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COSMO-2 Model Performance in Forecasting south foehn: a Systematic Process-oriented Verification

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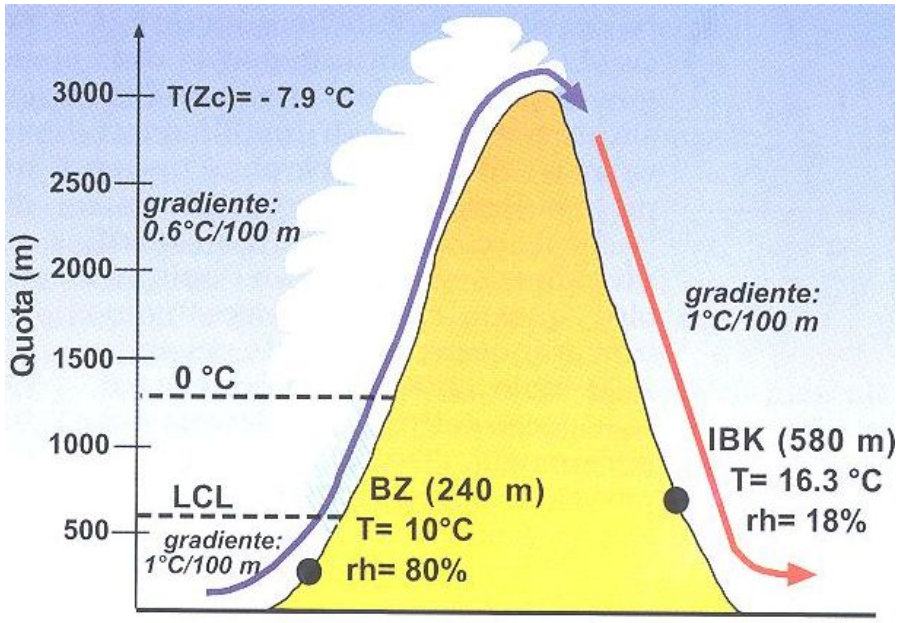
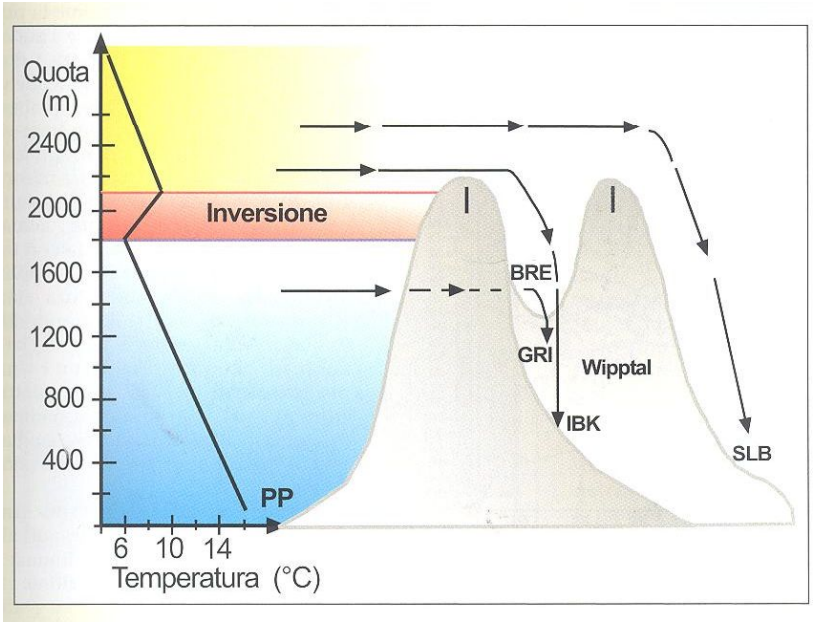
Foehn definition

WMO (1992): a "wind [which is] warmed and dried by descent, in general on the lee side of a mountain."

