Estimated observation error statistics of radar data and evaluation of EMVORADO settings

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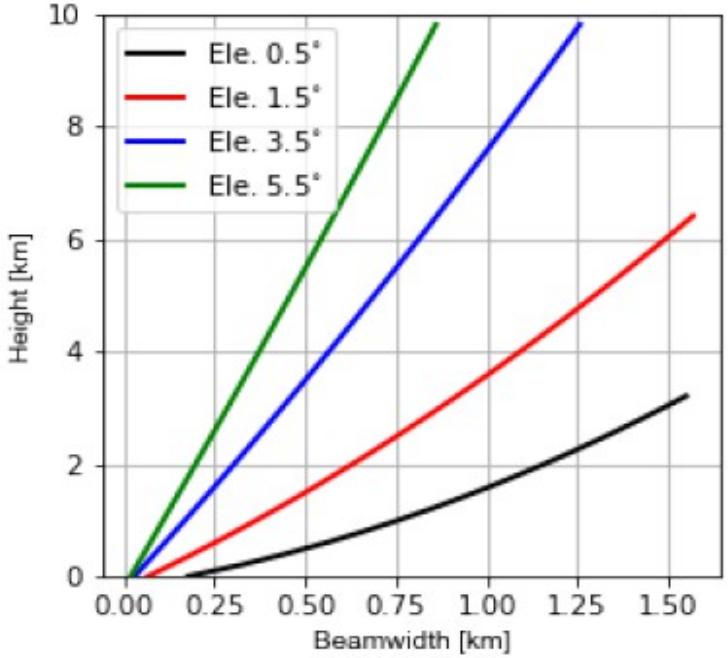
Outline

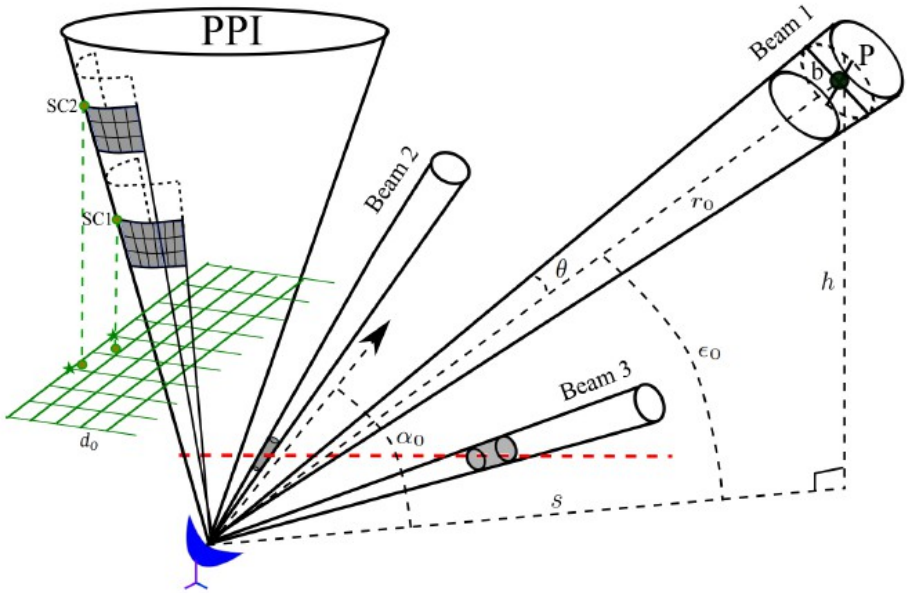
1. Introduction

2. Representation error due to unresolved scales and processes

3. Representation error due to inaccurate forward operator

Introduction





- Observation error (OE)
  = Instrument error (IE)
  + Representation error due to unresolved scales and processes (RE)
  + Forward operator error & pre-processing or quality control error (FE)

- ICON-LAM KENDA system
- Radar forward operator: EMVORADO
- Obs.: Radar reflectivity and radal wind

