Impact of cloud longwave scattering on radiative fluxes associated with the Madden-Julian Oscillation in the Indian Ocean and Maritime Continent

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"Radiative and turbulent fluxes are responsible for the growth and maintenance of the MSE anomalies associated with the MJO."

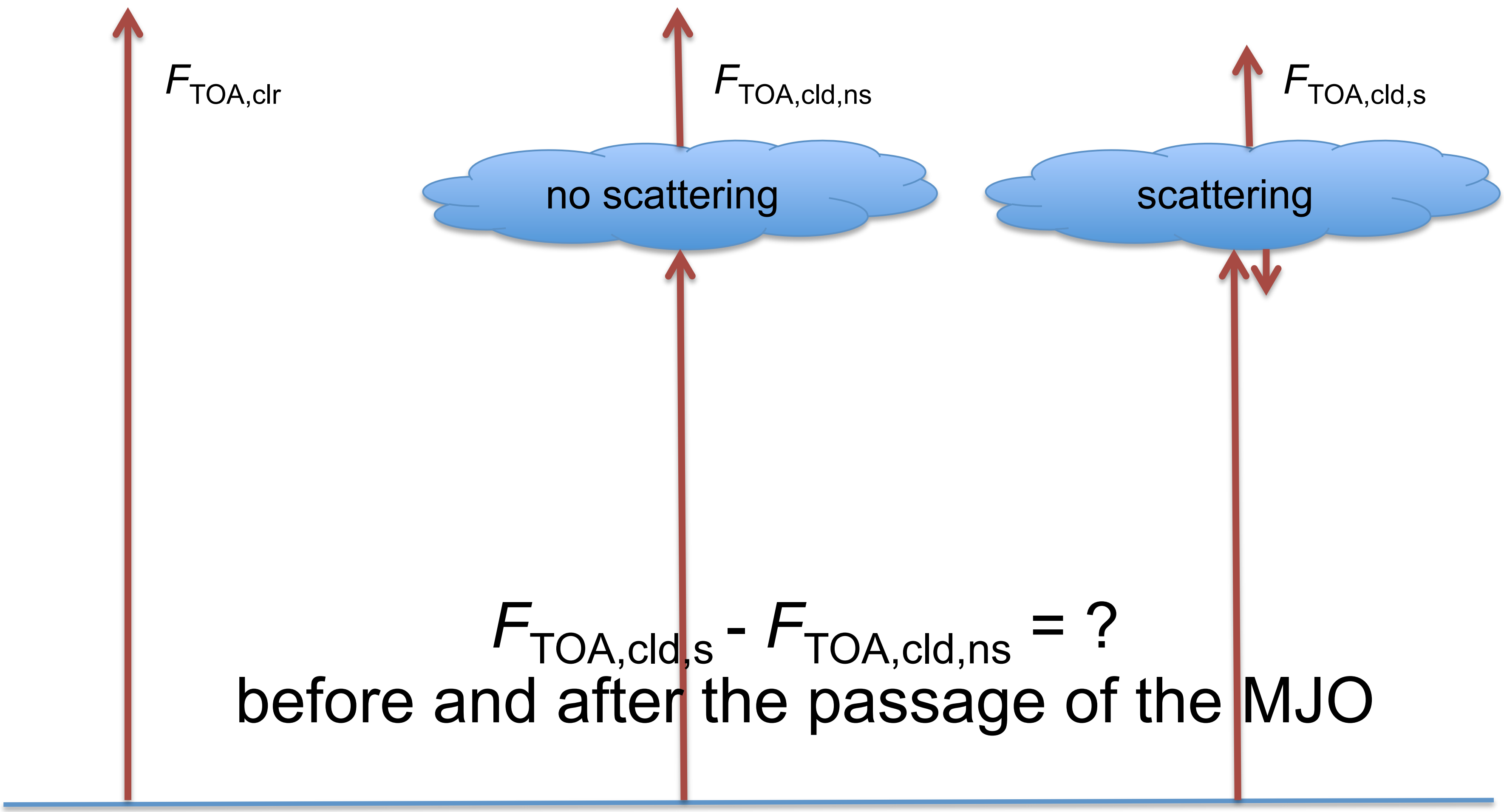
—Sobel et al. (2014)

"The radiative heating and surface fluxes destabilize the MJO disturbance by amplifying and maintaining MJO."

