CONTRIBUTED TALKS

SESSION 1:

T1.1 "Towards understanding the sources of gravity waves at mid and high latitudes using COSMIC GPS temperature data." by Sergeï Khaykin

T1.2 "Wind at high altitude: Analyze and comparisons between high altitude (25 km-40 km) wind measurements deduced from balloon borne flights and ERA-Interim Re-analysis." by **Fabrice Duruisseau,** N. Huret, A. Andral

T1.3 "Links between mesopause temperatures and ground-based VLF narrowband radio signals" by **Israel Silber,** Colin Price, Craig J. Rodger, Christos Haldoupis

T1.4 "Atmospheric Wave Observations with the E-Region Wind Interferometer" by **Samuel Kristoffersen,** Alexis Le Pichon

SESSION 2:

T2.1 "Potential Impacts of ARISE Measurement Techniques on Weather Forecasts" by **Christopher F. Lee,** Claud Chantal

T2.2 "Gravity Wave Observations using an All Sky Imager situated at the Polar Environment Atmospheric Research Laboratory at Eureka, Canada (80 N)" by **Chris Vail,** William Ward

T2.3 "Gravity wave momentum flux variability in the high latitude northern hemisphere winter mesosphere/lower thermosphere" by **Rosmarie J. de Wit,** R.E. Hibbins, P.J. Espy

T2.4 "Planetary wave structure in the MLT derived from a chain of northern hemispheric Super DARN radars" by **Nora H. Kleinknecht,** Patrick J. Espy, Robert E. Hibbins

SESSION 3:

T3.1 "Passive monitoring of Mt Etna volcano to probe the upper atmosphere" by **Jelle Assink,** Alexis Le Pichon, Elisabeth Blanc

T3.2 "Infrasonic signature: a new way of monitoring sudden stratospheric warmings" by **Pieter Smets,** Läslo Evers, Kees Wapenaar

T3.3 "Remote infrasound monitoring of Mount Etna: Observed and predicted network detection capability" by **Dorianne Tailpied,** A. Le Pichon, E. Marchetti, M. Ripepe, M. Kallel, L. Ceranna

T3.4 "Thunderstorm simulation over the OHP, using the WRF model" by **Lorenzo Costantino,** Heinrich

SESSION 1

Towards understanding the sources of gravity waves at mid and high latitudes using COSMIC GPS temperature data.

Abstract No.: **T1.1** Authors: **Sergeï Khaykin**

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Wind at high altitude: Analyze and comparisons between high altitude (25 km-40 km) wind measurements deduced from balloon borne flights and ERA-Interim Re-analysis.

Abstract No.: **T1.2** Authors: **Fabrice Duruisseau,** N. Huret, A. Andral

This study is motivated by the improvement of balloon trajectory forecasts, the knowledge of the vertical variability of the wind at high altitude and the evaluation of the ability of models to represent this variability. To do that, 327 balloons (opened stratospheric balloons operated by CNES agency) flights trajectories were retrieved from 1989 to 2011. Balloons are considered as perfect tracers at high altitude. We deduce from the trajectories zonal and meridional wind to provide a unique database in the stratospheric range 25-40 km. The collected data covers various seasons and different locations: Polar region (launch base at Kiruna (67.9°lat, 23.1°lon)) mid-latitudes (Gap (44.4°lat, 6.0°lon) and Aire-sur-Adour (43.7°lat, -0.25°lon) in France) and Tropics (Hawaii (19.1°lat, -155.8°lon), Teresina (-5.1°lat, -42.9°lon) and Bauru (-22.4°lat, -49.0°lon) in Brazil, Niamey (13.5°lat, 2.1°lon) in Niger). We can explore the wind variability as a function of geophysical conditions: polar vortex, spring and summer turn around in polar region, mid-latitude circulation in spring and autumn, and in the tropic East and West phase of the Quasi Biennale Oscillation.
We extract wind, geopotential height, pressure and temperature fields from Era-interim re-analyses every 6 hours and interpolate the model results on each exact time/location of measurements. Results obtained on the comparisons between model and measurements highlight bias in Era-Interim wind fields that will be presented.

Winds at high levels appear to be more variable in direction and intensity than those calculated by the model. Winds are distributed in layers with thickness sometimes lower than 100 m. To investigate the wind variability as a function of altitude we develop a method to determine the characteristics of those layers in wind direction and intensity and their distributions as a function of the geophysical conditions.

Links between mesopause temperatures and ground-based VLF narrowband radio signals.

