



Cloudy and clear cases in Sodankylä

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**Nordic temperature problem
Sodankylä data
HIRLAM experiments
January 2007 comparisons
Conclusions**





Nordic temperature problem

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Nordic temperature problem

In the model, too warm predicted near-surface temperatures in a stable arctic boundary layer. Differences between observation and forecast of the order of ten degrees are common. In reality, clear sky, no significant SW radiation, shallow surface layer with strong surface temperature inversion over snow covered surface. Relative humidity may be large but not close to saturation. Observed latent and sensible heat fluxes are small, in the model generally somewhat larger. Extra clouds/fog may form in HIRLAM.

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Nordic temperature problem

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Contributing factors

- Radiation fluxes: the role of clouds ?
- Heat flux from soil : the role of snow ?
- Turbulent fluxes : handling of very stable surface layer ?
- Surface data-assimilation ?
- Vertical resolution of the model ?

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Sodankylä data

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Sodankylä data

- High temporal resolution soundings
- AWS data, including ceilometer
- Radiation measurements
- Profiles from 50m mast
- Turbulent fluxes from mast
- Soil and snow temperatures

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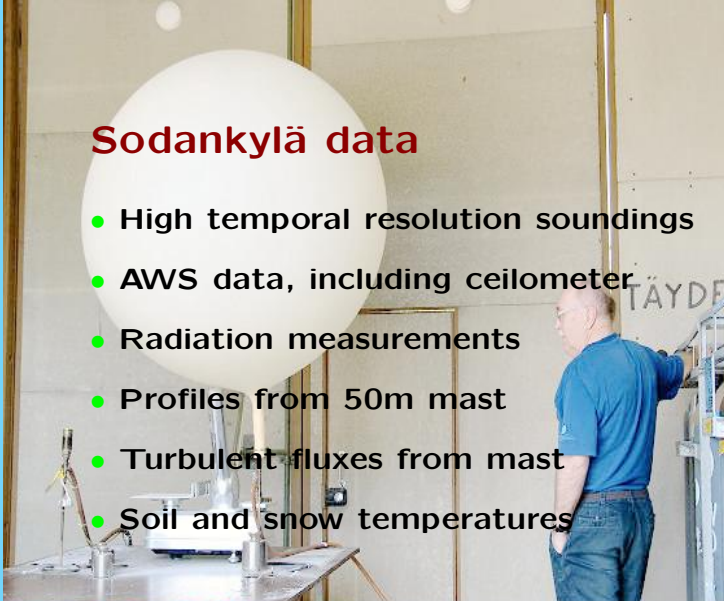
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⇒ Analysis of surface energy balance + clouds

