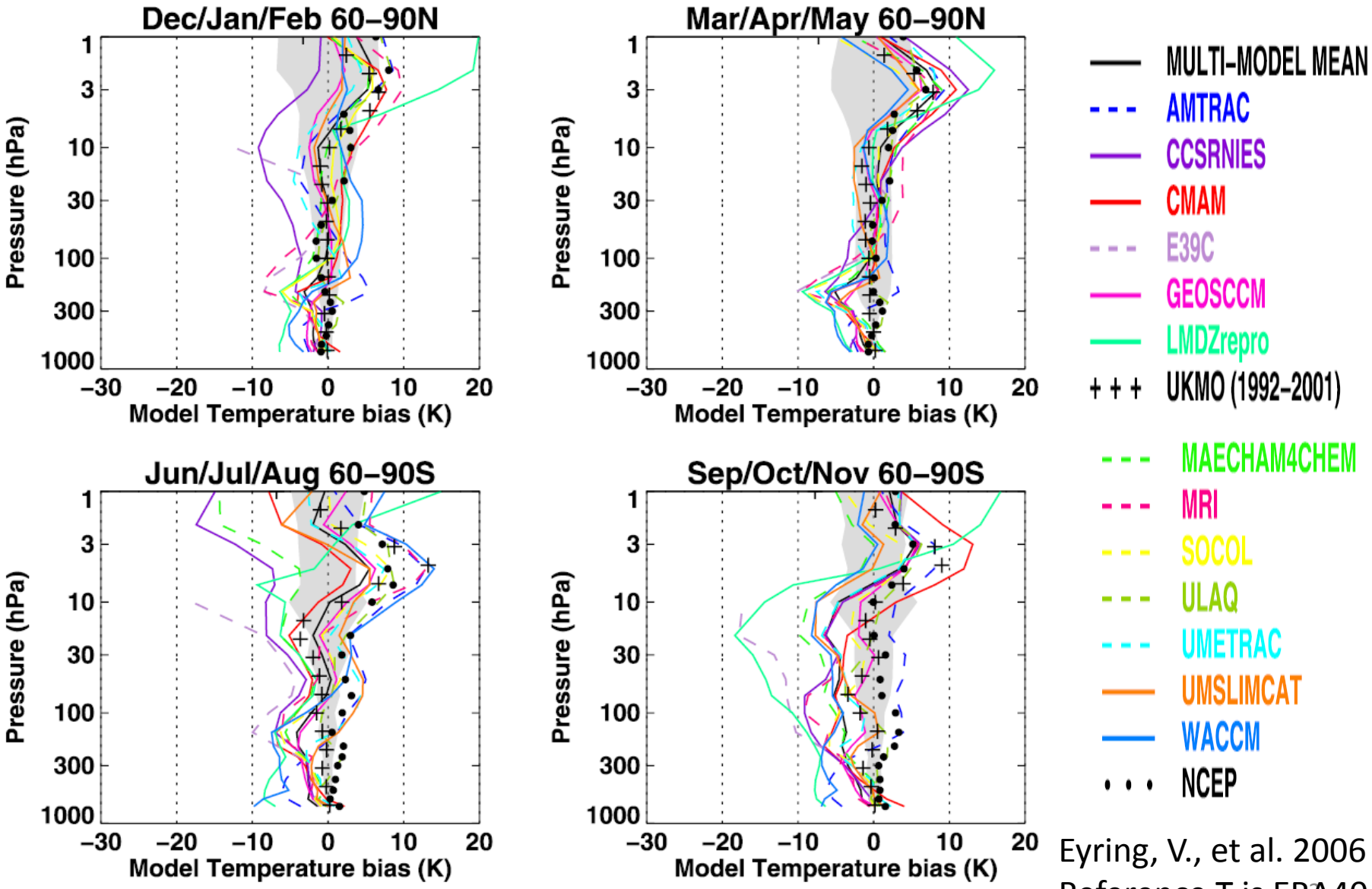
Effects of inertial gravity wave forcing on the stratospheric polar region and cold pole bias of general circulation models

