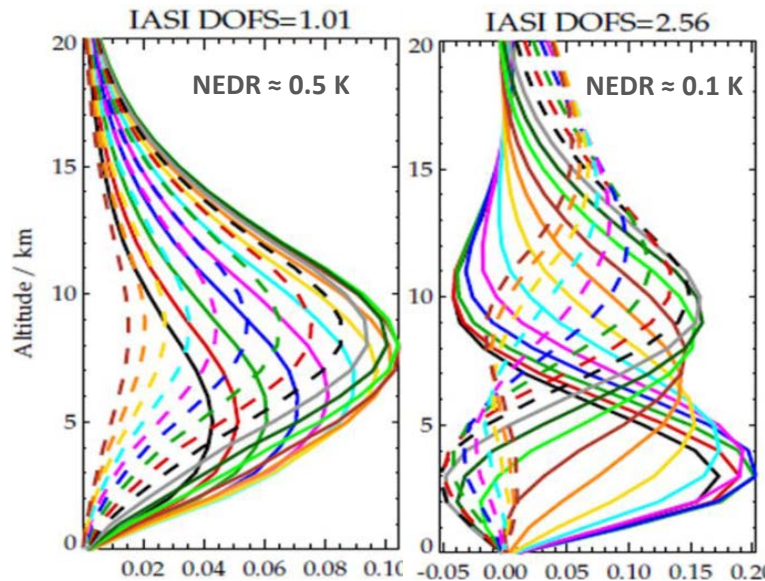


Methane Retrievals in the Thermal and Short-Wave Infrared from IASI

**Diane Knappett, Richard Siddans, Brian Kerridge,
Alison Waterfall and Jane Hurley**

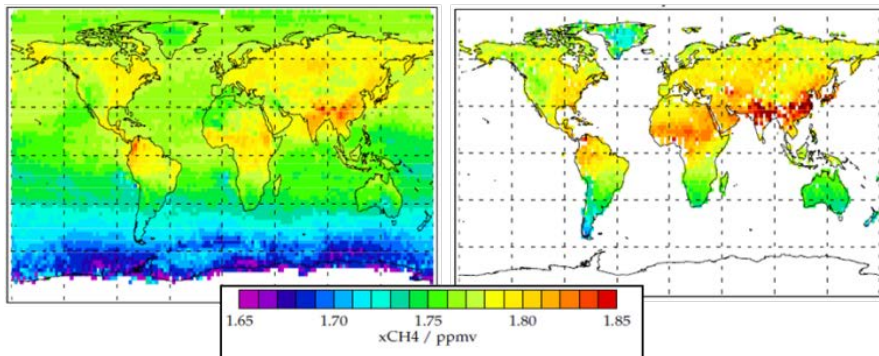
Rutherford Appleton Laboratory

CH₄ Retrievals in the TIR



IASI

GOSAT



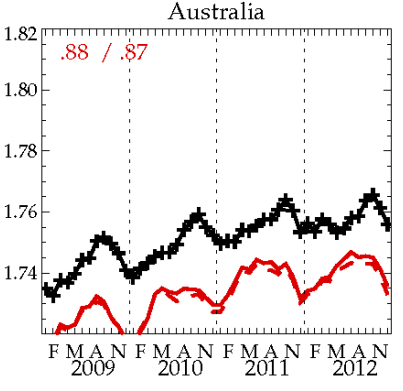
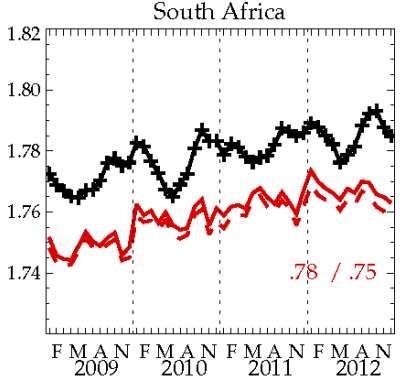
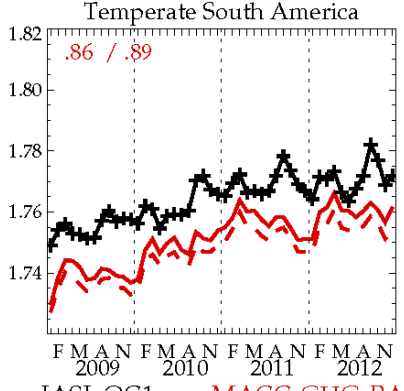
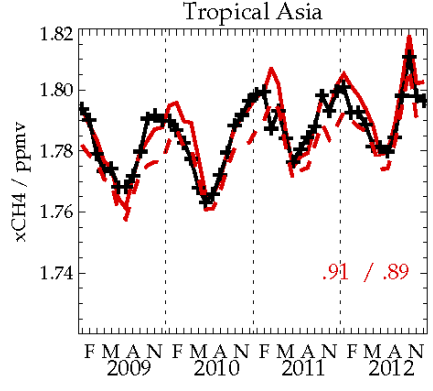
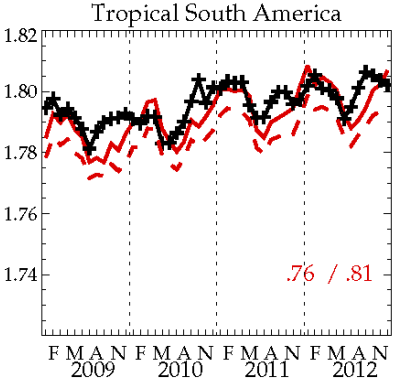
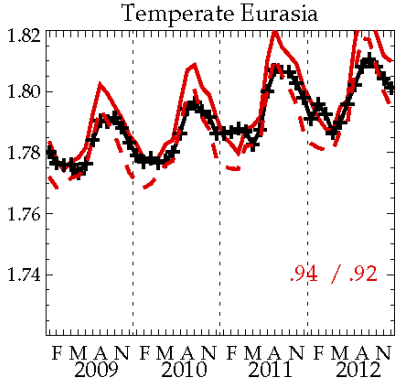
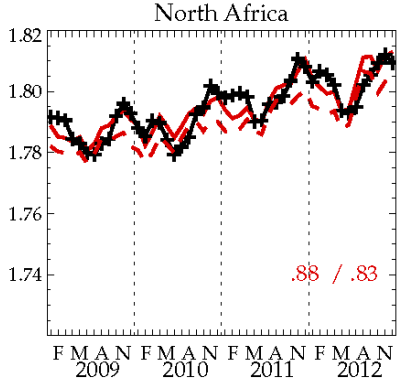
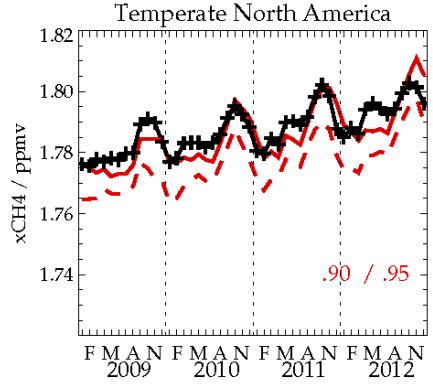
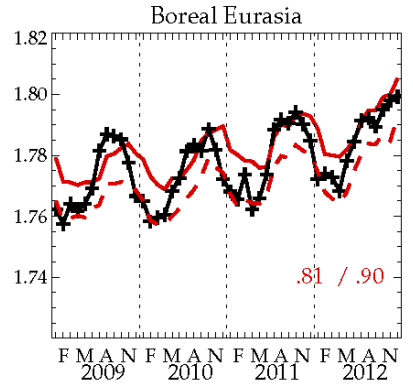
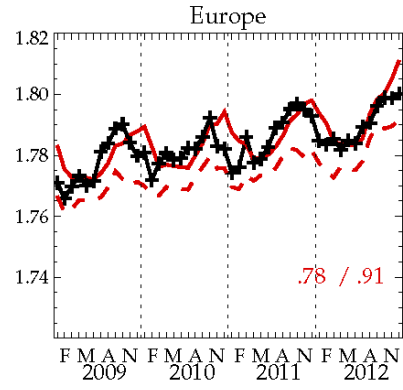
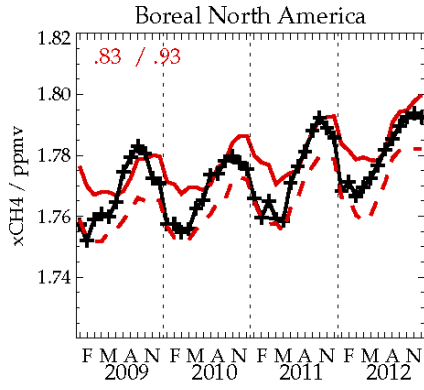
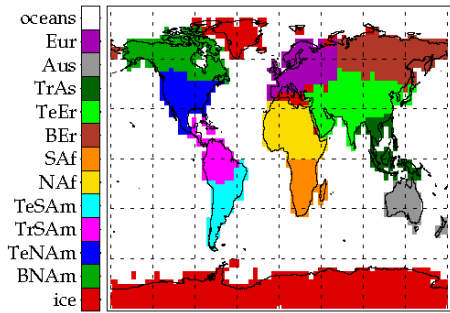
RAL-RSG IASI CH₄ retrieval

- Optimal estimation retrieval scheme which fits the TIR spectral range **1232-1290cm⁻¹**.
- Jointly fits **CH₄** with **H₂O**, **HDO**, **surface temperature**, **cloud fraction**, **cloud altitude** and **scale factors for two systematic fit residuals**.
- Retrieval of **effective cloud parameters exploits information provided by N₂O absorption** within the fit window.
- IASI measured spectra are fitted to a BT RMS of 0.1K; at this precision, the scheme delivers **XCH₄** to a **precision of 20-40 ppbv**.

Recent advances

- Scheme has been extensively compared to Leicester GOSAT retrievals, models (GEOSCHEM, TOMCAT and ECMWF) and TCCON ground-based observations
- Processed Metop-A from 2007-2013 (2014 on the way)
- Scheme adapted to Metop-B (giving virtually identical performance)

