HYMAS – Filterbank spectrometers for HYperspectral Microwave Atmospheric Sounding

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Met Office

Question:

Can we achieve the same performance with a microwave instrument under cloudy sky conditions as infrared instruments under clear sky?

What is the current state of atmospheric sounders?

IR sounders

- IASI, AIRS
  - 2378-8534 channels
  - 19-83 THz
  - NEDT 0.14 - 2.0 K
- Good performance
- Limited to *clear sky conditions* only

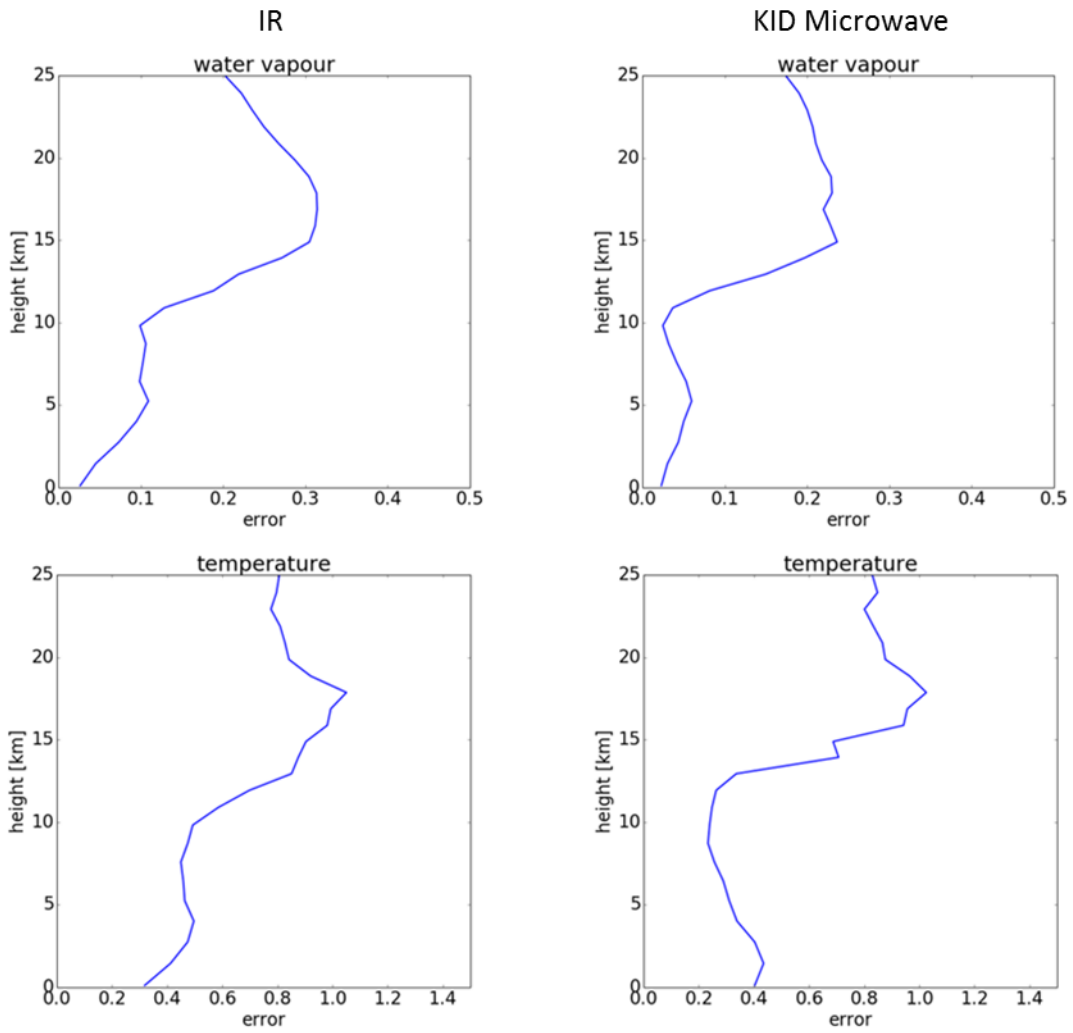
MW sounders

- AMSU-A/B, MWS, MWI
  - 5 – 26 channels
  - 18.7 - 229 GHz
  - NEDT 0.15 – 1.2 K
- Poor vertical resolution
- Can see down into cloud

