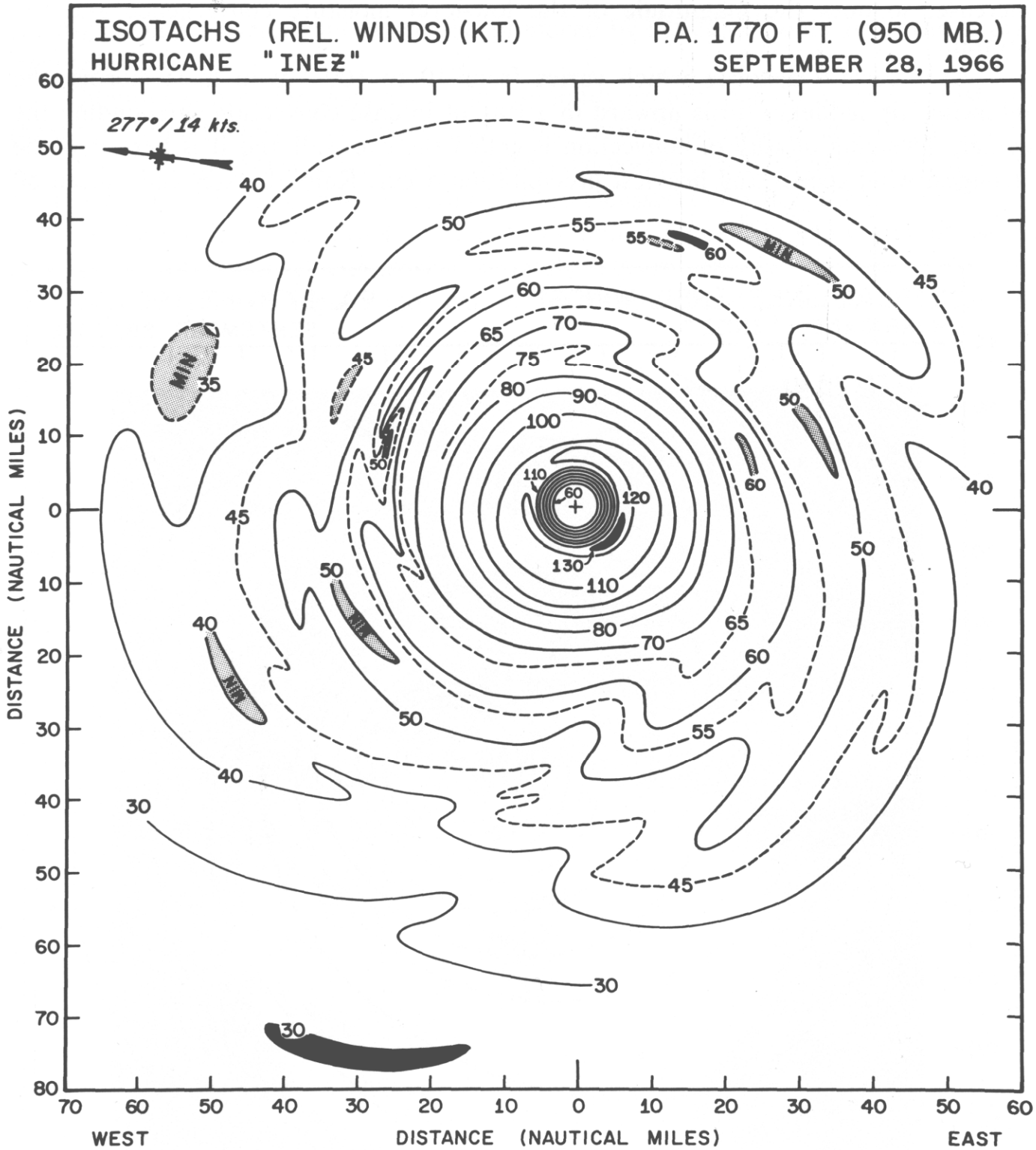


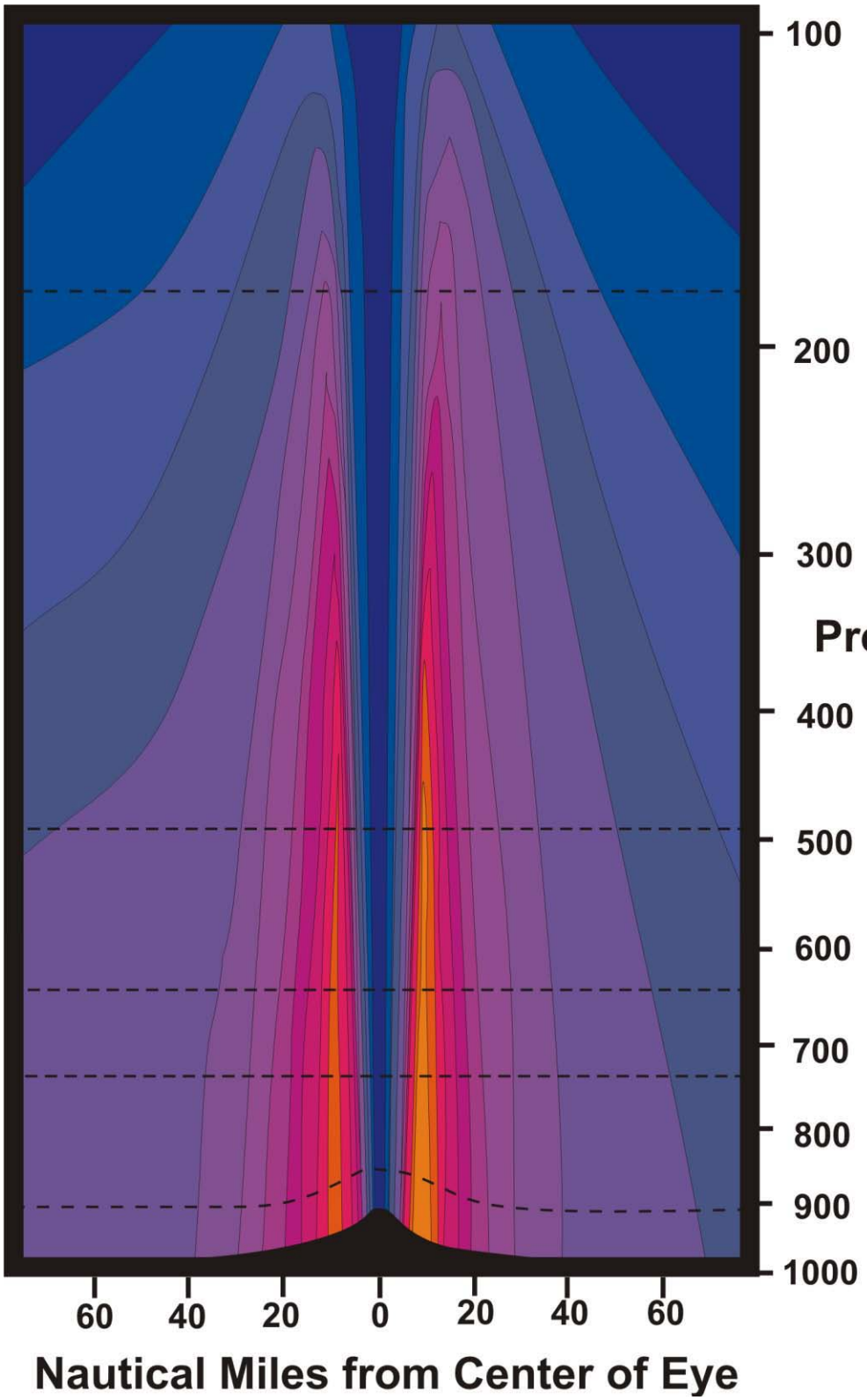
Airborne Radar: Horizontal Map



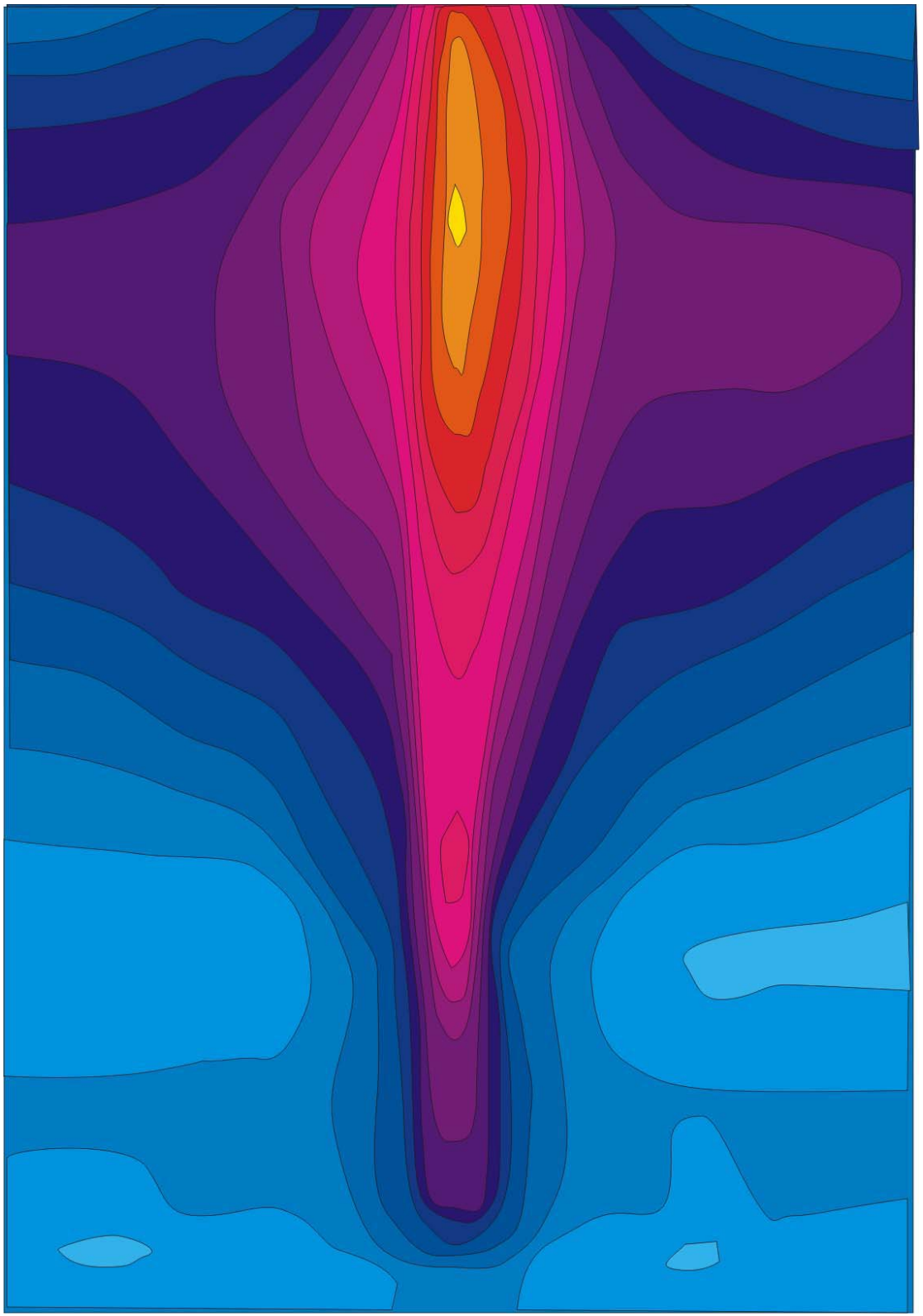
Airborne Radar: Vertical Slice




ISOTACHS (REL. WINDS) (KT.)
HURRICANE "INEZ"
P.A. 1770 FT. (950 MB.)
SEPTEMBER 28, 1966
277°/14 kts.
DISTANCE (NAUTICAL MILES)
WEST
DISTANCE (NAUTICAL MILES)
EAST
MIN
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80



