Implementing Arakawa's Unified Parameterization in the GFS

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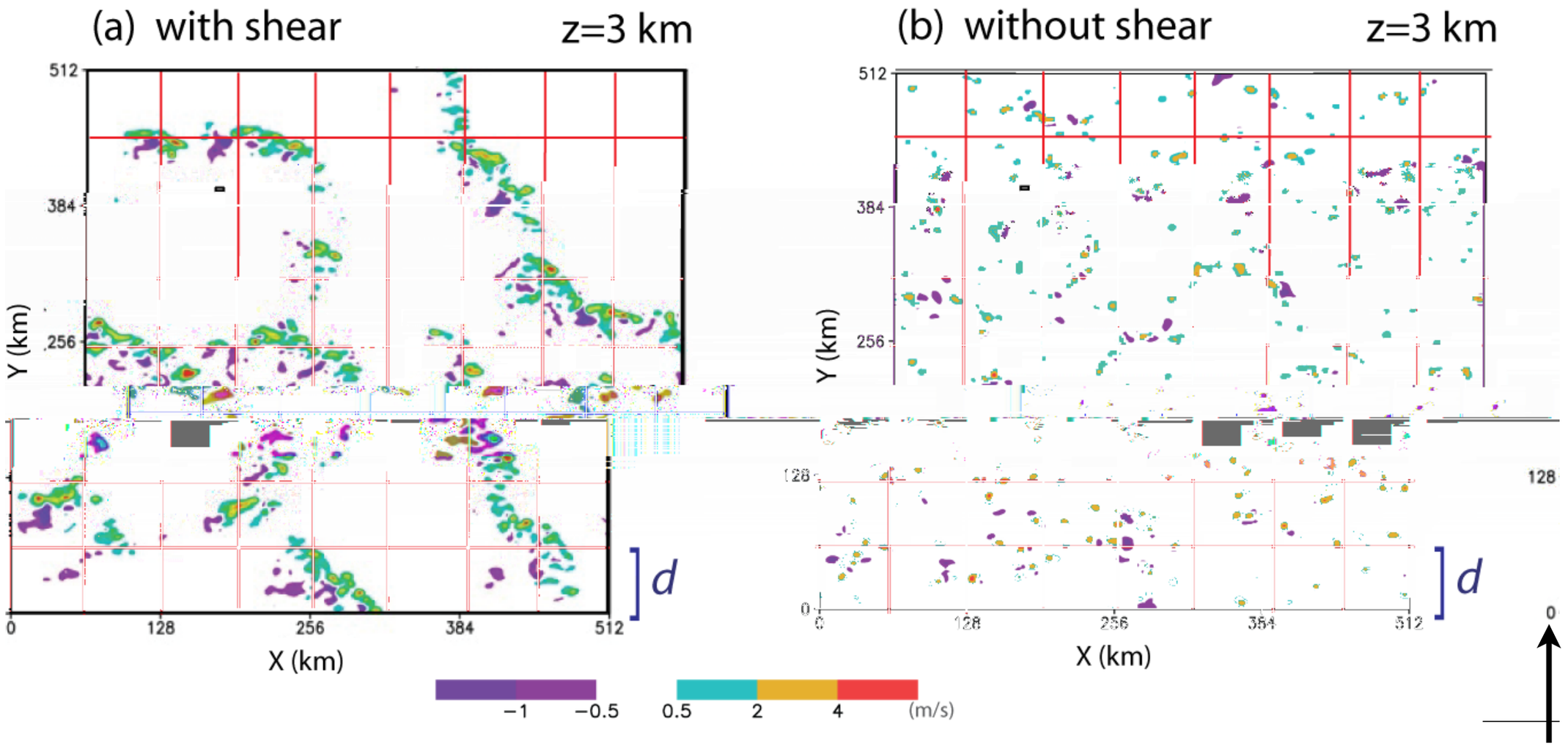
Goal:

- Grow individual clouds when/ where the resolution is high.
- Parameterize convection when/ where resolution is low.
- Continuous scaling.
- One set of equations, one code.
- Physically based.

Use a CRM to test ideas.