Bo Tan, Hanli-Liu, Xinzhao Chu

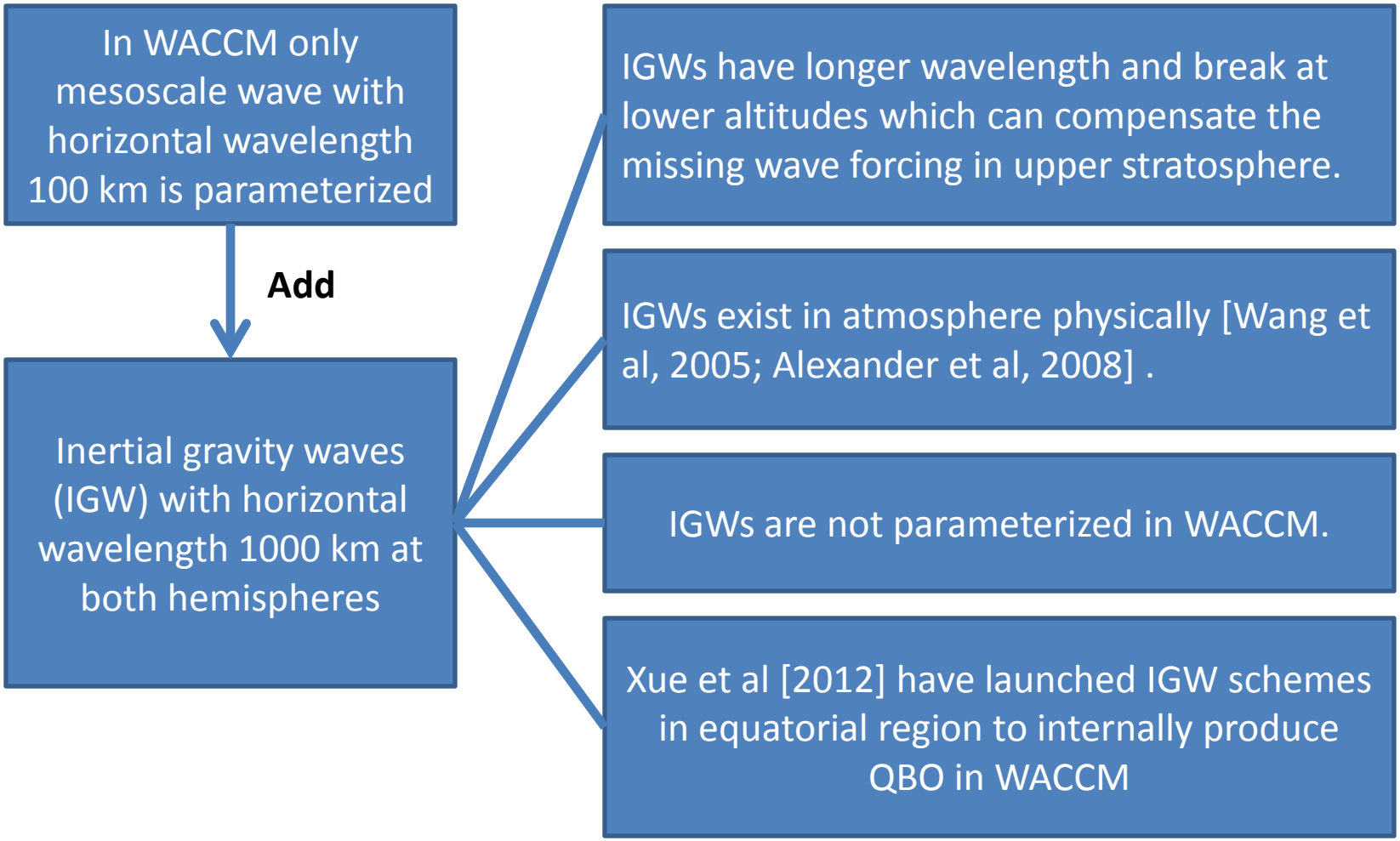
Simulated temperature minus ERA40



Eyring, V., et al. 2006

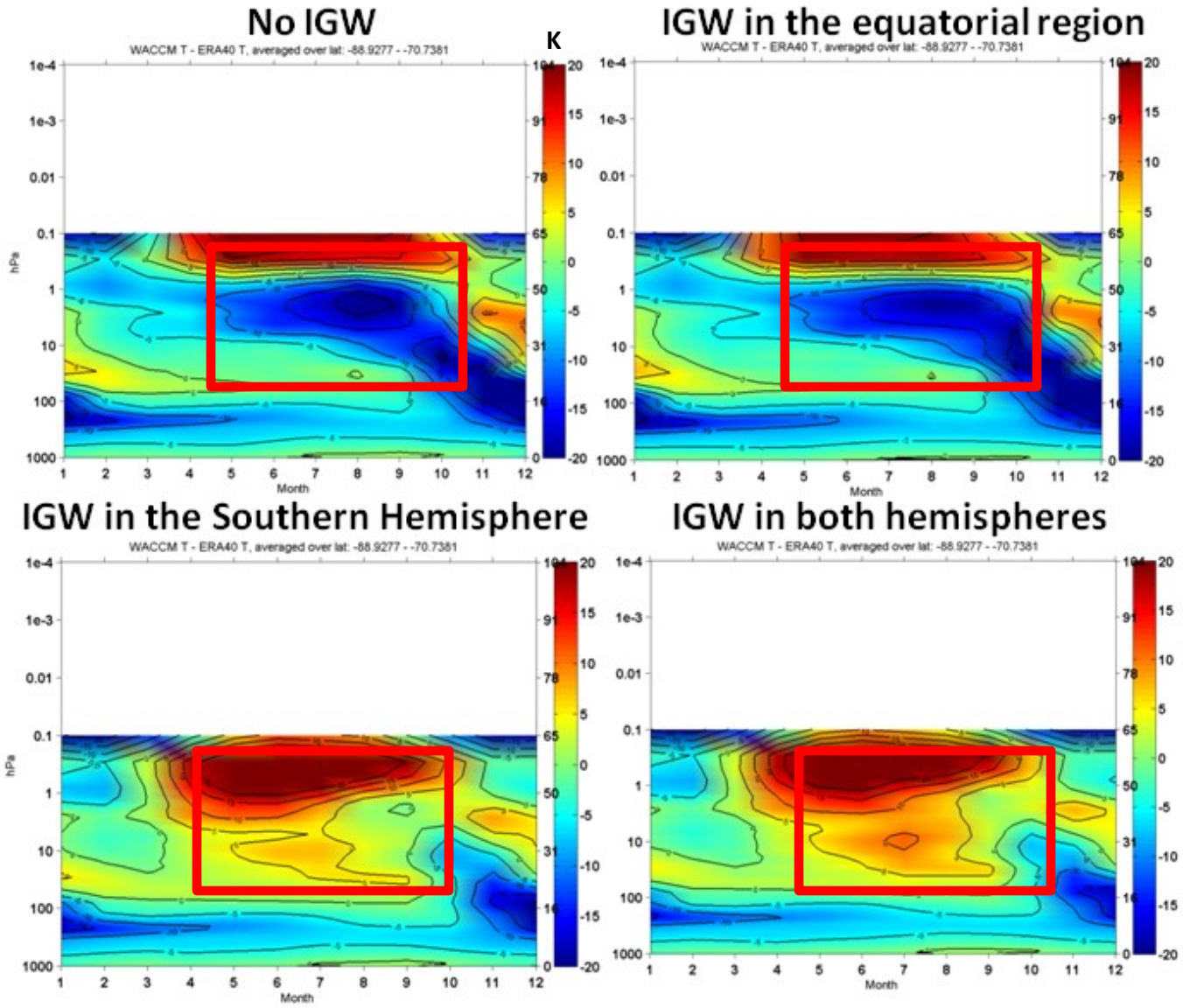
Reference T is ERA40

GW scheme to reduce cold pole bias in WACCM



Temperature difference: WACCM minus ERA40

Interactive Chemistry WACCM

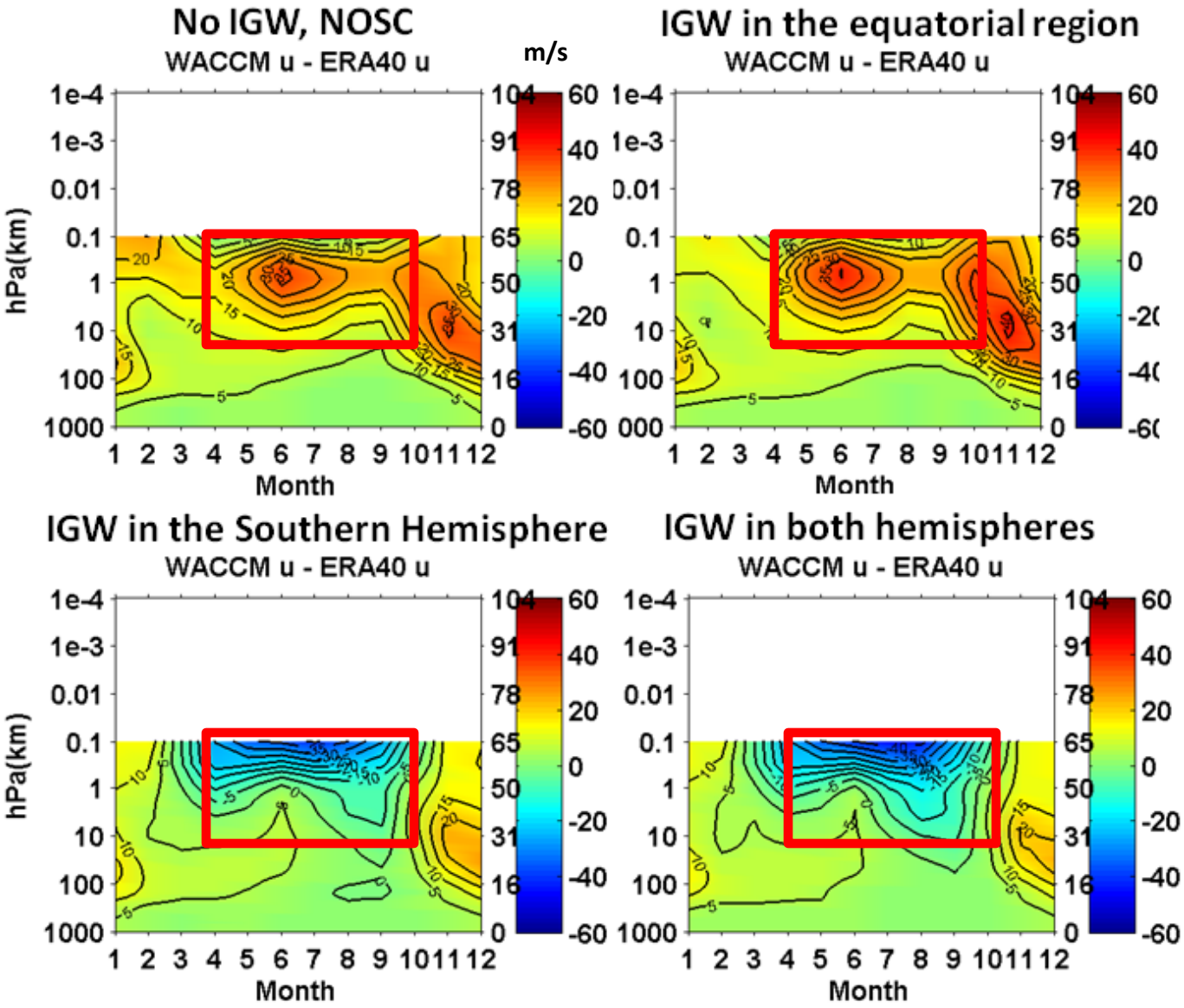


Blue area represents the cold pole bias in WACCM simulation relative to ERA40

When the IGW is launched, the cold pole bias in WACCM is significantly reduced

Wind difference: WACCM minus ERA40

Interactive Chemistry WACCM



Red area represents the wind simulation in WACCM is too strong relative to ERA-40

