

Rosseland  
Centre  
for Solar  
Physics

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*Observations and simulations  
of small-scale dynamics events with ALMA*

Henrik Eklund



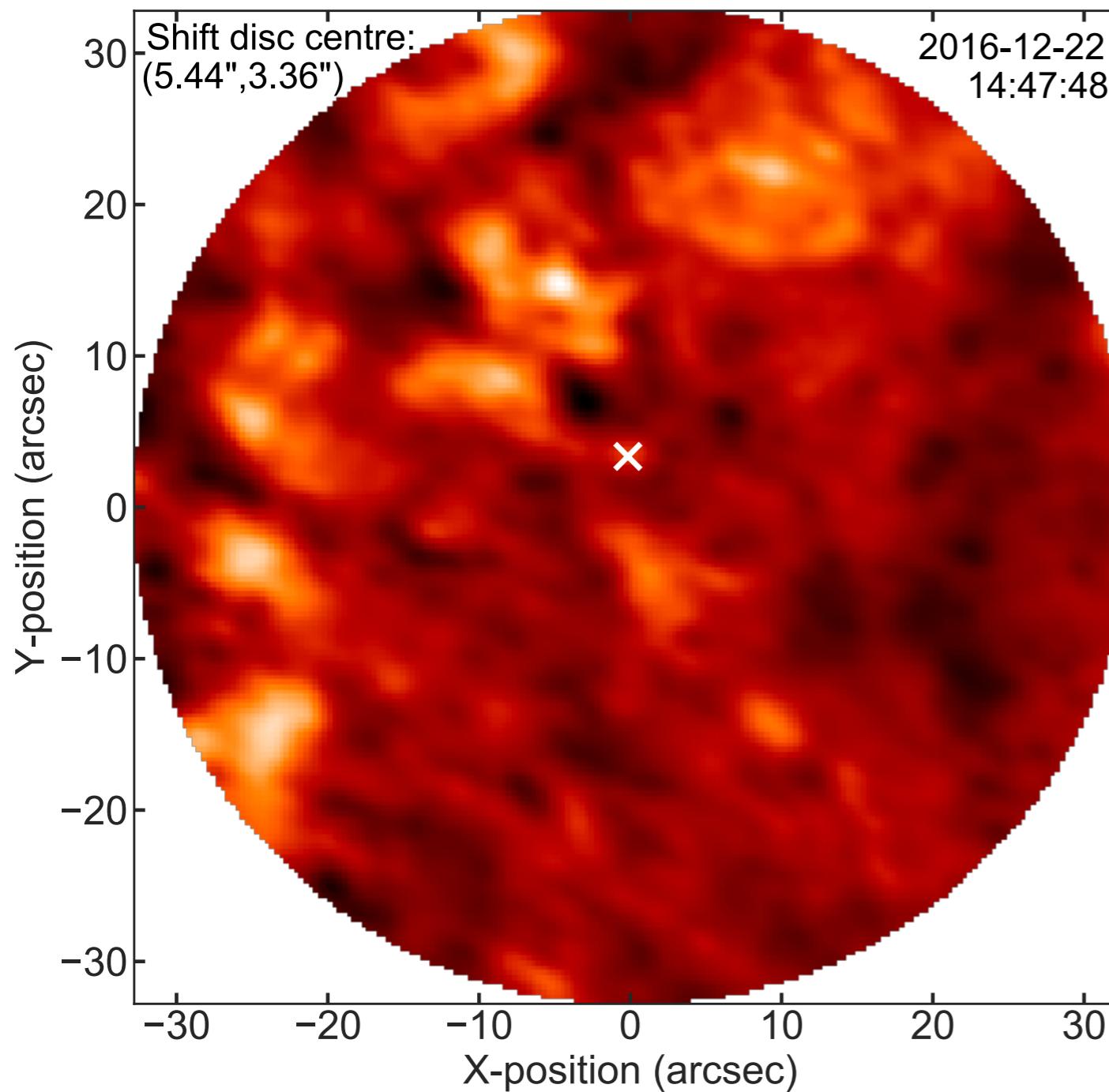
# Atacama Large Millimeter/Sub-millimeter Array (ALMA)

Formation in LTE - linear temperature dependence

Observational data

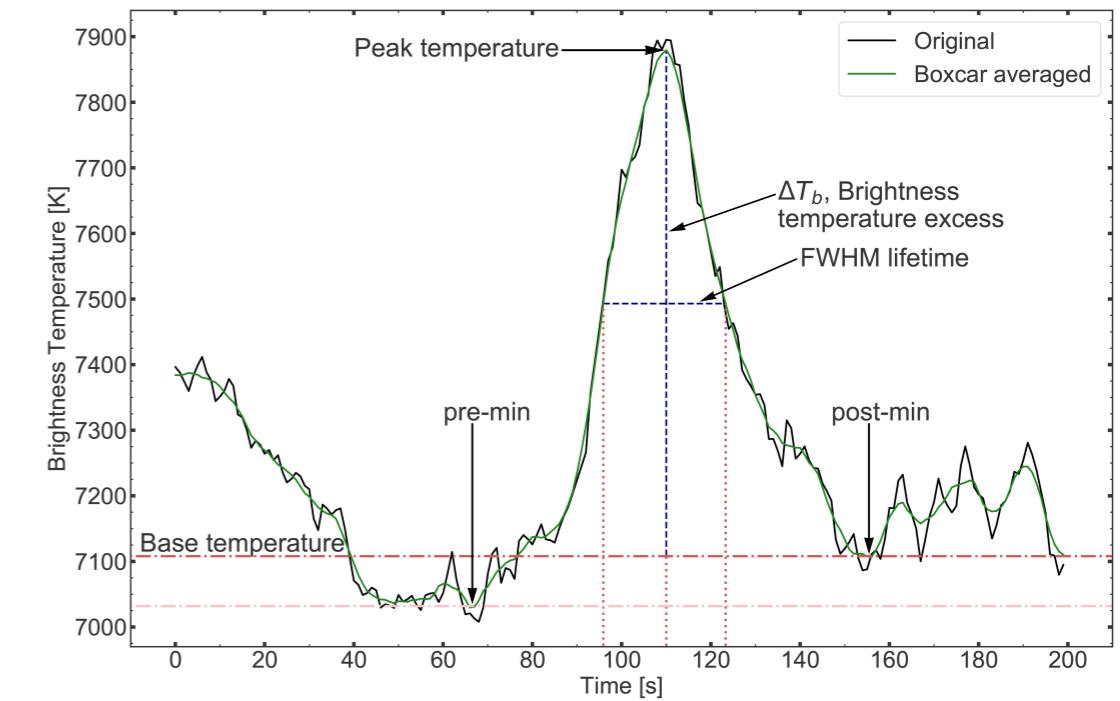
Band 3 (3 mm / 100 GHz)

