# Assessment of H-SAF MSG/SEVIRI snow cover product over the UK

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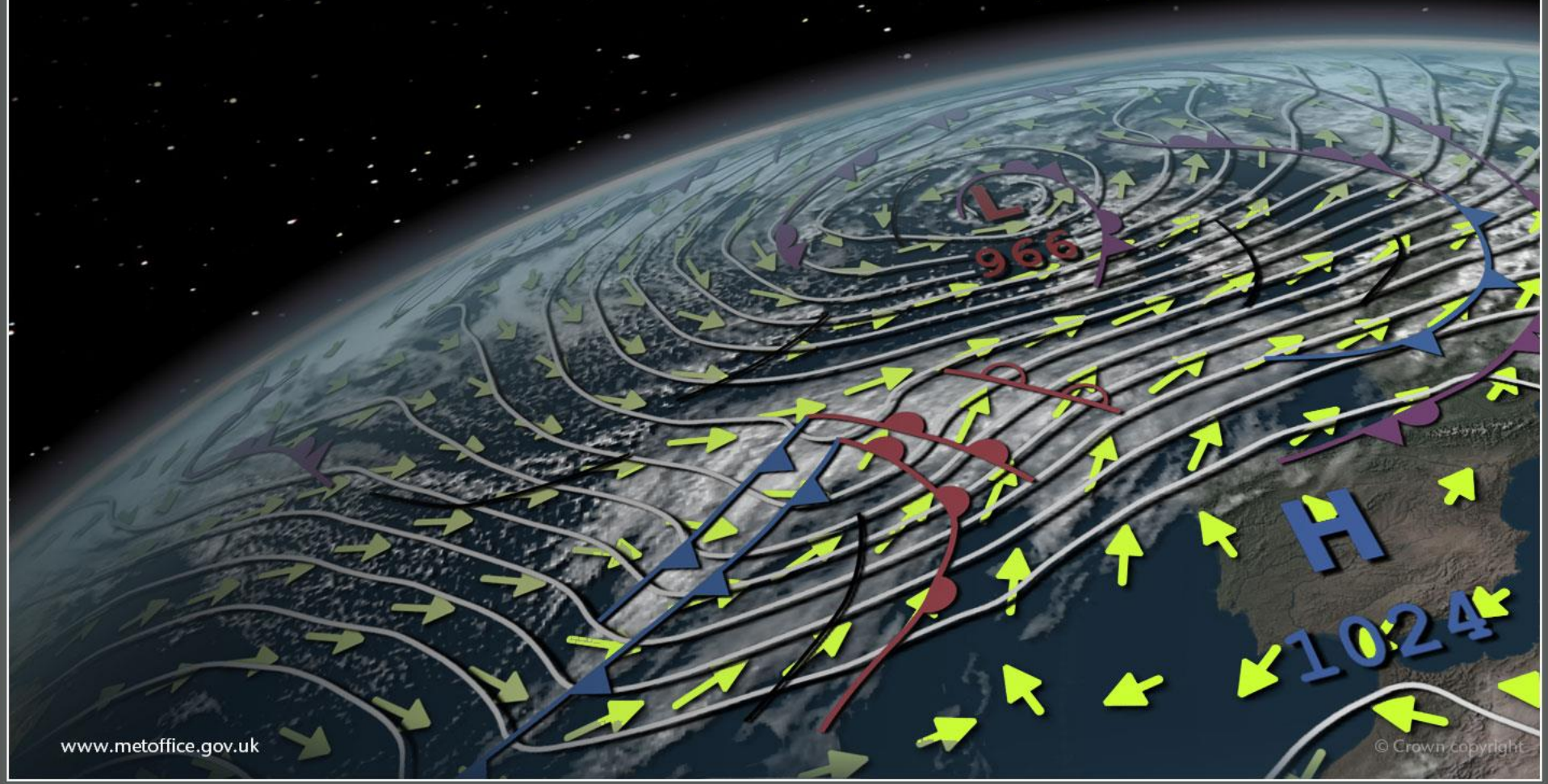
2nd ISSPI Workshop, 14-16th September 2015, Boulder.



