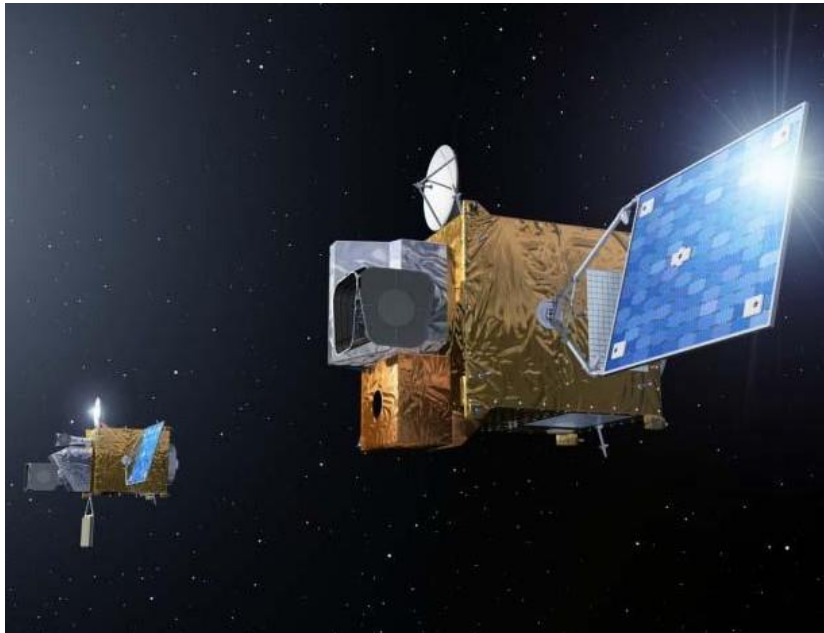
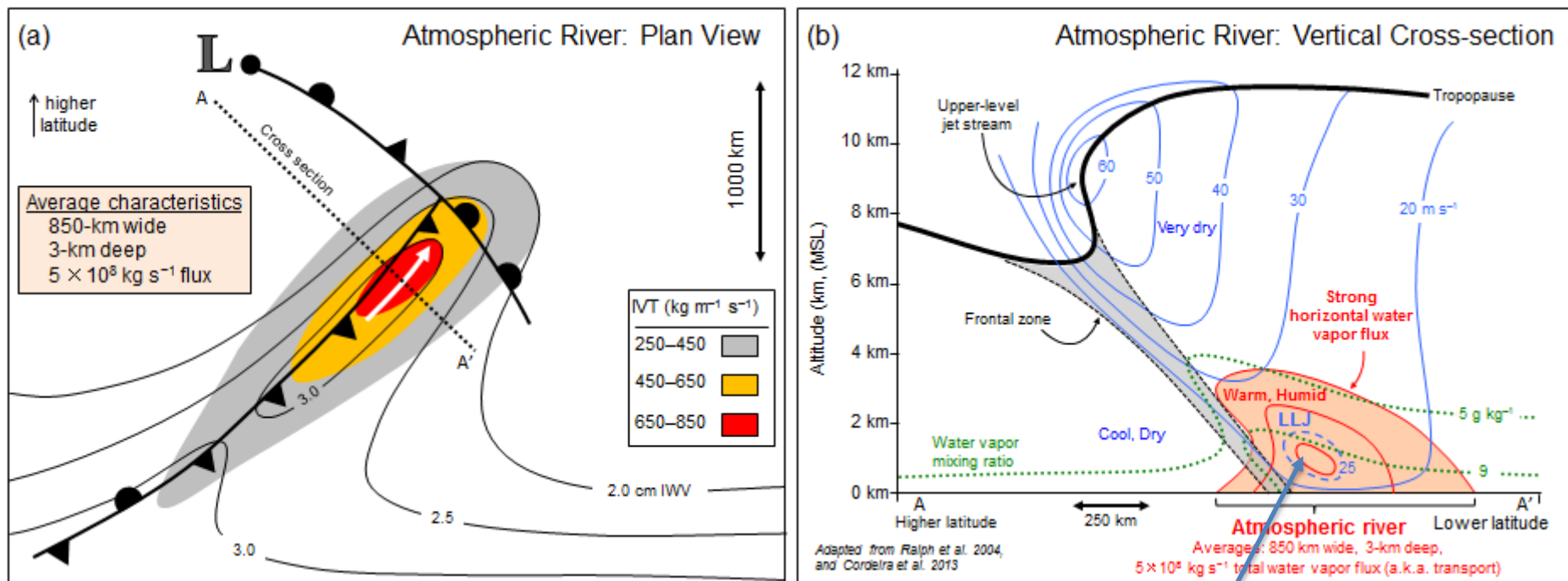


Potential for MTG-IRS to impact the forecasting of severe precipitation cases

David Lavers, Mark Rodwell, Tony McNally, Linus Magnusson, David Richardson, Florian Pappenberger



Atmospheric Rivers (AR)



Images from the AMS Glossary

Low level jet

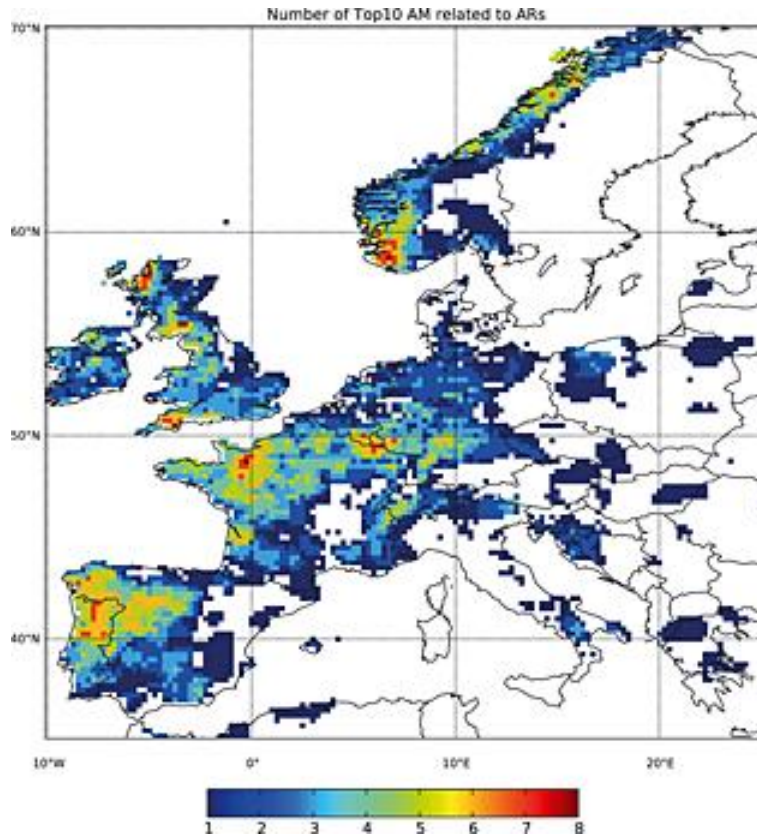
AR link to extreme precipitation and floods



