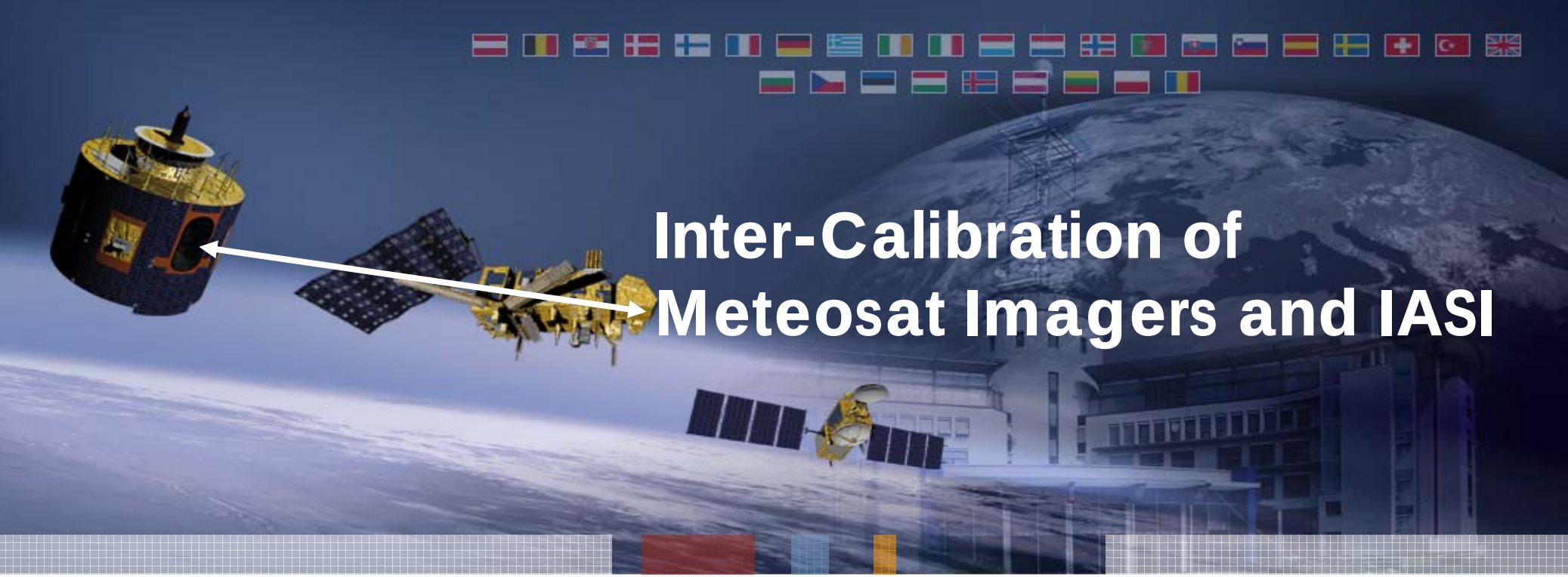

Inter-Calibration of Meteosat Imagers and IASI

Tim Hewison

Marianne König

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Contents

- Introduction to GSICS
- Meteosat-IASI Inter-Calibration Method
- Meteosat-IASI Inter-Calibration Results
  - Changing Bias in IR13.4 channel
- Meteosat Ice Contamination Model
- Conclusions

Global Space-based Inter-Calibration System

- What is GSICS?
  - Global Space-based Inter-Calibration System
  - An effort to produce consistent, well-calibrated data from the international constellation of operational satellites
- What are the basic strategies of GSICS?
  - Make pre-launch instrument tests traceable to SI standards
  - Improve on-orbit calibration by integrated cal/val system
    - Initially by LEO-GEO Inter-satellite/inter-sensor calibration
- This will allow us to:
  - Better specify future instruments
  - Improve consistency between instruments' observations
  - Produce less bias in Level 1 and 2 products
  - Retrospectively re-calibrate archive data using this

