Verifying NWP-model chains by using model independent analyses

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1. Motivation

Draw-up an “ideal“ verification scheme for an inter-comparison of model chains

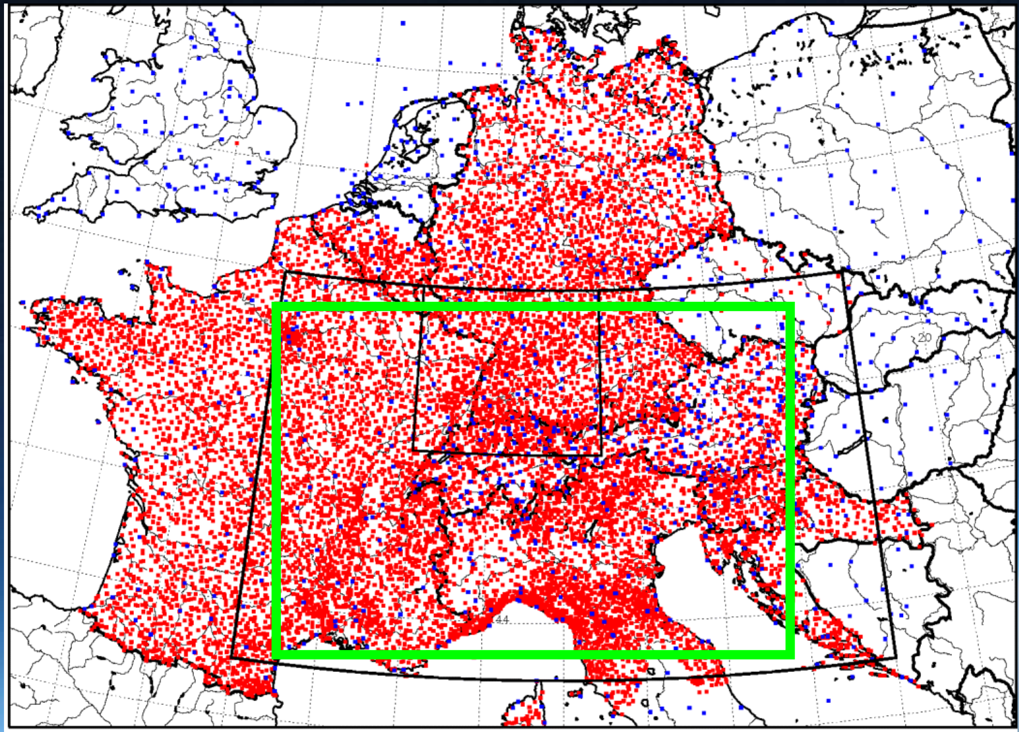
Criteria/Tasks/Challenges:

- verify the whole model chains including their global model
- use same initialisation time and forecast periods for all models
- run over unified verification area
- use novel (spatial) verification methods
- verify multiple meteorological parameters (not only precip.)
- use NWP model independent analyses as reference

2. Data

2.1. Observation data (JDC-data) and VERA analysis

JDC-data: WWRP D-PHASE (FDP, Rotach, et al., 2009, BAMS) and WWRP COPS (RDP, Wulfmeyer, et al., 2008, BAMS), data available: (http://cera-www.dkrz.de/WDCC/ui/Index.jsp)



- 32 data providers
- GTS-Stations: 1232
- NGTS-Stations: > 13000
- Mean station distance: GTS: ~ 36km GTS+Non-GTS: ~ 12km

Frames: D-PHASE (black, large)
COPS (black, small)
this study (green)

Red: Non-GTS stations
Blue: GTS stations

2.1. Observation data (JDC-data) and VERA analysis

The analysis scheme VERA

(Vienna Enhanced Resolution Analysis)

Data quality control scheme

+

Thin-Plate-Spline algorithm

+

Downscaling via the „Fingerprint“ method

⇓

Not dependent on first guess fields – „model independent“

Wind	Potential Temperature	Precipitation: Accumulated to 1h, 3h, 6h, 12h, 24h	Post processing: - Mixing Ratio - Moisture Flux Divergence
MSL - pressure	Equivalent – Pot. Temperature		

Further reading: Steinacker, et al. 2000 (MWR), Steinacker, et al. 2006 (MWR), Steinacker, et al. 2011(MWR)

2.2. NWP-model chains

- Selection from D-PHASE model ensemble

- selected models should reflect the variety of model types in terms of dynamics, parametrisation, hydrostatic vs. non-hydrostatic and convection-permitting models
- same initialisation time → do not use the coupled model runs, model starts from the same observations.
- same forecast period
- overlapping of the model domains maximized → same topography and same weather situation are described by the models

