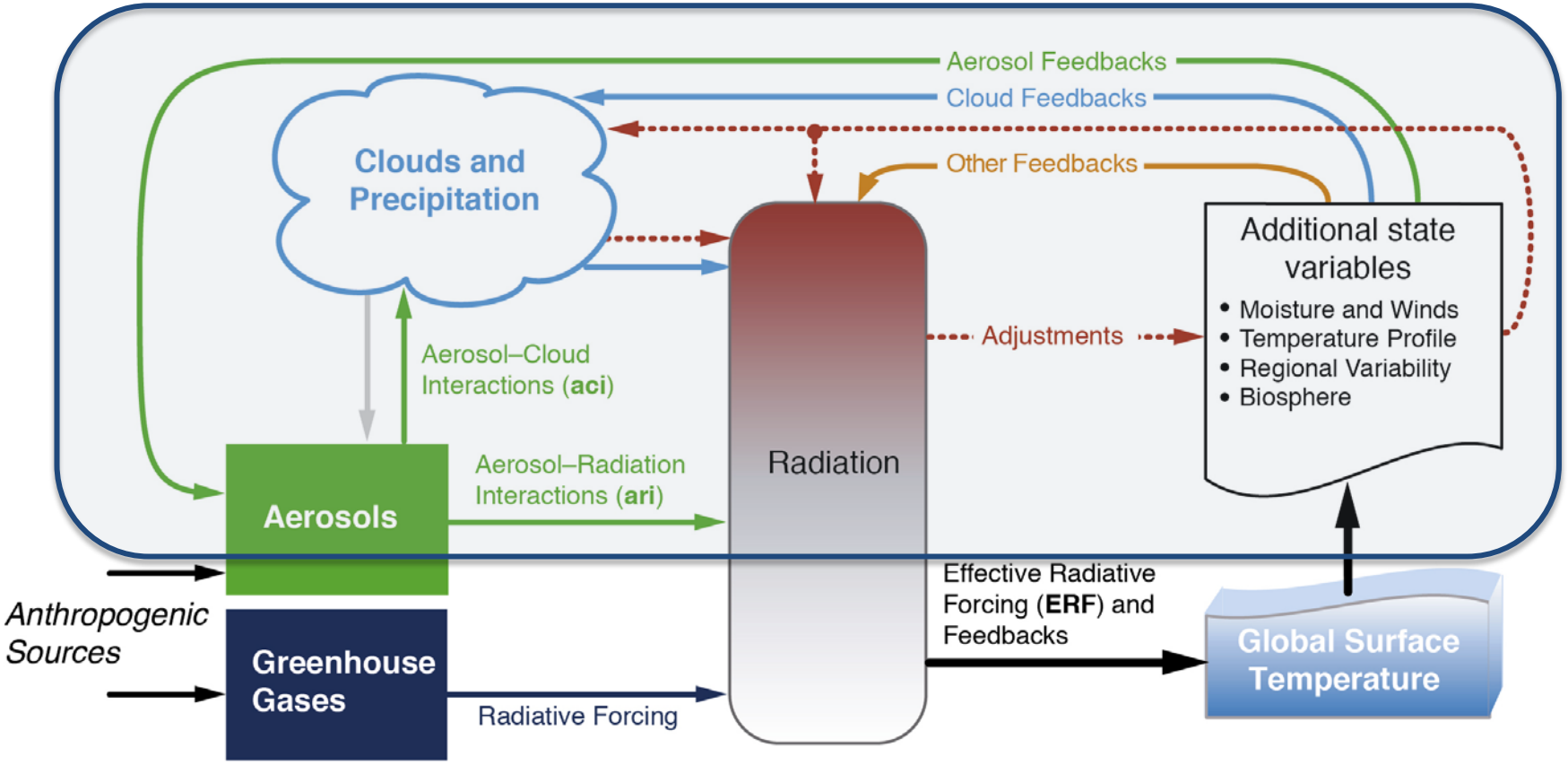
Monitoring and Understanding Trends in Surface Radiation, Clouds, and Aerosols

Monitoring and Understanding Trends in Surface Radiation, Clouds, and Aerosols



Monitoring and Understanding Trends in Surface Radiation, Clouds, and Aerosols

monitoring changes | process understanding | model development | satellite evaluation

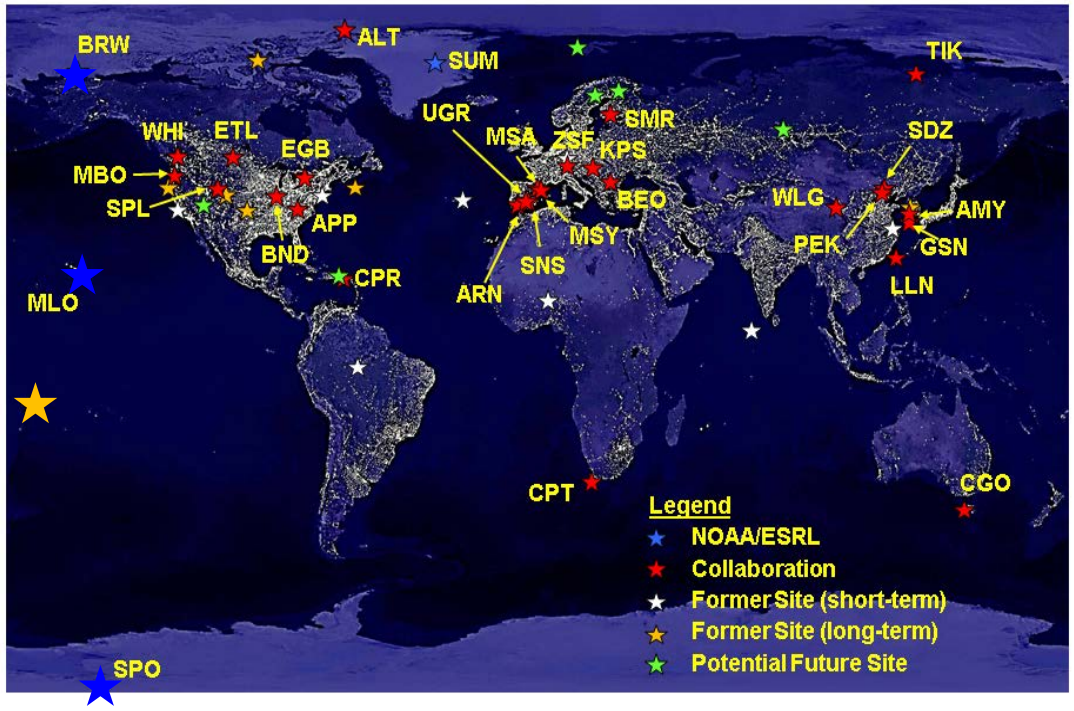
GMD Measurement Networks for Radiation, Clouds, and Aerosols

Sheridan – P-53

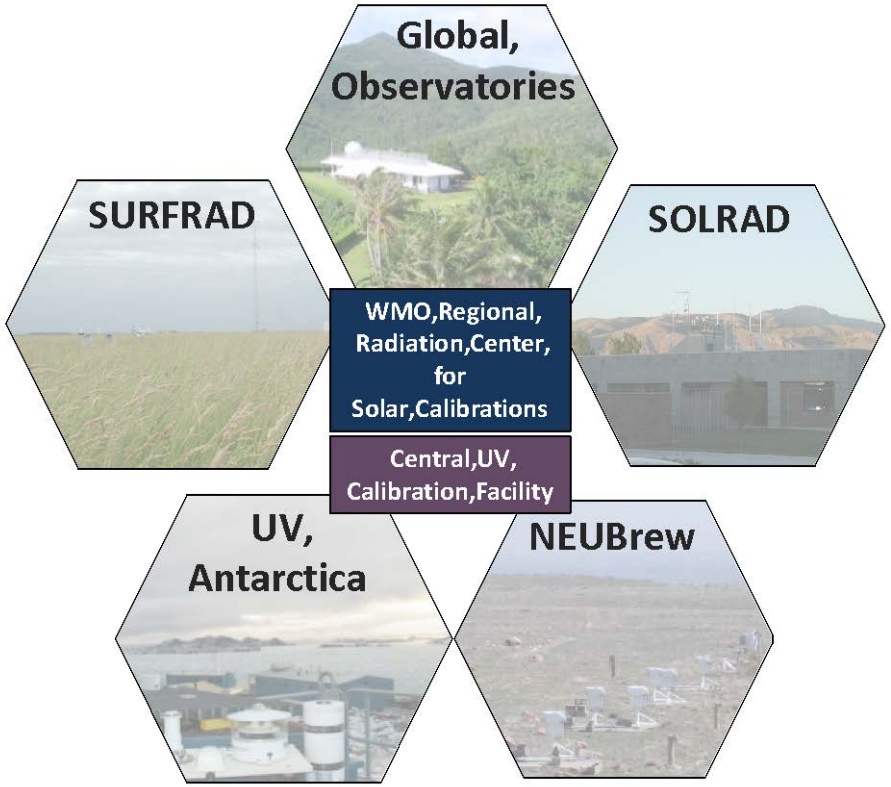
Hall, B. – overview
Hall, E. – P-40

The NOAA Federated Aerosol Network

'A collaborative effort that benefits all parties'



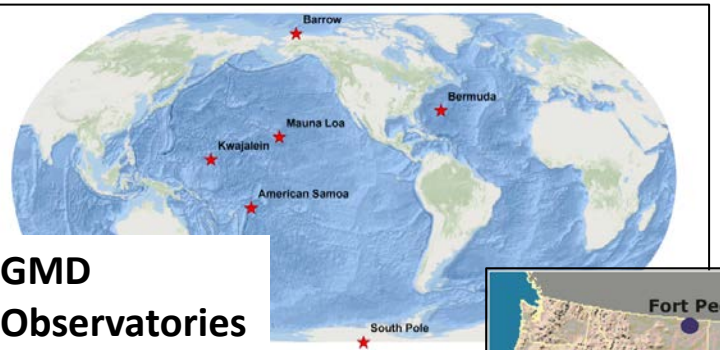
Global Surface Radiation Networks



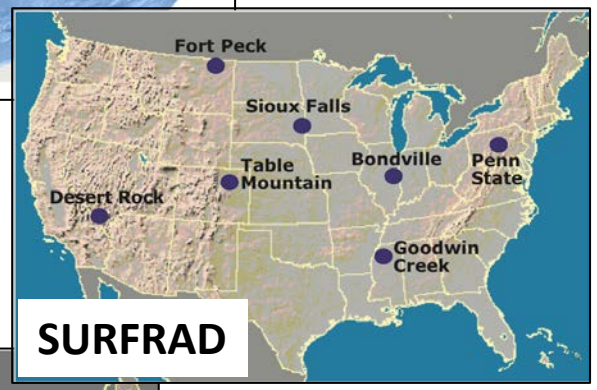
monitoring changes | process understanding | model development | satellite evaluation

