Application and verification of ECMWF products 2010-2011 at the Finnish Meteorological Institute

by Eerik Saarikalle, Antti Kangas, Anssi Vèhèmèki, Juhana Hyrkkènen, Ari-Juhani Punkka

1. Summary of major highlights

FMI's production system relies heavily on deterministic ECMWF model which is used in our edited quality controlled database. ECMWF also provides boundaries to the high resolution models run at FMI. Moreover, the development and the better usability of the EPS system has been very useful from the point of forecasting weather extremes and issuing early warnings which is strongly in focus at FMI.

The negative temperature BIAS has continued also during spring 2012.

2. Use and application of model output

The most of the weather forecasting products are based or depends on ECMWF. FMI has a forecaster-corrected gridded database which uses ECMWF data as a background field.

The ECMWF model data (gradually also EPS-data) is used widely and operatively by meteorologists in FMI's SmartMet-workstation. ECcharts ╨service (http://www.ecmwf.int/eccharts/) is useful globally and provides forecast data for monitoring severe weather events abroad.

2.1 Post-processing of products

Kalman filter post-processing is done to ecmwf t2m and to other parameters in the future. Nevertheless, a manual editing (by choosing different model or adjusting ECMWF) will still play a crucial role in our production system.

2.2 Use of products

ECMWF output is used widely supporting the traditional weather service, and also as input for various applications like limited area NWP modelling (HIRLAM, AROME), dispersion and trajectory models, hydrological models (run by Finland ╒s Environmental Administration), road condition models and wave models.

FMI forecasters have been quite satisfied with ECMWF EPS system. It is mainly used in evaluation of long term warnings. In our experience, both EFI and conventional probability products are useful. However, probabilistic forecasts for the general public are still in development or not very mature. ECMWF operational model is part of FMI's in house ensemble forecast system (so called poor man's eps).

3. Verification of products

3.1 Objective verification

Surface parameter verification results at FMI are from our in-house verification system. Objective information about the performances of the different data sources is available from Finnish observation stations.

3.1.1 Direct ECMWF model output (both deterministic and EPS)

According to the FMI ╒s verification data ECMWF model had during last winter and autumn a slight negative bias, mostly between 0 and -0,5 in most forecast lengths (figure 1.) During spring and summer negative BIAS has been even worse especially forecasts for evening hours in spring time (figure 2.). GFS model seems to suffer from similar problems. Kalman filtering improves ECMWF deterministic forecast somewhat. However, by correcting systematic errors in forecasts FMI's edited data has been really good, all forecast lengths up to 5 days have improved from previous years (not shown).

