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ASCAT soil wetness bias correction

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ECMWF-MO-UoR Workshop

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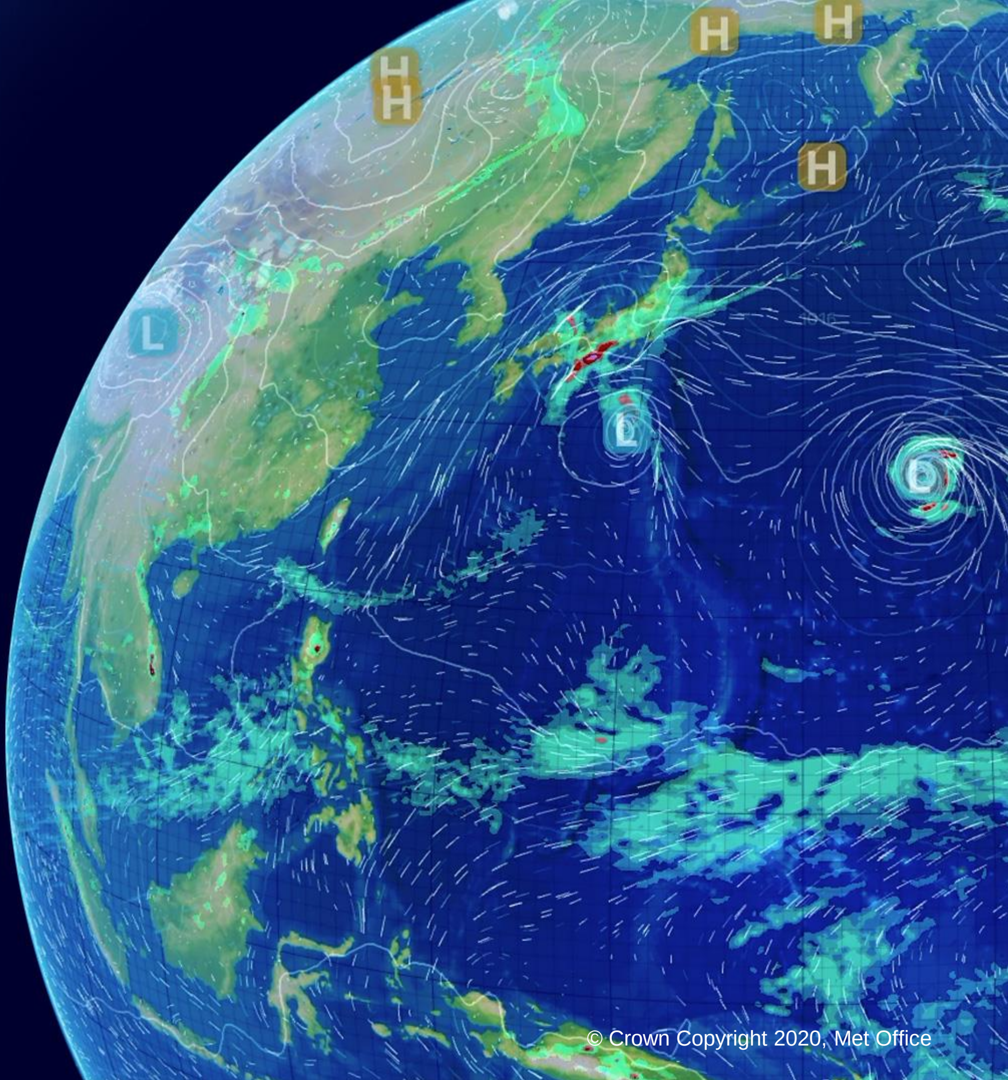

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Outline

- Motivation
- Old and new bias correction methods
- Error boosting of ASCAT Soil Wetness Index near extremes
- Model climatology changes

