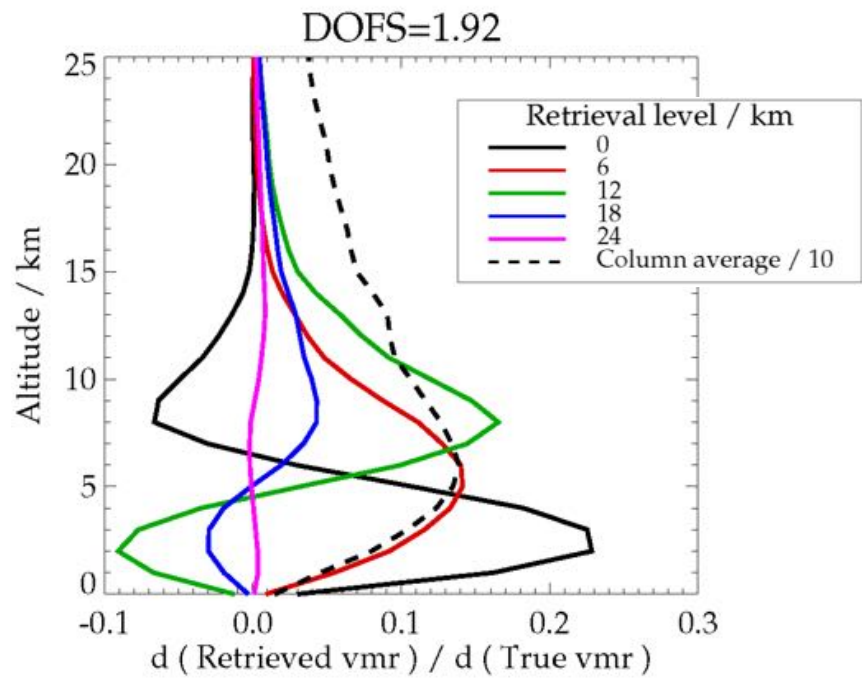


# Methane Retrievals in the Thermal Infrared from IASI

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

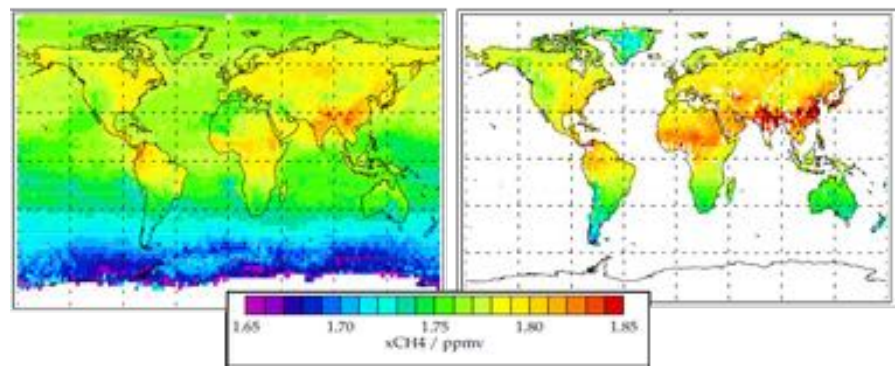
**STFC – Rutherford Appleton Laboratory**

# RAL IASI Methane Retrieval Scheme



IASI

GOSAT



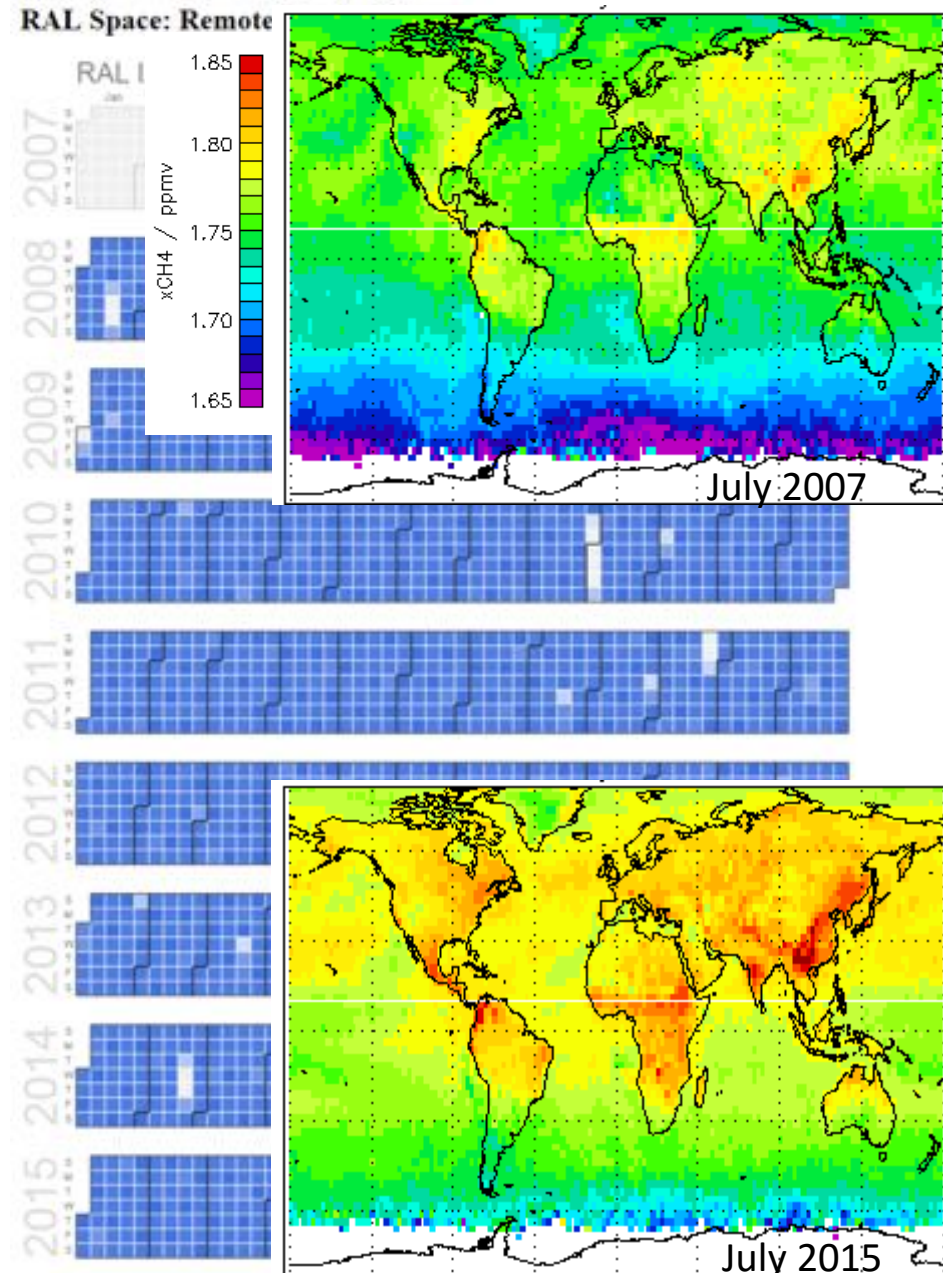
- Optimal estimation retrieval scheme
  - Simple a priori methane field
  - Temperature and humidity profiles from ECMWF reanalysis
  - Surface spectral emissivity from University of Wisconsin
- Fits the TIR spectral range 1232-1290cm<sup>-1</sup> (RMS of 0.1 K)
  - Scheme extracts two independent pieces of information on the methane profile
- Column-averaged methane of precision 20-40 ppbv
- H<sub>2</sub>O, HDO, T<sub>surf</sub>, cloud fraction, cloud altitude & scale factors for two systematic fit residuals co-retrieved with methane
- Retrieval of effective cloud parameters achieved by fitting N<sub>2</sub>O, which has a well known distribution
  - Corrects for the effect of optically thin cloud not screened out by initial cloud filtering
- Scheme has been extensively compared to GOSAT, GEOSchem, TOMCAT, MACC and TCCON
- Paper in preparation for AMT (R.Siddans et al.)

