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Consistency between Measurements

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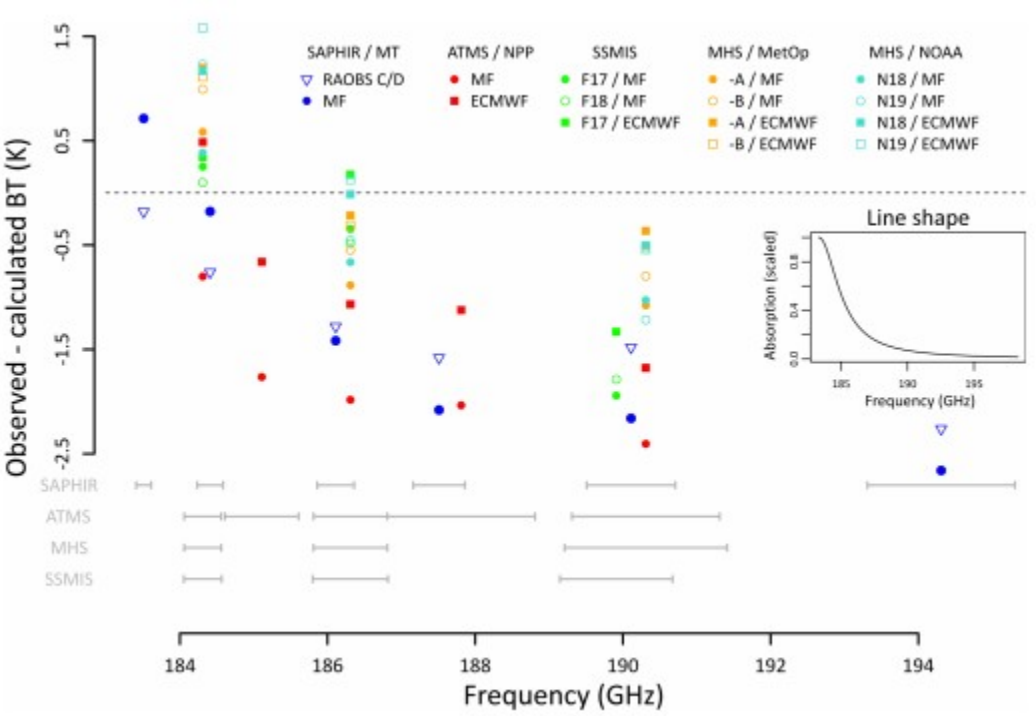
Consistency between Measurements

- Different Measurement Systems should give the “same” (consistent) values of the parameter being measured
- For Water Vapour, there are some examples where measurements are consistent and some in which they are not
- Ideally, before measurements from different systems are combined they should be proven to be consistent → Otherwise combination becomes difficult

