HIRLAM physics changes and their possible impact on ACT

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Physics changes

- Vertical diffusion
  - Stable mixing
  - Moist conservative parameters
- Orographic drag parameterization
- Other reference convection/condensation scheme
- New surface scheme development

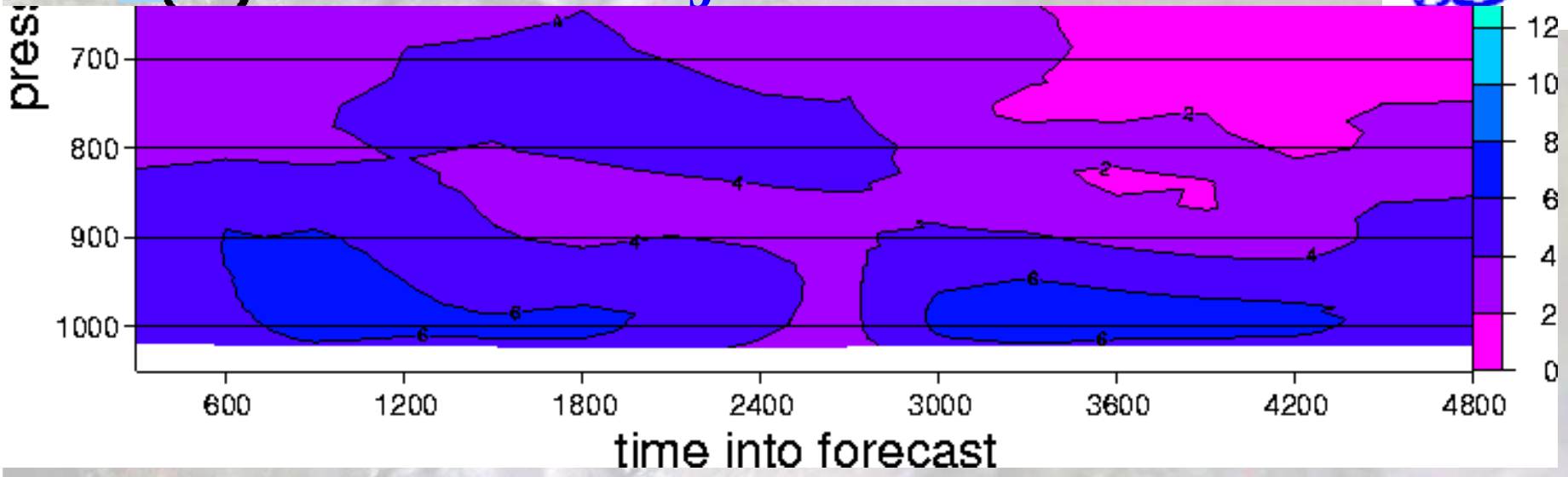
Importance physics

- ACT modeling strongly influenced by meteorology of model
- Large scale flow characteristics determined by data assimilation
- Local details determined by physics
  - PBL mixing
  - Surface fluxes (and emissions)
  - Rain out and wash out
  - Advection by local flow

Physics

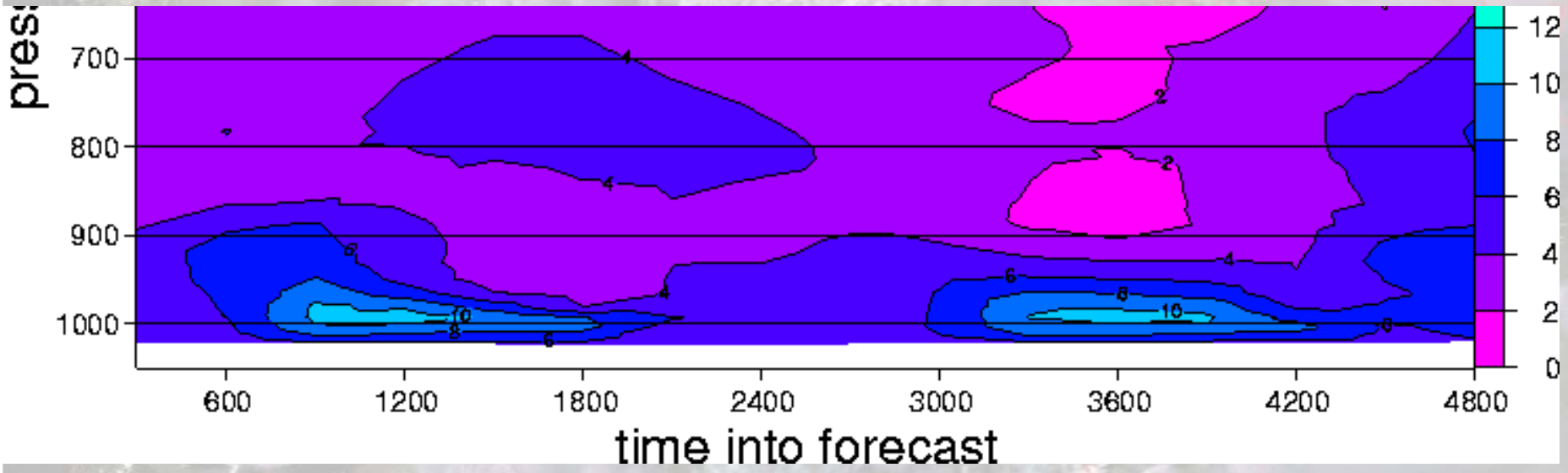
- Vertical diffusion
  - In older versions more vertical diffusion (around version 6.2.4), improved in 6.3.5, small changes again in 7.2
  - Impact on wind speed profiles and 10-m wind in stable conditions
  - Transition from dry conservative parameters to moist conservative parameters
  - Impact on cloud water profiles and precipitation from certain cloud types (stratocumulus), fewer small precipitation amounts