Representation error due to unresolved scales and processes

Methodology:

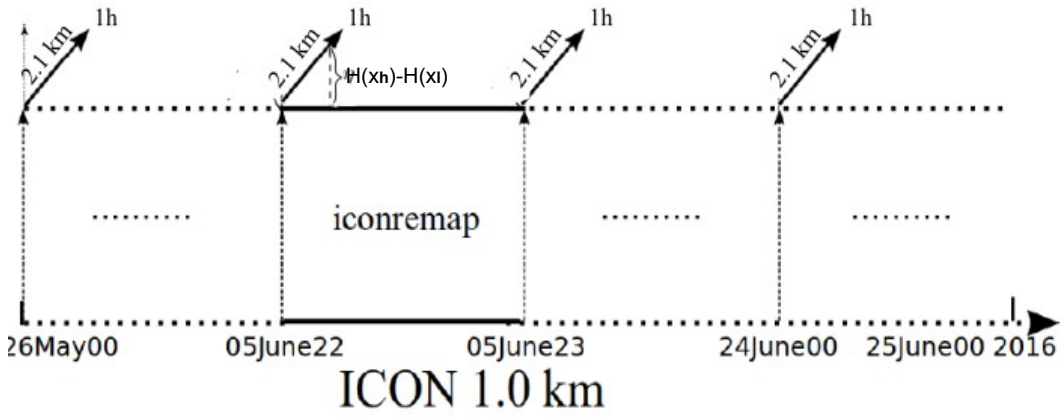
1. Estimation of RE: Consider model equivalents of radar data from a high-resolution model run as observations and compare them with those from a low-resolution run

2. Desroziers method for OE:

   $\mathbf{R}_{\text{est}} = E[\mathbf{d}_{o-a}\mathbf{d}_{o-b}^{T}]$, obtained by DA experiments

Experimental setup:

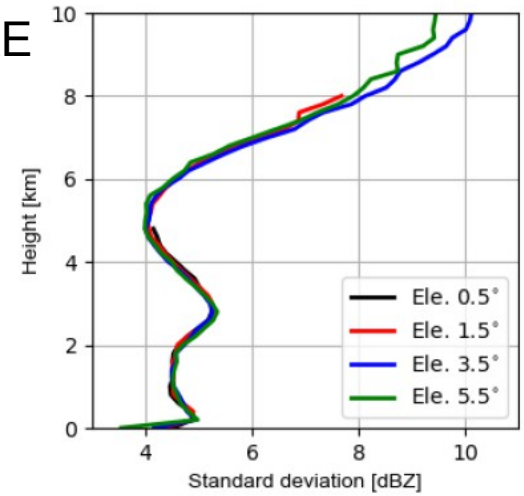
1. A set of samples for $H(x_h)$-$H(x_l)$ is obtained

