Evaluation of tropical anvil cirrus in high-resolution DYAMOND simulations

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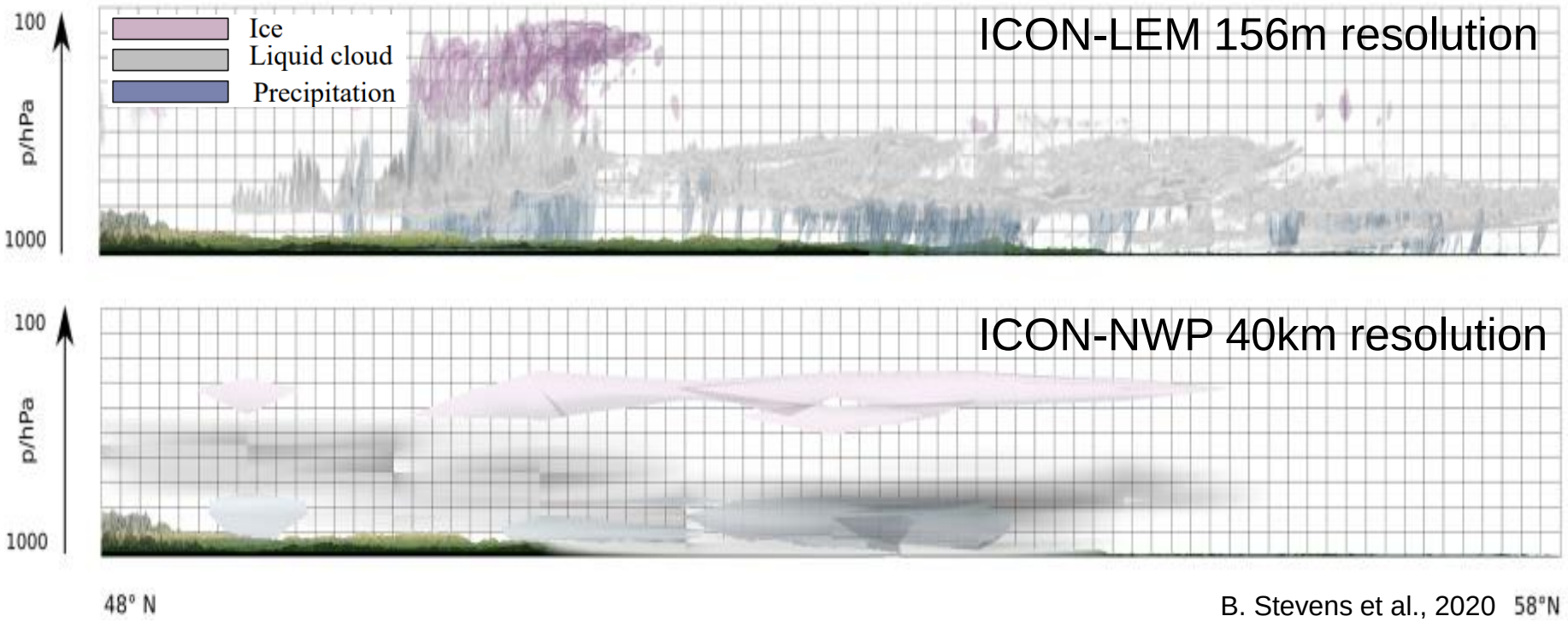
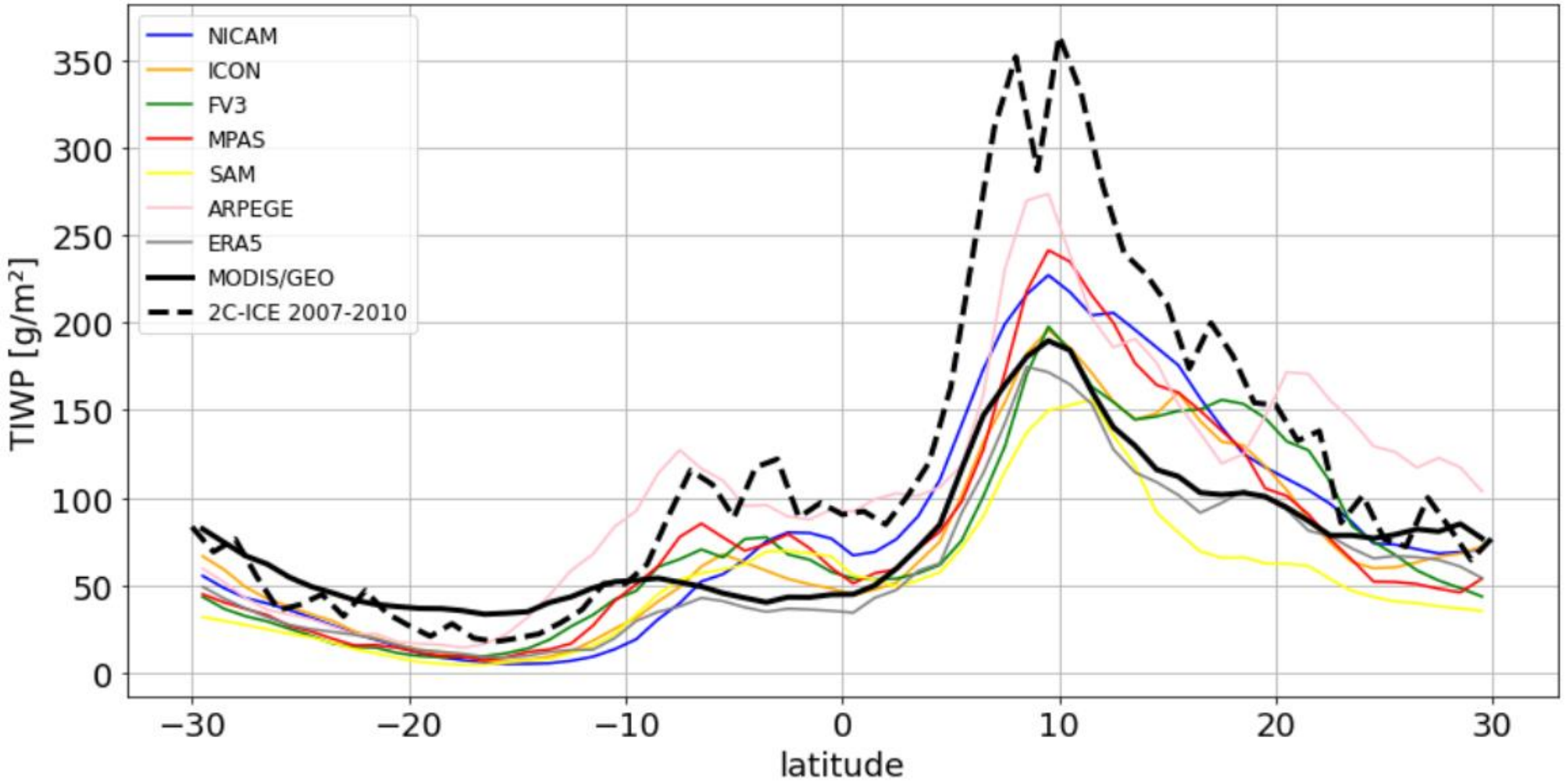


