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Polar Radiant Energy in the Far InfraRed Experiment

ASDC PREFIRE Webinar, January 30, 2026

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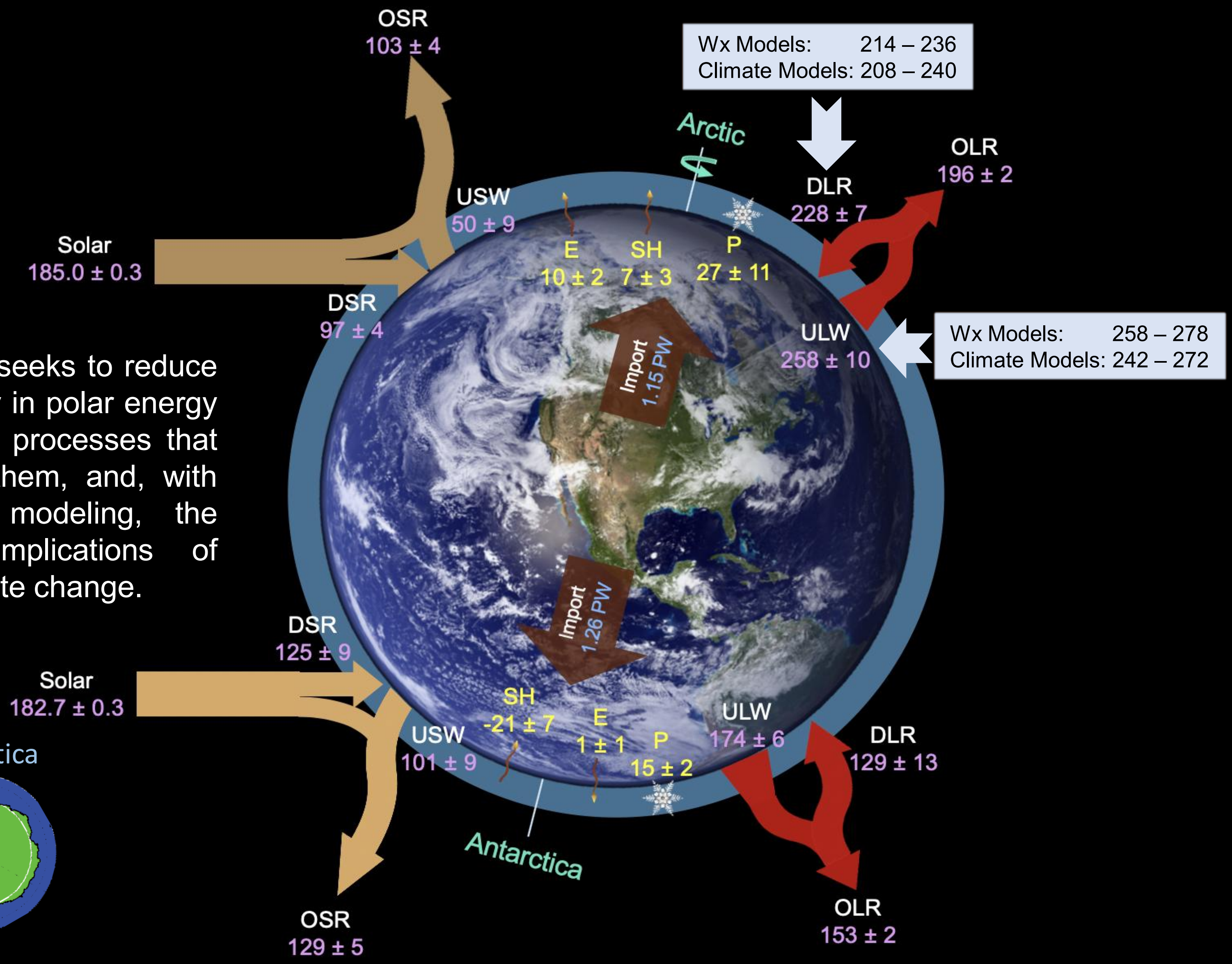
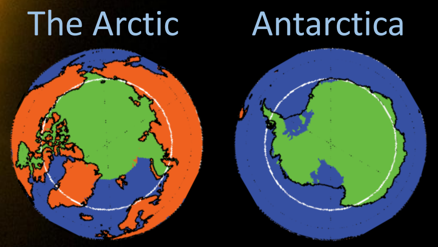
BLUE CANYON TECHNOLOGIES

Goal: Reduce Uncertainty in Polar Climate

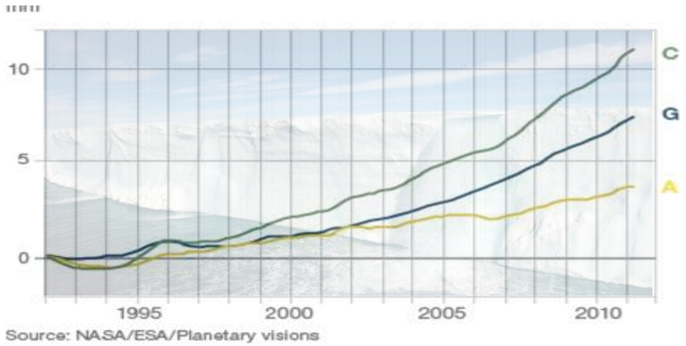
PREFIRE seeks to reduce uncertainty in polar energy fluxes, the processes that influence them, and, with improved modeling, the societal implications of polar climate change.



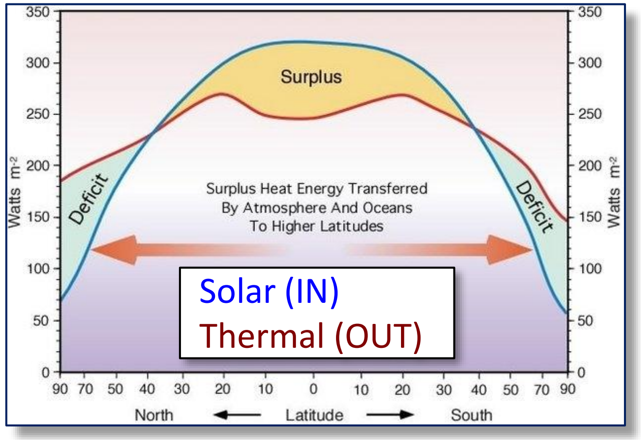


Uncertainties in Polar Fluxes Have Global Implications

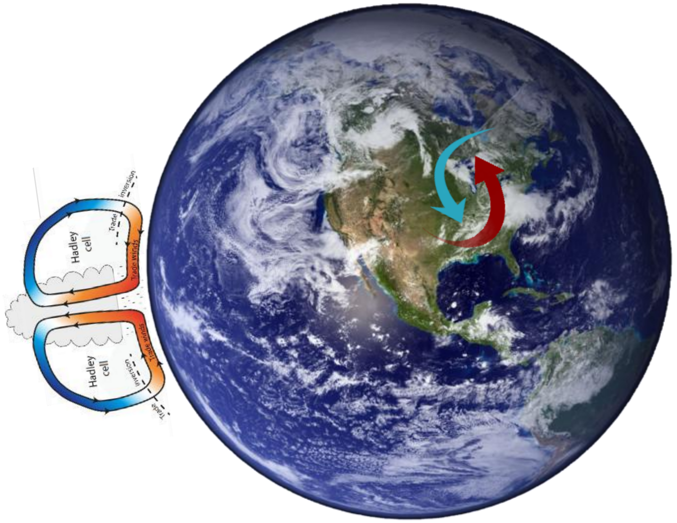
GLOBAL SEA LEVEL RISE



Polar heat flows directly influence ice sheet melt, a significant source of global sea level rise.



