First mesoscale model intercomparison

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Motivation

- How do mesoscale models reproduce the BLLAST observations during IOP9-11 (30 June, 1st and 2nd July 2011).

- How important are the PBL and surface schemes.

Methodology

- BLLAST observations including:
  - Radiosounds: GRAW, MODEM, SUMO.
  - Surface and EC stations at the different sites.

- Mesoscale models with different parameterizations and land use schemes: MesoNH, WRF, MM5.

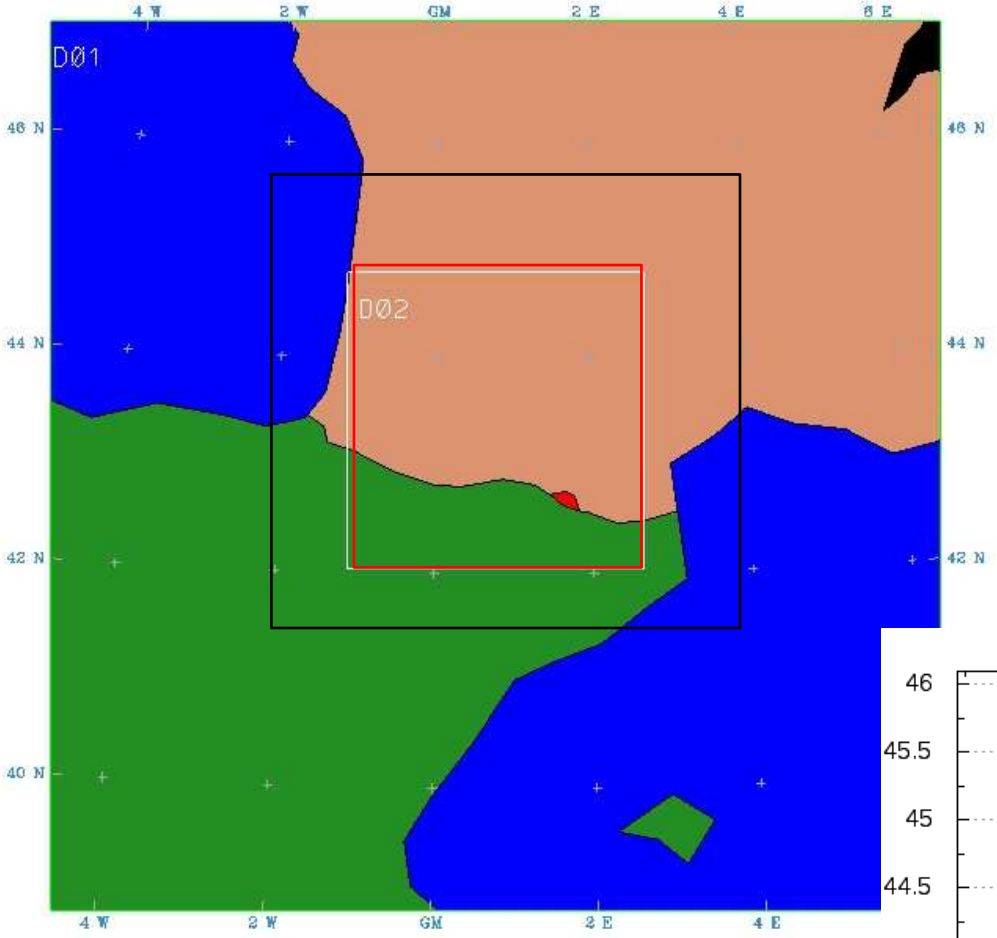
Numerical set up (I)

- 2 nested domains of 100x100 points of 9 and 3 km horizontal resolution (MM5 and WRF). MesoNH uses only 1 domain of 2 km horizontal resolution.

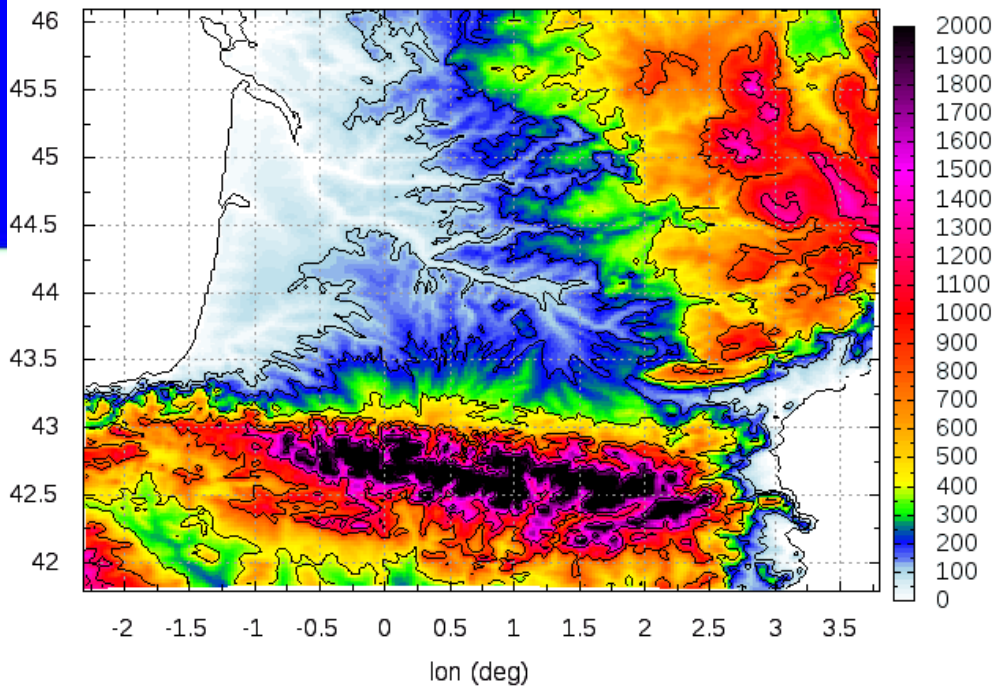
- Initial conditions from ECMWF 0.125ºx0.125º analysis included every 6 hours.

- 50 σ-levels up to the tropopause (85 z-levels for MesoNH)

- Two-way nesting. Orographic shadowing



MM5-WRF

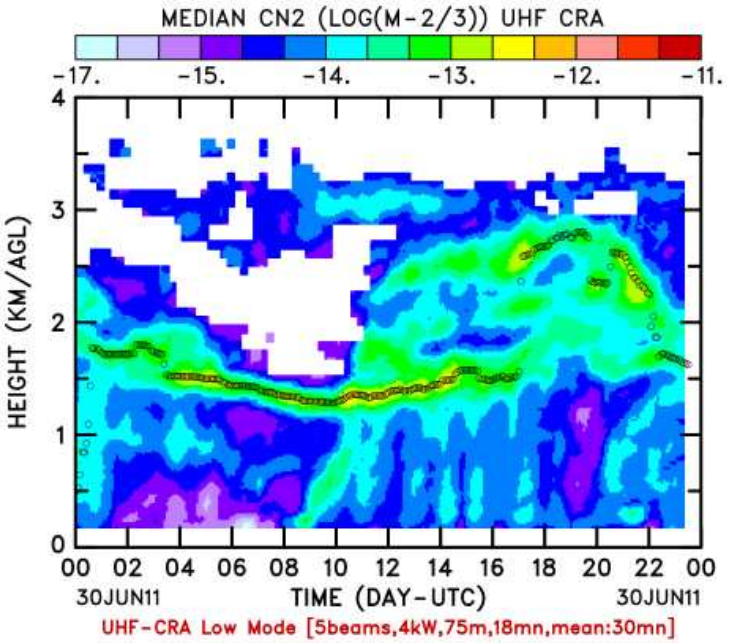


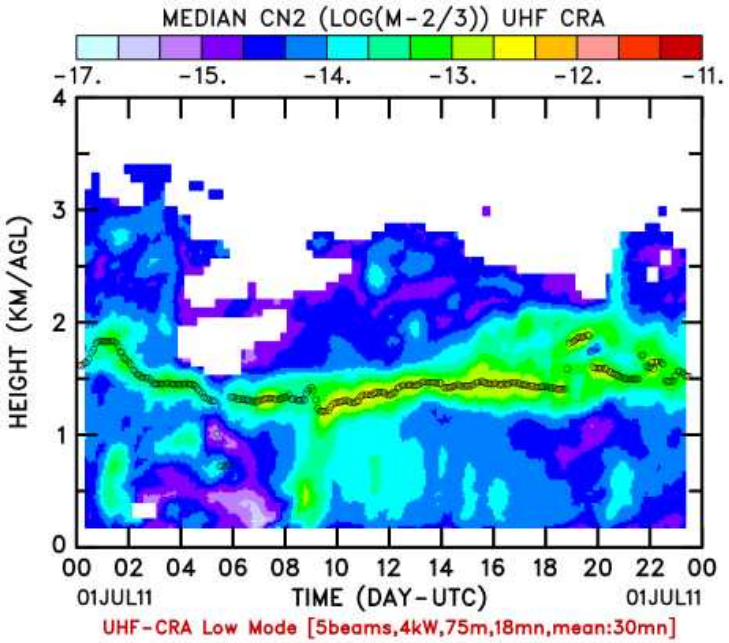
MesoNH

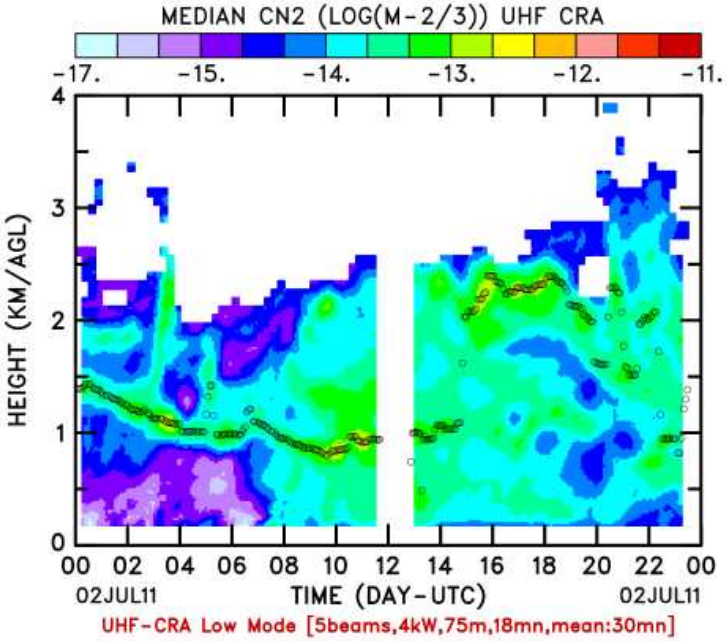
Numerical set up (II)

Parameterization/model	PBL	Surface	Cumulus (Domain1/2)	Radiation	Moisture
MM5 (UPC)	MRF-Eta	5 layer	Kain-Fristch/None	Cloud radiation	Simple ice
WRF (NOAA-WU)	TEMF-MYJ MRF-YSU-MYNN-QNSE	Noah 5 layer/Noah	Kain-Fritsch/none	RRTM-G Shortw: Dudhia; Longw: RRTM	WSM 3
MesoNH (UIB)	1.5 TKE (Cuxart et al 2000)	ISBA (Noilhan and Planton, 1989)	None (the run is made with 1 domain at 2km resolution)	ECMWF radiation scheme Morcrette (1989)	'ICE3' vapor, rain, cloud, ice, snow, and graupel

IOPs 8-10 (30th June-2nd July)



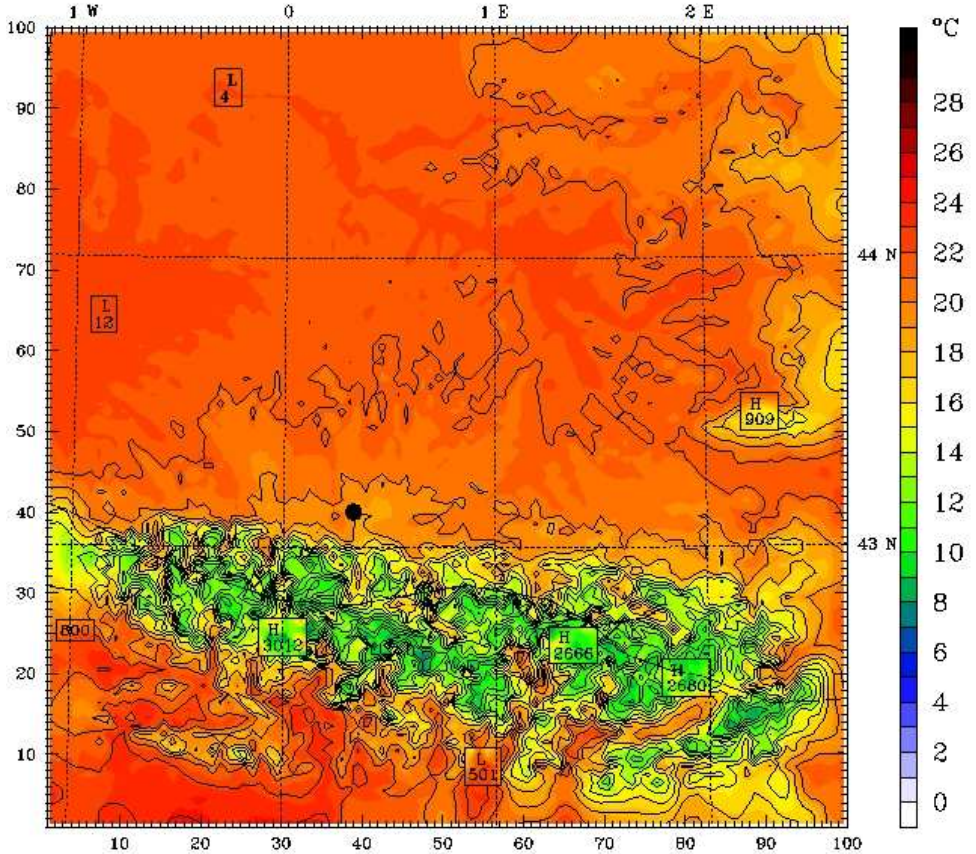




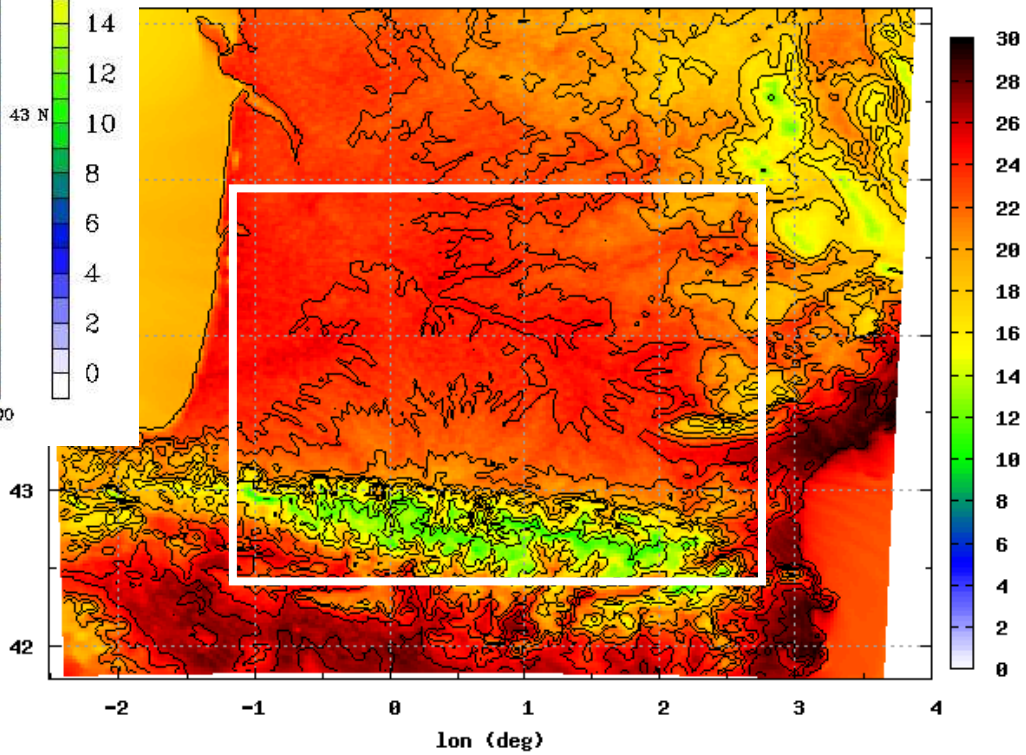
Cloud free except 30th June.
Winds: N in the BL, W aloft.
q for three days: around 6 g/kg during the day in the BL.
Larger T on 2nd July.

