

Observed and modeled spatial variability on 25 June and 1 July

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Beniamino Gioli, Pierre Durand

Objectives :

- Explore the submesoscale horizontal variability
- Detect differences between models
- Compare model fields with aircraft observations
- Evaluate whether late afternoon brings more challenge

Tools :

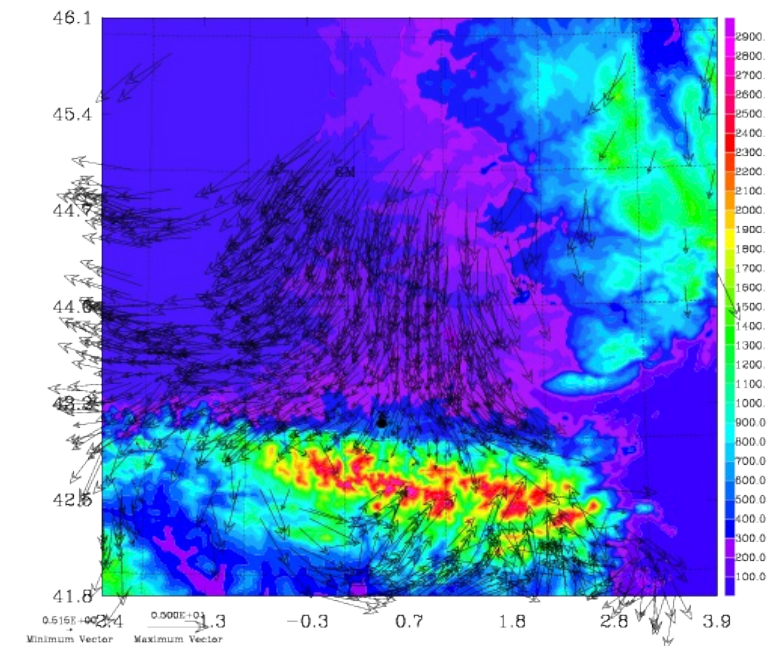
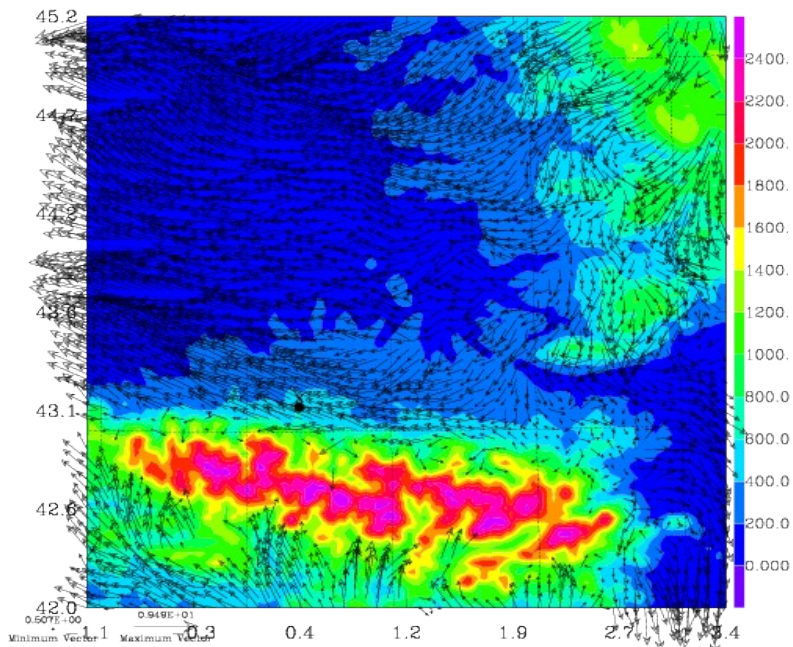
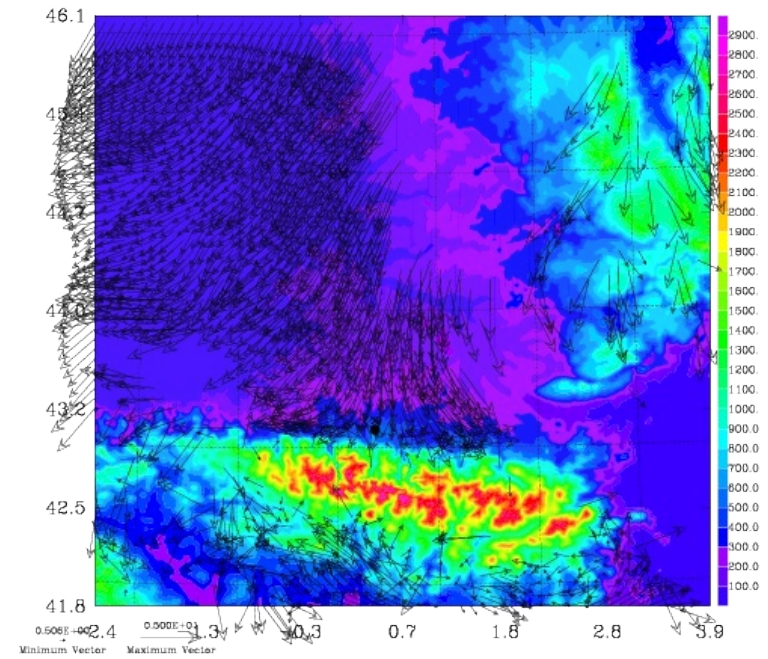
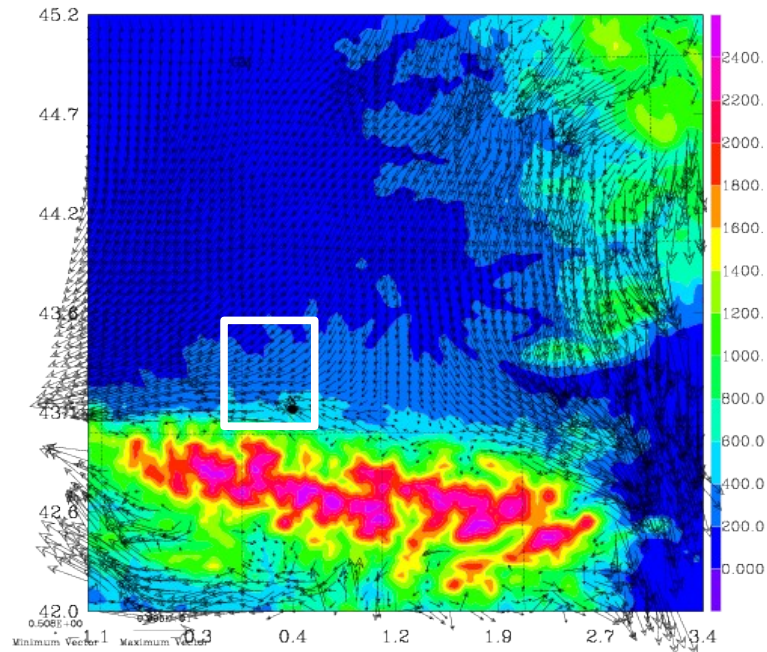
4 mesoscale models : Meso-NH, AROME, ARPEGE, WRF

Aircraft observation over a 50 km x 50 km area

Synoptic features

25 June

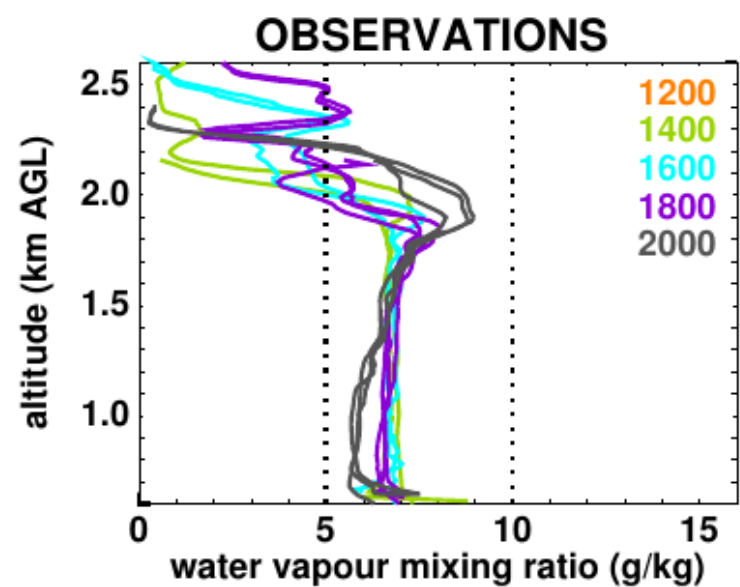
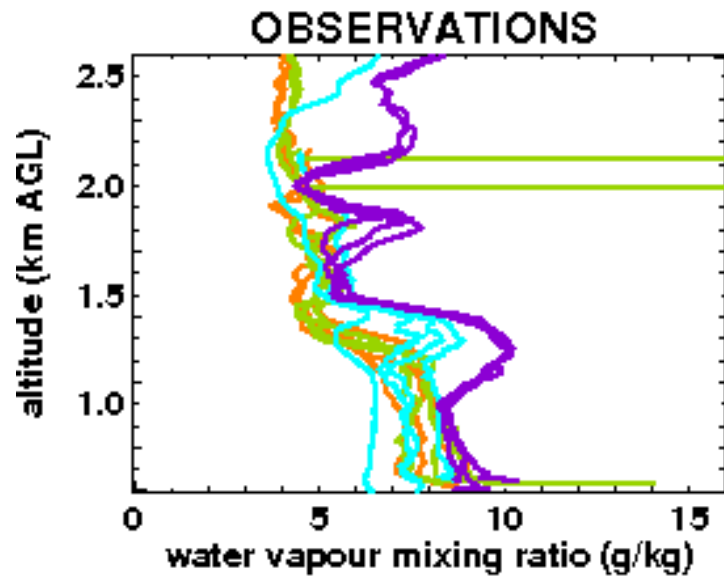
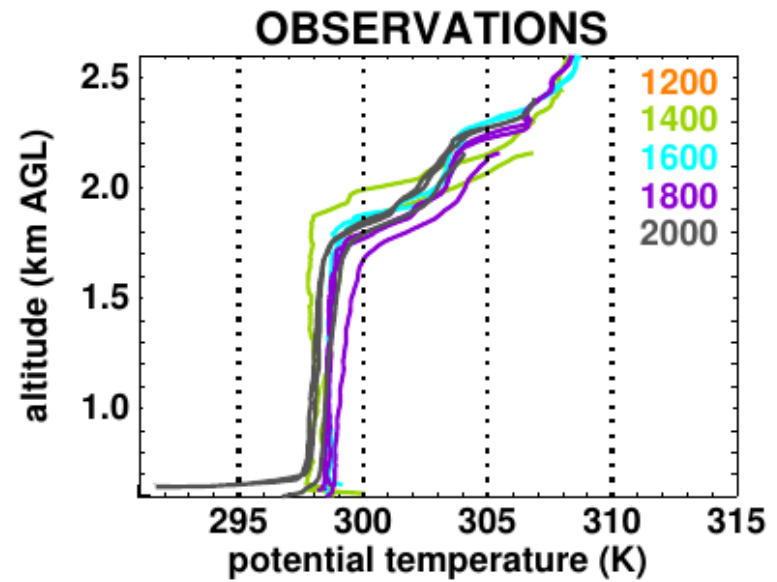
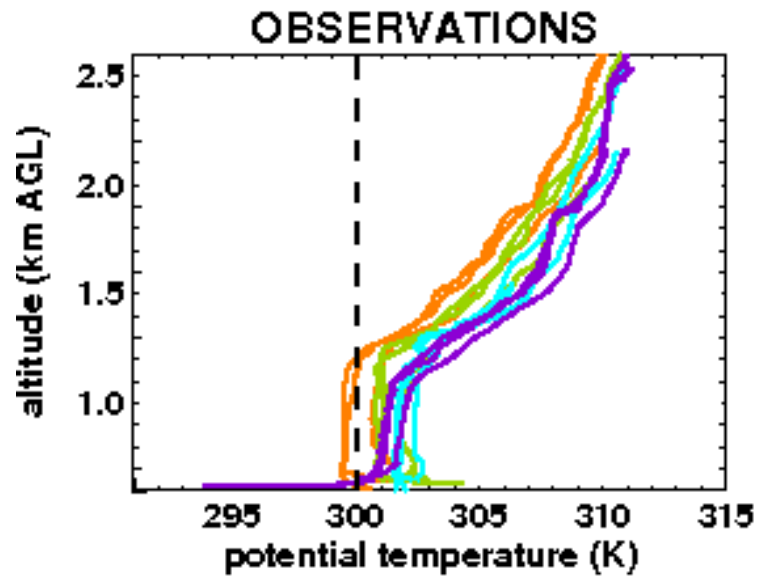
1 July



Vertical profiles

25 June

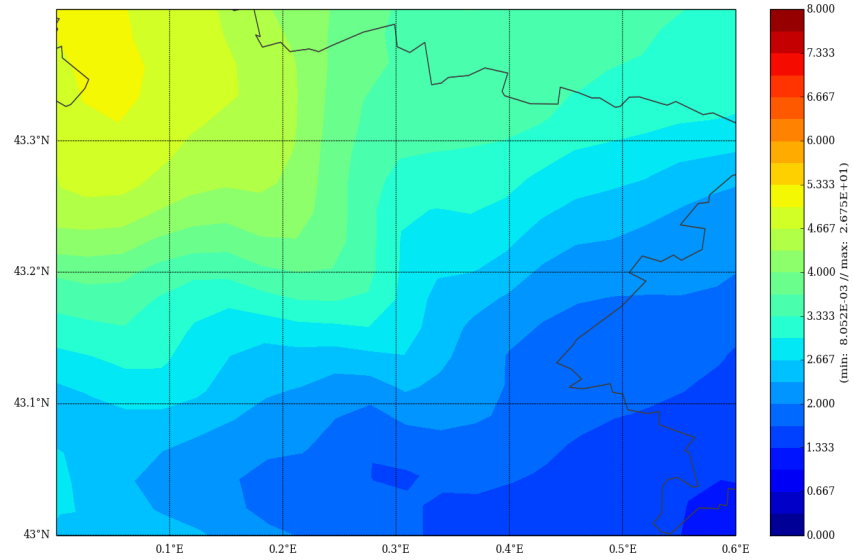
1 July



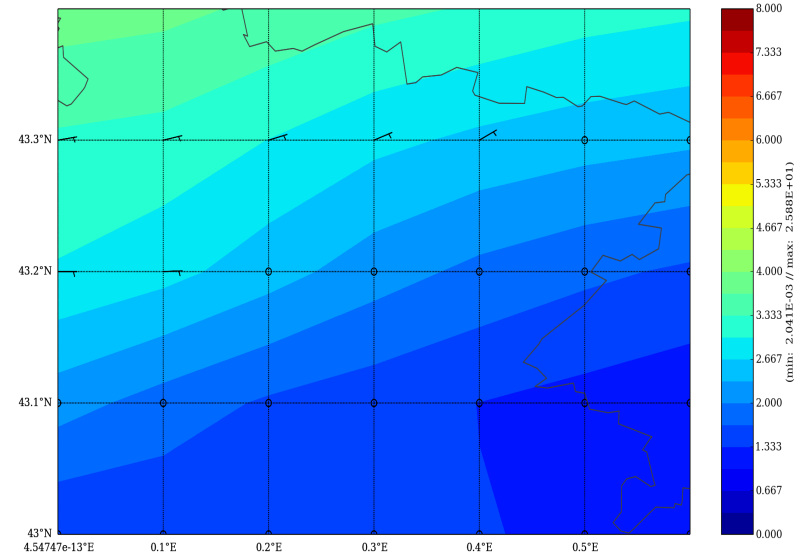
Reproduction of synoptic features

Wind speed, 1000m agl, 25 June 0600 UTC

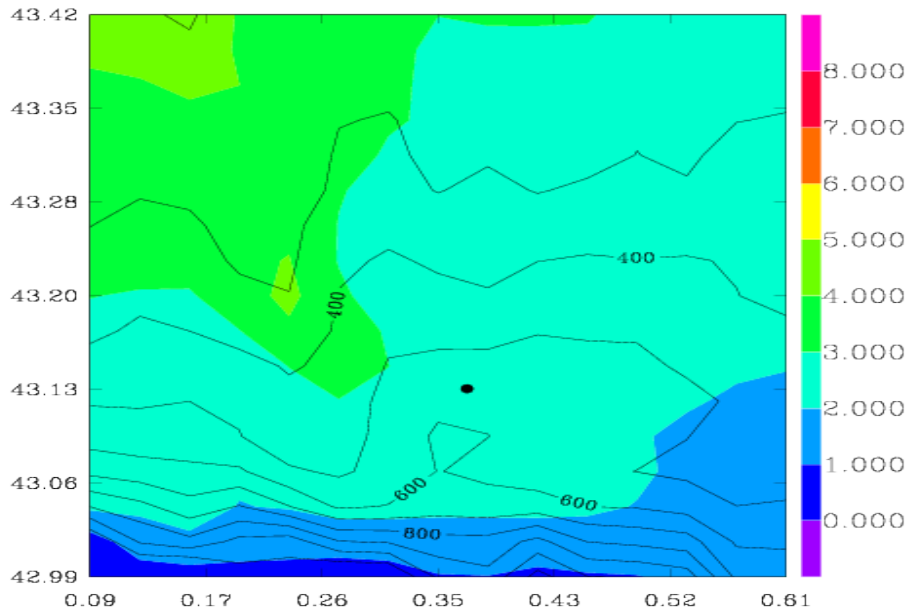
AROME (2.5 km reso)