Azimuthal wind

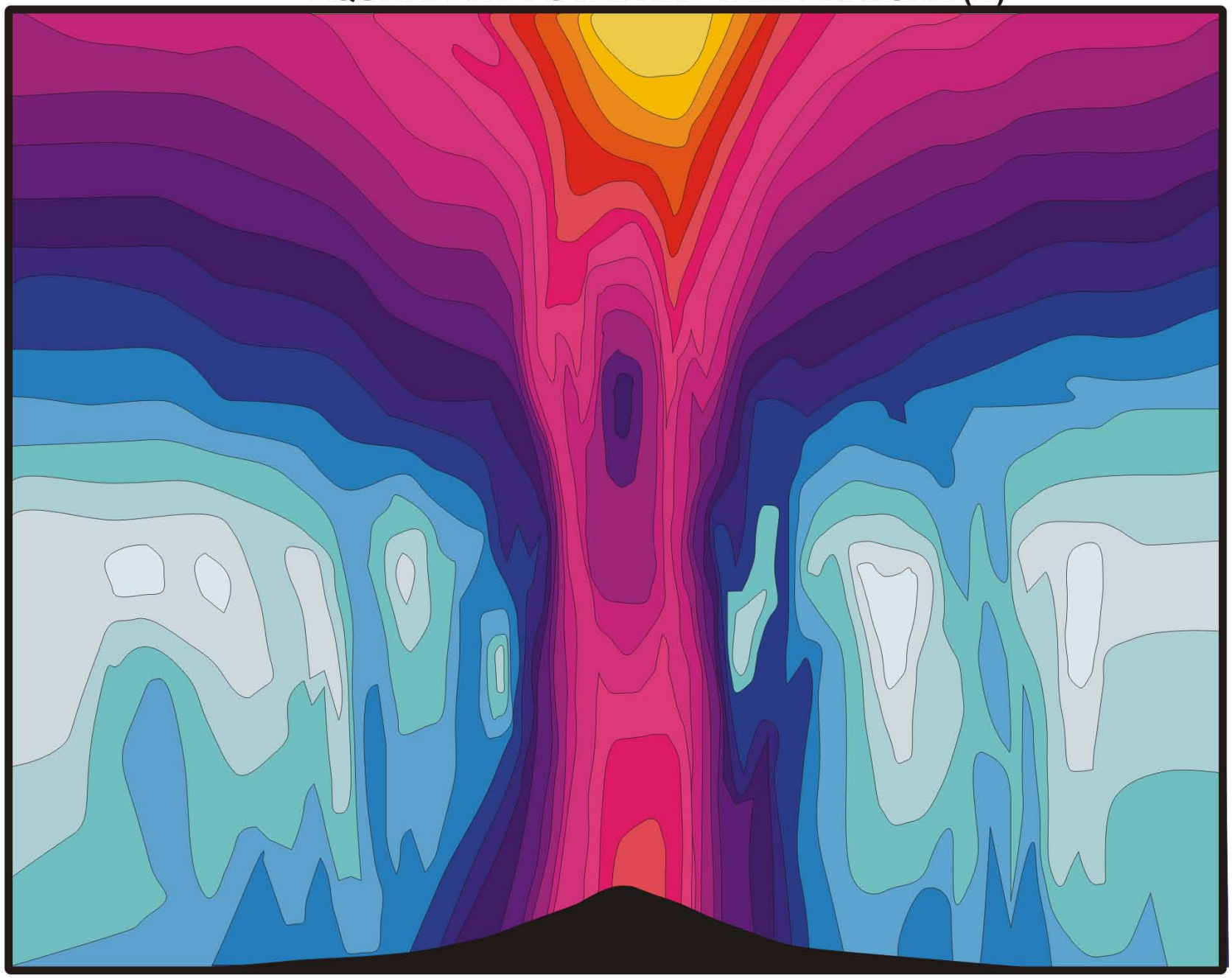


Temperature perturbation at constant altitude

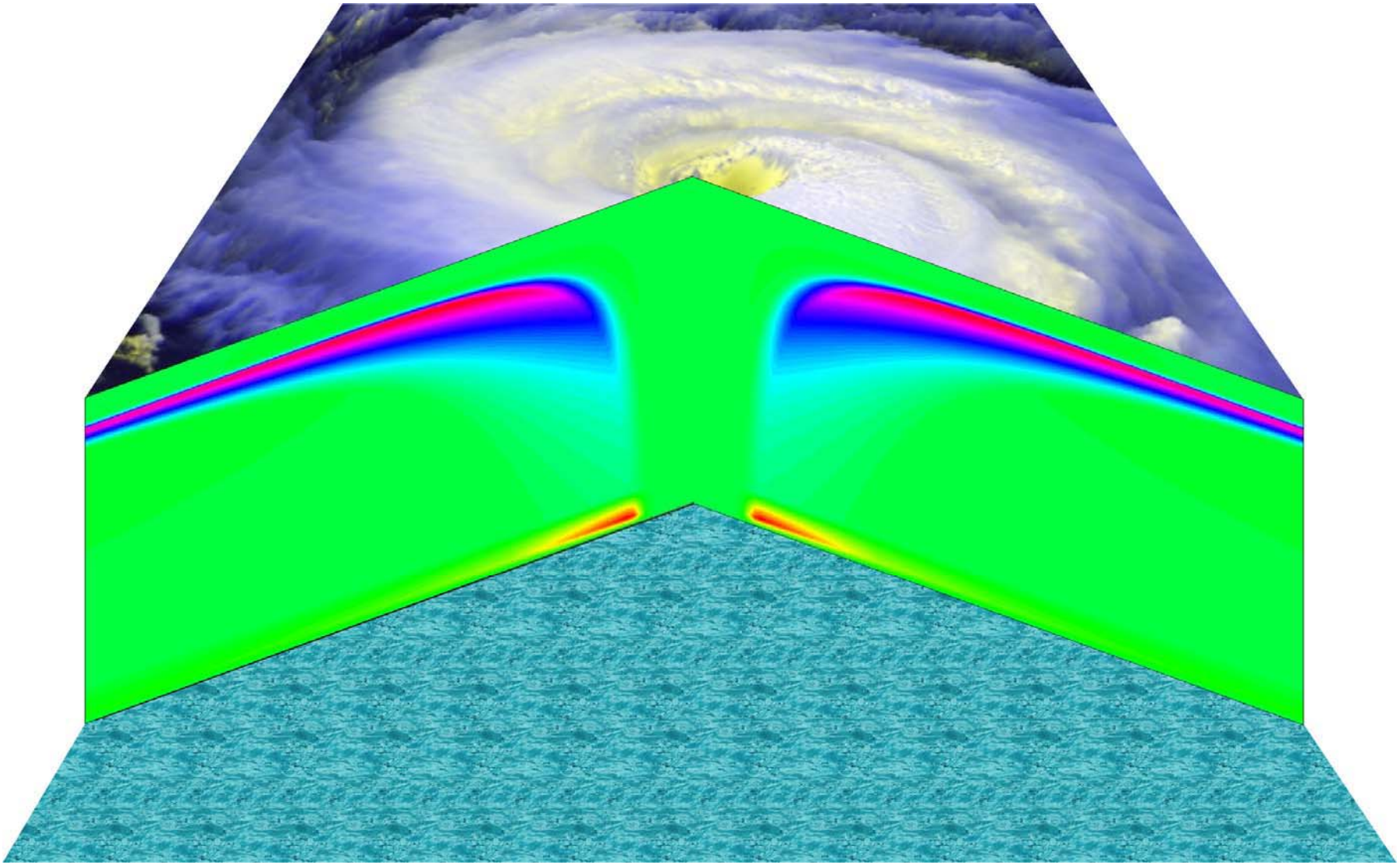
HURRICANE INEZ

SEPTEMBER 28, 1966

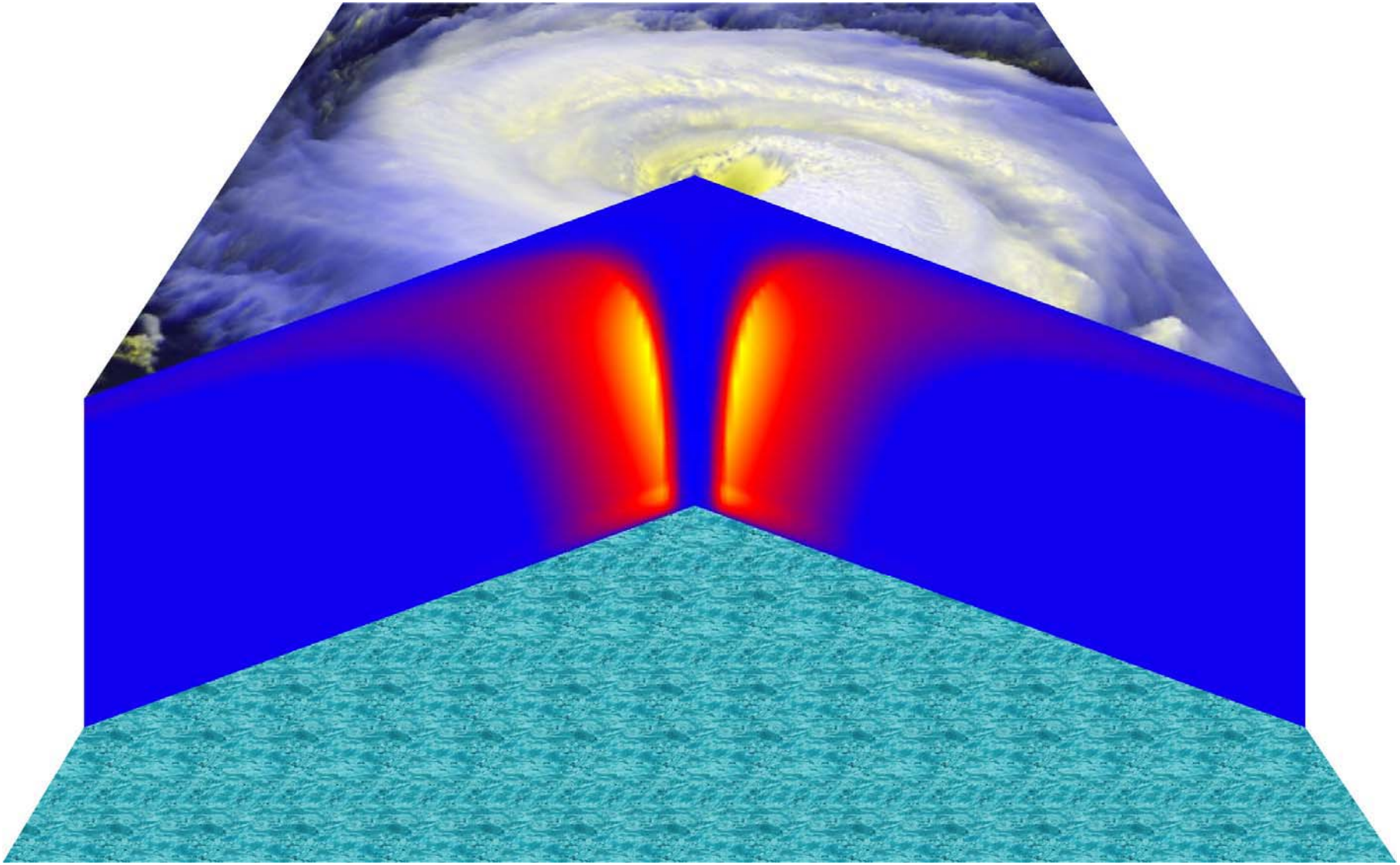
EQUIVALENT POTENTIAL TEMPERATURE (K)

