CROSS-VALIDATION OF SCATTEROMETER WINDS VIA SEA-LEVEL PRESSURE RETRIEVAL

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The models are

WRONG!

Except one...

The solution for the PBL boundary layer (Brown, 1974, Brown and Liu, 1982), may be written

$$U/V_G = e^{i\alpha} - e^{-z}[e^{-iz} + ie^{iz}]\sin\alpha + U_2$$

where $\mathbf{V_G}$ is the geostrophic wind vector, the angle between $\mathbf{U_{10}}$ and $\mathbf{V_G}$ is $\alpha[u^*, \nabla_H \mathbf{T}, (T_a - T_s,)_{PBL}]$ and the effect of the organized large eddies (OLE) in the PBL is represented by $U_2(u^*, T_a - T_s, \nabla_H \mathbf{T})$

This may be written:

$$\mathbf{U/V_G} = f\{\alpha(u^*), \mathbf{U_2}(u^*), \mathbf{u^*}, z_o(u^*), \mathbf{V_T(\nabla_H T)}, \Psi(T_a - T_s), \lambda\}$$

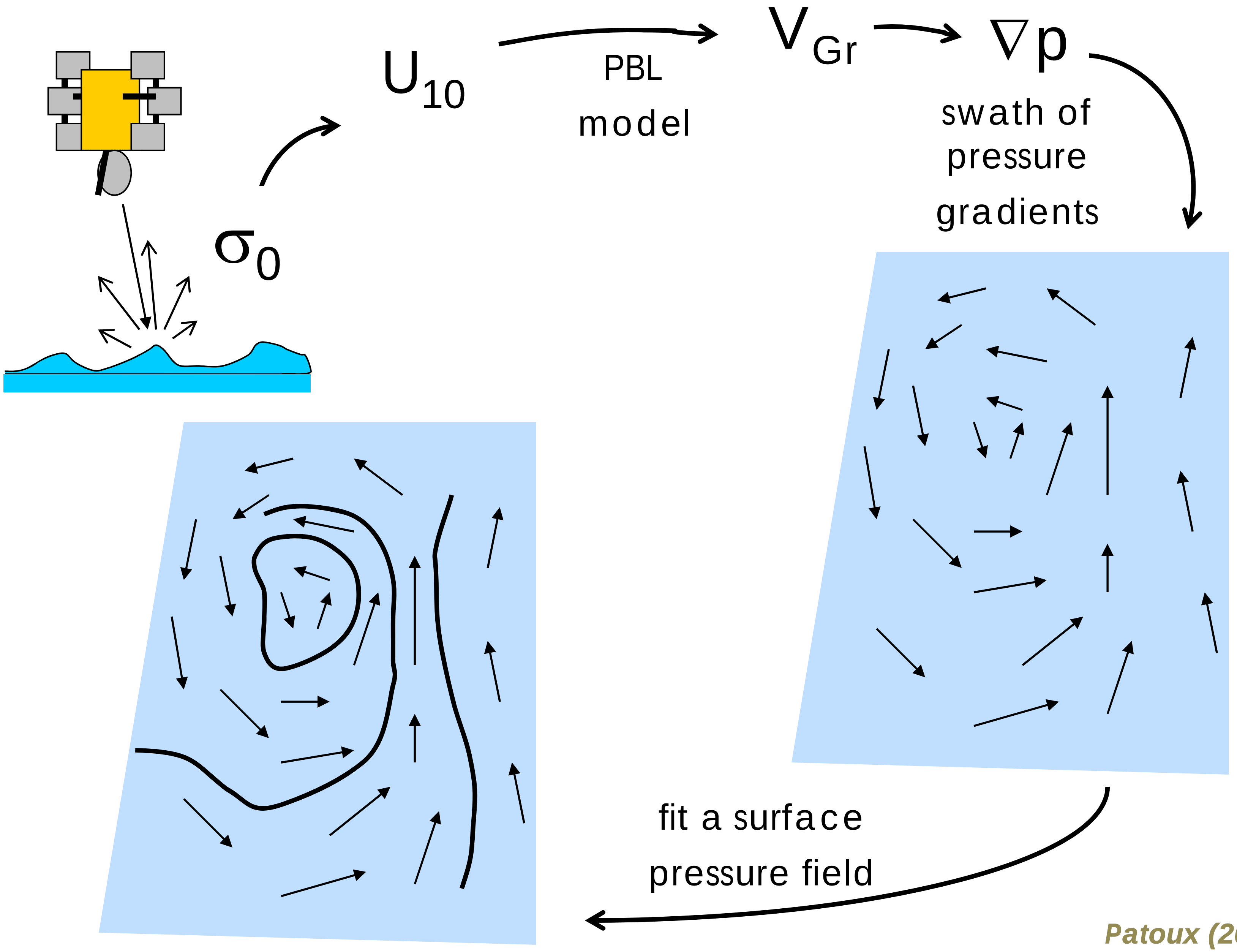
Or $\mathbf{U/V_G} = f[\mathbf{u^*}, \mathbf{V}_T(\nabla_H \mathbf{T}), \Psi(T_a - T_s), \lambda, k, a] = f\{\mathbf{u^*}, \nabla_H \mathbf{T}, T_a - T_s\}$,

for $\lambda = 0.15$, $k = 0.4$ and $a = 1$

In particular,

$$V_G = f\,(u^*, \nabla_H T, T_a - T_s) \equiv f_n(\nabla P, \rho, f)$$

Hence $\nabla \mathbf{P} = f_n\,[u^*(k, a, \lambda), \nabla_H T, T_a - T_s, \rho, f\,] \approx \mathbf{f_n(\sigma_o)}$



σ_0
U_{10}
PBL
model
V_{Gr}
∇p
swath of
pressure
gradients
fit a surface
pressure field

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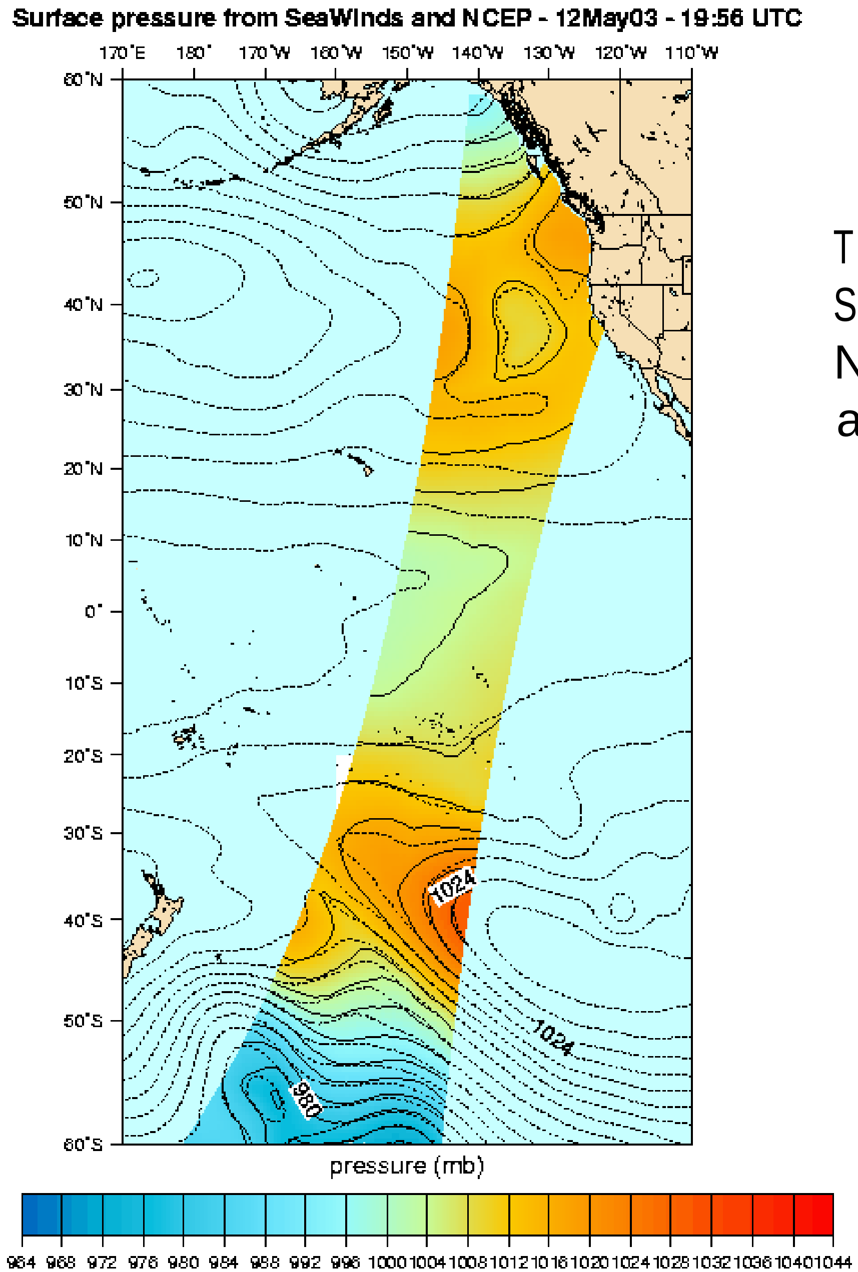

The scatterometer-derived SLP fields compare well with NCEP and ECMWF SLP analyses.

