Atmospheric Moisture and Cloud Cover Characteristics Forecast by AMPS

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Outline

- Study period from December 2003 – February 2005
  - Relative humidity at McMurdo and South Pole
  - Cloud fraction (CF) at McMurdo, nearby runways, and South Pole
- January 2006
  - Pseudo Satellite Product Skill
- Investigation into sources of model error
- Conclusions

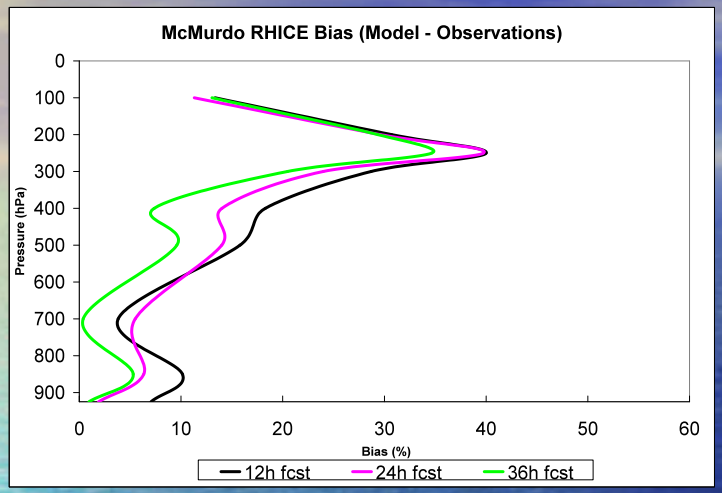
Results from: Fogt, R.L, and D.H. Bromwich, 2007: Atmospheric moisture and cloud cover characteristics forecast by AMPS. *Wea. Forecasting*, provisionally accepted.