Examples of NO Consistency

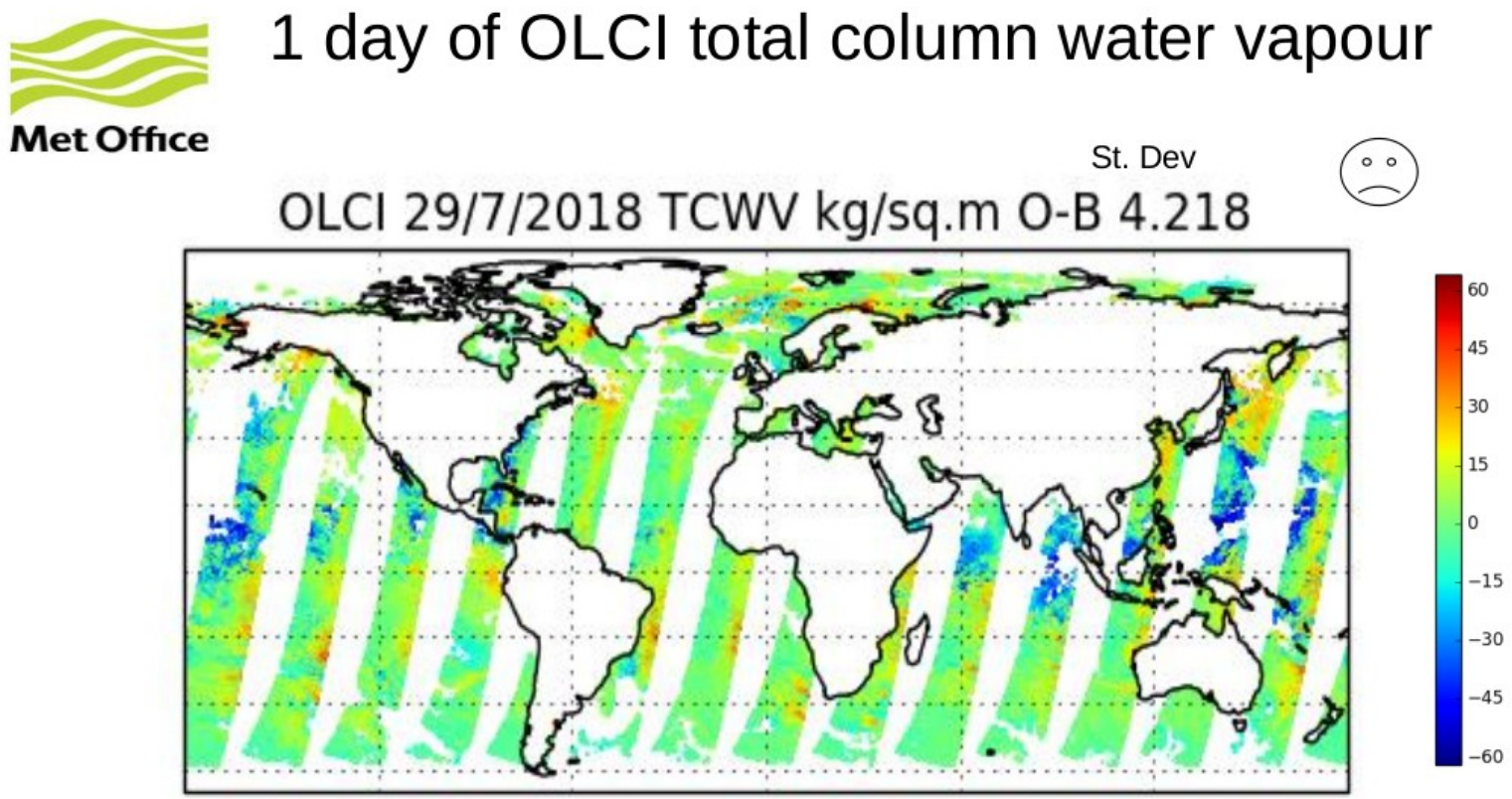
183 GHz Biases



Brogniez et al., AMT, 2016

Examples of NO Consistency

OLCI TCWV



Saunders, EUMETSAT Conference, 2018

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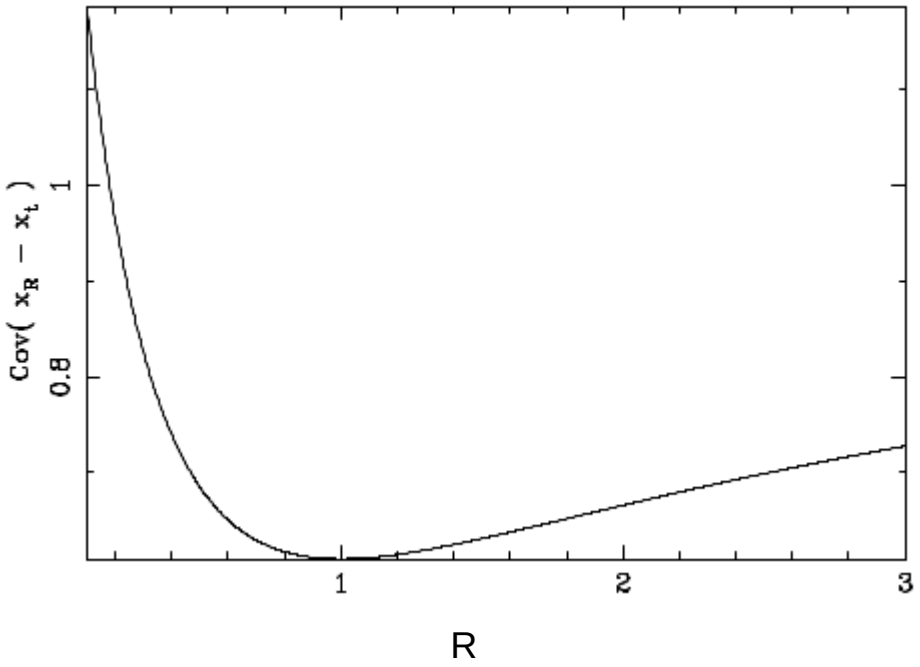
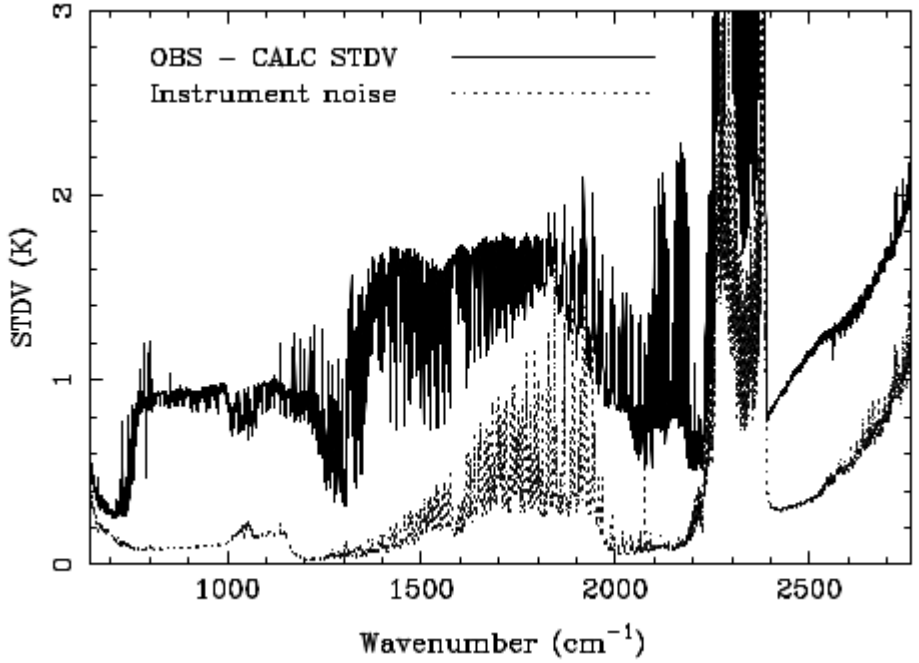
Examples of NO Consistency

