Applications of sea-level pressure retrieval from scatterometer winds

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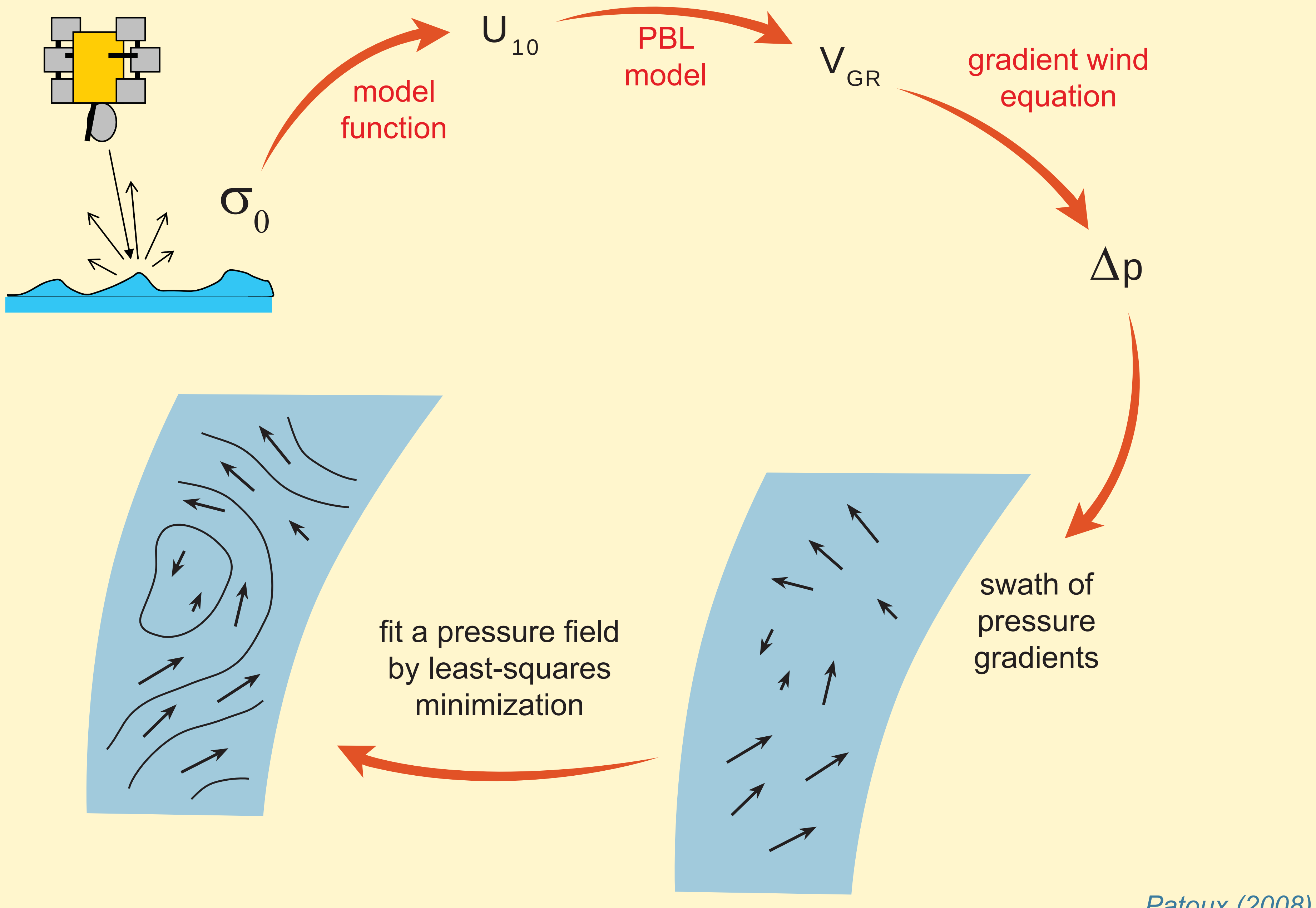
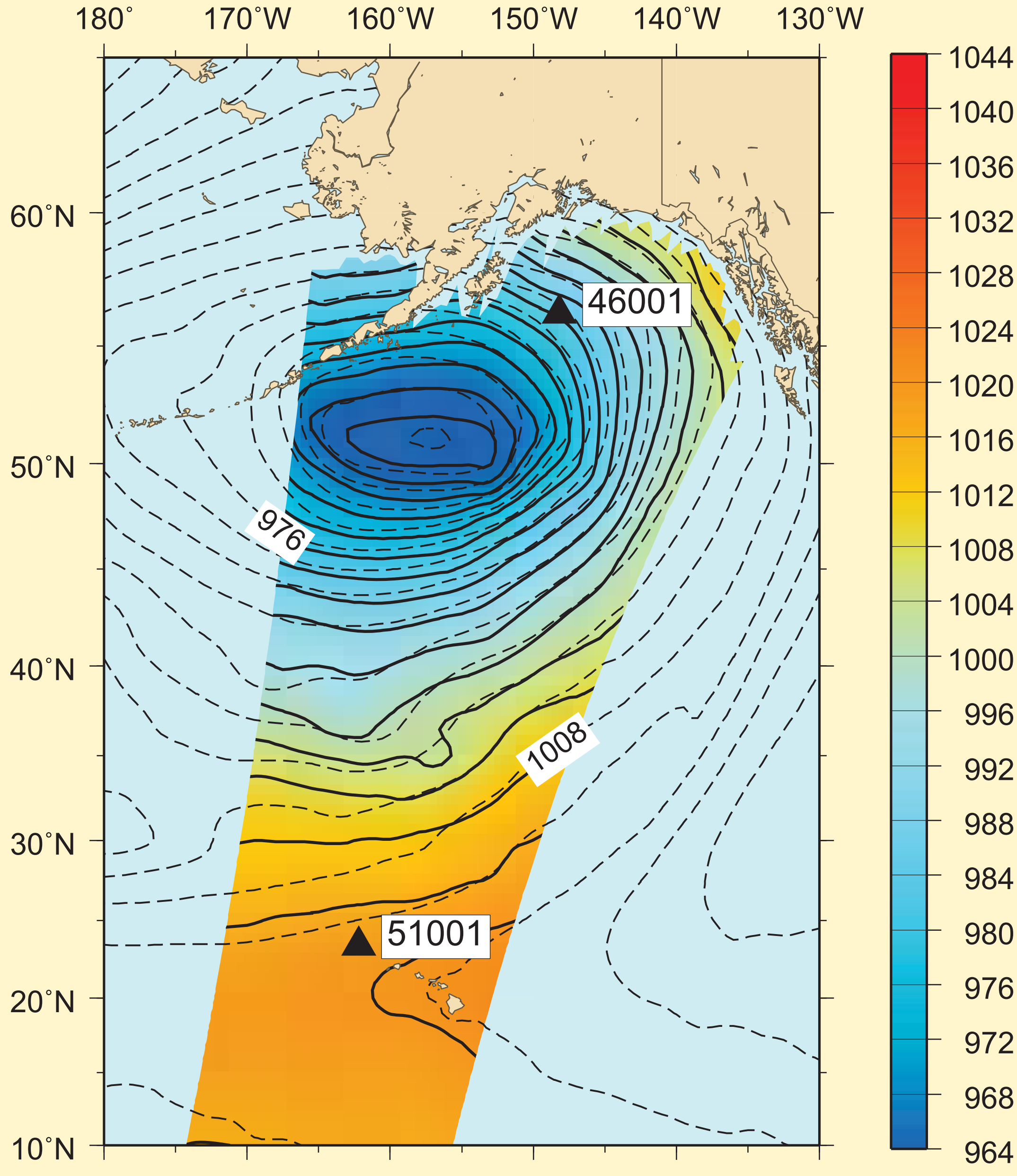
OVWST meeting
Seattle, November 20, 2008

Pressure retrieval: how does it work?



How good are the resulting pressure fields?

Compare the pressure difference between two buoys with the corresponding pressure difference in the UWQS pressure swath.



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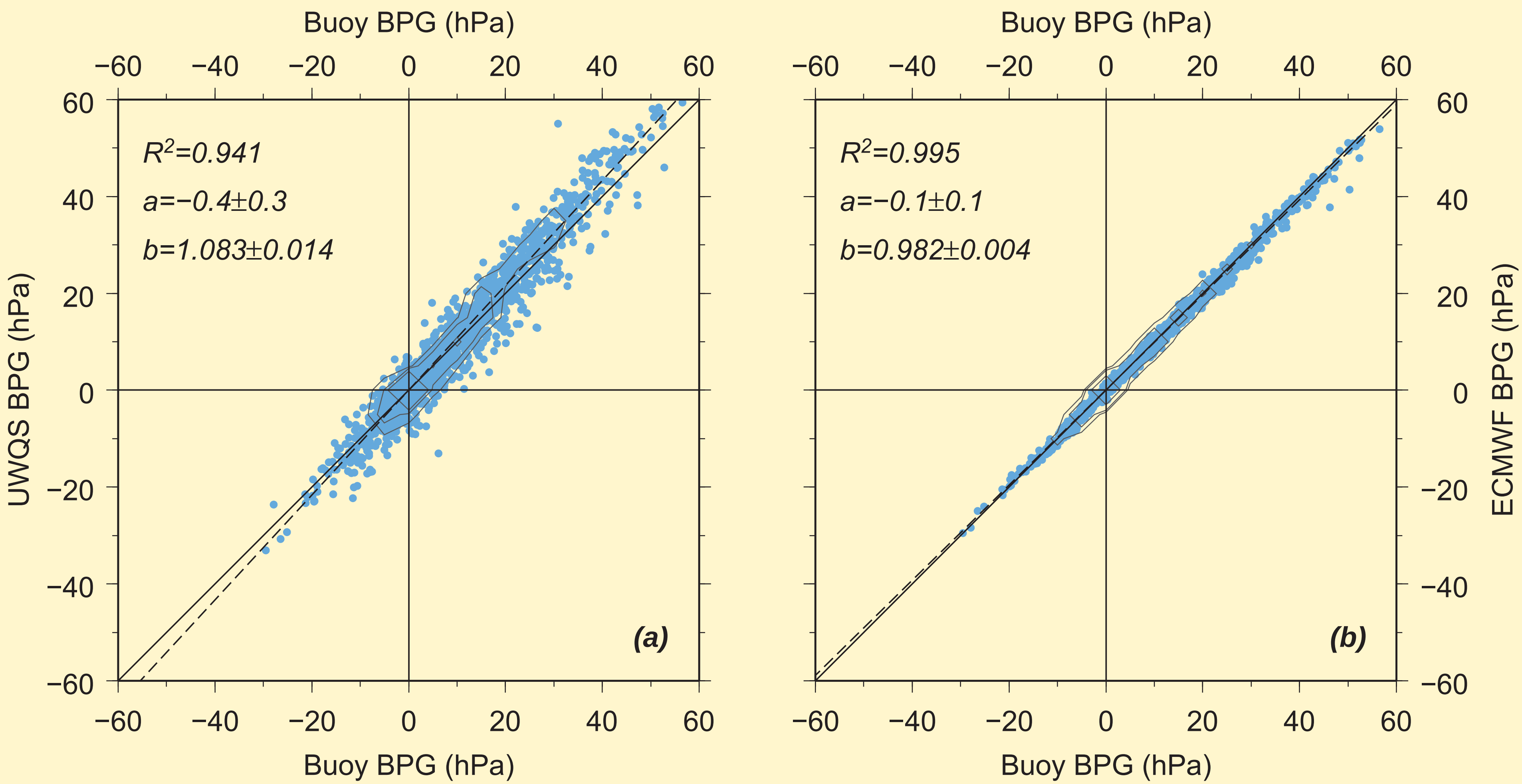
UWQS vs. buoy

