Fog Forecasting at Roissy Airport (Paris) with 1D model

Thierry Bergot and Joël Noilhan
Météo-France

1) Methodology
   Cobel : 1D model of boundary layer
   Isba : soil/vegetation/ atmosphere interactions

2) Specific measurements at Paris airport

3) Preliminary results for 2002-2003 winter season

4) Towards an estimation of the uncertainty of the forecast

requirement for fog forecating

Roissy (Paris) airport

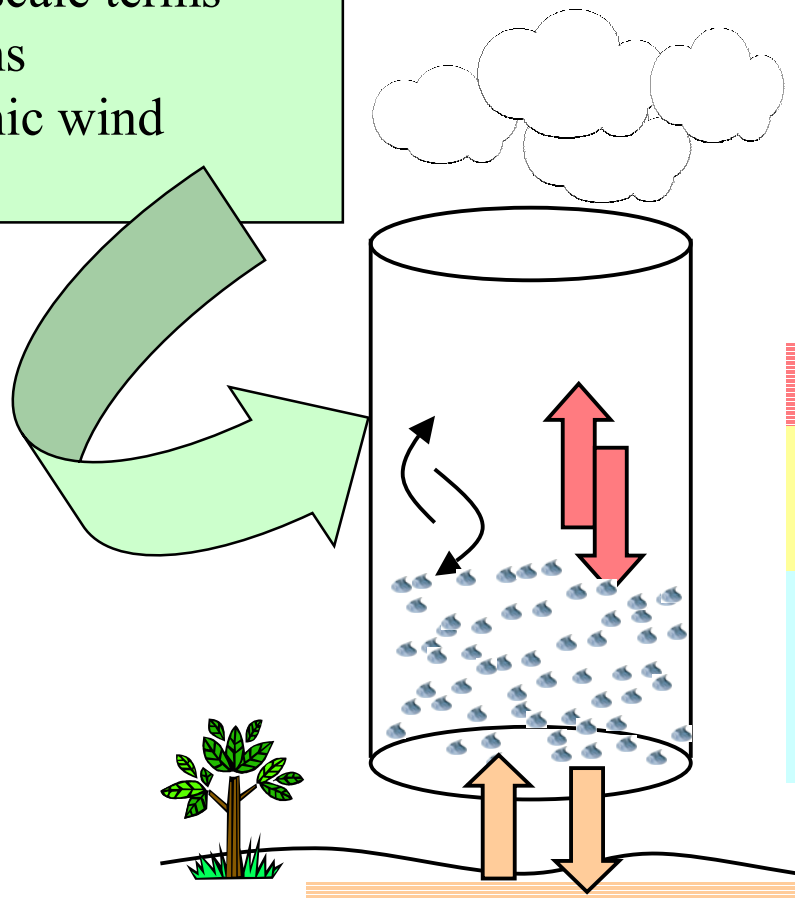
- 6th world airport in term of aircraft landing
- 42 days / year of fog (visibility < 600m)
- Saturation during fog events : it is necessary to improve the forecast of low visibility at very short range (1 to 6 hours)

Research at Météo-France

- Beginning of a research program in 2002
- Goal : study how to improve the forecast of low visibility at very short range for specific site (numerical model, observations)
- Roissy : selected site for testing the method

The numerical methodology

Mesoscale terms
- Advections
- Geostrophic wind
- clouds



COBEL

Radiative processes (IR+vis)

Turbulent processes (stable cases)

Microphysical processes (condensation-evaporation, sedimentation)

