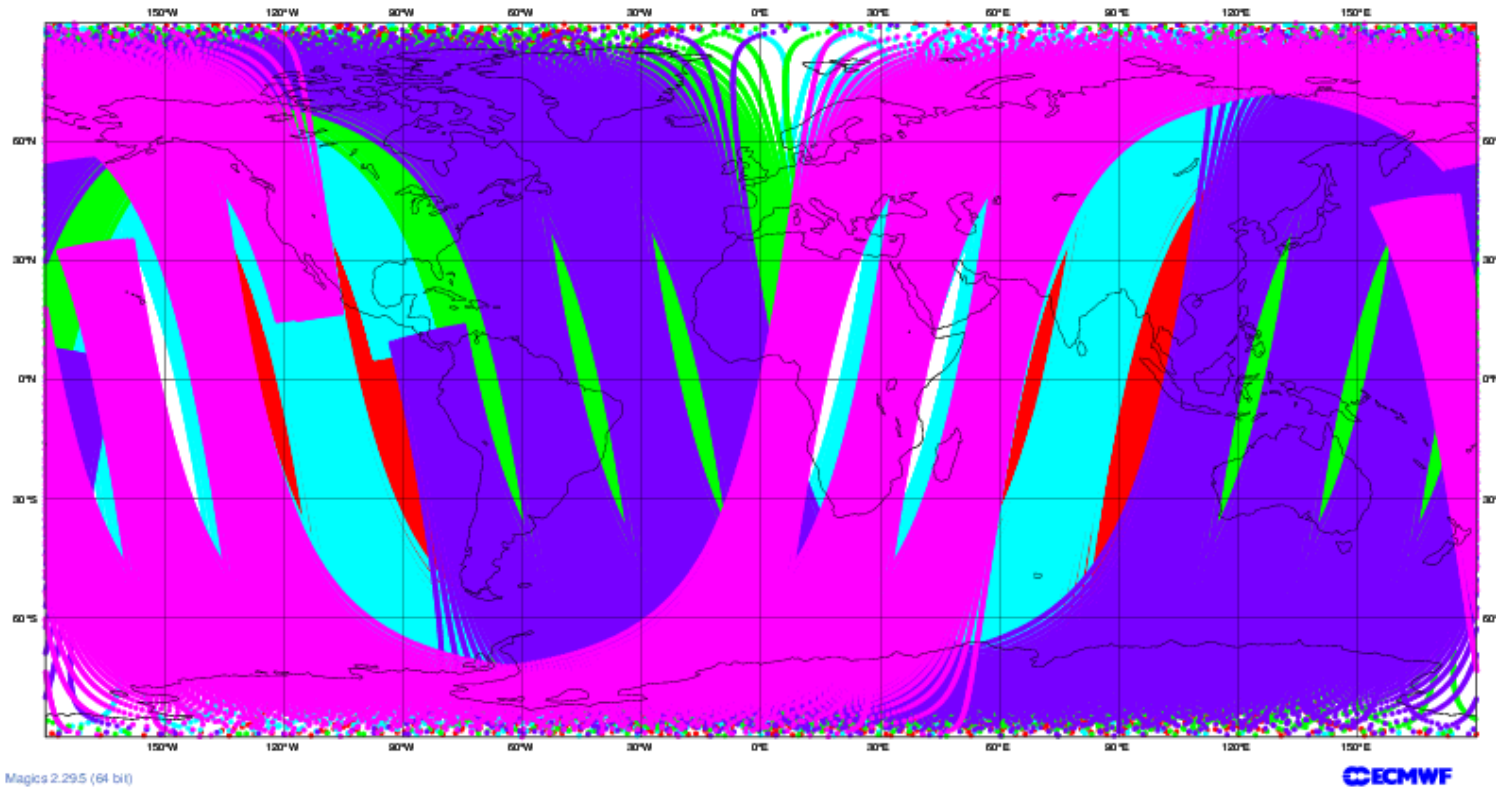# Potential for MTG-IRS to impact the forecasting of severe weather events

Kirsti Salonen, Tony McNally, David Lavers

ECMWF

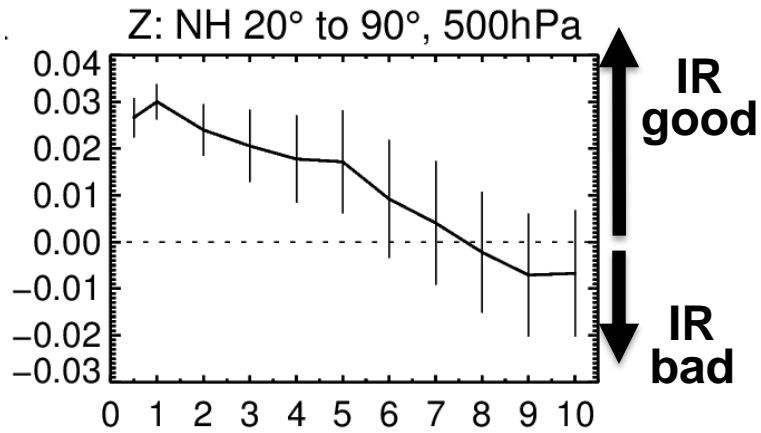# Current hyperspectral IR sounders, sample coverage
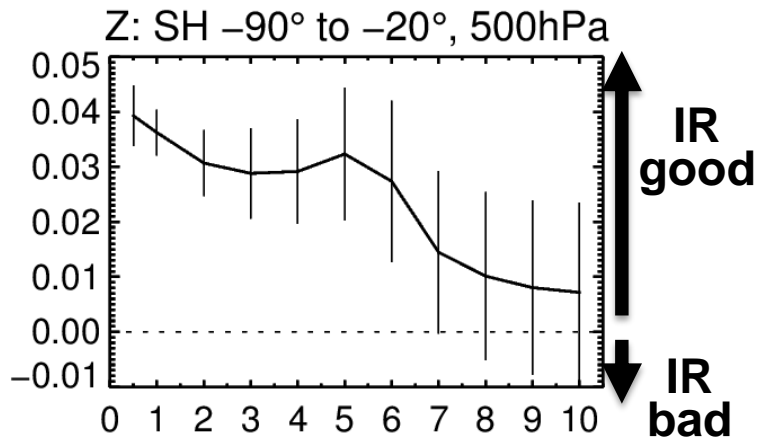