Use of IASI as a Reference

Meteosat Geostationary Imager

+

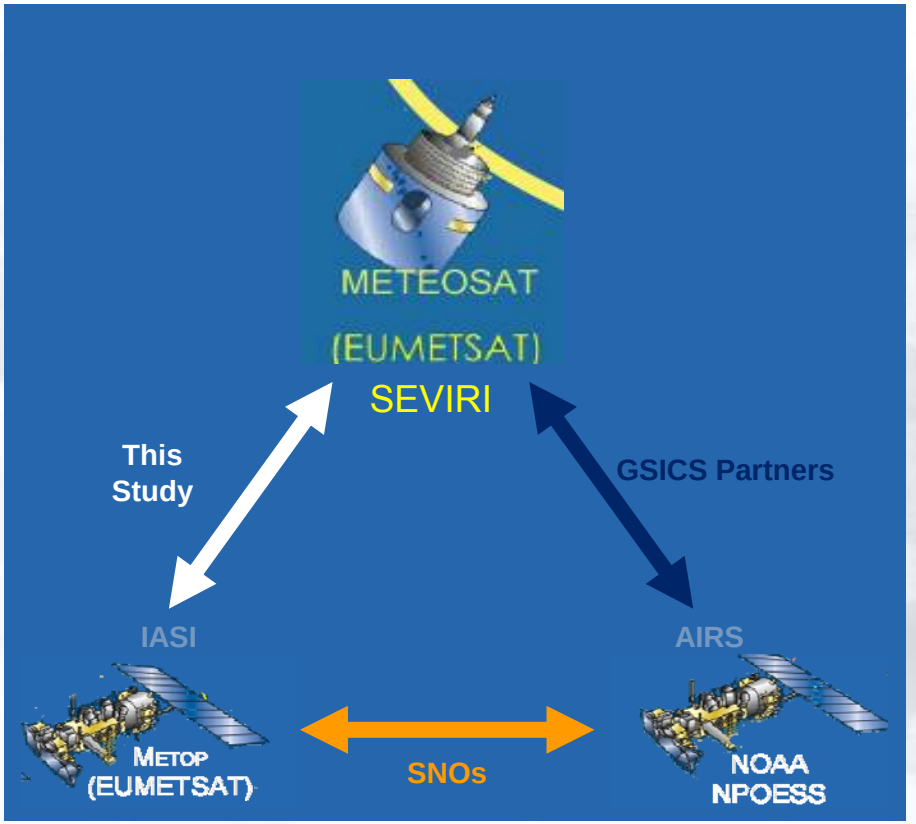
Infrared Atmospheric Sounding Interferometer, IASI, on Metop polar-orbiting satellite

Benefits of IASI as reference:

- Well-characterised
- Carefully controlled calibration
- Built-in linearity controls
- No spectral gaps
- On same platform as HIRS/4

Can cross-check with AIRS:

- Simultaneous Nadir Overpasses: SNOs
- Inter-calibrating Meteosat-AIRS



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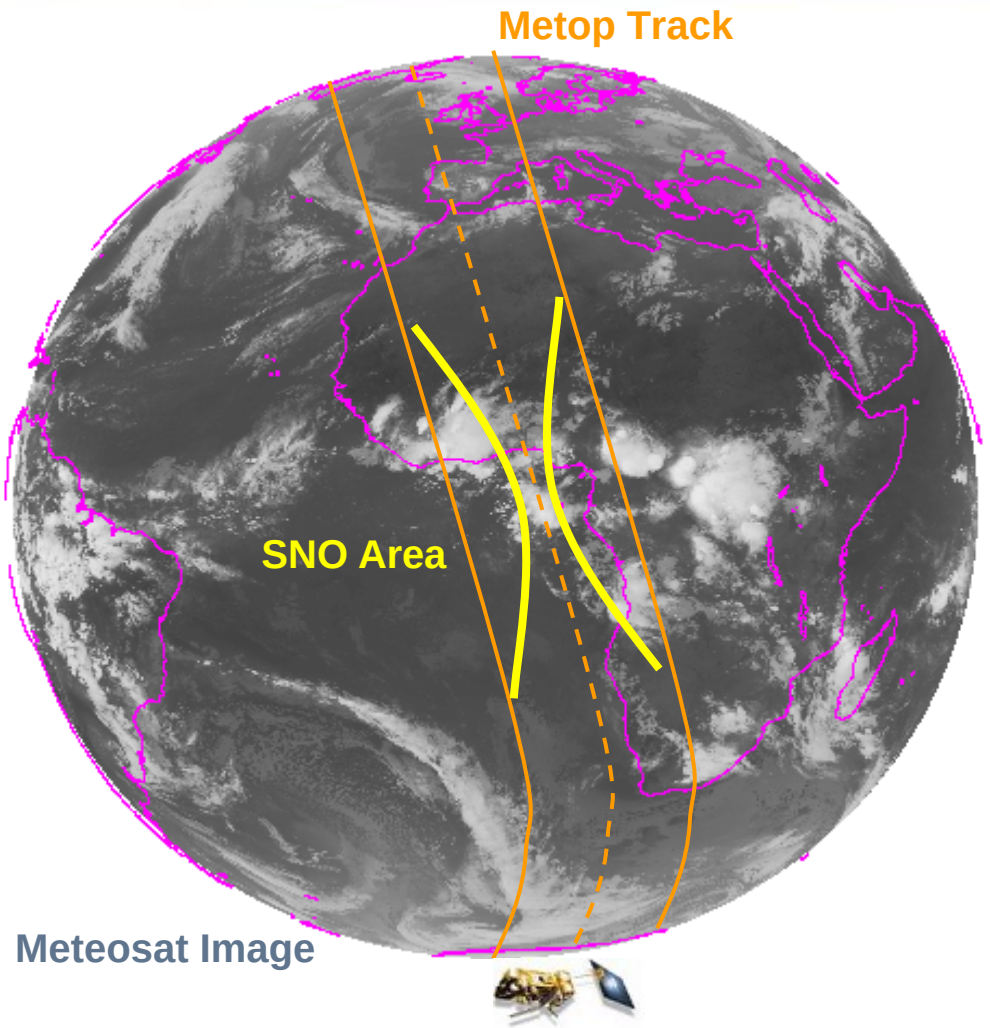
Collocation Criteria

