

Feasibility and sensitivity studies for CLARREO

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Space & Atmospheric Physics

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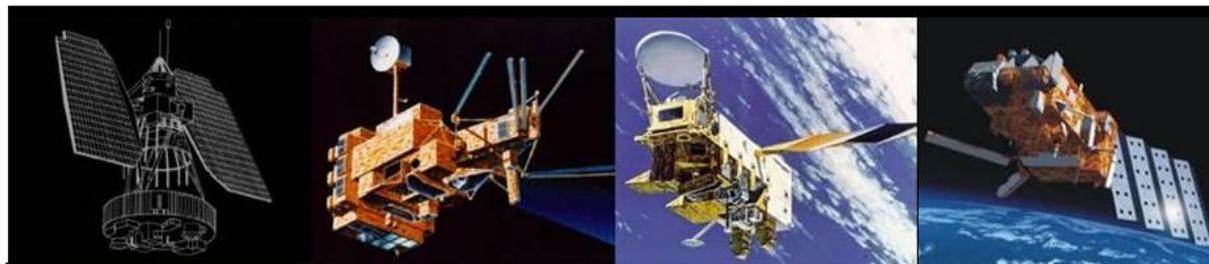
Outline

- Proposal to CLARREO SDT
- IR spectral signatures from satellite interferometer data
- Modelled 'clear-sky' IR variability from ERA Interim reanalyses
- All-sky sampling studies using SEVIRI data
- Future developments and activities

CLARREO SDT Proposal

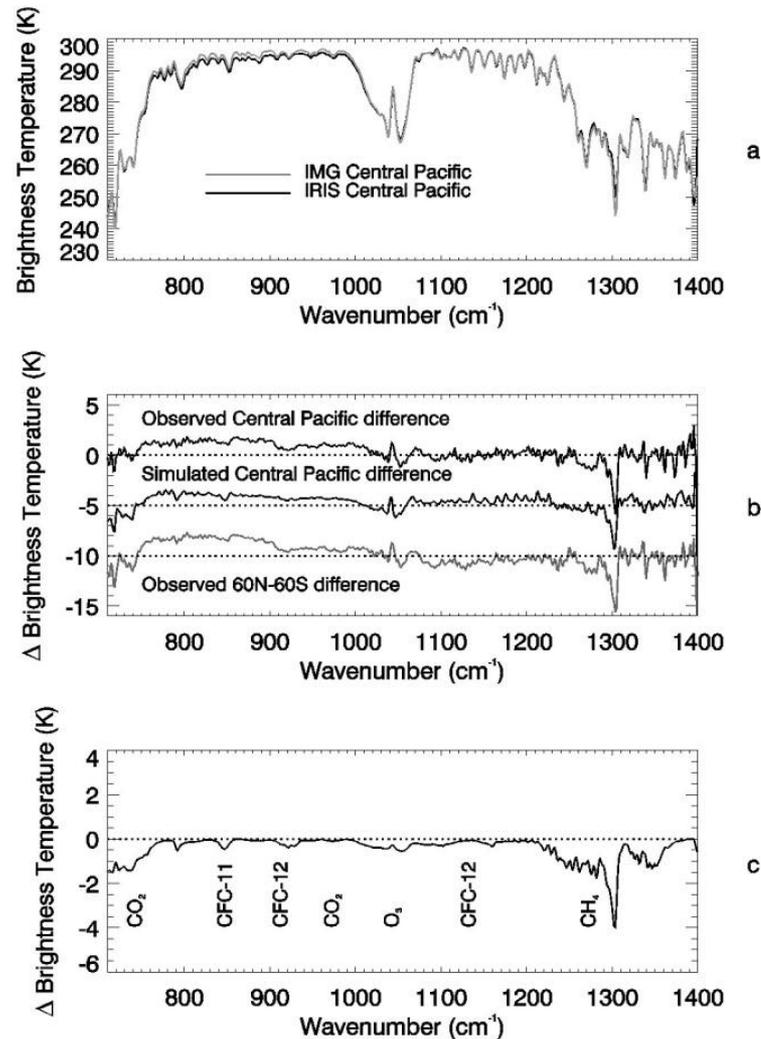
- Imperial Team: H. Brindley, R. Bantges, C. Belotti, J. Harries, J. Murray, J. Russell
- IR Benchmarking
 - Natural variability in resolved IR spectrum
 - Satellite sampling / instrument characteristics
- Calibration-Validation
 - In-flight validation (simulations)
 - Far IR specific (TAFTS experience)
 - Ground to space calibration transfer
- Promotion of CLARREO within UK

Spectral signatures from satellite data at Imperial

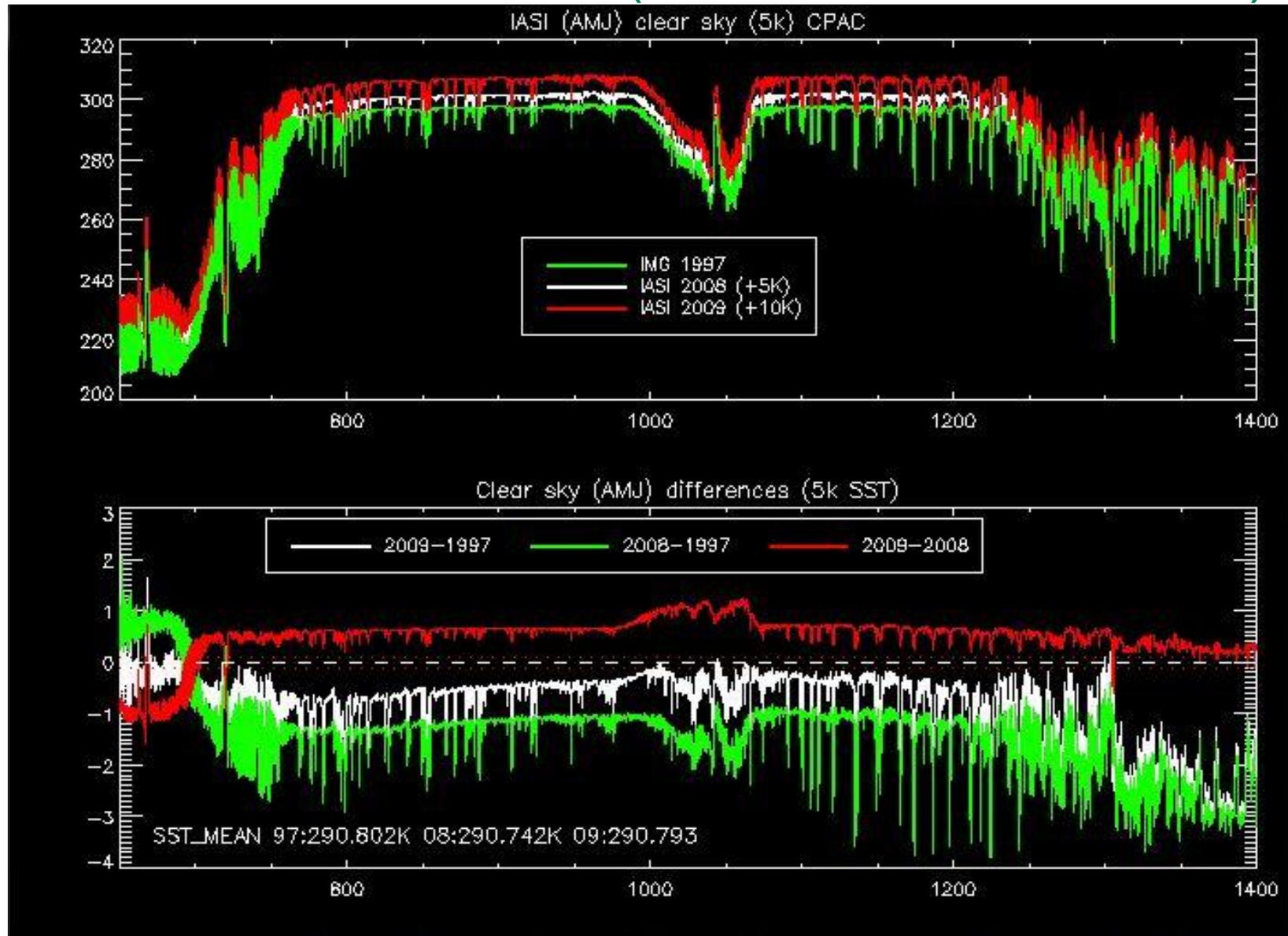


Instrument	IRIS	IMG	AIRS	IASI
Satellite	Nimbus 4	ADEOS	AQUA	METOP-A
Spectro-meter type	FTS	FTS	grating spectrometer	FTS
Data available	Apr 1970 – Jan 1971	Oct 1996 – Jun 1997	2002 - present	2007 - present
Spectral coverage (cm ⁻¹)	400 – 1600 cm ⁻¹ continuous	715 – 3030 cm ⁻¹ 3 bands	650 – 2700 cm ⁻¹ 2378 bands	645 – 2760 cm ⁻¹ 3 bands
Spectral resolution	2.8 cm ⁻¹	0.1 cm ⁻¹	0.4–1.0 cm ⁻¹	0.5 cm ⁻¹
Footprint (nadir)	95 km diameter	8km x 8km	13 km diameter	12 km diameter