Low level jet in HIRLAM



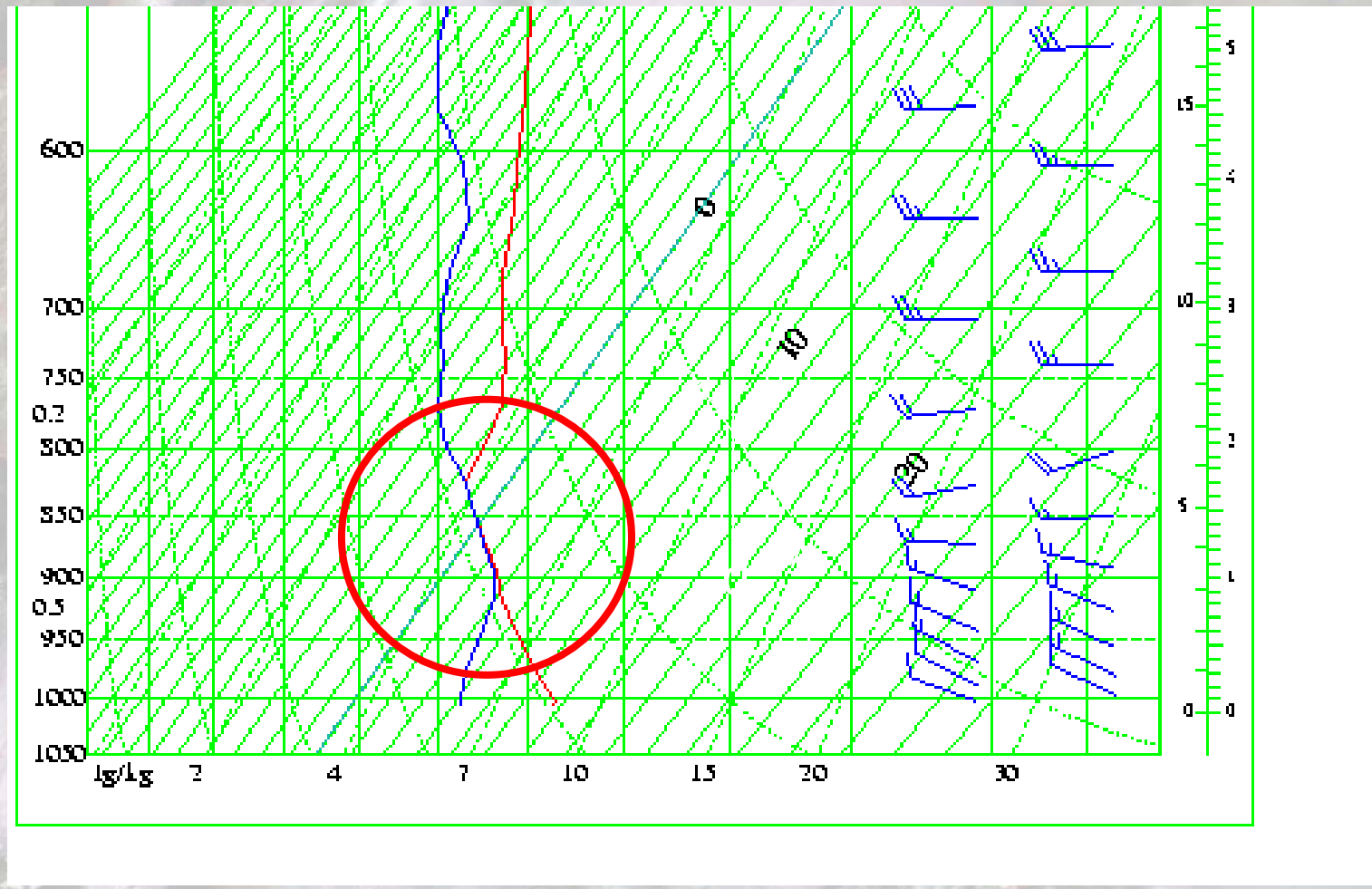
6.2.4 (before 2005)

6.3.5 (2005-now)