ECMWF vs. buoy



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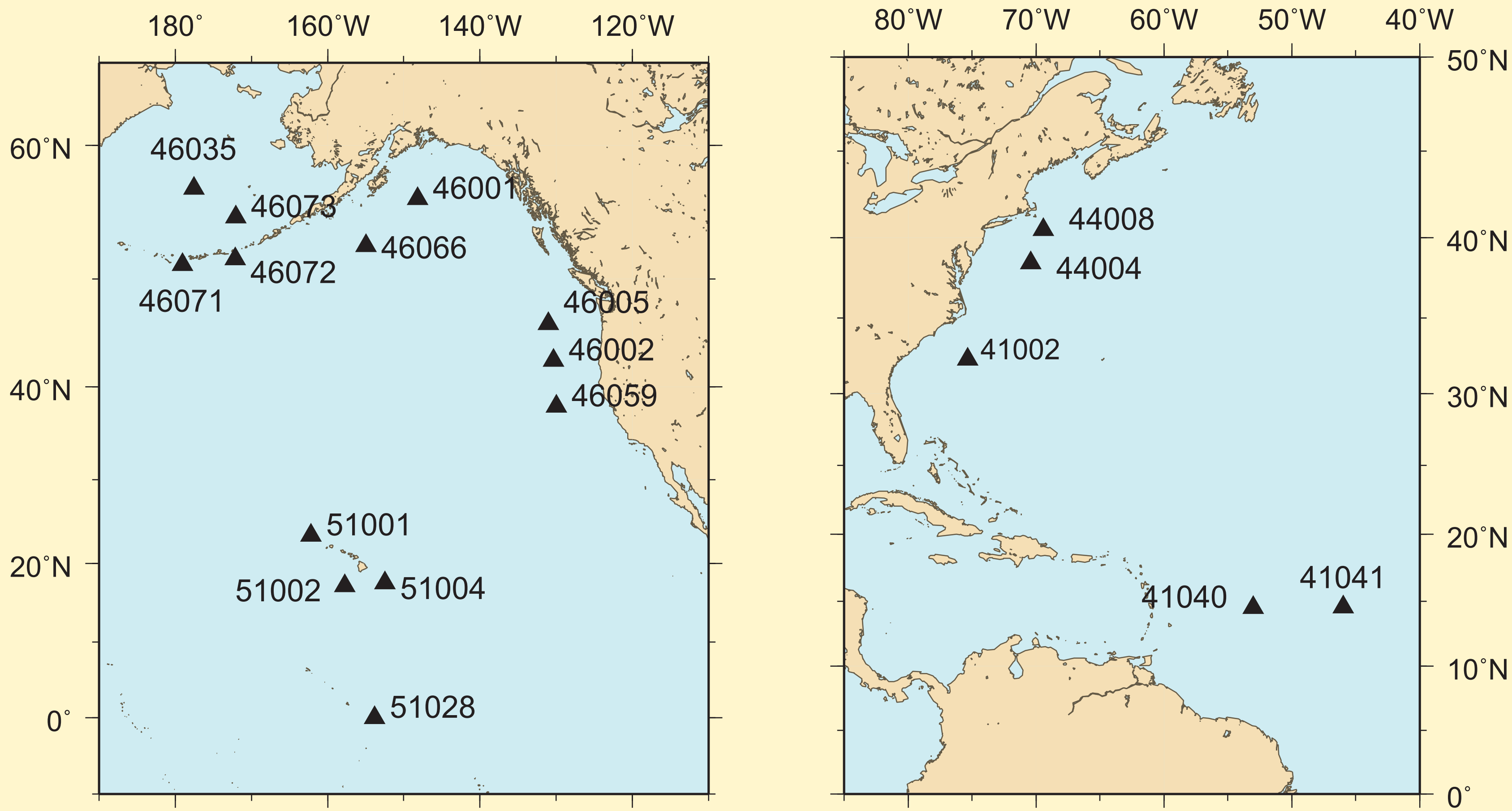

→ *Repeat the comparison with all possible pairs of NDBC buoys over the QS period.*

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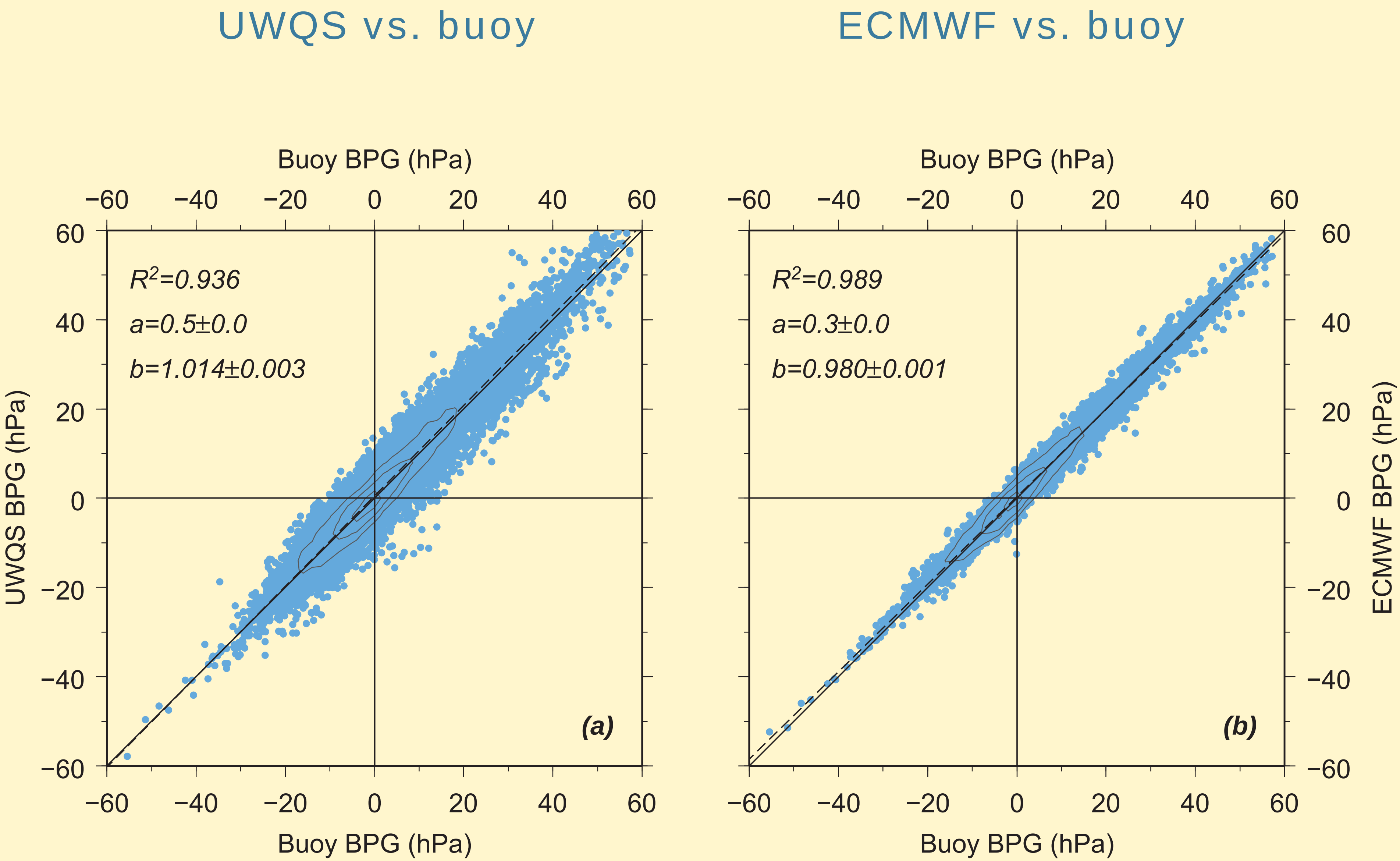
UWQS vs. buoy
ECMWF vs. buoy
Buoy BPG (hPa)
UWQS BPG (hPa)
ECMWF BPG (hPa)
R2=0.936
a=0.5±0.0
b=1.014±0.003
R2=0.989
a=0.3±0.0
b=0.980±0.001
(a)
(b)
−60
−40
−20
0
20
40
60

