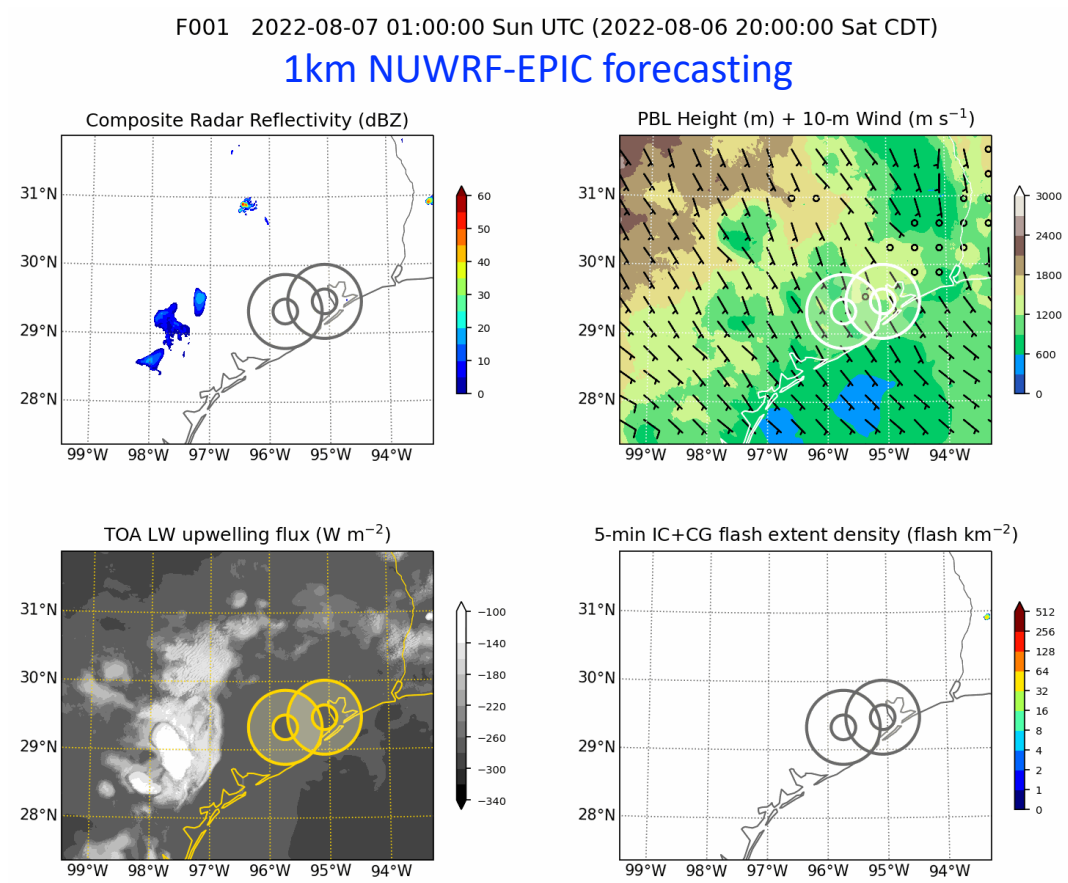
Model-Observation Integration: Approaches, Challenges, and Opportunities

