Surface activities

Met office activities on surface processes

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JULES: a new surface scheme

Joint UK Land Environment Simulator

JULES and the Unified Model

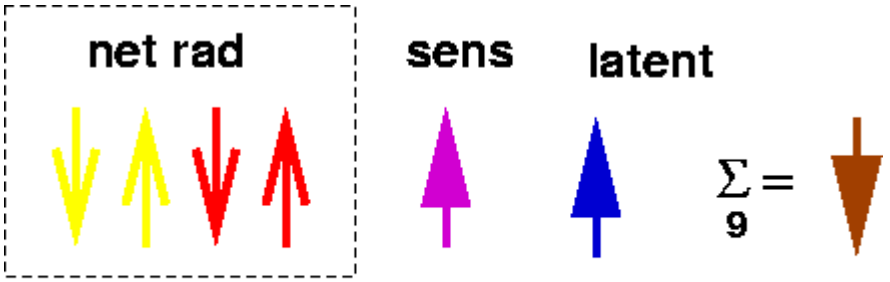
- The Met Office Unified Model (UM) is used for both climate and NWP.
- The land surface in the UM is modelled by the Met Office Surface Exchange Scheme, MOSES (e.g. HCTN 30, or Rooney & Claxton, QJRMetS 2006)
- A stand-alone version of MOSES was produced at UM Version 5.5.
- This led to the release of the academic community resource JULES, **http://www.jchmr.org/jules/**

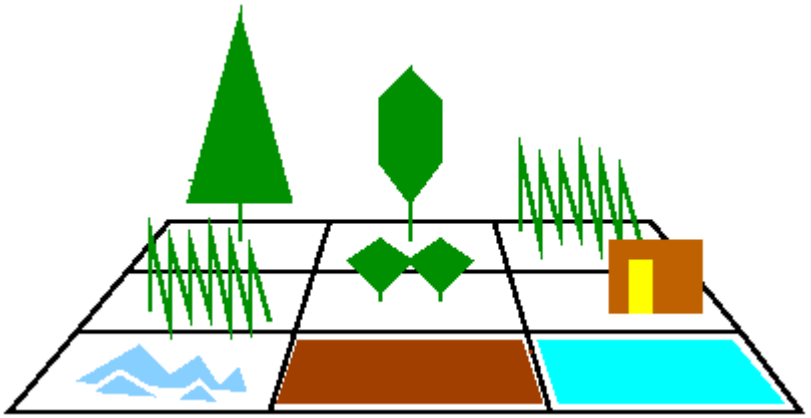
Overview of JULES

9 tiles, 5 veg + 4 non-veg

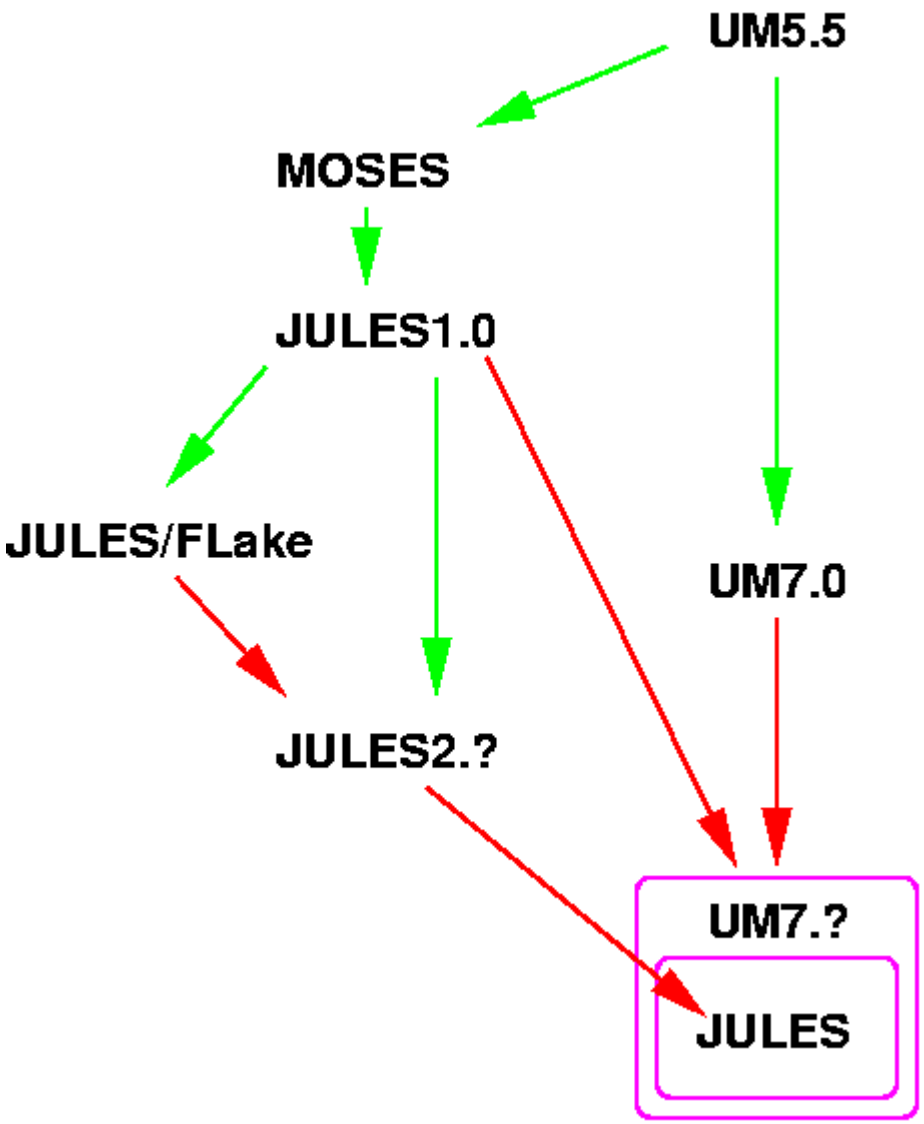
Forced with observables:
T, P, q, DWSW, DWLW,
windspeed, rain, snow