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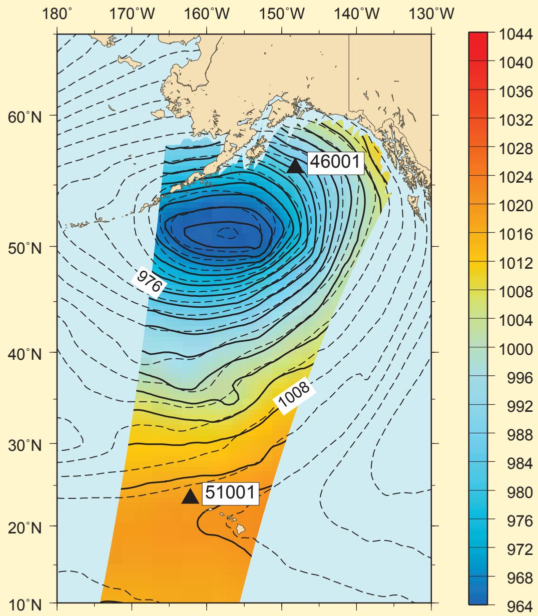
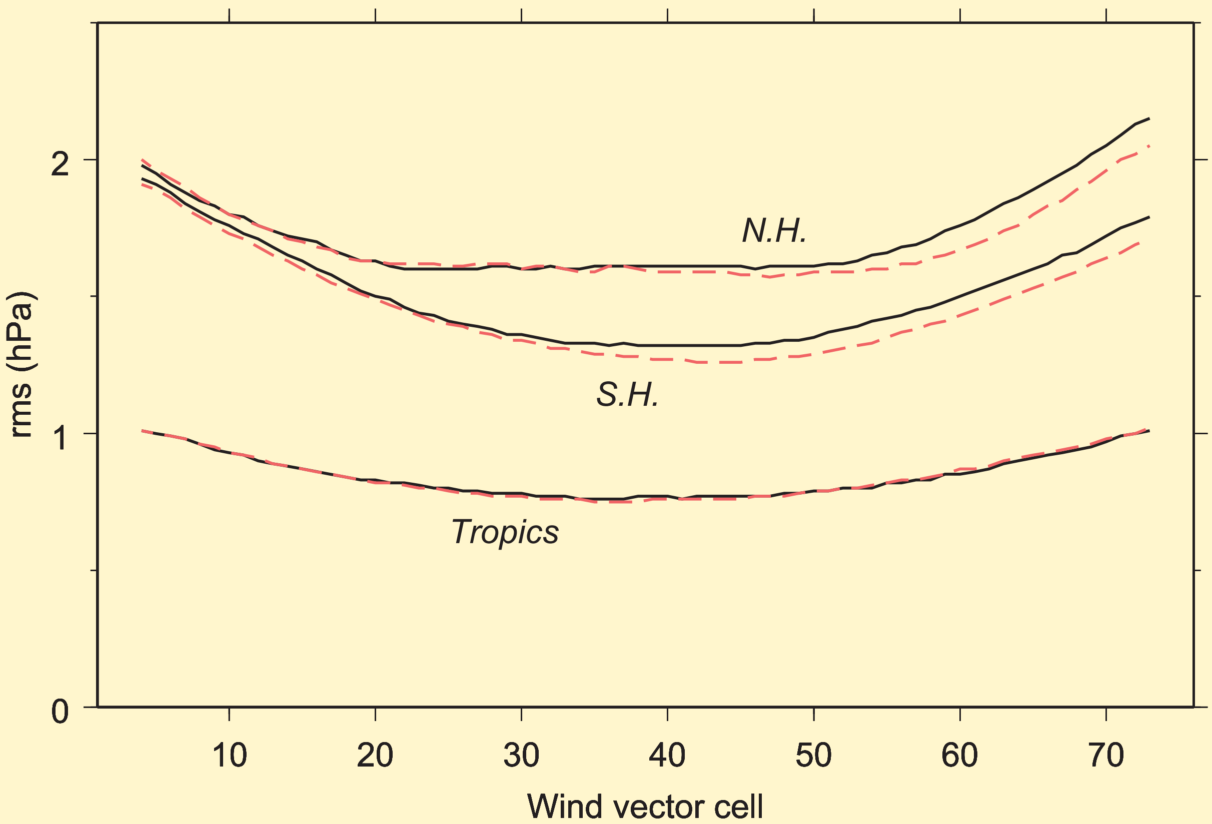
How do the UWQS pressure swaths compare to the ECMWF global sea-level pressure fields?

Calculate the rms difference between ECMWF sea-level pressure field and QS swaths that fall within one hour of synoptic time.





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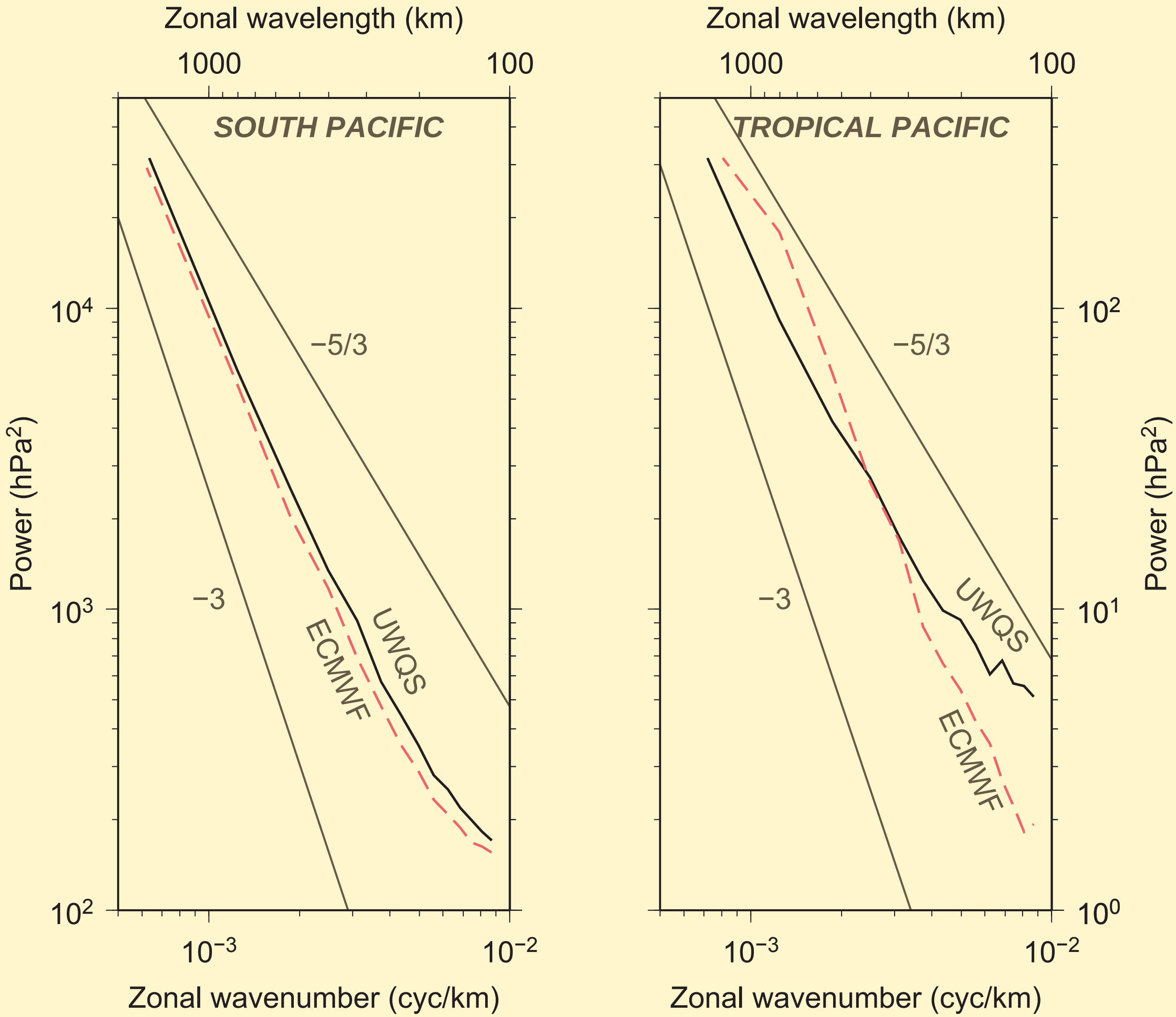
How do the UWQS sea-level pressure spectra compare to ECMWF?



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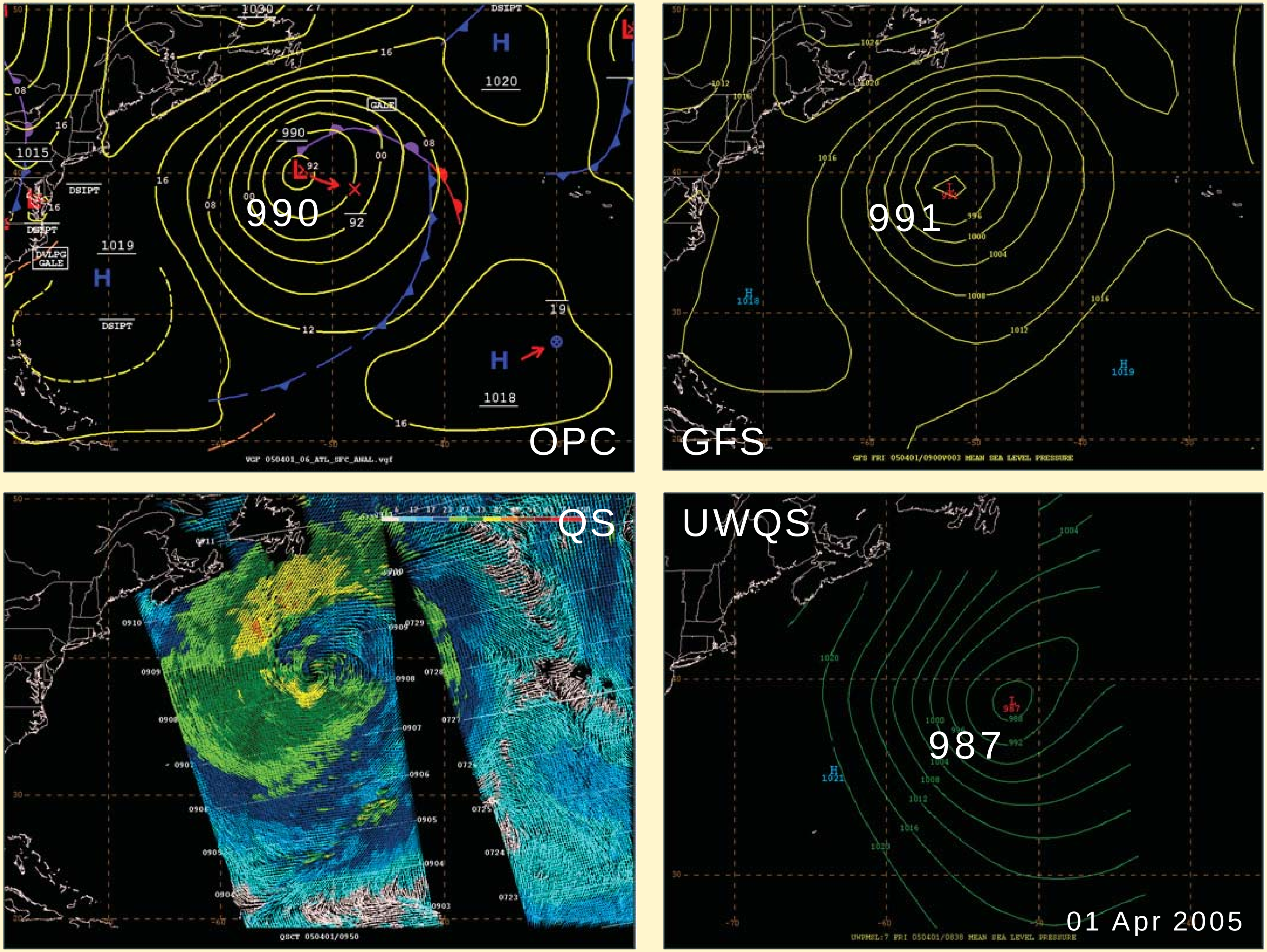
For more details, see:

Patoux, J., R. C. Foster and R. A. Brown (2008): An evaluation of scatterometer-derived oceanic surface pressure fields, *J. Applied. Meteor. Clim.*, **47**, 835-852.