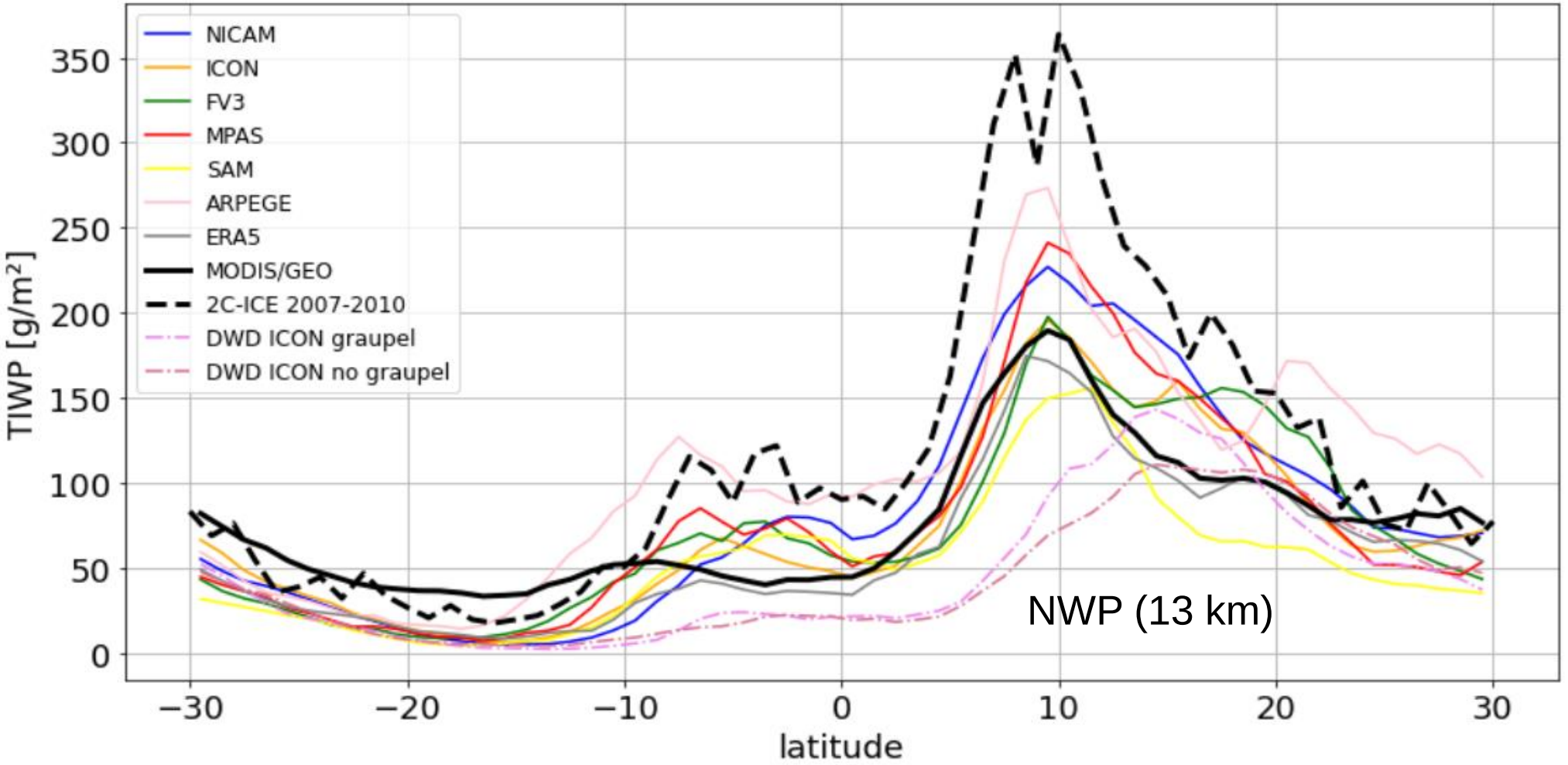
With deep convection mainly resolved, how well is the tropical UT cloudiness simulated?