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- Ground-based snow reporting
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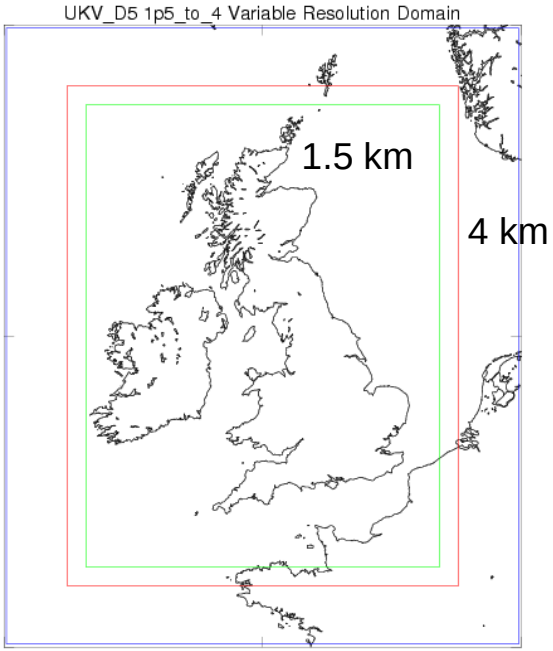
  - Progress towards a solution

# Snow DA for the UK NWP system

Met Office

UKV
Unified model (UM) coupled with JULES land surface model




No assimilation of land surface observations yet

In development….

| Data source | Snow depth values |
|---|---|
| Ground-based obs of snow depth, and state of ground (snow or no snow) from synoptic network | SD where reported<br>0 m SD from snow-free state of ground reports |
| Satellite-derived snow cover from H-SAF (MSG-SEVIRI) daily product | 0 m SD from snow-free pixels<br>0.05 m SD from snow-covered pixels where model snow-free |

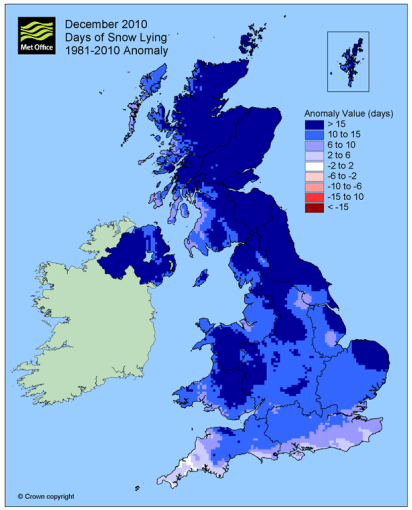
Model first-guess SD

Optimal Interpolation

Snow depth analysis

# Assessment of H-SAF snow cover for potential assimilation

December 2010




- ❑Widespread snow across most UK, most of month
- ❑Multiple snowfall/melt cycles
- ❑Good test period for snow datasets
- ❑UK particularly valuable validation site for snow data products

## Data sources

1. H-SAF daily snow cover (H31) – composite from temporal integration of scene classifications at 15 minute intervals, over previous 24 hours.
2. Ground-based snow depth reports from UK SYNOP network 06UTC. Positive snow depth measurements plus snow-free (zero depth) diagnosed from state of ground
3. UKV T+1 forecast fields from 06UTC. Snow amount (kgm$^{-2}$)

## Experiments

1. H-SAF (test) vs UKV (reference)
   closest grid box to each pixel
2. H-SAF (test) vs SYNOP (reference)
   closest pixel to each SYNOP, if classified
3. UKV (test) vs SYNOP (reference)
   grid box that SYNOP within

Compare diagnosed snow cover using model threshold:
Snow covered if snow amount > 0.1 kgm$^{-2}$

| | Test snow-covered | Test snow-free |
|---|---|---|
| Reference snow-covered | a | b |
| Reference snow-free | c | d |

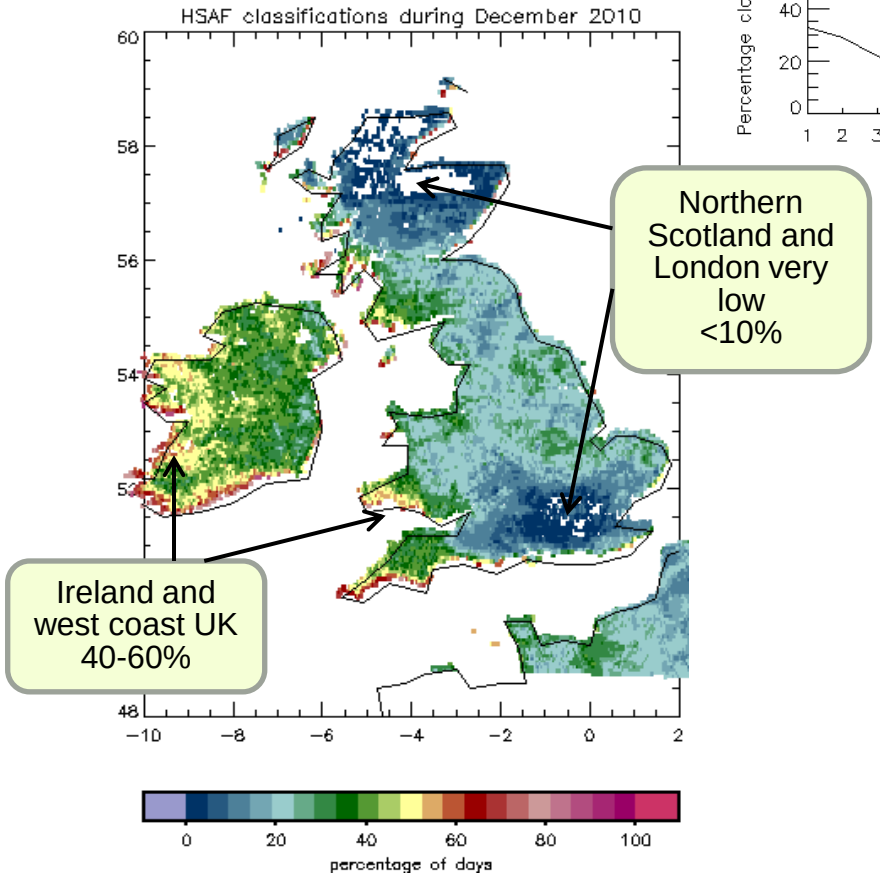
Rate of agreement $R_a = \frac{\sum^n (a) + \sum^n (d)}{n} \times 100\ \%$