TIR Retrieval Comparisons with MACC



IASI_QC1 MACC-GHG-RA

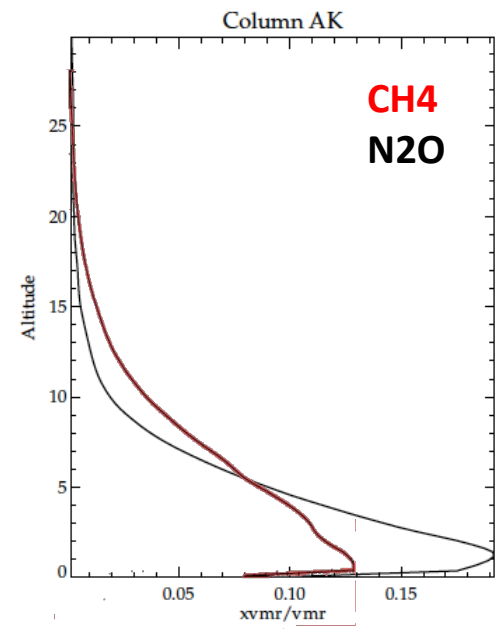
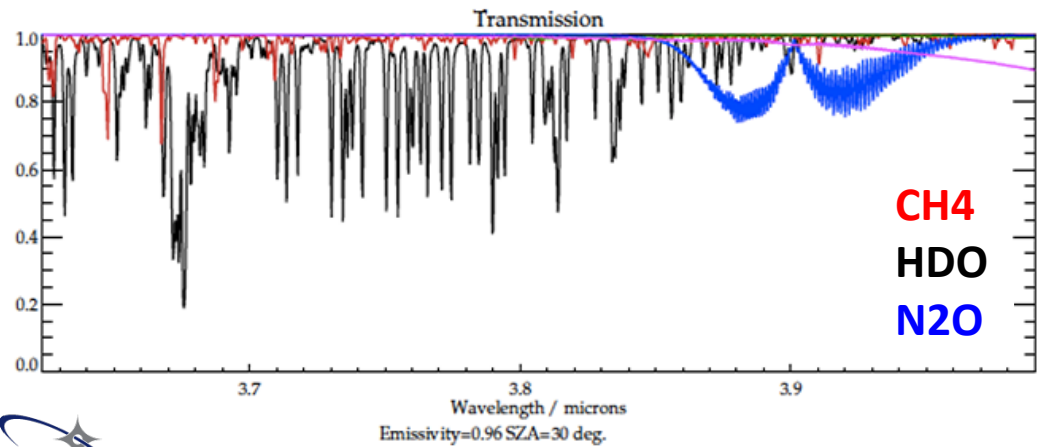
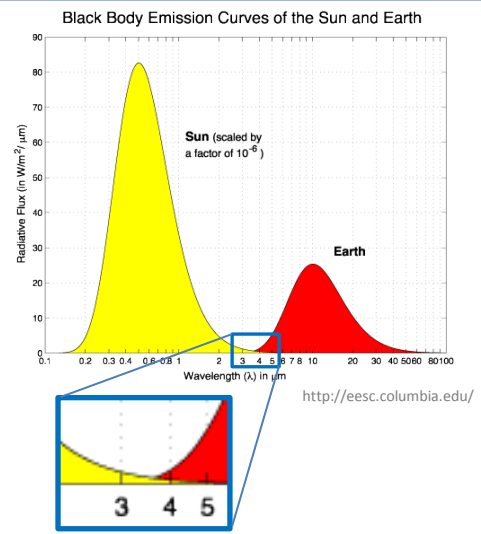
CH₄ Retrievals at 3.7 μm

Background

- IASI measures methane lines in the **3.7-3.9 μm** (2500-2700 cm⁻¹) SWIR spectral range, where there is a significant solar component.
- AK peaks sharply near the surface at ~3.7 μm
 - Solar component provides retrieval **sensitivity to the boundary layer** where trace gas emissions peak
- Combination of SWIR and TIR** retrievals has the potential to provide both height resolved information and surface sensitivity.