Vertical velocity 3 km above the surface

Subdomain size, used to analyze dependence on grid spacing

Starting point

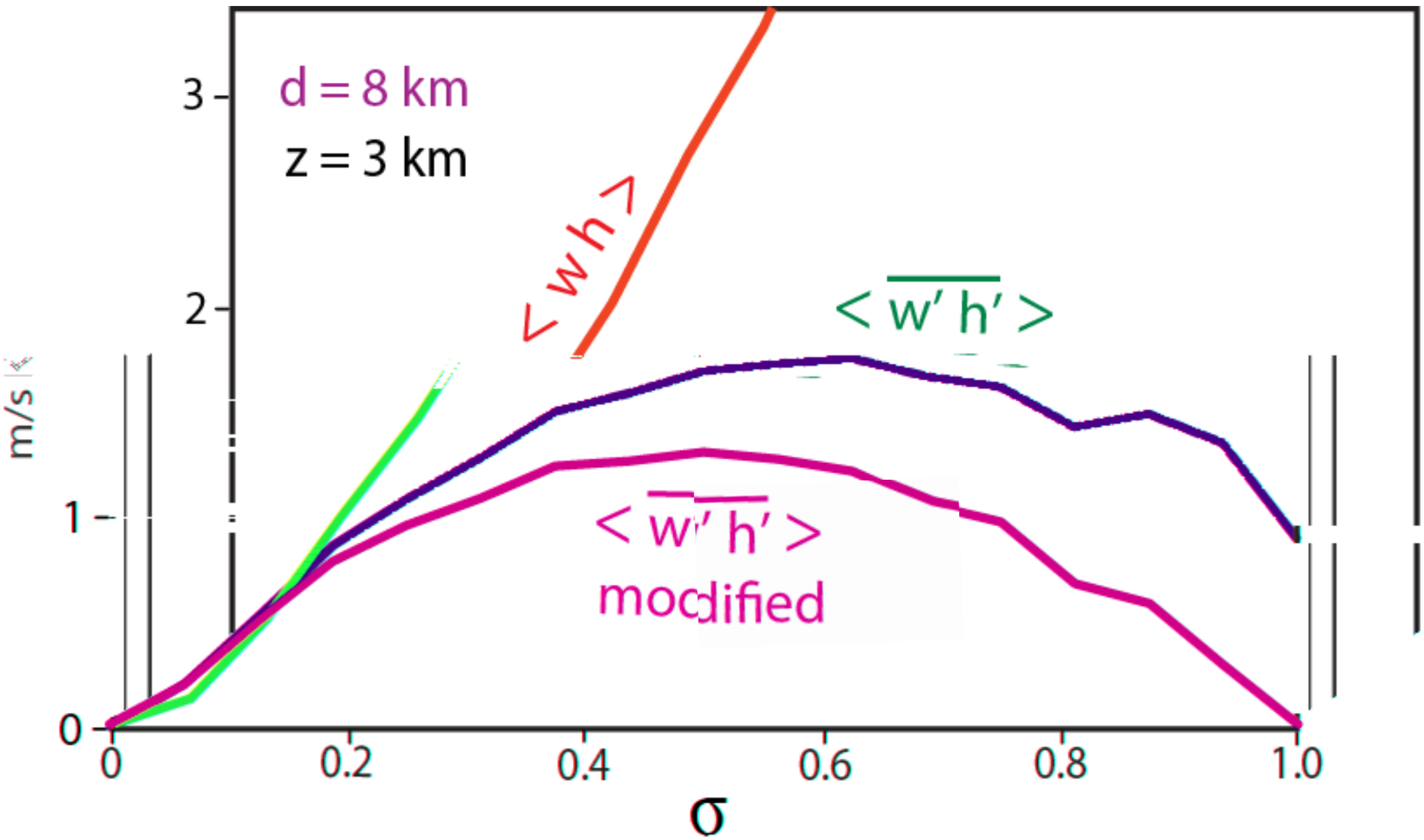
F e ca e f a - a PDF, e ca de e

$$\overline{w'\psi'} \equiv \overline{w\psi} - \overline{w}\,\overline{\psi} = \sigma\left(\ -\sigma\right)\Delta w \Delta\psi\ , \tag{1}$$

e e

$$\left(\bar{}\right) \equiv \sigma\left(\ \ \right)_c + \left(1-\sigma\right)\left(\tilde{}\right)\ \text{a}\ \ \text{d}\ \Delta\left(\ \ \right) \equiv \left(\ \ \right)_c - \ \tilde{}$$

Flux partitioning as function of sigma



$$\overline{w'\psi'} \equiv \overline{w\psi} - \overline{w}\,\overline{\psi} = \sigma(1-\sigma)\Delta w \Delta\psi$$

"Modified" means that the data is averaged over updrafts and environment before computing the flux. In other words, a "top-hat" structure is imposed by averaging.