# RAL IASI Global Methane Dataset

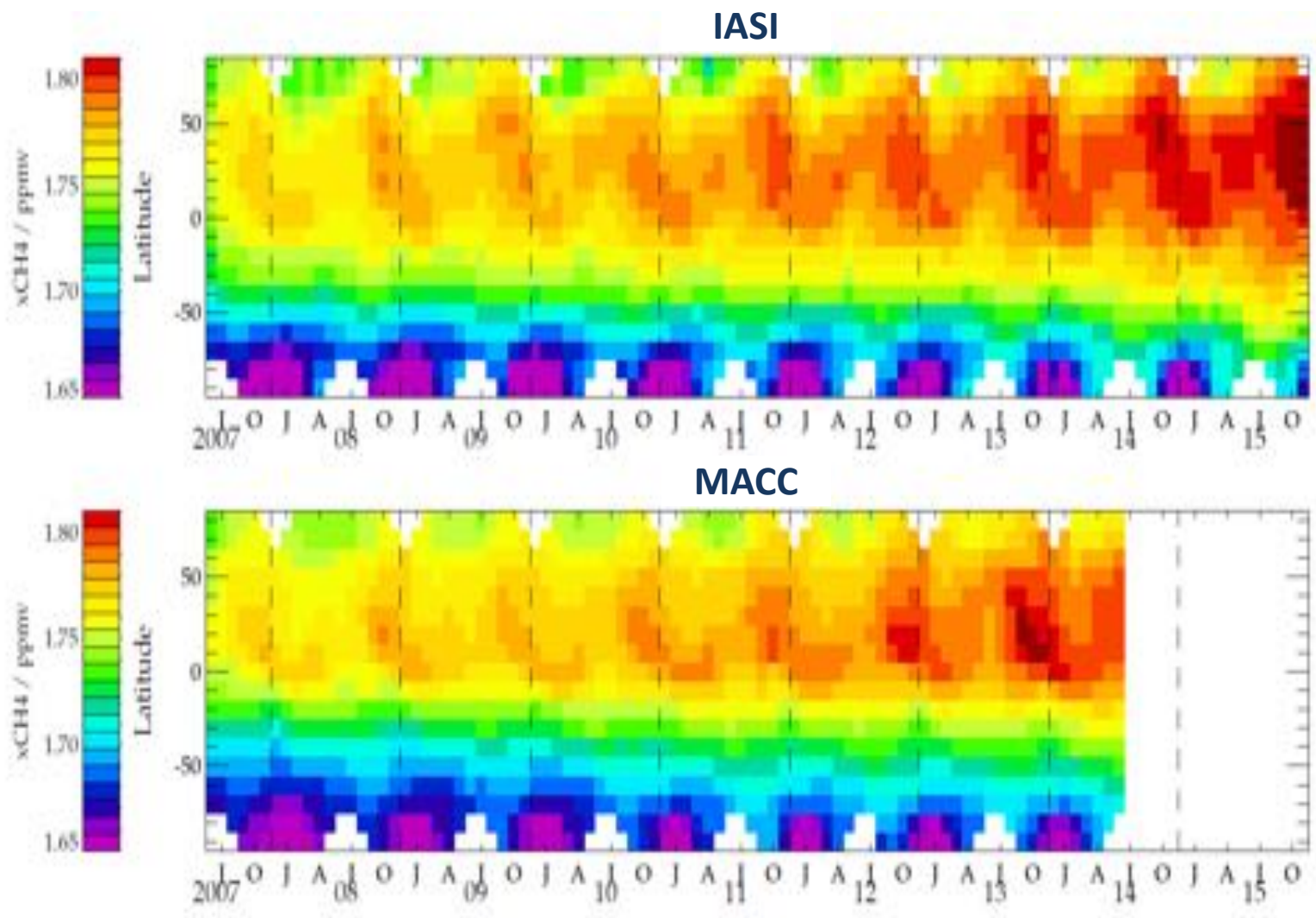
## Key features:

- IASI MetOp-A (05/2007–11/2015)
- Processed all available days
- Processed one in four IASI detectors (least cloudy only)
- Archived with CEDA and publically available:

<http://catalogue.ceda.ac.uk/uuid/510b22c6d12e4635b604c172b583167e>

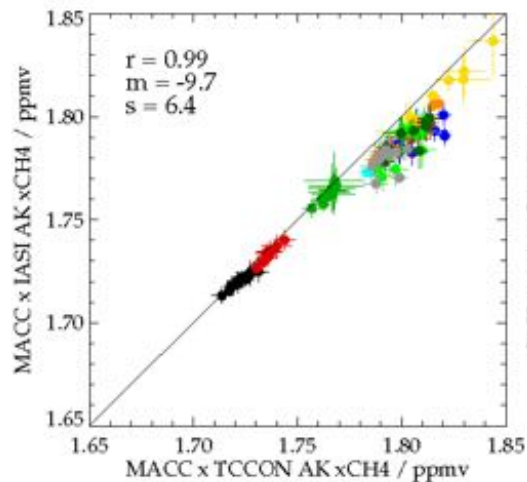


# IASI CH4 vs MACC-II GHG Inversion

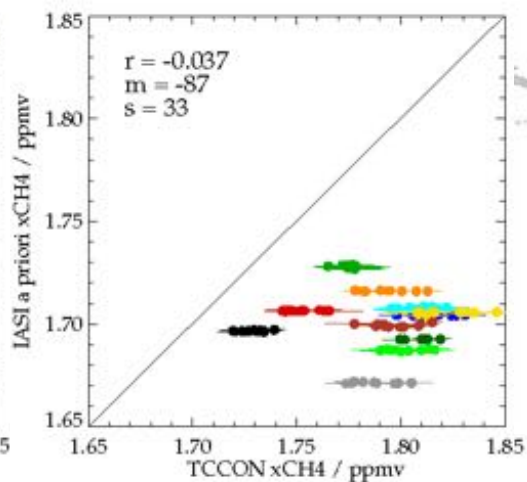


# TCCON Comparison (2013)

## MACC with AK's



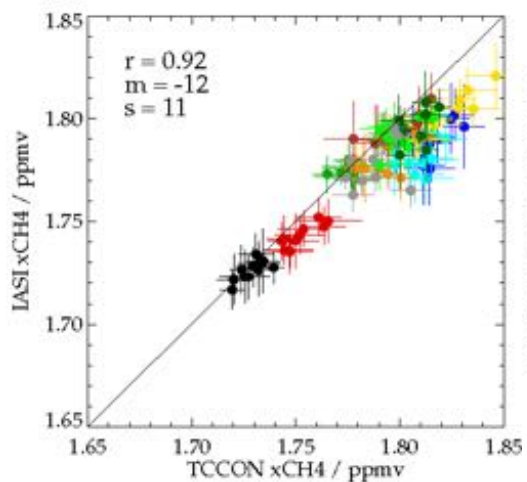
## IASI a priori



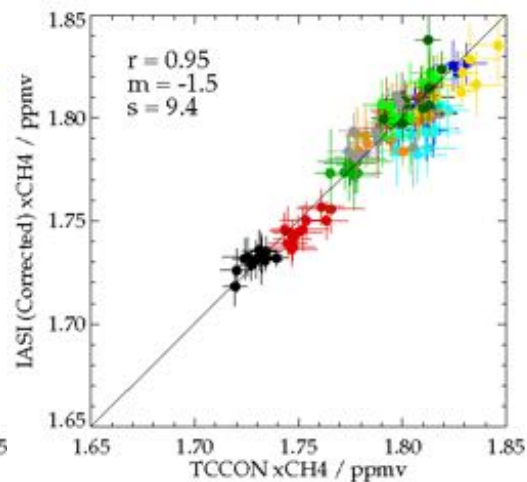
## TCCON Sites



## IASI



## IASI (corrected)



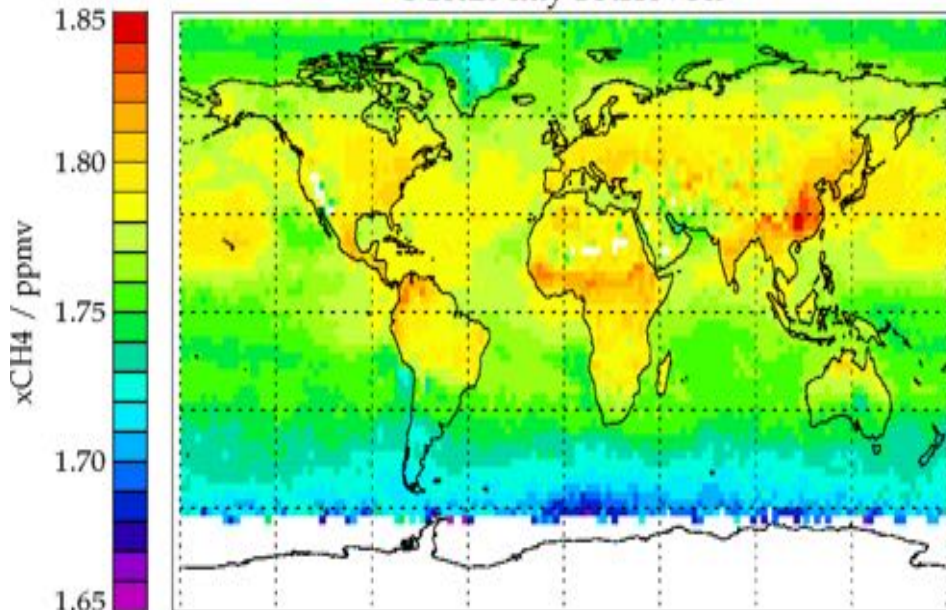
- Sodankyla, Ny Alesund
- Paris, Orleans
- Bialystok, Bremen, Karlsruhe, Garmisch
- Park Falls, Influx
- Izana
- Saga, Tsukuba, Rikubetsu
- Edwards, JPL, Caltech
- Lamont
- Ascension Island, Reunion Island, Darwin
- Wollongong
- Lauder

# IASI/MHS/AMSU T, q and Emissivity

- RAL has enhanced EUMETSAT's operational IASI OEM retrieval
  - Combines IASI with collocated microwave data from MHS and AMSU
  - Named the **Infrared Microwave Sounder (IMS)** retrieval
- IMS retrieved T, q and emissivity are being used as input to the IASI methane retrieval
- Eliminates errors encountered through use of interpolated ECMWF reanalyses (ERA-Interim) data and modelled surface spectral emissivity from the University of Wisconsin database.

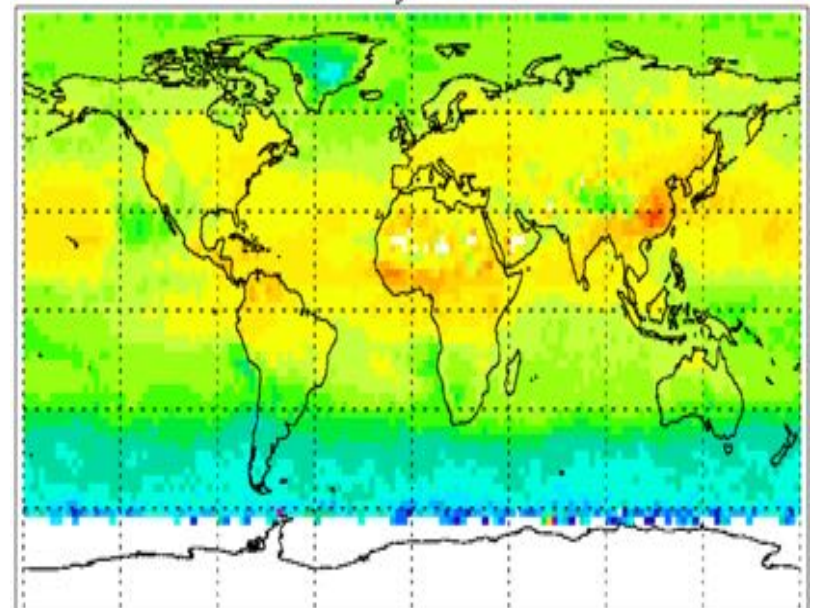
**Standard** – June 2014 (QC=5)

