Land Surface Data Assimilation at the Met Office

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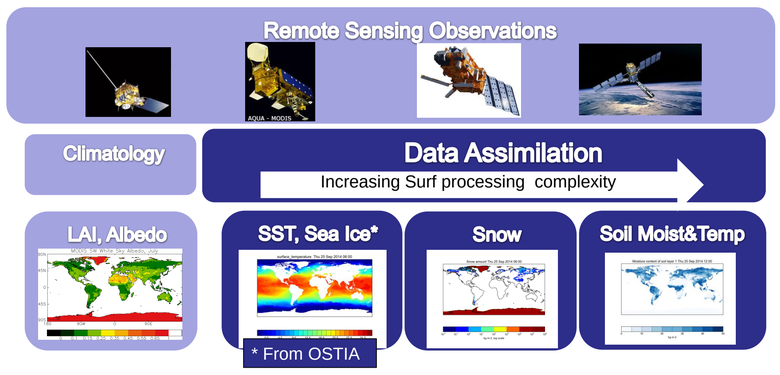
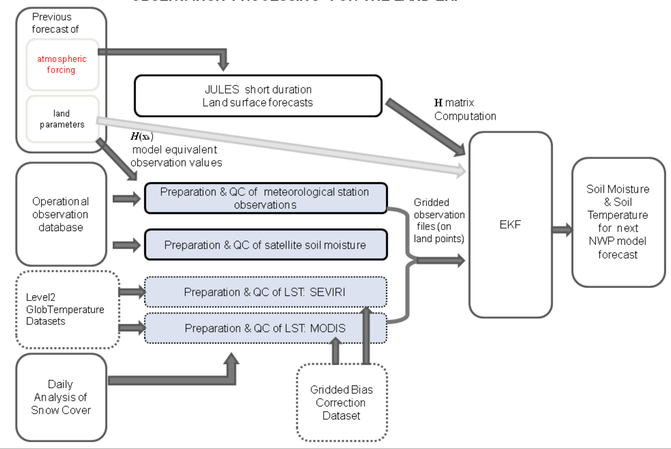
Introduction

The Land Surface Data assimilation team is responsible for providing high quality initialisation fields to the Atmospheric model forecast. Our main contribution is an EKF scheme that provides global soil moisture analysis for NWP but we are also responsible for SST and Sea Ice initialisation as well as Snow Cover Analysis. Here we describe our current system and ongoing developments.

LAND SURFACE INFOGRAM



OBSERVATION PROCESSING FOR THE LAND EKF



Current System

Soil moisture and Temperature

Extended Kalman Filter runs every six hours on global domain using observations of near surface temperature / humidity from Met stations & satellite observations of soil wetness from the ASCAT scatterometer.

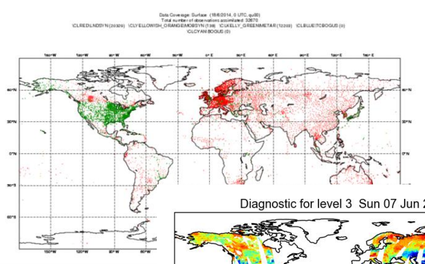
A global soil moisture and soil temperature analysis is produced. The soil moisture analysis is only used for NWP. Additionally, the soil moisture analysis is reconfigured into the UKV domain daily for high-resolution forecasts over the British Isles.

Snow Analysis

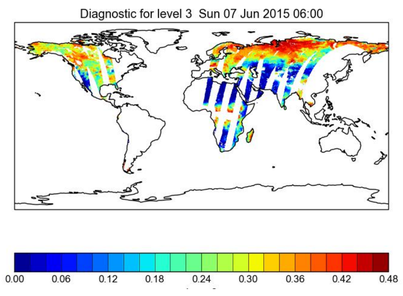
Snow amount and cover is produced for the northern hemisphere on a daily basis based on NESDIS IMS analysis.