2 s cadence



Further specifics on dataset in:  
Wedemeyer et al. 2020  
Jafarzadeh et al. 2021

Dynamic brightening events

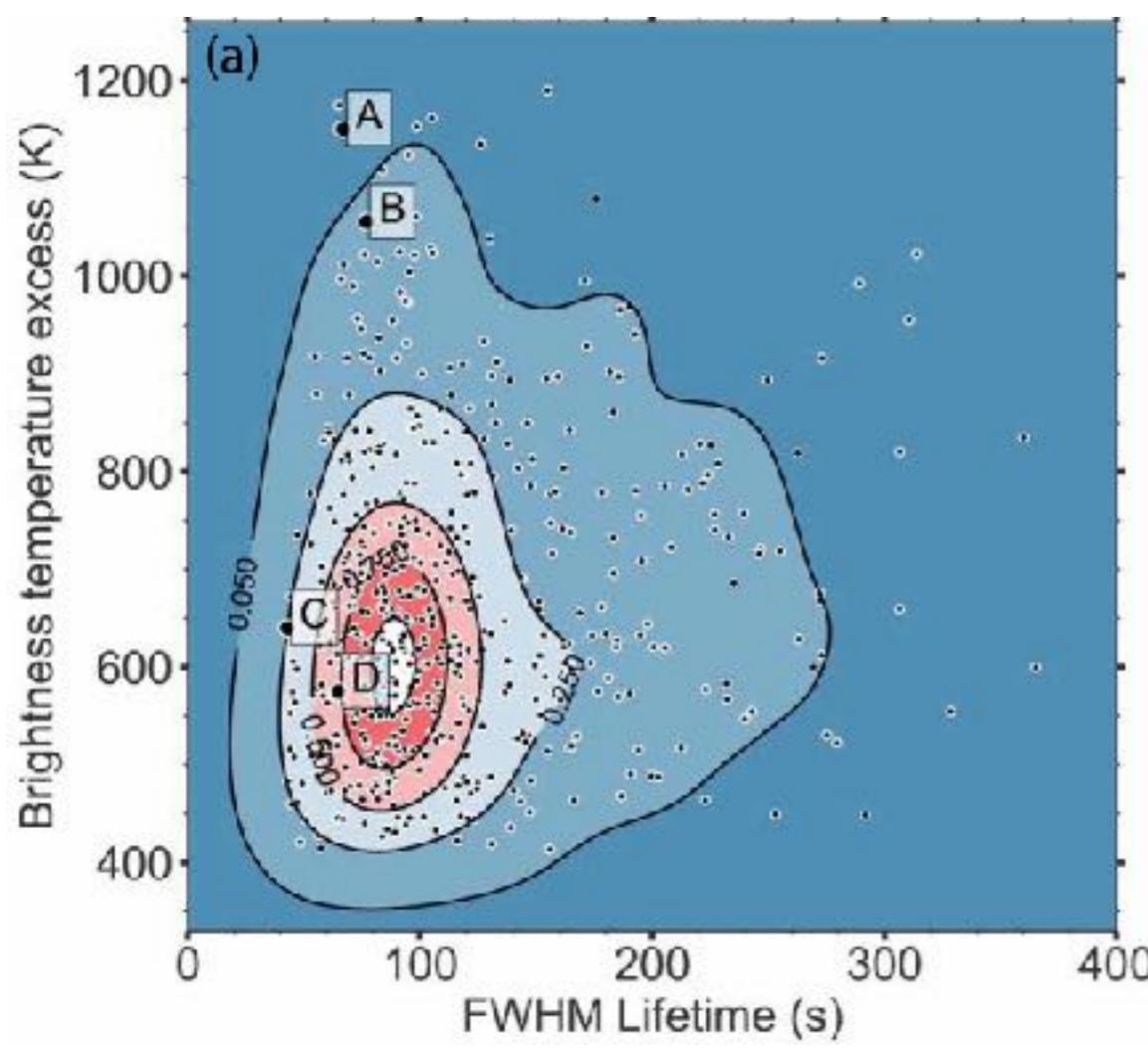


40 min data ~ Several hundred events detected.

