

The ECMWF forecasting system: data impacts and prospects for ADM-Aeolus

Adrian Simmons

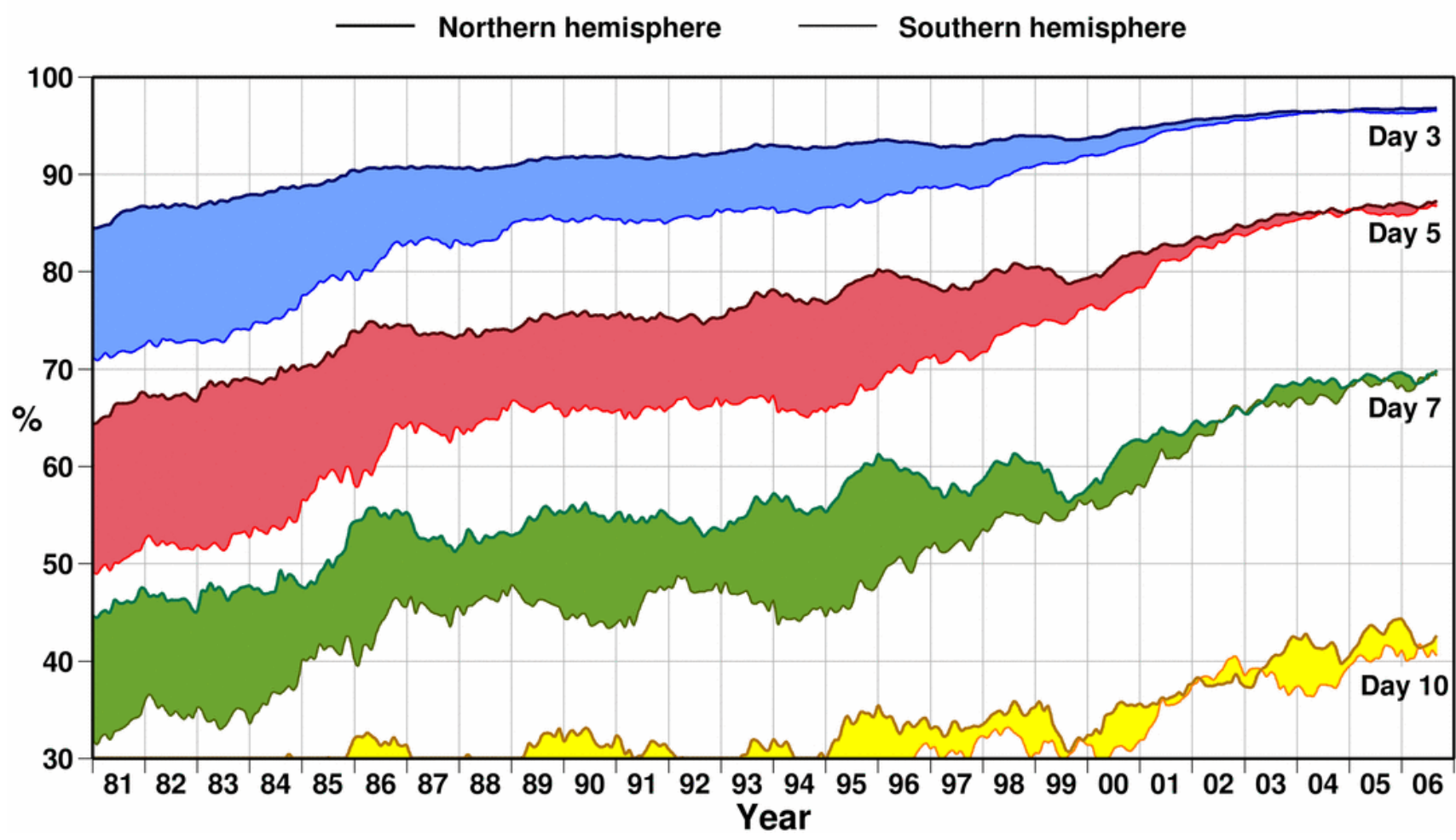
Graeme Kelly and Jean-Noël Thépaut

David Tan and Erik Andersson

European Centre for Medium-Range Weather Forecasts

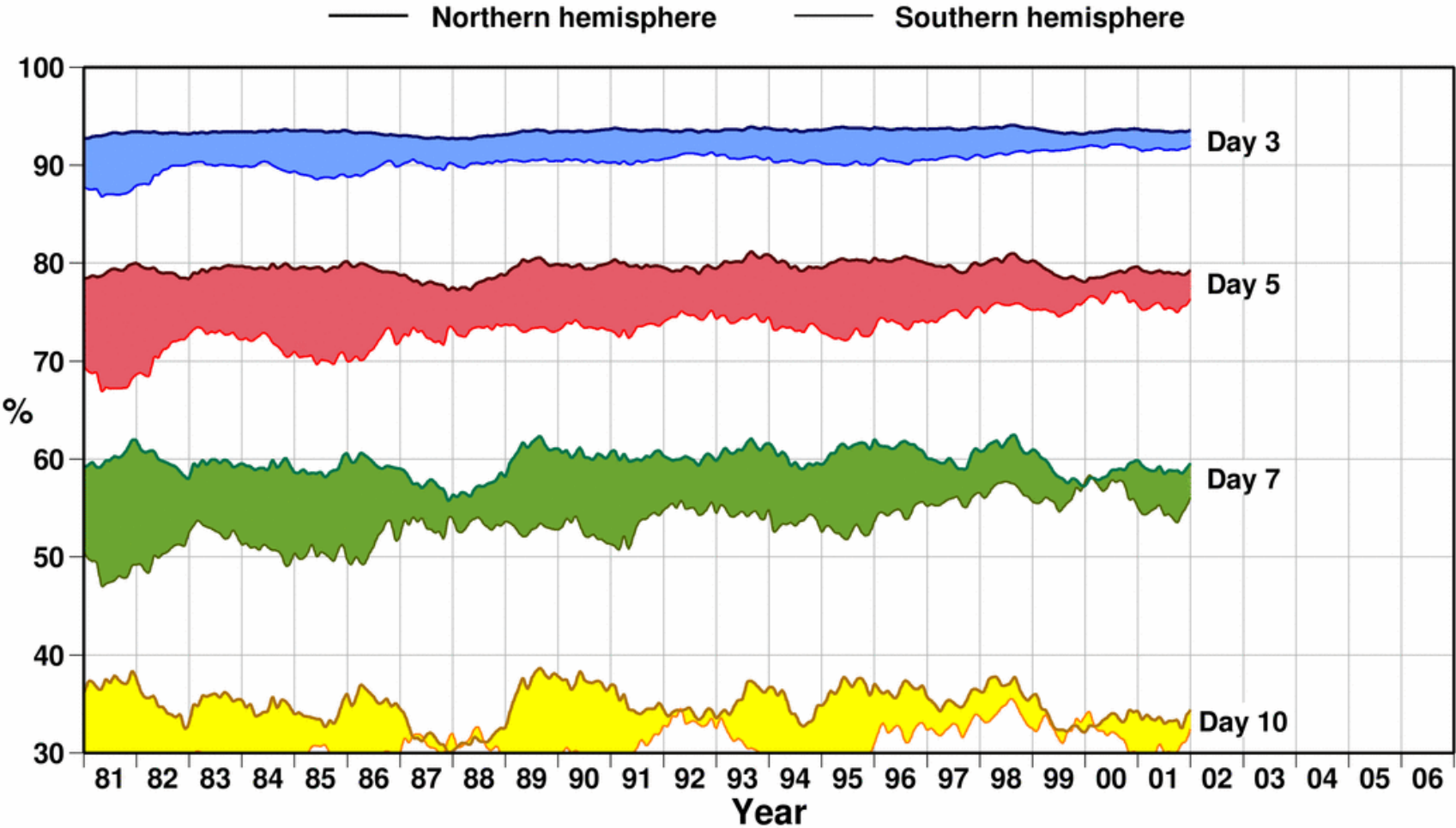
Improvement of operational ECMWF forecasts

