Simulator Practical Intro

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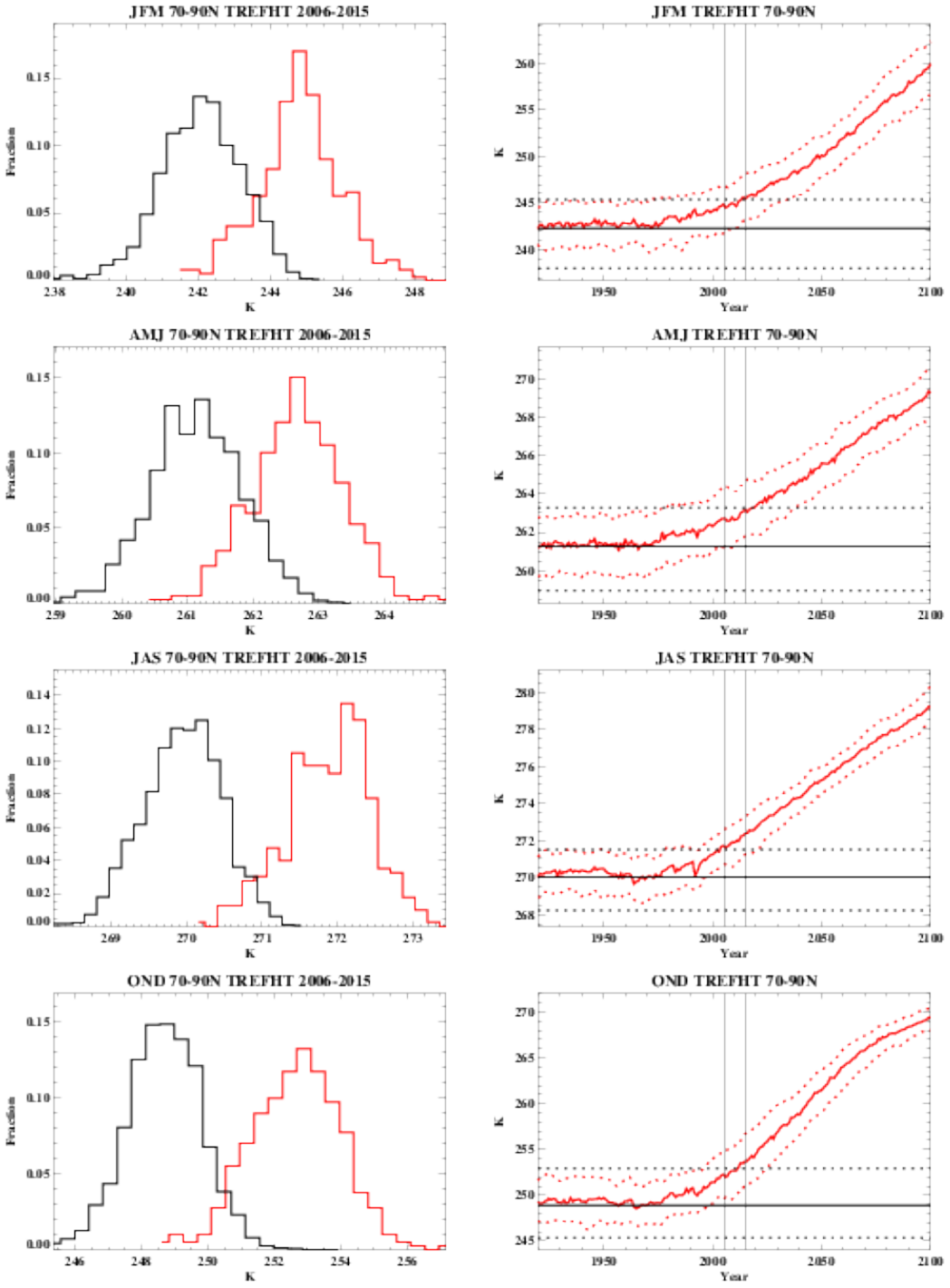
WHERE DISCOVERIES BEGIN

