Surface Energy Balance Measurements
and Subsurface Properties during MATERHORN

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all other MATERHORN-X participants

MATERHORN Investigator Meeting, 9 Oct. 2014, Salt Lake City, UT

Introduction

Land surface contrasts ↔ Land-Atmosphere energy exchange

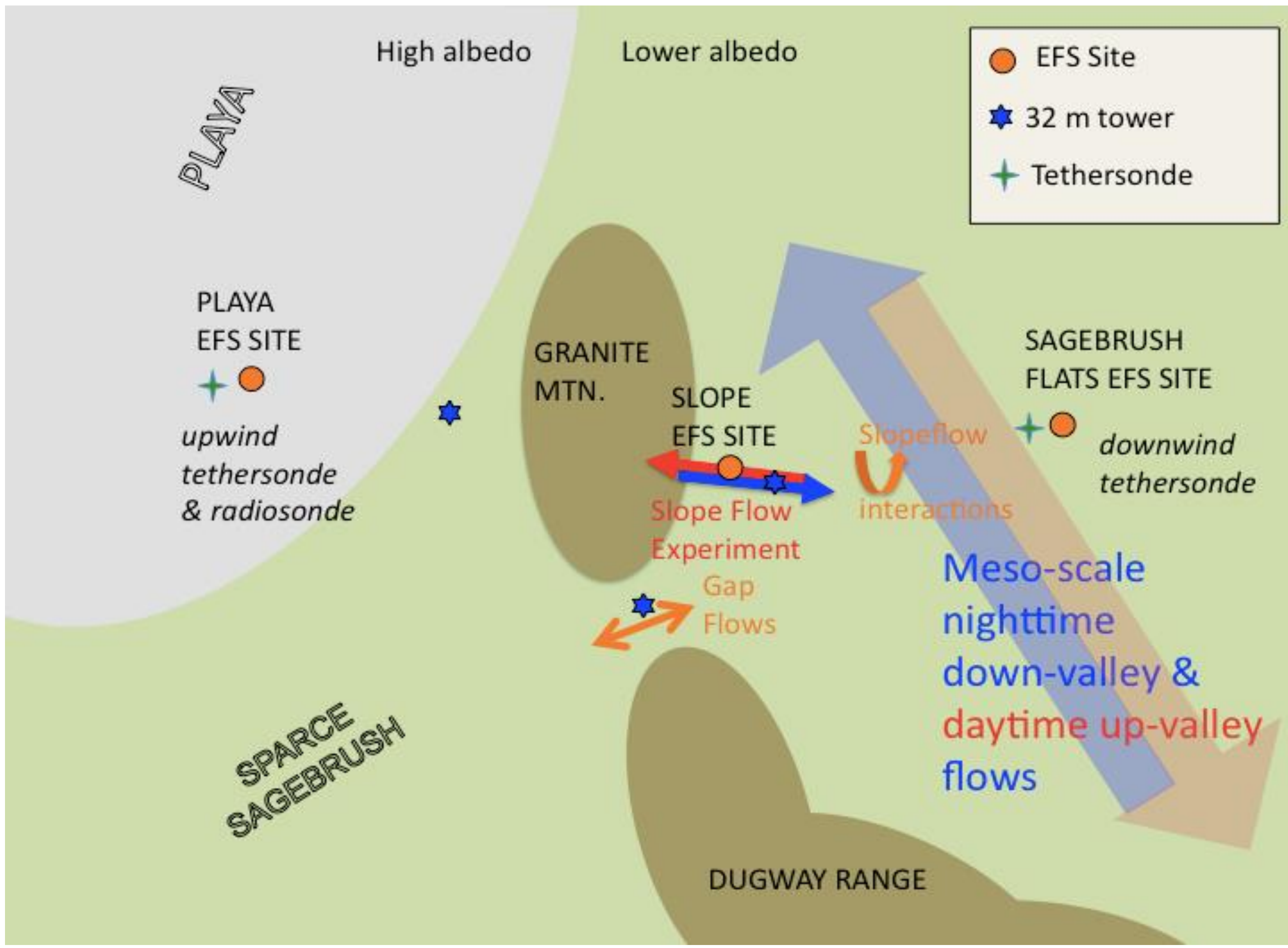
Topography ↔ Land-Atmosphere energy exchange

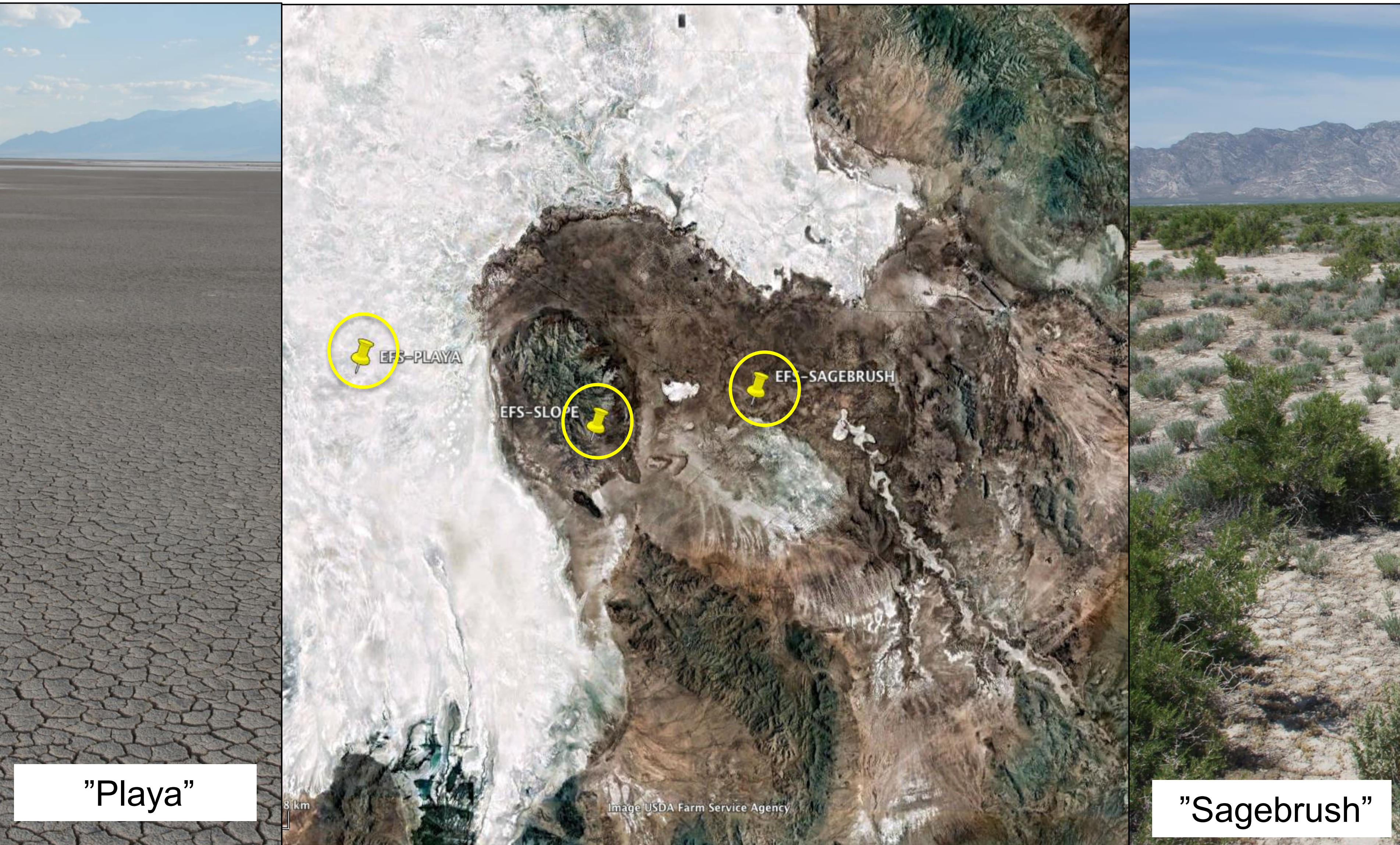
Land-Atmosphere energy exchange ↔ Synoptic forcing

