The Third Workshop on Remote Sensing and Modeling of Surface Properties

18-20 October 2011

Beijing,China

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AGENDA

Place: Shanghai Hall, Hotel Nikko New Century Beijing

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09:30 – 09:50 Developing a VIS and NIR surface reflectance model for RTTOV - Jerome Vidot (Meteo-France) and Eva Borbas (CIMSS/SSEC))

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10:10 – 10:30 Integrated Infrared Land Surface Emissivity Spectral Dataset for Hyperspectral Infrared Retrievals - Haibing Sun (RTI), W. Wolf (NOAA), T. King (RTI), C. Barnet (NOAA) and M. Goldberg (NOAA)

10:30 – 10:40 Coffee Break

10:40 – 11:00 Improvement of CRTM Surface TIR Emissivity: In Search of a Physically-Based Canopy Emissivity Model - Ming Chen (IMSG) and Fuzhong Weng (NOAA)

11:00 – 11:20 A Two-Layer Microwave Snow Emissivity Model Applicable for Satellite Data Assimilation - Banghua Yan/Fuzhong Weng (NOAA) and Ding Ellen Liang (IMSG)

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15:00 – 15:20 Microwave Observations of Land Surface emissivity(Nai-Yu Wang, Kaushik Gopalan, Ralph Ferraro, Joe Turk)

15:20 – 15:40 Land surface emissivity retrievals from AMSR-E over Northern Africa(Ying Wu, Fuzhong Weng, Banghua Yan)

15:40 – 16:00 Microwave Land surface Emissivity Estimation over the Indian Subcontinent from Satellite data(Tinu Antony, Korak Saha, Suresh Raju and K. Krishnamoorthy)

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10:50 – 11:10 IASI retrievals over Concordia within the framework of the Concordiasi programme in Antarctica.(Anais Vincensini, Aurelie Bouchard, Florence Rabier, Vincent Guidard, Nadia Fourrie)

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16:20 – 16:40 Development and evaluation of a dual-pass land data assimilation system (Kun Yang (yangk@itpcas.ac.cn), Jun Qin, Long Zhao, Yingying Chen)

16:40 – 17:00 China land soil moisture EnKF data assimilation based on satellite remote sensing data(SHI ChunXiang1*, XIE ZhengHui2, QIAN Hui3, LIANG MiaoLing4 & YANG XiaoChun1)

17:00 – 17:20 Assessing Soil Moisture Impacts on GFS Forecasts via Assimilating Observations from AMSR-E, MWRI and SMOS Observations(Xiwu Zhan, Weizhong Zheng, Jesse Meng, Fuzhong Weng, Hu Yang, Michael Ek

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Session Chair: Yihong Duan

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09:20 – 09:40 Land Surface Temperatures from AMSR-E with an Emissivity Database(Jean-Luc Moncet, Pan Liang, Gennady Uymin, John Galantowicz, Alan Lipton, Catherine Prigent

09:40 – 10:00 A Simplified Approach for Measuring Land Surface Temperature and Emissivity Simultaneously Using Thermal Infrared Channels(Yunyue Yu, Li Fang, Donglian Sun, Hui Xu)

10:00 – 10:20 Using Satellite Data for Global Surface Monitoring(Daniel K Zhou)

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11:10 – 11:30 Multiresolution data classification for land surface properties retrieval(Hankui Zhang and Bo Huang

11:30 – 11:50 Perspectives of Using MODIS and VIIRS Observations on Snow Fraction for Modeling Surface Properties(Igor Appel)

11:50 – 12:10 NOAA's Operational Ocean Color Products from the CoastWatch Okeanos System: Product Overview and Characteristic Analysis(Banghua Yan, L. Stathoplos, H. Gu, P. Keegstra, S. Ramachandran, Wei Li, Knut Stamnes, Antonio.Irving, F. Weng, X. Liu, R. Williamson, D. Lengyel-Frey, Jerry Guo, M. Soracco)

12:10 – 12:30 An Assessment of Ocean Color Contribution to Satellite Radiance: Implication for Ocean Color Assimilation(W. Li1, Y. Fan1, B. Yan2, J. J. Stamnes3, and K.

Stamnes1)

12:30 – 13:00 Lunch Break

Tour

Thursday afternoon, 20th October

14:00 – 18:00 Tian An Men and The Imperial Palace

Friday morning, 21th October

08:00 – 12:00 The Great Wall and The Ming Tombs

ABSTRACT

Session1: Emissivity and reflectance modeling

1. **Improvements in MIcrowave and Infrared Land Emissivity Models**	
Author:	Fuzhong Weng, Ming Chen, Banghua Yan, Xiaolei Zou and Lihang Zhou
Affiliation:	NOAA/NESDIS
Currently, NWP community is driven for extracting more information on atmospheric lower boundary layer from current and future satellite systems to improve short-term to medium range forecasts. However, a large variability in surface emissivity can introduce biases in forward calculations and therefore many of sounding channels are rejected during the data assimilation process. The situations have been significantly improved since the first implementation of land emissivity model and data base in the NWP systems. Microwave land emissivity for snow-free conditions is simulated using a radiative transfer model with the input parameters from the NWP boundary layer analysis. Infrared and microwave land surface emissivity data bases are used for forward calculations. This study will further improve the microwave land emissivity model through a multilayer approach. A new infrared land emissivity model is developed with the inputs from land surface model. The simulated emissivity is being compared with satellite retrievals for its accuracy and error characterizations.	

Session Chair: Catherine prigent

2. **Developing a VIS and NIR surface reflectance model for RTTOV**	
Author:	Jerome VIDOT (Meteo-France) and Eva Borbas (CIMSS/SSEC)
Affiliation:	Meteo-France
The objective of this study is to investigate the possibility to extend the RTTOV IR land surface emissivity module to provide VIS and NIR reflectance as an input for the RTTOV surface reflectance model. The RTTOV IR emissivity module provides high spectral resolution (HSR) IR emissivity spectra between 3.6 and 14.3 microns. The HSR IR emissivity spectrum is derived by using an eigenfunction representation of high spectral resolution laboratory measurements of selected materials applied to the UW/CIMSS Baseline Fit (BF) global infrared land surface emissivity database, which is a MODIS-based, global, gridded, monthly database. The methodology would follow the algorithm of the RTTOV IR emissivity module but using a newly selected set of laboratory (reflectance) spectra measurements within the extended spectral range of 715-23800 cm-1 (0.42-14.0 microns. The laboratory spectra were selected from the new ASTER Spectral Library Version 2.0. During this study the big challenge is how to handle and take into account the	

bidirectional feature of the VIS-NIR part of the laboratory reflectance spectra. Preliminary results of this study will be presented.

3. Integrated Infrared Land Surface Emissivity Spectral Dataset for Hyperspectral infrared Retrievals	
Author：	Haibing Sun, W. Wolf, T. King, C. Barnet and M. Goldberg
Affiliation：	DELL-PEROT(NESDIS)
The operational temperature, water vapor, and trace gas retrievals from hyperspectral infrared instruments (AIRS/IASI/CrIS) requires a high spectral resolution land surface emissivity dataset as a first guess. One solution is to use the global land surface emissivity product from other observations, but generally those products have different spatial resolutions. An integrated approach has been developed to provide a \"real\" time land surface emissivity datasets that will be used in the NOAA hyperspectral infrared temperature, water vapor, and trace gas retrievals. The new approach uses a physical collocation technique to \"average\" the surface emissivity product (from MODIS et al) within each hyperspectral field of view (FOV). The approach generates the land surface emissivity with the same \"physical\" spatial representation as the hyperspectral radiance observation. In this paper, the detail of the approach is presented.	

4. Improvement of CRTM Surface TIR Emissivity: In Search of a Physically-Based Canopy Emissivity Model

Author：	Ming Chen and Fuzhong Weng
Affiliation：	IMSG at NOAA/NESDIS

The interaction of electromagnetic radiation with plant leaves depends on a variety of canopy physical and chemical characteristics such as leaf area index, leaf biochemical compositions, leaf thickness, leaf water content, and so on. The radiative transfer modeling of canopy is therefore challenging in practice, yet desirable for accurate canopy radiation calculation and indispensible for the inference of vegetation properties from remote sensing data. Theoretically, a physically-based canopy model consists of two major radiative processes: the interactions of electromagnetic waves with individual leaf, and the multi-scattering among canopy leaves. As our initial effort, the PROSPECT leaf optical property model (Jacquemoud,1990), together with the SAIL (Scattering by Arbitrarily Inclined Leaves) canopy model (Verhoef, 1984, 1985), were adopted into the NOAA Community Radiative Transfer Model (CRTM) to simulate the two canopy radiative processes and to calculate the canopy directional-hemispherical emissivity. Although being widely used, the original combined PROSPECT and SAIL model, also referred to as PROSAIL, was mainly applied to the visual and near-infrared domain of 0.4um-2.5um. In our study, the PROSAIL model was expanded to thermal infrared range with the construction of the essential leaf absorption spectra and the leaf bulk refractive index over the range of 0.4um-15um. Various sensitivity tests and analyses were performed with the expanded CRTM-PORSAIL model. The model physical structures and the performance with respect to various canopy parameters are discussed in our presentation. In particular, the Kramers-Kronig-constrained variational function analysis (Kuzmenko, 2005) is introduced for the estimation of the leaf bulk refractive index (wavelength dependent) from leaf absorption spectra. A group of leaf \"trait\" parameters are used to characterize different canopy types. And the biophysical relationship between the original PROSAIL input parameters and the \"trait\" parameters is formed. Although our tentative leaf absorption spectra data were collected from literatures, it will be shown that the expanded CRTM-PORSAIL model could be used to successfully simulate the emissivity of the basic forest and grass types of the JPL emissivity library. In real applications, the expanded

CRTM-PORSAIL model can be used for global emissivity mapping when combined with proper soil emissivity model or soil data library, and can be used for land surface property retrieval when coupled with CRTM.