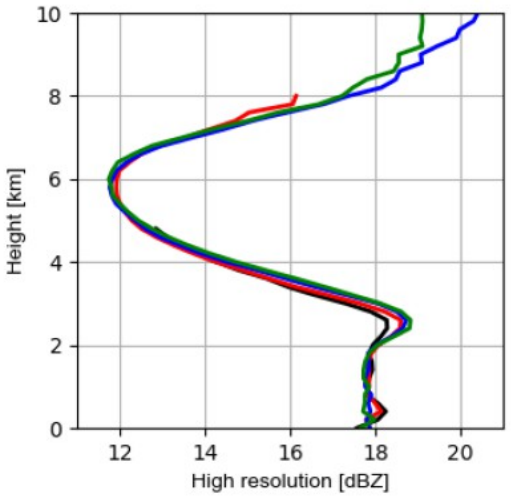


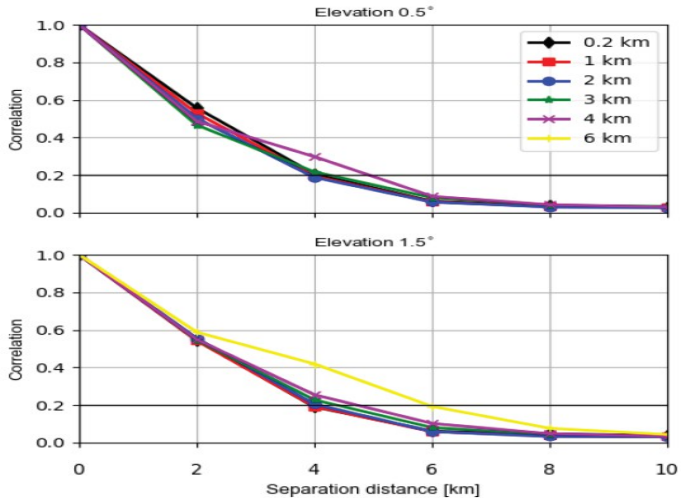
2. ICON-LAM KENDA from 3 to 17 June 2019, with superob. resol. 5 km for radar data

Results: Reflectivity (greater than 5 dBZ)

