Institute of Space Sciences

EXCELENCIA MARÍA DE MAEZTU

Results of the multi-center exercise

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Plan de Recuperación, Transformación y Resiliencia

AGENCIA ESTATAL DE INVESTIGACIÓN

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IEEC Institut d'Estudis Espacials de Catalunya

- Forward operator
  - Interpolation
  - WC → Kdp → Δϕ
- Results for operational model outputs
  - ECMWF IFS
  - JMA
- Results for WRF runs
  - Atmospheric rivers
  - Tropical Cyclones

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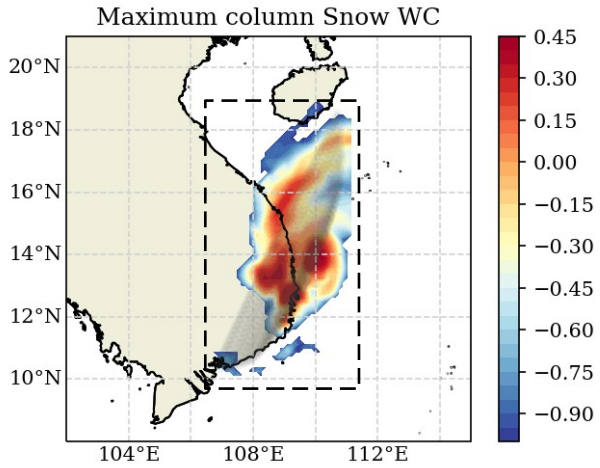
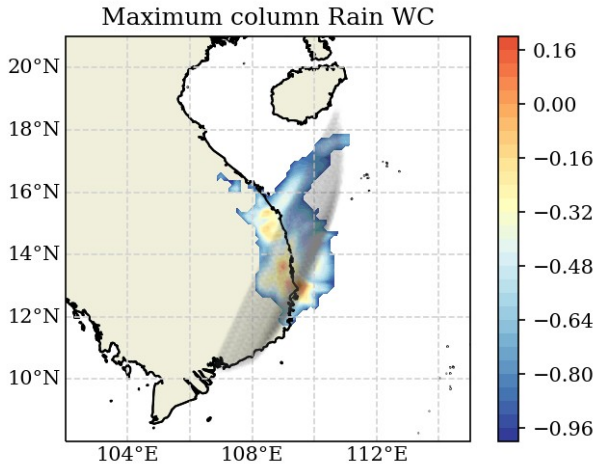
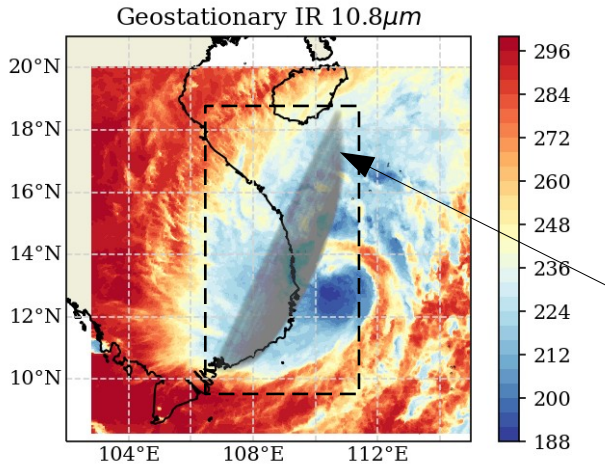
Forward operator

Case example: Tropical Cyclone Matmo (2019-10-30 9:35)



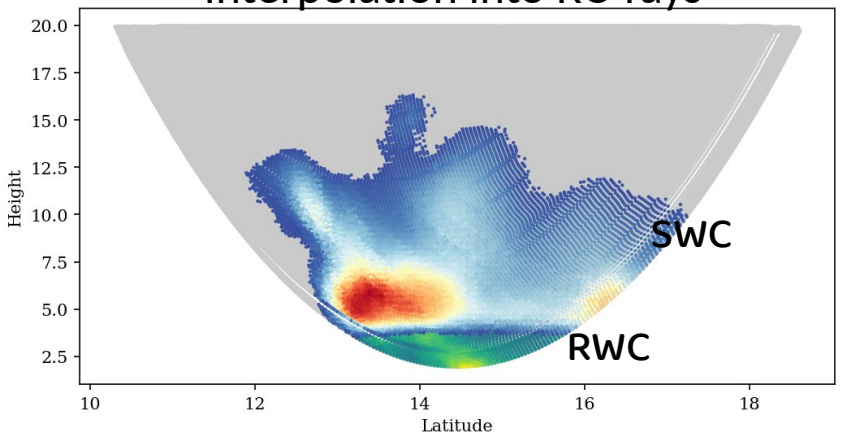


Snow water content and rain water content fields from the ECMWF IFS model



projection of RO rays

Interpolation into RO rays



Forward operator

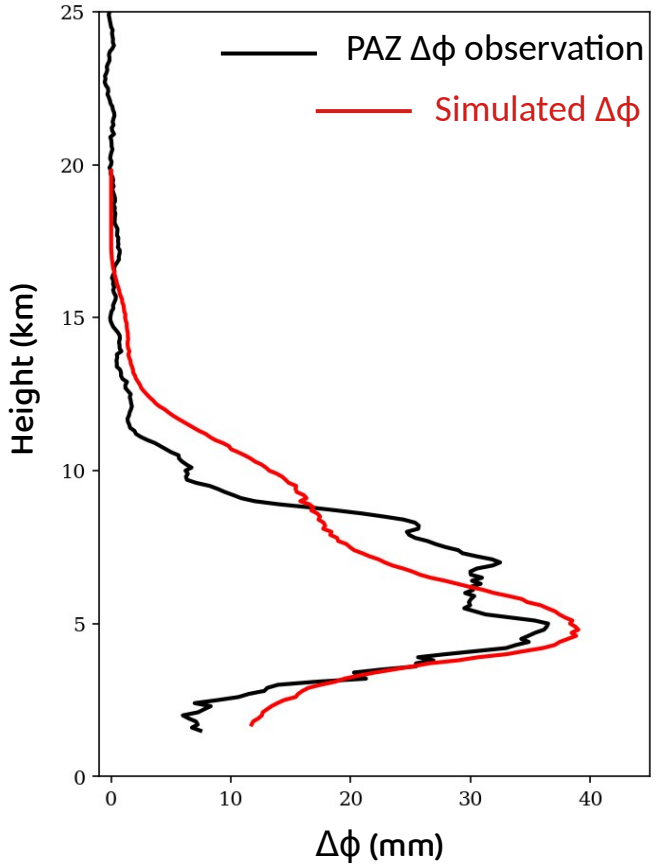
Case example: Tropical Cyclone Matmo (2019-10-30 9:35)

$$\Delta\Phi = \int K_{\mathrm{dp}} dL$$

simplification: $$K_{\mathrm{dp}} = \frac{1}{2} C\, \rho\, \mathrm{IWC}\, (1 - ar);$$

