An aerial photograph of a large agricultural field featuring a prominent circular irrigation system. The field is divided into numerous smaller plots, some of which are circular, creating a complex geometric pattern. The colors range from dark green to light brown, indicating different stages of crop growth or soil conditions. The circular irrigation system is a key feature, with a central pivot point and radial lines extending outwards.

Modelling the impact of irrigation in the Ebro basin using the Meso-NH mesoscale model (preliminary study)

P. Le Moigne, S. Donier, A. Boone

CNRM Météo-France/CNRS, Toulouse

Outline

Motivation

Accounting for irrigation in Meso-NH model

Impact of irrigation on surface fields, and the boundary layer

Conclusions and Perspectives

Motivation of the study

To simulate irrigation with Meso-NH model in the Ebro basin

- How to identify and isolate the irrigated vegetation type
- How to simulate irrigation in the model

To assess the role of irrigation at mesoscale

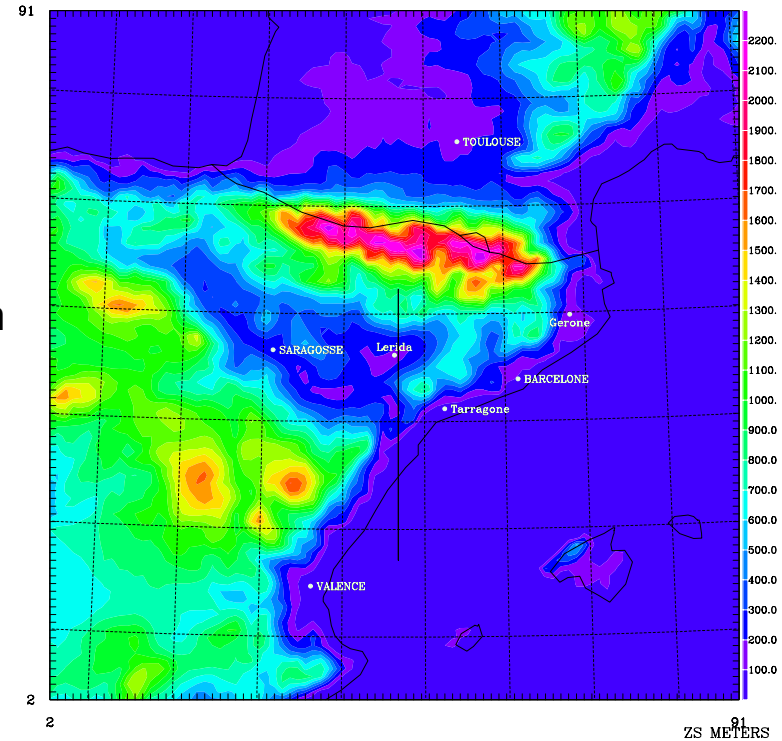
- Using Meso-NH model in two configurations with and without irrigation
- Impacts on surface and PBL variables

