

# Report on frequent thunderstorm event 24-25 May 2014

## Background and Impacts

On May 24<sup>th</sup> 2014 a pre-frontal trough and cold front approached Bermuda from the west. This trough and the subsequent cold front were successfully forecast to bring showers and thunderstorms to Bermuda over the holiday weekend. Thunder was introduced to the public forecast as early as 7:30pm Tuesday May 20<sup>th</sup> for Saturday, and on Friday May 23<sup>rd</sup>, a Small Craft Warning and a Thunderstorm Advisory were issued for Saturday afternoon through Sunday morning. By 12z (9am local time) on May 24<sup>th</sup>, the pre-frontal trough was very close to the island (Figure 1.) and shower and thunderstorm activity associated with it would commence by around 15z (12pm local time).

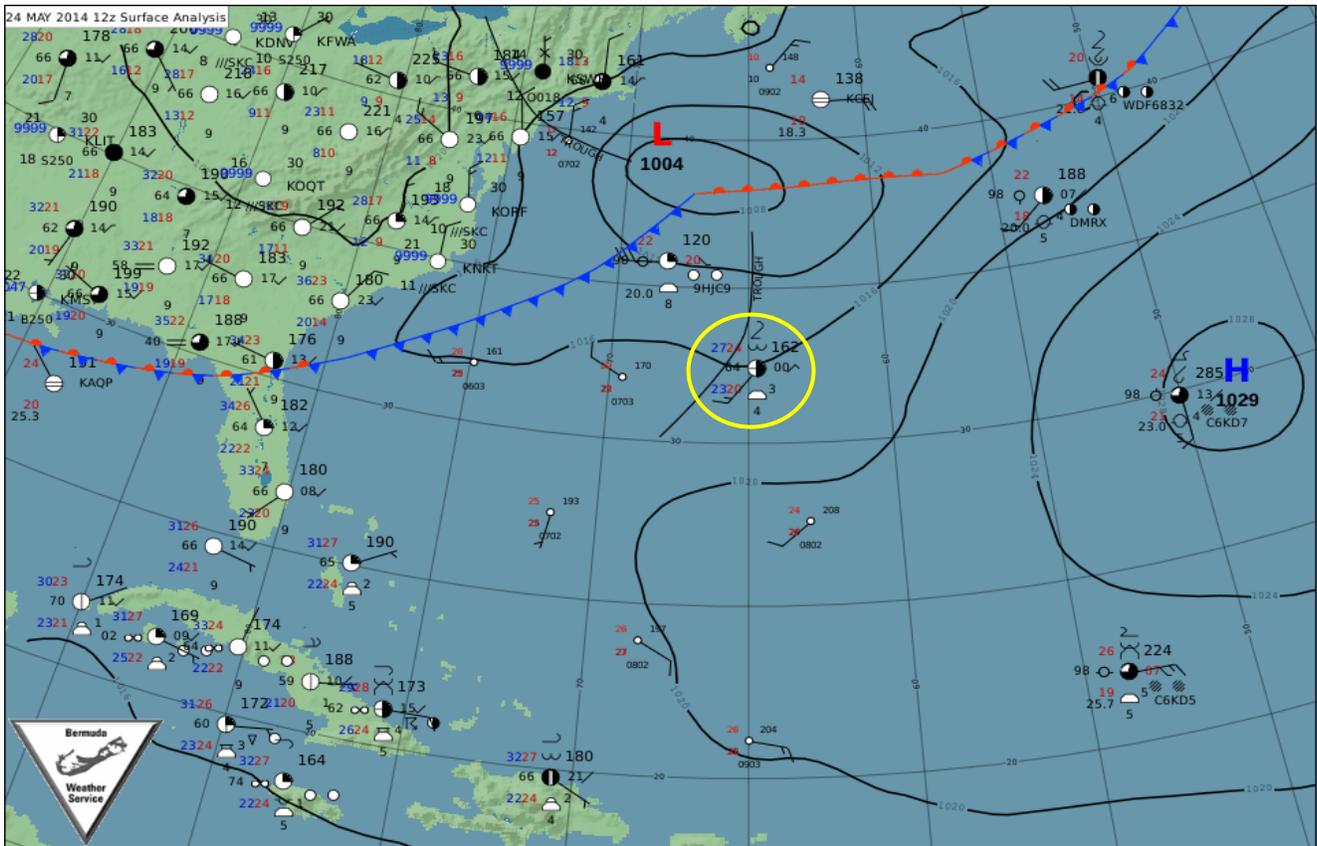


Figure 1: Local Synoptic Chart produced by the Bermuda Weather Service, valid at 12:00 UTC (9:00am Atlantic Daylight Time, ADT), Saturday May 24<sup>th</sup>. The observation at L.F. Wade International Airport is circled in yellow.