GMD Measurement Networks for Radiation, Clouds, and Aerosols

Broadband Shortwave and Longwave Radiation Networks



Global,
regionally representative

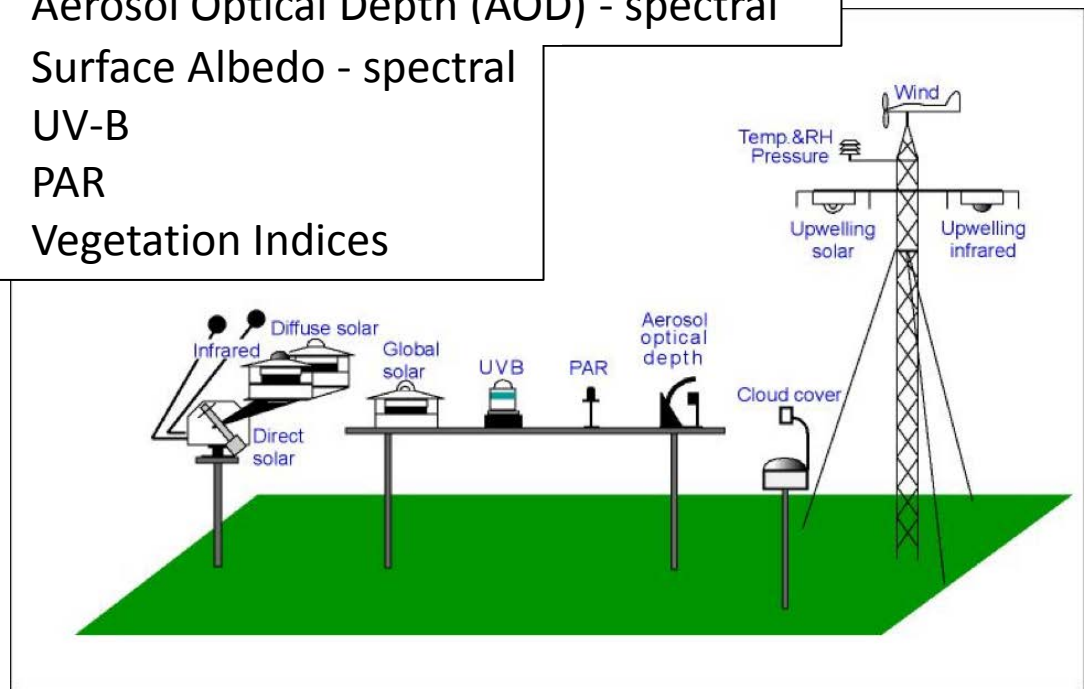


Continental U.S.,
regionally representative

Continental U.S.,
urban environment

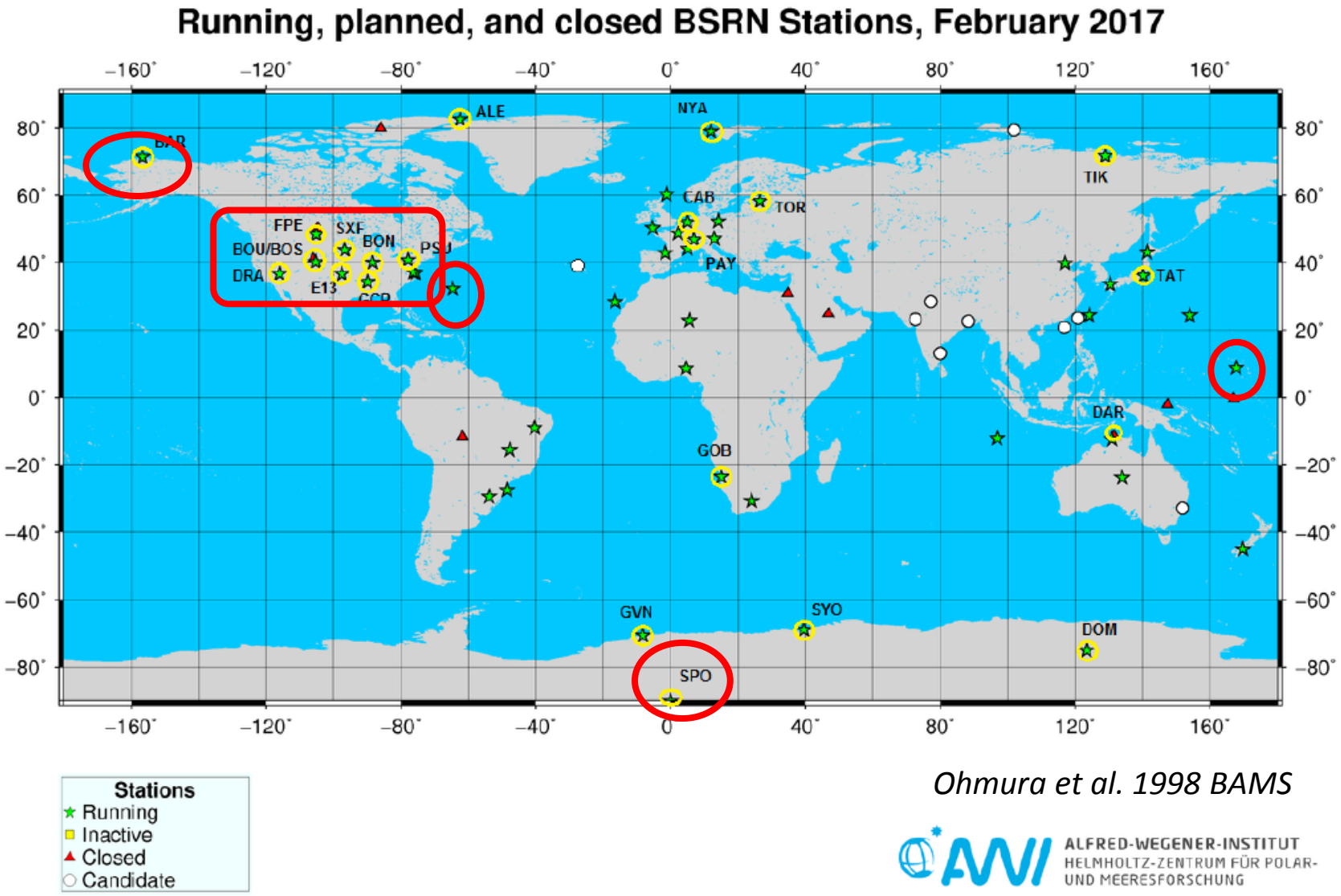
Properties – Measured and Derived:

- Surface Radiation Budget - components
- Sky Cover/Cloud Fraction
- Cloud Optical Depth (overcast)
- Cloud Radiative Effect
- Aerosol Optical Depth (AOD) - spectral
- Surface Albedo - spectral
- UV-B
- PAR
- Vegetation Indices



monitoring changes | process understanding | model development | satellite evaluation

WCRP Baseline Surface Radiation Network (BSRN)



Ohmura et al. 1998 BAMS

12 stations of 59 directly operated by NOAA ESRL GMD, the largest single contributing organization

Support measurements at an additional 9 sites

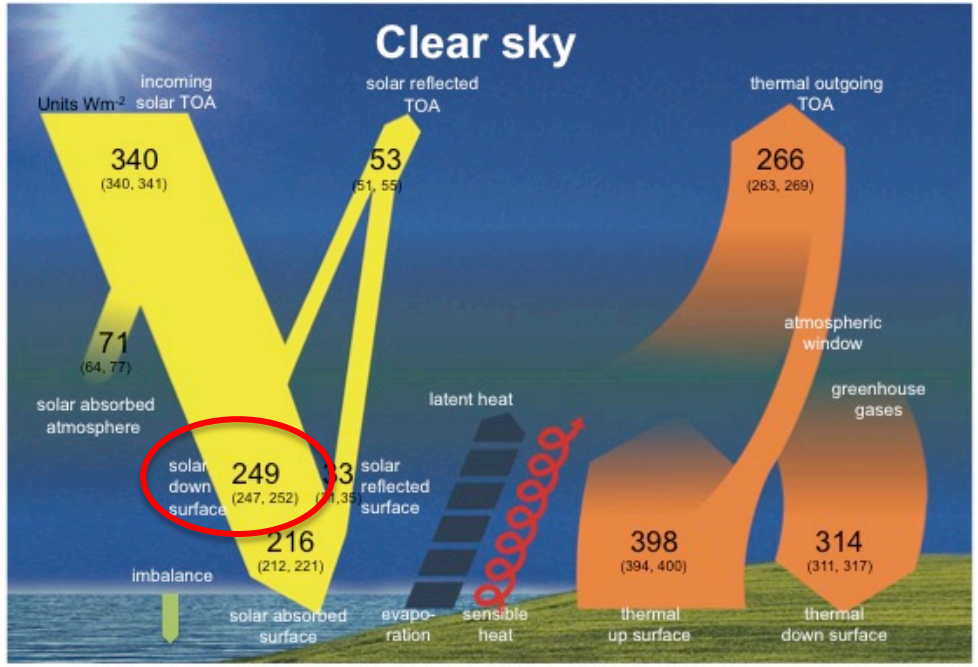
GMD is associated with 21 of the 59 sites that have contributed to the BSRN Archive (35%)

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

monitoring changes | process understanding | model development | satellite evaluation

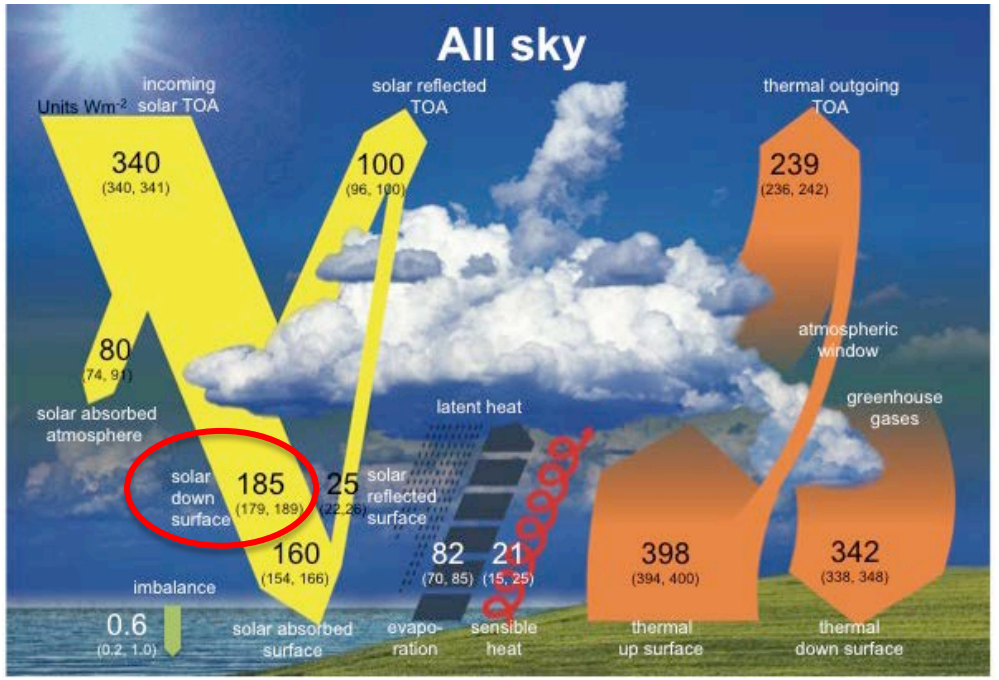
WCRP Baseline Surface Radiation Network (BSRN)

Global All- and Clear-sky Estimates using Observations and Models



New estimates for global mean radiation budget without cloud effects

Wild et al. submitted

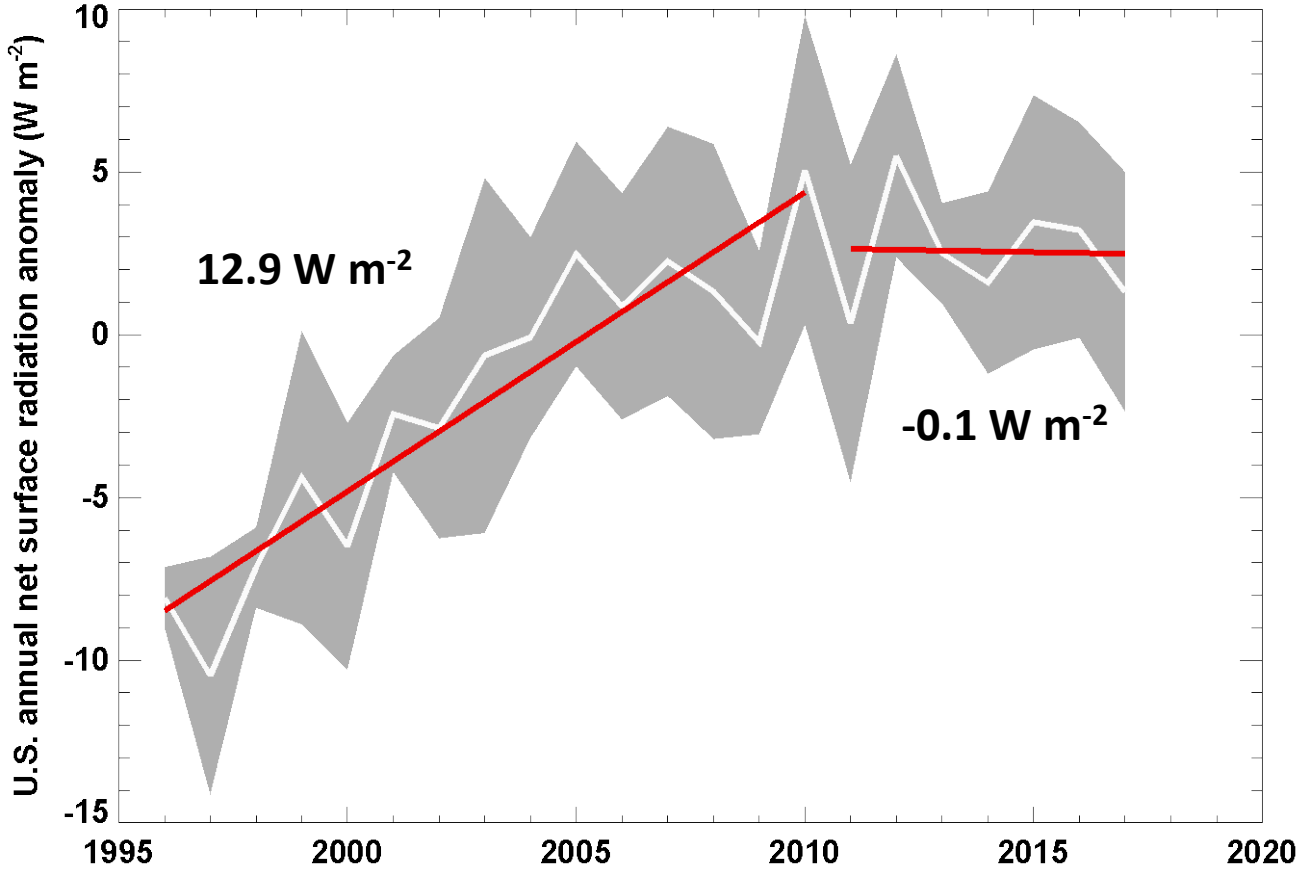


Combined with all sky budgets provides **estimation of global mean surface, atmosphere, and TOA cloud radiative effects**

