Updates to Kain-Fristch convection in HIRLAM

Javier Calvo

Spanish Meteorological Agency (former INM)

AEMet
Agencia Estatal de Meteorología

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Outline of the talk

- The Kain-Fritsch convection in HIRLAM reference
- A new version based on KFeta from WRF model.
- Main differences between KFeta and KFref.
- Performance of the schemes.
- Conclusions and prospects.

KF-RK moist physics in the reference system

- Three new components
  - Kain-Fritsch convection
  - Rasch-Kristjansson large scale condensation
  - Diagnostic cloud fraction scheme
- Current version of KF in HIRLAM reference system
  - Comes from the original version of Jack Kain code. It is very close to the version described in Kain, 2004: “The Kain-Fritsch Convective Parameterization: An Update”
  - Some HIRLAM updates/tuning mainly concerning shallow convection
- Code in Fortran 77, messy, poorly documented and difficult to follow. Debugging is difficult.
- We have a version suitable for vector computers.

A slightly different version of KF: KFeta

- Motivation:
  - We need a Fortran 90 version of the code to build the IFS version of KF
    - There are already versions of KF in F90.
    - According to Jack Kain the version performing better is the one used in ETA model and included in WRF model.
- So, Why don't we take this KFeta code and see how it performs in HIRLAM.
  - This gives us the opportunity of checking the different tuning options adopted in HIRLAM.
  - The code is prepared for more prognostic variables: ice, rain, snow.
  - Main disadvantage of this approach is that we would need to develop a vector version of the code.
    - We know how but it would take some effort.
  - The code is cleaner and it seems more robust.
  - Due to the adoption of F90 standards is easier to read the code (Not very easy anyway)

Main modifications in this KFeta code

- Differences from the evolution of J. Kain's scheme:
  - Downdrafts source level: Use a fix height from cloud based instead of min Θ_{es}
  - In the closure, use CAPE including mixing instead of undiluted CAPE.
- Differences in the set up:
  - Shallow clouds:
    - In KFref, they are shallower and the mixing with the environment is bigger
      - Lower cloud radius
      - Smaller layer to build source layer: lower DPMIN
      - Lower initial vertical velocity
    - In KFeta this parameters take the same values as in deep convection.
      - Probably less realistic but the continuity between shallow and deep convective points is larger.
  - TIMEC, the time scale to consume CAPE is function of the time that would take the cloud to cross the grid. Updates not included yet inKFeta:
    - In KFref, TIMEC is also function of grid spacing, Δx, to enhance large scale precipitation at enhanced resolutions
    - An promising approach tested by Lisa an not yet included is to make TIMEC~H/w_u (naturally smaller for shallower clouds)

Performance of KFeta compared with KFref.

- Set up:
  - Mainly HIRLAM 7.2beta1
  - Domain RCR_7.1.
  - 0.15 horizontal resolution, 60L
  - Without its own upper level analysis.
  - Using new Rash-Kristjansson –CAM3- for large scale condensation