Yields:
surface (canopy) T,
sensible + latent heat fluxes,
soil temperature and moisture





Re-integrating JULES

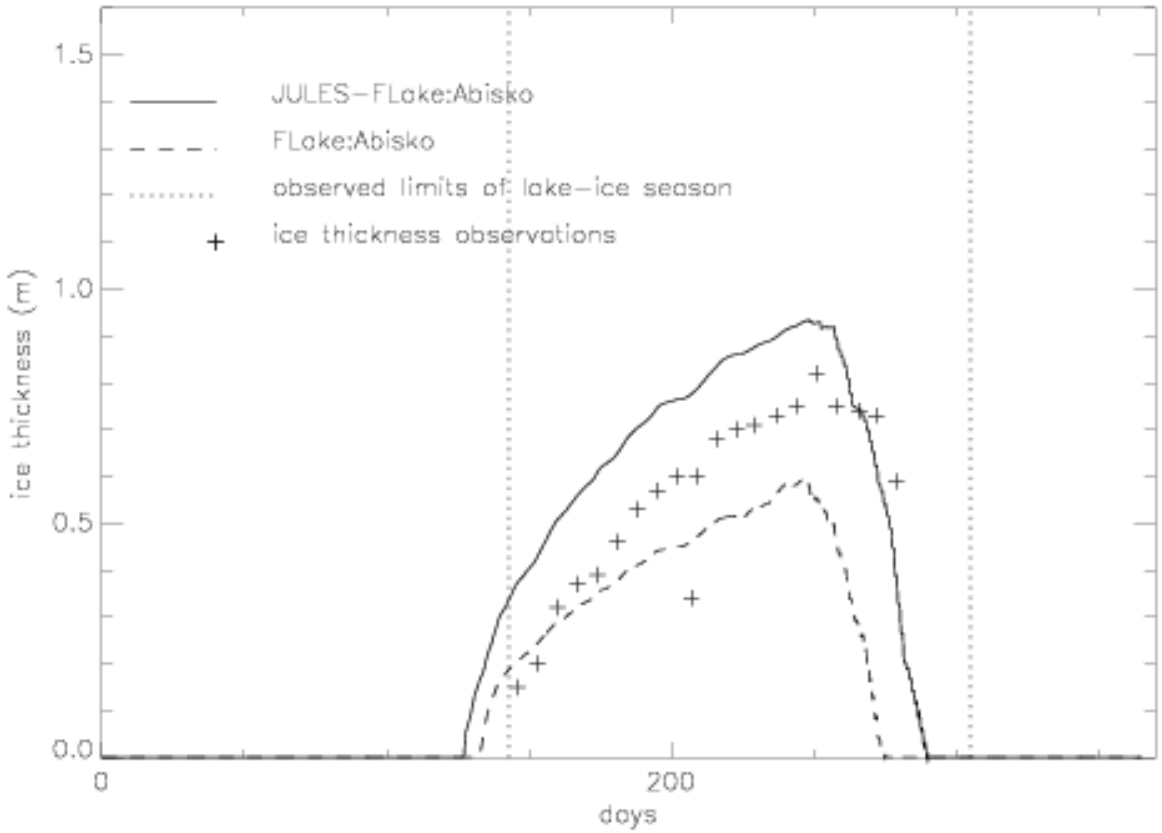


Multi-layer snow scheme

- Main new science going into the UM through JULES
- Developed by Richard Essery, Univ of Edinburgh
- Specify maximum number of snow layers
- Model compacts and relayers
- Not documented yet!