IRIS & IMG Clear Sky comparisons



Cloud-free IASI / IMG (Central Pacific – AMJ)



Regional assessment of IR spectral variability

IACONO AND CLOUGH: SPECTRAL RADIANCE AND CLIMATE VARIABILITY

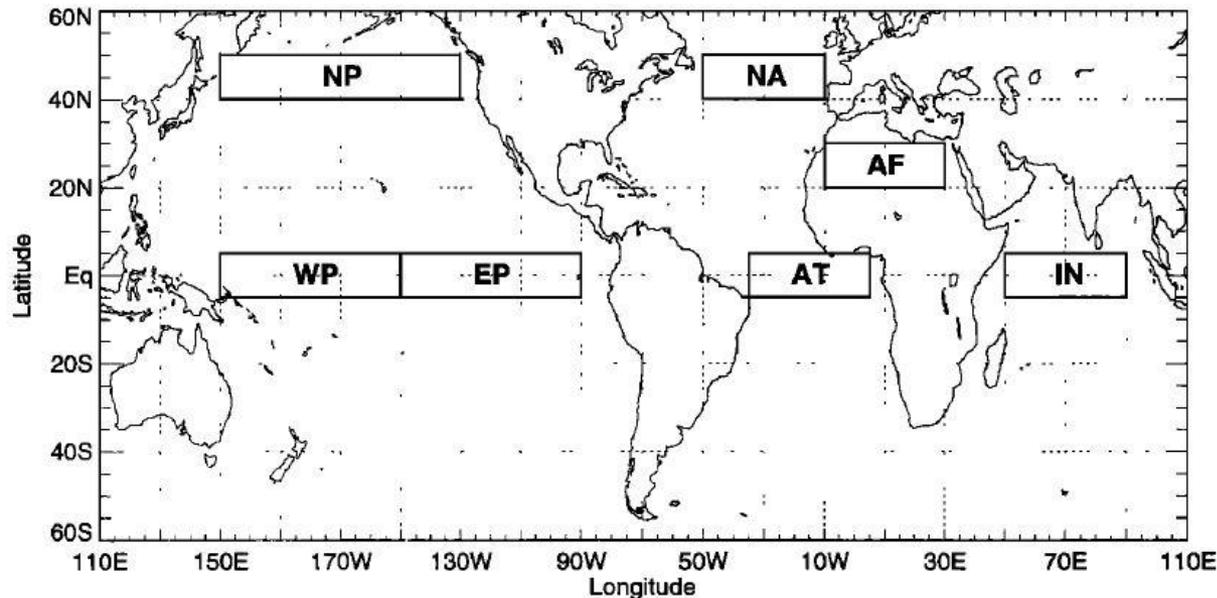
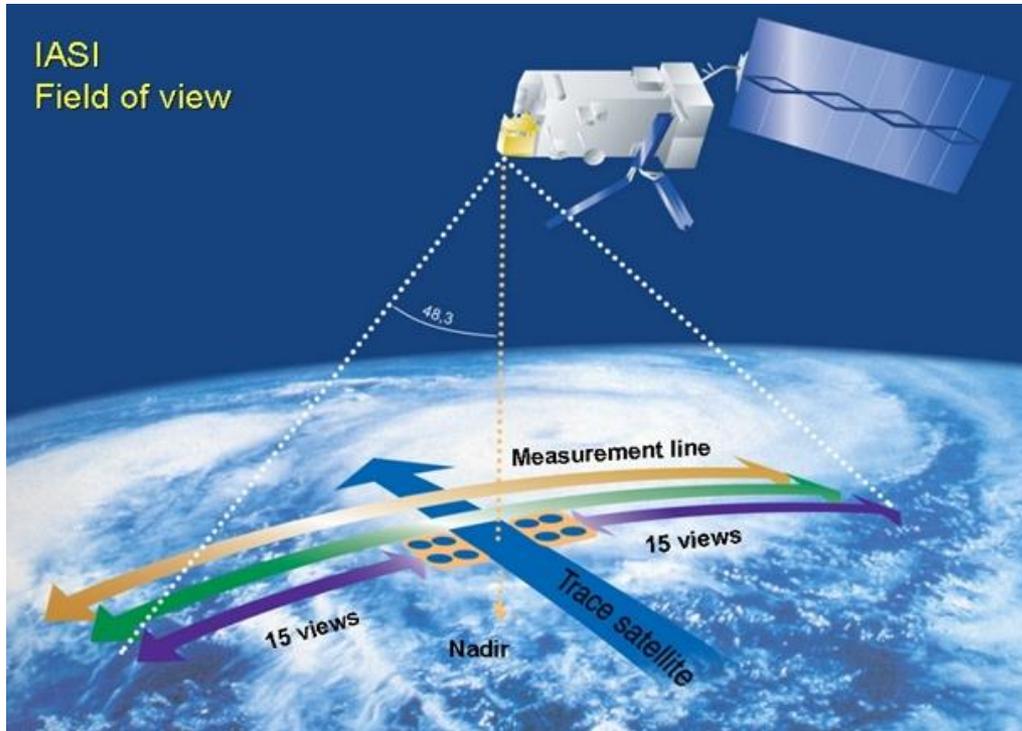


Figure 3. Geographic regions examined in this study. “WP” refers to western Pacific, “EP” to eastern Pacific, “AT” to Atlantic Ocean, “IN” to Indian Ocean, “AF” to Sahara Desert, “NP” to North Pacific, and “NA” to North Atlantic.

