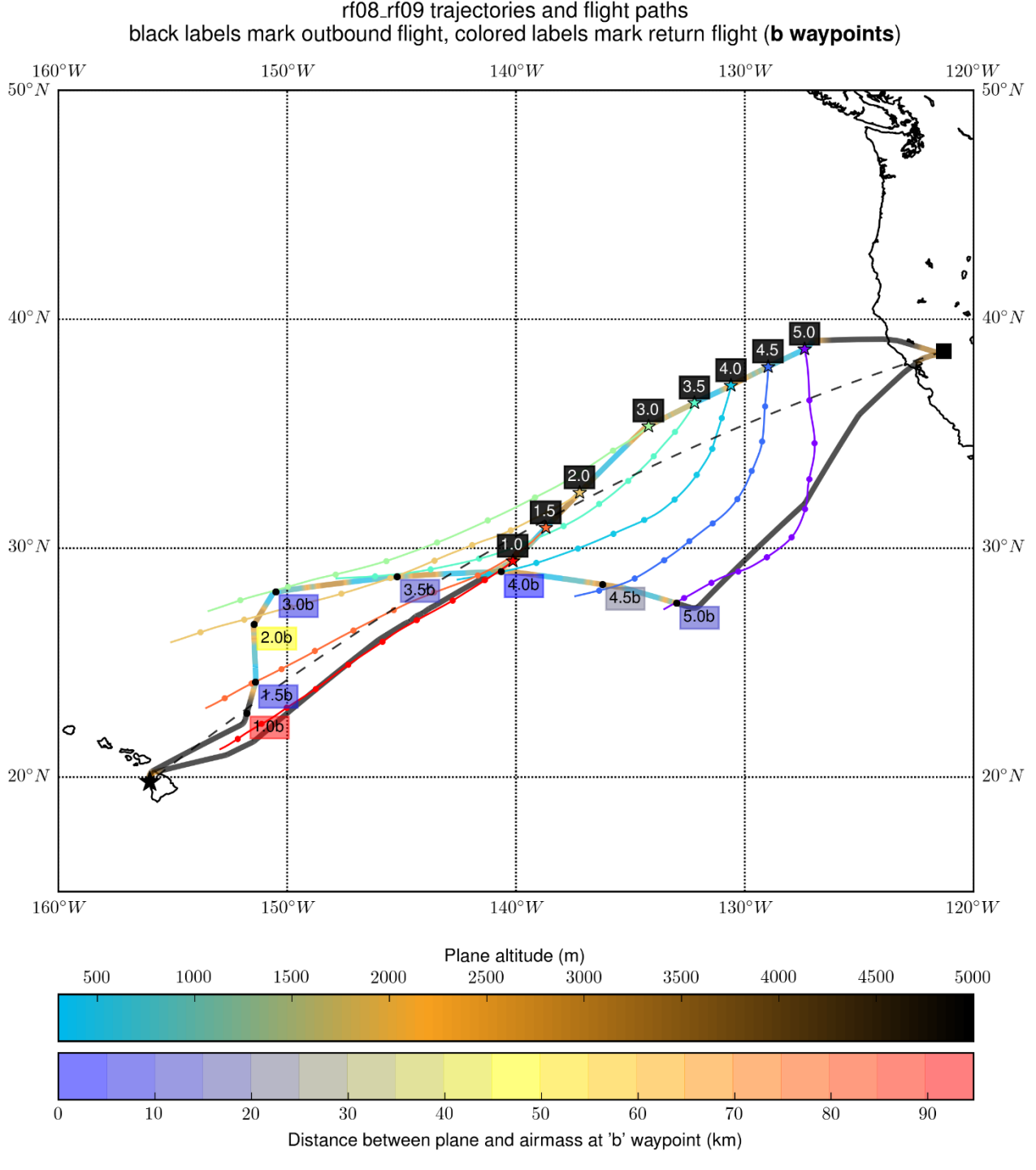
Lagrangian evolution in CSET with GOES

Hans Mohrmann, Isabel McCoy, Jeremy McGibbon,
Kyle Bretherton, Dylan Tom, Rob Wood, Chris Bretherton

CSET Trajectories

- HYSPLIT trajectories, initialized from outbound flight to HI, for planning resampling on return flight to CA
- initialized at 500m, isobaric, run on NCEP GFS (forecast) and NCEP GDAS (analysis)
- Total of 53 trajectories between 7 mission pairs, 72 hours forward from initial outbound sampling, most resampled ~50 hours later
- Available on field catalog (or email me!)
- http://www.atmos.washington.edu/~jkcm/CSET_plots/GOES_loops/rf06_rf07_12fps_boxes.mp4



