Characteristics of Storm Tracks in JMA's Seasonal Forecast Model

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Motivation

- When we develop a numerical model, mean error (=>model's climatology) and scores (RMSE, ACOR, etc.) are estimated mainly to know the model's performance (skill).
- In addition, it is also very important to know how well atmospheric phenomena are seen realistically in the model.
  - Teleconnection, typhoon, blocking high, etc.
- As previous studies showed, synoptic-scale baroclinic eddies along 'storm tracks' play an important role in the climate system by transporting heat, moisture and angular momentum.

Purpose

- To examine the characteristics of storm tracks in JRA-25.
  - Similar to those seen in previous studies ?
- To examine the characteristics of storm tracks in JMA's seasonal forecast model.
- In the view of seasonal change of storm tracks.
- In this study, storm track is defined as a region of eddies associated with baroclinic waves extracted using high-pass filter.
  - It may be helpful to examine the characteristics of an individual cyclone activity.

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Data

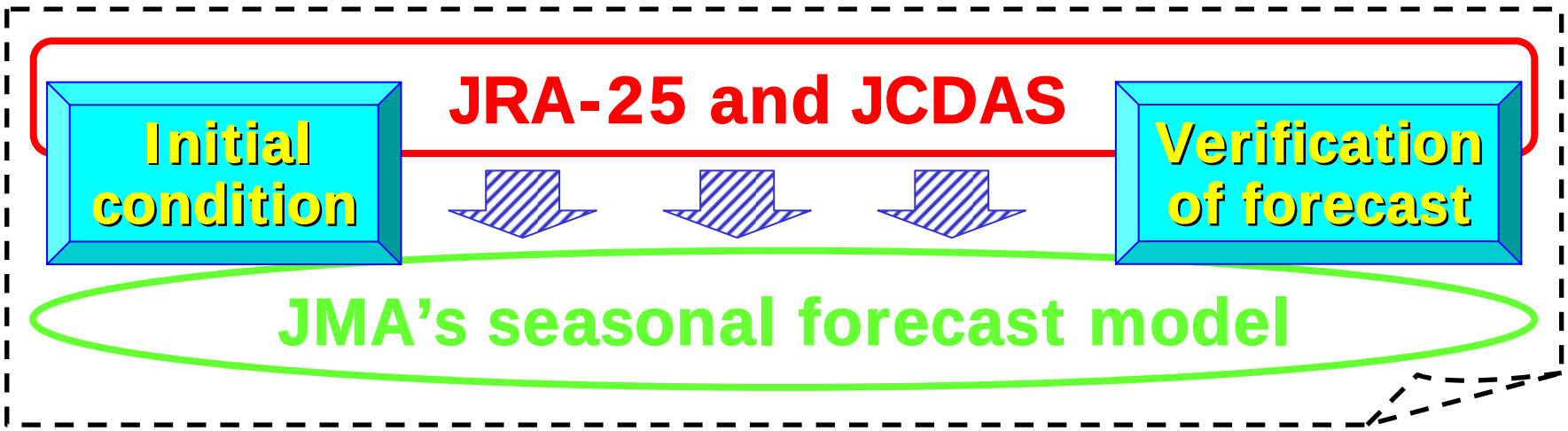
- Analysis: **JRA-25** (+JCDAS)
  - 2.5°x2.5°grids, 6 hourly, 1979 ~ present

- Forecast: **JMA's seasonal forecast model**
  - T_L95L40 (~180km horizontal res., model top=0.4hPa)
    => 2.5°x2.5°grids for verification, 6 hourly
  - Initial condition: JRA-25
  - Two-tier method -> NOT "A.-O. coupled model"
- Setting of hindcast (-> SVS-LRF)
  - Initial date: 1984 ~ 2005 (22yrs), 10th of every month
    In this study, results from 10th of November are used.
  - Ensemble size: 11, Forecast period: 210 days.

- Target: 84/85 ~ 05/06 (22 winters) in NH

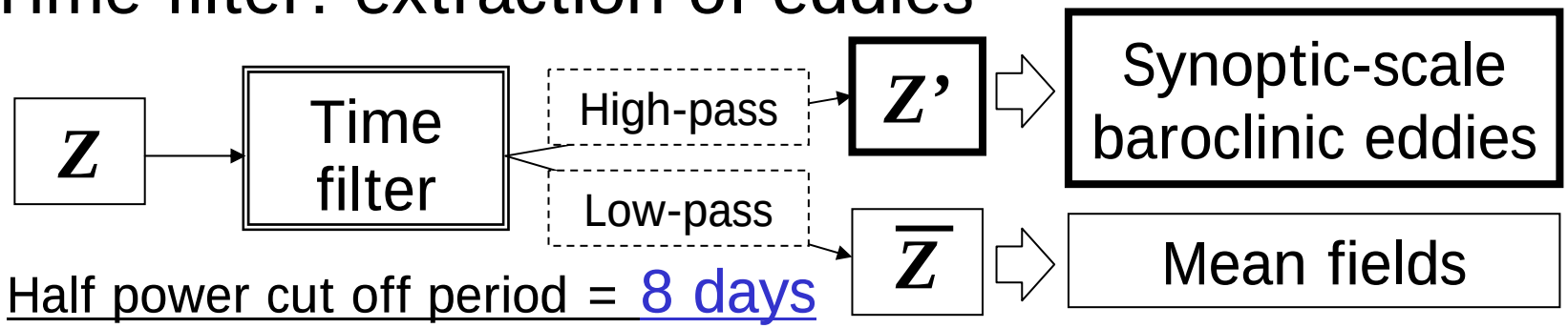
JRA-25 for JMA's seasonal forecast model

- **JRA-25** and JCDAS, which are real-time operational analysis products using the same assimilation system as JRA-25, are used as a basis for validation of the **JMA's seasonal forecast model**.