- Rayleigh regime
- effective density
- water content
- axis ratio

Initial assumptions: ρ=0.2 ; ar=0.5



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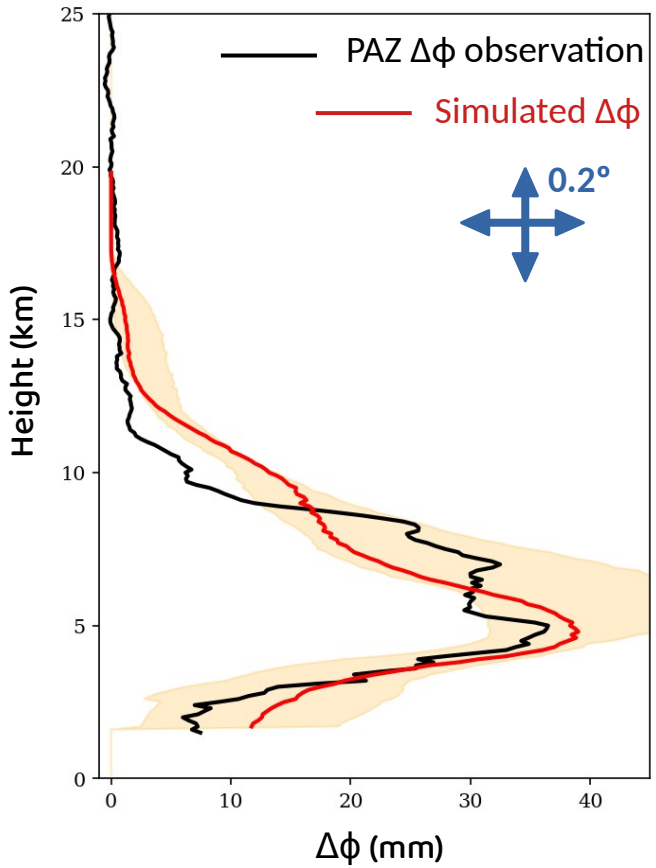
Sensitivity to horizontal displacement



Forward operator

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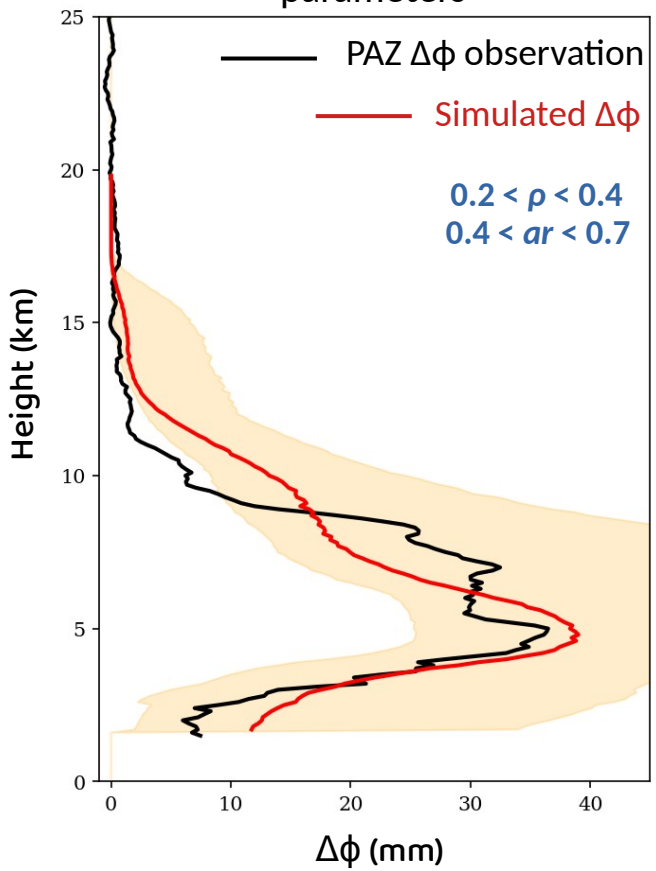
- Rayleigh regime
- effective density (ρ)
- water content (IWC)
- axis ratio (ar)

Initial assumptions: ρ=0.2 ; ar=0.5

Sensitivity to horizontal displacement and FO parameters



Multicenter exercise

ECMWF	Operational IFS	• Rain WC • Snow WC	• Large scale and convective
JMA	Operational	• *Cloud* WC	• From large scale • From convective
Scripps UCSD	WRF	• Rain WC • Snow WC • Cloud WC • Ice WC • Graupel WC	• Initialized using two models: ECMWF and GFS
UCAR, NCU	WRF	• Rain WC • Snow WC • Cloud WC • Ice WC • Graupel WC	• Initialized using two models: ERA5 and GDASfnl • 7 different microphysics schemes for each case
ECMWF	ERA5 reanalysis	• Rain WC • Snow WC • Cloud WC • Ice WC	Only large scale part is stored

To see what is in the operational models.

