SMOS Instrument Performance and Calibration after 3 Years in Orbit

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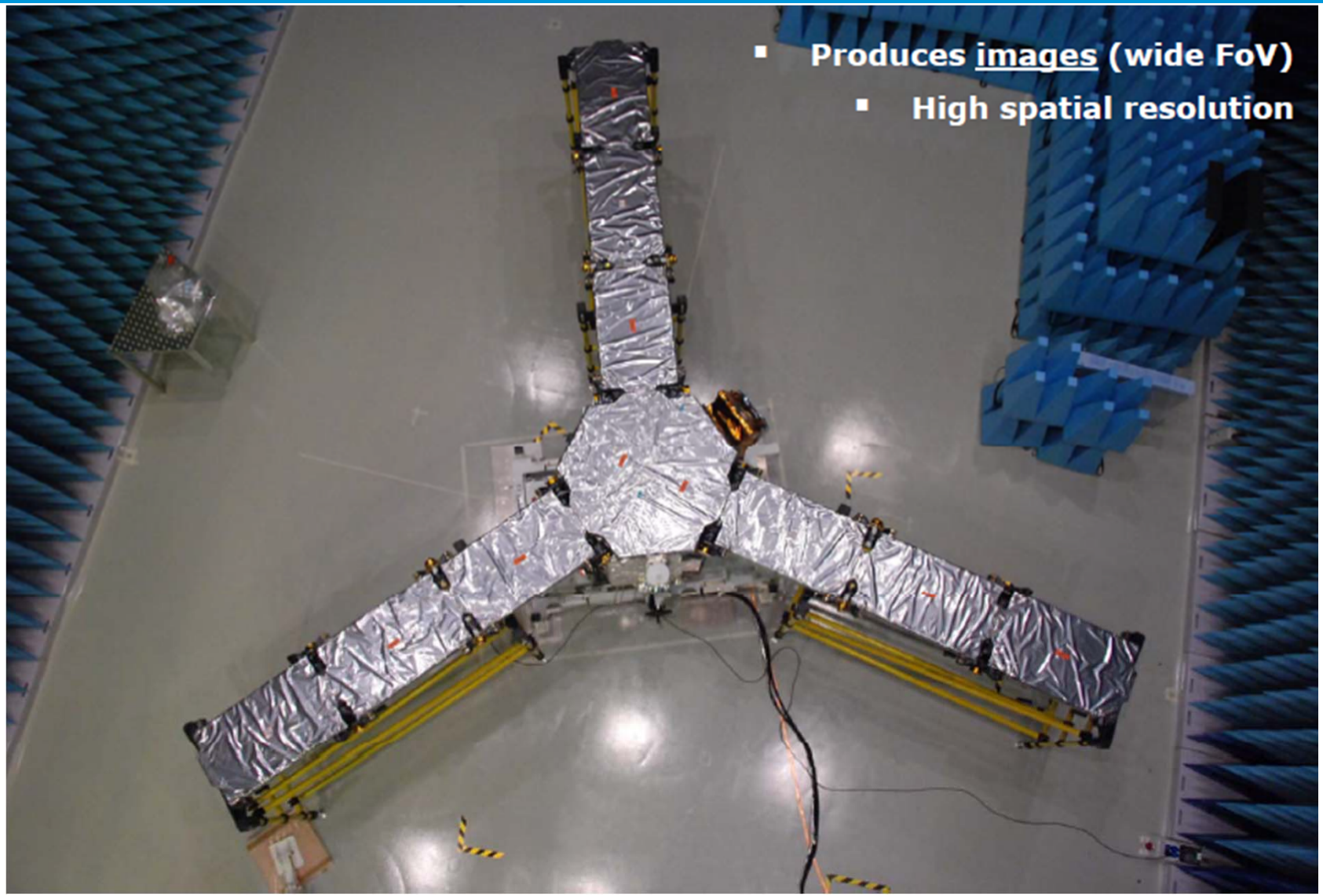
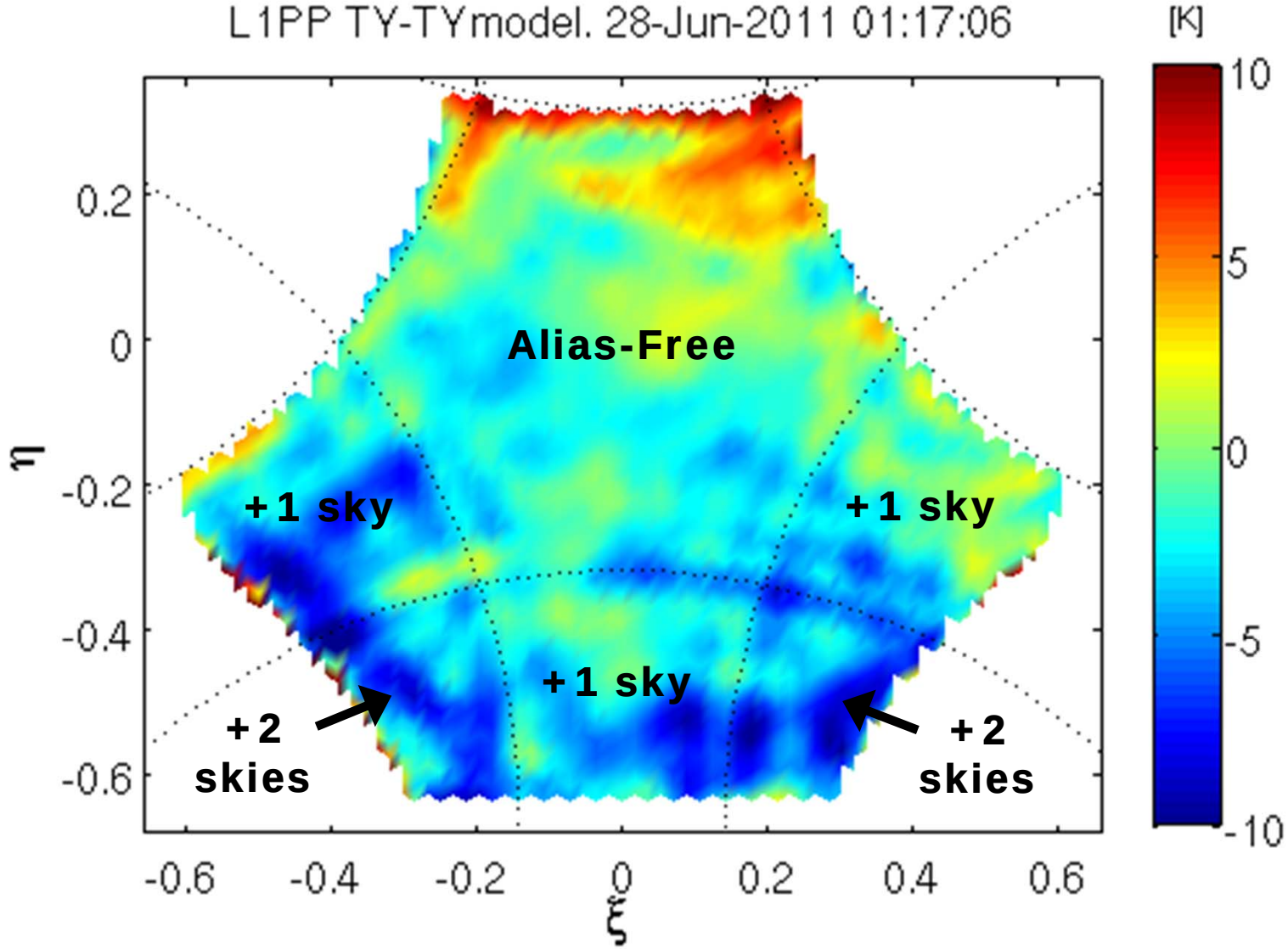
MIRAS: the SMOS Payload