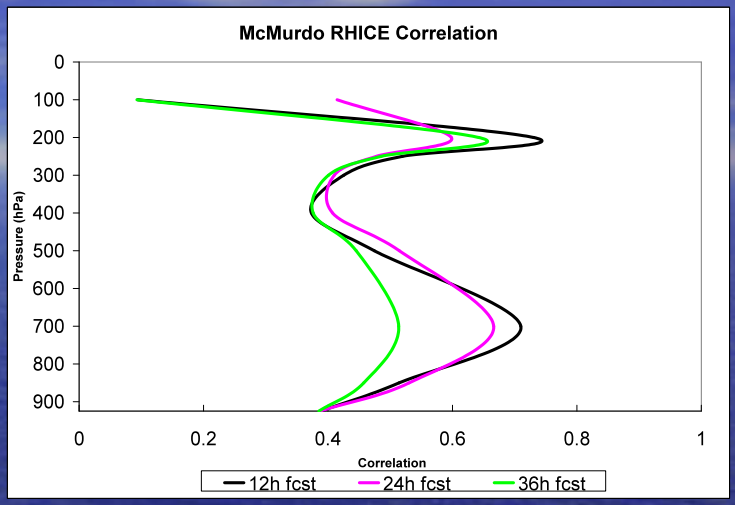
Relative Humidity Performance

Bias

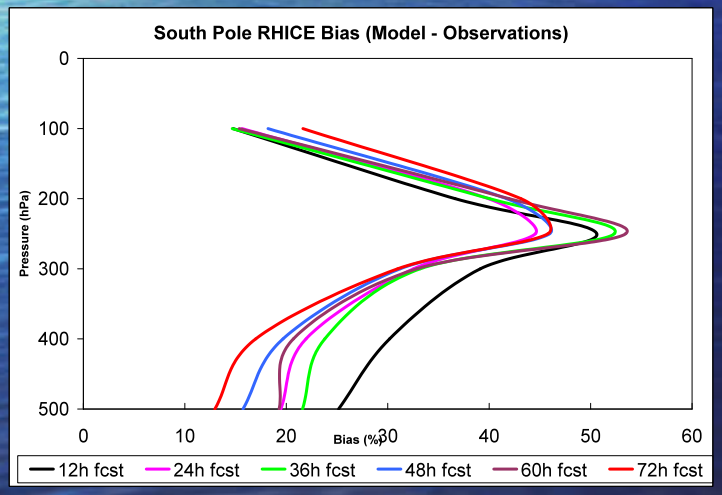
Correlation

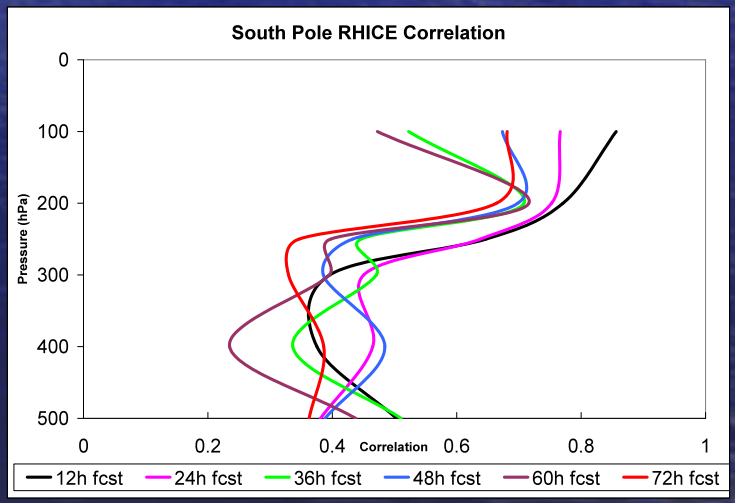
McMurdo





South Pole





Both stations show a positive bias that increases up to ~ 200 hPa, the mean height of the tropopause. The correlation ranges from 0.4 – 0.8 and is highest at ~200 hPa with another peak at 700 hPa at McMurdo. Skill decreases slightly with forecast hour.

Cloud Fraction (CF) Performance

location	season	# obs	mean obs CF	Old CF Algorithm bias	Old CF Algorithm correlation	New CF Algorithm bias	New CF Algorithm correlation	p-level
McMurdo	summer	1688	0.620	-0.137	0.394	-0.050	0.394	0.000
Williams Field	summer	1090	0.632	-0.201	0.345	-0.113	0.342	0.000
Pegasus South	summer	419	0.698	-0.136	0.364	-0.021	0.369	0.000
McMurdo	fall	505	0.576	-0.087	0.459	0.009	0.453	0.001
McMurdo	winter	445	0.358	0.028	0.419	0.105	0.389	0.013
McMurdo	spring	802	0.638	-0.038	0.428	0.050	0.457	0.000
South Pole	summer	1652	0.569	-0.250	0.427	-0.129	0.455	0.000
South Pole	fall	851	0.449	0.048	0.506	0.178	0.428	0.000
South Pole	winter	663	0.416	-0.092	0.481	0.071	0.468	0.000
South Pole	spring	765	0.595	-0.128	0.566	-0.002	0.534	0.000

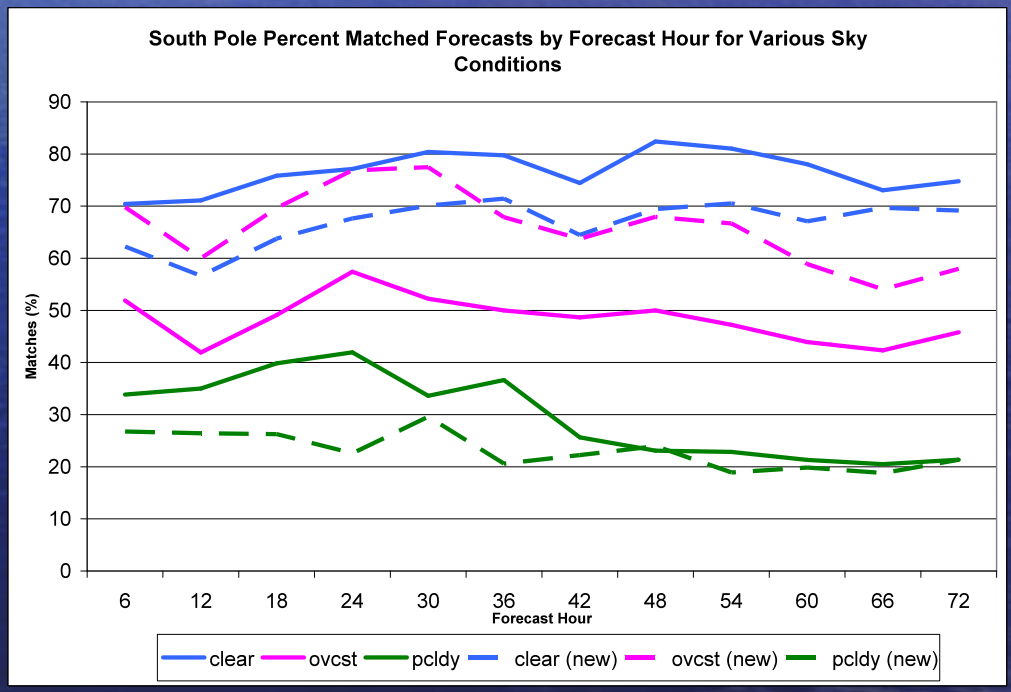
$$CF = \tau = \sum_{sfc}^{toa} (0.1CLWP + 0.0735CIWP)$$ old