—Inoue & Back (2015)

$$\frac{\partial\langle h\rangle}{\partial t} = -\langle \mathrm{v}\cdot\nabla h\rangle - \left\langle \omega\frac{\partial h}{\partial p}\right\rangle + \underline{\langle Q_R\rangle} + \mathrm{SF}$$

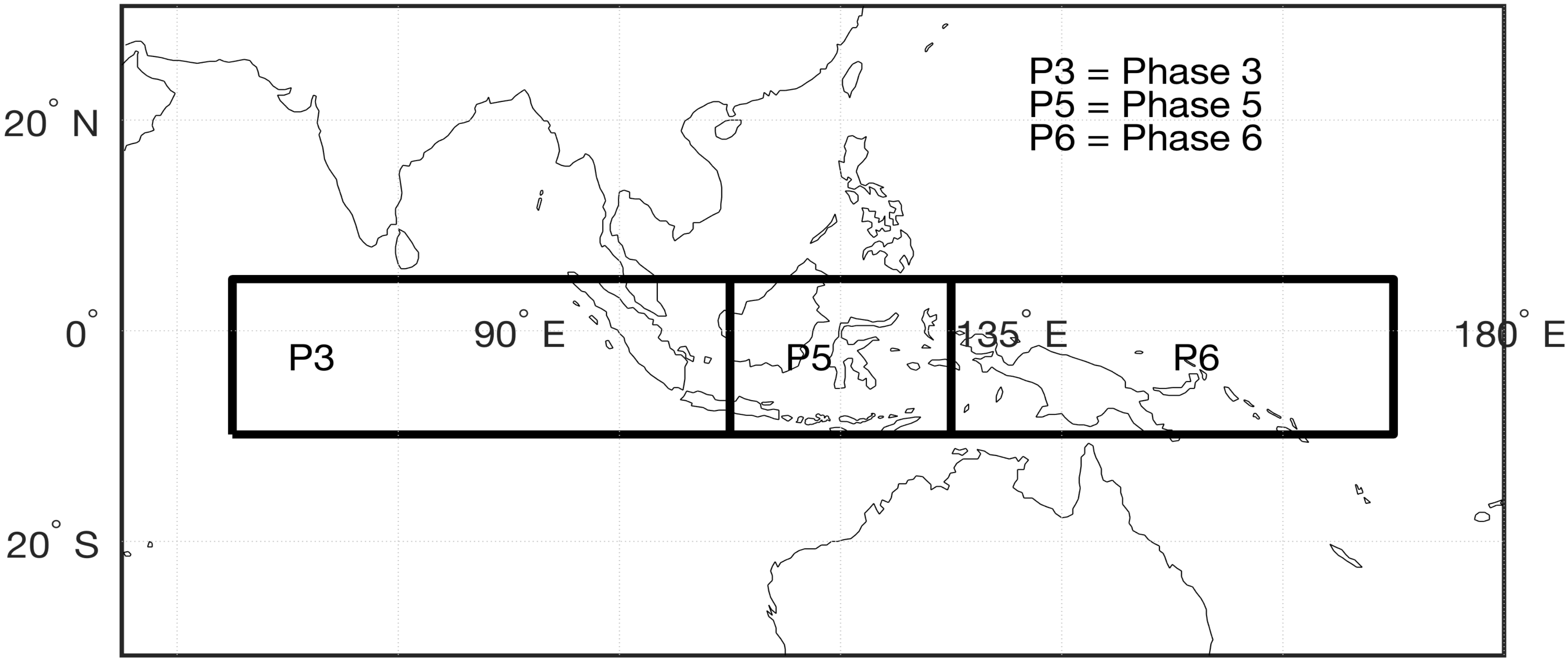
$$F_{\mathrm{TOA,cld,s}} < F_{\mathrm{TOA,cld,ns}} < F_{\mathrm{TOA,clr}}$$