To prepare for higher resolution simulations



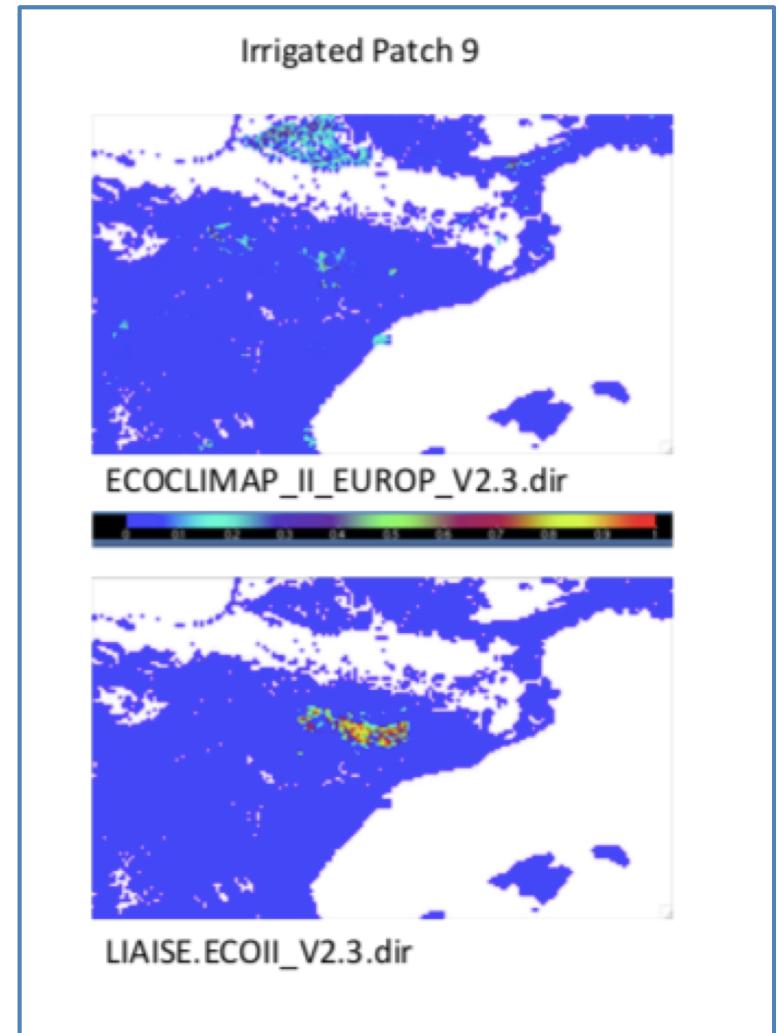
Meso-NH mesoscale model setup

- Non-hydrostatic model (Lac *et al.*, 2018)
- Scales from meters to kilometres
- 1d turbulence scheme (BL89)
- Shallow (EDMF) and deep convection (KF)
- Microphysics (ICE3)
- LBCs 3h from AROME operational model @1.3km
- Test case 16 July 2016, anticyclonic situation
- 90x90 points, 8km grid mesh, 8s timestep
- 90 vertical layers (44 in PBL < 2500m)
- Irrigation option:
 - ✓ Initial soil moisture at field capacity
 - ✓ Water supply of 10^{-4} kg/m²/s (i.e. 8.6mm/d)



SURFEX Land Surface Model setup

- SURFEX LSM (Masson *et al.*, 2013) is coupled to Meso-NH
- ISBA model for vegetation (diffusive transfers)
- Representation of land covers is based on the 1km **ECOCLIMAP** global database, representative of vegetation types in the period 1999-2006
- SURFEX uses 19 classes, 1 for irrigation
- Modified land cover map
 - ✓ To irrigate only the Ebro basin on C3 crops
 - ✓ To increase the irrigated fraction
- **Sensitivity experiments:**
 - ✓ **ARO** without irrigation
 - ✓ **IRR** with irrigation

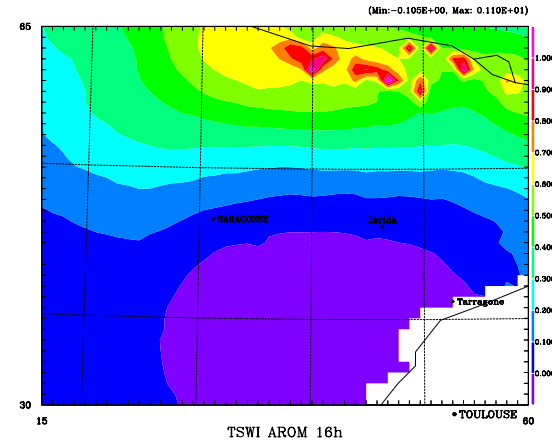
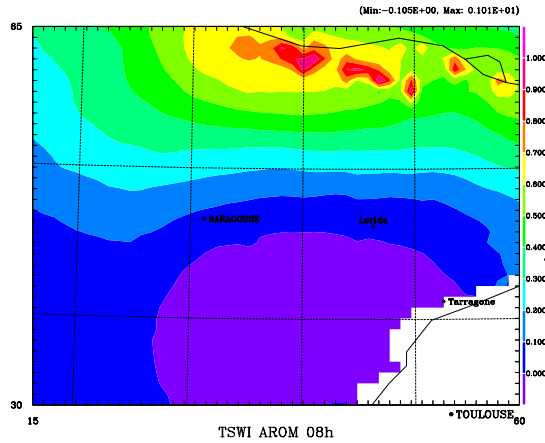


Soil Wetness Index

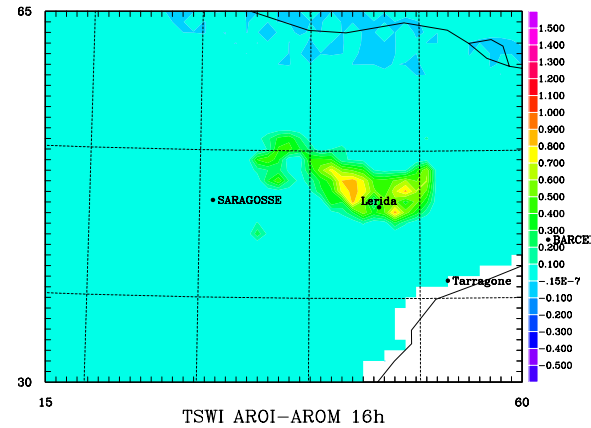
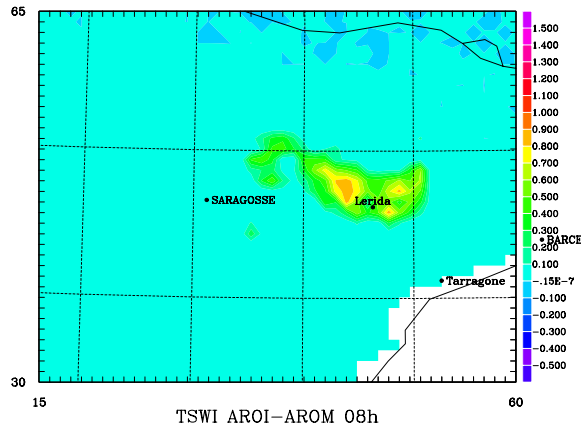
8UTC

