The transition from practical to intrinsic predictability of midlatitude weather

Tobias Selz[1], Michael Riemer[2] and George Craig[1]
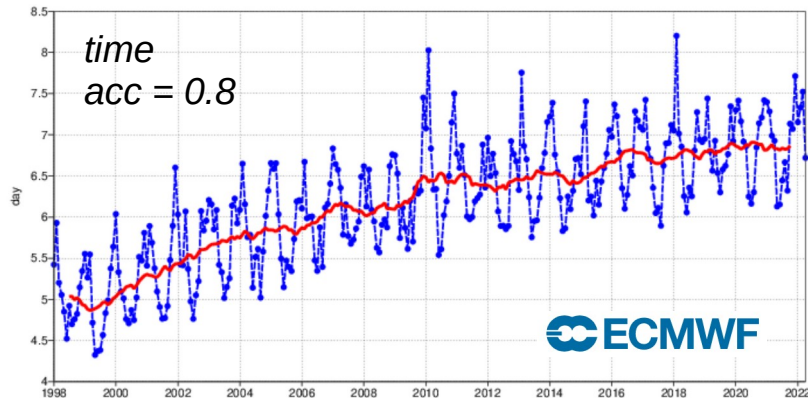
1) Ludwig-Maximilians-Universität München
2) Johannes Gutenberg-Universität Mainz

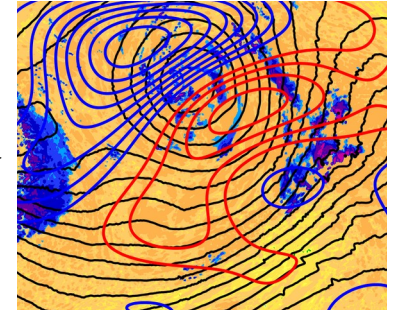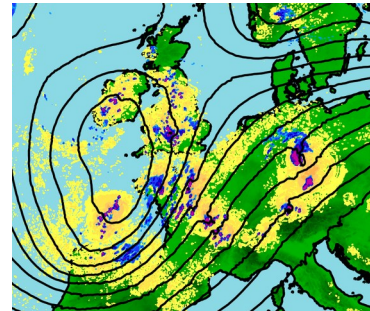# Practical vs. intrinsic predictability

Practical predictability

- Ability to predict with current methods
- Continuously improving over the last decades

Intrinsic predictability

- Fundamental, physical limit
- Caused by scale interactions ("Butterfly effect")

(Selz and Craig, 2015)

Where are we right now?
How much improvement potential?
How can we tell?
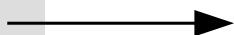
Experimental design

ECMWF
Analysis

Initial condition uncertainty
(ECMWF EDA-system)

ICON-simulations (R2B6, 40km)
with stochastic convection scheme (Plant-Craig)
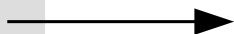
12 cases
(Oct 16 – Sep 17)

