Measuring scattering phase function and BER using Parasol measurements

A work in progress…

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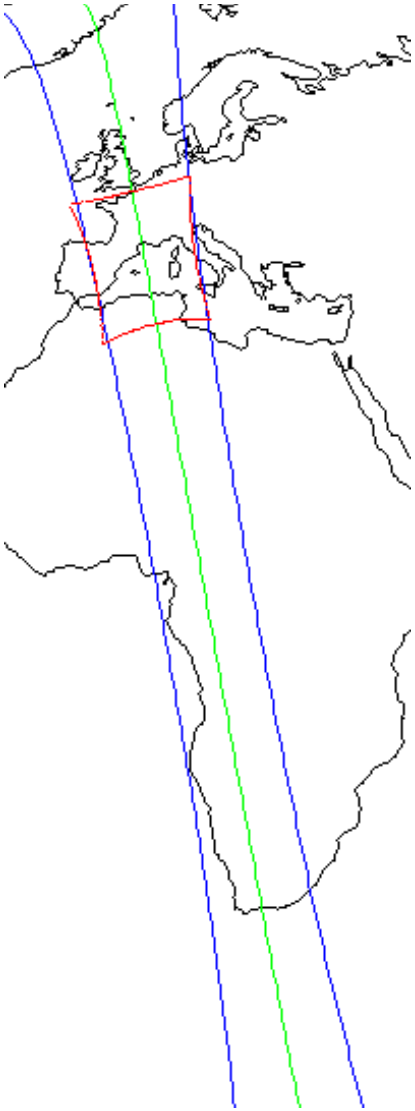
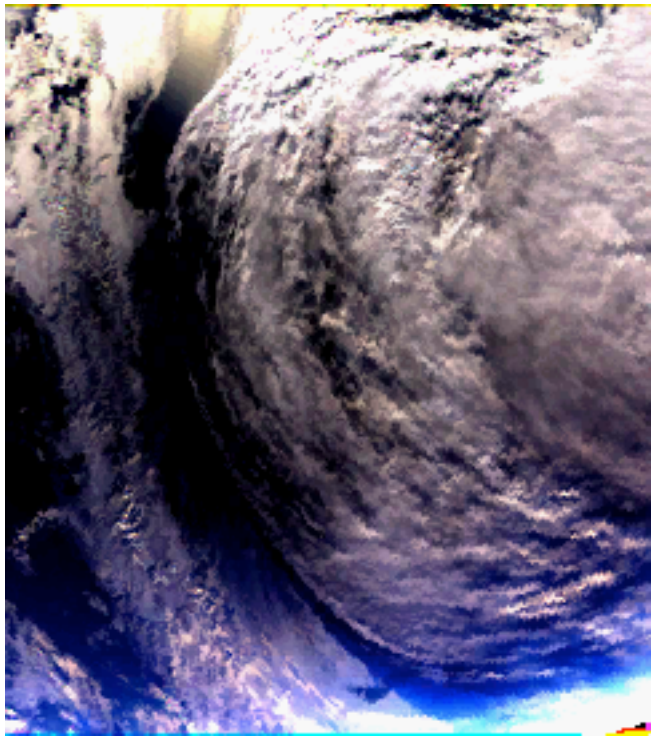
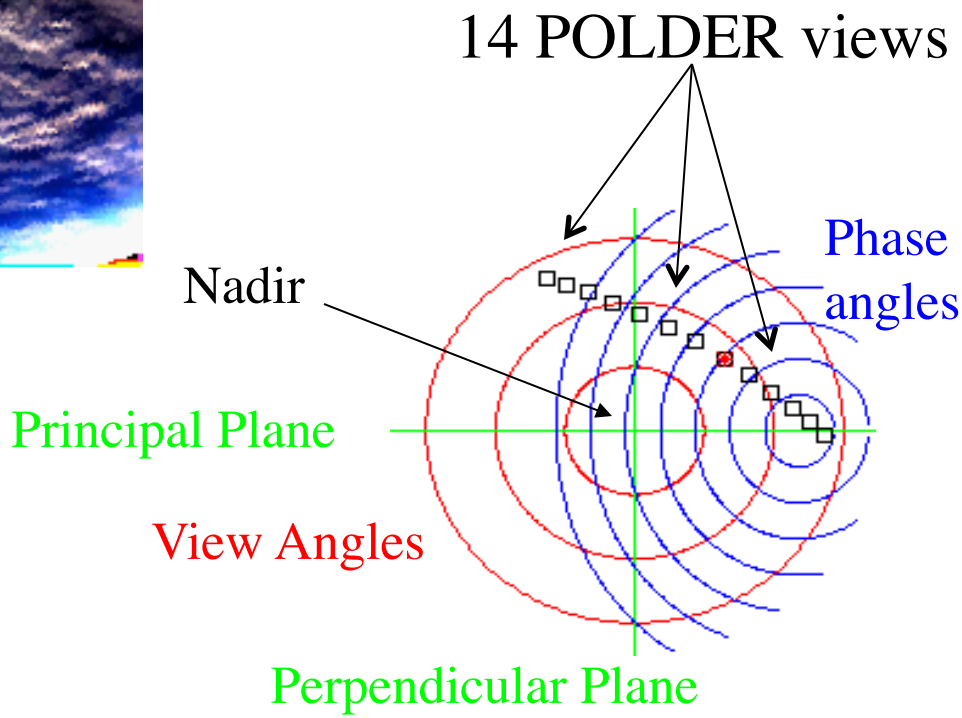
POLDER Multidirectional acquisition