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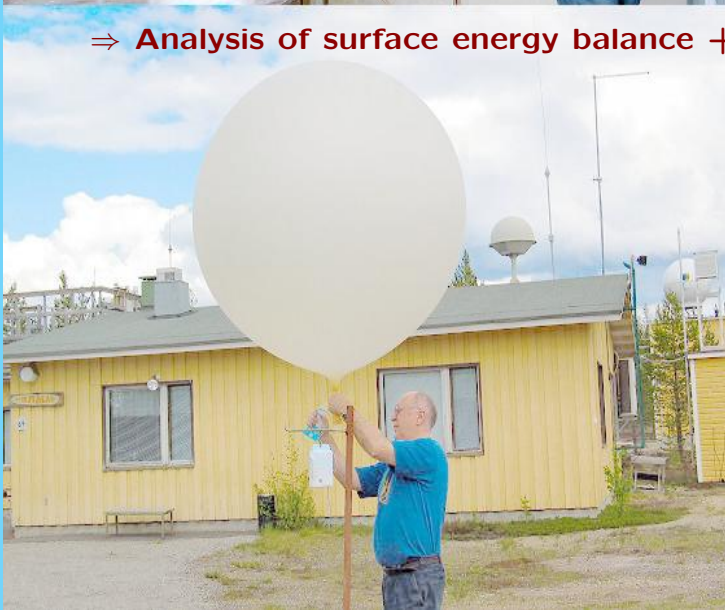
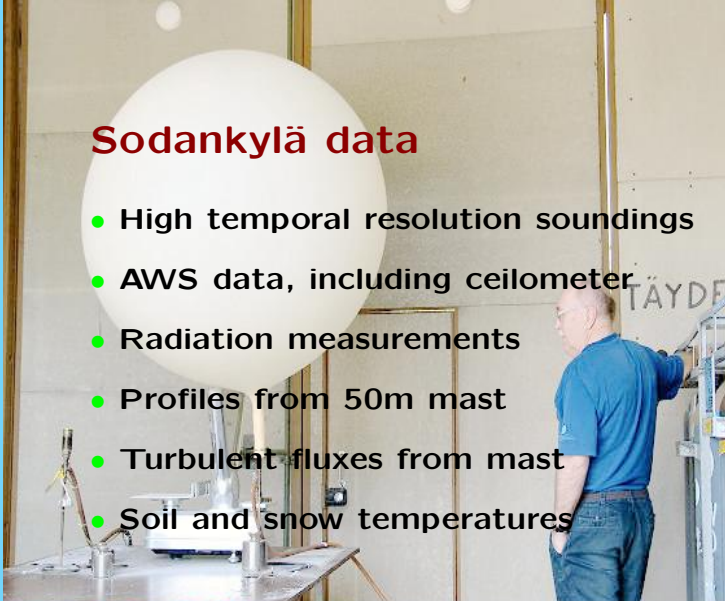
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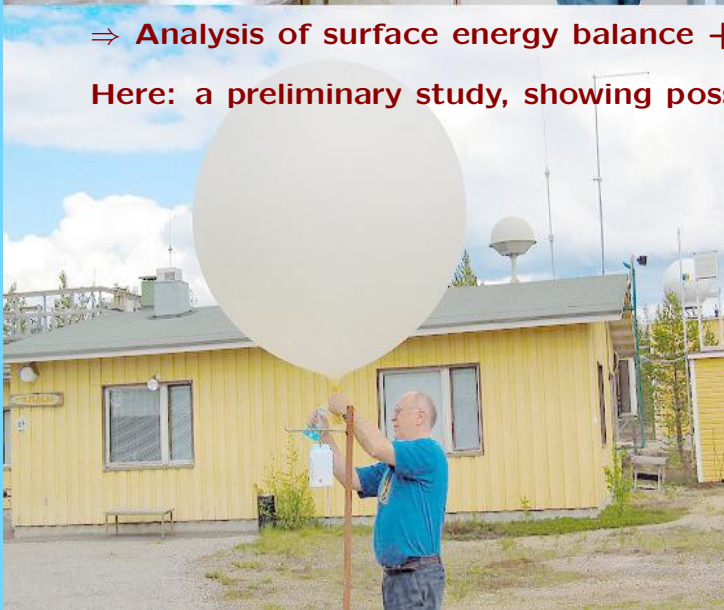
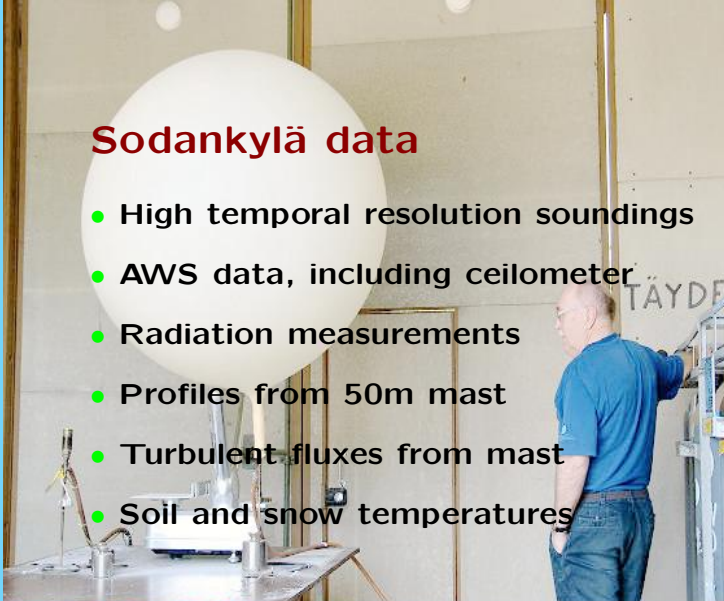


Sodankylä data

- High temporal resolution soundings
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- Radiation measurements
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⇒ Analysis of surface energy balance + clouds

