Scientific motivation for ADM/Aeolus

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Main scientific objectives

• Improve representation of wind field in atmospheric analyses
  – Tropics: Wind field governs dynamics
  – Midlatitudes: Intense storm developments and mesoscale circulation systems

• Numerical weather prediction

• Climate sensitivity
Additional objectives

• Aerosol information
• Cloud properties
Atmospheric circulation systems

Aqua-planet simulation, 10 days (Satoh, 2005)
Present observing system

- Radiosondes
- Pilot balloons and profilers
- Satellites (temperature, humidity, cloud drift winds)
- Aircraft data
Radiosondes

1 Nov 2004, ECMWF Total: 590
Satellite temperature and humidity
1 Nov 2004, ECMWF Total: 247309
Aircraft data
1 Nov 2004, ECMWF Total 26219
ADM/Aeolus
Using ADM wind information

• **Assimilation** of line-of-sight winds in NWP system is necessary
• Wind information will complement already existing observational network
• Maximum impact expected in the tropics
Tropical circulation systems

- Tropical waves
- El Nino
- Troposphere-stratosphere exchange
Re-analyses of zonal winds

NCEP

DJF Zonal Average u [m s⁻¹]
Period: 7801–9402

ERA-15

Difference
NCEP/ERA-15

Kistler et al., 2001
Analysis of equatorial Rossby wave

Truth

Today:
Height field only

Tomorrow:
Height and ADM wind field

Zagar, 2004 (JAS)
Stratosphere-troposphere interaction (Holton, 2004)
3D trajectory dispersion computations

Schoeberl, Douglass, Zhu and Pawson (JGR, 2003)
El Niño

Normal Conditions

Convective Circulation

Equator

Thermocline

120°E  80°W

El Niño Conditions

Equator

Thermocline

120°E  80°W
Upper level (150 hPa) divergent winds

Normal conditions
(March 1982)

El Nino conditions
(March 1983)
Midlatitude storms

• Strong upper level jet is a pre-condition for a developing storm
• Frontal development – winds are of major importance (ageostrophic circulations)
GUDRUN major storm over Scandinavia 8 January 2005

2005-01-08 18:00 UTC
24 hours earlier…
Upper level flows (300 hPa)
NWP predictability improvements
Gain in skilfull forecast length, subjective assessment from WMO (2004)
Climate sensitivity

- Tropical motion fields determine cloud distribution
- Climate change sensitivity crucially dependent on cloud and water vapour feedbacks
  - Iris effect (Lindzen)
  - Water vapour – controlled by advection
- Cloud heights, cloud thickness, aerosols, cloud water droplets, ice crystals etc.
Future global mean temperature change

IPCC (2001)

Several models all SRES envelope

Model ensemble all SRES envelope

Large CO₂ increase

Low CO₂ increase

Bars show the range in 2100 produced by several models
Aerosols

• Direct and indirect effect of aerosols partly compensate for global warming by greenhouse gases
  – Large uncertainties
  – Observations of aerosol properties are needed
Change in radiative forcing 1750-2004

- Long-lived greenhouse gases
  - CO₂
  - N₂O
  - CH₄
  - Halocarbons

- Ozone
- Stratospheric water vapor
- Land surface albedo
- Total Aerosol
  - Direct effect
  - Indirect cloud albedo effect
- Contrail cirrus

- Natural
  - Solar

Radiative Forcing (W m⁻²)
Aerosol cloud
Conclusions I

• **Wind profile information**
  – needed to improve analysis of tropical circulation systems
  – storm prediction improvement expected
  – climate change sensitivity – improved understanding coupled to circulation dynamics
  – more accurate stratospheric mixing calculations
Conclusions II

• Additional information from ADM/Aeolus
  – Cloud properties (coverage, vertical structure, optical properties)
  – Aerosol concentrations and vertical distribution