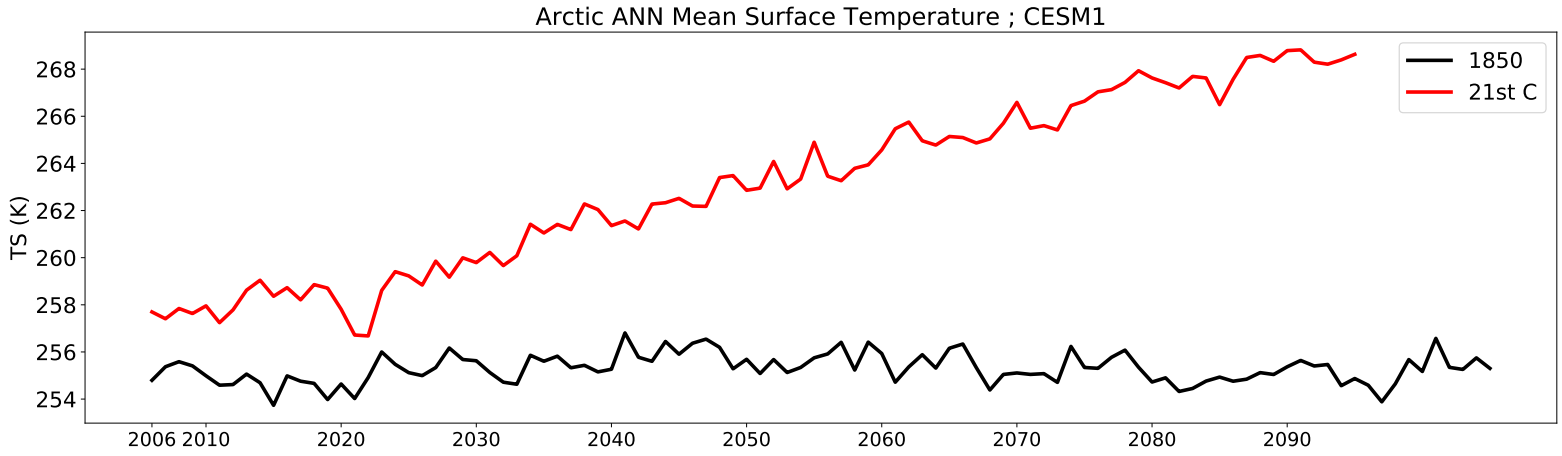
Remember Marika's Predictability Practical??

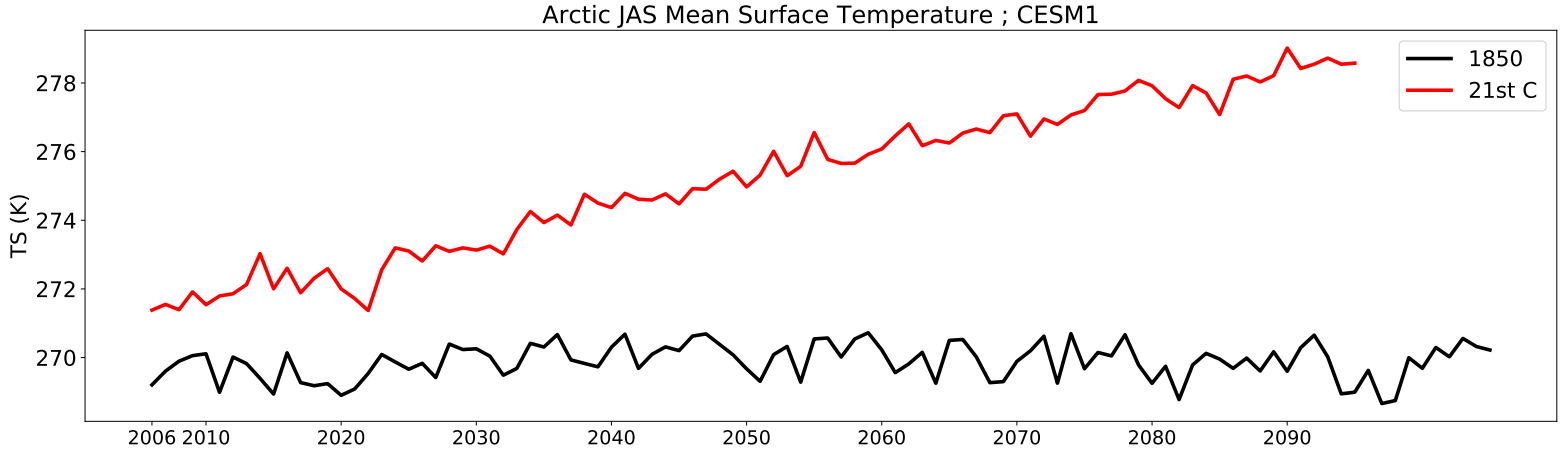
Arctic Surface Air Temperature in the CESM Large Ensemble

When does a detectable forced climate change signal emerge?

