Environmental parameters for forecasting tornado outbreak on the outer rainband of typhoon

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1．Introduction

Typhoon is one of major meteorological disturbance causing tornado outbreak in Japan. About 19% of tornadoes occurred around typhoons (1991- 2011). Most of tornado outbreaks concentrate in the outer rainband of typhoon as shown in Fig. 2. This fact means that the environment of the outer rainband tends to cause mini supercells.

The present study aims to decide the environmental parameter which can predict the tornado outbreak in the outer rainbands of typhoons more accurately.
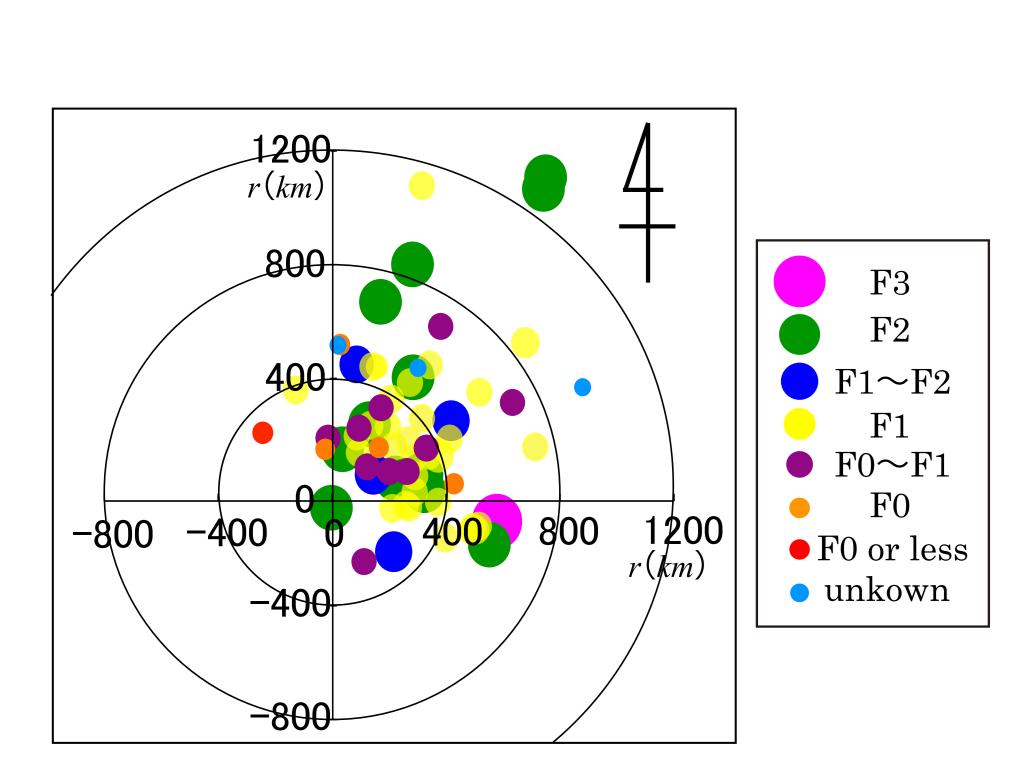
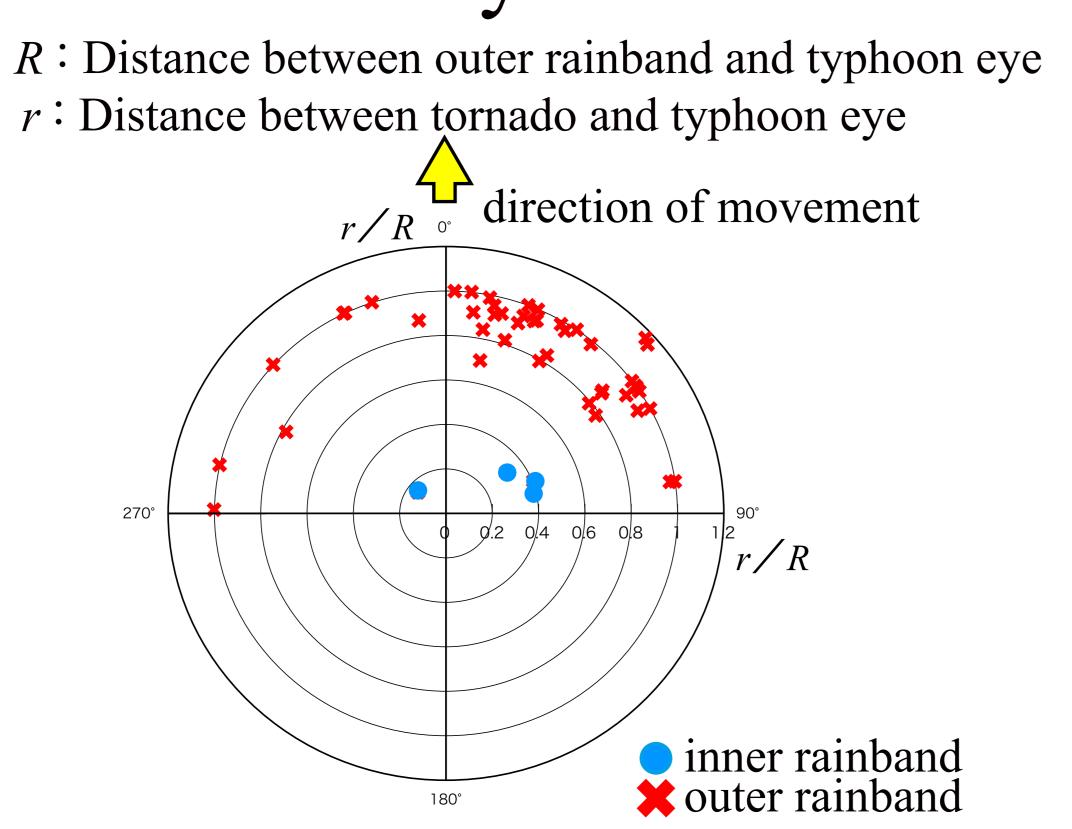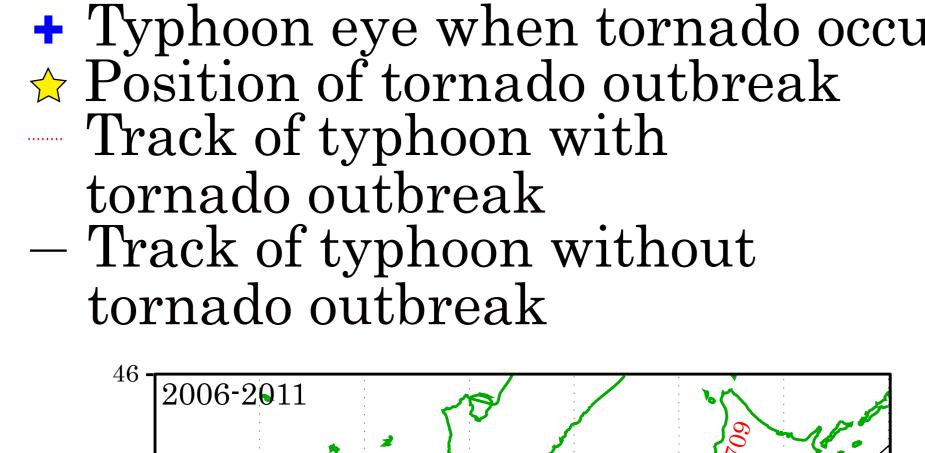R : Distance between outer rainband and typhoon eye
r : Distance between tornado and typhoon eye