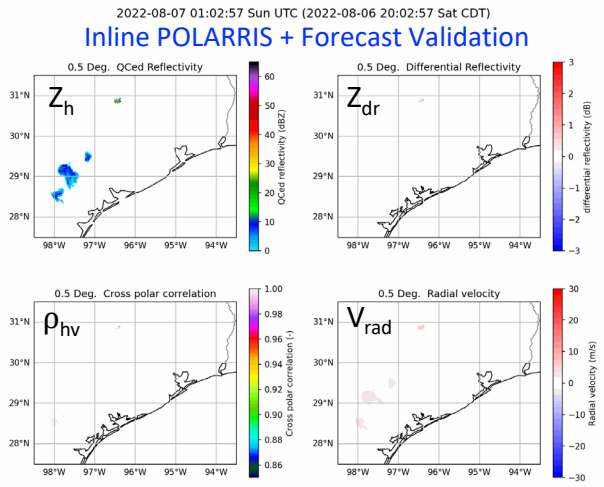
Deep Convection & Radar

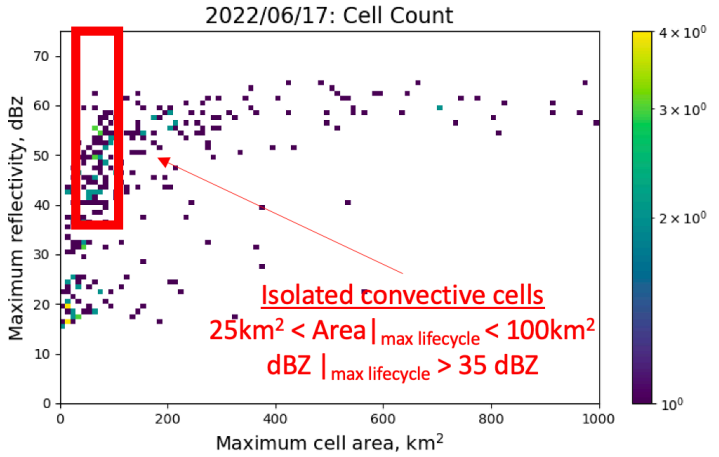
"Simulating isolated storms observed during TRACER using NU-WRF EPIC, a high-resolution weather model with polarimetric radar forward-simulation and prognostic electrification"

Toshi & Marcus

Forecasting microphysics, convection, lightning and polarimetric radar
during TRACER IOP



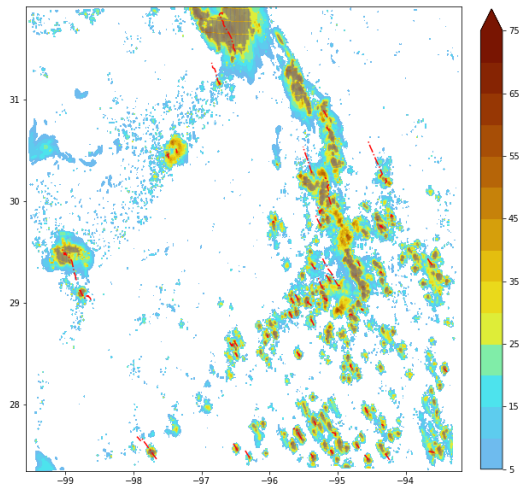




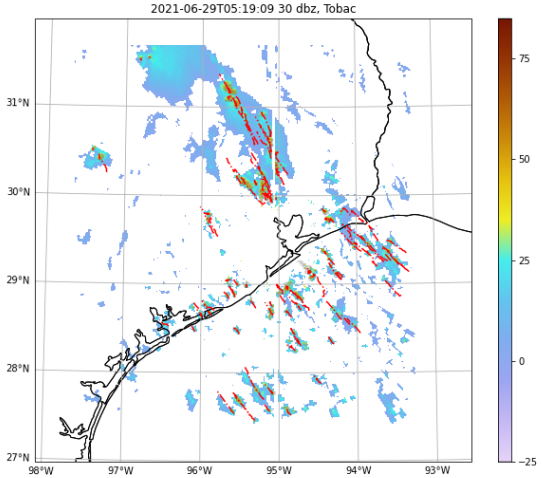
NUWRF-EPIC 1km simulations from June 1 to Sep 30, 2022.
https://portal.nccs.nasa.gov/datashare/tracer/