Other developments

- FLake in JULES
- Urban extensions



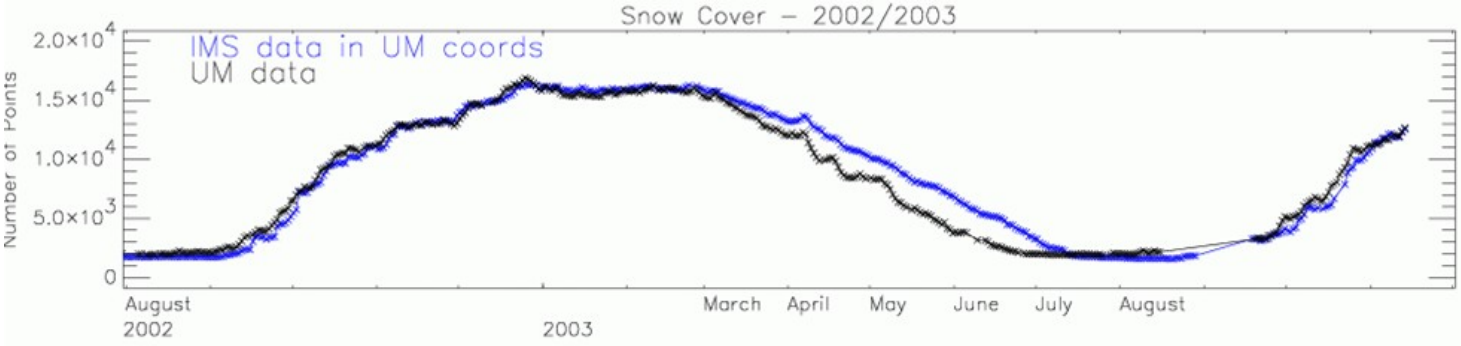
A snow analysis for the global model

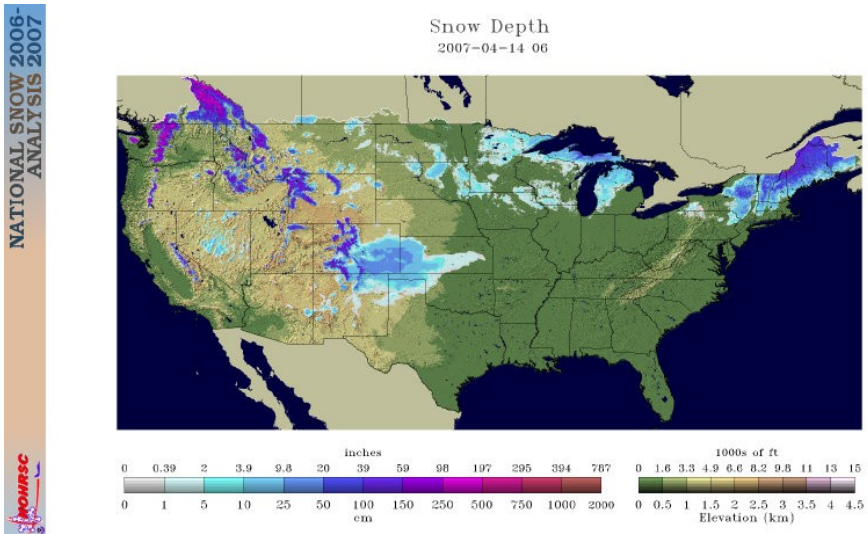
Motivation

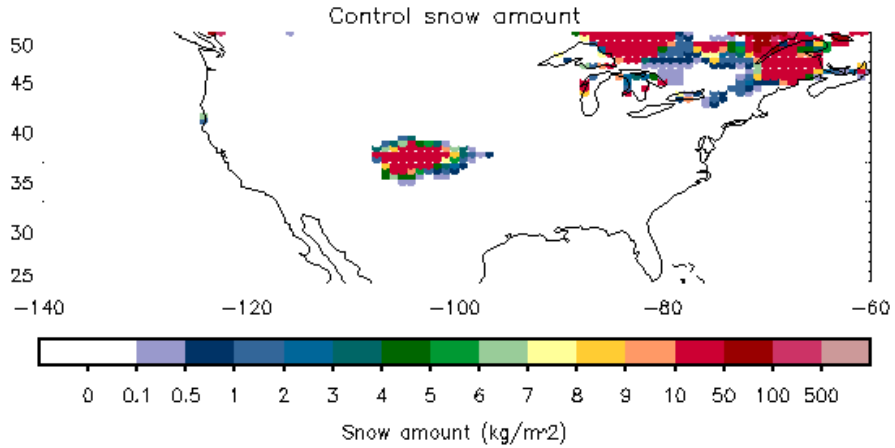
Freely evolving snow amounts → Not enough

Too much variability

Early snowmelt



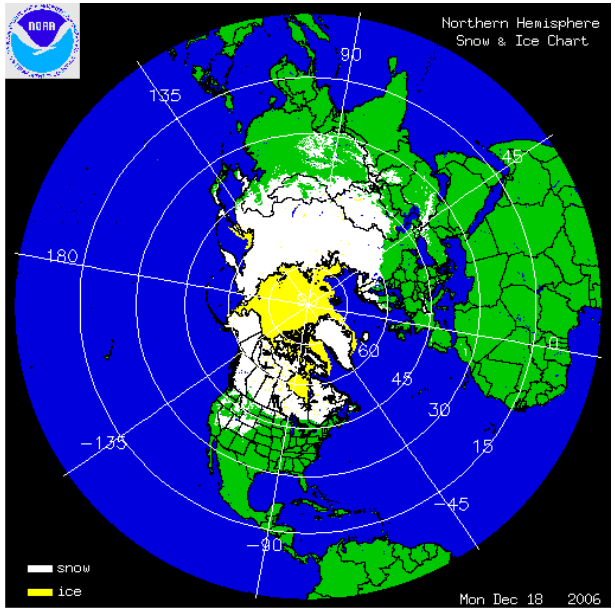




Satellite data

NESDIS Interactive Multisensor Snow and Ice Mapping System (IMS)

- GEO, LEO (GOES, Meteosat, MTSAT, AVHRR, MODIS, SSM/I, AMSU)
- Derived products (e.g. USAF Snow and Ice Analysis Product)
- In situ data
- Analyst