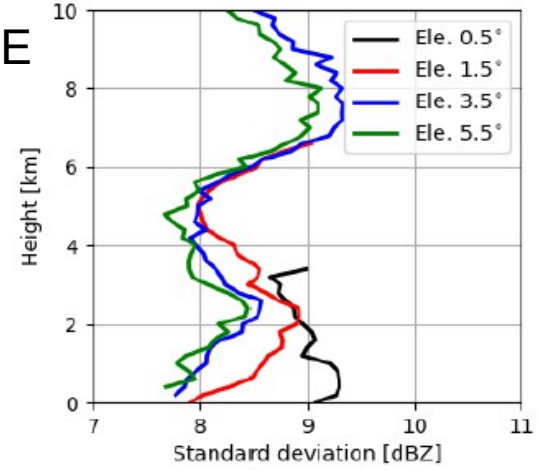
RE

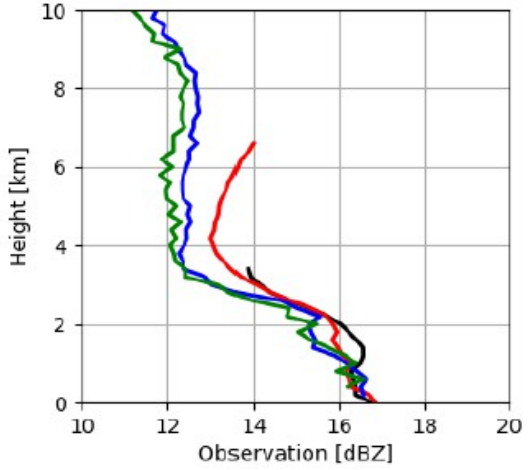


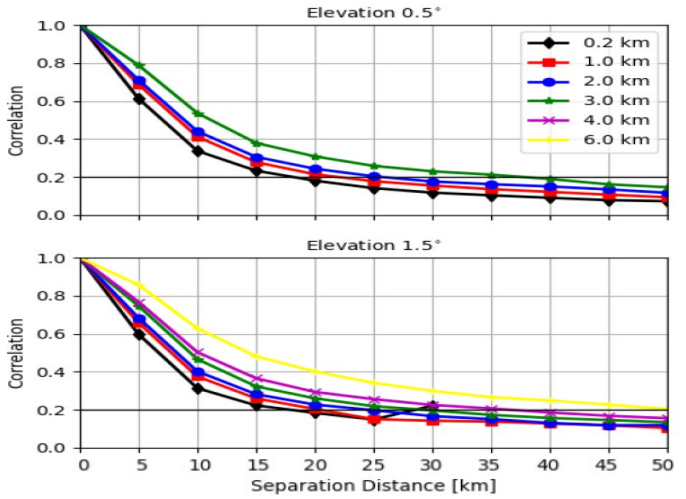




OE







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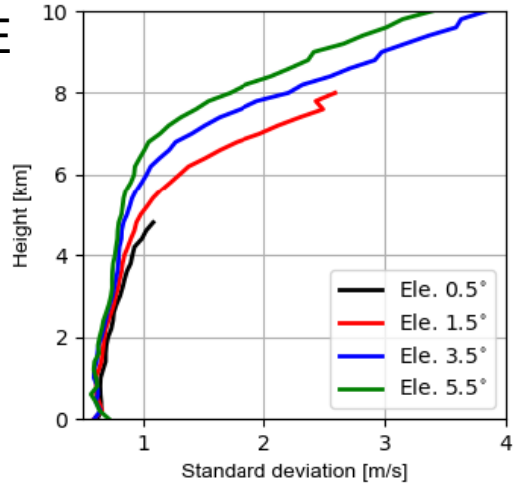
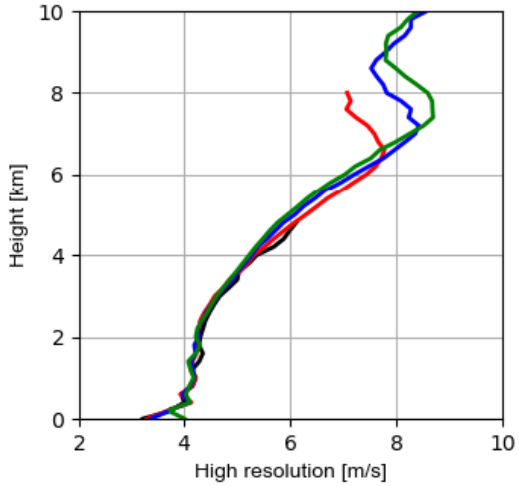
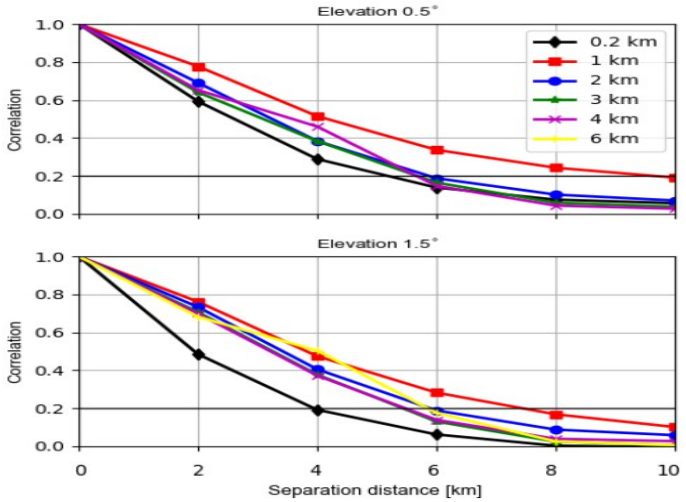
Results: Radial wind

RE







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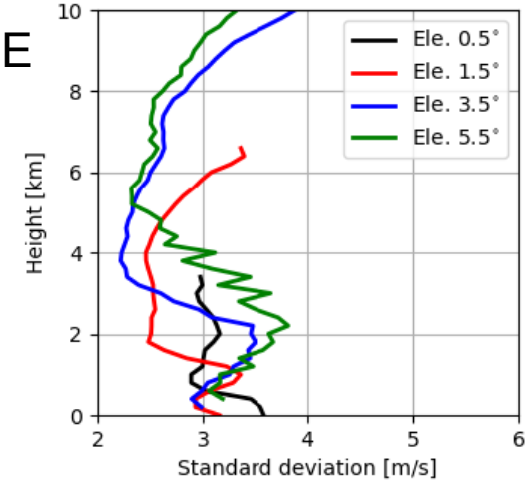