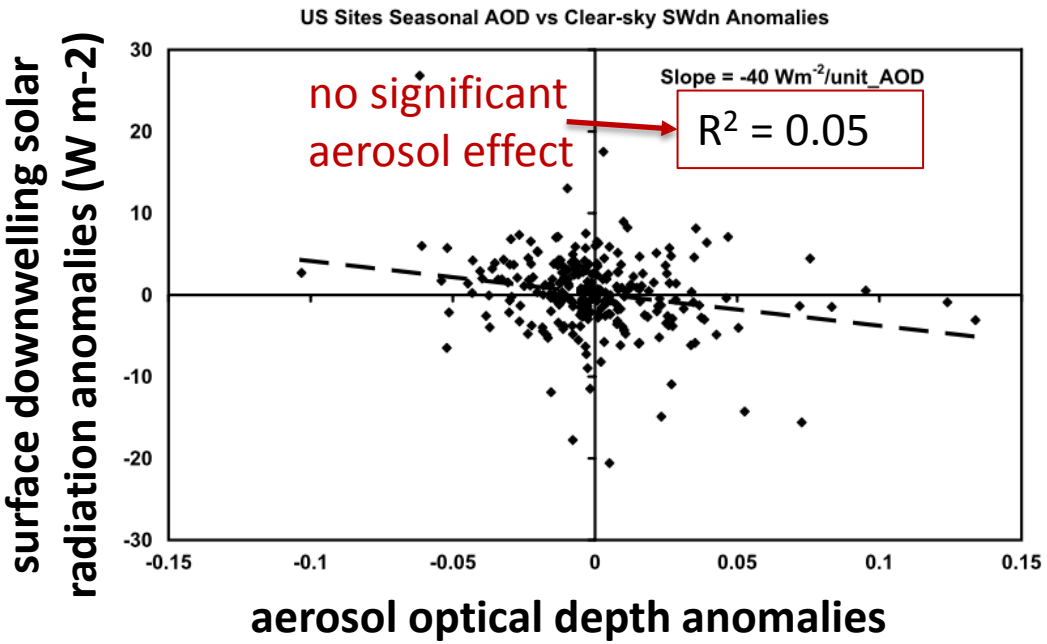
Wild et al. 2015 Clim. Dyn.

monitoring changes | process understanding | model development | satellite evaluation

Surface Radiation Variability over the U.S.



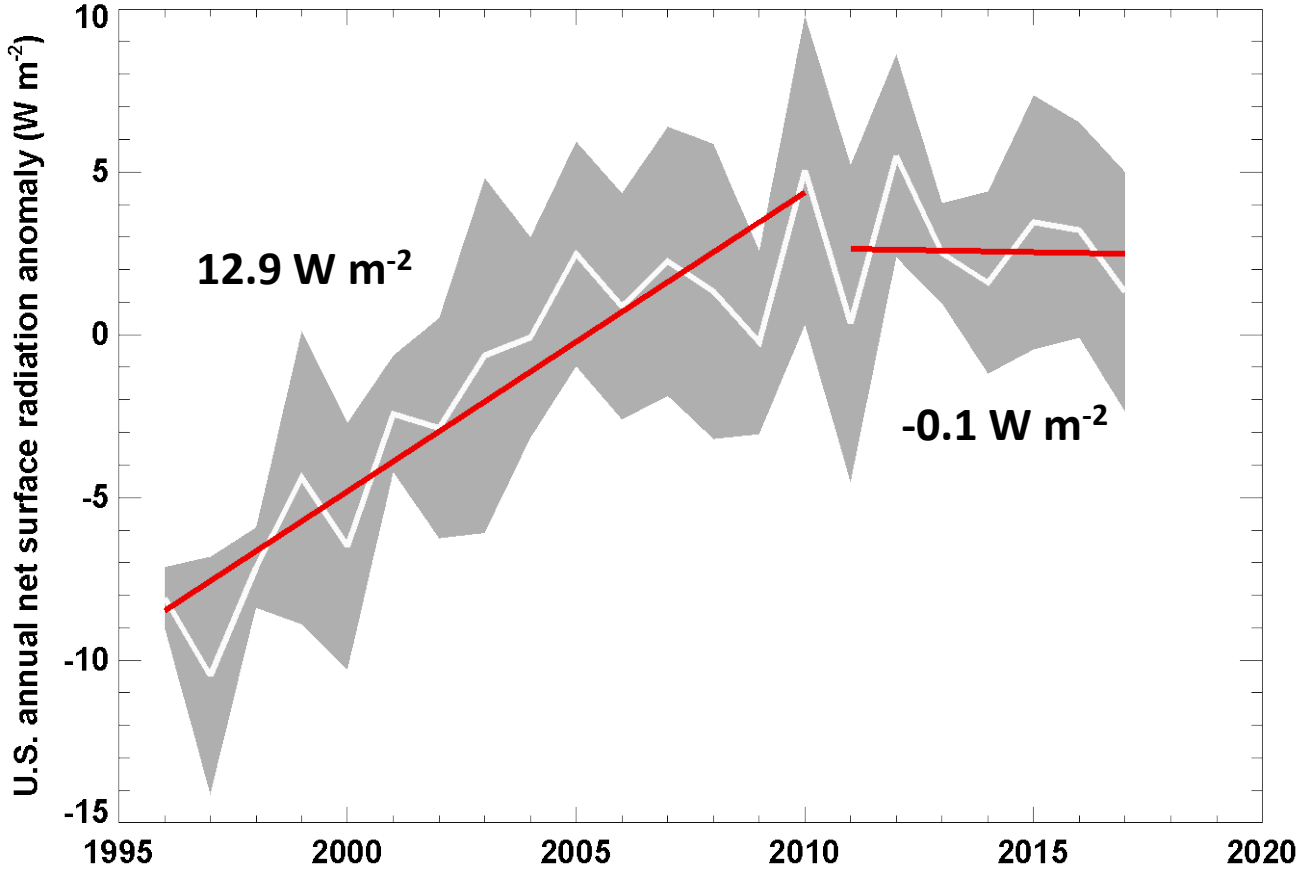
updated from Augustine and Dutton 2013 JGR



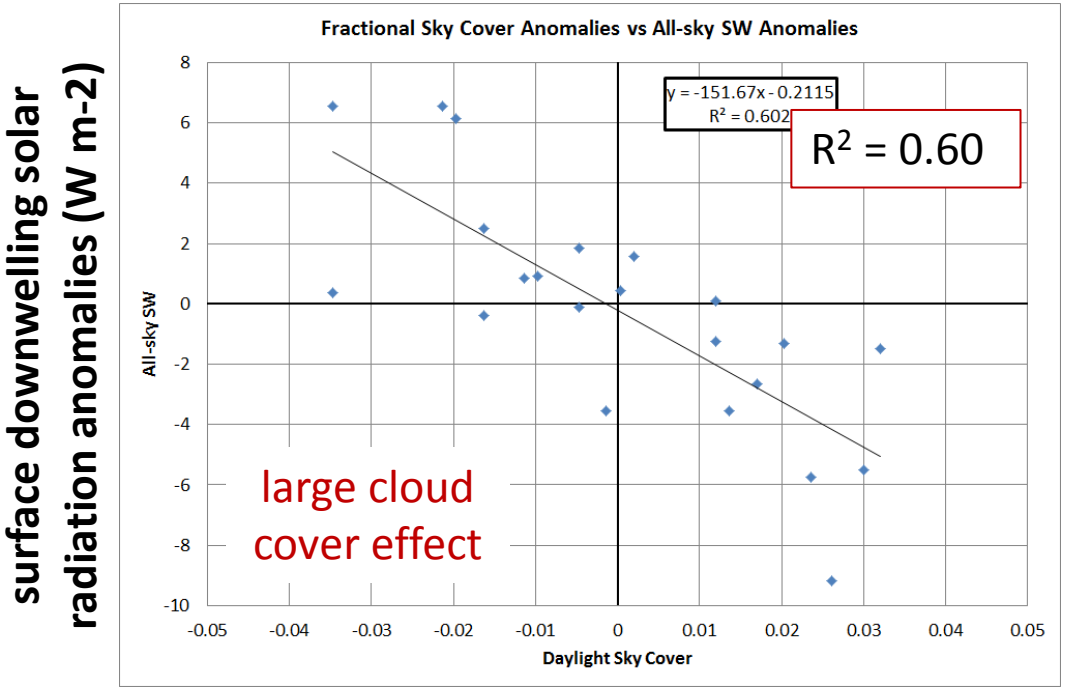
Long et al 2009 JGR

monitoring changes | process understanding | model development | satellite evaluation

Surface Radiation Variability over the U.S.

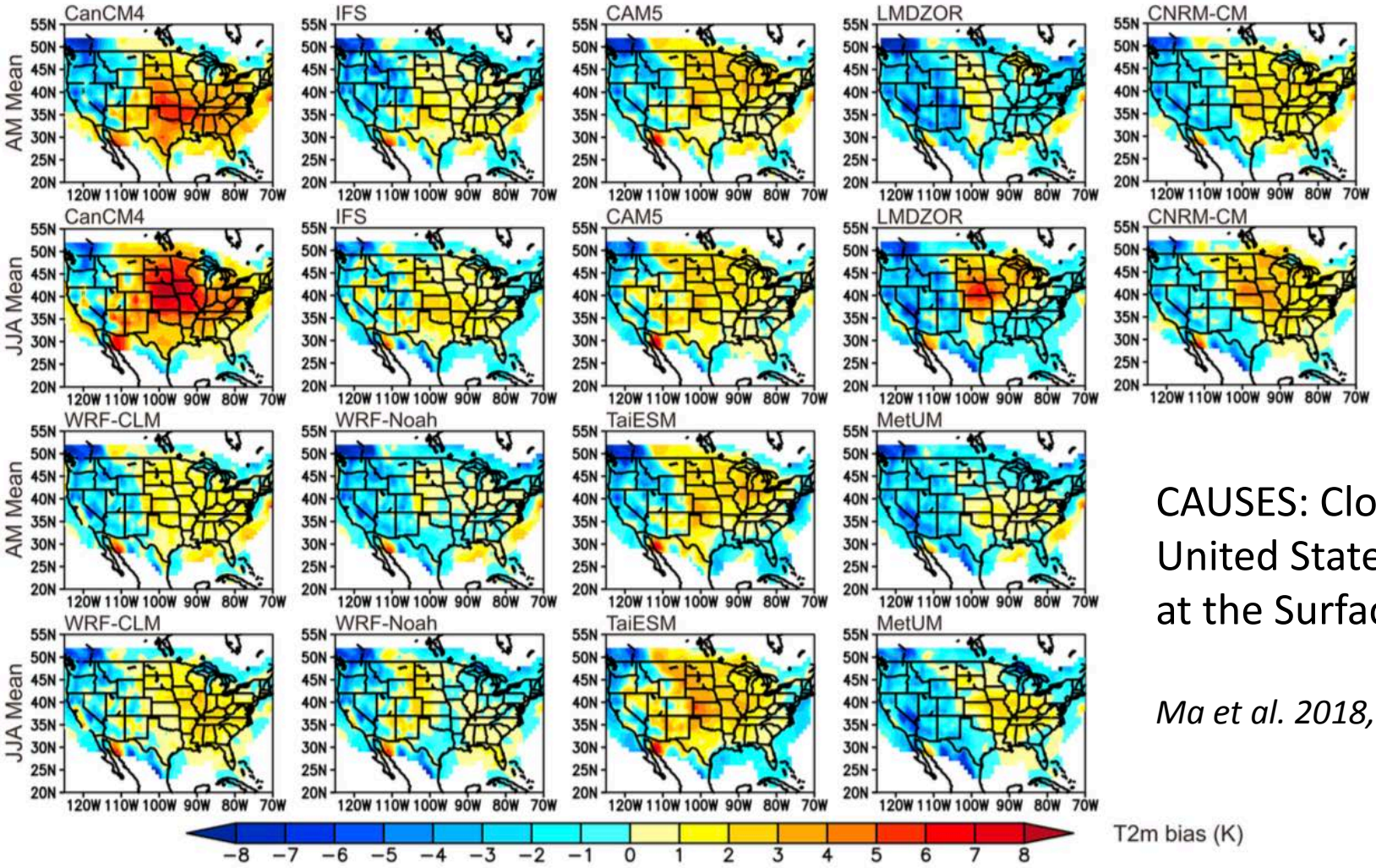


updated from Augustine and Dutton 2013 JGR



monitoring changes | process understanding | model development | satellite evaluation