OEM IASI WV Retrievals need R matrix values much bigger than instrument noise

$$J = (y - F(x))^T R^{-1} (y - F(x)) + (x - x_a)^T B^{-1} (x - x_a)$$





Calbet, arxiv, 2012

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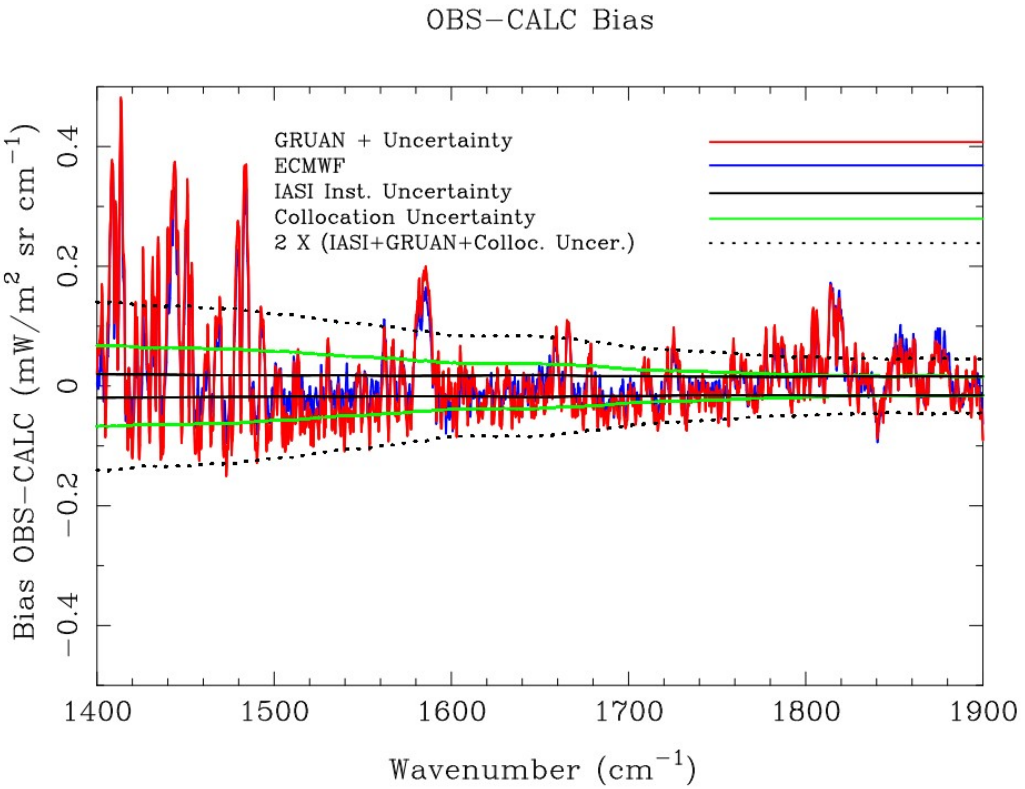
Examples of Consistency

Consistency between GRUAN sondes, LBLRTM and IASI



Calbet et al., AMT, 2017

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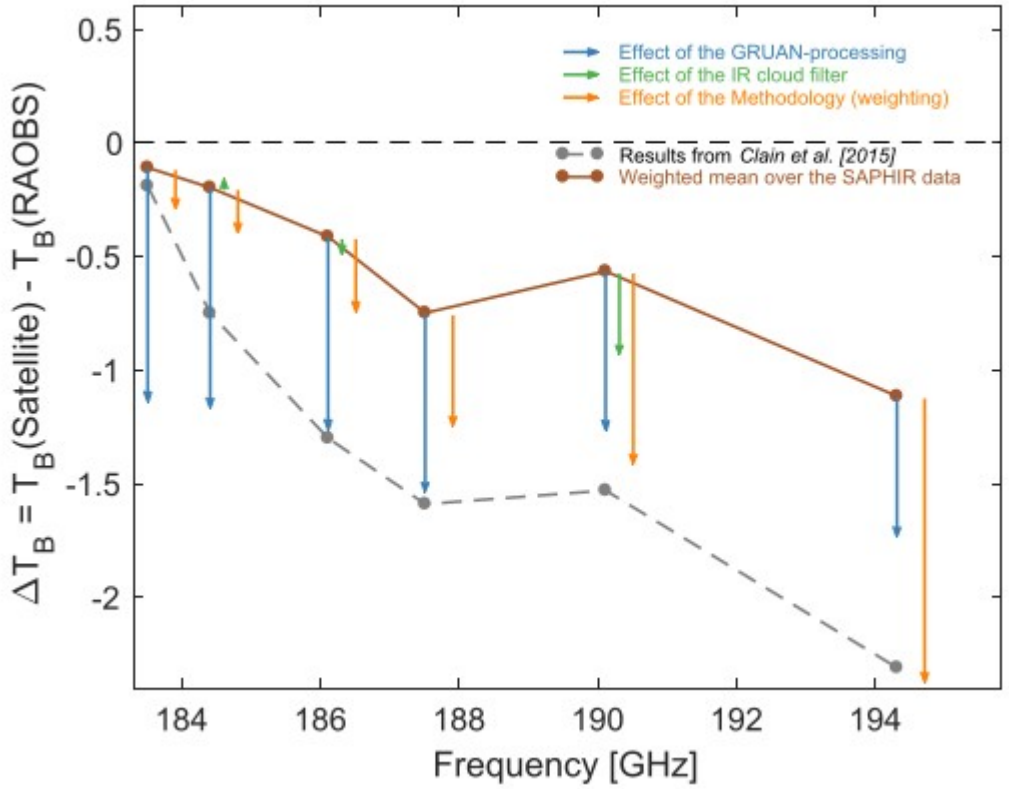
Examples of Consistency

Consistency between GRUAN and MW over homogeneous scenes



Bobryshev et al., IEEE Trans. Geo. Rem. Sen., 2018

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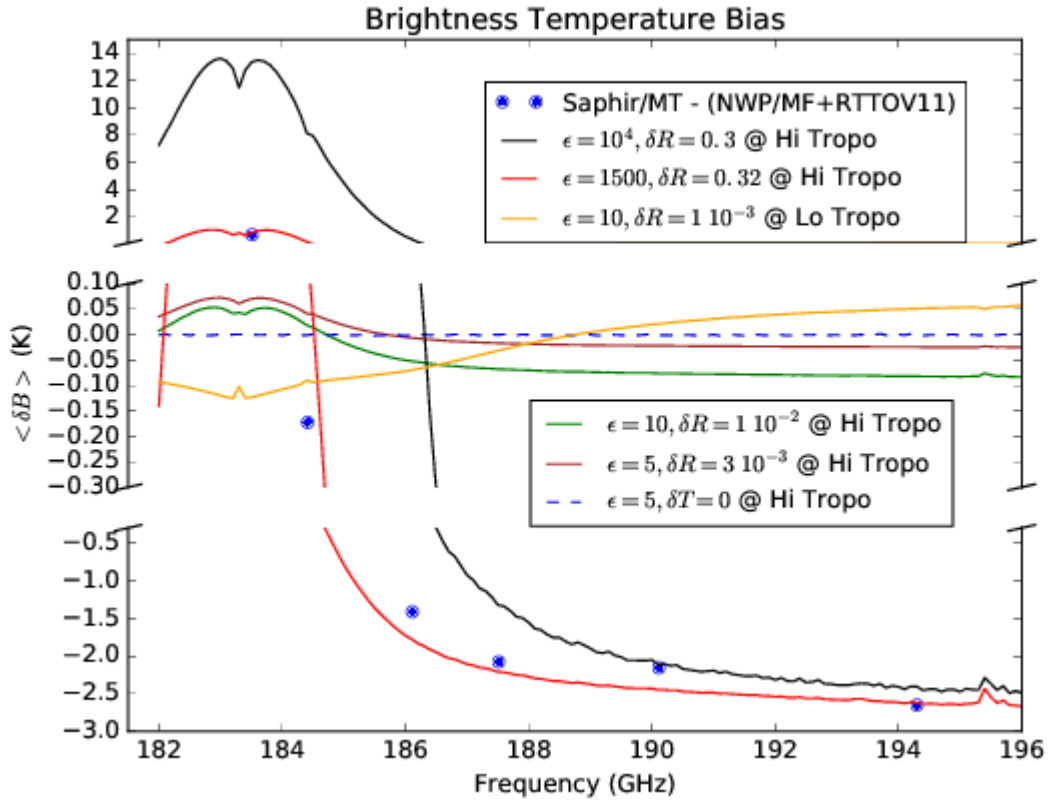
What is going on?