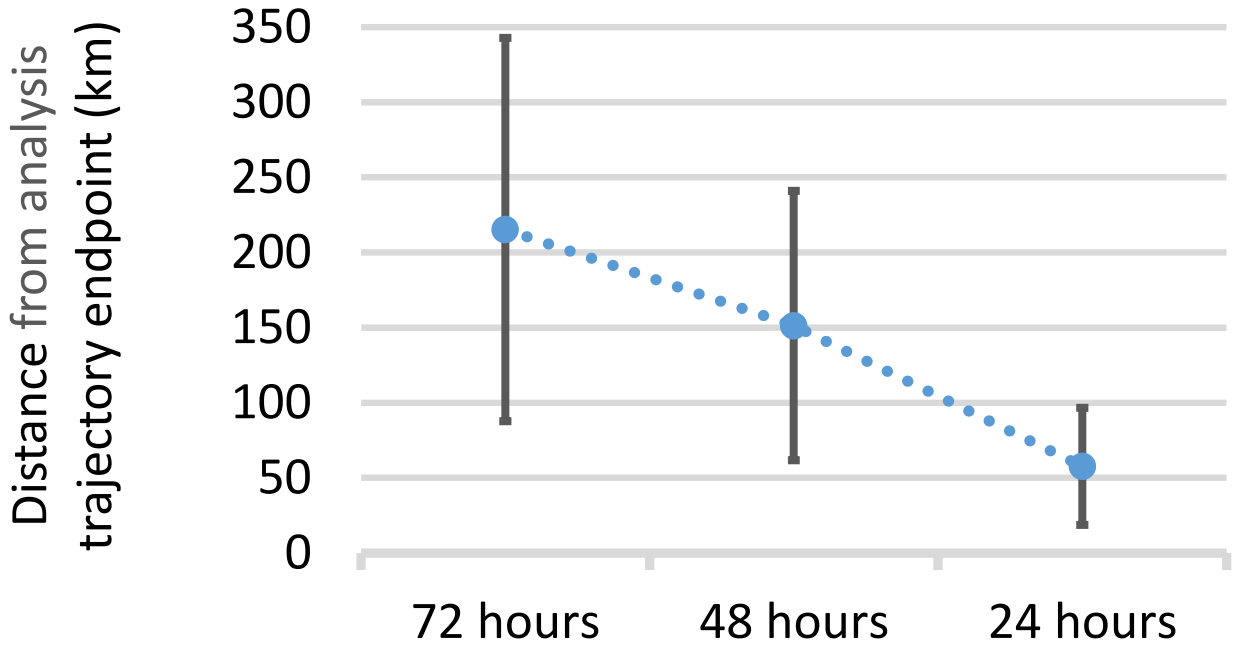
How good were the trajectories?

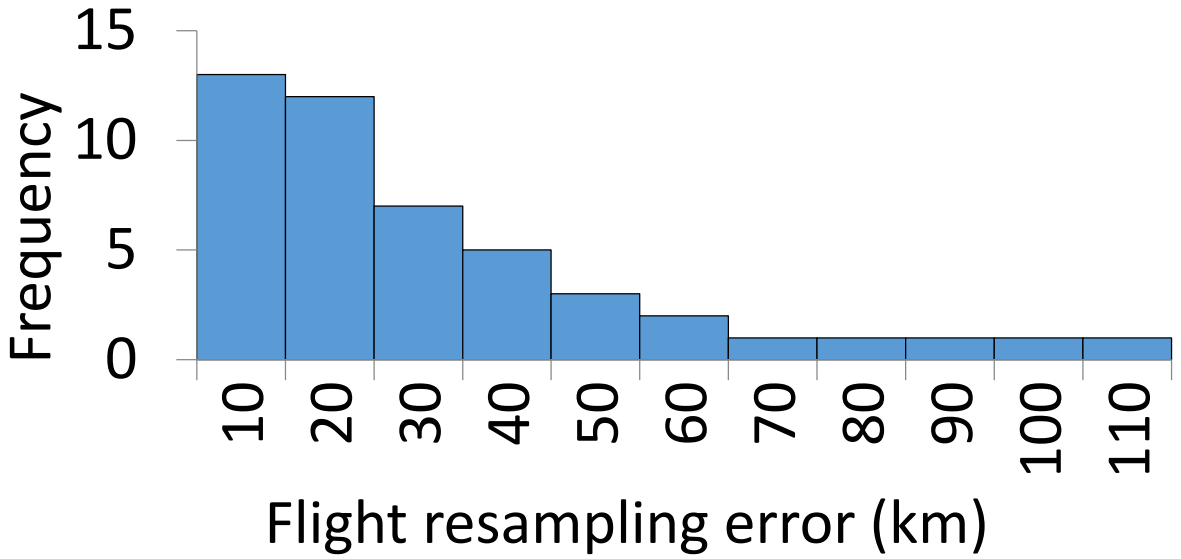
Forecast error:

- measure of how close forecast was to analysis at 48h trajectories
- 215 km forecast error at 72 hours lead time (good enough for outbound flight planning)
- 58 km forecast error at 24 hours lead time meant that accurate return flight plans could be filed by FAA deadlines

Flight resampling error:

- Min distance between plane and *analysis-based* trajectory
- Mean flight resampling error was 27.3 km; more than half of all resampled trajectories were intercepted within 20km of analysis airmass location.