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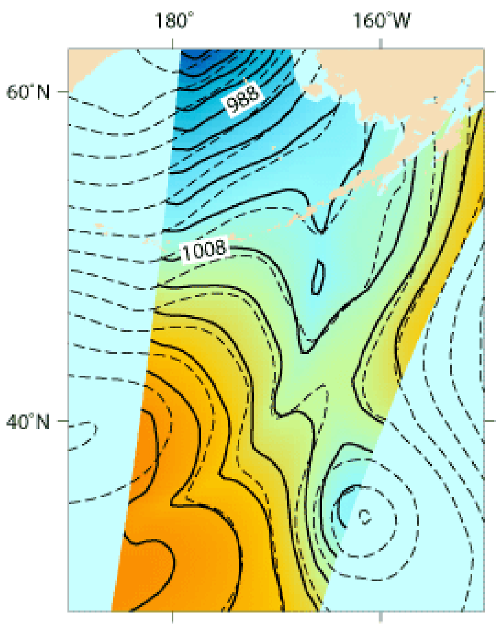
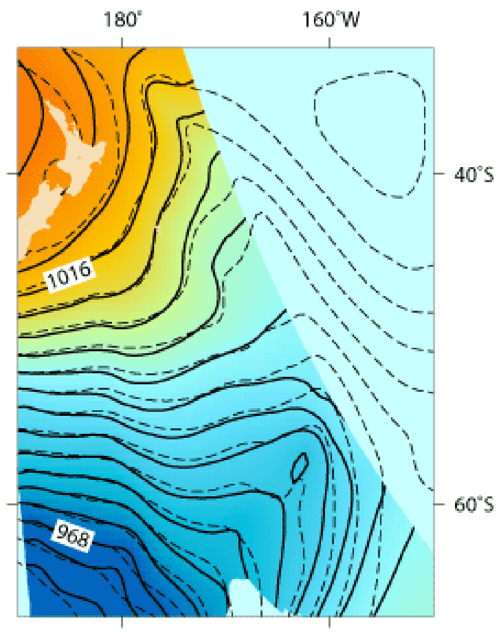
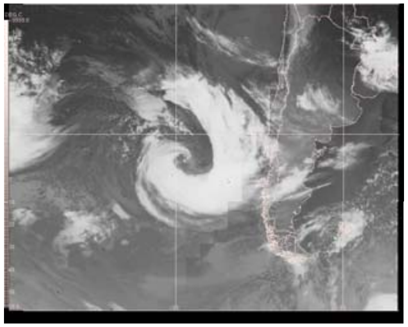
Applications: Identification and diagnosis of frontal wave development.



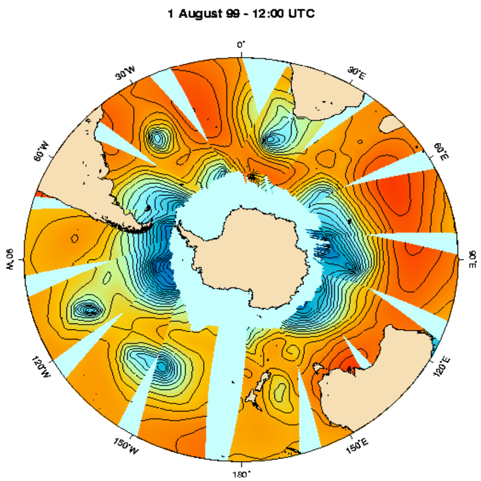


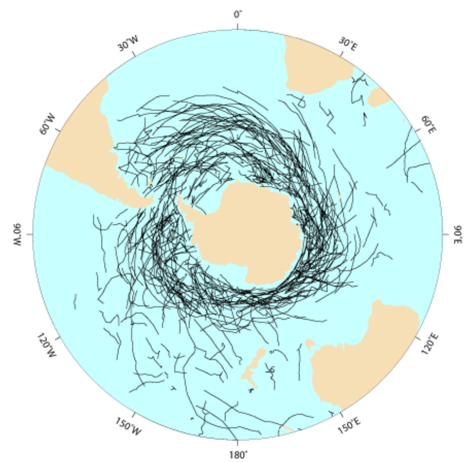


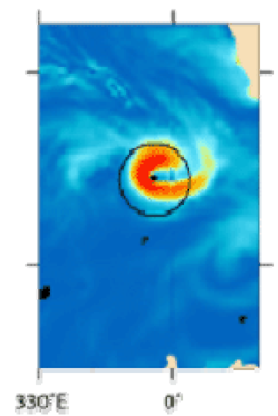
Patoux, J., G.J. Hakim and R.A. Brown, 2005: **Diagnosis of frontal instabilities over the Southern Ocean**, *Mon. Wea. Rev.*, 133, 863-875.

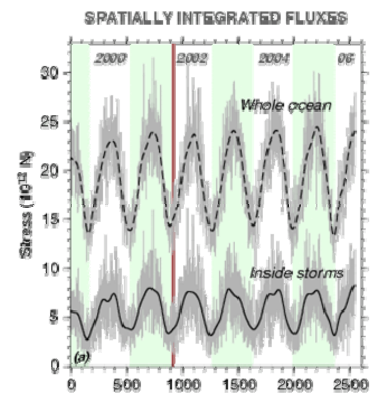
Patoux (2010)

Applications: Midlatitude cyclone intensification, tracking, and climatology of air-sea fluxes.









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. of Geophys. Res.*, D04105, doi:10.1029/2008JD010873 .

Yuan X., J. Patoux and C. Li, 2009: **Satellite-based midlatitude cyclone statistics over the Southern Ocean. Part II: Tracks and surface fluxes**, *J. of Geophys. Res.*, D04106, doi:10.1029/2008JD010874.

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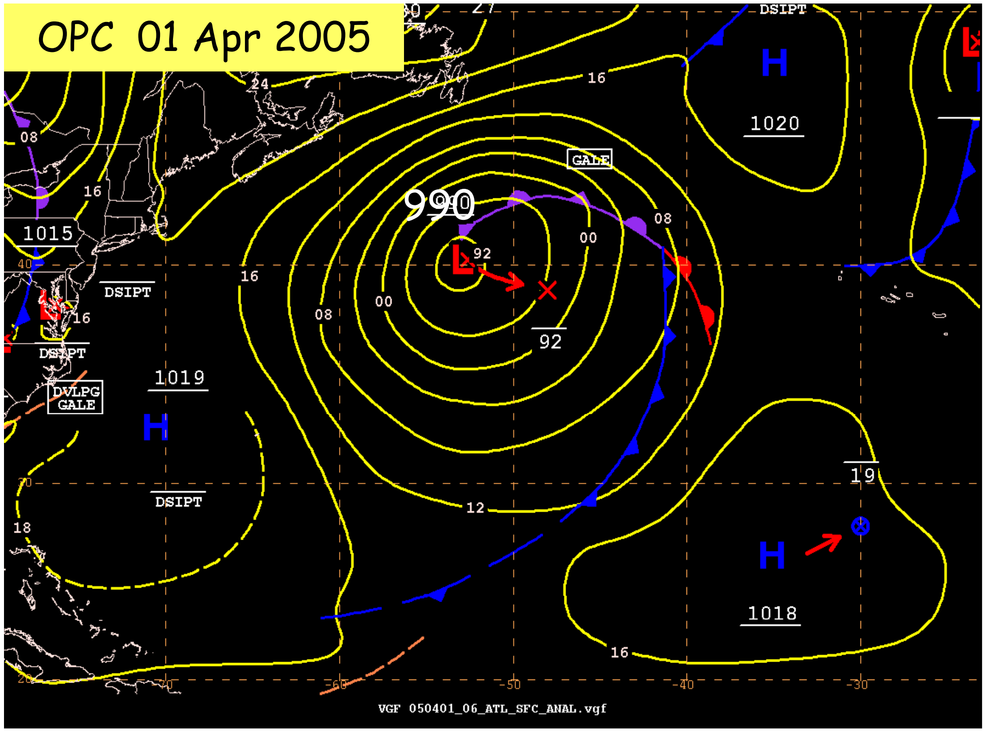
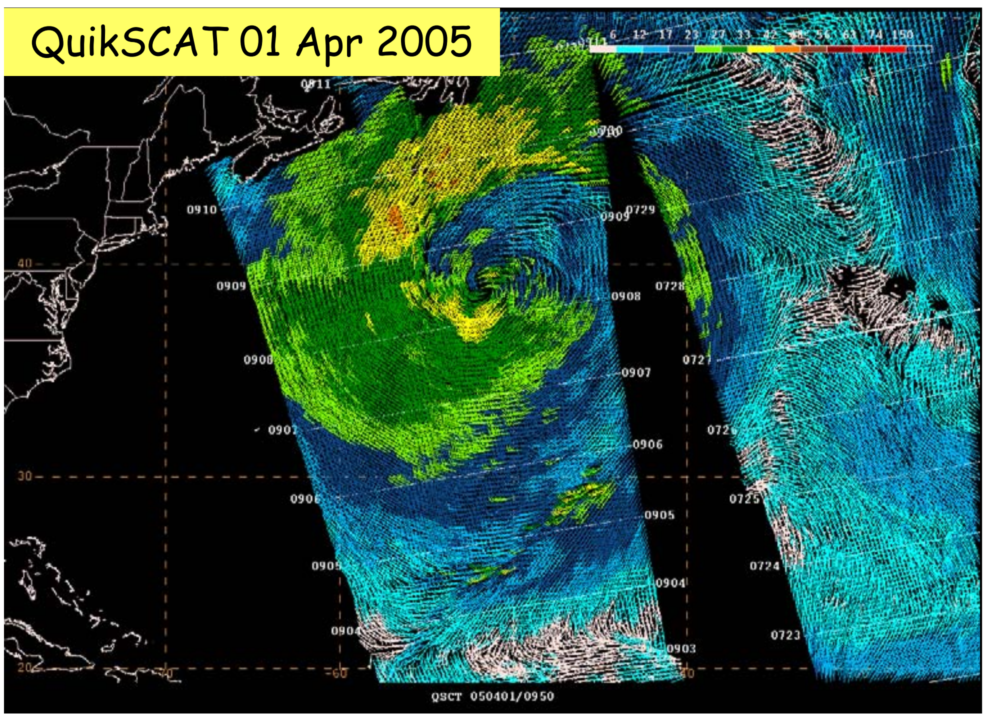
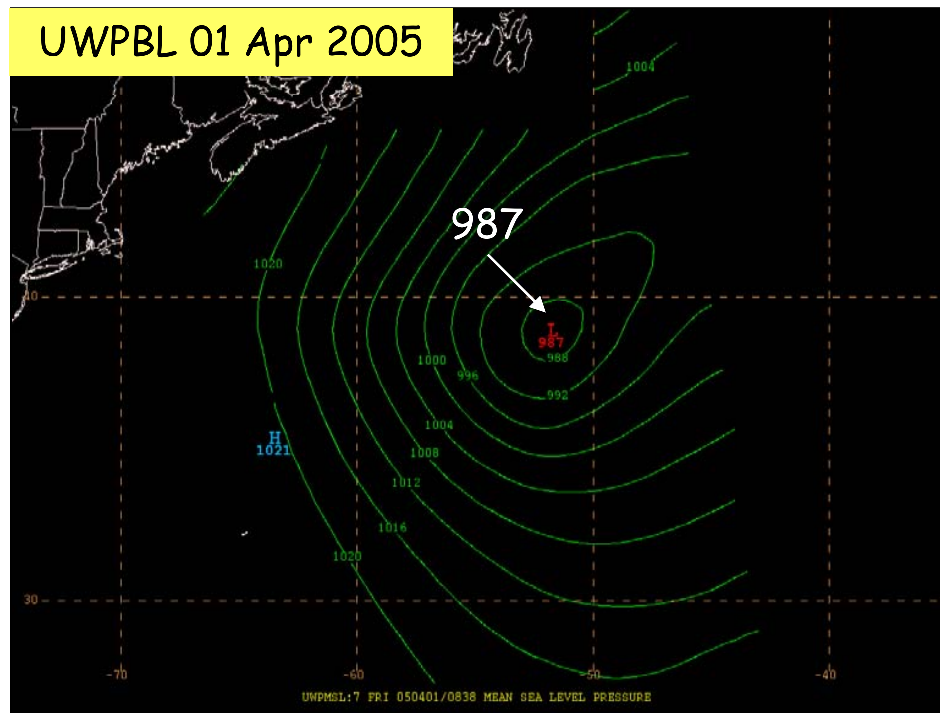


