Interannual modulations of mesoscale oceanic imprints on the wintertime atmospheric boundary layer under the changing dynamical regimes of the KE

~ Atmospheric imprints of KE variability ~

→ Masunaga et al. (2016) (*J. Climate.*; under revision)

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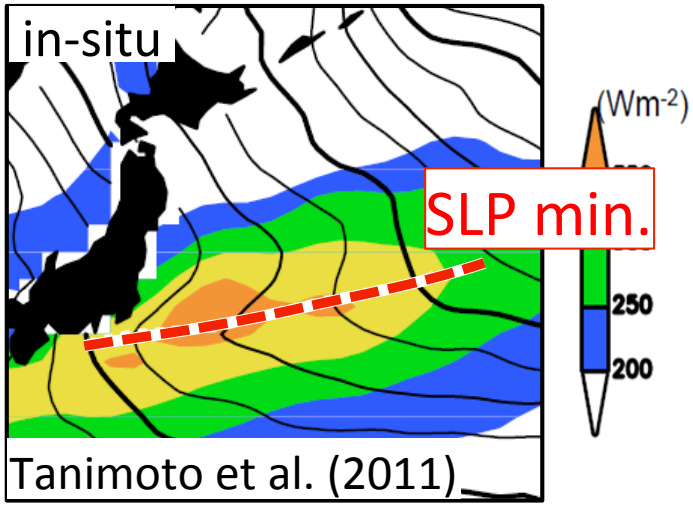
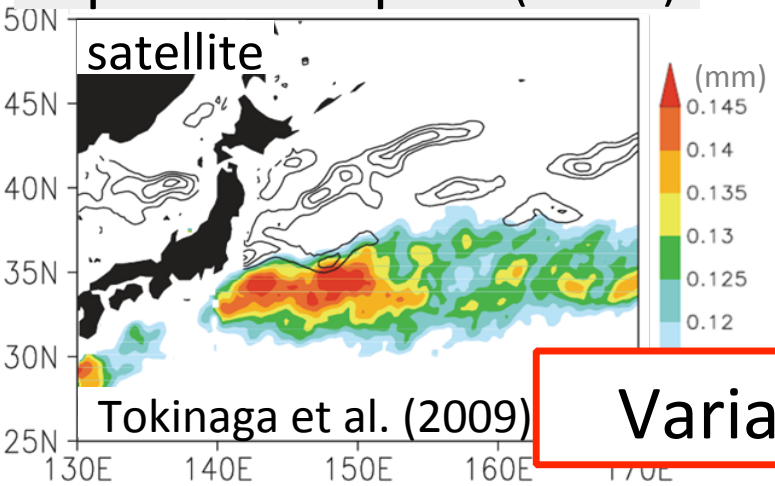
Climatological influence of KE on Atmospheric Boundary Layer

wintertime climatologies

SLP (contour)
sensible+latent heat fluxes (shade)



SST gradient (contour)
liquid water path (shade)



Under the monsoonal northerlies

Heat fluxes max. along the KE
↓
ABL is locally warmed
↓
Mesoscale SLP minimum

Hydrostatic effect (Lindzen and Nigam 1987)