Here: a preliminary study, showing possibilities



Micrometeorological mast

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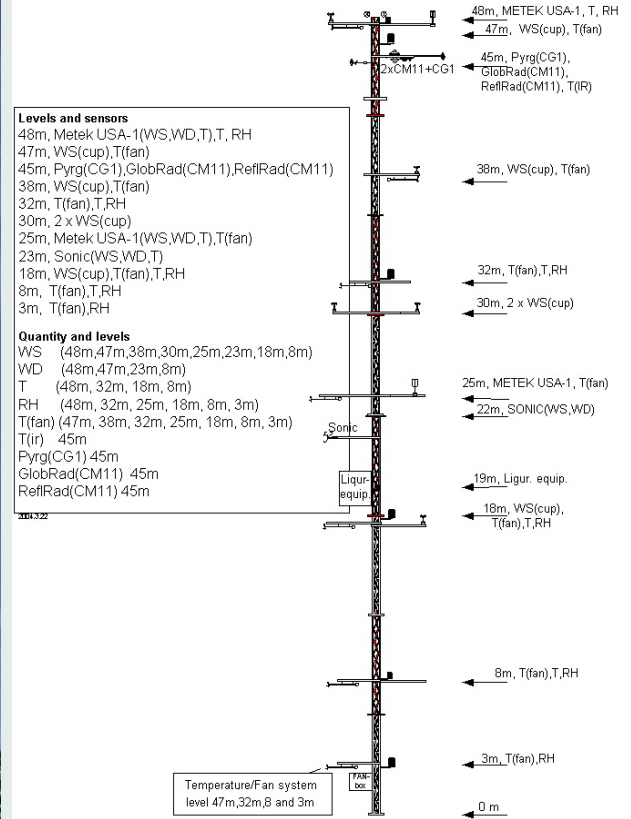
SODANKYLÄ MICROMETEOROLOGICAL MAST

Levels and sensors

48m, Metek USA-1(WS,WD,T),T, RH
 47m, WS(cup),T(fan)
 45m, Pyrg(CG1),GlobRad(CM11),RefRad(CM11)
 38m, WS(cup),T(fan)
 32m, T(fan),T,RH
 30m, 2 x WS(cup)
 25m, Metek USA-1(WS,WD,T),T(fan)
 23m, Sonic(WS,WD,T)
 18m, WS(cup),T(fan),T,RH
 8m, T(fan),T,RH
 3m, T(fan),RH

Quantity and levels

WS (48m,47m,38m,30m,25m,23m,18m,8m)
 WD (48m,47m,23m,8m)
 T (48m,32m,18m,8m)
 RH (48m,32m,25m,18m,8m,3m)
 T(fan) (47m,38m,32m,25m,18m,8m,3m)
 T(ir) 45m
 Pyrg(CG1) 45m
 GlobRad(CM11) 45m
 ReflRad(CM11) 45m





HIRLAM experiments

Table 1: HIRLAM experiment setup

boundaries	HIRLAM RCR 22km/40L
domain	Northern Europe
resolution	11 km / 60 lev
HIRLAM versions	7.1beta and "newsnow"
initial analysis	surface analysis only
validation	standard + Sodankylä

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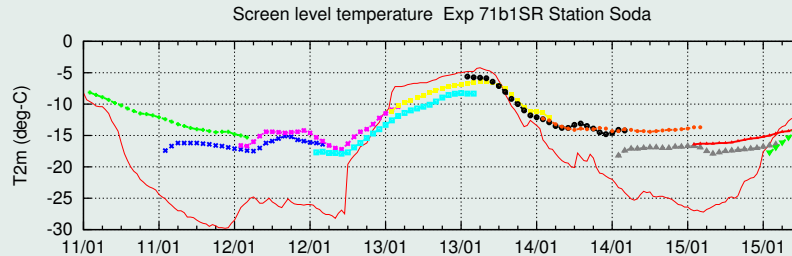
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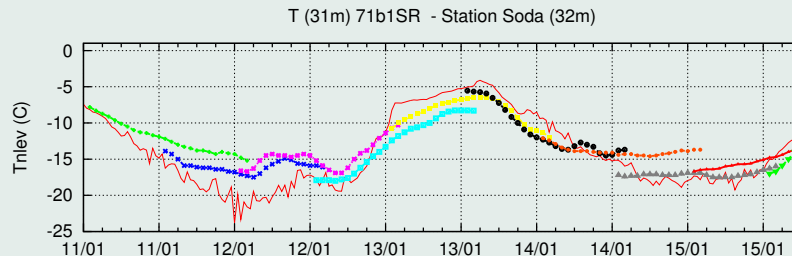


January 2007 example: HIRLAM reference

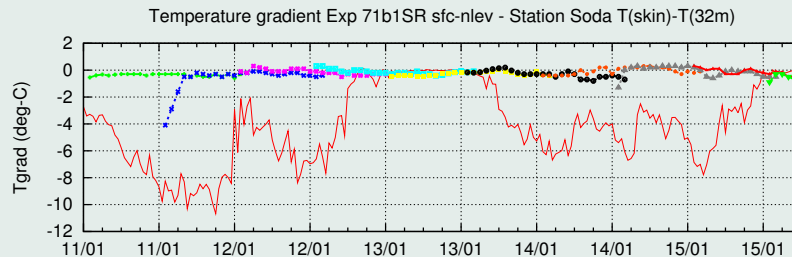
Temperature AWS 2m/Hirlam 2m



Temperature mast 31m/Hirlam 32m



Temperature gradient Ts-Tnlev mast/Hirlam



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Observed temperatures -1 ... 48 m: soil, snow and mast

