

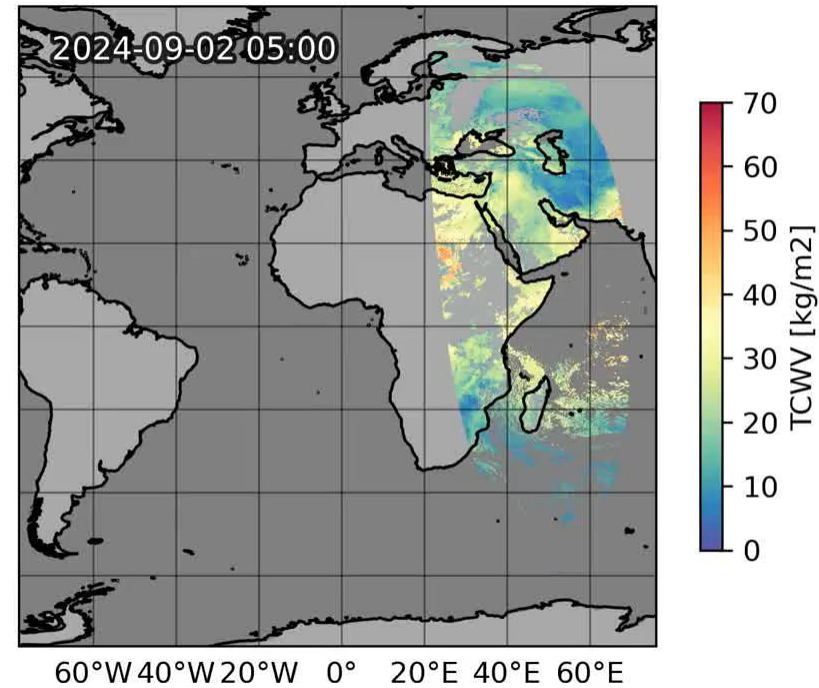
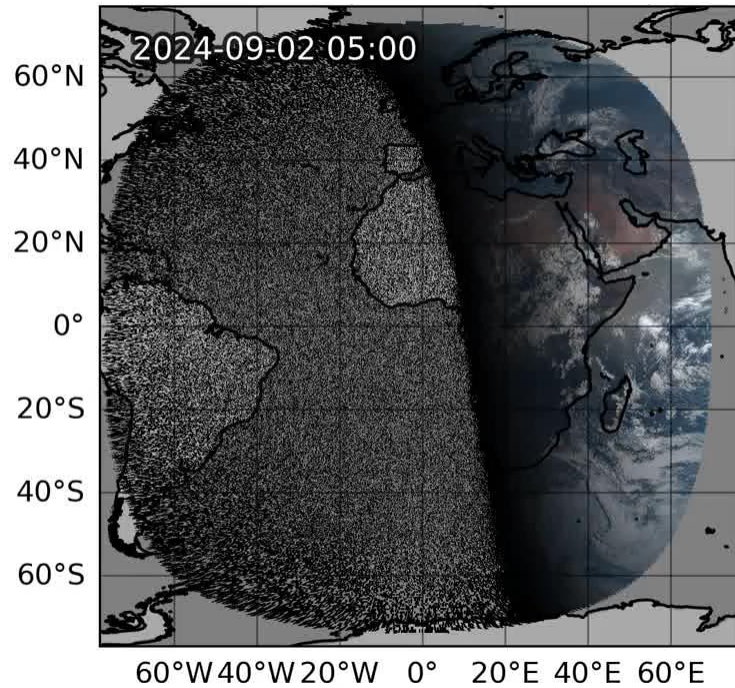
Exploring Total Column Water Vapor Retrievals from satellite NIR measurements - in pre-convective environments

Cintia Carbajal Henken, Jan El Kassar & Rene Preusker
Freie Universität Berlin

RealPEP Meeting, Berlin, Germany
9 October 2024

MTG-FCI TCWV

First version of Retrieval Framework for MTG-FCI TCWV running on EWC!



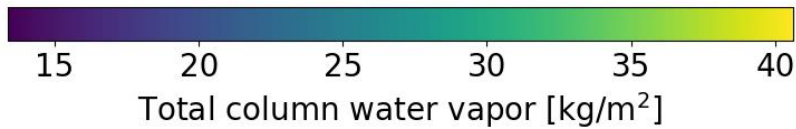
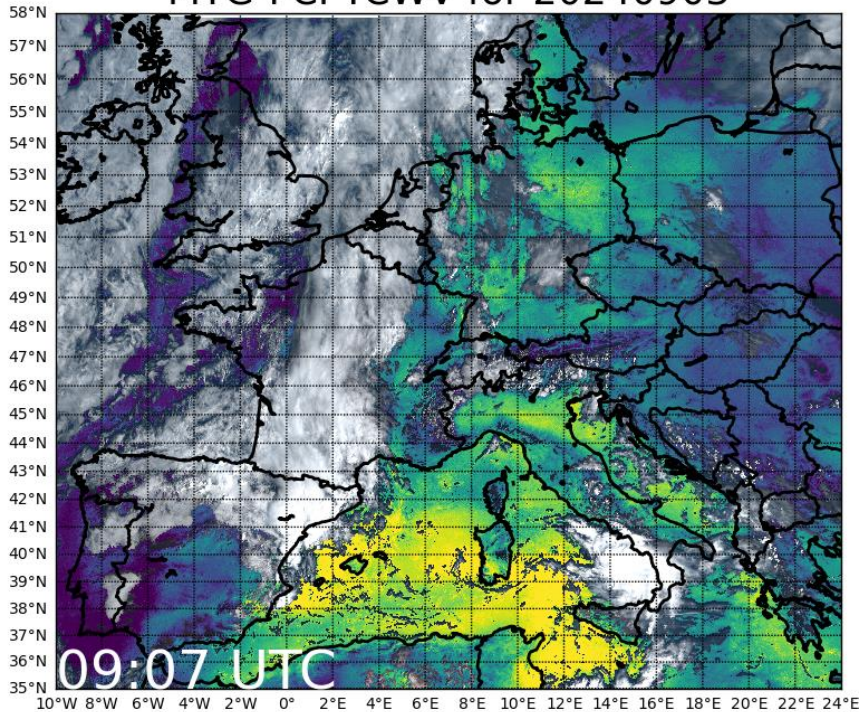
Most recent L1 data version made available 24 Sept
On EWC since end of July