- Test periods:
  - January 2006
  - January 2007
  - 1-14 October 2006

  } 7.2beta1

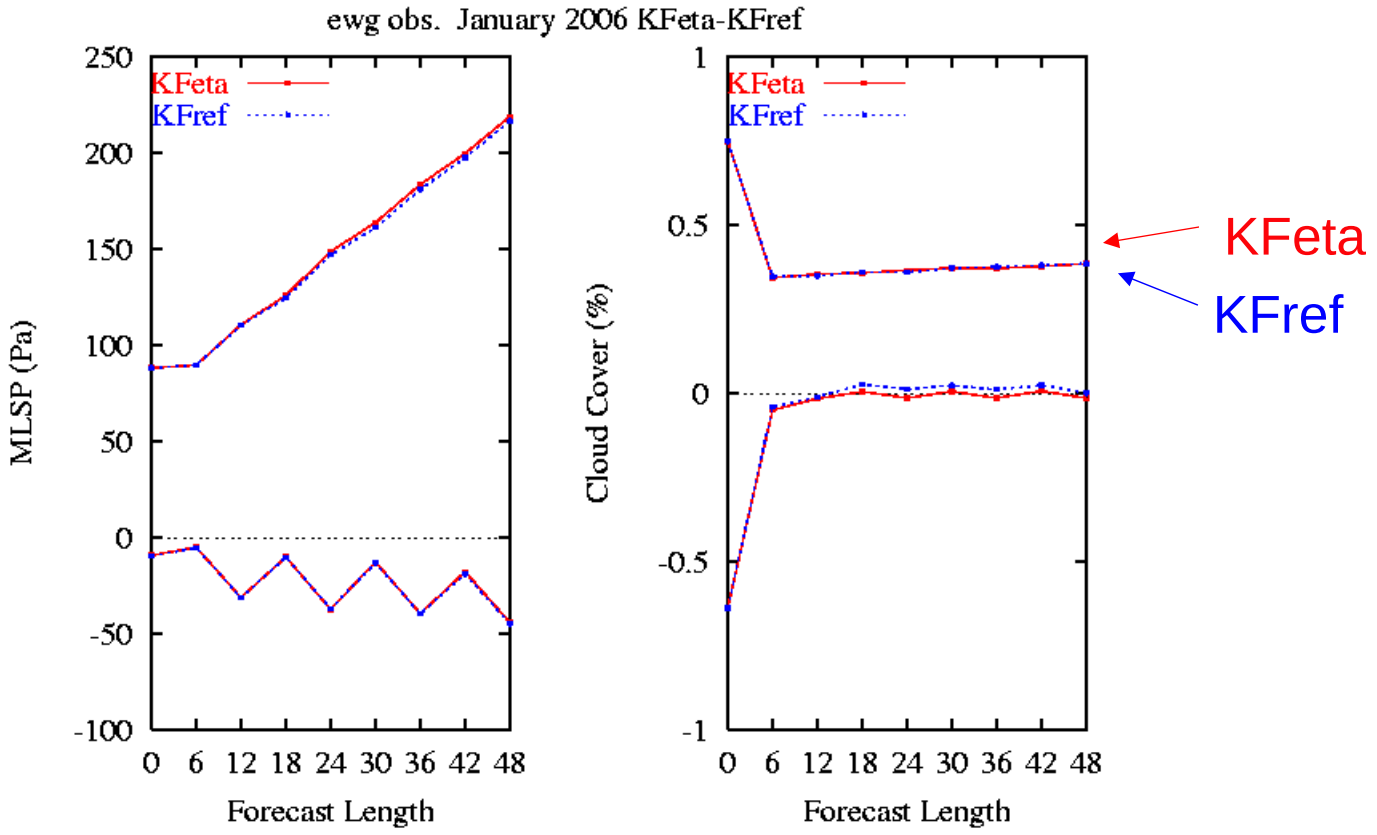
  - 1-10 July 2006
  - 1-10 August 2006

  } 7.2rc2

- Standard verification using EWGLAM stations
  - Surface
  - Upper level
  - Precipitation