- Daily, 4km resolution, NH
- Polar stereographic 6144 X 6144
- Snow cover (0 or 100), ice (0 or 1)
- Received in MetDB since Nov 06
- Processed within SURF

The snow analysis scheme

Observations | Background | Analysis

Frac cover = 0

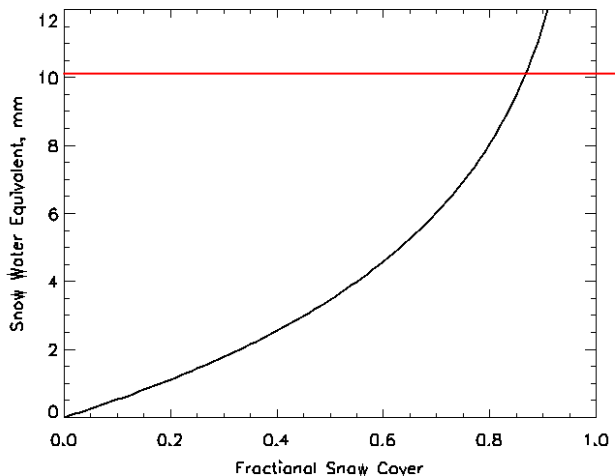
Analysed snow = 0

Frac cover > 0

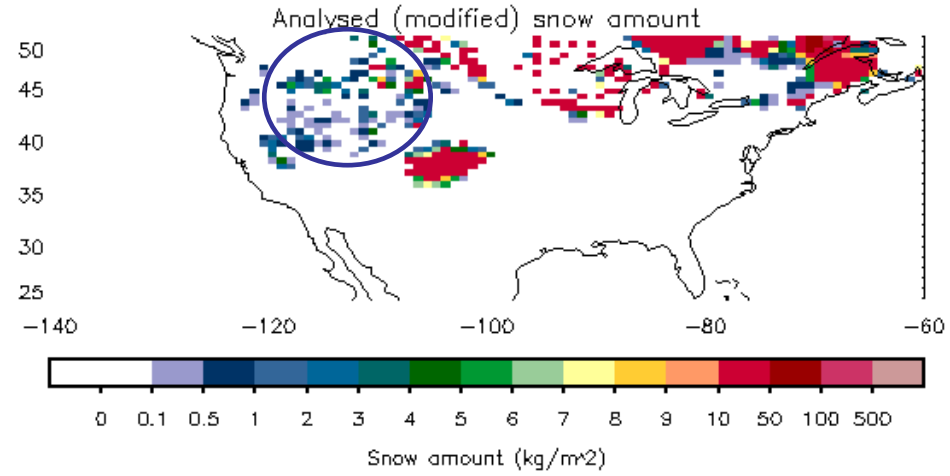
UM snow > 0

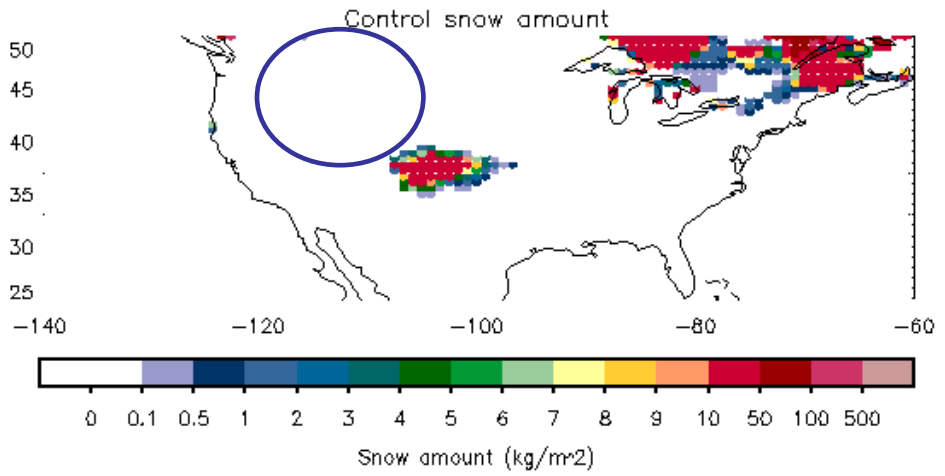
Analysed snow = UM snow

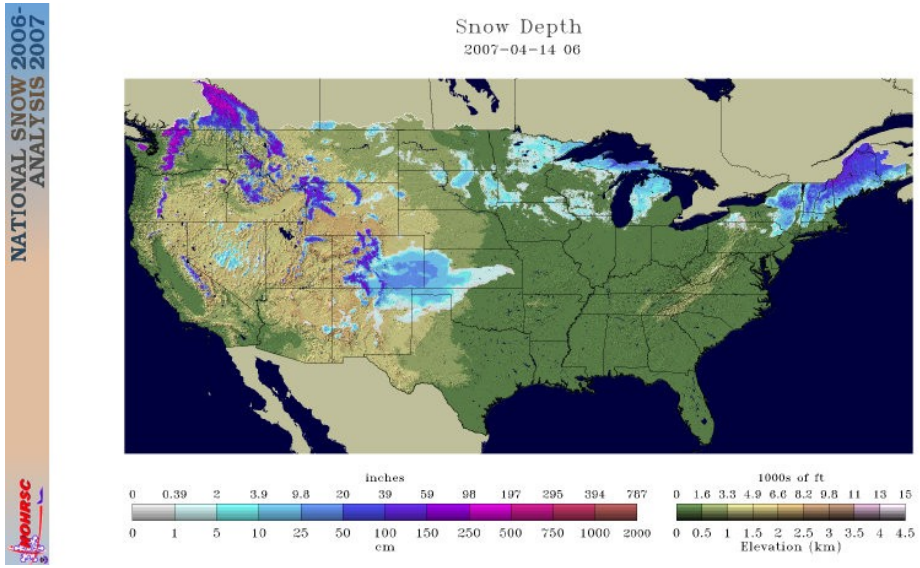
UM snow = 0



Spring season trial (MAM07)