Recent Changes

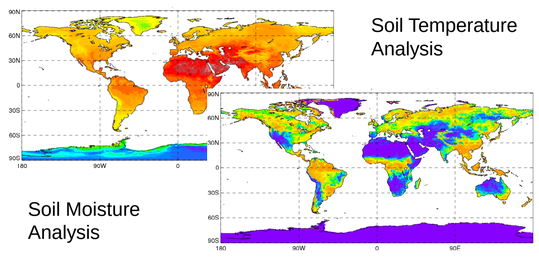
•Reduction of specified screen temperature observation errors from 2K to 1.5 K
• Introduction of MetOp-B scatterometer
• Improved conversion from satellite soil wetness to model soil moisture via a new soil moisture climatology driven by the latest WFDEI forcing data and latest land surface ancillary fields (soil parameters)



Met Station observations



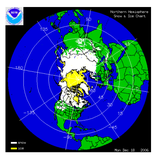
Soil moisture from ASCAT instruments onboard Metop-A,B



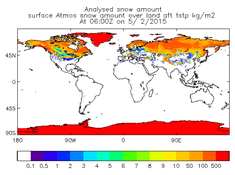
Soil Temperature Analysis

Soil Moisture Analysis

NOAA/NESDIS IMS snow cover



Snow amount analysis



Land Surface Temperature

Potential benefits

There are now several sources of good quality land surface temperature (LST) measurements from both polar and geostationary infrared instruments. These observations have the potential to improve both the soil temperature and soil moisture.

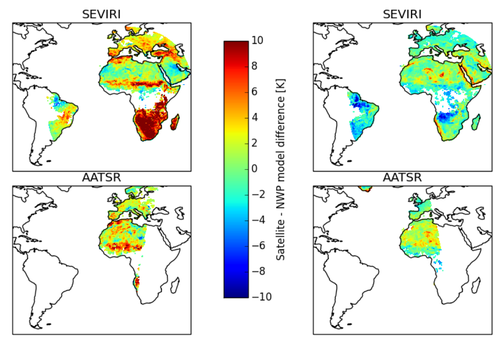
Verification

Comparisons between Met Office Global Model LST [left] and observations from ESAs GlobTemperature LST dataset reveal large biases (model not warm enough), particularly during daytime. This result is also seen when other sources of satellite LST are compared to the NWP Model.

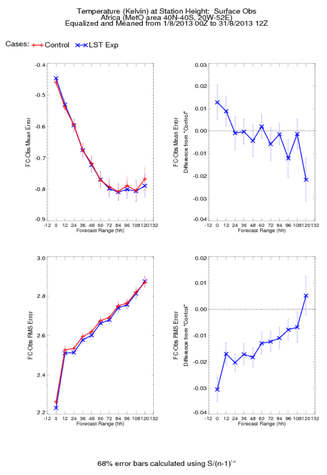
Impact on NWP

Despite these differences in model and satellite, after bias correction of the observations initial experiments show a small improvement to near surface air temperature forecasts, for instance over Africa [right]

Satellite minus Model



Verification vs. Station Data



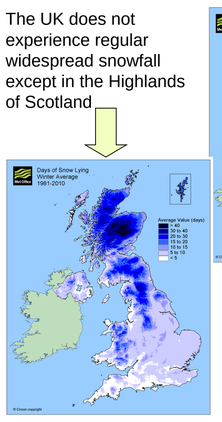
Red: Control [met station data & scatterometer]

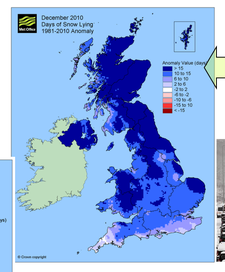
Blue: Control + LST assimilated

68% error bars calculated using S/(n-1)^½

Snow assimilation for the UK

The UK does not experience regular widespread snowfall except in the Highlands of Scotland





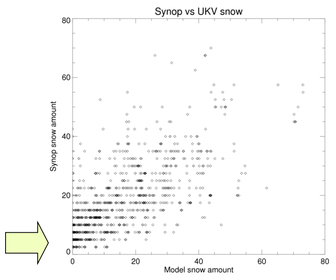
Significant snow events cause widespread disruption

e.g. December 2010

Snow in the UK is a low frequency, but high impact event. Accurate analyses and forecasts of snowfall and lying snow are extremely important.

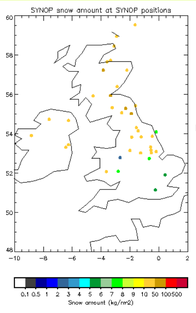
The Met Office UK forecasting model (UKV) does not currently assimilate any snow observations.