Little impact on surface fields except temp. and humidity

January 2006

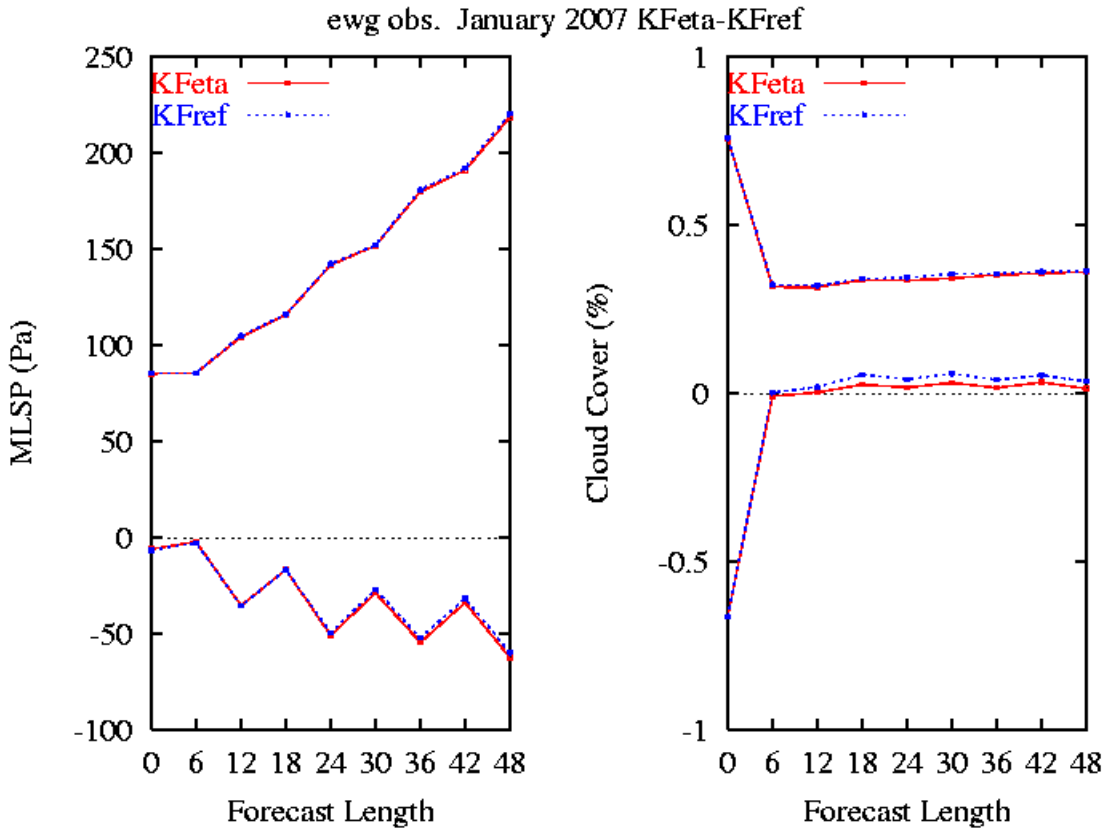


MSLP

Cloud cover

Little impact on surface fields

January 2007

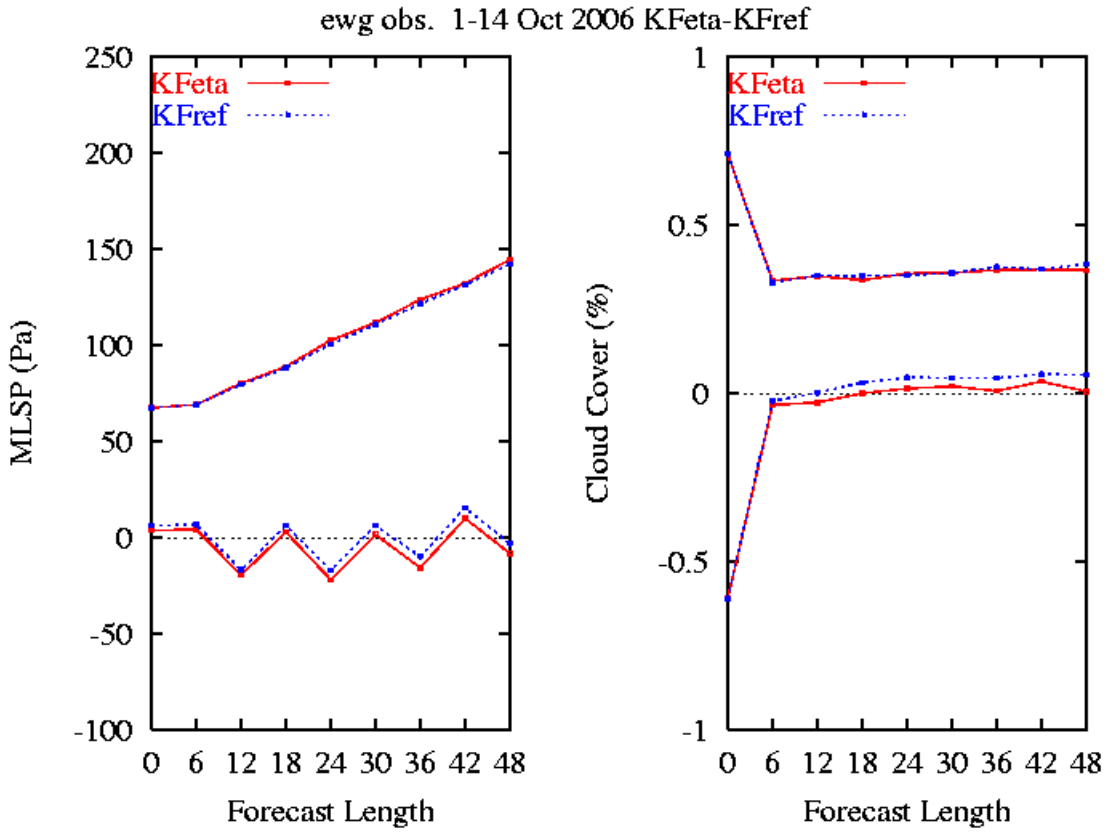


MSLP

Cloud cover

Little impact on surface fields

October 2006



MSLP

Cloud cover

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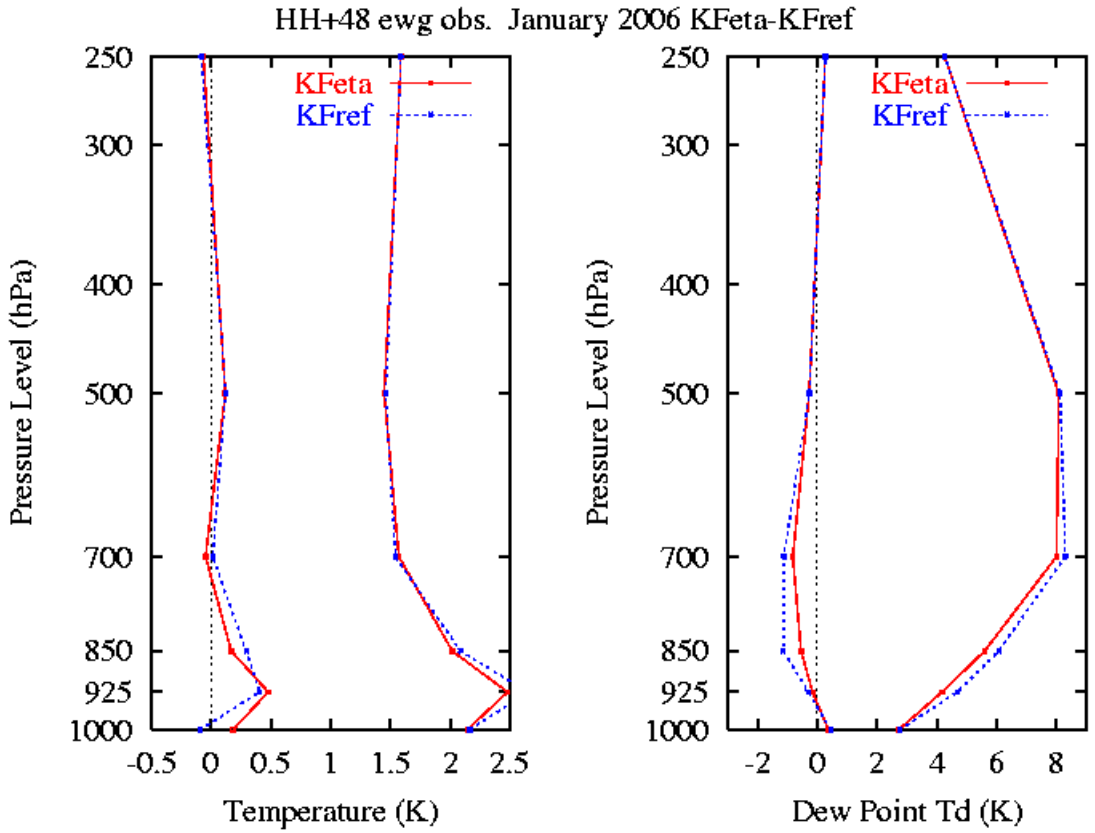
Forecast H+48 against EWGLAM soundings