Total (ice + snow + graupel) ice water path (TIWP) in high-resolution DYAMOND models



Tropical TIWP generally underestimated

Total (ice + snow + graupel) ice water path (TIWP) in high-resolution DYAMOND models



Tropical TIWP generally underestimated

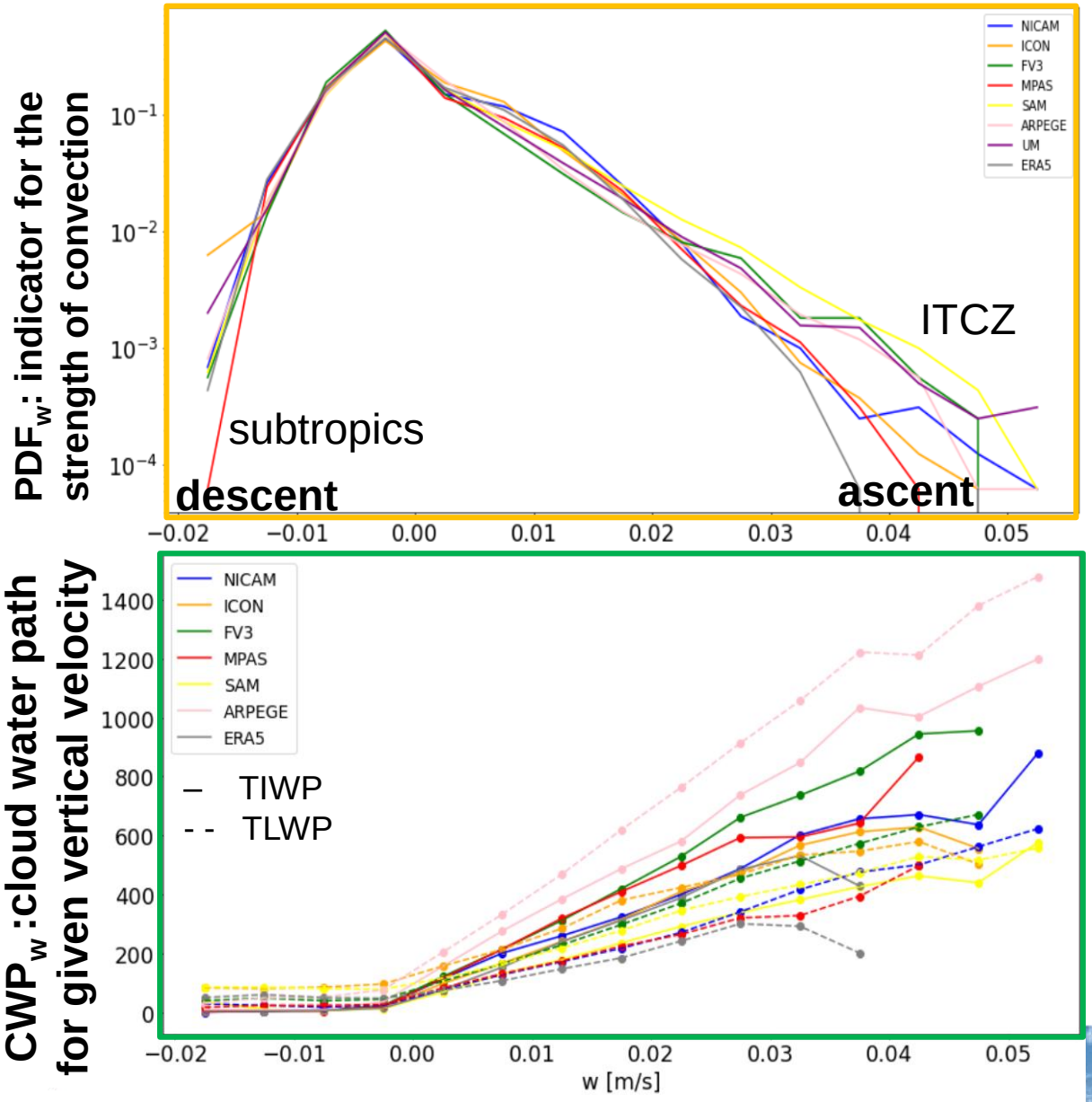
Different TIWP distributions (too little IWP, maxima displaced) in NWP ICON

DLR

	Model & native resolution		Convective param. (D:deep, S:shallow)
DYAMOND MODELS	NICAM	3.5 km	None
	ICON	2.5 km	None
	FV3	3.25 km	S
	MPAS	3.75 km	D, S
	ARPEGE	2.5 km	None
	SAM	4 km	None
NWP models	DWD ICON	13 km	D, S
Reanalysis data	ERA5	0.25°	D, S
Observations	MODIS/GEO	1°	
Time period & area	11^{th} Aug – 10^{th} Sept 2016, Tropical ocean		
Resolution of analysis	1° x 1°		

Is lack of TIWP in models due to dynamics or cloud scheme?