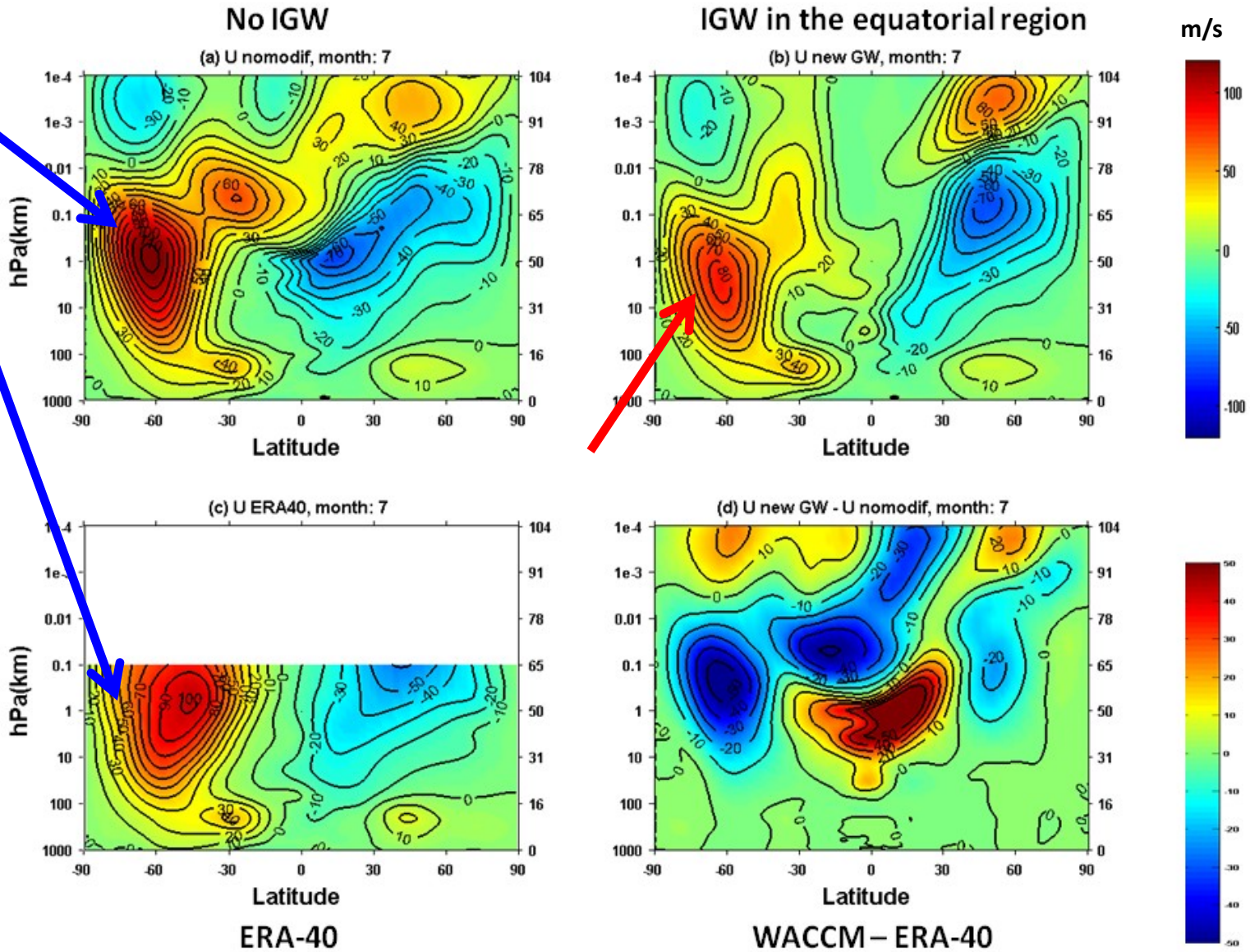
When the IGW is launched, the wind in WACCM is decelerated and consistent with ERA40 better