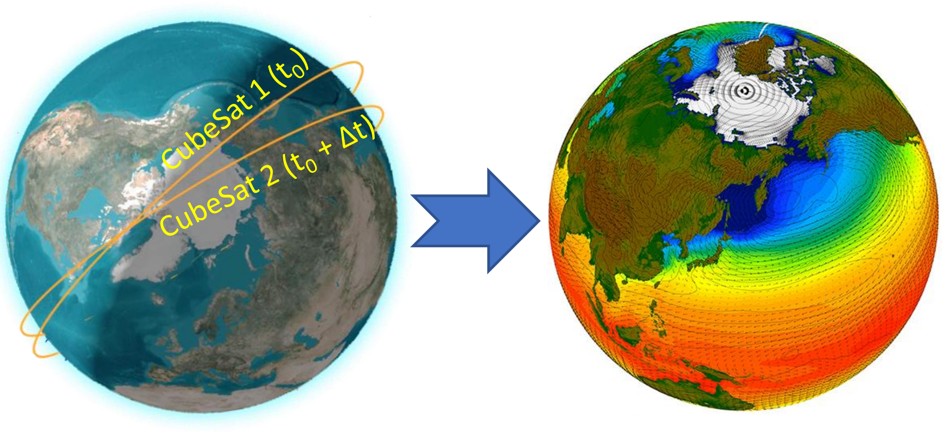
The poles emit more energy than they receive driving heat transport from lower latitudes.



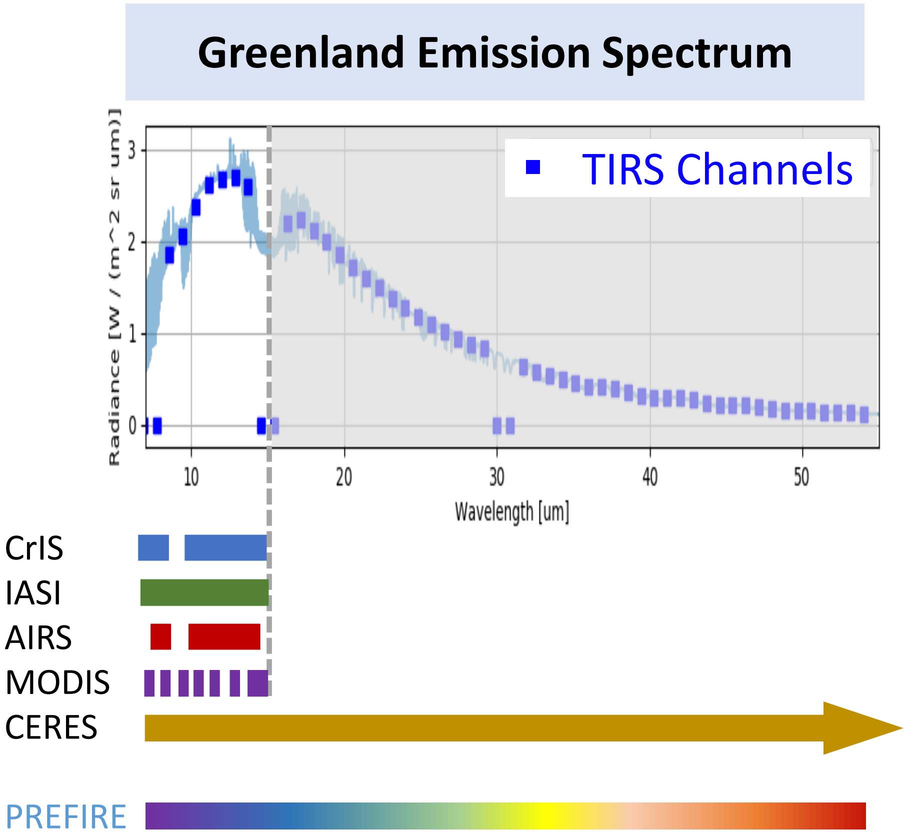
This transport is accomplished by the world's weather systems

Polar Radiant Energy in the Far InfraRed Experiment

PREFIRE fills the far-infrared observing gap by documenting variability in spectral fluxes from 5 - 54 µm on hourly to seasonal timescales.

