



Intercomparison of Tropospheric and Stratospheric Mesoscale Kinetic Energy Resolved by the High-Resolution Global Reanalysis Datasets

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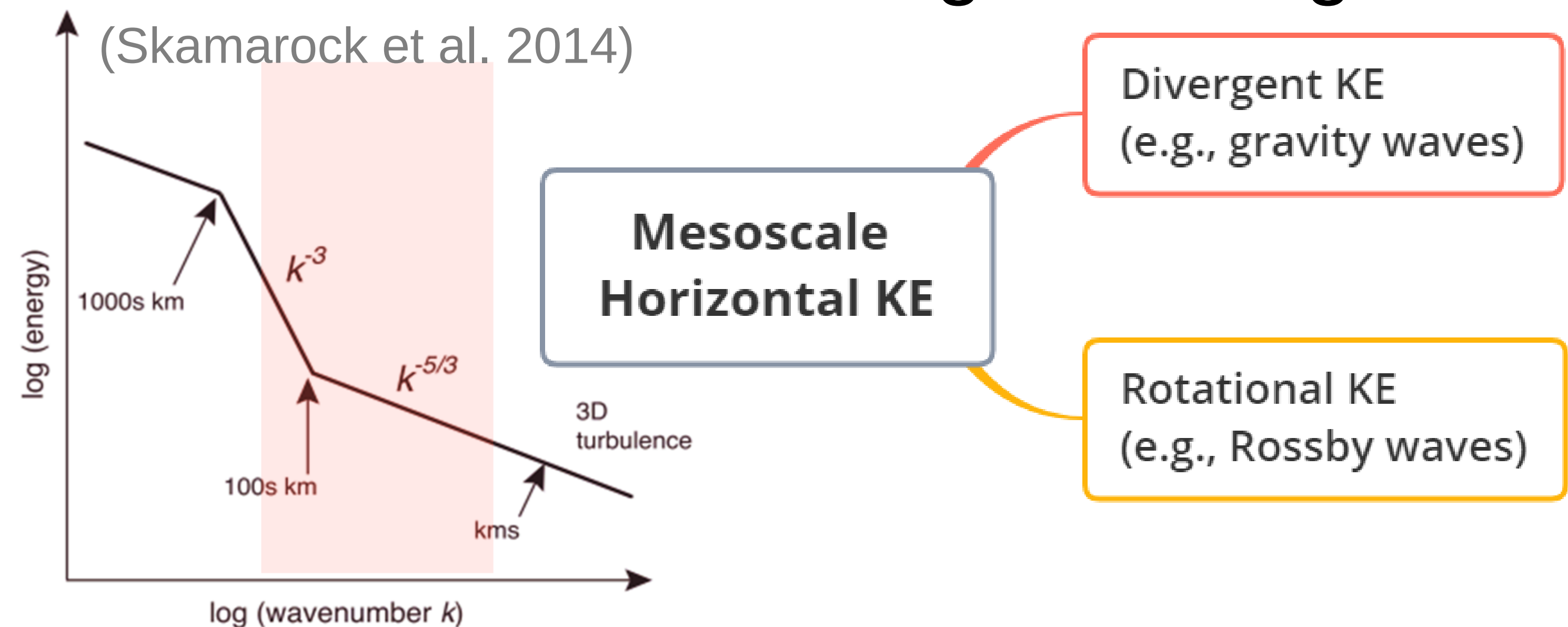
Y. Qiang Sun Rice University

Background

Modern high-resolution global reanalysis datasets could partly resolve mesoscale.

	ERA5	CRA	MERRA2	CFSv2	JRA-55	ERA-I
Horizontal grid	0.25*0.25 (~ 30km)	0.25*0.25 (~ 30km)	0.5*0.625 (~ 60km)	0.5*0.5 (~ 60km)	1.25*1.25 (~ 150km)	0.75*0.75 (~ 90km)
Model resolution	T639 L137	T574 L64	L72	T574 L64	T319 L60	T255 L60
Model top	0.01hPa	0.27hPa	0.01hPa	0.266hPa	0.1hPa	0.1hPa
Data assimilation	4D-Var	3D-Var	3D-Var	3D-Var	4D-Var	4D-Var

Large uncertainties remain at mesoscale, but a clear understanding is lacking.