Simulated wind climatology during July

Interactive chemistry WACCM

Without the IGWs, the jet is too fast, relative to ERA-40

When the IGWs are added, the jet is decelerated

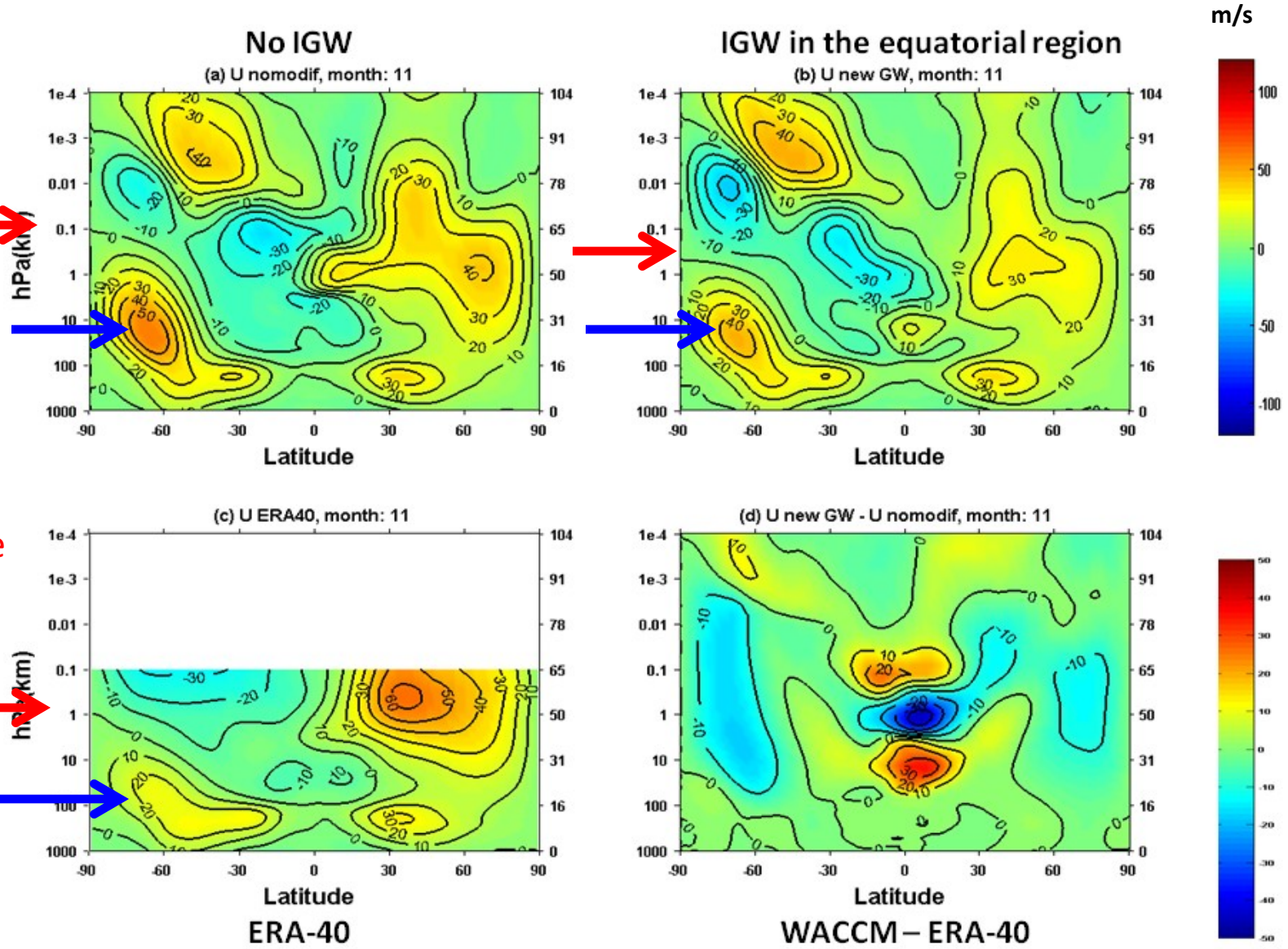


Simulated wind climatology during November

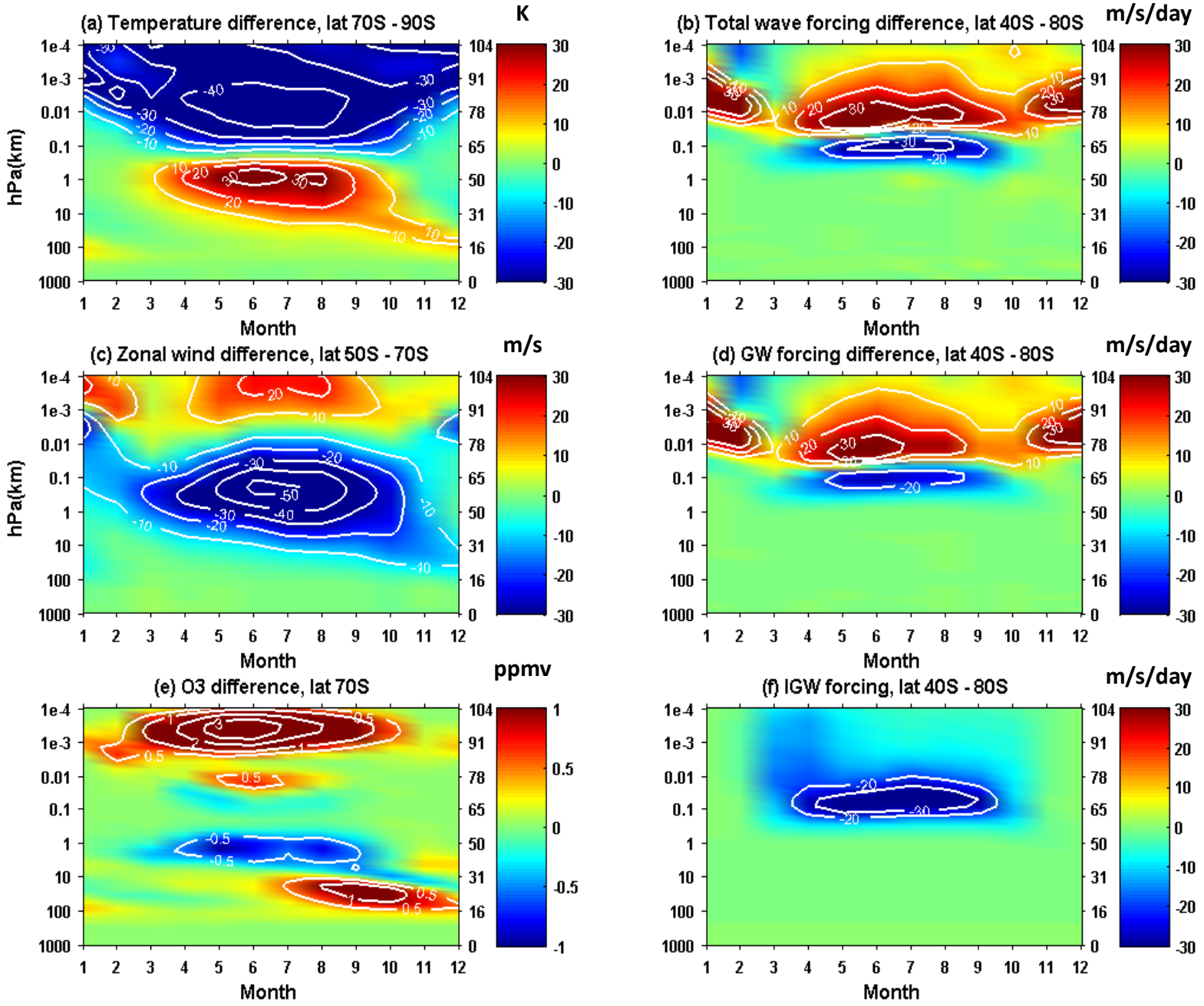
Interactive chemistry WACCM

IGW decelerate the jet

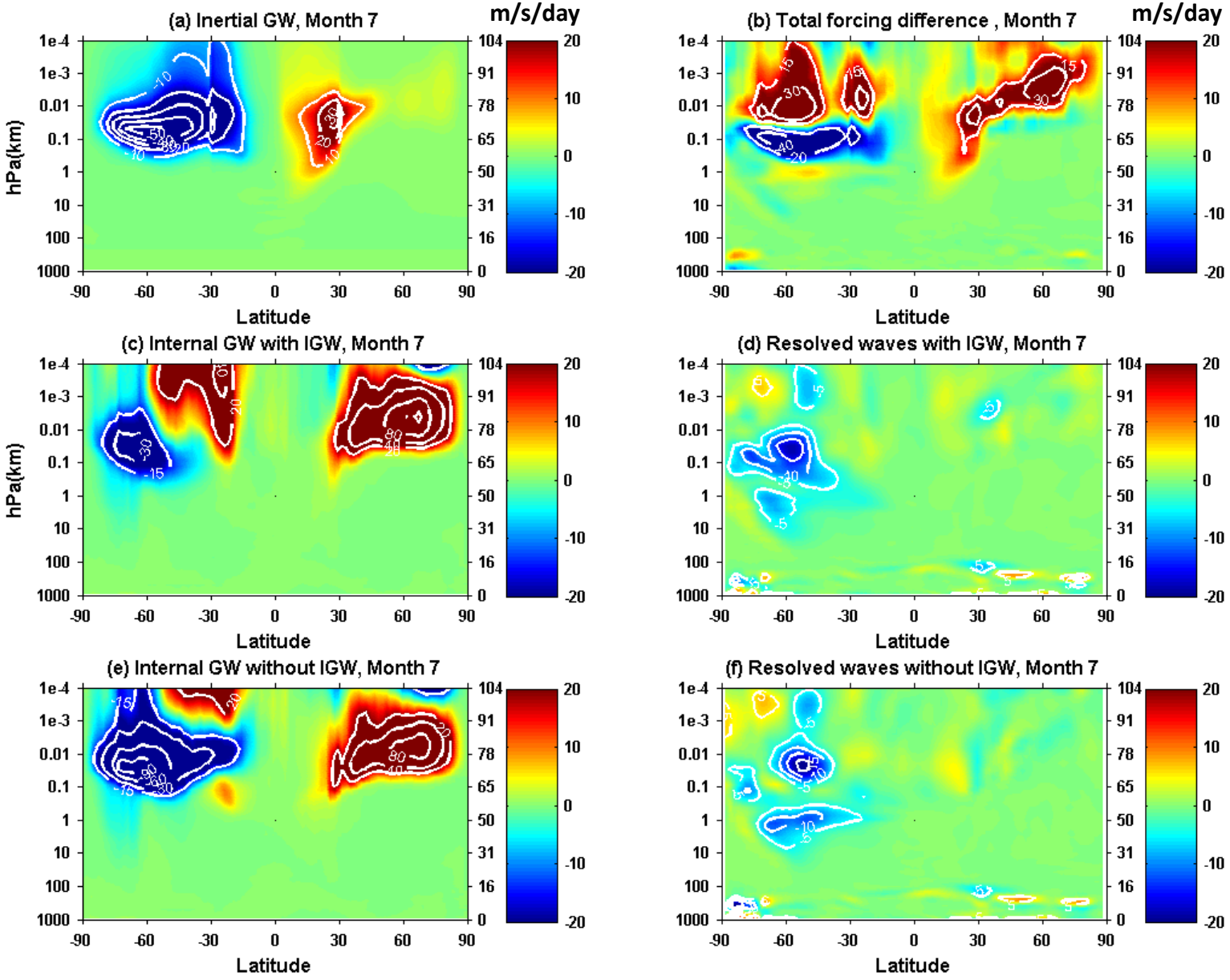
IGW reduce the wind reversal level



Simulation with IGW minus simulation without IGW



How IGWs affect internal GWs and resolved waves



Conclusions

- Launching inertial gravity wave is one method to reduce the cold pole bias in the southern polar region in WACCM simulation. The stratosphere temperatures, stratosphere circulations and wind reversal levels are improved in WACCM simulation.

- IGWs affects the breaking of internal GWs. The total wave forcing change induced by new scheme includes both the new IGW breaking and the change of internal GW breaking.