Monthly mean



$$\overline{CWP} = \int_{-\infty}^{\infty} PDF_w \; CWP_w \; dw$$

CWP – Cloud water path
PDF_w – PDF of vertical velocity w;
CWP_w – Cloud water path for given vertical velocity

Reasons for differences in dynamics (PDF_w):

a) Process

b) Distribution

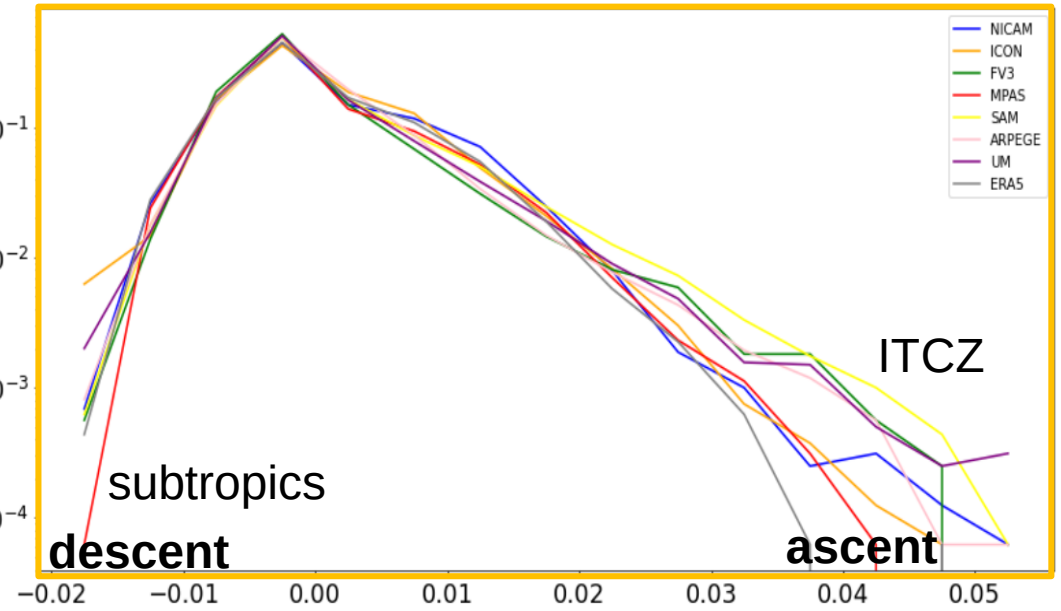
Large variability in cloud water path reaction to convection!

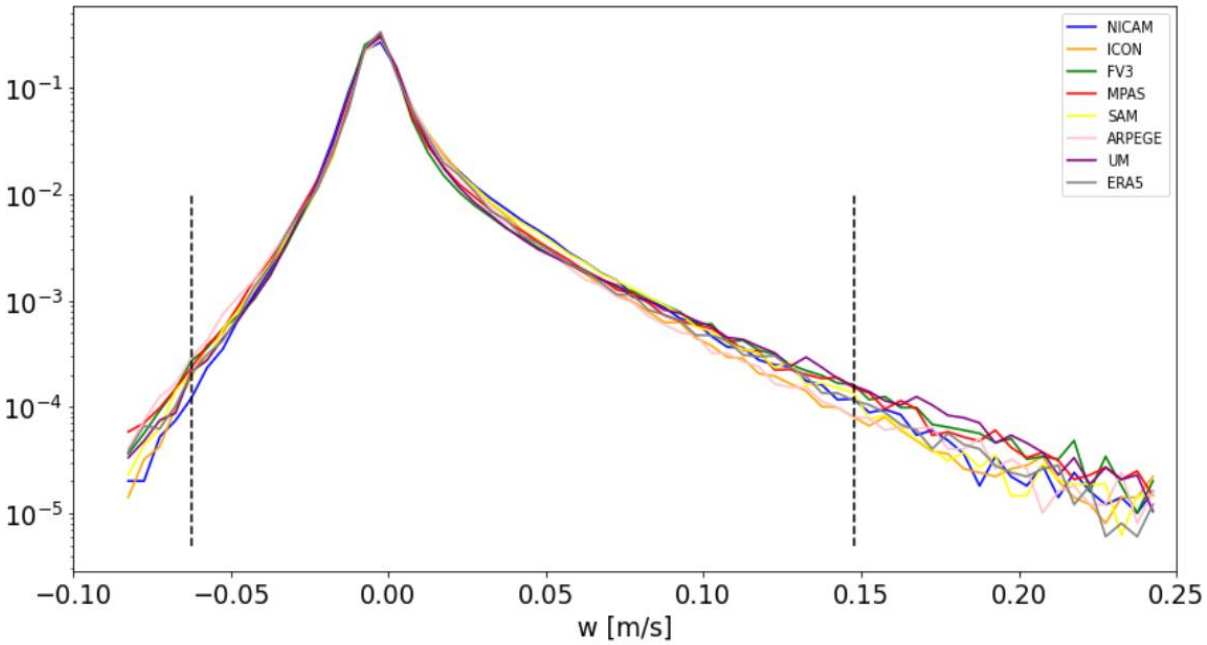
How different is dynamics between the high-resolution models?

