

# **Tropical Storm Karen Synoptic and Convair Flight Summary**

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[Reference to the figures indicated in brackets]

Tropical Storm Karen made landfall on the south shore of Nova Scotia on Monday, October 15<sup>th</sup>, 2001. Although Karen was little more than an inconvenience to the public, it was an unusual storm in that it was predominantly tropical in nature when it arrived. The Canadian National Research Council's Convair aircraft flew into the storm during landfall to study what would have been the early stages of this extratropical transition. In addition to aircraft operations including dropsondes and cloud microphysical measurements, radar [\[Imagery\]](#) from the new doppler radar west of Halifax was collected. These data should provide some detailed information on the structure of this storm and possibly some new understanding of storms like it. This report serves as a synoptic summary of Karen and a brief outline of the activities of the Convair mission on October 15th.

## **TRACK/HISTORY** [\[Track Map\]](#)

Karen actually evolved from an extratropical storm, which formed just south of Bermuda on October 10th and 11th. This incipient cyclone was originally very large and produced hurricane-force gusts to 78 kts in Bermuda. As the low moved northwest, convection became organized near the centre, and the National Hurricane Center dubbed the system as sub-tropical storm #1, at 21Z October 12th. By the morning of the 13th, the system had acquired significant tropical characteristics to be called Tropical Storm Karen, and later that day winds reached hurricane-force. Karen continued to move erratically northward, speeding up and slowing down with occasional departures in the mean heading, which made forecasting difficult. By the afternoon of the 14th, Karen's winds dropped below hurricane force when it moved over cooler waters. The heading became more north-northwestward, putting it on a bee-line toward southern Nova Scotia. The centre reached the coast at 1115Z October 15th at Western Head. The NOAA polar-orbiting satellite captured a nice [\[AVHRR Satellite Image\]](#) of the storm about an hour and a half before landfall. Maximum sustained winds at the time were estimated to be near 45 kts, mainly over water. As the storm moved north-northeastward into the Gulf of St. Lawrence it merged with a cold front over eastern Quebec.

## **MARINE IMPACTS**

### ***Winds***

Storm-force winds would have occurred over the southern part of the West Scotian Slope when Karen was still a 50-kt tropical storm. Otherwise, gales were experienced out to approximately 50 nm west (left) of the track and 150 nm to the east (right). While in the Gulf of St. Lawrence, only a small area of sustained gales occurred about 50 nm east and south of the centre. A force-8 gale was blowing up the length of

Halifax Harbour (35-40 kt) Monday morning.

### ***Seas***

Significant wave heights up to 6.2m (20') were reported at the LaHave Bank buoy (44142 - 42.5N, 64.1W) just east of the track at 08Z on the 15th. Significant wave heights reached 5.1m (17') at the Halifax Harbour buoy (44258 - 44.5N, 63.4W) at 15Z. The highest sea state occurred 2 to 3 hours after Karen's closest approach to these buoys. The gale blowing in Halifax Harbour created breaking waves at the docks and frequent white-capping Monday morning.

#### Noteworthy Data:

Id	TDDHH	Lat	Long	Wind	Cld	VVWX	Air	Dew	Sea	Pressure	DV	WaveIce
44142	1508	42.5N	64.0W	1834/40			17.2		15.8	029	\022	0 6.2
44258	1515	44.5N	63.3W	2229/34			16.3		15.6	045	/013	0 5.1

## **INLAND IMPACTS**

### ***Rainfall***

Much of the heavy rainfall was skewed to the western side of the storm, which is exactly what we would expect from a transitioning system. Heaviest amounts (25 to 50 mm) were reported over western Nova Scotia and southeastern New Brunswick based on surface observations and radar imagery. The [\[Surface Analysis\]](#) valid 12Z October 15th shows the distribution of rainfall in Karen at that time. Rain bands were noticed around the storm, even to the east, but these eastern bands were relatively weak and only produced brief, drizzly showers throughout the Halifax area amounting to about 10 mm. Yarmouth picked up 22 mm in one hour and 45 mm overall.

