Fiji Meteorological Service

Report on Severe Tropical Cyclone Lola

19th-26th October 2023.
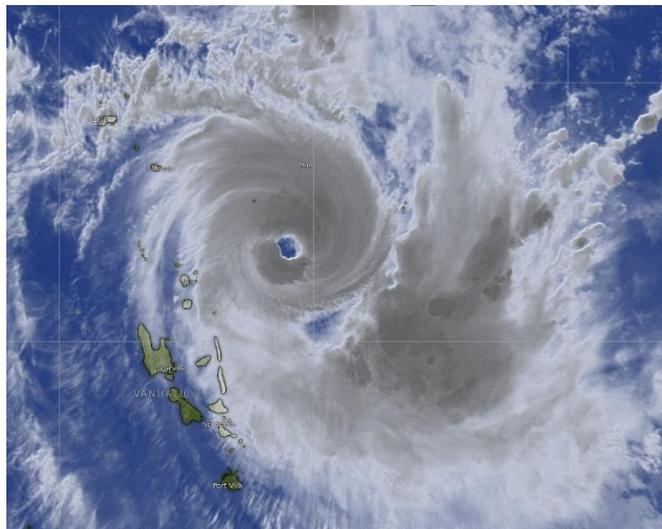
Figure 1: STC Lola near peak Strength before making landfall in Vanuatu.

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Introduction

RSMC Nadi

The Regional Specialized Meteorological Centre (RSMC) in Nadi plays a crucial role in monitoring and forecasting weather patterns in the Southwest Pacific. Located in Fiji, this centre, officially known as the RSMC Nadi Tropical Cyclone Centre, specializes in providing information related to tropical cyclones for the region. Its primary responsibilities include monitoring the development, intensification, and movement of tropical cyclones in the South Pacific, as well as issuing timely warnings and advisories to assist nations in the region in making informed decisions for disaster preparedness and response.

RSMC Nadi utilizes available meteorological information, satellite imagery, and numerical weather prediction models to track and analyse tropical cyclones. The centre collaborates with national meteorological services, international organizations, and governments representatives across the South Pacific to ensure a coordinated and effective response to potential weather-related threats.

In addition to its focus on tropical cyclones, RSMC Nadi also provides general weather forecasts and information on other meteorological phenomena affecting the South Pacific region. Its efforts contribute significantly to enhancing the resilience of nations in the area to the impacts of severe weather events. The centre's commitment to accurate and timely weather forecasting is instrumental in safeguarding lives, property, and critical infrastructure in the South Pacific.

Tropical Cyclone Lola

In the 2023–24 South Pacific cyclone season, Tropical Cyclone Lola etched its name as a formidable force, escalating to the ominous Category 5 on the severity scale. Its emergence marked a significant meteorological event that unfolded with potent intensity. This report endeavours to delve into the intricate details of Cyclone Lola, encompassing its meteorological evolution, the far-reaching impacts it inflicted upon diverse regions, and the comprehensive response efforts that unfolded in the aftermath of its destructive path.

As a Category 5 severe tropical cyclone, Lola's meteorological history is a compelling narrative of atmospheric dynamics and intensification. The report aims to unravel the intricacies of its formation, track, and intensification, providing insights into the factors that contributed to its unparalleled strength. Understanding the meteorological nuances of Lola becomes a key factor in comprehending the magnitude of its impact on the affected areas. This report explores the implications of Lola's meteorological trajectory, painting a vivid picture of the atmospheric scenario that unfolded during its presence in the South Pacific cyclone basin.

Meteorological History

On October 19, the Fiji Meteorological Service announced the development of Tropical Disturbance 01F from a low-pressure area situated approximately 1300km northeast of Honiara in the Solomon Islands. During this period, the system was positioned in a favourable environment for further development, characterized by warm sea-surface temperatures ranging from 30–31 °C and low to moderate vertical windshear.
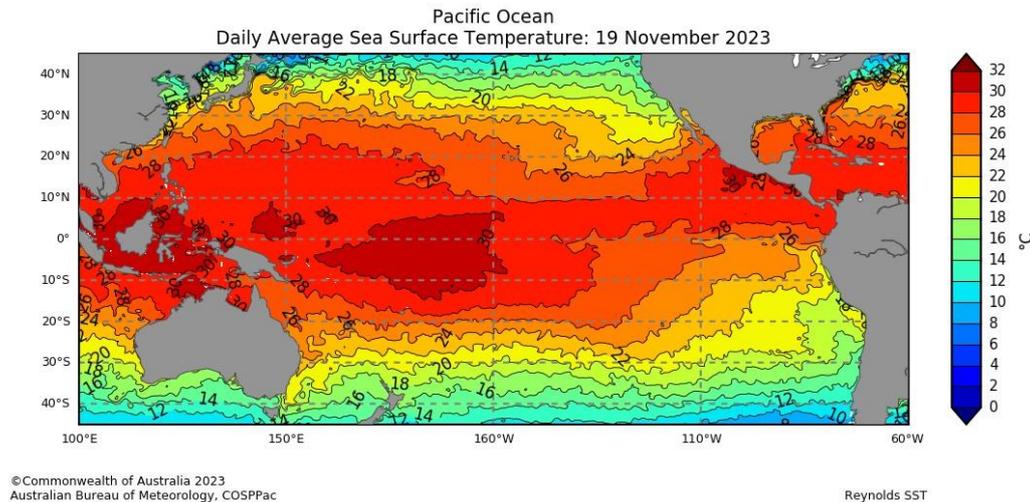
Figure 2: Sea Surface Temperature analysis of the Pacific Ocean in November 2023.

Over the subsequent days, the system evolved as it moved south-westwards toward the Santa Cruz Islands (Solomon), eventually being classified as a tropical depression by the FMS on October 21 (0600UTC). Shortly thereafter, the Joint Typhoon Warning Centre (JTWC) issued a Tropical Cyclone Formation Alert (TCFA) in response to the development of a partially exposed low-level circulation centre.
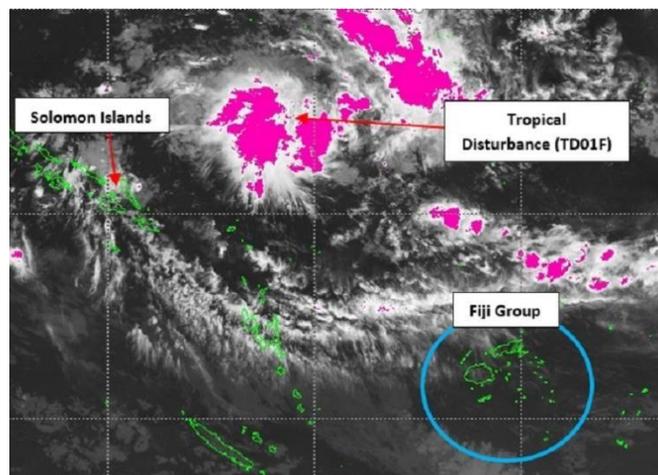
Figure 3: Satellite image portraying location of TD01F with reference to Fiji and Solomon Islands.

