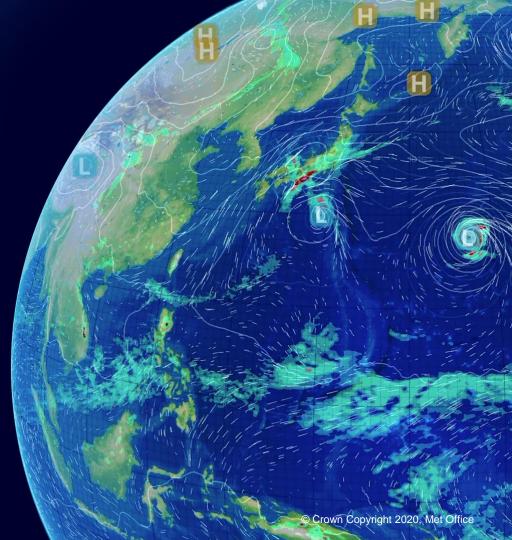


# ASCAT soil wetness bias correction

Cristina Charlton-Pérez, Breogán Gómez and Chris Harris

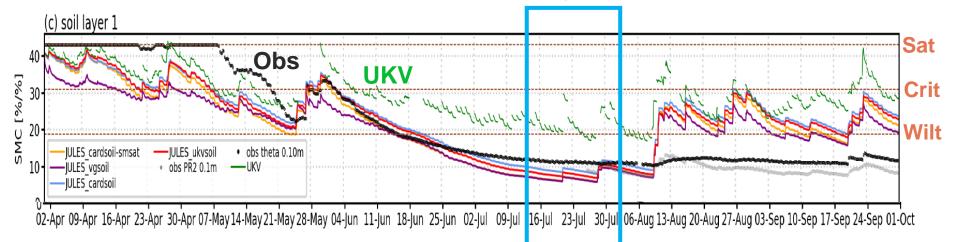
ECMWF-MO-UoR Workshop 14 December 2020



## Outline

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

### Motivation: Dry-down at Cardington Summer 2018



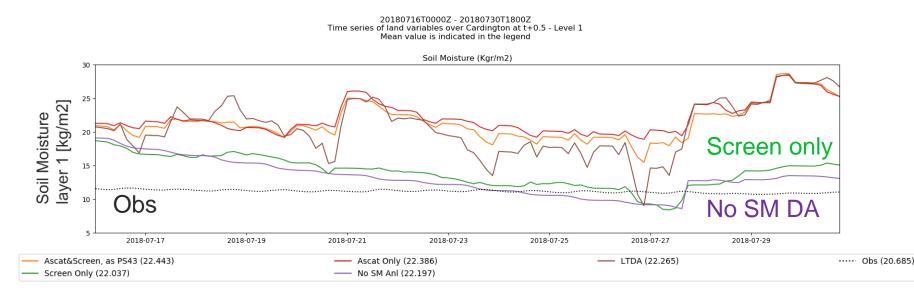
#### Operational UKV (OS42) was too wet during May-Aug 2018

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 <u>J. Hydrometeorology</u>

# 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<sup>2</sup>]
- Bias correction applied using soil moisture climatology.

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

- $\overline{\theta_{L1}}$  estimated by running standalone JULES at 0.5deg with WFDEI forcing
- SW ASCAT Soil Wetness Index measurement
- *SW* ASCAT Soil Wetness Index climatology

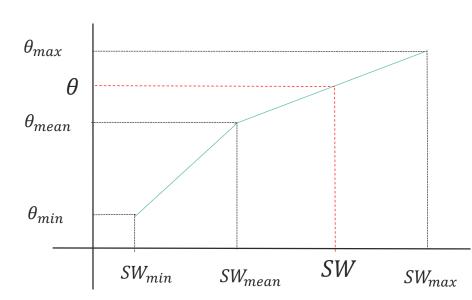
**Met Office** 

- $\theta_{DR}$ 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<sub>DR</sub>* Soil wetness index dynamic range (1.0)

#### Met Office ASCAT conversion and bias correction

- Soil wetness (SW) index must be converted to model soil moisture  $\theta$  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  $\theta_{\text{mean}}$ ,  $\theta_{\text{max}}$ ,  $\theta_{\text{min}}$ are estimated by statistics from a 40-year standalone JULES run at 0.5 deg forced by WFDEI dataset and CRU precipitation
- *SW<sub>mean</sub>* provided with product.
- $SW_{min} = 0$  and  $SW_{max} = 1$  by construction



