University of Trento
Department of Civil, Environmental and Mechanic Engineering

HIGH-RESOLUTION NUMERICAL SIMULATIONS OF WINTERTIME ATMOSPHERIC BOUNDARY LAYER PROCESSES IN THE ADIGE VALLEY DURING AN ALPNAP PROJECT FIELD CAMPAIGN

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Outline

1. WHY THIS RESEARCH?

2. HOW TO?

- Field Database → Period of investigation
- WRF → Simulation setup

3. WHAT DID WE FIND OUT?

- Standard results
- Modifications to the scheme
- Improved results

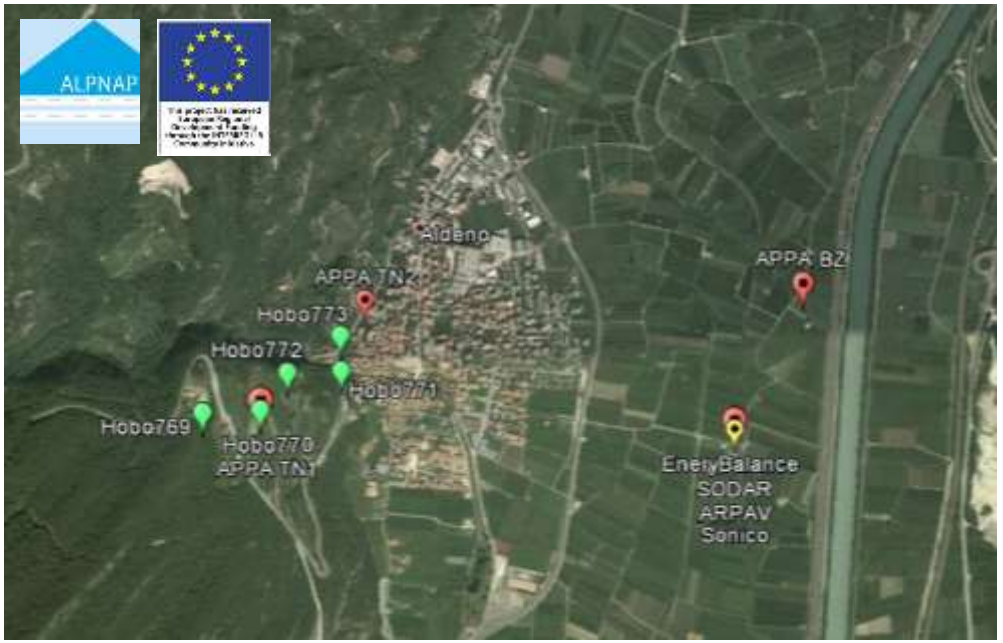
Objective

1. Test WRF on a local scale over complex terrain
2. Analyze WRF land surface parameterization schemes performance
3. Improve two different LSMs: Noah and Noah_MP schemes

Analysis: the database

ADDITIONAL MEASUREMENT POINTS

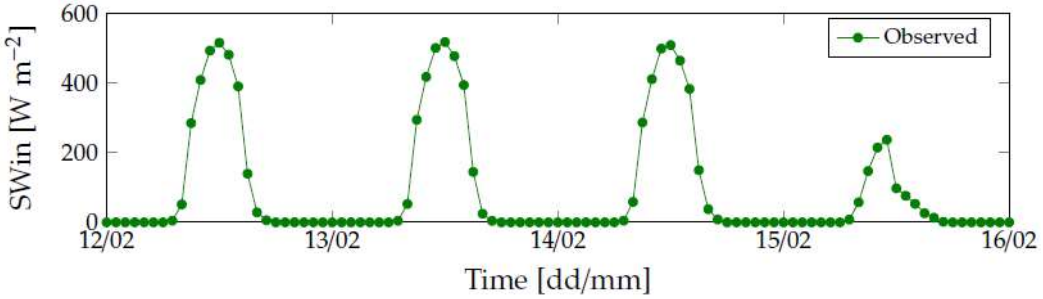
THE **ALPNAP** PROJECT FIELD CAMPAIGN



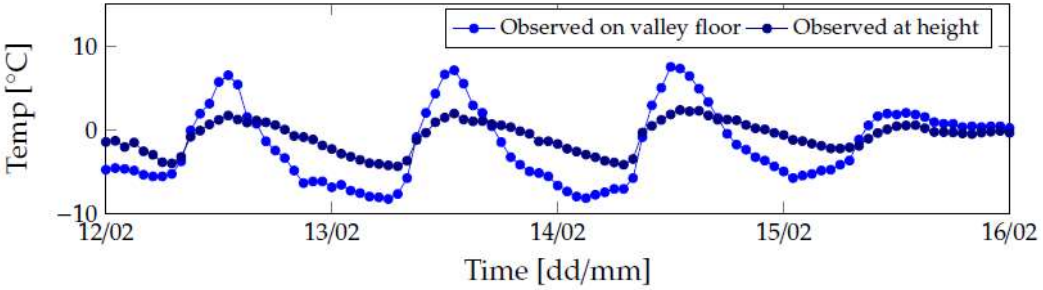
Analysis: the investigation period

INTERESTING METEOROLOGICAL CONDITIONS

1 Transition from clear sky to clouds



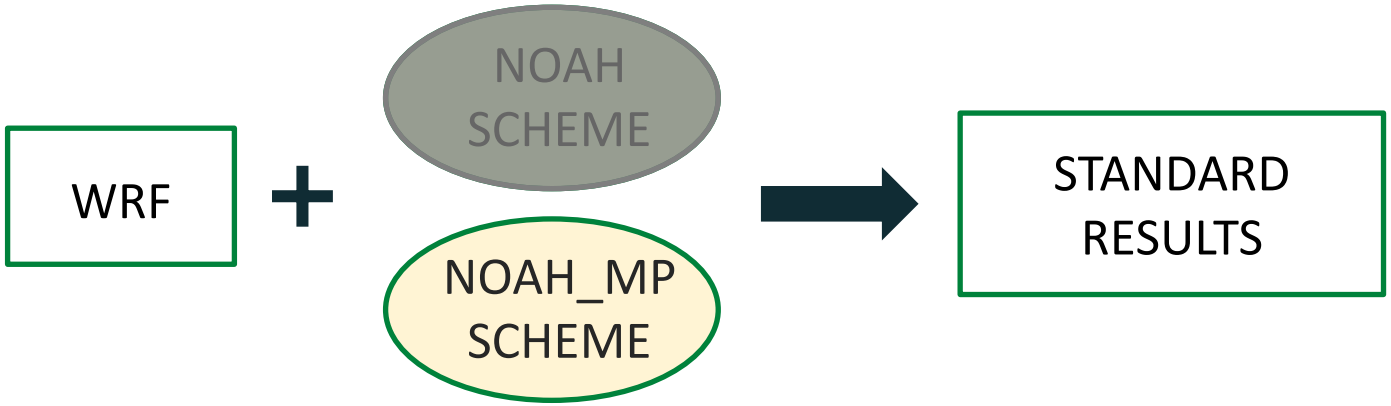
2 Strong ground-based thermal inversion at night



