

Dynamical Downscaling: Assessment of model system dependent retained and added value

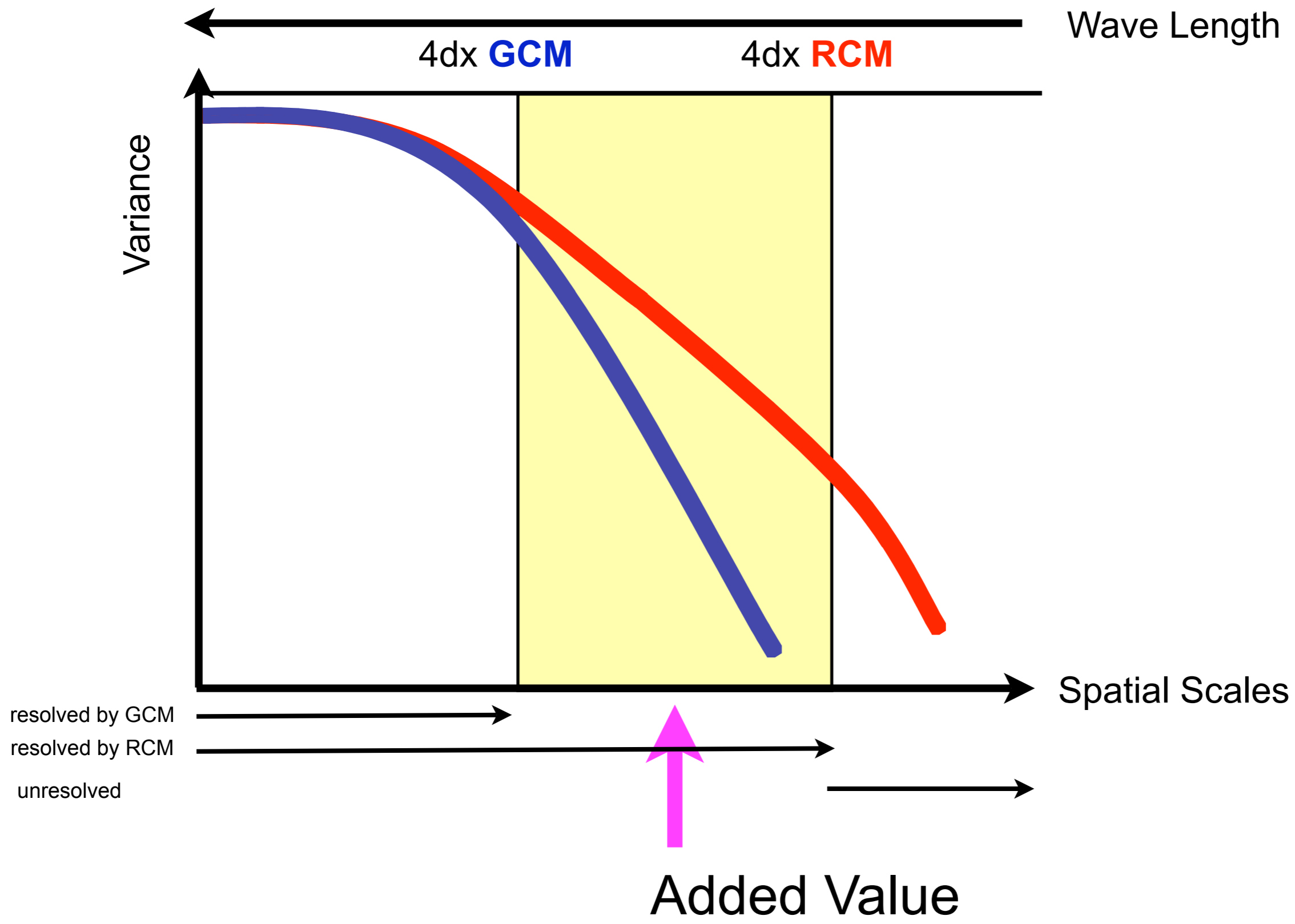
Burkhardt Rockel
GKSS Forschungszentrum Geesthacht

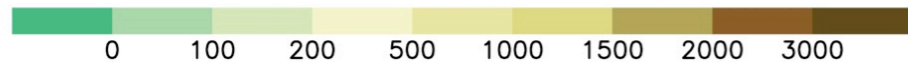
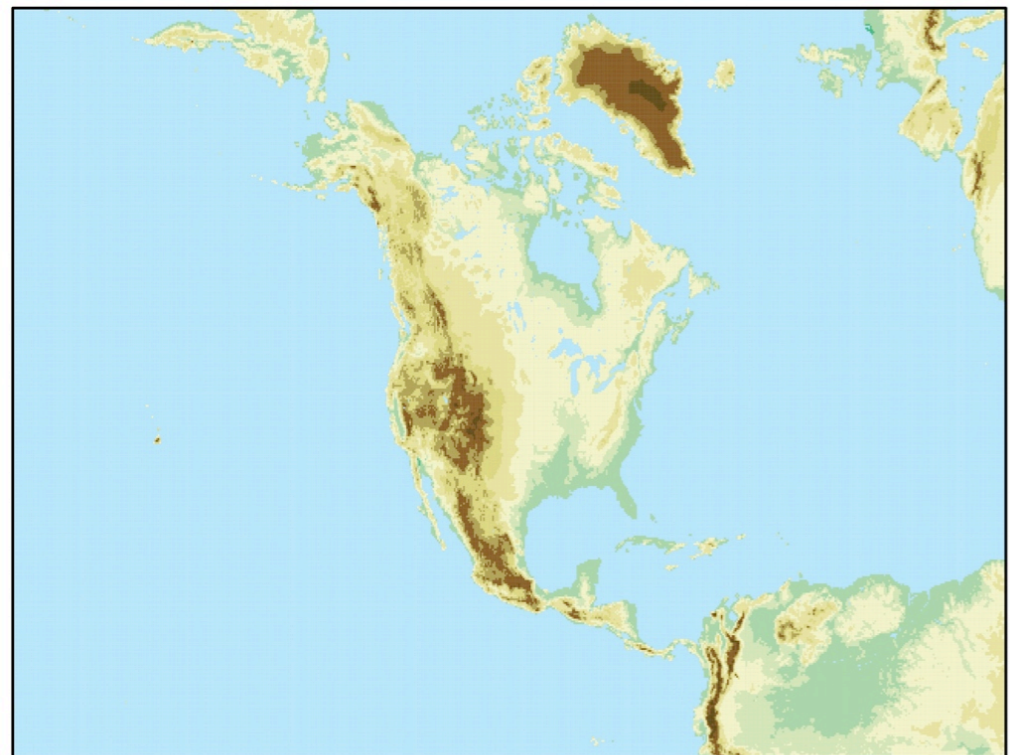
Dynamical downscaling as „poor man's“ regional reanalysis

- hindcasting by downscaling global reanalysis (e.g. ERA40, NCEP-Reanalysis)

Aim

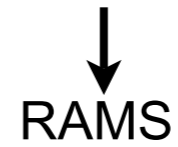
- retain value of global reanalysis at large scales (i.e. scales that can be resolved by the global reanalysis; features larger $4dx$)
- add value at smaller scales





Castro et al. 2005: Dynamical downscaling .., JGR

NCEP Reanalysis 2.5 x 2.5 degrees



RAMS

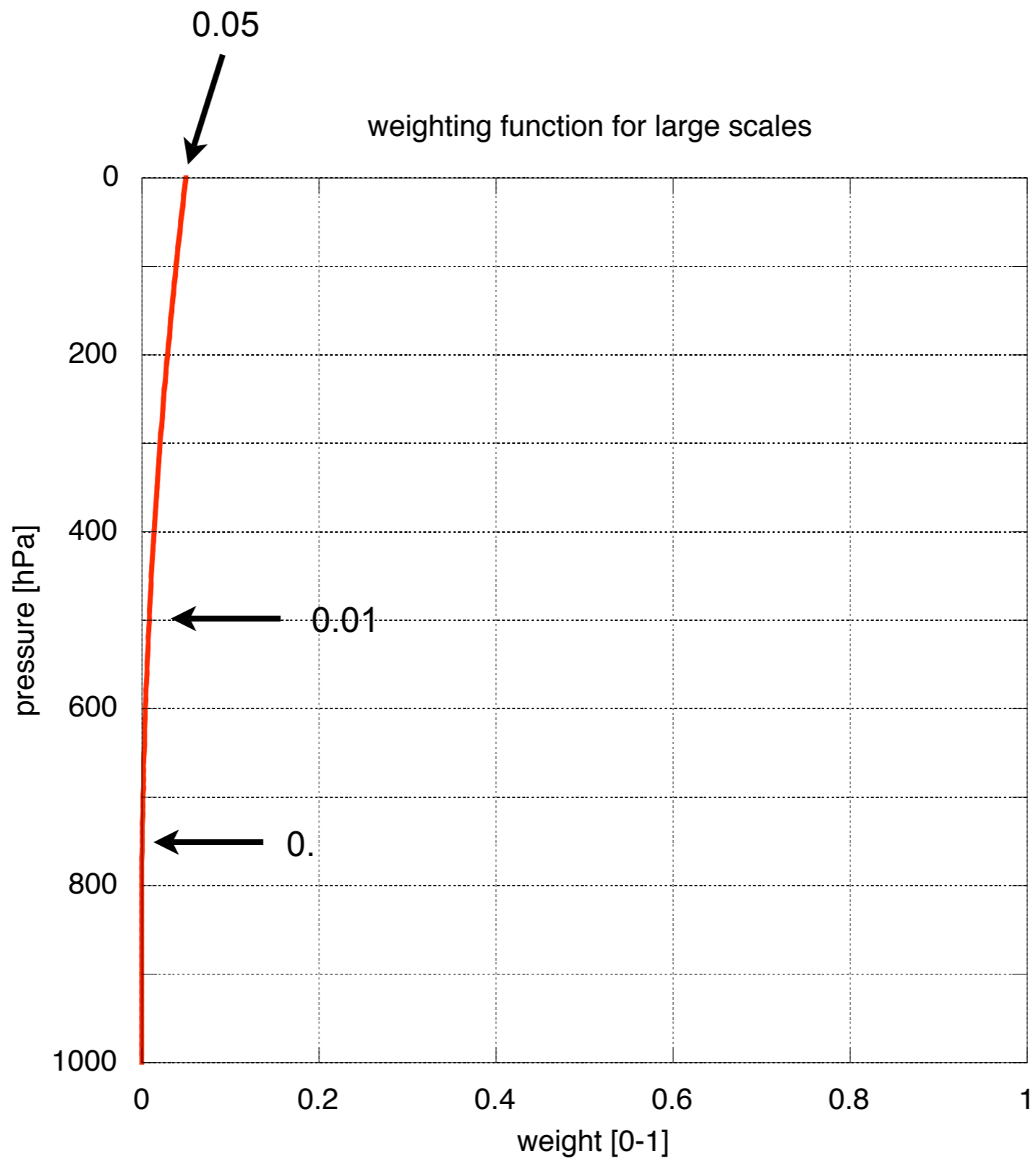
Experiments:

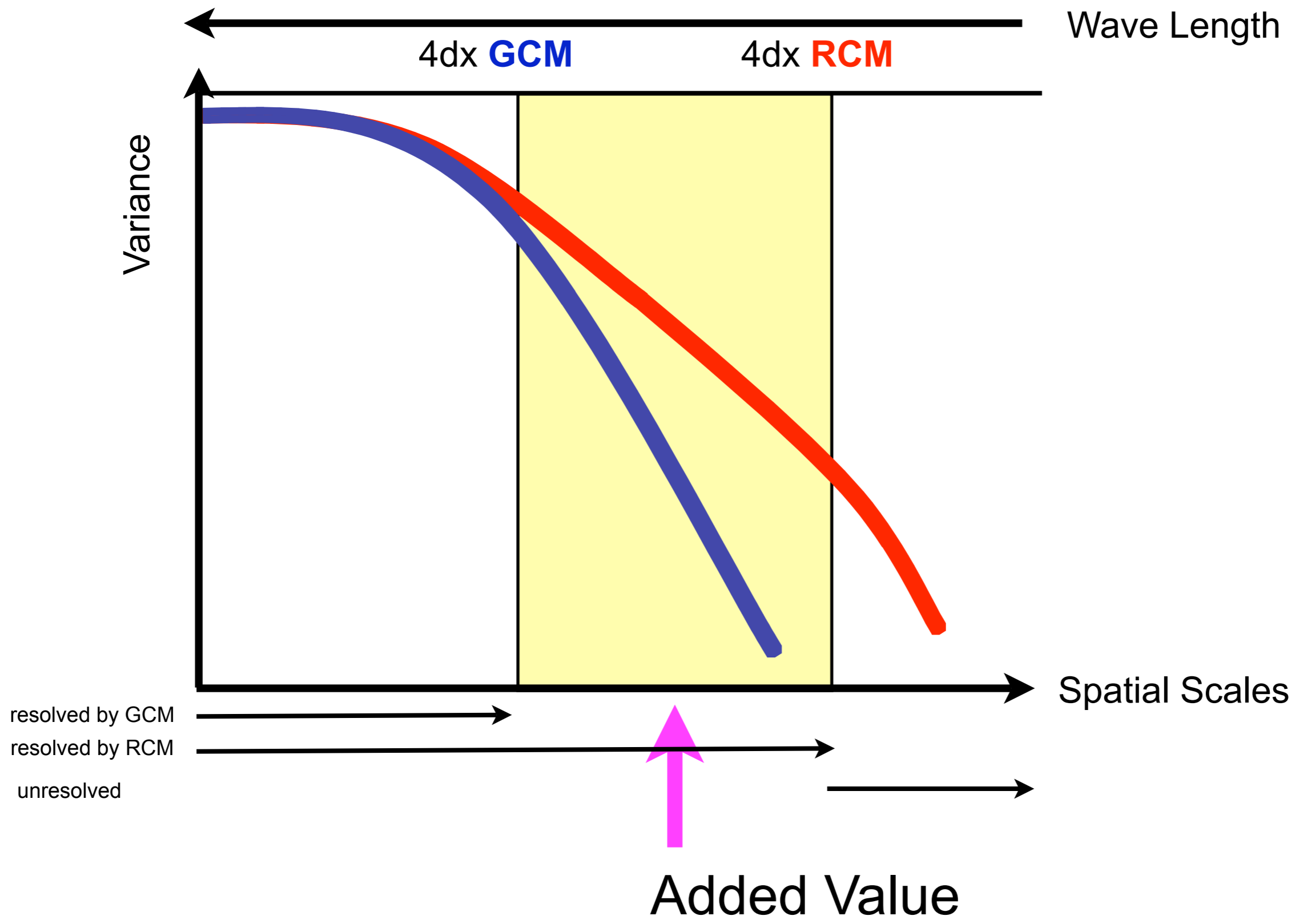
- May 1993 continuous simulations
- Grid meshes: 200, 100, 50 km
- Small and large domain
- Traditional and internal nudging

Does CLM give similar results?

Simulation period: May 1993 / Continuous Run

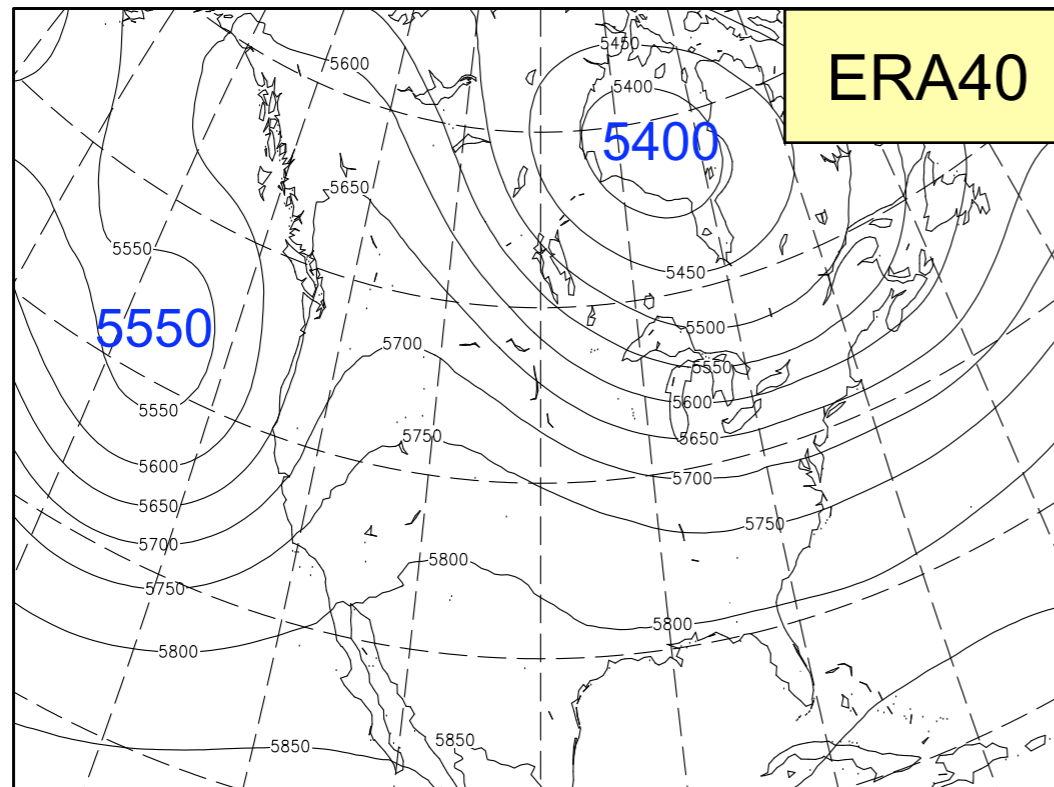
RAMS	CLM (version 2.4.9)
<p>Horizontal grid mesh sizes</p> <p>NCEP (dx ~ 278km)</p> <p>RAMS (dx 200, 100, 50 km)</p> <p>GPs 40x25 to 320x200</p>	<p>Horizontal grid mesh sizes</p> <p>ERA40 (dx ~ 125 km)</p> <p>CLM (dx 100, 50, 25 km)</p> <p>GPs 80x50 to 640x400</p>
<p>Interior Nudging</p> <p>grid nudging</p> <p>all prognostic variables, all wavelengths</p>	<p>Interior Nudging</p> <p>spectral nudging (lspecnudge=.true.)</p> <p>U, V, wavelengths larger 4dx (1000 km)</p> <p>alpha_sn = 0.05 / pp_sn = 850 hPa</p>



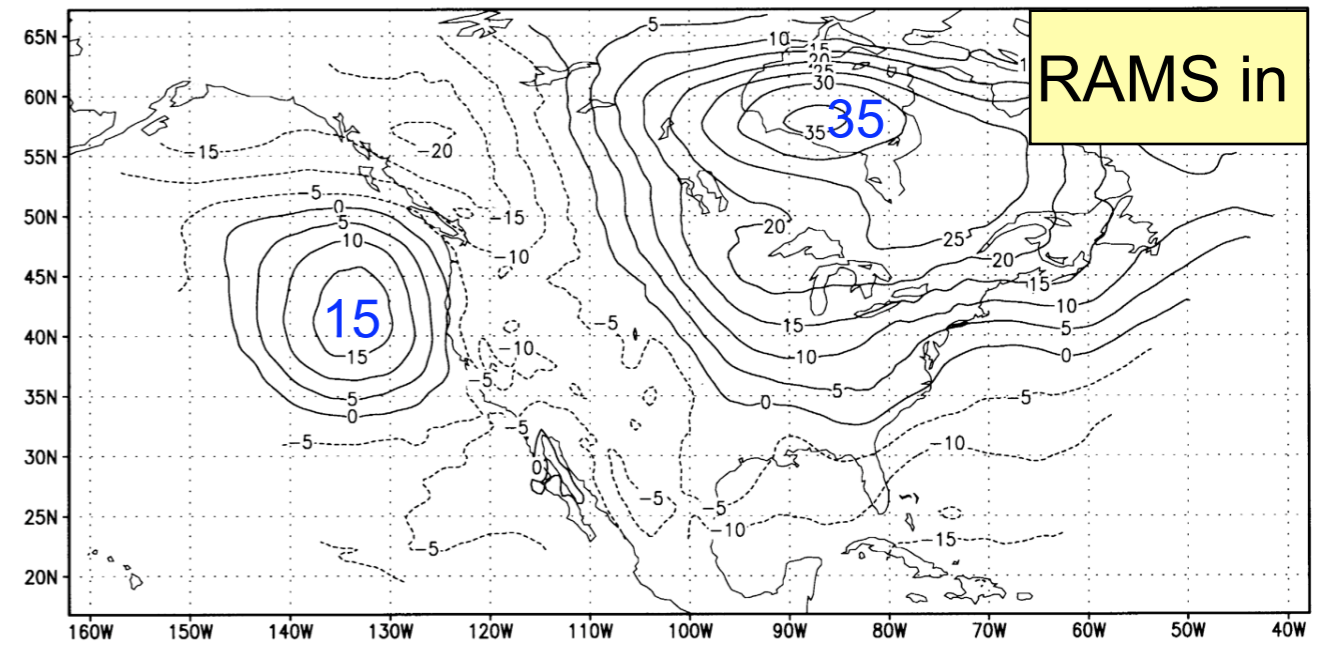


Error in 500 hPa height (mean over 16-31 May)