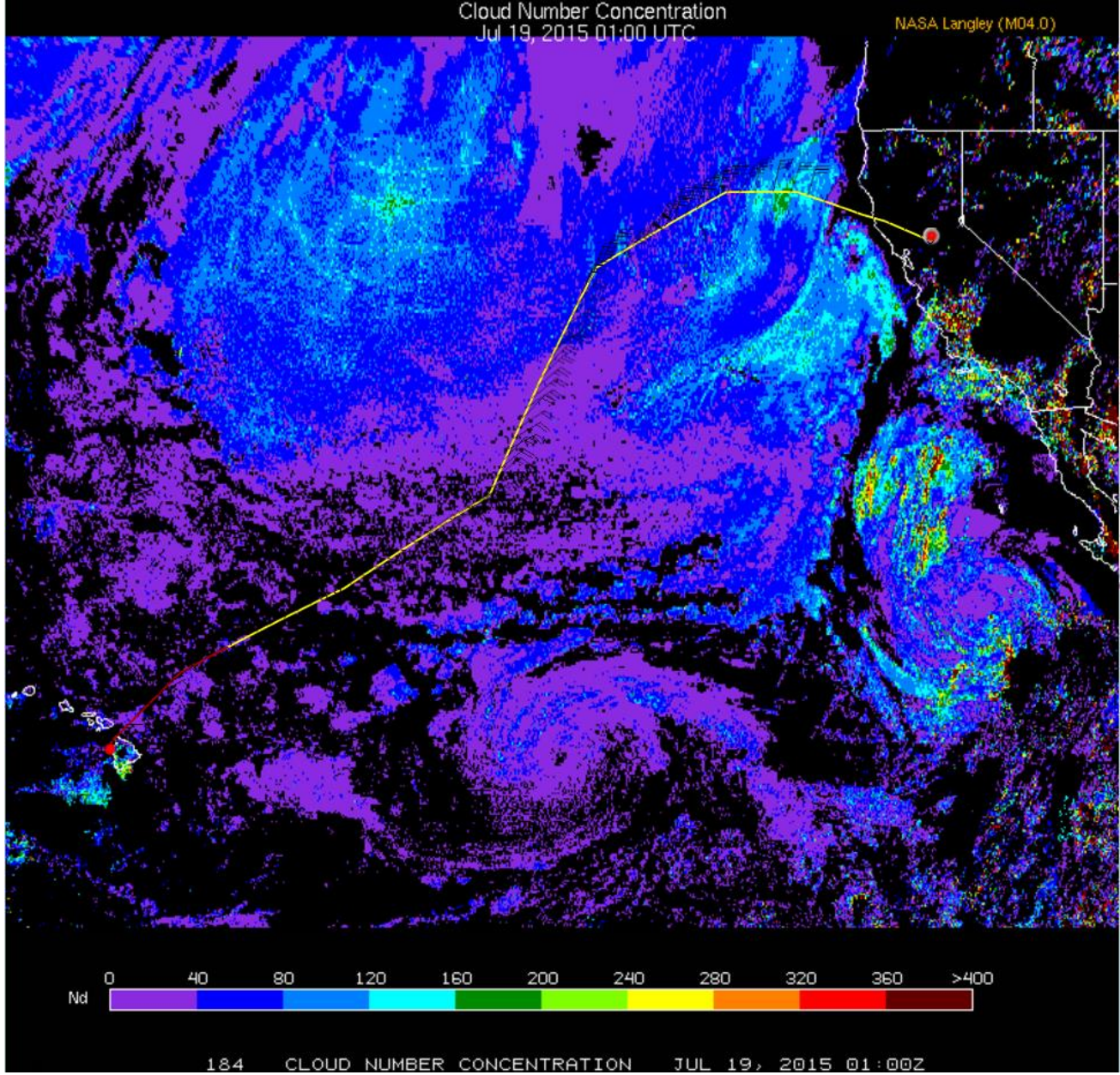
NASA Langley Cloud and Radiation Properties Data

- Based on VISST/SIST algorithms (many thanks to Pat Minnis!), ~.1°x.1°
- Day only: cloud LWP, clould r_{eff}, cloud τ, visible count
- Day/Night: cloud phase, CTH, CTP, CTT, *skin temp*

UW added variables:

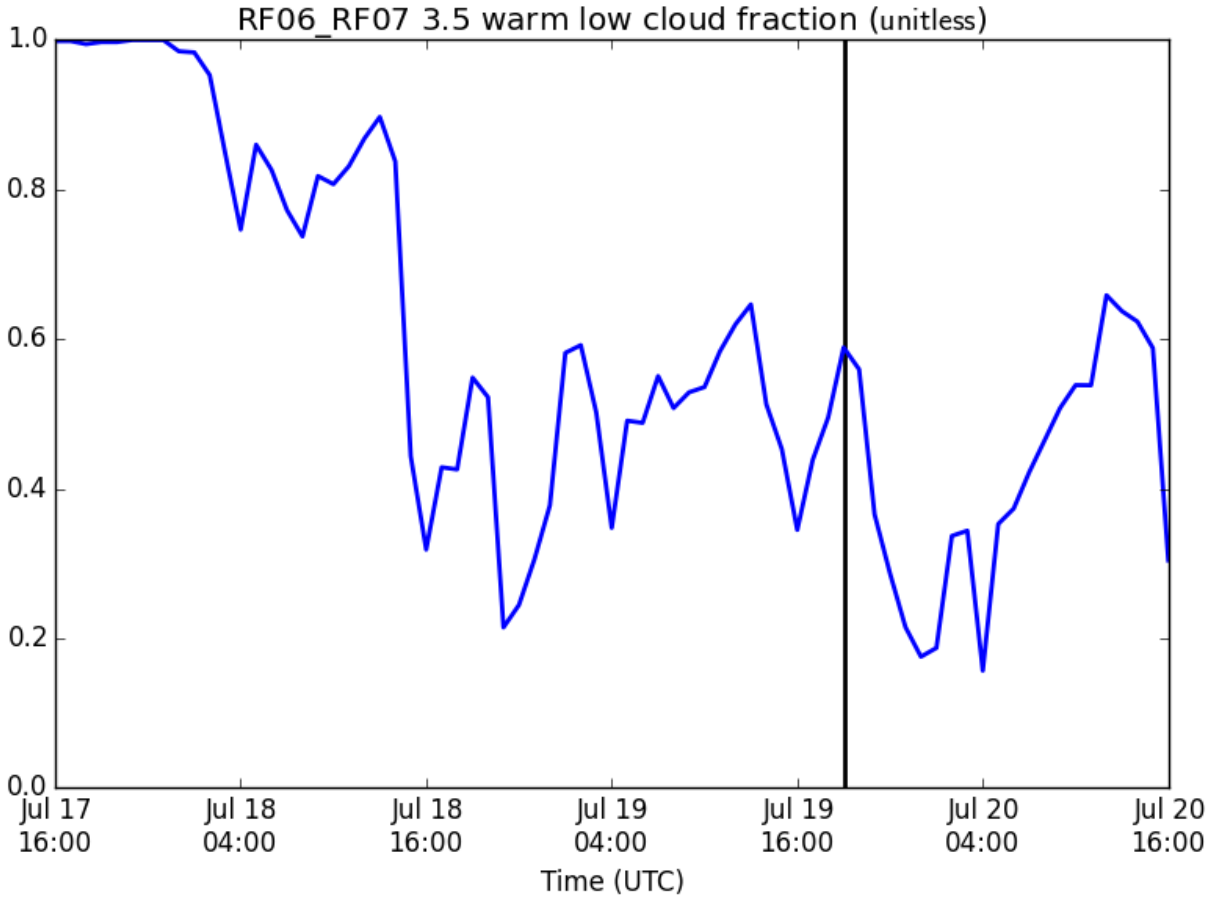
- low cloud flag: CTH<4km, CTT>273.15K, 'cloud phase' = liquid
- N_d (Painemal and Zuidema, 2011):