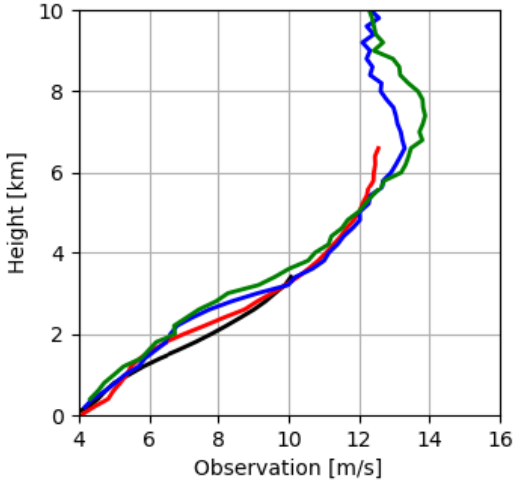

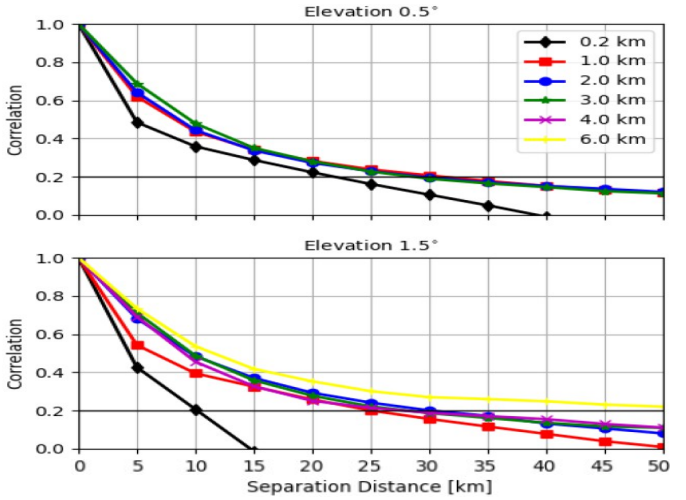

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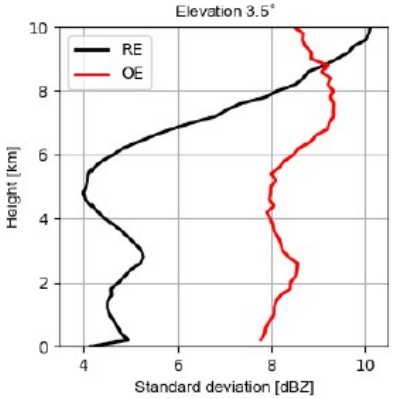
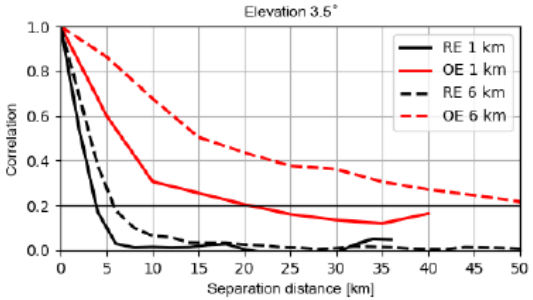
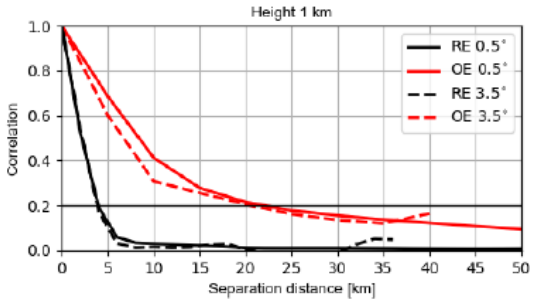
Results

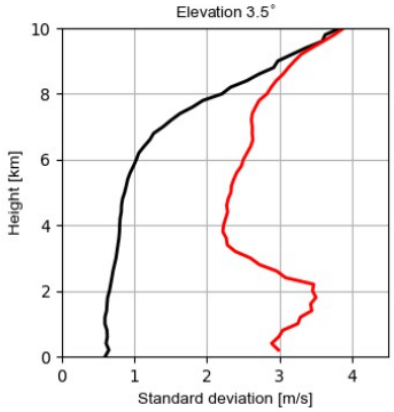
Reflectivity (greater than 5 dBZ)

