Japan Area Meso-ensemble Forecast Experiments using JMANHM

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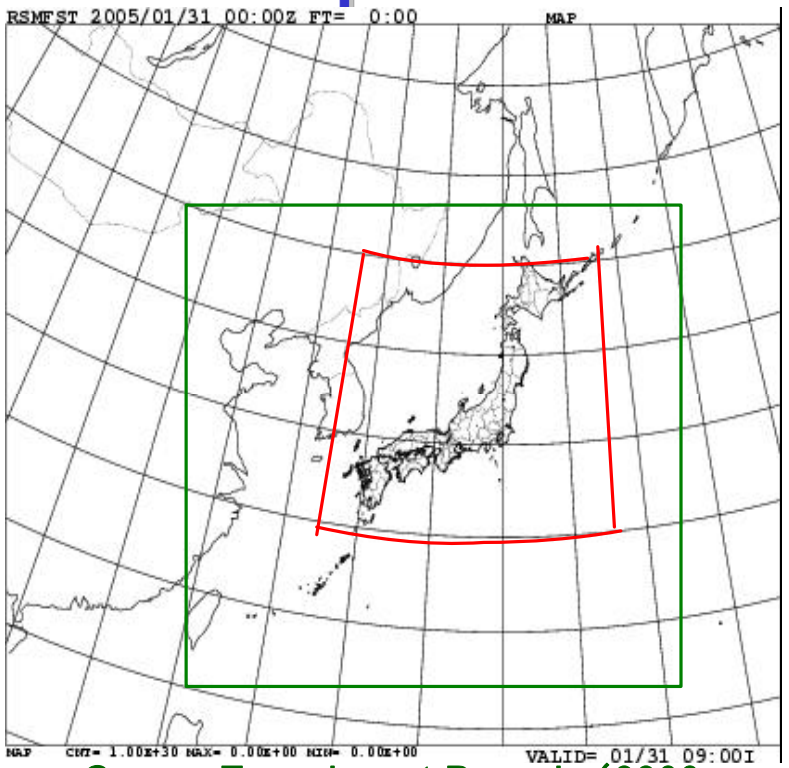
Motivation

- Ensemble forecast adds the information of the probability to the deterministic weather forecast. The forecasts of members can reduce the risk of undetected heavy rainfalls. Therefore, ensemble forecast is expected to be useful for the disaster prevention.
- With collaborating with JMA, MRI participates in the meso-ensemble forecast component of WWRP Beijing 2008 FDP/RDP. It is instructive to apply the techniques, which have been developed in RDP project, to other ensemble experiments in order to confirm of their validity.
- The result of Japan-area ensemble experiments using the technique developed by Saito et al. (2006) is explained in this study.

Specification of Ensemble Experiments

Forecast	36 hour, 12 UTC, 11 members
Horizontal mesh	221 x 201 (DX=15 km), Lambert conformal
Vertical levels	40 terrain following, DZ=40-1180m
Initial condition (CNTL)	JMA regional 4D-Var analysis at 12 UTC
Lateral boundary	JMA RSM forecast
Initial perturbation	JMA one-week global EPS (normalized)
Dynamics	HE-VI, DT=1 min, Dt=17 sec
Moist physics	3 ice bulk microphysics
Convection	Kain-Fritsch (modified at JMA)
Turbulence	Diagnostic TKE
Ground temperature	4 soil, initialized by RSM



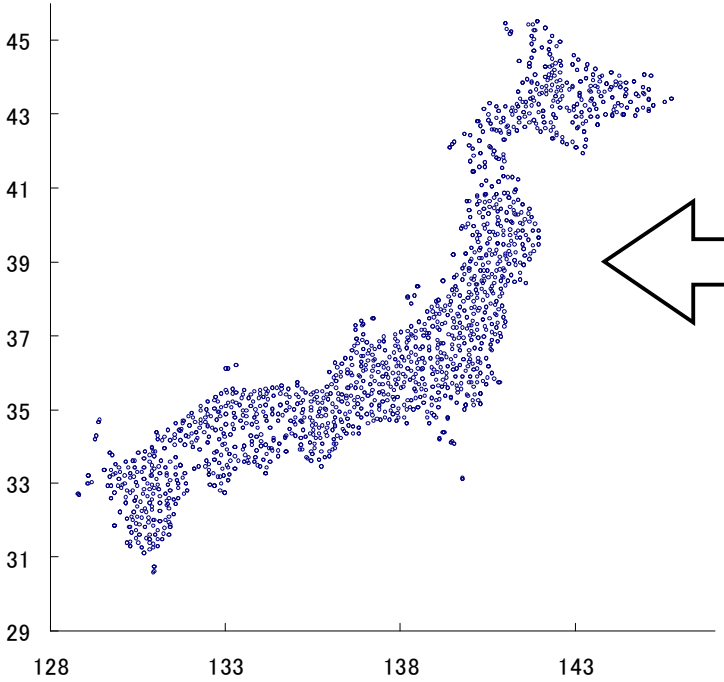
Green: Experiment Domain (3300 km x 3000 km)

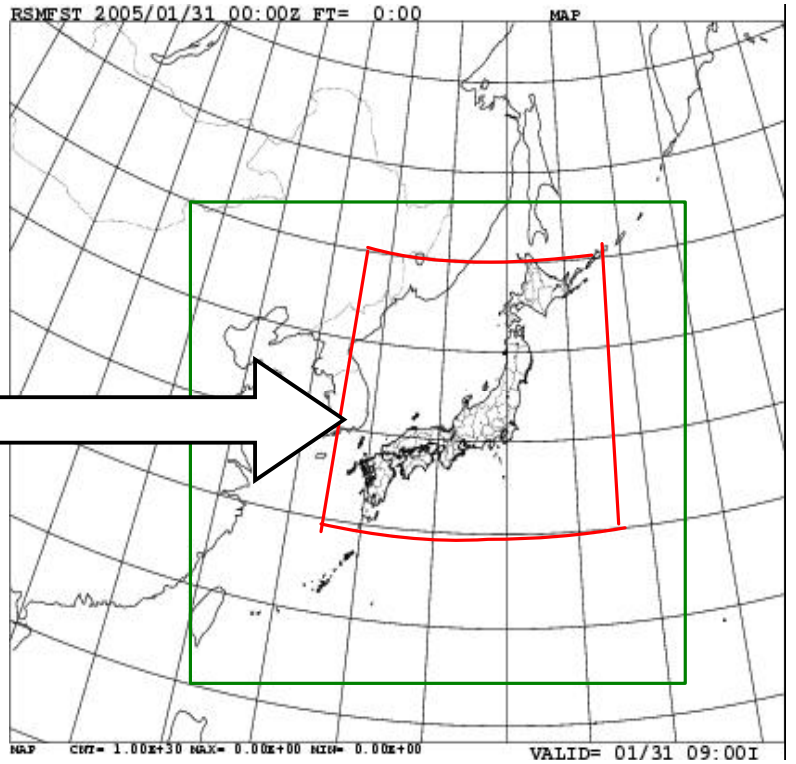
Red: Domain for verification (20 deg x15 deg)

- Experiment domain was 3000km x 3300km. Grid interval was set to be 15km.
- The initial perturbation was produced by adding the normalized perturbation of JMA operational one-week ensemble to the initial fields (Saito et al. 2006).
- 11 members (M00, M01p,M01m,…M05m) of 36 hour-forecast were conducted for 9-20 August.