$$CF = \tau = \sum_{sfc}^{toa} (0.075CLWP + 0.170CIWP)$$ new

- Modifying CF algorithm produces a near zero bias in roughly all seasons and for both McMurdo and South Pole
- Correlation does not improve suggesting changes to the cloud liquid water content and / or timing of the clouds is needed to improve CF variability
- Nonetheless, AMPS does a good job predicting overall CF amount using new algorithm

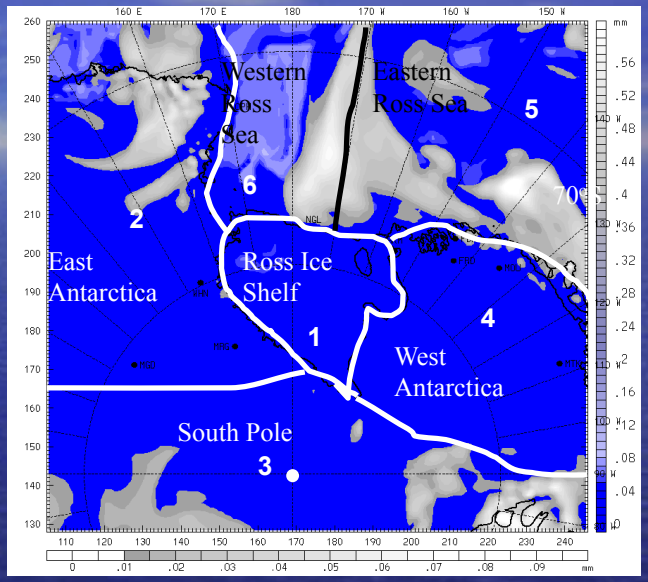
CF Performance by Forecast Hour, South Pole

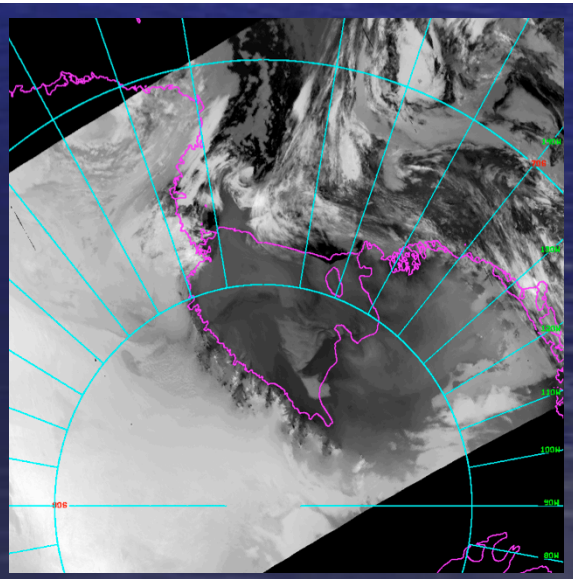
- CF performance is highest for clear conditions using old algorithm (solid lines)
- Using new algorithm (dashed lines), the performance for clear is roughly equivalent to overcast conditions, while the decreasing skill with forecast hour for partly cloudy conditions is removed



Pseudo Satellite Product --Further Testing

- Compared 35 pseudo satellite forecasts against satellite imagery (as at right) during January 2006
- Evaluated forecast skill separately for high (based on CICE) and low (based on CLW) clouds, using 2x2 contingency tables