Anomaly correlation of 500hPa height forecasts

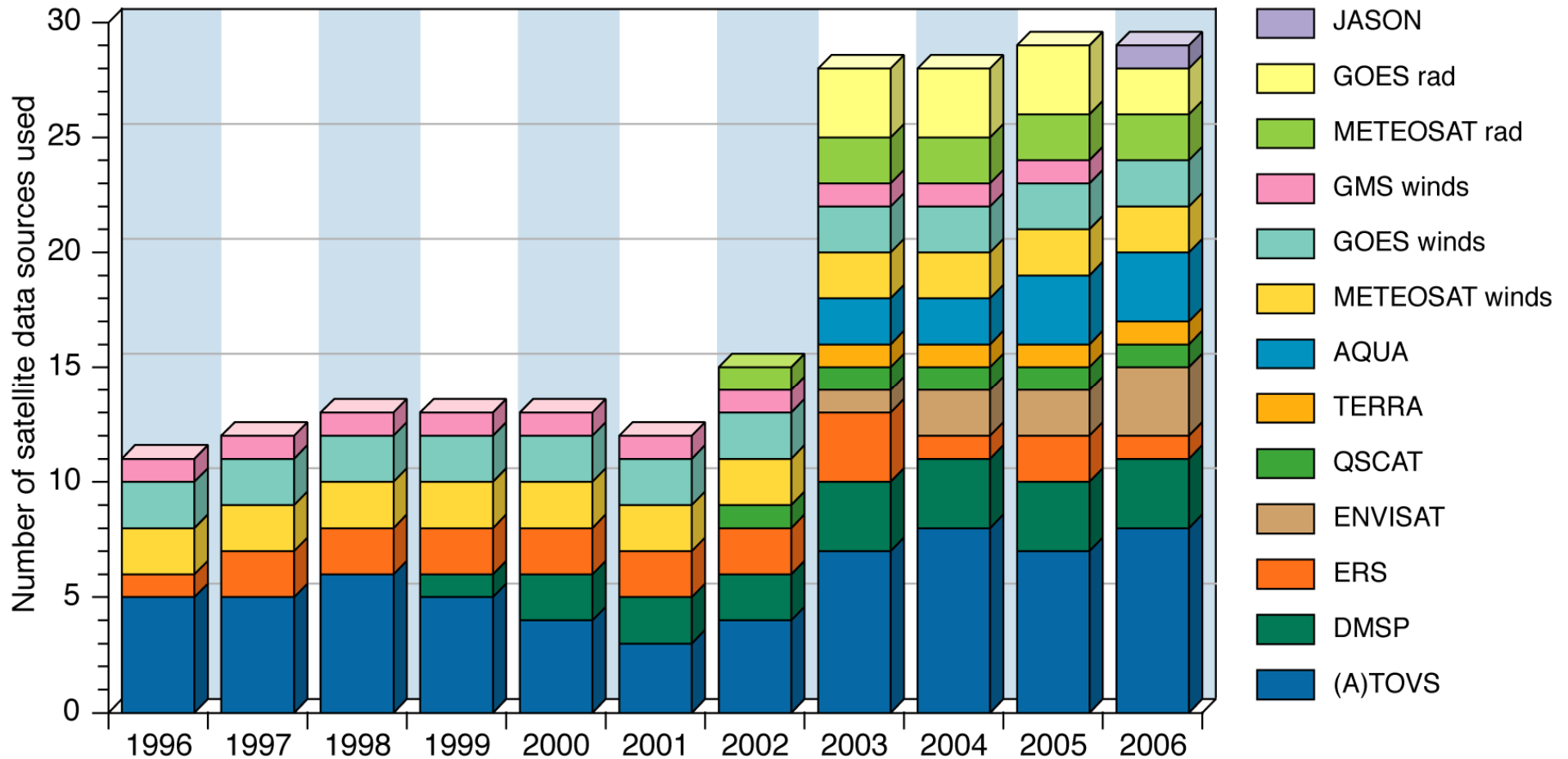


Forecasts from the ERA-40 reanalyses

Anomaly correlation of 500hPa height forecasts



Data from around 30 sources used daily

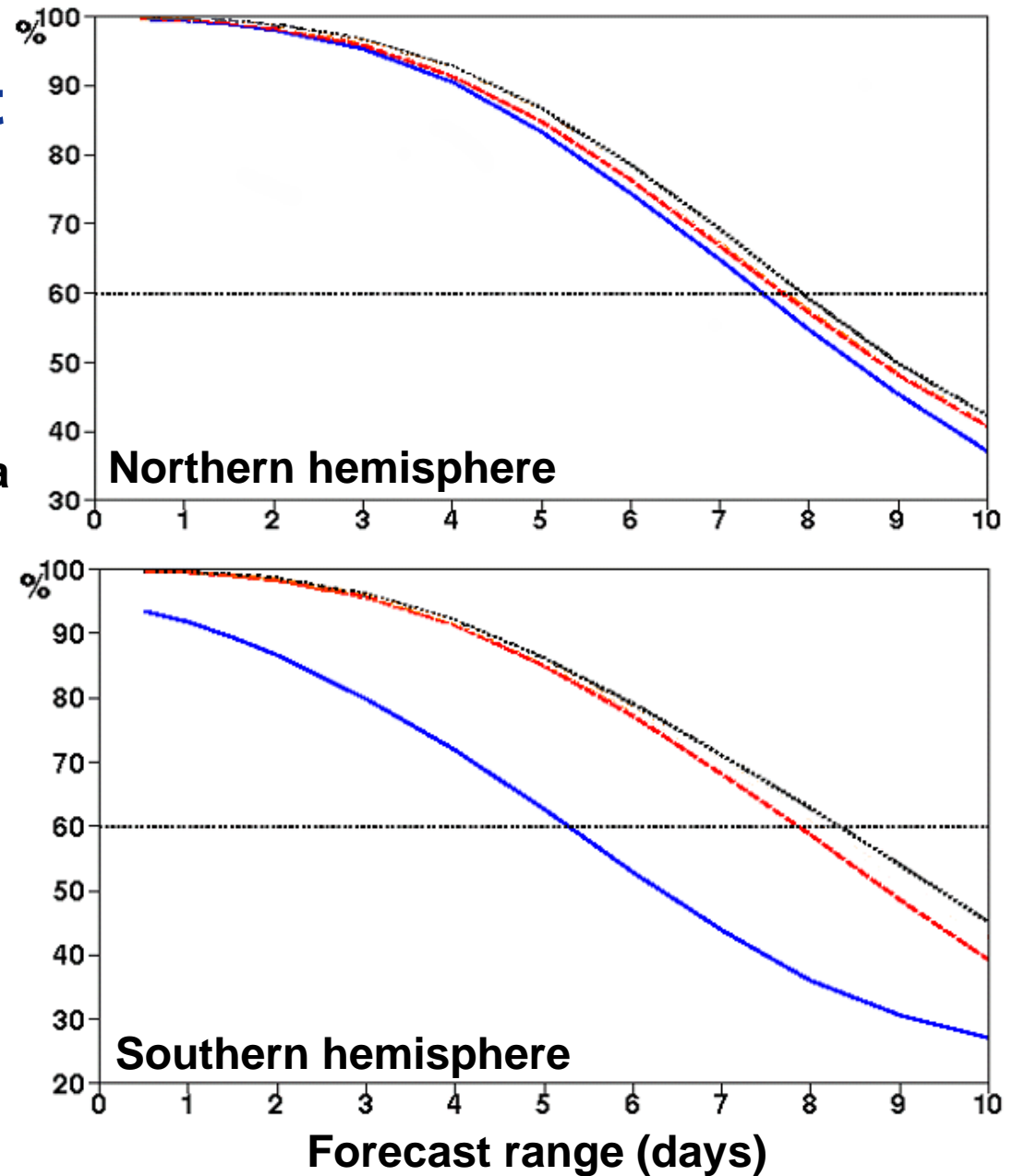


Impact of different observation types

- No satellite data
- - - No sonde/profiler data
- Control

Anomaly correlation of 500hPa height

Mean over two summer and two winter months