16UTC

ARO



IRR - ARO



• VALENCE

TSWI D2 ISBA -

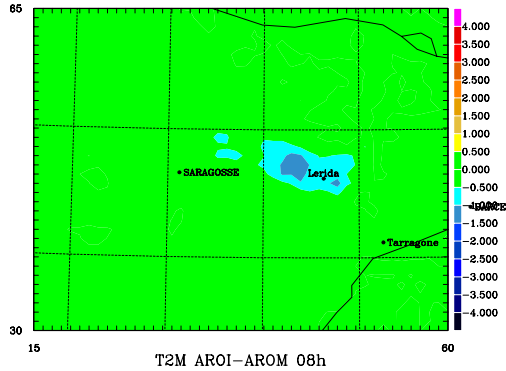
• VALENCE

TSWI D2 ISBA -

Impact on surface variables: IRR - ARO @8UTC

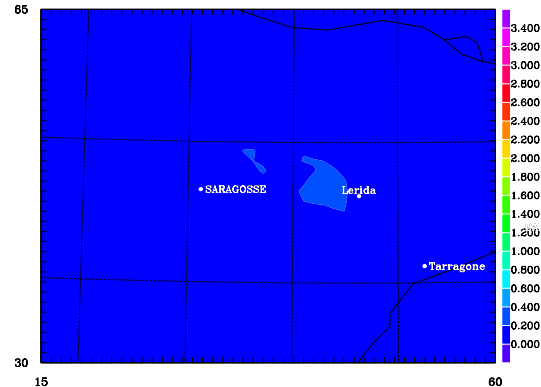
T2M

•TOULOUSE



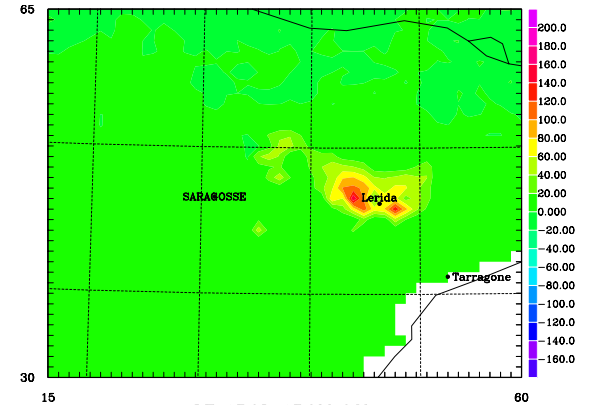
T2M AROI-AROM 08h

U10M



vent 10m AROI-AROM 08h

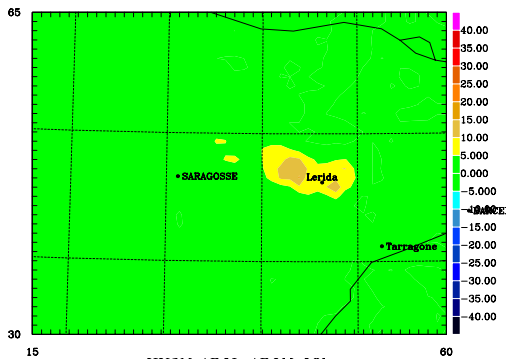
LE



LE AROI-AROM 08h

HU2M

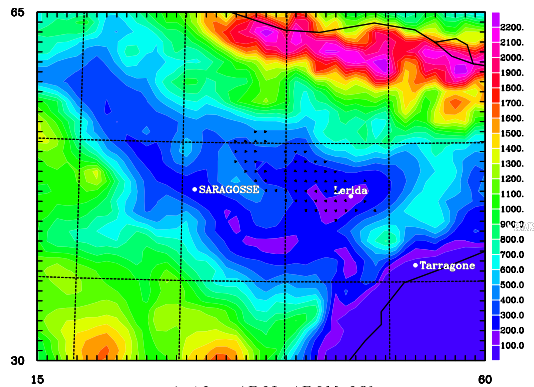
TEMP C K= 2
•TOULOUSE



HU2M AROI-AROM 08h

DIR10M

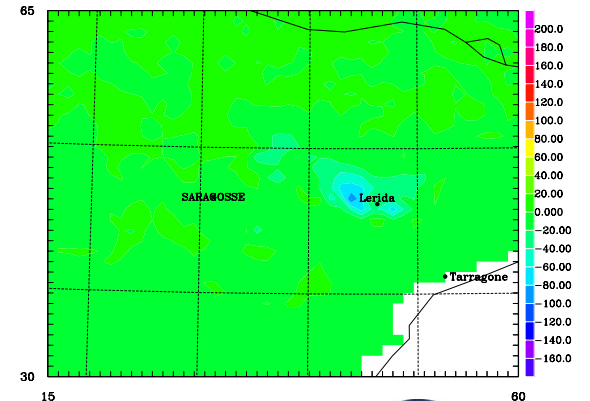
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vent 10m AROI-AROM 08h
vent 10m AROI-AROM 08h