Figure credit: Jan El Kassar

MTG-FCI TCWV

MTG-FCI

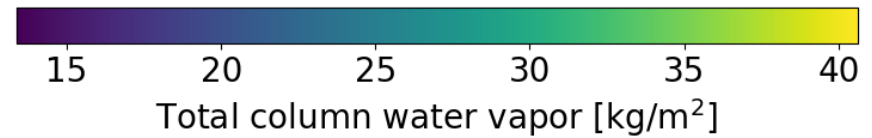
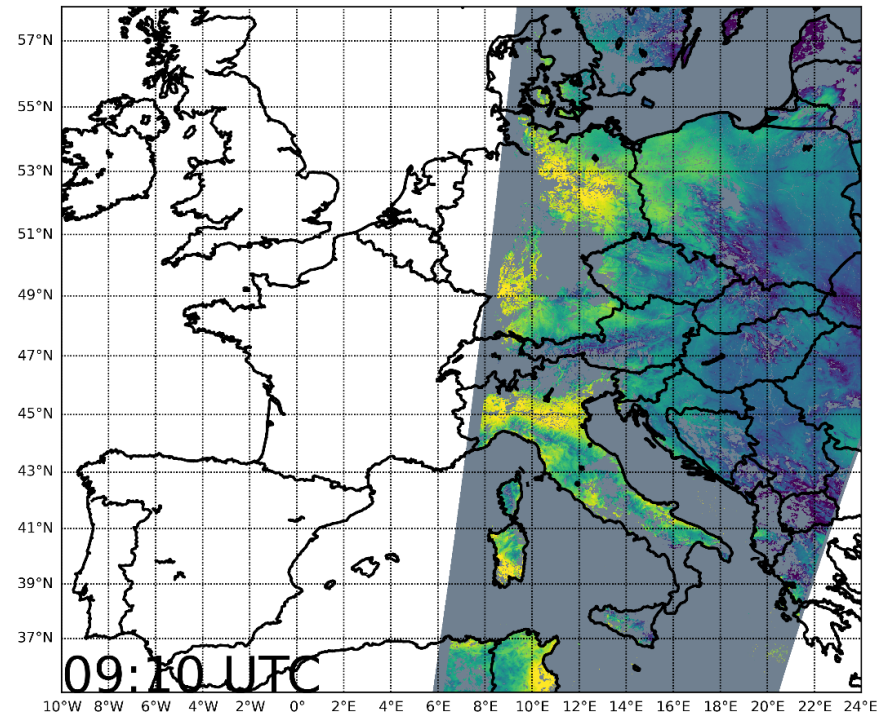
MTG-FCI TCWV for 20240903



FCI pixel size about 2 km
Every 10 (2.5) min

Sentinel-3/OLCI

S3A-OLCI TCWV for 20240903

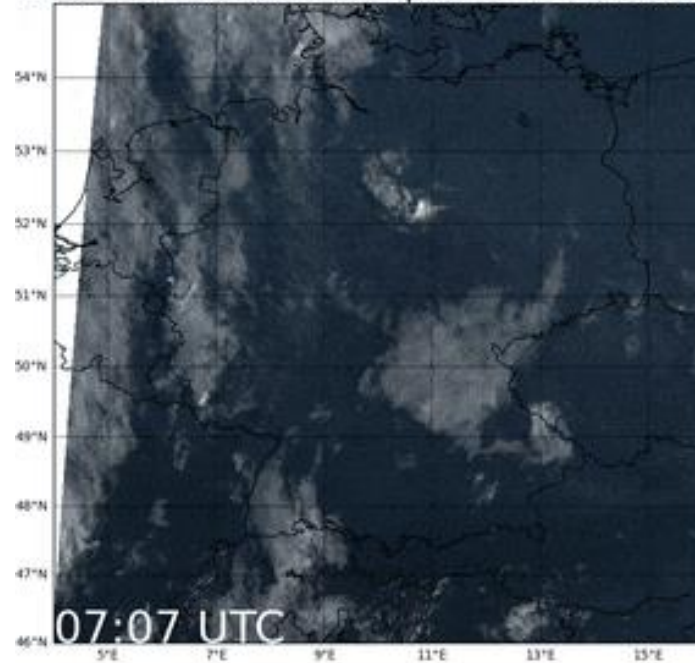


$\Delta x \sim 300 \times 300 \text{ m}^2$
One or two snapshots in late morning time

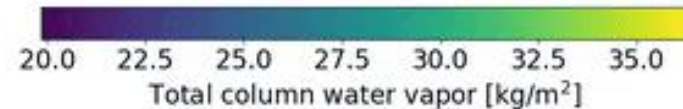
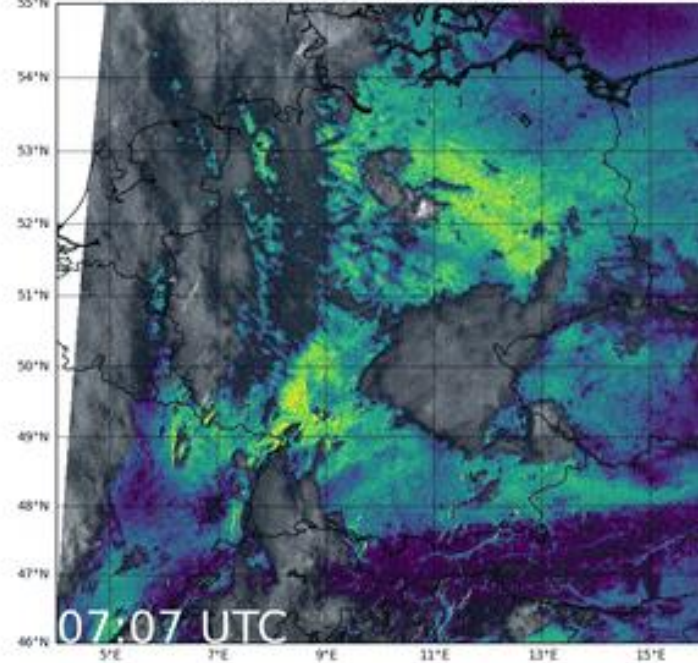
MTG-FCI TCWV

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MTG-FCI True color composite for 20240903