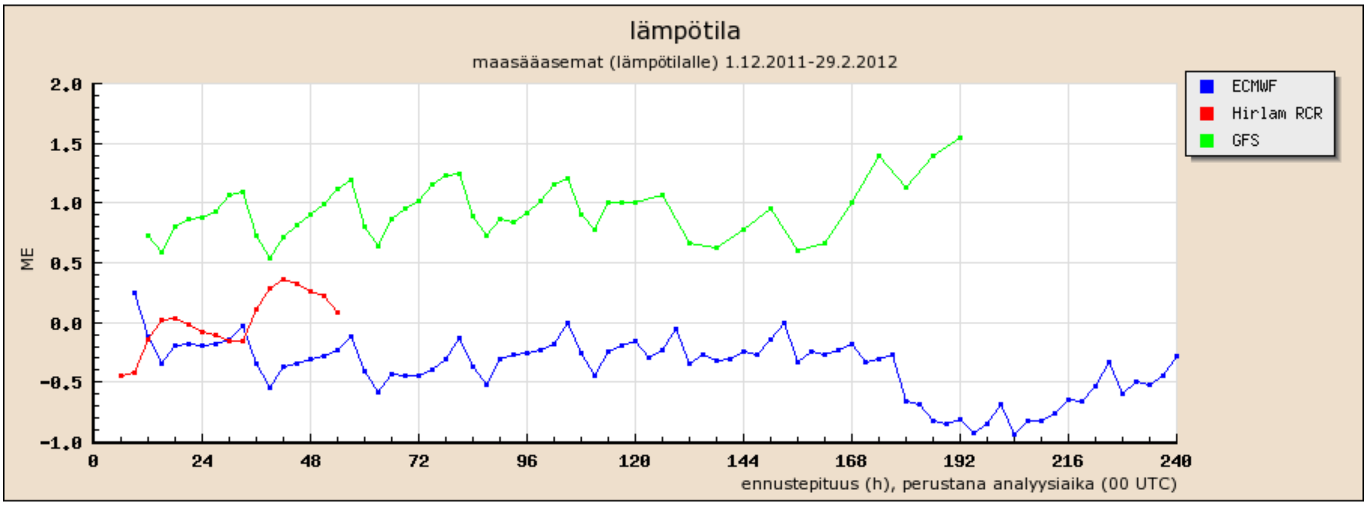

Figure 1 Mean error (ME) of different models in a group of 30 inland observation stations in Finland in winter months (DJF) 2011-2012Figure 1: Mean error (ME) of different models in a group of 30 inland observation stations in Finland in winter months (DJF) 2011-2012.

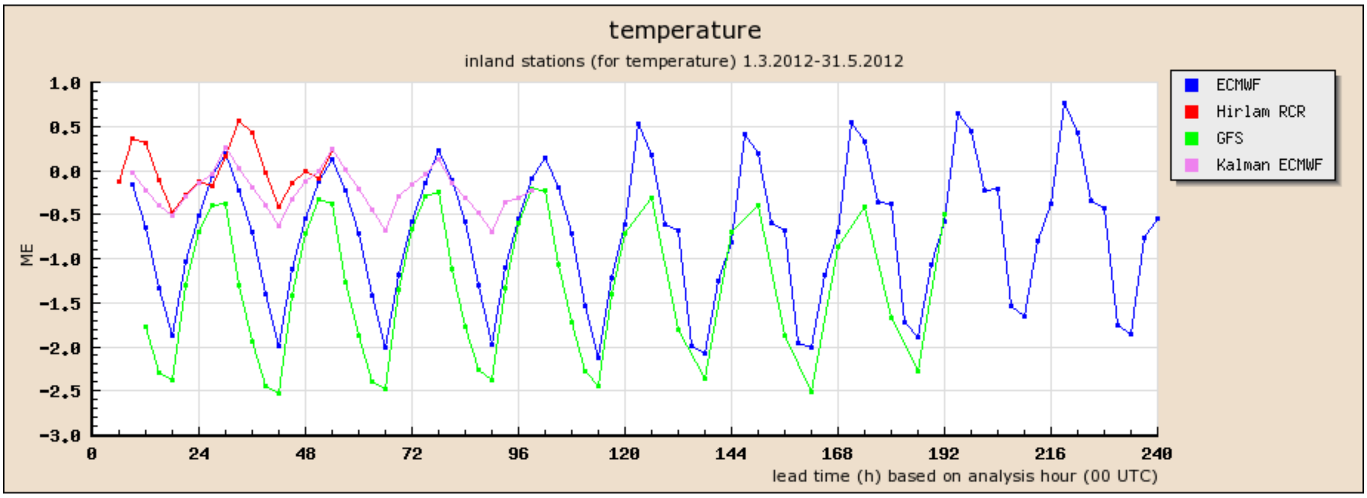

Figure 2 Mean error (ME) of different models in a group of 30 inland observation stations in Finland in spring MAM 2012

Temperature hit rate (difference between forecast and observation less than 2,5 degrees) figure 3.