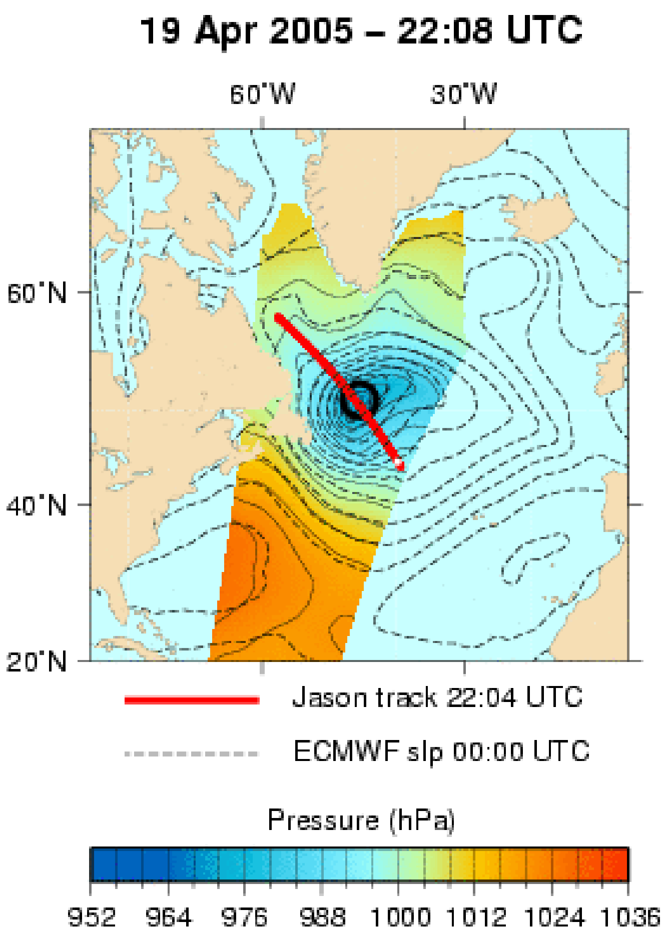
Applications: NRT QS-derived SLP fields at the Ocean Prediction Center.

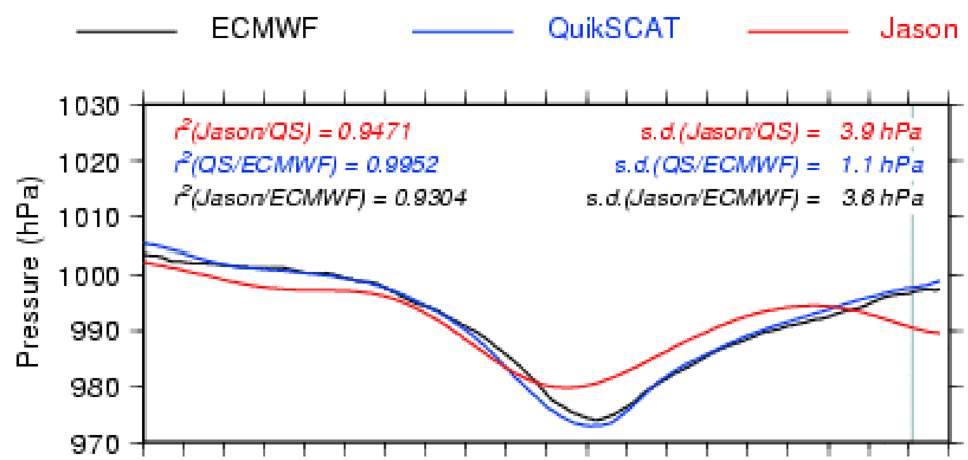
(In coll. with Joe Sienkiewicz.)





Applications: Synergy between scatterometry and altimetry in midlatitude cyclone studies.





Carrère, L., F. Mertz, J. Dorandeu, Y. Quilfen and J. Patoux, 2009: **Observing and studying extreme low pressure events with altimetry**, in *Sensors*, Special Issue "Ocean Remote Sensing", 9(3), 1306-1329, doi:10.3390/s90301306.

What next?

- Is the SLP retrieval methodology applicable to other scatterometers?
- How will the SLP fields derived from different instruments compare with each other?
- Can we consider a long-term multi-instrument climatology of global SLP fields?
- Could such a SLP climatology guide our construction of a ***wind*** climatology?

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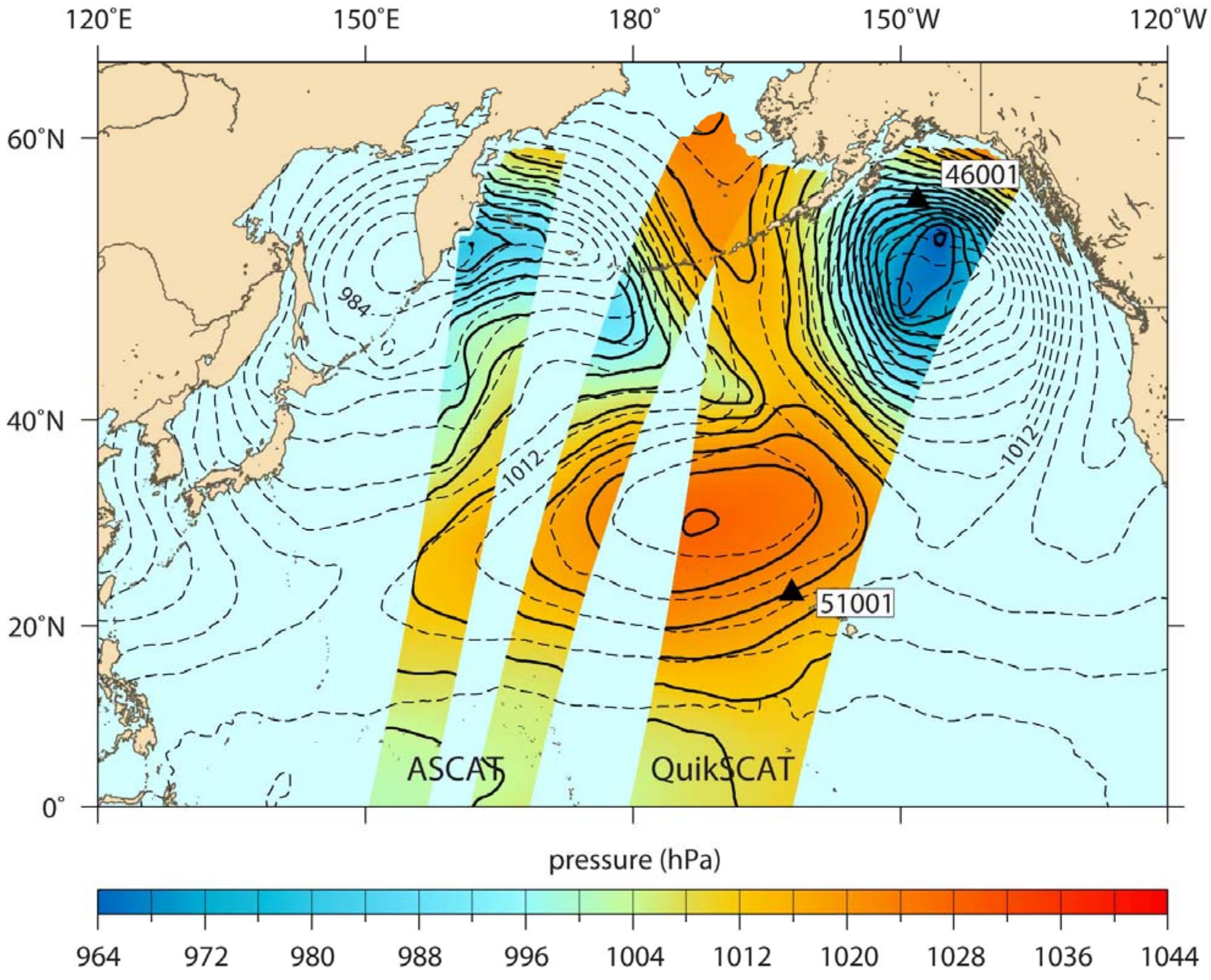
Comparison of QS- and ASCAT-derived SLP fields