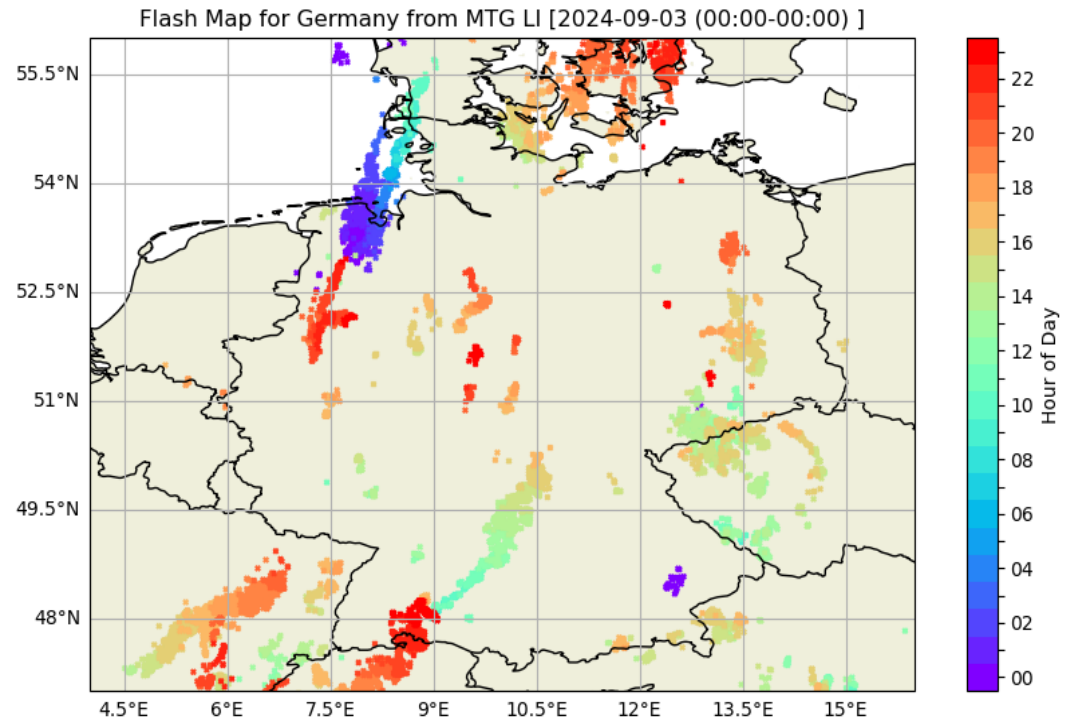
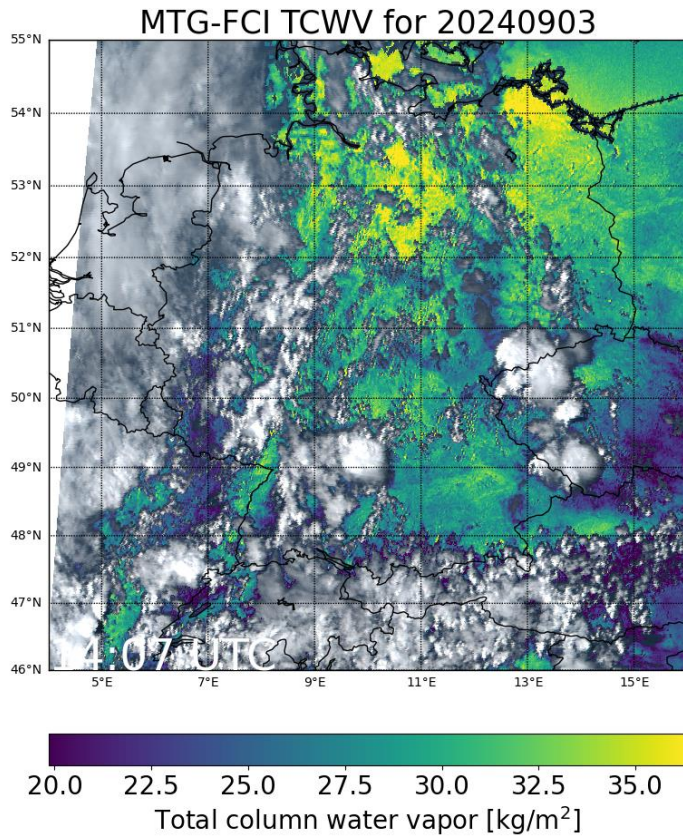


MTG-FCI TCWV for 20240903



MTG-FCI TCWV

FCI + Lightning imager (LI)



MTG-FCI TCWV

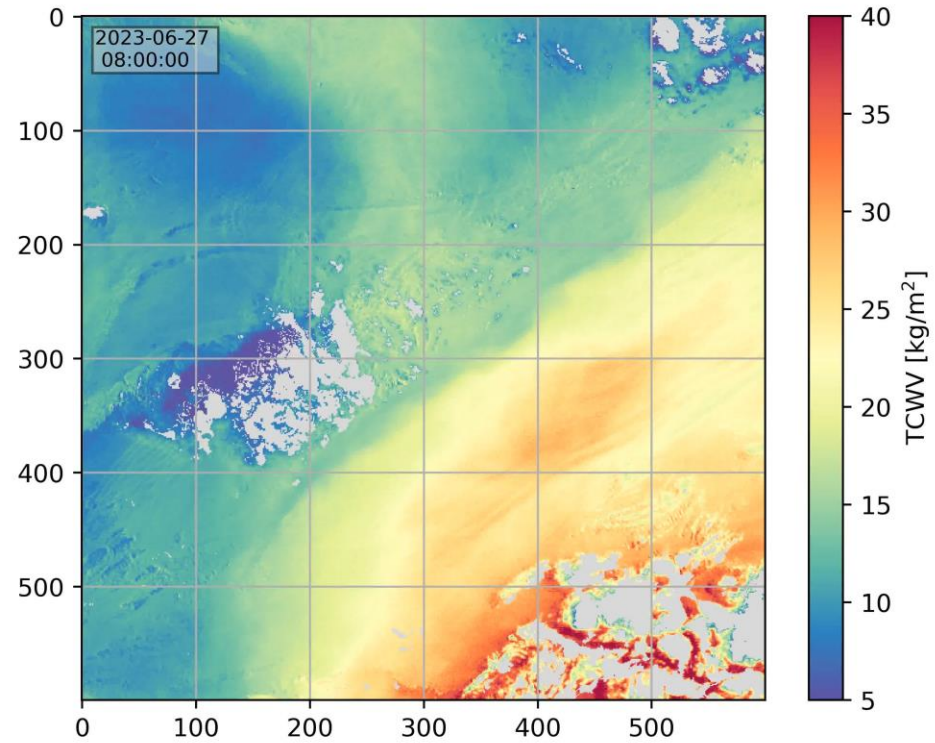
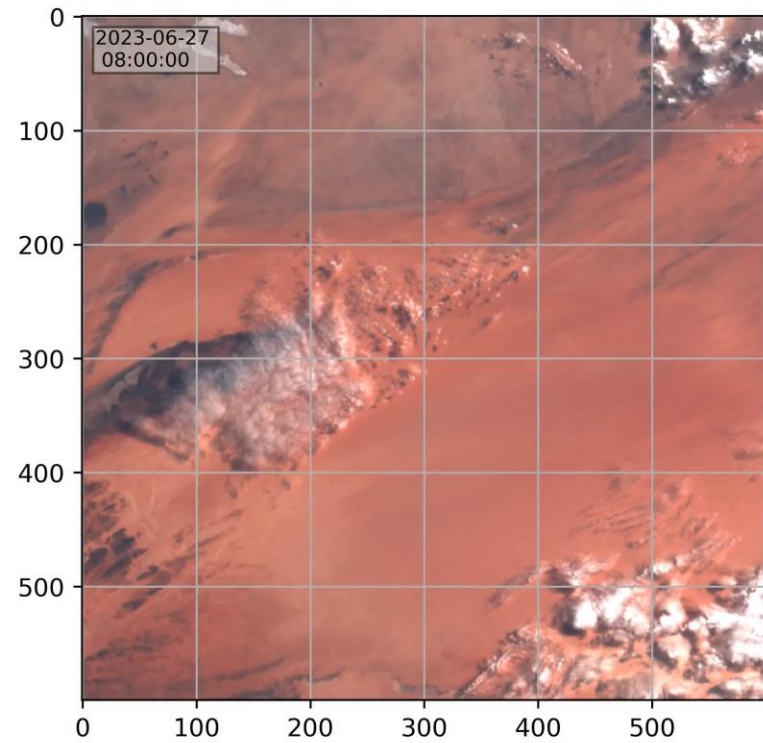


Figure credit: Jan El Kassar

Satellite-observed TCWV in pre-convective environments

Low-level moisture is a key ingredient for deep, convective cloud development

What is the **predictive potential** of satellite-based TCWV fields?

