Intercomparison of numerical models for the prediction of fog

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Intercomparison of 1D-models

- ✓PHASE I: selected cases
- ✓PHASE II: seasonal comparison

COST ACTION 722:
SHORT-RANGE FORECASTING METHODS OF FOG VISIBILITY AND LOW CLOUDS

Background

- ✓Shortcomings of op. NWP models

- ✓1D models: An alternative

Shortcomings of operational NWP models in predicting fog

- ✓Horizontal and vertical resolutions are too coarse
- ✓Surface and boundary layer processes are not accurately enough parameterised, especially under stable conditions
- ✓Initialisation of surface and boundary layer is not good enough.

Photo: Ted Eckmann, UCSB Geography Department

1D (single column) models: an alternative

✓May improve vertical resolution

✓May use more expensive parameterisations

✓May assess new schemes of physical processes

✓May modify the initialisation, using or discarding specific data or introducing data from dedicated observational systems.

✓May introduce climatological knowledge

Main goals of the experiment

- ✓Identify capabilities and limitations of SCM in fog forecast
- ✓Find out reasons behind different evolutions
- ✓Assess the importance of vertical resolution

Phase I: Intercomparison of six different single-column models for two selected cases

- ✓Case 1: Fog
- ✓Case 2: Near-Fog

References:

✓Bergot et al. (2007), J. Appl. Met. and Clim. (in press)

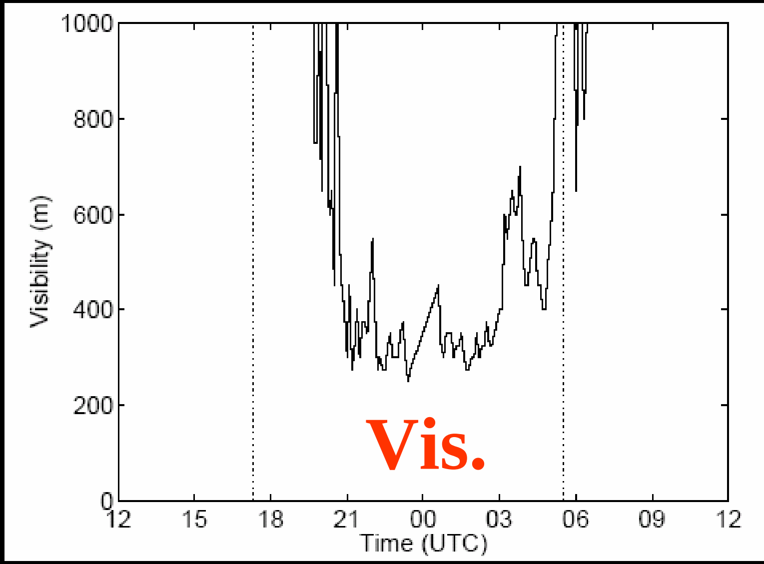
✓Bergot et al. (2007), COST 722 Final Report (in press)

The models

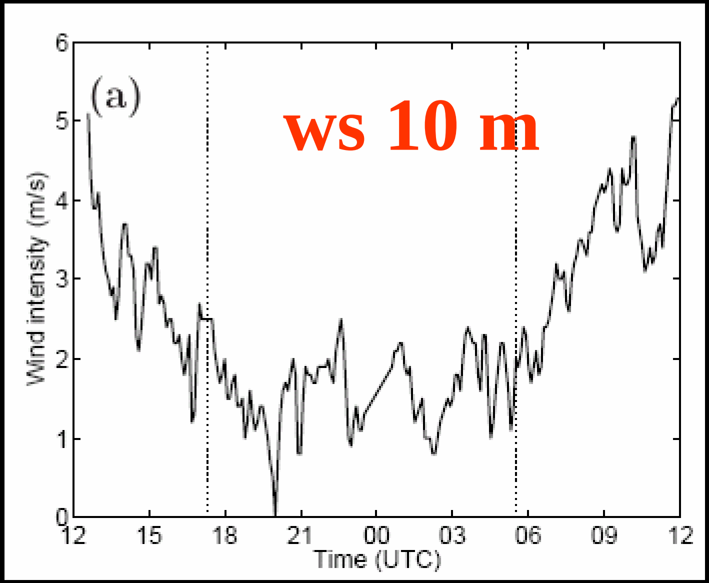
participant	model	Levels < 50 m	Levels < 200 m
Enric Terradellas	HIRLAM-ISBA	1	3
Olivier Liechti	TBM	2	7
Niels W. Nielsen	DMI / HIRLAM	13	20
Thierry Bergot	COBEL-ISBA	13	20
Mathias Mueller	COBEL-NOAH	18	30
Joan Cuxart & Toni Mira	MESO NH-ISBA	50	89

