# Using OpenIFS to describe specific weather events at the Carpathian Basin

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# OUTLINE

1. Motivation
2. Experimental design
3. Results
4. Conclusions, outlook

# Background

- Hungarian Meteorological Service:
  - ALADIN/HARMONIE consortium, participation in ALADIN and AROME development
  - Operational weather forecasts based on ALADIN and AROME
  - Using ECMWF data and products (e.g., LBCs, EPS)
  - Teaching numerical modelling for meteorologist and mathematician students at the University (CHAPEAU, Lorenz model)
  - Coupled models (CHIMERE, etc.), regional climate modelling (ALADIN-Climate, REMO)
- Eötvös Loránd University:
  - WRF for everyday weather forecasts (GFS LBCs)
  - Adaptation of CHAPEAU model
  - Several coupled models (TREX, etc.)
  - Regional climate modelling based on 2 models

# Motivation

- Two licence agreements for the OpenIFS model in Hungary:
  - Hungarian Meteorological Service (OMSZ; 2013)
  - Eötvös Loránd University (ELTE; 2014)
- Installation on the SGI supercomputer of OMSZ in 2013
- Cooperation of the two institutes on a Master Thesis: supervision of its synoptic part by University, its modelling part (including model execution) by OMSZ

# Experimental design

- Resolution: T639 spectral truncation (~34 km horizontal resolution) and 91 vertical levels – full capacity of SGI
- Period: 13 November and 4 December 2011 with 24-hour integrations
- Spatial focus on Carpathian Basin
- Weather situation: persistent cold air pool

# Cold air pool

- Persistent inversion in winter anticyclonic situation
- More humidity in the cold air layer → cooling down to its dew point temperature → fog during the night
- Fog does not dissolve in daytime → elevation → stratus layer → in daytime the cloud top radiates out → cooling
- Low mixing → dramatic impact on air pollution
- Frequent weather phenomenon over the Carpathian Basin in winter providing modelling challenge → great IFS development based on forecasters’ feedbacks

# Verification

- Location: Szeged
- Verification against surface and radiosonde measurements
- Evaluated variables:
  - mean sea level pressure
  - **shallow convective potential energy** (Bozóki, 1987)
  - top and base of inversion layer
  - height of cloud top and cloud base

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- Energy needed to shallow convection
- Area between state curve and dry adiabat from 850 hPa to surface
- Modification of CAPE equation (Williams & Renno, 1993):

$$SCP^{850} = -R_d \int_{p_0}^{850} \left(T_{vp} - T_{ve}\right) d\left(\ln p\right)$$

$T_{vp}$ and $T_{ve}$: virtual temperature for air parcel and environment

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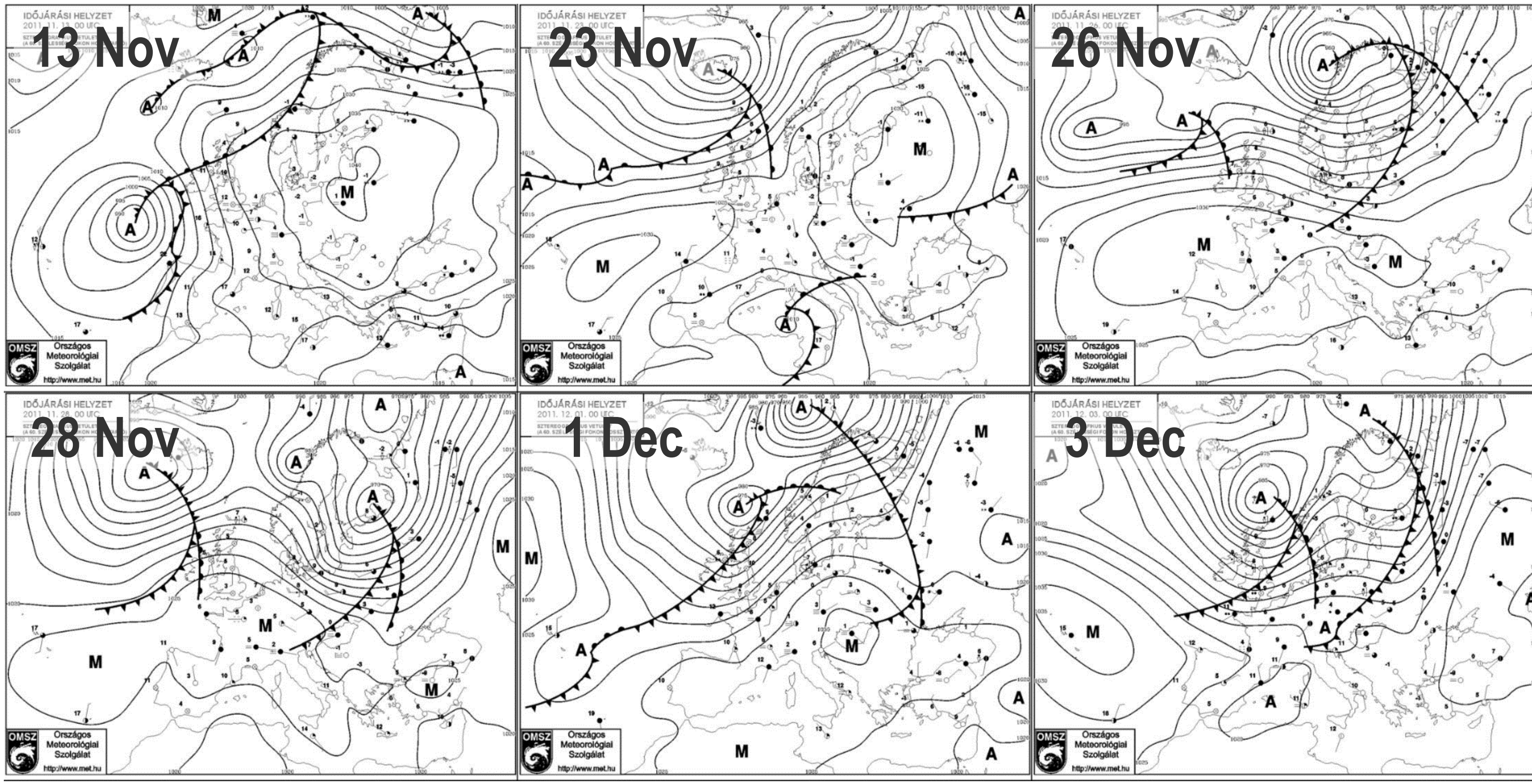
- Calculated based on vertical temperature gradient
- For measurements: from the surface
- For model data: using levels between 1000 and 700 hPa