Classical foehn



More offen observed foehn



Motivation

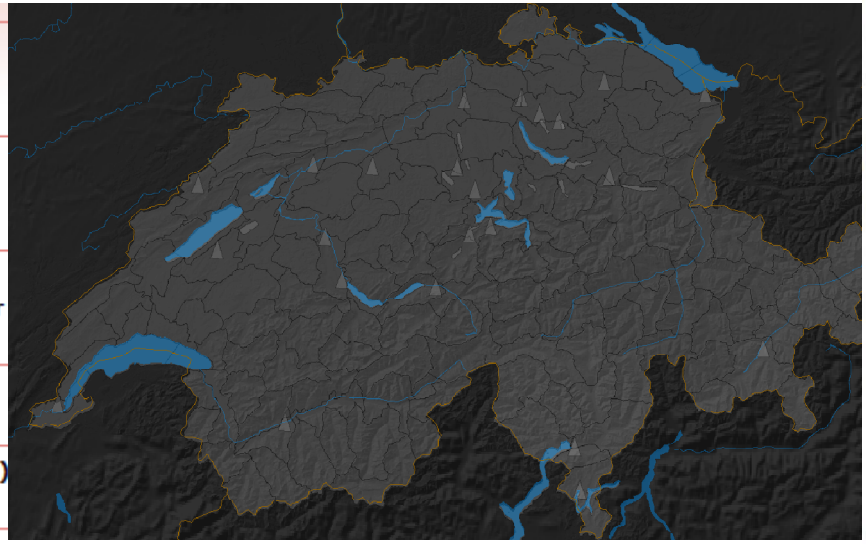
Level 1
no or minor danger

Level 2 (yellow)
moderate danger

Level 3 (orange)
considerable danger

Level 4 (red)
high danger

Level 5 (dark red)
very high danger



Tödlicher Seilbahnunfall: Föhnsturm vermutlich Ursache

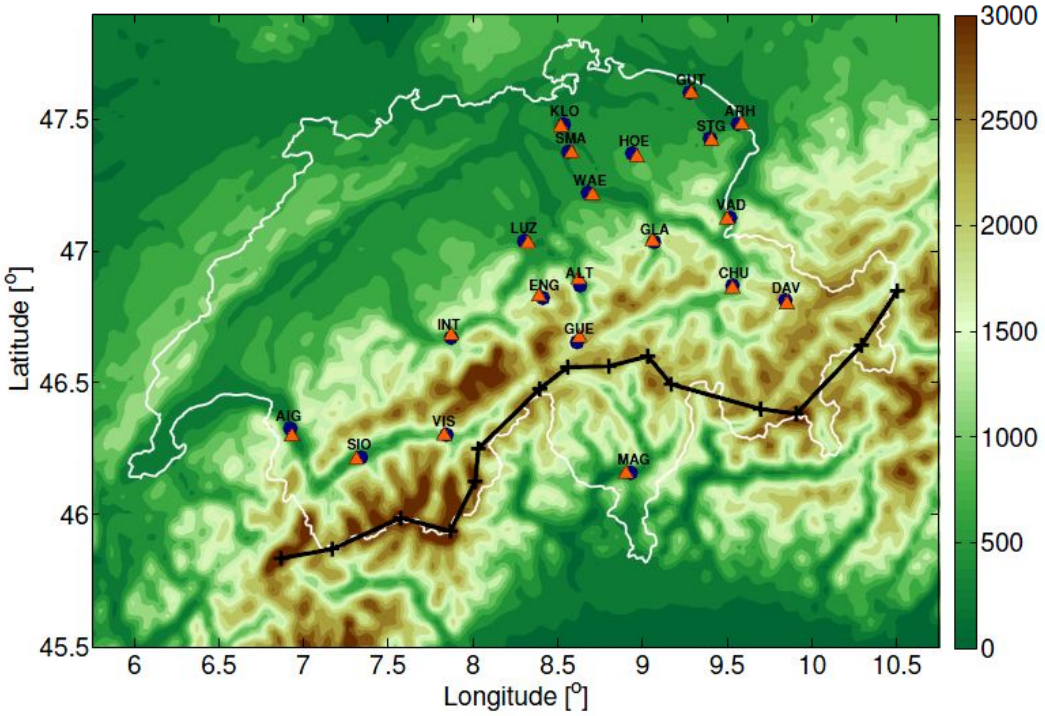
0 Dots 04.01.08 | Welt | | Schrift a / A |

Empfehlen

Bern - Für das tödliche Seilbahnunglück in der Schweiz könnte ein schwerer Föhnsturm die Ursache gewesen sein. Das vermuten die Untersuchungsbehörden. Bei dem Unglück im Gebiet Kleine Scheidegg im Berner Oberland war am Donnerstag ein Seil an einem Pfeiler aus den Rollen gesprungen.