H

LE ISBA W/m2



H AROI-AROM 08h

•VALENCE

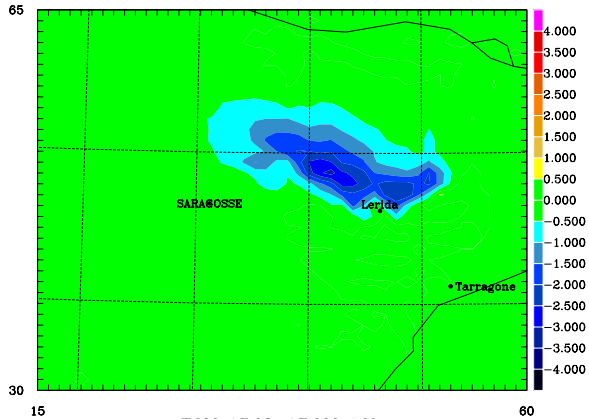
REHU % K Minimum Vector Scale

VALENCE

50400 25 METERS

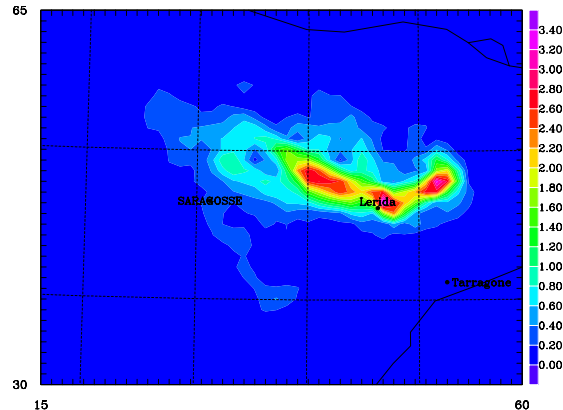
Impact on surface variables: IRR - ARO @16UTC