Metop-A IASI

Metop-B IASI

Aqua AIRS

Suomi-NPP Cris
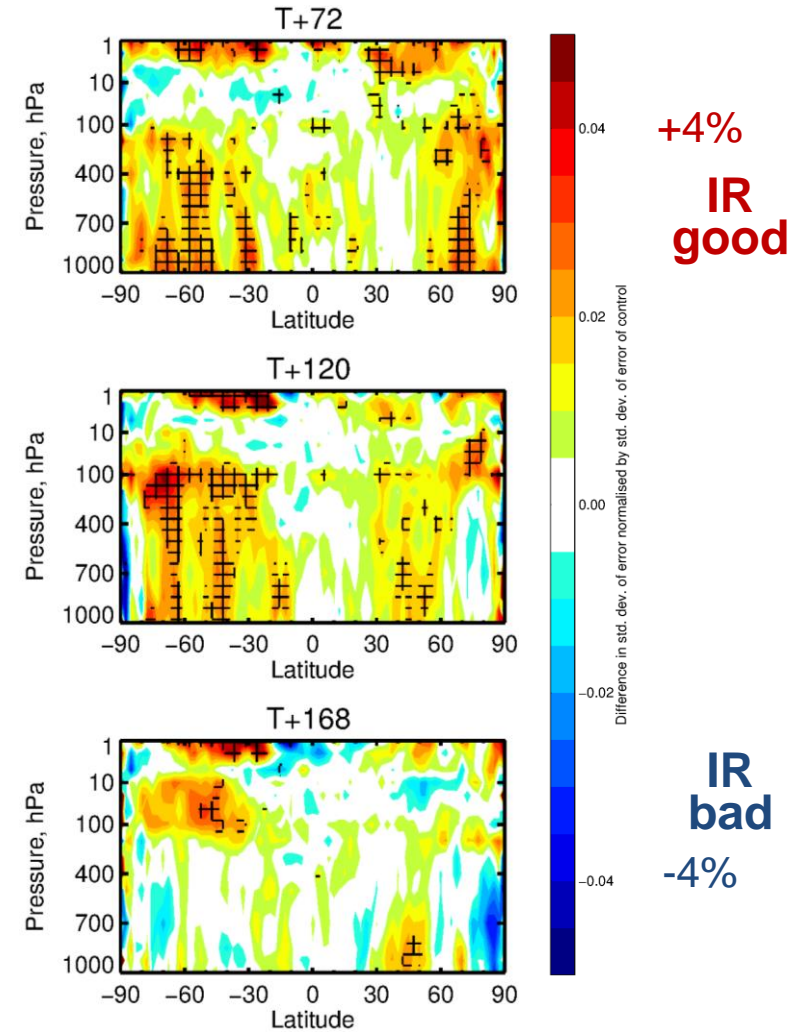
Current hyperspectral IR sounders, impact

Z500 RMSE

Vector wind error St.Dev.

Scores cover a total of 9 months in Nov 2015 – Sep 2016

MTG-IRS

• The Infrared Sounder (IRS) on MTG-S will provide information on water vapour and temperature structures of the atmosphere.

- Spatial resolution of 4 km at nadir and ~10 km at the edges (~7km over Europe)

- Temporal resolution up to 30 min.

Atmospheric river

- A long, narrow and transient corridor of strong horizontal water vapour transport.

- Typically associated with a low-level jet stream ahead of the cold front of an extratropical cyclone

- Frequently lead to heavy precipitation where they are forced upward

- Horizontal water vapour transport in the mid-latitudes occurs primarily in atmospheric rivers and is focused in the lower troposphere.
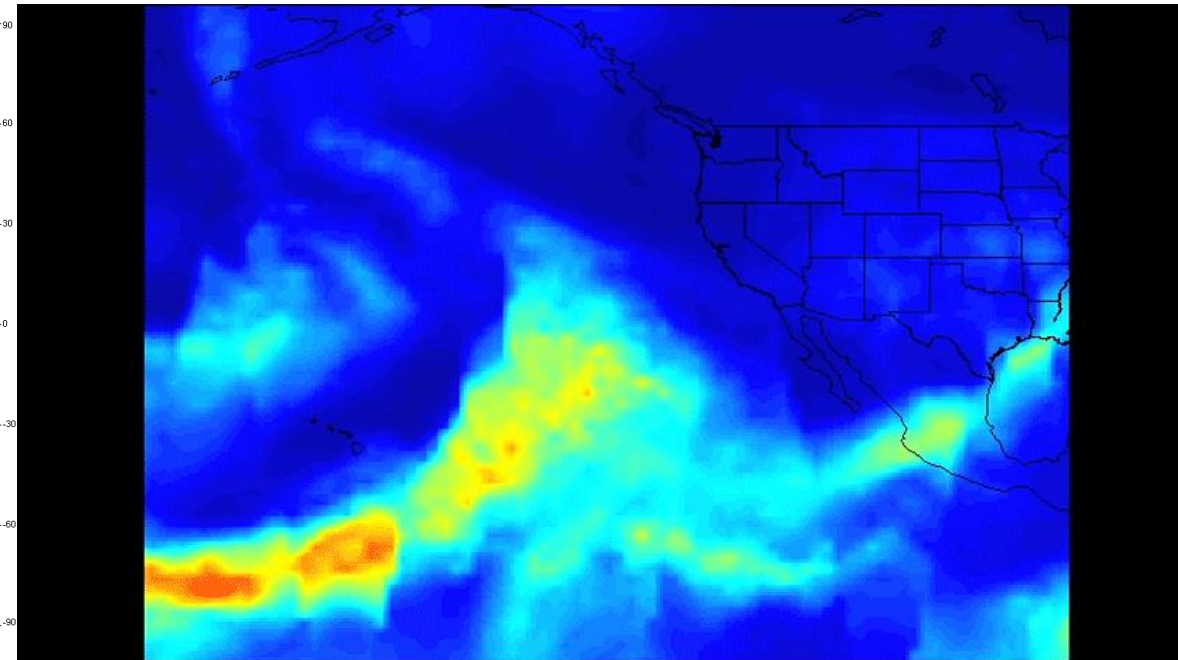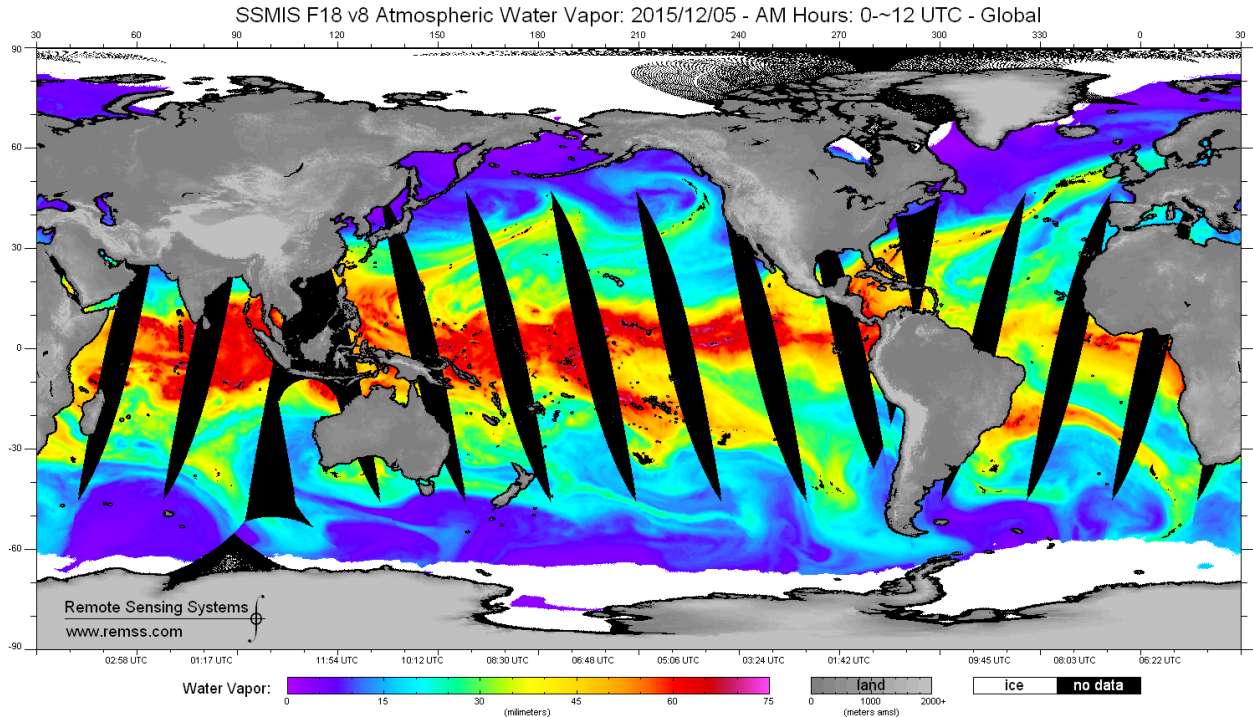