Application #1: Can the UWQS slp fields help improve weather forecasting?

Implementation at the Ocean Prediction Center (Joe Sienkiewicz, Joan Von Ahn).



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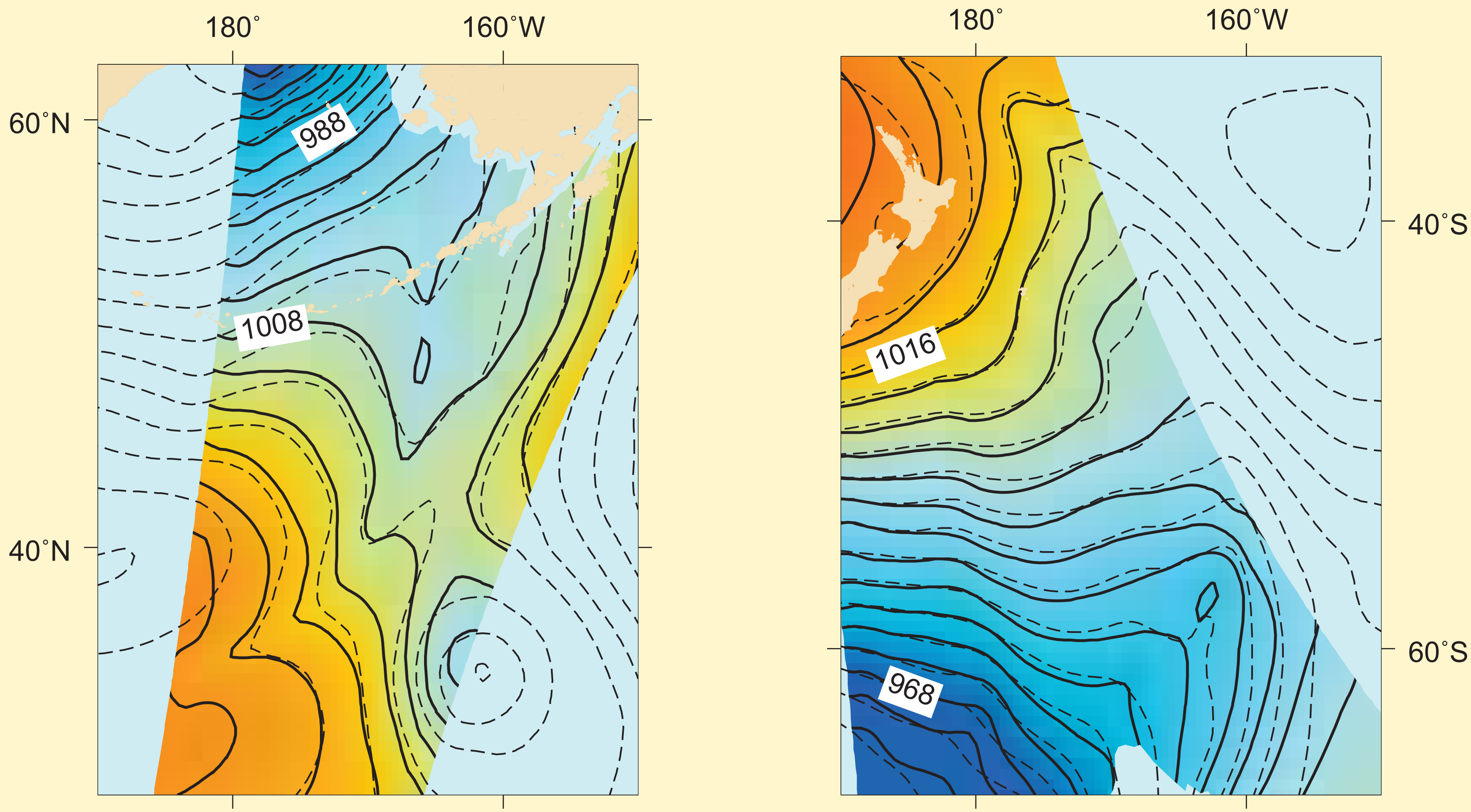
The UWQS sea-level pressure fields contain mesoscale information that is absent from NWP analyses.

<u>Example</u>: secondary lows

(frontal waves? mesoscale lows? mesocyclones?)



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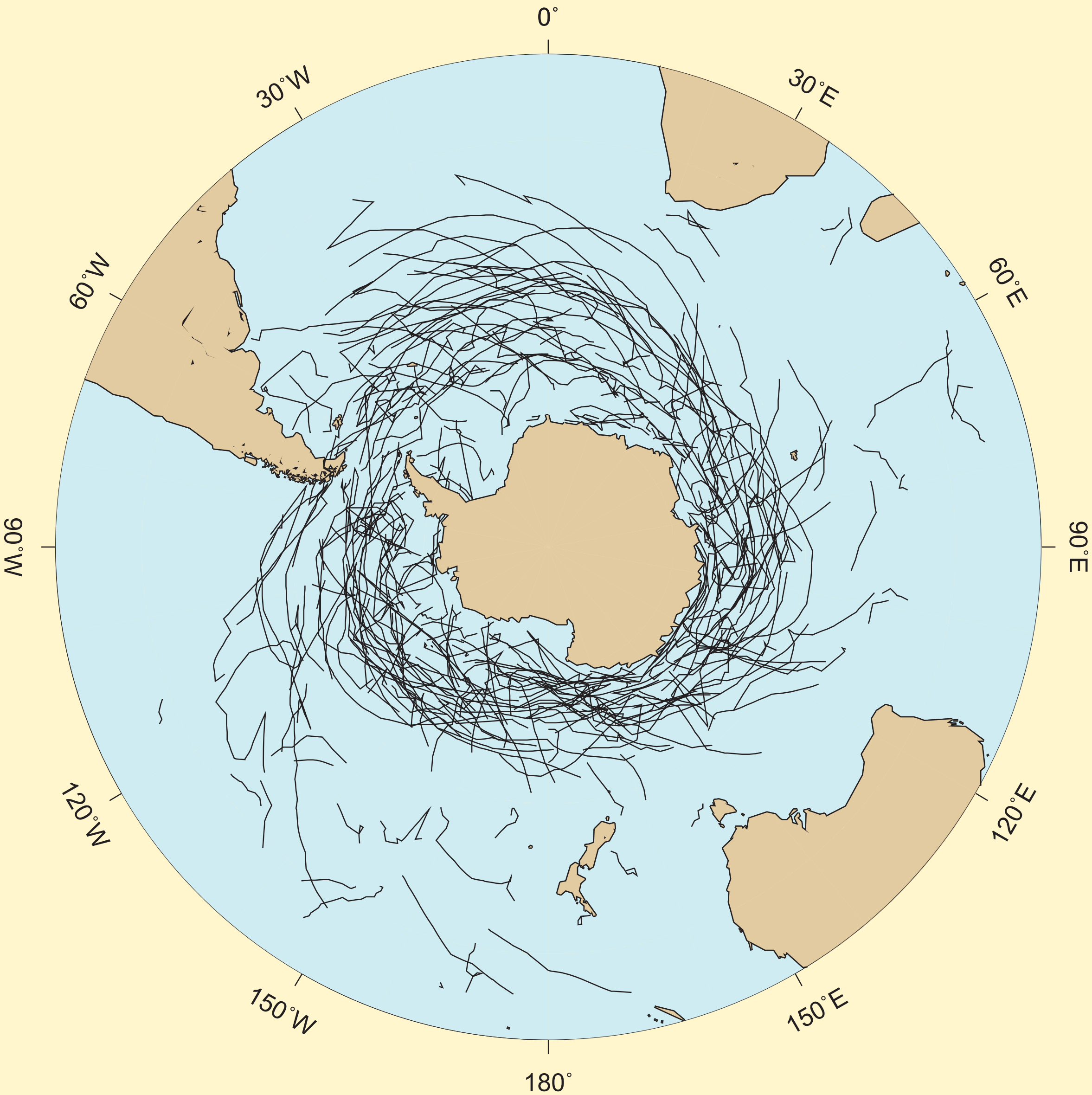
Application #2: Can the UWQS slp fields help improve midlatitude cyclone statistics (intensity, structure, tracks, etc.)?



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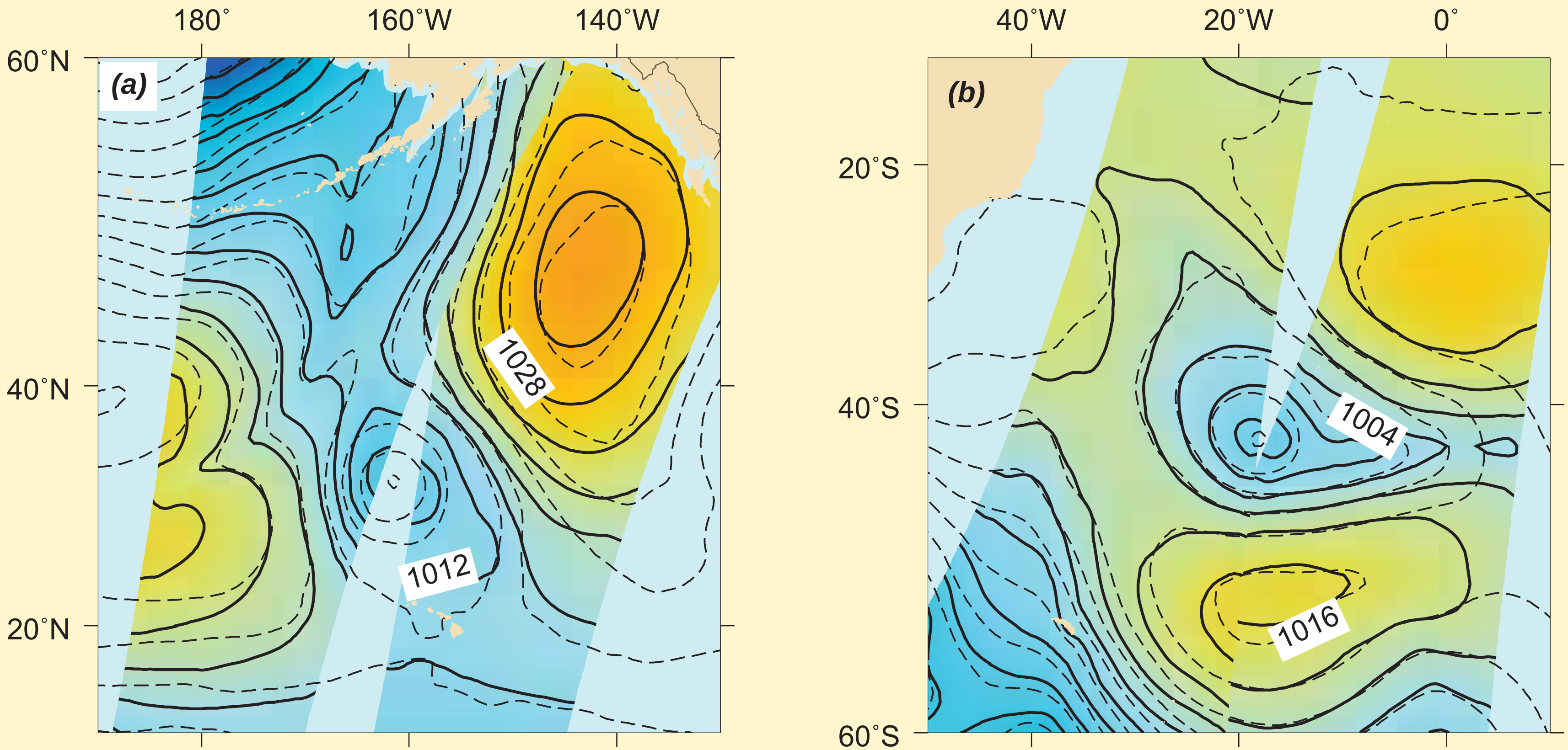
Maybe... but building cyclone tracks from scatterometer-derived pressure swaths alone is impractical, because cyclone centers can fall in the gaps...



