LATE REQUEST FOR A EMI R&D PROJECT 2026–2027

Country/Organisation: .... Israel Meteorological Service (IMS) ....

Principal Investigator[1]**:** .... Elyakom Vadislavsky ....

Affiliation: .... Israel Meteorological Service (IMS) ....

Address: .... P.O.B. 25 Bet-Dagan, 5025001, Israel ....

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Other researchers: ... Pavel Khain, Harel Muskatel, Yoav Levi, Amir Givati ....

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Project Title: ... Convection permitting precipitation forecasting using Correction Diffusion AI model: calibration and training ....

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To make changes to an existing project please submit an amended version of the original form.

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP**	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2026	
Would you accept support for 1 year only, if necessary?	YES X	NO ☐

Late EMI R&D Projects are normally approved for 1 year, but exceptionally can be approved for 3 years.

Computer resources required for project year:		**2026**	**2027**	**2028**
High Performance Computing Facility	[SBU]			
Graphics Processing Unit Cluster-A	[GBU]	1.05M	1.05M	
Graphics Processing Unit Cluster-B	[GBU]	0.99M	0.99M	
Accumulated data storage (total archive volume)[2]	[GB]	1000	1000	

[1] The Principal Investigator will act as contact person for this EMI R&D Project and, in particular, will be asked to register the project, provide annual progress reports of the project's activities, etc.

[2] These figures refer to data archived in ECFS and MARS. If e.g. you archive x GB in year one and y GB in year two and don't delete anything you need to request x + y GB for the second project year etc.

[3]The number of vGPU is referred to the equivalent number of virtualized vGPUs with 8GB memory.

EWC resources required for project year:		2026	2027	2028
Number of vCPUs	[#]	0	0	0
Total memory	[GB]	0	0	0
Storage	[GB]	0	0	0
Number of vGPUs[3]	[#]	0	0	0

Continue overleaf.

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Project Title: …………… Convection permitting precipitation forecasting using Correction Diffusion AI model: calibration and training …………

Extended abstract

All EMI R&D Project requests should provide an abstract/project description including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The completed form should be submitted/uploaded at https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission.

Following submission by the relevant Member State the EMI R&D Project requests will be published on the ECMWF website and evaluated by ECMWF and its Scientific Advisory Committee. The requests are evaluated based on their scientific and technical quality, and the justification of the resources requested. Previous EMI R&D Project reports and the use of ECMWF software and data infrastructure will also be considered in the evaluation process.

Requests exceeding 10,000,000 SBU should be more detailed (3-5 pages).

Scientific Plan

Correct precipitation forecasting in high resolution remains one of the main challenges of national weather services. The common approach is tuning and running numerical models and model ensembles in convection permitting resolution of ~1km. These models, however, require significant amount of computer time, and often limited number of ensemble members is affordable.

During the last years, an alternative approach is being developed, namely replacing the numerical models by ML models. Most of them, however, are being trained on global convection parametrizing models (e.g. ERA5), and therefore typically provide smooth precipitation forecasts, which fail to represent the real precipitation rates distribution. Recently, NVIDIA [Mardani et al., 2025] developed a Correction-Diffusion Model (hereafter, CORRDIFF) which is aimed to downscale convection-parametrizing coarse models to high convection permitting resolution. In [Mardani et al., 2025], CORRDIFF was trained using the Convection permitting WRF model, and used to downscale ERA5 to the WRF's resolution. Besides near surface fields, CORRDIFF provides ensemble of gridded hourly precipitation forecasts in convection-permitting resolution, which preserve the spatial sharpness of precipitation fields and often look similar to radar precipitation images.

During the last year, as part of a scientific collaboration of the Israel Meteorological Service and NVIDIA, CORRDIFF was trained over the Eastern Mediterranean using the ICON 2.5km resolution model, using IFS high resolution forecasts as input.

Figure 1 shows an example of CORRDIFF forecast (right panel) during a major flash flood event in the Judean desert on 27/4/2026, in comparison to ICON 2.5km forecast driven by IFS (centre), and the radar-rain gauges precipitation composite (right).