Verification of Ensemble forecasts

Distribution of AMeDAS point

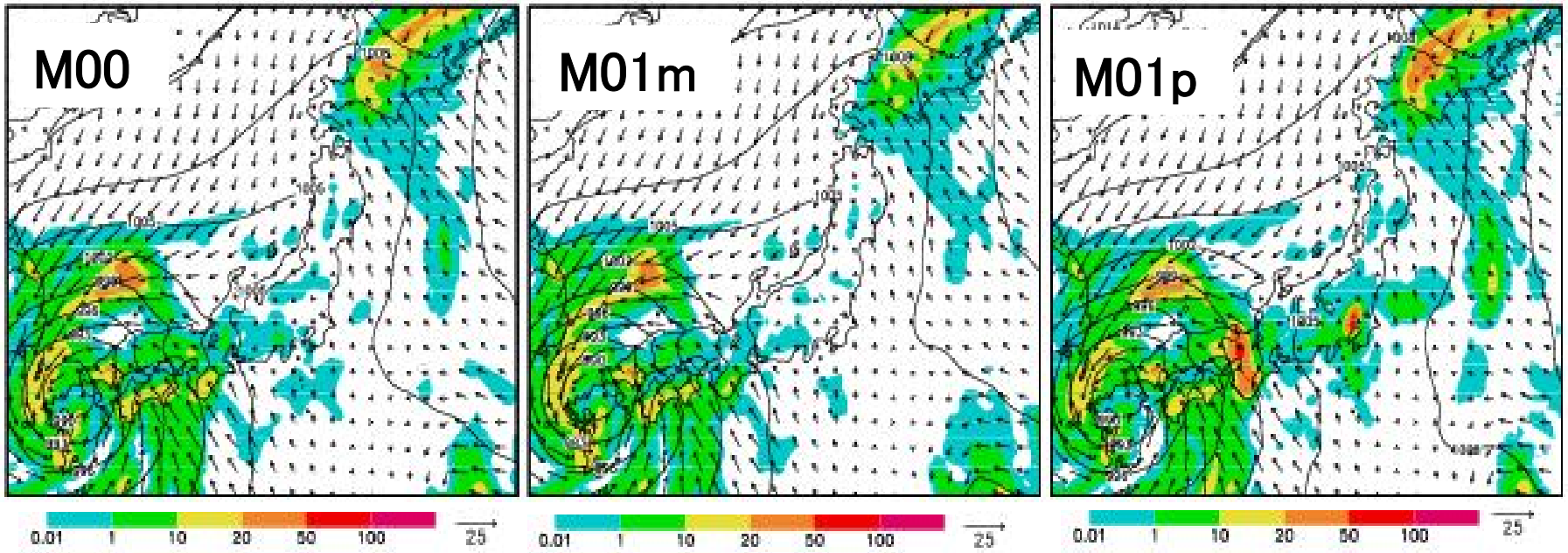




Green: Experiment Domain (3300 km x 3000 km)
Red: Domain for verification (20 deg x 15 deg)

- Verification was performed by comparing the forecast outputs to observation data.
- Left panel indicates the distribution of surface meteorological observation site.
- Grid point values with 0.15 interval were produced by interpolation of forecast outputs.
- The observation data closest to the grid points were used in this comparison.

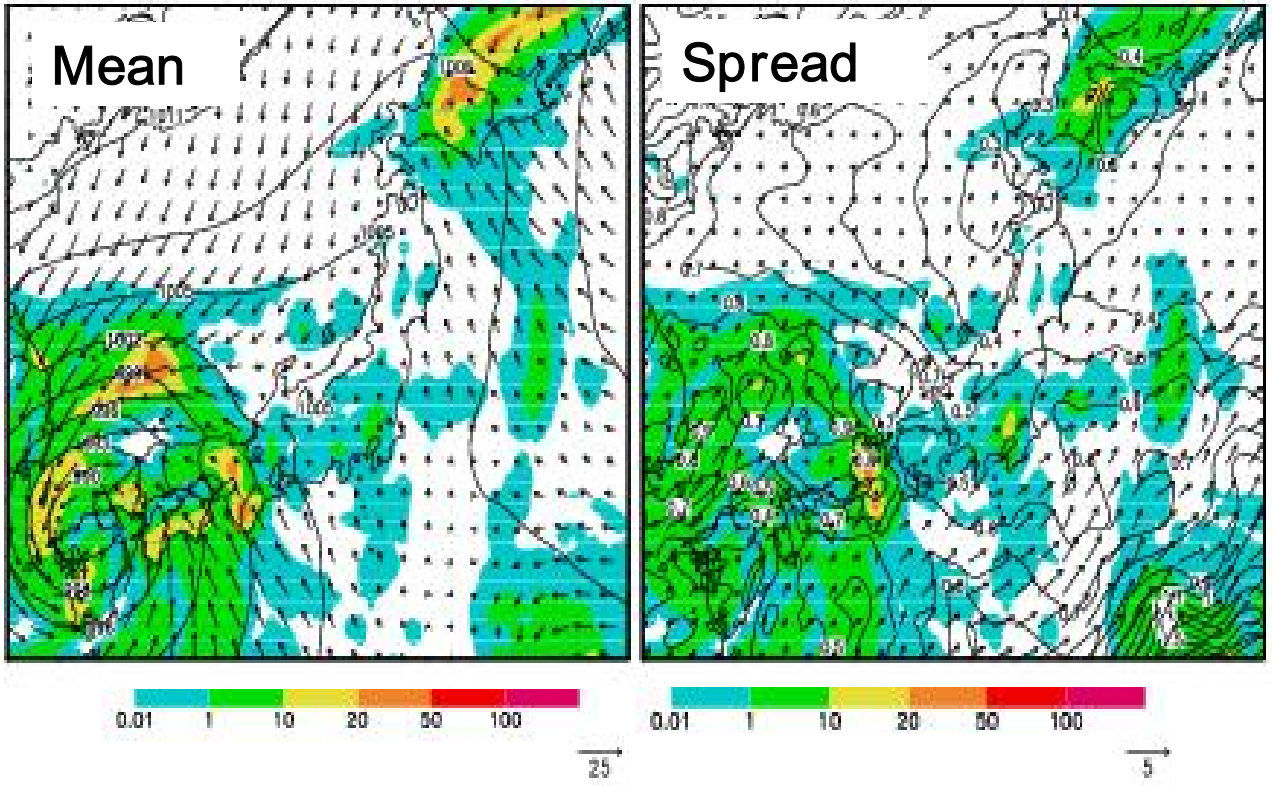
Examples of Ensemble Forecasts



Part of ensemble members' forecast. 3hour rainfall (colored), SLP (contour) and Horizontal wind (vectors) at 03 LST 19th August (Initial 21 LST 18th).

- Typhoon 0613 was moving northward over the western part of Japan. The cold front stayed over Hokkaido, the northern main island of Japan.
- The rainfall along the southern coast of Honshu, main island of Japan, was produced by the southerly wind that was enhanced by the typhoon circulation.
- Differences among the members are clearly seen in the rainfall region. For instance, rainfall on the southern side of Japan was more intense in the member of M01p.

Ensemble Mean and Spread

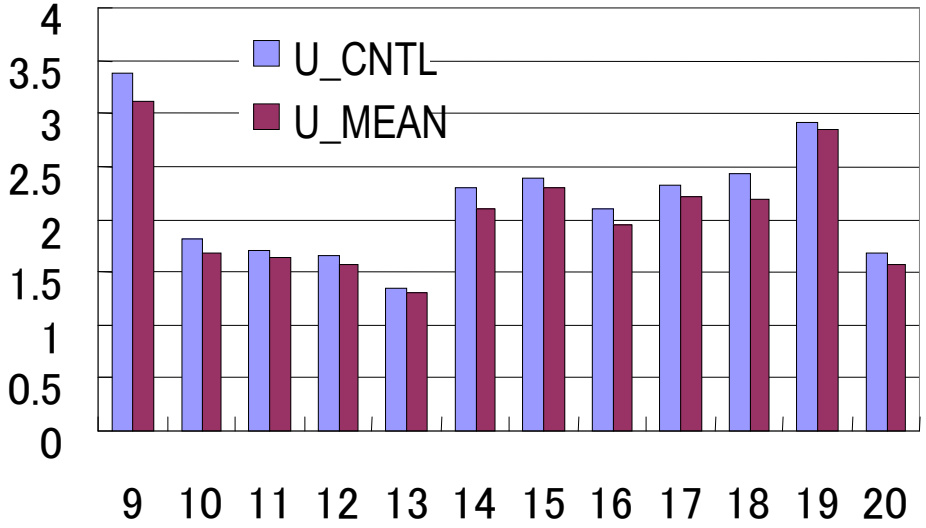


(Left) Ensemble mean and (Right) spread at 03 LST 19th August.

- Spreads of surface pressure and horizontal wind near the T0613 and over the Pacific Ocean were large.
- Large spreads near T0613 were produced by the difference of moving speed of T0613.
- Large spread of horizontal wind over the Pacific Ocean caused the large spread of rainfall along the southern coast of Honshu.