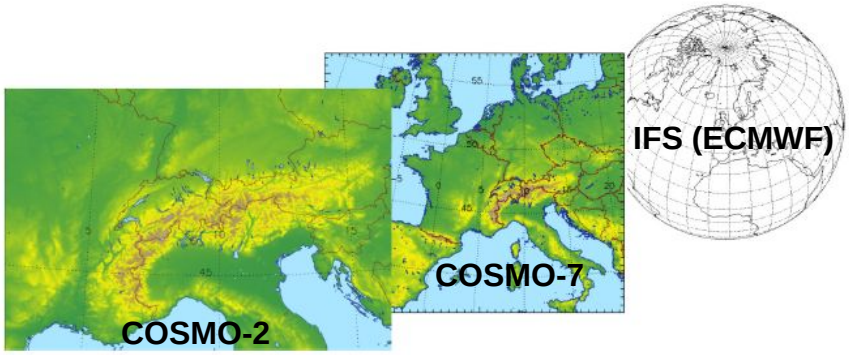
Observation data

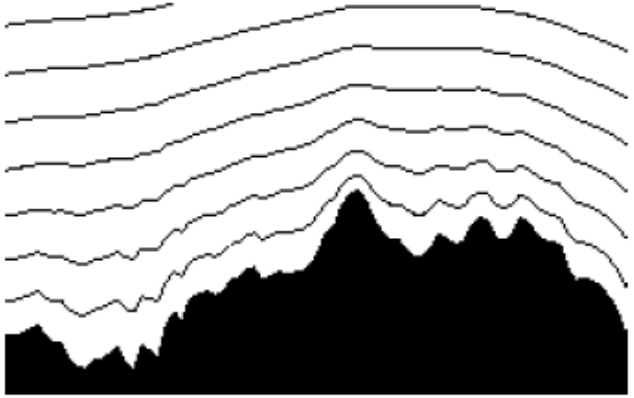
- 2008-2011: Hourly data during foehn days (≥10min foehn observed)
- T, P, RH, V, Vmax, Vdir
- 17 foehn stations
- 1 Alpine crest station (Gütsch)



COSMO-2 data

- Hourly analysis data (2008-2011) during foehn days (≥10' foehn **observed**)
- T, P, RH, V, Vmax, Vdir
- Gridpoint interpolation (Kaufmann, 2008)
- Surface and last 3 model levels





How to identify Foehn

1. **South flow over the alpine crest**:
   - reference station on the alpine crest
   - wind direction, wind speed
2. **Same air mass** at the stations and **at the alpine crest**:
   - conservative variable: potential temperature

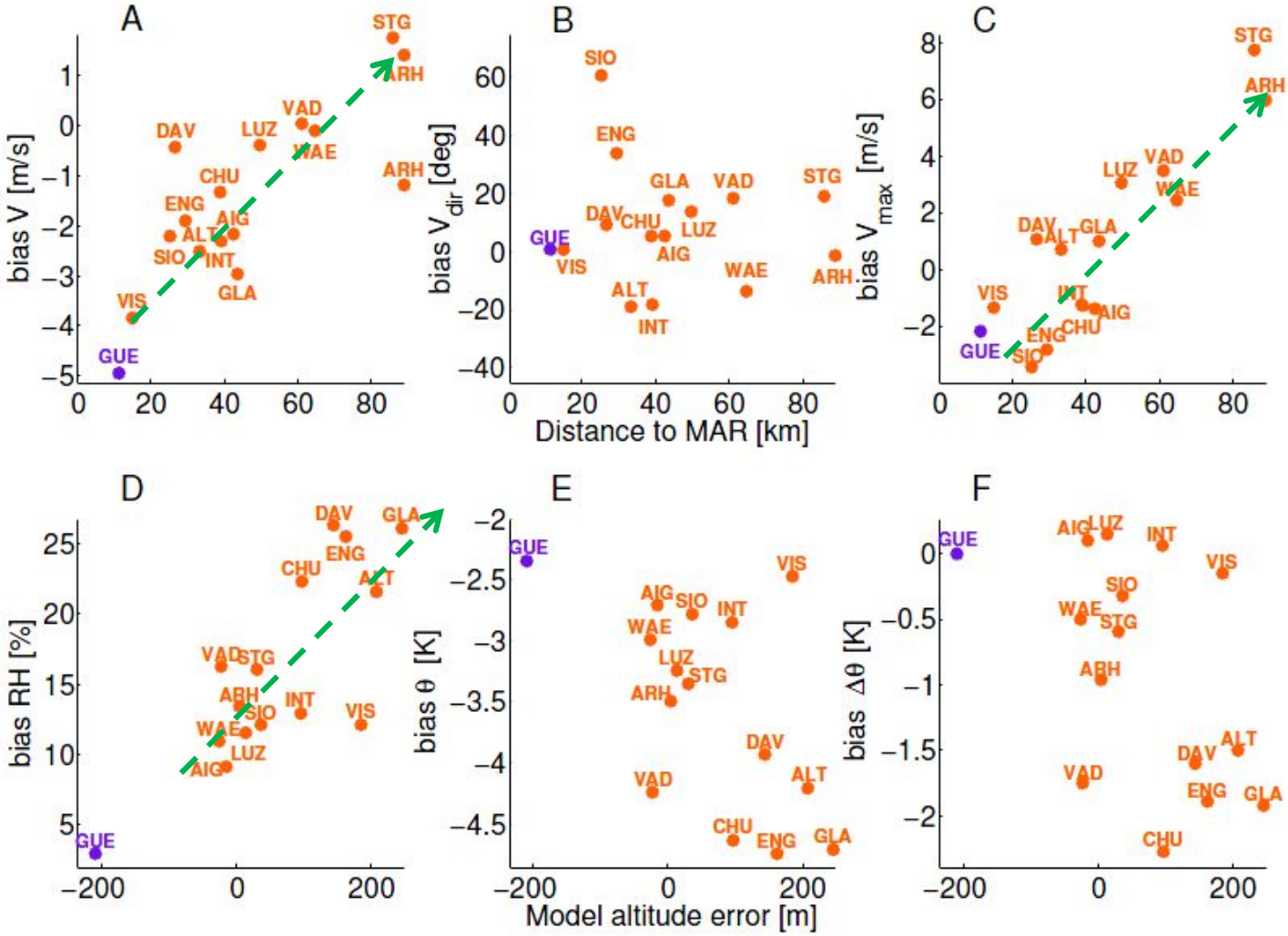
$$\Delta\Theta_{STA-GUE} = \Theta_{STA} - \Theta_{GUE} \geq 0 - \alpha$$