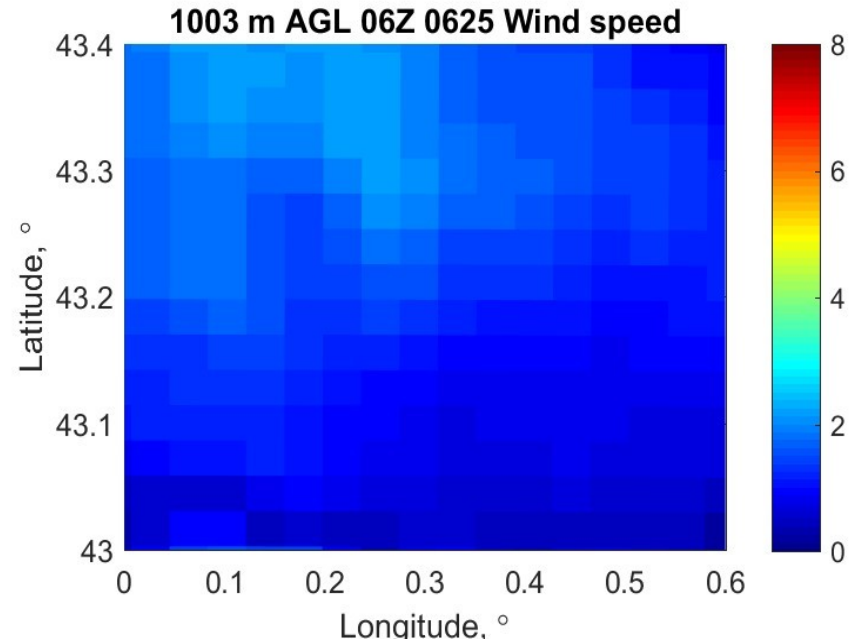
ARPEGE (10 km reso)



MNH (2 km reso)



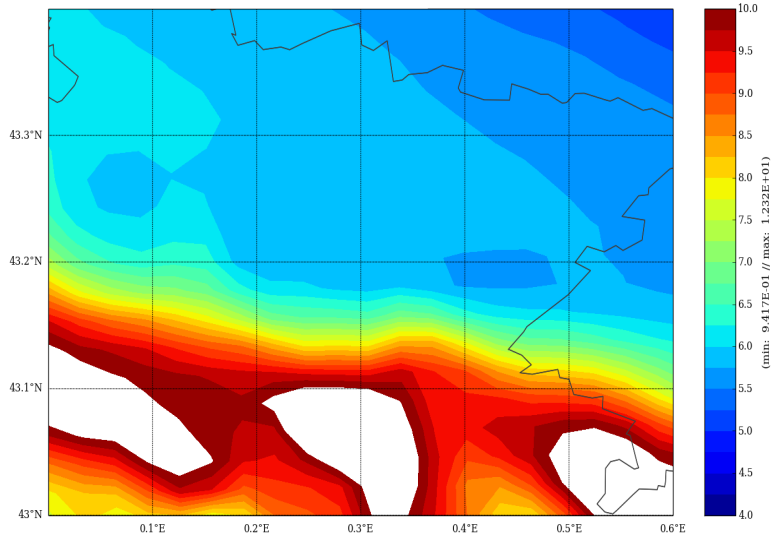
WRF (2 km reso)



Reproduction of synoptic features

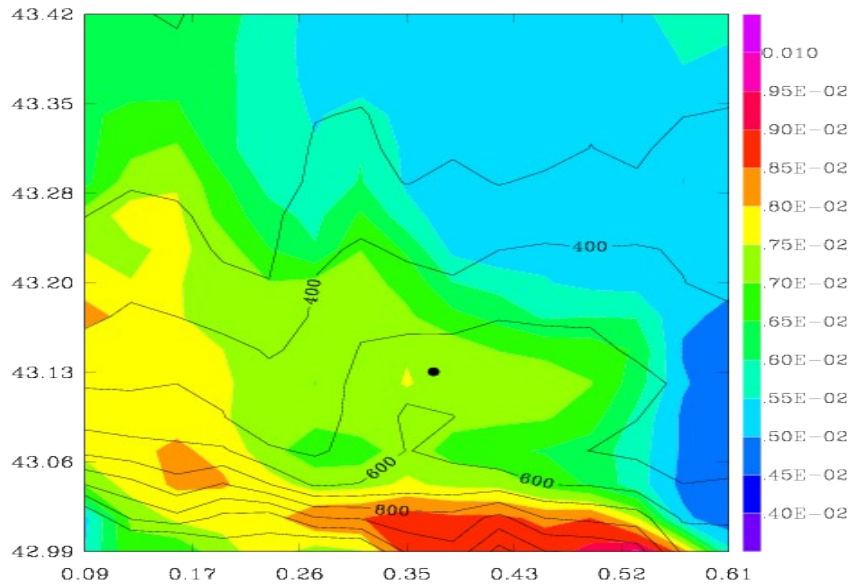
Humidity, 1000m agl, 25 June 2200 UTC

AROME

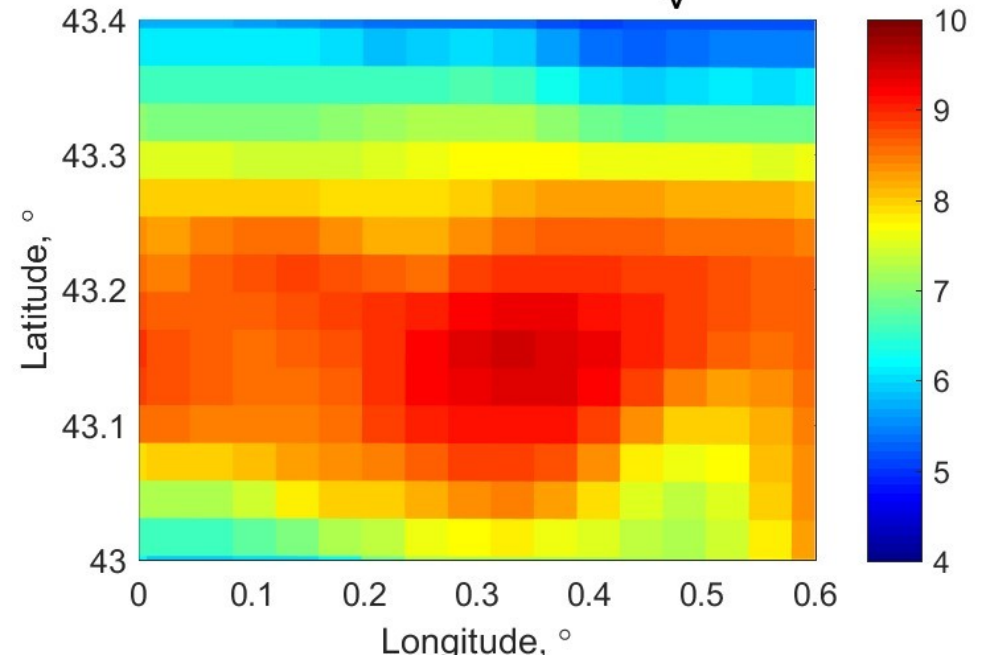


Advection of humidity in the night
Found in all models
With time delays between them

MNH

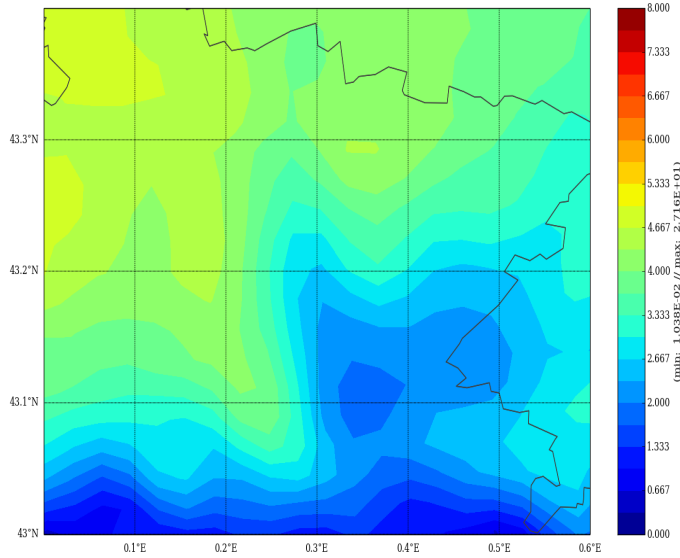


1003 m AGL 22Z 0625 q_v

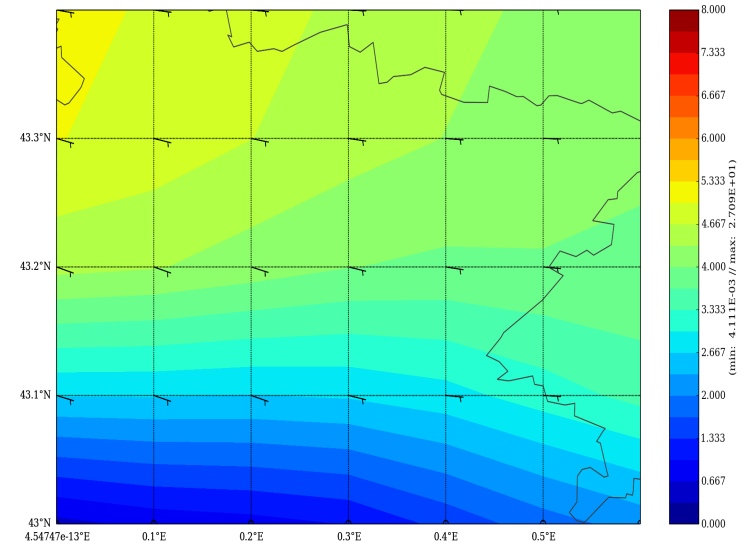


Wind speed variability 1000m agl, 25 June, 1500 UTC

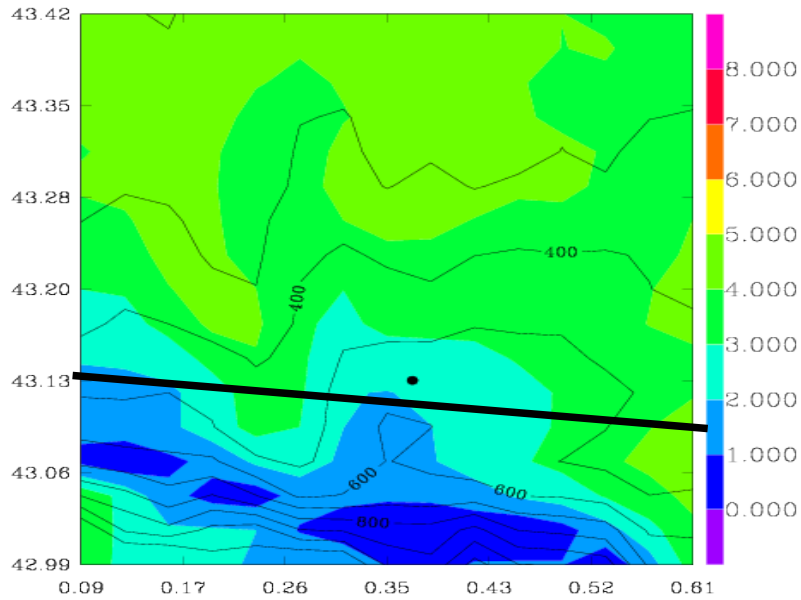
AROME



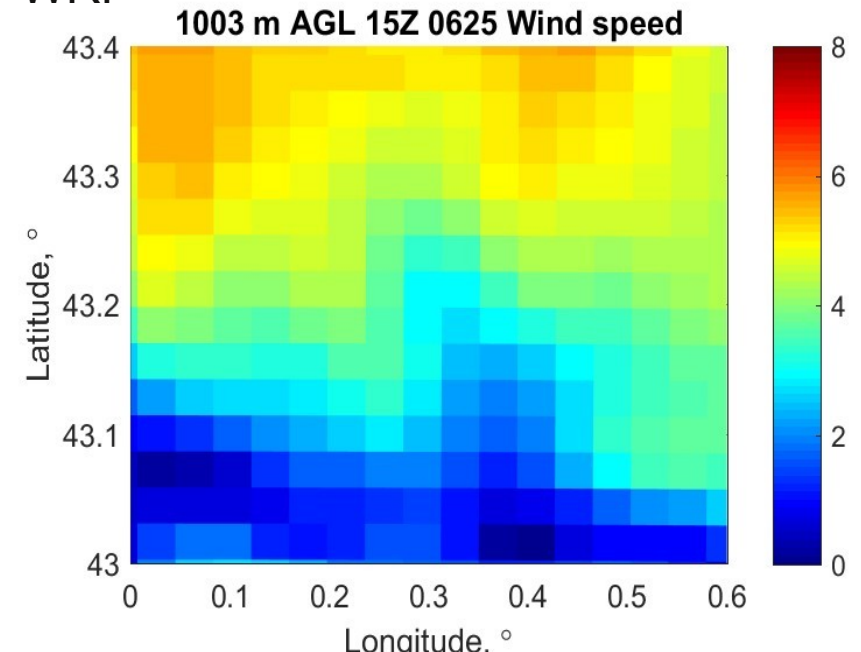
ARPEGE



MNH



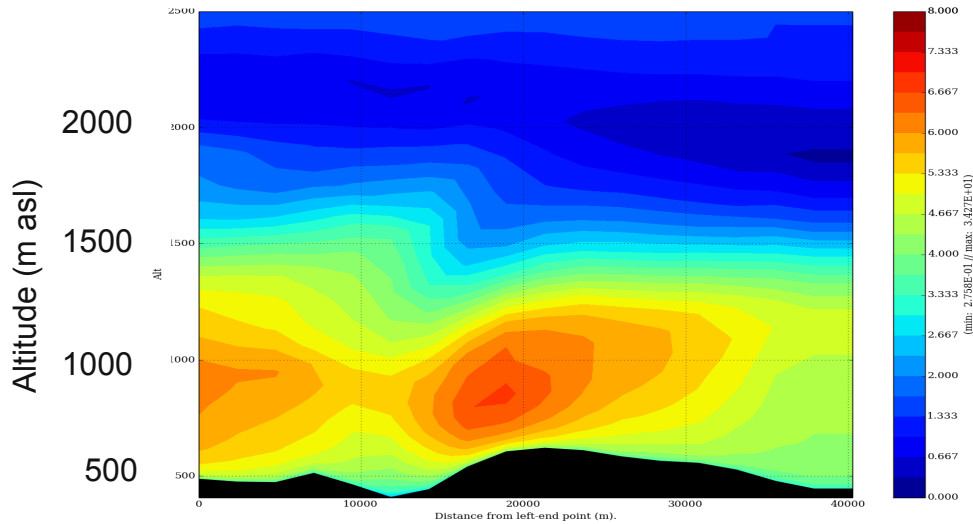
WRF



Wind speed variability

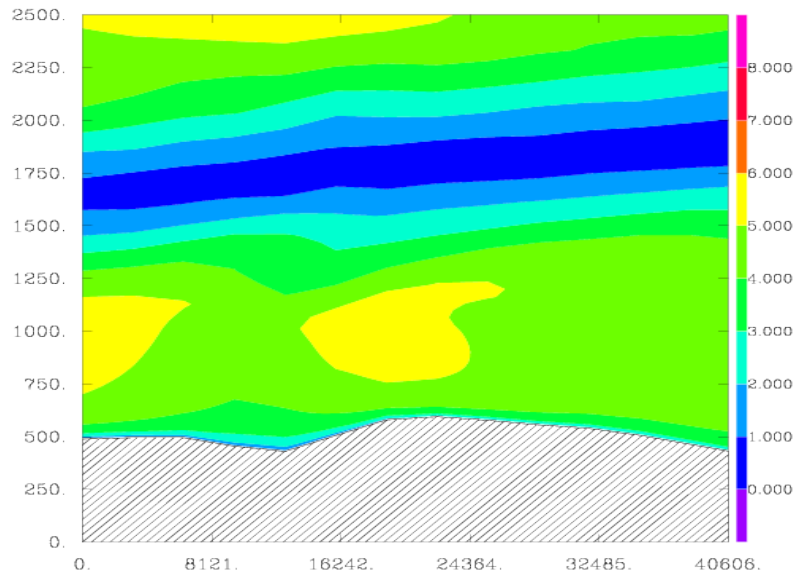
EW cross section, 25 June 2011, 1500 UTC

AROME



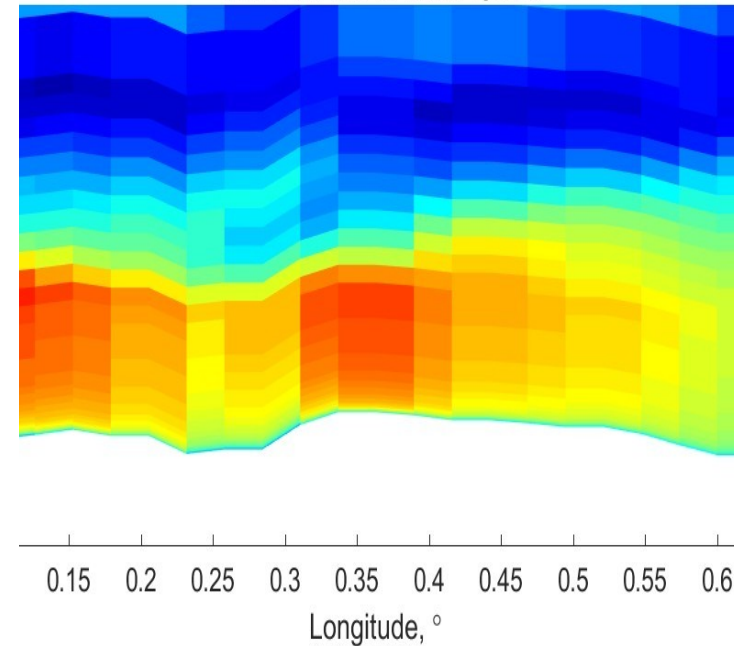
A maximum over the Lannemezan Plateau
Found in all models
Meso-NH little weaker