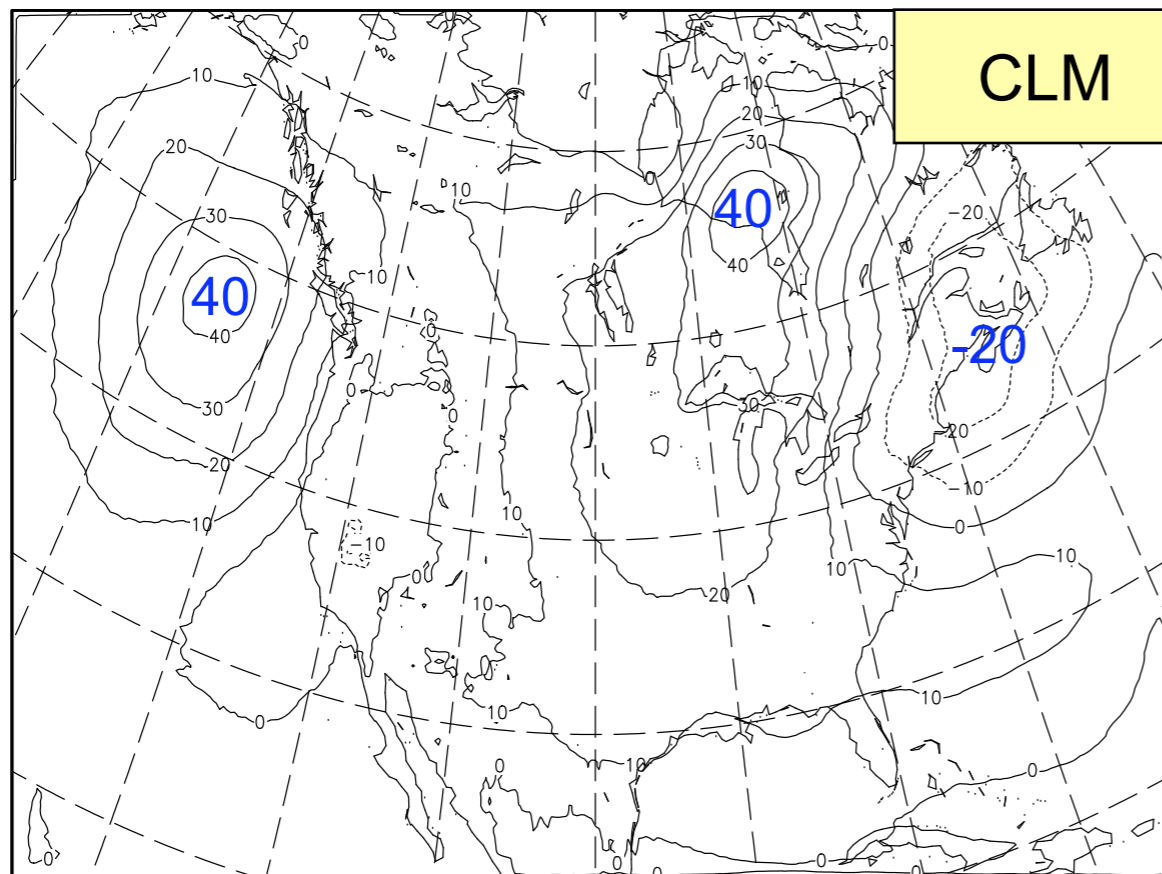
ERA40 50si HHL500 16-31 May [m]



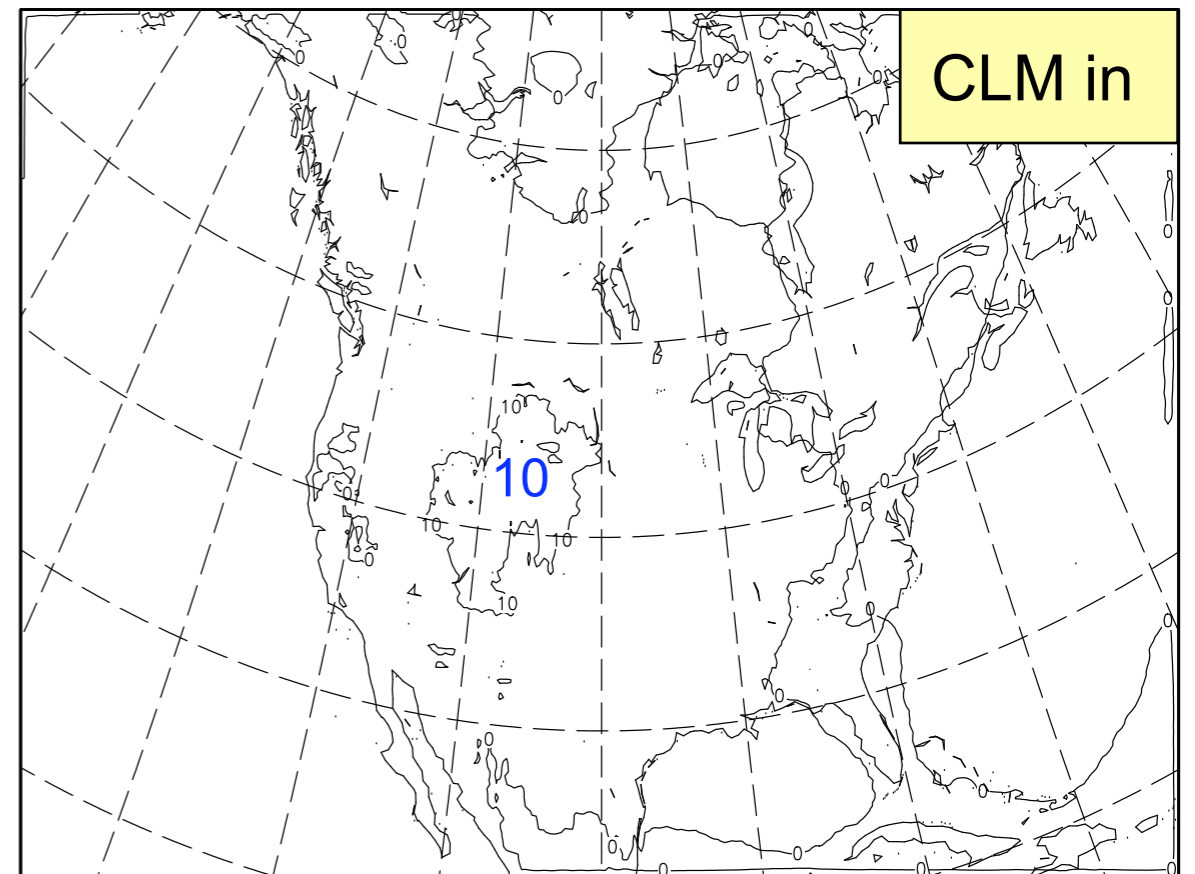
Small Domain: 50 km (internal nudging)



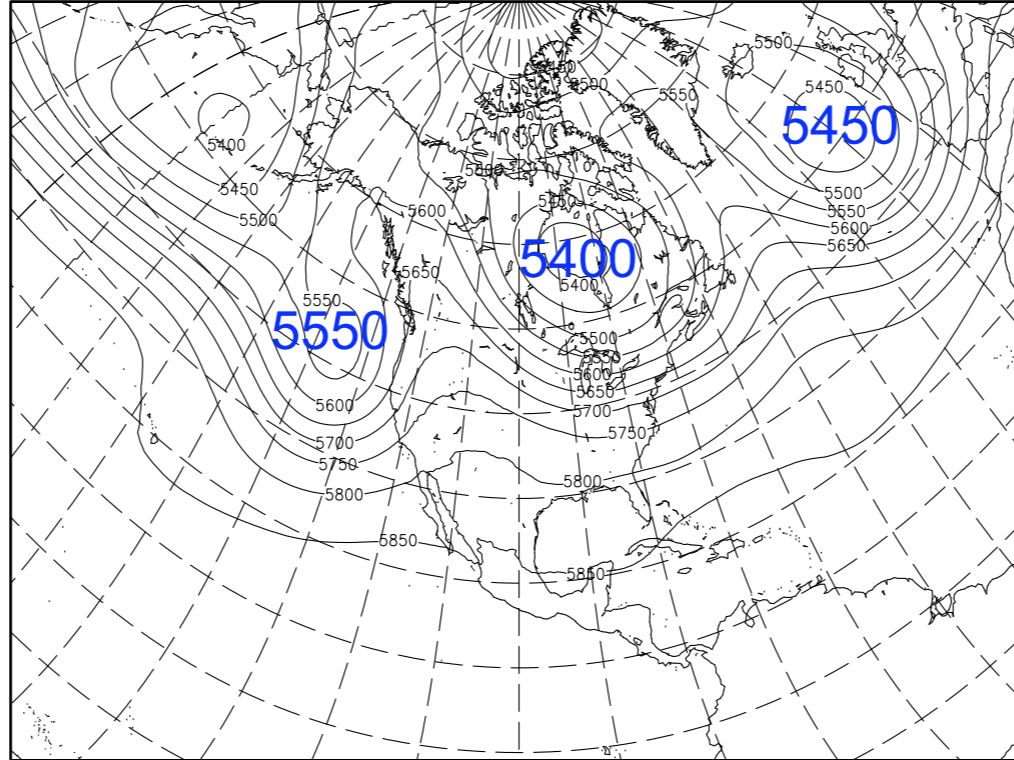
ERA40 25s HHL500 Error [m]



ERA40 25ss HHL500 Error [m]