ALIAS-FREE and EXTENDED FIELDS OF VIEW



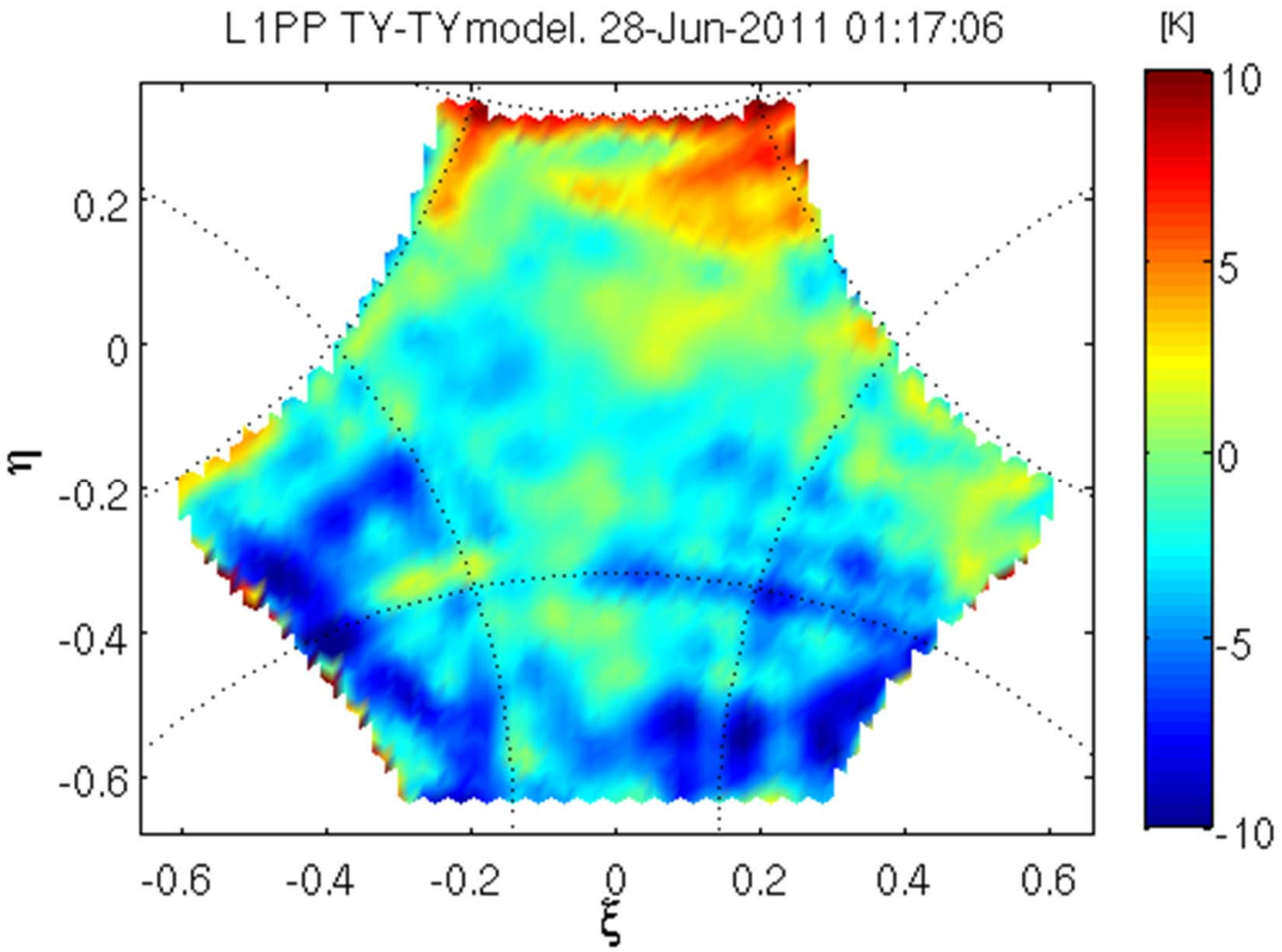
SMOS IMAGE FEATURES

Spatial Biases:

- Ripple
- Slope
- Borders
- Sun tails

Temporal Drifts:

- Orbital
- Seasonal
- Yearly



SPATIAL BIASES: Cold Sky Visibilities

– **Cold Sky Visibilities**

• **improved matching between expected and measured values** by antenna pattern study:

– use of **average pattern** across 3 frequencies

– use of **back lobes**

– **replace pattern of hinge elements** by their neighbours'

– use of cross-polar (marginal impact)

– **independent checks** carried out

• remaining discrepancy probably caused by different reasons:

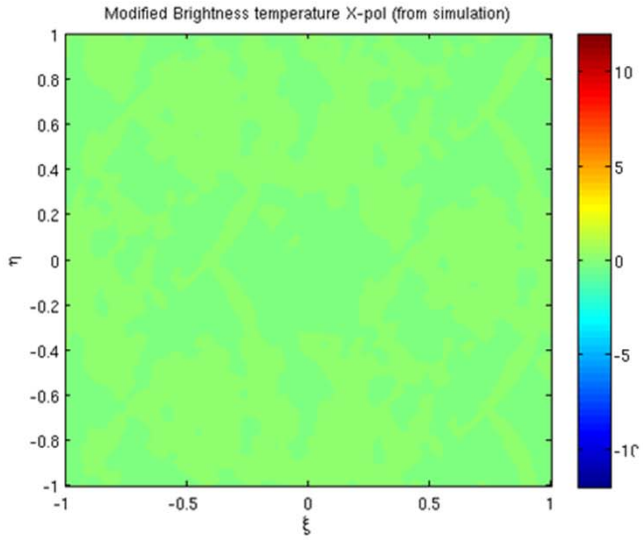
- **antenna range limitations**
  (increased coupling, noise floor, limited reflectivity…)

- **set-up differences** between ground and flight near hinges
  (confirm by electromagnetic simulations)

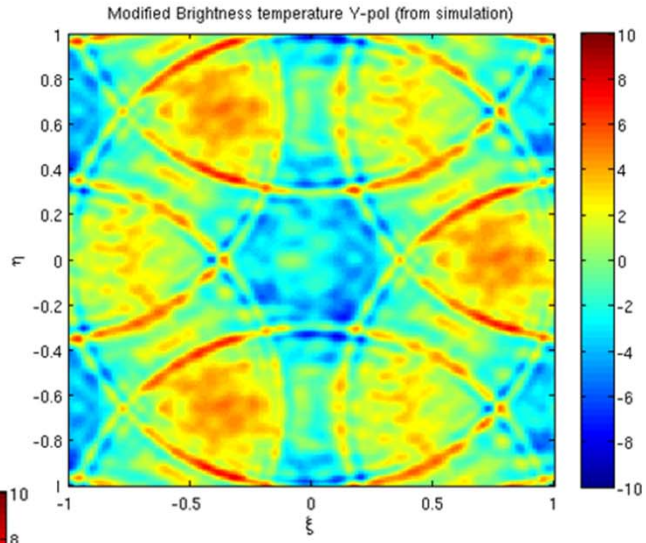
- purely image processing issues as **grid type and resolution**