Limited changes

More freedom to change parameters:
- model initialization
- microphysics

Comparison purposes

- Forward operator
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  - WC → Kdp → Δϕ
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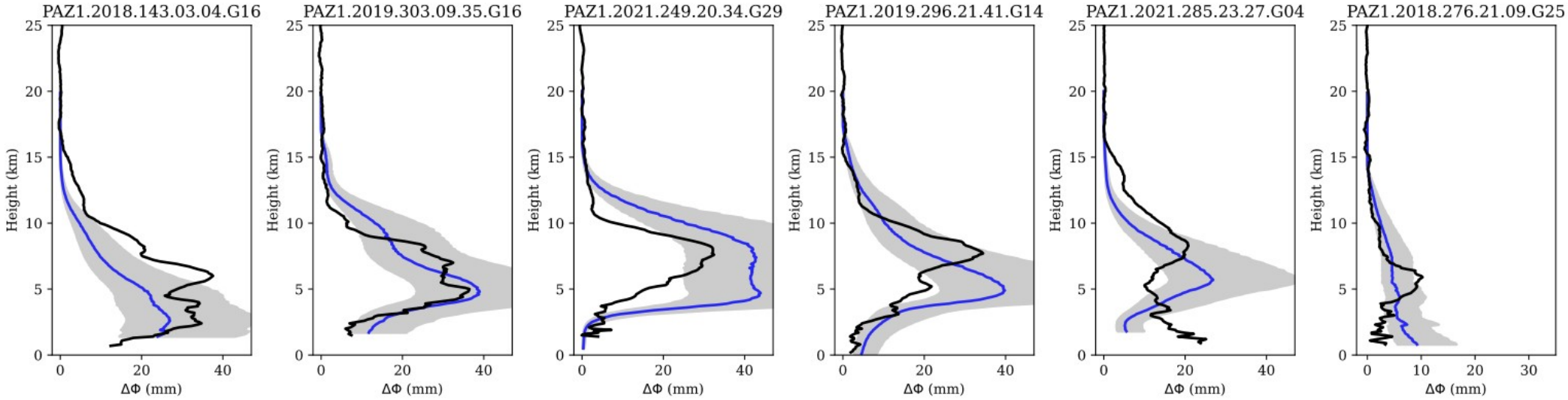
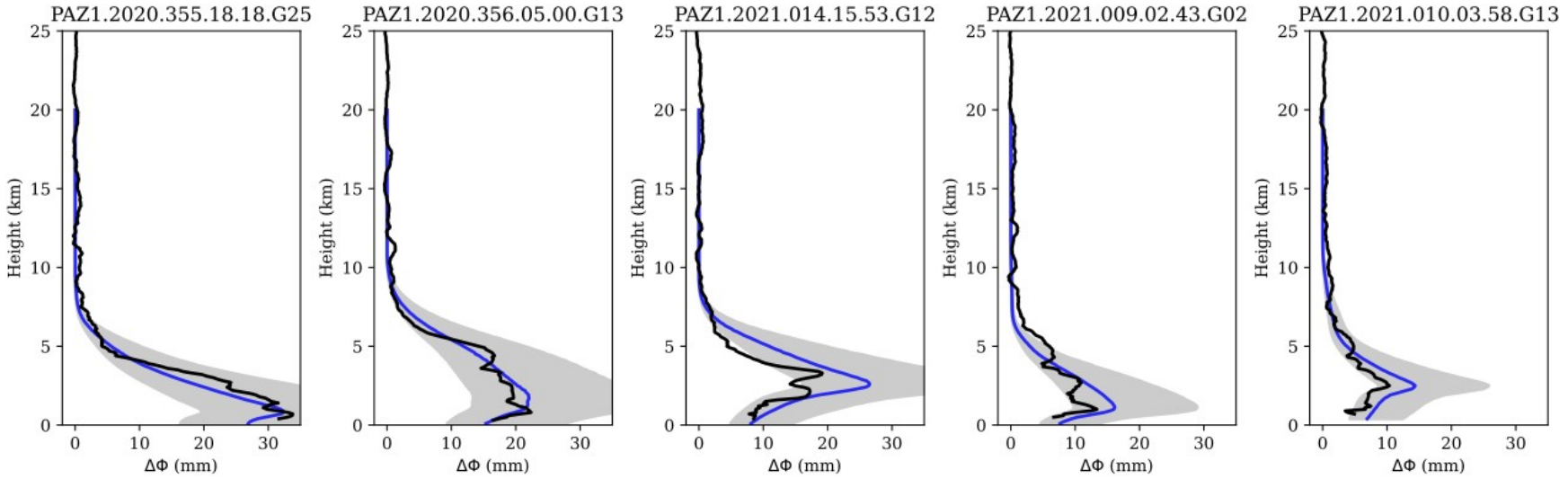
Results for ECMWF IFS