Land-Atmosphere energy exchange ↔ Boundary Layer Evolution

Synoptic forcing ↔ Circulation patterns

Boundary Layer Evolution ↔ Circulation patterns

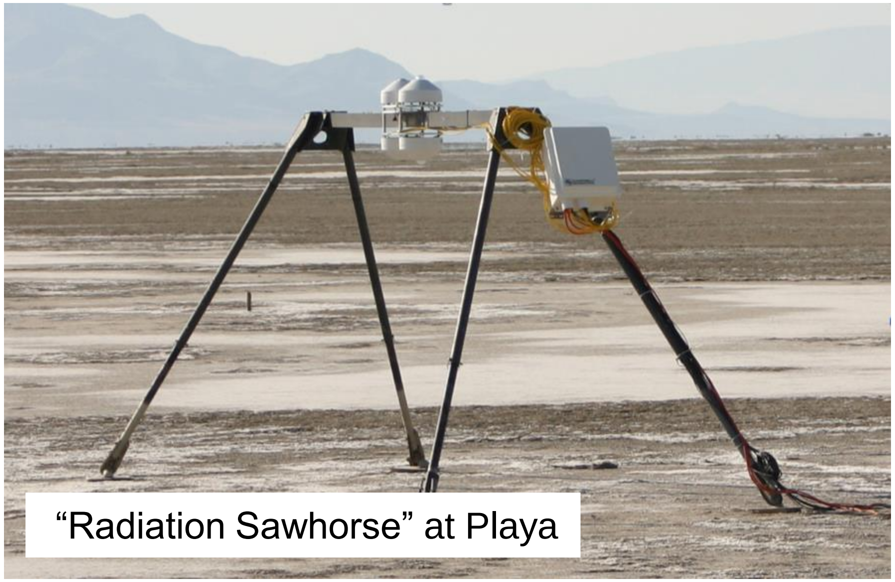




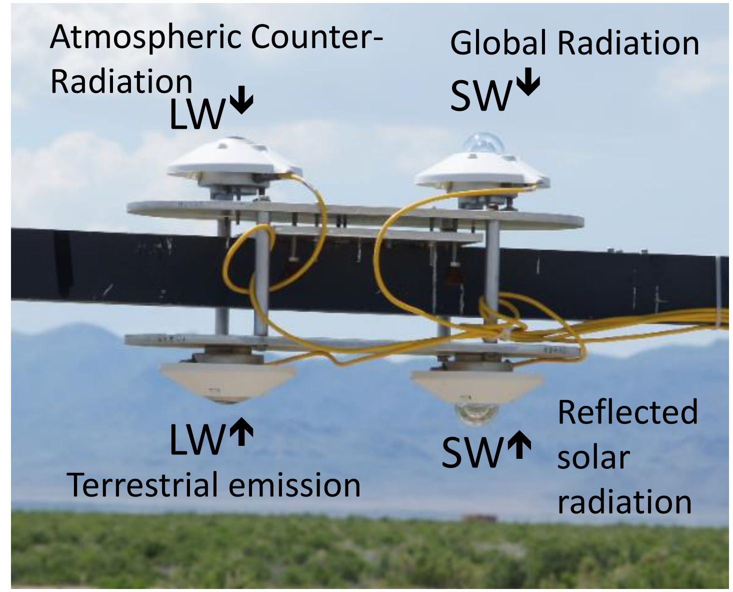
Google Earth™ imagery of Dugway Proving Ground, UT.

Radiation Balance

$NR = SW^{\downarrow} + SW^{\uparrow} + LW^{\downarrow} + LW^{\uparrow} \;=\; (1-\alpha)\, SW^{\downarrow} + LW^{\downarrow} + LW^{\uparrow} \;=\; SW^{*} + LW^{*}$



