Assessment of the Model for Prediction Across Scales (MPAS) in AMPS

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AMPS

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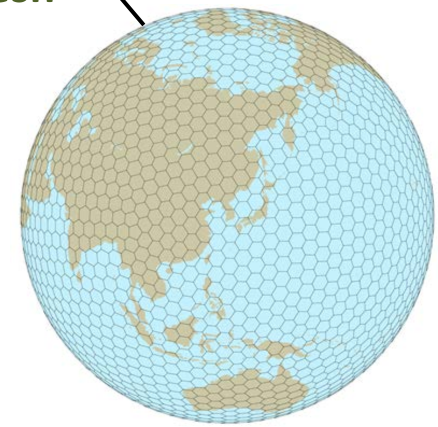
Background

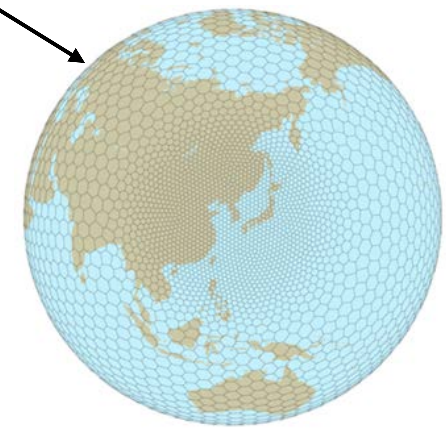
- **MPAS: Model for Prediction Across Scales**
  - Global atmospheric NWP model designed to simulate down to the cloud-resolving scales

    http://mpas-dev.github.io/

  - Global mesh required
    - Regional refinements supported
    - No limited-area capability (e.g., WRF) … yet
  - MPAS setup in AMPS: Variable-resolution mesh w/refinement over Antarctica