Exchanges between soil, vegetation and atmosphere

ISBA

The Cobel 1D model

(Bergot 1993 ; Bergot and Guedalia 1994 ;Guedalia and Bergot, 1994)

$$\frac{\partial u}{\partial t} = f(v - v_g) - \frac{\partial}{\partial z}(\overline{w'u'}) - \left[\frac{\partial u}{\partial t}\right]_{meso}$$

$$\frac{\partial v}{\partial t} = -f(u - u_g) - \frac{\partial}{\partial z}(\overline{w'v'}) - \left[\frac{\partial v}{\partial t}\right]_{meso}$$

$$\frac{\partial \theta}{\partial t} = -\frac{\partial}{\partial z}(\overline{w'\theta'}) + \frac{\theta}{\rho C_p T}\frac{\partial F_r}{\partial z} + \frac{\theta L}{C_p T}C - \left[\frac{\partial \theta}{\partial t}\right]_{meso}$$

$$\frac{\partial q_v}{\partial t} = -\frac{\partial}{\partial z}(\overline{w'q_v'}) - C - \left[\frac{\partial q_v}{\partial t}\right]_{meso}$$

$$\frac{\partial q_l}{\partial t} = -\frac{\partial}{\partial z}(\overline{w'q_l'}) + C - P + \frac{\partial G_c}{\partial z} - \left[\frac{\partial q_l}{\partial t}\right]_{meso}$$

$$\left[\frac{\partial X}{\partial t}\right]_{meso} = u\frac{\partial X}{\partial x} + v\frac{\partial X}{\partial y} + w\frac{\partial X}{\partial z}$$