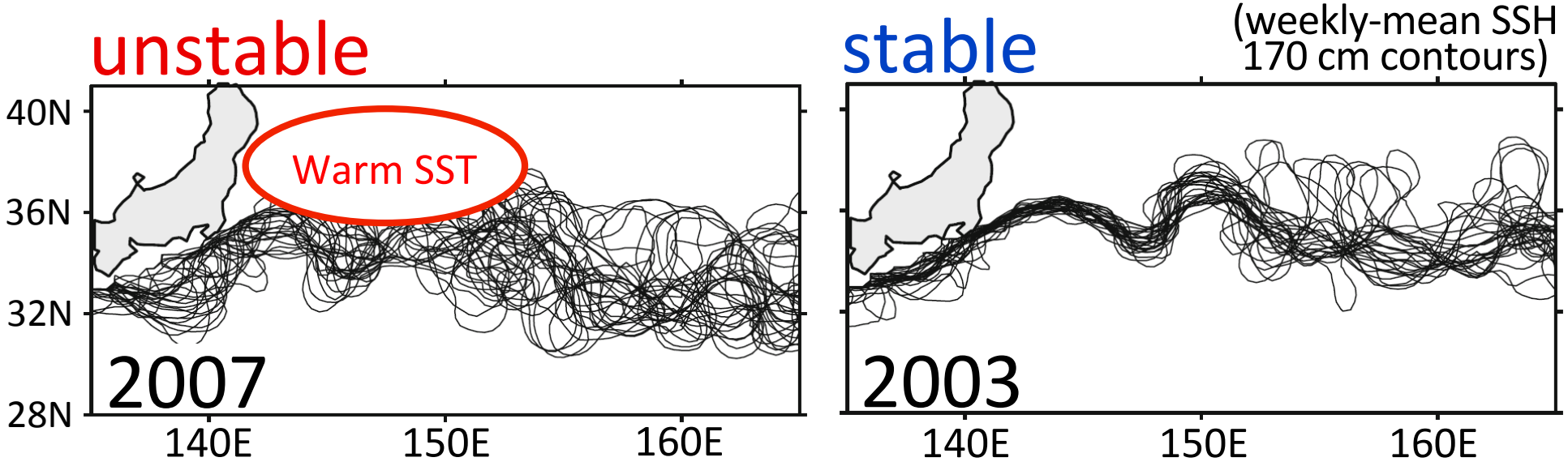
Vertical mixing effect (Wallace et al. 1989)

✓ Downward transport of wind momentum associated with local SST anomalies

Frictional surface wind convergence associated with the SLP minimum
↓
Local maximum of LW path along KE

Variability has not been investigated yet

Two regimes of KE path & purpose & methods



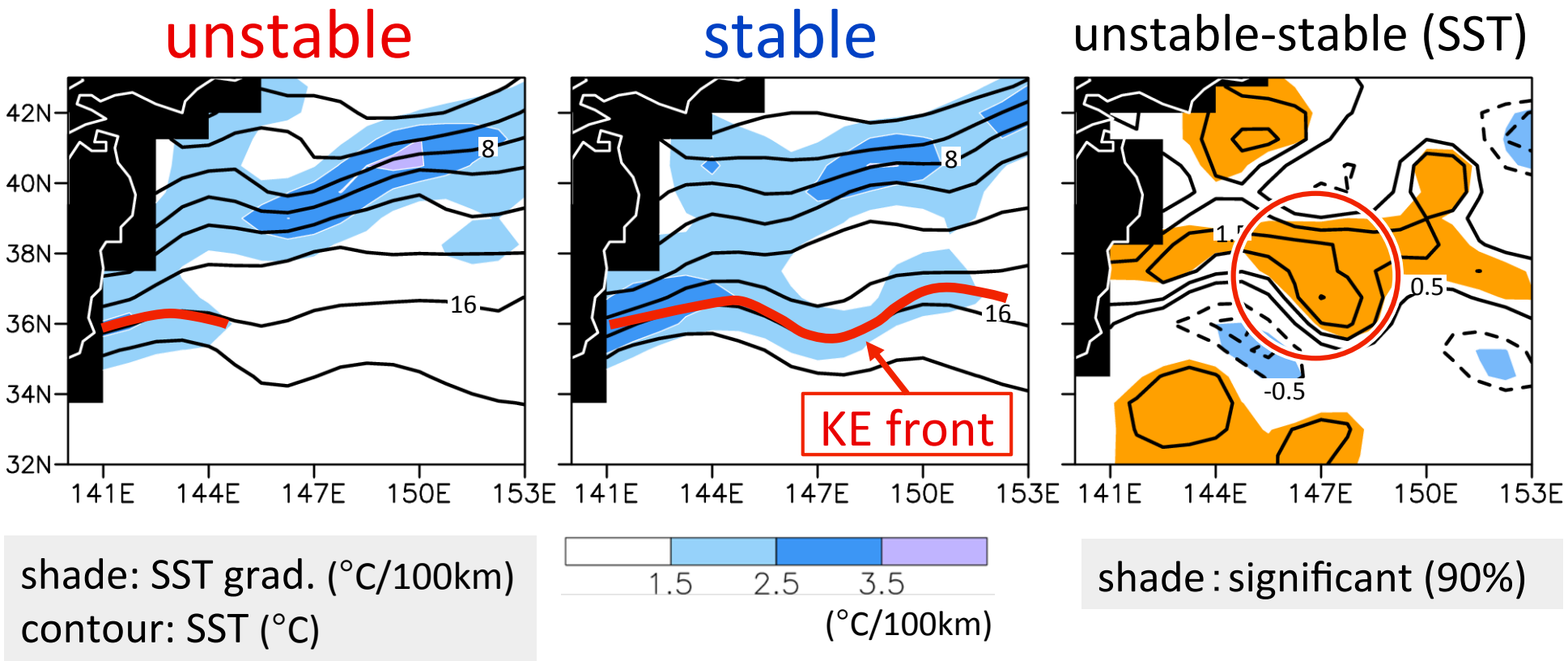
- KE path fluctuates between unstable/stable regimes
  (e.g., Qiu and Chen 2003,2005)
- Many warm eddies are shed from unstable KE
  → Warm SST anomalies to the north of mean KE axis
  (Sugimoto and Hanawa 2011; Sasaki and Minobe 2015)