Over the next day, the system continued its southward trajectory, gaining further classification as a tropical depression by the FMS. The convective structure notably improved, leading the JTWC to issue advisories and classify it as Tropical Cyclone 01P. The cyclone drifted southward until an upper-level ridge compelled it further south. Subsequently, the FMS named the system Lola at around 0300 UTC on October 22, marking its transition into a Category 1 tropical cyclone on the Australian tropical cyclone intensity scale.

Within twelve hours, Lola intensified into a Category 2 tropical cyclone, characterized by fragmented banding wrapping broadly into the slowly consolidating central dense overcast (CDO). The JTWC upgraded Lola to a Category 1-equivalent cyclone on the Saffir–Simpson hurricane wind scale (SSHWS), with maximum one-minute sustained winds of 120 km/hr. By early October 23, Lola further intensified into a Category 3 tropical cyclone, featuring tightly wrapped convective banding circulating around a ragged eye. The rapid intensification culminated in Lola reaching Category 4 intensity by 1200 UTC that day, with maximum ten-minute sustained winds of 175 km/hr.
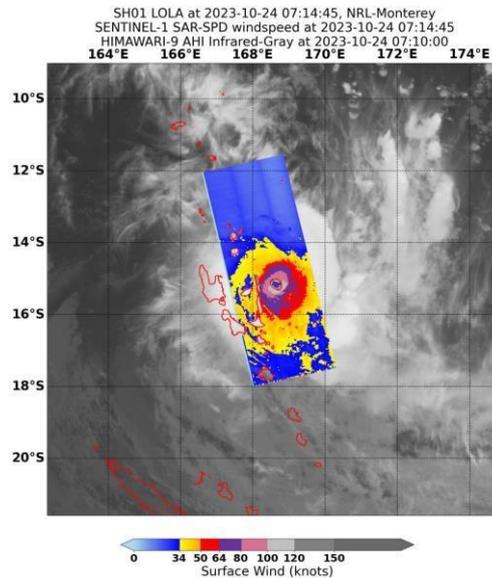
Figure 4: Image of SAR pass over STC Lola with colors depicting winds of over 100 knots surrounding the centre.

At 0000 UTC on October 24, the JTWC reported Lola's peak intensity with one-minute sustained winds estimated at 230 km/hr, classifying it as a Category 4 tropical cyclone on the Saffir-Simpson hurricane wind scale. Around the same time, the FMS estimated Lola's peak intensity with ten-minute sustained winds of 215 km/hr, designating it as a Category 5 severe tropical cyclone. Consequently, Lola became the earliest Category 5 tropical cyclone on record in the southern hemisphere. Lola's eye disappeared, indicating a phase of rapid weakening. Rapidly weakened due to vertical wind shear, Lola made landfall in Sowan at around 0300 UTC on October 25, with winds weakening to 100 km/h (65 mph) as the system tracked over Malakula.

During October 26, Lola degenerated into a tropical depression, and by the next day, the JTWC issued its final advisory on the storm. Lola's remnants passed near New Caledonia's Loyalty Islands on October 27, moving out of the FMS area of responsibility and into New Zealand's area of responsibility monitored by Met-Service where it was later classified as a subtropical system.

Impacts and Effects

Vanuatu

Cyclone Lola had severe consequences for Vanuatu, causing widespread damage across multiple provinces. The National Disaster Management Office (NDMO) activated disaster relief and rescue plans, with six provinces implementing immediate assessments. Vanuatu Prime Minister Charlot Salwai, along with international defence forces, conducted inspections and provided aid. Unfortunately, the cyclone resulted in two reported fatalities and at least four injuries, impacting essential infrastructure, homes, schools, and crops.

One of the impacts of Tropical Cyclone Lola on Vanuatu was the severe disruption of essential services and infrastructure across the affected provinces. The cyclone, escalating rapidly from a Tropical Low to a Category 5 storm, caused widespread damage and disruptions, affecting nearly 100,000 people, especially in the remote and isolated islands of Malampa and Penama provinces.

The destructive impact of the cyclone severely disrupted access to clean water, sanitation facilities, healthcare services, and education. The cyclone damaged water supply and sanitation systems, increasing the risk of waterborne diseases, particularly impacting children. The destruction of schools and classrooms hampered education, with notable psychological effects on students. Child health and nutrition faced threats due to the disruption of health services and food sources.

Furthermore, the situation was aggravated by the destruction of farms, food crops, and gardens, making affected families, especially young children and those vulnerable to food insecurity and malnutrition. The cyclone also increased overall child protection risks, requiring additional resources and efforts to prevent violence and abuse, as well as to identify, support, and protect children most in need.

The impacts were further exacerbated by damages that pre-dated Tropical Cyclone Lola, as recovery plans were inadequate in areas affected multiple times in recent months and years by earlier cyclones. The UNICEF response plan titled "Breaking the Cycle of Devastation by Recurring Cyclones in Vanuatu" aimed to address immediate humanitarian needs, with a focus on the most vulnerable, particularly children. It outlined key objectives across health, nutrition, WASH, education, child protection, and humanitarian cash assistance, seeking financial support to provide direct benefits to over 50,000 people and build resilience in the face of recurring disasters and the ongoing impact of climate change.

Solomon Islands and New Zealand

The Solomon Islands experienced impacts, particularly on Tikopia, where four people, including a young child, suffered injuries, and numerous homes were damaged. Cyclone Lola's remnants merged with another low-pressure system, affecting northern areas of New Zealand on October 30. This system caused flooding, power cuts, and disruptions to transportation.

Humanitarian Response

In the wake of the devastating impact wrought by Cyclone Lola, the Vanuatu government swiftly enacted measures to address the unprecedented scale of the disaster. Recognizing the severity of the situation, the government declared a State of Emergency which spanned six months and encompassed several provinces grappling with the aftermath of the cyclone's fury. This strategic move aimed to empower authorities with the necessary tools and resources to coordinate an effective response, rehabilitation, and reconstruction effort.

The cyclone's wrath left an indelible mark on the affected regions, with the estimated population surpassing a staggering 110,000 individuals. Homes were not merely damaged; many were razed to the ground, and critical infrastructure lay in ruins. The extent of the destruction posed an immense challenge to the local government's capacity for immediate and sustained recovery. The State of Emergency, therefore, became a pivotal mechanism to marshal resources, enact emergency measures, and streamline efforts toward the comprehensive restoration of affected communities.

Figure 5: Damaged to homes by TC Lola in Vanuatu

As the Vanuatu government grappled with the enormity of the task at hand, international aid emerged as a crucial lifeline for the battered nation. The global community rallied to provide support, dispatching surveillance flights to assess the full extent of the damage. This data proved invaluable in creating a comprehensive understanding of the affected areas, aiding in the formulation of targeted and effective relief strategies. Shelter kits, a fundamental necessity in the post-cyclone landscape, were dispatched to provide immediate respite and protection to displaced families.