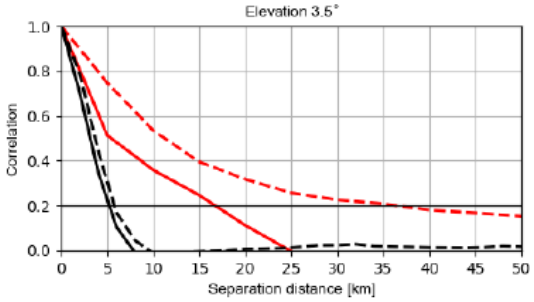


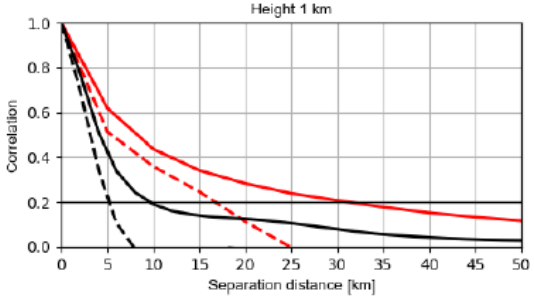




Radial wind







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Conclusion

1. RE is a dominant component of OE for radar reflectivity

2. For the radial wind, FE may be also an important error source

3. For the radial wind, higher elevations exhibit shorter obs. error correlation length scales; For the reflectivity, sensitivity to elevations is insignificant

Representation error due to inaccurate forward operator

Methodology: Desroziers method

Experimental setup: ICON-LAM KENDA from 3 to 10 June 2019, with superob. resol. 5 km for radar data

Table 1. Experimental setups: ✓ means “on” or "applicable" and × means “off” or "not applicable"

EXP	Ray./Mie	Term. fall speed	Reflect. Weighting	Broaden. effect	Atten.
E_Ray	Ray.	×	×	×	×
E_Fall	Ray.	✓	×	×	×
E_Fallwt	Ray.	✓	✓	×	×
E_B15	Ray.	×	×	1 × 5	×
E_B35	Ray.	×	×	3 × 5	×
E_FallwtB15	Ray.	✓	✓	1 × 5	×
E_Mie	Mie	×	×	×	×
E_MieAtt	Mie	×	×	×	✓