3. **Wind direction** (inside alpine valleys): south directions
4. **Wind speeds and gusts** (inside alpine valleys: >4-5 m/s)
5. **Low relative humidity** depending on the altitude **(35-70%)**

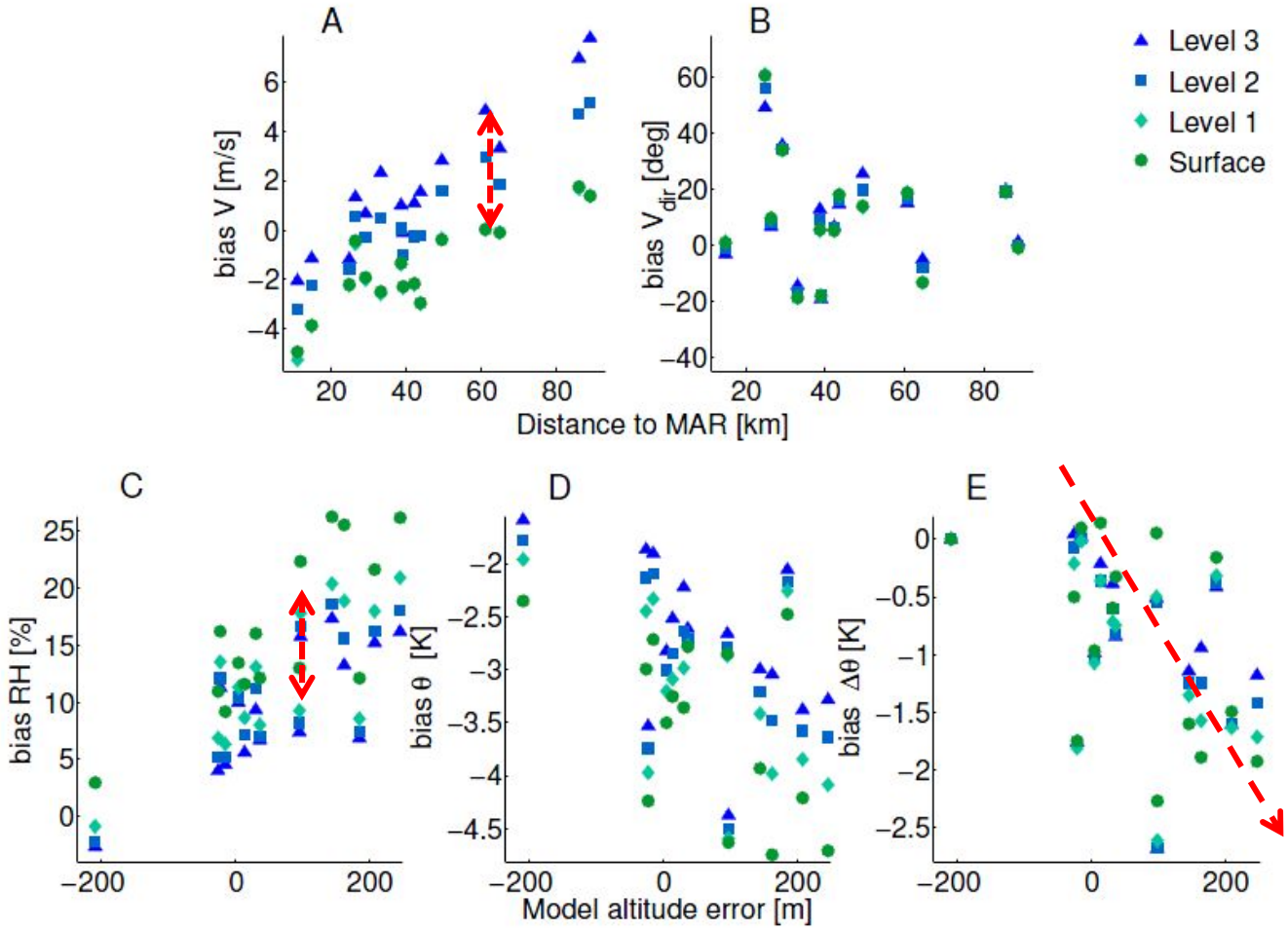
Dürr (2008)

Forecasting foehn is a very challeging task!

