The directory \\psd2app\psd3data\arctic\barrow\ARM_site\SEB_data contains preliminary surface energy budget files from the Barrow ARM site for 2003-2014, and include bulk turbulent fluxes calculated from a modification of the Andreas et al (2010) bulk scheme to be applicable over land. The scheme modifications include determining if the tundra is snow-covered or just grass-covered, and estimation of soil moisture (see description below). Simple thresholds for the surface albedo are used for both. These thresholds are based on the statistical performance compared to the covariance fluxes at the ARM site from 2014. The latent heat flux is the most sensitive parameter to these thresholds.

Two key data streams (upwelling shortwave and longwave radiation) are missing from the ARM archives for YD202 2011 to YD180 2013. Hence, no surface temperature is available for this time period, and therefore neither the bulk turbulent fluxes nor the net surface energy flux could be calculated. Basic quality control of the key parameters and radiative fluxes from the ARM site have been done, include selection of the most physically reasonable value when more than one value is available for a parameter, so the data is considered to be an improvement on that directly available from the ARM site.

The 10-minute data are provided as Matlab files, netcdf files and png files. The png files show the annual plots of many of the variables. While these data are considered preliminary, the comparisons with the 2014 covariance fluxes are satisfactory (e.g., $R^{\wedge 2}$ ~0.68-0.75). I will also be writing up the bulk flux - covariance flux comparisons and the changes I made to the Andreas et al 2010 scheme to be more appropriate for a terrestrial site.

Turbulent Heat Fluxes at the ARM NSA Site

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Feb. 20, 2015

Radiation measurements have been made for many years at the North Slope of Alaska (NSA) ARM site near Barrow, AK. However, sensible and latent turbulent heat fluxes have only been directly measured by covariance techniques for part of 2013 and 2014. Because the turbulent heat fluxes are important terms in the surface energy budget (SEB) along with the radiative terms, it is desirable to obtain reliable estimates of the turbulent heat fluxes for a much longer period than is available from the covariance turbulent fluxes. Hence, in order to better understand the SEB over many years at the NSA site, a bulk scheme for the turbulent heat fluxes is used and compared to the covariance fluxes for 2014. This bulk flux scheme is based on the Andreas et al (2010a,b) scheme intended for sea-ice conditions, but modified for a terrestrial site. The modifications to this scheme are summarized below. Comparisons of the bulk fluxes from the modified scheme with the covariance fluxes available at the NSA site are shown in Fig. 1. These fluxes have so far been used for evaluating surface energy budget responses to cloud processes (Shupe and Persson 2015a,b,c).

Scheme Modifications:

Combine SHEBA sea-ice parameterization (Andreas et al 2010a,b) with modifications for land sites:

Arctic tundra – snow covered, grass (Barrow, Tiksi), rocks (Alert), mixed soil/grasses (Eureka)

Key parameters to consider:

- soil moisture content (MC) - % of saturation water vapor (100% snow/ice; < 100% land)
- roughness lengths (z_0, z_{0t}, z_{0q})

Preliminary optimized parameters for Barrow ARM Site (Validation period 1/1/2014-12/10/2014):

$\alpha \geq 0.25$ -- snow-covered tundra grass (assumed same as snow-covered sea ice from SHEBA)

MC = 100%; $z_0 = 4.5 \times 10^{-4}$ m; $z_{0t} = 1 \times 10^{-4}$ m; $z_{0q} = 1 \times 10^{-4}$ m (Andreas et al 2010)

$\alpha < 0.25$ -- tundra grass

MC = 88%; $z_0 = 2.0 \times 10^{-3}$ m; $z_{0t} = 4 \times 10^{-4}$ m; $z_{0q} = 1 \times 10^{-4}$ m (statistical testing)