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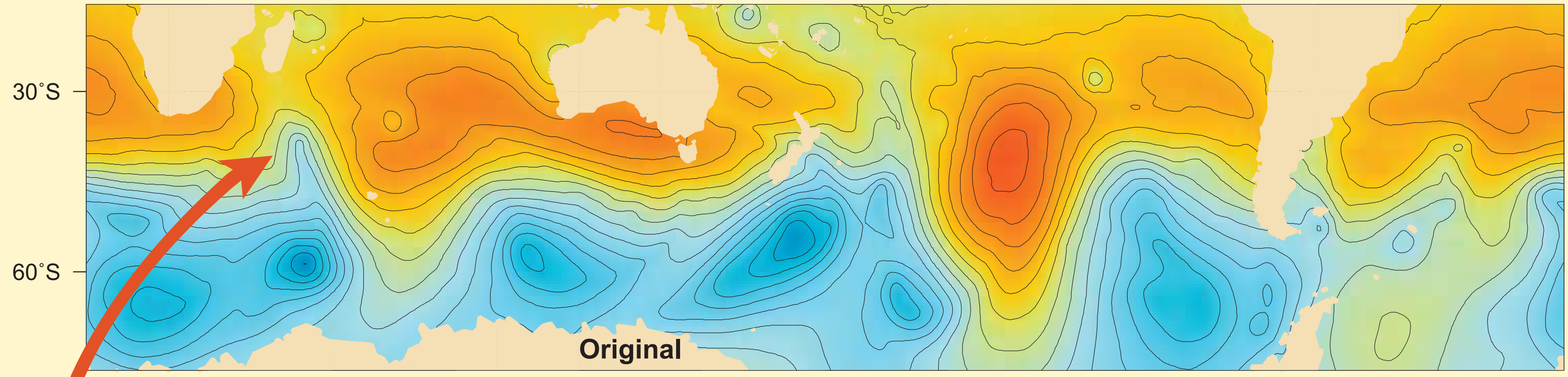
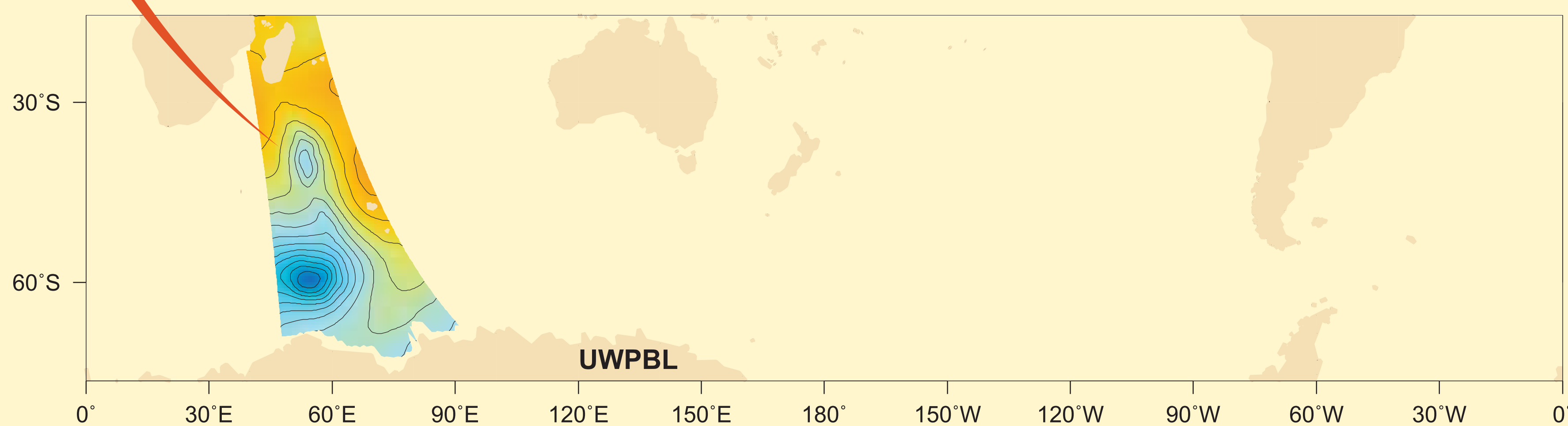
QS-modified ECMWF sea-level pressure - 27 Jan 2003 - 00:00 UTC/02:56 UTC



➡ Inject UWQS mesoscale pressure information into ECMWF analysis by:

- decomposing the two pressure fields by wavelet analysis
- swapping the high wavenumber wavelet coefficients
- reconstructing the ECMWF pressure field enhanced by UWQS mesoscale detail



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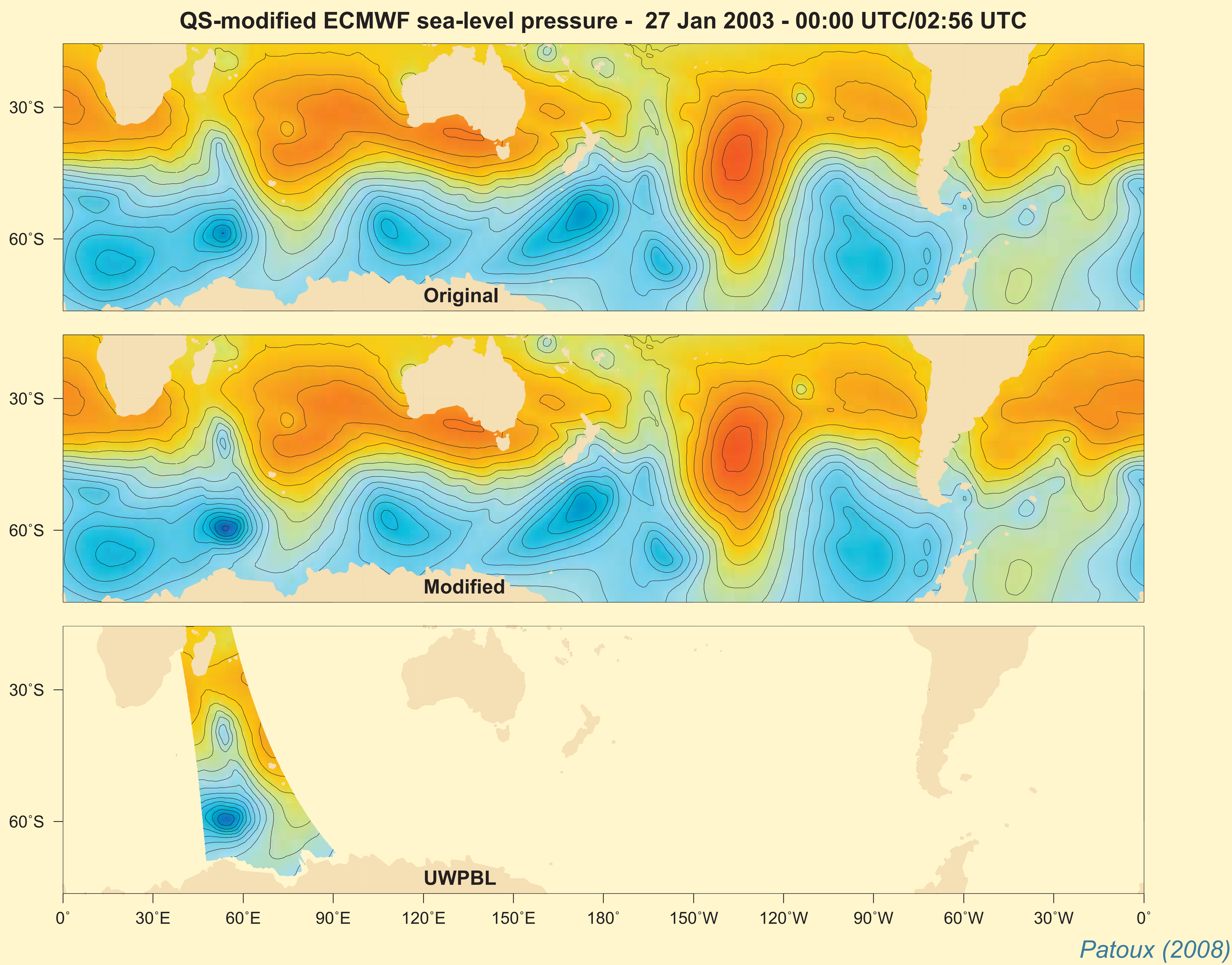
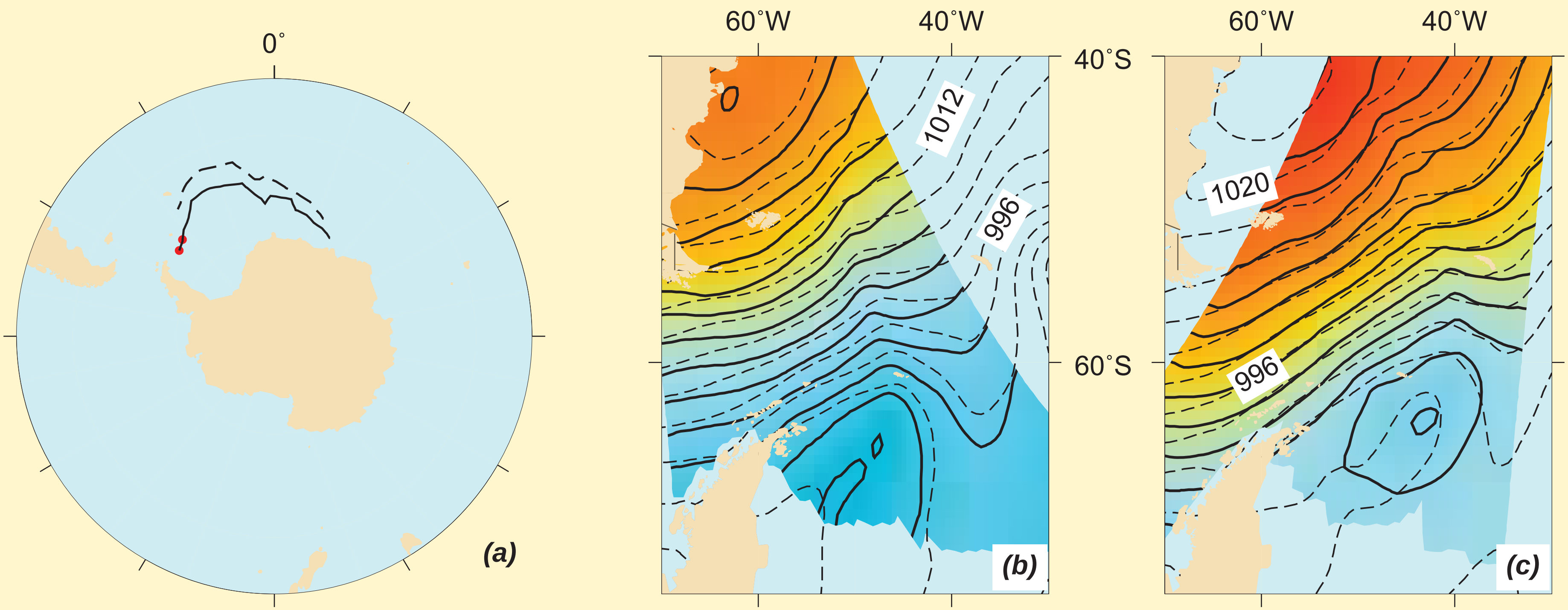