Iacono and Clough, JGR Vol.101, D23, 1996

IASI Satellite Configuration and Budgets

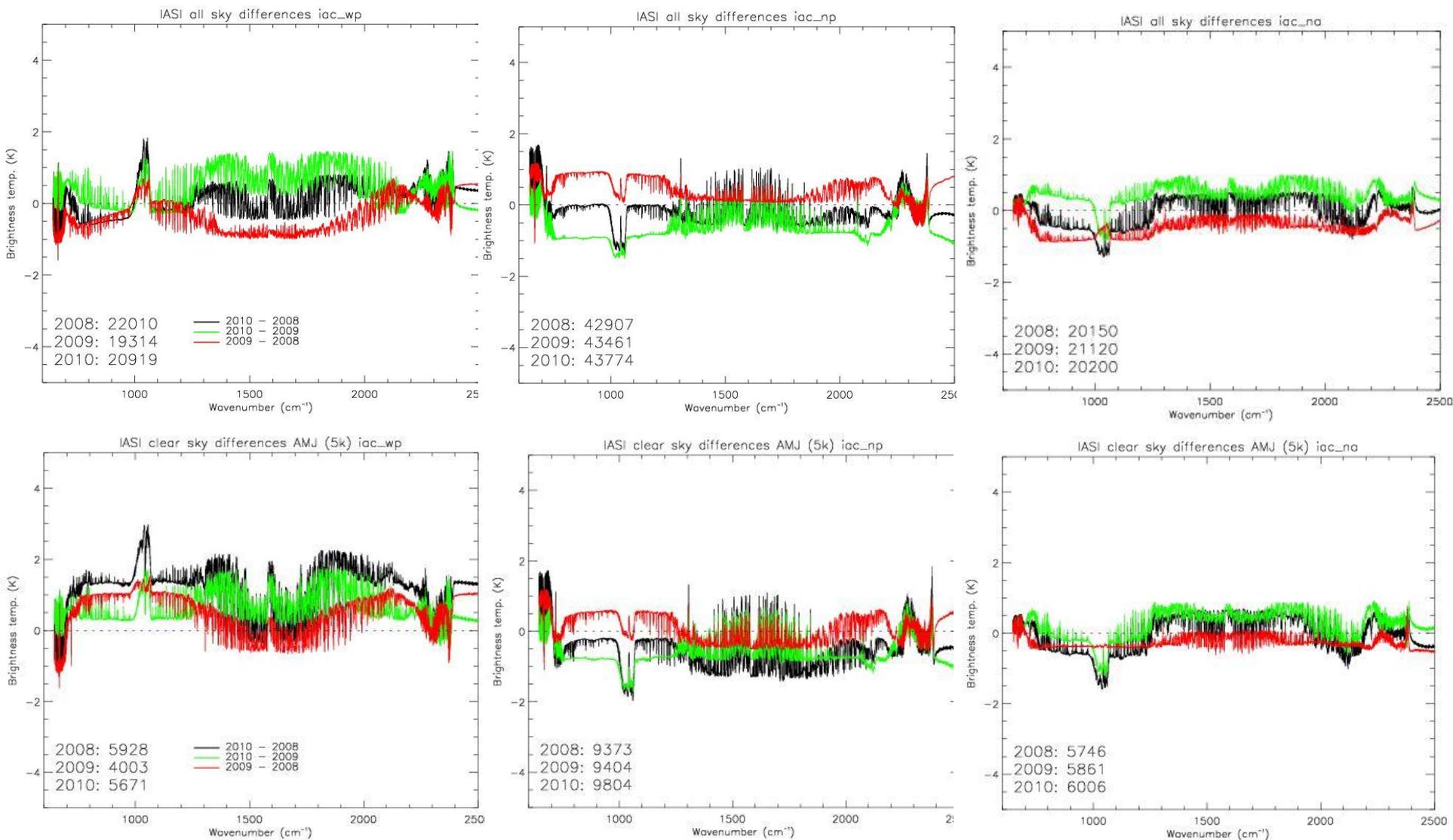


IASI Summary Budgets

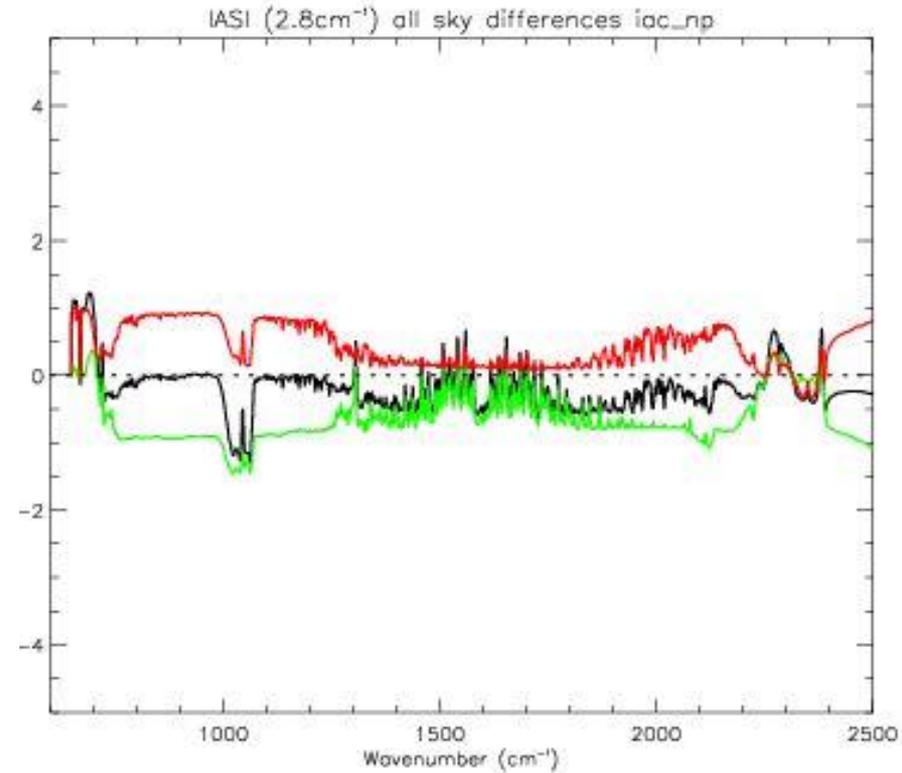
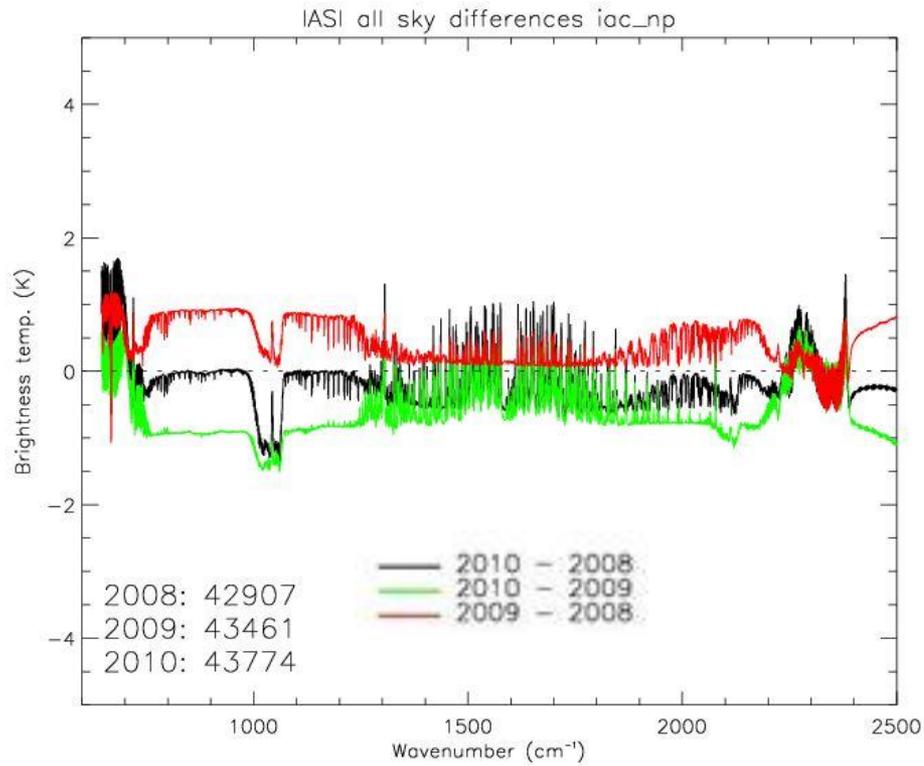
Scan Rate	8 secs
Scan Type	Step and dwell
Pixel IFOV	0.8225°
IFOV size at Nadir	12 km
Sampling at Nadir	18 km
Earth View Pixels / Scan	2 rows of 60 pixels each
Swath	± 48.98°
Swath	± 1066 km
Spectral Range	645 to 2760 cm ⁻¹
Spectral Sampling	0.25 cm ⁻¹
Lifetime	5 years
Power	210 W
Size	1.2 m x 1.1 m x 1.3 m
Mass	236 kg
Data rate	1.5 Mbps

IASI Data: Level 1C ~ 900GB/month ~ 11TB/yr
 Archiving data at Imperial from 2008 – onward
 Infrastructure now in place

Regional variability (allsky top, clr lower) Nadir only



Spectral resolution



Modelled 'clear-sky' variability from ERA Interim

- ERA Interim covers period 1989* onward
- Profiles of T, H₂O_(g), O₃ from reanalyses
- CO₂, CH₄, N₂O from UKMO records (total column, 5 year global mean, interpolation)
- Surface emissivity constant at 0.99 globally
- Spectral radiances simulated at nadir using Oxford RFM (HITRAN 2008, MT CKD1.1)