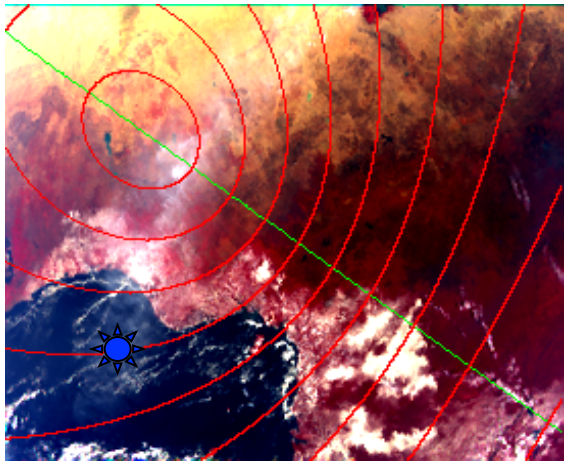


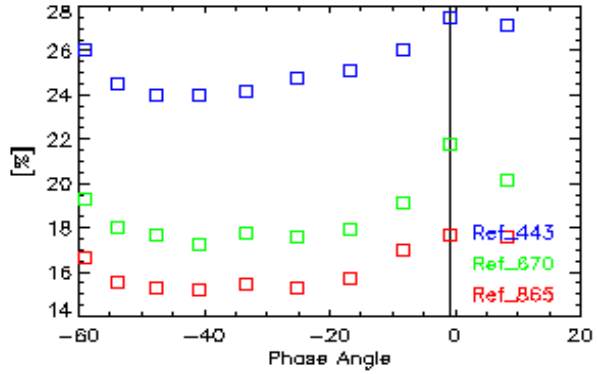


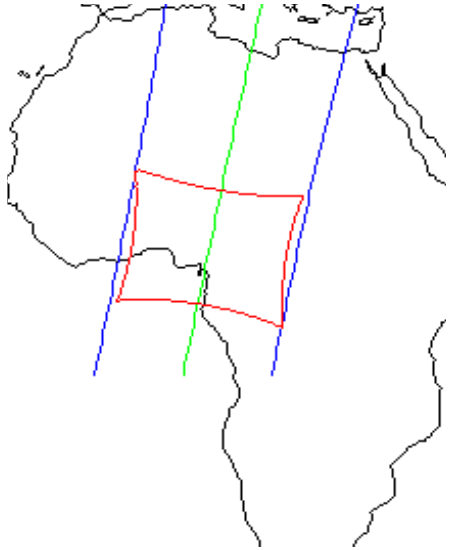
Multispectral measurements acquired every 20 sec