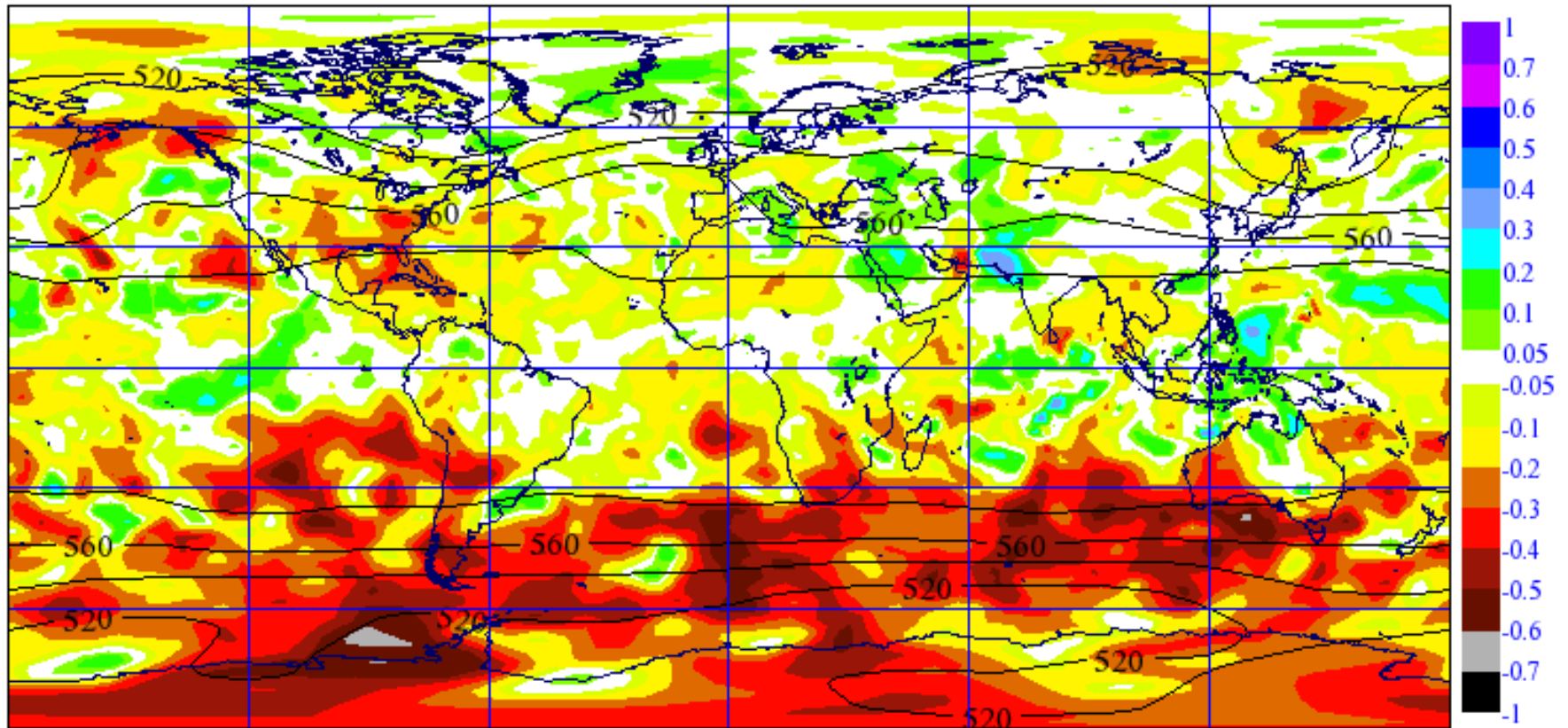


Observing System Experiments with EUCOS and EUMETSAT

- **For space-based system:**
 - **Control:** Full observing system
 - **Baseline:** Non-satellite observing system
 - **Impact runs:** Add data from one or more satellite instruments
- **For terrestrial system:**
 - **Control:** Full observing system
 - **Baseline:** Full satellite system plus GUAN/GSN ground-based networks
 - **Impact runs:** Add other data from terrestrial system