Radar imagery indicated the approach of an initial band of showers with isolated thunder that crossed the island from west to east at about 12:45pm local time (Figure 2a). The first thunderstorm was observed at the Bermuda Weather Service at 12:45pm in association with that initial band of showers and thunderstorms. Our peak sustained wind for the day of 25kts was reported ahead of these showers at about 11:00am.

Those first showers and thunderstorms cleared away to the east of Bermuda by 2:00pm, leaving more isolated showers with some thunder in the area. This was simply the clearing between the pre-frontal trough and the actual cold front that continued a rather slow approach from the west. By 8:00pm, thunderstorms associated with the cold front began to develop to the northwest of Bermuda. These storms filled in eastward forming a west-east oriented line of thunderstorms just offshore to the north of Bermuda as seen on Bermuda Weather Service Radar Imagery (Figure 2b). This line of thunderstorms gradually migrated southward towards and eventually across Bermuda, and thunderstorms were observed in association with this band for over 7 hours as it crossed the island.

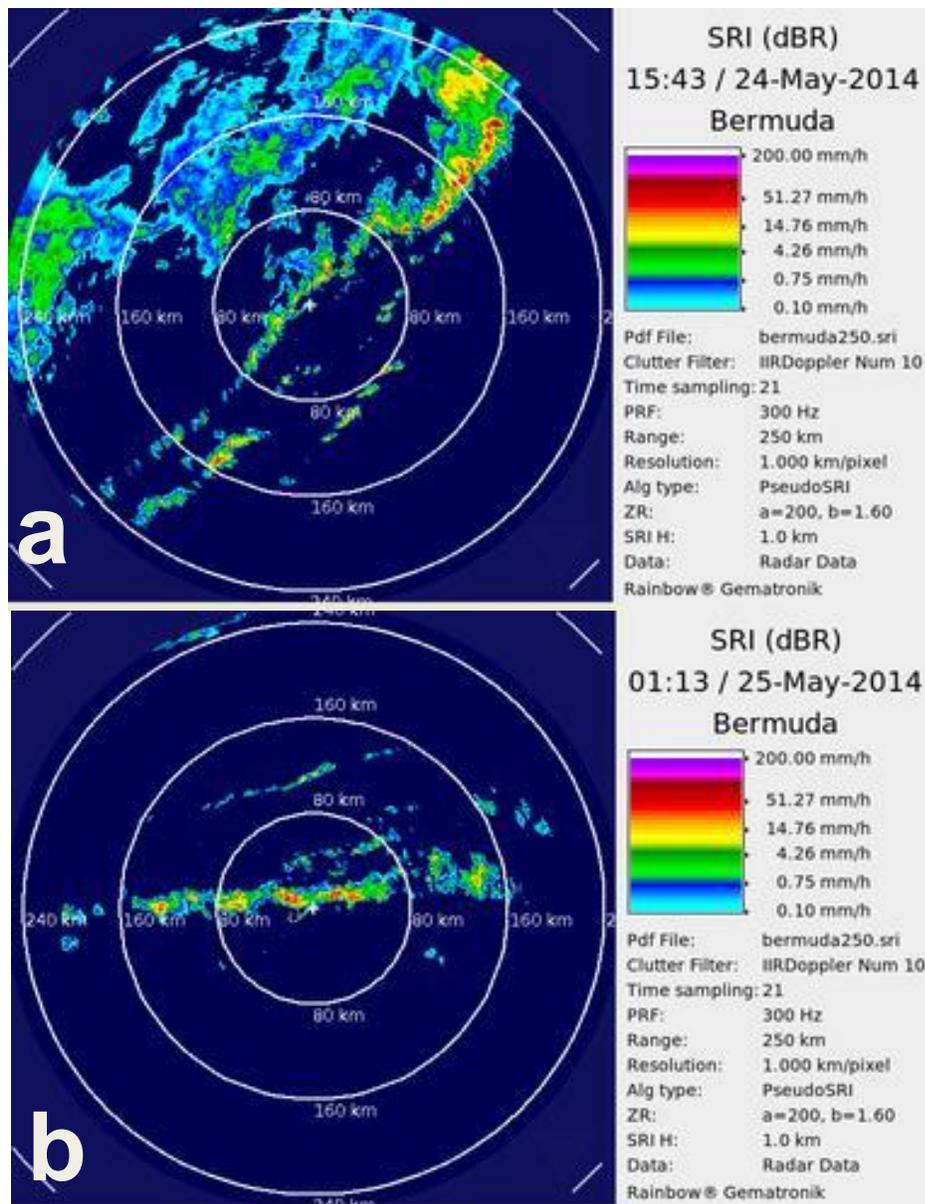


Figure 2: Surface Rainfall Intensity (SRI) imagery product derived from Doppler Weather Radar data. Times on upper right are in UTC (3 hours ahead of local time, ADT).

The band of thunderstorms associated with the cold front produced significant lightning, including frequent cloud-to-ground strikes that resulted in structural damage and communication interruptions. News reports (appendix A) indicated that a church in Southampton sustained roof damage, while government communications and several internet/network systems were also impacted, with some remaining offline for many days. These lightning strike reports support satellite and sferic imagery that show a large area of frequent to continuous lightning overhead of Bermuda (Figure 3). Gusty winds were also observed as this band of thunderstorms drifted across the island. A peak gust of 31kts was observed at the airport at 10:50pm. A total of 1.04 inches of rain were recorded at the Bermuda Weather Service (for the climatological day, 24hrs to 06:00 UTC, 3am ADT on 25<sup>th</sup> May), the majority of which (1 inch) came from the slow-moving overnight thunderstorms. There were some spatial differences in the intensities across the island, with a rain gauge in the West End recording 0.73 inches of rainfall for the whole event.