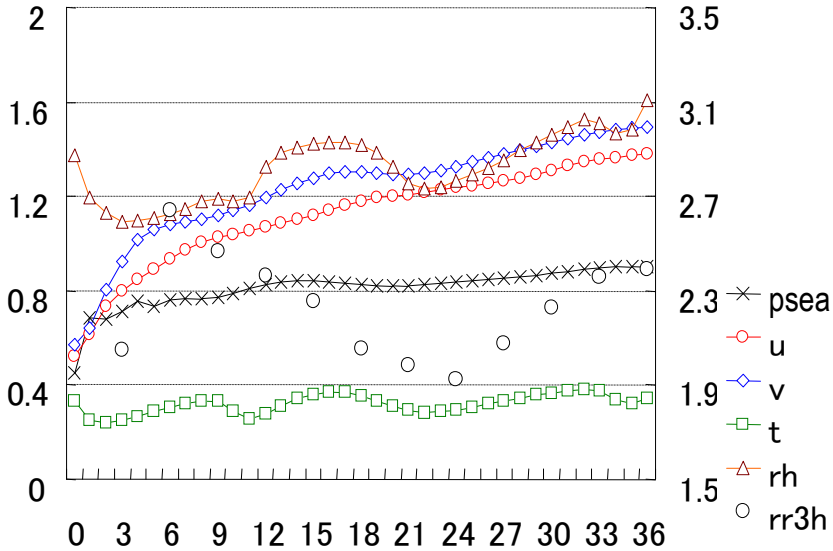
Results of Ensemble Experiments

Comparison of 24h-forecast with next day's initial data.



Blue and red bars indicate RMS of control run and ensemble mean.

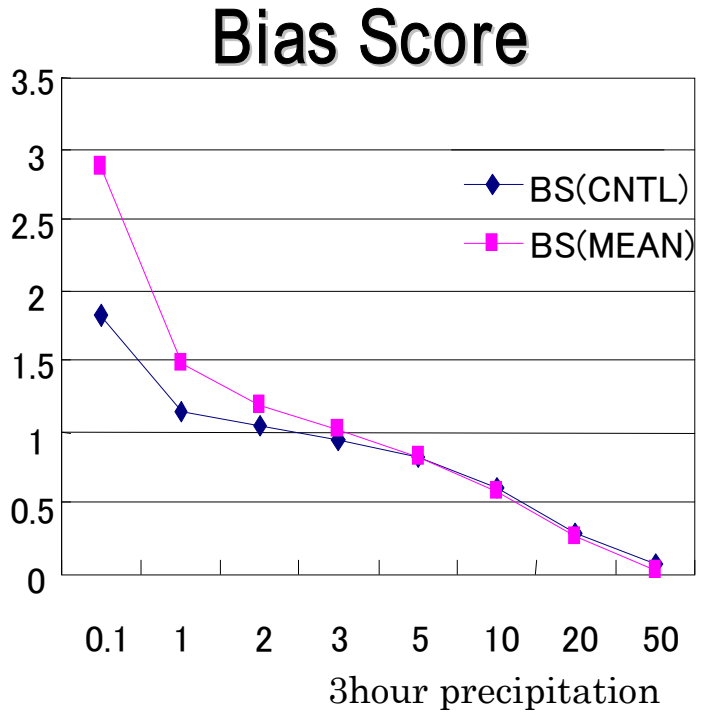
Time variation of Spreads

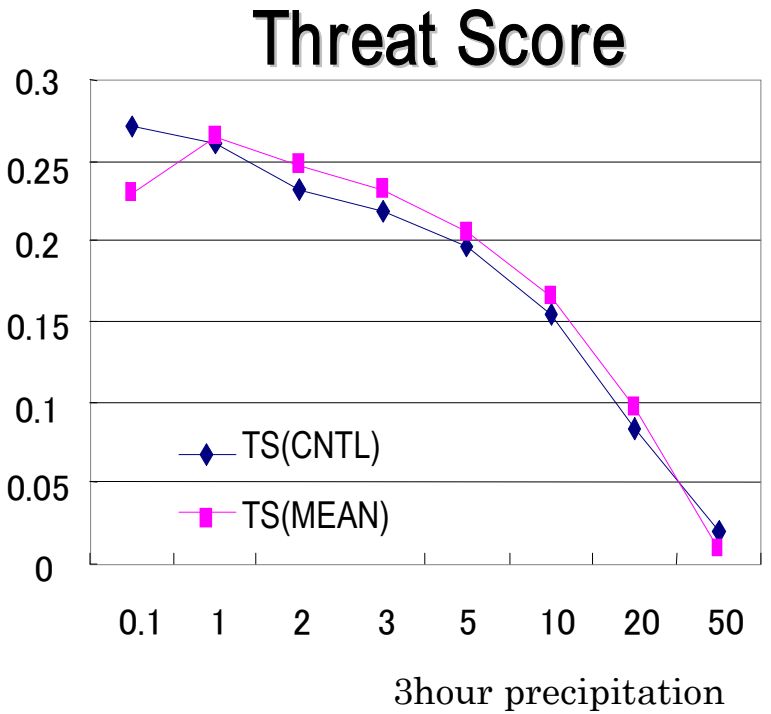


Horizontal axis is forecast time. Left axis shows surface pressure, T2m and UV10m. Right axis shows RH2m and 3hour-rainfall.

- The control run (CNTL) is the forecast from the initial condition without initial disturbances. Next day's initial fields of CNTL is expected to be close to real fields because they are produced from analyzed fields. RMSE of the ensemble mean (MEAN) was smaller than those of CNTL.
- The spreads of surface pressure (p) and horizontal wind (u,v) had increased during the forecast period. Diurnal variation is clearly seen in temperature (t), relative humidity (rh) and rainfall (rr3h).

Results of Ensemble Experiments



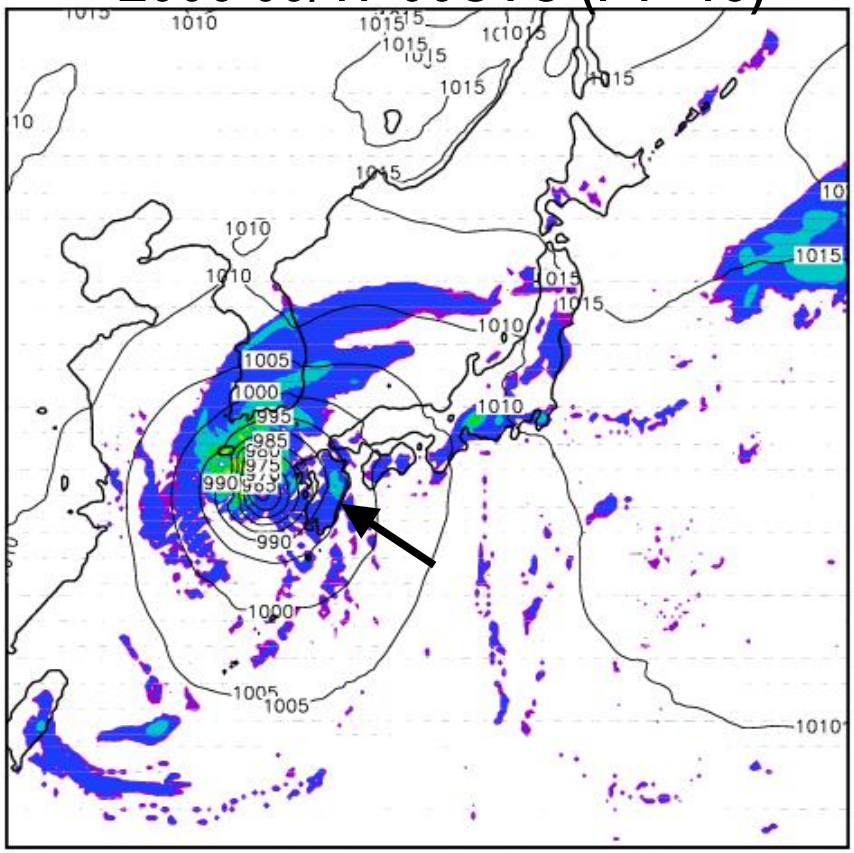


- When the threshold value is set to 0.1 mm, the bias score of MEAN is much larger than CNTL, due to the expansion of the weak rainfall region by the averaging of the members.
- Threat score of MEAN is larger than CNTL, except 0.1mm.