Impact of AMV data

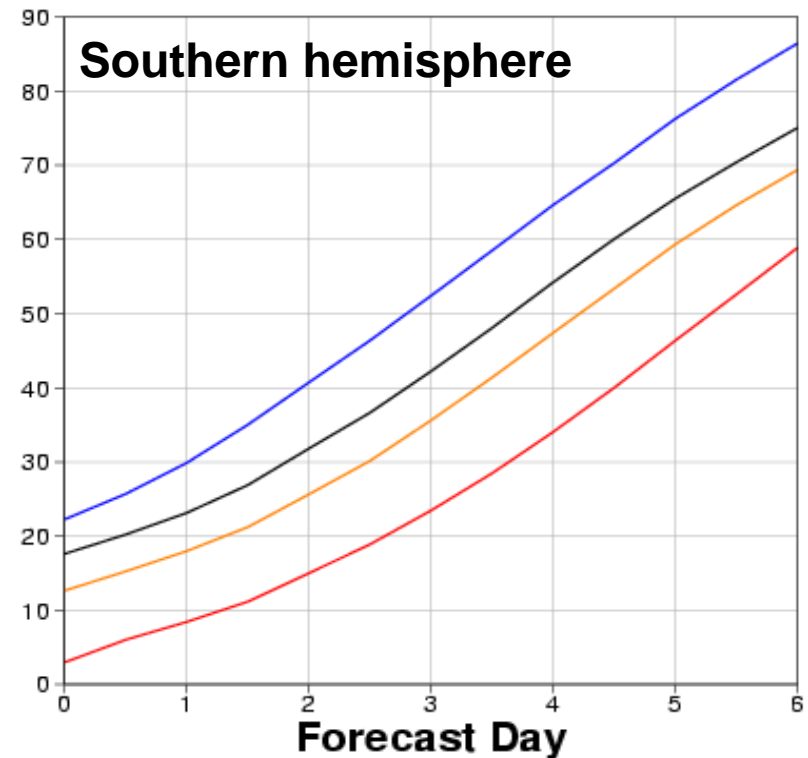
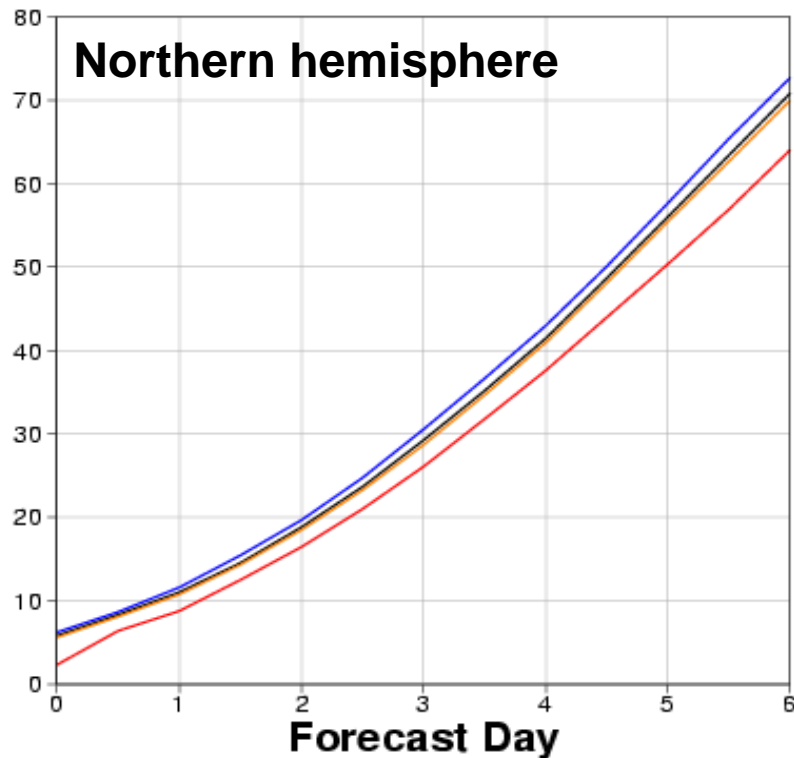
Normalised difference in RMS error of 72h 500hPa height forecasts
(Baseline + AMVs) - Baseline



Additional impact of polar AMVs

RMS error of 500hPa height forecasts from 14 Dec 2004 to 25 Jan 2005

— Control — Baseline + AMVs from GEOs
— Baseline — Baseline + AMVs from GEOs and MODIS