Mean day retrieved



**IMS** – June 2014 (QC=5)

Mean day retrieved

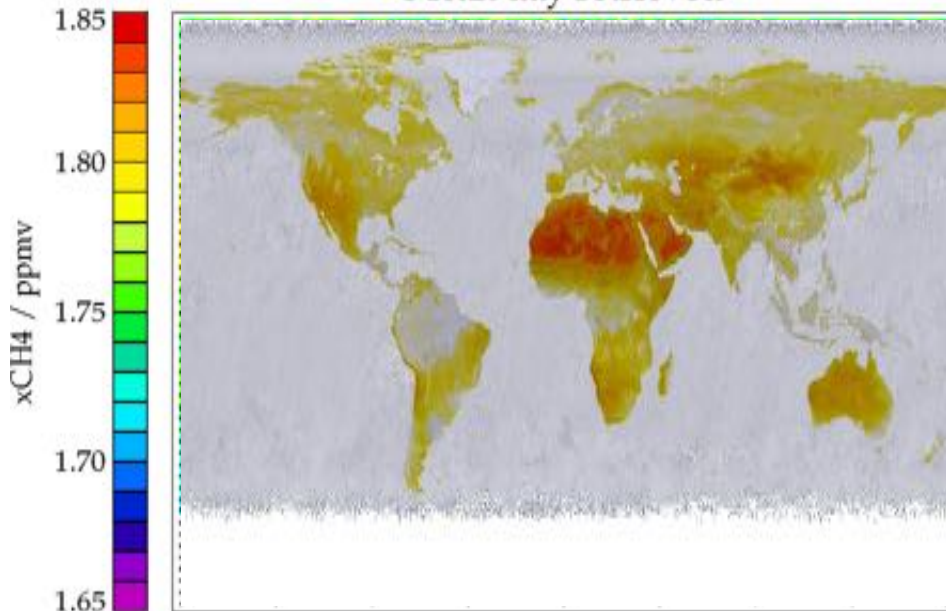


# IASI/MHS/AMSU T, q and Emissivity

- RAL has enhanced EUMETSAT's operational IASI OEM retrieval
  - Combines IASI with collocated microwave data from MHS and AMSU
  - Named the **Infrared Microwave Sounder (IMS)** retrieval
- IMS retrieved T, q and emissivity are being used as input to the IASI methane retrieval
- Eliminates errors encountered through use of interpolated ECMWF reanalyses (ERA-Interim) data and modelled surface spectral emissivity from the University of Wisconsin database.

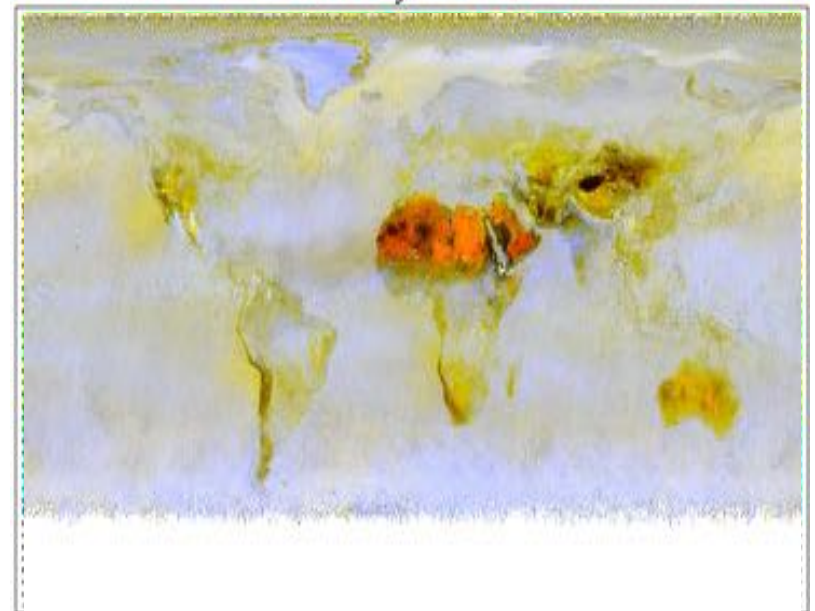
**Standard** – June 2014 (QC=5)

Mean day retrieved



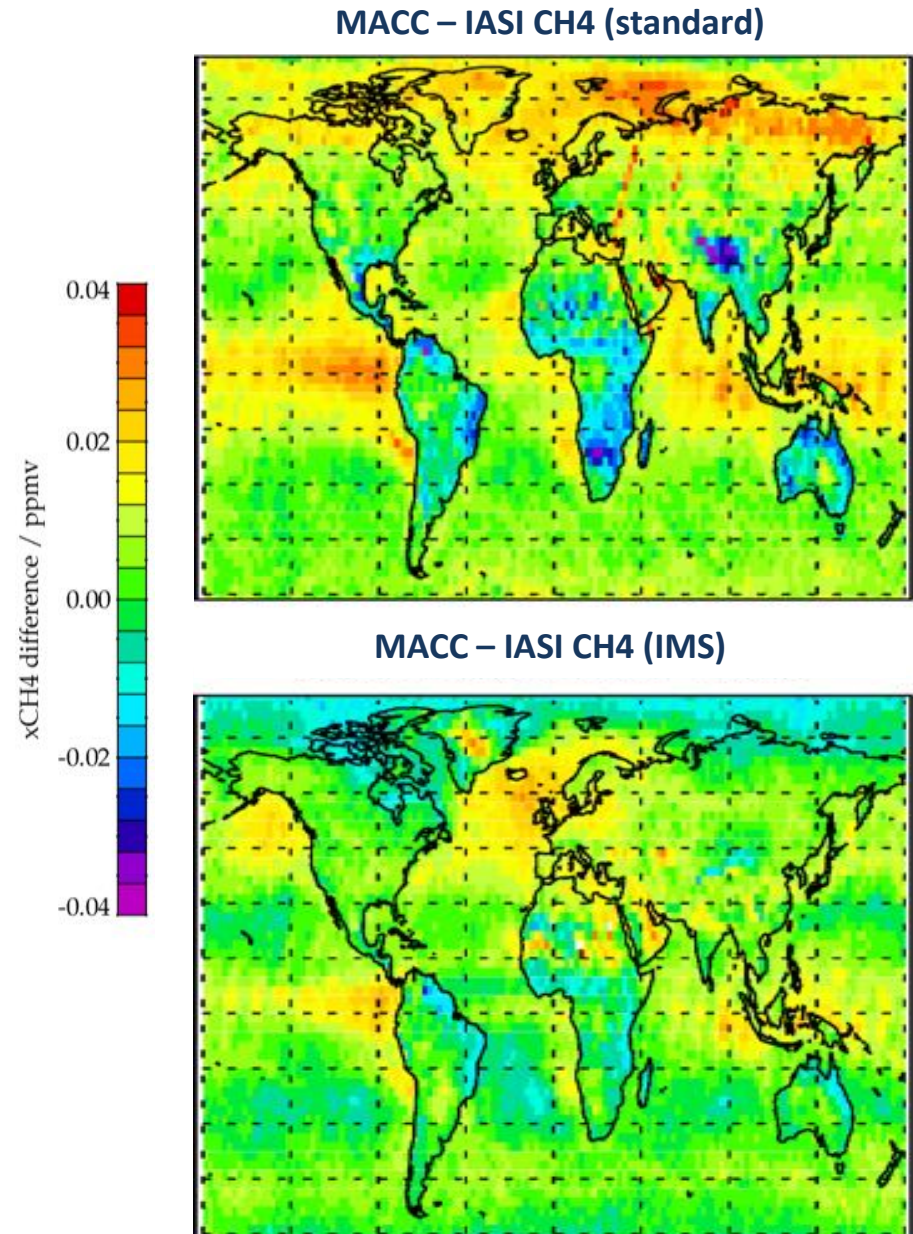
**IMS** – June 2014 (QC=5)