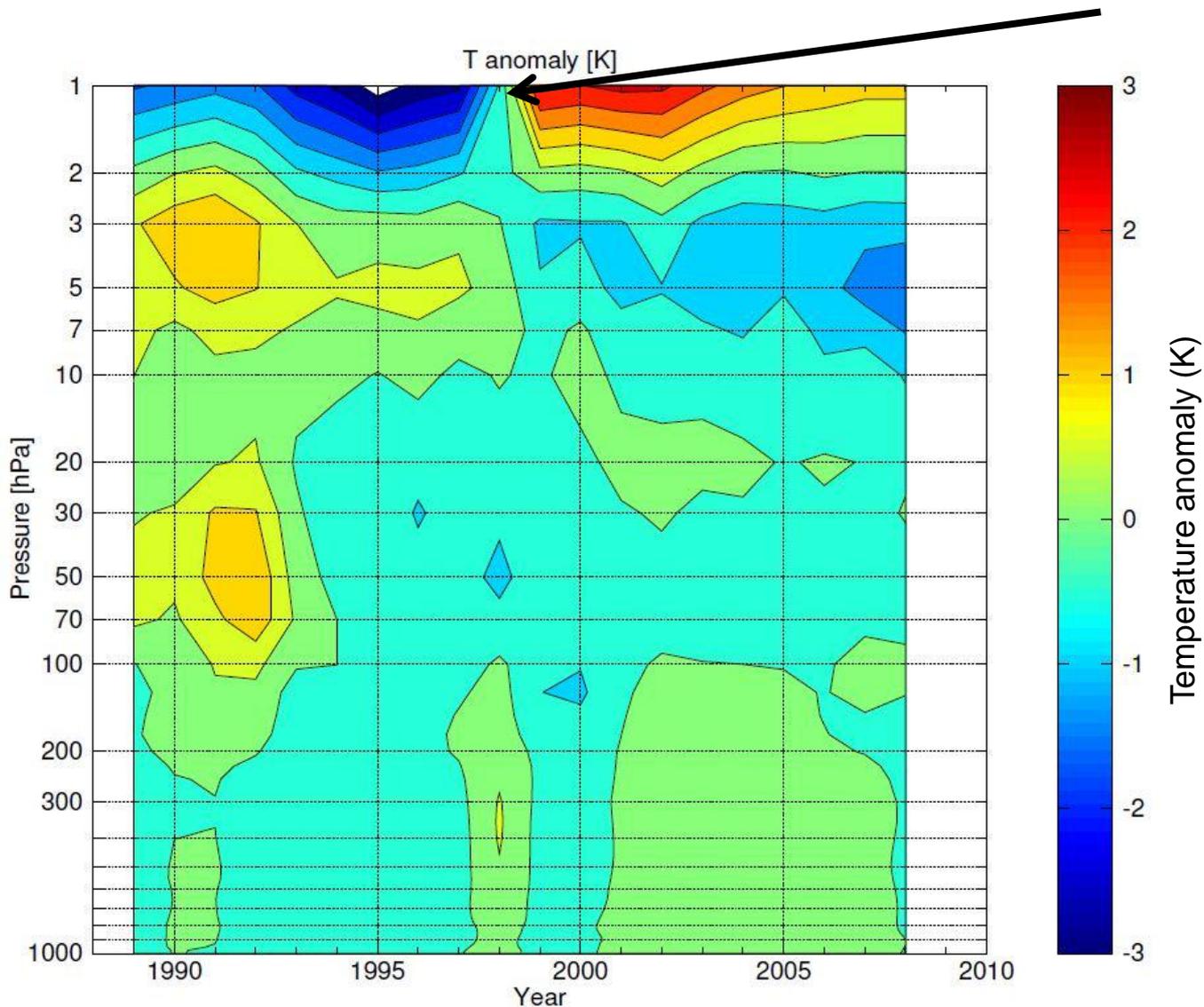
* 1979 planned

RFM model runs

- So far: 1989, 1994, 1999, 2004-2010 (here only AMJ)
- monthly mean fields ('clear-sky' but using all profiles)
- 37 atmospheric levels (1000-1mb)
- spatially resolved $1.5^{\circ} \times 1.5^{\circ}$
- 100-2500 cm^{-1} , spectral resolution 0.5 cm^{-1}
- ~29000 RT simulations per month
- Imperial College HPC (~7000 nodes)

ERA Interim – temperature anomalies

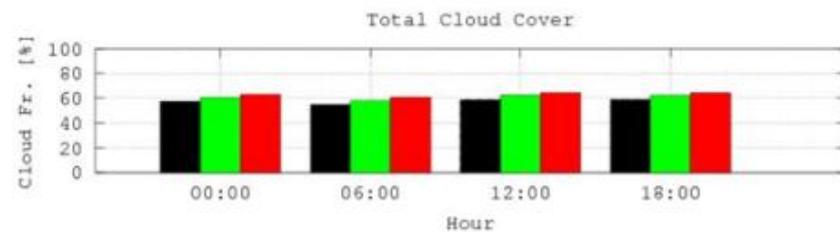
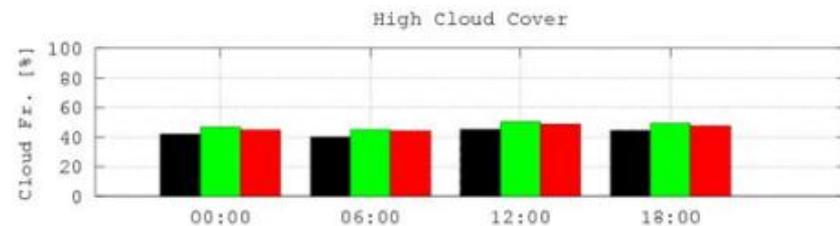
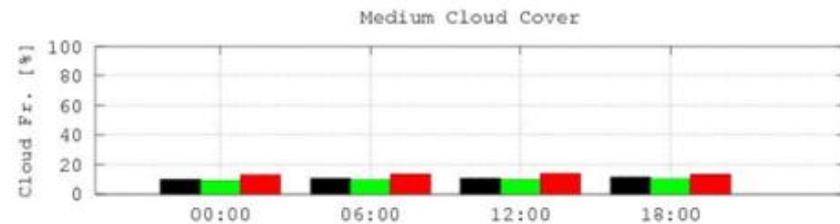
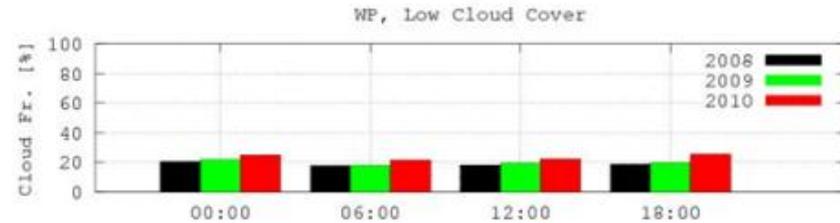
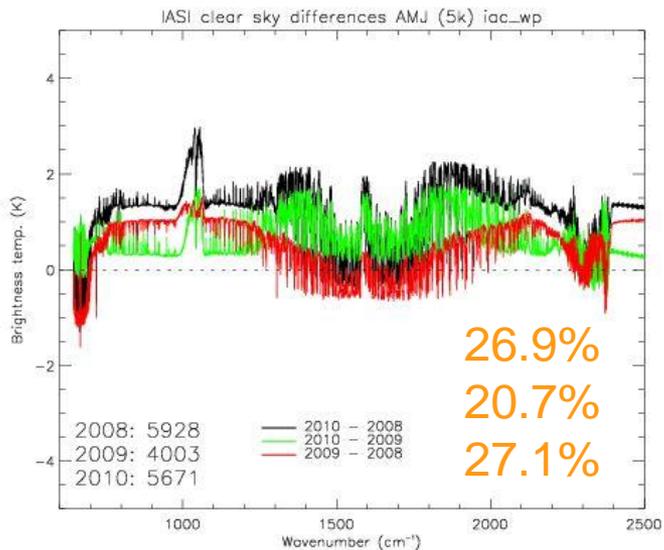
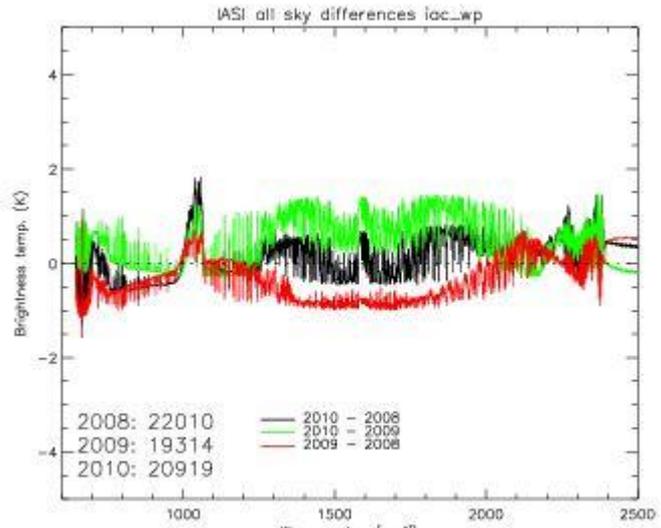
Step change: 1998: SSU
replaced by AMSU-A