Monthly mean

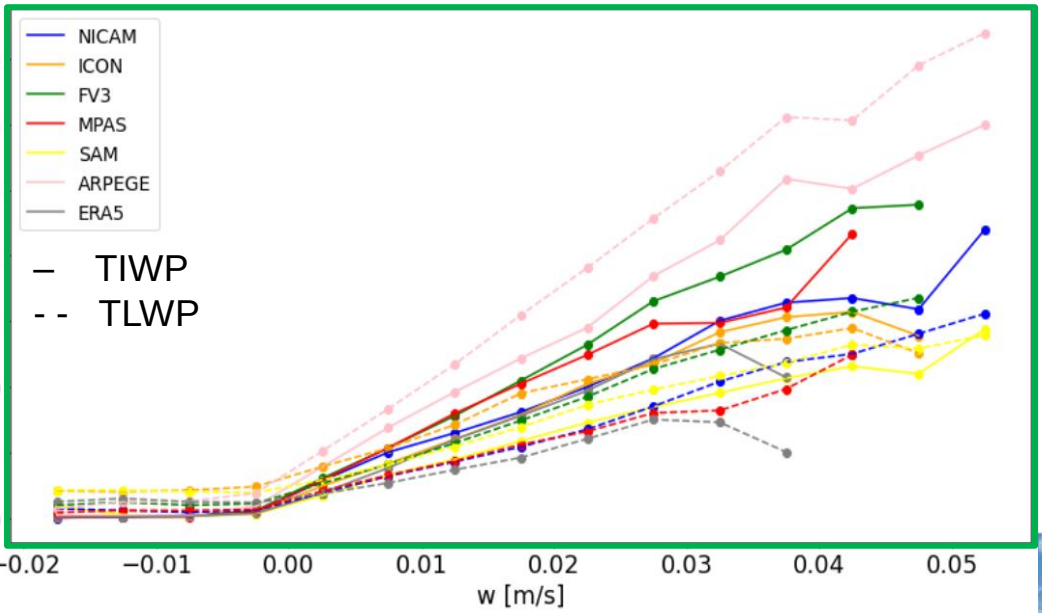
Daily mean

PDF_w: indicator for the strength of convection





CWP_w: cloud water path for given vertical velocity



→ Convective activity (dynamics) is similar

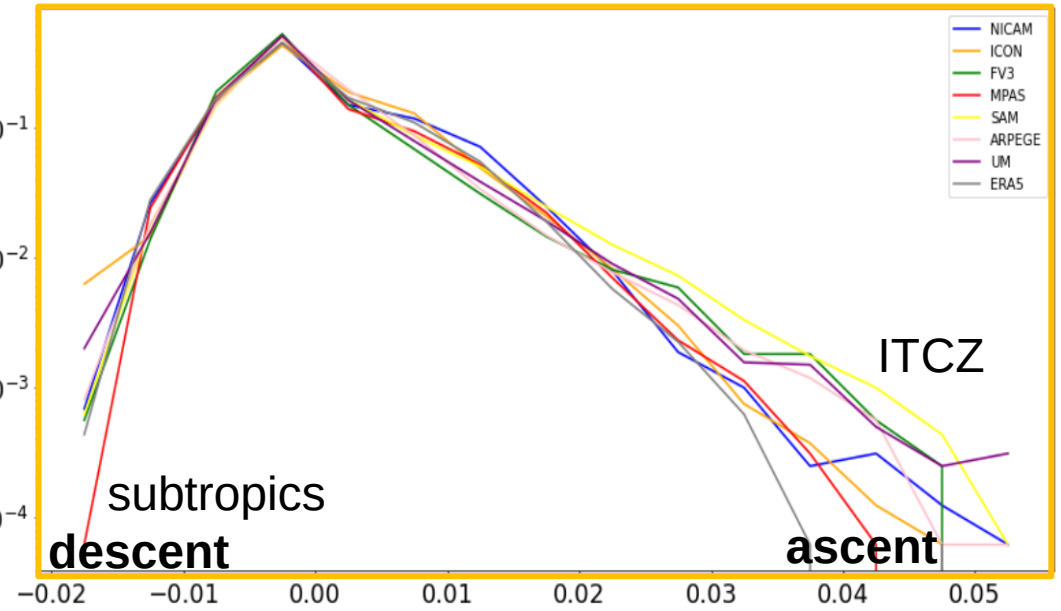
→ Different spatial distribution (scattered in ERA5)