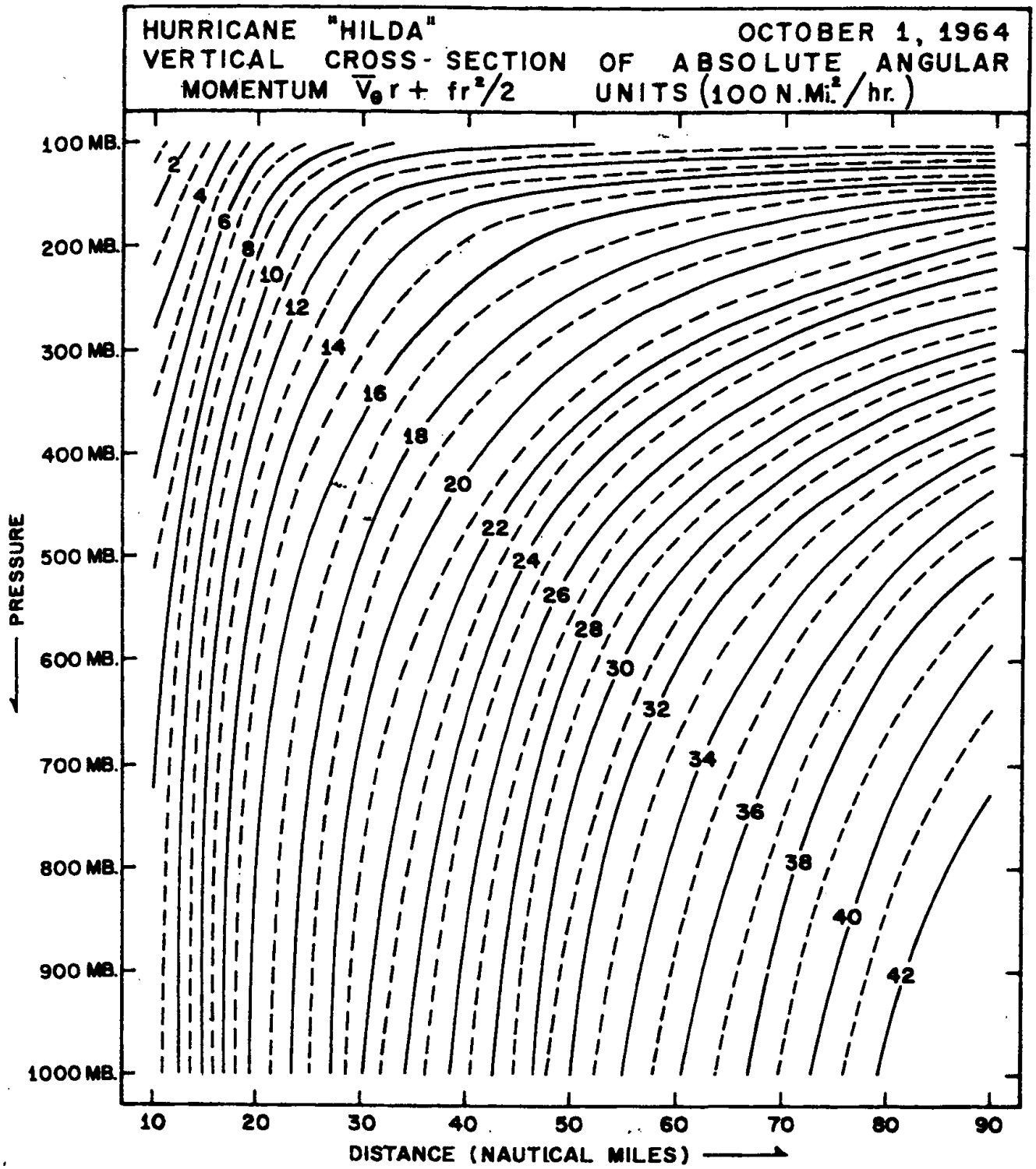


Radial wind



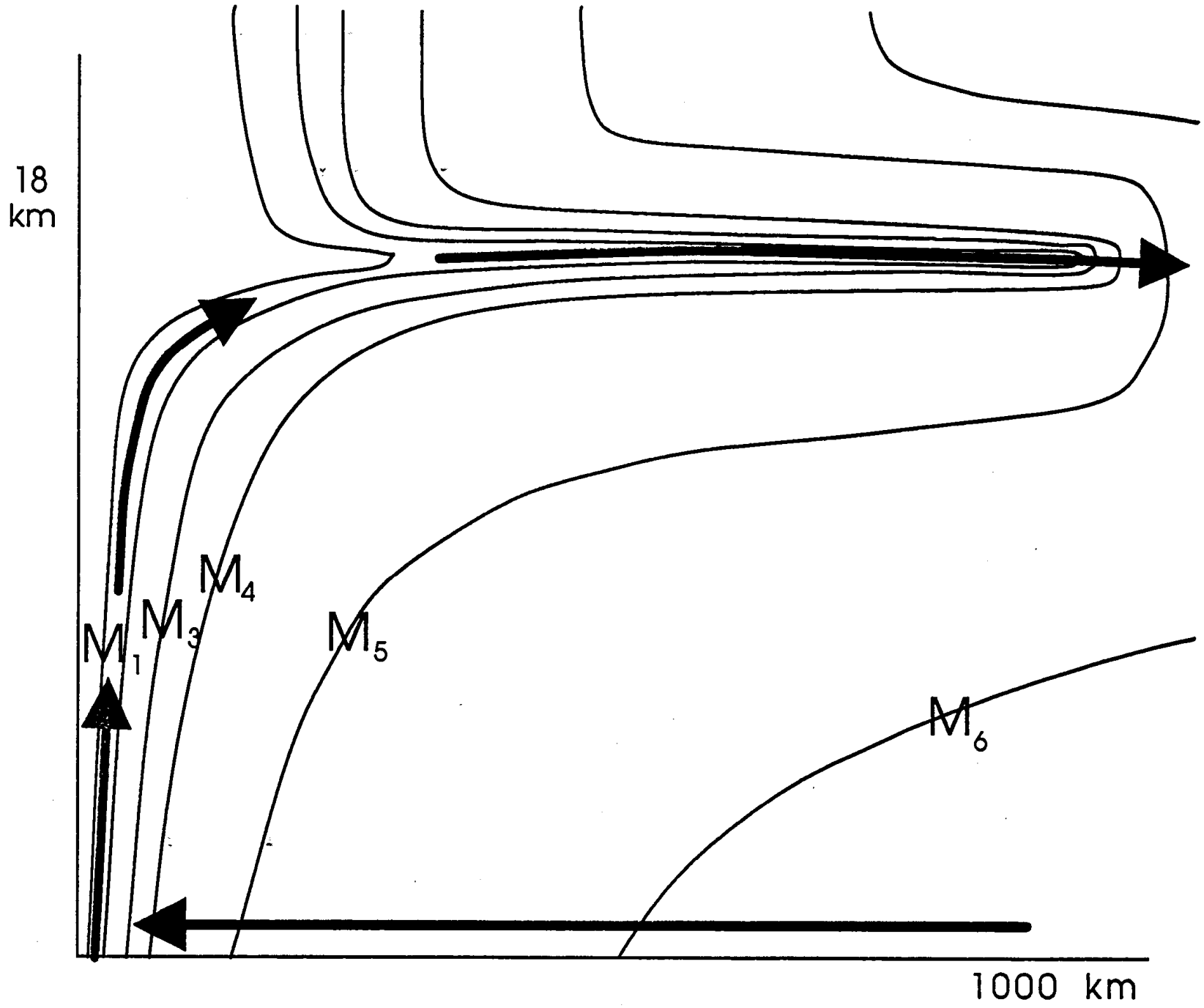
Vertical velocity

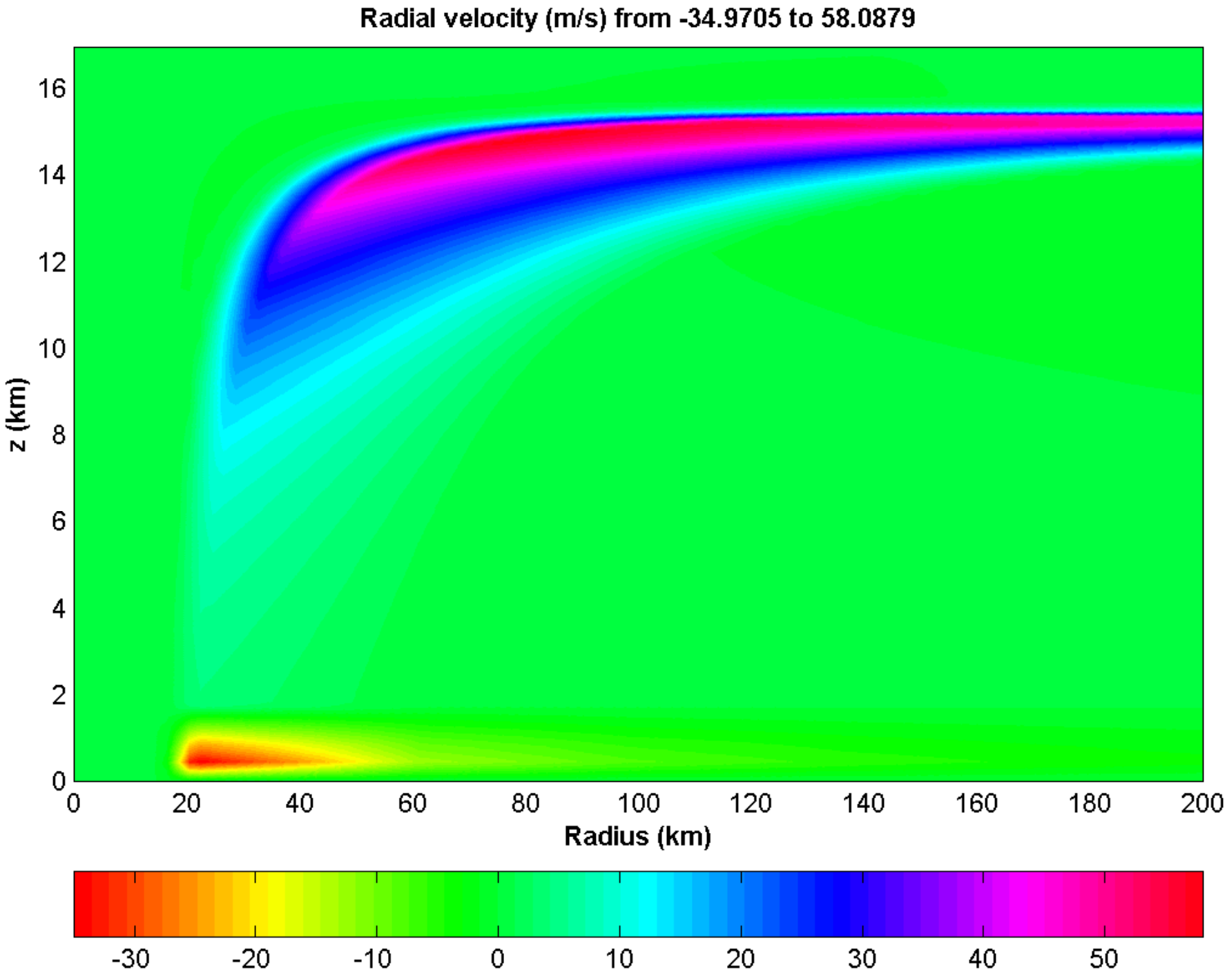


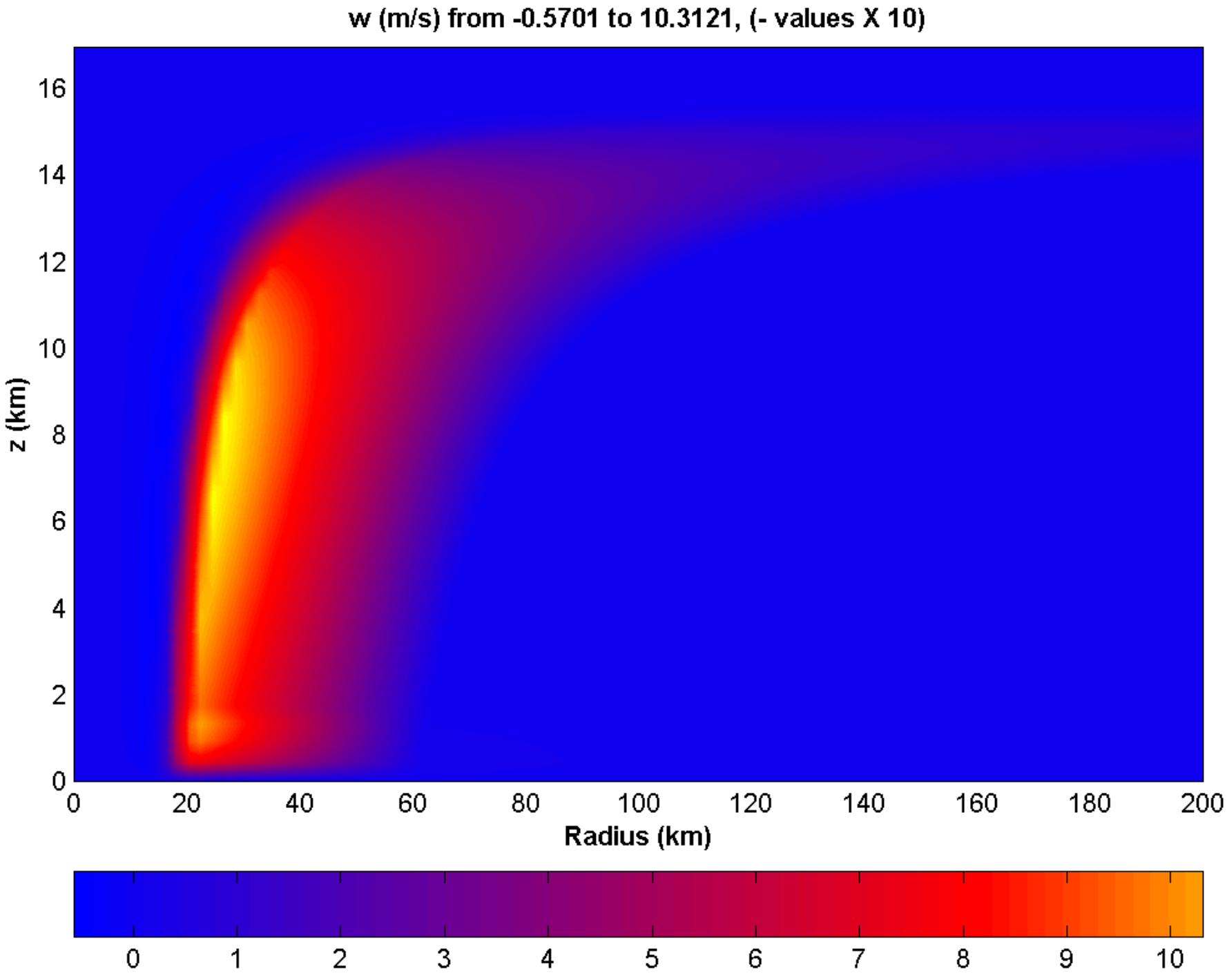


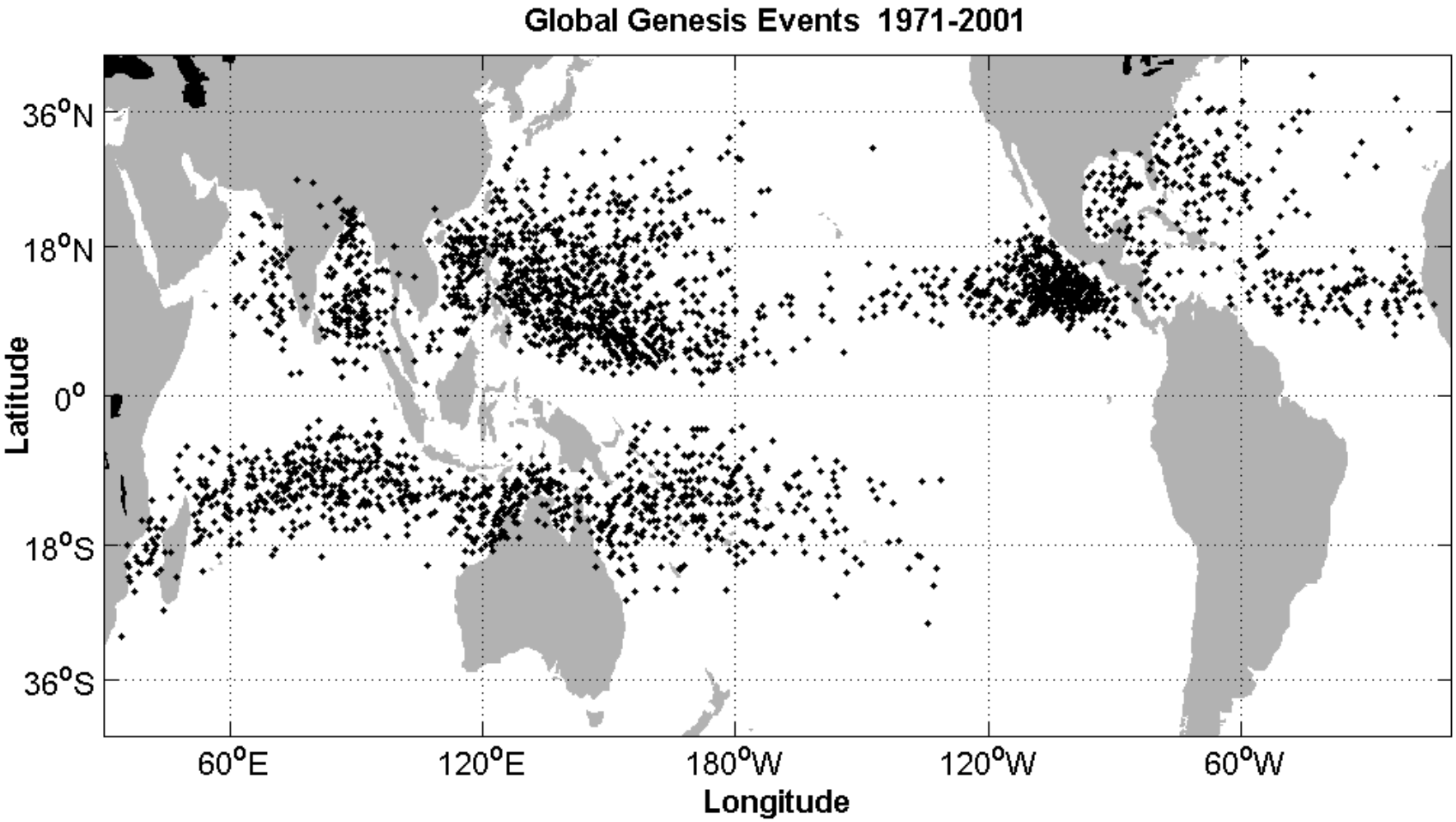
Angular momentum per unit mass

