



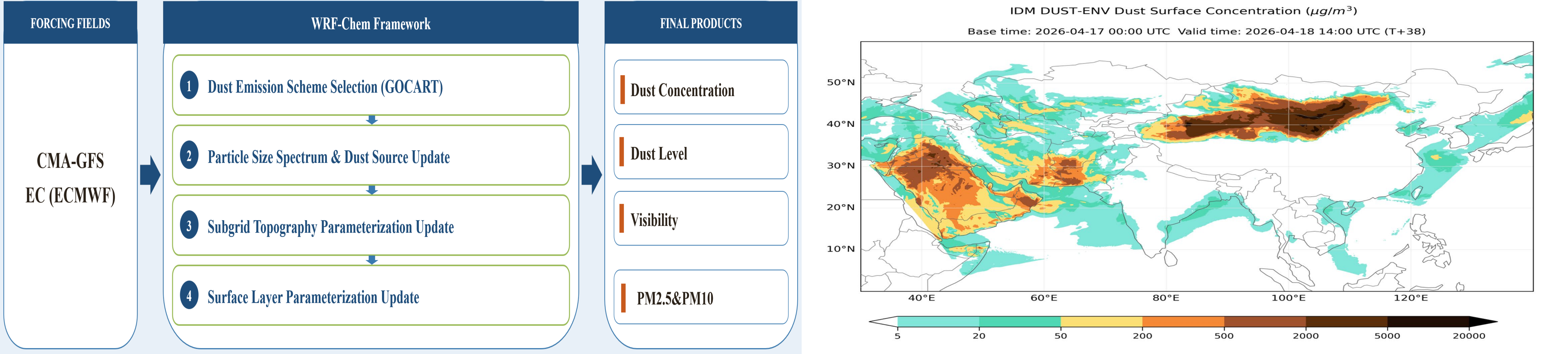
中国气象局乌鲁木齐沙漠气象研究所沙尘环境预报系统



DUST-ENV数值预报系统 · AI-DUST 人工智能预报系统

DUST-ENV沙尘数值预报系统

空间分辨率：9 km · 时间分辨率：1 h · 预报时效：7 天



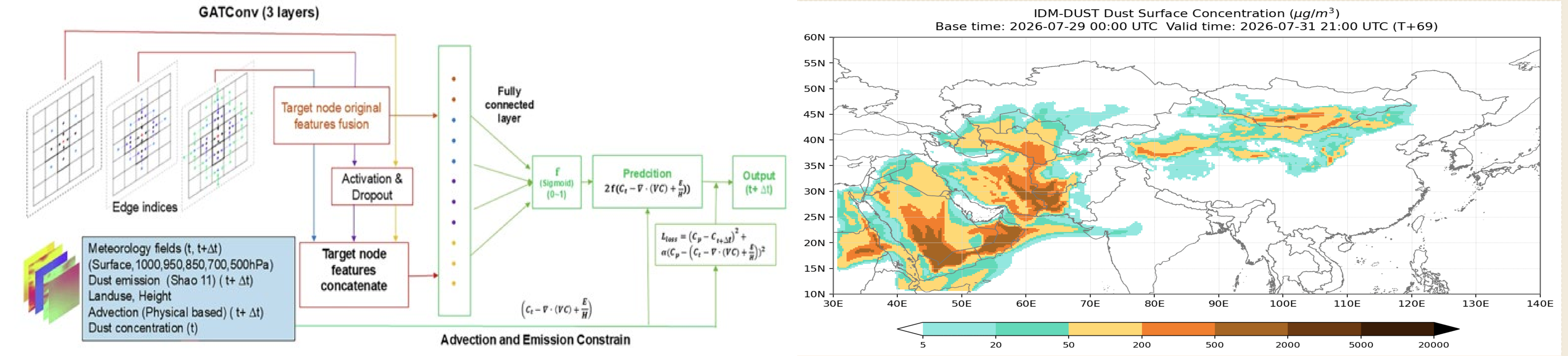
系统简介

本系统为中亚区域沙尘—环境预报系统（DUST_ENV），以WRF-Chem为动力框架，以CMA-GFS和EC预报场为背景场，包含五大功能模块：模式背景场与观测资料前处理、污染物同化分析、预报积分、产品后处理与数据归档、系统自动化智能运行。围绕中亚地区沙尘预报能力提升，系统通过起沙方案优选确定物理框架，通过粒径谱与沙源更新提供物质基础，通过地形参数化改进刻画动力条件，通过近地层方案改进保障近地层风速精度，形成了完整的改进技术链条。改进后，模式对中亚地区沙尘天气的模拟能力全面提升，预报时效达168小时，产品涵盖能见度、沙尘等级、沙尘浓度、污染物六要素等核心预报因子，形成系列化预报产品；支持图片、文本、MICAPS格式及网站展示等多种输出形式，并通过API、Web及分布式共享数据库实现产品分发。