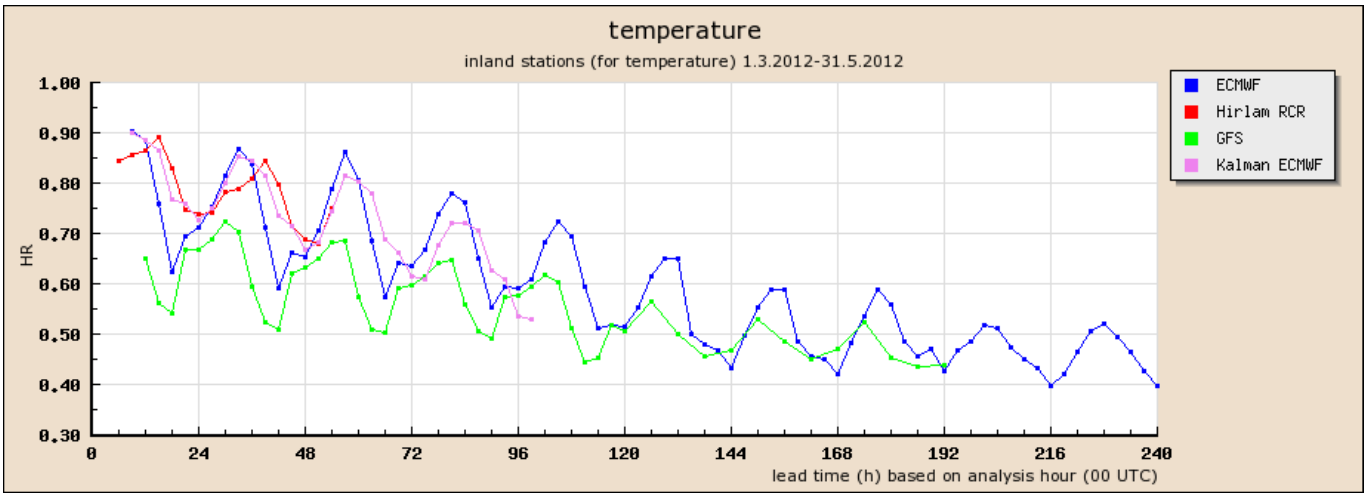

Figure 3 Hit Rate (HR) of different models in a group of 30 observation stations in Finland in spring 2012.

FMI has implemented SEEPS verification measure for precipitation forecasts (figures 4.,5., and 6.). There seems to be some improvements from the previous full year (2010). According to these results, ECMWF underestimates precipitation especially in forecasts whose lead time is three days or more.

