Panalytical (Inc.) SW Spectroradiometer at WAIS Divide Ice Camp Dec 2015 – Jan 2016

- Retrieval of single-phase cloud $\tau_c$ and $r_e$ in climatological summer conditions followed by warm surface melt event (Nicolas et al. 2017)
- Wilson et al., 2018: JGR, doi:10.1029/2018JD028347

MFRSR and SKYRAD at McMurdo Station during 2015-16 summer season

- Retrieval of mixed-phase cloud $\tau_c$ from MFRSR
- Identification of prevailing meteorological regimes using $k$-means clustering ➔ influence on surface flux
- Scarci et al., 2019: GRL, in review

The ARM West Antarctic Radiation Experiment (AWARE) was jointly supported by DOE ARM/ASR and NSF Office of Polar Programs.
WAIS Divide Ice Camp

- Small equipment suite optimized for surface energy budget (SEB) measurement
- In location highly relevant for sea level rise
- 4 Dec 2015 – 17 Jan 2016
AWARE sampled major surface melt event Jan 10-18 2016

Atmospheric “river” brought huge impulse in temperature and moisture

Measured SEB diagnoses cloud LW & SW role
SW Spectral and MPL Data

- Left: Micropulse Lidar (MPL) data identify cloud phase via depolarization ratio
- Below: Information content in SW spectra, particularly in 1.6-μm window

**Clear Sky – Liquid Water Cloud – Ice Cloud**

Ice clouds of similar $\tau_c$, different $r_e$
(DISORT-based lookup table, least-squares minimization technique adapted from McBride et al. (2011))

Results suggest a bimodal $r_e$ distribution before melt event

Right: Concurrent MODIS retrievals are qualitatively consistent with AWARE results
Correlating $r_e$ with sonde moisture: Smallest $r_e$ are in driest environment (pre-melt)
AMF2 on Ross Island

AMF2 deployed at the CosRay site
- ~1 km from McMurdo Station
- Best compromise for hemispheric radiometry
- Dec 2015 through Dec 2016

- Lots of great instruments, but no SW spectroradiometer until Feb 2016
- First summer – we use MFRSR and SKYRAD to examine cloud properties and their influence on SW surface radiation
Using \( k \)-means clustering we identify four prevailing meteorological regimes

1. Blocking high over Amundsen Sea, northeasterly onshore flow
2. Low over Bellingshausen Sea causes outflow of continental polar air
3. Anticyclonic flow over Ross Sea advects marine air toward Ross Island
4. Large-scale cyclonic flow brings air from over Transantarctic mountains
We use MFRSR 870-nm channel to retrieve cloud optical depth. Averaged over 10 minutes to eliminate autocorrelation (Bretherton et al. 1999). TSI total cloud cover >95% for overcast skies. Radiative transfer – surface irradiance is simple monotonic function of $\tau_c$. Smaller range of $\tau_c$ for regime 2 (cold) and regime 3 (warm, infrequent). Larger and similar ranges of $\tau_c$ for regime 1 (warm onshore) and regime 2 (orographic).
We find statistically significant differences between clusters, in constant $\tau_c$ bins

Average SKYRAD flux difference between regimes 1 and 4 is 6.6 W m$^{-2}$
MODIS cloud data product shows greater cloud liquid water in warm, onshore flow regimes and greater ice content in orographic regime.

MODIS also shows greater cloud geometrical extent for the cold regime (2) and particularly the orographic regime (4).

THANKS!  QUESTIONS?