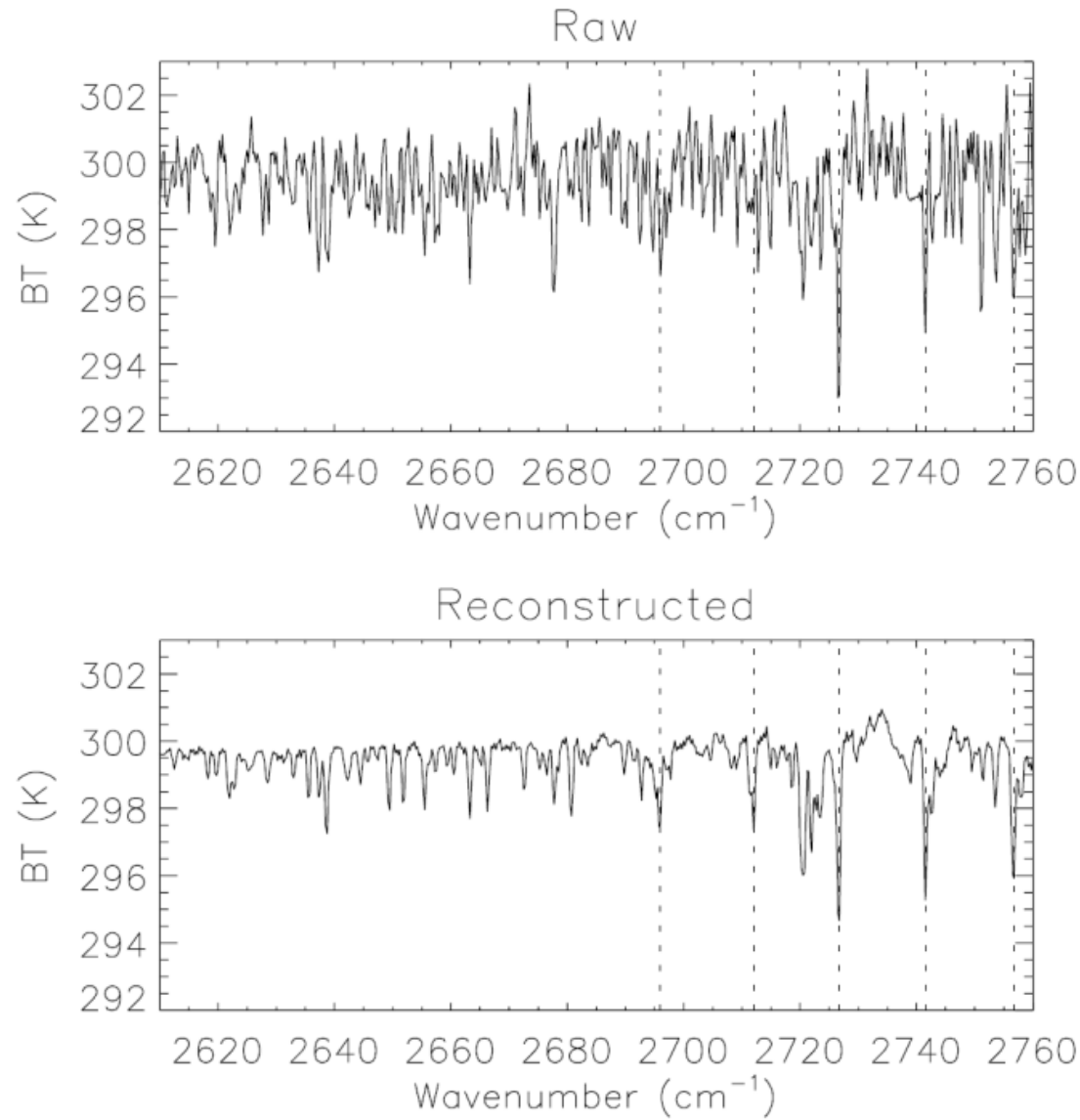
Challenges

- Complexity of modelling both solar and thermal terms
- Relatively **high IASI noise** in this spectral region
- RTTOV solar spectrum **missing significant solar lines** – replaced with ACE

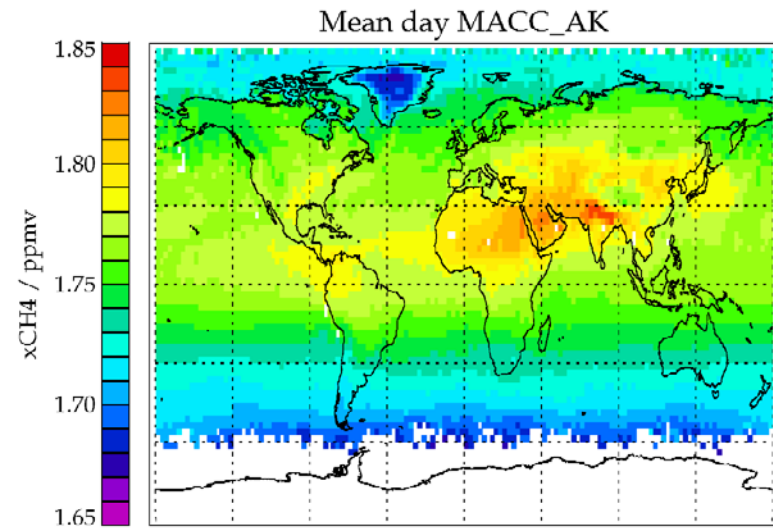
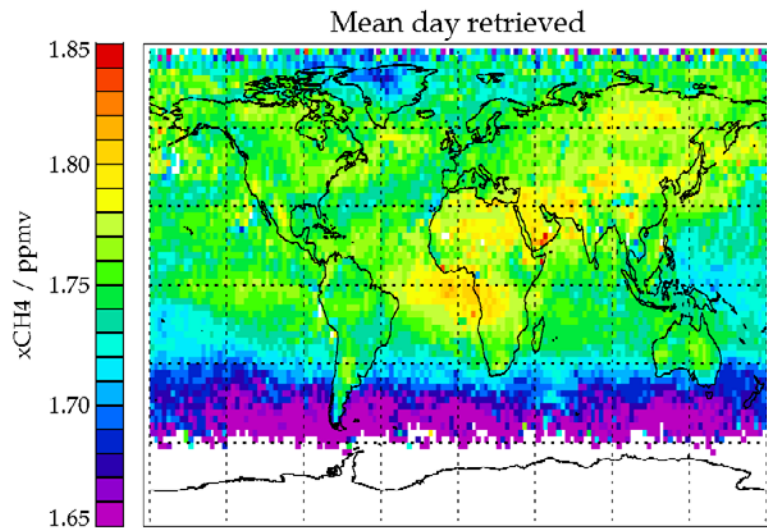
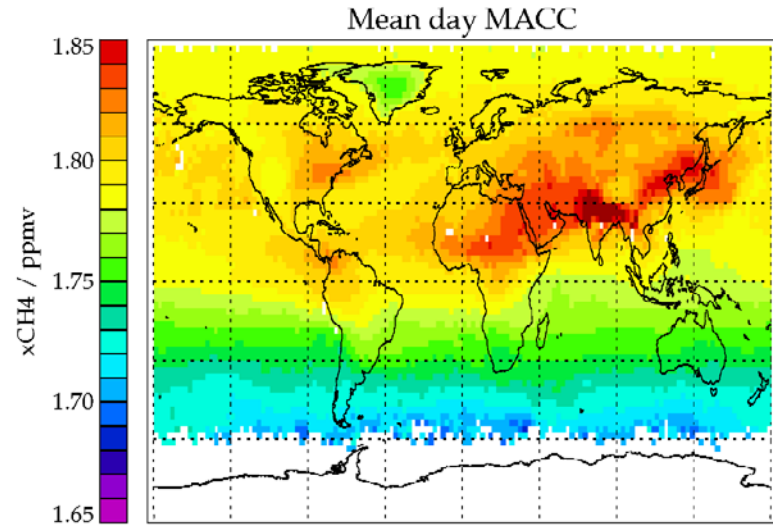
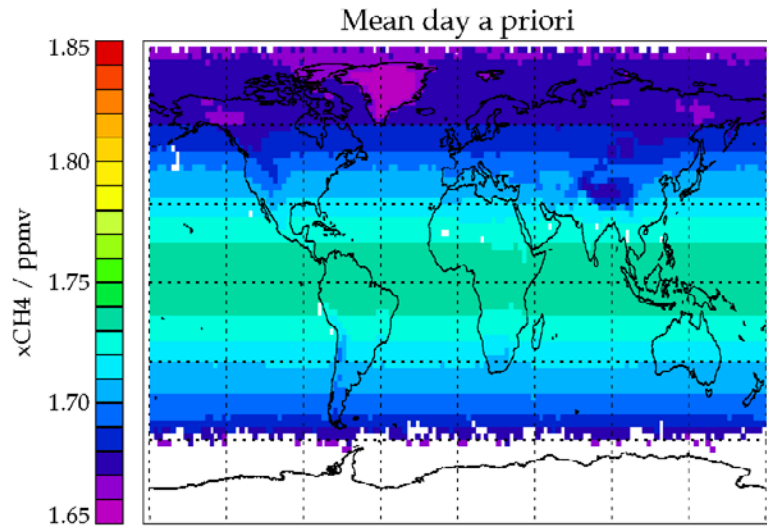