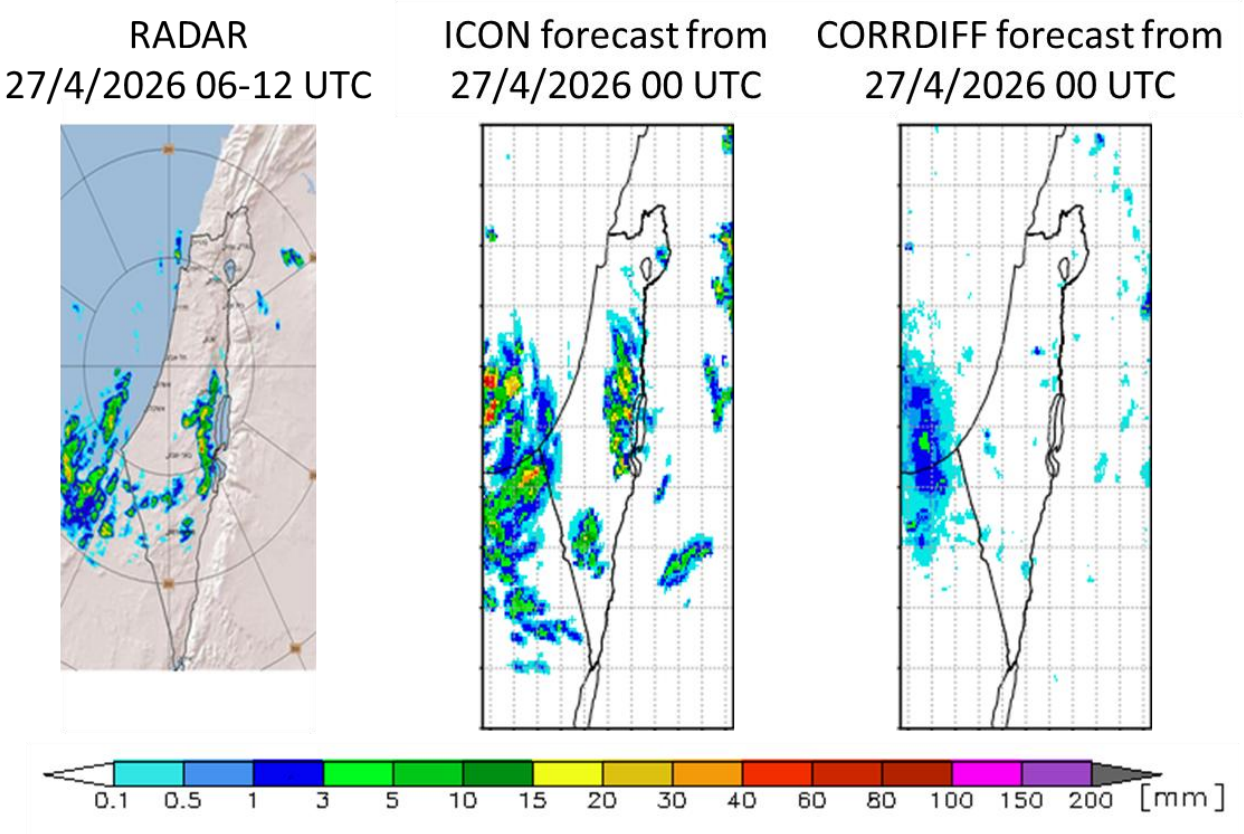

Figure 1: CORRDIFF forecast (right panel) during a major flash flood event in the Judean desert on 27/4/2026, in comparison to ICON 2.5km forecast driven by IFS (centre), and the radar-rain gauges precipitation composite (right).

Figure 2 shows rain rates distributions in rain gauges locations, versus rain gauges data (blue). The distributions of IFS 9 km resolution and ICON 2.5 km resolution are shown in orange and green, respectively. The rain rates distributions of CORRDIFF ensemble members are presented in red (ensemble mean), purple (80^{th} percentile), brown (90^{th} percentile) and pink (95^{th} percentile). ICON 2.5 km resolution (green) shows the best agreement with the observed distribution. IFS and ensemble mean of CORRDIFF are characterized by smooth precipitation fields, which is reflected in wrong distribution of high rain rates (orange and red). Higher CORRDIFF ensemble percentiles correspond better to the observed distribution, but even percentile 95 fails to describe the very high precipitation rates, while overestimating the bulk of the distribution.