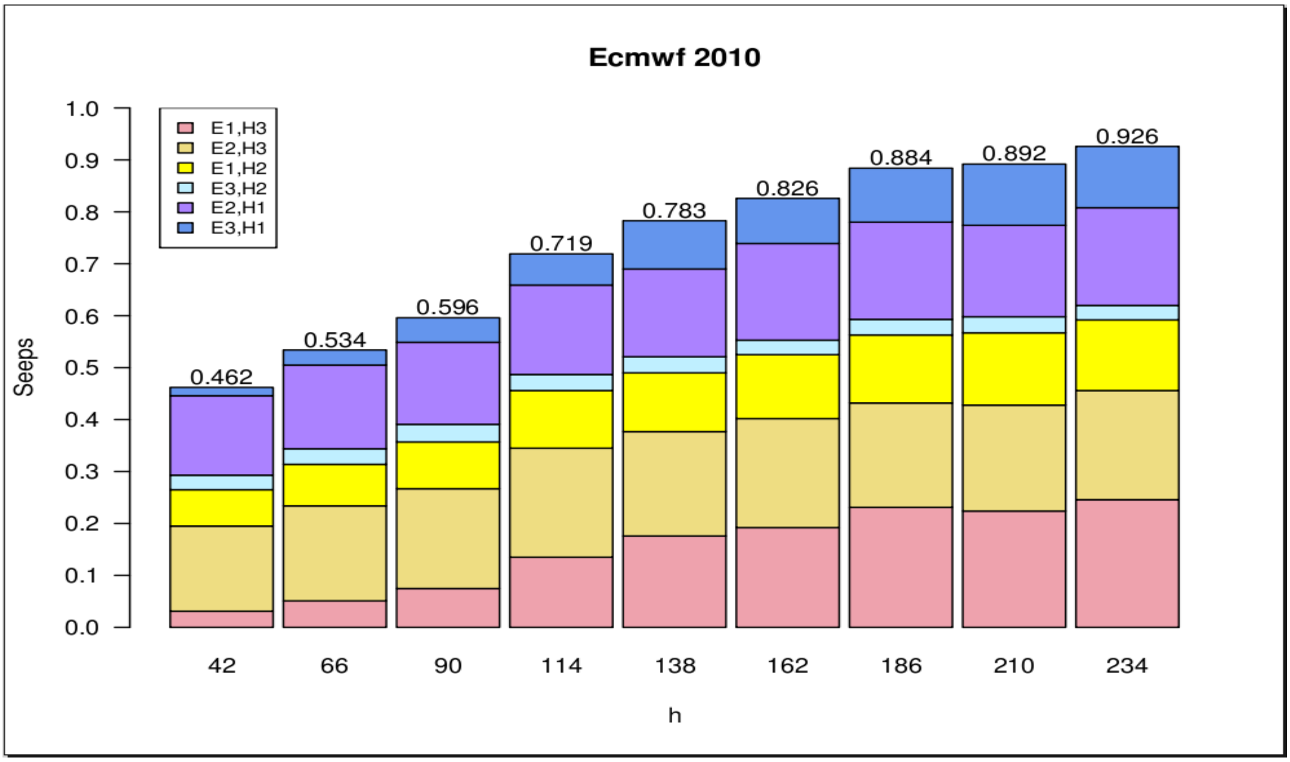

Figure 4 ECMWF SEEPS verification 2010 in Finland (60 stations) showing each component of the score. 'E' means forecasted category,H is observed category. Category 1=dry, 2=light and 3=heavy rain. 12 utc run.