January 2006



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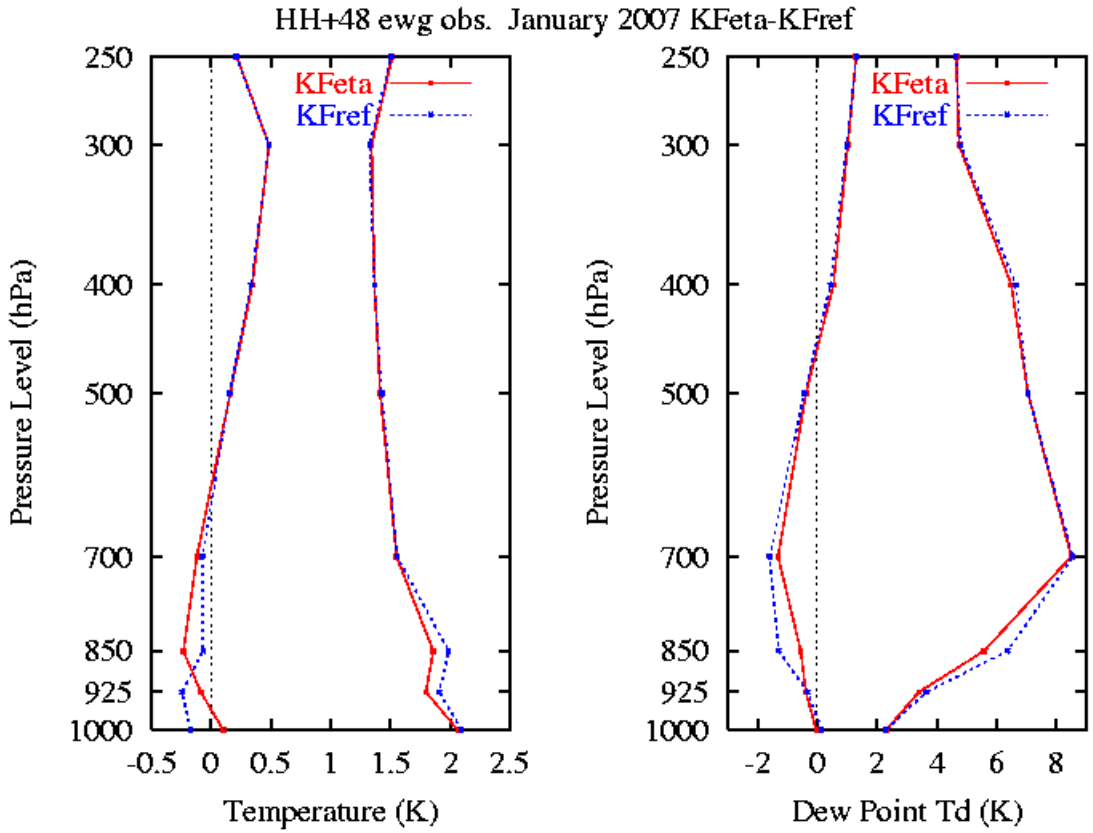
Larger impact on temperature and humidity at lower levels

Forecast H+48 against EWGLAM soundings

January 2007



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Forecast H+48 against EWGLAM soundings

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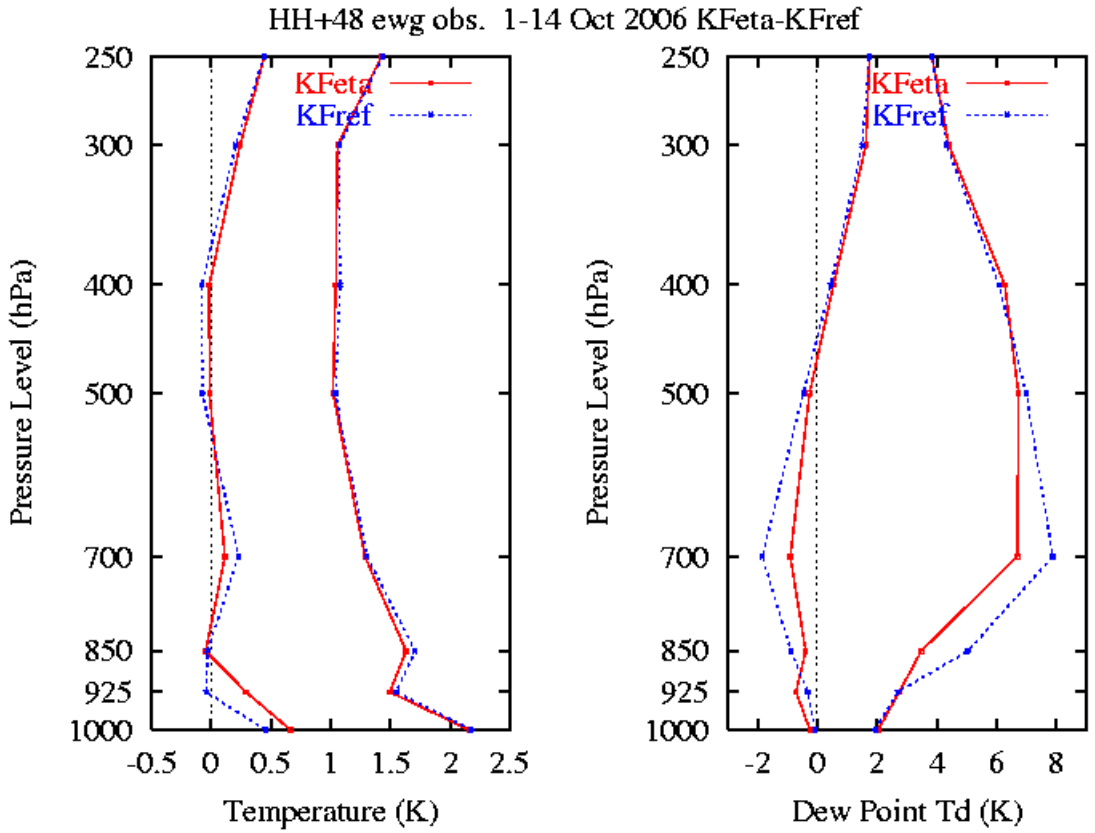

