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# Examples of possible evaluation of GCMs using cloud radar and lidar satellite data

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# Examples

- 1. Cloud top height of low clouds
- 2. Marine fog
- 3. Phase of clouds
- 4. Fall velocity of cloud ice

## Cloud top height of mid-latitude low clouds

Kawai et al. (2015, JMSJ)



CALIPSO enabled this study! High vertical resolution is needed for low cloud studies.

In the past

- Estimation of CTH was terribly inaccurate.
- Difficult to study mid-latitude low clouds.

#### CTH and stability index



Monthly data (12 for each location) are plotted.



# Geographical variations in CTH in SH and NH





- CTH is too low in the model.
- CTH increases poleward in obs. But it decreases in the model.

# Frequency of fog occurrence

Kawai et al. (2015, JMSJ)

July



KU Cloud mask (CALIPSO) 0-240m (2007-2009)



CALIPSO seems to capture fogs relatively well (Impossible for other satellites)!

Can observe areas where shipboard obs. are impossible.

High frequency obs.

## Occurrence of fogs



North Pac. NW Atlantic NE Atlantic Southern Ocn.

Fog is defined as cloud (CALIPSO) in a bin of 0-240m.

#### Occurrence of fogs and meteorological factors



Meteorological data: ERA-Interim

Monthly data (12 for each location) are plotted.

#### Improvement in clouds in MRI-ESM2



## Various improvements related to clouds...

- i. Stratocumulus parameterization (turbulence scheme)
- ii. Cloud microphysics
- iii. Vertical resolution
- iv. Convection scheme (shallow convection)
- v. Cloud overlap scheme for radiation
- vi. Radiation process
- vii. Bug
- viii. Aerosol mode radii
- ix. Cloud ice fall calculation

### Impact of modified cloud microphysics



# Fall velocity of ice cloud



These ice velocities can be evaluated by EarthCARE data?

#### How should we calculate ice fall properly?



# Summary

Four examples of possible evaluation of GCMs using cloud radar and lidar satellite data are introduced.

Cloud top height of low clouds
Marine fog
Phase of clouds
Fall velocity of cloud ice
Kawai et al. (2015)
Kawai et al. (2019)
Kawai et al. (2019), Kawai (2005)

- Other important cloud properties for GCMs that could be obtained from cloud radar and lidar satellite.
  - Cloud water contentCloud ice content

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