Post-processing of model output made easy

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NWP forecasts not perfect

- Systematic errors

- Uncertainty in the initial conditions

- Influence of the resolution of the model

- Global model to Regional domain

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Model Output Statistics

- Determining a statistical relationship between forecast and observation

- Sufficient historical archive

- Quantify the systematic forecast errors (bias) for each observation point

- Error at each point is then used to correct future forecasts at the respective point

- MOS requires separate calculations of statistics based on forecast-observation pairs for each lead-time, for each observation location and for each variable
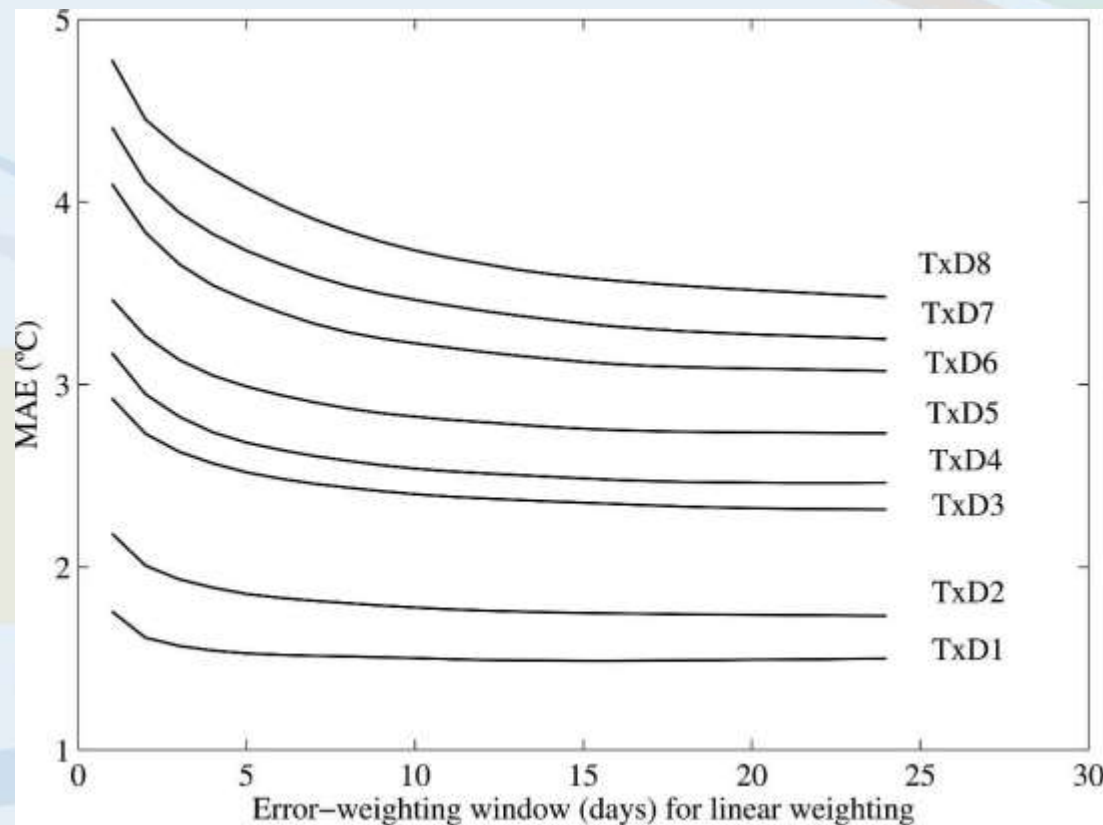
Warner, 2011

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Model Output Statistics

- Short-training periods are possible for MOS-based methods

- HOWEVER:

  - Longer lead-time forecasts

  - Rare-events

  - Surface variables with significant bias

  ALL need longer training periods

Warner, 2011

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Model Output Statistics

- Short-training periods are possible for MOS-based methods
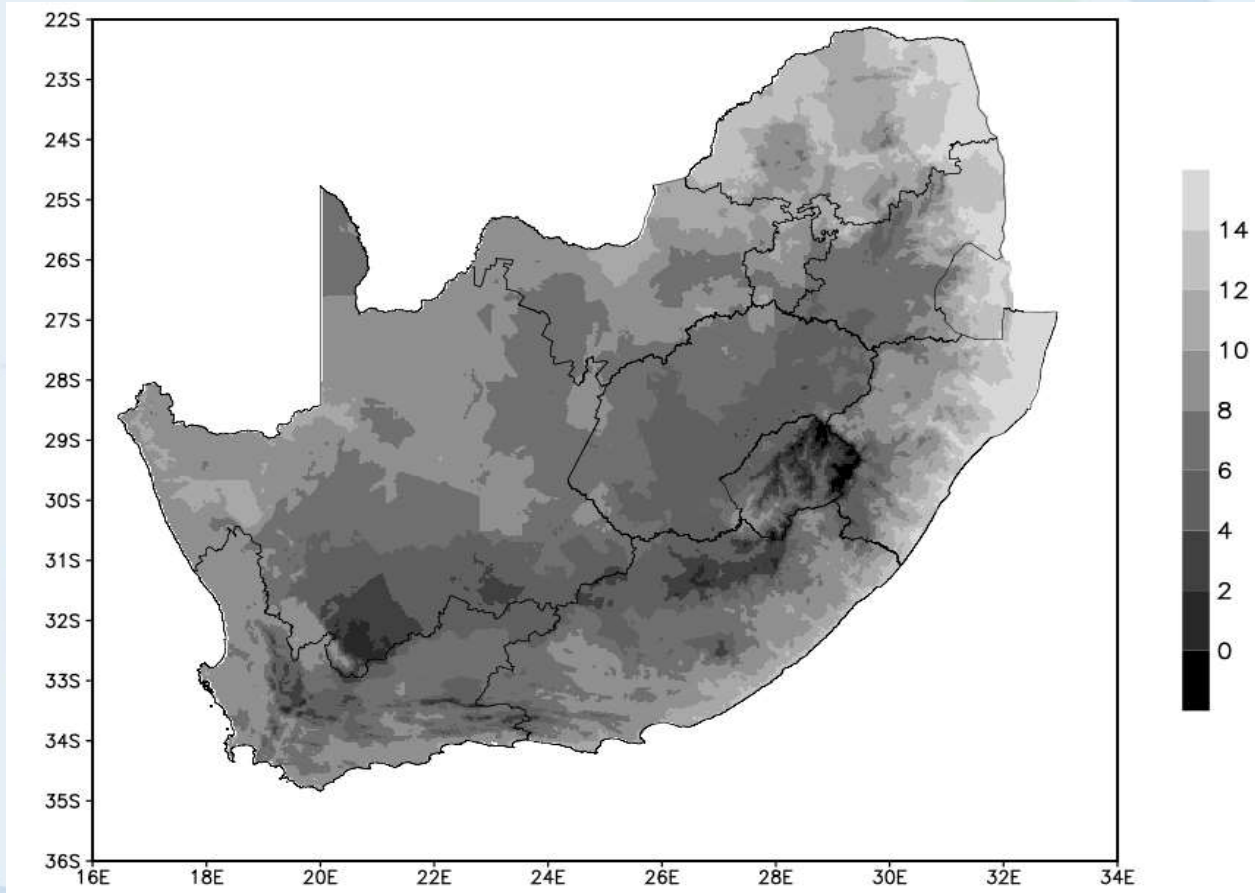

Warner, 2011

Model Output Statistics : Bias Correction Methods

- Very-short-update-period dynamic MOS

- Bias-calculation approach:

  - *Seasonal-mean-error* : average mean forecast error is calculated for 6-month period of previous "warm season". Error then is used to correct forecast of "warm season".

  - *Moving average with uniform weighting* : mean forecast error is calculated using an unweighted average of the bias error from the previous *n* days.

  - *Moving average with linear weighting :* Same, but linearly average, with recent errors weighing more – responsive to regime changes but have long averaging period in order to provide statistical stability

  - *Moving average with non-linear weighting :* Same, but using a nonlinearly weighted average.

Warner, 2011

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Bias Correction Methods :
A SAWS Eample