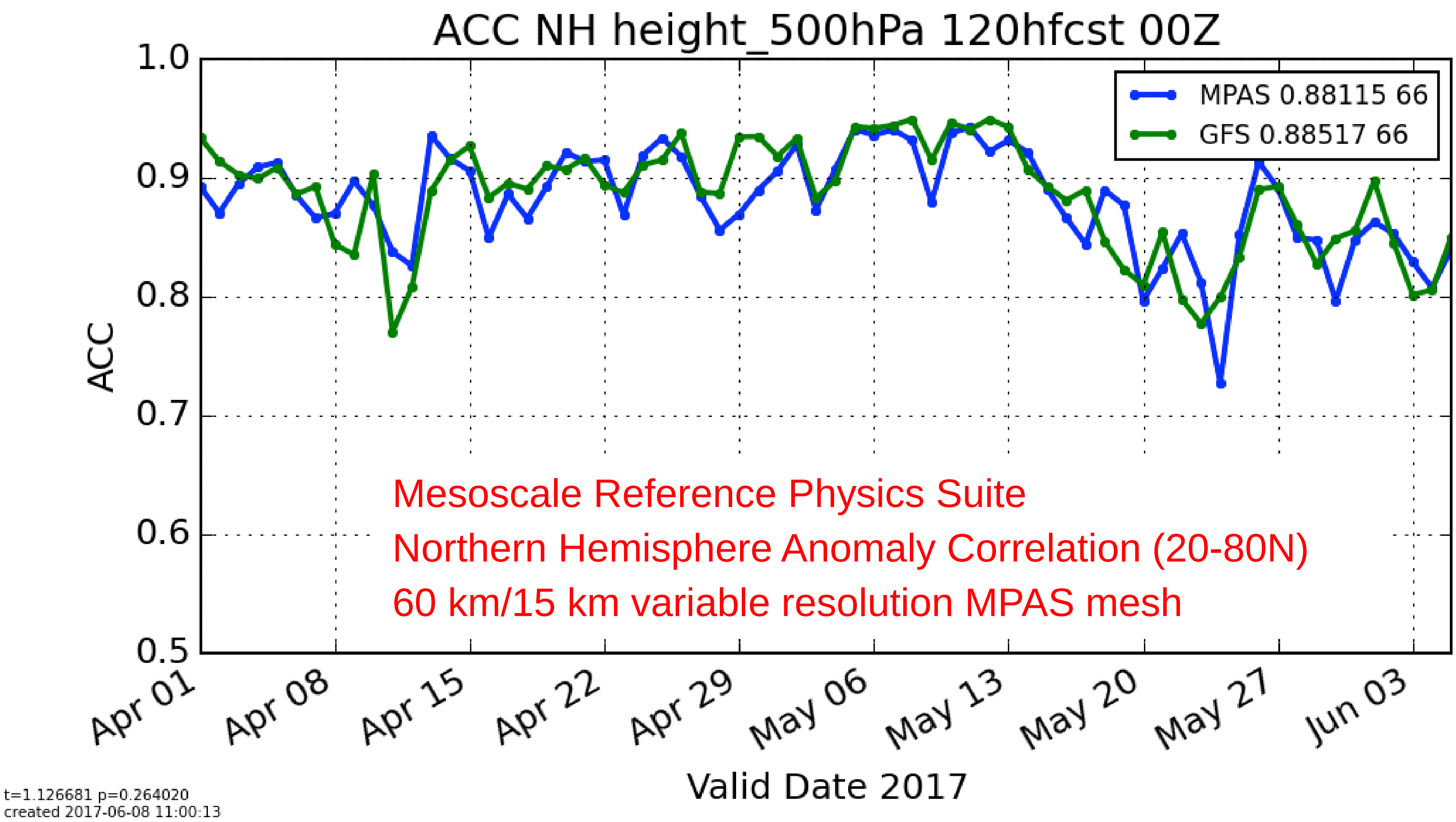
Uniform Mesh





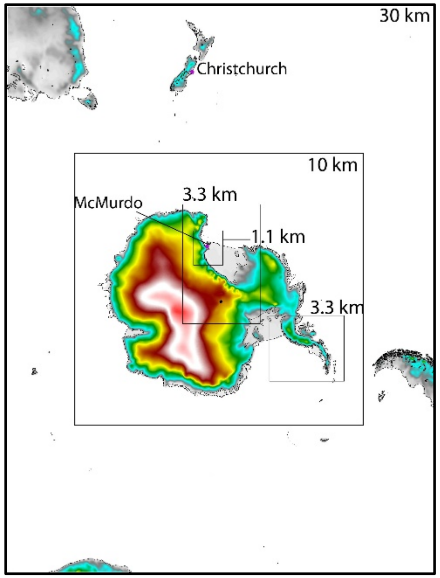
Variable Resolution Mesh

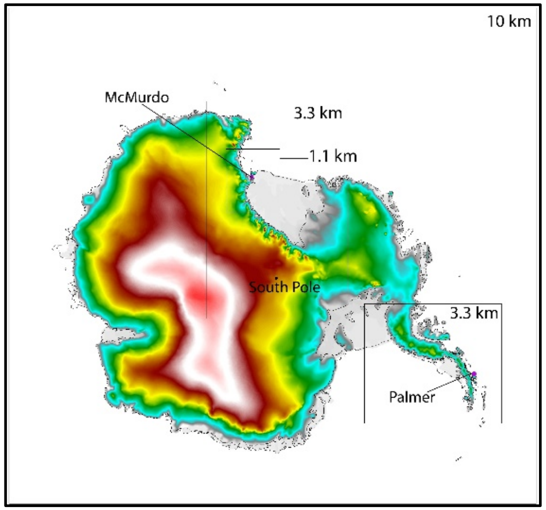
Recent MPAS Northern Hemisphere Evaluation

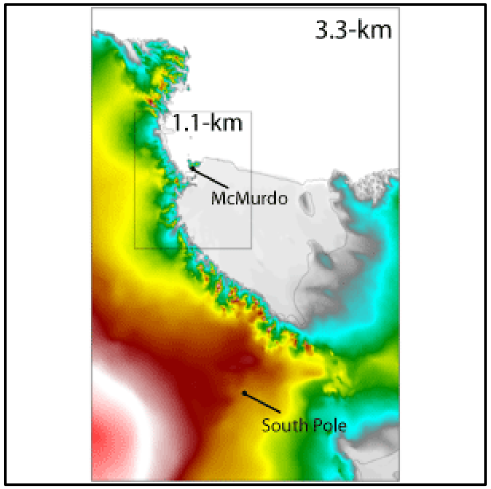


AMPS WRF and Model Configurations

- **Model Setups**
  - WRF domains: AMPS configuration 30/10/3.3/ 1.1-km
  - MPAS domain: 60-km global / 15-km Antarctic
  - Vertical levels: WRF: 61 MPAS: 46
  - Model Tops: WRF: ~31 km (10 mb) MPAS: 30 km (~12 mb)







AMPS WRF Domains

Terrain height shaded

Methodology (cont'd)

- **Differences in MPAS and WRF: Practical Constraints Prevent Identical Setups**

(i) Resolution: 10 km WRF (& finer) v. 15 km MPAS

(ii) Terrain data: RAMP2 (WRF) (200 m) v. GTOPO30 (MPAS) (30 sec)

(iii) Data assimilation & reanalysis: WRF– Yes MPAS– No

(iv) Subsurface temperature initialization: WRF–Cycled MPAS– GFS

(v) Physics: Not all WRF physics packages/versions available to MPAS

Different schemes	WRF	MPAS
♦ PBL:	MYJ	YSU
♦ Microphysics:	WSM-5	WSM-6
♦ SW rad:	Goddard	RRTMG

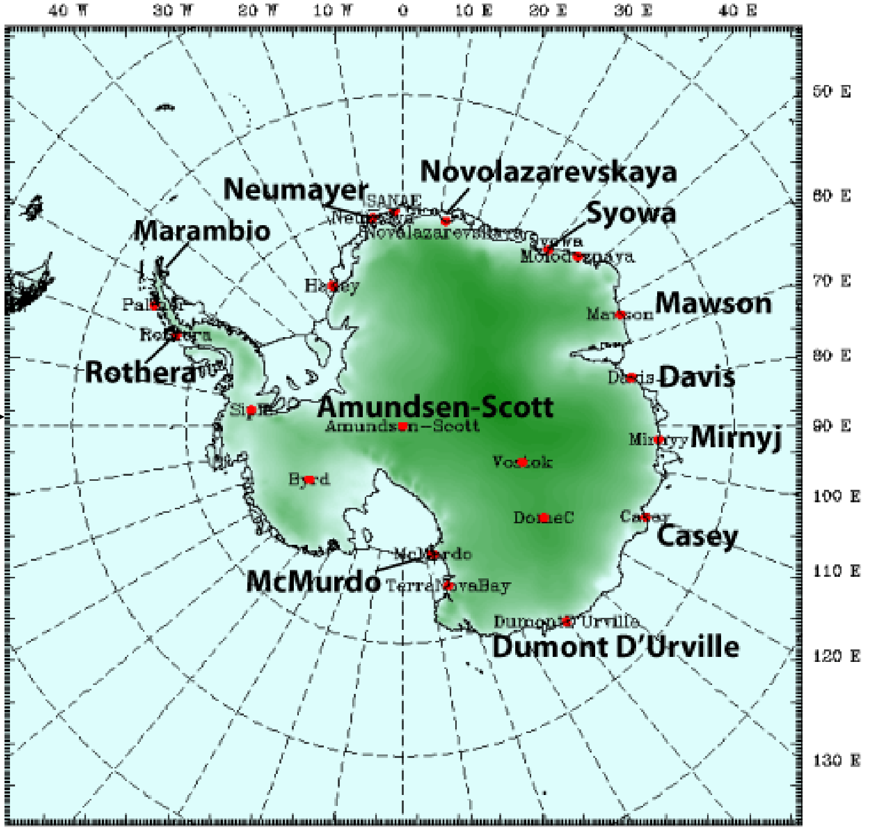
Common

- ♦ LSM: Noah ♦ Cu: Kain-Fritsch
- ♦ LW rad: RRTMG ♦ Surface layer: Eta

Methodology (cont'd)

- **Periods Examined**
  - (i) Winter (Jul.–Aug. 2016): Surface
  - (ii) Summer (Dec.–Jan. 2016–2017): Surface
  - (iii) Autumn (Apr.–May 2017): Upper air

