

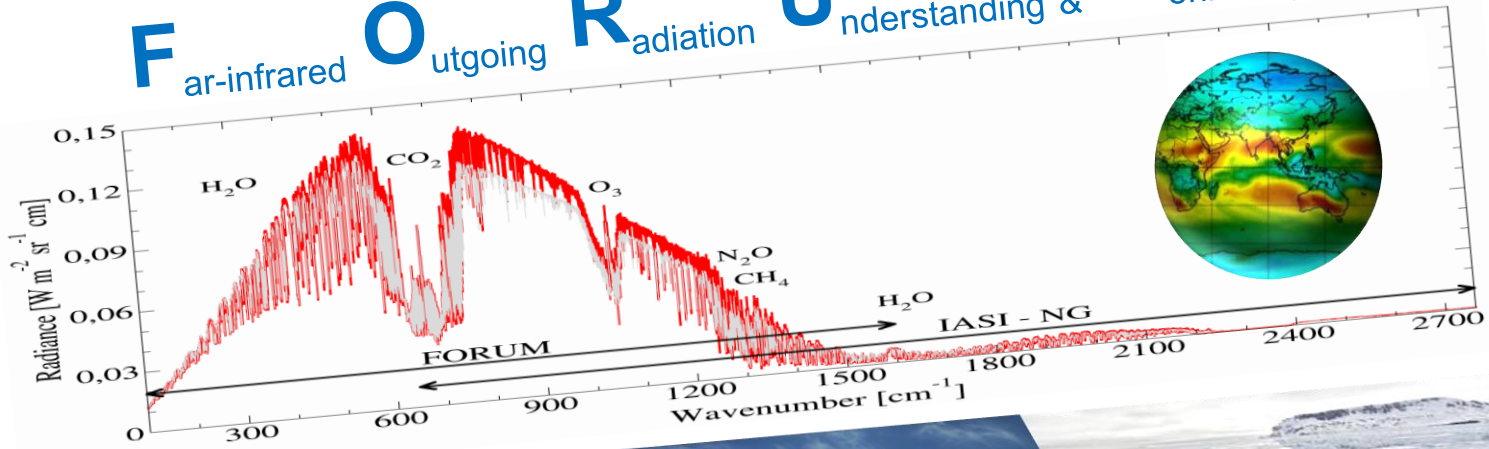
Science Opportunities with FORUM

Helen Brindley

Space and Atmospheric Physics and
National Centre for Earth Observation,
Imperial College London

Why FORUM?

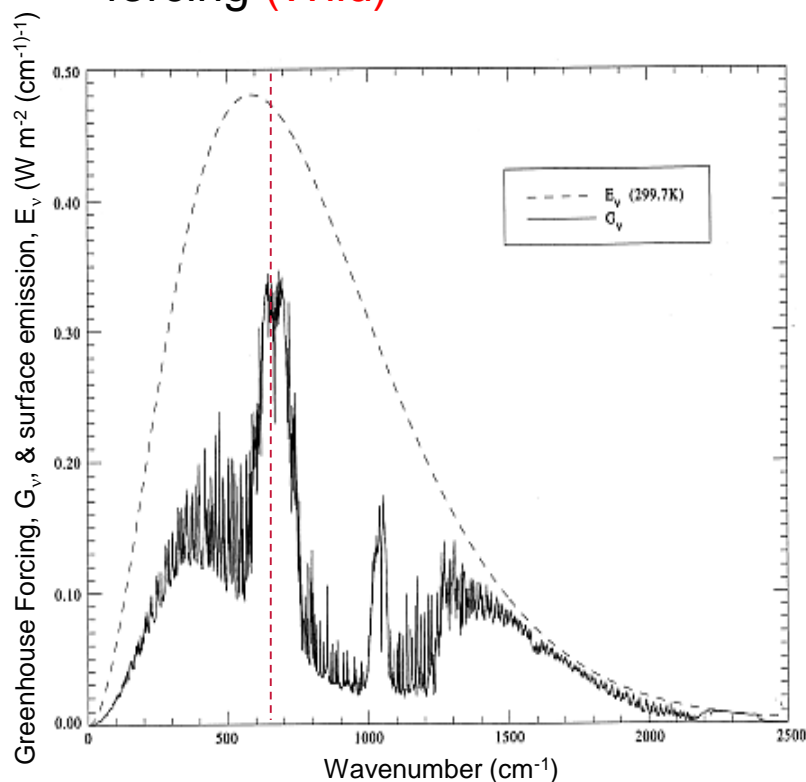
Far-infrared **O**utgoing **R**adiation **U**nderstanding & **M**onitoring



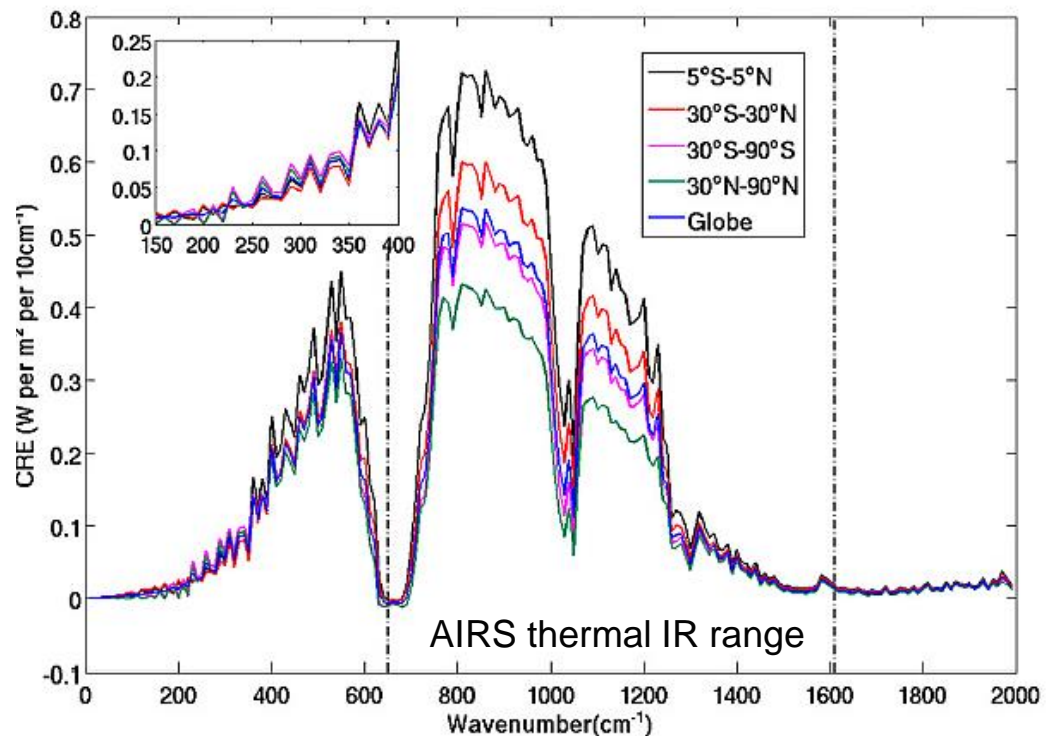
Why FORUM?

But we can measure broadband OLR so why do we care?