Mean day retrieved



# MACC CH4 – IASI CH4 (MAM 2014)

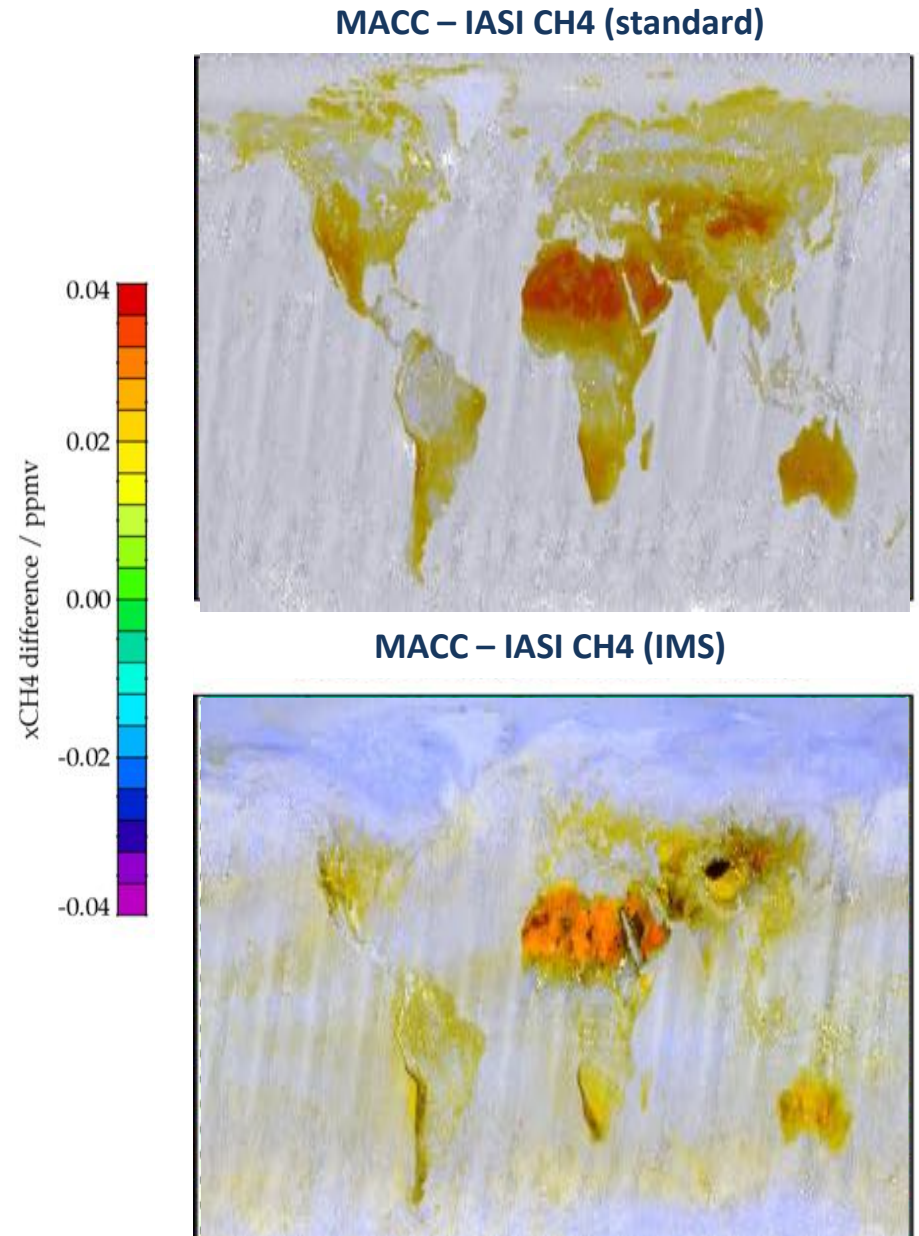
- MACC CH4 minus IASI CH4 (standard and IMS)
- Land-sea difference reduced in IASI CH4 (IMS) comparison
- Overall differences significantly reduced
- Remaining structure over ocean possibly related to N2O