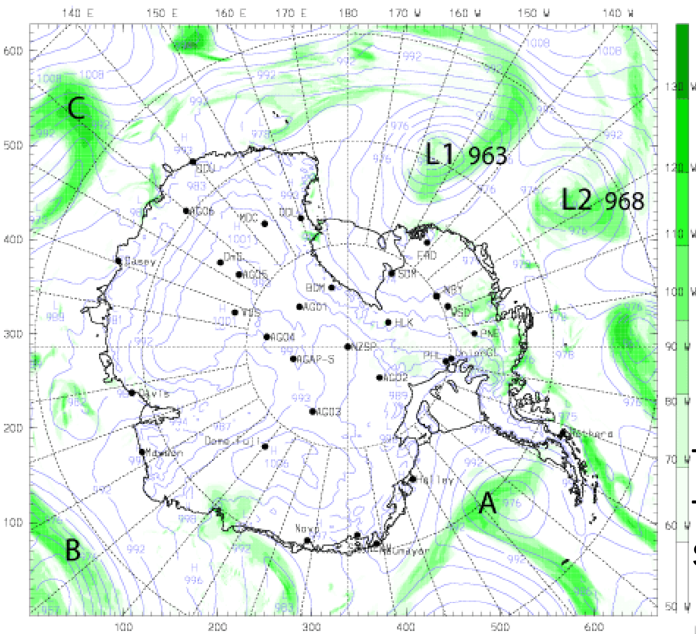
- **Model Verification**
  - Data:
    - AWS (~80 sites) for surface
    - Radiosonde (12 sites) for upper-air



  - Fields examined: T, Wind speed, Pressure, RH, U, V
  - Statistics: Bias, RMSE, Corr

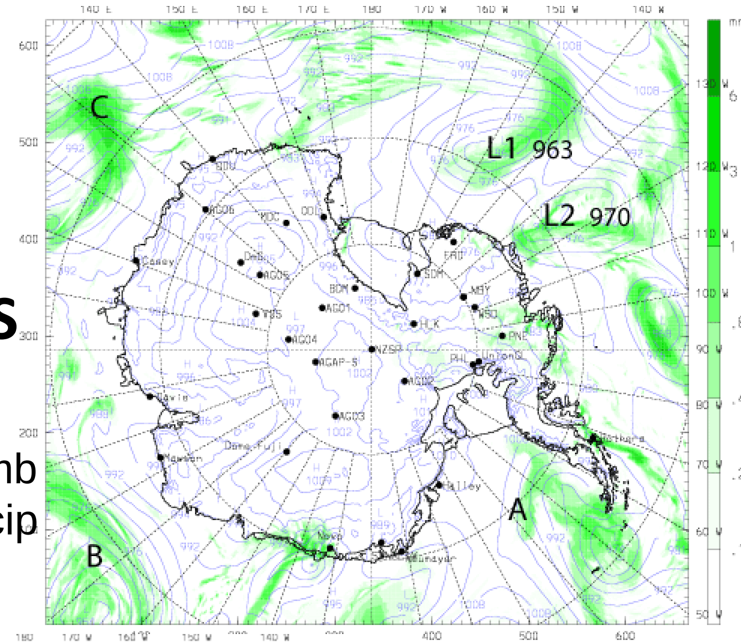
Forecast Comparison: WRF & MPAS (Hr 96)

1200 UTC 5 June 2017 (1200 UTC 1 June init)

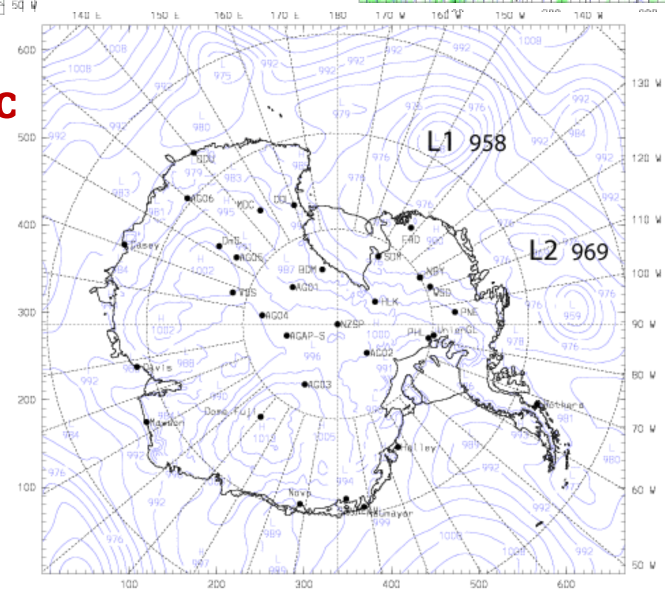


WRF

MPAS



– SLP: int= 4 mb
– 3-hourly precip shaded



Analysis

– **Correspondence of synoptic and mesoscale systems and precip areas**

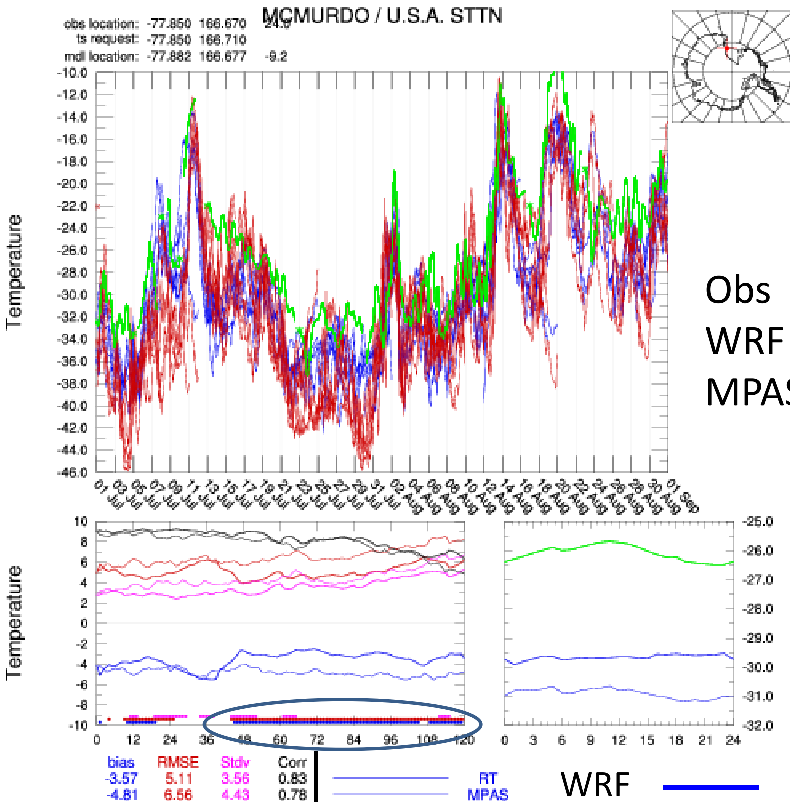
– Evolution similar through 96 hrs

(72 hrs more generally)