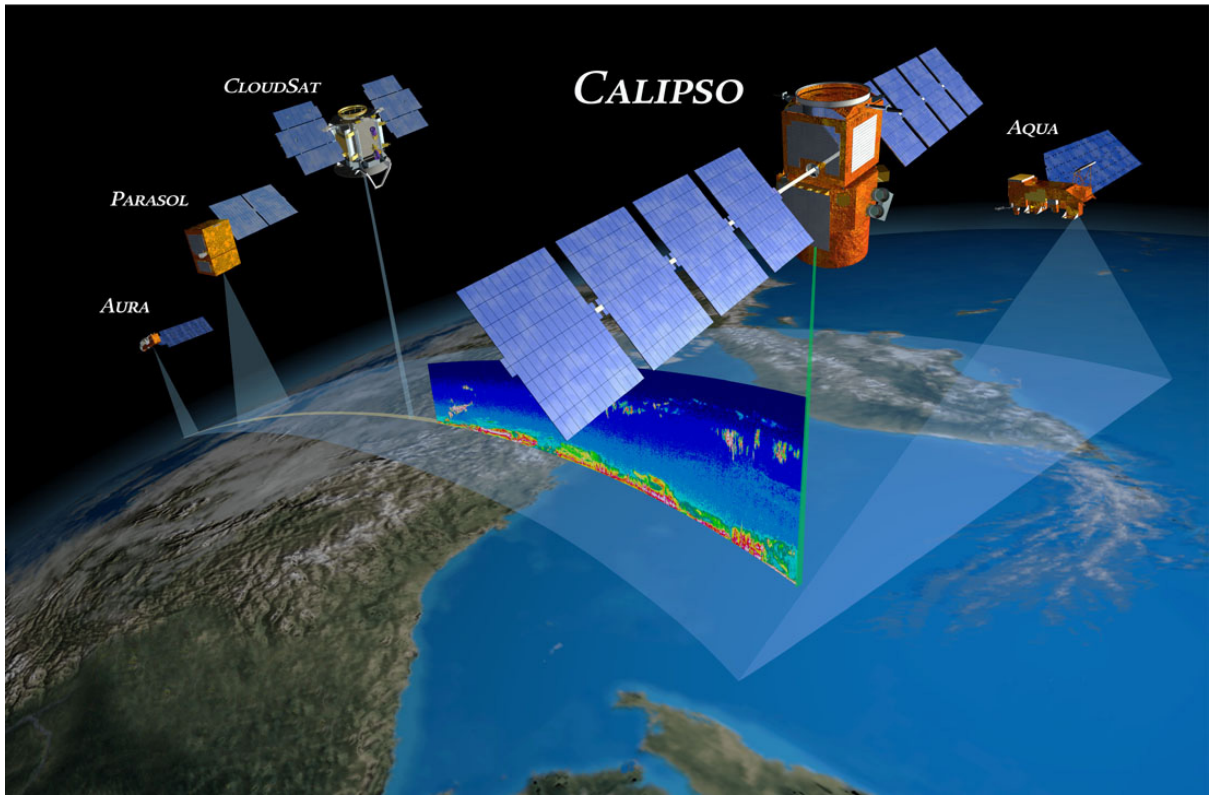


Results from Jen's additional CESM Large Ensemble member…





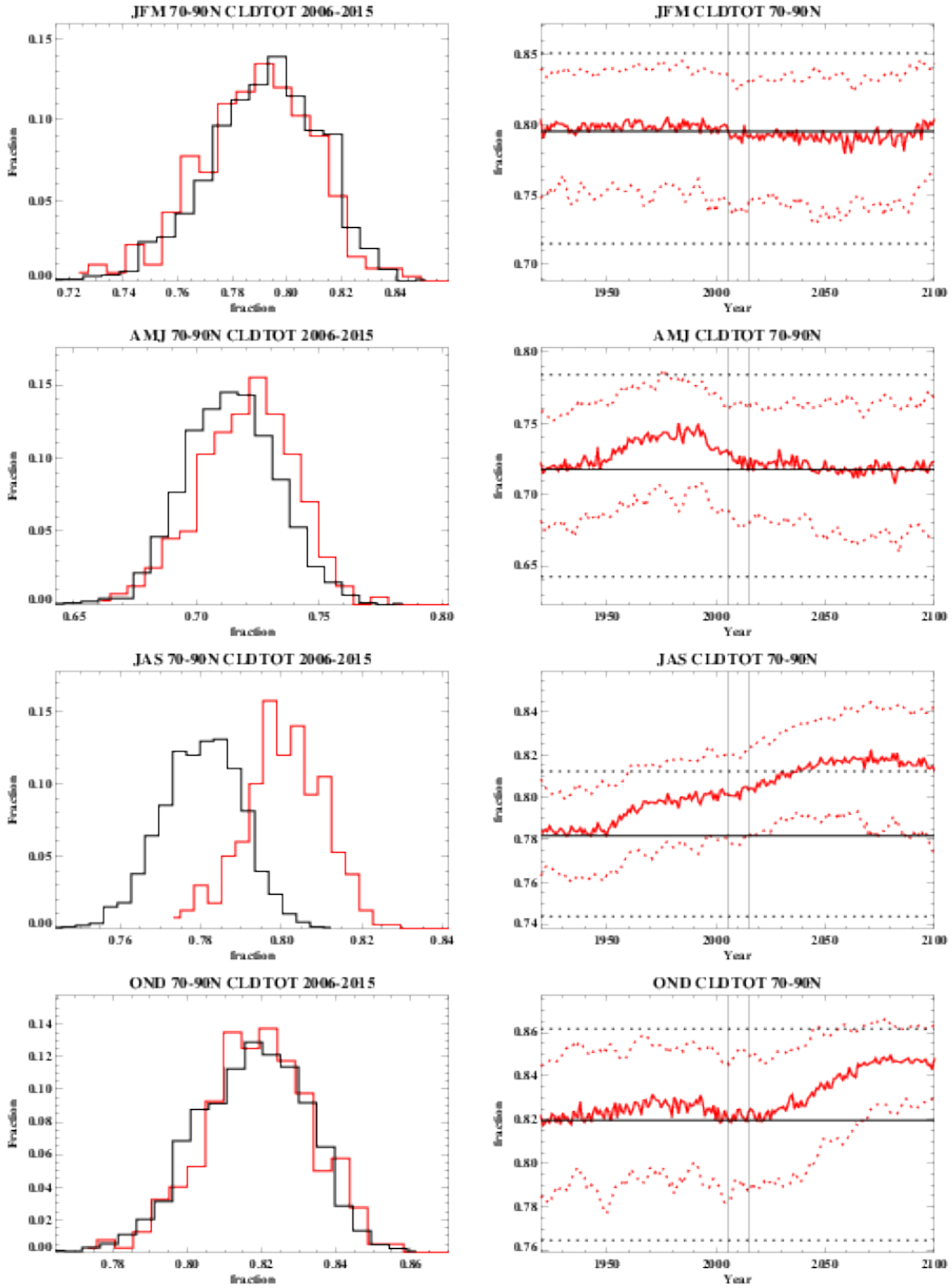
Detection and Attribution – Can we detect the emergence of forced change in the hydrologic cycle with current and future satellites?



