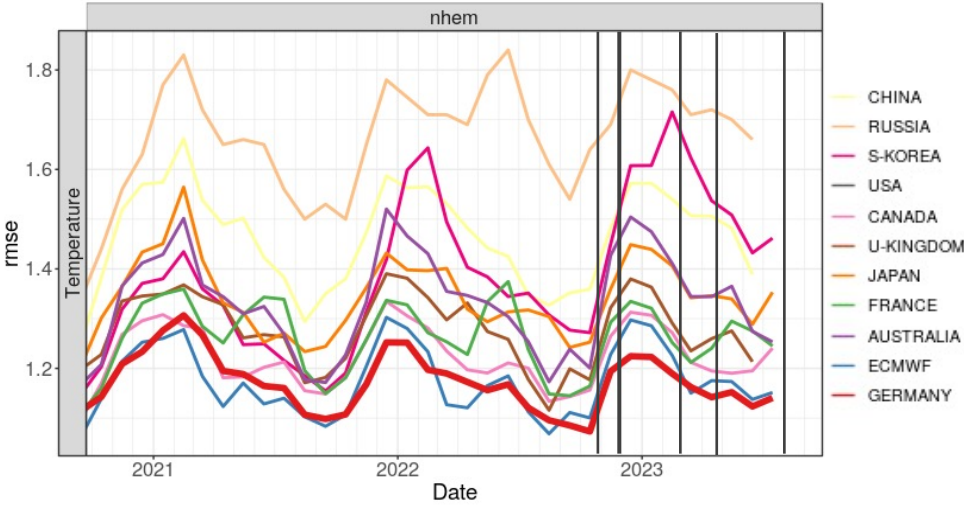
ICON news – 12 months

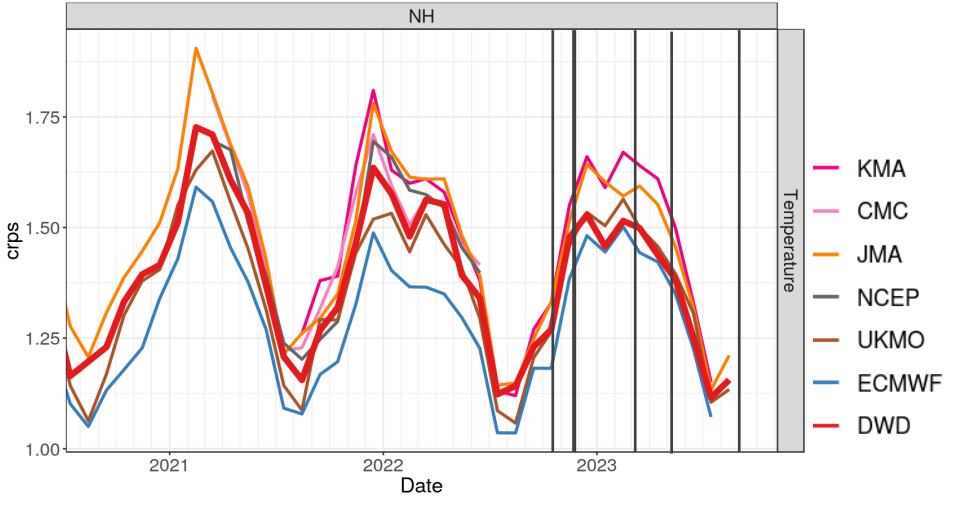
Günther Zängl, Martin Köhler
Deutscher Wetterdienst DWD

T850hPa scores WMO

deterministic 24h vs. obs



ensemble 7d vs. ana



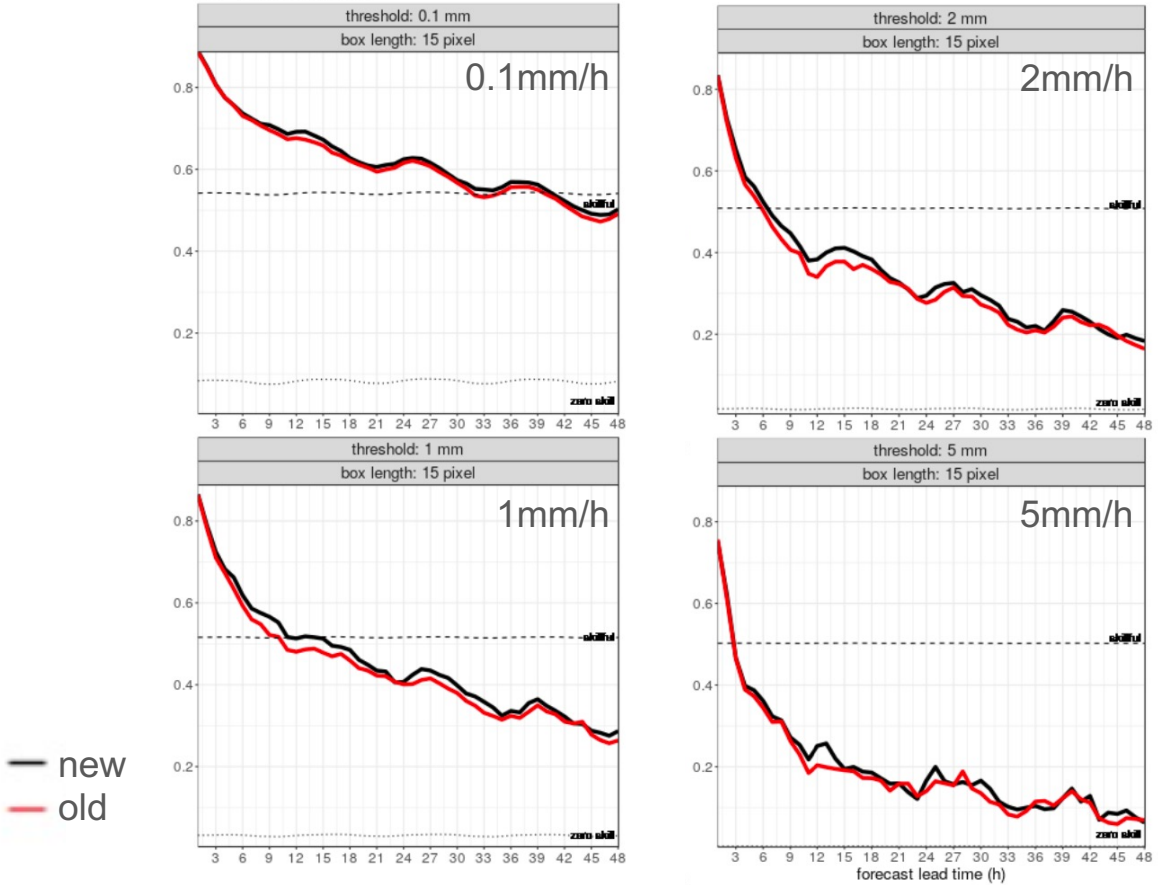
2022-10-12: sub-grid latent heating

Latent heating related to changes in sub-grid cloud-cover is passed to dynamics.

Impacts:

- Global ICON: Small because parameterized deep convection.
- ICON-D2: Reducing tendency to initiate convection too sparsely and too late in situations of weak synoptic-scale forcing. Small improvement of precipitation forecasts.