MNH



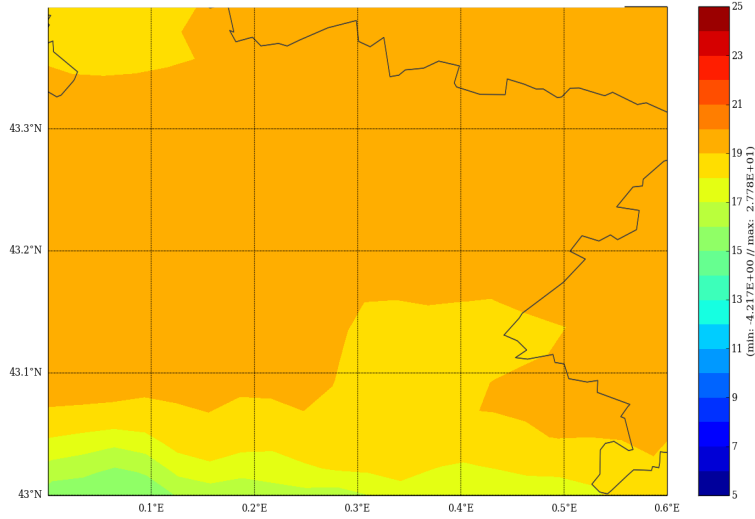
WRF

Line 3 15Z 0625 Wind speed

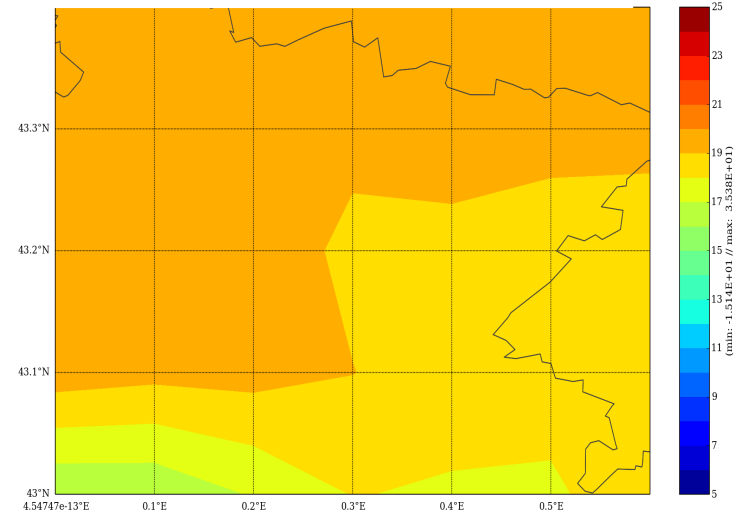


Temperature variability 1000m agl, 25 June 1500 UTC

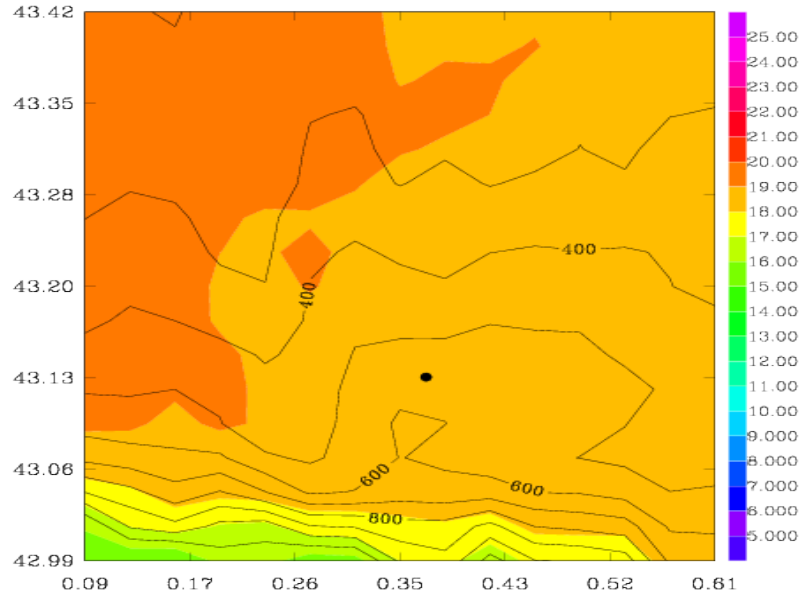
AROME



ARPEGE



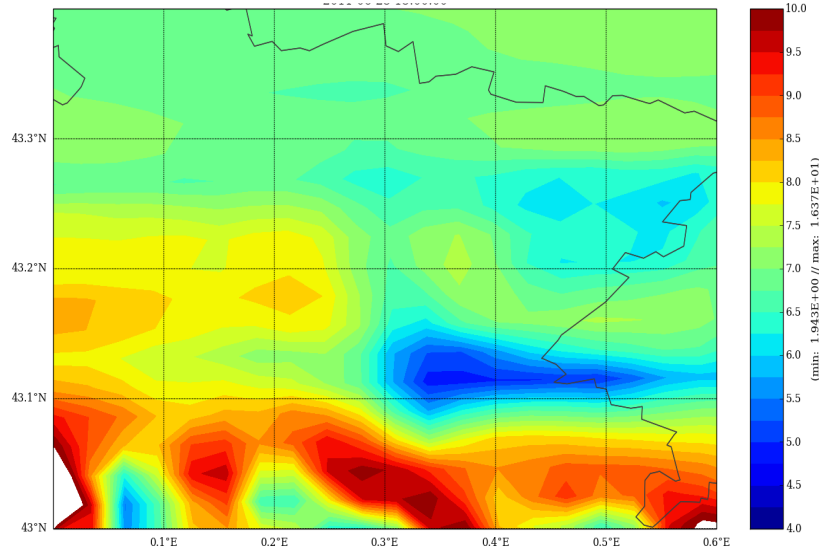
MNH



No marked variability of temperature

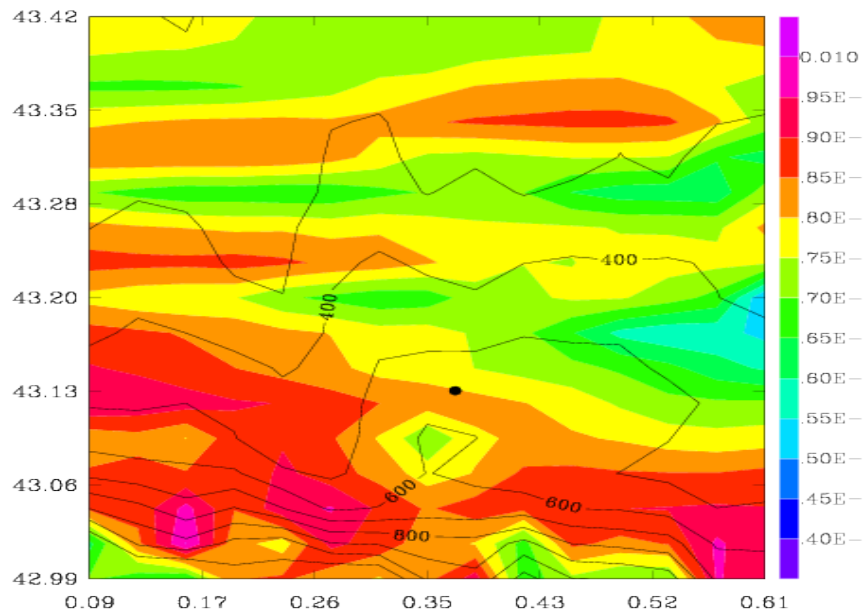
Humidity variability 500 m agl, 25 June, 1500 UTC

AROME

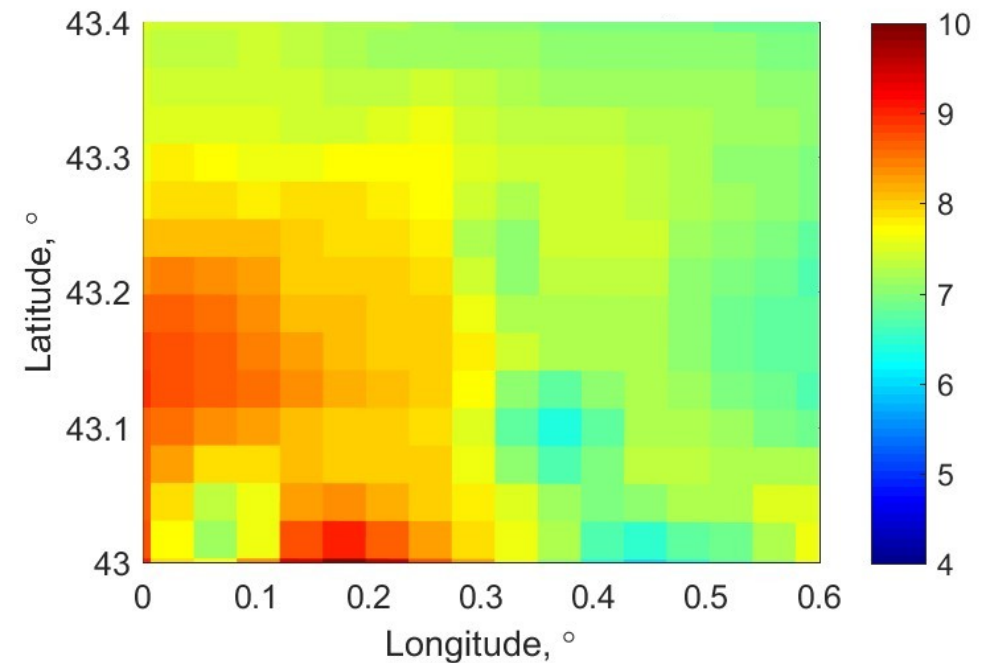


Heterogeneous and complex moisture field

MNH



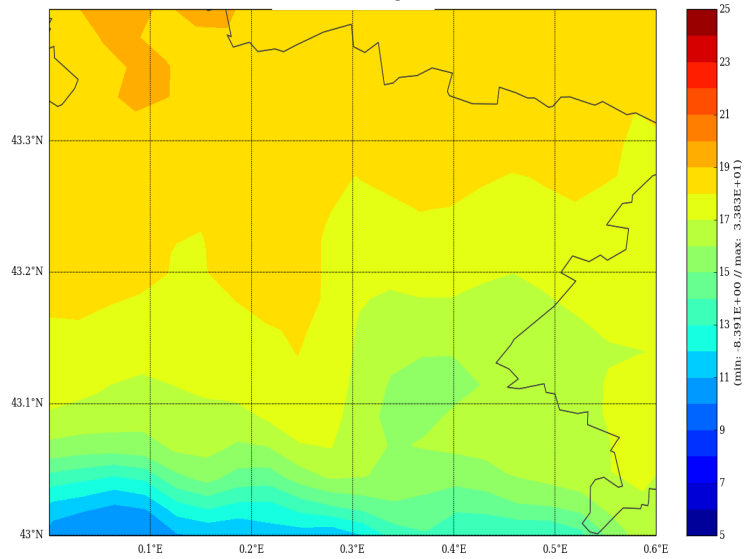
WRF



Comparison 25 June / 1 July

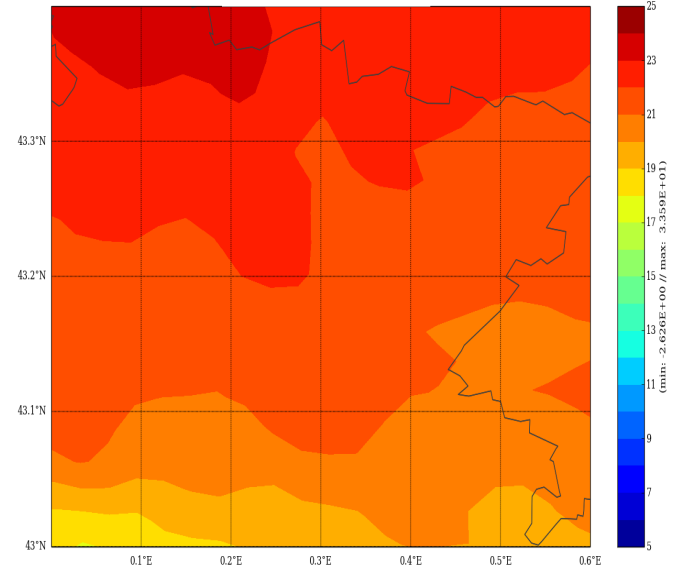
Temperature, 500 m agl, 1700 UTC

1 July

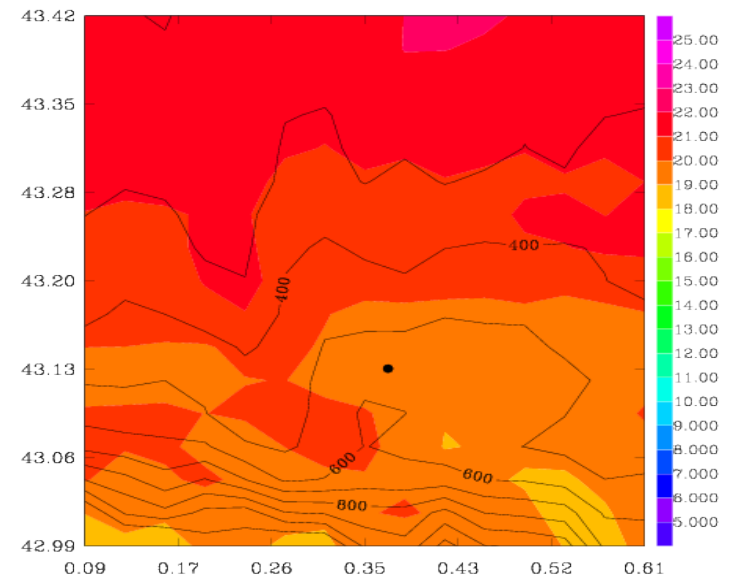
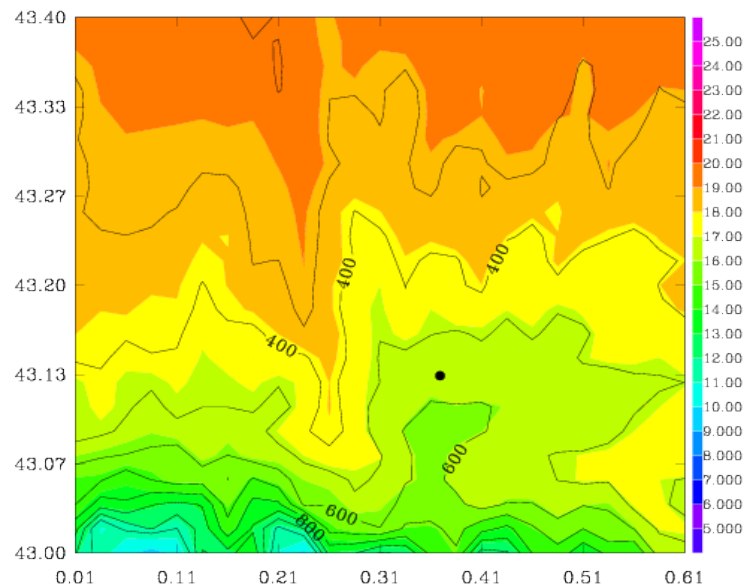