Bias surface variables during foehn



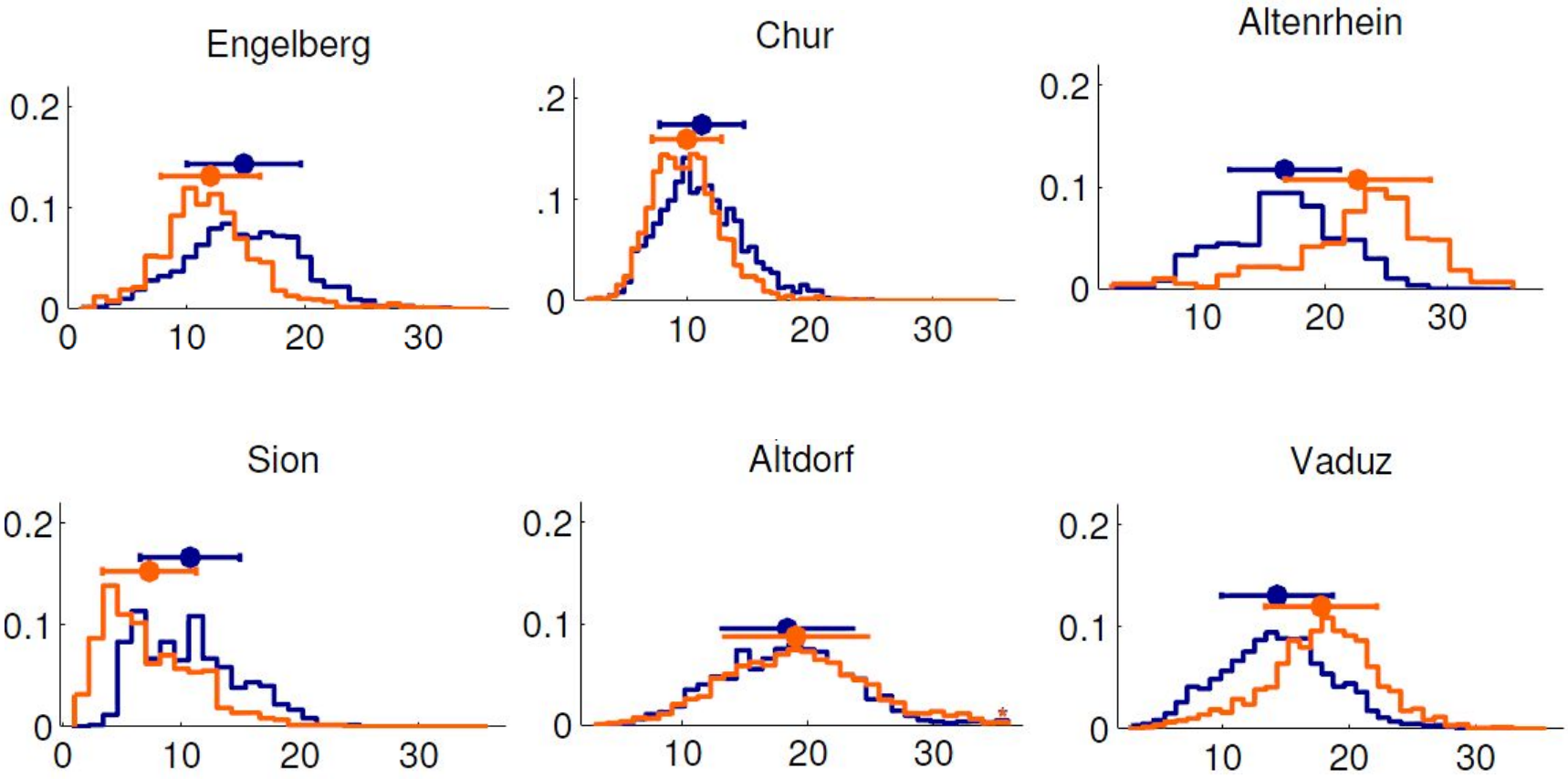
Bias and model level during foehn