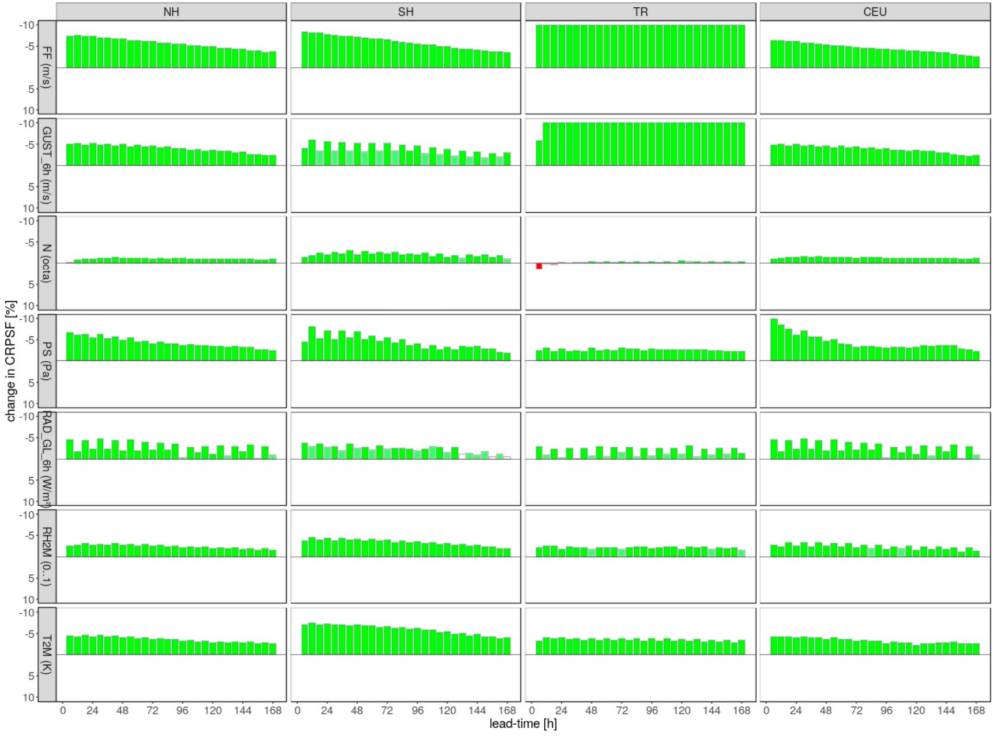
ICON-D2 (det.) Fraction Skill Score
2020-07-20 – 2020-09-27



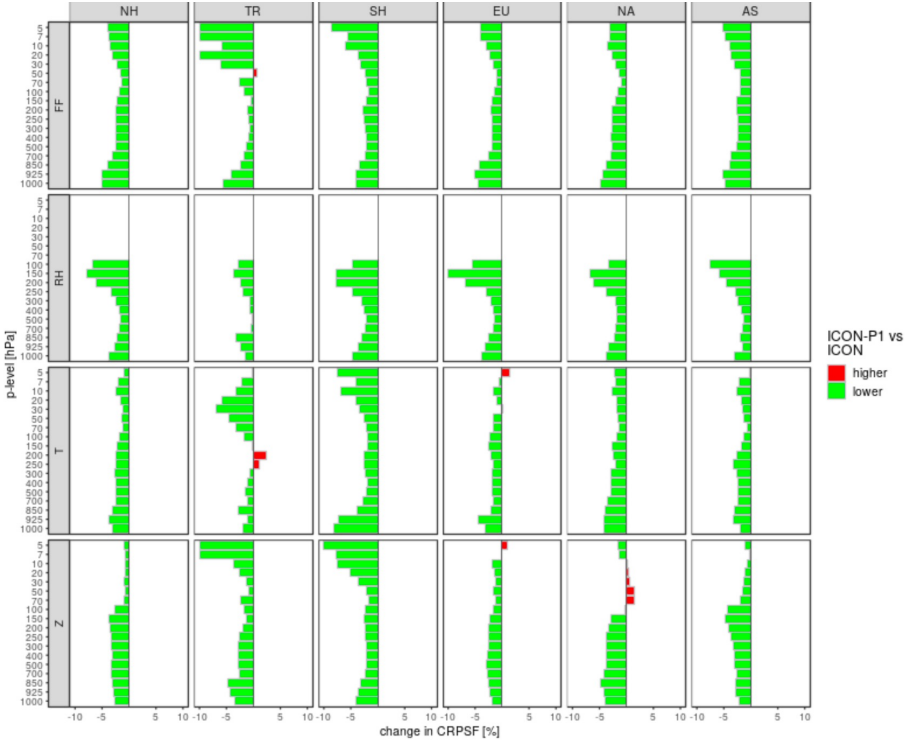
2022-11-23: resolution update

- 120/74 levels (global/EU)
- 13/26 km ensemble (global/EU)
- MERIT+REMA orography
- adaptive surface friction
- LPI lightning index (global/EU)

Surface CRPS scores (July-Oct 2022)

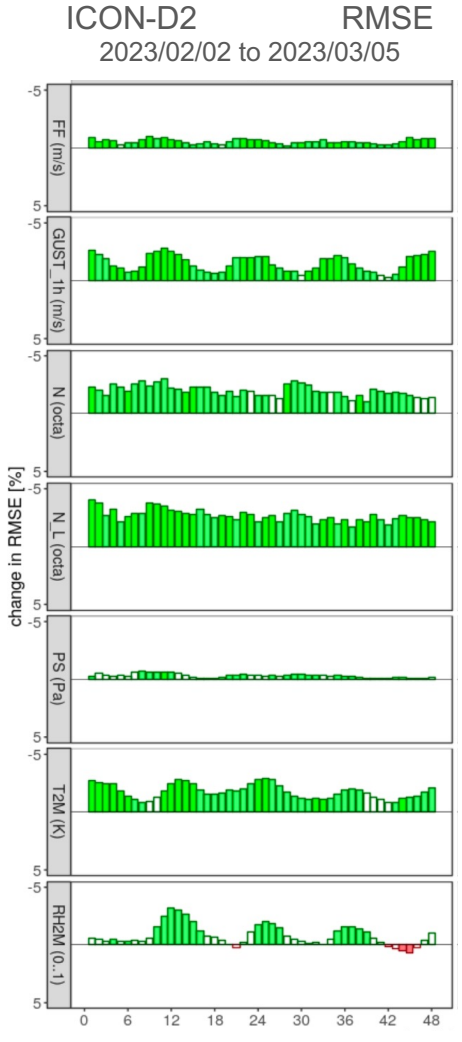


TEMP CRPS scores (July-Oct 2022)



2023-03-15: EIS stratus, adapting parameter tuning

- **Estimated Inversion Strength (EIS) to turn off shallow convection**
- artificial turbulence tuning in Tropics removed (vert. smoothing TKE source terms)
- reduced ocean roughness for winds >25m/s (Charnock parameterisation, stronger TCs)
- adaptive parameter tuning based upon data assimilation (DA) increments extended to the near-surface profile function of the minimum vertical diffusion coefficient for heat. (paper Günther Zängl)
- density of snow wind-speed dependent
- gust parameterisation: limit of SSO blocking correction
- extension of FF10M assimilation to Russia