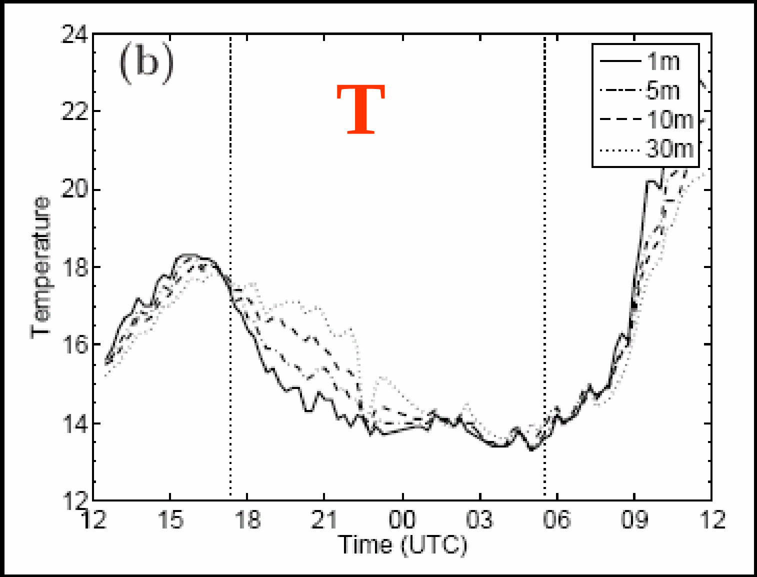
Case 1: fog
1-2 Oct 2003

Classical radiation fog between 20:30 and 06:00. Its depth progressively grows



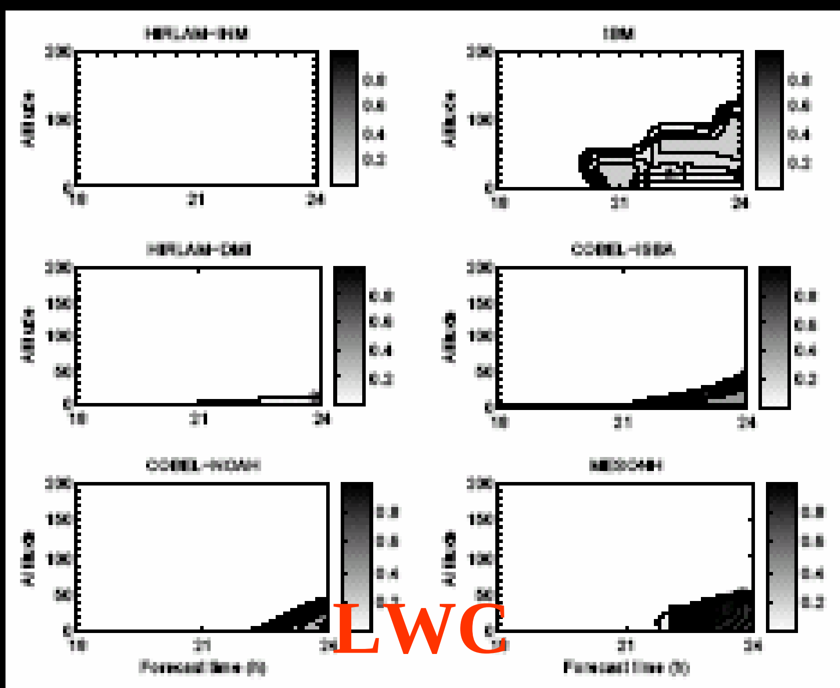
Visibility

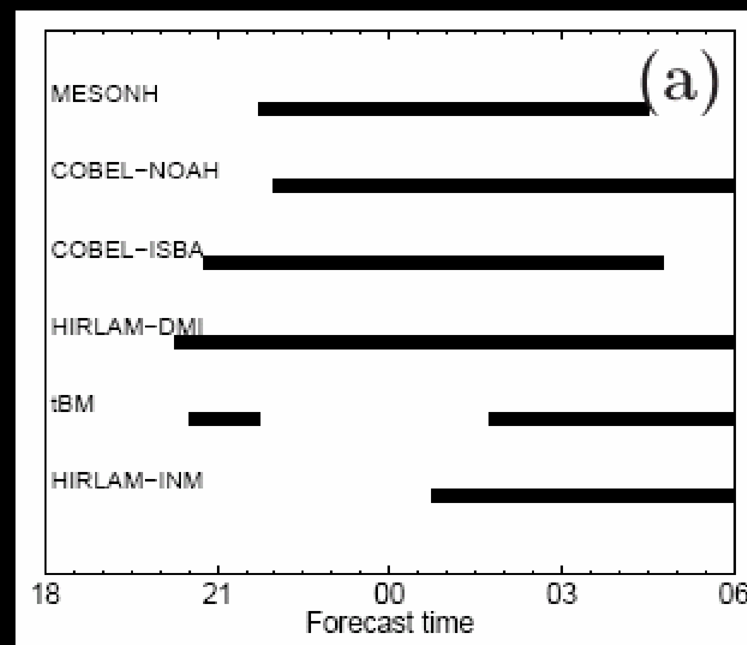




Case 1: fog. Init.: 18 UTC

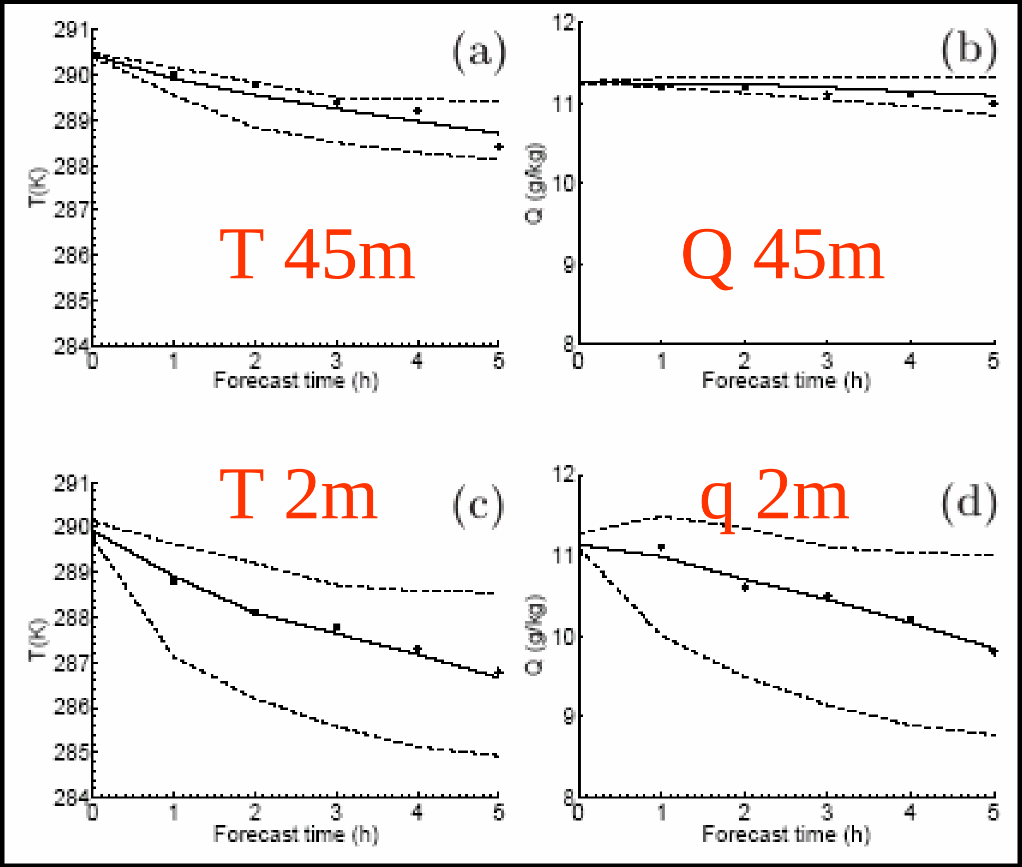
All models predict fog, but at different times and with very different depths and liquid water contents





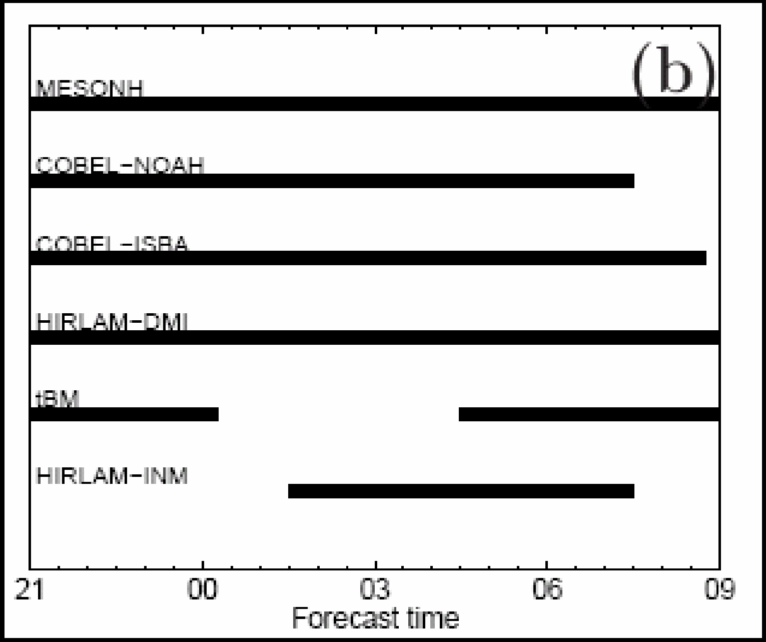
Case 1: fog. Init.: 18 UTC

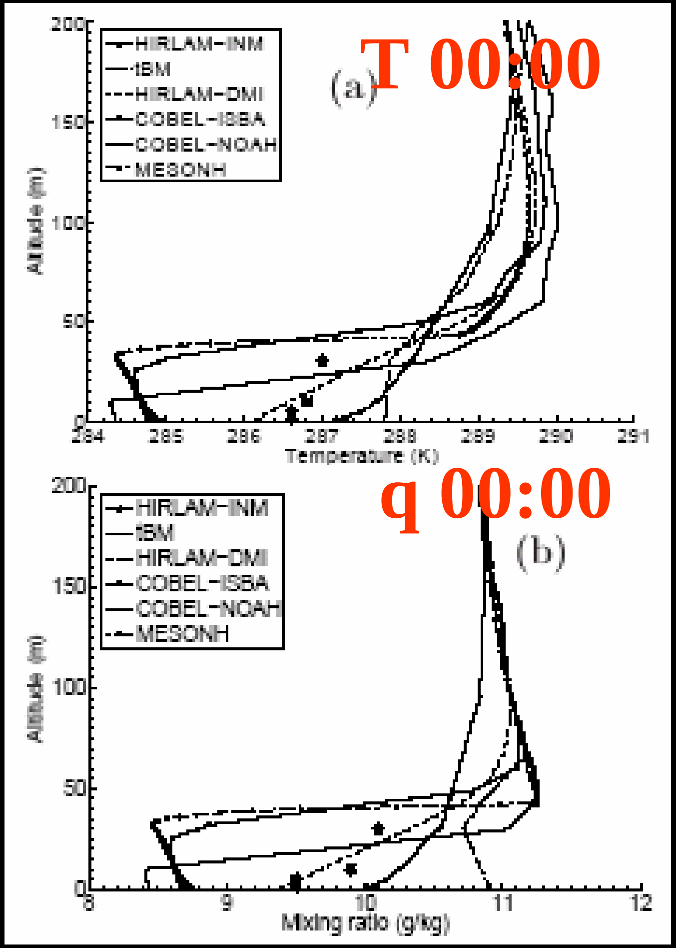
Average evolutions of T and q are quite correct, but individual low-level evolutions considerably diverge, partly because of the data assimilation.