$$F_{\mathrm{TOA,cld,s}} - F_{\mathrm{TOA,cld,ns}} = ?$$

before and after the passage of the MJO

Study area and period

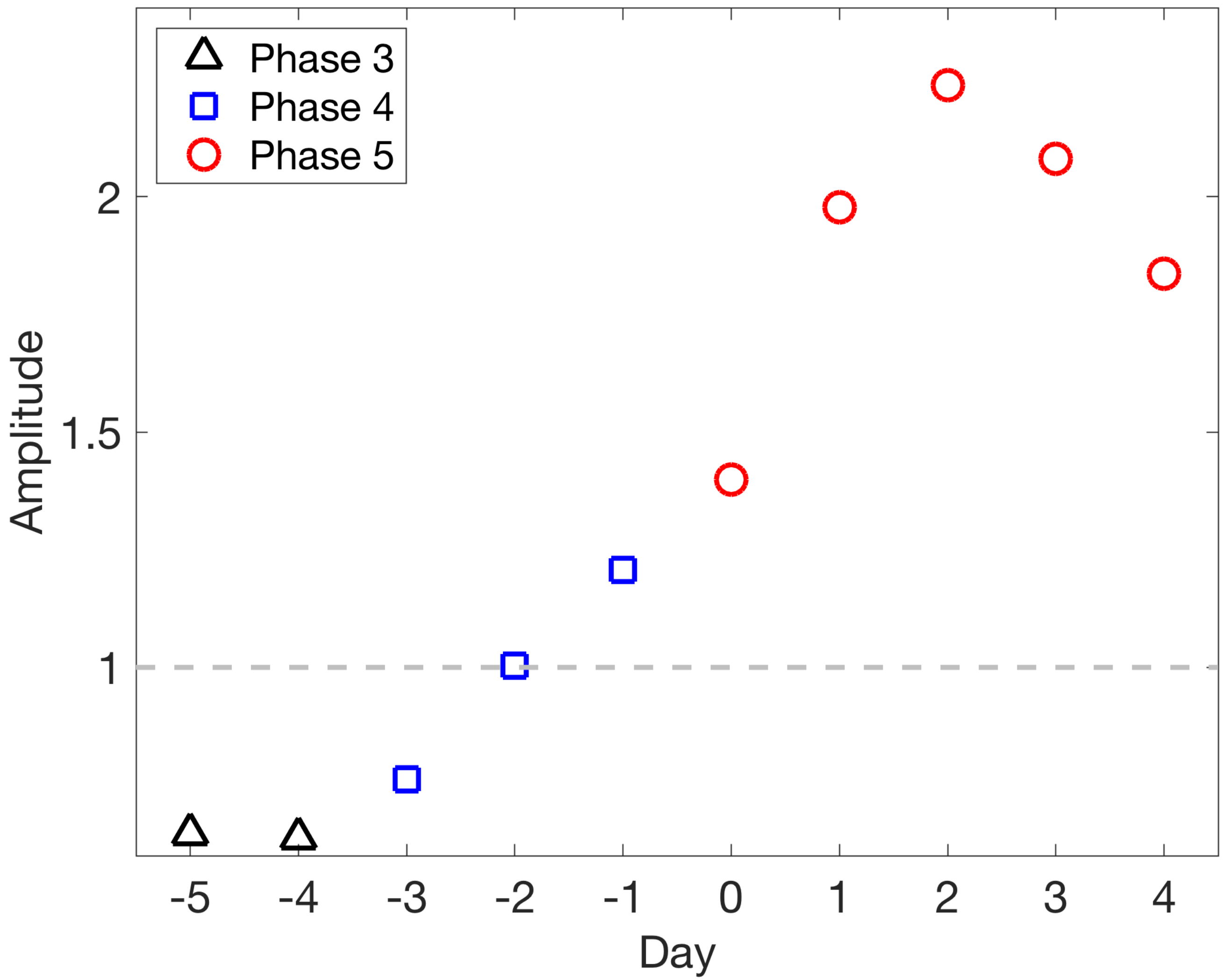


(Ren et al. 2020)