(I) Measure, for the first time, the spectral greenhouse effect, spectral cloud radiative forcing (Wild)



Brindley and Harries, 1998



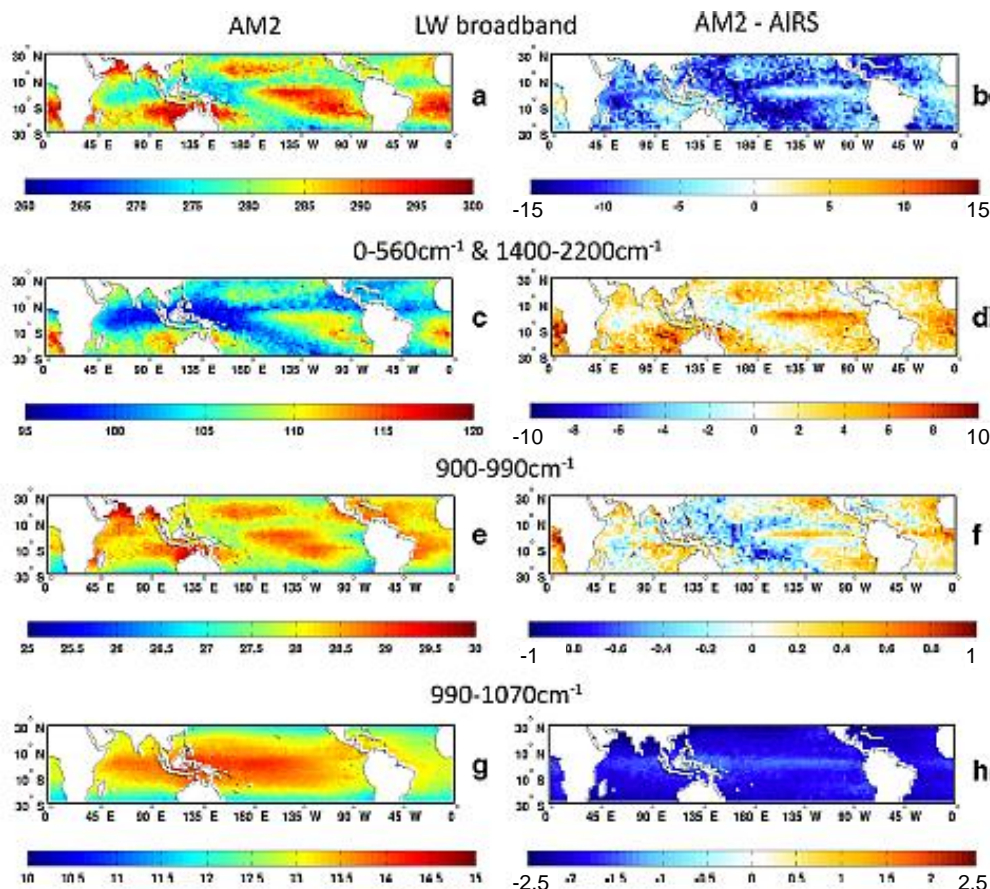
Huang *et al.*, 2014

Why FORUM?

But we can measure broadband OLR so why do we care?

Diagnosis of gross biases and compensation effects in Forecast/Climate/ES Models

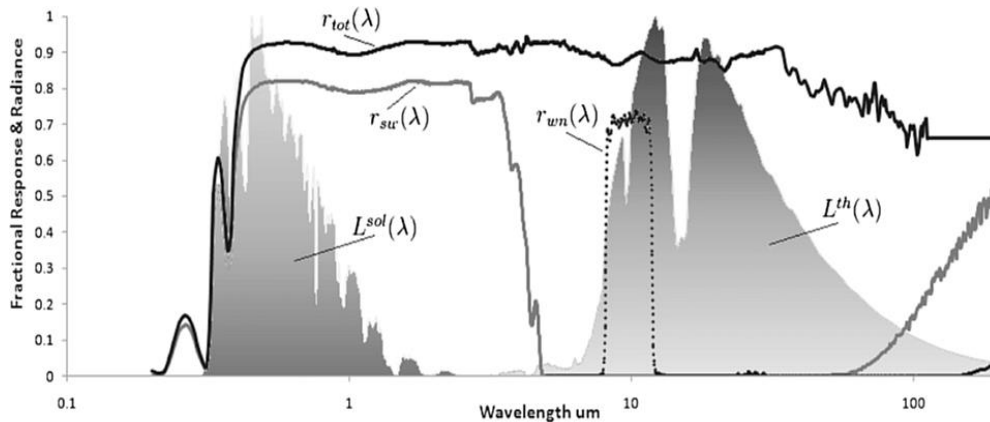
(Huang)



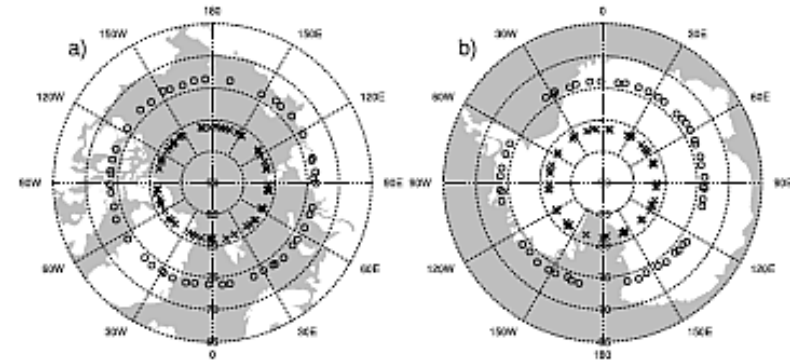
Simulated clear-sky OLR (left column) and difference with AIRS estimates (right column) for different spectral bands. (adapted from Huang *et al.*, 2008)

Why FORUM?

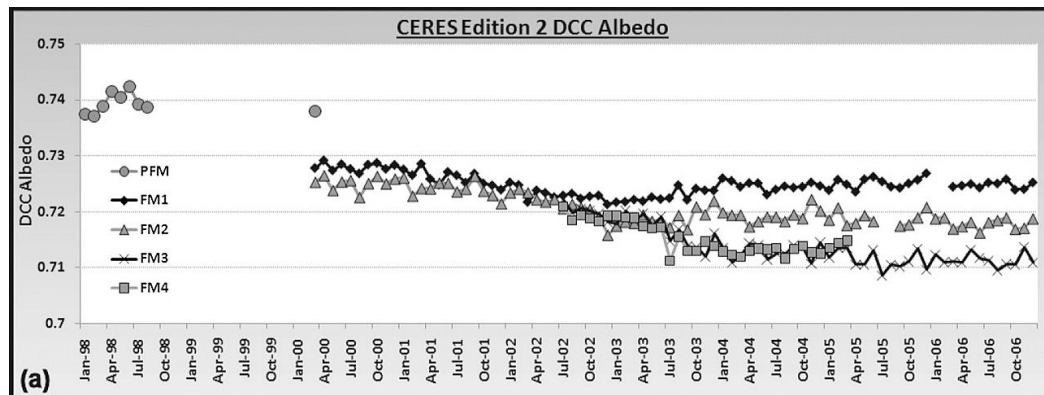
Enhancing confidence in long-term records of global ERB



Filter functions on CERES, with typical scattered solar and emitted thermal radiation (Wielicki *et al.*, 2007)



SNOs identified for CERES and MetOp-A IASI (Turner *et al.*, 2015)