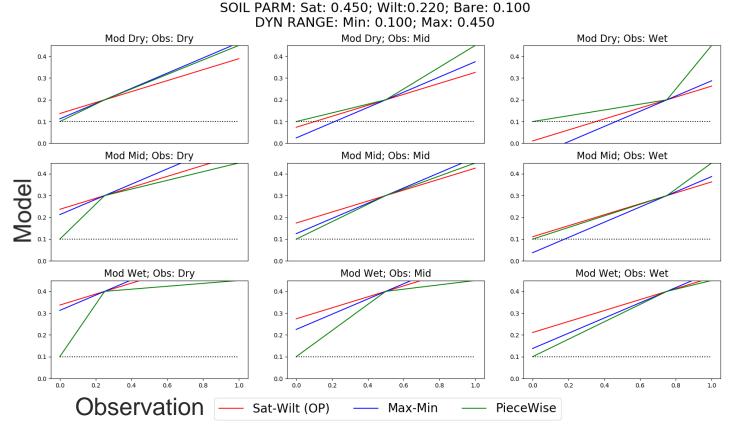


#### How do the linear BC methods work?

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

Dynamic range = Max - Min

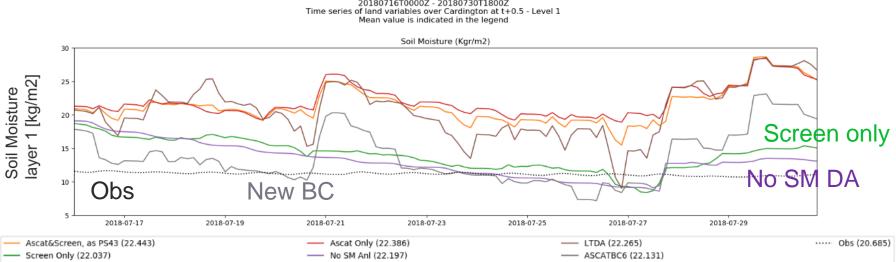
Piecewise interpolation matches the mean and respects the entire model range of SM values



Observation Climate Mean = 0.25, 0.5, 0.75 [swi u.] Model Climate Mean = 0.2, 0.3, 0.4 [m<sup>3</sup> m<sup>-3</sup>]

### Test ASCAT bias correction in UKV (Summer 2018)

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



20180716T0000Z - 20180730T1800Z

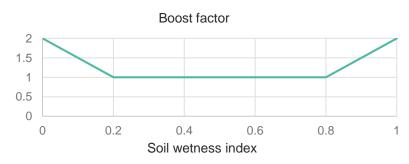
# **Met Office** ASCAT Error boost

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

% Difference (Stretch vs. Conservative) - overall 0.12% RMSE against observations for 20180715 to 20181015

R	N	13	SI	E	٧				) 20		3	0	.1	29	%	RMS	Ē	V	S.	E			aı × =			y	si	S	0.	14
NH_PMSL	1				·					1	1	1	1.1		surf	NH_W250		1					$\mathbf{x}_{i}$							aı
NH_W250															AMDARS	NH_W500														a
NH_W500	$\sim$														sondes	NH W850														a
NH_W850													•		Satwind	NH W10m														a
NH W10m															surf	NH T250		ŕ												
NH T250			•												sondes	NH T500							•							a
NH_1200															sondes															a
NH															sondes	NH_T850			j.t	j.t.	÷.,		÷							aı
NH T 2m															surf	NH_T_2m					•	•	•	•						a
NH Z250															sondes	NH_Z250											1	13		a
NH Z500															sondes	NH_Z500														a
NH Z850															sondes	NH Z850														a
TR W250						1		•							AMDARS	TR W250														a
TR W500											•	-	• •			TR W500														
TR_W500															sondes	TR W850														a
TR W10m															Satwind			ų.												a
TR T250															surf	TR_W10m		11												a
TR_1250 TR_T500	-														sondes	TR_T250										•	•	•		a
							*								sondes	TR_T500														a
TR_T850	1								•		•		1.1		sondes	TR_T850														a
TR_T_2m	•	•	•	•	•					•		•	•		surf	TR T 2m			:.											l ar
SH_PMSL	1														surf	SH W250		1.1												a
SH_W250															AMDARS	SH W500														
SH_W500	1														sondes	SH_W850														a
SH_W850	$\sim 10^{-1}$														Satwind			1.1												a
SH_W10m	$\sim$														surf	SH_W10m		11												a
SH_T250	1														sondes	SH_T250				•	•	•	÷							a
SH_T500													*		sondes	SH_T500						·	·			$\cdot$				a
SH_T850	1														sondes	SH_T850				•										a
SH T 2m															surf	SH_T_2m														a
SH Z250															sondes	SH Z250										. 1				a
SH Z500															sondes	SH Z500														a
SH Z850															sondes	SH Z850														a
Euro PMSL												٠			surf	Euro W250						•								
Euro W250															AMDARS						÷.	÷.				4	4			a
Euro W850													•		Satwind	Euro_W850		1.1					•			14				a
Euro W10m	1														surf	Euro_W10m		•					•			•				a
Euro T250	-														sondes	Euro_T250							•		•		•		÷.	a
Euro T850	E.					-	÷	÷				÷			sondes	Euro_T850				4	۸	4			+		4			a
Euro T 2m	L.					÷	-				÷	÷	-		surf	Euro_T_2m														a
Euro Z500			:	:		•									sondes	Euro Z500												•		a
Euro RH 2m	-									· • • •						Euro RH 2m														a
	·		•	•	•								•		surf	UK4 T 2m														
UK4_T_2m UK4_RH_2m	-												• •		surf	UK4 RH 2m		1							• 1				÷.,	a
	1.				*								• •		surf															a
Kindex_T_2m	•														surf	UKIndex_T_2m														a
Index_RH_2m	•	1	1		+					1	1	۸			surf	JKIndex_RH_2m														aı
t boc	ŝ	5+6	12 ₽	T+24	T+36	T+48	T+60	T+72	T+84	T+96	T+108	T+120	T+132 T+144	T+168			T+0 T+6	T+12	T+24	T+36	T+48	T+60	T+72	T+84	T+96	T + 108	T+120	T+132	T+144 T+168	

% Difference (Stretch vs.

Conservative) - overall 0.14%

RMSE against ecanal for 20180715 to 20181015

# 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?**

#### Email:

c.charlton-perez@metoffice.gov.uk

Paper published in special issue

Remote Sensing of Land Surface and Earth System Modelling

#### The Met Office Land Surface Data Assimilation System

Gómez, Charlton-Pérez, Lewis and Candy