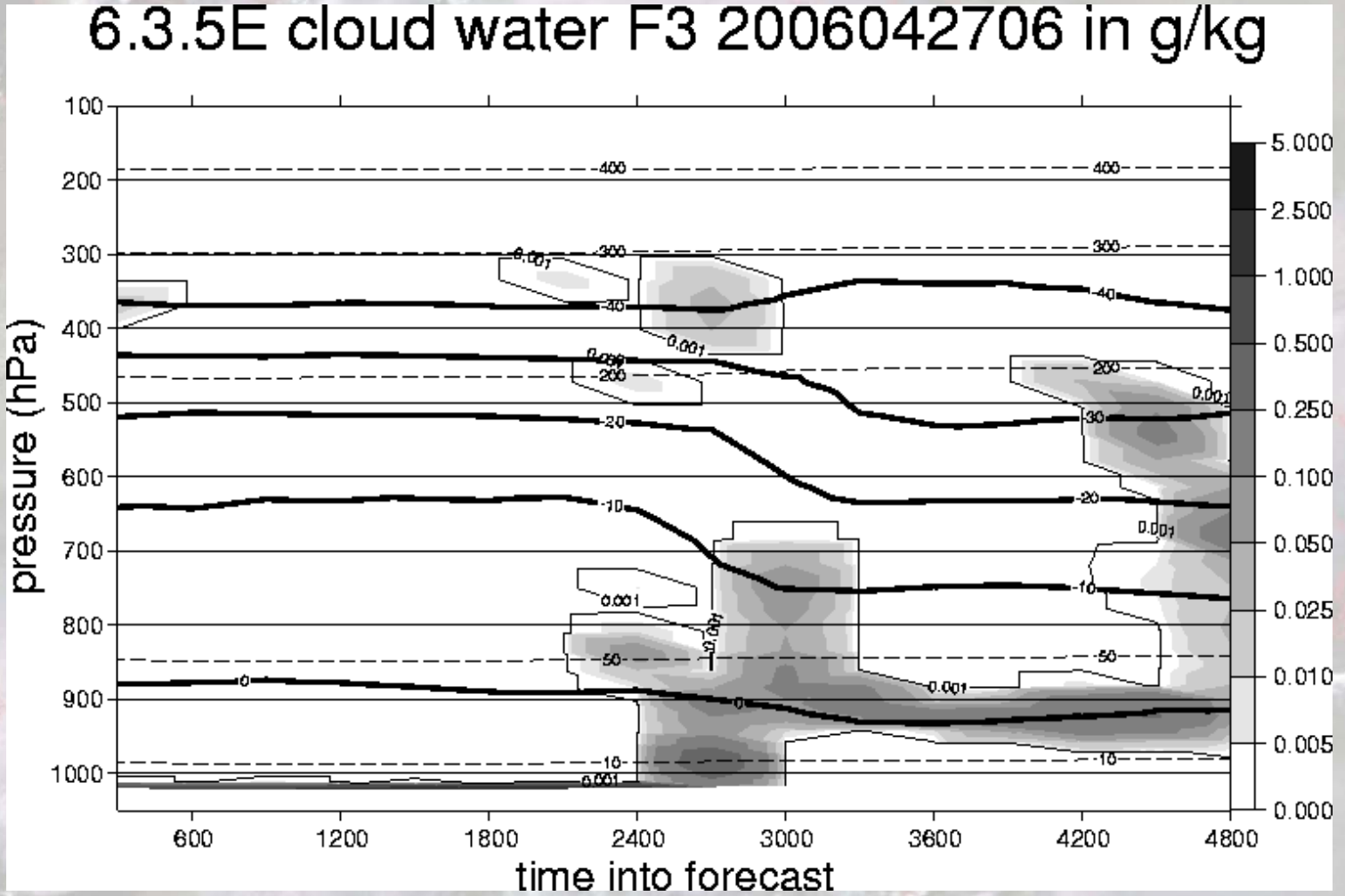
Moist conservative parameter

- Dry unstable profile in moist conditions



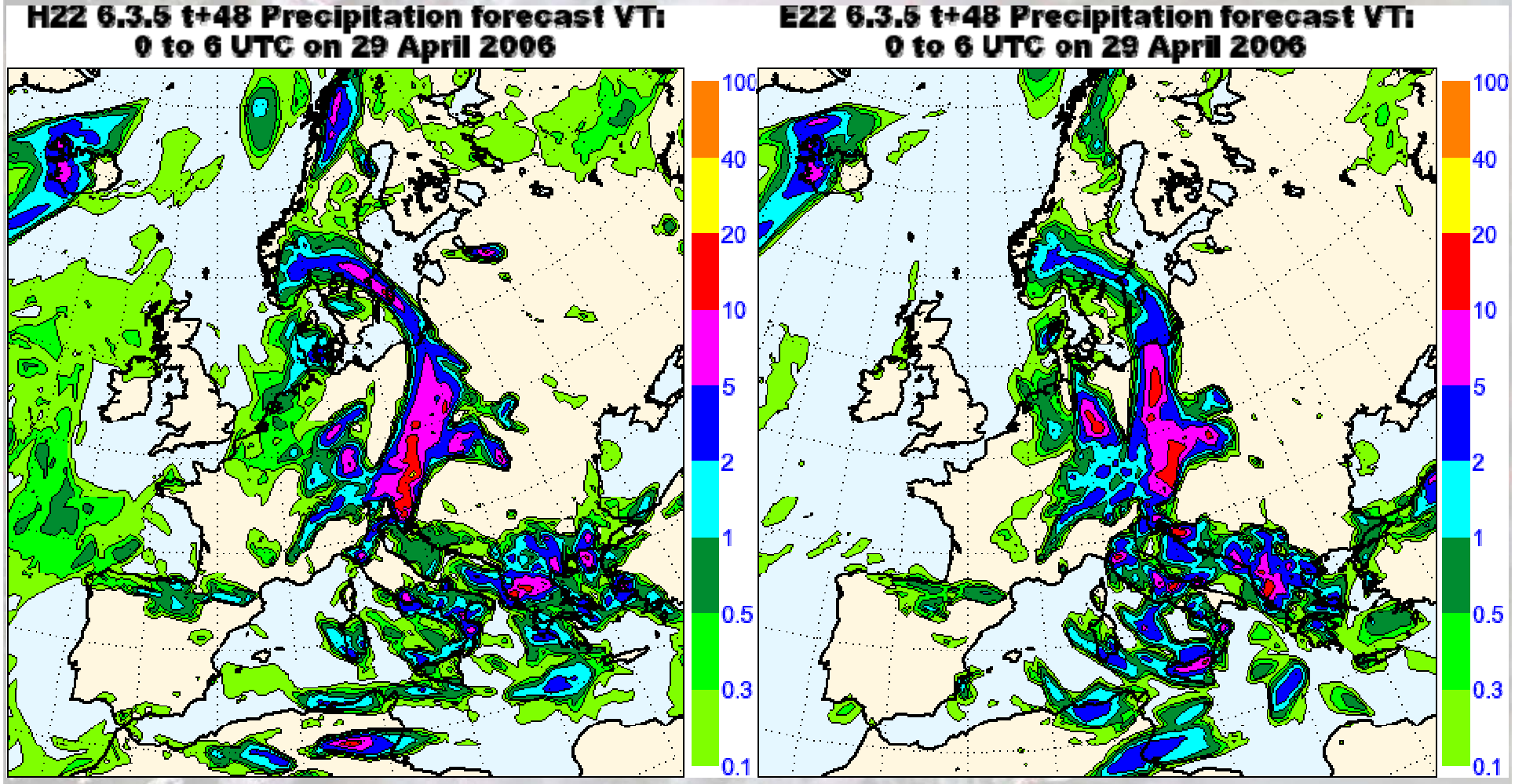
Moist CBR

- Impact on cloud water profiles



Moist CBR

- Impact on precipitation



Physics

- MSO/SSO
  - MSO: applies the impact of mountains and mountain ridges on flow (flow blocking, mixing high in atmosphere due to breaking waves). Larger scales in orography. Decreasing importance with increasing resolution
  - SSO: represents the impact of subgrid scale orography on the turbulent characteristics of the flow. Smallest scales only have impact on turbulence.
  - Not yet reference option in HIRLAM, when switched on, much lower roughness in mountains

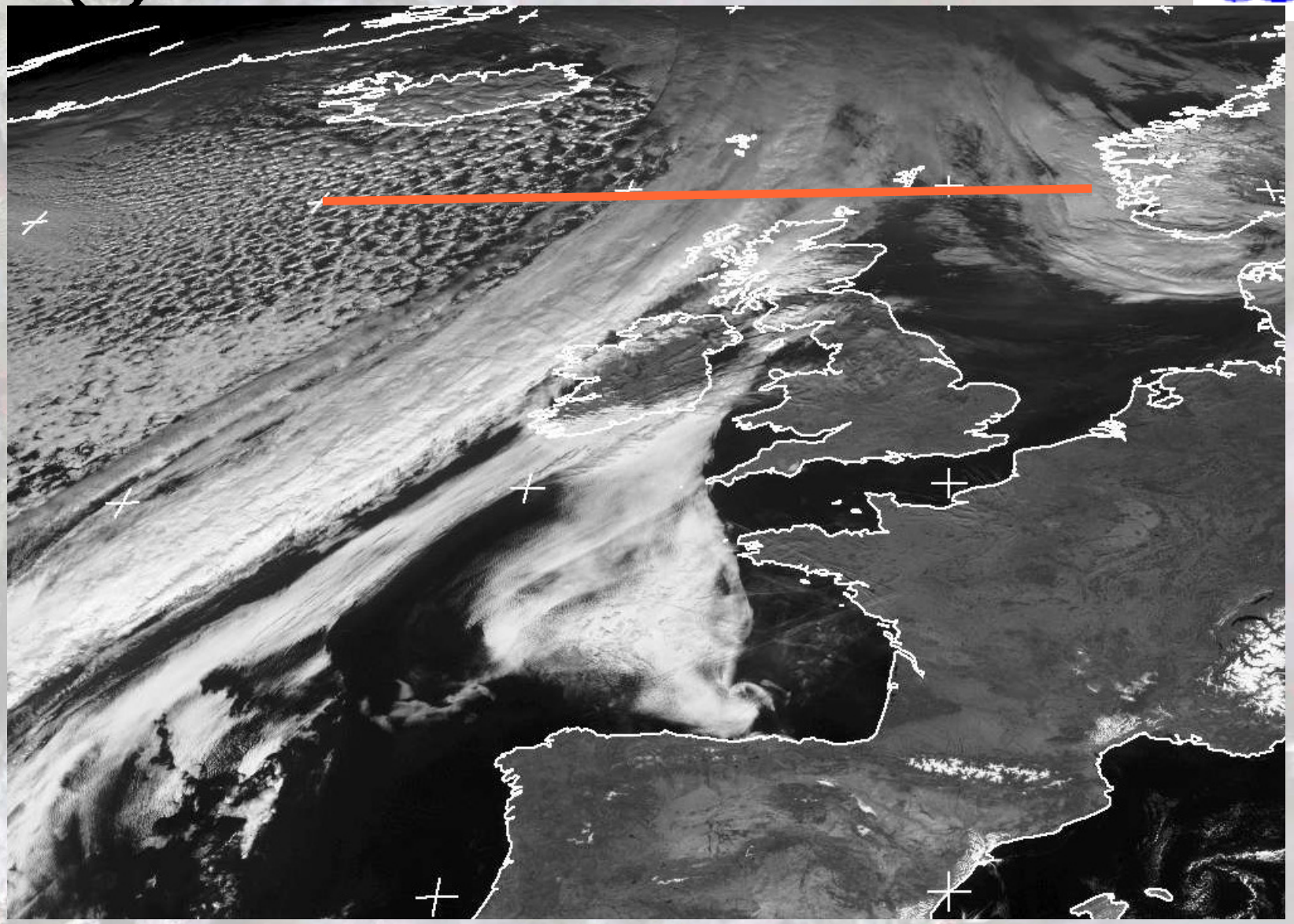
Convection and condensation

- Two possible options
  - STRACO (reference scheme until HIRLAM version 7.1, still current reference)
  - Kain-Fritsch Rasch-Kristjansson (HIRLAM reference from version 7.2)
  - Large differences in characteristics of both schemes
  - Significant impact on cloud water and precipitation distribution (and therefore important for ACT)
  - Small differences in meteorological scores.