"Radiation Sawhorse" at Playa



Surface Energy Balance

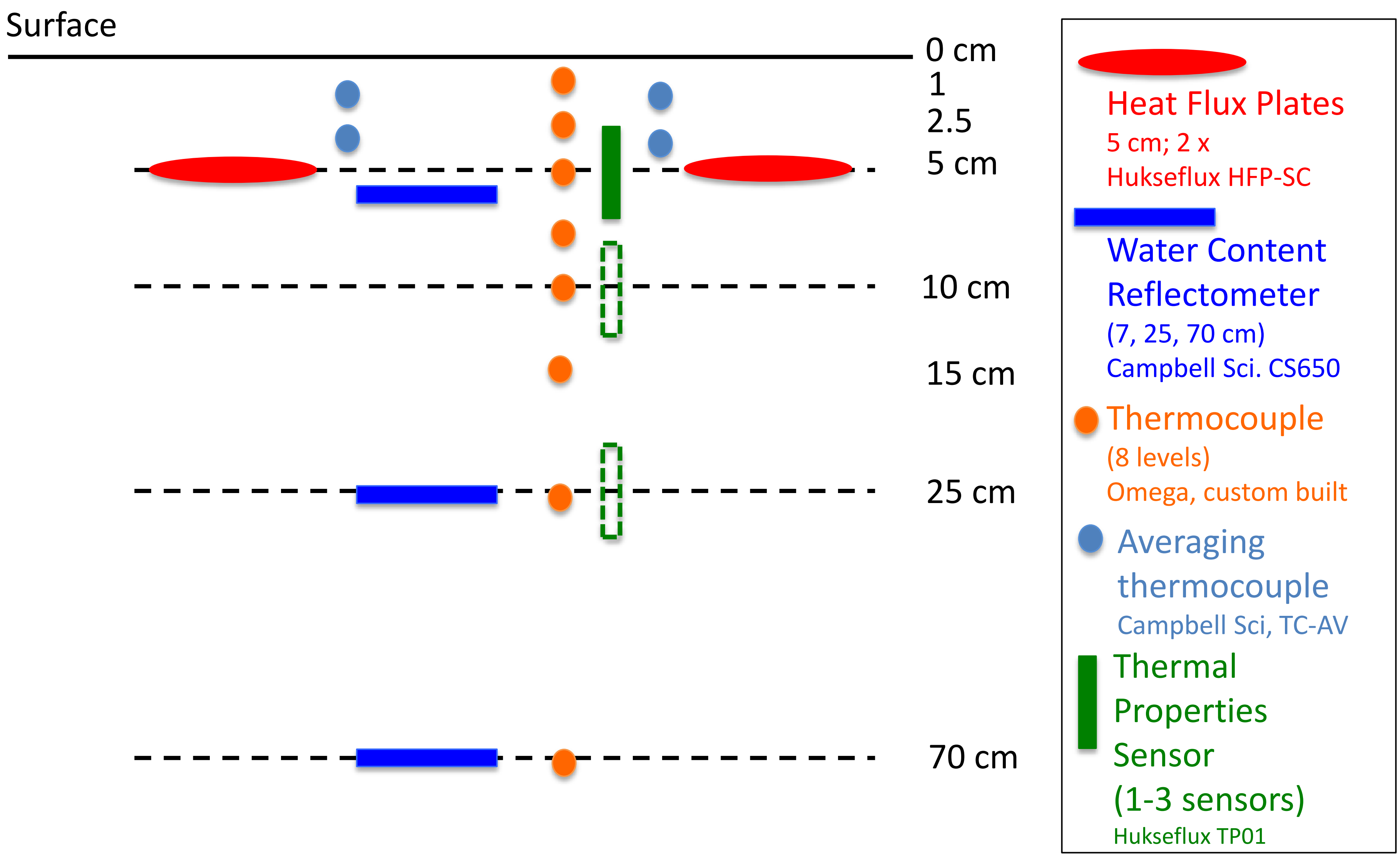
$NR + H + L_vE + G$ = Residual

Eddy-Covariance measurements of Sensible Heat flux (H) and Latent Heat Flux (L_vE) ; CSAT3 and IRGAsonde - *Derek Jensen*

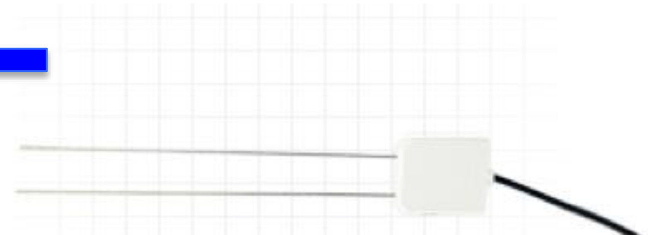
EC150 at Playa

Subsurface Heat Flux / Soil Thermal Properties

at EFS Sagebrush, EFS Playa, EFS Slope/ES5



Campbell Scientific CS650 / CS655 water content reflectometer



© Campbell Scientific

Hukseflux TP01 thermal property sensor

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Hukseflux HFP01-SC self-calibration heat flux plate

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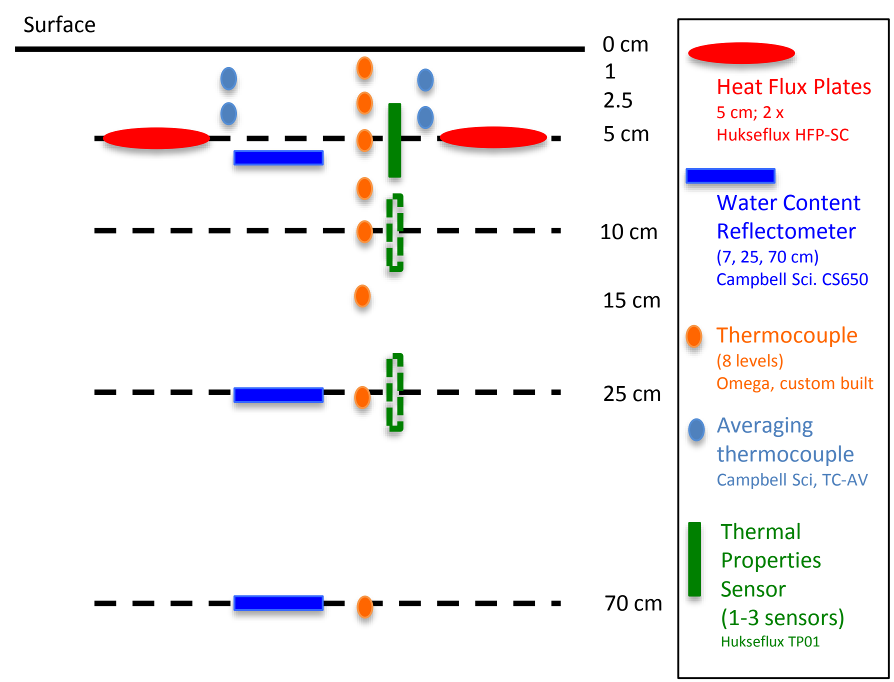
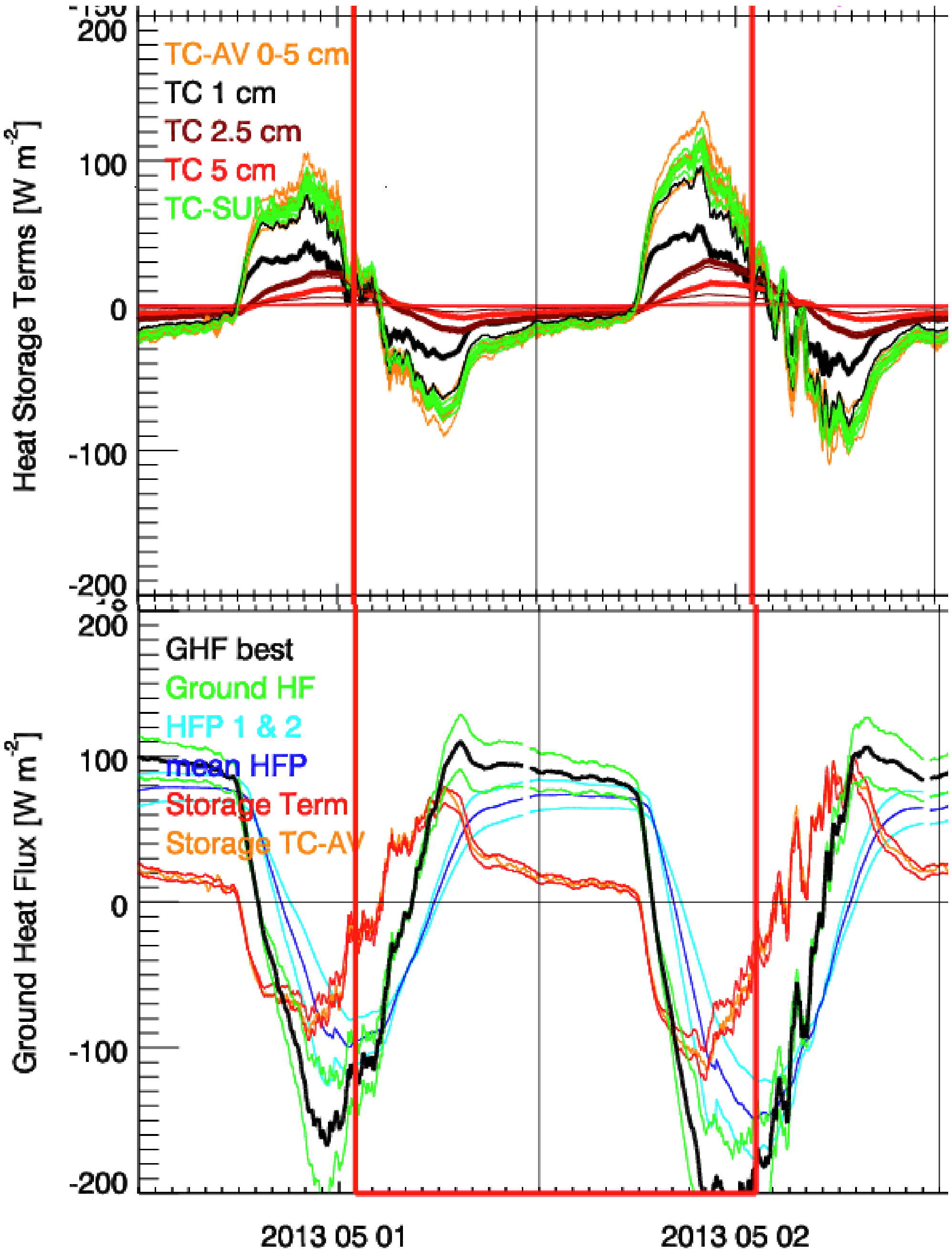