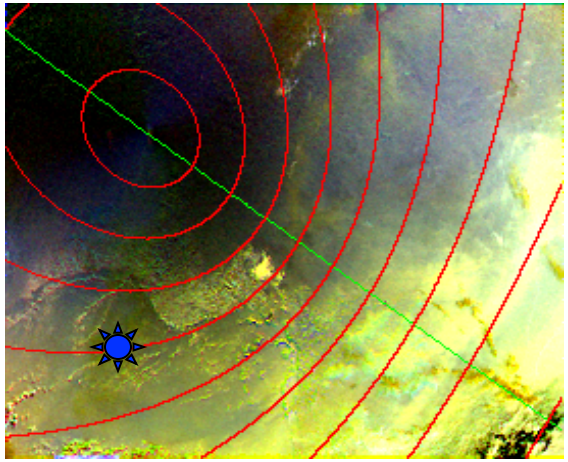


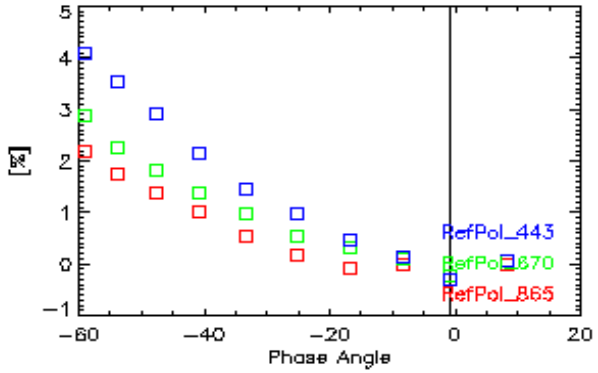
Biomass Burning Aerosol

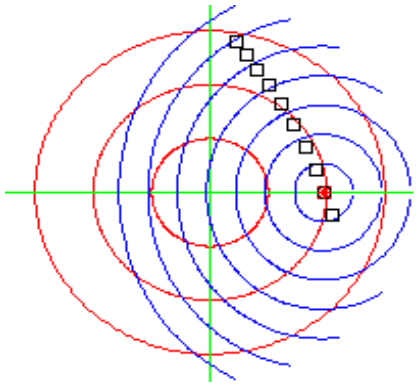




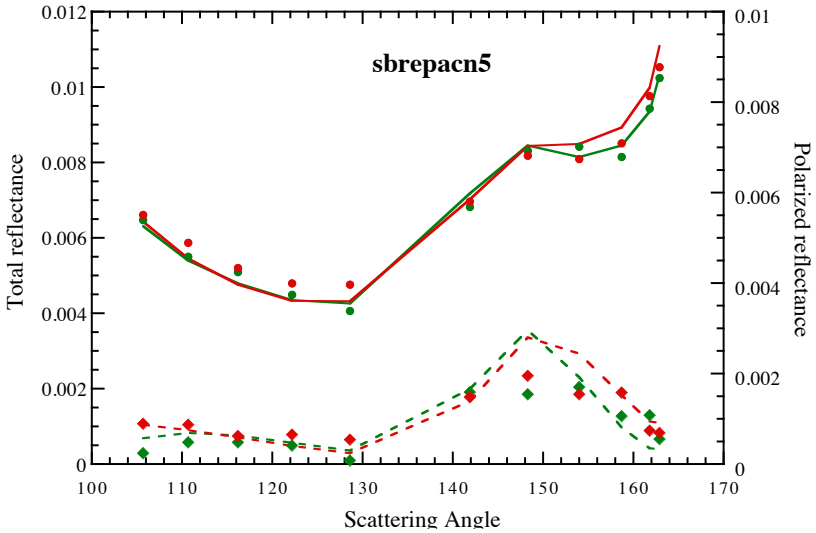


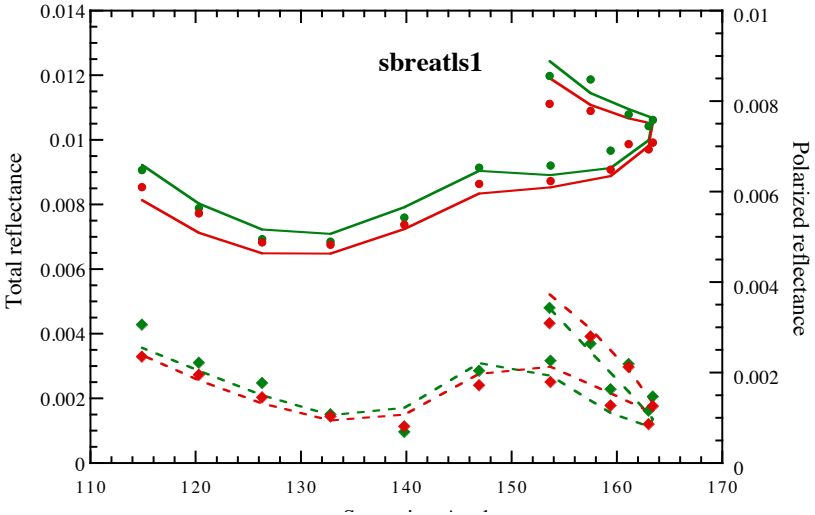




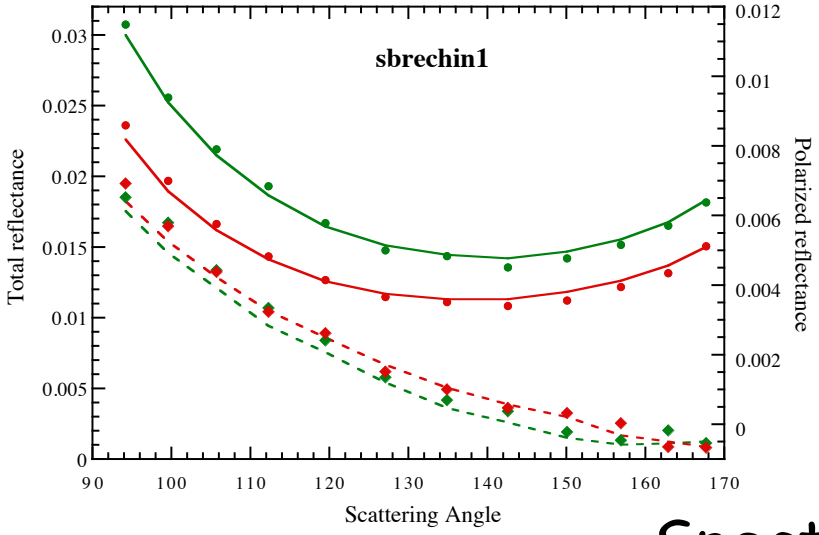


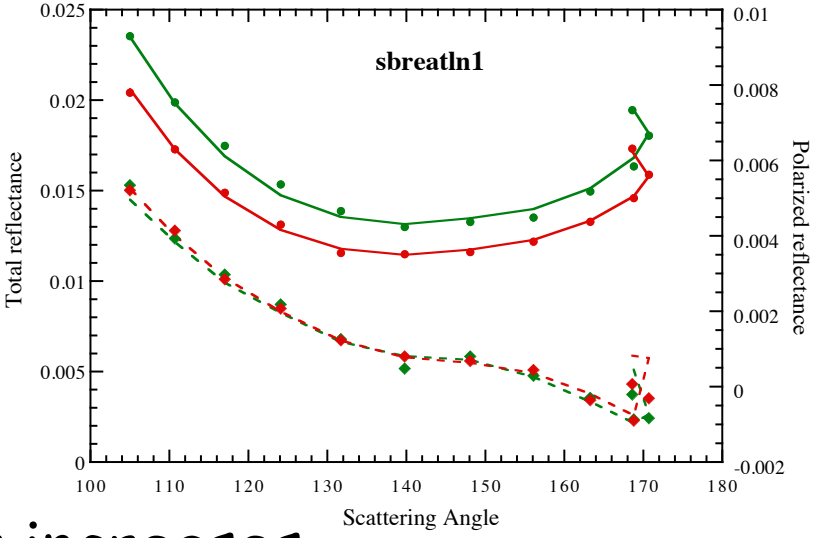
Aerosol Inversion over the oceans





Large to small particles





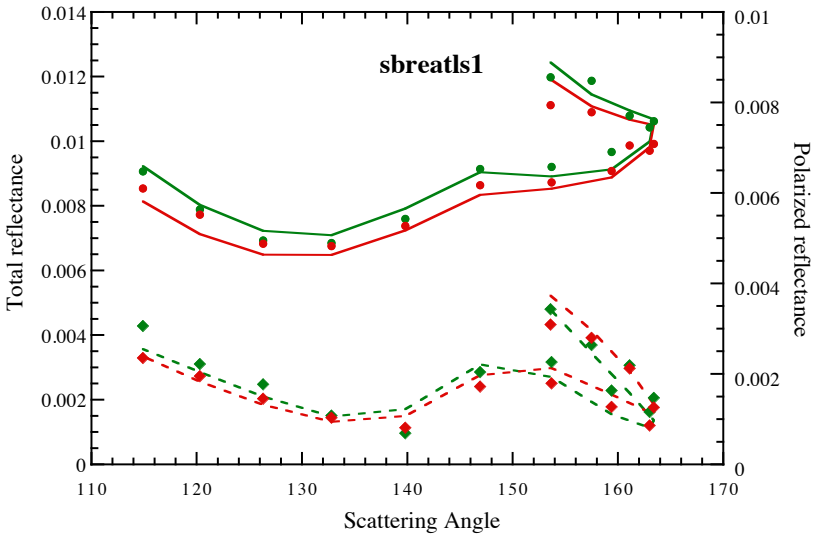
Spectral effect increases
150° arc decreases

Deuzé JL. et al., GRL, 1999
Deuzé JL. et al., JGR, 2000

How to retrieve phase function ?

1. Use look-up tables with a large number of aerosol model and optical depth
2. Retrieve aerosol model and AOD from multispectral reflectances (best fit with interpolations)