Simultaneous near-Nadir Overpasses

of Meteosat and Metop

- Only night-time data
- $\Delta Lat < 30°$, $\Delta Lon < 30°$ of SSP
- $\Delta t < 15$ mins (=scan period)
- $|\theta| < 15°$ (Incidence angle)
- $\Delta\theta < 2°$ (Incidence angle diff.)
- 5x5 MSG pixels / IASI iFoV

Restricts collocations to Tropics
~1 orbit/day
~200 good collocations



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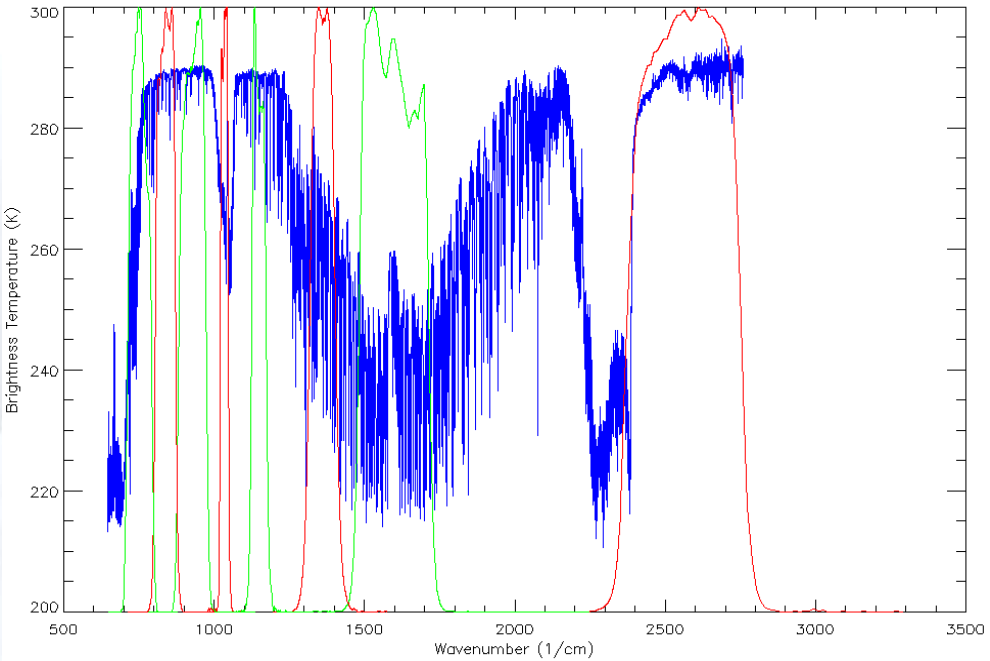
Data Transformations (Spectral and Spatial)

Spectral Convolution:

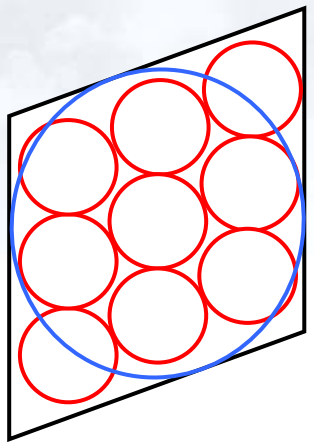
- Convolve IASI Radiance Spectra with Meteosat Spectral Response Functions
- to synthesise radiance Meteosat channels

(IASI *almost* covers Meteosat's channels')



Spatial Averaging:

- Average Meteosat pixels in each IASI iFoV
- Estimate uncertainty
  - –due to spatial variability
  - –as Standard Deviation of Meteosat pixels
- Use in weighted regression