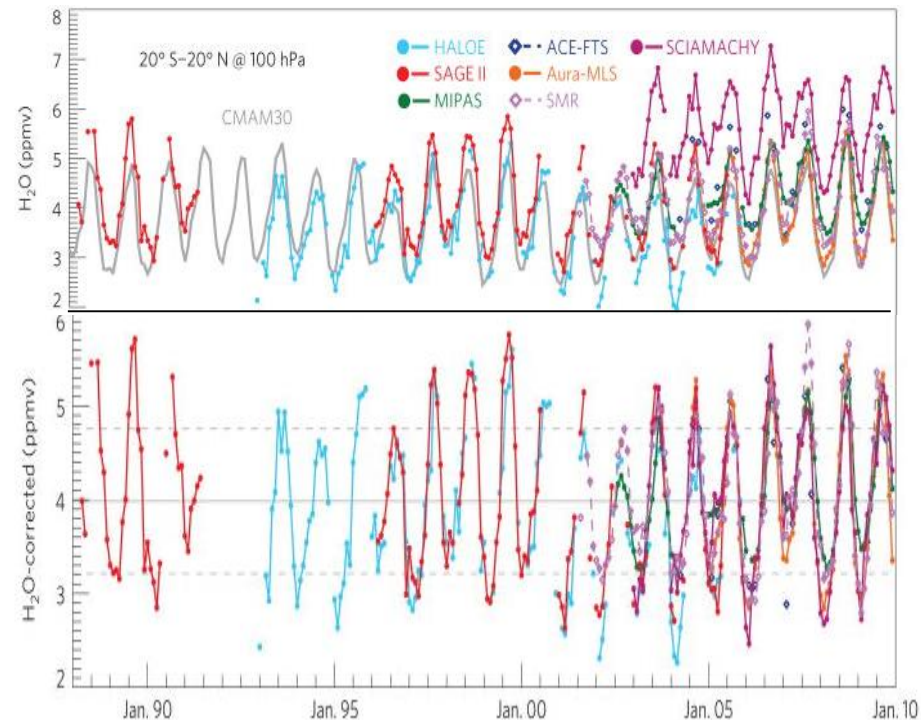
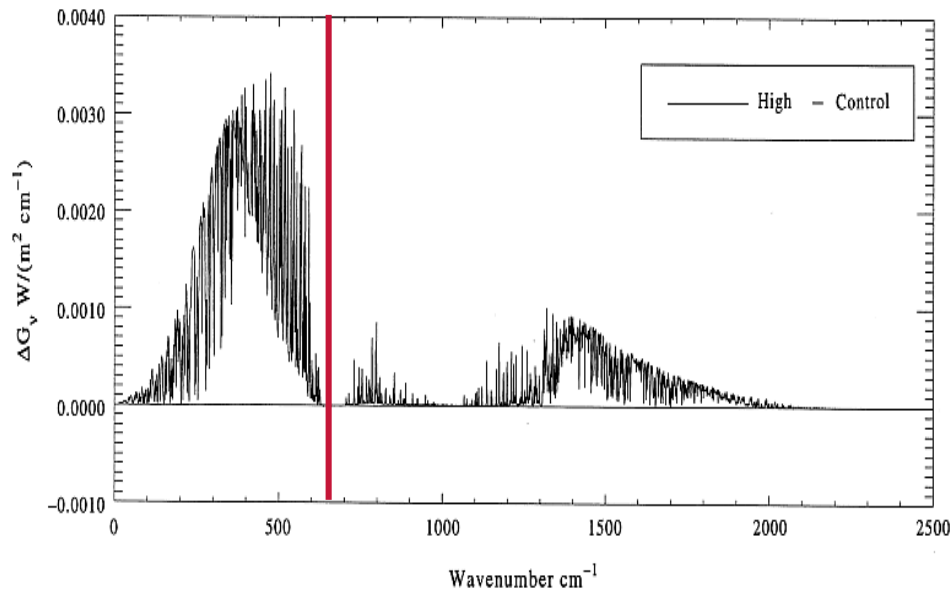


Optical degradation in original Edition 2 measurements of DCC (Wielicki *et al.*, 2007)

Why FORUM?

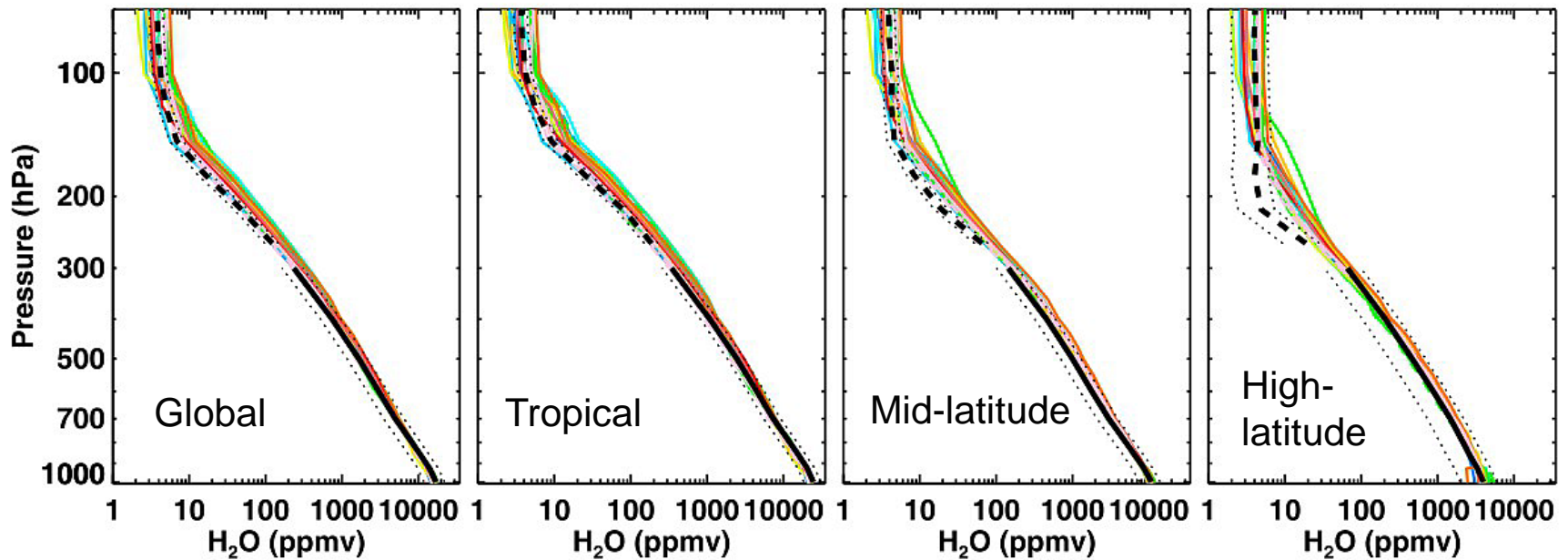
(II) Improve retrievals of key geophysical parameters for climate sensitivity

(A) Upper tropospheric/Lower stratospheric water vapour (Hegglin, Buehler)



“...need for independent and redundant global measurement systems characterized by high long-term accuracy (and precision) to be able to quantify long-term changes in stratospheric water vapour with more confidence.” Hegglin *et al.*, 2014

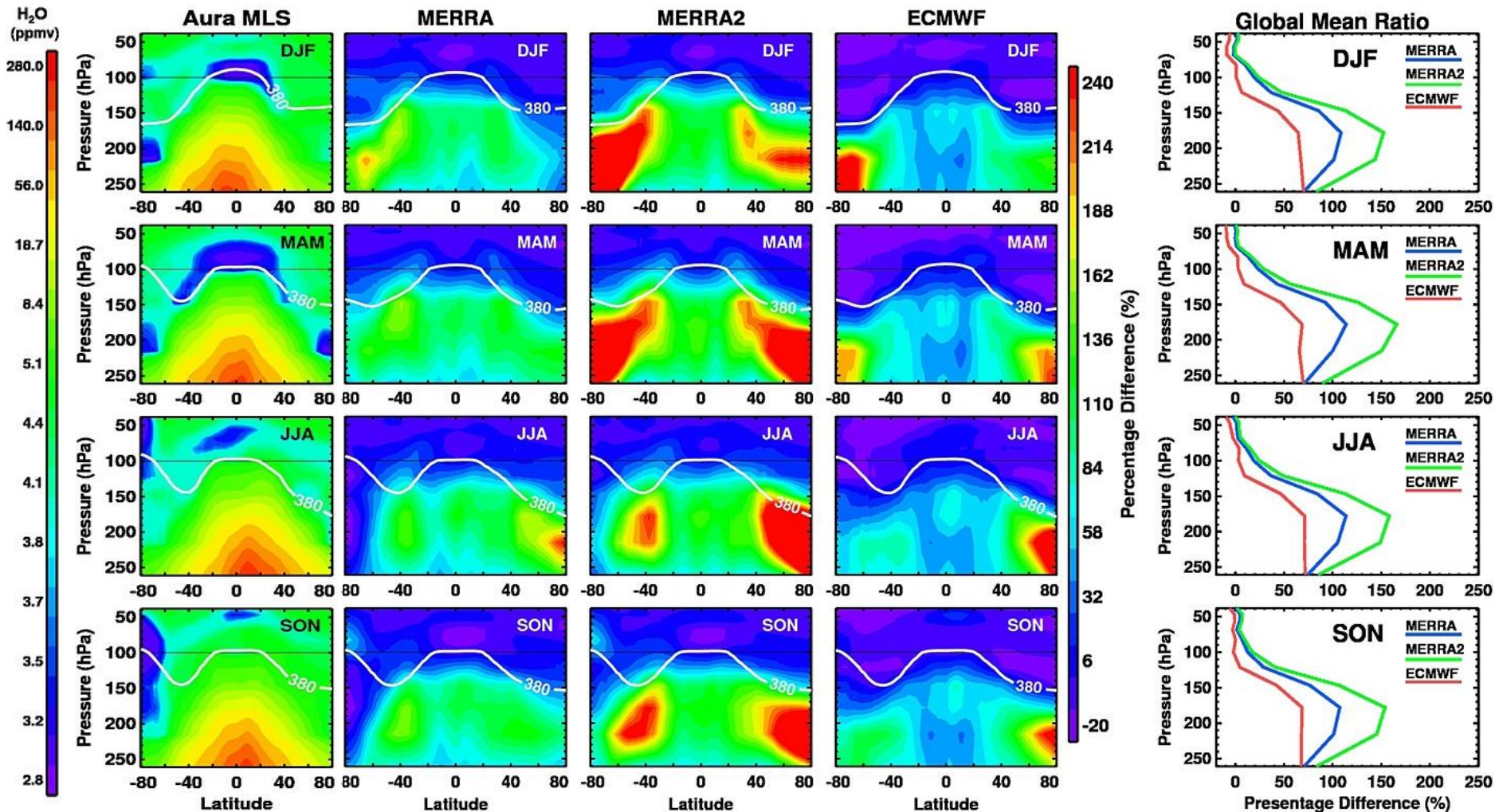
Why FORUM?