Noise Reduction using Principal Components

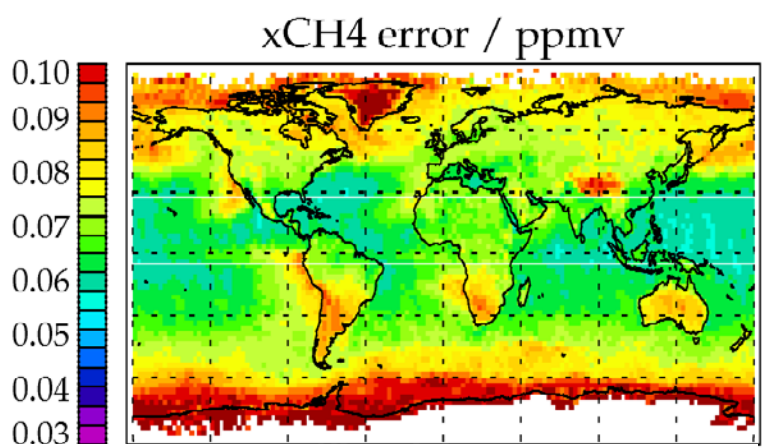
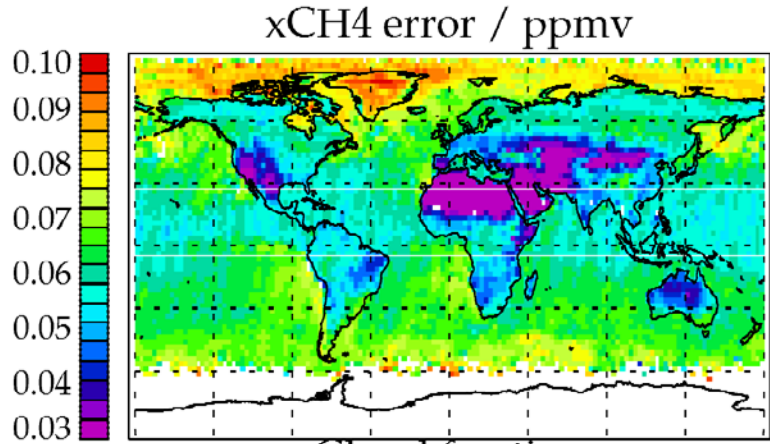
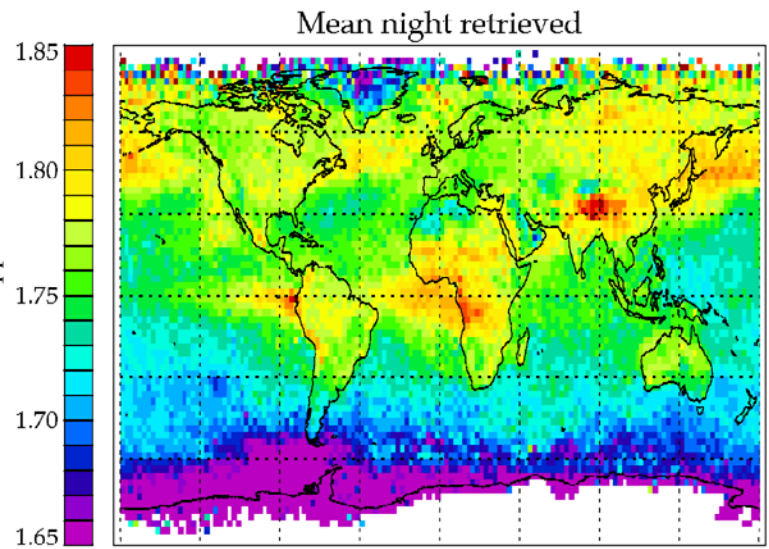
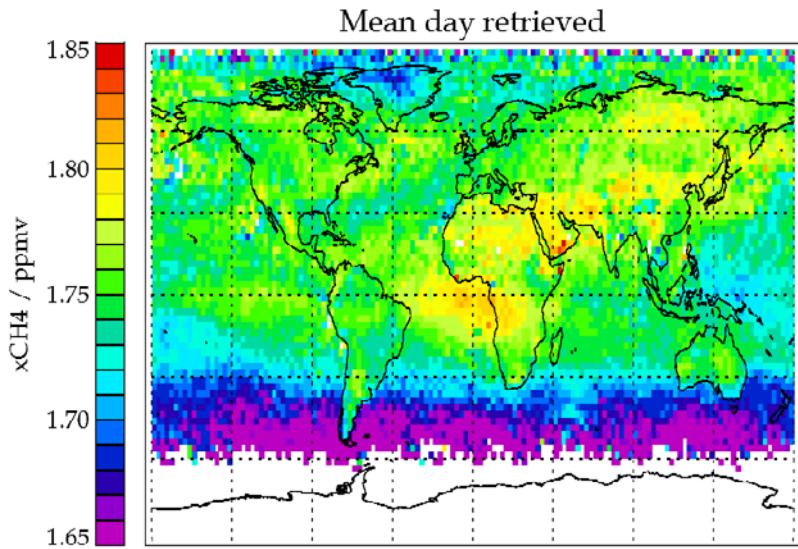
Example of the noise reduction achieved by using PC reconstructed spectra (Atkinson et al., 2010).