5. A Two-Layer Microwave Snow Emissivity Model Applicable for Satellite Data Assimilation

Author：	Banghua Yan, Fuzhong Weng, and Ding Ellen Liang
Affiliation：	USA/NOAA/OSPO

The one-layer Microwave Land Emissivity Model (MELM) developed by Weng et al. (2001) has been used in the NCEP Global Forecast System (GFS) through the Joint Center for Satellite Data Assimilation (JCSDA) Community Radiative Transfer Model (CRTM). The introduction of the MLEM into the NCEP assimilation system has significantly increased uses of satellite microwave data over most land conditions. However, the model displays a large uncertainty in simulating snow emissivity especially at frequencies above 30 GHz thus resulting in a low utilization rate of satellite data at window and surface-sensitive channels over snow surfaces in global satellite data assimilation system. This degraded performance of the model stems primarily from the invalidity of the dense medium theory (Tsang et al. 1984) in computing snow optical parameters at middle and high frequencies. It is also partially due to neglecting snow stratification in the model since satellite observations within field-of-view (FOV) may be sensitive to snow stratification at depths of a few centimeters from the surface especially for snows after a period of metamorphosis. In this study, the Dense Media Radiative Transfer theory (DMRT) with the Quasi-Crystalline Approximation (QCA) (Tsang et al. 2001 and Liang et al. 2008) simulations are used to generate a look-up table (LUT) including single scattering-albedo, extinction coefficient, and asymmetry factor vs. grain size and fractional volume (proportional to snow mass density). The LUT is implemented into the MLEM to improve calculations of snow parameters. Meanwhile, the MLEM is extended to two layers to catch stratification features of snow medium at shallow depths (mostly two top layers), simply named to be 'two-layer snow emissivity model' hereinafter. This consideration is especially useful for a newly falling snow overlying aged snow. The performance of the new two-layer model with the LUT of snow optical parameters is assessed by applying the model to a series of snowpacks in Colorado Rocky Mountains in late winter of 2002 and 2003. Mass density, grain size and temperature of these snowpacks at multi-depths were measured through the NASA Cold Land Processes Field Experiment (CLPX). The model-simulated emissivities are compared with ground emissivity retrievals from the University of Tokyo's ground-based passive microwave radiometer (GBMR-7) observations from 18.7 to 85 GHz and as well with satellite emissivity retrievals from Advanced Microwave Sounding Unit (AMSU)-A/B observations from 23.8 to 150 GHz.

6. Radiative Transfer in Coupled Media: Atmosphere/Snow/Ice/Ocean Systems

Author:	S. Stamnes, B. Hamre, W. Li, J. J. Stamnes, and K. Stamnes
Affiliation:	Stevens Institute of Technology

In many applications an accurate description is required of light propagation in two adjacent slabs separated by an interface, across which the refractive index changes. Such a two-slab configuration will be referred to as a *coupled* system. Three important examples are atmosphere-water systems, atmosphere-sea ice systems, and air-tissue systems. In each of these three examples, the change in the refractive index across the interface between the two slabs must be accounted for in order to model the transport of light throughout the *coupled* system correctly. In the second example, the refractive-index change together with multiple scattering leads to a significant trapping of light inside the strongly scattering, optically thick sea ice medium.

For imaging of biological tissues or satellite remote sensing of water bodies an accurate radiative transfer (RT) model for a *coupled* system is an indispensable tool. In both cases, an accurate RT tool is essential for obtaining satisfactory solutions of retrieval problems through iterative forward/inverse modeling. Here we describe recent developments in both scalar RT models that ignore polarization effects as well as vector radiative transfer models that include polarization. The models to be discussed here represent significant extensions of the popular discrete-ordinate radiative transfer code DISORT (*Stamnes, K., S.-C. Tsay, W.J. Wiscombe and K. Jayaweera, Numerically stable algorithm for discrete-ordinate-method radiative transfer in multiple scattering and emitting layered media, Applied Optics, 27, 2502-2509, 1988*) designed for scalar radiative transfer in *uncoupled* systems. Scalar models for coupled media have already been used extensively as forward models to develop inversion algorithms for atmosphere-water, atmosphere-snow-ice, and air-tissue systems. Similarly, vector RT models for coupled media have been and will be more extensively used to develop retrieval algorithms that rely on observations of polarized radiation as such data are expected to become more frequently available in the future from instruments deployed onboard Earth-orbiting satellites.

7. CALCULATIONS OF THE BIDIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTION (BRDF) OF A PLANETARY SURFACE	
Author：	Snorre Stamnes
Affiliation：	Stevens Institute of Technology
Current passive microwave rain retrievals over land are known to contain large uncertainties. A major setback for over land rain retrieval is its reliance on ice scattering information. The relation between ice aloft has variable relations with rainfall at the surface. In some cases, problems arise since rainfall is not directly proportional to ice. By analyzing TRMM data and performing radiative transfer modeling, here we argue that a combination of TMI channels does contain liquid information. Additionally, it is found that land surface type and 2-meter air temperature have significant skills in characterizing rain cloud types. An effective use of such information can lead to significant improvement for land rain retrieval.	

8. The land emissivity characteristcs analysis over different geographical distribution	
Author：	Lijuan Shi,Yubao Qiu
Affiliation：	CEODE

The microwave emissivity over land is significant for describing the microwave emission characteristics of the land, different land covers have their own emission behavior, which is related to structure, water content, surface roughness ect.. Emissivity performance of the same land cover in different regional environment should also be different. In this study, the global land surface emissivities have been calculated using six month (the summer time from June,2003 to August,2003 and the winter time from Dec,2003 to Feb,2004) AMSR-E L2A brightness temperature, MODIS land surface temperature and the layered atmosphere temperature, humidity and pressure profiles data retrieved from MODIS/Aqua under clear sky conditions. We analyzed the emissivity changes of the same land cover in diverse regions at continental scale, and discussed time-series variation regularity of this change at monthly scale. In the regional climate change and the land parameters retrieval, the emissivity difference characteristics in different geographical distribution is also critical, thus we evaluate quantitatively the land covers emissivity changes with altitude and latitude using the GTOPO30 DEM data.

9. Fast Microwave Ocean Emissivity Model (FASTEM) Updates and Validation	
Author：	Quanhua Liu, Stephen English, and Fuzhong Weng
Affiliation：	CEODE
An update (FASTEM-5) to the fast microwave emissivity model (FASTEM) version 4 (FASTEM-4) has been developed jointly by the Satellite Application Facility for NWP (Europe), CPTEC (Brazil) and the Joint Center for Satellite Data Assimilation (JCSDA) of the United States. The model has been implemented in RTTOV10 and is also being implemented into CRTM. The implementation is now being tested in both models. The updates to FASTEM are: a) Added a constraint to reflectance fitting equations, ensuring same vertically and horizontally polarized reflectance at nadir; b) Reverted foam coverage because previous foam coverage form from Monahan et al.(1986) agrees with from satellite signatures derived; c) A look-up table can be alternatively used for the large-scale reflectance calculation, reducing fitting error. This updated FASTEM is called FASTEM-5. In FASTEM-5, a new permittivity model is generated by using the measurements for fresh and salt water at frequencies between 1.4 GHz and 410 GHz. A modified sea surface roughness model from Durden and Vesecky is applied to the detailed two-scale surface emissivity calculations. The two-scale model simulates azimuthal variation of the sea surface emissivity, therefore the model is applicable in determining wind direction.	

FASTEM-5 can be used for using microwave radiometric measurements to study wind speed, wind direction, sea surface temperature, and salinity. FASTEM-5 is being validated using the match-up data set for Aqua AMSR-E and MHS from Ralf Bennartz at the University of Wisconsin, collocated satellite data and ECMWF model data from the NOAA Microwave Integrated Retrieval System (MiRS, Sid Boukabara), and finally data from the NOAA NCEP GSI system. The results show that FASTEM-5 has improved performance in comparison to previous FASTEM versions.

10. On the Evaluation of Land Emissivity Model Accuracy by Using Car-borne Multi-channel Radiometer Observations over Grassland	
Author：	Hu Yang Ruijin Sun Shengli Wu Fuzhong Weng
Affiliation：	
Microwave Land Emissivity information is very important for satellite remote sensing of land. However, problems remain in using microwave radiometer measurements over land when the channels are affected by the surface and the variation of surface emissivity can not be accurately characterized. The community has recently requested developments of microwave land emissivity datasets and models that can be directly used in satellite radiance assimilation. For a bare soil, the emissivity can be derived as a function of soil moisture, soil textural components, and surface roughness parameter. The most commonly used physical model for bare soil microwave emissivity simulation is AIEM model, which was proved to be able to simulate the bare soil microwave emissivity with certain accuracy. But due to the complexity of this model, it is very difficult to directly using this model either in data assimilation or in physical retrieval algorithms. Except for AIEM model, the QH model and QP model was two widely used semi-emperical microwave emissivity model for bare soil, but the model accuracy was depends on the empirical parameters set in models. The emissivity of a vegetation canopy can also be simulated by using	

either a single layer model (model) or a multi-layer model(Double Matrix, etc). For these microwave land emissivity models commonly used in NWP data assimilation and physical retrieval, evaluation of model accuracy are needed.
In this paper, different models generally used for microwave emissivity simulation for bare soil and vegetation canopy was evaluated by using datasets from a field campaign performed during year 2008 and 2010 in inner-mongolia grassland. Brightness temperatures from 6.9 to 36GHz V/H channel was collected by using a car-borne 10 channels microwave radiometer, the soil moisture, surface roughness as well as vegetation water content parameters were measured simultaneously with TB observations during the field campaign.

Session 2：Emissivity and reflectance retrieval from satellite

Session Chair: Fuzhong Weng

11. Estimation of MW emissivities using TELSEM for the retrieval of atmospheric water vapour over the continents: Application to the Megha-Tropiques mission.

Author：	Filipe Aires, Catherine Prigent, Freeric Bernardo
Affiliation：	Estellus

A Tool to Estimate Land Surface Emissivities at Microwave (TELSEM) frequencies has been developed, for use with the RTTOV model. Its objective is to provide a good estimate of the microwave surface emissivity to improve the retrieval of atmospheric profiles or the direct assimilation of radiances in Numerical Weather Prediction (NWP) models using microwave sounder data over land. TELSEM provides emissivity estimates and error covariance matrices for all land surfaces, between 19 and 100~GHz, and for all angles and linear polarizations.
Results show that with TELSEM, radiative transfer simulations are closer to real observations. This is important when RTTOV is used to generate simulated datasets, to analyze new instrument concepts, or for assimilation schemes. Experiments also

show that TELSEM can be applied to provide a first guess of the surface emissivity down to 6~GHz and up to 190~GHz (extrapolating the SSM/I emissivities). These emissivities are essential for atmospheric profile retrievals over land: Results for water vapour retrieval show that surface-contaminated channels can be utilized, and that the retrieval is improved, in particular for the lower troposphere. Furthermore, TELSEM emissivity first guesses can be improved in emissivity retrieval schemes.
An operational retrieval chain using TELSEM has been produced for the French-Indian Megha-Tropiques mission, expected to be launched in automn 2011. The algorithm has been further developed for the instruments AMSR-E/HSB (resp. AMSU-A/MHS) onboard AQUA (resp. MetOp) platforms in order to be able analyzing real observations. The water vapour is retrieved for clear and cloudy scenes, over both ocean and land surfaces. The atmospheric relative humidity profile is retrieved on six atmospheric layers, together with the total column water vapour. By-products are also retrieved by the algorithm, including surface temperature and microwave emissivities over continents. Results of the retrieval algorithm are evaluated for AQUA and MetOp observations using comparisons with ECMWF analysis and radiosonde measurements.