Persistent Model Biases – Relationships to Surface Radiation Budget

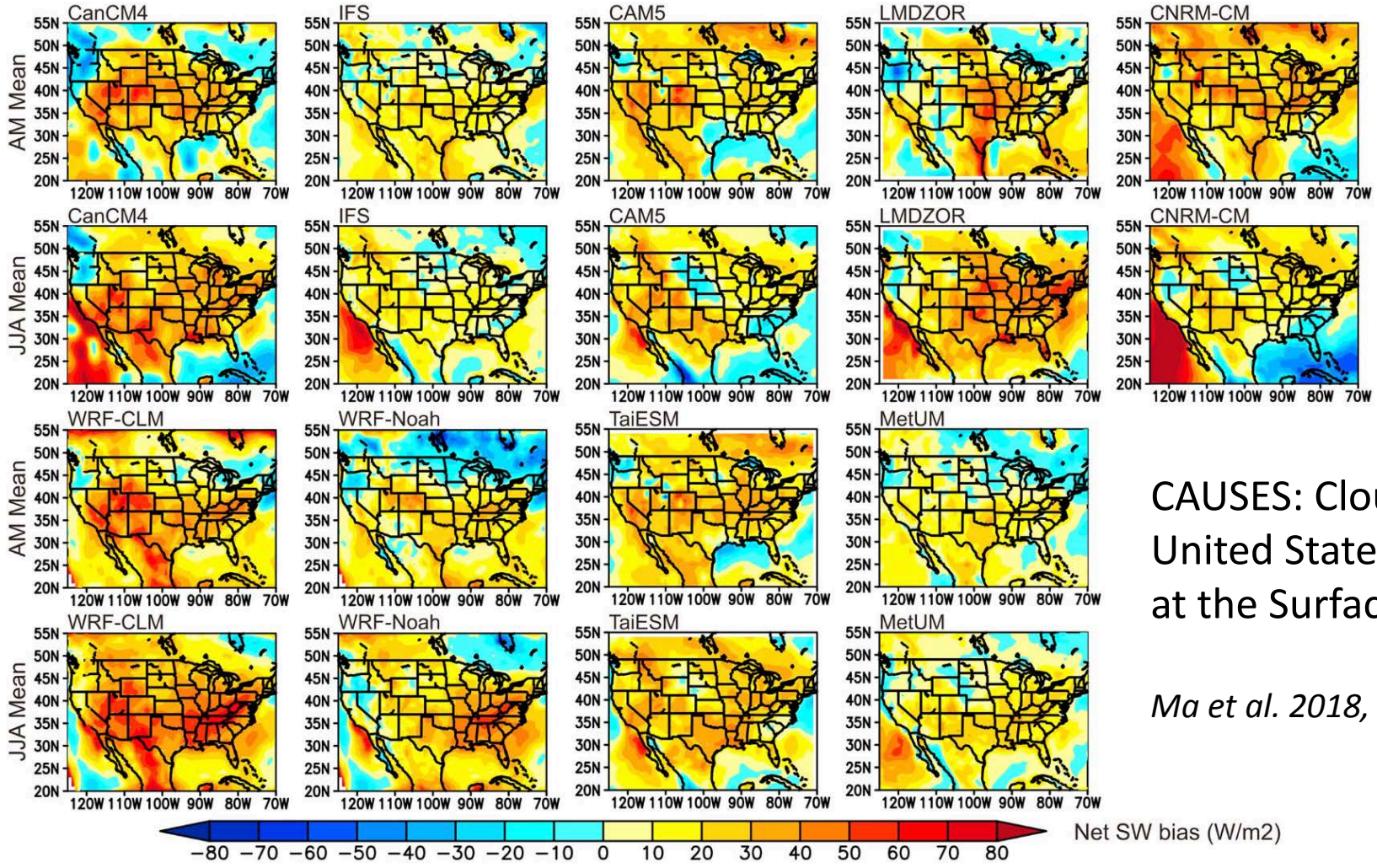


CAUSES: Cloud Above the United States and Errors at the Surface

Ma et al. 2018, JGR

monitoring changes | process understanding | **model development** | satellite evaluation

Persistent Model Biases – Relationships to Surface Radiation Budget



CAUSES: Cloud Above the United States and Errors at the Surface

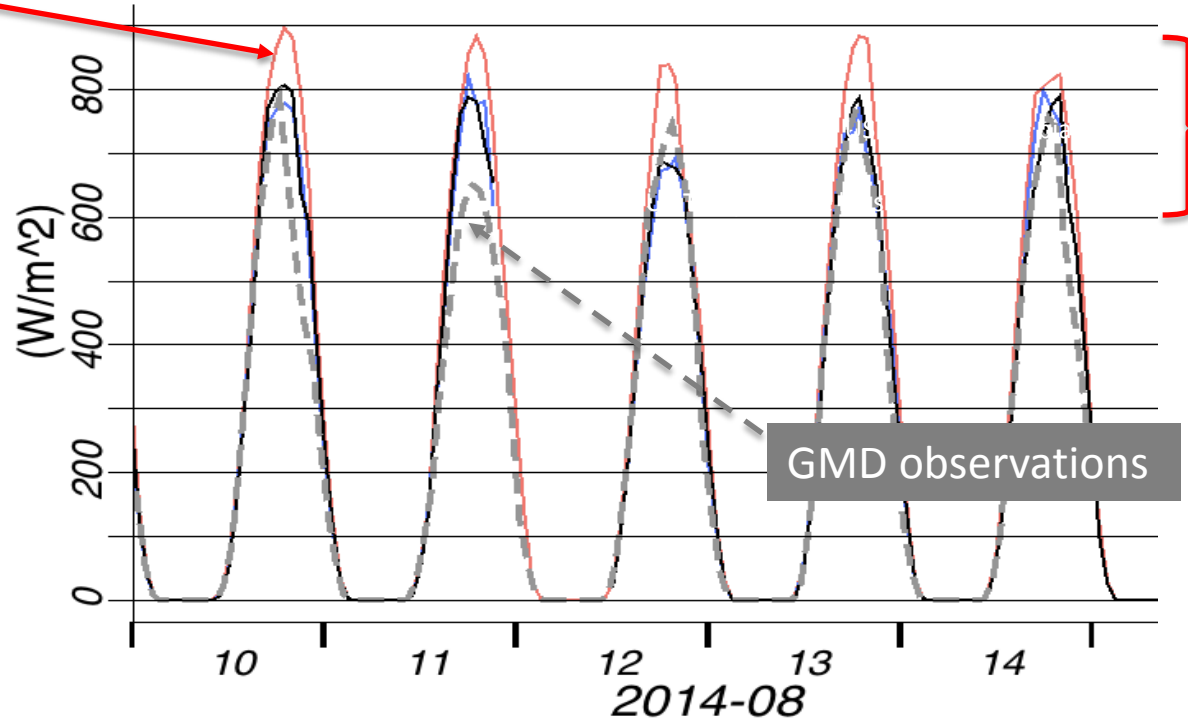
Ma et al. 2018, JGR

monitoring changes | process understanding | **model development** | satellite evaluation

SURFRAD Observations in Numerical Weather Prediction Model Development

NOAA NWP Rapid Refresh Model (RAP) – SURFRAD comparisons

NOAA operational weather forecast

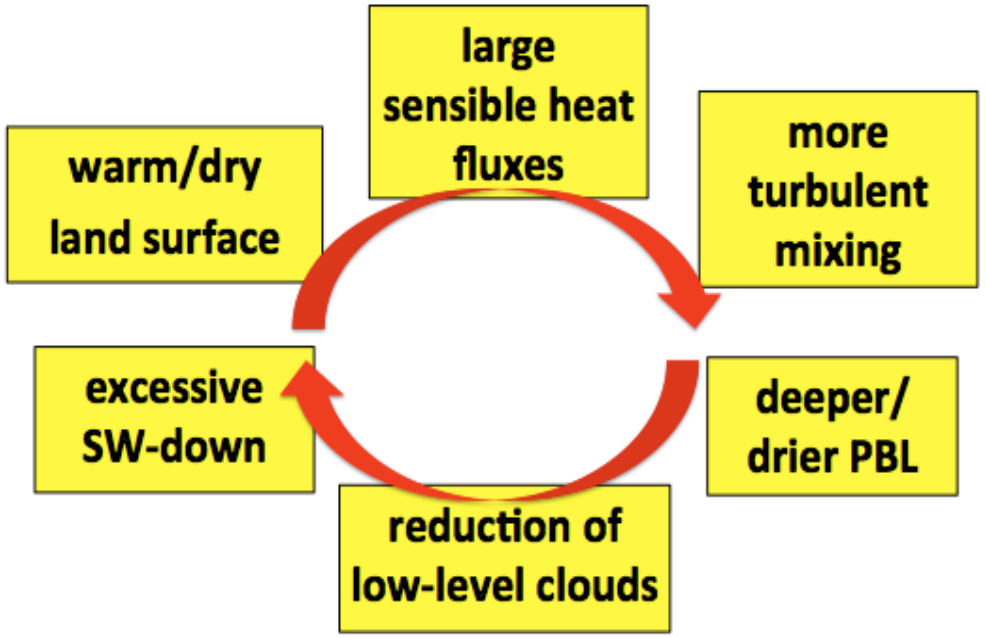


100-200 Wm^{-2} mid-day bias

monitoring changes | process understanding | **model development** | satellite evaluation

SURFRAD Observations in Numerical Weather Prediction Model Development

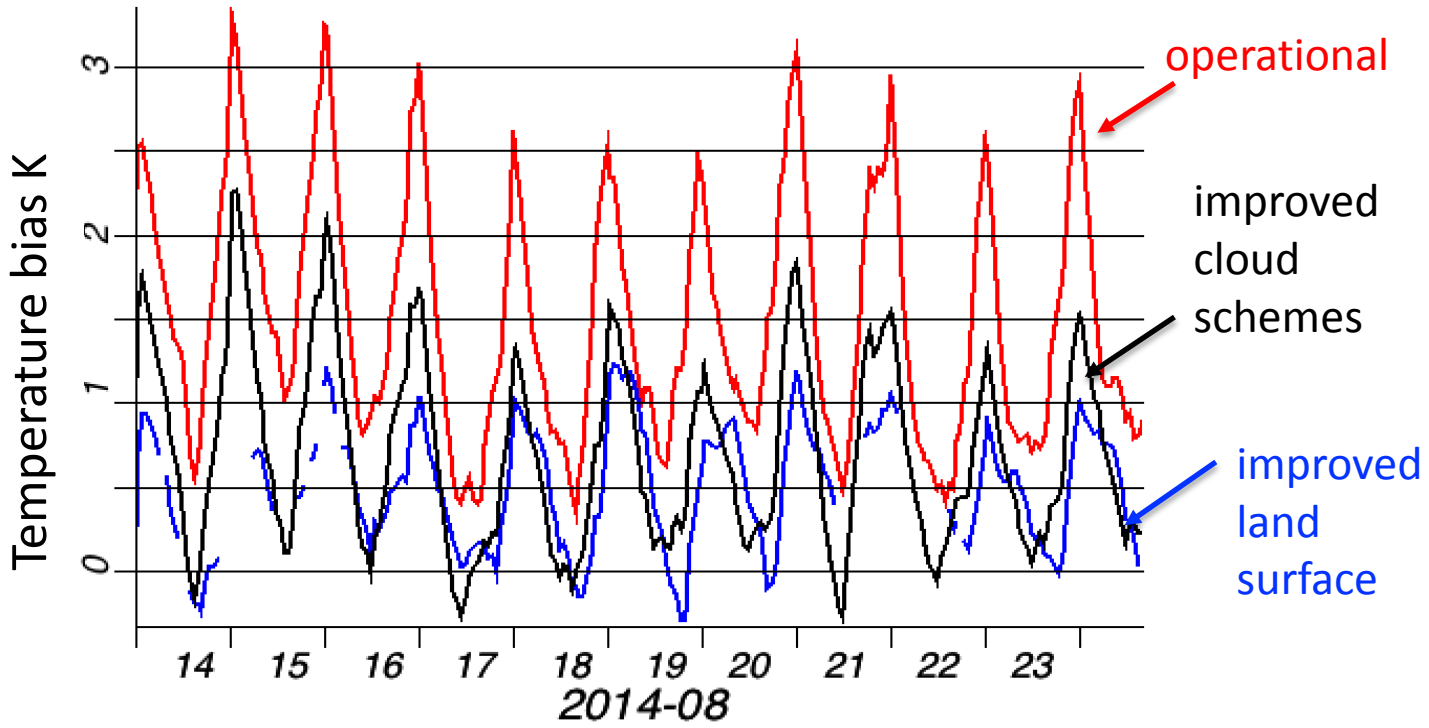
NOAA NWP Rapid Refresh Model (RAP) – SURFRAD comparisons