QS-modified ECMWF sea-level pressure - 27 Jan 2003 - 00:00 UTC/02:56 UTC
Original
Modified
UWPBL
30˚S
60˚S
0˚
30˚E
60˚E
90˚E
120˚E
150˚E
180˚
150˚W
120˚W
90˚W
60˚W
30˚W
0˚
Patoux (2008)

Patoux, J., X. Yuan and C. Li (2009): Satellite-Based Midlatitude Cyclone Statistics Over the Southern Ocean. Part I: Scatterometer-Derived Pressure Fields and Storm Tracking, *J. Geophys. Res.*, in press.



In the enhanced UWPBL sea-level pressure fields:

- **5-10%** more cyclone centers are identified
- the cyclones are slightly deeper than in ECMWF
- **8%** tracks are initiated at least 6 hours earlier, while **7%** tracks are extended by at least 6 hours
- the UWPBL sea-level pressure fields contain **~1%** more spectral energy than ECMWF

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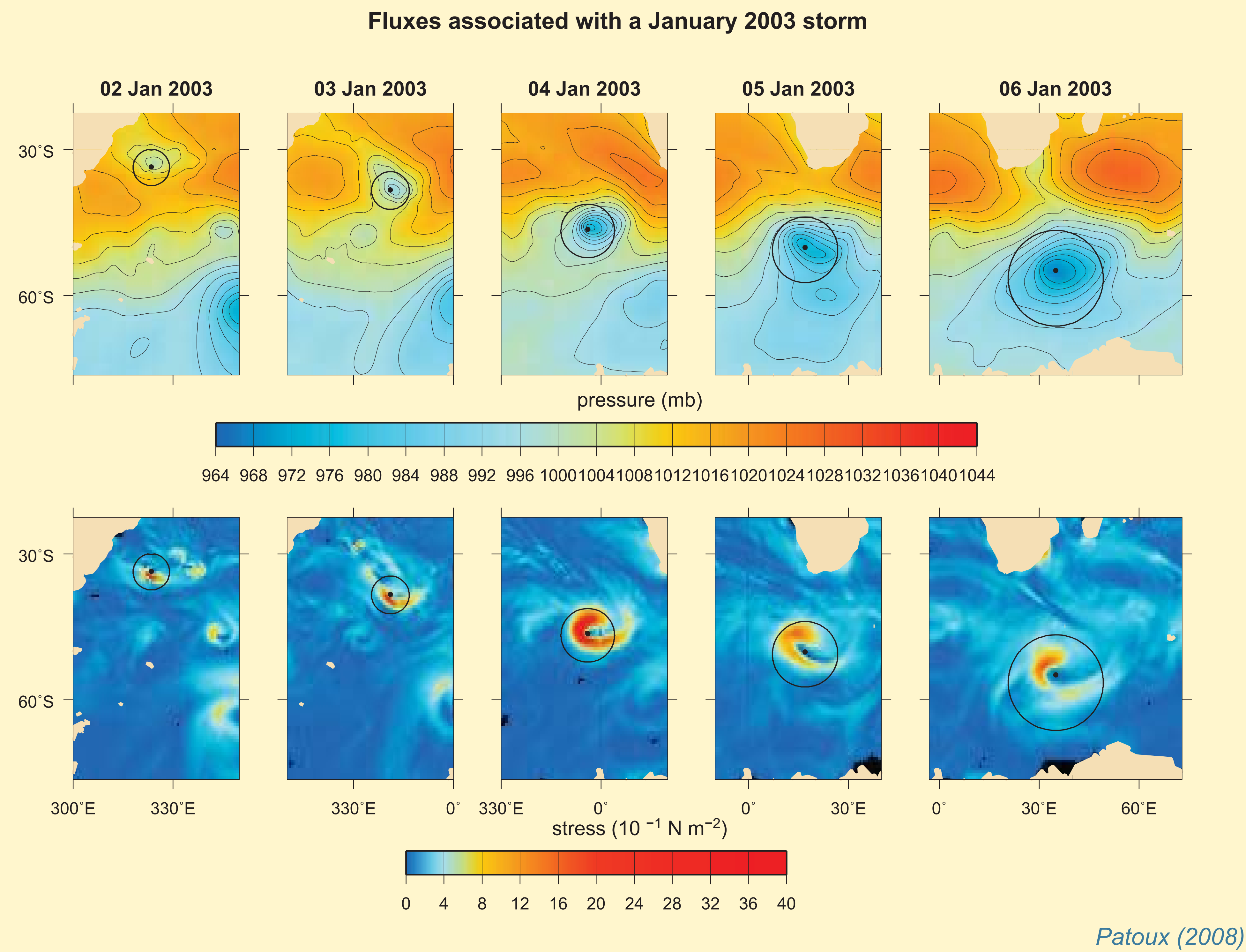
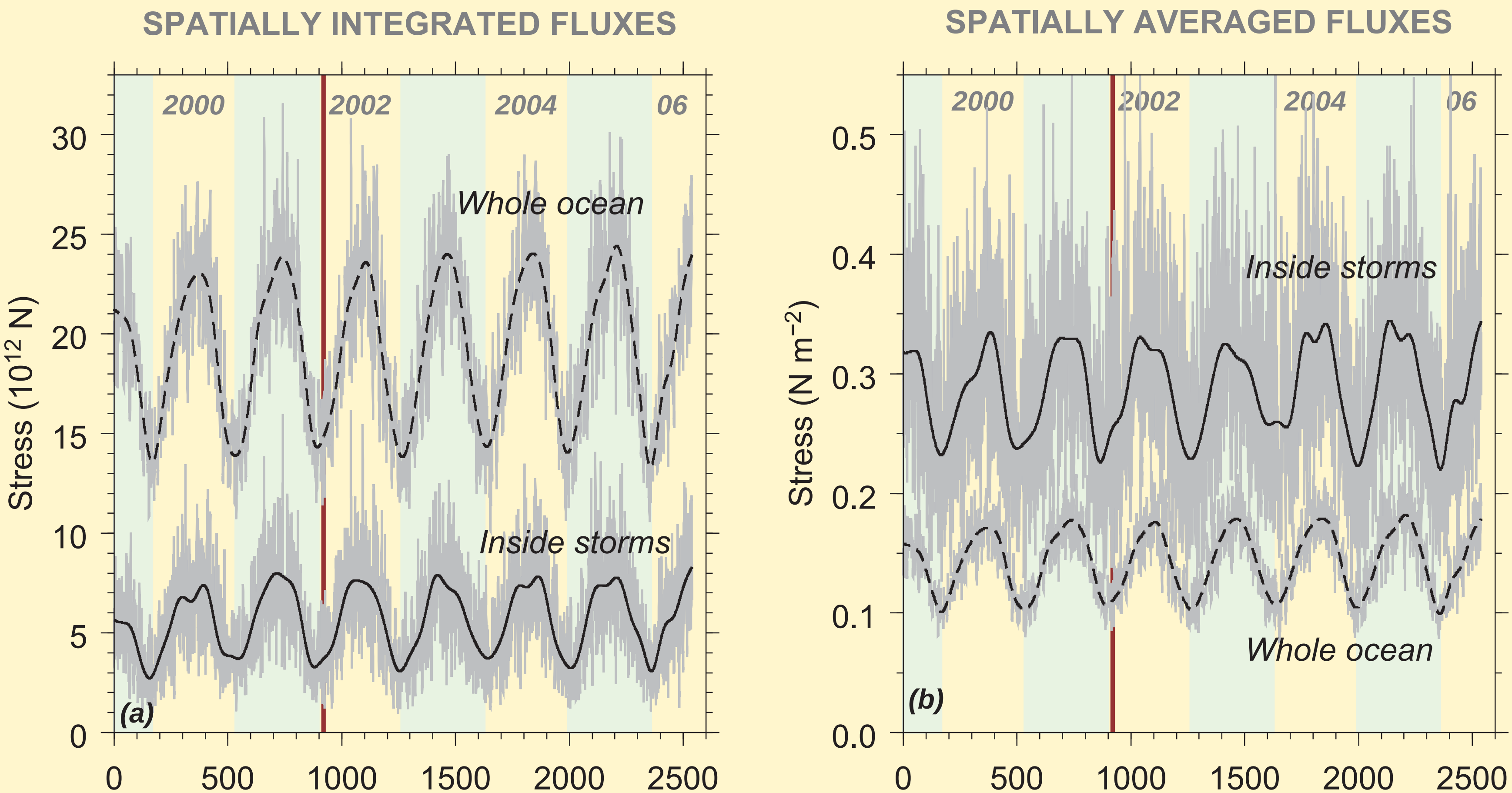


Fluxes associated with a January 2003 storm
02 Jan 2003
03 Jan 2003
04 Jan 2003
05 Jan 2003
06 Jan 2003
30˚S
60˚S
pressure (mb)
964 968 972 976 980 984 988 992 996 1000 1004 1008 1012 1016 1020 1024 1028 1032 1036 1040 1044
300˚E 330˚E 330˚E 0˚ 330˚E 0˚ 0˚ 30˚E 0˚ 30˚E 60˚E
stress (10 ⁻¹ N m⁻²)
0 4 8 12 16 20 24 28 32 36 40
Patoux (2008)

Yuan, X., J. Patoux and C. Li (2009): Satellite-Based Midlatitude Cyclone Statistics Over the Southern Ocean. Part II: Tracks and Surface Fluxes, *J. Geophys. Res.*, in press.