# MACC CH4 – IASI CH4 (MAM 2014)

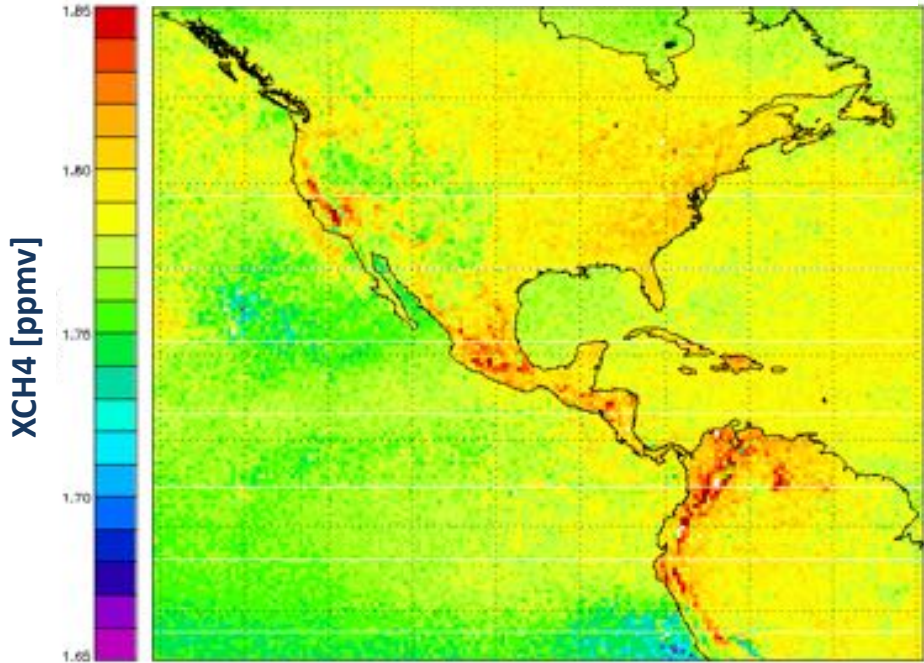
- MACC CH4 minus IASI CH4 (standard and IMS)
- Land-sea difference reduced in IASI CH4 (IMS) comparison
- Overall differences significantly reduced
- Remaining structure over ocean possibly related to N2O



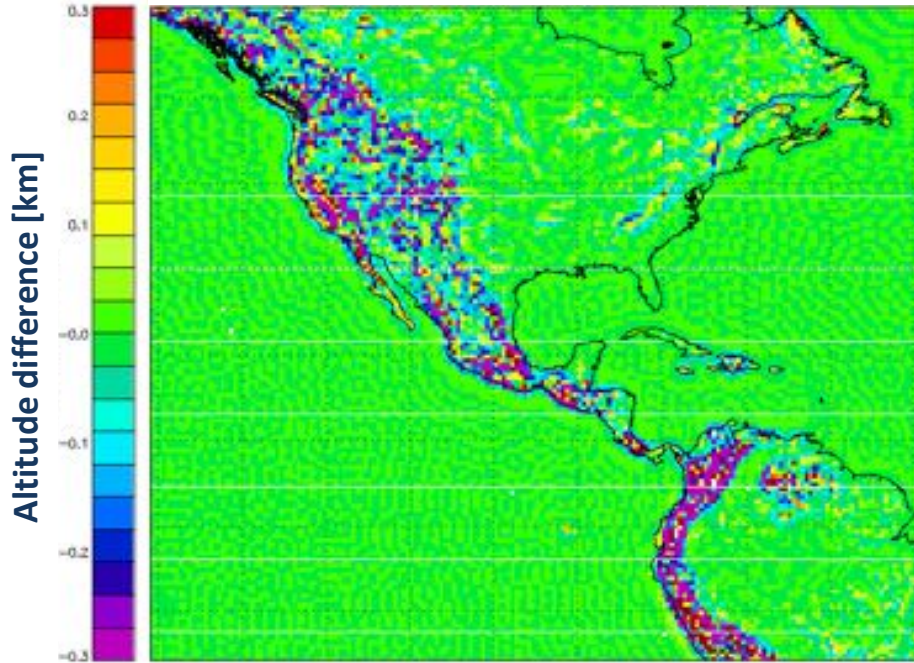
# Regional Comparison: The Americas

**Standard** IASI Methane Retrieval  
June 2014 (QC=0)

XCH4 (Day)