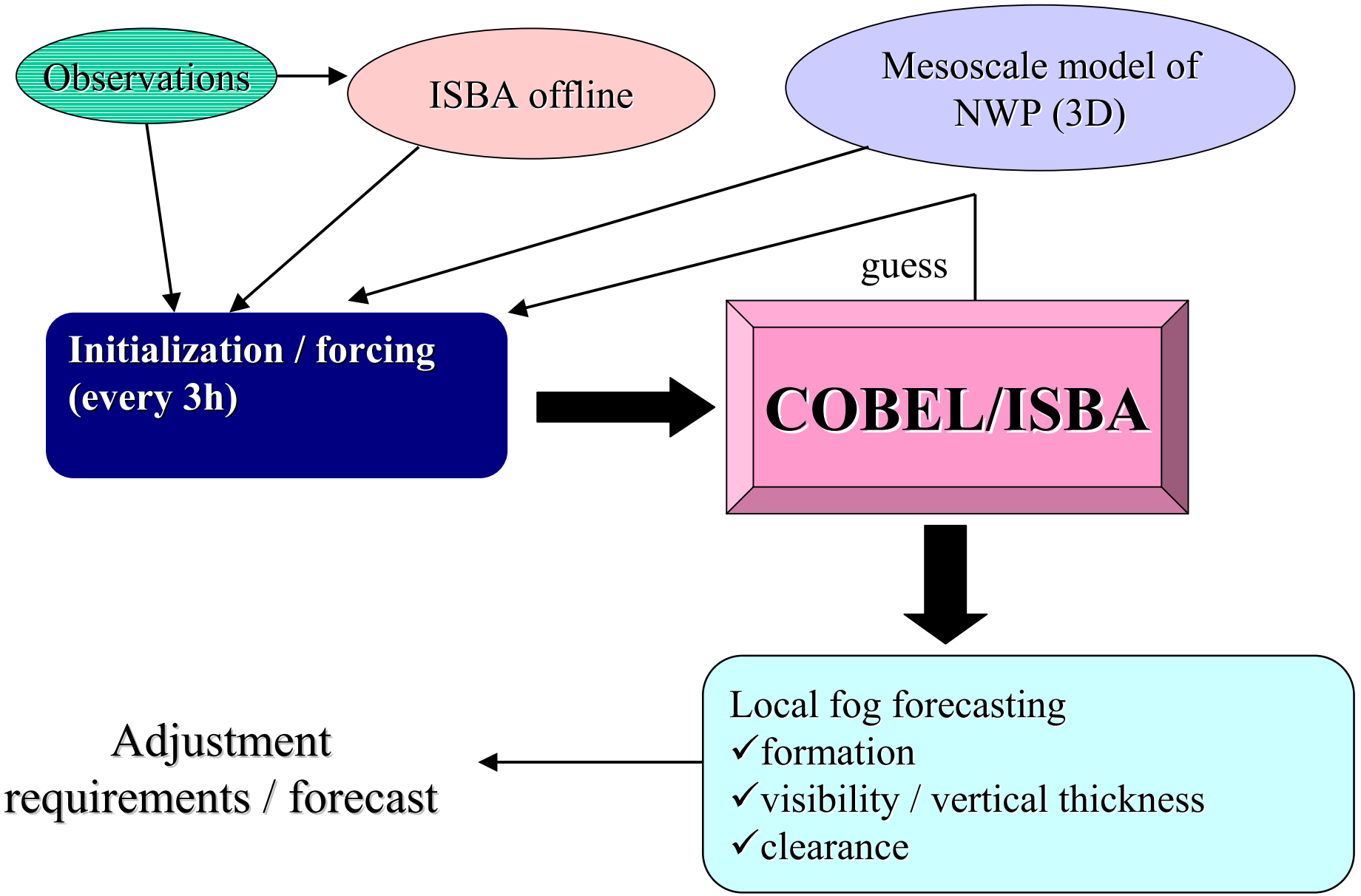
Physical parameterizations

- Radiative transfer (232 spectral intervals)
- Turbulent scheme : turbulent kinetic energy

Fine mesh vertical grid

- First level : 0.5m
- 20 levels below 200m

The local forecast method

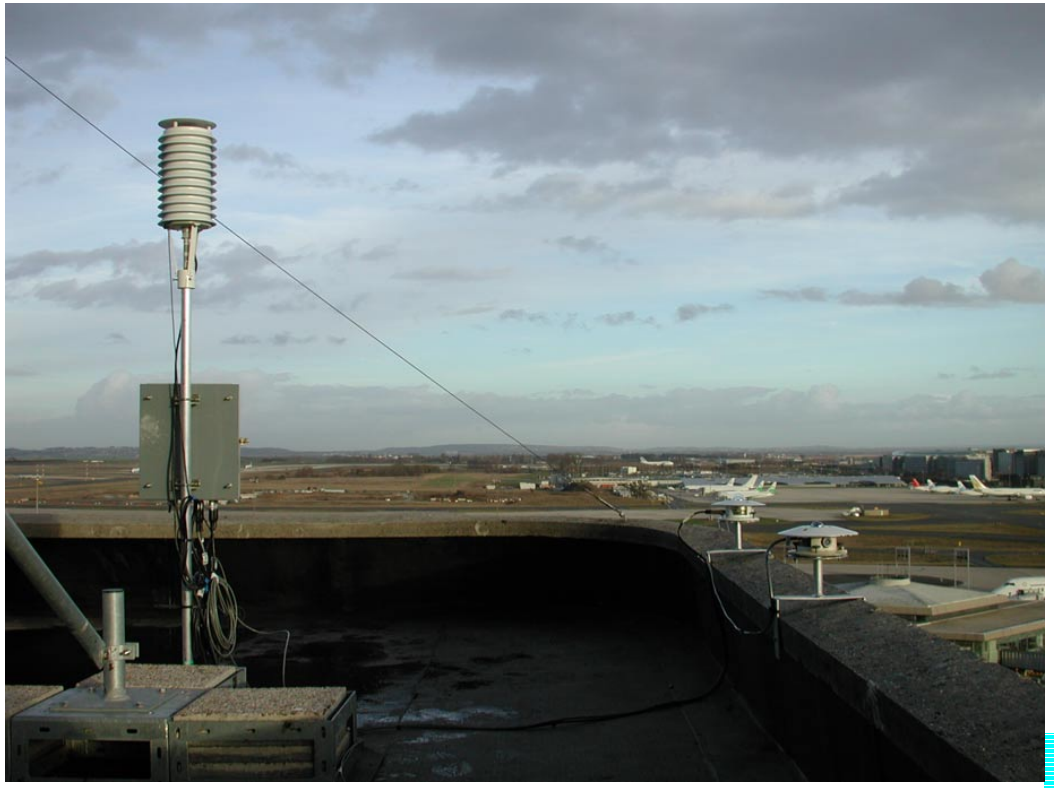


specific observations at Roissy airport

30 meters height tower :
measurement of temperature and humidity at 1, 5 10, 20, 30m