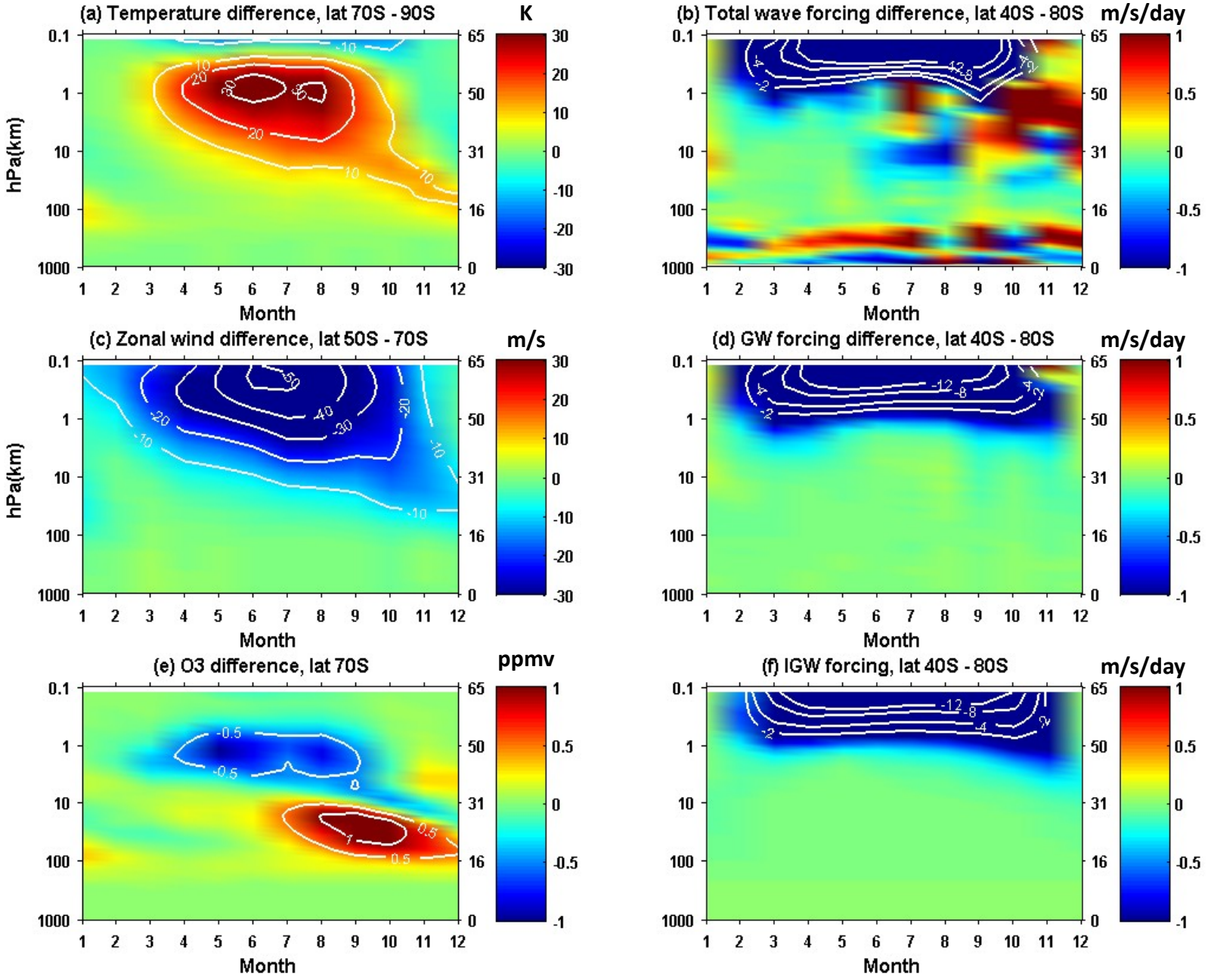
- Inertial gravity waves in the southern hemisphere are the main contributor of the improvement.

- IGW scheme works for both specified chemistry WACCM and interactive chemistry WACCM.

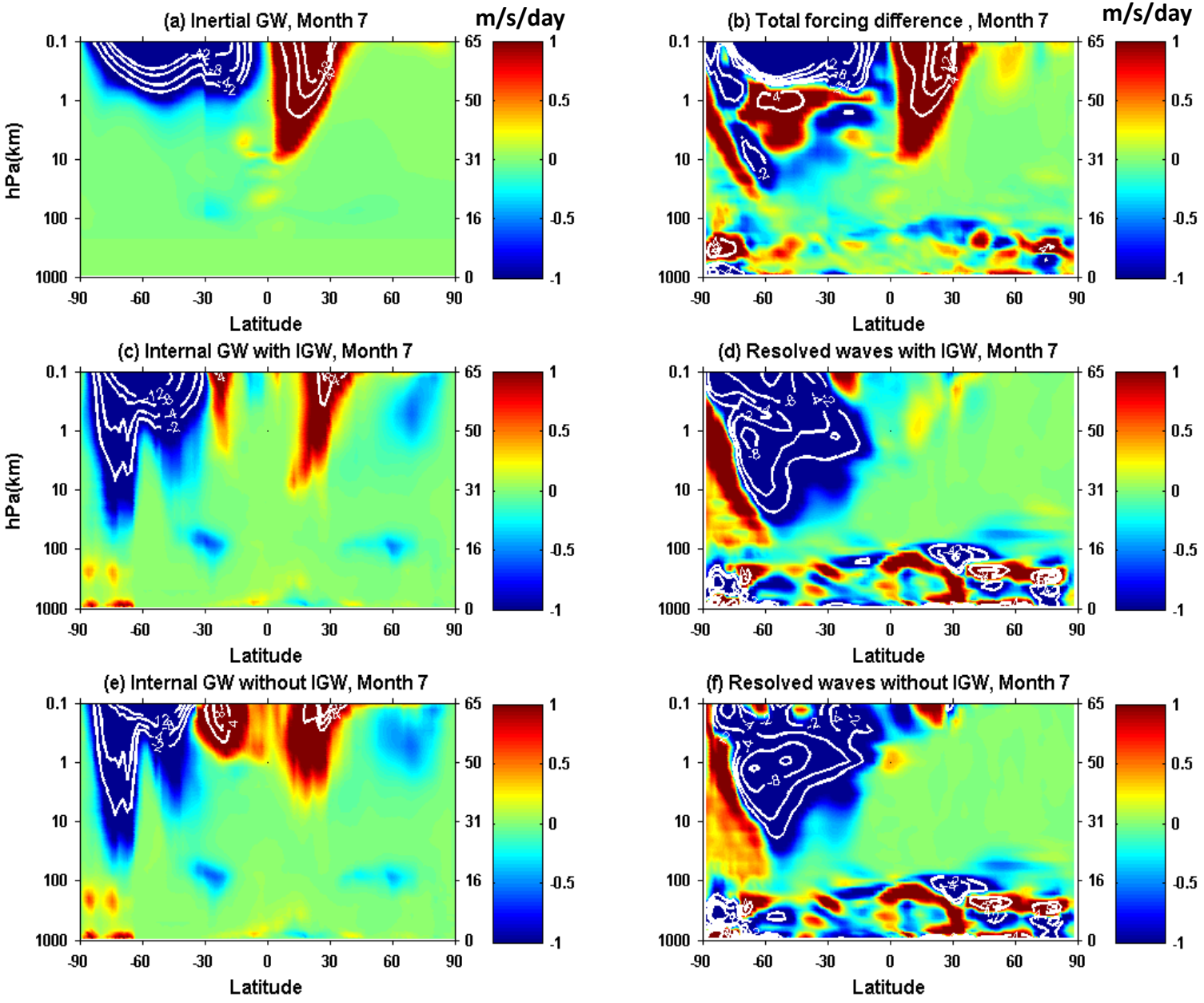
- The ozone bias associated with the cold pole bias is reduced by the IGW scheme.