SWIR XCH₄ Retrieval

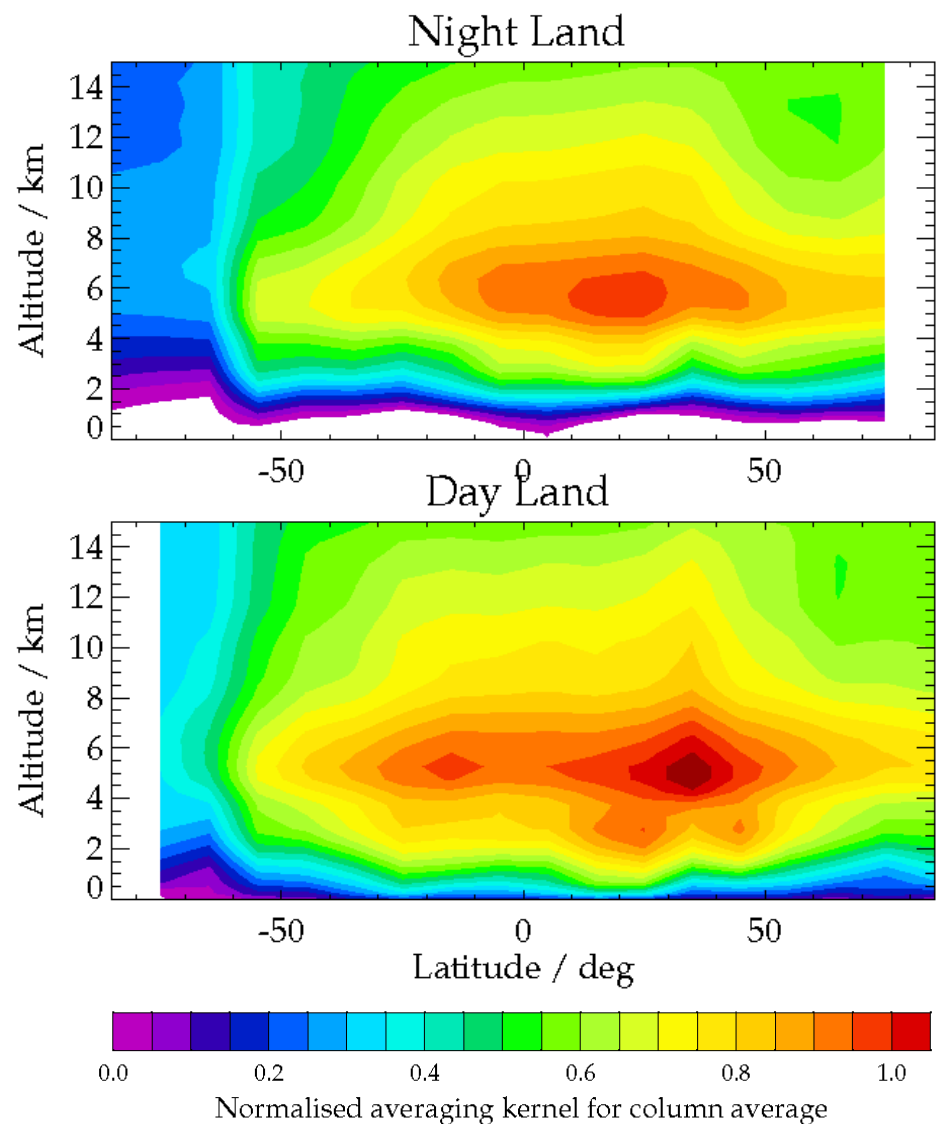


SWIR XCH₄ Day vs Night



SWIR Averaging Kernels

Day-time SWIR averaging kernel shows that the solar component is delivering retrieval sensitivity that extends down to the surface.