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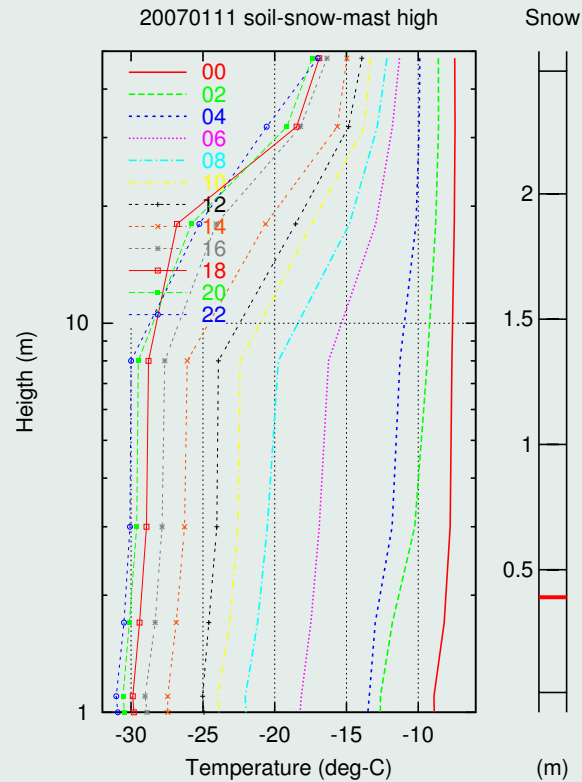
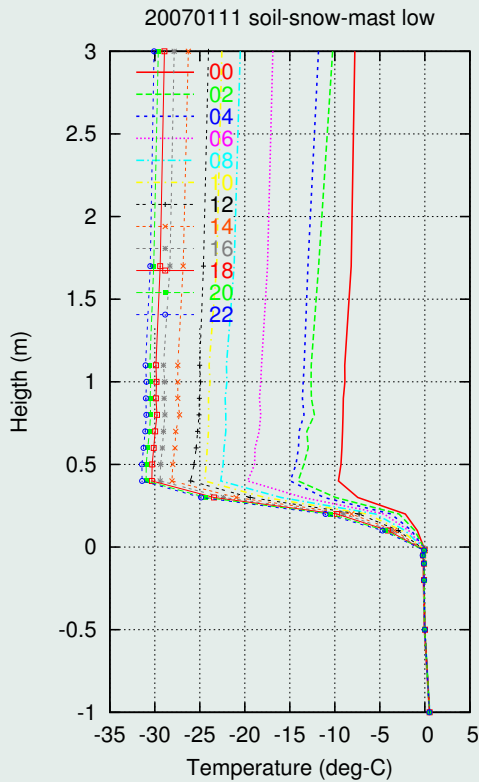
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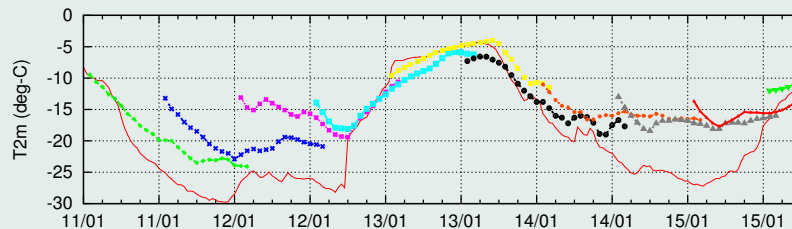


January 2007: HIRLAM “newsnow”



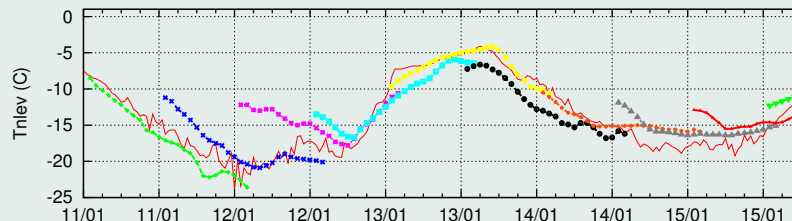
Temperature AWS 2m/Hirlam 2m

Screen level temperature Exp 71a3nS Station Soda



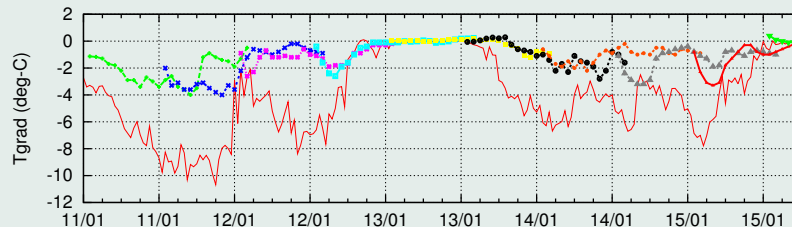
Temperature mast 31m/Hirlam 32m

T (31m) 71a3nS - Station Soda (32m)