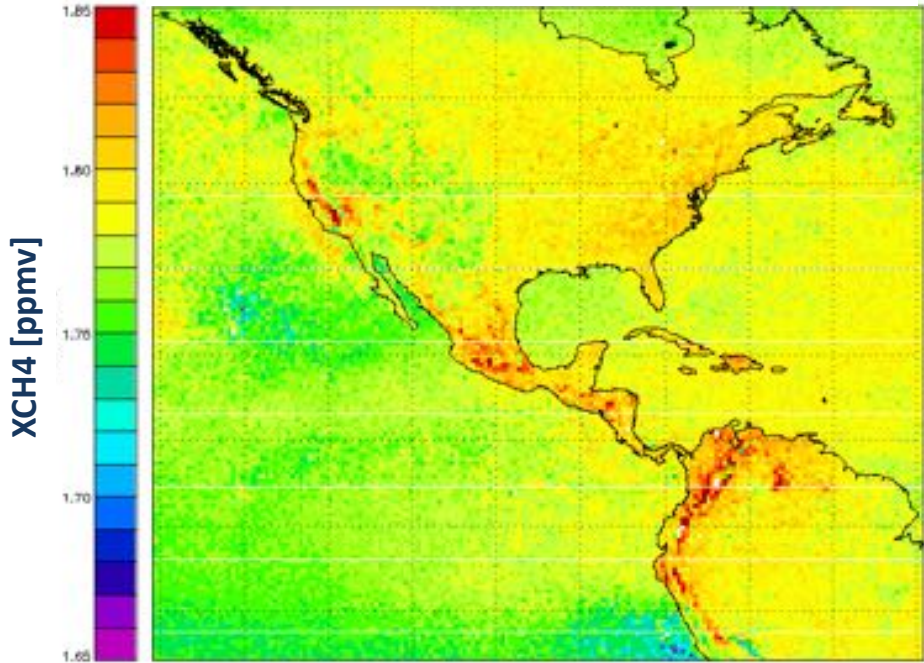
Actual – ECMWF Altitude



# Regional Comparison: The Americas

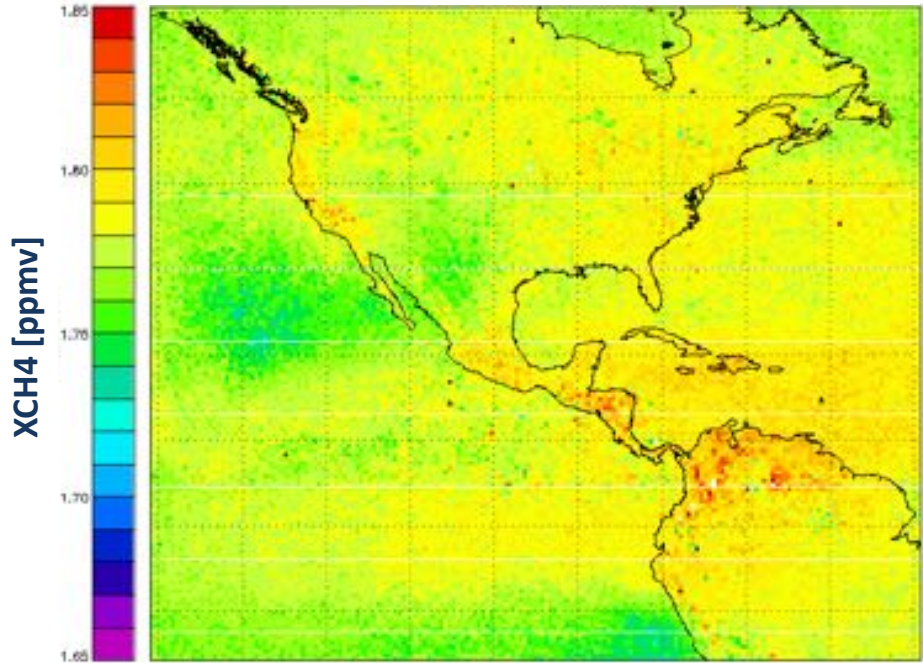
**Standard**  
June 2014 (QC=0)

XCH4 (Day)



**IMS**  
June 2014 (QC=0)

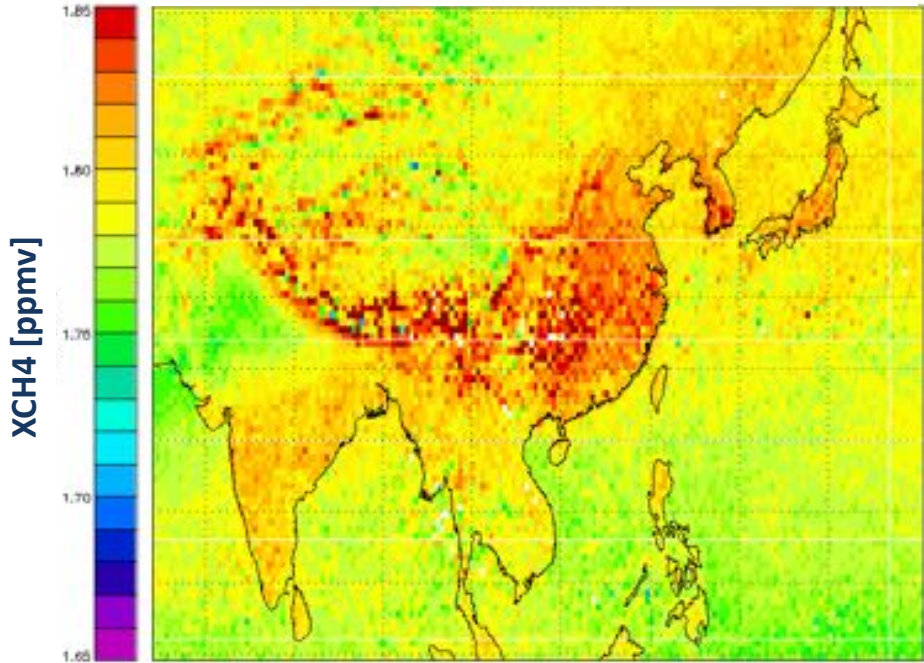
XCH4 (Day)



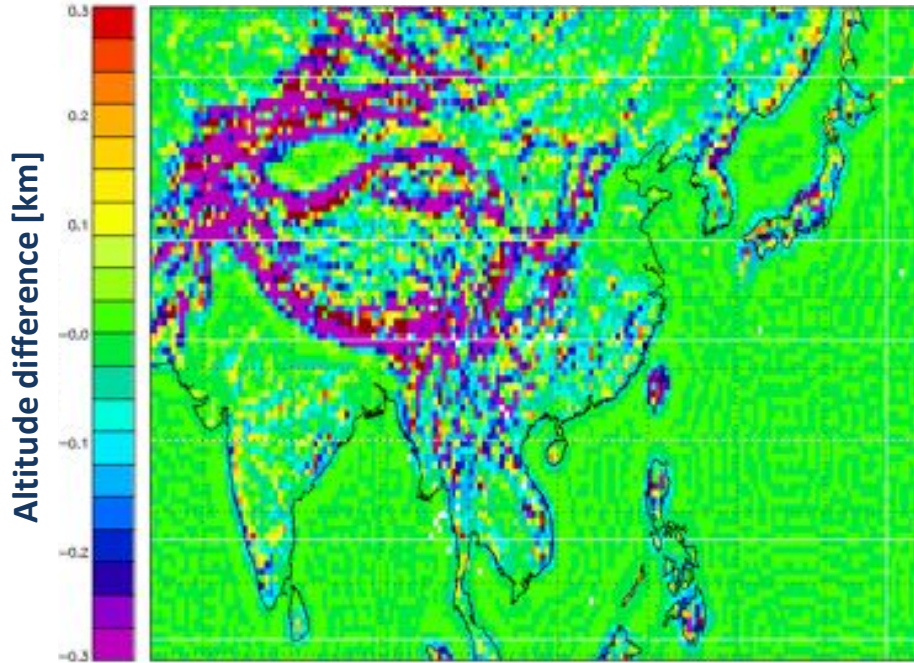
# Regional Comparison: East Asia

## Standard IASI Methane Retrieval June 2014 (QC=0)

XCH4 (Day)