- With NIR-based TCWV retrievals, we can accurately observe small-scale variations in the boundary layer
- Observations of boundary layer dynamics and clear-sky convective initiation before onset of (convective) clouds and precipitation

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Areas of interest, subset of cases with OLCI observations

- Dominant clear-sky conditions in morning time
- More isolated/scattered convective development in late morning/early afternoon
- Larger differences between model and observation TCWV
- Some convective potential present (non-zero CAPE values, low CIN values)

Initiation of deep, moist convection:

Combination of CI and RDT product from NWCSAF software using SEVIRI and ERA5 reanalysis data

Satellite-observed TCWV in pre-convective environments

MODIS-TERRA at 10.04 UTC

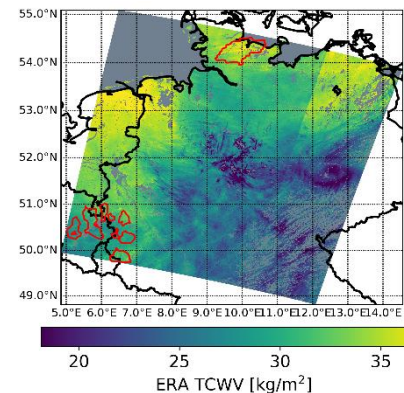
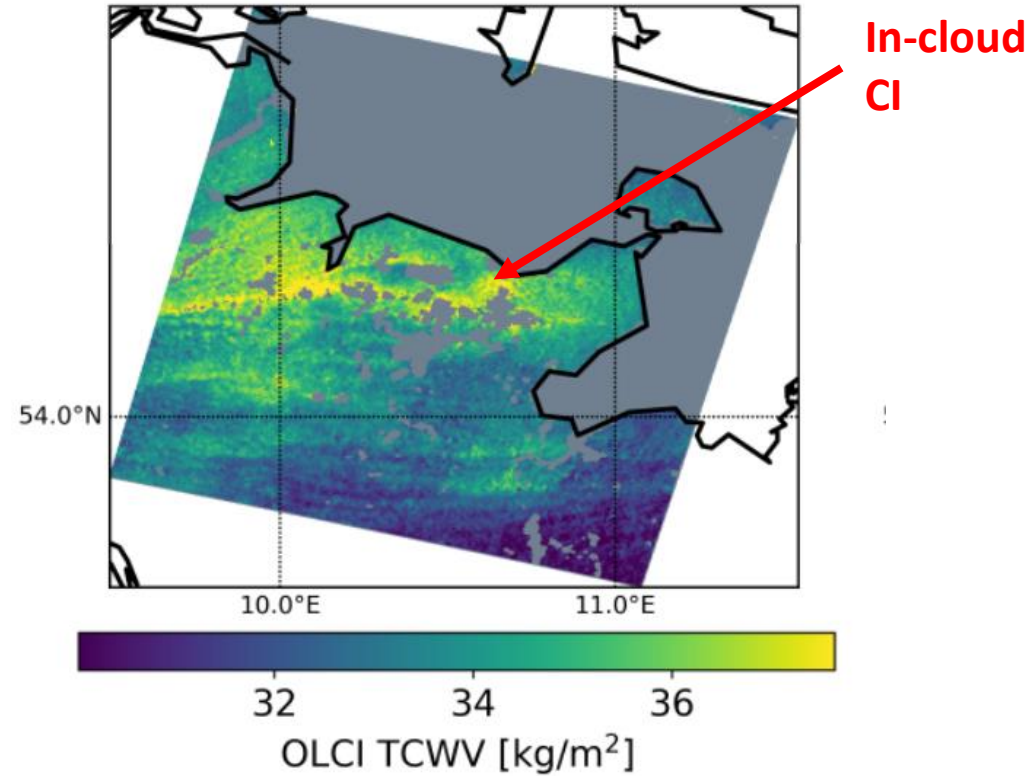


MODIS-Aqua at 11.50 UTC



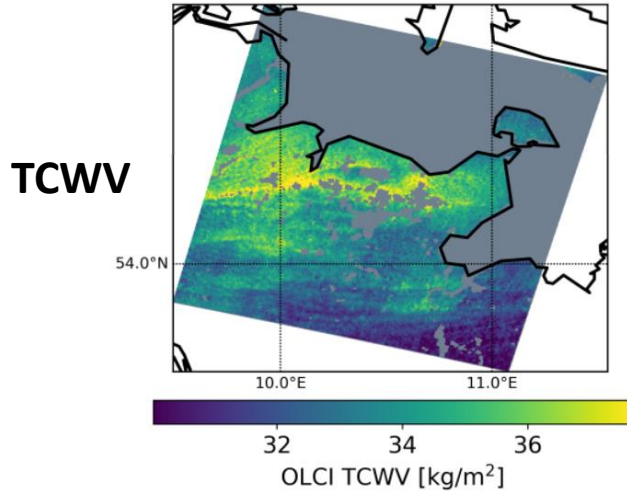
Cloud streets + locally developing deep convection

Horizontal convective rolls (HCRs)
+ Sea breeze?

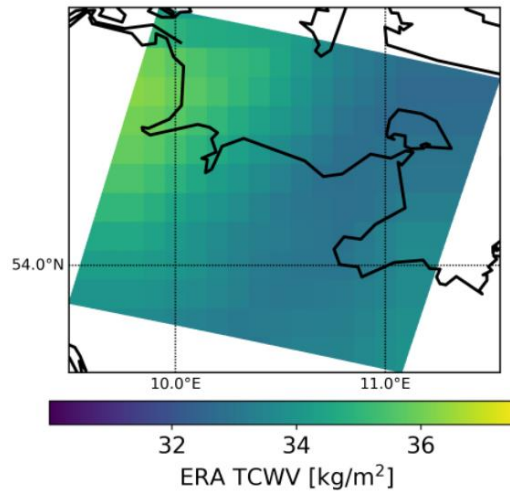


Satellite-observed TCWV in pre-convective environments

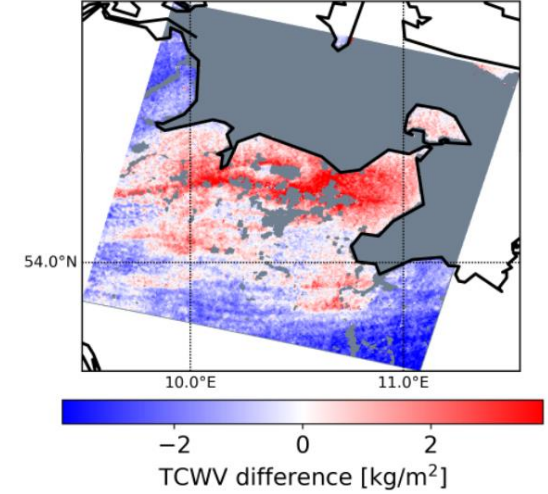
Observation



Model forecast 6 UTC + 3



Observation - Model



Sharpened CAPE (CIN)

Low-level moisture is a key ingredient for deep, convective cloud development

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How to **feed this TCWV information** into a direct parameter related to atmospheric instability

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CAPE: Convective Available Potential Energy

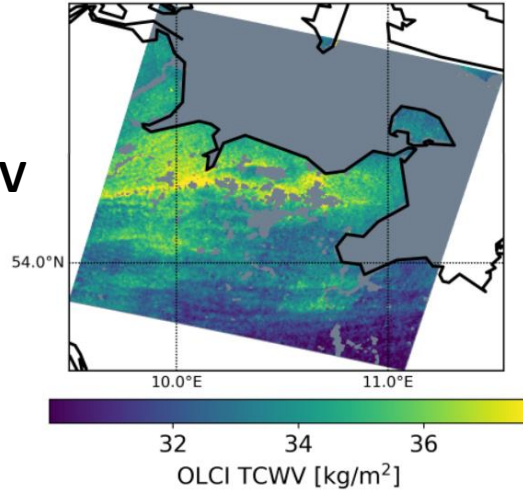
Strongly controlled properties of the boundary layer: Temperature and humidity

$$\frac{\partial CAPE}{\partial TCWV} = \frac{\partial CAPE}{\partial q} * \frac{\partial q}{\partial TCWV}$$