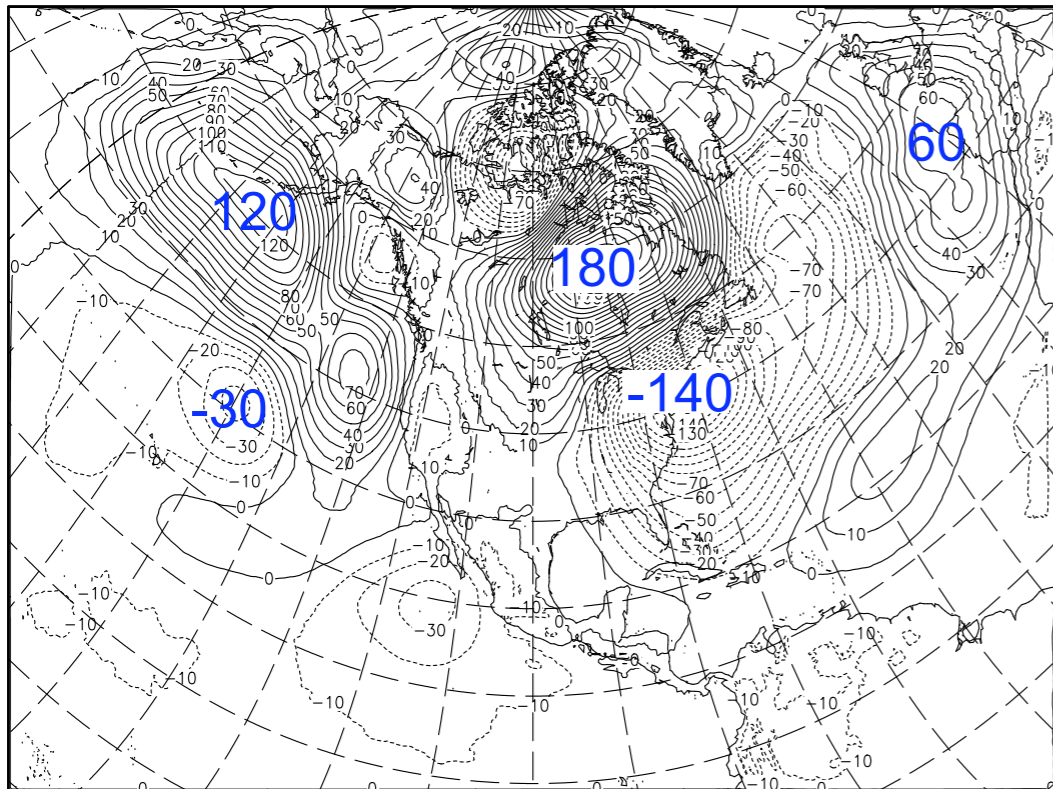
ERA40 50si HHL500 16-31 May [m]



ERA40

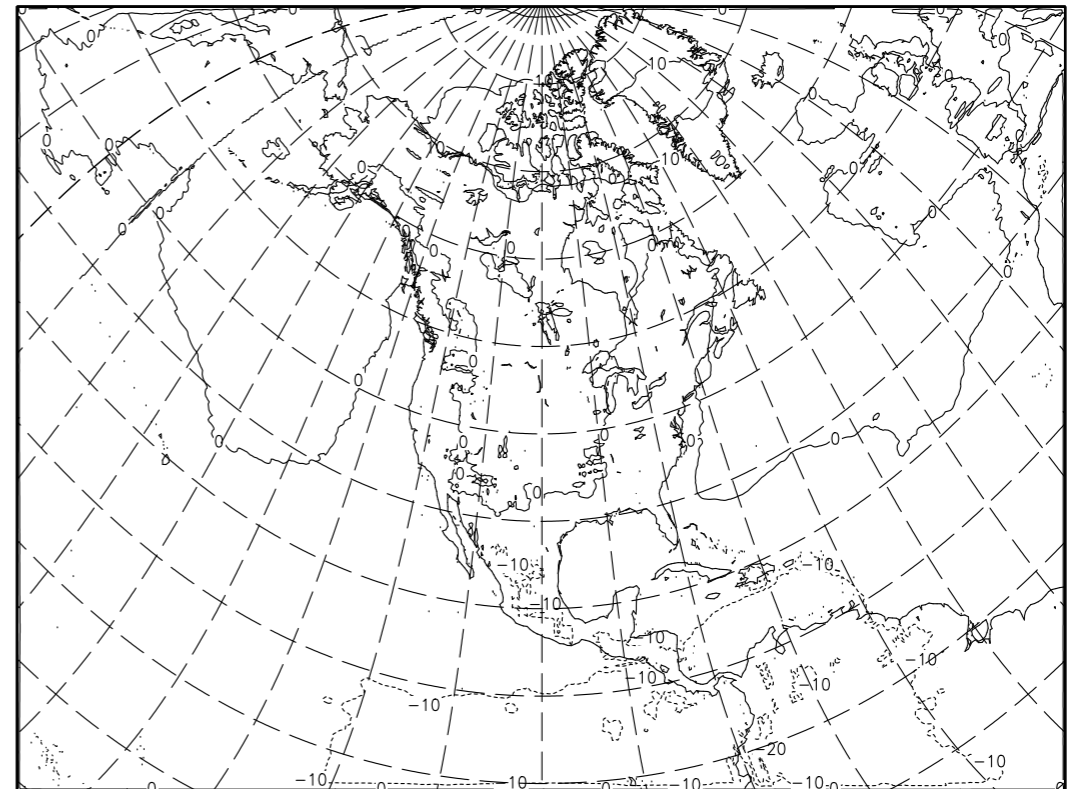
CLM

ERA40 25I HHL500 Error [m]



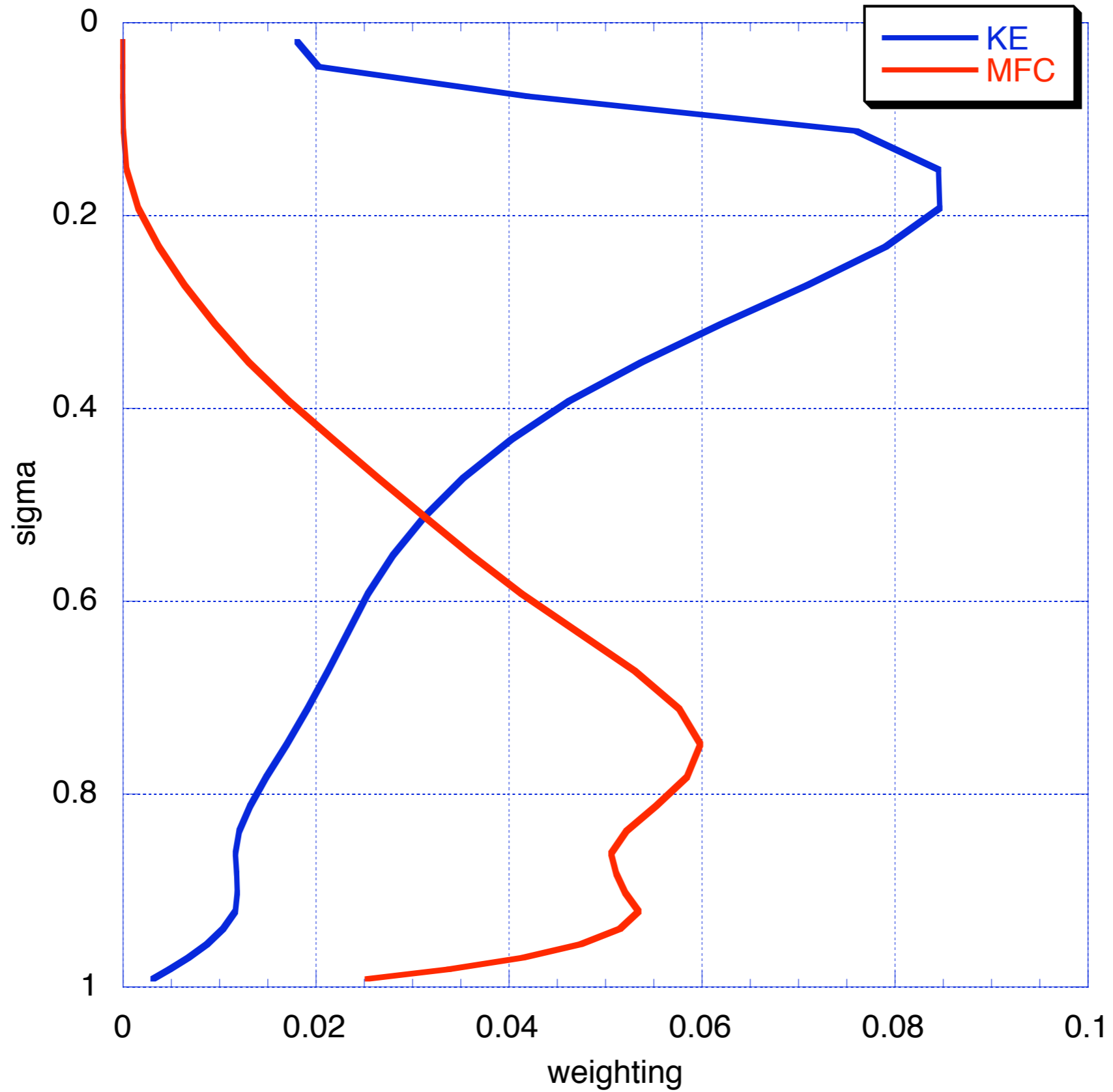
CLM in

ERA40 25Is HHL500 Error [m]