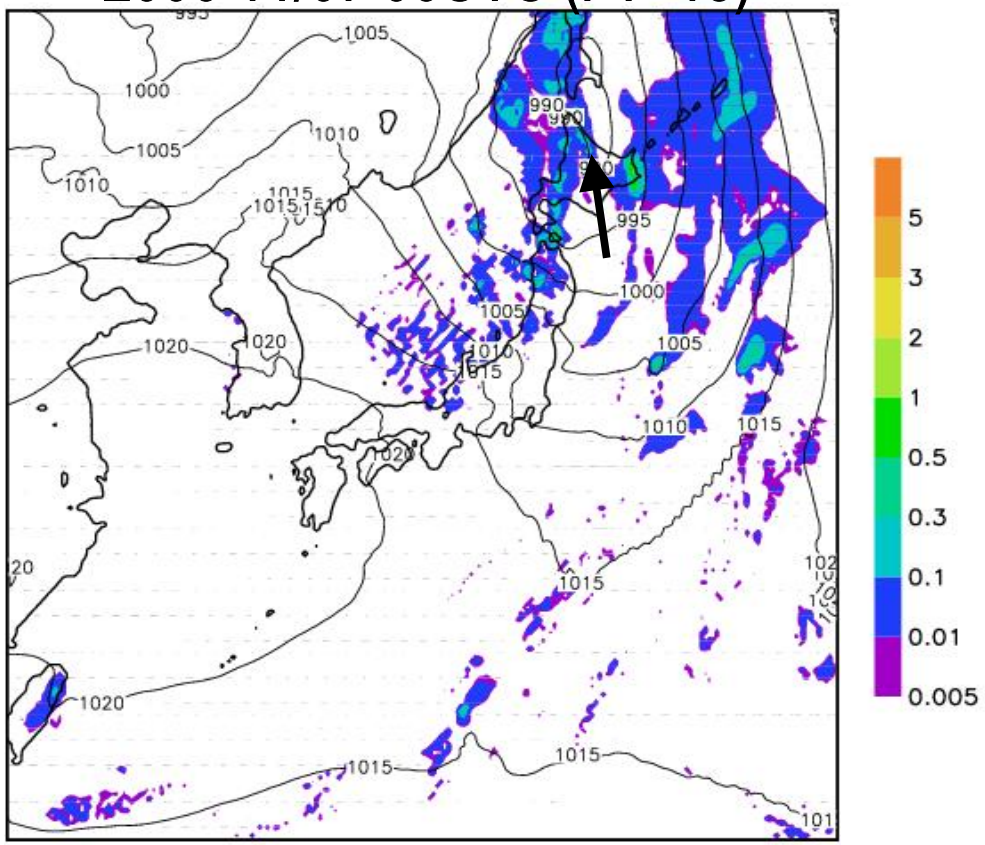
- These scores mean that the MEAN is closer to the observation. This comparison indicates the usefulness of the ensemble forecast.

Ensemble forecast of Tornado formation days

2006 09/17 06UTC (FT=18)

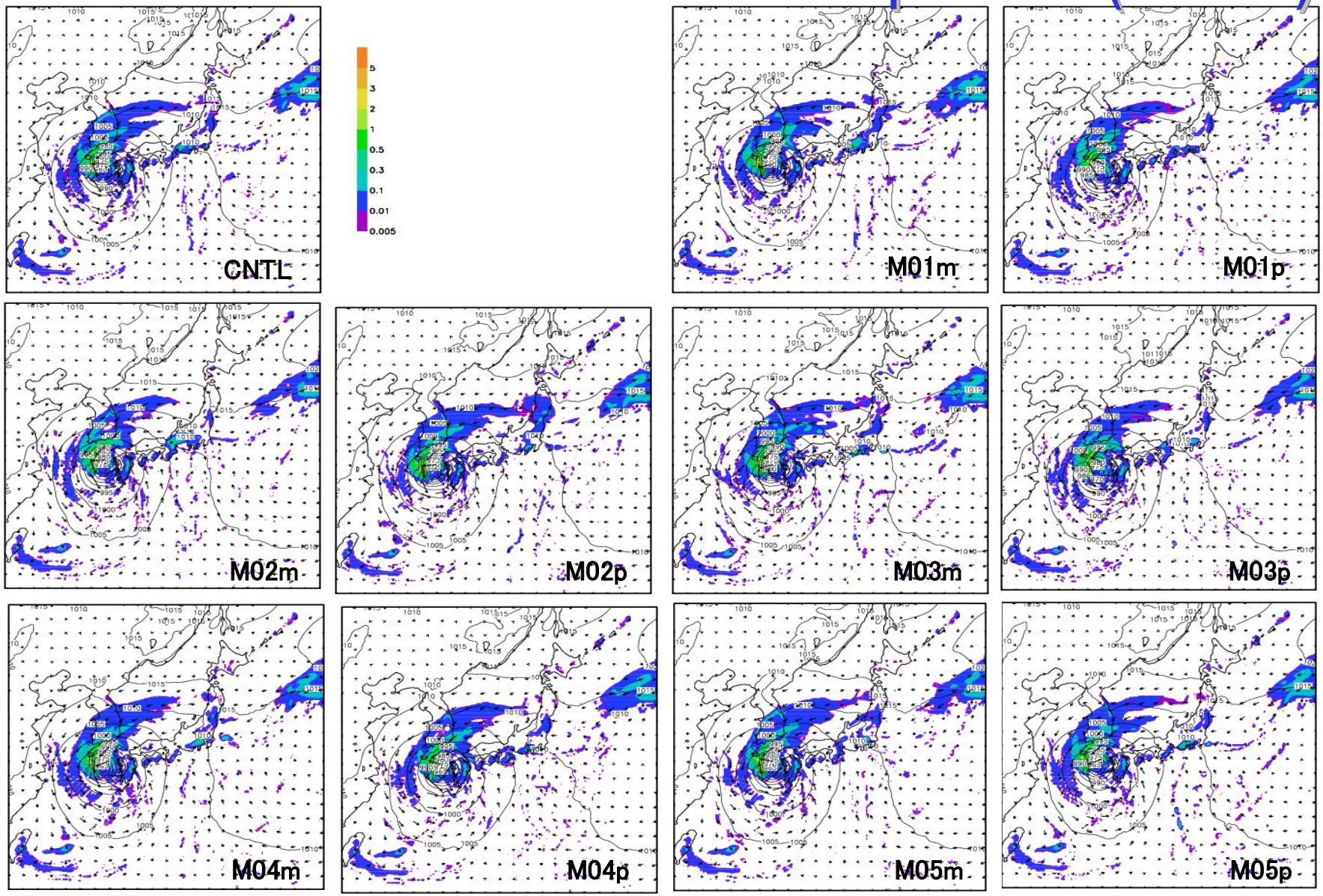


2006 11/07 06UTC (FT=18)



- So far, results of ensemble forecast on temperature or rainfall are explained.
- F2-3 scale tornados occurred in Kyushu and Hokkaido, last year.
  Probability of tornado parameter is investigated with ensemble forecast.

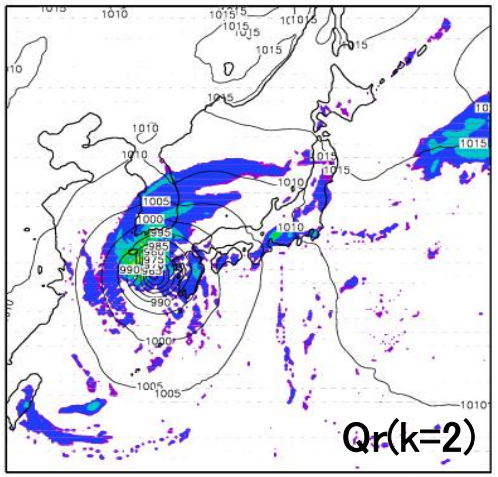
Ensemble forecast 06UTC 17 Sep. 2006 (FT=18)

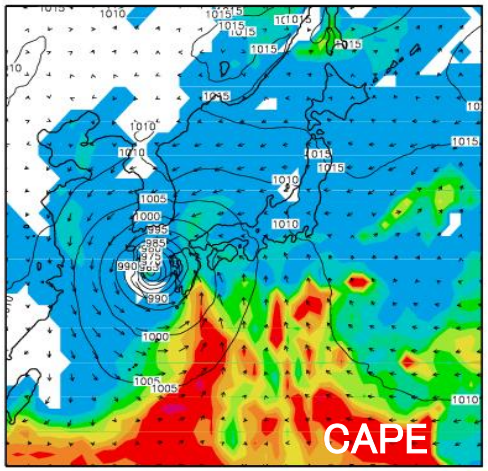


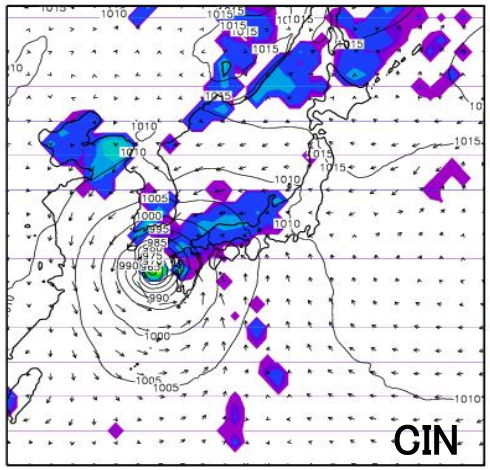
- Ensemble forecasts were conducted with the same way of 'Japan Area Ensemble', except the initial time of forecast.