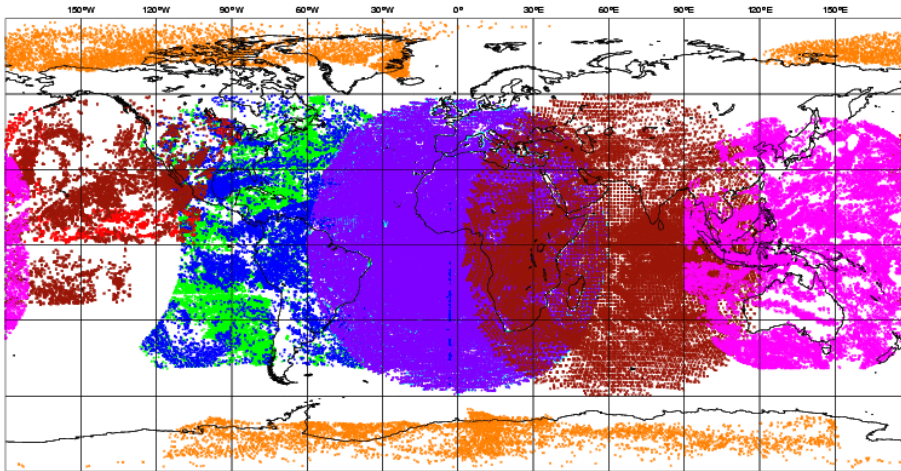


Satellite winds received

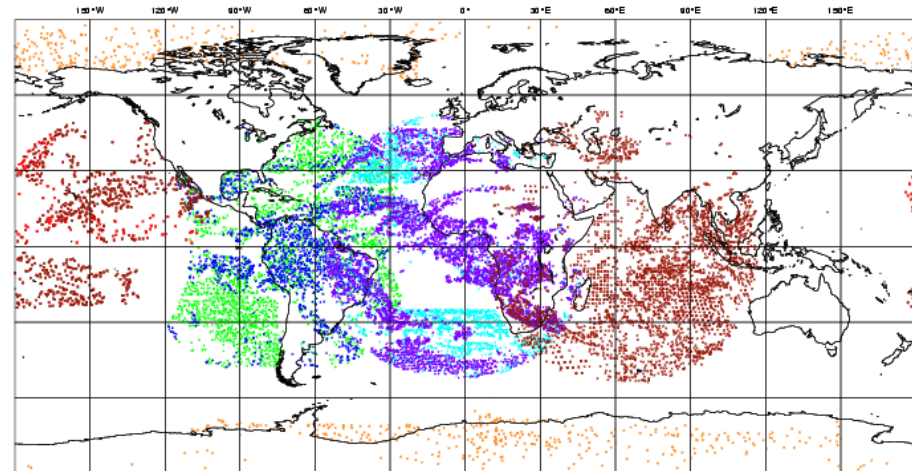
Satellite winds used

21UTC 16 March to 03UTC 17 March 2006

Total number of obs = 287456



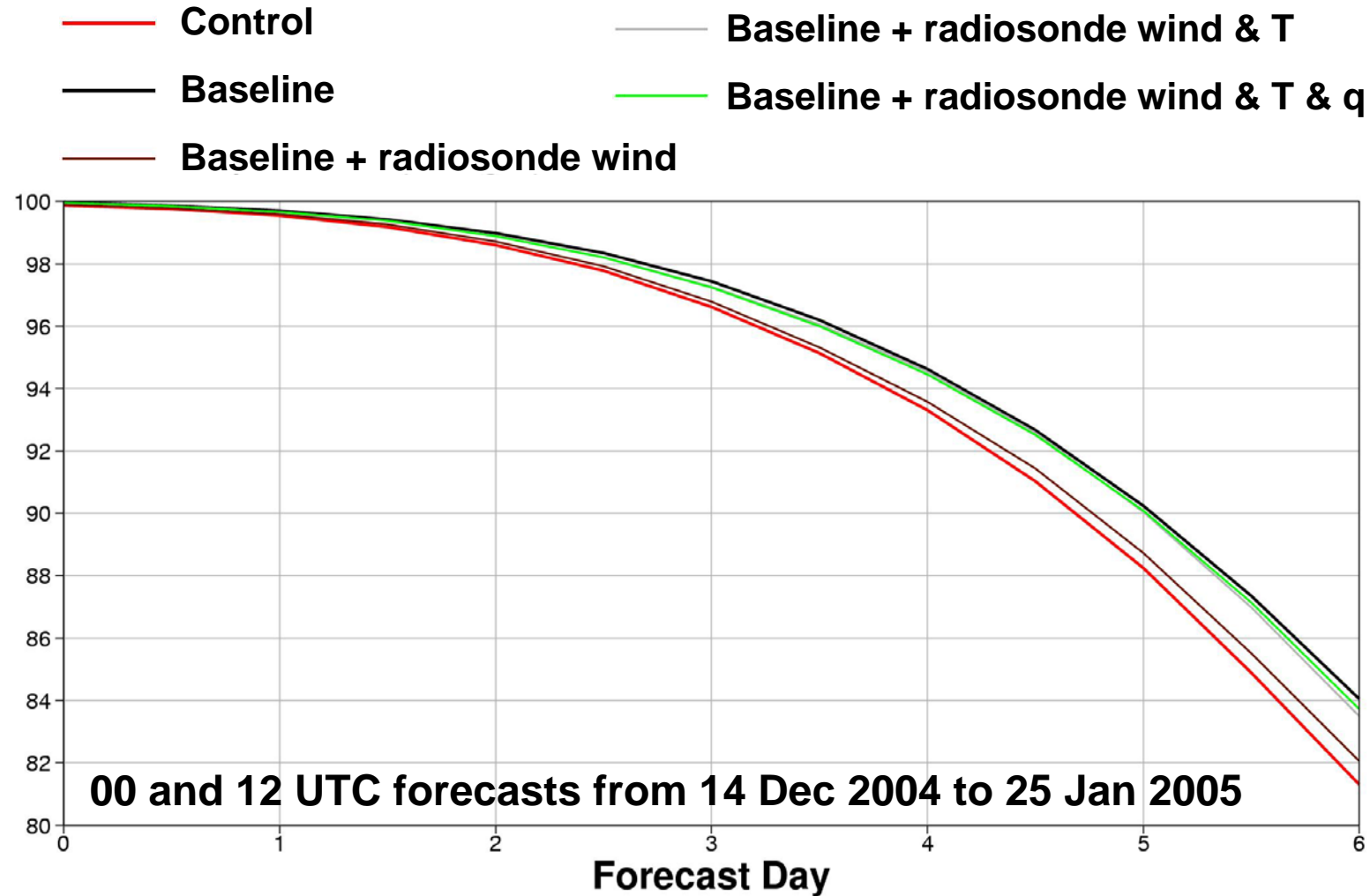
Total number of obs = 20065



Data from ADM-AEOLUS should provide new opportunities for validation, product improvement and better utilization of AMVs

Impact of radiosonde data

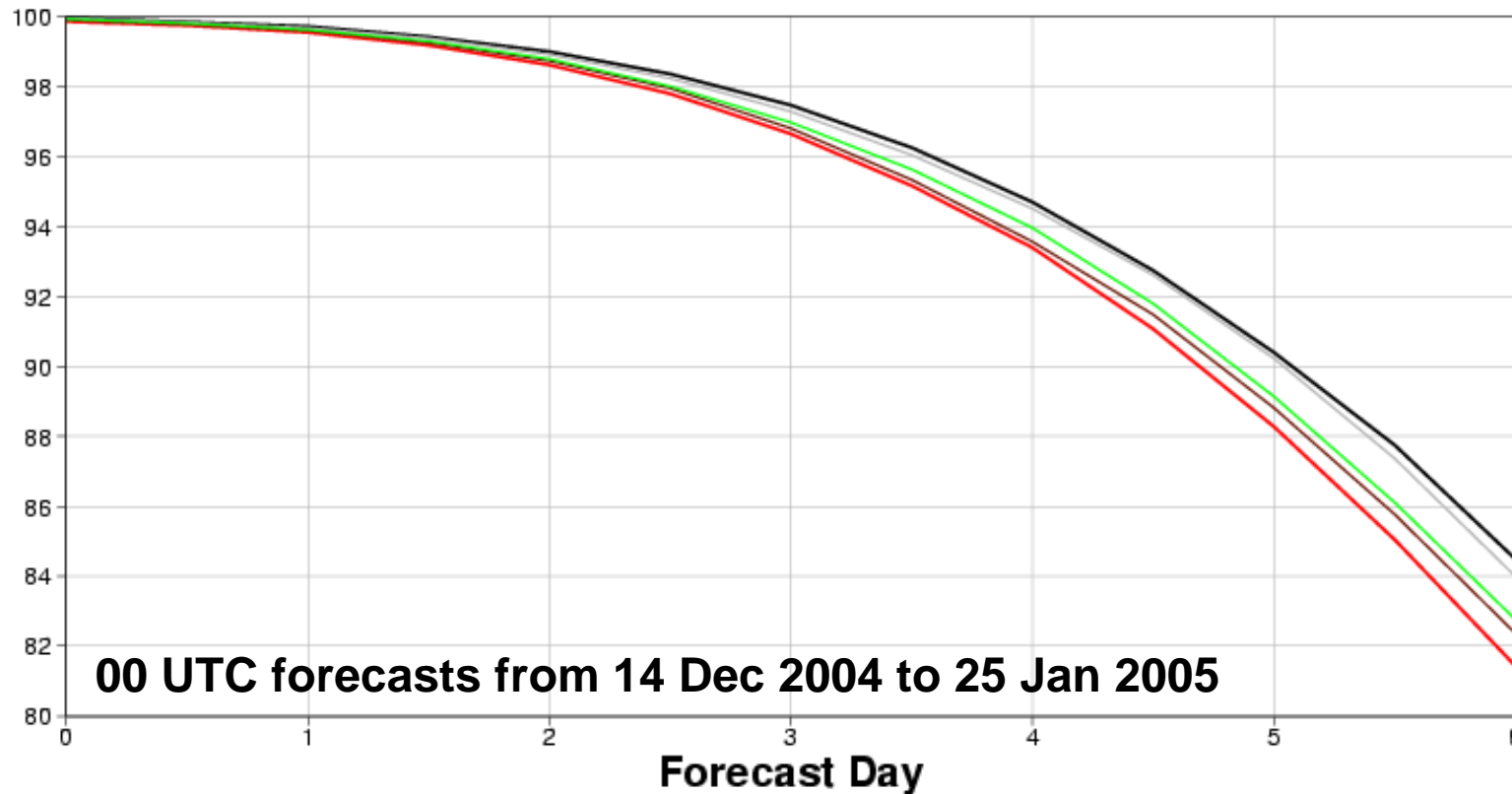
Anomaly correlation of 500hPa height forecasts for northern hemisphere