Comparing SWIR XCH₄ Retrievals with MACC

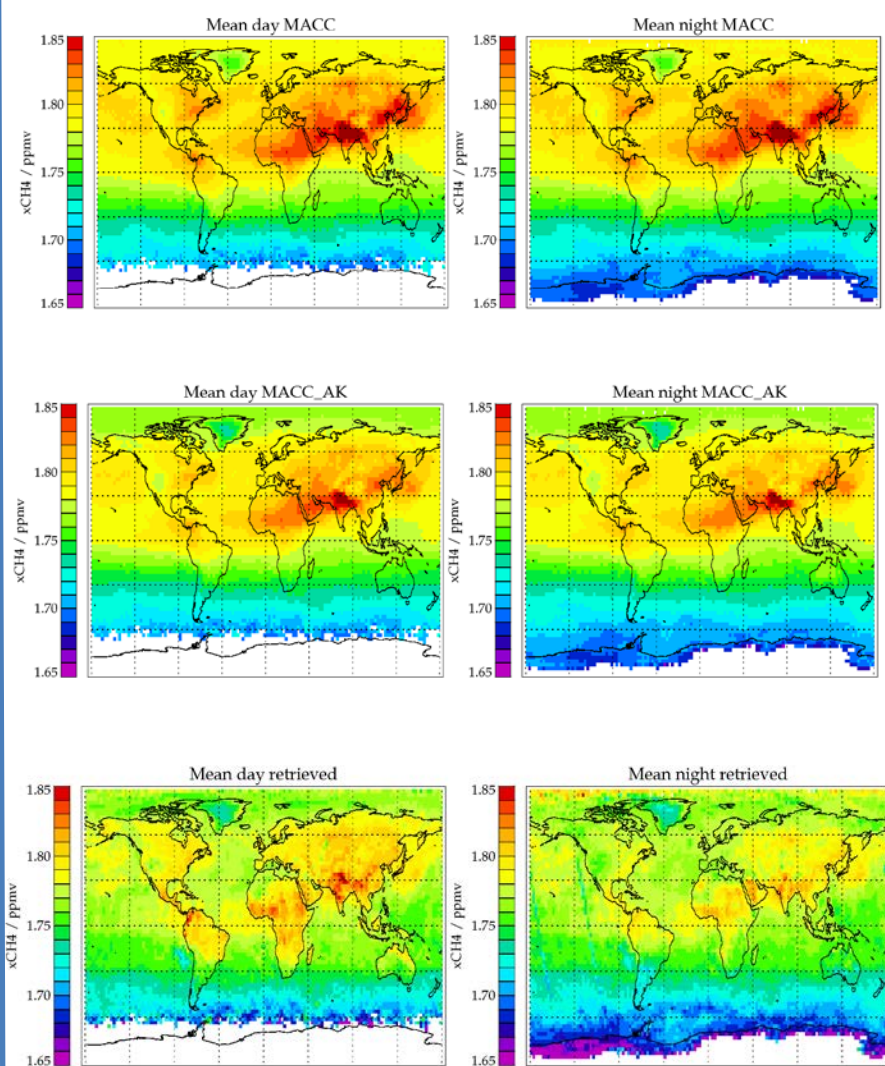
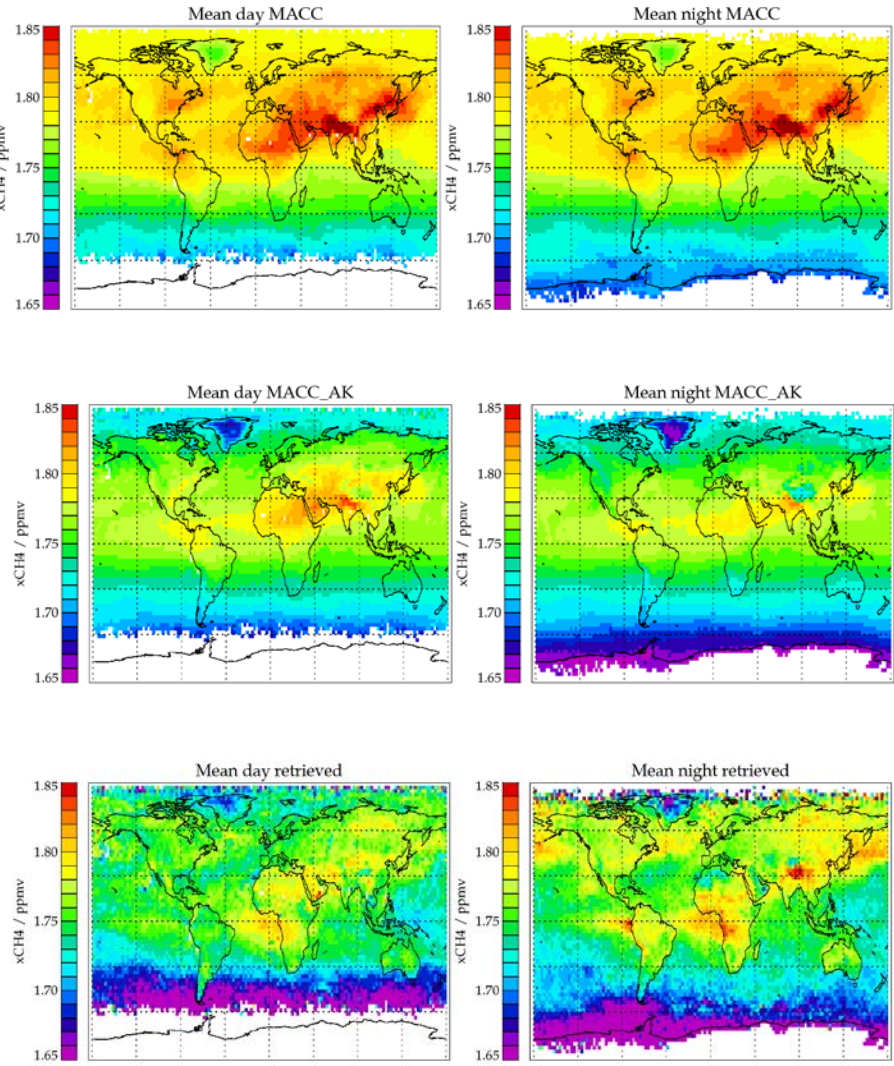
SWIR

