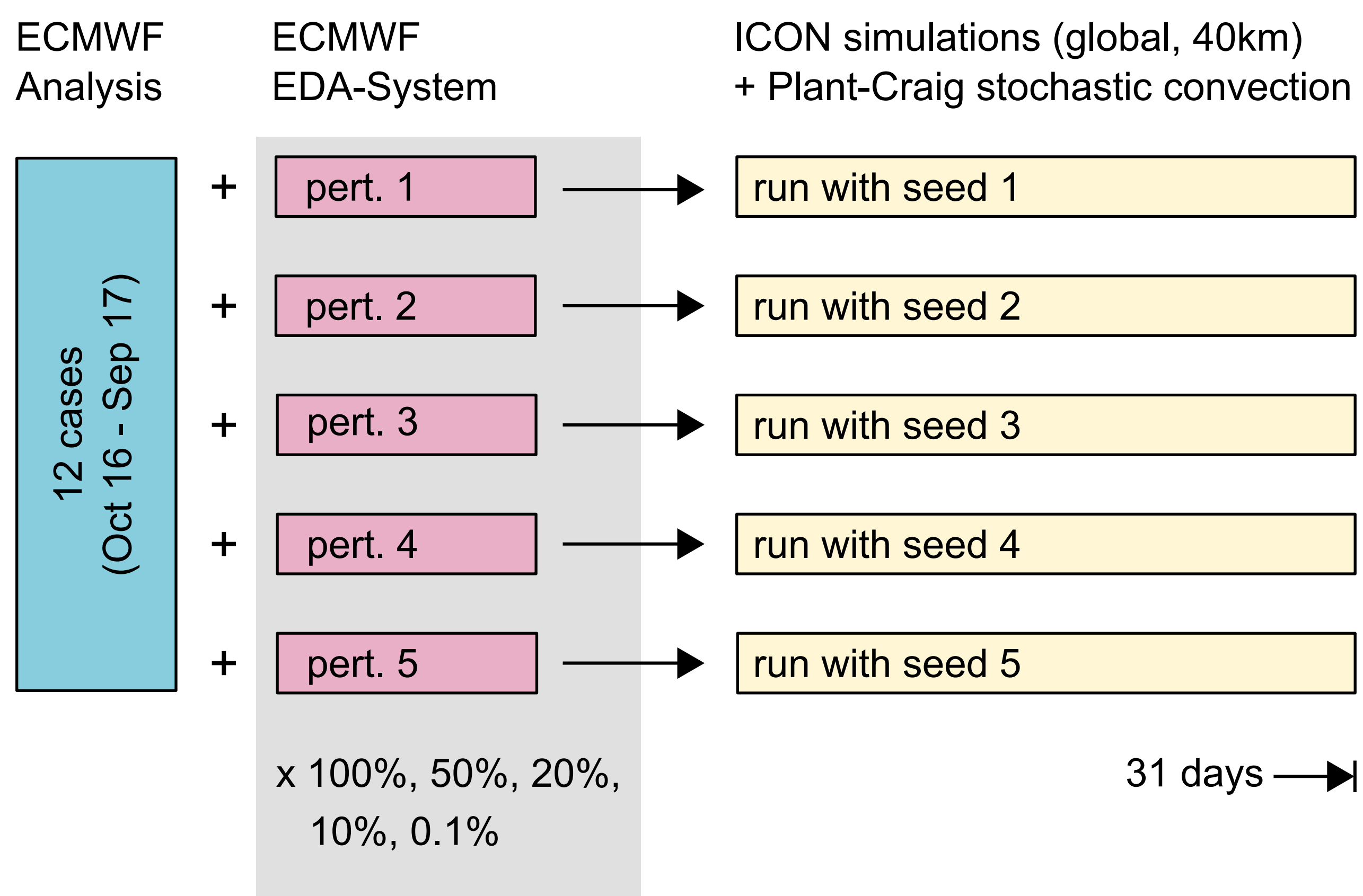# The transition from practical to intrinsic predictability of midlatitude weather

Tobias Selz[1] (tobias.selz@lmu.de), Michael Riemer[2] and George Craig[1]