Verification Results– Surface

McMurdo— Temperature

Winter

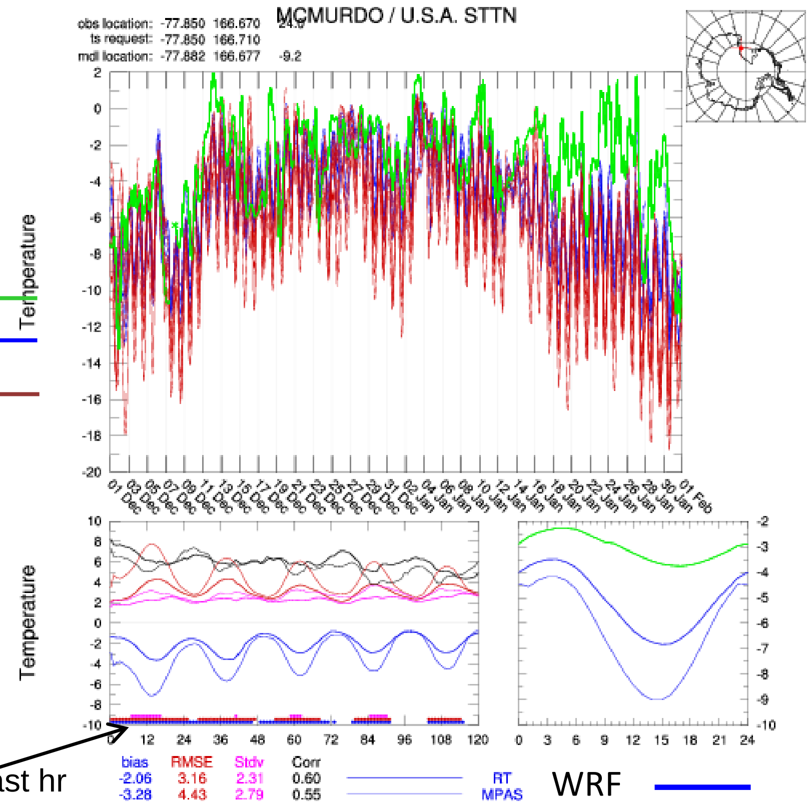


Obs
WRF
MPAS

WRF
MPAS

Stat significant difference

Summer



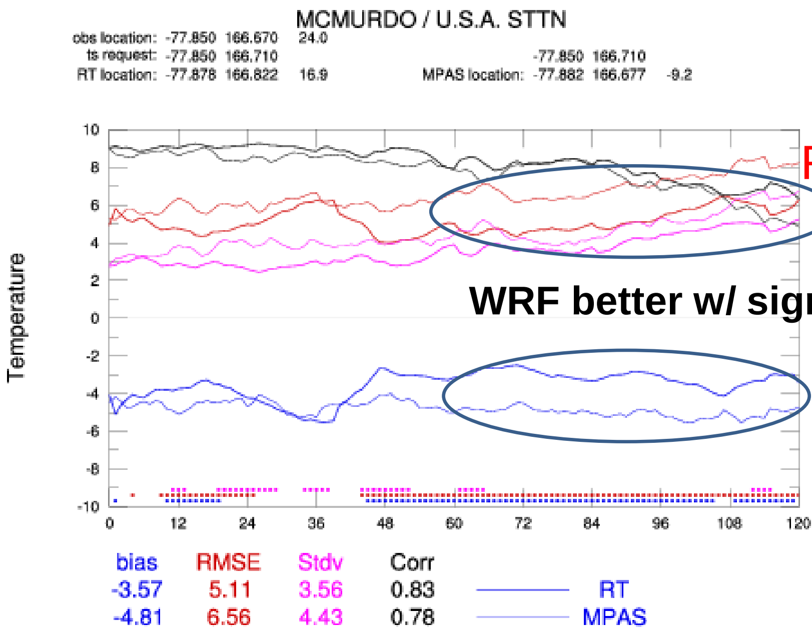
Forecast hr

WRF
MPAS

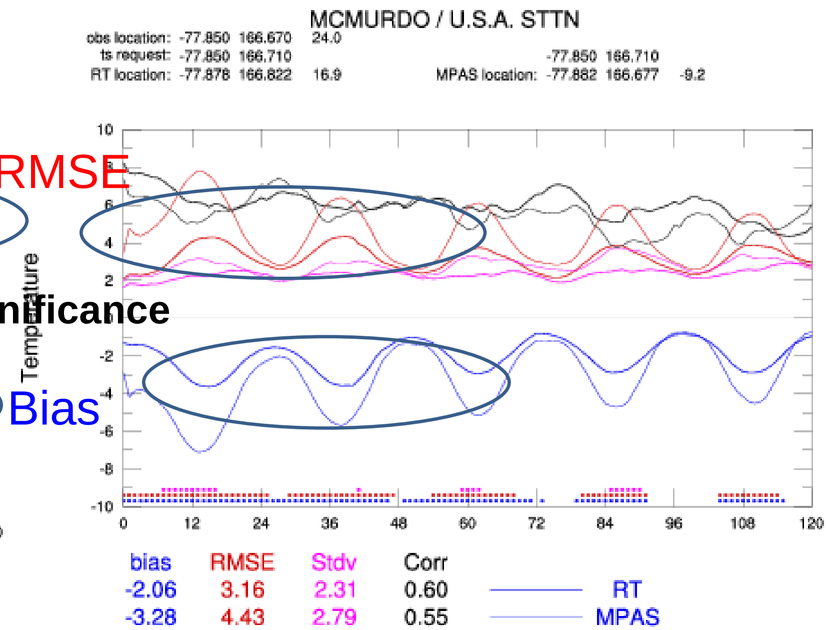
WRF & MPAS: Cold biases both seasons

McMurdo— Temperature Stats

Winter



Summer



Winter
Bias: WRF= -3.6C
MPAS= -4.8C

RMSE: WRF= 5.1C
MPAS= 6.6C

Bias
WRF
MPAS

Summer
Bias: WRF= -2.1C
MPAS= -3.3C

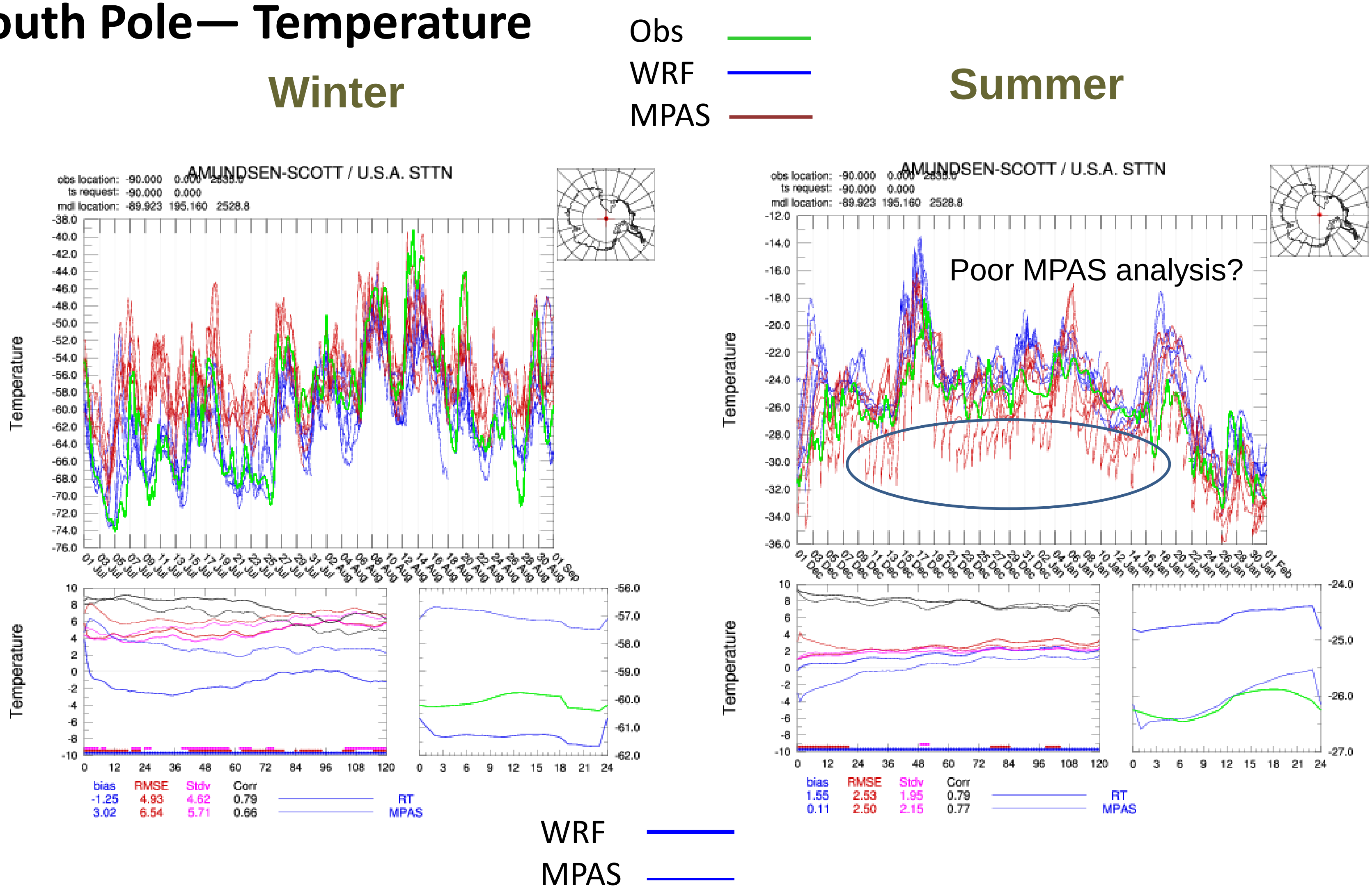
RMSE: WRF= 3.2C
MPAS= 4.4C

Winter— Increased error in *both* models