Kinetic Energy (KE) and Moisture Flux Convergence (MFC) vertically integrated

Weighting Functions of KE and MFC



Definition: Fractional Change in Spectral Power

$$\Delta S(k)_{frac} = \begin{cases} \frac{S(k)_{mod_1}}{S(k)_{ana}} - 1, & \text{for basic experiments} \\ \frac{S(k)_{mod_1}}{S(k)_{mod_2}} - 1, & \text{for follow up experiments} \end{cases}$$

k wave number

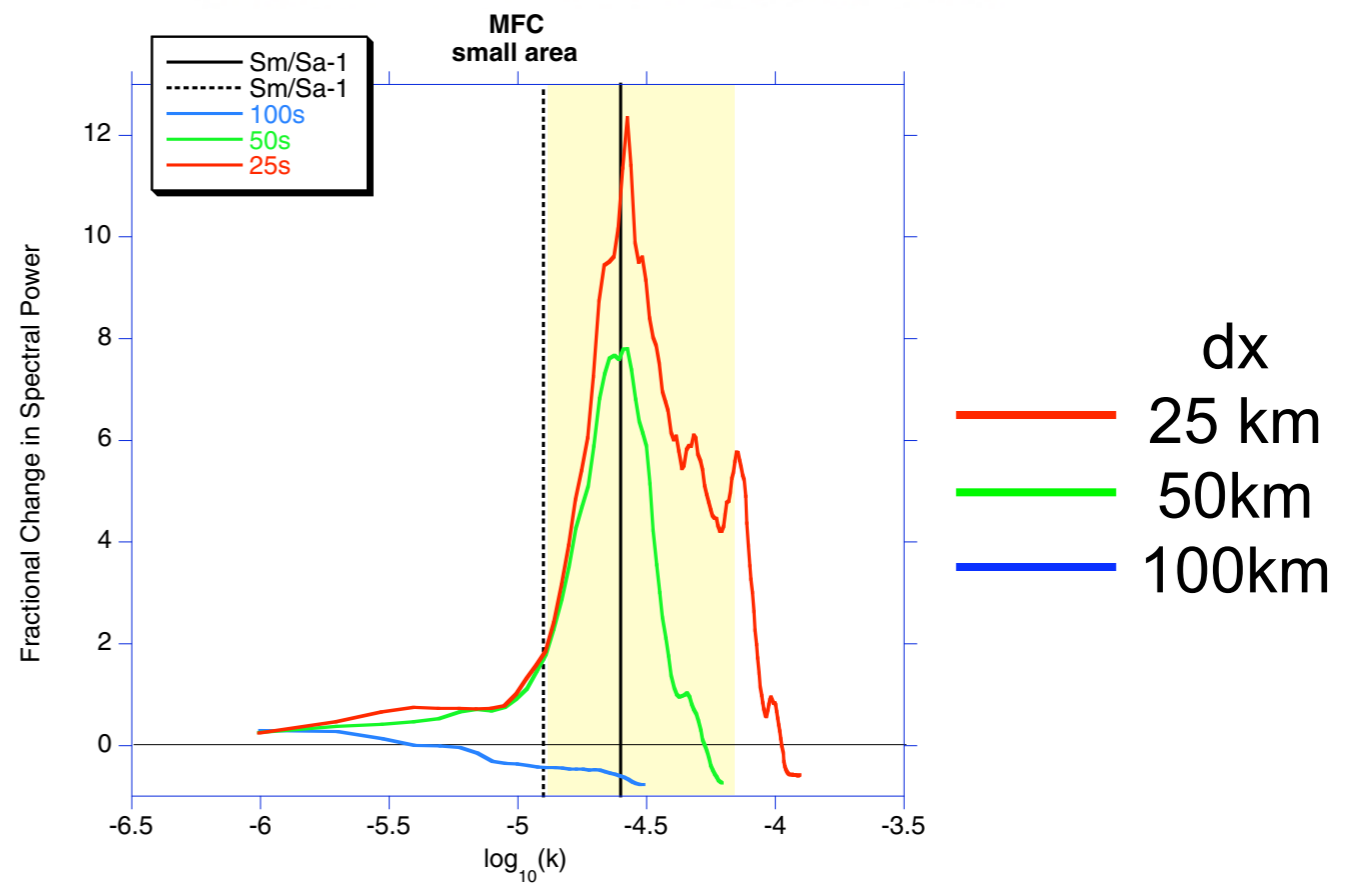
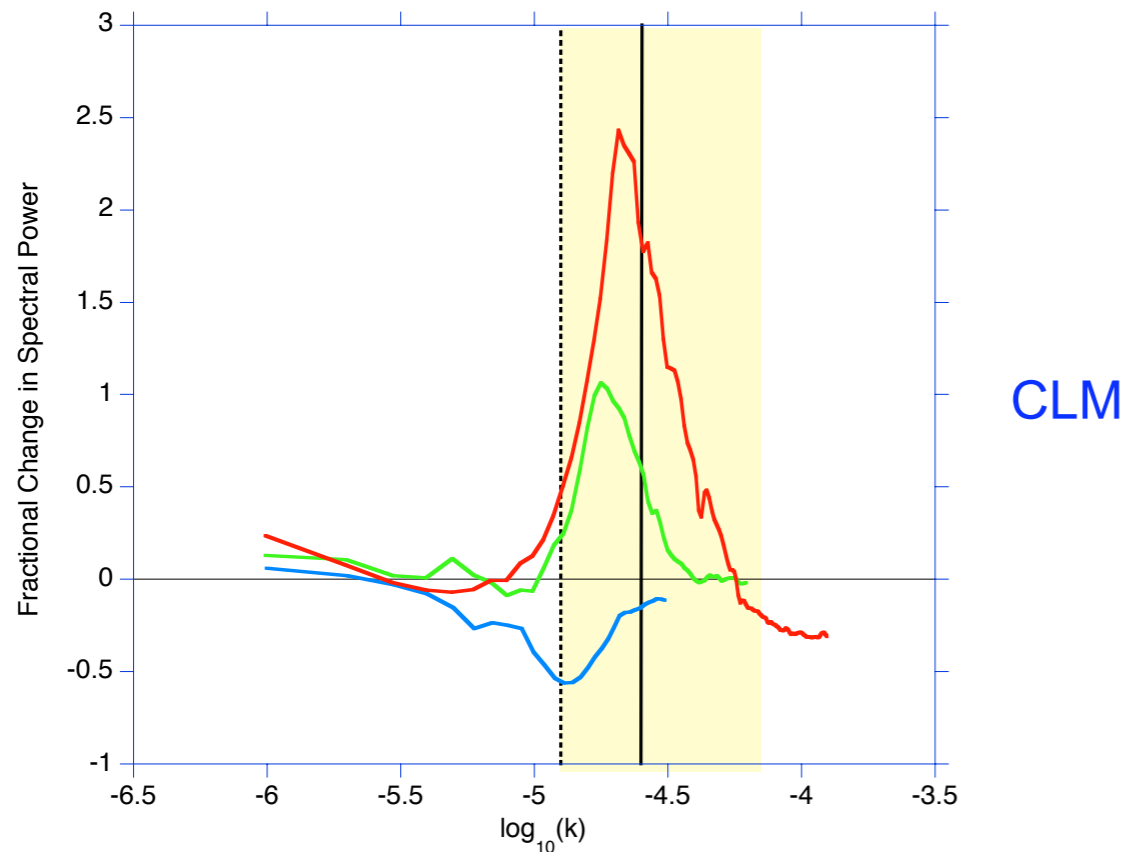
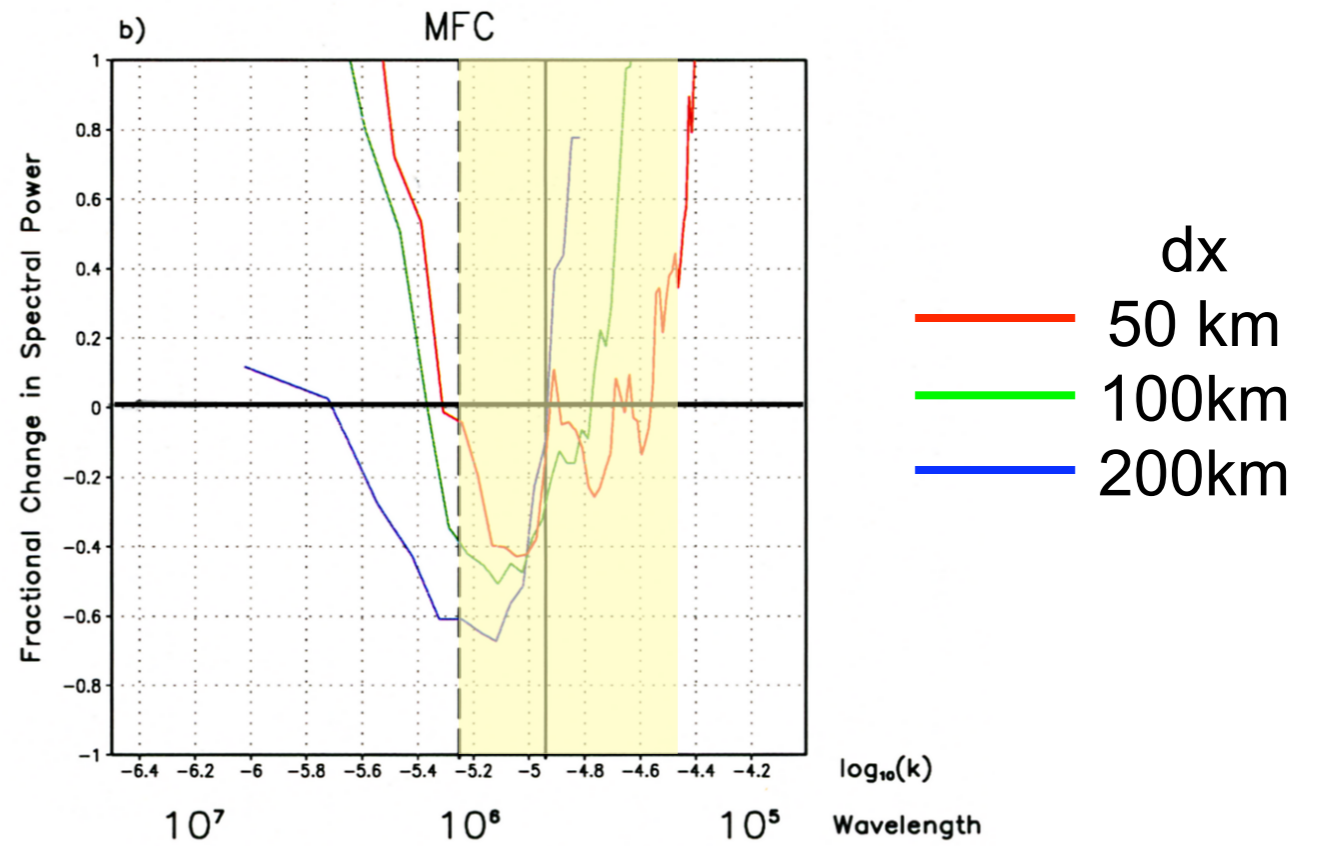
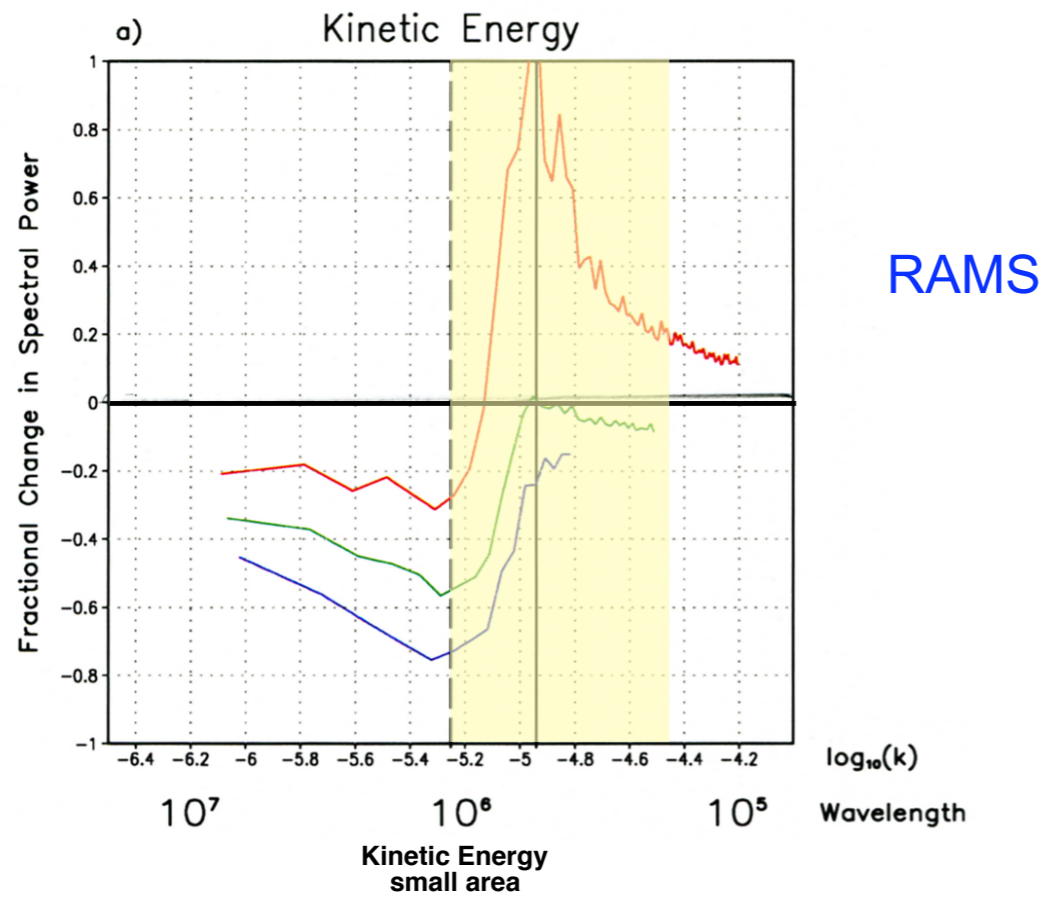
$S(k)$ power spectrum