12. Microwave Observations of Land Surface emissivity

Author：	Nai-Yu Wang, Kaushik Gopalan, Ralph Ferraro, Joe Turk
Affiliation：	University of Maryland/ESSIC

The microwave emissivity over land is important in describing the characteristics of the land surfaces and is an essential factor for retrieving geophysical parameters (e.g., soil moisture and precipitation) from land and atmosphere. This study examines the microwave retrievals of surface emissivity spectra from AMSU and AMSR-E in the summer and winter months under clear sky conditions over C3VP site. The cloud-free atmospheric contribution is calculated from AIRS temperature and humidity profiles, and NWP model reanalysis from GDAS and ECMWF. The land surface temperature from MODIS, GDAS and ECMWF are used for comparison purposes. The differences in the atmospheric contribution due to different inputs of temperature and humidity profiles along with the effect of surface temperature are discussed. The relationship between the land surface emissivity, surface temperature and snow water equivalent in the winter months is also analysed. The potential for using microwave emissivity for precipitation retrievals over land is discussed.

13. Land surface emissivity retrievals from AMSR-E over Northern Africa	
Author：	Ying Wu, Fuzhong Weng, Banghua Yan
Affiliation：	Nanjing University of Information & Science Technology (NUIST)
Retrievals from AMSR-E aqua are tested and grouped over Northern Africa according to surface texture and soil composition information from NOAH LSM. Since AMSR-E has 6.925, 10.65 GHz channels, retrievals can be extended to cover larger dynamic range. In retrievals, some quality controls are performed, specifically retrieving rain contaminations, RFI effects, etc. To understand the dependence of emissivity on soil type, we specifically regroup the emissivity spectra over the desert area in Northern Africa according to soil texture. It is clear that the emissivity significantly varies with soil composition. Also, variation with season is evident for soils which are abundant of organic materials. Lower emissivity is for clay, bedrock. For frequencies higher than 30 GHz, the emissivity is nearly constant for silty clay loam and sandy clay, and the emissivity in general decreases (increases) with frequency for the vertical (horizontal) polarization for sand and sandy loam. Silt and sand soil are in general display larger polarization difference at lower frequencies. These characteristics are probably related to material dielectric properties should be further investigated the emissivity simulation.	

14. Microwave Land surface Emissivity Estimation over the Indian Subcontinent from Satellite data	
Author：	Tinu Antony, Korak Saha, Suresh Raju and K. Krishnamoorthy
Affiliation：	Vikram Sarabhai Space Center,ISRO
The microwave land emissivity for the Indian subcontinent (lat: 00 – 400N & Long: 60-1000E) is retrieved from the DMSP Special Sensor Microwave/Imager (SSM/I) data for the years 2007 and 2008 and monthly mean emissivity maps of Indian Subcontinent for all the SSM/I channels are generated for the two years. Wide variety of geographical features and climatic conditions prevail over the Indian sub-continent and their detailed characterization in terms of microwave emissivity has been studied in detail. Apart from that, the Indian monsoon which is a unique feature also influences the land use/land cover and climatic variability over this region. Based on the microwave emissivity maps, the spectral and seasonal variations of various land classes are analyzed using multifrequency and dual polarization data. Such analyses have potential applications in land surface charcterisation (waterlogged marsh lands/ arid or semiarid regions , sandunes and rock cutcrop, snow and ice cover) and to discriminate various vegetation classes like	

the tropical rain forest, deciduous forest, etc. The seasonal and interannual variability of emissivity of different land surface classes like tropical evergreen and deciduous forests, agriculture area, wet land and deserts region like the hot deserts (Thar) and cold deserts(Taklamakan) have also been studied. The study also extended for assessing the flood affected area in the Indian Subcontinent during the Indian monsoon for a period of four years (2007-2010).

15. An innovative physical scheme to retrieve simultaneously surface temperature and emissivity from IASI

Author：	Maxime Paul, F. Aires, C. Prigent
Affiliation：	LERMA

The retrieval of key atmospheric parameters such as water vapor or temperature close to the surface from satellite measurements is difficult to perform over land areas. A precise knowledge of the state of the surface is needed in order to interpret as precisely as possible its interaction with the measured radiation. A way to characterize this interaction is to determine the surface emissivity and skin temperature. This study focuses on the infrared wavelength domain. The objective is to create a retrieval algorithm based on infrared measurements (here IASI instrument will be used) that gives real time access to the surface emissivity and skin temperature. This algorithm uses as inputs an emissivity and surface temperature first guesses and IASI measurements. It retrieves directly both the effective emissivity and the surface skin temperature.

To get the emissivity first guess required by the retrieval algorithm, a spectral emissivity interpolator has been built. It is based on MODIS emissivity retrievals and laboratory measurements at IASI spectral definition. A non-linear method (neural network) has been used to better represent the fine spectral features. To reduce the time of the calculations, a principal component analysis is performed over the high spectral emissivity spectra. This dataset has been developed to provide an emissivity first guess compatible with the principal component analysis used in the retrieval algorithm.

A retrieval scheme is built using IASI measurements, the interpolated emissivities and corresponding ECMWF analysis as inputs and the surface temperature and the effective emissivity spectrum as outputs. Its principle is based on a local linearization of the radiative transfer equation. The interpolated emissivities and the ECMWF analysis are used to perform a radiative transfer calculation to get a first guessed IASI spectrum used by the retrieval.

In order to measure the precision of this algorithm an a posteriori method is adopted. It consists in comparing radiative transfer simulated data using different emissivity datasets as inputs, combined with ECMWF analyses. The infrared emissivity datasets come from different sources: NASA (D. Zhou), UWIREMIS (E. Borbas) and the ARA group. Such comparisons show the importance of a precise emissivity knowledge. The use of a monthly mean emissivity climatology instead of a real time retrieval reduces the quality of the surface characterization (by up to 5K in the 1000 to 1100 cm-1 band) and thus can induce errors in the following atmospheric retrievals. Indeed, as this surface characteristic retrieval will be used as a first step before atmospheric parameter inversions, if its results are not precise enough, mischaracterization of the surface will imply errors in the atmospheric state.

16. Land Surface Emissivity Retrievals from FengYun-2 Measurements and Cross-validation with MODIS and IASI Products

Author：	Geng-Ming Jiang and Daniel K. Zhou
Affiliation：	IMSG at NOAA/NESDIS

This work will address the Land Surface Emissivity (LSE) retrievals from the measurements of the Visible and Infrared Spin Scan Radiometer (VISSR) on board the Chinese first generation geostationary satellites FengYun-2C (FY-2C) and FengYun-2D (FY-2D) from the region of western China. The VISSR/FY-2 infrared channel 1 (~10.9 Î¼m), channel 2 (~11.9 Î¼m), and channel 4 (~3.8 Î¼m) have been inter-calibrated with the Atmospheric Infrared Sounder (AIRS) and the MODerate resolution Imaging Spectroradiometer (MODIS) channels in tropical region to improve the accuracy, using the Ray-Matching (RM) method and High Spectral Convolution (HSC) method. The atmospheric contribution is removed from the VISSR/FY-2 data using MODTRAN radiative transfer model calculations together with the European Center for Median-range Weather Forecast (ECMWF) analysis data. Based on the concept of Temperature Independent Spectral Indices of

Emissivity (TISIE) constructed with one channel in middle infrared and the other in thermal infrared, and assumption of that the TISIEs do not change between daytime and nighttime, the land surface emitted and reflected radiances in VISSR/FY-2 channel 4 in a clear-sky daytime are first separated, and then the directional reflectances at different angles are obtained. Finally, the LSE in VISSR/FY-2 channel 4 is modeled with the RossThick-LiSparse-R model and the Kirchhoffâ€™s law, and then LSEs in VISSR/FY-2 channels 1 and 2 are deduced using the TISIE concept again. Cross-validation of the retrievals is performed with those derived from the MODIS and the Infrared Atmospheric Sounding Interferometer (IASI) measurements. Results show that the retrievals are consistent with the MODIS and IASI products, and some problems are also revealed and need further investigation.

17. Snow Albedo Retrieval over Greenland from MODIS data	
Author：	Nan Chen, Wei Li, Snorre Stamnes, Tomonori Tanikawa and Knut Stamnes
Affiliation：	Stevens Institute of Technology
An algorithm for retrieval of broadband snow albedo has been developed for GCOM-C1/SGLI by using a radiative transfer model for the coupled atmosphere/snow system. The correlated-k distribution method is applied in the calculation of broadband albedo, and an effective cloud masking algorithm is applied to screen out the impact of cloud over snow. The algorithm was tested against MODIS data over Greenland and verified by comparison with field measurements. Multiple-year and seasonal variations of snow albedo over Greenland are analyzed and compared with field measurements.	