SPATIAL BIASES:
Cold Sky Images and the Corbella Equation

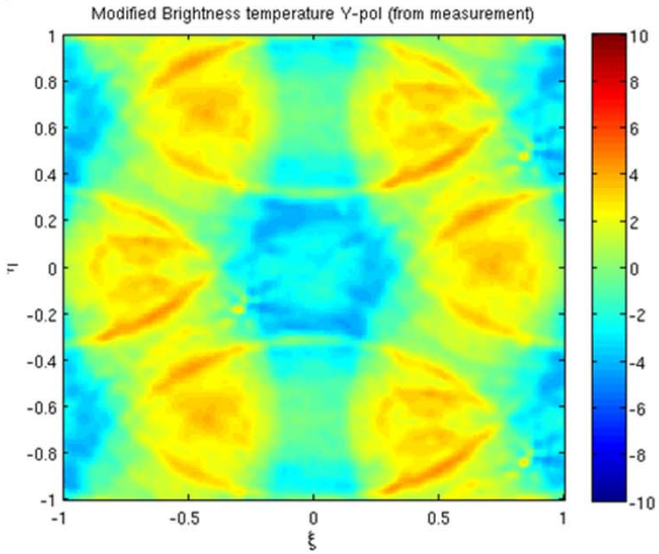
RADIO-ASTRONOMY



CORBELLA

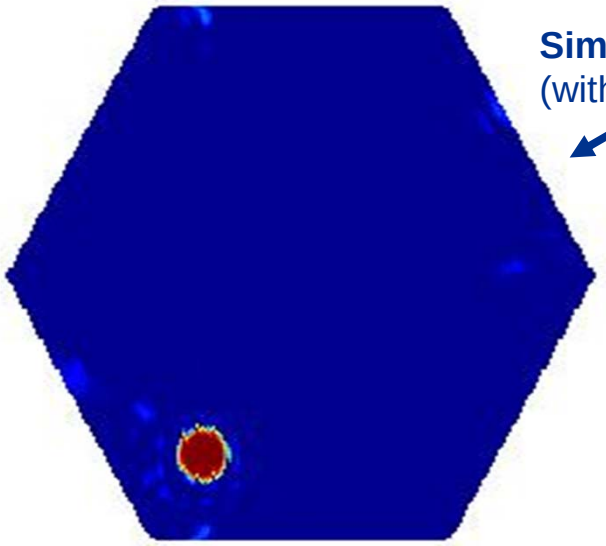


SMOS MEASUREMENTS

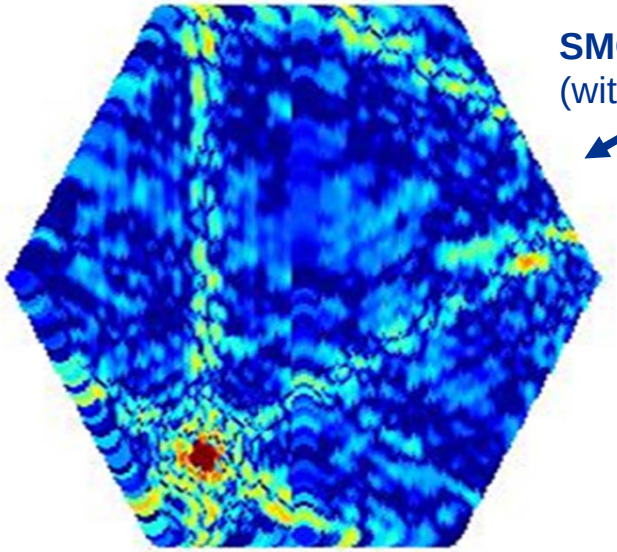


SPATIAL BIASES: Spatial Ripples I

- **Spatial Ripples** are now better understood; they are caused by
  - **side-lobes**
  - **antenna pattern errors**
- **Side Lobes** is the dominant contributor to
  - **spatial ripples**
  - **land-sea** and **ice-sea** contamination
  - **Sun** and **RFI tails** spreading through the image



Simulated Sun image
(with **low** side lobes)



SMOS Sun image
(with **actual** side lobes)

SPATIAL BIASES: Spatial Ripples II

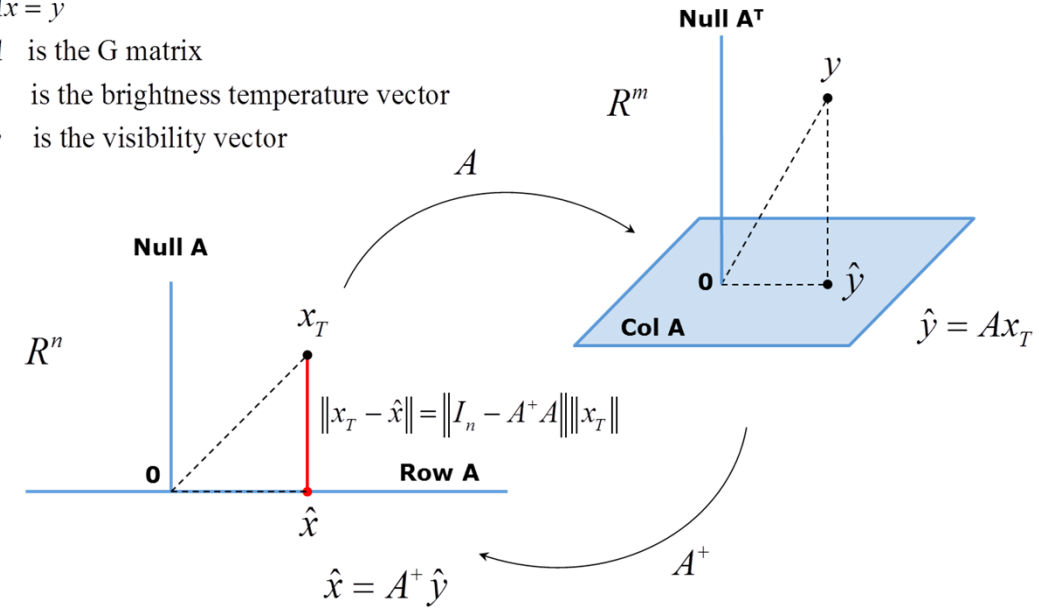
– **Spatial Ripples** are difficult to correct (even for a known instrument)

$Ax = y$

A is the G matrix

x is the brightness temperature vector

y is the visibility vector



Kelvin (1 sigma)	SMOS MEASUREMENTS	PERFECTLY KNOWN INSTRUMENT	ANTENNA and CALIBRATION ERRORS
Tx	2.14	**1.68**	1.33
Ty	2.41	**1.25**	2.06

- the **FTT** (Flat Target Transformation) is the best initial correction
- the **OTT** (Ocean Target Transformation) is currently needed for SSS
- tests of a **multiplicative mask** have shown limited results so far
- an **OCT** (Ocean Calibration Target) technique (variation of **OTT**) is under test
- a **review** of the **image reconstruction** started in parallel

SPATIAL BIASES: Slopes and Borders I

– **Negative Trend at Low Incidence**

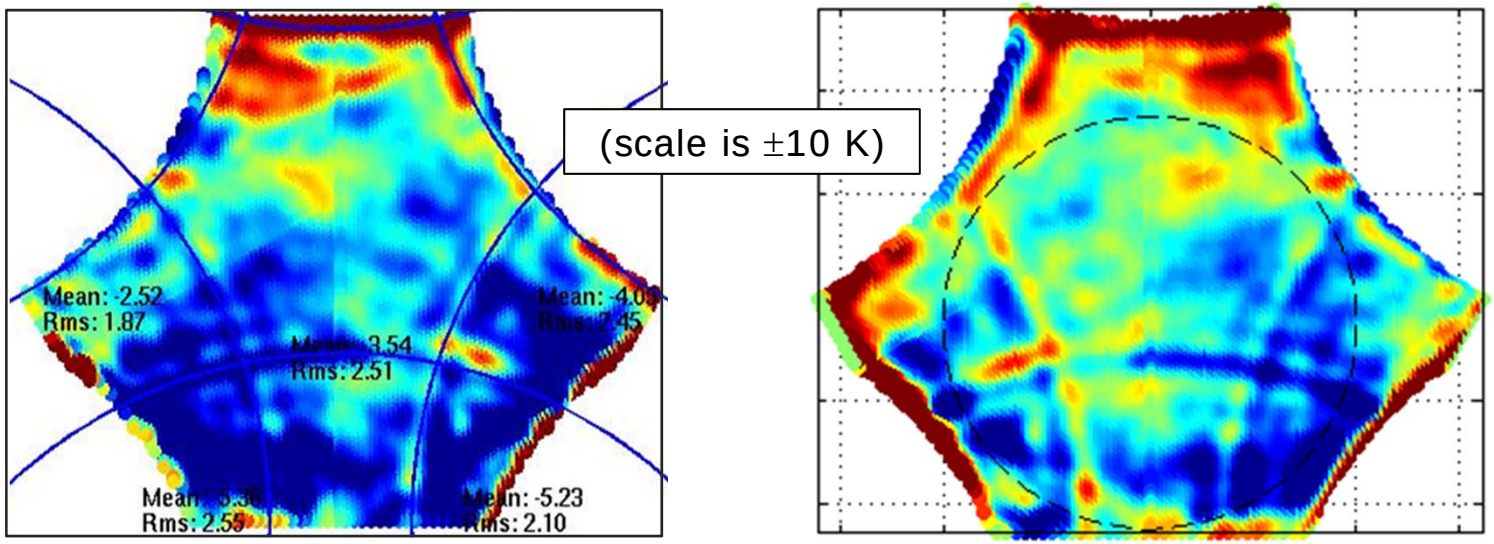
  • dependent on L1b image reconstruction approach