$$M = rV + \Omega \sin(\theta) r^2$$

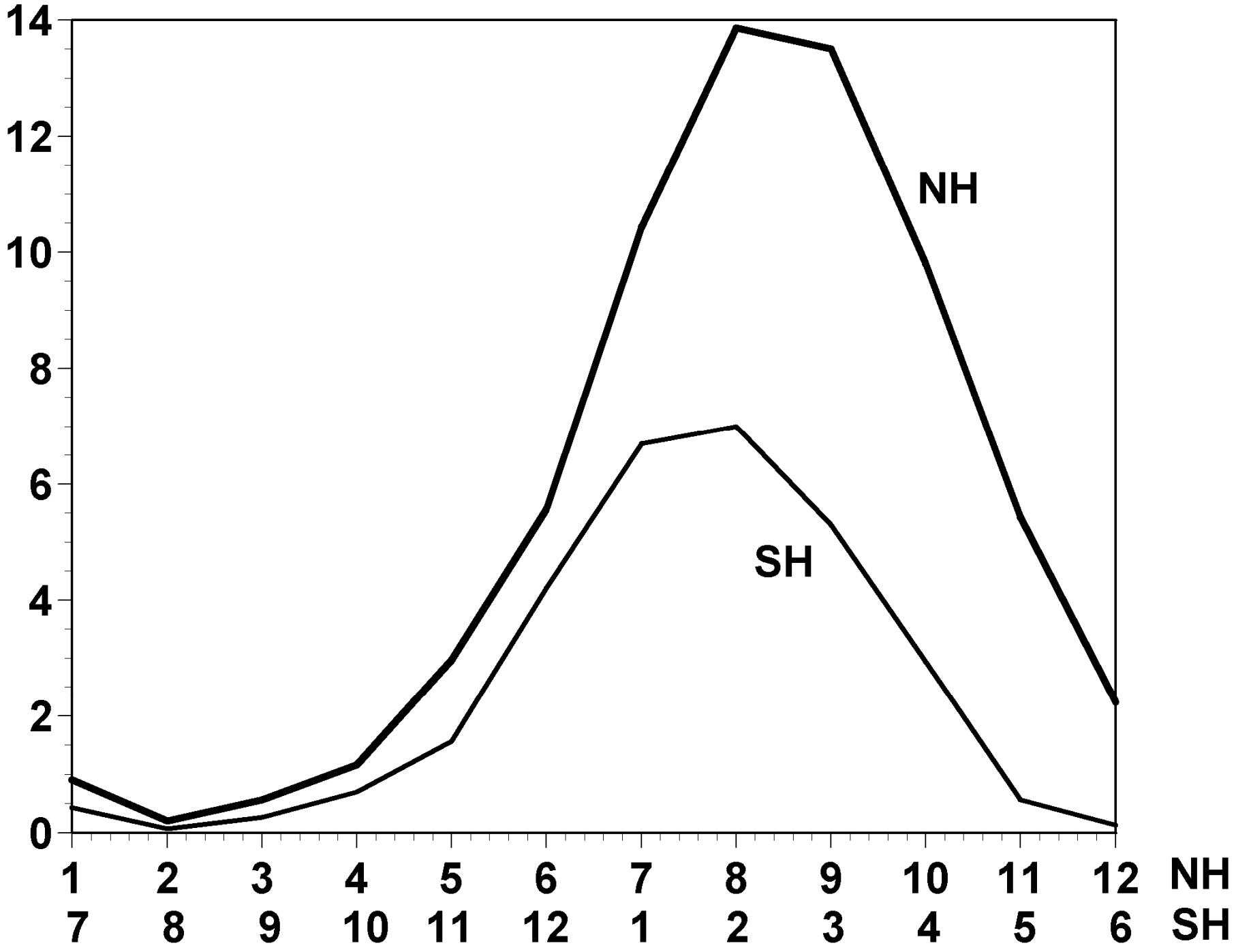

18
km
M1
M3
M4
M5
M6
1000 km

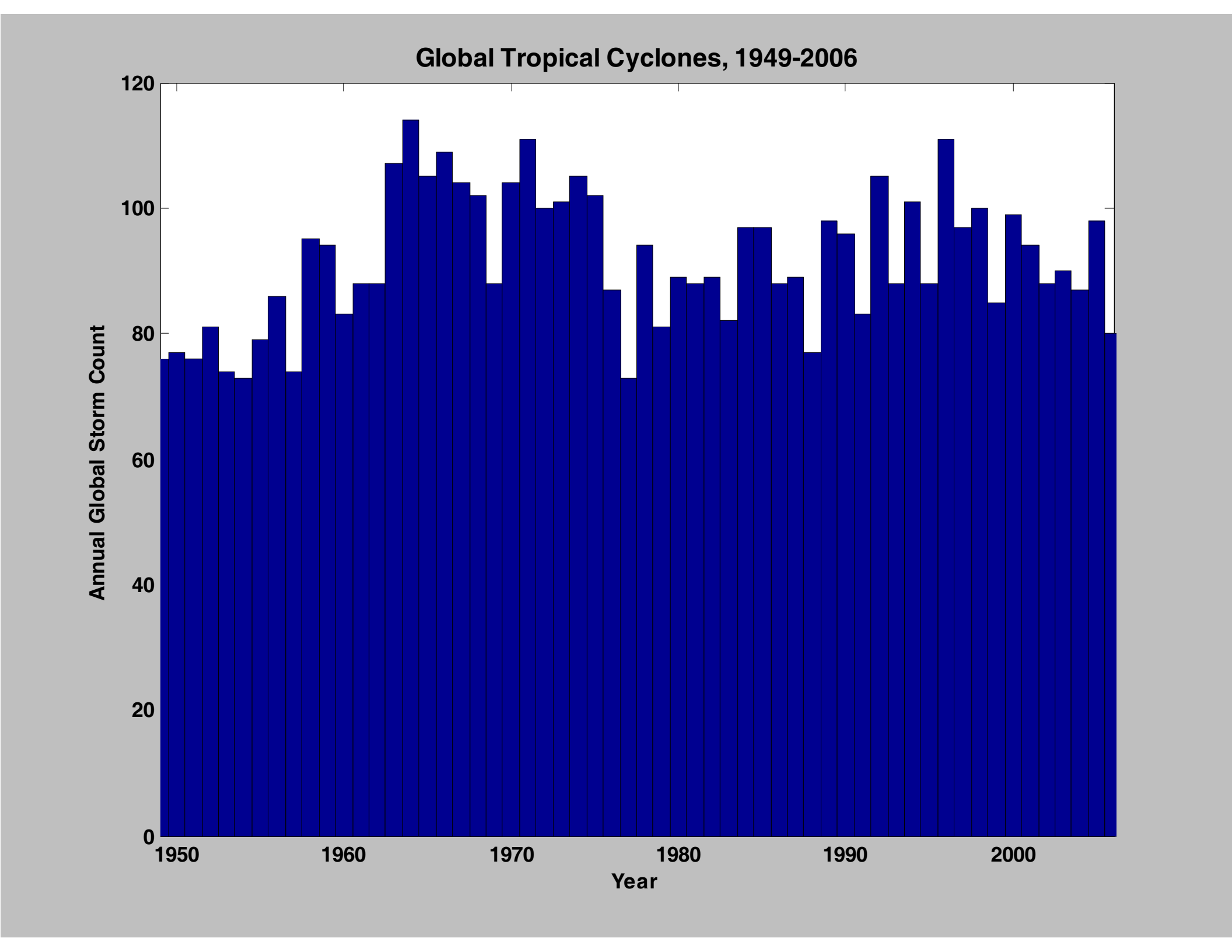

Radial velocity (m/s) from -34.9705 to 58.0879
z (km)
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100
120