IASI iFoV~12km

5x5 MSG pixels

3x3 MFG pixels

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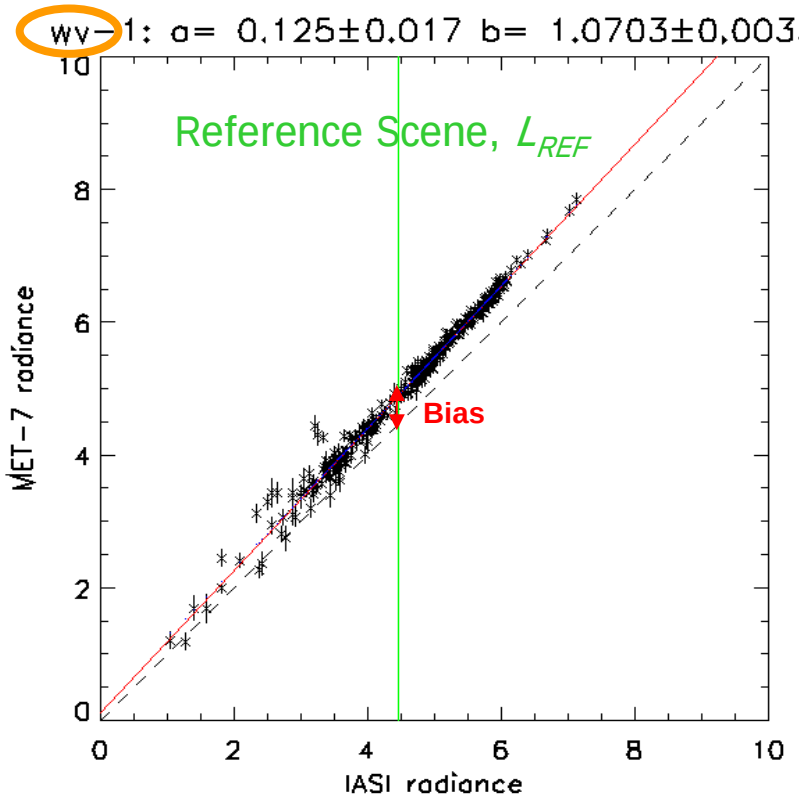
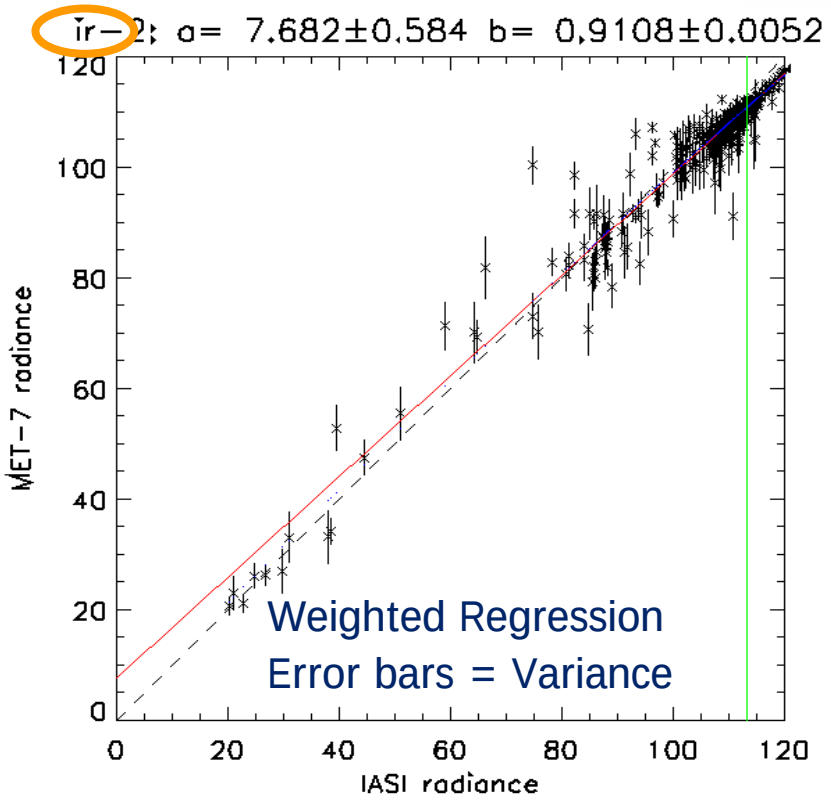
Regression

Offset ≠ 0 Slope ≠ 1 => Difference is scene-dependent





Reference Scene
defined as modal value
(typical clear sky radiance)

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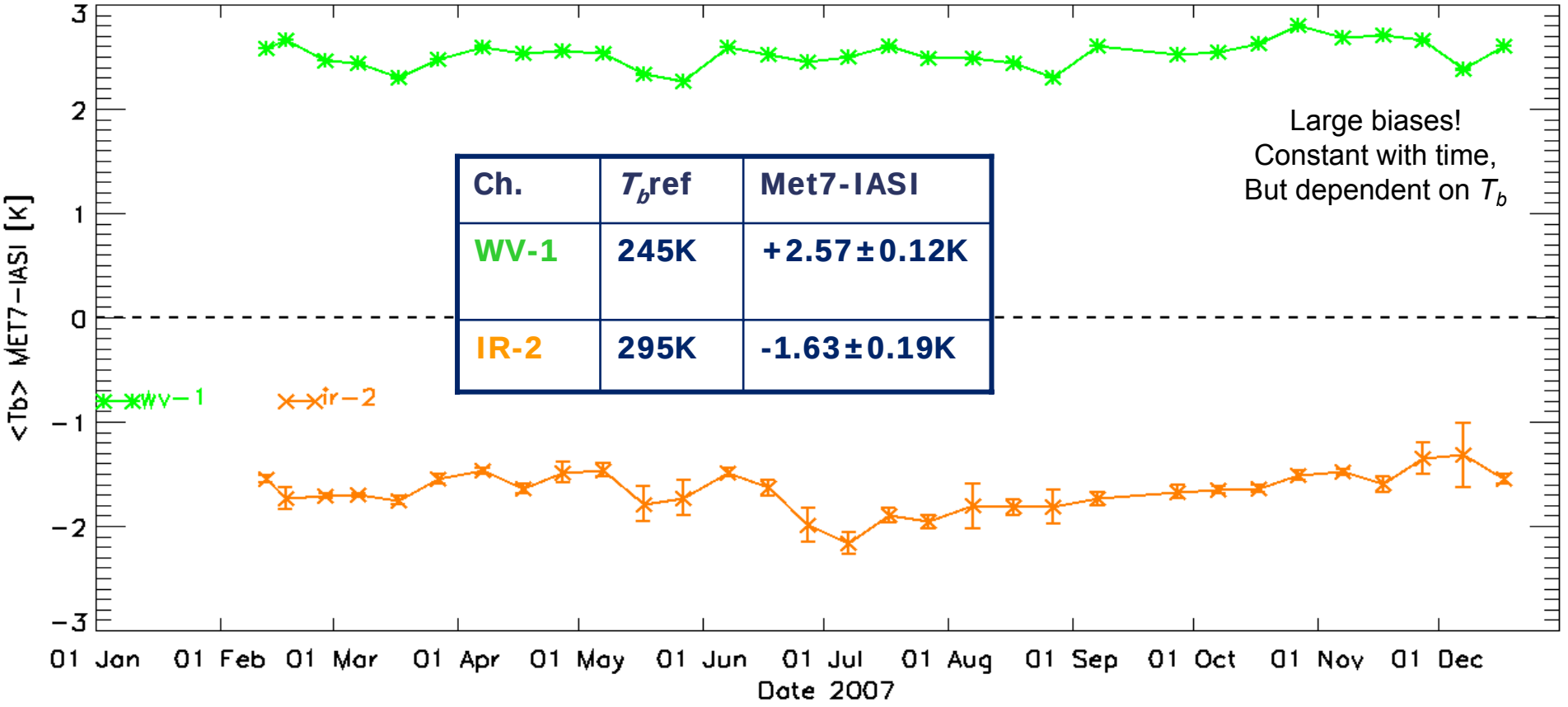
MVIRI on Meteosat-7 – IASI on Metop-A



