

Recent Breakthroughs in AI Weather Forecasting Models

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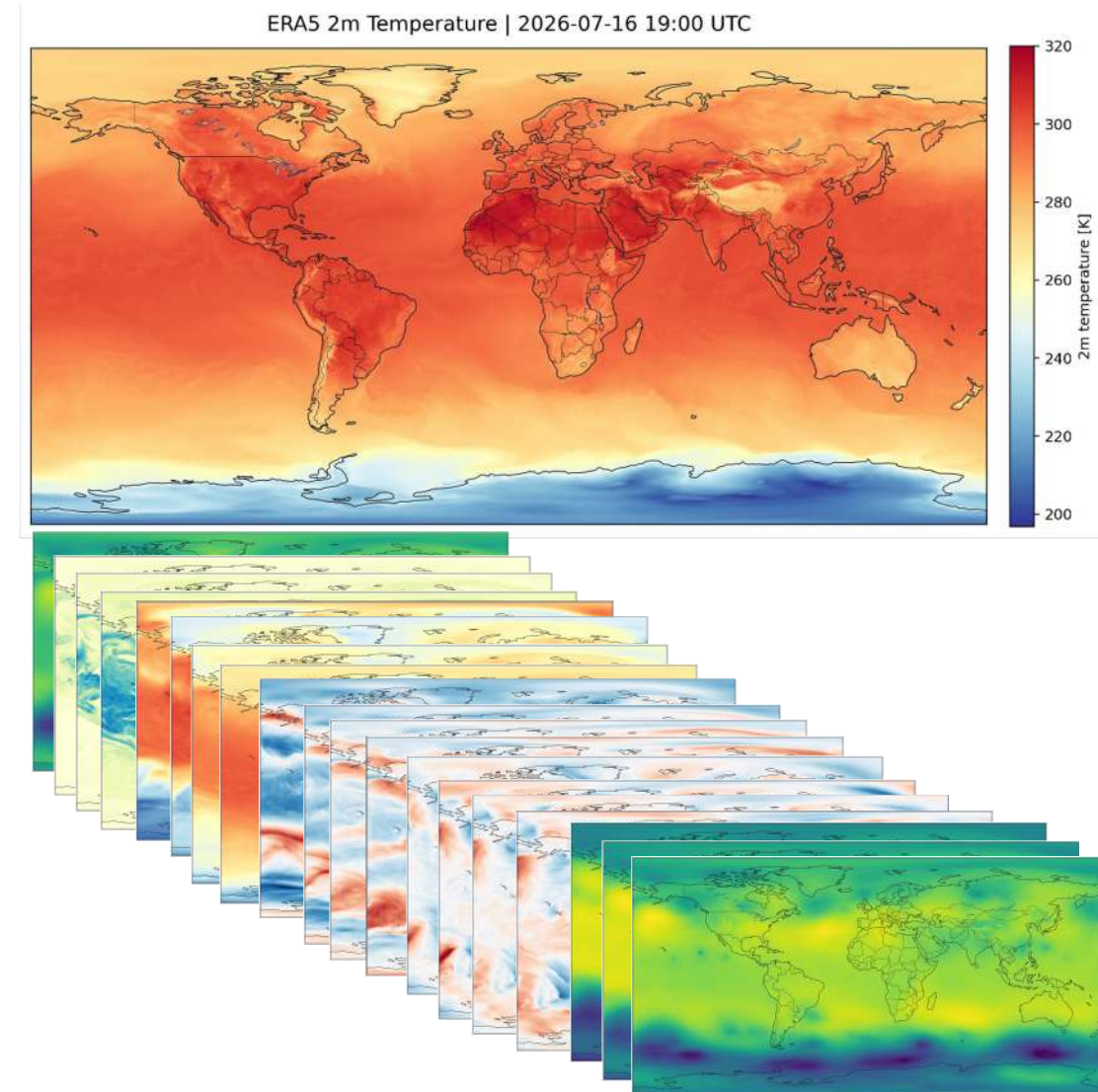