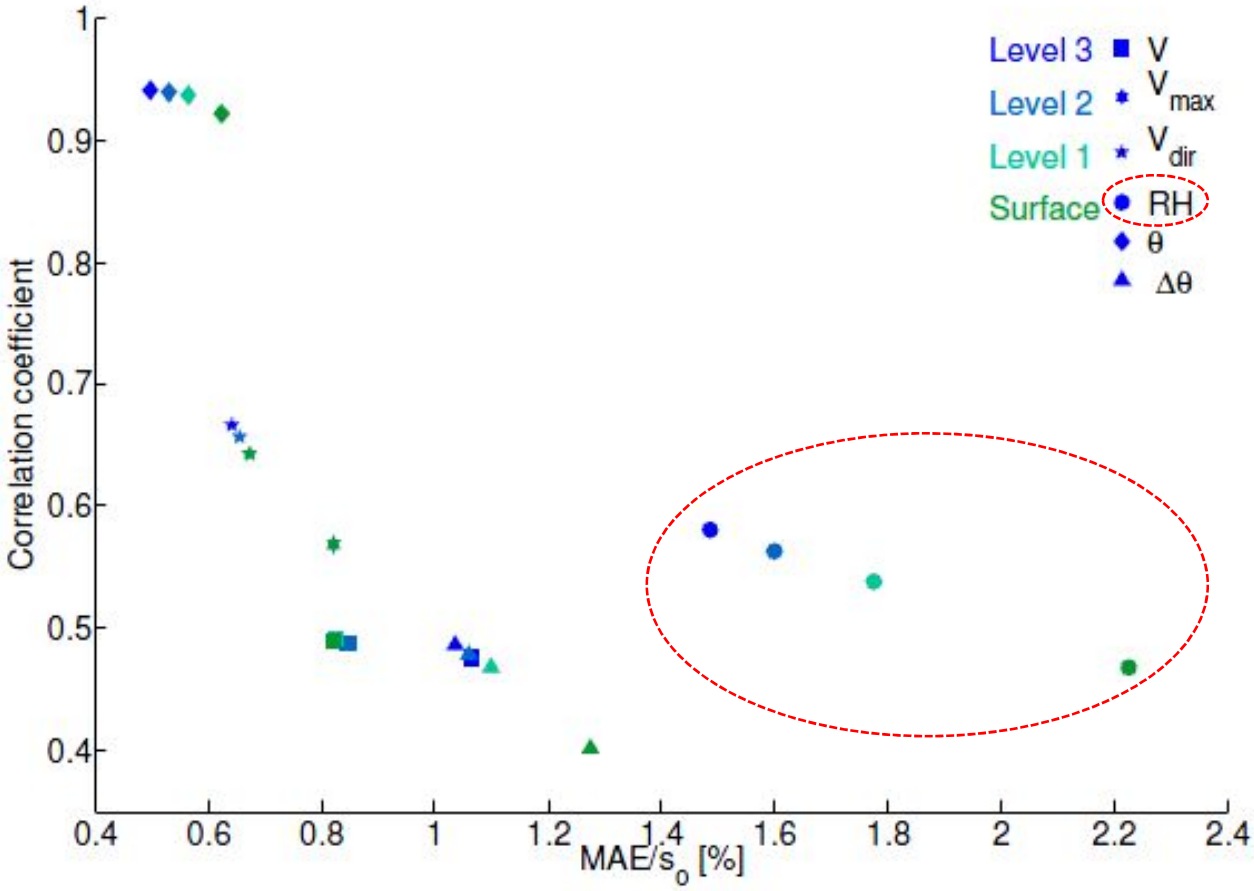
Wind gust distributions

obs
COSMO-2

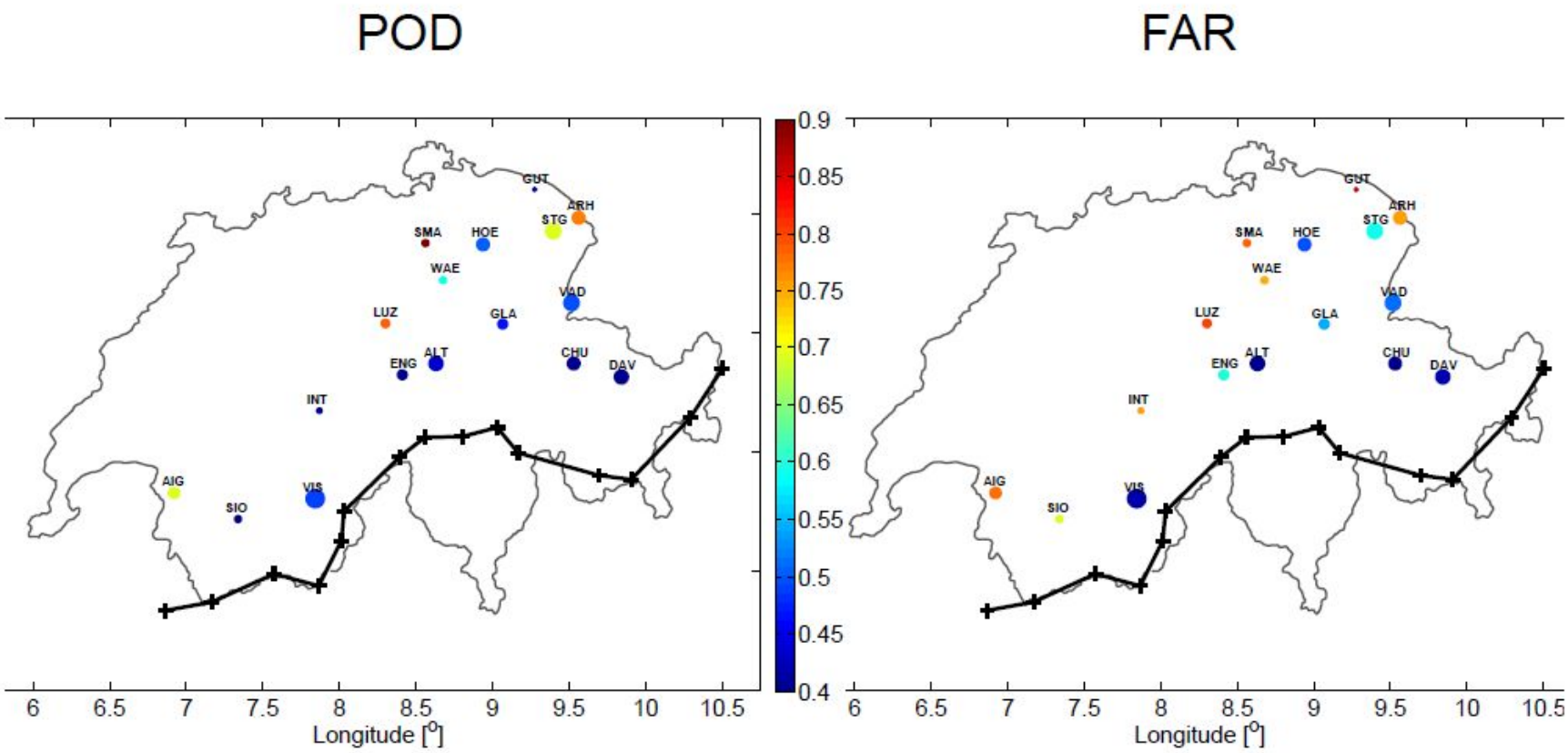