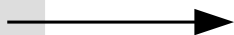+   pert. 1 → run with seed 1

+   pert. 2 → run with seed 2

+   pert. 3 → run with seed 3

+   pert. 4 → run with seed 4
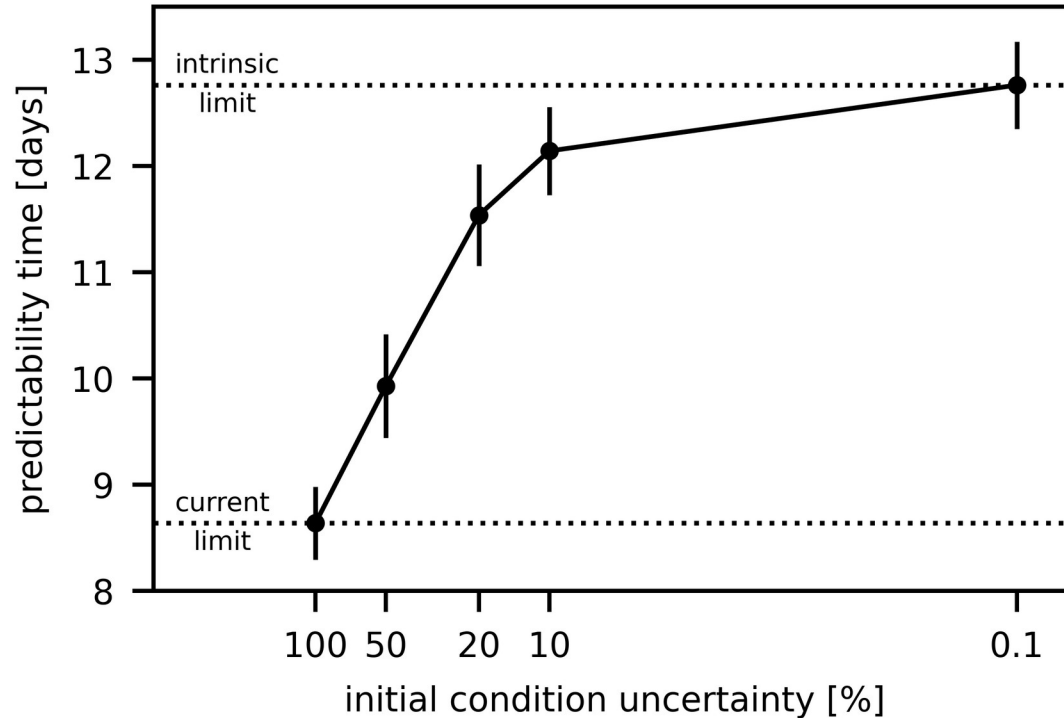
+   pert. 5 → run with seed 5

rescaled to:
100%, 50%, 20%, 10%, 0.1%

Stochastic convection scheme to better represent
error growth from unresolved convective motions

Predictability time

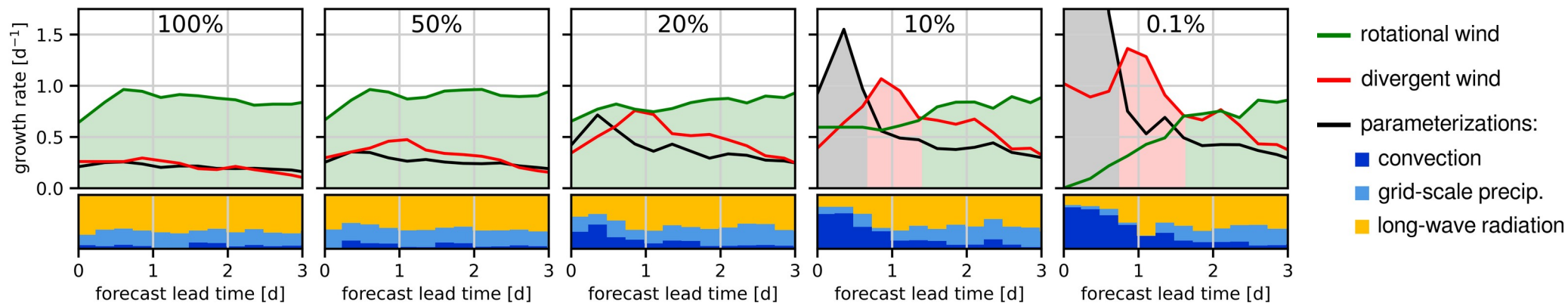*time to reach 50% of clim. variance of 300hPa DKE*

- Possible gain through initial condition-perfection: ca. **4-5 days**

- Can be achieved with **≈90% reduction** of initial condition uncertainty

- Further improvement will show little benefit

Process-specific growth rates from PV-tendency equation

Summary

- Possible gain through initial condition-perfection: **4-5 days** (model improvement excluded)

- **Reduction** of current initial condition uncertainty **by 90%** is required to reach the limit

- Further improvement would give **little additional benefit**

- **Current predictability** is mostly limited by error growth in **large-scale** 2D dry motions

- **Intrinsic predictability** is limited by diabatically-driven error growth on **convective scales** and subsequent upscale interactions

- The **transition** occurs at **90% reduction** of current initial condition uncertainty

For more details see:

Selz, T., M. Riemer, and G. Craig, 2022: The transition from practical to intrinsic predictability of midlatitude weather. JAS, EOR available.