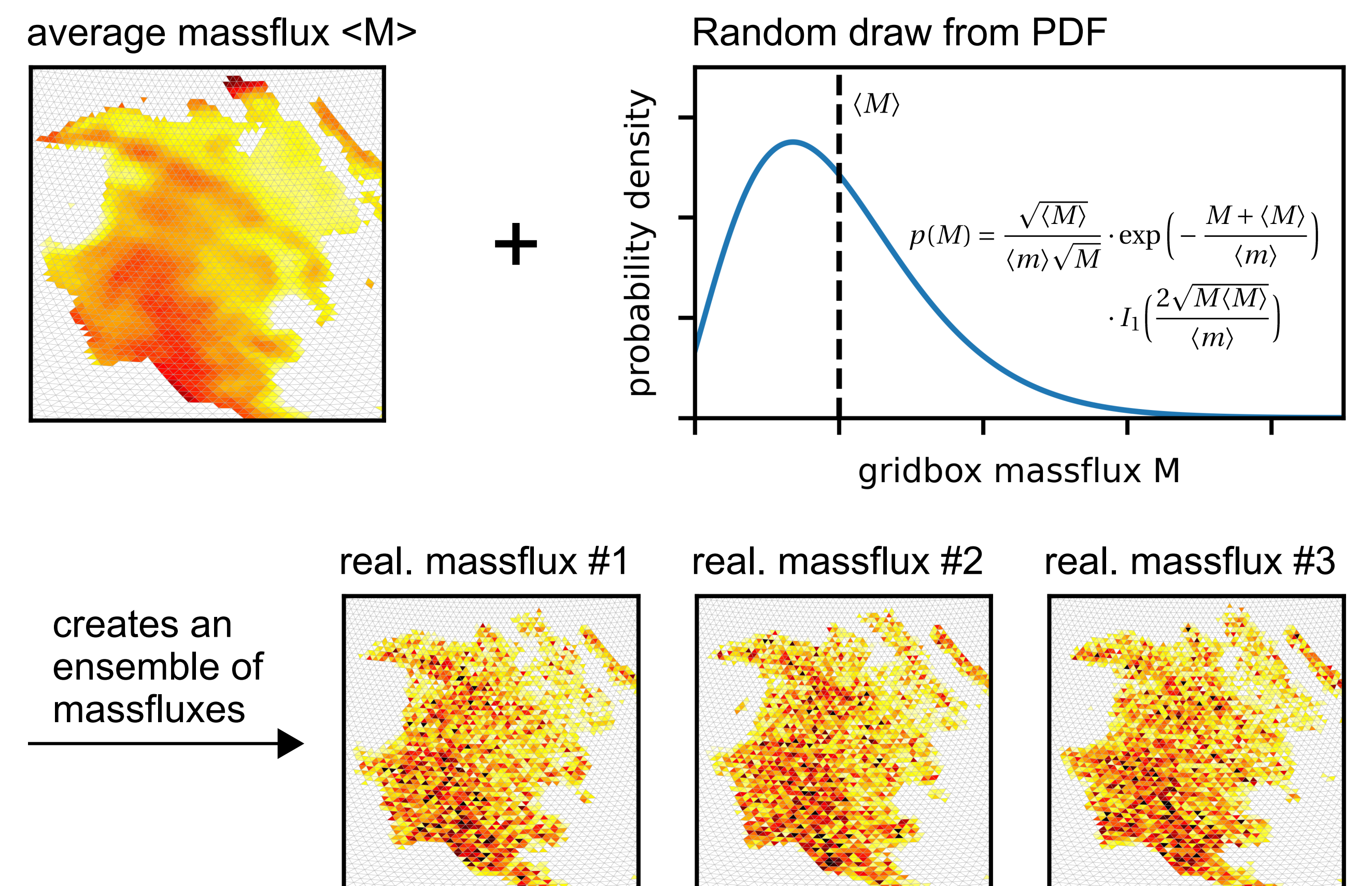1) Ludwig-Maximilians-Universität München, 2) Johannes Gutenberg-Universität Mainz

WAVES TO WEATHER

Experimental design

ECMWF Analysis

ECMWF EDA-System

ICON simulations (global, 40km) + Plant-Craig stochastic convection

12 cases (Oct 16 - Sep 17)

+ pert. 1 → run with seed 1
+ pert. 2 → run with seed 2
+ pert. 3 → run with seed 3
+ pert. 4 → run with seed 4
+ pert. 5 → run with seed 5

x 100%, 50%, 20%, 10%, 0.1%

31 days →

The initial condition uncertainty is rescaled in several steps down to 0.1% to investigate the transition to the intrinsic limit.