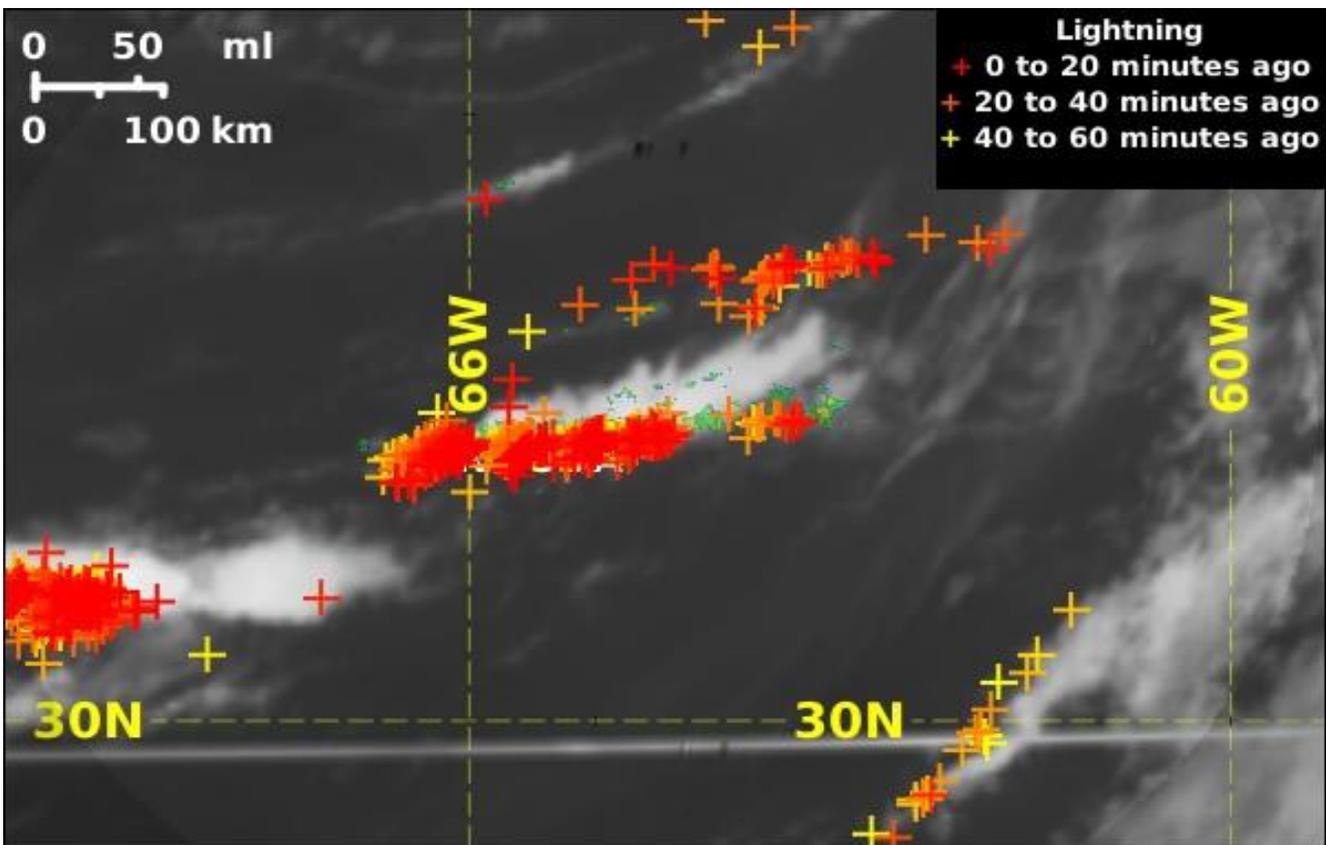
