The cloudy radiances project

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Introduction

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Achieving these initial conditions needs observations that:
1. Contain convective-scale information.
2. An assimilation system that can use them.

Example of cloud affected obs not used at Geosphere (yet)

- Visible satellite images contain an abundance of information.
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- In contrast to radar, clouds can be observed before they produce precipitation.
- Water vapor infra-red channels track deep convection and cloud top height.

Normalised Weighting Function
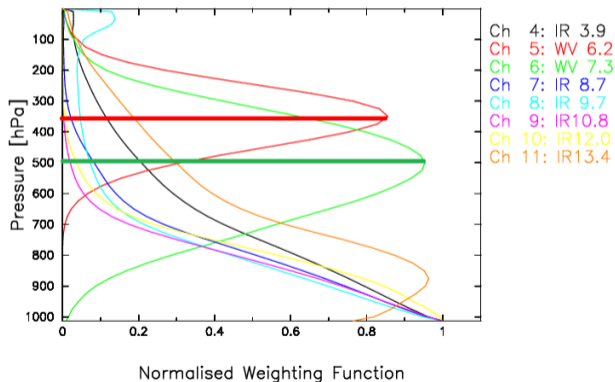
Switch to gifs.

Assimilating such observations requires

1. An observation operator (H) that converts from model state to the observations.

Focus of cloudy radiances with Sandy and Adhithiyan

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2. Model error estimates that can take convection-scale features into account.

Focus of ensemble variational project with Kaushambi

Observation operators for cloud-affected sat images

Challenges

- Speed, computational cost
- Linearized operator
- Highly variable errors
- Systematic model errors/biases

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Recent progress

- Operators that are sufficiently fast and have adjoints (Scheck 2021)
- Idealized studies have succeeded in assimilating (Geiss 2021, Kugler 2023)

We aim to assimilate cloud affected satellite images in AROME-AUT, which will require substantial code development, and the operator needs to be tweaked to dealing with the Alps.

Convective-scale model errors I

Current operational setting is climatologic/static and not adapting to weather conditions.
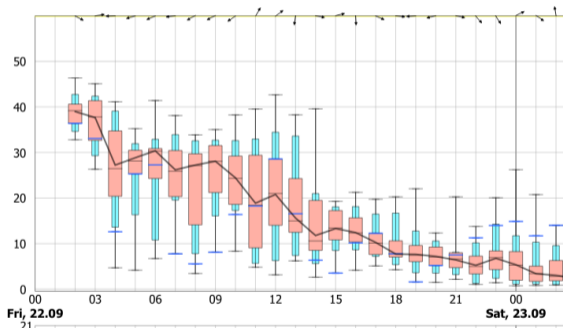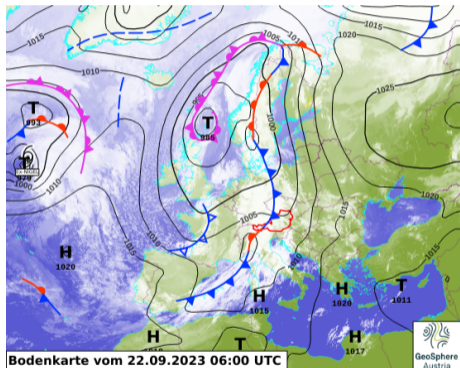
Example from 2023-09-22, cold front passing Innsbruck

Convective-scale model errors II

- Static errors very poorly suited to estimating errors and cross-correlations of hydrometeors (cloud water, ice).

- Static errors contain no convective-scale features.

Ensembles can address all three problems, but also come with their own issues. Kaushambi will have more details.

Summary

- Making the most of convection-permitting weather predictions requires assimilating observations that capture the timing and location of clouds.
- Cloud-affected visible and infra-red satellite images hold great potential, but were not assimilated because assimilation system could not digest them.
- New observation operators and ensemble systems have made it possible to assimilate them.

Summary

- Making the most of convection-permitting weather predictions requires assimilating observations that capture the timing and location of clouds.
- Cloud-affected visible and infra-red satellite images hold great potential, but were not assimilated because assimilation system could not digest them.
- New observation operators and ensemble systems have made it possible to assimilate them.
- Adhithiyan (who could not attend) got the all-sky assimilation of SEVIRI water vapor channels running within AROME cy48t1op1.
- Sandy will present next, and Kaushambi will present on using ensembles to estimate model errors.