Ch.	$T_b$ref	Met7-IASI
WV-1	245K	+2.57±0.12K
IR-2	295K	-1.63±0.19K

Time series of brightness temperature differences between Met7-IASI for typical clear-sky radiances: Each Met7 infrared channel is shown in a different color, with different symbols, following the legend. Error bars represent statistical uncertainty on each mean bias (may be very small).

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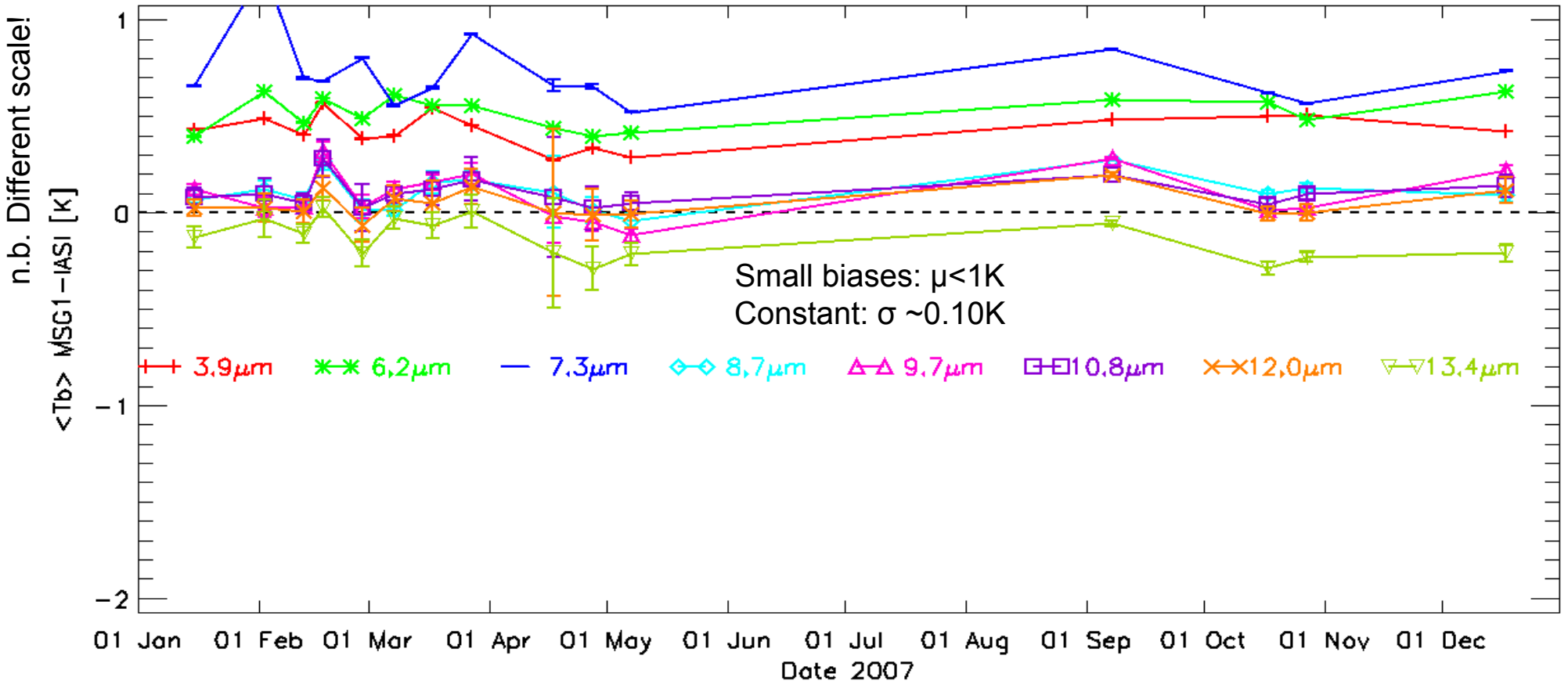
SEVIRI on Meteosat-8 – IASI on Metop-A



Time series of brightness temperature differences between MSG1-IASI for typical clear-sky radiances. Each MSG infrared channel is shown in a different color, with different symbols, following the legend. Error bars represent statistical uncertainty on each mean bias (may be very small).