140
160
180
200
Radius (km)
-30
-20
-10
0
10
20
30
40
50

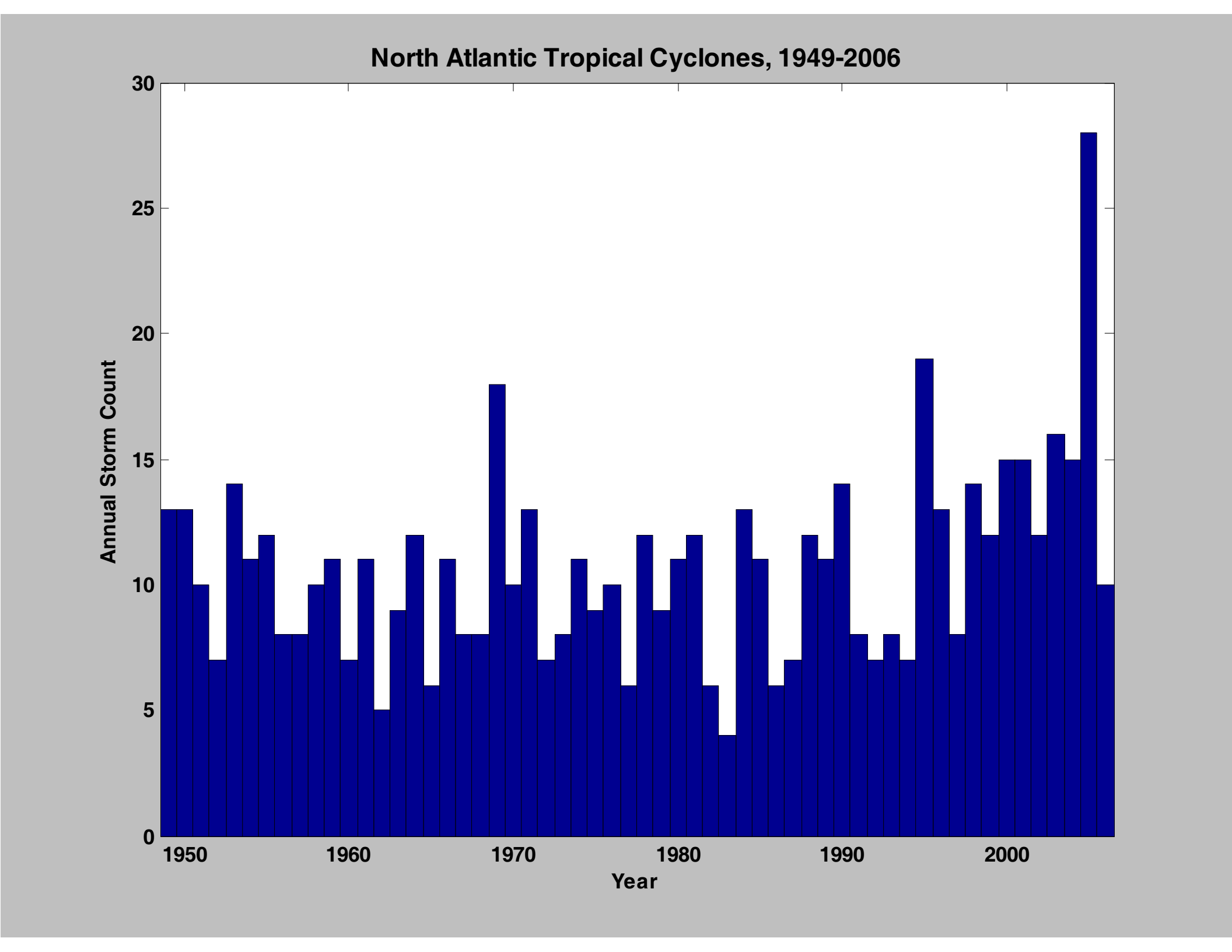

w (m/s) from -0.5701 to 10.3121, (- values X 10)
z (km)
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100
120
140
160
180
200
Radius (km)
0
1
2
3
4
5
6
7
8
9
10