Foremost among the international entities at the forefront of this humanitarian endeavour were organizations such as UNICEF and the International Federation of Red Cross (IFRC). These entities played pivotal roles in the response mechanism, demonstrating agility and efficiency in the face of a crisis. UNICEF, with its focus on the well-being of children, and IFRC,

renowned for its expertise in disaster response, collaborated closely with local authorities to provide relief aid where it was needed most. Their efforts extended beyond the immediate provision of essentials, encompassing damage assessments, the identification of long-term needs, and the implementation of strategies to address the multifaceted challenges faced by the affected communities.

Figure 6: Destroyed infrastructure

The aftermath of Cyclone Lola not only tested the resilience of Vanuatu's people but also underscored the significance of international cooperation in times of crisis. The State of Emergency declared by the government served as a rallying point for collective action, laying the groundwork for a sustained and collaborative effort to rebuild shattered lives and communities.

Education and Health Impact

The aftermath of Cyclone Lola cast a long shadow over the educational landscape of Vanuatu, leaving in its wake a staggering disruption that impacted the lives of over 28,000 students. The widespread damage inflicted upon schools across the affected regions was nothing short of challenges faced by an already vulnerable education system. The cyclone's ferocity not only tore through buildings but also disrupted the daily routines of students, teachers, and administrators alike, creating a significant setback in the pursuit of academic continuity.

As the winds of Cyclone Lola wreaked havoc, schools bore the brunt of its force, resulting in structural damages, collapsed classrooms, and the destruction of essential learning materials. The consequential disruptions not only halted ongoing educational activities but also raised formidable barriers to the resumption of classes in the immediate aftermath. The profound impact on educational infrastructure underscored the need for concerted efforts and resources to rebuild and revitalize schools, providing a conducive environment for the affected students to resume their studies.

In addition to the educational upheaval, the aftermath of Cyclone Lola triggered grave health concerns that loomed large over the affected regions. Reports surfaced of outbreaks of diarrhoea and dysentery, indicating a pressing need for urgent intervention in the realms of health, nutrition, and water, sanitation, and hygiene. The cyclone's devastation had disrupted essential services, leaving communities grappling not only with the physical aftermath but also with heightened health risks, particularly for vulnerable populations.

Figure 7: Roof of School blow away by TC winds.

The urgency of addressing health concerns post-Cyclone Lola emphasized the critical importance of swift and targeted responses. The need for immediate access to health services, nutritional support, and sanitary supplies became paramount to mitigate the potential escalation of health crises. The widespread disruption to sanitation facilities and water supply systems posed an elevated risk of waterborne diseases, underscoring the necessity of prioritizing interventions that would safeguard the well-being of the affected population.

In the broader context, the aftermath of Cyclone Lola necessitated a multifaceted approach, weaving together education, health, and infrastructure restoration efforts. The challenges posed by the cyclone were not confined to a singular dimension but rather manifested across interconnected sectors, demanding a comprehensive strategy for recovery. As the affected communities grappled with the daunting task of rebuilding, the collaboration of government agencies, non-governmental organizations, and international entities became instrumental in charting a course towards holistic recovery and resilience building in the face of recurrent climatic adversities.

Discussion

Tropical Cyclone Lola an off season Severe Tropical cyclone reaching Category 5 on the Australia Saffir Sympson scale was an eye opener to the changing patterns of TC activity in the region and the globe. Having rapid intensification as well as rapid weakening, TC Lola pushed the limits of TC forecasting at RSMC Nadi due to various reasons. Being outside the TC season, the preseason preparation at FMS had just begun, however this system tested the abilities of these resources. Furthermore, offseason cyclones of this nature are rare hence less is known about the behaviour of such systems posing a challenge on the levels of warnings to be issued. Rapidly intensifying systems decay rapidly as well and there remained a chance that TC Lola weaken well before major impacts over Vanuatu.

Warnings and Advisories

Throughout the lifecycle of TC Lola, RSMC Nadi issued relevant warnings for this system as per need and renewed them in a timely manner as per criteria for the duration.