Fig.1 Distribution of tornadoes around typhoon eyes

Fig.2 Relative Locations of tornadoes from typhoon eyes.

2．Methodology and Data

We evaluated various environmental parameters for 15 typhoons from 2006 to 2011 shown in Fig. 3 by using WRF-ARW model. Three typhoons, TD0613, TD0709 and TD0918 resulted in tornado outbreak. The results of mesoscale model (MSM) of JMA for every 3 hours were employed as initial and boundary data. The resoultions of grids are 25km for the 1st domain and 5km for the 2nd domain, respectively.
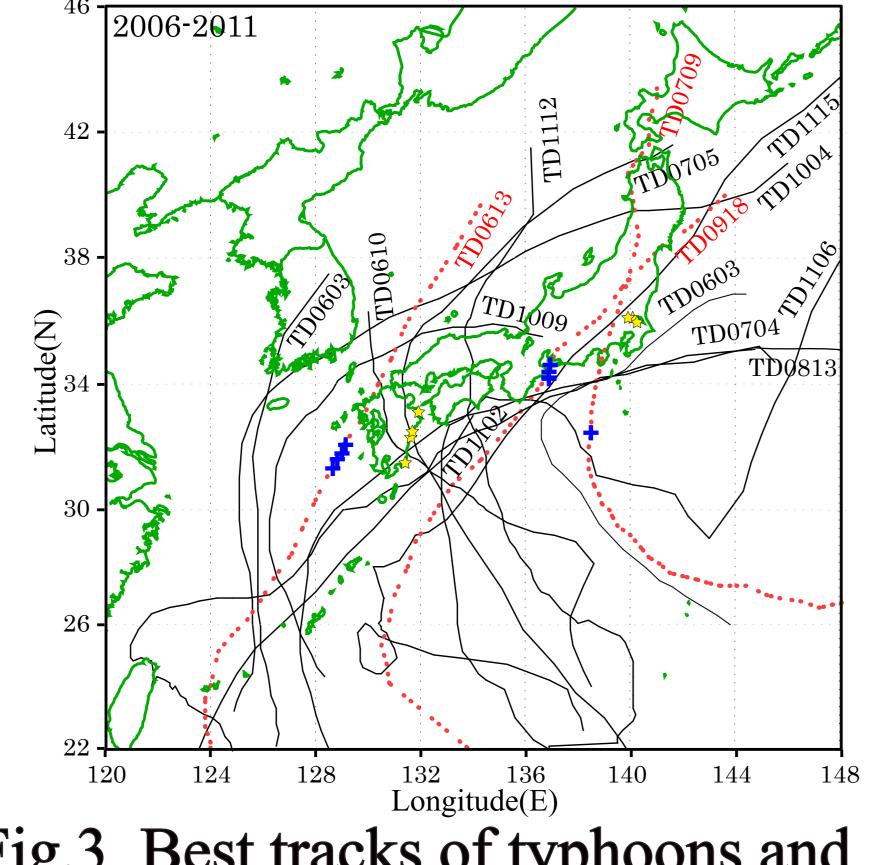
+ Typhoon eye when tornado occurs
☆ Position of tornado outbreak
— Track of typhoon with tornado outbreak
— Track of typhoon without tornado outbreak

Fig.3 Best tracks of typhoons and locations of tornado outbreak

3．Results

--- Track of typhoon   ○T Tornado outbreak position   + location of typhoon eye
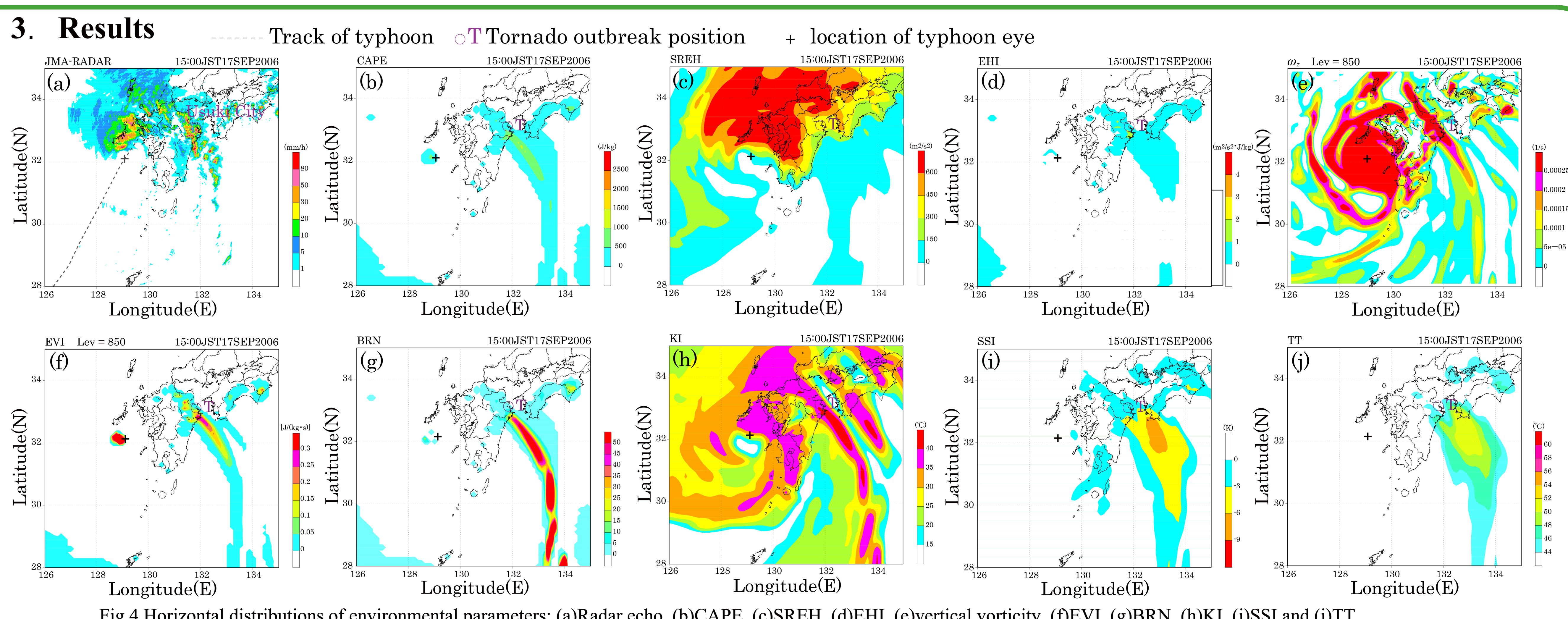