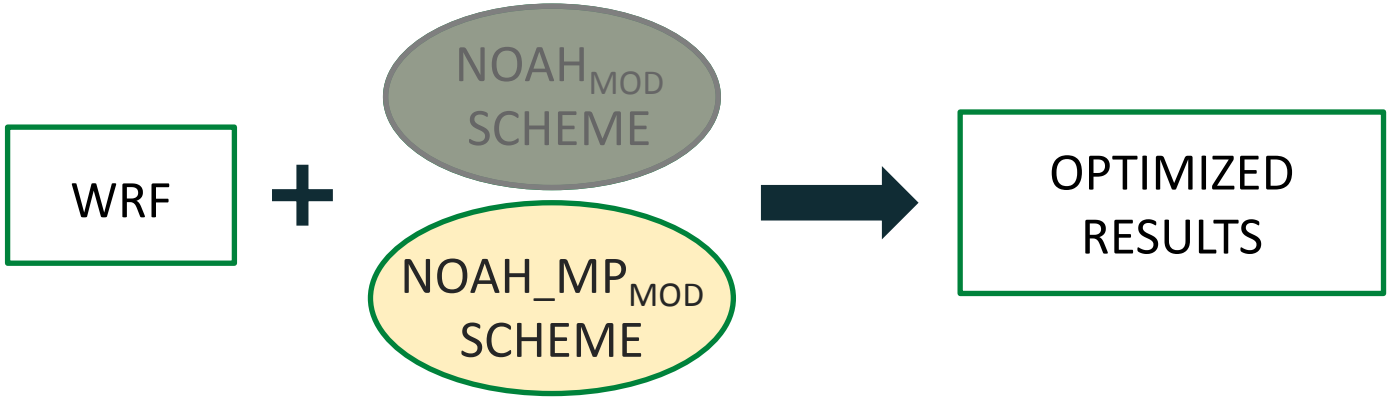
3 Presence of 15-day-old snow

Analysis: simulation setup

STANDARD MODEL SIMULATIONS:

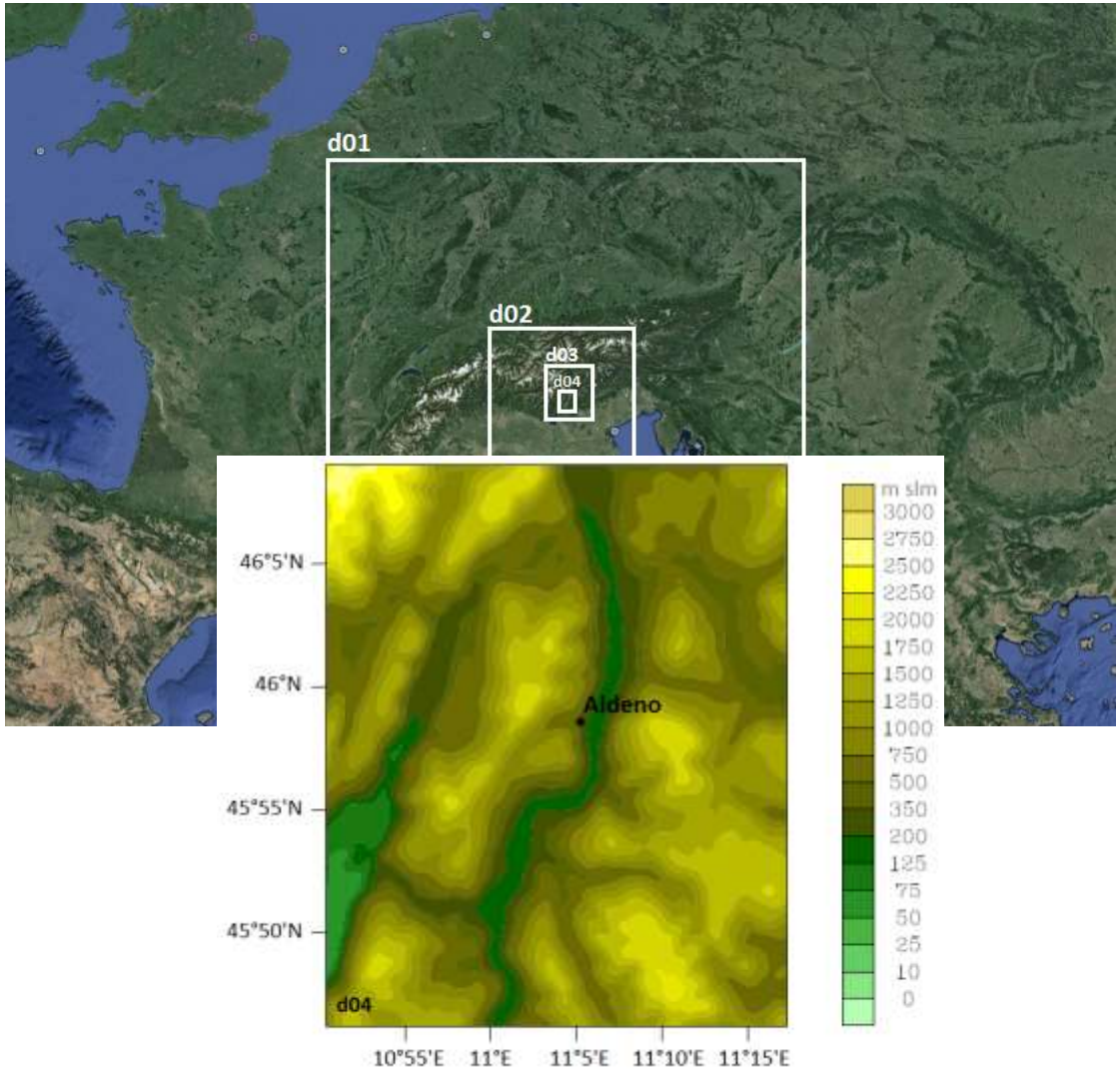


IMPROVED MODEL SIMULATIONS:



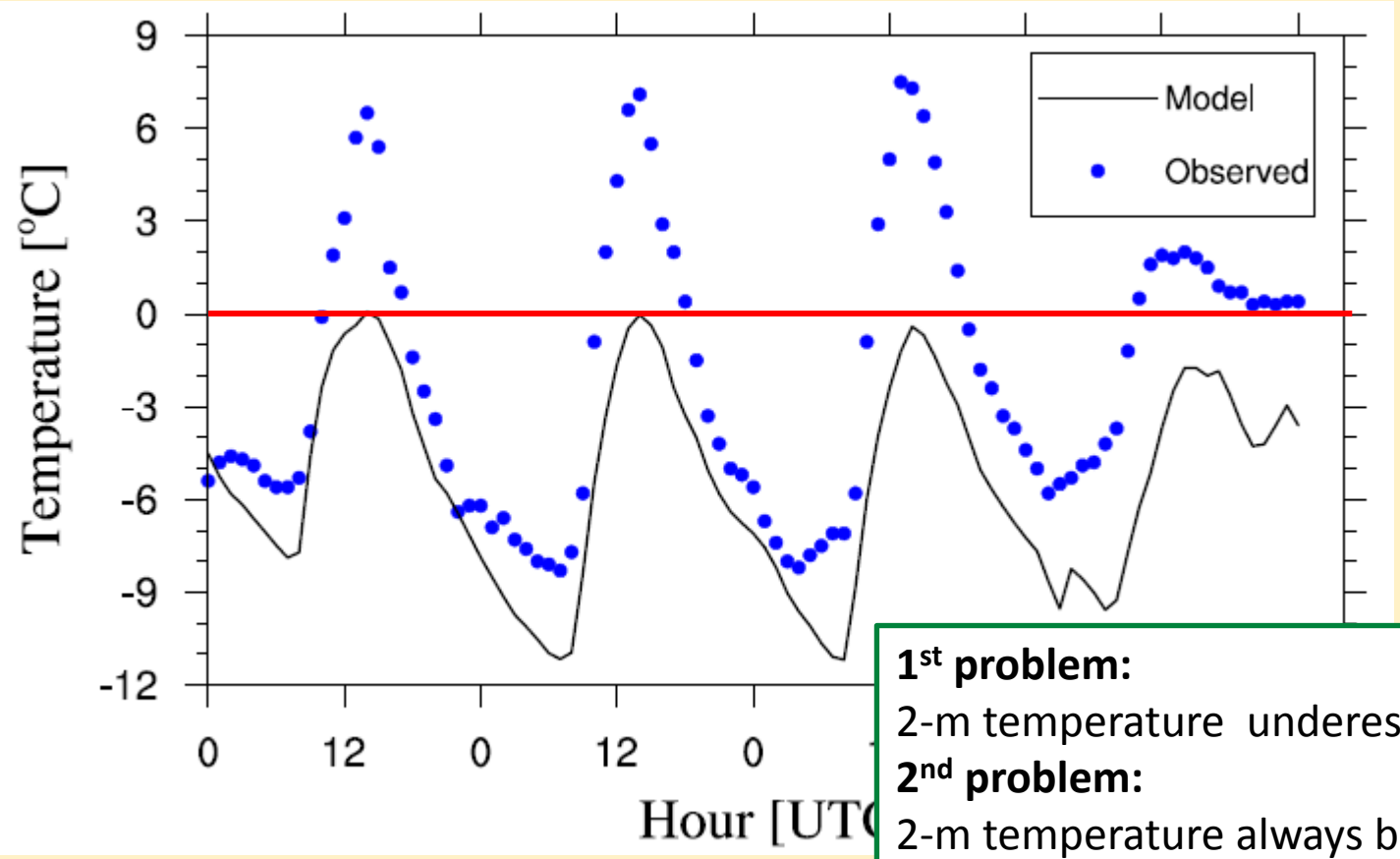
Analysis: simulation setup

- WRF v 3.5.1
- 4 nested domains
  - →Inner domain:
    Horizontal grid resolution: 400m
    Vertical resolution: 40 levels
    Time step: 3.7s
- Topography
  - →Inner domain resolution: 30m
- Land use
  - →Inner domain resolution: 100m
  - →Corine reclassified to Modis
- NCEP Reanalysis
- Parameterizations:
  - →PBL: YSU
  - →Microphysics: WSM3
  - →Radiation: Dhudia-RRTM