Rate of overestimation $R_o = \frac{\sum^n (c)}{n} \times 100\ \%$

Rate of underestimation $R_u = \frac{\sum^n (b)}{n} \times 100\ \%$

# Cloud-free classification rates

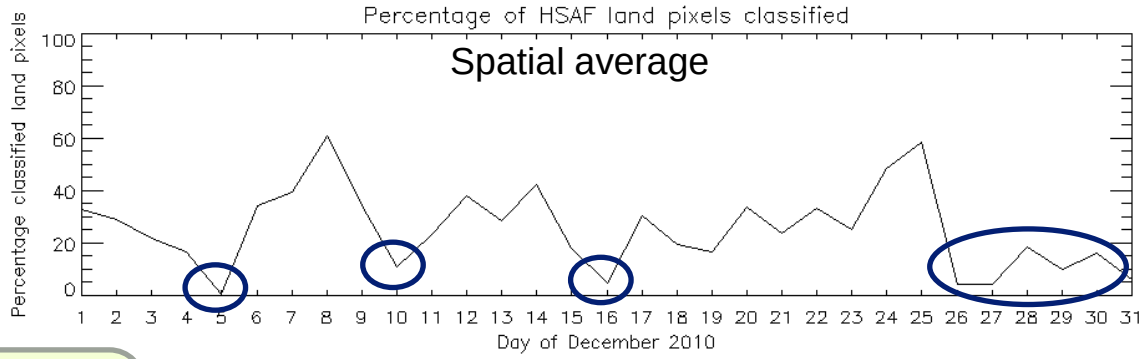
Temporal average




Northern Scotland and London very low <10%

Ireland and west coast UK 40-60%

Spatial average




Most of UK, only 20-40% cloud-free classifications With very high temporal variability.

Some days allow very few scene classifications

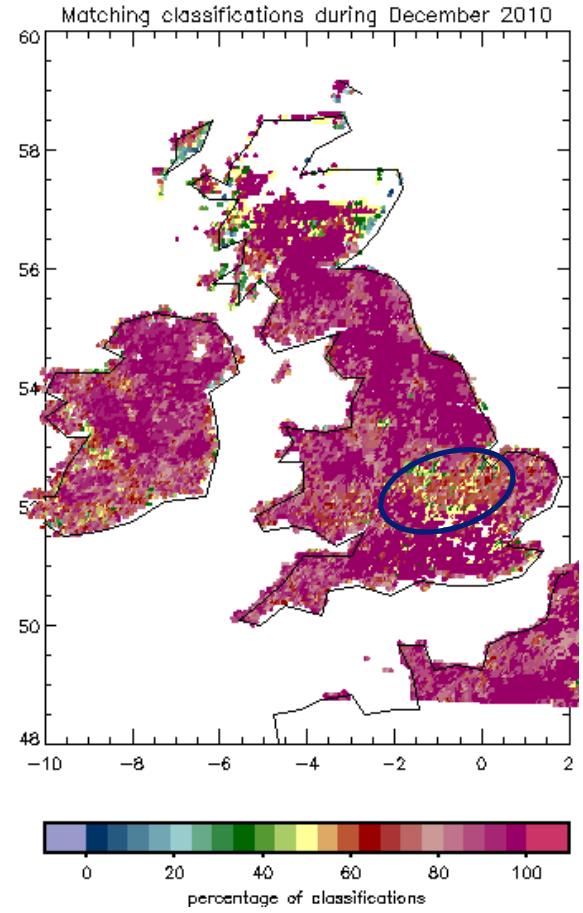
However…..
High temporal sampling of H-SAF product results in large reductions of cloud-affected pixels in composite product relative to products from sun-synchronous sensors