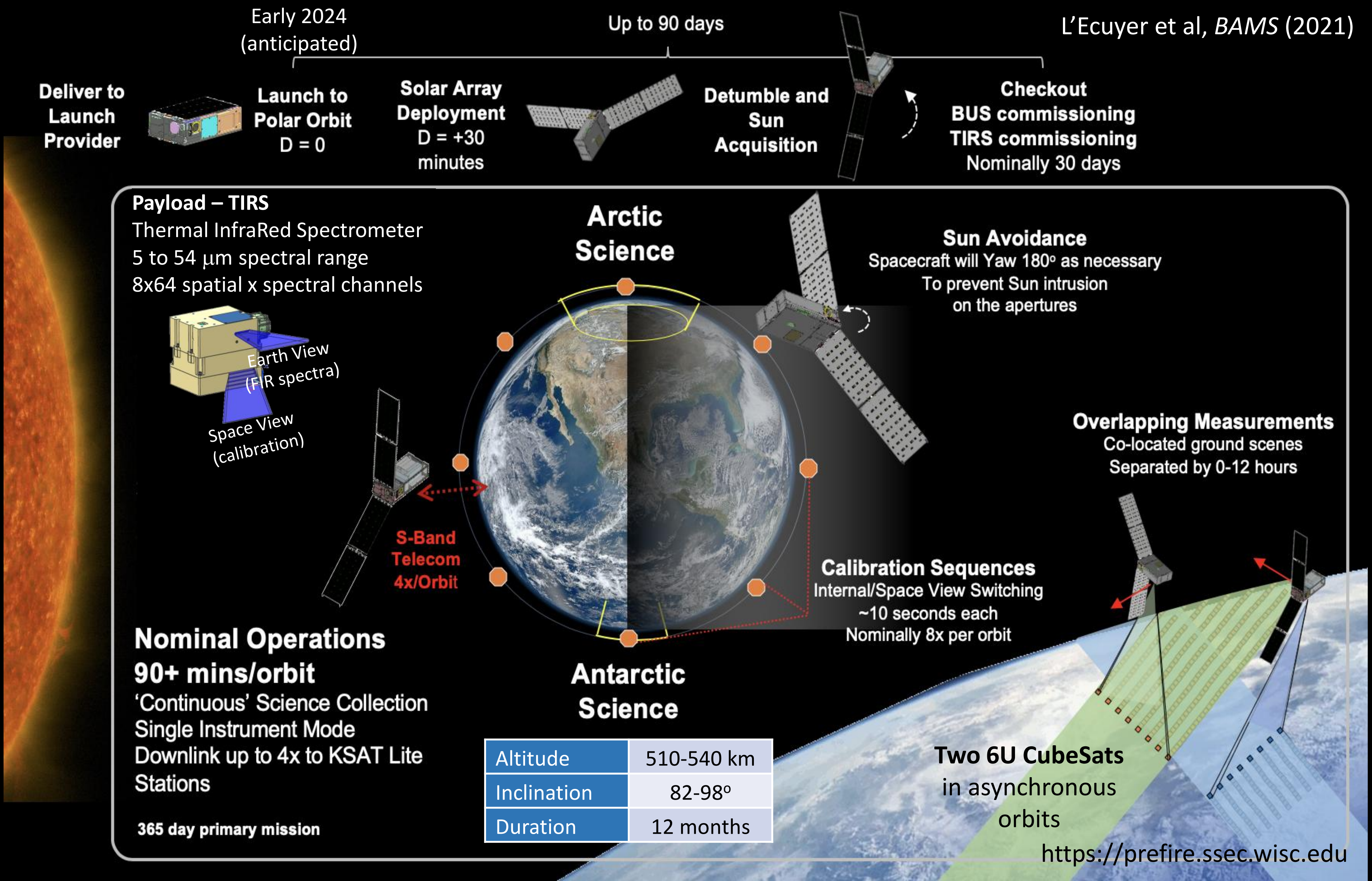


PREFIRE maps polar far infrared emission spectra with two CubeSats flying in distinct 470–650 km altitude, near-polar (82°-98° inclination) orbits each carrying a miniaturized infrared spectrometer, covering 5-54 µm with 0.84 µm spectral sampling, operating for one seasonal cycle (a year).



Mission Overview / ConOps

L'Ecuyer et al, *BAMS* (2021)



Altitude	510-540 km
Inclination	82-98°
Duration	12 months

Two 6U CubeSats
in asynchronous orbits

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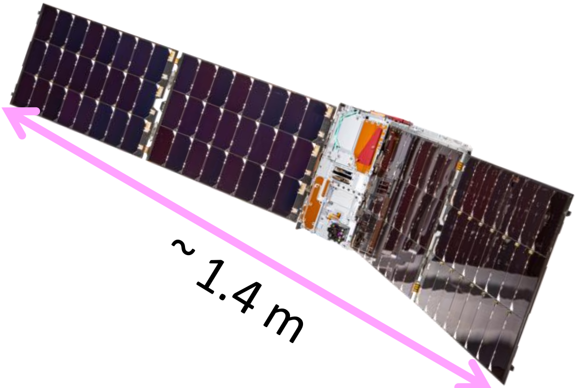
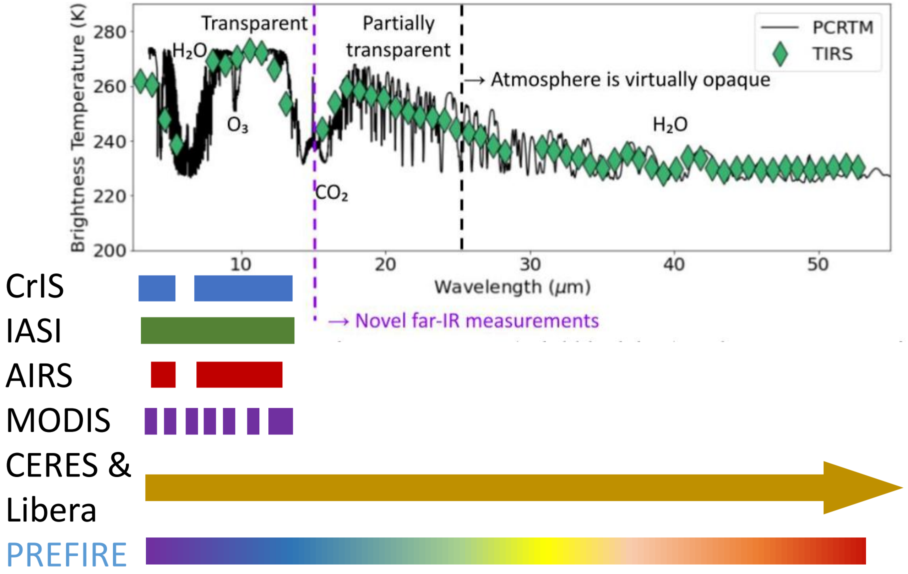
PREFIRE Launches

Launched by Rocket Lab from Mahia, NZ

Two 6U CubeSats
(1U = 10x10x10cm)





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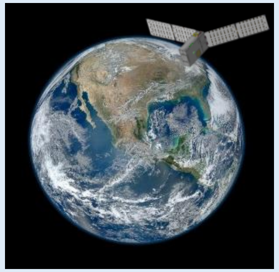
Connecting Observations to Predictions

PREFIRE Tests Two Hypotheses By Coupling Observations to Models

1. Time-varying errors in far infrared emissivities and atmospheric greenhouse effects (GHE) bias estimates of energy exchanges between the surface and the atmosphere in the Arctic.
2. These errors are responsible for a large fraction of the spread in projected rates of Arctic warming, sea ice loss, ice sheet melt, and sea level rise.

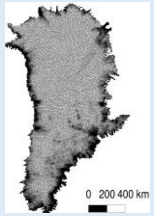
Observe FIR Spectra at the Poles

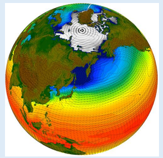


Establish Climatologies and Process Signatures

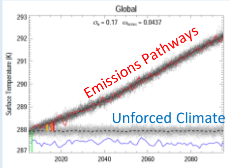
- Aggregate data using contextual data
- Time-difference TIRS 1 & 2 spectra

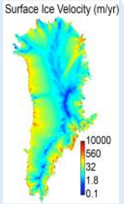
Evaluate and Improve Process and Climate Models





Perform New Process and Climate Model Simulations





Calibrate; geolocate; apply L2 algorithms

Analyze L3 Products

Integrate and Test Emissivity Modules

Hypothesis 1 is addressed by comparing observed spectral fluxes with those simulated from model output.