Analysis method (1)

- Time filter: extraction of eddies



Half power cut off period = 8 days

- Envelope function: amplitude of eddies

$$Ze = \sqrt{2 \times \overline{Z'^2}} \times \frac{\sin(45°N)}{\sin(lat)}$$

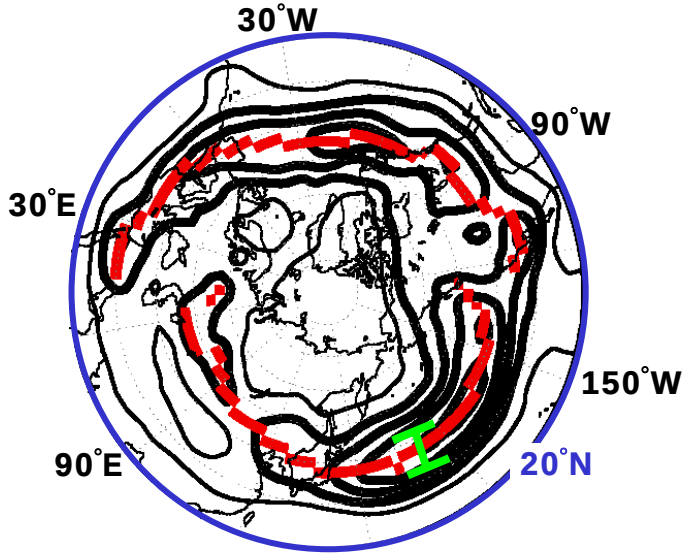
(Nakamura and Wallace ,1990)

* $\overline{\ }$: low-pass filter
* (sin(45°N)/sin(lat)): -> stream function

- -> 31-day running mean -> climatological mean (22 years)
  - Only data at 12Z are used as daily data.
- 300/850 hPa as upper/lower troposphere

Analysis method (2)

- Axis of eddies
  - An axis of a storm track is defined daily (12Z) at each meridian in Ze at 300hPa (15°N~75°N).
  - The quantities along the axis are defined as **10°-latitudinal band averages**.



Ze & axis at 300hPa
(15 JAN. 2001 12Z)
Contour:(60),90,120,...

- Extended EP-flux : group velocity of propagation

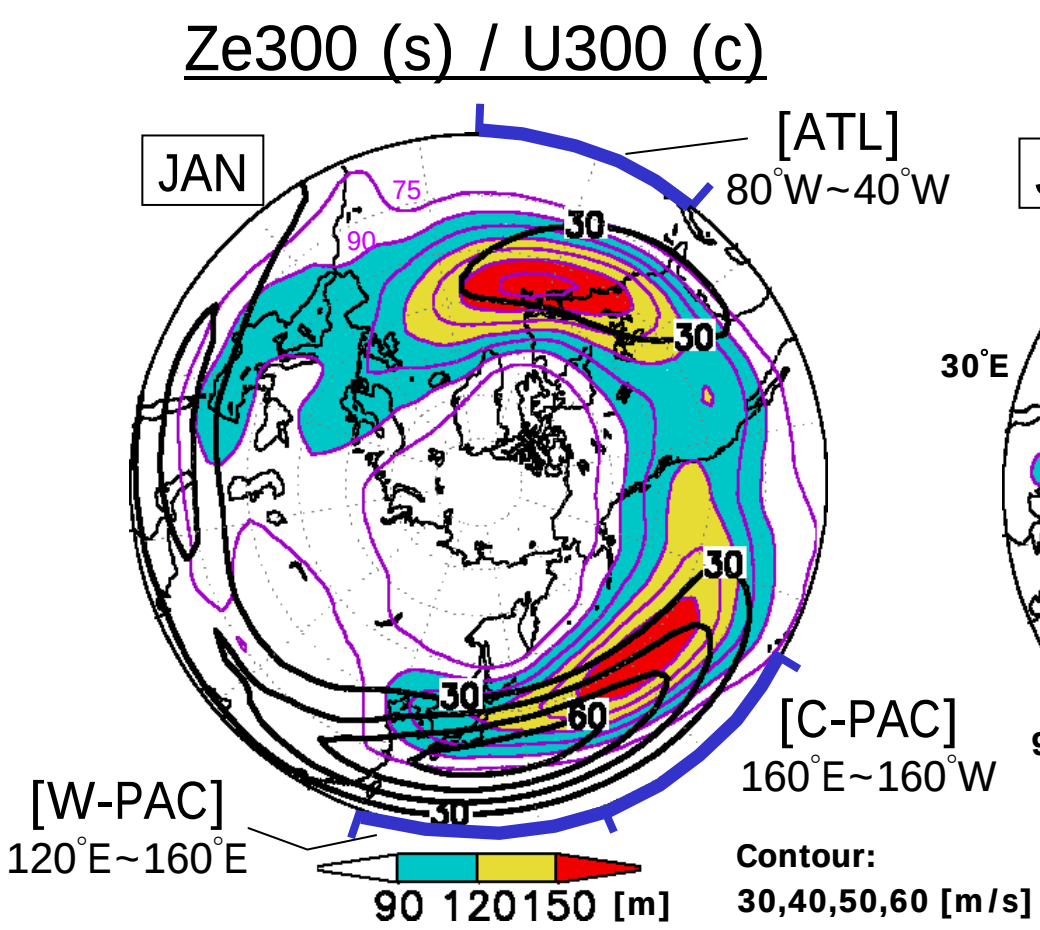
$$\mathbf{E}_{\mathrm{H}} = \left(\frac{\overline{v'^2} - \overline{u'^2}}{2}, -\overline{u'v'} \right)^{\mathrm{T}} \cos(lat)$$