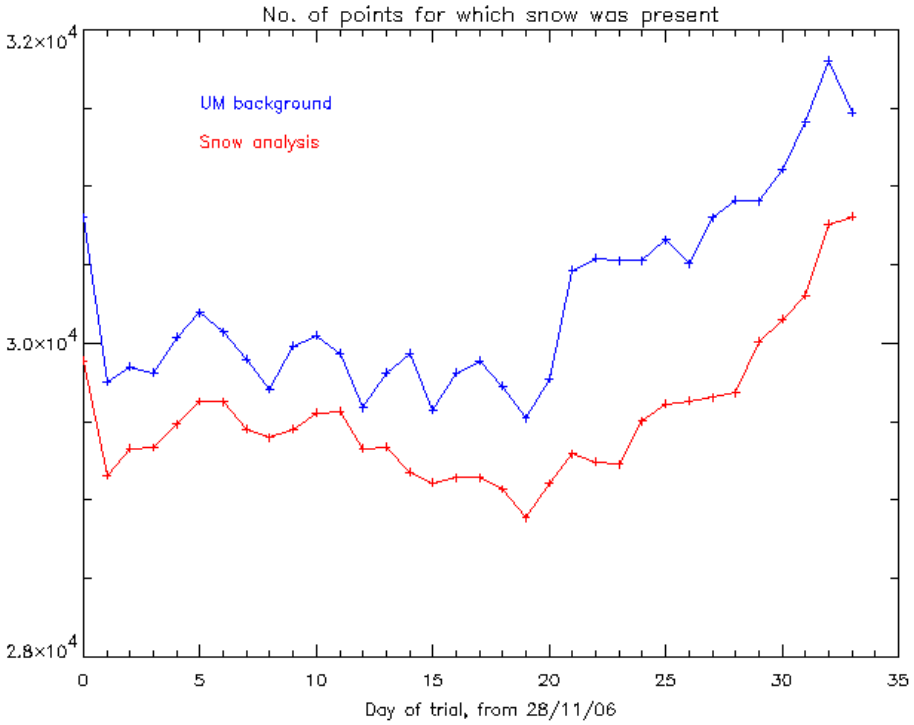




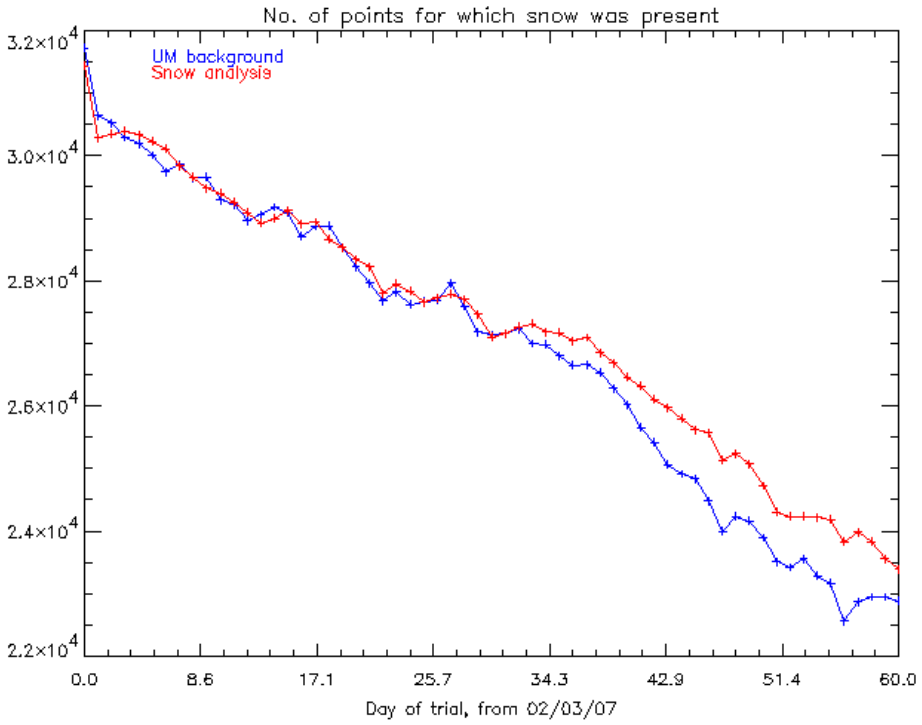
14-04-07

Number of snow-covered points

Winter



Spring



Dec 06 – snow removed overall

Mean difference=-744 (299)

Approx 1% of NH gridpoints

March/April 07 - Snow added overall

Mean difference = +350 (421)