Low level jet

http://glossary.ametsoc.org/wiki/Atmospheric_river
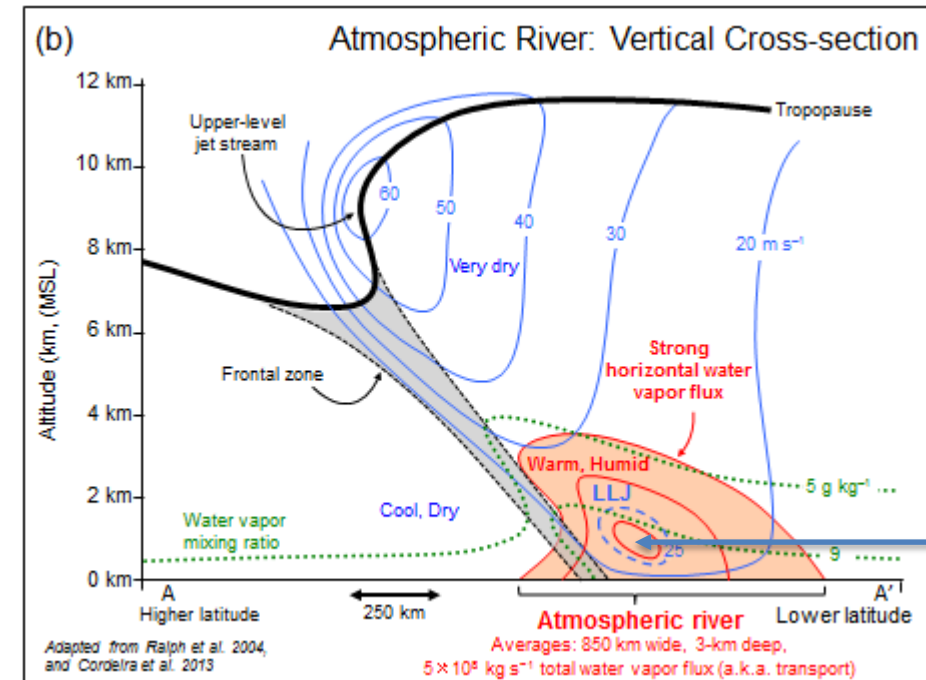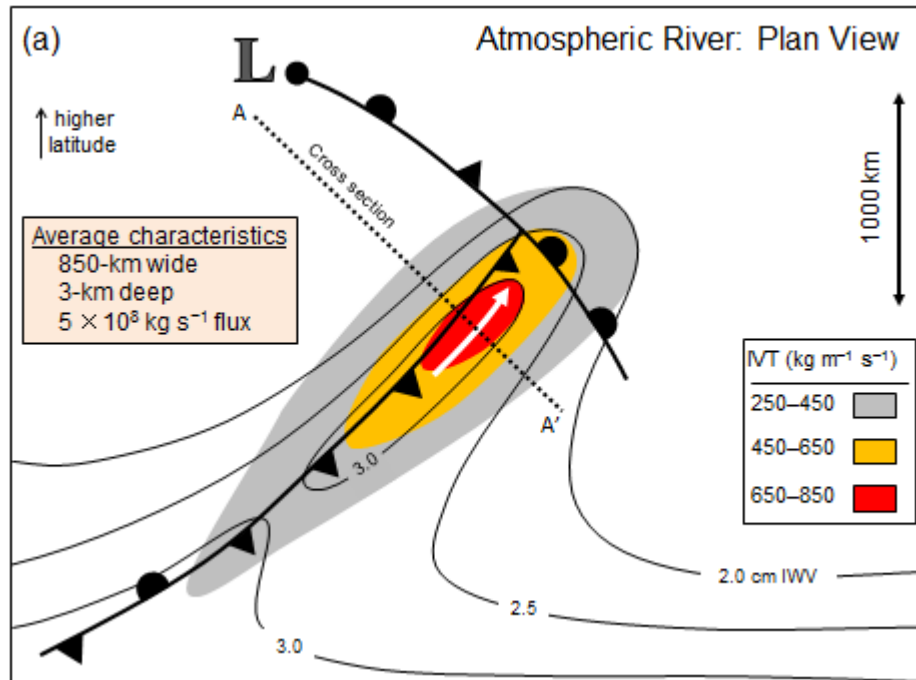
Examples of atmospheric river events seen from polar orbiting satellites