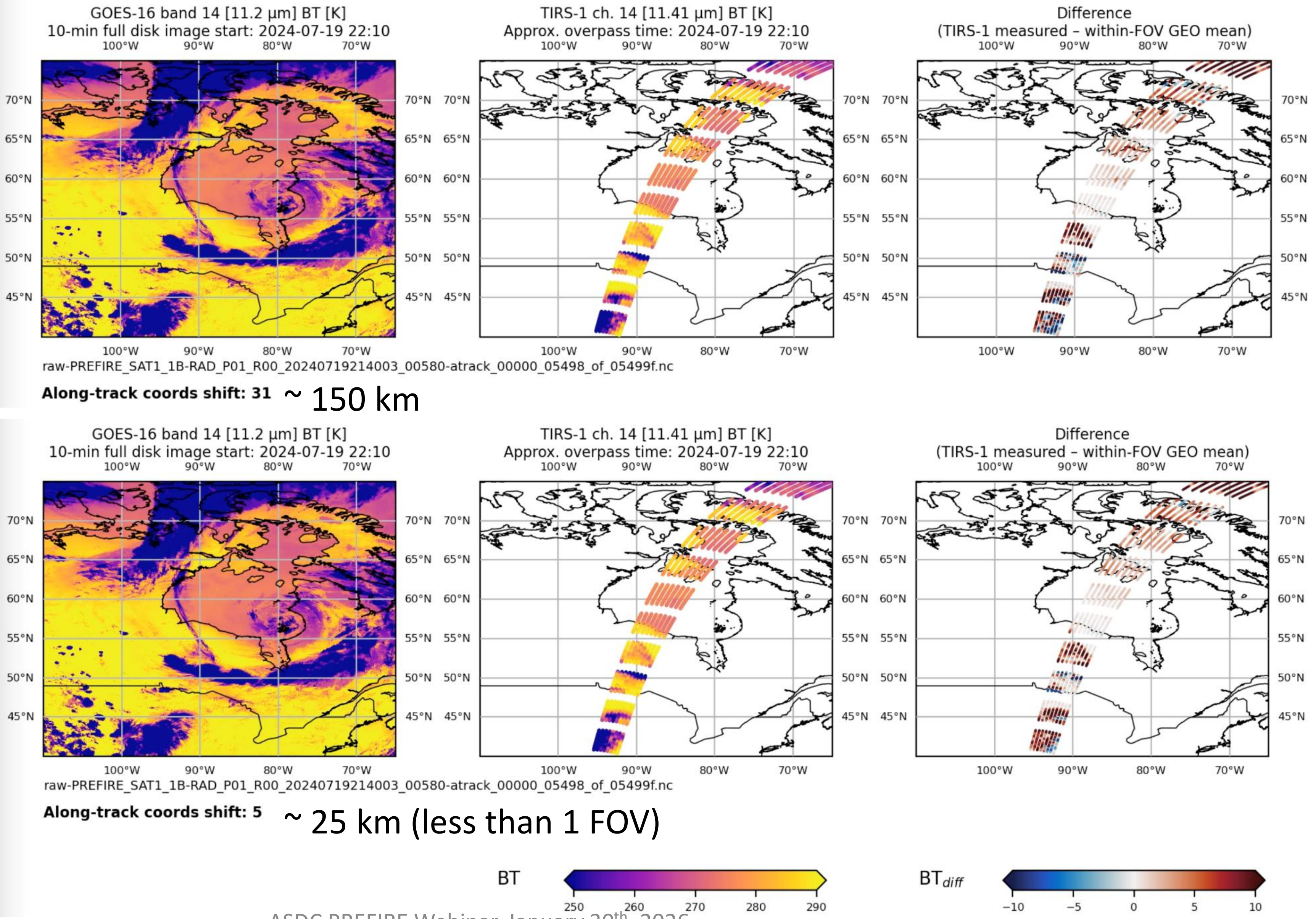
Hypothesis 2 is addressed by modifying emissivity models and examining impacts on ice sheet dynamic processes, ice sheet melt, Arctic warming, sea ice loss, and sea level rise.

Verification using Geostationary Satellites

Bus Telemetry

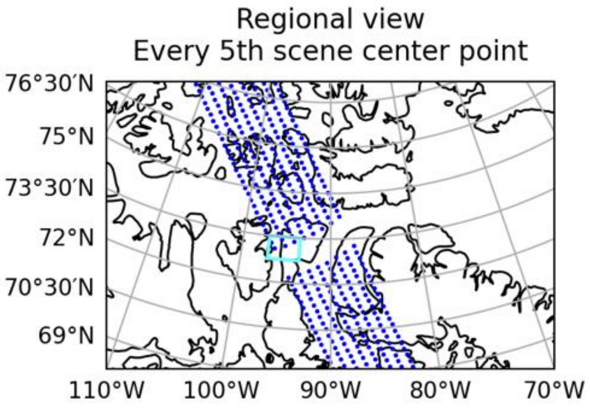
TLE Propagation

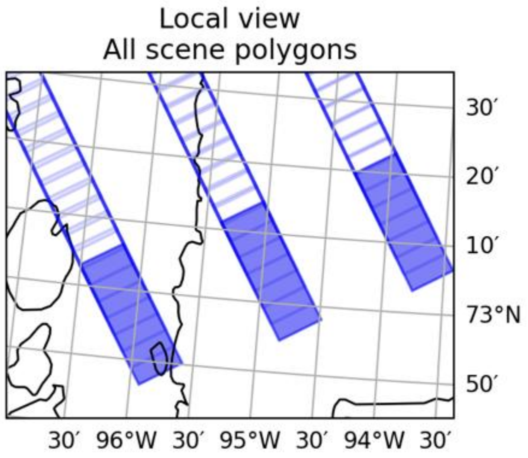
* Residual difference is due to mirror pointing variations (not corrected for here).



