RADARSAT OBSERVATIONS OF EXTREME WEATHER EVENTS

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ABSTRACT

Recent evidence suggests that natural disasters such as hurricanes and floods are increasing in frequency. The Synthetic Aperture Radar (SAR) onboard the RADARSAT satellite is being used to monitor these phenomena.

1. RADARSAT

Canada's RADARSAT, launched in 1995, carries a C-band, HH polarization SAR that can provide imagery during day or night, and for any weather conditions. RADARSAT has several modes (Table 1) that trade swath width for image resolution [e.g. http://radarsat.space.gc.ca]. The application requirements drive the choice of beam mode. Fine, Standard, and Wide modes provide smaller area coverage with higher resolution. These modes are often used for flood monitoring. ScanSAR provides larger area coverage with lower resolution. ScanSAR modes are often used for hurricane monitoring.

Table 1: *RADARSAT beam modes.*

Mode	Nominal Swath [km]	Nominal Resolution [m]
Fine	50	10
Standard	100	25
Wide	130	30
ScanSAR Narrow	300	50
ScanSAR Wide	500	100

2. HURRICANES

RADARSAT imagery can show a hurricane's imprint in the ocean surface roughness; surface roughness is a function of wind speed. For the past two years, CCRS has acquired images of hurricanes to evaluate wind retrieval and to address hurricane morphology and propagation.

In 1998, RADARSAT images were acquired of Hurricanes Bonnie, Danielle, Georges, and Mitch [Vachon *et al.*, 1999]. Fig. 1 shows Hurricane Georges in the Gulf of Mexico on Sept. 26, 1998. Rain bands, a pre-hurricane squall line, and boundary rolls and gravity waves in the marine atmospheric boundary layer are visible in the image. The image was processed using the Ocean Monitoring Workstation (OMW) [http://www.satlantic.com/omw] wind retrieval module (Fig. 2). The OMW is an automated system that estimates wind speed and direction

Figure 1: *W1 image of Georges (©CSA 1998).*

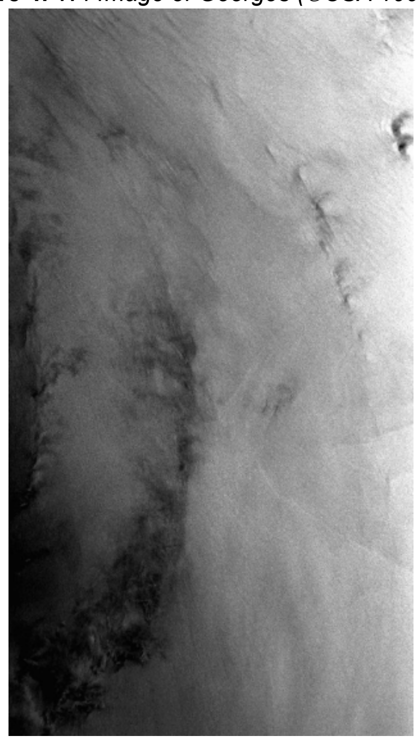
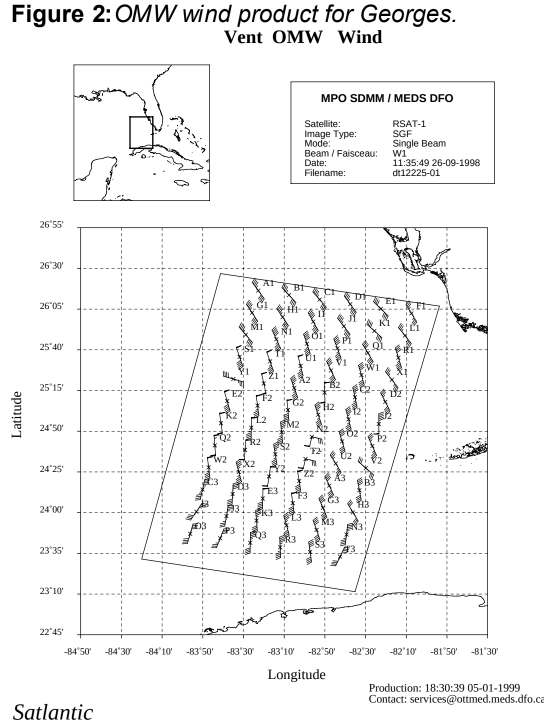