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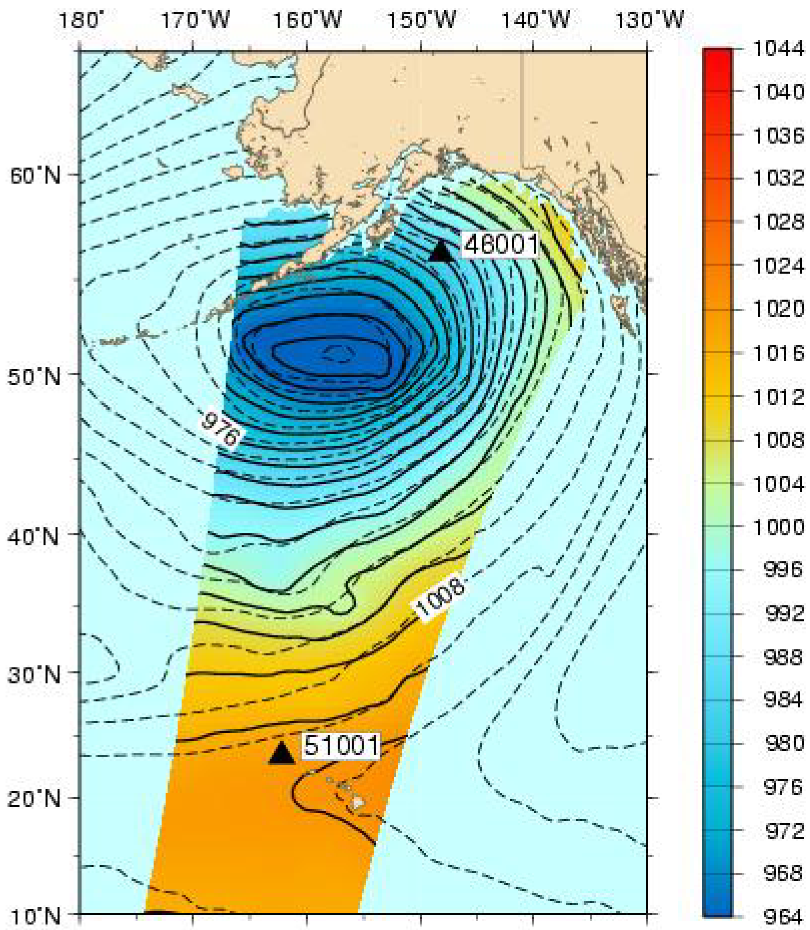
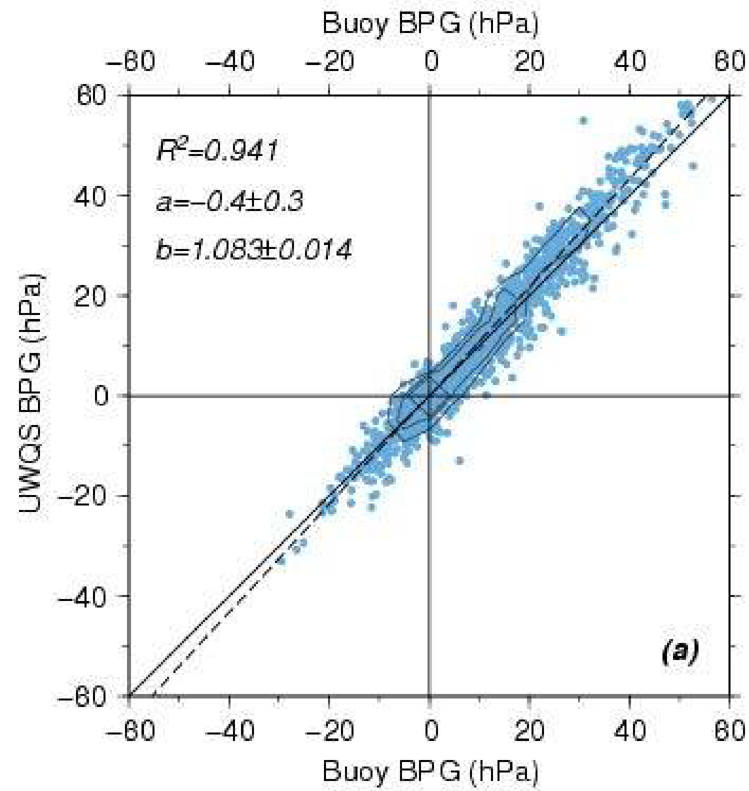
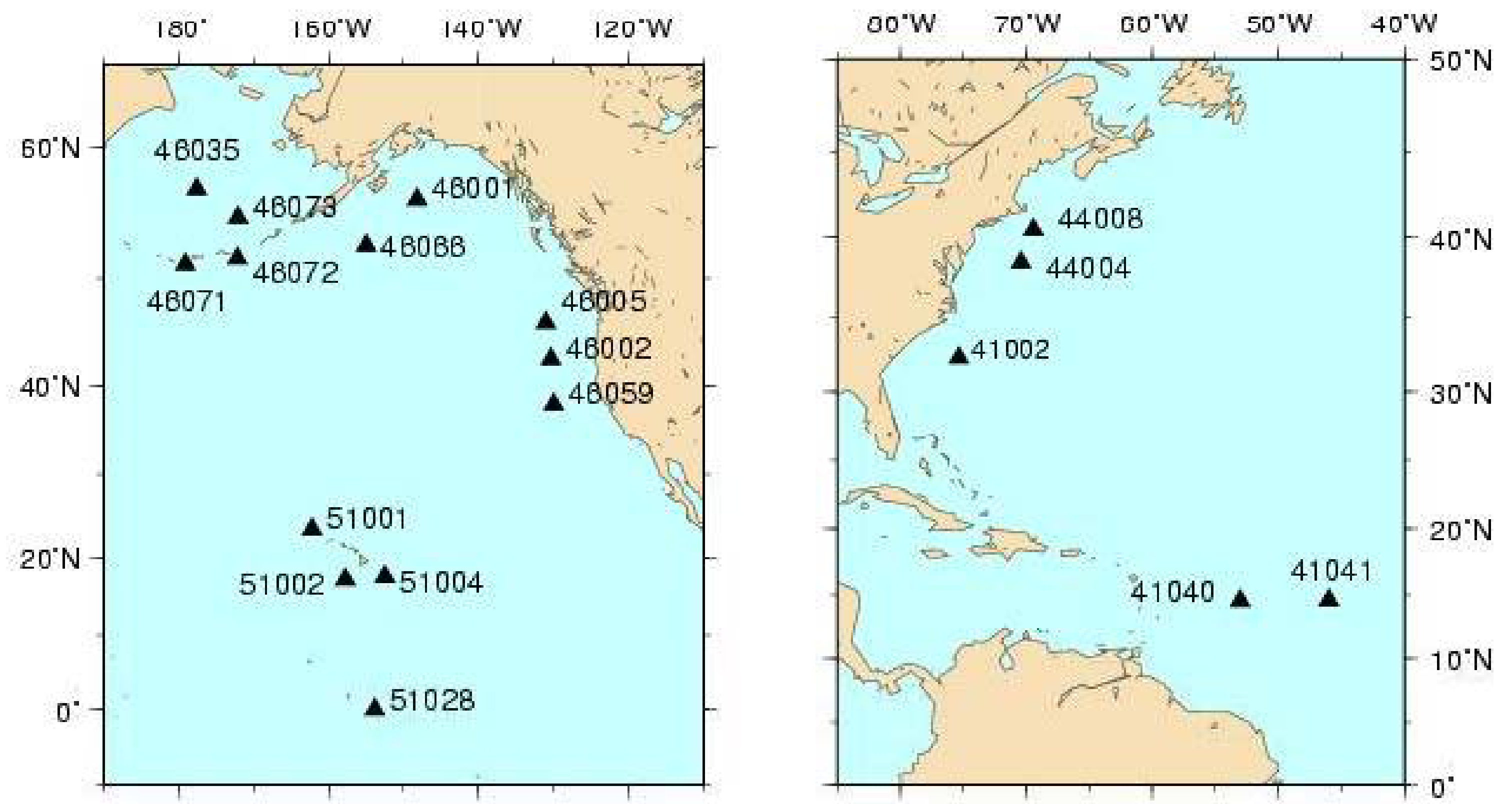
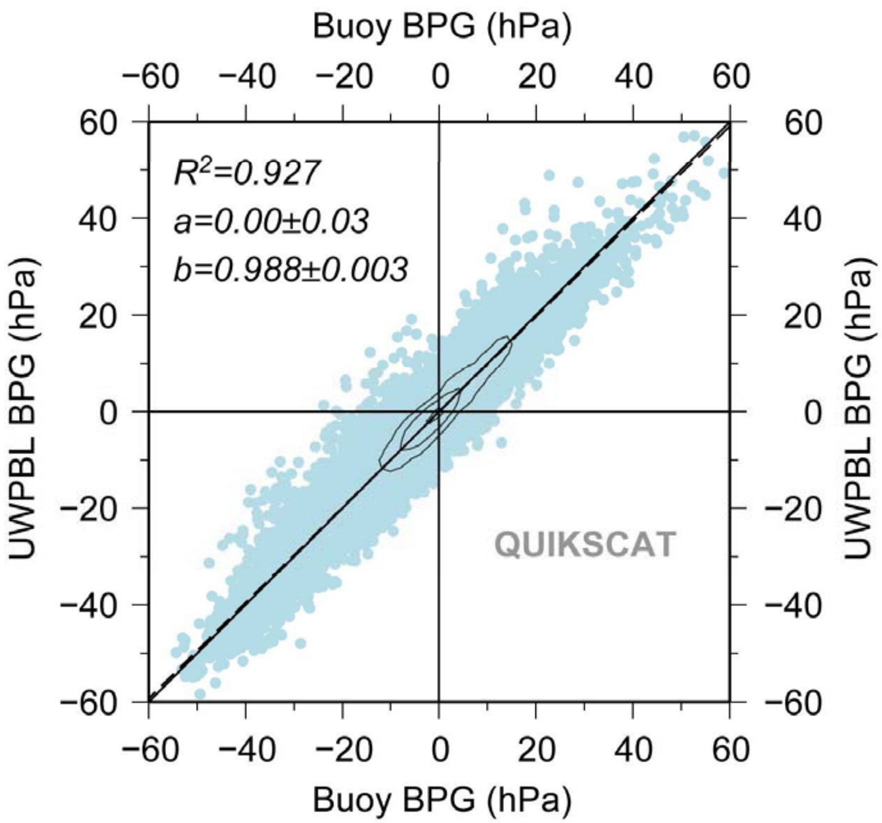
Comparison of buoy (bulk) pressure gradients with QS-derived (bulk) pressure gradients