T2M



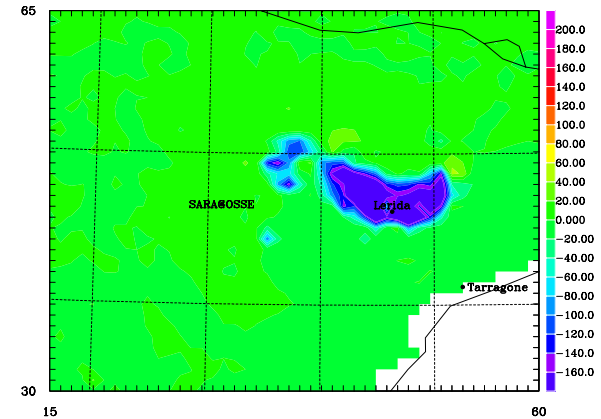
T2M AROI-AROM 16h

U10M



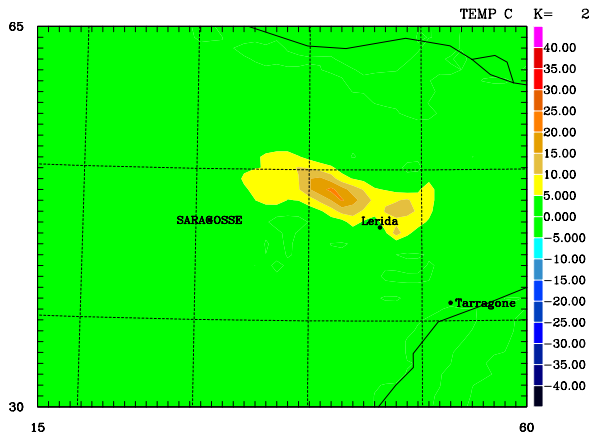
vent 10m AROI-AROM 16h

LE



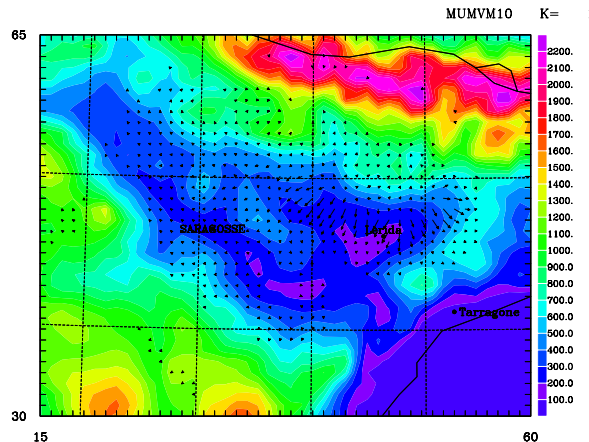
H AROI-AROM 16h

HU2M



HU2M AROI-AROM 12h

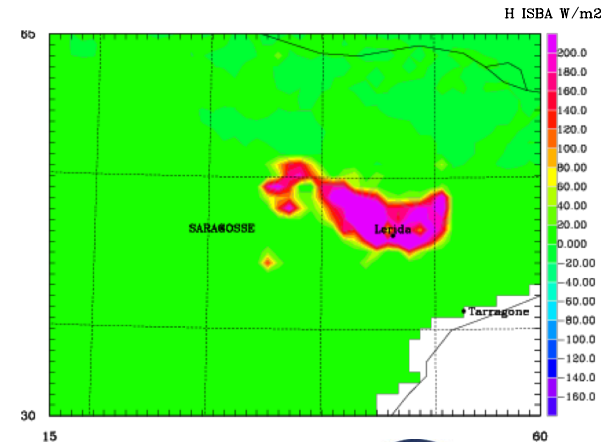
DIR10M



vent 10m AROI-AROM 16h

vent 10m AROI-AROM 16h

H



LE AROI-AROM 16h



0.100E+00
Minimum Vector
REHU % K= 2

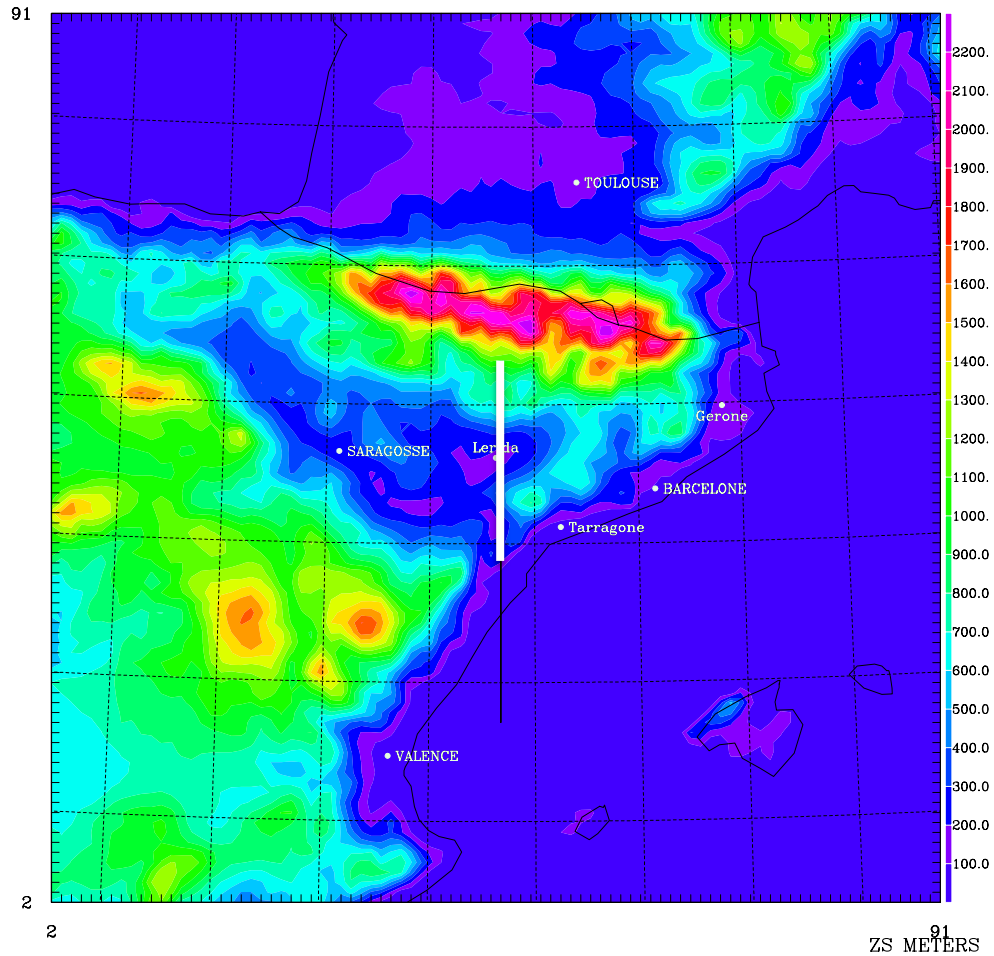
0.100E+02
Scale

7800. 25 METERS



Impact on PBL

- Vertical NS cross section
- Potential temperature, Mixing Ratio, Turbulent Kinetic Energy