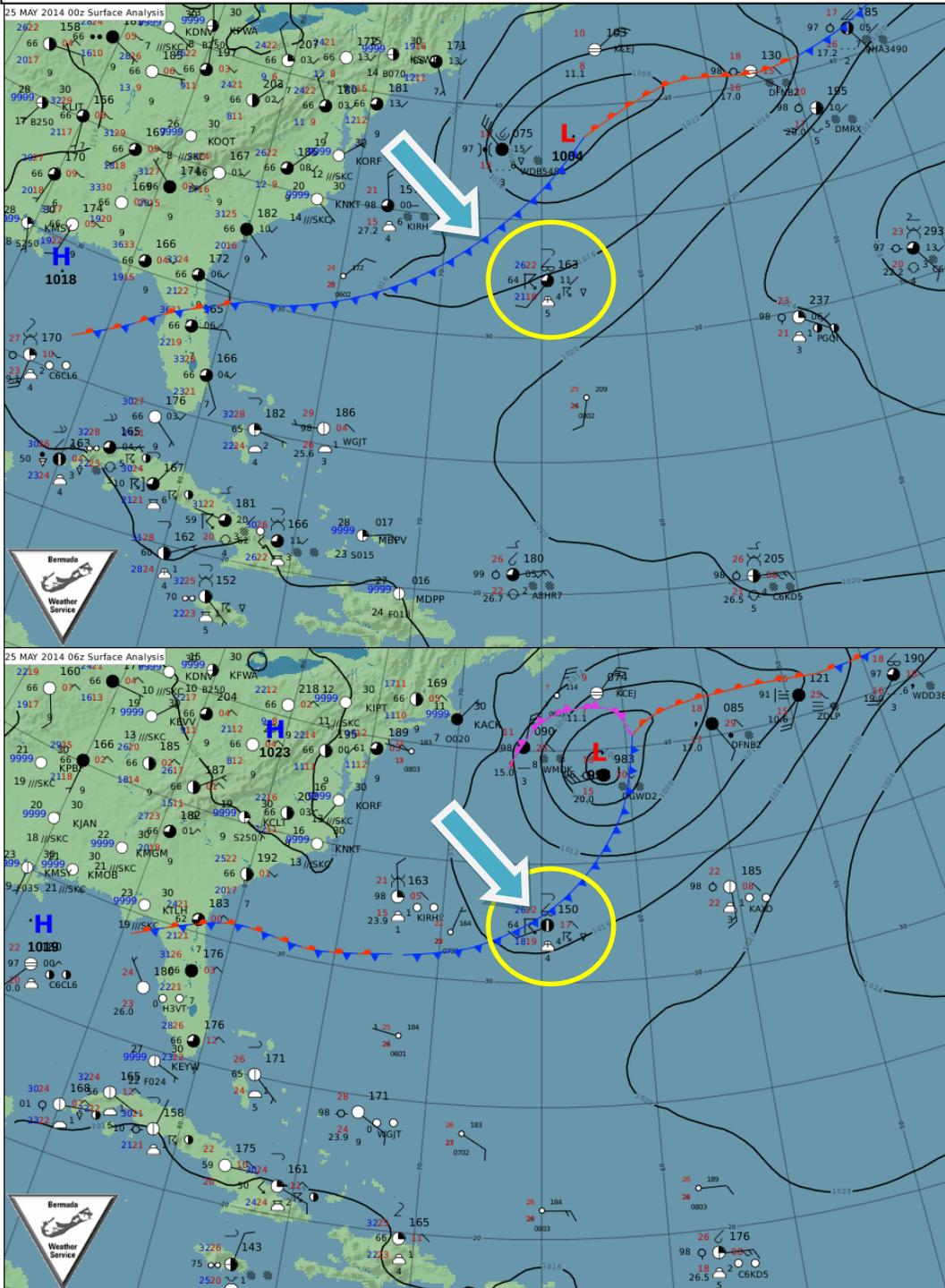