Tropical Cyclones



Atmospheric rivers



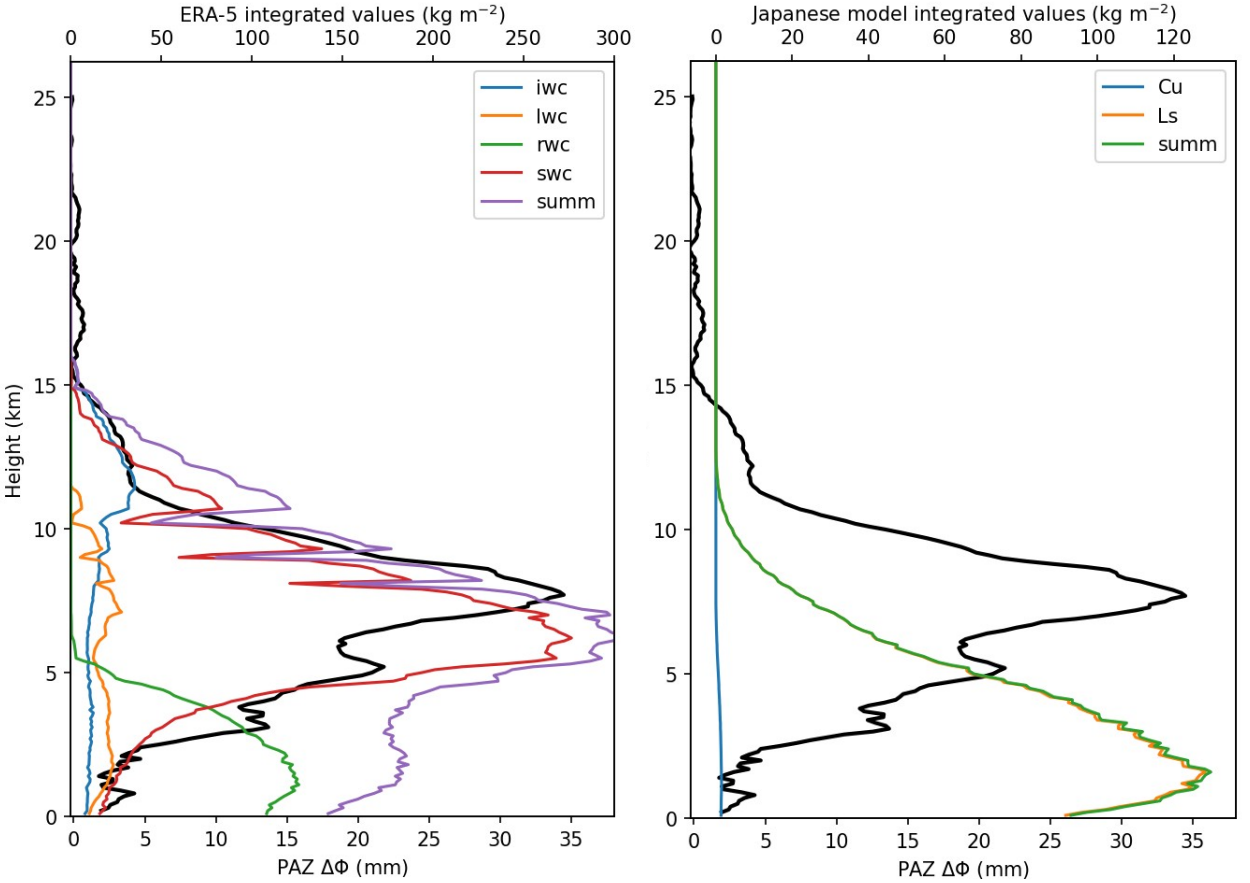
Black: PAZ observation

Blue: IFS Large scale scheme
Gray: sensitivity to displacement and FO params.

More about this in the next talk

Results for JMA

- In JMA model, the large hydrometeors are instantaneously converted into surface rain when they exceed a certain threshold (*from Daisuke*)
- Therefore, CuWC and LsWC only account for small particles
- To use Polarimetric RO effectively, we need that the model stores all hydrometeors fields



Fails to reproduce observations, both in shape and magnitude

- Forward operator
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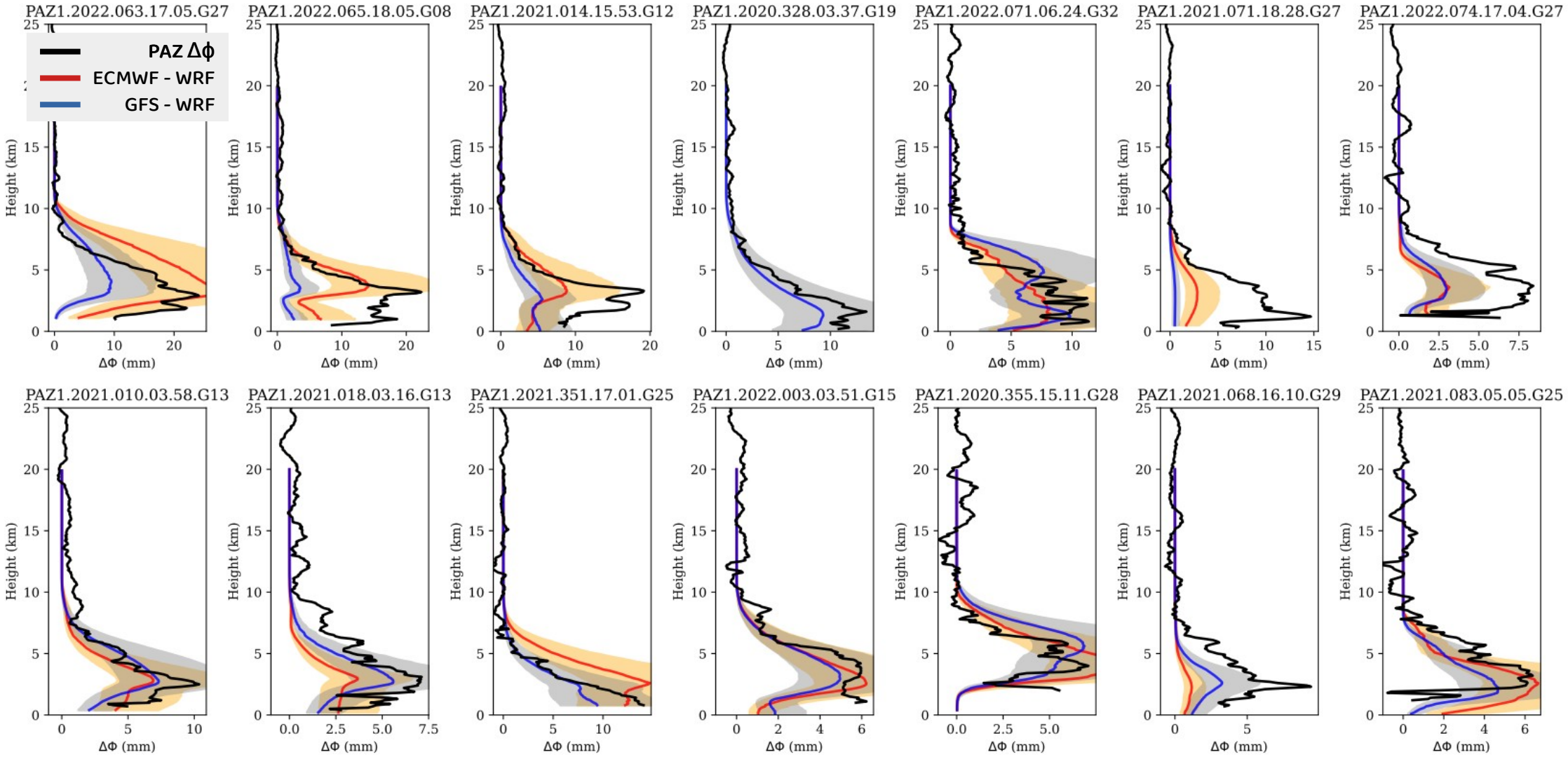
- **Results for WRF runs**
  - Atmospheric rivers
  - Tropical Cyclones