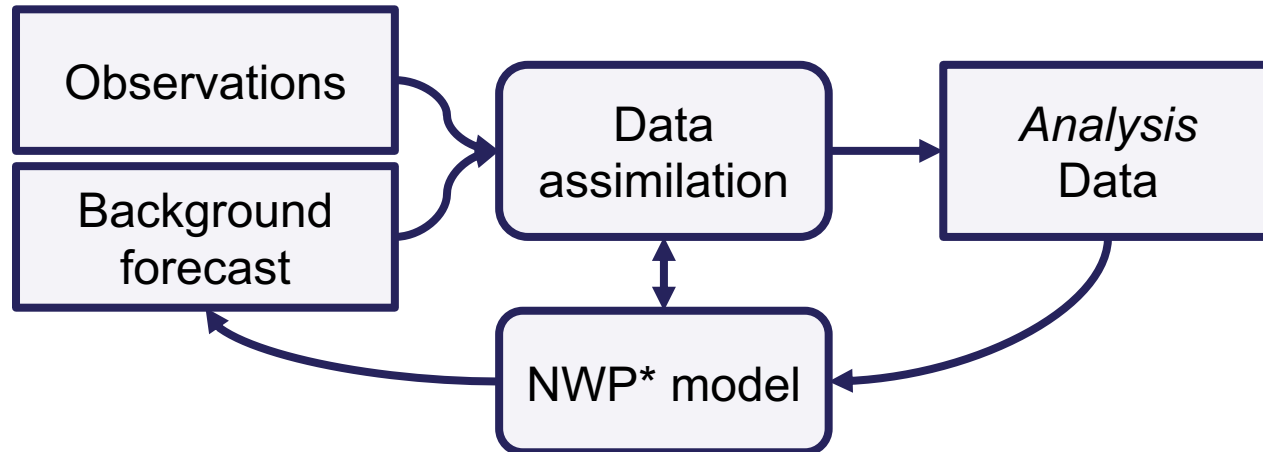
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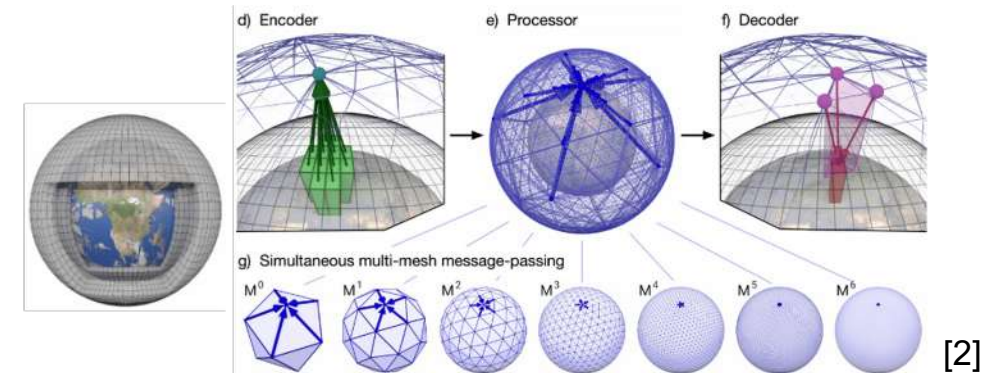