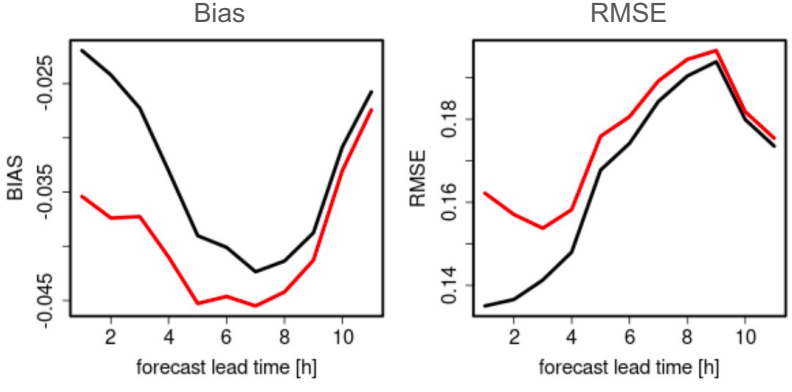


2023-03-15: visible SEVIRI in ICON-D2

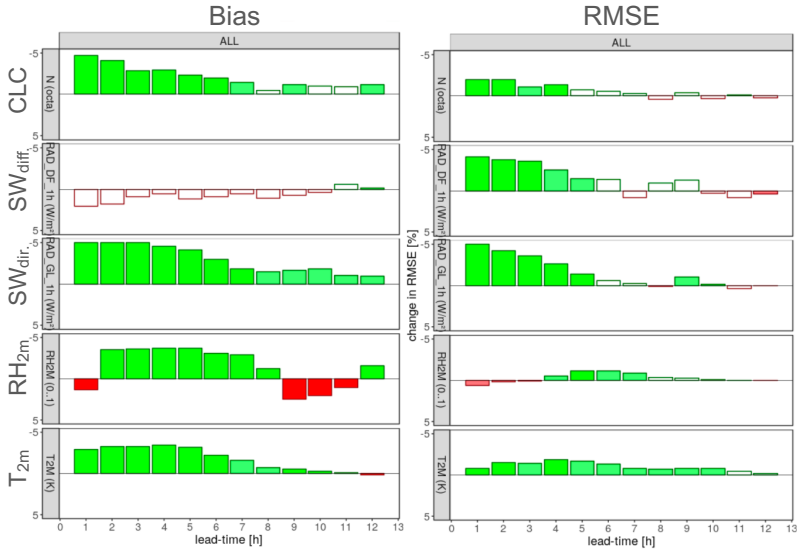
data assimilation of 0.6µm visible SEVIRI channel
(*Lilo Bach, Annika Schomburg*)

- first time satellite data in ICON-D2 data assimilation
- first time cloud data in ICON data assimilation
- first time visible data in DA in any NWP center world-wide
- forward operator MFASIS (HErZ-Munich) used

ICON-D2 vs. SEVIRI visible
2023/02/02 to 2023/03/05



ICON-D2 vs. SYNOP
Aug/Sep 2022



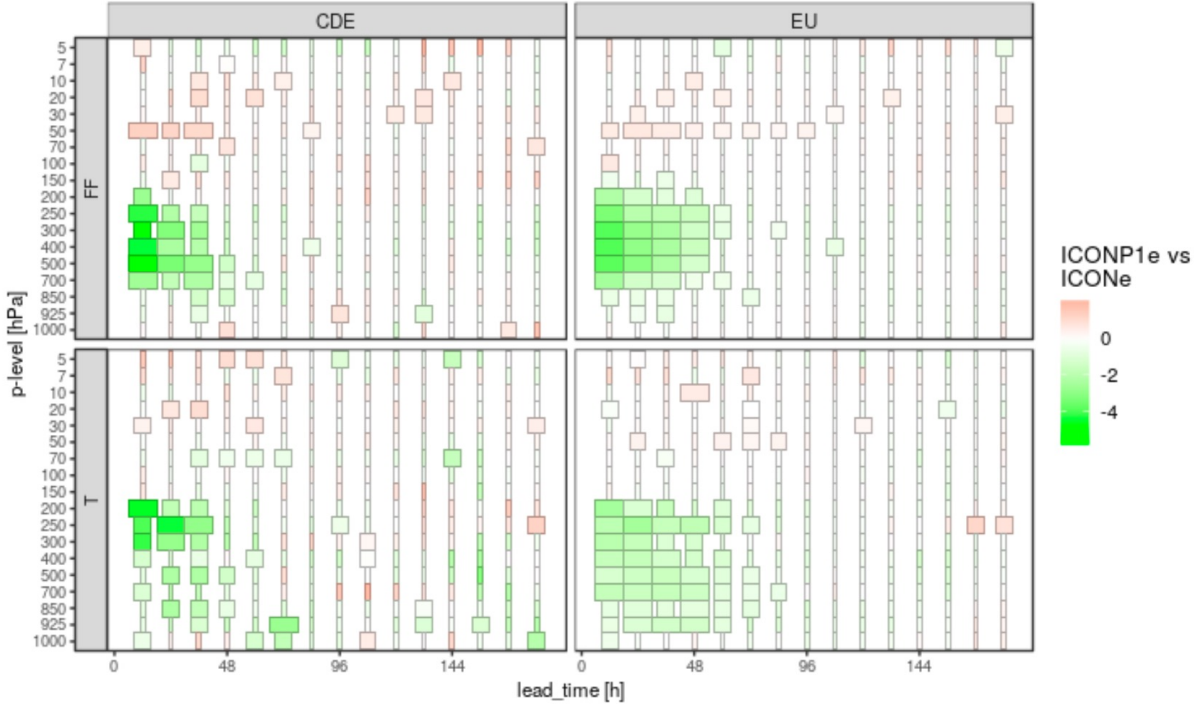
2023-05-03: MODE-S in global DA system

High-density MODE-S aircraft data of temperature and wind over Europe.

(Alexander Cress, Harald Anlauf, Christoph Schraff)