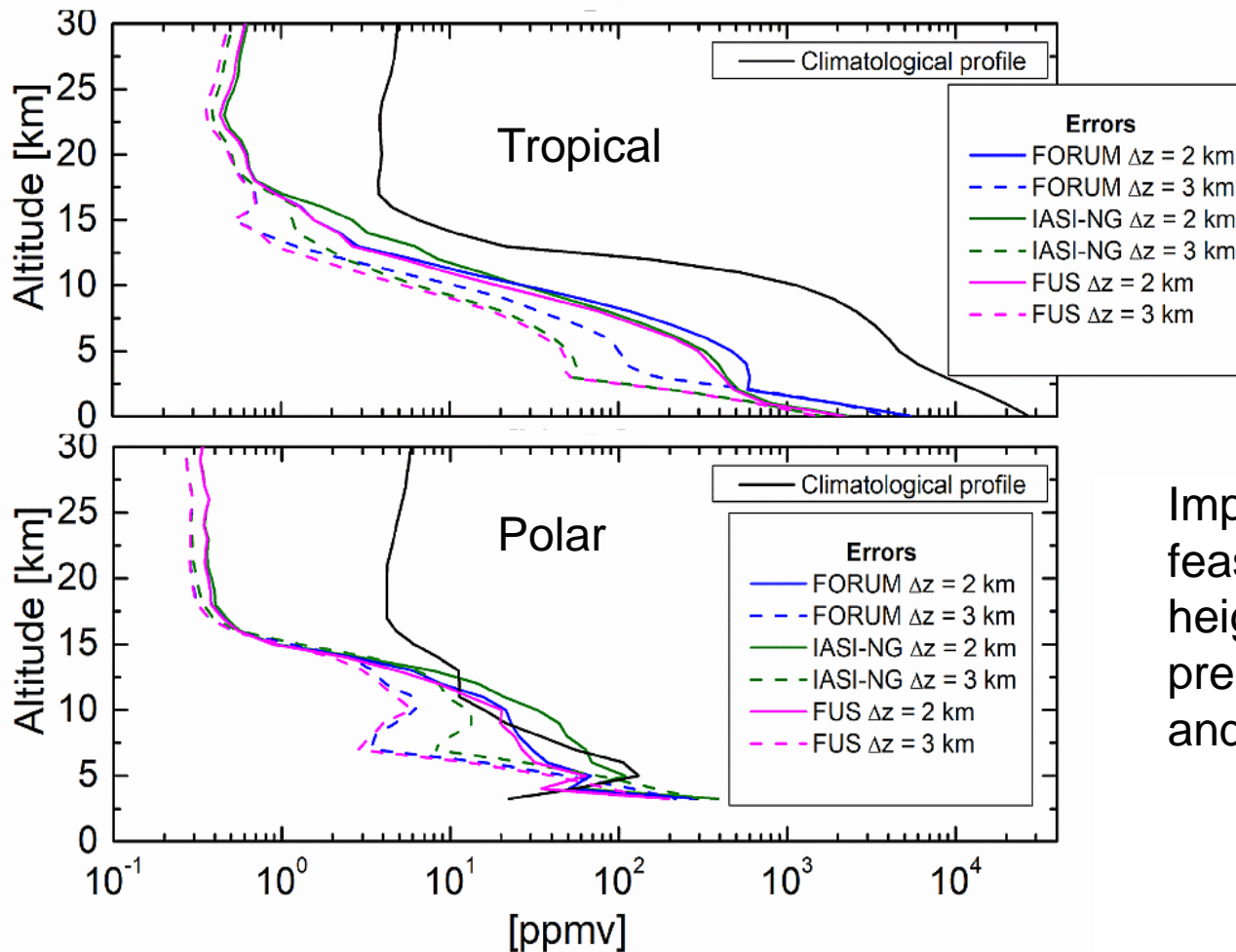
Multiyear mean H₂O vertical profiles from CMIP5 models (coloured lines) and retrieved from A-Train observations. Retrievals are from Aqua AIRS (black line) below 300 hPa and from Aura MLS (dashed lines) above 300 hPa (After Jiang *et al.*, 2012)

Why FORUM?

Jiang *et al.*, 2015



Why FORUM?



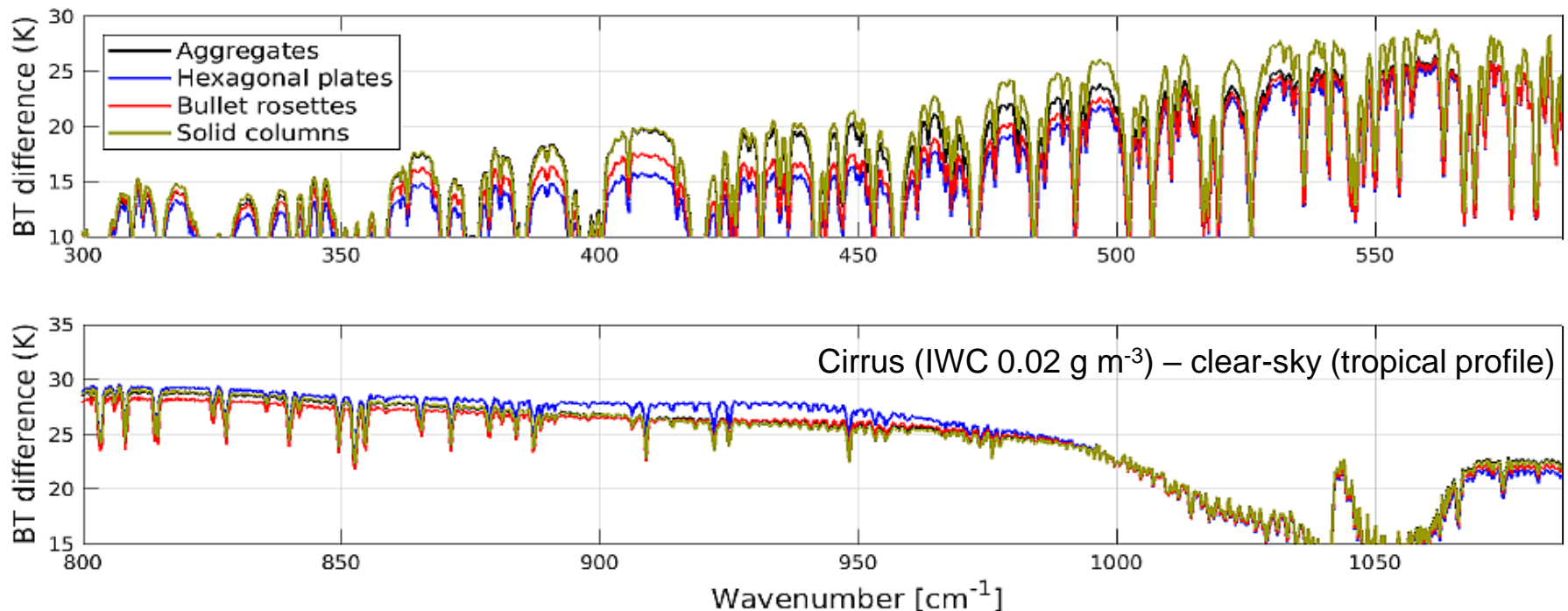
Improved retrievals also feasible above cloud top height (e.g. in the presence of cirrus, Feng and Huang, 2018)

Why FORUM?