MATERHORN EFS-QUICKLOOKS

Ground heat flux

Calculation & QC

Sum of

1) Flux at heat flux plate (self calibrated at midnight / power outage corrected)
2) Heat storage change above flux plate (calculated for individual layers); Volumetric heat capacity from TP01 sensor

Radiation QC

Correction for positive and negative night-time offsets

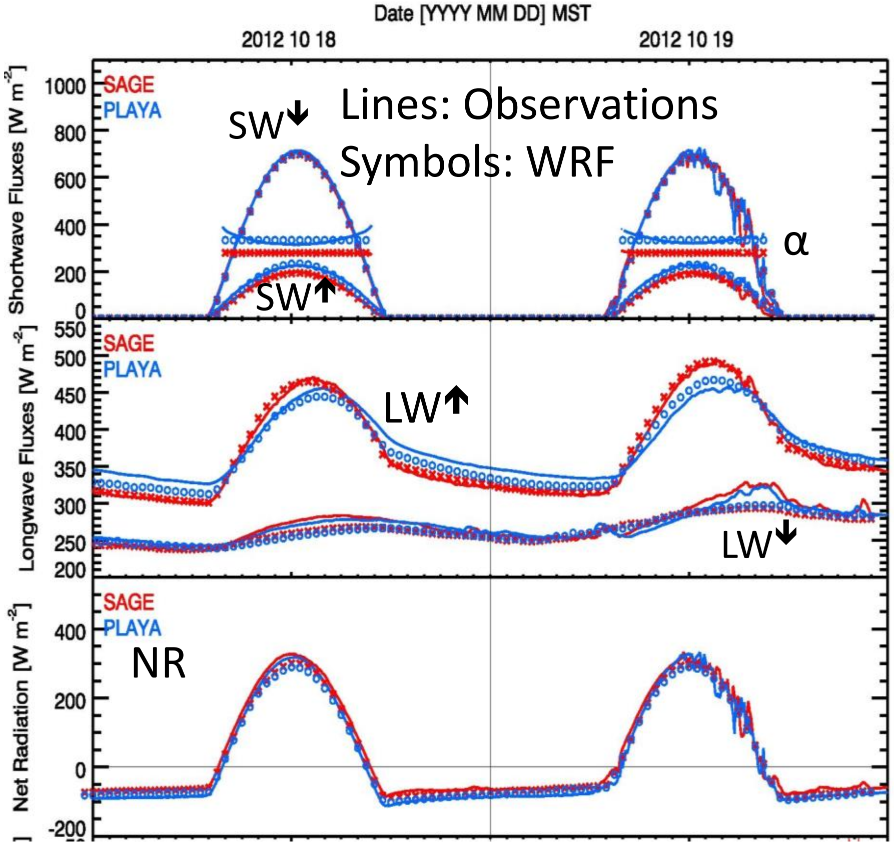
Turbulent Fluxes QC

See UTESpac / Derek Jensen

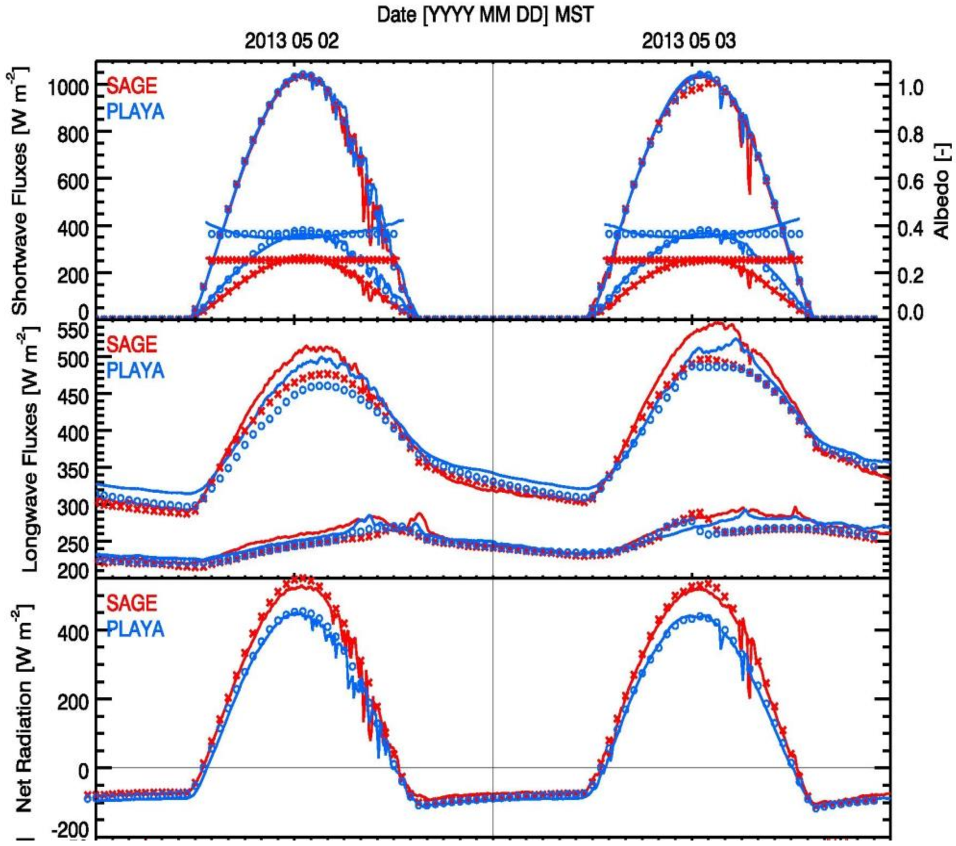
Results

- Two days (18-19 Oct 2012) during the Fall campaign / Two days during Spring campaign (2-3 May 2013)
- EFS-Sagebrush site vs EFS-Playa site
- WRF model results (tuned by using observed albedo values); Massey at al. 2014 soil parameterization and moisture (fix night time warm bias; silt loam sites)
- Surface radiation balance
- Surface energy balance $NR + H + L_vE + G = \text{Residual}$