  • the negative trend has been reduced in the new V600 of the L1 processor

– **Borders** (belt/suspenders)

  • dependent on grid type and resolution

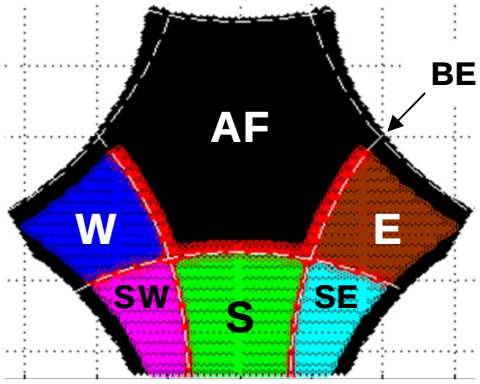
  • trade-off between spatial ripple and belt/suspenders in L1b approach



Current L1 Processor **New V600 of L1 Processor**

SPATIAL BIASES: Slopes and Borders II

Field of View partition to evaluate metrics of the different Level-1B processors



Spatial Ripple	DPGS	**V600** (Model)
X	1.61 K	**1.52 K**
Y	2.22 K	**1.97 K**

X-pol	AF	W	SW	S	SE	E	BS
DPGS	0.10 ± 1.30	0.70 ± 1.30	0.20 ± 1.60	-1.30 ± 1.80	0.00 ± 1.70	-0.30 ± 1.30	0.20 ± 2.10
Basic Approach	1.10 ± 1.49	-0.64 ± 1.88	-0.85 ± 3.21	-0.66 ± 1.82	0.32 ± 2.05	1.19 ± 2.81	-0.37 ± 2.05
Model Aproach ← *best*	1.02 ± 1.14	-0.09 ± 0.85	1.15 ± 2.09	0.95 ± 1.30	0.96 ± 1.73	0.45 ± 1.36	-0.88 ± 1.82
FTR Approach	1.08 ± 1.18	-0.17 ± 1.15	-0.08 ± 2.11	0.53 ± 1.27	0.97 ± 1.83	1.78 ± 1.05	1.02 ± 1.82

Y-pol	AF	W	SW	S	SE	E	BS
DPGS	-1.10 ± 1.70	-2.50 ± 1.90	-5.30 ± 2.60	-3.30 ± 2.10	-5.20 ± 2.10	-4.10 ± 2.50	-3.50 ± 2.50
Basic Approach	-0.04 ± 1.43	0.87 ± 2.25	-1.45 ± 2.49	1.53 ± 2.32	-1.43 ± 2.62	-0.97 ± 2.20	0.38 ± 2.48
Model Aproach ← *best*	-0.31 ± 1.48	-0.77 ± 1.71	-2.10 ± 2.13	-1.60 ± 1.58	-4.32 ± 2.36	-2.16 ± 2.11	-3.39 ± 2.25
FTR Approach	-0.16 ± 1.40	-0.96 ± 2.15	-2.98 ± 2.14	-1.38 ± 1.75	-4.08 ± 2.24	-1.99 ± 1.54	-1.83 ± 2.43

– The new Level-1 Processor (**V600**) with the **Model Approach** will bring:

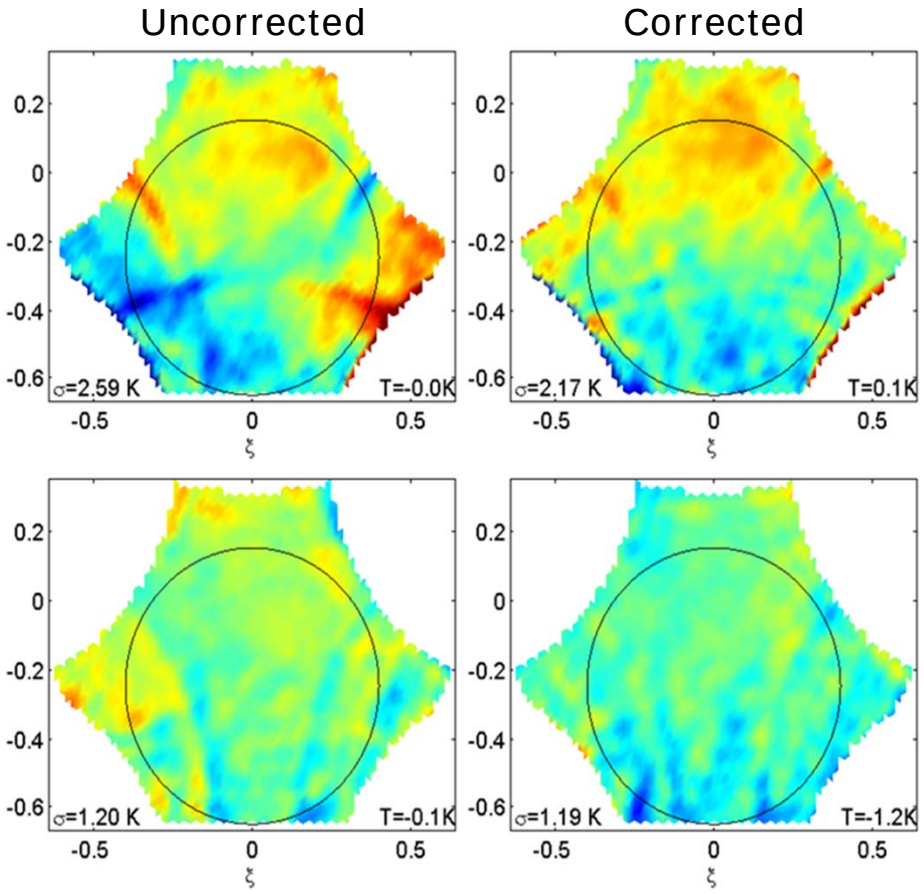
  • **reduced slopes, borders and ripple** (improvement mostly in Y-pol)