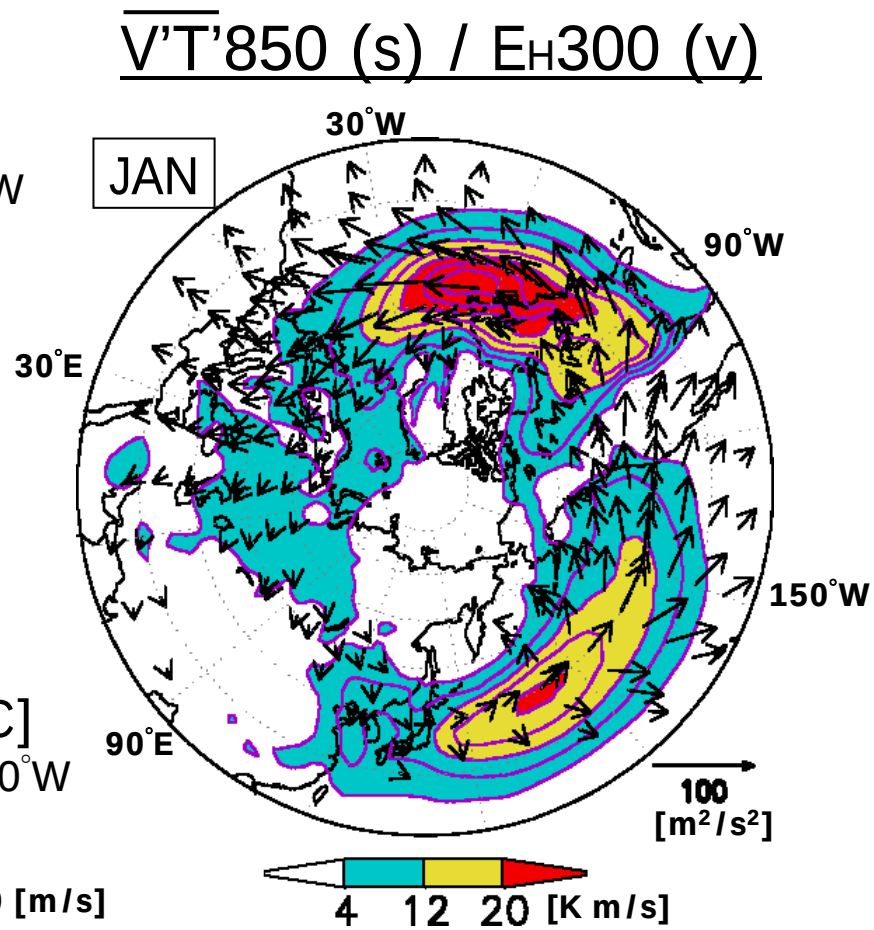
(Trenberth,1986)

- Poleward heat flux $\overline{v'T'}$

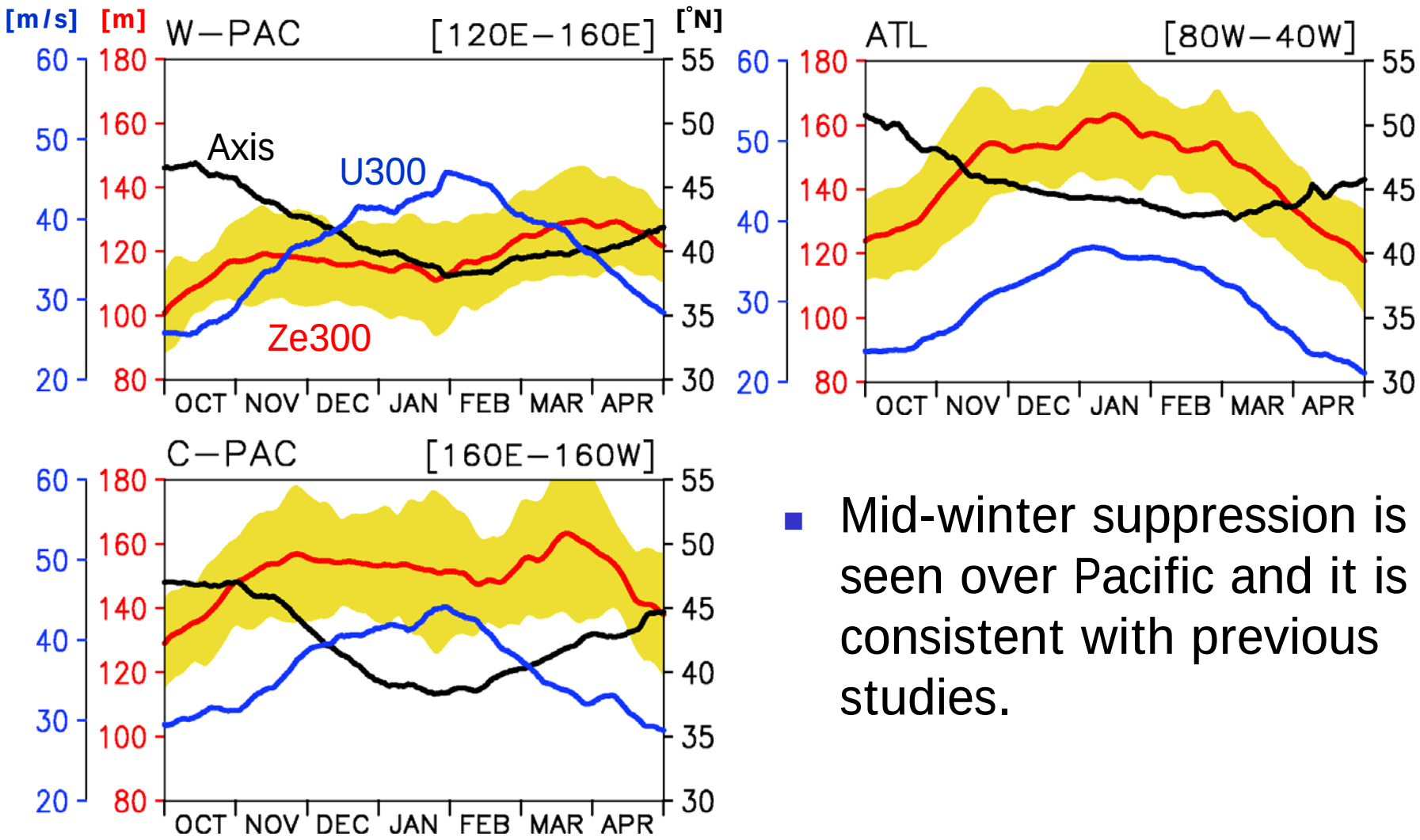
Analysis: average in Jan.