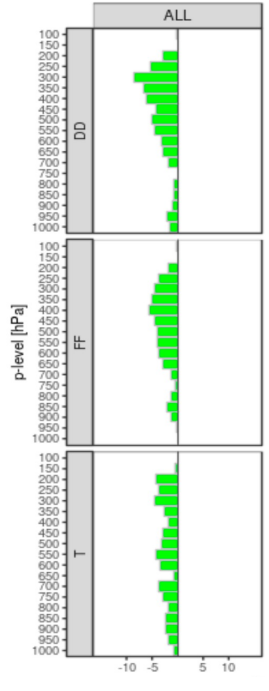
ICON global

2023/03/17 to 2023/04/25



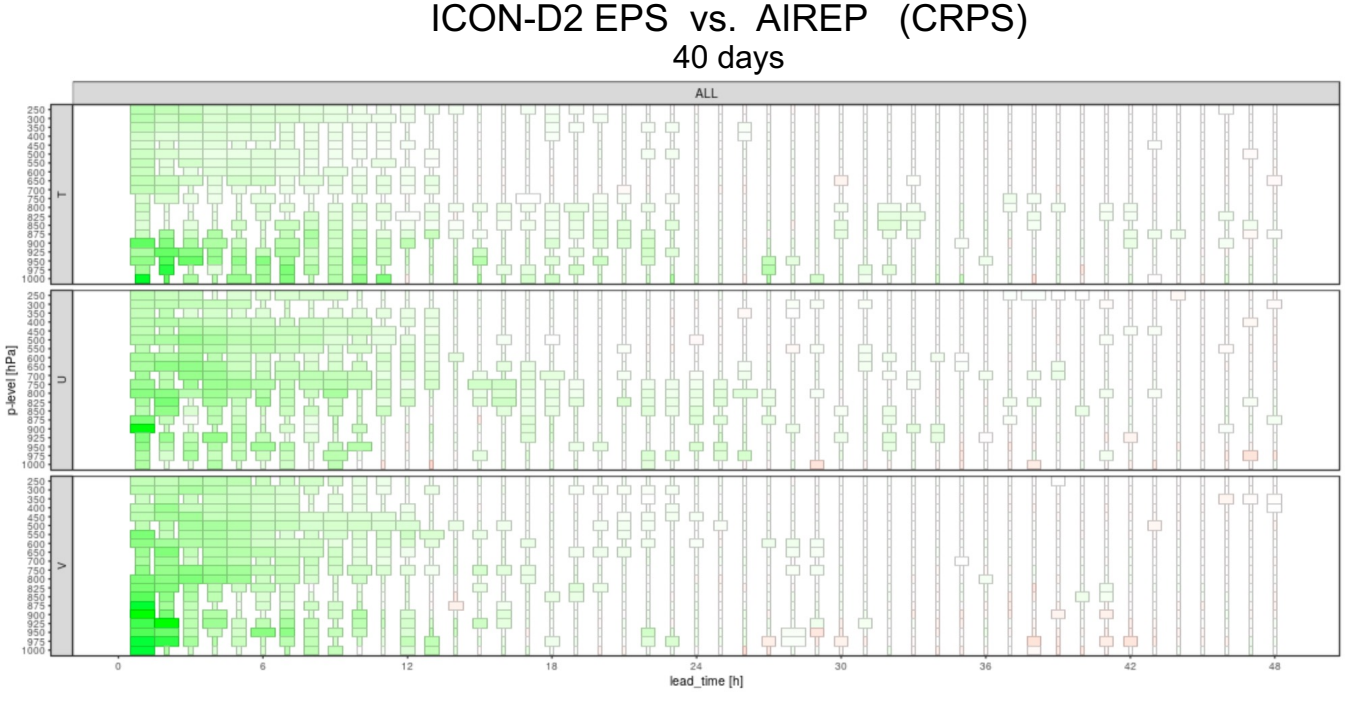
ICON-D2

2023/03/23 to 2023/04/25



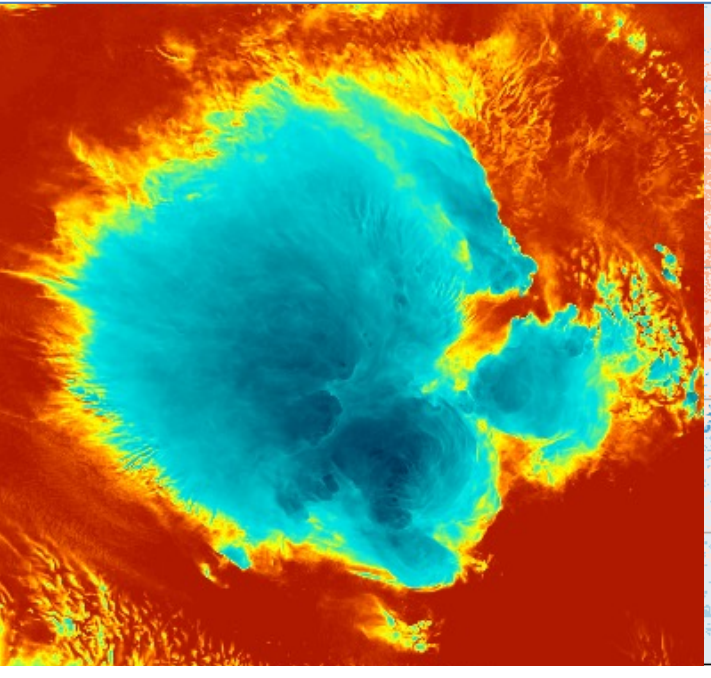
2023-09-06: ICON-D2 ensemble perturb. in first-guess

- Temporal variation by sinusoidal function with a period of about 2 weeks. This will avoid larger steps within parameter values between consecutive first guess runs of the assimilation cycles.
- Values in uncertainty range.
- Larger amplitudes of perturbations.

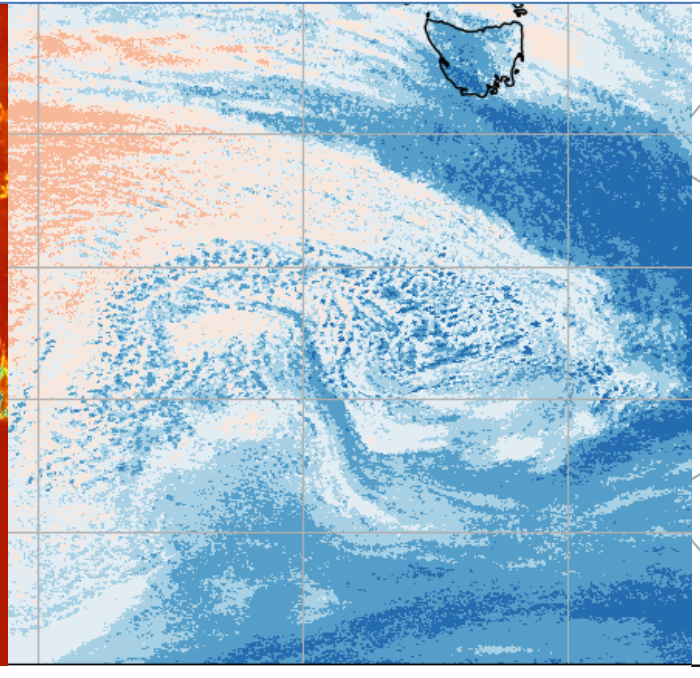


ICON seamless from 100m to 100km

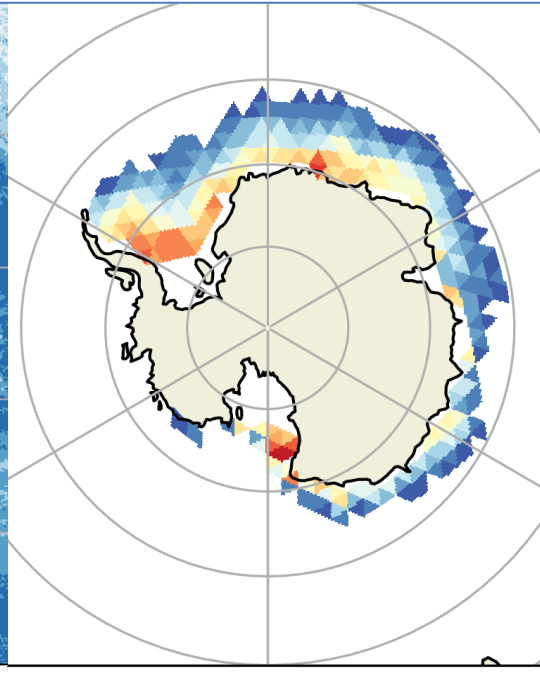
75-600m (LES)
TOA-LW, North of Australia, TWP-ICE