Impact of radiosonde data

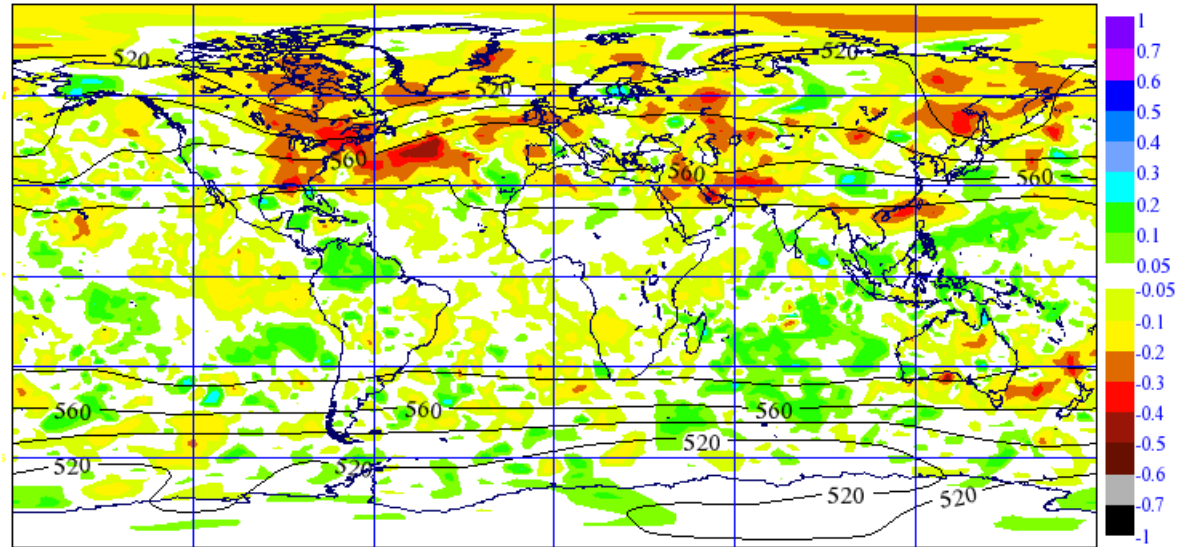
Anomaly correlation of 500hPa height forecasts for northern hemisphere

- Control
- Baseline
- Baseline + radiosonde wind
- Baseline + radiosonde wind & T
- Baseline + radiosonde T