Results (I)

2m temperatures (1st July 12UTC)

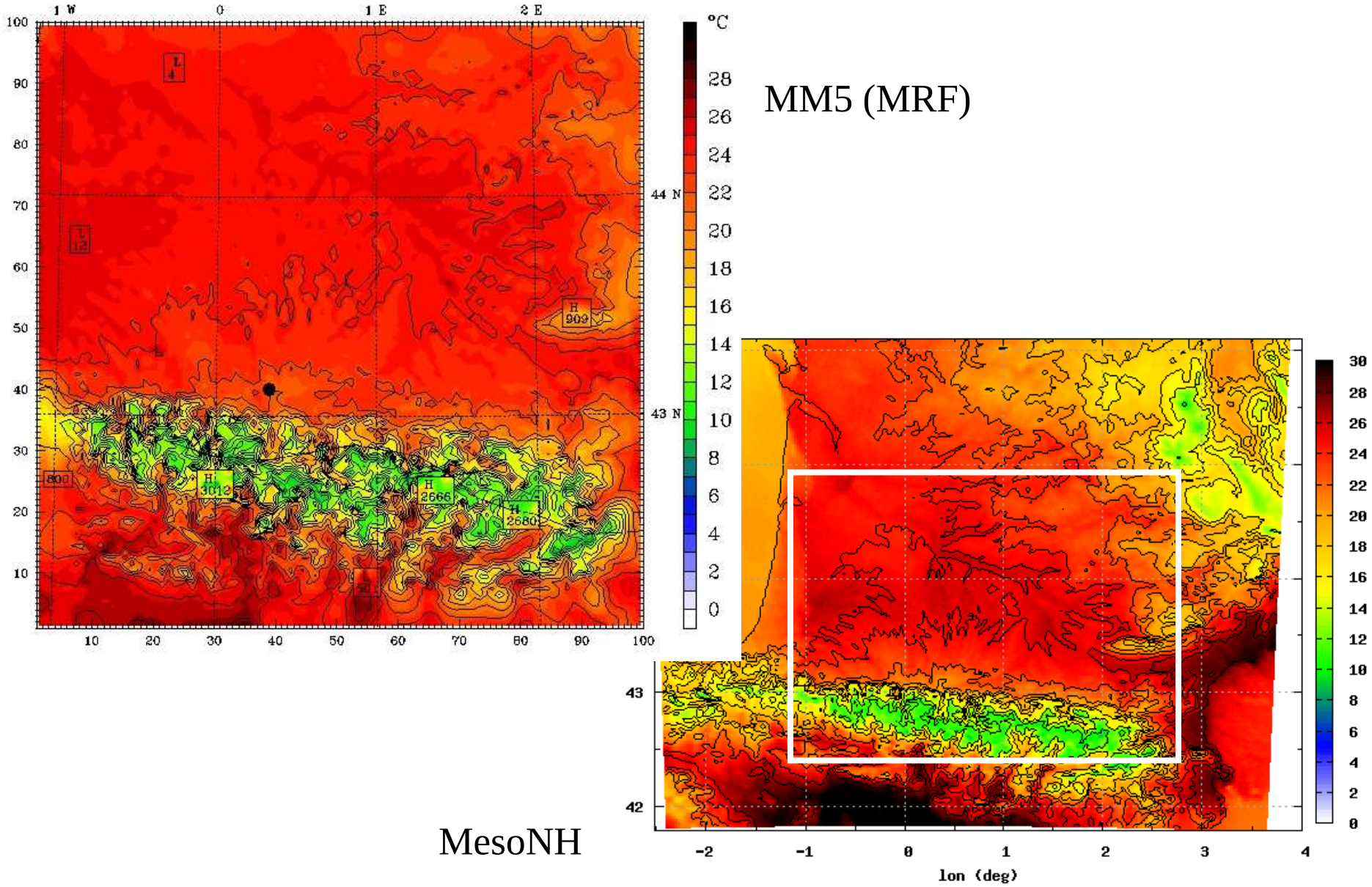


MM5 (MRF)

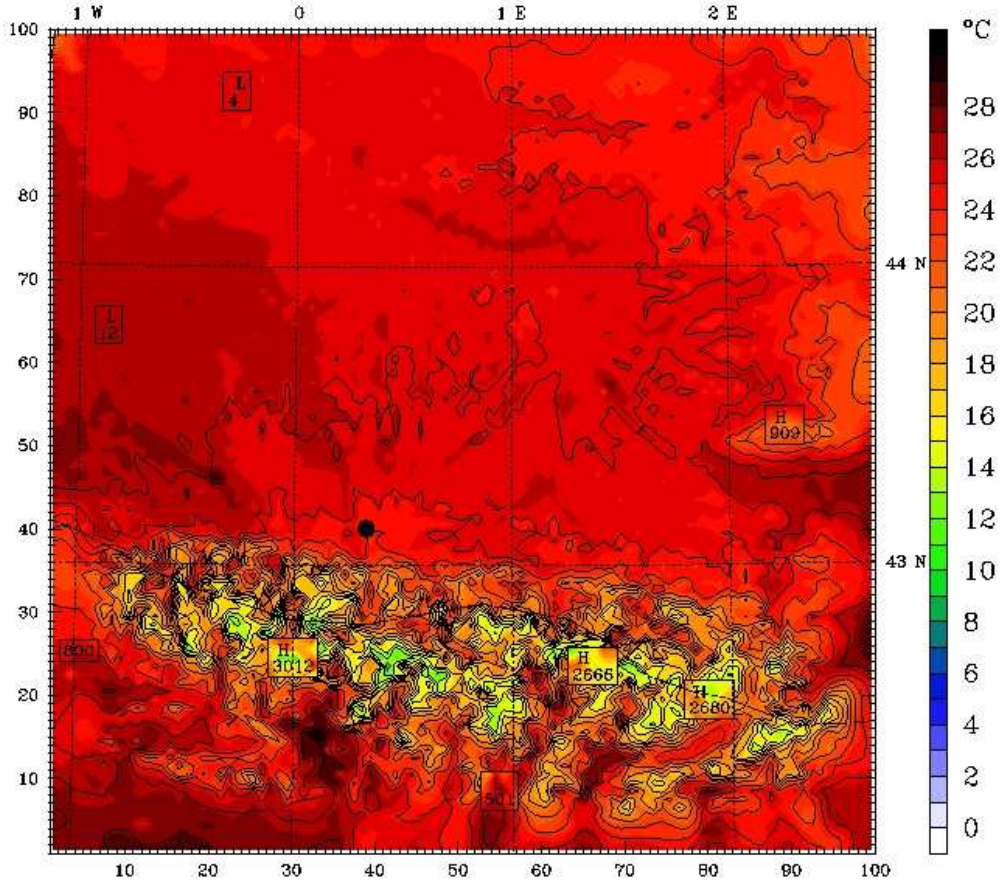


MesoNH

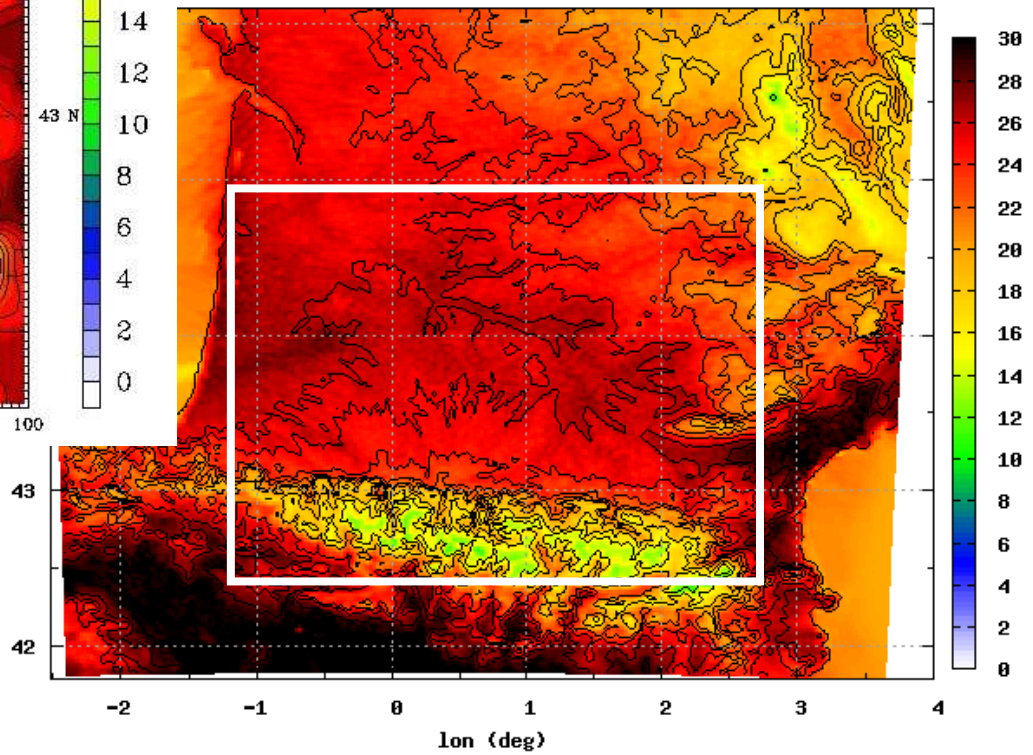
2m temperatures (1st July 18UTC)



2m temperatures (2nd July 12UTC)

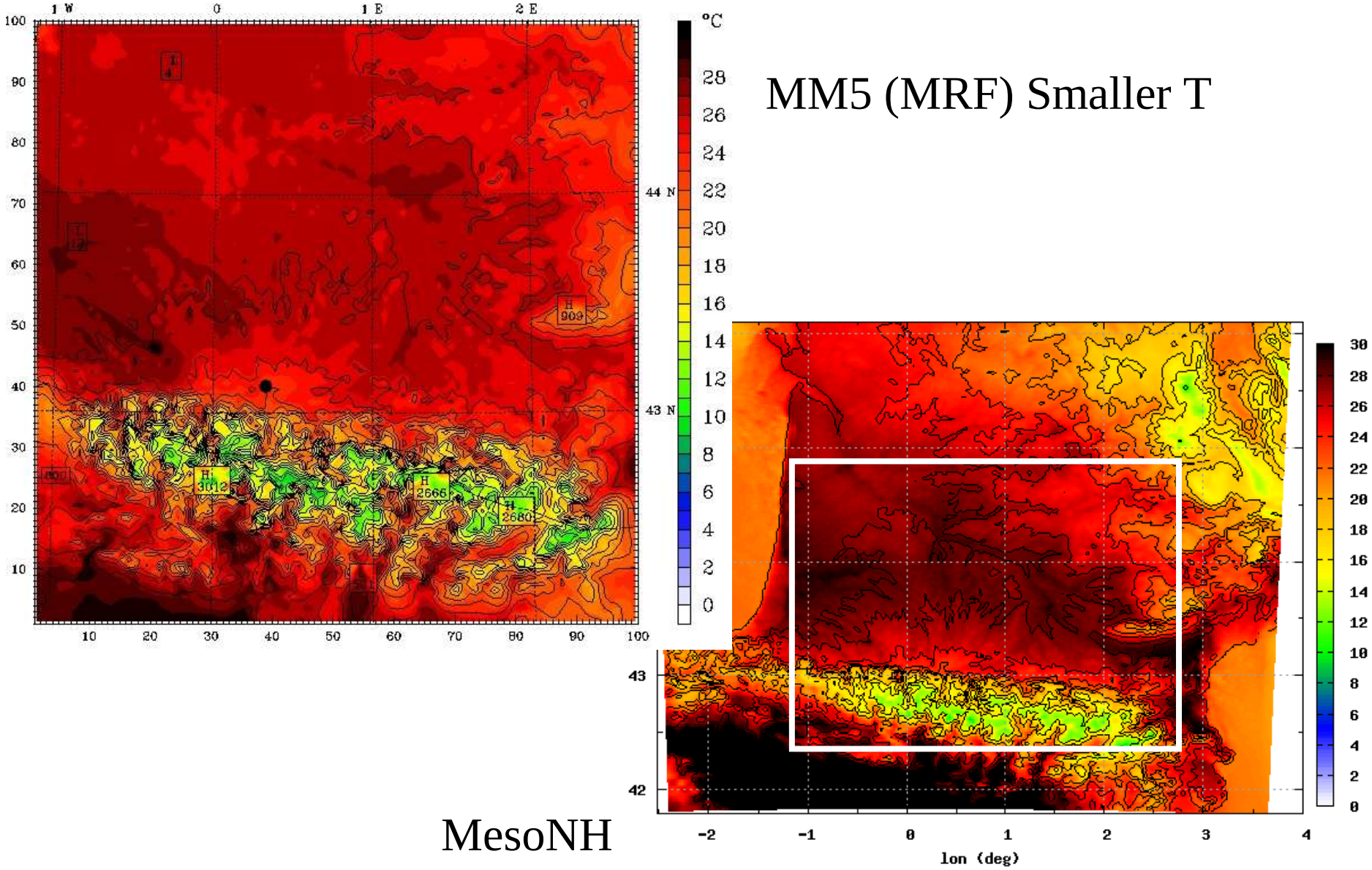


MM5 (MRF)



MesoNH

2m temperatures (2nd July 18UTC)