AMPS \ observations	yes	no
yes	a	b
no	c	d

Low Clouds in Pseudo Satellite Product

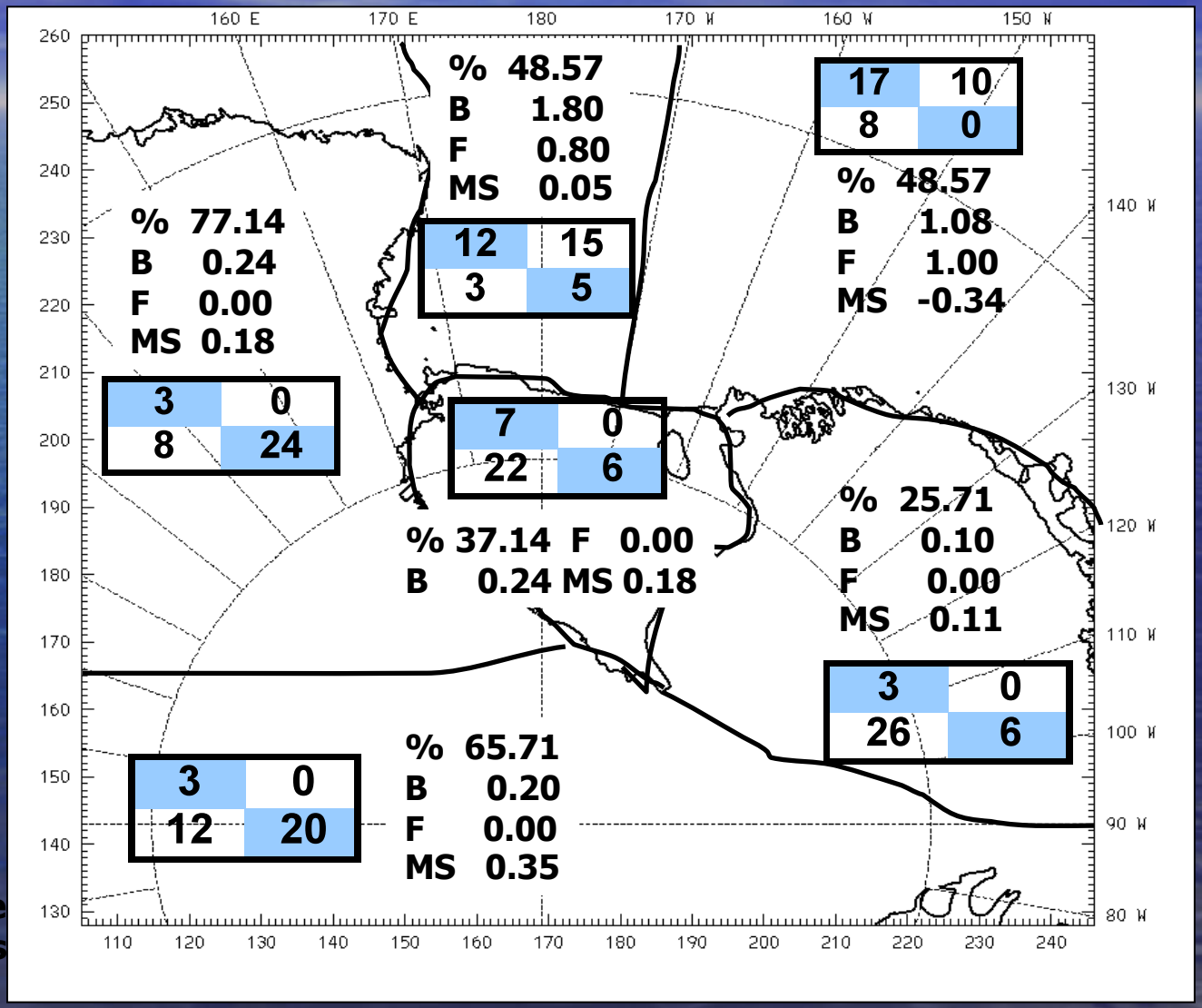
AMPS \ observations	yes	no
yes	a	b
no	c	d

% = percent correct
=(a + d) / 35 * 100

B = bias
= (a + b) / (a + c)

F = false alarm
= b / (b + d)

MS = mean skill
= the mean of 3 different statistical skill scores.
Perfect forecasts receive skill scores of 1, forecasts better than random chance receive positive skill scores and vice-versa.