WRF: Lower bias, RMSE for both seasons

WRF & MPAS: Cold biases, both seasons

South Pole— Temperature



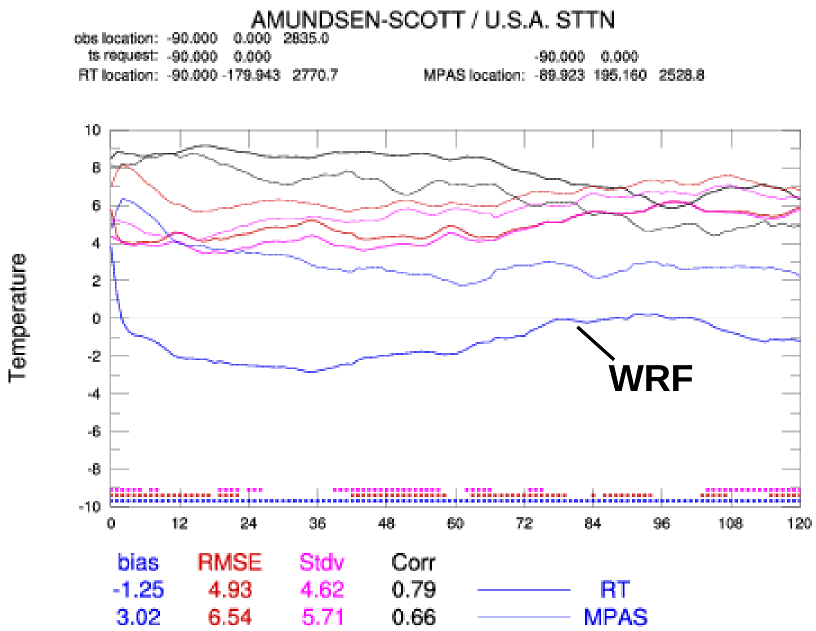
MPAS: Warm bias winter

WRF: Warm summer

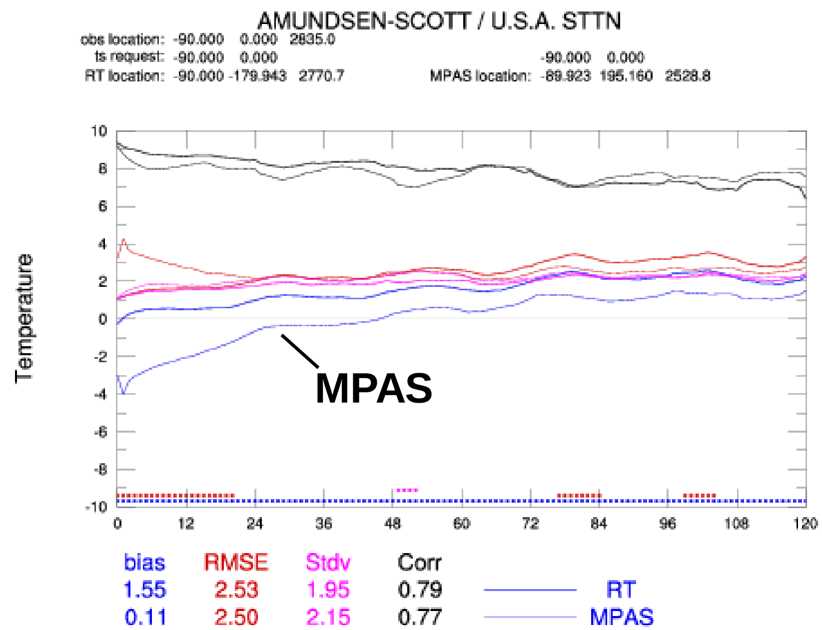
MPAS: Summer– Analysis error issue

South Pole— Temperature Stats

Winter



Summer



Winter
Bias: WRF= -1.3C
MPAS= 3.0C

RMSE: WRF= 4.9C
MPAS= 6.5C

<u>Bias</u>
WRF
MPAS

Summer
Bias: WRF= 1.6C
MPAS= 0.1C

RMSE: WRF= 2.5C
MPAS= 2.5C

WRF: Better winter

MPAS: Better summer

Both models: Winter— Increased error

Regional Surface T (°C) and Wind Speed (ms^{-1}) Errors