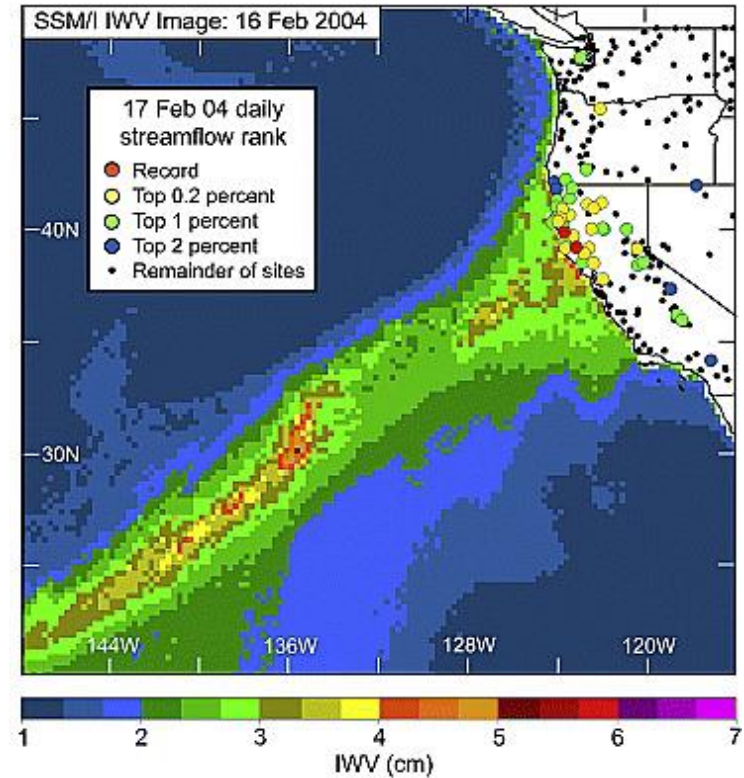
Storm Desmond in December 2015



AR link to extreme precipitation and floods



Strong AR link on Iberian Peninsula, western UK, France, and Norway.



Ralph et al 2006, GRL

Strong AR link in western USA.

Due to their potentially dramatic impact
Atmospheric Rivers are an active area of
research...



F. Martin Ralph, K. Prather, D. Cayan (Co-Leads)
UC San Diego/Scripps Institution of Oceanography

Key Agencies

NOAA, DOE, NSF, CA DWR, NASA, ONR

Overview article

Ralph et al. 2015 (Bull. Amer. Meteor. Soc.)

CalWater 2

Precipitation, Aerosols, and Pacific Atmospheric Rivers Experiment

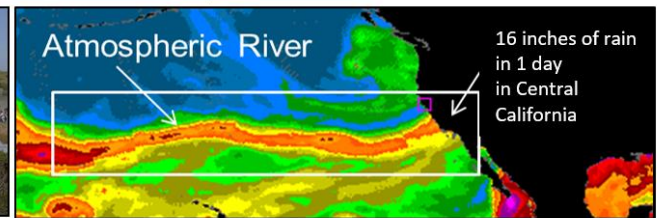
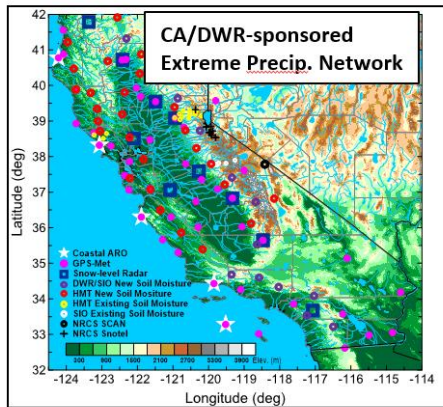
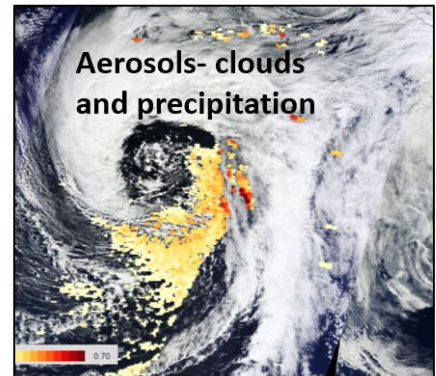
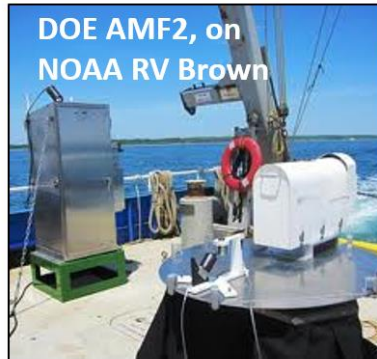
"CalWater – 2015" Field Experiment on Atmospheric Rivers & Aerosols

Steering Committee

Co-Chairs: F.M. Ralph
K. Prather, D. Cayan of USCD
+ NOAA, DOE, USGS, NASA
and other Univ. members

Atmospheric Sci., Chemistry,
Hydrology, Oceanography

Ralph et al. 2016
Bull. Amer. Meteor. Soc.