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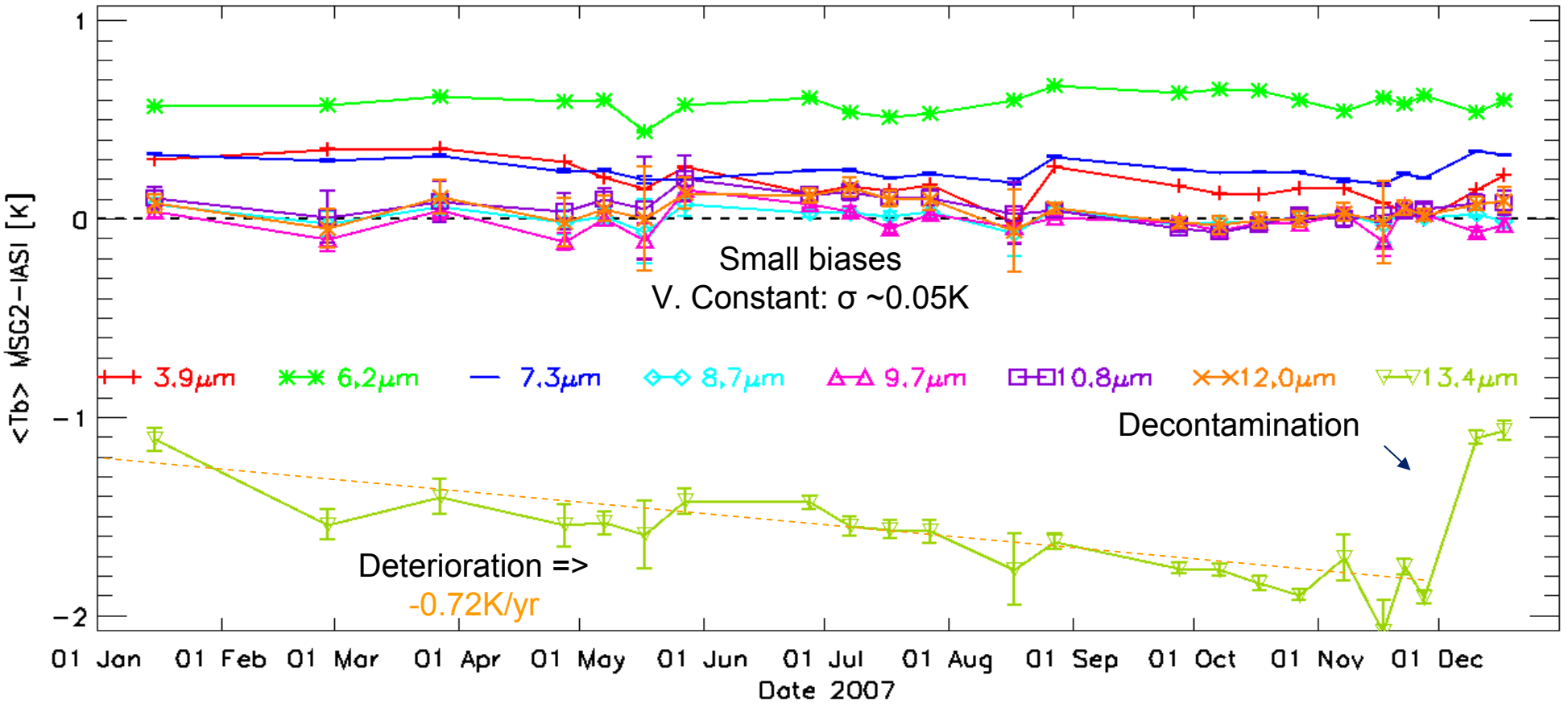
SEVIRI on Meteosat-9 – IASI on Metop-A



Time series of brightness temperature differences between MSG2-IASI for typical clear-sky radiances. Each MSG infrared channel is shown in a different color, with different symbols, following the legend. Error bars represent statistical uncertainty on each mean bias (may be very small).