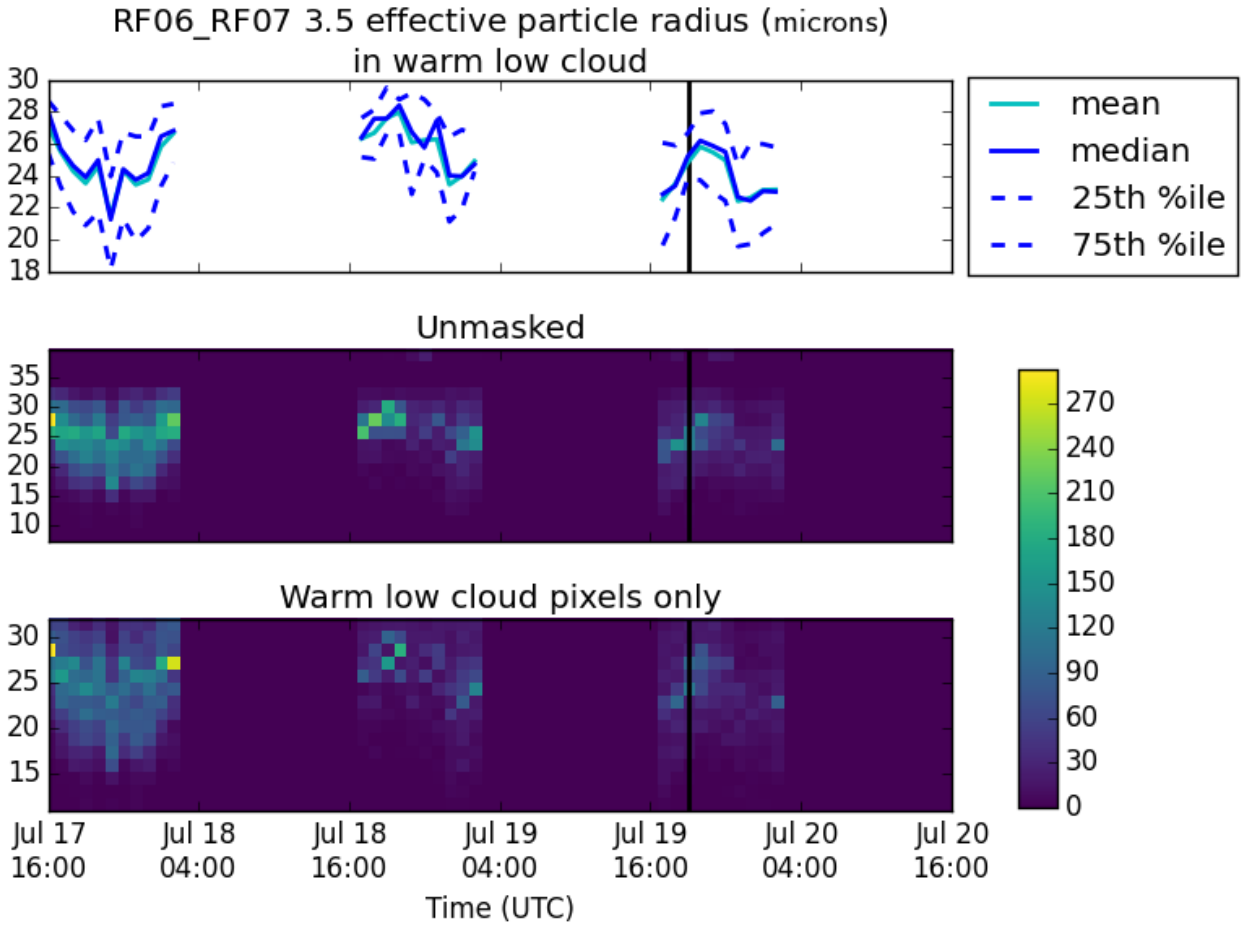
$$N_d = 1.4067 \cdot 10^{-6} \left[\mathrm{cm}^{-1/2}\right] \cdot \frac{\tau^{1/2}}{r_e^{5/2}}$$



UW Lagrangian GOES products