Approx 0.5% of NH gridpoints

Summary of snow trials

- The snow analysis improves the analysed snow field, in terms of presence/non-presence of snow
- Some evidence of improvements in surface/low level T and RH, especially where snow is predominantly removed.
- Little of the information is retained, especially where snow is added
- A time lag of up to 36 hours in the IMS data is potentially problematic

Land-surface properties and data assimilation

http://metscience:sc1ence@www.metoffice.gov.uk/research/nwp/publications/papers/technical_reports/reports/528.pdf

New soil properties and SYNOP assimilation

- PS18 – April 2008
  - New soil hydraulic properties – wilting and critical points.
    - Added to global UM, NAE (North Atlantic European) and UK4 (UK 4km) models.
    - A longstanding error in the UM code to calculate soil hydraulic properties is corrected.
  - New soil thermal conductivity.
    - Added to global UM, NAE and UK4 models.
    - New scheme based on Johansen (1975).
  - Assimilation of SYNOP T/RH/Wind data (global UM).
    - Added to global UM.
    - SYNOP T/RH/Wind data already assimilated by NAE and UK4 models.
    - SYNOP pressure data already assimilated by all models for many years.
  - Soil temperature nudging (global UM).
    - Added to global UM, already used by NAE and UK4 models.

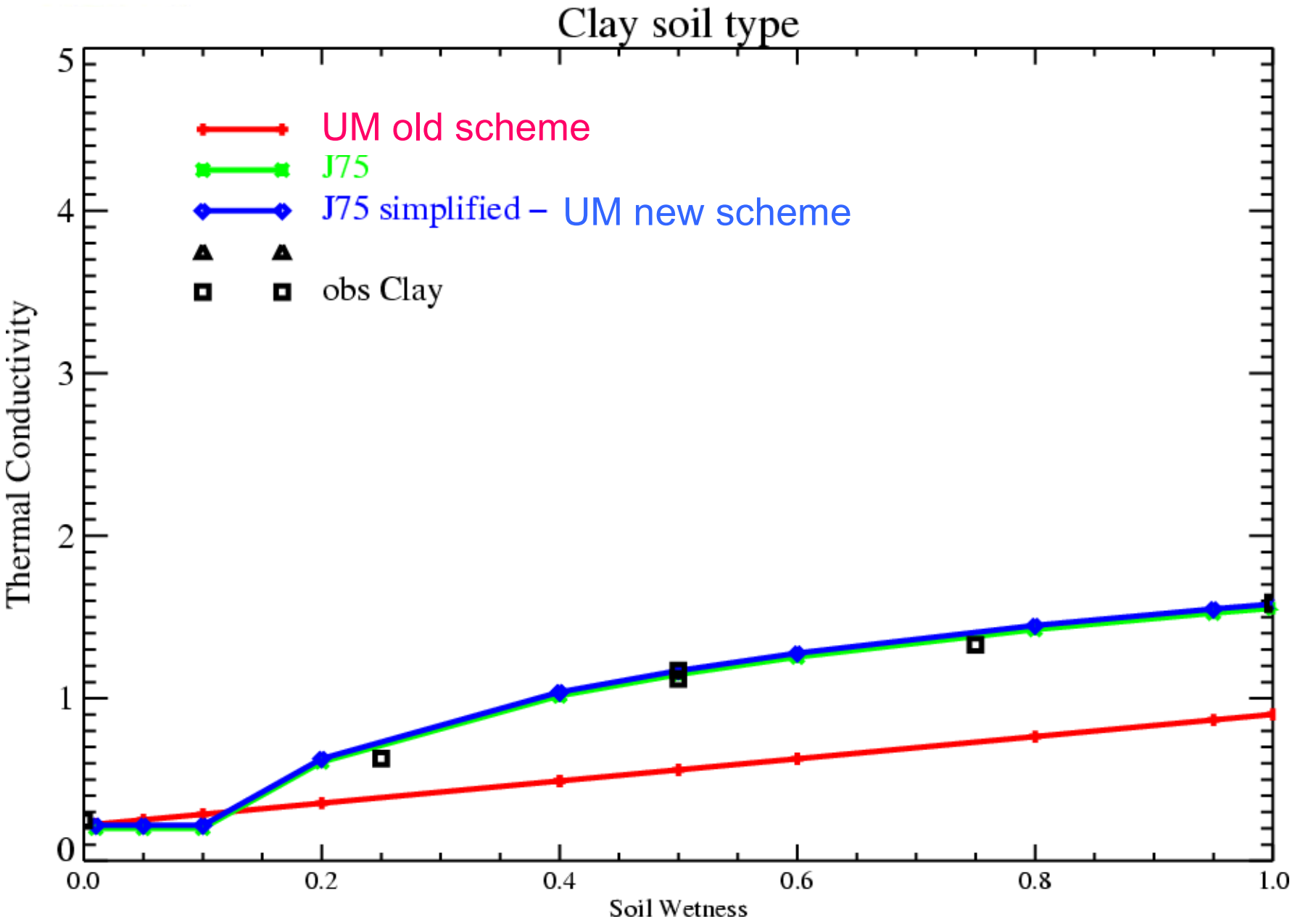
Errors in UM soil hydraulic properties

- An error is discovered in the code used to calculate UM soil hydraulic properties in April 2007.
  - Correcting this error results in significantly higher wilting and critical points.
    - The new wilting and critical points are in much closer agreement with those used at ECMWF, other Met centres and observations.
  - Correcting the error also results in lower values for the saturated hydraulic conductivity.
- Trials with NWP models, climate models and offline land surface models all show that the new soil properties result in much higher soil moisture content.