Session 3: Atmospheric retrieval over land and sea ice: assimilation experiment

Session Chair: Fatima Karbou

18. Impact of Microwave Land Emissivity Information on Satellite Data Assimilation	
Author：	Yong Chen, and Fuzhong Weng
Affiliation：	CIRA, JCSDA

A robust schedule for assimilating satellite microwave sounding data at surface-sensitive channels in numerical weather prediction (NWP) models is very important since the measurements contain rich information about lower-level temperature, water vapor, cloud liquid water, and precipitable water. Recently, two global land emissivity datasets named TELSEM and CNRM Microwave Atlas have been produced directly from satellite observations using Special Sensor Microwave/Imager (SSM/I) and Advanced Microwave Sounding Units (AMSU). These emissivity datasets are included in the Radiative Transfer for the Television and infrared Observation satellite operational Vertical Sounder (RTTOV)-10. An interface software is also developed to link the RTTOV-10 emissivity data base with the Community Radiative Transfer Model (CRTM). The land emissivity can be calculated before calling CRTM main functions (such as Forward, and K-Matrix models), and passed to CRTM through Options structure instead of using the internal default physical emissivity models. In CRTM, the physical model can simulate land emissivity and its variation in time and space through a set of surface parameters such as soil type, roughness and moisture content. The model requires accurate input parameters for emissivity calculations. On a global scale, these input parameters are still poorly described although some improvements have been recently made. These are two physical models available in CRTM: (1) NESDIS default model, in which volumetric scattering was calculated using a two-stream radiative transfer approximation; Soil moisture content, vegetation fraction, soil temperature, and skin temperature are input parameters. (2) NESDIS_new model, in which additional input parameters are added, such as leaf area index, vegetation type, and soil type. In this study, we have evaluated impacts of these microwave land emissivity model and data sets on assimilation of AMSU data. Results show that more observation data are assimilated for datasets than physical models for AMSUA channels 1, 2, and 3. The impact on forecast scores positive in the tropics within 4 day forecast range for CNRM but neutral for both southern and northern hemispheres.

19. Assimilation experiments of surface-sensitive microwave radiances in JMA global data assimilation system

Author：	Masahiro Kazumori
Affiliation：	Japan Meteorological Agency

Japan Meteorological agency (JMA) operates a global model for short to medium range weather forecast and a four dimensional variational method is employed to produce the initial state of the forecast. Since 2003, satellite observed radiance data has been assimilated by using a fast radiative transfer model (RTTOV) in the global data assimilation system. However, the current use over land is limited to channels those are not sensitive to the surface. Recent studies suggest that it is possible to make use of the information of surface-sensitive microwave radiances if improved land surface emissivity and land surface temperature estimates are used together in radiative transfer calculation. The goal of this research is to improve global forecast skills by using lower tropospheric microwave channels in the data assimilation. In the current JMA's radiative transfer calculation of the satellite data assimilation, land surface emissivity is set to a fixed value, and the atmospheric temperature at the lowest model level from short range global forecast is used as a substitute for land surface temperature. In order to assimilate surface-sensitive microwave radiances from various microwave radiometers, climatological land surface emissivity values supplied with RTTOV-10 were employed in the assimilation experiments. And hourly land surface temperature from the JMA global land surface model was used together. Although inflation of observation error of AMSU-A channel 6 over land was applied in the current system due to inappropriate land surface emissivity use, the use of climatological land surface emissivity values could reduce the inflation factor. The hourly land surface temperature was utilized for all the satellite's radiance calculation and also used as one of the predictors in variational bias correction of radiance data. With these improvements, lower tropospheric channels of MHS (Channel 3, 4 and 5) over land were newly incorporated in the assimilation experiments. Impacts of assimilating MHS over land were found in desert area with increase of Total Column Water Vapor (TCWV). In verifications, the increased TCWV was consistent with ground-based GPS integrated water vapor data and retrieved TCWV from MERIS on ENVISAT in the desert area. And reduction of O-B departure during the assimilation experiment period was found for AMSU-A channel 6. And improvement of short range forecast errors of temperature at 850 hPa was also found globally. It is planned to extend the use of climatological surface emissivity values for other microwave radiance data (such as SSMIS, AMSR-E, and AMSR2 on GCOM-W1). Further, in order to obtain more realistic information from the measurements, dynamical estimation of land surface emissivity and/or land surface temperature in the JMA global data assimilation system will be planned.

20. IASI radiances assimilation over land.	
Author：	Anais Vincensini, Nadia Fourrie, Florence Rabier, Vincent Guidard
Affiliation：	Meteo-France

Observations from satellite infrared measurements have large atmospheric and surface information contents and are known to improve Numerical Weather Prediction (NWP). However, the use of these observations is still not optimal over land because of uncertainties about land emissivity and skin temperature. Indeed, only radiances that are not affected by the surface are currently assimilated. Previous studies, on microwave observations from AMSU-A and AMSU-B or on infrared observations from SEVIRI, have shown that the use of land emissivity climatologies together with land surface temperature retrievals improves the assimilation system. The aim of this study is the improvement of the simulation and the assimilation of the Infrared Atmospheric Sounding Interferometer (IASI) data over land. Emissivity climatologies from the Land-SAF (EUMETSAT Land Surface Analysis - Satellite Application Facilities) and atlases computed from MODIS (Moderate Resolution Imaging Spectroradiometer) emissivity products are used. Land surface temperatures are retrieved using one IASI window channel and inverting the radiative transfer equation. Assimilation experiments will be run to include channels which have never been assimilated over land in the ARPEGE NWP of Meteo-France within the French 4D-Var system.

21. Assimilation of SEVIRI radiances over land in the French meso-scale models	
Author：	Stephanie Guedj, Fatima Karbou and Florence Rabier
Affiliation：	METEO-FRANCE

This work aims to improve the assimilation of low-level SEVIRI (Spinning Enhanced Visible and Infra Red Imager) IR (Infra-red) observations over land to better constrain atmospheric analyses in meso scale models operating at Meteo-France. To date, only high-peaking Water Vapour channels are operationally assimilated over land and IR channels are entirely rejected over land surfaces. The assimilation of IR observations over land is possible only if several limitations are accounted for: a reliable description of the surface emissivity, a more accurate estimation of the surface temperature and an effective bias correction scheme. Feasibility studies have been undertaken in order to assimilate as many SEVIRI observations as possible over land surfaces in the ALADIN and AROME French systems. The land surface emissivity was described using climatologies from the EUMETSAT Land-SAF (Satellite Application Facilities). The land surface emissivity and SEVIRI Tb were used as input parameter in the radiative transfer model to retrieve the surface temperature (Ts) over Europe. The retrieved Ts were then successfully evaluated by comparison with independent temperature estimates (MODIS, Land-SAF products, ...) and were later used within the assimilation process to constrain the analysis of surface temperature. These developments have allowed us to run impact studies for two distinct seasons by assimilating observations never assimilated over land. We show that the forecast impact when assimilating these data is generally neutral to positive (mainly over Southern Europe). We also show that the assimilation of many more SEVIRI data improves the quality of analyses, particularly those of Total Column Water Vapour (TCWV), and this is substantiated through comparisons with independent GPS measurements. A description of the methods for temperature retrievals will be given together with an evaluation of the retrieved Ts against independent measurements. An overview of main assimilation experiment results when SEVIRI IR observations are assimilated over Europe will be also presented.

22. The assimilation of microwave observations from AMSU-A and AMSU-B over sea ice

Author：	Fatima Karbou, Florence Rabier
Affiliation：	Meteo-France, CNRM-GAME/CEN

Until recently, a lot of microwave observations were rejected over sea ice during the assimilation process. Inappropriate description of sea ice in the model (constant value of 0.99) is one of the reasons for such a limited use of observations. Following the work on the land surface emissivity undertaken at Meteo-France (Karbou et al. 2010ab), a new sea ice emissivity model has been developed covering the frequency range of 23 to 150 GHz. This model was built by studying the spatial and temporal variability of the emissivity of sea ice directly inferred from satellite observations. The model was evaluated in the context of global assimilation experiments by assimilating, for the first time, observations sensitive to the surface from AMSU-A and AMSU-B. It has been shown that the use of this model allows the assimilation of the surface sensitive channels over polar regions and at the same time improves the quality of analyses/forecasts of the global model ARPEGE. In this presentation, the sea-ice emissivity model will be presented and its impact within the radiative transfer model RTTOV quantified. We will then give elements on the data impact studies carried out during the winter of 2009/2010.

23. IASI retrievals over Concordia within the framework of the Concordiasi programme in Antarctica.	
Author：	Anais Vincensini, Aurelie Bouchard, Florence Rabier, Vincent Guidard, Nadia Fourrie
Affiliation：	Meteo-France

One of the main goals of the Concordiasi campaign was to improve satellite data assimilation at high latitudes, and in particular, the assimilation of the Infrared Atmospheric Sounding Interferometer (IASI) data over the southern polar region. This study focuses on the retrieval of IASI data using a one-dimensional variational data assimilation (1D-Var) system, which was carried out at the Concordia station and within the framework of Concordiasi. The study period lasted from the 20th of November until the 12th of December 2009. Radiosonde measurements are utilized to validate temperature and water vapor retrieved profiles. Baseline Surface Radiation Network (BSRN) data and manned measurements in Concordia are used to verify skin temperature retrievals and to derive information about cloudy conditions. This study assesses the impact of several parameters on the quality of the retrieved profiles. In particular, the background error specification is crucial. The background error covariance matrix is optimally tuned to provide the best possible retrievals, computing and maximizing the Degrees of Freedom for Signal (DFS). The DFS characterizes how the assimilation system uses the observation to pull the signal from the background. Thus, for the period of study, the retrieved profiles of humidity and of temperature are optimally improved compared with background profiles, with the largest reduction in error for the skin temperature.

<u>Session 4</u>: Atmospheric retrieval over land and sea ice: impact of surface information on cloud and rain retrieval

Session Chair: Sid Boukabara

24. On the Sensitivity of TRMM Microwave Imager Channels to Over-Land Rainfall	
Author:	Y. You and G. Liu
Affiliation:	Florida State University
Current passive microwave rain retrievals over land are known to contain large uncertainties. A major setback for over land rain retrieval is its reliance on ice scattering information. The relation between ice aloft has variable relations with rainfall at the surface. In some cases, problems arise since rainfall is not directly proportional to ice. By analyzing TRMM data and performing radiative transfer modeling, here we argue that a combination of TMI channels does contain liquid information. Additionally, it is found that land surface type and 2-meter air temperature have significant skills in characterizing rain cloud types. An effective use of such information can lead to significant improvement for land rain retrieval.	

25. Cloud detection and characterization in AIRS/IASI observations over land and sea-ice in the French Global Numerical Weather Prediction model	
Author:	N. Fourrié, V. Guidard, T. Perttula and F. Rabier
Affiliation:	CNRM-GAME Meteo-France and CNRS

The aim of the poster is to illustrate the cloud detection from hyperspectral infrared sounders over land and sea-ice. Currently stratospheric, upper- and mid-tropospheric channels of advanced sounders are assimilated operationally in the Numerical Weather Prediction global model. For AIRS only pixels over sea are assimilated in operations for clear-sky conditions and low to mid-level clouds. For IASI, 77 channels are assimilated over sea if not affected by clouds. A subset of these channels not affected by the surface are used over land and over sea ice. As the surface parameters play a key role for the cloud detection, characteristics of clouds detected with a CO2-slicing method over land will be presented for AIRS and IASI. Moreover in the framework of the Concordiasi experiment, cloud detection and characterization have been studied over sea ice and the plateau over Antartica with data of the A-Train. Sensitivity studies to surface and low-level temperature have been conducted to improve the cloud detection.