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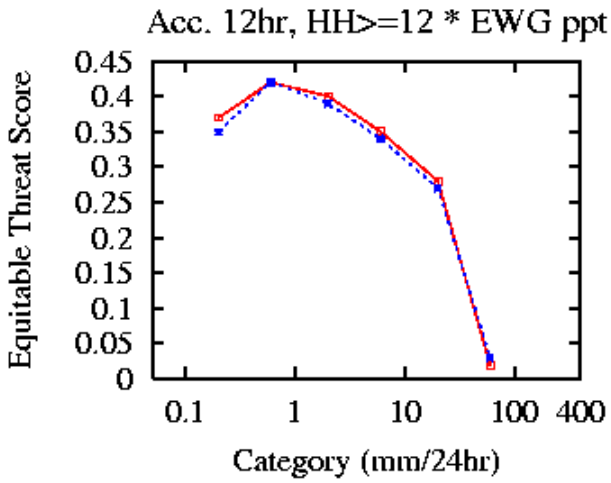
Precipitation verification for different categories

January 2006

ETS



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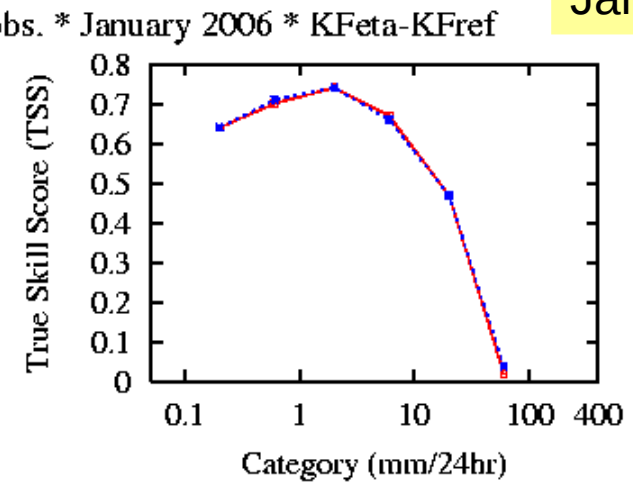

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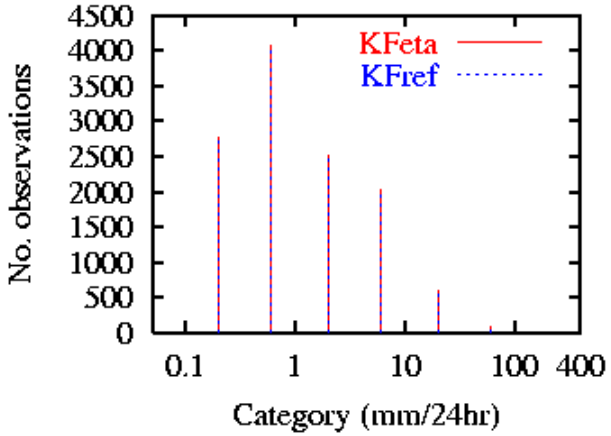
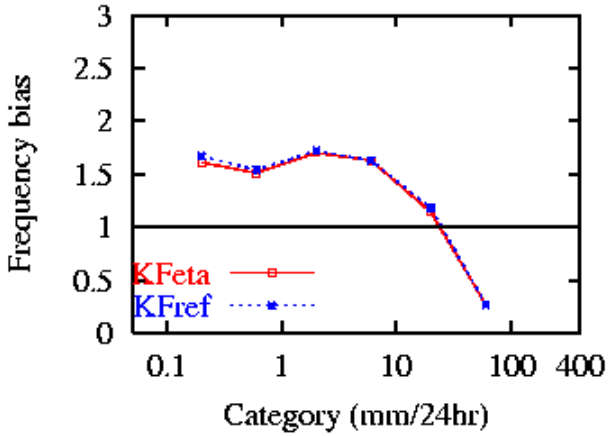


Bias



Small precipitation less frequent in KFeta and improved scores for the small amount categories.

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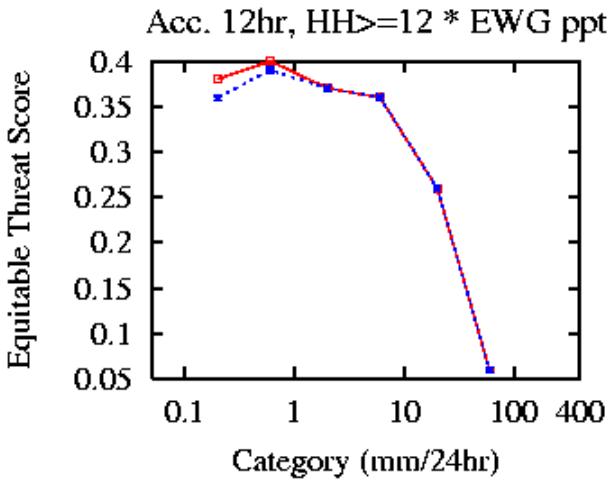

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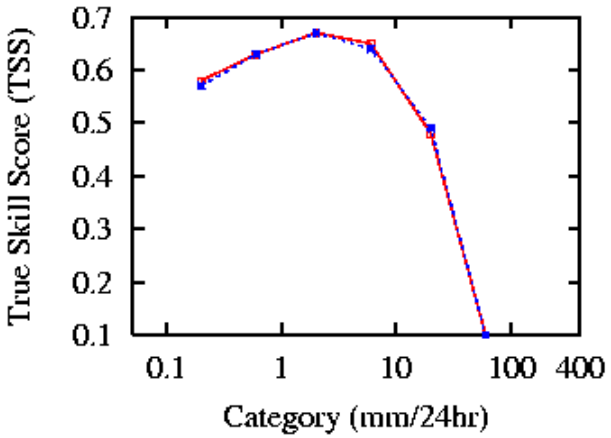