Global Spectroradiometric Sampling

PREFIRE samples the full spectrum of the hottest and coldest parts of the planet

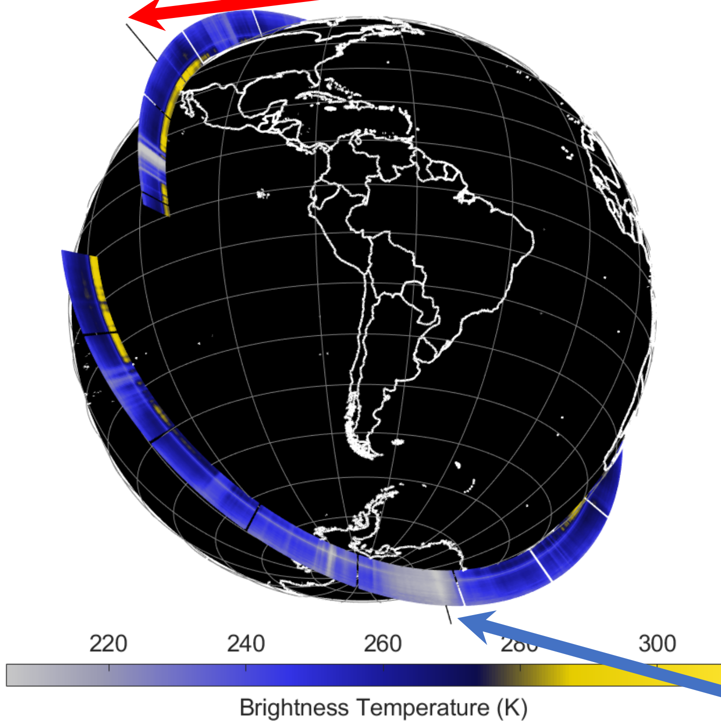


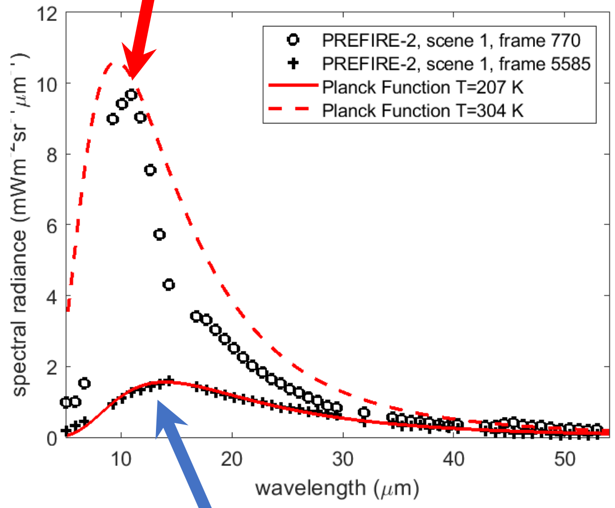


At Launch (530.7 km)

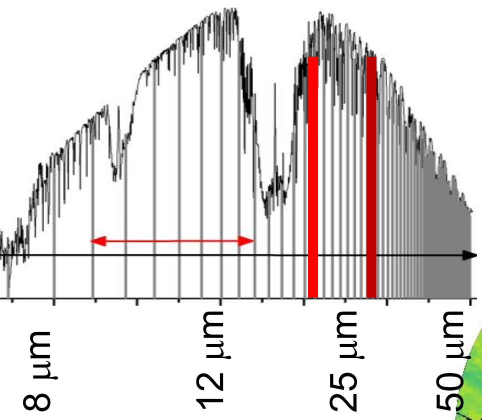
EFOV: 11.8 km (cross-track) x 34.8 km (along-track)
Overlapping FOVs: 6.55
Effective Frame Size: 11.8 km (cross-track) x 5.3 km (along-track)

The along-track overlap of TIRS FOVs resolves signatures of spatial features < 15 km.





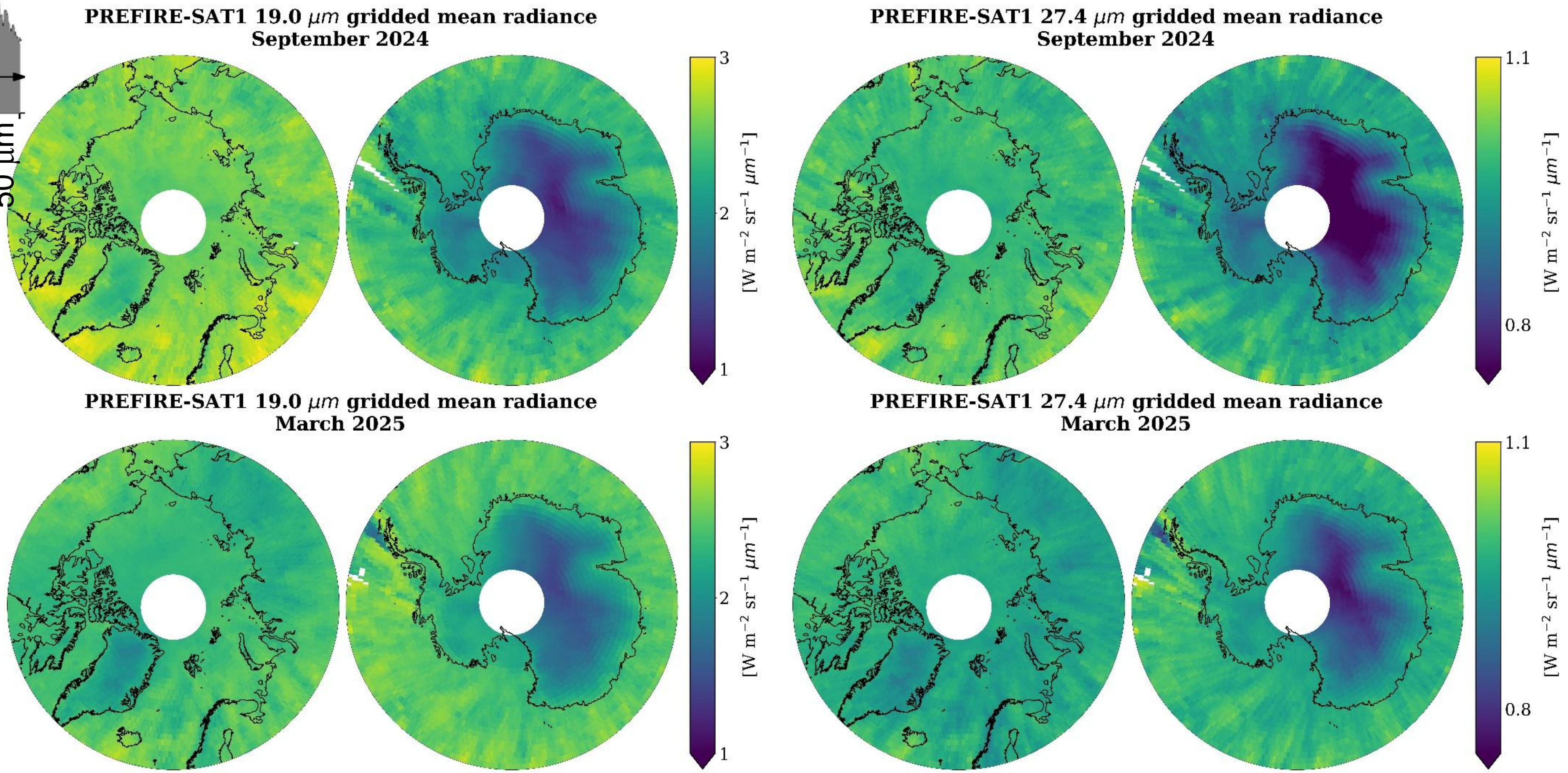
Seasonal Sampling in the dirty window



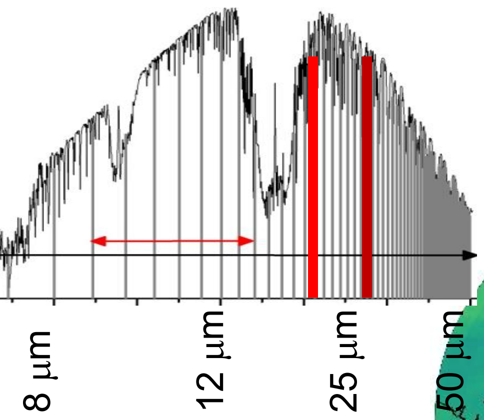
September
Arctic Summer
Antarctic Winter

March
Arctic Winter
Antarctic Summer

Both PREFIRE Cubesats have sampled both poles in multiple seasons.