26. Assessing the Surface Contribution in Passive Microwave Measurements for Physical Retrieval of Precipitation

Author：	Sarah Ringerud
Affiliation：	Colorado State University

In the GPM era, physical retrievals of precipitation over land using passive microwave radiometers will require the ability to separate emission contributions from the atmosphere from those of the surface. This requires information about the nature of the surface, itâ€™s dynamic properties, and the effective result of these (along with their heterogeneity) as viewed from the space borne sensor. In an effort to gain insight into these parameters and how they might effect future physical retrievals of precipitation, three datasets are assembled for analysis. Oklahoma is chosen as a study area so as to utilize itâ€™s high-density network of available observations. Nine years of clear sky satellite emissivity retrievals are performed over the region using AMSR-E satellite overpasses. Retrieved values are compared with 9 years of modeled values compiled from a combination of land surface model results and a forward emissivity model. Brightness temperatures computed from each will then be compared to the observations. In addition, data from the recent MC3E field campaign over the region will be analyzed comparing brightness temperatures measured using instruments above the ER2 high altitude aircraft with coincident surface measurements. Results will be interpreted in terms of their correlation to surface parameters such as soil type, soil moisture, and vegetation, in an attempt to pinpoint information that will be necessary for a future physical precipitation retrieval for passive microwave sensors.

27. Improving Uses of Cloudy Radiances at Surface-Sensitive Channels in NWP

Author：	X. Zou, X. Wang, F. Weng, Y. Chen and M.-J. Kim

Affiliation：	Florida State University

The GOES imager radiance observations on board Geostationary Operational Environmental Satellite (GOES), GOES-11/12, that are of high spatial and temporal resolution were added to the assimilation of AMSU-A and conventional observations, which produced the best 24-h quantitative precipitation forecasts (QPFs) for a coastal storm over the northern Gulf of Mexico. Both the National Centers for Environmental Prediction (NCEP) Gridpoint Statistical Interpolation (GSI) analysis system and the Community Radiative Transfer Model version 2.02 (CRTM2.02) were utilized to ingest GOES IR clear-sky data and the Weather Research and Forecast (WRF) model was used for model forecasts. The WRF outputs of temperature, water vapor, hydrometeor profiles and surface winds in Gulf region were then used as input to CRTM2.02 and RTTOV10 to simulate brightness temperatures (TB) of microwave sounding instruments as a function of cloud liquid water and ice water contents for a given surface wind speed and SST condition (ocean only). The TB responses to cloud and other surface parameters such as sea surface temperature and surface wind speeds are simulated by both CRTM 2.02 and RTTOV10 and compared for understanding and quantifying O-B biases. The observation error covariances are derived and parameterized as functions of observed and model cloud and surface parameters. These are required inputs for improving uses of cloudy radiances at surface-sensitive channels in NWP.

28. An Evaluation of Microwave Land Surface Emissivities for use in Precipitation Algorithms

Author：	C. Hernandez, R. Ferraro, C. Peters-Lidard, and members of the PMM Land Surface Working Group

Affiliation:	ESSIC / UMD
One of the most important physical parameters that can be retrieved from passive microwave radiometers is emissivity, in particular, over land. Emissivity can provide information on surface parameters such as soil condition, vegetation, and land cover. To advance the current state of empirically driven land-based precipitation algorithms, precipitation estimates can be improved over land if an accurate emissivity can be retrieved. Therefore, surface characterization is highly needed to dvance the GPM-era recipitation over land algorithms.An intercomparison study under the auspices of NASA's Precipitation Measurement Missions (PMM) Science Team was organized to assess the current status of established and emerging emissivity data sets and techniques. Currently, the PMM Land Surface Characterization Working Group (LSWG) is comparing seven algorithms that use different techniques to estimate emissivity (e.g., by direct observational, by using a land surface model, and by physical retrieval). These algorithms are compared during a three year period (July 2004 to June 2007), initially at three different sites (continental US (central, and southern) and in southern Canada). Amongst the data set being compared are estimates coming from passive microwave radiometer (e.g. SSMI/I, SSMI/S, AMSR-E, TMI, AMSU/MHS, WindSat), or in combination with ancillary data (e.g. land surface model data, ISSCP cloud mask, satellite-based precipitation data). The comparison study tries to explore similarities and differences between the different techniques. These techniques are being compared by time series, monthly means, and percent of difference between them during periods of land surface change, such as snow cover, vegetation, presence of clouds, and precipitation.The results to date demonstrate that emissivity is affected by these conditions, more or less depending on the target site, but some of the discrepancies between these techniques are still unknown, and are under current evaluation.	

Session 5: Surface parameter retrieval: assimilation experiments

Session Chair: Xiaolei Zou

29. Preparation activities for the assimilation of SMOS data in the ECMWF land surface analysis system	
Author：	J. Munoz Sabater, P. de Rosnay, M. Drusch, A. Fouilloux, M. Dahoui, S. Mecklenburg
Affiliation：	ECMWF

The 2 November 2009 the Soil Moisture and Ocean Salinity (SMOS) mission of the European Space Agency (ESA) was successfully put into a polar orbit around the Earth. Since then SMOS has continuously been providing global multi-angular and multi-polarized maps of brightness temperatures at the L-band. Although the technical and operational challenges of this mission are multiple, SMOS data has already proved its potential to deliver valuable information about the water content of a shallow surface.

Since the beginning of the mission, the European Centre for Medium-Range Weather Forecasts (ECMWF) has been actively involved in this mission. At ECMWF the main objective is to study the potential impact that the assimilation of SMOS brightness temperatures has on the weather forecast skill, by improving the initialization of the global soil moisture state before a forecast run. However, prior to assimilation, SMOS data needs to go through a series of steps which guarantee a good quality dataset ready to be assimilated. Firstly, an operational chain was developed which makes it possible to monitor SMOS data in Near Real Time. As a consequence, global statistical maps of the observations, a model equivalent of the observations and the difference between both sources of information (also called first-guess departures), are systematically being produced just a few hours observation time, among others. These statistics are an excellent tool to localize systematic bias or drifts in the observations or in the model. They also provide support to calibration and validation teams. Secondly, SMOS data needs to be significantly thinned as the data volume contained in a single orbit is too large for the current operational capabilities in Numerical Weather Prediction systems. Different thinning strategies were analysed and tested. Thirdly, SMOS observed brightness temperatures are significantly noised, due the different complex geometry of the multi-angular observations. In this respect, a simple but efficient noise reduction scheme is currently being tested, which not only reduce random observational noise from the observations, but also thin the data before assimilation. Finally, a bias correction scheme based on a future available re-processed dataset will be applied to the observed brightness temperatures as to ensure the assimilation of an unbiased dataset.

This paper will show the current status of these activities aiming to prepare SMOS data for the assimilation in the ECMWF land surface analysis system.

30. Use of active and passive microwaves satellite data for NWP soil moisture analysis	
Author：	P. de Rosnay, C. Albergel, G. Balsamo, L. Isaksen, J. Muñoz Sabater, J.-C. Calvet, C. Gruhier, Y. Kerr, T. Pellarin

Affiliation：	
Soil moisture initialisation is of crucial importance for Numerical Weather Prediction (NWP). It influences the land-atmosphere exchange processes, which determines the partitioning of energy between latent and sensible heat fluxes, and it has a strong influence on forecast screen level temperature and relative humidity. Satellites, such as ASCAT (Advanced Scatterometer) and SMOS (Soil Moisture and Ocean Salinity) provide highly suitable data from active and passive microwave sensors for soil moisture remote sensing. For NWP applications, satellite data monitoring provides a continuous evaluation of observations and first guess departures (observation minus model) values at global and regional scales. It also allows identifying systematic features in the data set and supports bias correction activities. Monitoring results of SMOS brightness temperature and ASCAT surface soil moisture data are presented. In addition, based on in-situ ground measurements available in Europe, USA, Africa and Australia, ASCAT and SMOS surface soil moisture products are evaluated and compared with ECMWF surface soil moisture analysis. Results show good performance of the three sources with respect to capturing surface soil moisture annual cycle, as well as short term variability. Both monitoring and ground validation results show high complementarities between remotely sensed products and ECMWF soil moisture. This highlights the potential of using satellite data for NWP soil moisture analysis. In order to make it possible to combine the use of satellite, in-situ and proxy observations to analyse soil moisture, ECMWF recently implemented an Extended Kalman Filter (EKF) soil moisture analysis. The EKF soil moisture analysis is presented as well as its recent developments to use active (ASCAT) and passive (SMOS) microwave satellite data. ASCAT soil moisture data assimilation results are presented and the impact on soil moisture analysis and on lowest atmospheric level parameter forecast is shown. The ECMWF land surface data assimilation system is designed to combine different sources of information, from SYNOP ground data and from satellite sensors, to correct the model state variables. It is well suited to use future satellite data, such as Soil Moisture Active and Passive (SMAP) data.	

31. A microwave land data assimilation system: Scheme and preliminary evaluation over China	
Author：	Xiangjun Tian,1 Zhenghui Xie,1 Aiguo Dai,2 Binghao Jia,3 and Chunxiang Shi4

Affiliation：	IAP/CAS

To make use of satellite microwave observations for estimating soil moisture, a dual pass land data assimilation system (DLDAS) is developed in this paper by incorporating a dual pass assimilation framework into the Community Land Model version 3 (CLM3). In the DLDAS, the model state (volumetric soil moisture content) and model parameters are jointly optimized using the gridded Advanced Microwave Scanning Radiometer EOS (AMSR-E) satellite brightness temperature (Tb) data through a radiative transfer model (RTM), which acts as an observation operator to provide a link between the model states and the observational variable (i.e., Tb). The DLDAS embeds a state assimilation pass and a parameter calibration pass. In the assimilation pass, the whole soil moisture profiles are assimilated from the Tb data using an ensemble based four dimensional variational assimilation method (En4DVar). Simultaneously, several key parameters in the RTM are also optimized using the ensemble Proper Orthogonal Decomposition based parameter calibration approach (EnPOD_P) in the parameter optimization pass to account for their high variability or uncertainty. To quantify the impacts of the Tb assimilation on CLM3â€

were run separately over China on a 0.5Â° grid forced wit identical, observation based atmospheric forcing from 2004 to 2008. Soil moisture data from 226 stations over China are averaged over seven different climate divisions and compared with the soil moisture from the Sim and Ass runs. It is found that the assimilation of the AMSRâ€

within the top 10 cm with reduced mean biases and enhanced correlations with the station data in all divisions except for southwest China, where the current satellite sensors may have difficulties in measuring soil moisture due to the dense vegetation and complex terrain over this region. The results suggest that the AMSRâ€

data can be used to improve soil moisture simulations over many regions and the DLDAS is a promising new tool for estimating soil moisture content from satellite Tb data.