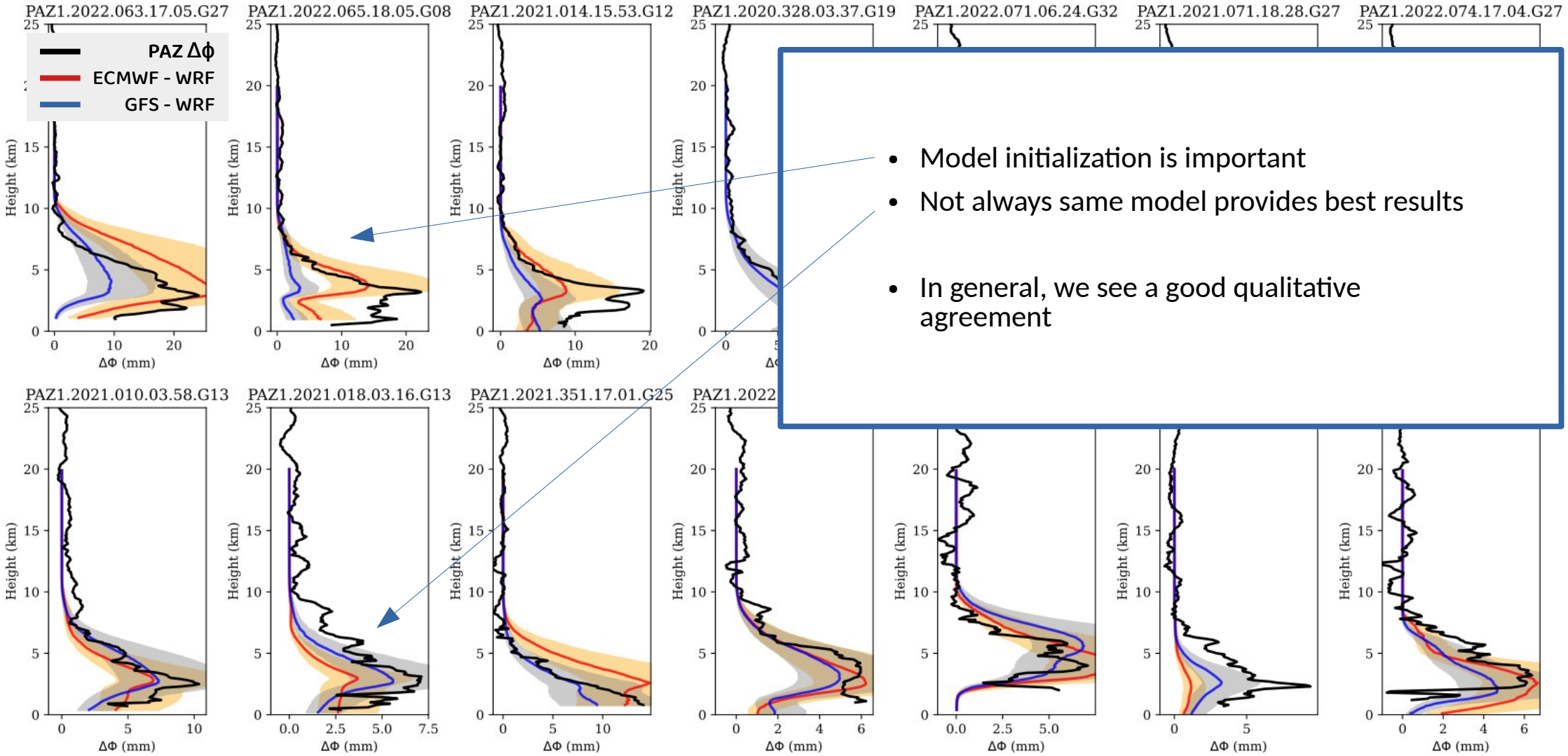
Results for Scripps UCSD WRF runs

Atmospheric rivers



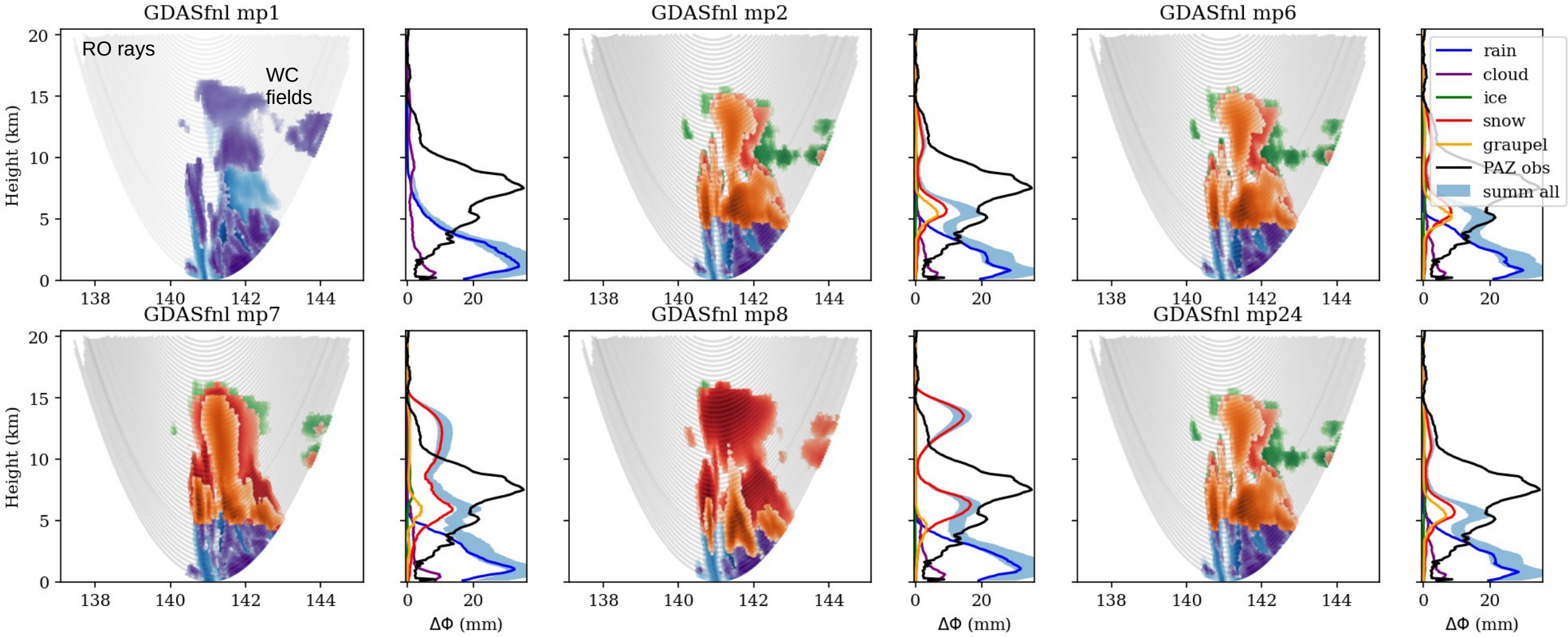
Results for Scripps UCSD WRF runs

Atmospheric rivers