Warning Type	Number sent
International Marine Warnings	22
Tropical Disturbance Advisory	22
Tropical Cyclone Advisory	16
CREX	22
SIGMET (TC)	17
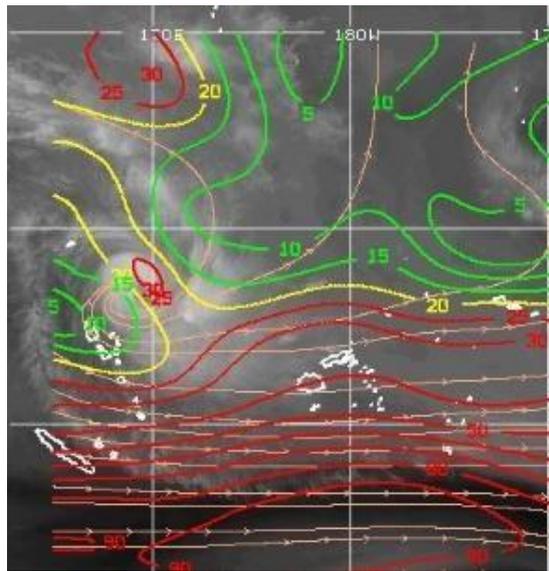
System was in a region of low wind shear which is ideal for TC formation.
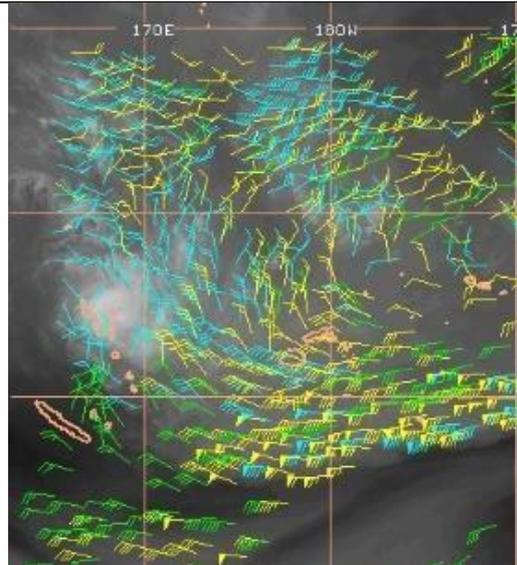
Uni-Directional upper wind flow with good outflow channels to the north and southeast which allowed for rapid intensification.
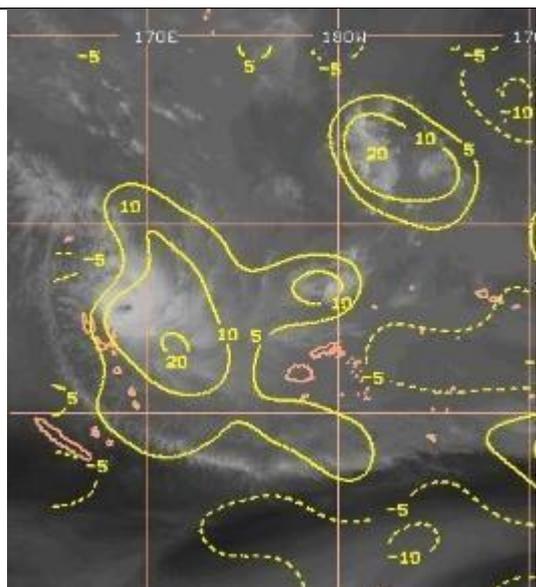
Upper Divergence was good, and this is a key ingredient to intensify a tropical cyclone.
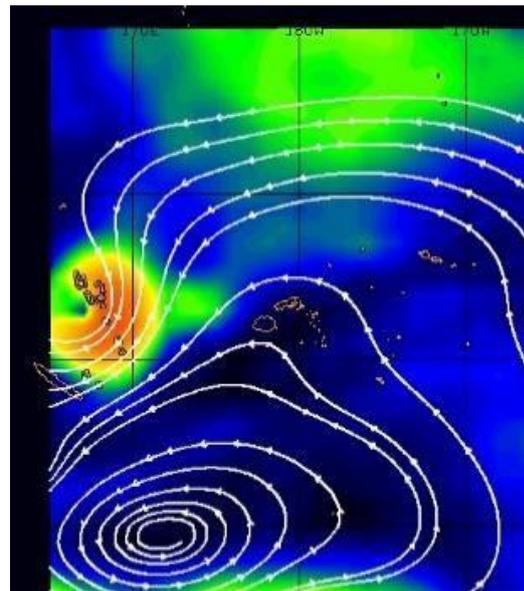
System was steered by Sub-tropical ridge.
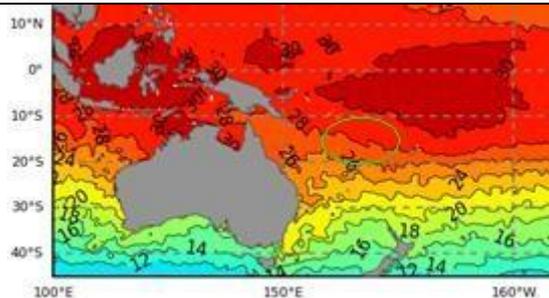
Sea Surface Temperature in area of formation was above 26°C.
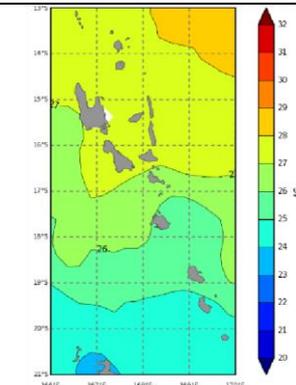
26°C isotherm passing just over the southern parts of Vanuatu.
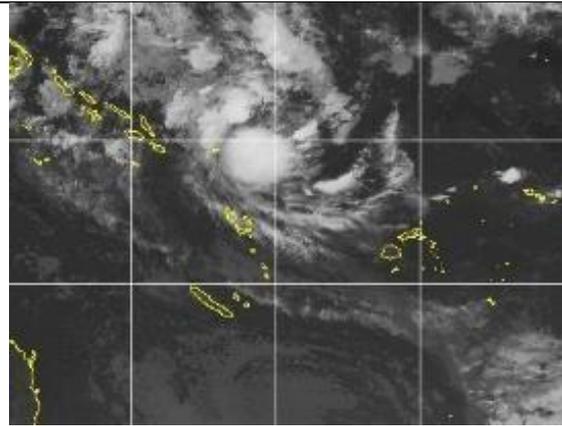
Tropical Disturbance 01F in the early stages sustaining convection around its LLCC for at least 24 hours.
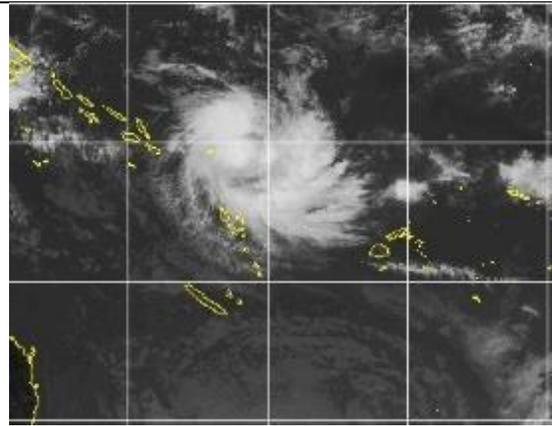
Tropical Depression 01F showing signs of organizing hence upgraded to a Depression status.
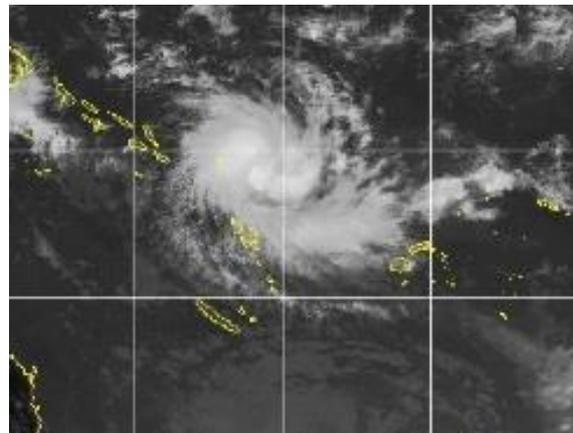
TC Lola Category 1 system after being named at 0300UTC on the 22nd.
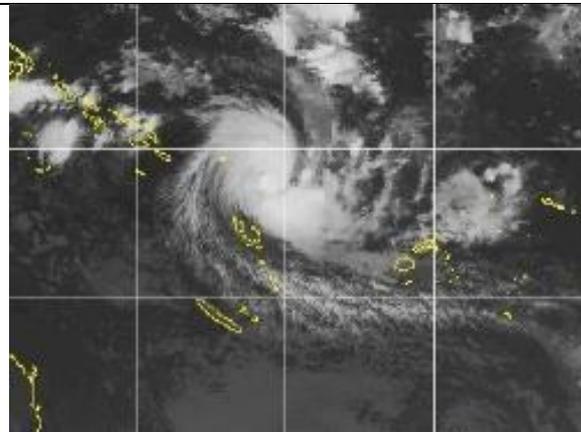
TC Lola Category 2 system with bands wrapping further and organization improving.
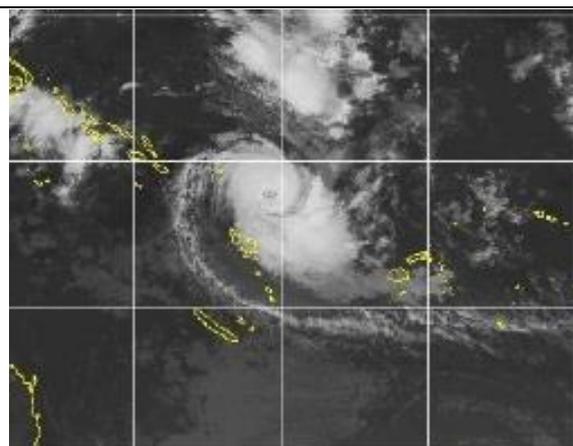
STC Lola Category 3 with a hint of an eye indicating hurricane force winds likely to be present near the centre.
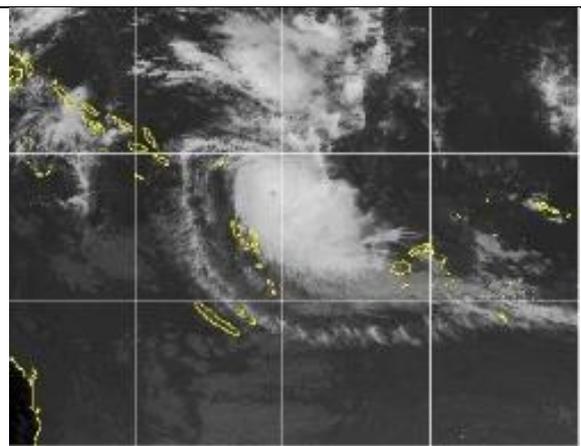
STC Lola Category 4. Continuing rapid intensification organization with definite hurricane force winds.
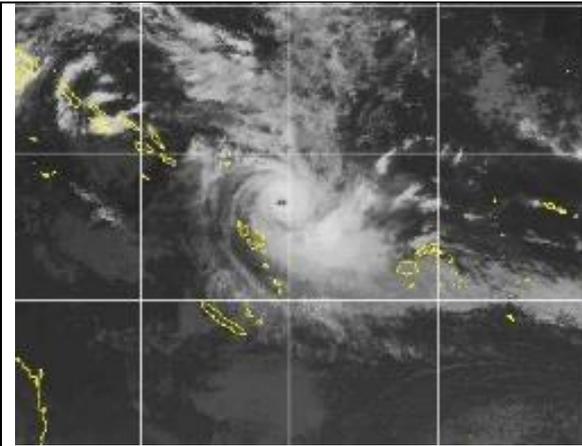
STC Lola Category 5 with clear eye visible and close to peak intensity and a more compact appearance.
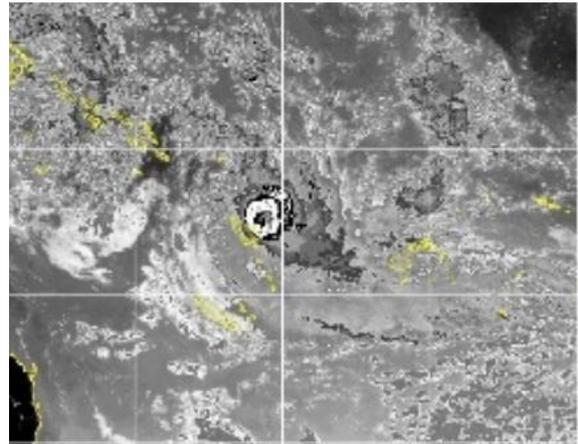
Enhanced IR image depicting Eyewall with convection around the eye.
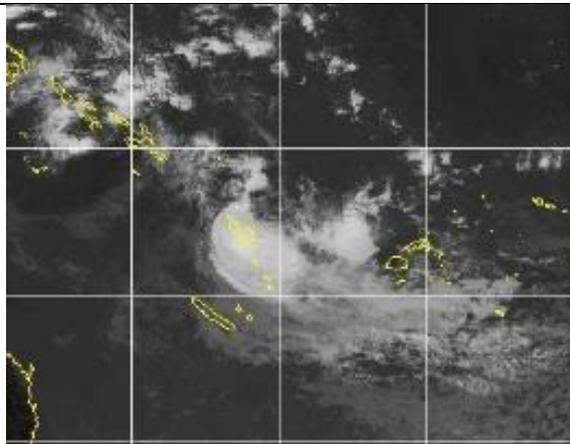
TC Lola weakening with organization rapidly deteriorating.