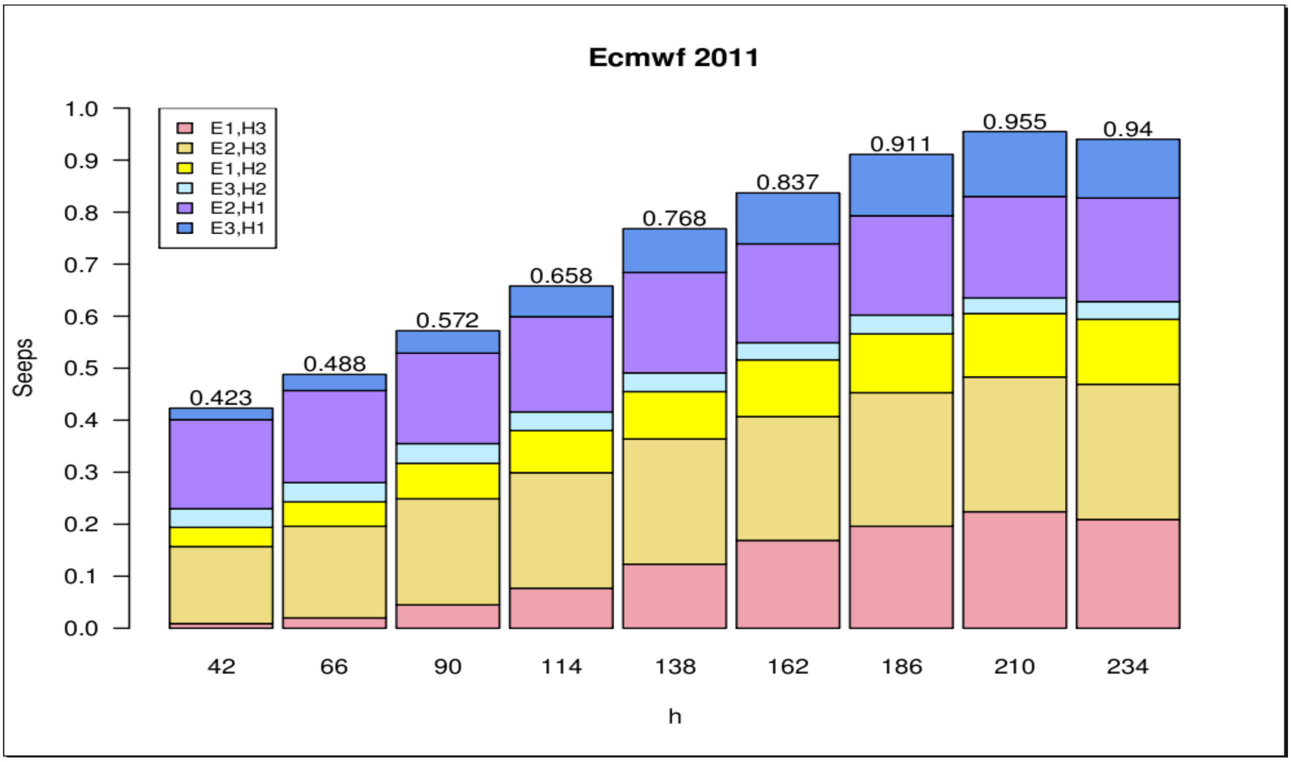

Figure 5 ECMWF SEEPS verification 2011 in Finland (60 stations) showing each component of the score. 'E' means forecasted category,H is observed category. Category 1=dry, 2=light and 3=heavy rain. 12 utc run.

