Overview

• Satellite atmospheric science group
• Motivation
• Instruments
• UTH measurements
• Conclusion
• Outlook
Satellite atmospheric science group

- **Radiative Transfer:**
  Maintenance and extension of the Atmospheric Radiative Transfer Simulator (ARTS).

- **Humidity and Cloud Research:**
  We use available satellite data (operational and research satellites)
  - hydrological cycle in the upper troposphere
  - climatology of humidity and clouds.

- **Development of New Satellite Sensors:**
  - Contribution to new satellite sensor concepts, particularly in the context of future missions of ESA.
  - Development of a satellite sensor to study ice clouds in the sub-millimetre wave spectral range, CIWSIR proposal.
The group

We are currently expanding:

Open positions:
1) Assistant Professor (Forskarassistent) in Experimental Cloud Microphysics

2) Assistant Professor (Forskarassistent)
   Announcement will come out soon

3) Postdoc Position in Satellite Cloud Remote Sensing

4) PhD Student Position in Millimeter/Sub-Millimeter Wave Observations of Ice Clouds

5) PhD Student Position in Parameterizations of Cloud Ice Microphysics in Climate Models

Motivation

• Water vapor is thought to be responsible for roughly half the climate response to increased CO$_2$

• Upper tropospheric humidity (UTH):
  • Important for radiative budget
  • Uncertainties w.r.t. variability, distribution, etc.
  • Accurate in situ measurements vary locally
  • Radiosondes

• Large uncertainties in UTH in climate models used for IPCC AR4

• Large uncertainties on global distribution and role of UTH

Time series and climatology of self consistent UTH data can help to understand processes and trends and lead to improvements in models and in understanding of UTH
Motivation

Model mean diff.

# models with pos bias

Satellite borne observations of UTH

- Operational measurements since 1979 (HIRS)

- Different instruments and properties
  - Spectral range (IR and MW)
  - Systematic attributes
    (channels, geometry, instrument design, clouds, etc.)
  - Overlapping measurement periods

- Biases between models and satellite observations
## Satellite Sensors

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Satellites</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSM/T-2 (1994-present)</td>
<td>DMSP F-11 F-12 F-14 F-15</td>
<td>Microwave (183 GHz)</td>
</tr>
<tr>
<td>MHS (AMSU-B successor)</td>
<td>NOAA-18, MetOp</td>
<td>Microwave (183 GHz)</td>
</tr>
<tr>
<td>HIRS/2-4</td>
<td>TIROS, NOAA, ...</td>
<td>Infrared</td>
</tr>
<tr>
<td>AIRS</td>
<td>Aqua</td>
<td>Infrared</td>
</tr>
<tr>
<td>IASI</td>
<td>MetOp</td>
<td>Infrared</td>
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</tbody>
</table>

- **AMSU-B (HSB)**: Dataset with monthly means exists (2000-2007)
- **Comparison to AMSU-B on going**

The northernmost University of Technology in Scandinavia
Top-class Research and Education L
AMSU-B

Instrument:
• 183 GHz water vapour line
• UTH obtained by the scaling method by Buehler et al. (2005)

Dataset
• presented in Buehler et al, JGR, 2008 (in press)
• Monthly mean UTH from 2000 to 2007
• Covered range: ± 60° latitude
• Available under www.sat.ltu.se
AMSU-B

Median UTH, NOAA 16
Annual Cycle of median UTH, NOAA 15
Microwave versus Infrared Instruments

Spectral properties

- **IR:**
  - sensitivity to clouds
  - several channels around 6.3 \( \mu \text{m} \)

- **MW:**
  - insensitive to (thin) clouds
  - fixed to one spectral line (183 GHz)

- Vertical resolution and covered height range
AIRS versus AMSU-B

Comparison procedure:
Use T, H2O, O3 profiles from AIRS (L2)
→ simulate AMSU-B radiances (brightness temperatures) (ARTS)

Use simulated brightness temperatures to obtain UTH
(same procedure as for AMSU-B)

Comparable results w.r.t spectral and instrumental properties
AIRS versus AMSU-B

- AIRS has a slight (1-3 \%RH) moist bias against AMSU-B in the UT.
- Models moist bias even larger against AMSU-B.
HIRS 3/4 versus AMSU-B
HIRS 3/4 versus AMSU-B

Comparison procedure:
HIRS: jacobian weighted relative humidity in the UT
No cloudy regions $\rightarrow$ clear-sky (dry) bias

Definition of UTH products differs.

HIRS: 6-9% dry bias compared to AMSU-B

Further examination of differences is on going
Conclusion

- Satellite observations of UTH necessary to understand its in the climate system and to improve climate models.
- Timeseries of operational UTH observations since 1979
  - different satellites/orbits
  - different instruments
  - Different spectral ranges
  - ...
- 7 years dataset exists for three AMSU-B instruments (NOAA 15, 16, 17)
- Small wet bias of AIRS compared to AMSU-B
- Large dry bias of HIRS compared to AMSU-B
Outlook

- Understand and define differences between AIRS and AMSU-B
- Understand differences between HIRS and AMSU-B
- Include SSM/T-2 data to expand MW-observations to early 90s
- Include MHS data to continue MW-observations
Our home page:
www.sat.ltu.se/irv