OCTOBER 2012 / FALL / MH-X1

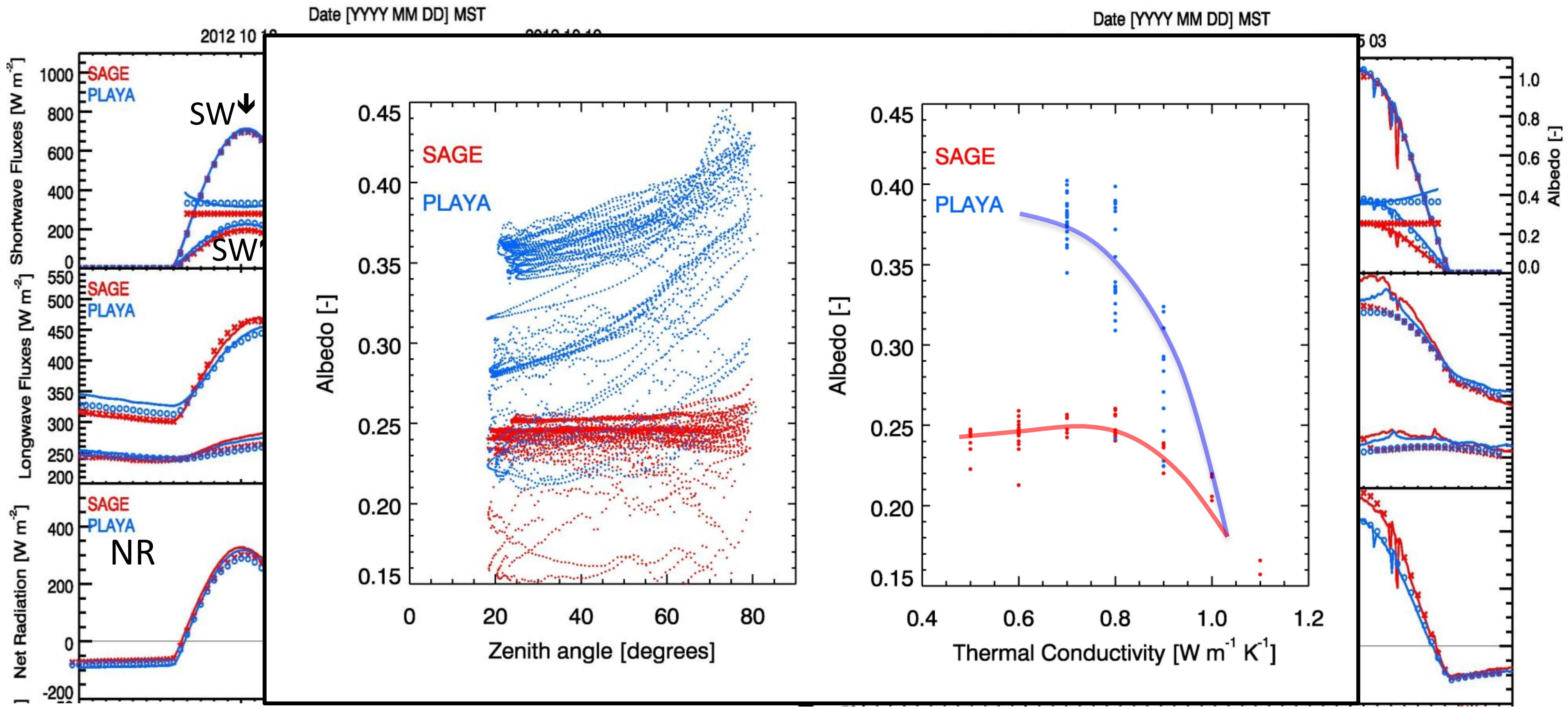


MAY 2013 /SPRING / MH-X2



- Albedo differences among the sites are the main cause of variations in shortwave energy input. Differences are more pronounced in spring, as albedo values are then lower at Sagebrush and higher at Playa than in the fall.
- In the fall, the (smaller) effect of the albedo differences is compensated by higher longwave emission at Sagebrush, and net radiation differences are higher at night than during the day. In spring, daytime net radiation at Sagebrush exceeds values observed at Playa.

OCTOBER 2012 / FALL / MH-X1 MAY 2013 /SPRING / MH-X2



- Especially in Spring, WRF under-predicts daytime temperatures at both sites(cold bias), under-predicts night-time temperatures at Playa (cold bias).
- Specular reflectance plays a role at Playa and leads to a pronounced diurnal cycle of albedo.
- Albedo at Playa varies with thermal conductivity (proxy for soil moisture).

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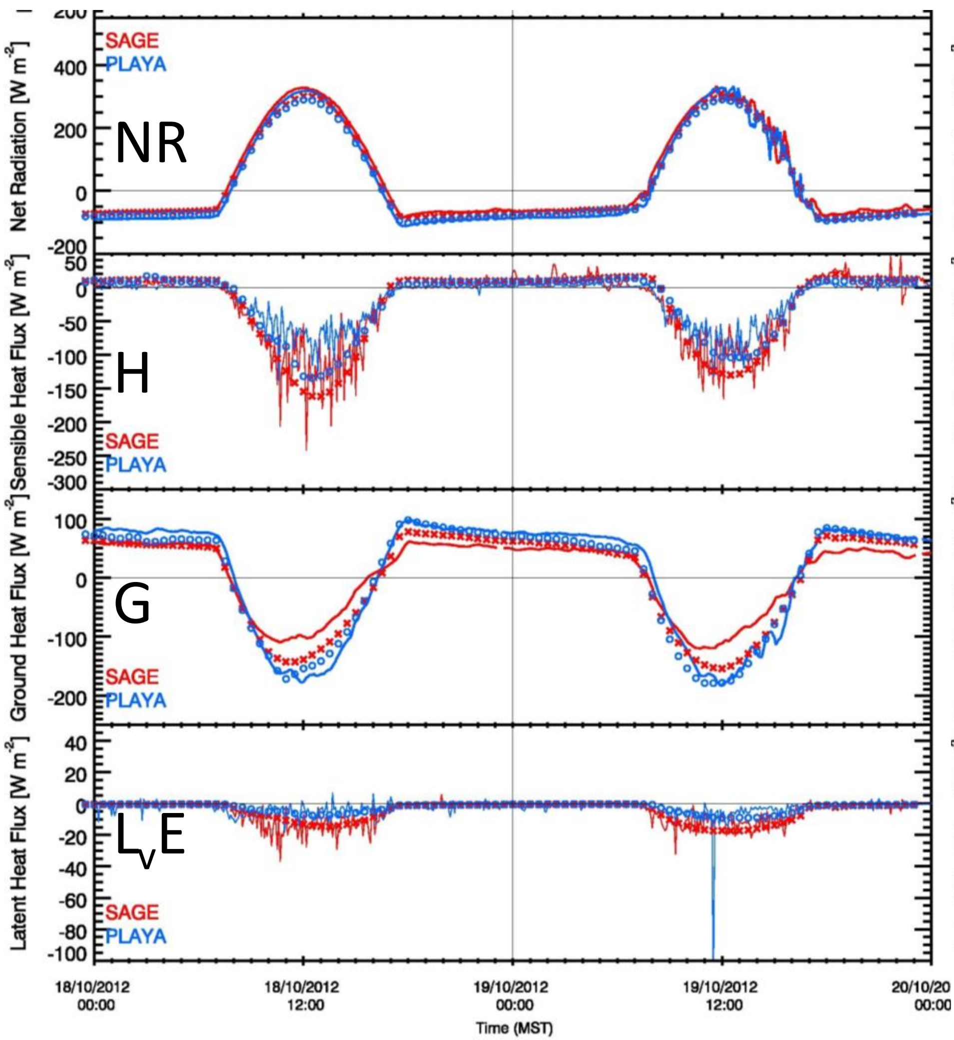