Special Sensor Microwave Imager/Sounder (SSMIS)

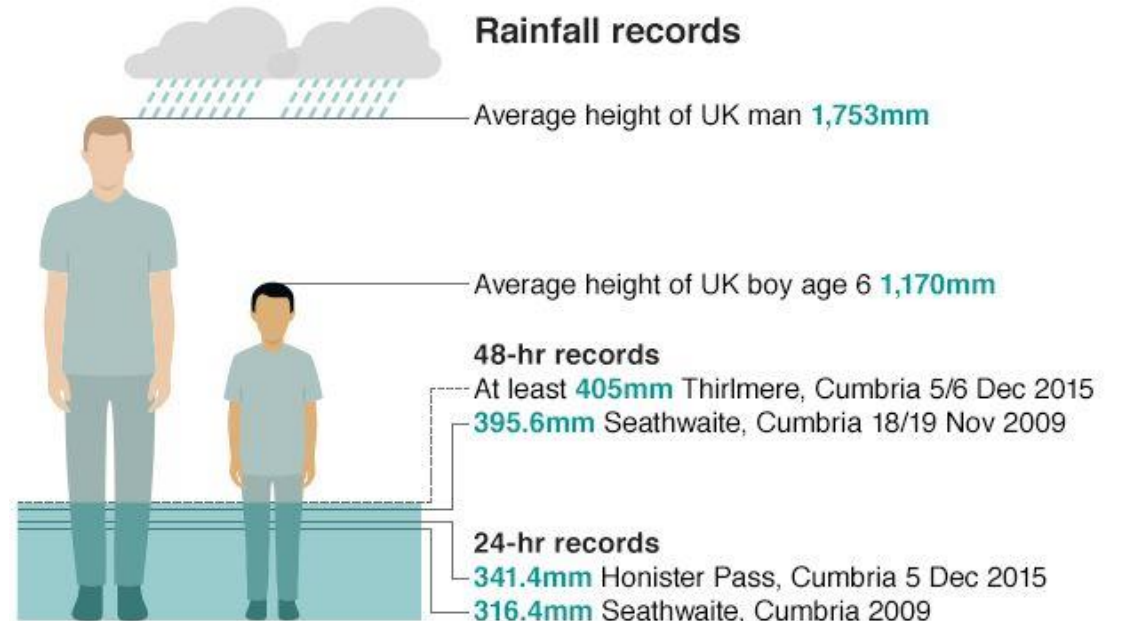Atmospheric Infrared Sounder (AIRS) on NASA's Aqua satellite

Storm Desmond, 5th December 2015.

A series of atmospheric rivers that brought drought-relieving rains, heavy snowfall and flooding to California 7-11 Jan 2017.

Could MTG-IRS help to detect the initiation of the atmospheric river events?
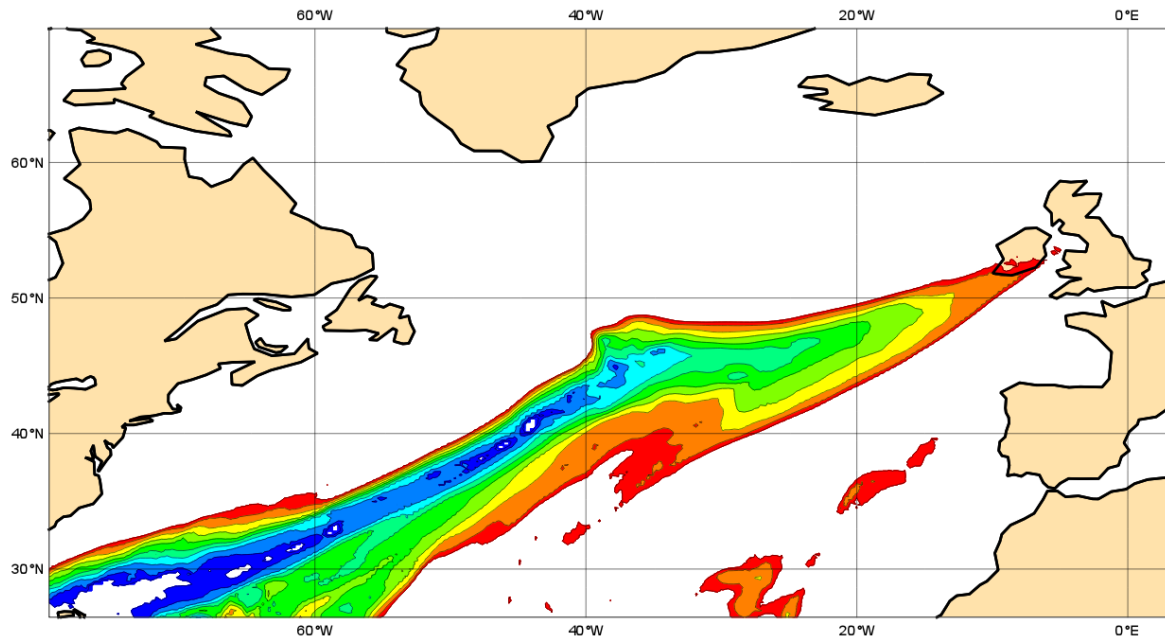
- Polar orbiting satellites:

  - Microwave sensors give good information on the total column water vapour and its spatial extent but little on the vertical location of the humidity.

  - Hyper-spectral IR provides more information on vertical location and spatial extent but potential issues of cloud contamination of the humidity signal.

- Geostationary satellite:

  - Current instruments give excellent time sampling and the ability to dynamically trace the transport of humidity but low vertical skill.

  - Hyper-spectral IR could provide information on vertical location, with excellent time sampling for early warning and jet speed tracing.