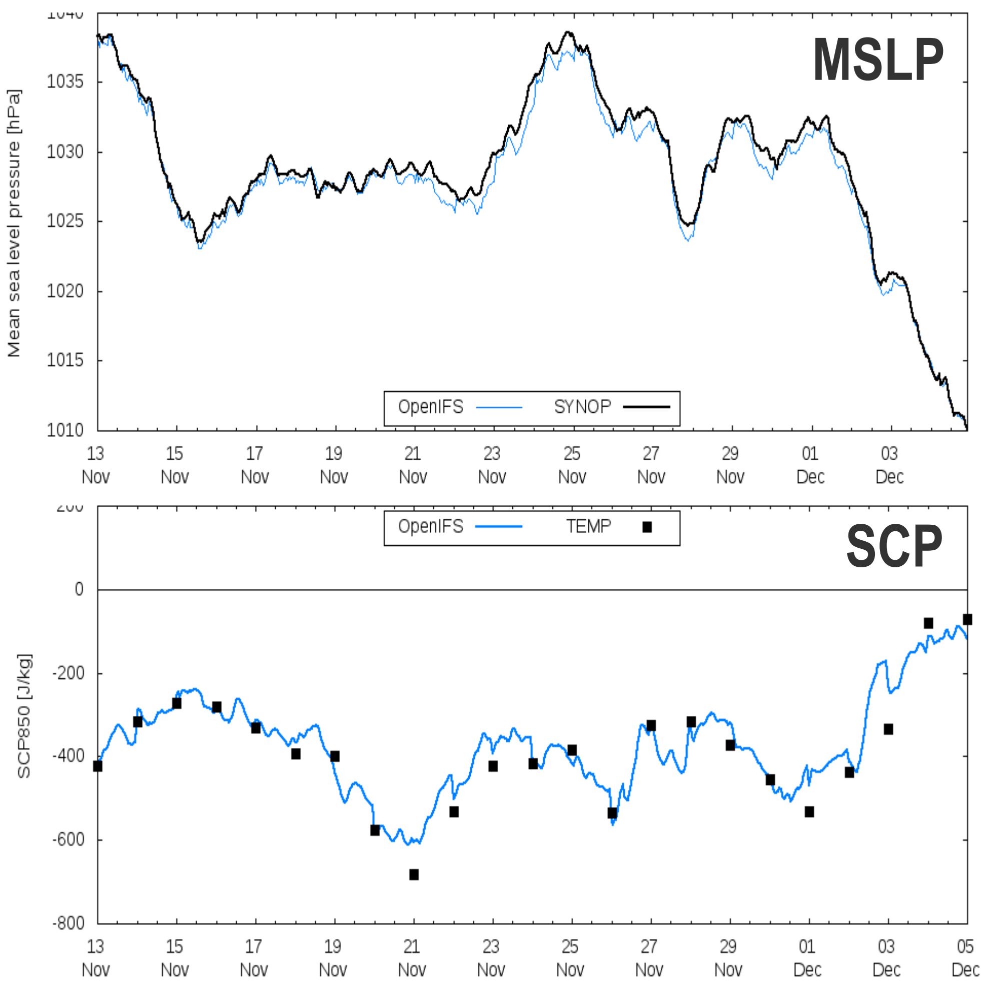
# Synoptic situation




Anticylone over Eastern Europe (M) → warm front → broken cold air pool → re-formation after cold front → total break up