SPATIAL BIASES: Slopes and Borders III

– **Slopes** in T3 and T4

- due to **wrong sign** in the horizontal cross-polar antenna pattern
- corrected in the new V600 of L1 processor; hence slopes are removed

Evaluation of Residual Errors in T3 and T4 (scale is ±10 K)



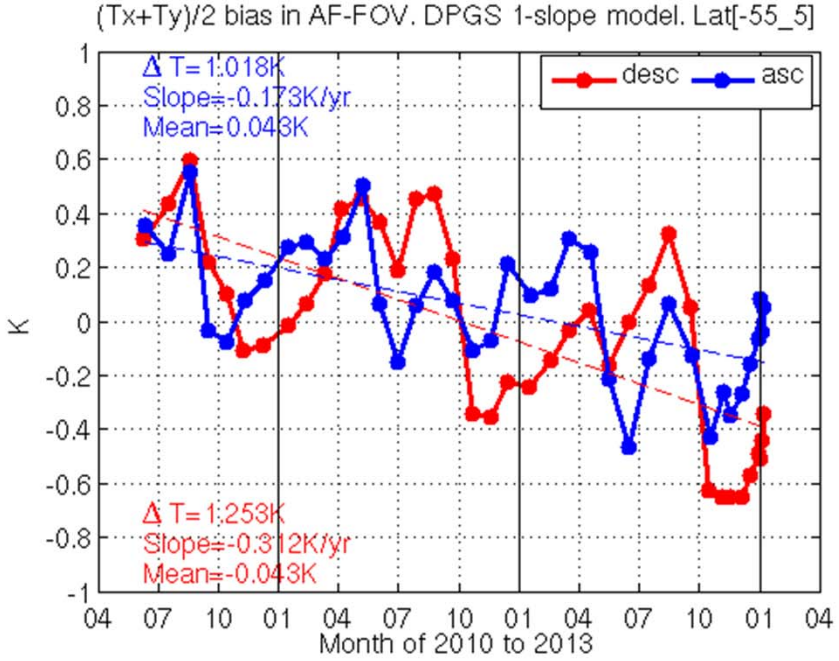
T3 ≡ Re {Txy}

T4 ≡ Im {Txy}

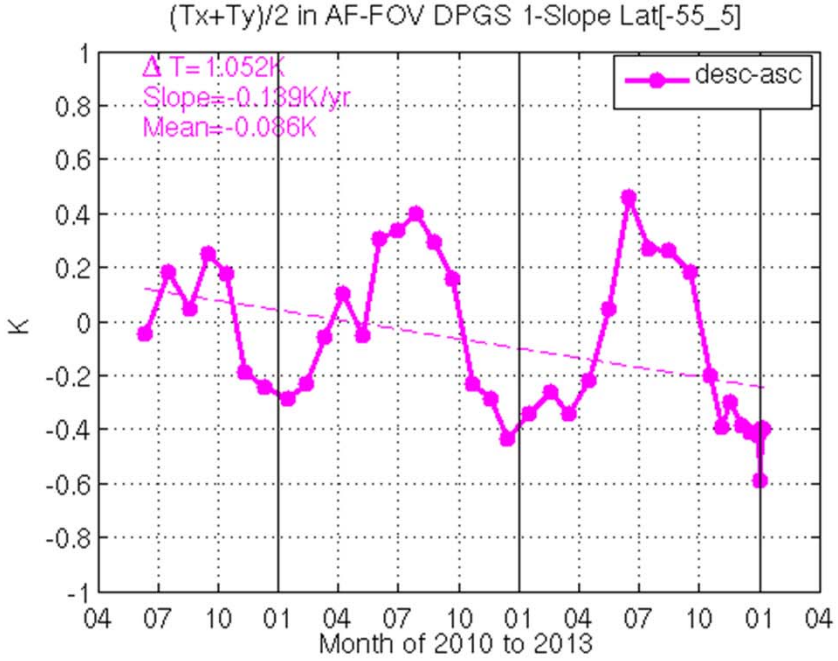
TEMPORAL DRIFTS:
Orbital, Seasonal and Yearly Drift I