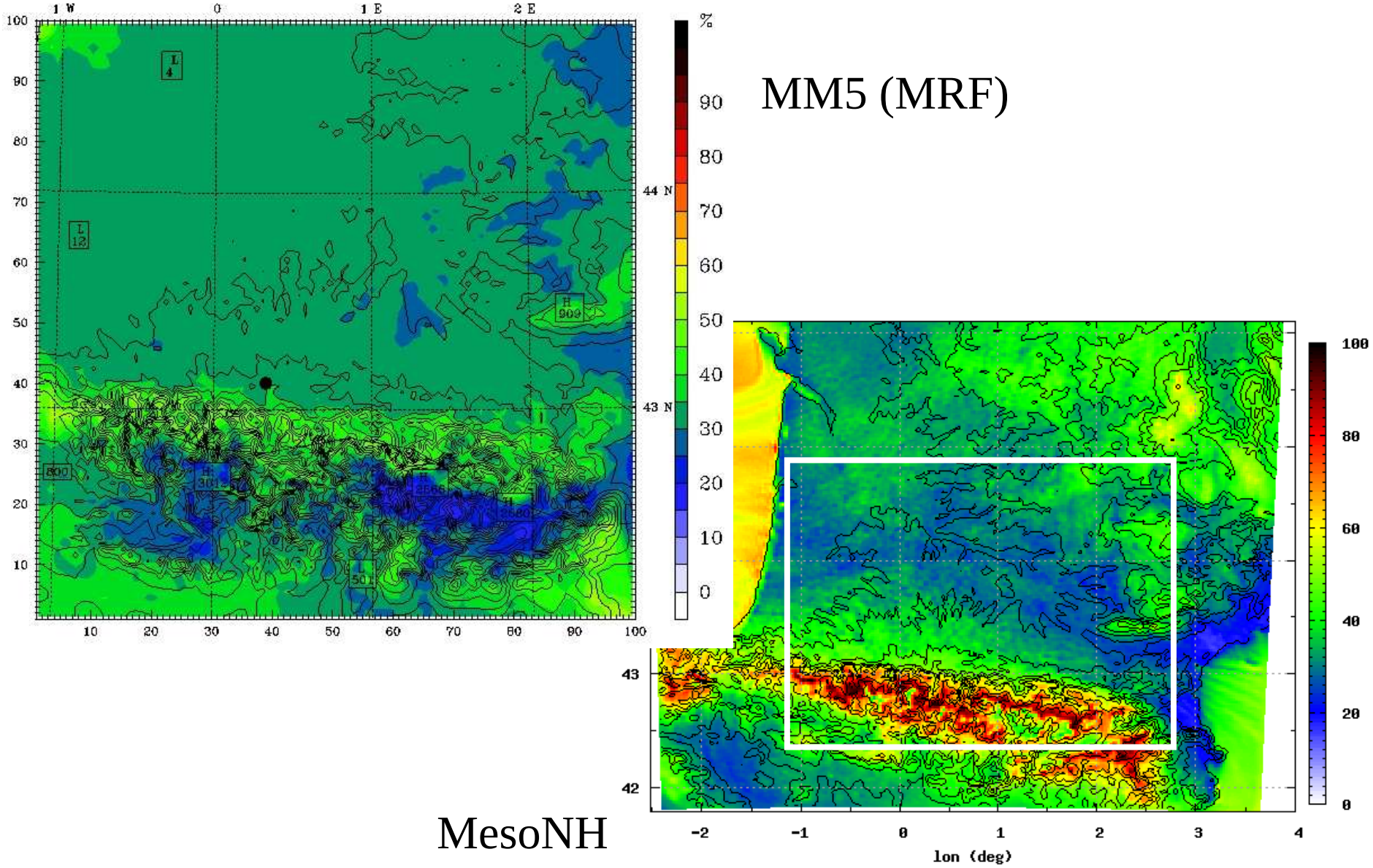


MM5 (MRF) Smaller T

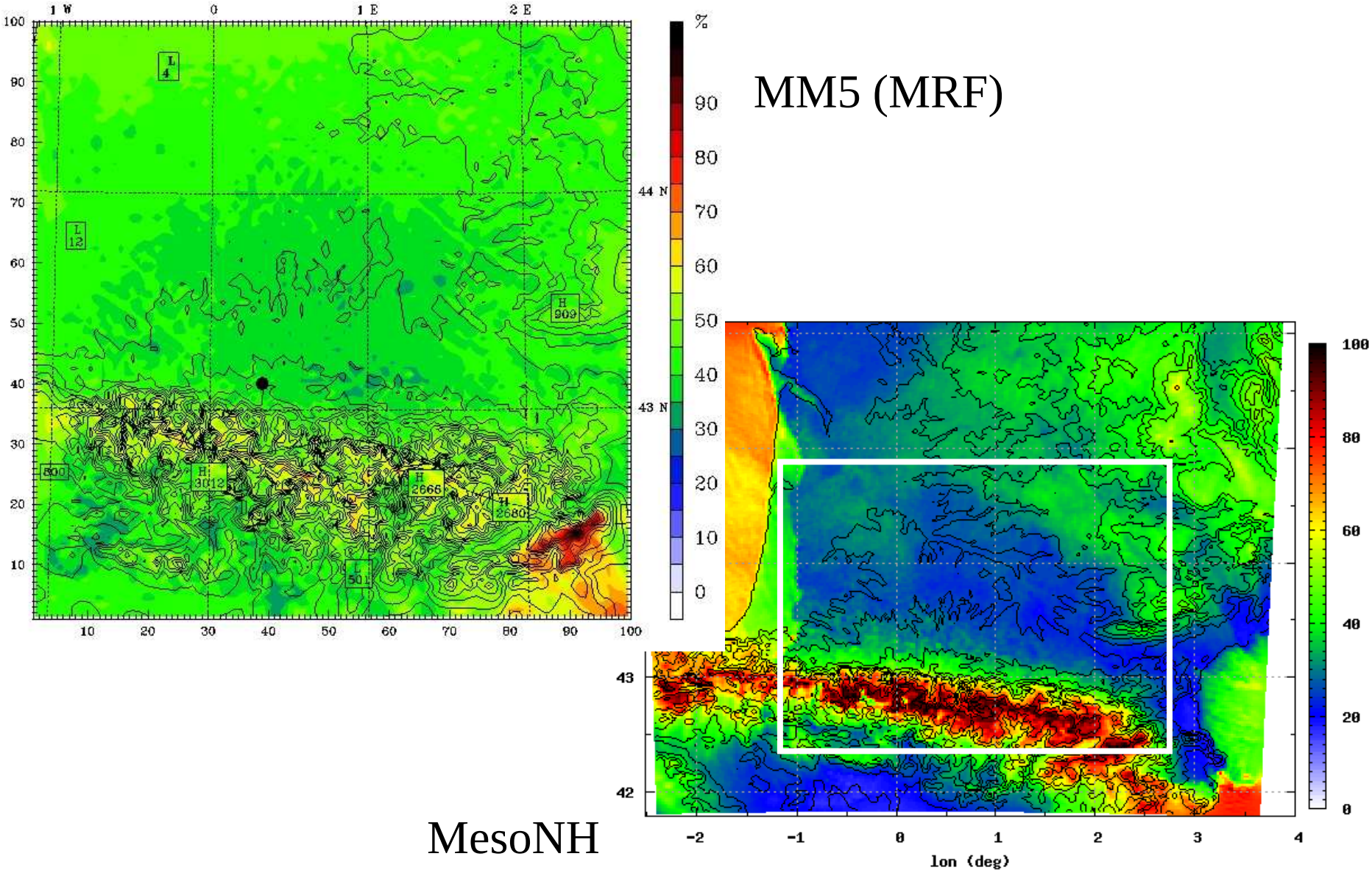
MesoNH

Results (II)

2m relative humidity (1st July 12UTC)

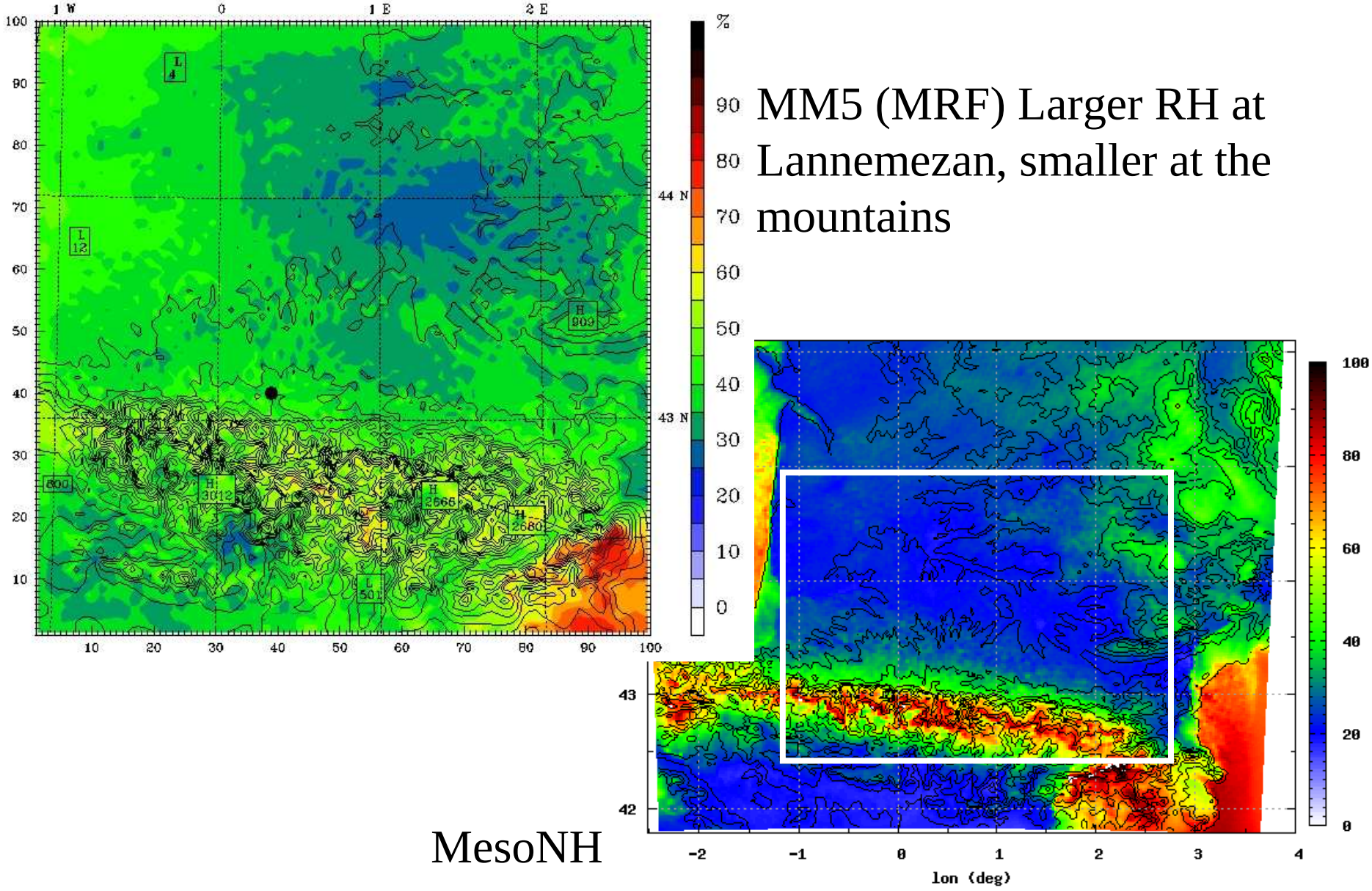


2m relative humidity (1st July 18UTC)



Results (II)

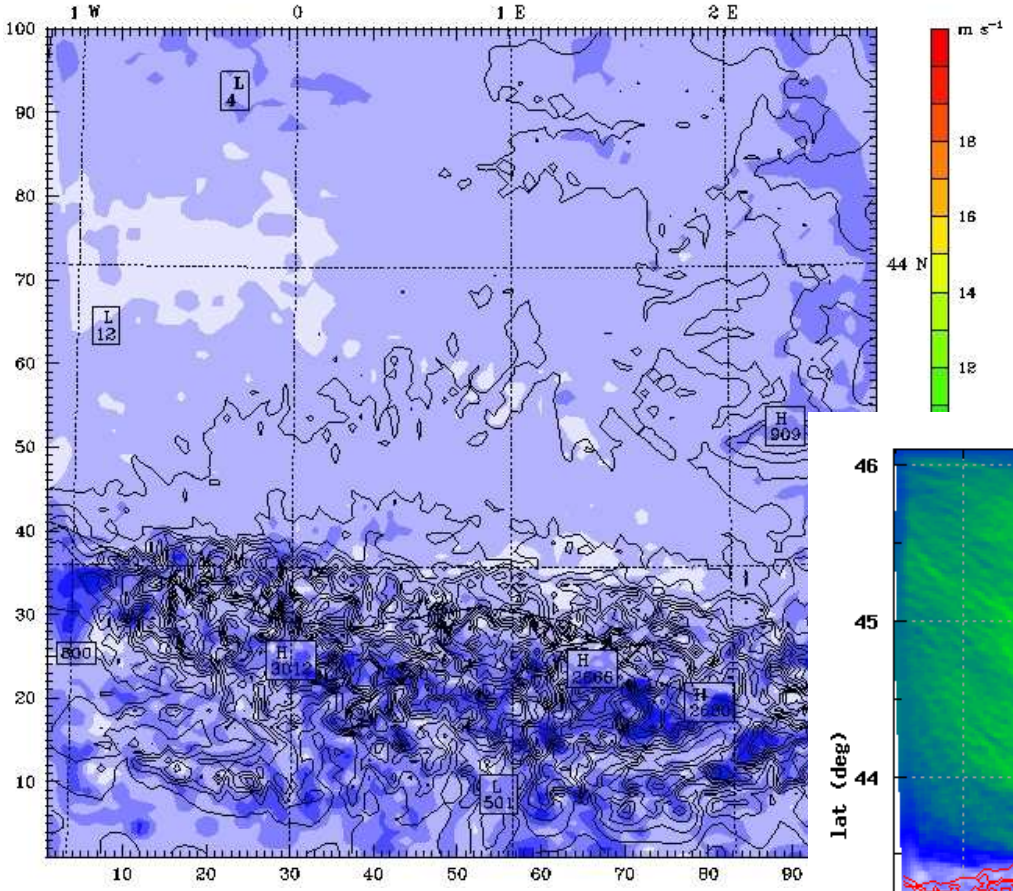
2m relative humidity (2nd July 18UTC)



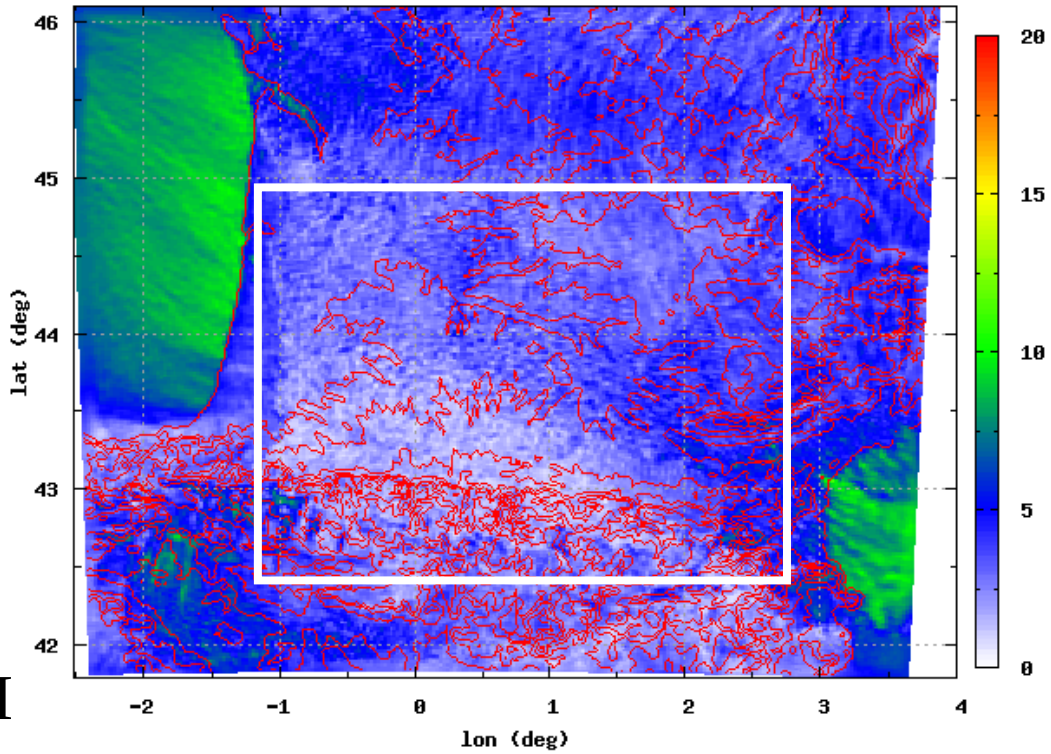
MM5 (MRF) Larger RH at Lannemezan, smaller at the mountains

Results (III)

10m wind speed (1st July 18UTC)

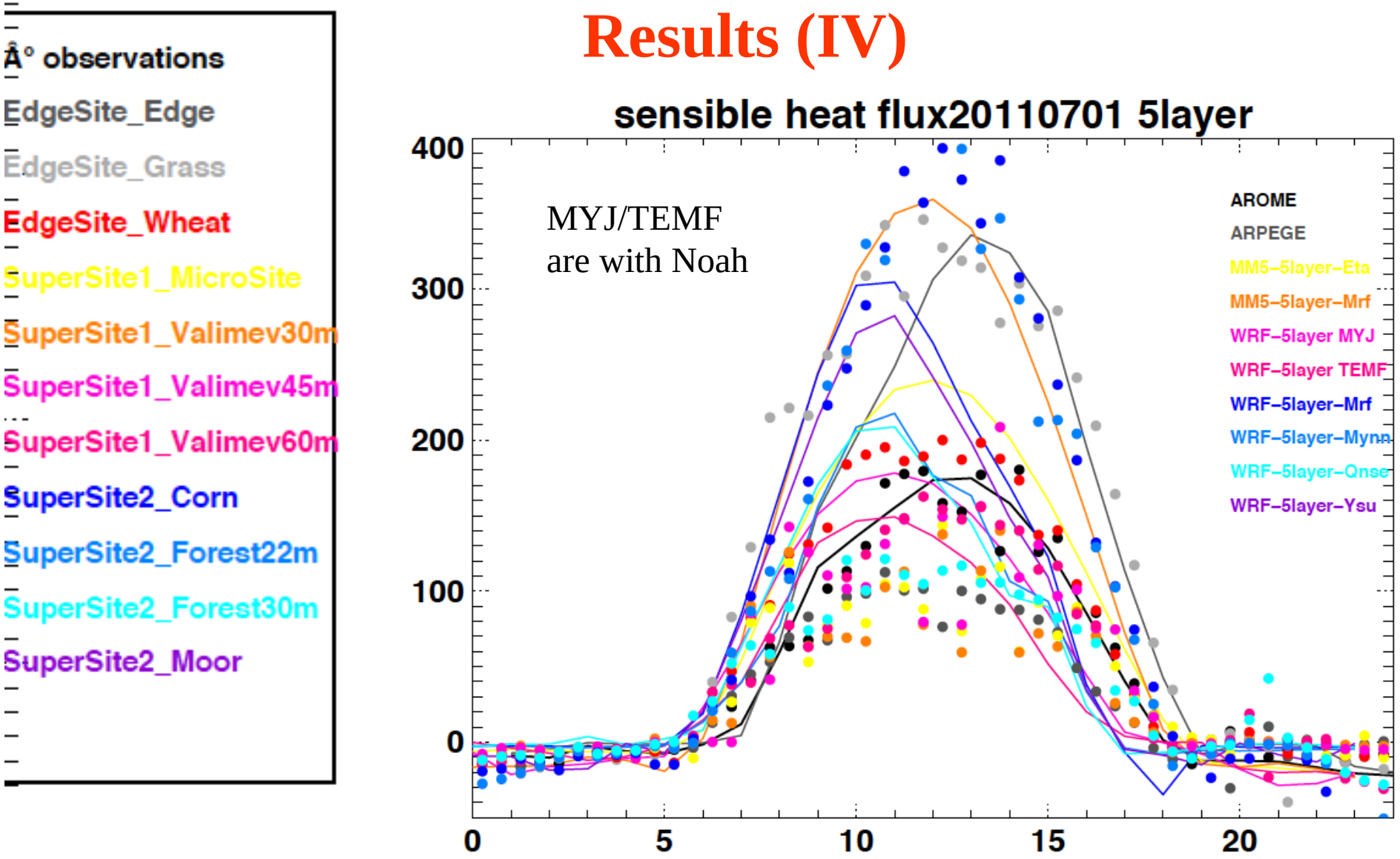


MM5 (MRF)