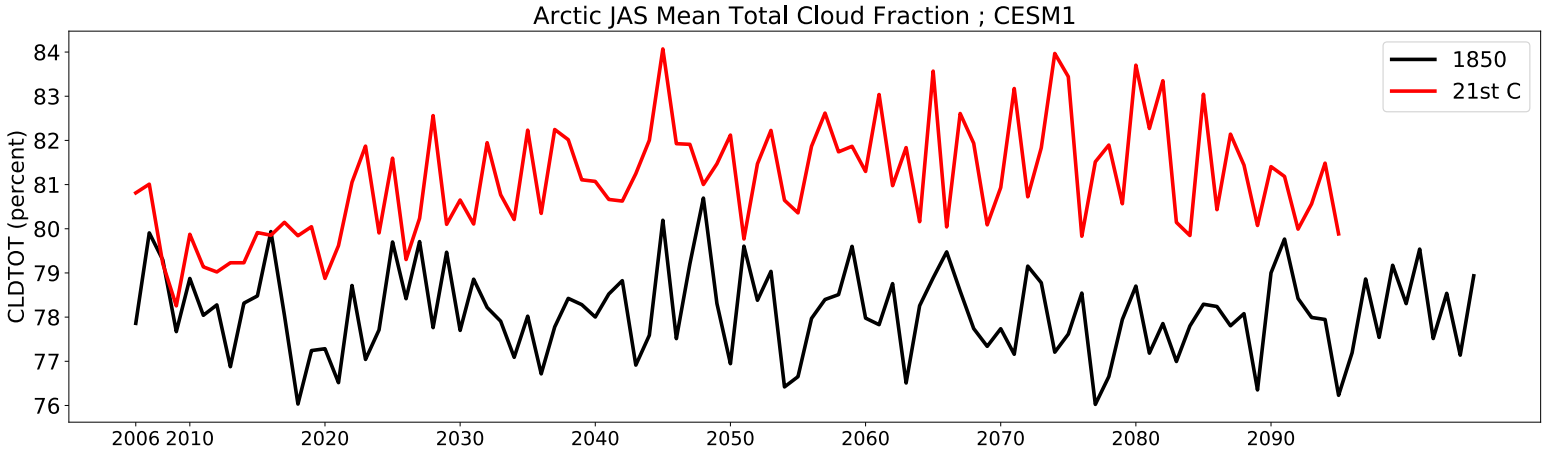
Context from the 2018 NASA Decadal Survey…