Brightness Temperature Residuals over Ocean

Ascending and Descending Orbits Separately



Descending minus Ascending

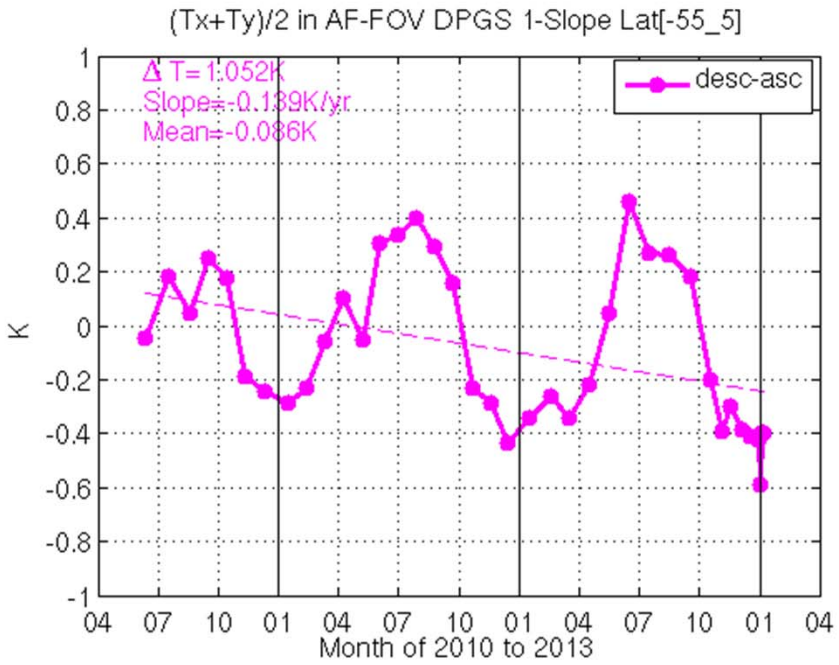


Orbital (peak-to-peak)	**1.05 K**
Seasonal (peak-to-peak)	**1.0 K**
Yearly (slope in worst polarisation)	**–0.31 K/year**

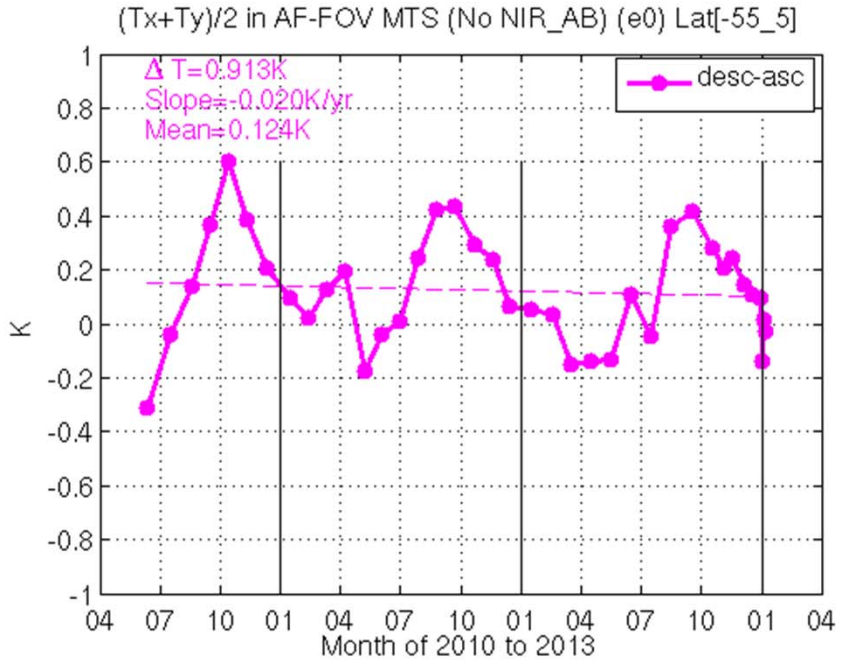
TEMPORAL DRIFTS:
Orbital, Seasonal and Yearly Drift II