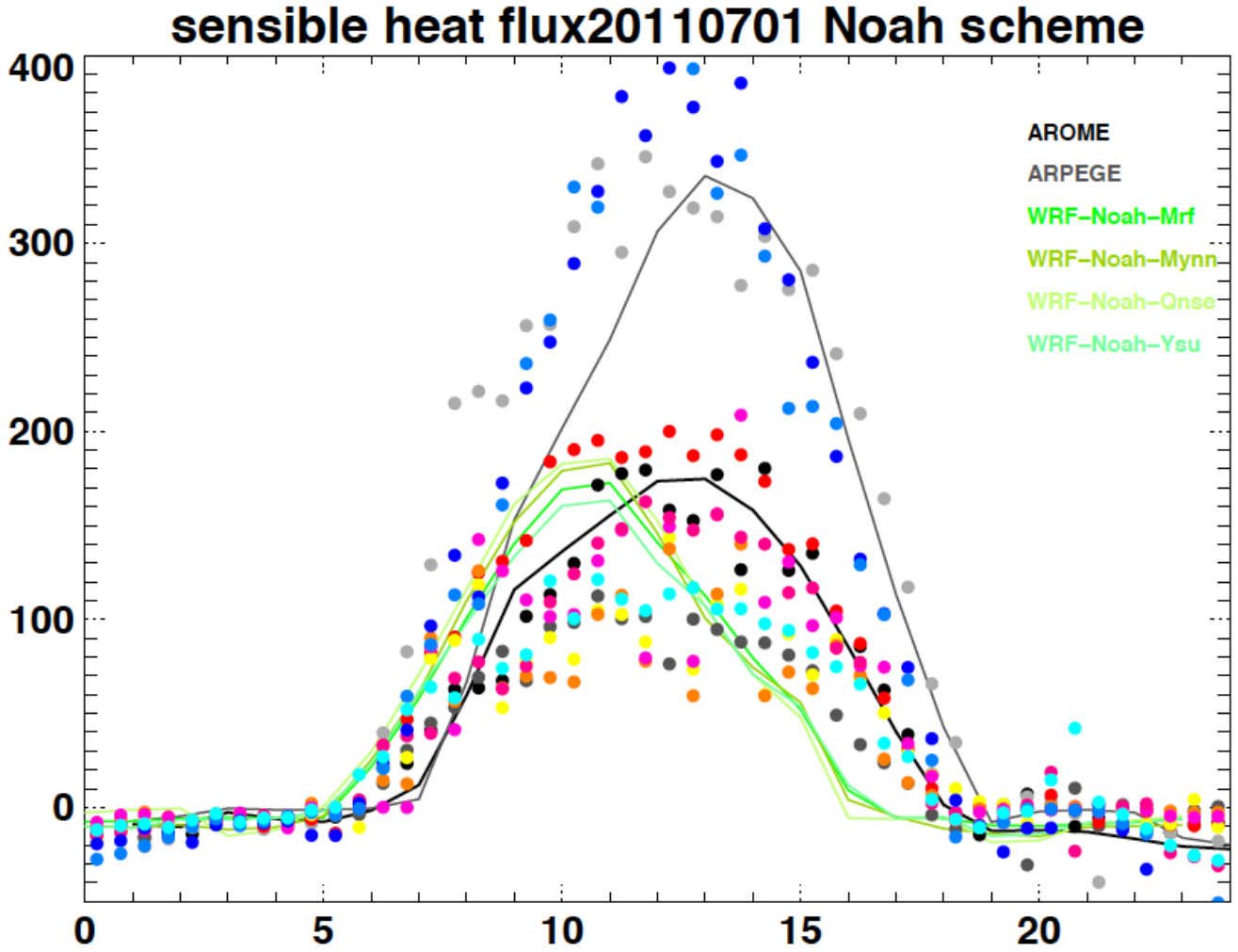
MesoNH

Results (IV)

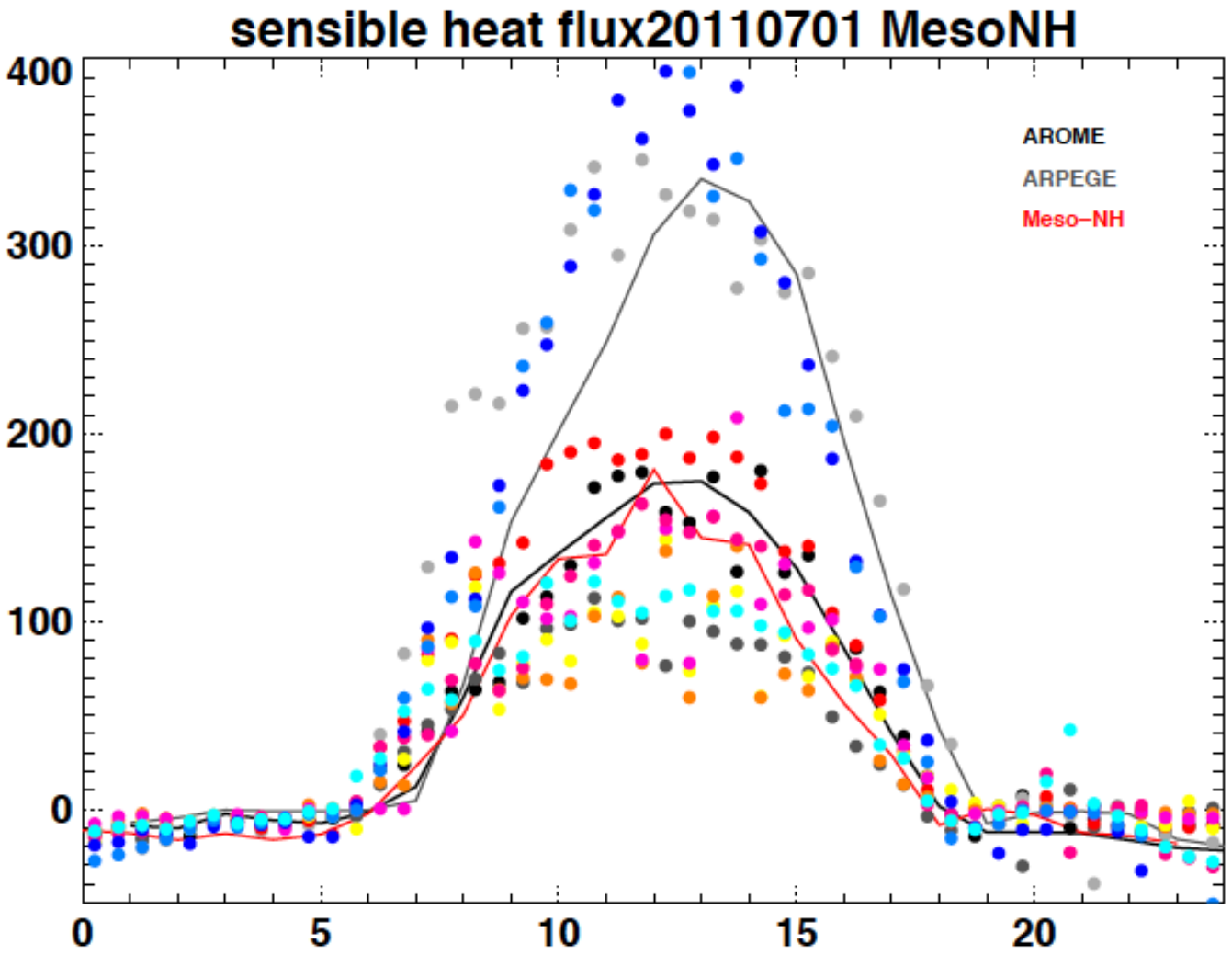


•MM5-MRF tends to have too large sensible heat flux (similarly to ARPEGE) on the closest point to Lannemezan.

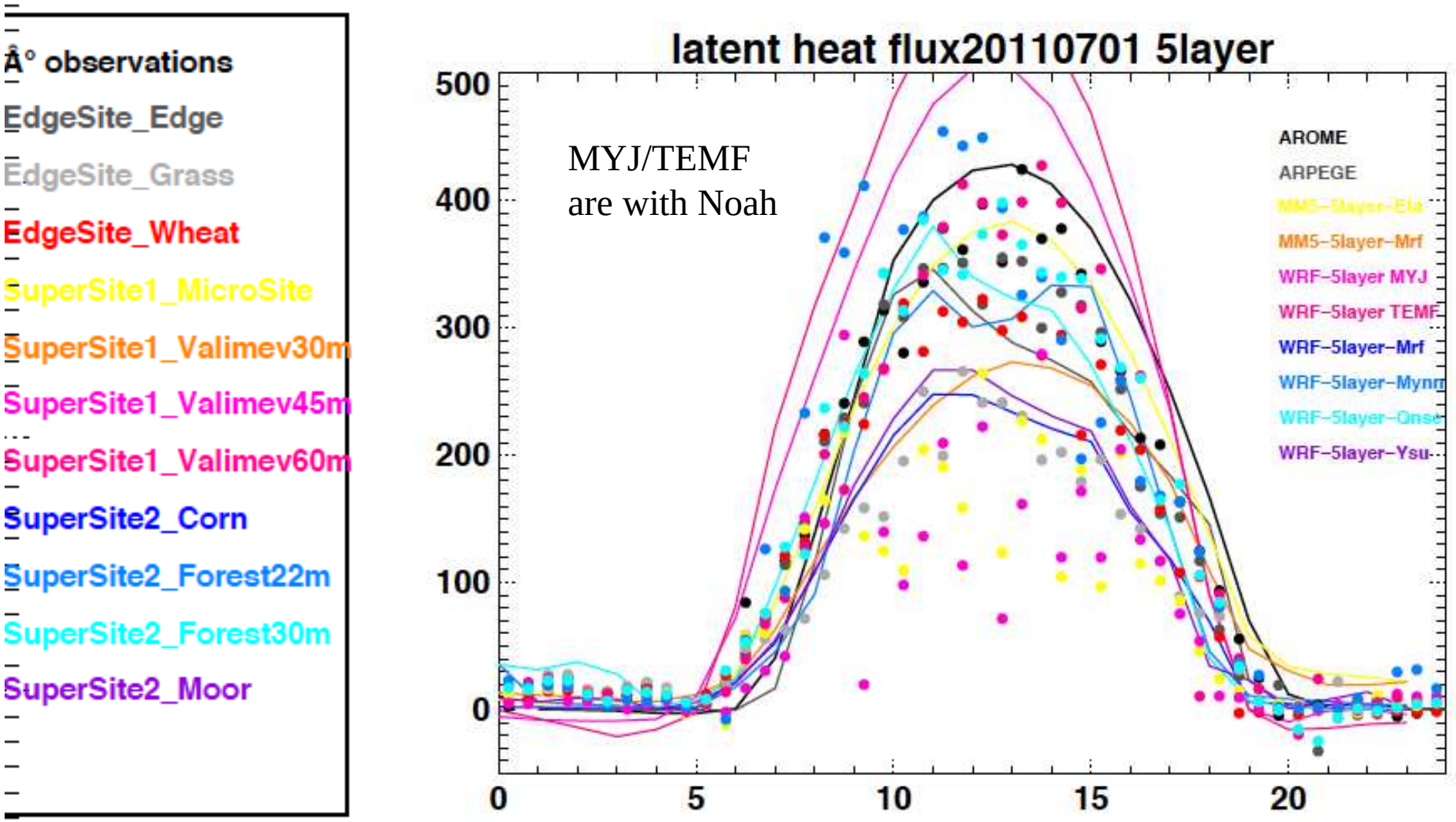
•WRF-5layer with MRF and YSU also tends to have a slightly too large sensible heat flux.



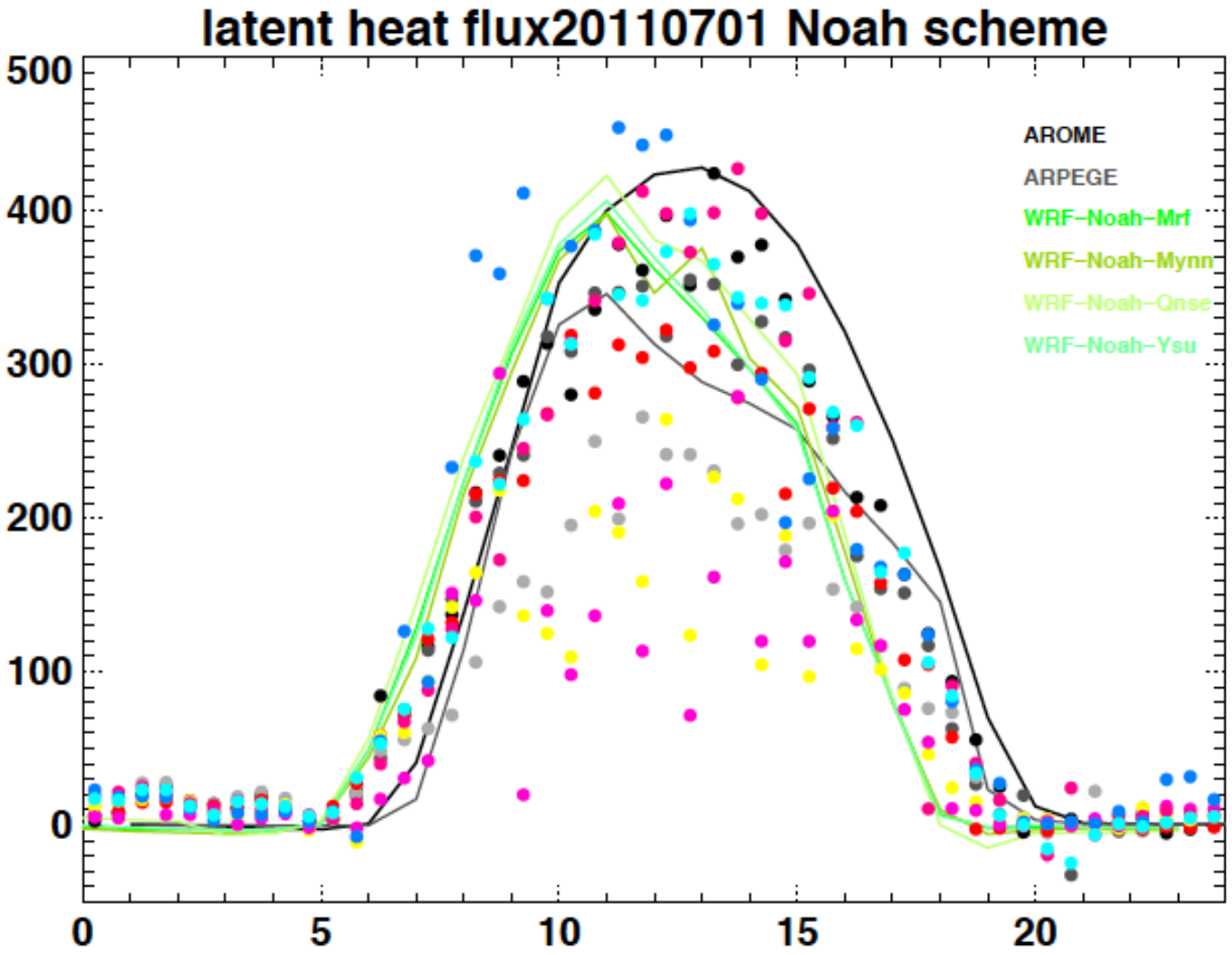
• WRF-Noah with all the parameterizations except TEMF and MYJ tends to underestimate SH during the afternoon