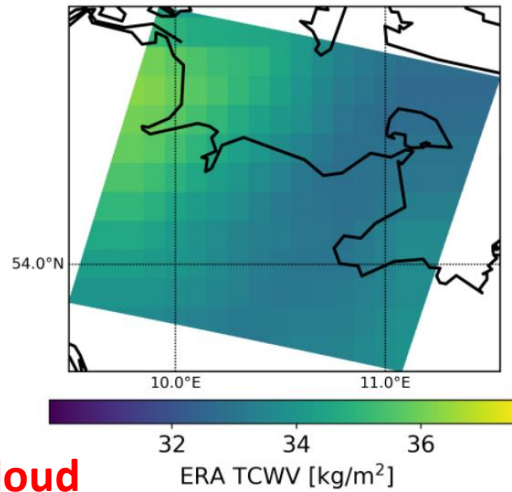
Satellite-observed TCWV in pre-convective environments

Observation

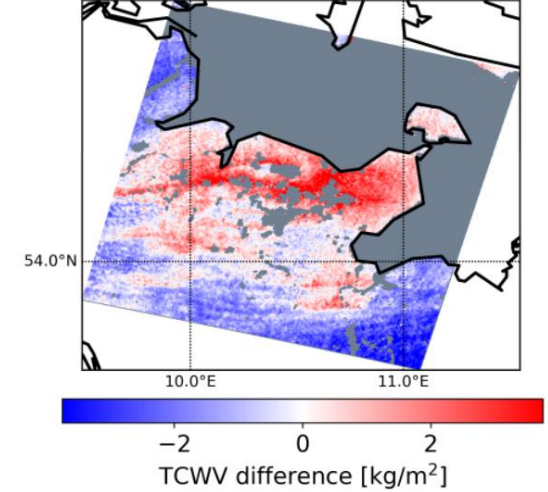
TCWV



Model forecast 6 UTC + 3

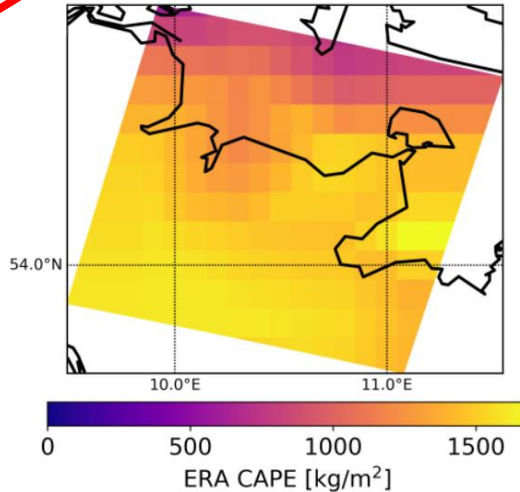
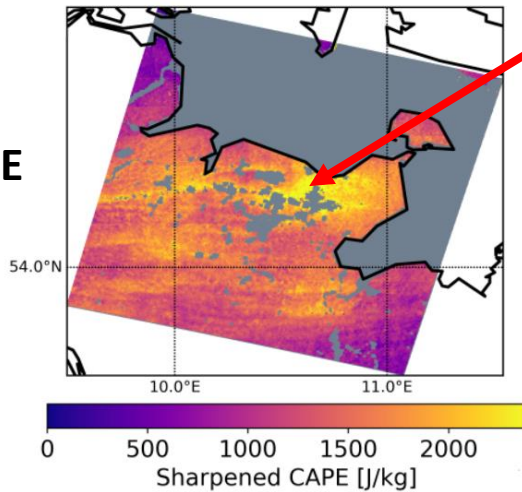


Observation - Model



In-cloud
CI

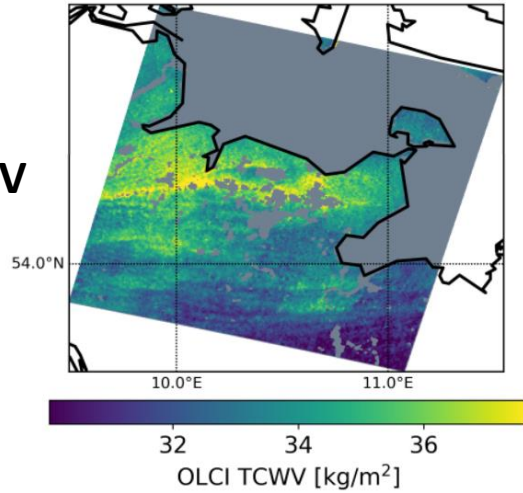
CAPE



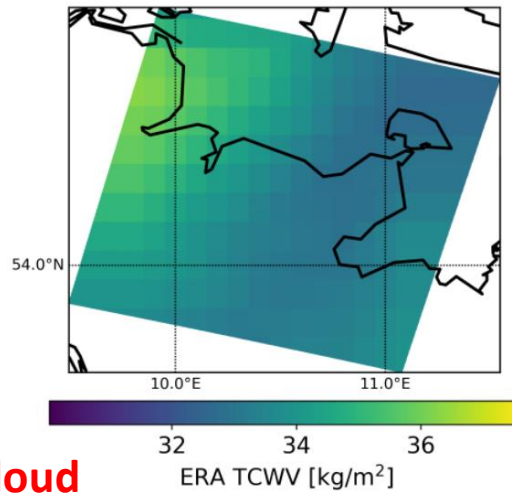
Satellite-observed TCWV in pre-convective environments

Observation

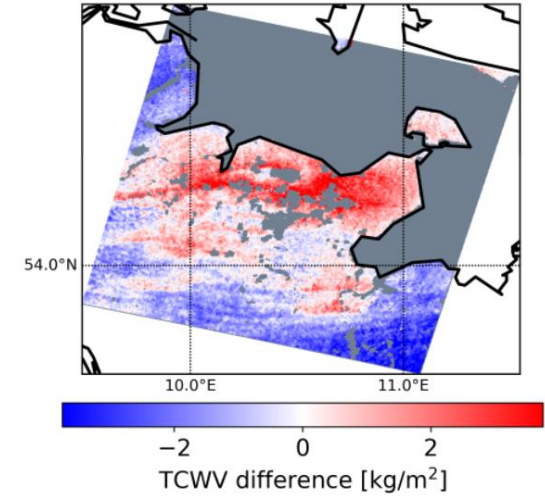
TCWV



Model forecast 6 UTC + 3

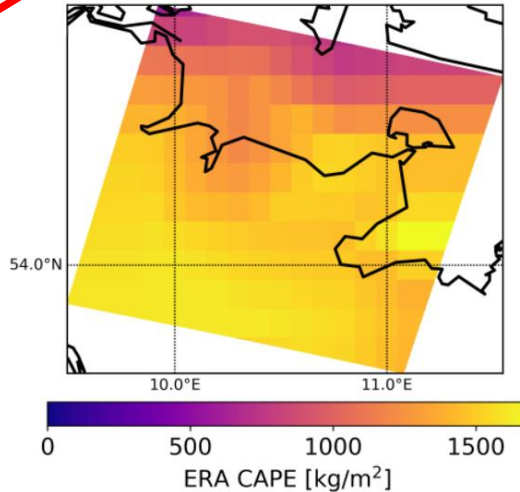
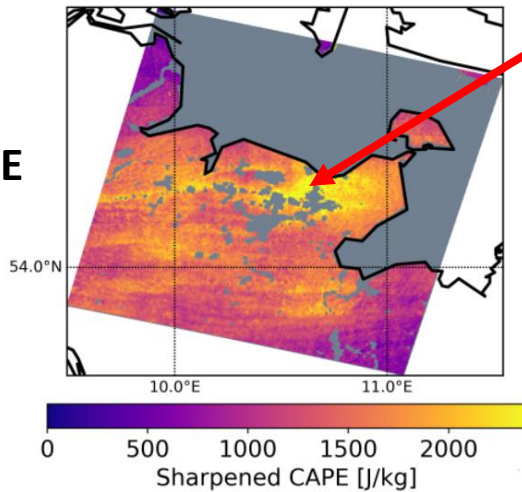