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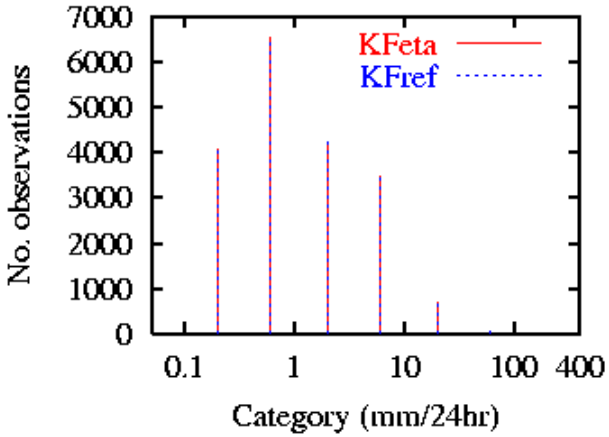

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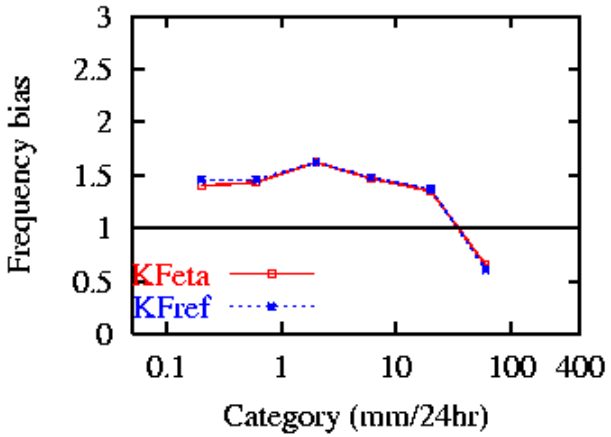

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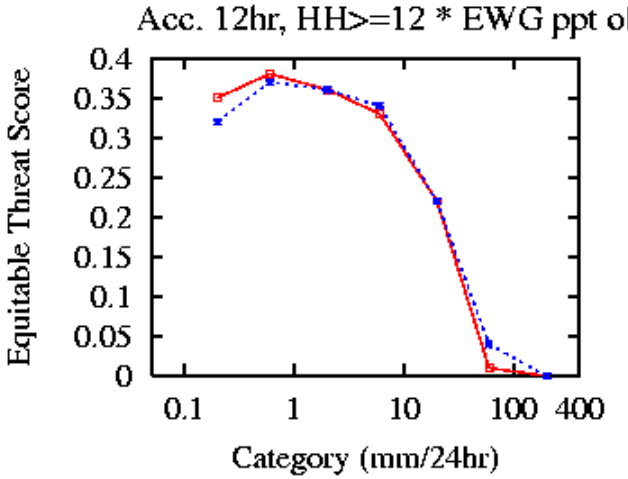

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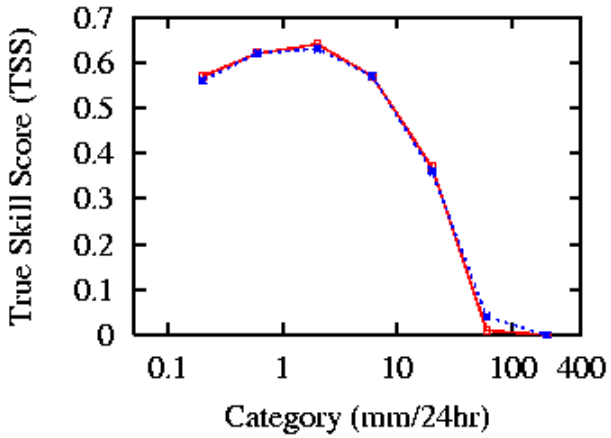

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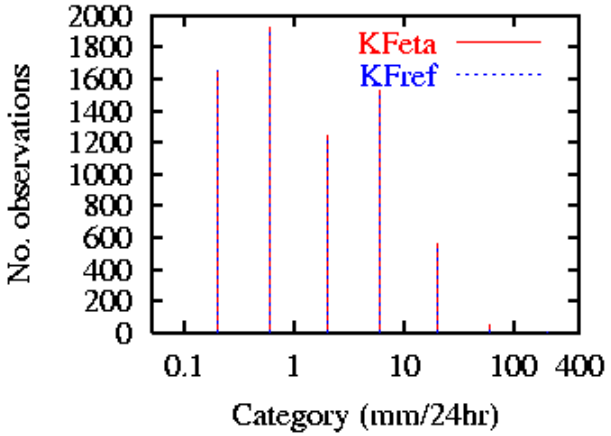

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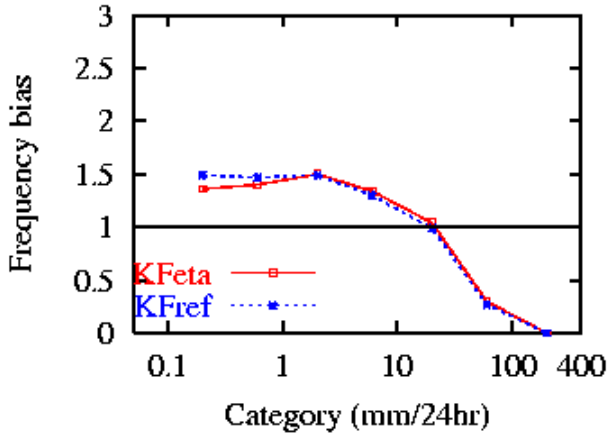