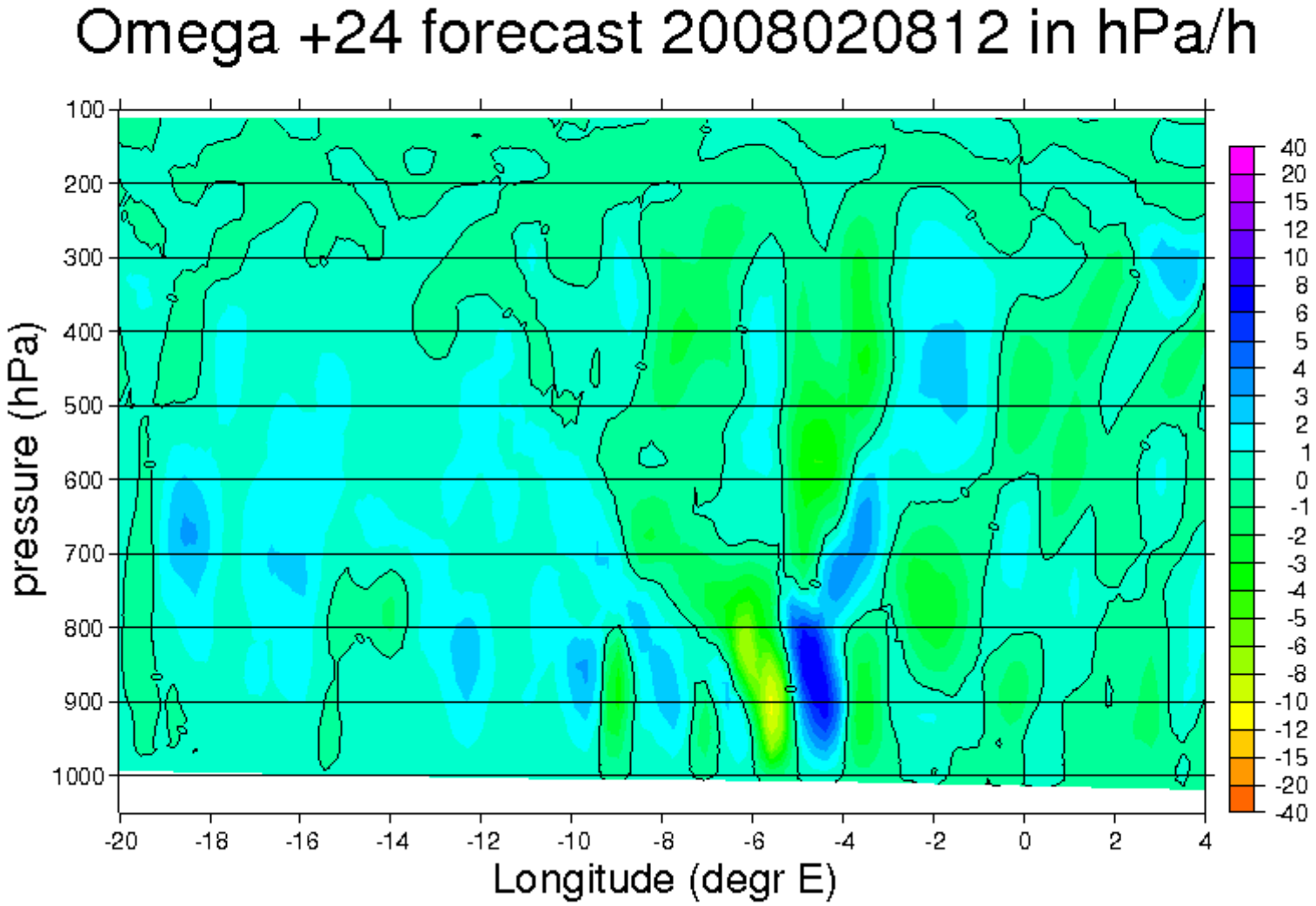
Convection and condensation

- Impact of change from STRACO to KFRK
  - Impact on small precipitation amounts, increase in HIRLAM 7.2, transfer to old KF-RK. Decrease to below STRACO values in HIRLAM 7.3 (RK-CAM3, SMHI already using this, verification on www.hirlam.org).
  - Impact on dynamics. Less small scale lows and high wind speeds superposed on strong winds in unstable conditions.
  - Impact on cloud water: No cloud water in convective grid boxes in KF-RK, immediately evaporates when given to large scale