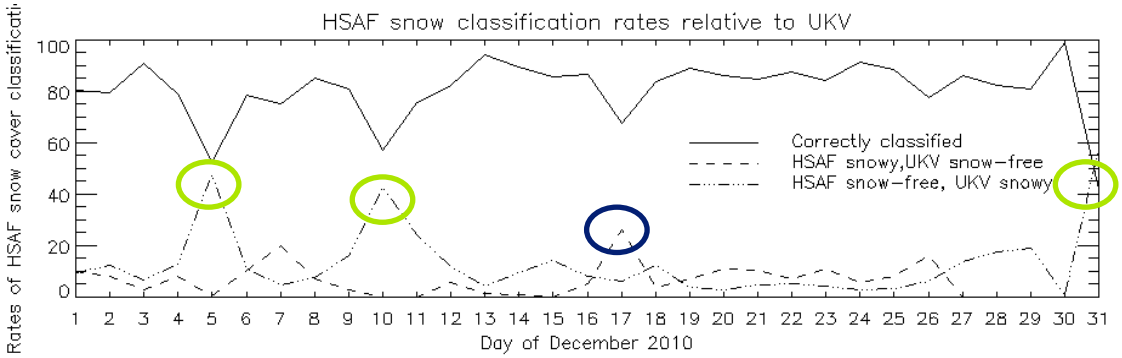
Results in comparable or higher mapping accuracy, despite coarser spatial resolution of SEVIRI product (Surer et al., 2013 doi:10.5194/hessd-10-12153-2013)

# H-SAF comparison with UKV

Disagreements do not necessarily indicate errors in H-SAF product – most likely combination of H-SAF and model errors

Rate of agreement




Rate of agreement 80-90% over most of UK, most of time

High rates of underestimation seem to correspond to cases of particularly low classification rate (extensive cloud cover)

High rate of overestimation rate on 17th associated with new snowfall sweeping south.
Rapidly changing snow cover - representation likely to differ between datasets with different time windows.

# H-SAF and UKV comparisons with SYNOP

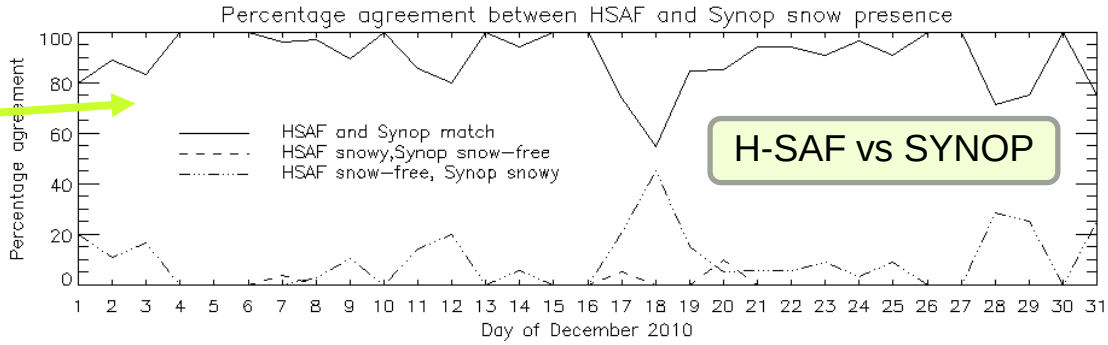
H-SAF vs SYNOP agreement well over 90% most of period

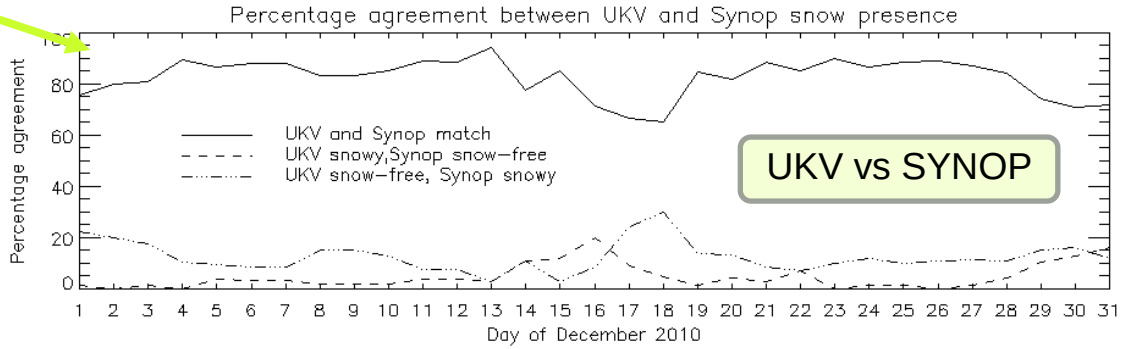
Often low coincidence of SYNOP with classified pixels - beware

UKV vs SYNOP agreement high but not as high as H-SAF

Large reduction in agreement rate 17-19th (both comparisons).