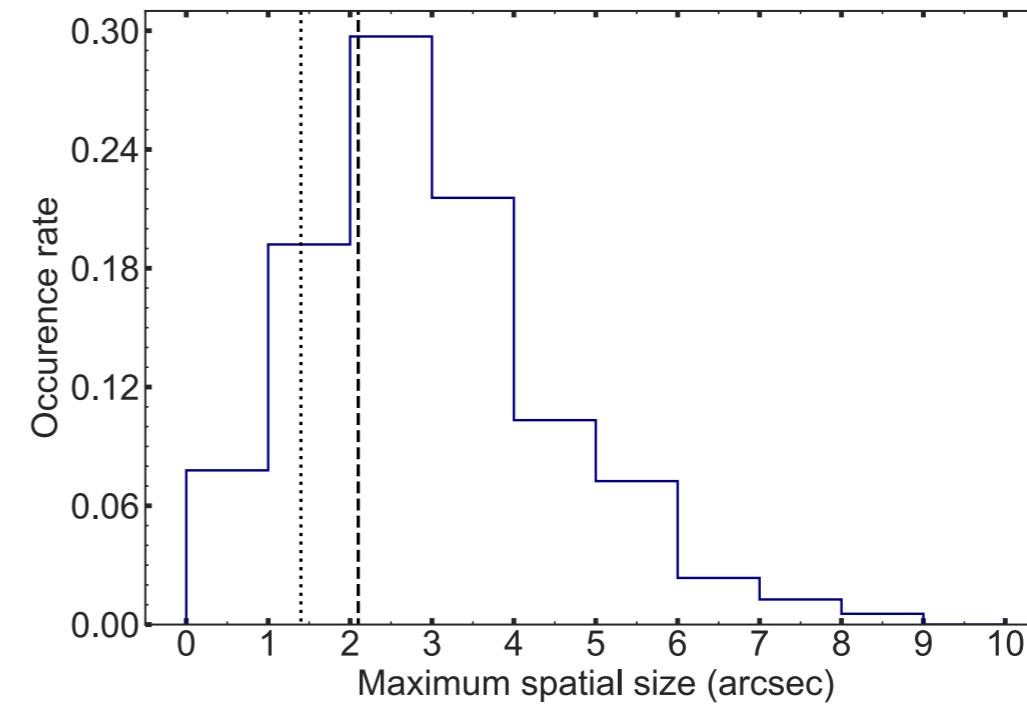
Eklund et al. 2020

# Brightening events in observational data

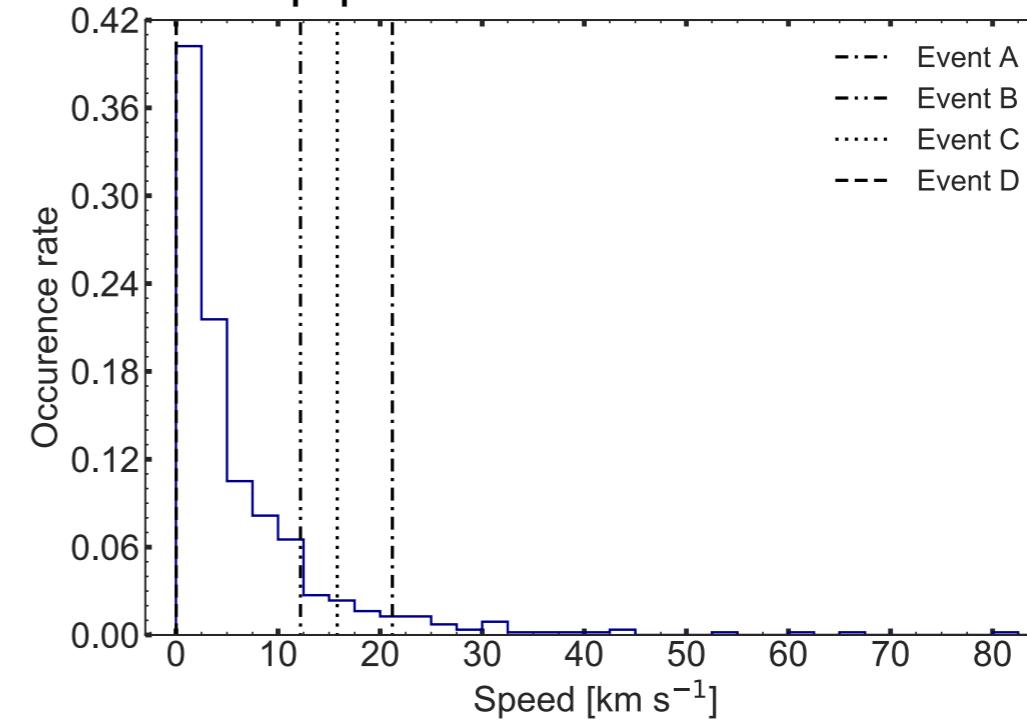
Brightening magnitude  
and lifetime



Sizes

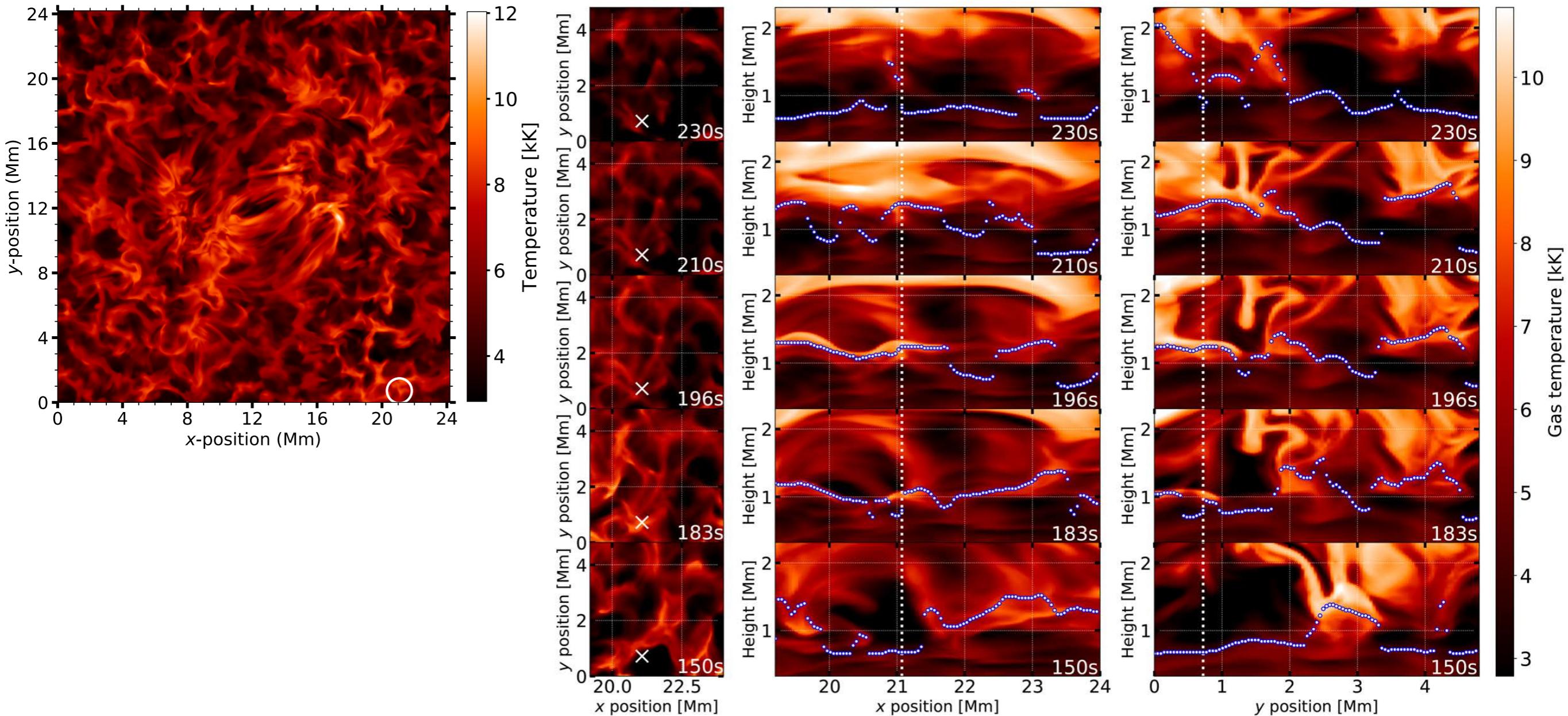


Apparent Velocities



# Simulations — Bifrost ‘enhanced network’

(Carlsson et al. 2016, Gudriksen et al. 2011)

