Columbia University in the City of New York

National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y. 10025

Cloud vertical distribution in extratropical cyclones

Catherine Naud (Columbia Univ.), Anthony Del Genio (NASA-GISS), Mike Bauer (Columbia Univ.) and William Kovari (CCSR, Columbia Univ.). Contact: cnaud@giss.nasa.gov. ***J. Climate*****, in press.**

Objectives

Composite CloudSat cloud vertical distribution across warm and cold fronts in oceanic midlatitude cyclones (30-70°N), for two winters to:

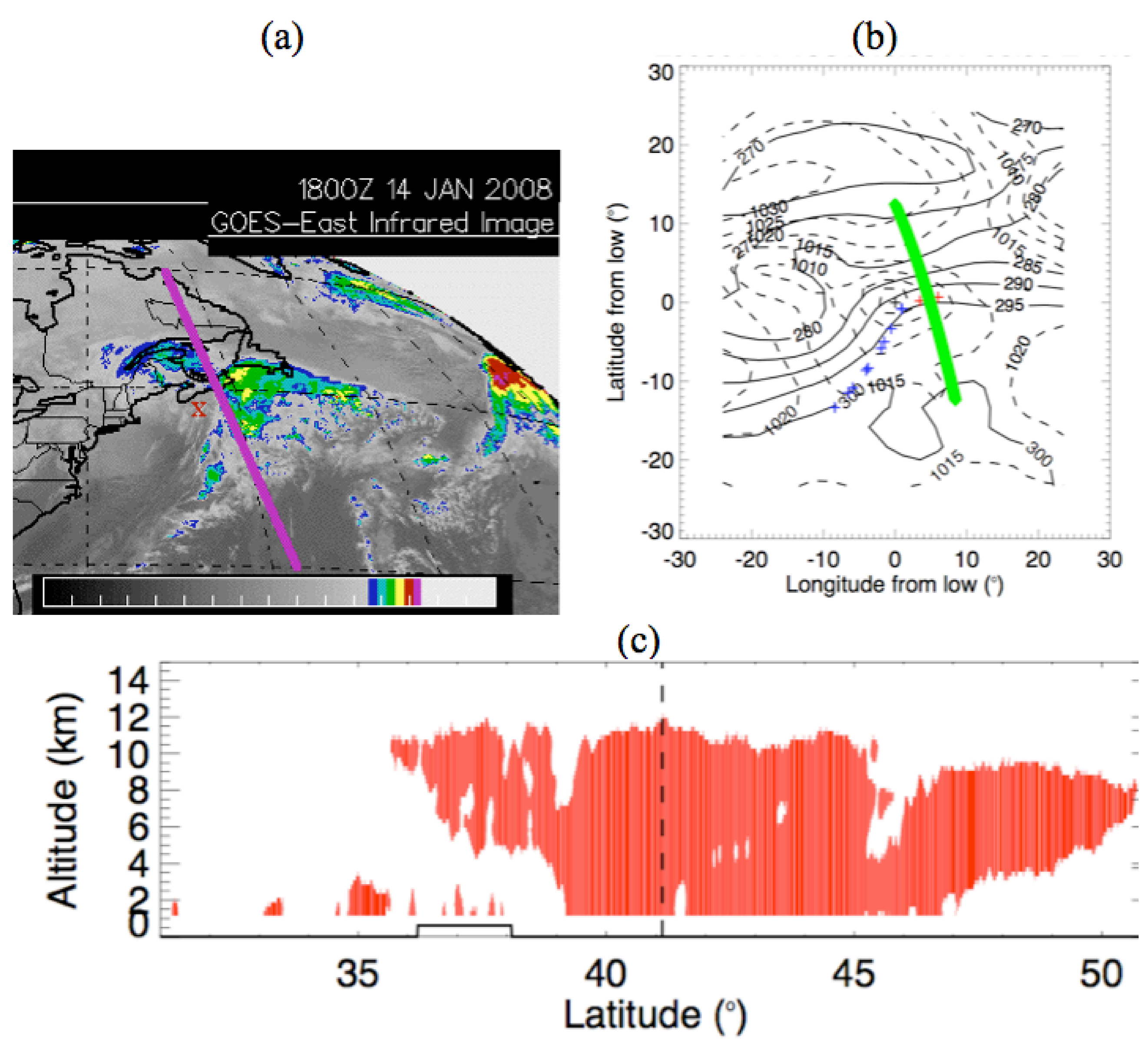
1. Verify if cloud vertical distribution in midlatitude cyclones follows the classical picture for frontal cloudiness (1).
2. Assess the performance of the GISS GCM model-E for the representation of cloudiness in midlatitude cyclones

Technique

- Use NASA-MAP Climatology of Mid-latitude Storminess (MCMS) database based on NCEP-2 reanalysis sea level pressures to automatically detect midlatitude cyclones and apply Hewson (1998) method to NCEP-2 850 mb potential temperatures to detect warm and cold fronts
- Select CloudSat cloud observations when the orbit track crossed a front and build composites of cloud frequency of occurrence in a latitude-height grid across the fronts (2).
- Apply a similar technique onto GISS model-E (2°x2.5°x40L version) outputs for 5 winter months (3).