- Rapidly changing snow cover, timing of obs relative to falling snow, model evolution.
- SYNOP too sparse for detailed validation of snow edge.




## Overall results

(Repeated using common set of SYNOP for direct comparison)

| | $R_A$ | $R_O$ | $R_U$ |
|---|---|---|---|
| H-SAF vs UKV | **80.82** | **6.16** | **13.05** |
| H-SAF vs SYNOP | **89.38 (89.10)** | **0.64 (0.33)** | **9.98 (10.57)** |
| UKV vs SYNOP | **82.65 (85.64)** | **4.86 (3.83)** | **12.49 (10.53)** |

H-SAF closer to ground truth than UKV

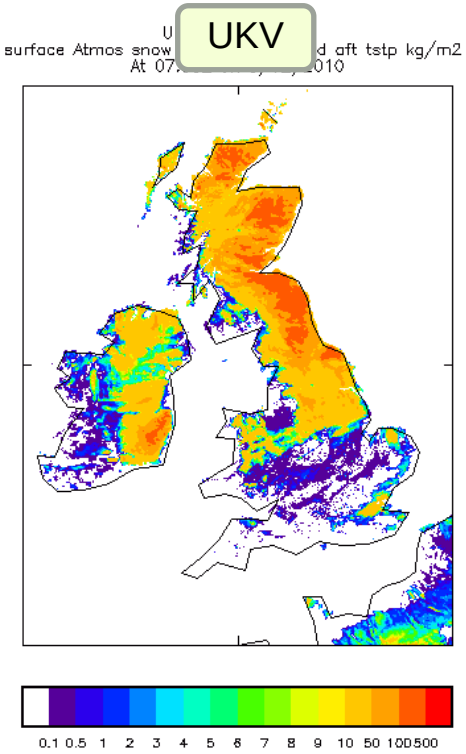
Where H-SAF and UKV differ, can infer that UKV errors proportionally greater than H-SAF errors on average

