# Cloud microphysics sensitivities in the Southern Ocean: what have we learned and what is next

A. Gettelman (NCAR), R. Marchand (UW)
R. Forbes, M. Fielding (ECMWF)

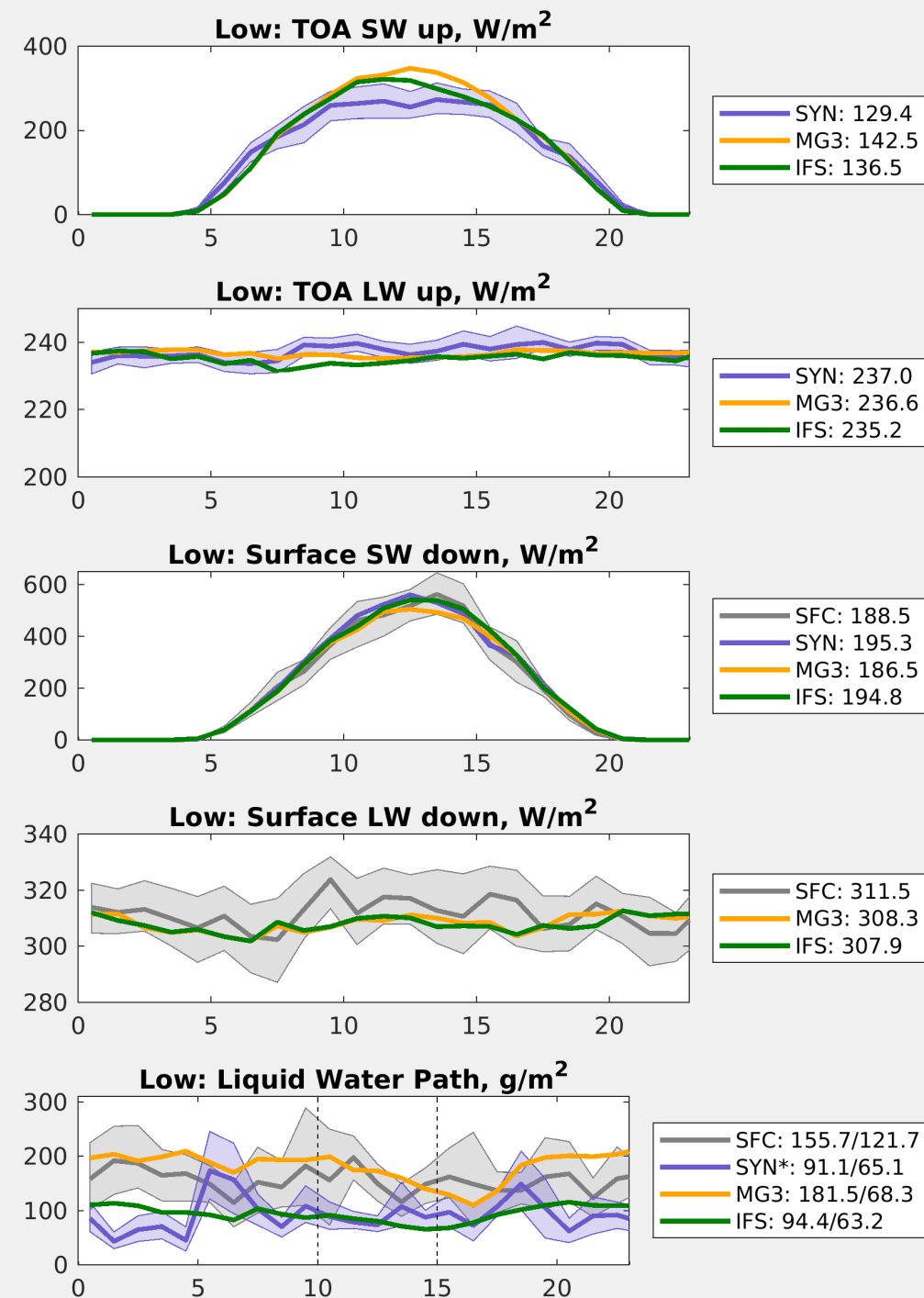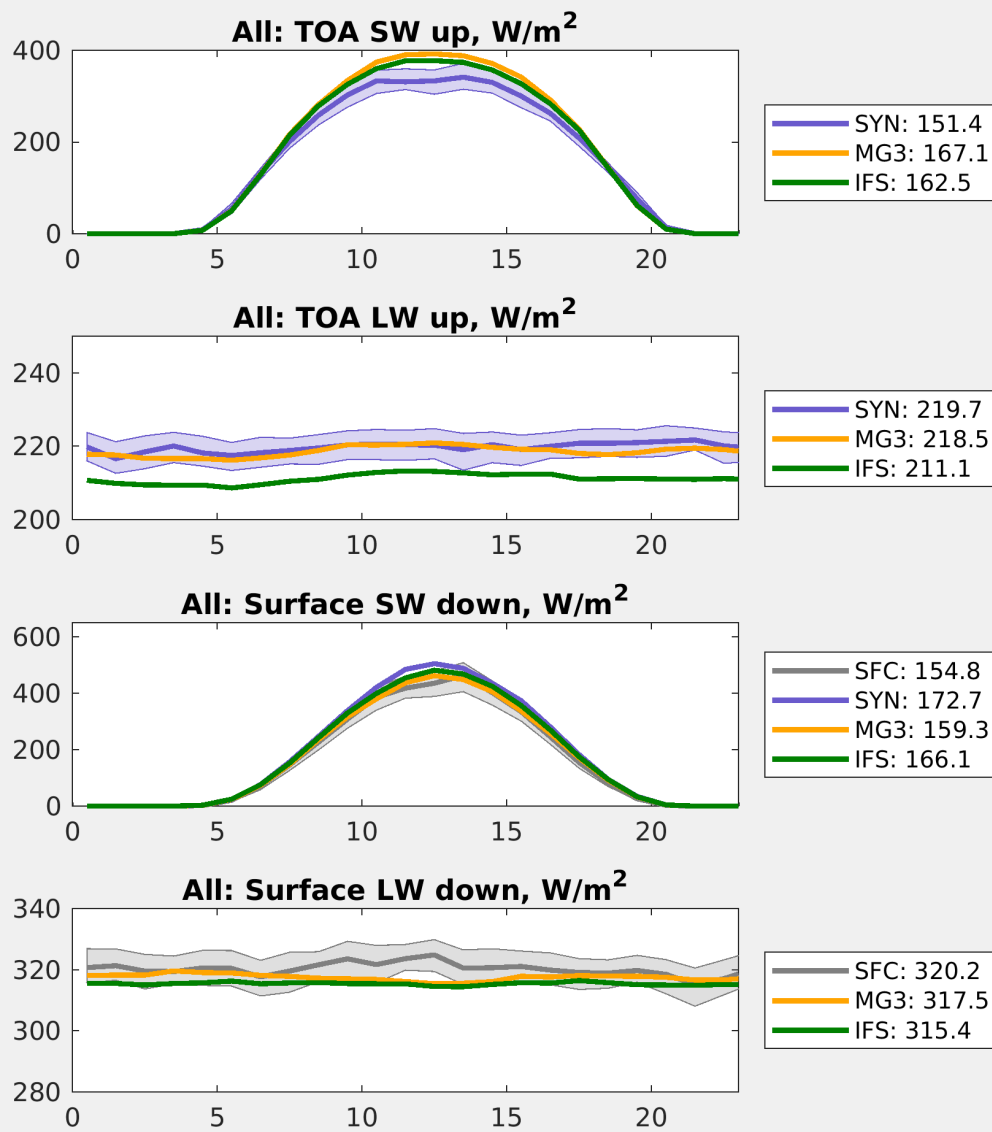NSF · ECMWF · UNIVERSITY OF OXFORD · NCAR NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Simulating MICRE