Hyperspectral MW

- HYMAS
  - 100 – 1000 channels
  - 50 - 850 GHz
  - NEDT 0.007 – 0.024K
- Same as MW but:
- Increased channels
- Higher Sensitivity

Why do we need a Hyperspectral solution?



Improvement in Temperature and Water vapour retrievals

Increased data synergy by combining a hyperspectral MW & IR data

Impact to future Numerical Weather Prediction

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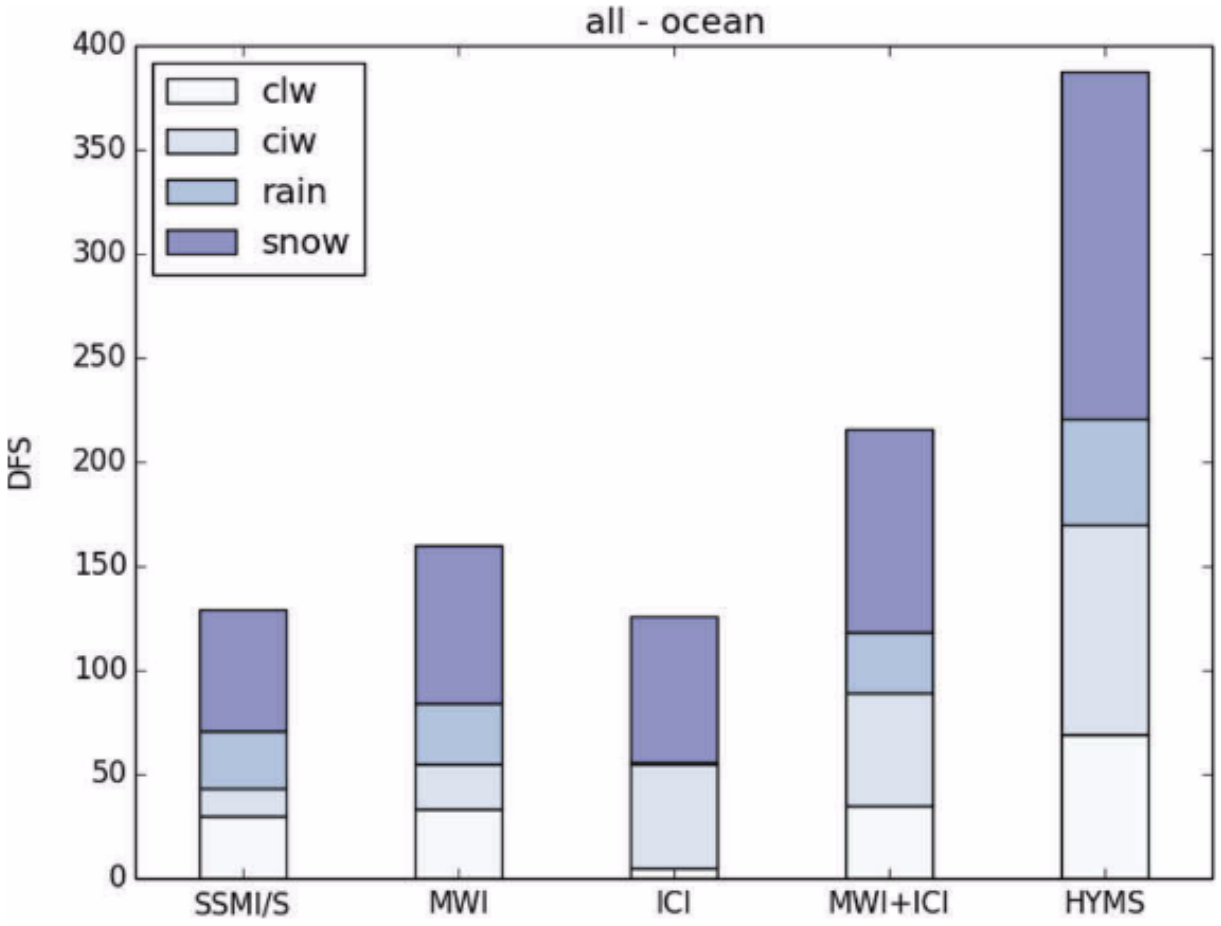