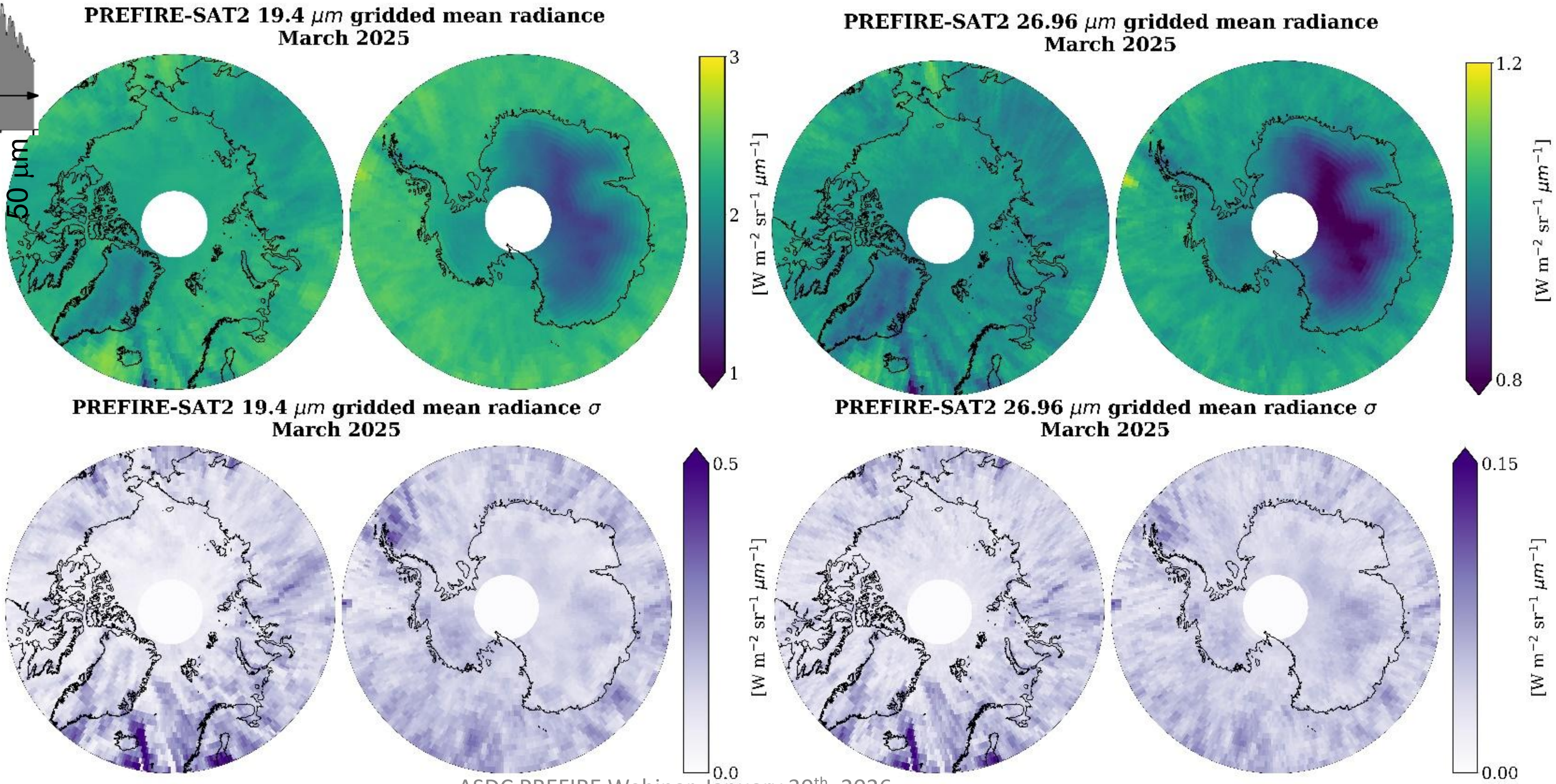
Variability in the dirty window



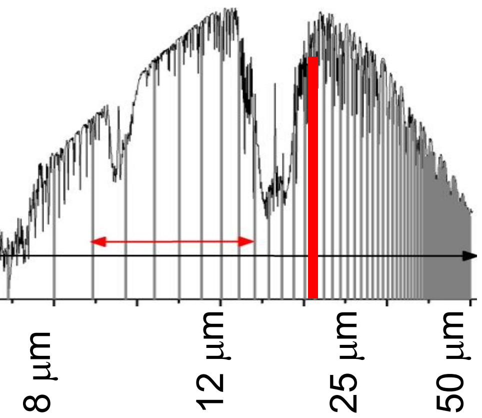
PREFIRE has characterized variability of longwave radiation