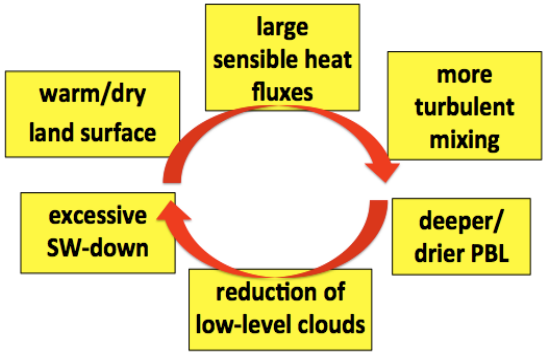


SURFRAD Observations in Numerical Weather Prediction Model Development

Benjamin – Session 7

NOAA NWP Rapid Refresh Model (RAP) – SURFRAD comparisons





~70% reduction in bias

monitoring changes | process understanding | **model development** | satellite evaluation

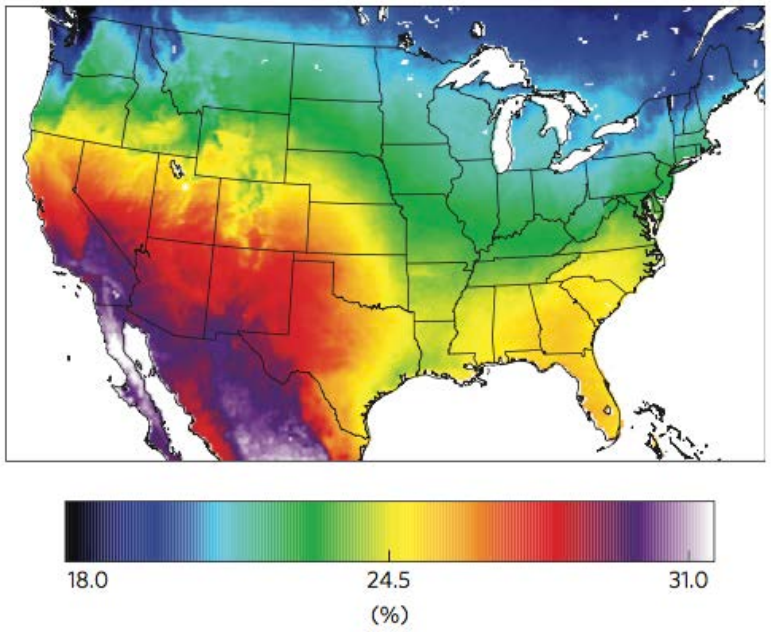
Atmospheric Science for Renewable Energy

Lantz – Session 7

ARTICLES
PUBLISHED ONLINE: 25 JANUARY 2016 | DOI: 10.1038/NCLIMATE2921
nature climate change

Future cost-competitive electricity systems and their impact on US CO_2 emissions

Alexander E. MacDonald[1*†], Christopher T. M. Clack[1,2*†], Anneliese Alexander[1,2], Adam Dunbar[1], James Wilczak[1] and Yuanfu Xie[1]

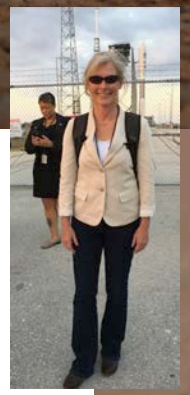


Model treatments and parameterizations addressed:

- Cloud cover – amount, nature, timing
- Land surface cover – albedo
- Aerosol – burden, transport, physical and optical properties
- Radiative transfer – link to cloud and aerosol properties, cloud overlap assumptions
- Diurnal cycles – shortwave and longwave fluxes and relationship to boundary layer growth and decay
- Meteorological regimes – e.g., cold pools

monitoring changes | process understanding | **model development** | satellite evaluation

NOAA GOES-R Cal/Val: Red Lake, AZ



GOES-16 Data Products for Validation:

- Downwelling Shortwave Radiation
- Aerosol Optical Depth (AOD)
- Land Surface Temperature
- Downwelling Longwave Radiation
- Upwelling Longwave Radiation
- Surface Albedo
- Vegetation Index (Planned)
- Green Vegetation Fraction (Planned)
- Aerosol Particle Size (Planned)

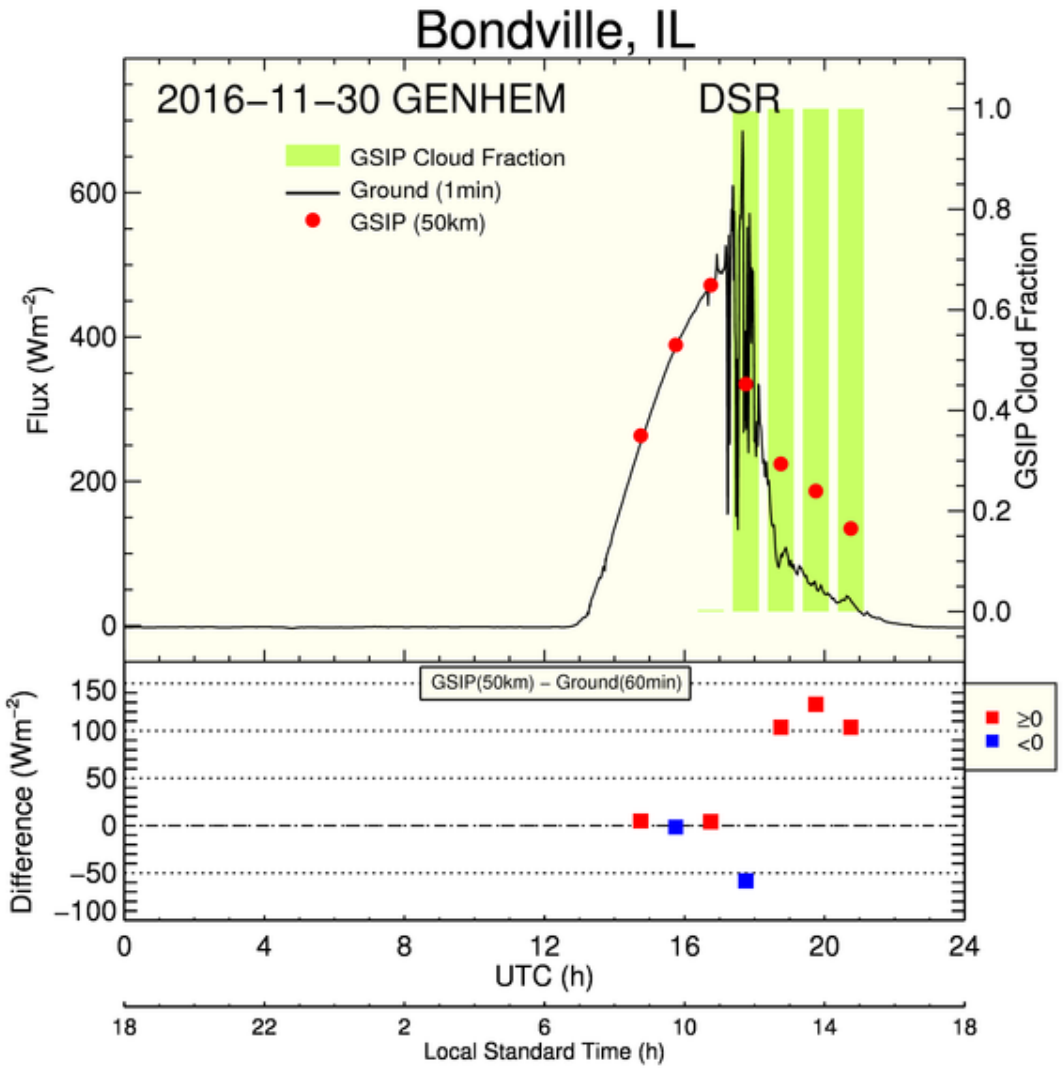
monitoring changes | process understanding | model development | **satellite evaluation**

Operational Satellite Product Evaluation

Long – Session 3

Global Operational Satellite Products:

- GEWEX Surface Radiation Budget (SRB) Product
- Geostationary Surface and Insolation Product (GSIP)



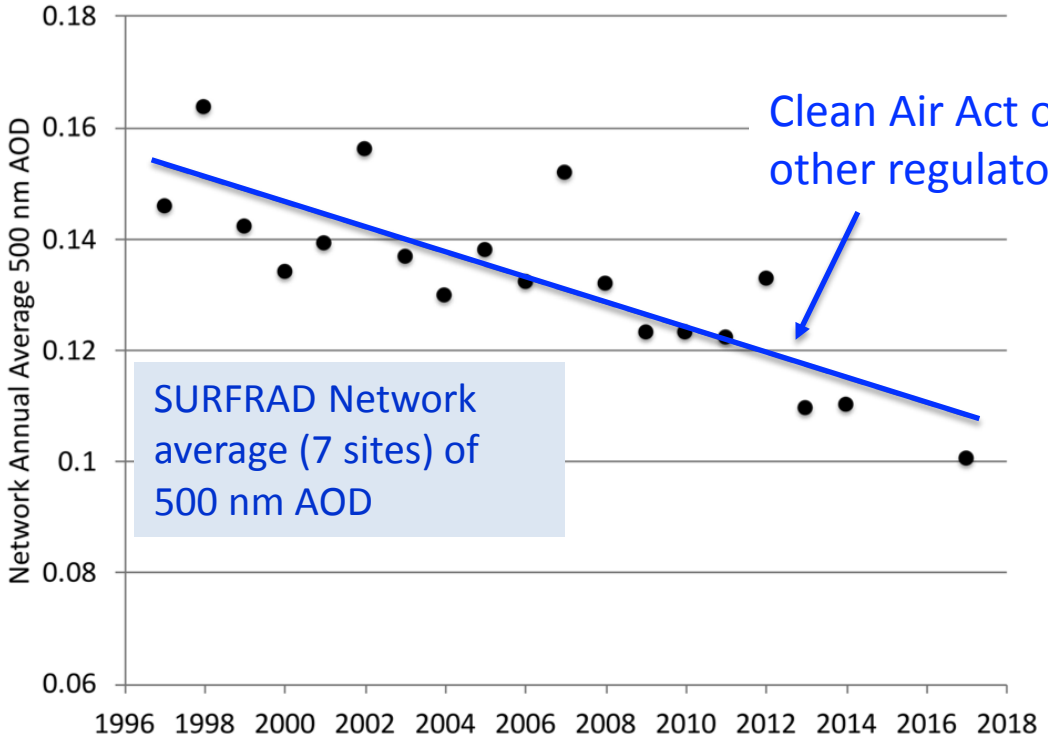
monitoring changes | process understanding | model development | satellite evaluation

Augustine – Session 3
Pagowski – P-7

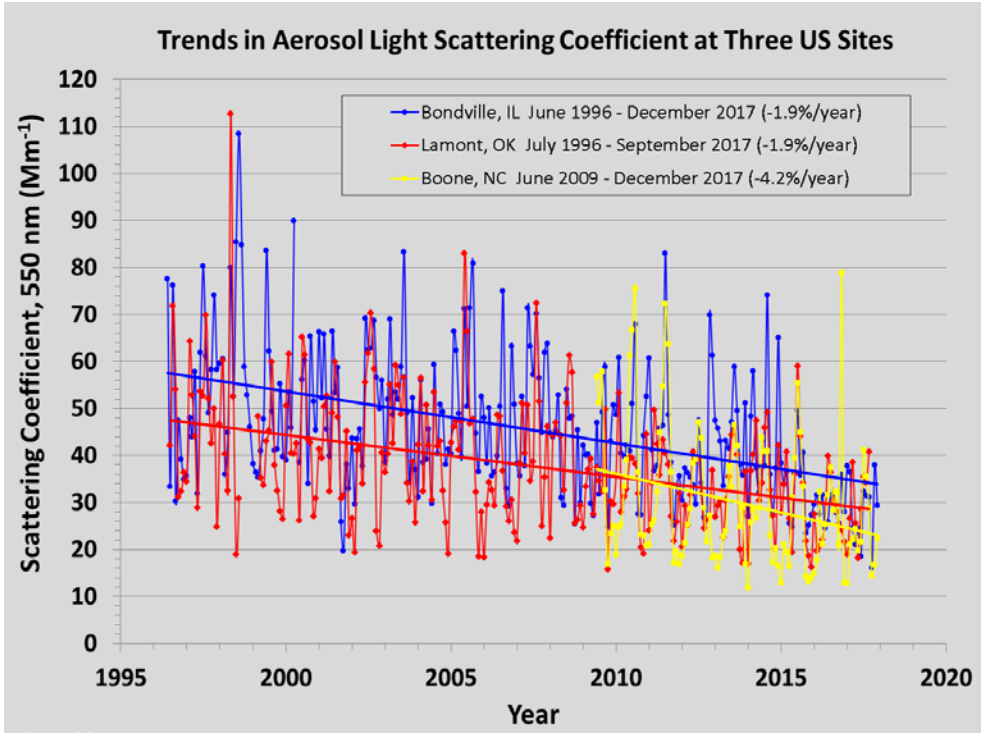
Trends in Aerosol over the U.S.