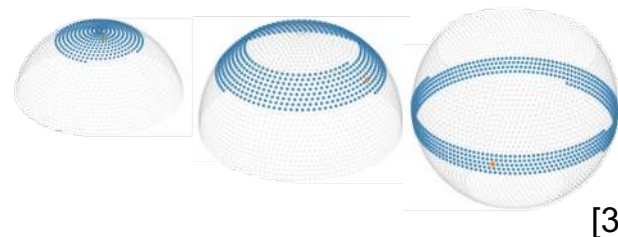
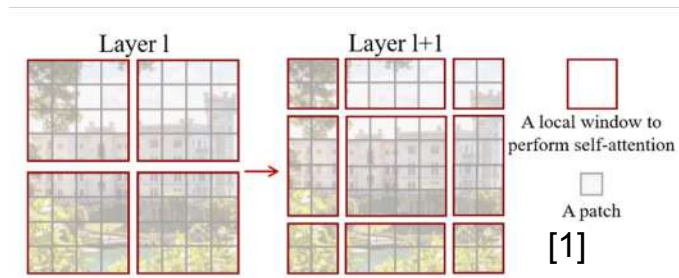
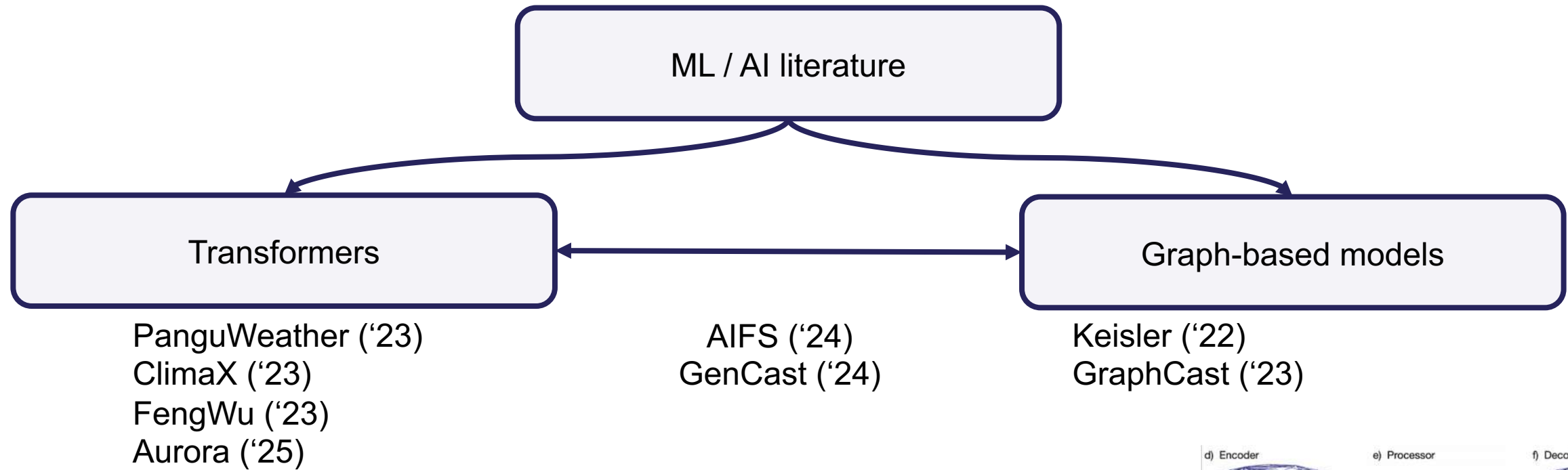