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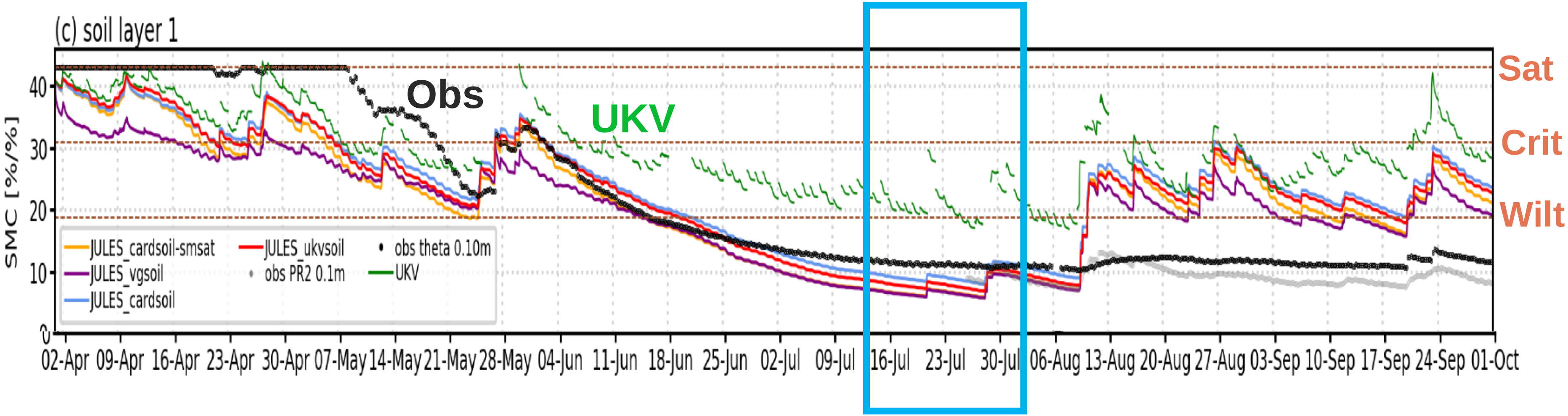
Motivation: Dry-down at Cardington Summer 2018



Operational UKV (OS42) was too wet during May-Aug 2018

No active Soil Moisture DA at that time. UKV received a global daily update.

Observations and modeling of evapotranspiration and dewfall during the 2018 meteorological drought in southern England Osborne and Weedon, 2020 J. Hydrometeorology

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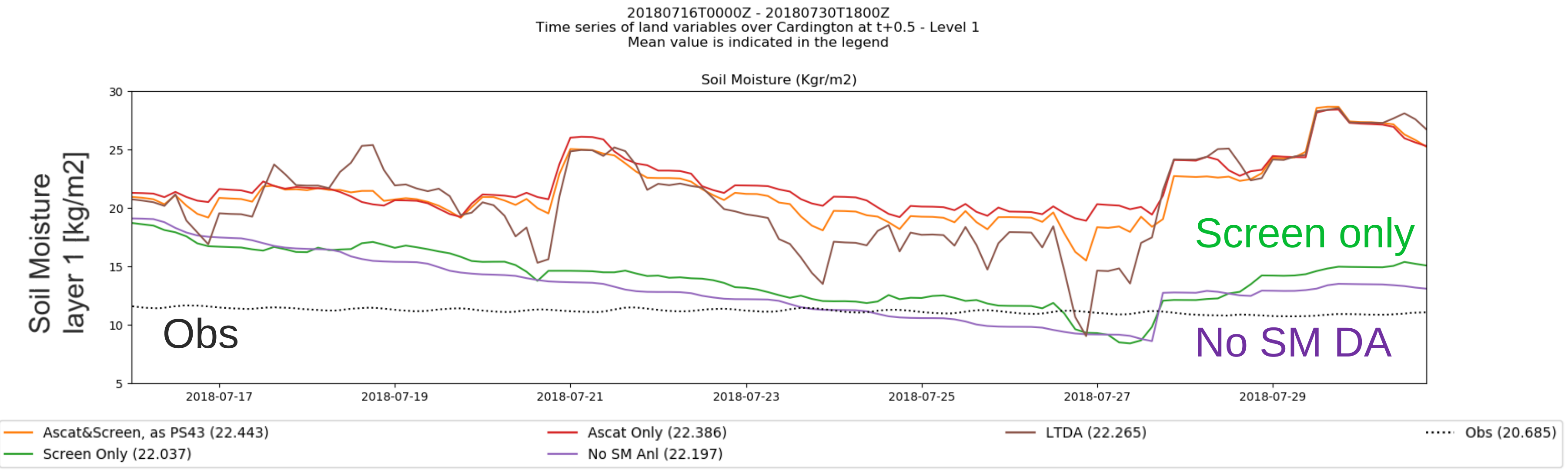
Motivation: review of ASCAT bias correction