When the air-sea fluxes are calculated from the enhanced UWPBL sea-level pressure fields:

- the spatially integrated stress magnitude is **7.8%** higher inside cyclones and **2.1%** higher over the entire Southern Ocean
- the spatially averaged stress magnitude is **4.6%** higher inside cyclones and **3.1%** higher over the entire Southern Ocean

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Application #3: Can we assimilate the UWQS slp fields in a NWP model?

→ Bob Atlas, Joe Ardizzone...

?

(4:30... stay tuned...)

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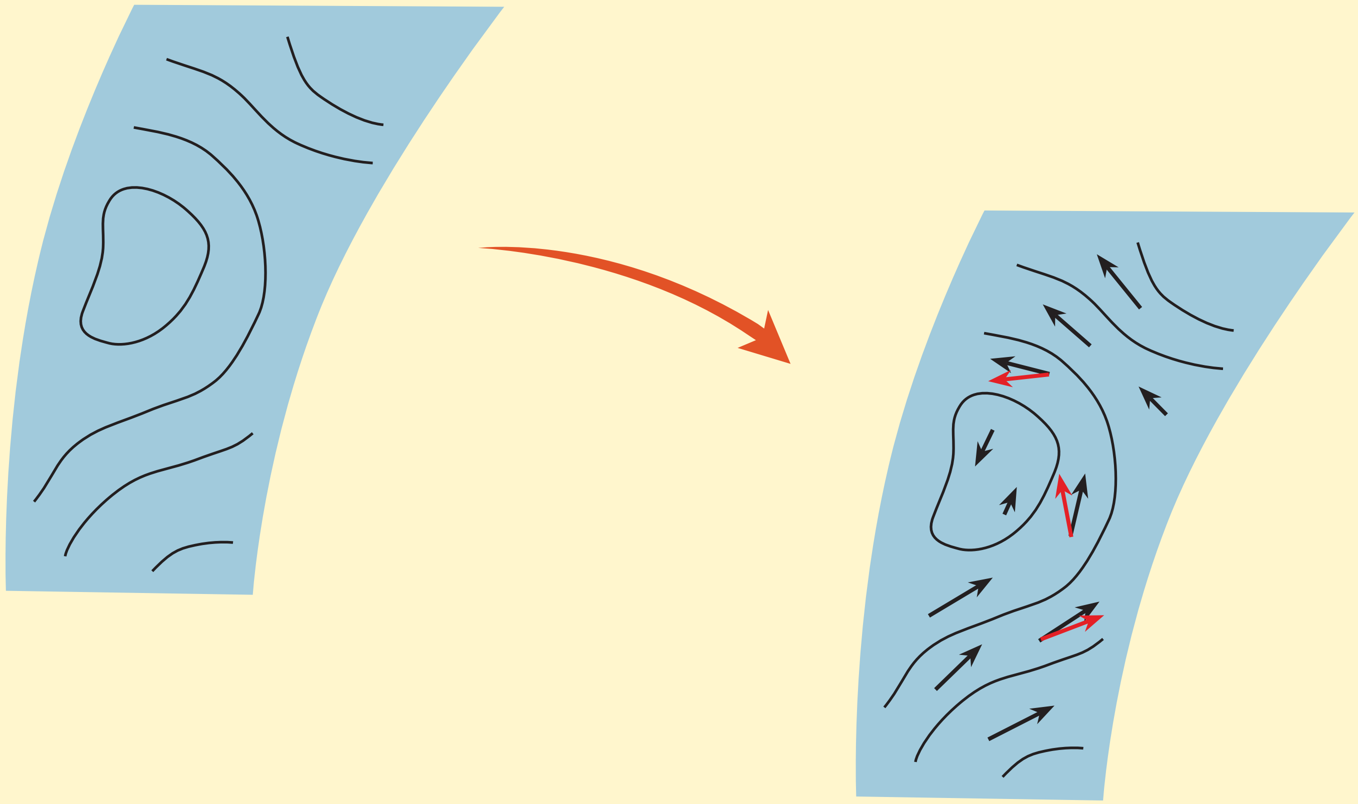
Application #4: If we re-derive the surface winds from the UWQS sea-level pressure fields, how do they compare with the original QS winds?



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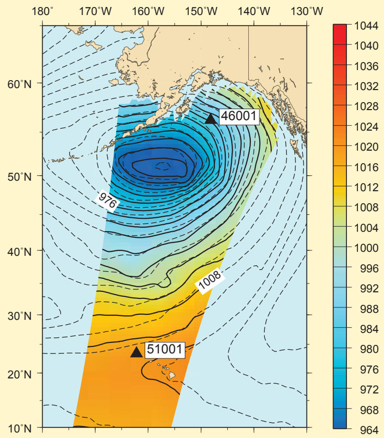
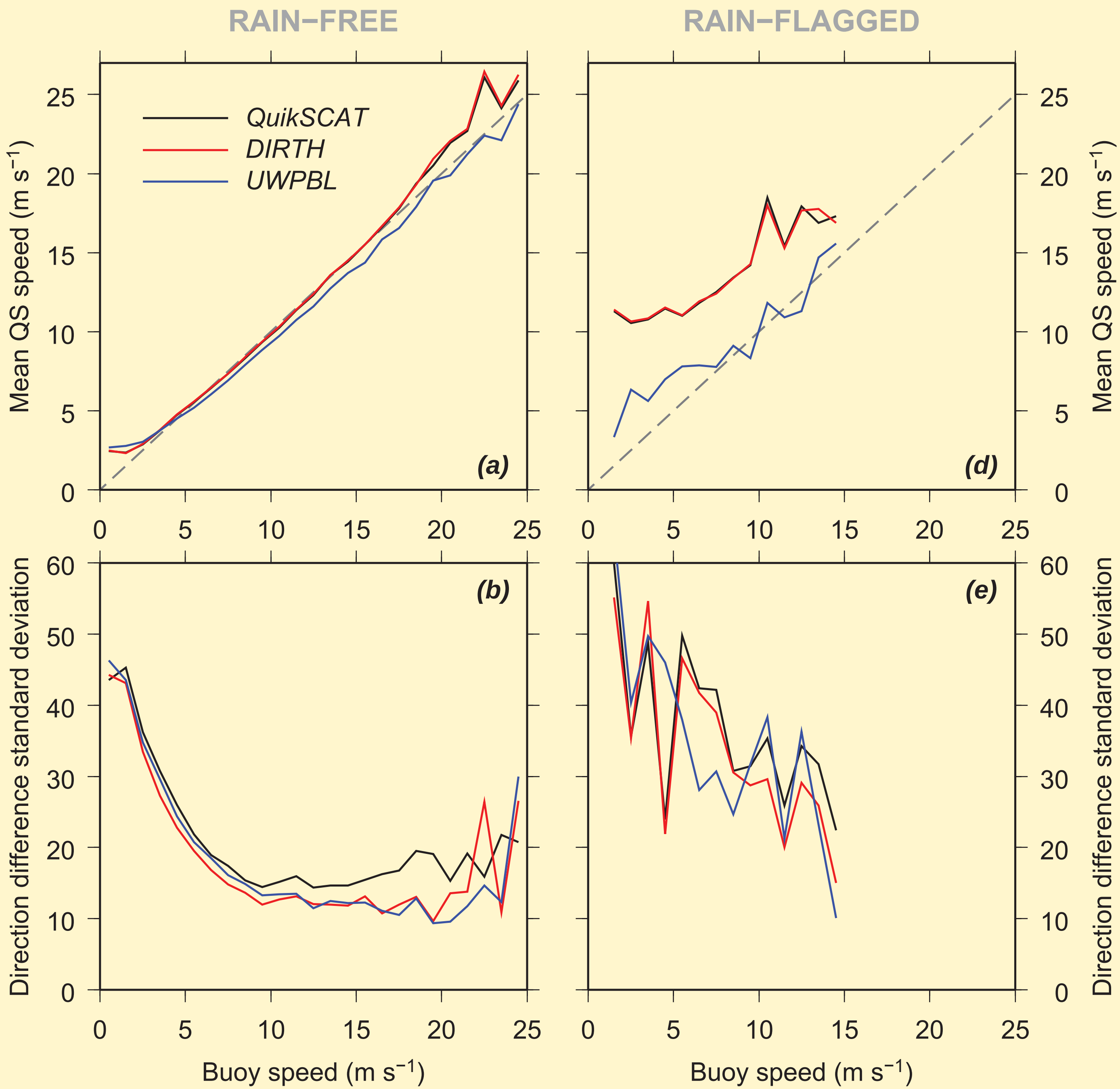
Compare QS/DIRTH/UWPBL surface winds with buoy winds





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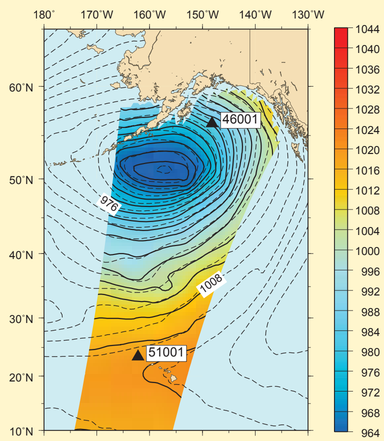
Compare QS/DIRTH/UWPBL surface winds with buoy winds



Vector correlation (rain-free)

	QS	DIRTH	UWPBL	UWPBL *(dir. only)*
All buoys	1.77	1.82	1.80	1.81
North Pacific	1.77	1.82	1.82	1.82
North Atlantic	1.73	1.80	1.76	1.78

Vector correlation (rain-flagged)