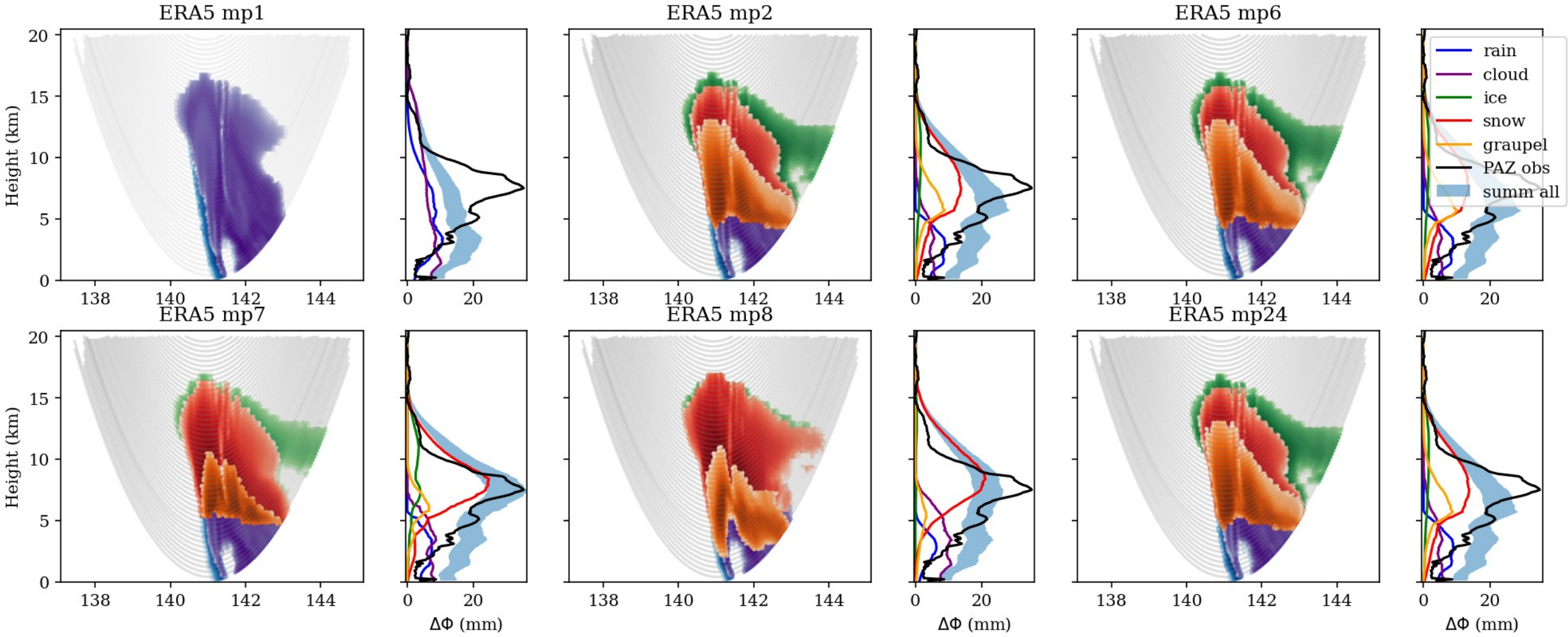


- Model initialization is important
- Not always same model provides best results
- In general, we see a good qualitative agreement