Closure assumption

$\left(\overline{w'\psi'}\right)_E$ -

σ

$$\sigma = \frac{\left(\overline{w'\psi'}\right)_E}{\left(\overline{w'\psi'}\right)_E}.$$

(3)

- (3) σ. . (3)

$0 \le \sigma < 1$

(4)

B

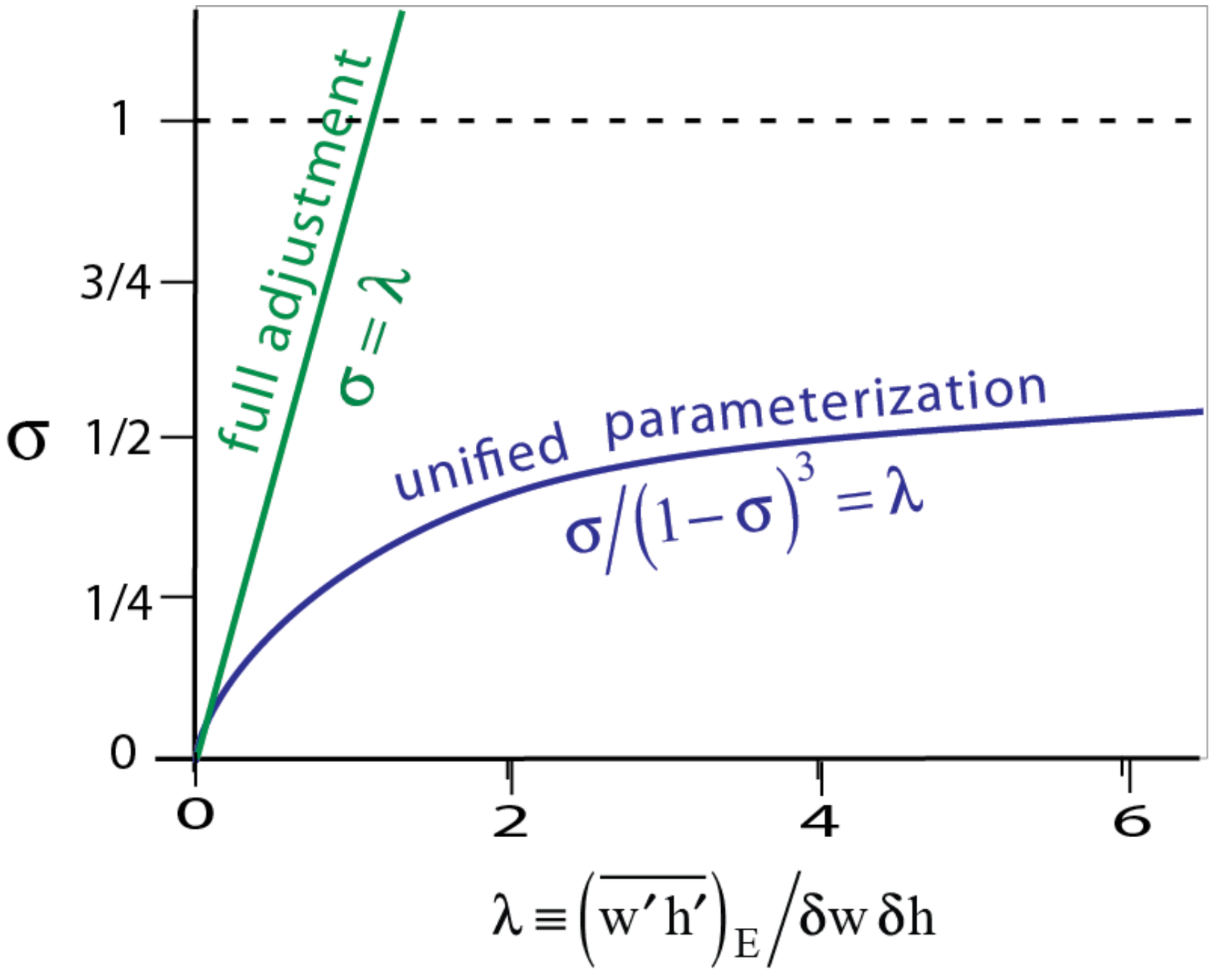
$$= (1-\sigma)^2 \left(\overline{w'\psi'}\right)_E .$$