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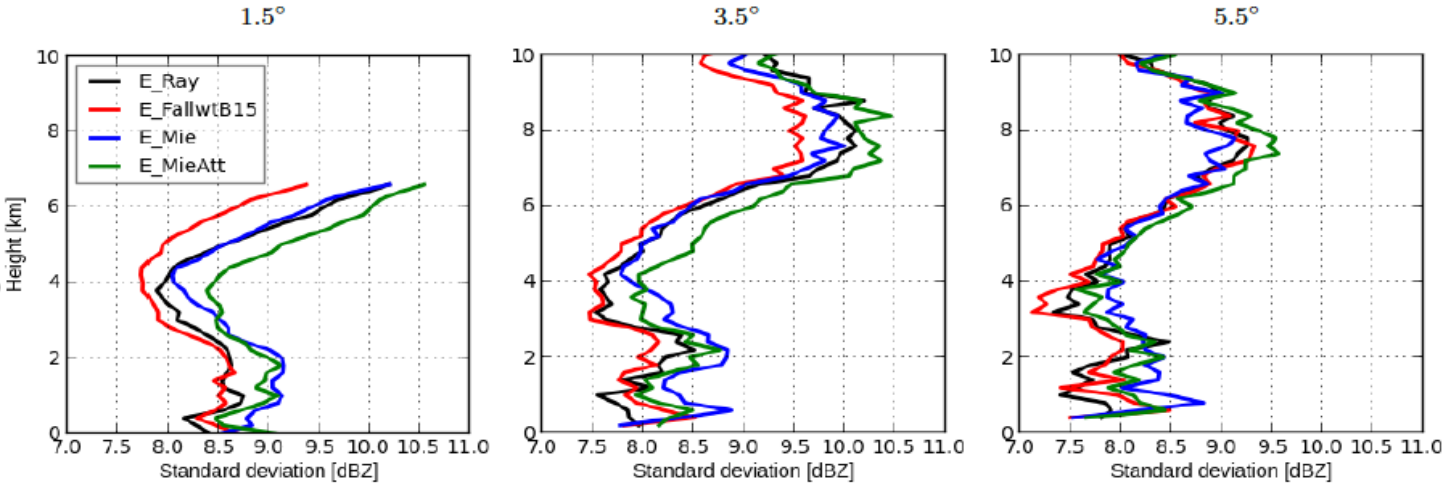
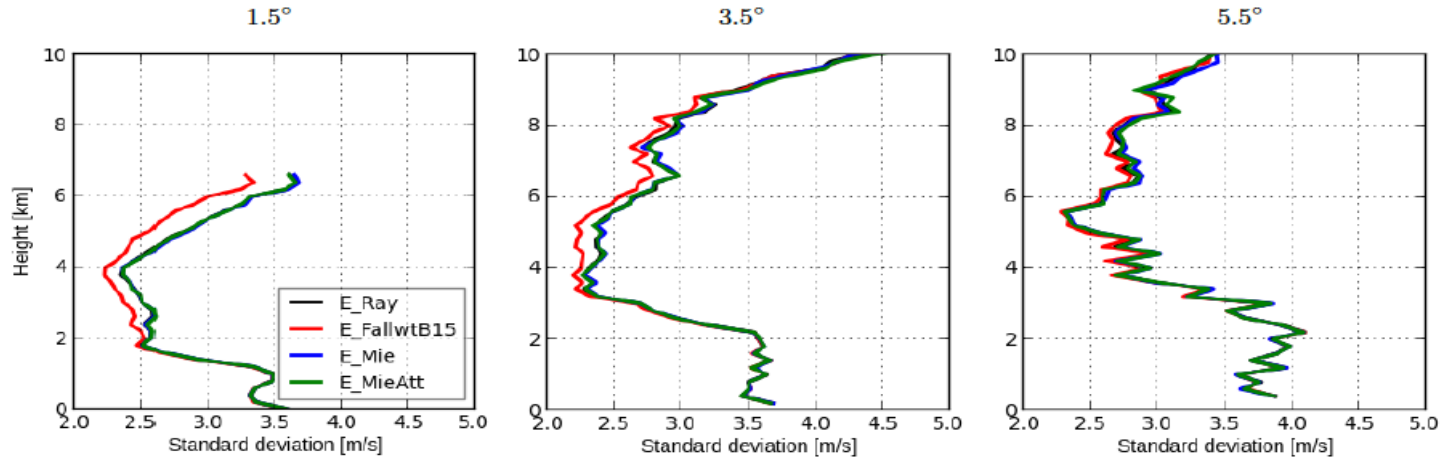
Representation error due to inaccurate forward operator

Results:

Reflectivity (greater than 5 dBZ)