Marx & Landman, 2011

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Bias Correction Methods : A SAWS Eample
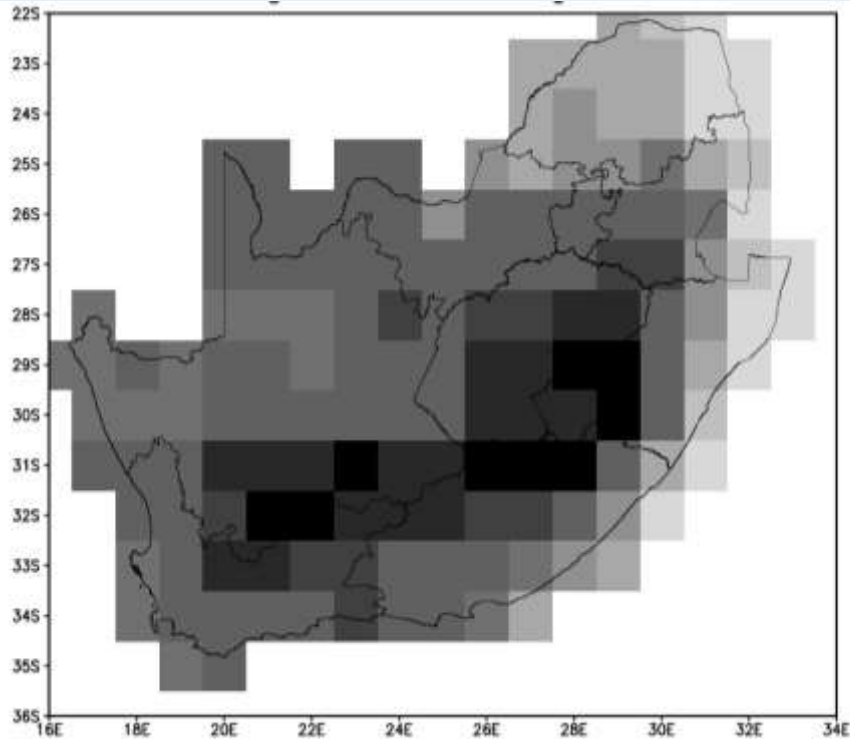
1Deg NCEP forecast