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Summary of Meteosat-IASI during 2007
(using original IMPF radiance definition)

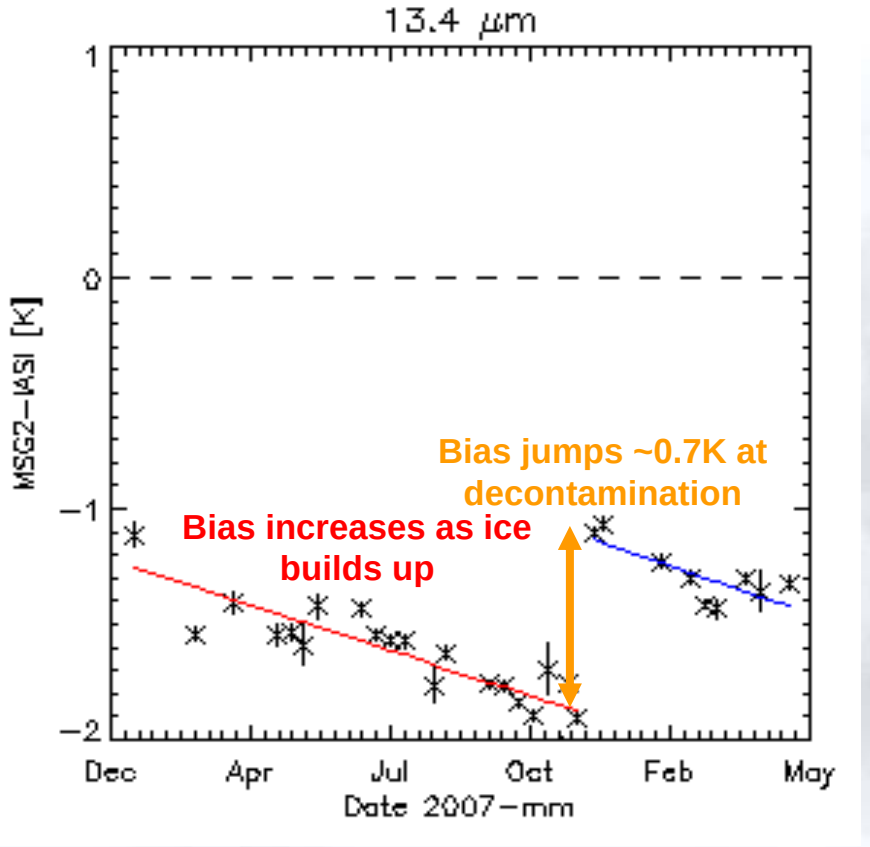
Channel (μm)		3.9	6.2	7.3	8.7	9.7	10.8	12.0	13.4
Ref Scene T_{bref} (K)		290	240	260	290	270	290	290	270
Meteosat-7	Mean Bias (K)		**+2.57**				**-1.63**		
	Std. Dev. (K)		0.12				0.19		
Meteosat-8	Mean Bias (K)	**0.46**	**0.56**	**0.77**	**0.22**	0.19	**0.16**	0.13	-0.13
	Std. Dev. (K)	0.09	0.08	0.18	0.09	0.14	0.07	0.07	0.16
Meteosat-9	Mean Bias (K)	0.17	**0.61**	**0.25**	0.02	0.00	0.03	0.05	**-1.63**
	Std. Dev. (K)	0.10	0.05	0.04	0.04	0.07	0.06	0.06	0.26

Brightness Temperatures, T_b, for Reference Scenes and Mean Difference between Meteosat and IASI during 2007.

Statistically significant (at >95% level) biases highlighted in **bold**.

Ice Contamination of Meteosat IR13.4

- Inter-calibration of MSG-IASI showed bias in 13.4µm channel, degraded by -0.7K/yr
- Recovers after decontamination
- Theory: Due to Ice on optics



Time series of relative bias (Meteosat-9 – IASI) Lines show fits to data before and after decontamination

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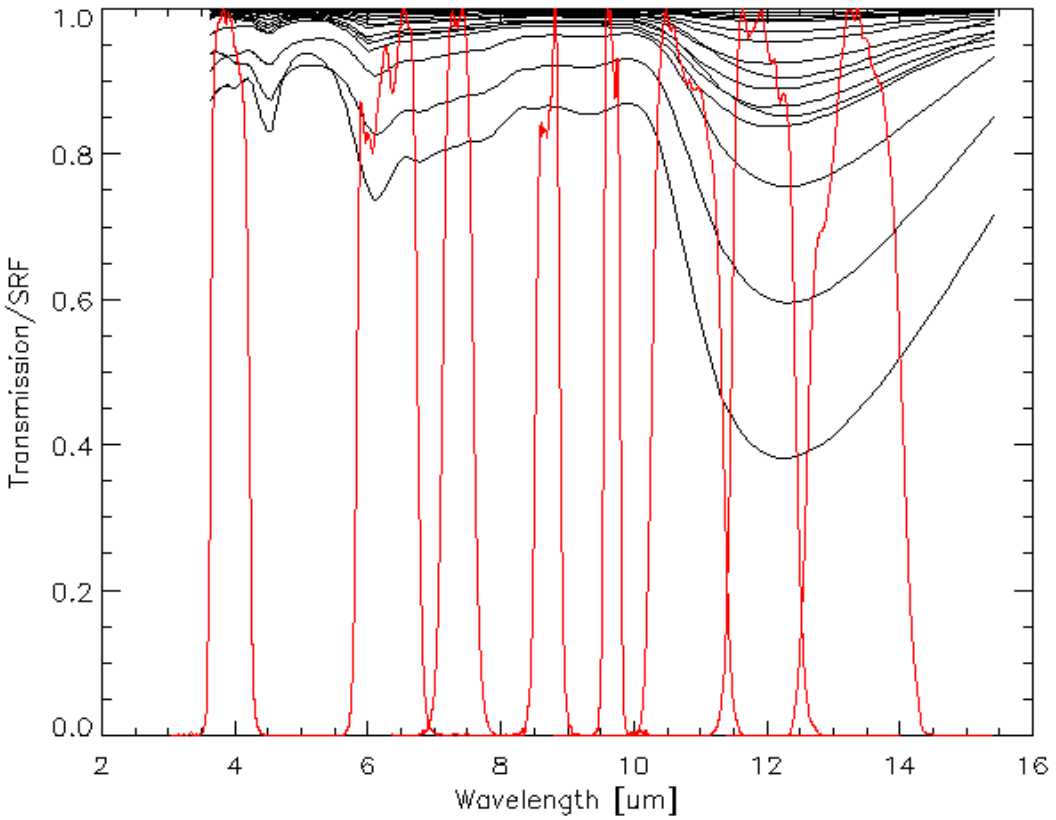
Ice Contamination of Meteosat IR13.4