Plant-Craig stochastic convection scheme

average massflux <M>

Random draw from PDF

$\langle M \rangle$

$p(M) = \dfrac{\sqrt{\langle M \rangle}}{\langle m \rangle \sqrt{M}} \cdot \exp\left(-\dfrac{M + \langle M \rangle}{\langle m \rangle}\right) \cdot I_1\left(\dfrac{2\sqrt{M\langle M \rangle}}{\langle m \rangle}\right)$

probability density

gridbox massflux M

+

creates an ensemble of massfluxes

real. massflux #1   real. massflux #2   real. massflux #3

The Plant-Craig scheme is used to better represent error growth from unresolved convective motions and to improve the perfect-model-assumption.

Dominant error growth process changes with initial condition uncertainty (ICU)

ICU   current estimate   "butterflies"

growth rate [d^{-1}]

100%   50%   20%   10%   0.1%

forecast lead time [d]

- rotational wind
- divergent wind
- parameterizations:
- convection
- grid-scale precip.
- long-wave radiation

predictability limited by large-scale error growth

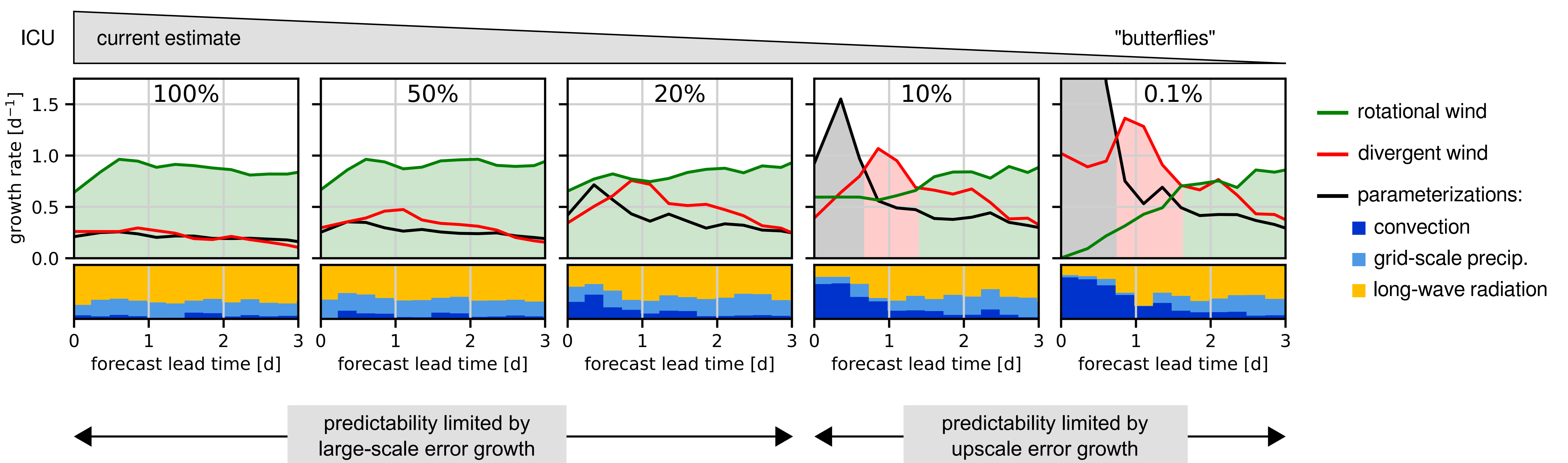predictability limited by upscale error growth

Figure shows the contribution from different processes to error growth, estimated with a diagnostic based on potential enstrophy.