1' NCEP bi-linear interpolation forecast

Marx & Landman, 2011

Bias Correction Methods :
A SAWS Eample
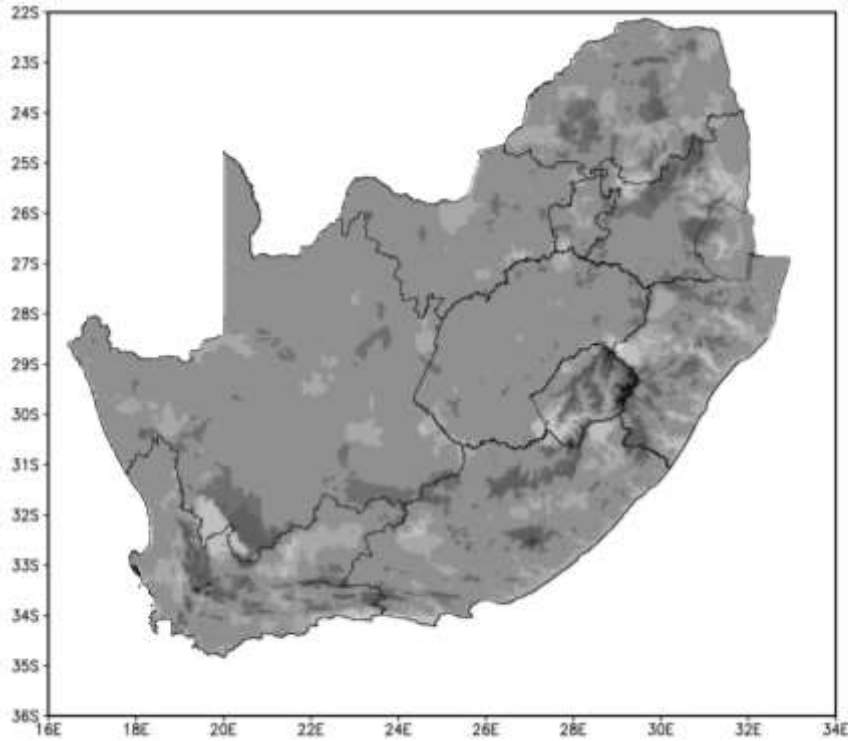
Average monthly map - NCEP
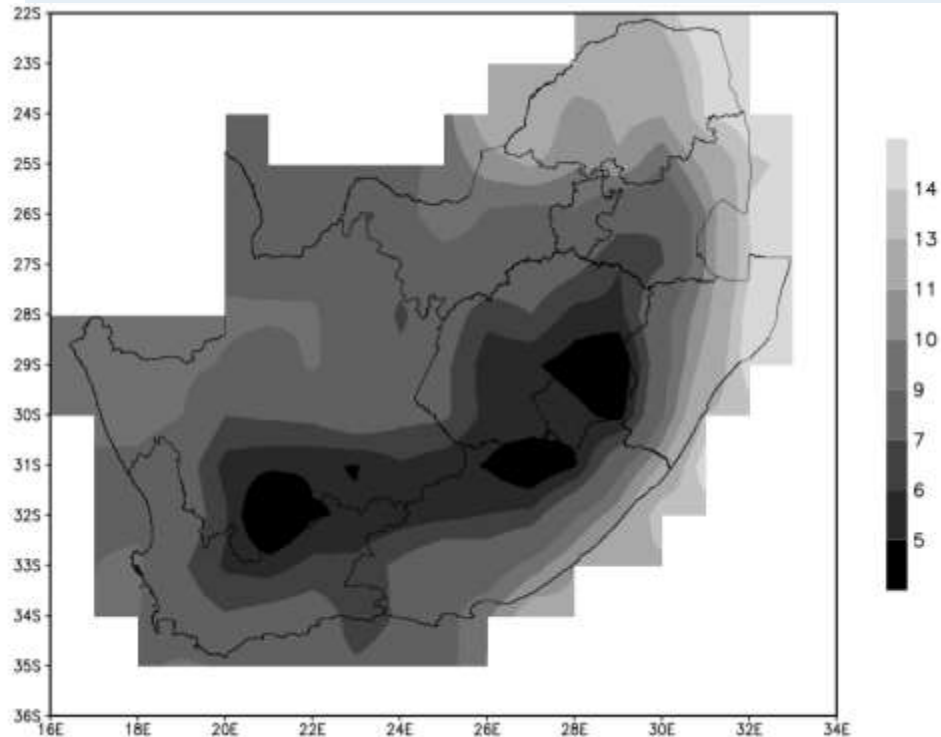1' interpolated forecast
CLIMATE ERROR
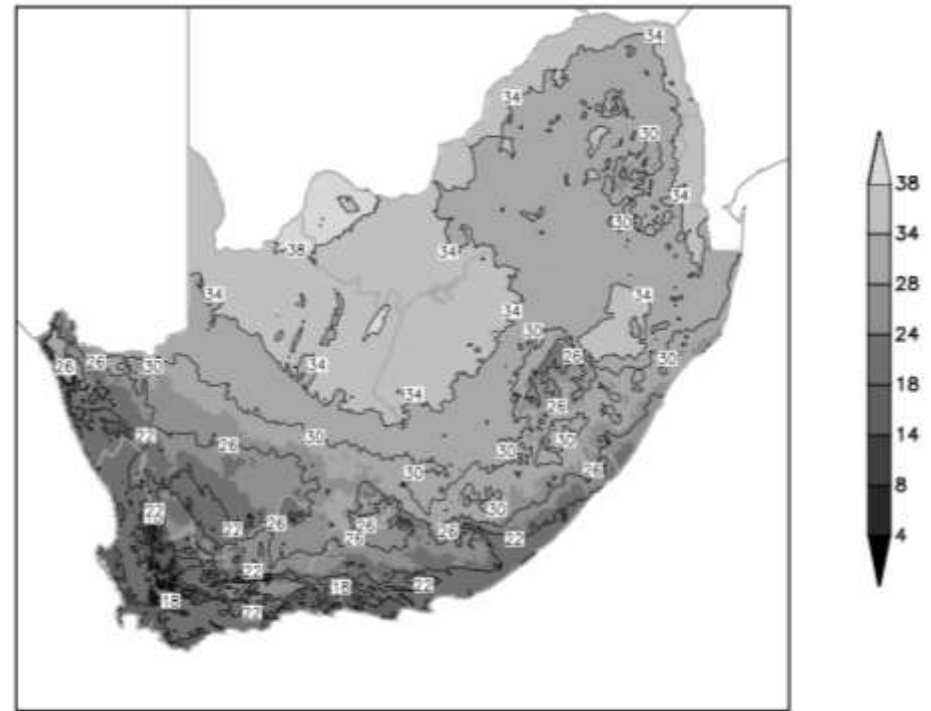
CLIMATE ERROR
field applied to 1'
interpolated forecast

Marx & Landman, 2011

Bias Correction Methods : A SAWS Eample

14-day running unweighted bias corrections on 167 stations – inverse bi-linear interpolation to apply bias to whole domain