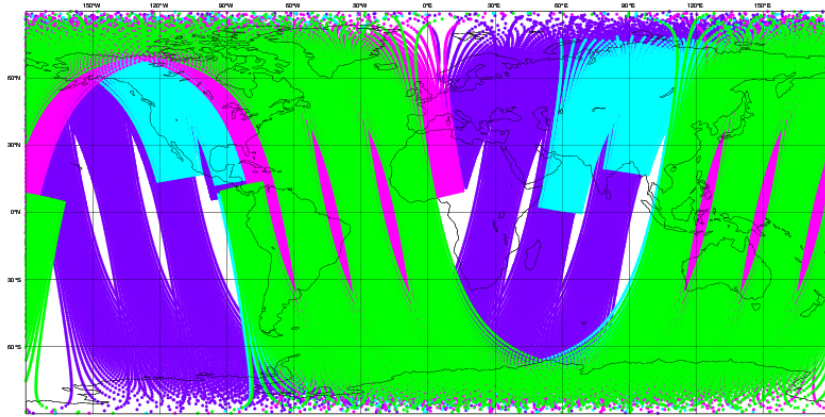


What routine observations do we have ..?
...essentially satellite only over the oceans

Satellite observations of atmospheric humidity

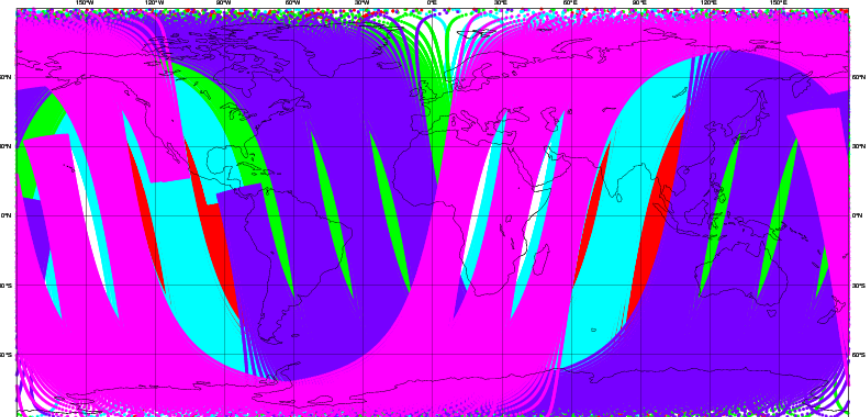
LEO Microwave imagers / sounders

LEO Hyper-spectral infrared sounders



Mapas 2.295 (64 bit)

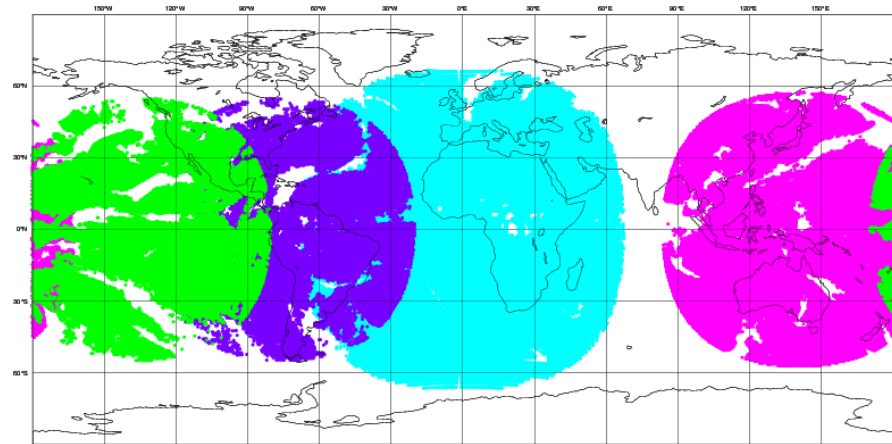
ECDFW



Mapas 2.295 (64 bit)

ECDFW

GEO infrared sounders



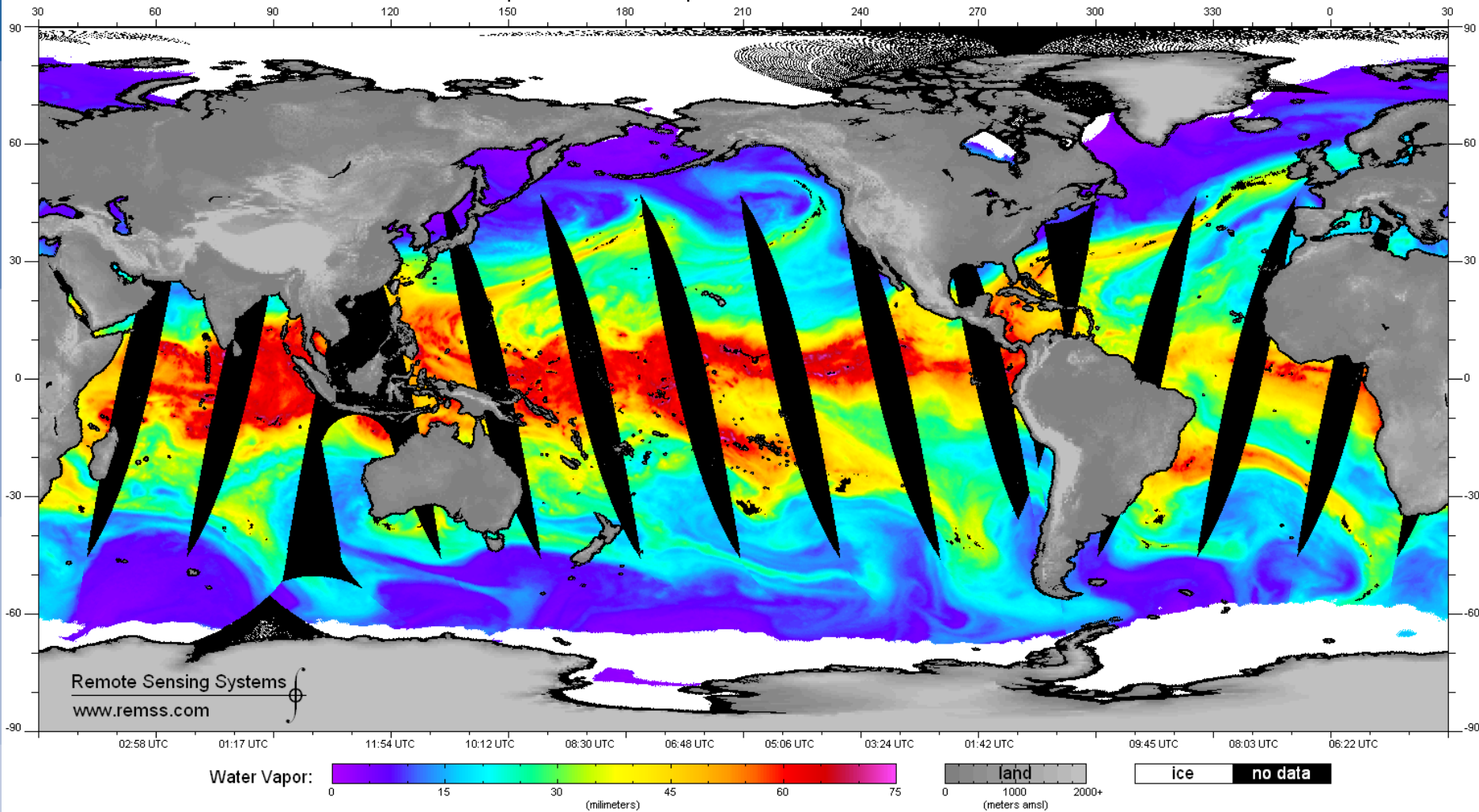
Mapas 2.295 (64 bit)