Boreal non-summer months (September-May) during September 2006 to May 2010

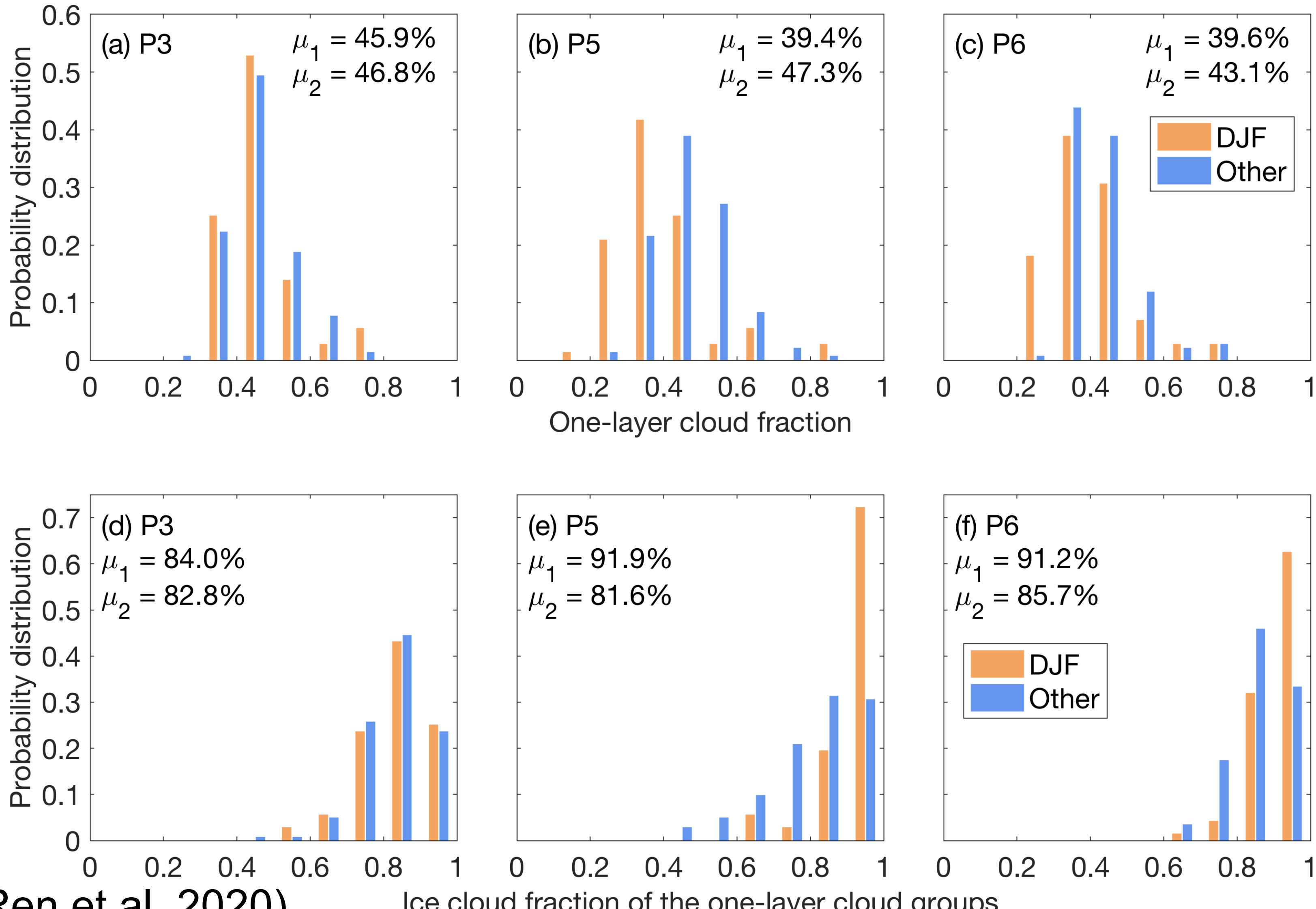
Following Del Genio & Chen (2015)