Abstract No.: **T1.3** Authors: **Israel Silber,** Colin Price, Craig J. Rodger, Christos Haldoupis

The Upper Mesosphere-Lower Thermosphere (UMLT) region of the atmosphere is known to vary on many temporal and spatial scales. However, this region of the atmosphere is very difficult to measure and monitor continuously. In this paper we demonstrate an intriguing connection between mesopause temperatures and the intensity of Very Low Frequencies (VLF) narrowband (NB) signals reflected off the lower ionosphere. The temperature data used are from the SABER instrument on-board the TIMED satellite, while the VLF data are obtained from various ground-based receiving systems. The results of the analysis show a high anti-correlation between temperature and VLF amplitude. It is shown that the variability of the UMLT temperatures and VLF amplitudes can be explained by global seasonal solar irradiance changes (~72% of the variability), while the remaining variability has its origins from other sources (~28%). High resolution mesopause temperature estimates might be achieved in the future by combining VLF NB observations and calculated solar irradiance variability (as a function of hour, day, and location, i.e., latitude).

Atmospheric Wave Observations with the E-Region Wind Interferometer.

Abstract No.: **T1.4** Authors: **Samuel Kristoffersen,** Alexis Le Pichon

The E-Region Wind Interferometer (ERWIN) has been operating at the Polar Environment Atmospheric Research Laboratory (PEARL), located in Eureka, Nunavut (80N 86 W), since 2008. ERWIN measures mesospheric winds by detecting Doppler shifts in three airglow layers (green line – 557.7 nm, O2 – 860 nm, and OH – 843 nm). Through use of a quad mirror in the optical train, winds from the four cardinal directions (at an elevation of 38.7 degrees) and the zenith are measured simultaneously, resulting in a final observational cadence of ~3 minutes, with a wind precision of ~2 m/s. This high temporal resolution allows for the determination of both lower frequency waves (e.g. tides), and higher frequency waves (e.g. gravity waves). Gravity wave observations will be presented, as well as, vertical wind observations and comparisons with the irradiance.

SESSION 2

Potential Impacts of ARISE Measurement Techniques on Weather Forecasts.

Abstract No.: **T2.1** Authors: **Christopher F. Lee,** Claud Chantal

This study examines the potential impact that ARISE measurements could have on numerical weather prediction. The particular focus is on the upper stratosphere, where routine measurements of temperature and winds are sparse. The experiments in this study use an idealized general circulation model (the HADGEM2 Met Office Unified Model - UM), to investigate the impact of constraining forecasts with ARISE observations. In this study, the forecasting procedure is replicated using an ensemble of model runs about a ‘true’ atmospheric state (a free-model run that has not been altered). The assimilation of ARISE network measurements is replicated by re-running these ensembles, with some nudging towards the true state. The improvement in predictability offered by ARISE observations is judged by comparing nudged and un-nudged ensembles. Of particular interest are the onset and evolution of stratospheric sudden warmings. Existing ARISE observations, for example, have shown that models can struggle to replicate upper stratosphere temperatures in the wake of a vortex split.

Gravity Wave Observations using an All Sky Imager situated at the Polar Environment Atmospheric Research Laboratory at Eureka, Canada (80 N).

Abstract No.: **T2.2** Authors: **Chris Vail,** William Ward

Observations of airglow (oxygen green line, sodium and hydroxyl) with an all sky imager situated at the Polar Environment Atmospheric Research Laboratory at Eureka, Canada (80 N) have been taken since 2007. Analysis of these observations in terms of gravity wave signatures is reported in this paper. Of interest are the phase speed and period of atmospheric gravity waves and the correlation between propagation direction and these quantities. Occurrences of waves, defined in terms of amplitude, spatial wavenumber, phase and time are summarized and compared with the phase information deduced from consecutive images which contain wave signatures with similar spatial wavenumbers. Monthly variations in these quantities will be presented. Of particular interest are results taken during the major stratospheric warming of January 2009.

Gravity wave momentum flux variability in the high latitude northern hemisphere winter mesosphere/lower thermosphere.

Abstract No.: **T2.3** Authors: **Rosmarie J. de Wit,** R.E. Hibbins, P.J. Espy

A new SKiYMET meteor radar was installed in Trondheim, Norway (63°N, 10°E) and has been operational since August 2012.

The 30 kW transmitter array directs most of the radar power into eight beams at 45° azimuth increments with peak power around 35° off zenith, and a majority of meteor detections at zenith angles between 15° and 50°. High meteor count rates of up to 15000 per day are observed in the mesosphere and lower thermosphere region between 75 and 105 km altitude. The high meteor count rates, combined with the beam geometry, make the system particularly well suited for measuring horizontal winds at very high vertical and temporal resolution. The system is also optimized to derive the vertical flux of horizontal momentum carried by high frequency gravity waves through the mesosphere and lower thermosphere.

The radar has been used to study short term variability in gravity wave momentum flux. Preliminary results on the gravity wave momentum flux variability in the MLT region for the 2012-2013 high latitude northern hemisphere winter season will be presented, together with a description of the system design.

Planetary wave structure in the MLT derived from a chain of northern hemispheric SuperDARN radars.