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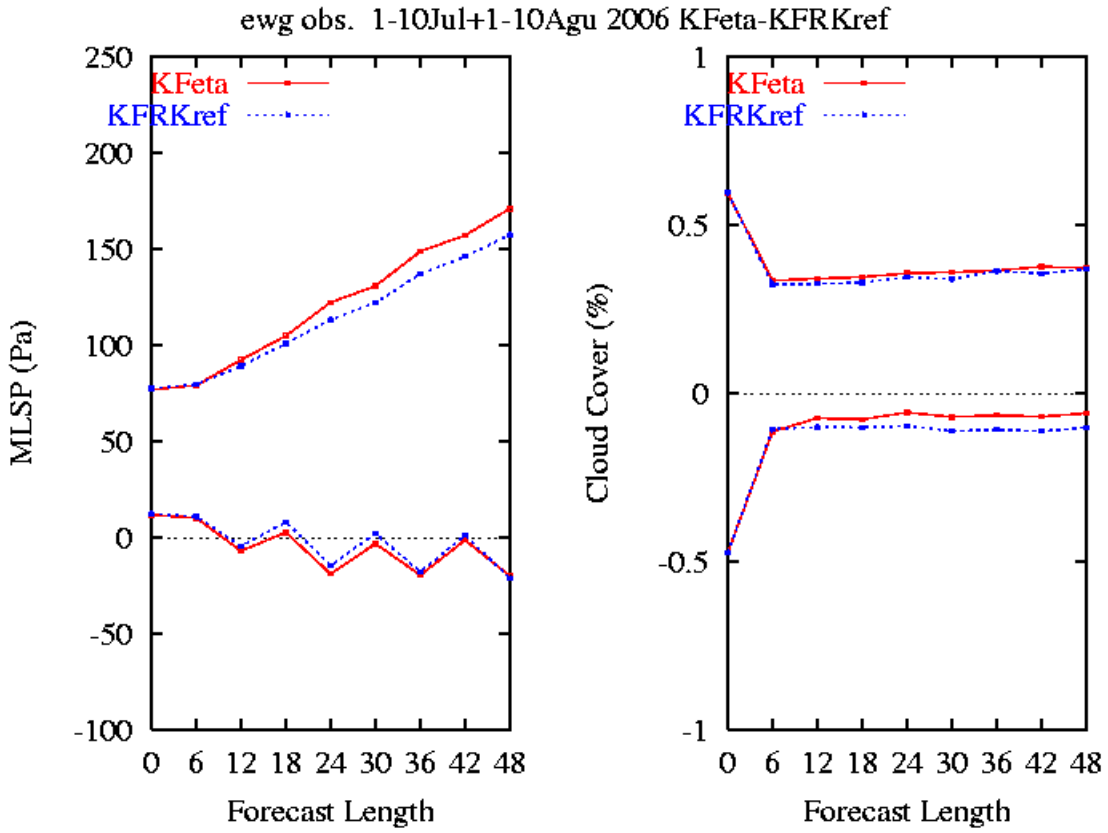
So far so good

Now the problems !!