All sensitivity experiments using ASCAT (warm colours) are too wet compared to *in situ* soil moisture



ASCAT to Model: Variable

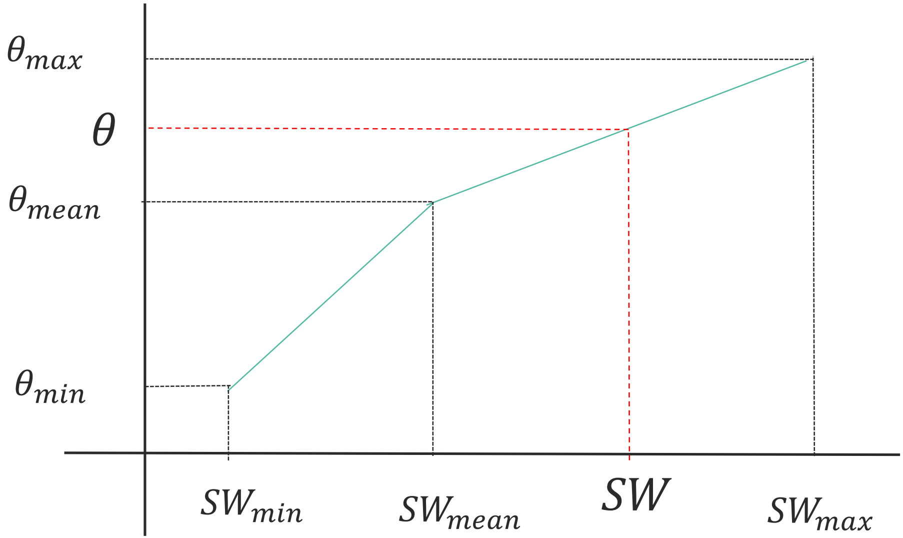
- ASCAT soil wetness converted to UM units: Soil Moisture Content [kg/m^2]
- Bias correction applied using soil moisture climatology.

$$\theta_{L1} = \overline{\theta_{L1}} + \frac{\theta_{DR}}{SW_{DR}}\left(SW - \overline{SW}\right)$$

- $\overline{\theta_{L1}}$ estimated by running standalone JULES at 0.5deg with WFDEI forcing
- SW ASCAT Soil Wetness Index measurement
- $\overline{SW}$ ASCAT Soil Wetness Index climatology
- θ_{DR} Soil moisture dynamic range per grid point can be determined by
  - OS43: Soil and land surface properties: Saturation - (1.0-BareSoil)*Wilting
  - JULES soil moisture climatology: Maximum – Minimum
- SW_{DR} Soil wetness index dynamic range (1.0)

ASCAT conversion and bias correction

- Soil wetness (SW) index must be converted to model soil moisture θ and bias corrected
- **New method at OS44**
- Use a piecewise linear function, loosely based on CDF matching (i.e. Pseudo-Quantile Regression)
- Climate model parameters θ_{mean}, θ_{max}, θ_{min} are estimated by statistics from a 40-year standalone JULES run at 0.5 deg forced by WFDEI dataset and CRU precipitation
- SW_{mean} provided with product.
- $SW_{min} = 0$ and $SW_{max} = 1$ by construction