Comparisons over Macquarie Island in S. Ocean between a **precipitation radar** and single column simulations with **one-moment** and **2-moment** microphysics in the ECMWF-IFS SCM.
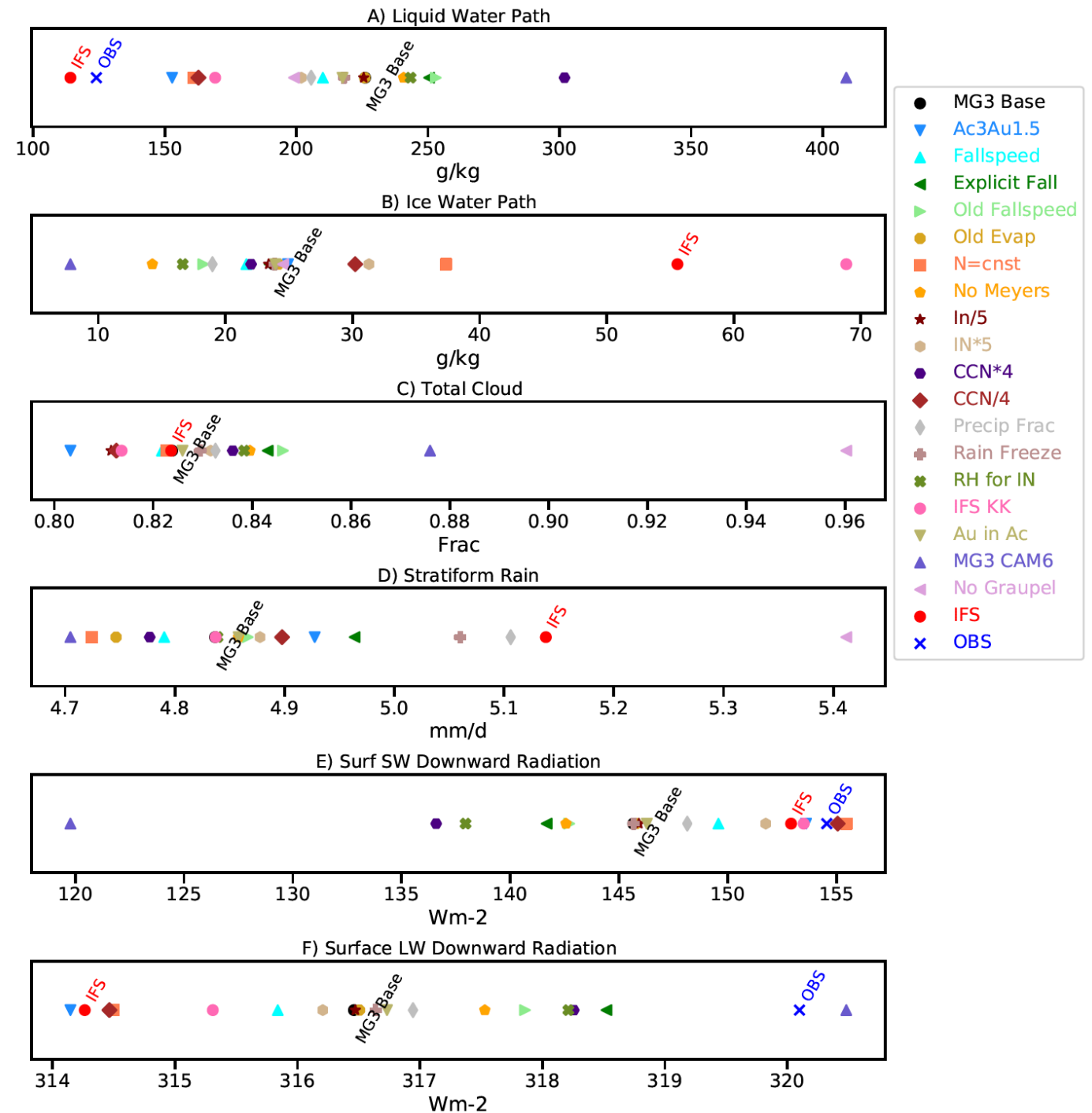