The purpose of this study:
Atmospheric imprints of the KE variability in winter

Composited analysis based on **ERA-I data** (2002-2014; DJFM-mean)

✓ ERA-I (1979-2001) uses low-resolution SST (discuss later)

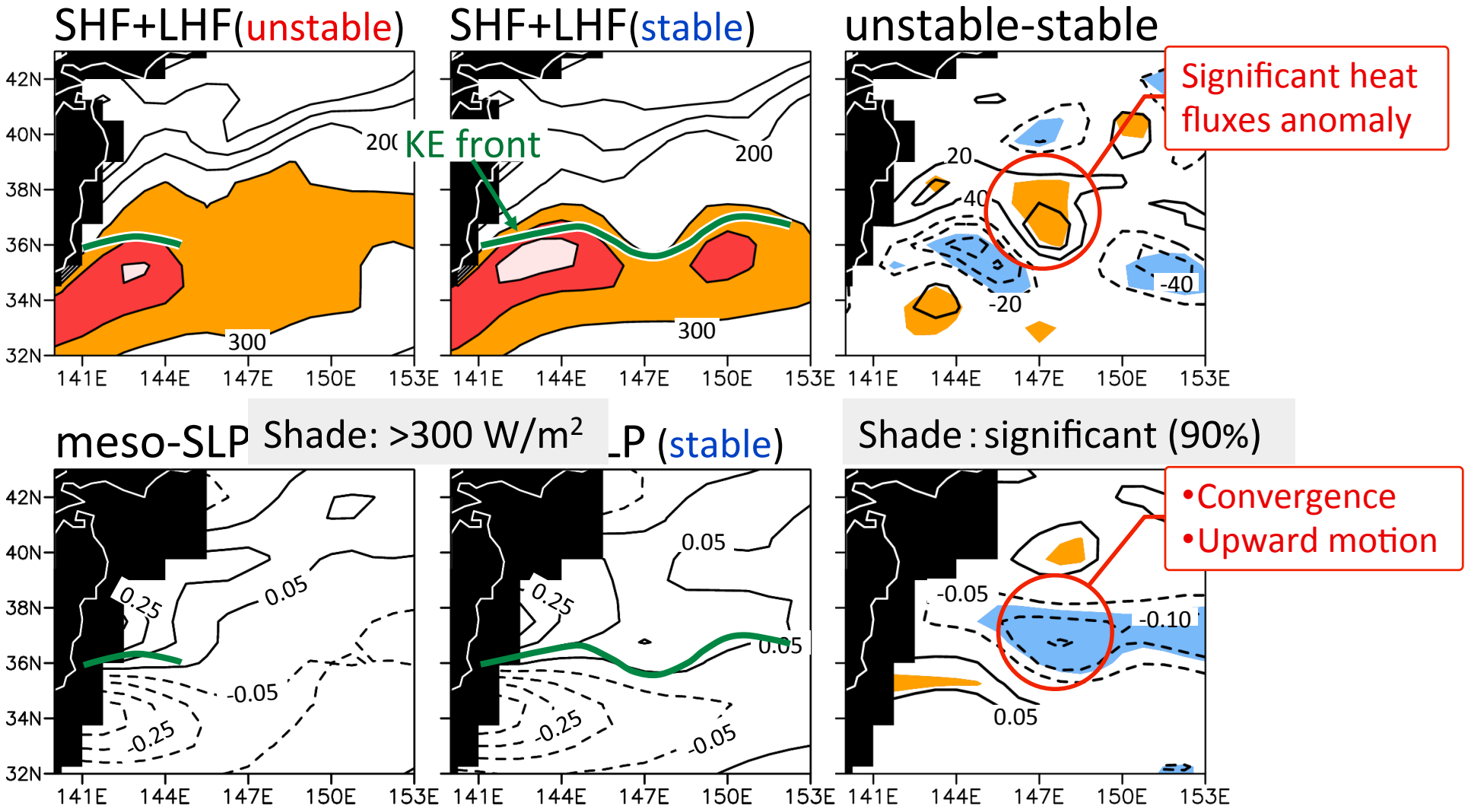
Composite | SST & SST gradient



- ✓ Grid intervals are 0.75°×0.75°