Haller – Session 3
Sherman – Session 7

Aerosol optical depth over the U.S.

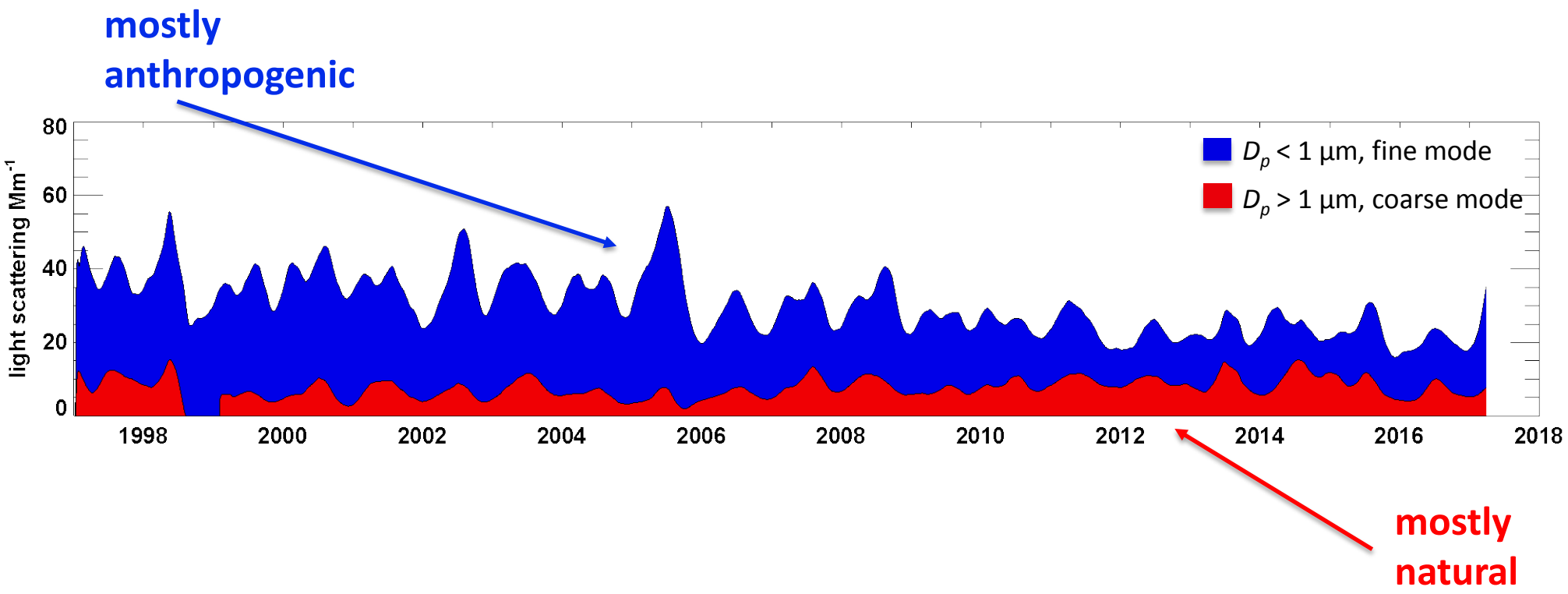


Surface dry aerosol scattering



monitoring changes | process understanding | model development | satellite evaluation

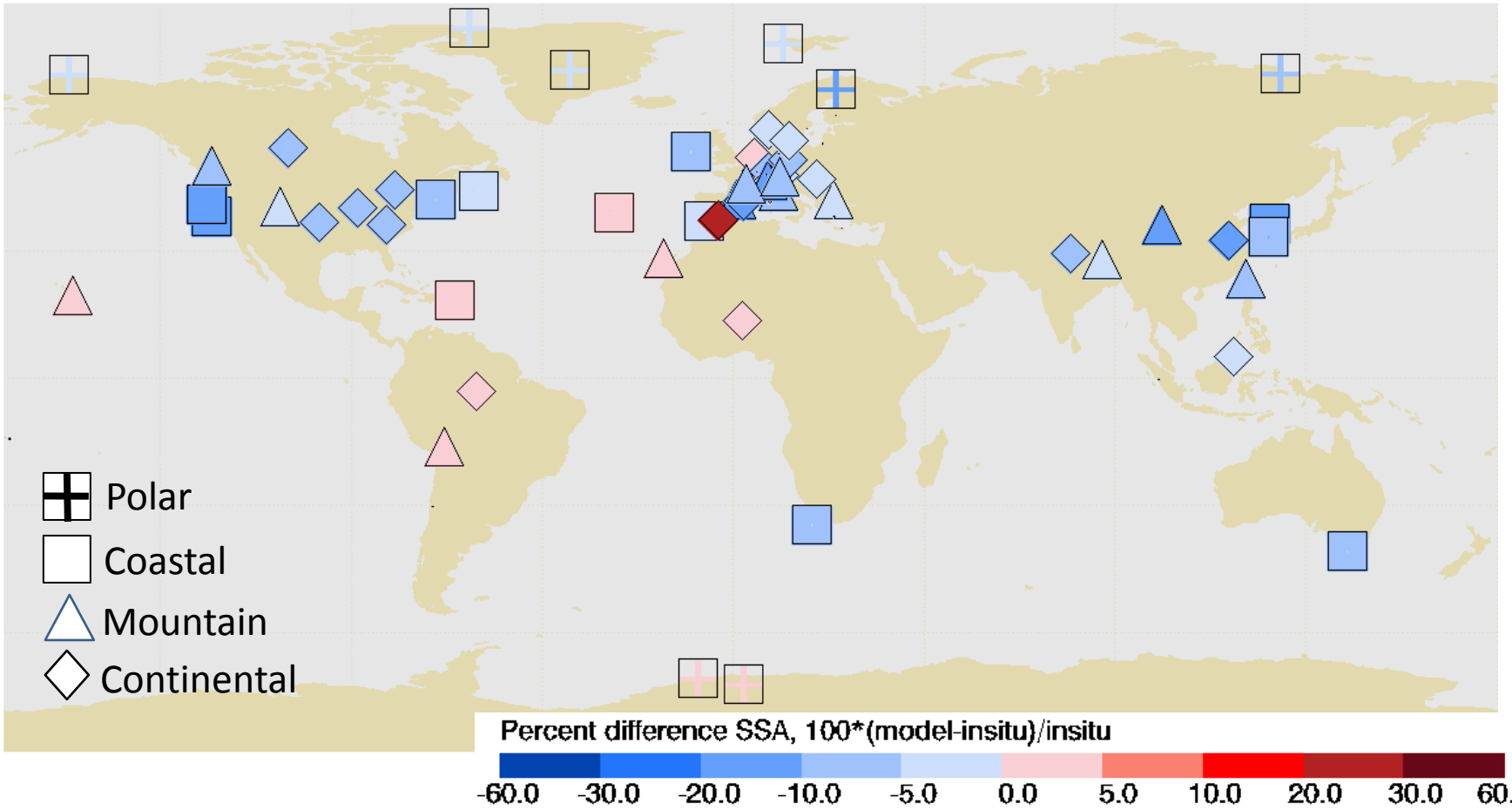
Trends in Aerosol over the U.S.



monitoring changes | process understanding | model development | satellite evaluation

NOAA Federated Aerosol Network Observations in AEROCOM Experiments

Andrews – Session 7
Pagowski – P-7

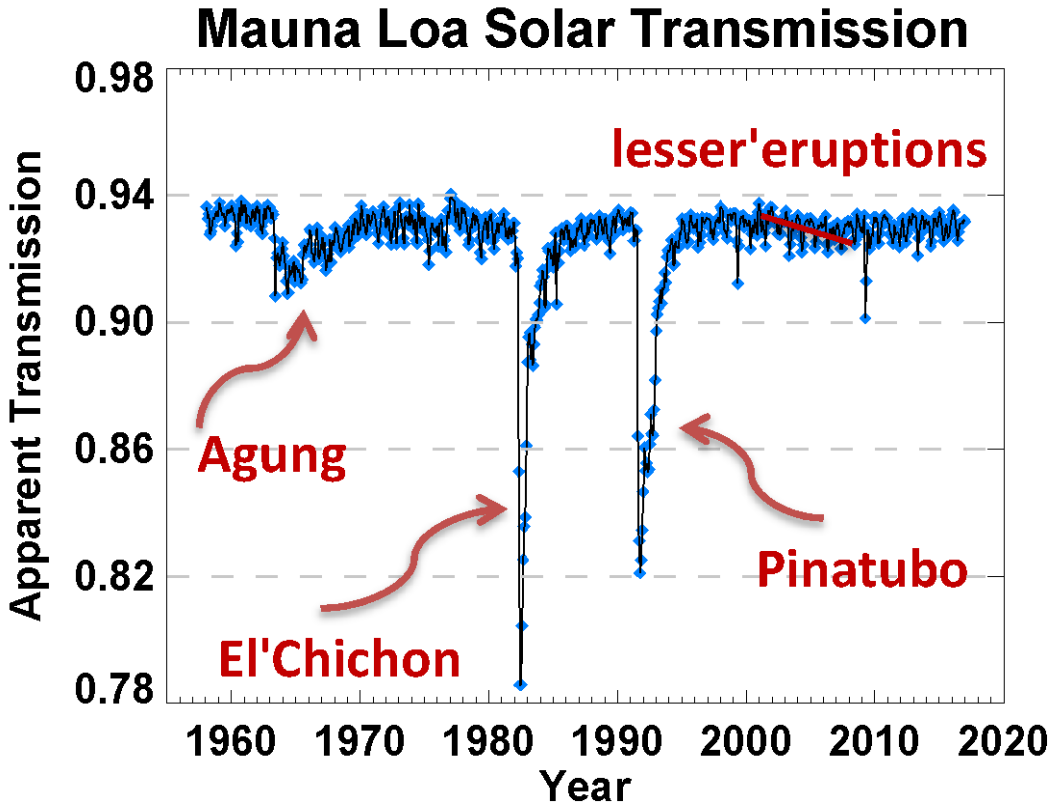


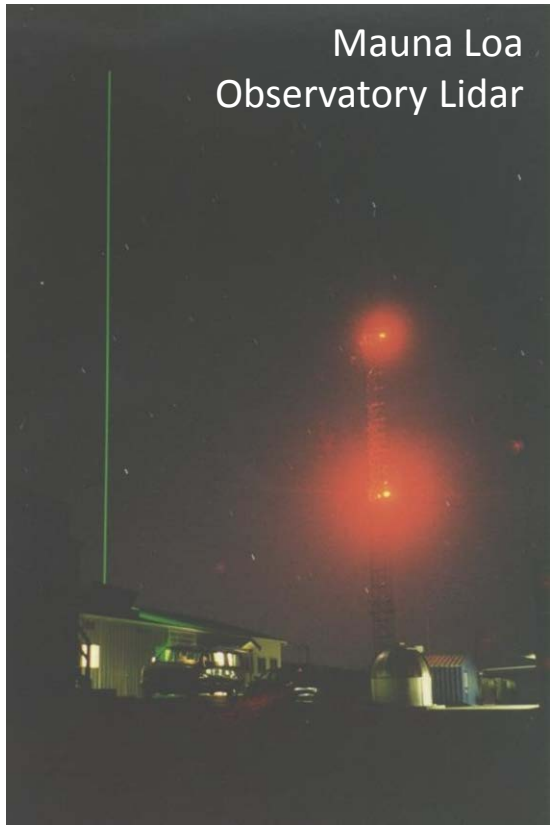
14 global climate models – in situ observations at surface:

- **model median values**
- **models underestimate observed SSA**
- **models simulate darker aerosol than observed**

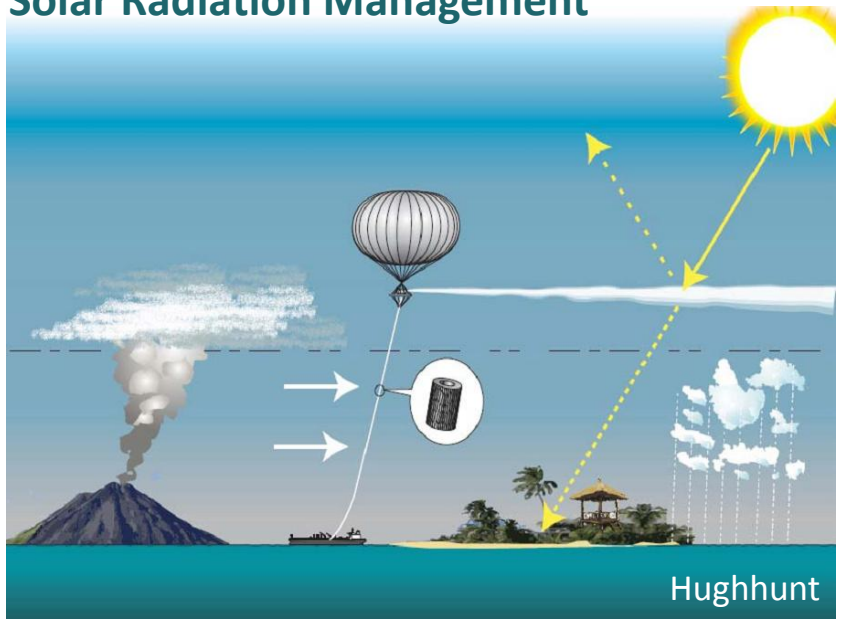
monitoring changes | process understanding | **model development** | satellite evaluation

Mauna Loa Transmission and the Stratospheric Aerosol Record





Climate Intervention:
Solar Radiation Management

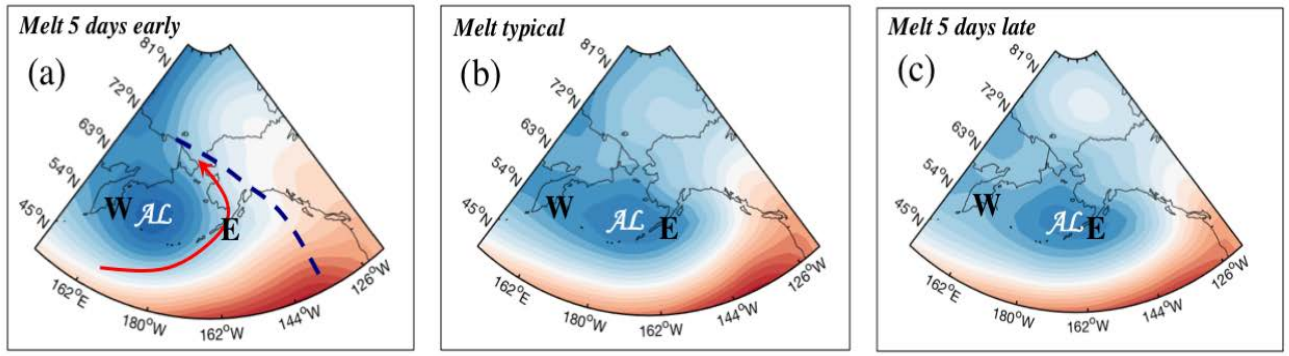


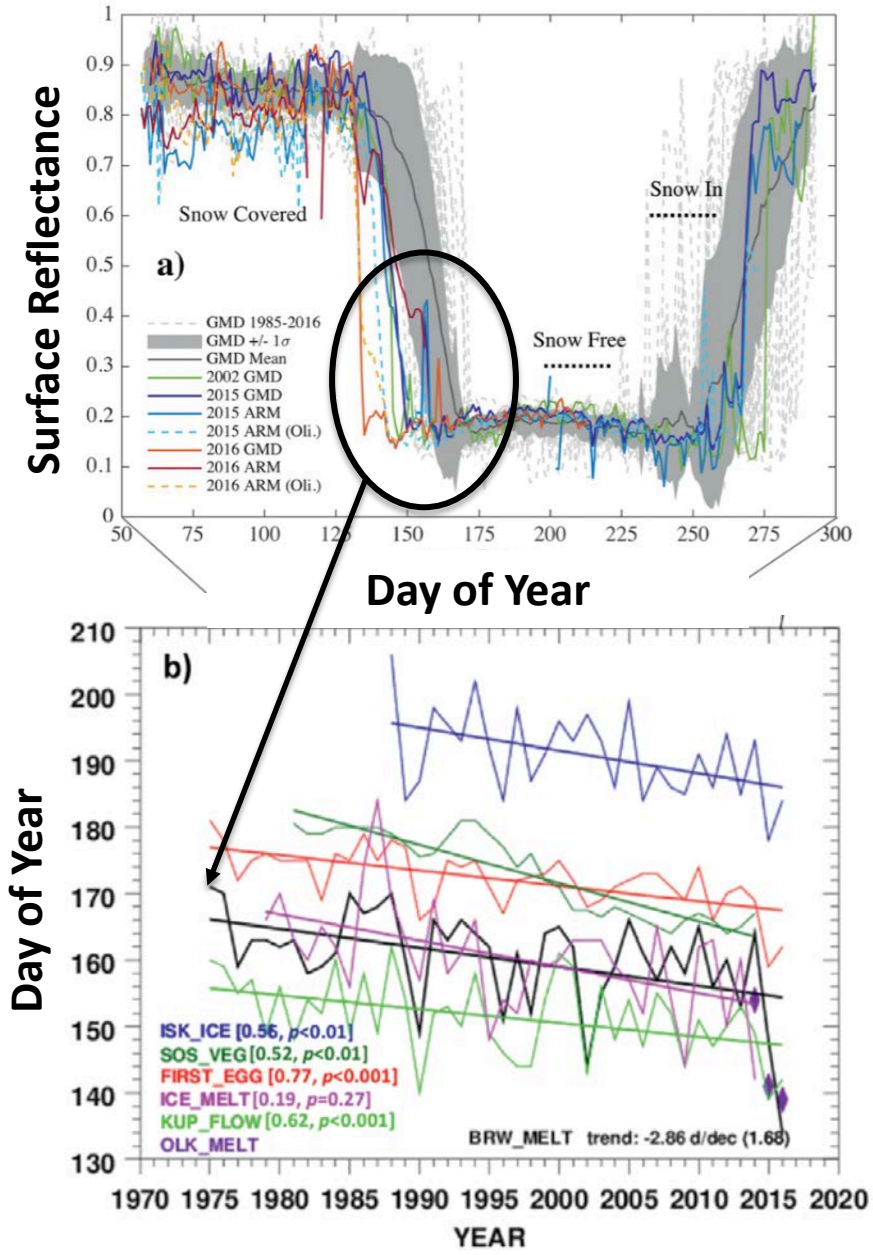
Barnes – P-43
Keen – P-41

monitoring changes | process understanding | model development | satellite evaluation

DRIVERS AND ENVIRONMENTAL RESPONSES TO THE CHANGING ANNUAL SNOW CYCLE OF NORTHERN ALASKA

CHRISTOPHER J. COX, ROBERT S. STONE, DAVID C. DOUGLAS, DIANE M. STANITSKI, GEORGE J. DIVOKY, GEOFF S. DUTTON, COLM SWEENEY, J. CRAIG GEORGE, AND DAVID U. LONGENECKER



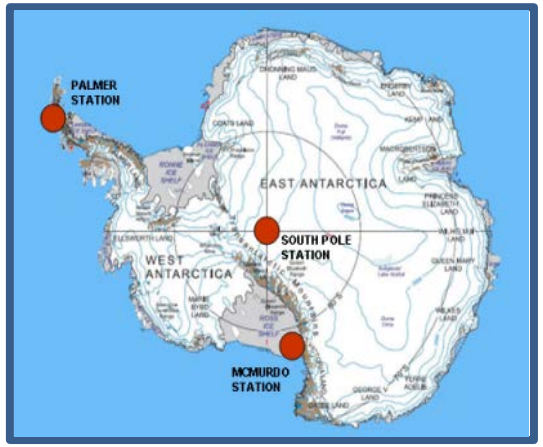


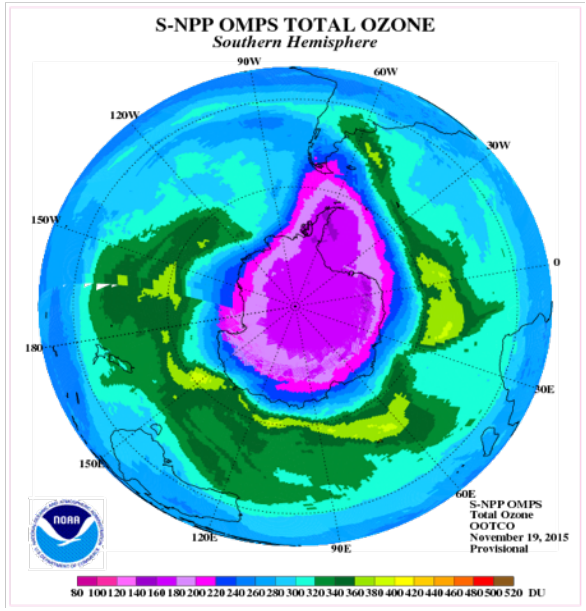
Cox – Session 3
Morris – Session 3

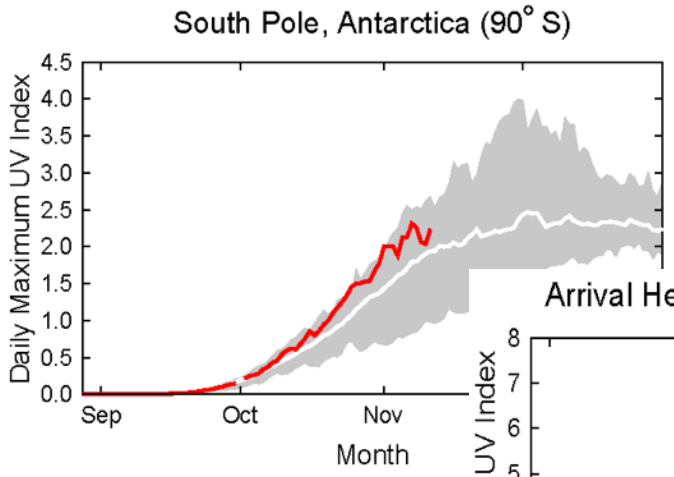
monitoring changes | **process understanding** | model development | satellite evaluation