Case 1: fog. Init.: 21 UTC

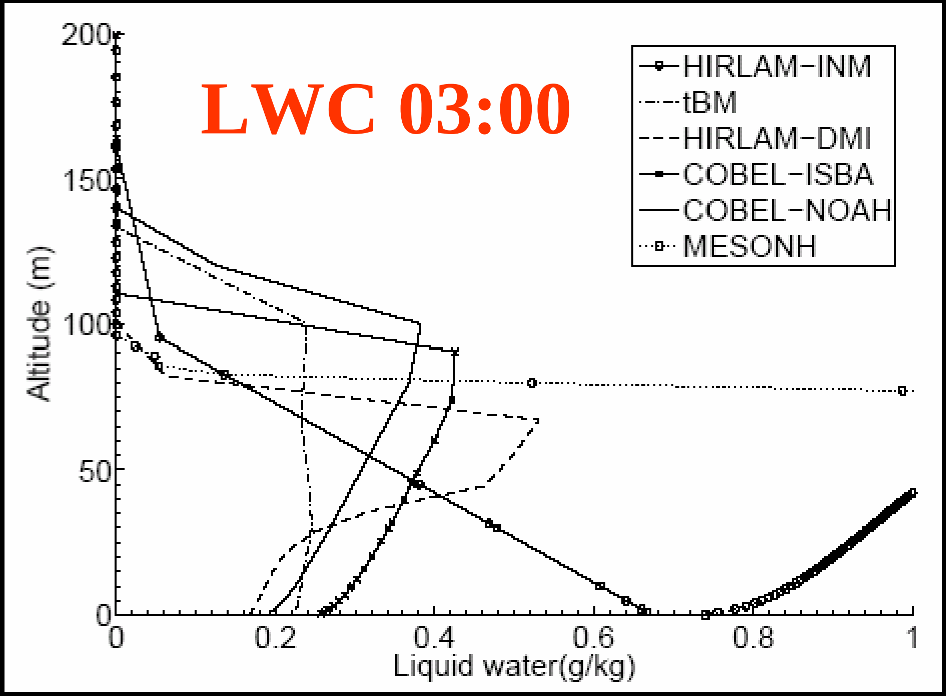
All models predict a late dissipation





Different fog layers

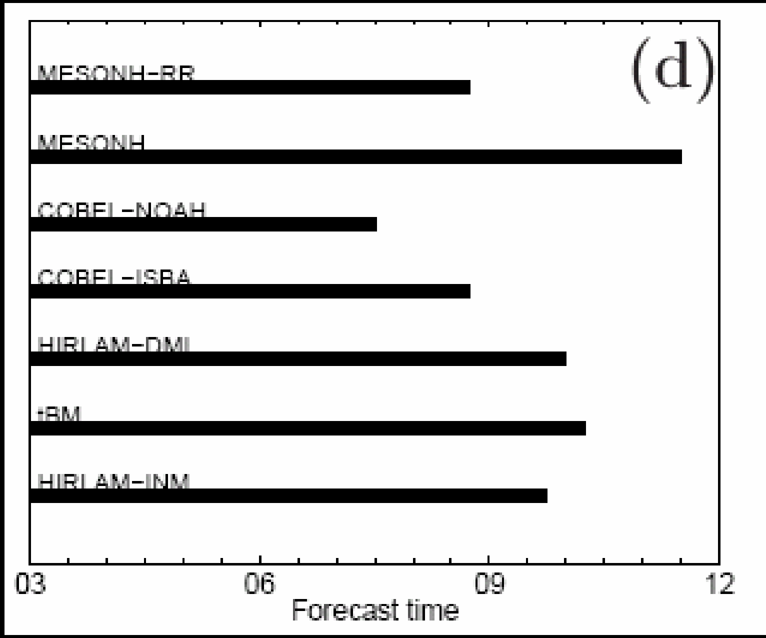
Case 1: fog. Init.: 00 UTC



With a thick fog layer, the evolution is not so fast and the simulations tend to converge.

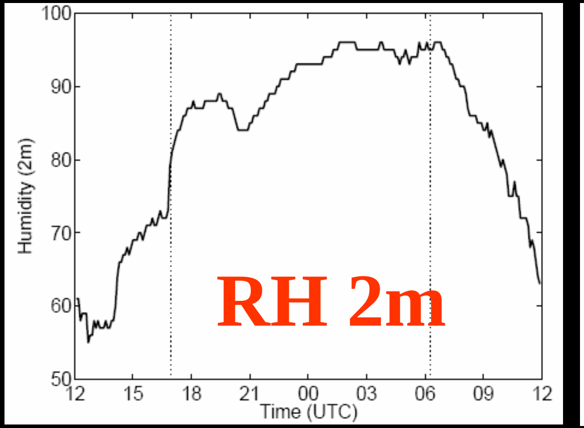
The resolution of HIRLAM/INM is too coarse. MESO-NH has been run without gravitational settling.

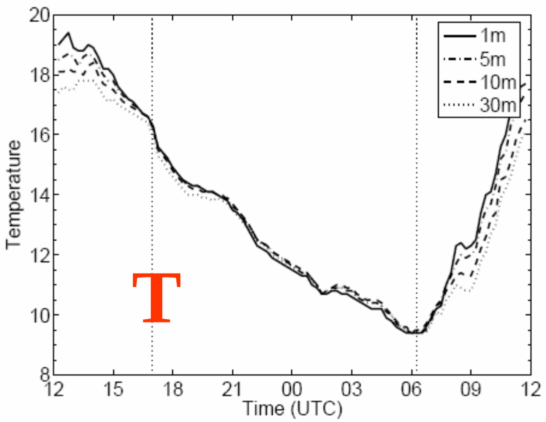
Case 1: fog. Initialisation: 03 UTC

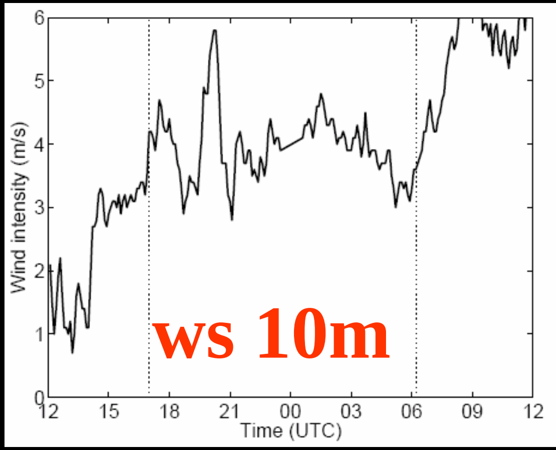


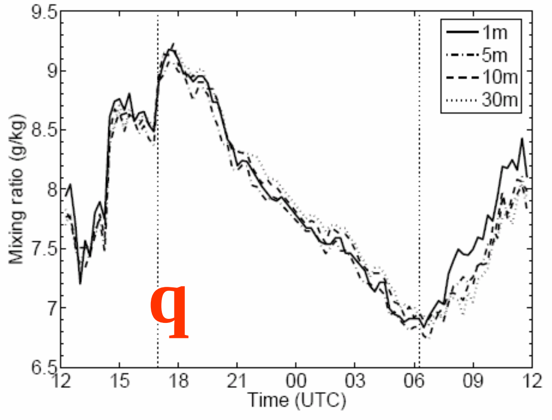
The dispersion in the burn-off time forecast is similar to that in the onset time.