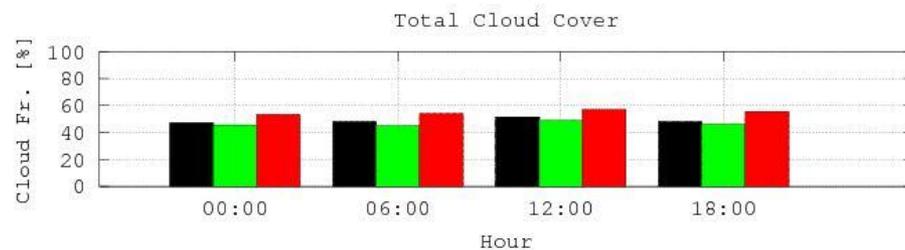
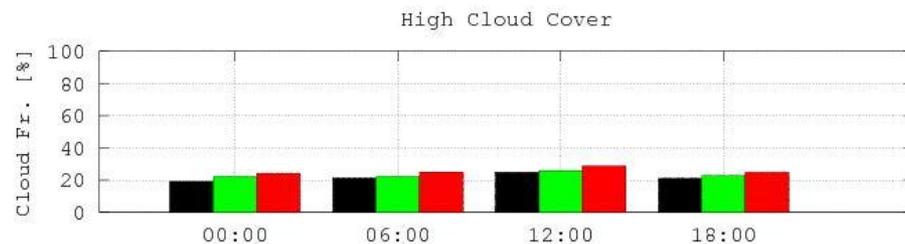
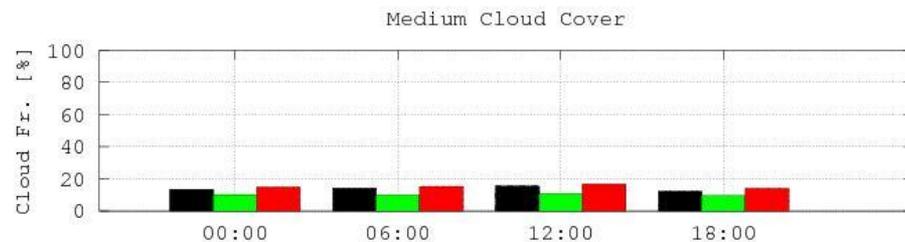
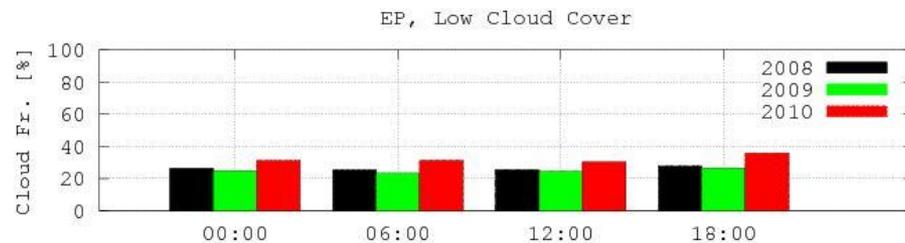
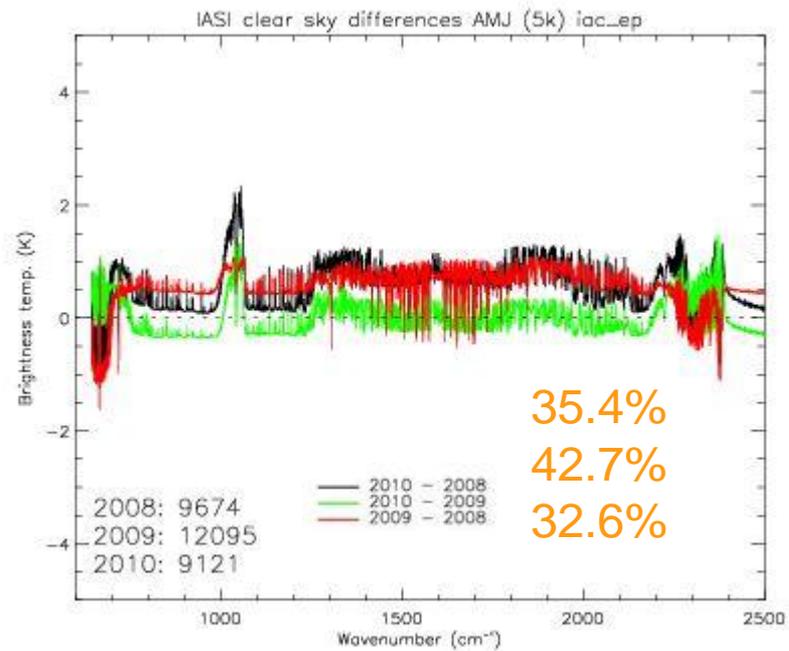
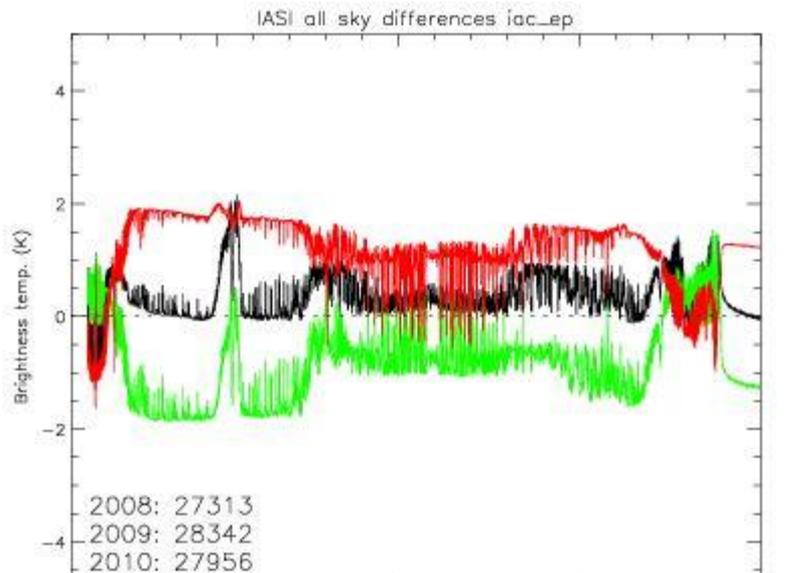
IASI variability AMJ 2008/9/10

- Contrast IASI spectral variability with RFM/ERA simulated spectra
- Will be enhanced to compare “matched” IASI observations with 6-hourly ERA-I (and 3-hourly)
- Increased IASI data (entire years, 2008 -)

Observations vs modelled spectra



L:>800hPa, M:800-400hPa, H:<400hPa

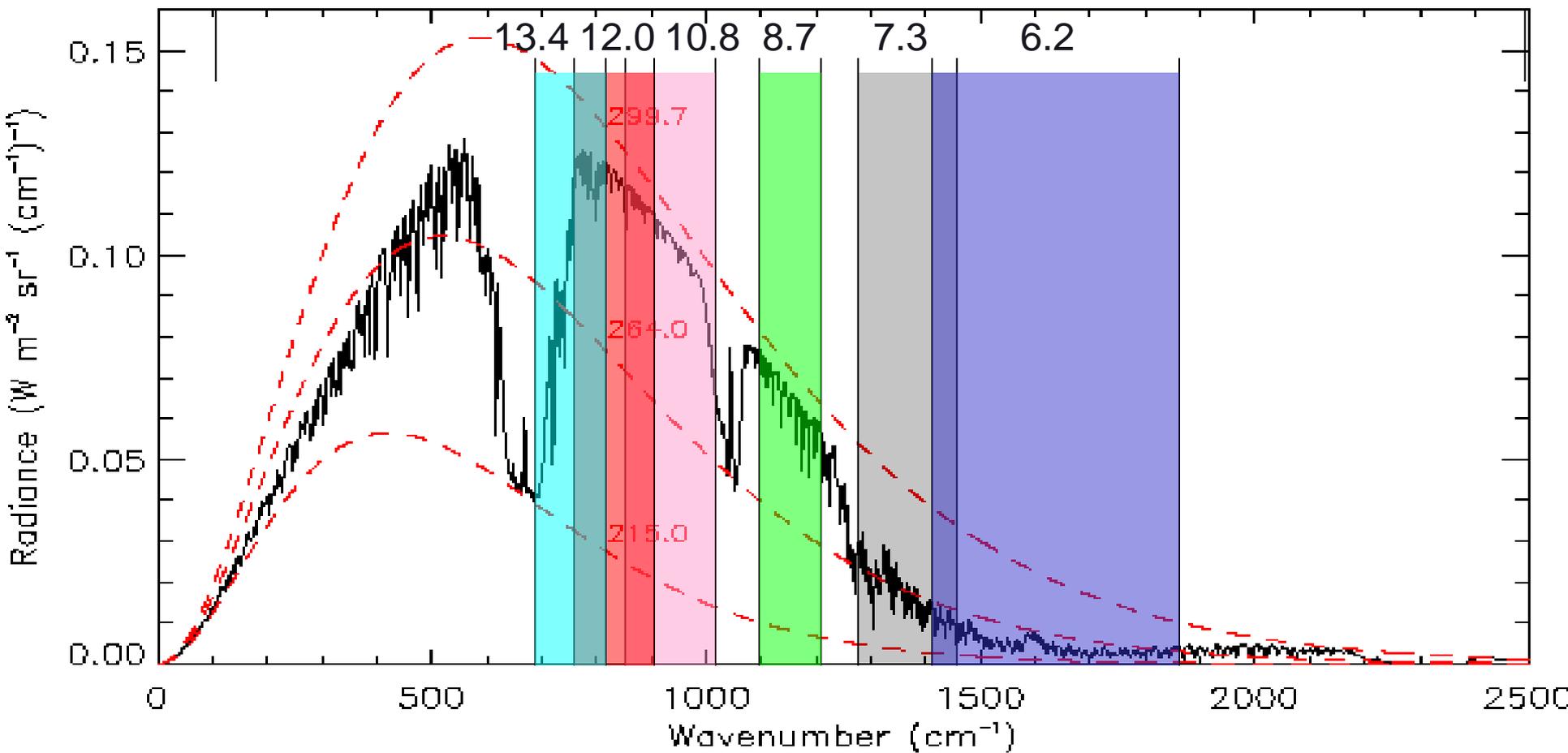


L:>800hPa, M:800-400hPa, H:<400hPa

All-sky sampling studies using SEVIRI

- Investigate impact of sampling strategies using narrow-band spectral channels
- What is the effect of increased spectral resolution on previous results? (e.g. Doelling, Kirk-Davidoff)
- What is seen at different wavelengths?
- What degree of averaging is required to meet desired accuracy (i.e. do we need all wavelengths – e.g. different requirements may have different needs)?