- ✓ unstable (4 winters), stable (9 winters) for 2002-14 (Qiu et al. 2014)

- ■ Distinct KE front only in stable KE regime
- ■ Significant warm SST anomalies in unstable KE regime, consistent with previous studies

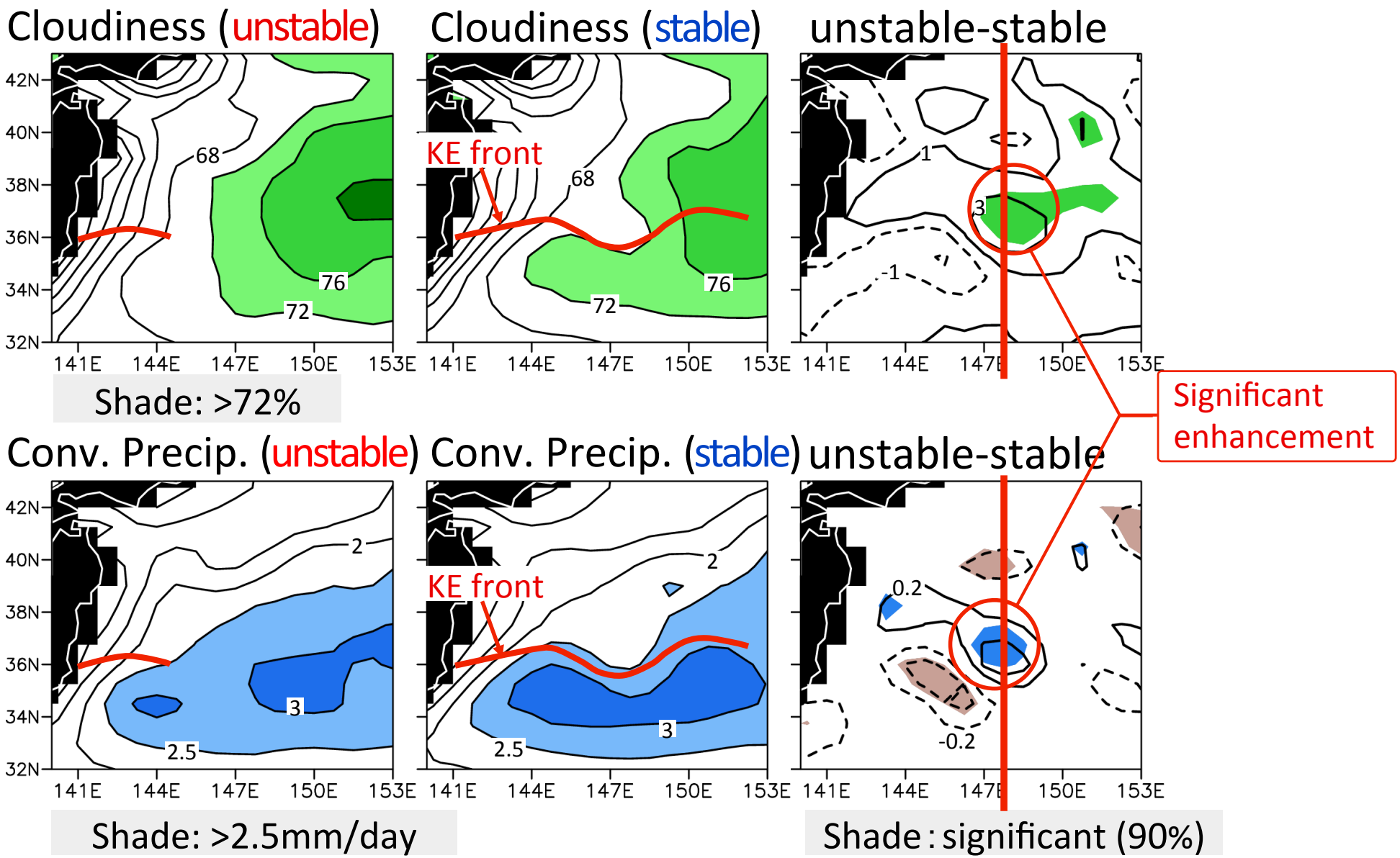
Composite | turbulent heat fluxes & meso-SLP