ECDFW

Examples of AR events from LEO microwave data

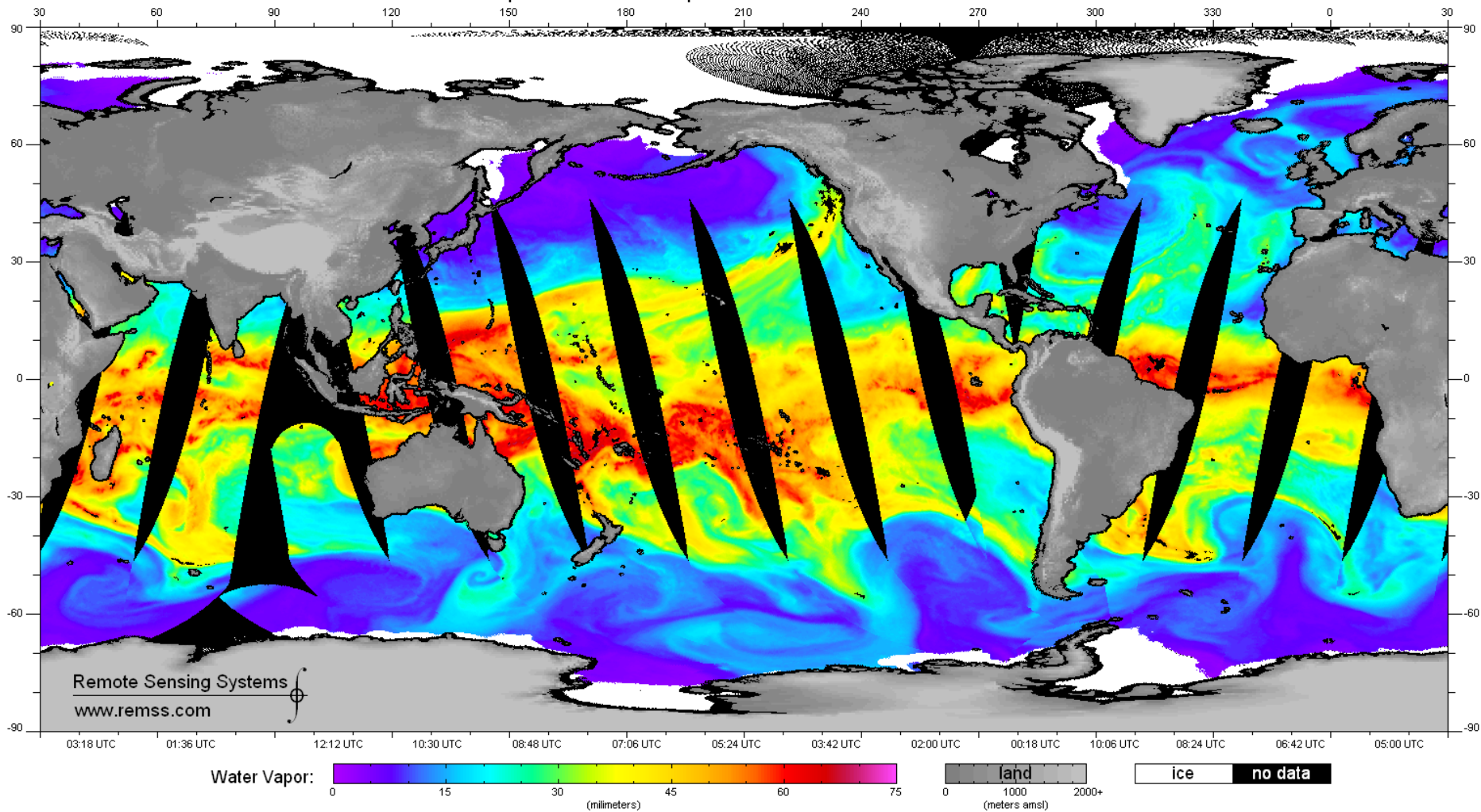
Special Sensor Microwave Imager Sounder (SSMIS)

SSMIS F18 v8 Atmospheric Water Vapor: 2015/12/05 - AM Hours: 0~12 UTC - Global



Special Sensor Microwave Imager Sounder (SSMIS)