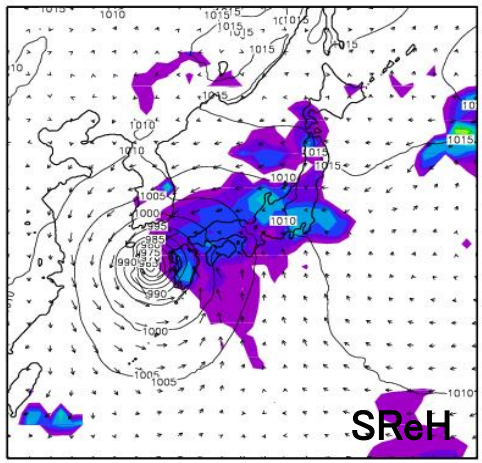
Parameters for Tornado formation

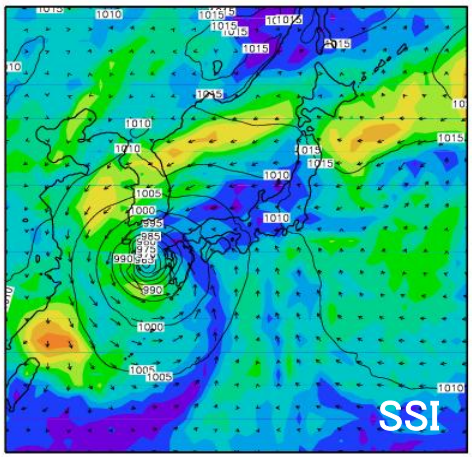
06UTC 17 Sep. 2006 (FT=18)

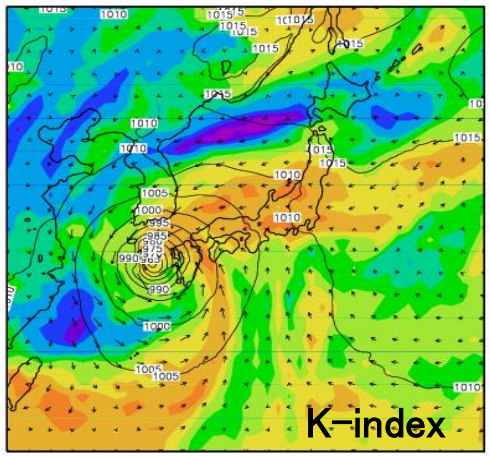






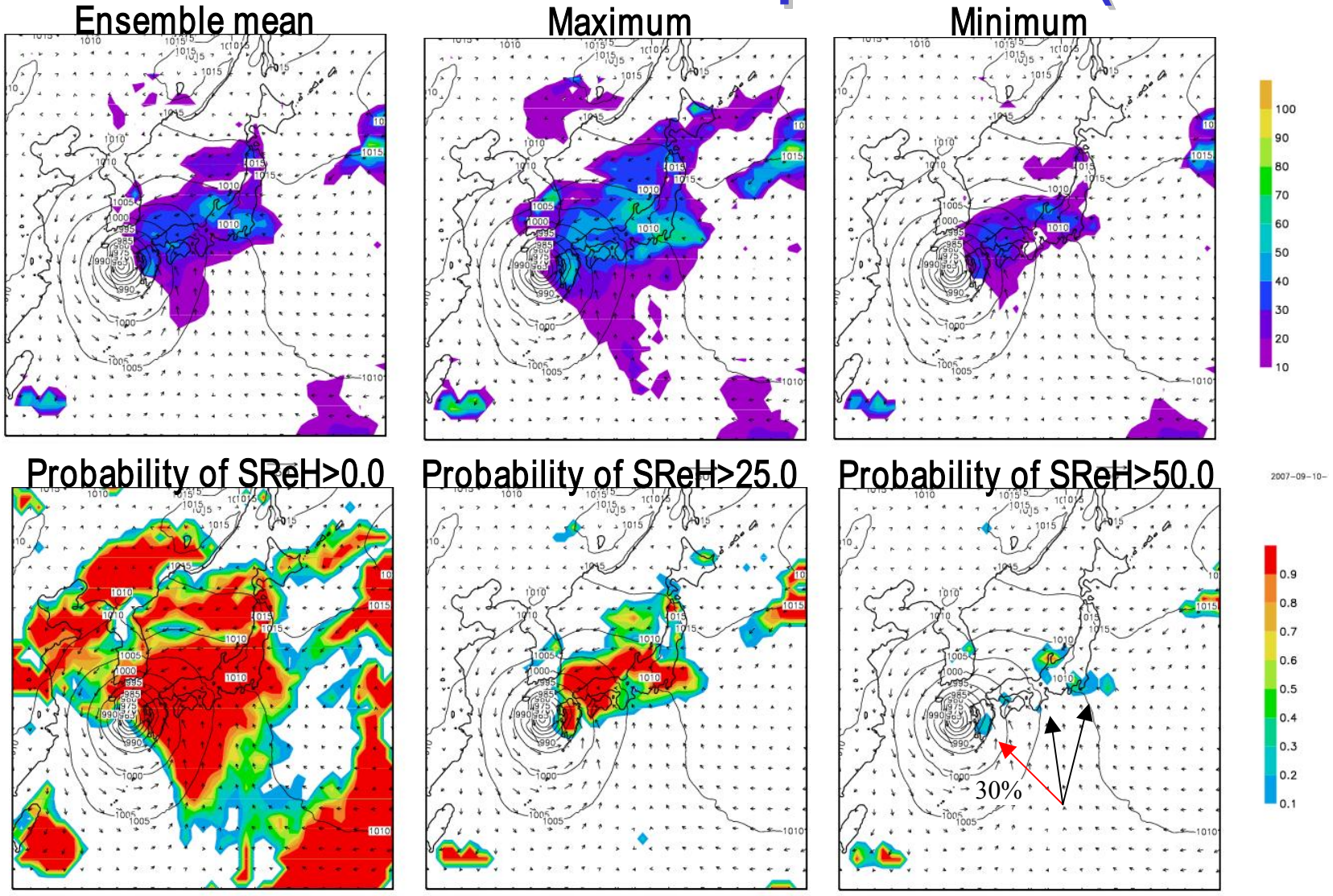






- More than 20 parameters are calculated with 'Cape7m', which has been used in JMA.
- In this study, CAPE and SReH were chosen as parameters for tornado.

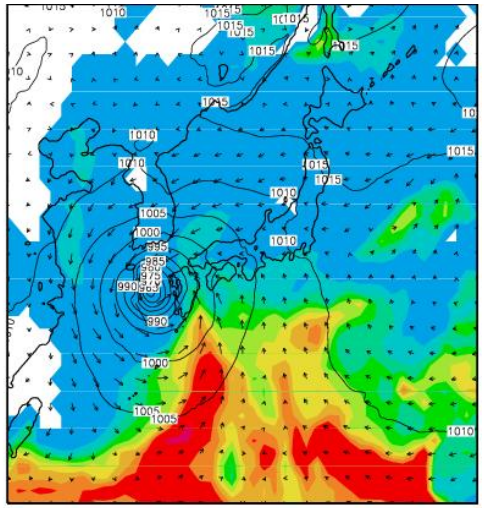
SReH 06UTC 17 Sep. 2006 (FT=18)



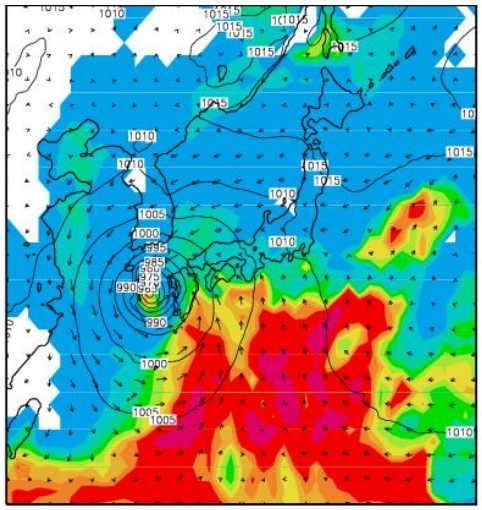
- SReH indicates the vorticity that was supplied by low-level air flow.
- High probability areas of high SReH exits at Kyushu(→) and the central Japan (→).