AROME

25 June



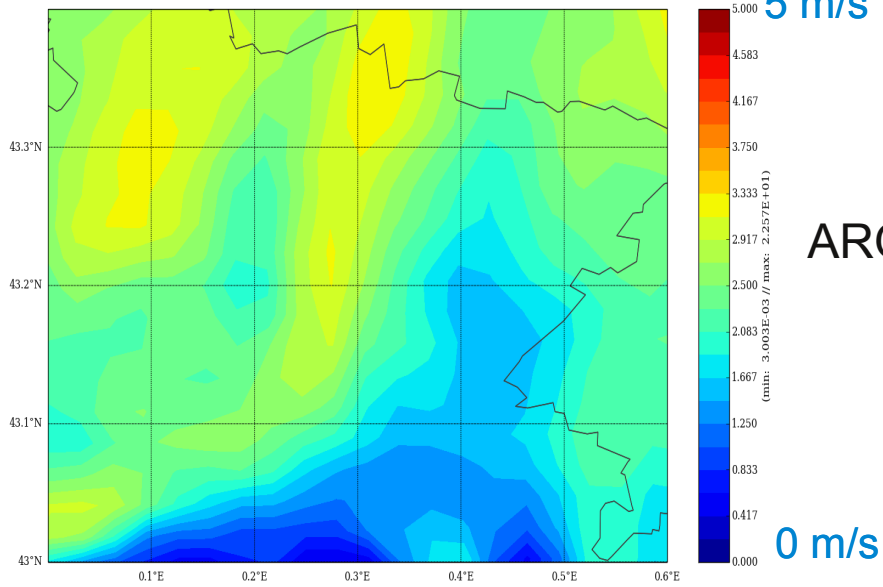
MNH



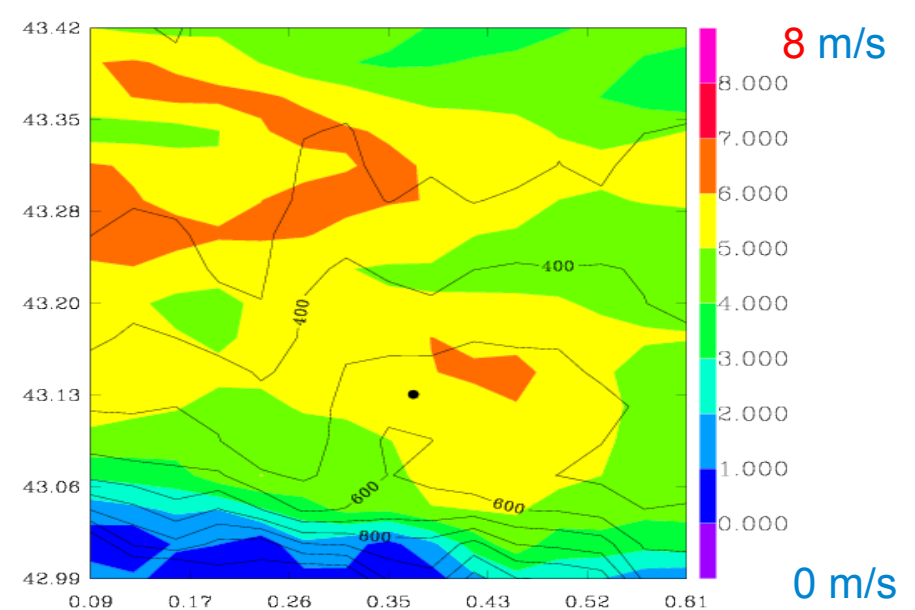
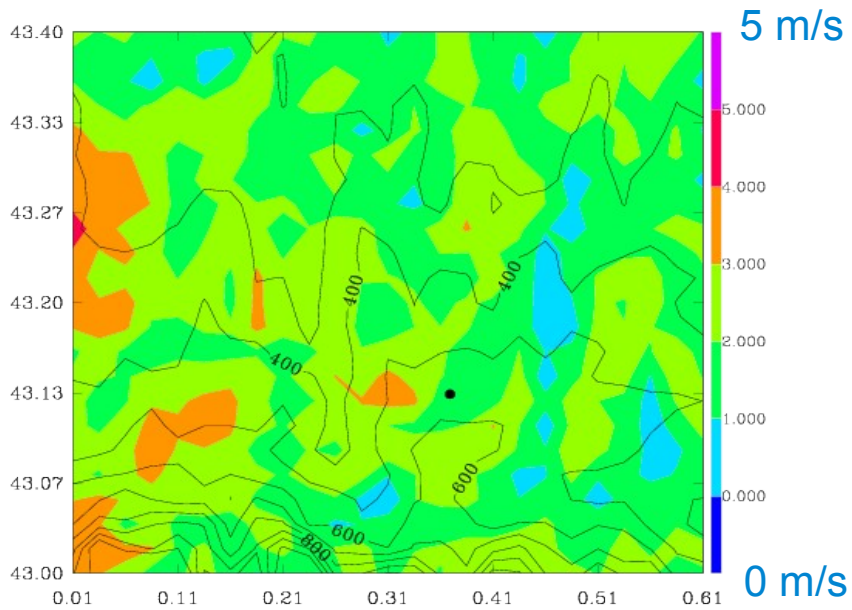
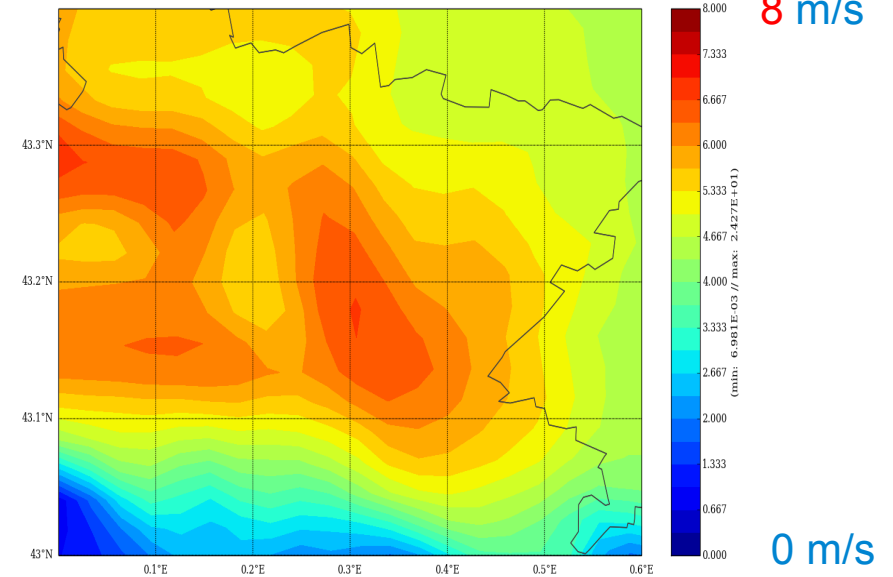
Temperature exclusively forced by terrain on 1 July

Wind speed, 500 m agl, 1700 UTC

1 July



25 June

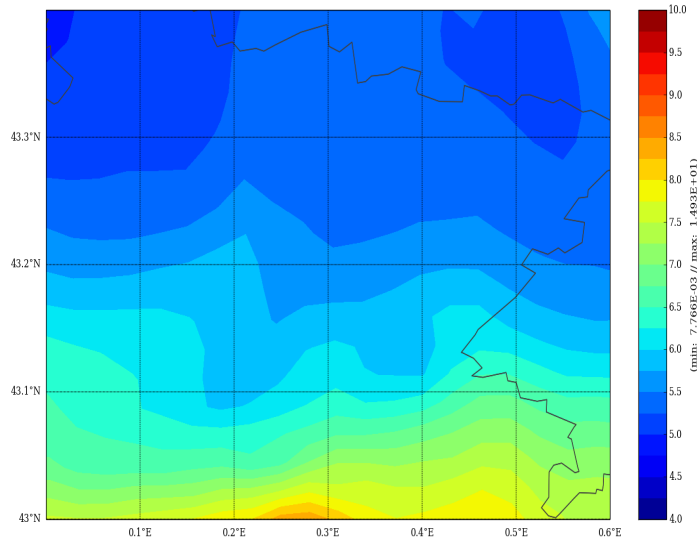


Smaller winds
steady along the afternoon

Stronger winds, more variability

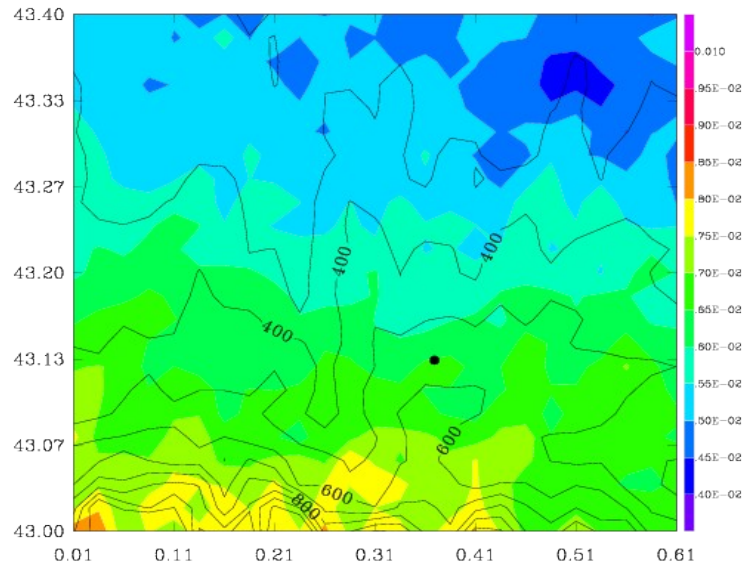
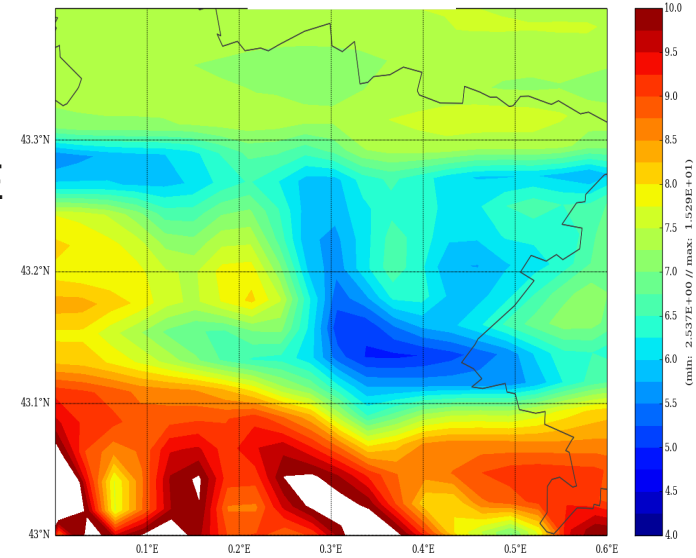
Water vapour mixing ratio, 500 m agl, 1700 UTC

1 July

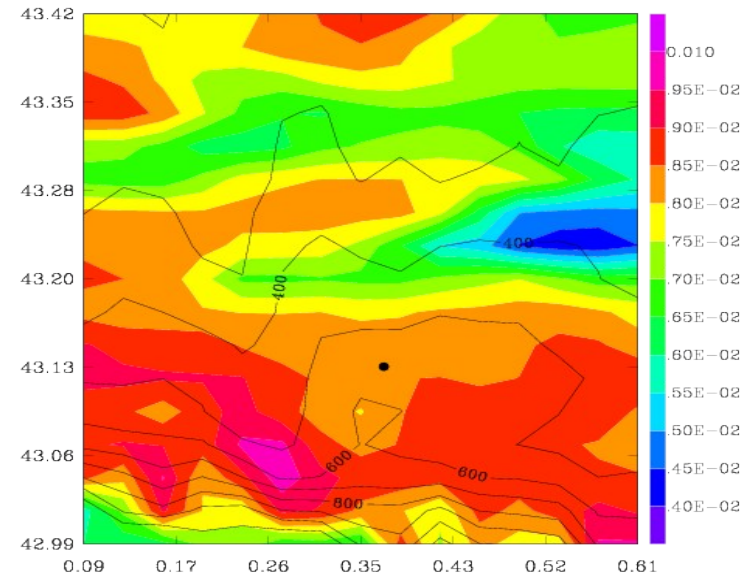


25 June

AROME



MNH

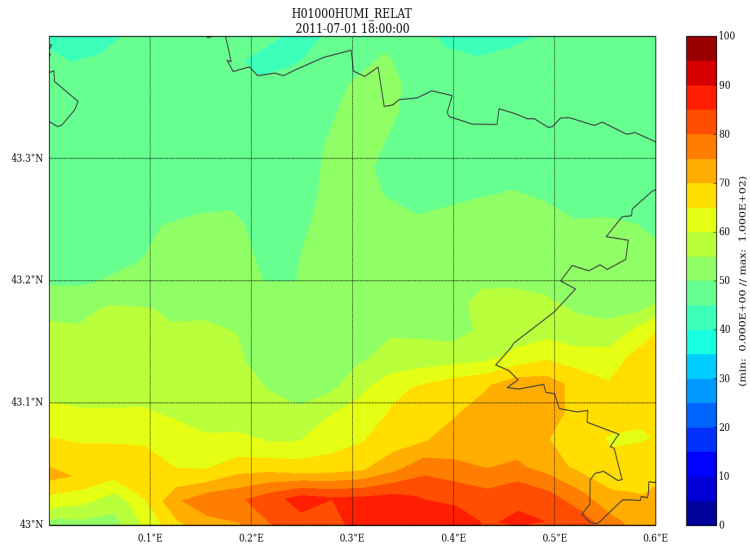


Clear NS gradient, no EW gradient

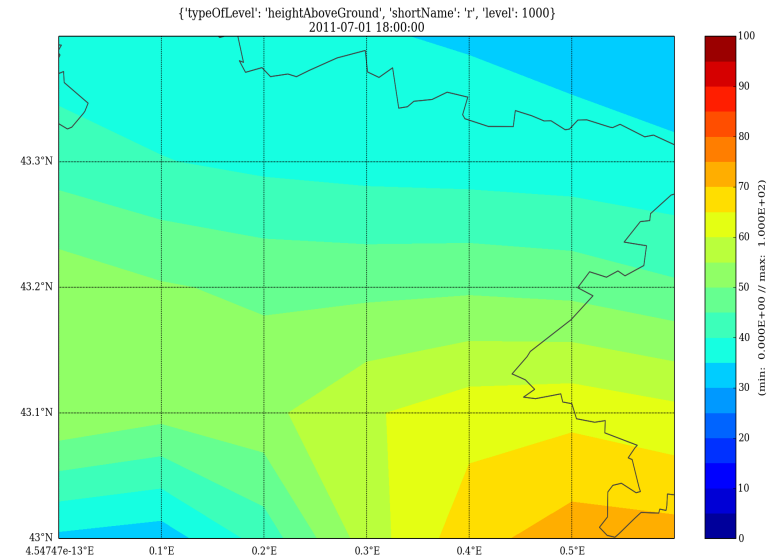
Heterogeneous field of moisture

Water vapour mixing ratio 1 July, 1000 m agl, 1800 UTC

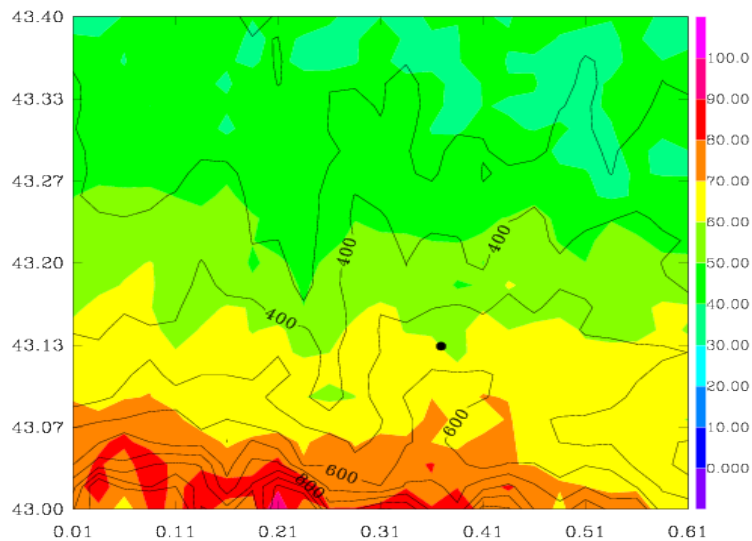
AROME



ARPEGE



MNH

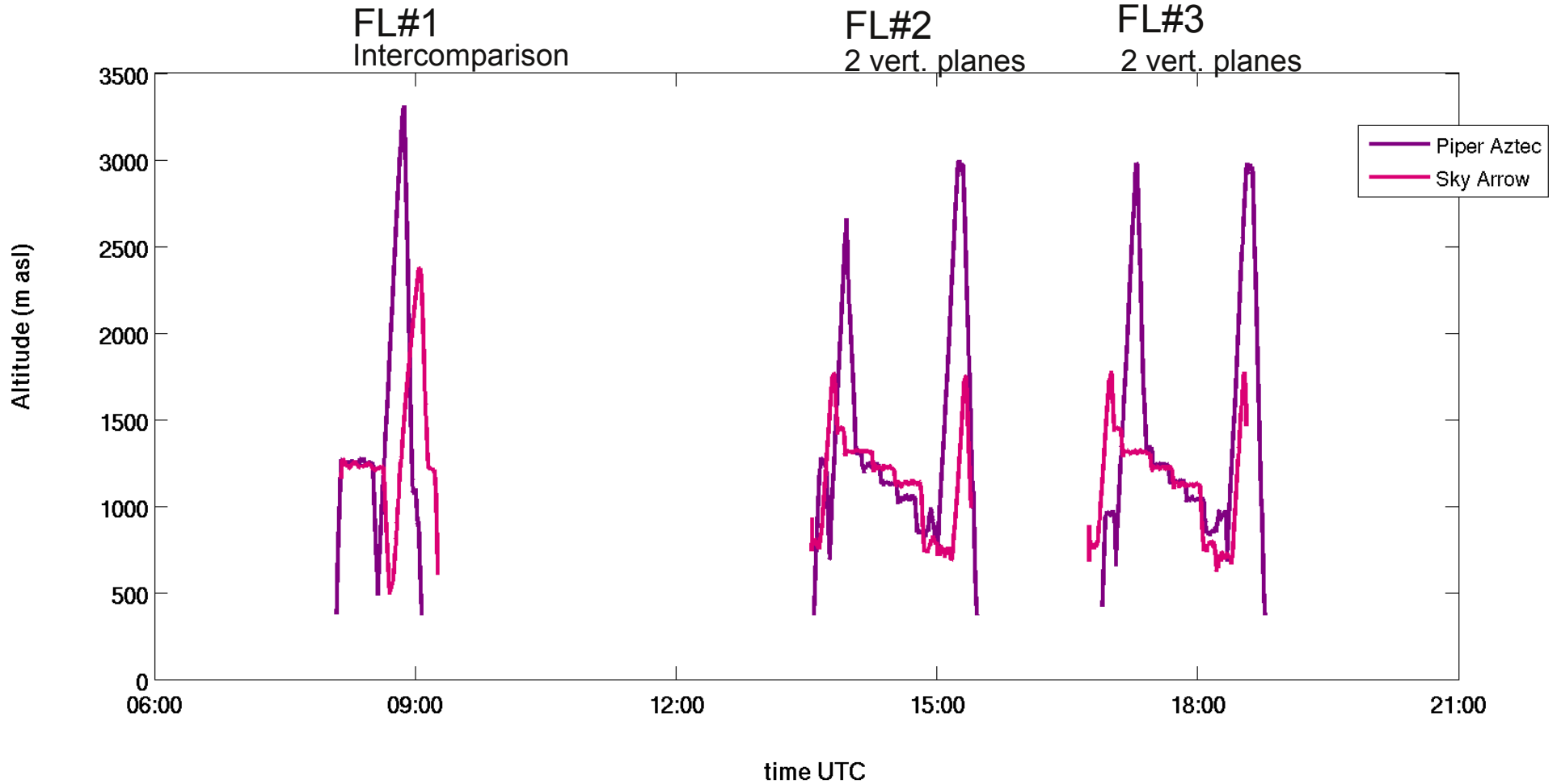


Some differences among the models
Variability/oscillation of humidity along the day in AROME and ARPEGE
→ an EW gradient of moisture in addition to the NS gradient in those two models, that is not seen in Meso-NH