2500m (GSRM)
TOA-SW, South of Australia, SOCRATES



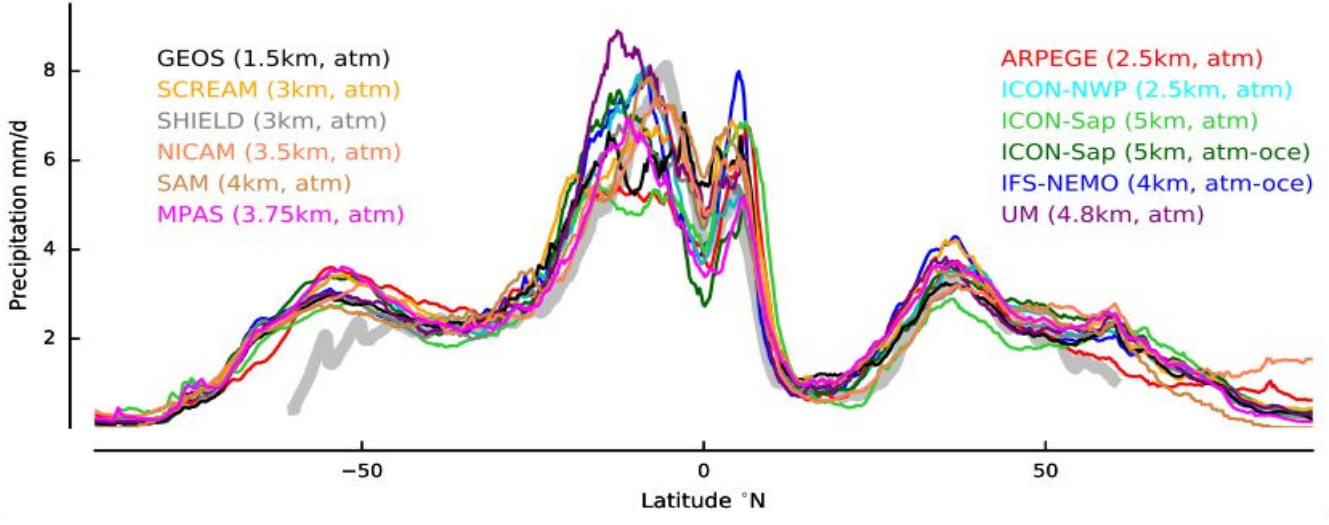
160km (GCM)
sea-ice fraction, Antarctica



Climate simulation at 1-5km resolution

Earth Virtualisation Engines (EVE)

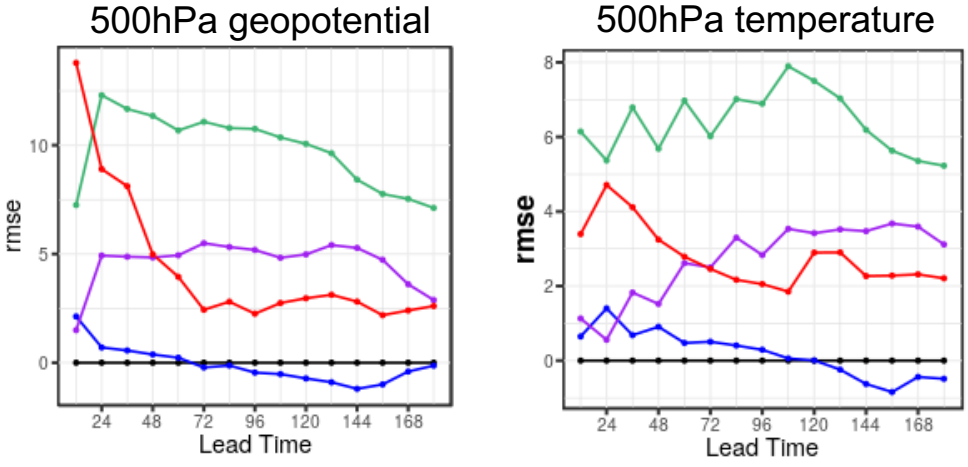
- Berlin meeting July 2023 (140 part.)
- 3-5 centers (each 300M€/year)
- km-scale modeling
- machine learning



precip reference: GSMaP-7

Duras, Ziemen, Klocke EGU2021

Sensitivity to horizontal resolution



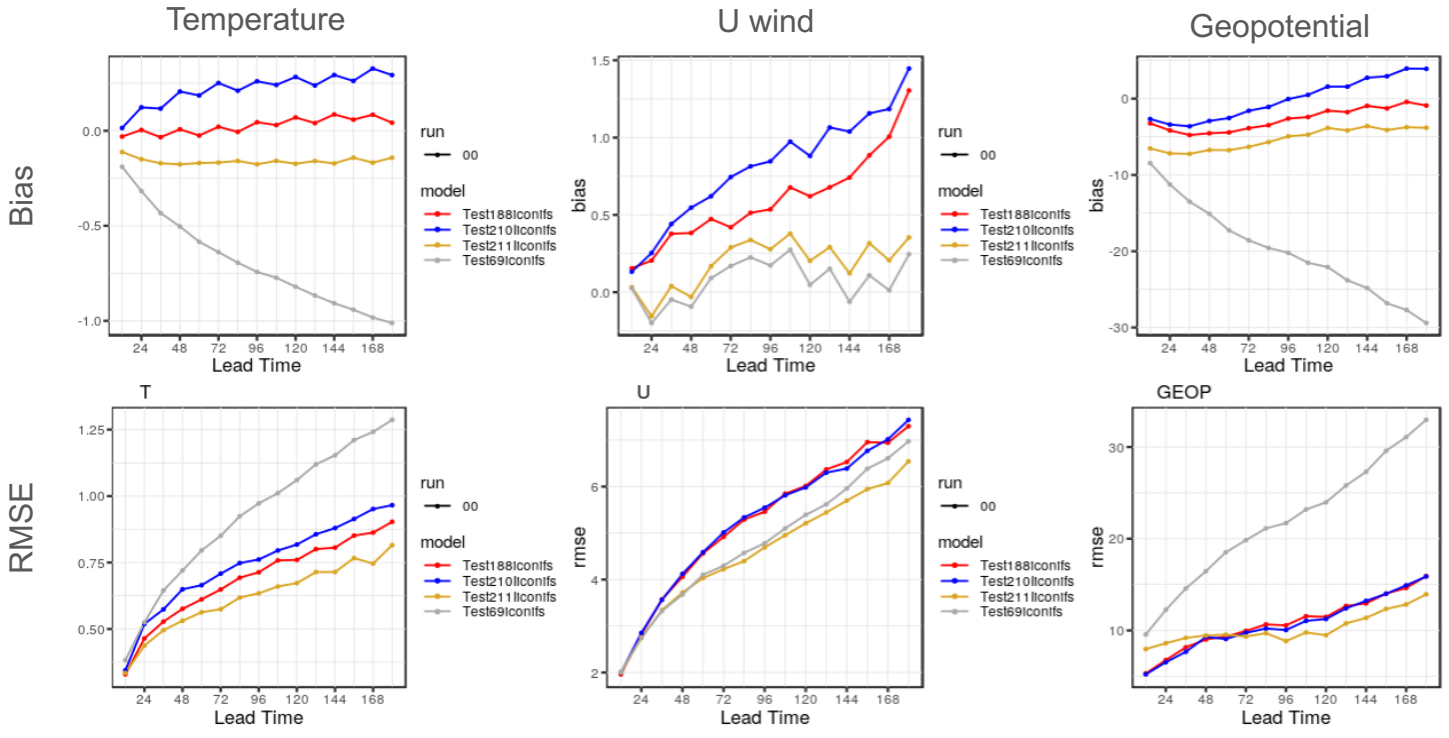
(Europe nest)
40km (20km) ← old EPS
26km (13km) ← new EPS
13km (6.5km) ← oper deterministic
10km (5km)
6.5km