Case 2: near-fog 11-12 Oct. 2003



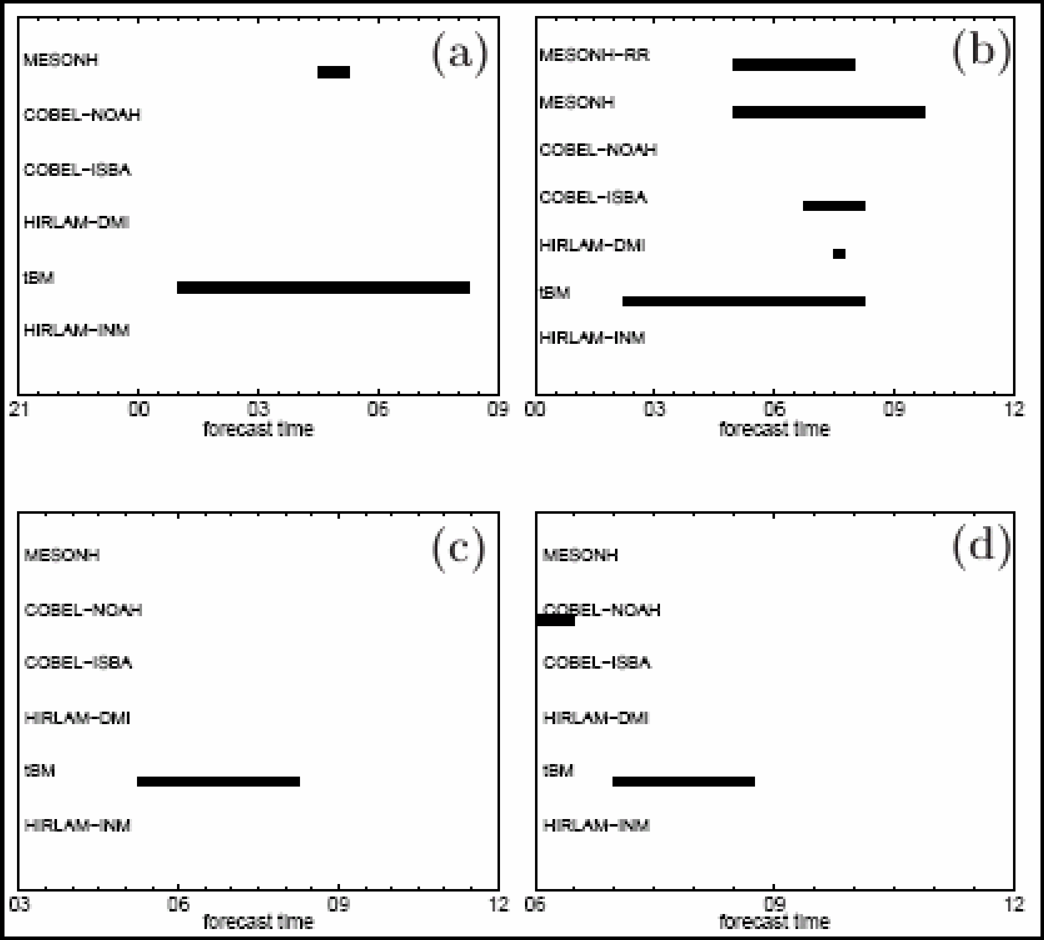






- Weak stability (moderate wind speed and weak inversion)
- Strong cooling
- High dew deposition

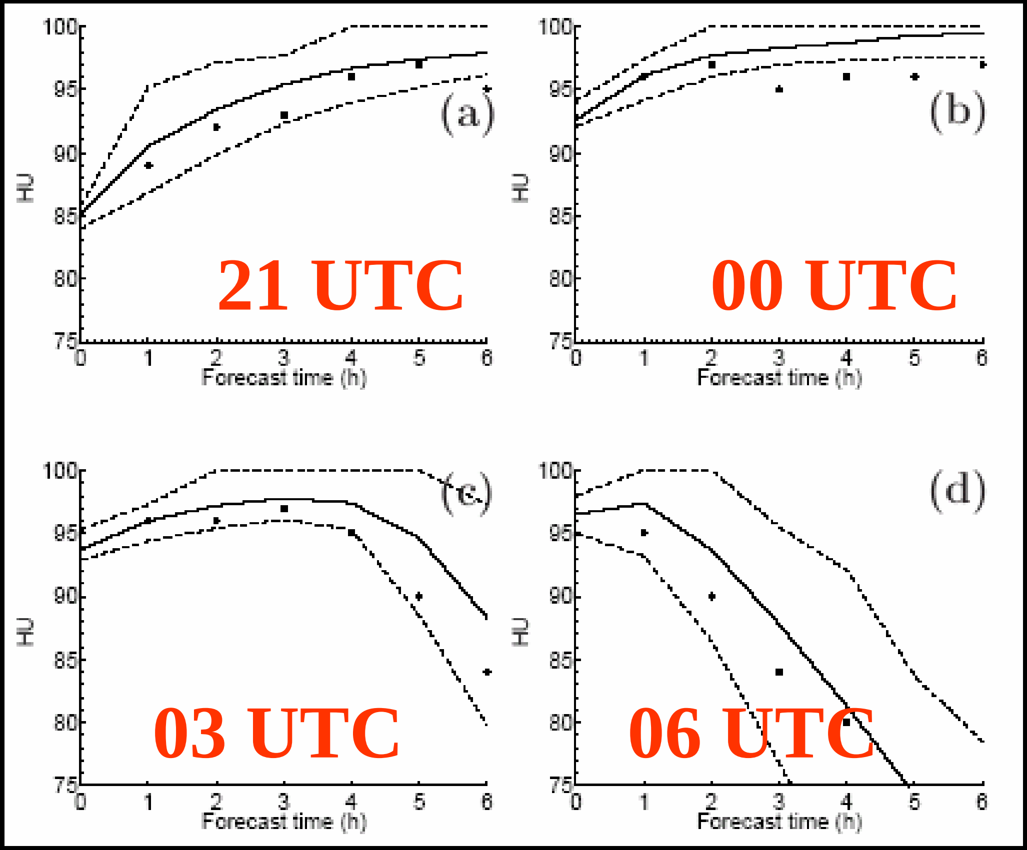
Case 2: near-fog



All models, except HIRLAM/INM predict fog.

HIRLAM/INM underestimates the cooling rate.

Case 2: near-fog



The evolution of the screen T and q is correctly simulated by all models.

Conclusions of phase I

- ✓Under conditions of strong stability, the models present very different behaviour.
- ✓The simulation of fog needs models with a high vertical resolution.
- ✓Hi-res. does not release the models from the need of accurate parameterisations.
- ✓The adaptation of parameterisations to the resolution is crucial
- ✓The role of the gravitational settling and the dew deposition rate has to be highlighted

Phase II: Comparison of H1D (INM) and COBEL-ISBA (Météo-France) during a whole winter season

Reference:

- ✓ **Terradellas and Bergot (2007), COST 722 Final Report (in press)**

Paris-ChdG airport

Paris-Charles de Gaulle airport is located over relatively flat terrain.

Test period: 16 Jan.-14 Feb. 2005

H1D runs: 0000, 0600, 1200, 1800. Runs start 3h30m after nominal runtime. 24h fcst

COBEL-ISBA runs: 0000, 0300, 0600, 0900, 1200, 1500, 1800, 2100. 12h fcst

Full season comparison: 1 Oct. 2005 – 28 Feb. 2006

H1D runs: 0000, 0600, 1200, 1800. Runs start 3h30m after nominal runtime. 24h fcst.