Mean

Variability

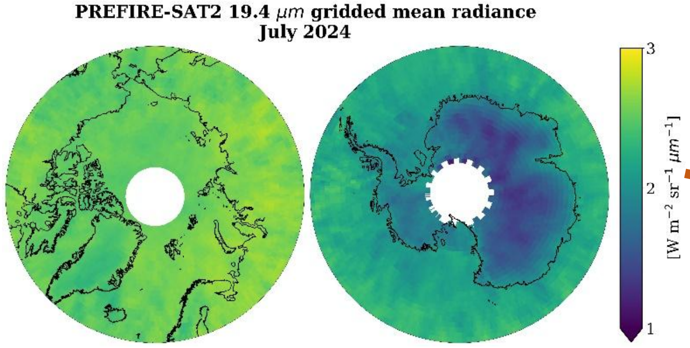


Surface Emissivity and Atmospheric Greenhouse Effect

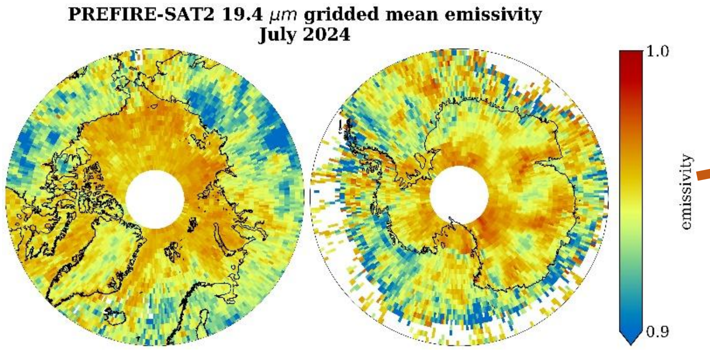


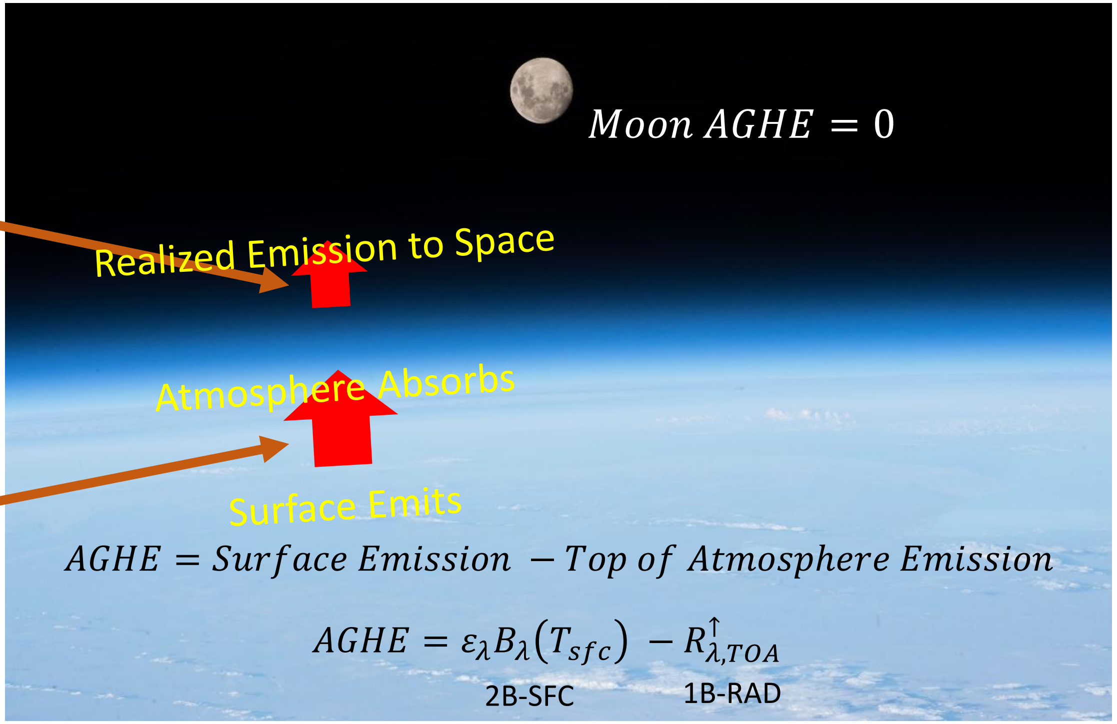
PREFIRE retrieves surface emissivity and the atmospheric greenhouse effect (AGHE), allowing for full understanding of the outgoing longwave emission to space

19.4 µm Top of Atmosphere Emission



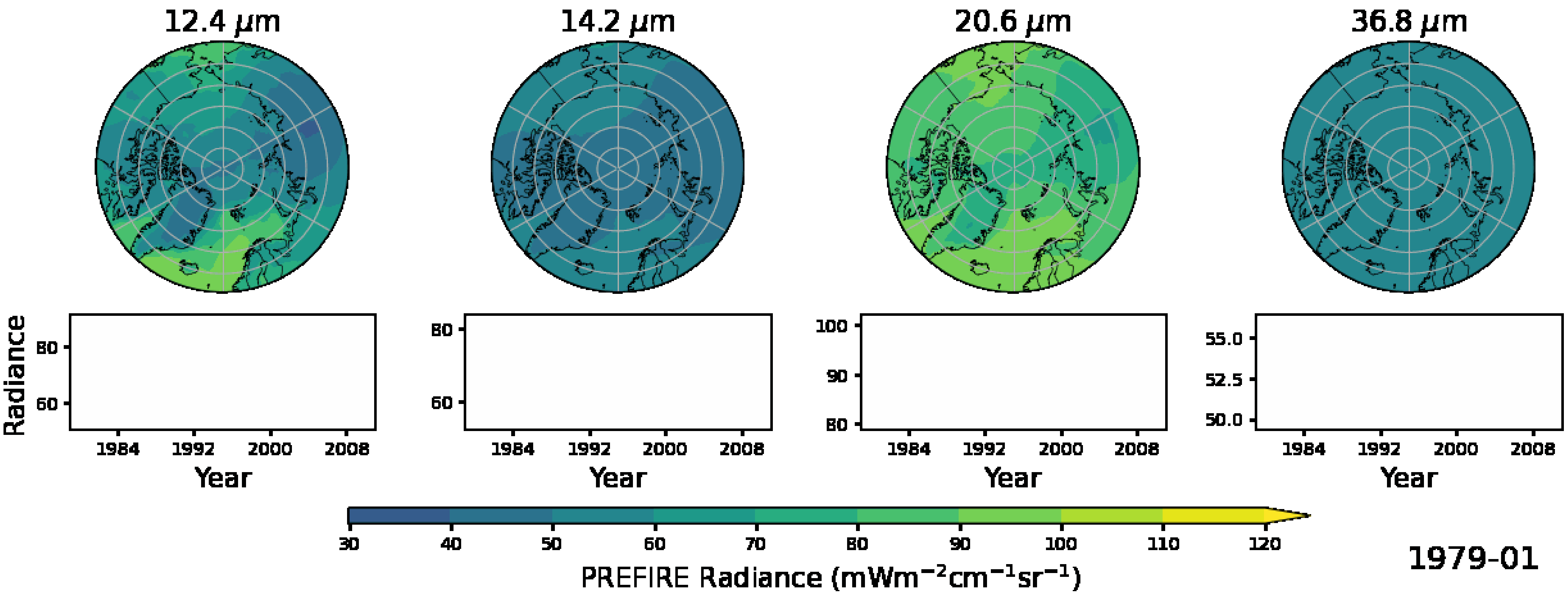
19.4 µm Surface Emissivity



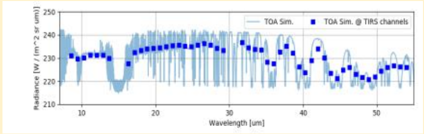
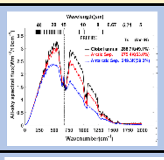
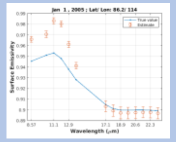
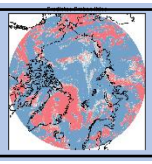
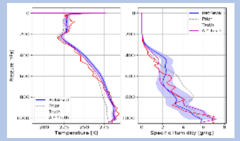
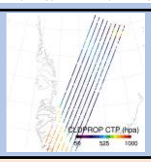
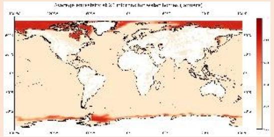


PREFIRE Improves Prediction

PREFIRE is interfacing with Earth system models through new surface emissivity models and a COSP-compatible simulator.