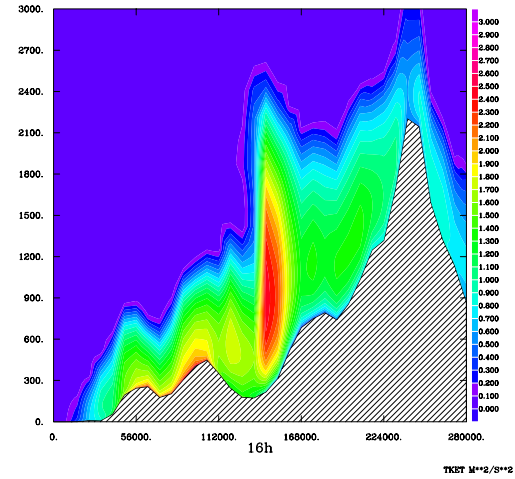
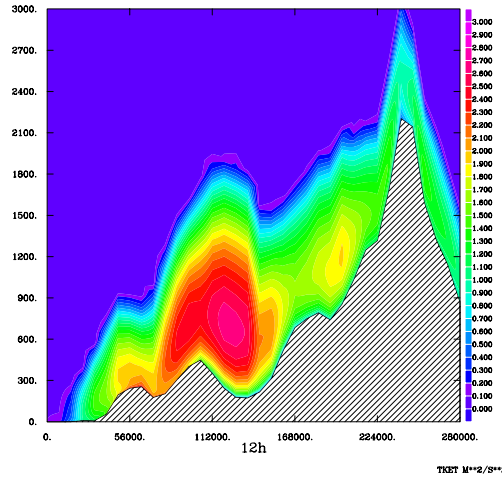
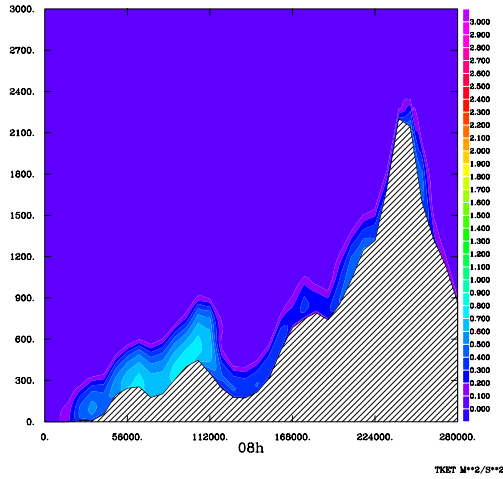
Turbulent Kinetic Energy TKE

8UTC

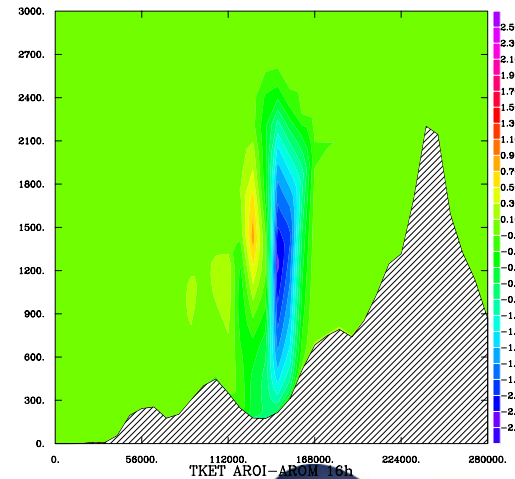
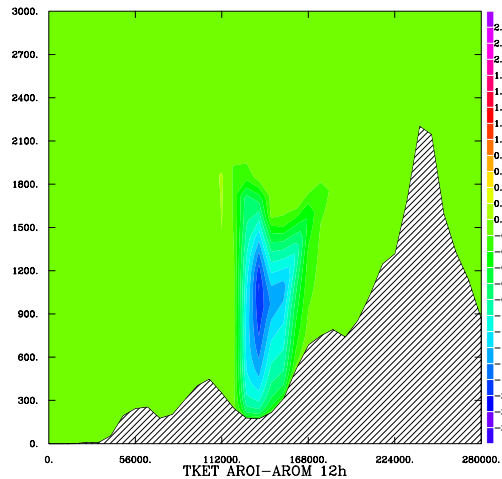
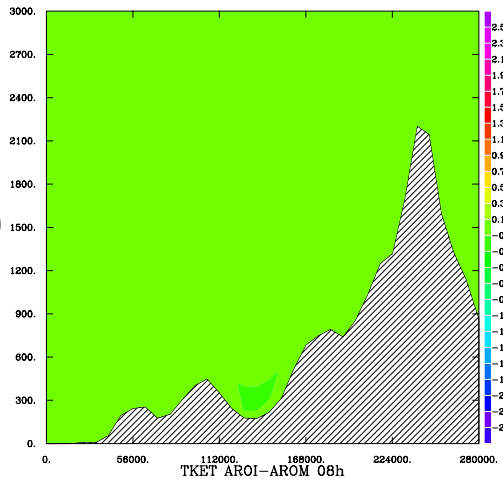
12UTC