Future work

Use ARM profiles of IWP/LWP, effective particle size and integrated optical thickness (e.g. Mace et al. PI product) to study cloud properties across fronts



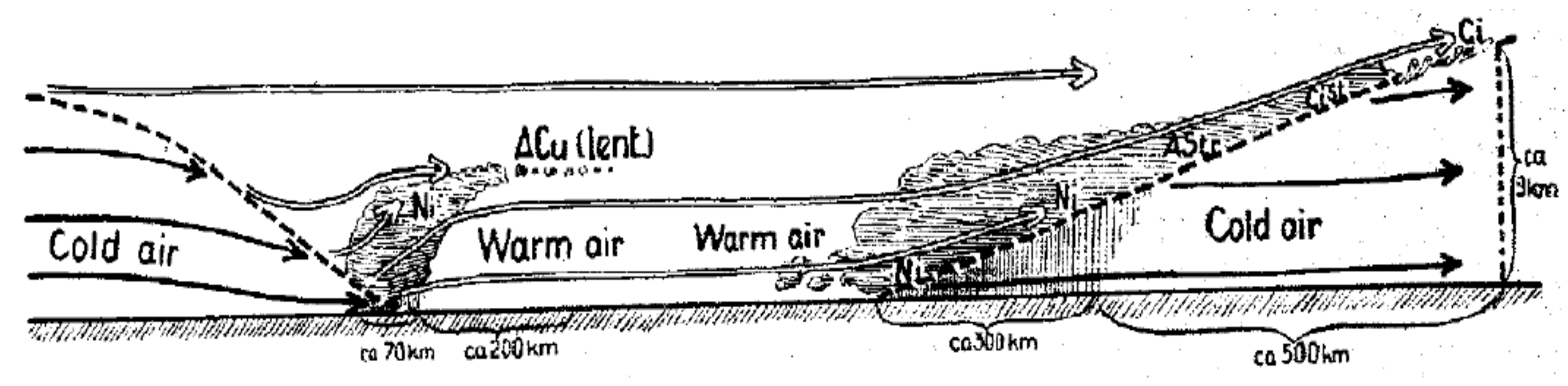
Example of cyclone for 2008-01-14, 18UTC, 40.83°N and 65.98°W

(a) GOES-EAST IR (red X=storm center), color scale = CTT every 5°C, from -40 to -70°C (*Courtesy of the California Regional Weather center*). purple line = CloudSat orbit.

(b) NCEP-2 SLP (dashed) and 850 mb θ (solid) centered on 40.83°N and 65.98°W with cold (blue +) and warm (red +) fronts and CloudSat orbit = green line

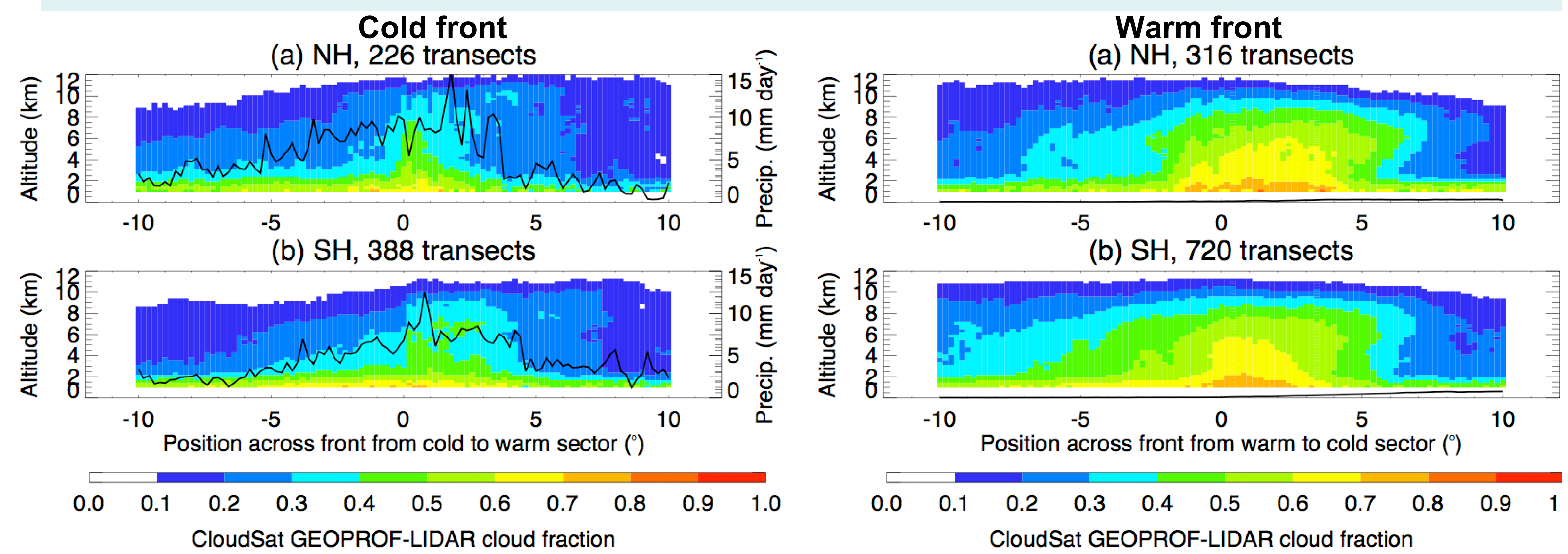
(c) GEOPROF-LIDAR cloud mask (red = hydrometeors, i.e. clouds and precipitation) along the satellite orbit, warm front intersect = dashed line.