- Is there or is there NOT consistency?
- Are we missing anything?
- Perhaps the difference is in the homogeneity or inhomogeneity of the scenes → How much water vapour varies within the Field of View of the instrument

Effect of FOV inhomogeneity

Can turbulence (= inhomogeneity) within the field of view cause significant biases in radiative transfer modelling at the 183 GHz band?



Calbet et al., AMT, 2018

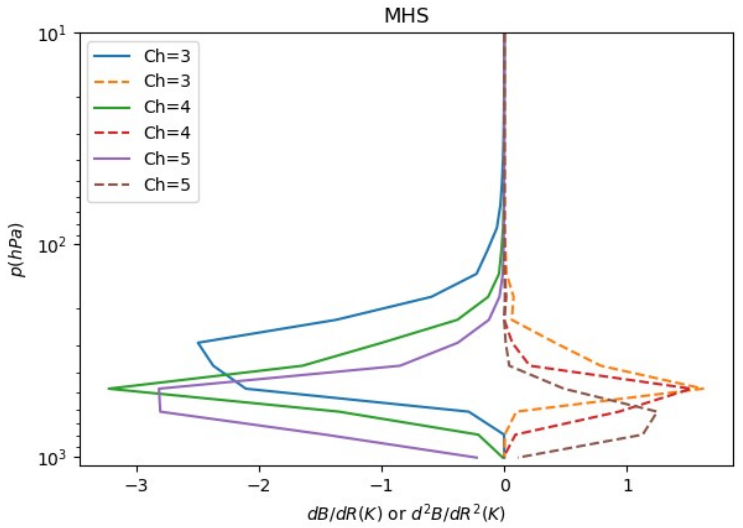
Effect of FOV inhomogeneity

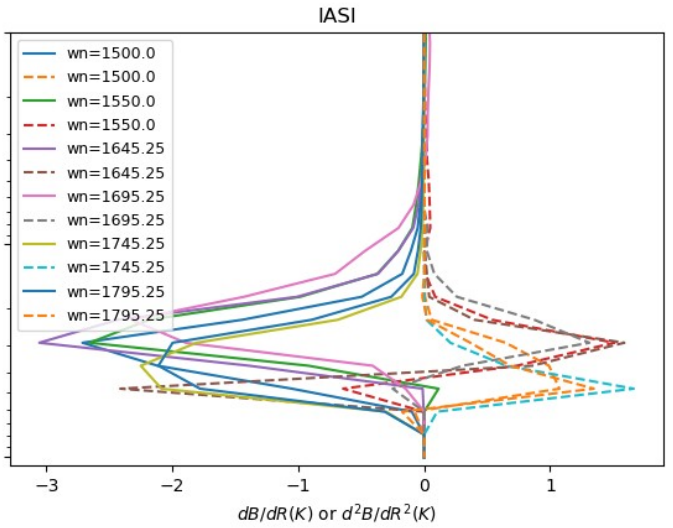
Can turbulence=inhomogeneity within the Field of View cause significant biases in radiative transfer modelling in MW or IR?

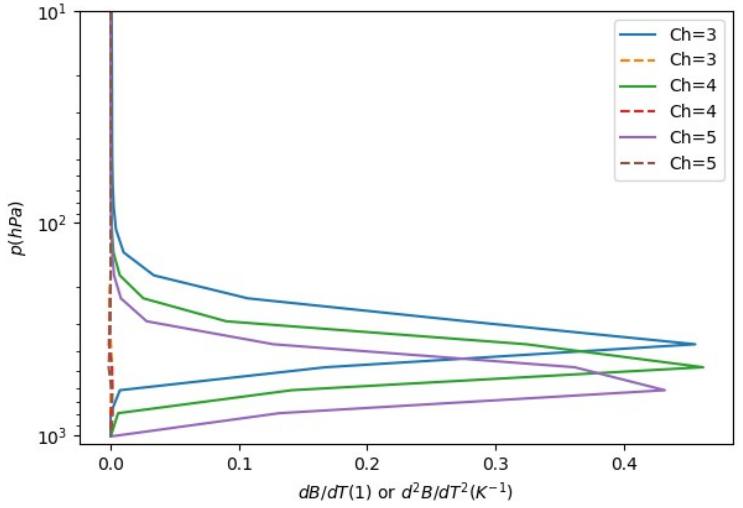
$$< \delta B > \approx \sum_{i=1}^{\text{All Levels}} \frac{dB}{dR_i} < \delta R_i > + \frac{1}{2} \frac{d^2 B}{dR_i^2} < (\delta R_i)^2 >$$

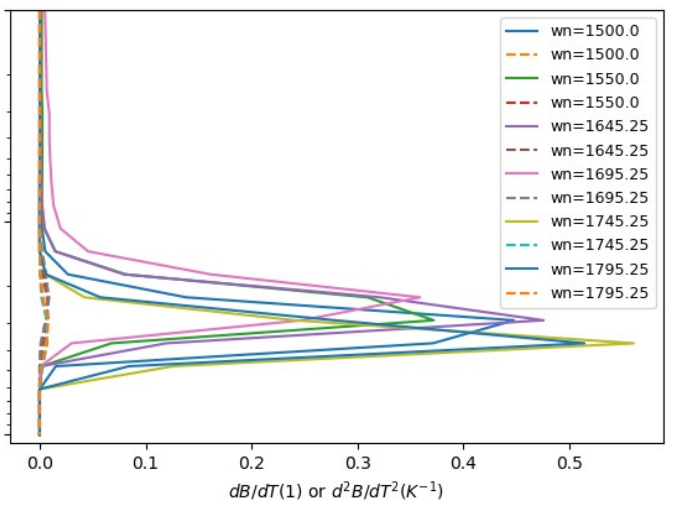
Effect of FOV inhomogeneity

Why can turbulence within the FOV cause big differences in BT?