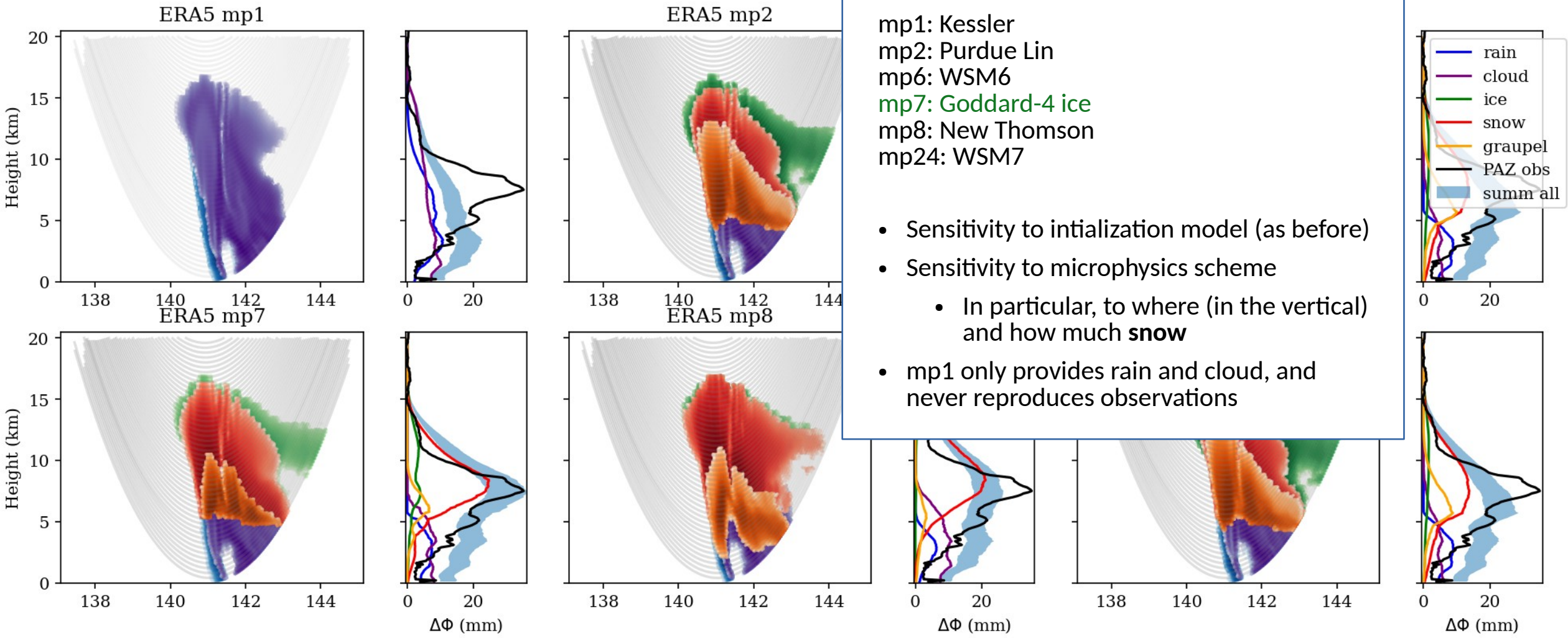
Results for NCU / UCAR WRF runs



Results for NCU / UCAR WRF runs



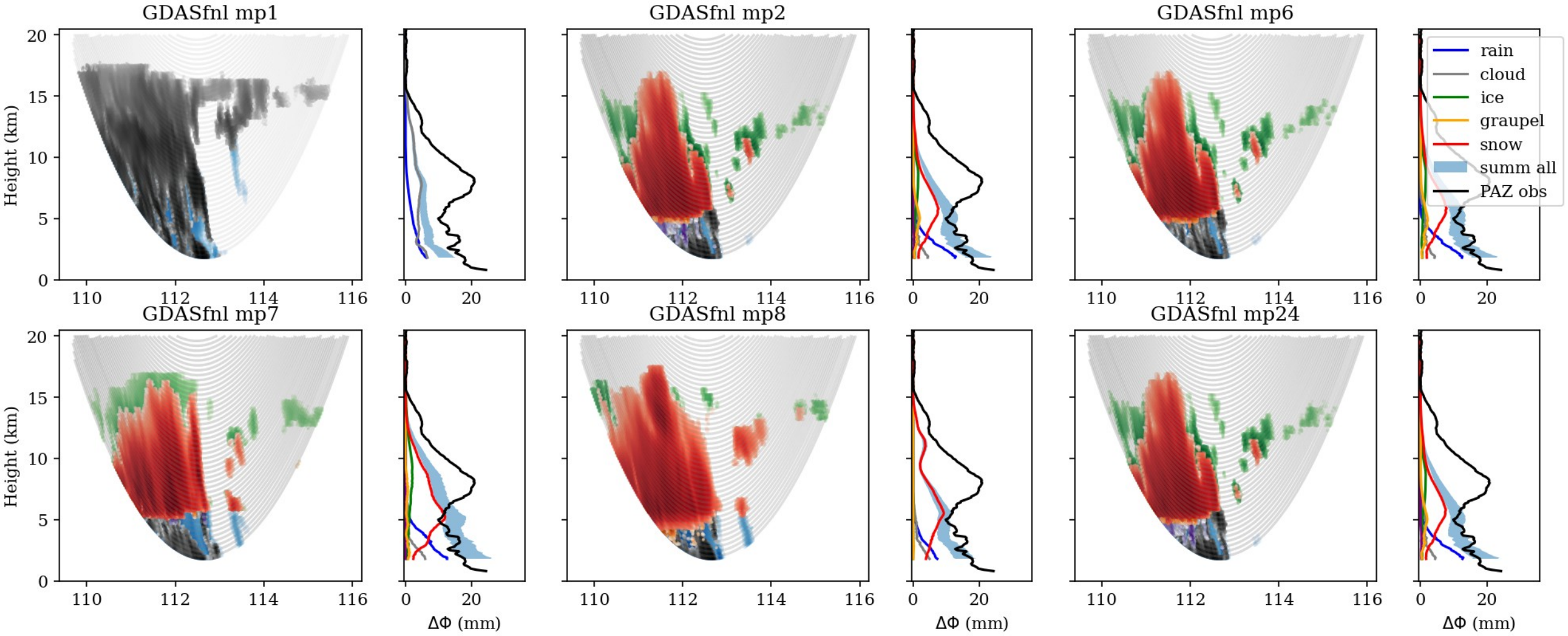
Results for NCU / UCAR WRF runs



mp1: Kessler
mp2: Purdue Lin
mp6: WSM6
mp7: Goddard-4 ice
mp8: New Thomson
mp24: WSM7

- Sensitivity to intialization model (as before)
- Sensitivity to microphysics scheme
  - In particular, to where (in the vertical) and how much **snow**
- mp1 only provides rain and cloud, and never reproduces observations