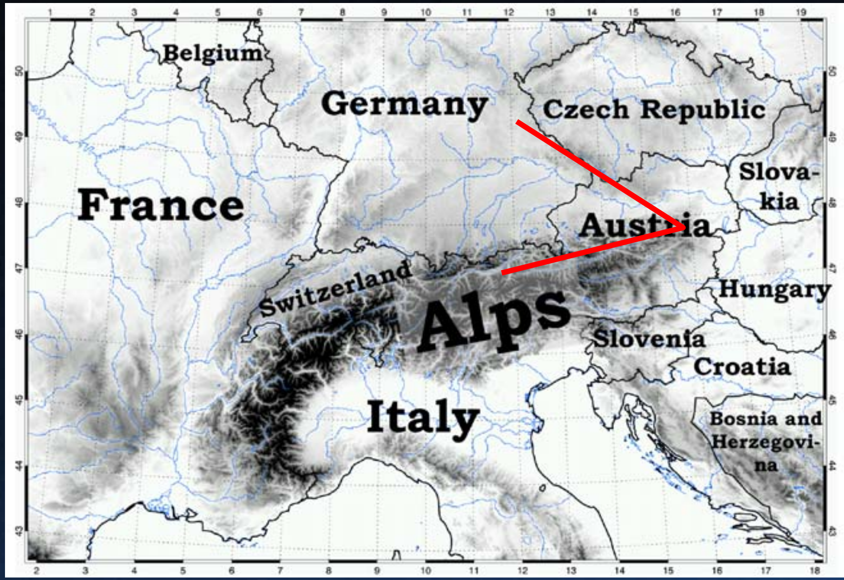
2.2. NWP-model chains

- Selection from D-PHASE model ensemble

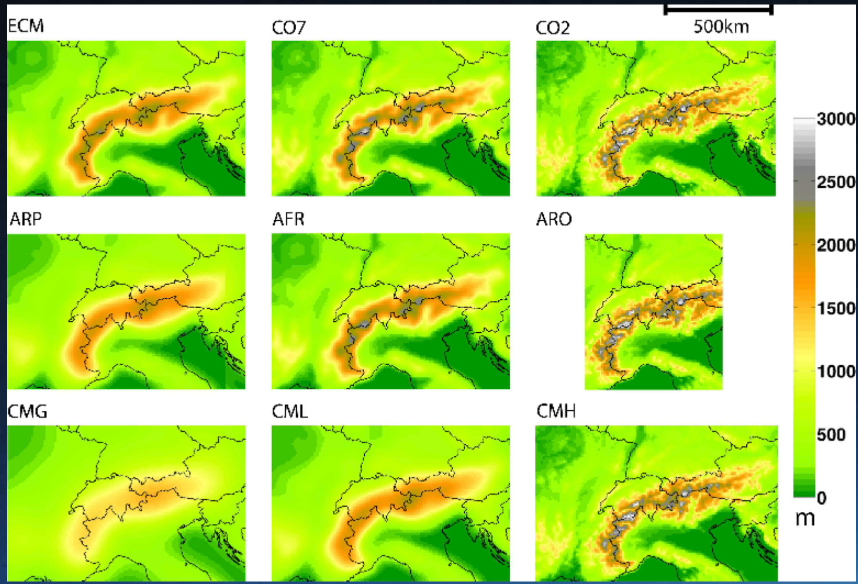
Model	Model abreviation	Mesh Size	Init. UTC	Forec. Range[h]	Provider
Chain 1					
ECMWF-	ECM	25km	00, 12	240	ECMWF
ECMWF-BC		25km	00, 06, 12, 18	90	ECMWF
COSMO-7	CO7	7km	00, 12	72	Meteo Swiss
COSMO-2	CO2	2.2km	00, 03, 06, 09 12, 15, 18, 21	24	Meteo Swiss
Chain 2					
ARPEGE	ARP	0.25/0.5 deg (lat/lon)	00	72	Météo-France
ALADIN-FR	ALA	9.5km	00	30	Météo-France
AROME	ARO	2.5km	00	30	Météo-France
Chain 3					
CMC-GEM	CMG	0.3/0.45 deg (lat/lon)	00	24(144)	Environment Canada
CMC-GEM-L	CML	15km	00	24	Environment Canada
CMC-GEM-H	CMH	2.5km	06	18	Environment Canada

2.2. NWP-model data

D-PHASE domain



Verification domain



All model data are interpolated on the VERA 8 km grid:

ARO:	600 x 704 km; 6764 GP
All other models:	1056 x 704 km; 11837 GP

3. Verification strategy and methods

Evaluation period:

- Overall evaluation (D-PHASE period; Jun-Nov 2007)
- Case studies

Evaluation domain:

- whole domain
- elongated sub-domain (analyse frontal propagation)

Parameters:

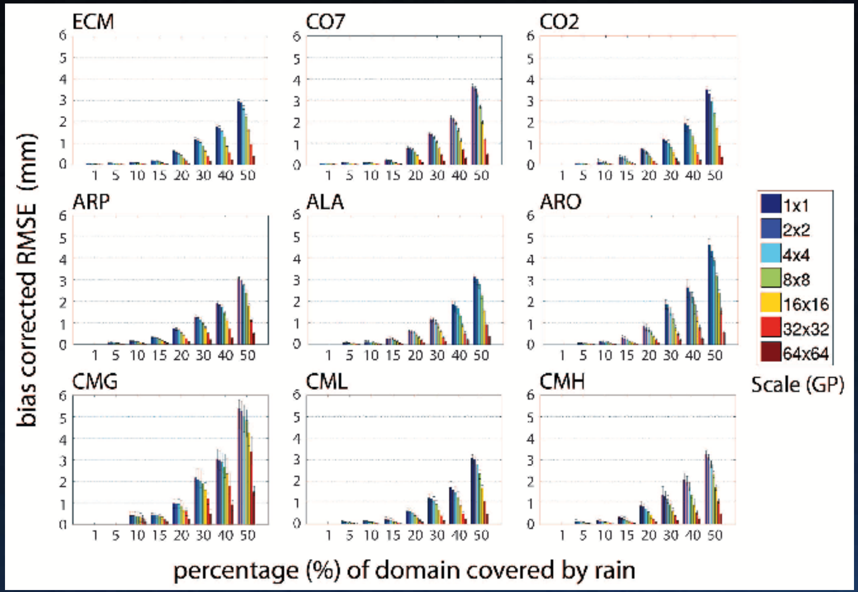
- precipitation
- but also Θ_e, wind, frontal speed and location

Verification scores:

- traditional verification metrics (e.g., bias-corrected RMSE)
- novel verification metrics (e.g., SAL, ISS, wavelet coherence)

