Tropical Severe Thunderstorms

The material in this fact sheet is to complement the "Storm Spotters' Handbook", published by the Commonwealth Bureau of Meteorology, 1995. Page and Figure references are to this publication.

The Tropics are Different

Northern Australia has its own distinctive tropical climate and lifestyle, quite different from what is to be found further south. Similarly, the types of violent thunderstorms we experience can have different characteristics to those typical of southern and central Australia.

The Bureau of Meteorology's "Storm Spotters' Handbook" contains much useful information, and is particularly relevant to thunderstorms occurring in southern parts of Australia. Care is needed when applying some of this information to the tropics. For instance, storm features such as a "large, solid, boiling cloud mass" and multiple lightning bolts (Page 9) might be indicators of severity in non-tropical regions, but are commonplace in the tropics. This fact sheet provides some information more specific to severe tropical thunderstorms.

Severe Thunderstorms in the Tropics

The Australian definition of a "severe thunderstorm" (Page 1) is one which produces any of:

- damaging wind gusts (90 km/h or greater);
- heavy rainfall resulting in localized flash-flooding;
- damaging waterspouts or tornadoes;
- large hail (2 cm diameter or greater).

Nightcliff waterspout

The main severe weather types produced by thunderstorms in the tropics are damaging wind gusts and heavy rainfall (Page 7). The wind gusts are "straight line gusts", that is, not associated with the rotating winds within a tornado, but due to the outflow from the downdraught of a thunderstorm as the air hits the ground and spreads out (Figure 1). The name given to an intense thunderstorm downdraught concentrated on a small area is a microburst. Flash flooding can occur with tropical thunderstorms when they are slow-moving (so that the one location receives a prolonged downpour) or when successive storms move over the same spot, like the carriages in a train. (This is aptly called the train effect.)

Waterspouts are occasional visitors to tropical seas. They are a weak form of tornado (Pages 13-16) and are not always associated with thunderstorms—often they develop at the base of smaller (cumulus) clouds which are rapidly growing. Waterspouts pose a danger to boaters, and can sometimes cause damage at the coast if they move over land.

Tornadoes are thought to be extremely rare over land in the tropics, but they can occur. Tropical tornadoes are at the weaker end of the scale, but even so, can leave a trail of damage to trees and buildings. The presence of an intensifying tropical low pressure system or tropical cyclone in the waters around the Northern Territory can give rise to an environment which is conducive to tornado formation at long distances from the centre of the low. Tornadoes have also been observed to develop in the core of tropical cyclones as they cross the coastline, adding to the their destructive power.

Gustnadoes (Page 16), tornado-like features at the edge of thunderstorm downdraughts, are sometimes seen in tropical thunderstorms. They can cause minor damage, and are evidence of a strong downdraught which may lead to damaging straight line wind gusts.

A few reports per year are received of hail in northern Australia. Large hail is very rarely observed in the tropics. All thunderstorms contain hail high up in the cloud, but in the warm tropical atmosphere, the hail generally melts before it can hit the ground (Page 7).

Types of Tropical Severe Thunderstorms

There are two particularly common types of thunderstorms in the tropics. These are known as pulse storms and squall lines, and both can sometimes lead to severe weather.

A pulse storm comprises a single thunderstorm cell (Page 3) with a brief lifecycle—typically under an hour. Pulse storms tend to form in conditions where there is small vertical wind shear: that is, the direction and strength of the wind does not change much with height. When the conditions are right for pulse storms, the clouds will develop in a vertical fashion. Pulse storms are characterized by one strong updraught punching up through the atmosphere, followed by one sharp downdraught which, if intense enough, can bring violent wind gusts and, very occasionally, hail. The effects are usually brief and localized, being limited to the area directly underneath the single downdraught. Pulse storms usually occur during the afternoon, when the hot ground can provide maximum energy for the storm updraught. If the atmosphere is very moist and the storm is slow moving, the storm can lead to flash flooding. Conversely, dry layers of air at an altitude of several kilometres can enhance the strength of the downdraught at the surface.

A squall line is a long line of thunderstorm cells, sometimes several hundred kilometres in extent. Squall lines can last for hours or even days, with new storm cells continually forming along the leading edge of the line. They form in conditions where there is large vertical wind shear, with the winds near the surface being very different from the winds higher up. As the clouds develop on days suitable for squall lines, they will tend to look "tipped over" as their tops are pushed by the winds higher in the atmosphere. A squall line can arrive at your location at any time of day or night, depending on where it initially formed and how quickly the line has been propagating forward. Top End squall lines often originate over Arnhemland, or further afield over Cape York. The approach of a squall line is heralded by a wind squall (the sudden onset of gusty winds lasting several minutes). This often coincides with the arrival of an ominous dark bank of low cloud called a shelf cloud (Page 10). Localized damaging wind gusts can occur beneath the most intense storm cells in the line.

A shelf cloud evident as a squall line nears Darwin

There is another type of severe thunderstorm known as a supercell (Page 4). Supercells are among the most violent storms, and can be accompanied by strong tornadoes and huge hail. Luckily for those of us who live in the tropics, true supercells are not usually found within tropical regions, although storms with similar characteristics to supercells have been identified in association with tropical cyclones.