# Results

# MSLP and SCP




- Reasonable MSLP and SCP results
- Negative SCP → stability in lower atmosphere
- 3 SCP minima
- 20–24 Nov, 1–3 Dec: slightly less stable atmosphere in the model → slower development of cold air pool

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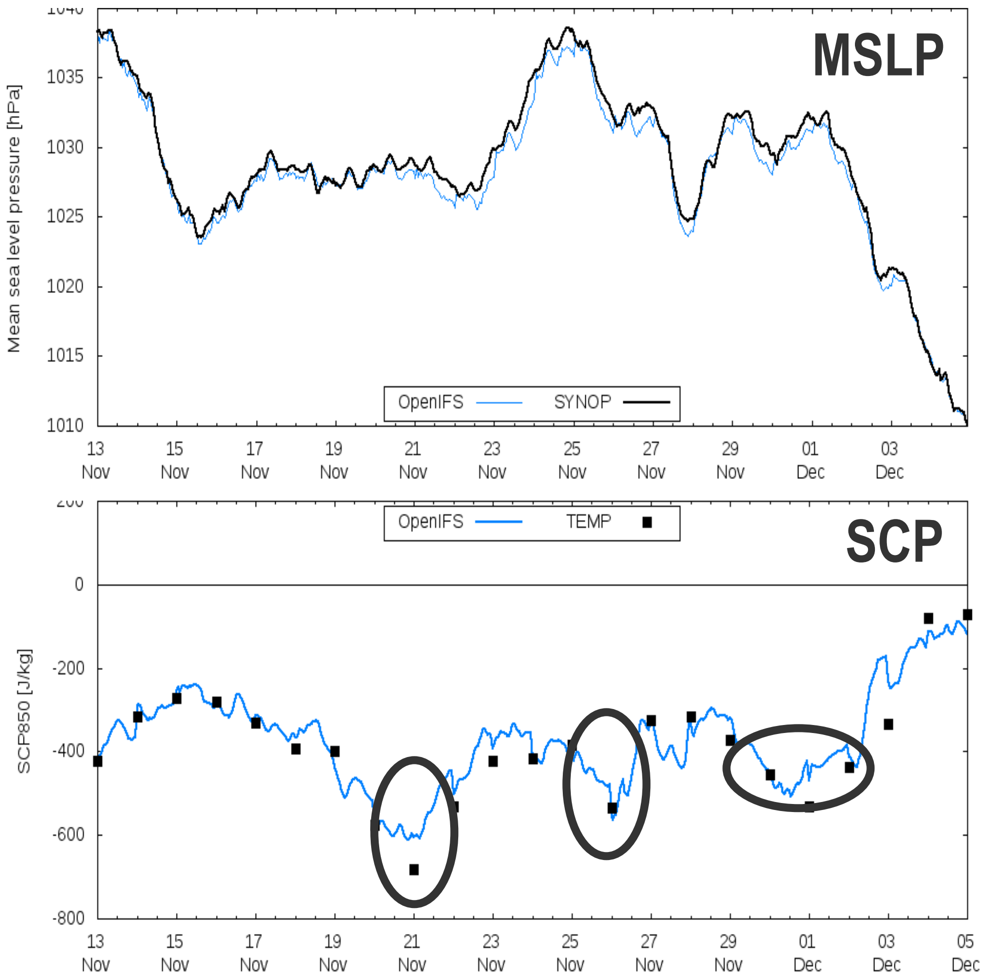