Temperature gradient Ts-Tnlev mast/Hirlam

Temperature gradient Exp 71a3nS sfc-nlev - Station Soda T(skin)-T(32m)



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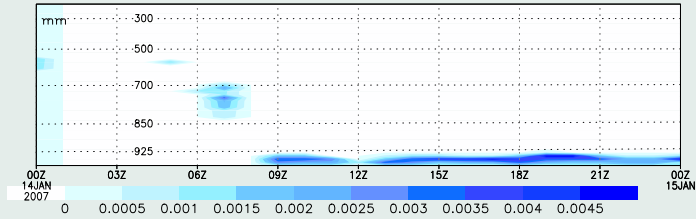
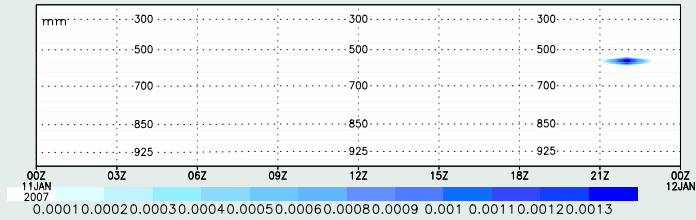
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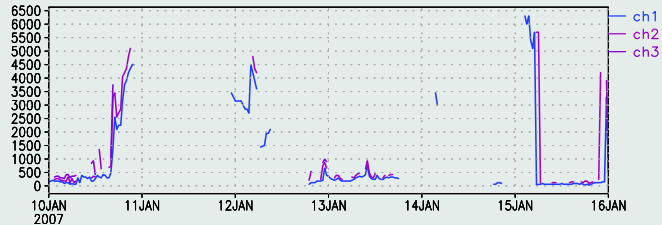
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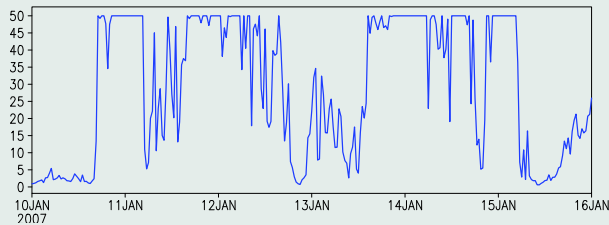
Cloud condensate beta1



Cloud height, m

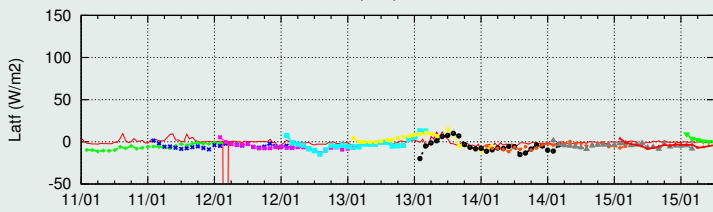
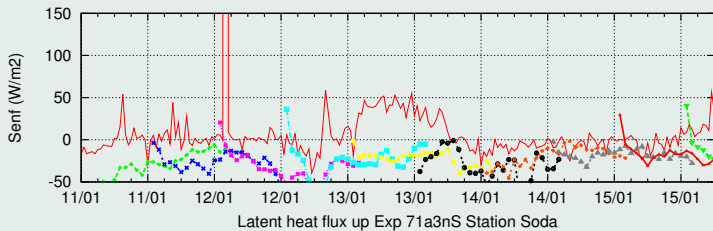
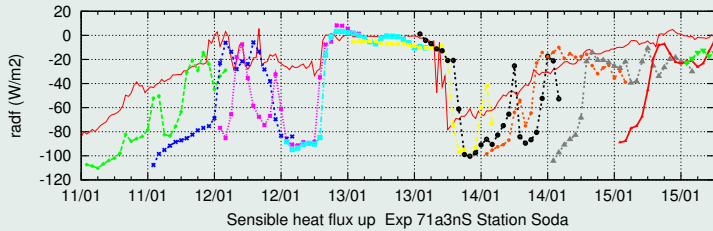
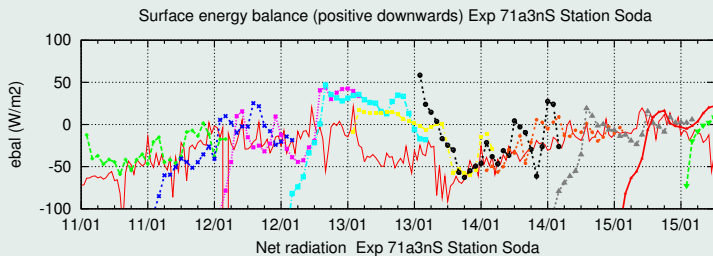