1. Classical cloud distribution across cold and warm fronts



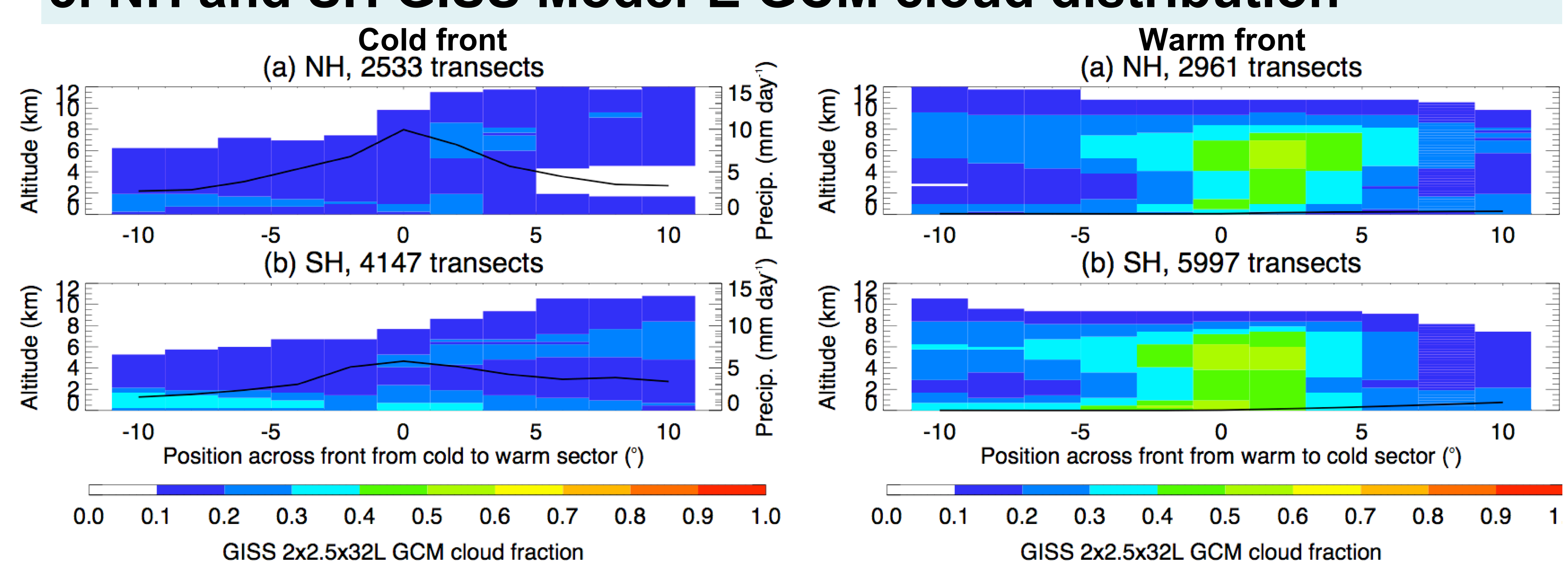
Cold front Fig. 1. Idealized cyclone. **Warm front**

2. NH and SH CloudSat-CALIPSO cloud distribution



Slight difference with classical model: low-level clouds everywhere across cold and warm fronts, high level clouds ubiquitous across warm fronts and upright convection at warm front. Solid line (left) = precipitation rates.

3. NH and SH GISS Model-E GCM cloud distribution



General features of distribution close to observations but cloud fraction much smaller: humidity not transported along vertical, resolution too coarse => GCM storms too shallow and frontal motion not resolved. Solid line (left) = precipitation rates.

4. Problems with moisture vertical transport in GISS GCM and possible improvements: slantwise convection

(a) RH cold fronts **(b) RH warm fronts** **(c) Impact of slantwise convection**