✓ **meso-**: deviation from latitudinal 7° running-mean

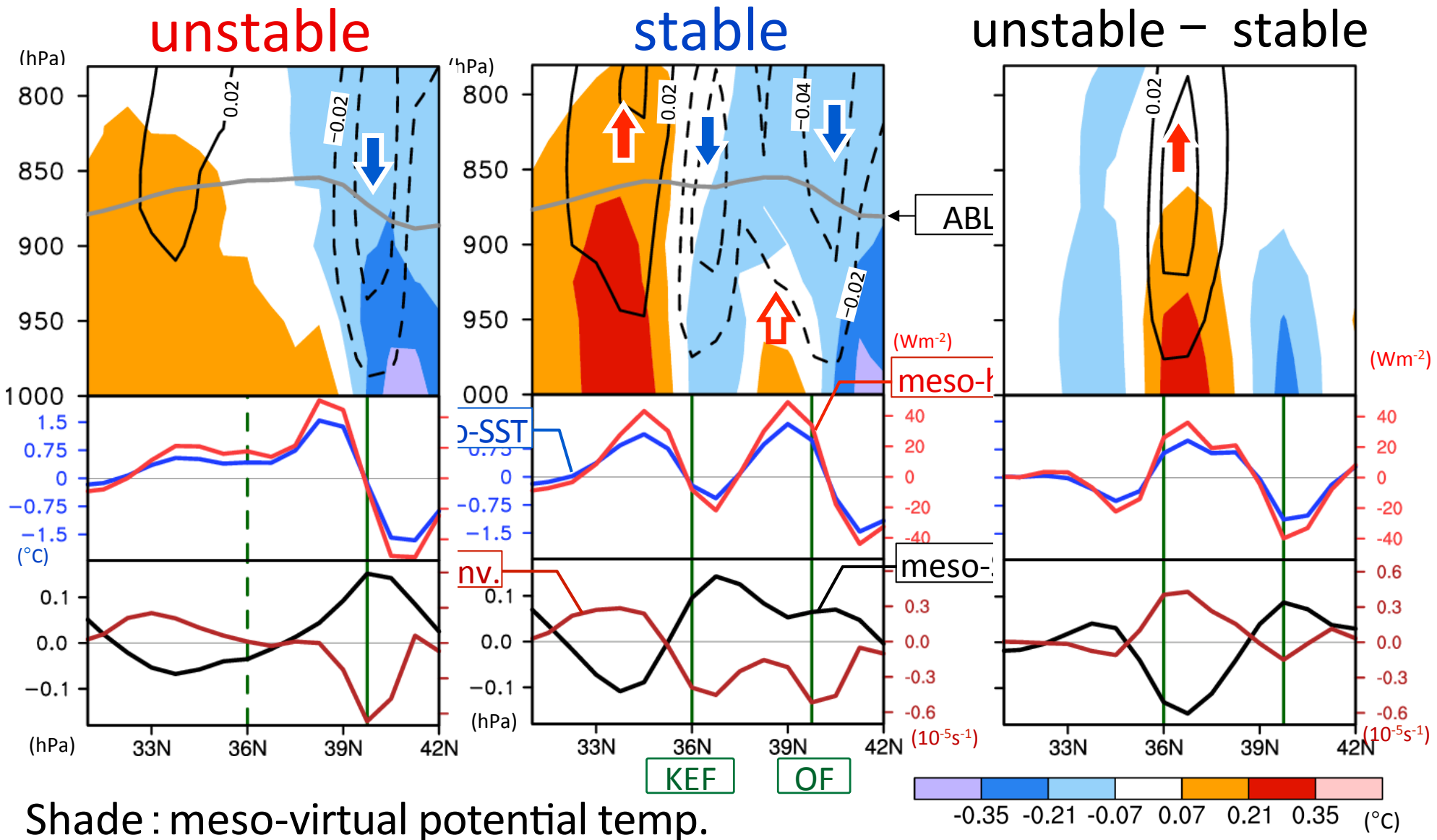
- Cyclonic **meso-SLP** anom. coincide with upward **heat fluxes** anom.
- **Sfc. wind convergence** and **upward motion** are also enhanced