Visibility, km





Components of energy balance - HIRLAM "newsnow"



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Components of energy balance - HIRLAM "newsnow"

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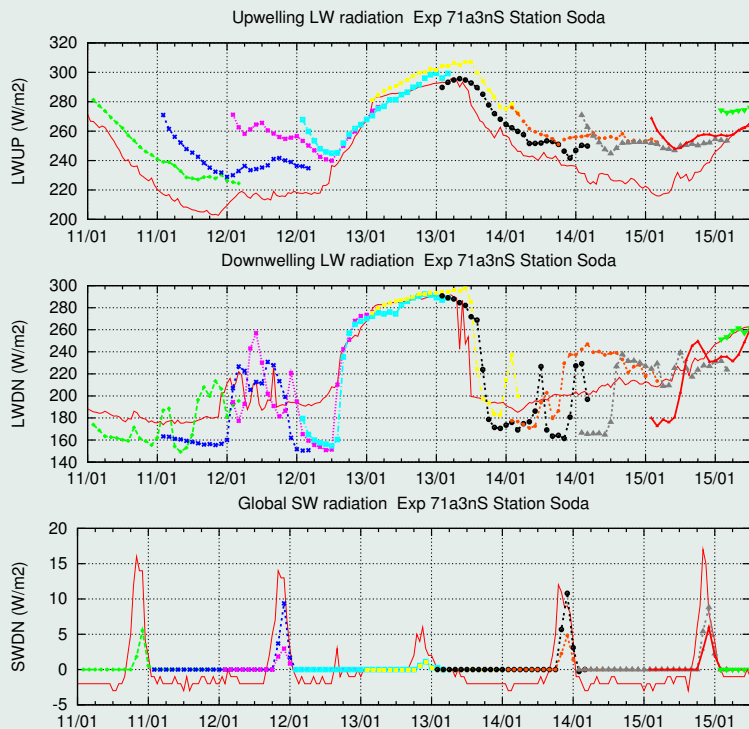
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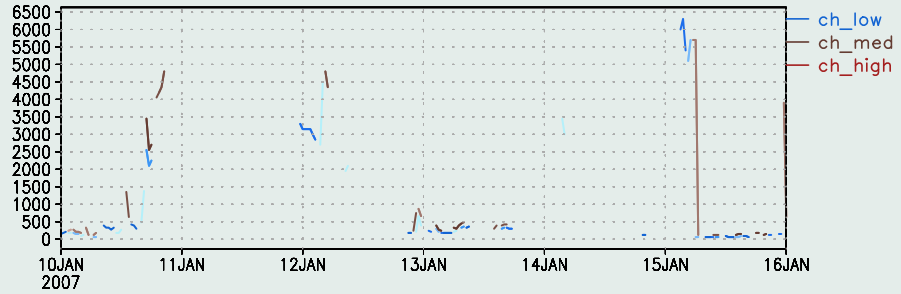
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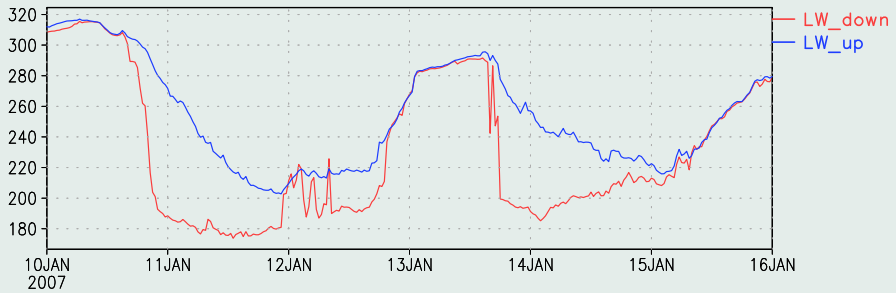
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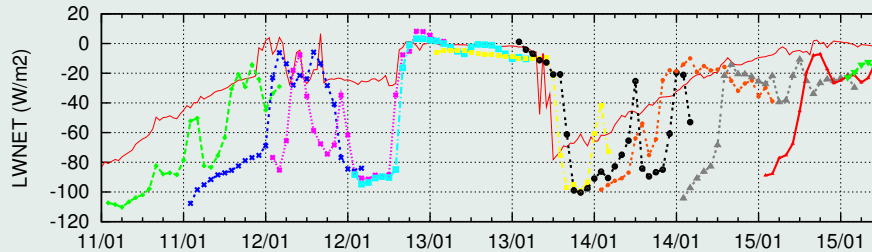
Cloud height, m