Figure 3: Infrared Satellite with sferics overlaid. Image valid at 1:15am 25<sup>th</sup> May local time. The Bermuda marker and label are completely obscured by the multiple sferics in the area.

Local synoptic analyses follow (Figure 4), clearing showing the approach of the cold front during the early hours of the 25<sup>th</sup> May.

Figure 4: The subsequent 00:00 UTC (9:00pm Atlantic Daylight Time, ADT) and 06:00 UTC (3:00am ADT), Sunday 25<sup>th</sup> May, local synoptic charts clearly depict the associated cold front continuing to approach and eventually move across the island area. The observations at L.F. Wade International Airport are circled in yellow.



## Stability Indices & Airfield Operations

Upper air profiles were obtained via balloon before and after the main overnight thunderstorm activity starting during the evening of the 24<sup>th</sup> May. While the K-index was relatively low, the Total Totals and CAPE were more supportive of thunderstorm activity before the event (Table 1). Although the timing of the main event in terms of precipitation and thunderstorm activity bounced between later Saturday morning and Saturday night, the stability indices were well predicted.

Terminal Aerodrome Forecasts (TAFs) before the thunderstorms at 24/1732z included a “PROB30 TEMPO 2418/2506 VRB25G35KT 1600 TSRA BKN008CB”. This was then upgraded at 24/2331z to include “PROB40 TEMPO 2500/2506 VRB25G35KT 1600 TSRA BKN008CB” for the increasing likelihood of moderate thunderstorms with low ceilings and visibilities.

Airfield Warnings were issued for thunderstorms with strong surface winds and gusts at 24/1310 UTC to cover the initial line of thunderstorms. “SHRA W/DVLPG TSRA WNW MOV ENE MAY AFFECT TXKF THRU PERIOD. WINDS VRB 25 KTS W/GUSTS 35KTS IN/NEAR SHRA AND TSRA.” Further Airfield warnings were issued at 24/2050 UTC for the later, more vigorous thunderstorms with a similar message, “SHRA W/DVLPG TSRA W MOV E MAY AFFECT TXKF THRU PERIOD. WINDS VRB 25KTS W/GUSTS 35KTS IN/NEAR SHRA AND TSRA”. This second airfield warning was extended for two more periods until it was cancelled at 25/0746 UTC when the thunderstorms had moved sufficiently southeast of Bermuda to not affect the airfield. These airfield warnings verified according to observations.

Time/Date	12z 24 May 2014	12z 25 May 2014
K-index	19.9	10.3
Total Totals	45.2	41.2
CAPE	939 J/kg	157 J/kg

Table 1: Stability indices derived from skew-T.

Table 1 shows some of the instability data from the radiosonde balloon launches at 12z (9am ADT) on the 24<sup>th</sup> and 12z (9am) on the 25<sup>th</sup> May. At 12z on the 24<sup>th</sup> indices were rising ahead of the main event (as per numerical model data). The 12z data for the 25<sup>th</sup> then shows significant stability as the overnight thunderstorms cleared well out of the area. A 00z launch was attempted for the 25<sup>th</sup> (9pm on the 24<sup>th</sup>). However, with so much lightning activity around at the time of launch, the sonde failed to return data beyond a couple of thousand feet, most likely due to being caught in a vicious updraft/downdraft or by being struck by lightning.

Note the analysed ASCAT pass which coincided with the developing overnight event. It clearly shows an additional area of convergence near/over Bermuda that helped to contribute to the frequent thunderstorm activity (Figure 4).