relative differences [%] to operational configuration (13/6.5 km)
verification against IFS analyses (January 2021)

10-13km best with
deep convection parameterization

Analysis verification, tropics, 200 hPa

2021010101 - 2021010112



6.5 km

3.25 km
deepconv

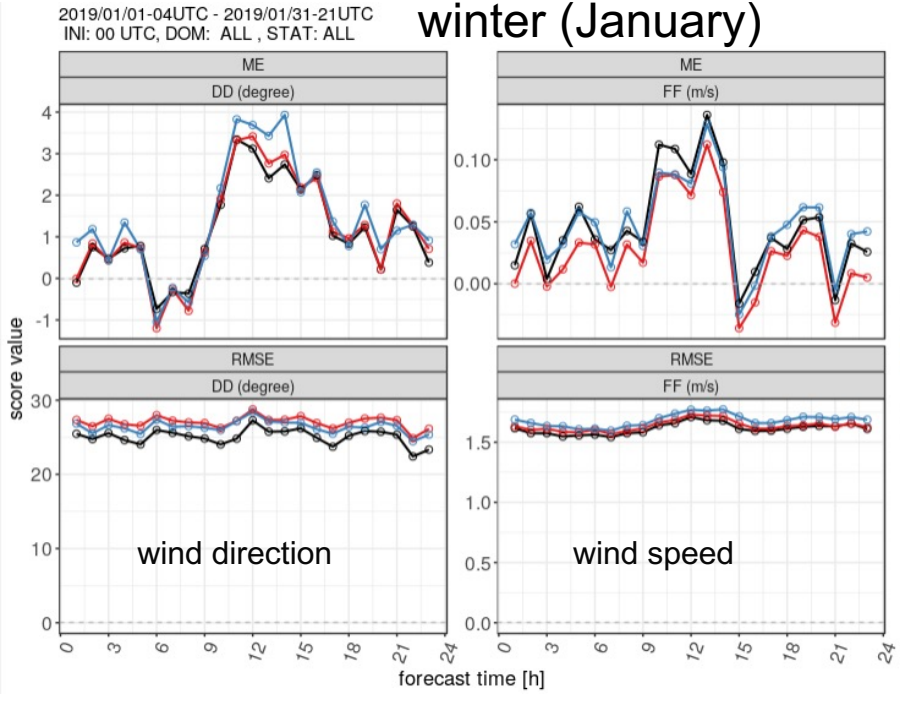
3.25 km
shallow conv.

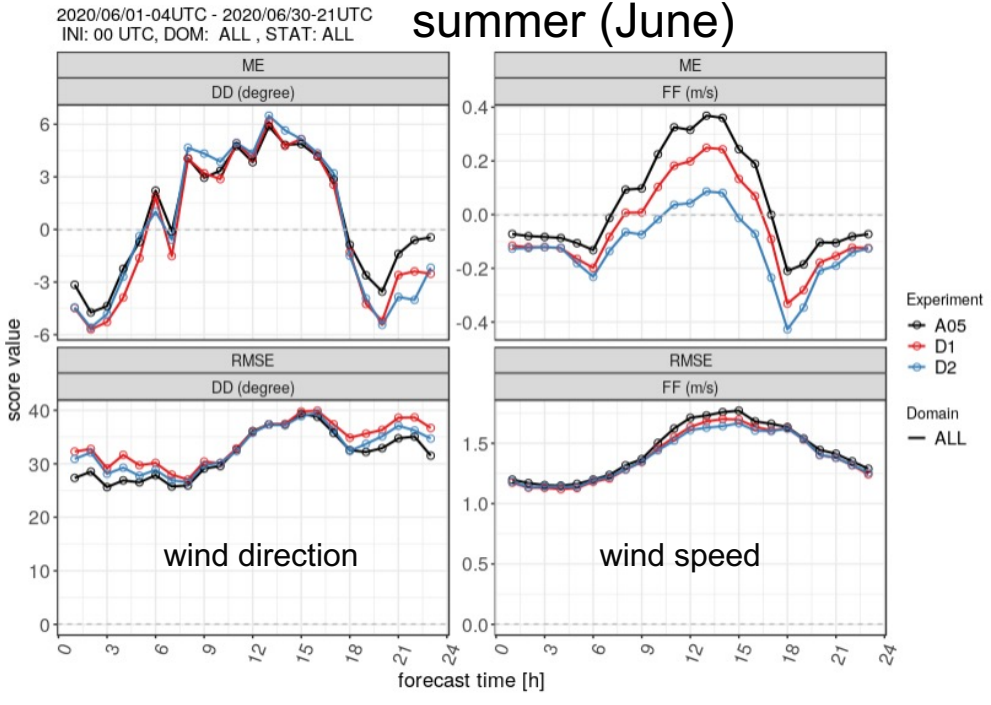
3.25 km
shallow conv. first try

3.25km best without deep convection parameterization (but shallow)

