Update on Hybrid Detection DWL Study*

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WG on Space-based Lidar Winds

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Study Team

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Outline

- Importance of global wind observations
  - OSE and OSSE results
  - Current wind observing systems
- Accuracy, coverage and resolution
- Role for Doppler wind lidars
  - Direct detection
  - Coherent detection

Primary
Current Wind Observing Systems

- Rawinsondes (~ 1-3 m/s)
- Surface stations (~1 m/s)
- ACARS (~1 m/s)
- Scatterometer (~2 m/s)
- Cloud motion (5-7 m/s)
- Water vapor motion (4 -5m/s)
- Assimilating model's first guess (~2-3 m/s)

Potential new wind observing systems

- Constant level balloons with dropsondes or DWLs
- UAVs for targeted observations
- Higher resolution water vapor winds (GIFTS)
- GPS soundings…derived winds

Data Utility

- Most global wind information results from assimilating direct (t,q.u,v…) observations into numerical models
- 4DVAR data assimilation becoming common
- All observations must “compete” with other observations and model derived “first guesses”
- Consequently the NWP community favors accuracy over coverage if trade is necessary
- Spatial averaging < .1-.5 the model resolution (not necessarily the grid size) ~ 15 - 25 km averaging for today’s global research models

Direct Detection

- Photon counting
  - spectral bins or channels
  - edge filter
- Broad molecular velocity spectrum
- Narrow aerosol velocity spectrum
- Instrument measurement **accuracy** is a function of #photons

Coherent Detection

- Heterodyne…frequency shift detection
- Aerosol (and cloud particle) motions
- Inherently accurate (<1 m/s) for SNR >2-5 dB
- Data **coverage** is a function of threshold sensitivity (`10-30 coherent photons)

Baseline Systems

- Each concept is considered as SOA and is held to 250 watts for the laser subsystems and flown in a 400 km orbit
- Non-scanning (for ease of comparison) with an along track product resolution of 200 km
- LOSP σ_{Direct} = 2.43 m/s at 3.5 km AGL
- LOSP $\sigma_{Coherent}$ = .15 m/s at 3.5 km AGL
- $\beta(90)$ for coherent system = 1.4 E-9 $m^{-1}sr^{-1}$

Target Data Product

- An LOSP with a normally distributed error of $\sigma = 1$ m/s
- Horizontal resolution: 100 X 100 km
- Vertical resolution: 1 km (worst case)
- Minimum swath width: 1300 km (50% coverage of equatorial band)
- Useful data product obtained 90% of time from 3-4 km layer when intervening cloud fraction is < 50%

Scaled Rayleigh System

ORBIT	EAP	PWR
Baseline	6.2	.25 KW
400 KM	2474 (400X)	25 KW*
833 km	6630 (1060X)	67 KW*

* assumes a 2 meter telescope

Scaled Coherent System

ORBIT	EAP	PWR
Baseline	2.4	.25KW
400 km	49 (20X)	1.2 KW*
833 km	118(49X)	3.0 KW*

* assumes a 1 meter telescope

Hybrid System Data Products

(400 km orbit)

Sub-system	Resolution (km)	Soundings* (#)	LOSP σ (m/s)
Rayleigh	300	266	1.6
Coherent	100	1864	.71**

* number of LOS soundings per orbit (may involve shot accumulation per sounding)

** β (90) = 5.4 E-8 (6.8 E-8) $m^{-1} sr^{-1}$