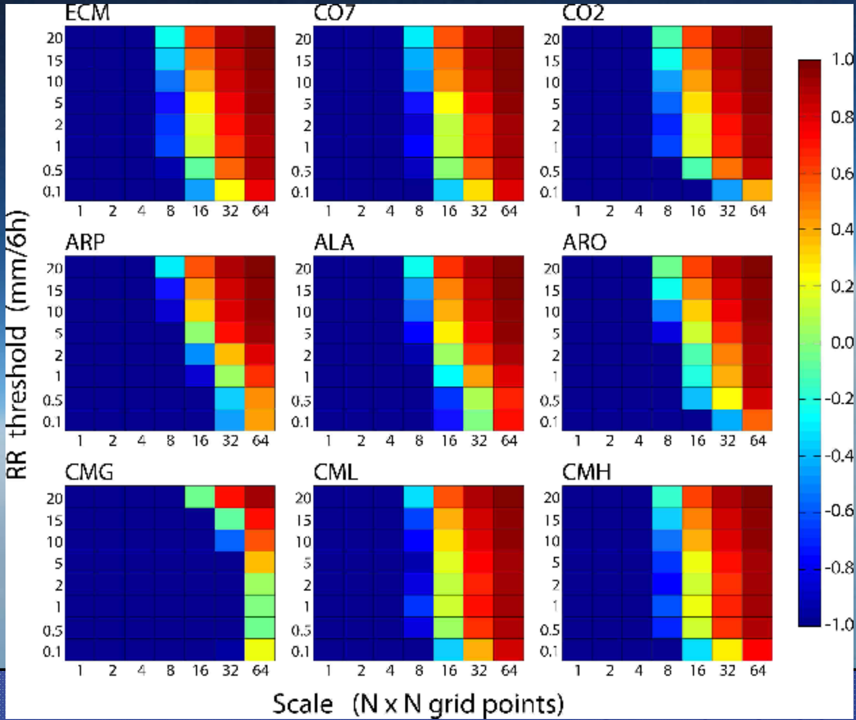
4. Results

4.1 Overall evaluation



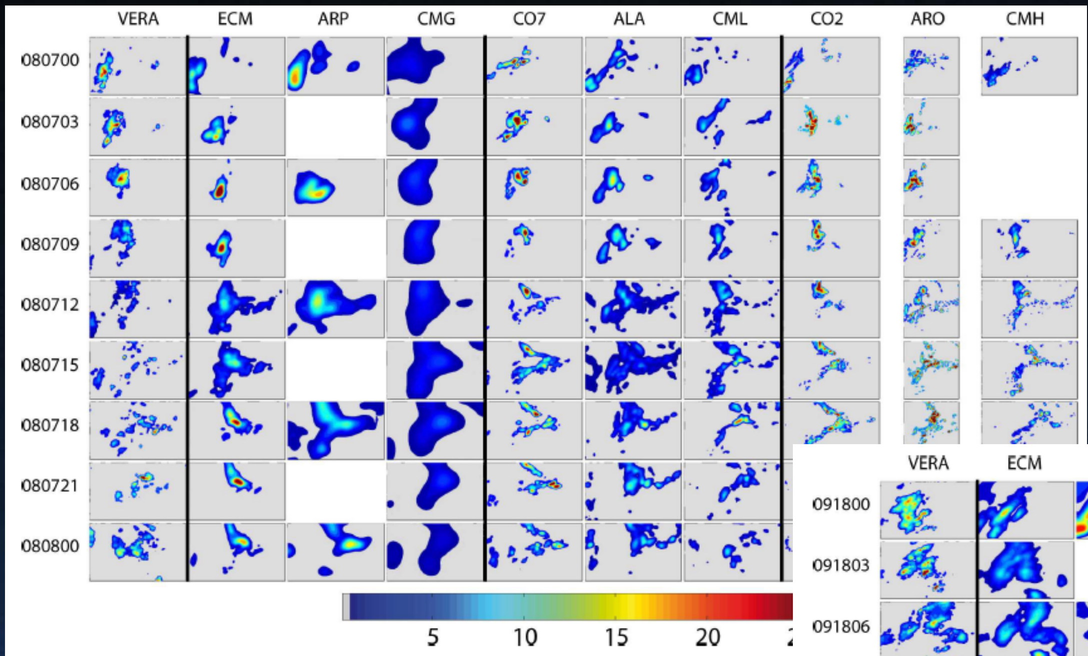
BC_RMSE: no added value of HRES models visible → double penalty problem

Intensity-scale skill score (ISS, Casati et al., 2004)
1: perfect forecast
0: no skill added to reference forecast