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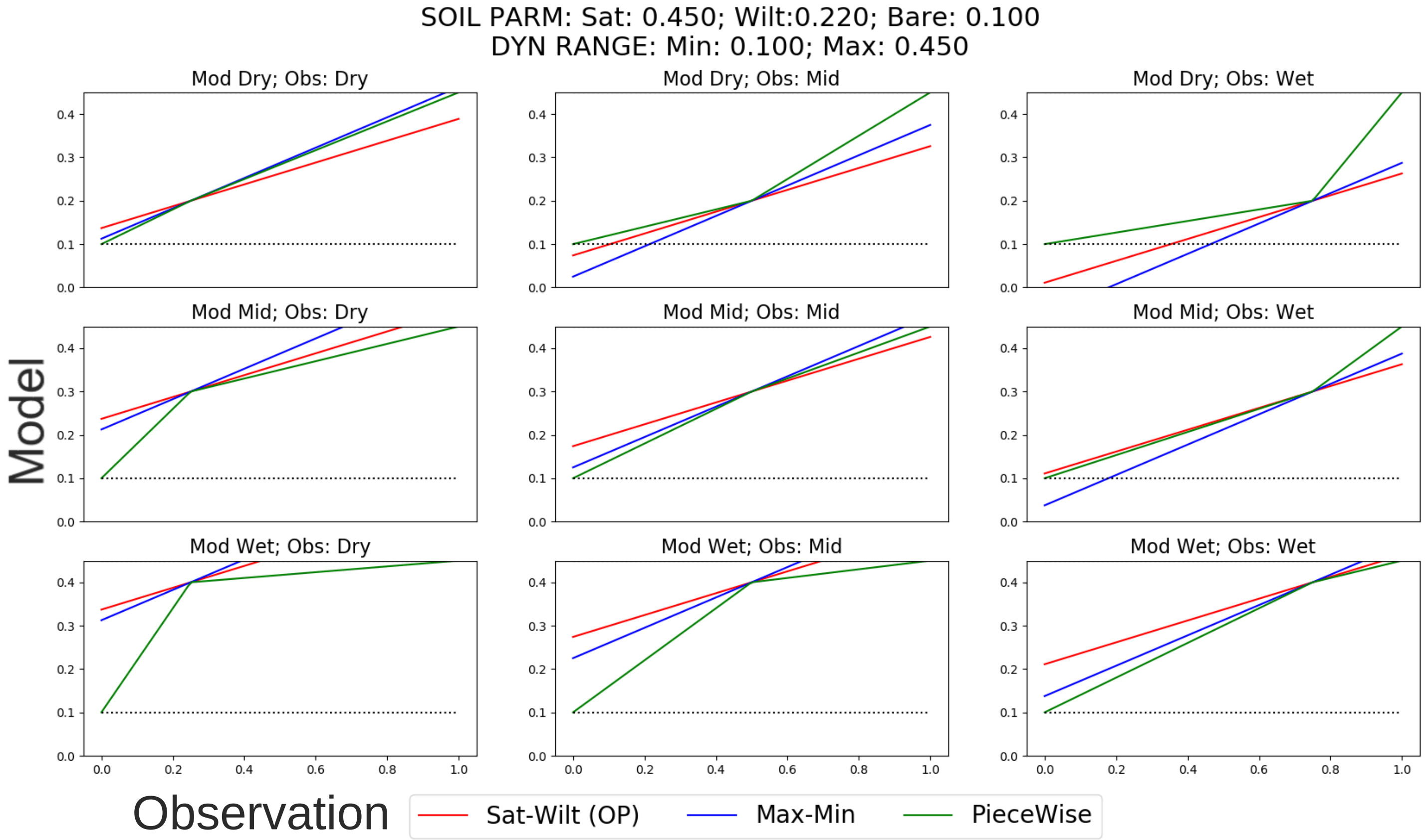
How do the linear BC methods work?