Retrieving Turbulence?

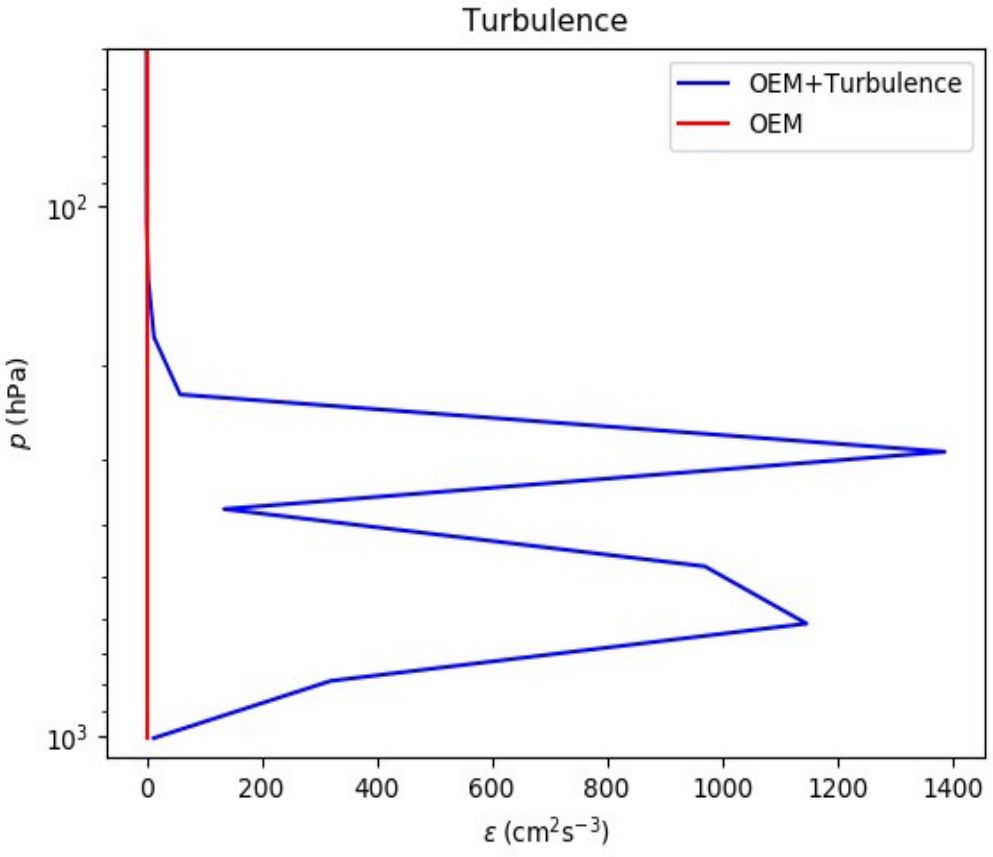
- We can try Optimal Estimation Method (OEM) like techniques to retrieve the T and WV profiles and also WV Turbulence (= FOV inhomogeneity)

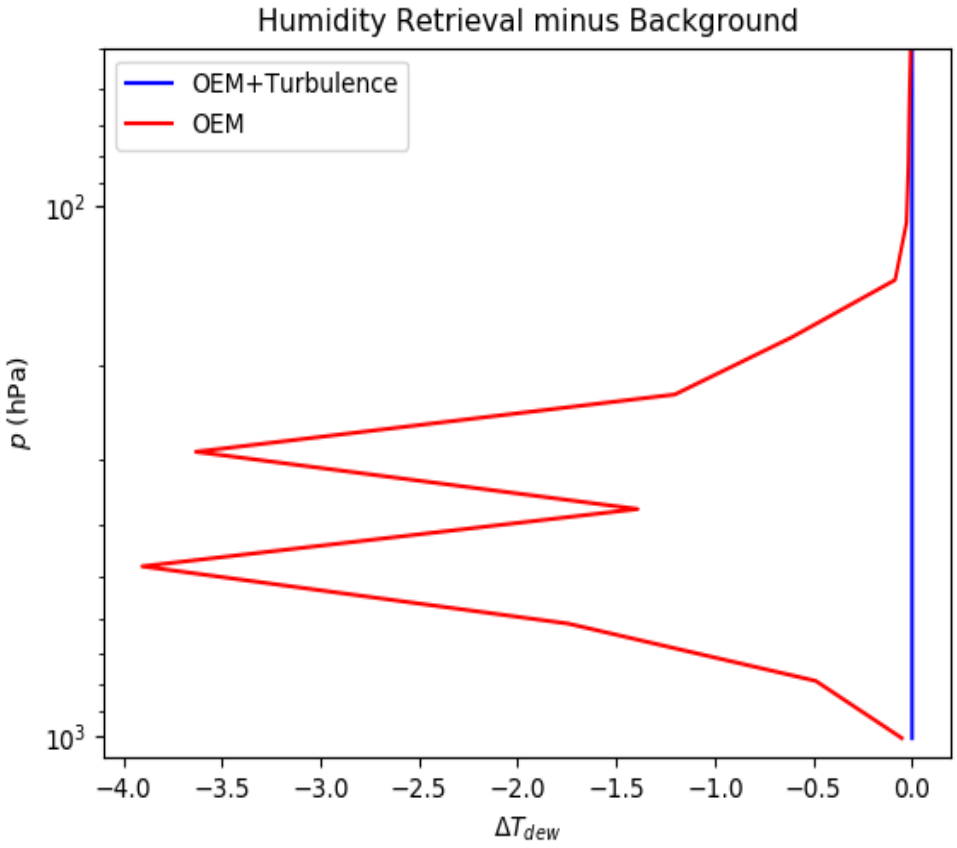
- Do we retrieve anything reasonable?