Results: standard model simulations

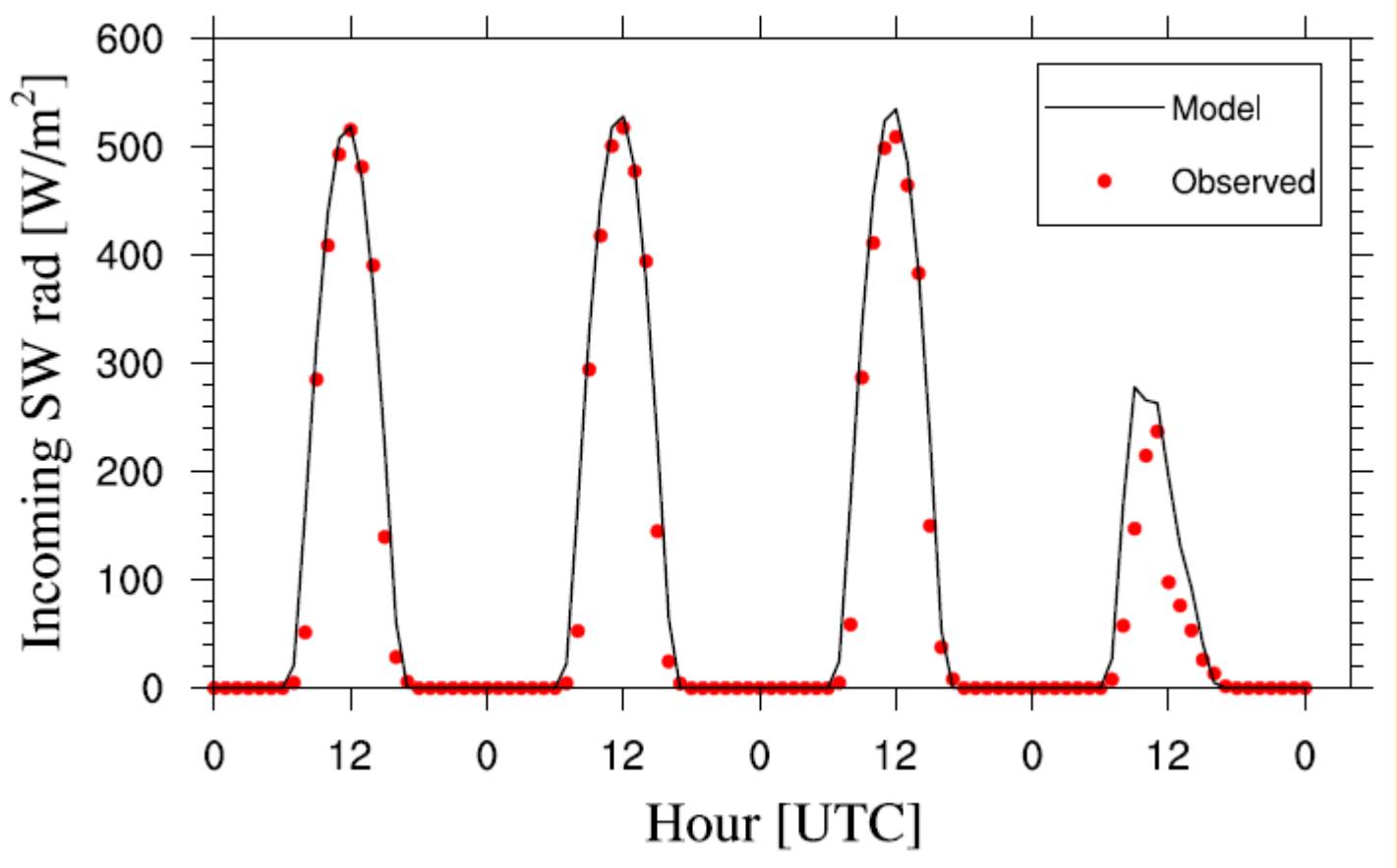
2-m TEMPERATURE



1st problem:
2-m temperature underestimated
2nd problem:
2-m temperature always below 0°C

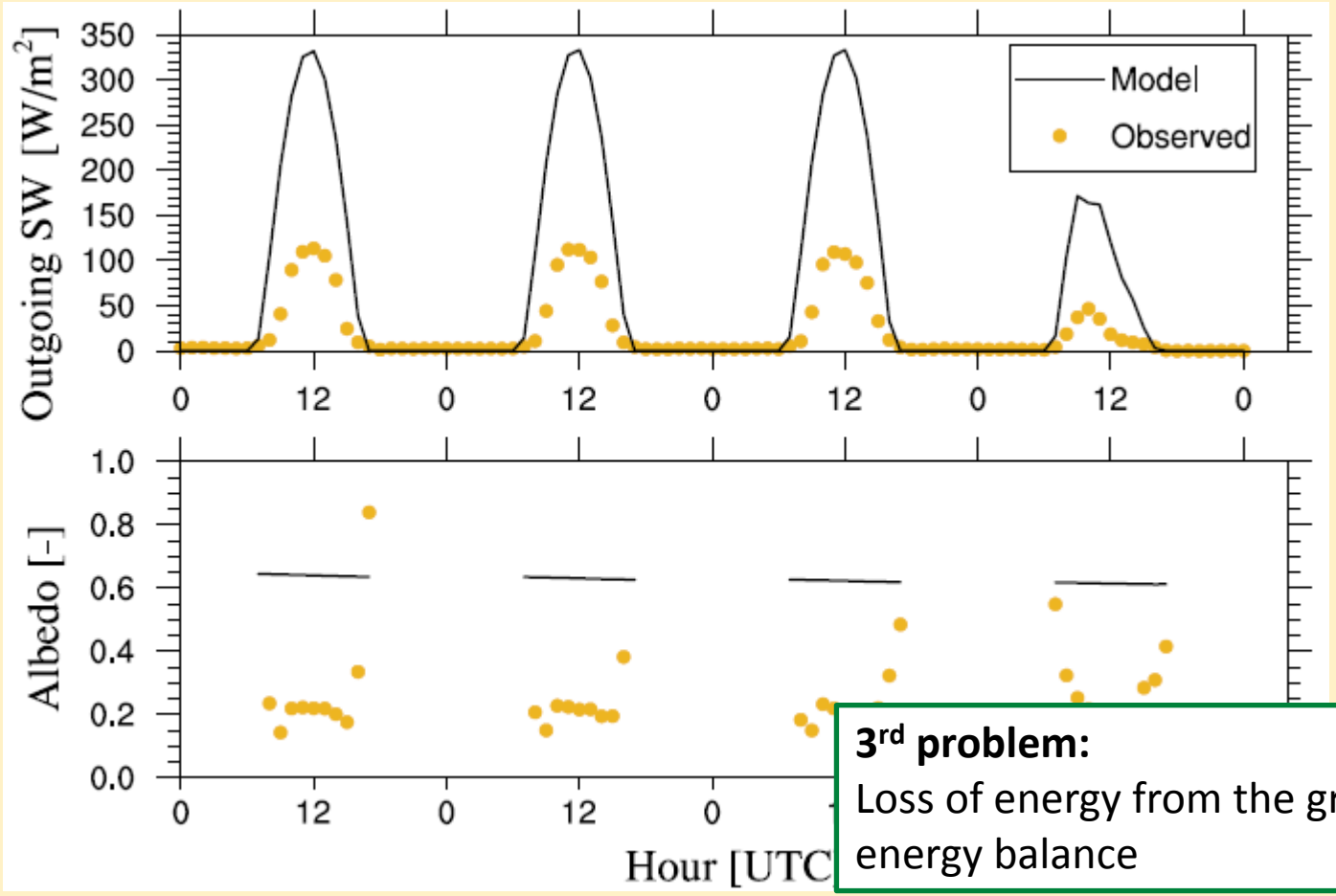
Results: standard model simulations

INCOMING SHORTWAVE RADIATION



Results: standard model simulations

OUTGOING SHORTWAVE RADIATION and ALBEDO



3rd problem:
Loss of energy from the ground energy balance

Results: proposed modifications

2-m T = f(Ground T) = f(Energy Balance, Vegetation Fraction)

1. ENERGY BALANCE

- We need to fix the calculation of the cell albedo
- Cell albedo → Amount of snow → Snow fraction → Snow Density

PROBLEM: initialization of fresh snow

→

SOLUTION: initialization of 15-day-old snow

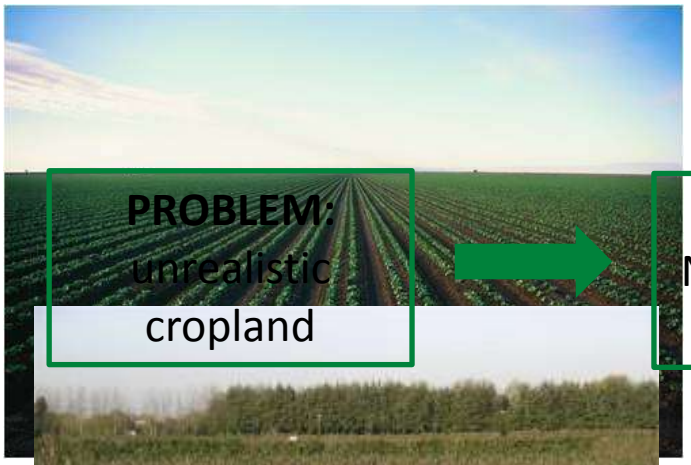
Results: proposed modifications

2-m T = f(Ground T) = f(Energy Balance, Vegetation Fraction)