Strong MJO phase identification



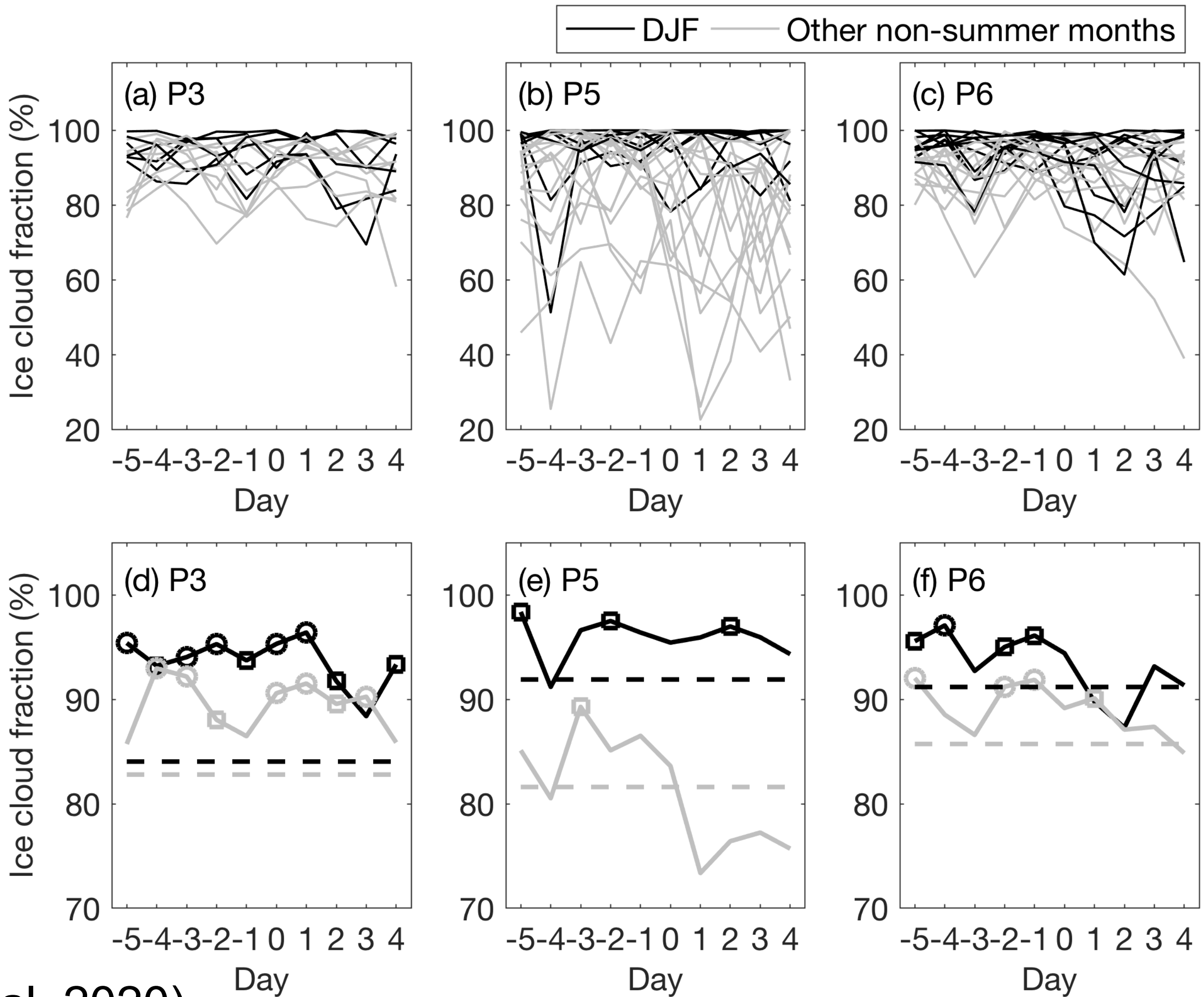
Total: 15 Phase 3, 23 Phase 5, and 23 Phase 6

Near half of the cloudy areas consist of one-layer clouds that are mostly ice clouds



(Ren et al. 2020)