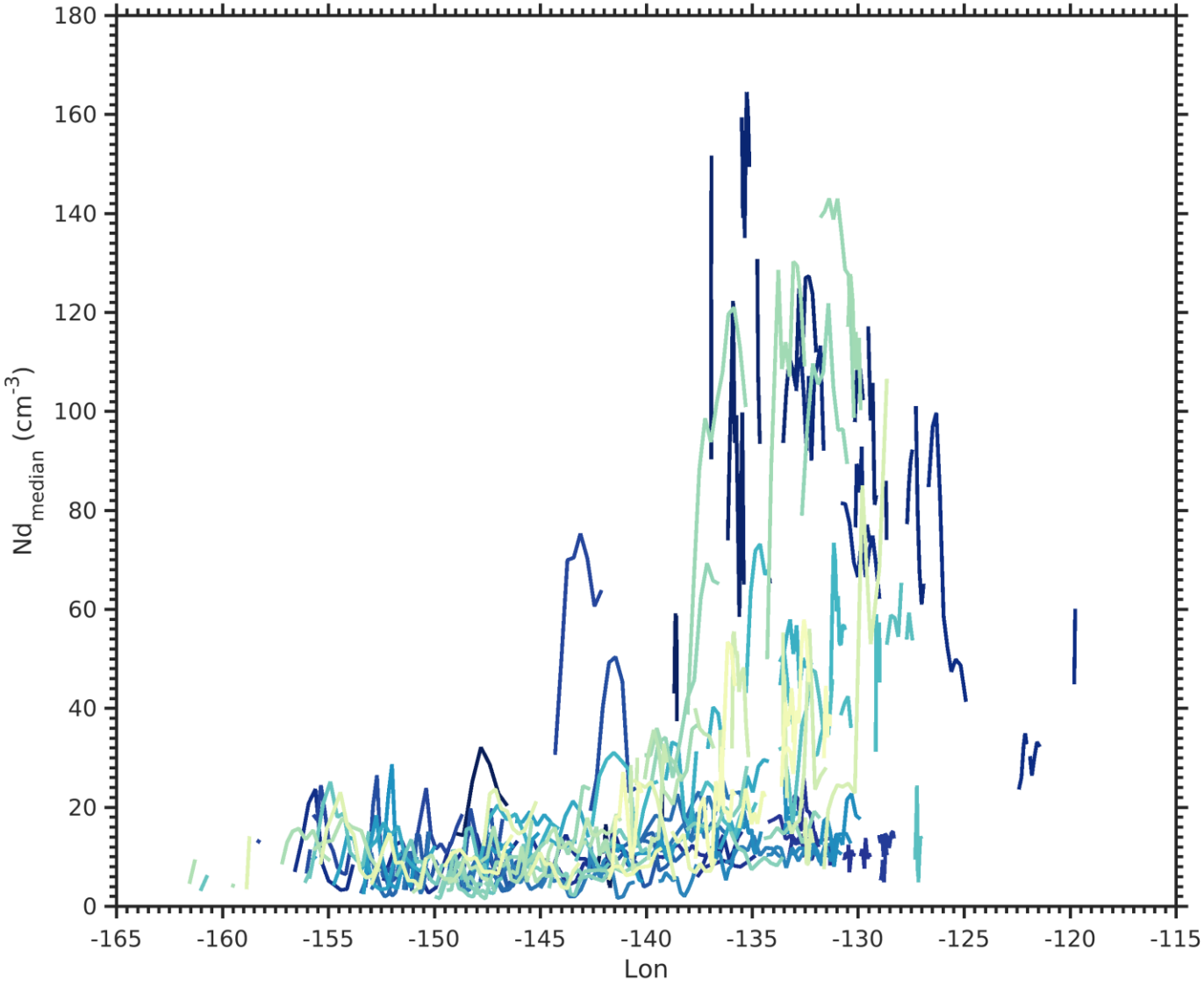
1. Extract GOES products along all CSET trajectories in 1x1°, 2x2°, 4x4° boxes
2. Compute statistics (25th, 50th, 75th %ile, mean) + cloud fraction for each box