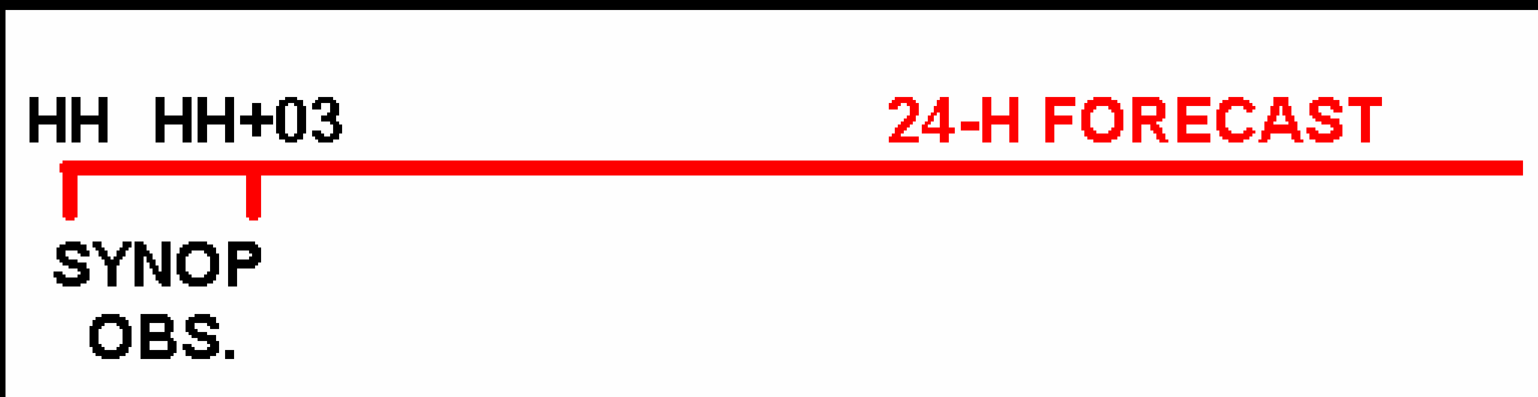
COBEL-ISBA runs: 0000, 0300, 0600, 0900, 1200, 1500, 1800, 2100. 6/8h fcst.

Initialisation

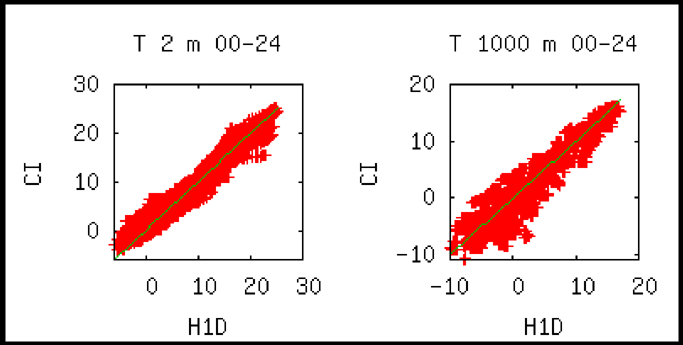
Dedicated obs. system:

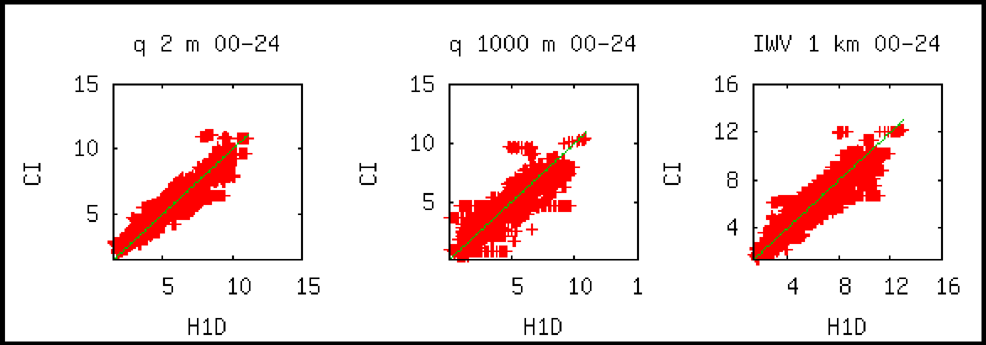
- 30-m tower: T, RH
- Soil T and humidity
- SW and LW radiation