Assimilation of H-SAF into UKV will add value

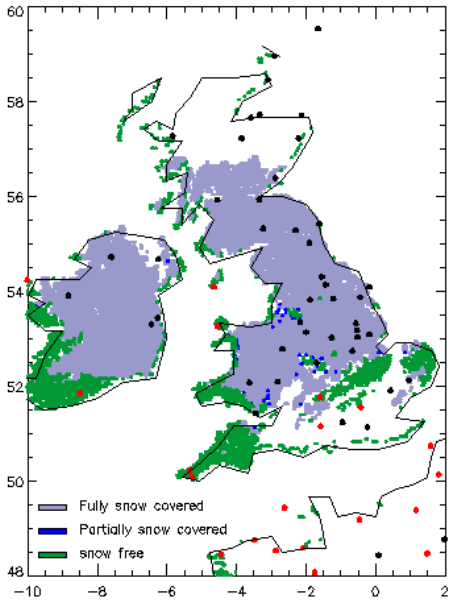
# 8th December 2010

Fresh snow, little cloud, good agreement overall…

UKV

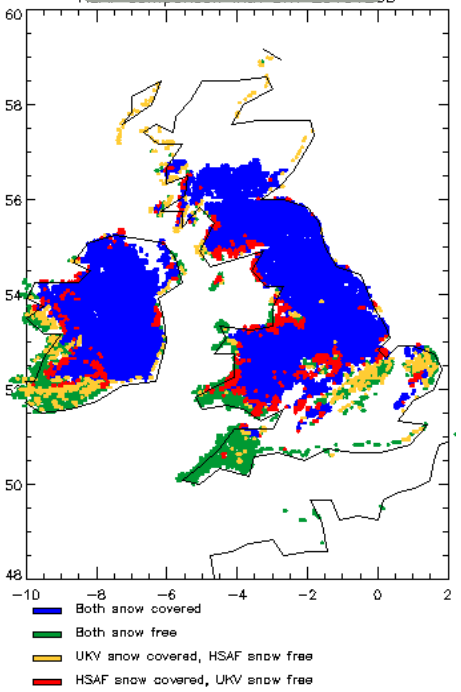



H-SAF + SYNOP




Black dots = snow-covered SYNOP
Red dots = snow-free SYNOP

H-SAF vs UKV

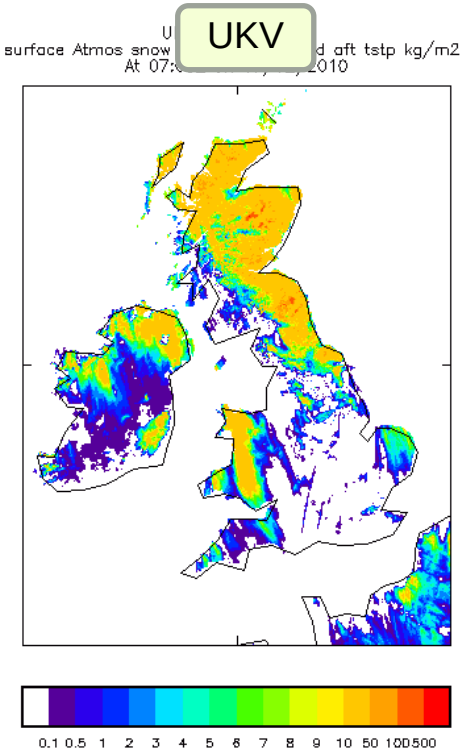



- Valuable case for intercomparison – snow cover extensive, very little cloud cover, lot of available data
- Disagreements mainly on western and southern edge of snow field, but ground station coverage not dense enough to verify which is closer to reality
- Good coincidence of SYNOP and H-SAF pixels ⇨ 97% agreement (UKV vs SYNOP 89%)

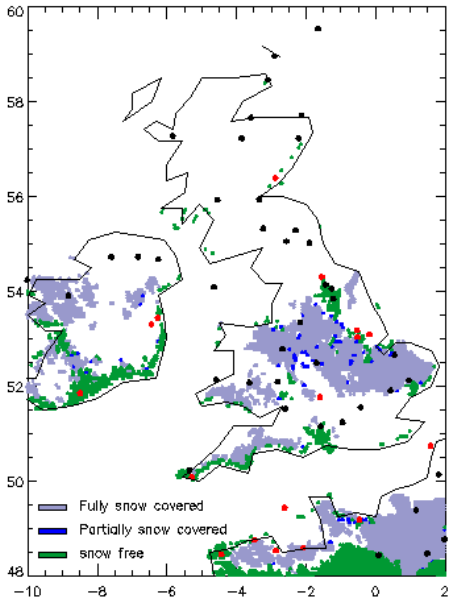
# 17th December 2010

Fresh snow fall sweeping south, extensive cloud cover

UKV

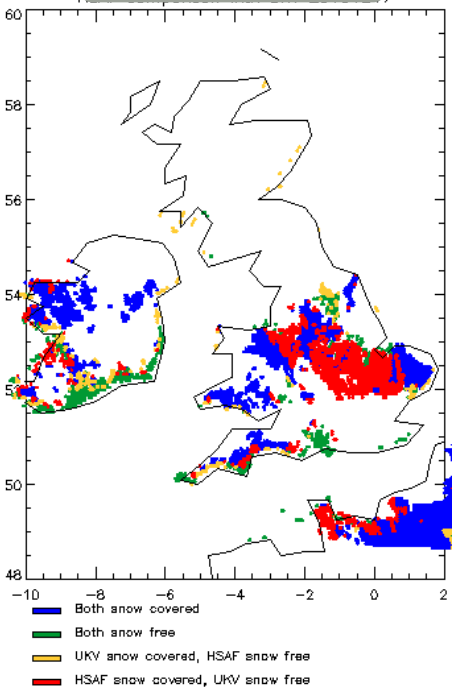



H-SAF + SYNOP




Black dots = snow-covered SYNOP
Red dots = snow-free SYNOP

H-SAF vs UKV

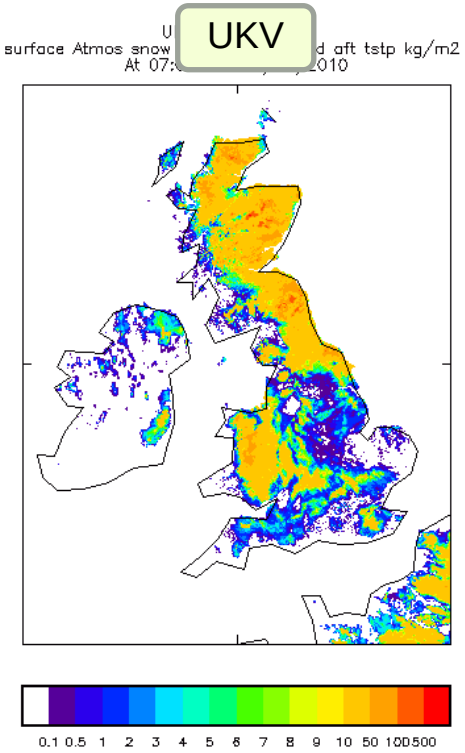



- Discrepancy between H-SAF and UKV and between UKV and SYNOP
- SYNOP mainly corroborated H-SAF in area of disagreement
- Model underestimation, or just validity time of datasets in rapidly evolving snow cover
- Model snow cover extended over next few days and its agreement with H-SAF and SYNOP improved