Observation - Model



In-cloud
CI

CAPE

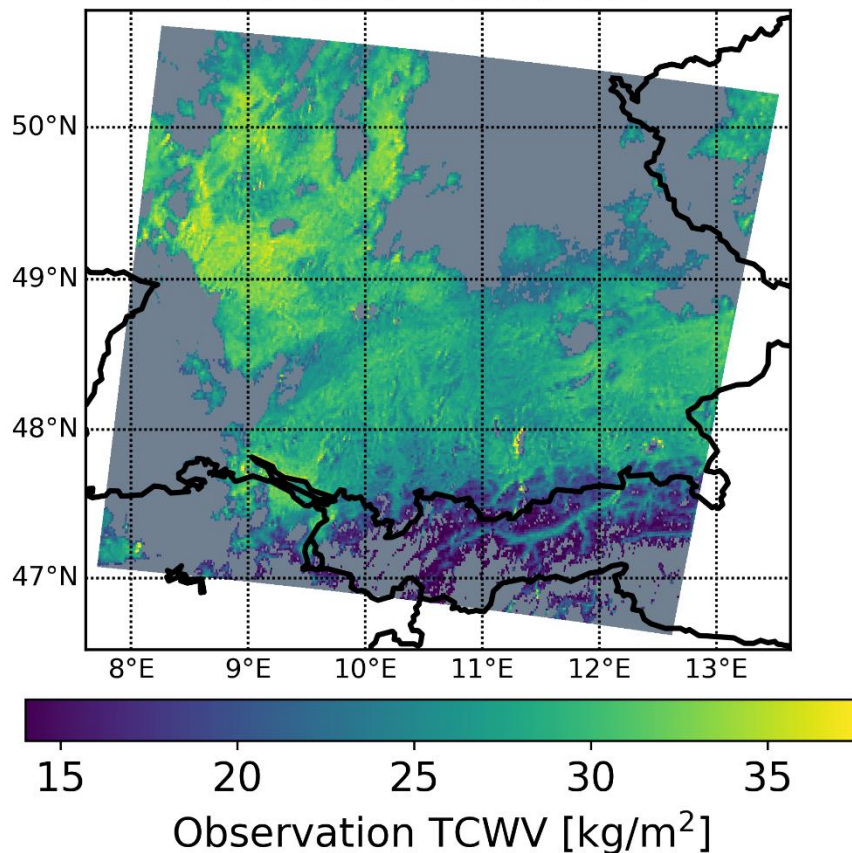


MTG-FCI for Germany:

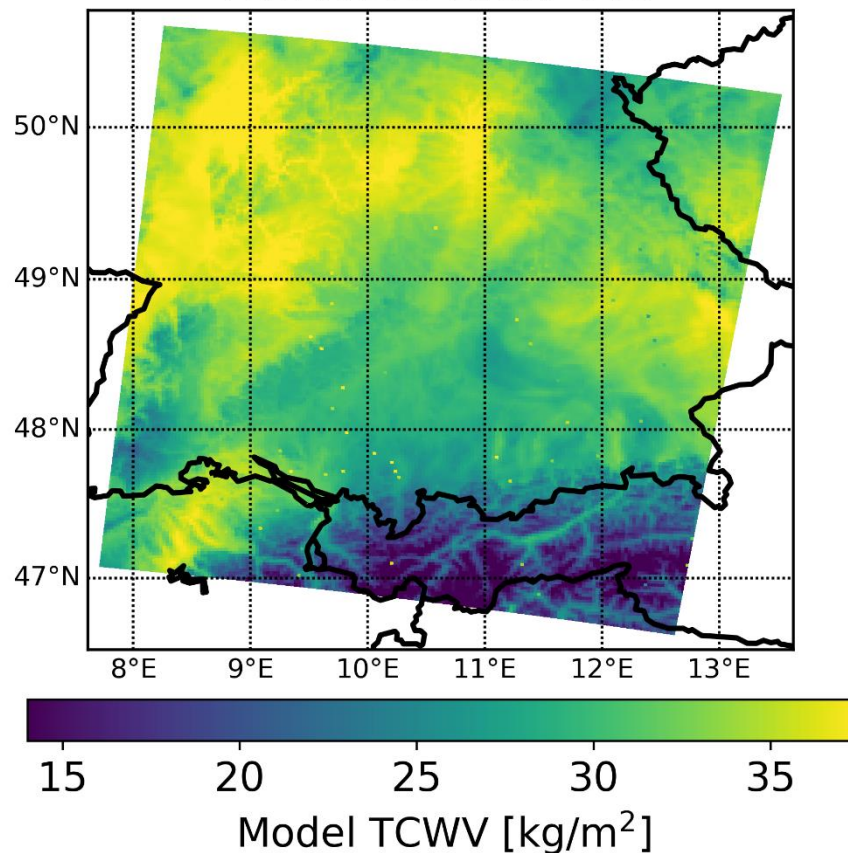
- about 50 OLCI pixels in 1 FCI pixel
- Snapshots every 10 min