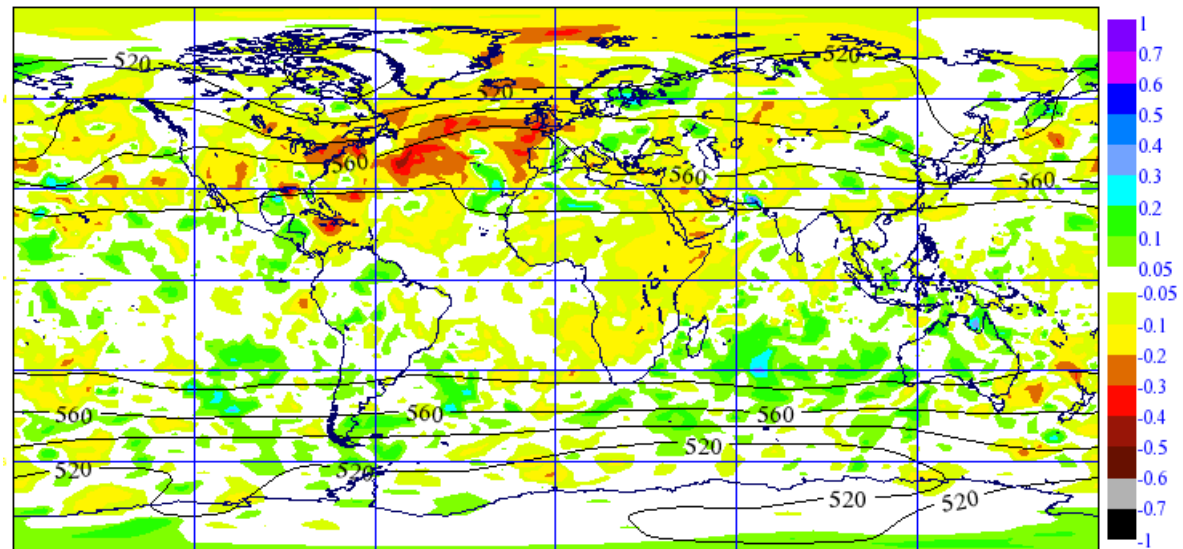


Reduction in RMS 500hPa height error of 48-hour forecasts

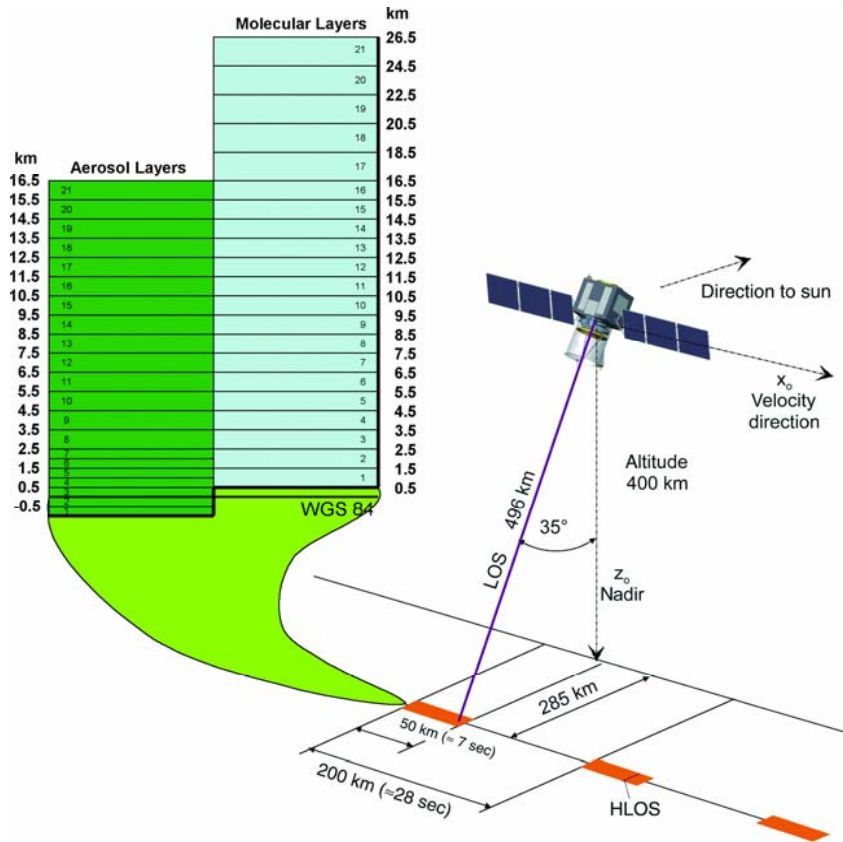
Adding non-GUAN radiosonde data



Adding aircraft data



ADM-Aeolus: Wind profile measurements from space

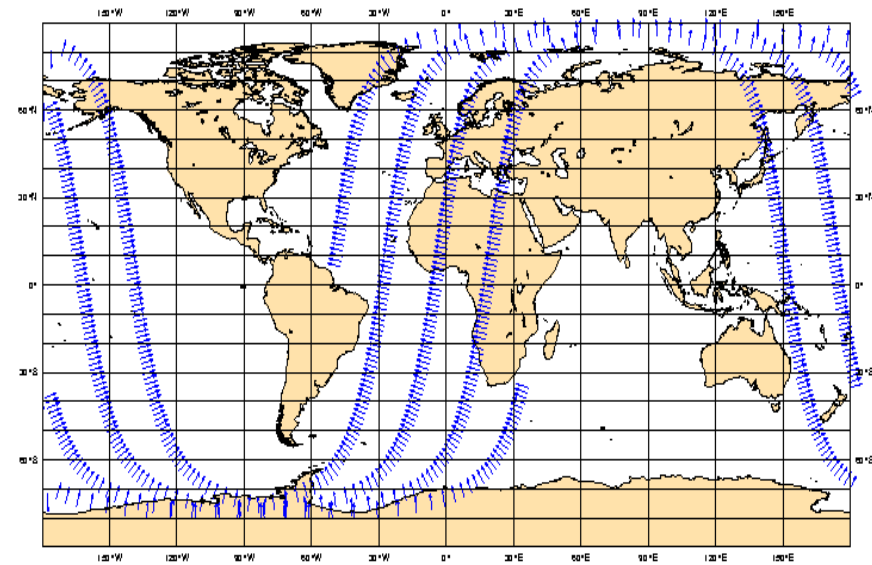


UV lidar (355 nm) with two receivers

- Mie (aerosol), Rayleigh (molecules)
- both use direct detection

Wind profiles from surface to 27 km with resolution varying from 0.5 to 2 km

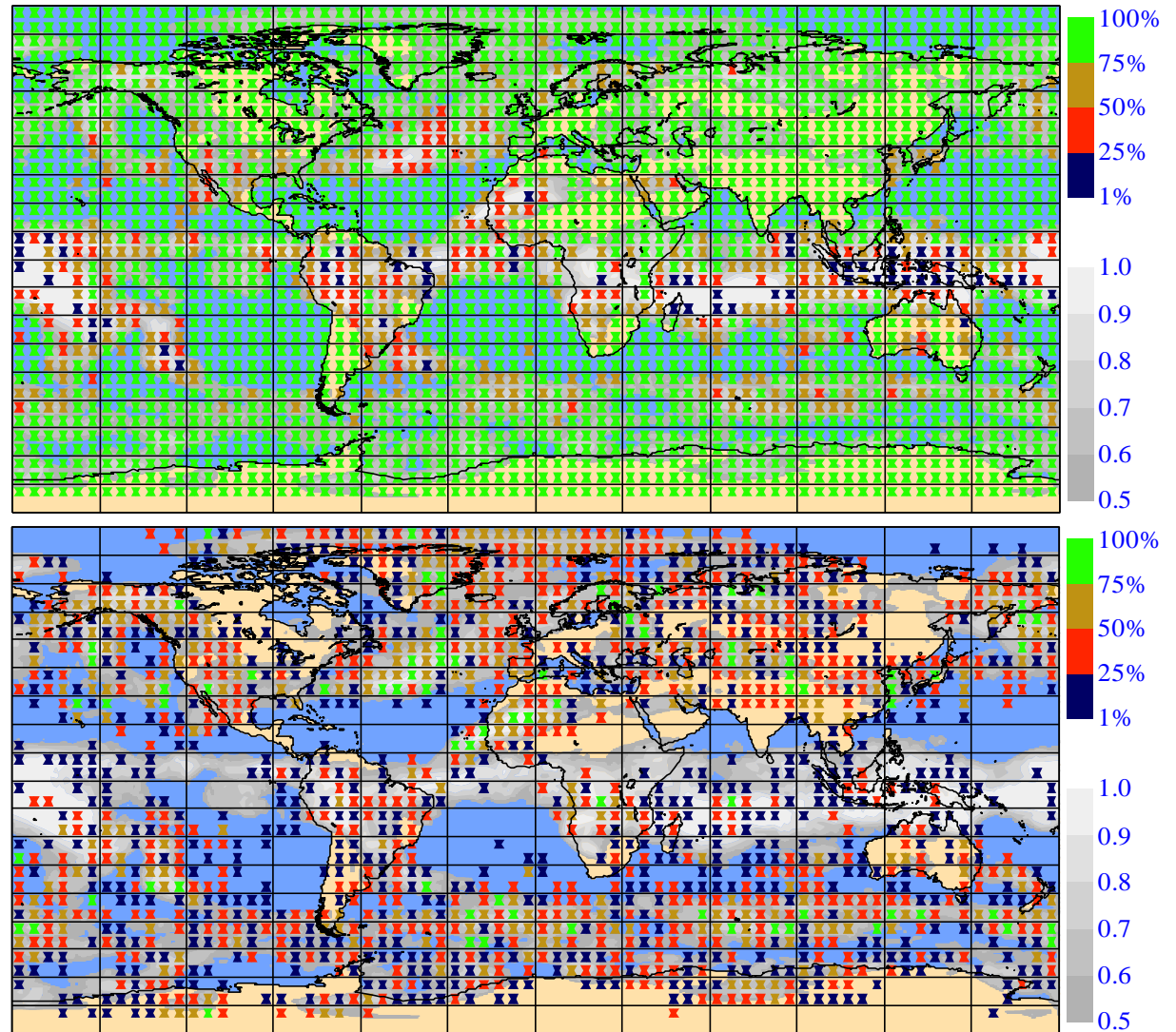
- vertical bins configurable in flight
- HLOS component only
- direction 7° from zonal at equator
- 6 hour coverage shown