CLIMATE-BIAS CORRECTED FORECAST
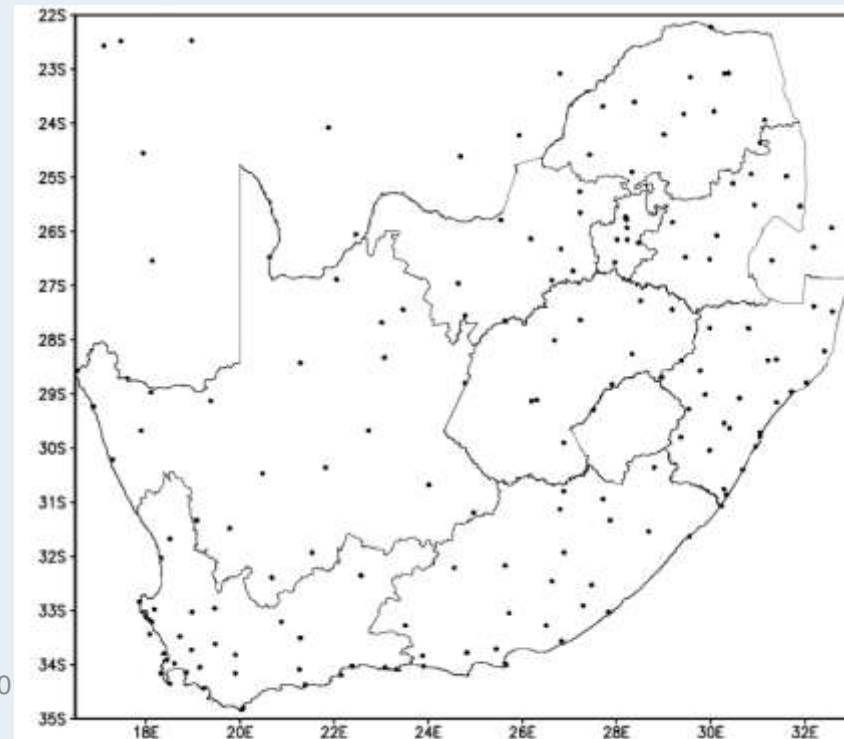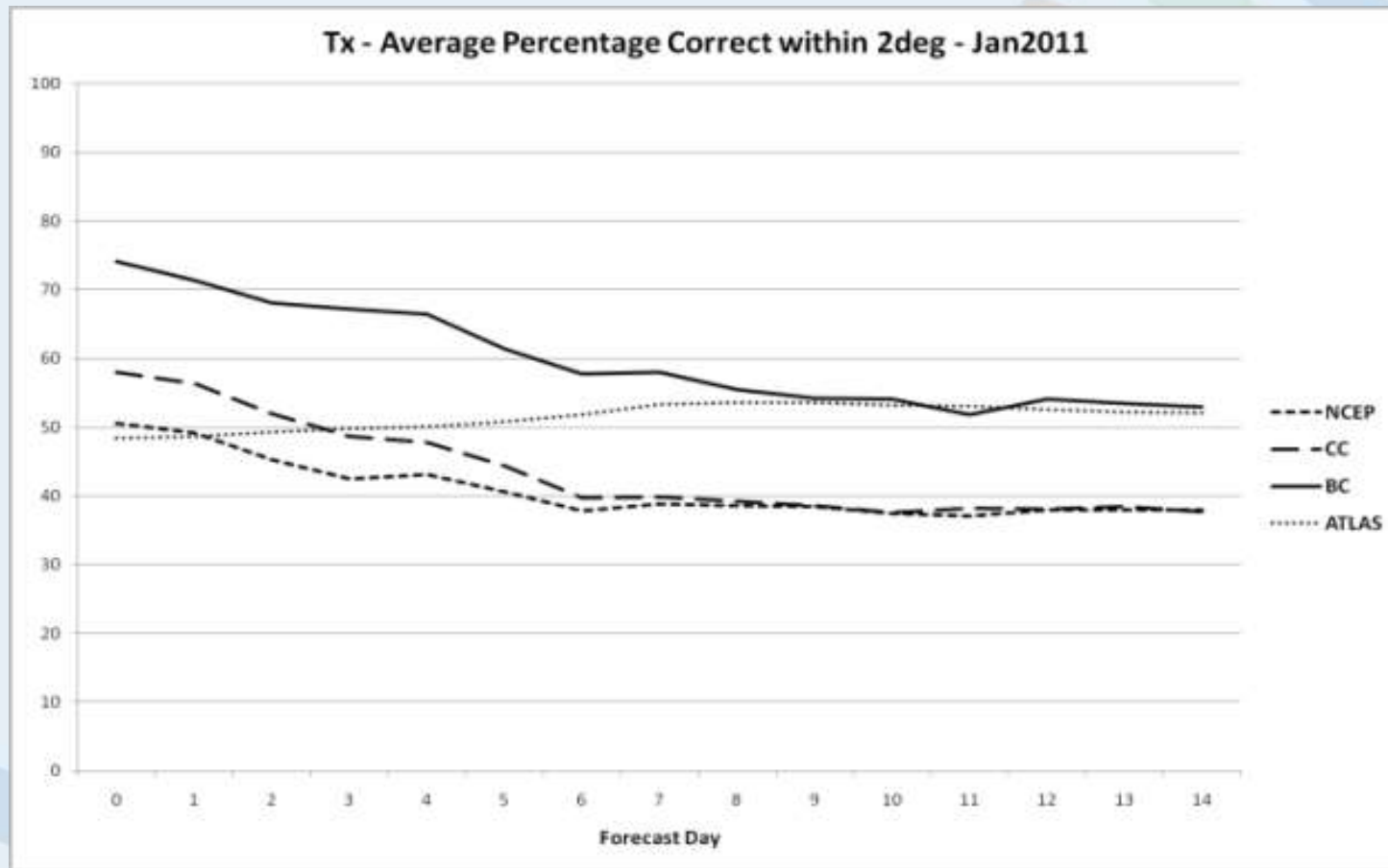
Marx & Landman, 2011