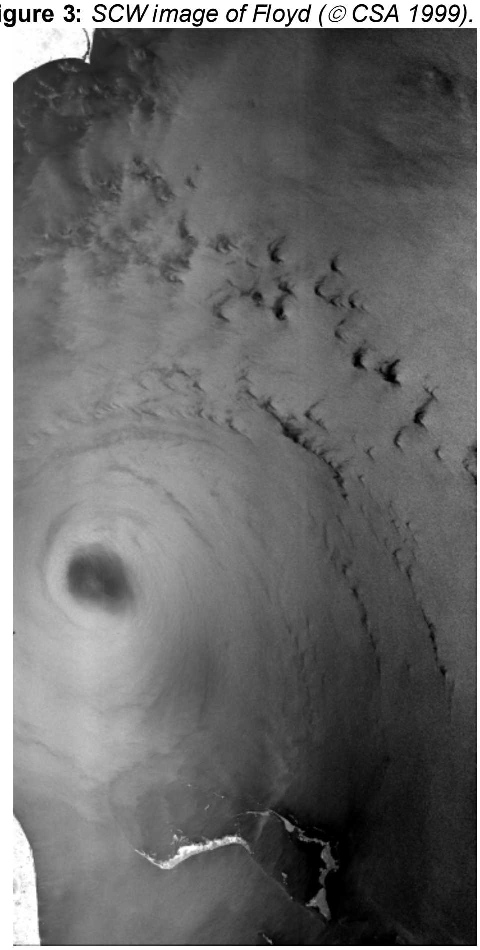
Figure 2: *OMW wind product for Georges.*



from SAR imagery. The OMW wind field has a 180º direction ambiguity (thus, the opposing wind barbs) and shows the circulation around the storm's eye.

Following serendipitous observations in 1998, in collaboration with the Canadian Space Agency (CSA) and NOAA's Atlantic Oceanographic Meteorological Laboratories (AOML), CCRS initiated a "Hurricane Watch" program to routinely acquire ScanSAR Wide (SCW) imagery during the 1999 Atlantic Basin hurricane season (August through October). CSA made special efforts to enhance RADARSAT scheduling, while AOML attempted to coordinate their P-3 hurricane penetration flights with the RADARSAT pass times. These flights provide the near surface wind field based on navigation data and on board scatterometers and microwave radiometers. Many RADARSAT images were acquired, including five that show the eyes of Hurricanes Cindy, Dennis and Floyd. Fig. 3 shows Floyd as a level four hurricane on Sept. 15, 1999. The eye appears darker due to its lower winds. Rain bands and squall lines are again apparent.

Figure 3: *SCW image of Floyd (© CSA 1999).*



3. FLOOD MAPPING

RADARSAT SAR images are excellent for monitoring floods since it is straightforward to differentiate between land and water [Cranton *et al*., 1999]. CCRS has used these data to monitor flood conditions caused by snow melt during the Red River flooding in 1996 and 1997, by extreme rain events such as in the Saguenay in 1996, and following hurricanes. Fig. 4 is an analysis of North Carolina after Floyd on Sept. 25, 1999 that shows drainage under normal conditions in dark blue, flood extent in light blue, roads in red, and political boundaries and coastlines in green. The flood extent was established with a straightforward image thresholding procedure. Table 2 shows reported river levels in North Carolina for Sept. 25, 1999; the measurements at the time of the RADARSAT acquisition are significantly above normal conditions.

Figure 4: *SCW of North Carolina (©CSA 1999).*

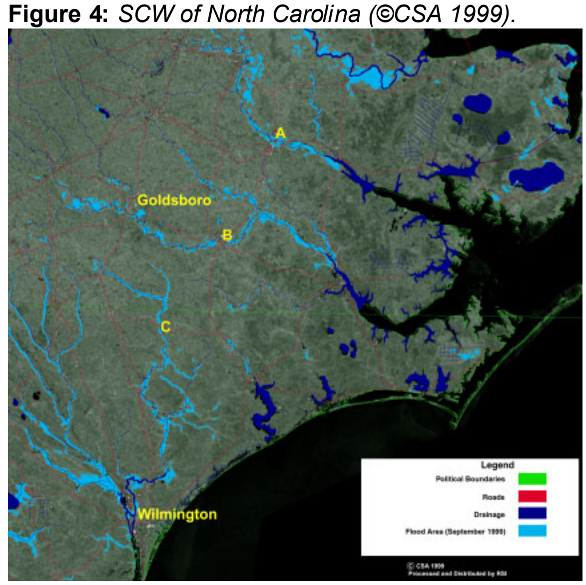


Table 2: *North Carolina streamflow data following Hurricane Floyd.*

Reported River Levels
gage information obtained from USGS North Carolina Current Streamflow Data

Map Location	Station	Stage(m)	Flood Threshold (m)
A	Tar River at Greenville	8.06	3.96
B	Neuse River near Kinston	8.08	4.29
C	NE Cape Fear near Chinquapin	4.59	3.96

4. SUMMARY and OUTLOOK

Canada's RADARSAT acquires SAR imagery that can be used to monitor the earth's surface during severe weather. RADARSAT provides a straightforward, all-weather means of mapping flood extent. It is also beneficial for mapping the effects of hurricanes through observation of their influence on the ocean's surface. RADARSAT images may lend insight to hurricane morphology and prediction, and could have a role in hurricane tracking. Continued access to this class of image data is ensured through the upcoming RADARSAT-2 mission, now scheduled for launch in 2002.

5. ACKNOWLEDGEMENTS

We thank Satellite Operations at CSA for their efforts during "Hurricane Watch". We thank L. Wu (Noetix Research Inc.), S. McDonald (Uwaterloo) and J. Wolfe (CCRS) for their help with the acquisition planning and data processing. M. Leahy (CCRS) and V. Bulzgis (CCRS) contributed to the analysis of the flood image.

6. REFERENCES

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