(II) Improve retrievals of key geophysical parameters for climate sensitivity

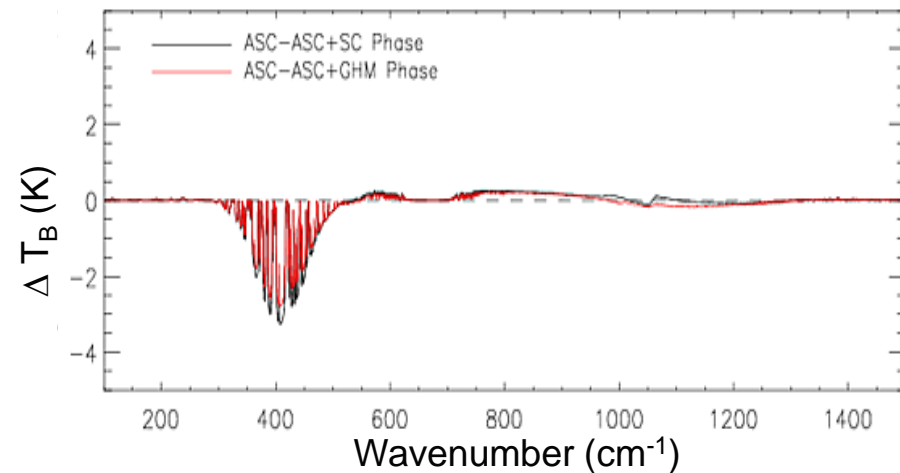
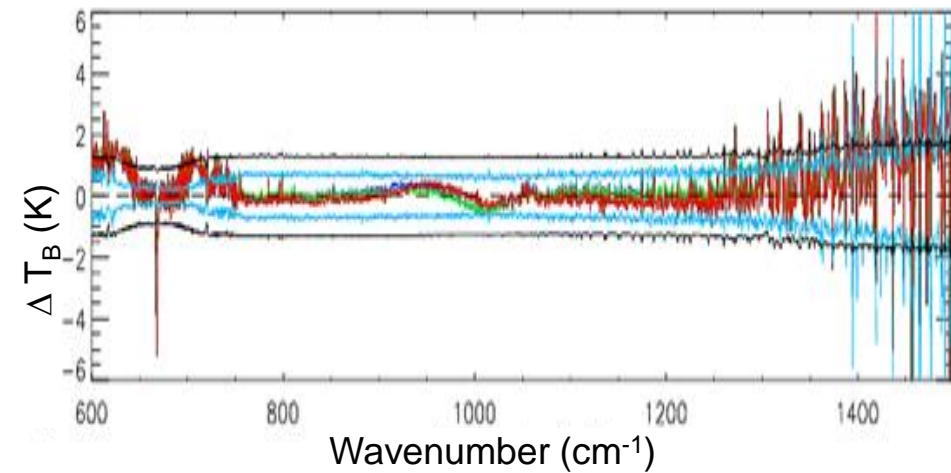
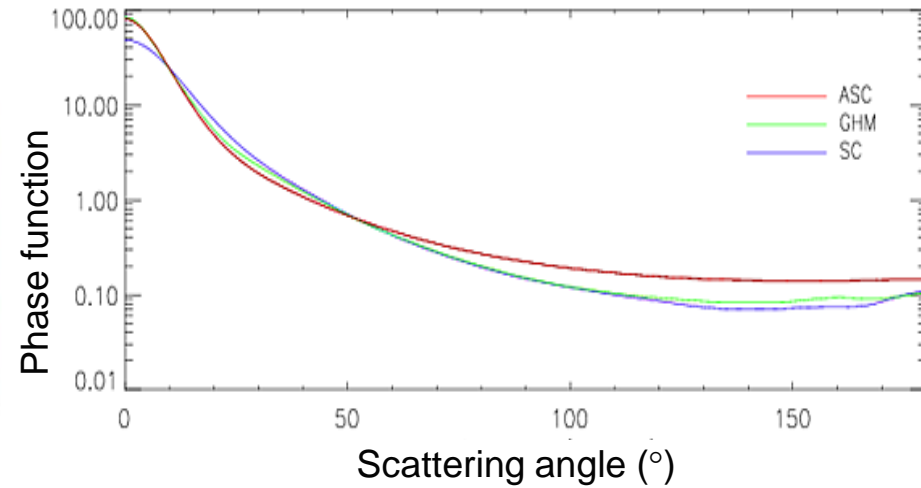
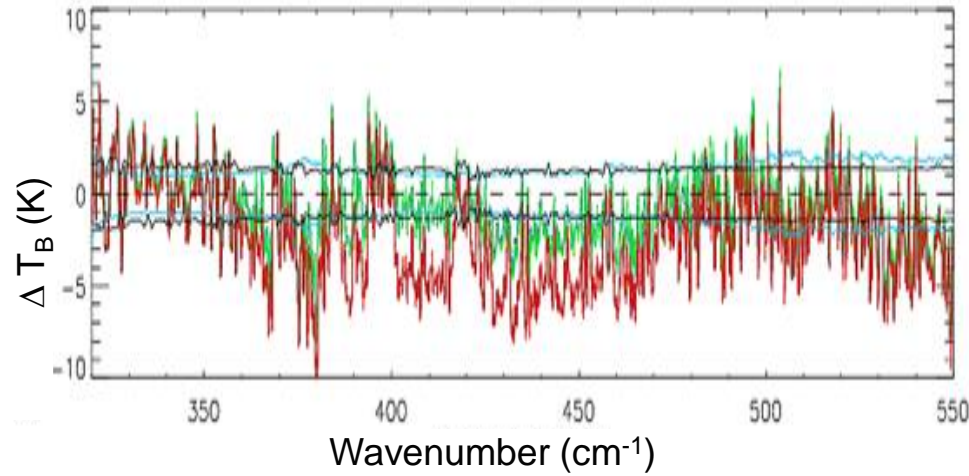
(B) Cirrus (and mixed phase?) cloud (Yang, Maestri)

“The role of thin cirrus clouds for cloud feedback is not known and remains a source of possible systematic bias... the representation of cirrus in GCMs appears to be poor... such clouds are microphysically complex” (IPCC, 2013)



Why FORUM?

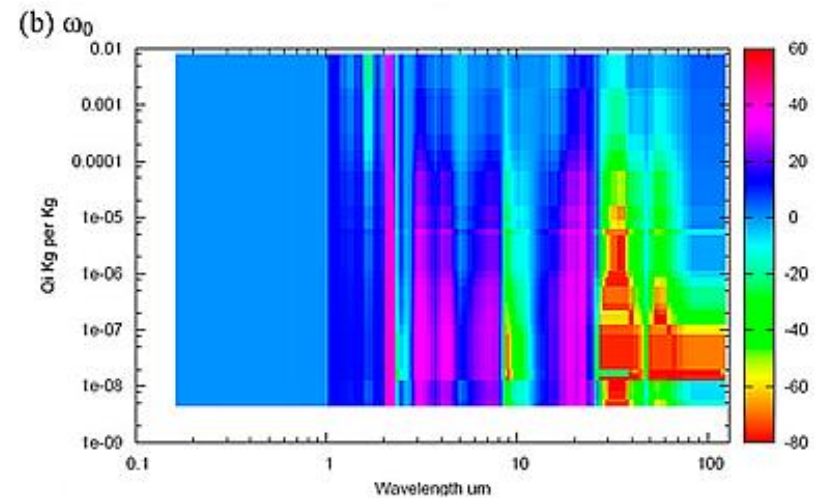
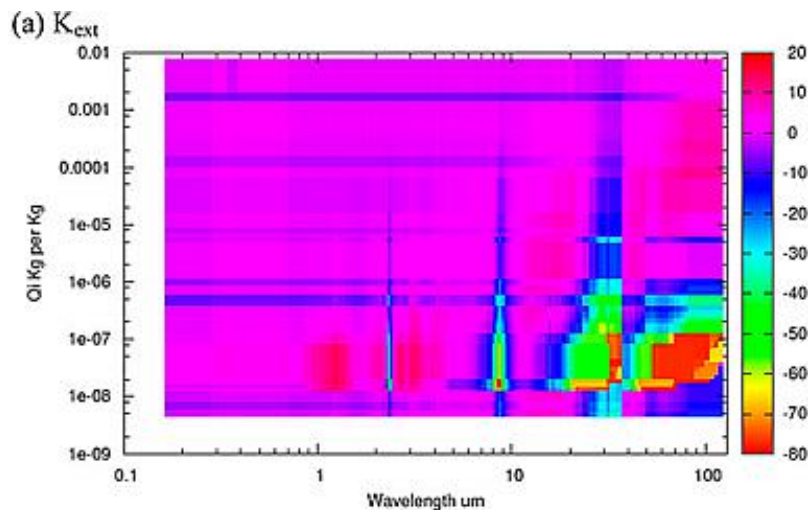
CIRCCREX Flight B818



Why FORUM?