25 June

Comparison obs-model

Description of the flight trajectories on 25 June

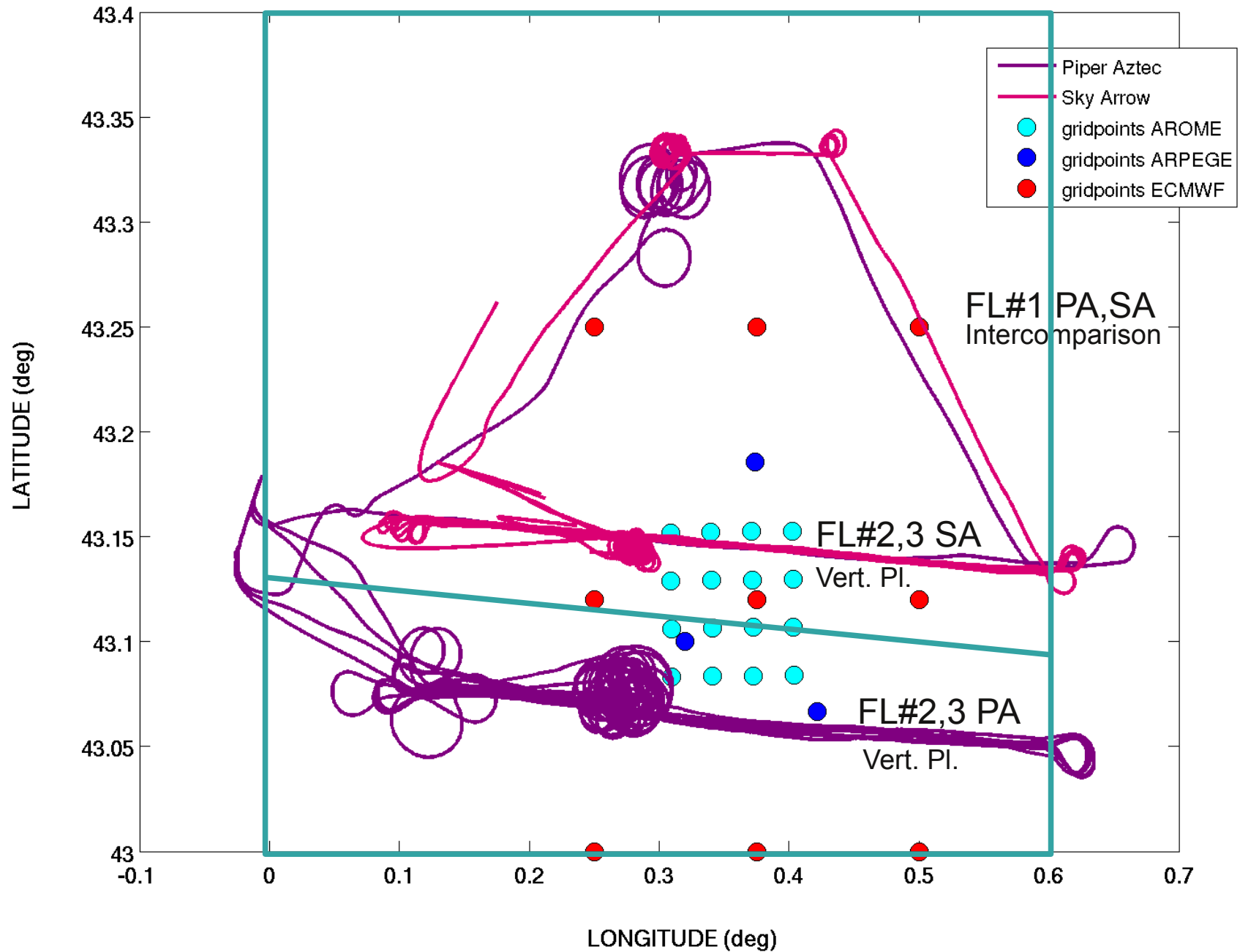


Piper Aztec
70 m/s airspeed



Sky Arrow
40 m/s airspeed

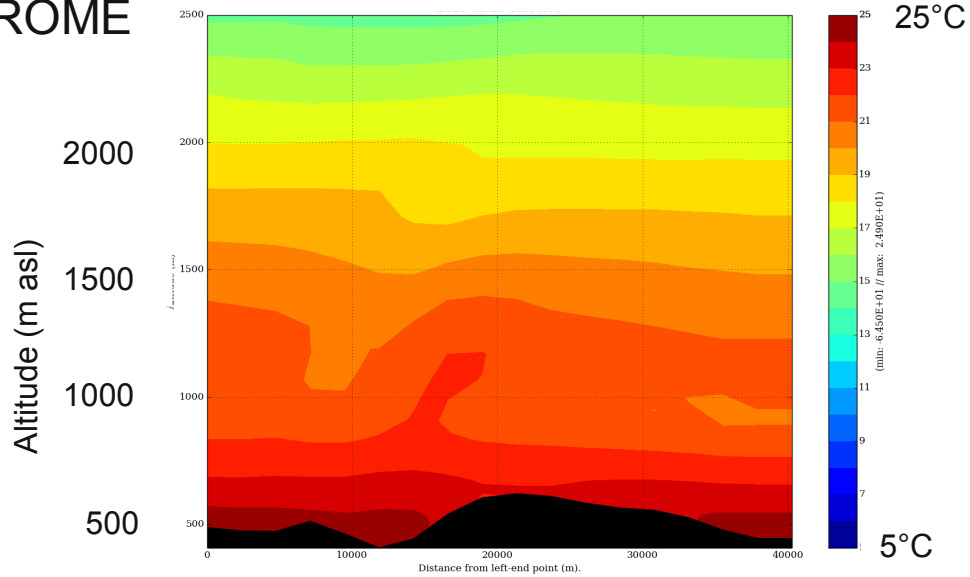
Description of the flight trajectories on 25 June



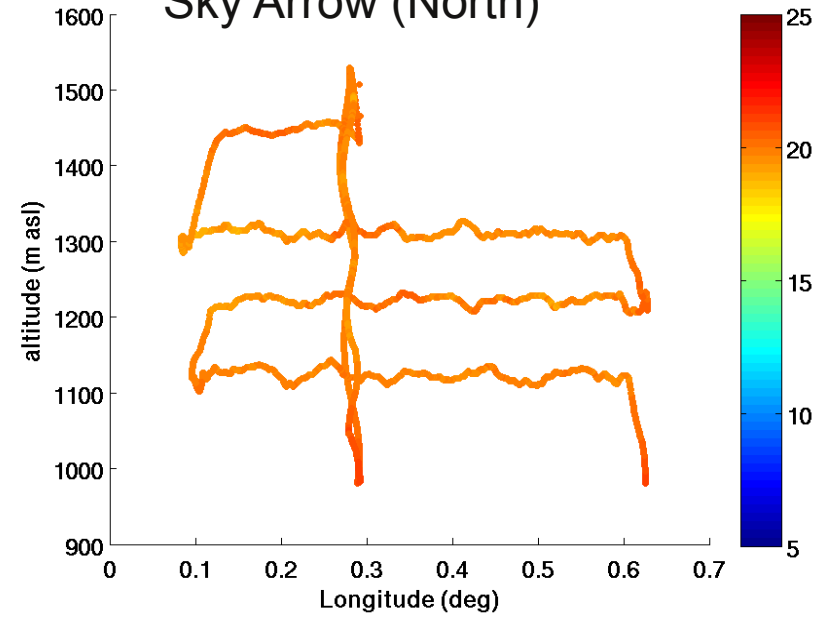
Temperature 1800 UTC

EW cross section

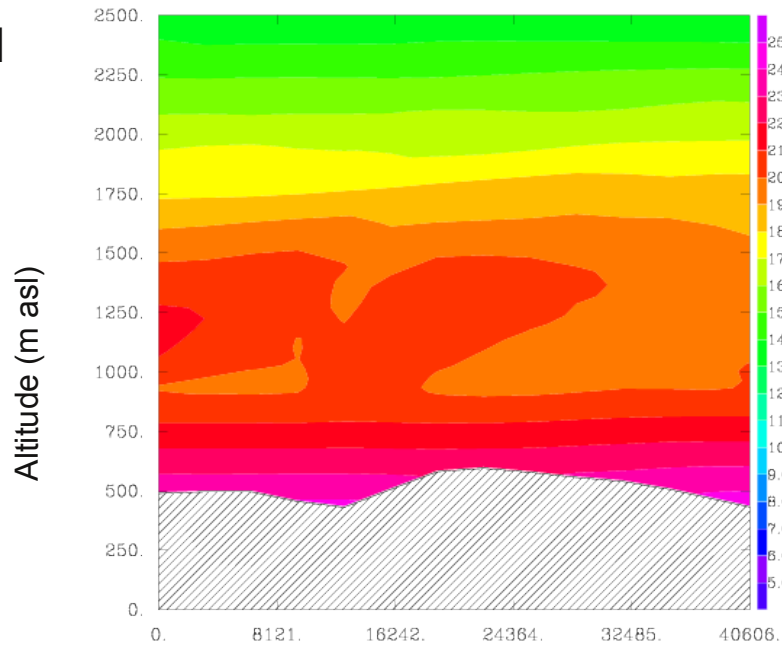
AROME



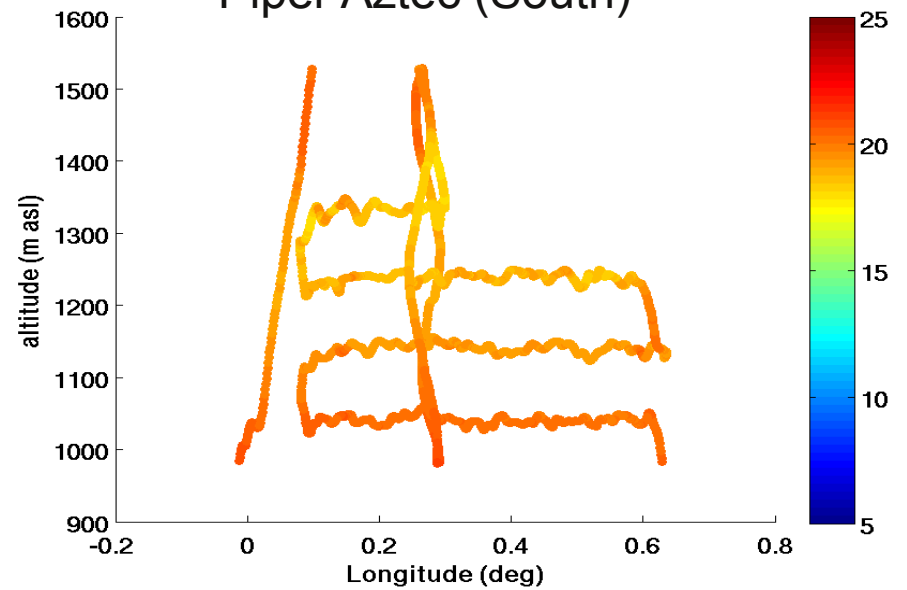
Sky Arrow (North)



MNH



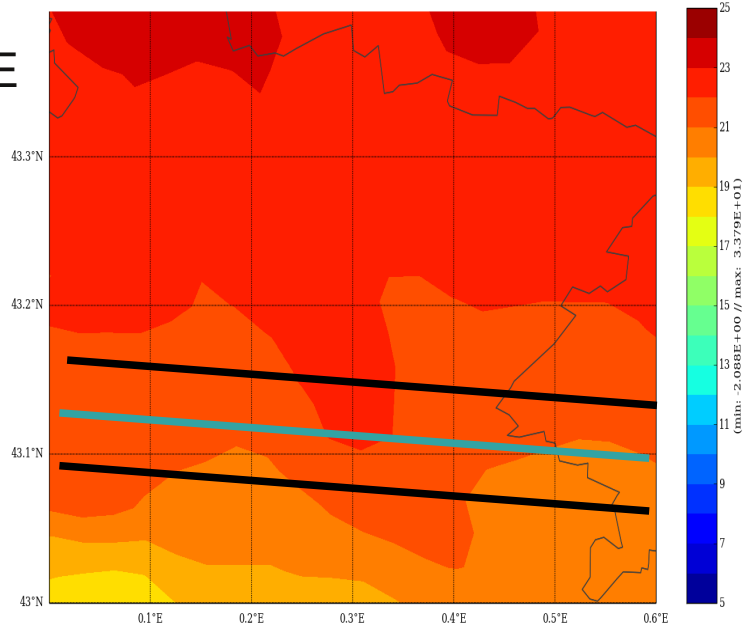
Piper Aztec (South)



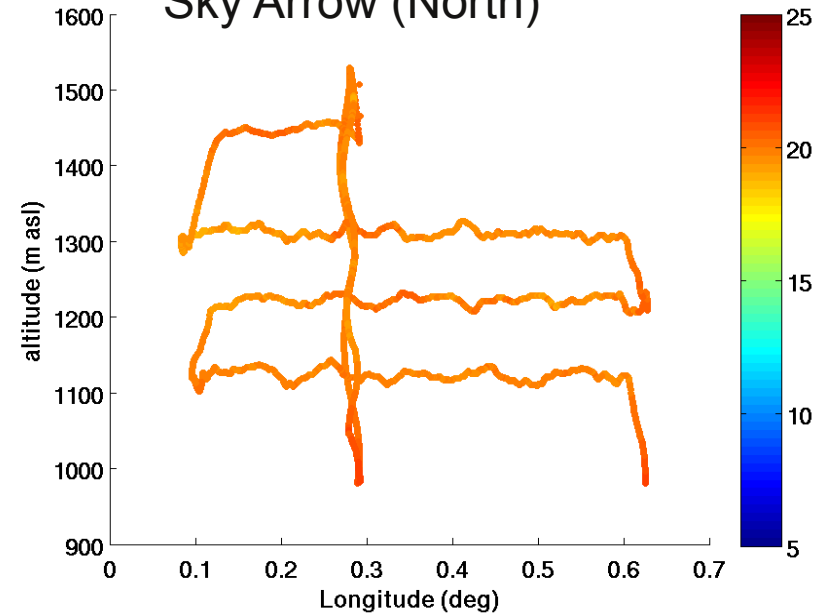
Temperature 1800 UTC

Horiz cross section 500 m

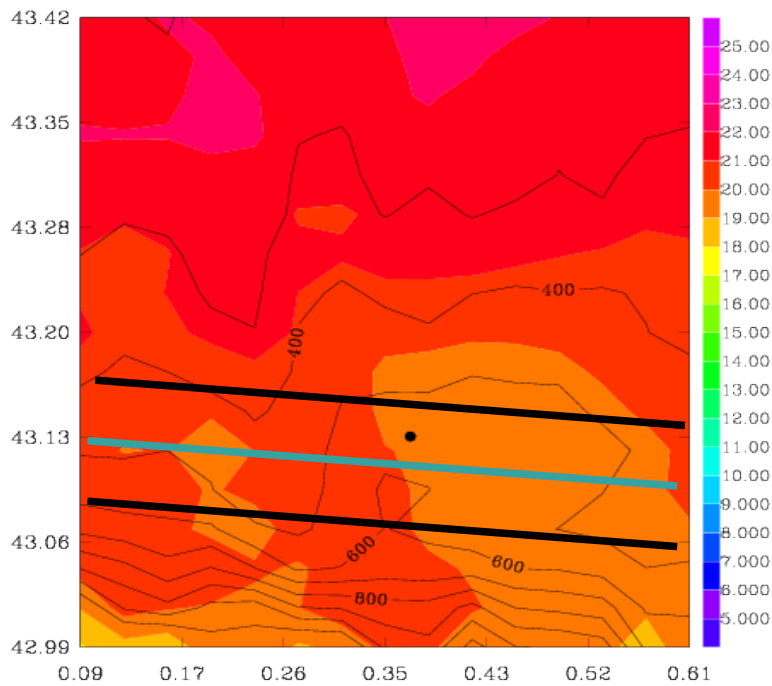
AROME



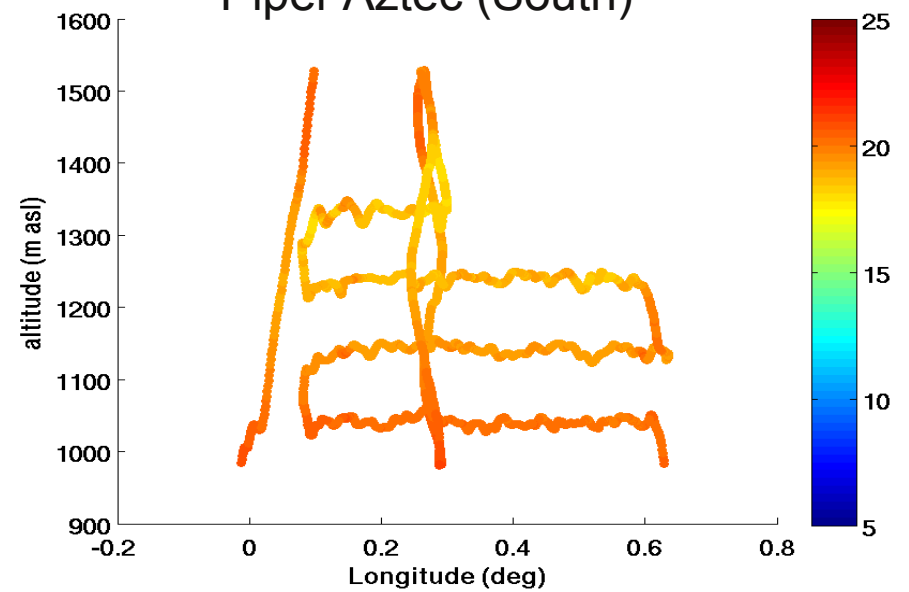
Sky Arrow (North)