3. Use error of fit to correct aerosol phase function in the single scat approximation

$$P_{aer}(\gamma) = P_{aer}^{\mathrm{mod}} + \frac{\mu_s \, \mu_v}{\omega \, \tau}\left(R^{mes} - R^{\mathrm{mod}}\right)$$



Phase Function and EBR

Passive measurements : Single scattering reflectance

$$R_{ss} = \frac{1-\exp\left[-\tau\left(\frac{1}{\mu_s}+\frac{1}{\mu_v}\right)\right]}{\mu_s+\mu_v}\,\omega\,P_{aer}(\gamma)$$

$$\approx \frac{\omega\,\tau\,P_{aer}(\gamma)}{\mu_s\,\mu_v}$$

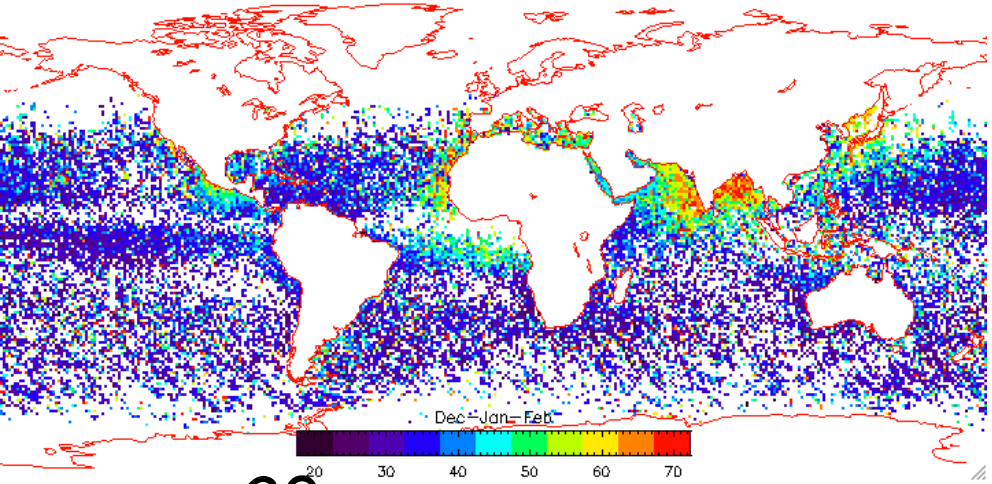
Active measurements: $dP(z) = \exp\left(-2\tau\left[z \Rightarrow +\infty\right]\right)\,\omega\,\frac{P(180)}{4\,\pi}\,d\tau$