TOBAC Cell-Tracked Objective Cloud Types

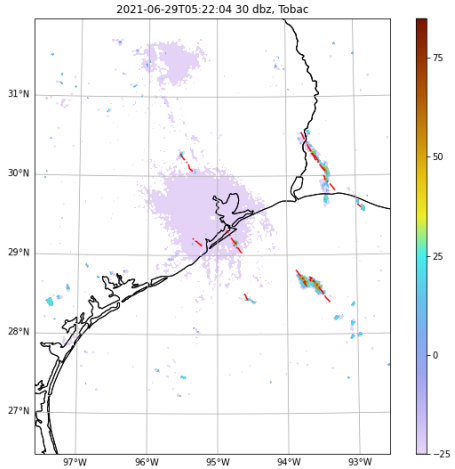
WRF



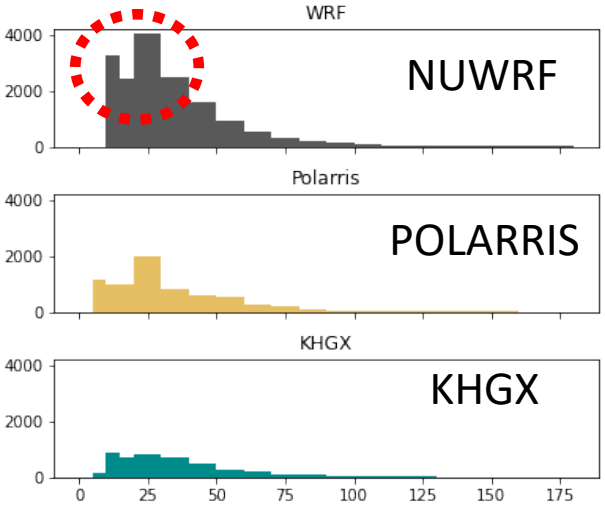
POLARRIS



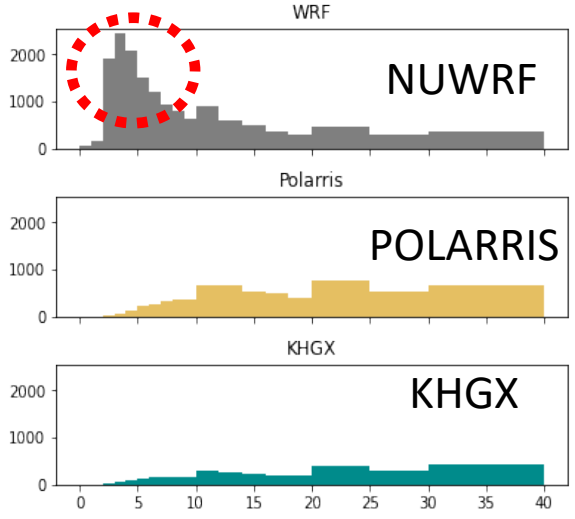
KHGX



Cell Duration (minutes)