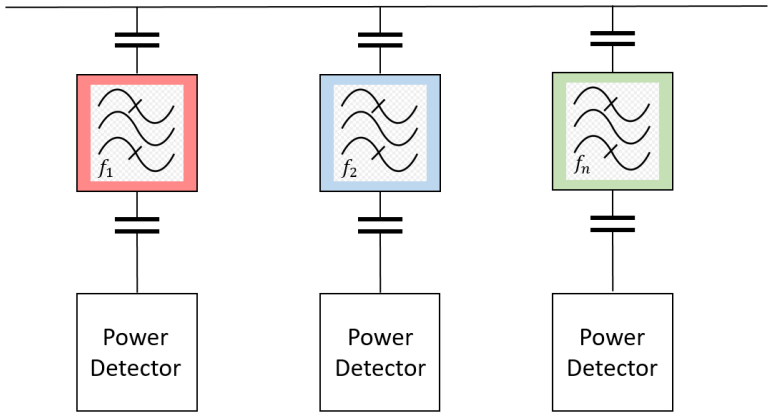
Increase in channels provide an increase in information content

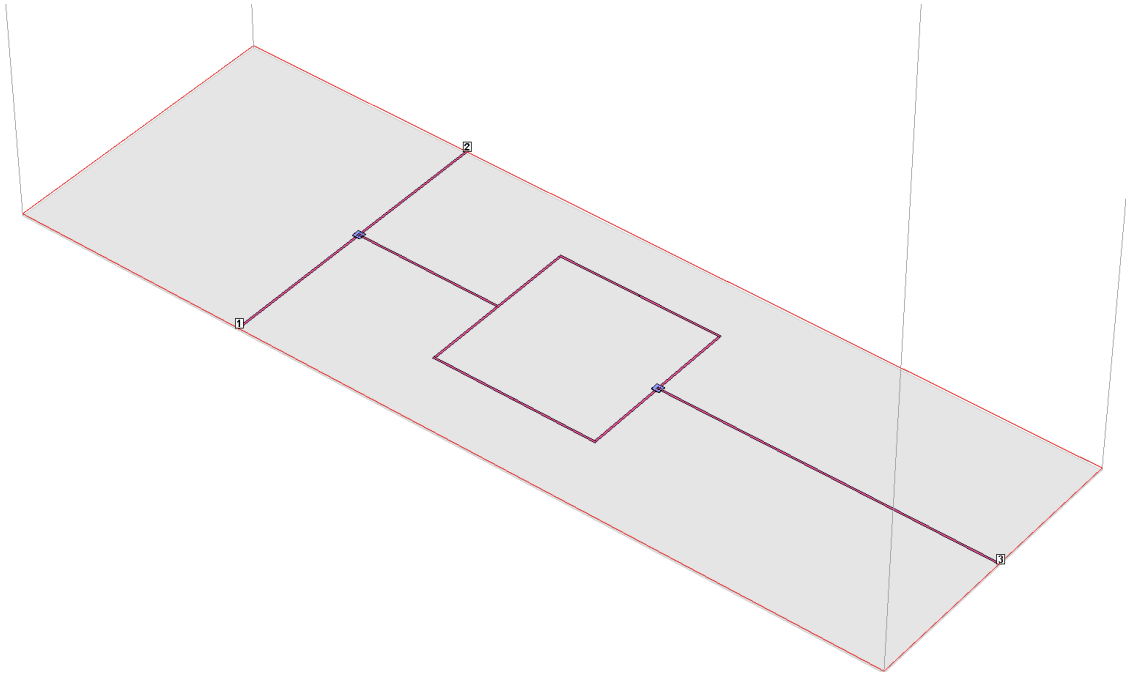
Improved retrieval of hydrometeor variables such as ice particle size