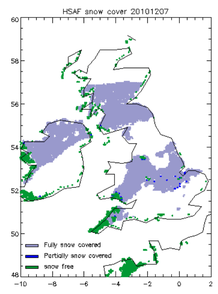
Comparison of UKV snow amounts with those from SYNOP station observations shows considerable scatter, suggesting that assimilation of these snow depth observations could improve modelled snow amounts

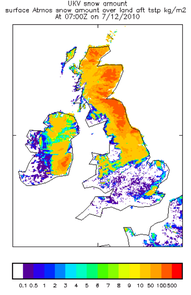


A new snow assimilation scheme

...in development







Data source

Ground-based obs of snow depth, and state of ground (snow or no snow) from synoptic network

Satellite-derived snow cover from H-SAF (MSG-SEVIRI) daily product

Model first-guess SD

Snow depth values

SD where reported

0 m SD from snow-free state of ground reports

0 m SD from snow-free pixels

0.05 m SD from snow-covered pixels where model snow-free

Optimal Interpolation

Snow depth analysis

EKF for the UK model

Surf EKF can now be used on any UM domain, including variable grids. Two trials have been run to evaluate its performance using the same set-up with different initialisation.

Set-up

•Error-covariance statistics from the Global set-up.

•Screen temperature and humidity pseudo-observations

•Analysis every 3hours. Jacobians are calculated on a 2 hour window.

• Two different soil initializations are used.

- •*Global Reconf:* Global, low resolution, temperature and humidity. Temperature has a coarse structure. Soil moisture structure is defined by soil properties.
- •*Jules Spin-up:* Long JULES land surface model spin-up run in standalone mode. Finer scale temperature. Much drier soil.

•Trial period: from 15/06/2015 to 03/07/2015.

- •5 days are allowed to spin-up the upper soil layer.
- •15 days used for verification against surface obs.

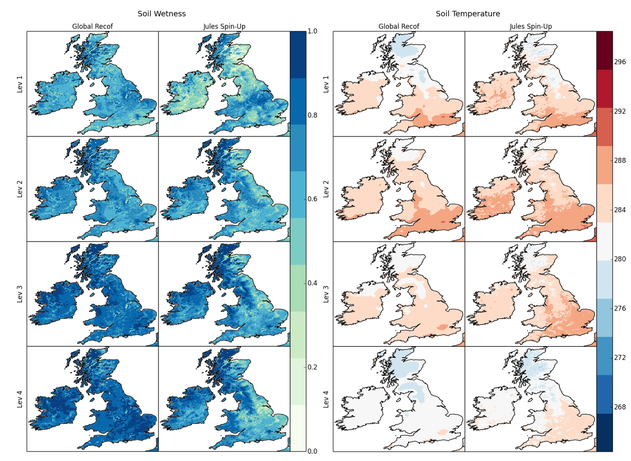
Verification

Relative Humidity (left picture)*: Global Reconf* trial shows a slightly dry bias and no impact on the RMSE. *Jules Spin-Up* trial has a substantial dry bias and larger RMSE.

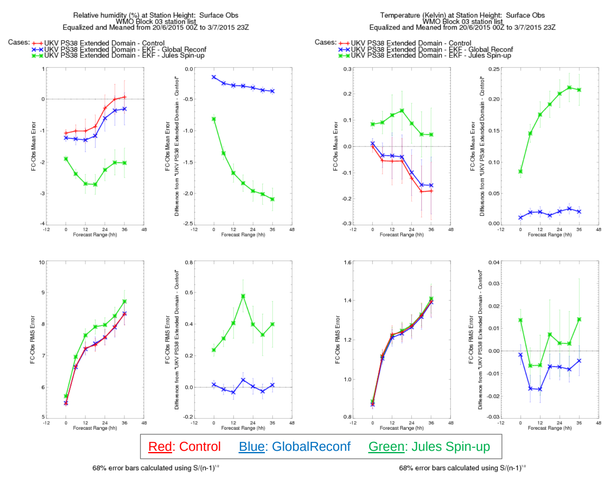
Temperature (right picture): *Global Reconf* trial shows a cold bias, similar to the control experiment. *Jules Spin-up* trial has a warm bias of a similar magnitude to the control. No impact is observed on RMSE for any experiment.

Summary: *Global Reconf* trial shows a neutral impact and *Jules Spin-up* trial shows a poorer performance. There is a large sensitivity to the initialisation which needs to be improved. However these results are not conclusive and longer trials are needed.

Trial initialisation



Verification vs. Station Data



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