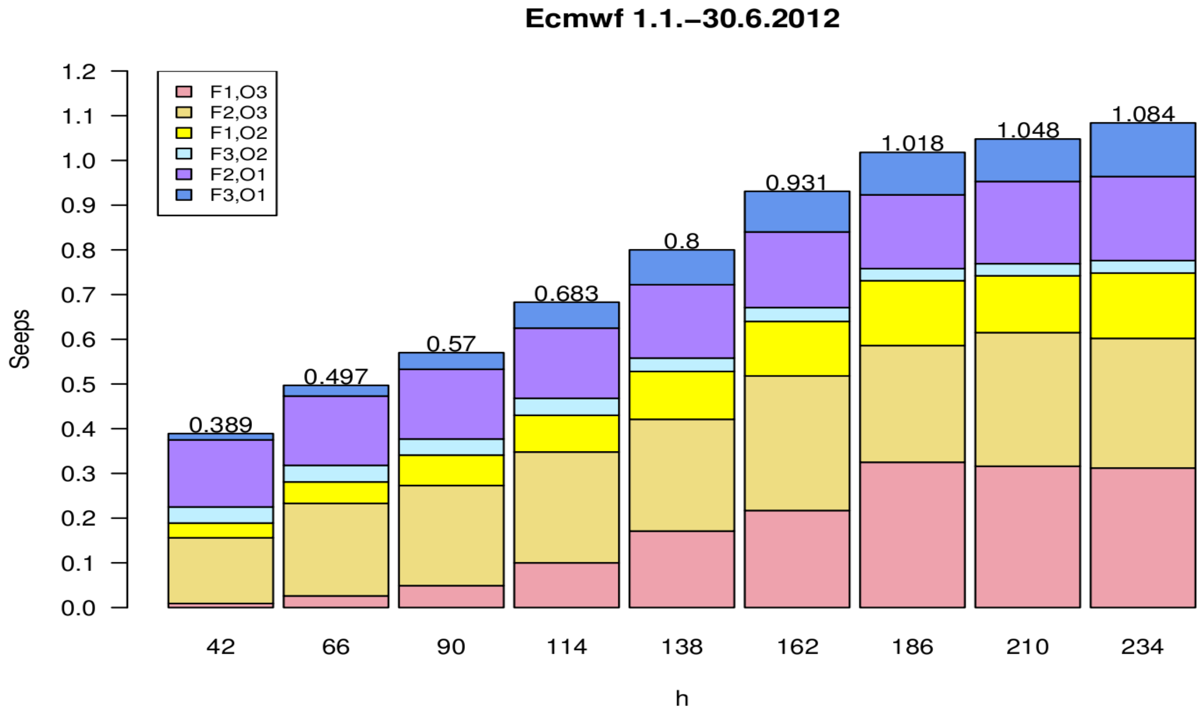

Figure 6 ECMWF SEEPS verification 2012 (first half) in Finland (60 stations) showing each component of the score. 'E' means forecasted category,H is observed category. Category 1=dry, 2=light and 3=heavy rain. 12 utc run.

3.1.2 ECMWF model output compared to other NWP models

See figures 1., 2. and 3.

3.2 Subjective verification

3.2.1 Subjective scores (including evaluation of confidence indices when available)

FMI forecasters have made some remarks about ECMWF model as follows:

- Major winter storm hit Finland 26. December 2011, wind damages were extensive in the southwest Finland. 300 000 households were left without electricity, tens of thousands for extended periods of time. FMI was able to issue warning before Christmas eve by following ECMWF EPS and deterministic forecasts and other model guidance. Actual route and intensity of the storm altered later but the signal was there. ECMWF operational model (25. December 00utc and 12utc runs) wind gust product forecasted 25 m/s gusts over land. The model underestimated wind gust force, FMI fortunately warned over 30 m/s gusts which were also measured in many inland stations. Upper air winds were though quite realistic in ECMWF so if there is a problem it may just concern wind gust parameterization.
- Two low pressure related wind gust events were missed. One was clearly because of underestimated intensity of a small low pressure system (27 September near city of Oulu). EPS probability in that case for over 20 m/s gusts was just 2% one day before. Another one in the spring time was missed due to underestimated wind gusts. These problems were somewhat present in all models.
- Gale-force (and stronger) winds on sea areas underestimated by the model. Channeling effect too weak on Gulf of Finland (probably model resolution issue).
- Forecasters reported that in spring daytime over snow ECMWF model had sometimes much lower diagnostic t2m than the lowest model level (91) temperature was. The solution was to use model level 91 as a t2m forecast which was better.

- Aviation meteorologists reported that cloud base forecasts (from model soundings) are often too low compared to observations
- Sea surface temperature was reported to be problematic especially in the southwest coast of Finland during summer 2012 (near city of Turku on Sea of Archipelago). ECMWF Sea temperature has been too low compared to observations and also to OAAS model which is run at FMI (Figure 7.). OAAS is 3-D hydrodynamic model. OAAS models SST over Sea of Archipelago actually warmer than environment as it should be, not colder. See attached current observations (Figure 8.) and ECMWF short term SST forecast (Figure 9.). Cold temperature sst bias was even stronger in earlier in the summer and it affected also 2m temperature forecasts (figure 10.).