16UTC

ARO



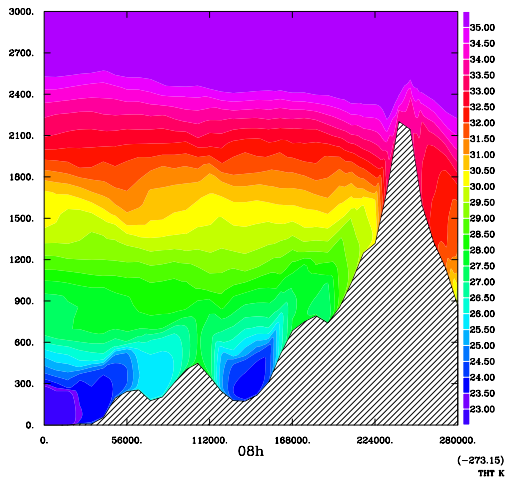
IRR - ARO



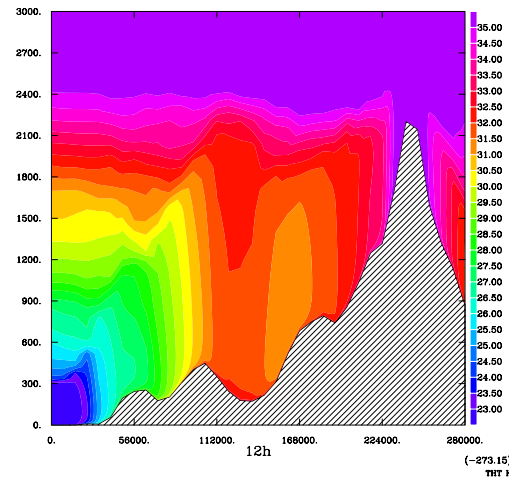
Potential Temperature Theta

ARO

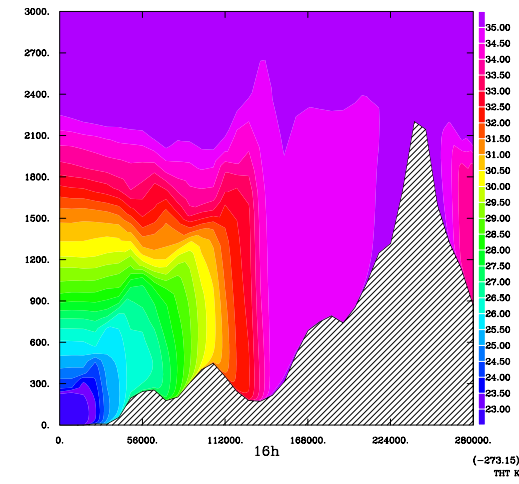
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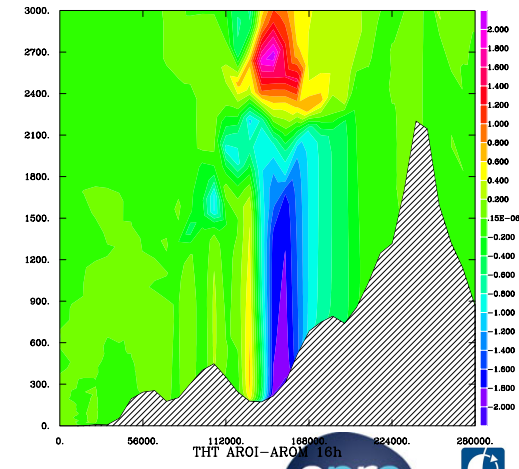
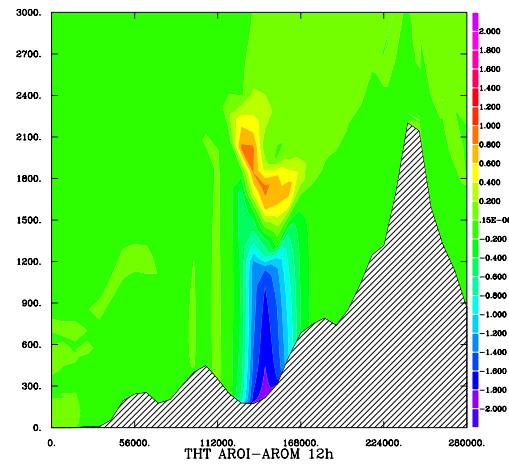
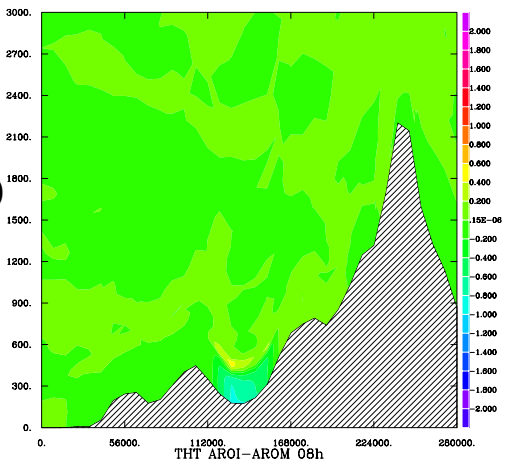
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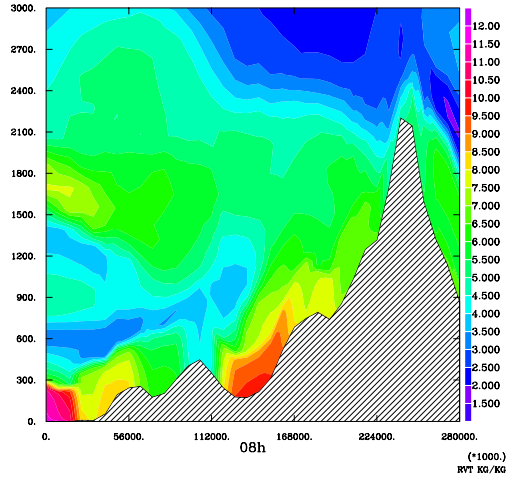
IRR - ARO