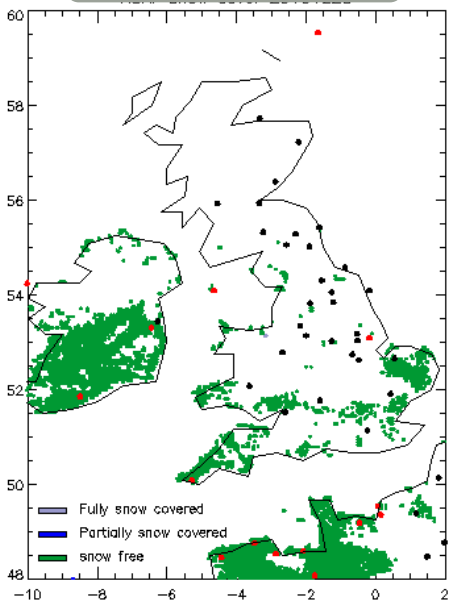
# 28th December 2010

## Widespread snow melt, extensive cloud cover

UKV

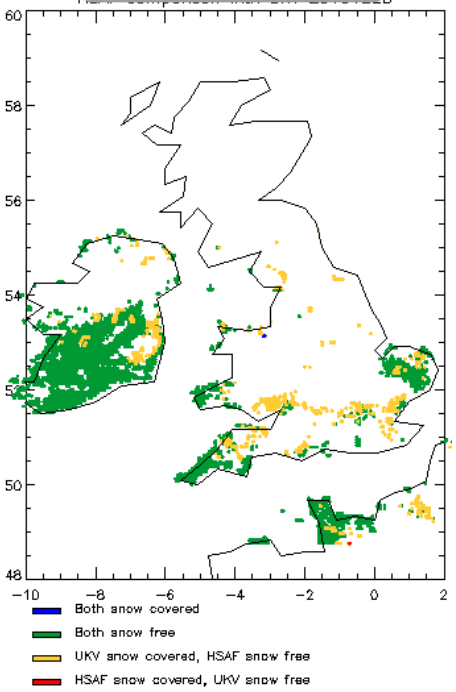



H-SAF + SYNOP




Black dots = snow-covered SYNOP
Red dots = snow-free SYNOP

H-SAF vs UKV




- Snow-free agreement generally good
- Disagreements are all underestimations of H-SAF relative to UKV, common behaviour during the snow melt
- UKV agrees better than H-SAF with SYNOP
- Consistent with findings of increased rate of underestimation of H-SAF relative to UKV on severely cloud-affected days

# Conclusions of H-SAF snow cover assessment

- Generally good agreement between H-SAF and UKV snow cover, with an overall rate of agreement of over 80%

- On particularly cloud-affected days there was a tendency for the H-SAF product to underestimate snow cover relative to UKV

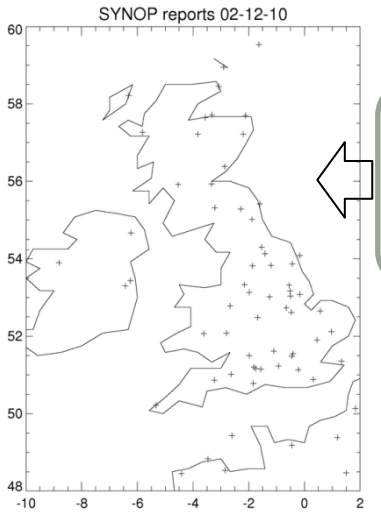
- Agreement between H-SAF and in situ data was extremely high, > 89% overall. This was higher than the equivalent comparison between UKV and in situ data (85%).

- Proportionally more underestimations than overestimations in H-SAF-SYNOP comparisons than UKV-SYNOP comparisons, consistent with there being an overall bias in H-SAF product towards underestimation of snow cover.

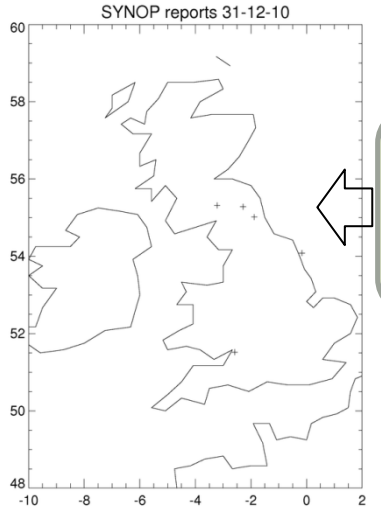
- Overall H-SAF product is closer to ground truth than UKV. Using H-SAF product to constrain UKV should add value to the model snow cover representation.

- H-SAF snow cover will add valuable additional snow data to supplement the rather sparse and variable coverage by SYNOP observations, in particular contributing important observations of snow-free surface.