Thanks

Simulation with IGW minus simulation without IGW

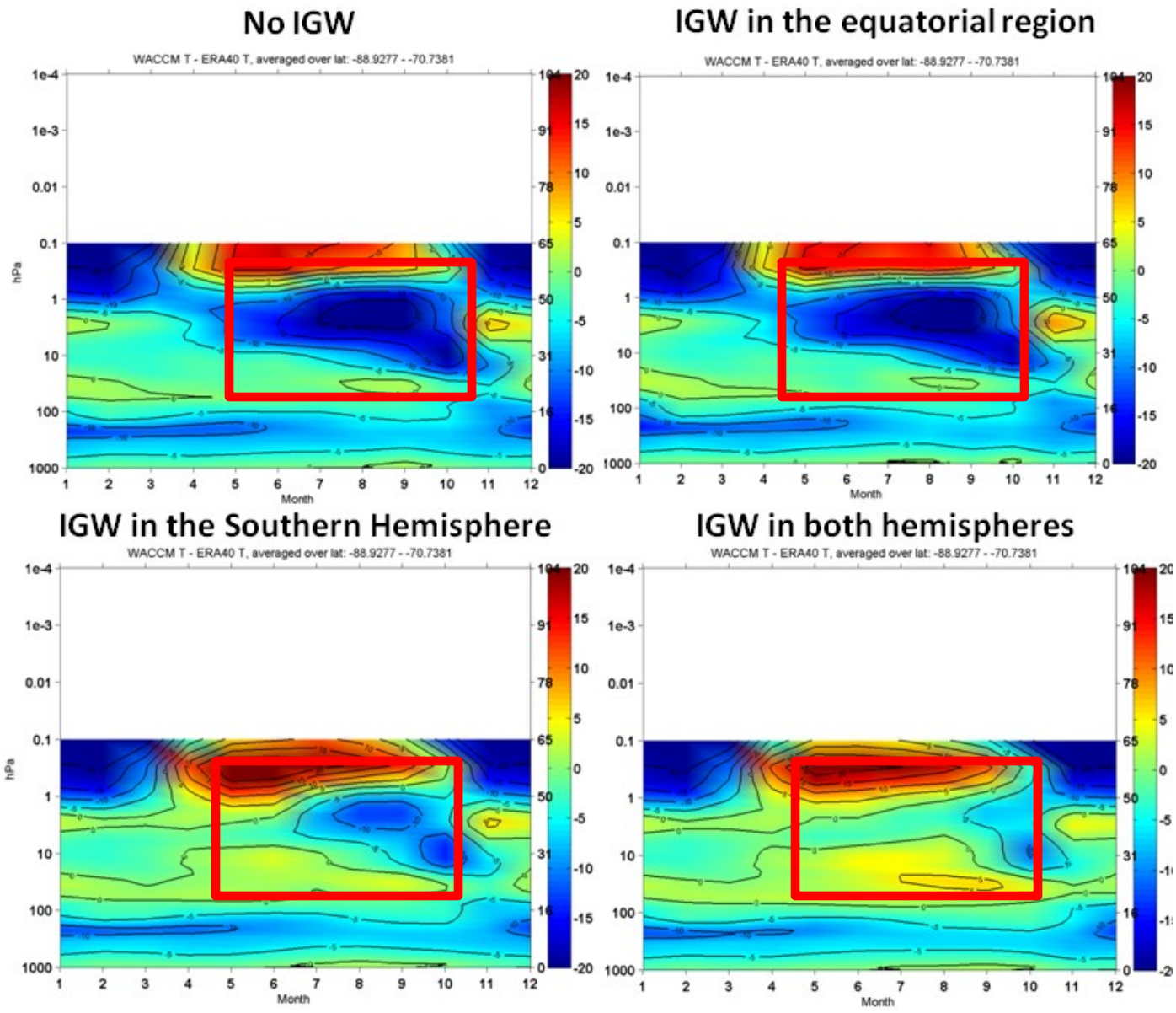


How IGWs affect internal GWs and resolved waves



Temperature difference: WACCM minus ERA40

Specified Chemistry WACCM



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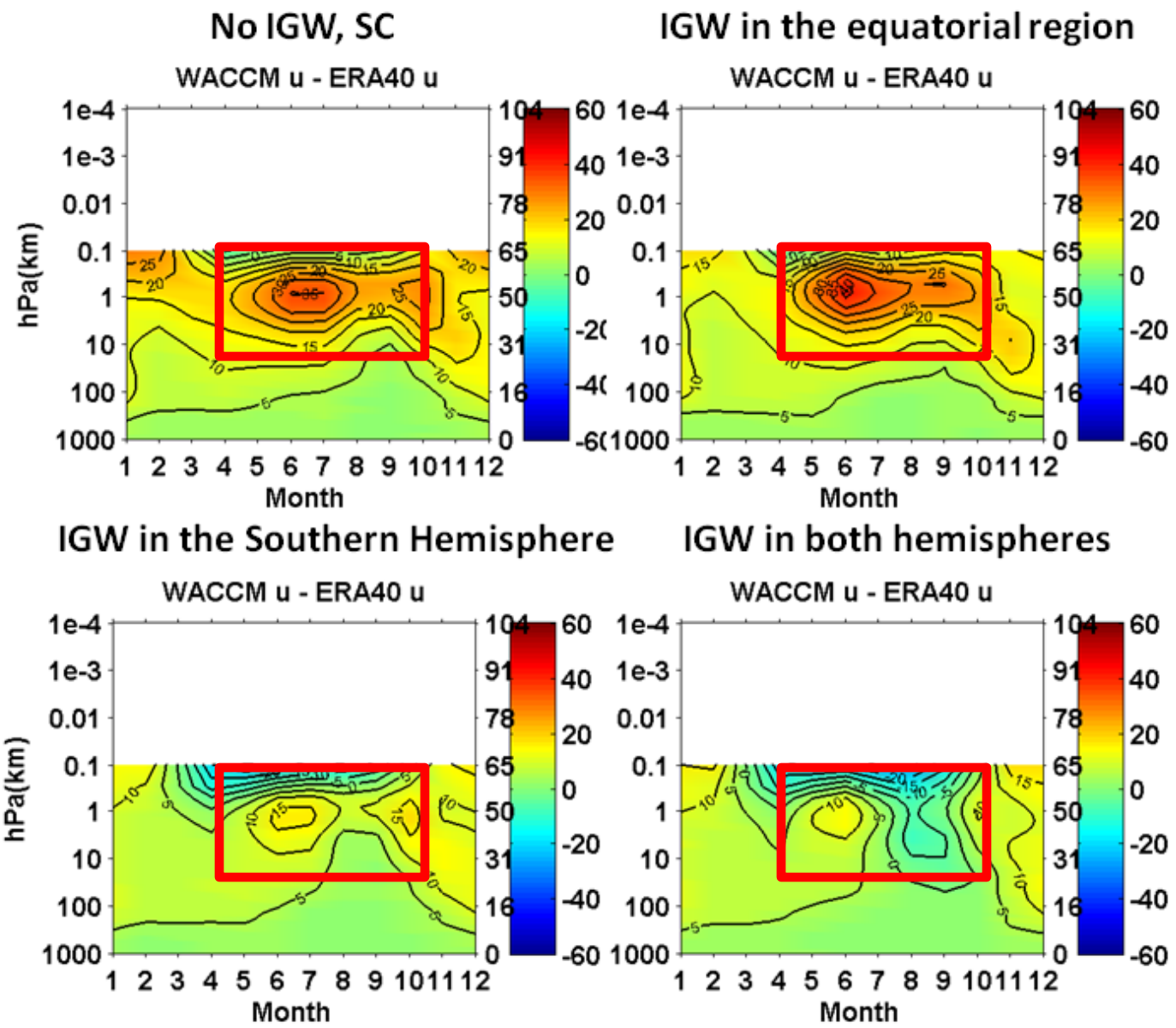
Wind difference: WACCM minus ERA40

Specified Chemistry WACCM



Red area represents the wind simulation in WACCM is too strong relative to ERA-40