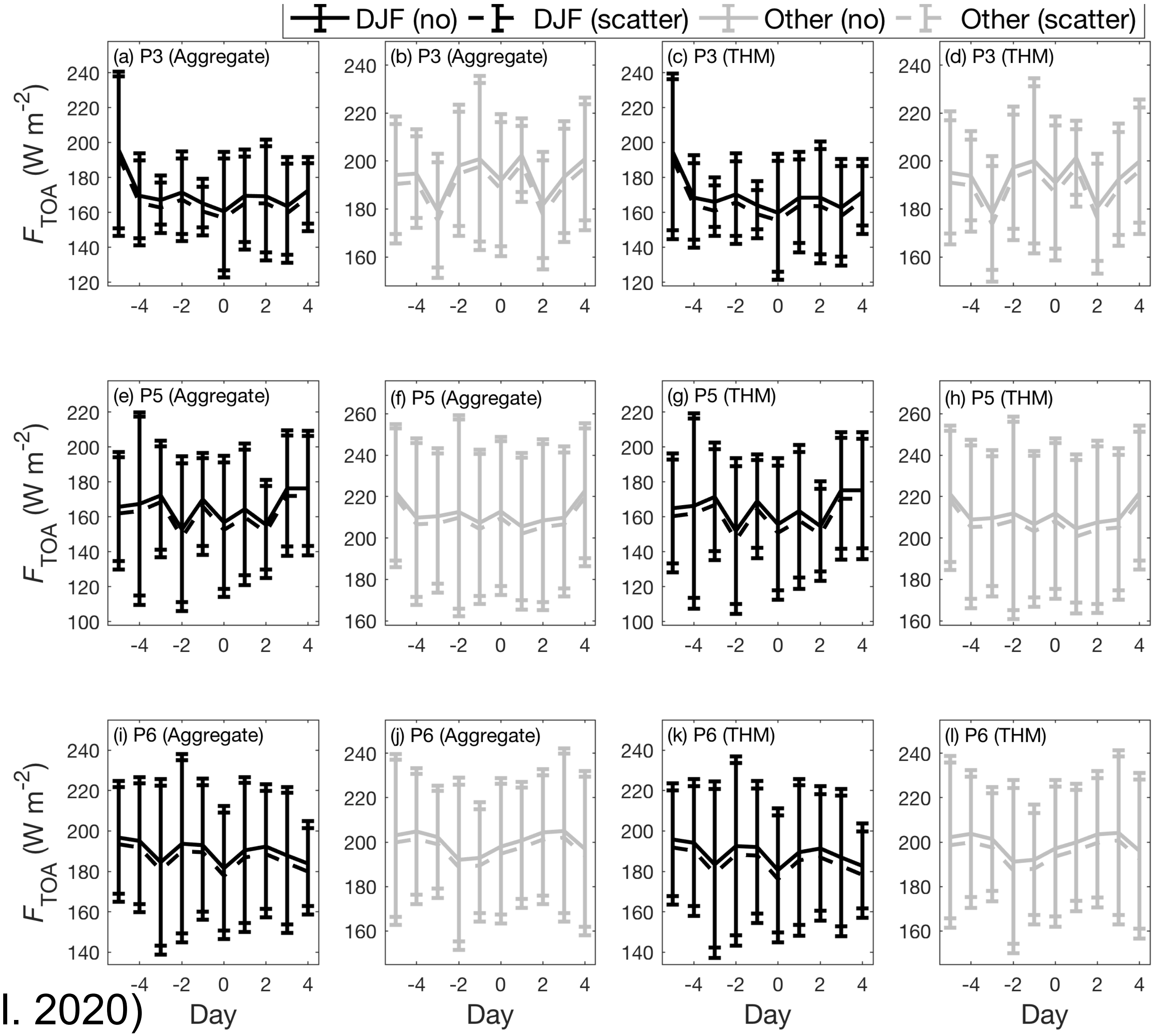
Increased one-layer ice cloud area fraction before the strong MJO onset



(Ren et al. 2020)