Alpine domain: 10m wind

2 km 1 km 500 m





Clear improvement in winter due to better resolution of the orography

Positive bias during daytime in summer that increases with increasing resolution

EPS resolution increase 26km vs 40km and L120 vs L90

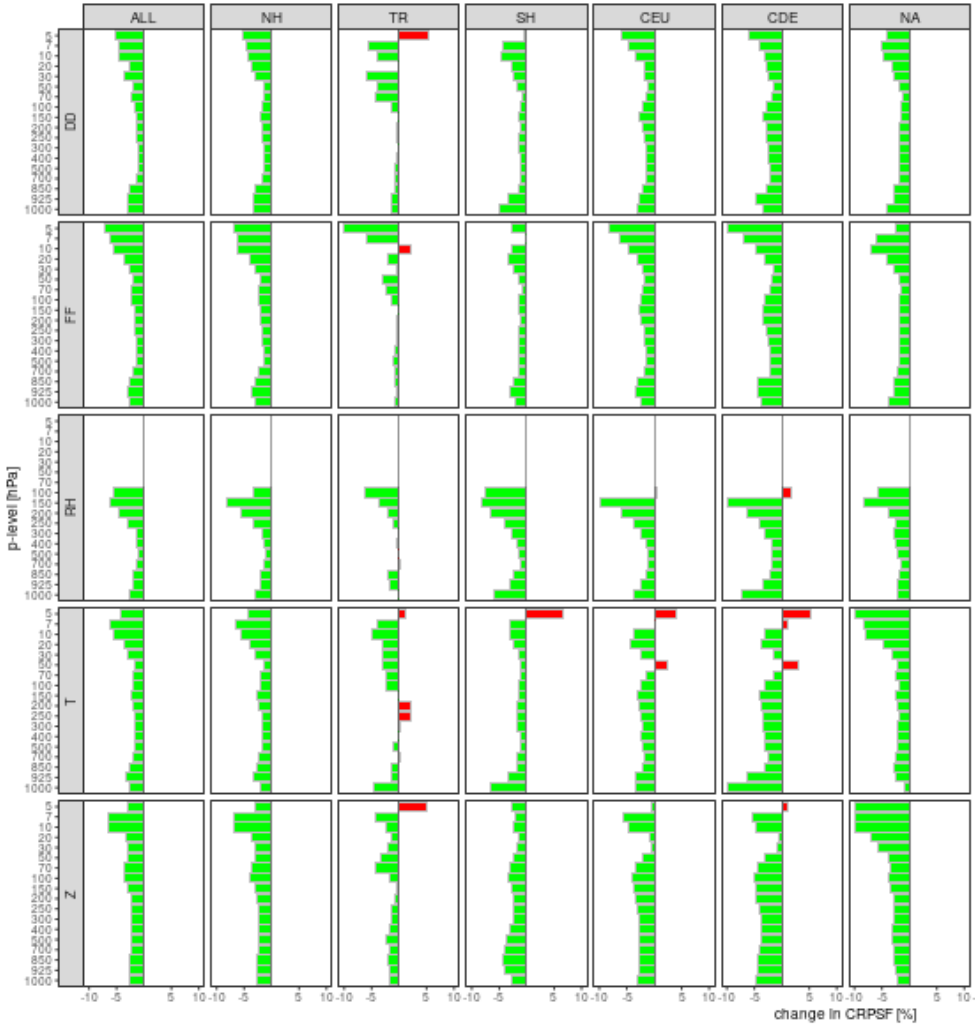
wind direction

wind speed

rel. humidity

temperature

geopotential

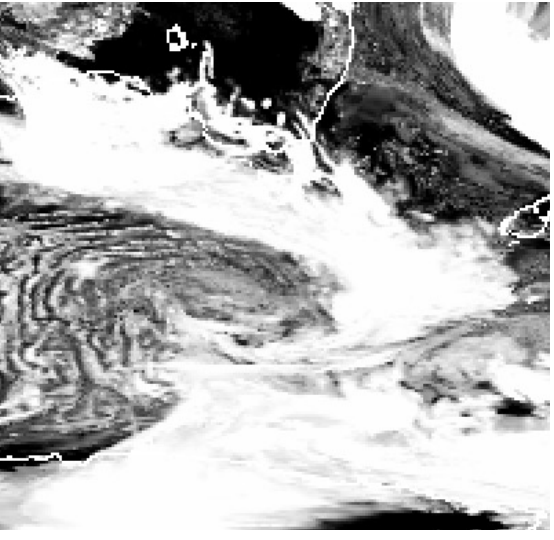


green:
26km is better
change in CRPSF [%]

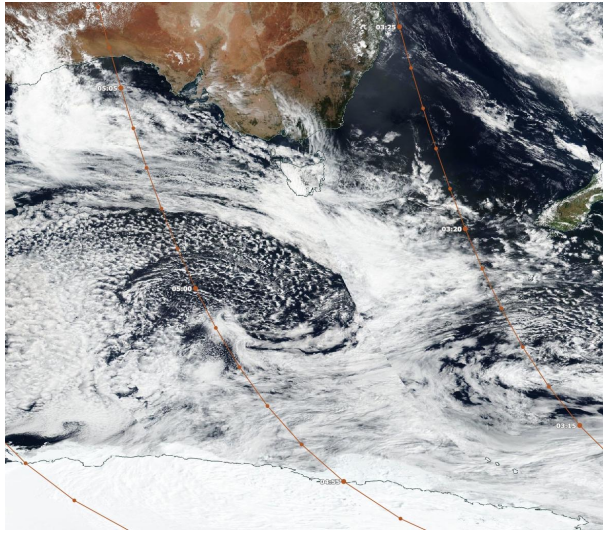
Winter 2020/21
80 days

SOCRATES region 20180217

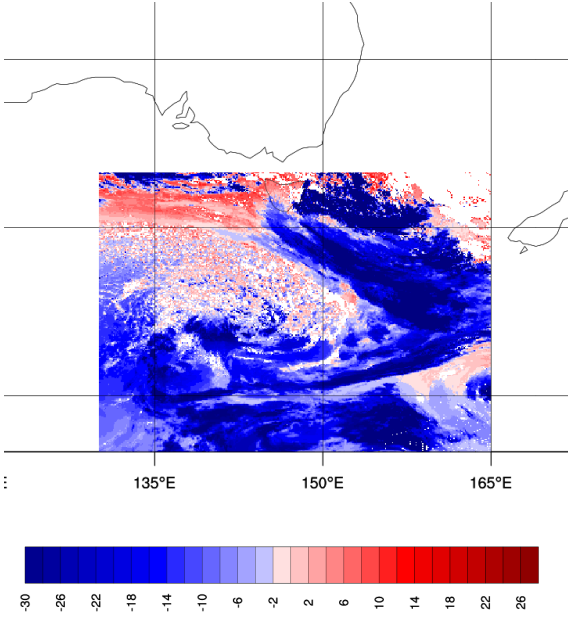
default ICON (6UTC)
cloud cover



CERES on VIIRS (4UTC)
true color



Himawary
cloud top temperature



Estimated Inversion Strength (EIS)

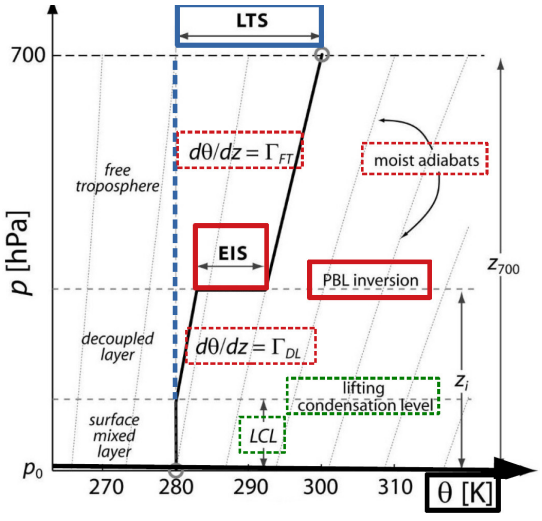


Figure 1: *The same Fig.1 of WB06 with coloured boxes.*

LTS: Klein, Hartmann (1993)
EIS: Wood, Bretherton (2006)
EIS_{new}: Marquet, Bechtold (2020)