Wind gust PDF for all Föhn cases



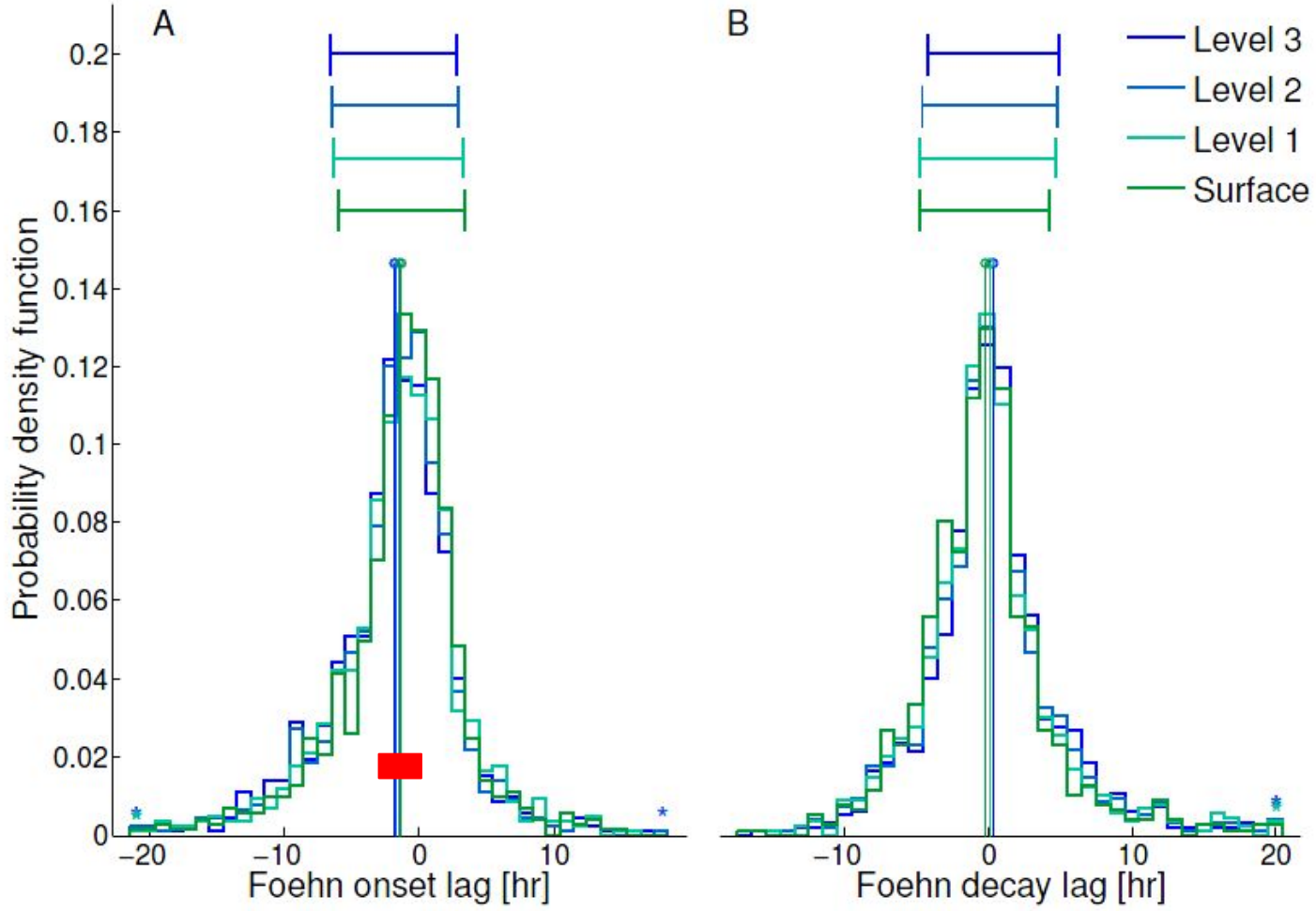
Which parameter is better forecasted?