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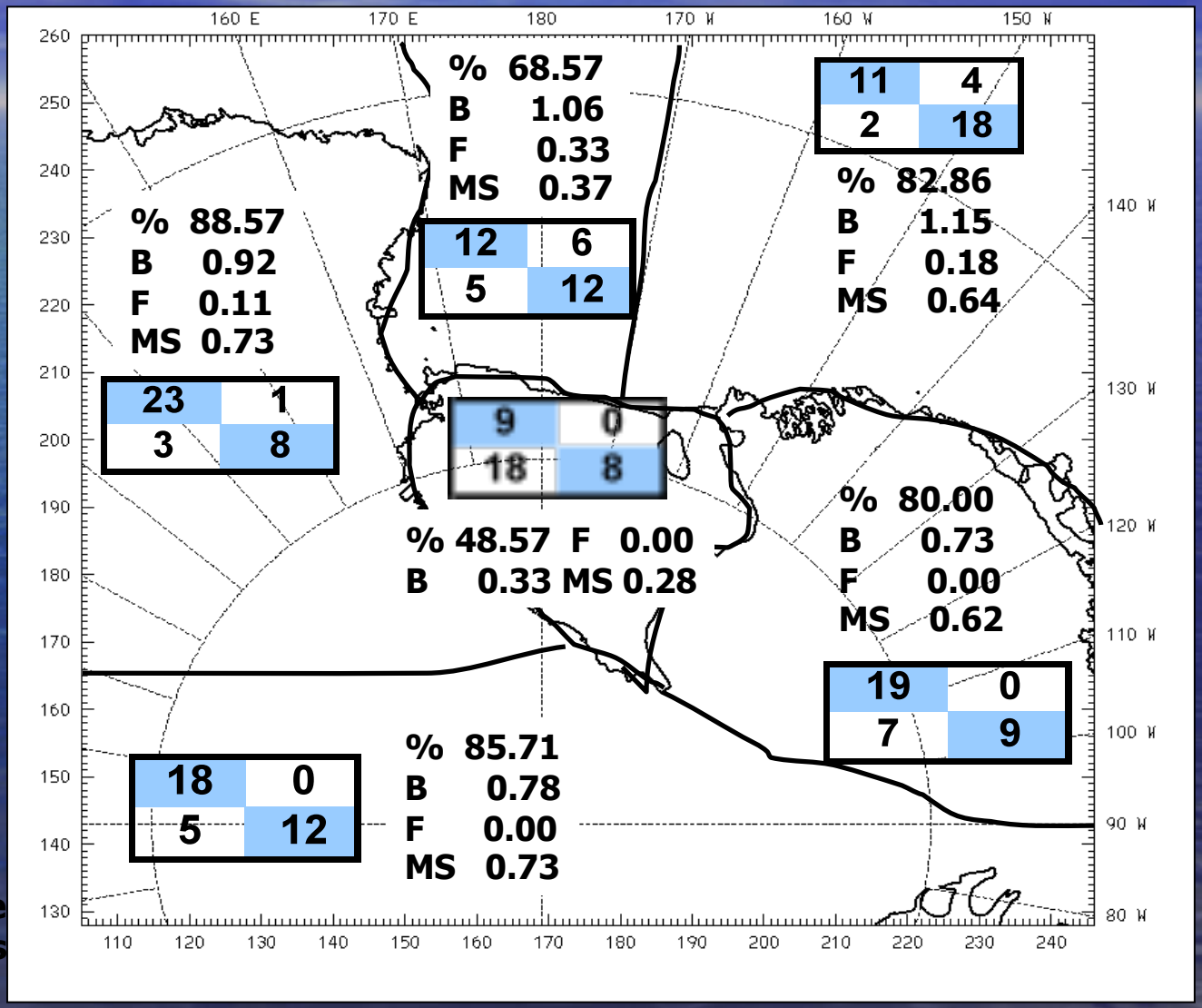
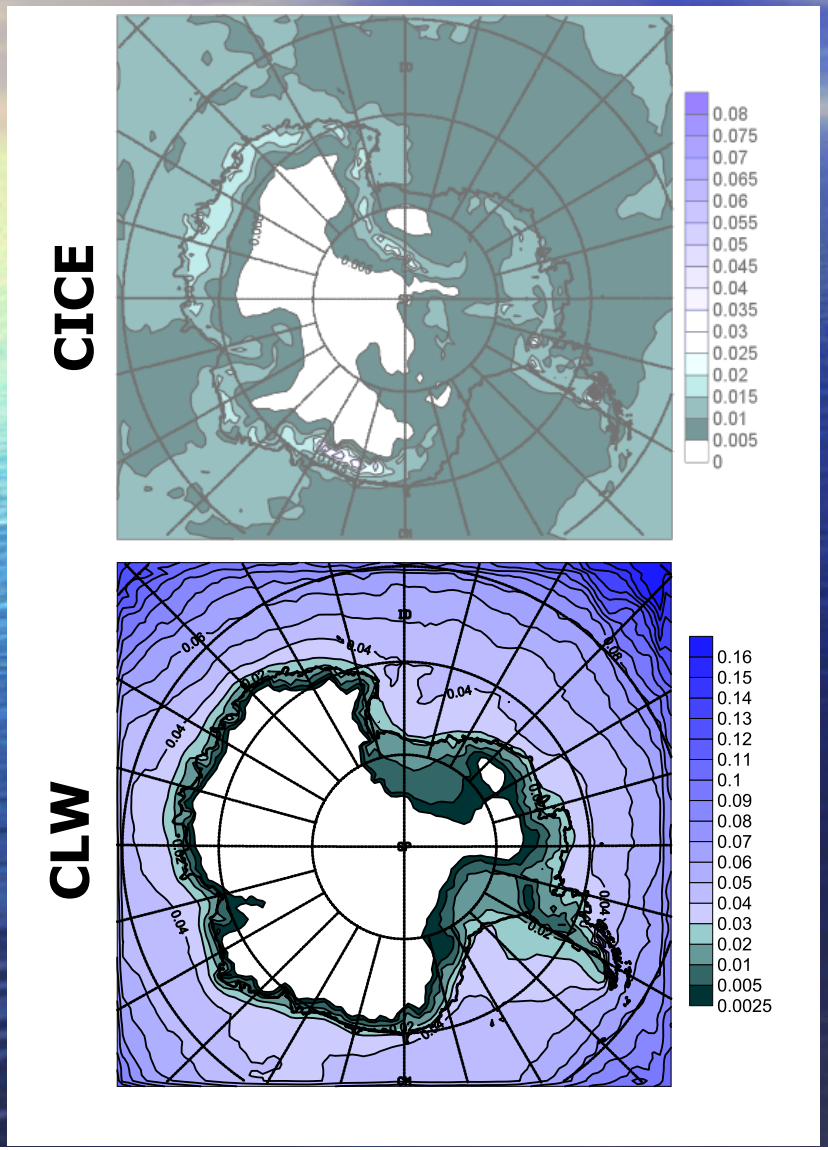