WRF better **MPAS better**

Summer

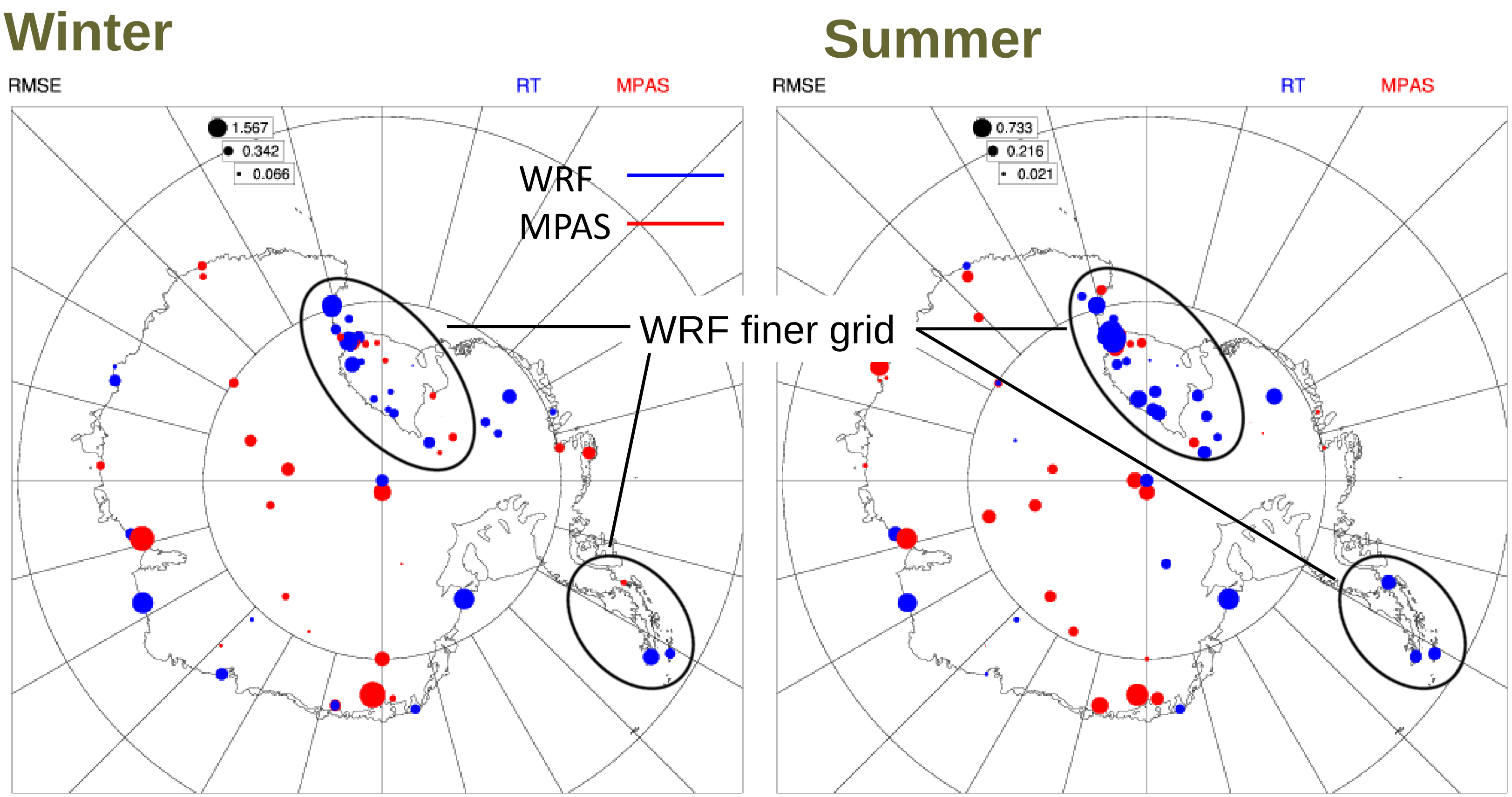
	T RMSE		WS RMSE	
	WRF	MPAS	WRF	MPAS
Ross Is.	2.49	3.05	3.42	3.63
East Antarctica	2.73	2.14	1.45	1.41
Plateau/Pole	2.55	2.77	2.40	2.55
Queen Maud Land	2.95	2.77	2.83	2.53
West Antarctica	2.46	2.72	2.54	2.68
Ant. Peninsula	2.29	3.08	3.41	3.79

Both models: Winter performance dropoff

Winter

	T RMSE		WS RMSE	
	WRF	MPAS	WRF	MPAS
Ross Is.	5.16	6.14	4.96	5.26
East Antarctica	5.08	7.24	2.49	1.93
Plateau/Pole	4.87	5.72	3.50	3.17
Queen Maud Land	5.39	5.30	5.77	4.83
West Antarctica	6.85	4.68	3.75	4.03
Ant. Peninsula	5.71	5.39	5.20	4.95