CAPE 06UTC 17 Sep. 2006 (FT=18)

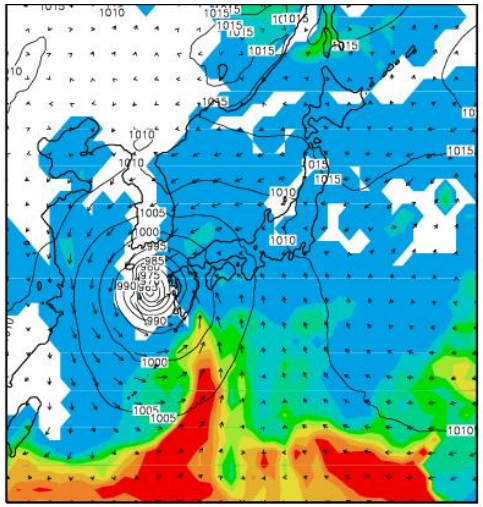
Ensemble mean

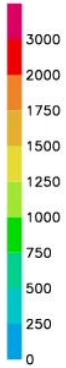


Maximum

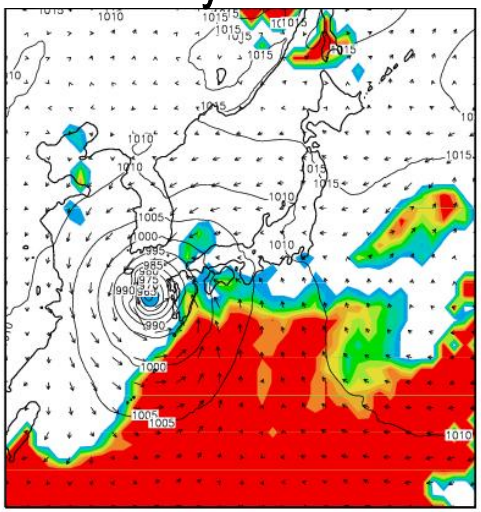


Minimum

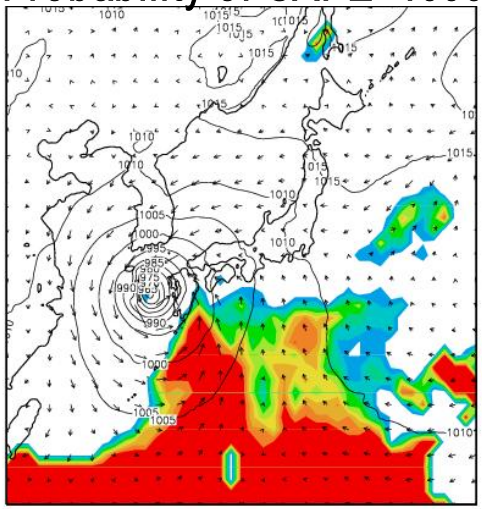




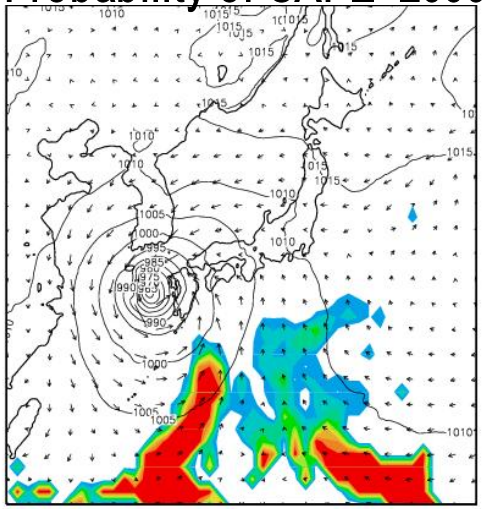
Probability of CAPE>500



Probability of CAPE>1000



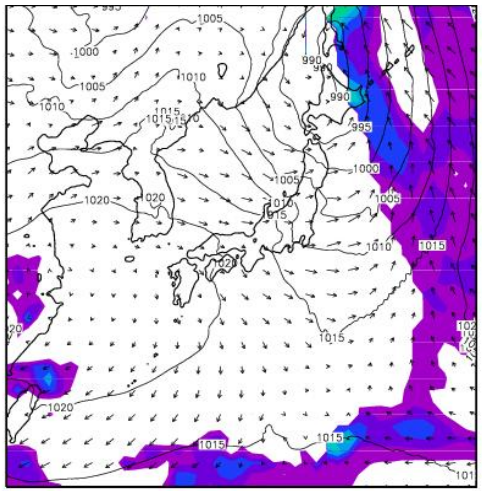
Probability of CAPE>2000



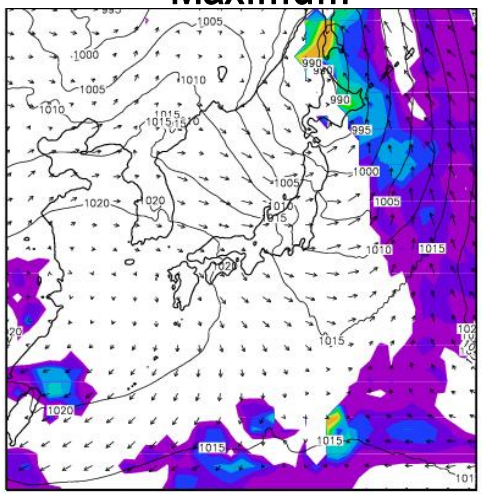
- CAPE indicates the convective energy that was supplied by the low-level inflow.
- There are high CAPE areas on the southern side of the western Japan.

SReH 06UTC 07 Nov. 2006 (FT=18)