CF vs. Pseudo Satellite Performance

- Why low CF bias, but problems accurately modeling low clouds?
  - Diagnostic CF algorithm (especially new algorithm) is more dependent upon CICE content than CLW
  - Observations at McMurdo and South Pole indicate high clouds dominate total CF
- Low CF correlation is likely a combination of insufficient CLW (supercooled water / mixed phase clouds) in the model and inaccurate timing of cloud movement

CICE vs. CLW in AMPS



- Mean summer CICE (top) and CLW (bottom) in AMPS given the 2m relative humidity > 80%
- Model depicts CICE content everywhere, but no CLW in the interior and little over the Ross Ice Shelf
- Observations, however, do indicate the presence of supercooled liquid water in clouds at Pole (mostly in Dec – Jan) as well as on the Antarctic Peninsula (also in summer).

Conclusions

- There is excessive moisture in the model near the tropopause, with relative humidity correlations around 0.4 – 0.6
- AMPS predicts high cloud movement and coverage well, leading to a low bias in the CF, especially with a modified algorithm that gives much more weight to CIWP
- Improvements are needed in the representation of supercooled liquid water / mixed phase clouds in the model in order to better predict low cloud coverage, which will likely improve the CF correlation
- Nonetheless, the prediction of high cloud cover and CF amount in AMPS is above that for other regional mesoscale models