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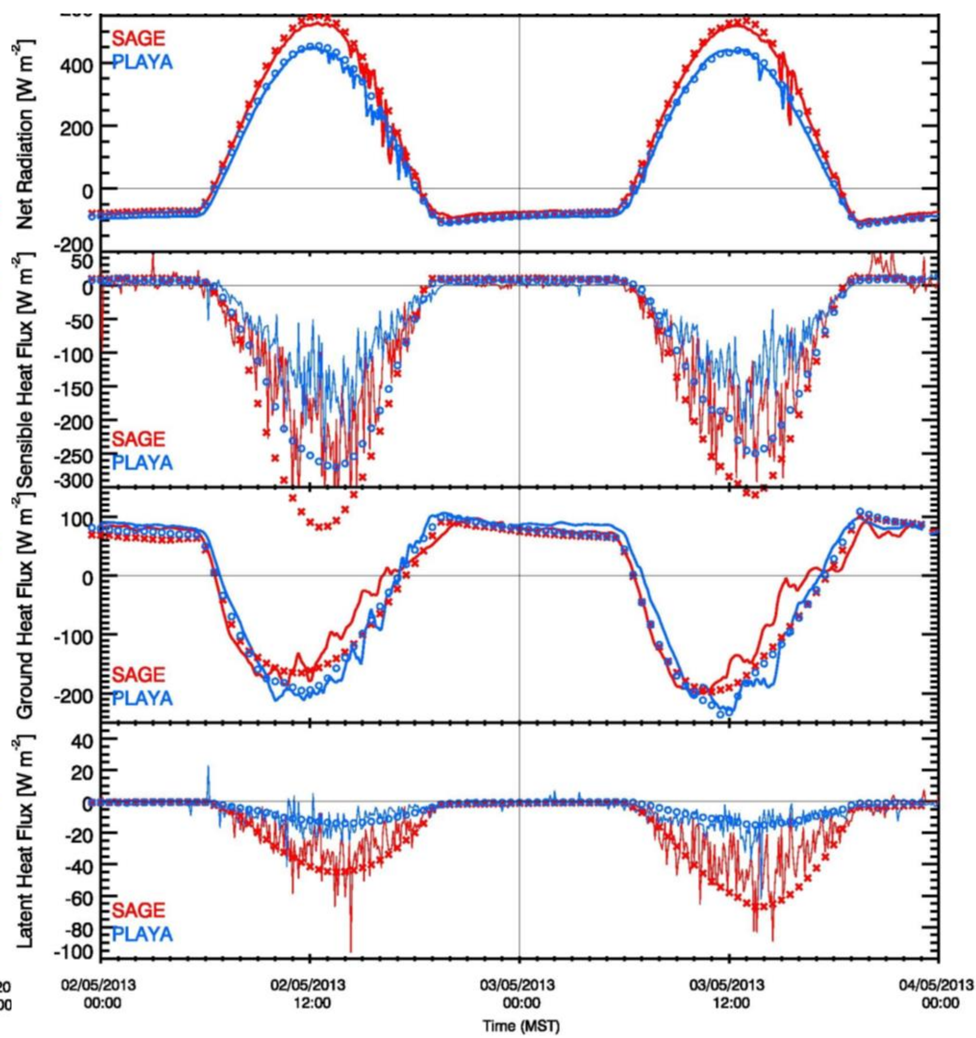
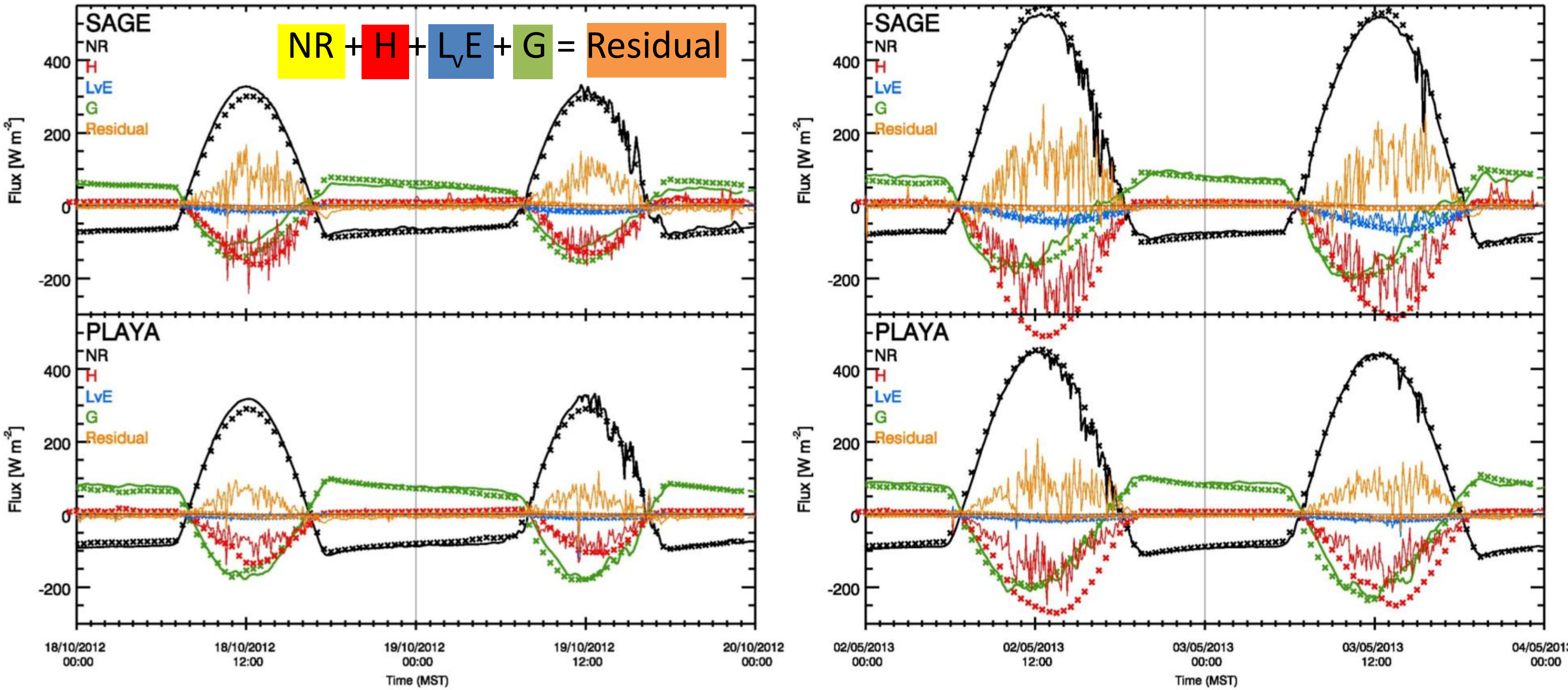