MNH

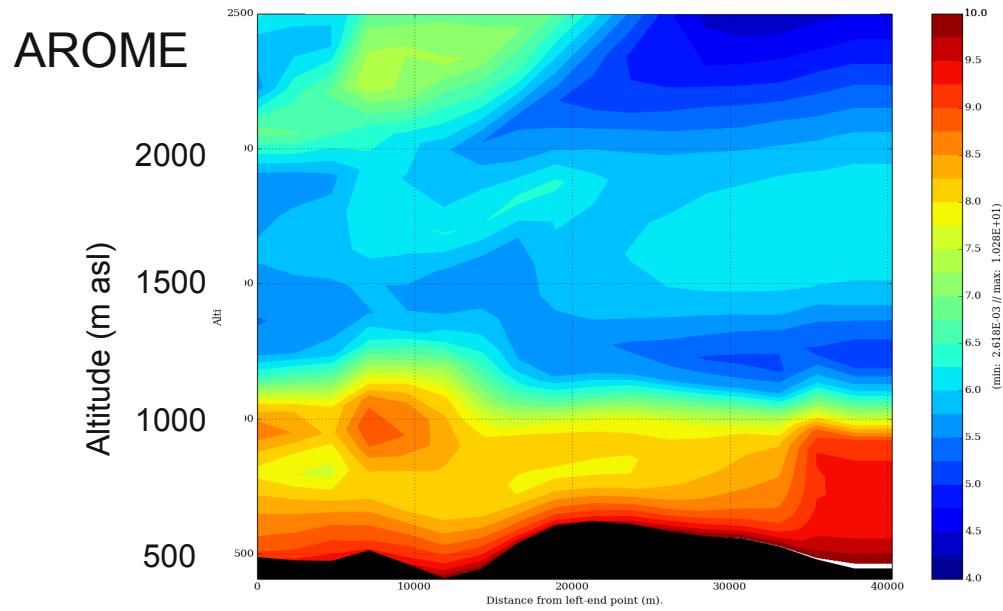


Piper Aztec (South)

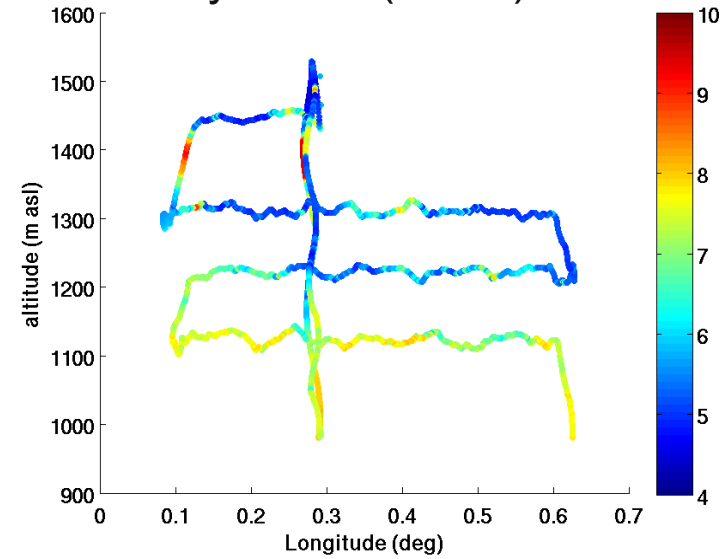


Water vapour mixing ratio 1800 UTC

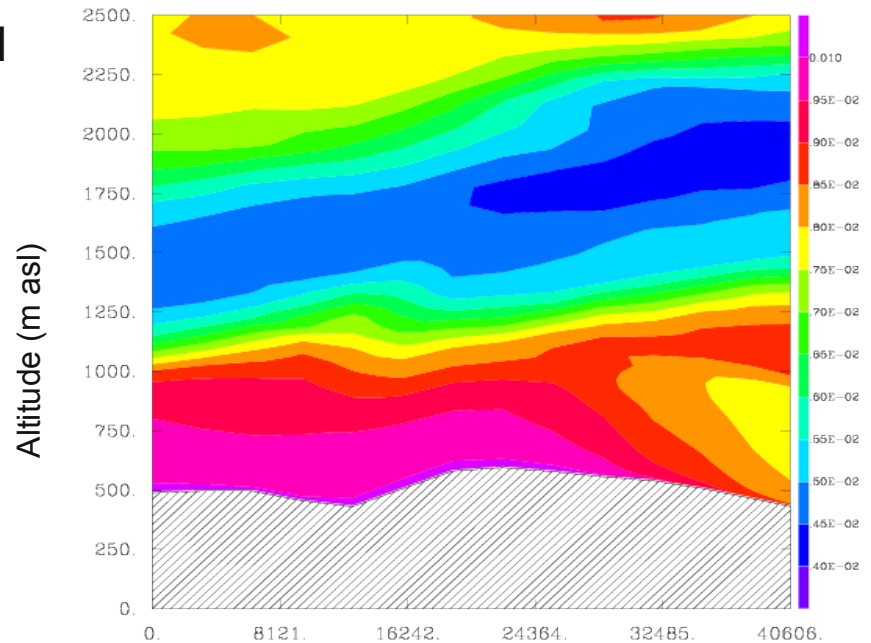
EW cross section



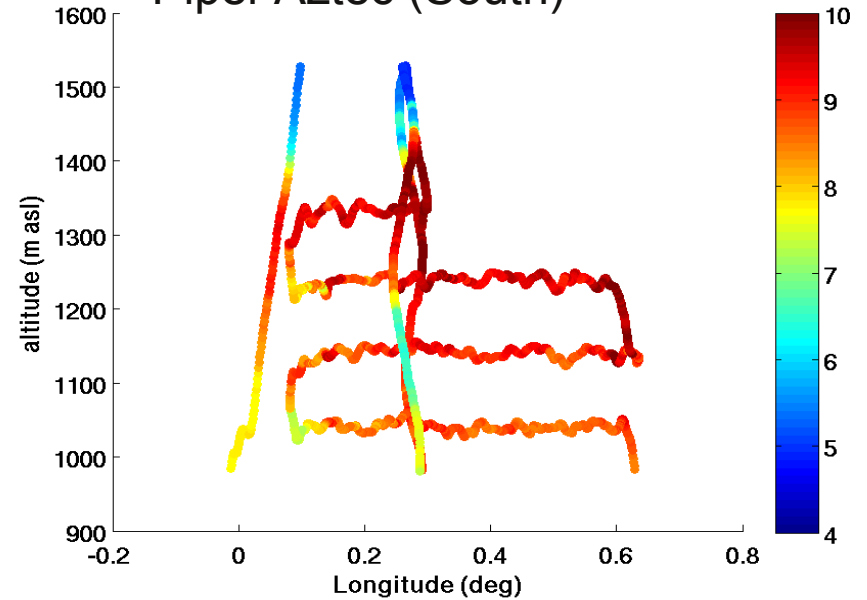
Sky Arrow (North)



MNH

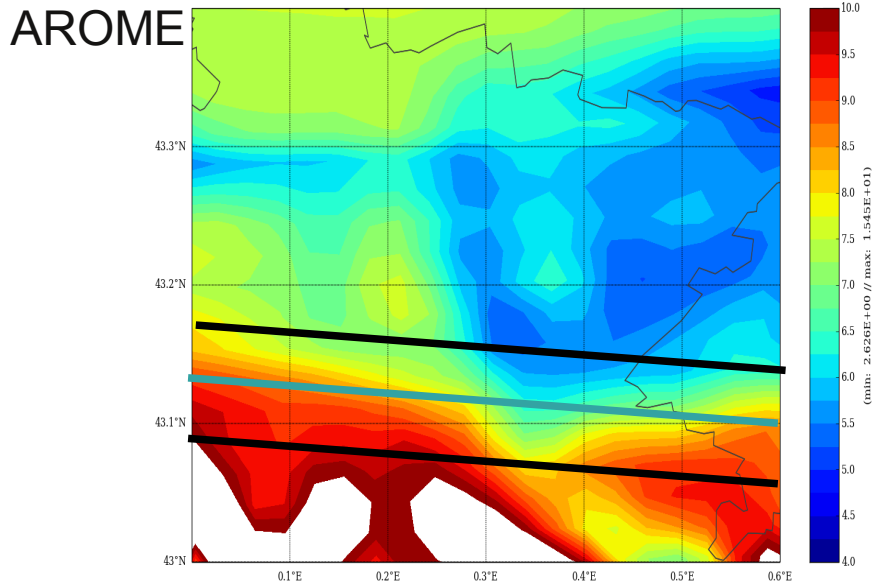


Piper Aztec (South)

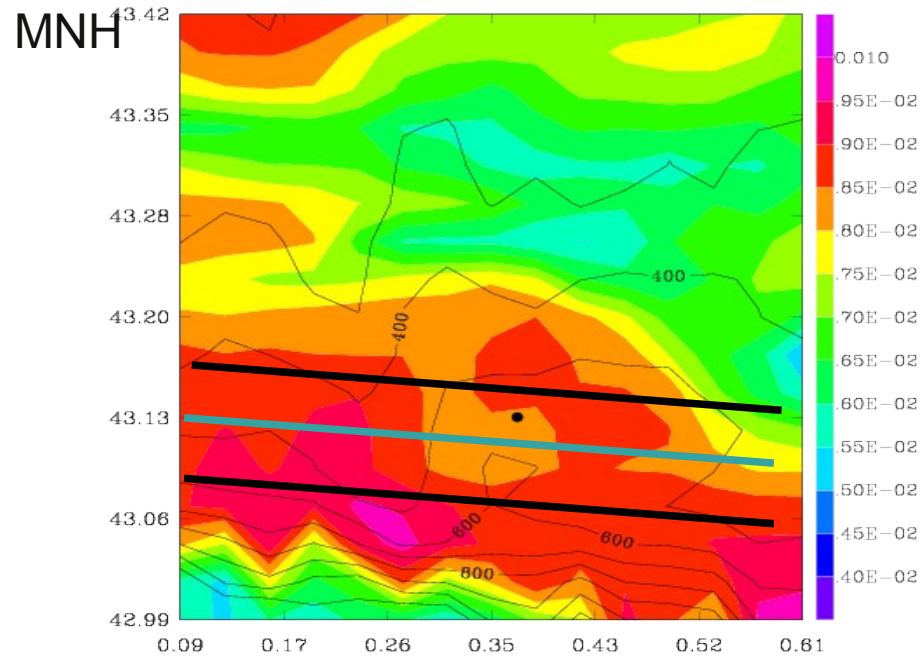
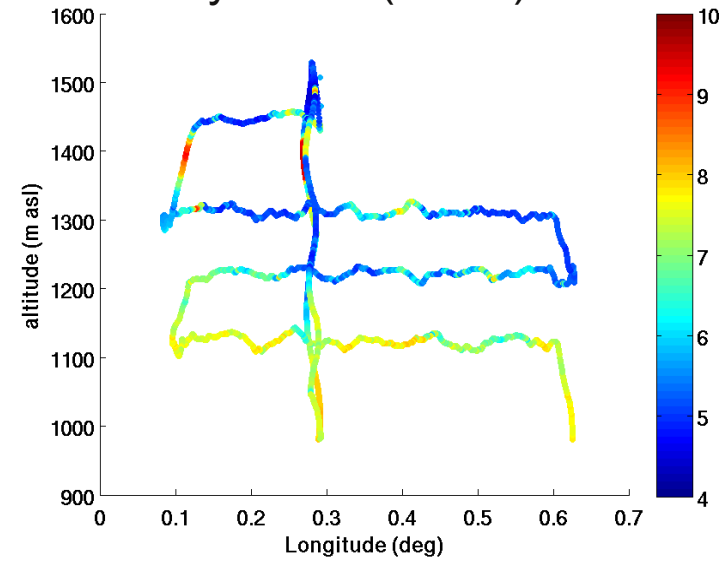


Water vapour mixing ratio 1800 UTC

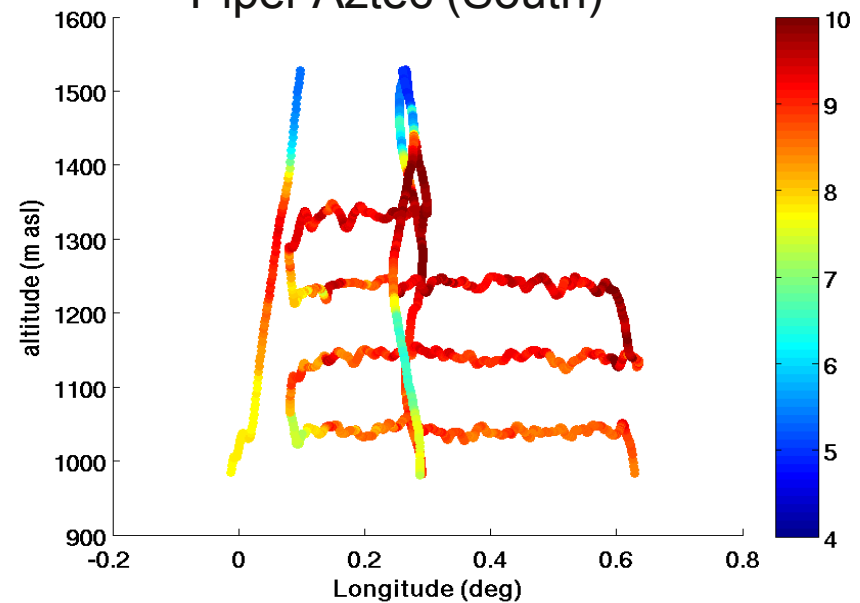
Horiz cross section 500 m



Sky Arrow (North)



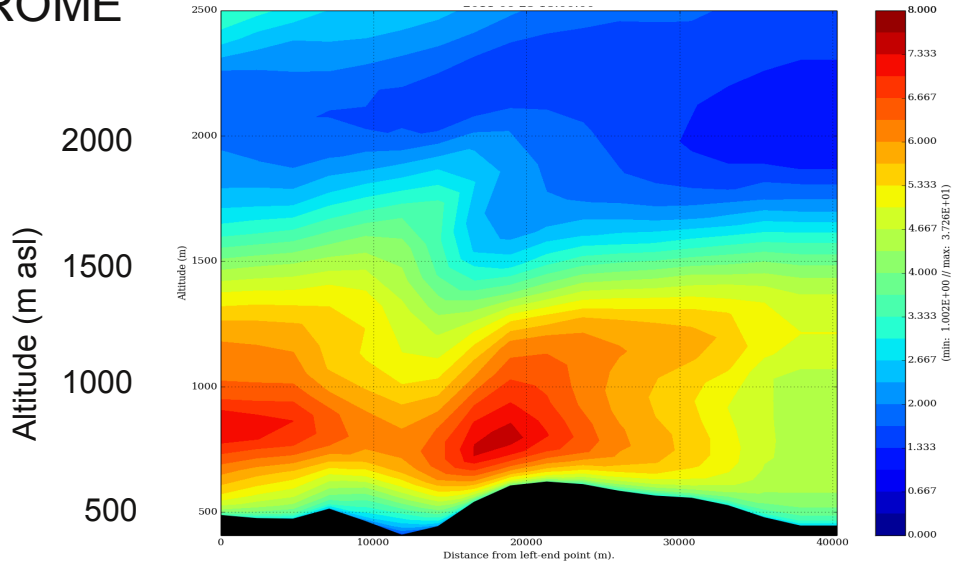
Piper Aztec (South)



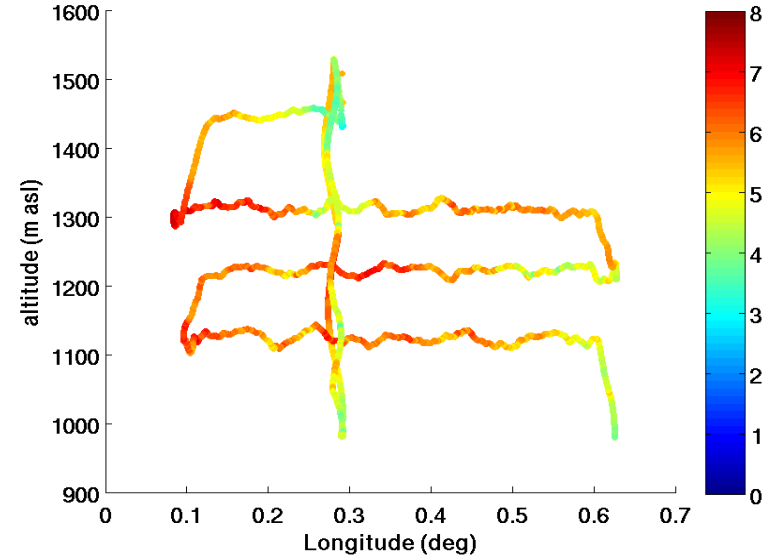
Windspeed at 1800 UTC

AROME

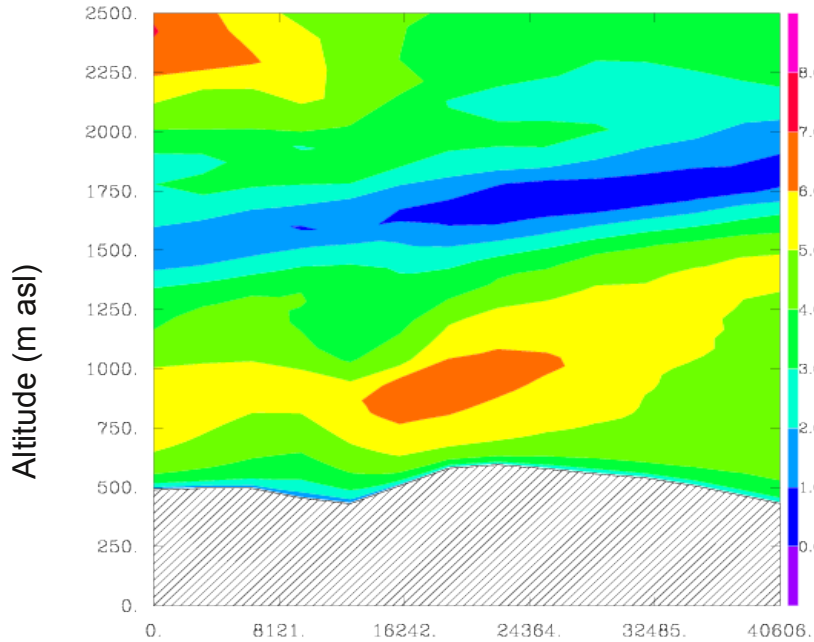
EW cross section



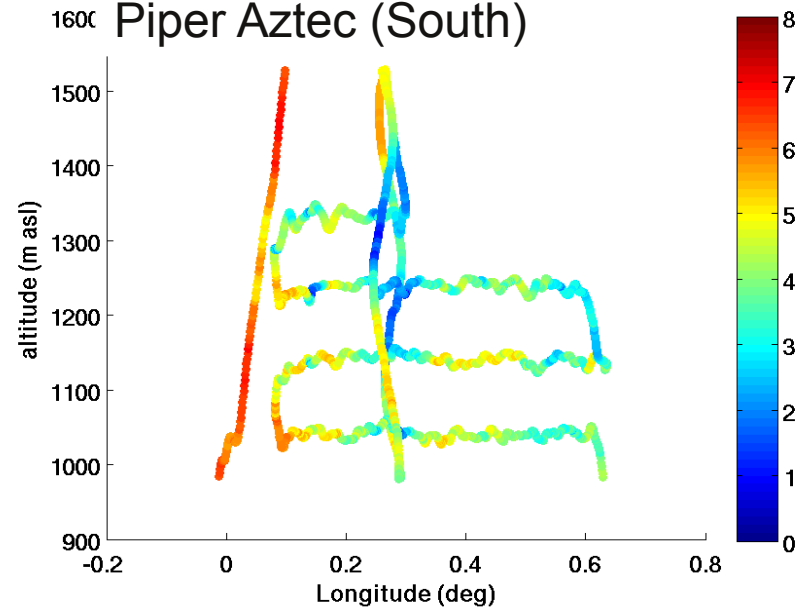
Sky Arrow (North)



