Satellite-based albedo, sea surface temperature and effective land roughness maps used in the HIRLAM model for weather and climate scenarios

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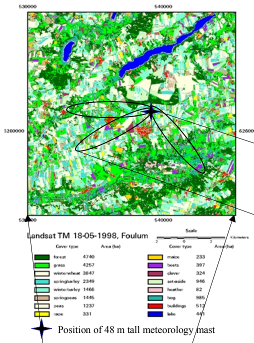
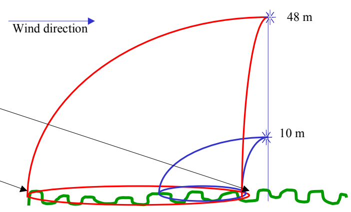
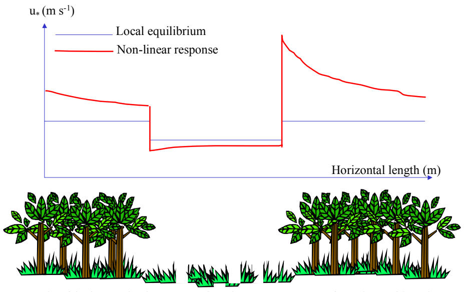


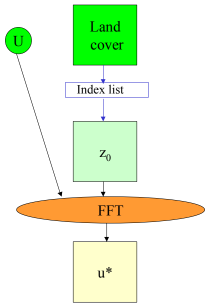
Multi-year observations of local and effective roughness. The effective roughness is observed at 3 tall masts 32-48 m high. The local roughness is observed at 7 masts 2-10 m high.



The footprint "seen" by a tall mast includes many patches in the landscape. The small mast "sees" only a single local patch.



The friction velociy (u_*) varies downstream as a function of local roughness and patch size. The equilibrium values (for very large pacthes) and the real non-linear behaviour is shown.

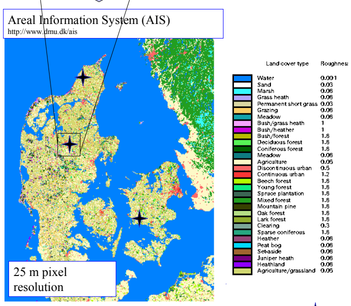


The non-linear variations of friction velociy (u_*) is modelled in a horizontal 2-dim domain for arbitrary roughness variations in real terrain by a microscale surface-flux aggregation model. The effective roughness is calculated per HIRLAM grid cell (for references see below)

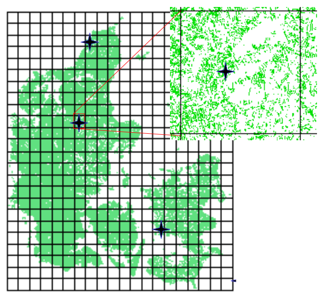
$$< u_* > = \sqrt{\frac{1}{n_1 n_2} \sum_{x=1}^{n_1} \sum_{x=2}^{n_2} u_*^2(x, y)}$$

$$< u_* > = \frac{\kappa u(z)}{\ln(\frac{z}{z_{0\_eff}})}$$

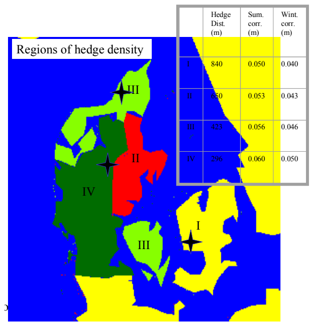
Production of effective roughness maps



Position of tall meteorology masts
Land use map input for the microscale model

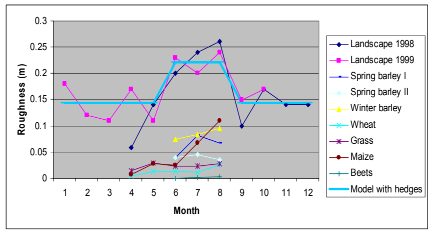


Vector map from The National Cadaste and Survey (KMS) input for calculating the hedge density map