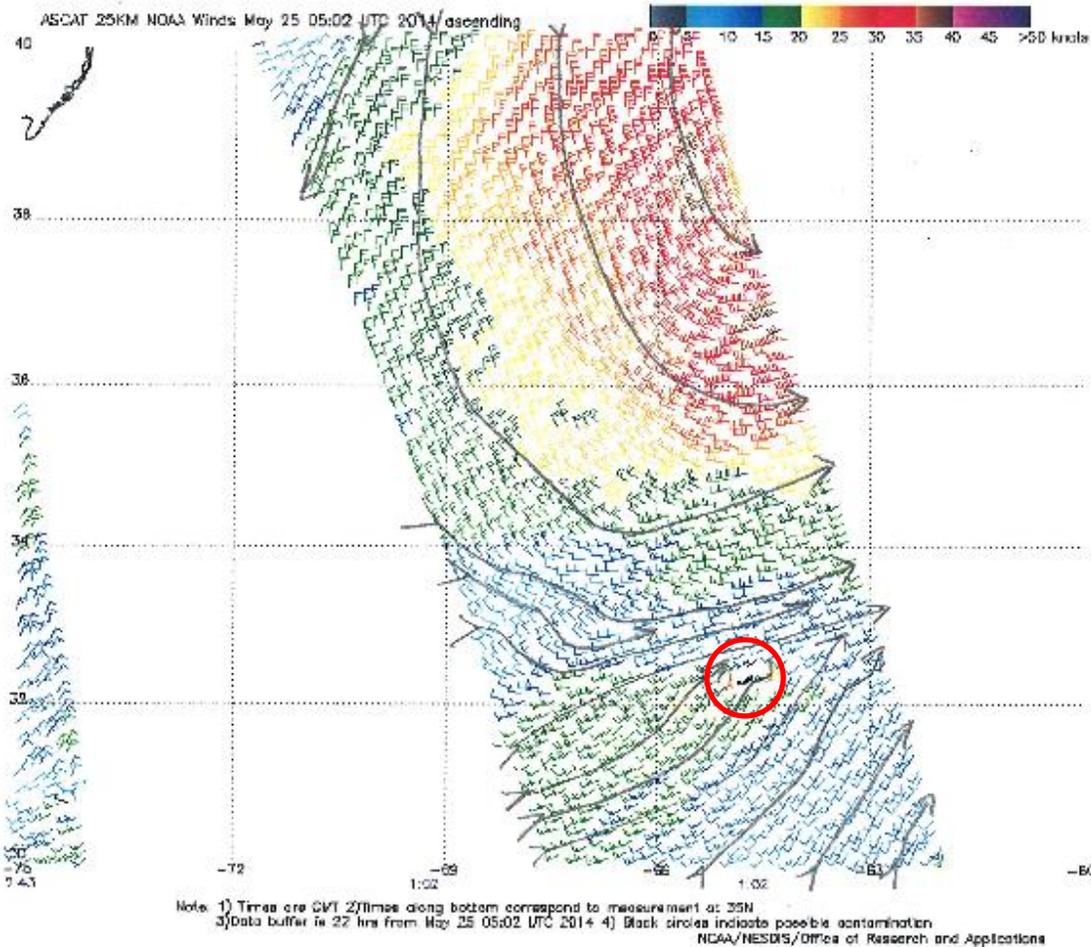


Figure 4: 25/01z Streamlined ASCAT pass showing SW and W winds converging over Bermuda (highlighted by red circle).

Over the 24-25<sup>th</sup> May 2014 Holiday weekend thunderstorms impacted Bermuda with significant lightning and heavy rain. These thunderstorms had been in public forecasts since 20<sup>th</sup> May. Furthermore, a Thunderstorm Advisory was issued at 4:30pm Friday May 23<sup>rd</sup> (21 hours before the first observations of thunder, and 25 hours before the more significant, continuous lightning began. News media reported a Southampton church was struck by lightning resulting in roof damage and several businesses and government reported communication (telephone and internet) disruptions as a result of the overnight storms. Observations show that thunder was reported at TXKF for 7hr10min (from 23:06z-6:16z). Along with the thunder, 1.00" of rain was also recorded during this main overnight event. Peak 10min sustained winds reached 25kts earlier in the day with the initial line of thunderstorms (at 14:13z), while a peak gust reaching 31kts was measured around the first of the more persistent thunderstorms (at 01:50z); at that time sustained winds were 23kts. As mentioned these occasionally strong winds were accounted for by a Small Craft Warning.