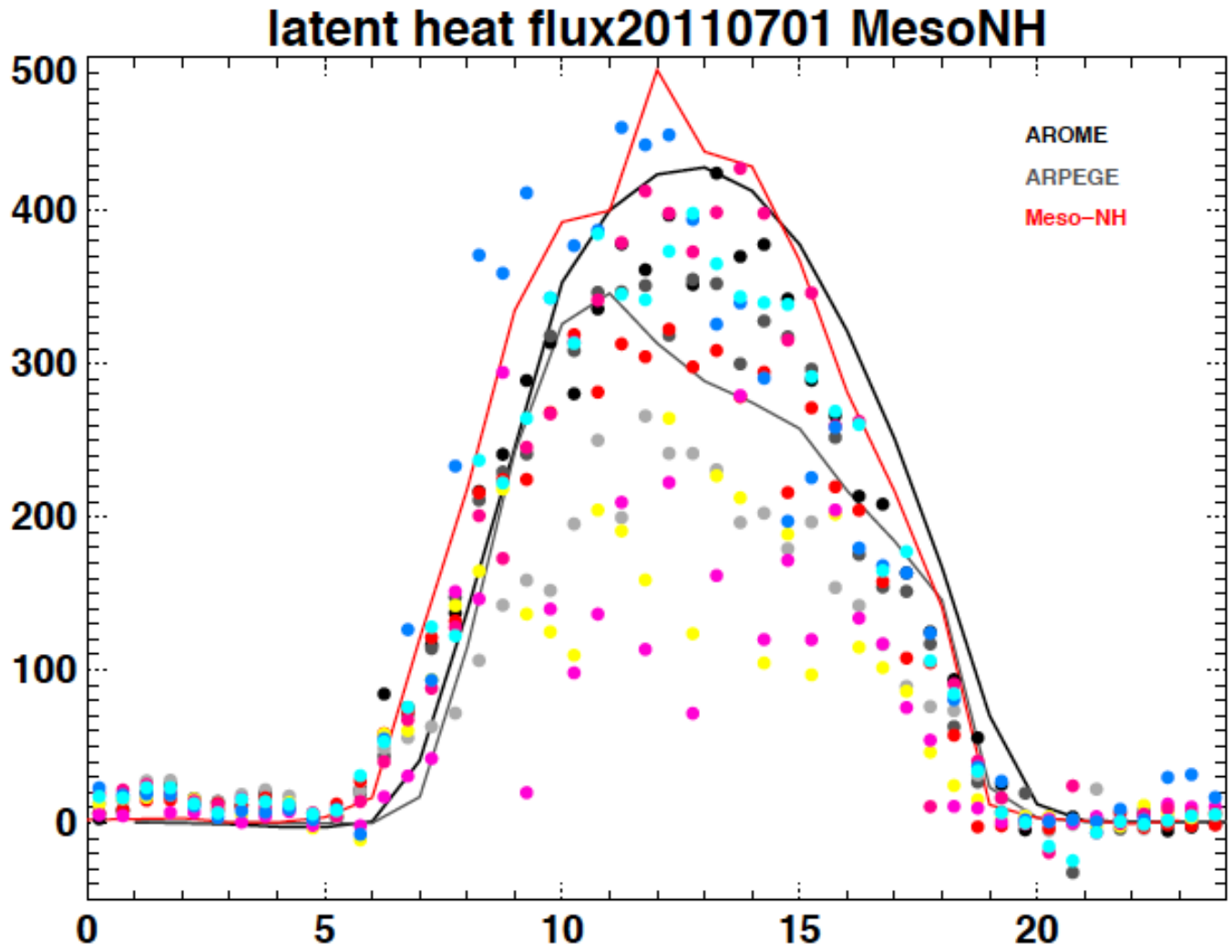


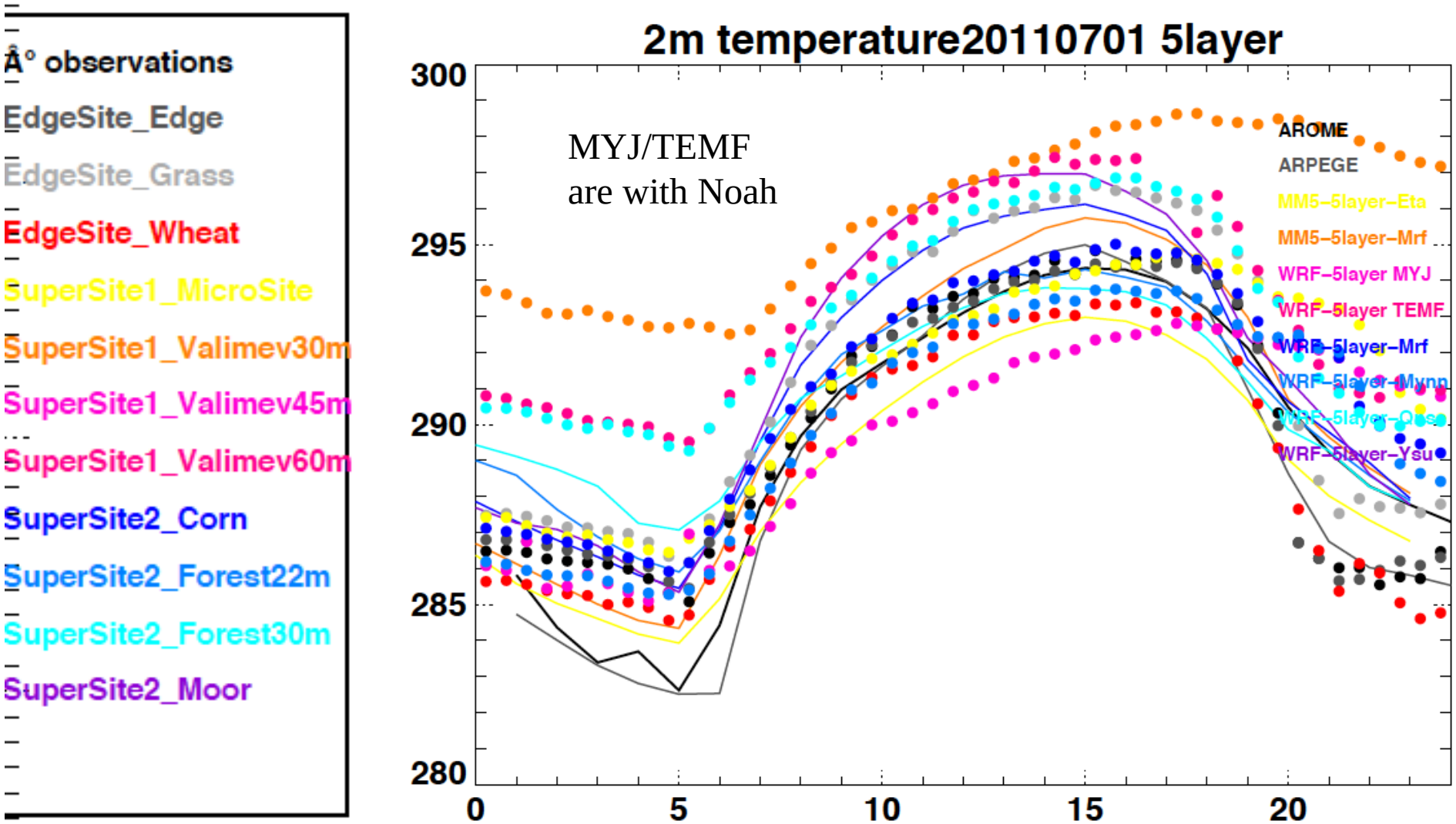
- MesoNH and AROME give similar SH to the observed ones



- Large variation of LE.
- WRF-Noah MYJ and EMF overestimate LE.

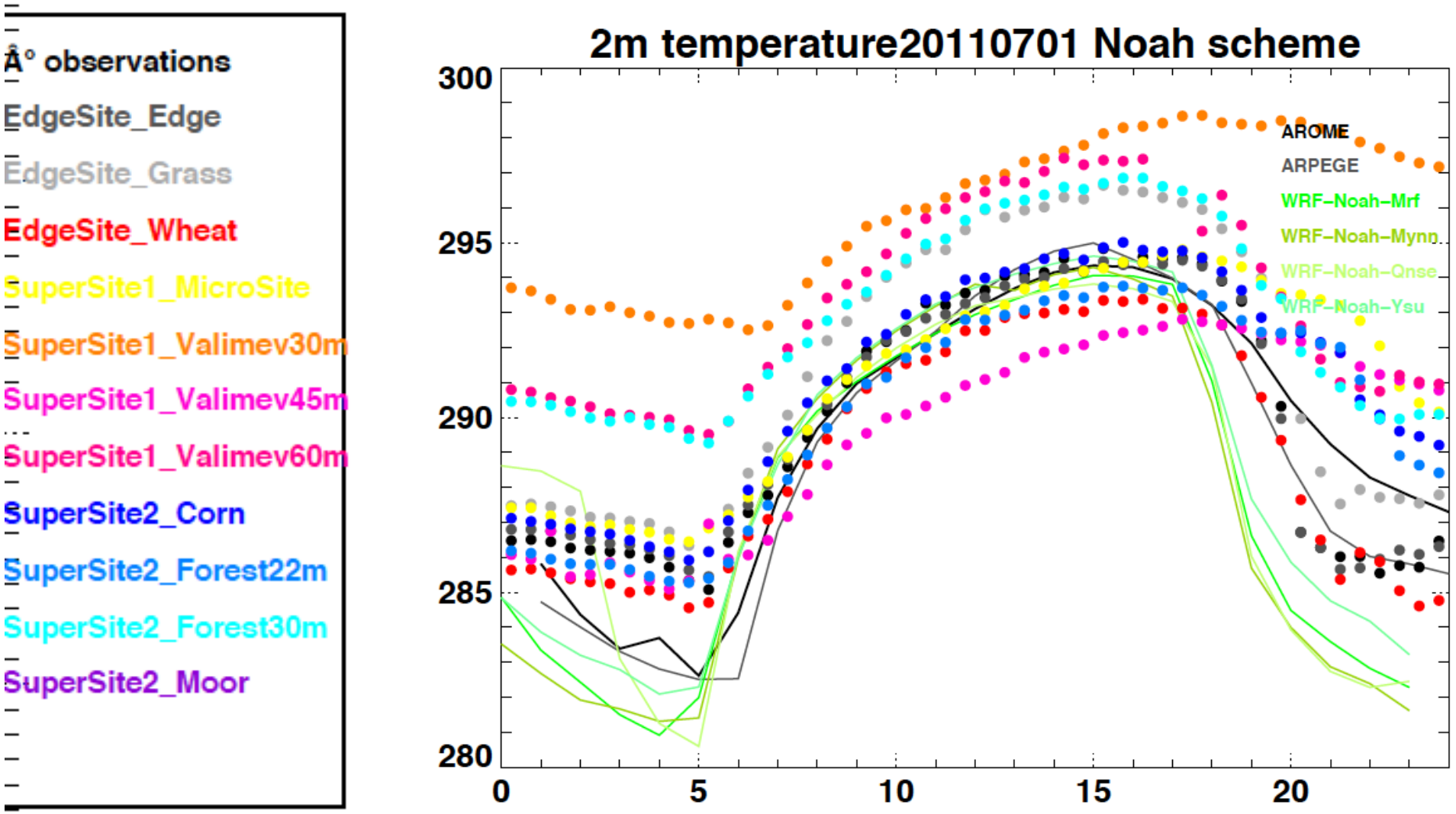

latent heat flux20110701 Noah scheme
500
400
300
200
100
0
0
5
10
15
20
AROME
ARPEGE
WRF–Noah–Mrf
WRF–Noah–Mynn
WRF–Noah–Qnse
WRF–Noah–Ysu


latent heat flux20110701 MesoNH
AROME
ARPEGE
Meso-NH
500
400
300
200
100
0
0
5
10
15
20

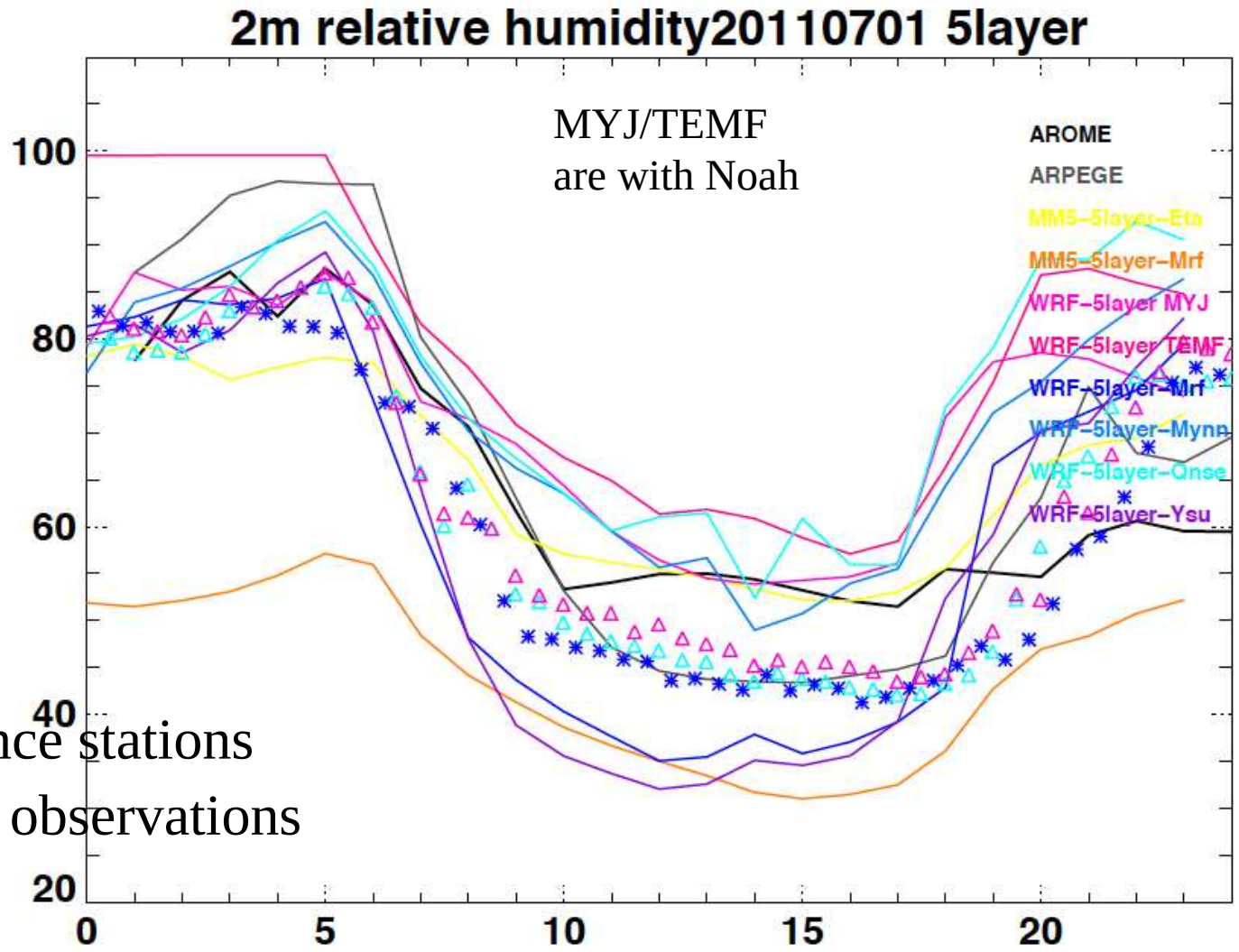


•Too cold night T simulated by AROME and ARPEGE during early morning.

•MesoNH performs well.