Ability to help constrain Global Circulation Models (GCMs) by improving the understanding of radiative effects

Figure: Birman, Camille, et al. "Information content on hydrometeors from millimeter and sub-millimeter wavelengths." *Tellus A: Dynamic Meteorology and Oceanography* 69.1 (2017): 1271562.

How will we achieve this?... HYMAS!



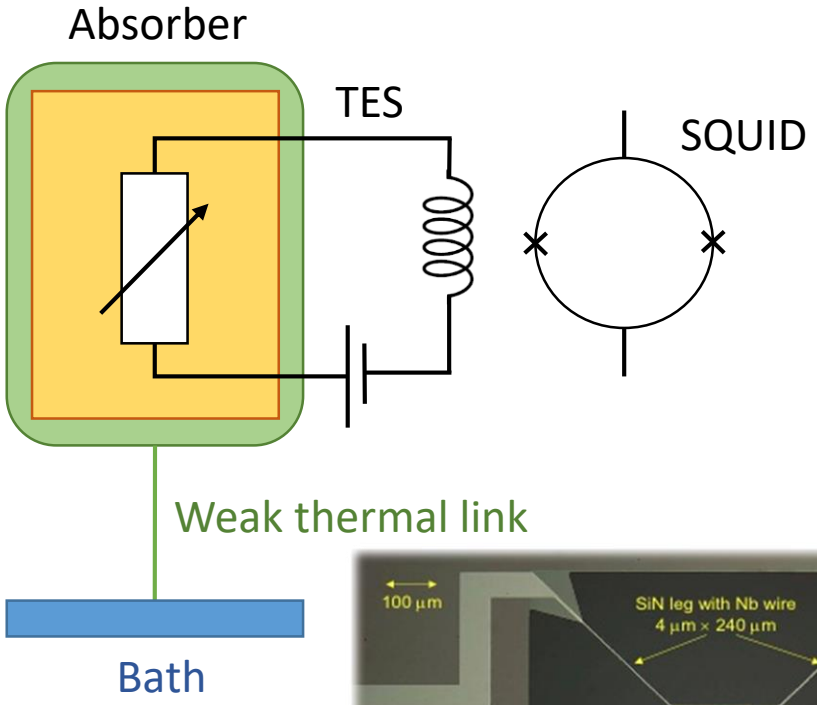


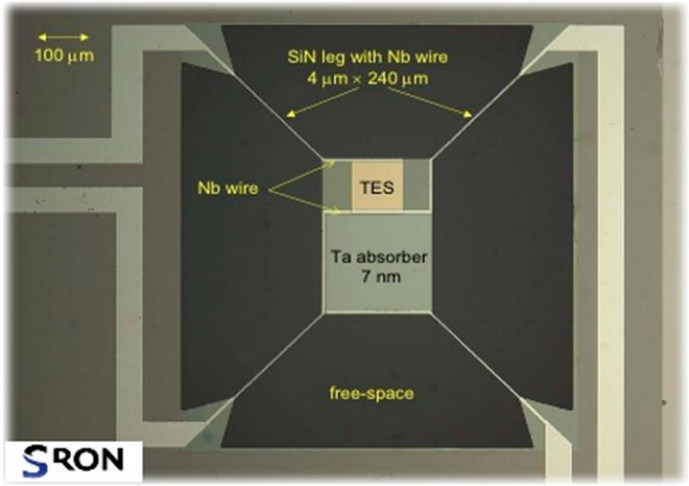
Possesses key benefits over optical gratings or Fourier Transform Spectrometers (FTS)