MTG-FCI TCWV observations vs model

20240903 09:10 UTC



20240903 09:00 UTC



ICON-D2

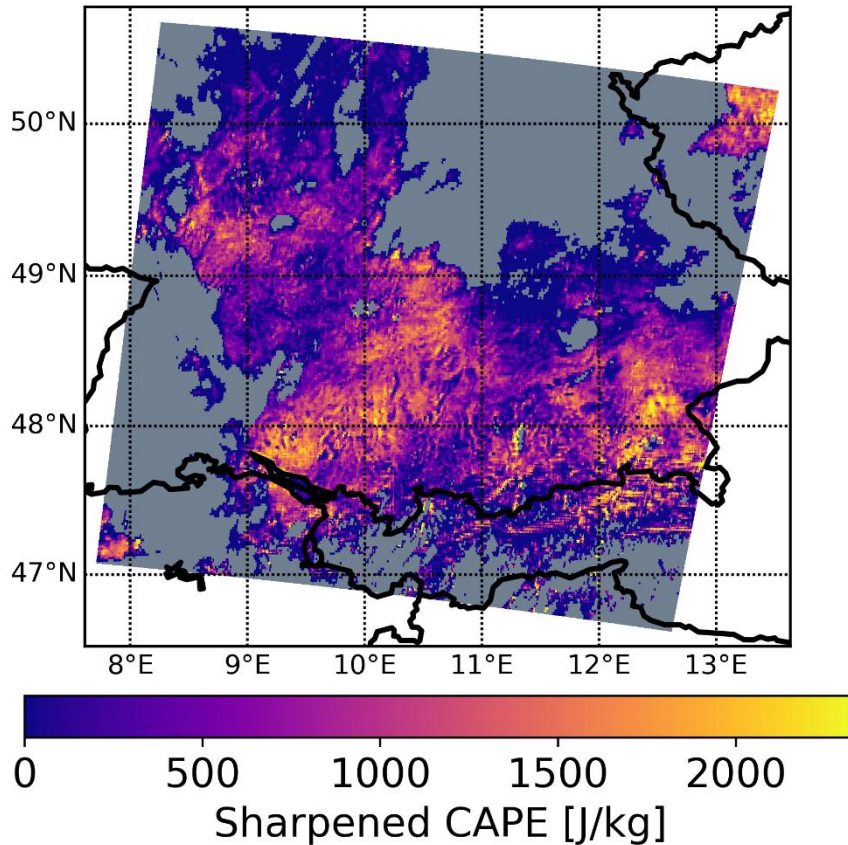
$\Delta x \sim 2\text{km}$

Effective spatial resolution?

MTG-FCI TCWV in pre-convective environments

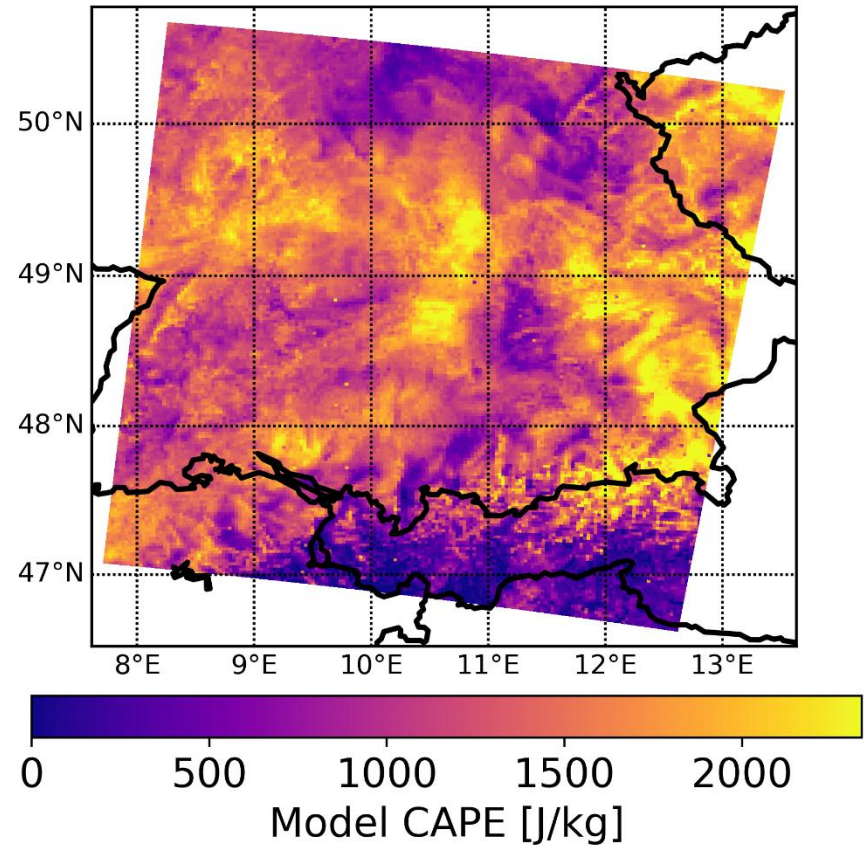
Observation

20240903 09:10 UTC



Model

20240903 09:00 UTC

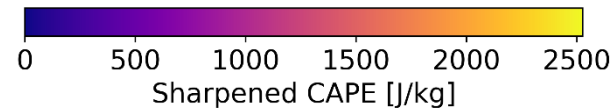
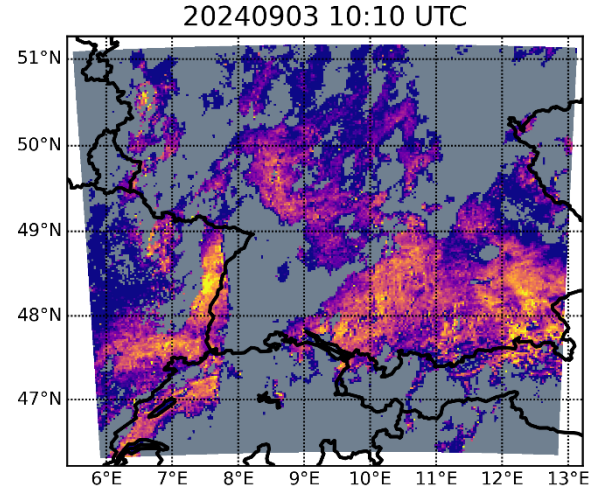
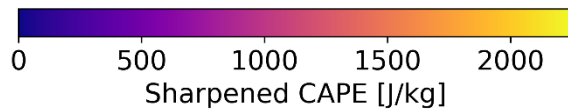
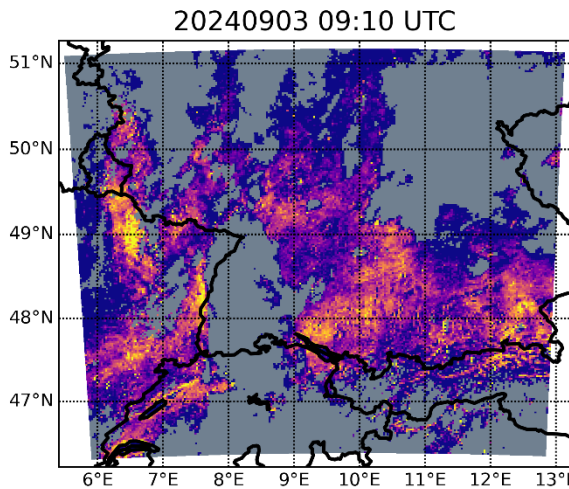
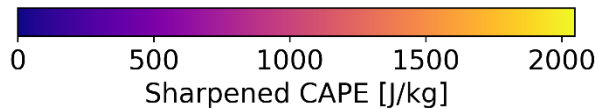
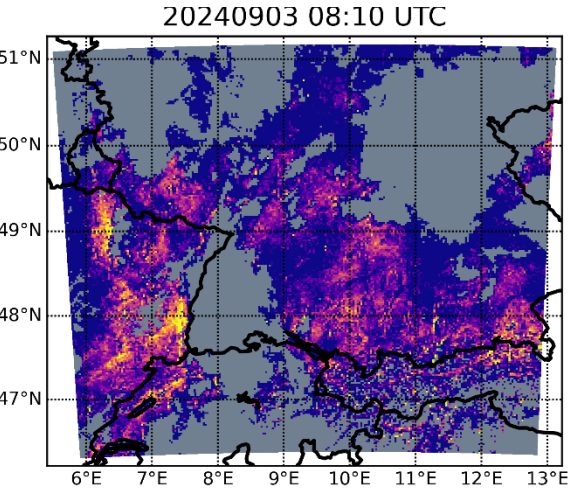
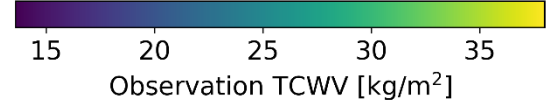
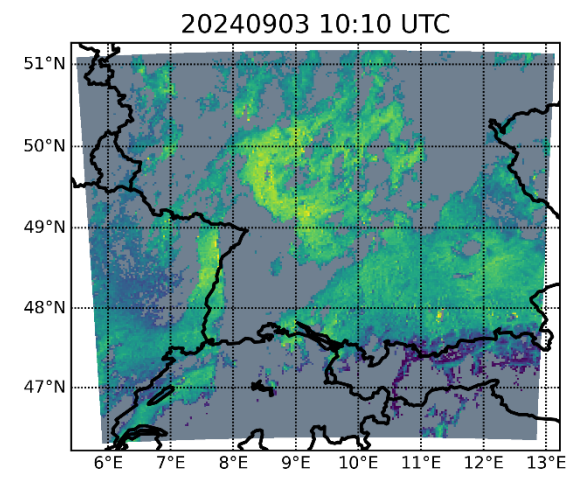
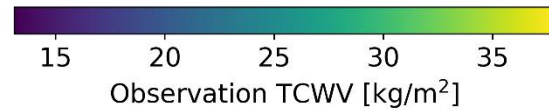
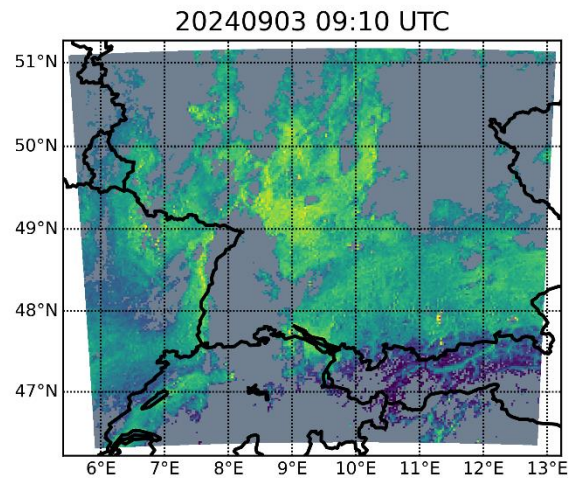
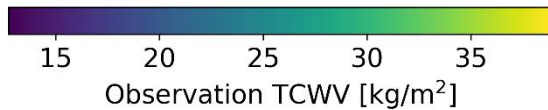
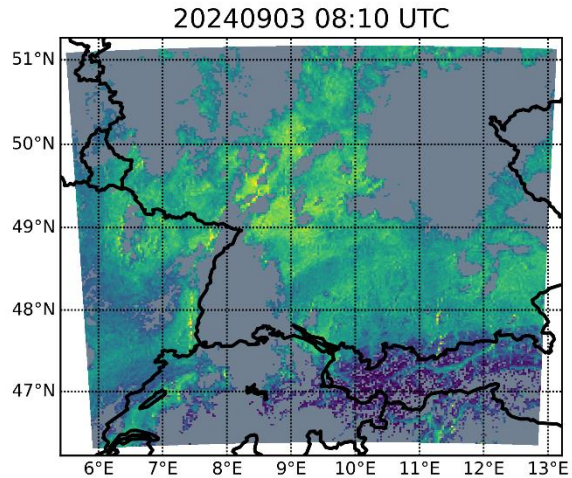