Storm Desmond 5-6th December 2015

STORM DESMOND

⚠️⚠️ Very wet in the northwest

⚠️ Windy, with a risk of severe gales in the north

Very mild for most

TONIGHT

Rainfall records

Average height of UK man **1,753mm**

Average height of UK boy age 6 **1,170mm**

48-hr records
At least **405mm** Thirlmere, Cumbria 5/6 Dec 2015
395.6mm Seathwaite, Cumbria 18/19 Nov 2009

24-hr records
341.4mm Honister Pass, Cumbria 5 Dec 2015
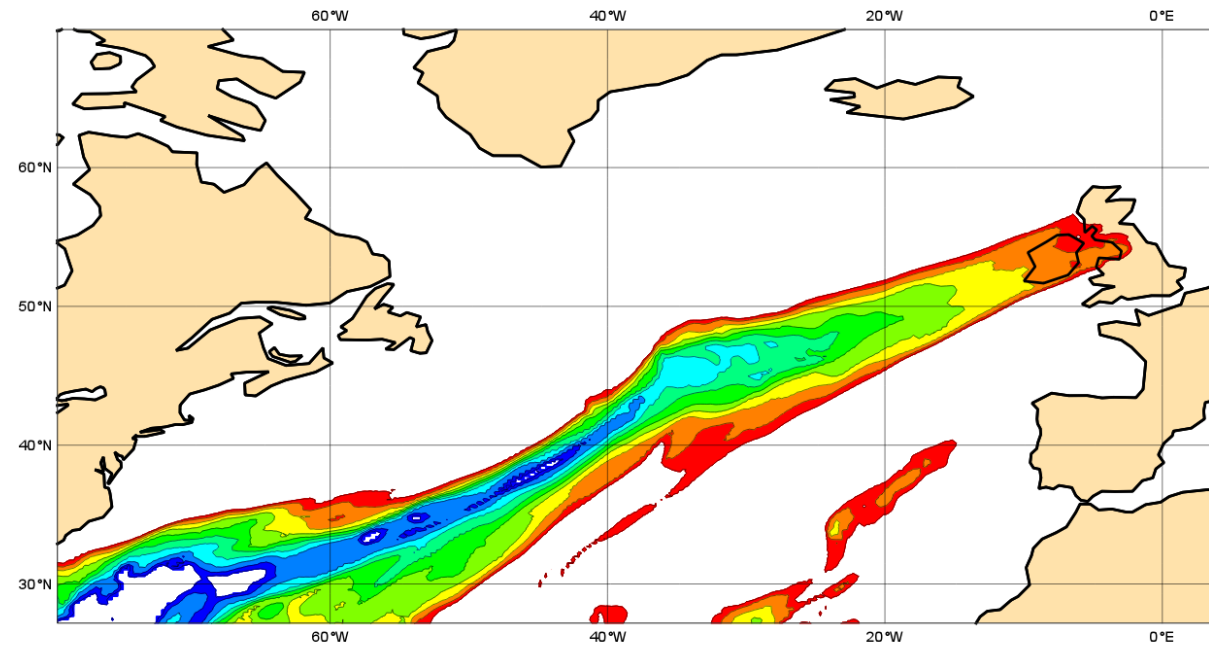**316.4mm** Seathwaite, Cumbria 2009

