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Numerical Prediction

ICON-Info

Adaptive Parameter Tuning, and more

Die Zusammenfassung auf Deutsch finden Sie auf Seite 2. / Le résumé en français se trouve à la page 3.

Summary

On **12 August 2026, with the 12 UTC forecast cycle**, MeteoSwiss will introduce changes to the following components of its operational ICON model system: **ICON-CH1-EPS, ICON-CH2-EPS, and KENDA-CH1.**

These changes will **reduce systematic model errors in near-surface temperature and relative humidity.**

Users can expect the following changes to data quality:

– Reduction of systematic mean error (ME) as well as standard deviation of the error (STDE) for near-surface temperature and relative humidity.

– Slightly improved uncertainty information for near-surface temperature and near-surface dewpoint temperature.

– Removed "block-patterns" in direct solar radiation.

Users need to be aware of the following technical impacts of the changes:

– No user action required.

For more details on the changes to the ICON model system and their impact on data quality, please refer to the relevant sections on pages 4 ff.

Contact form https://www.meteoswiss.admin.ch/about-us/contact/contact-form.html
Kontaktformular https://www.meteoschweiz.admin.ch/ueber-uns/kontakt/kontaktformular.html
Formulaire de contact https://www.meteosuisse.admin.ch/portrait/contact/formulaire-de-contact.html
Formulario di contatto https://www.meteosvizzera.admin.ch/chi-siamo/contatto/formulario-di-contatto.html

Zusammenfassung

MeteoSchweiz wird am **12. August 2026 mit dem 12-UTC-Prognosezyklus** Änderungen an den folgenden Komponenten seines operationellen ICON-Modellsystems einführen: **ICON-CH1-EPS, ICON-CH2-EPS und KENDA-CH1.**

Diese Änderungen **verringern systematische Modellfehler für Temperatur und relative Luftfeuchtigkeit in Bodennähe.**

Die Nutzenden können hinsichtlich der Datenqualität folgende Änderungen erwarten:

– Reduktion des systematischen mittleren Fehlers (ME) sowie der Standardabweichung des Fehlers (STDE) für die Temperatur und die relative Luftfeuchtigkeit in Bodennähe.

– Leicht verbesserte Unsicherheitsangaben für die Temperatur und den Taupunkt in Bodennähe.

– Beseitigung von „Blockmustern“ bei der direkten Sonneneinstrahlung.

Die Nutzenden müssen folgende technische Auswirkungen der Änderungen beachten:

– Keine Massnahmen erforderlich.

Weitere Einzelheiten zu den Änderungen am ICON-Modellsystem und deren Auswirkungen auf die Datenqualität finden Sie in den entsprechenden Abschnitten ab Seite 4.

Résumé

Le **12 août 2026, avec le cycle de prévisions de 12 UTC**, MétéoSuisse introduira des modifications dans les composants suivants de son système opérationnel ICON : **ICON-CH1-EPS, ICON-CH2-EPS et KENDA-CH1**.

Ces modifications permettront **de réduire les erreurs systématiques du modèle concernant la température et l'humidité relative près de la surface.**

Les utilisatrices et utilisateurs peuvent s'attendre aux changements de qualité de données suivants :

– Réduction de l'erreur moyenne systématique (ME) ainsi que de l'écart-type de l'erreur (STDE) pour la température et l'humidité relative près de la surface.

– Légère amélioration des informations relatives à l'incertitude pour la température et le point de rosée près de la surface.

– Suppression des « motifs en blocs » dans le rayonnement solaire direct.

Les utilisatrices et utilisateurs doivent tenir compte des conséquences techniques suivantes :

– Aucune action n'est requise.

Pour plus de détails sur les changements apportés au système de modélisation ICON et leur impact sur la qualité des données, veuillez-vous reporter aux sections correspondantes à partir de la page 4.

In detail: Changes and their impact on data quality

The figures can be found at the end of the document.

Adaptive Parameter Tuning

Calibrating physical parameters at the land-surface interface is a critical challenge in numerical weather prediction, as soil and vegetation properties are uncertain, spatially heterogeneous, and only imperfectly represented in the model. These uncertainties can introduce systematic biases in near-surface variables.