- What are the distinctions among these leading reanalysis datasets on mesoscale?

Methodology

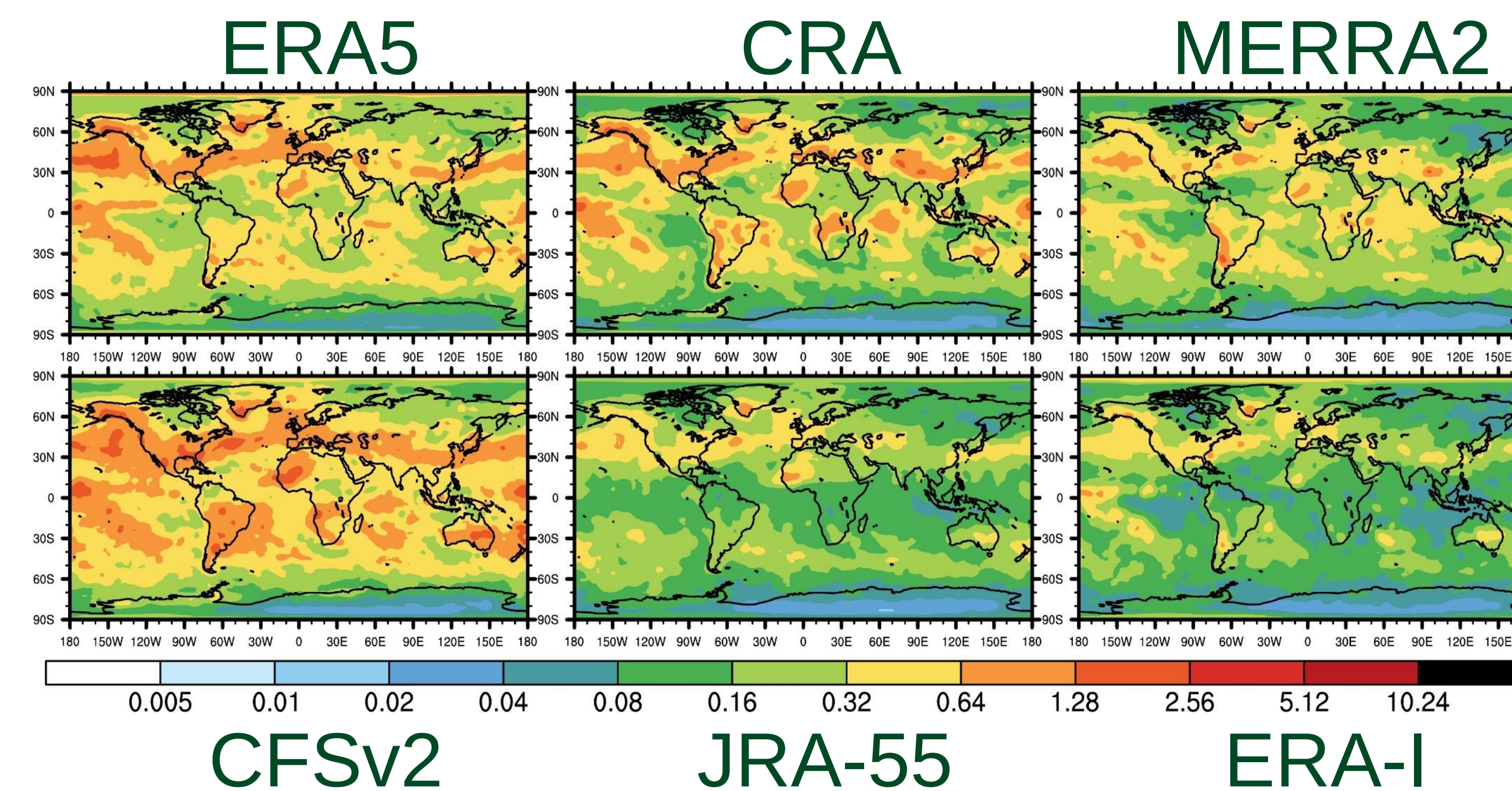
Mesoscale KE $E = \frac{1}{2} \rho_0 (\overline{u'^2} + \overline{v'^2})$