Extinction to Backscatter Ratio: EBR^{-1}

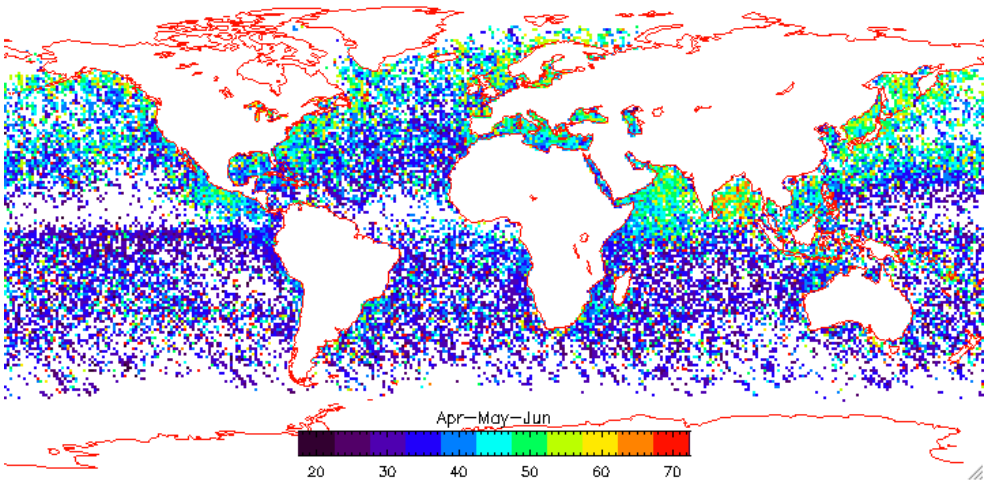
Parasol data may provide a near direct measurement of the lidar EBR (column integrated), provided suitable observation geometry (backscatter)