Bermuda Weather Service Doppler Weather Radar showed the development of several west-east oriented lines of showers that quickly (within an hour) grew into thunderstorms to the north, west, and later south of the island. These linear bands were steered mainly to the east by winds that were westerly throughout the lower troposphere as seen on upper air profiles before and after the event.

Radar imagery revealed the slow southward progression of the west-east oriented bands of thunderstorms over the island. Infrared Satellite imagery with sferics indicated that although lightning was nearly continuous at times, the thunderstorms spatially covered a small area near and over Bermuda.

Factors that supported the development of thunderstorms the night of the 24<sup>th</sup> into the 25<sup>th</sup> May included an area of convergent surface winds as indicated by an ASCAT satellite derived wind pass at around 01:02z – this had westerly winds over and to the north of the island, and southwesterly winds south of the island. Additionally, upper air dynamics were very favourable with Bermuda lying on the forward side of a sharpening upper trough. Furthermore, several commonly used measures of instability as measured by upper air soundings and numerical computer models were supportive of thunderstorm activity. A 12z 24th May 2014 skew-T had K-Index at 19.9, Total Totals at 45.2, CAPE at 939.5J/kg, and PWAT at 30.7kg/m<sup>2</sup> (1.21”). Total Totals were significant as well, at 45.2.

Modelled K-indices for 12z 24<sup>th</sup> May were: <30 for both the UK and GFS. While for 6z 25<sup>th</sup> May, just after much of the thunderstorms, modelled indices from the UK were ~32 @t+18h, ~34 @t+30h, ~33 @t+42h, ~32 @ t+54h, and ~31 @t+66h. Further, modelled CAPE values at 6z 25<sup>th</sup> May were ~900J/kg @t+18h, ~1000J/kg @t+30h, ~700J/kg @t+42h, ~800J/kg @t+54h, and ~500J/kg @t+66h.

Forecast Discussions begin to mention the instability indices being supportive of thunderstorm development as early as the morning on the 21<sup>st</sup> May 2014. The timing of the main event wasn't well established until the 22<sup>nd</sup> with several models showing more precipitation and higher instability earlier in the day on Saturday, rather than Saturday night into Sunday morning.

A Thunderstorm Advisory was first issued Friday afternoon for Saturday Afternoon and Sunday Morning. This was sufficient to allow suitable expiry at the Sunday morning forecast update. Airfield Warnings were issued for thunderstorms with strong surface winds and gusts at 24/1310 UTC to cover the initial line of thunderstorms. “SHRA W/DVLPG TSRA WNW MOV ENE MAY AFFECT TXKF THRU PERIOD. WINDS VRB 25 KTS W/GUSTS 35KTS IN/NEAR SHRA AND TSRA.” Further Airfield warnings were issued at 24/2050 UTC for the later, more vigorous thunderstorms with a similar message.

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Report completed by Michael Johnston (student) under the direction of James Dodgson, Deputy Director, Bermuda Weather Service.

## **Appendix A – News and media reports**

Lightning interferes with internet service (28 May 2014 – The Royal Gazette)

<http://www.royalgazette.com/article/20140528/BUSINESS03/140529767>

Govt. Telephone System Damaged By Storm (27 May 2014 – Bernews)

<http://bernews.com/2014/05/govt-telephone-system-damaged-by-storm/>

Lightning blows hole in Southampton church (25 May 2014 – Bermuda Sun)

<http://bermudasun.bm/Content/FAITH/Faith/Article/Lightning-blows-hole-in-Southampton-church/42/140/77762>

Lightning Strikes Roof Of Southampton Church (25 May 2014 – Bernews)

<http://bernews.com/2014/05/lightning-strikes-roof-of-southampton-church/>

Photos: Last Night's Lighting & Thunderstorm (25 May 2014 – Bernews)

<http://bernews.com/2014/05/photos-last-nights-lightning-thunderstorm/>

Govt. Telephone voicemail system remains out of service ten days later (3 June 2014 – Bernews)

<http://bernews.com/2014/06/govt-voicemail-out-of-service-for-ten-days/>