To address this issue, we are introducing Adaptive Parameter Tuning (APT; Zängl 2023, 2026). This method uses a dynamic feedback loop that continuously monitors model performance against real-time observation data. When persistent systematic errors are detected, the scheme automatically adjusts empirical model parameters regulating the 2-metre temperature and 2-metre relative humidity. Model errors are estimated from the time-averaged analysis increments from the KENDA-CH1 analysis system. These are then used to adjust the uncertain parameters dependent on time and space. The increment memory lives in the assimilation cycle but is also passed to the forecasts during initialisation.

Adaptive Parameter Tuning has been extensively tested during a 6-week summer and a 2-week winter period. The results demonstrate that APT consistently reduces near-surface temperature and humidity biases across all three MeteoSwiss model system components (KENDA-CH1 analyses, ICON-CH1-EPS, and ICON-CH2-EPS forecasts). The magnitude of the improvement varies considerably, with KENDA-CH1 showing the largest gains, ICON-CH1-EPS showing moderate improvements, and ICON-CH2-EPS showing the smallest benefits - likely because model errors diagnosed on the finer 1 km analysis grid are not always representative of those on the coarser 2 km forecast grid.

Verification against surface and radiosonde observations shows that both the mean error (ME) and the standard deviation of the error (STDE) generally decrease for most variables, regions, and seasons, with particularly strong improvements for temperature and relative humidity (Figures 1 and 2). The slight degradation in STDE for 2-metre dew point temperature is an expected trade-off, as it is derived from the optimised temperature and relative humidity fields (Figure 1). For other variables such as wind, pressure, cloudiness, and precipitation, the impact remains minimal.

Sea-surface and soil perturbations in KENDA-CH1

Together with the update of the LETKF data assimilation software, perturbations of sea-surface temperature, soil temperature, and soil water content are now included in the KENDA-CH1 data assimilation system. The perturbations lead to a slight increase in the ensemble spread of 2-metre temperature and 2-metre dewpoint in the ICON-CH1-EPS and ICON-CH2-EPS forecasts, resulting in a more realistic representation of forecast uncertainty for these variables.

External parameter fields fixed to remove direct solar radiation artefacts

The previous external parameter dataset contained two fields, the ERA5 topography and the sea salt aerosol optical thickness (AOT), that introduced artefacts in the direct downward shortwave radiation. The ERA5 topography is used to compute a reference surface pressure, which is then applied to distribute the AOT vertically. Previously, the ERA5 topography was conservatively remapped to the ICON grid, resulting in a block-like pattern in the direct downward shortwave radiation. This issue has been resolved by using bilinear interpolation instead. We thank SLF for identifying and reporting this issue. In addition, an artefact in the sea salt AOT input field has been corrected. This has only a minor impact across the MeteoSwiss ICON domain, where sea salt AOT is generally much smaller than other aerosol components.

The full model changelog is available in the ICON model repository (https://gitlab.dkrz.de/icon/icon-model); the relevant commit is 11fc76ba.

Figures:

KENDA-CH1

Summer

PARAMETER	ΔSTDE / REF STDE			Δ|ME| POOLED / REF STDE		
	SP	AV	AM	SP	AV	AM
T_2M	-10%	-10%	+1%	-3%	-25%	-13%
TD_2M	-3%	+3%	-2%	+3%	-17%	-6%
RELHUM_2M	-8%	-5%	-3%	-8%	-26%	-10%

Winter

PARAMETER	ΔSTDE / REF STDE			Δ|ME| POOLED / REF STDE		
	SP	AV	AM	SP	AV	AM
T_2M	-3%	-8%	+1%	+8%	-36%	-11%
TD_2M	-2%	+5%	-1%	-26%	-0%	+1%
RELHUM_2M	-4%	-1%	-2%	-20%	-23%	-2%

ICON-CH1-EPS

Summer

PARAMETER	ΔSTDE / REF STDE						Δ|ME| POOLED / REF STDE					
	SP		AV		AM		SP		AV		AM	
	01-12	13-24	01-12	13-24	01-12	13-24	01-12	13-24	01-12	13-24	01-12	13-24
T_2M	-8%	-6%	-5%	-6%	-1%	-2%	-1%	+1%	-13%	-6%	-10%	-7%
TD_2M	-3%	+1%	+4%	+4%	-2%	-3%	+5%	-15%	-14%	-16%	-3%	-0%
RELHUM_2M	-8%	-4%	-2%	-2%	-3%	-3%	-8%	-23%	-30%	-33%	-6%	-3%