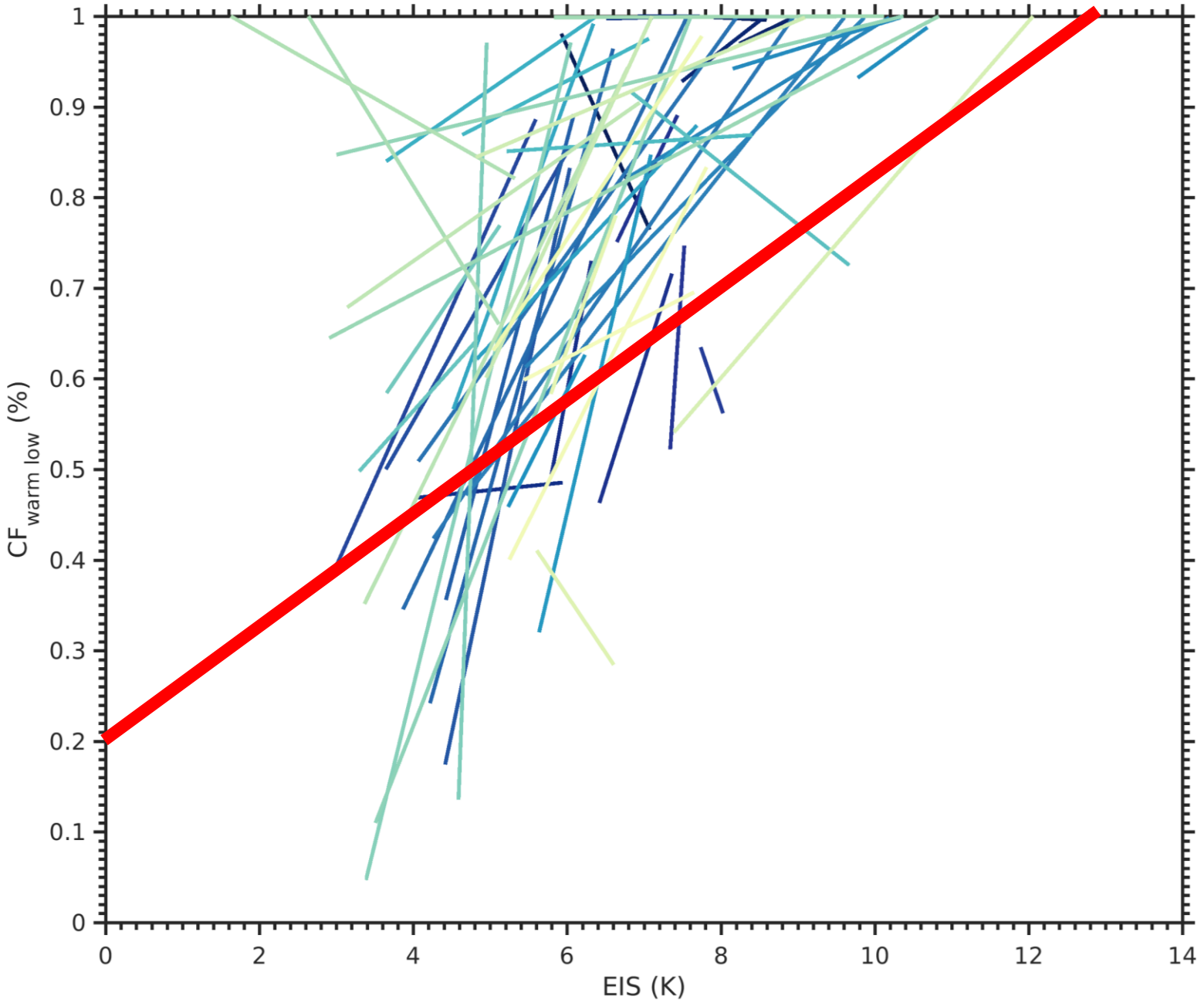
N_d along all trajectories

- Most trajectories cover 155W-130W
- No high N_d west of ~145W



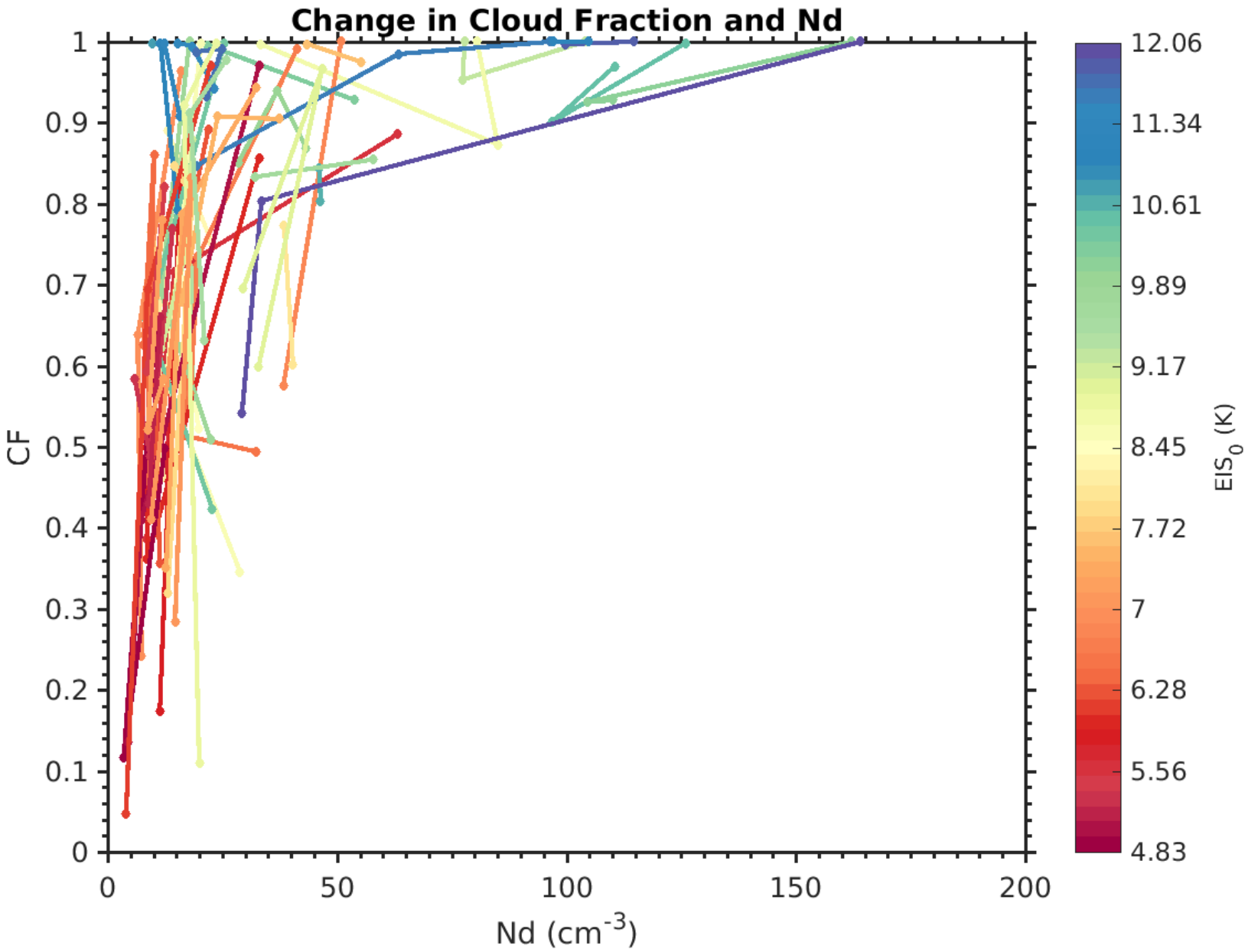
EIS and CF

- EIS (estimated inversion strength) main controlling factor in Sc-Cu transition
- Correlates strongly with CF
- Somewhat consistent with Wood and Bretherton (2006) – red line
- Shows sampling bias towards high CF