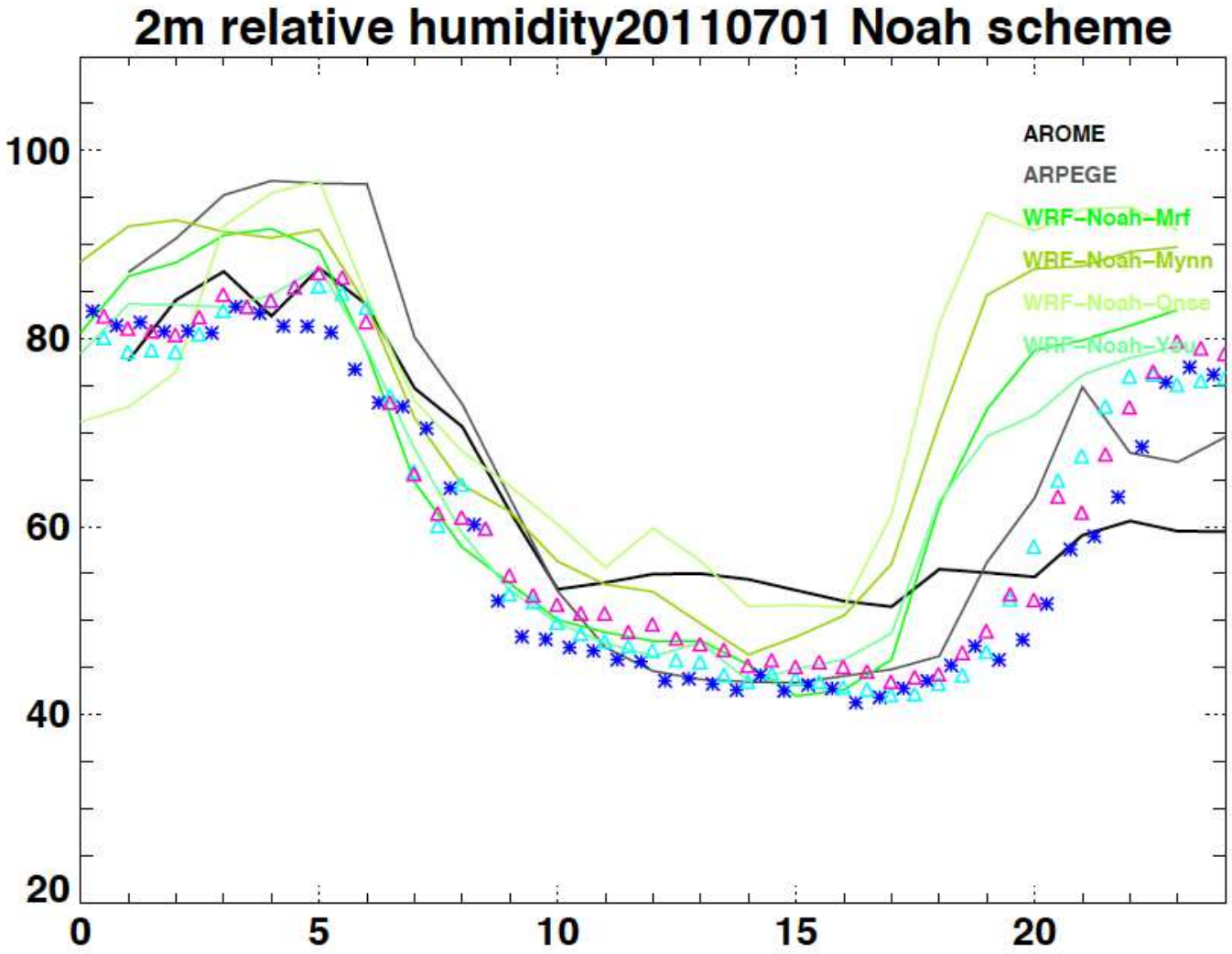
• WRF-Noah underestimates nighttime and afternoon T (MRF, MYNN, YSU) due to low SH.



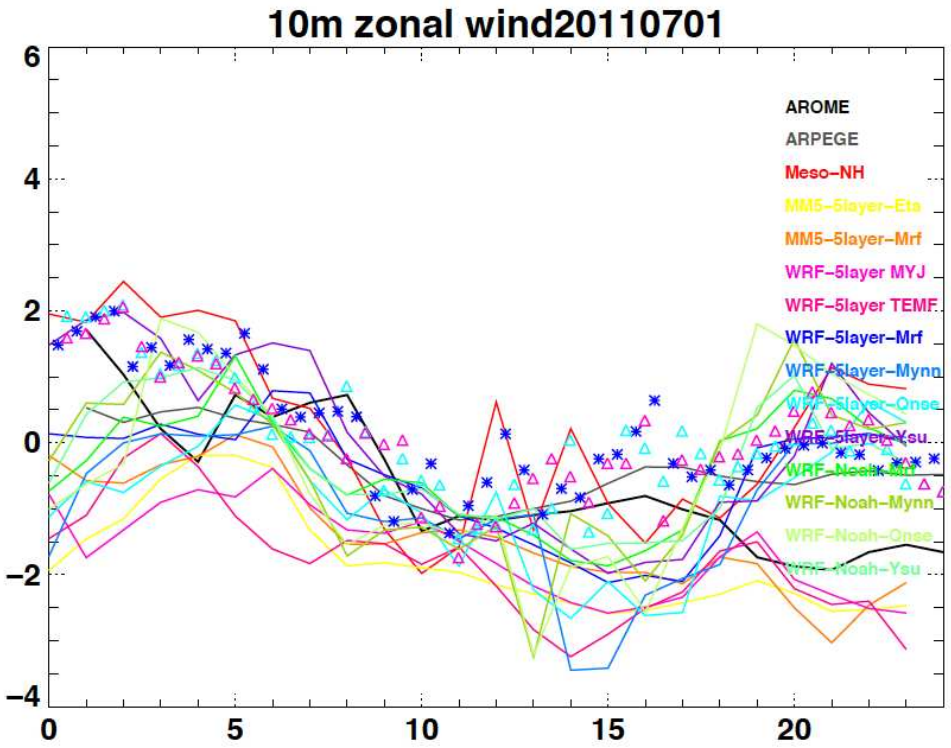
Δ MeteoFrance stations

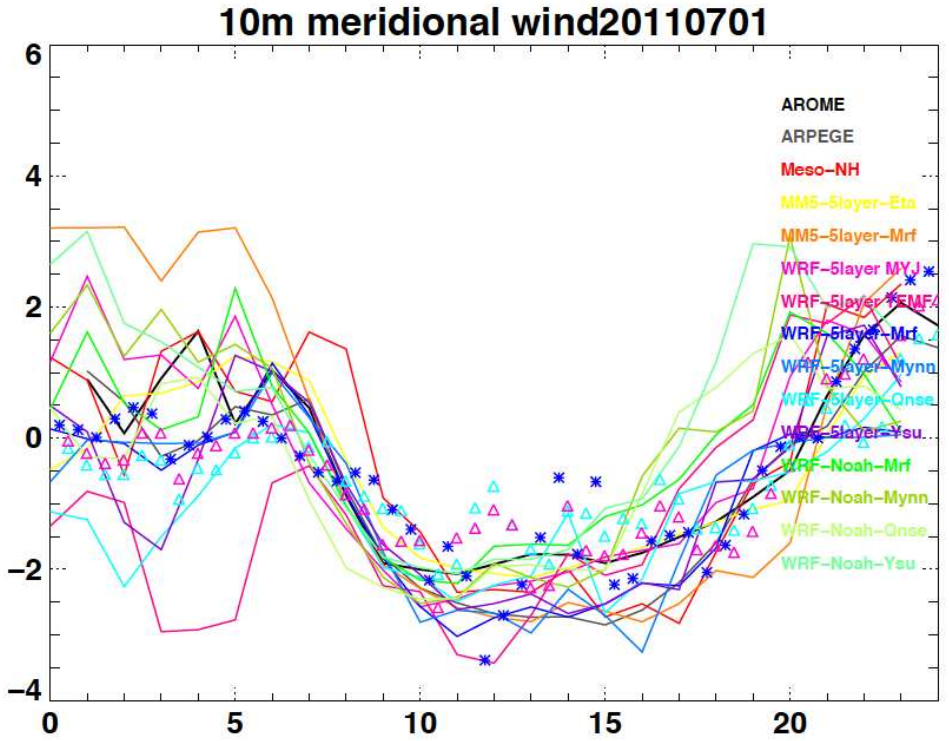
* 65m tower observations

- MM5-MRF underestimates nighttime relative humidity
- WRF-Noah (MYJ, TEMF) overestimates RH (in agreement with the too large latent heat flux).
- MesoNH performs well.

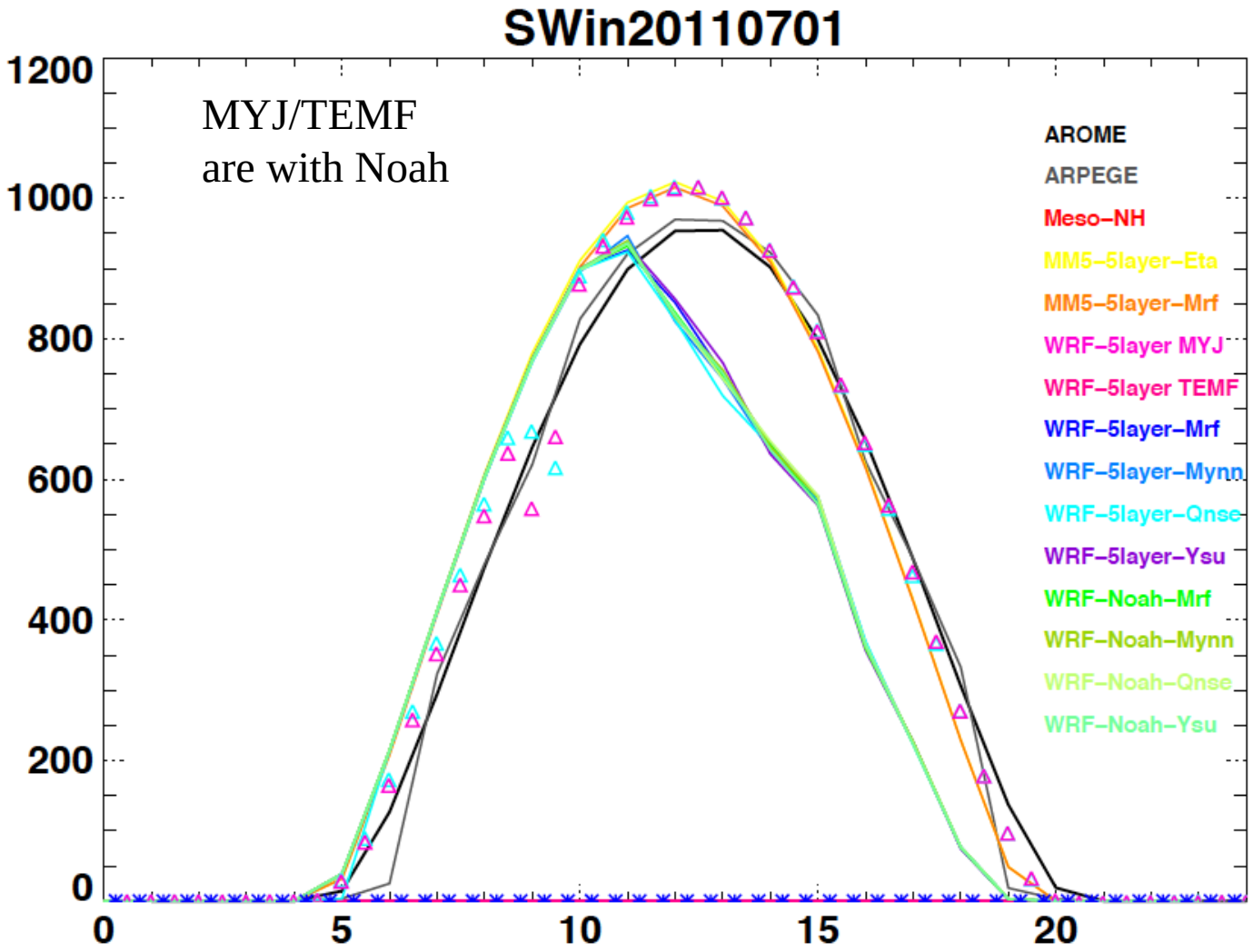


- WRF-Noah overestimates RH at night.

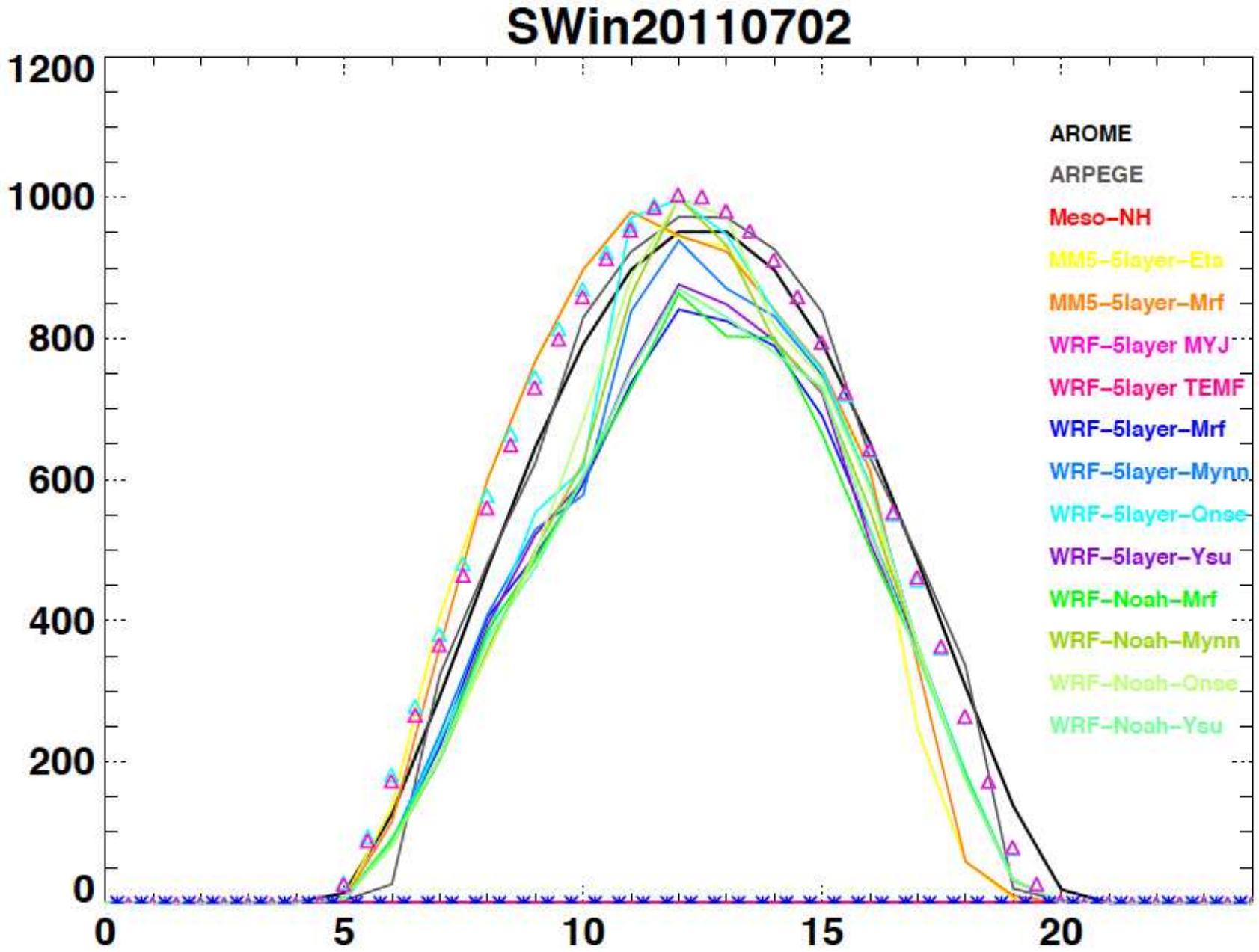




U is too negative in the models.V is better reproduced



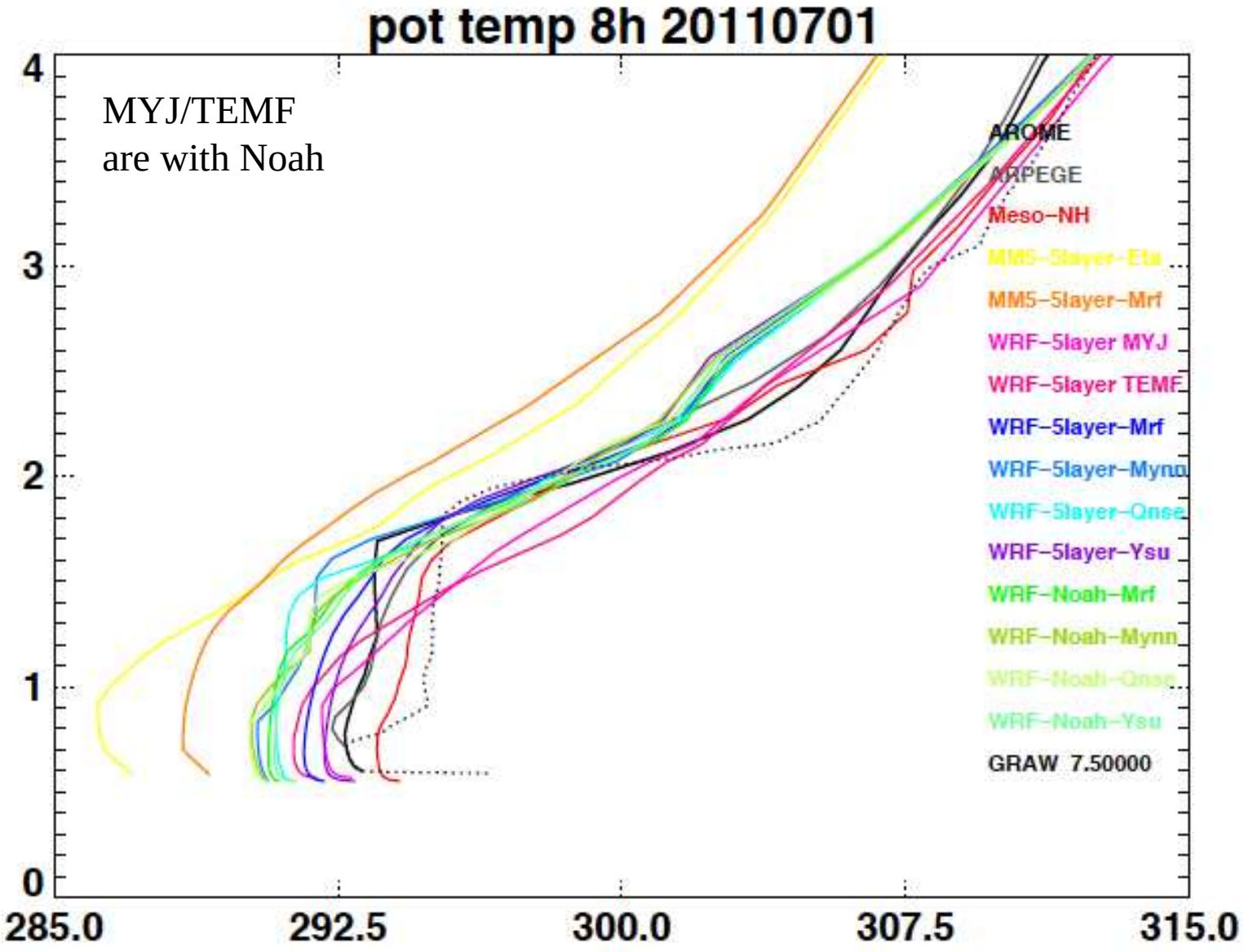
•SWin: a decrease in the afternoon in WRF for the 1st July (presence of clouds? not observed)