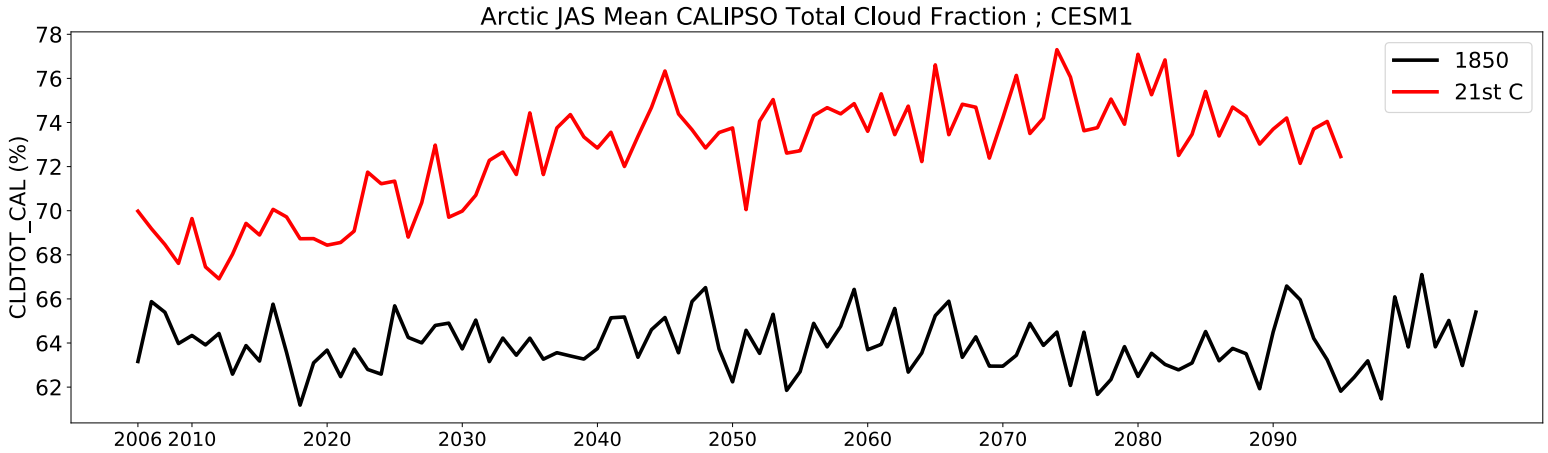
TARGETED OBSERVABLE	SCIENCE & APPLICATIONS SUMMARY	SCI/APPS PRIORITIES (MI, VI, I)	RELATED ESAS 2007 and POR	IDENTIFIED NEED/GAP	CANDIDATE MEASUREMENT APPROACH	ESAS 2017 DISPOSITION
TO-5 **Clouds, Convection, & Precipitation**	• Cloud coverage & optical properties • Solid & liquid precipitation rate • Liquid and ice water path • Convection & cloud dynamics • Diurnal cycle of clouds and precipitation	- **H-1a, 1b, 1c,** 3b, 4b - **W-1a, 2a,** W3a, **4a,** 9a, 10a - S-1c, 4b - **E-3a** - **C-2a,** 2g, **2h,** 3f, 5d, 7e, 8h	***ESAS 2007:*** ACE ***POR:*** CPR/EarthCARE, GPM, CloudSat, MODIS, VIIRS, SSMI, TROPICS	POR does not address diurnal cycle and does not cover precipitation after EarthCARE, GPM and SSMI, or snowfall, convection, and cloud dynamics after EarthCARE	***Similar to:*** **CloudSat, CPR/EarthCARE** • Radar(s) and multi-frequency microwave radiometer • Sampling with 1-4 km horiz & 250 m vert resolution & 0.2 mm/hr precip (rain) accuracy • Doppler for dynamics/ convection (1 m/s) • Spatial resolution ~4-10 km for global precip & snowfall; 1mm/hr snowfall accuracy	**DESIGNATED** PROGRAM ELEMENT Maximum development cost $800M; considerable synergistic value in TO-5 being coordinated in time with TO-1 and TO-2

Arctic Total Cloud Fraction in the CESM Large Ensemble



Results from a single ensemble member offshoot experiment from the CESM Large Ensemble.