32. Development and evaluation of a dual-pass land data assimilation system

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Assimilating satellite data into a hydrological model or a land surface model is a promising tool to improve our understanding to land hydrology at regional scales. China comprises a number of geographic elements, from the Tibetan Plateau and deserts in the West China to the lowland and humid regions in the East China. It is challenging to develop a LDAS applicable for China territory, due to its diverse climate regimes and land use. This paper first briefly introduces a dual-pass data assimilation system developed by the authors, including the following four aspects.

(1) Dual-pass LDAS. This LDAS assimilates AMSR-E brightness temperature of vertical polarization of 6.9 GHz and 18.7 GHz. The system consists of a land surface model (improved SiB2) used to calculate surface fluxes and soil moisture, a radiative transfer model (Q-h model) to estimate the microwave brightness temperature, and an optimization scheme to search for optimal values of soil moisture by minimizing the difference between modeled and observed brightness temperature. In the dual-pass assimilation system, Pass 1 inversely estimates the optimal values of several model parameters with long-term (~months) forcing data and brightness temperature data, while Pass 2 estimates the near-surface soil moisture in a daily assimilation cycle.

(2) LDAS validation. This system was tested at two CEOP reference sites, respectively, on the Tibetan Plateau and Mongolian Plateau. The applications show that simulations of soil moisture and the surface energy budget were improved compared with the case without assimilation, and the soil moisture and energy partition after assimilation is less contaminated by negative biases in input precipitation data.

(3) LDAS forcing data. To facilitate the application of the LDAS, we developed a high-resolution (0.25 deg, 3-hr), long-term (1981-2008) forcing data for the mainland of China. The new forcing data set is a fusion of global satellite products (GEWERX-SRB, TRMM rainfall) and global forcing data (Princeton data, GLDAS) with surface observations at 716 CMA (China Meteorological Administration) stations. As far as we know, this is the first forcing data set based on CMA observations and specifically developed for China. This data set has been applied to drive the LDAS and soil moisture maps for the mainland of China have been available.

(4) Soil moisture observing network. To validate LDASs and remote sensed soil moisture, a soil moisture and temperature observing network was constructed in a mesoscale region (100km by 100km) of central Tibetan Plateau in 2010-2011. The network is composed of 52 sites, and each of them has 4-levels of soil moisture and temperature sensors located at 0-5 cm, 10, 20, and 40 cm soil depths, respectively.

References:

(1) Yang, K. et al. 2009: Validation of a dual-pass microwave land data assimilation system for estimating surface soil moisture in semi-arid regions, JHM, 10, 780-794.

(2) Yang, K. et al. 2007: An auto-calibration system to assimilate AMSR-E data into a land surface model for estimating soil moisture and surface energy Budget, JMSJ, 85A, 229-242.

33. China land soil moisture EnKF data assimilation based on satellite remote sensing data

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Soil moisture plays an important role in land-atmosphere interactions. It is an important geophysical parameter in research on climate, hydrology, agriculture, and forestry. Soil moisture has important climatic effects by influencing ground evapotranspiration, runoff, surface reflectivity, surface emissivity, surface sensible heat and latent heat flux. At the global scale, the extent of its influence on the atmosphere is second only to that of sea surface temperature. At the terrestrial scale, its influence is even greater than that of sea surface temperatures. This paper presents a China Land Soil Moisture Data Assimilation System (CLSMDAS) based on EnKF and land process models, and results of the application of this system in the China Land Soil Moisture Data Assimilation tests. CLSMDAS is comprised of the following components: 1) A land process modelÃ¢ï¿½ï¿½ Community Land Model Version 3.0 (CLM3.0)Ã¢ï¿½ï¿½developed by the US National Center for Atmospheric Research (NCAR); 2) Precipitation of atmospheric forcing data and surface-incident solar radiation data come from hourly outputs of the FY2 geostationary meteorological satellite; 3) EnKF (Ensemble Kalman Filter) land data assimilation method; and 4) Observation data including satellite-inverted soil moisture outputs of the AMSR-E satellite and surface soil moisture observation data. Results of soil moisture assimilation tests from June to September 2006 were analyzed with CLSMDAS. Both simulation and assimilation results of the land model reflected reasonably the temporal-spatial distribution of soil moisture. The assimilated soil moisture distribution matches very well with severe summer droughts in Chongqing and Sichuan Province in August 2006, the worst since the foundation of the PeopleÃ¢ï¿½ï¿½s Republic of China in 1949. It also matches drought regions that occurred in eastern Hubei and southern Guangxi in September. EnKF land data assimilation, AMSR-E soil moisture, Fy2C stationary satellite, high-resolution precipitation, surface incident solar radiation	

	34. Assessing Soil Moisture Impacts on GFS Forecasts via Assimilating Observations from AMSR-E, MWRI and SMOS Observations
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Using Kalman filters for hydrological data assimilation has been investigated for more than a decade. Many land surface observational data sets, such as land surface skin temperature (LST) and soil moisture (SM), have been made available from various research and operational satellites. Efforts for coupling NASA Land Information System (LIS) with the North America Mesoscale (NAM) model at NOAA-NCEP for using the ensemble Kalman filter (EnKF) data assimilation utilities to assimilate land observations have been ongoing. However, none of the available satellite soil moisture or surface temperature data products has been assimilated into the operational weather and climate prediction models at NOAA-NCEP. This study attempts to implement the Ensemble Kalman filter (EnKF) to the NCEP Global Forecast System (GFS) for assimilating the AMSR-E, MWRI, and SMOS soil moisture observations. This attempt implements an online soil moisture data assimilation rather than the offline data assimilation strategy using LIS, and tests the implementation using soil moisture observational data from AMSR-E, MWRI and SMOS. The AMSR-E soil moisture data are generated with NOAA's Soil Moisture Product System while SMOS soil moisture data are obtained from ESA SMOS team. The benefits and uncertainties of assimilating the satellite data products in GFS are examined by comparing the GFS forecasts of surface temperature and rainfall with and without the assimilation. The next step toward operationally assimilating soil moisture and other land observations into GFS will also be discussed.

35. Assimilation of High Resolution MODIS Snow Cover Data into the LIS Noah and SAC-HT/SNOW17 Models over the Continental United States (CONUS)

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In the western United States, over half of the water supply is derived from mountain snowmelt. In many mid latitude and high altitude regions, the snow delays runoff and provides water in the spring and summer when it is needed most. Therefore, accurate knowledge of snowpack properties is important for short-term weather forecasts, climate change prediction, and hydrologic forecasting.

As both the model predictions and passive microwave snow water equivalent (SWE) observations contain large errors due to land surface complexities and temporally frequent snowmelt processes in the western United States, the 500-m daily MODIS snow cover area (SCA) product has been used in this study as an important constraint on snowpack processes in land surface and hydrological models. The uncertainty in the MODIS SCA product has been assessed over some selected regions, and quality control will be applied to the MODIS SCA product before it is assimilated into the SNOW17 model.

In this study, we assimilate the MODIS derived snow cover fraction (SCF) into the LIS Noah land surface and SAC-HT/SNOW17 hydrological models operating on the HRAP (Hydrologic Rainfall Analysis Project) grid at 4.7625-km resolution over the test regions and potential over the entire CONUS. To avoid cloud contamination, we update the snow cover fraction at pixels which feature less than 50% cloud coverage. Because the change in snow cover fraction makes no change to the amount of SWE in the SNOW17 module, we have developed a new scheme to account for the effect of a change in snow cover fraction to total SWE. We select the traditional bisection method to study this inverse problem, and perform a series of tests to assess the assimilation algorithm performance. Multi-year model simulations with and without MODIS SCF assimilation are presented, and evaluated with in-situ SWE observations and stream flow records.

<u>Session 6</u>: Surface parameter retrieval: LST, snow and ocean color

Session Chair: Yihong Duan

36. All-weather estimates of the land surface skin temperatures from combined analyses of microwave and infrared satellite observations	
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The surface skin temperature (Ts) is a key parameter at the land-atmosphere interface. Upwelling longwave radiation directly depends upon Ts. Energy exchanges at the landsurface boundary are largely controlled by the difference between Ts and the surface air temperature, the air and the surface reacting with different time and space scales to external forcing while still being complexly interconnected. Global datasets of Ts are traditionally estimated from satellite infrared radiance observations, under clear sky conditions. First, the inter-comparison of different IR land surface temperature satellite datasets (ISCCP, MODIS, and AIRS) are presented, along with an evaluation with in situ measurements at selected stations archived during CEOP (Coordinated Enhanced Observing Period). The objective is to assess the accuracy of the Ts estimates, and to evidence the major error sources in the retrieval. Both the Ts and the radiance at the top of the atmospheres are evaluated, to potentially separate the contribution of the calibration and algorithm errors in the Ts estimates. Results show that the major sources of differences between the different satellite products come from instrument calibration differences, especially for high Ts, followed by the impact of the water vapor treatment in the algorithm, and the differences in surface emissivities [1]. The main limitation of satellite infrared measurements of Ts is their inability to penetrate clouds, limiting them to clear conditions. Microwave wavelengths, being much less affected by clouds than the infrared, are an attractive alternative in cloudy regions as they can be used to derive an all-sky skin Ts product. A neural network inversion scheme has been developed to retrieve surface Ts along with Ts also atmospheric water vapor, cloud liquid water, and surface emissivities over land from a combined analysis of Special Sensor Microwave /Imager (SSM/I) and International Satellite Cloud Climatology Project (ISCCP) data [2]. The retrieval scheme uses first guess information to better constrain the inversion problem, and provides along with the retrieved parameters an estimate of the retrieval error by judging the closeness between observed SSM/I radiances and the simulated radiances corresponding to the retrieved atmospheric state. In the absence of routine in situ Ts measurements, retrieved all-weather Ts values are first evaluated globally by comparison to the surface air temperature (Tair) measured by the meteorological station network [3]. The Ts-Tair difference from the global comparisons showed all the expected variations with solar flux, soil characteristics, and cloudiness. During daytime the Ts-Tair difference is driven by the solar insulation, with positive differences that increase with increasing solar flux. With decreasing soil and vegetation moisture, the evaporation rate decreases, increasing the sensible heat flux, thus requiring larger Ts-Tair differences. Nighttime Ts-Tair differences are governed by the longwave radiation balance, with Ts usually closer or lower than Tair. The presence of clouds dampens all the difference. The Ts evaluation has been recently extended locally at a few sites by using the Ts in-situ measurements from several CEOP stations representing different biomes. The ISCCP infrared Ts estimates, the derived microwave Ts, and a different microwave Ts estimate obtained by a linear regression with the 37 GHz measured radiances [4], are compared for selected months in 2003. Under clear sky conditions, the quality of our microwave neural network retrieval is equivalent to the infrared ISCCP products, for most in situ stations. For a given location, the performance of the microwave algorithm is similar under clear and cloudy conditions, confirming the potential of the microwave Ts retrieval under clouds. The accuracy of the Ts estimate does not depend upon the surface emissivity, as the variability of this parameter is accounted for in the processing. Our microwave Ts estimates have been calculated for more than 15 years (1993-2008). These “all weather” Ts estimates are a very valuable complement to the IR-derived Ts, for use in atmospheric and surface models. [5]