TIR

MACC

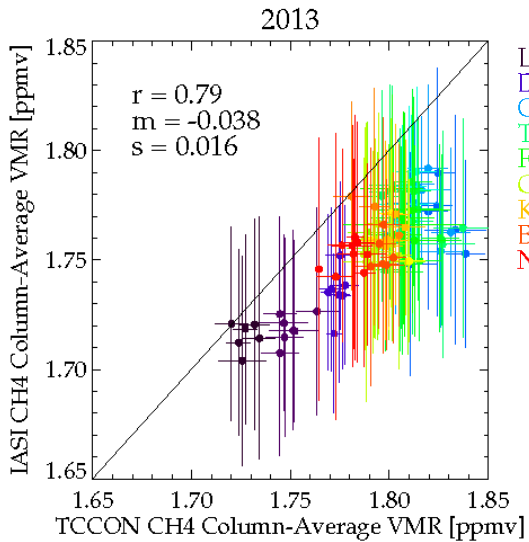
MACC (AK applied)

RAL-RSG



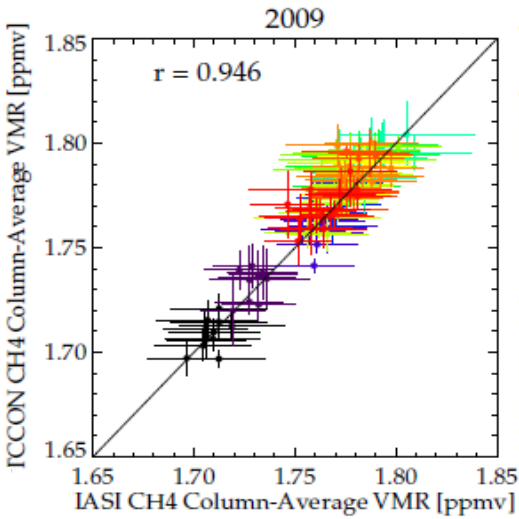
Retrieval validation with TCCON

SWIR (day-time)



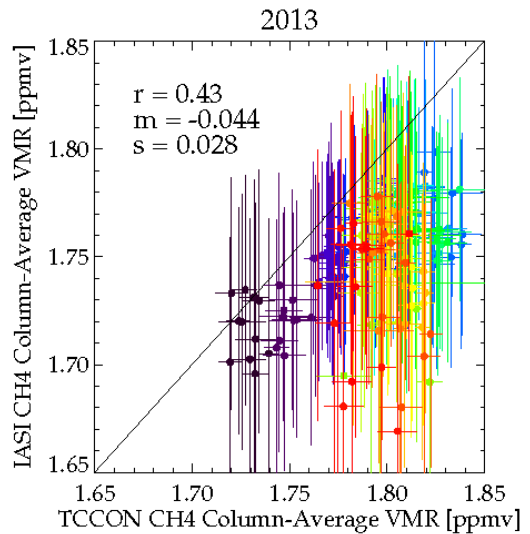
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- Darwin
- Caltech
- Tsukuba 125HR
- Four Corners
- Garmisch
- Karlsruhe
- Bialystok
- Ny Alesund
- Wollongong
- Saga
- JPL 2011
- Lamont
- Park Falls
- Orleans
- Bremen
- Sodankyla
- Eureka

TIR (day and night)



- Lauder 120HR
- Lauder 125HR
- Wollongong
- Reunion Island
- Darwin
- Ascension Island
- Zana
- Saga
- Caltech
- JPL 2011
- Tsukuba 120HR
- Tsukuba 125HR
- Lamont
- Four Corners
- Park Falls
- Garmisch
- Orleans
- Karlsruhe
- Bremen
- Bialystok
- Sodankyla
- Ny Alesund
- Eureka

SWIR (night-time)



- Lauder 125HR
- Reunion Island
- Ascension Island
- Saga
- JPL 2011
- Lamont
- Park Falls
- Orleans
- Bremen
- Sodankyla
- Eureka
- Wollongong
- Darwin
- Zana
- Caltech
- Tsukuba 125HR
- Four Corners
- Garmisch
- Karlsruhe
- Bialystok
- Ny Alesund

TIR CH₄ retrievals

- XCH₄ with precision of 20-40 ppbv achieved
- Scheme has been extensively compared with GOSAT and model data (GEOSCHEM, MACC) and validated against TCCON network.
- Paper currently in preparation... publication imminent!

SWIR CH₄ retrievals

- Current results look extremely promising!
- Need to optimise the retrieval by...
 - improving spectral sampling and handling of systematic fit residuals
 - improving cloud modelling/filtering

Combination of TIR and SWIR retrievals

Thank you for listening

Any questions?

