



# Using satellite-derived snow cover data to implement a snow analysis in the Met Office global NWP model

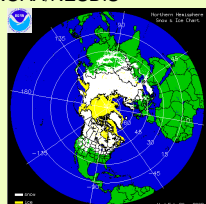
Samantha Pullen, Gabriel Rooney, Clive Jones

## Introduction

Snow cover and amount are important components in the interaction between the land surface and atmosphere, with considerable impacts on the radiative and hydrological properties of the land surface. Accurate representation of snow cover in NWP models is essential for calculations of surface exchange fluxes, and subsequent forecasts of atmospheric variables. An accurate knowledge of surface emissivities, which are affected by snow cover, is also important to enable the assimilation of satellite sounding data from surface-affected channels. Increases in the number of usable sounding channels could potentially yield considerable improvements to forecast accuracy, so efforts to improve the surface representation are also important from the satellite data assimilation point of view. Until recently there had been no observational snow information incorporated into the Met Office's global NWP model. This poster presents a Northern Hemisphere snow analysis, based on satellite-derived observations of snow cover, which has recently been implemented in the Met Office's operational global NWP model.

## Satellite data

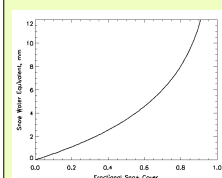
Interactive Multisensor Snow and Ice Mapping System (IMS)  
NOAA/NESDIS



- Daily snow map, 4 km resolution, NH
- Polar stereographic 6144 x 6144
- Snow cover (0 or 100), ice (0 or 1)
- Primarily geostationary imagery (GOES, Meteosat, MTSAT)
- Plus AVHRR, MODIS, SSM/I, AMSU
- Plus derived products, in situ data
- Analyst

## Analysis method

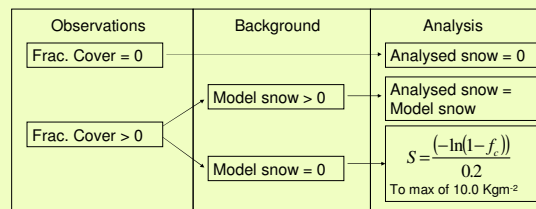
Fractional snow cover is derived from IMS snow cover by resampling onto the NWP model grid. The presence of snow can then be compared directly between the derived fractional cover and the model background snow amount field. Analysed snow is calculated following the following rules:



Snow is added by relating fractional cover to snow amount:

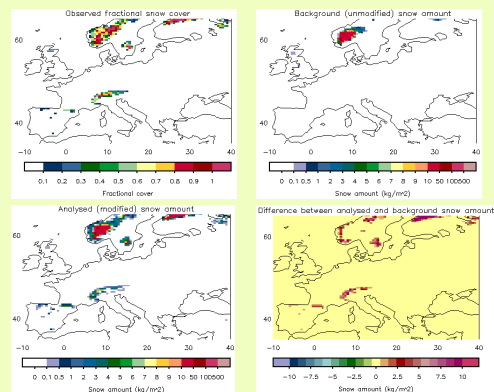
$$S = \frac{(-\ln(1-f_c))}{0.2}$$

$S$  = snow amount,  $f_c$  = fractional cover



## An example

10-11-2008



## Assimilation experiments

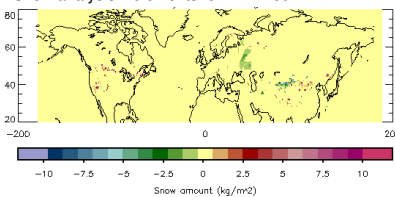
### Experiment 1 - December 2006

This period was chosen to test the snow analysis during the accumulation of snow in the NH. Forecast skill impacts were small but slightly positive. There were small improvements in surface or low level temperature forecasts, and in relative humidity where snow was removed. Snow was consistently added in the Sierra Nevada and Rocky Mountain ranges of North America, and removed in the region of the Tibetan Plateau. Snow was initially added, then removed over large areas along the Eurasian snowfield edge. The net effect over the experiment was snow removal.

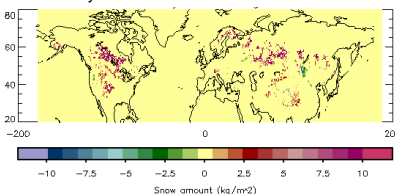
### Experiment 2 - March-April-May 2007

A longer experiment was run throughout the main period of NH snow melt. Forecast skill impacts were small and slightly negative. There were snow additions over progressively larger areas at the edges of the snow field in North America and Eurasia, as the analysis attempted to restore snow that had been prematurely melted by the model. However, this added snow was not retained by the model and the reduction in forecast skill for NWP variables was probably due to the effects of the model repeatedly melting large areas of snow added by the analysis.

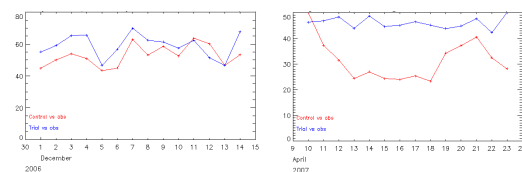
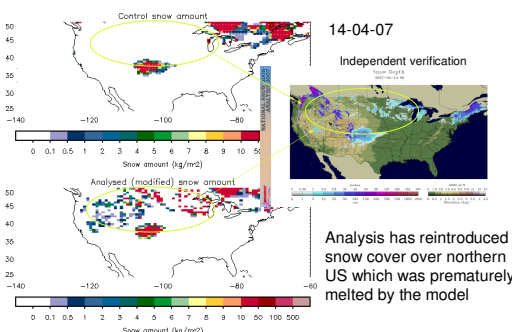
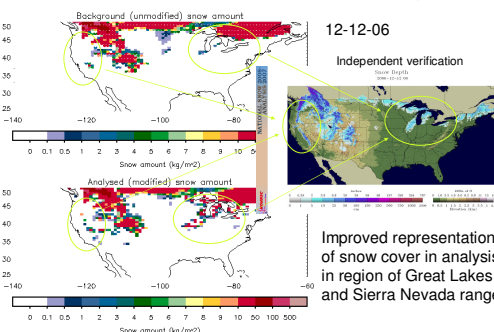
### Snow analysis increments for 14-12-06



### Snow analysis increments for 15-04-07



## Verification of snow analysis against independent snow observations



Percentage of model grid points over Europe with snow presence in agreement with SYNOP snow reports, for a 2-week period during each experiment: percentage agreement was increased compared with the control run (with no snow assimilation) for both seasons, but particularly during the snow melt season.

## Summary

- The Northern Hemisphere snow analysis has been operational in the Met Office's global NWP model since November 2008.
- There is clear evidence that the snow analysis improves the analysed snow field in terms of presence/non-presence of snow.
- There is some evidence of small improvements in surface/low level temperature and relative humidity forecasts, especially where snow is predominantly removed by the analysis.
- Little of the information introduced by the analysis is retained in subsequent forecasts, especially where snow has been added. Future development of the model snow physics hopes to address this problem.
- An upgrade to the snow analysis is currently being tested to mitigate the effects of time delays in the IMS data which can lead to exclusion of snowfall events from the analysis.