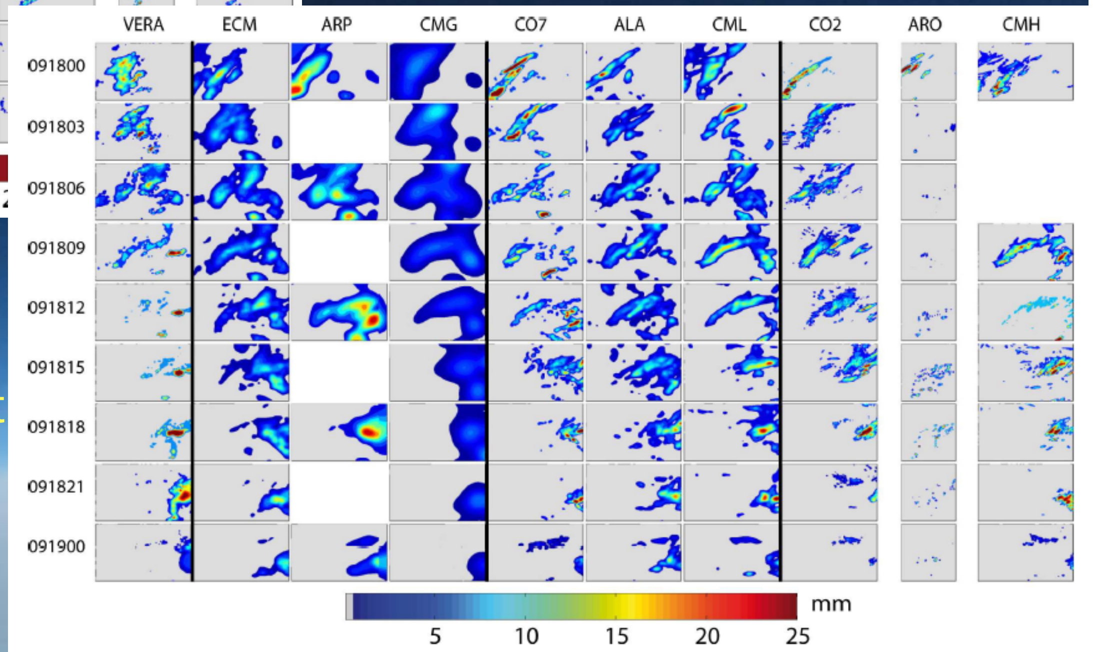
4. Results

4.2 Case studies



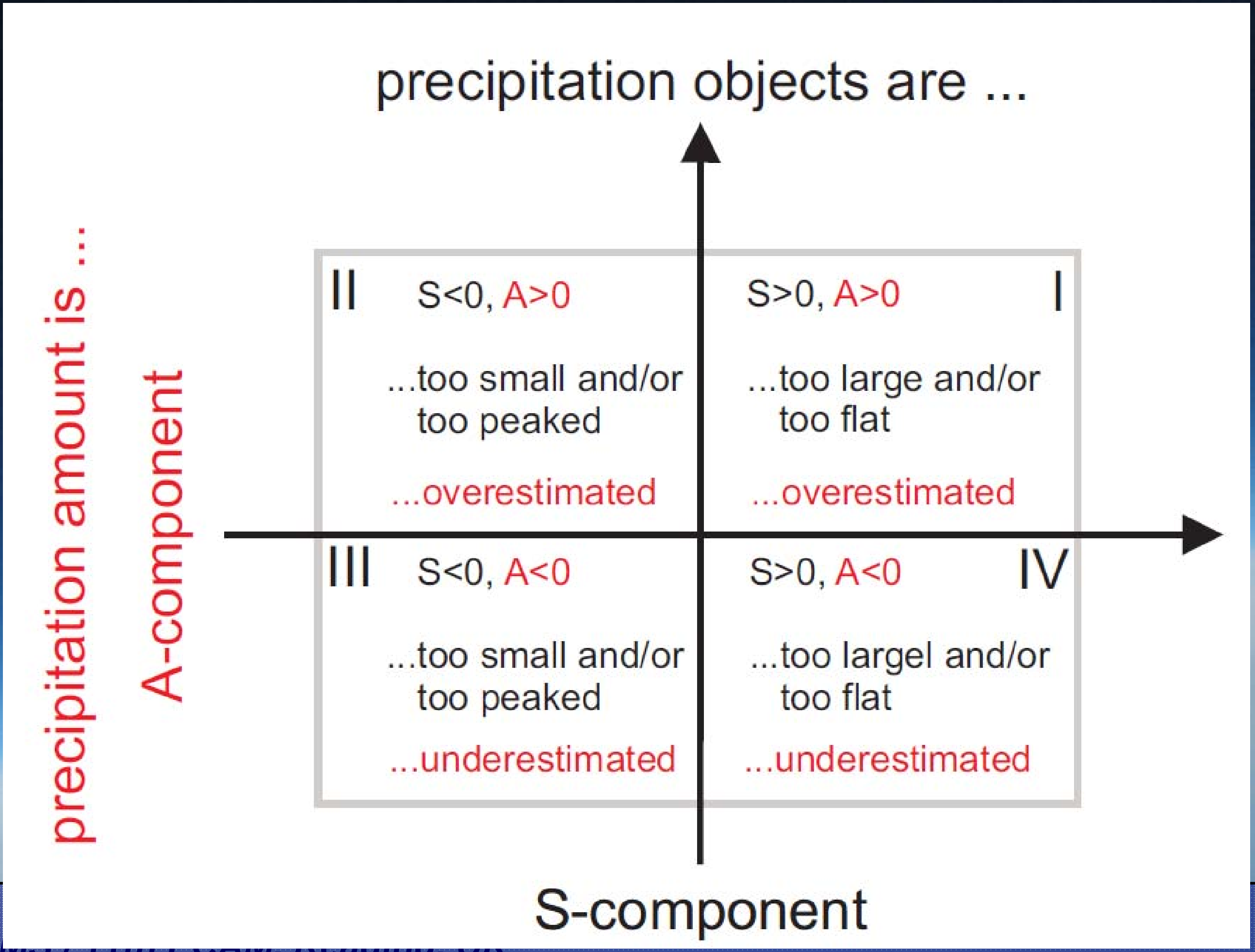
Convective case: 7 Aug. 2007
Morning hours: MCS
Afternoon: shower cells over large area

Frontal case: 18 Sept.. 2007
Fast moving front from west to east impinging the Alps