Composite | cloudiness & convective precipitation



KE can modulate mesoscale cloudiness & precipitation fields

Composite | latitudinal sections



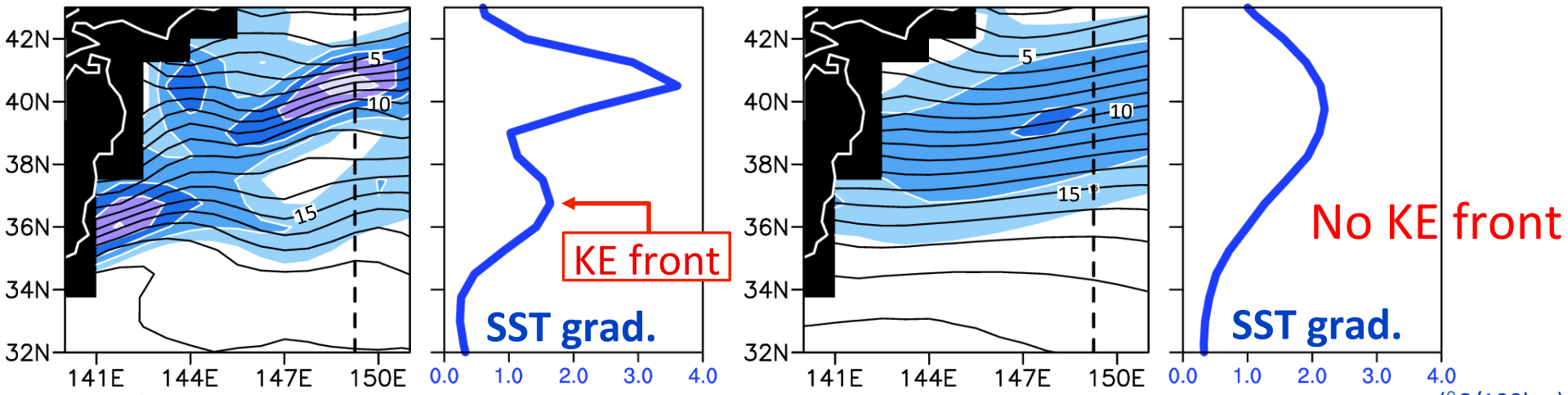
Shade : meso-virtual potential temp.

- The KE variability can vary mesoscale atmospheric fields within ABL
- Modulation in **hydro.** & **mixing effects** (Masunaga et al. 2016; under revision)

SST prescribed for the ERA-Interim

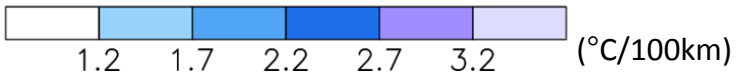
2002-2014 (13 years) DJFM
SST resolution: **0.5° or finer**