observations near the ground :
- temperature and water content inside the soil
- radiative fluxes

specific observations at Roissy airport



observations at 45m :
- radiative fluxes
- temperature / humidity

Other instruments :
- Sodar (detection of the fog top)
- 12 PTA (RVR) (visibility)
- 4 cloud telemeters

beginning : December 2002
data : mean every 15 minutes

preliminary results for 2002-2003 winter season

➢Number of events

not enough for statistical evaluation

✓10 events in December 2002-March2003 period
✓representativeness of these events?

➢Requirement of local observations

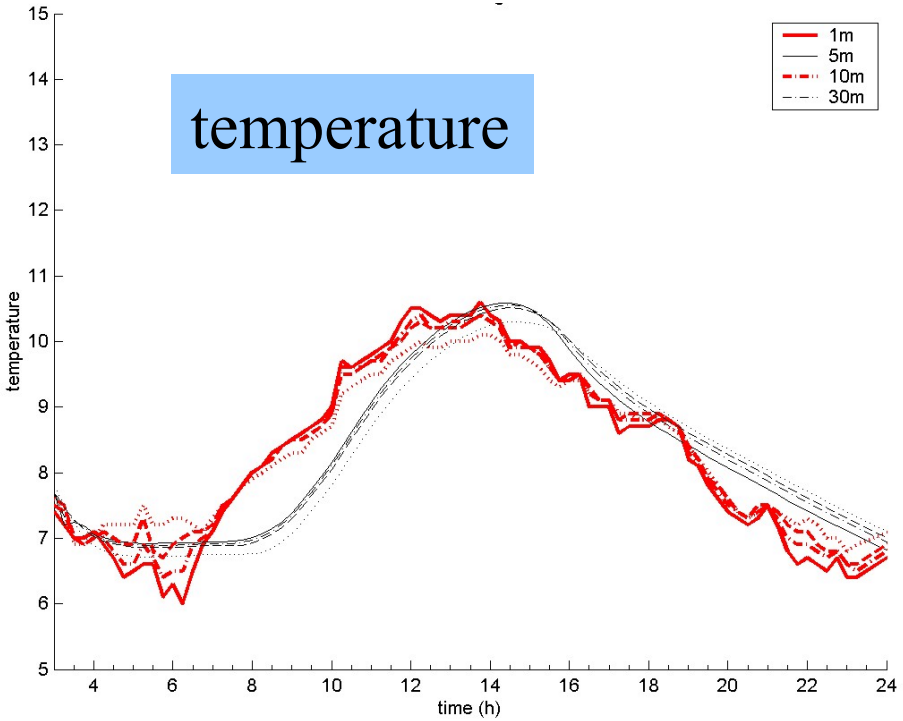
✓the forecast of mesoscale NWP model is not precise enough to initialize the local COBEL/ISBA model