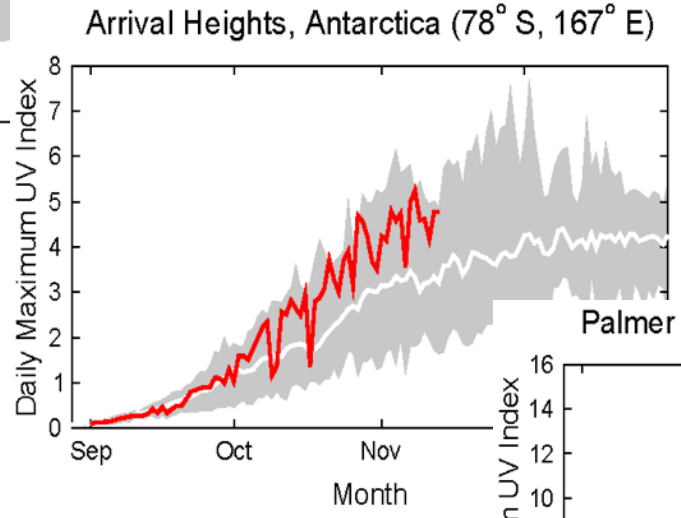
Spectral Ultra-violet (UV) Networks

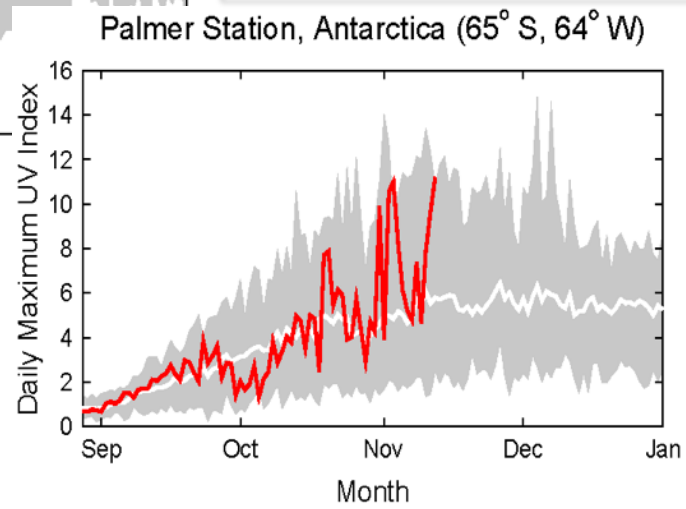
NOAA Antarctic UV Monitoring Network





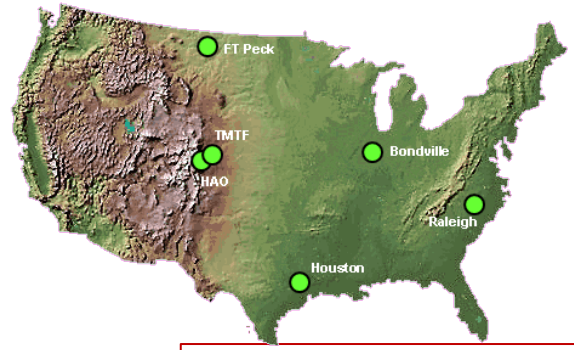






McKenzie – P-48
Shiobara – P-44

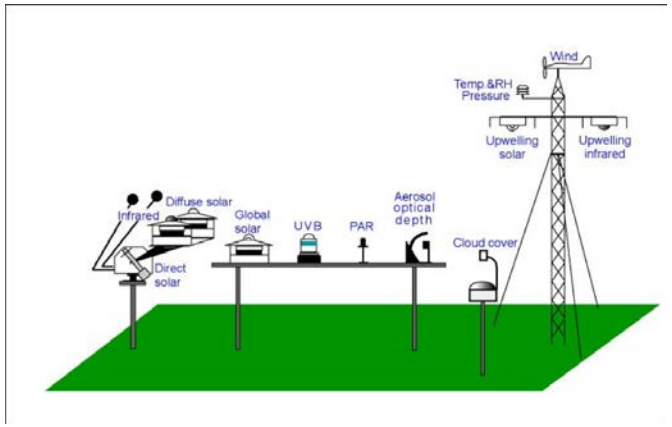
NEUBrew
NOAA Environmental Ultraviolet-ozone Brewer Network



Disterhoft – P-49
Montzka – Theme 3

monitoring changes | process understanding | model development | satellite evaluation

Looking Forward
New Instrumentation for Cloud Properties at SURFRAD Sites

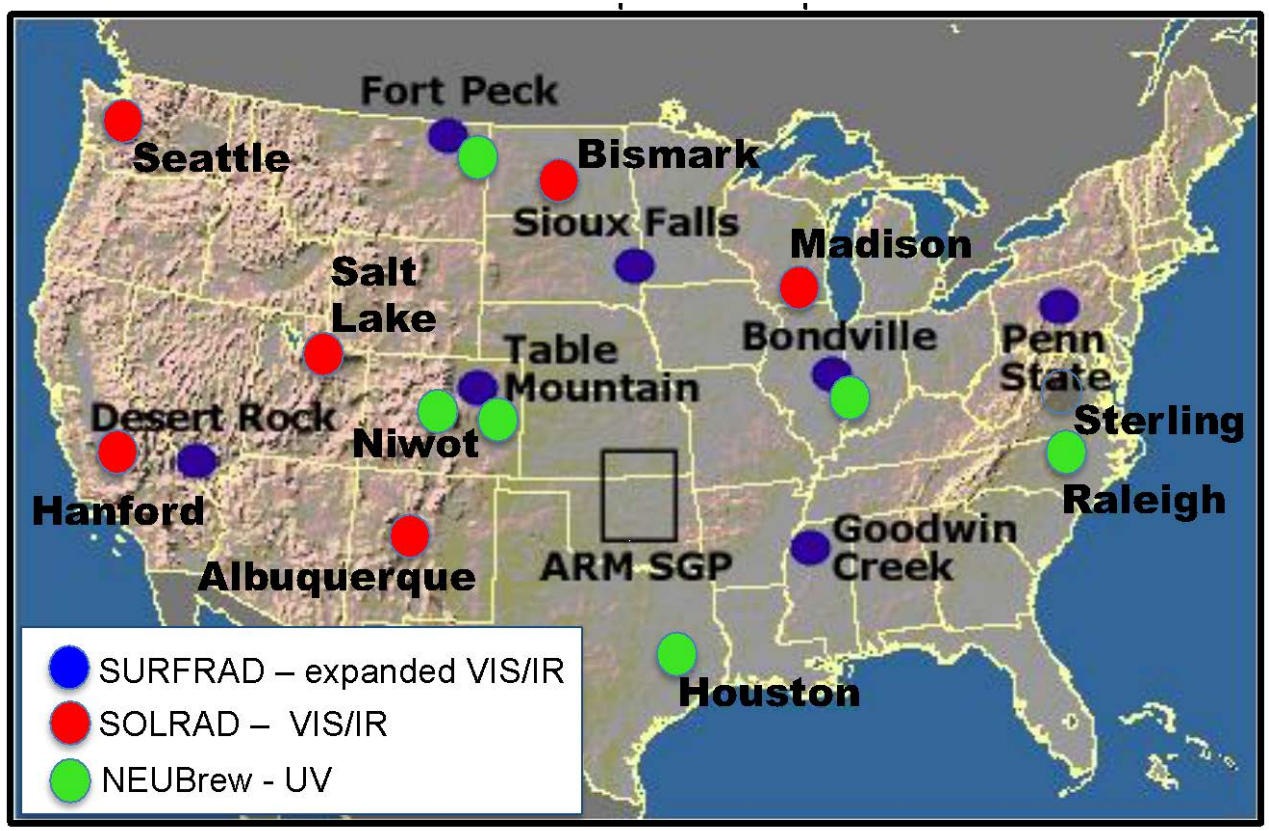


Measurements and Data Products

- Surface Radiation Budget – all components
- Sky cover/cloud fraction
- Cloud optical depth (overcast)
- Aerosol Optical Depth (AOD)
- Surface in situ aerosol optical properties
- Spectral Surface Albedo
- UV-B
- PAR
- Vegetation Indices (NDVI, GVF)
- Spectral UV irradiance, Ozone, UV Index
- Cloud Height, Cloud Layers (overlap)
- Boundary (mixing) Layer Height
- Cloud optical depth (broken cloud)
- Cloud microphysics – effective radius, drop size, phase
- Cloud liquid water path (derived)
- Ambient Column Aerosol Size Distribution, Single scattering Albedo, Asymmetry Parameter
- Spectral AOD – UV to NIR (aerosol type/composition)

Looking Forward
An Expanded Aerosol Optical Depth Monitoring Network

Instrument upgrades, new deployments, and development of aerosol optical property retrieval algorithms will results in an expanded network.

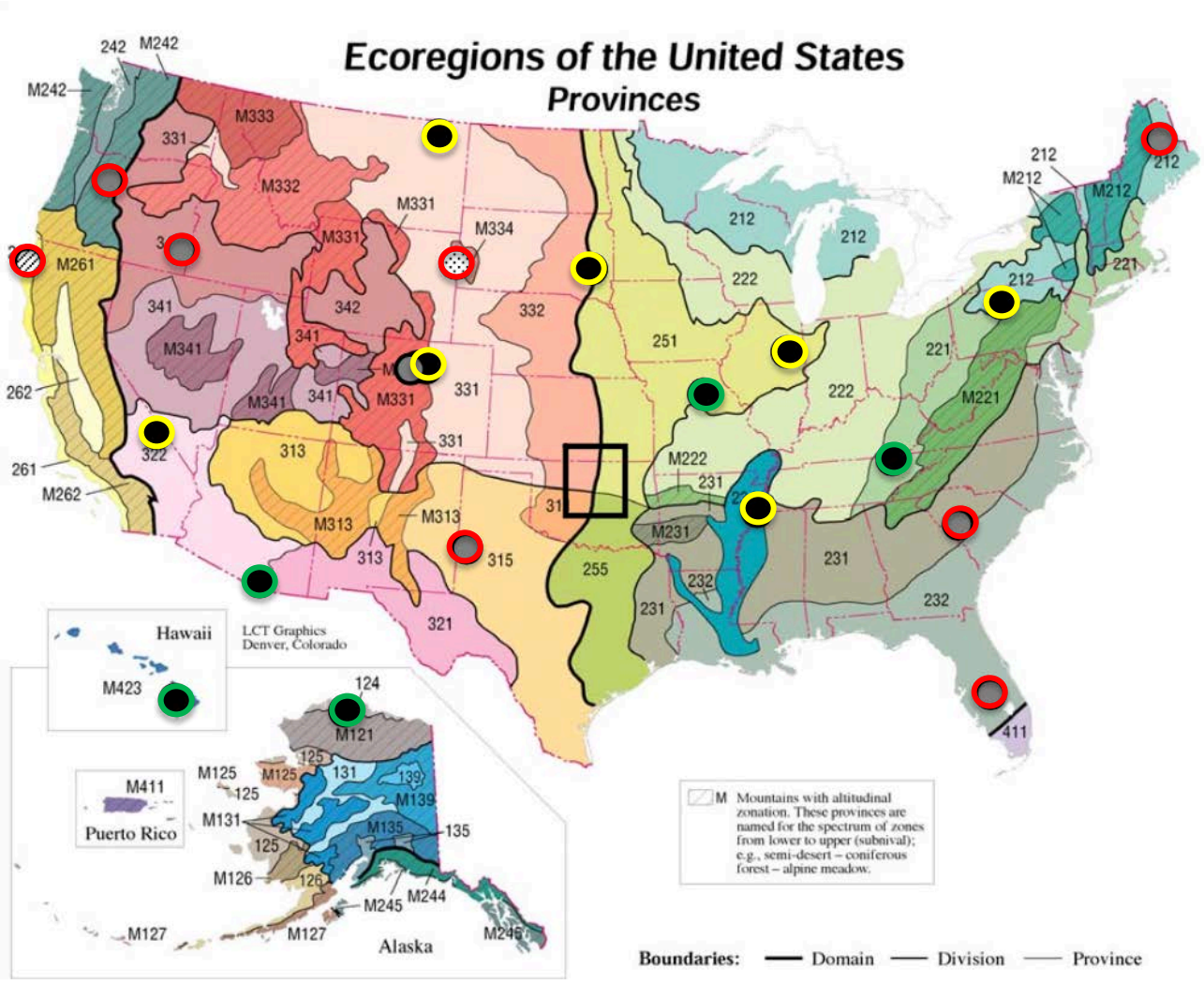


- use of newly expanded spectral measurements at **SURFRAD** and DOE ARM sites for routine retrievals of improved aerosol microphysical and optical properties
- addition of refurbished instruments to **SOLRAD** sites for expanded spatial coverage of aerosol optical depth
- development of a spectral ultraviolet aerosol optical depth product from Brewer spectrophotometers in the **NEUBrew Network** for information on aerosol composition and its radiative impacts

Looking Forward

A NOAA Surface Energy Budget Network

for Improving Weather and Climate Predictability



- existing radiation measurements
- existing heat flux measurements
- proposed new sites

Monitoring and Understanding Trends in Surface Radiation, Clouds, and Aerosols

WCRP Grand Challenge: Clouds, Circulation, and Climate Sensitivity

How the interaction between clouds, greenhouse gases, and aerosols affect temperature and precipitation in a changing climate

WCRP Initiatives:	GMD Research:
Climate and hydrological sensitivity	Small- and large-scale atmospheric dynamical effects on cloud properties
Coupling clouds to circulation	Regionality of cloud and aerosol responses to local and large-scale forcing
Changing patterns	Decadal to multi-decadal observations to constrain cloud processes and feedbacks
Leveraging the past record	Persistent model biases evaluation and improving physical understanding
Towards more reliable models	

https://www.wcrp-climate.org/gc-clouds