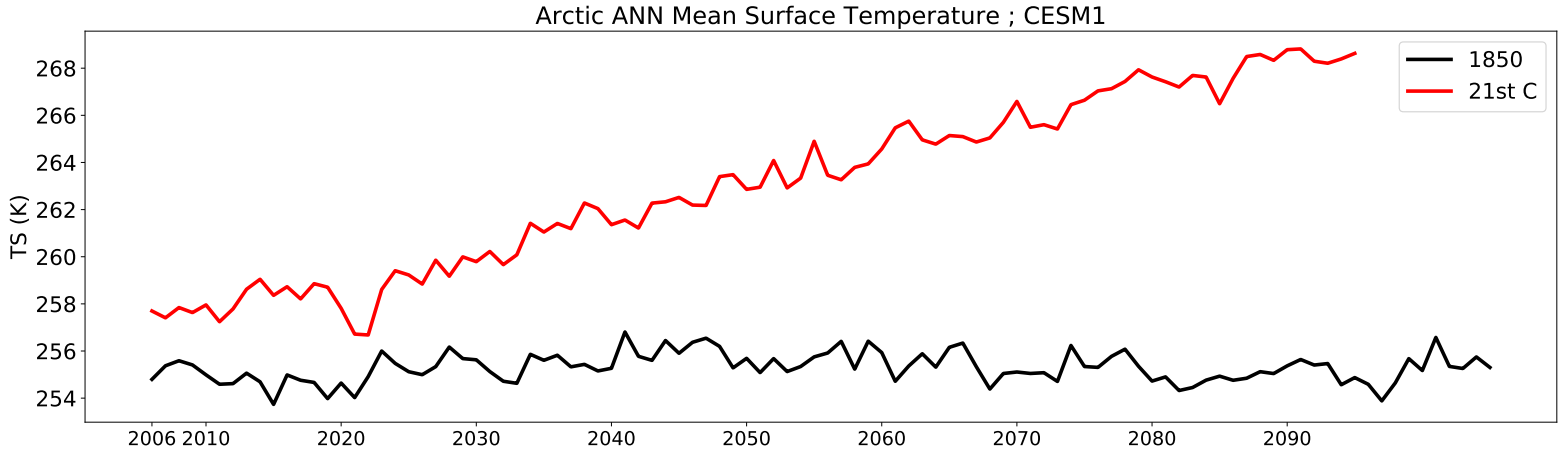


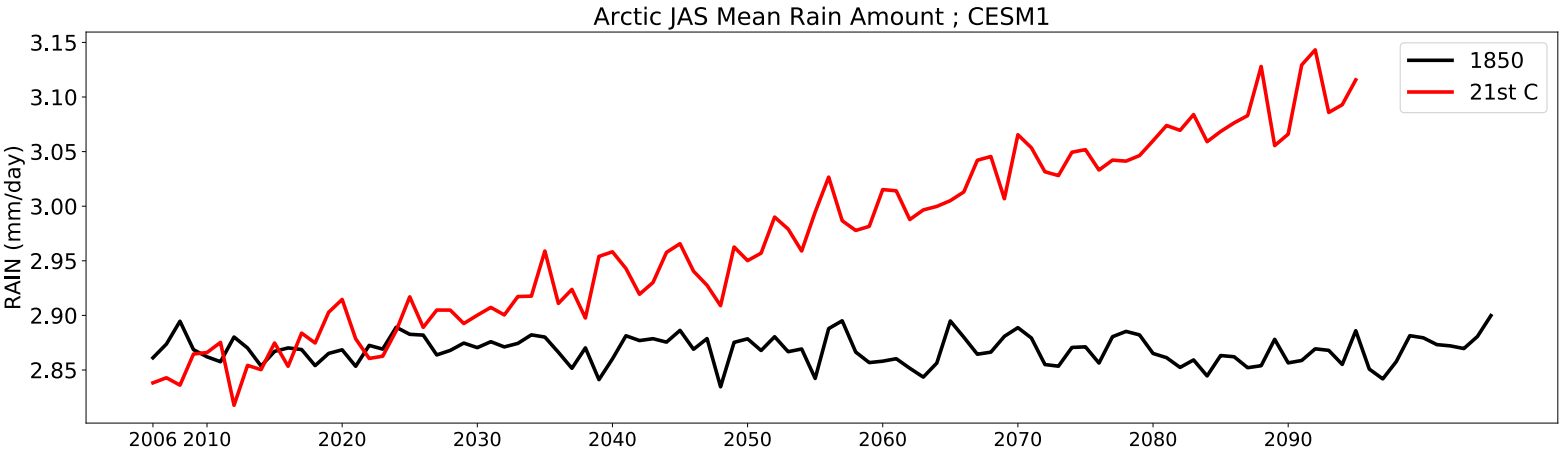
AHH!!! The model cloud cover variable (CLDTOT) gives a different answer than the lidar simulator variable (CLDTOT_LIDAR) .

Why?

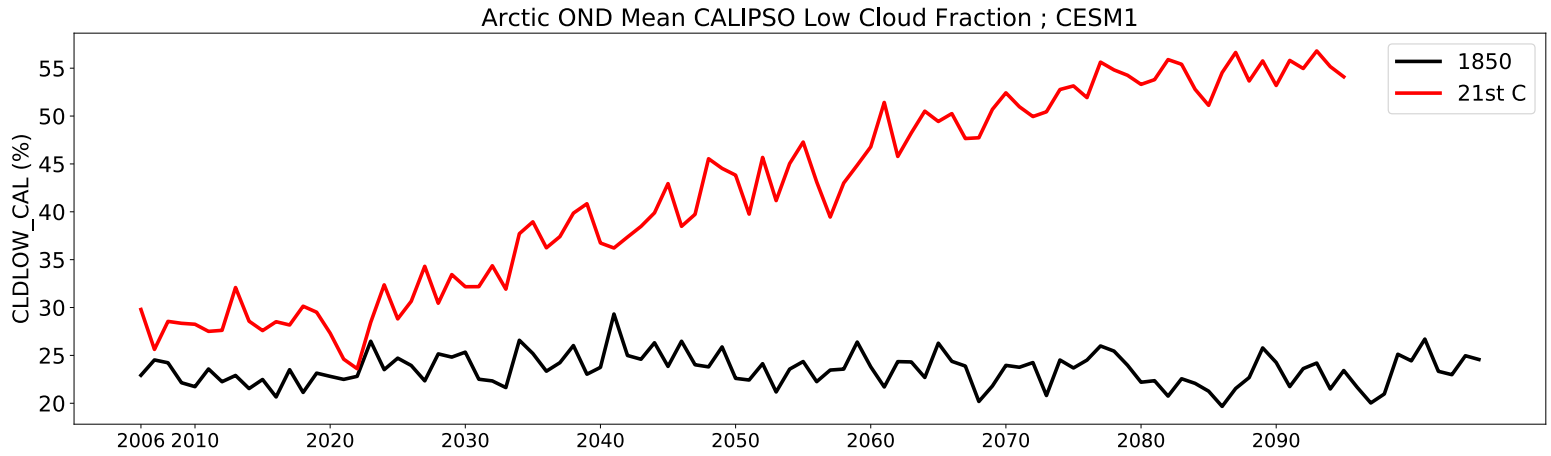
Hint: using the model native cloud cover fields (i.e., CLDTOT, CLDLOW) isn't telling you about the radiatively important clouds and the clouds that would be observed by CALIPSO.