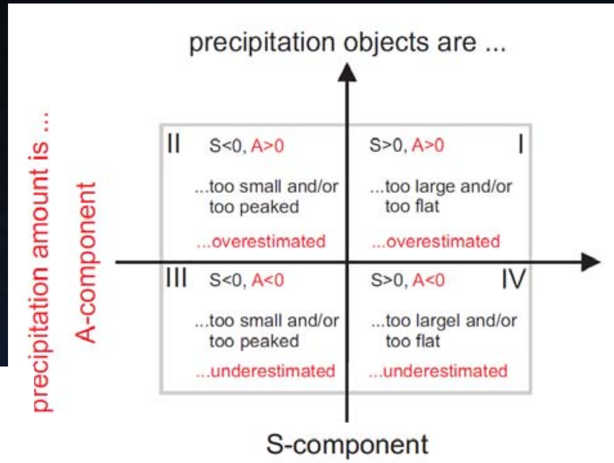
4. Results
4.2 Case studies

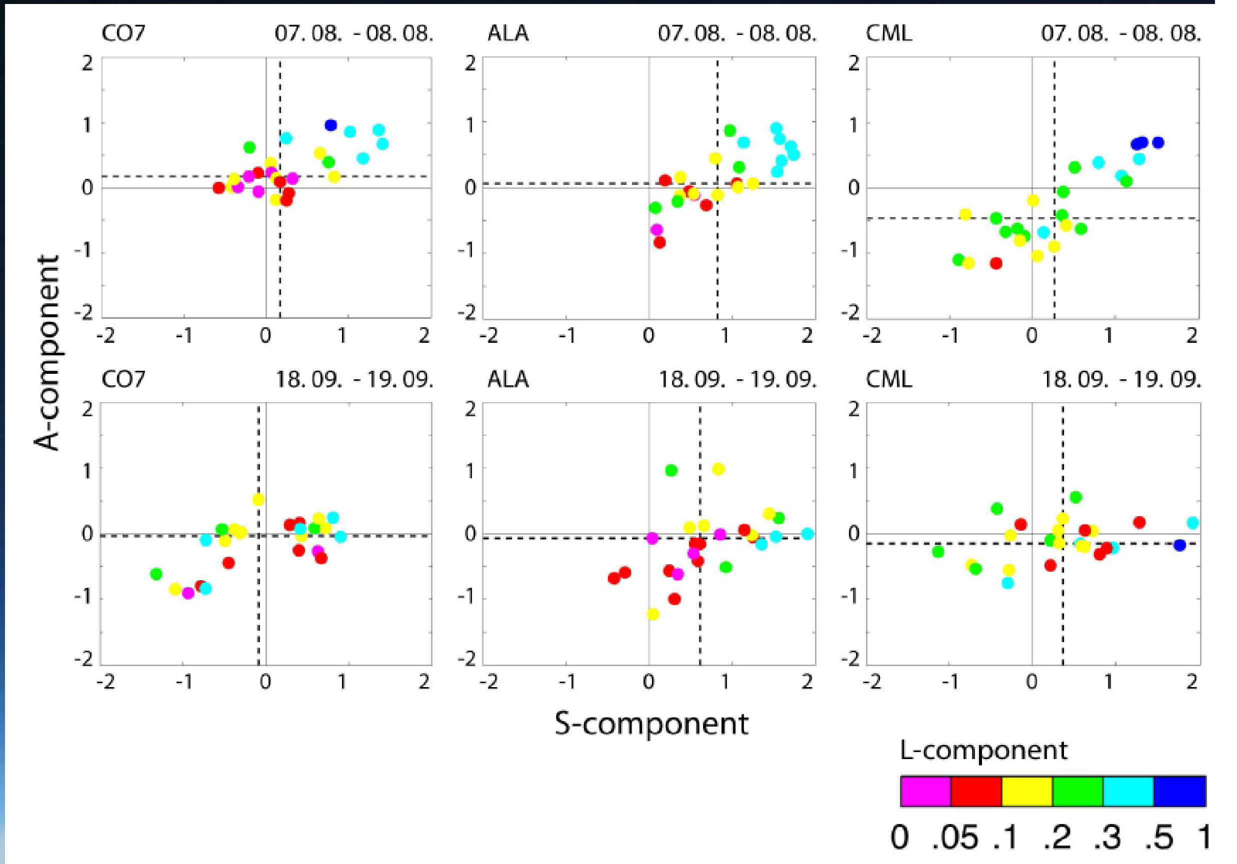
SAL: Structure – Amplitude – Location (Wernli et al., 2008)
perfect forecast: S=A=L=0