[1] Jimenez, C., C. Prigent, J. Catherinot, W. B. Rossow, Comparison of AIRS, MODIS, and ISCCP land surface températures, to be submitted to GRL, 2011.

[2] Aires, F., C. Prigent, W. B. Rossow, M. Rothstein, A new neural network approach including first-guess for retrieval of atmospheric water vapor, cloud liquid water path, surface temperature and emissivities over land from satellite microwave observations, J. Geophys. Res., 106, 14 887-14 907, 2001.

[3] Prigent, C., F. Aires, and W. B. Rossow, Land surface skin temperatures from a combined analysis of microwave and infrared satellite observations for an all-weather evaluation of the differences between air and skin temperatures, J. Geophys. Res., 108, 4310-4321, 2003.

[4] Holmes, T. R. H., R. A. M. De Jeu, M. Owe, and A. J. Dolman, Land surface temperature from Ka band (37 GHz) passive microwave observations, J. Geophys. Res., 114, D04113, doi:10.1029/2008JD010257, 2009.

[5] Catherinot, J., C. Prigent, R. Maurer, F. Papa, C. Jimenez, F. Aires, W. B. Rossow, Evaluation of ’all weather’ microwave-derived land surface temperatures with in situ CEOP measurements, submitted to JGR, 2011.

37. Land Surface Temperatures from AMSR-E with an Emissivity Database

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Land surface temperature (LST) has been retrieved from AMSR-E microwave data. A monthly emissivity database built from clear-sky AMSR-E brightness temperature and MODIS LST measurements provides the background surface emissivity, and NCEP atmospheric profiles are used in the RT retrieval. Over vegetated areas where sub-surface penetration at low microwave frequencies can be considered negligible, LST is derived from AMSR-E 10.65-GHz V-polarization data. Over arid or sub-arid areas, LST is derived from 89-GHz channels and water vapor is retrieved simultaneously, since 89-GHz channels are the least penetrating and the effective emitting temperature is closest (among the AMSR-E channels) to the surface skin temperature. We retrieve day and night LST (at about 13:30 and 01:30 local time) daily on a fixed 28-km sinusoidal earth grid, and monthly-averaged LST database is computed from the days where the surface emissive properties are considered stable and representable by the emissivity database. MODIS produces monthly infrared (IR) LST estimates, but IR-derived LST data are produced in clear conditions only and are sometimes contaminated by undetected clouds or aerosols. We compared monthly-averaged day and night LST, as well as mean day-night temperature difference produced by AMSR-E and MODIS. In particular, we are interested in quantifying the impact of various sources of bias in IR estimates on spatially/temporally averaged product and providing some estimates of the accuracy of the MW and IR products compared to in-situ air temperature measurements. The emissivity database was generated with MODIS V4 LST product, the latest V5 algorithm incorporating in particular improved cloud flags was available afterward, in this study, we also compare MODIS V4 and V5 LST. The comparison of global database shows the MODIS V5 LST quality flagging is much less conservative than the V4 flagging, however, their differences from AMSR-E LST have roughly the same monthly statistics, which indicates the samples flagged as high quality in V5 may contain significant cloud contamination. The temporal averaged (i.e., monthly) IR LST is often biased toward the clearest part of that time period, and the bias is the largest in regions that are often cloudy. Over cloud-persistent regions such as the Amazon, where MODIS LST is unavailable, AMSR-E provides continuous accurate day and night measurements, as verified against the in-situ measurements. Microwave observations, although they are inherently limited by the low spatial resolution (of the order of a few tens of km) have the advantage over the IR that they are much less sensitive to clouds. Therefore they provide almost seamless time coverage at any given location, providing estimates under both clear and cloudy phases (outside of precipitation), and are immune to errors in cloud/aerosol detection schemes used to identify clear areas. The latter characteristics make the microwave observations potentially useful for quality control of the IR estimates.

38. A Simplified Approach for Measuring Land Surface Temperature and Emissivity Simultaneously Using Thermal Infrared Channels

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Accurate derivations of land surface temperature (LST) and land surface emissivity (LSE) from satellite measurements are difficult tasks mainly because they are closely coupled. Features of significant/insignificant temporal variation of LST/LSE are recognized to de-couple the LST and LSE values using multiple-temporal satellite observations over a same geolocation. In this study, a new approach is presented for deriving LST and LSE simultaneously by utilization of the multiple-temporal satellite observations. Two split-window regression LST formulas are carefully selected for the approach; and two satellite observations over a same geolocation within a certain time period are utilized. The method is particularly applicable to geostationary satellite missions in which qualified multiple-temporal observations are easy to obtain. The approach is designed and implemented for generating the LST and LSE values from the U.S. Geostationary Operational Environmental Satellite (GOES) 8 Imager data and the Spinning Enhanced Visible and Infrared Imager (SEVIRI) data. The retrieval results are evaluated using ground truth observations from the U.S. Atmospheric Radiation Measurement (ARM) facility. It is shown that the method is feasible in principle as well as in practice. The method is applicable to the U.S. GOES-R mission and the European Meteosat Second Generation (MSG) mission considering that the Advanced Baseline Imager (ABI) onboard the GOES-R satellite and the SEVIRI onboard the MSG satellite have the similar split-window bands.

39. Using Satellite Data for Global Surface Monitoring

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Surface skin temperature and emissivity derived from the current and future operational satellites can and will reveal critical information on the Earth's ecosystem and land surface type properties. Presented here is the global surface IR emissivity and skin temperature retrieved from IASI measurements under \"clear-sky\" conditions. We are to demonstrate that surface emissivity and skin temperature from satellite IASI measurements can be used in assistance of monitoring global change. Monthly surface emissivity and temperature with a spatial resolution of 0.5x0.5 degrees of latitude-longitude are produced with temporal variation to indicate seasonal diversity of global surface emissivity and temperature. Global surface monitoring over more than 4 years IASI measurements is under investigation. It is attempted deriving a trend as the measurements continuously provided.

40. Assessing soil hydraulic parameter retrieval from Land Surface Models using surface data

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The water and energy fluxes at the land-atmosphere interface depend heavily on the soil moisture content, which imposes a significant control on evaporation, infiltration and runoff. Moreover, the rate of water uptake in the vadose zone by vegetation is regulated by the soil moisture content. Thus soil moisture plays an essential role in most scientific disciplines related to environmental science.Nonetheless, soil moisture evolution is not easy to measure or monitor at large scales due to the spatial variability of the subsurface hydraulic characteristics, which are driven by the local variation in soil properties. As a consequence, soil moisture dynamics are generally estimated using land surface models, with model parameters based on large scale soil property maps, which include significant uncertainty. Extrapolation of soil parameters using pedotransfer functions over large areas yields crude estimates of soil hydraulic properties with large standard deviations, and hence the use of this data deteriorates the accuracy of the model simulations. Conversely, remote sensing techniques using satellite and airborne sensors which are able to supply a long time series of data in near-real time over wide areas, offer a novel approach to estimating soil hydraulic properties with high spatial resolution. This data can be harmoniously used with model simulations and observed surface soil moisture data for the estimation of soil hydraulic properties with high spatial resolution. Hence to retrieve soil hydraulic parameters using the remotely sensed surface soil moisture information, it is necessary to indentify a land surface model that best suits the requirements of this problem. A large number of land surface models exist, most of which include differing characteristics and model physics. This study is an assessment of soil hydraulic parameter retrieval capability of two prominent land surface models from surface soil moisture observations, the Community Atmosphere Biosphere Land Exchange (CABLE) model and the Joint UK Land Exchange Simulator (JULES). To achieve the objective, the study was conducted in two steps; (a) identifying the soil parameters which have the greatest impact on soil moisture evolution and (b) assessing the capability of the model to retrieve such parameters. A range of sensitivity studies were performed on both of these land surface models using the parameter sensitivity index (S) to identify the model parameters with the highest impact on soil moisture prediction. Subsequently, a set of ‘true’ parameters were used to derive the ‘true’ soil moisture dynamics. The parameter values found to be observable from surface soil moisture observation sensitivity analysis were then changed to 'best guess’ values, and the model parameter values optimized by matching predicted near-surface soil moisture with those from the 'truth run'. Parameter retrieval capability was assessed for both land surface models, based on comparison with the ‘true’ soil parameters, deeper layer soil moisture estimation and replication of field observed soil moisture profile data. Both models captured the wetting and drying trends of the real-world scenario but over-estimated the soil moisture after wet-up periods for the near-surface layers and under-estimated the moisture for deeper layers.