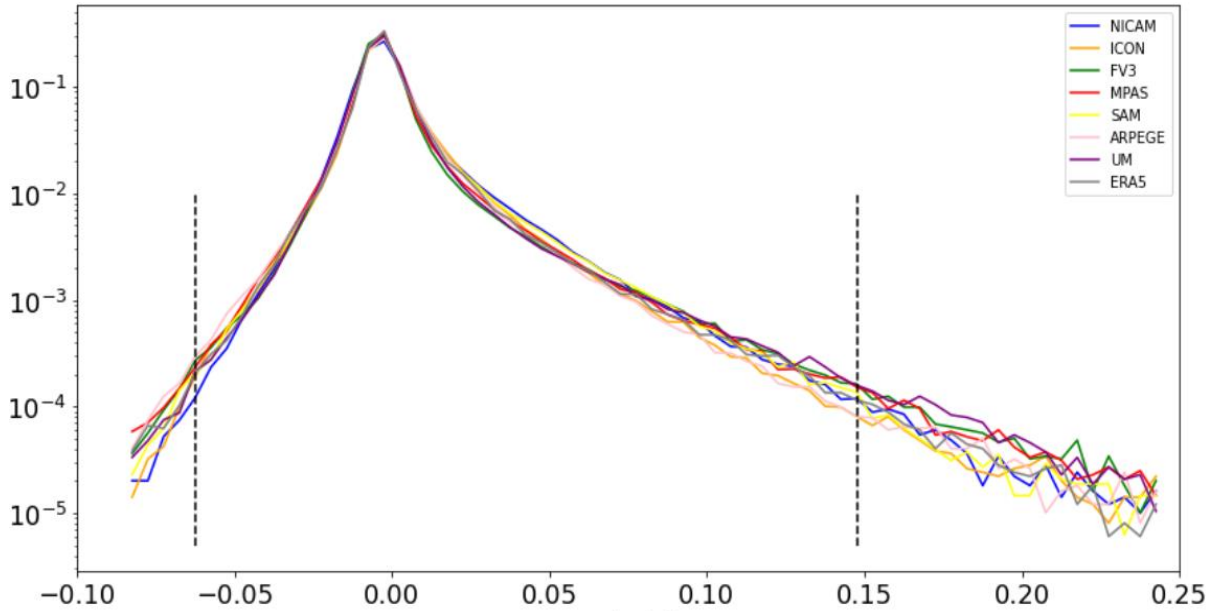
Impact of convection on UT cloudiness varies strongly!

Monthly mean

Daily mean

PDF_w: indicator for the strength of convection





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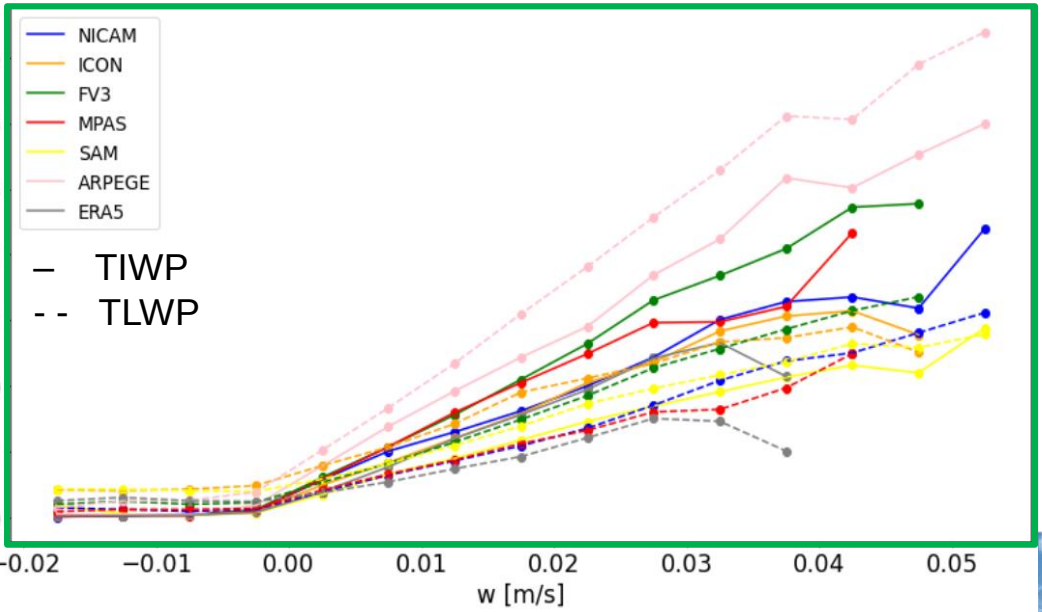
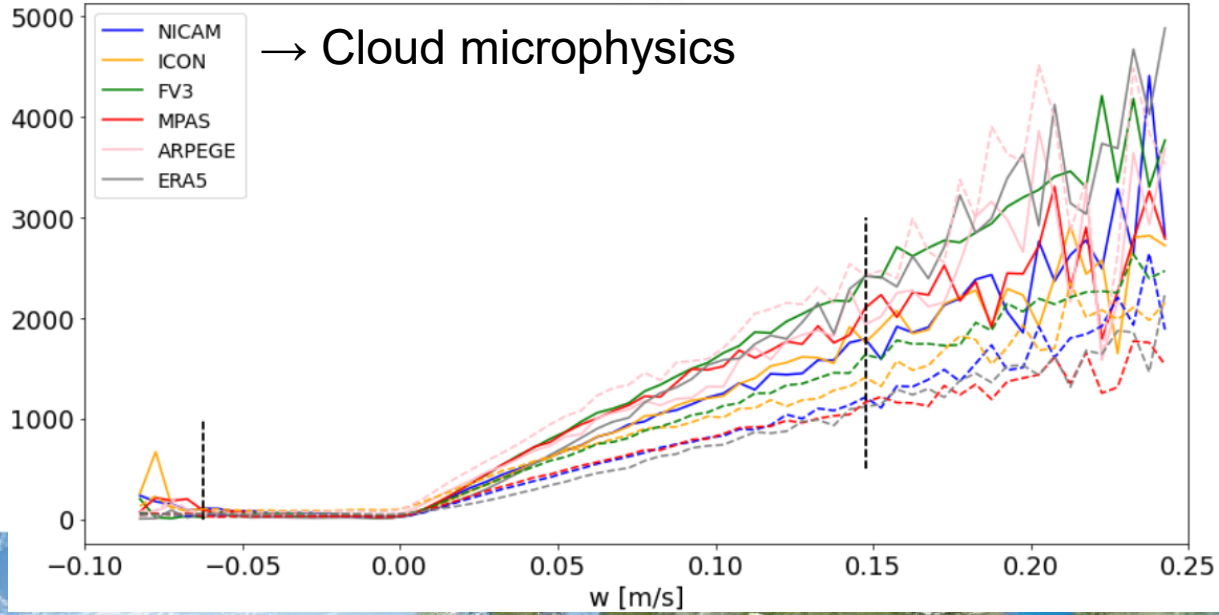