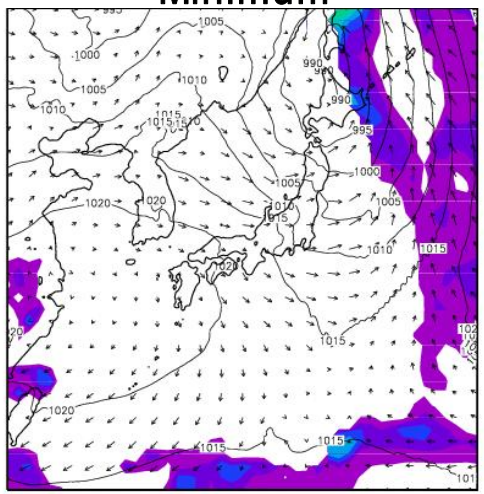
Ensemble mean

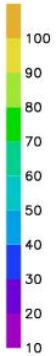


Maximum

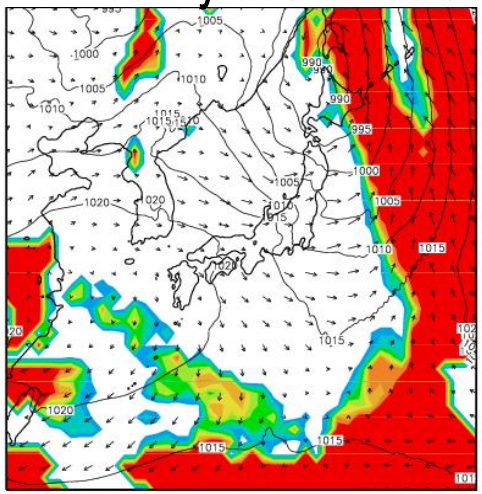


Minimum

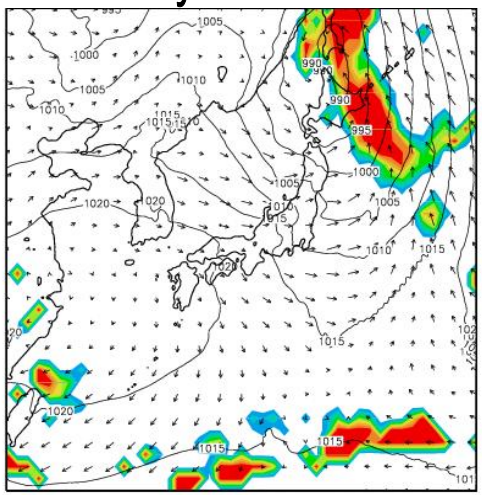




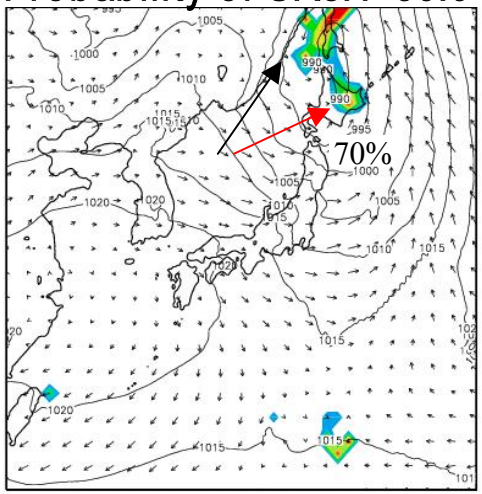
Probability of SReH>0.0

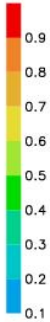


Probability of SReH>25.0



Probability of SReH>50.0

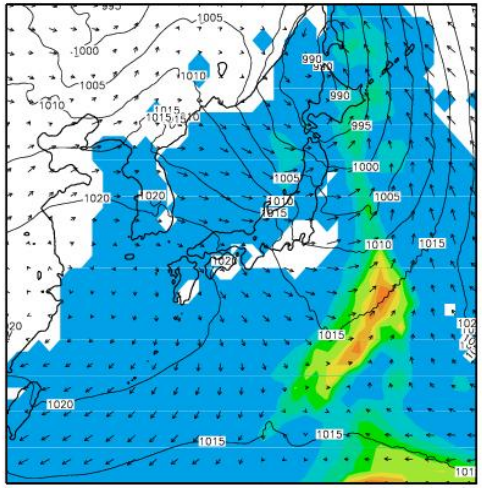




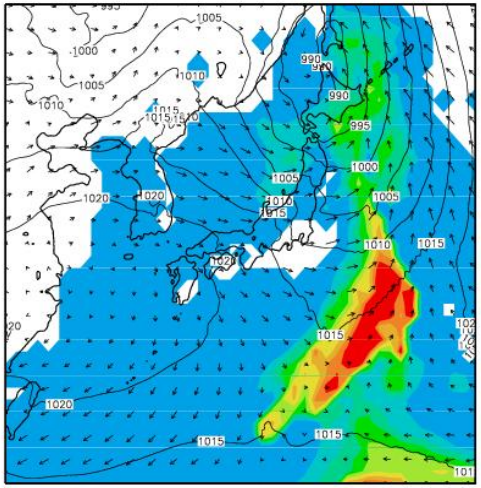
- High SReH areas on the eastern side of L is common with the case of T0613.
- High SReH area extended north from the Hokkaido(→), where Tornado occurred.
- Probability of high SReH is larger than that of T0613 case.

CAPE 06UTC Nov. 2006 (FT=18)

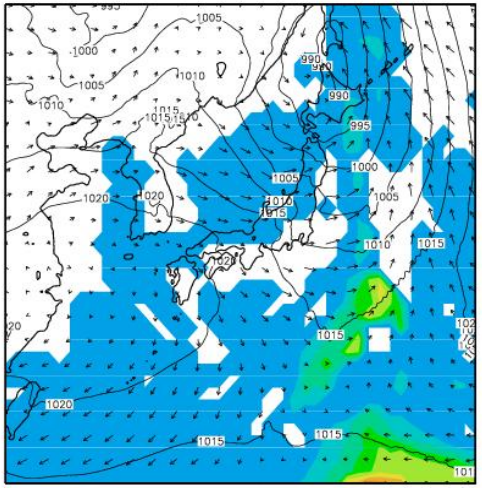
Ensemble mean

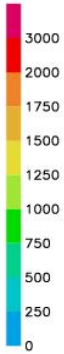


Maximum

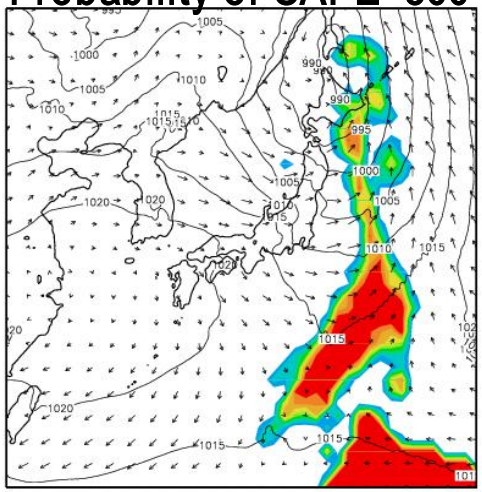


Minimum

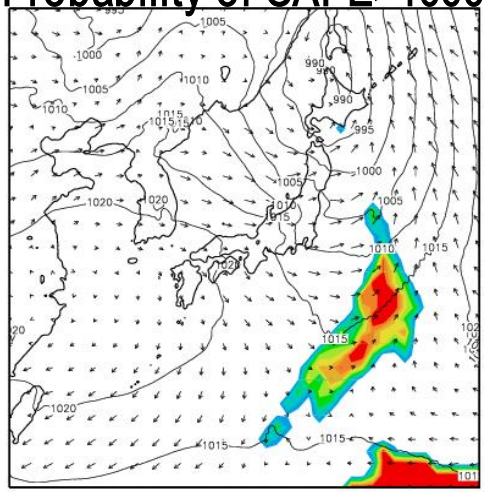




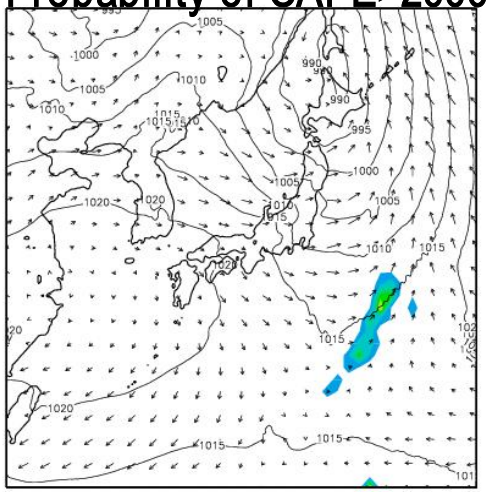
Probability of CAPE>500

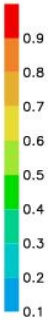


Probability of CAPE>1000



Probability of CAPE>2000

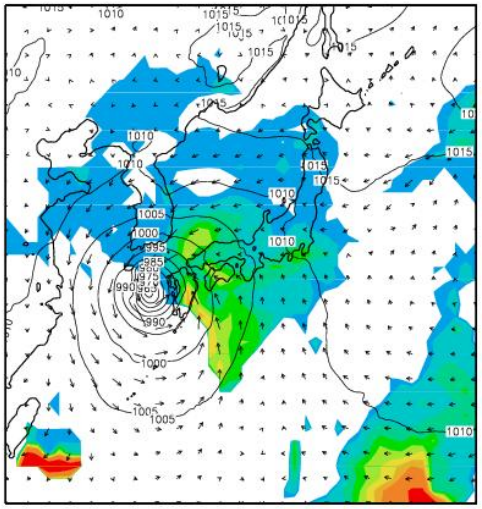




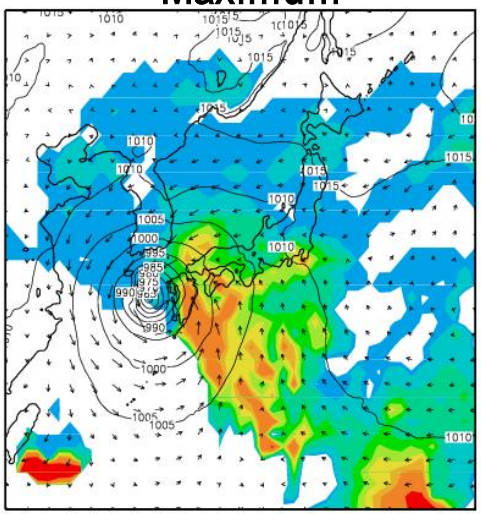
- High CAPE areas extents form Pacific Ocean to Hokkaido, where Tornado occurred.
- However, CAPE was smaller the those of T0613 case, because Tornado occurred at the higher latitude area and at cooler season.