Global Genesis Events 1971-2001
36°N
18°N
0°
18°S
36°S
Latitude
60°E
120°E
180°W
120°W
60°W
Longitude

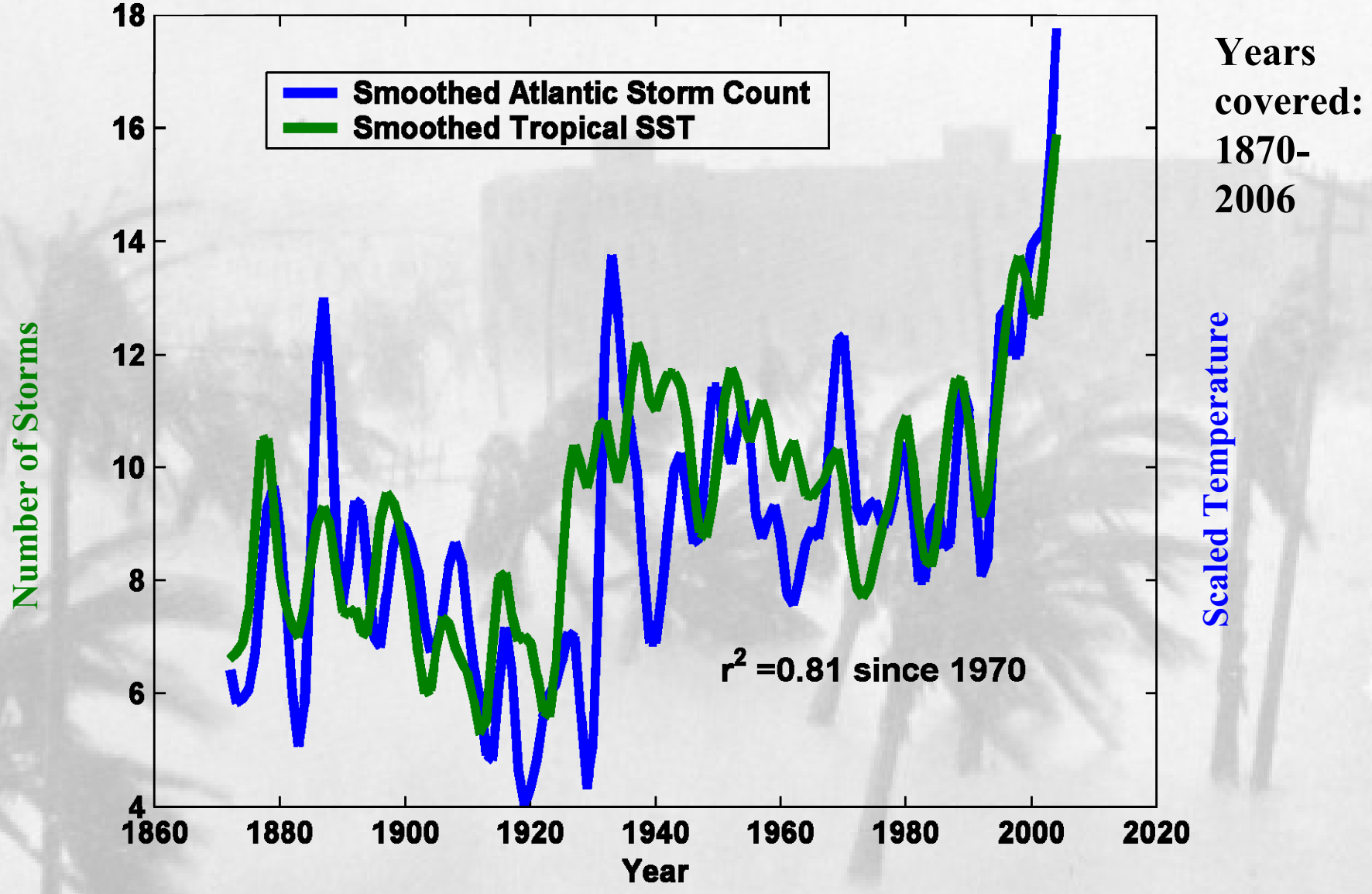
Number of Genesis Events per Month




Global Tropical Cyclones, 1949-2006
Annual Global Storm Count
Year
0
20
40
60
80
100
120
1950
1960
1970
1980
1990
2000


North Atlantic Tropical Cyclones, 1949-2006
Annual Storm Count
Year
0
5
10
15
20
25
30
1950
1960
1970
1980
1990
2000

In Atlantic, the Frequency of Storms is Well Correlated with Tropical Atlantic Sea Surface Temperatures



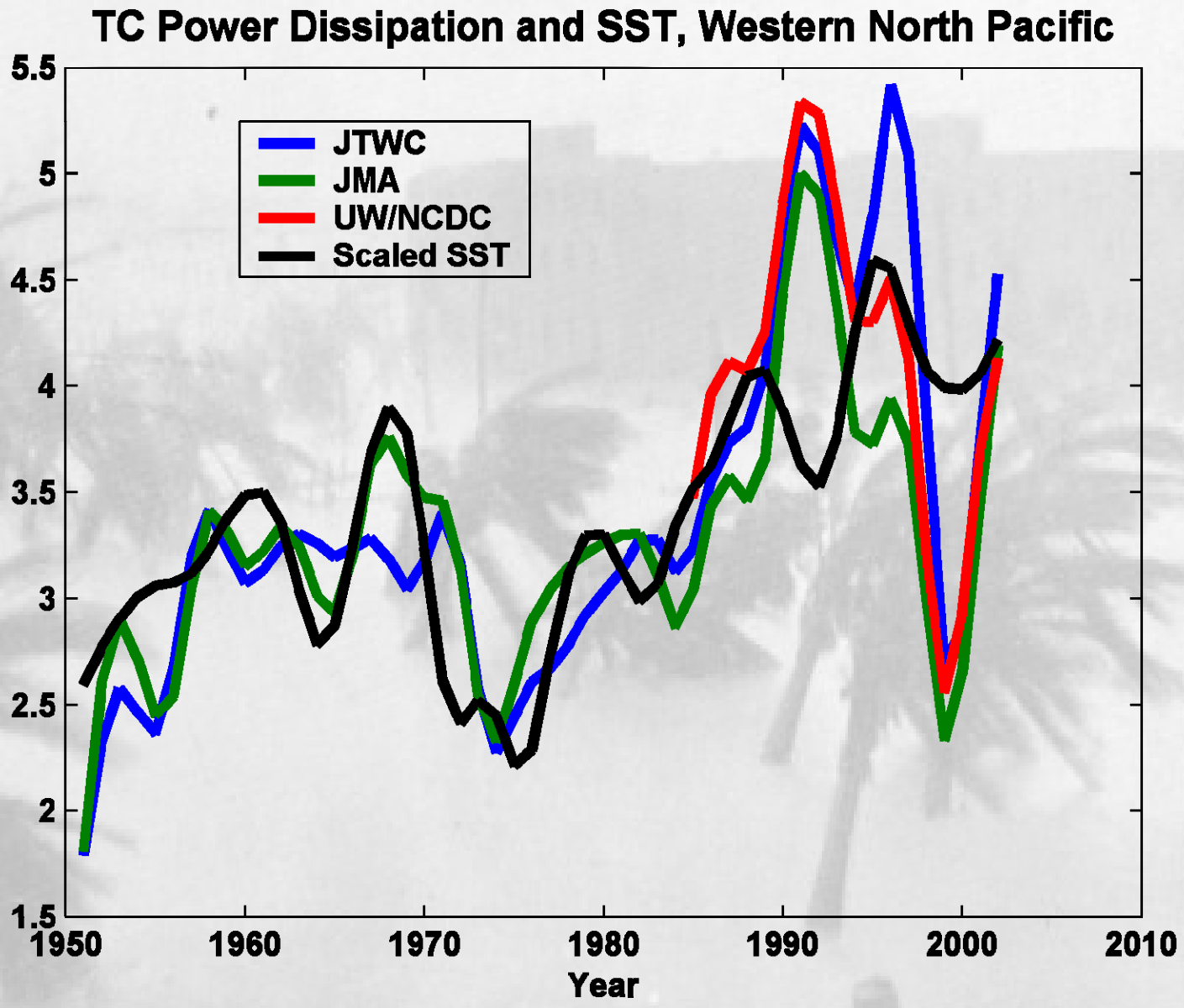
Better Intensity Metric:

The Power Dissipation Index

$$PDI \equiv \int_0^{\tau} V_{max}^3 \, dt$$

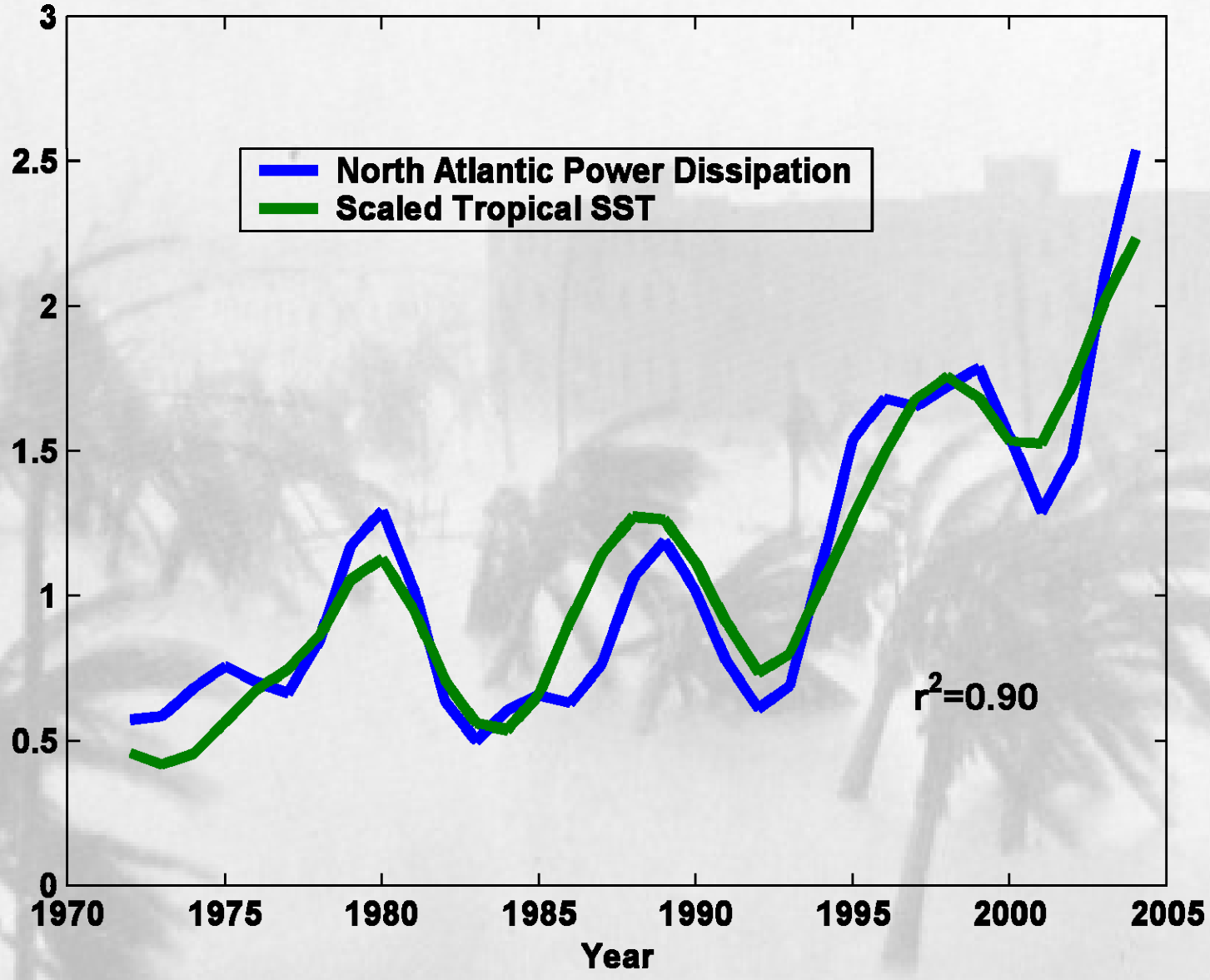
A measure of the total frictional dissipation of kinetic energy in the hurricane boundary layer over the lifetime of the storm