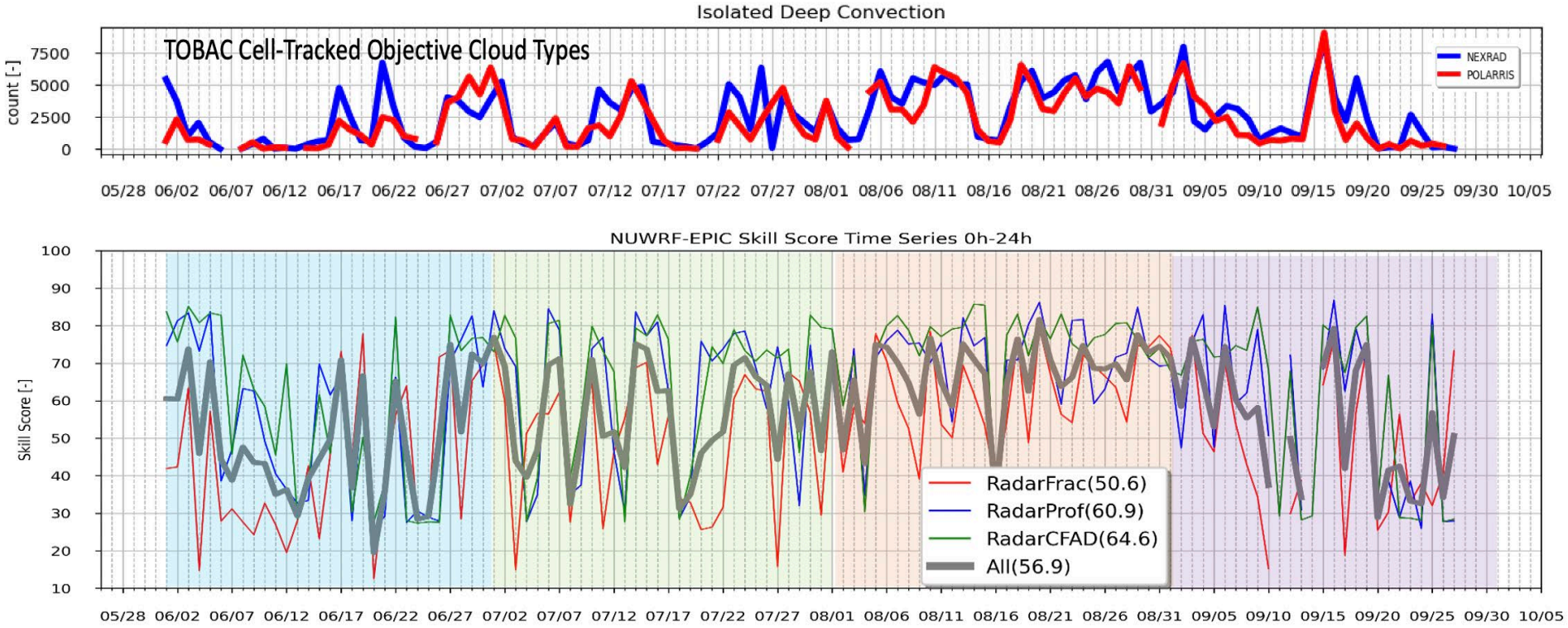
Max Cell Area, km^2



Inline POLARRIS suppress overestimated cell features and numbers from WRF radar composite (direct output).

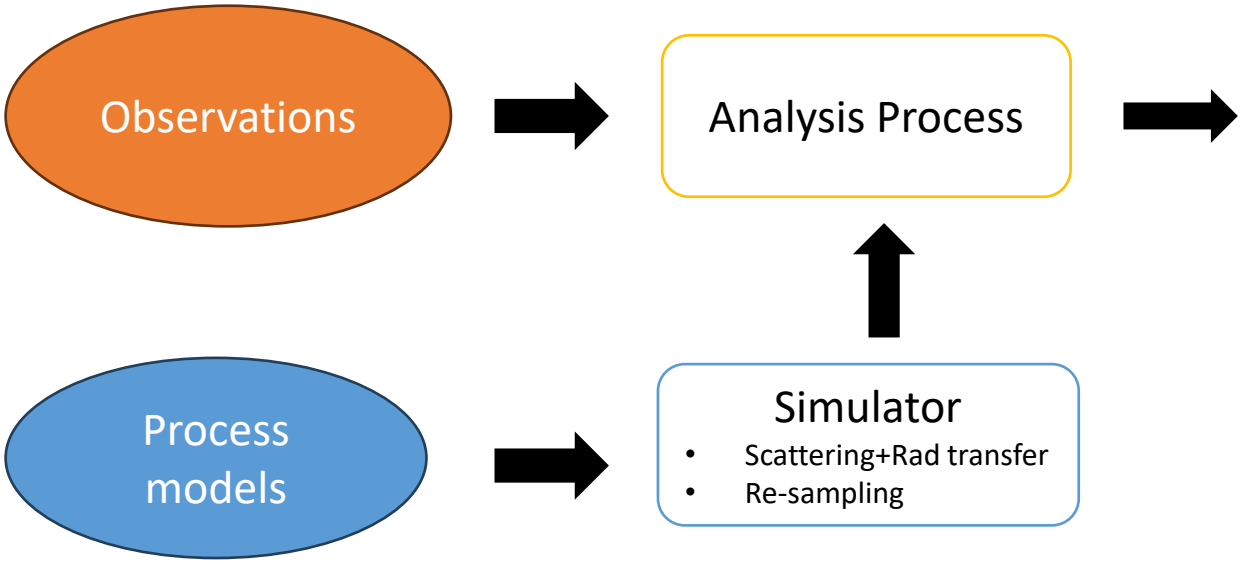
Contributed From Kelcy Brunner & Eric Bruning