(II) Improve retrievals of key geophysical parameters for climate sensitivity

(B) Model evaluation – can current bulk models capture the radiative signature of cirrus consistently across the EM spectrum? Can the self-consistency in ESM cloud/radiation modules be tested and improved? (Yang, Baran)

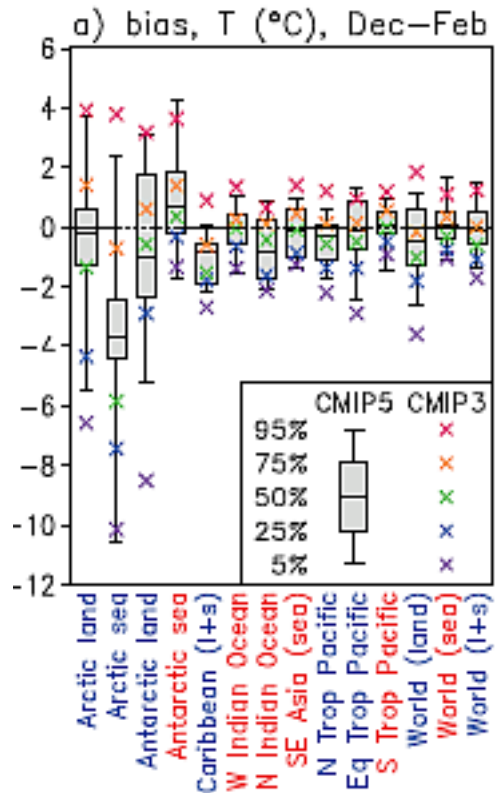


Relative percent error in bulk cirrus properties as a function of ice water content and wavelength (after Baran *et al.*, 2014)

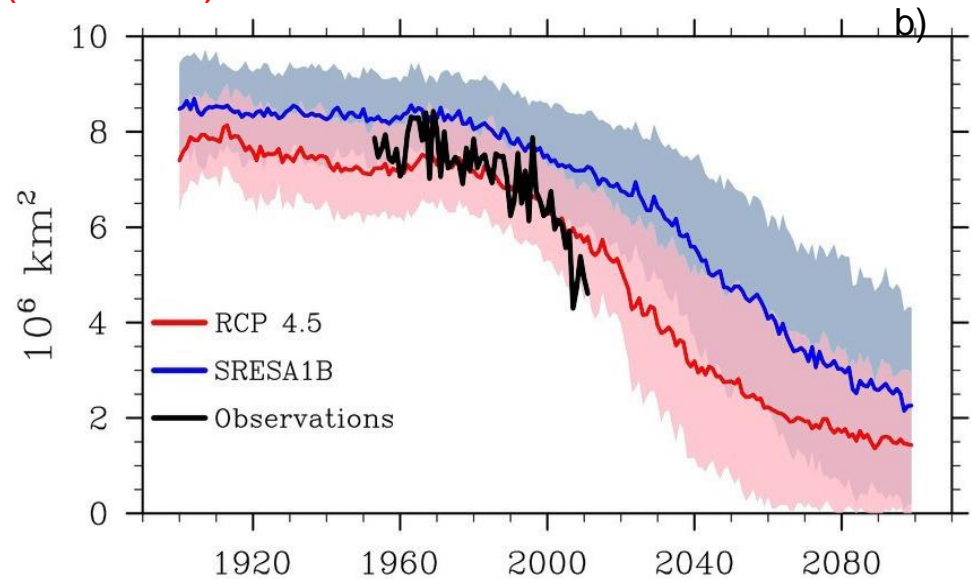
Why FORUM?

(II) Improve retrievals of key geophysical parameters for climate sensitivity

(C) High-latitude surface emissivity (Feldman)

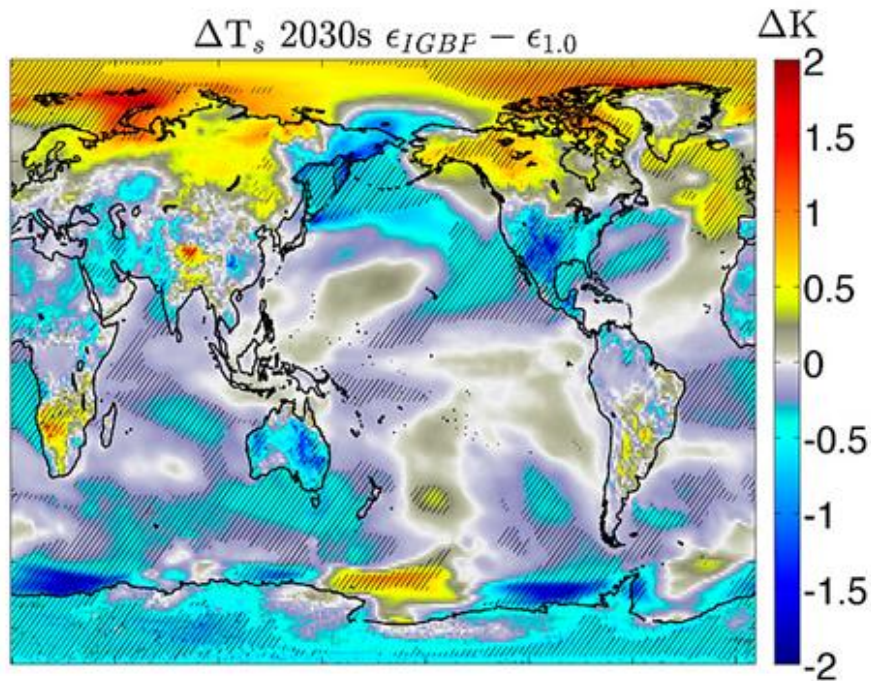


(a) Dec-Feb multi-model temperature biases relative to ERA-I from 1986-2005 (Flato et al., IPCC, 2013)

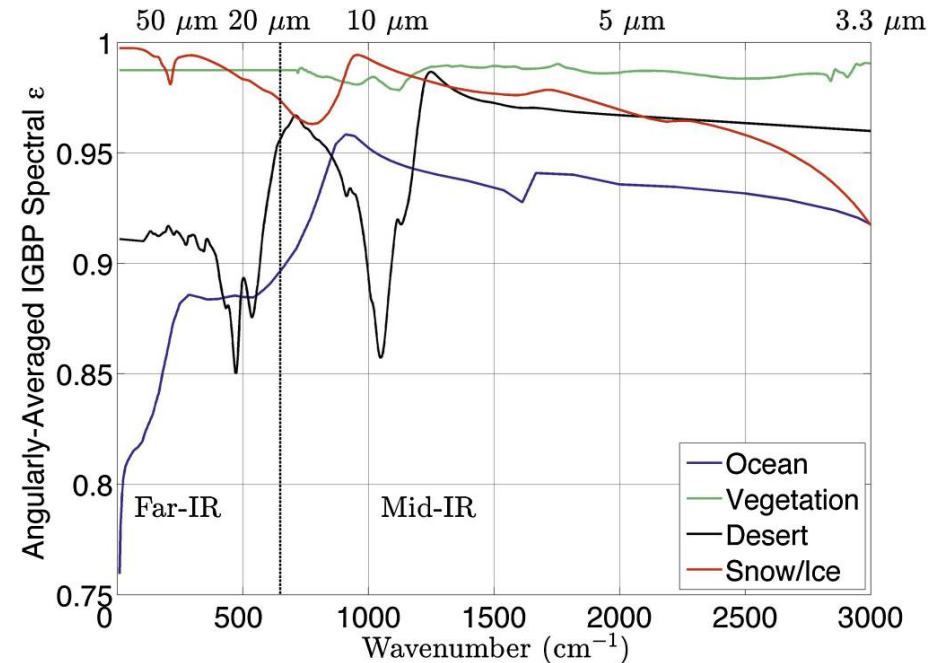


(b) Observed September sea-ice extent from 1952-2010 (black) and from 1900-2100 under BaU scenario (CMIP3 models – blue) and RCP 4.5 scenario (CMIP5 models – red). (from Stroeve et al., 2012)

Why FORUM?