- Ground heat flux very important at both sites
- Model seems to over-predicts magnitude of sensible heat flux (H) and latent heat flux (L_vE)
- Ground heat flux (G) at Playa is well captured / slight over-prediction at Sagebrush

SEB

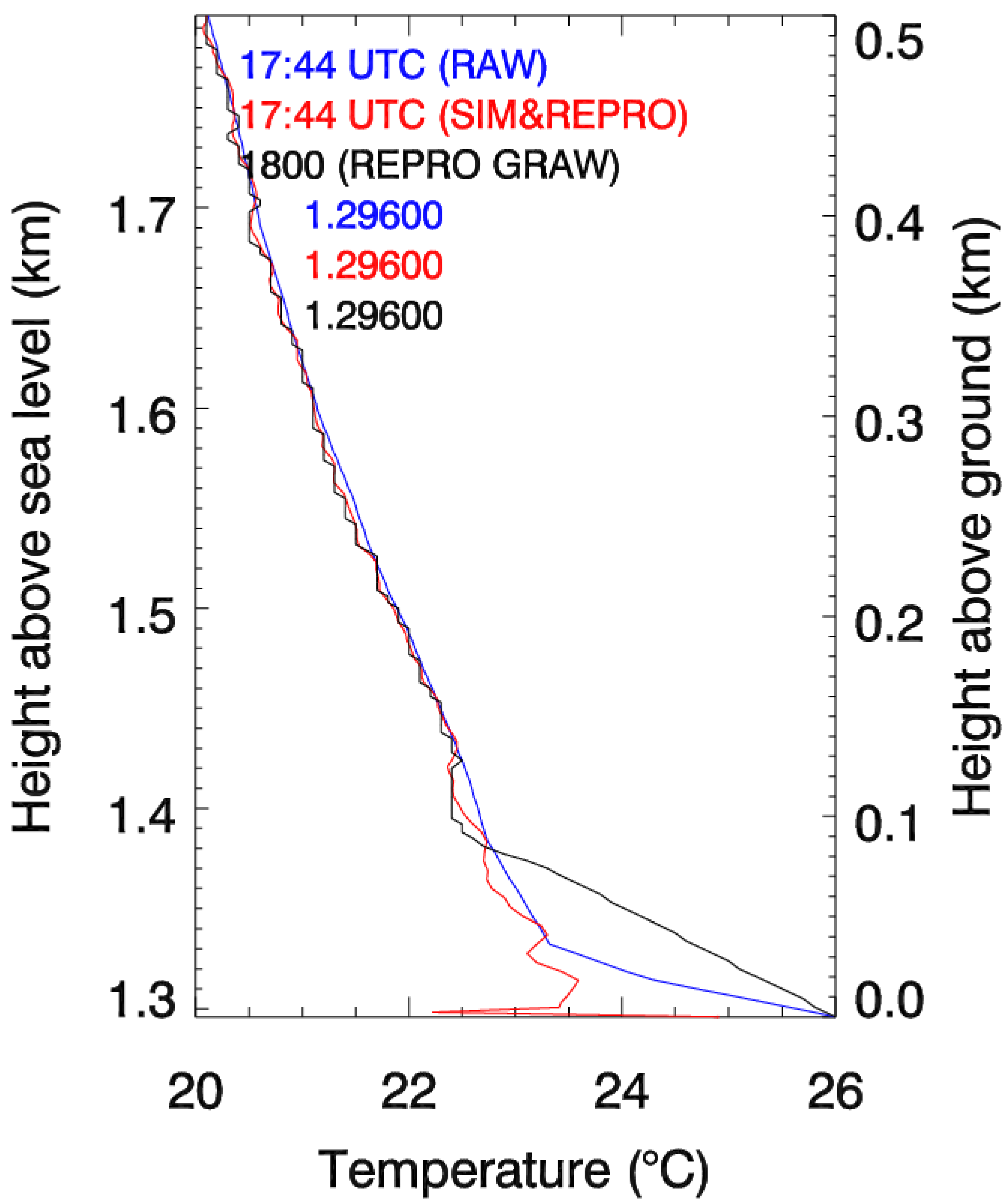
OCTOBER 2012 / FALL / MH-X1 MAY 2013 /SPRING / MH-X2