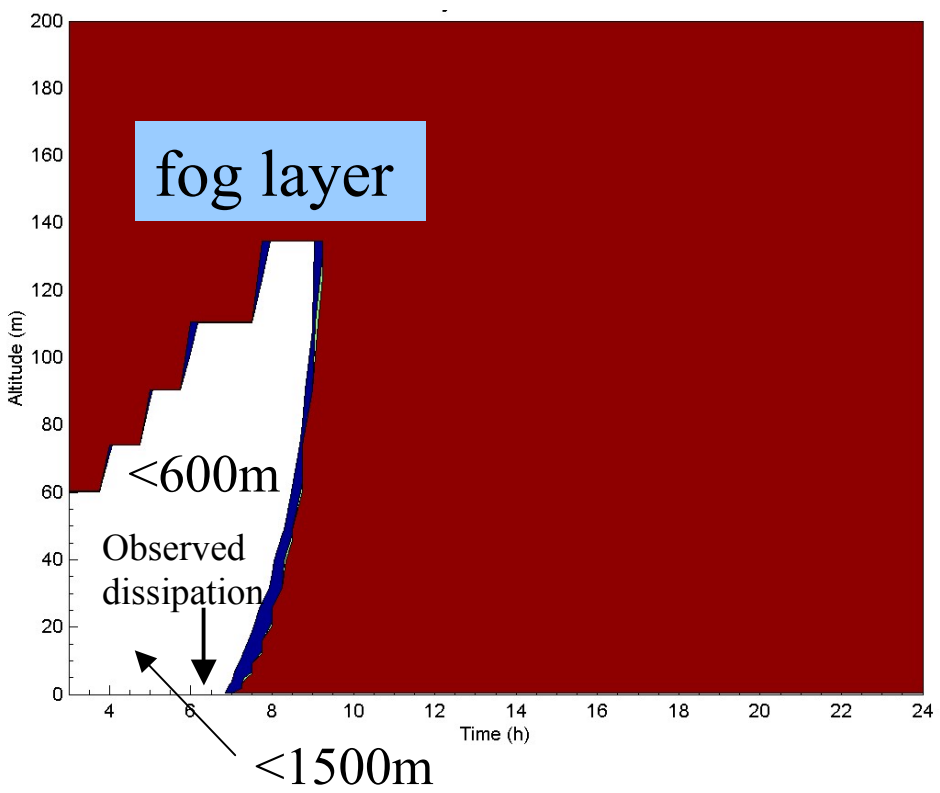
➢Forecast performance

✓fog piloted by the radiative processes are well forecasted (3 hours)
✓the effect of the mesoscale processes (advection, clouds) is predominant after 3-6 hours

a well forecasted fog case

28 december 2002





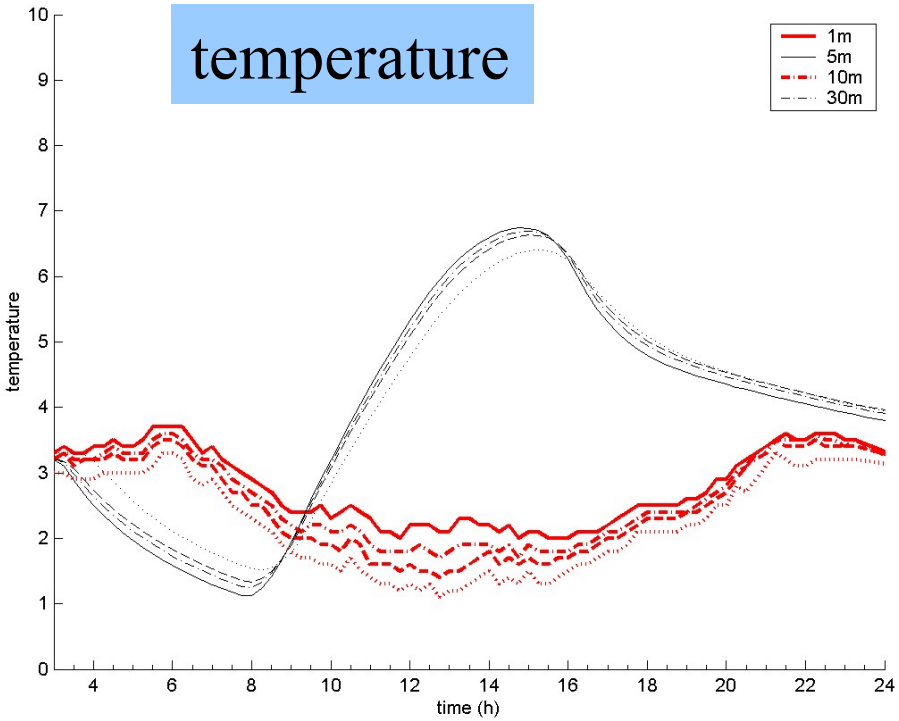
✓thermodynamical evolution of the atmosphere is well forecasted (simulated temperature : black, observed temperature : red)