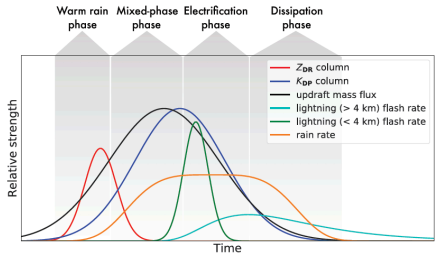
Finding Golden Cases



NUWRF-EPIC skill scores and isolated deep convective cells (IDC) counts are correlated each other. (Higher skills → More isolated deep convections)

Observation-Model Integration



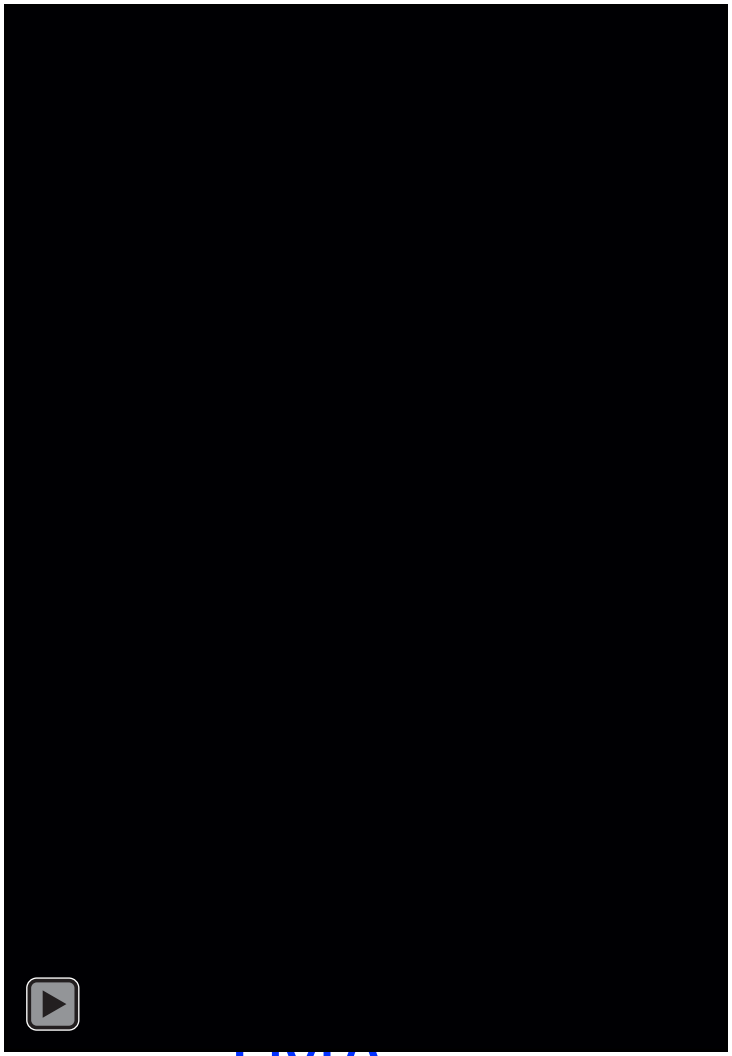


Process Understanding

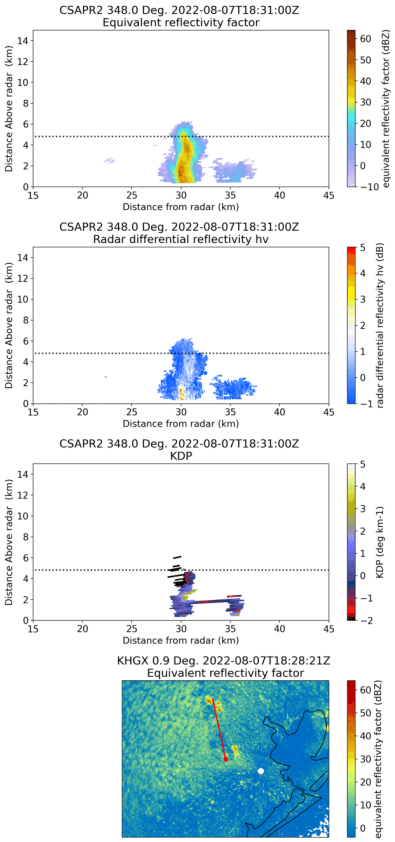