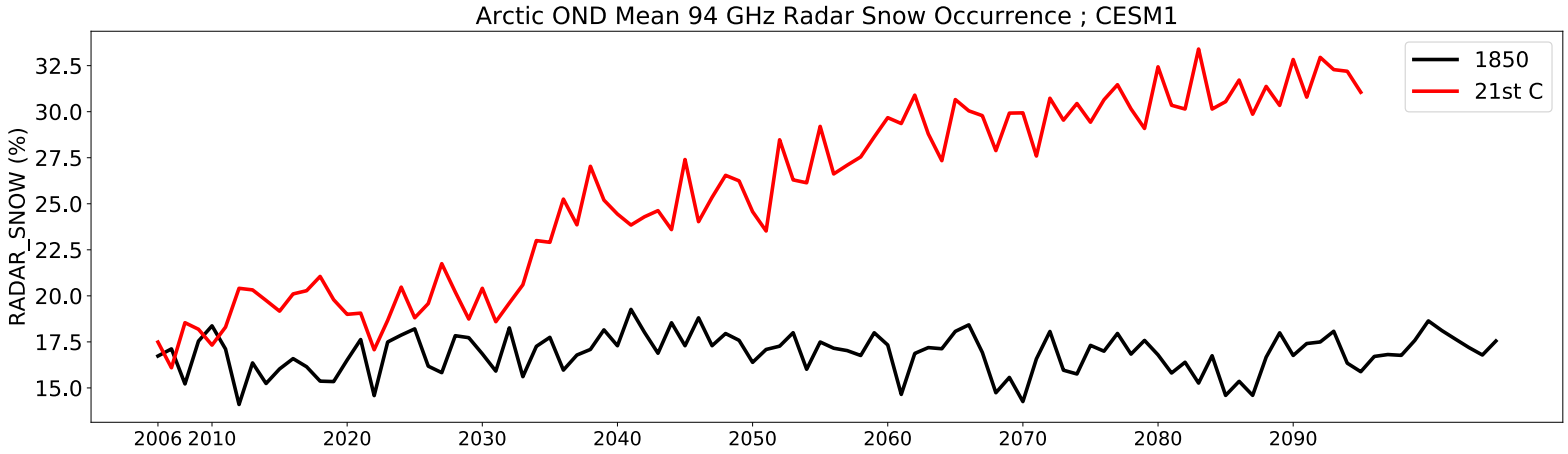
How does the emergence of the forced signal vary depending on the variable you consider?