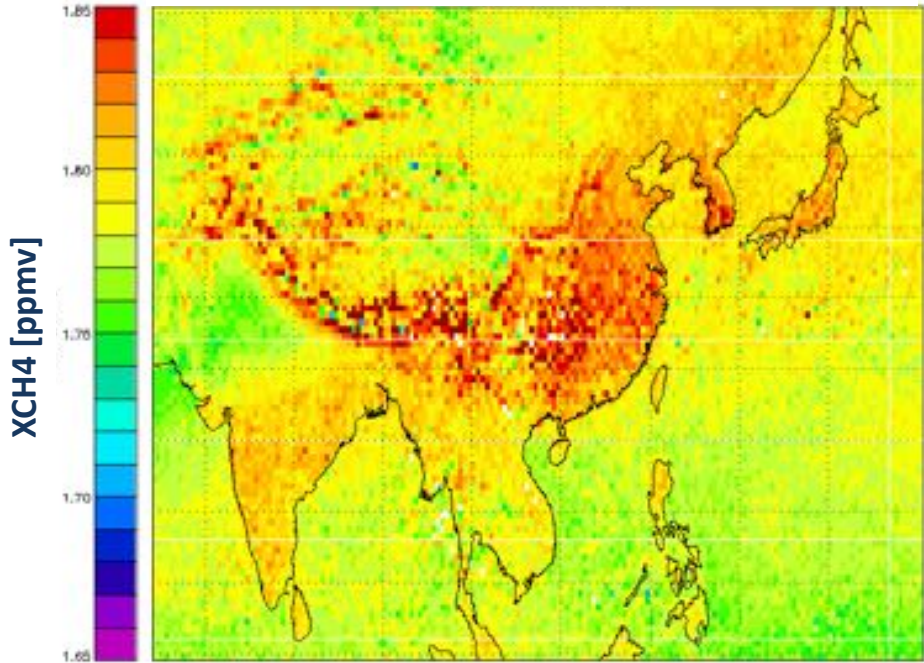
Actual – ECMWF Altitude



# Regional Comparison: East Asia

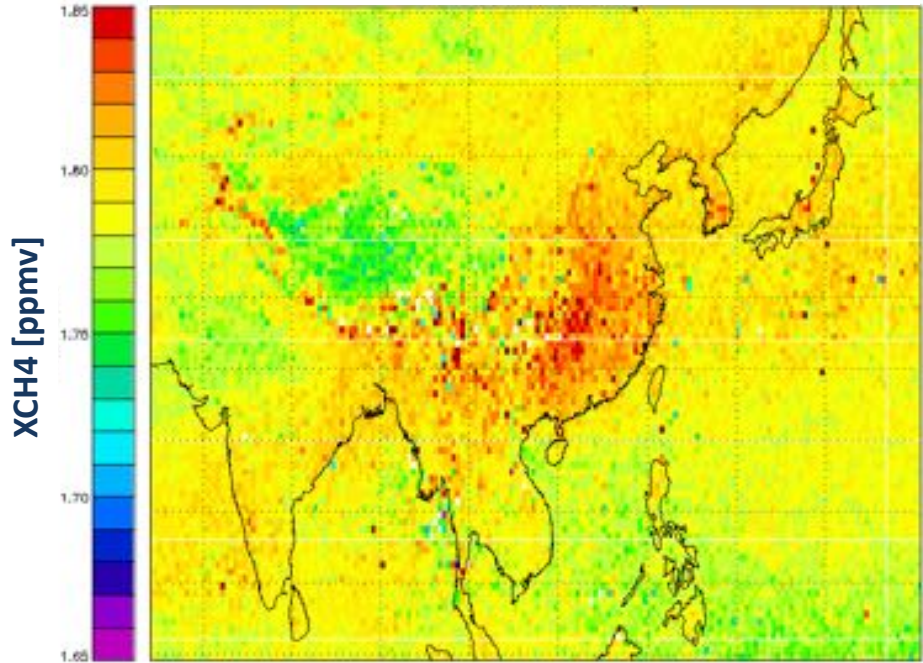
**Standard**  
June 2014 (QC=0)

XCH4 (Day)



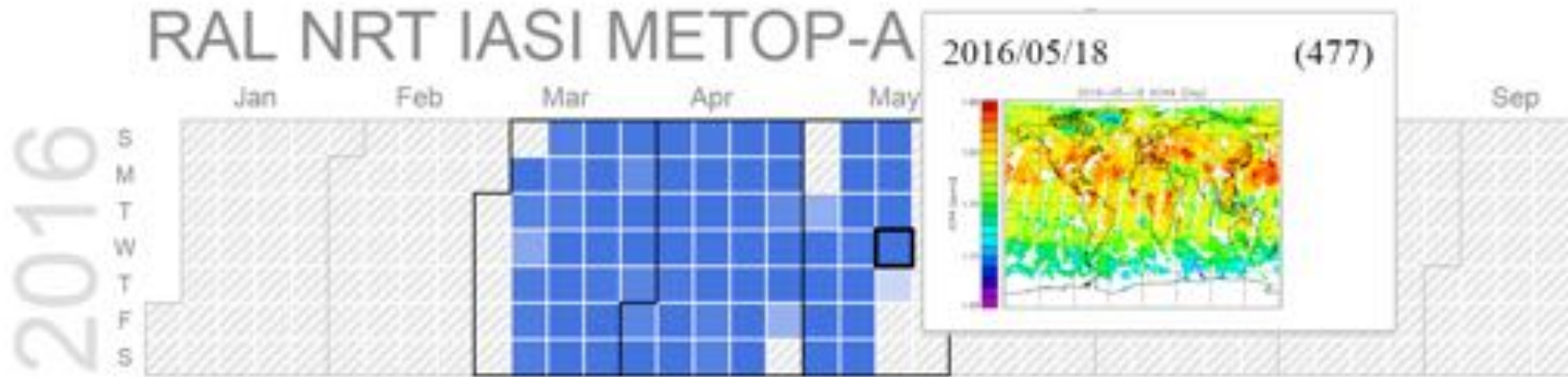
**IMS**  
June 2014 (QC=0)

XCH4 (Day)



# Near-Real Time (NRT) Retrievals

## RAL Space: Remote Sensing Group



### MetOp NRT IASI methane chain established on JASMIN-CEMS in March 2016

- High-resolution met forecast data from ECMWF & IASI L1 data via Eumetcast
- Event detection, support to field campaigns

# Summary & Future Work

## IASI TIR OE Retrieval Scheme

- 8 year IASI MetOp-A methane dataset available via CEDA (<http://catalogue.ceda.ac.uk/uuid/510b22c6d12e4635b604c172b583167e>)
- Algorithm and validation paper to be published shortly (R.Siddans et al.)

## IASI/MHS/AMSU L2 Temperature, Humidity and Emissivity

- Co-located IASI/MHS/AMSU retrieved T, q and emissivity used as input to IASI methane retrieval
  - Improves on use of ECMWF T, q and UoW surface spectral emissivity database

## Near-Real Time MetOp Chain

- IASI CH<sub>4</sub> processor incorporated into RAL's MetOp NRT chain on JASMIN-CEMS
  - Event detection, support to field campaigns
  - Monitoring trials in ECMWF/Copernicus Atmosphere Monitoring Service

## Development of 3.7 micron Retrievals

- To improve near-surface sensitivity with the solar reflected term

## Sentinel-5P (SWIR) & Suomi-NPP CrIS (TIR)

- S5P scheduled to launch in 2016
  - *Fully exploit co-located TIR and SWIR observations for height-resolved methane profiles*

# Thank you for listening

[www.ralspace.stfc.ac.uk/remotesensing](http://www.ralspace.stfc.ac.uk/remotesensing)

## Acknowledgements:

**Centre for Environmental Data Analysis (CEDA)** for their support in the use of the JASMIN-CEMS computing facility and the archival of the IASI MetOp-A TIR methane dataset.

**EUMETSAT** funding of the IMS methane study through contract *EUMETSAT RfQ 15/211387*