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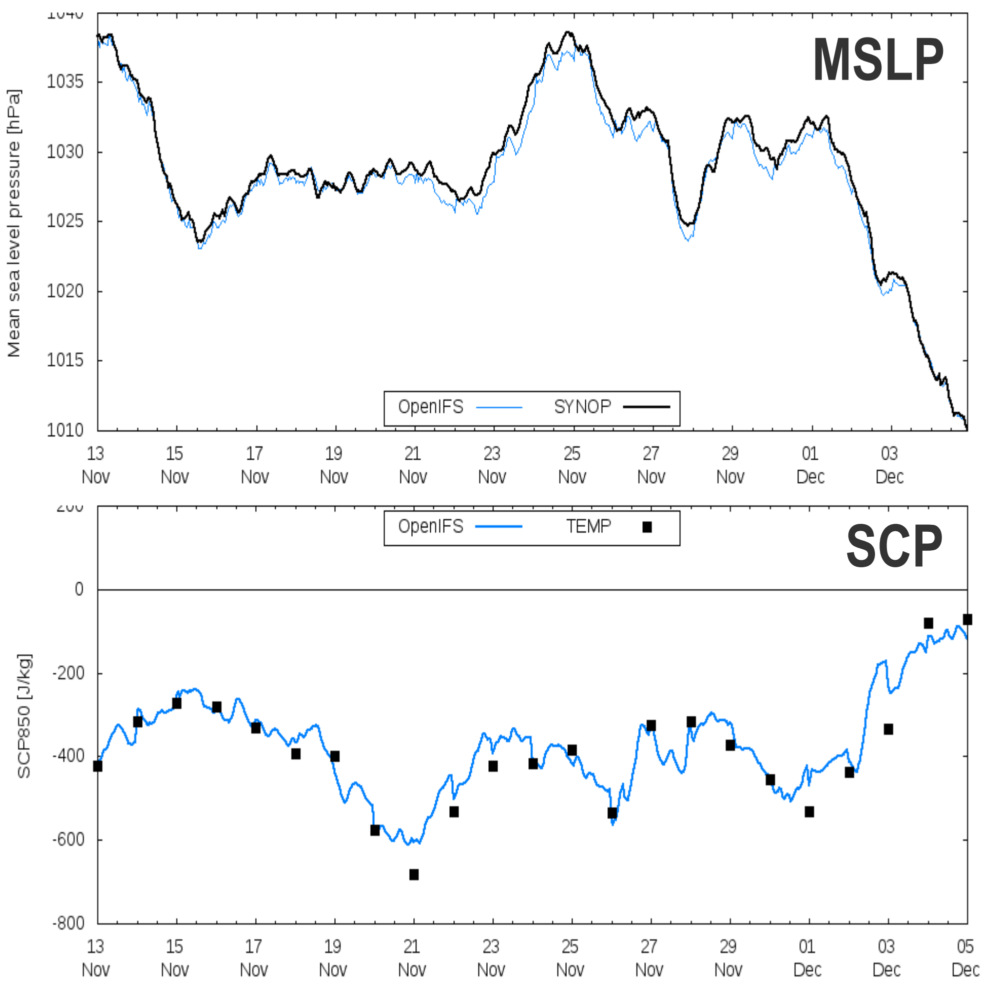


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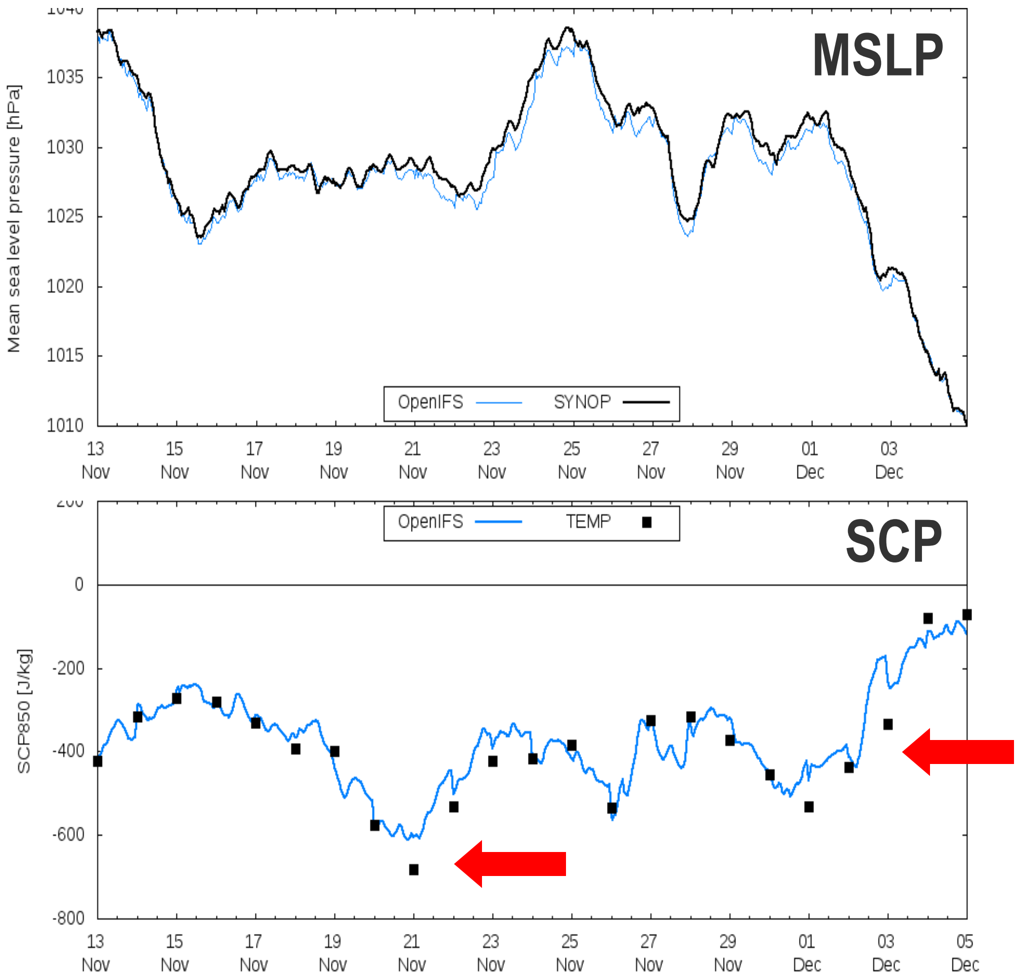