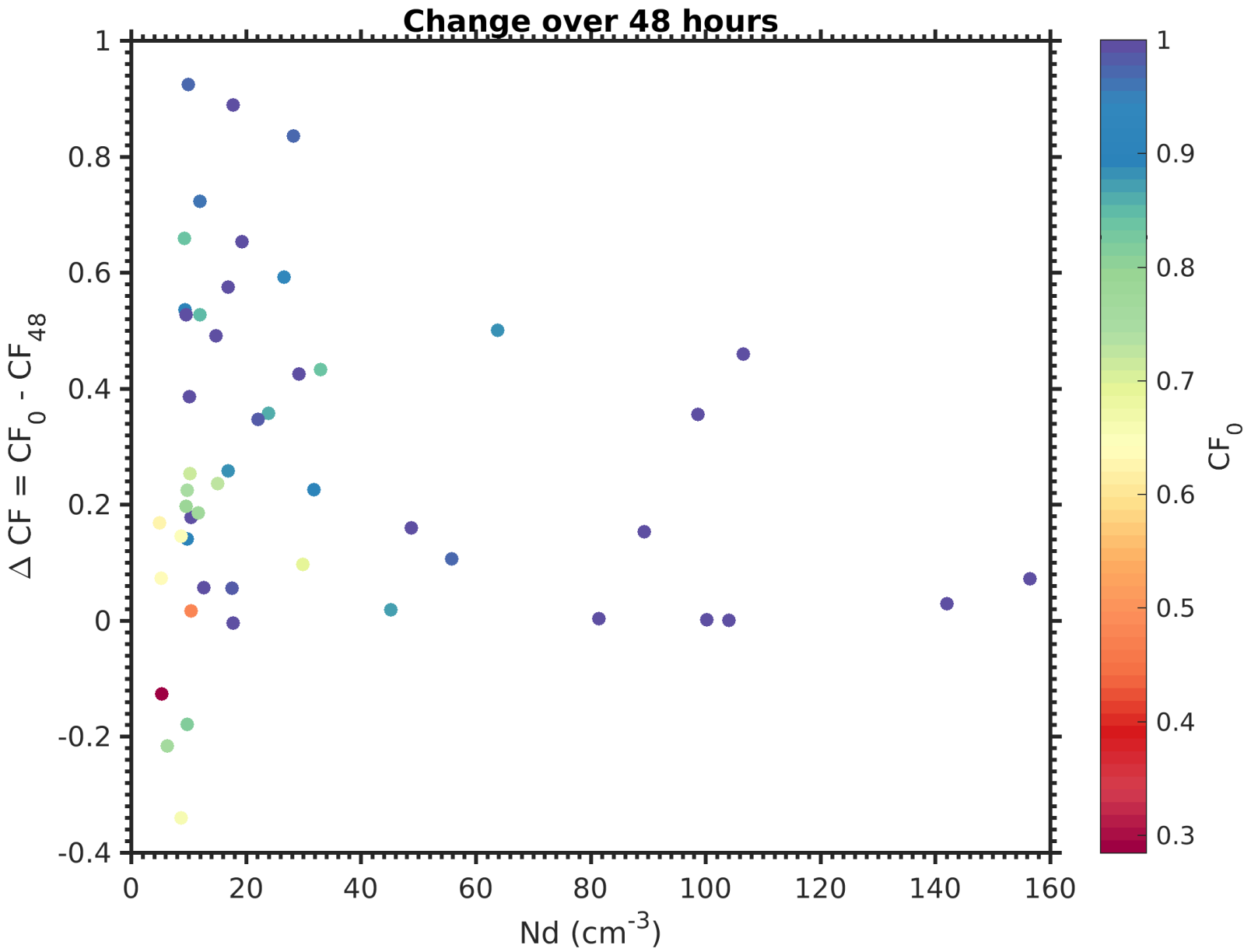
N_d vs CF

- need evolving N_d in LES to capture breakup processes?
- During CSET, only trajectories starting with extensive cloud cover (CF > 0.8) had N_d > 40 cm^{-3}
- Transition to lower CF along Lagrangian trajectories was associated with N_d values < 40 cm^{-3}



N_d and ΔCF

- suggests larger change in CF if initial N_d is lower



Next Steps

- Validate against aircraft *in-situ* obs of N_a, N_d, CF
- Generate many more trajectories (since we're not actually limited by aircraft resampling), filter for e.g. trajectories starting as 'classic' Sc, sort by EIS_0
- Assess LWP as proxy for rain rate
- Validate GOES LWP against GCOM

Feedback?

N_d and ΔCF (Normalized by EIS)

- suggests larger change in CF if initial N_d is lower