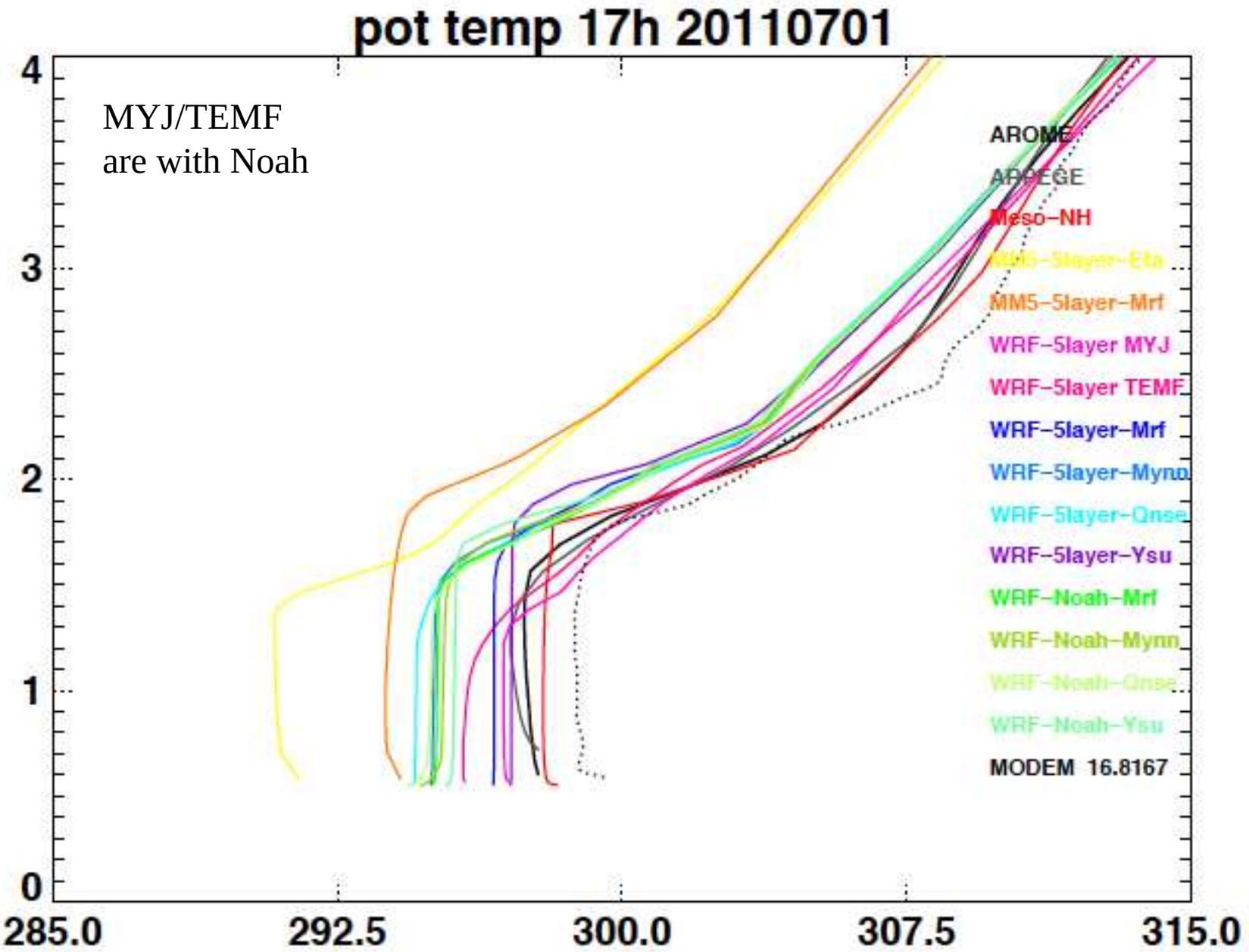


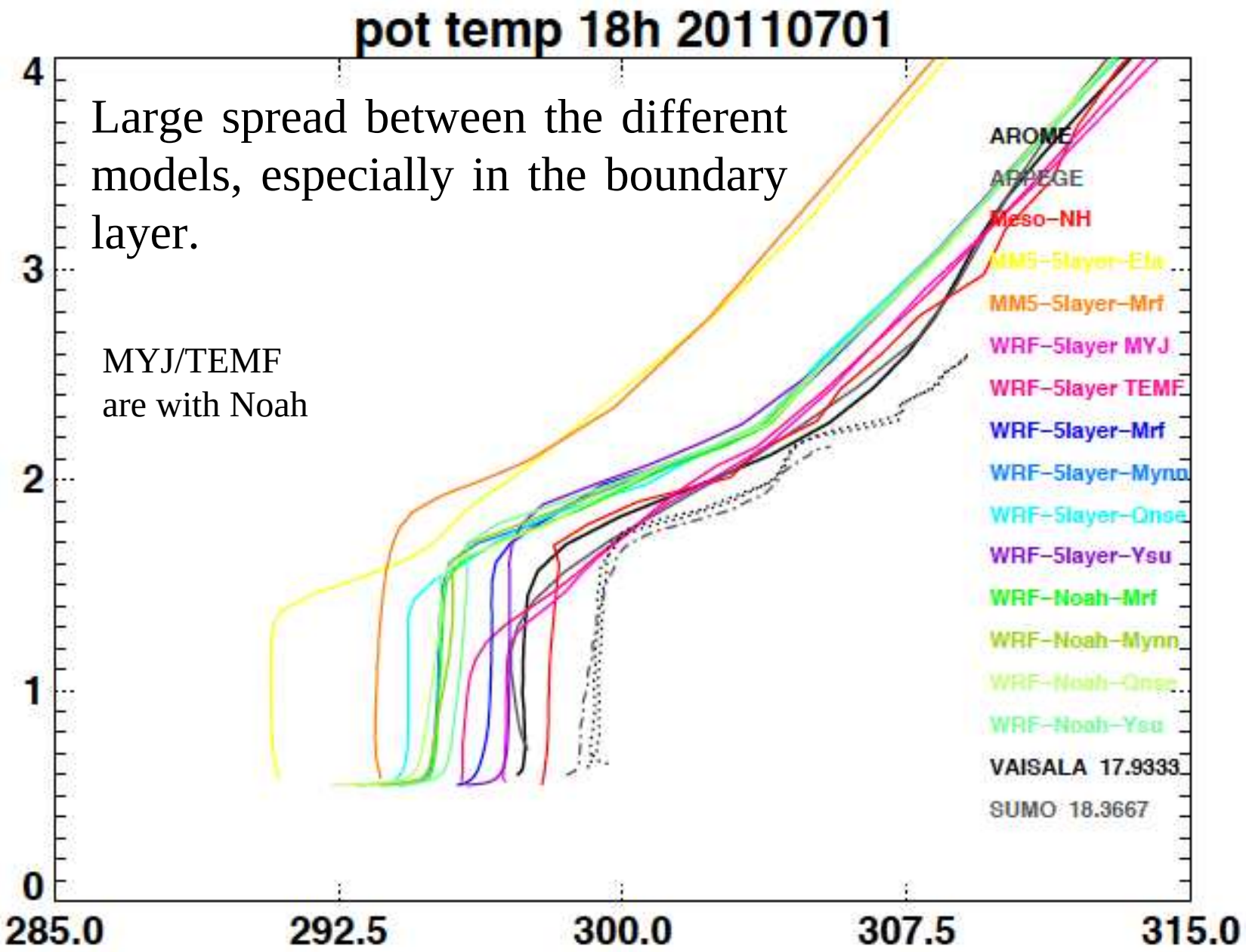
Clouds simulated???

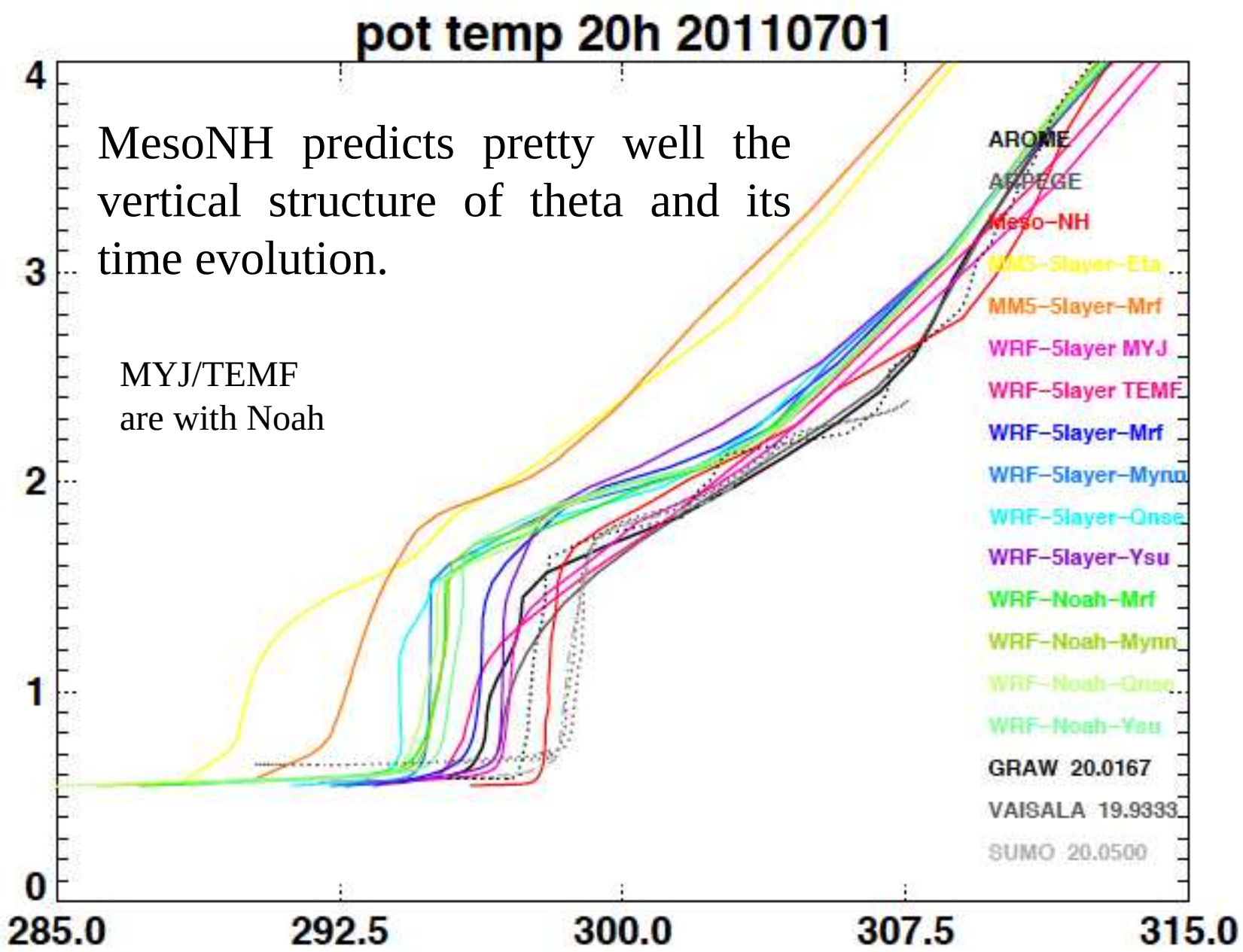
Results (V)

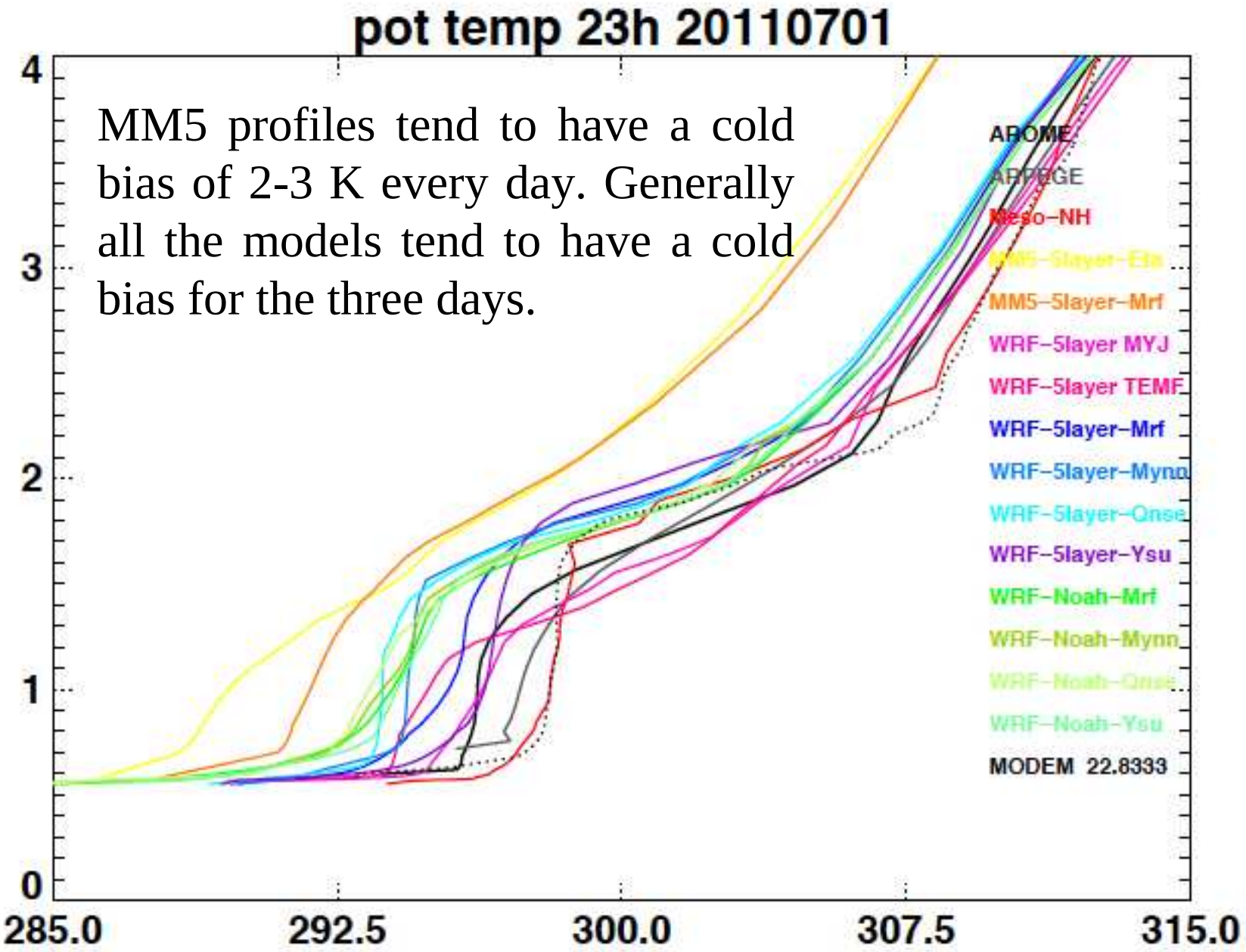
Vertical profiles of the main variables at Lannemezan