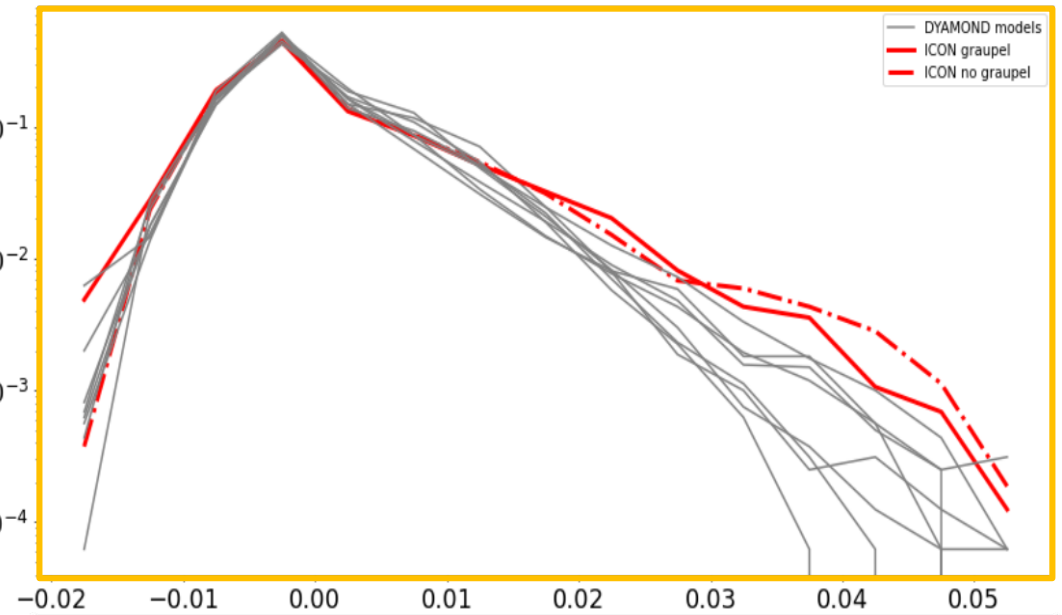


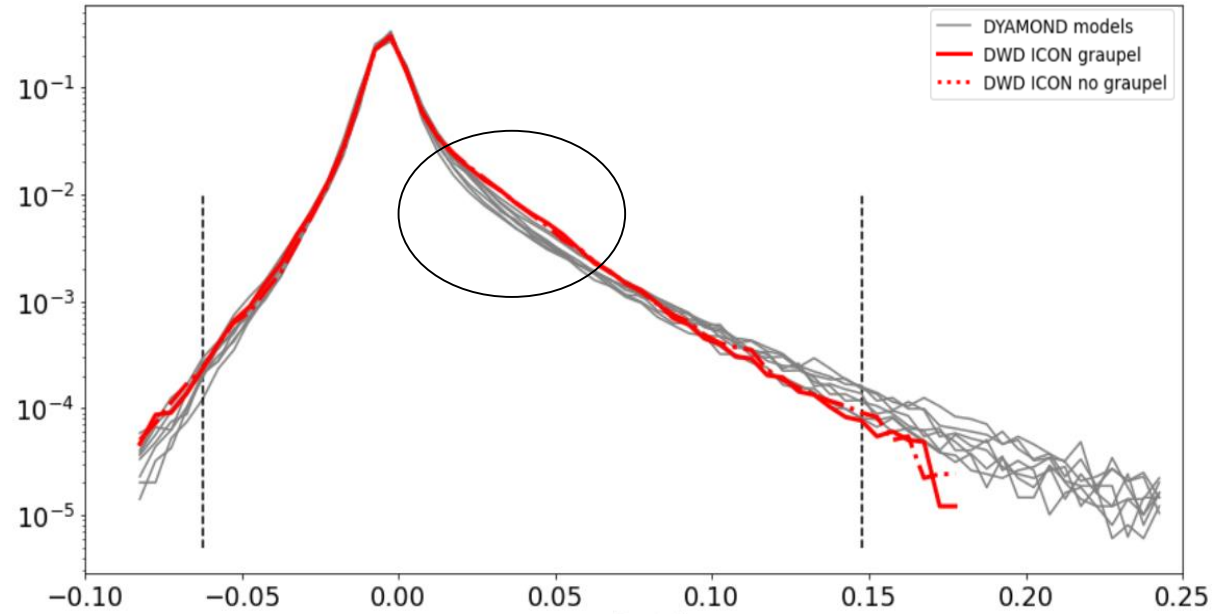
How different are NWP models compared to high-resolution models?