EBR @ 670 nm from Parasol

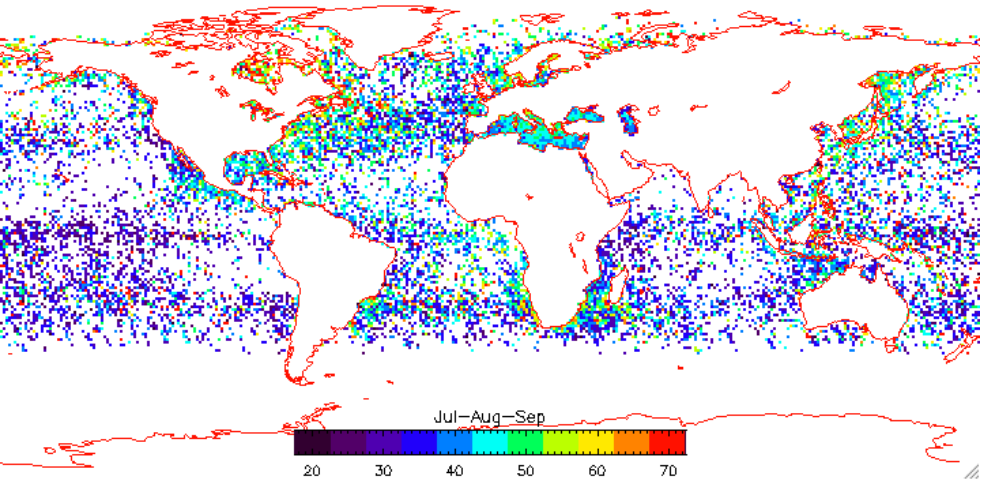
Dec-Jan-Feb



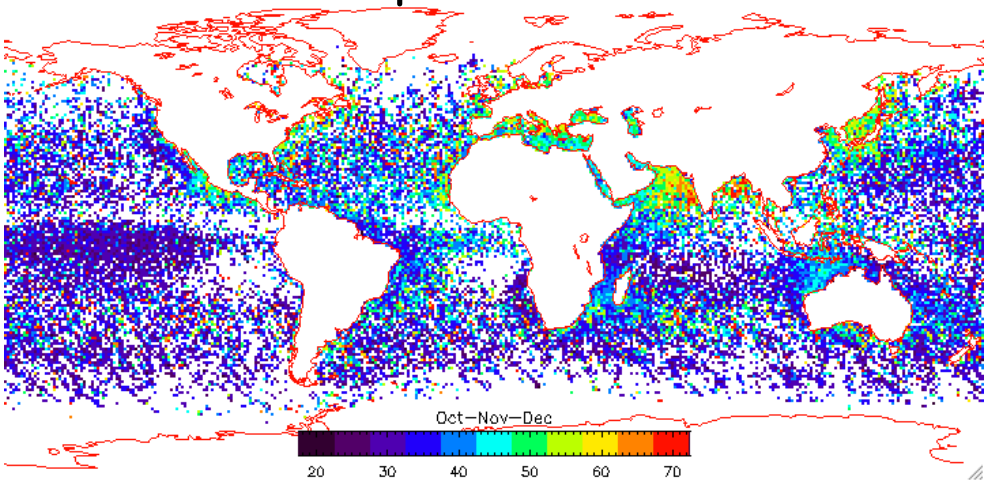
Mar-Apr-May



20 Jun-Jul-Aug 70



Sep-Oct-Nov

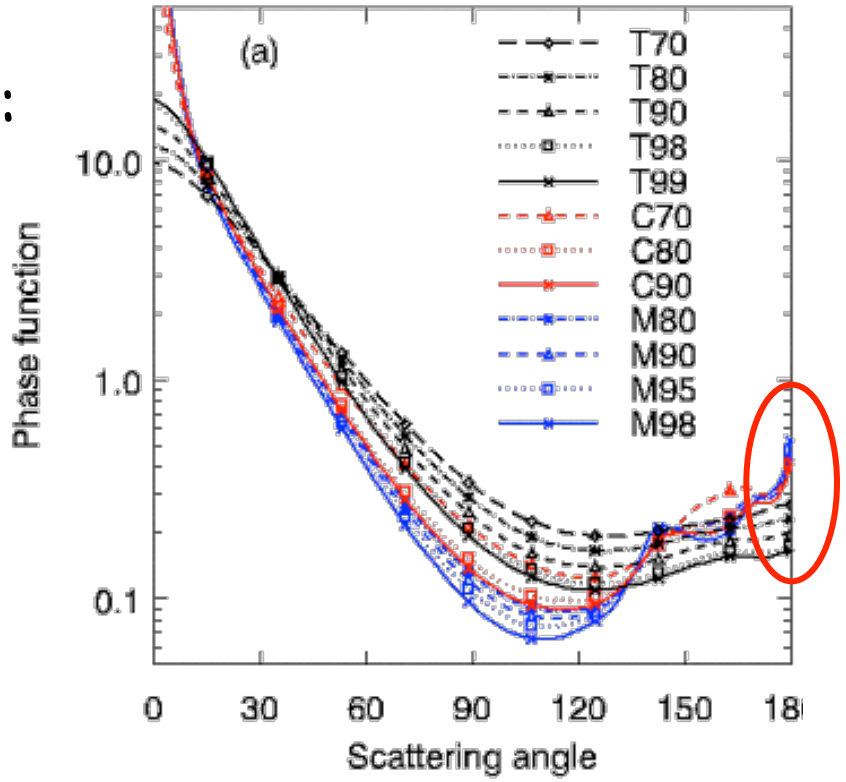


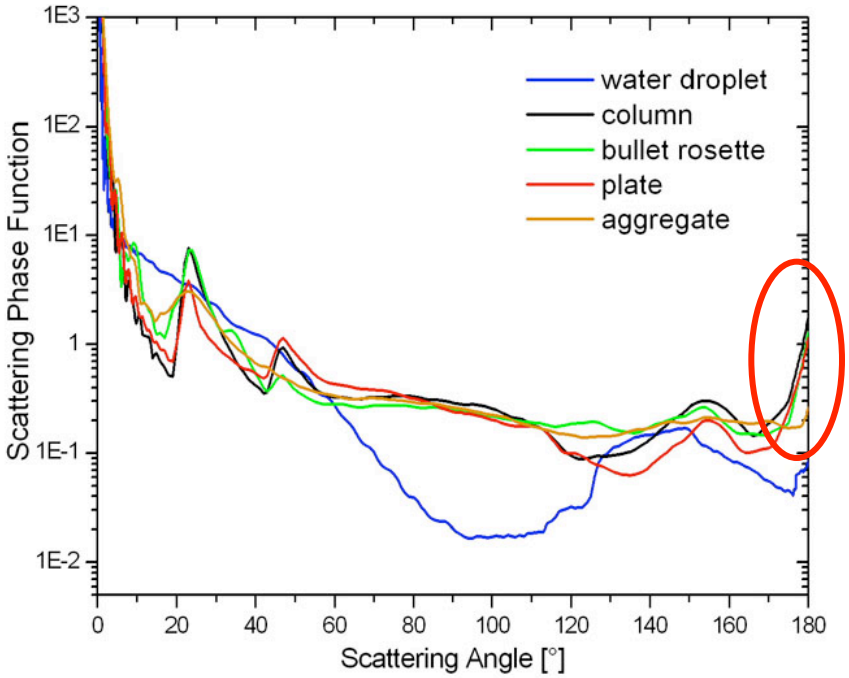
Open Ocean: ≈30-35
Pollution : ≈50-70
Dust : ≈50

Selected cases with 0.1 < AOD < 0.25

Behavior of $P(\gamma)$ close to backscatter

Spherical particles:

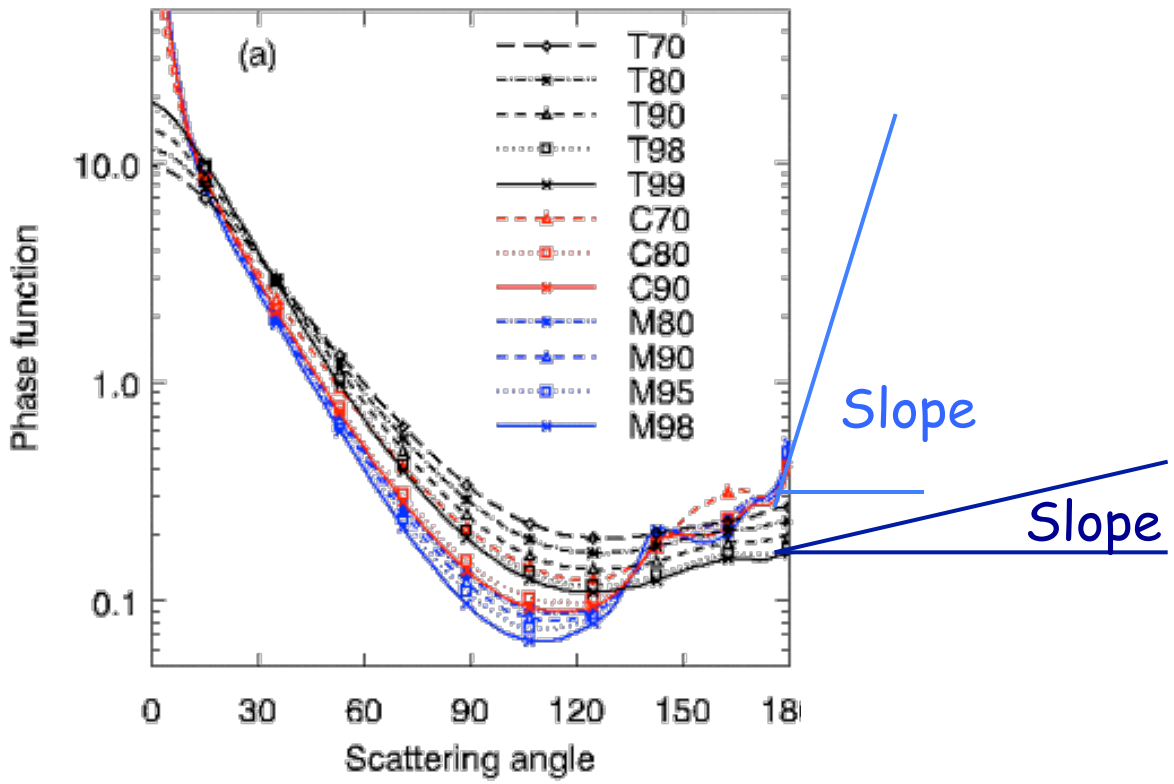




For these simulations, factor of up to 10 increase of P(γ) within a few degrees of backscatter

Can we observe such behavior with Parasol measurements ?

Compute $P(\gamma)$ slope at backscatter



$$BS = \partial \ln(P) / \partial \gamma$$

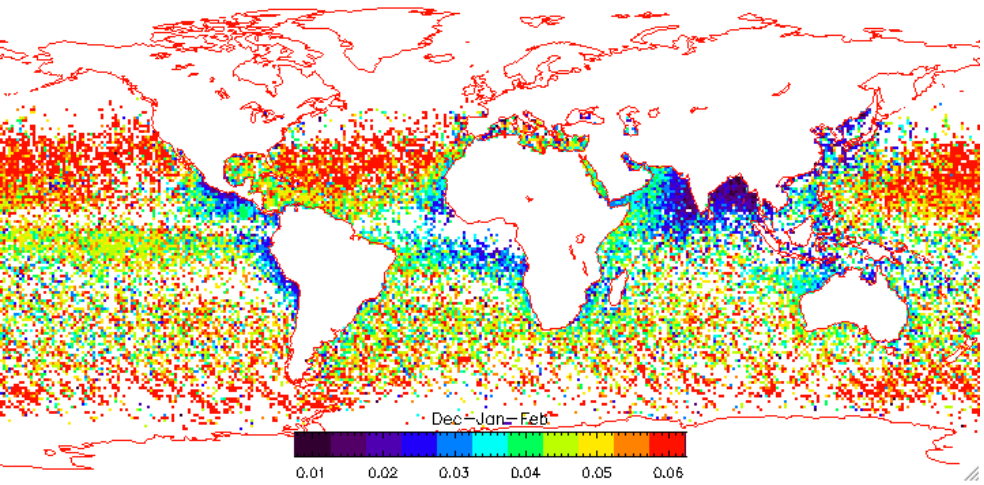
Select measurements acquired close to backscatter ($\gamma > 179°$)