	QS	DIRTH	UWPBL	UWPBL *(dir. only)*
North Atlantic	1.08	1.20	1.34	1.13

$\rho = 2$, *perfect vector correlation*

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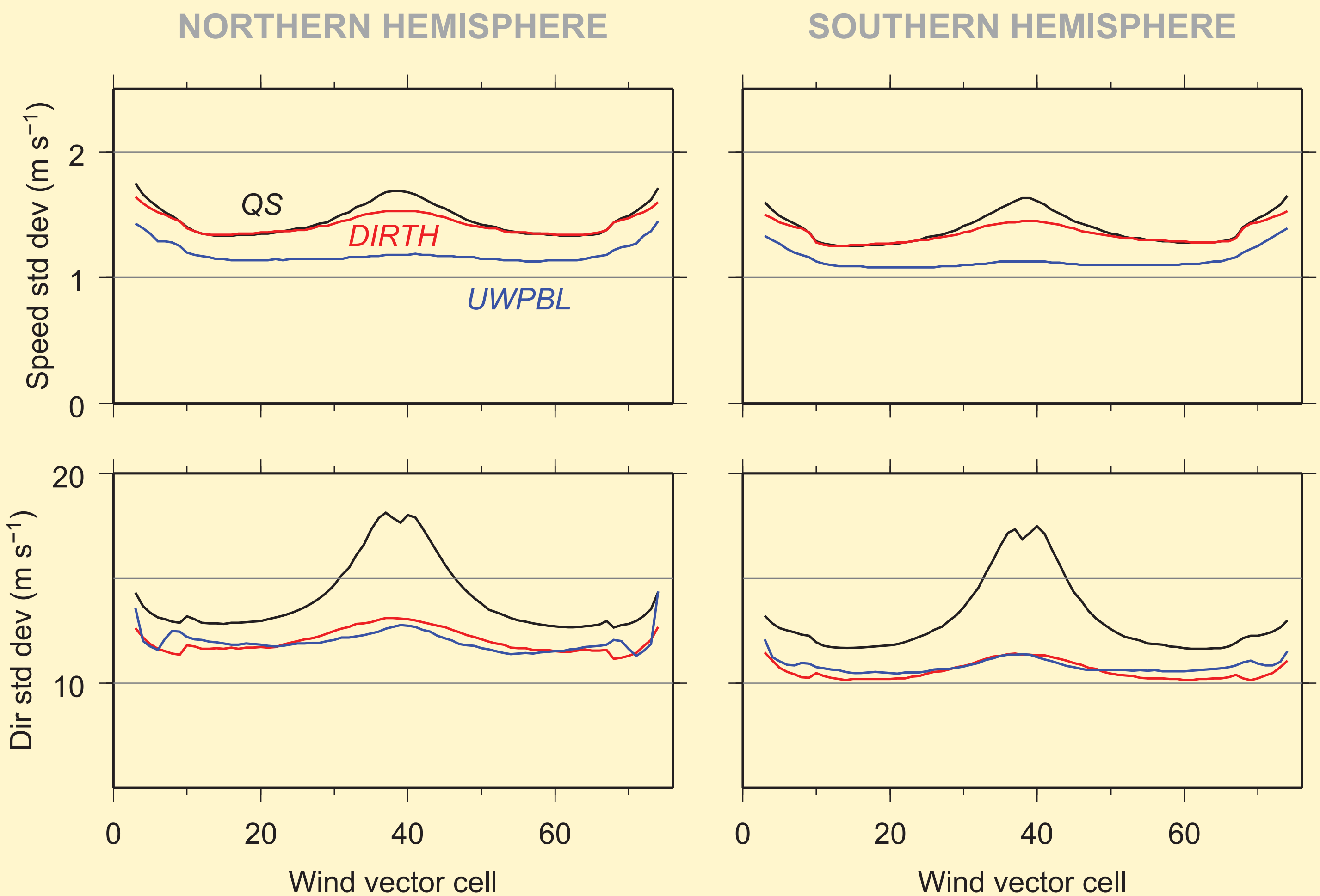
Calculate the rms difference between ECMWF and QS/DIRTH/UWPBL surface wind speed and direction



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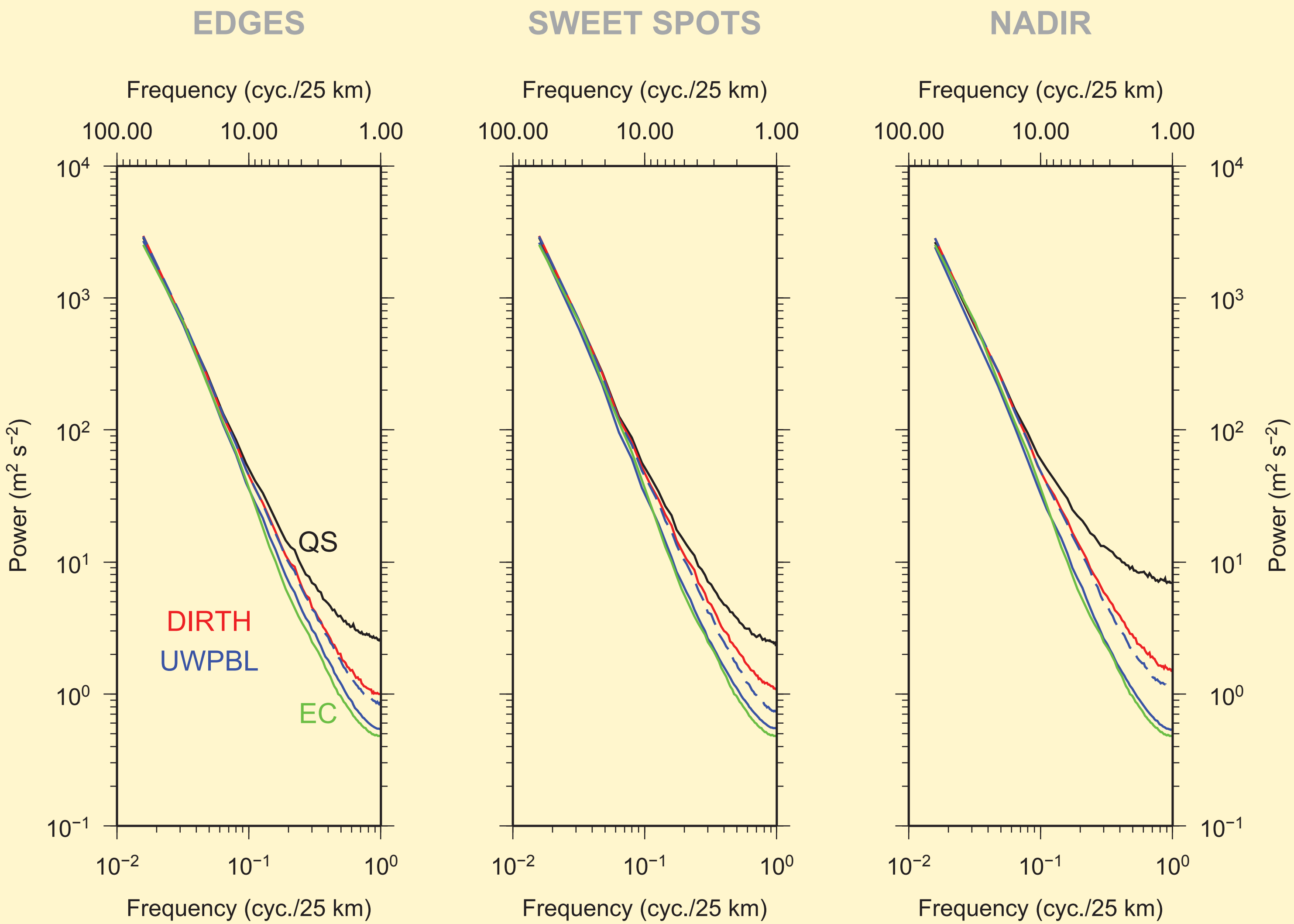
Compare QS/DIRTH/UWPBL and ECMWF spectra



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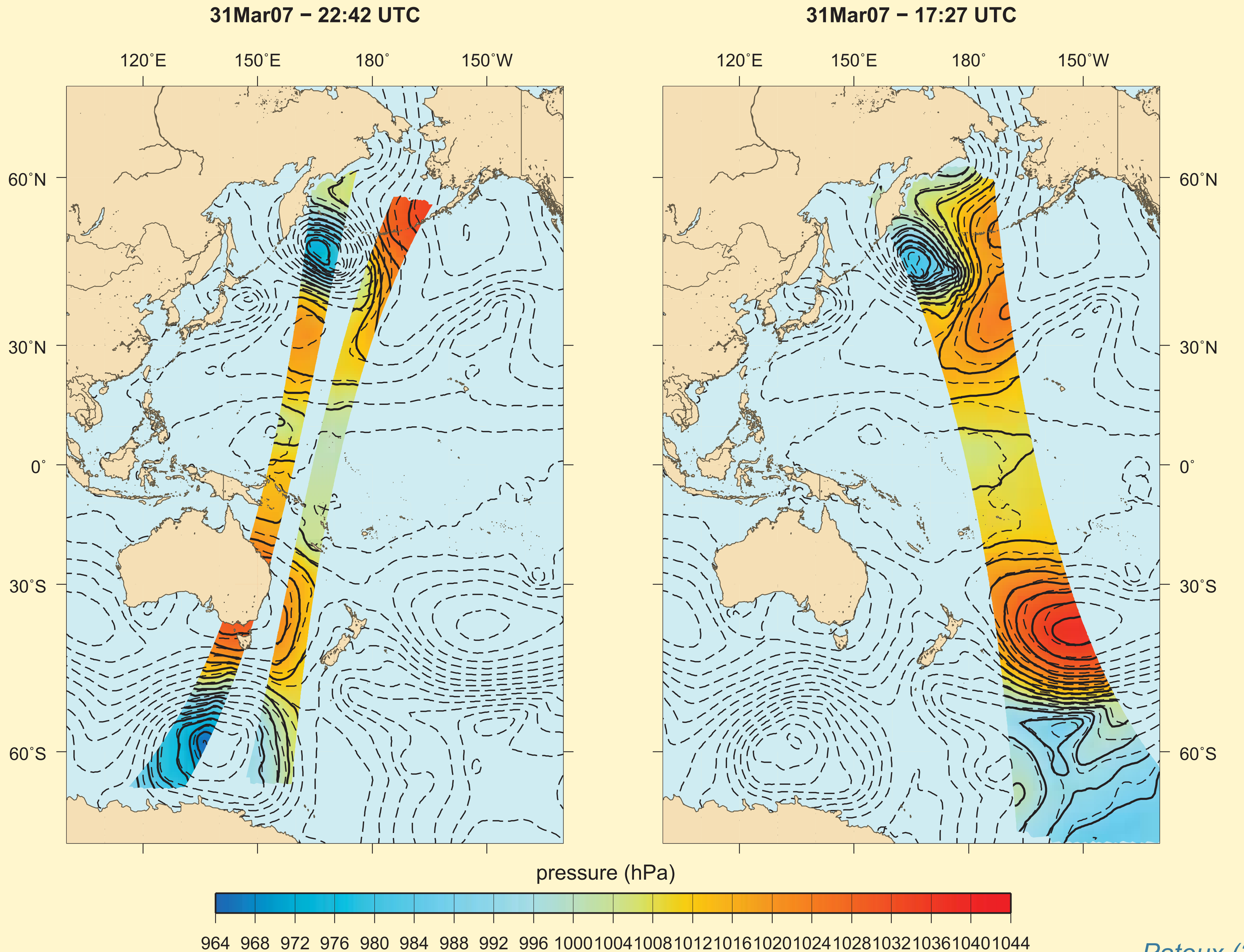
Application #5: We can use the sea-level pressure retrieval as an independent measure of performance (ASCAT, Oceansat-2, etc.)



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Thank you!