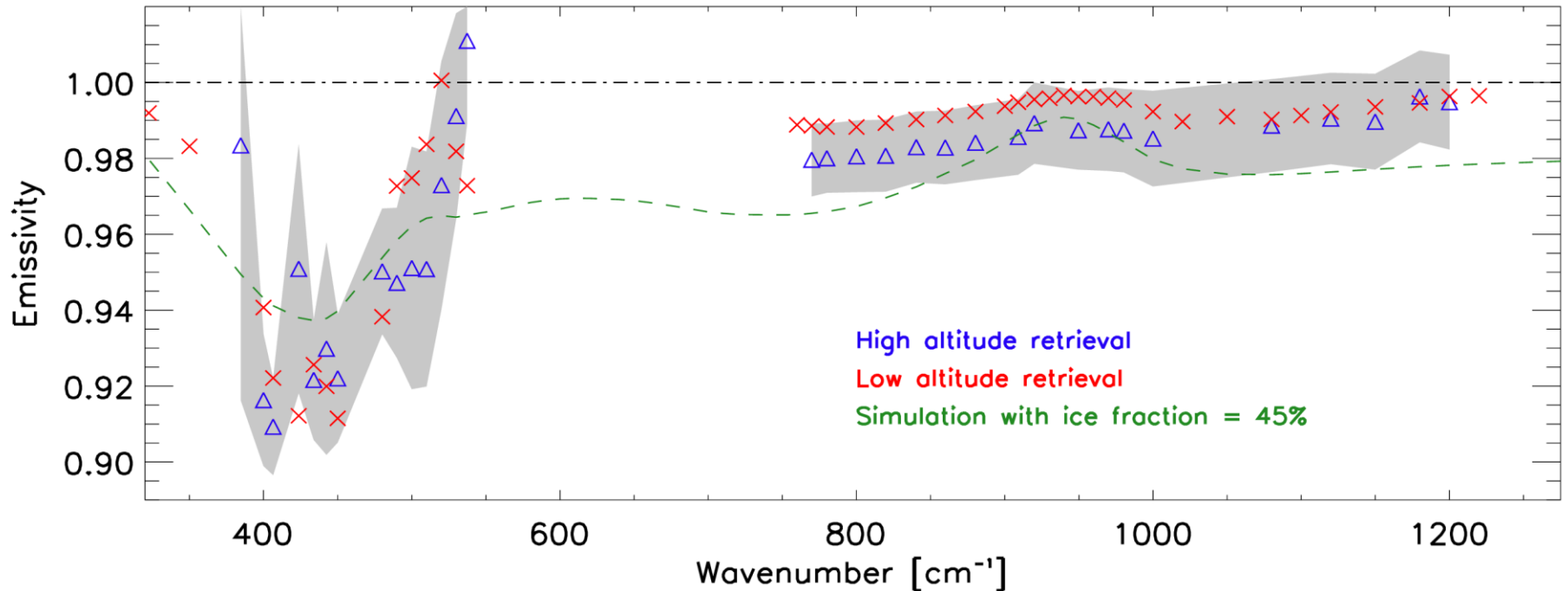


Feldman *et al.*, 2014



- Implementing estimates of spectral snow/ice surface emissivity reduces cold Arctic bias in CESM (Kuo *et al.*, 2018).
- Role of emitted far infra-red radiation seems important in determining future Arctic change (Feldman *et al.*, 2014, Huang *et al.*, 2018)
- Caveat: All studies use theoretical FIR surface emissivities

Why FORUM?



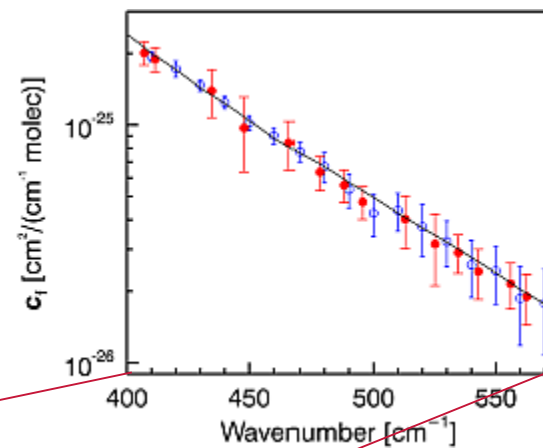
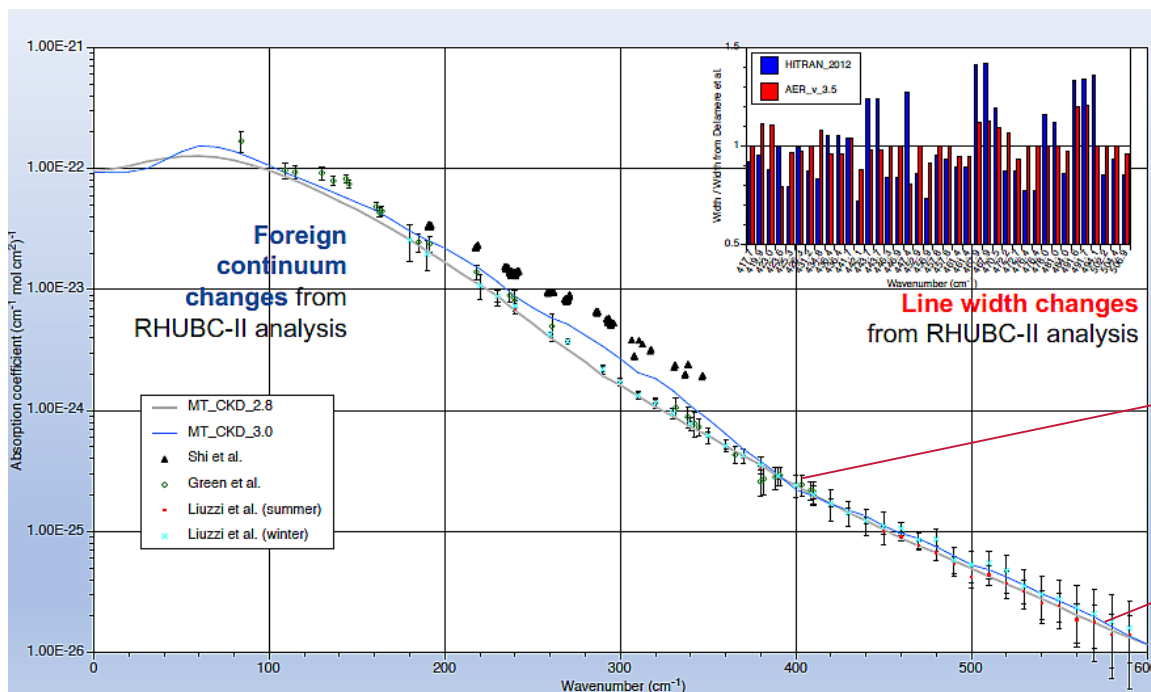
- Aircraft observations imply that retrievals of FIR emissivity should be in scope for FORUM



Why FORUM?