- The distributions of storm tracks are in agreement with previous studies using other analysis or observations.



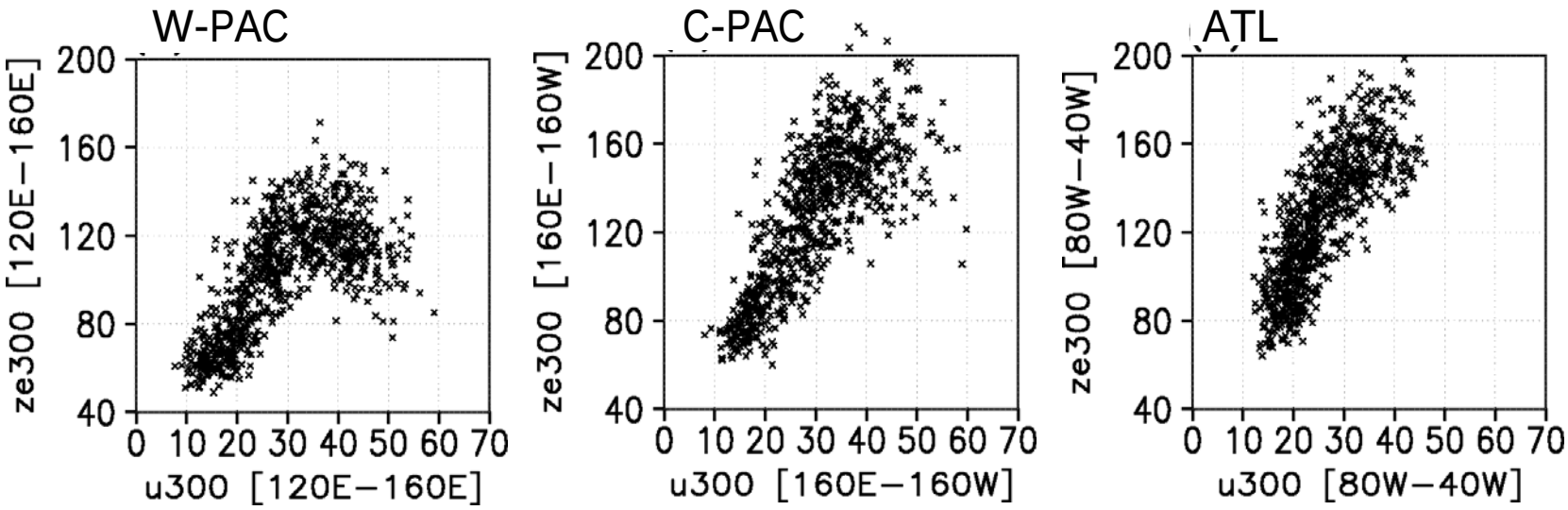


Analysis: seasonal change

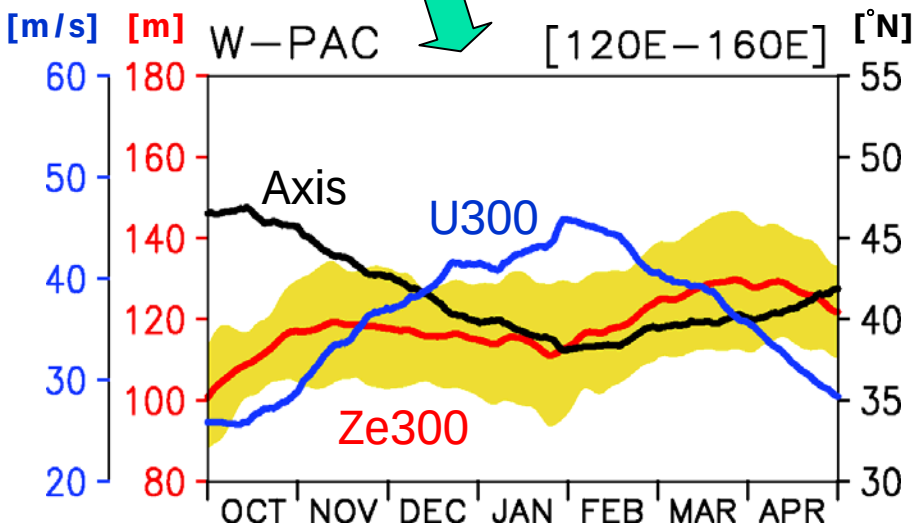


- Mid-winter suppression is seen over Pacific and it is consistent with previous studies.