ana ERA40 reanalysis

mod_1 without internal nudging

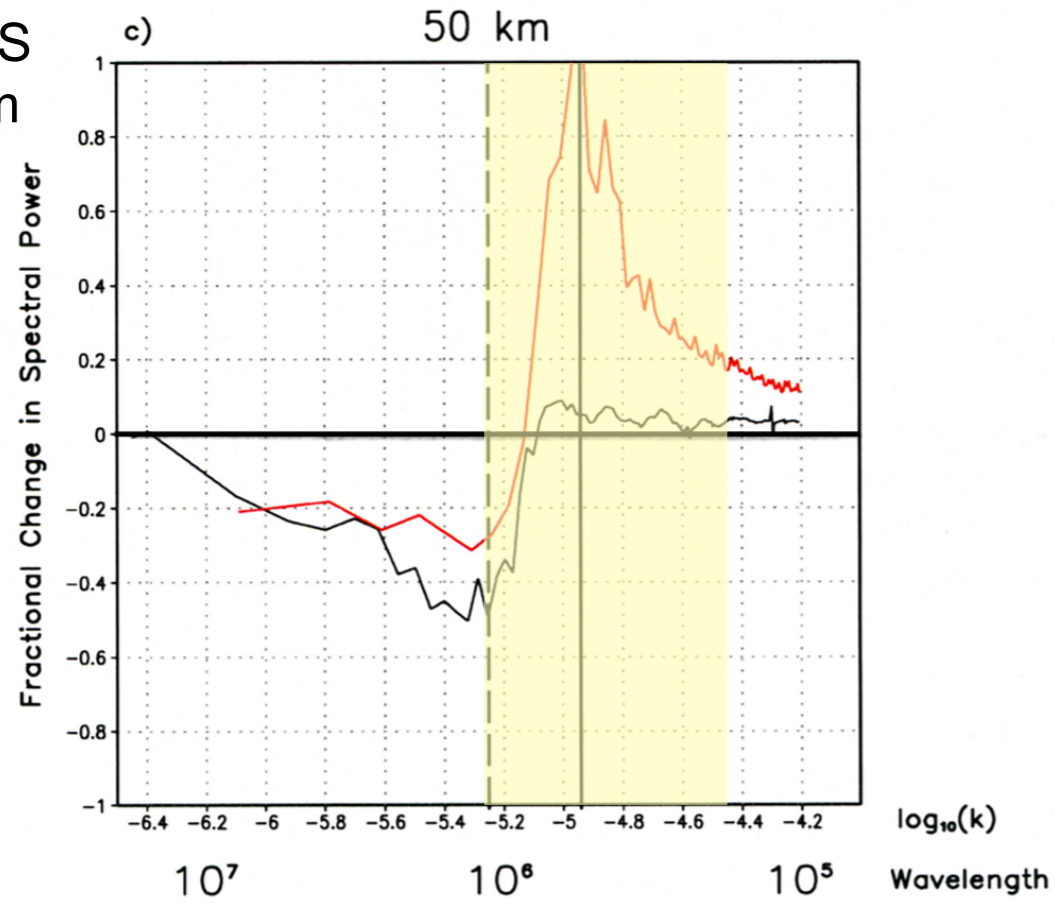
mod_2 with internal nudging

ΔS mod1/ana (small domain)

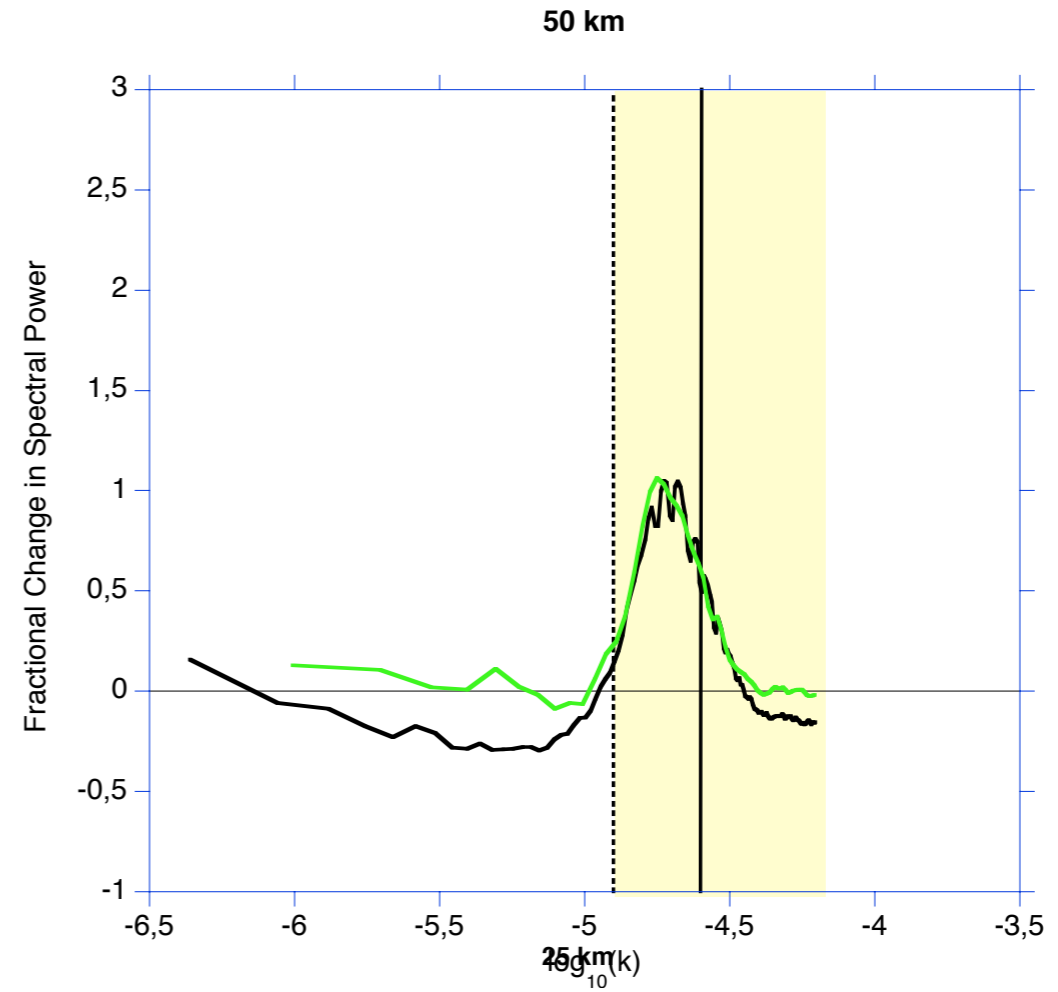


ΔS mod1/ana Kinetic Energy small (color) vs. large domain (black)