Three Analyses of Tropical Cyclone Power Dissipation in the Western North Pacific, and SST in the Main Development Region



Years covered: 1949-2004

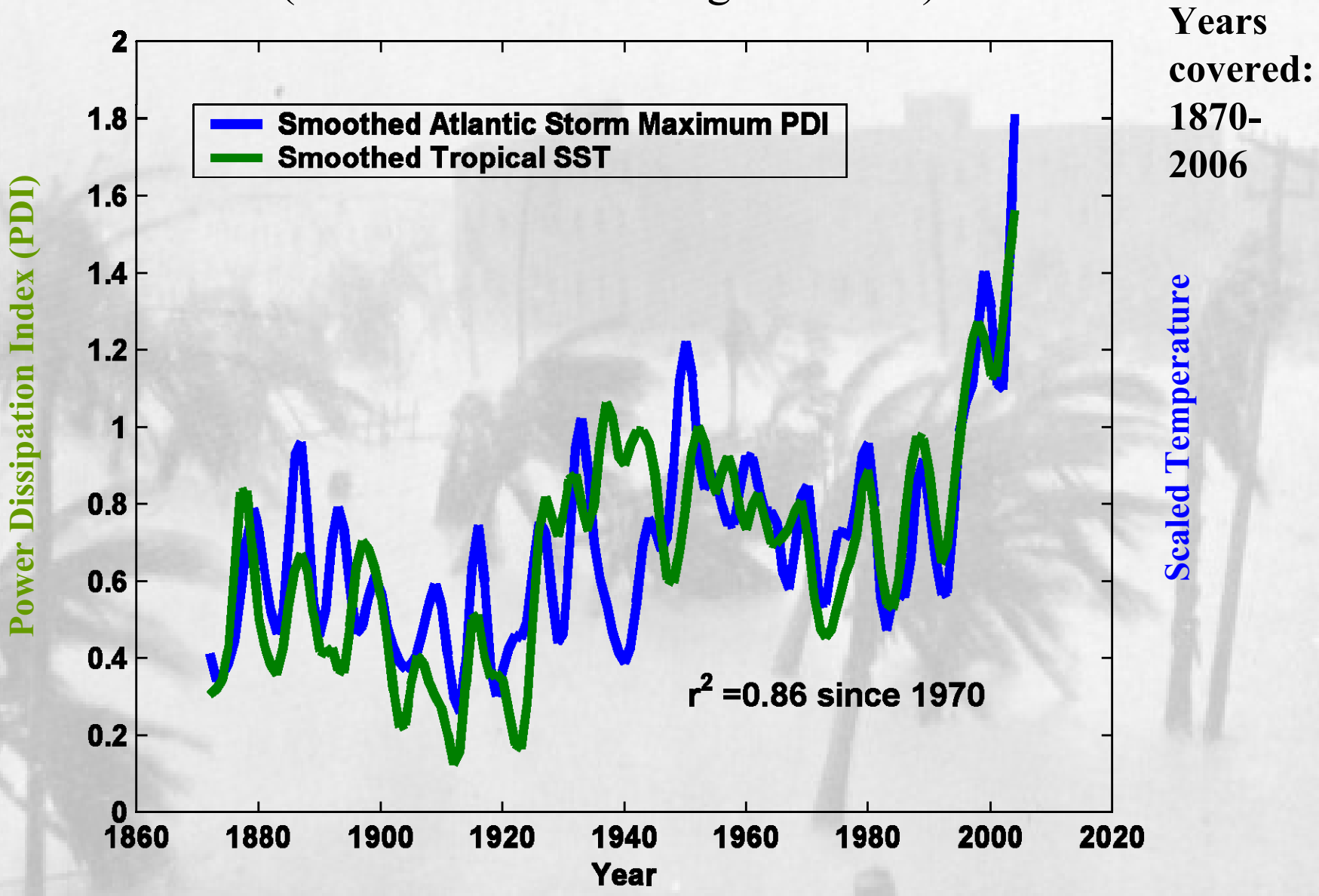
In the Atlantic, Power Dissipation and SST are Exceptionally Well Correlated through the Modern Instrumental Record