✓the evolution of the fog layer (dominated by the local term for this case) is well forecasted

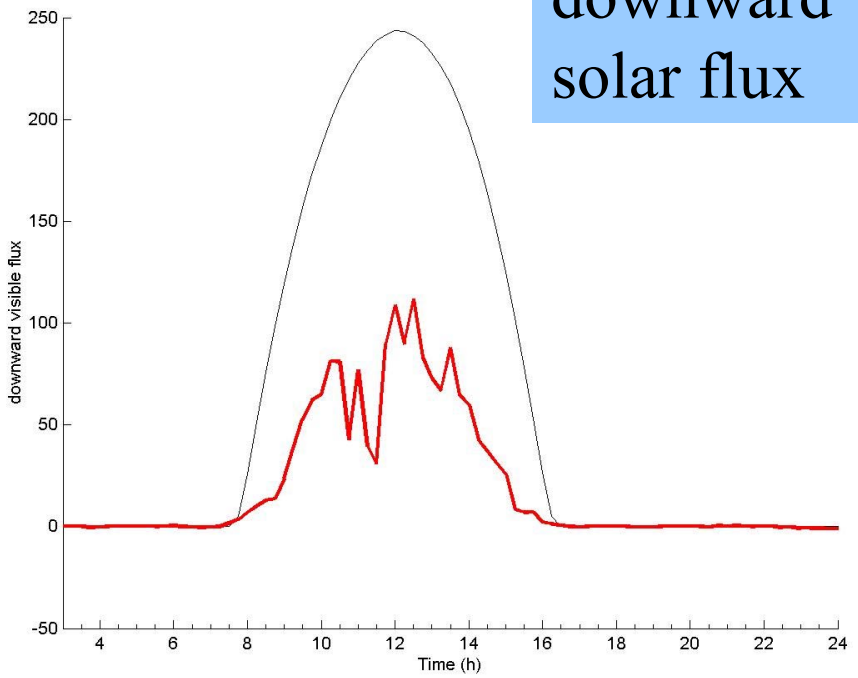
a non-initialized stratus

18 january 2003

temperature



downward solar flux



✓stratus observed at initial time (radiative flux in red) – not initialized in the COBEL-ISBA forecast (radiative flux in black)

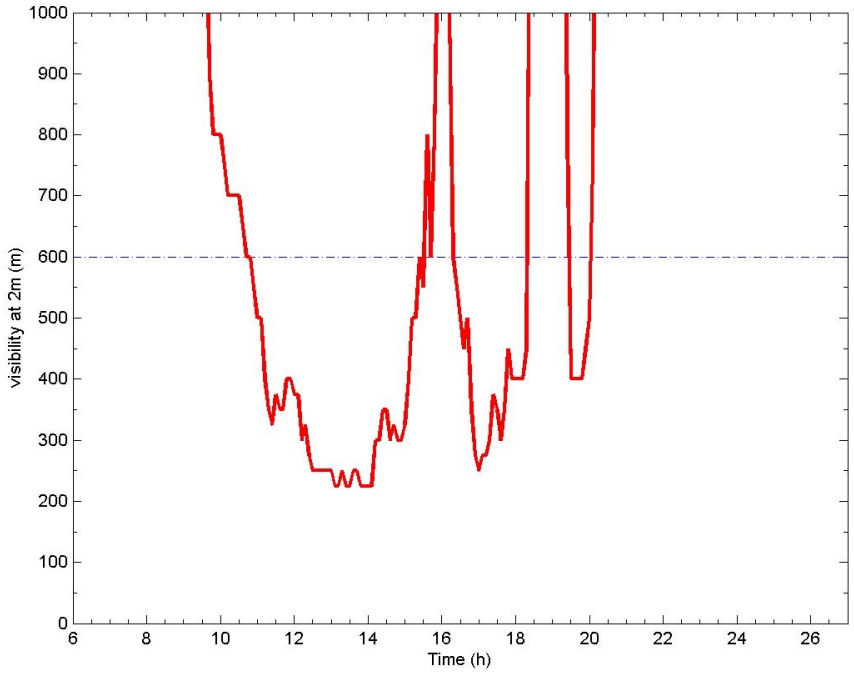
✓strong effect on the evolution of the temperature near the ground (observed in red, forecasted in black)