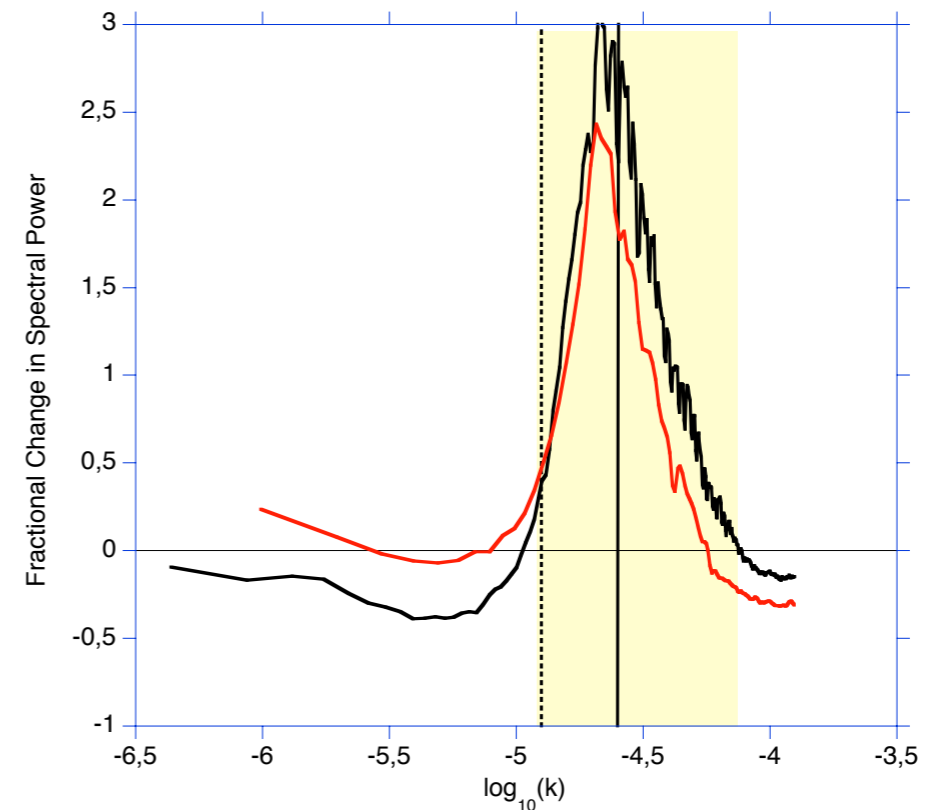
RAMS
50km



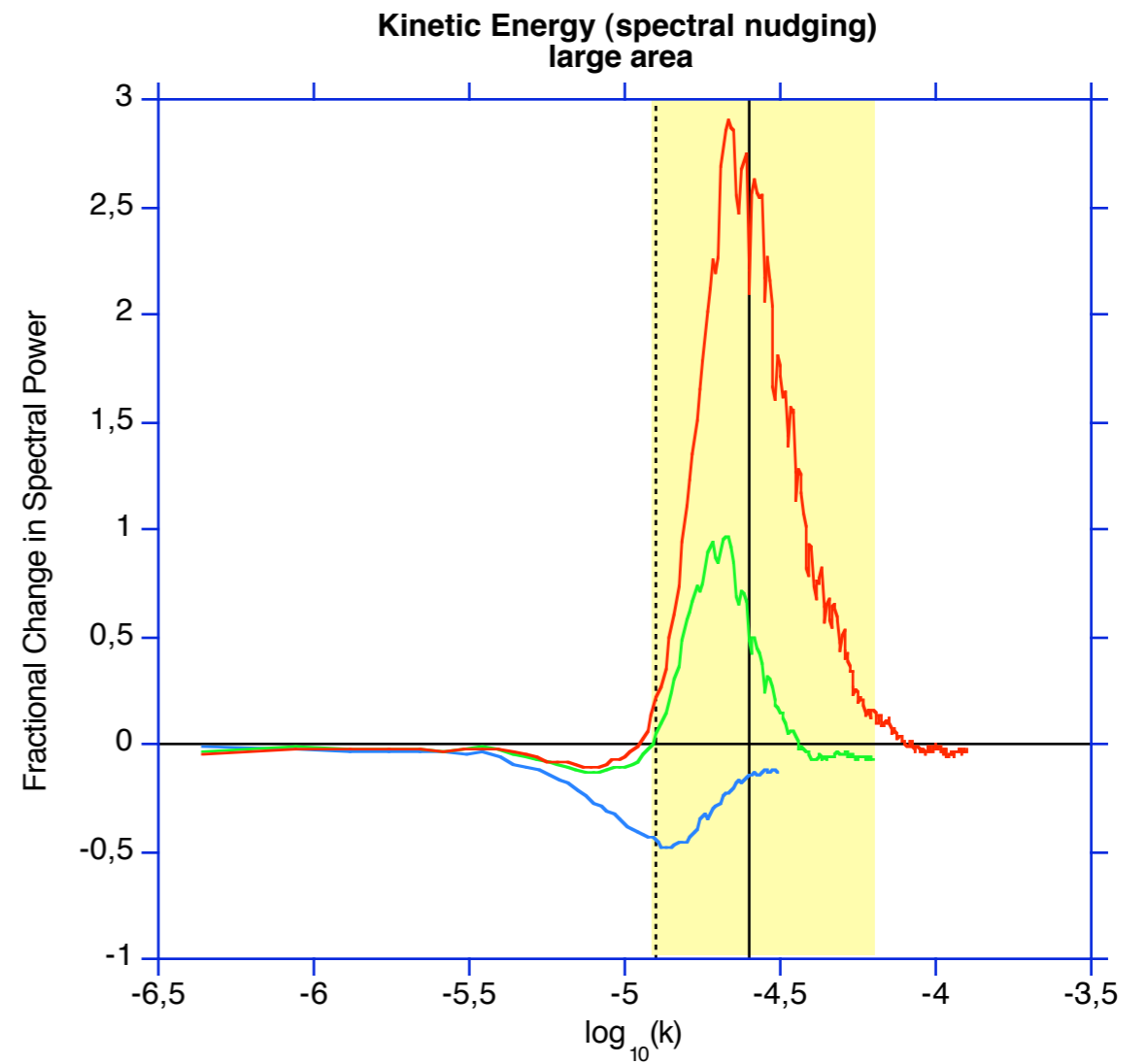
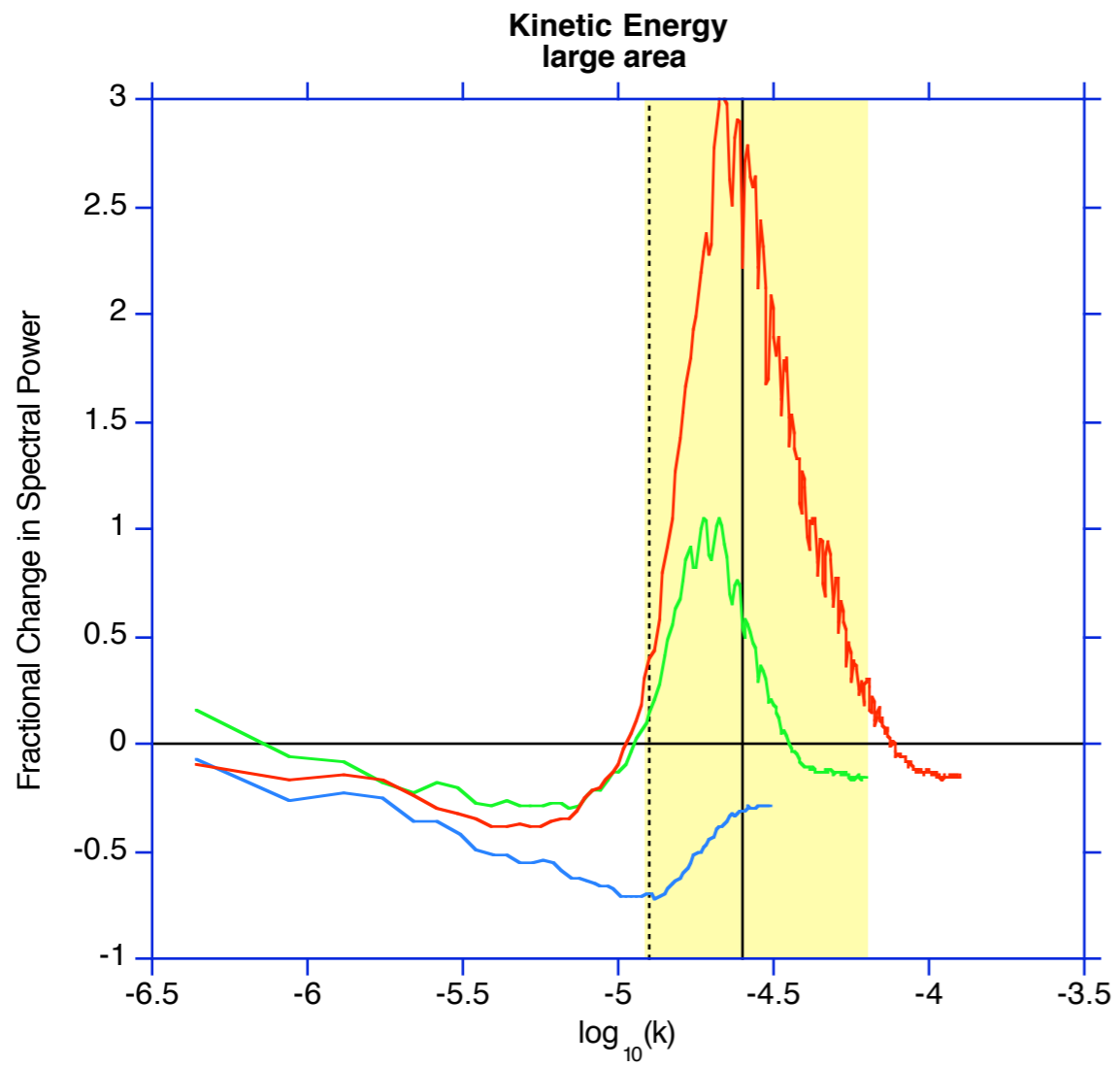
CLM
50km