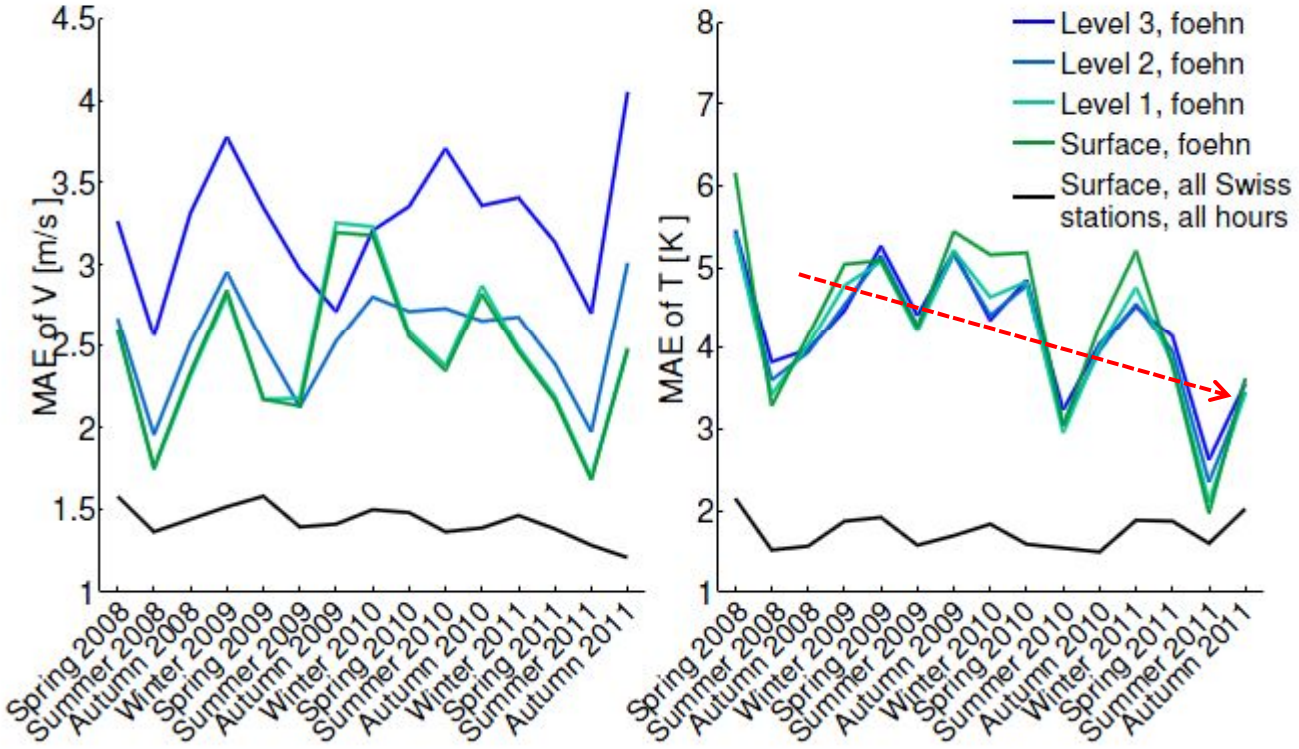
Foehn detection and false alarms



Onset and decay of foehn



4 years of COSMO-2



Conclusions 1

- Foehn occurrences extended **too much northward into the planes:** tendency to erode faster cold pools over the planes
  - *Too much mixing in the PBL*

- **Model levels**:
  - Wind speed performance better at 10m
  - RH better at the third level
    - *Surface exchange problems?*

- **RH**: worst performance
  - Altitude error, difference with real topography, PBL
    - *PBL and surface parameterisations?*
    - *Chance for COSMO-1*

Conclusions 2

- **POD on average very poor:** can be slightly increased with an optimal choice of parameters
  - *Postprocessing is necessary for foehn forecasts and automatic warnings*

- Distributions of wind gusts are **not systematic shifted**, depending on station and position in the alpine chain
  - *Difficult to generalize*

- Onset and decay error not really systematic: tendency to earlier onset
  - *Too much mixing in the PBL?*

- Error evolution: reduction for temperature, unchanged for wind

Process oriented verification (conditional verification) can be very useful for forecasters.


Thank you for your attention!

Foehn detection and false alarms: optimized choice of the model level