4. Results

4.2 Case studies

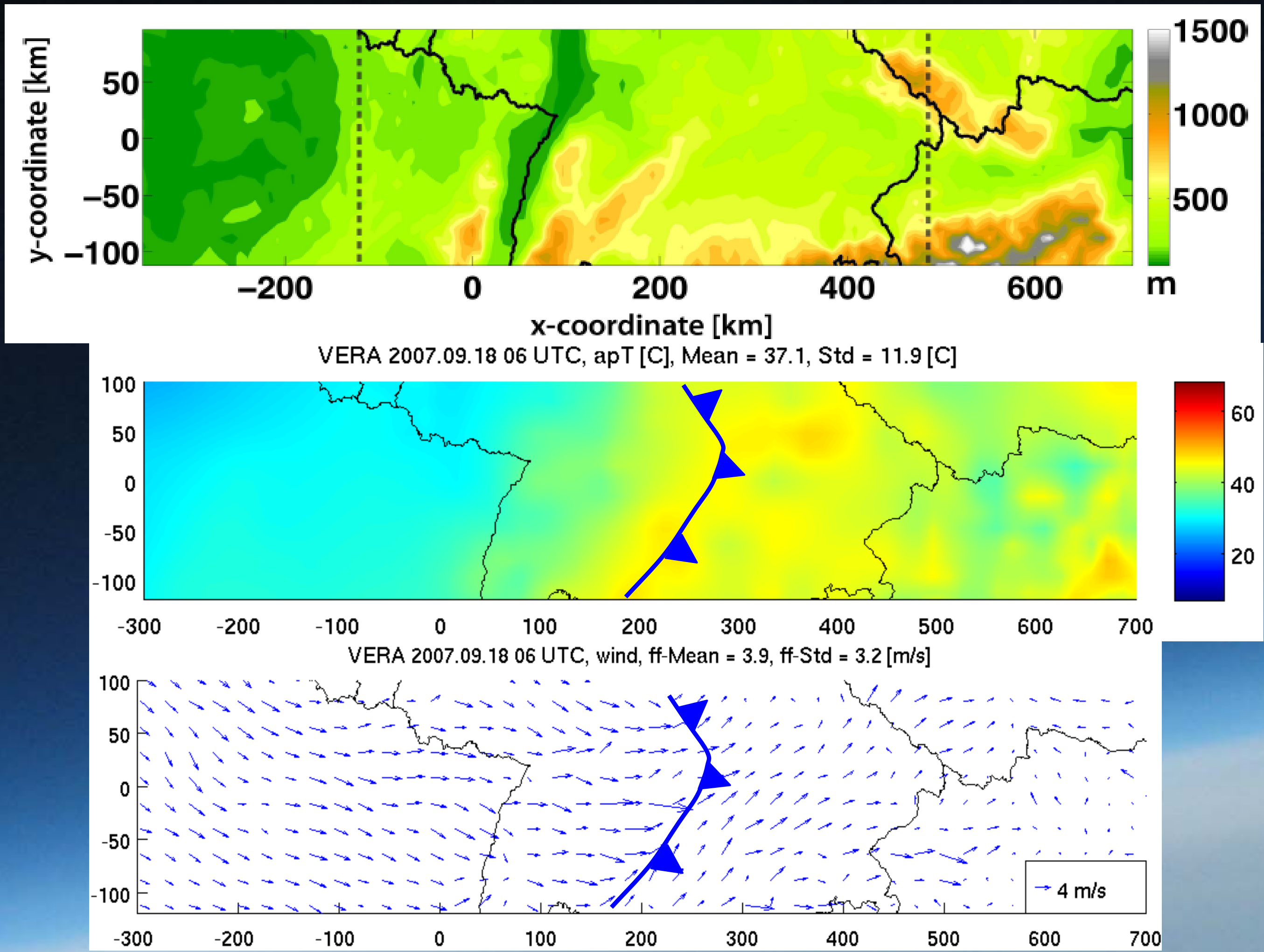




convective case

frontal case

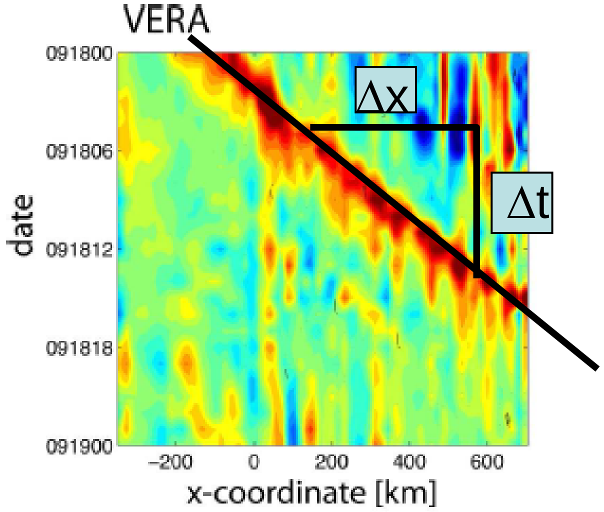
4. Results
4.2 Case studies



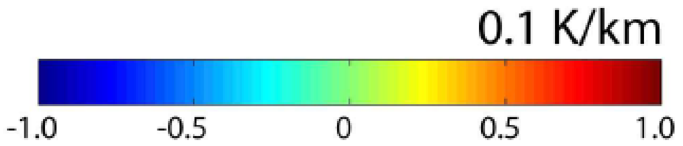
Frontal case:

meridional mean of W-E gradient of Θ_e.