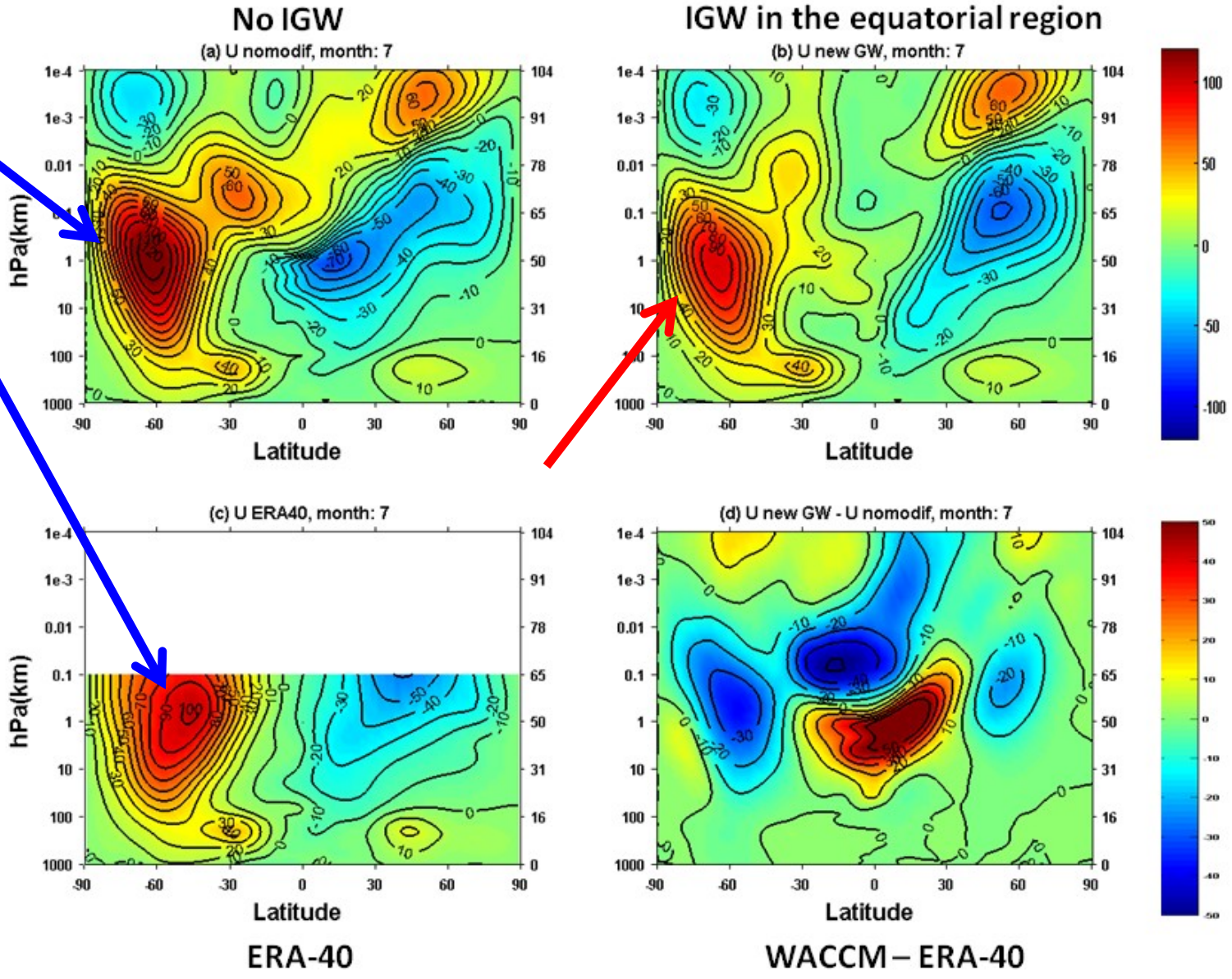
When the IGW is launched, the wind in WACCM is decelerated and becomes closer to ERA-40