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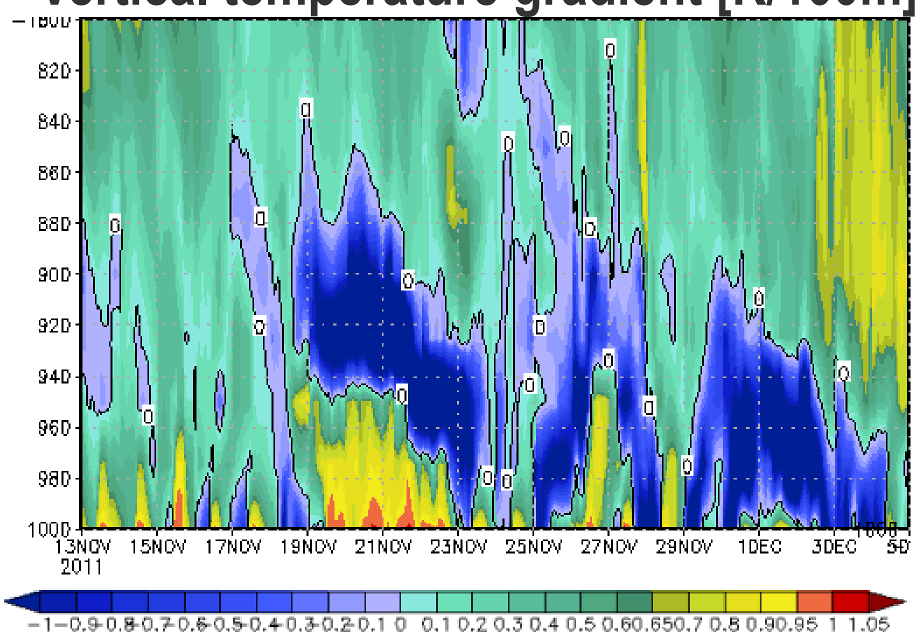
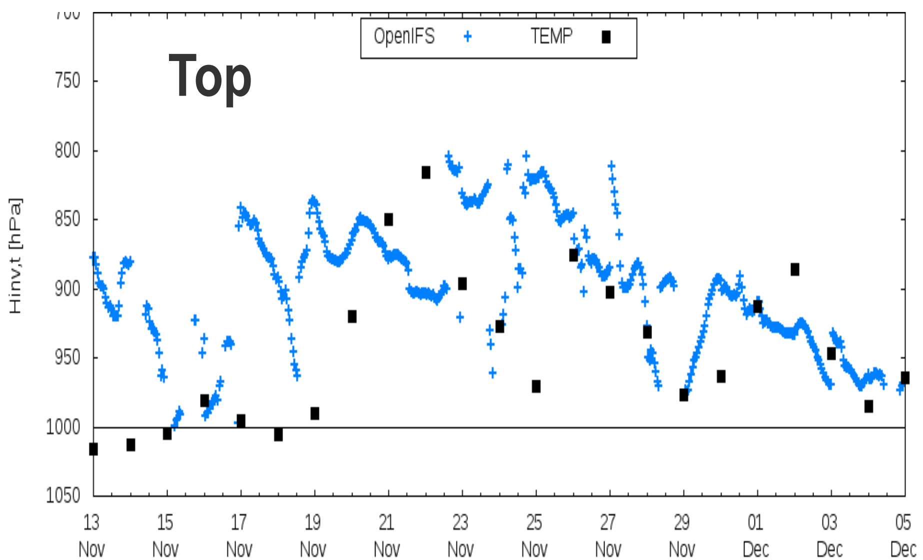
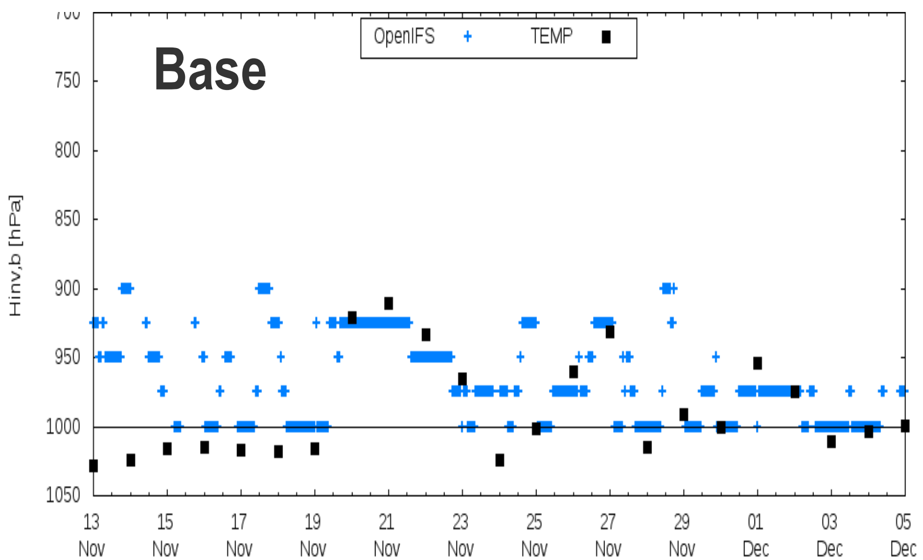
# Inversion layer