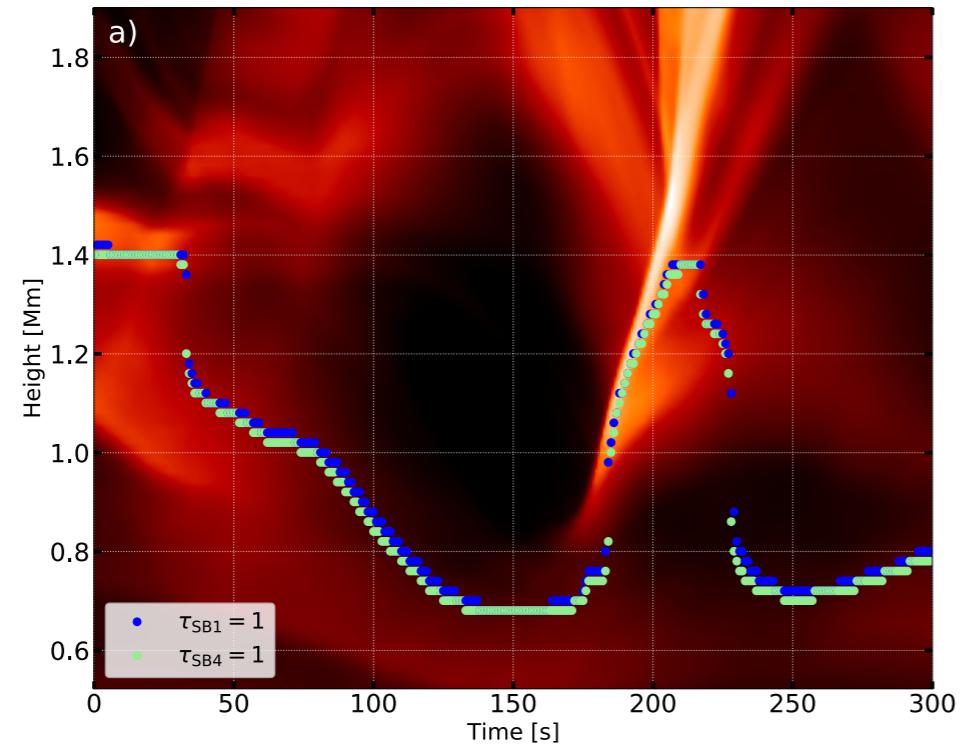


Eklund, H., et al., Phil. Trans. A, 2021.

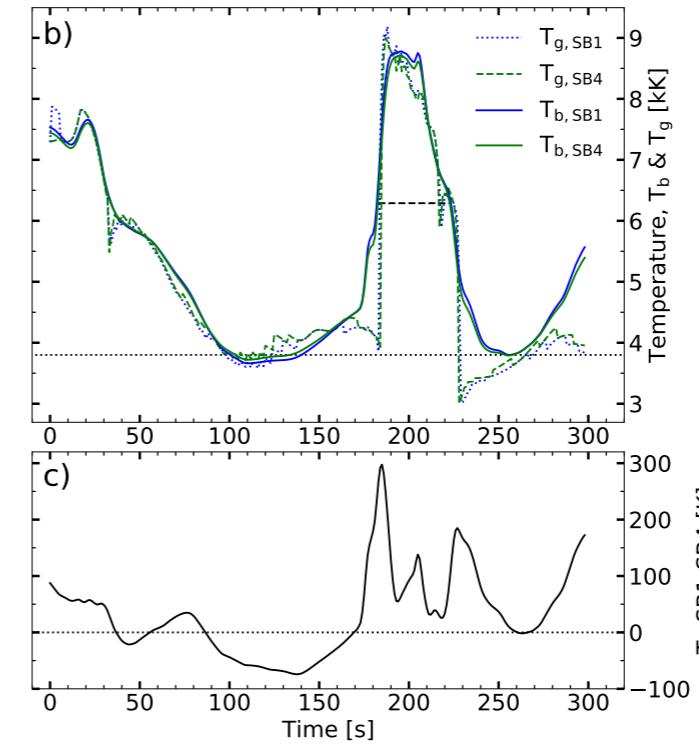
# Simulations — radiative transfer calculations