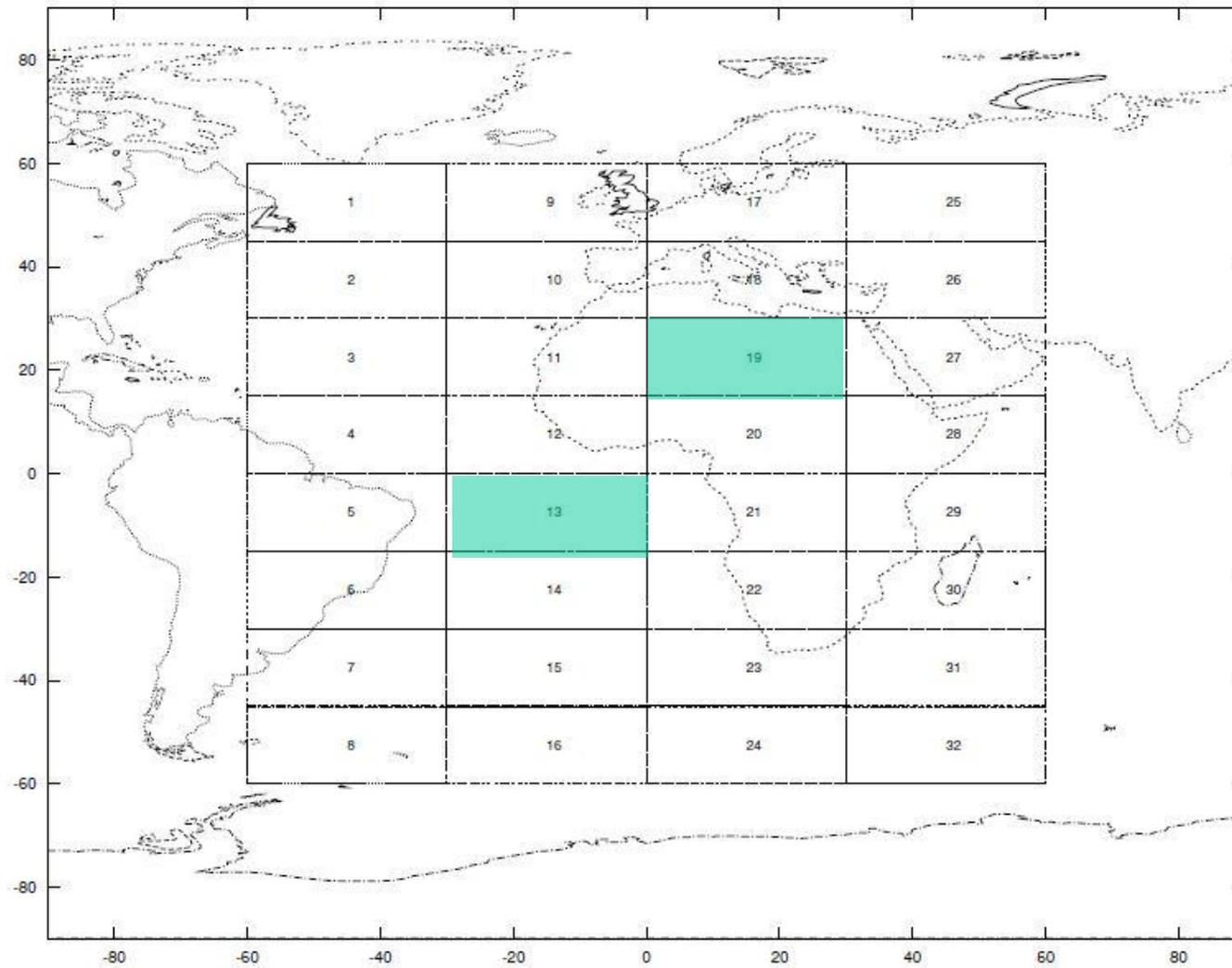
SEVIRI narrow-band channels



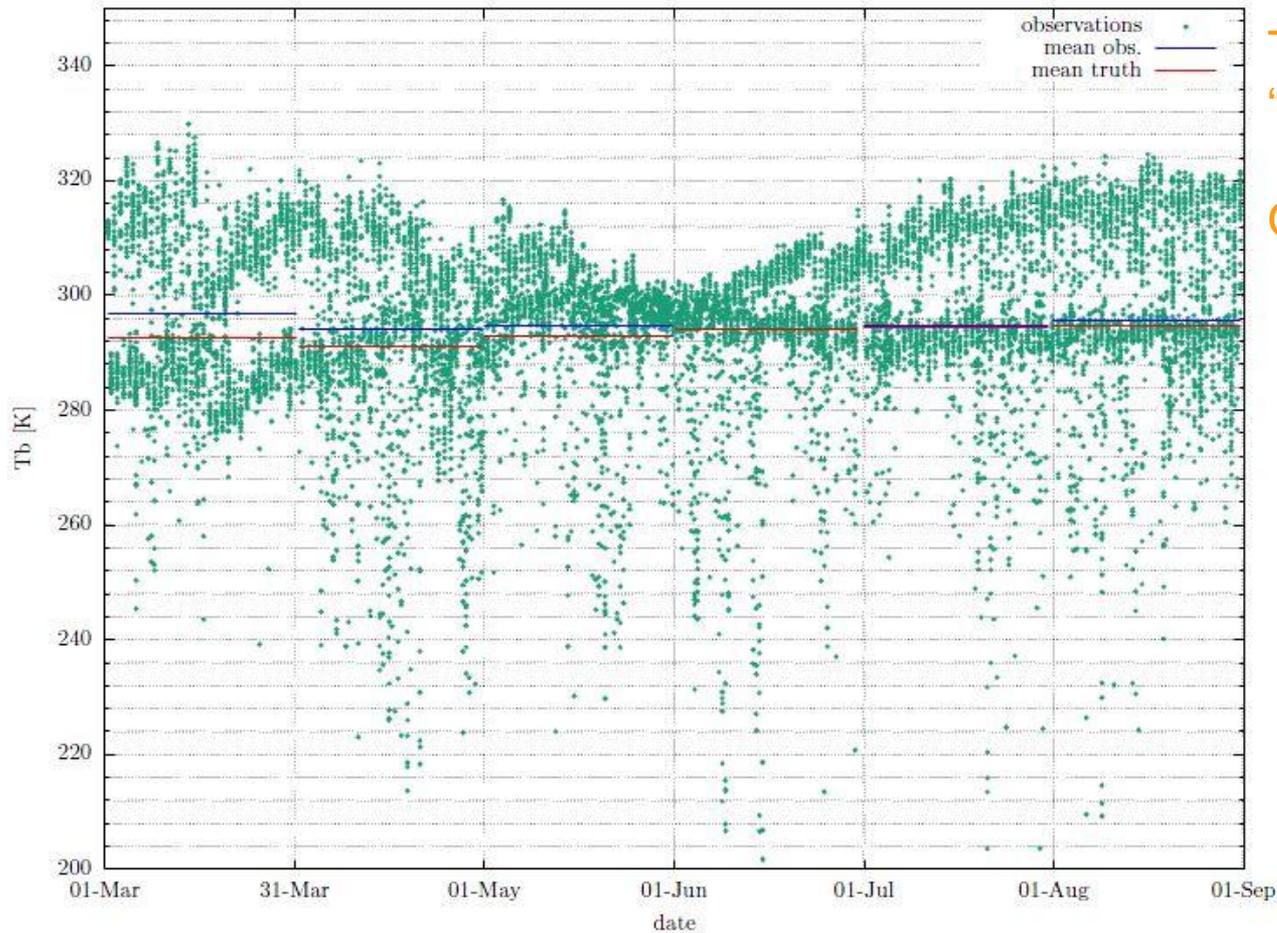
Sampling strategy

- SEVIRI (METEOSAT-9) is used as “truth”
- virtual orbiter(s) are flown over the “true” field (true 90° polar orbits) -> “observations”
 - Orbital parameters from D. Doelling
- the 15min SEVIRI observations are averaged over 15° lat x 30° lon boxes
- the mean of obs over the box is compared to the “true” mean field (sampling error)