1979-2001 (23 years) DJFM
SST resolution: **1.0°**



✓Resolution of prescribed SST has been improved

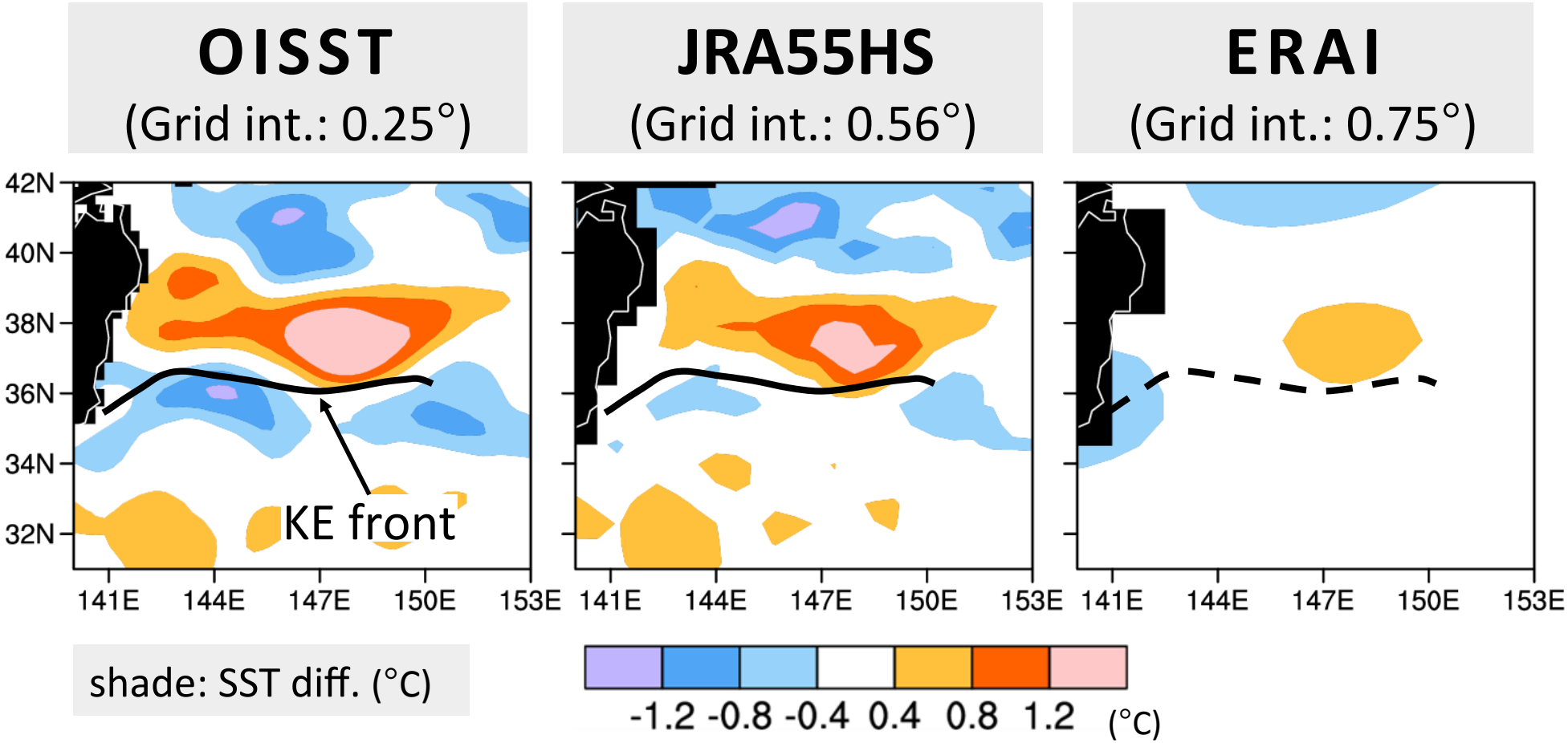
shade: SST grad. (°C/100km)
contour: SST (°C)



In our latest study (→ Masunaga et al. 2015, *J. Climate*)
The SST resolution change has significant impact on climatological-mean mesoscale atmospheric fields

Comparison between **JRA-55HS** and **ERA-I** for **1989-1999**
Unstable (5 winters), Stable(4 winters)