All methods work well near the SM mean but old method fails at the extremes

Dynamic range = Max - Min

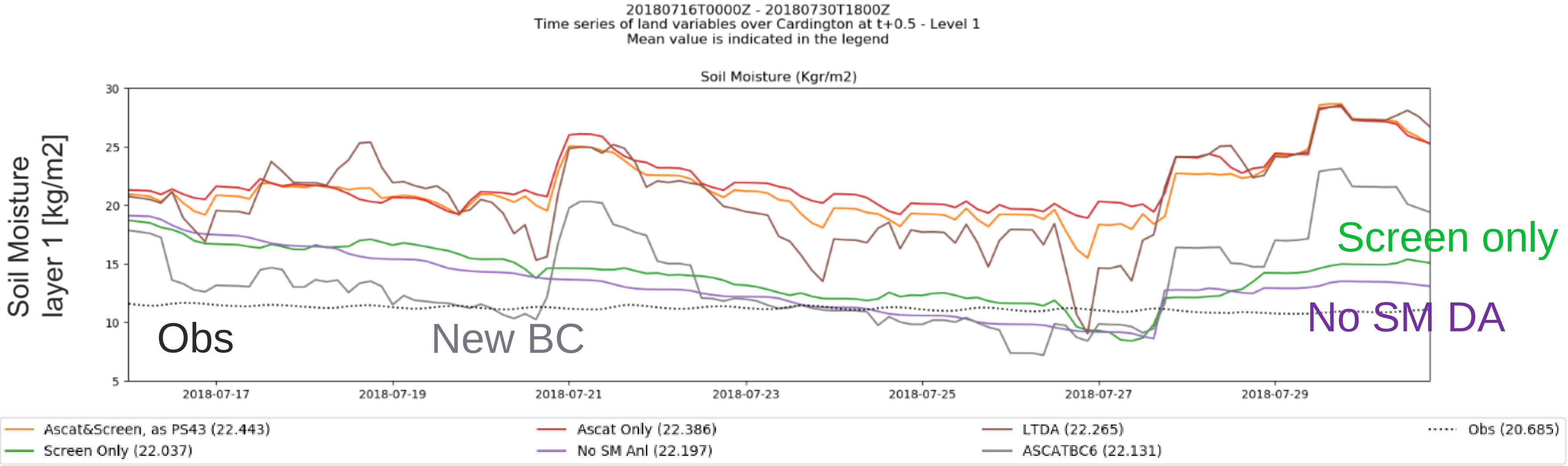
Piecewise interpolation matches the mean and respects the entire model range of SM values



Observation Climate Mean = 0.25, 0.5, 0.75 [swi u.]
Model Climate Mean = 0.2, 0.3, 0.4 [m^3 m^{-3}]

Test ASCAT bias correction in UKV (Summer 2018)

New BC dries faster than old BC and stays closer to observation over dry-down time than any other experiment.