Retrieving Turbulence?

- We try OEM with an R exactly equal to instrument noise → We know this has failed before = too unconstrained system
- We use as background ECMWF analyses
- What happens when retrieving also turbulence?

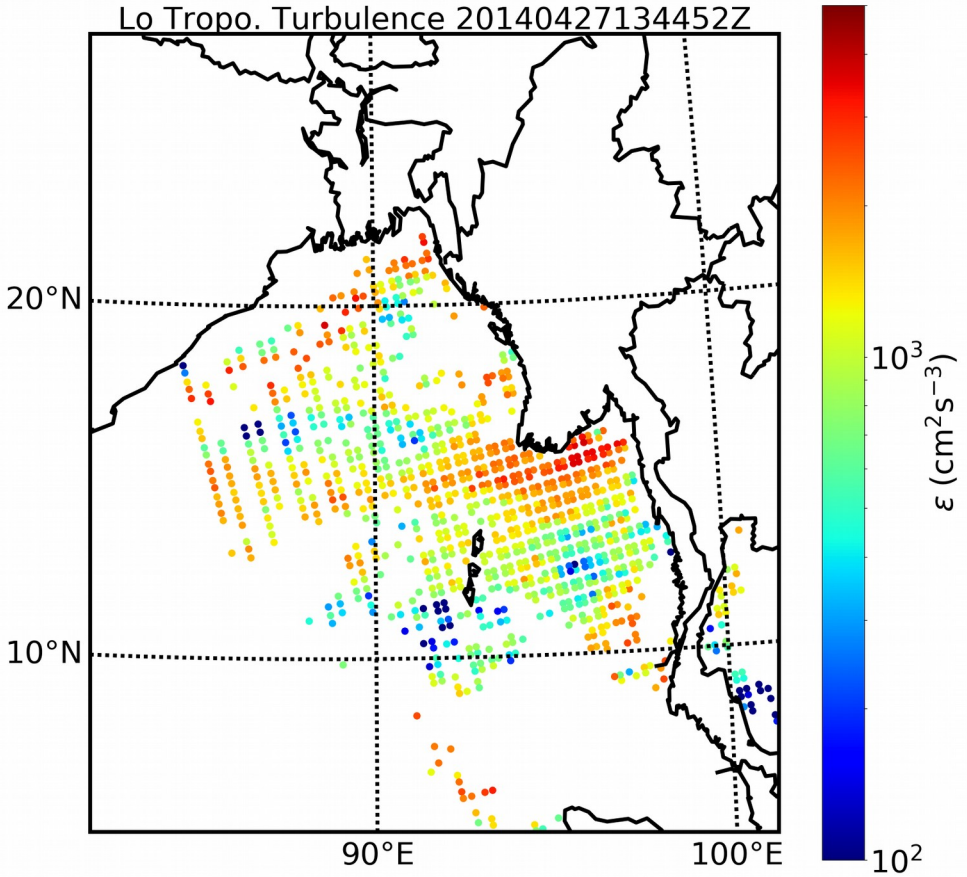
Retrieving Turbulence?

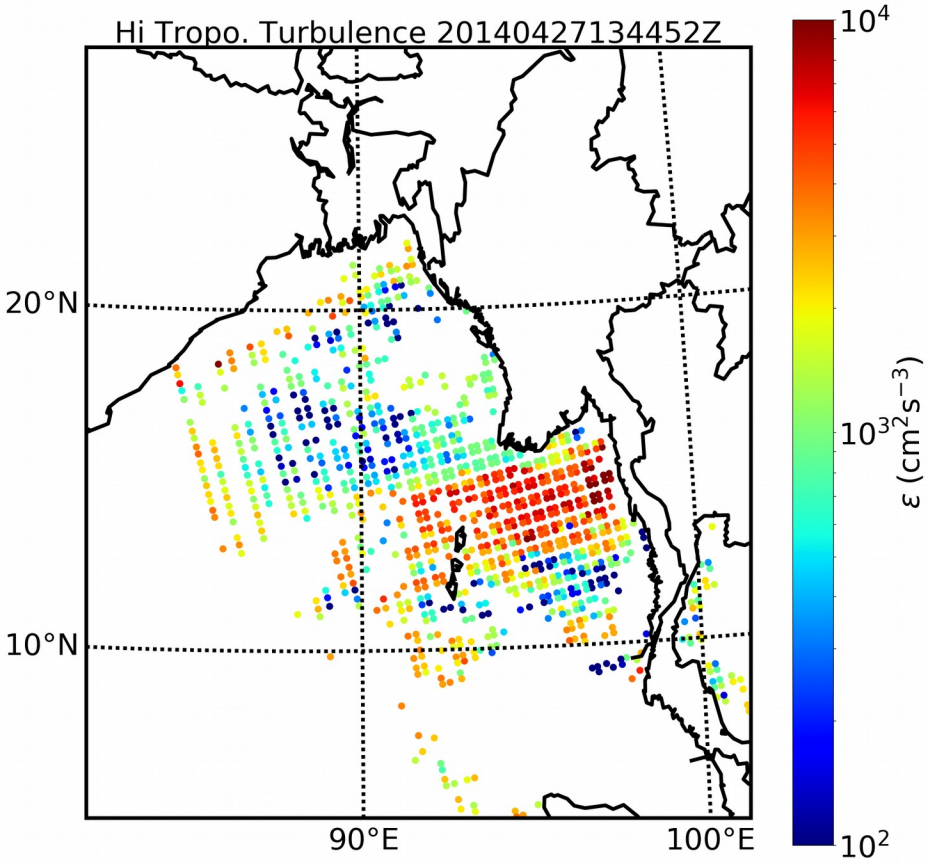




Retrieving Turbulence?