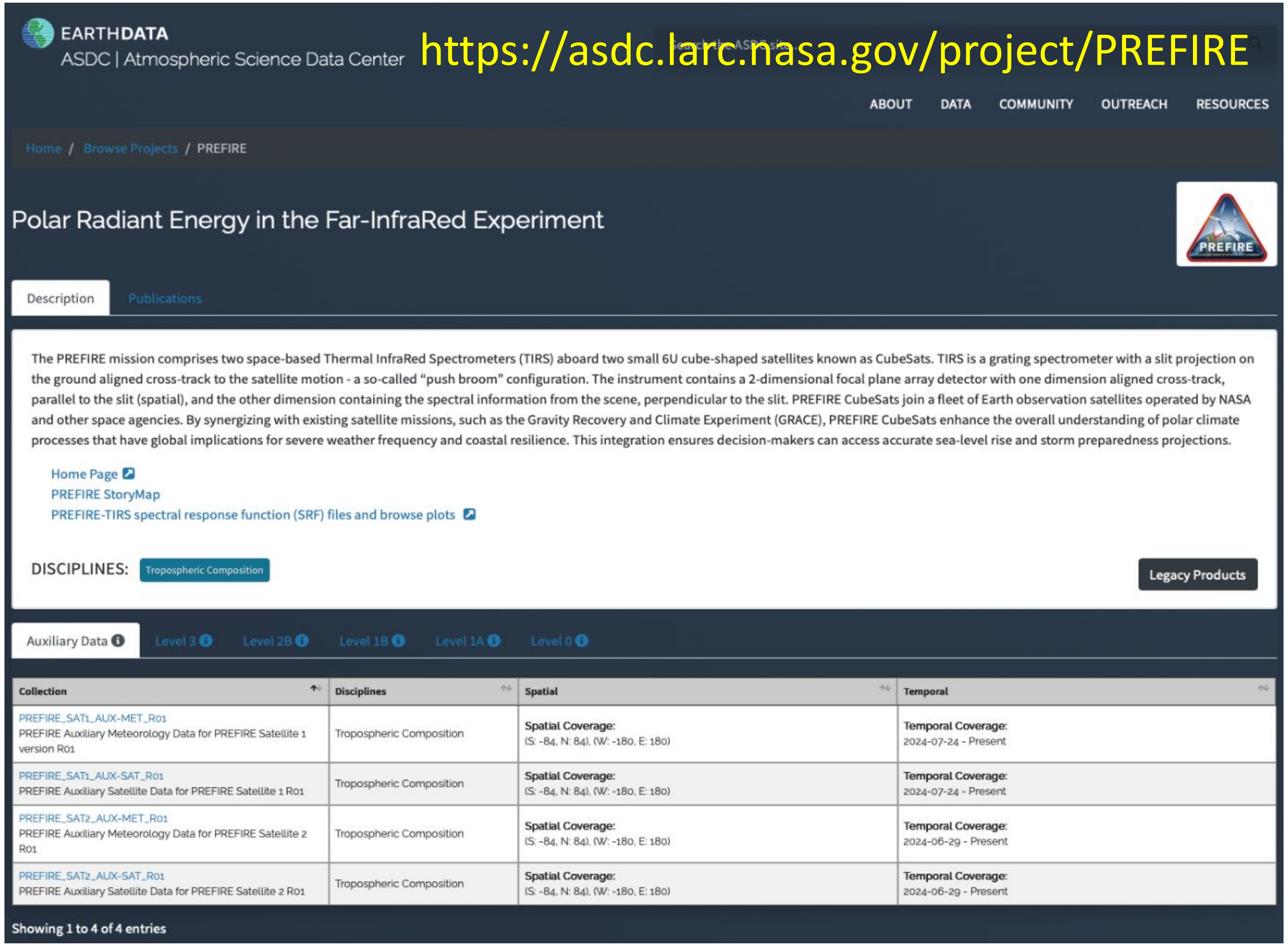


Data Products and Points of Contact

Product	Contact	Details	Examples
L0 (telemetry+ instrument)	B. Drouin	Time-stamped instrument and spacecraft data	
L1B Radiances/ Fluxes	B. Drouin	Instrument model	
L2B Flux	X. Huang	3% accuracy (8 W/m^2 for total and 4 W/m^2 for FIR)	
L2B Surface Emissivity	X. Huang	1% accuracy spectral emissivity	
L2B Cloud Mask	B. Kahn	Detect 80-90% of clear-sky occurrences; confidence flags; MODIS and AIRS heritage	
L2B Atmospheric Properties	A. Merrelli	T/q profiles; 10% accuracy for column water vapor	
L2B Cloud Properties	N. Miller	Cloud top pressure, cloud optical thickness, effective cloud fraction Cloud phase, ice particle size	
L3 Gridded Climatology	N. Vos	Daily and monthly gridded products for each CubeSat	

Data available at the ASDC DAAC

All PREFIRE L0 data and L1, L2, and L3 products have been delivered to the ASDC DAAC



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https://asdc.larc.nasa.gov/project/PREFIRE

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Polar Radiant Energy in the Far-InfraRed Experiment

Description Publications

The PREFIRE mission comprises two space-based Thermal InfraRed Spectrometers (TIRS) aboard two small 6U cube-shaped satellites known as CubeSats. TIRS is a grating spectrometer with a slit projection on the ground aligned cross-track to the satellite motion - a so-called "push broom" configuration. The instrument contains a 2-dimensional focal plane array detector with one dimension aligned cross-track, parallel to the slit (spatial), and the other dimension containing the spectral information from the scene, perpendicular to the slit. PREFIRE CubeSats join a fleet of Earth observation satellites operated by NASA and other space agencies. By synergizing with existing satellite missions, such as the Gravity Recovery and Climate Experiment (GRACE), PREFIRE CubeSats enhance the overall understanding of polar climate processes that have global implications for severe weather frequency and coastal resilience. This integration ensures decision-makers can access accurate sea-level rise and storm preparedness projections.

Home Page
PREFIRE StoryMap
PREFIRE-TIRS spectral response function (SRF) files and browse plots

DISCIPLINES: Tropospheric Composition

Legacy Products

Auxiliary Data Level 3 Level 2B Level 1B Level 1A Level 0

Collection	Disciplines	Spatial	Temporal
PREFIRE_SAT1_AUX-MET_R01 PREFIRE Auxiliary Meteorology Data for PREFIRE Satellite 1 version R01	Tropospheric Composition	Spatial Coverage: (S: -84, N: 84), (W: -180, E: 180)	Temporal Coverage: 2024-07-24 - Present
PREFIRE_SAT1_AUX-SAT_R01 PREFIRE Auxiliary Satellite Data for PREFIRE Satellite 1 R01	Tropospheric Composition	Spatial Coverage: (S: -84, N: 84), (W: -180, E: 180)	Temporal Coverage: 2024-07-24 - Present
PREFIRE_SAT2_AUX-MET_R01 PREFIRE Auxiliary Meteorology Data for PREFIRE Satellite 2 R01	Tropospheric Composition	Spatial Coverage: (S: -84, N: 84), (W: -180, E: 180)	Temporal Coverage: 2024-06-29 - Present
PREFIRE_SAT2_AUX-SAT_R01 PREFIRE Auxiliary Satellite Data for PREFIRE Satellite 2 R01	Tropospheric Composition	Spatial Coverage: (S: -84, N: 84), (W: -180, E: 180)	Temporal Coverage: 2024-06-29 - Present

Showing 1 to 4 of 4 entries