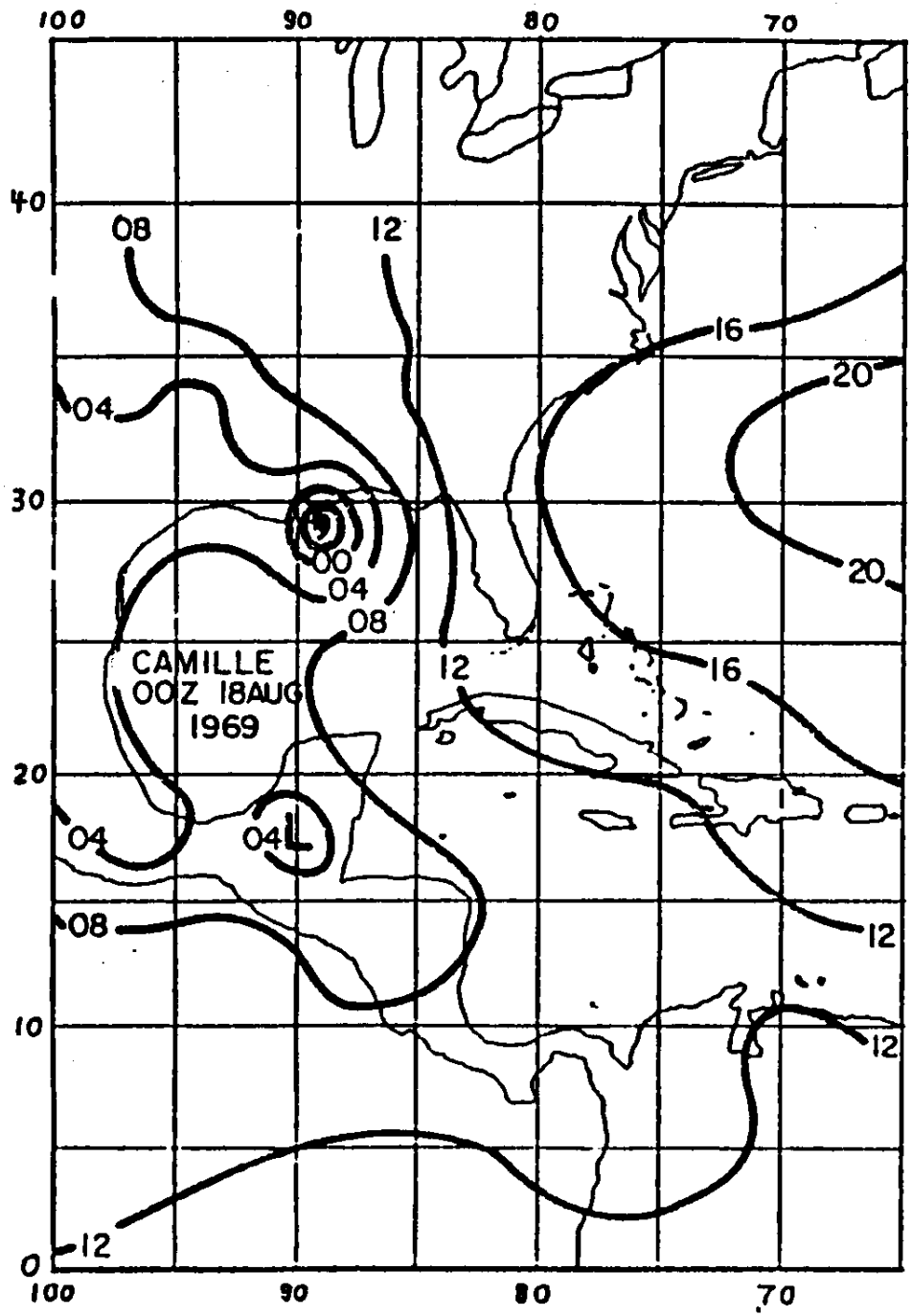
Years covered: 1970-2006

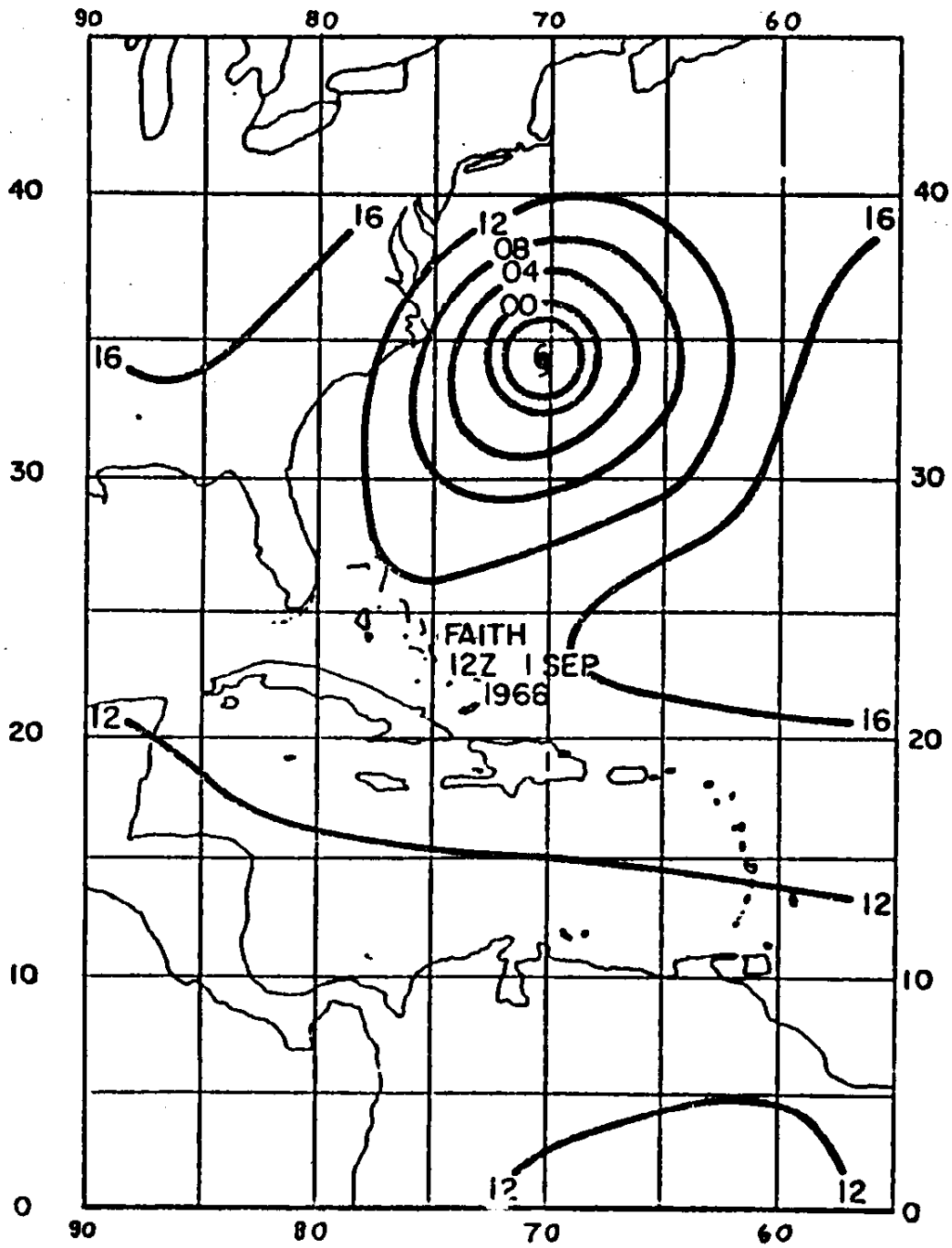
Atlantic Sea Surface Temperatures and Storm Maximum Power Dissipation

(Smoothed with a weighted filter)



Years covered: 1870-2006


100
90
80
70
40
30
20
10
0
08
12
16
20
04
00
CAMILLE
00Z 18AUG
1969


90
80
70
60
40
30
20
10
0
16
12
08
04
00
FAITH
12Z 1 SEP
1966

Infamous U.S. Hurricanes

Galveston, 1900

Image courtesy of NOAA.

Miami, 1926

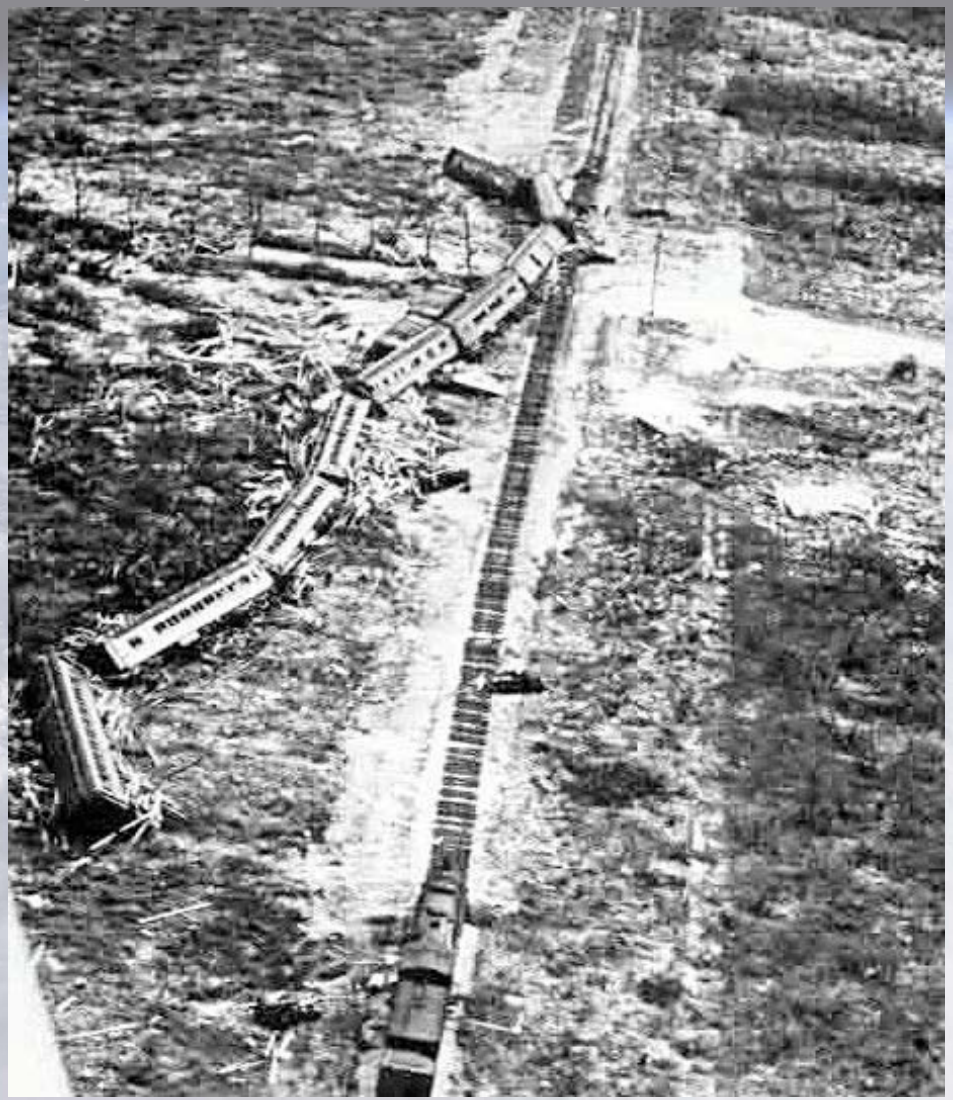
Image courtesy of NOAA.

Okeechobee Hurricane of 1928

Belle Glade: Wreckage of Ford garage. Boree building (left); Pioneer building (right).

Image courtesy of NOAA.

Labor Day Hurricane of 1935, Florida Keys



Indian Key absolutely swept clean, not a blade of grass, and over the high center of it were scattered live conchs that came in with the sea, craw fish, and dead morays. The whole bottom of the sea blew over it.

- Ernest Hemingway

Image courtesy of NOAA.

Andrew, 1992

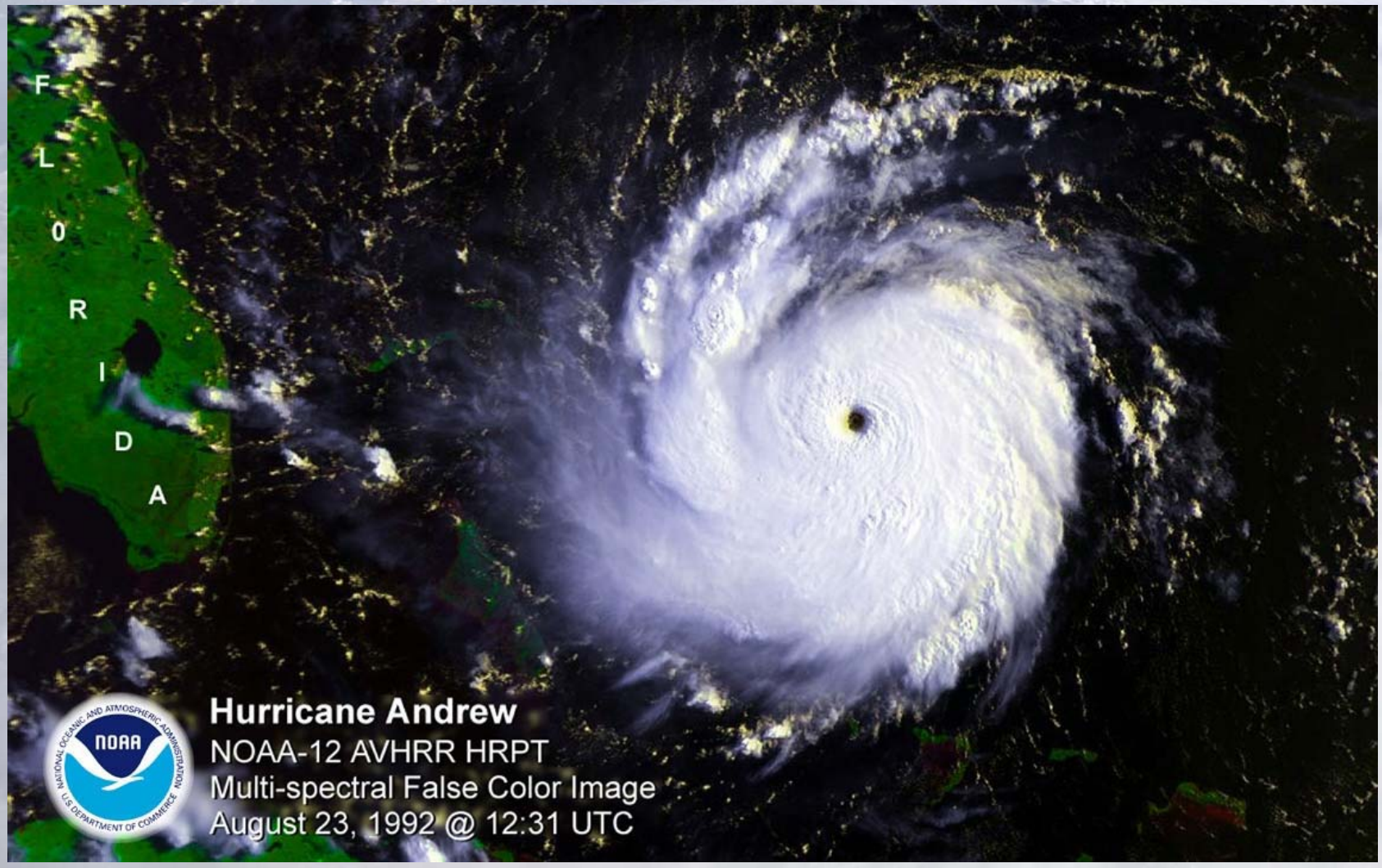


Image courtesy of NOAA.

Hurricane Katrina, 2005

Image courtesy of NOAA.

12.103 Science and Policy of Natural Hazards
Spring 2010