	Wilting Point (m^3/m^3)	Critical Point (m^3/ m^3)	Saturated Hydraulic Conductivity (mm/s)
UKMO medium soil - Old	0.14	**0.24**	0.0047
UKMO medium soil - New	0.19	**0.33**	0.0028
ECMWF - 2007	0.17	0.32	0.0056
ECMWF medium soil - 2008	0.15	0.35	0.0012

Soil Thermal Conductivity

- Anne Verhoef and Pier Luigi Vidale at Reading university have suggested that the UM soil thermal conductivity is too low and that parameterisations based on Johansen (1975) are more accurate.
- Increasing the thermal conductivity will increase the heat flow between the ground and the atmosphere.
- Heat flow will still be from warmer to colder
  - Summer day – cooling of the boundary layer
  - Summer night – warming of the boundary layer
  - Winter – warming of the boundary layer
- The Johansen parameterisation requires knowledge of soil sand/silt/clay fractions so we have implemented a simplified version of the Johansen parameterisation which doesn't require this information.



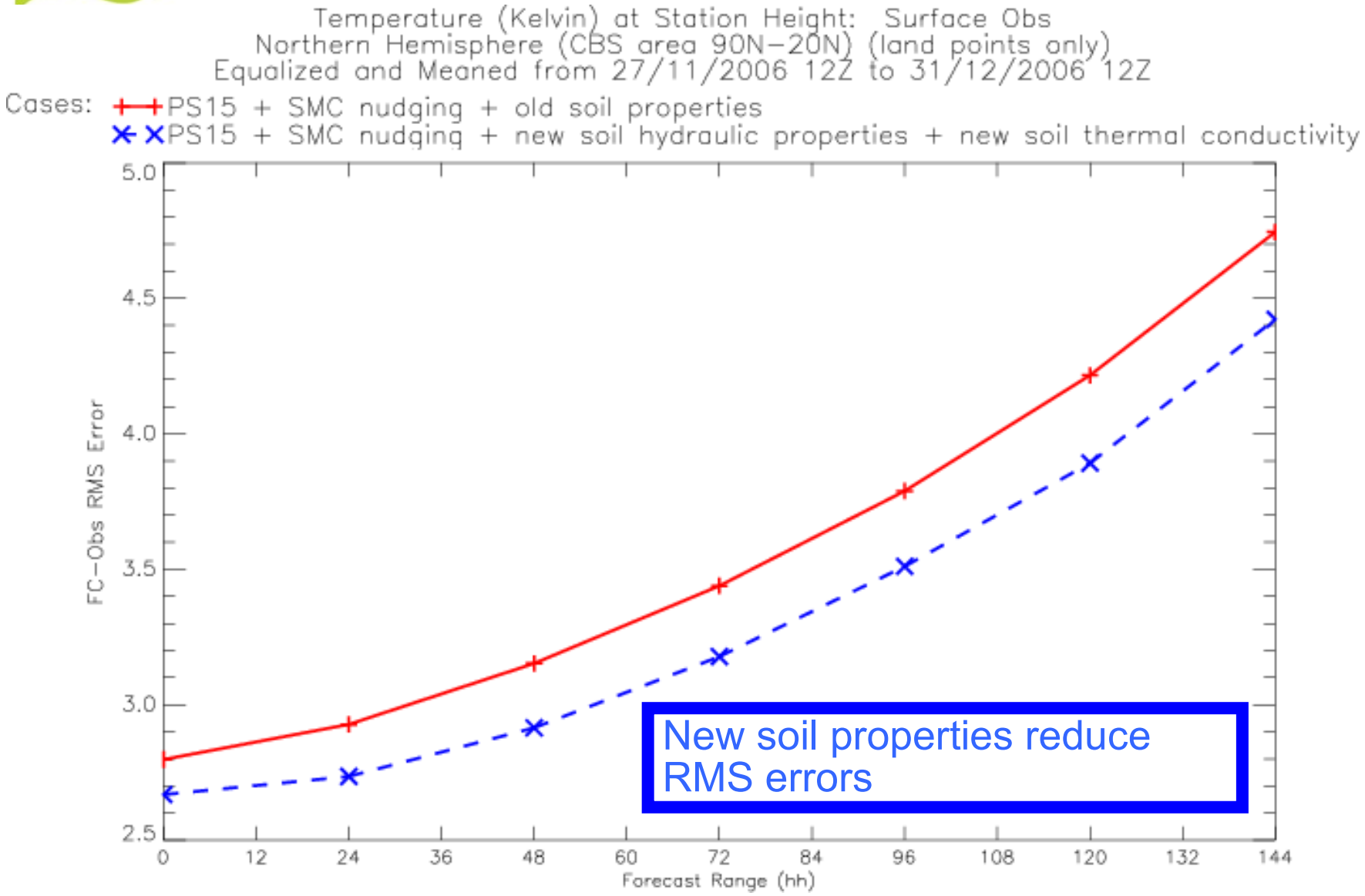
Impact of new soil thermal conductivity parameterisation

- Global Unified Model NWP trials, Climate runs and UK 4km model trials show that the new soil thermal conductivity parameterisation significantly reduces biases and RMS errors in screen temperature.