Analysis: scatter diagram



Term: annually

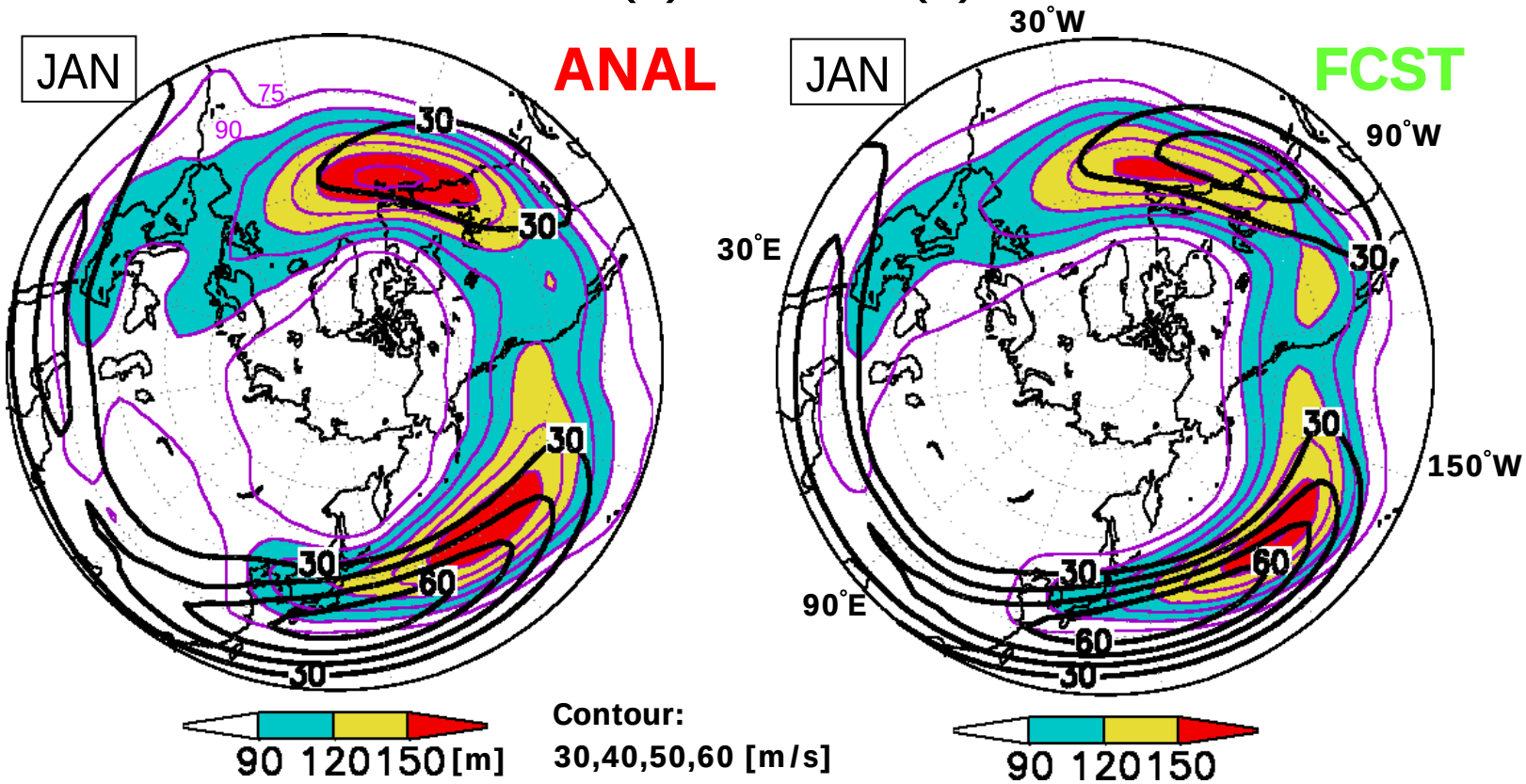


- Mid-winter suppression is also seen over Pacific in scatter diagrams

Anal vs. Fcst: average in Jan.(1)

- JMA's seasonal forecast model represent distribution of storm tracks well, however, there are some differences.