Repeat for all possible pairs of buoys...





Good agreement with buoys:

R^2 = 0.927
Slope = 0.988

Patoux, J., R.C. Foster and R.A. Brown, 2007: **An Evaluation of Scatterometer-derived Oceanic Surface Pressure Fields**, *J. Appl. Meteor.*, 47, 835-852.

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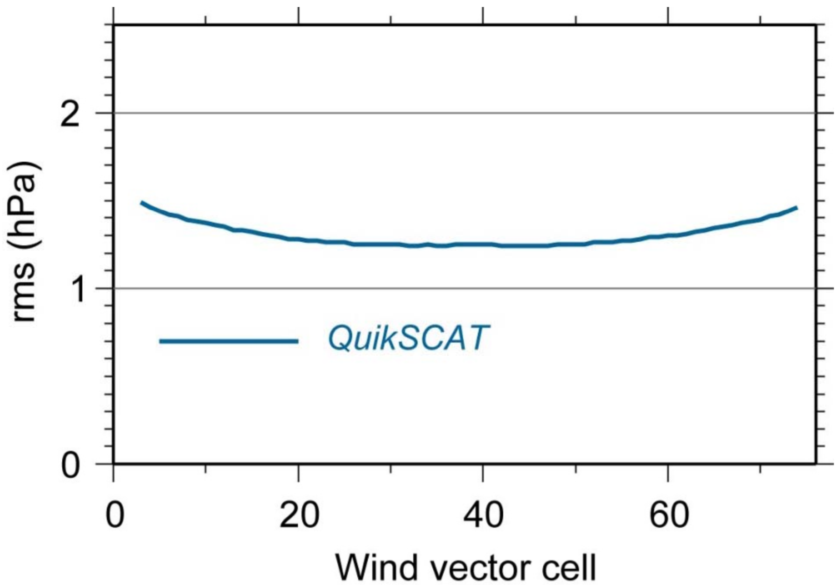
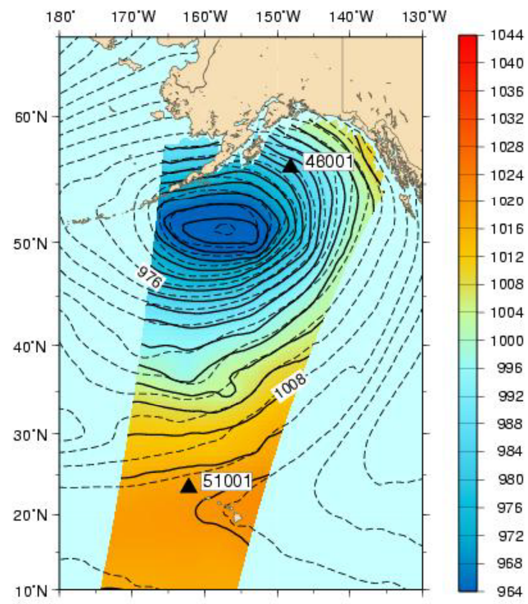
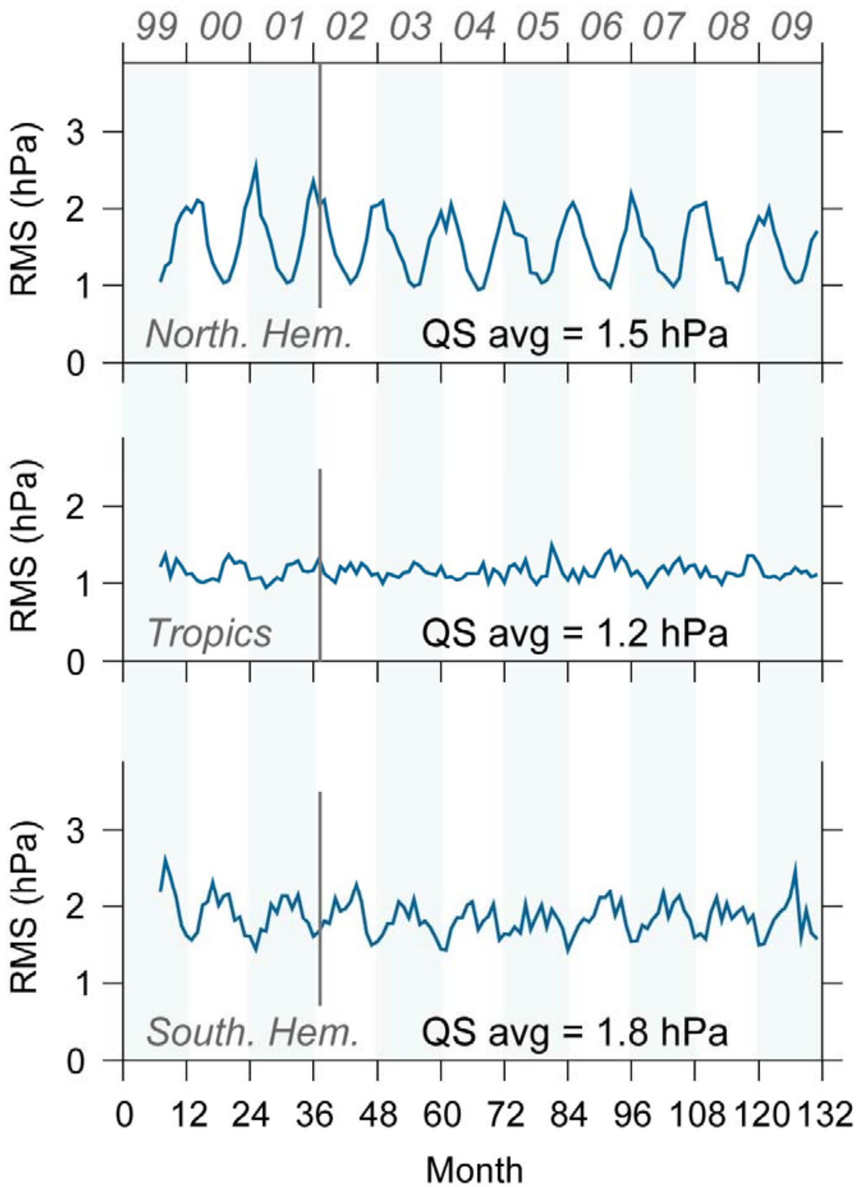


Rms differences with ECMWF:

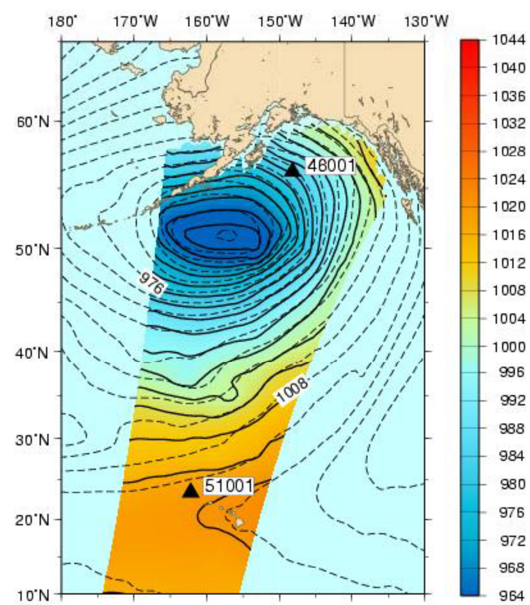
1.2-1.5 hPa across the swath.