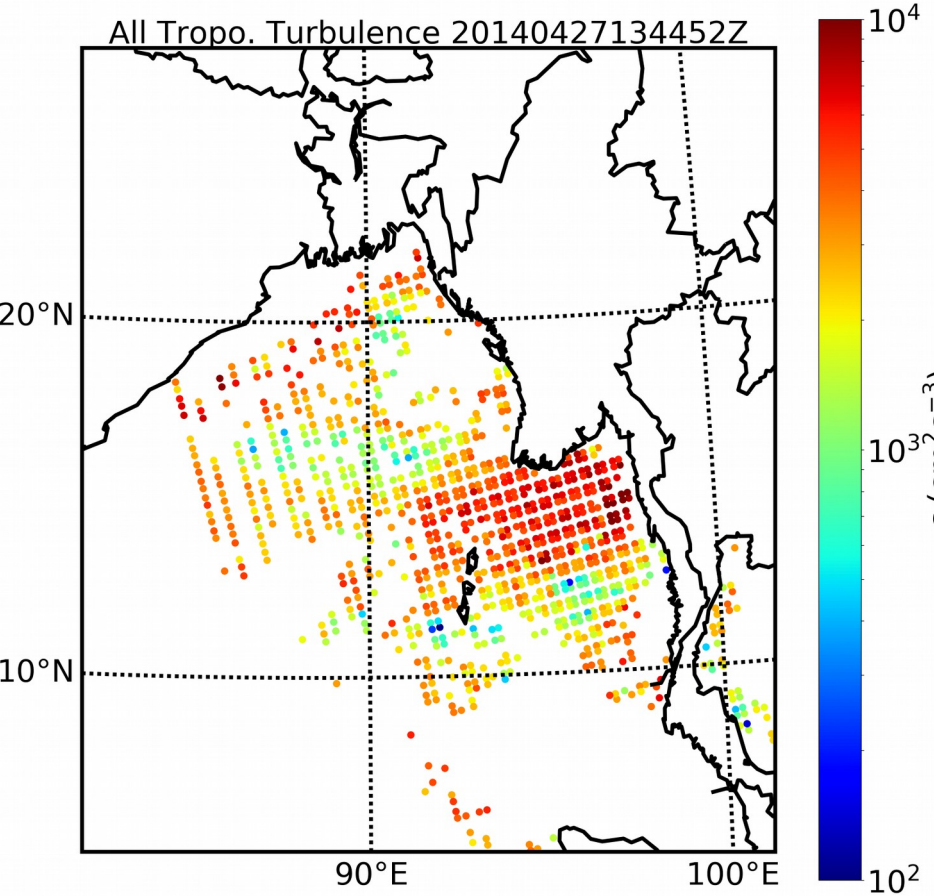
How does it look spatially?



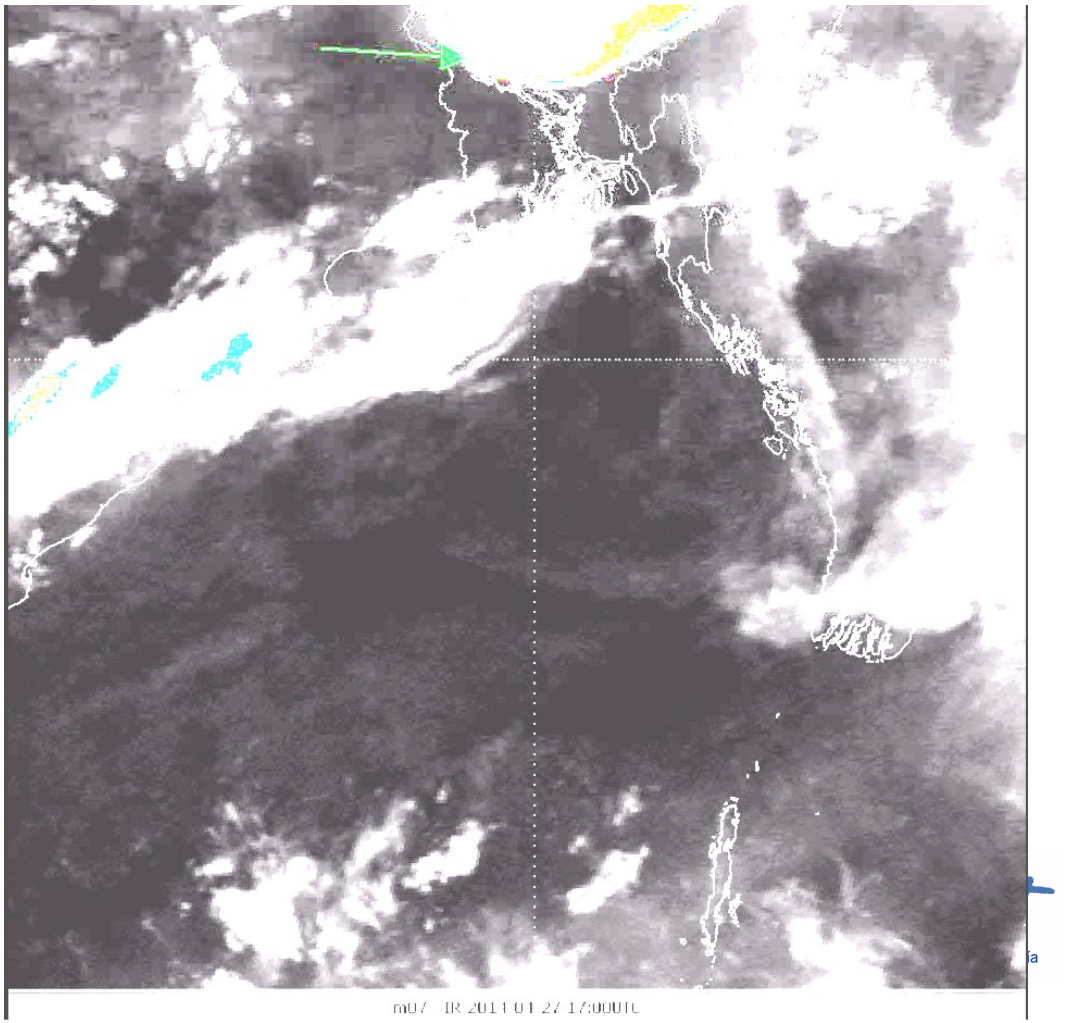


Retrieving Turbulence?