SSMIS F18 v8 Atmospheric Water Vapor: 2017/02/15 - AM Hours: 0~12 UTC - Global

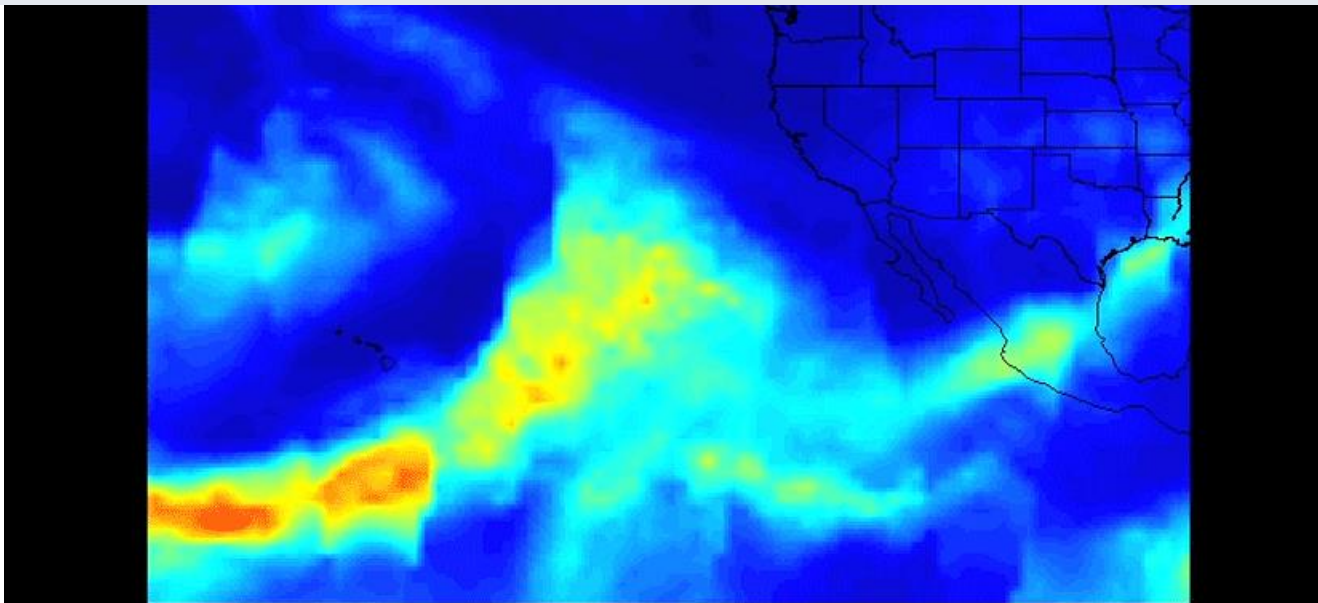


Examples of AR events from LEO infrared data

AIRS on the NASA AQUA satellite



Jet Propulsion Laboratory
California Institute of Technology



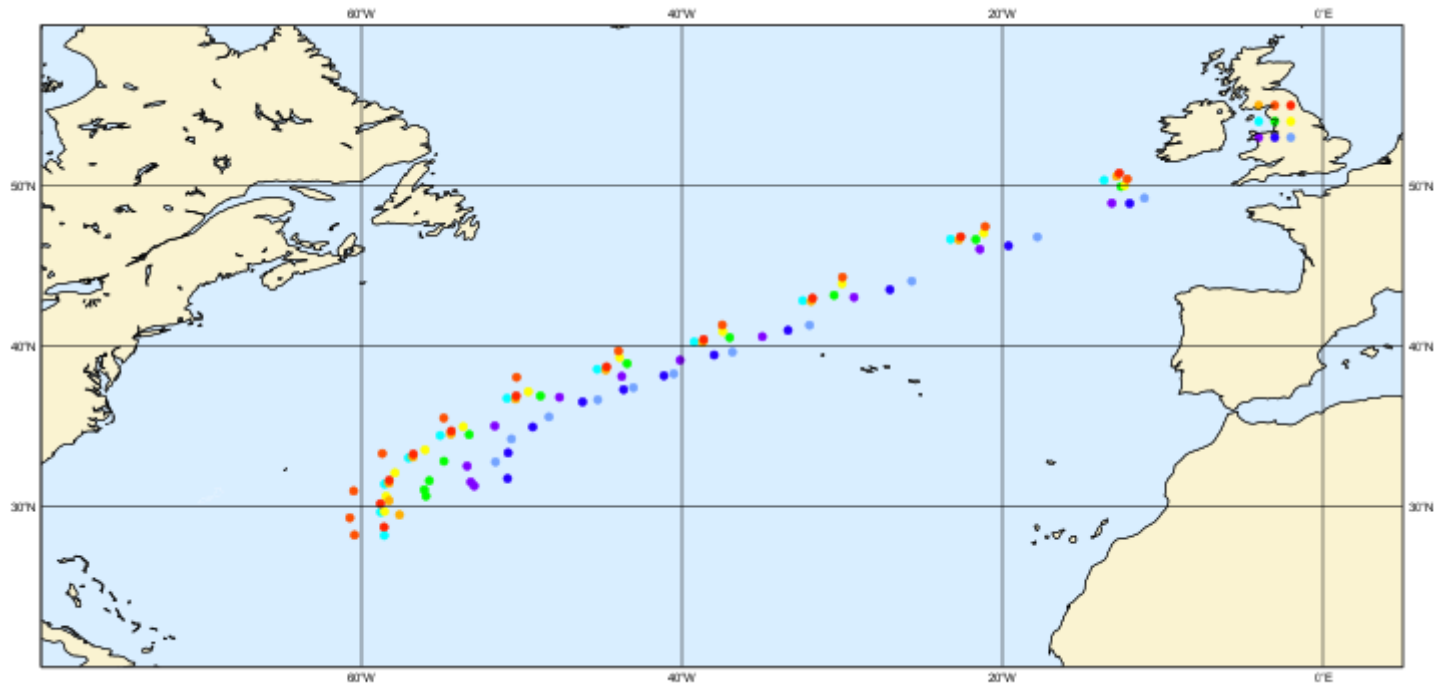
...but time sampling from LEO is poor...

Can MTG-IRS detect the initiation of
these AR events ?

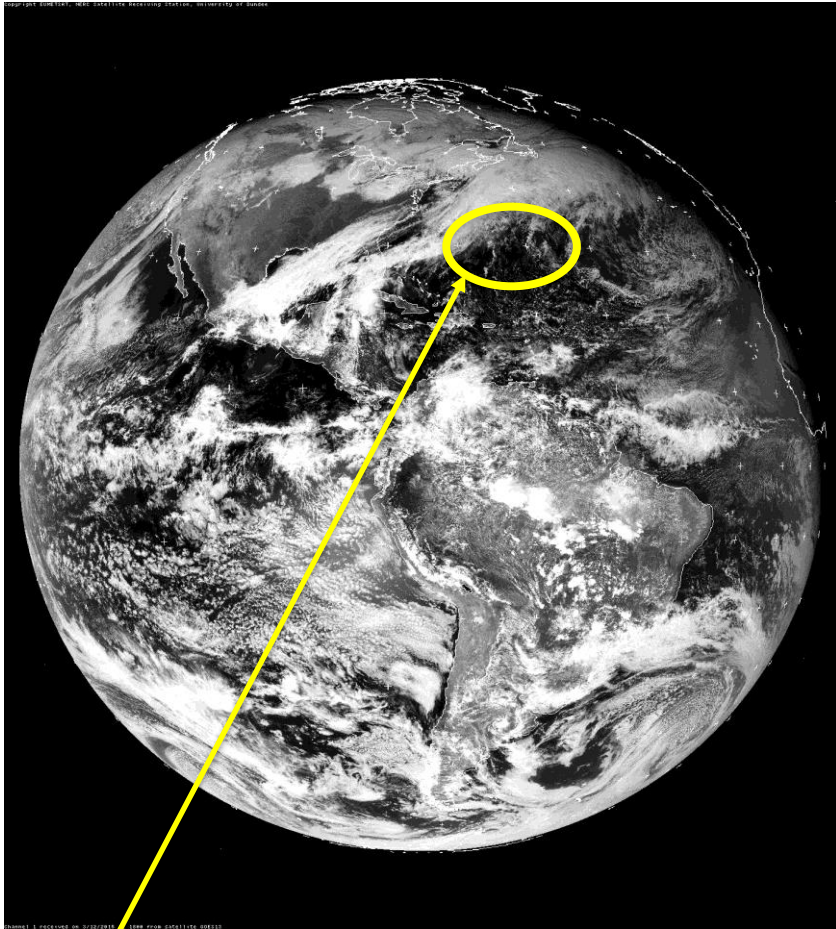
MTG-IRS fills a gap in the market....