- The summer period

Summer: Worst scores with KFeta in MSLP

Jul Ago 2006

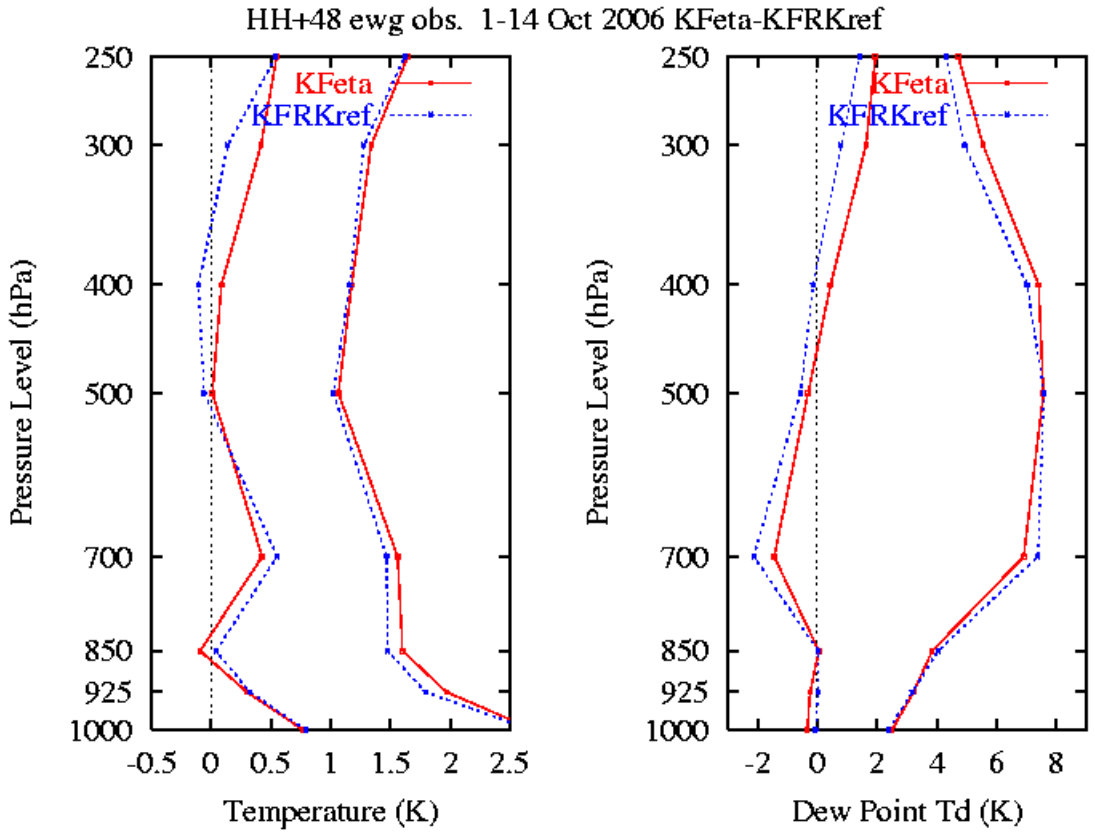


MSLP

Cloud cover

Also worst scores in T and Td

Jul Ago 2006



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Precipitation verification

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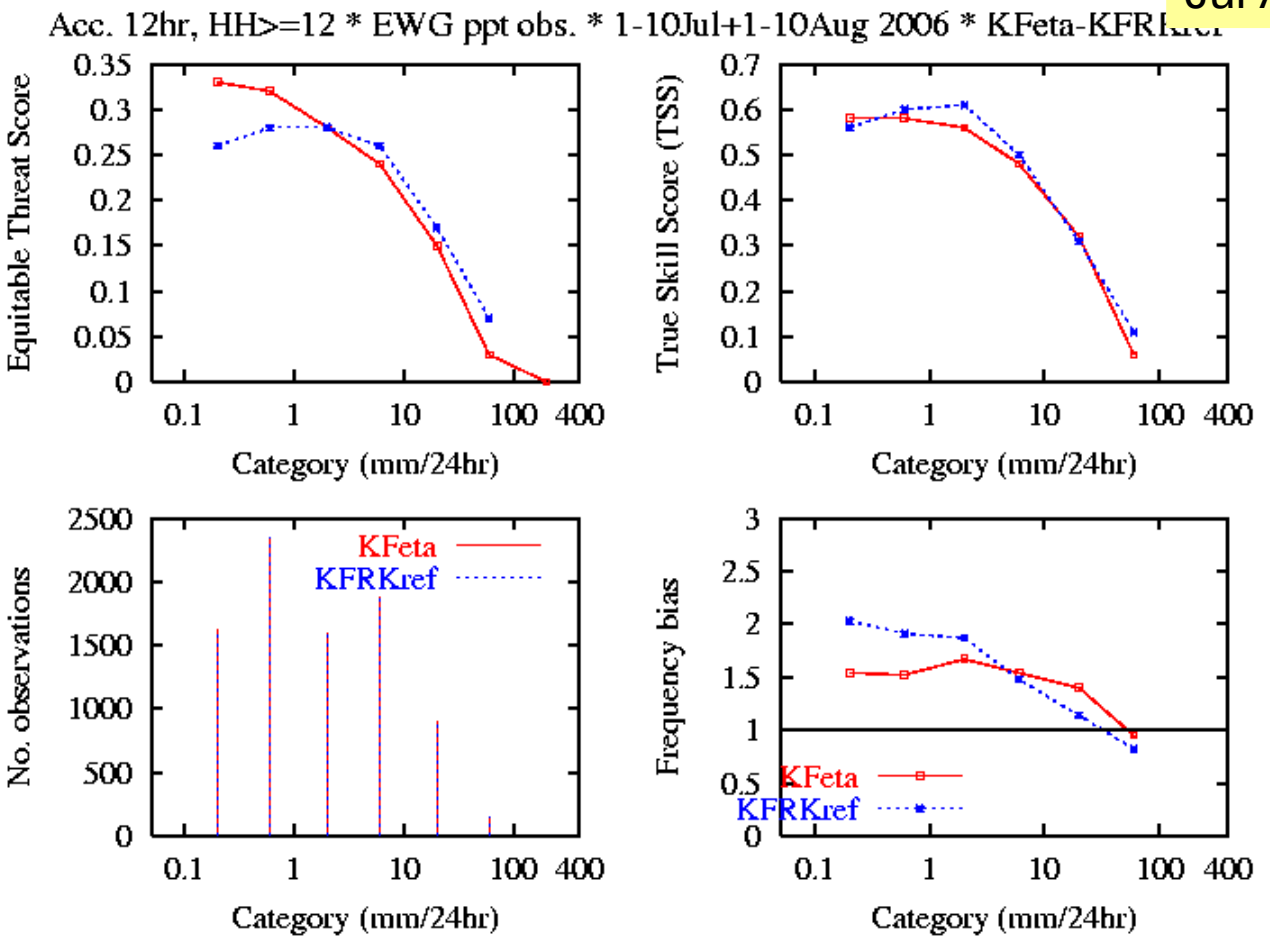

Better for small amounts but worst for ppt >10 mm/day. Too much precipitation at big rates?

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Errors in summer

- Errors are larger in the ‘drier’ period: (July 2006) than in the ‘wet’ one (August 2007).
- Are problems in summer big enough disencourage implementation of KFeta?
  - My opinion is that improvements in other seasons compensate.
  - More research is need to see if the problems appears also in other summer periods.
  - Is it possible to improve the performance in the summer without degrading the performance in other seasons?

Conclusions and prospects

- A slightly different version of KF known as KFeta has been tested in HIRLAM.
- Tested in combination with a bigger update in HIRLAM: The Rash-Kristjansson large scale condensation.
- Code in fortran 90, better written and in principle more robust.
- Improves Temperature and Humidity at low levels (≤700 hPa).
- Less small amount precipitation (a problem of KFref) and better precipitation scores at these ranges.
- Main problem: performance in summer.
- Should we include KFeta in the new HIRLAM release?
  - Depends on the date of the new release.
  - We had problems with the implementation on 7.2rc2 and some more work is needed. A possibility could be to start with RK CAM3 and then KFeta in the next release.
  - The IFS version of this code will be ready soon.

That's all folks