2. VEGETATED FRACTION

Simulated "Cropland"

Existing "Cropland"



Results: proposed modifications

2-m T = f(Ground T) = f(Energy Balance, Vegetation Fraction)

1. GROUND TEMPERATURE

- We need to fix the upper limit at 0°C

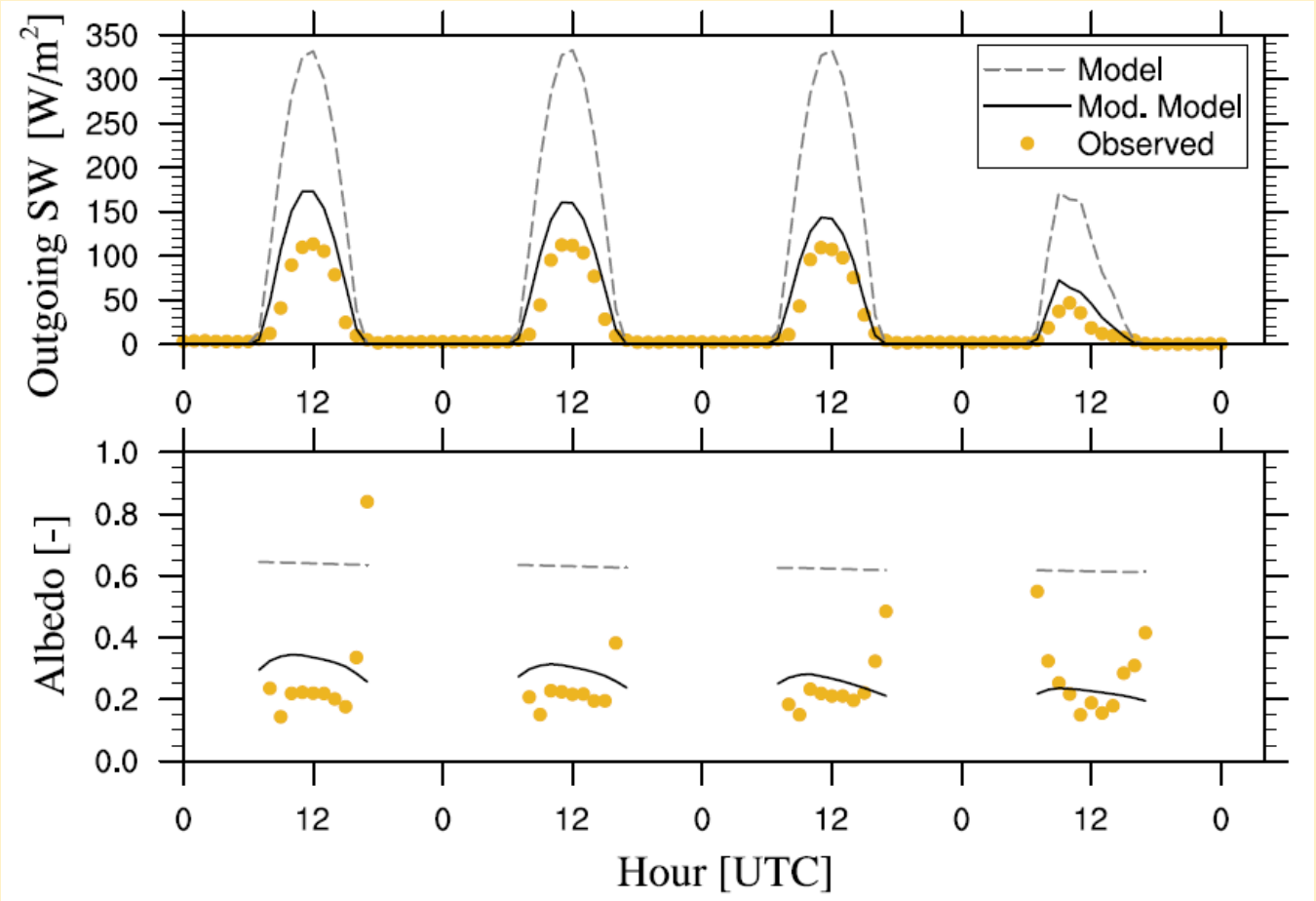
PROBLEM:
Ground T < 0°C
if
SnowHeight > 5cm