# Reporting zero snow depths




(02-12-10)
Extensive snow cover
Reports from most stations




(31-12-10)
Little snow cover
Almost no data to assimilate

- Snow depth reported only when snow is present – no zero snow depth reports.
- Missing data could mean no snow, technical problem, station out of service – ambiguous – cannot be used
- For assimilation, obs of zero snow are as important as obs of snow, for constraining model snow extent
- Actively reporting zero snow depth would provide the data user community with a huge amount of valuable additional data, providing positive observations of snow-free conditions.

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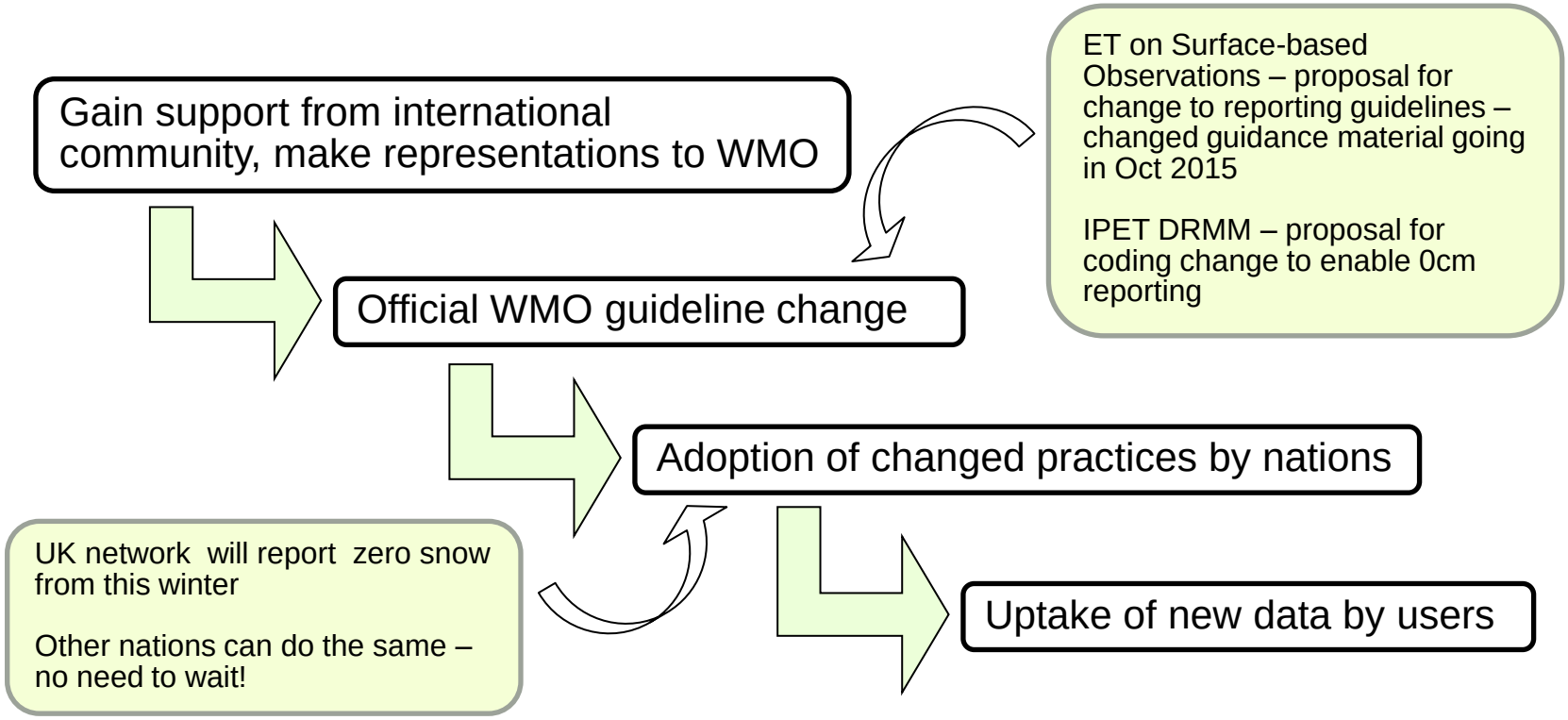
- Observing network reporting practice governed by WMO CBS guidelines, snow reporting deferred to regional practice.
- Regional Reporting Practices – Manual on Codes Volume II states for Europe (Region VI) that snow depth and state of ground "shall be included only if snow or ice cover is observed on the ground"
- Regional guidelines differ - reporting not consistent from region to region.

**The WMO guidelines need to change**

# What is happening….

A GCW Snow Watch Activity

## Achieving a WMO CBS guideline change is a long process




September 2016 – anticipate CBS approval – NEW GUIDELINES sign-off

Met Office

Questions?

Thank you