#### Storm-total Rainfalls:

Yarmouth, NS (CYQI)	44.6 mm (1.8")
Saint John, NB (CYSJ)	36.1 mm (1.4")
Greenwood, NS (CYZX)	16.0 mm (0.6")
Moncton, NB (CYQM)	14.6 mm (0.6")
Western Head, NS (WWE)	13.4 mm (0.5")
Halifax Int'l, NS (CYHZ)	10.3 mm (0.4")
Shearwater, NS (CYAW)	9.3 mm (0.4")
Sydney, NS (CYQY)	4.6 mm (0.2")
Charlottetown, PEI (CYYG)	1.0 mm (<.1")

### ***Winds***

Strongest winds were experienced east of landfall with a few official reports in exposed coastal areas sustaining tropical storm force winds (35 kts). Hourly observations from Halifax International (CYHZ) and Shearwater (CYAW) indicated near tropical storm-force sustained winds of 30 kts around 14Z October 15th. It is very likely that during a short time frame sustained 35-kt winds were achieved here; there were certainly tropical storm-force gusts. The winds were enough to break a few branches off trees between Halifax and New Glasgow. There was one report of a whole tree uprooted in New Glasgow, and there were likely other isolated cases of tree damage like this. Below is a summary of maximum sustained winds and peak winds at several observing sites on Monday, October 15th:

### Maximum Wind Data (kts):

Yarmouth, NS (CYQI)	310/15+20	1050Z	
Baccaro Pt, NS (WCP)	030/32+41	0730Z	
Western Head, NS (WWE)	250/20+37	1400Z	
McNabs Island, NS (XMI)	180/38+56	1330Z	(peak 104 km/h)
Shearwater, NS (CYAW)	170/30+39	1330Z	
Halifax Int'l, NS (CYHZ)	160/30+39	1400Z	
Beaver Island, NS (WBV)	180/39+47	1545Z	(peak 87 km/h)
Hart Island, NS (WRN)	190/31+42	1745Z	
Sydney, NS (CYQY)	200/24+34	1900Z	
Grand Etang, NS (WZQ)	120/36+47	1000Z	
Cape George, NS (WGU)	170/41+56	1630Z	
Caribou Pt, NS (WBK)	180/31+39	1545Z	
Brier Island, NS (WVU)	250/22+27	2200Z	
Saint John, NB (CYSJ)	220/17+24	1725Z	
Moncton, NB (CYQM)	240/20+25	1800Z	
Charlottetown, PEI (CYYG)	240/23+34	1845Z	
Grindstone Is, QB (CYGR)	220/27+40	2000Z	

### **WARNINGS**

Warnings that were in effect as of 09Z (6am) the morning of October 15th include:

**Heavy Rainfall Warnings:** Eastern Shore, Northern Nova Scotia, Halifax and Vicinity, South Shore, Valley, Central Nova Scotia, Minas Shore, Southeast New Brunswick, Fundy National Park and Prince Edward Island.

**Inland Wind Warnings:** Cape Breton Highlands (others previously ended for eastern mainland NS and remainder of Cape Breton)

**Gale Warnings:** All Maritime waters except for Fundy, Grand Manan, Banquereau, Laurentian Fan and Chaleur Miscou.

**Storm Warnings:** Expired/Ended

### **CONVAIR RESEARCH FLIGHT**

A team of meteorologists and researchers participated in a reconnaissance flight into Karen early Monday morning. Among the 11- member crew on the [\[NRC Convair Aircraft\]](#) were Walter Strapp and George Isaac from the Cloud Physics Research Division, Downsview, and myself as the on-board support meteorologist. Mike Campbell was the ground support meteorologist in Dartmouth. The aircraft left Halifax International airport before sunrise (just after 7 am), initially heading south over the Atlantic. Once over the water we paralleled the south coast of Nova Scotia, intersecting the storm centre very near landfall at a flight level of about 22000'. Arcing bands of cloud were evident from the aircraft with an over-running layer of cirrus topping the storm. [\[Storm Clouds\]](#) We continued past Cape Sable, and then turned east. Several dropsondes were launched along this leg while radar and cloud microphysical measurements were continuously being monitored. The second (east-bound) leg brought us south of the centre once again, after that point we headed due north along a line back toward the centre, which was by this time over land. Some moderate icing (but little turbulence) was experienced while over mainland Nova Scotia around 20000'. Our final

dropsonde was over the Bay of Fundy, in the northern part of the storm. From there we headed south again, concentrating on collecting cloud-water data while spiraling down to 4000'. Around 1330Z we began flying back to Halifax above what was mostly low-level cloud southeast of the centre. Landing at the airport proved to be a problem as the pilot was forced to abort on approach due to strong low-level wind shear at a time when YHZ was receiving the strongest winds from Karen. From there we diverted to our alternate, Quebec City, ending the four and-a-half-hour flight.

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