4. Results
4.2 Case studies

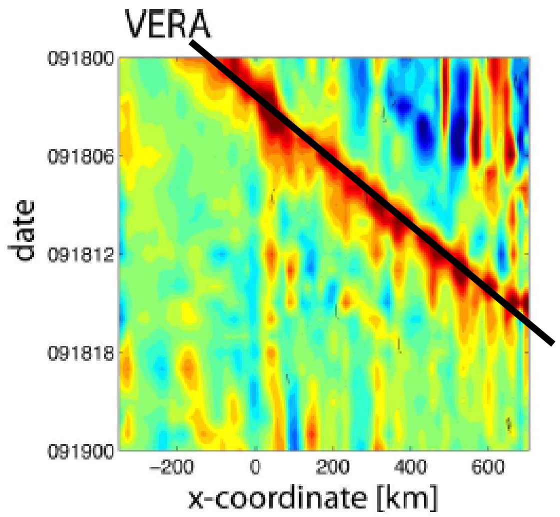


Hovmöller diagram
Propagation speed: inverse slope→ Δx/Δt
Horizontal line → prop. Speed = infinite
Vertical line→ stationary „system“

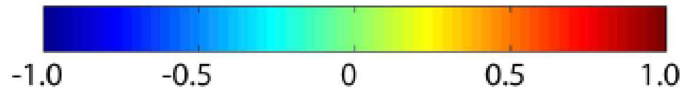


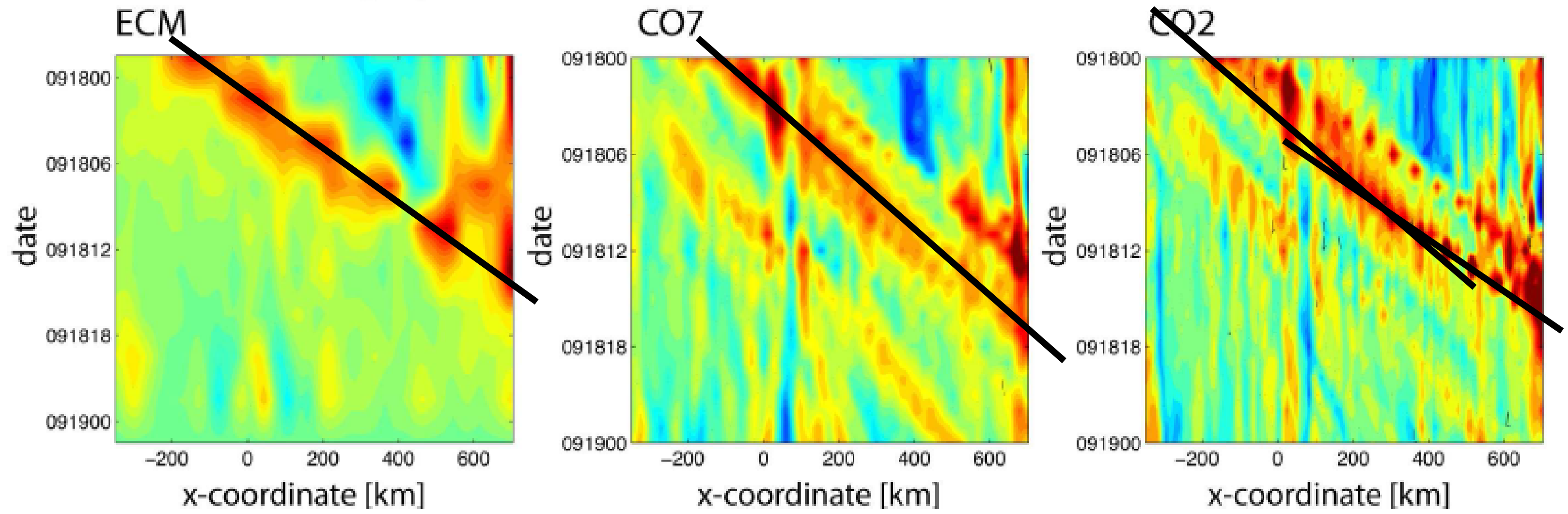
4. Results

4.2 Case studies



Estimated propagations speeds:
VERA: 15 m/s
ECM: 17 m/s
CO7: 15 m/s
CO2: 12 m/s – 18 m/s





5. Summary and Outlook

- Criteria established for a fair model chain inter-comparison
- use of NWP model independent analyses as reference based on JDC-data set
- selection of verification scores used to address the question: Can HRES models add skill to their coarse driving models?
- other meteorological parameters than precipitation are verified
- results indicate a different picture for each model chain

→Invitation to participate in ICP2:

side meeting at 18h30 in G10

http://www.ral.ucar.edu/projects/icp/index.html

References:

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