## Vertical temperature gradient [K/100m]

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- Top: 3 maxima, but with wrong phase → too early built up and destroy in the model
- Base: good during cold air pool

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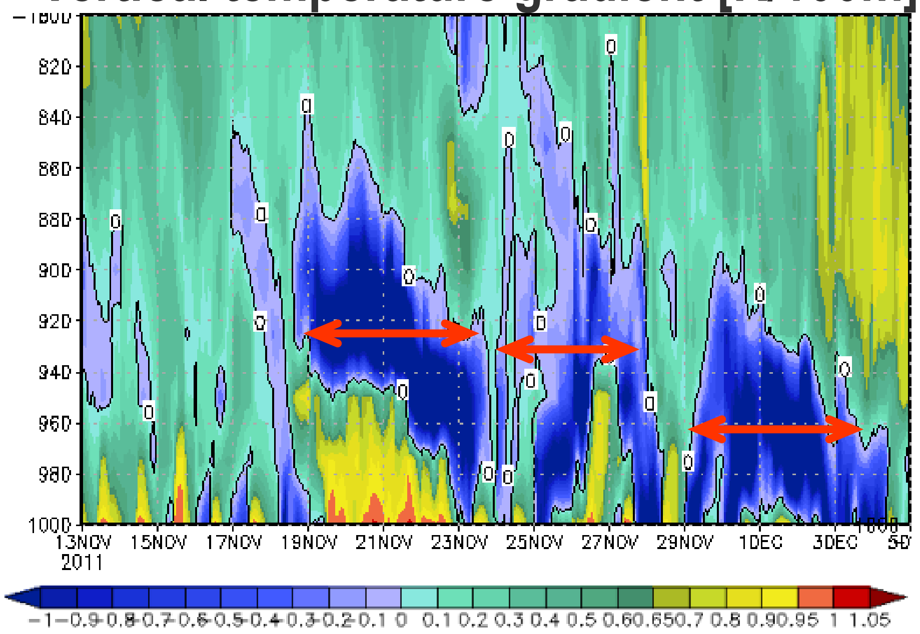