Keys of observation-model integration

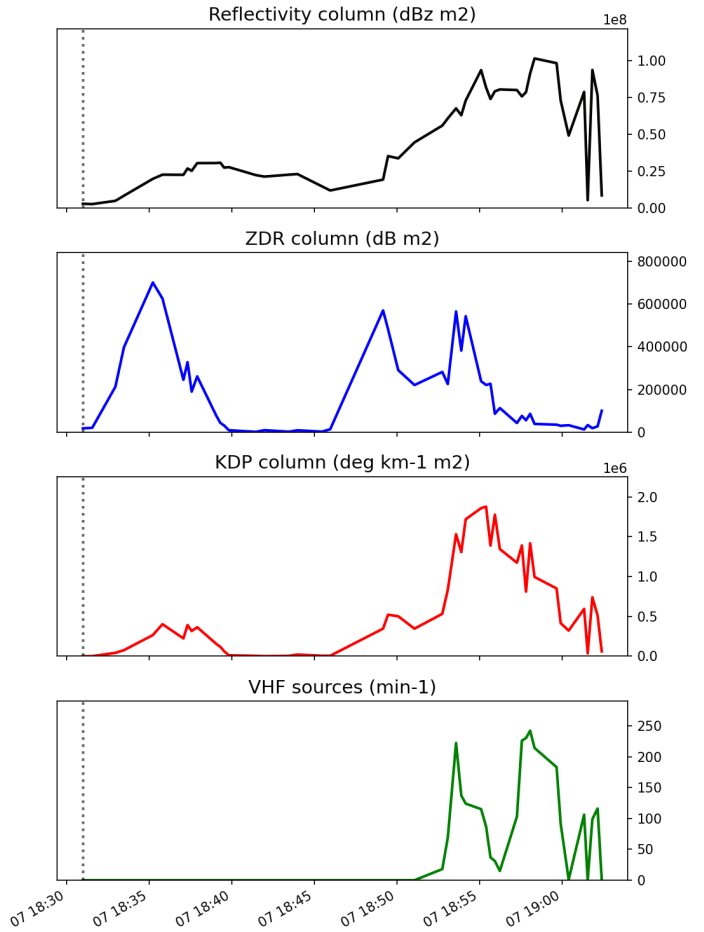
1. Same statistics analysis should be conducted between observations and process models.
2. Simulators play roles to convert model-derived parameters close to observations.
3. Tight collaboration between observation and modeling scientists is CRITICAL.