Wind climatology during July

Specified Chemistry WACCM

Without the IGWs, the jet is too fast, relative to ERA-40

When the IGWs are added, the jet is decelerated

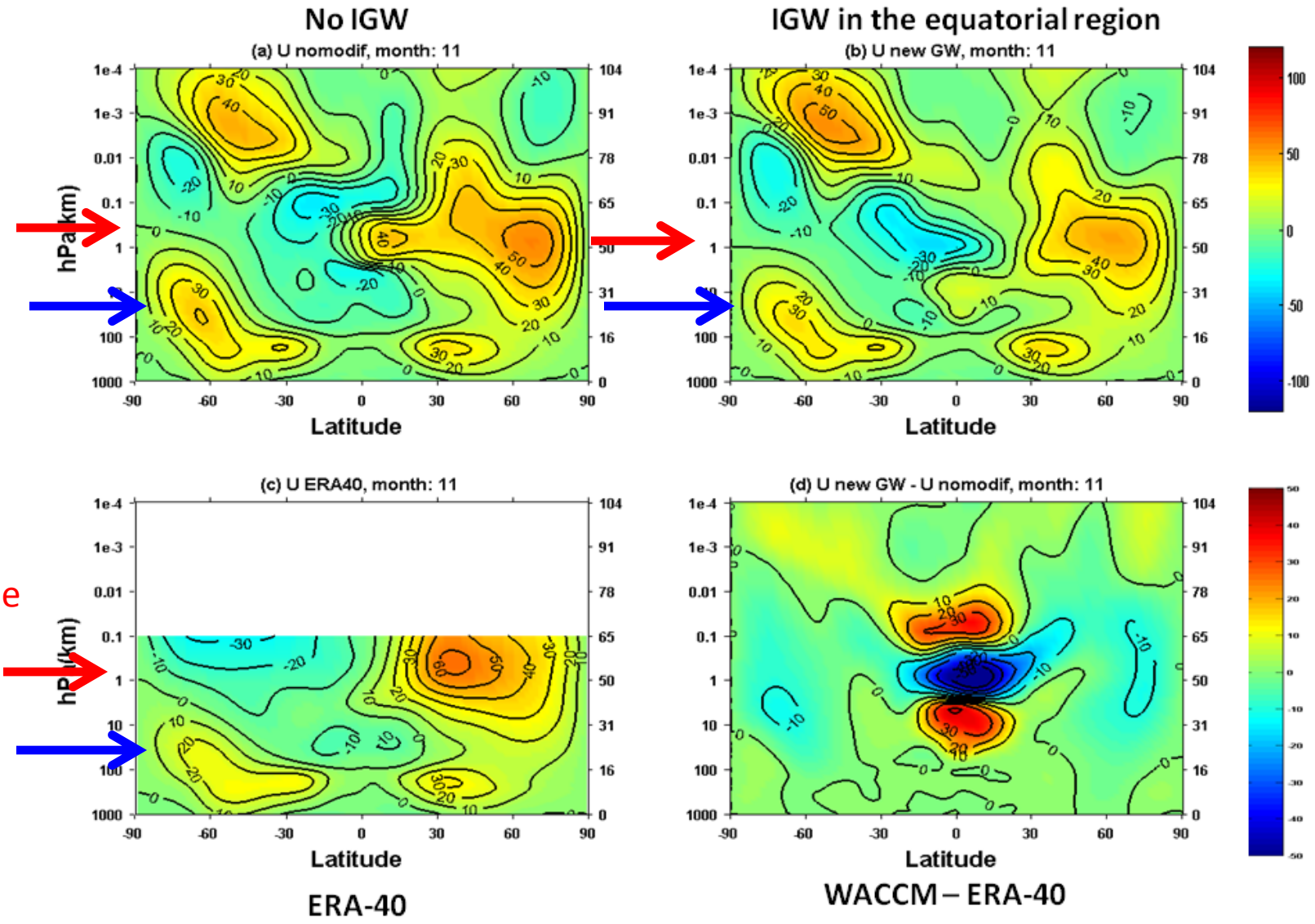


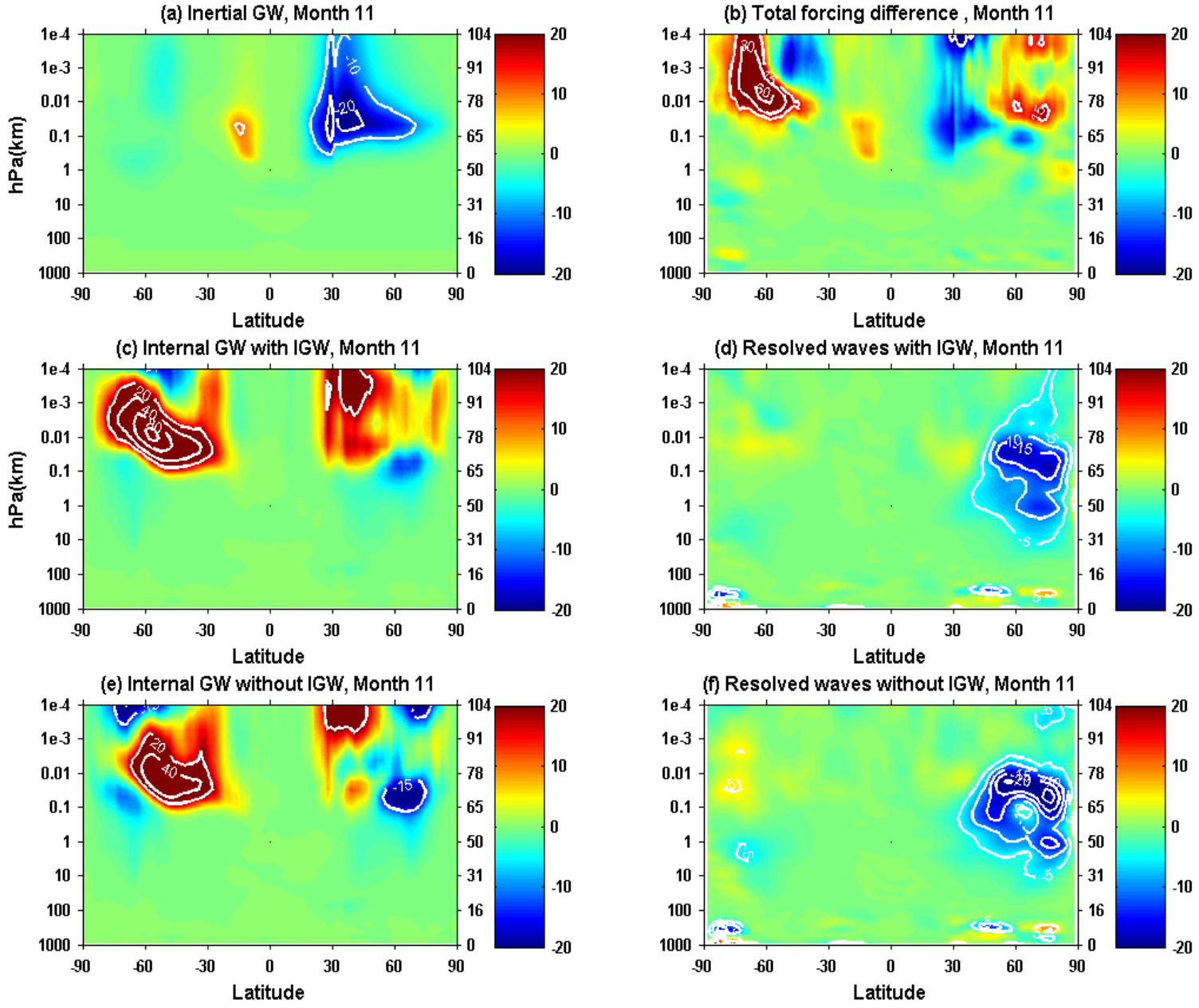
Wind climatology during November

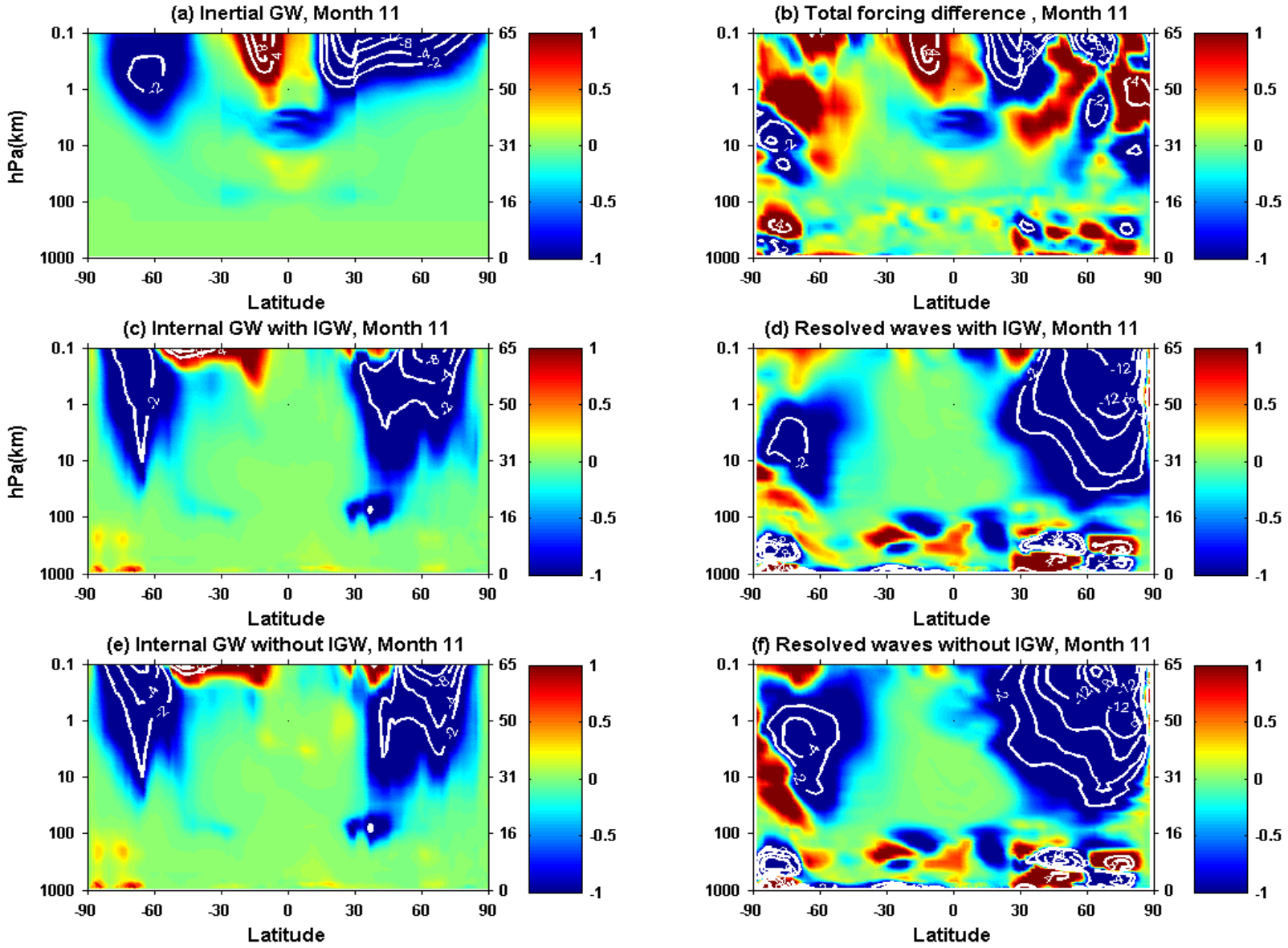
Specified Chemistry WACCM

IGWs decelerate the jet

IGWs reduce the wind reversal level




(a) Inertial GW, Month 11
(b) Total forcing difference , Month 11
(c) Internal GW with IGW, Month 11
(d) Resolved waves with IGW, Month 11
(e) Internal GW without IGW, Month 11
(f) Resolved waves without IGW, Month 11
hPa(km)
Latitude
1e-4
1e-3
0.01
0.1
1
10
100
1000
104
91
78
65
50
31
16
0
-90
-60
-30
0
30
60
90
20
10
0
-10
-20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(e) Internal GW without IGW, Month 11
(f) Resolved waves without IGW, Month 11
hPa(km)
0.1
1
10
100
1000
65
50
31
16
0
1
0.5
0
-0.5
-1
-90
-60
-30
0
30
60
90
Latitude