Brightness Temperature Residuals over Ocean

Current Level-1 Processor



New V600 of Level-1 Processor

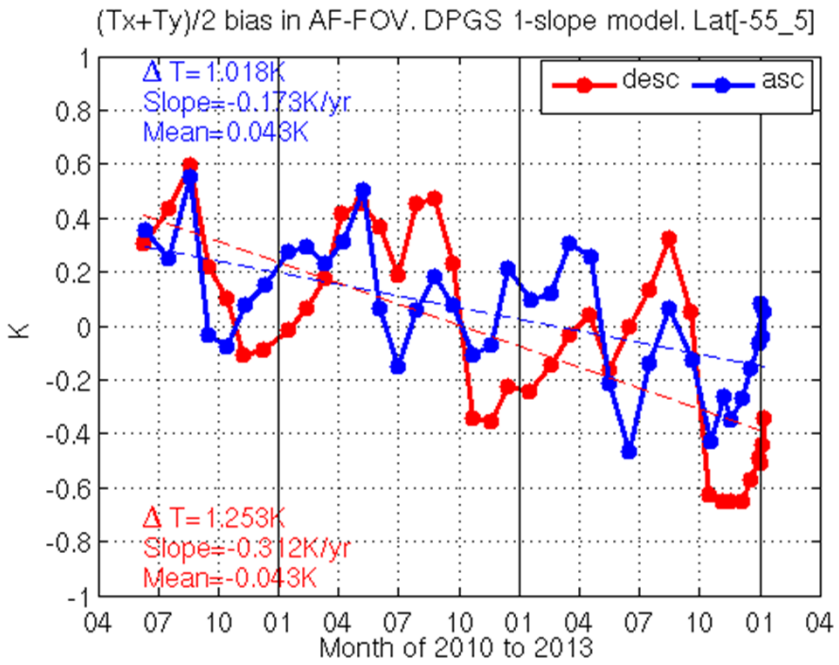


	Current L1	**New V600 L1**
Orbital (peak-to-peak)	1.05 K	**0.91 K**

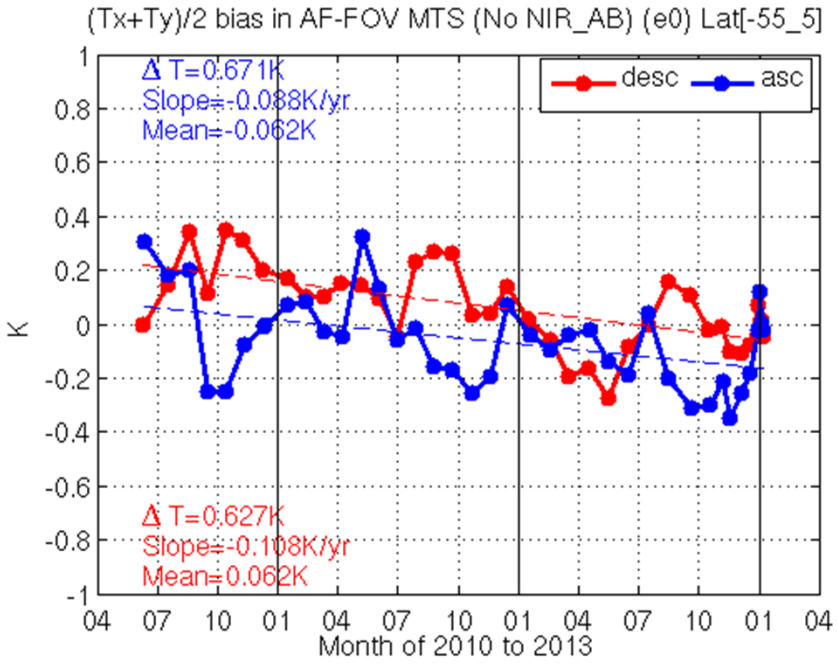
TEMPORAL DRIFTS:
Orbital, Seasonal and Yearly Drift III

Brightness Temperature Residuals over Ocean

Current Level-1 Processor



New V600 of Level-1 Processor

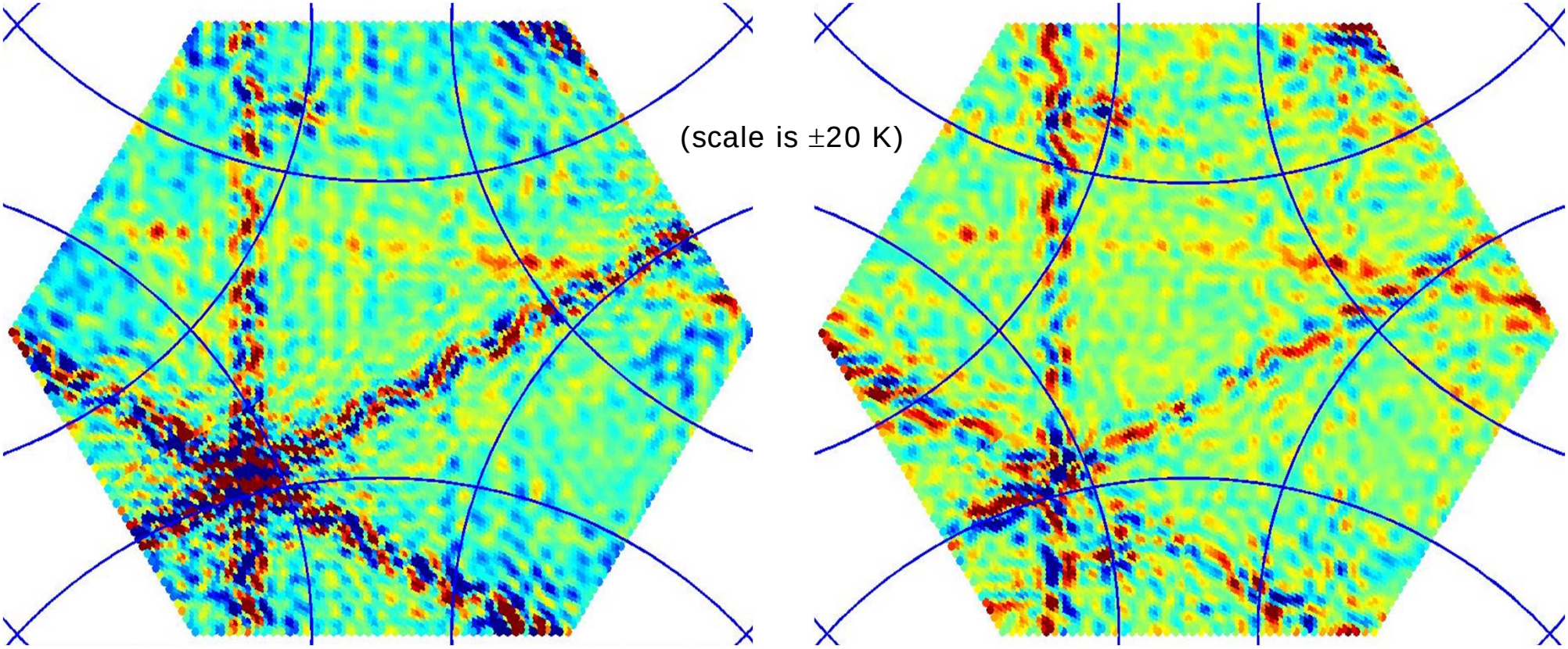


	Current L1	**New V600 L1**
Seasonal (peak-to-peak)	1.0 K	**0.6 K**
Yearly (slope in worst polarisation)	–0.31 K/year	**–0.11 K/year**

Sun Correction using Sun Response

Current Sun Correction

New Sun Correction (under test)



(scale is ±20 K)

- improvement in the range between **20 %** to **50 %**

CONCLUSIONS

- Corbella equation successfully verified
- Important progress in the understanding of spatial ripples in the images
- Software inconsistencies corrected, resulting in significant improvements
- Optimised Level-1B processor (image reconstruction)
- Reduced slopes, borders and ripples with the new V600 L1 processor
- Instrument stability improved with the new V600 L1 processor
- Full polarimetric data processing with the new V600 L1 processor