- MW sensors on LEO can give good information on the total column WV and its spatial extent, but little on the vertical location of the humidity.
- Hyper-spectral IR on LEO can provide more information on vertical location and spatial extent, but potential issues of cloud contamination of the humidity signal.
- GEO IR gives excellent time sampling and the ability to dynamically trace the transport of humidity, but with almost no vertical skill.
- Hyper-spectral IR on GEO could provide information on vertical location, with excellent time sampling for early warning and jet speed tracing.

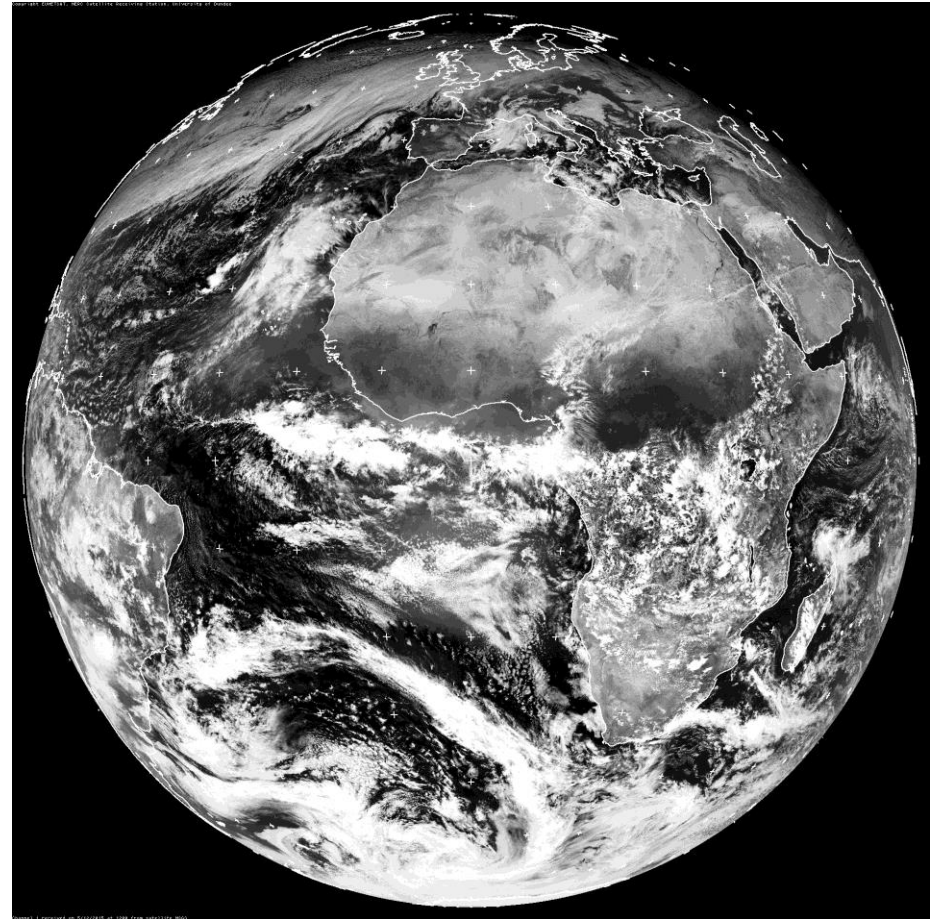
(Back Trajectory from 18UTC 5th Dec. 2015 to 00UTC 3rd Dec. 2015)



Visible image (Dundee Satellite Receiving Station)



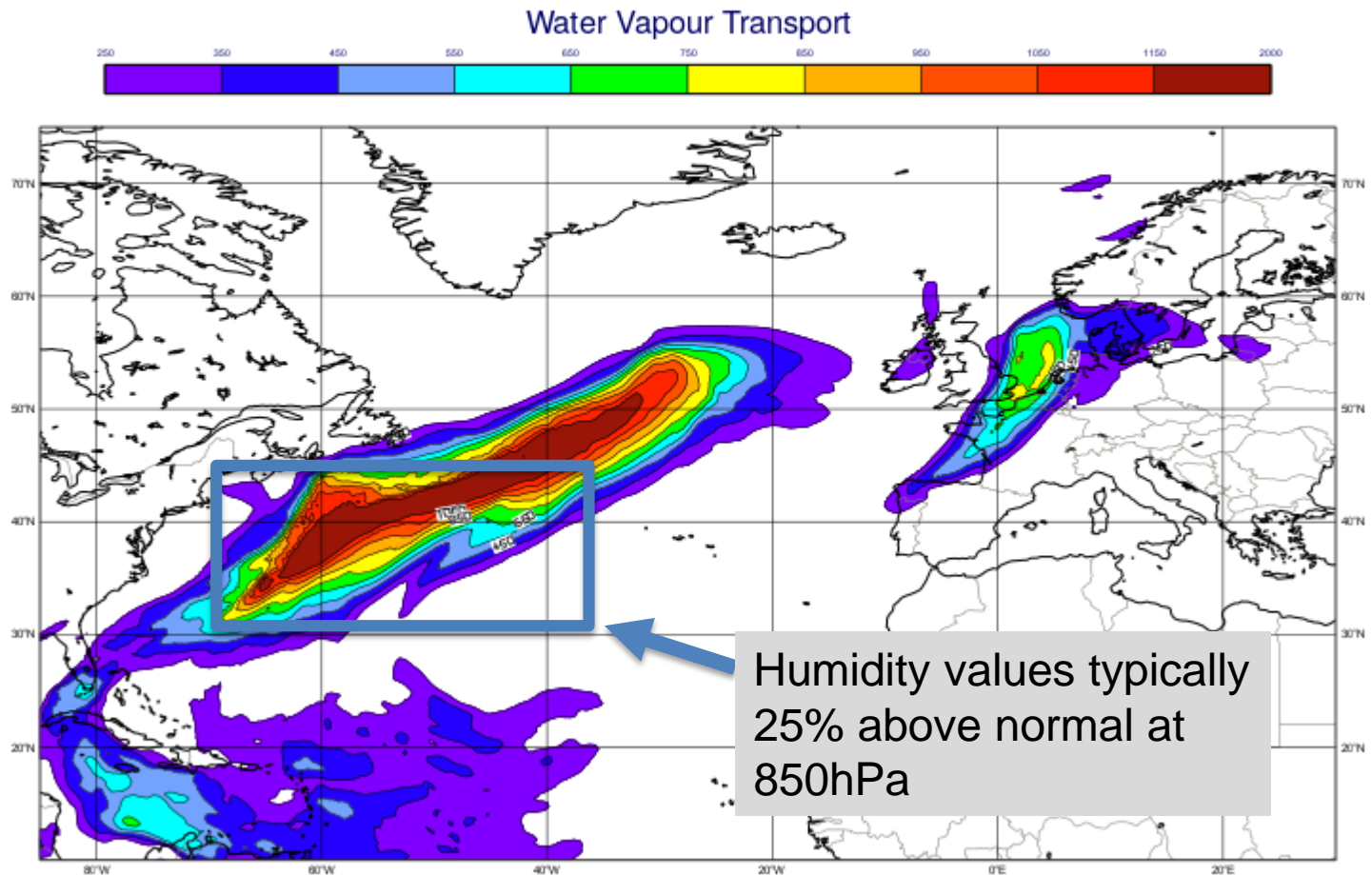
18UTC 3 DEC 2015 (left)