$$\mathrm{EIS_{new}} = \mathrm{Max}\left(S_{700} - S_{950}\,;\; S_{950} - S_{\mathrm{surf}}\right)$$

moist entropy static energy:

$$S_m = c_{pd}\,(1 + 5.87\,q_t)\,T - L_v\,q_l - L_s\,q_i + g\,z$$

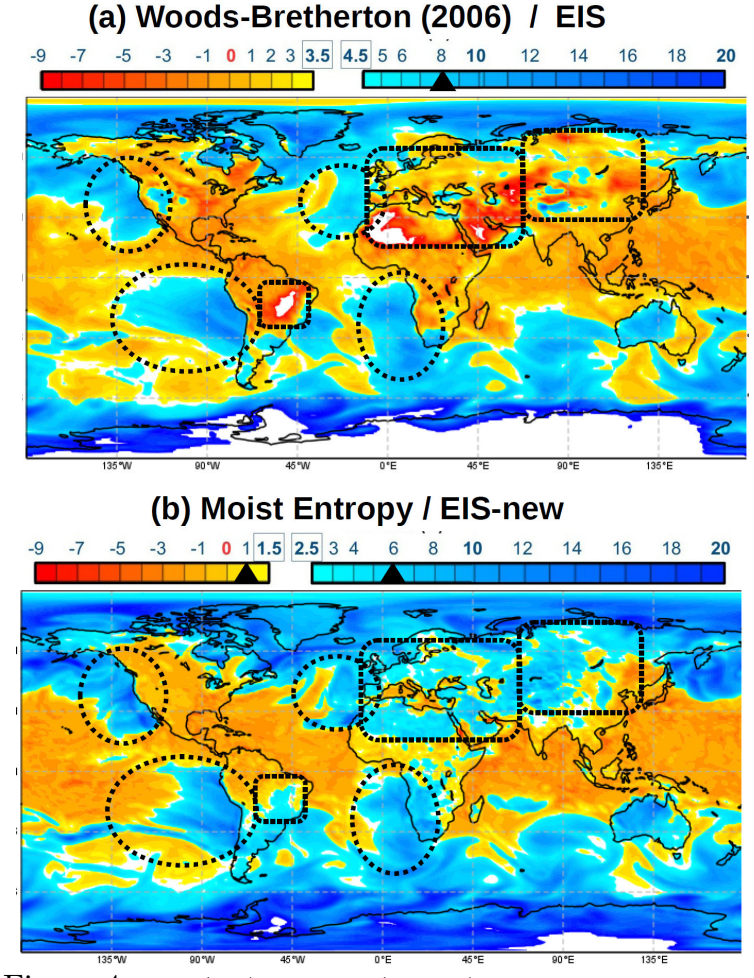
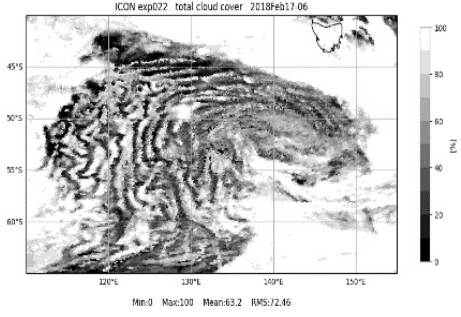


Figure 4: *Old (top) and new (bottom) EIS computed with IFS.*

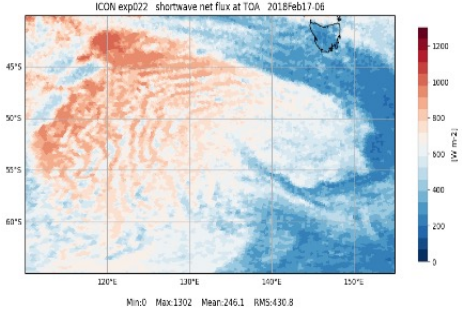
Bias in Southern Ocean: ICON in SOCRATES region 20180217 6UTC

default ICON

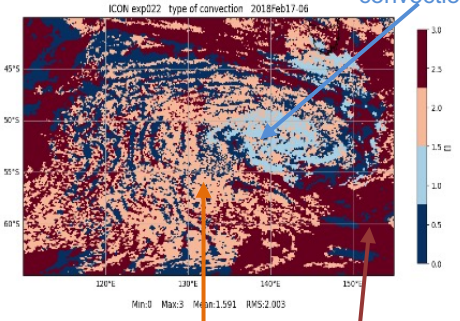
cloud cover



SW net TOA



type of convection

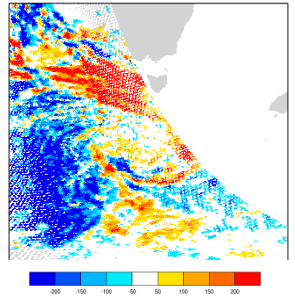


deep convection

shallow convection

mid-level convection

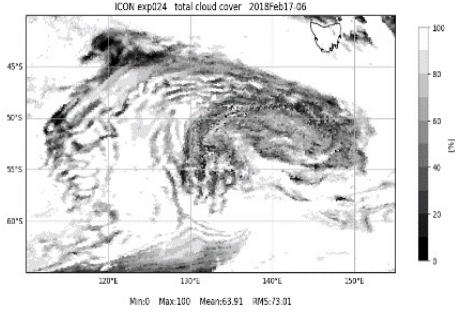
SW TOA flux up versus CERES [W/m2]



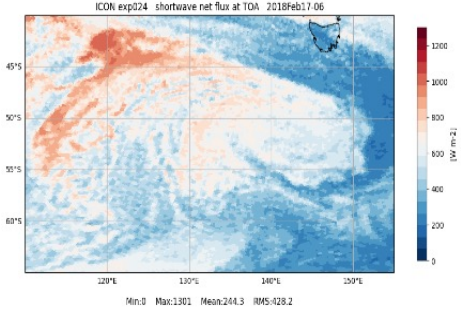
5:20UTC

turn off shallow convection if EIS_{new} > 7K

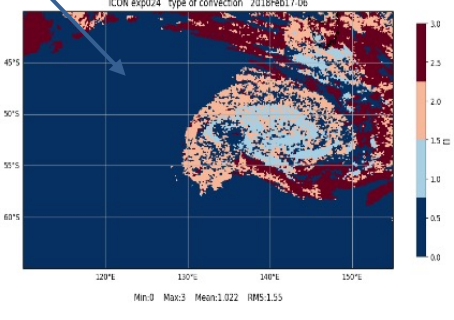
cloud cover



SW net TOA

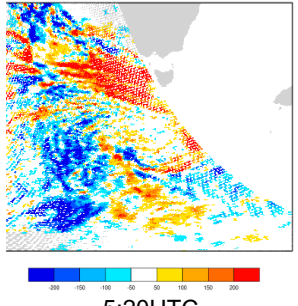


type of convection



no convection

SW TOA flux up versus CERES [W/m2]



5:20UTC

ICON news

Günther Zängl, Martin Köhler
Deutscher Wetterdienst DWD

- resolution update
  - 120 levels
  - 26km ensemble
  - MERIT orography
- stratus improvement
  - EIS as shallow convection switch

- MODE-S aircraft data
- visible SEVIRI in ICON-D2
- physics perturbation in ICON-D2 first guess