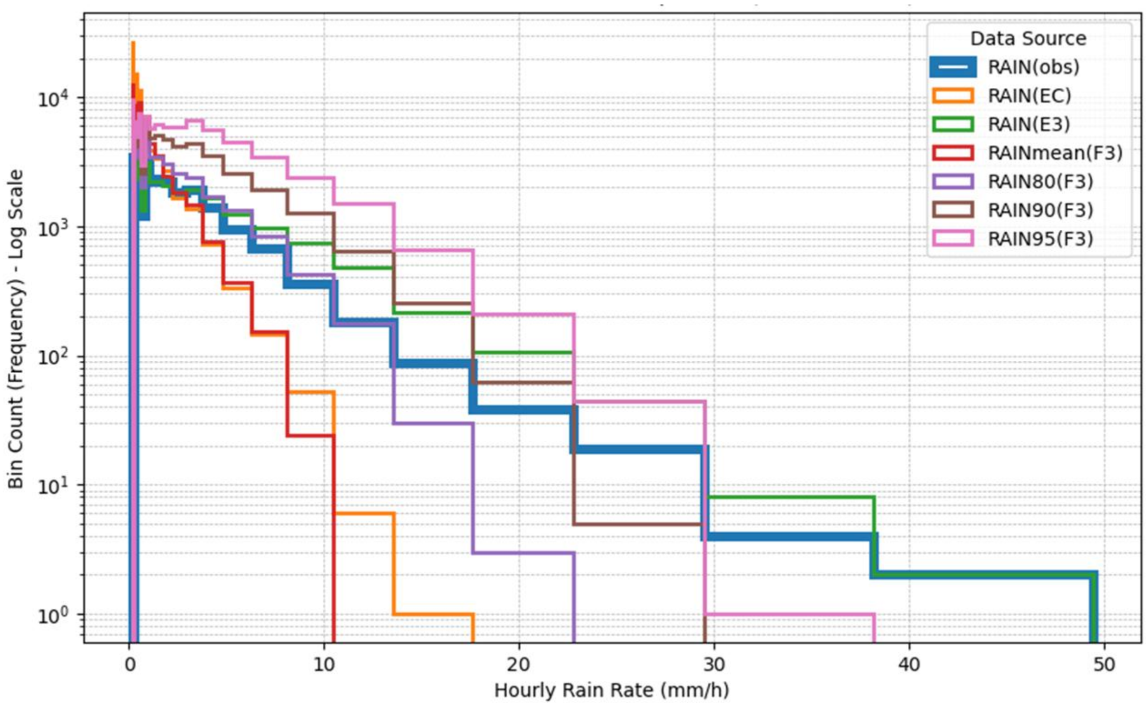

Figure 2: Rain rates distributions in rain gauges locations, versus rain gauges data (blue). The distributions of IFS 9 km resolution and ICON 2.5 km resolution are shown in orange and green, respectively. The rain rates distributions of CORRDIFF ensemble members are presented in red (ensemble mean), purple (80th percentile), brown (90th percentile) and pink (95th percentile).

One can see, that CORRDIFF typically underestimates precipitation over the Eastern Mediterranean, highlighting the need of further investigation and improvement of this approach in order to be used for weather prediction. Our experience with training CORRDIFF, shows significant acceleration when using GPU instead of CPU, as expected from AI model.

The following working plan is proposed for years 2026-2027:

2026:

Step 1 of the working plan includes installing the working environment and training CORRDIFF on 6 years of the recently tuned ICON 2.5km over the Eastern Mediterranean. For that purpose, 1.05M are required on Graphics Processing Unit Cluster-A and 0.99M on Cluster-B.

Following the verification of step 1 above versus radar-rain gauges composite, step 2 of the working plan includes detailed analysis of several possibilities to improve CORRDIFF performance:

2027:

- Investigating the effect of adding significantly more fields as an input from the IFS model, and using more pressure (or model) levels. This part requires development of a "fast check" method, where partial training is used to predict the benefit of an additional input field.
- Investigating the effect of adding basic dependence of the predicted CORRDIFF field on the previous time step(s) of the coarse input fields.
- Performing final training of the improved CORRDIFF version, and presenting the conclusions to the NWP community.

For that purpose, 1.05M are required on Graphics Processing Unit Cluster-A and 0.99M on Cluster-B.

We believe that CORRDIFF is able to present high forecasting skill, which is comparable to that of convection permitting numerical models. In case of positive results, our recommendations on its optimal utilization for precipitation forecasting may become highly valuable for the community.

References

Mardani, M., Brenowitz, N., Cohen, Y. *et al.* Residual corrective diffusion modeling for km-scale atmospheric downscaling. *Commun Earth Environ* 6, 124 (2025). https://doi.org/10.1038/s43247-025-02042-5