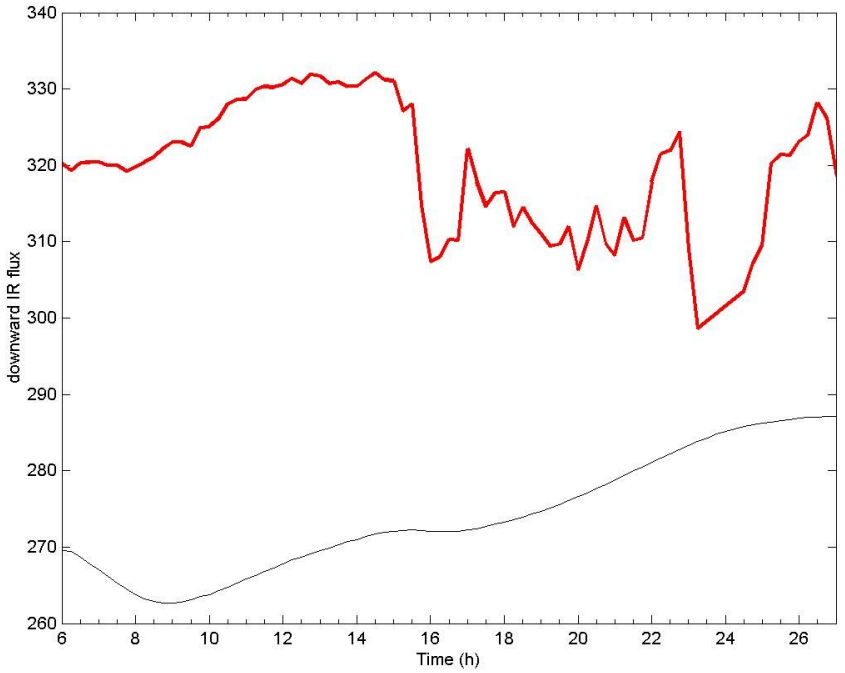
a stratus evolving in fog

visibility at 2m

12 december 2002

downward IR flux





✓stratus observed at initial time (radiative flux in red) – not initialized in the COBEL-ISBA forecast (radiative flux in black)

✓the stratus layer evolve in a fog layer, after sunrise

conclusions (partial!)

➢Not enough documented cases !

The field experiment will continue in Roissy!

➢Some preliminary results

- situations dominated by local effect are well forecasted
- influence of mesoscale forcing after 3-6h
- importance of the low level clouds (initialization)

future work

➢Optimal use of local observations

How to use the local observations?

- •atmosphere / soil : 1D-Var
- •low clouds : telemeters, radiative fluxes, sodar

➢Study of fog predictability

statistical postprocessing of COBEL-ISBA forecast :

- •local parameters (nocturnal inversion, etc)
- •physical processes (microphysics, etc)

ensemble forecast :

- •1D ensemble forecast (on PC!)
- •uncertainty on mesoscale forcing terms (clouds!)
- •uncertainty on local conditions