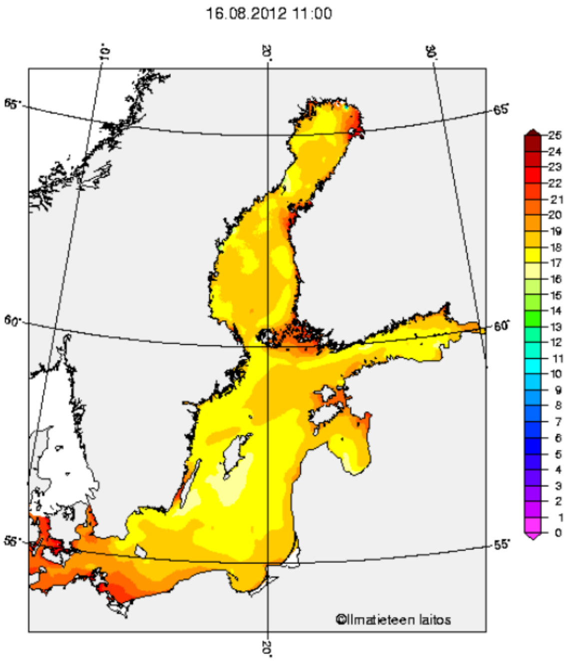

Figure 7 OAAS short term SST forecast 16.8.2012

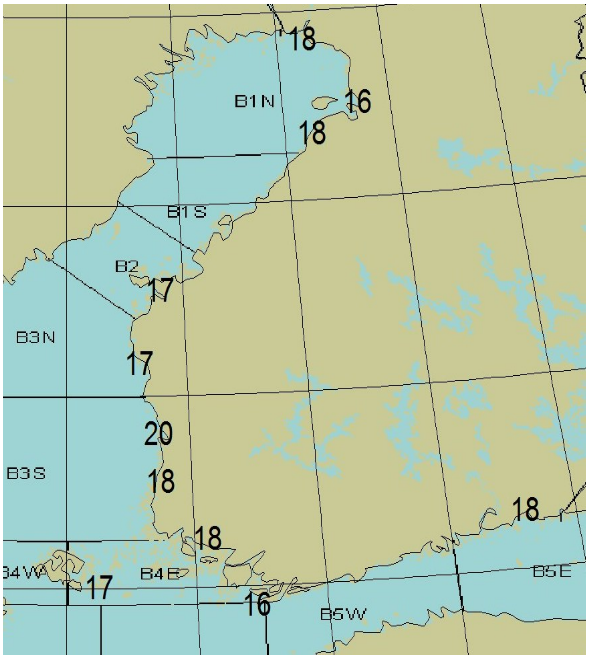

Figure 8 SST observations 16.8.2012

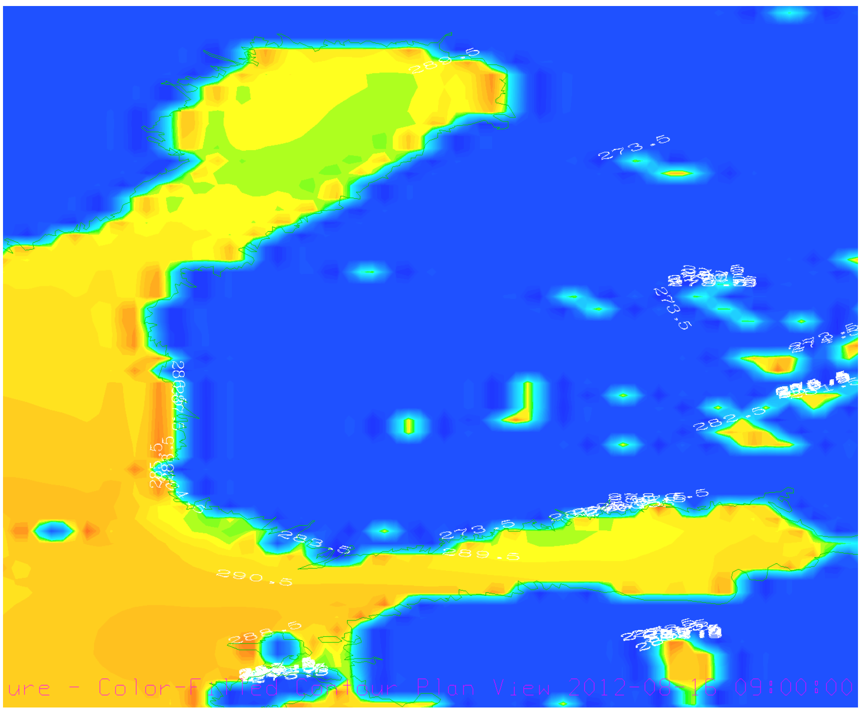

Figure 9 ECMWF short term SST forecast.16.8.2012