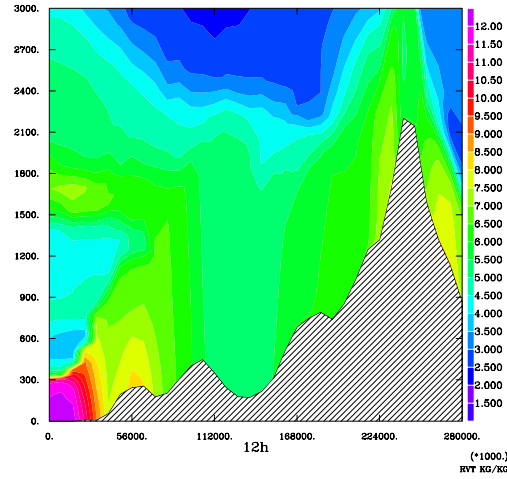
Mixing Ratio Rv

ARO

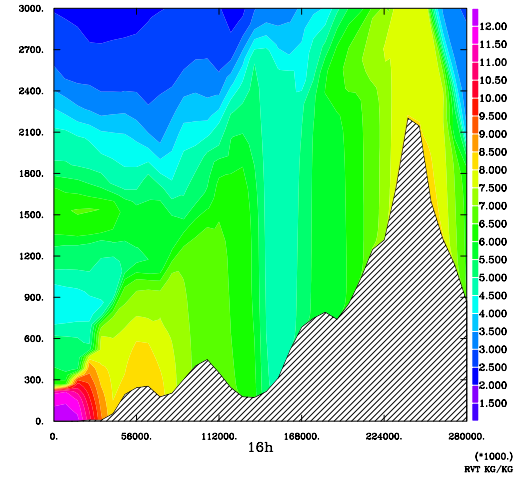
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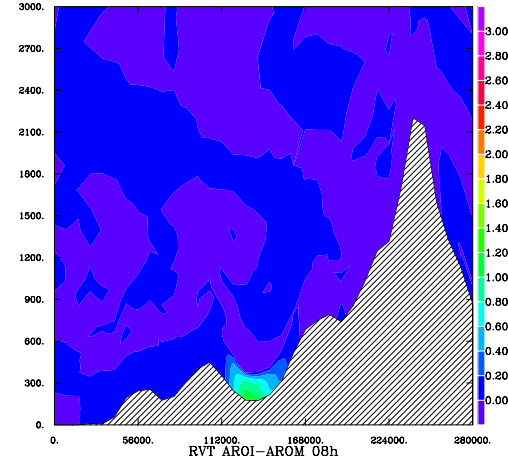
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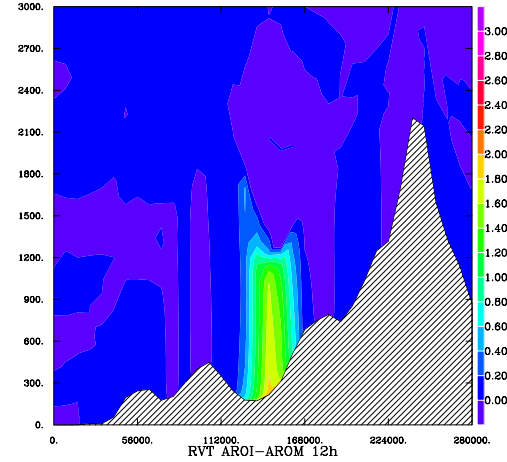
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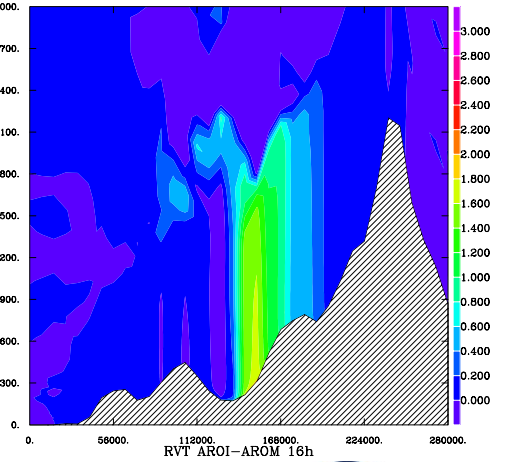
RVT(1000) RVT(1000)



RVT(1000) RVT(1000)



RVT(1000) RVT(1000)



IRR - ARO

Summary and Outlook

- An irrigation parameterization was successfully tested in Meso-Nh model coupled to SURFEX
- A water supply of 8.6mm/d has a large impact on surface and boundary layer variables
- Important to select vegetation surfaces to be irrigated (land cover)
- Close to the surface, an important cooling is experienced associated to an air moistening
- Boundary layer height is impacted, as well as vertical transport of humidity, and vertical distribution of heat
- Starting point for higher resolution simulation (@2km) with Meso-NH
- Need to refine selection of irrigated areas
- Use of higher resolution ECOCLIMAP-SG @300m resolution