Potential predictability gain: 4-5 days

predictability time [days]

intrinsic limit

current practical limit

initial condition uncertainty [%]

- ● stochastic convection
- ✕ + singular vectors
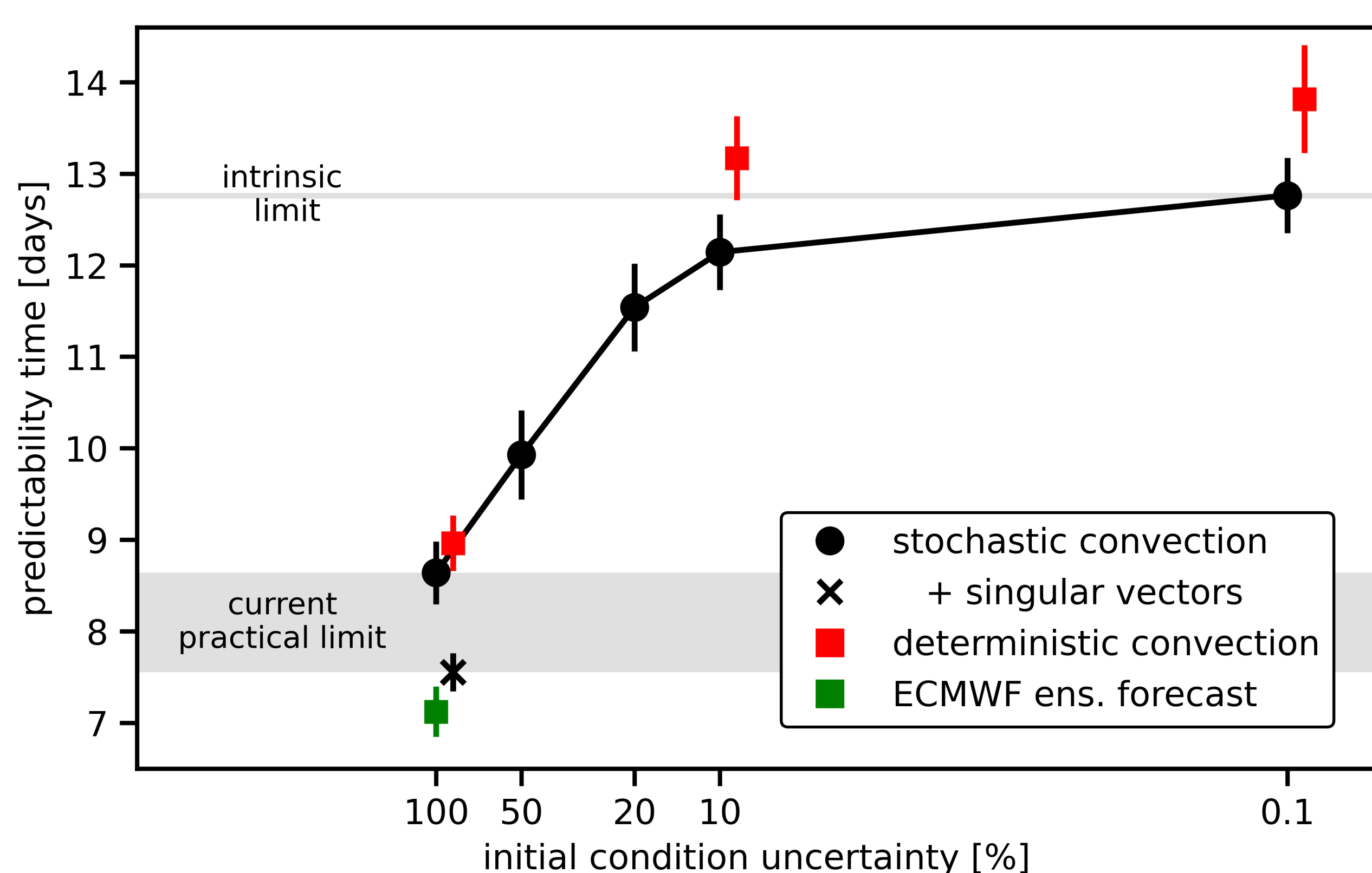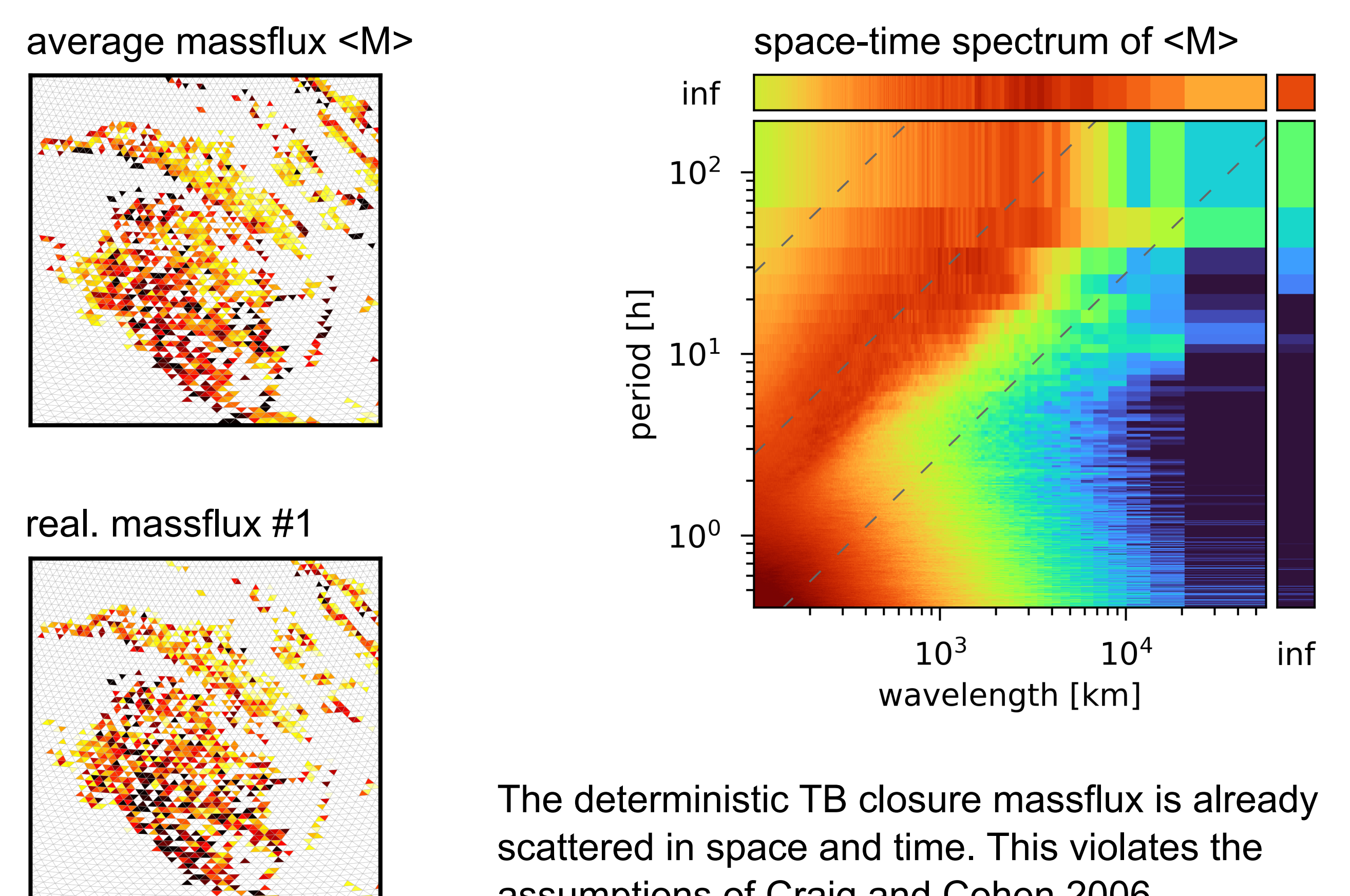- ■ deterministic convection
- ■ ECMWF ens. forecast

Figure shows the time when the 300hPa DKE ensemble spread reaches 50% of the climatological variability (from ERA5). Vertical bars show the 95%-confidence range of the estimate.

A stochastic TB scheme for future work?

Based on Machulskaya and Seifert 2019, a stochastic Tiedtke-Bechtold (TB) deep convection scheme has been implemeted by DWD (Maike Ahlgrimm).

average massflux <M>

space-time spectrum of <M>

period [h]

inf

real. massflux #1

wavelength [km]

The deterministic TB closure massflux is already scattered in space and time. This violates the assumptions of Craig and Cohen 2006.