1st Golden Case -8/7 case-



LMA





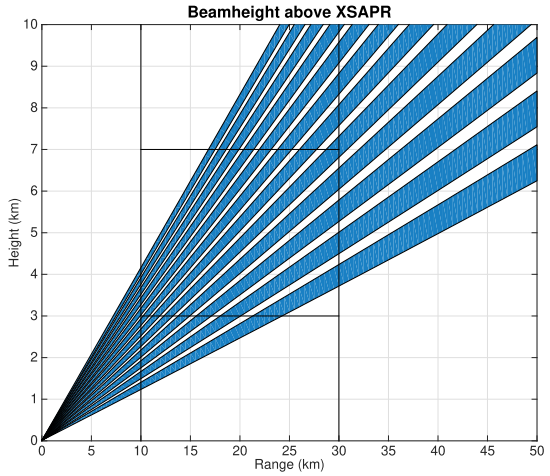
CSAPR

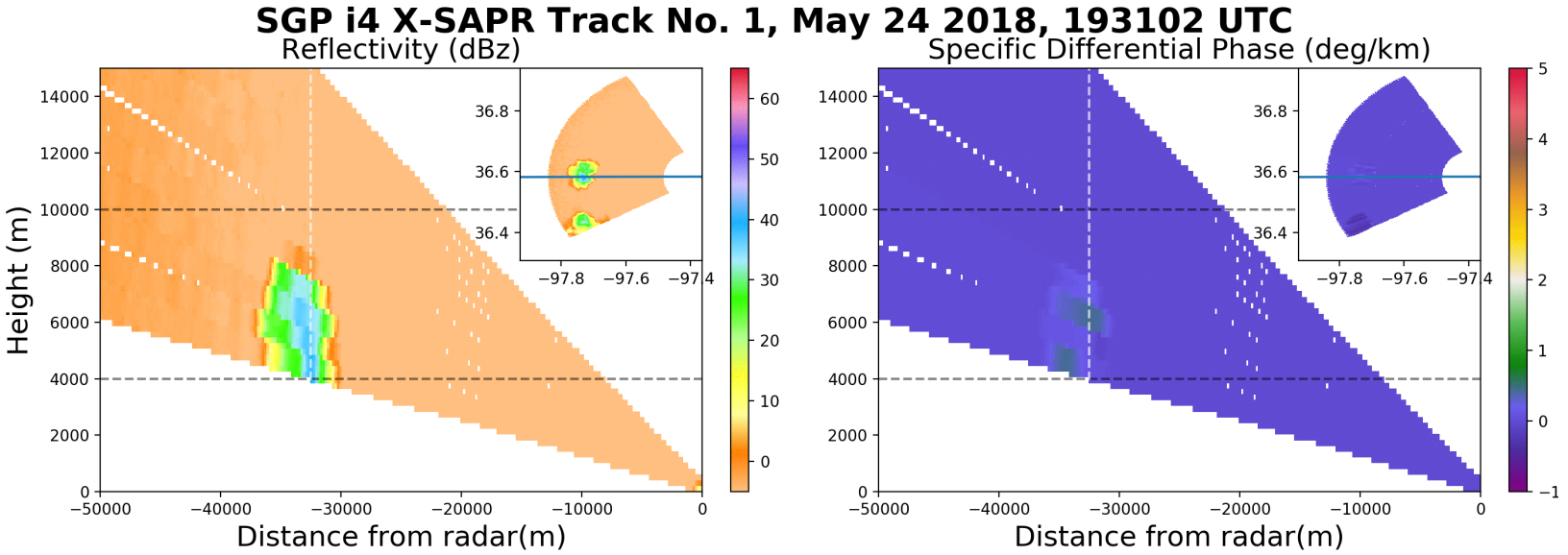
How best to sample with radars?