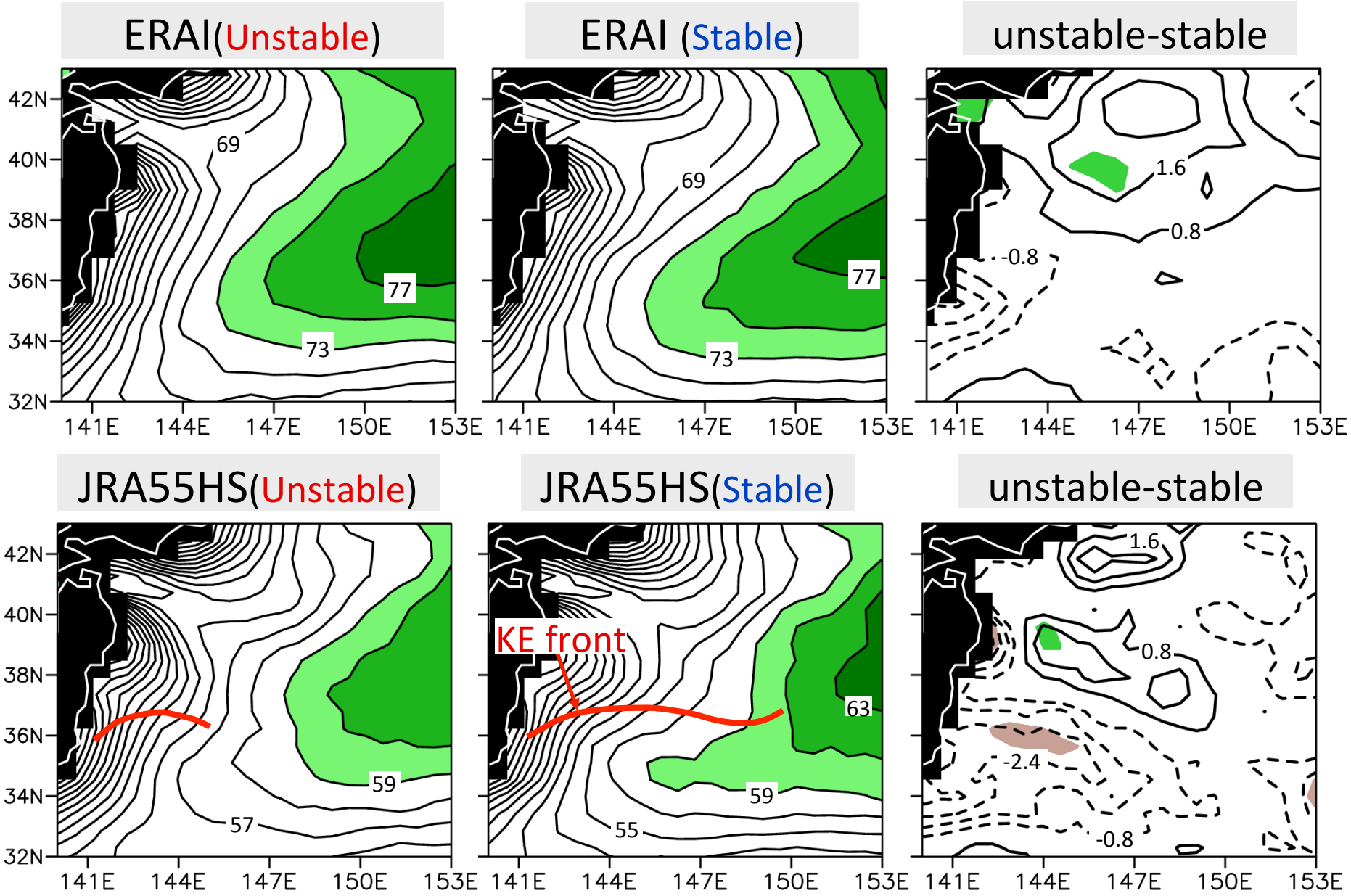
Composited **SST** difference (unstable-stable) **1989-99**



✓ unstable (5 winters), stable (4 winters) (Qiu et al. 2014)

- Much weaker SST difference in ERAI SST
- JRA55HS SST is consistent with OISST

Composites | Total cloudiness (**1989-99**)



- ERAI(1989-1999) does not resolve meso-scale structure

Summary

Composite analysis for the KE variability based on the ERA-I (High-res. SST)

- Warm SST anomalies to the north of mean KE front in unstable KE regime
- Mesoscale atmospheric fields show significant anomalies associated with the KE variability
  → modulation of “hydrostatic effect” and/or “mixing effect”
- Satellite data overall show consistent anomaly patterns (not shown)

Comparison between ERA-I(Low-res. SST) and JRA-55HS

- ERA-I(Low-res. SST) is not similar to JRA-55HS

  → Importance of high-resolution SST data for atmospheric reanalysis