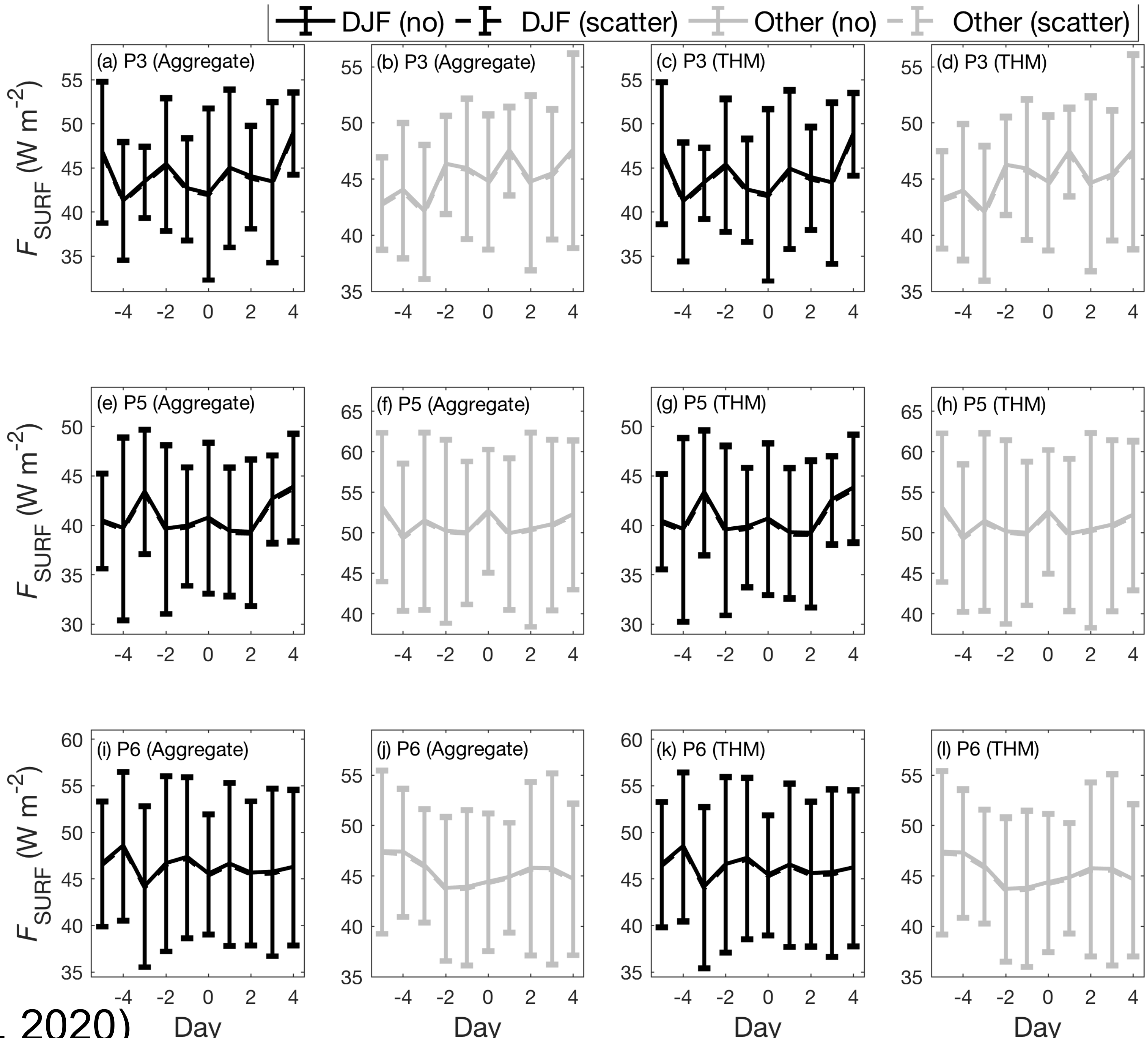
In agreement with Masunaga & Bony (2018)