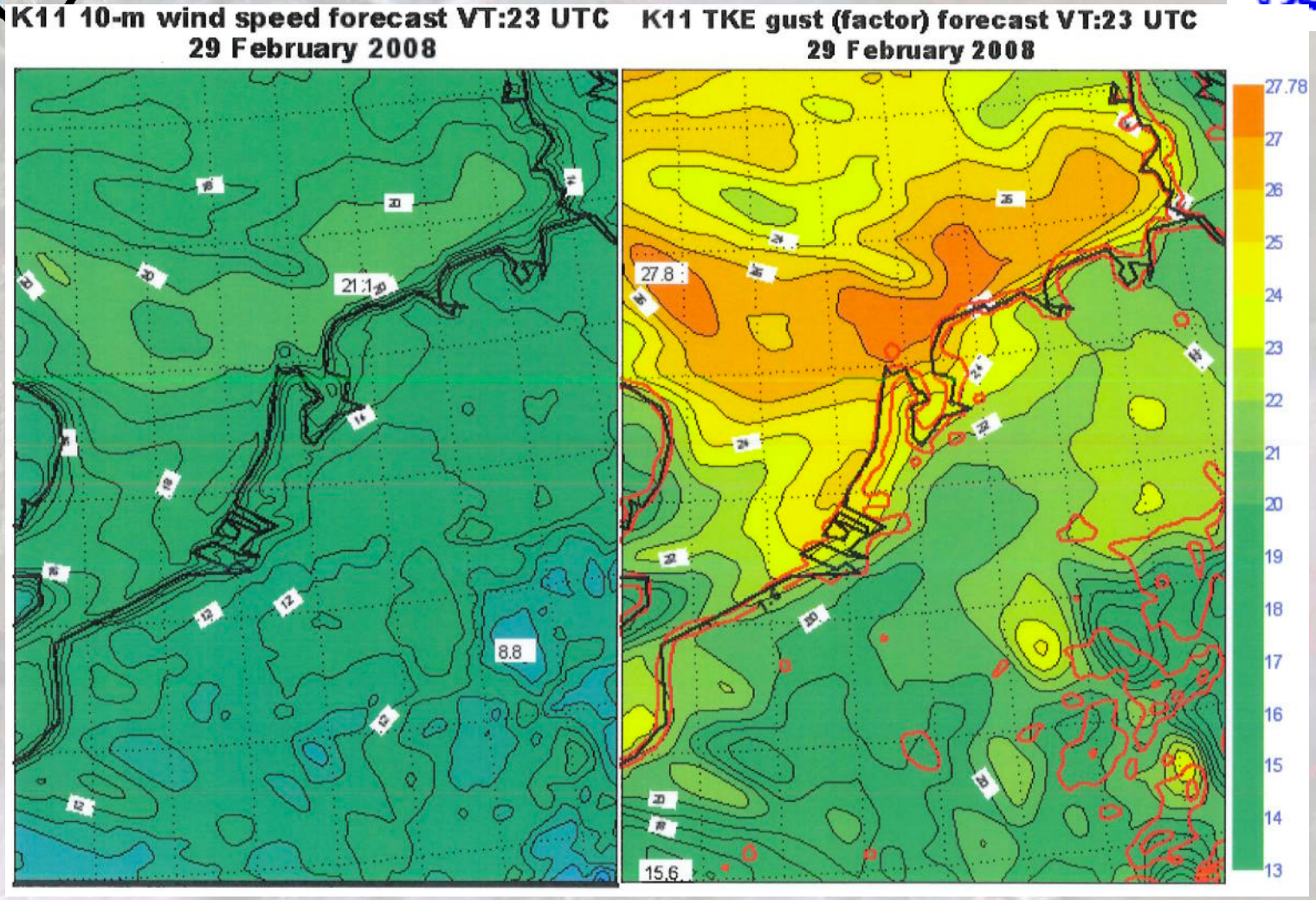
Two convections schemes: 13-02-2008



Influence convection on dynamics



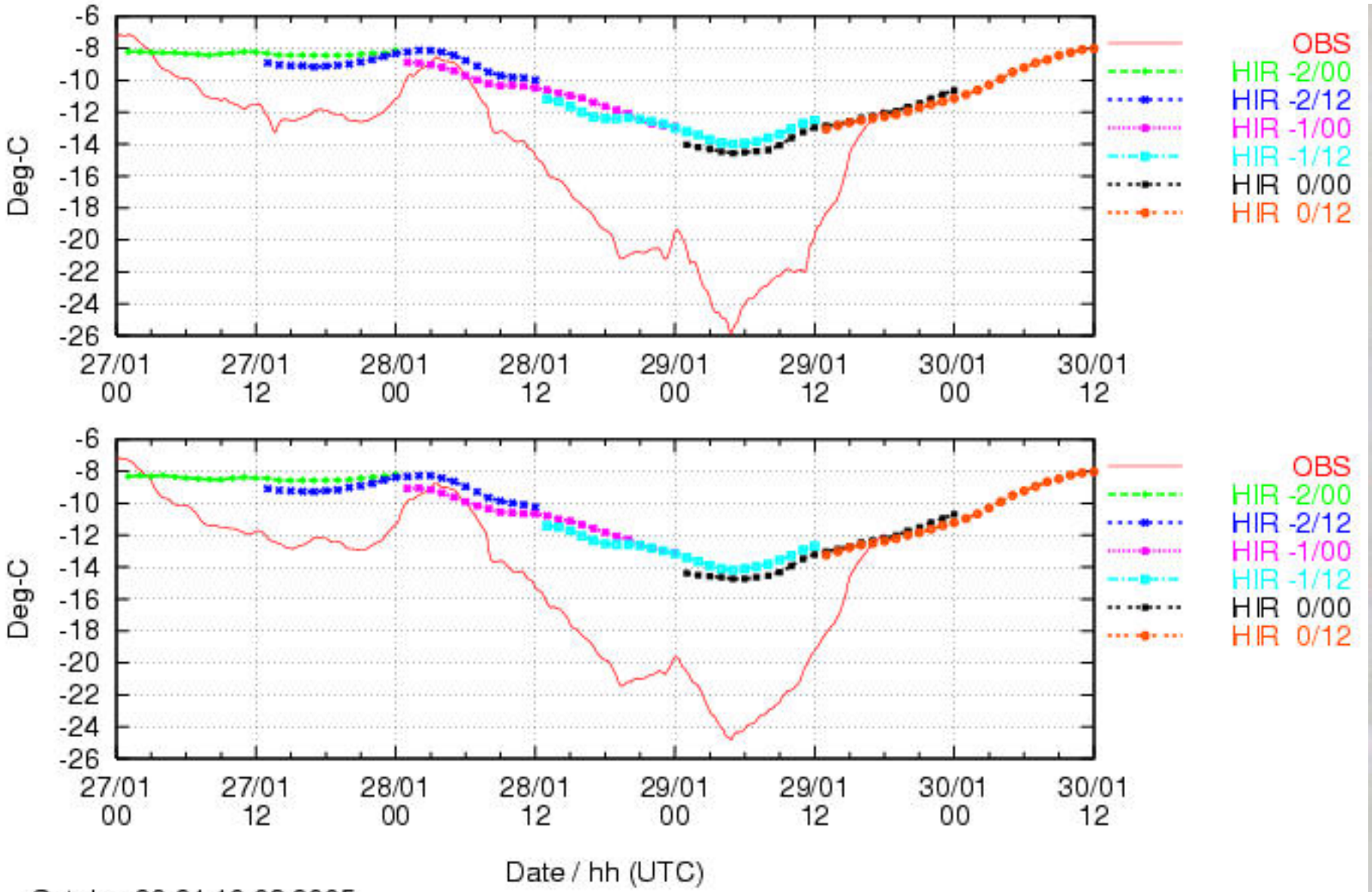
Influence convection on wind



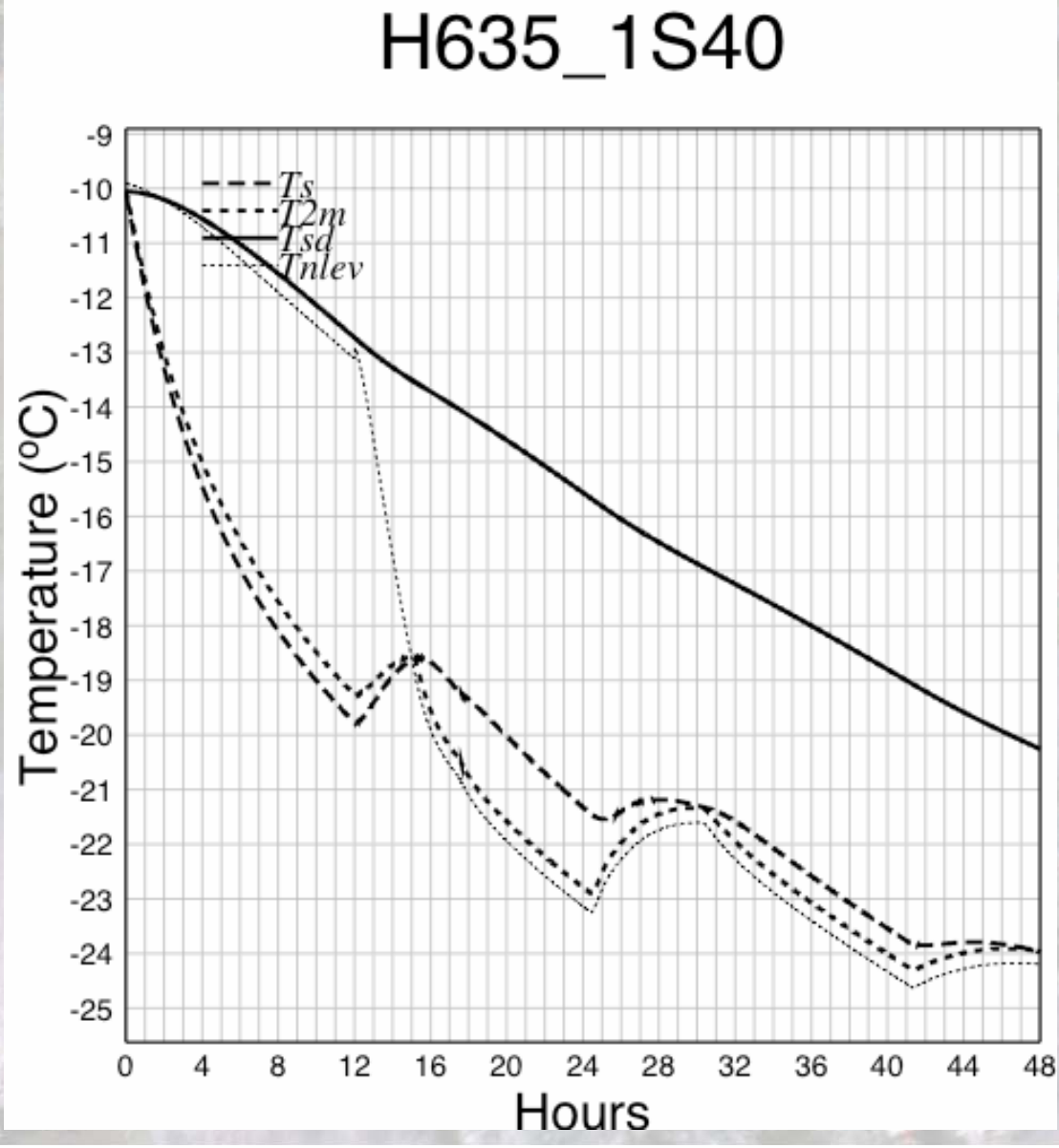
Surface scheme

- Surface processes
  - Surface scheme too slow in winter and spring, T not low enough during polar night with snow cover, snow disappearing too quickly in spring, forest effects not taken into account
  - New modules in surface scheme:
    - Extra tiles for snow (bare soil+low veg; high veg)
    - Canopy model added