Sfc Wind Speed— RMSE – Performance varies by region



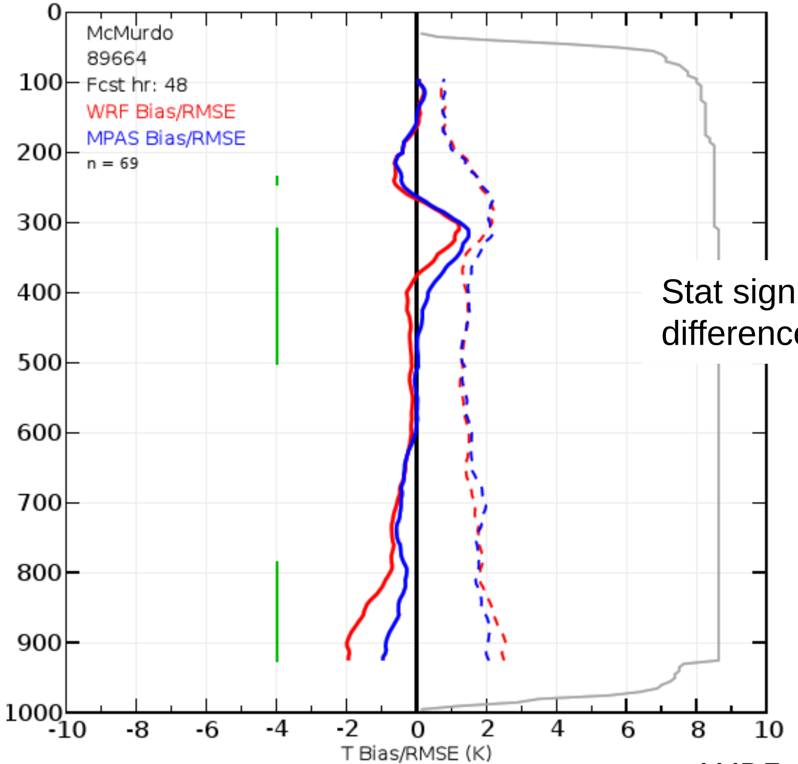
Wind Speed RMSE

WRF better: Ross Ice Shelf, Ross Is. region, West Antarctica, Peninsula

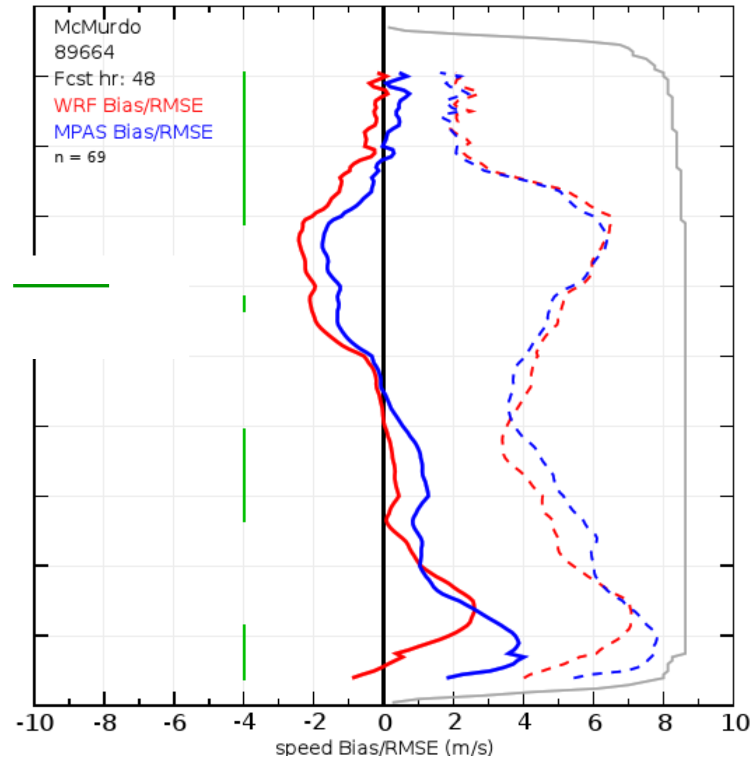
MPAS better: Plateau, East Antarctica, DML

McMurdo— Upper Air Verification (Hr 48)

Temperature



Wind Speed



Stat significant difference

WRF

MPAS

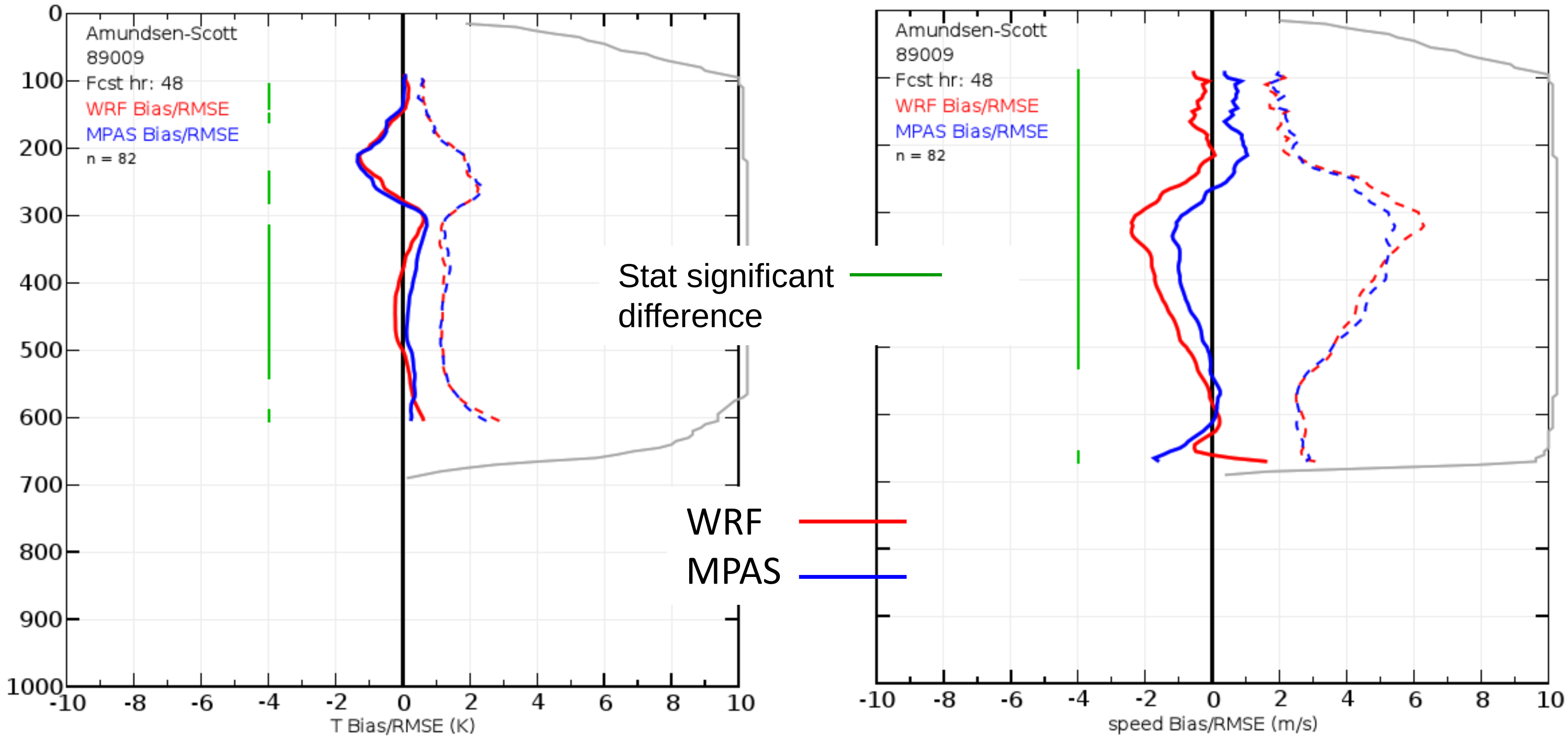
T: Low biases for both models / MPAS better lower trop