Use multi-directional Parasol observations for this pixels

Compute slope of $P(\gamma)$ variation with γ for $\gamma \approx 180°$

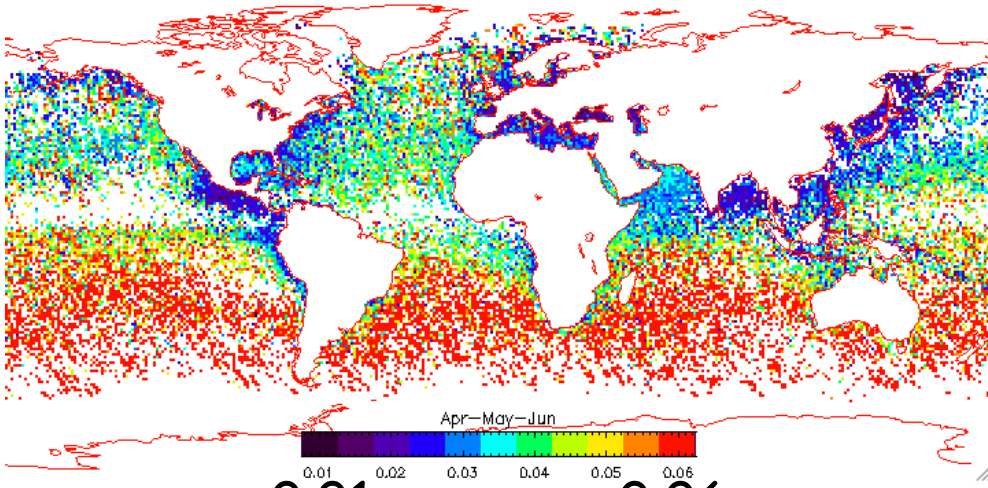
Slope @ 670

Dec-Jan-Feb



0.01 0.06

Mar-Apr-May



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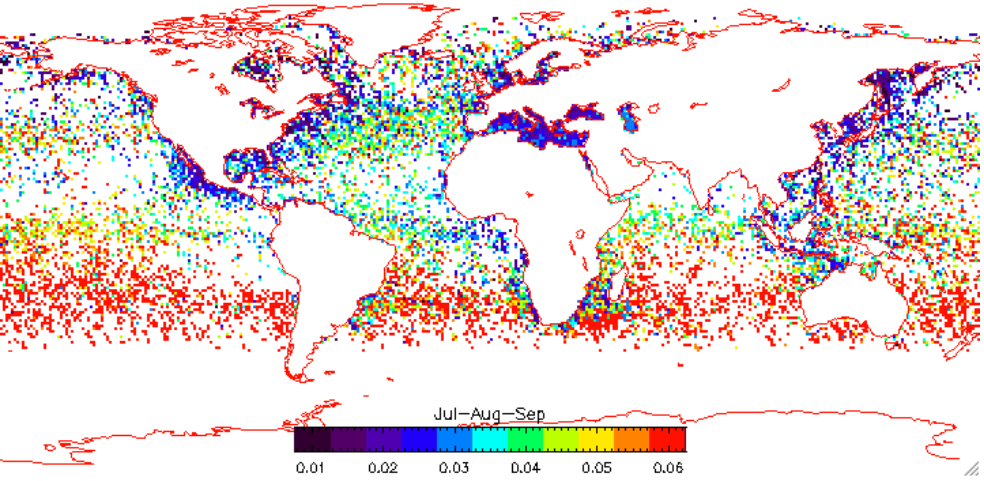

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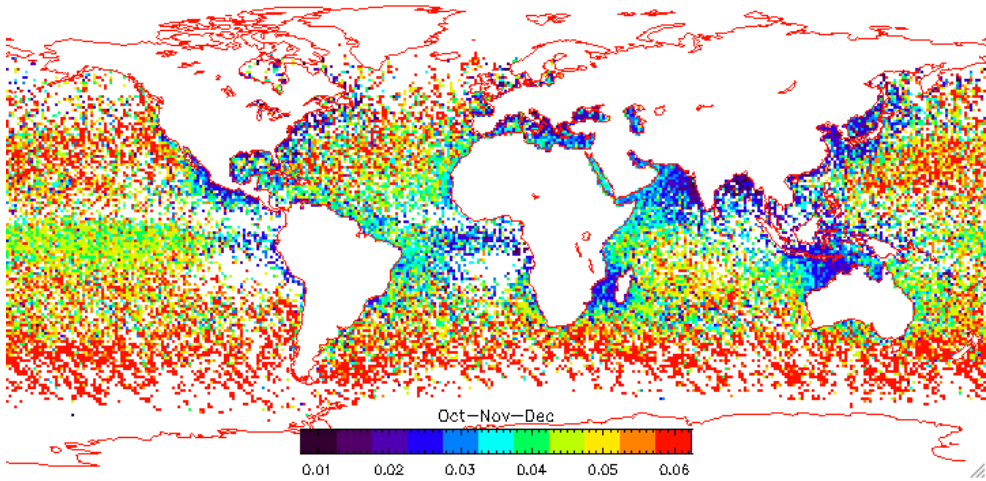

Conclusions

Parasol is a great tool to measure scattering phase functions and their variability

A few measurements are acquired in the backscatter geometry which makes them well suited to quantify the extinction to backscatter ratio

Work in progress…

Global distribution clearly shows coherent patterns of both EBR and BS.

Values of EBR are consistent with those of other methods, but larger climatology

Need more work on data selection and variability analysis