Data simulations for ADM-Aeolus

Yield of good-quality data, at 10 km

- 90% of molecular returns give accuracy better than 2 m/s
- Complemented by good returns from cloud-tops/cirrus (5 to 10%) and aerosol returns at lower levels

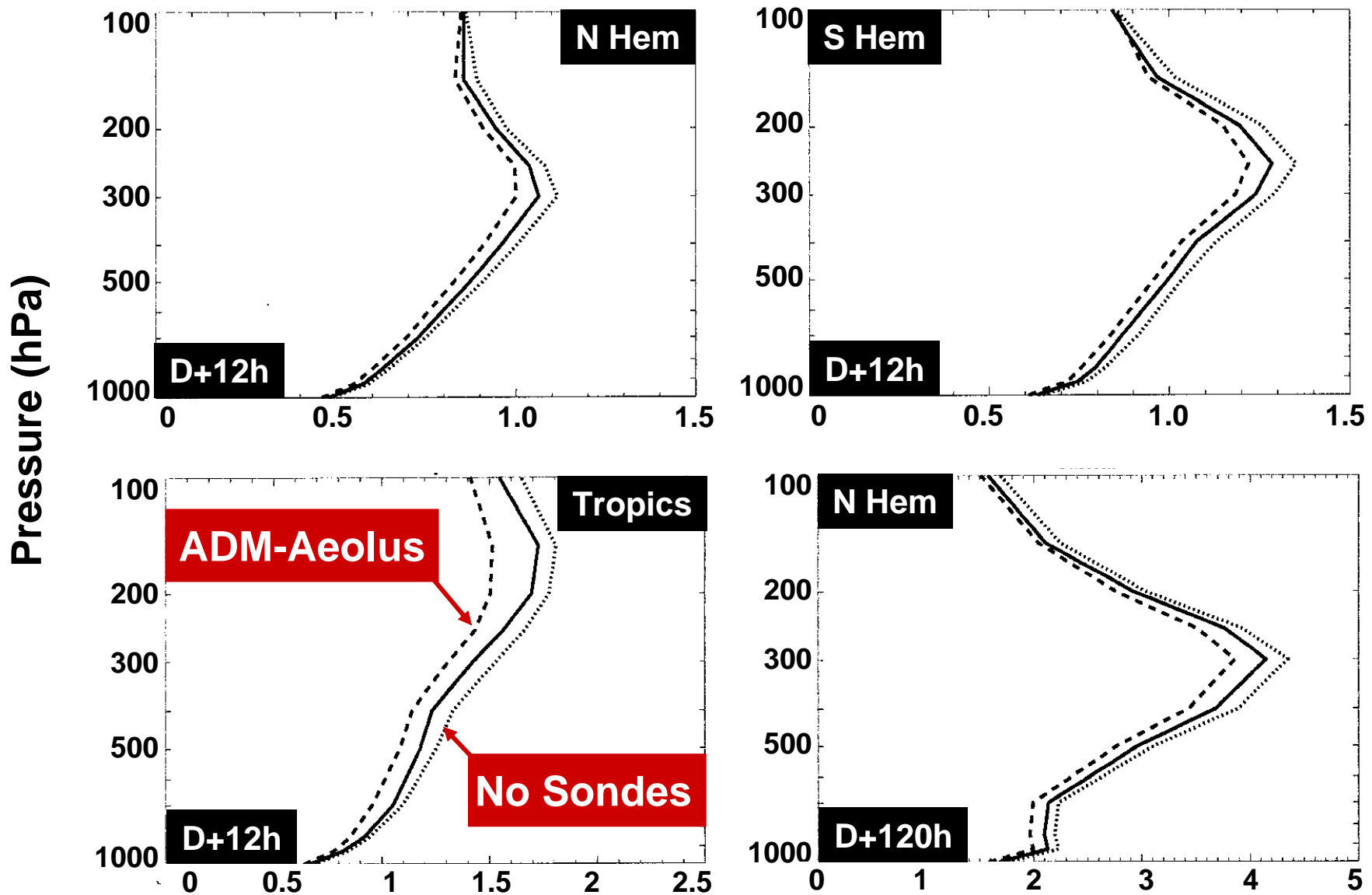


ADM simulator developed by Stoffelen and Marseille (KNMI)

Analysis/forecast ensembles for data impact assessment

- Run two separate ensembles of analyses and forecasts, with and without the observations to be assessed
- In each ensemble, observations are perturbed consistent with assumed error statistics
- Each ensemble assimilates differently the perturbed observations
- Use ensemble spread as proxy for analysis and forecast error, and spread difference as proxy for analysis and forecast impact of the assessed observations

Profiles of zonal-wind forecast impact (m/s)



Information content – global diagnostics

**Entropy Reduction
& Degrees of
Freedom for Signal
(DFS) from 4D-Var
ensembles**

Fisher, 2003

Cardinali et al., 2004

	TEMP/PILOT	Simulated DWL
Data considered	u,v to 55 hPa	HLOS to 55 hPa
Entropy reduction	4830	3123
DFS	3707	2743
Number of obs	90688	50278
Bits of info per ob	0.053	0.062
(Number of obs)/DFS	24.5	18.3

Conclusions

- **Improvement of NWP in recent years has been substantial**
 - due partly to better use of pre-existing types of data
 - due partly to use of new types of data
- **Impact of wind data is significant**
 - especially when allied with temperature data in some cases
 - ADM-Aeolus data may complement thermal sounding data
 - ADM-Aeolus data may help improve winds from imagery
- **Preparations for assimilation of ADM-Aeolus data are progressing well**
- **Direct impact of ADM-Aeolus data on forecast accuracy may be comparable to that of radiosonde data**
- **If promise is realised, what is prospect for early follow-on?**