- 高分辨率**
9km水平分辨率，精细捕捉局地沙尘过程
 - 高频更新**
逐小时输出（1 h），满足短临预警需求
 - 物理机制**
基于大气动力学与沙尘传输方程，可解释性强
 - 参数化改进**
基于观测资料进行参数化改进，提高了预报精度。
- 双模式协同运行

AI-DUST 智能预报

速度快 · 高效推理 · 空间分辨率：25 km · 时间分辨率：3 h · 预报时效：15 天



系统简介

本系统是面向中亚区域的人工智能沙尘预报系统，以风清数值预报产品为气象驱动，结合 GOCART 起沙方案、沙源分布、地形网格和深度学习模型，建立气象场获取、起沙计算、AI 推理、浓度预报、等级转换、产品生成与业务分发的完整流程。系统采用 ONNX 推理框架，降低部署环境依赖，支持业务服务器稳定运行。产品覆盖近地面沙尘浓度、能见度和沙尘天气等级，可输出 GRIB2、MICAPS4 和 PNG 图片，并通过定时任务自动生成和 FTP 分发。当前系统支持 360 小时、逐 3 小时沙尘预报，可为中亚区域沙尘监测预警、机场保障和环境气象服务提供支撑。

- 深度学习**
神经网络端到端沙尘预报，数据驱动
- 快速推理**
秒级生成结果，计算效率大幅提升
- 长时效**
支持15天中期预报，延长预警窗口
- 数据驱动**
可融合多源观测与再分析数据持续优化

系统关键参数总览

传统数值预报系统

水平分辨率 9 km
输出频率 逐小时（1 h）
预报时效 7 天
技术路线 数值天气预报
核心优势 高分辨率 · 高频更新

AI-DUST 智能预报

水平分辨率 25 km
输出频率 每 3 小时
预报时效 15 天
技术路线 深度学习 / 数据驱动
核心优势 速度快 · 长时效

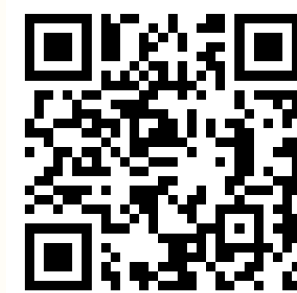
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系统访问





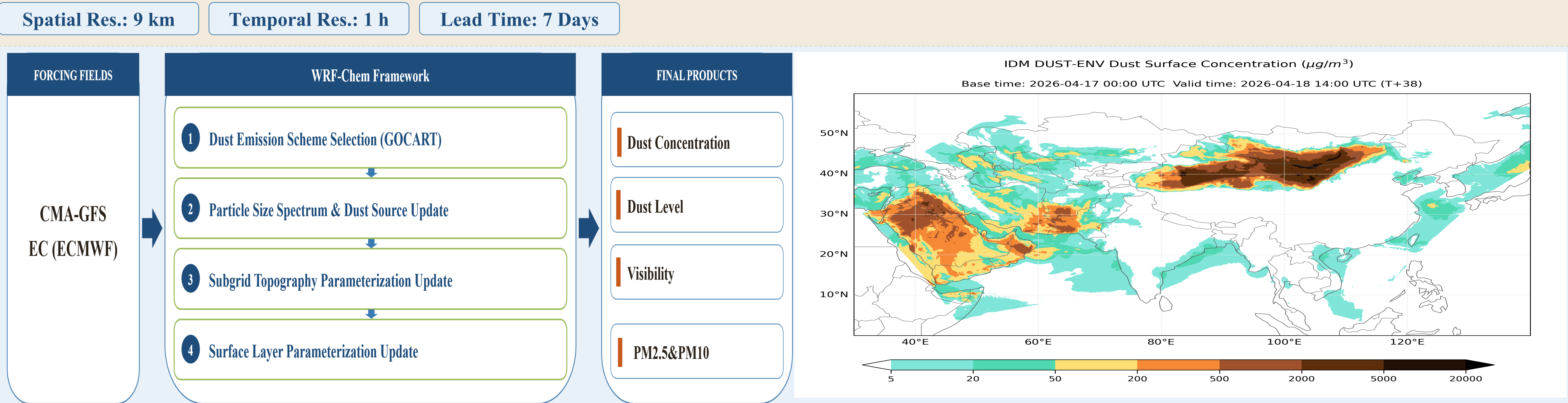
Dust Forecasting System

Institute of Desert Meteorology, China Meteorological Administration, Urumqi



DUST-ENV Numerical Forecasting System · AI-DUST Intelligent Forecasting System

DUST-ENV Dust Numerical Forecasting System



System Overview

The system is the Central Asia Regional Dust–Environment Forecasting System (DUST_ENV). It uses WRF-Chem as the dynamical framework and CMA-GFS and EC forecast fields as background fields. It comprises five functional modules: preprocessing of model background fields and observational data; pollutant data assimilation analysis; forecast integration; product post-processing and data archiving; and automated intelligent operation of the system. To enhance dust forecasting capability over Central Asia, the system establishes its physical framework through optimal selection of dust emission schemes, provides the material basis through updates to the particle size spectrum and dust sources, characterizes dynamic conditions through improved topograpy parameterization, and ensures near-surface wind speed accuracy through an improved surface layer scheme, thus forming a complete technical chain of improvements. The products cover core forecast variables such as visibility, dust category/level, dust concentration, and the six key air pollutants (PM2.5, PM10, SO2, NO2, CO, and O3), forming a suite of forecast products. The system supports multiple output and display forms, including images, text, MICAPS format, and web display, and enables product dissemination through APIs, Web interfaces, and a distributed shared database.