- **Desirables:**
  - Fast scanning to capture microphysics of (sub 1-minute) thermal evolution
  - Volumetric information --- 2D scans can miss important aspects of 3D thermals
- **Realistic constraints:**
  - Probably don't have, e.g. Phased Array Radars, so scanning rate is limited, so we must limit scan domain and actively target cells.
  - Spinning dish radars don't like doing limited-sector PPIs, so might need to stick to RHIs
  - What is a "target"? How do we prevent preferentially sampling "interesting" but unrepresentative population of convective storms?

One past approach: 2018 X-SAPR experiment

- X-SAPRs were run in limited angle (roughly 90 degree) PPIs, targeting a “sweet spot” for mixed-phase processes every 120 sec

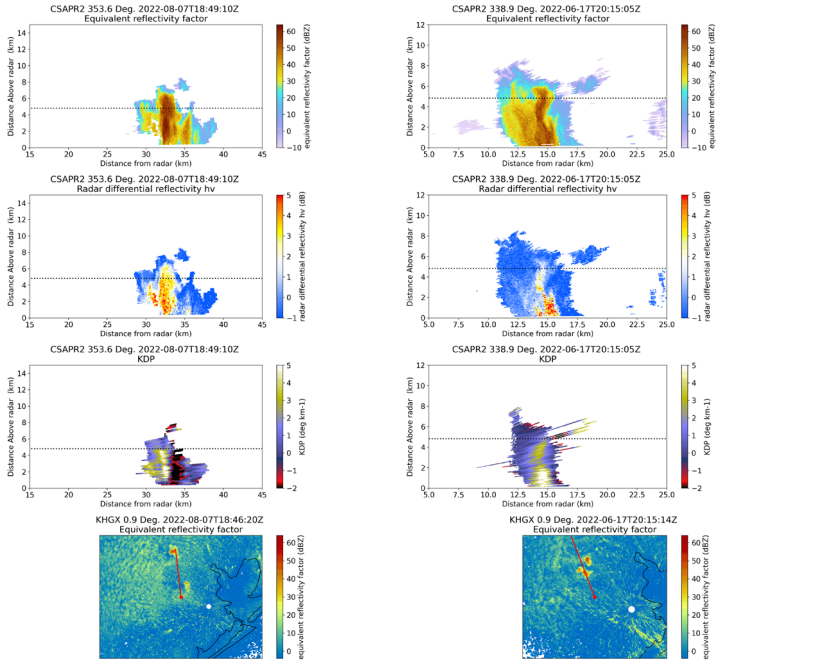




TRACER C-SAPR2 scan strategy

- Use satellite and radar information to identify target cells
- Perform 3 PPIs, 1-6 RHIs (see chart from Mariko Oue ->)
- Are cells sampled for full lifecycle?
- Do the RHIs represent most *meaningful* slices through 3D thermal volume?
  - What does this even mean??

Time period	PPI	RHI
06/01/22 – 06/15/22	PPI_1: cell top PPI_2: cell middle PPI_3: 3° elevation	RHI_1: cell centroid
06/16/22 – 08/01/22		RHI_1: cell centroid RHI_2: cell max VIL RHI_3: cell max Z RHI_4: cell max Z_{DR}
08/02/22 – 09/08/22		RHI_1: cell centroid RHI_2: cell max VIL RHI_3: cell max Z RHI_4: cell max Z_{DR} RHI_5: cell max Z RHI_6: cell max Z_{DR}
09/09/22 – 09/30/22		RHI_1: cell centroid RHI_2: cell max VIL RHI_3: cell max Z RHI_4: cell max $\frac{\Delta" \#}{\Delta\$}$ RHI_5: cell max Z RHI_6: cell max $\frac{\Delta" \#}{\Delta\$}$



Some conclusions (or lack thereof…)

- It's clear we want high spatial and temporal resolution 4D observations to compare to model thermals
  - This ideal should motivate whatever approach is taken
- It is *not* clear how best to approximate this ideal given the limitations of currently available
  - There is a temporal lag between when measurements are taken and when scientists start complaining about them