MNH



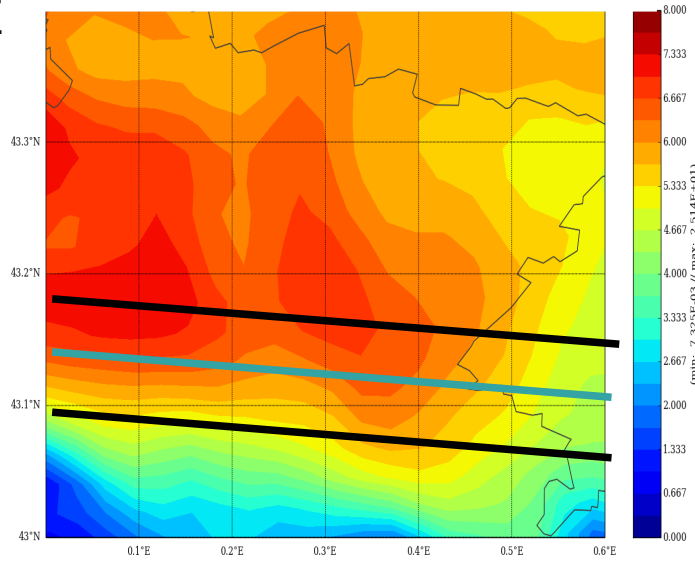
Piper Aztec (South)



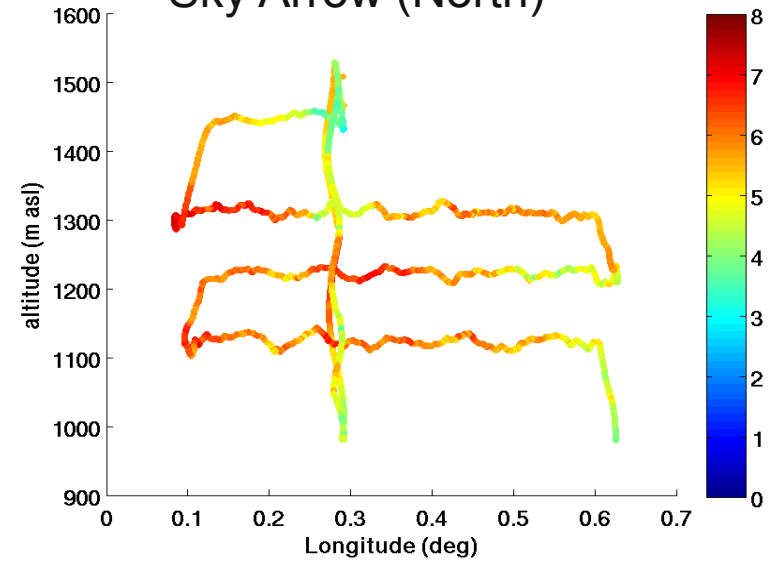
Wind speed 1800 UTC

AROME

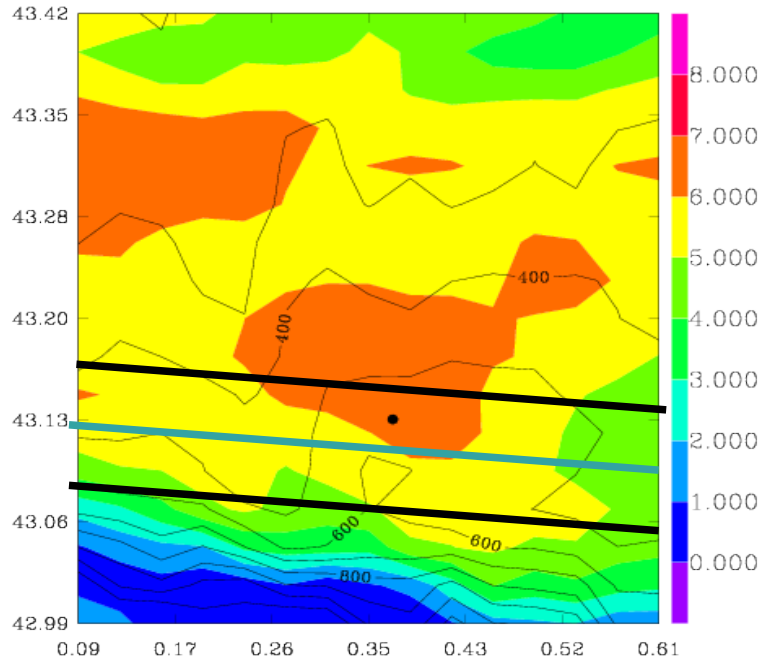
Horiz cross section 500 m



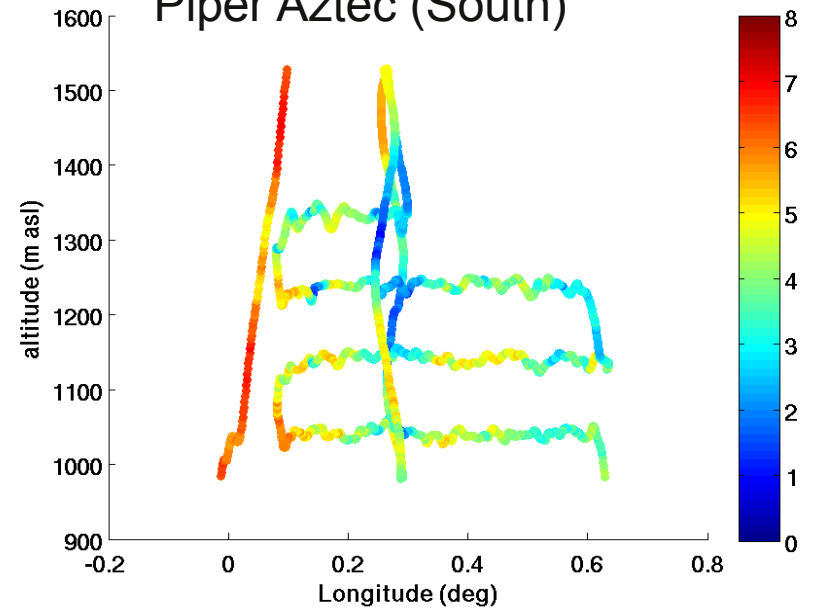
Sky Arrow (North)



MNH



Piper Aztec (South)



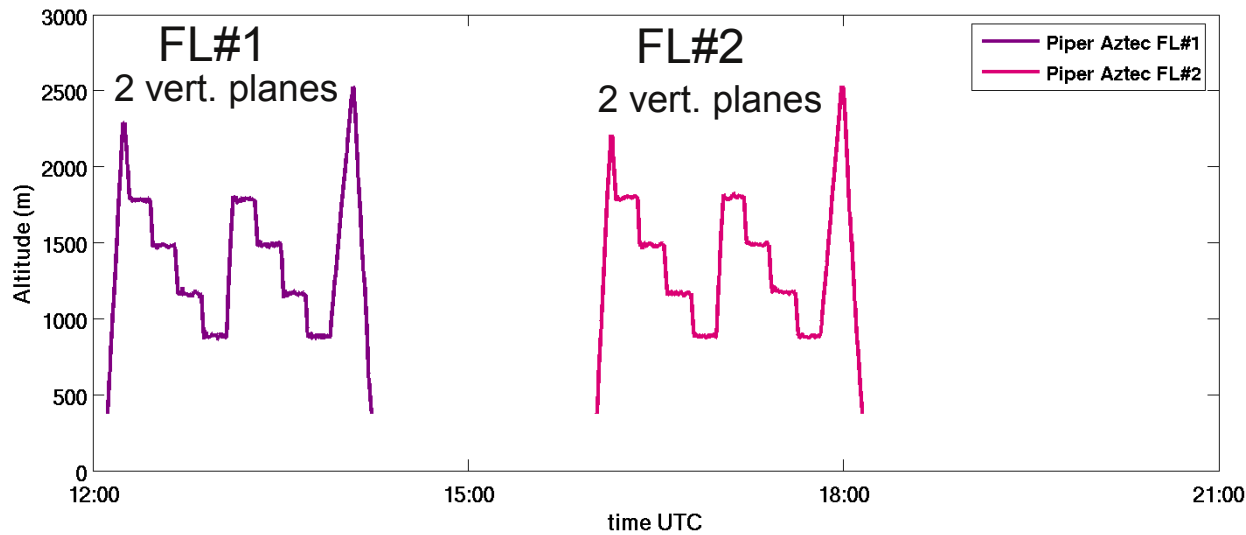
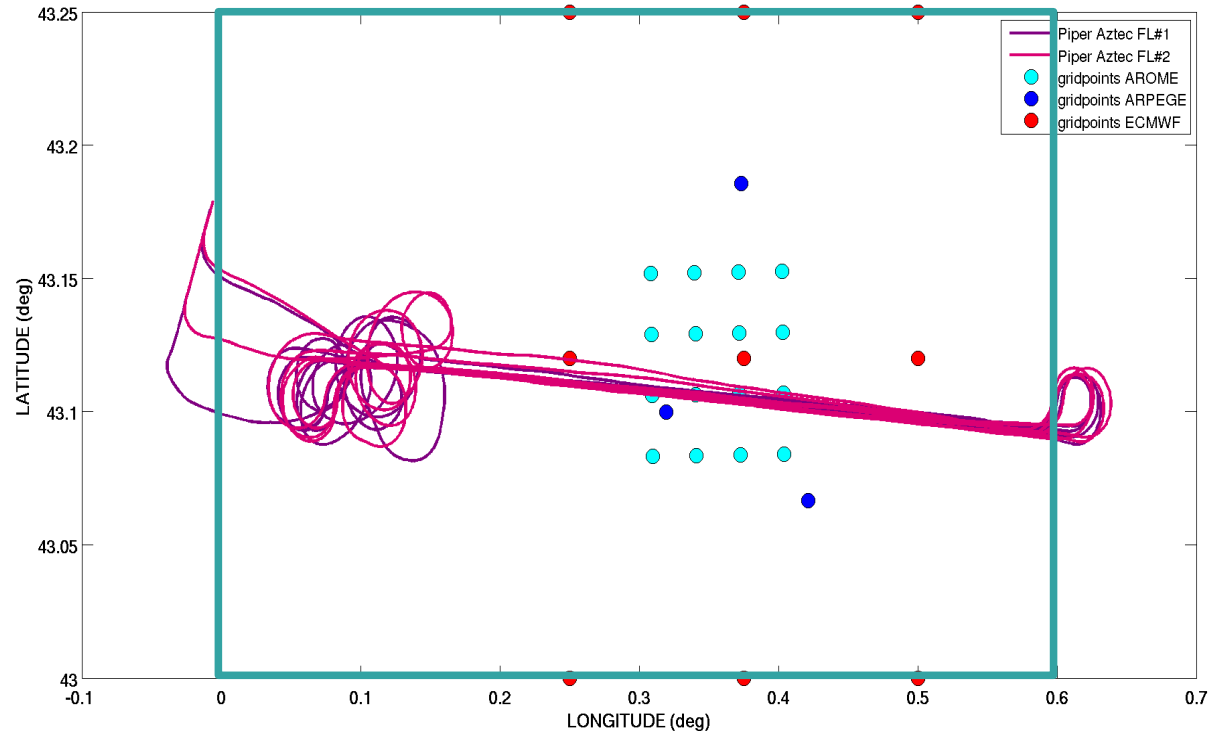
1st July

Comparison observation/models

Description of the flight trajectories on 1 July

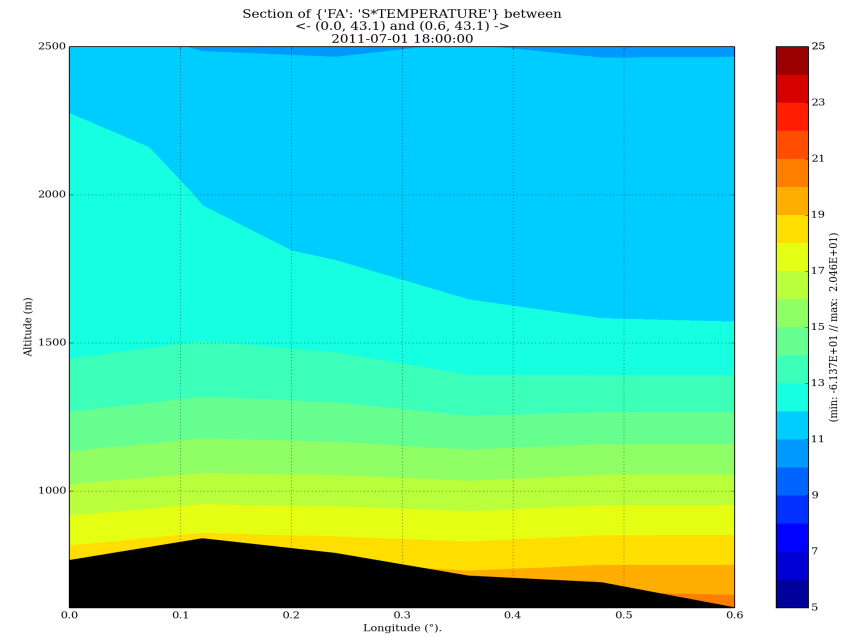
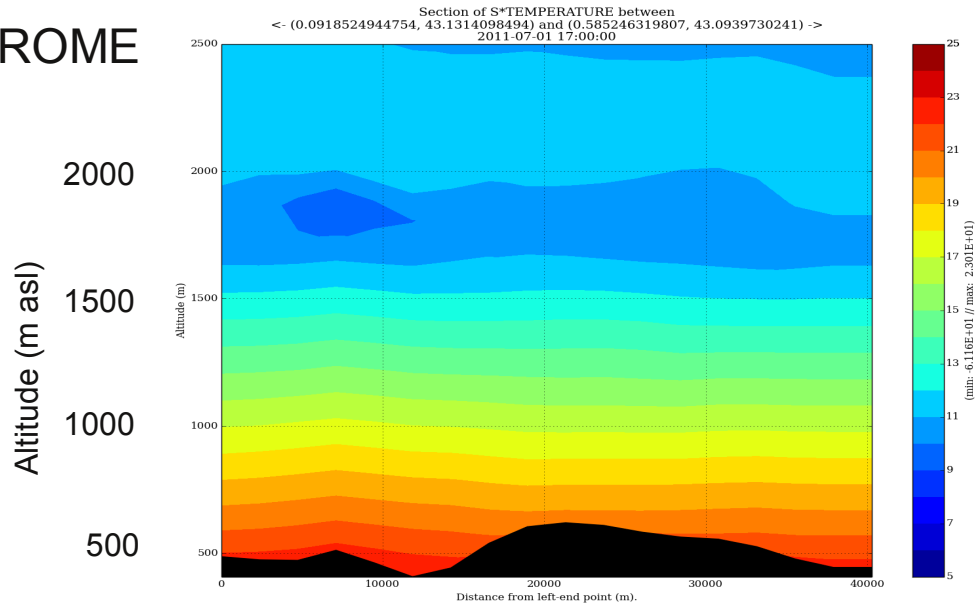