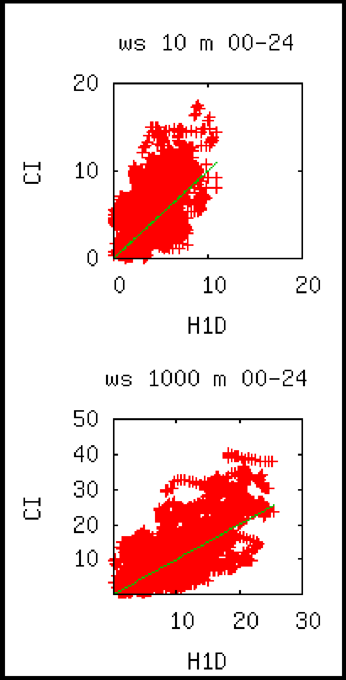
Initialisation

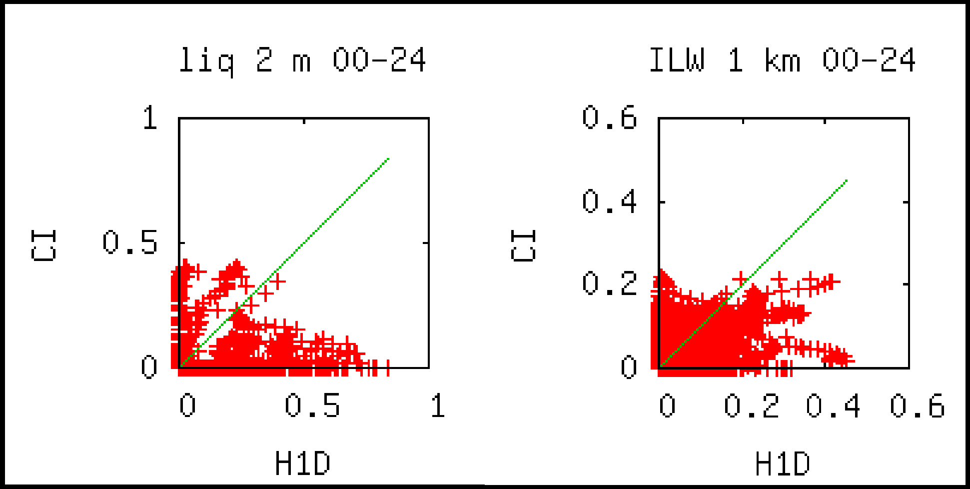


The problem of fog forecasting

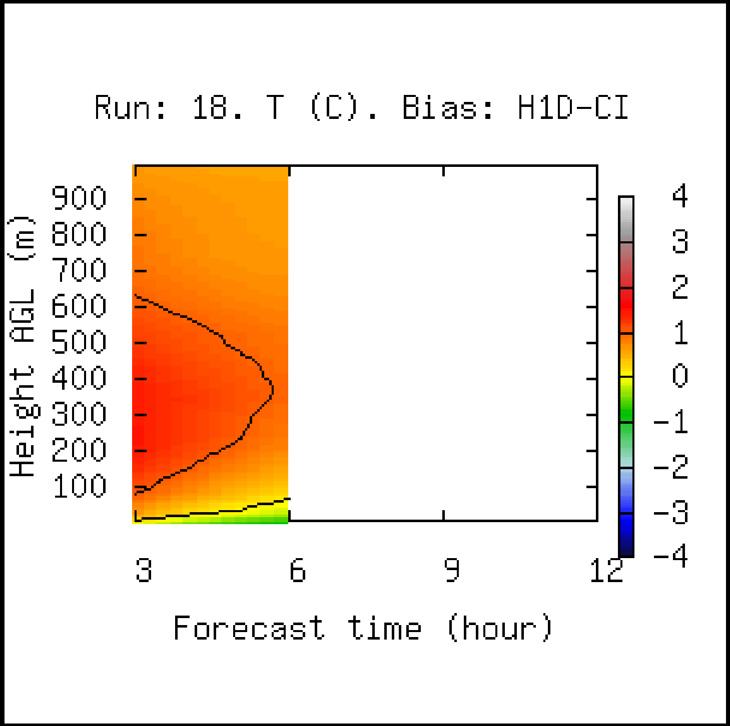


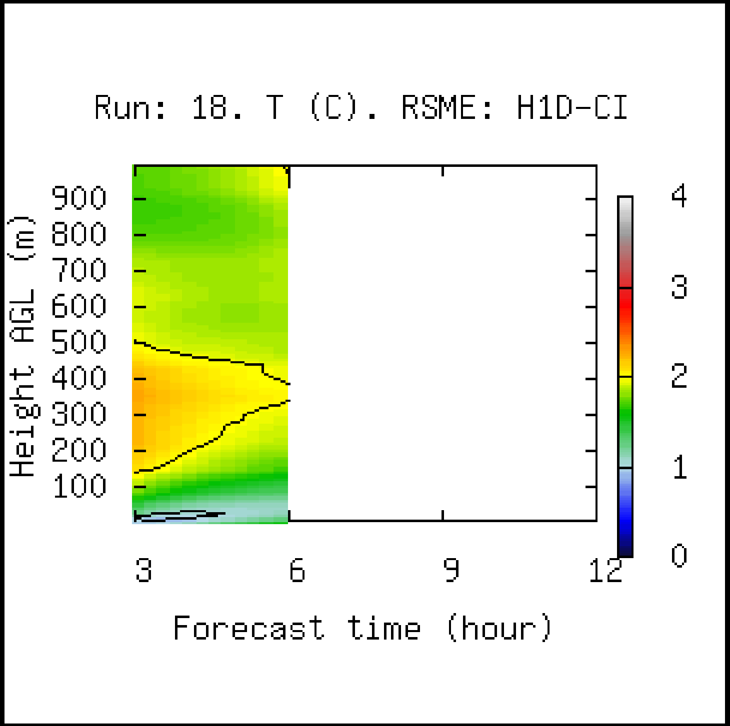






H1D/COBEL. Night BL temperature

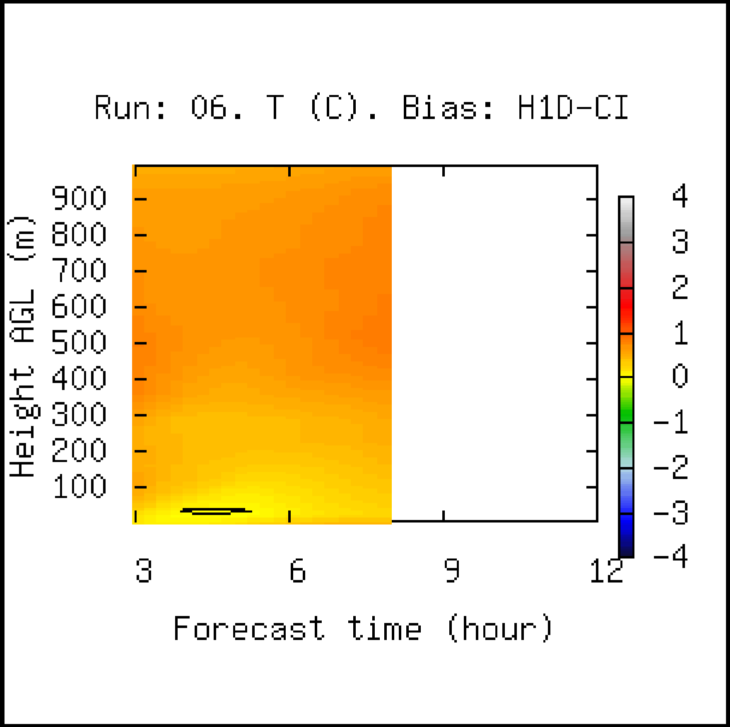


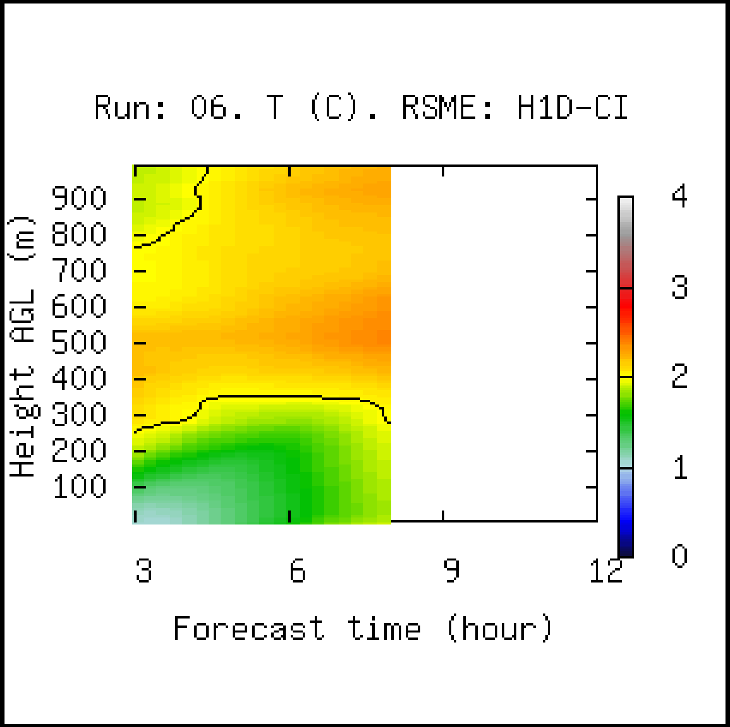


Systematic difference in the cooling rate: nocturnal cooling is greater in H1D. Cloud shortage?

Lower part of the column is more stable in HIRLAM

H1D/COBEL. Daytime temperature

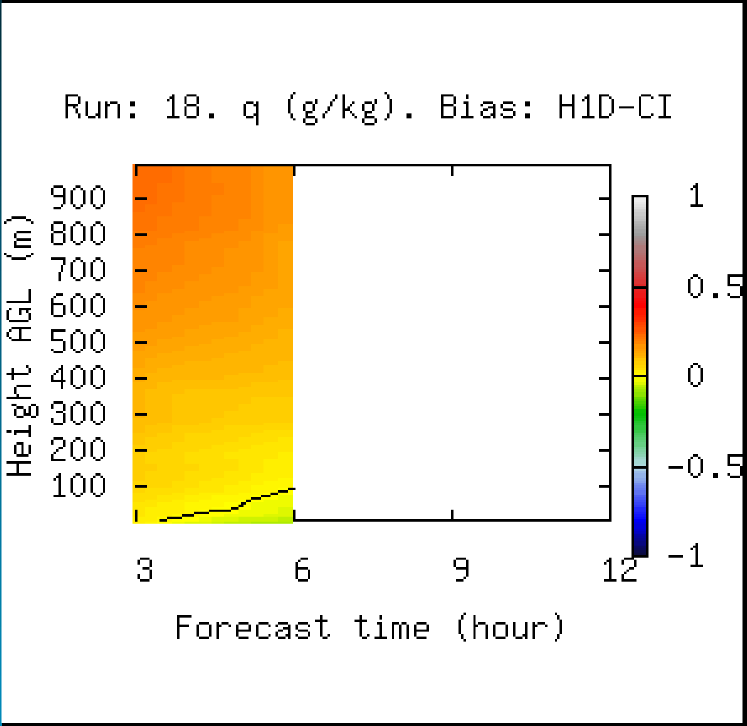


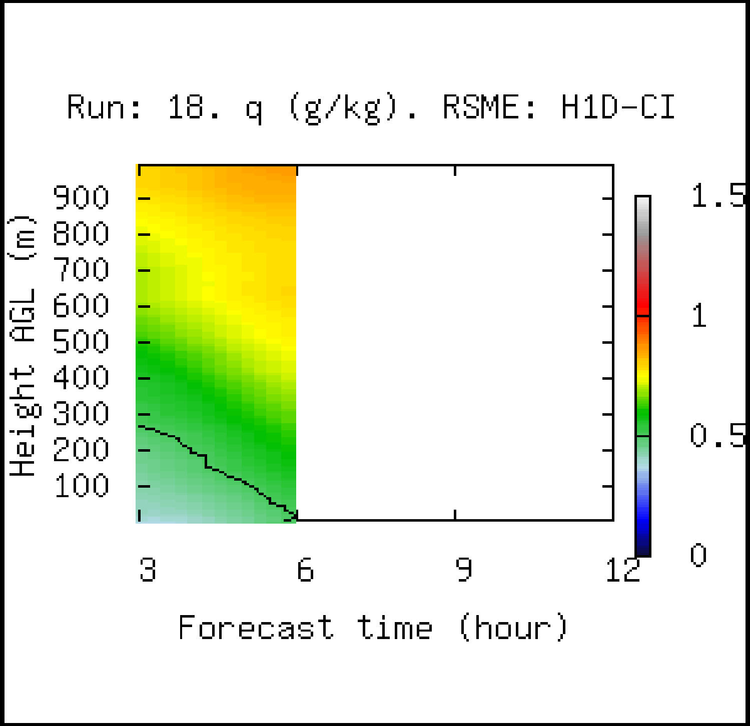


Daytime behaviour is "normal":