Source: Met Office

BBC

Storm Desmond 5-6th December 2015

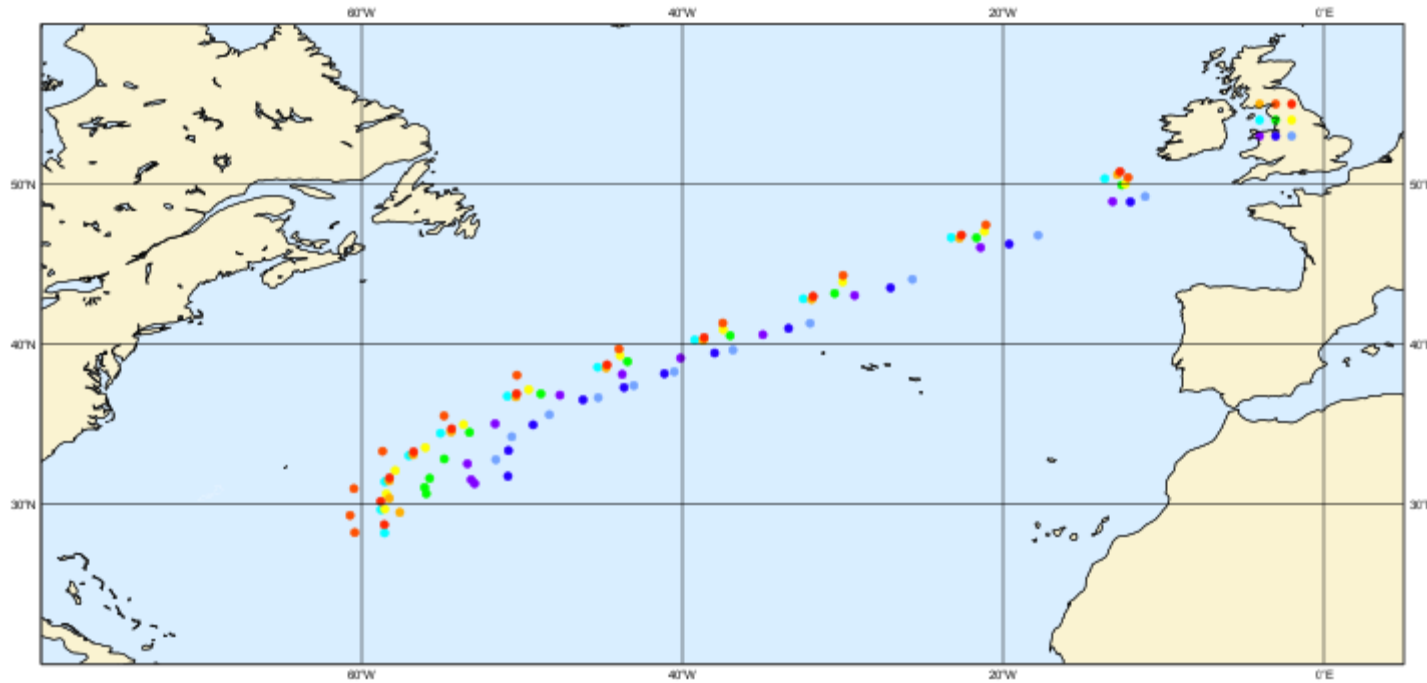2nd December 2015, FC 00 UTC + 72 h

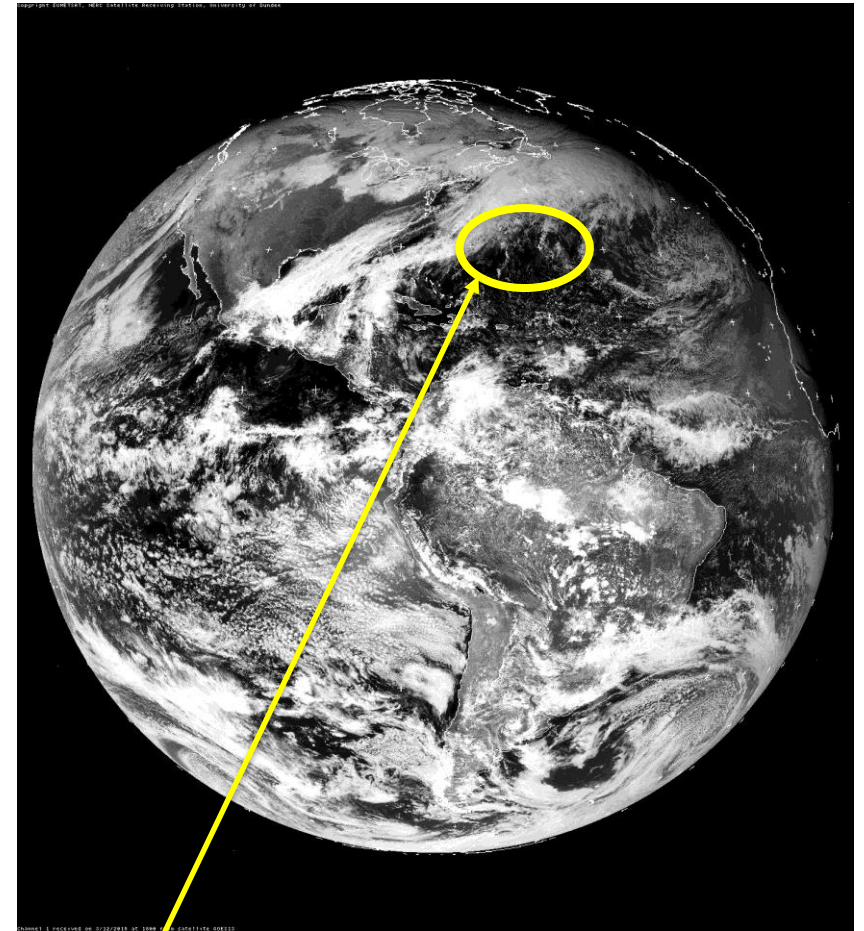5th December 2015, AN 00 UTC

Total column water vapour

Initiation of the event

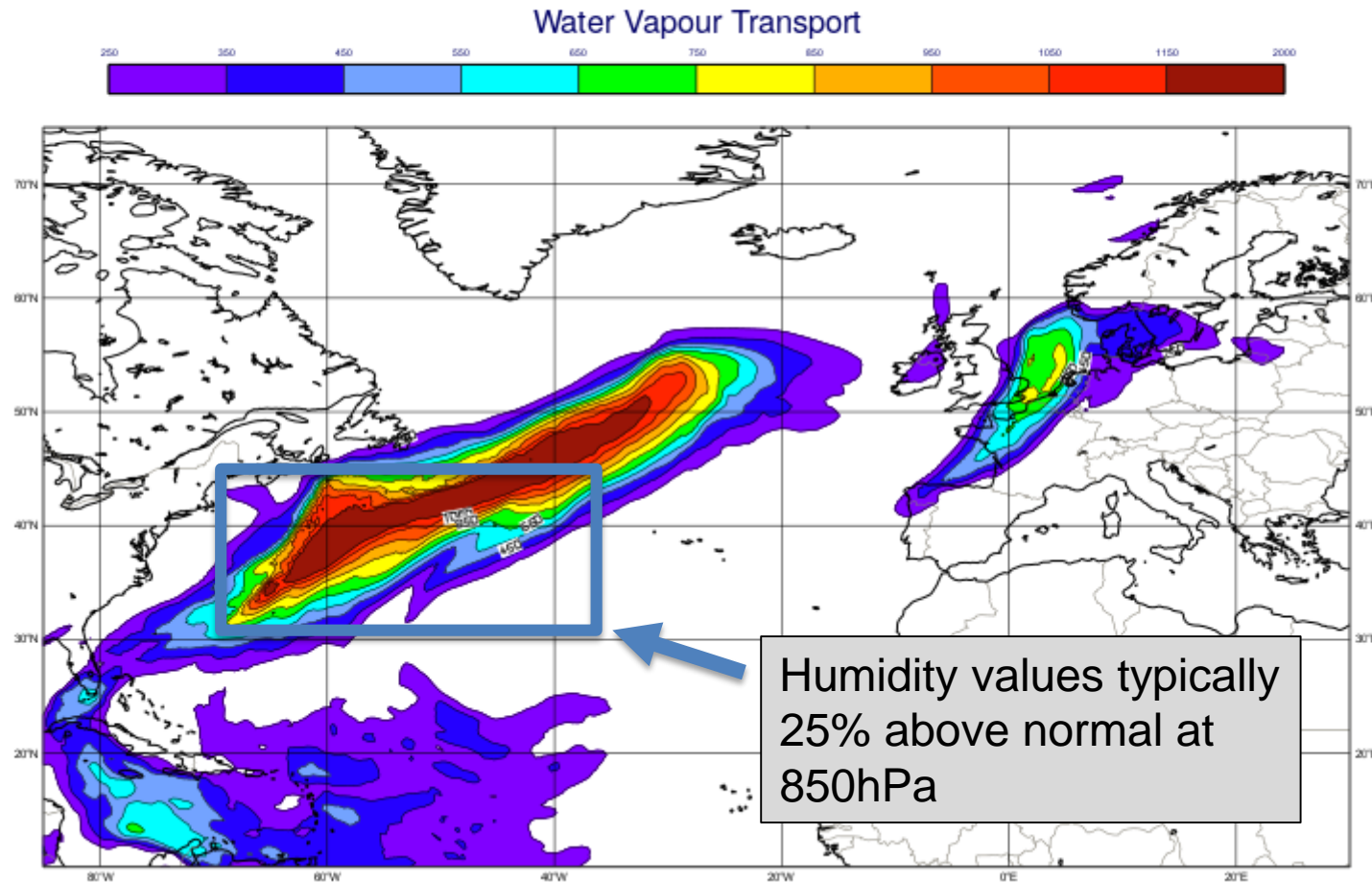Back Trajectory from 18UTC 5th Dec. 2015 to 00UTC 3rd Dec. 2015   18UTC 3rd December 2015


Region where trajectories go back to

Water vapour transport field at analysis (12UTC 4th Dec. 2015, 00UTC 5th Dec. 2015, 12UTC 5th Dec. 2015)