(5)

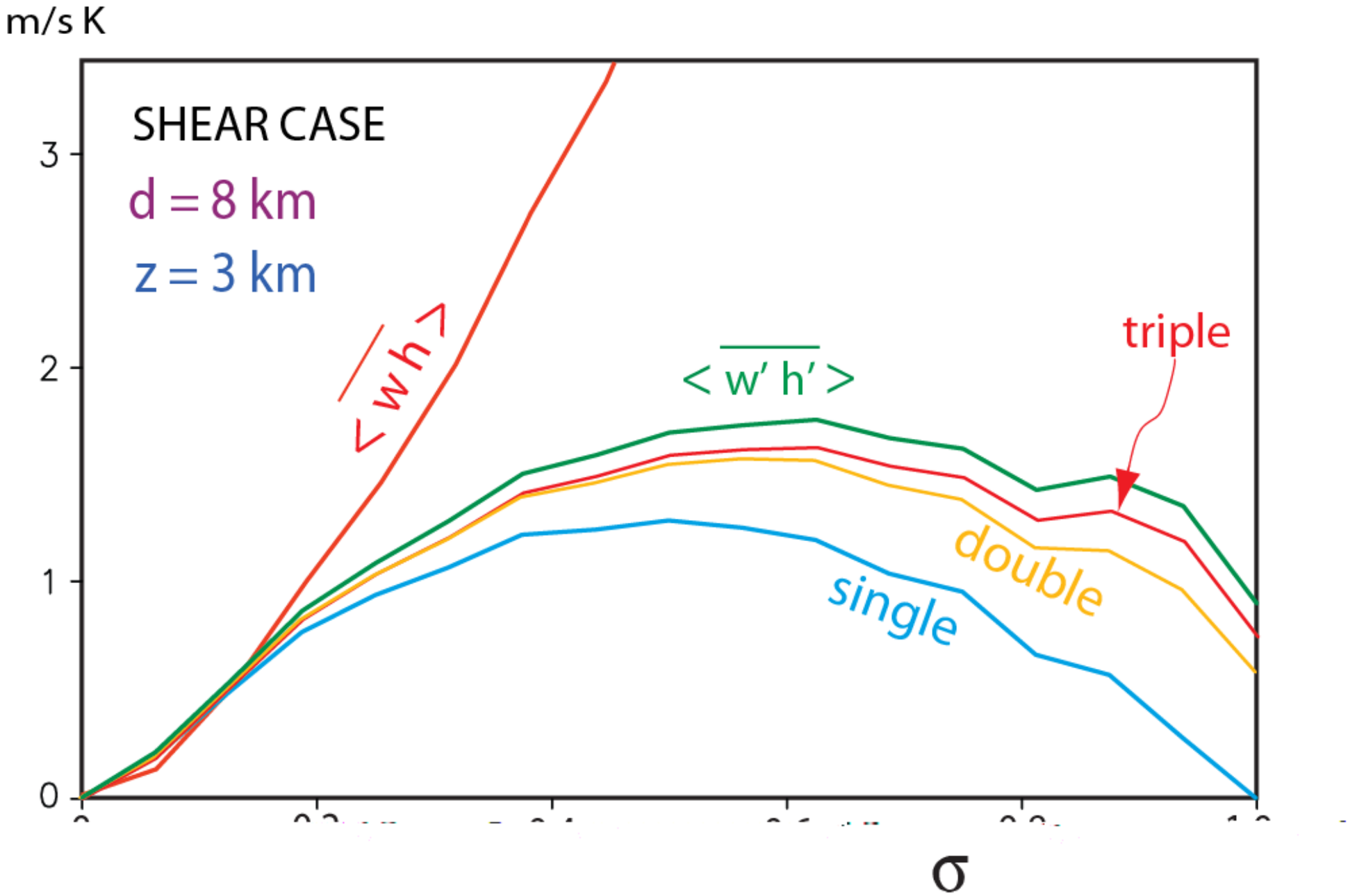
-

. $\sigma \to 1$.

How sigma depends on lamda



Including substructure



Substructures are significant for large sigma, but the eddy flux becomes unimportant for large sigma.

References

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Status & Next Steps

- The CS parameterization is running in the GFS. Tests are under way.
- Chikira has generalized UP for use with multiple cloud types and downdrafts.
- We will now begin implementing UP in GFS.