High Resolution

9-km resolution resolves local dust events in fine detail

High-Frequency Updates

Hourly (1 h) outputs to support nowcasting and early warning

Physical Mechanisms

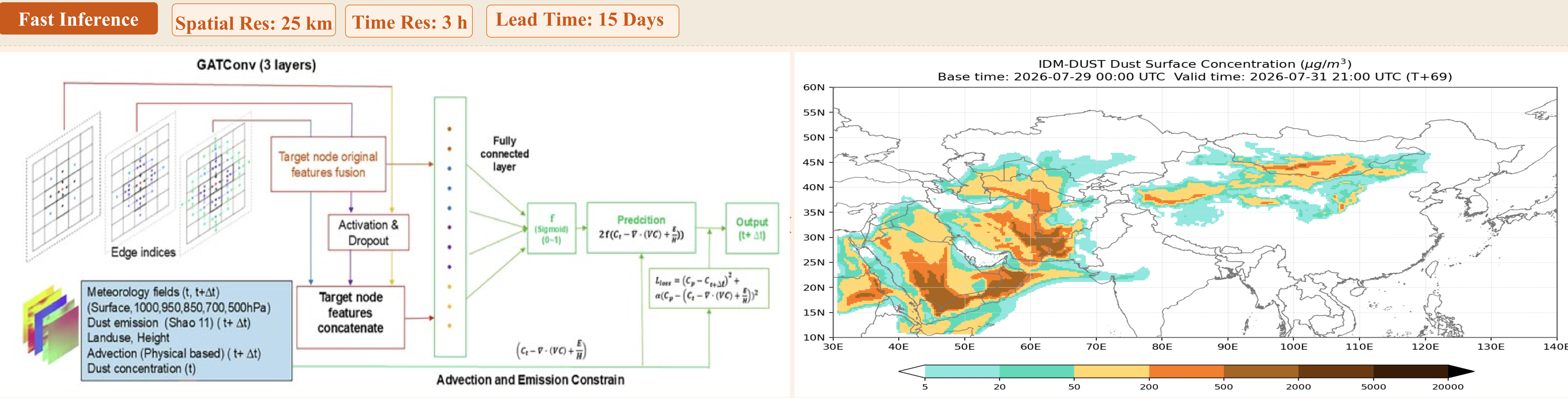
Built on atmospheric dynamics and dust transport equations; physically interpretable

Parameterization

Observation-based parameterization to improve forecast accuracy

Dual-Mode Collaborative Operation

AI-DUST Intelligent Forecasting System



System Overview

This system is an AI-based dust forecasting system for Central Asia. Using forecast products from the FengQing AI model as the meteorological forcing, it integrates the GOCART dust emission scheme, dust source distribution, terrain grid, and deep learning models to establish an end-to-end workflow covering meteorological field acquisition, dust emission calculation, AI inference, concentration forecasting, category conversion, product generation, and operational dissemination. The system adopts the ONNX inference framework to reduce deployment environment dependencies and ensure stable operation on operational servers. Its products cover near-surface dust concentration, visibility, and dust weather category, and can be output in GRIB2 and MICAPS4 formats as well as PNG images; they are automatically generated and distributed via FTP through scheduled tasks. At present, the system supports 360-hour dust forecasts with 3-hourly output, providing support for dust monitoring and early warning, airport/aviation support, and environmental meteorological services in Central Asia.

Deep Learning

End-to-end neural-network dust forecasting, data-driven

Rapid Inference

Results produced in seconds, greatly boosting efficiency

Extended Lead Time

15-day medium-range forecasts extend the warning window

Data-Driven

Continuously refined by fusing multi-source observations and reanalysis data

Overview of Key System Parameters

Conventional NWP System

Horizontal Res. 9 km

Output Frequency Hourly (1 h)

Lead Time 7 Days

Approach Numerical Weather Prediction

Key Strengths High Res. · Frequent Updates

AI-DUST Intelligent Forecasting

Horizontal Res. 25 km

Output Frequency Every 3 Hours

Lead Time 15 Days

Approach Deep Learning / Data-Driven

Key Strengths Fast · Extended Range

Organization

Institute of Desert Meteorology, CMA, Urumqi

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System Access