Results for NCU / UCAR WRF runs



Results for NCU / UCAR WRF runs

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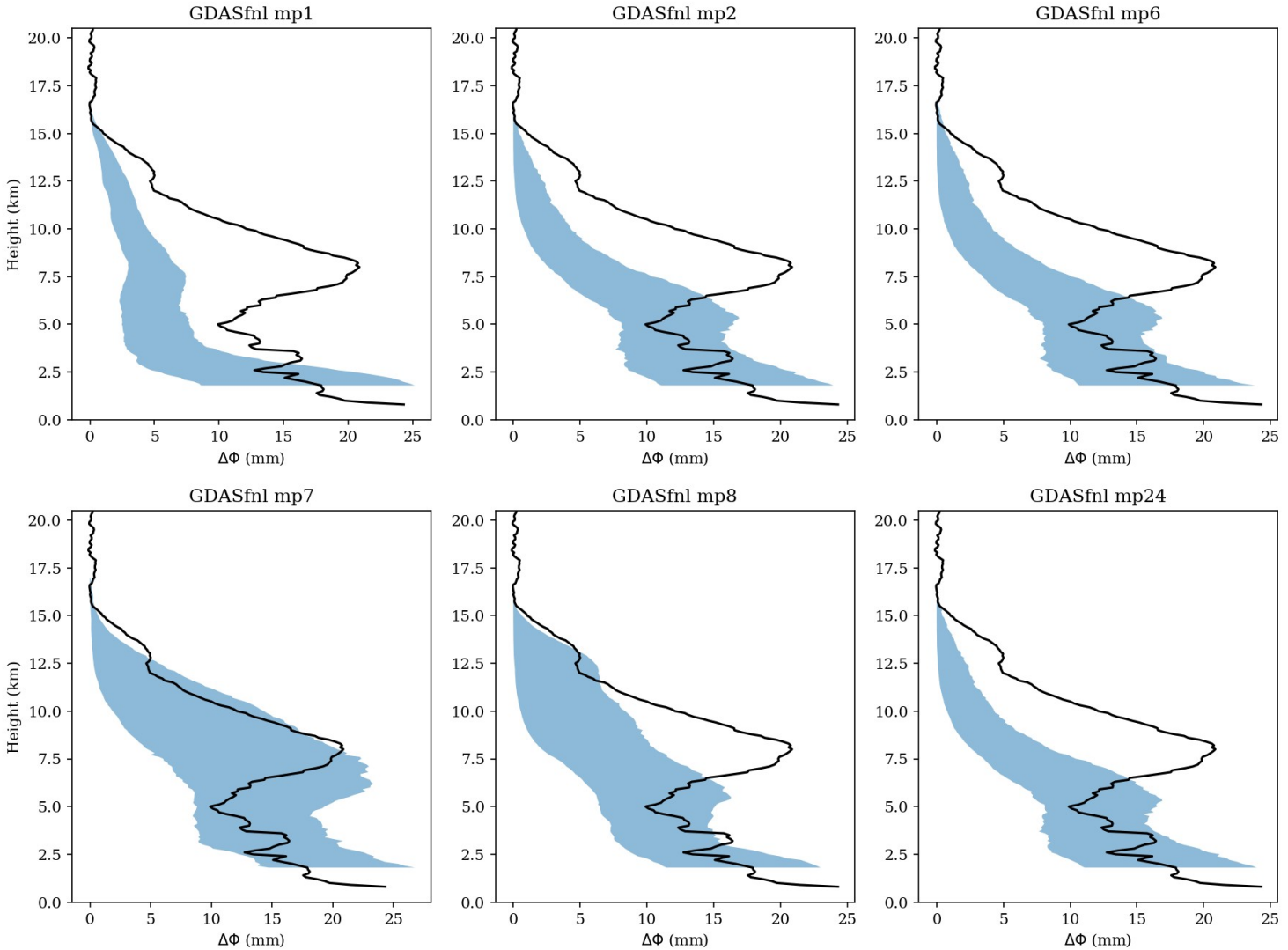
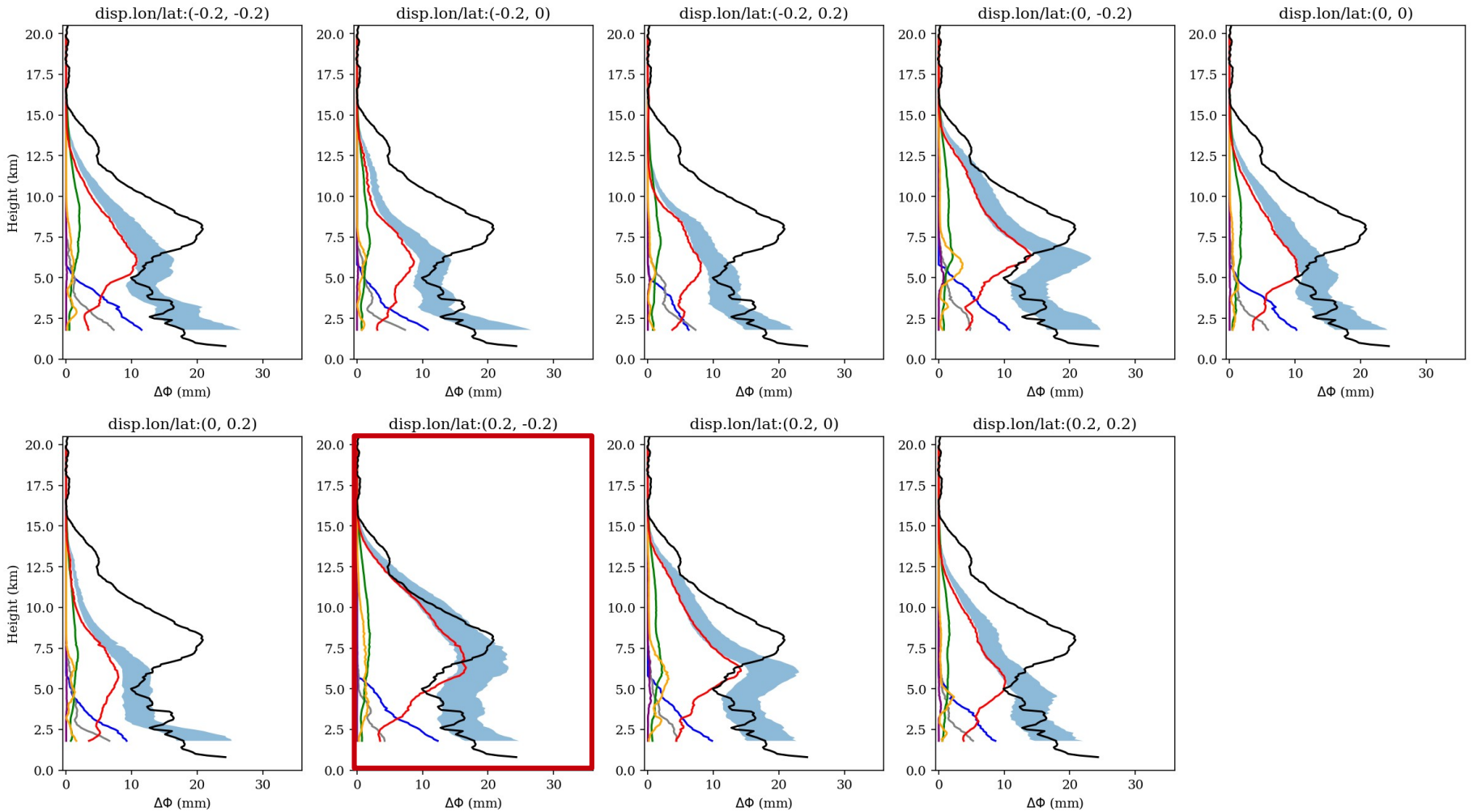
What happens when we displace the rays +- 0.2 deg in lat and lon ?

- If the model output is failing in representing the exact location of the convective cells, the result can change a lot
- Moving the rays we can check the sensitivity of PRO to these “errors” in location
- For this case, it seems that after moving the rays, one model input and one microphysics could agree with observations (GDASfnl + MP7)



Results for NCU / UCAR WRF runs

Detail of displacement results using GDASfnl and MP7:



Conclusions and next steps

- Model outputs:
  - Important which fields are stored/output/provided
- WRF runs
  - Sensitivity to initial model
  - Sensitivity to microphysics
- Forward operator
  - Sensitivity to horizontal displacement
  - Sensitivity to density and axis ratio parameters choice

- More realistic forward simulations? → important for inter-comparison with other observations
- Understand the importance of microphysics choice:
  - Why does it change from one to another?
  - Does this impact forecast?

Thanks!

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