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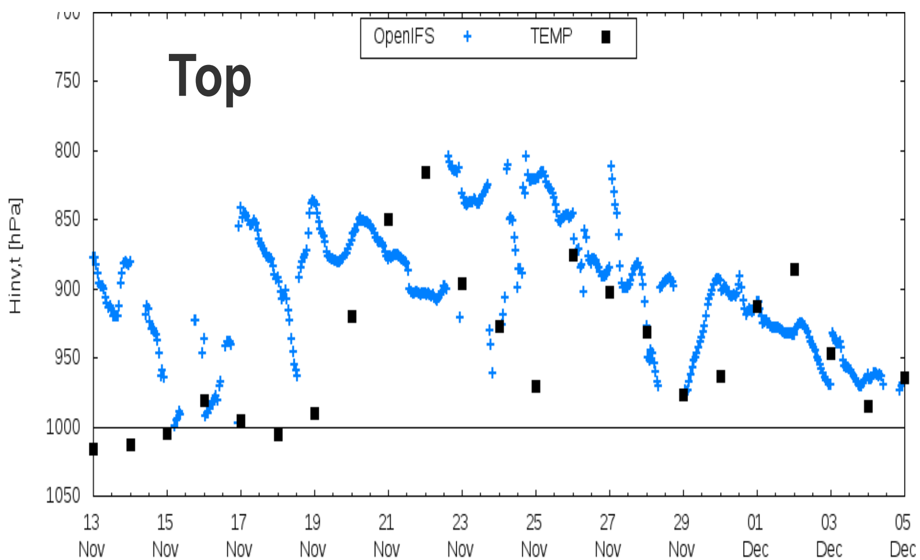
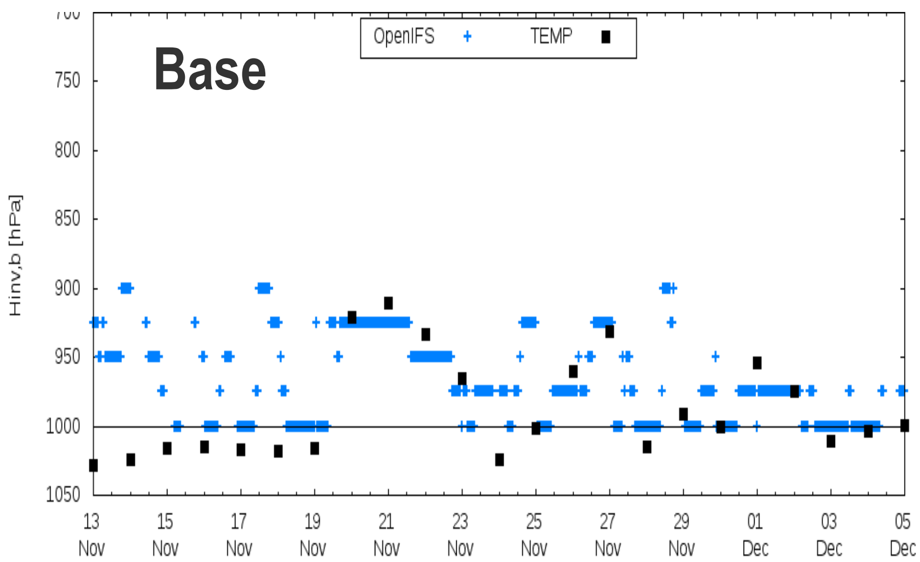
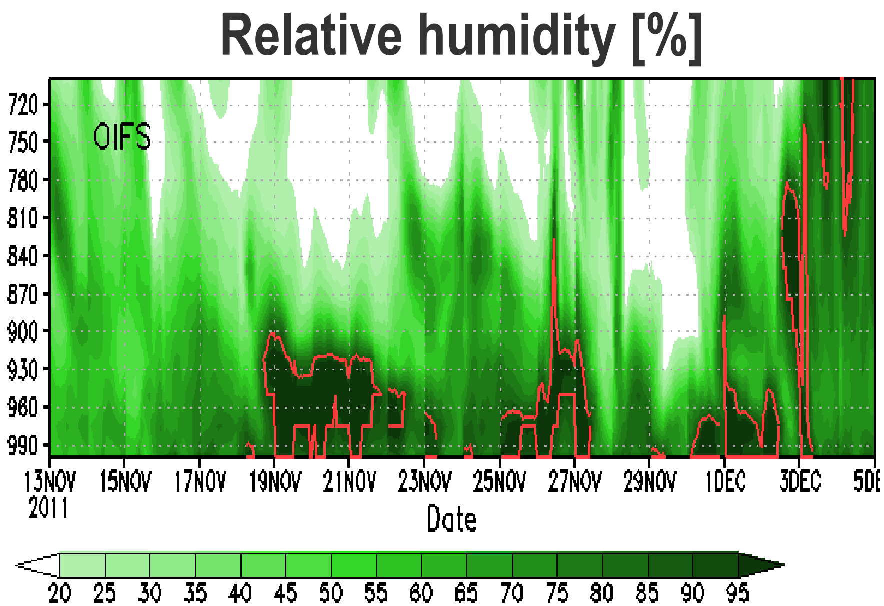
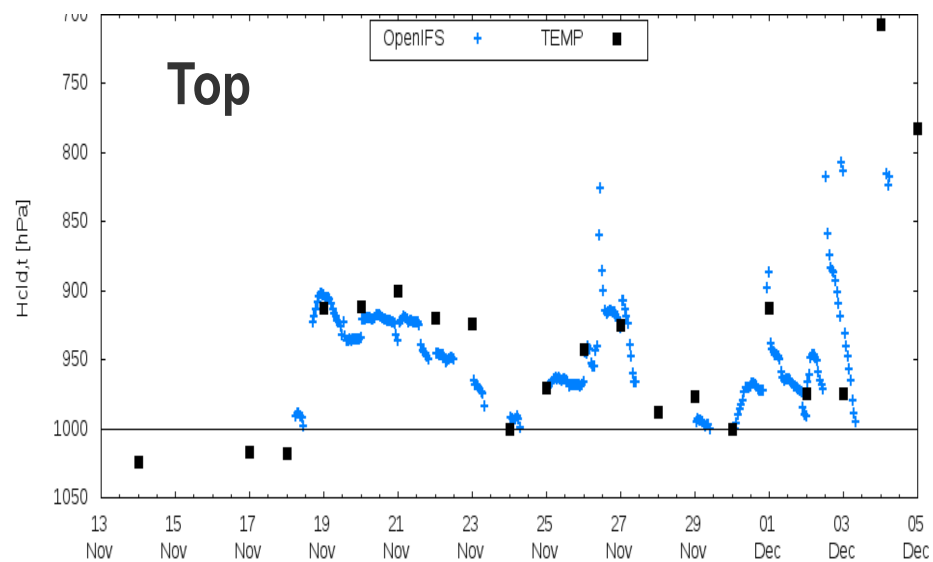
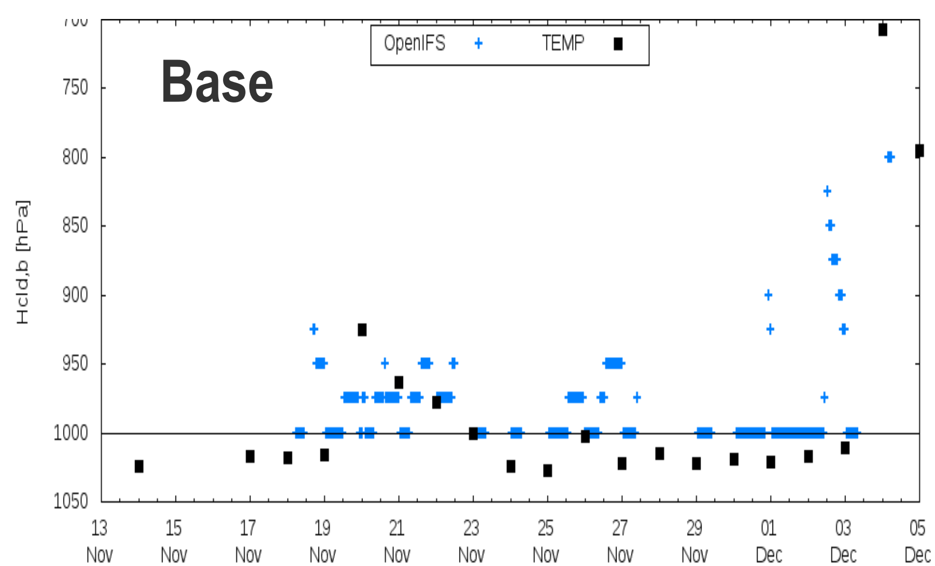