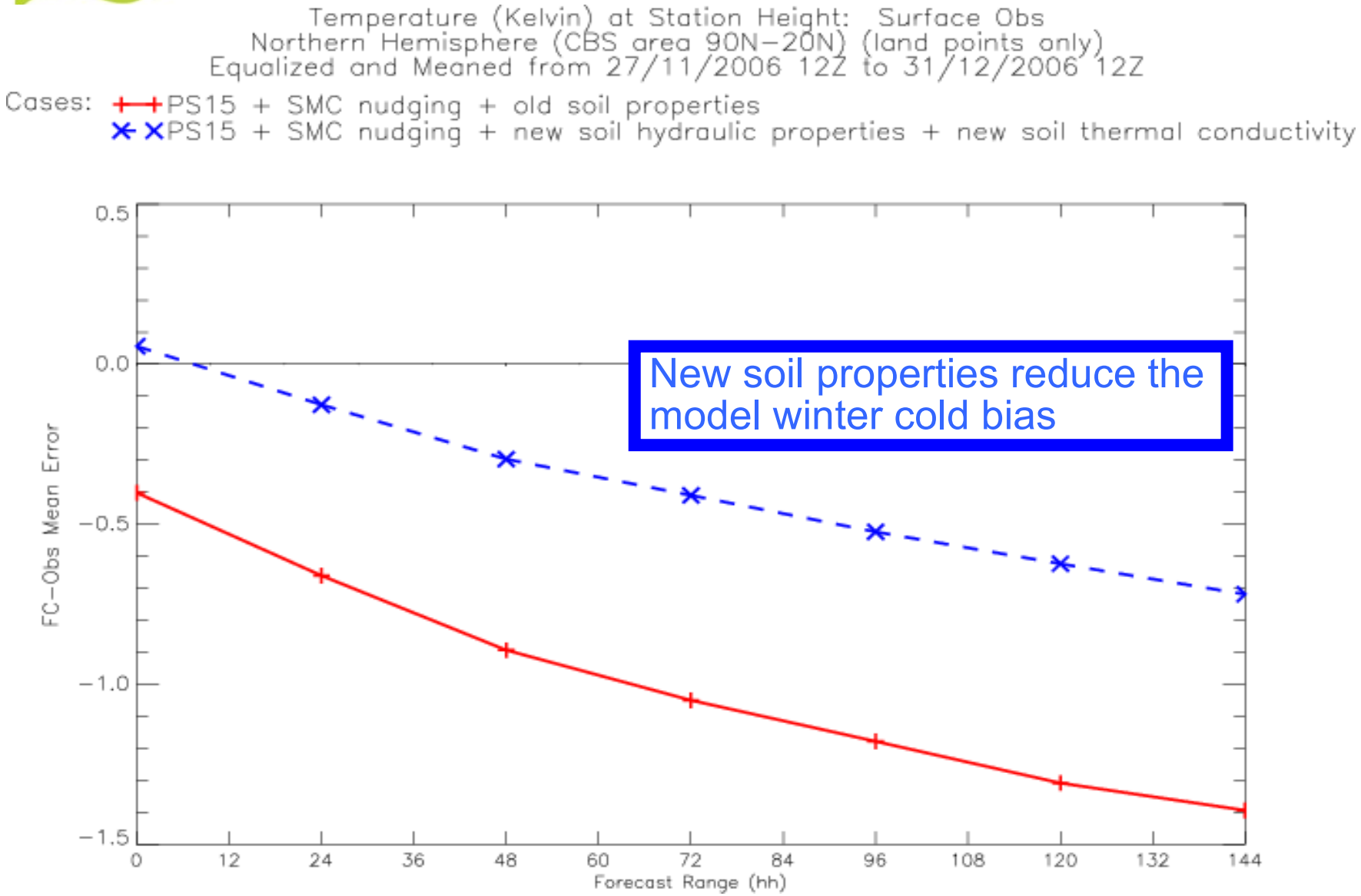
- The impact is greatest in winter and reduces the model NH winter cold bias by ~ 0.6 Kelvin. RMS errors in screen temperature are reduced by ~ 10%.

- For the summer, the new soil thermal conductivity parameterisation reduces the model NH summer warm bias by ~ 0.2 Kelvin. RMS errors in screen temperature are also reduced.

RMS errors in screen T for Dec 2006



Bias in screen T for Dec 2006



Future work on land-surface properties (2009/2010)

- Derive global soil hydraulic properties using the recently released Harmonized World Soil Database.
- Use van Genuchten soil hydraulics instead of Clapp and Hornberger.
- Assimilate ASCAT derived surface soil wetness.
  - ASCAT (advanced scatterometer) is carried on board the meteorological operational (MetOp) satellite.
- Drive our land surface model (JULES) with near real-time observation based forcing data.

GABLS
GEWEX ABL Study

- SCM and LES intercomparison for stable boundary layers
- Current intercomparison is GABLS3, diurnal cycle, clear skies, based on data from Cabauw
- Links
  - LES: http://www.atmo.ttu.edu/basu/GABLS3/
  - SCM: http://www.knmi.nl/samenw/gabls/
- most major forecasting centres in Europe and North America are participating

Questions and answers