ART code: de la Cruz Rodríguez et al. 2021

Gas temperature

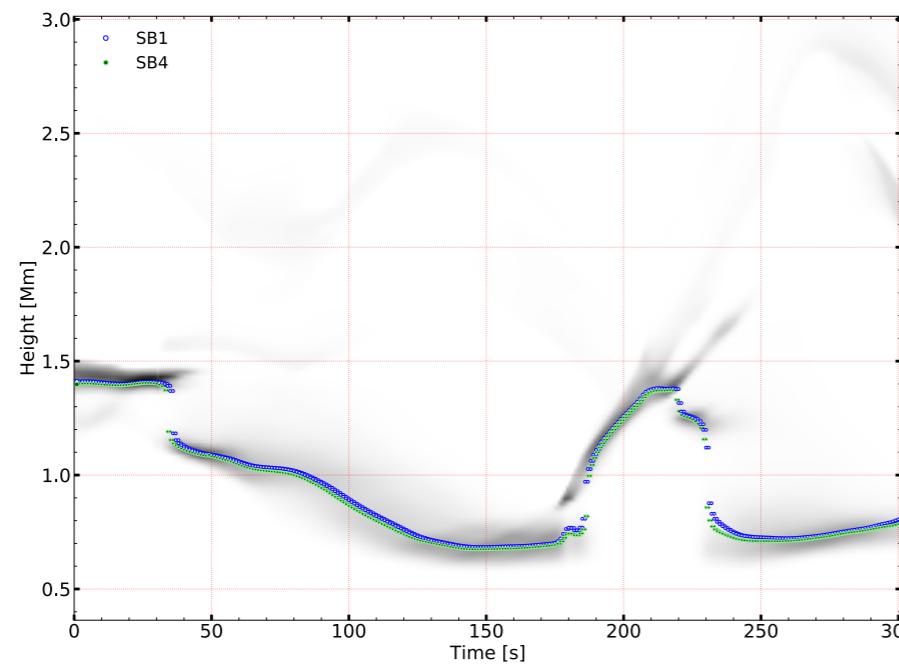


Brightness temperature



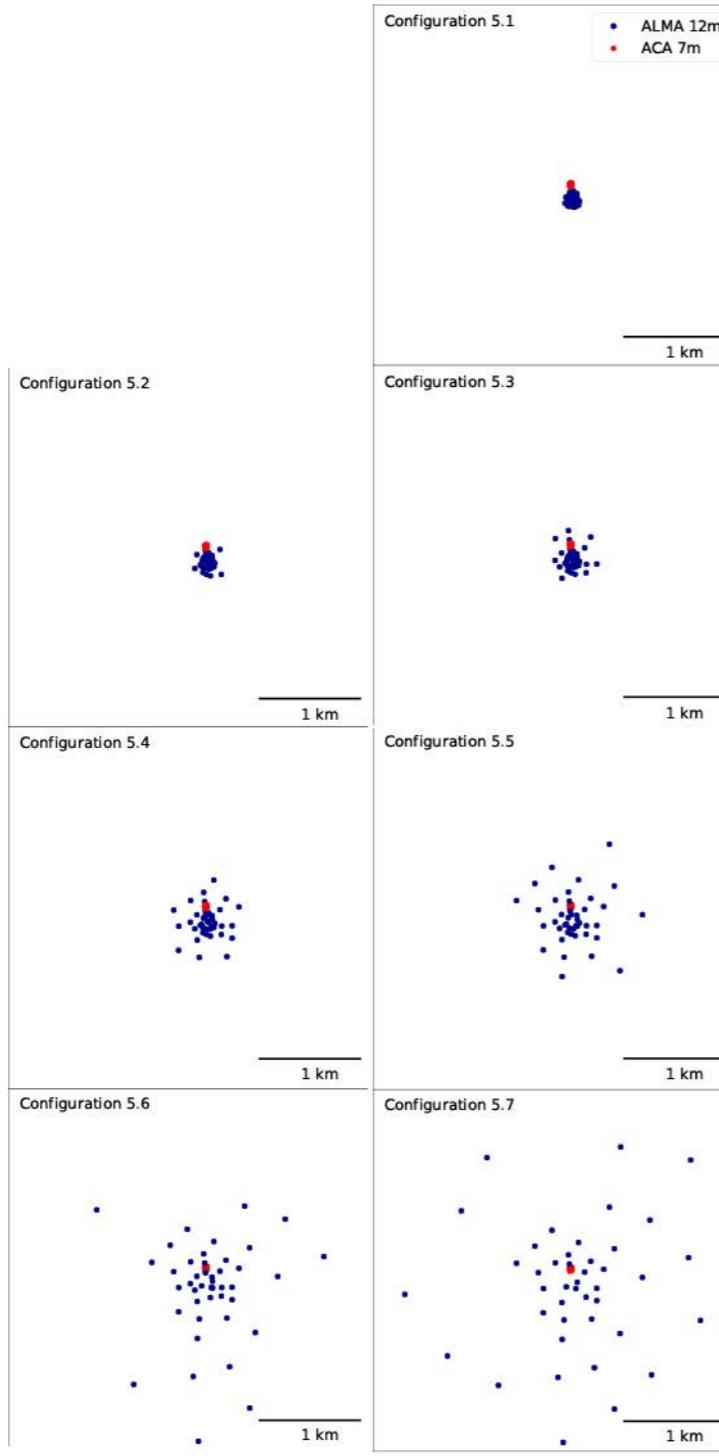
$$\Delta T_b \sim 4.5 \text{ kK}$$

Contribution function