Bias Correction Methods : A SAWS Eample

Tx - Average Percentage Correct within 2deg - Jan2011

- - - - NCEP
— - CC
—— BC
········· ATLAS

Forecast Day

Marx & Landman, 2011

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Bias Correction Methods : Operational at SAWS to fcstrs

Date of forecast	Probability of Rainfall > 1mm	Probability of Rainfall > 8.5mm	Probability of 24H Tx change > 2 deg	Probability of 24H Tn change > 2 deg	Sea-level Pressure	500hPa Heights	Thickness Probabilities	CAPE & Precip Water	Tmin climate corrected	Tmax climate corrected
Thursday 14 Nov 2013 Day: 1										
Friday 15 Nov 2013 Day: 2										
Saturday 16 Nov 2013 Day: 3										
Sunday 17 Nov 2013 Day: 4										
Monday 18 Nov 2013 Day: 5										
Tuesday 26 Nov 2013 Day: 13										
Wednesday 27 Nov 2013 Day: 14										

Tmax climate/bias corrected   Day 1   14nov2013

GrADS: COLA/IGES   2013-11-14-02:16

Bias Correction Methods : Made Easy

1. Daily minimum and maximum temperature forecast

2. Daily minimum and maximum temperature observations

3. Calculate daily: $Bias = (F - O)$

4. After at least 14-days, calculate:

$$raBias = \frac{1}{n} \mathop{\mathring{a}}_{k=1}^{n} (F_k - O_k)$$

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Bias Correction Methods : Made Easy