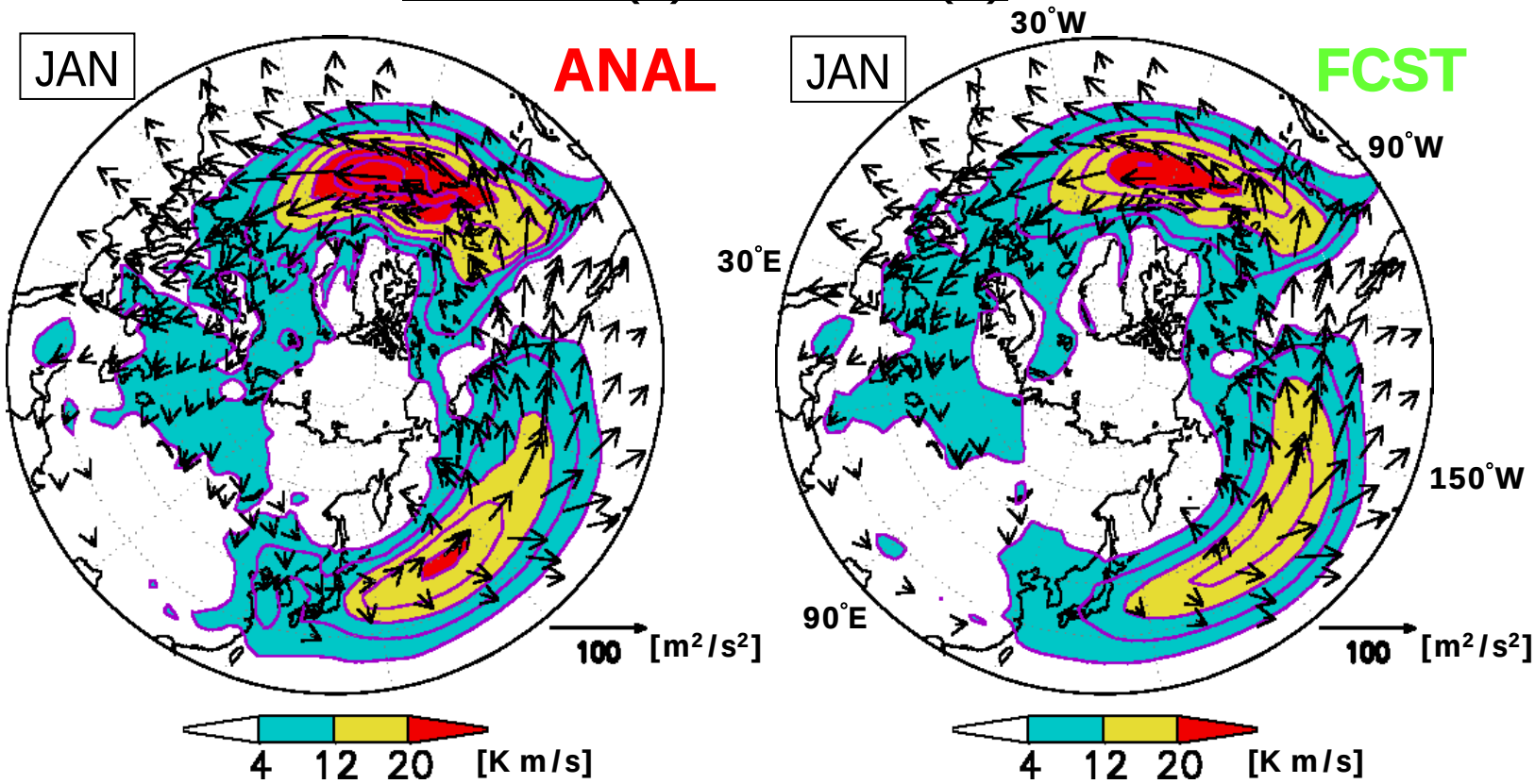
Ze300 (s) / U300 (c)



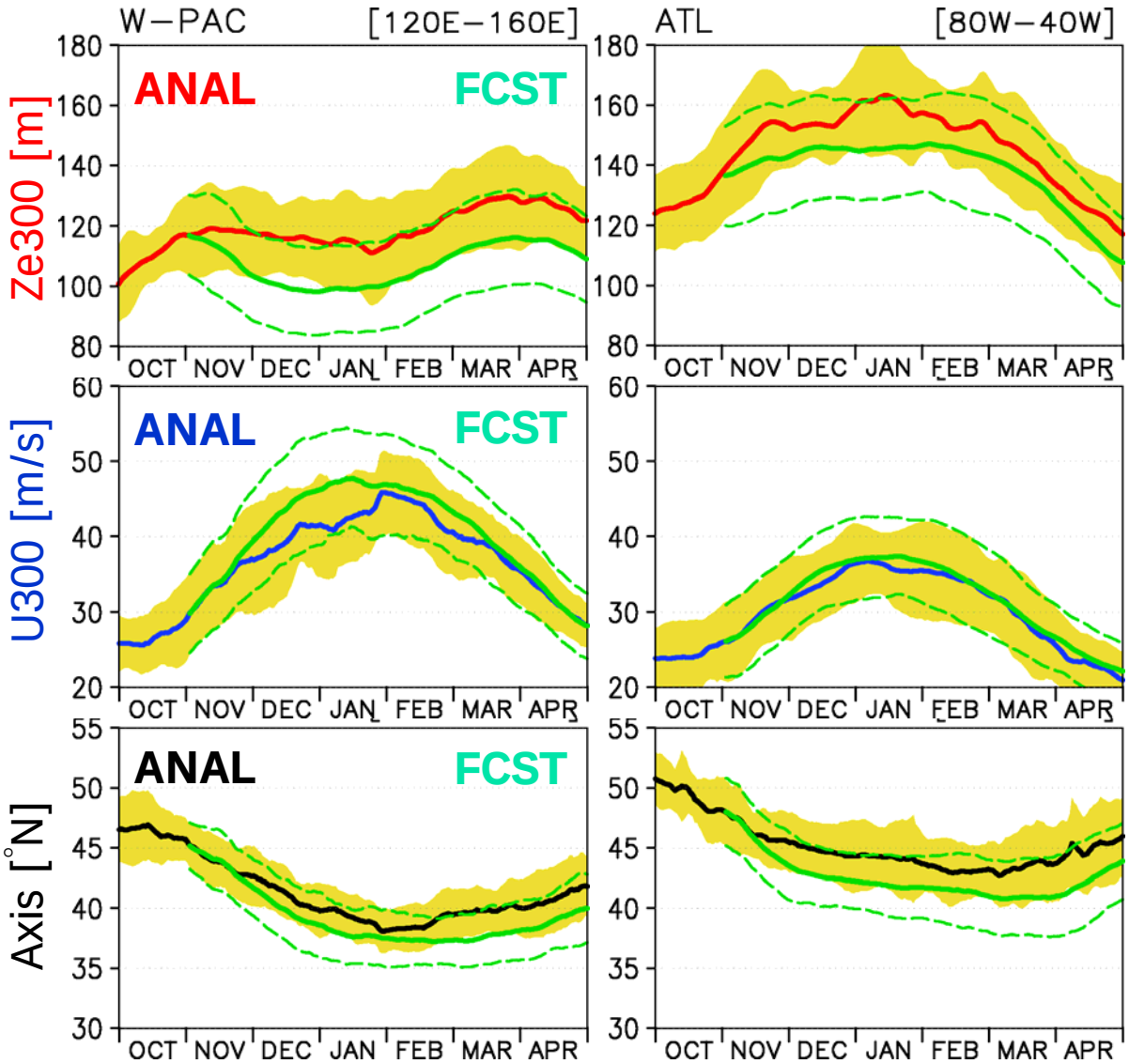
Anal vs. Fcst: average in Jan.(2)

- JMA's seasonal forecast model represent distribution of storm tracks well, however, there are some differences.