- **Bias is small and stable with time**
- **Rmse increases with time**

H1D / COBEL. Night BL sp. humidity

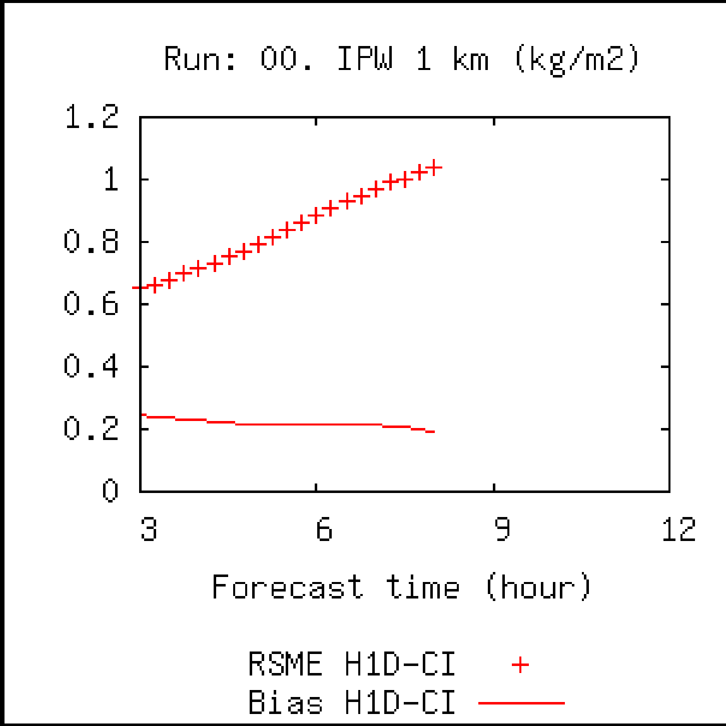


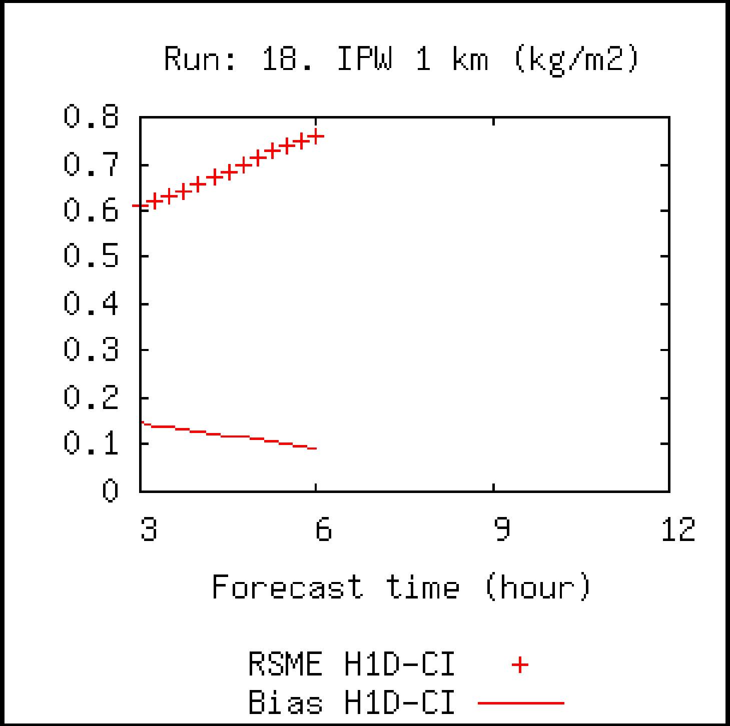


"Normal" behaviour for the specific humidity

H1D is slightly moister than COBEL

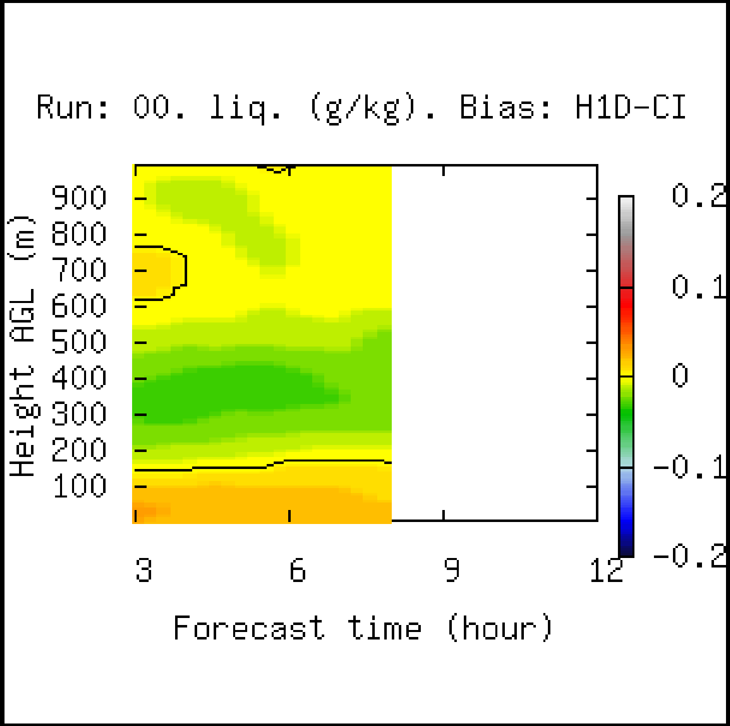
H1D / COBEL. Night BL IPW

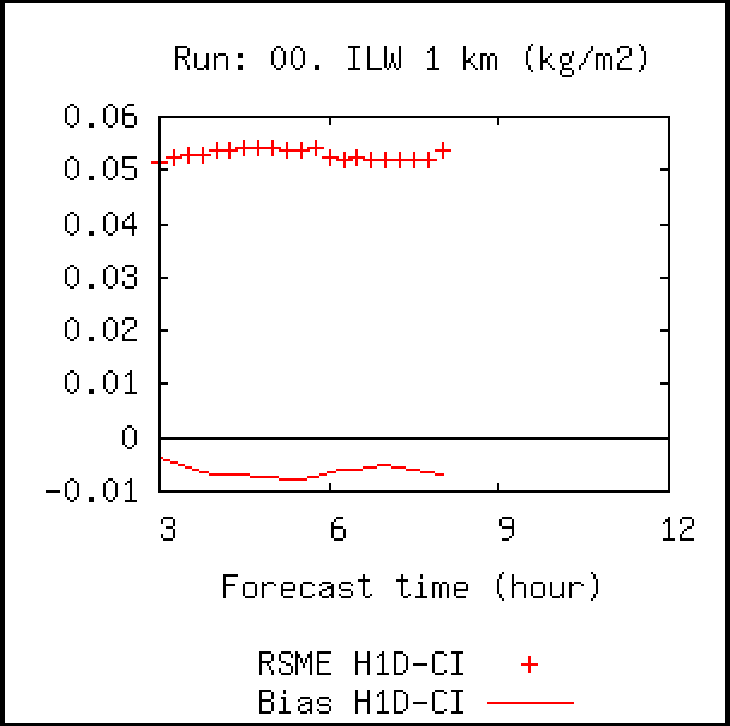




H1D is slightly moister than COBEL.
The difference comes from the initialisation.