# Cloud top and base



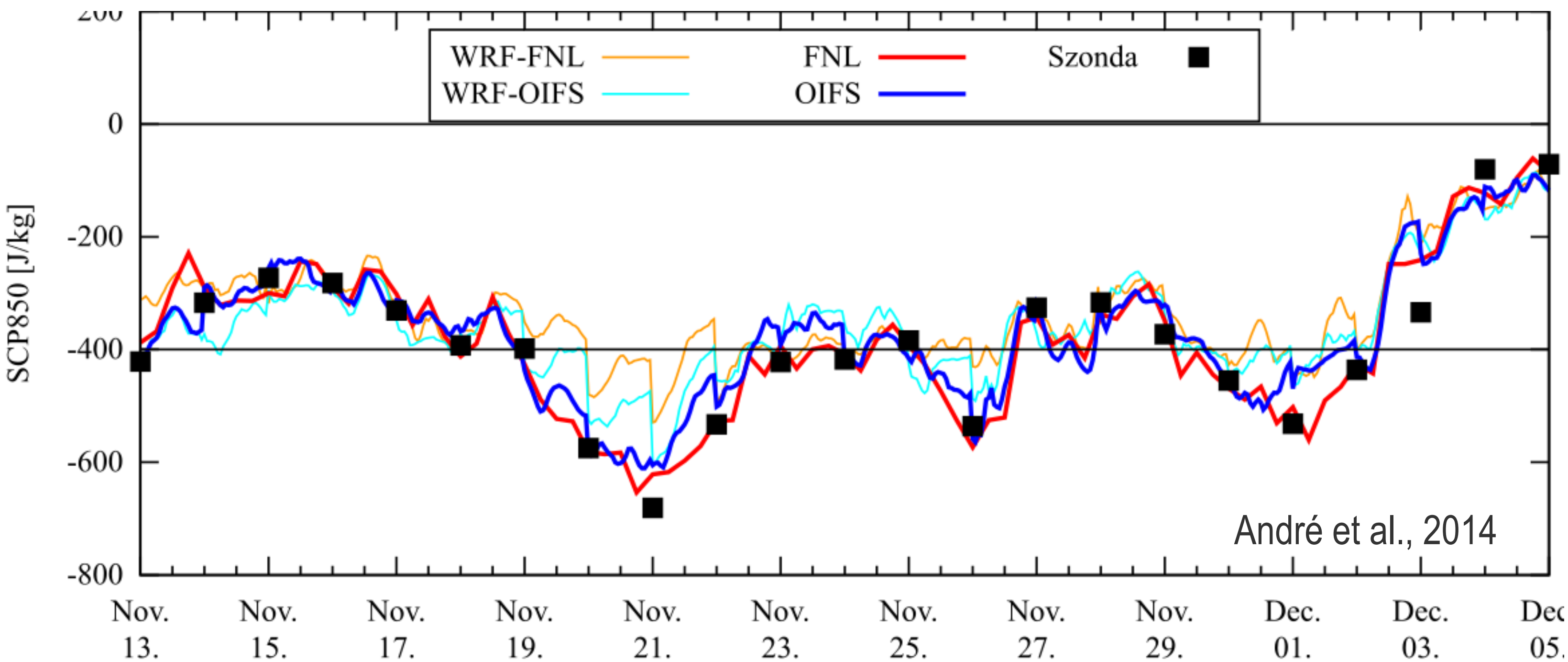

- Good RHU results during cold air pool events
- Fog was not well reproduced (due to some technical issues)

# Conclusions

- Using $SCP^{850}$ an appropriate definition can be created by the persistent cold air pool → search algorithm
- Relative humidity was not a good precursor of the phenomenon
- OpenIFS was capable of describing persistent cold air pool

# Outlook

- OpenIFS provided LBCs for limited area WRF runs
- Comparison of WRF runs driven by GFS analyses



# Outlook

# Thank you for your attention!

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