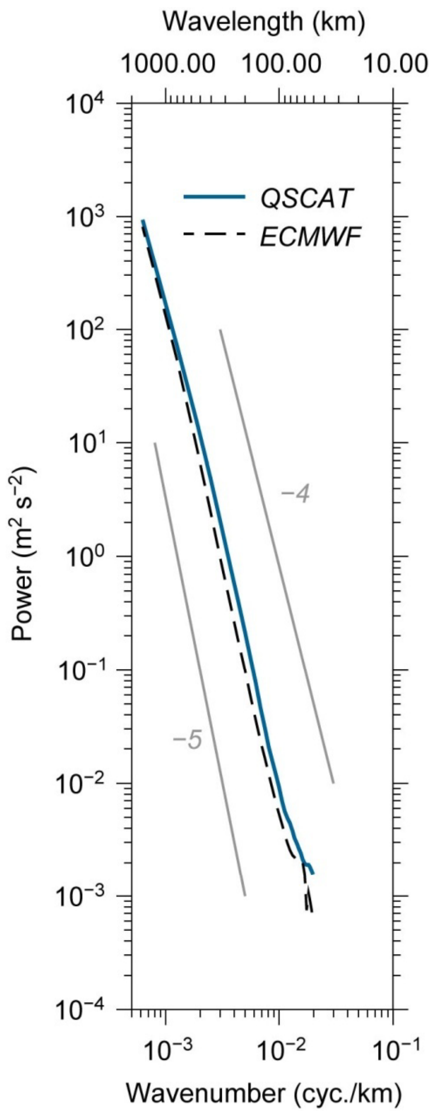




Rms differences with ECMWF:

~1-2 hPa, depending on latitude and season.





Spectral analysis:

Slope = -4.3
(consistent with wind spectral slope of ~-2.2-2.4)

More energy in QS spectra at all scales below ~1000 km.
(ECMWF slope = -4.4)

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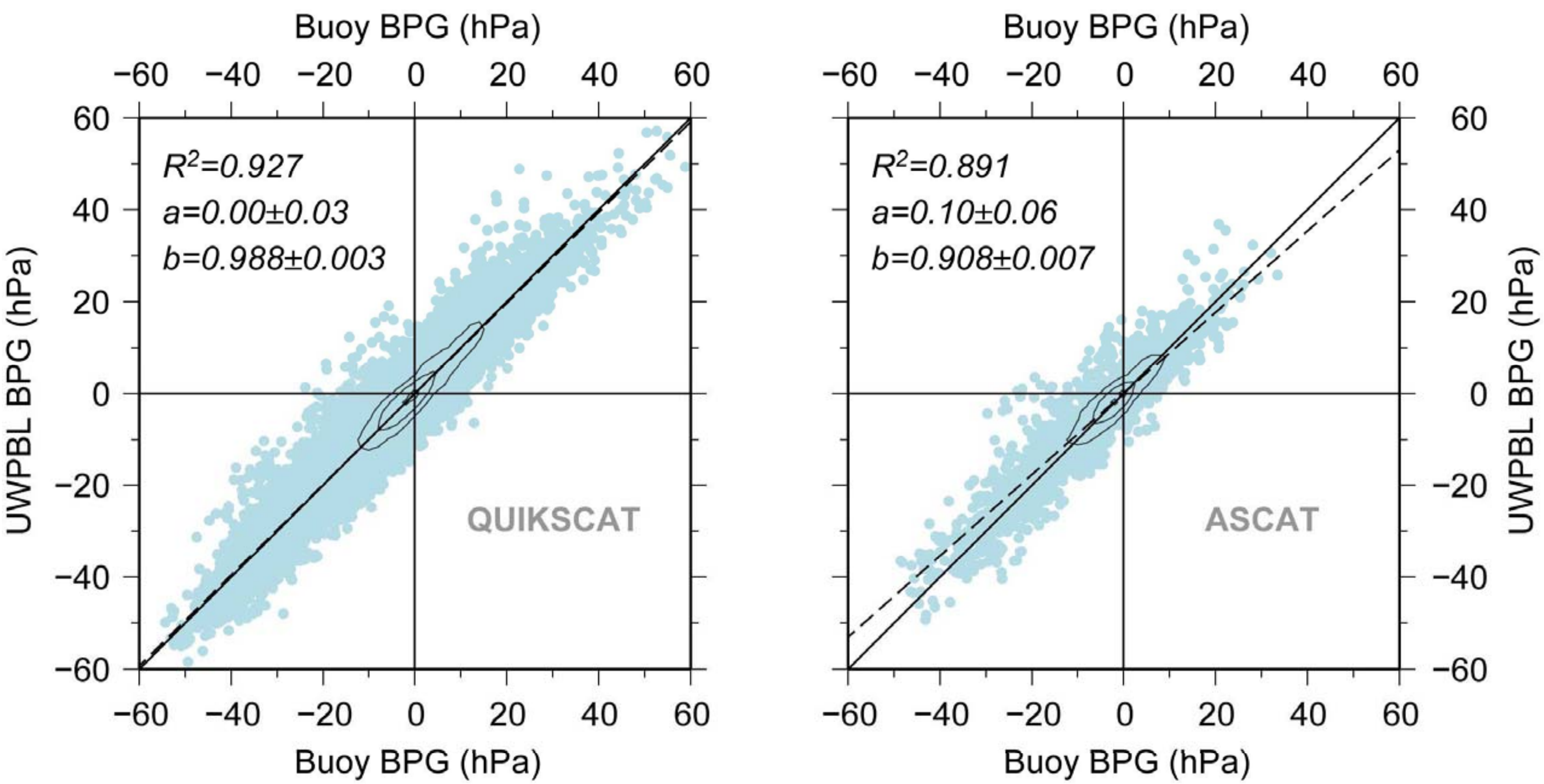
Compare ASCAT with QS:



QuikSCAT: **R^2 = 0.927**
Slope = 0.988

ASCAT: **R^2 = 0.891**
Slope = 0.908

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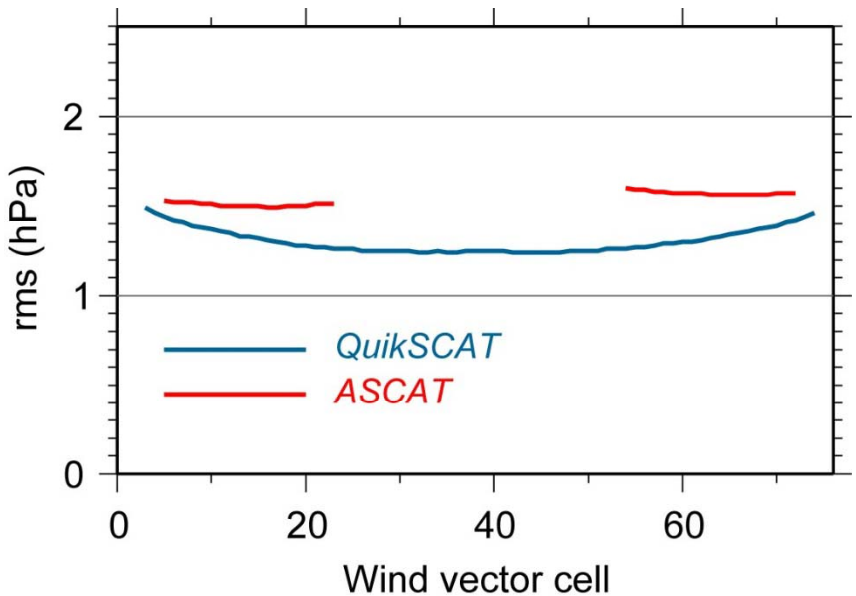

The rms differences between ASCAT and ECMWF are **0.2-0.3 hPa** larger than the rms differences between QS and ECMWF.

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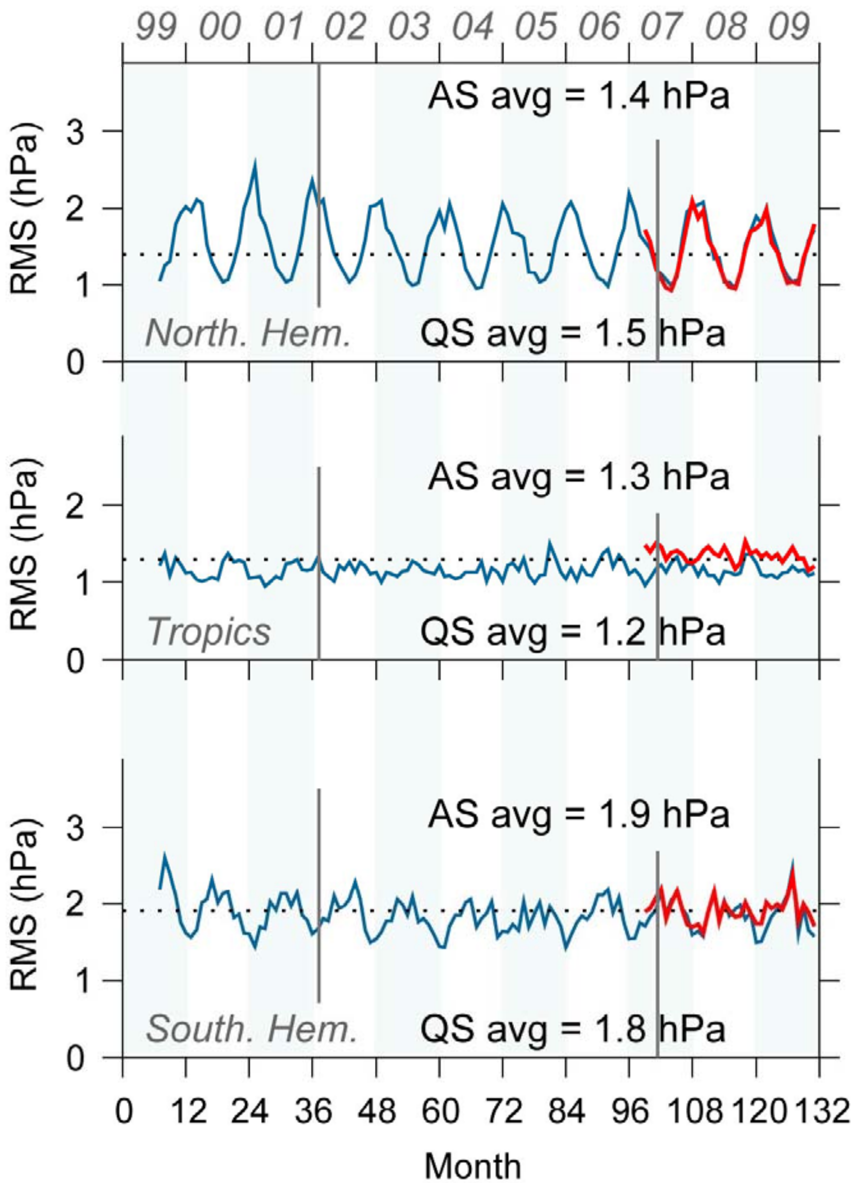

The rms differences with ECMWF agree within **~0.1 hPa** and the seasonal variations agree well with each other.

