APPENDIX-I

The synoptic overview of cyclones studied in the present thesis. JTWC analyzed best track of all the cyclones discussed below are shown in Figure-A1. The summary of all the cyclone cases are given in the Table-A1.

1. Synoptic overview of cyclone Orissa Super Cyclone (October 1999)

The Orissa super cyclone, as referred by India Meteorological Department (IMD), is the most intense cyclonic storm experienced over Bay of Bengal for the last 114 years since the false point cyclone of 1885. The storm achieved minimum central sea level pressure of 912 hPa and associated maximum sustained wind of 75.6 knots.

A tropical disturbance developed in the South China Sea in mid-to-late October. The initial vortex of storm was observed over the Gulf of Thailand at 0000 UTC 24 October 1999. The convective area consolidated, and it became Tropical Depression 5B on October 25 over the Malay Peninsula. The depression tracked northwestward under the influence of the subtropical ridge to its north. Warm water temperatures and favorable upper level winds allowed further strengthening, and it became tropical storm 5B on October 26, 345 km south-southwest of Yangon, Myanmar. The storm passed to the south of Myanmar and continued to strengthen, and intensified to a cyclone on the 27th in the open Bay of Bengal. On October 28, the cyclone rapidly intensified to a peak of 70 m/s winds, the equivalent of a Category 5 hurricane. Just prior to its landfall, the cyclone weakened slightly to a 69 m/s. Cyclone with an estimated minimum central pressure of <912 hPa on 1200 UTC October 29, cyclone hit the Indian state of Orissa near Paradip (20.50 N, 86.0 E). The ridge to the north blocked further inland movement, and the cyclone stalled about 30 miles (50 km) inland of the ocean. It slowly weakened, maintaining tropical storm strength as it drifted southward. The cyclone re-emerged into the Bay of Bengal on October 31, and dissipated on November 3 over the open waters.
2. Synoptic overview of cyclone Mala (April 2006)

Tropical cyclone Mala formed in the Bay of Bengal on 24th April 2006 and laid centered at 0600 UTC of 25th April 2006 near Latitude 9.8° N and Longitude 90.5° E. After remaining stationary for 12 hours it moved slightly northeastward. During next 12 hours it remained almost stationary and laid centered at 1500 UTC of 25th April 2006 near Lat. 10.0° N and Long. 89.5° E, about 400 km southwest of Port Blair and 1100 km southeast of Chennai. During the next 24 hours it moved slightly northeastward and lay centered at
1500 UTC of 26th April 2006 near Lat. 12.00 N and Long. 90.50 E, about 250 km west of Port Blair. The maximum sustained wind speed (MSW) of this cyclone at this stage was 22 m/s. On 27th April, MALA reached the intensity of a severe cyclonic storm, and was positioned at 12.5°N, 90.5°E at 0600 UTC. In next 6 hours, the cyclone intensified rapidly to very severe cyclonic storm and moved in a northward direction. On 27-April-2006, at 1200 UTC, the cyclone center was located at 13.0 N, 90.5 E. The maximum sustained wind at that time was 43 m/s. During next 24 hours, the storm moved in north­eastward direction and intensified to 59-69 m/s storm. On 28-April, at 1730 UTC, the storm position was located at 15.5 N, 92.5 E. At this point, most of the empirical and numerical models predicted a slow movement towards Myanmar coast, and predicted a landfall during evening of 29 April. However, the storm moved faster than expected and made a landfall on 0600 UTC at Arakan coast in Myanmar (17.7 N, 94.5 E). Estimated intensity of the storm at the time of landfall was 62 m/s.

3. Synoptic overview of cyclone Mukda (September 2006)

An area of disturbed weather in the Arabian Sea was classified as Tropical Cyclone 04A by the Joint Typhoon Warning Center (JTWC) on 21 September 2006. The India Meteorological Department began monitoring the system as a deep depression later that day, and designated it cyclonic storm mukda early on September 22, 2006. Mukda slowly and erratically meandered to the northeast and intensified into a severe cyclonic storm later that day. On 24 September 2006, Mukda weakened into a depression under increasing wind shear. The remnant circulation lingered for four more days before dissipating on 28 September 2006.

4. Synoptic overview of cyclone Akash (May 2007)

Cyclone Akash was the first named tropical cyclone of 2007 North Indian Ocean cyclone season. An area of convection developed on 11 May 2007 across the Bay of Bengal, and the next day IMD classified it as a depression. By May 13, 2007 the pressure had dropped to 1000 hpa as wind shear levels dropped significantly. An anticyclone developed over the system, while a mid-latitude trough over the northeastern India provided favorable outflow. JTWC upgraded it to Tropical Cyclone 01B at 1121 UTC on May 13, 2007.
while located about 545 km west-northwest of Yangon, Myanmar. Early on May 14, 2007 the system achieved deep depression status and six hours later it became Cyclonic Storm Akash. An eye began to form as the storm approached land, and at 1800 UTC on May 14, 2007 JTWC estimated 1-min sustained winds of 33 m/s. Officially, Akash attained peak 10-min sustained winds of 24 m/s and a minimum central pressure of 988 hPa. As it interacted with the mid-latitude westerlies, it began to become extratropical. Shortly after reaching peak winds, Akash made landfall about 115 km south of Chittagong at 92.1 E, 21.4 N on 14 May, 2007 at 1800 UTC.