Monthly mean

Daily mean

PDF_w: indicator for the strength of convection





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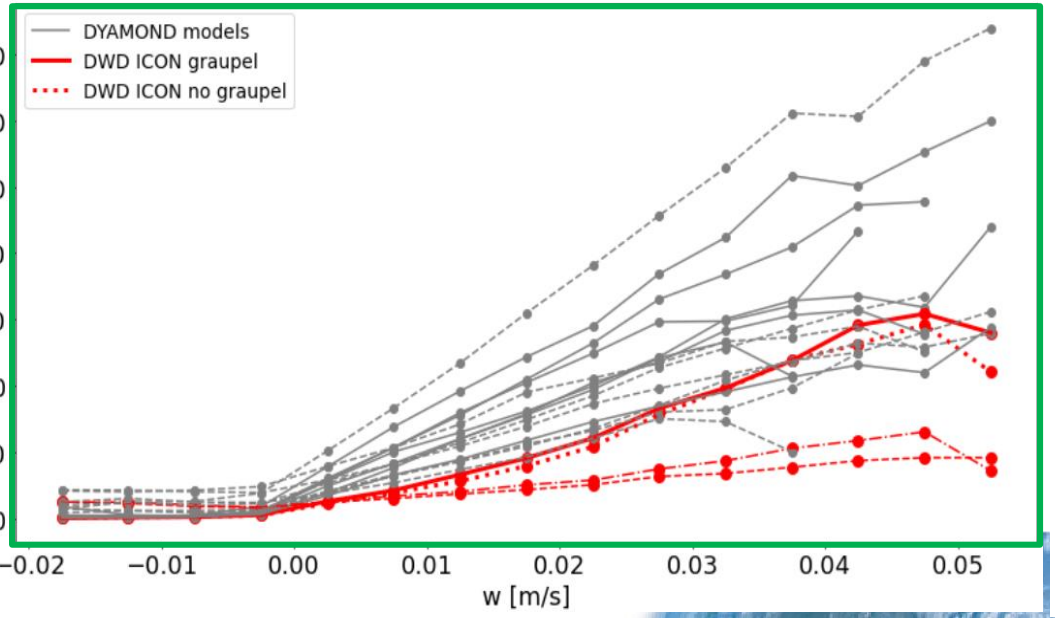

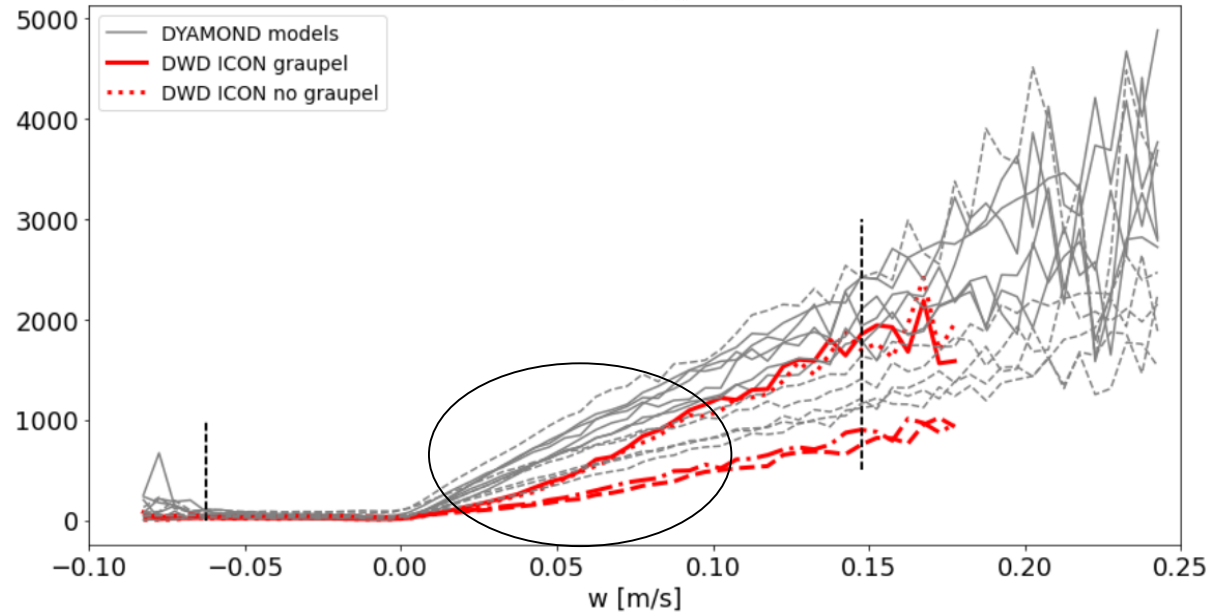

Conclusions

Deep convection is mainly resolved in DYAMOND models (resolution < 5km):

→ Tropical TIWP still generally underestimated

→ Similar convective activity but less scattered convection than in ERA5

→ Reaction of cloud properties (TIWP & TLWP) to strength of convection shows large model variability (differences in cloud microphysics)

→ Improvement compared to ICON-NWP (generally larger TIWP, in particular at lower convective strength)

→ longer atmospheric lifetime of convective water

→ underestimation of TIWP is connected to overestimation of precipitation

(talk: Ulrike Burkhardt, Wednesday A33F-05)

THANK YOU