→

SOLUTION:
Modification of the limit

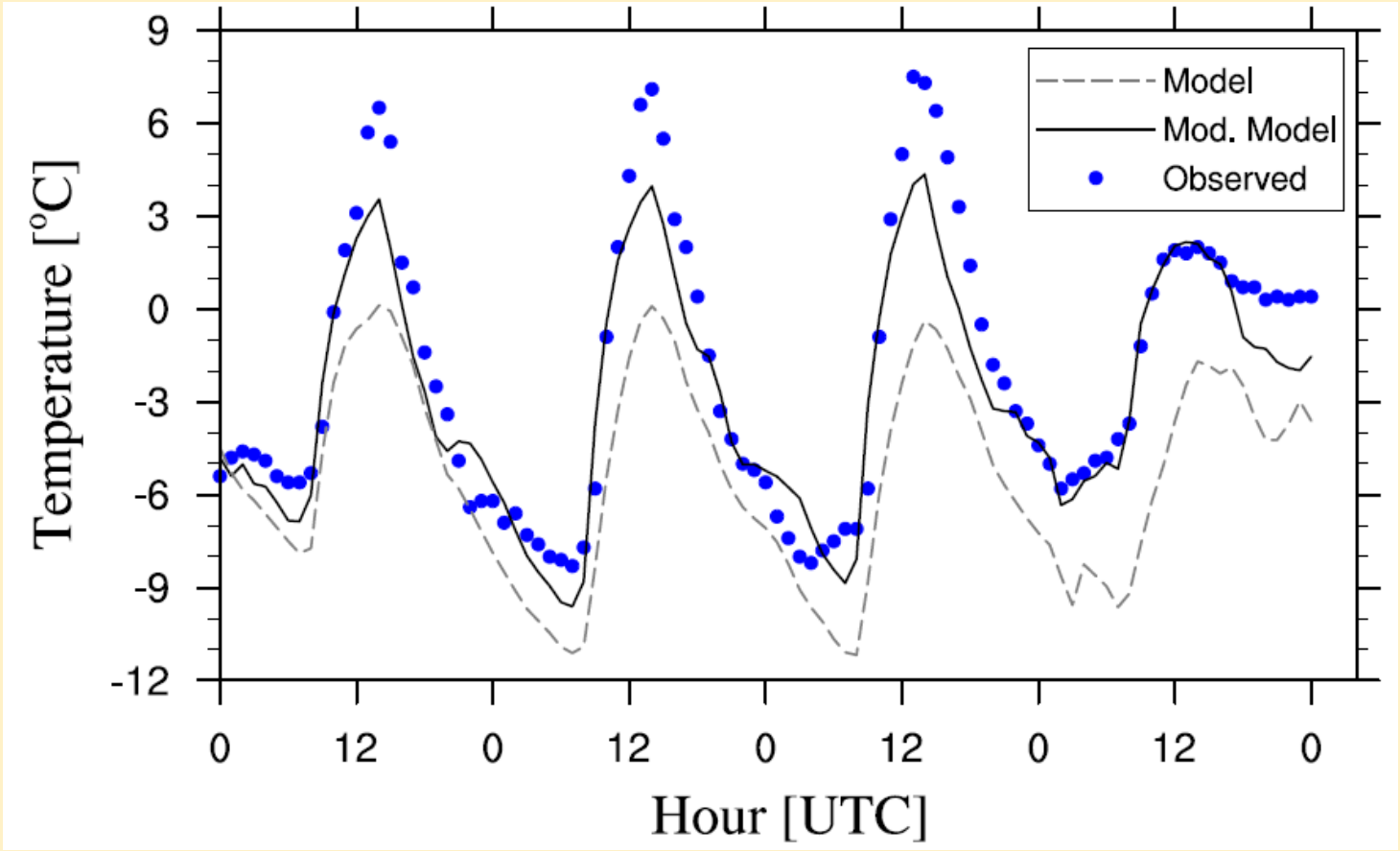
Results: improved model simulations

OUTGOING SHORTWAVE RADIATION



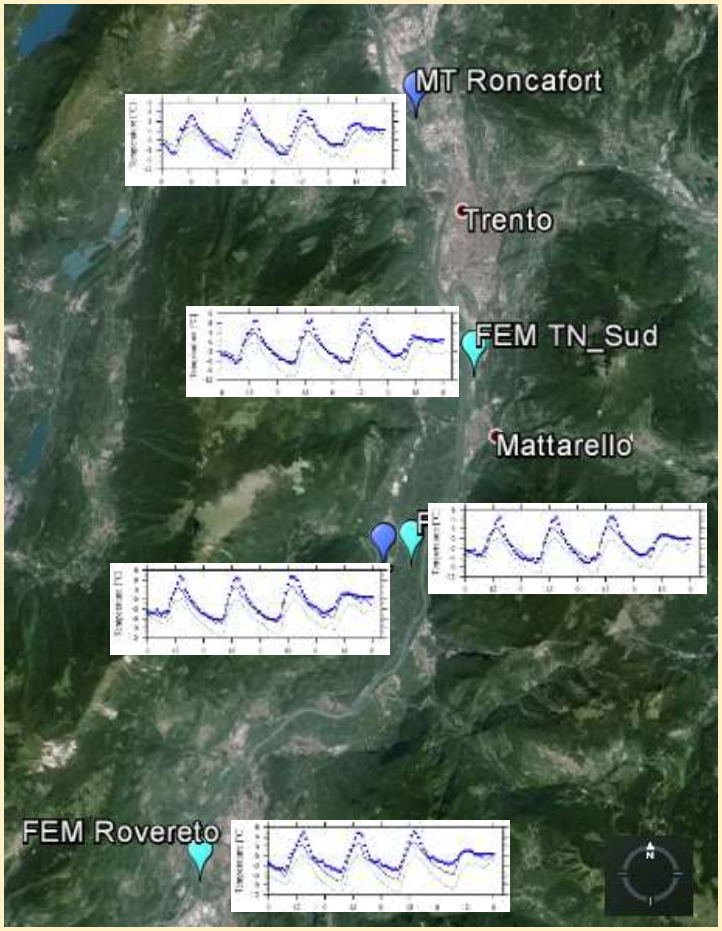
Results: improved model simulations

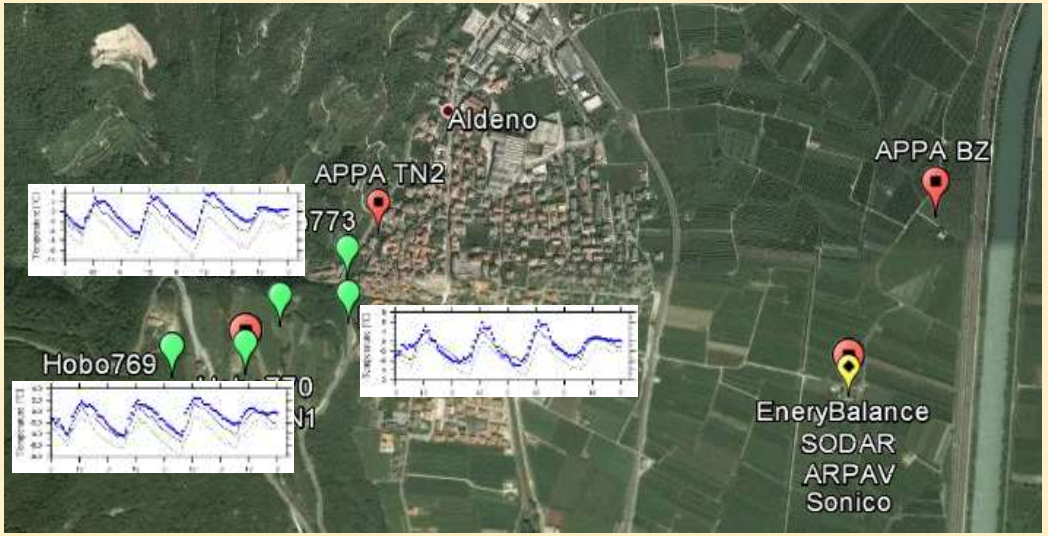
2-m TEMPERATURE

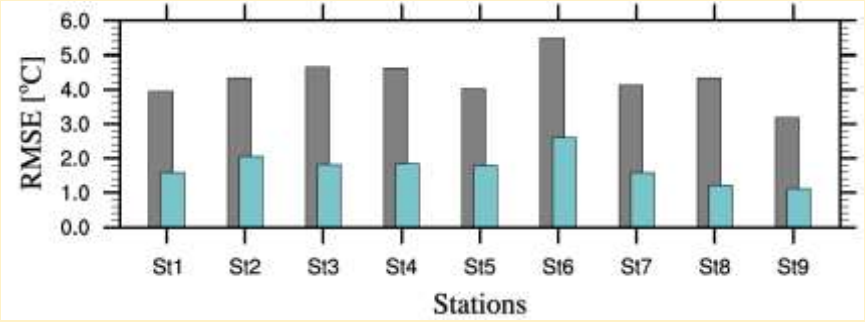


Results: improved model simulations

OTHER MEASUREMENT POINTS

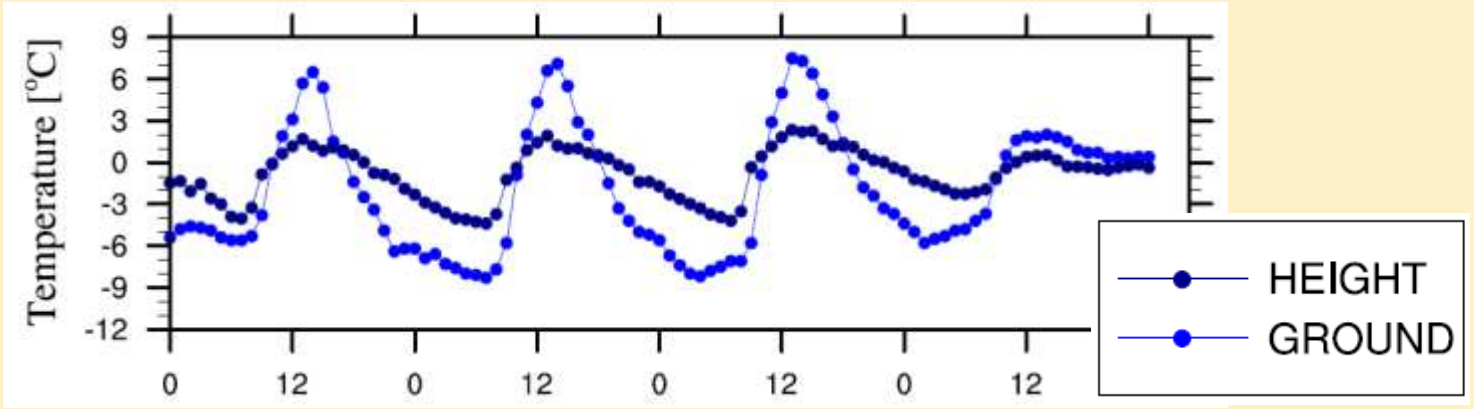


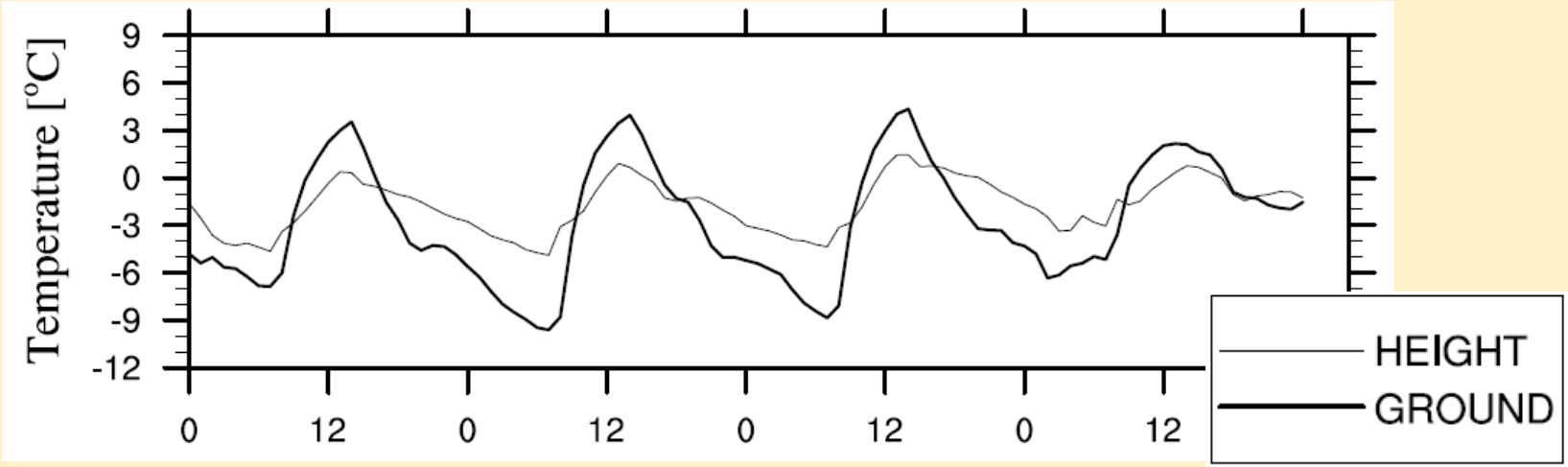




Results: improved model simulations

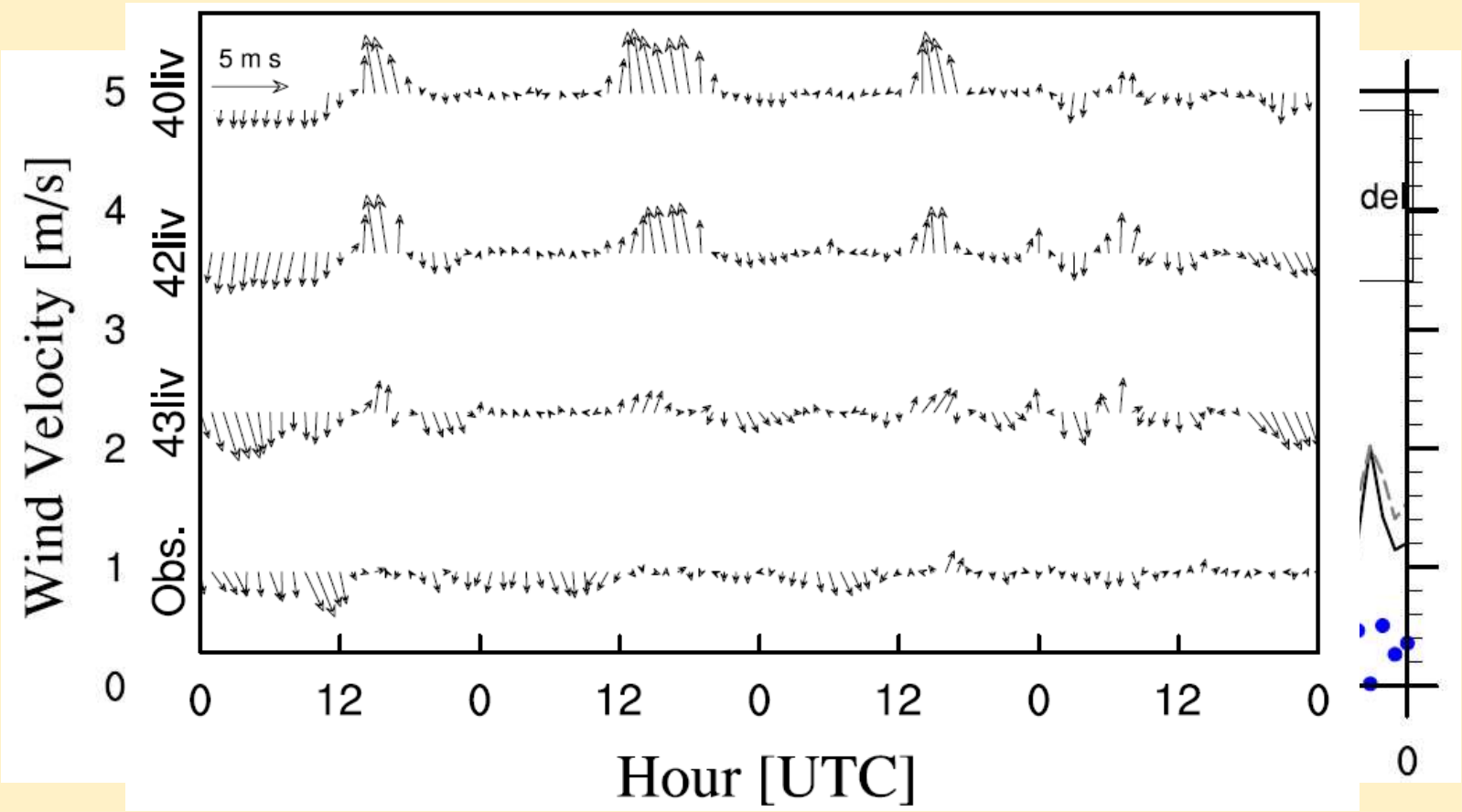