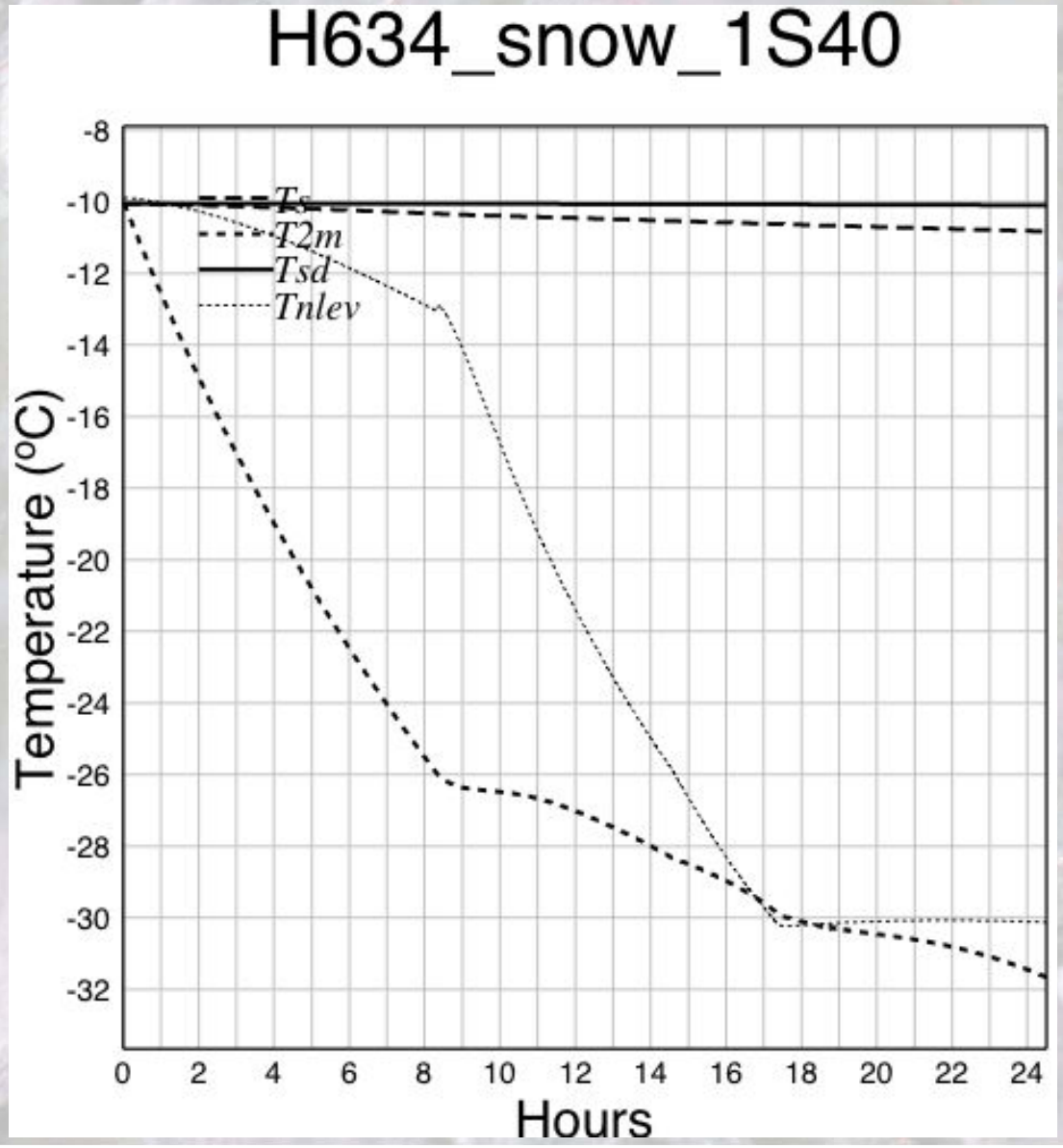
Nordic winter problem



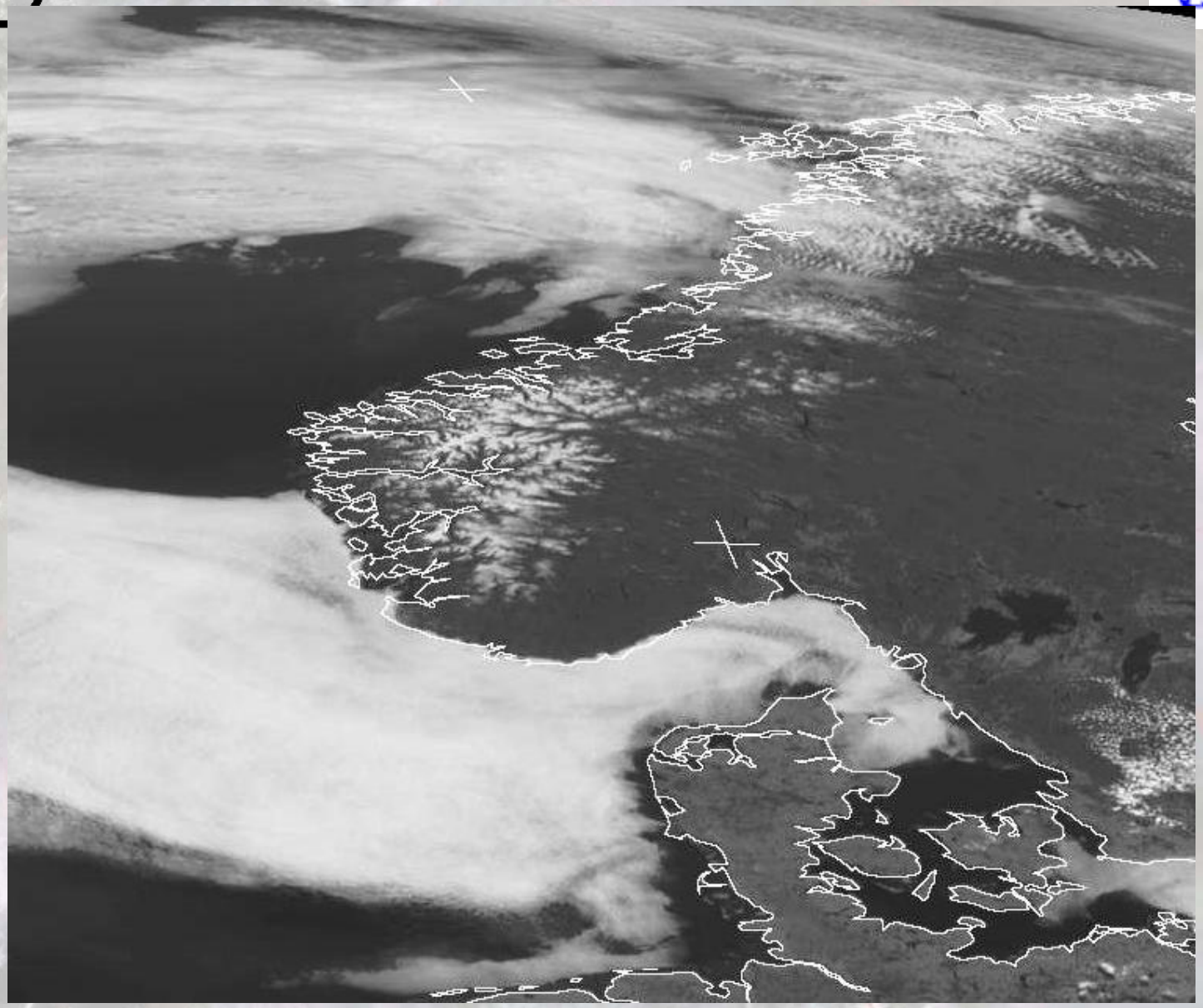
Nordic winter problem, 1D 6.3.5a



Nordic winter problem, 1D 6.3.4s

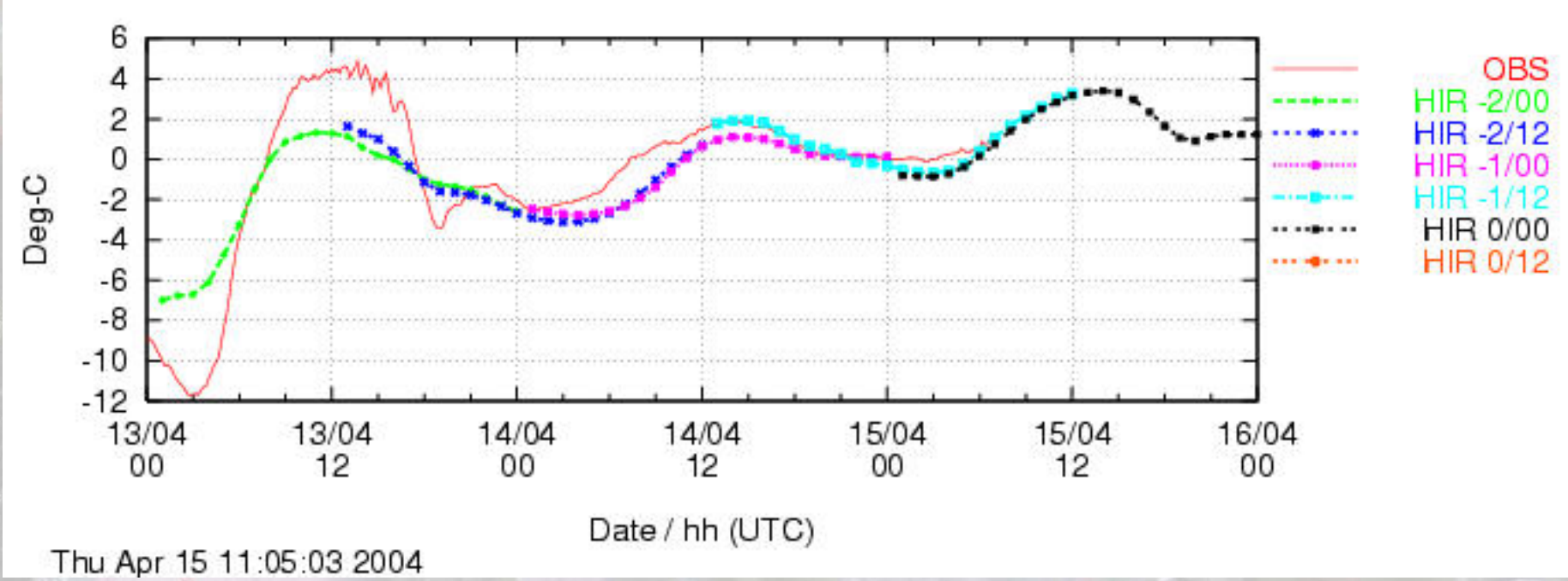


Snow scheme

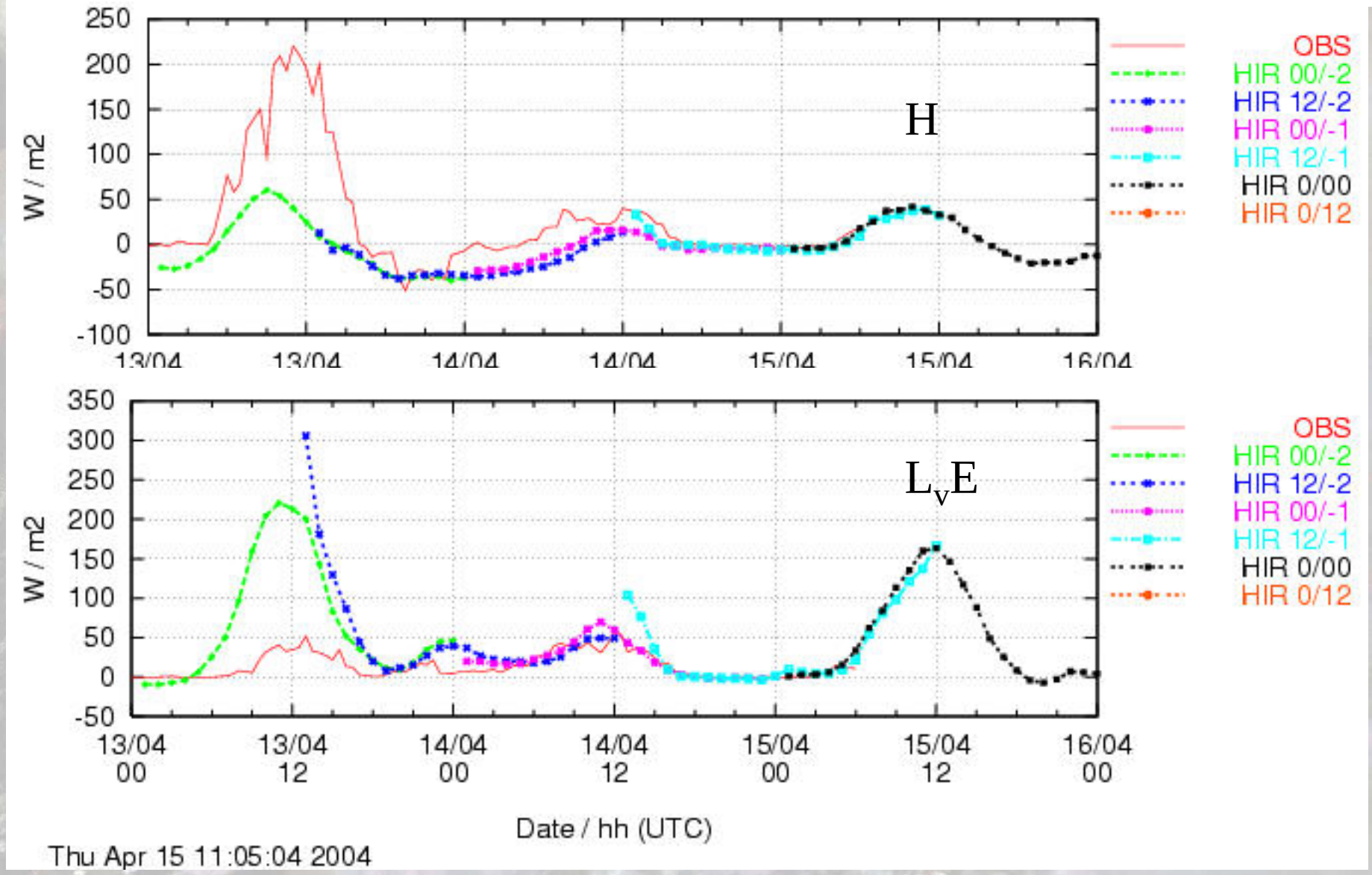


Spring problem

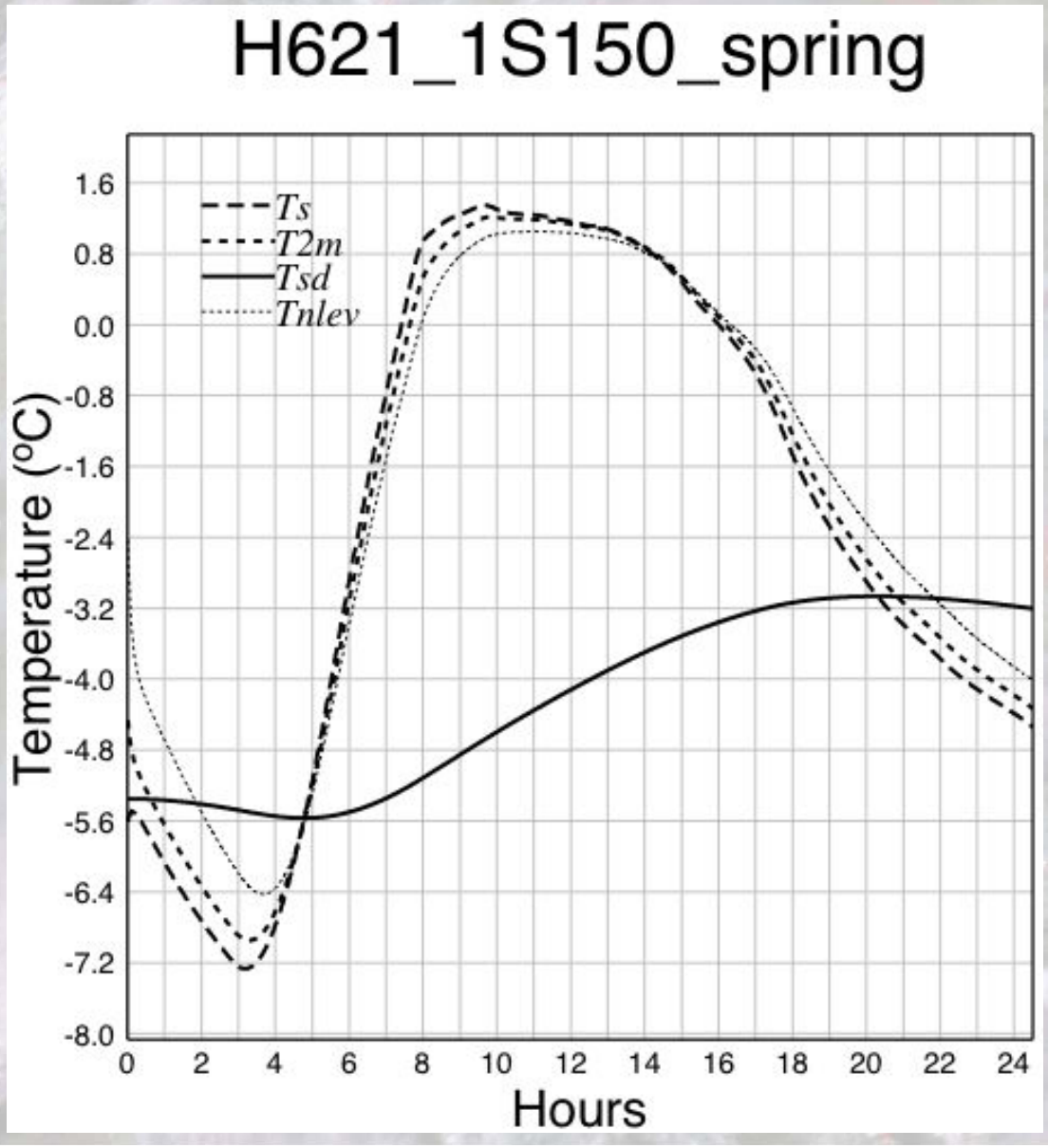
- Daily cycle wrong, min T too high, max T too low, fluxes wrong.



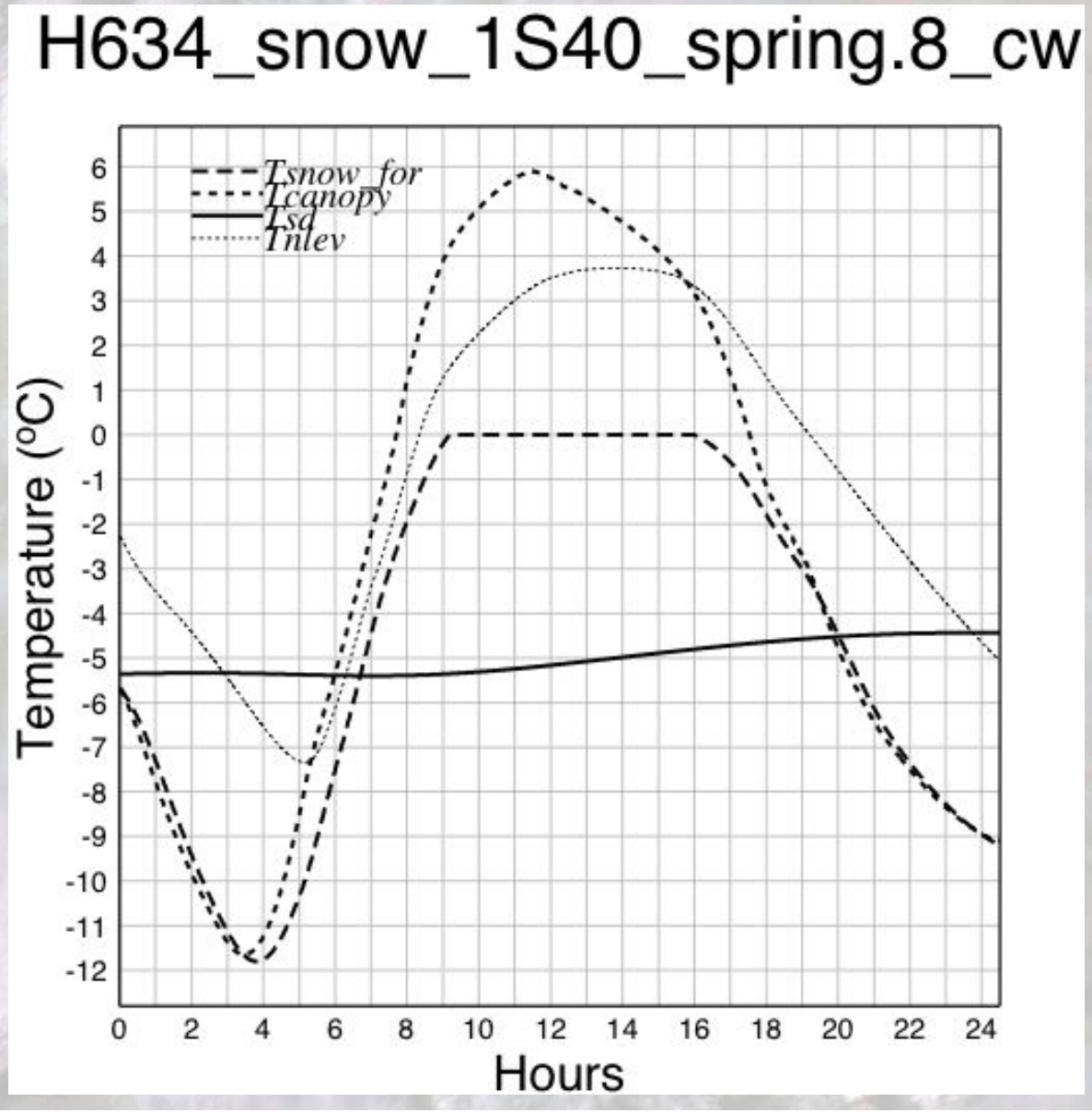
Spring problem



Spring problem (6.2.1)



Spring no problem! (6.3.4snow)



Characteristics of model

- Very important to know characteristics of model that is used for interpretation of ACT results
- How meteorological information is used also important!
- Examples:
  - Vertical diffusion too strong in stable conditions? Deeper stable boundary layer and too weak low level jets!
  - Too many light precipitation amounts? Too much rain out of chemical species
  - Too much fog over sea? Wet deposition of chemical species
  - Use of precipitation for rain out of entire column? Chemical species rain out from place without clouds!

Conclusions

- HIRLAM physics changing considerably, also in future HIRLAM versions
- Changes have big impact on boundary layer and precipitation
- Therefore impact on ACT will be large
- Users must know the impact of this on ACT, else interpretation of results will be difficult.