- Inter-calibration of MSG-IASI showed bias in 13.4µm channel, increasing by ~1K/yr
- Recovers after decontamination
- Theory: Due to Ice on optics
- 2 Models of ice absorption
  - –from CNES & Astrium
- Changes SRF of IR13.4
- Introduces bias when not accounted for in calibration



Transmission spectra of ice layers of different thicknesses (black): 12 - 2000 nm layers.
Spectral Response Functions of Meteosat-9 (red).

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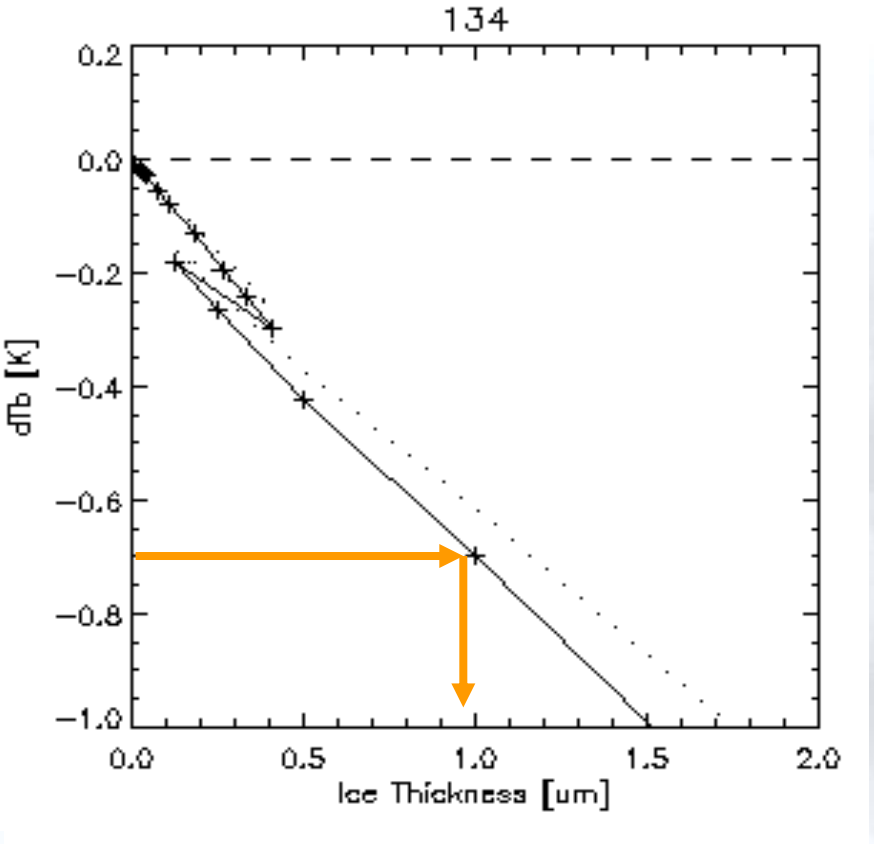
Ice Contamination of Meteosat IR13.4

- Inter-calibration of MSG-IASI showed bias in 13.4µm channel, increasing by ~1K/yr
- Recovers after decontamination
- Theory: Due to Ice on optics
- 2 Models of ice absorption
  - –from CNES & Astrium
- Changes SRF of IR13.4
- Introduces bias when not accounted for in calibration
- Can be modelled by ~1µm ice
- Consistent with observed gain changes
  - –Potential for operational correction



Brightness temperatures Bias modelled by modifying Meteosat-9's SRF by the absorption of different thicknesses of ice.

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Conclusions

- Inter-calibration of Meteosat IR imager channels with IASI
  - Can be used to monitor relative biases
  - With a repeatability of ~0.05 K
  - Detect day-to-day changes, or monthly trends
  - Develop and validate correction algorithms
  - Near real time and archive applications

- Example of application of GSICS
  - Global Space-based Inter-Calibration System

Thank you

Questions and Answers