41. NESDIS Global Soil Moisture Operational Products System (SMOPS): Development, Validation and Applications

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Soil moisture has long been recognized as one of the critical land surface initial conditions for numerical weather, climate, and hydrological predictions, particularly for transitional zones between arid and humid climate regions. However, none of the currently existing soil moisture data products has been used operationally in these models because of their accuracy or reliability issues. A climatologically consistent and qualitatively reliable global soil moisture product, is thus in urgent need to improve the weather, climate and hydrological predictions. To meet this data need and make good use of the observations of the existing and future satellite microwave sensors, such as the Advanced Microwave Scanning Radiometer (AMSR-E) on NASA EOS Aqua satellite, the Soil Moisture and Ocean Salinity mission of ESA, the Advanced Scatterometer (ASCAT) on Metop satellites of EUMETSAT, and Soil Moisture Active/Passive mission (SMAP) of NASA, NOAA-NESDIS is developing a Global Soil Moisture Product System (SMOPS).This paper will present the SMOPS design, retrieval algorithm and validation of the SMOPS data products against available in situ soil moisture observations at locations around the, globe. Using SMOPS to generate global soil moisture data products from the Microwave' Radiometric Imager (MWRI) on Fengyun-3 satellite of China Meteorological Administration and the upcoming AMSR2 on the GCOM-W satellite of Japan Aerospace Exploration Agency (JAXA) will be discussed. Assimilation of the SMOPS data products in NOAA NCEP Global Forecast System will also be introduced

42. Multiresolution data classification for land surface properties retrieval

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Understanding and predicting the impact of surface processes on climate required accurate mapping of land cover and measurements of land cover conversions. Some of the land cover may exactly be the land surface properties, such as snow cover (Masson et al., 2003); while in many other cases land cover is necessary for other surface parameters retrieval, e.g. retrieving LAI depends on different land cover types (Chen & Cihlar, 1996). There seems to be a trade off in terms of spatial and temporal resolution which blocks the precisely and effectively mapping land cover from currently available multispectral satellite imagery. Either of high spatial but low temporal resolution or low spatial but high temporal resolution can be achieved (Munyati & Ratshibvumo, 2010; Gao et al., 2006), such as MODIS and TM/ETM plus image. In addition, traditional mapping approaches using per-pixel classifications have not generated consistently satisfactory results (Liu et al., 2006).

This paper tried to map land cover distribution for land surface properties retrieval by combining multi resolution data, in terms of both spatial and temporal resolution, plus spatial contextual information. The support vector a machine (SVM) (Vapnik, 1995) was used to classify the multi-temporal. The SVM probability was used to initialize a spectral classification result for each individual pixel. The spatial contextual information is expressed based on Markov random fields (MRFs) theory (Geman & Geman 1984). Through MRFs and Maximum a posteriori, the classification task becomes minimizing an energy function associated with the spectral and spatial information, which can be solved by the iterated conditional modes (ICM) algorithm (Dubes & Jain, 1989).

The study area located at a boreal forest area near Sudbury, Ontario, Canada. The TM data was collected at September 2008, while the MODIS data series (nadir BRDF-adjusted reflectance data based on the MODIS BRDF/albedo product (Lucht et al., 2000; Schaaf et al., 2002) was used since MODIS instrument views the earthâ€™s surface from a range of view zenith angles) was from April to October in the growing season of the boreal forest. Five cover types (mature coniferous, deciduous, and regrowth forests, and water and rocky/road areas) was separated by the proposed the classification method. The mapping result was validated based on an independent sample at the research area. Samples were selected by stratified random sampling, observed land cover for which was determined from high spatial resolution data of the Google Earth. The overall accuracy and error matrix of the map result show that the temporal information even in a low resolution with a large resolution ratio to the high resolution data still improves the classification result and additional accuracy was added by introducing the spatial information.

43. Perspectives of Using MODIS and VIIRS Observations on Snow Fraction for Modeling Surface Properties

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Snow cover dramatically influences the processes of land-atmosphere interaction as well as retrieval of various atmosphere and land products, which explains an increasing interest to implementation of remote sensing information on snow cover in a wide range of applications including data assimilation and radiative transfer models. Recent changes in data assimilation introduced the Northern Hemisphere snow analysis created on the basis of remote sensing into the global European Center for Medium-Range Weather Forecasts (ECMWF) model. The progress in the development of Community Radiative Transfer Model (CRTM) included modeling of multi-layer snow emissivity depending on snow properties More realistic description of surface properties includes allowing for fractional snow cover in cells (grid boxes) especially significant for the period of melting. The National Polar-Orbiting Environmental Satellite System (NPOESS) Preparatory Project (NPP) and the Joint Polar Satellite System (JPSS) will generate snow cover Environmental Data Records (EDR), including fractional snow cover, from the Visible Infrared Radiometer Suite (VIIRS) instrument. It has been decided to develop improved VIIRS fractional snow cover algorithm for NPP on the basis of the heritage Moderate Resolution Imaging Spectroradiometer (MODIS) algorithm currently routinely employed to generate fractional snow cover. A central feature of the MODIS snow cover algorithms is the Normalized Difference Snow Index (NDSI). Salomonson and Appel demonstrated that the NDSI approach could be extended to calculate the fraction of snow cover in a pixel and showed that a NDSI based regression technique provided fairly robust determination of the fraction of snow cover within 500 m cells. The task of snow remote sensing is significantly complicated by variability of natural conditions. Improved snow cover retrieval is achievable by an algorithm that takes into account the variability in space and time of snow and non-snow spectral signatures. The enhancement could be made by employing scene-specific parameters characterizing local properties of snow and non-snow spectral endmembers.Proper validation is a critically important means to develop snow cover retrieval. Daily snow depth data acquired from more than 1000 World Meteorological Organization (WMO) stations and approximately 1500 US Cooperative stations are currently used to estimate the accuracy of snow derivation from simulated VIIRS observations. Another method implemented to analyze the performance of snow algorithms utilizes high-resolution observations as an effective source of ground truth information. The results of validation valuable to tune algorithms for better performance confirm that the development of scene-based algorithms suppressing sensitivity to viewing geometry, illumination, snow, and non-snow cover conditions is a very powerful way to significantly improve the accuracy of fractional snow cover derivation.

44. NOAA's Operational Ocean Color Products from the CoastWatch Okeanos System: Product Overview and Characteristic Analysis	
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Ocean Color (OC) is the water hue due to the presence of tiny plants containing the pigment chlorophyll, sediments, and colored dissolved organic material (DOM). Its observations from space can be used to monitor the variability of marine primary productivity and the occurrence of harmful algal blooms. Since 2006, a series of OC operational products have been created from multiple satellite sensors in the NOAA CoastWatch (CW) Okeanos system, which is a flexible, expandable software system for generating ocean color products using NOAA and NASA OC algorithms. Product type, coverage, and application in ecosystem management will be discussed. The current OC products include daily chlorophyll concentration (anomaly), water turbidity, and remote sensing reflectance from Moderate-resolution Imaging Spectroradiometer (MODIS)/Aqua and MEdium Resolution Imaging Spectrometer (MERIS)/Envisat. The products will be extended to NPP and JPSS Visible/Infrared Imager Radiometer Suite (VIIRS) and other upcoming ocean color sensors in the next few years. These products have been widely applied to USA local and state ecosystem research, ecosystem observations, and fisheries managements for coastal and regional forecasting of ocean water quality, phytoplankton concentrations, and primary production. For example, the chlorophyll concentration product has been used to predict harmful algal blooms in the Gulf of Mexico by the NOAA Center for Operational Oceanographic Products and Services (CO-OPS) (http://tidesandcurrents.noaa.gov/hab/).

Water-leaving radiance emanating from chlorophyll and other colored DOM also plays an important role in satellite data assimilation systems because it can be up to 10 % of satellite-observed radiance in the visible channels (Li et al, presentation at this workshop). However, the OC products haven't been assimilated into Numerical Weather Prediction (NWP) models. To help modelers understand the potential of OC products, temporal and spatial characteristics further explored for MODIS/Aqua derived chlorophyll concentrations over the thirteen CW regions (e.g., Gulf of Mexico, Chesapeake Bay, Eastern Tropical Pacific, Great Lakes, etc). The resultant changes in ocean remote sensing reflectance at visible and NIR channels from changeable chlorophyll concentrations are also estimated using a bio-optical model. This analysis can provide useful information for the improvement of the JCSDA Community Radiative Transfer Model (CRTM) and the assimilation of OC products into NWP models.

45. An Assessment of Ocean Color Contribution to Satellite Radiance: Implication for Ocean Color Assimilation

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Ocean Color (OC) is the water hue due to the presence of tiny plants containing chlorophyll pigments, sediments containing inorganic particulate matter (IPM), and colored dissolved organic material (CDOM). The upwelling OC radiance due to scattering from chlorophyll-containing particles and IPM will contribute to satellite radiance observations at visible (both over open ocean and coastal areas) and Near-InfraRed (NIR) (primarily over coastal areas) wavelengths. How much of the observed satellite radiance comes from the ocean? Can ocean color (OC) signals be assumed to be constant when satellite ocean color observation data are assimilated into numerical weather prediction systems? In this presentation, the contribution of the OC radiance to satellite observations is assessed using a coupled atmosphere-ocean radiative transfer model (Stamnes et al., presentation at this workshop). Results from a sensitivity study will be reported that quantify how the satellite radiance varies with the amount of chlorophyll, IPM, and CDOM in the water. To understand the significance of using realistic ocean color data in assimilation of satellite OC radiances, the difference between the satellite-observed radiance and the model-computed radiance using retrieved atmosphere-ocean parameters is also analyzed. These retrieved parameters are obtained from an inversion scheme that employs the coupled atmosphere-ocean radiative transfer model to simulate satellite-measured radiances. MERIS (the Medium Resolution Imaging Spectrometer on Envisat) images over the Santa Barbara Channel (SBC) and the North Sea will be used in study.

In contrast to traditional decoupled OC retrieval algorithms that rely on atmospheric corrections, the coupled atmosphere-ocean forward/inverse radiative transfer approach provides a direct link between the OC products and the satellite radiances, thereby making OC data assimilation possible. We can apply this coupled forward radiative transfer model in conjunction with standard nonlinear optimal estimation for simultaneous retrieval of aerosol and marine parameters (*Li et al., Int. J. Rem. Sens., 29, 5689-5698, 2008*) as well as for system error analysis (to quantify the difference between satellite-observed and model-simulated radiances based on the retrieval parameters). This forward/inverse modeling approach has been successfully applied to different satellite sensor data, including SeaWiFS, MODIS, and MERIS data. Further, we will show how this approach could also be applied to existing ocean color products derived from decoupled OC retrieval algorithms.

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