Gettelman, Forbes, Fielding, Marchand, in Prep
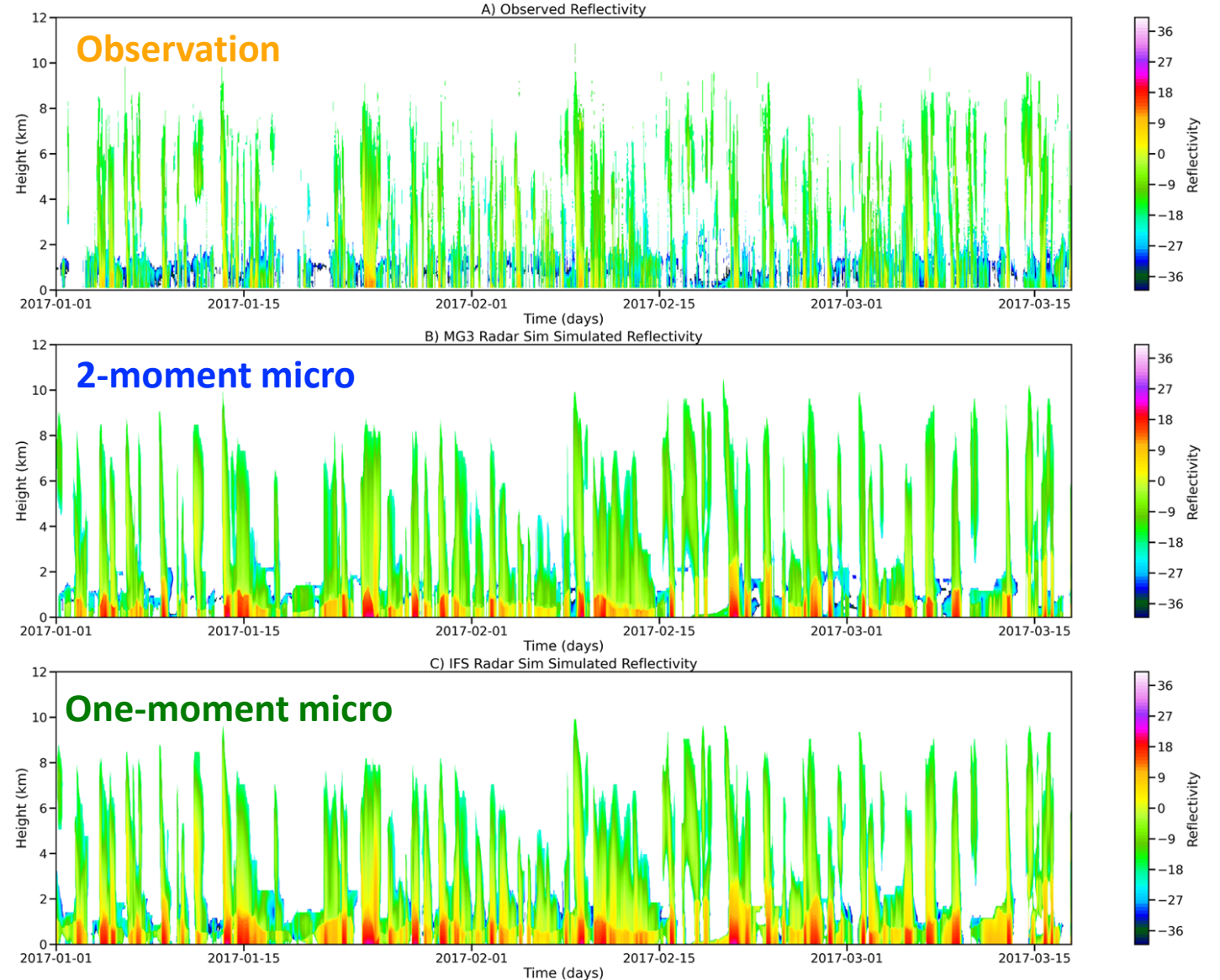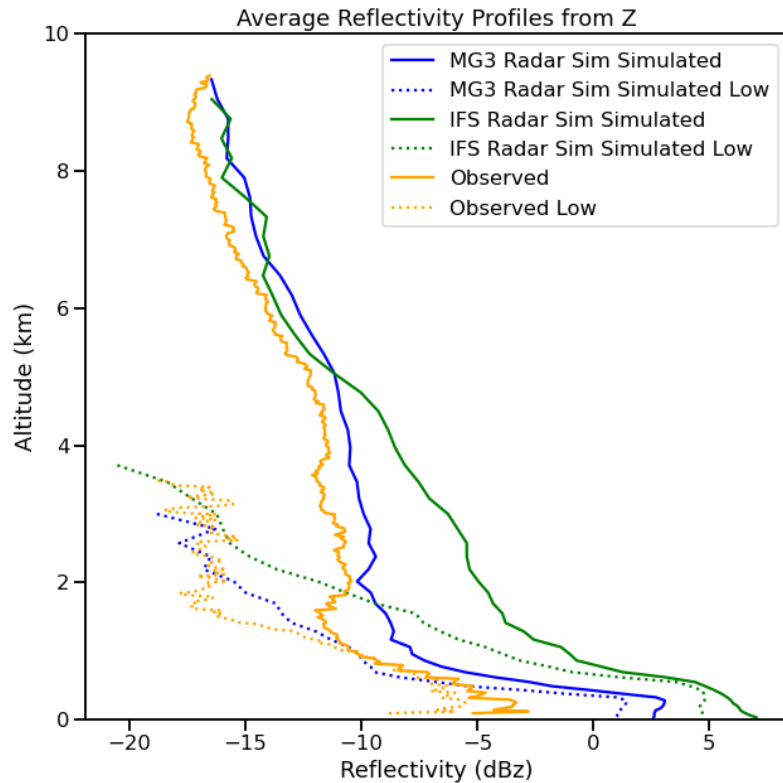
Radiation