- Helmholtz decomposition $u = u_{DIV} + u_{ROT}$
- Spherical harmonic transform
- Spatial smoothing $\overline{u'_{DIV}} = \overline{u_{DIV}} - (\overline{u_{DIV}})_{ST_{k \leq 40}}$
 $\overline{u'^2_{DIV}} = (\overline{u'^2_{DIV}})_{Boxcar_smth}$

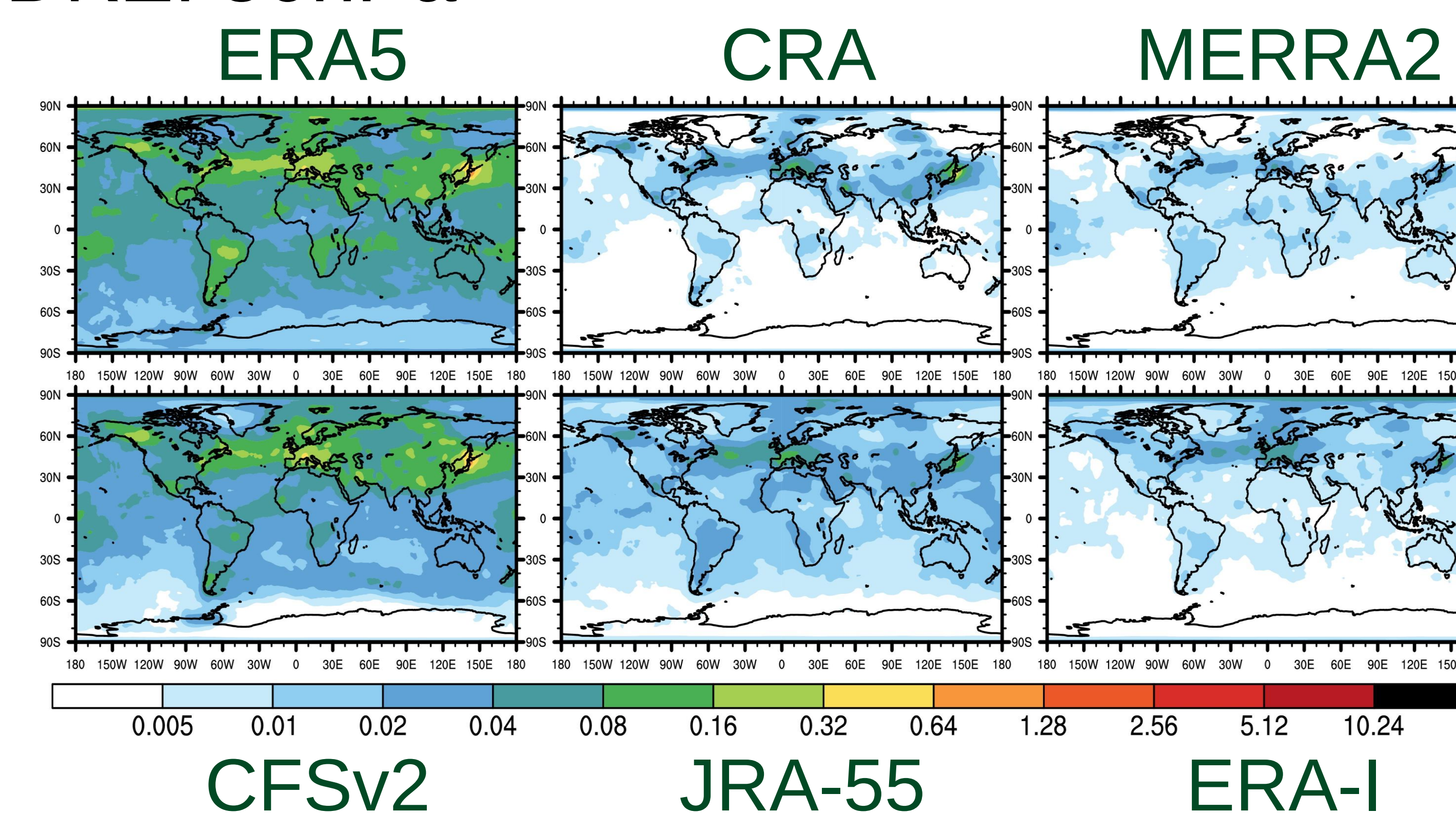
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Distribution of mesoscale KE