(III) Provide a 'modelling relevant' test of current spectroscopic knowledge

(A) First assessment of FIR water vapour spectroscopy over the full range of global conditions (Mlawer, Sussman)



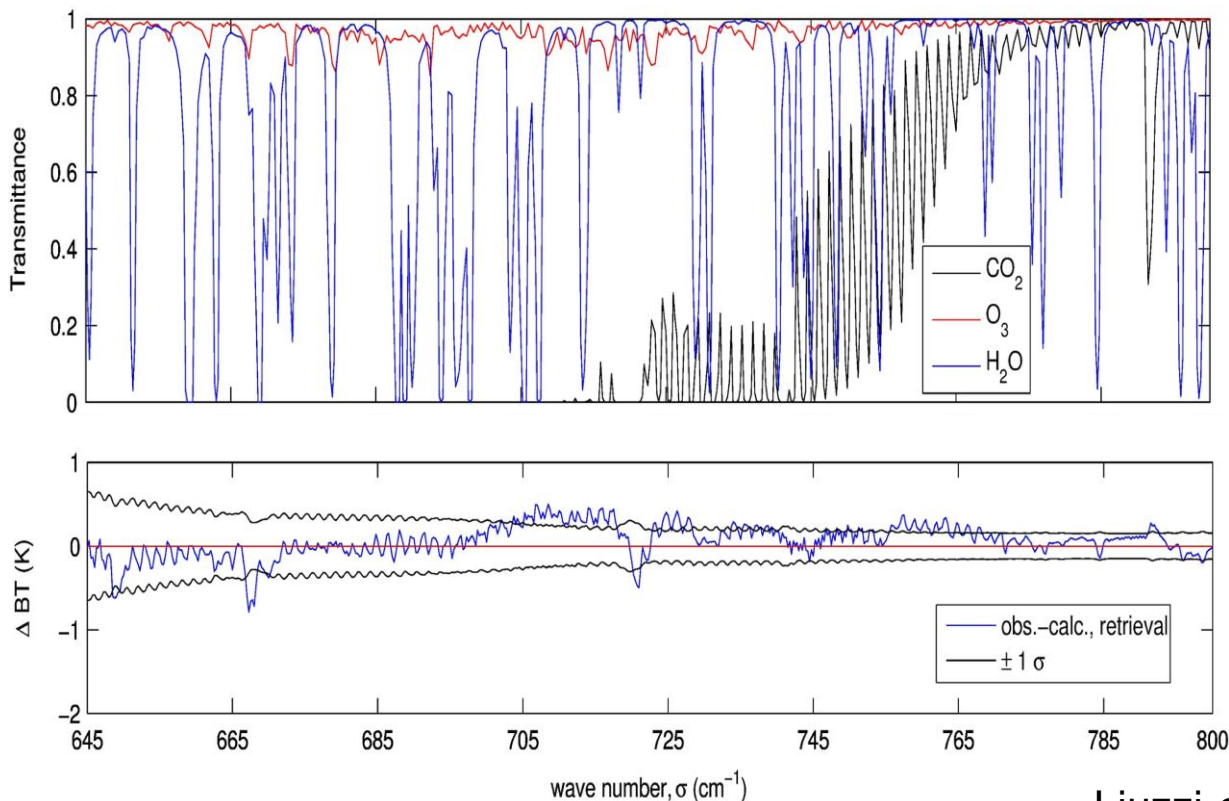
Sussman *et al.*, 2016

Mlawer *et al.*, 2018 (ECMWF Workshop)

Why FORUM?

(III) Provide a 'modelling relevant' test of current spectroscopic knowledge

(B) Application to CO₂ and minor atmospheric constituents (Serio, Flaud, Perrin)



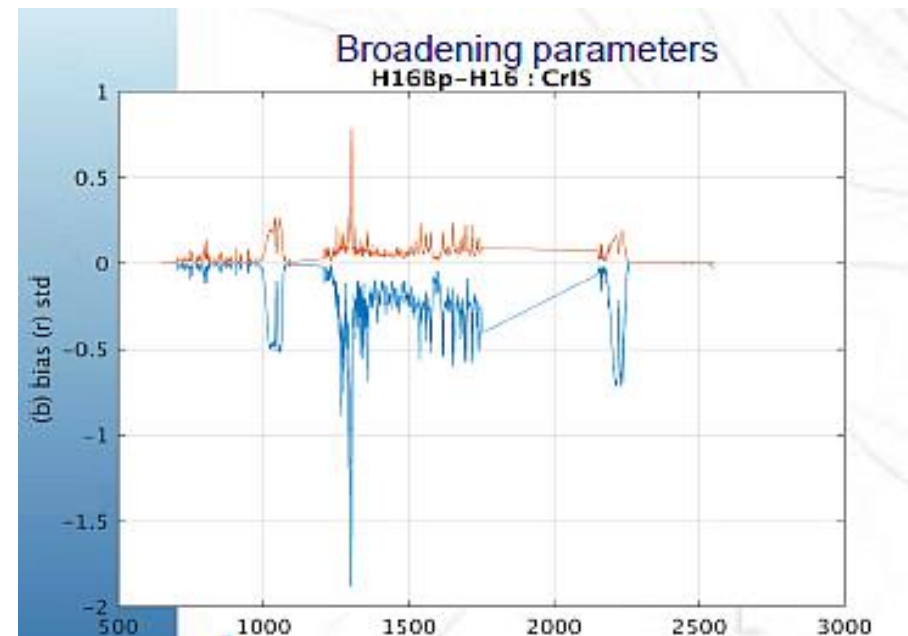
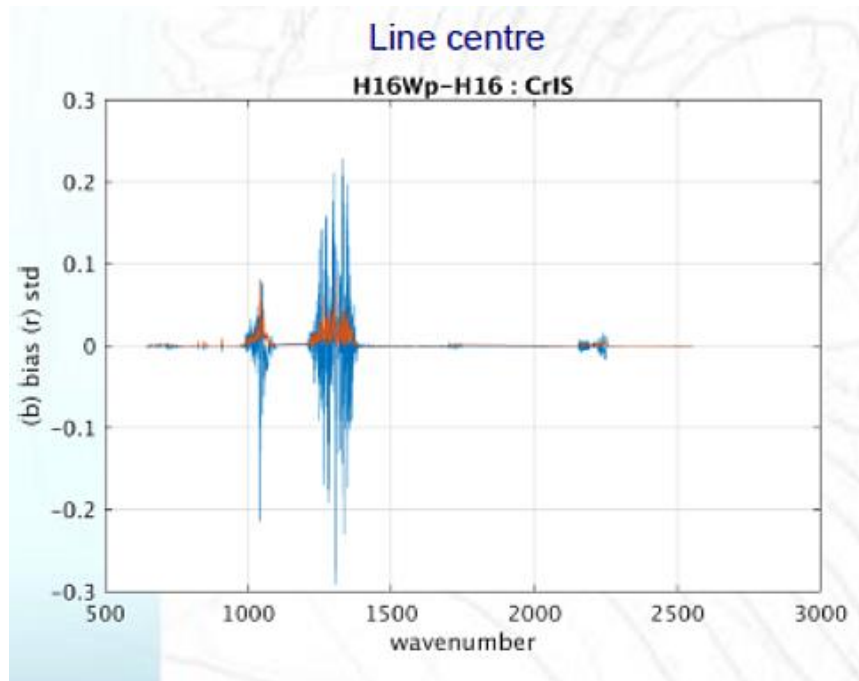
Potential for
combined T and
CO₂ retrieval?

Establishment of
'FIR benchmark' for
future reference?

Why FORUM?

(III) Provide a 'modelling relevant' test of current spectroscopic knowledge

(C) Assess impact of estimated uncertainties in current spectroscopic databases



Δ H₂O, O₃, N₂O, CO, CH₄, SO₂, HNO₃

HITRAN 2016 uncertainties vs CrIS (De Souza-Machado)

Schedule

Overall Programme Logistics

- E2E simulator under construction
- Planned ground and flight campaigns autumn 2018/spring 2019
- Down selection to 1 mission scheduled for summer/autumn 2019
- Nominal launch date: 2025

Upcoming Meetings

EGU, Far infrared session (provisional),
Vienna, April 2018

Living Planet Symposium, Milan, May 2019
(abstract deadline, 11 Nov 2018)