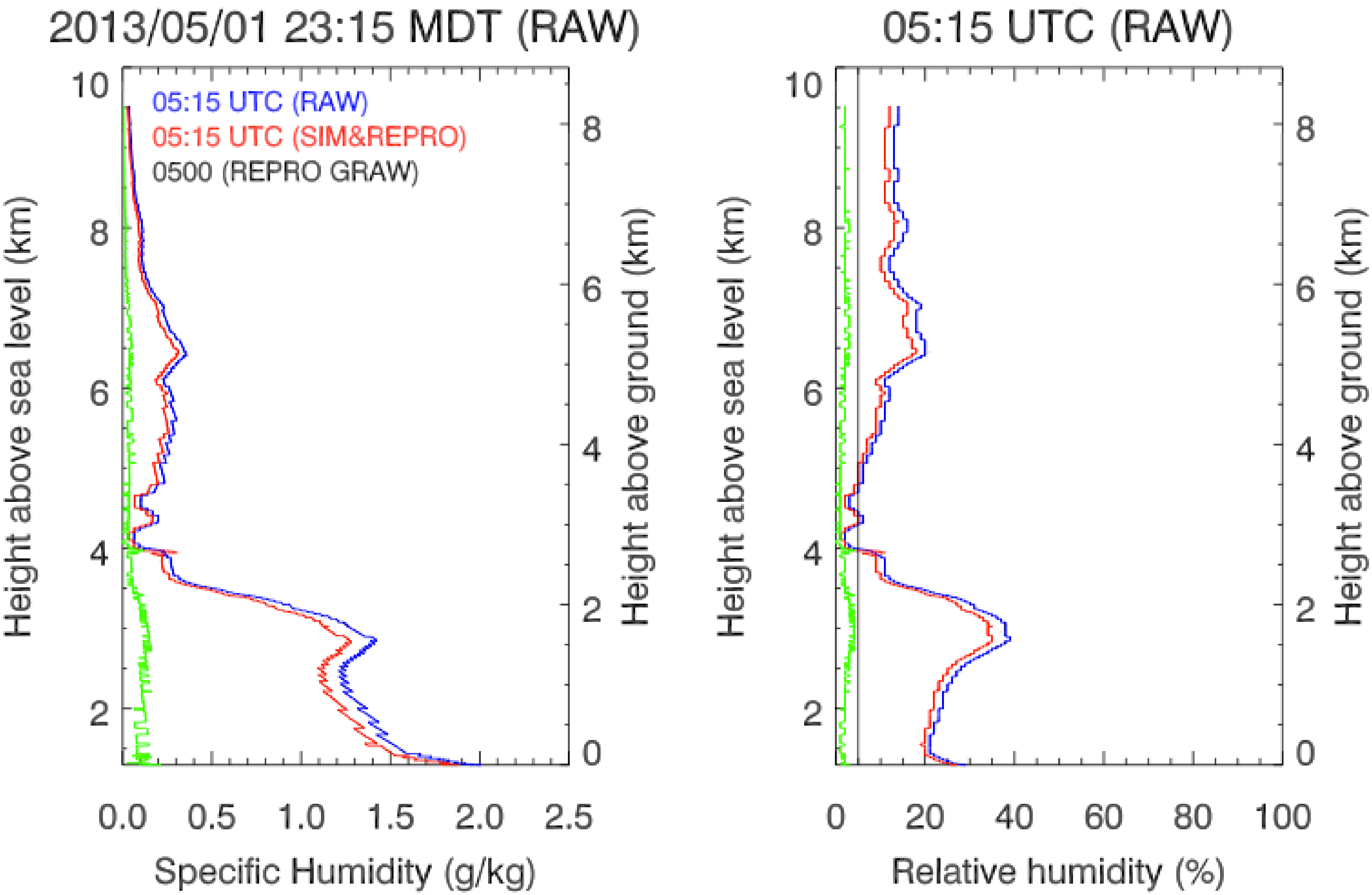
- The energy balance is closed at night.
- A significant residual term remains during daytime when observation do not close the energy balance. WRF simulations show a higher sensible heat flux than observations, closing the balance.
- Representativeness of albedo?

… a word about … RADIOSONDES & QC

- Issue with reprocessing software
- Moisture error introduced
- Currently working with GRAW technicians to solve the issue



Moisture error



Acknowledgements

- **Office of Naval Research ONR**
- Dugway Proving Ground
- All MATERHORN participants

Site	EFS-Sagebrush		EFS-Playa	
Season	Fall	Spring	Fall	Spring
Albedo [-]	0.27	0.24	0.31	0.33
Thermal Conductivity [W m^{-1} K^{-1}]	0.59	0.73	0.98	0.79
Roughness, z_0 [m]	0.24		6×10^{-4}	

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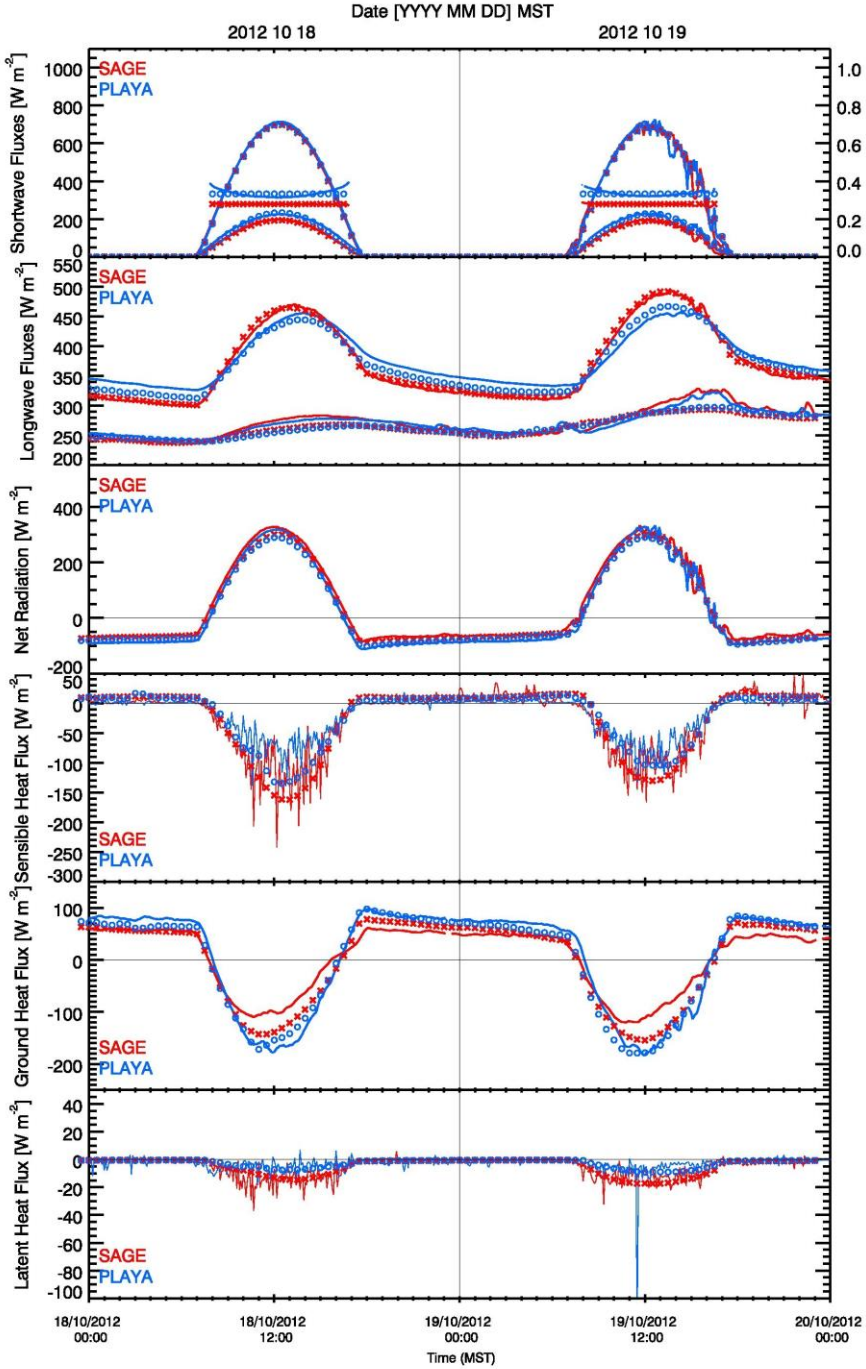

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