ICON-D2

$\Delta x \sim 2\text{km}$

Effective spatial resolution?

MTG-FCI TCWV in pre-convective environments



Outlook

Processing of MTG-FCI TCWV

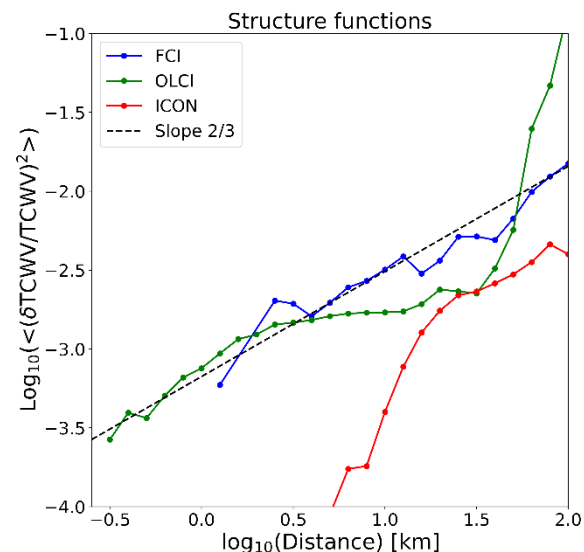
- L1 data collection, cloud masking
- Robust validation, fine-tuning

Coherence TCWV model vs observation

- Temporal & spatial TCWV distributions
- Regions of interest, pre-convective environments

TCWV predictive potential in pre-convective environments

- Feeding observed (small-scale variability) TCWV (BL moisture) information into instability indices: CAPE/CIN, works for subset of convective cases in Germany
- Towards low-level moisture estimates
- Prepare for Machine learning/DL methods



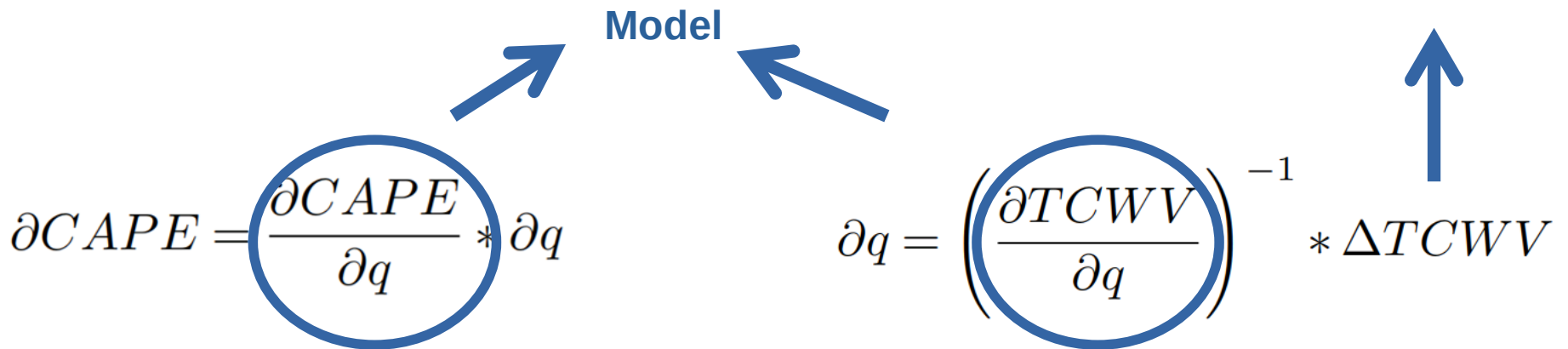
Thanks!

Sharpened CAPE

$$\frac{\partial CAPE}{\partial TCWV} = \frac{\partial CAPE}{\partial q} * \frac{\partial q}{\partial TCWV}$$

$$\partial CAPE = \frac{\partial CAPE}{\partial q} * \cancel{\frac{\partial q}{\partial TCWV}} * \cancel{\partial TCWV}$$

Model - Observation



Sharpened CAPE

T-skew, log-p diagram