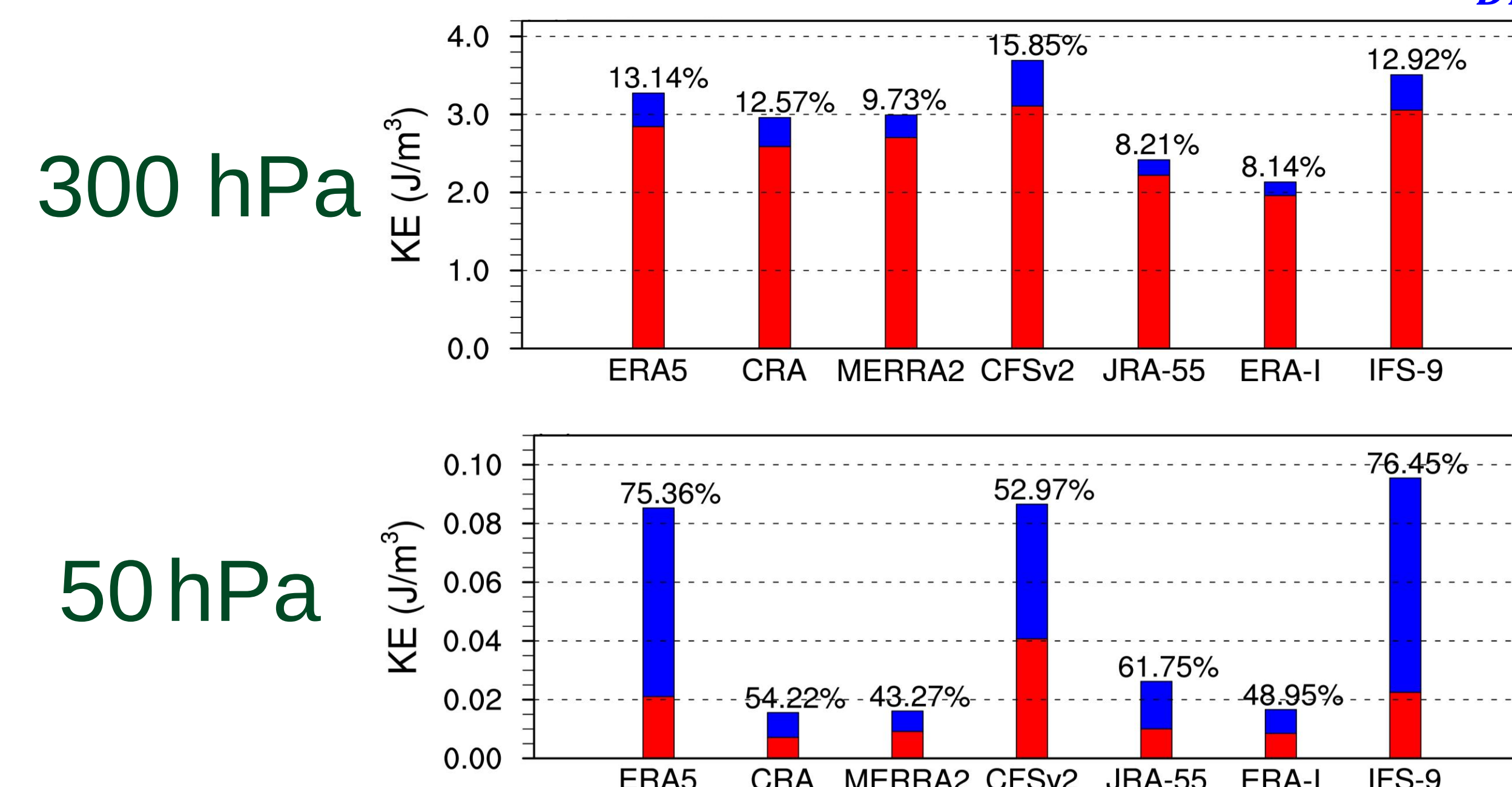
DKE: 300hPa



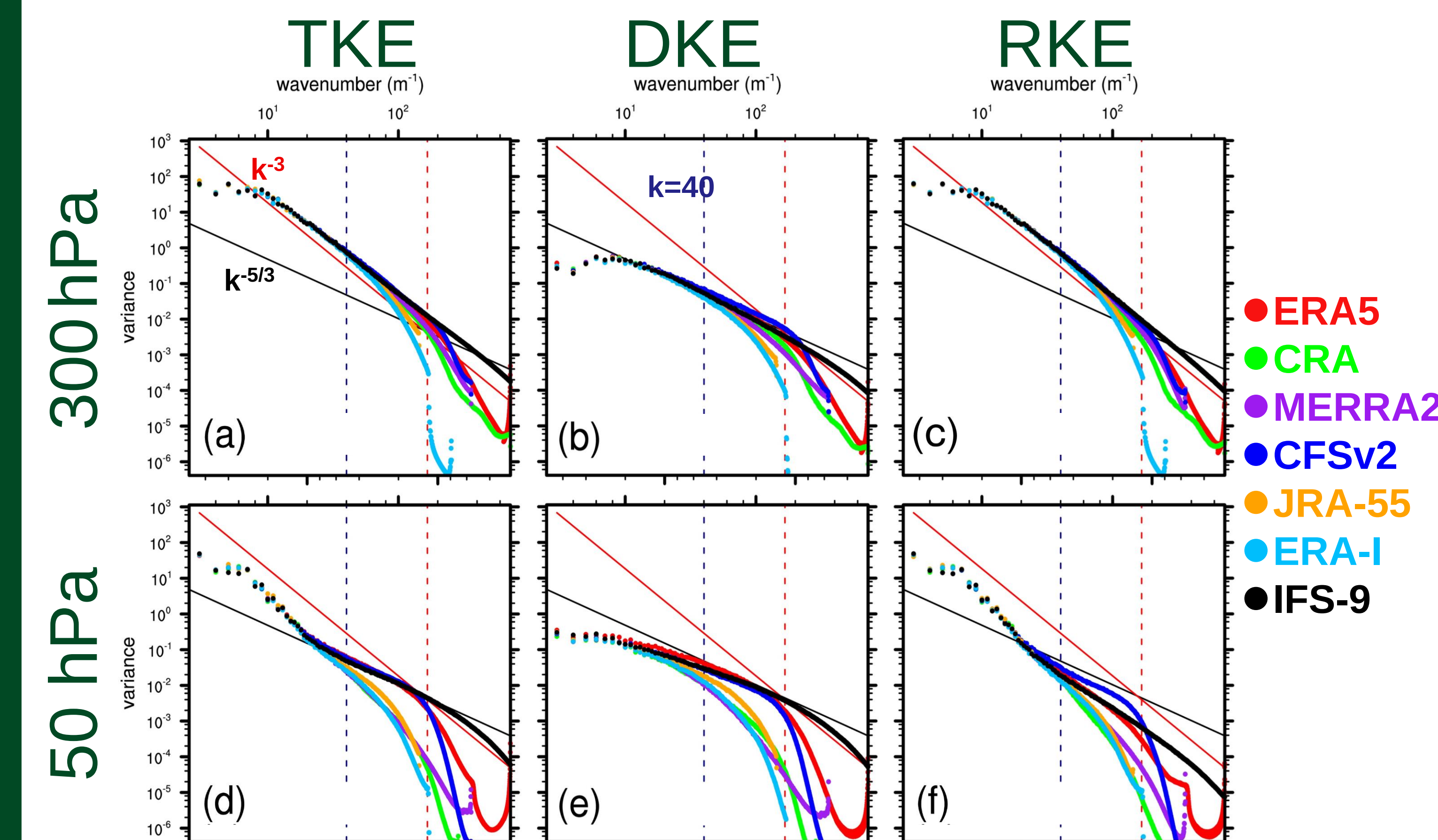
DKE: 50hPa



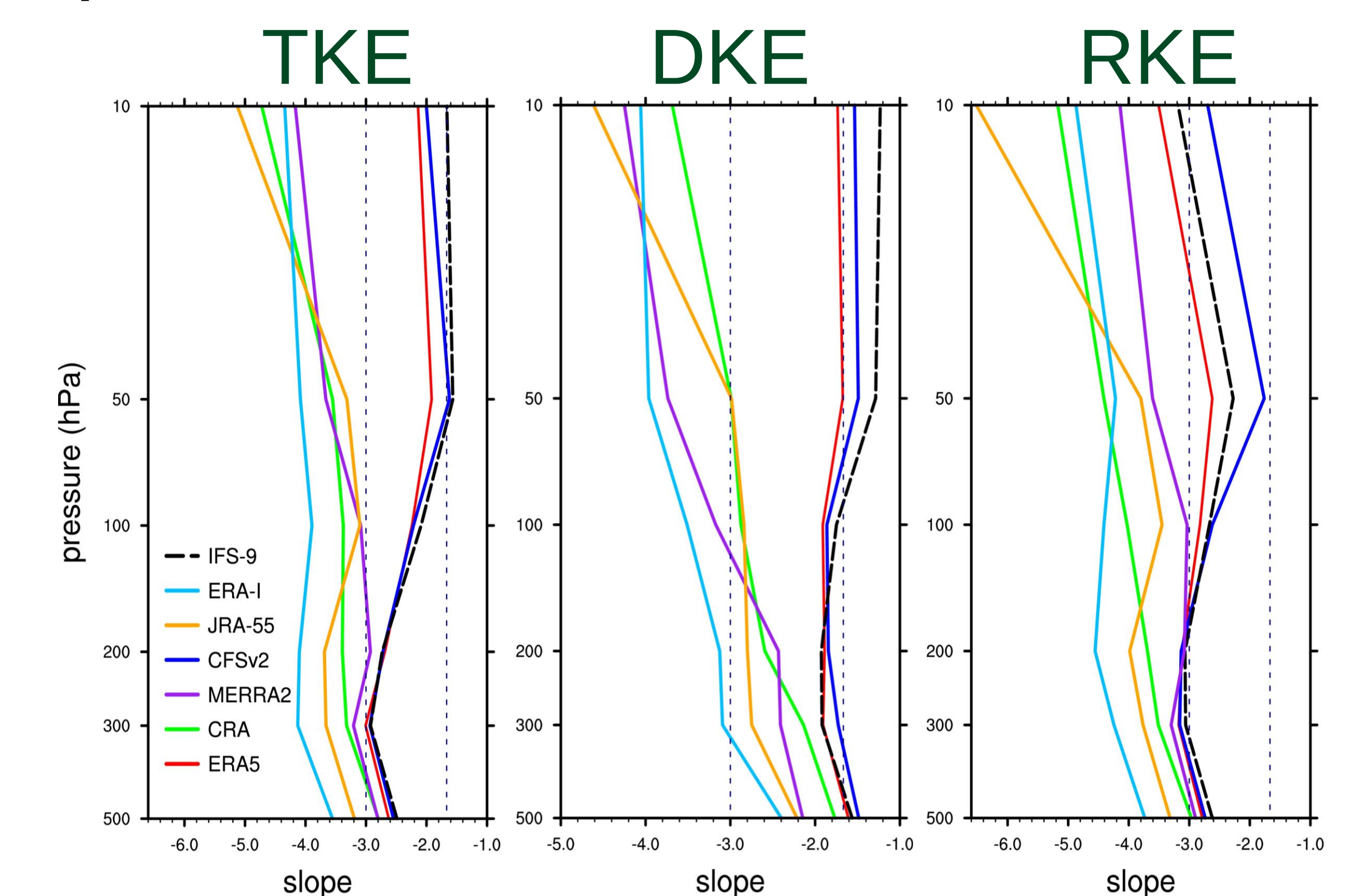
Contribution of DKE and RKE %: $\frac{DKE}{DKE+RKE}$



Distribution of KE spectrum



Slope: k between 40 and 100



Regional correlation

	ERA5	CRA	MERRA2	CFSv2	JRA-55	ERA-I
60°N-90°N	1***	0.901***	0.888***	0.911***	0.874***	0.894***
35°N-50°N	1***	0.590***	0.628***	0.551***	0.674***	0.819***
10°S-10°N	1***	0.101	0.194	0.439***	-0.032	0.195
35°S-50°S	1***	0.752***	0.777***	0.600***	0.795***	0.660***
60°S-90°S	1***	0.878***	0.790***	0.899***	0.834***	0.795***

Note: ***, **, * represent 1%, 5%, 10% significance levels, respectively

Take-home Messages

- The ability to capture mesoscale signals is strongly influenced by resolution, but it is also related to other factors.
- Only ERA5 and CFSv2 can reproduce observed KE spectrum in the stratosphere.
- Differences increase with height, more pronounced in the divergent component.