Water Vapour Transport

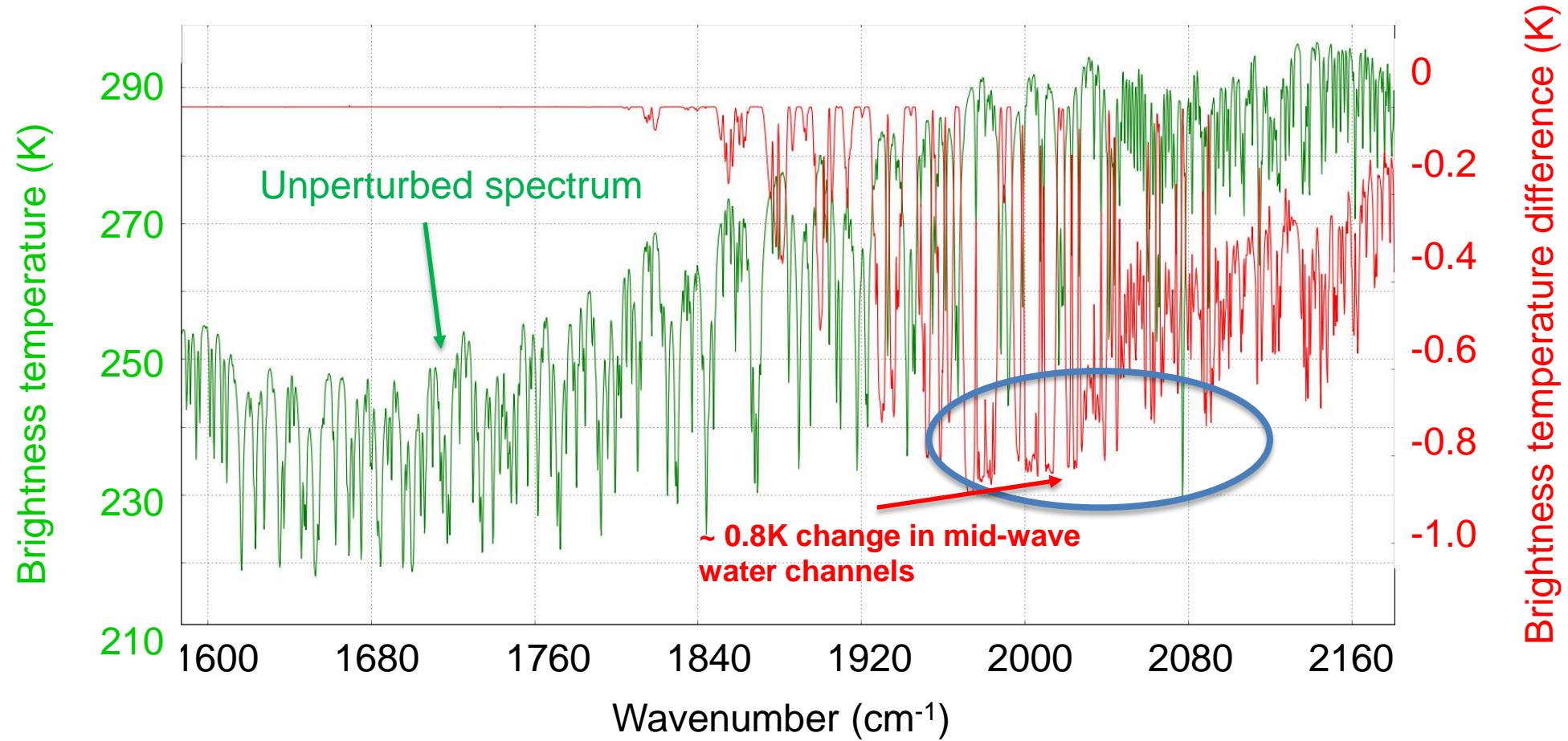Humidity values typically 25% above normal at 850hPa

Can MTG-IRS detect elevated humidity values at the altitude of the low level wind jet?
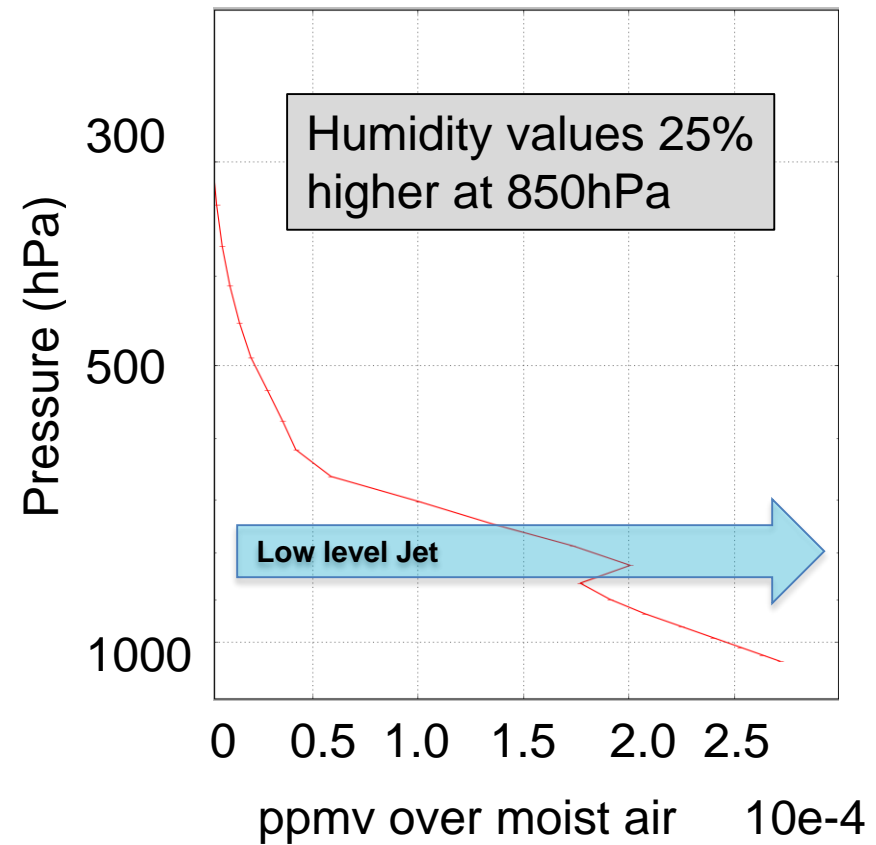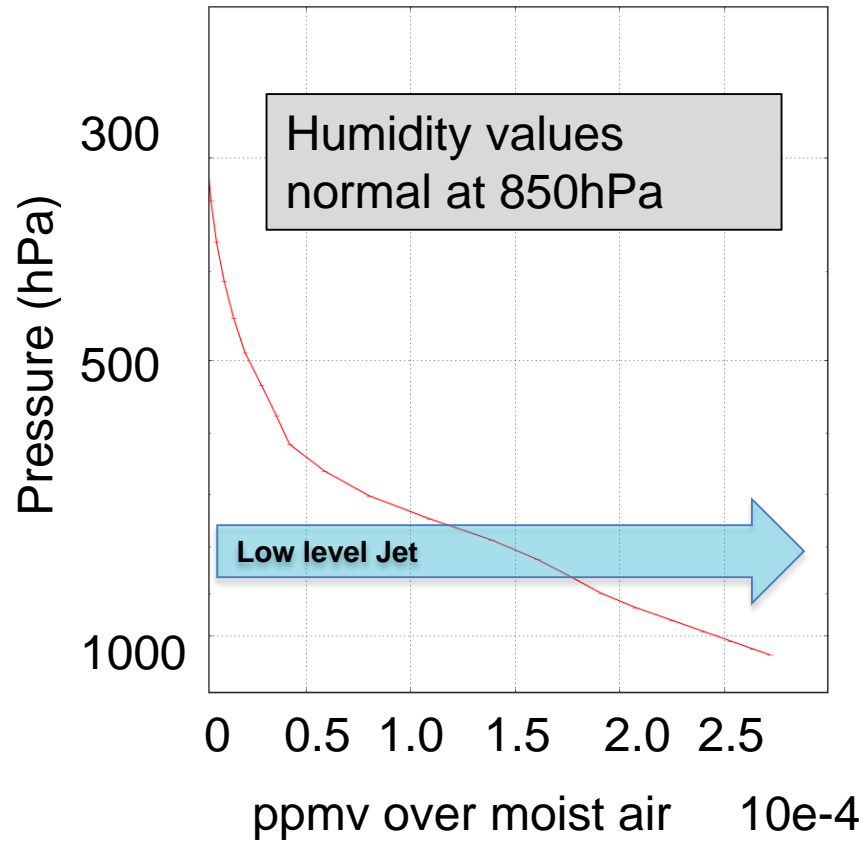
Radiance response to elevated humidity in MTG-IRS long-wave band 700–1210 cm-1