High Quality Reanalysis Dataset (ERA5)

- ERA5 (1940, today - **6days**)
 - Spatio-temporally gridded, global data
 - Implicitly inherits millions of heterogeneous observations
 - Spatial resolution of 0.25° (~28km-pixels)
 - 1440 x 721 pixels
 - 137 model levels (37 pressure levels)
 - Hourly resolution



Different neural network architectures, same input data

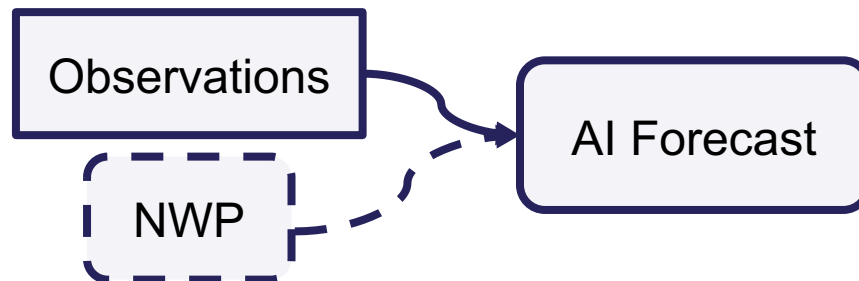
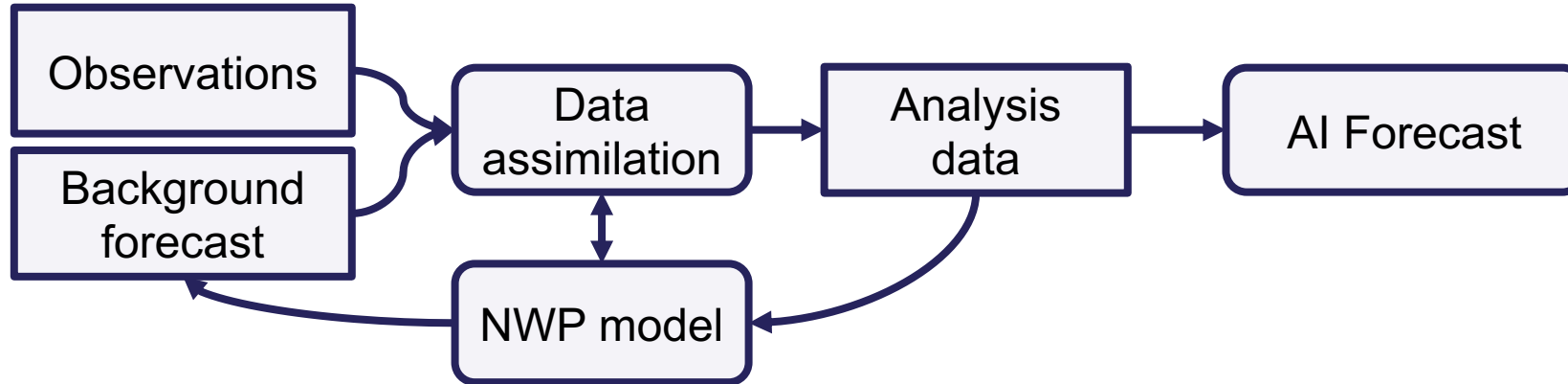


AI weather forecasting is getting competitive

	<u>AI competitive with NWP?</u>
Medium-range (1-15 day) global forecast skill	✓
Probabilistic / ensemble forecasting	✓
Tropical-cyclone tracking	✓
Tropical-cyclone intensity forecasting	Increasingly ✓
Extreme precipitation	?
Other rare events	?

Moving forward

- NWP and (re-)analysis data are invaluable
 - Expensive to generate at high resolution and low latency
 - Inherit model and assimilation biases

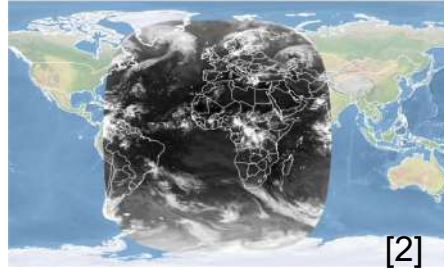


Observational data is messy!

Satellite swaths



Geostationary satellite images



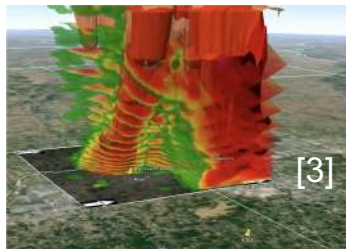
Point measurements

- buoy, balloon, station
- aircraft, ship



Doppler weather radars

- NEXRAD

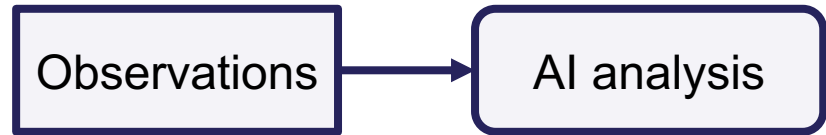


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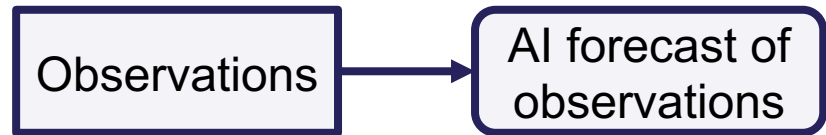
ERA5:
VS. (721 x 1440 x vars x plevs)
Every hour, everywhere