Abstract No.: **T2.4** Authors: **Nora H. Kleinknecht,** Patrick J. Espy, Robert E. Hibbins

A method of utilizing a longitudinal chain of SuperDARN radars to extract planetary waves in the mesosphere lower thermosphere (MLT) and resolve their zonal wave structure at high northern latitudes is presented. The first three zonal wave number components (s=0-2) were extracted from the meridional wind along the latitude band of 51-66 N for the years 2000-2008 using 8 SuperDARN radars spanning longitudes from 25 E to 150 W. Hovmöller diagrams of each zonal component shows stationary as well as eastward and westward travelling waves representing super positions of all meridional wavenumbers. The observed behaviour clearly shows the propagation of planetary waves in the background wind, and specific planetary-wave periods can be extracted using temporal bandpass filters. This technique to detect zonal planetary wave components and their periods is validated by comparison to a generally accepted ground based method for retrieval of zonal planetary-wave components. In addition the derived planetary wave activity during winters with major and minor stratospheric warming events was compared.

SESSION 3

Passive monitoring of Mt Etna volcano to probe the upper atmosphere

Abstract No.: **T3.1** Authors: **Jelle Assink,** Alexis Le Pichon, Elisabeth Blanc

Within Atmospheric dynamics Research InfraStructure in Europe (ARISE) framework, a multi-disciplinary network of atmospheric probes has recently been established. The network includes airglow, Light Detection And Ranging (LIDAR), microwave and infrasound measurements. Such a network will allow for future cross-comparison and validation studies. Airglow measurements allow predominantly for mesopause region temperature determinations; the LIDAR facility provides temperature measurements within the stratosphere from the upper troposphere to the lower mesosphere. The microwave radiometer is specifically designed for the measurement of middle atmospheric horizontal wind (30-80 km) by observing ozone emission.

We present a case study in which the influence of atmospheric dynamics on infrasound propagation is studied. We make use of over 6 years of nearly continuous volcanic infrasound recordings from Mount Etna, Italy (37 N). The infrasound has been measured both in the near field and the far field.

The infrasound observables are compared to theoretical estimates obtained from propagation modeling using existing European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric databases. While first-order agreement is found, we report on significant discrepancies around the equinox period and during intervals during which anomalous detections occur during the winter. In the future, we will focus on inverse studies and combine the results with independent wind and temperature measurements that are available through the ARISE network.

Infrasonic signature: a new way of monitoring sudden stratospheric warmings.

Abstract No.: **T3.2** Authors: **Pieter Smets,** Läslo Evers, Kees Wapenaar

Sudden stratospheric warmings, a drastic change in the stratosphere, generate a clear infrasonic signature that can be used for acoustic remote sensing. An analysis of the 2009 and 2013 major SSW is made to identify the signature in infrasound microbarom observations at IMS stations above 30 degrees latitude. In what extend can back-azimuth, apparent velocity, frequency, and amplitude provide information on the state of the stratosphere? Furthermore, propagation modelling provides additional information on the sensitivity of some arrays and the lack at others. These signatures are then compared with catalogued stratospheric warmings of the last decade as a verification and to test the sensitivity of infrasound observing both major and minor warmings.

Remote infrasound monitoring of Mount Etna: Observed and predicted network detection capability.

Abstract No.: **T3.3** Authors: **Dorianne Tailpied,** A. Le Pichon, E. Marchetti, M. Ripepe, M. Kallel, L. Ceranna

Volcanic eruptions are valuable calibrating sources of infrasonic waves worldwide detected by the International Monitoring System (IMS) of the Comprehensive Nuclear Test-Ban-Treaty Organization (CTBTO) and other experimental stations. In this study, we assess the detection capability of the European infrasound network to remotely detect the eruptive activity of Mount Etna. This well-instrumented volcano offers a unique opportunity to validate attenuation models using multi-year near- and far-field recordings. The seasonal trend in the number of detections of Etna at the IS48 IMS station (Tunisia) is correlated to fine temporal fluctuations of the stratospheric waveguide structure. Modeling results are consistent with the observed detection capability of the existing regional network. In summer, during the downwind season, a minimum detectable amplitude of ~10 Pa at a reference distance of 1 km from the source is predicted. In winter, when upwind propagation prevails, detection thresholds increase up to ~100 Pa. However, when adding four experimental arrays to the IMS network, the corresponding thresholds decrease down to ~20 Pa in winter. The simulation results provide here a realistic description of long- to mid-range infrasound propagation and allow predicting fine temporal fluctuations in the European infrasound network performance with potential application for civil aviation safety.

Thunderstorm simulation over the OHP, from WRF model

Abstract No.: **T3.4** Authors: **Lorenzo Costantino,** Heinrich

The Numerical simulation of Stratospheric Sudden Warming over the OHP, comparison of WRF and Lidar measurements