Winter

PARAMETER	ΔSTDE / REF STDE						Δ|ME| POOLED / REF STDE					
	SP		AV		AM		SP		AV		AM	
	01-12	13-24	01-12	13-24	01-12	13-24	01-12	13-24	01-12	13-24	01-12	13-24
T_2M	-0%	-2%	-3%	-0%	+1%	-0%	+22%	+20%	-37%	-28%	-6%	-4%
TD_2M	-0%	-4%	+3%	+3%	-1%	+1%	-32%	-38%	-5%	-12%	+1%	+1%
RELHUM_2M	-2%	-4%	-2%	-2%	-2%	+0%	-30%	-30%	-30%	-35%	-0%	+0%

ICON-CH2-EPS

Summer

PARAMETER	ΔSTDE / REF STDE												Δ|ME| POOLED / REF STDE											
	SP				AV				AM				SP				AV				AM			
	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120
T_2M	-3%	-4%	-2%	-2%	+3%	+1%	+2%	+1%	+3%	+1%	-0%	-0%	+8%	+8%	-4%	+1%	+1%	+5%	-3%	-6%	-7%	-6%	-2%	-2%
TD_2M	-1%	+1%	-0%	+2%	+3%	+4%	+5%	+4%	-2%	-2%	-2%	+0%	+8%	-13%	-16%	-12%	+5%	-5%	-12%	-6%	-2%	-0%	-0%	-0%
RELHUM_2M	-4%	-3%	+1%	+1%	+1%	+1%	+2%	+2%	-2%	-2%	-1%	+0%	+3%	-19%	-22%	-16%	-15%	-18%	-25%	-22%	-4%	-2%	-1%	-0%

Winter

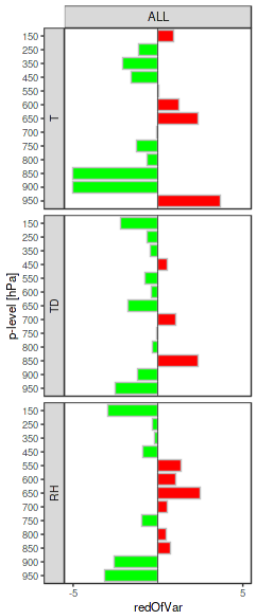
PARAMETER	ΔSTDE / REF STDE												Δ|ME| POOLED / REF STDE											
	SP				AV				AM				SP				AV				AM			
	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120	01-12	13-24	61-72	109-120
T_2M	-1%	-4%	-1%	+0%	-1%	-0%	+2%	+5%	+1%	+1%	+1%	+1%	+11%	+11%	-15%	-9%	-36%	-33%	-28%	-19%	-4%	-3%	-2%	-4%
TD_2M	+1%	-3%	-3%	-3%	+5%	+5%	+4%	+5%	+0%	+1%	+1%	+0%	-32%	-37%	+19%	+19%	-10%	-15%	-8%	+9%	+1%	+2%	+1%	+2%
RELHUM_2M	-1%	-4%	-3%	-2%	-0%	-2%	-2%	-1%	-1%	-0%	+1%	+0%	-31%	-35%	-12%	+7%	-33%	-35%	-33%	-12%	+1%	+2%	+1%	+1%

Figure 1) Score cards for temperature (T_2M), dew point temperature (TD_2M) and relative humidity (RELHUM_2M) verification against Swiss surface station observations. Shown are the percentage changes in the mean error (ME) and the standard deviation of the error (STDE) obtained with APT compared to the operational reference. Negative (positive) changes reflect improvements (degradations) of the APT experiment compared to the operational reference. Green (red) colours indicate larger improvements (degradations). The results are stratified by different regions (SP: Swiss Plateau, AV: Alpine Valleys and AM: Alpine Mountain stations) and different forecast time ranges (e.g., 01-12 indicating forecast times averaged from +01h to +12h).