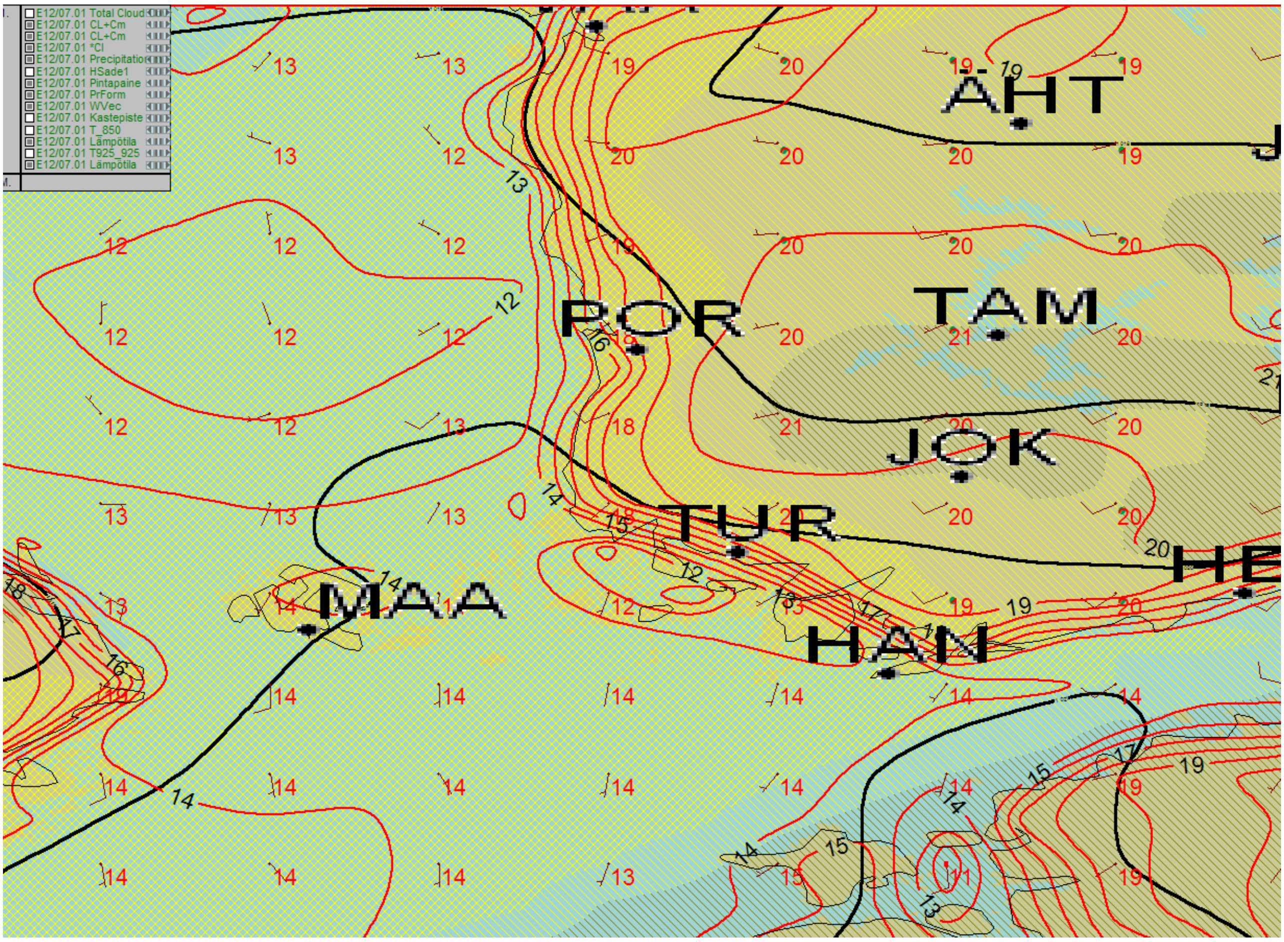

Figure 10 ECWMF 2m temperature forecast (red contours and value plots)30.7.2012 demonstrate the effect of very cool SST to the t2m in the Sea of Archipelago (southwest coast).