Wind speed: WRF better lower trop / MPAS better upper trop/lower strat

South Pole— Upper Air Verification (Hr 48)

Temperature

Wind Speed



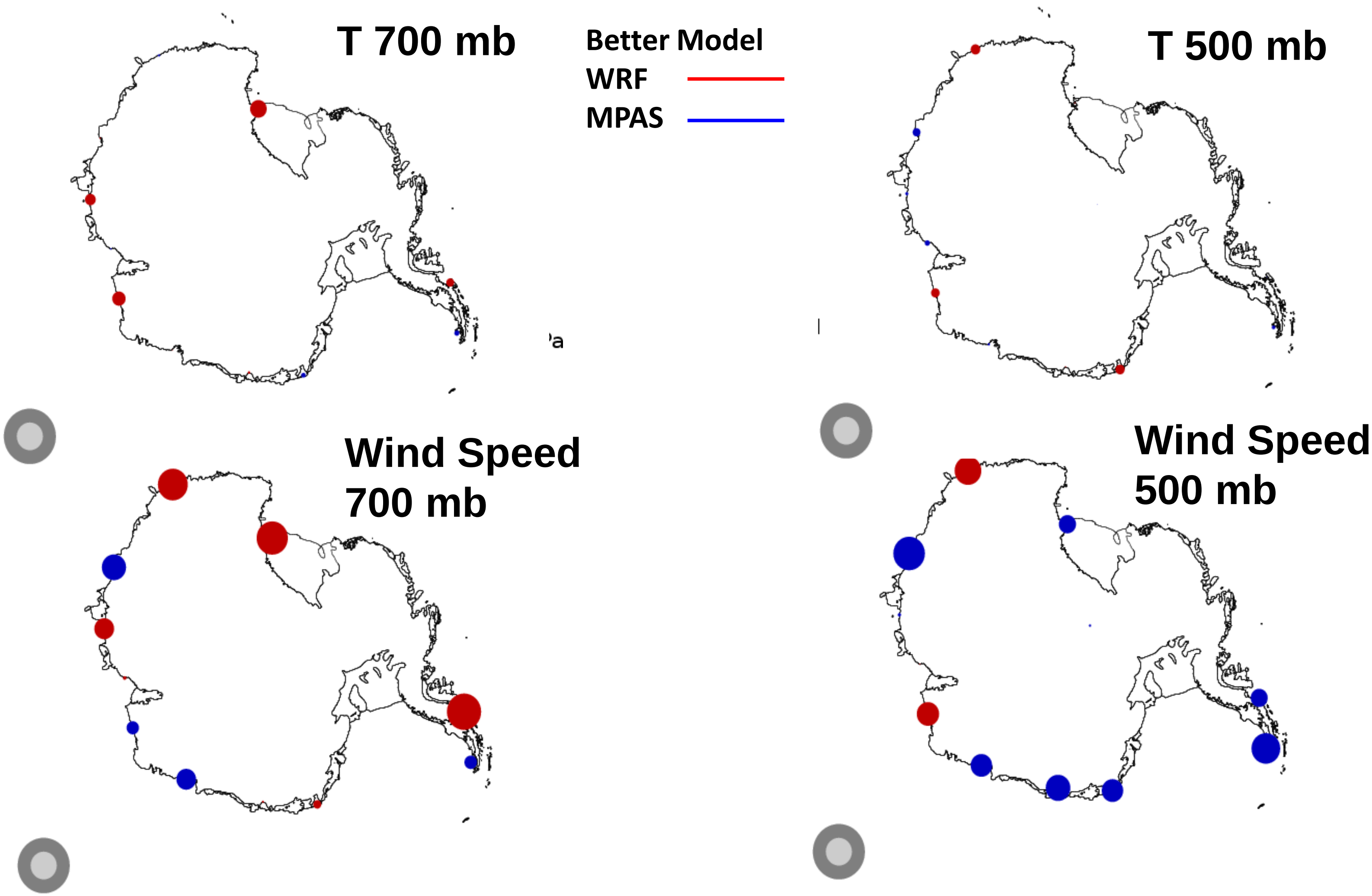
T: WRF generally better, but difference ('tho stat significant) is minimal

WS: WRF better lower trop and strat, MPAS better middle trop

Overall: T, WS biases are small, with no big differences between models

Upper Air Verification— Hr 48

RMSE differences: Size proportional to improvement



Overall: Balanced performance (mix of results aloft)

Summary

- **MPAS Assessment**

Synoptic/mesoscale forecast evolution

- ♦ WRF & MPAS progs in step w/producing same structures
- ♦ Fcsts close though 72 hr, solution divergence afterward

Sfc verification

- ♦ WRF overall better statistically than MPAS
- ♦ Both WRF, MPAS degrade in winter forecasts
- ♦ MPAS shows an analysis issue 2-m T

Upper-air verification

- ♦ Overall: Model error differences generally small: Balanced performance aloft
- ♦ MPAS relative performance (winds) tends to improve with height

→ Sfc physics, terrain resolution differences of less influence

Plans: Interoperability of WRF and MPAS

- ✓ Capability to process MPAS data to initialize/drive WRF
- ✓ *Git* version control software for source code management for both
- Development of common physics repository: Availability of WRF packages to MPAS
- Development of inter-model common physics driver (CPD): Supports model interoperability and use of physics from many modeling systems (e.g., GFS, FV3)
- Common post-processing and graphics tools