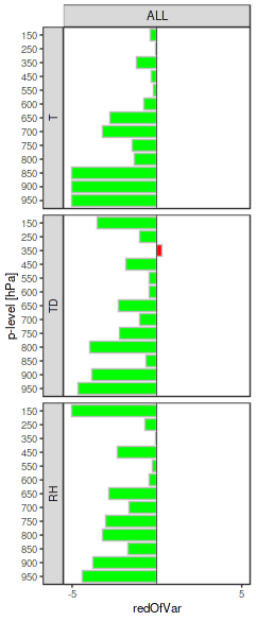
ICON-CH1-EPS

Summer

ME

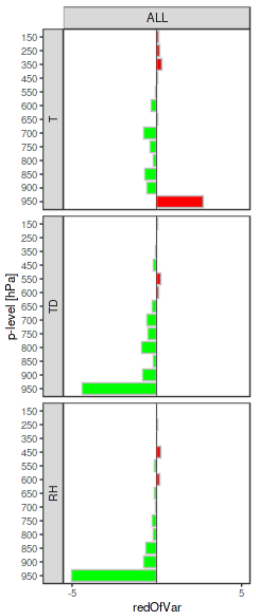


STDE

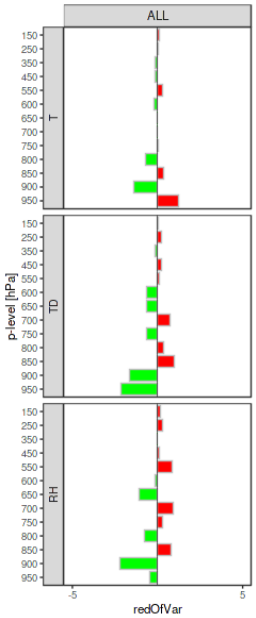


Winter

ME



STDE



ICON-CH2-EPS

Summer

Winter

ME STDE ME STDE

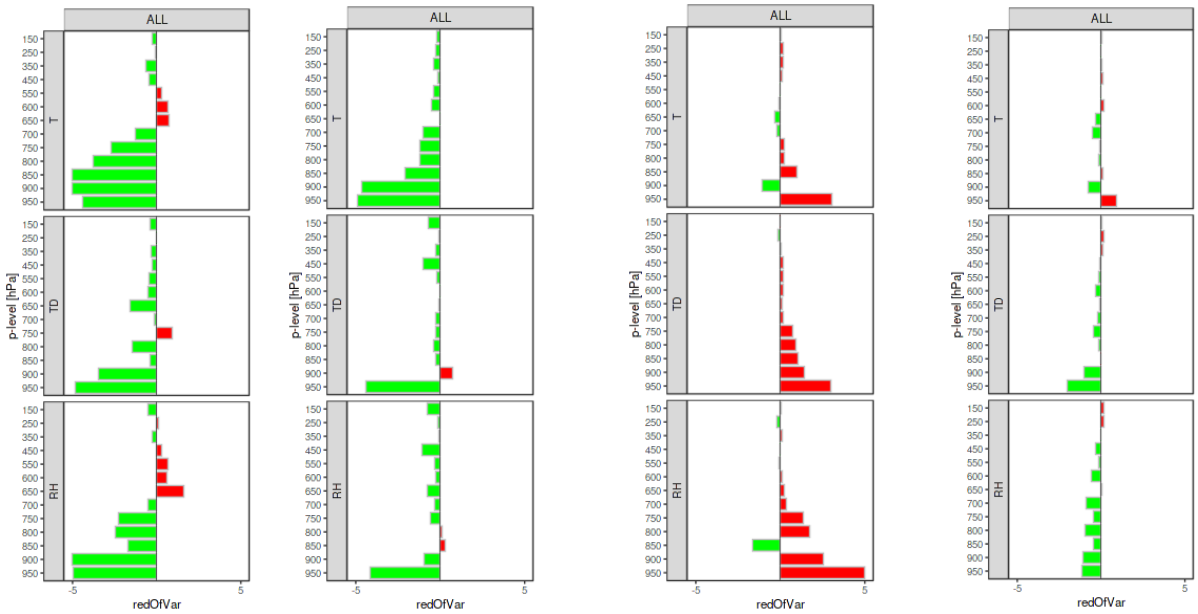


Figure 2) Score cards for temperature (T), dewpoint (TD) and relative humidity (RH) verification against all radiosonde observations in the ICON domain dependent on height (y-axis, pressure levels). Shown are percentage changes in the mean error (ME) and the standard deviation of the error (STDE) (x-axis) obtained with APT compared to the operational reference. Negative/Green (positive/red) values/colours indicate improvements (degradations) of the APT experiment compared to the operational reference. The results are averaged over all lead-times (+24h for ICON-CH1-EPS and +120h for ICON-CH2-EPS).