Different variables
Different geometries
Different resolutions
Different observation times
Irregular & incomplete coverage

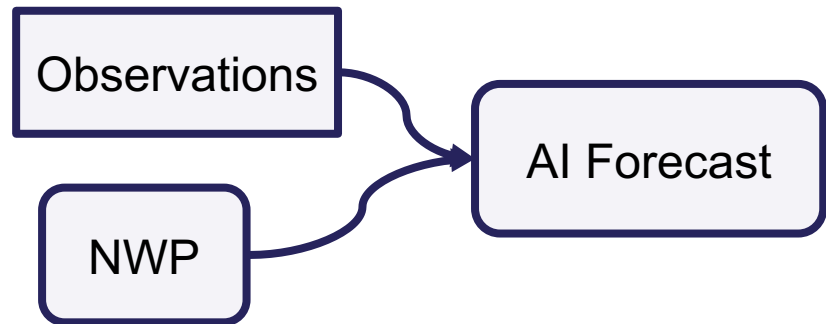
AI-based analysis & more



HealDA ('26) predicts analysis purely from observations, without a background forecast



GraphDOP ('24) predicts future observations from raw observations

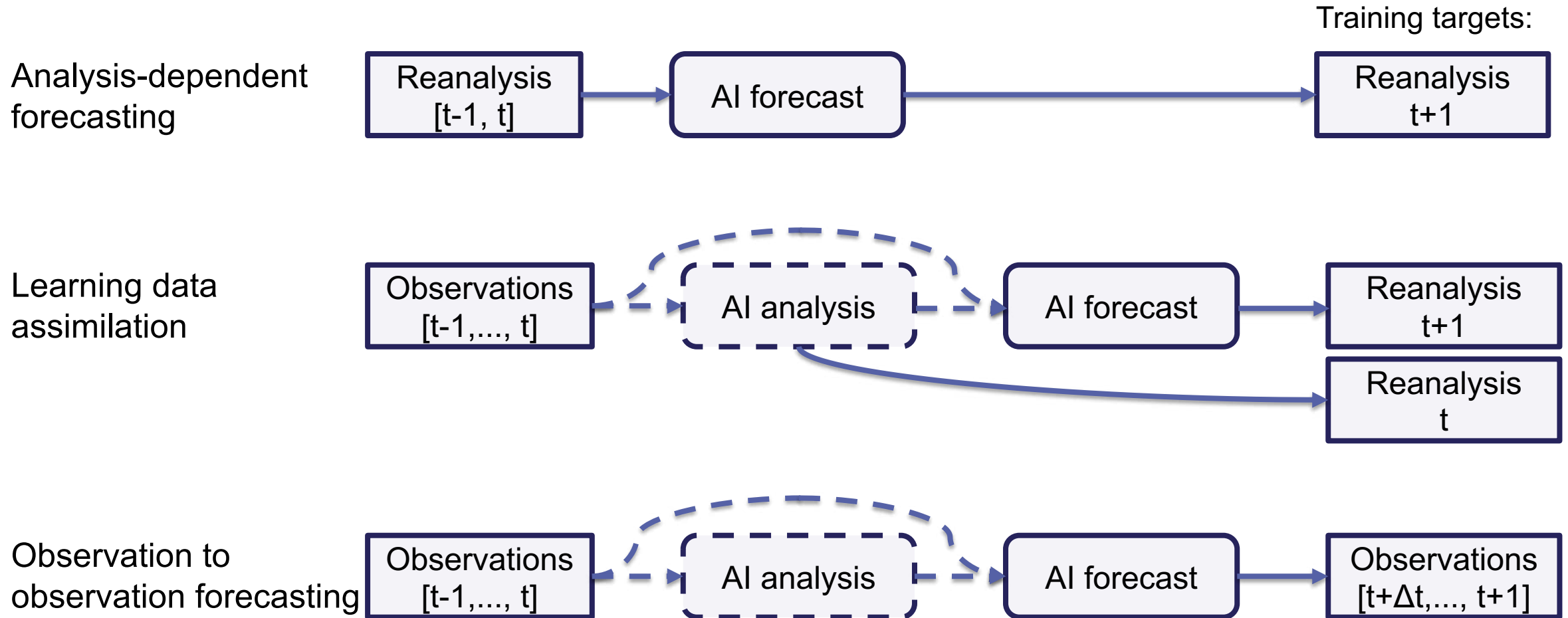


WeatherNext 3 ('26) predicts future global fields by augmenting stale NWP with recent (satellite) observations