Best Track

Tropical Cyclone Lola struck Vanuatu, causing substantial damage to infrastructure. As it made landfall, the system encountered adverse conditions and wind shear, leading to a rapid weakening process. It transitioned into a low-pressure system, with convective bands diminishing swiftly. The subsequent post event best track for Tropical Cyclone Lola is shown below.

Figure 8: Best Track for TC Lola.

Conclusion

Tropical Cyclone Lola's impact on the South Pacific nations highlights the susceptibility of the region to extreme weather events. Collaborative response efforts by national and international agencies emphasized the crucial role of preparedness and swift assistance in mitigating the impact of such disasters.

Cyclone Lola, a Category 5 severe tropical cyclone during the off-season, posed significant challenges to forecasting and response agencies. Its occurrence outside the typical cyclone season tested the limits of forecasting capabilities. The aftermath revealed widespread educational disruptions, affecting over 28,000 students in Vanuatu, and triggered health concerns, requiring immediate intervention in health and sanitation. The destruction of schools and infrastructure underscored the urgency of concerted efforts to rebuild and revitalize educational institutions.

The broader context of Cyclone Lola's aftermath necessitated a comprehensive approach, addressing interconnected challenges across education, health, and infrastructure sectors. The collaborative efforts of government agencies, non-governmental organizations, and international entities played a crucial role in responding to the multifaceted impact of the cyclone. The 2023–24 South Pacific cyclone season marked Lola's emergence as a formidable force, reaching Category 5 severity, emphasizing the need for ongoing evaluation and enhancement of forecasting models and disaster response strategies to bolster resilience in the face of future climatic adversities in the region.

References

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Appendices

Track WMO Format Data

Post Event Best Track

Time (UTC)	Latitude	Longitude	Uncertainty	Mean Wind	Wind Gust	Category	Pressure	Radius of Max Winds
19/0000	-3	172	40	15	25	0	1009	
19/0600	-3.3	171.7	40	15	25	0	1009	
19/1800	-5	170.5	40	20	45	0	1008	
20/0000	-5	170.3	40	20	30	0	1007	
20/0600	-5.4	169.1	40	20	45	0	1008	
20/1200	-6.5	169.2	40	20	45	0	1006	
20/1800	-7.2	169.2	40	20	45	0	1005	
20/2100	-7.3	168.7	40	20	45	0	1008	
21/0000	-7.4	168.6	40	20	45	0	1004	
21/0300	-8.1	168.3	40	25	35	0	1004	
21/0600	-8.7	168.1	40	25	45	0	1004	
21/0900	-8.9	167.9	40	25	45	0	1004	
21/1200	-9	167.8	60	25	45	0	1004	
21/1500	-9.3	167.6	60	25	45	0	1003	
21/1800	-9.5	167.4	30	30	45	0	1001	
21/2100	-9.7	167.4	30	30	45	0	999	
22/0000	-9.9	167.5	40	35	50	1	996	
22/0300	-10.2	167.8	40	40	55	1	995	40
22/0600	-10.6	168.2	40	45	60	1	993	40
22/0900	-10.8	168.7	30	50	70	2	989	50
22/1200	-11.2	169	40	50	70	2	985	50
22/1500	-11.6	169.2	40	55	75	2	980	50
22/1800	-11.9	169.2	40	60	85	2	975	50
22/2100	-12.2	169.2	40	65	90	3	970	50