Fig.4 Horizontal distributions of environmental parameters; (a)Radar echo, (b)CAPE, (c)SREH, (d)EHI, (e)vertical vorticity, (f)EVI, (g)BRN, (h)KI, (i)SSI and (j)TT at 1500 JST, 17 Sepetember, 2006. TD200613 whose track denoeted by dashed line in (a) caused 4 tornadoes.

Fig. 4 shows typical examples of the distributions of environmental parameters. At this time, the tornado attacked Usuki city located in the outer rainband of TD200613. CAPE (b) is large in the outer rainband but SREH (c) is all over the north side of TD200613. Then the large EHI (d) area does not correspond to the outer rainband. The other parameters, KI (h), SSI (i) and TT (j) also spread in wide area. EVI (f) and BRN (g) seem to be good indices to represent the environment of the outer rainband.
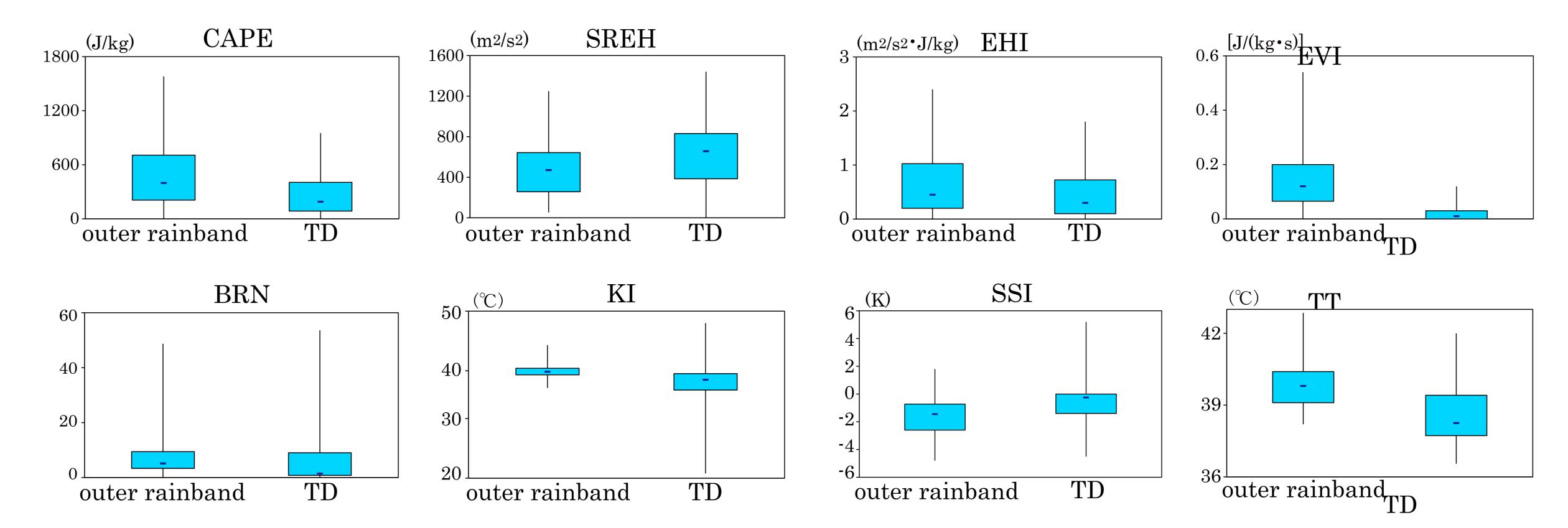
EVI is our newly proposed parameter. It is a product of CAPE and vertical vorticity at 850 hPa. Though the data includes no tornadic typhoon, the results in Fig. 5 shows that EVI is the best parameter to represent the environment of the outer rainband.

Fig.5 Box and whiskers plots of environmental parameters, TD denotes the other portion of typhoon.

4．Conclusion

The new parameter, EVI introduced by us, is confirmed to be the best index to represent the environement of tornado outbreak in the outer rainband of typhoons.