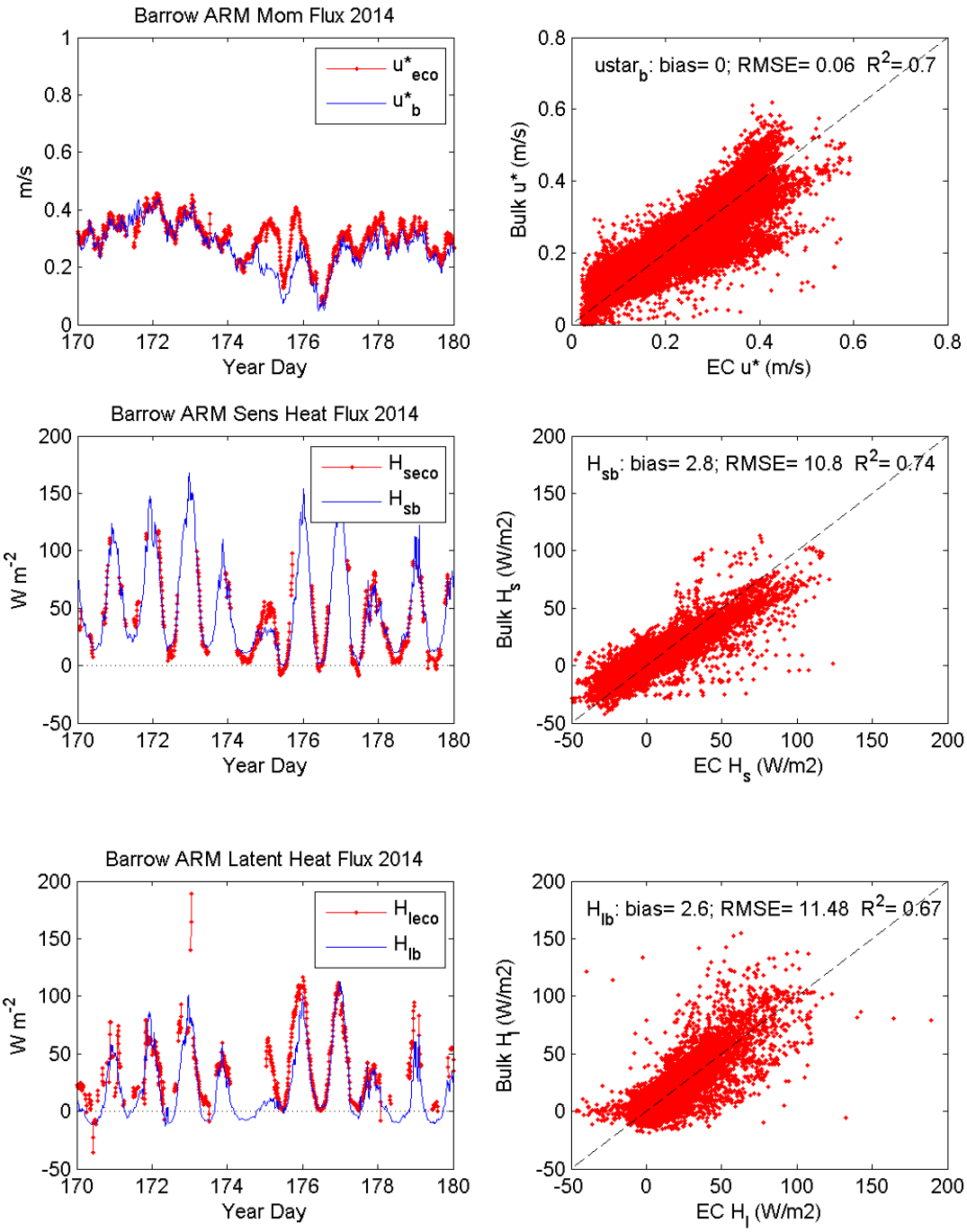

Fig. 1: Left column: Sample time series of eddy covariance (red) and bulk scheme momentum (top), sensible heat (middle), and latent heat (bottom) fluxes during 2014 at Barrow. Right column: statistical comparisons of the bulk fluxes with the eddy covariance fluxes at Barrow for the entire 2014 year.

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