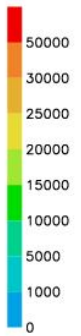
SReH×CAPE 06UTC 17 Sep. 2006 (FT=18)

Ensemble mean



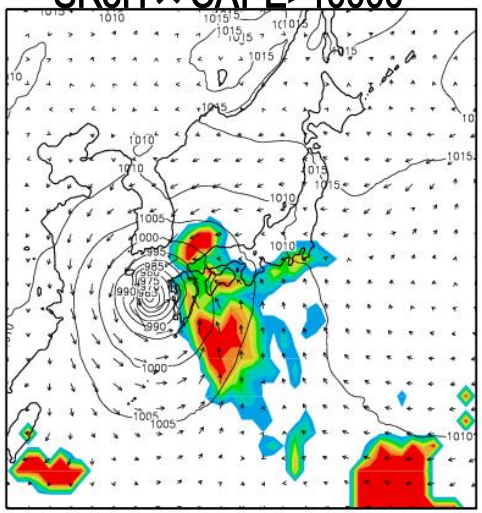
Maximum

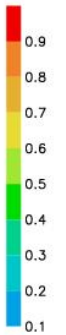




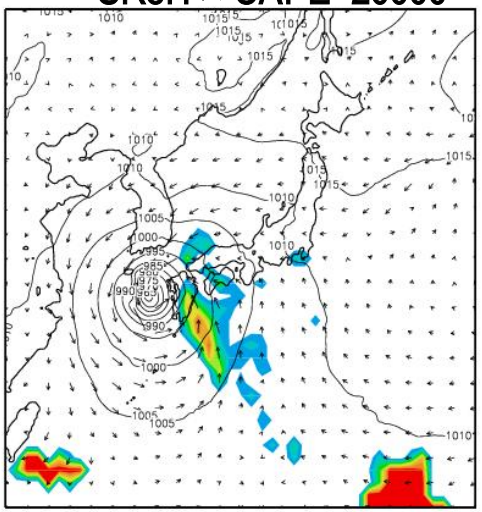
- When SReH was multiplied with CAPE, high probability area at Kyushu remained
- This probability distribution indicates that SReHxCAPE is useful parameter.

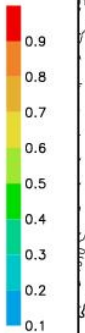
Probability of SReH × CAPE>10000



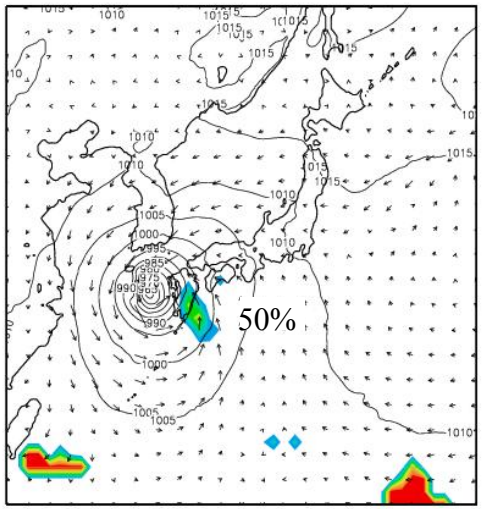


Probability of SReH × CAPE>20000



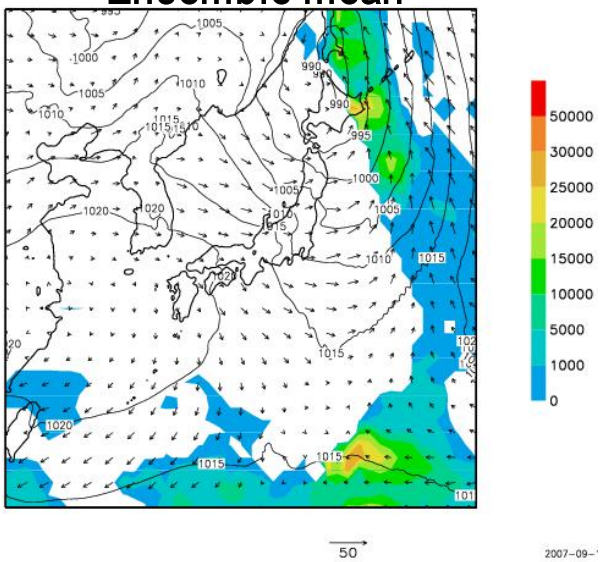


Probability of SReH × CAPE>30000

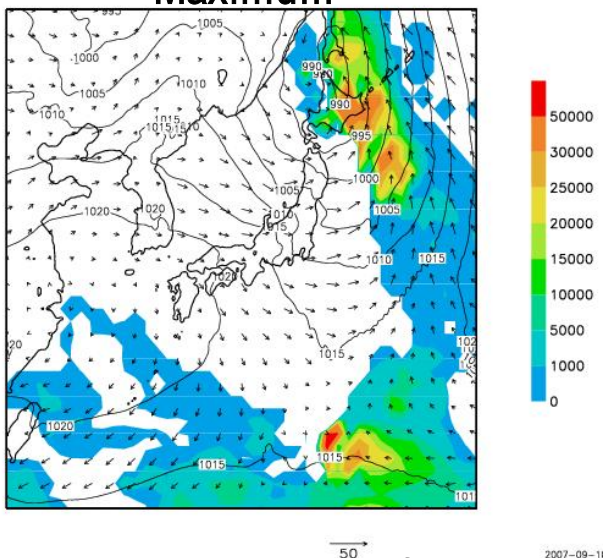


SReH×CAPE 06UTC 07 Nov. 2006 (FT=18)

Ensemble mean

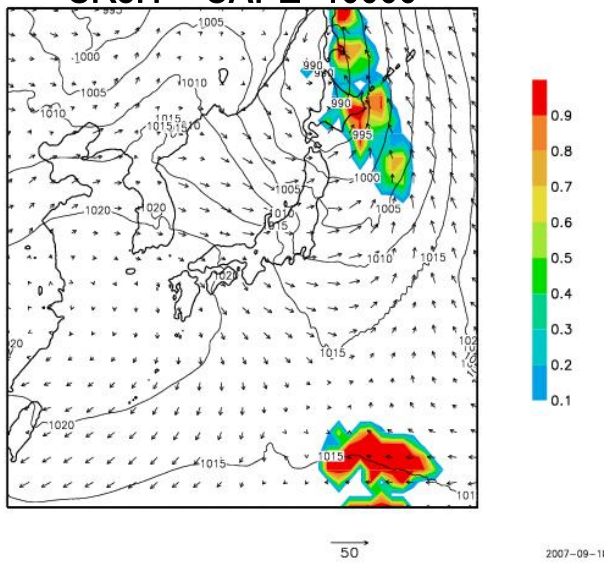


Maximum

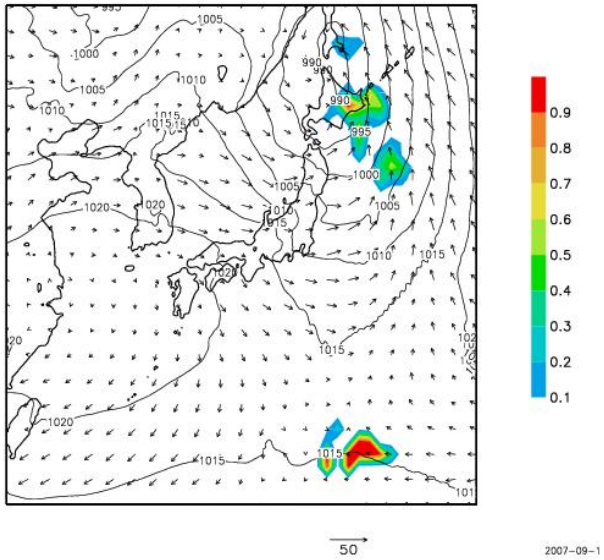


- When SReH was multiplied with CAPE, high probability area at Hokkaido remained.
- This probability distribution indicates that the tornado can occur in the high SReH area, even if in winter.

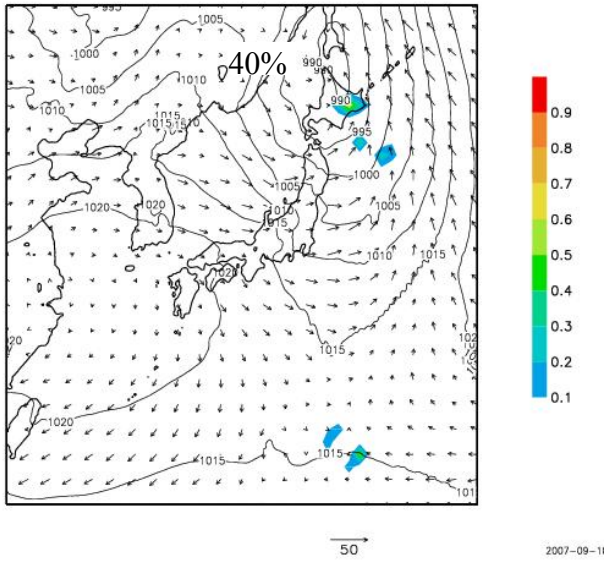
Probability of SReH × CAPE>10000



Probability of SReH × CAPE>20000



Probability of SReH × CAPE>30000



Summary

- Usefulness of ensemble forecast is confirmed through the Japan area ensemble experiment, of which setting is the same as those of B08RDP project.
- Through the ensemble experiments of two tornado case events, it is confirmed that CAPExSReH is one of useful parameters for the potential prediction of tornados.

Danke

Thank you

Merci

Gracias

Grazie

ありがとう