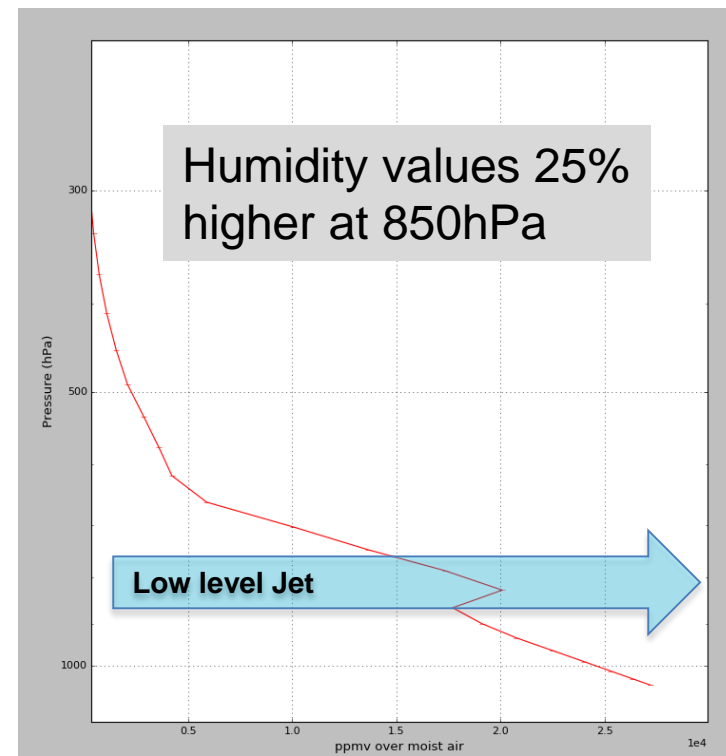
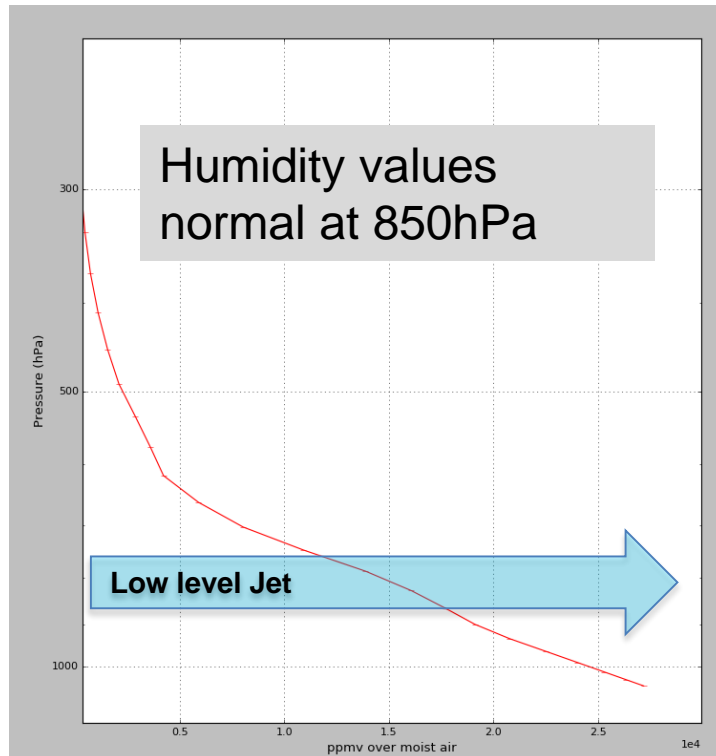
12UTC 5 DEC 2015 (right)

Region where trajectories go back to

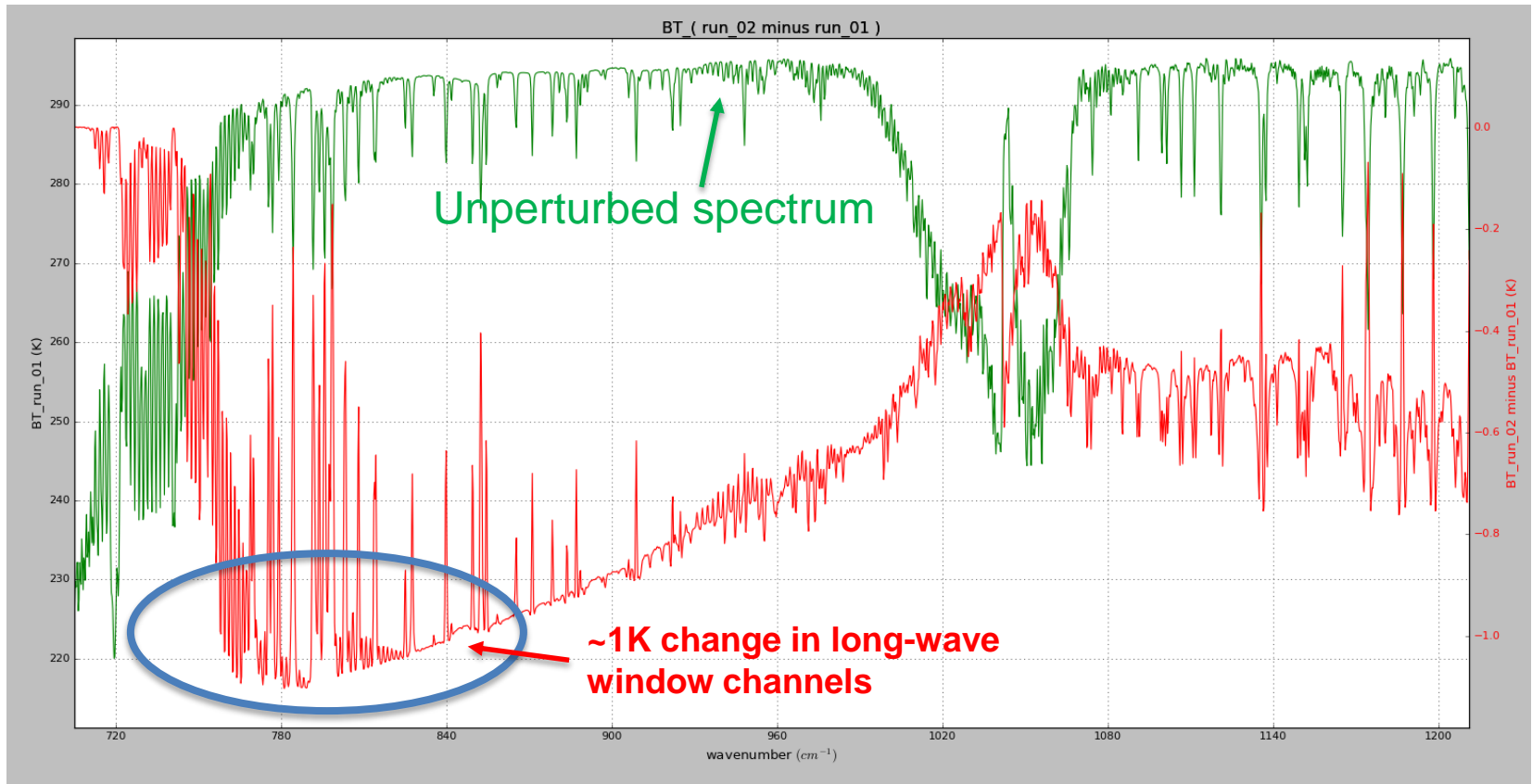
Water vapour transport field at analysis (12UTC 4th Dec. 2015, 00UTC 5th Dec. 2015, 12UTC 5th Dec. 2015)