Radial wind



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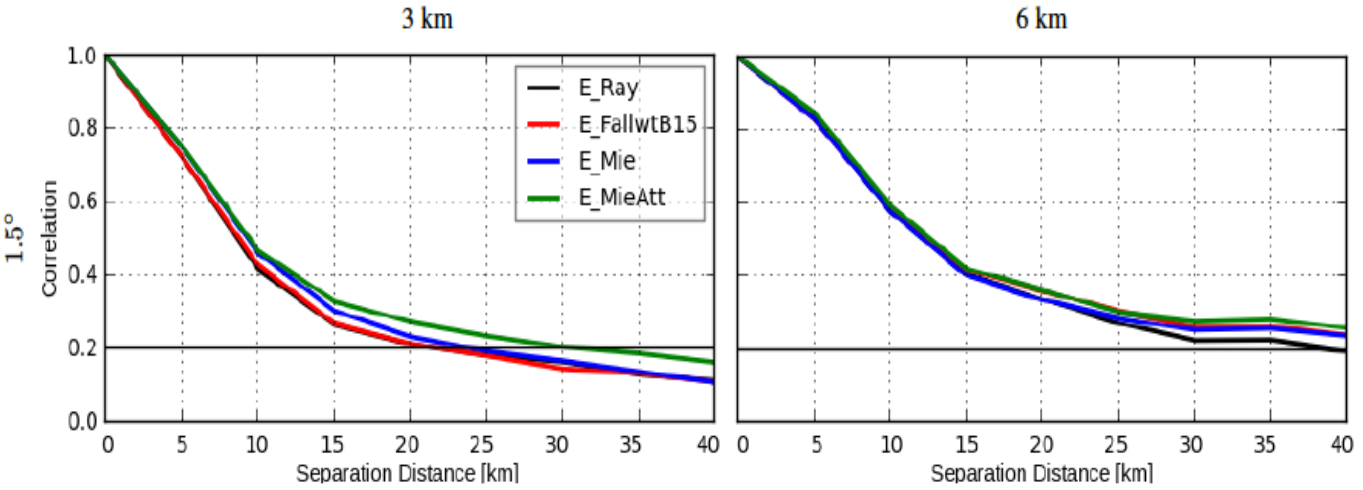
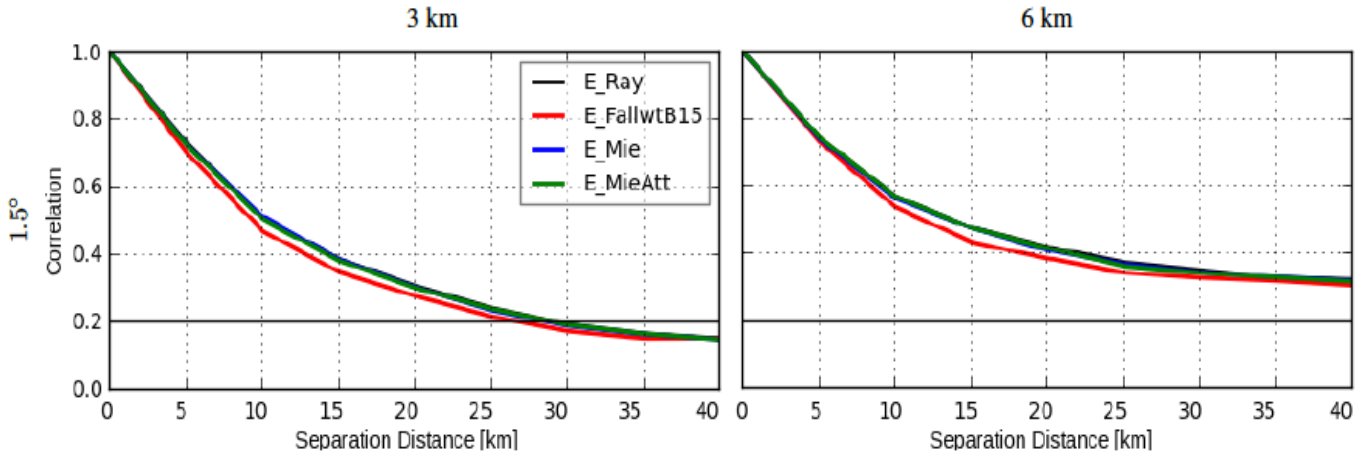
Representation error due to inaccurate forward operator

Results:

Reflectivity (greater than 5 dBZ)



Radial wind



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Conclusion

1. Accouting for beam broadening effect considerably reduces standard deviations of obs. errors

2. Mie scheme produces larger standard deviations for reflectivity at bright-band zone

3. Taking the terminal fall speed of hydrometeor and the reflectivity weighting into account does not make remarkable differences