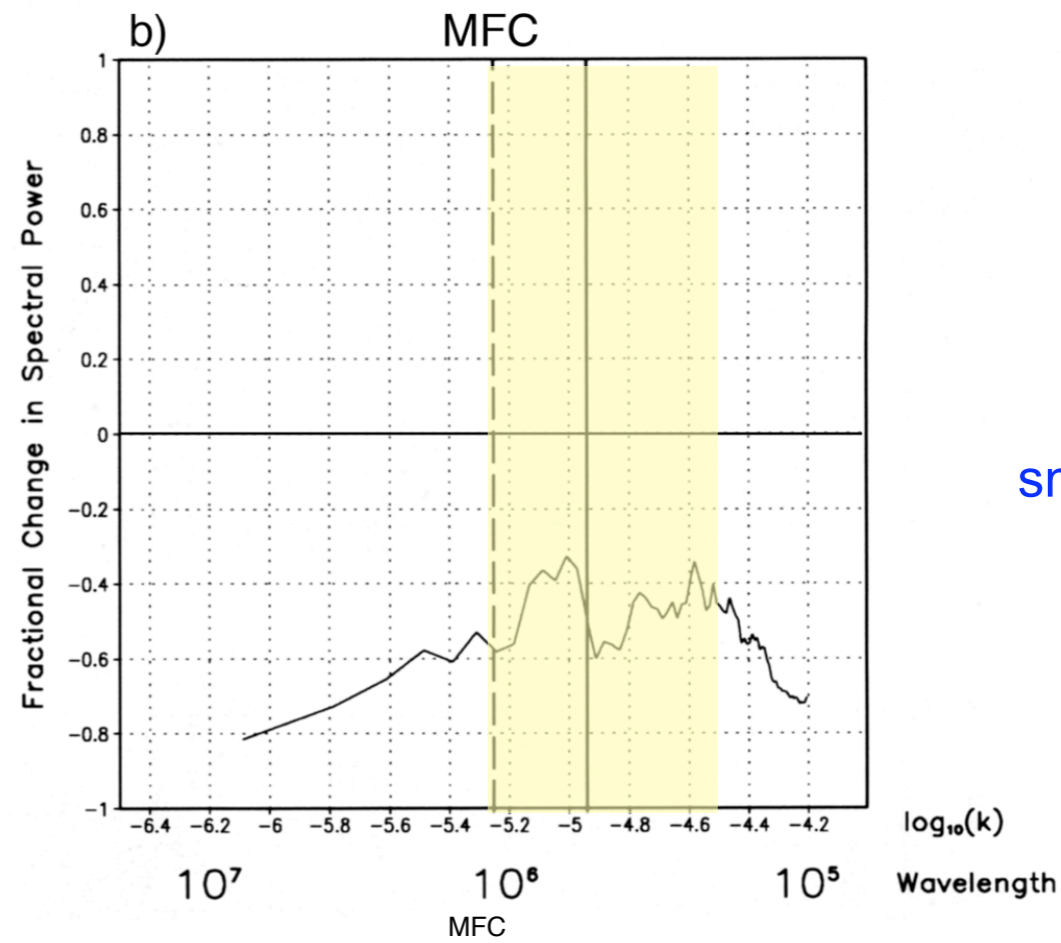
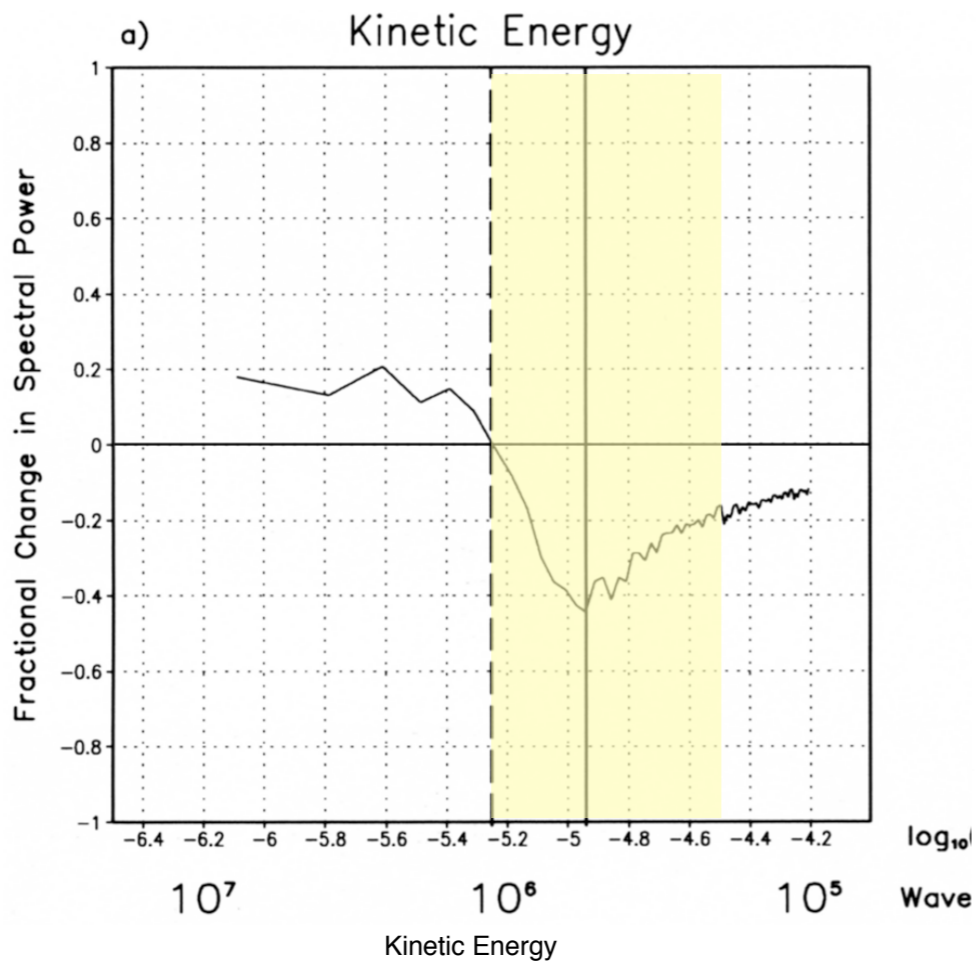
CLM
25km



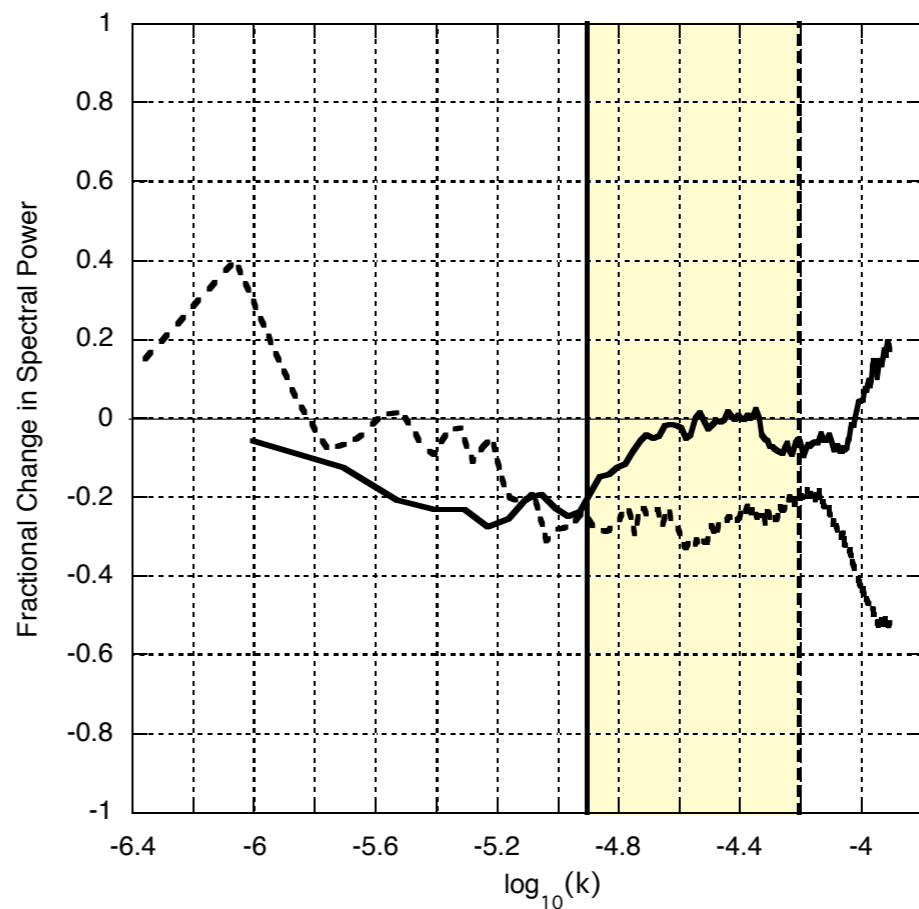
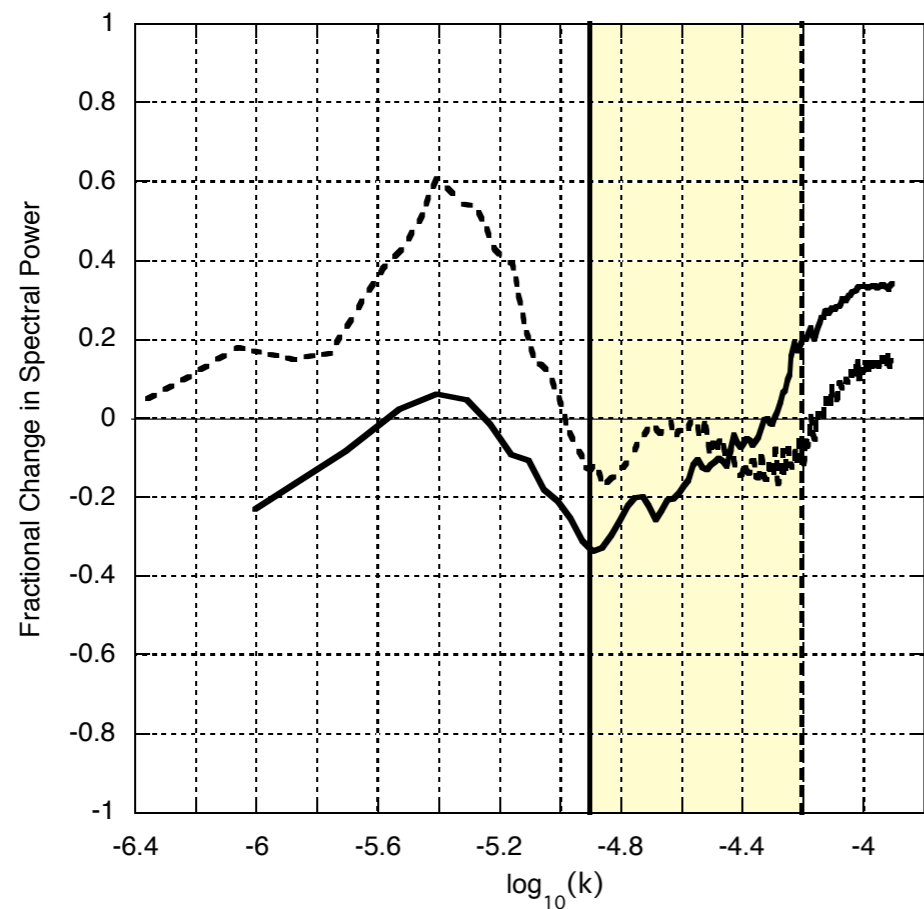
$\Delta S \text{ mod1/ana}$ and $\Delta S \text{ mod2/ana}$ Kinetic Energy



ΔS mod1/mod2 Internal Nudging vs. boundary nudging



RAMS
50km
small domain



CLM
25km
small domain
(solid)
large domain
(dashed)

Summary

RAMS and CLM show similar results for standard configuration, but differences when internal nudging is applied.

Retain variability at large scales

	small domain	large domain
boundary nudging	○	-
internal nudging grid space	+	+
internal nudging spectral space	+	+

Add variability at small scales

	small domain	large domain
boundary nudging	+	+
internal nudging grid space	-	-
internal nudging spectral space	○	○