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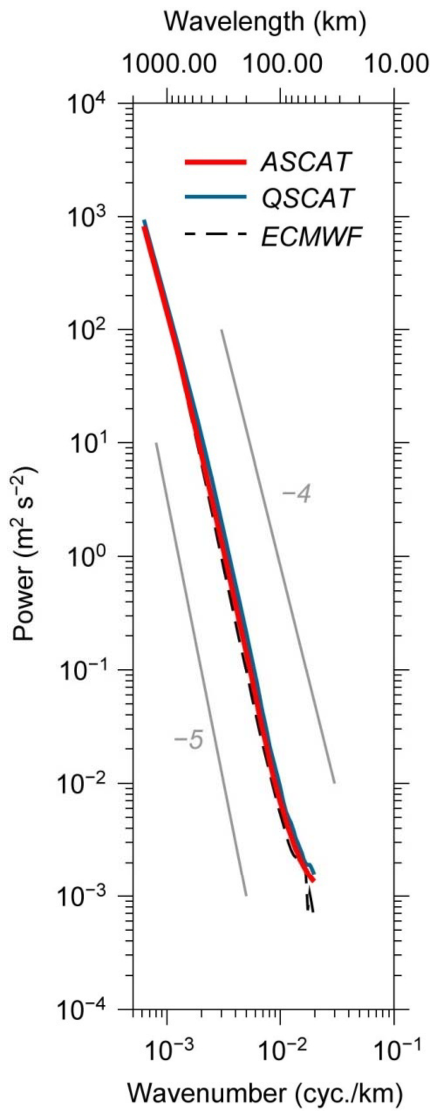

Spectral analysis:

Identical slopes (-4.3)
Slightly less energy in ASCAT spectra, as compared to QS.

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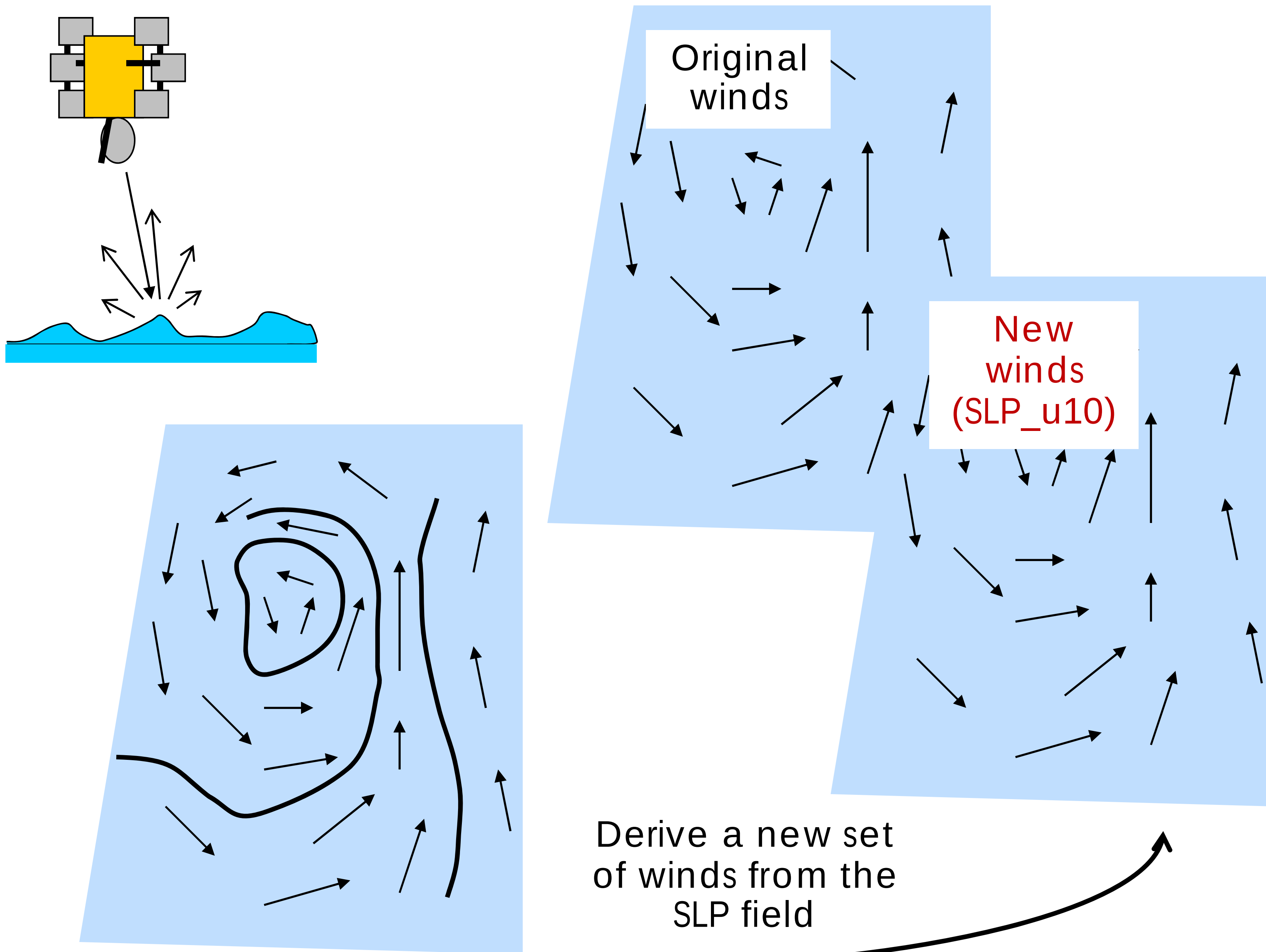
Original winds
New winds (SLP_u10)
Derive a new set of winds from the SLP field

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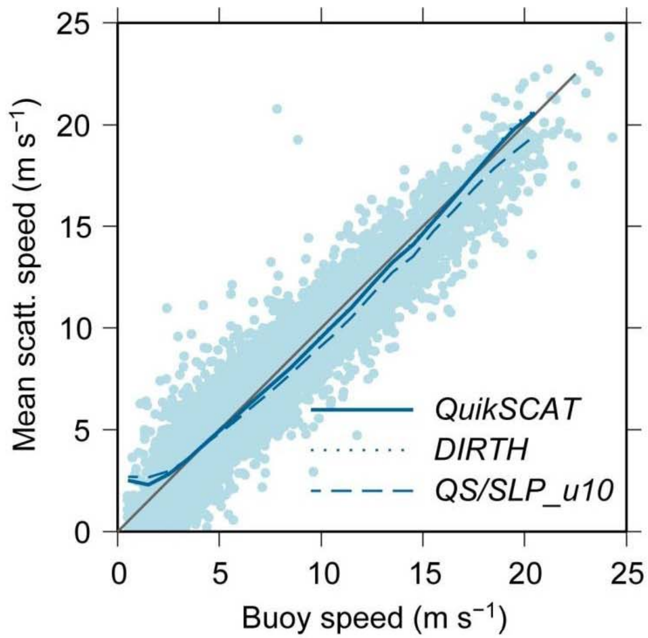
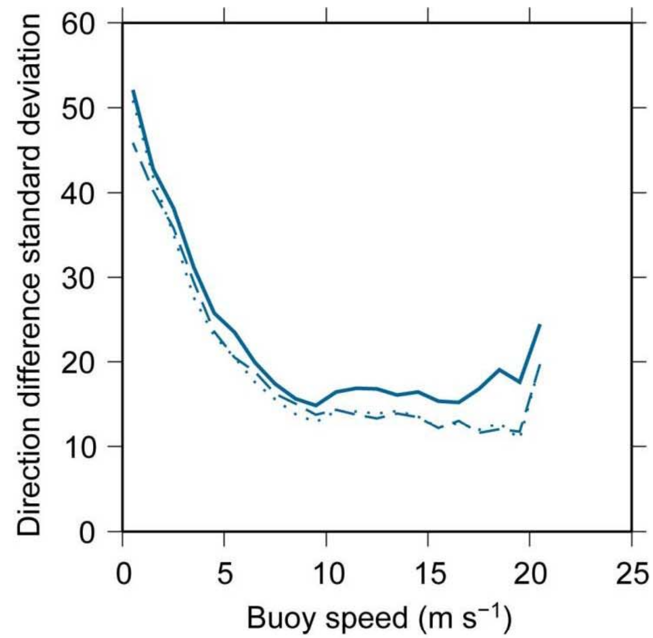
Comparison of QS winds with buoy measurements:





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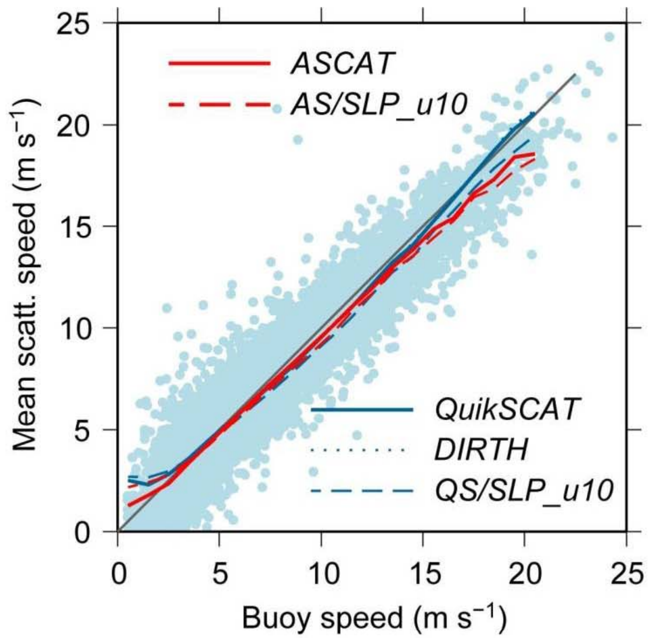
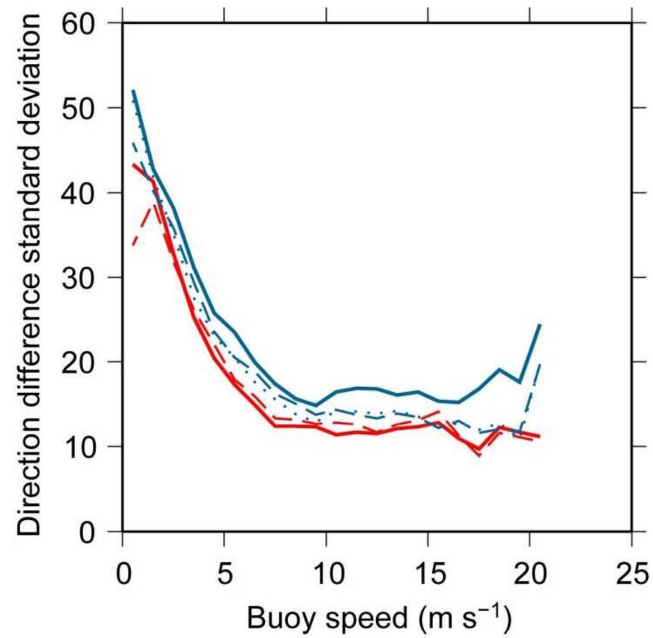
Comparison of QS and ASCAT winds with buoy measurements:





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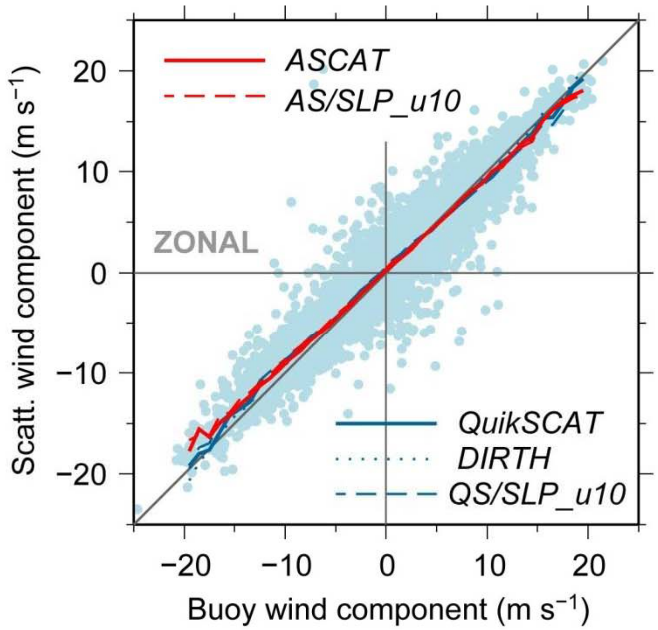
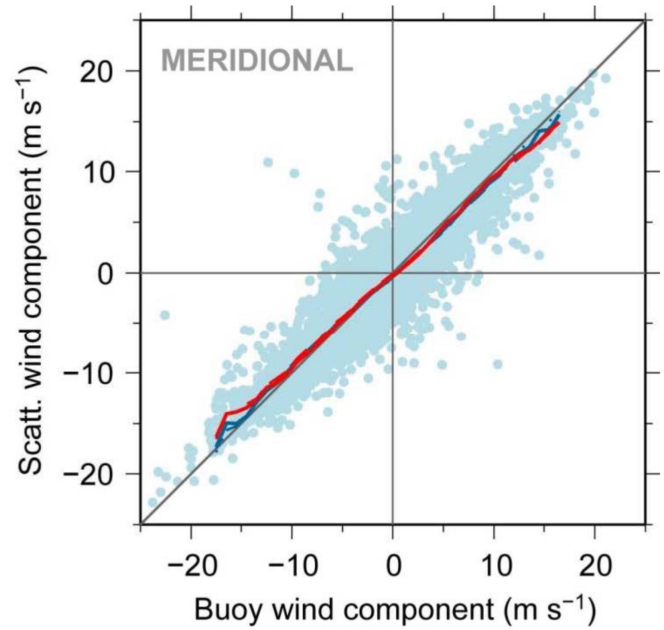
Comparison of QS and ASCAT wind components with buoy measurements:





		QuikSCAT	DIRTH	QS/SLP_u10	ASCAT	AS/SLP_u10
u	R^2	0.89	0.92	0.91	0.94	0.93
	Slope	0.93	0.95	0.90	0.93	0.91
v	R^2	0.85	0.87	0.86	0.91	0.90
	Slope	0.90	0.92	0.89	0.93	0.91

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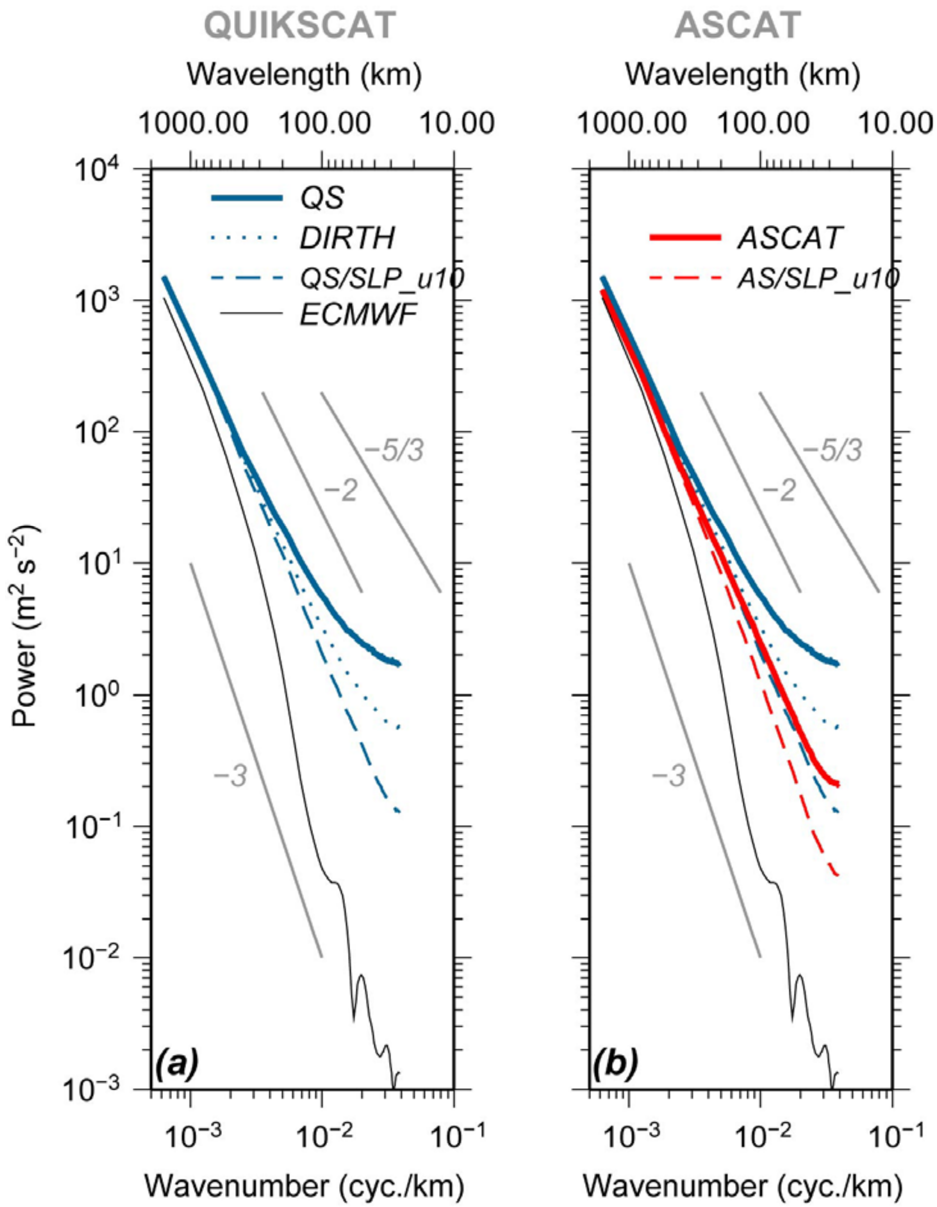

Spectral analysis:

The average AS Wind spectrum has the same slope (**-2.4**) as the SLP-filtered QS winds, and both have a power lay behavior down to 50 km.

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Conclusions

QS- and ASCAT-derived SLP fields are very similar in a statistical sense (and the agreement could presumably increase with higher ASCAT wind speeds).

The SLP fields can be used as a metric to compare the performance of different scatterometers.

They can also be used to:
- Filter the scatterometer winds
- Guide the ambiguity selection (?)
- Align different scatterometer wind products with each other by filtering each wind data set appropriately to meet specified requirements.

N.B.: QuikSCAT, SeaWinds, and ASCAT SLP fields are archived at:
http://pbl.atmos.washington.edu

Patoux (2010)