Piper Aztec
70 m/s airspeed

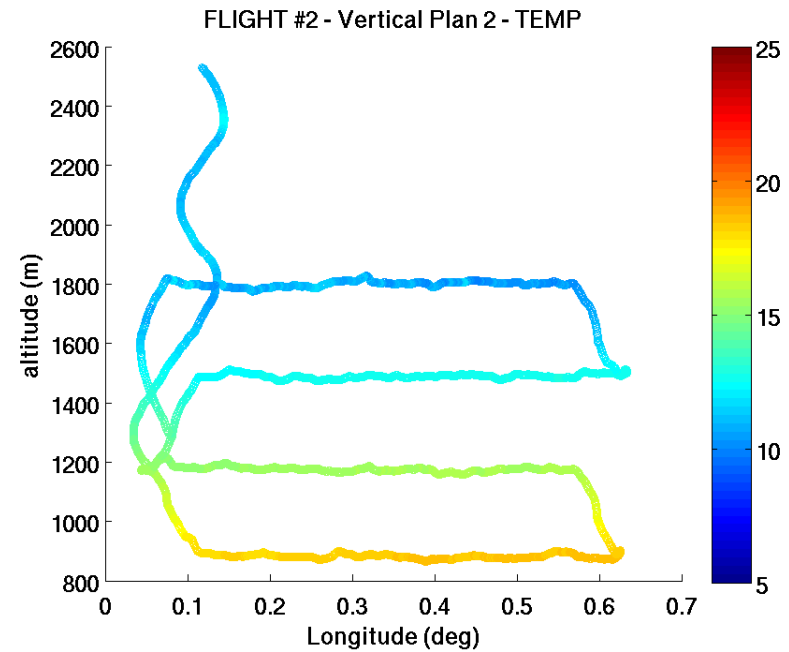
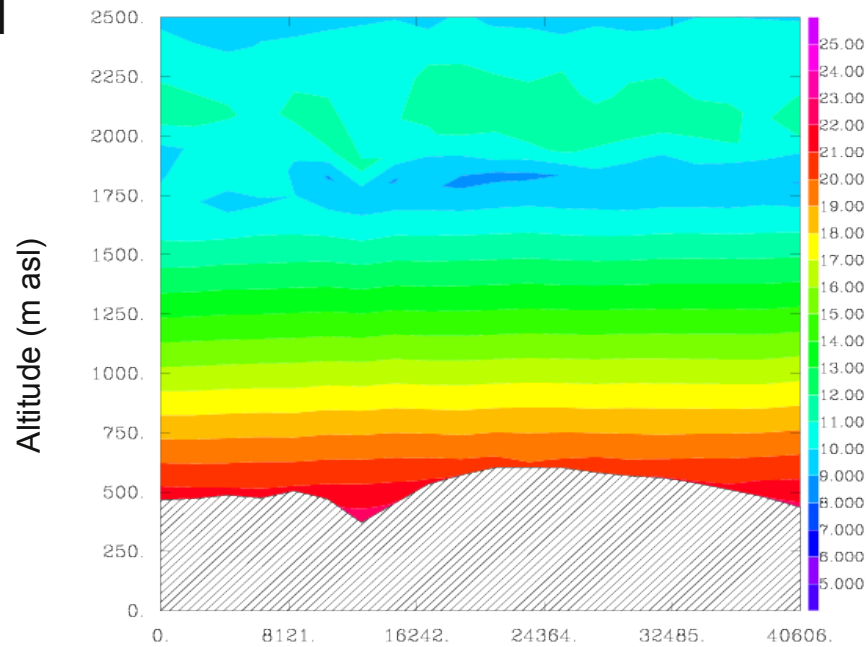


Temperature, EW cross section, 1700 UTC

AROME

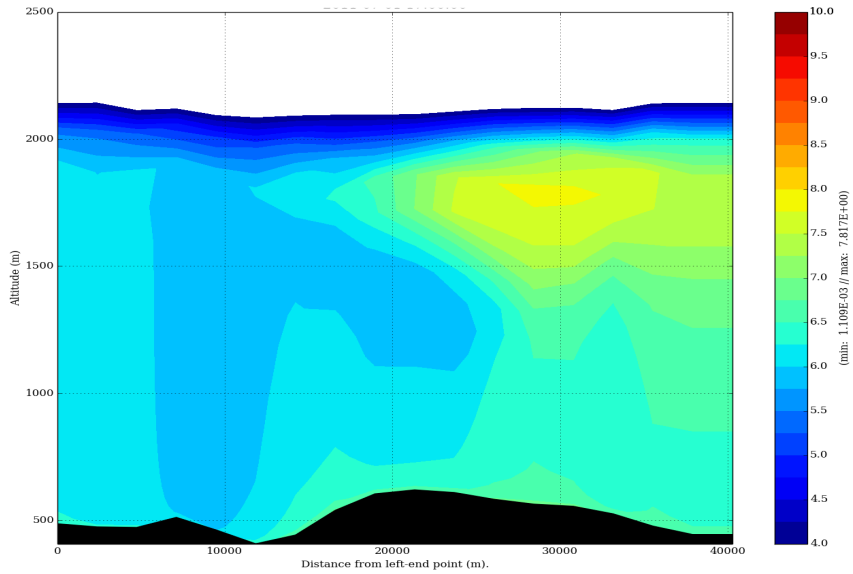


MNH

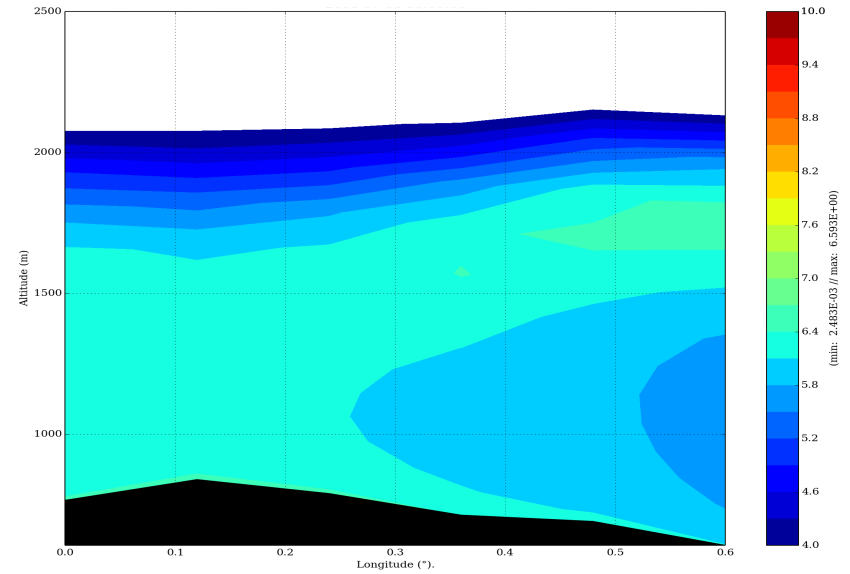


Humidity, EW cross section, 1700 UTC

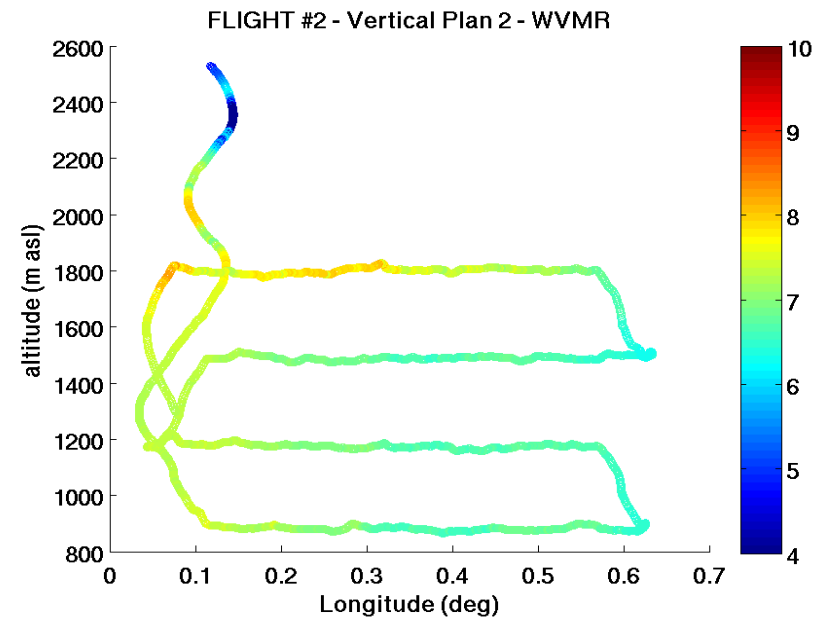
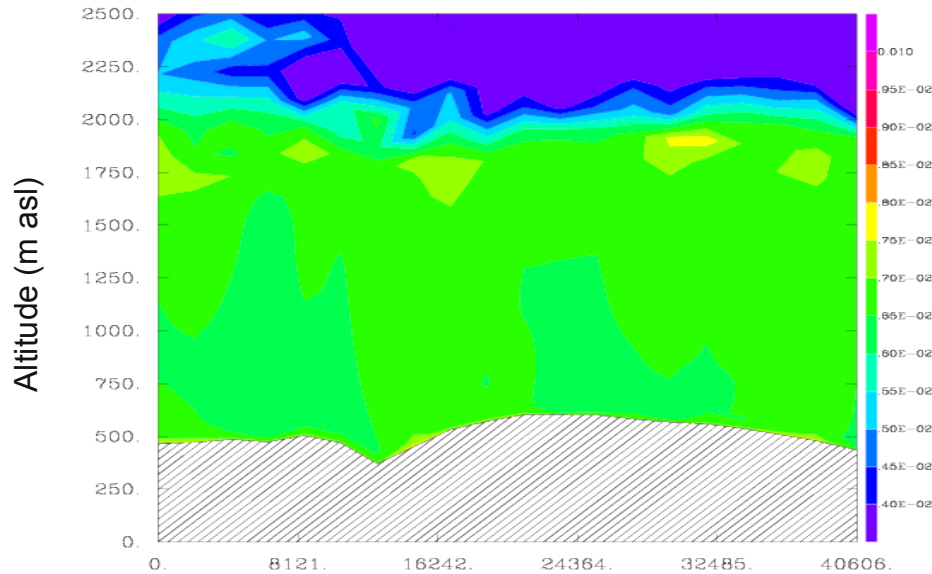
AROME



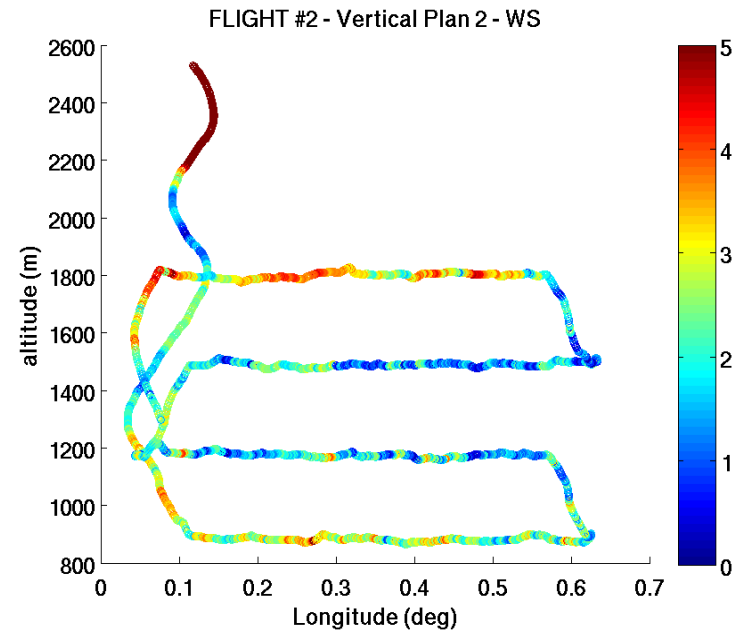
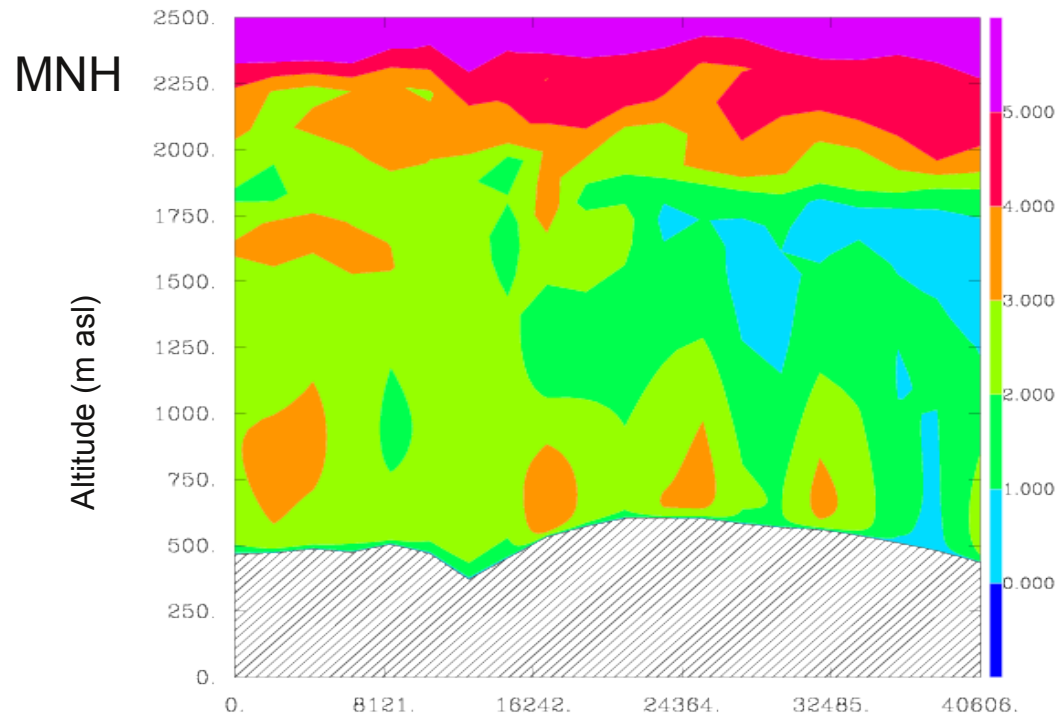
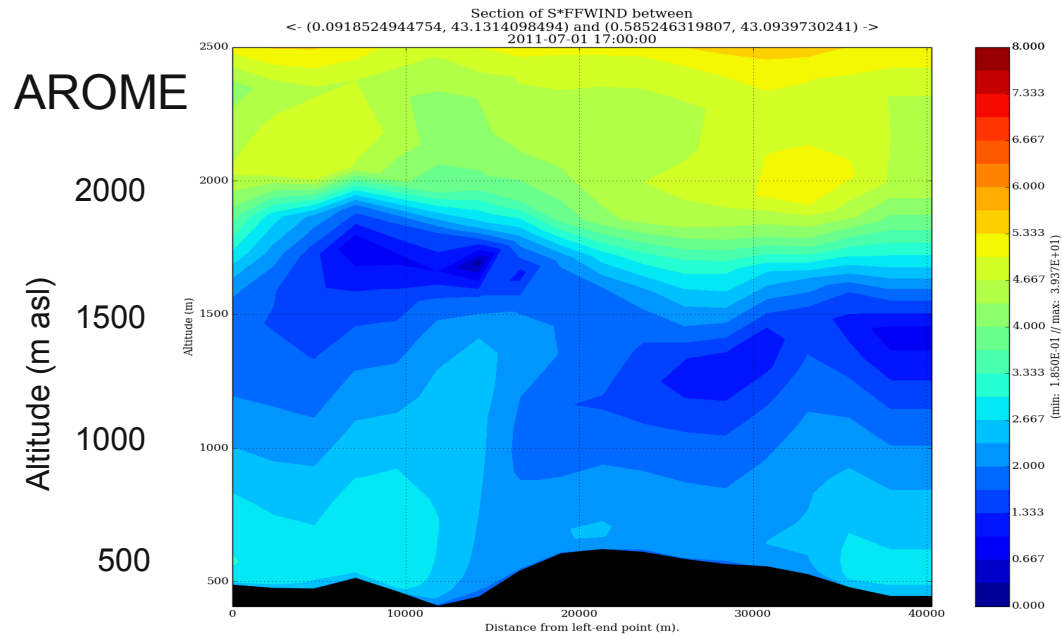
ARPEGE



MNH



Wind speed, EW cross section, 1700 UTC



Estimates of the horizontal gradients

Variation of potential temperature, humidity
and wind speed over a 50 km distance

			EW			NS		
			OBS	MNH	ARO	OBS	MNH	ARO
25/06	14:00	dθ (K)	-0,5	-0,3	-0,5	~0	-5,2	-5,7
		drm (g/kg)	~ 0	-3		-4,4	-0,9	
		dRH (%)	+1,6	-20	0	-25	-9	-17
		dFF (m/s)	-1,7	-2	-1,8	+2	+3	+5
	17:00	dθ (K)	-0,25	-0,4	0,5	~0	-5	-4,5
		drm (g/kg)	-0,16	-0,4		+0,5	+1,2	
		dRH (%)	-0,4	-2	-10	~0	+4	-34
		dFF (m/s)	-0,7	-1	-2	~0	+3	+3
01/07	13:00	dθ (K)	+0,7	0,16	0		-1,6	-0,9
		drm (g/kg)	-0,7	-0,16			-2	
		dRH (%)	-8	-2	0		-25	-50
		dFF (m/s)	-0,5	-0,4	+0,5		-0,7	+1
	17:00	dθ (K)	+0,5	+0,3	-0,3		+0	-0,9
		drm (g/kg)	-0,69	-0,64			-3	
		dRH (%)	-7,6	-6,6	0		-36	-50
		dFF (m/s)	-0,6	~0	-0,5		-0,6	+3

Conclusions

- A possibility to confront the models with some observations thanks to the aircraft exploration, even if the area remains small
- Interesting differences between the 2 cases, 1 July having a very marked signature of the mountain-plain circulation on all fields
- A good match within the ensemble of models
- Moisture fields are heterogeneous on 25 June, and complex. But Models manage to represent it partially, even if differently among the different types of models.
- EW gradients are usually very small, NS gradients are significant, especially on 25 June, with a specific feature at Lannemezan latitude
- temperature and wind field more easily represented by the models
- Not more complexity in late afternoon than earlier. The profound changes occur later, around 20 UTC with the meso-scale circulation reversion, and a transition time of complexity.