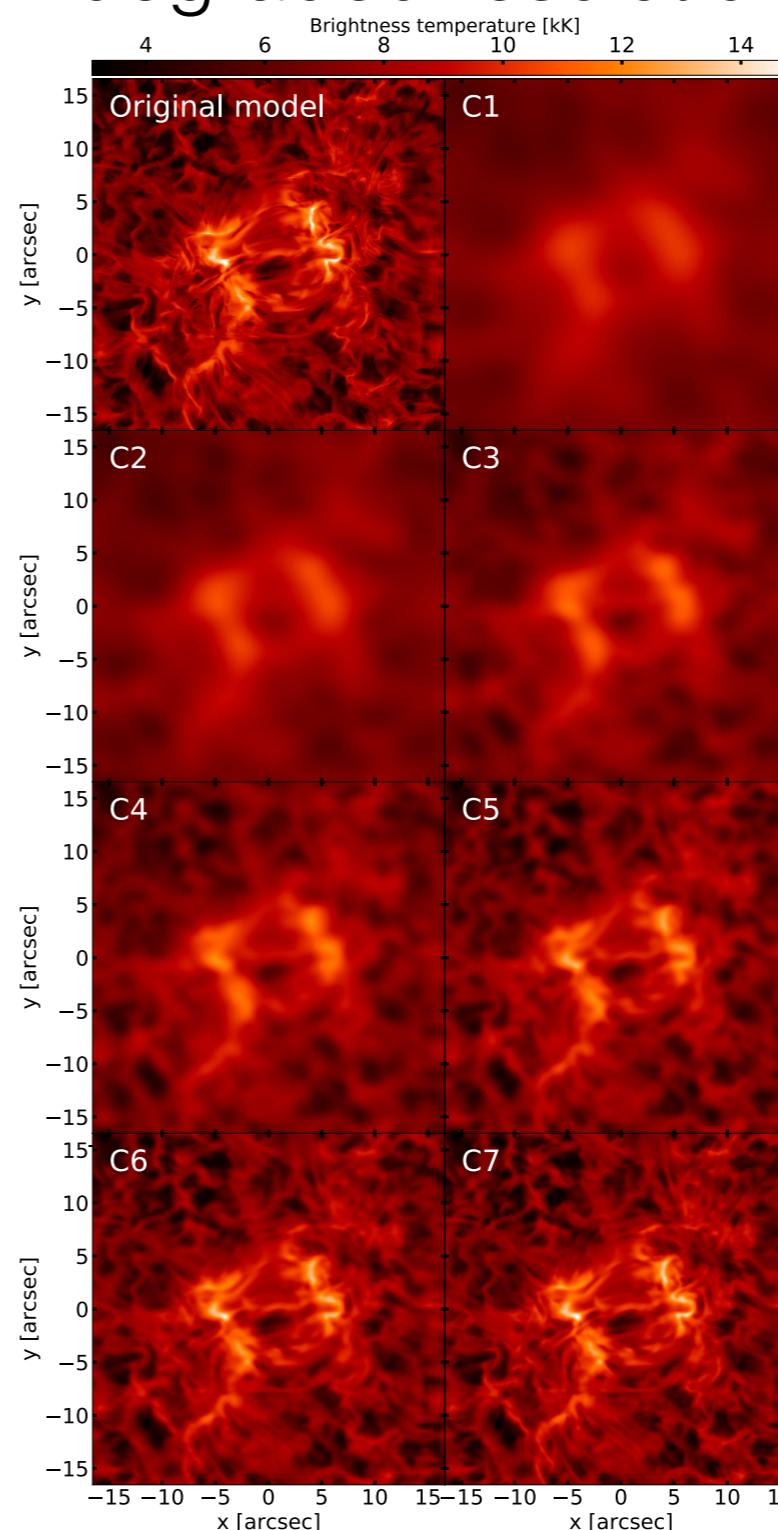


# ALMA — different resulting angular resolution, by adjustable antenna array configuration

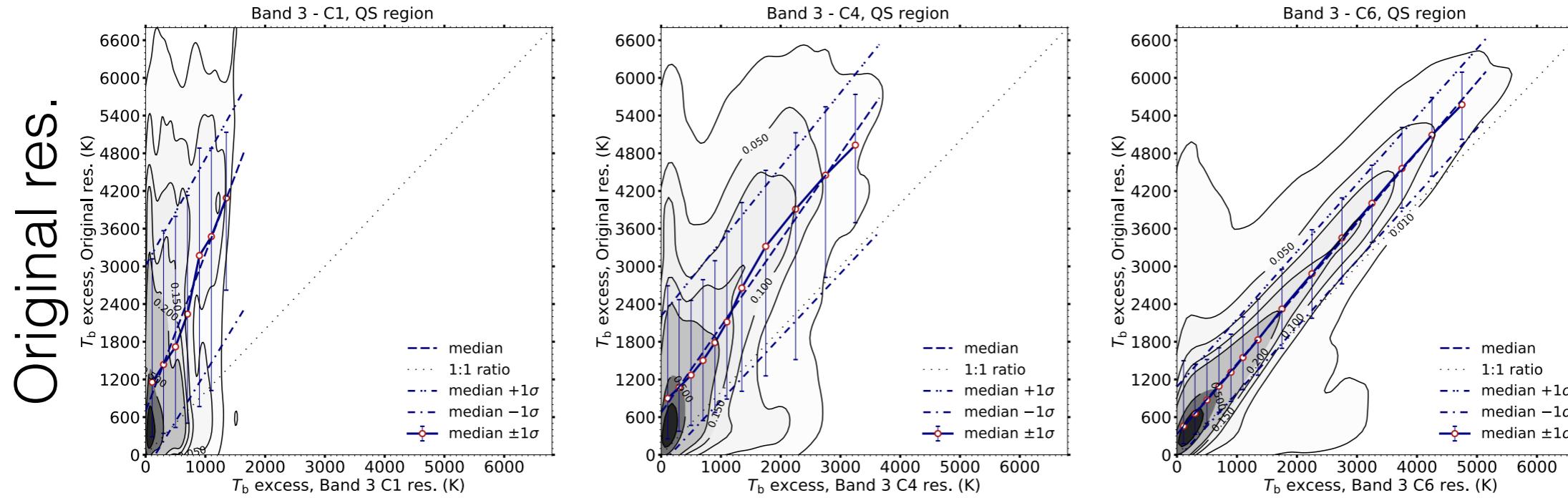
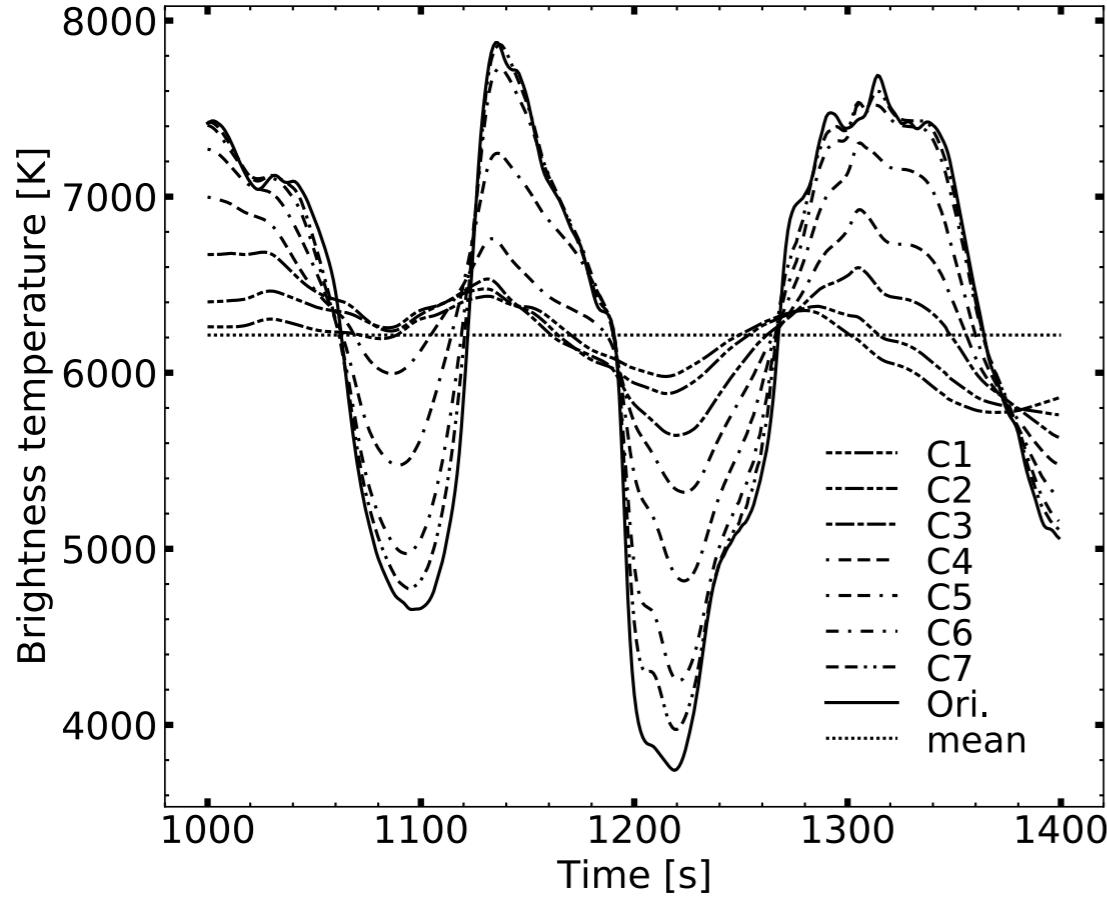
## Antenna positions