23/0000	-12.5	169.2	40	75	105	3	970	30
23/0300	-12.7	169.3	15	80	110	3	964	30
23/0600	-13	169.4	20	85	120	3	960	30
23/0900	-13.2	169.5	15	90	125	4	954	30
23/1200	-13.5	169.5	15	95	135	4	950	30
23/1500	-13.7	169.4	30	100	135	4	945	30
23/1800	-13.9	169.3	30	110	155	5	940	30
23/2100	-14.2	169.2	30	110	155	5	940	30
24/0000	-14.5	168.9	30	115	160	5	935	30
24/0300	-14.8	168.8	15	115	160	5	931	40
24/0600	-15.1	168.8	30	110	160	5	930	40
24/0900	-15.3	168.7	40	105	145	4	940	35
24/1200	-15.5	168.5	40	100	140	4	945	35
24/1500	-15.7	168.3	40	95	135	4	950	30
24/1800	-15.9	168.1	40	90	125	4	955	20
24/2100	-16.1	167.9	40	85	120	3	965	20
25/0000	-16.2	167.7	40	80	110	3	970	20
25/0300	-16.4	167.6	50	70	105	3	970	20
25/0600	-16.6	167.6	60	65	90	3	981	20
25/0900	-16.9	167.6	90	60	90	3	982	20
25/1200	-17.1	167.4	90	50	75	2	985	20
25/1500	-17.2	167	90	45	70	2	987	20
25/1800	-17.3	166.4	90	40	65	1	994	20
25/2100	-17.3	165.8	15	30	45	0	998	
26/0000	-17.4	165.4	15	30	45	0	1002	

Nadi Analysis Track

Time (UTC)	Latitude	Longitude	Uncertainty	Mean Wind	Wind Gust	Category	Pressure	Radius of Max Winds
19/0000	-3	172	40	15	40	0	1009	
19/0600	-3.3	171.7	40	15	40	0	1009	
19/1800	-5	170.5	40	20	40	0	1008	
20/0000	-5	170.3	40	20	40	0	1007	
20/0600	-5.4	169.1	40	20	45	0	1008	
20/1200	-6.8	170	40	20	40	0	1006	
20/1800	-7.3	169.2	40	20	40	0	1005	
20/2100	-7.2	168.6	40	20	45	0	1008	
21/0000	-7.4	168.6	40	20	45	0	1004	
21/0300	-8.2	168.3	40	25	45	0	1004	
21/0600	-8.7	167.9	40	25	45	0	1004	
21/0900	-9.4	167.4	40	25	45	0	1004	
21/1200	-9	167.8	60	25	45	0	1004	
21/1500	-9.3	167.5	60	25	45	0	1004	
21/1800	-9.5	167.3	30	30	45	0	1002	
21/2100	-9.7	167.4	30	30	45	0	1002	
22/0000	-9.9	167.5	40	30	45	1	1000	
22/0300	-10.2	167.6	40	35	50	1	995	
22/0600	-10.6	168.2	40	45	65	1	993	
22/0900	-10.6	168.8	30	50	70	2	989	50
22/1200	-11.2	169	40	50	70	2	985	50
22/1500	-11.6	169.2	40	50	70	2	980	50
22/1800	-12	169.4	40	60	85	2	975	50
22/2100	-12.4	169.4	40	65	90	3	970	50
23/0000	-12.5	169.2	40	80	110	3	970	20
23/0300	-12.7	169.4	15	80	110	3	964	30
23/0600	-13.1	169.4	20	85	120	3	960	30

23/0900	-13.2	169.5	15	90	125	4	954	30
23/1200	-13.5	169.6	15	95	135	4	950	30
23/1500	-13.8	169.3	30	100	135	4	945	30
23/1800	-13.9	169.3	30	110	155	5	940	30
23/2100	-14	169.2	30	110	155	5	940	30
24/0000	-14.4	169	30	115	160	5	935	30
24/0300	-14.8	168.8	15	115	160	5	931	40
24/0600	-15.1	168.8	30	115	160	5	930	40
24/0900	-15.2	168.7	40	105	145	4	940	40
24/1200	-15.4	168.6	40	100	140	4	945	35
24/1500	-15.7	168.3	40	95	135	4	950	30
24/1800	-16	168.02	40	90	125	4	955	20
24/2100	-16.1	167.9	40	85	120	3	965	20
25/0000	-16.2	167.7	40	80	110	3	970	20
25/0300	-16.4	167.6	50	80	105	3	970	20
25/0600	-16.6	167.6	60	65	90	3	981	20
25/0900	-16.9	167.7	90	65	90	3	982	20
25/1200	-17.2	168.3	90	55	75	2	985	20
25/1500	-17.4	168	90	50	70	2	987	20
25/1800	-17.4	166.4	90	45	65	1	994	20
25/2100	-17.3	165.7	15	30	45	0	998	
26/0000	-17.4	165.5	15	30	45	0	1002	
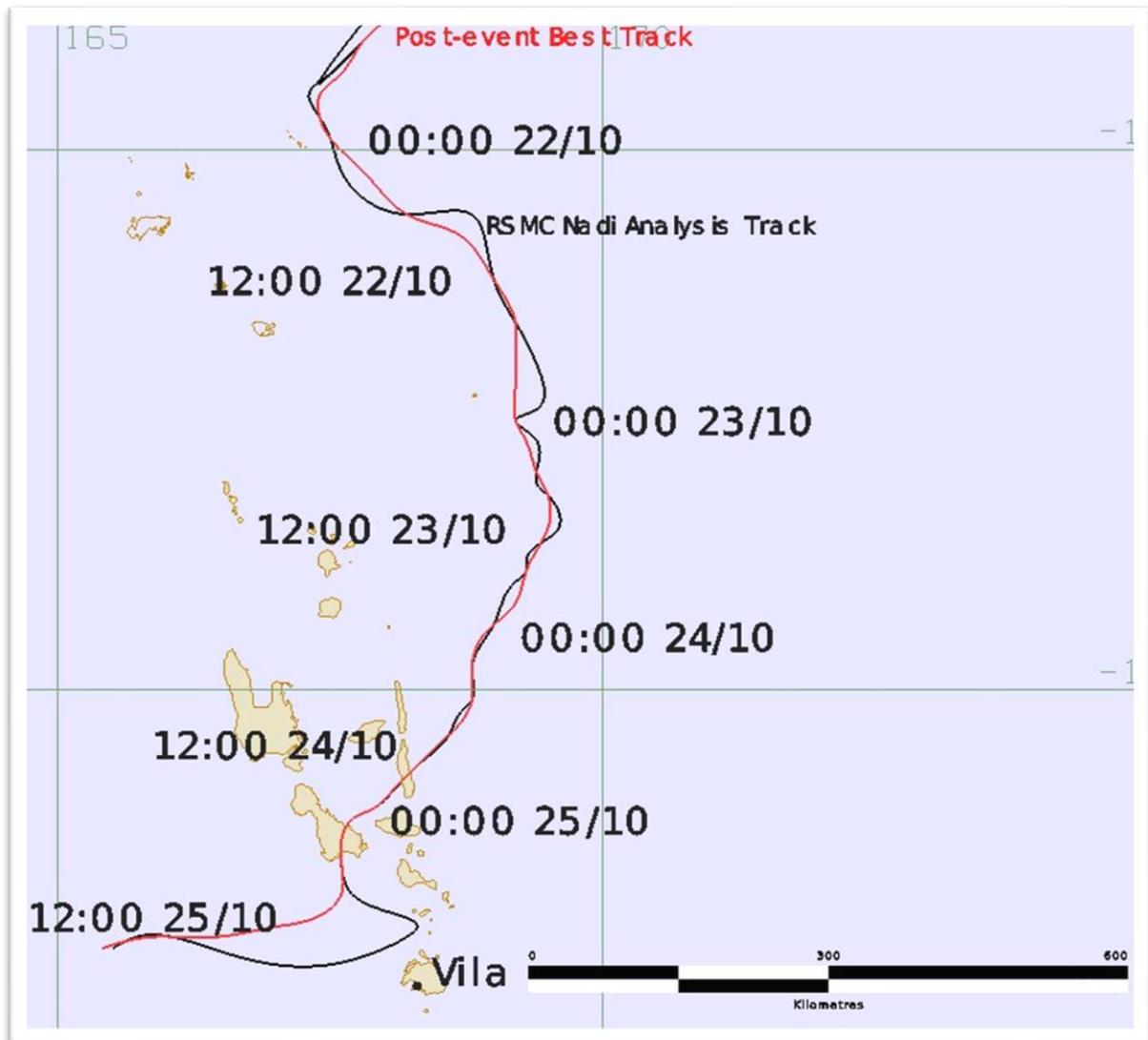
Best track (red) against Nadi Analysis track (black) throughout the life cycle of TC Lola.