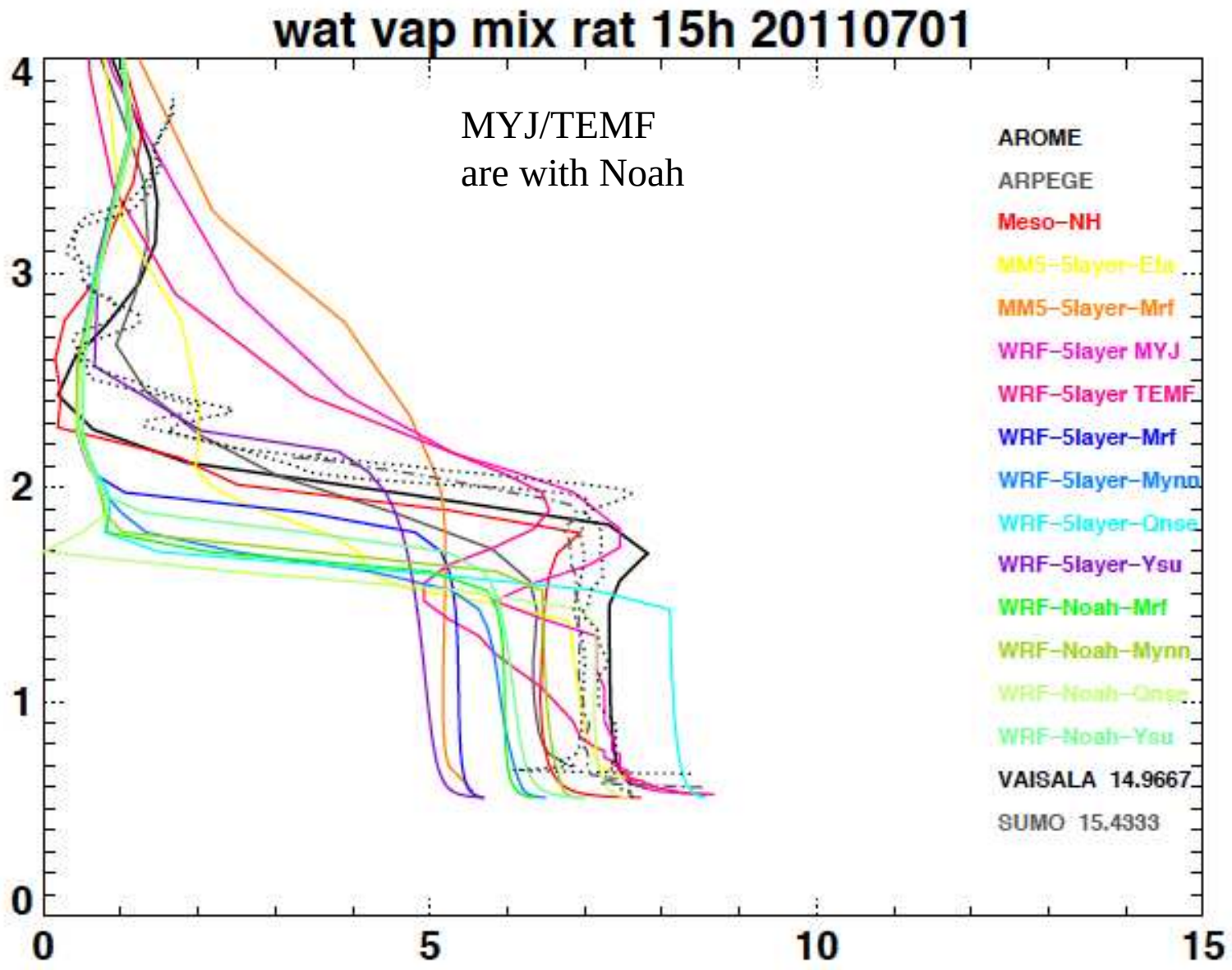



pot temp 17h 20110701
MYJ/TEMF
are with Noah
AROME
ARPEGE
Meso-NH
MM5-5layer-Eta
MM5-5layer-Mrf
WRF-5layer MYJ
WRF-5layer TEMF
WRF-5layer-Mrf
WRF-5layer-Mynn
WRF-5layer-Qnse
WRF-5layer-Ysu
WRF-Noah-Mrf
WRF-Noah-Mynn
WRF-Noah-Qnse
WRF-Noah-Ysu
MODEM 16.8167
4
3
2
1
0
285.0
292.5
300.0
307.5
315.0

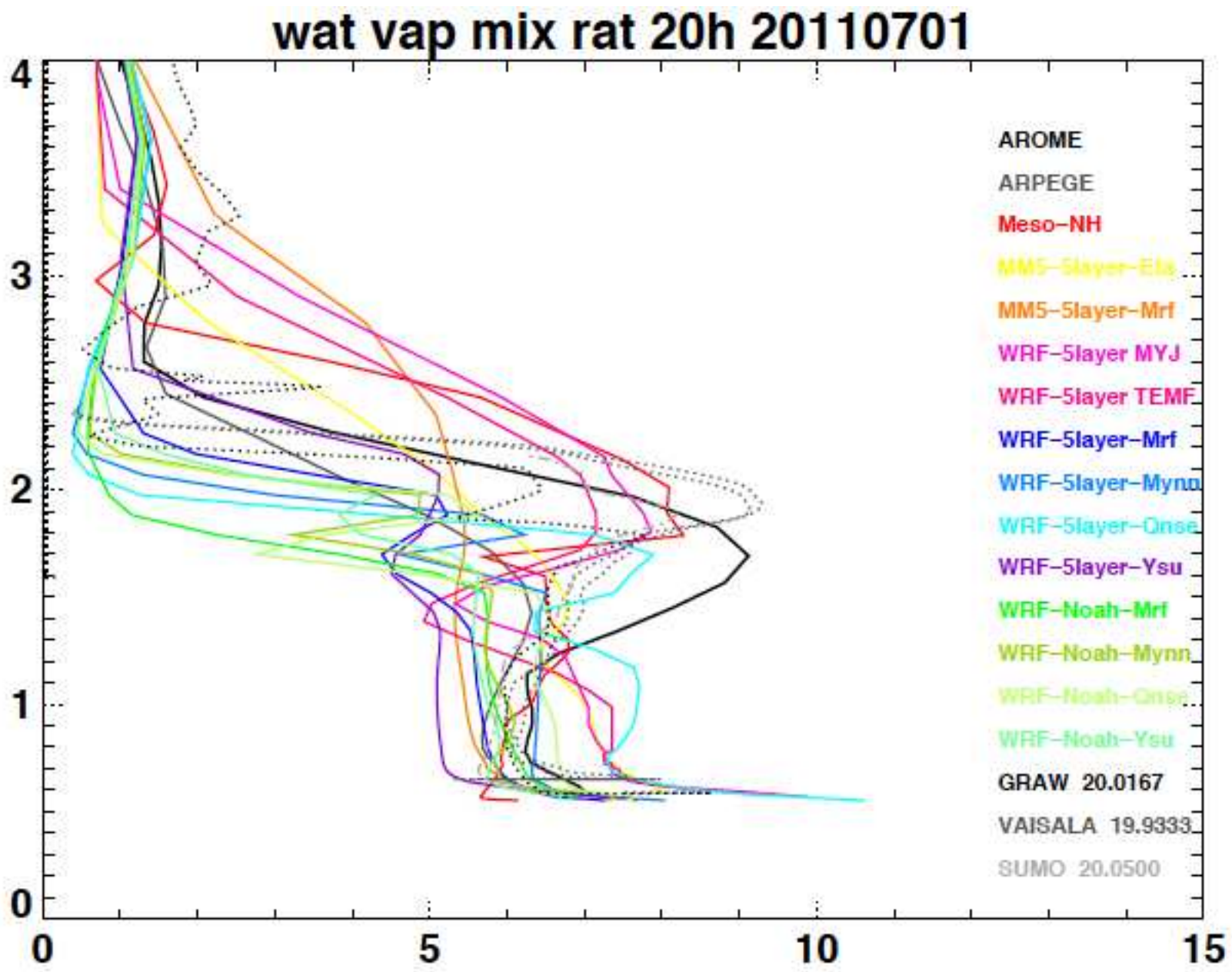

pot temp 18h 20110701
Large spread between the different models, especially in the boundary layer.
MYJ/TEMF
are with Noah
AROME
ARPEGE
Meso-NH
MM5-5layer-Eta
MM5-5layer-Mrf
WRF-5layer MYJ
WRF-5layer TEMF
WRF-5layer-Mrf
WRF-5layer-Mynn
WRF-5layer-Qnse
WRF-5layer-Ysu
WRF-Noah-Mrf
WRF-Noah-Mynn
WRF-Noah-Qnse
WRF-Noah-Ysu
VAISALA 17.9333
SUMO 18.3667
4
3
2
1
0
285.0
292.5
300.0
307.5
315.0


pot temp 20h 20110701
MesoNH predicts pretty well the vertical structure of theta and its time evolution.
MYJ/TEMF
are with Noah
AROME
ARPEGE
Meso-NH
MM5-5layer-Eta
MM5-5layer-Mrf
WRF-5layer MYJ
WRF-5layer TEMF
WRF-5layer-Mrf
WRF-5layer-Mynn
WRF-5layer-Qnse
WRF-5layer-Ysu
WRF-Noah-Mrf
WRF-Noah-Mynn
WRF-Noah-Qnse
WRF-Noah-Ysu
GRAW 20.0167
VAISALA 19.9333
SUMO 20.0500
4
3
2
1
0
285.0
292.5
300.0
307.5
315.0


pot temp 23h 20110701
MM5 profiles tend to have a cold bias of 2-3 K every day. Generally all the models tend to have a cold bias for the three days.
4
3
2
1
0
285.0
292.5
300.0
307.5
315.0
AROME
ARPEGE
Meso-NH
MM5-5layer-Eta
MM5-5layer-Mrf
WRF-5layer MYJ
WRF-5layer TEMF
WRF-5layer-Mrf
WRF-5layer-Mynn
WRF-5layer-Qnse
WRF-5layer-Ysu
WRF-Noah-Mrf
WRF-Noah-Mynn
WRF-Noah-Qnse
WRF-Noah-Ysu
MODEM 22.8333



Large difference very different boundary layers schemes


wat vap mix rat 20h 20110701
4
3
2
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0
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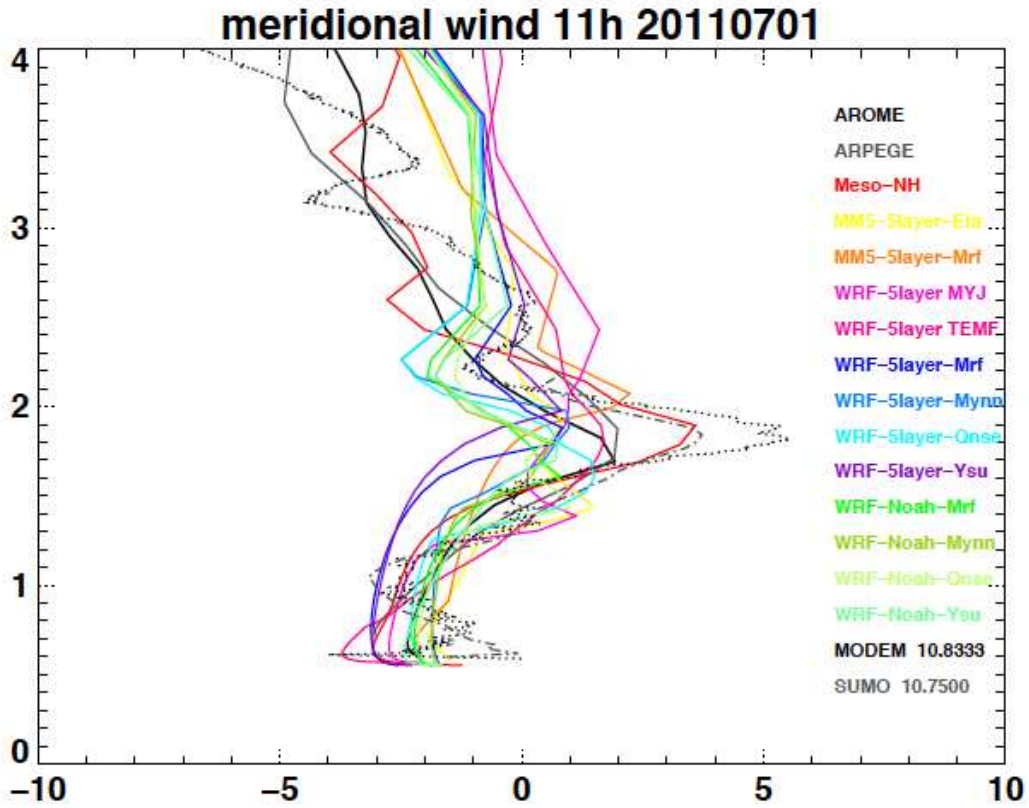
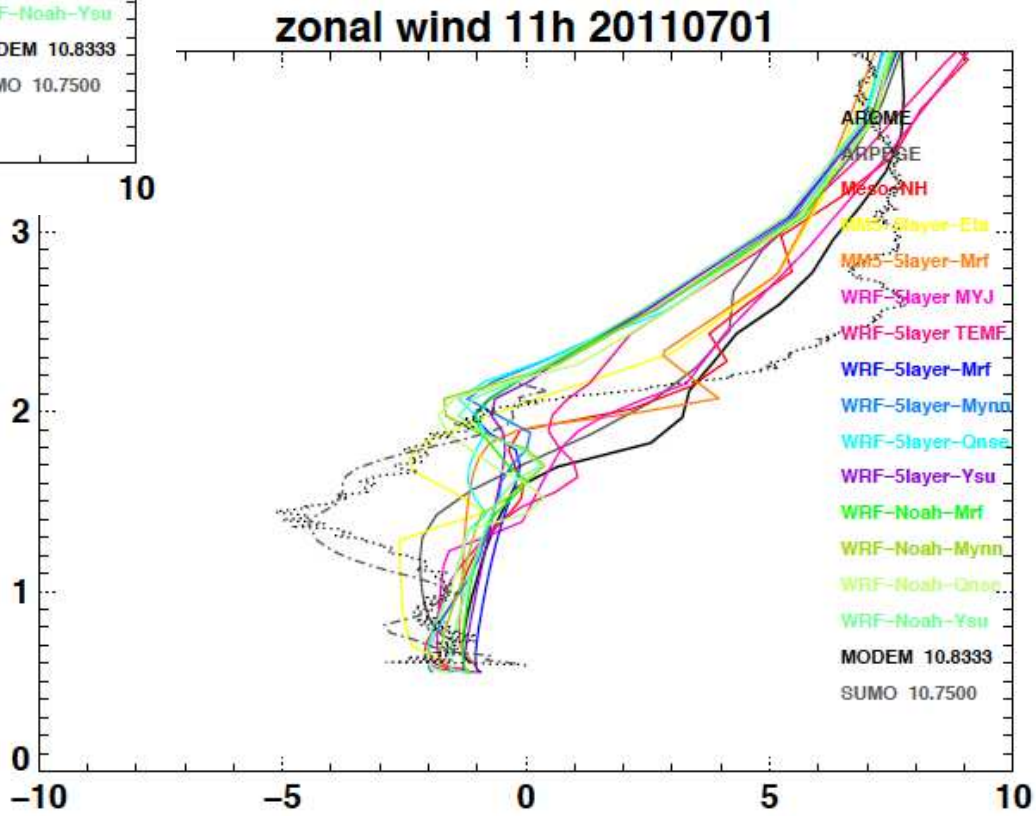
5
10
15
AROME
ARPEGE
Meso-NH
MM5-5layer-Eta
MM5-5layer-Mrf
WRF-5layer MYJ
WRF-5layer TEMF
WRF-5layer-Mrf
WRF-5layer-Mynn
WRF-5layer-Onse
WRF-5layer-Ysu
WRF-Noah-Mrf
WRF-Noah-Mynn
WRF-Noah-Onse
WRF-Noah-Ysu
GRAW 20.0167
VAISALA 19.9333
SUMO 20.0500



U is well mixed in the models but not in the observations.

Difference of wind direction at site 2 (VAISALA) and site 1 (MODEM).



Conclusions

- Despite all the models have the same initial and boundary conditions large differences have been found between them: 4 K, 30%, 5 m/s.

- These differences are found between different PBL parameterizations for the same model or same parameterizations of different model.

- MesoNH is the best model fitting the fluxes observations and MM5-MRF the worst.

- Regarding the afternoon transition, the models without Noah-LSM reproduce better the observations.

Future work

- To analyse the sources of the difference encountered: SWin, SH, LE, …

- To study why LS schemes don’t produce better results.