## Synthetic maps with degraded resolution



# Simulations — degradation of brightening events with lower angular resolution



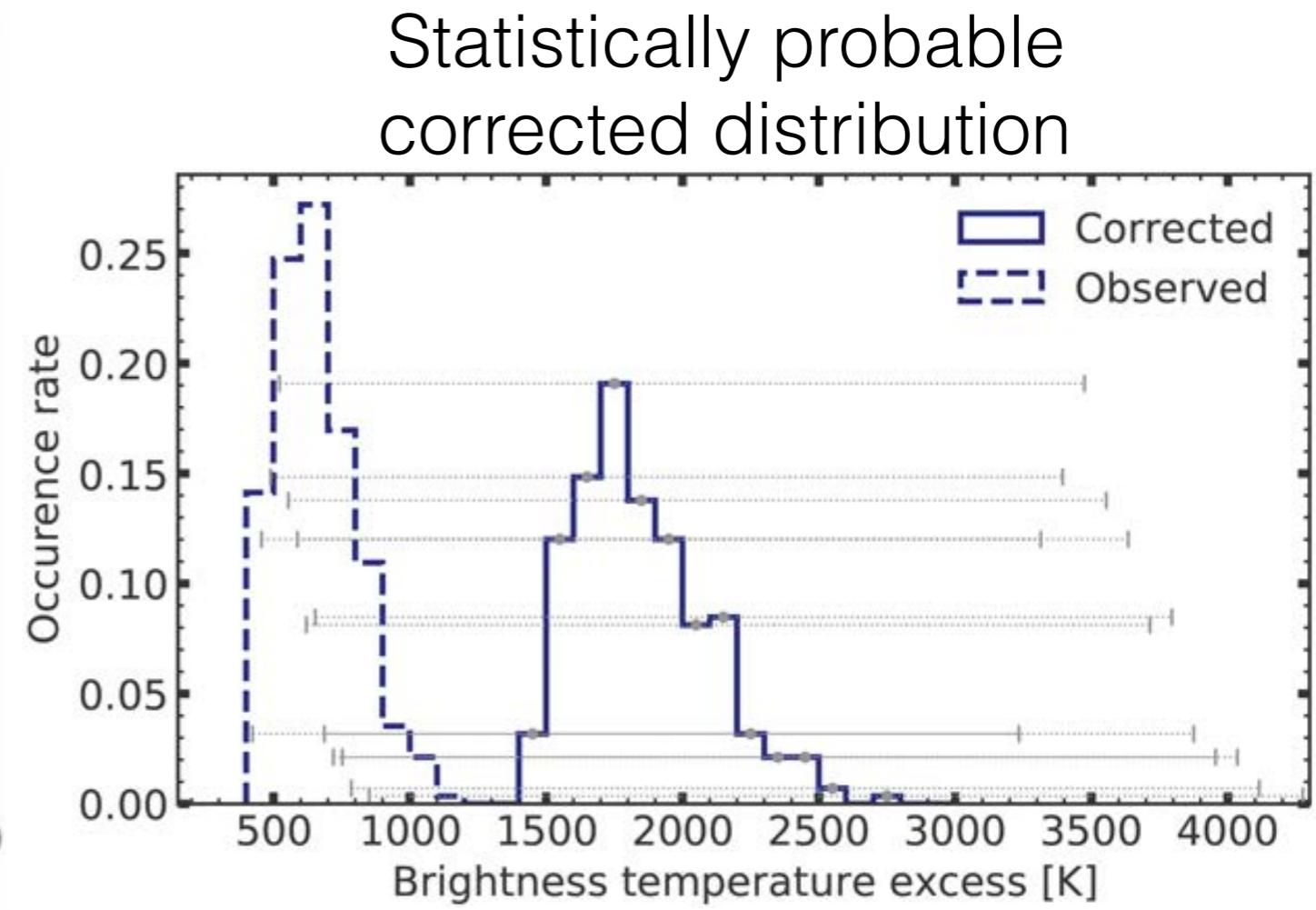
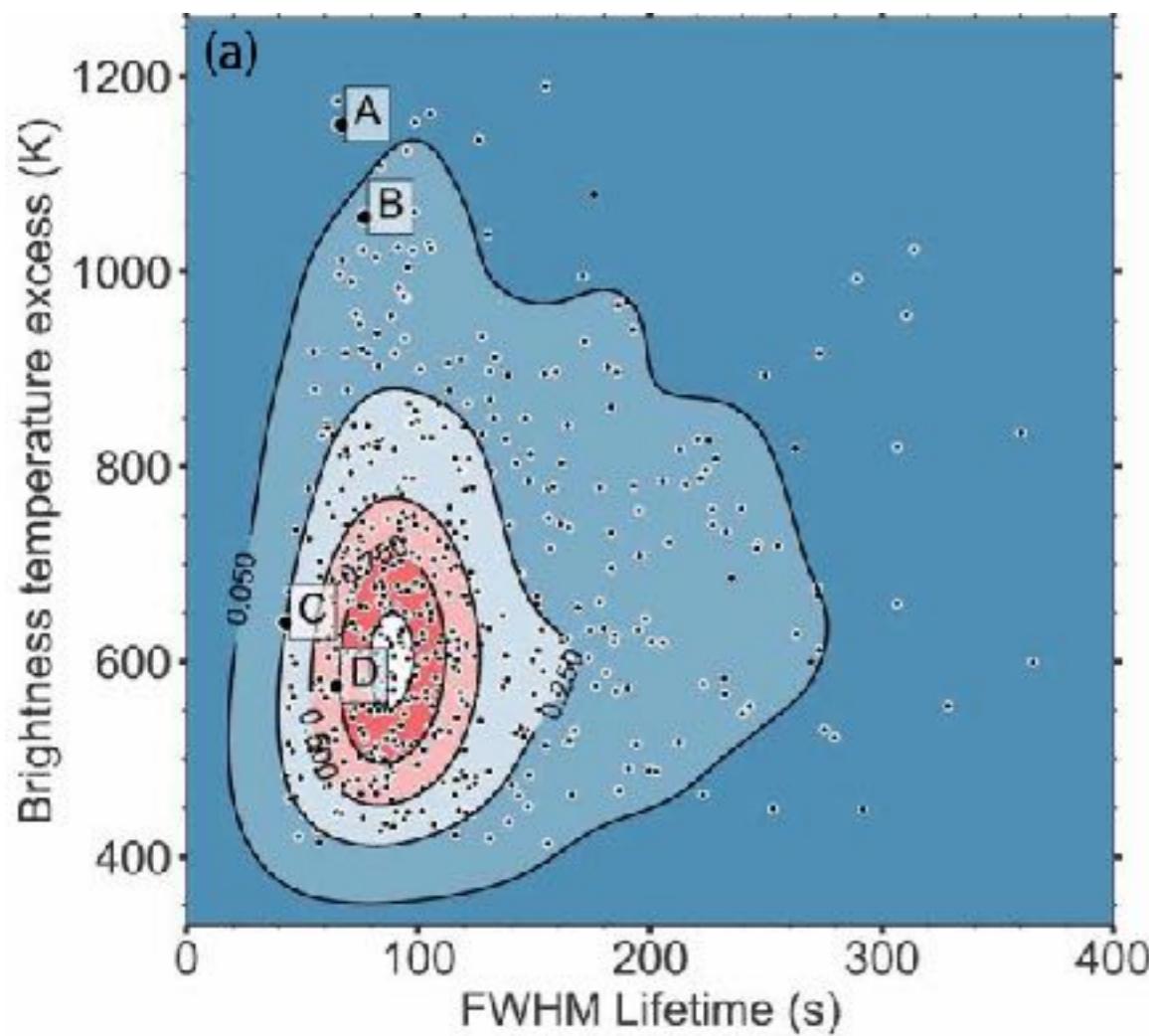
C1