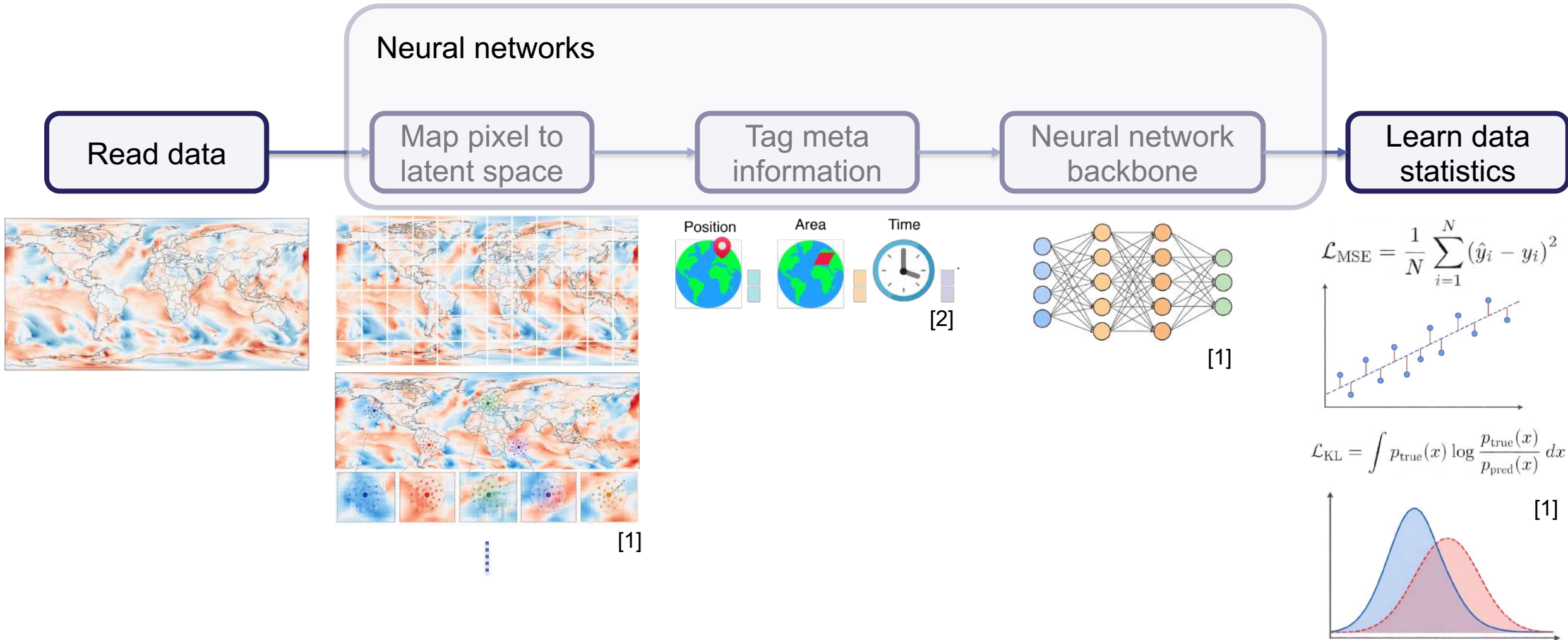
Other recent work using observation data:

Transformer-DOP ('24), DAWP ('25), FuxiWeather2 ('26), AIFS-DOP ('26),...

Learning ERA5 → Observed Earth system



Data flow



Thank you!



Earth System Foundation Model - ESFM