LW radiation, Tower, 18m, W/m^2



Net longwave radiation Exp 71a3nS Station Soda

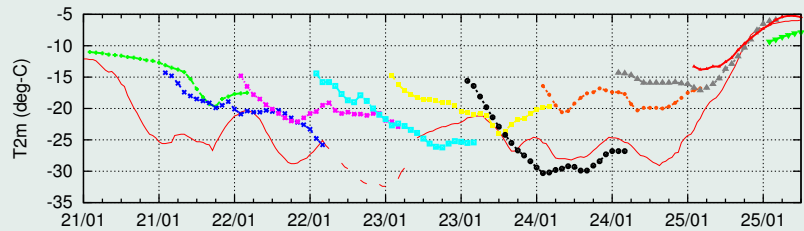




January 2007: HIRLAM "newsnow"

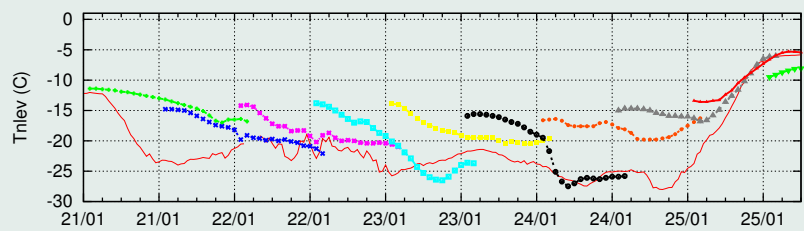
Temperature AWS 2m/Hirlam 2m

Screen level temperature Exp 71a3nS Station Soda



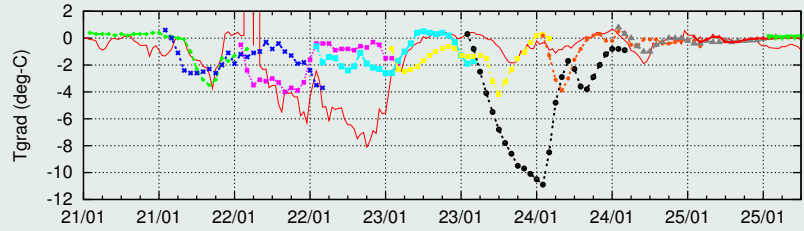
Temperature mast 31m/Hirlam 32m

T (31m) 71a3nS - Station Soda (32m)



Temperature gradient Ts-Tnlev mast/Hirlam

Temperature gradient Exp 71a3nS sfc-nlev - Station Soda T(skin)-T(32m)



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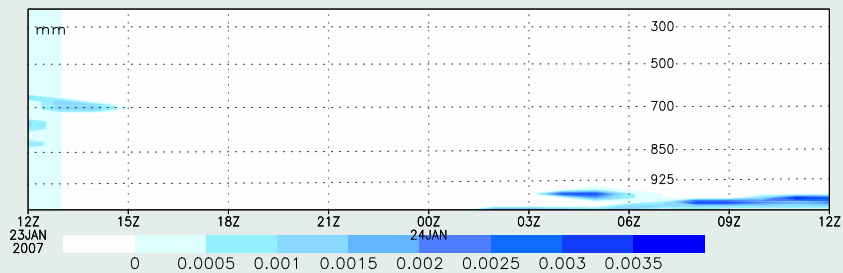
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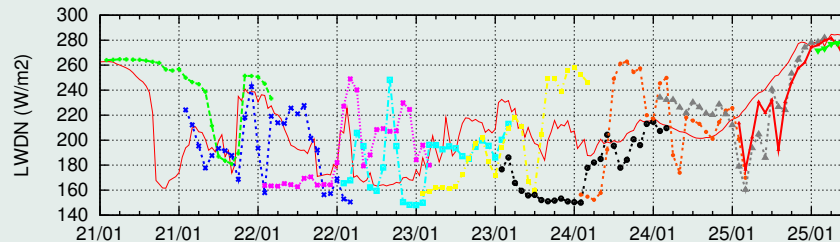
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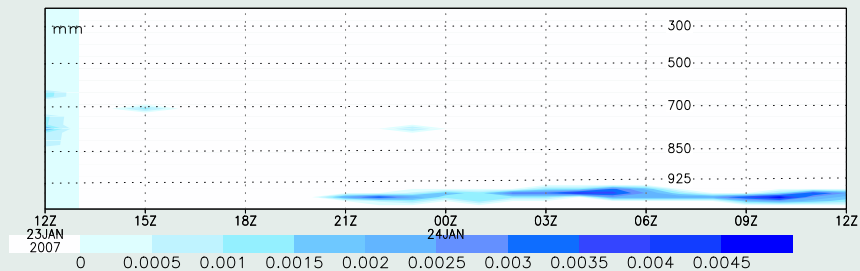
Cloud condensate newsnow