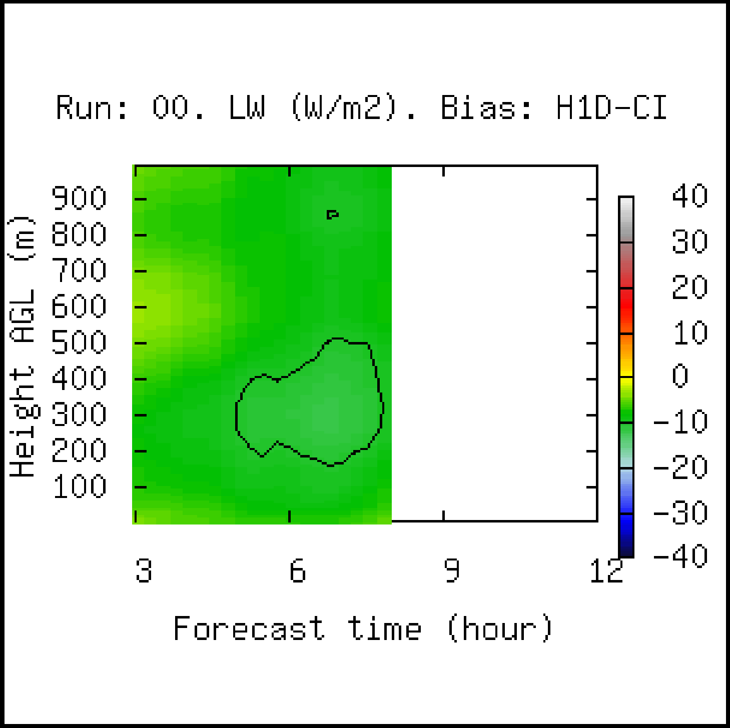
H1D / COBEL. Night BL liquid water

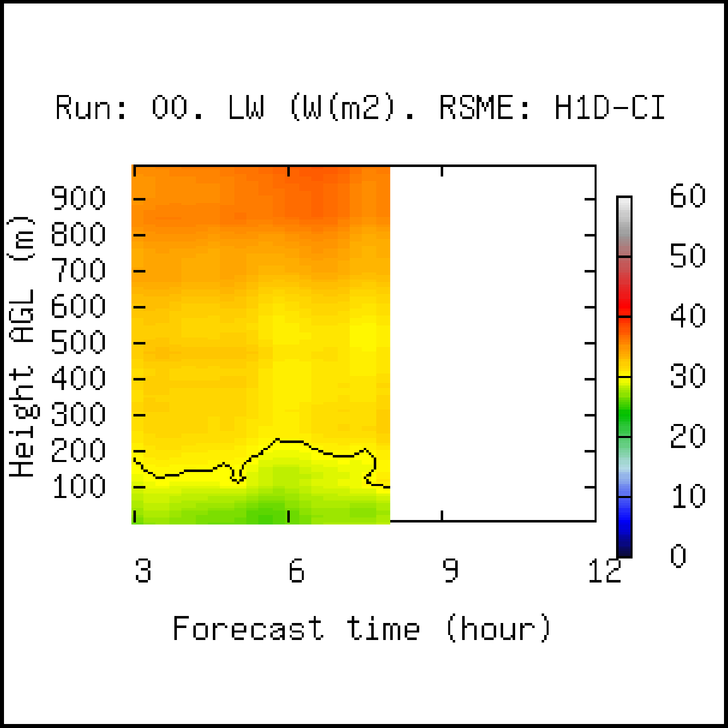




Above 200 m, H1D presents less liquid water than COBEL → higher cooling rate → more liquid water at low levels (fog)

H1D/COBEL. Night longwave radiation

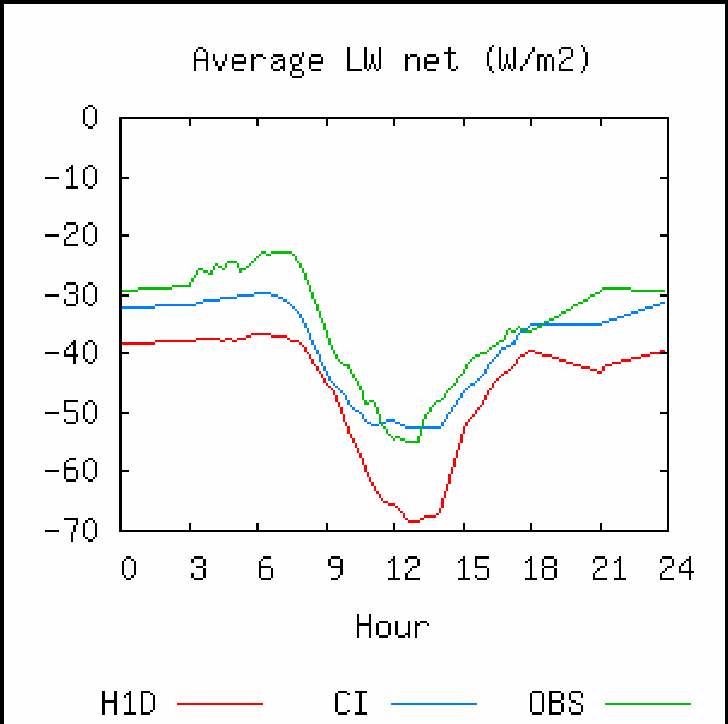




(downward positive)

H1D: less liquid water → more loss of longwave radiation

Net radiation at ground



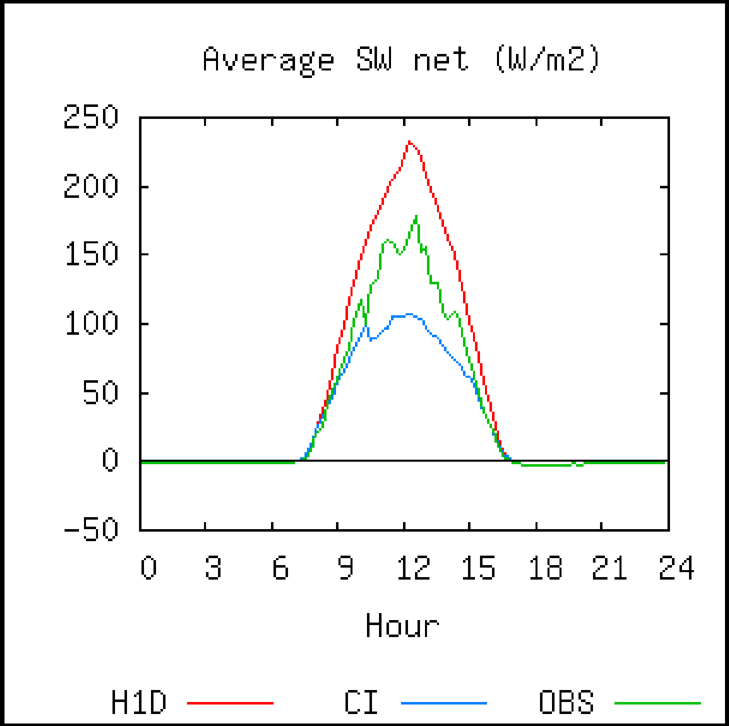


Figure on the right is from the test period

H1D overestimates both, the downward SW radiation and the upward LW radiation, probably because it underestimates cloudiness

Low C&V conditions

Low C&V conditions for LFPG:

- Visibility < 600 m or
- Ceiling < 200 ft

7.2% of observations during the analysed period (0.4% only low visibility reported, 2.9% only low clouds reported and 3.9% both). That is 240 hours

Verification

LOW C&V 3-4 h FCST	CI	H1D
POD	56	73
FAR	38	57

H1D: HH+06 / HH+07, that is, 3-4 h after ending the assimilation cycle.

3-4h fcst. Similar performance. H1D: higher POD and FAR. Because its higher cooling rate?

Before. COBEL performs better. Because its better initialisation?

Later. H1D performs better. Because its better treatment of horizontal unhomogeneity?

Conclusions

- SCM, in particular COBEL-ISBA and H1D, are useful tools for short-term C&V forecast.

- The initialisation is very important. Future development of H1D should, probably, focus on it.

- COBEL development should, probably, focus on its treatment of horizontal unhomogeneity.

- Model intercomparison experiments are excellent tools to identify the weakest part of a model, to find out which aspect is worth to work on.