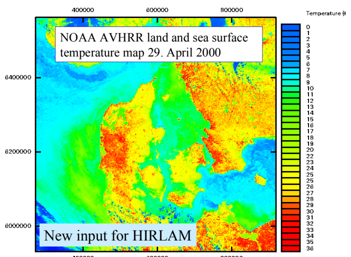
	Hedge Dist. (m)	Sum. corr. (m)	Wint. corr. (m)
I	840	0.050	0.040
II	650	0.053	0.043
III	423	0.056	0.046
IV	296	0.060	0.050

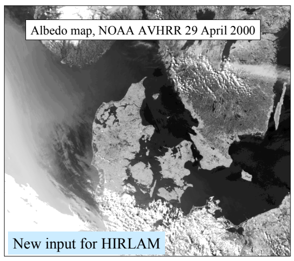
Hedges density map with roughness corrections based on the microscale model



Effective roughness (landscape level) measured from tall mast and modelled with microscale model including correction for hedge density. The local roughnesses in 7 crops are also shown. Note these are an order of magnitude smaller than the landscape roughness.

Results of new sea surface temperature, albedo and roughness maps in HIRLAM weather forecasting



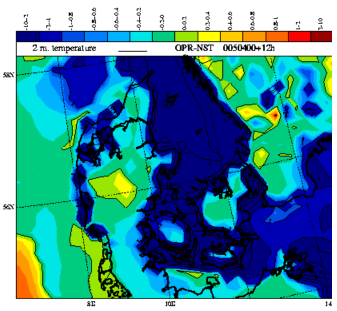


Conclusions

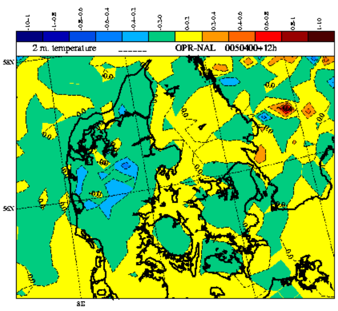
The sea surface temperature maps from NOAA AVHRR have a significant influence to the HIRLAM forecasting of air temperatures. The difference between the climatological seasonal mean values used operationally and the new SST maps differ by several degrees in the cases analysed. The land-sea breeze distance seems to be better modelled with the new SST input.

The albedo maps from NOAA AVHRR have a very small influence to the HIRLAM forecasting of air temperatures. The difference between the climatological seasonal albedo maps used operationally and the new maps is only minor.

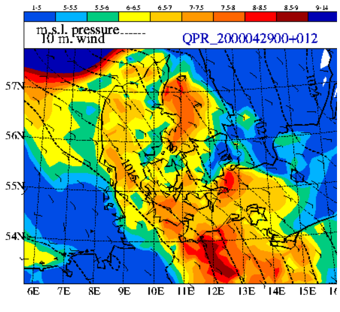
The roughness maps based on land use maps from Landsat TM and vector-based map of hedges, calculated into effective roughness maps by the microscale aggregation model, are generally more rough than the roughness maps operationally used in HIRLAM. The HIRLAM forecasting of wind speeds in April shows a decrease in wind speed over land with the new roughness map. This is a positive result as the operational seasonal bias on wind speed over land is +0.5 m/s and over sea is –0.2 m/s.



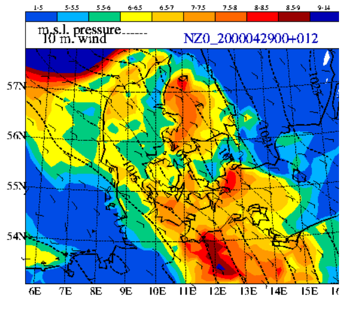
HIRLAM 12 hour forecast of air temperatures. Difference map with input of climatological sea surface temperature and actual NOAA AVHRR.



HIRLAM 12 hour forecast of air temperatures. Difference map with input of climatological albedo and actual NOAA AVHRR.



HIRLAM 12 hour forecast of wind speed based on the operational roughness map



HIRLAM 12 hour forecast of wind speed based on new effective roughness map from the microscale model

References: Hasager C.B. and N.O.Jensen, 1999 Surface flux aggregation in heterogeneous terrain *Quart. J. Royal. Meteorol. Soc.* **125**, 2075-2102;
Nielsen, N.W., B.H.Sass and J.U.Jørgensen 1995 Meso-scale forecasts with an atmospheric Limited Area Model. *Meteorol. Appl.* , **2**, 351-361.

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