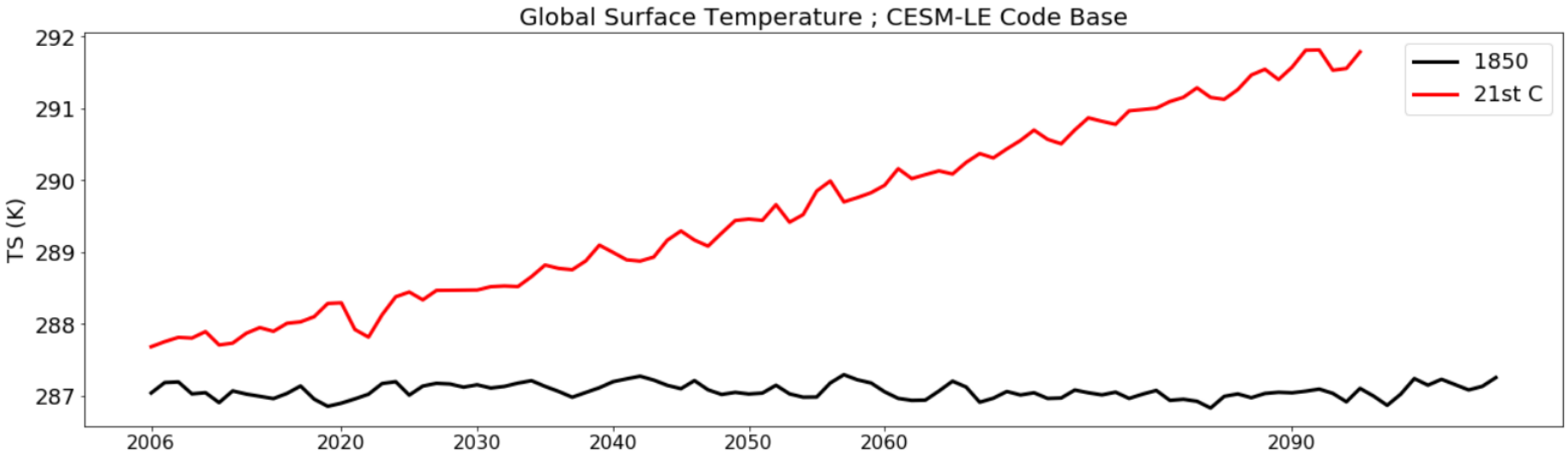


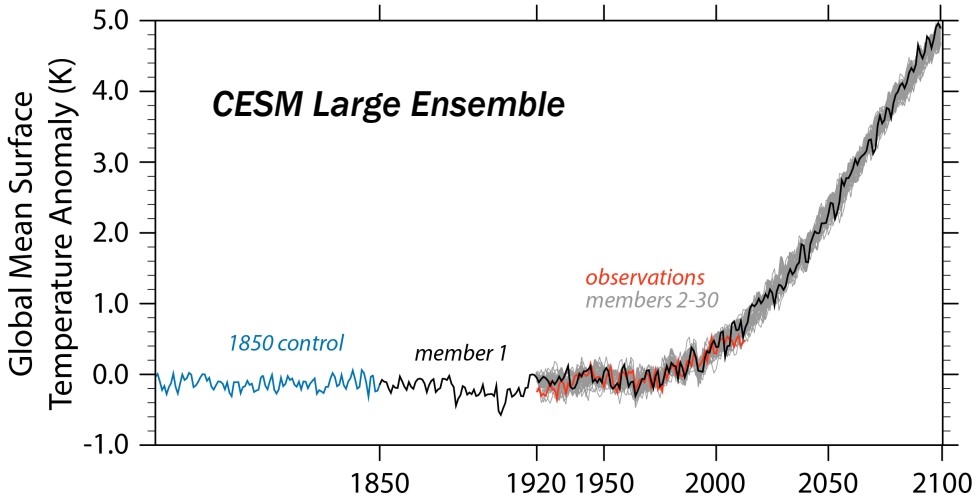
What might you be able to observe with a future spaceborne radar or lidar?





Question: How can you leverage a large ensemble if you only have one member with your diagnostics?





Simulator Practical Instructions

1) Use Day4_PythonNotebookInstructions.pdf to open a jupyter notebook session

2) Open the notebook - CESM1_detectionandattribution.ipynb

3) Select variable, season in Box 2

4) Work through the rest of the notebook to graph and calculate statistics related to emergence of forced climate change signals

Notes on Variables –

Variables in red are from the satellite simulators

CLDTOT is the model total cloud cover.

CLDLOW is the model low cloud cover.

CLDTOT_CAL is the total cloud fraction detected by a lidar (like CALIPSO)

CLDLOW_CAL is the low cloud fraction detected by a lidar (like CALIPSO)

SNOW is the annual mean snow amount.

RAIN is the annual mean rain amount.

RADAR_SNOW is the average annual frequency of snow detected by a 94 GHz radar (like CloudSat).

RADAR_RAIN is the average annual frequency of rain detected by a 94 GHz radar (like CloudSat).

Question to ponder when comparing the lidar-detected cloud cover with the model cloud cover

Do clouds emerge earlier or later than surface temperature? Do the CALIPSO-simulated cloud fractions (CLDLOW_CAL, CLDTOT_CAL) exhibit the same behavior as the model-native cloud fraction variables (CLDLOW, CLDTOT)? If you were planning on launching a future CALIPSO mission – When would you expect to first see cloud cover change in the Arctic? What are the next steps for this analysis beyond the provided jupyter notebook?

Question to ponder when comparing the RADAR precipitation frequency with the model precipitation amount

Does precipitation emerge earlier or later than surface temperature? Do the CloudSat-simulated precipitation frequencies (RADAR_RAIN, RADAR_SNOW) exhbit the same behaviour as the model-native precipitation amount variables (RAIN, SNOW)? What are the obvious next steps for this analysis? If you were planning on launching a future CloudSat-like mission – When would you expect to first see precipitation change in the Arctic? What are the next steps for this analysis beyond the provided jupyter notebook?

Have Fun!