$\overline{V'T'}$850 (s) / E_H300 (v)

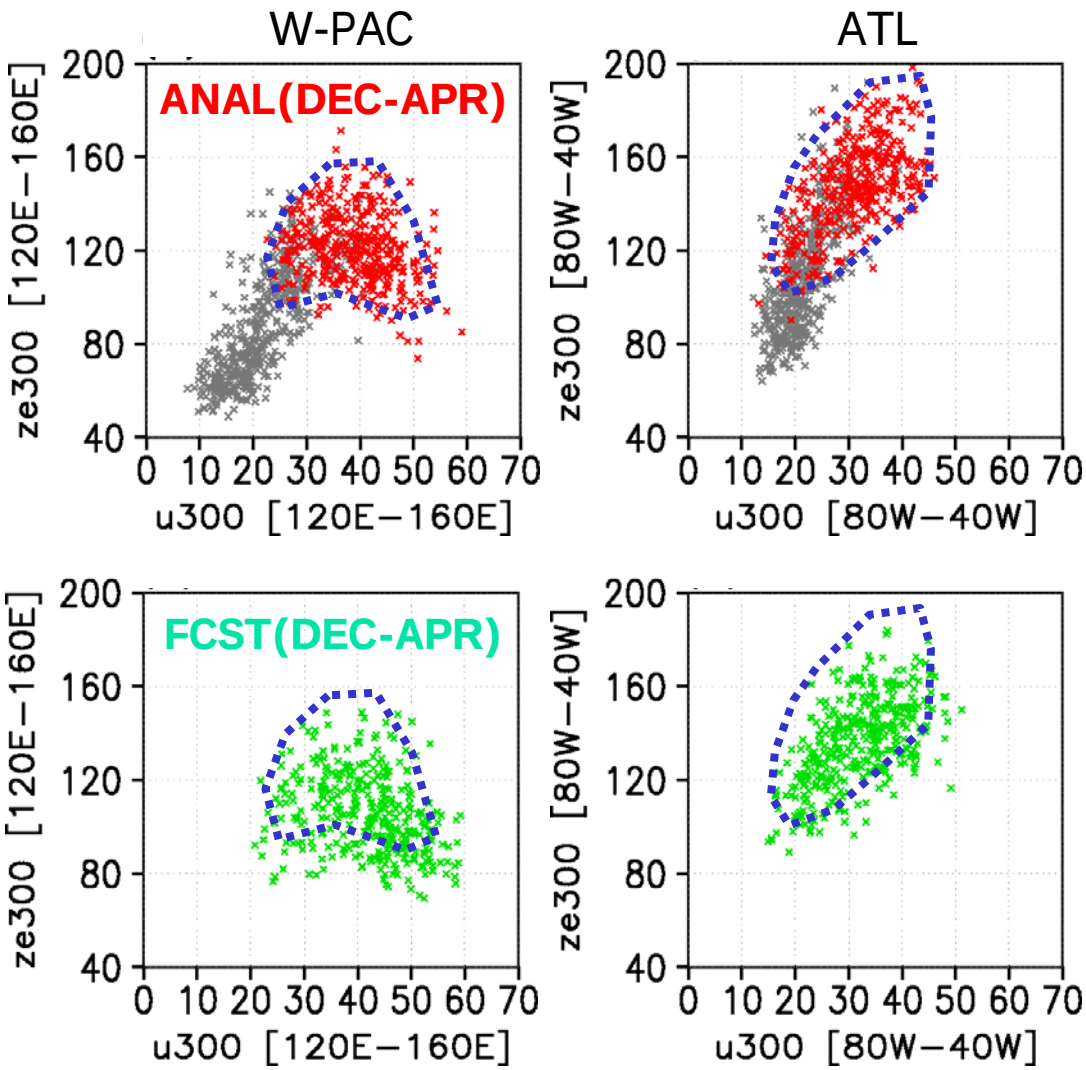


Anal vs. Fcst: seasonal change



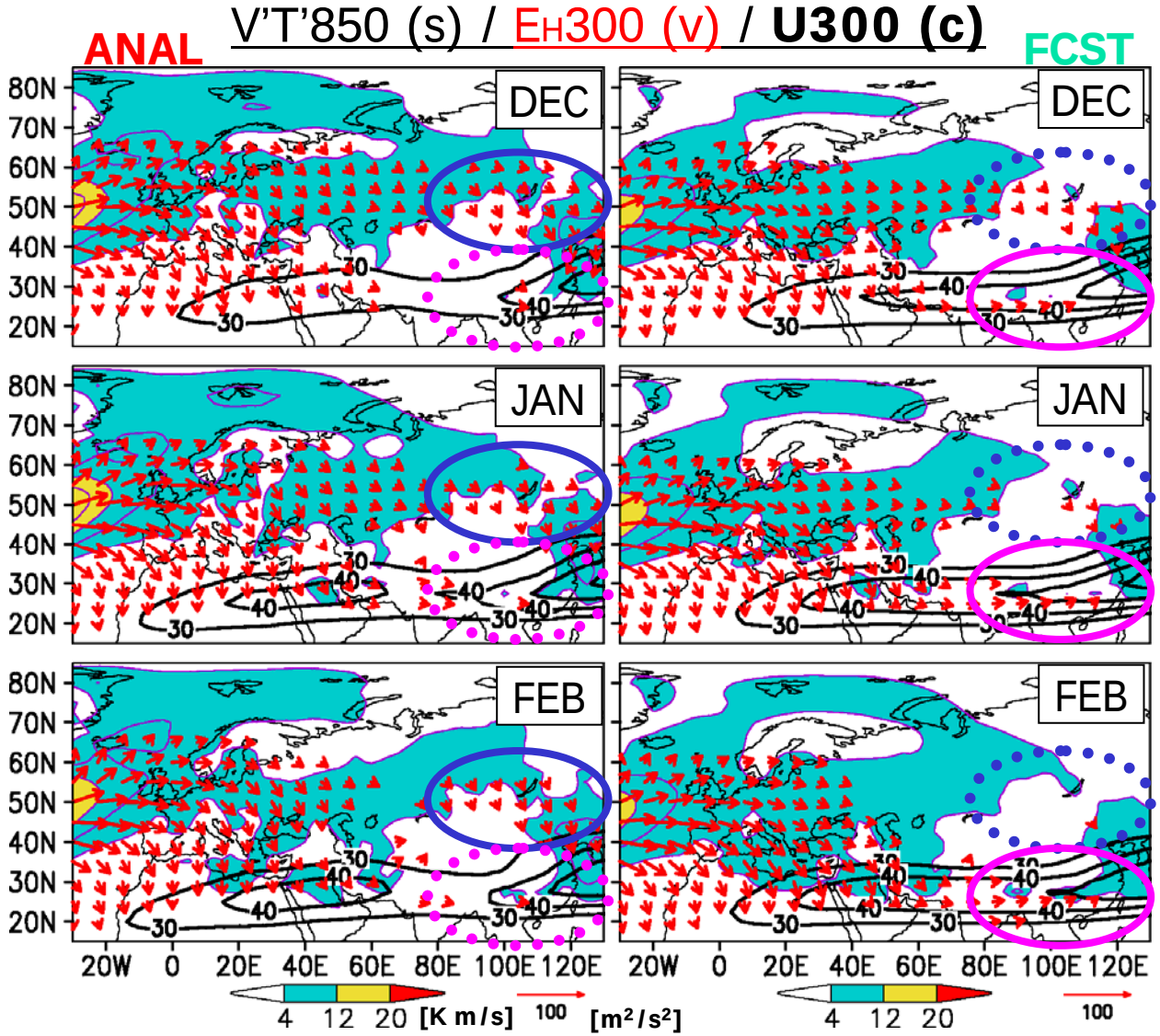
- In forecast,
  - Envelope function is **smaller**.
  - Mean westerly wind speed is **larger**.
  - Storm track shifts **southward**
  - Over Atlantic, seasonal change of envelope function becomes smaller.

Anal vs. Fcst: scatter diagram



- The distributions of scatters shift lower values of envelope function at each mean westerly wind speed.
- It suggests that synoptic-scale baroclinic eddy might difficult to grow in JMA's seasonal forecast model.

Anal vs. Fcst: over Eurasia

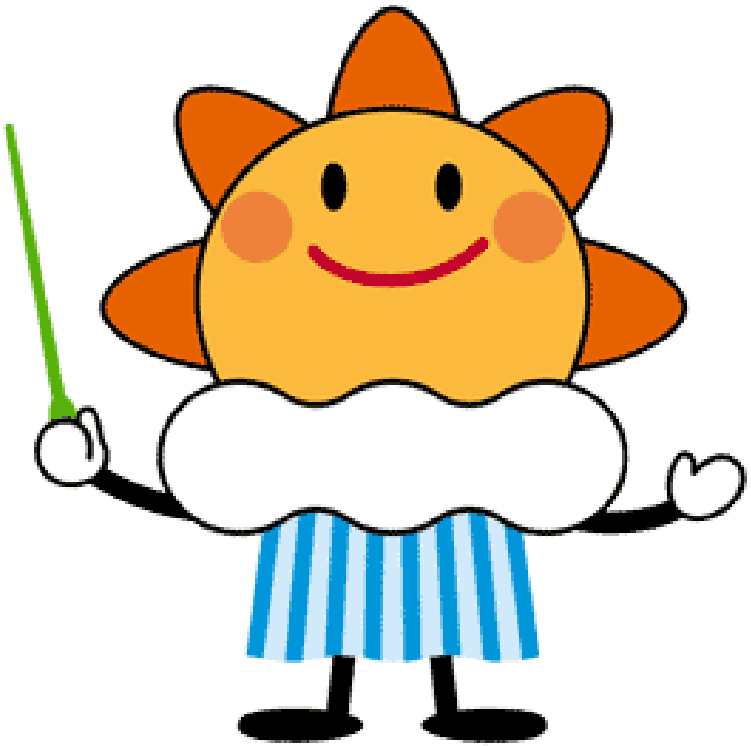


- The eddy propagation is observed in high latitude mainly over Eurasia in JRA-25, while it is in low latitude in forecast.
- This difference may influence not only the storm track activity over pacific but also the mean westerly wind fields locally.

Summary

- In the view of seasonal change, characteristics of storm tracks in JRA-25 are similar to previous studies using other analysis data sets.
- Roughly estimated, seasonal change of storm tracks in JMA's seasonal forecast model is in agreement with that in JRA-25.
- However, some differences are seen.
  - Smaller amplitudes, shift southward, etc.
- Reasons of these differences ?
  -> More examinations are needed.
- Next Issue: Interannual variability, predictability of storm track activity (strength, position, etc.), relation to individual cyclone activity, in CGCM ?

Thanks !



“Harerun”, JMA’s mascot