THERMAL INVERSION AND DIURNAL TEMPERATURE RANGE





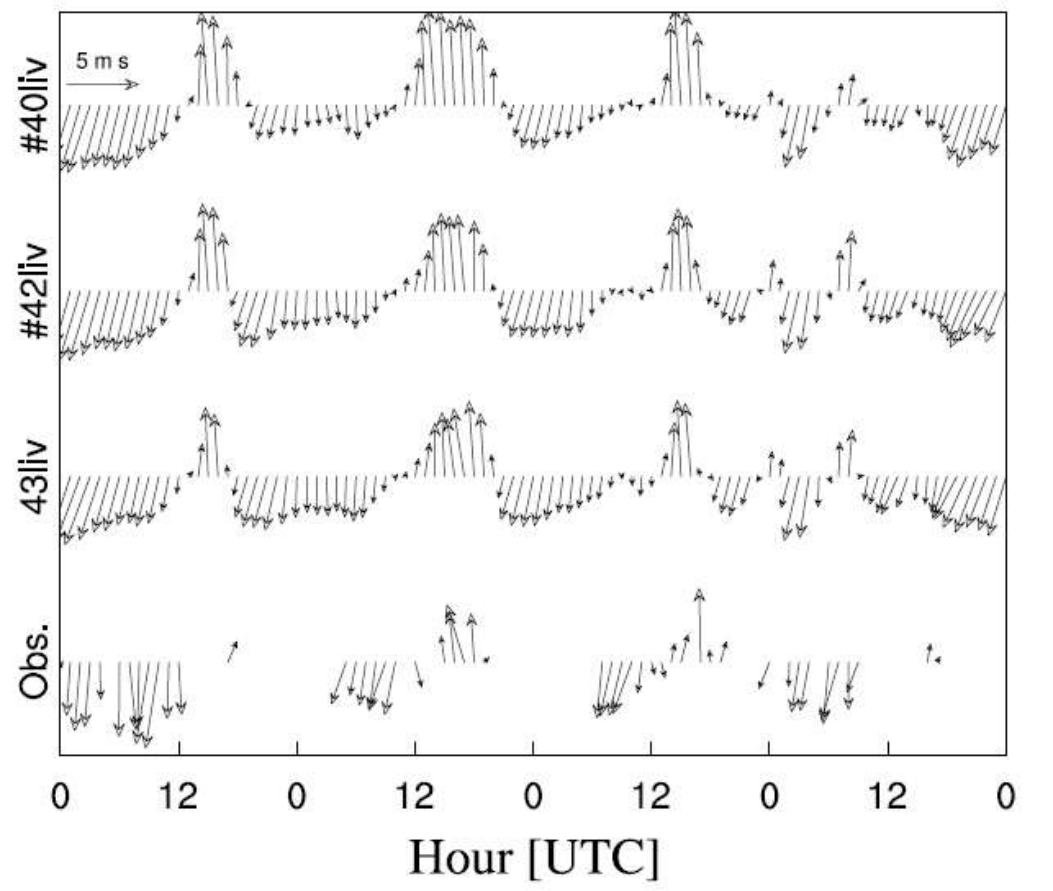
Results: improved model simulations

WIND INTENSITY AT GROUND LEVEL IN THE VALLEY FLOOR



Results: improved model simulations

WIND INTENSITY AT 170m OVER THE VALLEY FLOOR



Conclusions

1. There is space to improve existing land surface schemes and their parameterizations → but we can't go too far;

2. Field data are fundamental to achieve this kind of improvements;

3. The initializing of WRF model is crucial and parameters describing land use classes really matter;

4. Improving LSMs can lead to a proper identification of thermal inversion and its evolution in time;

5. Wind intensity near ground strictly depends on vertical resolution.

THANK YOU!

- (0) 6 livelli di confronto con le misure alle quote [m]
- (0) 20
- (1) 40
- (2) 80
- (3) 120
- (4) 170
- (5) 230
- (0) la prova numero 1 ovvero la b ha:
- (0) 6 livelli di confronto con le misure alle quote [m]
- (0) 20
- (1) 60
- (2) 100
- (3) 130
- (4) 190
- (5) 280
- (0) la prova numero 2 ovvero la c ha:
- (0) 4 livelli di confronto con le misure alle quote [m]
- (0) 30
- (1) 90
- (2) 180
- (3) 290