Unperturbed spectrum

~1K change in long-wave window channels
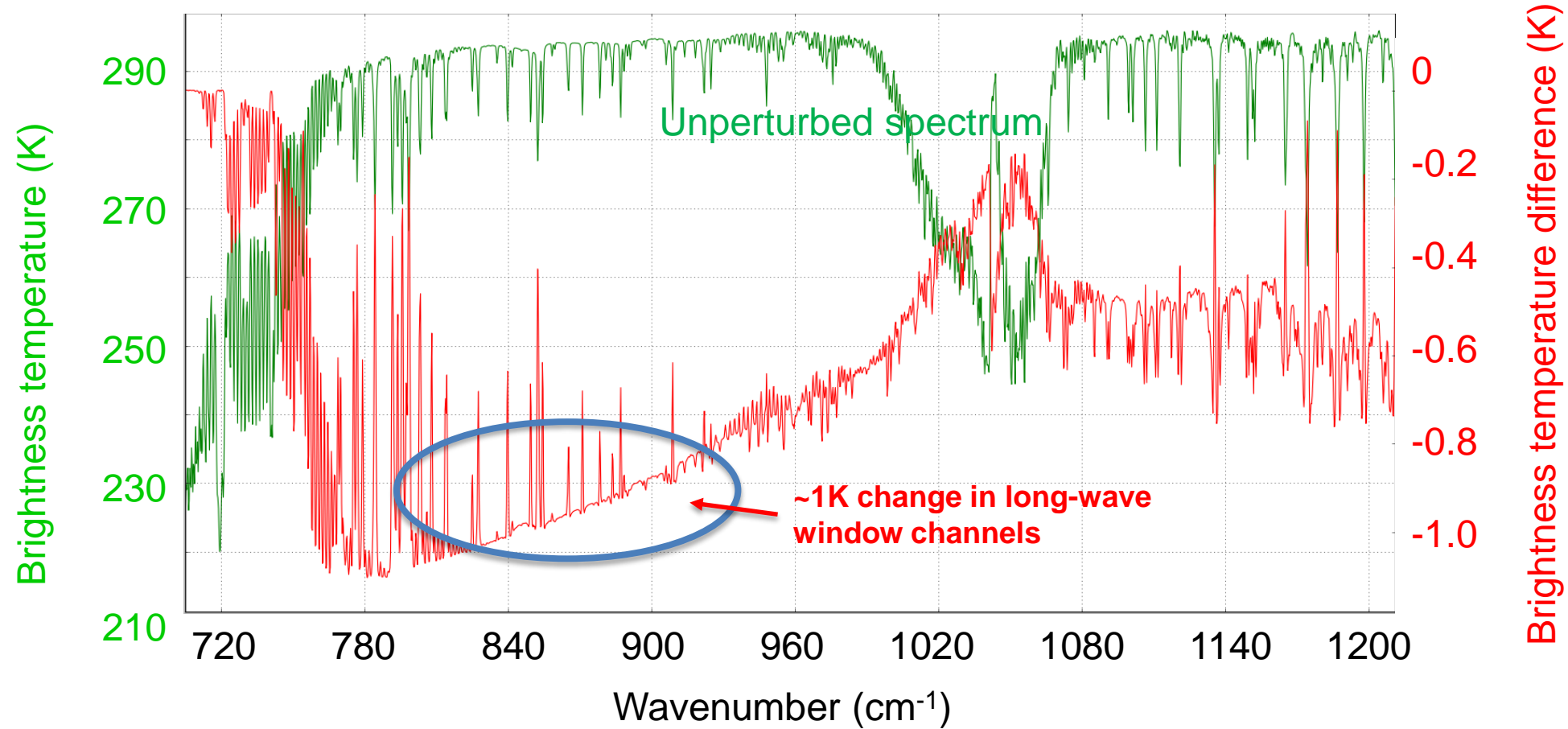
Radiance response to elevated humidity in MTG-IRS mid-wave band 1600–2175 cm-1

Potential problems

- The radiance signal is not large (lack of thermal contrast) so noise and radiative transfer errors should be kept low.

- In the early stages there are fully clear sky pixels, but these must be detected accurately.

- The underlying emission from the ocean surface (temperature and emissivity) must be modelled accurately to expose the water vapour signal.

Summary

- Hyperspectral IR instruments on board polar orbiting satellites are very beneficial for NWP. Expectations for the new generation geostationary instruments are high.

- AR events can cause extreme weather events and severe flooding. Once established they can be observed from existing microwave and infrared instruments.

- MTG-IRS will have the potential to observe the initiation of these events with high temporal resolution.