Microwave Imagery
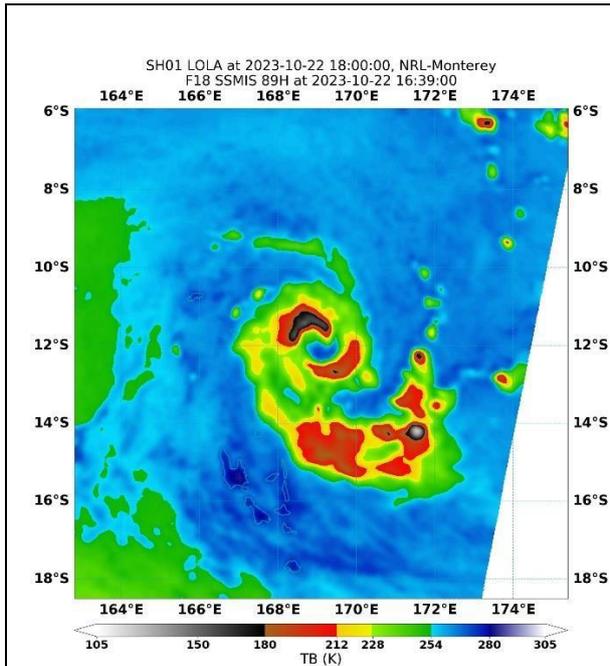
STC Lola close to its peak intensity.
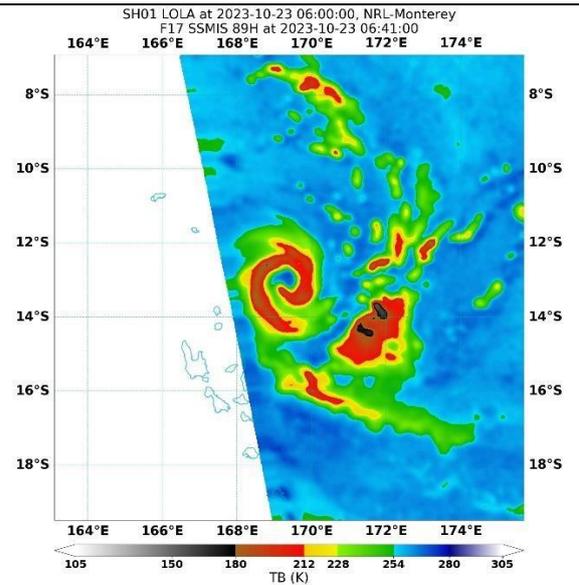
STC Lola with eye, with system close to peak intensity before landfall in Vanuatu.
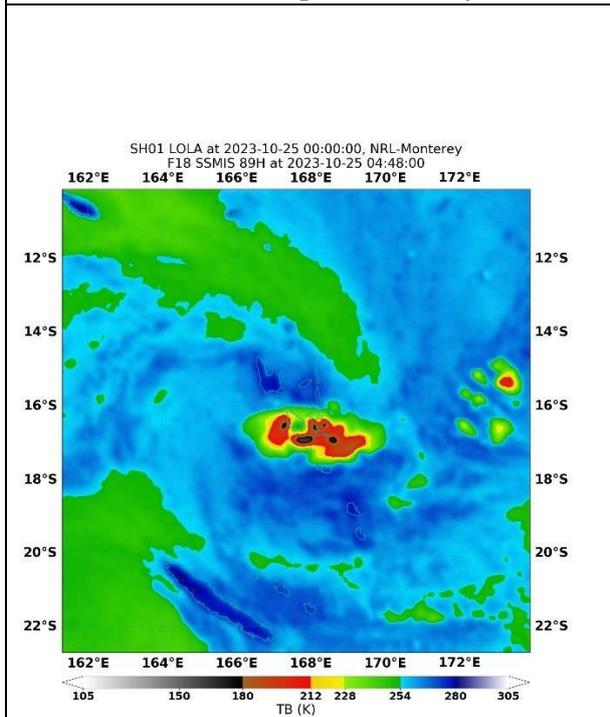
TC Lola weakening with organization rapidly deteriorating.
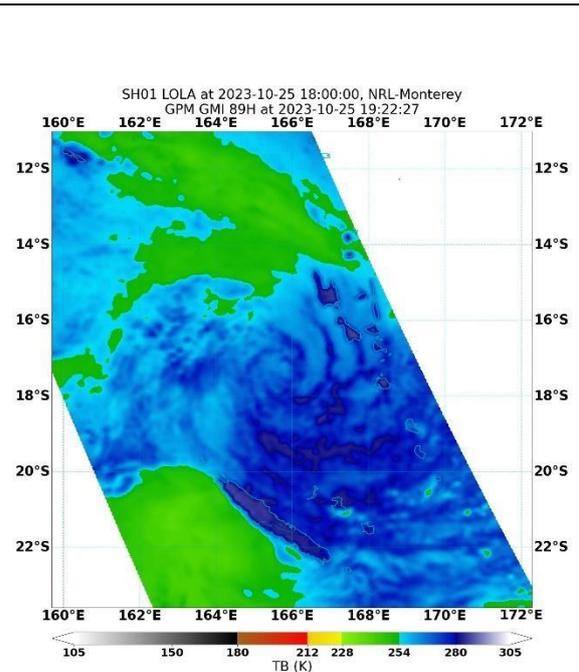
Remnants of TC Lola with no active convection and exposed LLCC.