OLR overestimations are 3.5 to 5.0 W m^{-2}



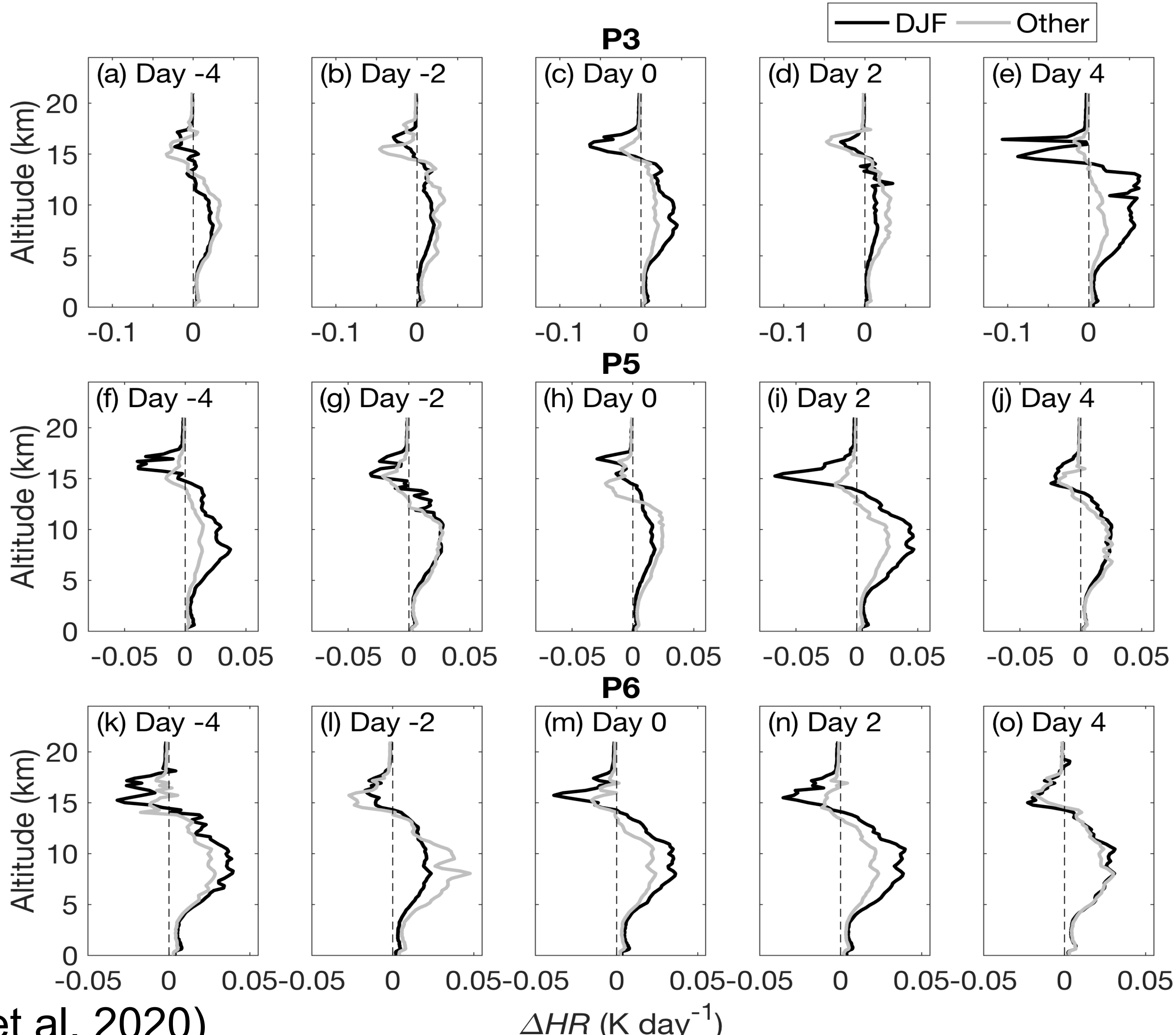
(Ren et al. 2020)

F_{SURF} overestimations are small (0.2 to 0.3 W m^{-2})



(Ren et al. 2020)

LW scattering enhances in-cloud *HR* gradient



(Ren et al. 2020)

Summary

- Duration of one-layer ice cloud coverage increases up to 5 days before the MJO passage.
- Neglecting LW scattering leads to a 3.5 to 5.0 W m^{-2} OLR overestimation.
- Neglecting LW scattering leads to a less sharp heating gradient from cloud base to cloud top.
- We expect that the MJO-like disturbance will be stronger and its eastward propagation will be slower in superparameterized GCMs if cloud LW scattering is included.