C4

C6

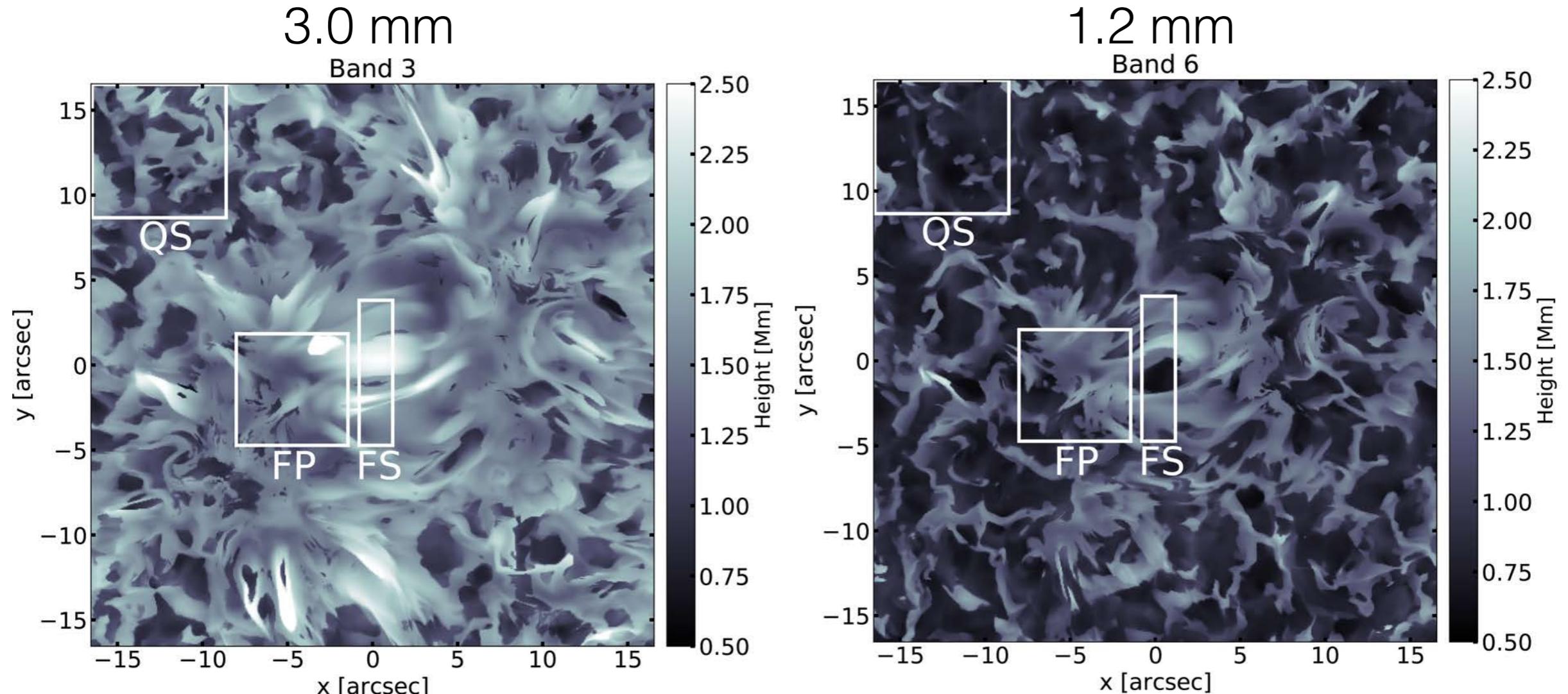
# Application of derived correction factors on the observational events

Observed brightening events



# Simulations — Formation heights

Bifrost ‘enhanced network’ - radiative transfer with ART



1. Carlsson, M., Hansteen, V. H., Gudiksen, B. V., Leenaarts, J., & De Pontieu, B. 2016, A&A, 585, A4
2. de la Cruz Rodríguez, J., Szydlarski, M., & Wedemeyer, S. 2021, ART: Advanced (and fast!) Radiative Transfer code for Solar Physics (<https://github.com/SolarAlma/ART>).
3. Eklund, H., Wedemeyer, S., Szydlarski, M., Jafarzadeh, S., & Guevara Gómez, J. C. 2020, A&A, 644, A152
4. Eklund, H., Wedemeyer, S., Snow, B., et al. 2021, Philosophical Transactions of the Royal Society of London Series A, 379, 20200185
5. Gudiksen, B. V., Carlsson, M., Hansteen, V. H., et al. 2011, A&A, 531, A154
6. Jafarzadeh, S., Wedemeyer, S., Fleck, B., et al. 2021, Philosophical Transactions of the Royal Society A: Mathematical, 379, 20200174
7. Wedemeyer, S., Szydlarski, M., Jafarzadeh, S., et al. 2020, A&A, 635, A71