

EXTRATROPICAL TRANSITION OF TROPICAL CYCLONES: TENDENCIES OF CHANGE

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Significant part of tropical cyclones transform into extratropical cyclones (Jones et al., 2003; Klein et al., 2000). Tendencies of change for characteristics of extratropical transition (ET) for different oceanic basins in the Northern (NH) and Southern (SH) Hemispheres on the basis of observations for the period 1970-2012 are analyzed.

Table 1 shows annual-mean numbers of tropical cyclones N_{tc} , tropical cyclones transformed into extratropical cyclones N_{etc} and their relationship N_{etc}/N_{tc} from observations during 1970-2012 for different basins: Western North Pacific (WNP), North Atlantic (NA), Eastern North Pacific (ENP), Northern Indian Ocean (NIO), Southern Indian Ocean (SIO), Southern Pacific (SP) and also for the globe, NH and SH as a whole.

Table 1. Annual-mean numbers of tropical cyclones N_{tc} , tropical cyclones transformed into extratropical cyclones N_{etc} and their relationship N_{etc}/N_{tc} for different basins with hemispheric (NH, SH) and global means from observations for the period 1970-2012.

| Basin | | Tropical cyclones annual-mean number N_{tc} | Tropical cyclones transformed into extratropical cyclones annual-mean number N_{etc} | N_{etc}/N_{tc} |
|--------|-----|---|--|------------------|
| NH | WNP | 25.3 | 8.9 | 0.35 |
| | NA | 11.1 | 4.5 | 0.41 |
| | ENP | 15.4 | 0.2 | 0.02 |
| | NIO | 4.9 | 0 | 0 |
| NH | | 56.7 | 13.7 | 0.24 |
| SH | SIO | 15.8 | 4.9 | 0.31 |
| | SP | 9.0 | 4.3 | 0.48 |
| SH | | 24.8 | 9.2 | 0.37 |
| Global | | 81.5 | 22.9 | 0.28 |

The largest ET frequency about 9 events per year is in the WNP basin. The appropriate events in the NA, SIO and SP basins are significantly more rare (less than 5 events per year).

Table 2 shows annual-mean values of N_{tc} , N_{etc} and N_{etc}/N_{tc} in the WNP basin for different decades. According to Table 2 there is a general inter-decadal decrease of N_{tc} in the WNP basin with an appropriate general increase of N_{etc} . As a result the ET probability in the WNP was in the first decade of the 21st century about 50%.

Table 2. Annual-mean numbers of tropical cyclones N_{tc} , tropical cyclones transformed into extratropical cyclones N_{etc} and their relation N_{etc}/N_{tc} in the WNP basin for different decades.

| WNP | N_{tc} | N_{etc} | N_{etc}/N_{tc} |
|-----------|----------|-----------|------------------|
| 1970-1979 | 26.6 | 8.1 | 0.30 |
| 1980-1989 | 26.6 | 6.7 | 0.25 |
| 1990-1999 | 25.8 | 9.6 | 0.37 |
| 2000-2009 | 23.6 | 11.6 | 0.49 |

Table 3 shows annual-mean values of N_{tc} , N_{etc} and N_{etc}/N_{tc} in the NA basin for different decades. According to Table 3 there is a general inter-decadal increase of N_{tc} in the NA basin with a general increase of N_{etc} during last decades.

Table 3. Annual-mean numbers of tropical cyclones N_{tc} , tropical cyclones transformed into extratropical cyclones N_{etc} and their relation N_{etc}/N_{tc} in the NA basin for different decades.

| NA | N_{tc} | N_{etc} | N_{etc}/N_{tc} |
|-----------|----------|-----------|------------------|
| 1970-1979 | 8.1 | 4.0 | 0.49 |
| 1980-1989 | 8.6 | 2.8 | 0.33 |
| 1990-1999 | 10.5 | 4.2 | 0.40 |
| 2000-2009 | 14.8 | 5.7 | 0.39 |

Statistically significant positive trends for the number of extratropical cyclones (N_{etc}) transformed from tropical ones (N_{tc}) were obtained for the NH and for the globe as a whole with the largest trends for the WNP and NA basins (about 0.8 per decade). Statistically significant trends are obtained also for the part of tropical cyclones transformed into extratropical ones (N_{etc}/N_{tc}) for the NH (about 4% per decade) and for the globe as a whole (more than 3% per decade) with the largest trend for the WNP basin (more than 5% per decade). At the same time no statistically significant trend was found for N_{etc}/N_{tc} in the NA basin.

Analysis of relationships of the ET characteristics with temperature changes during last decades shows positive correlation of N_{etc}/N_{tc} for the NH and WNP basin with surface temperature changes in tropical latitudes. There is also negative correlation of the ET probability in the NH with temperature difference between tropics and extratropics. Significant coherency was obtained for the ET events in the WNP basin with El-Nino conditions.

References

- Jones S.C., Harr P.A., Abraham J. et al., 2003: The extratropical transition of tropical cyclones: Forecast challenges, current understanding, and future directions. *Weather and Forecasting*, **18**, 1052-1092.
- Klein P.M., Harr P.A., Elsberry R.L., 2000: Extratropical transition of Western North Pacific tropical cyclones: An overview and conceptual model of the transformation stage. *Weather and Forecasting*, **15**, 373-395.