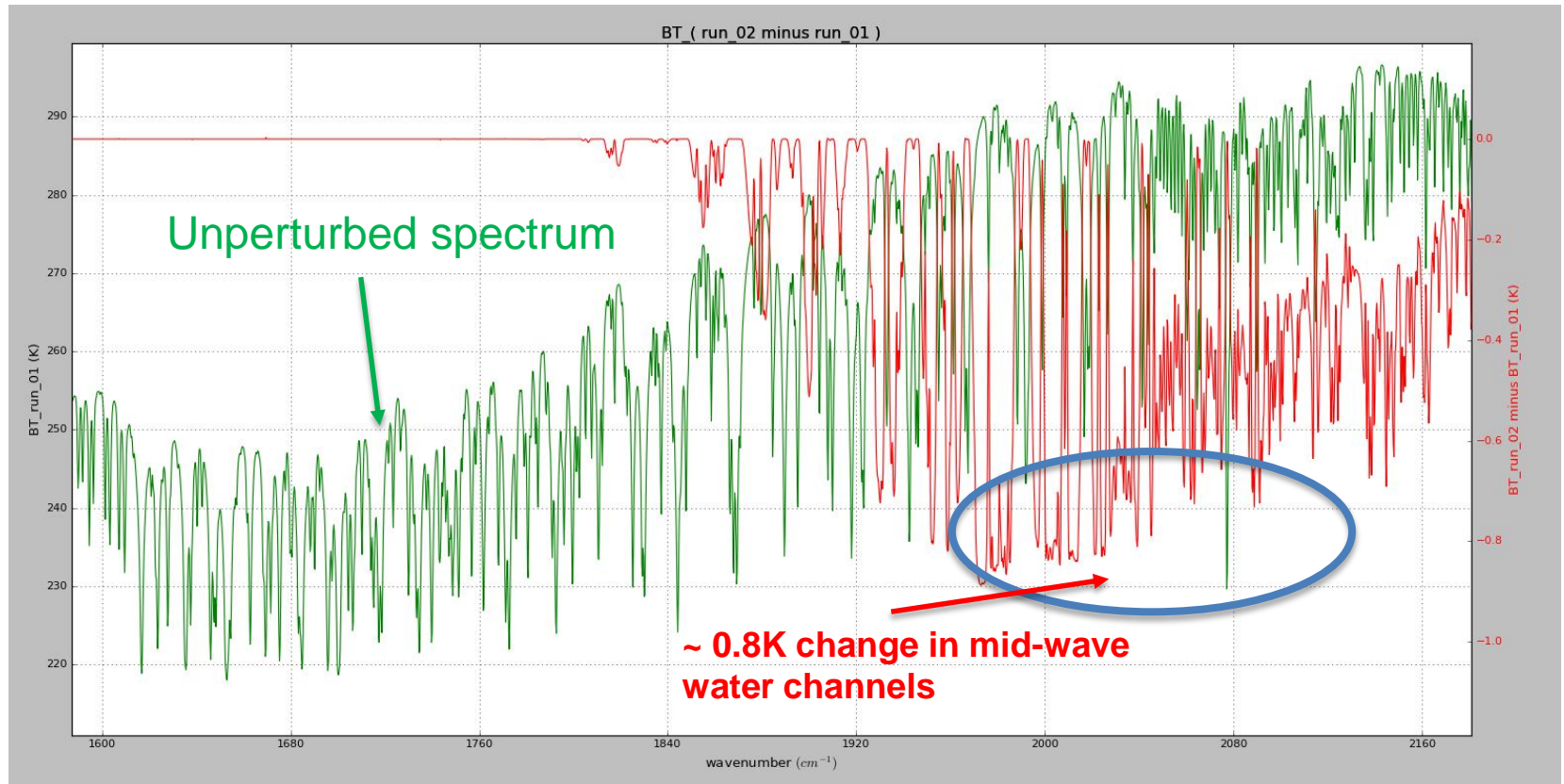
Can MTG-IRS detect elevated humidity values at the altitude of the low level wind jet ?



Radiance response to elevated humidity in MTG-IRS long-wave band 700–1210 cm^{-1}



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 must kept be low.

In the early stages there are fully clear sky pixels (at MTG-IRS 4km), 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

- AR events are drivers of extreme weather events in the US and Europe and can cause severe flooding.
- Once established they can be observed from existing microwave and infrared satellites.
- MTG-IRS has the potential to observe the initiation of these events (with high time resolution) as water vapour is injected to the low level wind jet.
- But successful observation will require noise to be kept very low, accurate cloud detection, and accurate modelling of the underlying surface emission.