How does it look spatially? → Comparison with MSG seems consistent

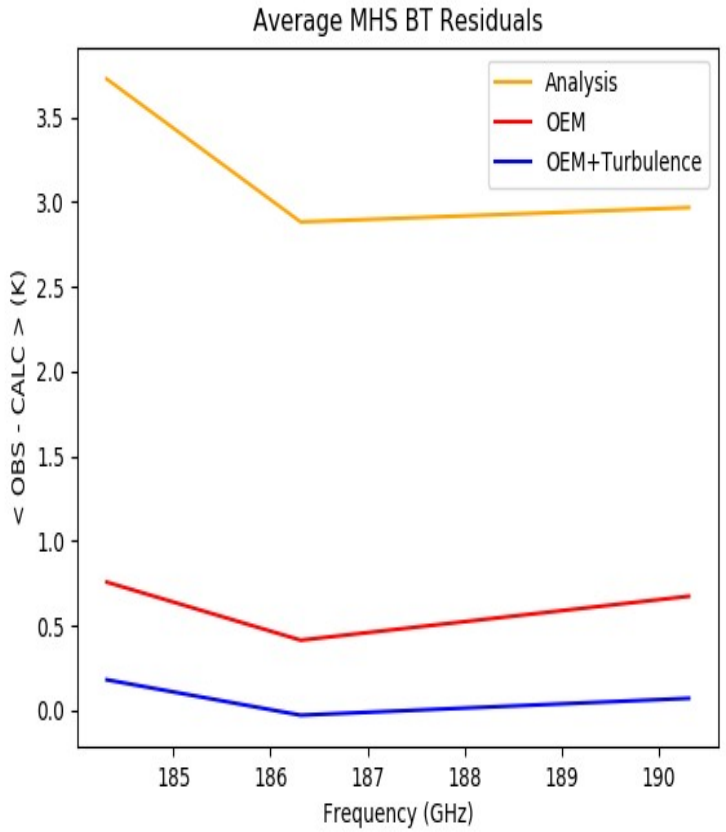


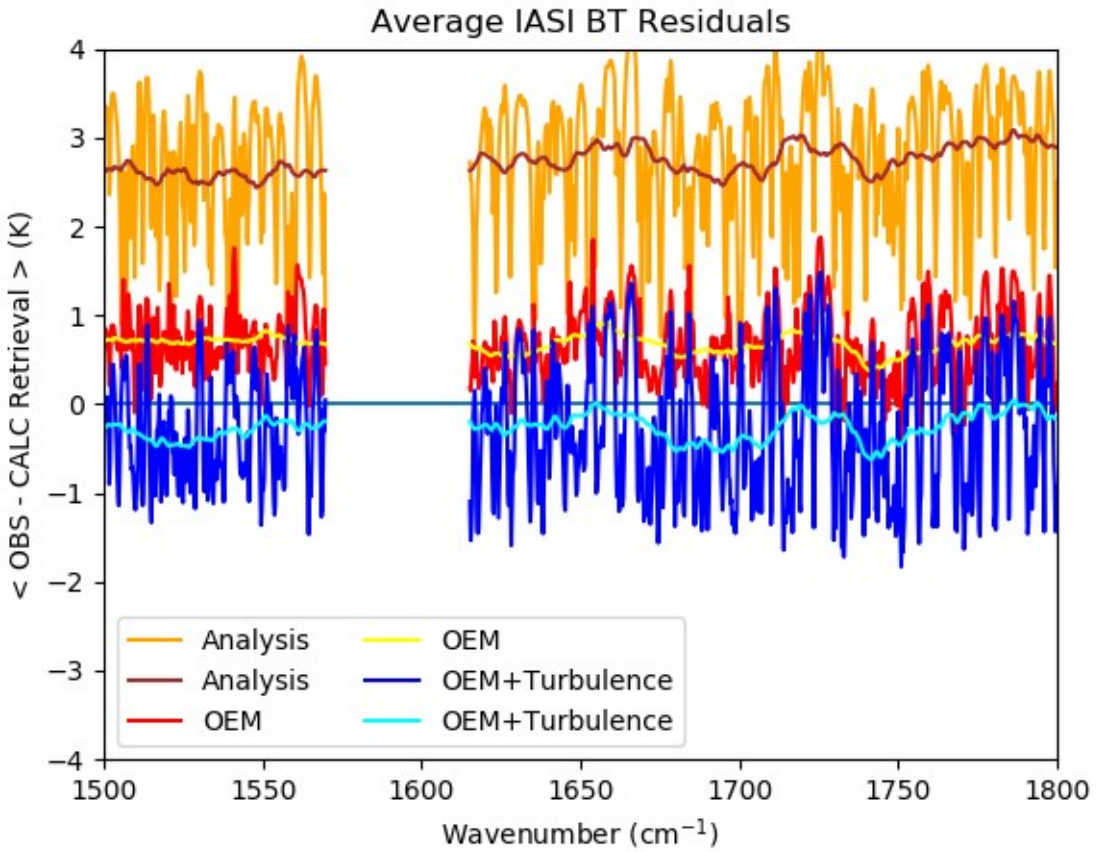
MSG IR Image 17:00



Retrieving Turbulence?

Radiance residuals? Retrievals done for MHS → MHS
Residuals should be low → How about residuals for IASI?





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Summary

- Ideally we should strive for consistency before combining different measurements
- There are still some remaining inconsistencies between different WV measurements
- Inhomogeneities within the FOV (turbulence) might explain the remaining inconsistencies
- Retrievals with turbulence (inhomogeneities) provide different humidity values with respect to OEM
- This would potentially allow the retrievals of turbulence, but would also complicate retrievals
- High spatial resolution humidity fields would help in this puzzle

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