5. Synoptic overview of cyclone Gonu (June 2007)

Cyclone Gonu was the strongest tropical cyclone on record in the Arabian Sea. Gonu developed from a persistent area of convection in the eastern Arabian Sea on 1 June 2007. By late on June 1, the system developed to a depression. Early on June 2 the Joint Typhoon Warning Centre (JTWC) classified it as tropical cyclone 02A while it was located about 685 km southwest of Mumbai (72.56 E, 18.57 N), India. Upon first forming, the system contended with the entrainment of dry air to the northwest of the storm; this was expected to limit intensification. The storm steadily intensified and was classified as Cyclonic Storm Gonu while it was located 760 km southwest of Mumbai (72.56 E, 18.57 N), India. As midlatitude trough developed over Pakistan, Gonu turned to the north and northeast, though resumed a westward track after ridging built to the north of the storm. Gonu rapidly intensified to attain severe cyclonic status, and lay centered at 0600 UTC of 3rd June 2007 near Lat. 16.9 N and Long. 67.5 E. With low amounts of vertical wind shear and favorable upper-level outflow, Gonu strengthened further to while located about 285 km east-southeast of Masirah Island on the coast of Oman. It became Super cyclonic storm Gonu late on June 4, with sustained winds reaching 67 m/s and an estimated pressure of 920 hPa. After maintaining peak winds for about 9 hours, Gonu downgraded to very severe cyclonic storm status early on June 5. Cyclone gradually weakened as it continued tracking northwestward over cooler water temperatures and drier air. Due to land interaction with Oman late on June 5, the inner core of deep convection rapidly weakened, and over a period of 24 hours the intensity decreased by 27 m/s. After emerging into the Gulf of Oman, the cyclone intensified
slightly, becoming the first recorded tropical cyclone in the Gulf of Oman. On June 6, the cyclone turned to the north-northwest as an approaching shortwave trough created a weakness in the ridge, and later that day Gonu downgraded to severe cyclonic storm status and later to cyclonic storm status early on June 7. Gonu crossed the Makran coast in Iran six hours later.

6. Synoptic overview of cyclone Yemyin (June 2007)

Early on June 21, 2007 the IMD declared the area a depression, 430 km east-southeast of Kakinada, Andhra Pradesh, India. The depression moved quickly west-northwest towards the northern Andhura Pradesh coast. The system intensified to a deep depression on June 22, 2007 and made landfall near Kakinda at 0600 UTC at 80.1E 15.7N. The system began to weaken due to land interaction and wind shear and downgraded to a depression while it crossed the Deccan Plateau, despite the storm having moved into the Arabian Sea on June 24. Strong monsoonal low-level flow contributed to increased cyclonic vorticity, with low vertical wind shear and warm sea surface temperatures. Early on June 25, 2007 the system crossed the coast into the Arabian Sea. As it moved northwest just off the Pakistani coast, winds of about 14 m/s and a surface pressure of 990 hPa (hPa) were observed in Karachi near midday on June 25. The centre of the system reached within 90 km of Karachi. With favorable conditions and deep convection, the system intensified into a deep depression that day. After further organization, it made its second landfall at about 0300 UTC June 26, 2007 along the Makran coast, near Ormara and Pasni, Balochistan province, in southwestern Pakistan.
Table-A1: Summary of the cyclone cases selected for study in the thesis.

<table>
<thead>
<tr>
<th>Cyclone</th>
<th>Date</th>
<th>Landfall</th>
<th>Peak MSW (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orissa Super Cyclone</td>
<td>24-29 October 1999</td>
<td>20.50 N, 86.0 1200 UTC October 29</td>
<td>70</td>
</tr>
<tr>
<td>Mala</td>
<td>24-29 April 2006</td>
<td>17.7 N, 94.5 E 0600 UTC 29-04-2006</td>
<td>62.5</td>
</tr>
<tr>
<td>Mukda</td>
<td>18-24 Sept 2006</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Akash</td>
<td>11-14 May 2007</td>
<td>21.4N, 92.1E 1800 UTC 14 2007</td>
<td>33</td>
</tr>
<tr>
<td>Gonu</td>
<td>3-7 June 2007</td>
<td>22.6N,60E 0000 UTC 6 June 2007</td>
<td>70</td>
</tr>
<tr>
<td>Yemyin</td>
<td>21-26 June 2007</td>
<td>25.1N, 65.2E 0000 UTC 26 June 2007</td>
<td>25</td>
</tr>
</tbody>
</table>