Sampling



Sampling SEVIRI 10.8 μ m (1 Satellite 0°) Saharan Desert / North Africa

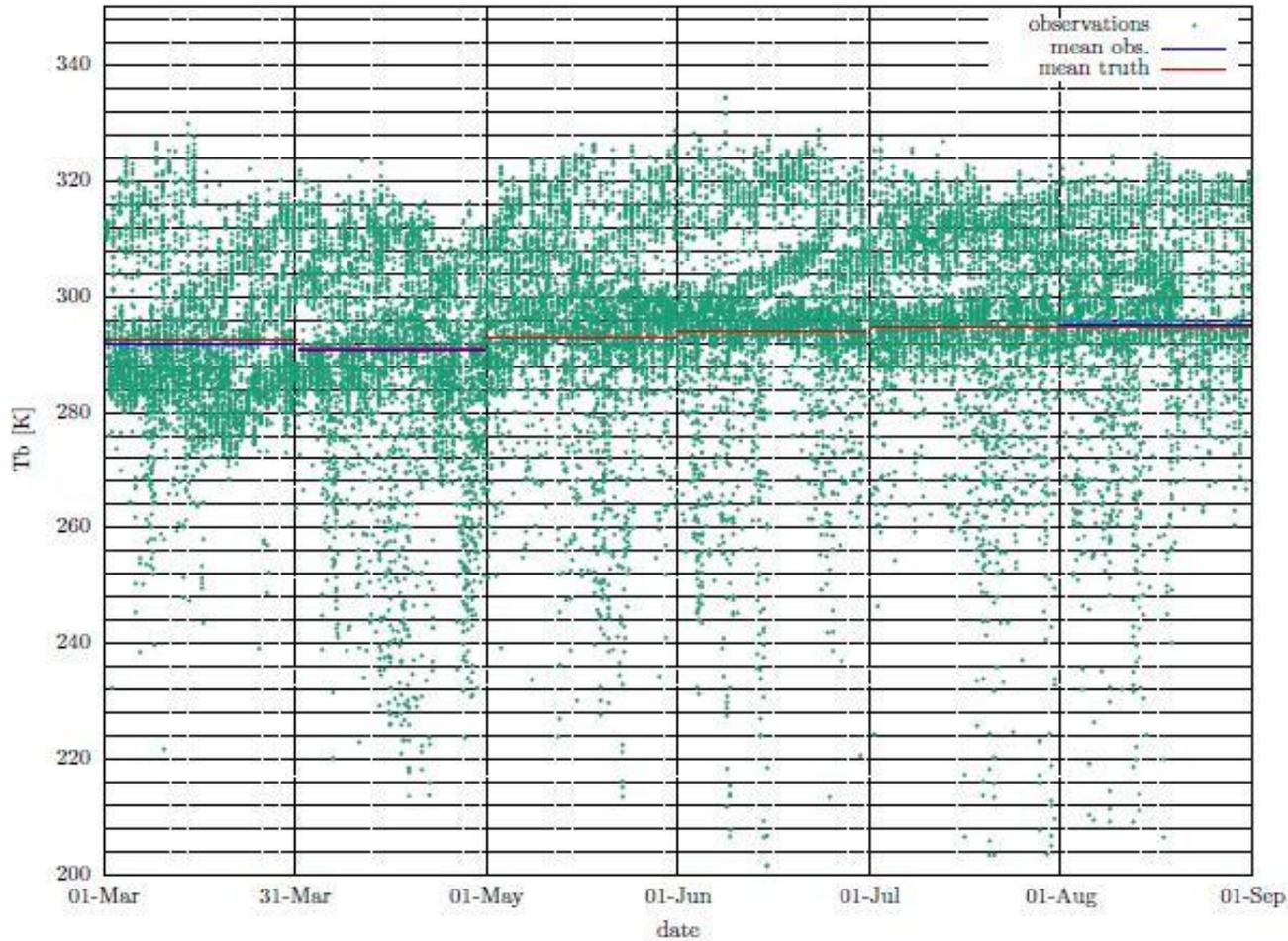


Truth: 294.70K

“Observations”: 295.48K

Obs – Truth: 0.78K

Sampling SEVIRI 10.8 μ m (2 Satellites 0°,90°) Saharan Desert / North Africa

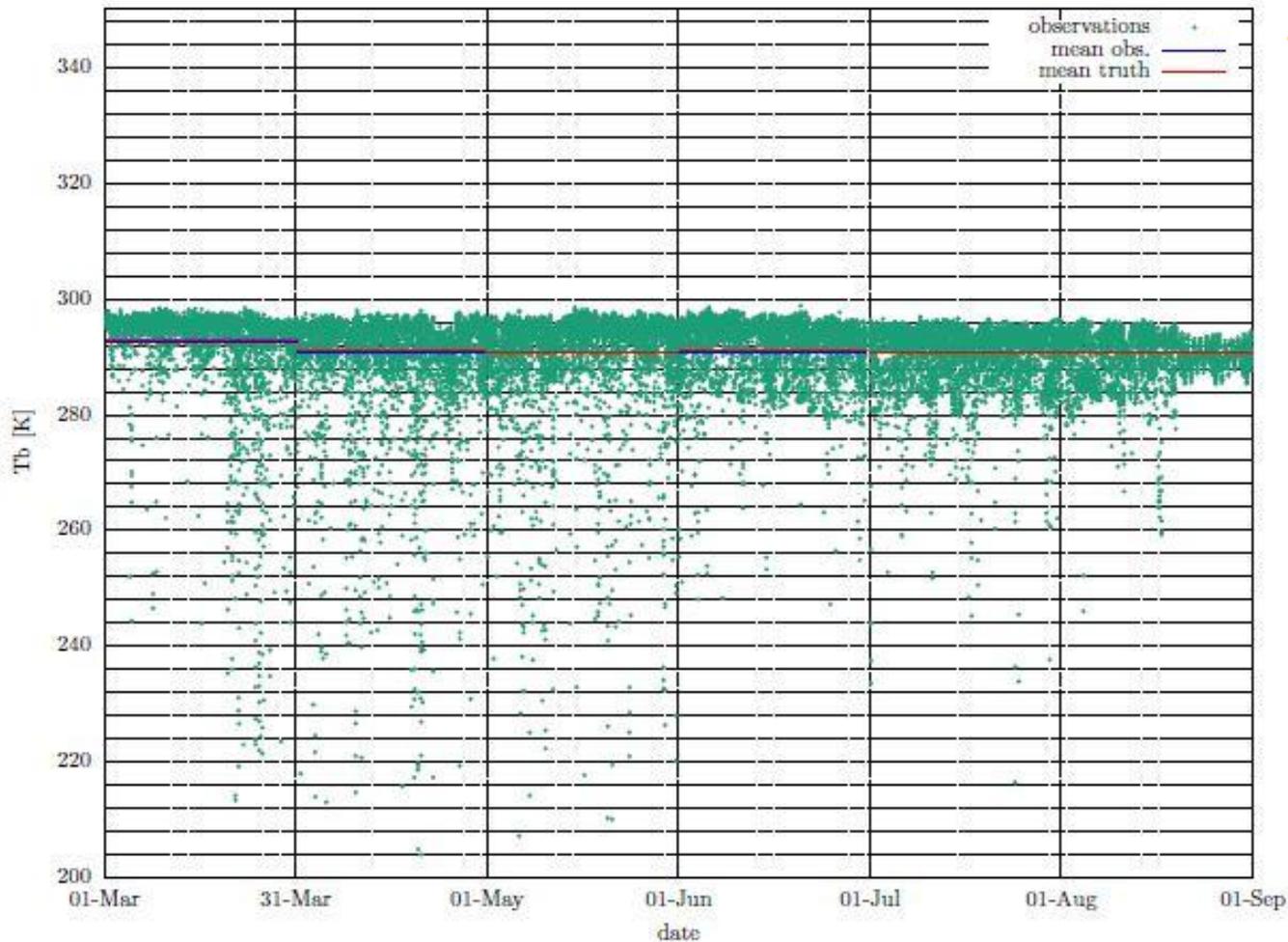


Truth: 294.70K

“Observations”: 295.01K

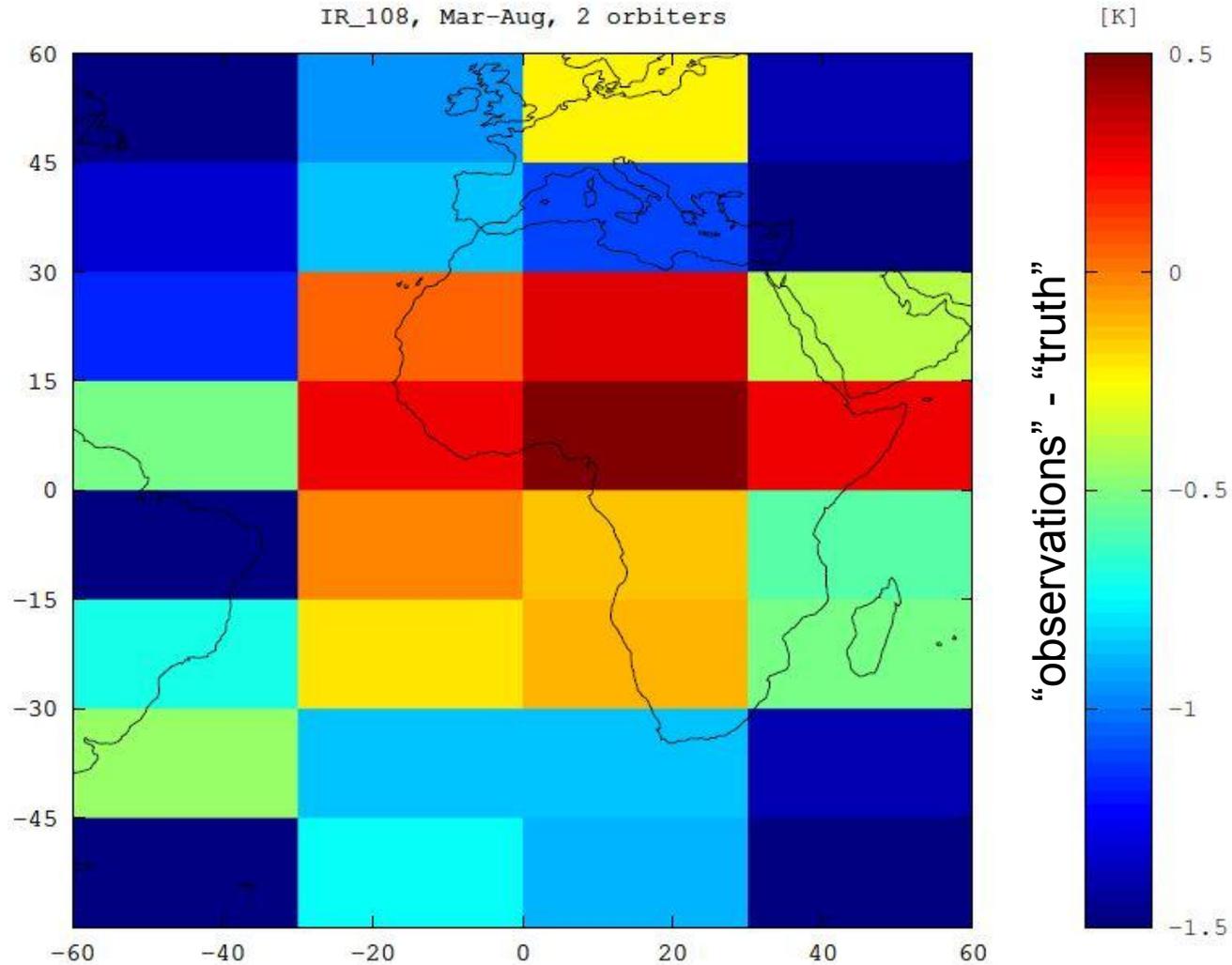
Obs – Truth: 0.31K

Sampling SEVIRI 10.8 μ m (2 Satellites 0°,90°) Atlantic Ocean

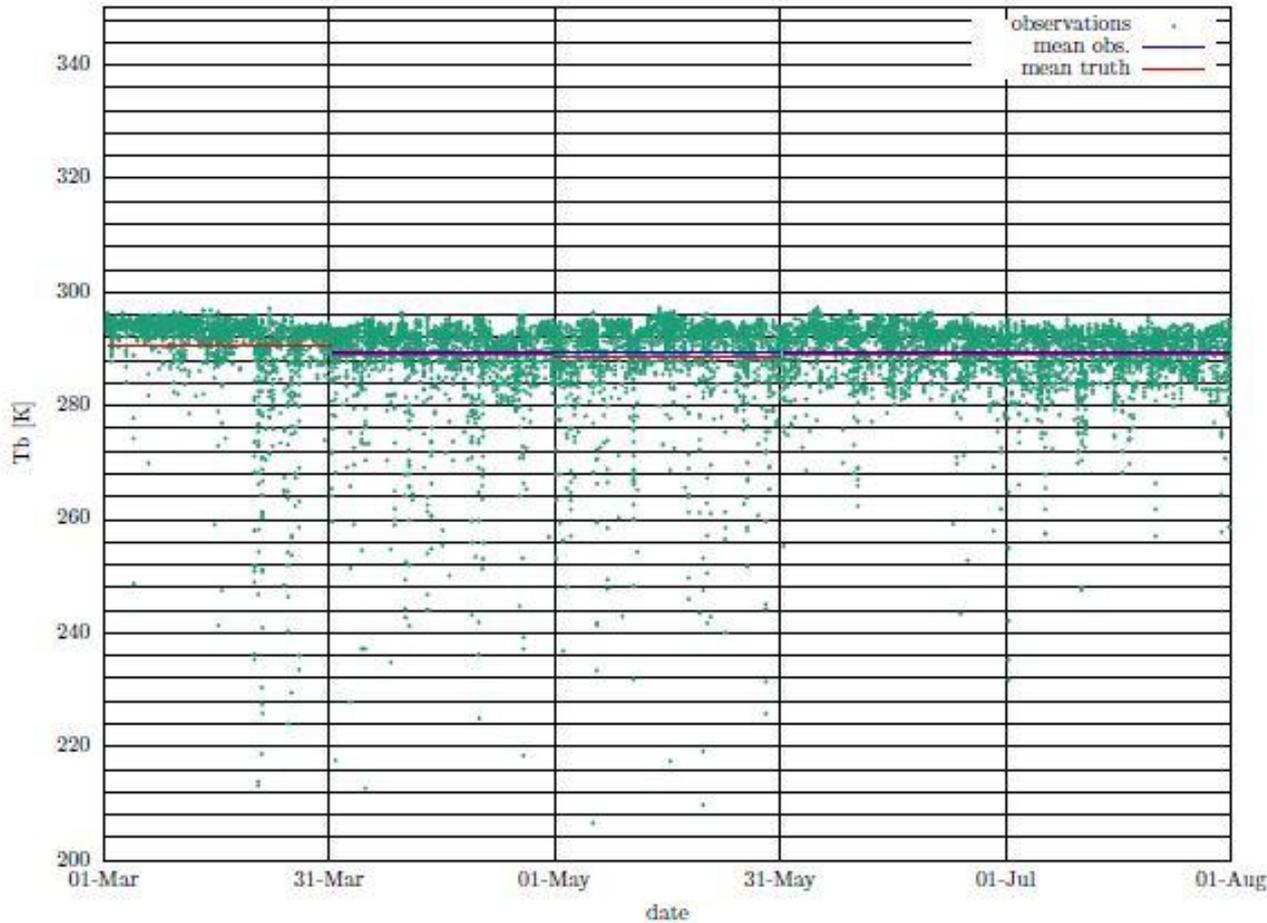


Truth: 290.63K
"Observations": 290.60K
Obs – Truth: -0.03K

Sampling – regional variation



Sampling SEVIRI 12 μ m (2 Satellites 0°,90°) Atlantic Ocean



Truth: 288.88K
"Observations": 288.80K

Obs – Truth: 0.08K

Summary

- Investigating the regional variability in the spectrally resolved OLR from direct observations
- Assessing the ability of ERA-I with RFM to capture regional variability compared with the direct observations
- Sampling studies using geostationary data as “truth”

Future developments

- Scaled-back CLARREO mission impacts funding streams / research focus in the UK (statement)
- Spectral variability – full multi-year IASI comparisons
 - Compare with IRIS, IMG, TES, AIRS
- Simulated OLR using ERA-I
 - Regional “matched” (EOF analysis)
 - Extended to full years
 - Simulation of cloud fields
- Potential UK Met Office collaboration – use of COSP