Verification

Numerical Weather Prediction with relation to Operational Centre Position Best Track

Legend: NFFN (Mal), GFS, ECMWF, JTWC, UKMO, ACCESS, JMA

Numerical Weather Prediction with relation to Operational Intensity Best Track

Legend: NFFN, GFS, ECMWF, JTWC, UKMO, ACCESS, JMA
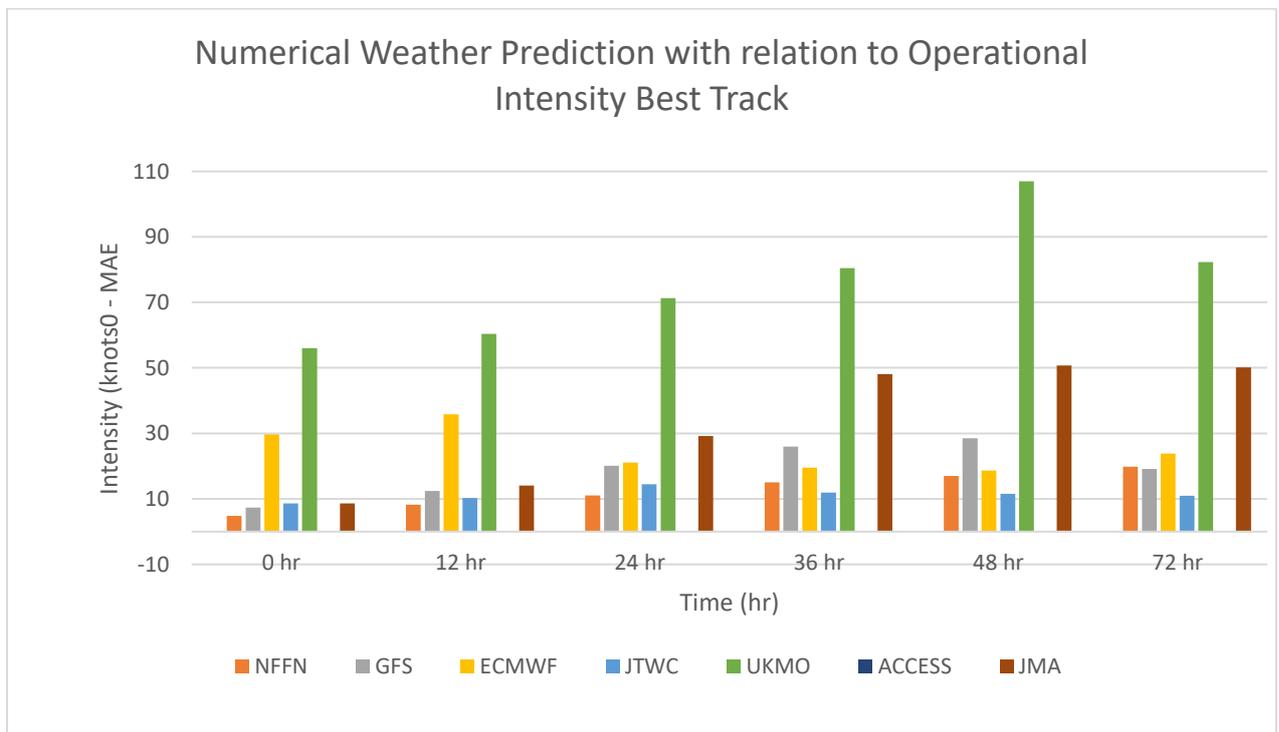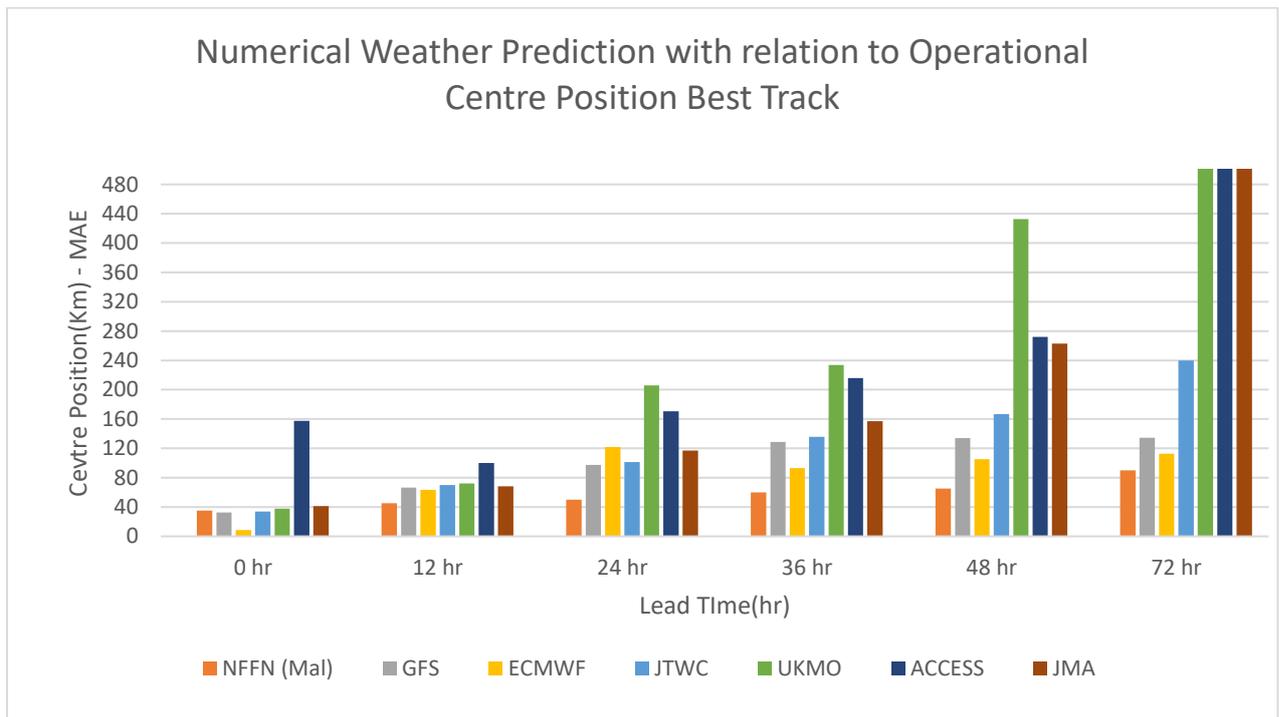
Historical Average Comparison

TC LOLA POSITION ACCURACY AGAINST 6-YEARS AVERAGE

MAE - DISTANCE (KM) vs LEAD TIME (HR)

6 Year Average values: 24.1, 75.4, 108.8, 134.9, 132.6, 163.7
NFFN (Mal) values: 35, 45, 50, 60, 65, 90

TC LOLA INTENSITY ACCURACY AGAINST 6-YEARS AVERAGE

MAE - INTENSITY (KNOTS) vs LEAD TIME (HR)

6 Year Average values: 2.6, 7.2, 9.7, 12.5, 14.8, 17.9
NFFN values: 4.8, 8.2, 11, 15, 17, 19.8

END.