5. For new forecast:

$$newFcst = NWPfcst - raBias$$

5. New forecast now bias corrected!

6. Adjust $raBias$ daily for current 14-day average.

7. Apply to Tn and Tx.
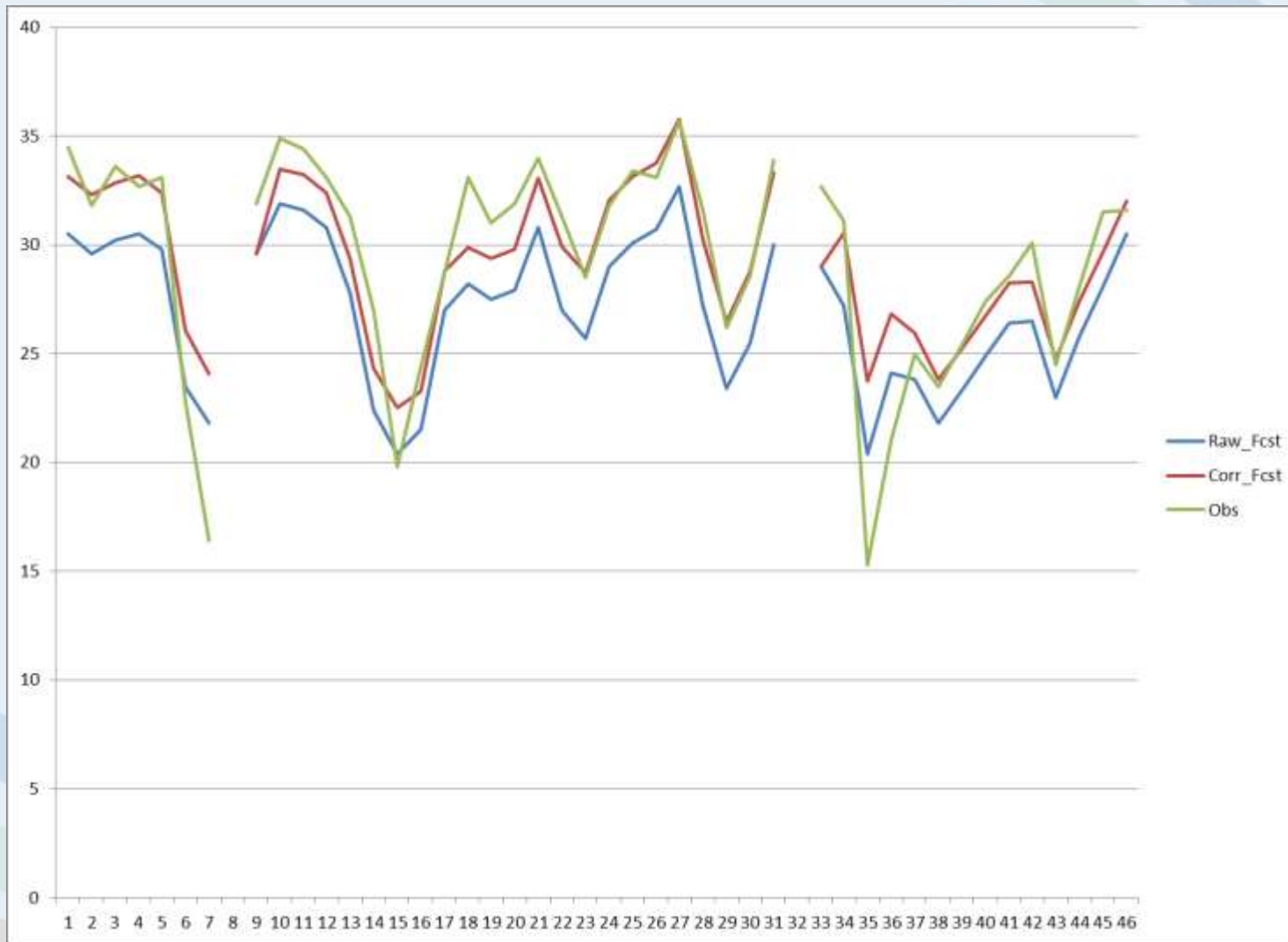
Bias Correction Methods : Made Easy - example

Date	ID	Lat	Lon	Txo	Txf	Bias	14d mean	Txf bc
20120801	68262	-25.74	28.18	222		-		
20120802	68262	-25.74	28.18	208	18.1	-2.7	-	
20120803	68262	-25.74	28.18	231	20.2	-2.9	-	
20120804	68262	-25.74	28.18	248	22.2	-2.6	-	
20120805	68262	-25.74	28.18	260	22.6	-3.4	-	
20120806	68262	-25.74	28.18	256	17.9	-7.7	-	
20120807	68262	-25.74	28.18	215	8.9	-12.6	-	
20120808	68262	-25.74	28.18	89	12.4	3.5	-	
20120809	68262	-25.74	28.18	148	15.5	0.7	-	
20120810	68262	-25.74	28.18	183	18.3	0	-	
20120811	68262	-25.74	28.18	219	21.1	-0.8	-	
20120812	68262	-25.74	28.18	251	12.3	-12.8	-	
20120813	68262	-25.74	28.18	154	16.6	1.2	-	
20120814	68262	-25.74	28.18	206	19.8	-0.8	-	
20120815	68262	-25.74	28.18	285	23.9	-4.6	-3.25	
20120816	68262	-25.74	28.18	250	21.1	-3.9	-3.33571	24.35
20120817	68262	-25.74	28.18	259	20.7	-5.2	-3.5	24.03571
20120818	68262	-25.74	28.18	197	19.3	-0.4	-3.34286	22.8
20120819	68262	-25.74	28.18	244	21.5	-2.9	-3.30714	24.84286
20120820	68262	-25.74	28.18	291	25	-4.1	-3.05	28.30714
20120821	68262	-25.74	28.18	298	25.9	-3.9	-2.42857	28.95
20120822	68262	-25.74	28.18	293	26.1	-3.2	-2.90714	28.52857
20120823	68262	-25.74	28.18	312	26.9	-4.3	-3.26429	29.80714
20120824	68262	-25.74	28.18	324	27.8	-4.6	-3.59286	31.06429
20120825	68262	-25.74	28.18	316	28	-3.6	-3.79286	31.59286
20120826	68262	-25.74	28.18	305	26.7	-3.8	-3.15	30.49286
20120827	68262	-25.74	28.18	233	24.1	0.8	-3.17857	27.25
20120828	68262	-25.74	28.18	280	24.5	-3.5	-3.37143	27.67857