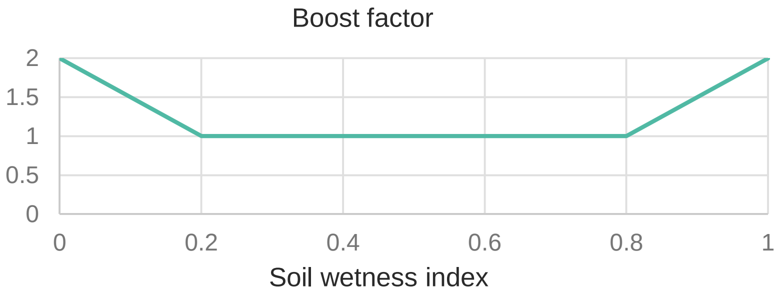
ASCAT Error boost

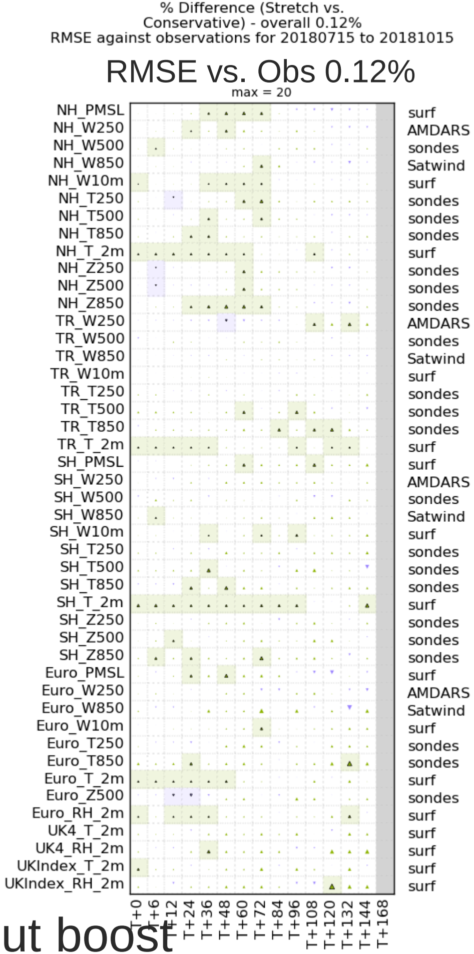
ASCAT Observation Error is “boosted”

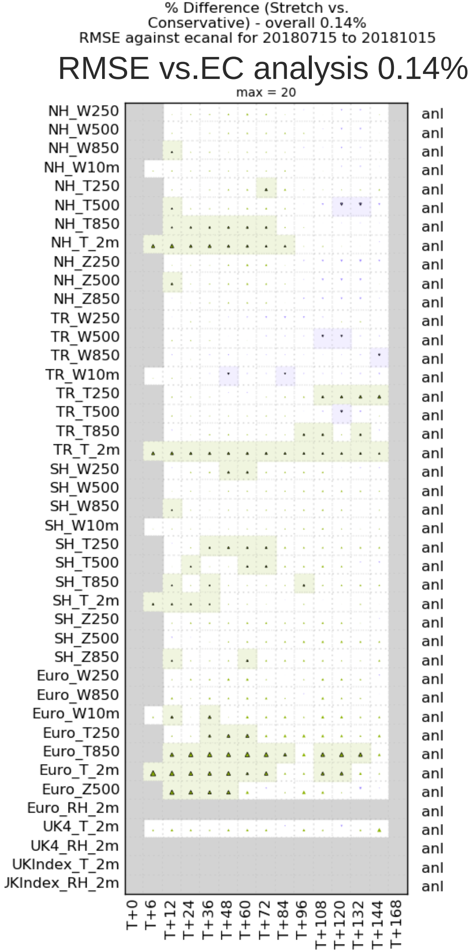
Accounts for higher errors in SW at extremes

Calculated using SW before bias correction

Factor is modelled as a piece wise linear function and is user-configurable







3 month global, low res trials with and without boost

Model Climatologies

- Minimum, maximum and monthly mean for model “climate” derived JULES
  - Offline JULES run for 40 years with WFDEI and CRU precipitation forcing
  - Parent file is at 0.5 degree global resolution and then interpolated to model resolutions
- Derived from different JULES land configurations
  - GL8 has a 9-tile land scheme JULES (broadleaf trees, needleleaf trees, C3 (temperate) grass, C4 (tropical) grass, shrubs, urban, inland water, bare soil and ice)
  - GL8.1 aggregate

Summary

- New ASCAT BC with piecewise linear matching to mean and max/min values improvement over old scheme
- Model climatologies used in BC are consistent with latest science configuration in the UM-JULES land component.
- Error Boost when observations approach extremes has shown some benefit
- Evaluation of global (low resolution) trial Winter/Summer and over the UK (Summer 2018) show improvement of temperature diurnal bias and RMSE
- Similar results in other parts of the globe

Questions?

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Paper published in special issue

Remote Sensing of Land Surface and Earth System Modelling

The Met Office Land Surface Data Assimilation System

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