HYMAS is an on-chip Integrated Filterbank Spectrometer (IFBS)

Based on current state of the art spectrometers such as DESHIMA, SuperSpec and CAMELS in development for astronomy applications

Transition Edge Sensors (TES)



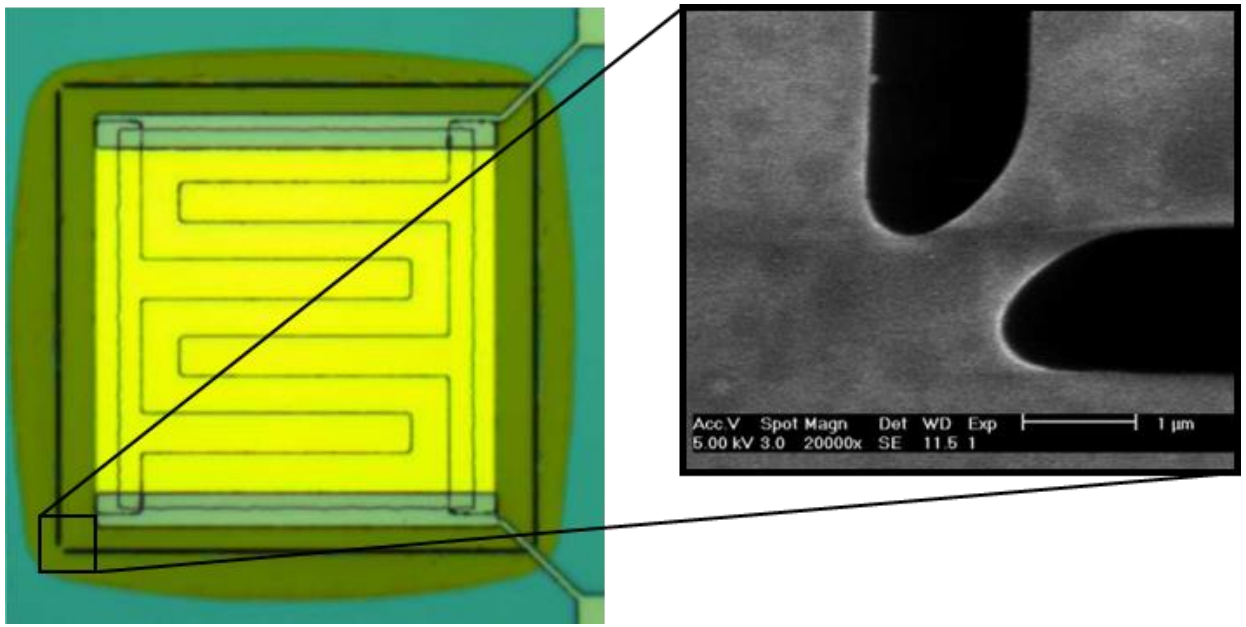


TESs can reach the important 50-60GHz O_2 lines, Kinetic Inductance Detectors (KIDs) cannot.

Can be read out with Superconducting Quantum Interference Devices (SQUIDs)

Traditionally require long Silicon Nitride legs to improve sensitivity

Few-Mode Ballistic TESs



Few-Mode Ballistic Transition Edge Sensors

- Ultra-Compact
- High Sensitivity
- High Dynamic Range
- Highly Robust

Improved physical understanding due to Few-Mode Ballistics

Figure:Osman, Djelal, et al. "Transition edge sensors with few-mode ballistic thermal isolation." Journal of Applied Physics 116.6 (2014): 064506. APA

In conclusion

- Ultra compact, microwave spectrometer using novel Few-Mode TES technology
- High future potential impact to Numerical Weather Prediction and Global Circulation Models
- Temperature and humidity retrievals to equal or exceed current or future planned hyperspectral IR instruments

Thank you for your time

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