- **MG3** Good agreement with **surface** & **satellite**
- Good LWP agreement for 'low cloud' periods
  - Note: LWP is preliminary

Sensitivity Tests
MG3 Microphysics

- LWP sensitive to CCN and Autoconversion

- Total LWP is 'high'

- IWP sensitive to to mixed phase IN (Meyers)

- LWP governs Surf SW Radiation

A) Liquid Water Path
g/kg

B) Ice Water Path
g/kg

C) Total Cloud
Frac

D) Stratiform Rain
mm/d

E) Surf SW Downward Radiation
Wm-2

F) Surface LW Downward Radiation
Wm-2

Legend:
- MG3 Base
- Ac3Au1.5
- Fallspeed
- Explicit Fall
- Old Fallspeed
- Old Evap
- N=cnst
- No Meyers
- In/5
- IN*5
- CCN*4
- CCN/4
- Precip Frac
- Rain Freeze
- RH for IN
- IFS KK
- Au in Ac
- MG3 CAM6
- No Graupel
- IFS
- OBS

Where does that leave us (1)?

- Free running models do NOT get PBL structure right.
  - Need strong nudging (8 hour relaxation) to get decent temp & clouds (SCM)
  - Global model still needs some nudging (24 hours)
- We are making progress in reducing S. Ocean radiation biases.
- Moderate sensitivities of SW radiation. Too much LWP it seems with MG3, but doesn't always matter for radiation (saturated)
  - LWP is sensitive to mixed phase INP (when there is a lot, e.g. Meyers)
  - LWP sensitive to CCN
  - CCN (supersaturation) and entrainment related to turbulence. [Turbulence]

Where does that leave us (2)?

- Still don't have enough ice in models. Hard to make it in mixed phase.
  - Might be turbulence issue?
  - Are INP wrong because the dynamics of clouds is wrong?
  - I don't think is 'missing' INP (e.g. biological): [Challenge me on that!]
- Secondary Ice Processes (SIP) seem to be 'buffered': mostly they doesn't matter much, but it can be important for ice number in some cases. [Challenge me on that!]
- How well do we know what the ice number is?
- Not much sensitivity of radiation to ice nucleation (buffered by other processes)?