Downwelling LW radiation Exp 71a3nS Station Soda



Cloud condensate beta1





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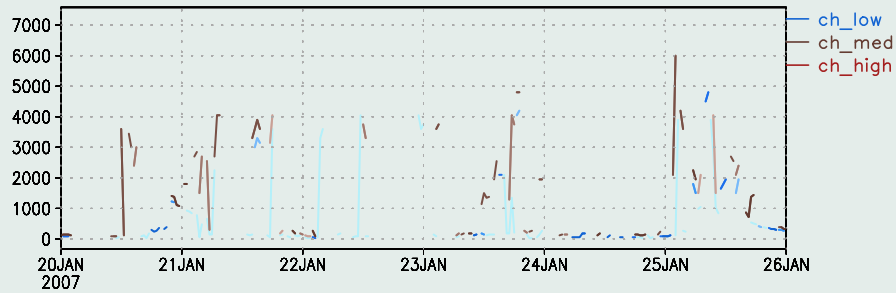
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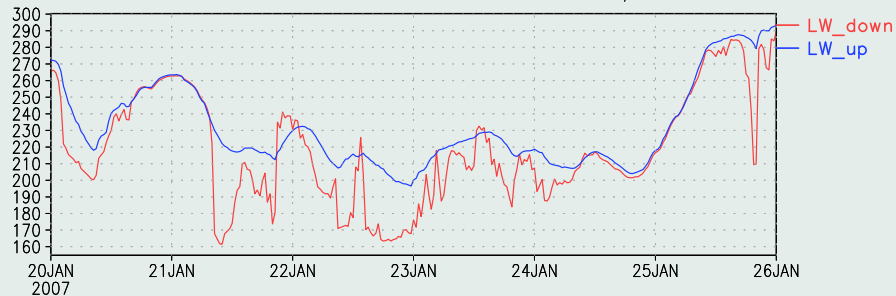
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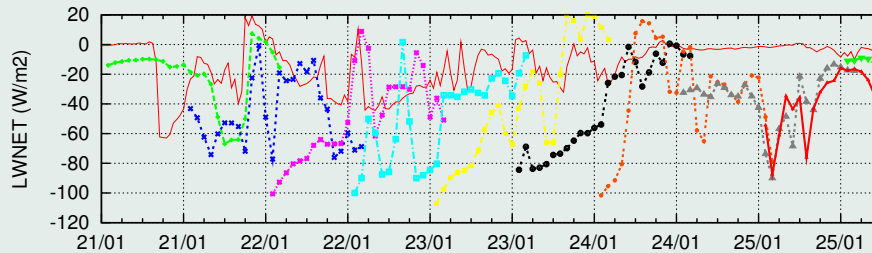
Cloud height, m



LW radiation, Tower, 18m, W/m^2



Net longwave radiation Exp 71a3nS Station Soda





Conclusions

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Conclusions

- Done and learned until now
- Unique data + tools for Sodankylä comparisons available
- Sensitivity of the energy balance in the shallow, stable arctic PBL
- Strange behaviour of the initial state with the HIRLAM “newsnow” - bugs ?

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Conclusions

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Possibilities for further studies

- Improved use of observations:
ceilometer, fluxes at different levels, high resolution sounding data ...
- 1D and 3D studies related to turbulent fluxes
- Long-term comparisons using statistical measures

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Thanks

Antti Aarva, Mika Aurela, Reijo Hyvönen, Markku Kangas
Rigel Kivi, Ivan Mammarella, Antti Poikonen
Jani Poutiainen, Daria Stepanova, Timo Vihma

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Thanks

Antti Aarva, Mika Aurela, Reijo Hyvönen, Markku Kangas

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Jani Poutiainen, Daria Stepanova, Timo Vihma

Thank YOU for attention!

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