Bias Correction Methods : Made Easy - example

Date	ID	Lat	Lon	Txo	Txf	Bias	14d mean	Txf bc	New Bias	OBS	ABS Bias	ABS Nbias	Event	Nbias<Bias
20130902	68262	-25.74	28.18	195	16.7	-								
20130903	68262	-25.74	28.18	235	20.4	-3.1	-							
20130904	68262	-25.74	28.18	257	22.7	-3	-							
20130905	68262	-25.74	28.18	283	25.4	-2.9	-							
20130906	68262	-25.74	28.18	267	23.4	-3.3	-							
20130907	68262	-25.74	28.18	277	23.9	-3.8	-							
20130908	68262	-25.74	28.18	276	24.2	-3.4	-							
20130909	68262	-25.74	28.18	284	26.4	-2	-							
20130910	68262	-25.74	28.18	313	29.1	-2.2	-							
20130911	68262	-25.74	28.18	311	26.9	-4.2	-							
20130912	68262	-25.74	28.18	307	28.6	-2.1	-							
20130913	68262	-25.74	28.18	293	25.7	-3.6	-							
20130914	68262	-25.74	28.18	300	28	-2	-							
20130915	68262	-25.74	28.18	298	30.2	0.4	-							
20130916	68262	-25.74	28.18	325	30.7	-1.8	-2.64286							
20130917	68262	-25.74	28.18	345	30.5	-4	-2.70714	33.14286	-1.35714	34.5	4	1.357143	1	1
20130918	68262	-25.74	28.18	318	29.6	-2.2	-2.65	32.30714	0.507143	31.8	2.2	0.507143	1	1
20130919	68262	-25.74	28.18	336	30.2	-3.4	-2.68571	32.85	-0.75	33.6	3.4	0.75	1	1
20130920	68262	-25.74	28.18	327	30.5	-2.2	-2.60714	33.18571	0.485714	32.7	2.2	0.485714	1	1
20130921	68262	-25.74	28.18	331	29.8	-3.3	-2.57143	32.40714	-0.69286	33.1	3.3	0.692857	1	1
20131025	68262	-25.74	28.18	254	23.3	-2.1	-1.84615	25.23846	-0.16154	25.4	2.1	0.161538	1	1
20131026	68262	-25.74	28.18	274	24.9	-2.5	-1.85385	26.74615	-0.65385	27.4	2.5	0.653846	1	1
20131027	68262	-25.74	28.18	286	26.4	-2.2	-1.79231	28.25385	-0.34615	28.6	2.2	0.346154	1	1
20131028	68262	-25.74	28.18	301	26.5	-3.6	-1.73077	28.29231	-1.80769	30.1	3.6	1.807692	1	1
20131029	68262	-25.74	28.18	245	23	-1.5	-1.63077	24.73077	0.230769	24.5	1.5	0.230769	1	1
20131030	68262	-25.74	28.18	281	25.8	-2.3	-1.56923	27.43077	-0.66923	28.1	2.3	0.669231	1	1
20131031	68262	-25.74	28.18	315	28.1	-3.4	-1.53077	29.66923	-1.83077	31.5	3.4	1.830769	1	1
20131101	68262	-25.74	28.18	316	30.5	-1.1	-1.5	32.03077	0.430769	31.6	1.1	0.430769	1	1
						-2.29318			-0.059				44	37

84.091

Bias Correction Methods : Made Easy - example

Bias Correction Methods : Made Easy

QUESTIONS?

Warner, T.T., (2011): *Numerical Weather and Climate Prediction*. University Press, Cambridge. P366-377

Marx, E. and Landman, S., (2011): *Towards downscaling NCEP Medium-Range temperature Forecasts Conditioned on Detailed Climate Information*, 27th Annual Conference of the South African Society for Atmospheric Sciences, September 2011, Pretoria. ISBN 978-0-620-50847-0

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